A Silicon Valley start-up in an established industry with large barriers to entry and resistance to change? The case of Elon Musk and Tesla Motors

by
Edward Stringham

The automobile industry’s high costs of entry, economies of scale, and network effects from distribution, fueling, and service lead many to conclude that potential new entrants have no chance. Tesla Motors, however, has overcome many barriers and is helping pioneer electric cars. Their cofounder and CEO Musk believes in reasoning using first principles to envision how markets might be rather reasoning using analogy of how they are. Musk believes in identifying economically feasible goals and implementing them rather than just thinking about them. Starting with partnerships for its first minimum viable product, Tesla is continually working to innovate and scale up. Tesla now produces one of the top selling luxury cars in the United States and has a market capitalization about twice that Fiat Chrysler and half as much as General Motors and Ford. Musk has shown that a Silicon Valley start-up can enter and disrupt the status quo in one of the most established industries.

(Keywords: reasoning from first principles, design iteration, agile, flexible, lean start-up, entry and innovation in mature industries, electric cars)

INTRODUCTION

Are certain industries so difficult to enter that they are destined for lower levels of entrepreneurship and innovation? If one looks at Porter’s five forces analysis, certain industries, like the automobile industry, seem especially immune to the threat of new entry and upstart competitors. Numerous factors that Porter identifies, including economies of scale, learning curves, access to distribution channels, patents, unrecoverable up-front R&D expenditures, and other capital requirements can serve as barriers to entry, and all of them seem to be present in the auto industry. Thirty-five years ago, Porter wrote, “In the auto industry economies of scale increased enormously with post-World War II automation and
vertical integration—virtually stopping successful new entry.”¹ At that time, General Motors, Ford, Chrysler (plus AMC/Jeep), Honda, Nissan, and Toyota constituted six of the seven top-selling car companies in the United States, and the same is true today.²

The high costs of entry in the auto market have led many to speculate that even if a better product existed, incumbents could successfully keep it off the market. A prime example is the electric car, which has long been a dream of those seeking to reduce auto emissions but a product that many considered as too difficult to introduce. The documentary *Who Killed the Electric Car?* suggests that electric cars benefit everyone for reducing emissions and improving air quality and are “a winner for consumers.” But it says that electric cars “are a threat to the profitability of the conventional gas-powered auto industry” so “economics and corporate power stopped California’s electric car program in its tracks.”³ Compared to gas-powered vehicles, electric cars lack a refueling infrastructure and a distribution and service network. To frame the problems using the language of potential market failure, introducing an electric vehicle means facing network externalities associated with electric cars (such as the need for new charging stations compared with the fueling stations that gas-powered vehicles already have) and high barriers to entry (such as the high fixed costs of introducing new technology and building the production capacity that incumbents already have).

Although innovation in an industry does not necessarily require new entrants (incumbents will and frequently do innovate whenever they can),⁴ new entrants often view industries in a totally different way and embrace such change. Yet entering certain industries is more difficult and that has the potential to affect outcomes in an industry. In 2014, one observer stated, “The higher the capital requirements, the higher the barriers to
entry . . . When there are high barriers to entry, then you don’t see new entrants, and you don’t see innovation. It’s really the new entrants are what drives innovation.” This observer was Silicon Valley entrepreneur Elon Musk, Tesla’s initial investor, cofounder, and CEO, who viewed all of the barriers in the auto industry as ones that could be overcome. Electric car company Tesla, founded in July 2003, produced its first car, a $110,000 Roadster, from 2008 through 2012; it has produced its second car, a $70,000 base price four door Model S since 2012; it is planning a similarly priced crossover for summer 2015; and it anticipates producing a $35,000 sedan for 2017. As Musk explains, “Our goal when we created Tesla a decade ago was the same as it is today: to drive the world’s transition to electric mobility by bringing a full range of increasingly affordable electric cars to market.”

Tesla’s long-run success, with or without current preferential tax treatment, is to be determined. Nevertheless, within twelve years, Tesla has created one of the top-selling full-sized luxury cars in the United States and has built a company with a market capitalization, about twice that of Fiat Chrysler and half of Ford or General Motors. (The 2014 year end market capitalization for Tesla, FiatChrysler, Ford, and General Motors were $28 billion, $12 billion, $60 billion, and $56 billion and average market capitalizations over the course of the year were $28 billion, 10 billion, $62 billion, and $55 billion.) Its Model S has won multiple car of the year awards and earned an all time top rating from Consumer Reports.

In this article we document some of the ways that that Elon Musk and Tesla have overcome barriers to enter the automobile industry and help pioneer electric cars. We gather information mostly from taped interviews, corporate documents, industrial and media reports, and personal interviews with people in Silicon Valley and the electric car industry including Tesla. Between the three of us, we have spoken with various people at
Tesla including Musk, but we do not have any close connection with them or financial stake in Tesla.\textsuperscript{6} We would be just as happy to see another company succeed, but we should admit we are impressed with Musk and Tesla’s achievements and think others can learn from them.

In an industry with many challenges, including large fixed costs, network effects, and incumbents that might prefer to preserve the status quo, Tesla is showing that a Silicon Valley start-up can overcome what many would have been considered insurmountable economics problems. Tesla also has relied heavily on alliances allowing Tesla to leverage expertise and infrastructure of other firms rather than having to constantly reinvent the wheel.\textsuperscript{7} It began by partnering with Lotus for its first minimum viable product and has since built its own production capacity by transforming an outdated 5.5 million square foot former General Motors and Toyota plant in Fremont, California, into a high technology production facility. Tesla is now attempting to address network effects in the electric car industry by building distribution, service, and charging centers and encouraging other firms to get into the industry.

