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Examination session (May or November)	May	Year	2015

Diploma Programme subject in which this extended essay is registered: ITGS

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Title of the extended essay: To drive or not to drive!

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The extended essay I am submitting is my own work (apart from guidance allowed by the International Baccalaureate).

I have acknowledged each use of the words, graphics or ideas of another person, whether written, oral or visual.

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Tuesday February 24th 2015.

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The candidate demonstrated clear and consistent intellectual understanding of the tasks and skills required to complete the extended essay. By working with their mentor, the candidate was able to improve their skill development, critical thinking and essay writing. By responded to positive criticism they were able to improve the quality of their essay. The authenticity of this extended essay was verified through an exit interview with the candidate's extended essay mentor and the suitable submission of the extended essay to Turn-it-in.com.

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Candidate session number		

Criteria	Achievement level Examiner 1	maximum	Examiner 2	maximum	Examiner 3
A research question	1	2		2	
B introduction	1	2		2	
C investigation	4	4		4	
D knowledge and understanding	3	4		4	
E reasoned argument	3	4		4	
F analysis and evaluation	2	4		4	
G use of subject language	3	4		4	
H conclusion	1	2		2	
I formal presentation	3	4		4	
J abstract	1	2		2	
K holistic judgment	3	4		4	
Total out of 36	25				

Name of examiner 1: _____ Examiner number: _____
(CAPITAL letters)

Name of examiner 2: _____ Examiner number: _____
(CAPITAL letters)

Name of examiner 3: _____ Examiner number: _____
(CAPITAL letters)

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To drive or not to drive!

ITGS Extended Essay
Total Word Count: 3970

Abstract

Word Count: 265

This paper examines the affect Google's autonomous car will have on the current insurance procedures. Drivers of the autonomous vehicle will not be blamed for motor vehicle accidents that have occurred, as the vehicle is self-driving. This paper investigates the question: **In what ways and with what results will the Google Car alter motor vehicle liability in California?** In theory, **since humans have reduced control over the Google Cars, the manufacturer will receive increased liability for the car, resulting in a change of current insurance procedures.**

The scope of this investigation is that it mainly focuses on insurance practices within California as Google's autonomous vehicle has mainly driven within the bounds of this state. This state also has their own set of laws regarding autonomous vehicles within the California Vehicle Code. The purpose of this investigation is to determine the degree to which the insurance actions will be altered due to the implementation of the Google Car along with determining the extent to which drivers of the Google Car will be able to put onus on the manufacturer, Google, for motor vehicle accidents. Key sources consulted for this investigation were an interview with Nancy Gorski, an actuary from Manulife, regarding the impact of Google Car on current insurance protocols and an article from Contingencies Magazine called "Look, Ma, No Hands" by Laura Mullane.

This investigation concludes that the manufacturer will indeed receive a percentage of the liability regarding the autonomous vehicle, but it may unfair for Google to receive this due to the improved safety Google Cars will have on the road for drivers and pedestrians.

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Thesis: Since humans have reduced control over the Google Cars, the manufacturer will receive increased liability regard ng the car, resulting in a change of the current insurance protocols.

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Introduction

According to the 2004 WHO report, 90% of automobile accidents were caused by human error. This explains why the Google Car, developed in California, is likely to change human transport forever. The Google Car is an autonomous vehicle that can drive itself without human assistance, removing the possibility of human error. Similar to many other technological advancements, Google Car will soon be a household name. With fewer humans driving, there will be fewer accidents.

Even though this autonomous vehicle removes the possibility of human error, it is, by no means, a perfect invention. Bryant Walker Smith from Stanford University argues that while automobile accidents will still occur, it is not fair for the driver to responsible for the accident because he or she was not even driving the car. Further, car insurance is a multi-billion dollar industry. Should drivers have to pay for insurance when they are not the cause of the accident? Thus, Google cars bring an important question to mind regarding the insurance liability of autonomous vehicles: **In what ways and with what results will the Google-Car alter motor vehicle liability in California?**

This essay only covers the liability regarding autonomous cars in California, as that is the only place Google Car has been used. As well, California's Vehicle Code has a separate set of laws, taking autonomous vehicles into consideration. Since primary and secondary sources were used to conduct academic research, another California Code that was used for research is the California Insurance Code. It is also important to consider the opinion of an actuary regarding this issue, thus an interview with Nancy Gorski, an actuary from Manulife was conducted. Other research taken from secondary sources include an article from Institute of Electrical and Electronics Engineer Spectrum called "How Google's Self Driving Cars Works" along with another article from Contingencies Magazine called "Look, Ma, No Hands". As well, a TED talk by Sebastian Thurn, the head engineer of the project was consulted.

It appears that the history regarding the driver will not be used in determining the liability of a motor vehicle accident involving Google Cars; instead the background information regarding the car will play a greater role. Other insurance protocol factors that may be changed, as a result of Google Cars include the cause of motor vehicle accidents, in relation to manual cars, which cannot be given equivalent influence for determining liability regarding Google Cars. Instead these factors have to be placed against the autonomous technology of the vehicle along with additional factors created regarding the maintenance of the autonomous system. This leads to the conclusion that, **since humans have reduced control over the Google Cars, the manufacturer will receive increased liability for the car, resulting in a change of current insurance procedures.**

Argument 1: Change in Insurance Procedure

Google's self-driving car is exactly as it sounds, a car that does not need a human operator. Rather than starting from scratch and creating a car that operates itself, Google has implemented the autonomous technology as an addition on an already existing cars, such as the Toyota Prius[1]. The following figure shows an autonomous Toyota Prius, which Google has been testing on the roads of California and has logged more than 700, 000 miles as a prototype [2].

