Analysis of the Development and Production of the 2011 Ford Focus Electric: Ford's Path to Electrification

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Pallavi Kulkarni

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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

Advisor

Pedro A. P. Francisco, Department of Engineering and Society

Introduction, Background, & Significance:

In 1981, the Society of Automotive Engineers (SAE) developed a racing series for student engineers, the Formula SAE Competition (FSAE) (*About – formula SAE California*, n.d.). The competition tests the students' abilities in engineering design, manufacturing, testing, analysis, performance, financial management, and business tactics. Virginia Motorsports, a (501) c3 non-profit CIO, has an FSAE Team that competed in the internal-combustion engine (ICE) division for the previous two years. The competition recently developed an electric division as well, reflecting the up-and-coming electric vehicle market from powerhouses, such as Tesla. To keep up with the automotive industry, the team will begin the development of a fully electric formula car which is anticipated to compete in the 2024 FSAE Electric division. Therefore, it is imperative to understand the technical and social aspects needed to undertake a seamless transition for ICE to EV.

The main points of concern and contention for such a transition typically focus on the technical aspects. The differences in vehicle structure, design, alignment, packaging, manufacturing techniques, etc. A transition to a fully electric powertrain is a large technical undertaking for an industry that relied and developed so heavily on Internal combustion engines which are rapidly becoming outdated and unsustainable. However, if one looks at the transition with a wider lens, there are various actors, including technical, social, and economical, which are factored in and help create and lead to the of certain networks. Actor-Network Theory (ANT) prescribes and analyzes a network builder who recruits human and non-human actors to accomplish a particular goal. The generation and stabilization of the developed network are known as translation (Callon, 1986). This sociotechnical framework is applied and used to understand a case study of a large automotive powerhouse undergoing a transition from ICE to

EV. The 2011 Ford Focus Electric is a relevant case study to the overall goal of the technical project, as it highlights not only the technical aspects that Ford fell short of when releasing their first electric car, but also the social and economic factors which affected and ultimately led to the dissolution of this vehicle. Evaluating this case study stands as an insight for the Virginia Motorsports Formula SAE team to consider as their transition begins from ICE to EV. The research question this paper will aim to answer what network of economic and social actors were responsible for the development, sustainment, and eventual dissolution of the 2011 Ford Focus Electric. Prior to undertaking a thorough literature review, it is important to provide relevant context for this case study.

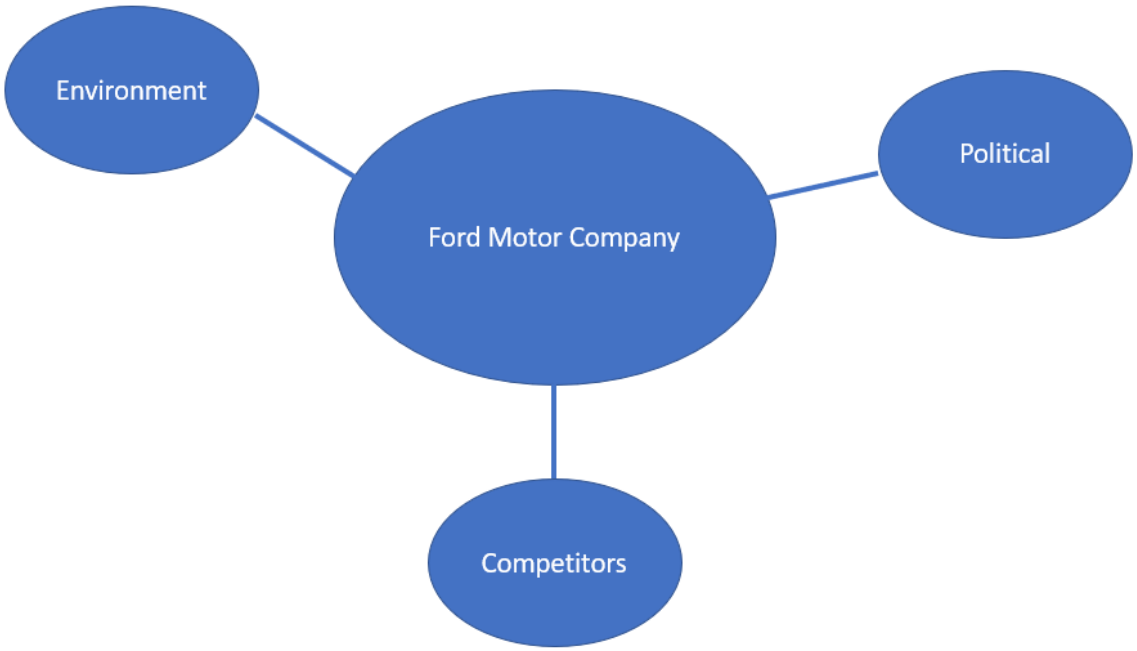
Ford Focus Electric Background & Methodology:

