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Tesla, Inc.

October 2, 2017. As he took a sip from the Monster low-carb energy drink, Elon Musk glanced at his computer screen to look at real time production run data for the newly introduced Model 3. He was distraught by what he saw. Musk had promised that Tesla would build 1,500 vehicles of its newest car model in the third quarter of 2017, and then ramping up production to 5,000 Model 3 vehicles per week in the fourth quarter (for a total of 65,000 cars). The reality: the maker of all-electric vehicles barely managed to build 260 vehicles of the new Model 3 in the entire third quarter.[1] The poor result is a huge disappointment.

Much like with a prior model in 2015 – the Model X – Tesla had missed production targets by a wide margin. He knew it would be a tough call with investors the next morning. How could Tesla manage to satisfy the 500,000 pre-orders Tesla had received for its Model 3? Not only would investors want to know an answer to this question, but Musk knew all too well that what he predicted a few weeks ago during a launch event of the Model 3: "It's an amazing car, but we're going to go through at least six months of manufacturing hell."[2] Now he wondered whether six months of "manufacturing hell" would turn into years of purgatory...

In 2017, Tesla, Inc. boasted a market capitalization of some $60 billion, an appreciation of more than 1,300 percent over its initial public offering price in 2010 (**Exhibit 1**). Indeed, Tesla had become the most valuable American car maker, ahead of both, GM and Ford. In comparison, GM made some 10 million vehicles in 2016, while Tesla made less than one percent of GM's volume, selling some 76,000 cars.

As he looked over the production data, Musk also reminded himself of the company's strategy he announced just a year earlier. In 2016, ten years after Tesla's initial "secret strategy," Elon Musk had unveiled the second part of his master plan for the company ("Master Plan, Part Deux") to continue the pursuit of its vision "to accelerate the advent of sustainable energy." [3] Again, Tesla's CEO and co-founder Elon Musk detailed a set of stretch goals:

1. Create stunning solar roofs with seamlessly integrated battery storage.
2. Expand the electric vehicle product line to address all major segments.
3. Develop a self-driving capability that is 10 times safer than manual via massive fleet learning.
4. Enable your car to make money for you when you aren't using it.

In the updated strategy, Step 1 leverages the 2016 acquisition of SolarCity. Tesla, Inc.—an American manufacturer of all-electric cars—has morphed into one of the first fully integrated sustainable energy companies, combining energy generation with energy storage, while providing zero-emission vehicles. Tesla provides energy generation via innovative solar roofs from SolarCity that look like regular shingles, but cost less, all things considered, and last longer. Tesla also offers its Powerwall to residential consumers, which allows customers to store the solar energy captured on their roofs for later use. Energy generation, therefore, becomes decentralized. This implies that consumers can generate and use energy without being dependent on any utility, and can sell back excess energy to utilities. Indeed, consumers will generate not only energy for the use of their Tesla cars but also enough to cover the energy needs of their entire house.

In Step 2, Elon Musk is planning to expand the lineup of Tesla's electric vehicles to address all major segments, including pickup trucks, buses, and heavy-duty semis. In Step 3, Tesla is aiming to further develop the self-driving capabilities of its vehicles. The goal is to make self-driving vehicles 10 times safer than manual driving, and thus being able to offer fully autonomous vehicles.

Fully autonomous driving capabilities are required for Tesla to fulfill Step 4 of the new master plan: Turn your car into an income-generating asset. Musk's goal is to offer an Uber-like service made up of Tesla vehicles, but without any drivers. On average, cars are used less than three hours during a day. The idea is that an autonomous-driving Tesla will be part of a shared vehicle fleet when the owner is not using their car. This will drastically reduce the total cost of ownership of a Tesla vehicle, and it will also allow pretty much anyone to ride in a Tesla because of the sharing economy.

Now Elon Musk just needs to pull all this off...

Elon Musk: Engineer Entrepreneur Extraordinaire

At the age of 17, Elon Musk left his native South Africa (in 1989) to avoid being conscripted into the army. Says Musk, "I don't have an issue with serving in the military per se, but serving in the South African army suppressing black people just didn't seem like a really good way to spend time." He went to Canada and subsequently enrolled in Queen's University in 1990. After receiving a scholarship, Musk transferred to the University of Pennsylvania. He graduated in 1995 with bachelor's degrees in both economics and physics and then moved to California to pursue a PhD in applied physics and material sciences at Stanford University.[5]

After only two days, Musk left graduate school to found Zip2, an online provider of content publishing software for news organizations, with his brother, Kimbal Musk. Four years later, in 1999, computer-maker Compaq acquired Zip2 for $341 million (and was in turn acquired by HP in 2002).

Not one to stand still, Elon Musk moved on to co-found PayPal, an online payment processor. In 2002, eBay acquired PayPal for $1.5 billion, netting Musk $175.5 million for his 11.7 percent share of the company. Although it was financially lucrative, Musk still harbors resentment about this deal. He feels that letting eBay acquire PayPal sold short the company's potential, dooming it to a future as a niche tool rather than a launch pad for a full-fledged, online financial institution.

Musk describes himself as an "engineer and entrepreneur who builds and operates companies to solve environmental, social, and economic challenges."[6] He is now leading firms on three different

fronts: electric cars, renewable energy, and space exploration. At one point, Elon Musk led three companies simultaneously: Tesla, SolarCity, and SpaceX.

SpaceX, still privately held, sends commercial satellites into orbit at a quarter of the cost of that of competitors and government space agencies such as NASA. In May 2012, SpaceX's Dragon spacecraft attached to the International Space Station, exchanged cargo payloads, and returned safely to Earth. Until then, only governments had accomplished this technically challenging feat. In the meantime, SpaceX has taken over resupply missions to the International Space Station, has begun collaborating with NASA on a mission to Mars, and is working with Boeing to develop a market for commercial space passengers.[7]

Since Musk took over engineering responsibilities, he has managed to build a rocket that can be launched into space, and then the rocket returns itself safely to Earth—an astonishing engineering feat. By 2017, Musk had proven that costs of exploring and colonizing space could be lowered dramatically by successfully launching and recovering rockets. SpaceX was now able to reuse its rockets, as demonstrated in some high-profile successes with its Falcon 9 rockets. The Hawthorne, California space company, therefore, took a big step forward to make Elon Musk's dream a reality—to colonize Mars, and thus make the human species multi-planetary to avoid likely extinction.

Musk indeed has a large profile already and has been described as "Henry Ford and Robert Oppenheimer in one person," as well as "Tony Stark, the eccentric inventor better known as Iron Man."[8, 9] In fact, Musk made a cameo appearance in *Iron Man 2*. In line with his movie avatar, the real-live Elon Musk plans to retire on Mars.[10]

Brief History of Tesla, Inc.