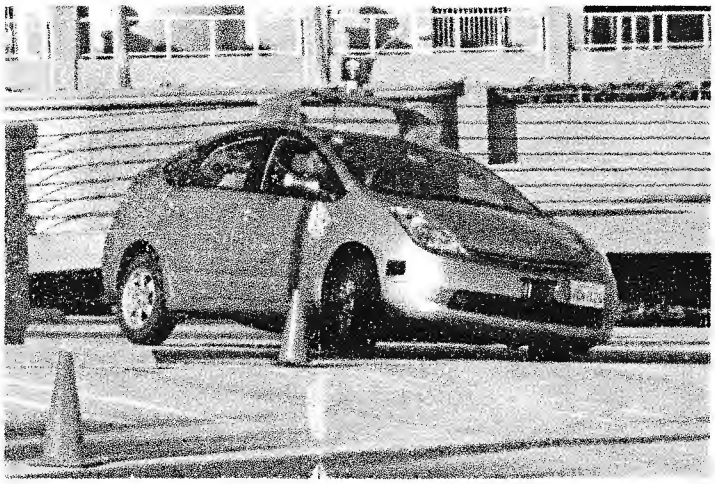

Figure 1: An image of a Google car[3]

An autonomous vehicle, by definition of the California Vehicle Code, is simply a vehicle that has the capability of driving without active physical control or monitoring by a human operator[4]. There are many parts which allow this car to work in autonomously, the most prominent feature would be the one seen over the car's roof. Those sensors allow the autonomous car to see in all four directions simultaneously, a task which is impossible for a human driver[5]. In addition to the sensors, this car has four radars, mounted to the front and back of the car. These radars, along with the sensors on the roof, work in harmony to scan the

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[1] Guizzo, Erico. "How Google's Self-Driving Cars Works" *IEEE Spectrum*. Accessed October 14th, 2013. http://spectrum.ieee.org/automaton/robotics/artificial-intelligence/how-google-self-driving-car-works.

[2] Anthony, Sebastian. "Google's self driving car passes 700, 000 accident free miles, can now avoid cyclists, stop at railroad crossings," Accessed October 1st, 2014. http://www.extremetech.com/extreme/181508-googles-self-driving-car-passes-700000-accident-free-miles-can-now-avoid-cyclists-stop-for-trains.

[3] Guizzo. "How Google's Self-Driving Cars Works".

[4] Sanghani, Radhika , " Google cars are safer than human drivers," *The Telegraph*. Accessed December 29th 2013. http://www.telegraph.co.uk/technology/google/10411238/Googles-driverless-cars-are-safer-than-human-drivers.html.

[5] "How does a self-driving car work?" *The Economist*. Accessed October 14th, 2013. http://www.economist.com/blogs/economist-explains/2013/04/economist-explains-how-self-driving-car-works-driverless.

surroundings environment of the car to build a 3D map, within the autonomous car's system[6]. This Google Car also has ultrasonic detectors, which once again aid in the process of mapping out the Google Car's environment[7].

The following figure shows an image of the environment created through the sensors' of a Google Car.

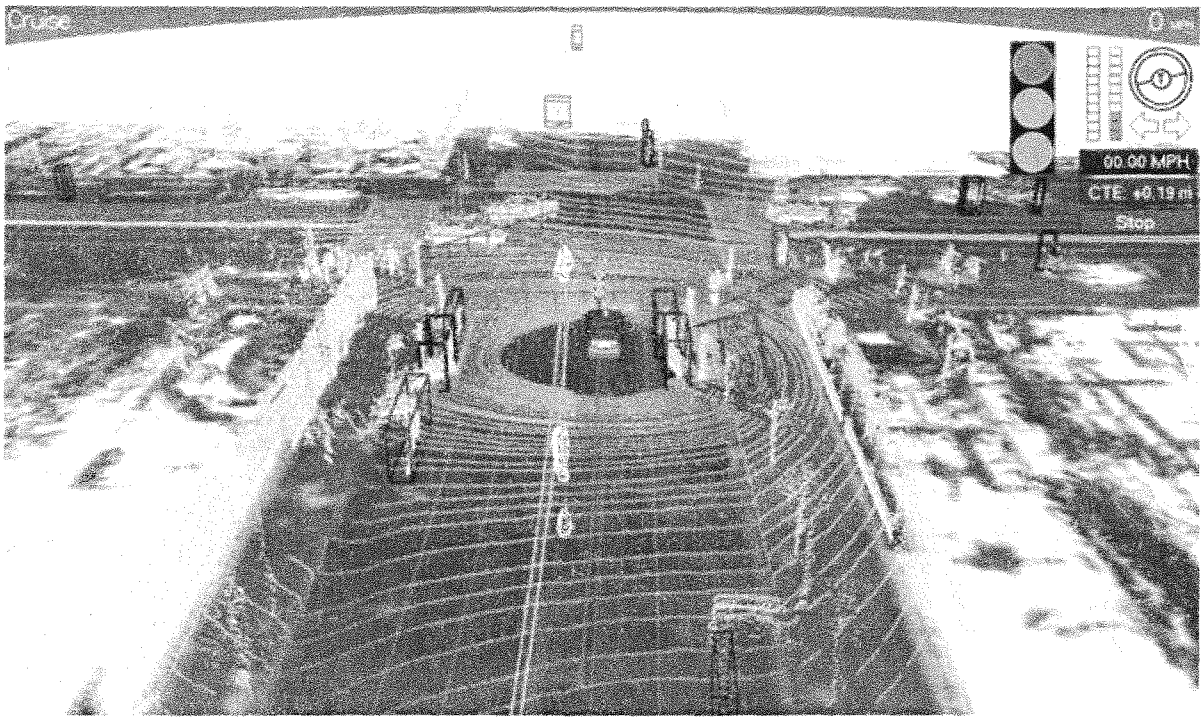

Figure 2: Google Car's environment mapping[8]

Image not explained

Google's autonomous vehicle heavily relies on satellite navigation system in order to understand the roads that it is driving on.[9] This is purely an extension of the simple Global Positioning System, allowing the vehicle to determine its location and keep track of its movement[10].

