Market entry strategies for electric vehicle start-ups in the automotive industry – Lessons from Tesla Motors

V. J. Thomas[1,]* and Elicia Maine[2]

[1]The University of the Fraser Valley, Abbotsford, Canada

[2]Simon Fraser University, Vancouver, Canada

Abstract

The entry and growth of Tesla Motors has produced enormous change in the automotive industry. What lessons can alternative energy start-ups learn when considering entry into an established industry? Reviewing the innovation management literature, we examine the emergence of Tesla Motors and analyze its commercialization of electric vehicles through an in-depth case-study. We draw on extensive secondary data and construct a performance trajectory depicting Tesla's entry into the automotive market, to demonstrate that Tesla Motors has not followed a disruptive innovation strategy. Instead, Tesla's commercialization strategy is explained through the lens of Architectural Innovation and the Attacker's Advantage. Implications are provided for new entrants.

Keywords

Disruptive innovation; Technology entrepreneurship; Commercialization strategy; Architectural innovation; Attacker's advantage; Clean technology

*Corresponding author

1.0 Introduction

Climate change is widely recognised as a serious and growing challenge facing society (Li et al., 2019). A major contributor to climate change is automotive vehicle emissions (Batur et al., 2019). Existing automotive technologies generate several noxious emissions which can lead to changes in the environment around us. A solution to this problem can be the rapid adoption of alternative energy technologies such as batteries and fuel cells by automotive manufacturers (Peters et al., 2017; Ma et al., 2012). However, the incumbent automotive industry has significant sunk costs in existing technologies such as internal combustion engines, and has limited incentives to change. For example, GM who designed and manufactured the EV1 abandoned their commercialization efforts (Baer, 2014; Black, 2009). Neither is the environment welcoming to technology start-ups who have to challenge entrenched industry incumbents. If we look at the history of the automotive industry in North America (the leading market for passenger vehicles), hardly any start-ups have survived in this highly competitive market place over the past century (Baer, 2014). Thus, it is very unusual to note the emergence and growth of Tesla Motors, an alternative energy start-up which has grown into a significant manufacturer of battery electric vehicles in North America.

Tesla Motors recently became the most valuable automotive manufacturer in North America by market capitalization (Lambert, 2017). Though this achievement has been dismissed as an overreaction by the market, investors and its own CEO, Elon Musk, the fact remains that Tesla Motors has become a major player in the automotive industry, and is now the pre-eminent battery electric vehicle manufacturer in the world. In this paper we conduct an in-depth case study, drawing on archival sources, company documents, government data, publicly available interviews and presentations of both the founders and the top management of Tesla Motors, to identify strategies followed by this technology start-up to gain successful market entry into one of the most competitive automotive markets in the world. Further, we analyse this case drawing on relevant innovation management frameworks to develop recommendations for alternative energy start-ups in the automotive industry.

Worldwide motor vehicle production is over 90 million vehicles per year, with half of that production stemming from the top 6 incumbent firms (OICA, 2016). The most recently founded of those top incumbent firms was Nissan, founded in 1967, whereas GM and Ford have over a century of experience in automotive manufacturing. Such industry concentration has led the incumbents to be complacent and resistant to change, despite policymaker pressure to reduce carbon emissions and the opportunity provided by alternative energy technologies (Hall and Kerr, 2003; Van den Hoed, 2007; Dijk and Yarime, 2010; Ahmadi and Kjeang, 2015). Strong barriers to entry such as design capabilities, manufacturing facilities, and distribution networks, have deterred new entrants (Porter, 1980; Helfat and Lieberman, 2002). However, with Tesla demonstrating that battery electric vehicles can look stylish, provide acceptable range, and boast sports car rates of acceleration, more and more car buyers are moving towards purchasing their first electric car. With nearly 400,000 pre-orders for the Tesla Model 3, the mainstream market is broadly accepting an electric vehicle for the first time (Lambert, 2016).

Technology management scholars, along with new entrants into the automotive sector, are keen to learn lessons from the commercialization strategy of Tesla Motors. Some authors have argued that Tesla has followed a disruptive strategy (Hardman et al., 2013, 2015), and thus that Christensen's advice on disruptive innovation strategy should be followed by other prospective entrants. In this paper, we focus on the following research questions: Is Tesla Motors' disruptive? How has Tesla Motors been able to enter a highly contested market dominated by well-entrenched incumbents? What market entry and innovation management lessons can new entrants learn from Tesla Motors' successful foray into the mainstream automotive market?

This paper is organized as follows: first, the relevant innovation management literature is reviewed. Next, a case study of the founding, product development and growth of Tesla Motors is presented. Tesla's commercialization strategy is then analyzed through the lens of disruptive innovation and, subsequently through a broader innovation management lens, drawing on the relevant strategies of architectural innovation and the attacker's advantage. We discuss our findings in the context of the literature, and draw implications for new entrants. We propose that new ventures seek to disadvantage well-entrenched incumbents by choosing product and distribution strategies which confront them with architectural innovation and by creating a novel value proposition which supports an attacker's advantage.

2.0 Literature Review

How should start-ups entering established markets launch products in the face of competition by well-entrenched incumbents? The innovation management literature has generally cautioned start-ups to avoid direct confrontation with incumbents who have design, manufacturing, distribution and regulatory advantages (Teece, 1986; Porter, 1980; Christensen, 1997; Gans and Stern, 2003; Maine, 2008). Many management scholars seek to identify the contingent factors which most greatly impact successful value creation and capture. By distilling only those factors which are most relevant to success, theories and frameworks are created which can usefully guide market entry and commercialization strategy. Three relevant innovation management frameworks are reviewed in this section.

2.1 Disruptive Technology

Clayton Christensen's concept of disruptive technology (Christensen, 1997) described why successful incumbent firms failed when confronted by an innovation which met certain conditions. This innovation management framework was so successful because it was adopted by start-up ventures to increase their chances of successful entry, and was studied by large incumbent firms, to mitigate the factors which led them to be vulnerable to disruption.

The theory of disruptive technology was based on Christensen's in-depth analysis of the disk drive industry over three generations of major shake-ups of incumbent manufacturers (Christensen, 1997, 2006). He and his co-authors expanded the theory of disruptive technology to many other industries (Christensen et al., 2015). Christensen observed that successful smaller entrants generally chose to launch products with inferior performance in low-end or new markets which were not of interest to the incumbents. Due to the nature of incumbents to listen to their most profitable customers, Christensen found that incumbent firms consistently preferred to manufacture products which targeted the higher end and more profitable segments of a market. Meanwhile, low-end or new markets, ignored by the incumbents, were the segments new entrants targeted as beachhead markets to generate revenues. Small markets which are generally underserved by the larger incumbents due to lower profitability are also known as beachhead markets (Christensen, 1997 & 2006). As they gained experience, these small start-ups were able to rapidly improve the performance of their products along key performance attributes of value to the buyers in each segment. This enabled them to move *upmarket* towards segments of higher profitability ultimately competing with the incumbent firms in mainstream markets. Christensen described the prevalence of this phenomenon of *Disruptive Technology* – later referred to as *Disruptive Innovation* - in multiple industries over long periods of time.