Tesla, Inc. (TSLA) was founded in 2003 in San Carlos, California as an automobile company dedicated to developing electric vehicles. The company is named in honor of 19th century engineer and physicist, Nikola Tesla. Tesla Motor's original design of its electric motors used the AC current concept first introduced by Nikola Tesla in 1882. The Serbian-born inventor was a contemporary of Thomas Edison. Indeed, Edison, the prolific inventor of the light bulb, phonograph, and the moving picture (movies), was at one-point Tesla's boss. The two geniuses fell out with one another and feuded for the rest of their lives. Edison won the famous "War of Currents" in the 1880s (DC vs. AC), and captured most of the limelight. Elon Musk is partly driven by restoring Nikola Tesla's reputation as the great inventor that he was, an honor that eluded him for the most part during his lifetime.[11]

Tesla Motor's co-founder Elon Musk was also one of its first investors, putting up $7 million initially, and later an additional $30 million out of his personal fortune. Tesla held a design contest for the styling of its first product: The Roadster, code-named "Dark Star." Lotus Cars, a British manufacturer, won the contest and jointly engineered and manufactured the new vehicle with Tesla Motors, as it was then known. Lotus was a natural partner for this project because of its experience and expertise in building its own line of sports and racing cars. In fact, the Tesla Roadster was modeled using the Lotus Elise as a template. The partners designed the Roadster's chassis using Lotus software tools and was manufactured by the Norwegian company that built the Elise.

In December 2006, *Time* magazine hailed the Tesla Roadster as the best invention of the year in the transportation category. In 2007, Musk was named "Entrepreneur of the Year" by Inc. magazine. In the

same year, however, it became clear that sales were not enough to sustain business; the company was bleeding money. After combing through Tesla's financial situation, Musk found that Tesla was losing $50,000 on each car sold. CEO, Martin Eberhard had led investors to believe that the manufacturing of the Roadster cost only $65,000 per car, which appeared to justify the $92,000 sticker price. Musk found that it cost Tesla $140,000 just for the parts, subassemblies, and supplies to make each vehicle, and that the Roadster could not even be built with Tesla's current tools. He also discovered major safety issues with the existing design. Completely taken aback by the messy state of affairs, Musk commented, "We should have just sent a $50,000 check to each customer and not bothered making the car."[12]

Consequently, Musk fired Martin Eberhard and took over the engineering himself. Almost every important system on the car, including the body, motor, power electronics, transmission, battery pack, and HVAC, had to be redesigned, retooled, or switched to a new supplier. Such dramatic changes were necessary to get the Roadster on the road at something close to the published performance and safety specifications, as well as to cut costs to make it profitable.[13]

By 2008, Tesla Motor was finally able to relaunch an improved version of its Roadster, and thus fulfill the first step of its initial strategy laid out two years earlier.

"TESLA'S SECRET STRATEGY" (PART 1)

In a blog entry on Tesla's website in the summer of 2006, Elon Musk explained the startup's initial master plan:[14]

1. Build sports car.
2. Use that money to build an affordable car.
3. Use *that* money to build an even more affordable car.
4. While doing above, also provide zero-emission electric power generation options.
5. Don't tell anyone.

Over the past decade, Tesla executed this strategy. In 2008, Tesla completed Step 1 as it introduced its first car: The Roadster, a $110,000 sports coupe with faster acceleration than a Porsche or a Ferrari. Tesla's first vehicle served as a prototype to demonstrate that electric vehicles can be more than mere golf carts. Tesla thus successfully completed Step 1 of the master plan.

In Step 2, after selling some 2,500 Roadsters, Tesla discontinued its production in 2012 to focus on its next car: The Model S, a four-door family sedan, with a base price of $73,500 before tax credits. The line appeals to a somewhat larger market and thus allows for larger production runs to drive down unit costs. The Model S received an outstanding market reception. It was awarded not only the 2013 Motor Trend Car of the Year, but also received the highest score of any car ever tested by Consumer Reports (99/100). Tesla manufactures the Model S in the Fremont, California factory it purchased from Toyota. By the end of 2016, it had sold around 125,000 of the Model S worldwide.

Hoping for an even broader customer appeal, Tesla also introduced the Model X, a crossover between an SUV and a family van with futuristic falcon-wing doors for convenient access to second- and third-row seating. The $100,000 starting sticker price of the Model X is quite steep, however; thus, limiting mass-market appeal. The Model X premium editions, for instance, range from $132,000

to $144,000. Technical difficulties with its innovative doors delayed its launch until the fall of 2015. Combining sales of both the Model S and the Model X, Tesla sold 50,658 vehicles in 2015, 76,297 vehicles in 2016, and for the first three quarters in 2017, it sold 73,227 vehicles. In total, Tesla sold a bit over 200,000 vehicles since 2015. In comparison, GM sold 10 million vehicles in 2016 alone.

Tesla has now reached Step 3 of its original master plan. In 2017, Tesla delivered the company's newest car: The Model 3, an all-electric compact luxury sedan, with a starting price of $35,000 (and up to $60,000 fully loaded. Tesla received some 375,000 preorders within three months of unveiling its model. Many of the want-to-be Tesla owners stood in line overnight, eagerly awaiting the opening of the Tesla stores to put down a $1,000 deposit to secure a spot on the waiting list for the Model 3, a car they had never even seen, let alone taken for a test drive. By the time Tesla delivered the first 30 cars of its new Model 3 (to Tesla employees for quality testing and appreciation of their hard work), the California car maker had received over 500,000 preorders. This customer enthusiasm amounted to $500 million in interest-free loans for Tesla. Tesla hopes to sell 500,000 total vehicles by the end of 2018. To accomplish this ambitious goal, Musk also promised that Tesla would increase its annual production from 50,000 in 2015 to one million vehicles a year by 2020.

Noteworthy is also that Tesla has not spent a single dollar on marketing or advertising to date. The Tesla brand has a cult following not unlike Apple in its early days; indeed, several marketing professionals have created pro-bono Tesla ad campaigns and uploaded them on YouTube to show their enthusiasm for the company's vision.

Step 4 of Musk's initial master plan for Tesla aims to provide zero-emission electric power generation options. To achieve this goal, Tesla acquired SolarCity, a solar energy company, for $2.6 billion in the fall of 2016.[15] With the acquisition of SolarCity, where Musk is also chairman and an early investor, Tesla, Inc. is the world's first fully integrated clean-tech energy company, combining solar power, power storage, and transportation. In the process, Tesla's mission also changed from "to accelerate the advent of sustainable **transportation**" to "accelerate the advent of **sustainable energy**," thereby capturing the vision of a fully integrated clean-tech energy company.

