Date	Research	Thoughts
10/18/18	California allows self-driving vehicle testing to be monitored remotely. A safety driver no longer has to be inside of the vehicle as long as it is still monitored. Arizona and Nevada also allow this, but California is used more often for self-driving vehicle testing. Although they are allowed to be driven in these areas, incidents could make states want to decrease the autonomous vehicle testing. One of Uber's self-driving vehicles with a safety driver inside killed a pedestrian in Arizona. Another incident is that a Tesla in autopilot mode crashed into a highway median, killing the driver inside in California. I can use this information to show the controversies with self-driving cars. Source: www.brookings.edu/blog/techtank/2018/05/01/the-state-of-self-driving-car-laws-across-the-u-s/.	This research is interesting because it gives information on the current regulations in some areas. Although it only gives information on regulations for California and neighboring countries, it shows how currently some states are being lenient, giving self-driving cars a chance. However, if the crashes discussed further in the research keep occuring, there is a chance that states start to put stricter regulations on self-driving cars. This makes me want to see the regulations of other states besides California and of its neighboring states. If those are even stricter regulations, it will probably be even tougher to get these cars implemented into those areas.
10/20/18	Safety drivers are the ones that usually are inside of autonomous vehicles that are being tested. They are trained to take control of a vehicle if something goes wrong. Autonomous vehicles without a steering wheel or gas pedal have been used in Las Vegas, University of Michigan, and San Ramon, California. This means that these cars do not have safety drivers. The Department of Transportation and NHTSA sometimes change guidelines for self-driving vehicles, and states are also passing	It is interesting how the wording of laws and how things are defined change whether new technologies such as self-driving cars will be allowed, at least by modern laws. Although some wordings, such as specifically referring to humans, would not allow for autonomous vehicles, if autonomous vehicles prove to be be much safer than current driving, these laws should be updated. Safety drivers likely complicate laws even more because if a safety driver fails to do their job in taking over a car in time, causing an

	laws that regard self-driving cars. However, a number of states are not specifically addressing the vehicles and currently just base whether testing is allowed on the current wording of laws. For example, laws have different definitions of “vehicle operator”. Texas calls the vehicle operator a “natural person”, but Georgia refers to the vehicle operator as the one who engages the ADS. This means that Texas would not currently allow self-driving cars, but Georgia would, because engaging the ADS can be done remotely. I will likely use this information to discuss how the current laws are what determines, at least until new laws are written, whether the state legally allows autonomous vehicles. This will probably be part of when I discuss how long it will likely take for states to legally allow self-driving cars to be sold. Source: www.brookings.edu/blog/techtank/2018/05/01/the-state-of-self-driving-car-laws-across-the-u-s/.	accident, it brings the question on whether the people who made the autonomous vehicle or the safety driver is responsible. This also makes me wonder whether people involved in car accidents with autonomous vehicles would be responsible for accidents or if the car manufacturer would be responsible, in a time in which self-driving cars are common. I hope to find information answering this question from experts on who would most likely be responsible in cases like these.
10/20/18	Some laws have exceptions to following distance laws that specifically permits truck platooning, or where trucks follow each other closely using automated technology. Truck platooning is useful, in that it will save fuel. Truck platooning does not need to account for speed, road conditions, and human reaction time when the distance between trucks are autonomously controlled, allowing the following distance rule to be adjusted for this case. Besides truck platooning, states tend to support autonomous	Truck platooning is an interesting example of how vehicles could be semi-automated. This is something I definitely will want to research more. Although autonomous truck platooning is not currently ready to be used, some states already seem to support the idea. It is interesting how trucks closely following each other would save fuel. When I do a research log on truck platooning, I hope to find an answer to how this works. It is also interesting how some states are willing to not require a safety driver as long as the

	vehicle testing when there is few times in which a safety driver needs to take over. For example, a main state for autonomous vehicle testing, California, allows for autonomous vehicles to not need a safety driver, as long as the times in which a safety driver had to take over drops. Currently, the average disengagements for 1000 miles is about 5. Although the use of self-driving vehicles in testing causes accidents sometimes, a time in which accidents are rare or nonexistent due to autonomous vehicles makes it worth it. I will probably discuss specifically truck platooning later in my presentation because I plan to do more research on that topic later in the research logs. Source: www.brookings.edu/blog/techtank/2018/05/01/the-state-of-self-driving-car-laws-across-the-u-s/.	times in which the safety driver is needed is low. I think it is good that this is happening for the most part, allowing for self-driving cars to better develop and get more testing to find flaws. However, without a safety driver, those about 5 disengagements for every 1000 miles that would normally be fixed by the safety driver become accidents. Although it would be more efficient for these companies not to use safety drivers, there will be more accidents as a result, which creates the question of whether it is really worth it to be testing like this.

