Modification of a Golf Cart to Autonomous Campus Vehicle
(Technical Paper)

Social Side Effects of the Development of Autonomous Transportation
(STS Paper)

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On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

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Introduction

Automation is on the rise as many companies are investing more money so they can have the next big breakthrough and put their product on the market first. Currently, the automotive industry has gotten a lot of attention as many different semi-autonomous protocols have been added to new cars. These new developments can open up the world to new possibilities people have only seen in movies, however nothing comes free. If the costs of new autonomous systems outweigh the benefits, then maybe automation is not going to thrive in the future. The aim is to identify these costs of developing and implementing autonomous vehicles on a nationwide scale. The economic costs will be analyzed through the development of an autonomous campus vehicle and social costs will be considered through the analysis of how autonomous transportation affects society. In pursuit of more efficient campus transportation, a capstone team was formed to develop an autonomous campus vehicle. This development would fill in the gaps left by current public transportation, like busses, and allow students to ride from building to building even though they would normally have to walk. The addition would particularly help those who are disabled, pregnant, or elderly by allowing them to travel across Grounds without worry about time constraints. Currently, desires for safety and accessibility are driving the development of autonomous transportation. As autonomous transportation is implemented on a large scale, with many people taking advantage of the benefits provided and becoming consumed within the technology. Autonomous vehicles will soon shape society and culture around the opportunities it provides, based on the framework of Technological Determinism. By looking at the development of autonomous transportation through the lens of Technological Determinism, it shows there will be social side effects as society conforms to the world created by autonomy.

These social side effects must be analyzed before the leap to autonomy is taken and Technological Determinism takes control, because if the effects are negative then the autonomy push can be stopped but if the effects are good then more funding can be given to autonomy research under the mindset of creating a better world.

Autonomous Campus Vehicle Development

Administrative Details

The technical project is to develop an autonomous campus vehicle using a commercial golf cart as the base. Ideally, the vehicle would drive a predetermined route and stop to allow students on and off at requested destinations while avoiding obstacles such as people, bikes, and other hazards. The advisor for this project is Professor Tomonari Furukawa and he has been the advisor for this project for the past four out of five years. The team this year consists of five fourth year mechanical engineering students: Art Ken Fontelera, Jee Soo Shin, William Smith (myself), Peter Wellman, and Jack Yocom. The project is sponsored by Club Car who has donated four golf carts over the course of the five years this project has been active. The customer of the project is Club Car and if successful would allow them to make an entry into the autonomous vehicle realm. Club Car would then use the design to make more golf carts and sell them to universities and other communities to help improve transportation. The final end users would be the students, faculty, and other members of the community who would ride in the vehicle to move across campus after the universities program in their desired routes.

Background Research and Previous Work

This type of automation is becoming more common in full sized vehicles such as cars and trucks, but there is still room to improve. They offer insight about the requirements and

challenges faced during the design process. An investigation was conducted by the National Highway Traffic Safety Administration to evaluate the effectiveness and associated risk of Tesla Autopilot or Automated Emergency Braking of several common cars on the market (Habib, 2017). The report includes diagrams representing areas detected by the vehicle and common restrictions possibly leading to incidents on the road. The project has evolved numerous times over the course of its lifetime with the original intent being an autonomous campus vehicle but then shifted to a leader follower concept (a person drives the leader car and all cars set to follow behind it would follow like, follow the leader) and has now shifted back to an autonomous campus vehicle. Currently our sponsor, Club Car, offers an add-on package allowing greenskeepers' to remotely program golf cart restrictions such as: limited speed in certain areas, no go zones, locking (Becker, 2019). Detailed reports from previous teams efforts have been provided so the project will not be started from scratch as well as to help identify what modifications have already been applied to the golf carts. One of the biggest technical challenges is taking an existing design and modifying it for a different purpose. In this case the existing design applies to both the golf cart and the modification applied by previous teams.

Timeline and Goals

The current timeline for the project is highly dependent on the initial conditions of the golf carts modified by previous teams. Of the four golf carts, some have more modifications applied to them than others. The first major step is to make the golf carts functional, as they have been sitting unused for a little over a year and need some work to get running. After getting them functional, preliminary tests would be run to evaluate the results of the previous team's efforts and compare them to the results published in their reports. This should all be completed

before the end of the fall semester, along with abstract design concepts for the new modifications. Starting in January, design implementations will begin in two different groups, a mechatronics group and a software group. These groups will work independently, with corroboration to maintain consistency, to develop the necessary features needed for the vehicle to function as planned. As implementations are completed, basic tests will be conducted with major tests beginning in the middle of March, leaving time to correct any errors recorded. Final tests will be conducted at the beginning of April with a final demonstration to follow to demonstrate accomplishments and serve as a comparison between the final product and the goals of the project.

Goals

The main goal of the project is to modify and develop an autonomous campus vehicle with regularly available commercial parts with the ability to drive a predefined route without hitting obstructions and let students get on and off at their destinations. The current testing route is planned to be on Engineer's Way at the University of Virginia with the vehicle operating between Rice Hall (Whitehead Road) and Thornton Hall (McCormick Road).

Social Effects Created by Autonomous Transportation

Introduction

The Science, Technology, and Society (STS) research paper is on the topic of how the implementation of autonomous transportation will affect society and the current zeitgeist. The STS framework used for analysis will be Technological Determinism. Using the framework as guidance for detailing how society and technology interact, will allow for better conclusions to be drawn about possible outcomes of the implementation of autonomous transportation systems.