Step 5: "Don't tell anyone"—thus the cheeky title of Elon Musk's original blog post: "Tesla's Secret Strategy."

Along the way, Tesla completed an initial public offering (IPO) on June 29, 2010, the first IPO by an American automaker since Ford in 1956. On the first day of trading, Tesla's shares closed at $23.89 and generated $226.1 million for the company.[16] By 2017, Tesla, Inc.'s market cap was roughly $60 billion, or over 1,300 percent higher than at the IPO date, outperforming both the Dow Jones Industrial Average (as a gauge for the wider stock market) as well as the NASDAQ-100 (as an indicator of the tech sector) by a wide margin (**Exhibit 1**). Despite significant future growth expectations reflected in the Tesla's stock price appreciation, the company is still losing a significant amount of money: $900 million in 2015 and $675 million in 2017 (**Exhibit 2** provides an overview of Tesla's key financial data, 2012–2016). In March of 2017, Tencent, the Chinese owner of WeChat, paid $1.8 billion for a five percent stake in Tesla.

TESLA'S STRATEGIC PARTNERSHIPS

Tesla has managed to strike some important deals with big players in the automobile industry. In 2009, when Tesla was still a fledgling startup, German automotive engineering powerhouse Daimler purchased a nearly 10 percent equity stake in Tesla, worth an estimated $50 million.[17] Musk and

his team wowed the skeptical Daimler executives by modifying an off-the-shelf Daimler Smart car into an all-electric vehicle in only six weeks.[18] The collaboration deepened in February 2012, when Tesla released the following statement: "We are also pleased to announce the start of a development program with Daimler for a new Mercedes-Benz vehicle with a full Tesla powertrain."[19] By the end of 2014, however, Daimler had sold its equity holdings in Tesla, although the plans for partnership and cooperation continued.[20]

Daimler isn't the only traditional automaker to take an interest in Tesla. After Musk took the company public in 2010, Toyota bought $50 million (or 2.4 percent) of Tesla's stock.[21] With this deal, Tesla got ownership of the New United Motor Manufacturing, Inc. (NUMMI) automotive factory, which it later purchased outright in Fremont, California. NUMMI was initially set up as a joint venture between Toyota and GM. GM withdrew from NUMMI as part of its bankruptcy reorganization in 2009. Like Daimler, by the end of 2014, Toyota had sold some of its 2.4 percent stake in Tesla.[22] Both Daimler and Toyota walked away with sizeable capital gains. In 2017, Toyota announced that it had sold its remaining stake (1.43 percent) in Telsa.[23]

In addition, Tesla managed to bring Panasonic, one of the world's electronic giants, on board. Panasonic's aim is to combine its experience in battery technology with Tesla's capabilities in electric powertrain development. The goal for Panasonic is to become the number-one Green Innovation Company in the electronics industry by 2018, the 100th anniversary of its founding.[24] In addition to the Gigafactory in Nevada producing battery cells, Tesla operates Gigafactory 2 producing solar cells in a partnership with Panasonic in Buffalo, New York. Mass production is expected in October of 2017.

The U.S. Automotive Industry – A Brief Overview

In 2016, approximately 18 million cars, SUVs, and light trucks were sold in the U.S. Although the total units sold is down from an all-time high of over 20 million units in the early 2000s, in recent years, consumer demand shifted towards larger cars, SUVs, and trucks. This shift in demand is explained by falling gasoline prices, from an average high of $3.68 per gallon in 2012 to $2.25 in 2016. With lower gas prices and an economy on the upswing, Americans favored the Ford F-Series and the Chevrolet Silverado, making them some of the best-selling vehicles in 2016.

The Big Three automakers—GM, Ford, and Chrysler—have dominated the U.S. automotive industry for decades. GM was once the leading U.S. carmaker, with a market share of over 50 percent in 1962. By 2009, GM's market share had eroded to less than 20 percent, while the market share of the Big Three *combined* dropped below 50 percent for the first time ever.[25] GM and Chrysler filed for bankruptcy, while Ford was fighting hard to become profitable again.

GENERAL MOTORS (GM)

Given the sheer size of the U.S. automotive market, the "old" GM concentrated mainly on its domestic market. GM once held more than 50 percent market share in the United States and was the leader in global car sales (by units) between 1931 and 2007, before filing for bankruptcy in 2009. In its heyday, GM employed 350,000 U.S. workers and was an American icon.

Tesla Motors, Inc.

The new GM that reemerged 60 days after the bankruptcy filing had a significantly restructured balance sheet and four fewer brands (Hummer, Pontiac, Saab, and Saturn). To "bail out" the firm, the U.S. government provided close to $58 billion under the Troubled Asset Relief Program (TARP), making it the de facto owner of the company. In December 2012, GM announced that it was going to spend $5.5 billion to buy back a large portion of its stock that was being held by the U.S. Treasury, and the U.S. government sold the last of its shares in December 2013.[26] Overall, the U.S. government lost about $10.5 billion on its $49.5 billion investment in GM.[27] Meanwhile, in 2014, GM announced a record number or automobile recalls, including ignition switches attributed to several deaths.[28]

Since 2014, GM has seen an increase in earnings, rising from $3.95 billion in 2014 to $9.43 billion in 2016. In 2017, GM has sold more vehicles in the second quarter than Ford, much of those sales have been from trucks or SUVs rather than sedans or compacts.[29] For July 2017, GM saw a 15.4% drop in vehicle sales from July 2016 to 225,911 units. In foray in electric vehicles, GM launched the 2011 Chevy Volt, in 2010 as a plug-in hybrid at $41,000 before tax incentives, $8,000 more than the electric Nissan Leaf. The GM Volt has missed sales expectations by a wide margin.

In 2017, GM introduced the all-electric Chevy Bolt, with a range of over 200 miles per charge, similar to Tesla's Model 3. Sales, however, have also been disappointing. Available in California and Oregon initially, sales of the Bolt surpassed the Volt, with over 4,000 Bolts sold in July and August of 2017, compared to under 3,000 Volts in the same months.[30, 31, 32] The increased availability of the Bolt has driven sales since February.