Extant disruption research has argued that new entrants enter markets which are low-end or are previously unserved, they are able to do gain a foothold in a beachhead market, with products which underperform on attributes most valuable to customers in the mainstream segment, and which are usually low cost (Christensen, 1997; Christensen et al., 2015). Of late, some scholars have argued that disruption may also occur in high-end markets (Sandstrom, 2011; Furr and Dyer, 2015) and move downwards towards mainstream markets. While some business to business (B2B) examples have been provided in a few sectors, there remains no clear answer why incumbents fail to respond to a new entrant seeking to enter their most profitable segments. It is also not clear why the most discerning customers in these high-end market segments would adopt the offerings of new entrants which may underperform on several performance attributes. Thus, further research is needed to understand how new entrants can approach high-end markets which are the main focus of incumbent firms.

2.2 *Product Market vs. Market for Ideas*

Further innovation management frameworks were developed which explicitly guide market entry and commercialization strategy decisions for new entrants seeking to launch an innovation in an established industry. Building on David Teece's (1986) Appropriability Framework guiding value capture from innovation, technology entrepreneurship scholars Joshua Gans and Scott Stern developed a framework (**Figure 1**) informing the entrepreneurs' decision to operate in the product market (i.e. manufacture products, market them, distribute them) or in the market for ideas (i.e. commercialize your product through licensing the rights to it). The factors which matter are whether the "incumbent's complementary assets contribute to the value proposition of the new technology" and whether "innovation by the start-up preclude[s] effective development by the incumbent" (Gans and Stern, 2003). The combined answers to these questions lead to distinct commercialization recommendations, as depicted in the four quadrants of **figure 1**. If the answer to both questions is no, Gans and Stern (2003) argue that the start-up should enter the product market, looking for an "**Attackers' Advantage**" by establishing technological leadership, entering niche markets and by investing in complementary assets which reinforce a novel value proposition (top left hand quadrant of **figure 1**). In **greenfield competition**, start-ups have the opportunity to chose between contracting and product market entry and to use temporary monopoly power to build future positioning (Gans and Stern, 2003). In the cases of new technology reinforcing the complementary assets of the incumbent, **reputation-based ideas trading** and **ideas factory** are two strategies that start-ups may engage in to take their technology to market. Start-ups would want to work with established firms but imitation risks and bargaining power remain challenges (Gans and Stern, 2003).

Insert **Figure 1** here

Recently, Marx and Hsu (2015) have critiqued this framework for assuming a single binary choice, and argue that, in some sectors, tracking this choice over time is important. For example, the survival and ability of firms to capture value in an industry sector is influenced by industry architecture (Jacobides et al., 2006; Pisano and Teece, 2007), which evolves over time as firms specialize to greater degrees. Firms which are able to control bottlenecks in value chains may acquire a disproportionate "piece of the pie" (Jacobides and Tae, 2015). Such ability generally comes from firms with extensive resources and capabilities, though smaller firms may also be able to shape industry architecture to their advantage, typically in new sectors (Pisano and Teece, 2007).

2.3 *Transilience Map*

Building on prior research (Utterback and Abernathy, 1975), innovation management scholars asked the question: what causes incumbent firms to have difficulty with innovation? William Abernathy, along with Kim Clark, developed a typology to demonstrate when innovations caused most difficulty for organizations (Abernathy and Clark, 1985). Abernathy and Clark named this typology the **Transilience Map** (**Figure 2**) and identified two variables: 1) are technology and production competencies overturned by the innovation? and 2) are market and consumer links overturned by the innovation?

Insert **Figure 2** here

The Transilience Map, depicted in **figure 2**, categorized innovation management challenges for incumbent firms into four quadrants, based on these two variables. 1) **Regular Innovation** – here the incumbent does not experience many challenges because the innovation builds on technology and production competencies already resident in the organization, and will be sold into familiar markets, leveraging existing customer relationships. 2) **Revolutionary Innovation**– here the markets and customers remain established, but the technology and/or production competencies are overturned. This can present problems for incumbent firms, in that they may need to build new technology and production competencies, through hiring and re-education, leading to less of an advantage over a new firm. Still, the familiarity with market segments and existing customer relationships help the incumbent 3) **Niche Creation** – here the innovation builds on technology and production competencies already resident in the organization, but is targeted at markets unfamiliar to the firm or requires the creation of new customer linkages. 4) **Architectural Innovation** – here both the technology and production competencies are overturned and the innovation is targeted at markets unfamiliar to the incumbent firm or requires the creation of new customer linkages. This category of architectural innovation (top right hand quadrant of **Figure 2**) is thus the most difficult for an incumbent firm to accomplish and offers the most strategic conditions for a start-up venture to challenge an incumbent firm.

These frameworks from the innovation management literature can be applied to shed further light on the factors which enable or constrain market entry in a highly contested industry.

3.0 Research Methods

The unusual success of Tesla Motors in commercializing electric vehicles offers a unique opportunity to examine a technology start-up which has been able to establish a significant foothold in the highly competitive automotive industry. Case studies are particularly well-suited to develop an understanding of such evolving phenomena in emerging industries (Eisenhardt, 1989), and are particularly appropriate in addressing "how" and "why" questions (Yin, 2016), such as our main research question "how was Tesla been able to enter a highly contested market dominated by well-entrenched incumbents?". Case studies of "extremes" or "outliers" can offer valuable insights into the phenomena under study, as investigating such exemplars can shed light on nuances not easily observed in more standard cases (Pettigrew, 1990). We study the market entry strategies of Tesla Motors in the United States as a means to develop guidelines for technology start-ups in the emerging alternative energy vehicles industry. In doing so, we adopt a pragmatist world view which calls for applying methods relevant to the research questions identified (Yin, 2016). The pragmatist world view seeks a middle ground between the constructivist and the positivist world views (Yin, 2016), recognizing that "there may be causal relationships but … these relationships are transitory and hard to identify" (Teddlie and Tashakkori, 2009, p. 93). Operational tasks for conducting qualitative research in the middle ground can include strategically selecting material, keeping [both] the forest and the trees, acknowledging mutual influence and being pragmatic (Ellingson, 2013).

We begin by collecting secondary data on the genesis, founding, product development and strategic decisions of Tesla Motors through company documents, Security Exchange Commission (SEC) filings, published interviews of the leadership team, and publicly available information on the company weblog. This data is supplemented by in-depth searches for research papers, magazine articles and case studies on Tesla, its competitors, and technology suppliers. For key performance metrics and the context within which they exist, we gathered secondary data on the total range of all electric vehicles introduced in the US market from the US Department of Energy (www.fueleconomy.gov). Data on internal combustion engine vehicles at the luxury, main stream and low end of the market were collected. Vehicle acceleration data for all electric vehicles were obtained from publicly available websites such as zeroto60times.com and insideevs.com. Data on financing rounds was compiled from SEC filings, Tesla press releases, and Crunchbase.com. Reliability of a study demonstrates that the operations of a study – such as data collection – can be repeated with the same results (Yin, 2018). Collecting publicly available secondary data from a variety of sources (including government, regulatory agencies, and company websites), along with email interview data from the founder-CEO allows us to engage in data triangulation to mitigate concerns about the reliability of the study.

