Developing an Electrically Powered Waterjet Kayak Attachment
(Technical Topic)

Examining the Rise Electric Vehicles:
A Technological Fad or the Future of Transportation
(STS Research Topic)

A Thesis Project Prospectus Submitted to the

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

Signature 

Approved  Date 11/22/2019
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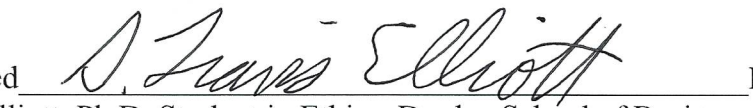
Approved  Date 12/10/19
Travis Elliott, Ph.D. Student in Ethics, Darden School of Business

Introduction:

Since the industrial revolution, energy needs have exponentially skyrocketed as modern industries have evolved to rely on various forms of energy. One of these modern industries reliant on large amounts of energy is the transportation industry. In the US, transportation accounts for approximately 28% of all energy used throughout the whole country (EIA 2019). Of that 28%, 96% is in the form of petroleum, with natural gas, biomass and electricity accounting for the rest (EIA 2019).

With growing concerns for a potential energy crisis on the horizon, the transportation industry has been looking to wean themselves off of non-renewable energy, like petroleum, and begin using cleaner, renewable energies, such as electricity. This had led to a revolution in the automobile industry, as more and more manufacturers are making fully electric and hybrid electric cars available to the general population. With these companies investing their futures into electrically powered vehicles, they are aiming to create a modern transportation industry completely run off renewable energy.

The technical project attempts to construct an electrically-powered waterjet apparatus to attach onto a kayak. The completed system will produce enough thrust to move the kayak and kayaker at a reasonable speed, as well as be able to steer, brake and reverse. By pairing an electric motor with a waterjet, rather than the conventional gasoline-powered propeller motors, the personal water craft will have more versatilcity in the water as well as produce zero harmful emissions to the nearby aquatic environment.

The STS prospectus discusses the rise of the electric power in the transportation industry, specifically exploring its rapid growth in the automobile industry. By examining the current electric car market, the advantages and disadvantages over conventional petroleum powered

vehicles, and overall acceptance by the general population, this topic hopes to provide some insight as to how the automobile industry will look moving forward into the future.

Technical Topic: Constructing an electrically powered waterjet to a personal water craft

The objective of this project is to create an electrically-powered waterjet attachment for a standard one-person kayak. By utilizing a waterjet system, similar to that of a jetski, the apparatus will be more versatile than conventional propeller trolling motors, as it will not draw any extra depth. The system will also be able to slow down, brake and reverse more effectively than the trolling motors currently available. The electric motor will require far less maintenance than its gasoline-powered counterpart and will use a cleaner, renewable source of energy. Overall, the project hopes to provide an easier to use and maintain alternative to the powered personal watercrafts already available on the market. Under the technical guidance of UVA Mechanical Engineering faculty member Professor Gavin Garner and the assistance of fellow engineers Justin Allen, Colin Allison, Julianna Chaput, Miles Coe, Brian Lithen, Troy Meurer, Jonathan Ramirez, and Bryce Shelton, a working electric waterjet kayak attachment will be designed and constructed throughout the Fall 2019 semester.