In anticipation of a future with many more electric vehicles than today because of tougher emissions regulations and the possibility that some markets (especially some large metropolitan cities such as Beijing, China) may ban cars powered by internal combustion engines altogether, traditional car makers such as GM are ramping up their investments in fully electric vehicles. In the fall of 2017, GM announced that in addition to the Chevy Bolt, it will introduce two more electric vehicles in the U.S. over the next 18 months and 20 new electric car models globally within the next six years.[33]

Although for many decades GM focus was on the U.S. domestic market, the future for the "new" GM may lie overseas, most notably in China. Some 65 percent of GM's revenues are now from outside the United States. This is quite a high level of globalization for a company that once was focused on the domestic market only. The Chinese market is becoming more and more important to GM's performance. In 2016, GM sold 3.9 million vehicles in China alone, which is 39 percent of total GM cars sold. China's share of GM's total sales is on a steady climb, reaching 40 percent of total revenues in 2017 (Q1).

While GM is doubling down on China, it has exited Europe. In 2015, GM stopped manufacturing cars in Russia, citing unstable business conditions as the main reason. After years of losing money and acrimonious parent–subsidiary relationship, GM sold its Opel (Germany) and Vauxhall (United Kingdom) divisions to Peugeot of France in 2017. In the same year, Barra also announced that the U.S. automaker will discontinue selling cars in India. This further retrenchment will allow GM to focus more on China and Brazil, and to fend off tech startups such as Tesla and Uber in the United States, where GM made an equity investment in Lyft, which in turn partnered with Waymo, Alphabet's self-driving car unit.

FORD MOTOR COMPANY

In 2008, Ford had raised $24.5 billion in capital by mortgaging almost all its assets during the height of the financial bubble, giving it access to a large line of credit.[34] This included Ford's trademark blue oval that it did not regain control over until May 2012.[35] While supporting GM's and Chrysler's requests for a government bailout, Ford did not request, nor did it receive, any government funding. Ford also claims to be now able to make money not only from larger vehicles such as SUVs and trucks, but also from smaller cars.

With declining earnings of $7.4 billion in 2015 to $4.6 billion in 2016, Ford was at risk of being overtaken by the investment in electric and autonomous driving technologies by other auto companies.[36] Bill Ford, the great-grandson of Henry Ford, had ideas of electric vehicles decades ago, only to be dismissed by the board, while cross-town rival GM launched the Volt and the Bolt. A month after Tesla's market capitalization passed Ford's, Bill Ford led the replacement of CEO Mark Fields, who saw a 40 percent fall in share price during his tenure, with Jim Hackett, Ford's head of innovation. To catch up, Ford invested $1 billion in Argo AI, to develop autonomous driving technologies. Ford also plans on electrifying 13 vehicles in the next five years, investing $4.5 billion, mostly as hybrid vehicles.[37] Hackett began a 100-day review and is set to announce his plan in October.

FIAT CHRYSLER (FCA)

In 1998, German car manufacturer Daimler paid $36 billion to acquire a troubled Chrysler Corporation. Touted by some as a "merger of equals," the true nature of the deal became apparent when several senior U.S. managers either left or were fired and then replaced by Daimler managers.[38] Theoretically, the acquisition gave Chrysler entry into European markets, created a larger, complementary product line (Chrysler sold SUVs, minivans, and mass-market cars, while Daimler specialized in luxury sedans and sports cars), and provided both companies with increased market power.

However, the management cultures of the two companies clashed, and DaimlerChrysler never achieved the anticipated synergies.[39] Ultimately deciding it was better off on its own, Daimler sold 80.1 percent of Chrysler to Cerberus Capital for $7.4 billion in August 2007. Cerberus took Chrysler private in a leveraged buyout, hoping to restructure the company away from the pressure of public financial reporting. Chrysler's problems, however, were too big for even Cerberus to fix, and the company declared Chapter 11 bankruptcy on April 30, 2009.

At this point, the federal government intervened, paying $6.6 billion to finance the company's restructuring into the "New Chrysler." Of that amount, 55 percent was owned by a pension fund and 25 percent by the Italian carmaker Fiat, with the U.S. and Canadian governments holding minority stakes.[40,41] Subsequent restructuring reached an important milestone with Fiat Chrysler beginning trading on the New York Stock Exchange on October 13, 2014.[42] Fiat provided Chrysler with a platform for smaller, more fuel-efficient cars and access to Fiat's global distribution network. Chrysler hoped to realize cost savings in design, engineering, manufacturing, purchasing, and marketing, while Fiat gained significant access to the U.S. auto market.

Chrysler has been looking for a partner to develop plug-in hybrids or full electric vehicles and to share the R&D and manufacturing costs.[43] Chrysler currently has the Pacific Hybrid in its line-up. After reports that Chinese auto manufacturers were interested in buying FCA, Dongfeng, and Geely denied those reports. In the fall of 2017, several newspapers reported that Hyundai has been in merger

discussions with FCA.[44] FCA has also approached GM for a possible merger, only to be turned away by GM CEO Mary Barra. In addition, FCA also has approached Volkswagen (VW) of Germany to be acquired by the much larger German car maker. VW, however, has to work through its emissions scandal and is not interested in buying FCA. Sergio Marchionne, FCA's CEO, believes that FCA is too small in terms scale to be an independent player in the global car industry.

FOREIGN COMPETITION

Since the first oil price shock in 1973–1974, foreign car manufacturers have made steady inroads into the U.S. market. Investing more in research and development, compared with the Big Three, German, Japanese, and Korean carmakers were perceived to offer vehicles of higher quality, more advanced engineering, and better fuel efficiency. Because they were not burdened with health care and pension costs, the foreign companies could also make and sell their vehicles at lower prices (leading to increased sales and/or higher margins). By 2012, Japanese automakers Toyota and Honda were numbers three and five in sales volume in the United States, respectively. Nissan (Japan), Hyundai (Korea), and Kia (Korea) have also become strong competitors in the U.S. market.[45]

Japanese carmakers, Toyota and Honda, have long been considered the leaders in producing high-quality, fuel-efficient cars. Toyota has always been Japan's largest automaker, and in early 2009, it overtook perennial world leader GM in both production and sales. Since then, GM and Toyota have exchanged positions several times for the top spot in total worldwide sales. Honda is Japan's second-largest automaker and ranks fifth in the world, behind GM, Toyota, Volkswagen, and Ford. Due to Voluntary Export Restraints (VERs) enacted by the Reagan administration in 1981, Japanese companies have invested heavily in U.S. production facilities. Japanese plants are typically non-unionized and are in the southern United States, where the costs of living are lower, away from their northern domestic competitors. Along with philanthropy, lobbying efforts, and sharing technology, establishing U.S. production facilities was a significant step in improving public relations and decreasing their liability of foreignness.