To test the disruptive innovation explanation for the successful market entry of Tesla Motors, we compare and contrast electric and internal combustion engine vehicles introduced in North America, analyzing them through a performance trajectory of their acceleration and the evolution of their range over time. Performance measured by acceleration and range have been found to be among the most common technical factors affecting EV adoption in both qualitative studies and large sample quantitative surveys across multiple nations (Rezvani et al., 2015). In addition to secondary data from multiple sources, we have email interview data from Martin Eberhard, the founder-CEO of Tesla Motors, who developed the initial business plan and led the commercialization strategy in the earliest phase of Tesla's growth, which is the focus of our study. After an initial correspondence and explanation of our purpose, we sent the founder-CEO of Tesla five detailed questions regarding our research questions and received over 1000 words of insightful response, which we have incorporated into the manuscript as corroborating evidence. Such email interviews, especially with individuals who are highly comfortable both with professional writing and with computer use, are a valuable source of qualitative interview evidence (Burns, 2010).

We further examine Tesla's commercialization strategy through the innovation management literature comparing the production, marketing and distribution capabilities chosen by Tesla Motors with those of North American incumbents. External validity deals with the problem of knowing whether a study's findings are generalizable beyond the immediate study, with such concerns being mitigated by incorporating "how" or "why" research questions (Yin, 2018). Other approaches we follow to address concerns about external validity and potential biases include soliciting feedback on our initial analysis through phone and in-person interviews with relevant industry professionals, through an active search for evidence from multiple sources, and through the use of numbers instead of adjectives when claiming something (Yin, 2016). These interviews were (approximately 30 minutes each) with two industry professionals with engineering design and business development experience. One of the interviewees has been in the automotive component design industry in California since before the time of Tesla's founding, with over 18 years of relevant experience including founding his own engineering design company and the other, currently a cleantech consultant with a consumer electronics and electric engineering background, had 16 years of relevant experience. In this manner, drawing on interview data with the founder-CEO of Tesla Motors, extensive secondary source data on range and performance, combined with published interviews and YouTube interviews (as a means of triangulation using multiple data sources, Yin, 2016) with other employees of Tesla in the early stages, we are able to develop a comprehensive understanding of the early years of Tesla Motors and how their commercialization strategy was developed.

4.0 Case Study Evidence

Although Tesla was founded in 2003, the electric vehicles they developed trace their roots back nearly three decades to the GM Impact concept car (**Figure 3**), and included development from two previous start-ups. **Figure 3** highlights the origins of the technology which formed the basis of the Tesla Roadster and also shows how Tesla was able to move forward with their own technology development in the early years. Alan Cocconi, an automotive engineer prominent in the development of the GM Impact electric concept car (while working at the California vehicle design firm, Aerovironment), founded AC Propulsion in 1992 (Eberhard, 2006a; Black, 2009). In 1996, the same year that GM launched the EV1, AC Propulsion demonstrated the 1st generation *tzero*, a battery electric vehicle with lead acid batteries and a total range of nearly 100 miles. The revolutionary drivetrain also enabled this prototype to accelerate rapidly from 0-60 mph in under 6 seconds, which was phenomenal for an electric vehicle at the time. It was this prototype that led Martin Eberhard to purchase a *tzero* in 2002 and to try to convince AC

Propulsion to manufacture and sell more of these vehicles. Notably, AC Propulsion also worked with several incumbent OEMs in the early 90s in developing EV components.

Using lead-acid batteries connected to a proprietary drivetrain, AC Propulsion's *tzero* was able to achieve a 0-60 mph acceleration of less than 4 seconds (Siry, 2009) and had a range of over 200 miles (Baer, 2014). These two characteristics addressed a long standing problem of electric vehicles, namely that they had a short range and needed frequent charging, and that the acceleration and top speed was nowhere close to that of comparable gasoline vehicles. The *tzero* completely changed that perception.

With investment and ideas from Eberhard, AC Propulsion further developed the *tzero*, creating a 2nd generation prototype, this time with lithium-ion batteries in 2003 (AC Propulsion, 2003) (**Figure 3**). Independently, both Martin Eberhard and Elon Musk approached Tom Gage, the CEO of AC Propulsion, to sell the *tzero* to them (Black, 2009). Realizing the huge potential of this technology, both also offered to help AC Propulsion manufacture these high speed, long range battery electric vehicles (Siry, 2009). Tom Gage and AC Propulsion were not interested in manufacturing automobiles, viewing themselves primarily as technology developers who could license their technologies to interested parties (Morris, 2014).

Insert **Figure 3** here

Martin Eberhard and Marc Tarpenning – who had earlier co-founded a successful consumer electronics venture *NuvoMedia* together - formed Tesla Motors in July 2003, licensing the technology from AC Propulsion (Baer, 2014). Elon Musk joined as the main investor for the Series A funding in early 2004. Martin Eberhard had realized that earlier attempts to commercialize electric vehicles had assumed that buyers were highly cost-conscious and would not mind the short range, the limited acceleration, or the boxy looks of the vehicles – which had more in common with golf carts than with standard gasoline vehicles. In contrast, Eberhard believed that eco-friendly technologies should be initially commercialized as premium products targeted to wealthy buyers keen to make a social statement:

> I tried to understand why past EV attempts had failed. One of the glaring mistakes made by practically every prior EV program was to try and enter the market at the low-end - trying to make a low-cost vehicle that would be affordable to "everyone." This seemed insane to me. Almost every new technology that has ever come along (flat screen TVs, smart phones, refrigerators, cars themselves, etc., etc.) starts out as an expensive "luxury good", and works its way down market as the technology improves, as production volumes increase, as the manufacturer learns how to make the product. (Eberhard, 2019).

He believed this market entry strategy to be the only way a new and small entrant could succeed:

> This is particularly true in a field so mature as the automobile industry. A small company will pay double or triple for every single component in a car (I mean the stuff that's in every car, like seats, airbags, brakes, wheels, paint, carpeting, etc.) compared to a high-volume, mature OEM. On top of that, the EV-specific technologies (batteries, motors, inverters) will be expensive because they are new (Eberhard, 2019).

The initial business plan for Tesla Motors thus emphasized targeting high-end buyers with a top-of-the-line battery electric vehicle called the Roadster with a 0-60 mph acceleration of under 4 seconds. This was comparable to the high-end luxury cars such as Lamborghini, Bugatti or Ferrari, priced well over a million dollars (Baer, 2014). The Roadster in comparison was priced in the range of US$110,000.

The automotive industry is extremely capital-intensive and launching a new model costs nearly a billion dollars (Shea, 2010). Typically, car manufacturers spend four years refining the designs of new models to ensure that they match or exceed the multiple regulations for each component in various countries and regions. Given economies of scale the industry has coalesced into a few large manufacturers with very few companies being formed. The last automobile manufacturer- prior to Tesla Motors - which went public in the US was the innovative Tucker Corporation, which raised an IPO in 1947 and was bankrupt by 1950. By the 1960s, the "Big Three" of Ford, Chrysler, and GM dominated the US market with 90% of market sales (Wards Auto, 2017). Although imported vehicles from Europe and Japan subsequently eroded the market share of the "Big Three," no other domestic firms were engaged in mass production of automobiles. Thus, when these established incumbents, some with nearly a century of experience, learned of Tesla Motors' plans, they were highly skeptical.

The Big Three had not fully accounted for the impact of the change in the structure of the automobile manufacturing industry. At the dawn of the automotive industry in the early 1900s, most, if not all, of the manufacturing was done in-house. However, as this industry evolved, particularly post-1980s, specialized manufacturers arose who manufactured and supplied critical components like windshields to the large incumbents like GM, who then assembled the components, branded and distributed them through their vast network of automotive dealers (Pilkington and Dyerson, 2002). OEMs held in-house core competencies in automotive design, engine design, high volume automotive production, branding, and financing.