Technological Determinism

Technological Determinism states society and technology are related, with technological advancements and developments forging society. This can be seen historically with the development of the automobile, initially the automobile industry was struggling to sell cars and the roads were mainly used by pedestrians, horses, and bicycles. Automobiles were viewed as scary and dangerous and a similar negative light is cast over autonomous vehicles today. Through successful lobbying and marketing, roadways became more friendly for automobiles. The moving assembly line and other production techniques were used to drop the price of automobiles so the everyday person could afford to purchase one. These changes in technology and policy shaped the rest of American culture, households started buying automobiles and the tourism industry was born as people had more free time. Eventually suburban communities were created for middle class families since the automobile enabled travel to and from the city. Automobiles even became a part of the American Dream (ushistory.org, 2020). All of this happened, not because a majority of people wanted automobiles in the first place, but because automobiles had potential to broaden everyday lives. The general public's view of automobiles completely changed from being distant and fearful to having desire and necessities because of the power automobile technologies possessed.

Although the term "Technological Determinism" was coined by Thorstein Veblen, an American economist, the key ideals were developed by Karl Marx, a German economist (Communication, 2015). There are accounts of the theory in Marx's book, *Capital. A Critique of Political Economy* (Marx, 1867), however Marx never addresses it directly as his own theory, instead Veblen pulled the different key points from Marx's works to formally define the theory of

Technological Determinism. The key aspects of Technological Determinism are: an initial motivating factor driving the development of new technology, the technology is then implemented, and social or cultural changes occur due to the implementation of the new technology. Typically, the initial motivating factor is economical in nature, such a desire for increased production efficiency, but the factor does not have to be economical. After the technology is developed, it must be implemented and integrated into society. Due to the power and influence possessed by the technology, it can shape society around it, making society the perfect match for the technology. This is due to society adapting and developing new behaviors meant to thrive with the new technology.

Technological Determinism works well for analyzing the technological and social interactions of autonomous transportation because the development of autonomy has the potential to shape society. In order to reasonably assume autonomous transportation will have a large impact on society, history must be revisited for correlations. The initial development of the automobile changed where and how people lived as well as paving the way for the concept of vacation (History.com Editors, 2018). Technological advancements regularly increase the safety of workers (Folk, 2019). Initially this is a benefit for working for a specific company or job, but eventually, it becomes expected workers will be safe either through laws or public consensus. Such as a demand for better training or more automated factory processes allowing workers to operate at a safe distance (Melo, 2019). After observing the trends in history, it would be safe to assume autonomous transportation will shape society just as technology has in the past.

Initial Research

After initial research, it has been determined there is a correlation between automation and changes in behavior due to the increased perception of safety and regulatory laws falling behind the technological curve (Miller, 2019). There are currently more discussions about social impacts being caused by the development of artificial intelligence since the potential impact is larger and it affects more aspects of life than autonomous vehicles. However the development of autonomous vehicles will most likely take advantage of the breakthroughs in artificial intelligence, more on the machine learning and machine vision side though. The goal of both autonomous vehicles and artificial intelligence are very similar. It is to make the world a better place for everyone but they both threaten to take away key aspects of our culture (Andersons & Rainie, 2018). These parallels between autonomous systems and artificial intelligence will allow for a better understanding of the actual desires of the people as it gives two vantage points. Travel is currently easier than ever with the increased number of flights to many destinations as well as the dropping costs, but travel could get even easier if all you had to do was hop in a car and plug in a destination since there could be minimal planning and reliance on a time consuming system. The number of travelers has increased with the increased ease of travel so it can be assumed travel and leisure will increase again (The Plaid Zebra, 2015). This could change the current social dynamics if people are traveling more and not putting down roots, job hopping could become more prevalent or the standard office environment could evolve to include remote work options all the time, not just during global emergencies. After exploring background research, it has led to the formation of several key concepts to be addressed during the analysis.

Research Methods

In order to determine the possible social changes that could occur after the implementation of autonomous transportation, case studies and historical examples will be analyzed to extract the correlation between autonomy and society. The analysis will be completed by exploring several key concepts:

- How impactful has the automobile industry been historically?
- Does a desire for safety drive technology?
- After safety has been increased, how does cultural behavior change? Is it more relaxed? Risk prone?
- Does the current transportation model have deep cultural significance? Does getting a driver's license become less of a coming of age moment?
- Will this allow for easier and longer road trips, where usually flights are taken?
- Will the data collected by autonomous vehicles reduce the feeling of freedom currently associated with driving?

Gathering reliable and adequate information is essential to answer the key questions and conduct a proper analysis, so this is the most vital step or the process. The information will be gathered by scouring the internet for case studies, statistics, and general news articles answering or providing insight for some of the questions. No source will provide an all encompassing answer but will instead be a piece to a puzzle. After understanding how society has reacted to similar new technologies in the past and how society feels about current technologies, a reasonable prediction of future responses can be presented.

Conclusion

Before fully accepting autonomous transportation as the future, the costs must be fully analyzed to determine if it is the best fit for society. By modifying a golf cart to act as an autonomous campus vehicle, it helps provide insight into the development of autonomous transportation by acting as a small scale case study while also developing a product for customers. Social factors are largely ignored in the technical development of products which leads to their failure. Therefore, for the product to succeed the social factors must be considered. After determining the effects of autonomous transportation on society, proper considerations can be made about what technical features should be included for optimal success. Using both the technical research and societal research conducted on the development of autonomous transportation will allow for the customer's needs to be represented.

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