Worries expressed in *Who Killed the Electric Car?* notwithstanding, start-ups care little about preserving the status quo and often want to dramatically change industry. Musk noticed that companies like General Motors were not developing electric cars as effectively as they could and that led him to enter that space. According to Musk, “the single largest macro problem that humanity faces this century is solving the sustainable energy problem—that is, the sustainable production and consumption of energy,” but rather than waiting for a solution, Musk stated, “the only way I could think to address that was with innovation.”\textsuperscript{8} Although electric cars do not necessarily reduce the consumption of fossil
fuels or emissions overall, they have the potential to, especially if lower emission power sources like nuclear become more widespread. Their battery storage also has the potential to draw from the grid at non peak hours or more effectively utilize intermittent energy sources like wind or solar.

Musk states that it is tempting to reason by analogy and infer that the market will be similar to how it exists now. But entrepreneurs are capable of bringing products to market that others did not envision. As another Silicon Valley entrepreneur, Steve Blank, has stated, “Capitalism is an evolutionary process where new industries and new companies continually emerge to knock out the old.” Following Schumpeter, Blank explains how “entry by entrepreneurs was the disruptive force that sustained economic growth even as it destroyed the value of established companies.” Despite the fact that many thought that electric cars could never compete with gas-powered vehicles, Tesla has shown that Silicon Valley-style thinking can help overcome entry barriers even in the most established of industries.

PERSPECTIVES ON ENTREPRENEURSHIP IN SILICON VALLEY

Bahrami and Evans write, “Silicon Valley is intensively competitive, continuously innovative, and lives with uncertainties about which there can be limited or no prior knowledge.” Although parts of the country and world are important sources of innovation, we think that Silicon Valley is the “capital of ‘technology’ in general” for a reason. As Musk stated, “Silicon Valley has evolved a critical mass of engineers and venture capitalists and all the support structure - the law firms, the real estate, all that - that are all actually geared toward being accepting of startups.” Silicon Valley has many people and many approaches,
but it has something of business culture and various authors have described aspects of it. This section describes some of Musk’s perspectives on entrepreneurship and relates them to business writings on Silicon Valley. We then discuss how Musk and Tesla have implemented the ideas in practice and summarize some lessons in Table 1.

We do not believe that any particular set of business writing fully describes or is completely consistent with what Tesla does, but we see a fair amount of overlaps and think that Tesla corroborates much of the writing about Silicon Valley. Many who write about Silicon Valley point out that markets are more open ended and dynamic than older structure-conduct-performance analysis that took snapshots of industry market share and assumed they would persist. Having a high market share in a market about to be displaced is not that valuable. To Bahrami and Evans the market is Darwinian process where firms need to constantly innovate and prune excess to survive. Musk’s former colleague Peter Thiel argues that entrepreneurs should avoid following trends and says that the most important entrepreneurs create new markets. To do this Musk maintains that one has to think about how matters could be rather than how they are. Musk advocates reasoning from first principles to think about what could exist, as opposed to reasoning from analogy to make inferences based on existing products. Musk explains:

The normal way we conduct our lives is we reason by analogy. We are doing this because it’s like something else that was done, or it’s like what other people are doing... Somebody could say, in fact people do, that battery packs are really expensive and that’s just the way they always will be because that’s the way they were in the past. But, no, that’s pretty dumb. Because if you applied that reasoning to anything new then you wouldn’t be able to get to that new thing. Like you can’t say ‘Nobody wants a car because horses are great and we are used to them and they can eat grass and there is lots of grass all over the place and there is no gasoline that people can buy so people are never going to get cars.’ And people did say that.
He states: “I think maybe some of the larger car companies are just trapped in their own history.”

Although Musk believes in theorizing about how things might be, Musk is a strong believer in coming up with ideas that can be implemented. Musk says although he admires Nikola Tesla, “on balance I am a bigger fan of Edison than Tesla, because Edison brought his products to market and bring those inventions accessible to the world.” Musk recommends “being focused on something that you are confident that will have high value to someone else.” He states, “A natural human tendency is wishful thinking. So a challenge for entrepreneurs is to say: what is the difference between really believing in your ideals and sticking to them versus pursuing some unrealistic dream that doesn’t actually have merit? Can you tell the difference between those two things?” At the end of the day Musk states “If the economics don’t work, you’re not going to have an effect on the future.”

Key economic constraints that pretty much every entrepreneur faces, including Musk who was a multimillionaire at the time, are limits in technology and initial capital. Although some entrepreneurs can invest a boatload before releasing their first product, such an option is rare and risky. Instead of attempting to design the ultimate product for initial release, authors like Ries, Blank and Dorf recommend starting with a minimum viable product and then expanding.14 Musk states, “The Tesla strategy has been the same from the beginning, which is to start out initially with a car that was expensive but low volume. It’s the only car that we could have really made and that was the Roadster sports car.” Musk explains how one must start small because of technology: “The reason for strategy is that in order to make any technology to mass market it takes time and you’ve go to go through major design iterations” and because of economics: “You also need
economies of scale, so you’ve got to have much bigger factories. In order to afford those factories you have to raise a ton money, and people will only give you money if you have shown some prior success. Otherwise they [look at you with a doubting look and] they don’t believe you.” Their goal was the bring a quality but niche car to market that could be “profitable on low volume”

As a firm is entering a market and updating its products, it must constantly seek feedback and figure out what customers really want. To Ries, Blank and Dorf entrepreneurs should constantly get out of the building to talk with customers and identify their needs. The goal is not to come up with a product that the entrepreneur personally prefers, but what consumers like most. Musk states, “Put yourself in the shoes of the consumer and say why would you buy it as a consumer?” Don’t assume that you know what is best and seek out constructive feedback, even if negative. Musk recommends, “Constantly seek criticism. A well thought out critique of whatever you are doing is as valuable as gold. And you should seek that from everyone you can, but particularly your friends. Usually your friends know what’s wrong but they don’t want to tell you because they don’t want to hurt you.” Musk recommends, “You at least want to listen very carefully to what they say and to everyone.” Musk states “It’s very important to actively seek out and listen very carefully to negative feedback. And this is something people tend to avoid because it’s painful, but it’s a very common mistake.” “I don’t say ‘Tell me what you like,’ I say ‘Tell me what you don’t like.’”