The founders of Tesla Motors realized that they could benefit from the changed industry structure and outsource the manufacturing and assembly of most of the standard components to these specialist manufacturers, thus avoiding the initial capital expenditure of setting up their own manufacturing plant (Baer, 2014). This approach also compensated for the founders lack of automotive industry experience (Taylor, 2006). Lotus Cars, a specialist manufacturer in the UK who had their own high speed vehicle called the Lotus Elise, was willing to assist with the design of the Tesla Roadster and with the assembly of the vehicle at their UK plant (Eberhard, 2006b). Thus the Tesla Roadster was based on the initial powertrain technology licensed from AC Propulsion embedded in a modified version of the Lotus Elise. The carbon fibre / epoxy composite body designed for the Tesla Roadster by Lotus Engineering and employees hired away from Lotus into Tesla Motors UK, enabled smaller vehicle production volumes, higher end performance attributes, and design flexibility (Eberhard, 2006a).

Tesla also made conscious trade-offs on product attributes based on their beliefs about their target customer and the realities of being a new company with few production resources:

> I also realized early on that the sports car enthusiast - the kind of person who might buy an expensive 2-seater - would be more willing to accept creature comfort deficiencies than the average driver - so long as the car delivered on its sports car promise: great driving experience and sporty looks. I recognized that, as newcomers to the automotive industry, and as a low-volume manufacturer, we would need to compromise on creature comforts on our first car - such as an off-the-shelf (aftermarket) infotainment system, simple, barely-adjustable seats, lower-quality fit-and-finish, difficult ingress and egress etc. (Eberhard, 2019).

They prioritized performance through acceleration and a focus on increasing range so that the Roadster would stand-out as a distinctive electric vehicle at the high-end of the market appealing to performance enthusiasts. As assembly of the Tesla Roadster began, several problems cropped up. The design of the Roadster was modified by Elon Musk, who felt strongly that the vehicle was not just a technology demonstrator but was a style statement by the buyers. Thus, he wanted the Roadster to meet or exceed the design cues of existing cars (Baer, 2014). This necessitated several costly modifications, for which Musk brought in replacement CEOs Michael Marks and Zeev Drori, who were experienced in manufacturing scale-up and cutting costs, though not in the automotive industry. Though very costly and time consuming in the short term, these interventions paid off, and established Tesla Motors' reputation.

Following the launch of the Roadster in 2008, Tesla acquired its own factory in Fremont, California, purchasing the GM–Toyota NUUMI facility in 2010. Initially retrofitting a small part of the NUMMI factory with innovative manufacturing equipment and extensive automation, Tesla Motors launched the aluminum-bodied Model S sedan in 2012 (Stringham et al., 2015). High media interest and coverage contributed to the Model S's iconic status and has meant that Tesla has not needed to conduct traditional advertising. The Model S was priced in the premium segment and has led to the formation of a dedicated base of Tesla buyers and to a reputation for quality, innovative design, and exceptional customer service. The Model X SUV followed in the fall of 2015. The much anticipated Tesla Model 3, priced at US$35,000 in April 2016, has received nearly 400,000 orders (Lambert, 2016). The launch of each model has steadily been *downmarket* to larger market segments. The market capitalization of Tesla Motors rose from US$226 million at IPO in June 2010 (Crunchbase, 2016) to over US$50 billion in 2017 (Lambert, 2017), announcing itself as a legitimate competitor to the Big Three automotive companies.

4.1.1 Tesla Motors' key performance attributes - Acceleration

In the automotive sector, a key performance attribute perceived by consumers is vehicle acceleration (Rezvani et al., 2015). All luxury vehicles advertise the number of seconds it takes their new model to accelerate from 0 to 60 miles per hour. Faster acceleration is strongly associated with higher performance and is perceived to represent higher quality. Sport cars, such as Ferraris and Lamborghinis, epitomize this performance attribute.

Insert **Table 1** here

As a key performance attribute, acceleration serves to segment mainstream customers of automobiles into three main markets: Low-end, mainstream, and high-end. Evidence on the evolution of Tesla's commercialization strategy can be gleaned from the acceleration of their vehicle model releases over time. Tesla moved from performance attributes of acceleration aimed at the high-end market with their 2008 release of the Roadster (0-60 mph acceleration = under 5 seconds) and proceeded downmarket with the 2012 release of the Tesla Model S (0-60 mph acceleration = under 6 seconds), and then the release of the Tesla Model 3 in 2017 (0-60 mph acceleration = under 6 seconds) (**Table 1**).

4.1.2 Tesla Motors' key performance attributes - Range

Beyond rapid acceleration, Tesla Motors is also known for its long range battery electric vehicles. Range – defined as the distance a vehicle can travel without needing refueling or recharging – is a performance attribute that some have argued shows electric vehicles could follow a disruptive path (Pearre et al., 2011; Egbue and Long, 2012). This is because range has generally been a limiting factor for electric vehicles, and of great concern to customers (Dijk and Yarime, 2010), particularly while rapid recharging stations are still not widely available.

Table 2 depicts the EPA certified total range of all-electric vehicles (launch, prototype or announced) between 1996 and 2016. The first mass produced all-electric vehicle was the GM EV1 (based on the GM Impact concept car) with lead acid batteries and a total range of about 55 miles in 1996 (Black, 2009; Baer, 2014). Even though customer reaction was positive, GM as an incumbent determined that the success of this battery electric vehicle would erode gasoline car sales and also the highly profitable spare parts business, as electric vehicles had fewer moving parts and thus lower maintenance costs (Baer, 2014). Similar pressures were felt by other automotive incumbents. **Table 2** provides evidence of the limited and delayed development of electric vehicle technology by incumbent automotive companies across the world. As an example, Honda which had achieved a range of 81 miles with its Honda EV plus in 1999, had a range of only 82 miles for the Honda Fit EV in 2015 (US Department of Energy, 2016). Other incumbents, such as Ford, Nissan and Mitsubishi were late to the market on EV technologies. The rapid growth of Tesla spurred these incumbents to start launching their own electric vehicles, though the range figures (almost all below 100 miles) show that they are well behind Tesla vehicles (which are over 200 miles with some Tesla models nearly reaching 300 miles of range). Through this focus on superior performance attributes Tesla has continued to grow in the highly competitive automotive market with well-entrenched incumbents.

Insert **Table 2** here

Tesla followed the bold commercialization strategy of targeting the high-end of the automotive market with their first product, the Tesla Roadster, sold at a price of over US$110,000 and superior performance attributes (Brown, 2016) (**Figures 1** & **2**, **Table 2**). The first Tesla Roadster launched in 2008 with a range of the Tesla Roadster was 245 miles, slightly higher than the 2nd generation *tzero* (**Table 2**). Continually refining its technologies through incremental innovation, Tesla moved downmarket, commercializing their Model S in 2012 and their Model X in 2015, both priced in the range of US$70,000, initially with slightly lower performance attributes (**Table 1**, **Table 2**). The Tesla Model 3 was unveiled at a price of US$35,000, targeting the mainstream automotive markets across the world. What is striking is the move downmarket and the use of high-end, low volume production to generate revenues to support the development of the Model 3 for the mainstream automotive market. Elon Musk has argued that this was the only way Tesla could have gained a foothold in the highly competitive automotive industry (Musk, 2006).

