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Literature Review
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Autonomous vs. Automated Cars

Autonomous cars, also known as driverless cars, are vehicles that do not require a human driver. Autonomous cars are very likely to replace automated cars (cars that require a human driver) as one of our main sources of transportation for the future. It is inevitable for technology to advance and along with these advancements the pros and cons associated with it. As a result, there are many equipments installed into autonomous cars to temp to make them better than automated cars. The purpose of these technologies is to prevent car accidents and ensure that autonomous cars are driven properly. Important things to consider for autonomous car technology are utilitarianism and the trolley problem. For society to accept new technologies, there must be benefits from the new technologies that previously did not exist.

Utilitarianism is an ethical theory which states that when you are to choose between two wrong doings, you must choose the situation with the least number of bad consequences. One of the prime issue is the correlation between utilitarianism and the trolley problem. The trolley problem originated from a track problem. Assume there is a train going towards five people and there is an option to save these five people by switching the tracks which will result in another person to die. Although, emergency killing is not rational, the fact that four extra lives can be saved must be taken into consideration. This situation brings up the morality debate of if one's life is worth being scarified for the life of the other five. Applying the trolley problem to the autonomous cars, if an autonomous car is to choose between a pedestrian's life or the passengers life, who should it choose to save and who should it choose to kill? With these questions going around, many engineers are stuck on the question of whether autonomous cars are worth releasing into the streets. When utilitarianism is applied to the trolley problem, it would be to kill as few people as possible. Although utilitarianism seems like the right approach, some disagree.

Nyholm states in the article "The Ethics of Accident-Algorithms for Self-Driving Cars: An Applied Trolley Problem?" that there are three main concerns about autonomous cars: decision making, moral and legal responsibilities, and risks and uncertainties. One main concern which society has on decision making is weather the autonomous car should be programmed to save the passenger or to crash into the obstacle. Nyholm explains that this can lead to car crashes but depending on the situation, it can lead to death. No program, along with autonomous cars, can be completely bug free. One concern about a preprogrammed car is that if the wrong data is given, society does not know who should take responsibility of the damage caused. These damages can be as little as tipping over a traffic cone or as serious as death. Since cars do not have the ability to think, should it be programmed to sacrifice the passenger or crash into the unknown obstacle which may or may not be pedestrians? This is significant because by knowing the answers to these concerns, there will be a lower chance of car crashes due to autonomous cars and fewer bad impacts of autonomous car in the streets.

Nyholm argues that autonomous cars are safer than automated cars in the long run. To support his claim, Nyholm states that there are flaws in all human beings. For example, humans will not always make the correct moral decision especially in a limited amount of time. This sheds light on the fact that not only do humans make mistakes, they also get distracted. Nyholm also states that autonomous cars use advance technology to be aware of its surroundings and to ensure that it is as safe as possible. These equipments are used to ensure that the car is not too close to obstacles to prevent crashes. Some equipments includes steer, sensor, active cruise control, etc. Steer is a device that is installed in cars is called a steer which will put the car in its own lane if it detects an obstacle next to it. The purpose of this is so that when the car is trying to change lanes, but there is a car or obstacle on the lane the car is trying to switch to, the car will steer itself back into the original lane. Nyholm says that the sensor has information and has access to other cars so that it can calculate multiple combinations of braking and swerving to result in as little damage as possible. Active cruise control is a device similar to the blind spot detection such that it uses a sensor to detect obstacles. In this case, while driving, if a car up ahead is too close to the autonomous car, the car will adjust its own speed so that it will not collide. Nyholm mentions that autonomous cars also contain a communicate device so that it can communicate with other autonomous cars to ensure it will have a better coordination with each other. This is important because these equipments will prevent car accidents among autonomous cars. Nyholm figured that the equipments installed in autonomous cars will help it avoid accidents that human mistakes are prone to cause.