Along with multiple radars and sensors, the Google Car also has a device called a lidar This works is the same way as the radar, but rather than using radio waves to map out the environment, it uses the pulse of light[11]. The final key component to the Google Car is the

How does lidar work

T.S. [6] S.T. "How does a self-driving car work?"

[7] Ibid

[8] Hockenson, Lauren. "A Sneak Peek Inside's Google's Self-Driving Car" *IGN.* Accessed June 2nd, 2014. http://ca.ign.com/articles/2013/05/03/a-sneak-peek-inside-googles-self-driving-car.

[9] Guizzo. "How Google's Self-Driving Cars Works".

T.S. [10] S.T. "How does a self-driving car work?"

[11] Ibid

IT system not completely explained

Velodyne 64-Beam Laser.[12] This instrument allows the car to produce data modules to avoid moving obstacles, such as pedestrians or other vehicles on the road[13]. Sebestian Thurn, the head engineer of the Google Car, feels that these improvements to a common will allow for the reduction in car accidents as human error is no longer a factor. Cars will be able to drive closer together at higher speeds[14].

Broad generalization — depends on GPS

Google's latest invention will help advance motor vehicle safety all over the world. One cannot fail to consider the effects of inserting the car into a society based on manual, human-driven cars. One radical change will be insurance. In Laura Mullane's article "Look, Ma, No Hands" in the September/October 2013 issue of the Contingencies Magazine, it discussed the implications of the autonomous Google Car to the casualty insurance industry[15]. The most prominent idea taken from this article was the difficulty of assigning blame in a motor vehicle accident involving the Google Car.

Currently, it would be the driver would be responsible since he/she was driving the car The driver is controlling all the actions in regards to the vehicle, but in the case of the Google Car; the vehicle is autonomous. It was driving itself. This is inconsistent with the Motor Vehicle Insurance Industry and their protocols for determining the liability of motor vehicle accidents. Usually with motor vehicle accidents, the history regarding the driver plays a pronounced role in determining the liability. According to the California Insurance Code, common aspects taken into account regarding motor vehicle accidents are age, gender, driving history of the driver and the color, make and year of the car, along with the geographical location of the car accident[16]. The Chauffeur AI will mean that all of these variables, except location, will be irrelevant.

? 'Chauffeur AI' not explained

An interesting way to discuss the current discrepancies of annual insurance costs is to consider age and gender. This following diagram shows the risk of an individual dying based on their age. As expected, there is a sudden increase in probability as age increases but there is also a sudden increase in probability of death during the "teen years". The main cause for this is motor vehicle accidents and carelessness by young drivers. Based on this analysis, the high annual auto insurance rates would be justified as seven teens are killed in motor vehicle accidents every single day[17] but in an autonomous car, the age and gender do not necessarily matter as the driver is just a monitor ensuring the safe driving of the vehicle.

To what extent can a driver override the IT System?

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[12] Guizzo. "How Google's Self-Driving Cars Works".

[13] Ibid

[14] Ibid

[15] Mullane, Laura. "Look, Ma, No Hands."

[16] "Automobile Insurance," *California Department of Insurance*. Accessed December 29th 2013, http://www.insurance.ca.gov/0100-consumers/0060-information-guides/0010-automobile/Auto-insurance-101.cfm.

[17] Mullane, Laura. "Look, Ma, No Hands."