4.2 Tesla Motors' technology and production competencies

Key components of Tesla Motor's vehicles and the company which held the associated technology and production competencies are depicted in **table 3**, along with the existing component technology competency held by the large automotive incumbent firms. The Big Three automotive incumbents have considered engine design, development & production, and body design & production to be core competencies to be retained in-house. Notably, Tesla, as a start-up, did not have all of these technology and production competencies in-house. Instead, as detailed in section 4.0 of this paper, they in-licensed the superior EV power system and charging system of AC Propulsion. For Tesla's first model, the Roadster, they leveraged the design and assembly experience of Lotus Engineering (**Table 3**), in particular for their development of the lightweight carbon fibre / epoxy composite vehicle body. In later assembly – with the models S and X– Tesla built their technology and production capabilities around innovations in aluminum automotive bodies – including hydroforming and tailor welding – which brought distinctive design possibilities and light weight advantages, contributing to both key performance attributes of acceleration and range.

Insert **Table 3** here

The incumbent automotive OEMs were constrained by their in-house design of internal combustion engines (ICEs) and by their predominant reliance on steel body-in-white vehicle design and production competencies. For example, the Ford Focus Electric, designed around the needs of a traditional internal combustion engine vehicle, is not optimized for an electric vehicle power system. And, although Ford also developed the capability to design aluminum frame vehicles, their core design and manufacturing competencies are still rooted in Steel Body-in-White production. Choosing to share a vehicle platform with the traditional ICE Ford Focus limits the acceleration and range of the Ford Focus electric (**Table 2**).

Underpinning and reinforcing technology and production competencies are the values, managerial processes, and skillsets of the firm (Leonard-Barton, 1995; Maine, 2008). In the case of the incumbent automotive OEMs, these processes all undermined successful development and sales of EVs. As explained by Tesla founder-CEO Martin Eberhard:

> Take a look at the BMW i3 as an example. BMW makes a lot of beautiful cars. And they also make the i3... One thing that is absolutely certain about the i3: a customer who is considering this car was never considering buying a (highly-profitable) 3-series or 5-series BMW. The i3 was designed so as not to cannibalize their profitable car lines at all. This mentality naturally permeates all of the car manufacturers. The only reason any of them made EVs (before the California ZEV mandate was gutted in 2002) was because they were required by CARB to do so, in order to also sell their petroleum-powered cars in California (and in the many other states that adopted CARB's rules) (Eberhard, 2019).

Organizational forces at the designer and product development levels led EV new product development teams at automotive OEMs to be overly constrained in their design choices. Thus, incumbent OEMs were essentially locked into their existing technology and production competencies by organizational processes.

4.3 Tesla Motors' customer linkages

Since the 1950s, US regulations have protected US automotive dealers by not allowing the automotive OEMs to compete with them (Crane, 2016). Thus, incumbent automotive OEMs are prohibited, in most US States, from direct distribution of their vehicles to end consumers. Lack of customer access and misalignment of incentives between automotive dealers and OEMs are believed to have slowed the adoption of alternative energy vehicles (Pilkington and Dyerson, 2002; Hall and Kerr, 2003; Crane, 2016). Elon Musk believed that automotive dealers were not properly incented or trained to effectively sell electric vehicles (Van den Steen, 2015). Importing ideas from the consumer electronics sector, Musk believed that high-end retail stores, owned and operated by the OEM, could be an effective marketing and consumer education tool (Falat and Holubcik, 2017; Mangram, 2012). The staff at these retail stores are incented to generate future interest in electric vehicles in general and Tesla in specific. They are also the customer-facing end of Tesla's high-end customer service. Tesla entered the automotive industry providing superior electric vehicles directly marketed and sold to customers in the high-end market segment.

Tesla's commercialization strategy includes both a network of retail stores in those US states which allow OEMs' to operate dealerships, lobbying to change regulations in those States which currently do not, and direct sales over the internet. To drive sales, Tesla again borrows from the consumer electronics industry in the excitement deliberately created by Musk around each new product launch. Beyond customer excitement, Tesla gathers paid pre-orders, which both reduce market uncertainty, and help finance production. The highly anticipated mass-market Tesla model 3 has garnered presales of nearly 400,000 vehicles, with US$1,000 deposits by customers (Lambert, 2016). Tesla continues to innovate in direct distribution, most recently establishing a mobile retail store which fits into a flat trailer bed (Hanley, 2015), with the intention of educating potential customers and driving sales in those regions which do not yet have a bricks-and-mortar retail outlet.

5.0 Analysis

Innovation management frameworks are useful when they guide strategy, giving firms, regions or nations better chances for value creation and capture. Disruptive Innovation is a useful framework to do just that, enabling new entrants to enjoy better odds of survival and success (Christensen et al., 2015; Hang et al., 2015). However, it is clear that the term is misused and vastly overused (Christensen et al., 2015). This is more than a problem of semantics, as the recommendations of an innovation management framework are only useful for firms meeting the conditions identified as relevant to the theory. Through our analysis we demonstrate that Tesla is not following a disruptive innovation strategy. Instead Tesla Motors pursued the attacker's advantage (Gans and Stern, 2003) against incumbent OEMs who were faced with architectural innovation (Abernathy and Clark, 1985). In this section, we discuss the findings and draw implications for new entrants.

5.1 Is Tesla Motors Disruptive?

A disruptive innovation is one that – on one or more performance attributes valued by an incumbent company's best customers – can be considered an inferior product. In fact, for a technology or business model to be disruptive, the incumbents need to consider that their mainstream customers would not have any use for the resultant product, because it just does not meet their minimal buyer purchase criteria. It is this rational rejection of the new technology or business model by incumbents, based on inferiority, which provides a head start to ventures following a disruptive innovation strategy (Bower and Christensen, 1995; Christensen et al., 2015). Most often, the margins obtainable from commercialization of the disruptive technology are also too small for the incumbent to consider the technology attractive (Bower and Christensen, 1995).

Disruptive innovation theory guides small firms to initially target small, beachhead markets which are generally underserved by the larger incumbents due to lower profitability. This helps the small firms to avoid head-on competition with established firms in their most profitable market segments. Disruptive technologies and business models initially underperform the established technologies and business models valued by the leading customers of incumbent firms. Logically, new product development resource allocation at incumbent firms will favour higher margin, higher performance, higher volume market applications (Cooper et al., 2004). Disruptive innovation theory argues that large incumbent firms are blind-sided by smaller disruptive firms because the internal resource allocation process at these large firms fails to value disruptive technologies (Christensen, 1997; Christensen et al., 2015). The e-bike industry in China is an example of small firms disrupting established motorcycle incumbents from below (Ruan et al., 2014).

Although it has been argued that Tesla Motors is disruptive (Hardman et al. 2013 & 2015; Furr and Dyer, 2015), we found that Tesla Motors chose to target high prestige, high margin, high performance market segments with new technologies and business models. Inferior performance along one or more key attributes would be consistent with a disruptive innovation strategy. This was not Tesla Motor's approach. To the contrary, Tesla entered the high-end of the automotive market with its first vehicle launch, the Tesla Roadster, competing head to head with incumbent luxury automotive brands, such as Lamborghini, on critical performance attributes such as acceleration (**Figure 4**).