10/21/18	Current leading self-driving car companies only work in large cities that have 3D maps made with manually labeled exact positions. These cars are capable of driving safely with pedestrians and other cars, but they still must have the 3D map for the location in which it is driving. Many roads with the current methods of autonomous vehicles would not get 3D maps, having little traffic and being unpaved or unlit. CSAIL developed MapLite, or Framework that does not need 3D maps for self-driving cars. It uses GPS data from Google Maps and sensors, such as LIDAR and IMU, to get road conditions. I will probably discuss this after discussing how most of the autonomous vehicles work; I will show how they work with the maps and other components, and then I will discuss how it is unrealistic for that method to work in all areas. I will then discuss the components of this car. Source: http://news.mit.edu/2018/self-driving-cars-for-country-roads-mit-csail-0507	So far, my research is doing good. This is an interesting source because most of the large companies making self-driving cars are using 3D maps, something that these cars do not need. I plan on researching cars that use 3D maps in depth, as well as research cars that use MapLite in more detail through the rest of this article. I will be able to find the strengths and weaknesses of both cars that use 3D maps and those that do not. When reading an article on the self-driving cars made by Google, which I plan to do research logs on, I found that the cars being created by Google also use the LIDARs. The article also includes more in depth information on how they work, which will help me get a better understanding hopefully on how they are used for this car too.

10/21/18	The GPS is just used for a general location. A final destination is set, and then local navigation goal is set for what is currently viewable for the car, setting a path to get to the local navigation goal. LIDAR is used to get an estimated distance to the edges of the road. Autonomous vehicles that use 3D maps generally have better accuracy than autonomous vehicles without 3D maps. 3D maps will likely still be used in the future for high traffic areas, but vehicles like the ones that use LiteMap may make it possible to use self-driving cars in rural and low traffic areas. It is not reliable enough for mountain roads currently because of the drastic change in elevation. I will likely use this information after the explanation of the cars that use LiteMap, to discuss the strengths and weaknesses of this car to other common model cars that use 3D maps. Source: http://news.mit.edu/2018/self-driving-cars-for-country-roads-mit-csail-0507	This research shows how the car created by CSAIL works. I plan on researching more on the components for general self-driving cars, such as seeing which other self-driving cars use LIDARs and how LIDARs actually work in more depth. Seeing that these cars do not work with mountain roads makes me wonder whether companies that use 3D maps are able to work with mountain roads, in order to better see the strengths and weaknesses of current self-driving vehicles. Although the approach that CSAIL is taking, without the use of 3D maps, is currently less accurate, it is a more realistic option for self-driving cars to be used in all areas. Currently, the leading self-driving car companies are using 3D maps with a combination of LIDAR and other sensors to sense pedestrians and other vehicles; however, this approach is unrealistic to be implemented into all roads due to the need for 3D maps. With an approach that uses just sensors and basic GPS information, it can be implemented into all areas no matter the traffic. If enough research goes into making self-driving cars work like this over the 3D map method, the accuracy could greatly increase, using a method that works for all roads.
10/22/18	Some of the current competing autonomous car companies are Nissan, Audi, Mercedes, Tesla, Google, and Uber. They must be able to efficiently be able to complete a series of tasks that can be completed using cameras and computers to be able to safely drive the car. The camera LIDAR, and the Radar for the car acts as the eyes and ears of a	This article provides details on the technology of autonomous vehicles. This information does not seem overly detailed, and the information is not too simple either. This will likely be overviewed in my presentation; I will likely have a picture labeling the parts of one of the well known self-driving cars that use these components to explain how they work.