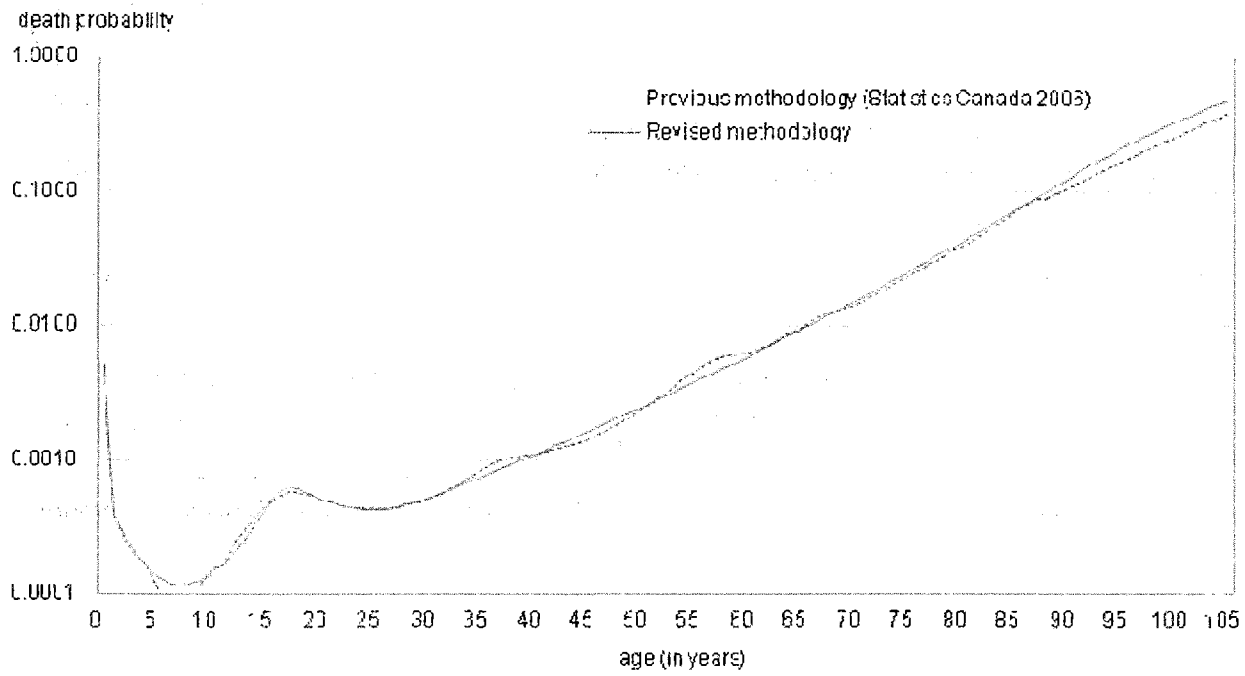

Figure 3: This shows the probability of death based on the age of an individual.[18]

Through the use of an annual auto insurance calculating website called ComparaSave, one can calculate the differences in annual prices between a 50 year old women and a 16 year old boy who both drive a 2013 McLaren MP4-12C Spyder which approximates the cost of a Google Car of around $300 000,[19] while assuming both drivers have minimal use for the car driving 8 000 km yearly. For a 16 year old driver the annual auto insurance was $18,910 while the annual auto insurance for a 50 year old women with all the same characteristics is $3,615[20]. There is a $15,295 difference between two individuals who have a 34 year difference but this difference should not be applicable if both of them drive an autonomous vehicle.

The removal of the driver has forced motor vehicle accident liability to bring a new side for the accident's liability. This new perspective would be the manufacturer of the autonomous vehicle, thus the manufacturer that actually implements the autonomous technology.

[18] "Methods for Constructing Life Tables for Canada" *Statistics Canada:* accessed June 2nd, 2014. http://www.statcan.gc.ca/pub/84-538-x/84-538-x2013001-eng.htm.

[19] "2015 Lamborghini Huracan LP610-4 Polizia" TopSpeed. Accessed June 2nd, 2014. http://www.topspeed.com/cars/lamborghini/2015-lamborghini-huracan-lp610-4-polizia-ar163669.html#main.

[20] "ComparaSave" InsuranceHotline.com, accessed June 2nd, 2014. https://comparasave.insurancehotline.com/Quote/Auto#Vehicles.

While it seems as if the manufacturer will have to be a recipient of liability for motor vehicle accidents for the Google Car, one also has to consider the impact the Google Car will have on decreasing the number of car accidents. In 2009, there were 10.8 million car accidents resulting in 35 900 accidents and 93% of these accidents were due to human error, but this number can be brought down to just one percent through the use of Google's Autonomous Car[21].

As well, since all autonomous vehicles will likely come with EDRs (Electronic Data Recorder) this allows the insurance companies to have a better understanding of the vehicle accident as EDRs record the speed, braking and vehicle stability, assisting them in which vehicle is likely to have been the cause of the accident[22].

With this in mind, is it still reasonable for Google's manufacturer to obtain a percentage of the liability despite helping reduce motor vehicle accidents dramatically? Drivers may argue that regardless of the circumstances, manufacturers should be given a portion of the liability since the drivers would not be responsible for the accident. On the other hand, Google Cars are improving the safety on roads by a large margin; they should not bear the entire cost of the rare motor vehicle accidents. At the same time, drivers' do not necessarily want to pay for the expenses for a luxurious vehicle, such as a Google Car with their money.

speculation - research shows dangerous when driver is handed over resp.

unclear

Another possibility is that Google can receive liability for their autonomous car in a manner similar to a doctor's malpractice insurance. Malpractice of medicine is clearly a human error that can be avoided but is something that puts life at risk for many people. For the malpractice of medicine, the planiff can receive a maximum of $250 000 compensation for suffering or death. As with doctors, engineers of the Google Car are also responsible for the lives of the individuals that drive their autonomous vehicle, and since a doctor can be taken responsible for his actions, engineers of the Google Car will have to follow the same route.

argument flawed; more factors involved, different factors

Putting autonomous vehicles onto the roads will no doubt increase the safety on the roads since in the 700,000 miles that this car has driven, only two accidents have resulted, both of which when a human driver was in control of the vehicle[23]. Insurance Companies also have to consider the fact that all the cars on the road will not change in being Google Self driving cars, overnight. The Insurance Companies have to move away from always giving the driver liability regarding motor vehicle accidents and also consider the manufacturer in the case of autonomous vehicles.

Speculative fallacy by induction

no evidence presented; 2 cases were human error.

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[21] Partha. " Look mum, no hands!".

[22] Steven Roshenbush, "Google's Auto Alliance Paves Way for Self-Driving Cars" *CIO Journal.* Accessed February 2nd, 2014. http://blogs.wsj.com/cio/2014/01/06/googles-auto-alliance-paves-way-for-self-driving-cars/.

[23] Anthony, Sebastian. "Google's self driving car passes 700, 000 accident free miles, can now avoid cyclists, stop at railroad crossings."