Insert **Figure 4** here

In contrast, Kia, the Korean automotive manufacturer, followed a disruptive innovation strategy, entering at the bottom end of the market. In **figure 4** this is depicted by the performance trajectory at the bottom of the figure, showing Kia's entry with the low performance 1994 Kia Sephia GS model (0-60 mph acceleration = 10.1seconds) and gradual evolution upmarket represented by their 2016 Optima SX Limited 2.0T model (acceleration = 6.6 seconds).

In so doing, Tesla Motors' is not operating in low-end market segments, but in the high margin, high-end segments with much more established competitors. These high-end market segments are very important to incumbent firms, as they are the most profitable. So the question then becomes, how is Tesla able to challenge incumbent firms in their most profitable markets?

5.2 Tesla Motors' Market Entry Strategy against Incumbent OEMs

Tesla Motors competed with differentiated products at the top-end of the automotive market. Conventional wisdom had it that electric vehicles could not compete in this luxury market. Why was it that the automotive incumbents did not expertly repel competition in this high margin market? We argue that it was because the Tesla Roadster electric vehicle and the technology components within that vehicle represented **Architectural Innovation** (Abernathy and Clark, 1985) for the large incumbent automotive OEMs. Tesla Motors, as a new venture, did not have existing technological competencies nor existing customer linkages, and thus were not constrained in the ways that the incumbents were.

To illustrate how producing compelling electric vehicles represented architectural innovation to the large incumbent automotive firms, we explore the dimensions of the transilience map (**Figure 2)**. Architectural innovation is challenging for incumbent firms, as it involves both overturning existing production and technology competencies, and also overturning existing customer linkages (Abernathy and Clark, 1985). We first demonstrate how Tesla made its bet on component technologies which challenged technology and production competencies at the incumbent automotive OEMs. Next we describe how Tesla also created entirely new linkages to the US automotive customers.

Tesla Motors succeeded where so many other ventures had failed because they placed the incumbent automotive OEMs in a disadvantaged position. The incumbents were faced with **Architectural Innovation** (**Figure 2**). By competing with the incumbents on an innovation that did not utilize the core complementary assets of the incumbent automotive OEMs (**Table 2**), and, in fact, undermined those assets in both technological and market domains, Tesla neutralized the

OEM's advantage and capitalized on their organizational constraints to innovation. Tesla compensated for limited initial knowledge and skills in automotive manufacturing by leveraging supplier knowledge, much in the way Volvo designed their Desirée hybrid electric vehicle (Pohl and Elmquist, 2010). However, unlike the moderately successful innovation development at Volvo (Pohl and Elmquist, 2010) and Ballard's attempts to commercialize fuel cells as an automotive component supplier (Hall and Kerr, 2003; Van den Hoed, 2007), Tesla employed a top-down approach to creating the values, norms and managerial systems around the development and commercialization of alternative energy vehicles. In other words, Tesla created an advantage over the automotive OEM incumbents by designing their company culture, including production competencies and market linkages, around the design, production and sales of electric vehicles.

Tesla then followed the **Attackers' Advantage** strategy (**Figure 1**), which recommends that the venture should "enter the product market, looking for an "Attackers' advantage" by establishing technological leadership, entering niche markets and by investing in complementary assets which reinforce a novel value proposition" (Gans and Stern, 2003). Tesla's in-licensing of AC Propulsion's drive train technology, their alliance with Lotus Engineering, their opening of retail stores, their focus on user experience and their entry into the automotive market with the high performance Roadster all represent such a strategy. Unlike Marx and Hsu's (2015) observation that start-ups may initially build capabilities via collaboration through licensing, Tesla never veered from their product market strategy. Their strategy allowed them to both minimize the liability of newness and to avoid the constraints to radical innovation experienced by incumbents (Pilkington and Dyerson, 2002; Maine, 2008).

New ventures have an advantage in not being bound to the routines which constrain product development in incumbent firms. New ventures are more open and willing to experiment with new technology competencies and to interact with customers in new ways. This openness can help small, fledgling start-ups create a convincing value proposition. Tesla Motors' drew on the expertise of AC Propulsion and Lotus to build its first Roadster, along with consumer electronics practices and expertise in re-imagining the design, marketing, distribution and customer service associated with electric vehicles. In doing so, Tesla Motors' pursued the Attacker's Advantage against incumbent OEMs who were faced with Architectural Innovation.

Will Tesla be successful in overturning the regulations against direct distribution in the rest of the US states? University of Michigan Professor Daniel Crane argues that the current regulations do not protect customer interests, but rather those of the dealers, and, further, that the current regulations stifle innovation (Crane, 2016). Regardless of the remaining regulatory battles, Tesla Motors has succeeded in challenging the Big Three automotive OEMs by placing them in a position where they would need to shift their both their production and their marketing competencies – Architectural Innovation – in order to respond effectively to Tesla's challenge. The OEMs would need to overturn their existing customer and marketing linkages, in particular those through their franchised dealerships.

5.3 Implications for New Entrants

The innovation management literature has traditionally cautioned technology start-ups to avoid a direct confrontation with incumbents in their most profitable high-end markets. They suggest that start-ups initially seek low-end or new beachhead markets which are not of interest to larger incumbents. Using such low-end markets to build their capabilities, start-ups can later improve their performance and challenge incumbents in mainstream markets in future. Our analysis of the market entry and commercialization strategy of Tesla Motors suggests that this may not be the only way. Instead, our analysis shows that technology start-ups could also consider lesser known innovation management frameworks – architectural innovation (Abernathy and Clark, 1985) and the attacker's advantage (Gans and Stern, 2003) – when formulating their market entry and commercialization strategies.

Three implications can be drawn from our analysis. *First*, new entrants need to make an active choice between entering the product market (manufacturing strategy) or the "market for ideas" (generally licensing) (Gans and Stern, 2003; Bliemel and Maine, 2016). A manufacturing strategy makes sense when the incumbents' complementary assets cannot be directly leveraged in competing with the new technology and value proposition (left hand side of **Figure 1**). Licensing the rights out to incumbents makes sense in conditions for which the incumbent has a distinct advantage in leveraging their current complementary assets (right hand side of **Figure 1**). *Second*, if manufacturing is chosen, what choices should be made about marketing and distribution? Since incumbent firms are disadvantaged when they are forced to confront **Architectural Innovation** (Abernathy and Clark, 1985), with their existing production, marketing and distribution capabilities overturned (see **Figure 2**), new entrants should choose their manufacturing investments, marketing strategy and distribution networks accordingly. *Third*, when the incumbent could still attempt to imitate the new entrants' product offerings (such as in alternative energy vehicles production), a new entrant can create an **Attacker's Advantage** (**Figure 1**) by "establishing technological leadership, entering niche markets and by investing in complementary assets which reinforce a novel value proposition" (Gans and Stern, 2003). For example, Tesla Motors chose novel distribution channels, borrowed marketing and retail store sales concepts from the consumer electronics industry, invested in both novel assembly and lithium ion battery manufacturing facilities, and made significant investments in electric vehicle charging infrastructure.