Among Japanese carmakers, Nissan fully embraced the "EV revolution." The Nissan Leaf is a compact five-door, five-passenger hatchback, with an all-electric range of around 85 miles on a single charge in city driving, and an estimated fuel economy of at least 99 miles per gallon gasoline equivalent. The Leaf (an acronym for Leading, Environmentally friendly, Affordable, Family car) is manufactured at Nissan's Smyrna plant in Tennessee. Since it was introduced in December 2010, the Nissan Leaf has become the best-selling electric vehicle, with more than 250,000 units sold. The 2017 Nissan Leaf model has a range of more than 100 miles per charge.

In late 2017, Toyota also announced that it is working on mass-producing an all-electric vehicle on its Pirus and Coralla platforms that would be launched in 2020.[46] Toyota, moreover, created a new joint venture called EV Common Architecture Spirit with Mazda, one of the smaller Japanese car makers to develop technology for a range of electric vehicles, including small cars, midsize cars, SUVs, and light trucks.[47]

Korean car manufacturers today occupy a position in the U.S. automobile market like that of the Japanese companies in the 1980s. Viewed as the cheaper, fuel-efficient alternatives to American, Japanese, and European cars, they are gaining more widespread recognition and acceptance among American car buyers. Some experts argue that Hyundai is already on par in quality with Toyota and Honda.

Other competitors on the horizon include the emergence of Chinese car manufacturers, including BYD Motors that is selling plug-in electric hybrids in China. BYD started as a battery company and has developed lithium iron phosphate batteries, which permit cars to run 250 miles on a single three-hour charge.[48,49] BYD has begun delivering a 40-foot bus with a 24-hour battery life that can travel 155 miles from its Lancaster, California plant in what is likely a first step to establishing a U.S. presence for electric automobiles.[50] As the first Chinese car manufacturer poised to break into Western markets, BYD has attracted the attention of Warren Buffett, who invested some $230 million for a 10 percent equity stake in the company. While BYD is not currently offering electric automobiles abroad, the sticker price of BYD cars is anticipated to be significantly lower than current Tesla models.

The three largest German carmakers—Daimler, BMW, and Volkswagen—each held between 1.3 and 2.1 percent of the U.S. market at the end of 2016.[51] Porsche, a wholly owned subsidiary of Volkswagen since 2012, is a strong niche player in the luxury vehicle segment, while Audi, a wholly owned subsidiary of Volkswagen since 1966, has gained a strong reputation for its mid-size luxury sedans and SUVs. Like their Japanese counterparts, German car manufacturers have gained market share steadily over the last several years through perceived superior engineering and styling capabilities. Since 2015, however, Volkswagen has been immersed in the "Diesel-gate" affair. It was revealed that VW had illegally installed diesel emissions cheat software in more than 11 million vehicles worldwide. VW's diesel engines were emitting up to 40 times the allowed level of pollutants. Even VW's high-end brands such a Porsche and Audi were not immune from these illegal activities.

Beyond the Internal Combustion Engine

The oil embargoes of the 1970s first highlighted the need for smaller, more fuel-efficient vehicles. Concerned about U.S. reliance on foreign oil, Congress established the CAFE (Corporate Average Fuel Economy) standards for passenger cars and light trucks, and set a goal of doubling new-car fuel economy by model year 1985.[52] In 2009, CAFE standards were further raised, requiring an average fuel economy of 35.5 miles per gallon for model years 2012–2016.

In 1990, the California Air Resource Board (CARB) passed a mandate for the introduction of zero emission vehicles (ZEVs). The act specified that two percent of the vehicles produced for sale in California had to have zero emissions by 1998, increasing to five percent in 2001 and 10 percent in 2003. Subsequent amendments dropped the 1998 and 2001 requirements, but left the 10 percent value for 2003 in place while also allowing credits for partial-ZEV cars.[53]

The ZEV mandate is credited with stimulating increased research and development of the electric-car prototype. The first electric production car EV1 (made by GM) came to market in 1996 in California and Arizona as a lease-only vehicle. Competitors Toyota and Honda quickly followed suit with their own EV cars. However, most of these early models were discontinued after automakers successfully challenged the mandate in Federal District Court in 2002, winning significant concessions and delays from the CARB.

In hindsight, former GM Chairman and CEO Rick Wagoner said that the worst decision of his tenure at GM was "axing the EV1 electric-car program and not putting the right resources into hybrids. It didn't affect profitability, but it did affect image."[54] GM research and development (R&D) chief Larry

Tesla Motors, Inc.

Burns wishes GM had not killed the EV1 prototype his engineers had on the road in the 1990s: "If we could turn back the hands of time," says Burns, "we could have had the Chevy Volt 10 years earlier."[55]

BATTERY ELECTRIC VEHICLES

There are two basic types of electric vehicles. One is the "pure" electric vehicle (sometimes referred to as the battery electric vehicle |BEV|), which uses only batteries to supply the electric energy needed for propulsion. The other type of electric vehicle relies on hybrid propulsion, which combines an electric motor with an internal combustion engine, and are called plug-in hybrid (electric) vehicles. We discuss BEVs first before turning our attention to plug-in hybrids in the next section.

Leveraging the fact that electric motors can also act as generators, electric vehicles utilize regenerative braking to save a significant portion of the energy expended during acceleration, thus increasing the energy efficiency of the vehicle. In addition, pure electric vehicles have a high torque over a larger range of speeds during acceleration compared with internal combustion engines. For example, the Tesla Roadster was rated at 288 horsepower (hp) and, with instant torque available, accelerated faster than a 911 Porsche GT.

Running and servicing costs of the electric car are also much lower than its gasoline-based counterparts; Tesla estimated that the cost per mile driven with the Roadster was just $0.02. This is because electric motors and gearboxes have relatively few moving pieces, compared with the hundreds of precision-engineered parts necessary for an internal combustion engine. BEVs are usually very quiet and do not emit any exhaust gases.

The major disadvantage of BEVs is the battery. It is the most expensive part of the car, is subject to deterioration over its lifetime, is heavy, requires long charging times, and offers a limited energy-to-weight ratio. This low ratio significantly restricts the driving range of electric vehicles. Finding an economic balance of range versus performance, battery capacity versus weight, and battery type versus cost therefore challenges every BEV manufacturer. A nickel-metal hydride (NiMH) battery typically lasts the life of the vehicle, but the range tends to be less than 200 miles, and it takes hours to recharge the battery.

Related to this issue, is "range anxiety," the concern that the battery will run out of power before the destination is reached. Americans cite range anxiety as the most important reason why they are reluctant to buy a zero-emission electric vehicle. According to the U.S. Department of Transportation Federal Highway Administration (FHWA), the average American driver logs 13,476 miles each year, which translates to about 37 miles a day.[56] The same agency found that the average American commutes about 16 miles per day to work (one way).