Argument 2: Factors of Accidents

Many current factors involved in determining the liability of a motor vehicle accident play a major role in the process of the Insurance Companies. These factors include traffic violations, driver's error, equipment failure and road conditions[24]. These factors cannot be given equivalent influence for determining liability regarding Google's autonomous cars; instead these factors have to be placed against the autonomous technology of the vehicle along with additional factors created in the maintenance of the Google Car's autonomous system. Indeed, Bryant Walker Smith, a legal fellow at Stanford's University's Law School and Engineering School, who studies Vehicle Law, would agree with this concept as he stated "If there's not a driver, these can't be driver negligence. The result is a greater share of liability of moving the manufacturers,"[25]

Both sides of argument needed

Equipment failure resulting in the cause of the accident has to put precedence on the manufacturer because the driver has no control of the performance of autonomous technology. The driver can ensure that the maintenance of the vehicle is satisfactory, but that is the extent of their control. Random equipment failure once again puts a percentage of the blame on the manufacturer. One can compare the failure rate of CPUs to compare length of time the autonomous technology for a Google Car would last. The failure rate of CPUs is generally 30,000 hours, which is approximately 3.4 years. Also, there is only a 2% chance that the expectancy rate falls out of this range. Thus, Google should try to estimate the life expectancy of the Google Car's autonomous technology and ensure the driver that if the failure of the technology is beyond the expectancy range, precedence should not be put on the manufacturer. Instead, the insurance companies should look to pay the repairing damages of the driverless car or put the responsibility on the driver to pay.

no evidence in fact how did accidents occur?

need evidence

Along with the life expectancy of the autonomous technology, insurance companies should also consider the possibility of a lemon car. Lemon cars are vehicles that are defective and bought by customers. If Google implements the technology of the Google Car onto a lemon, which results in a motor vehicle accident, Google Car could transfer the liability of the car accident from them to the manufacturer of the actual vehicle. This scenario brings the possibility of placing liability on the car manufacturer rather than Google. The probability of this scenario occurring is very rare as the possibility of buying a lemon in a new vehicle is less than one in

not clear

speculative

[24] "Car Accidents- Factors Contributing to Car Accidents" *Injury Legal Guide*: accessed February 24th, 2014. http://www.injurylegalguide.com/car-factors.html.

[25] Ward, Jacob. " Who Is To Blame When A Robotic Car Crashes." *Popular Science*. Accessed December 8th, 2013. http://www.popsci.com/cars/article/2012-04/who-blame-when-robotic-car-crashes.

hundred[26]. Regardless, Google has to be conscious of this circumstance in order to remove the liability of the motor vehicle accident from their hands.

Traffic violations are a common human error which causes motor vehicle accidents and regardless of how well the Google Car's CPU is programmed, mistakes will still happen. Currently, common traffic violations could include speeding, running a red light or driving on the wrong side of the road[27]. California is a city that issues approximately 6 million tickets every year[28] and the following figure shows the cost of some common traffic violations.

VC 16028(A) Failure to provide evidence of financial responsibility (insurance):
2010 Fine: $766
2011 Fine: $800

VC 21453(A) Failure to stop at a red signal:
2010 Fine: $380
2011 Fine: $400

VC 22349 Unsafe speed, 1 to 15 miles over the limit:
2010 Fine: $146
2011 Fine: $154

VC 22350 Unsafe speed, 16 to 25 miles over the limit:
2010 Fine: $266
2011 Fine: $280

VC 22450 Failure to stop at a stop sign:
2010 Fine: $146
2011 Fine: $154

VC 22454(A) Passing a school bus with flashing red signals:
2010 Fine: $570
2011 Fine: $600

Figure 4: Costs of common traffic violations[29]

While the driver have to be seated and be monitoring the safe operations of the vehicle by law, when driving a vehicle with autonomous technology implemented, the driver cannot predict the future and prevent the Google Car from violating a traffic accident due its rarity[30].

The only current factor which would give the manufacturer (both hardware and software) minimal liability of a motor vehicle accident involving the Google Car are accidents caused by road conditions. If the driver of the autonomous vehicle is unable to identify the fact that road conditions are not safe to drive in, the manufacturer should not be the one to blame for the poor

[26] Karesh, Michael. "True Delta Announces Reliability Survey Results." http://www.thetruthaboutcars.com/2009/11/truedelta-announces-reliability-survey-results/.

[27] "Car Accidents- Factors Contributing to Car Accidents"

[28] Chen, Caroline. "California drivers up traffic fines with fees earmarked for projects."http://cironline.org/reports/california-drives-traffic-fines-fees-earmarked-projects-5223.

[29] "New California traffic laws and fines." Last modified February 7th, 2011. http://www.courts.ca.gov/news.htm.

[30] Vehicle Code http://leginfo.legislature.ca.gov/faces/codesTOCSelected.xhtml

judgement of the driver[31]. The following diagram shows how wet conditions can effect stopping time. Drivers will need to be smart regarding their decisions of setting speed of the autonomous car to the surrounding speed limits, or adjusting it manually according to the conditions, because a speed limit is not necessarily a target.