Musk states that entrepreneur should start with the premise that he does not know everything and is often wrong. Nevertheless he states, “your goal is to be less wrong” and that requires constant learning over time. A common practice in Silicon Valley is for firms test out ideas or product features and potentially improve them use iterated design. Cole,
Finster, and Weston highlight the importance of using iteration to strive for continuous improvement and continuous innovation, concepts that come out of the theories of Total Quality Management. Blank and Dorf recommend treating product development scientifically and breaking ideas into hypotheses (often using a business model canvas), testing hypotheses, and learning along the way. Ries represents the process with “build-measure-learn” loop (Figure 1) where the entrepreneur is constantly building, learning, and updating rather than writing and sticking to a 200 page business plan. When asked how they came up with the design and whether they used a focus group or designed it to Musk’s preferred look Musk states:

No, it’s literally just a series of weekly iterations with the design team. Every Friday afternoon I meet with Franz and the design team and we go over every nuance of the car: every bumper, every curve, every little tiny piece of the car, what’s right, what’s wrong, and that has to be filtered against the engineering needs and the ergonomic needs and regulatory requirements. There’s a lot of constraints. You can’t just make a car any old shape you want and meet all of the regulatory requirements, the five star crash safe and all that. It just requires a lot of iterative activity and caring about every millimeter of the car and that what results in a good product.

With many interdependent aspects of a car it would be difficult to come up with a good final draft without iterations over time, and with each revision, the team has the ability to learn and improve. Musk states, “I think it’s very important to have a feedback loop, where you’re constantly thinking about what you’ve done and how you could be doing it better.”

Bahrami and Evans describe the importance of being agile or flexible, and although companies might have ultimate goal in mind, they can be open to how to achieves goals or alter specifics along the way. Tesla is constantly testing the possibility of different ideas like having easily replaceable batteries, no small feat for batteries weighing half a ton. But let us consider somewhat simpler choices that they have made. One of the cofounders Eberhard
describes the process they used to first pick the Roadster’s lead designer and key aesthetic features of the Roadster. First they hired one designer to describe key features and solicit multiple sketches from other designers. Eberhard hung up the dozens of sketches from each designer and gave fifty people green and red sticky notes to place on features of the designs they liked or disliked. A high concentration of green sticky notes on one, helped Tesla select Barney Hatt as the lead designer to submit his next proposal. Eberhard and Musk liked most it, but eventually convinced him to alter the nose, which they thought looked a Pontiac Firebird. In another example, Musk described how his daughter complained how the Model S lacked a rear seat reading light calling it “the stupidest car in the world.” The car now has the light.

“Insert Figure 1 Here”

Pointing out these examples or similarities between other writings on Silicon Valley is not meant to trivialize the achievements of a multibillion dollar firm or suggest that Tesla should be written up in the next version of The $100 Startup. Although one could debate the extent to which the literature on superflexibility or the lean start-up fully describes Tesla, we believe it’s safe to say that terms like agile, flexible, and lean better describe Tesla than its Detroit rivals on almost every margin. Clumsy, rigid and bureaucratic do not describe this Silicon Valley firm. The above approaches have proven successful at many technology firms, but the billion dollar question was whether they could work in the auto industry.

CAN COMMON PRACTICES FROM SILICON VALLEY BE USED IN THE AUTO INDUSTRY?

Let us consider how the theories worked in practice. Large firms like GM and Ford have decades of experience, massive infrastructure, and large design teams that often
spend two to four years and billions of dollars to develop new models and update factories. Imagine doing all of that from scratch. Although he thought it was worth trying, even Musk considered the probability Tesla could successfully get into the auto industry to be one in ten and others were more critical calling it the next Webvan. As Musk described: “There were certainly many hiccups. That’s an understatement. More like choking to death and barely surviving. So it was difficult. Never having been in the auto business, it was impossible to predict all of the issues we would encounter ahead of time. So we knew it would be hard, but we didn’t know it was going to be as hard as it was.” Yet Musk believed in learning while doing and starting “doing something which requires low capital . . . and with the success of that, then take the capital and try plowing it into your second company. That’s what I did basically.” Musk parlayed his experiences and capital from cofounding firms like PayPal into running an auto company, and he also parlayed experience and capital from his first small-scale car to larger-scale ones.

Tesla states that its culture is to “move fast” and “constantly innovate,” and it has created a “direct feedback loop” that “accelerates development.” Consider the time and investment Tesla spent bringing its first two products to market compared with its more established rivals. Each company uses different accounting methods to assign overhead, costs of shared components, and other costs such as building refitting often massive factories, so precise comparisons between firms about the cost of developing new cars are not possible. Nevertheless, an apples to oranges comparisons is revealing. The cost of developing the Roadster and Model S were around $140 million and $650 million. Those numbers are much bigger than many other firms in Silicon Valley, but they are less than what Tesla’s Detroit rivals spent developing traditional vehicles:
• Chrysler Cirrus, $1 billion
• Chrysler Dodge Ram, $1.3 billion
• Chrysler Dodge Neon, $1 billion
• Chrysler LH, $1.6 billion
• Ford Escort, $2.5 billion
• Ford Mondeo, $6 billion
• GM Saturn, $3.5 billion

Although much of these costs include the cost creating production facilities that can build hundreds of thousands of units per year, the fact remains that a less than billion investment from Tesla has yielded a company currently worth $28 billion, and we doubt that any of the above investments added close to that in the market capitalizations of Chrysler, Ford, or GM.