The Ford Focus Electric was unveiled at the 2011 Consumer Electronics Show (CES) in Las Vegas, as Ford's first EV for a compact car design (Cunningham, 2011). The 5-door hatchback was made in response to the 2010 Nissan Leaf, which introduced similar vehicle infrastructure (Harrison, 2021). The Ford Focus Electric implemented a completely electric powertrain unit into the existing chassis of its ICE counterpart and was produced on the same production line as ICE and Diesel vehicles (Harrison, 2021). Ford's first iteration boasted a 23-kilowatt-hour lithium-cooled battery pack with a 76-mile range, as calculated by the United States Environmental Protection Agency (Harrison, 2021). The production of the Ford Focus Electric began in the United States in 2011 and was released in Europe following the 16-million-pound investment by Ford in their production facility in Saarlouis, Germany (Eis, V. & Thomasen, F, 2013). In 2017, the EV implemented a 33-kilowatt-hour battery pack, which was able to sustain a driving range of 115 miles (Harrison, 2021). After a total of close to 9,000 sales within the United States, the production of the all-electric Ford Focus was terminated in 2018 (Harrison, 2021).

The demise of the Ford Focus Electric is typically attributed to factors involving design issues, performance issues, and the underdeveloped electric infrastructure at the time (Harrison, 2021). The design involved packaging an electric powertrain unit in the chassis of the ICE car, the Ford Focus was never intended to be an electric car (Harrison, 2021). The compact size of the car left minimal room for consumer storage, placing the electric car at a disadvantage to its ICE equivalent (Harrison, 2021). The sudden retrofit of an ICE powertrain into an electric powertrain was not the only major oversight. Looking at this failure solely from a technical lens fails to evaluate external pressure from competitors and poor marketing strategies as a contribution to the dissolution of the Ford Focus Electric. Ford did not effectively mold their production infrastructure, business strategies, and marketing tactics around their developing EV. Ford began as a manufacturer of ICE vehicles and garnered this reputation selling over one billion vehicles over the past century. Apart from the lack of technical understanding, many socioeconomic factors influenced the development of the Ford Focus Electric and considering these factors is important in gaining a complete understanding of the semi-failure of providing a seamless transition from ICE to electric-vehicle production. I retain the use of semi, as the insights learned from the Ford Focus Electric served as lessons learned for current success stories in the electric-vehicle arena for Ford. I argue that in tandem with the technical aspects lacking from the model, the external pressures from the success of competitors, the political climate about EVs at the time, and the failed marketing strategies led to the ultimate termination of the 2011 Ford Focus Electric.

Figure 1

Actor Network for the 2011 Ford Focus Electric



Results & Discussion:

Ford's Actor-Network prescribes hundreds of actors that could be analyzed and discussed when looking at the translation of this network. However, the two main categories of actors that are important to evaluate in the context of the Formula SAE team are the technical and social actors. The technical and social factors are defined first individually; their interaction will serve as discussion for this network.