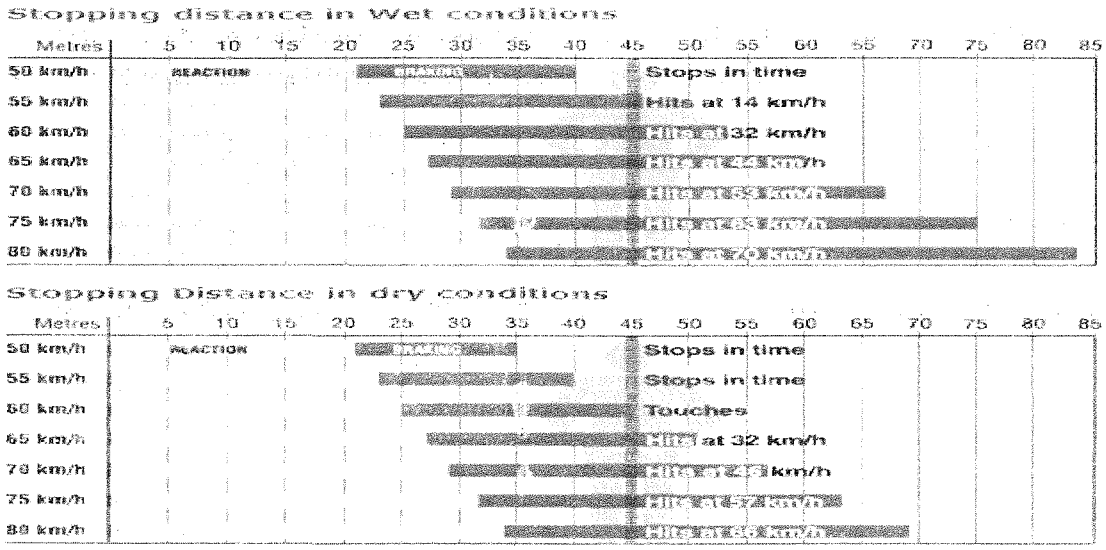

Figure 4: This shows the effect of wet conditions on driving and stopping at different speeds[32]

Not only will insurance companies have to alter the way they perceive these common factors during motor vehicle accidents but also possibly change their system in which the claims are divided in an accident. The two most prominent methods of claims would be the "No Fault" method or the Tort method. Within the "No Fault" method, regardless of who is liable for the motor vehicle accident, drivers' would pay for their own damages. This method favours the manufacturer as they do not have to be involved with the insurance companies, nor do they have to pay for any damages but the drivers would oppose this method as this does not necessarily offer financial protection in the event of an accident. The other method which can be used for claims is the Tort system. Using this method, Google Car drivers can claim that they were not the cause of the accident, causing the blame to lead up to the hardware and software manufacturers[33].

The Google Car and the Tort method it-self will play a major role in lowering auto insurance premiums as using the autonomous cars will not only lower the amount of motor vehicle accidents but also the need for auto insurance[34]. The Tort claim system will have the same affect, as when a rare motor vehicle accident regarding autonomous car occurs, the insurance company does not necessarily have to play for all the damages as some of the liability

[31] Nancy Gorski
[32] "Causes of Accidents." *Mayo Road Safety*. Modified 2014. http://www.roadsafetymayo.ie/CausesofAccidents/.
[33] Nancy Gorski. Personal Interview.
[34] Mullan. "Look, Ma, No Hands."

may be acclaimed towards the manufacturers. Using these two factors, auto liability premium is predicted to decline by 20% from 2013-2017 and decline by 60% from 2018-2022. Furthermore, auto premiums accounted for 59% of all insurance premiums in 2012 but this number will decrease to 19% in 2022 as the need for auto insurance will decrease as the popularity of autonomous vehicle increases[35].

The following figure gives a list of additional service requirements regarding autonomous vehicles; although Google Cars may be increasing the safety on the roads, the service to maintain the autonomous technology is more than maintaining a regular manual car and can cost up to $1 000 to$3 000 more annually, resulting in the possibility that Insurance Companies will opt to maintain their current insurance premiums to compensate for these additional costs.

speculative

Autonomous Vehicle Equipment and Service Requirements

- Automatic transmissions.
- Diverse and redundant sensors (optical, infrared, radar, ultrasonic and laser) capable of operating in diverse conditions (rain, snow, unpaved roads, tunnels, etc.).
- Wireless networks. Short range systems for vehicle-to-vehicle communications, and long-range systems to access to maps, software upgrades, road condition reports, and emergency messages.
- Navigation, including GPS systems and special maps.
- Automated controls (steering, braking, signals, etc.)
- Servers, software and power supplies with high reliability standards.
- Additional testing, maintenance and repair costs for critical components, such as automated testing and cleaning of sensors.

Figure 5: This figure shows the additional vehicle equipment and service requirements[36]

While the automaker companies of the autonomous technology will try to minimize the possibility of them being liable, since California's liability system is based on a percentage, it is possible for Google to receive a small yet some sort of liability for motor vehicle accidents. Since there are multiple ways through which Google can be liable for motor vehicle accidents, Google will obviously try to seek waivers regarding these circumstances, by avoid being liable, if the driver fails to clean the radars and sensors around the vehicle, preventing the autonomous technology from actually being able to create a visual image of their surroundings, or they will not be liable if the city conditions fails to maintain their road conditions[37].

Insurance Companies will have to also consider the degree to which both the driver and manufacturer can make the case against one another when a motor vehicle accidents concerning

[35] Ibid

[36] "Autonomous Vehicle Implementation Prediction" *Victoria Transport Policy Institute*. (June 4th, 2014). http://www.vtpi.org/avip.pdf.

[37] Bill Howard, "Who's liable when a self-driving car self crashes," *Extreme Tech*. Accessed February 2nd, 2014, http://www.extremetech.com/extreme/147020-whos-liable-when-a-self-driving-car-self-crashes.

Google's autonomous car occurs. Insurance companies have to consider a dirty radars or sensor and how to handle "unsafe" road conditions.

The ambiguity between whether the manufacturer or driver deserves a higher percent of the blame can only be clarified if each scenario is clearly distinguished. For example, maybe the the radars and sensors only have to be clean enough to do their job, because regardless of how they look, if the sensors can map their surroundings, manufacturers should not have a problem with the purity of the autonomous technology. In addition, road conditions can only be considered unsafe when it is proven that these conditions cause a high degree of accidents. Thus, Google can specifically state the areas and conditions in which the Google Car will be legally liable or have minimal liability.