Another revealing comparison is to look at how General Motors spent developing its first vehicle the EV1, produced from 1997 to 1999. The car had some loyal followers, but it had a range of less than 100 miles and top speed of 80 miles per hour. The program cost General Motors $1 billion and resulted in 1,117 cars produced.19

Quickly bringing the Roadster market helped Tesla show to consumers and investors show that a relatively high quality electric car was possible. As one Toyota executive stated, “This is a gut check for us . . . We said to ourselves, ‘Look at how Tesla is getting to market so quickly. They seem to be inventive and cutting edge. Are we too engrossed in our own culture?’” They followed a different approach rather than spending years in the drawing room, the Toyota executive stated, “Tesla is a lot different. They get the standards and specifications set, and then change it on the fly. They spend more time in the validation phase. We spend more time in up-front planning.” In 2009 Robert Lutz from General Motors stated, “All the geniuses here at General Motors kept saying lithium-ion technology is 10 years away, and Toyota agreed with us—and boom, along comes Tesla. So
HOW TESLA REDUCED COSTS OF ENTRY AND LEARNING CURVES: FORMING PARTNERSHIPS, LEVERAGING OTHER FIRMS’ CAPITAL, AND QUICKLY BRINGING PRODUCTS TO MARKET

Let us consider some of Tesla’s specific steps. Even though Tesla eventually hopes to produce mass market electric cars, spending years in the design room and the preproduction phase for a large scale could have ended in a disaster in many ways. Instead Tesla started small in with what can be considered a minimum viable product with their low volume roadster. Without a pipeline of products about to be released, a huge amount of capital, and the luxury of spending as much as many of their competitors, timing was important. In 2006 Tesla co-founder Martin Eberhard stated their goal was to bring their first car “to the market quickly and efficiently” and they did so through partnerships with existing firms.

In 2004 Tesla approached Lotus to discuss a partnership and over the next couple years formed relationship where Lotus would help with design, engineering, and technology and be the contract assembler of Tesla’s first vehicle. Eberhard stated, “Much as
I love cars, I am the first to admit that neither I, my co-founder, Marc Tarpenning, nor our original investor (and chairman of our board), Elon Musk, is an automotive engineer.” Lotus Engineering assisted with analysis and supply chain and starting with Lotus Elise licensed technology, Tesla’s U.K.-based engineering team designed the chassis. Tesla was able to “save time and money” by heavily relying on Lotus for issues related to structure and safety. Having shared safety components let Tesla buy windshields, airbags, and automatic braking systems from the same suppliers. Such modular relationships let Tesla incorporate relatively complicated components without having to design them anew. Jacobides, MacDuffie, and Tae discuss how modular relationships common in the technology industry let firms get into and out of new areas with relative ease, and Inkpen, Sarasvathy and Nicholas highlight how partnerships let firms leverage the knowledge and infrastructure of existing firms.22

Lotus assembled the car and about 6 percent of Roadster parts overlapped with those of its British relative. *Automobile Magazine* likely underestimated the Roadster's novelty, but it described them as: “Lotus Elises [converted] to run on batteries . . . everything else about the $100,000 Roadster felt like the $50,000 Lotus Elise on which it was based.” Yet the product turned out well and had a range and performance competitive with many high end gas vehicles. The Roadster had a 245 mile range, 0 to 60 miles per hour acceleration of 3.6 seconds, and a top speed of 130 miles per hour. Eberhard stated, “Just about three years from the day Marc and I started Tesla, we saw our first real Roadster from the assembly line.” Development of the Roadster cost more and took longer than they anticipated and Musk now states he wishes Tesla had had done more in house. But Tesla produced 2,500 Roadsters in its four years of production and that car enabled Tesla to
move toward its next stage. Musk stated it was “the beachhead of the technology. It’s the introductive product [that] allows us to refine the technology and make more affordable over time.”23

Tesla was then able to plan for the larger-scale production Model S and got there through partnerships with Daimler, Panasonic, and Toyota. In 2009, Daimler invested $50 million and subsequently formed an agreement for Tesla to supply drivetrains to Daimler’s Smart and Mercedes, and in 2010, Panasonic invested $30 million and created an agreement to develop batteries with Tesla. Some of Tesla’s most important transactions were with Toyota, which in 2010 invested $50 million for shares in Tesla’s IPO and sold Tesla its New United Motor Manufacturing, Inc. (NUMMI) plant in Fremont, California, for $42 million.

Tesla benefited from the purchase by having a space ready to retool and Toyota benefited by not having to write the space off at a total loss. Recycling the factory24 freed up by General Motors and Toyota gave Tesla space to produce the Model S and subsequent higher-volume vehicles (Figure 2). Introduced in June 2012, Tesla produced 35,000 Model Ss in 2014 and currently produces 1,000 cars per week with capacity to expand. Ward’s Auto classifies the Model S ($70,000-$105,000) as a middle luxury car that competes with the Audi A6 ($46,000-$60,000), BMW 5-Series ($50,000-$71,000), Cadillac XTS $45,000-70,000), Lexus GS ($47,000-$57,000), and Mercedes E-Class ($52,000-103,000) whereas others classify the Model S in the European Commission F-segment (full size luxury cars) competing with similarly priced Audi A8 ($77,000-138,000), BMW 7 Series ($74,000-141,000), Lexus LS ($73,000-88,000), Mercedes S-Class ($93,000-139,000), and Porsche Panamera ($78,000-$200,000). In the United States the competitors in middle luxury
segment sell between 20,000 and 70,000 units per year as opposed to the roughly 20,000 for Tesla. Among those in the full size luxury segment, Tesla has outsold all or all but the Mercedes S class for the past couple years (Figure 3). Such sales figures would not have been possible had Tesla not started relatively small with the Roadster and then scaled up.

“Insert Figure 2 Here”
“Insert Figure 3 Here”

OVERCOMING NETWORK EXTERNALITIES: EXPANDING MARKETS WITH CHARGING STATIONS, DISTRIBUTION, AND SERVICE

Tesla used knowledge from Silicon Valley to reduce potential barriers to entry, and Tesla is also knowledge from Silicon Valley thinking to deal with network effects, or network externalities, in the auto industry. A network effect is present when the value of a good depends on how many other consumers use the good. For example, being the only person in the world with a telephone or an Internet server would be of little value. From payment processing to software systems and social media, the value of many networked products depends on the number of users. Liebowitz and Margolis explain how goods less obviously connected to a network can also have network effects, including a “network of Chevrolet owners, whose relationship to each other is that they draw on common repair expertise.” Although some forms of network externalities will forever be present, Liebowitz and Margolis describe ways in which firms can overcome and internalize network externalities. Externalities can be internalized if a firm owns a network and subsidizes parts of a network to increase the number of users.