Newer BEVs (e.g., all vehicles in Tesla's line-up) are equipped with lithium-ion batteries that provide around 300 miles of range per charge. Many experts believe that battery-production problems could be the limiting factor for the electric-car industry. "Batteries are absolutely the No. 1 constraint for electric cars," says Mark Duvall, a researcher at the Electric Power Research Institute in Palo Alto, California, a utility-funded research organization. "It's also the single-most expensive component right now."[57] In 2014, Elon Musk announced that Tesla was making its patents open source.[58] The move has led established carmakers, such as BMW and Nissan, to consider using Tesla's technology.[59]

Tesla has also committed to building the Gigafactory, a 980-acre facility near Reno, Nevada, to build its own lithium-ion battery intended to produce 500,000 battery packs a year to supply its automobile assembly plant in Fremont, California.[60] The planned annual output battery capacity is 35 gigawatt-hours, nearly the entire world's current battery production combined. The Gigafactory, still under construction, began mass production of battery cells in January 2017 and requires a $5 billion investment that places the plant near sources of lithium and allows for powering the plant with renewable energy.[61]

There has been a steady increase in the number of battery electric vehicles (BEVs) sold in the United States since 2011 (see **Exhibit 4**). In 2016, some 160,000 BEVs were sold in the U.S., up from less than 20,000 BEVs in 2011. These vehicles are also called zero-emission vehicles or ZEV, as they release—in contrast to plug-in hybrid cards—zero emissions.

Exhibit 5 shows the number of motor vehicle registrations (ICE) in the U.S. for the past 100 years. **Exhibit 6** compares the number of ICE registration in the first seven of the industry with that of EV sales worldwide.

PLUG-IN HYBRID ELECTRIC VEHICLES

Hybrid electric vehicles (HEVs) attempt to combine the advantages of pure electric vehicles, but avoid the range-restriction problem using a gasoline-powered internal combustion engine. Plug-in hybrid electric vehicles (PHEVs) contain a battery that stores electricity for the electric motor and can be recharged. Because the battery shares the propulsion load, hybrid engines are significantly smaller than their traditional gasoline counterparts, reducing vehicle weight and cost share. PHEVs can reduce air pollution, dependence on petroleum, and greenhouse-gas emissions. Other benefits include improved national energy security, fewer fill-ups at gas stations, the convenience of home recharging, opportunities to provide emergency backup power in the home, and vehicle-to-grid applications.

Elon Musk is a strong opponent of hybrid vehicles. He argues that HEVs combine the disadvantages of both electric and gasoline-powered vehicles, negating the advantages that each type offers. He argues that hybrids are "bad electric cars" because they must carry around an additional engine and drive train, adding weight, cost, and additional parts to maintain and repair.[62] He criticizes the combustion engines as too small, "anemic," and inherently less efficient than full-size engines. Moreover, the combination of these technologies in a single vehicle adds to the technological complexity, which increases cost, error rates, and maintenance efforts. Hybrid supporters, on the other hand, are optimistic that these disadvantages can be mitigated through continued research and development.

Toyota has long endorsed that gasoline-electric hybrids will become the next dominant technology. Toyota has sold 10 million of its popular Prius cars since they were introduced in 1997. By 2020, Toyota plans to offer hybrid technology in all its vehicles. More recently, the Japanese car maker is focusing more on all-electric vehicles.

Electric-Car Infrastructure

There have been four major types of infrastructures under development to extend the range and decrease the charging times of pure electric vehicles. First, the U.S. National Institute of Standards and

Technology and the Federal Energy Regulatory Commission are heavily involved in the definition of future smart-grid standards.[63] The U.S. government currently offers economic incentives to encourage electric vehicle ownership (i.e., $7,500 federal tax deduction when purchasing a BEV, will phase out when manufacturer has sold 250,000 vehicles), and it realizes that an electric infrastructure must be in place to meet the needs of on-the-go Americans. Smart grids are electricity networks that utilize two-way digital metering, sensing, monitoring, and control technologies to improve electricity production, transmission, distribution, and consumption. By providing information about grid conditions to system users, operators, and automated devices, the smart grid enables dynamic responses to energy needs, which in turn saves energy, reduces costs, and increases reliability. Once installed nationwide, the smart grid could also provide a means of recharging batteries for electric-powered vehicles.

Tesla is prepared to build charging stations around the United States so that drivers can drive across the country. As of summer 2017, Tesla operates close to 861 supercharger stations worldwide with over 5,645 superchargers. Tesla's "supercharging" stations can charge a battery up to a 200-mile range in 30 minutes. The company has stated that the goal of the infrastructure is to enable "fast, purely electric travel from Vancouver to San Diego, Miami to Montreal, and Los Angeles to New York."[64] Tesla's charging stations, however, are compatible only with properly equipped Model S and Model X vehicles. Indeed, the owners of the new Tesla Model 3 will no longer be able to use superchargers without a fee, as do Model S and Model X owners.

The Sharing Economy and Car Ownership

As ride sharing and ride hailing become more popular, the race to develop autonomous driving technology will allow companies offering ride-sharing such as Uber and Lyft to scale the supply and reduce the labor cost to meet demand.[65] As autonomous technology becomes more common, the cost of owning a car will surpass using a ride sharing service, where the vehicles will have a higher utilization rate, and drastically reduce the need for parking lots, freeing space in urban areas. Instead of driving for Uber or Lyft, autonomous vehicle owners can release their cars to work for them while they are not using them. Step 4 in Musk's plan deux, describes how people's behavior changes in respect to use and ownership of cars. While Tesla vehicles built in Q3 of 2017 will have autonomous capability going forward, GM's subsidiary, Cruise is not far behind manufacturing Chevy Bolts with the necessary self-driving hardware. As Tesla, Waymo, and Uber compete to build self-driving technology, Lyft has created a platform where researchers and manufacturers can take their technology to market using Lyft's network.[66]

Tesla launched its autopilot feature in October 2015 that automatically steers on the highway, changes lane, and adjusts speed (**Exhibit 7**).[67] Tesla's CEO, Elon Musk, expects the company to be able to demonstrate a fully autonomous vehicle (Level 5: system takes over entire dynamic driving, person as driver is no longer needed) by the end of 2017.[68] Uber began testing self-driving cars with a human backup driver in Pittsburgh in late 2016.

One of the major competitors to Tesla in the autonomous vehicle space is Waymo, a subsidiary of Alphabet, Google's parent company. The company traces its history to software and sensor technology developed by Google in 2009. It has since accomplished major technical milestones, but financial achievements have been conspicuously absent. Meanwhile, competitors are catching up, often aided by former Alphabet employees.