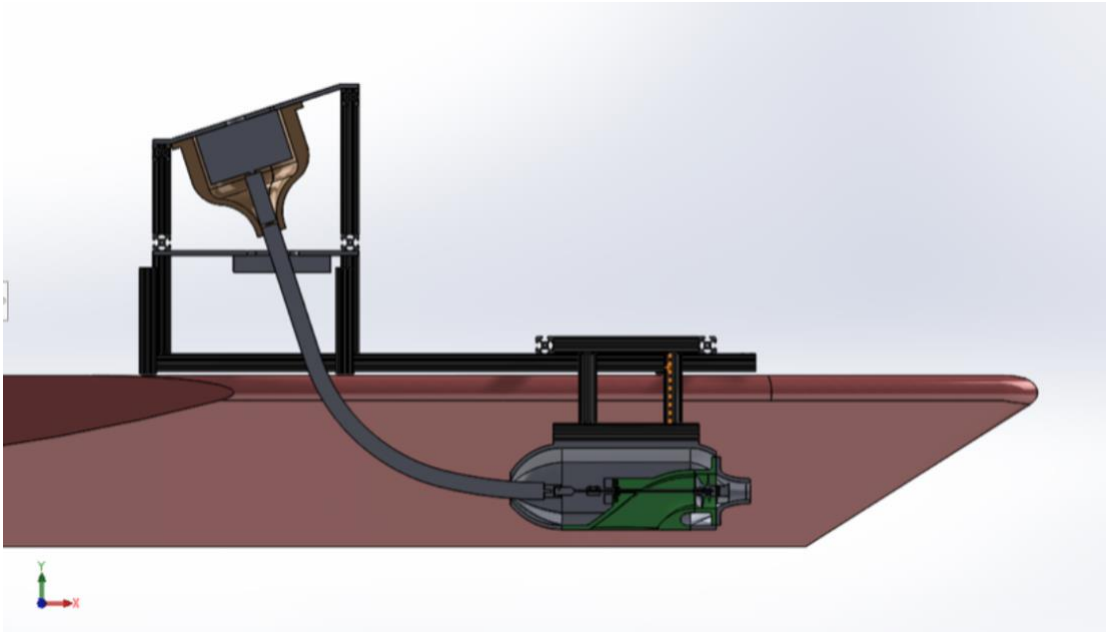


Figure 1: Sectioned view of the 3D CAD model of the technical project

Figure 1 shows a sectioned, sideview of a prototype model of the waterjet apparatus created in SolidWorks. Connected to the side of the kayak is the waterjet housing. The green section within the housing is the waterjet path. Water will be sucked up through the waterjet path by the impeller and expelled through the stator. This process will a positive thrust, moving the kayak forward through the water. The waterjet path, impeller, stator and housing will all be 3D printed in ABS plastic. Computational Fluid Dynamic (CFD) models were performed in SolidWorks on the model to optimize the waterjet path, impeller design and stator shape to minimize the losses as well as maximize the power.

The impeller is attached to a steel rod, that spins the impeller to create the thrust. The rod is held in place by bearings and is connected to the brushless electric scooter motors by the flex shaft, which is long curved beam going from the housing to the motor. The motor will be powered by a lithium iron phosphate battery and the all the parts will be connected together using 8020 aluminum beams shown above.

Along with CFD modeling, a test rig was constructed to measure the thrust produced by various combinations of impellers and stators. The data from the test rig will be used to decide the best impeller and stator combination in the final design. The final design will have two waterjet housings on either side of the kayak and will have an electronic control system powered by a Parallax Propeller microcontroller chip. Not in the model is the reversing and steering system. Early prototypes being modeled use various combinations of worm gears, servos and hydraulics to move 3D-printed nozzles and reversing buckets, directing the water flow in various directions, including backwards, to steer and reverse the kayak. The plan is to have a completed, working version of the apparatus by the end of the fall semester.

STS Topic: Analyzing the rise electronically powered automobile and their impact on the future of the transportation industry

Despite many of the first automobiles created being powered by electricity, the automobile's commercial success came with the creation of internal combustion engine. Henry Ford's mass-produced Model T, powered by a 4-cylinder gasoline engine, revolutionized transportation in the early 20th century (Zurschmeide 2018). With more of the population able to own cars, people moved farther away from city centers, effectively creating the modern suburban landscape. The automobile ushered in more freedom and opportunity for the average person, creating a much larger and stable middle class. The Model T's game changing integration into the transportation industry left a major mark on all aspects of society, but it also set the standard for gasoline powered automobile engines.

The Social Construction of Technology theory (SCOT) states that new technologies have to be accepted by a variety of relevant social groups in order to succeed. SCOT essentially

contrasts the idea of the 'best technology always wins', as it holds society's acceptance of the technology equally as important as the technology itself (Social construction of technology, 2019). The Model T is the perfect example of SCOT in action. There was a need for personal transportation devices in the early 20th century and the Model T's ability to cheaply mass-produced filled that need. The public accepted the notion of having a personal, gas-powered automobile and the infrastructure, such as paved roads, highway systems, and gas stations followed. Electric cars were around during this time, but the technology was not comparable to the gasoline engine, as their ability to be mass-produced and consistent reliability were far better than the electric options of the day. This led to the transportation industry shaping itself to suit gasoline engines.

Since SCOT fits perfectly over the rise of gasoline cars, it makes logical sense to examine the rise of electric cars through the same framework. Over 2 million electric cars were sold in 2018, up from just a few thousand in 2010. Current studies predict that by 2040, a majority of the cars sold will be electric (Berryman, Doherty, McKerracher, & Soulopoulos, 2019). These statistics show a growing number of people are placing their trust into electric car technology. However, SCOT theory suggests that the technology and the societal acceptance of it have to grow at similar rates in order to for electric cars to become the new standard in transportation. By examining the rise of the electric car industry through the lens of SCOT, a variety of societal factors have to be considered in parallel with the statistical data in order for any conclusions to be drawn.