Consider, for example, the strategy of one of Musk’s first cofounded companies, PayPal, which gave new users and their referral $10 bonus for each person who signed up.
This promotion was costly, but it helped increase the number of users from 1,000 in October 1999 to 1 million in April 2000 to 40 million when eBay bought the company for $1.5 billion in 2002. Other tech firms also subsidize different parts of a network to expand the number of users and increase the value of the product line. Hardware producers, such as video game console manufacturer Sony, benefit from having more designers and customers on their network, so they often initially sell consoles below cost or subsidize early software production on the hardware’s platform. With other arrangements, the subsidization can go in the opposite direction from software to hardware producers. Microsoft used to subsidize phone hardware producer Nokia to expand the amount of people with a Windows Phone. When capturing the benefits through such an arrangement is difficult, a third option for a producer to become and produce the hardware and software in a way that maximizes the value of both. Microsoft ended up choosing this route when it purchased Nokia’s handset business in 2013, and Apple’s phone business has been more vertically integrated all along. The “hardware-software paradigm” theory in economics explains how a hardware (or software) producer that receives spillover benefits from complementary software (or hardware) on its network, may want to subsidize the production of the complementary product or vertically integrate to produce both. The optimal arrangement is not set in stone, but firms will seek to maximize the joint value of the hardware and software and that can include subsidizing parts of the ownership experience.26

Tesla faces many of these dilemmas with electric vehicle technology, service, and charging. Consumer Reports stated it did not give the Model S a perfect score because of potential issues with range and access to charging. Although Tesla owners can charge their cars using any 120-volt outlet, faster charging requires a 240-volt outlet like the ones used
for home appliances, and even that takes hours. The more parking spaces that have 240-volt outlets and the more special charging stations there are, the more valuable Tesla cars become. One important step that Tesla is taking is building a network of faster charging stations that give Tesla owners electricity for 170 miles in a 30-minute charge. As of 2014, Tesla has built 100 stations, which charge just over 5,000 cars per week at zero marginal cost to the user.\(^{27}\) Spending $500,000 per station and not charging users anything is costly, but when viewing a charging network as equivalent to software in the “hardware-software paradigm,” one can understand why Tesla provides this complementary product at zero marginal cost. Tesla is also working with other potential charging-station companies and encouraging them to get into the space.

Another network effect that Tesla faces compared with established firms is a dealership, distribution, and service network. Tesla reports that one of customers’ most common questions is about servicing their cars, and to address this concern, Tesla has built and is expanding Tesla-owned and –operated service centers. Tesla currently has fifty (Figure 5) that operate with the following instructions from Musk: “What I’ve told the Tesla Service Division is their job is never to make a profit.” Here the firm is not acting altruistically, but working to increase Tesla’s profits overall by helping “quell fears about buying and maintaining an electric car and boost sales of the Model S sedan in the long run.”\(^{28}\) By subsidizing one aspect of the ownership experience (and pricing it into the car), Tesla is working to maximize the value of hardware and software and internalize those benefits.

One of Tesla’s most interesting moves to deal with network effects was to free all of its patents into the public domain. As of June 12, 2014, Tesla had hundreds of patents, yet
on that day Musk declared, “All our patents are belong to you.” By making the patents open to the public, Tesla is encouraging other firms to enter the electric car space. As Musk stated:

Our true competition is not the small trickle of non-Tesla electric cars being produced, but rather the enormous flood of gasoline cars pouring out of the world’s factories every day. We believe that Tesla, other companies making electric cars, and the world would all benefit from a common, rapidly-evolving technology platform. Technology leadership is not defined by patents, which history has repeatedly shown to be small protection indeed against a determined competitor, but rather by the ability of a company to attract and motivate the world’s most talented engineers. We believe that applying the open source philosophy to our patents will strengthen rather than diminish Tesla’s position in this regard.

Tesla has benefited from the existing technology and manufacturing infrastructure of other car companies like Daimler, Lotus, and Toyota, and it sees the benefits of having more companies and engineers working on electric vehicles. Although Tesla has paid research and development costs that other firms will not, it may benefit from having more participants in the electric car network.

Tesla’s approach flies in the face of theories that who assume that businesses must rely on restrictions to protect their market position. Bahrami and Evans describe how Silicon Valley firms often rely on cross pollination and adaption of others ideas and much of their success can be attributed to the ecosystem that facilitates both competition and collaboration. Jacobides, MacDuffie, and Tae argue that IBM (and later Microsoft and Intel) ended up having much more importance by making the architecture of its personal computer relatively modular and open. Being a key player in a large product infrastructure can be better than having complete control over a proprietary but small one. More recently Google has gained 85 percent of the smartphone operating system by making much of its Android operating system open source and even Microsoft is making
some of its products open source as well. Tesla seems to have gone a step further and is the largest company that we know of to make all of its intellectual property open source. By working to increase the size of the electric car market, Tesla has the potential to be in an important position in an increasingly large segment. The move may have other benefits too according to Musk: “Open sourcing the patents does have the advantage of making Tesla a more attractive place for the world’s best engineers to work. And it builds goodwill, which I believe will be important.”

**HOW MUCH DOES TESLA’S SUCCESS DEPEND ON GOVERNMENT SUBSIDIES?**

Tesla has become a valuable company, but it has countless critics who suggest that Tesla has not in fact created a valuable product but instead lives off government handouts. Pointing to a Department of Energy Loan, tax credits, and the sale of regulatory credits through California’s zero emission program, *The Wall Street Journal,* economist Benjamin Powell, and politician Mitt Romney refer to Tesla Motors as “the other Government Motors,” “crony capitalists in the auto industry” and “losers” similar to the failed firm Solyndra. One Forbes writer concludes: “If Tesla would stop selling cars, we’d all save some money.” Because such criticisms are so widespread, any analysis of Tesla of whether is successful at creating value must attempt to put the amount of subsidies versus the value of its product into perspective.