In October 2015, Google achieved the world's first fully self-driving trip on public roads, in a car without driver controls.[69] Steve Mahan, the blind 63-year-old passenger, commented that the "cars will change the life prospects of people such as myself."[70] The self-driving car project was made an Alphabet subsidiary in late 2016 and dubbed Waymo, short for "a new way forward in mobility."[71] The reorganization was motivated in part by maturity of the self-driving technology. "We're getting ready. And we want to tell the world about it," commented Waymo CEO John Krafcik.[72]

Although Google has developed its own pod-shaped "Koala" cars, the company has publicly disavowed any intentions to manufacture cars itself. "We are a self-driving technology company. We've made it pretty clear that we are not a car company," stated Krafcik.[73] Instead, Waymo is partnering with existing auto manufacturers like Fiat Chrysler to commercialize its technology. By 2017, Waymo's test fleet of commercial and custom-built vehicles had accumulated over 2.5 million miles of autonomous driving.[74] Between 2015 and 2016, the company reduced the number of times a human safety driver had intervened from an average of once every 1,250 miles to once every 5,000 miles.[75]

Tesla and Waymo are not alone in its quest to develop driverless cars. The ride-hailing company, Uber, is using the tests to gather feedback from customers and further its goal of developing an autonomous fleet of cars.[76]

In 2017, Waymo sued Uber for allegedly stealing Waymo's proprietary self-driving technology. Uber acquired the autonomous-vehicle startup Otto for $700 million in 2016. Otto was founded by Anthony Levandowski during the same time he was working for Waymo on its autonomous-vehicle program. Waymo claims Levandowski stole more than 14,000 proprietary files. In particular, Waymo alleges that Levandowski set up Otto to steal trade secrets and proprietary designs, and to turn around and use this knowledge to advance self-driving technology at Uber.[77] This is a stark turnaround from the earlier close relationship between Alphabet and Uber. Google Ventures, Alphabet's venture capital unit, had made a $200 million investment in the fledgling ride-hailing service in 2013. Alphabet's chief legal counsel was also a board member at Uber. He resigned from Uber's board one week after Uber acquired Otto.

Other technology and car companies are joining the fray as well. In the spring of 2017, Intel acquired Mobileye NV for $15 billion.[78] Mobileye specializes in driver assistance systems and is working with several major automakers including BMW, Ford, General Motors, Nissan, Volvo, Audi, and Hyundai.[79] General Motors spent $1 billion to acquire self-driving startup Cruise Automation in 2016. In early 2017, Ford announced that it would invest $1 billion in Argo AI to develop a virtual driver system for its fully autonomous vehicle due in 2021.[80]

Tesla's Manufacturing Challenges

Tesla's original production at the former NUMMI plant started with five Model S vehicles manufactured per month, but has climbed in a year's time to 500 vehicles produced per month.

Musk intends to eventually reach the NUMMI plant's 500,000 production capacity. The discontinuation of the Roadster and the low-end version of the Model S help with increasing production

capacity. Adding additional models such as the Model 3 to the production line potentially increases the complexity of manufacturing and managing demand for different vehicle models. Although Elon Musk hopes to produce 500,000 units of the Model 3 car in its Fremont, California plant, industry experts predict that Tesla can produce no more than 230,000 cars at this facility per year under the best of circumstances.[81]

Musk's current manufacturing challenge is to ensure a reliable supply chain to meet the demands of the production ramp up for the Model 3. In the fall of 2017, Tesla explained that it only produced 260 Model 3 instead of the predicted 1,500 because of "production bottlenecks." At the same time, CEO Musk also sounded a more confident note: "It is important to emphasize that there are no fundamental issues with the Model 3 production or supply chain. We understand what needs to be fixed and we are confident of addressing the manufacturing bottleneck issues in the near-term."[82]

By October of 2015, JB Straubel, Tesla's co-founder and CTO, said that most of their engineers were working on the Model 3. With 30 units delivered at the end of July 2017 and a goal of 5,000 vehicles by the end of the year, at the Model 3 handoff event, Musk welcomed the Tesla team to "production hell." For 2018, Tesla plans on ramping to 10,000 vehicles a week to hit 500,000 vehicles produced in 2018. In October of 2017, Tesla plans on unveiling a semi-truck, with Musk confirming that Tesla had been working with their "biggest customers" on the design.

Another manufacturing challenge facing Musk is how to maintain the high-quality standard cited in *Consumer Reports*' glowing review of the Model S and its sterling reputation as *Motor Trend*'s 2013 Car of the Year. With increased production rates and the introduction of another product line, Tesla must carefully design and implement new facilities and processes that will meet the standards set by the 2012 Model S. This is a very real threat to Tesla's brand, as early adopters suffered a few software glitches that kept the door handles, which retract into the body when not being used, from becoming accessible when the Model S owner wanted to get into the car. Early owners of the Model X had malfunctioning falcon wing doors. While the early adopters were willing to tolerate these types of glitches, the mass market would be much less sympathetic. With the Model 3, the initial 30 vehicles were delivered in July to Tesla employees for quality control, with customer deliveries planned for October, starting from the West Coast and moving East across the United States, with Tesla owners getting priority.

In Q3 of 2016, Tesla achieved record production levels of 25,185 Model S and X, a 92 percent increase from Q3 of 2015. Additionally, the Model X had captured six percent of the US large luxury SUV market in 2016 Q3.

Critics are skeptical that Tesla can get its prices down to a competitive level, produce the Models S and X on time, ramp up Model 3 production, and have them perform as promised. Moreover, due to the relatively low price of gas in the United States compared to Europe, for instance, where the price of a gallon of regular gas hovers around $10, the economic incentive to buy an electric vehicle is not there at this point.

Tesla Motors, Inc.

Elon Musk: Strategic Choices

Let's bring this back to the dilemma from the beginning, and highlight some of the challenges that Musk faces such as:

1. Production runs and supply chains for Model 3
2. Driving down the cost for Model 3, whileiimproving quality
3. Not cannibalize its higher prized Model S with the Model 3
4. Achieve autonomous driving and legal approval (mention fatality w/ autopilot)
5. Keep demand for EV vehicles in environment with low gas prices in U.S. and phasing out of federal tax incentives $7,500 tax deduction

As Elon Musk orchestrates the production ramp up of the Model 3, Tesla faces a stretch goal of 5,000 units a week by end of 2017 to meet a goal of 500,000 vehicles produced in 2018. The Model 3 has over 10,000 parts, with one third coming from outside of North America, complicating the supply chain, and threatening production targets. Tesla will also have to compete the Gigafactory successfully to mass produce lithium ion batteries to drive down the unit cost for Tesla vehicles and Powerwall units. Across the United States, the solar roofs production will be constrained by the success of the Gigafactory 2 in Buffalo, New York.