Nyholm believes that autonomous cars are more beneficial than automated cars, but he does not deny the fact that autonomous cars do have flaws. Nyholm explains that although there is the trolley problem with the autonomous cars, it is inevitable that an automated car will end up in the same situation as an autonomous car. All cars are heavy and should move in a fast pace as a result, there is a limited amount of control. When a car is driving at a very fast speed and there is a situation which needs the car to stop, it will not be able to stop completely in a short amount of time. During this scenario, a human driver will panic and do whatever is best for themselves before they consider the lives of others. This is significant because human mistakes cause accidents and regrets while autonomous cars will not. Sometimes, it is very hard to prevent a car accident regardless if it is caused by autonomous or automated cars.

Nyholm's theory mentions a lot of important concerns on automated cars, but it cannot be the only factor used to assume that autonomous cars are better for the world. Nyholm does not support his claim with evidence and makes up a lot of scenarios which is not likely to occur. With Nyholm's claim, we cannot guarantee that all autonomous cars have the required hardware installed so that it is always cautious. We also cannot guarantee that the hardware will not malfunction. In cases where a hardware malfunctions, it will cause more damage than an automated car would in other situations. Although Nyholm does agree that there are some flaws to autonomous cars, it is less likely to result in car crashes compared to automated cars. Nyholm talks about the morals and the equipments installed into autonomous cars to prevent car accidents.

Daily agrees with Nyholm in his article "Self-Driving Cars" that autonomous cars benefit society such that it is efficient, convenient, and safer than automated cars. Daily's curiosity and urge to prove this topic convinced him to do research in Asia, Europe, and America. Daily says that many countries in these continents are trying to develop an autonomous car with the capability of deep-learning. Baidu is a company located in China which is very similar to Google. Daily learned that Baidu has a self-driving platform that has many features including obstacle perception, route planning, cloud simulation, HD maps, and end-to-end learning. The reason China is putting so much effort into autonomous cars is because of their trucking industry. Daily indicates that as a result of Chinas high population, there are a lot of traffic and people who do not bind by the right morals. The government of China believes that by offering autonomous cars, there will be less traffic and accidents. This is implying that by introducing deep learning to autonomous cars, it can learn from the mistakes of other autonomous cars. The goal is to have less car accidents. Although this cannot solve the trolley problem completely, it tries to prevent the problem from occurring. When an autonomous car has an accident in one location, other autonomous cars can learn from this and take precaution at that location. Although other countries of Asia were not specifically mentioned, many of them are trying to approach autonomous cars in the same way China is. Daily comments that other than fixing population issues, autonomous cars can also be used to simplify lives. In first world countries such as America and Europe, time is very important yet, many of our hours are wasted on transportation. To summarize, governments in the countries that Daily visited believes that by offering autonomous cars, it can solve many traffic issues and overcrowding issues. As a result, the governments are working towards a better environment and reduction in traffic.

Daily's research is very useful and comprehendible, but there are some points which do not correspond well. Autonomous cars do not solve traffic issues since it will not reduce the number of cars in the streets. Daily mentions that the governments in China are working to reduce car accidents, but it is not guaranteed. The solution is unknown unless we test out the hypothesis. Daily does not describe how the governments of these countries will try to approach the problem, although he does list the equipments installed into the car. He lacks details of the task of each equipment and how it will deal with events such as the trolley problem. Unlike Nyholm, Daily does not mention how the equipments of the autonomous cars will help it reduce traffic and accidents.

In "Google's Driverless Cars Run Into Problem: Cars With Drivers," Richtel and Dougherty claims that the autonomous cars are programmed to follow the law and take precaution in all situations. For example, google autonomous cars are supposed to take the most caution while driving. It usually lets other cars go first before it proceeds. In a four-way stop, it will not make the best decision since it will let all other drivers go first, but this is only to be safe. This is significant because if the car is as cautious as Richtel and Dougherty claim them to be, there should not be any car accidents due to the fault of the autonomous cars. Richtel and Dougherty claim that autonomous cars are fine if it is isolated from automated cars since they do not complement well. Richtel and Dougherty explains that autonomous cars cause accidents only