The overall goal of this thesis is to examine and draw meaningful conclusions regarding the electric car industry. To set up the topic, the current landscape of the industry and its stakeholders has to be laid out and explained in order to try to predict its future trajectory. The

most important stakeholder to consider is the consumer. Consumers are the group that has to decide if electric vehicles are practical and economical, and the industry is completely reliant on how many consumers purchase EVs. Both the advantages and disadvantages of owning an electric car have examined to put the thesis into context. Commercial businesses requiring travel also fall into the consumer stakeholder category, as EV's could prove to be more economical for shipping goods, potentially saving businesses substantial amounts of money. Topics such as the cost of owning and maintaining an EV automobile, the environmental advantage, range anxiety and daily practicality will have to be explored first before diving into the STS theories and future predictions about electric automobiles.

Car companies are another large stakeholder when considering the current state of the electric vehicle industry. If there is a demand for EVs, then car companies will have to meet that demand in order to remain profitable. Car manufacturers such as BMW, Chevrolet, and Toyota are already selling electric and hybrid electric vehicles This shows that top car companies already see the EV industry as potentially profitable. When considering EV manufacturers, it is important to consider who are the dominant players in the EV market as well. Tesla makes up 45% of the total EV market in the US (McCarthy 2017). If Tesla were to have a scandal, like a major recall, this would be catastrophic to industry as a whole and would undoubtedly impede its growth. Taking into account all electric vehicle manufacturers within the SCOT framework would certainly make for a stronger thesis overall.

The government is another primary stakeholder that needs to be considered when examining the rise of electric cars. As stated before, the current infrastructure of the transportation industry is suited for gasoline powered cars, with an abundance gas stations available for use throughout the whole country. With the demand for electric cars rising, the

demand for communal car chargers will rise as well. It would be up to governments at all levels to meet this demand and provide the proper infrastructure to suit the electric vehicle market. Examining each of the three main stakeholders roles, as well as considering other stakeholders such as energy providers, oil companies, and environmental agencies, will be important in order to properly apply SCOT to the changing transportation industry.

Various key questions and concepts impacting the topic need to be considered while researching and writing. It is important to consider environmental concerns, as they are key social factors as to why people are wanting to drive electric cars. Also, examining how electric cars fit into the society currently will be important to understand how they will fit into society in the future. Exploring the current infrastructure in place, such as the availability of chargers and current charge times, will help determine if people will eventually accept electric vehicle's practicality as similar or better than gasoline-powered cars.

While considering all these factors and concepts, it is important to find a diverse list of sources while doing research. Many of the sources already found for this prospectus were informative but lacked depth on the topic. They provided enough information and data in order to frame how the topic will be explored, but the strength of the thesis will surely be dependent on finding a variety of scholarly articles and advanced studies.

The Bloomberg study "Electric Vehicle Outlook 2019" and the scholarly article "Socio-demographic characteristics, psychological factors and knowledge related to electric car use: A comparison between electric and conventional car drivers" found in the academic journal *Transport Policy* are two examples of strong, effective resources about the EV industry. The Bloomberg study was compiled by various data scientists, statisticians and investment experts to graphically map out the rate at which EVs are growing. The study is unbiased on the

topic, as the aim is to explain where one should invest their money moving forward. The scholarly article found illustrates its own STS type frame to look at the EV industry, which will be incredibly helpful and provide another perspective on the various factors involved with the rise of electric cars. Using resources such as the Virgo and the UVA library system will help find strong and informative sources while researching this topic.

It is also important to analyze the perspective of each source. The source "Electric Cars Pros and Cons" on the surface seems like a non-bias article examining the ups and downs regarding EVs. But the article is posted the website *Plugincars.com,* which is a pro-EV website. The article starts out by stating:

"You can expect a site like PluginCars.com to generally promote EVs as having, on balance, a lot more benefits than shortcomings—but that doesn't mean we can't offer an honest assessment of the pros and cons of cars that use electricity rather than petroleum (Berman 2014)."

Although Berman is attempting to remain impartial, one must be hesitant to draw any key conclusions while examining a source like this. Also, one must note the time the article was written. In 2014, EVs were not nearly as widely accepted as they are today, so a pros and cons list from back then will have some drawbacks when applying it to the electric cars of today. Understanding the various points of view on the topic as a whole will lead to a better and more thoroughly researched thesis.

Conclusion:

By examining the rise of electric cars in the automobile industry through the lens of SCOT, conclusions about the future of the transportation industry can be deduced. The technical project will serve to justify using an electrically-powered waterjet engine instead of the conventional gasoline engine. With the technical project providing an example of the feasibility

of using electric power for a transportation device, the STS topic will deconstruct the current landscape of EVs and examine the numerous societal factors and stakeholders involved with the use of reusable electricity. In conjunction, both the technical project and STS research paper will aim to discuss the use of electric automobiles and draw conclusions about the future trajectory of the transportation industry as a whole.

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