6.0 Conclusions

Tesla Motors' successful entry into the notoriously entrenched automotive industry, repeated successful product launches, growth to a market capitalization of over US$50 billion, and redefinition of the electric vehicle market is inspiring to many. Management scholars, engineering scholars and entrepreneurs want to understand how to emulate Tesla's commercialization strategy. In this paper, we carefully analyse the commercialization strategy of Tesla Motors in the context of competing electric vehicle models and incumbent internal combustion engine vehicle manufacturers, demonstrating through performance trajectories and comparative performance attributes that Tesla has not followed a Disruptive Innovation strategy. Instead, we draw on the innovation management literature to show that Tesla Motors followed an attacker's advantage strategy, and capitalized on their competitors facing the challenges of architectural innovation when confronted with Tesla's novel value proposition. Such strategies can be replicated by other alternative energy start-ups.

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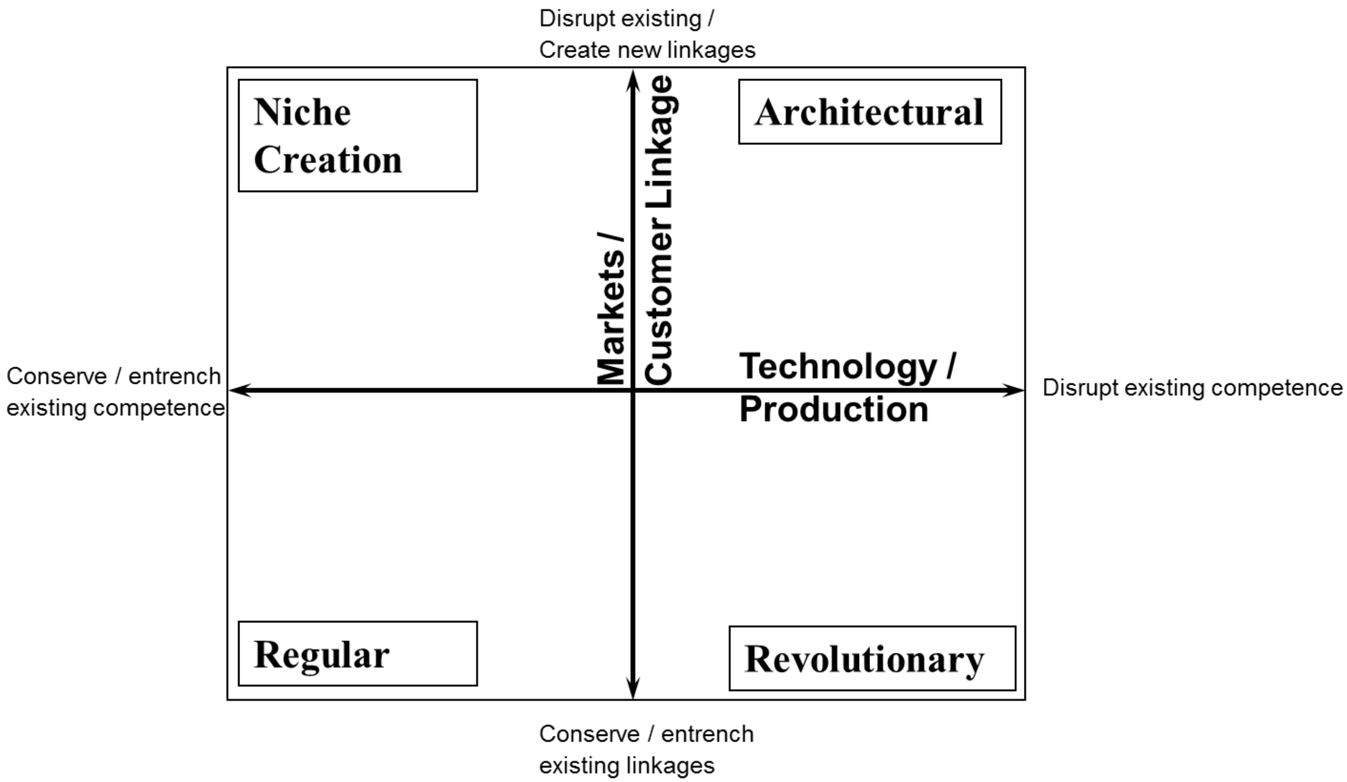
Do incumbents' complementary assets contribute to the value proposition from the new technology?

Can innovation by the start-up preclude effective development by the incumbent?		No	Yes
	No	Attacker's Advantage	Reputation-based Ideas Trading
	Yes	Greenfield competition	Ideas Factories

Figure 1: Attacker's Advantage

Source: Gans and Stern, 2003



Source: Abernathy and Clark, 1985

Figure 2: Transilience Map

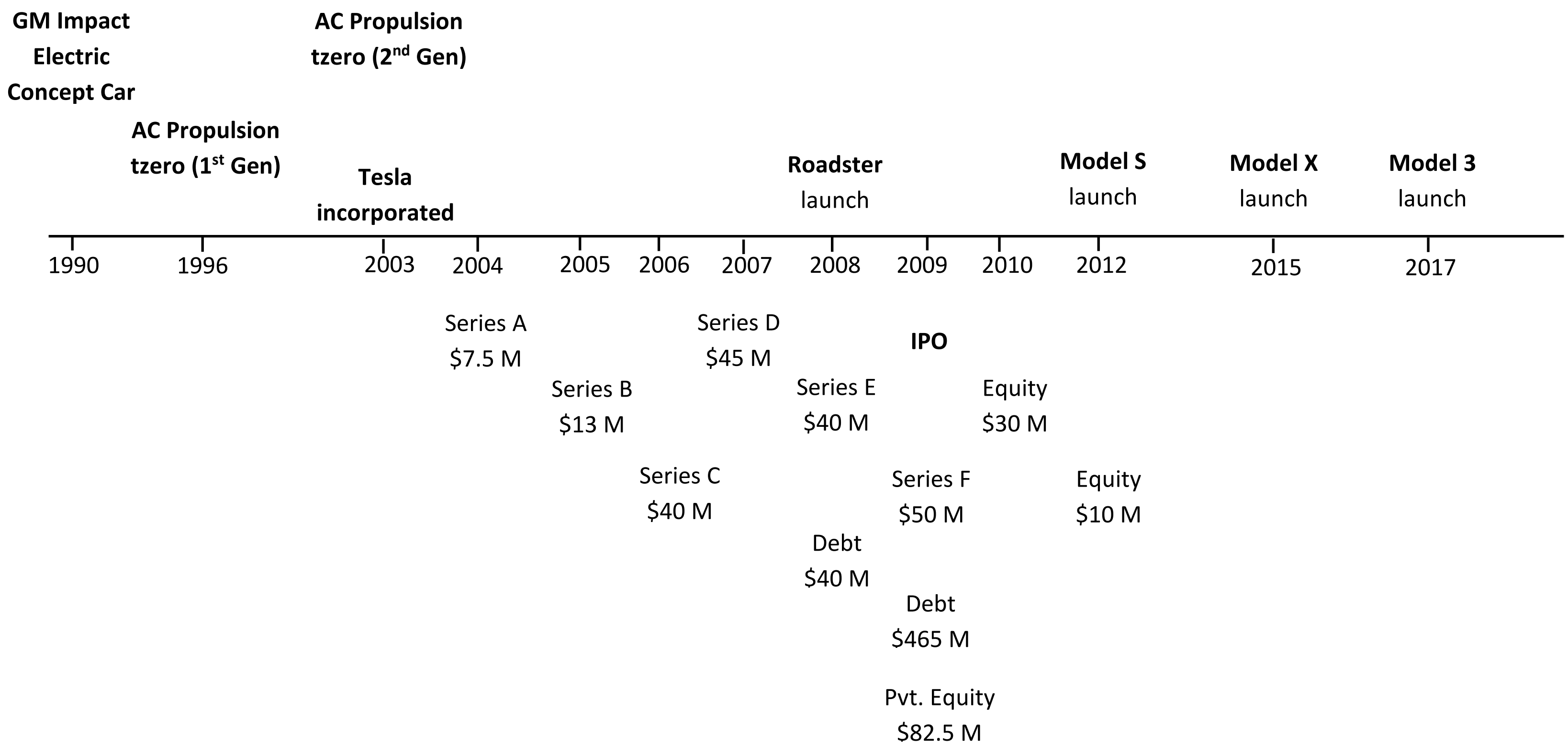


Figure 3: Tesla Motors' commercialization timeline

Source: Author's compilation from http://www.crunchbase.com (2016)