Another factor which insurance companies have to take in consideration when dealing with motor vehicle insurance is impaired driving. Impaired driving occurs when the driver of a vehicle is under the influence of alcohol or drugs while driving. Not only does this show poor judgement, on the side of humans but also the puts many pedestrians around the driver at risk. The following figure demonstrates that one-third of deaths for motor vehicle accidents and strictly because humans are unintelligent. It is not because of any distraction or an "accidental" mistake of crossing a stop sign or passing a red light. It is simply because humans are too irresponsible to realize the value of their life and the value of the people around them, putting both of them at danger.

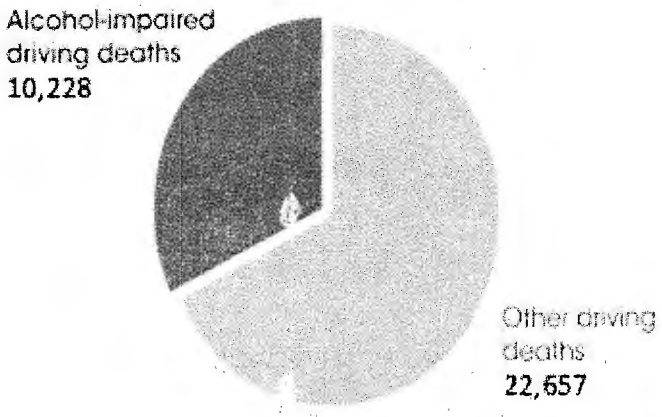

Figure 6: Motor vehicle accidents due to alcohol impaired driving in the US in 2009 [38]

Impaired driving will not play an important role in determining the liability of motor vehicle accidents. Even though the driver has to monitor the safe conditions of the vehicle, the driver cannot necessarily predict when the autonomous vehicle will make a mistake which will

[38] "Policy Impact: Impaired Driving". *Centres for Disease Control and Prevention*. Accessed June 2nd, 2014. http://www.cdc.gov/Motorvehiclesafety/alcoholbrief/.

possibly result in a motor vehicle accident. In this case, Google will once again have to be able to compensate for human mistakes. Google not resp, if driver cannot take resp. ?

Lastly, as insurance premiums rates are calculated through car insurance probabilities and severity built from the industry's past data, actuaries have no past data of autonomous technology available to them. As a result, actuaries will have to predict the probability and severity of the claim regarding Google-Cars[39]. It is possible that the predictions will not necessarily match the results. For instance, Google Cars may not necessarily reduce the level of motor vehicle collisions instantaneously, as majority of the population will still be driving manual vehicles. Thus, it a possibility that actuaries slowly reduce insurance premiums overtime as they see that the increase in implementing Google Car is increasing the safety levels. speculation

[39] Nancy Gorski

Conclusion:

Google's autonomous vehicles will improve the safety on roads significantly, but Google will acquire a share of liability for those vehicles. Even though Google will be able to solve hundreds of problems pertaining to motor vehicle safety, drivers will not hesitate to use Google as "fall guy" for motor vehicle accidents. This subject brings an important question at hand: **In what ways and with what results will the Google-Car alter motor vehicle liability in California?** While the history regarding the driver can no longer assist in determining the liability of the motor vehicle accidents, insurance companies will now have to analyse the background information regarding the car. Insurance companies have to take an additional step and not give the factors involved in car accidents equal weight for deciding the liability; instead these factors will have to be altered in the way they are perceived. The result of this outcome is that **manufacturers' of the Google Car will receive increased liability in relevance to the vehicle, resulting in the refinement of the insurance procedure used presently.**

not shown

speculative

Each argument within this essay separately analyses different factors involved in a motor vehicle accident. These factors aid insurance companies to determine legal responsibility and how these factors needed to be perceived in a different manner in order to fairly determine the liability. While the liability will be reduced for humans when the roads only contain autonomous vehicles, what will happen in the transition period? Even after cars are fully autonomous, they may not be able to drive on unmapped roads; who then will incur the liability?

speculative

No GPS data.

The creation of a new system of car insurance liability ensures equitability for all sides involved within a motor vehicle accident. It also minimizes the effect, on Google, of the negligible detriment a Google Car can have on society, in terms of liability confusion, compared to its enhancement of safety on the roads. The liability confusion the Google Car creates should not overlook and disregard the favour it is doing to mankind by making the roads safer for drivers and pedestrians.

? off-course

Implementation of Google's Car has a lot to offer as safety is the most important need humans could ask for after basic necessities. The Google Car allows humans to both enjoy the luxury and safety of the 21st century transportation without sacrificing one for the other.

Some relevance, speculative

Bod 4 = 1

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Appendix A: N G Personal Interview

G , N . *Personal Interview*. December 28, 2013.

Interview with N G
Life Insurance Actuary, FSA, FCIA
On December 28, 2013

1. How does one compare the process of determining the liability of a motor vehicle accident regarding an Autonomous Google-Vehicle compared to regarding only Non-Autonomous Vehicles?

Car insurance is the calculation of probabilities and severity. These probabilities and severities are built up based on past experience (experience based on your own company's data or industry data). The determination of a new risk or new situation lacks historical basis, so actuaries will have to guess at the probability and severity of a claim with the new cars. Due to this uncertainty, actuaries will undoubtedly "pad" their estimate and perform sensitivities on the claim models to understand the nature of the risk.

2. Since California Law determines the liability of a motor vehicle accident proportionally, how will one determine the percentage of liability on the driver and on the vehicle for a motor vehicle accident regarding an Autonomous Vehicle?

Claims are divided between two parties in an accident according to law (whether "no fault" or "tort"). I'm not familiar with Californian law, but if the system is "no fault" then the drivers will pay for damages to their own vehicle regardless who is at fault for the accident. Such a system may come under fire if Google cars become popular. Public opinion would force politicians to change the law to be more "fair" to Google car drivers. If the system is "tort" it would be easier for drivers of Google cars to claim they weren't the cause of an accident, perhaps leading to lower insurance premiums. Clearly Google car drivers would benefit in a tort system.