when there are reckless drivers who do not bind by the rules. They continue with the claim that all the 16 accidents involving google autonomous cars were caused by humans. For one of the accidents, Richtel and Dougherty explain that the google autonomous car slowed down for a pedestrian and as a result, the car behind it crashed into it. In another case, a google employee took over the car which resulted in the accident. Among all the car accidents, all of them involved a human driver being reckless. This is an important factor because as of now, there are no car accidents that was caused by autonomous cars. Although there are not as many car accidents as of now, it is impossible to tell what autonomous cars can result in the future. There are not many autonomous cars being tested and thus, we cannot conclude that autonomous cars will not cause any accidents in the future. Unlike the first two articles, Richtel and Dougherty gave examples and evidence of autonomous cars and the benefits of autonomous cars compared to automated cars.

Richtel and Dougherty claim that autonomous cars cause less fatalities, which is a better option for the future, but there are some cases which they did not consider. Richtel and Dougherty did not explain what laws are obeyed since laws vary within states. In some cases, laws contradict with moral. For example, when a pedestrian is j-walking, what would an approaching autonomous car do? There will always be situations where autonomous cars must make a decision, but Richtel and Dougherty did not mention it. Instead of approaching the trolley problem as if it does not exist, they try to avoid it by giving examples of the google car. Their approach on avoiding the trolley problem is very useful, but they should come up with a solution for when this problem occurs. Another case which they lack in is that not all cases are examined. Using the autonomous car that Google released into the streets is a very good source, but they did not state any examples of what would occur during a cross walk. Other than the automated cars who share the streets with autonomous cars, there are also pedestrians. A driver should know that regardless of the situation, they must always let the pedestrian go first. One flaw of the autonomous car which Richtel admits to is that drivers usually make eye contact to avoid crashes. Since autonomous cars are self-driving, it does not make eye contact with autonomous car drivers. Thus, a driver does not know the motivations of the autonomous car. Similar to Daily, Richtel and Dougherty explains how the autonomous car will avoid the trolley problem but they did not state how the autonomous car will handle the situation.

"Human Driver Could Have Avoided Fatal Uber Crash, Experts Say." is an article written by Beene that introduces an Uber driverless car that killed a pedestrian whom was crossing the street. A forensic that Beene interviewed said that if the car was automated, this situation could have been prevented. The driver would have tried to avoid crashing into the pedestrian by dodging her in any way possible. This contradicts with Nyholm's theory where he mentions that a human will panic during these situations. While Beene's statement is true, we cannot guarantee that the drvier will not cause more accidents as a result of trying to dodge the pedestrian. Beene explains that the car did not slow down nor swerve while hitting the pedestrian with full force due to the built-in sensor malfunctioning. In the case that if the car was automated, the driver will usually try to avoid the pedestrian even when they are in panic. As a

result, the pedestrian will not be hit with full force and, maybe have an opportunity to continue on with life. Although Beene claims that a driver will usually try to avoid the accident, there were incidents where the drivers are not fully alert. According to Beene, there is usually one death in every 86 million miles for a car driven. It is assumed that autonomous cars will result in death since they have only driven about 20 miles in total. Beene proposes that autonomous cars will cause as many accidents as automated car will. This is an important factor that should be put into consideration because if autonomous cars will result in as many car accidents as an automated car, the main reason for the existence of autonomous cars will vanish. The three articles previously mentioned all supported autonomous cars and their prime reason is because it is safer. If this statement can be proven false, autonomous cars may not be introduced to society. Another factor that should be considered is the malfunction of built-in equipments. For example, the vehicle is said to detect at least 100 meters of an obstacle, but it did not and thus result in the accident. This is an important factor because if the equipments malfunction, it can cause more damage than an automated car. According to Beene, the car accident occurred because the built-in sensor broke. This resulted in a death which would not have occurred if it was an automated car. Although Beene claims that the accident could have been avoided, he cannot deny Nyholms statement. Nyholm stated that automated cars are supposed to be safer than humans who usually get distracted while driving. Beene explains that there is no solution for when an autonomous car malfunctions, but there is always someone who can make decision for an automated car.