Tesla Motors, like every other American automobile company, has received certain government subsidies as well as having to pay taxes and deal with various regulations such as not being able to sell direct to consumers in most states. But judgment of whether Tesla is simply living off of taxpayer handouts versus producing something of value requires
looking at specific magnitudes rather than assuming that any firm that receives money from government is a drain on society.

First let us consider the loan that Romney and others criticize as either a $450 million bailout or handout. In 2007 the Department of Energy initiated a loan program to expand the production of fuel efficient vehicles, and after an application period in 2010 started disbursing loans of $5.9 billion to Ford, $1.4 billion to Nissan, $529 million to Fisker, and $465 million to Tesla at interest of 1.7 to 3.4 percent per year. Although the loans gave these firms access to cheaper capital, in 2009 Musk stated, “There’s a lot of misinformation out there . . . we’re already cash-flow positive. We would not need the loan to survive.” As of 2015 Nissan and Ford are still repaying their loans and Fisker defaulted on $139 million of its loan, but in May 2013, Tesla fully repaid the loan with $20 million in interest, nine years early. Let us assume that in 2010 Tesla would have had to borrow in the high yield corporate debt (junk bonds) market at between 7 to 10 percent interest and that equity financing was not an option. A 7 to 10 percent interest rate loan on $465 million would have required Tesla to pay $97-$139 million compared to the $20 million in interest that it paid. Tesla might have been able to borrow at less than the junk bond rate, raise money from equity financing, or done without the loan at all, but a below market interest does positively impact Tesla shareholders’ bottom line. Receiving a low interest rate loan, however, is not the same as a $465 million bailout or handout.

The next major area where Tesla receives money from governmental programs is by selling credits to other auto companies through the California Air Resources Board Zero Emission Vehicle program and other credit programs. Program formulas require manufactures to sell a certain number of electric cars (dependent on total number of cars
delivered in California) or buy permits from manufacturers who do, and Tesla has many permits it can sell. Such a policy advantages Tesla and others that produce electric cars including General Motors and Nissan compared to companies that do not have electric cars and choose to purchase credits from Tesla. In 2011, 2012, 2013, and 2014, Tesla made $2.7 million, $40 million, $194 million, and $216 million off of these programs representing 1.3, 9.8, 9.6, and 6.7 percent of Tesla’s $204 million, $413 million, $2.0 billion and $3.2 billion revenue. Critics can argue that 7.7 percent of Tesla’s revenue is not derived from a pure free market, but we think it is an exaggeration to state that “Tesla has not made one honest dollar.” How much does Tesla’s business model depend on the sale of these credits and would Tesla remain in business without them? Excluding revenue from regulatory credits, Tesla states that its gross margin is 22.0 percent and it expects its gross margin to continue to improve (Figure 6) indicating that that Tesla would produce cars even if this extra source of revenue disappeared.

Third let us consider the preferential tax treatment that Tesla receives. Since 2009, the U.S. Federal Government offers buyers of electric cars a $7,500 tax credit that consumers can claim to reduce their taxes by up to that amount. Although a large percentage of commentators refer to it as a $7,500 subsidy, the tax credit is not refundable (i.e. like a cash handout), and instead lets consumers potentially reduce their tax burden. Similar to the mortgage interest deduction, the policy gives preferential tax treatment to buyers of electric cars compared to gas powered cars. But a tax reduction for consumers is not the same as a $7,500 cash handout that requires the government to subsidize Tesla’s business. We are aware of how the marginal incentives of giving someone $7,500 versus not taxing someone $7,500 can end up being the same and can change relative prices by the
same amount, but those points are irrelevant to the discussion of whether a company is only in business at taxpayer expense. Other products that allow consumers to lower their tax burden include college, medicine, mortgages, and retirement accounts, but it would be odd to conclude that taxpayers would be better off if those products were not produced.

Another potentially preferential tax treatment that Tesla and many other firms receive are tax waivers to build factories in certain areas. Unlike most states, California taxes manufacturing equipment and decided to grant an exemption and waived an estimated $35 million in taxes to encourage Tesla to have their plant in California. Although a high percentage of authors refer to that as a subsidy, seeking competitive tax treatment and lowering tax burden is not the same as living off of government subsidies. We are fairly sure that every large company evaluates local tax rates when deciding where to locate factories and will seek to lower their tax burden if they can. That does not mean, however, they are a drain on the local or national economy.

Certain states such as California offer buyers of electric cars and plug in hybrids rebates of $2,500 (California has issued rebates of $184 million over the three year life of the program on all eligible hybrids and electrics including Tesla), but Tesla’s buyers in California also have to pay sales taxes based on jurisdiction of $5,243 to $6,815 for the base Model S and $6,815 to $10,189 the higher end (P85D) Model S meaning tax collectors are still gaining on each car sold. Such rebates change the relative prices of a Tesla versus a similarly price gas cars by 2.5 to 3.5 percent, but we doubt that Tesla sales would dry up were the rebate eliminated, especially because the average household income of Tesla buyers is $293,200.
In sum although Tesla received a below market loan and receives some preferential tax treatment compared to other firms, but we estimate the money they have made through governmental programs to be less than 10 percent of revenue and that percentage is declining. Moreover, analysts at JP Morgan and Morgan Stanley estimate that over the next ten years Tesla will end up paying $1 to $2.2 billion in corporate income taxes (not to mention taxes on labor and other factors of production) so concluding that Tesla is a loser similar to Solyndra or “If Tesla would stop selling cars, we’d all save some money” seem like exaggerations. Although certain tax incentives and governmental programs benefit investors in Tesla, we are fairly confident that Tesla would remain in business without them.