The first technical factor to be evaluated for this case study is the design similarities between the ICE Ford Focus and the 2011 Ford Focus Electric. Although the marketing tactics will be discussed in more detail later, the large selling point for Ford with this model was to have the electric powertrain packaged in the same chassis as its ICE counterpart. The potential reasons

that Ford would decide to do this were for ease of manufacturability, budget savings, and to minimize the amount of design changes needed to be made. Since the powertrain was the primary focus of the 2011 Ford Focus Electric, not only were they able to save time and resources in re-designing secondary subsystems, but they were also able to set feasible goals for manufacturing the model on the same assembly line with minimal changes. Although one of Ford's primary design goals was to maintain the same look of the third generation ICE Ford Focus, an electric powertrain has significant impact on weight as opposed to an ICE powertrain. Ford engineers spent a significant amount of time redesigning the Ford Focus chassis for the electric powertrain, in order deliver a similar overall look to the third generation ICE Ford Focus, without deterring from the overall performance of the vehicle (*Ford begins roll-out of focus electric; electrifying the platform efficiently*, 2012). As mentioned earlier, the weight of the powertrain can have significant impact on surrounding subsystems of the car, affecting the overall drivability and performance of the vehicle. For example, since the weight distribution is different than for the ICE powertrain, the Ford Focus chassis and suspension design needs to take the additional weight into account to maintain similar driving characteristics. Since the overall size of the vehicle needed to remain the same, packaging the electric powertrain was also another technical challenge faced by Ford engineers. Since the electric powertrain had larger components that needed to be mounted and secured within the Ford Focus chassis, there was less room left for storage within the 2011 Ford Focus Electric (Harrison, 2021). The design changes made by Ford engineers had major implications on the social actors at play in this network. This will be discussed after identifying the major social actors in play.

The three most significant social factors to consider in this case study are those of competitors to Ford, as well as environmental and factors that drove Ford to develop an electric

compact car. Just a year prior to Ford releasing their brand-new Ford Focus Electric at the 2011 CES conference in Las Vegas, Nissan had released an all-electric compact car, better known as the 2010 Nissan Leaf. Although the overall make of the two models remains vastly different, the target consumers for both companies were the same, considering that they both were electric compact cars, the first of their kind during that time. In a Ford Press Release, Ford boasted that the Ford Focus Electric could charge in half of the time of a Nissan Leaf (Ewing, 2011). Within the same press release, Ford also mentioned how their electric efficiency was superior to Chevrolet Volt, which was also another popular compact electric vehicle at the time (Ewing, 2011). Additionally, during this period, another huge EV competitor on the market was Tesla Motors. In the year of 2011, the Tesla Roadster had garnered quite a bit of attention, especially after debuting on Top Gear (*Tesla vs. top gear,* 2011). Tesla was slowly becoming a power-house EV manufacturer, especially considering that they were solely focused on developing electric vehicles, rather than juggling the development of both ICE and EVs, as most other large car manufacturers at the time. Considering the timing of all these releases, it's clear the development of electric vehicles was on the rise during the early 2010s. This further begs the question of how the environmental policies and political climate surrounding electric vehicles was at the time. During President Barack Obama's State of the Union address in 2011, he mentions a goal of placing one million electric cars on the road by the year of 2015, to further decrease the dependence of oil and fuel for everyday transportation (*One million electric vehicles by 2015 – energy,* 2011). Considering that the Nissan Leaf, Chevrolet Volt, and now the new Ford Focus Electric were all being released, if not already sold at the time, President Obama's sentiment in mentioning the importance of electric vehicle placed it on the map as a political goal for Congress and other Congressional Leaders to keep in mind. Prior to the announcement of the

2011 Ford Focus Electric, the Nissan Leaf and Chevrolet Volt were the most popular compact electric cars on the market. Additionally, Nissan and General Motors were also large scale manufacturers of ICE vehicles prior to their release of the electric vehicle models, which undoubtedly has an effect on the overall balance of the larger competitor network. Additionally, President Obama's endorsement of electric vehicles also had an impact on the overall nature of balance in the automotive industry. Although the social actors are mentioned as a separate unit to the technical actors, the interactions between these actors are what ultimately builds the actor-network that the 2011 Ford Focus Electric laid grounds on.