3. Will driving history and age be taken into consideration when determining the liability, even if the driving history was based on driving a non-autonomous vehicle? If so, how?

Common risks taken into account in car insurance are age, gender, driving history, car colour make & year, credit checks (for socioeconomic determination) and geographic location. Likely all factors will still be important, but as you point out some may be less so for the Google car. For driving history, consider the "operating" history of various Windows platforms (the ill-fated Vista, for instance) or bugs in other software. Certainly geographic location may also be a factor (snowy provinces vs. desert). It is unclear whether the Google car will have a switch to turn off

the automation. If so, the driver's history becomes a factor. Further while automation may reduce some risks, it does not eliminate all risks. For instance, if you open the Google car's door when a bike approaches or the Google car skids on ice or the Google car loses a tire on the highway, the liability and/or claim still exists. If your judgement on whether conditions are safe to drive is impaired (either through age, alcohol, drugs, or disability), wouldn't you still be at fault?

4. Since Autonomous Cars are drive-less, what criteria of individuals will actually be able to drive them? Physically disabled? Unlicensed driver? Underage driver?

This is likely a question for law-makers to decide. If unlicensed, underage or even intoxicated drivers are allowed to use the cars, it would be important for insurance companies (and the general public) for Google cars to have precautions around turning off the automation, the destination and/or road conditions and emergency procedures. A child that decides to take the Google car for a spin on the highway during an ice storm is a risk to all.

5. When society is composed of both autonomous-vehicles and non-autonomous vehicles, will Insurance Companies maintain two different sets of Insurance Protocols for each type of vehicle? If so, how will they differ?

Pricing of car insurance is already split into as many categories as insurers can reasonably request (they would like more, but are prevented by cost and/or difficulty to collect). There are many different ways to calculate a discount: a lower premium rate, a yearly cash return, higher coverage for a lower cost or anything an insurer can dream up. In an open market, the consumer will decide what form the discount takes.

Appendix B: California Vehicle Code Information

California Legislative Information," http://leginfo.legislature.ca.gov/faces/codesTOCSelected.xhtml.

Vehicle Code- VEH

Division 16.6 Autonomous Vehicles [38750- 38750.]

38750:

(1) "Autonomous technology" means technology that has the capability to drive a vehicle without the active physical control or monitoring by a human operator.
(2) (A) "Autonomous vehicle" means any vehicle equipped with autonomous technology that has been integrated into that vehicle.
(B) An autonomous vehicle does not include a vehicle that is equipped with one or more collision 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 or monitoring of a human operator.
(5) A "manufacturer" of autonomous technology is the person as defined in Section 470 that originally manufactures a vehicle and equips autonomous technology on the originally completed vehicle
(2) The driver shall be seated in the driver's seat, monitoring the safe operation of the autonomous vehicle, and capable of taking over immediate manual control of the autonomous vehicle in the event of an autonomous technology failure or other emergency.

The application shall contain, at a minimum, all of the following certifications:
(1) A certification by the manufacturer that the autonomous technology satisfies all of the following requirements:
(A) The autonomous vehicle has a mechanism to engage and disengage the autonomous technology that is easily accessible to the operator.
(B) The autonomous vehicle has a visual indicator inside the cabin to indicate when the autonomous technology is engaged.
(C) The autonomous vehicle has a system to safely alert the operator if an autonomous technology failure is detected while the autonomous technology is engaged, and when an alert is given, the system shall do either of the following:
(i) Require the operator to take control of the autonomous vehicle.
(ii) If the operator does not or is unable to take control of the autonomous vehicle, the autonomous vehicle shall be capable of coming to a complete stop.
(G) The autonomous vehicle has a separate mechanism, in addition to, and separate from, any other mechanism required by law, to capture and store the autonomous technology sensor data

for at least 30 seconds before a collision occurs between the autonomous vehicle and another vehicle, object, or natural person while the vehicle is operating in autonomous mode.

Appendix C: California Insurance Code

Davis, Gray. *California Insurance Code.* Bill. California: House of Representatives. 1907. http://www.loc.gov/teachers/usingprimarysources/chicago.html#government. Accessed December 24th, 2013. (Insurance Code)

California Insurance Code:

22. Insurance is a contract whereby one undertakes to indemnify another against loss, damage, or liability arising from a contingent or unknown event.

11628.3. (a) Based on the actuarial and loss experience data available to each insurer, including the driving records of mature driver improvement course graduates, as recorded by the Department of Motor Vehicles, every admitted insurer shall provide for an appropriate percentage of reduction in premium rates for motor vehicle liability insurance for principal operators who are 55 years of age or older and who produce proof of successful completion of the mature driver improvement course provided for and approved by the Department of Motor Vehicles pursuant to Section 1675 of the Vehicle Code.

(c) The percentage of premium reduction required by subdivision
(a) The insured's eligibility for any percentage of premium reduction shall be effective for a three-year period from the date of successful completion of the course described in subdivision
(1) Involved in an accident for which the insured is at fault, as determined by the insurer.

A=1 B=1 See comments

C=4 D=3

good range of resources; good knowledge, but shortcomings in understanding IT system and role of driver using systems

E=3

weaknesses in the argument as pointed out

F=2

some analysis, since the technology is not implemented, attempts to make speculative conclusions.

G=3

Unsufficient focus on IT systems with respect to driver control, lacks detail; poor image and lacks explanation

H=1 see conclusion

I=3 errors in bibliography and citation

J=1 see abstract

K=3 agreement w. Teacher

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