“Insert Figure 4 Here”

“Insert Figure 5 Here”

“Insert Figure 6 Here”

CONCLUSION

Tesla has shown that a Silicon Valley start-up can enter one of the most established industries of all. Even though incumbent firms and their market shares are large, this newentrant is changing market structure and the value of existing firms. Rather than looking at the market and assuming that matters will always be that way, Musk saw an unmet need and used innovation to fulfill it. Starting with a minimum viable product, partnering with other firms, recycling capital, and subsidizing aspects of the electric vehicle network, Tesla has altered the landscape of the auto industry. Some firms, perhaps including Tesla, will eventually be displaced, but this start-up has helped pioneer a new way of powering cars. When asked how he figured he could be successful, Musk stated, “Well, I didn’t really think
Tesla would be successful. I thought we would most likely fail. But I thought that we at least could address the false perception that people have that an electric car had to be ugly and slow and boring like a golf cart.”

Up until 150 years ago, whale oil was the preferred fuel for lamps, but that changed with the invention of kerosene, a cheaper alternative that could power the masses. Tesla is now offering an equivalent innovation that has the potential to reduce auto emissions, and let cars be powered by all types of energy, including nuclear and solar. One cannot predict what products or companies will reign supreme in the future, but the entrepreneurial process allows for innovation and the replacing of old ways of doing things.

Even if Tesla is ultimately outcompeted, its high market capitalization has already benefited its investors and acted as a signal and attracted more investment into the electric car industry. When General Motors and Chrysler veered toward bankruptcy, the market was signaling that the incumbents were doing something wrong, and as the value of Tesla rose, the market is signaling that Tesla is doing something right. Currently, Audi, BMW, Jaguar, and Mercedes all have new electric vehicles in the works, and even if they are more triumphant, Tesla will have helped pave the way for a new technology in much the same way that now-defunct or purchased firms like RCA, Zenith, Magnavox, Kodak, Polaroid, Amiga, Atari, and Commodore helped paved the way for modern computers, stereos, television, movies, photography, and home entertainment. The entrepreneurial process constantly encourages firms to come up with better products and, in the process, disrupt existing market structures for the ultimate benefit of consumers.

Figure 2. Tesla’s Product Strategy (Source: Tesla Motors. 2014. Tesla Motors investor presentation. Palo Alto: Tesla Motors, p. 19)
Figure 3. Full-size luxury sedan sales in the United States, 2013 (Source: Data are from Rogowsky, Mark. 2014. Tesla sales blow past competitors, but with success comes scrutiny. Forbes, January, 16, 2014.)

Figure 4. Tesla’s quarterly earnings (Source Duling, John. 2014. Tesla is profitable and the market doesn’t care. Quartz, May 8, 2014.)
Figure 5: States that allow Tesla-owned dealerships (Source: MojoMotors. 2014. "Where can Tesla sell cars?" Mojomotorsblog, May 20, 2014.)