When examining the development of this network, I argue that the social factors played the most influential role. Additionally, social factors are ultimately what led to the development of the technical actors in this network, which also were the reason for what caused this network to dissolve. The automotive industry is driven by the nature of competition. Competition is arguably the driving force for a lot of innovation within the field of technology. Within the automotive industry, the push for innovation amongst large powerhouses' insights is motivating factors for different companies to continue to release new models and products. In the case of the 2011 Ford Focus Electric, new legislation surrounding the importance of reducing carbon emissions also undoubtedly played a significant role in the development of this larger network. The social actors within Ford's network are what informed and guided the technical decisions and development made for this vehicle.

The sociotechnical relationship I will be examining is the connection between competing models and the 2011 Ford Focus Electric. The 2010 Nissan Leaf was arguably the largest competitor to the 2011 Ford Focus Electric. Even amongst blogs and car enthusiasts, there are several sources that clearly point out the differences between the two models, considering they

were both gunning for a similar consumer market. The 2011 Tesla Roadster, the fastest electric vehicle at the time, was marketed as a sports-car model, and therefore was unaffordable to the general public (*2011 Tesla Roadster specs and prices,* 2011). It was estimated to sell for around $109,000, which is a typical range for cars that are meant to be purchased as more of a luxury than for a necessity (*2011 Tesla Roadster specs and prices,* 2011). Both Ford and Nissan, with their two compact electric vehicle models, had the incentive to create an electric vehicle that was not only more sustainable to the earth, but also more affordable for the general public. It is arguable that Tesla was not aiming to sell the Roadster as their primary model to the general public, rather just demonstrate the possibilities that electric vehicles held for the future. Circling back to the similarities and differences between the 2010 Nissan Leaf and the 2011 Ford Focus Electric, the differences particularly are important to consider when examining why Ford's network may have been on weaker grounds than that of its competitor. When Ford announced its new Electric Ford Focus model in 2011, there were a lot of claims and promises made about the overall performance of the vehicle. Subsequent models of the Ford Focus Electric in 2012 and 2013 were similar in performance to the model promised by Ford in 2011. The comparison will be made between the 2013 Ford Focus Electric and the 2011 Nissan Leaf, since there is more data available on the driving characteristics and feedback for these slightly newer models. The power characteristics between the two models are extremely similar, but Ford consistently lags slightly behind Nissan. The 2011 Nissan Leaf is supplied with an 80-kilowatt AC Electric motor, with a total of 107 horsepower and delivers 207 foot-pounds of torque (Evans, 2015). The Leaf claims a top-speed of 95 miles per hour and a zero to 60 acceleration time of 10 seconds (Evans, 2015). As a comparison within the power dynamics of the car, Ford supplies a 100-kilowatt AC Electric motor, which produces 123 horsepower and 181 foot-pounds of torque (Evans, 2015).

While the Ford Focus does produce more horsepower, it is clear that the Nissan Leaf overall performs better due to a larger torque output and higher top speed. As mentioned earlier in this paper during the background, the Ford Focus boasts a faster charging time for the same level of voltage, as opposed to the Nissan Leaf. From a weighing standpoint, the Nissan Leaf weighs in at about 3400 pounds, while the Ford Focus Electric is roughly 300 pounds heavier (Evans, 2015). From this comparison alone, if the range of the two models is considered, they both are estimated to set a target driving range of around 70 to 100 miles; however, with the Ford Focus being heavier, it is likely that the Nissan Leaf will hold true for a larger range than the Ford Focus (Evans, 2015). The final metric to compare between these two models is their selling price. The Nissan Leaf is estimated to sell for between $25,000 and $32,000 (Evans, 2015). The Ford Focus Electric is estimated to sell between the mid-$30,000 to $41,000, which is a great deal higher than the Nissan Leaf (Evans, 2015). From comparing these technical characteristics alone, Ford had a high bar to reach when releasing the Ford Focus Electric. The Ford Focus Electric did not have incredible sale revenue as compared to the Nissan Leaf, likely in large part due to the affordability and similar characteristics. Ford took a large undertaking in developing this car, especially when Nissan beat them to it. Considering the Nissan Leaf was released a year prior that of the Ford Focus Electric, the release and popularity of the Nissan Leaf likely encouraged Ford engineers to work at a faster pace, potentially causing overlooks in the overall design of the car, ultimately leading to a slightly underperforming model. Additionally, when examining Ford's primary consumer market, it is clear that there is a discrepancy between the Ford Focus Electric and Ford's best-selling car. For over a decade, the Ford F-Series, Ford's premiere pick-up truck, has been the best-selling car in the United States (Rettie, 2022). Considering that Ford, in 2011, was best known for their pickup truck, it most certainly may