	human driver, the computer does the job of the human brain, and the control electronics does what the hands and feet would normally do. Cameras are able to get the colors and shapes of objects, but they cannot get the distance to an object. To get the distance, LIDARs (Light Detection and Ranging) are used. LIDARs use laser beams to get the time it takes to reflect the light, ultimately giving it a distance. Automated vehicles also use radars to detect objects near the car. A computer in the car combines data from the LIDAR, cameras, and Radar with GPS data in order to get the location of the car. This information is used with artificial intelligence to make decisions. This gives technical information on how most self-driving cars work. It will allow me to present this information, and also compare it to the car from CSAIL. I will generally discuss each of the components. Source: http://sitn.hms.harvard.edu/flash/2017/self-driving-cars-technology-risks-possibilities/	Some of these components such as LIDARs can be connected to the CSAIL article, which only briefly discussed how the components worked. In my explanation of the different types of autonomous vehicles, I can discuss the one from CSAIL and connect it through the similar components it has to the cars being discussed in this article. After discussing the components, I will likely discuss about how the information is used to make decisions, and mention how artificial intelligence is used to make these decisions, which was the topic of my last STEM presentation.
10/22/18	Self-driving cars have several advantages over how current driving is. For example, navigation will be more efficient, distracted and drunk drivers would no longer be an issue, and there would be overall less mistakes and accidents. Although there are these positives, self-driving cars currently require very detailed 3D model maps, and there are likely some not found situations that would cause accidents. The Department of Transportation made federal	This information discusses the positives of self-driving cars for when it does come out and what is currently holding it back from being ready. Similar to the CSAIL article, this article discusses the need for 3D maps for these cars. Although it seems like self-driving cars are almost ready when looking at how they perform in one area, it is important to realize that they would need to put in a lot of other work for the technology to work in other areas. Even after they would implement

	guidelines on testing self-driving vehicles, which allow for safety and at the same time, allow for companies to still test their self-driving cars. This technology is developing fast because of the competition between the major companies trying to be the first to put their self-driving car for sale. I will be able to discuss this information in the pros and cons. It has many different uses for when it does come out, but a con is that at least with the method of 3D maps, it will be almost impossible for it to actually be released to the public for any area anytime soon. Source: http://sitn.hms.harvard.edu/flash/2017/self-driving-cars-technology-risks-possibilities/	the 3D maps for other areas, they would still likely need a period for testing. At the same time though, with all of these companies competing to be the first one to sell the self-driving car, it will likely not be long until they are finally for sale.
10/23/18	Self-driving vehicles could use less fuel when traveling in platoons. This is because when close together in packs, there will be less aerodynamic drag. However, creating platoons would cause delay, with the first truck having to wait for the other trucks. Even with the delay, it may be worth it due to how much fuel is saved by the trucks in the middle of a platoon (20%). When the trucks are close to each other, there is less aerodynamic drag, and since most fuel is used by the aerodynamic drag, this helps save a large amount of fuel. The simplest approach, waiting intervals, is the best way to efficiently save time and fuel, meaning that platooning would still be worth it even with the delay. I will probably discuss the truck platooning on	This gives useful information on how truck platooning using autonomous vehicles would be used for companies. Although there is doubt due to the delays platooning creates, this article shows that it is still more efficient to use truck platooning. Truck platooning was discussed in the article discussing state laws, which will hopefully allow me to connect regulation and truck platooning if needed for my presentation. I feel that this gave a good enough description in that it is not overly complicated and it is not overly broad either; an explanation discussing how being closer lowers fuel use will probably convey the reason for truck platooning better.

	its own slide. This is an interesting real application of this technology that companies can use. Source: http://news.mit.edu/2016/driverless-truck-platoons-save-time-fuel-1221	
9/24/18	In San Francisco, a motorcyclist filed a lawsuit against the company that made a Cruise Automation autonomous vehicle, General Motors. According to the motorcyclist, the car was moving into the left lane before the incident, and it started to suddenly go back to the initial lane, causing an accident. However, the story was a bit different according to the California Department of Motor Vehicles. General Motors claims that the motorcyclist was not supposed to merge into the lane yet. This accident was right after General Motors announced its autonomous vehicle without a steering wheel and pedals. They had also announced a rideshare service for 2019. I will probably discuss this when I discuss what makes it difficult for self-driving cars to be tested by states with there being incidents like this, even if they were not responsible for the accident. Source: https://www.theverge.com/2018/1/23/16925396/gm-cruise-automation-self-driving-car-crash-lawsuit	This is an interesting accident because it highlights what many of the accidents from autonomous vehicles really are. If the DMV and General Motors are correct, they are having a lawsuit filed for no actual reason, with the motorcyclist being the one who actually caused the accident. Cases like these make it more difficult for people and states to trust autonomous vehicles. Although General Motors may have not been the actual cause of the accident, a case like this would probably make autonomous vehicles look bad. Even though a self-driving vehicle may not be the cause of an accident, it still is usually added to the number of accidents that the self-driving car is involved in, making people distrust autonomous vehicles
9/24/18	Self-driving cars can be hacked by unanticipated bugs being exploited by hackers. Based on previous incidents with cars that were not even self-driving,	This information on the cyber security of self-driving cars is interesting. There are some connections to the cyber security flaws of artificial intelligence that I