### Table 1: Approaches to entrepreneurship in Silicon Valley and ways Elon Musk and Tesla use them

<table>
<thead>
<tr>
<th>What to do</th>
<th>Why</th>
<th>What not to do</th>
<th>What Musk and Tesla do</th>
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<td>Envision markets dissimilar to existing ones</td>
<td>Markets can change and the role of the entrepreneur is to figure out new things. “Doing something different is what’s truly good for society—and it’s also what allows a business to profit by monopolizing a new market.” (Thiel, 2014, p.166)</td>
<td>Don’t assume that the world always has to be this way or that current products, market shares, or market prices will be the same in the future.</td>
<td>To Musk: “Don’t just follow the trend.” “I think it’s important to reason from first principles rather than by analogy.” Although he says “it’s mentally easier to reason by analogy rather than from first principles” he says to “boil things down to the most fundamental truths and say okay what are we sure is true or sure as possible is true and then reason up from there.”</td>
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<td>Even if big, focus on economically achievable goals</td>
<td>Differentiate between ideas that simply sound good versus ones that actually can be implemented for the benefit of consumers (Thiel, p.195)</td>
<td>Theorizing without doing amounts to little more than daydreaming.</td>
<td>To Musk: “If the economics don’t work, you’re not going to have an effect on the future.”</td>
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<td>Start small with a minimum viable product</td>
<td>Learn how to get into an industry with lower up front risks by starting small (Sarasvathy and Dew, 2013). Many tech companies started with public beta versions of their products before moving onto more advanced or refined ones (Ries, 2011).</td>
<td>Don’t attempt to come out with the ultimate or final market product on the first try.</td>
<td>To Musk: “The Tesla strategy has been the same from the beginning, which is to start out initially with a car that was expensive but low volume. It’s the only car that we could have really made and that was the Roadster sports car. And then step two was car that sort of mid priced, mid volume car and that’s the Model S and the Model X also fits into that category. And then our third generation car will be low price, high volume.”</td>
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<td>Seek feedback from others, even if negative</td>
<td>Constantly get out of the building and talk with potential customers to assess the potential need for the product. Ask others what can be improved. (Blank and Dorf, 2012)</td>
<td>Don’t ignore your potential consumers, don’t assume you know all of the answers, and don’t avoid constructive criticism, even if the criticism might hurt.</td>
<td>To Musk: “It’s very important to actively seek out and listen very carefully to negative feedback. And this is something people tend to avoid because it’s painful, but it’s a very common mistake.” “I don’t say ‘Tell me what you like,’ I say ‘Tell me what you don’t like.”</td>
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| Use iterated design and a feedback loop to update the product | Come up with an idea, design a product, test hypotheses, learn, update, and repeat (Ries, 2011, p.71). | Don’t assume you know the best imaginable product ahead of time or can get it right on your first try. Don’t spend too much time at the drawing boards or be the mad genius working in a hidden lab for too long. | Tesla uses what they call a direct feedback loop and Musk explains: “You’ve got to through major design iterations to achieve [a mass market product] and that’s why we are trying to get there as quickly as possible with three...
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<th>Be flexible based on consumer wants and knowledge gained along the way</th>
<th>Update plans, technology, partnerships, or approaches. Switch gears or alter directions when necessary. (Bahrami and Evans, 2010)</th>
<th>Don’t assume the first plan was the right plan or continue to do things this way because you have always done them this way.</th>
<th>To Musk: “I think that’s the single best piece of advice: constantly think about how you could be doing things better and questioning yourself.” Musk states, “Put yourself in the shoes of the consumer and say why would you buy it as a consumer?”</th>
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<td>Work with others to leverage existing industry expertise or infrastructure</td>
<td>See what is available and work with it. If other firms have capabilities and are willing to build part of the product, work with them. If possible, form modular relationships with others that you can start, finish, expand or contract with relative ease (Jacobides, MacDuffie, and Tae, 2012).</td>
<td>Don’t do everything in house or build everything from scratch. Try to avoid large in house investments in capabilities that potential partners already have.</td>
<td>Tesla started by working Lotus to help with technology, engineering, design, and assembly. Tesla formed partnerships with Panasonic, Toyota, and Daimler to develop batteries and supply drivetrains and purchased a former GM and Toyota in Fremont, California.</td>
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<td>Enhance the total product experience not just aspects of it</td>
<td>If the product involves complements like hardware and software, a producer may want to subsidize some aspects or become more vertically integrated and produce both (Katz and Shapiro, 1994)</td>
<td>Don’t ignore the availability and price of complements. Don’t nickel and dime users on the price of complements at the expense of the consumer’s overall product experience.</td>
<td>Tesla offers many free updates of software in shipped cars, subsidizes the production of zero priced charging stations, and has a network of service stations given instructions from Musk: “Their job is never to make a profit.”</td>
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<td>Enhance the value of the product network</td>
<td>The value of many products is affected by the number of users. If so, figure out how to expand the user base and that may include subsidizing the product’s expansion. (Leibowitz and Margolis, 1994)</td>
<td>Don’t be too proprietary or ignore the importance of having a big enough base and infrastructure for the product.</td>
<td>In addition to spending to expand dealerships and service centers, to encourage others to get into the electric vehicle space Tesla made its patents open source. To Musk: “All our patents are belong to you.”</td>
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<td>Figure out how to scale up</td>
<td>Products with relatively high fixed costs, learning curves, and network effects can have economies of scale over a relatively large range of production. Ideally a company will figure out how to make a product scalable without large growing pains and profitable at higher volumes (Thiel, 2014, pp.54-55)</td>
<td>Don’t ignore potential production costs at larger potential volumes. A handmade product may be designed not to scale, but otherwise don’t ignore the potential path of starting small to growing big.</td>
<td>To Musk: “You also need economies of scale, so you’ve got to have much bigger factories. In order to afford those factories you have to raise a ton money, and people will only give you money if you have shown some prior success. Otherwise they [look at you with a doubting look and] they don’t believe you.”</td>
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<td>Constantly innovate to better serve customers</td>
<td>Markets are always evolving and one must continue to adopt (Bahrami and Evans, 2010, p. 6. Cole, Finster, and Weston, 2001)</td>
<td>Even with past success, don’t rest on your laurels and assume future business is guaranteed.</td>
<td>To Musk: “I think it’s very important to have a feedback loop, where you’re constantly thinking about what you’ve done and how you could be doing it better.”</td>
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Notes
2 Only Volkswagen fell out of the top seven in the U.S. market, being replaced by Hyundai, itself a nearly half-century-old industrial conglomerate that is the fourth largest auto producer in the world.
4 Jacobides, MacDuffie, and Tae describe how various factors including a relatively high degree of vertical integration often prevented automobile companies from innovating as quickly as firms in other industries such as high tech. They do describe, however, how incumbent firms have actively been selling off parts of their firms to deverticalize in an effort to become move in the direction of technology firms. See Jacobides, Michael G., John P. MacDuffie, and C. Jennifer Tae. 2012. “How Agency and Structure Shaped Value Stasis in the Automobile Industry.” Working paper, London Business School.
6 YouTube channel Every Elon Musk Video has 150+ clips and most the quotes in this article are from interviews listed there. Specific references for each quote are available upon request.
7 Inkpen describes how General Motors was able to modernize many of its manufacturing techniques after it formed and learned from its joint venture with Toyota. In return Toyota benefited by having a jointly owned American plant where it could produce cars. Inkpen, Andrew C. 2005. "Learning Through Alliances: General Motors and NUMMI." California Management Review, 47(4): 114-136.
12 Peter Thiel criticizes that who use lean and flexible to refer to “unplanned” or “agnostic experimentation” and he would be correct to say that Tesla does not fit that bill. Too much of anything can be bad, so Thiel is probably reacting to those who have latched onto terms and attempted to push them too far. See, Peter Thiel. 2014. Zero to One. New York: Crown Business, p.20.


21 Ries writes, “Contrary to traditional product development, which usually involves a long, thoughtful incubation period and strives for produce perfection, the goal of the MVP is to begin the process of learning, not end it. Unlike a prototype or concept test, an MVP is designed not just to answer product design or technical questions. Its goal is to test fundamental business questions…A minimum viable product (MVP) helps entrepreneurs start the process of learning as quickly as possible. It is not necessarily the smallest product imaginable, though; it is simply the fastest way to get through the Build-Measure-Learn feedback loop with the minimal amount of effort.” The $140 million investments in the Roadster were not the smallest product imaginable, but it helped Tesla get into the auto business and improve its business over time. Ries, Eric. 2011. *The Lean Startup: How Today’s Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses*. New York: Random House Crown Business, p. 93.


29 For readers who do not get the reference, search for the video game reference: “All your base are belong to us.” Musk, Elon. 2014. All our patent are belong to you. *Tesla Motors*, June 12, 2014.

interoperability (“open and commonly used industry standards”) allowed the personal computer industry to
grow much larger than had it been under the control of one firm.

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