have played a role in failed marketing strategies for the compact car model. Comparatively, the Nissan Sentra, a compact car much like the Nissan Leaf, was Nissan's bestselling car (Rettie, 2022). It is clear that as far as the target consumer market goes, Nissan already had the upper hand over Ford for their shared audience.

Another sociotechnical relationship to examine is the connection between why Ford may have even pushed to release an electric counterpart to their ICE Ford Focus in 2011. As mentioned previously, the EV market was just beginning to be established, with the release of the Volt, Leaf, and Roadster. From Ford's perspective, it would be in their best interest to develop an electric vehicle to also stay in the race and not fall behind. General Motors, the other American Car Manufacturer and one of Ford's largest national competitors, was also showcasing their development and research in this new terrain. For Ford to start from scratch and develop a completely custom EV model would not only have exhausted the design process, but also would have made the production line much more difficult, considering their manufacturing facilities were only equipped with building ICE models. Ford's decision to retrofit an electric powertrain to the ICE Ford Focus was an economic and competitive decision. By doing so, they were able to save money in the design and manufacturing process, while also reducing the overall timeline and potential roadblocks they would have faced during the development stage. However, it was clear based on the previous discussion, that the Ford Focus was not meant to efficiently hold an electric powertrain in it. The lack of storage space and overall weight of the car were clear corners that Ford had to cut to deliver the product in a timely manner. Ford introduced a brand-new aerodynamics package, however, which likely helped to alleviate some of the design changes they had overlooked, but nothing quite as significant (Ewing, 2011).

Looking at the larger socio-technical network, each actor played a role in informing the decisions made by Ford when developing the 2011 Ford Focus Electric. It was ultimately the interaction between the social and technical actors that caused there to be some oversight in the design and delivery process, which ultimately led to the semi-failure of this network. The 2011 Ford Focus Electric stands as an example for Ford to follow the decisions they made that were tactful, while also being aware of the ones that were not. Overall, it has set the scene for Ford's success today in the EV industry and serves as a lesson learned for any company or team undergoing such a massive transition.

Conclusion:

The insights gained by analyzing the actor-network developed for the 2011 Ford Focus Electric serves as proving grounds for the Virginia Formula SAE Team to better understand the transition from an ICE to EV vehicle begins. It is important to clearly identify and understand the interaction that takes place between social and technical actors within the larger network and understand how social actors cause and insight certain technical decisions which could serve to help the team gain or overlook key features. For Ford, it was intelligent to begin by developing an electric powertrain for their existing ICE model; however, due to a tight deadline and overly ambitious agenda, there ultimately were key features in the car that were missing and that led it to be underperforming compared to competing models, even to its ICE counterpart. If Ford had recognized the clear limitations that they were running into when developing this car, unforeseen future issues could have been anticipated from the get-go.

It is extremely imperative to understand the social actors at play within the broader socio-technical network and understand how they might inform the technical actors. For future studies

like that of the 2011 Ford Focus Electric, understanding this interaction is ultimately what aids in making informed decisions that will not lead to further detriment of the network.

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