Table 1: Market Entry – Key Performance Attribute: 0-60 mph Acceleration (in seconds)

Model/ Year	Year of Launch	Acceleration
Tesla Roadster	2008	4.6
Tesla Model S	2012	5.9
Tesla Model 3	2017	5.6

Source: Author's compilation from https://www.zeroto60times.com/ and https://insideevs.com/

Table 2: EPA certified total range for all-electric vehicles (in miles)

Model/ Year	1996	2008	2012	2014	2015	2016
Tesla Roadster		245				
Tesla Model S			265			
Tesla Model S 70D					240	
Tesla Model S 90D						294
Tesla Model X 90D						257
Tesla Model 3						215
AC Propulsion *tzero* 1st gen (1996)	100					
AC Propulsion *tzero* 2nd gen (2003)		240				
GM EV1	55					
GM Chevrolet Spark EV					82	
GM Chevrolet Bolt EV (estimated)						200
BYD e6			122		127	
Toyota RAV4 EV			103	103		
MINI MiniE		100				
Kia Soul Electric					93	
CODA Automotive			88			
Mercedes-Benz B-Class					87	
Fiat 500e					87	
Nissan Leaf			73		84	
Volkswagen e-Golf					83	
Honda EV Plus	81					
Honda Fit EV				82		
Ford Focus Electric			76		76	
smart fortwo					68	
Mitsubishi i-MiEV			62			

Source: Author's compilation from US Department of Energy (2016)
https://www.fueleconomy.gov

Table 3: Key Components of Tesla Motors' Electric Vehicles vs. Automotive Incumbents

Component Technology	**Developing Company for Tesla Motors Vehicles**	**Automotive Incumbents' Component Technology**
EV Power System (Modules of Lithium Ion Batteries)	AC Propulsion (USA)	Internal Combustion Engine
Reductive Charging	AC Propulsion (USA)	Internal Combustion Engine
Vehicle Assembly (Roadster)	Lotus (UK) Carbon Fibre / Epoxy Composite body	Steel Body-in-White*
Vehicle Assembly (Model S, X)	Tesla Motors (USA) Aluminium Frame	Steel Body-in-White*

*Steel Body-in-White refers to the vehicle main structure or frame prior to painting or addition of sub-components like the engine or chassis sub-assemblies (Mayyas et al., 2011)

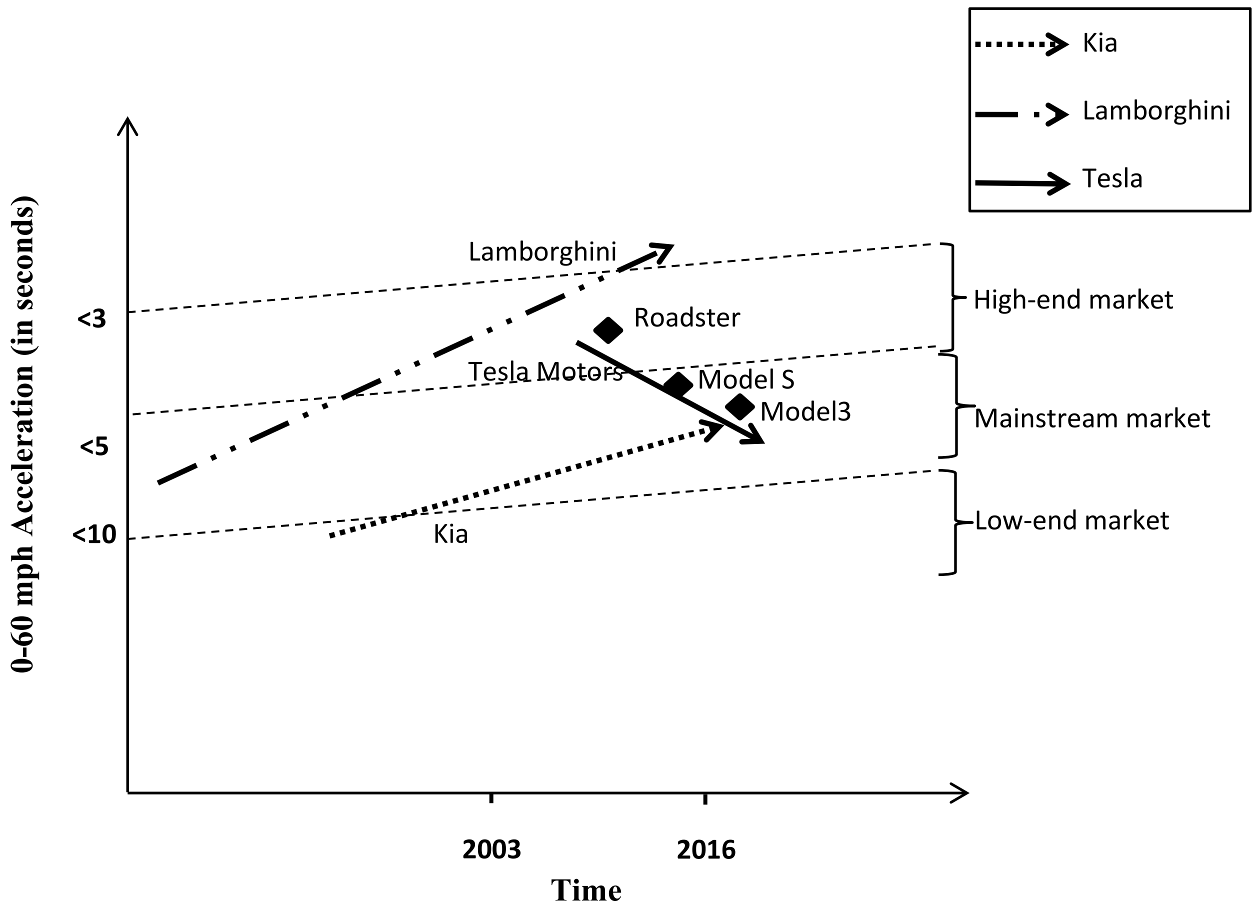


Figure 4: Examining Tesla Motors using a Disruptive Innovation lens

Note: This performance trajectory depicts the 0-60 mph acceleration of the fastest model (inclusive of internal combustion engine vehicles and alternative energy vehicles) of each firm over time.

The high-end, mainstream and low-end market segments are indicative and have been defined based on 0-60 mph acceleration data (in seconds).

Source: Author's compilation from https://www.zeroto60times.com/ and https://insideevs.com/