	cars can be hacked. Cybersecurity is a large priority for self-driving cars because if it is not well protected, it can be used to harm others. Currently, the government does not do a whole lot in terms of having regulation for cyber security of autonomous vehicles. Right now, self-driving cars are not completely developed to the point that they do not need any human input. They require human input, and there is still likely huge unforeseen security flaws. I will probably have a slide that discusses the flaws in cybersecurity of autonomous cars. This can be seen as a negative. Source: http://www.ece.neu.edu/news/are-self-driving-cars-hackable	researched for my last STEM project too. Although I discussed cyber security a bit for my last project, I may briefly go over it in a different type of example for this project due to the fact that autonomous vehicles use many different things that can be hacked. Cyber security can be an issue in many different things, but if the cyber security of a self-driving car is impacted, that could lead to the death of the person in the car. Although it is hard to completely prevent cyber attacks, cyber security should be a priority because a small flaw can lead to people dying from a hacker.
9/24/18	When CSAIL was determining how they would make their car change lanes, they did not want to do it based on algorithms because it would either be too simple or too complex to calculate from statistical models. They needed a mix of the two; it should be simple but at the same time, aggressive enough to actually change lanes. They wanted it to be based off of how a human would behave. They could make lane changes by using buffer zones. However, that is also complex to do in real time. Using a simpler buffer zone with other small equations, they figured out a solution that they could do in real time. I might use this information to discuss the difficulties of making the decisions and calculations be fast enough for real time. I will	This article presents an idea that i never thought of with autonomous vehicles that makes them harder to make. They must not only work properly, but they must be efficient enough to make decisions in real time. If they were not limited to lighter calculations for decisions, their job would probably be much easier in creating how the decisions are made. The people making the self-driving cars must spend extra time thinking about how much information they actually need to make decisions and to drive safely. This was an interesting article because it had a problem that many other autonomous vehicles likely face too, and they were able to give their process in how they came to their solution.

	probably not discuss this in too much detail though because it is starting to get specific for a 5 minute presentation. Source: http://news.mit.edu/2018/driverless-cars-change-lanes-like-human-drivers-0523	
9/24/18	A study from the Virginia Tech Transportation Institute reveals that autonomous vehicles are in less car crashes on average than human drivers. At the time of this article (2016), humans got in about 4.2 crashes per million miles while self-driving cars got in about 3.2 crashes for every million miles. This means that self-driving cars get in less crashes than human drivers. About a month before this study, California required for all autonomous vehicles to have a steering wheel, throttle, and brake pedals, as well as a safety driver. This was a study from 2016, and self-driving cars have only improved in terms of getting a lower crash rate, so it is likely a tiny bit smaller now in 2018. I will use this to show how already, self-driving cars are doing better than humans in terms of crash rates. Source: https://www.reuters.com/article/us-autos-alphabet-crashes/crash-rates-for-self-driving-cars-less-than-conventional-car-study-idUSKBN0UM27V20160108	This information is interesting because it shows that self-driving cars are actually better drivers in terms of getting into less crash rates. Of course, it has to be considered from the other research logs, that these cars still only work in specific locations, so they would only be better for where there are 3D maps made, but it is still a good accomplishment. It should also be considered that many of the mistakes of humans are from not being at their best ability, such as from being deprived of sleep or being drunk. Most of the mistakes from self-driving cars are programming issues and can a lot of the time be fixed later, assuming that it was the fault of the autonomous vehicle.
9/24/18	A study found that if cars are not electrified and they are automated, there will be an increase in	This article so far discusses the relationship between electric and automated vehicles. Electric is good for