Beenes claim is very accurate in the fact that autonomous cars will malfunction at times, but there are some flaws in his article. One fact that Benne did not mention is that the car had a backup driver. The driver was testing the car when the accident occurred. During the accident, the driver was not paying attention to his surroundings and was not keeping a keen eye towards the road. Another scenario which Beene did not mention is the trolley problem. Since the autonomous car was sharing the road with other cars, if the autonomous car was to swerve or stop rapidly, it can result in other injuries and car accidents.

In the article "Google It: Revamping the Trolley Car Problem for Use in Today's Ethics Classes." McGowan talks about his observations on Michael Sandel's ethic course at Harvard University. Sandel introduces his students to the trolley problem where majority of the students chose to save more lives. When a similar option was given to them such that they would have to push someone in order to save five other people, the students thought that it was morally wrong. The problem here is that there is no good or bad moral but what should be the right approach. If the students thought of it using utilitarianism, they would choose to save more lives. In another situation, Sandel gives the students the option to choose to save five people or a random person whether it be old, pregnant, or children, majority of his class chose to save more lives. Then, Sandel gave a situation where that one person would be the students child, majority of the class chose to save their own children and let the five people die. An autonomous car cannot be programmed to recognize a human being as being more important than others and saving this one person instead of the other five. Whatever is programmed into this autonomous car must be consistent.

There are many flaws to McGowan's observation such as not enough evidence. As stated in his article, many of the students do not know what an autonomous car is. Although the students were later introduced to autonomous cars, they did not know enough to make judgements. The observation was only done at an ethic course in Harvard University. This means that there is a high chance these students were exposed to similar questions. This study does not tell us how many classes were asked thus, we do not know the population of the study pool. For the most part, having a larger pool to study from is usually better since there are more inputs. McGowan should have observed other universities and other courses to make the study more diverse. The school where the research is done also matters. Since Harvard is an Ivy league university, these students are expected to be wiser an average person.

McGowan believes that autonomous cars are made for a better cause. Autonomous cars do not have human emotions which makes it better at preventing car crashes. He supports his claim by using Googles autonomous car. Google had a Rosen 2012 which drove three hundred thousand miles without any crashes. Before Rosen 2012, there were 2 accidents from other autonomous cars. These accidents, as stated by McGowan, were caused by humans. McGowan's statement was proven true by Matt Richtel and Conor Dougherty in the article "Google's Driverless Cars Run Into Problem: Cars With Drivers." As stated by Richtel and Dougherty, there are 16 google autonomous car accidents between the year 2009 and 2015, which were all caused by humans. This is significant because it means that there are less likely to be car accidents if autonomous cars are introduced to society. With less car accidents, there will be less injuries and deaths. Richtel and Dougherty states that for some incidents, the google car would slow down for pedestrians while the car behind it could not stop in time resulting in an accident. In other events, there were humans controlling the car resulting in a crash. This is important because the death rate is lowered and there will be less work for emergency services.

As technology advances, there are many concerns that arises around those technology. One of the concerns is the relationship between moral, utilitarianism and the trolley problem. Unlike automated cars that have a driver make a decision when needed, autonomous cars do not have the ability to make decisions. When a driver makes the wrong moral decision, they are put to blame. Unlike automated cars, we find it hard to blame non-existent driver of autonomous cars and pedestrians for an accident. In these scenarios, the pros and cons of autonomous cars should be put up to debate. Although there are many examples in the aforementioned articles on the beneficial factors of autonomous cars, equipments installed into autonomous cars can still be improved. This is proven by the Beene's article on self-driving Uber that killed a pedestrian. Our other concern is that society does not know who to blame if there is an accident with an autonomous car. In worst-case scenarios, these accidents can lead to death. Since autonomous cars are considered new technology, we do not have much evidence on how safe it can actually be and if other problems can arise from it. Overall, we can conclude that autonomous car is supported by utilitarian and majority of the people.

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