	greenhouse emission from the car. An example of an electric vehicle being combined with an autonomous vehicle would be truck platooning. Truck platooning also uses less fuel. With automated vehicles in the future, people can just use their car as a place to sleep or work instead of driving. It would also allow those with disabilities or are too old to drive to be able to use a car again too. It is estimated that deaths from car accidents every year would drop to as much as 90% with automated vehicles. I can connect some of these ideas to my previous research on truck platooning in my presentation, and truck platooning can probably be just part of the section talking about electric and automated vehicles together. Source: https://e360.yale.edu/features/will-self-driving-cars-usher-in-a-transportation-utopia-or-dystopia	the environment, and automated is a big convenience for people, and these two together help the environment even more. It is also interesting how it is estimated that 90% of car accidents would stop. I am assuming that this statistic refers to if everyone were to drive automated cars, but even then, if every car were perfect at driving, it makes me wonder how they actually would get into accidents besides of course any obstacles, animals, or pedestrians. Although this is a good source and is recent, I will probably not be using that statistic because I do not know exactly where it comes from. I am glad I found this article because I originally came to it to find simply the positives and negatives of autonomous vehicles, which will likely be later in the article, but so far, I also got research on how electric and autonomous vehicles have a relationship. I had no idea that autonomous and electric vehicles had any correlation.
9/24/18	With electric autonomous vehicles, there would be a drop in the use of parking spaces, as well as pollution. Pollution would drop too because 80% of the pollution from driving is released from the first five minutes, and with everyone using autonomous vehicles, there would be no need to stop the car; once a passenger gets dropped off, it would get a new one. With less need for parking space, with there being no need to park when another customer would just be picked up, there would be more room where parking would normally go too. All of these points, about not parking and not stopping the car,	This article is giving a lot of good information on pollution and the environment, which I never thought would relate to autonomous vehicles when choosing this topic. I also never thought of self-driving cars being a thing that relies strictly on services like Uber. I assumed that it would be something that people owned, but from the information that this article provides, it seems very beneficial for people to stop owning cars. However, there are certain problems with this thinking. For one, if the government were to ban cars for personal use, that would cause a lot of problems and controversy. If they were not getting

	assume that people stop owning cars, and that they start using automated vehicle services. Not only would this help the environment and people that cannot drive, but it would be more cost effective. I will use this to continue discussing the electric automated vehicle combination, with also talking about how it will be beneficial to limit people from having their own cars. Source: https://e360.yale.edu/features/will-self-driving-cars-usher-in-a-transportation-utopia-or-dystopia	banned, I am not sure how everyone would agree to give up their cars. Additionally, if the government were to take the cars of the people, and Lyft and Uber are allowed to have cars, they would probably need some sort of government regulation to become one of these because if not, people could probably get away with getting their own car as long as they are approved, and if it is very selective, unless they were somehow tied with the government, it could be seen almost as a monopoly.
9/24/18	Although it would be most beneficial for the environment to not have owned automated vehicles, people will still want to own their own vehicles. They would still want to even if the price were cheaper. If people were to own these vehicles, it would likely hurt the environment. For example, if someone arrives at work, it may be beneficial for them to send their car to their house. This way, they do not need to pay for parking, and they can just get it to come back when needed. This creates more pollution. I will use this research to continue discussing the electric automated vehicle combination, as well as discuss the negatives of people owning cars, not just the positives of using services over owning a car. It will also be important to discuss the unlikelihood of a situation like this actually happening. It would be difficult for the government to take away cars from the people. I will probably have a slide for automated vehicles and the	When I was thinking of the impacts on the environment from automated vehicles after reading the parts of the article from before, I was assuming that it would just mean that the pollution is the same rate, and we miss an opportunity to lower pollution. I never thought of it as this way. I know that personally, if I had a self-driving car and if it was that easy to just click a button for it to arrive somewhere, I would probably make use of that without thinking of the environment. I will probably discuss these ideas of the environment and connect them to electric vehicles somewhere in my presentation.

	environment and include much of the information from this source. I will also discuss platooning here. Source: https://e360.yale.edu/features/will-self-driving-cars-usher-in-a-transportation-utopia-or-dystopia	