While the Model 3 production is occurring, more configurations will be available to order and Tesla will have to maintain a high standard of quality while meeting customer demand and starting the prototyping of the semi-truck and the Model Y, in addition to managing the Federal tax deduction phase out after 250,000 units produced. With the previous production problems of early models of the S and X, Tesla faces wider backlash potential as the Model 3 is ordered by people outside of the early adopters who are not as tolerant of malfunctioning parts. With the increasing number of owners, Tesla will also have to expand the number of charging stations, especially in urban areas, where garage charging is often not available. The addition of the long-range Model 3 will compete with the lower range Model S, a problem that Tesla will have to solve to avoid cannibalized sales. In addition, as Tesla is expanding quickly, some of its service centers have received poor reviews with low-quality delivery service, poor maintenance service, and a long wait time for Tesla customers.

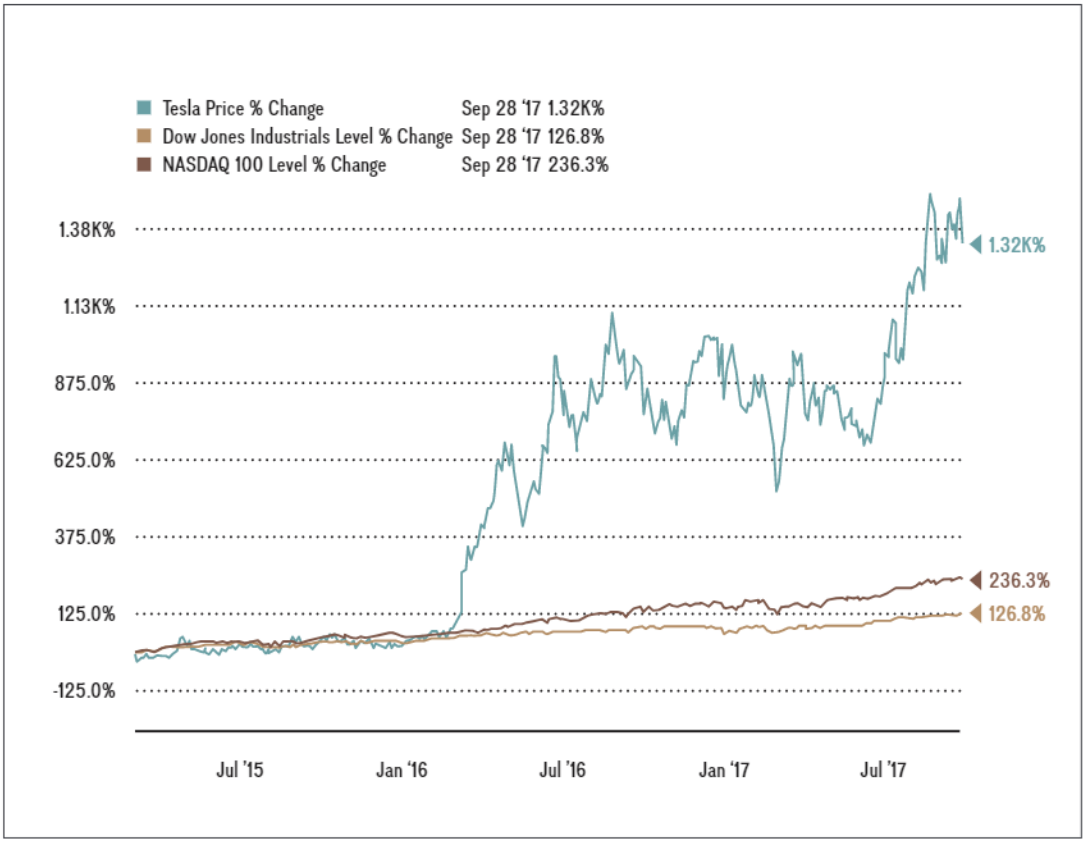
The Chevy Bolt might be a contender to the Model 3 with the Chevy Bolt's range (~ 240 miles per charge), GM's large-scale production capacity, and their ability to take losses when selling a vehicle. In addition, GM has a long way to go before reaching the 250,000 threshold (for each U.S. car manufacturer) when the $7,500 federal tax deduction for buyers of an all-electric vehicle will phase out. Tesla will have to ramp up production successfully to meet demand to avoid contributing to the possible adoption of the Bolt.

As more customers receive Tesla vehicles, the safety of the vehicle and the autopilot feature will come under more scrutiny as opportunities for accidents increase, especially with the high-profile death in 2016 of a Model S driver using the autopilot feature, as a glaring example.[83] As Tesla and other companies deploy autonomous driving technologies, they will need to navigate changing Federal and state regulations.

Thinking about all these issues, Elon Musk started to type up a priority "to do list" so that he could lead the execution of his new strategy, part two...

Tesla Motors, Inc.

EXHIBIT 1 Tesla's (Normalized) Stock Performance since Initial Public Offering vs. Dow Jones Industrial Average (DJIA), January 29, 2010–September 28, 2017



Source: Depiction of publicly available data.

Tesla Motors, Inc.

EXHIBIT 2 Tesla Financial Data, 2012–2016 ($ millions, except EPS data)

Fiscal Year	2012	2013	2014	2015	2016
Cash and short-term investments	220.98	848.90	1,923.66	1,219.54	3,498.74
Receivables (total)	26.84	49.11	226.60	168.96	499.14
Inventories (total)	268.50	340.36	953.68	1,277.84	2,067.45
Property, plant, and equipment-total (net)	562.30	1,120.92	2,596.01	5,194.74	9,117.04
Depreciation, depletion, and amortization (accumulated)	60.84	159.64	375.69	787.63	1,417.14
Assets (total)	1,114.19	2,416.93	5,849.25	8,067.94	33,664.08
Accounts payable (trade)	303.38	303.97	777.95	916.15	1,860.34
Long-term debt	411.46	598.97	1,818.79	2,040.38	6,053.86
Liabilities (total)	989.49	1,749.81	4,879.35	6,936.95	16,750.17
Stockholders' equity (total)	124.70	667.12	911.71	1,083.70	4,752.91
Sales (net)	413.26	2,013.50	3,198.36	4,046.03	7,000.13
Cost of goods sold	354.36	1,451.15	2,084.75	2,699.93	4,453.78
Selling, general, and administrative expense	424.35	517.55	1,068.36	1,640.13	2,266.60
Income taxes	0.14	2.59	9.40	13.04	26.70
Income before extraordinary items	-396.21	-74.01	-294.04	-888.66	-674.91
Net income (loss)	-396.21	-74.01	-294.04	-888.66	-674.91
Earnings per share (basic) excluding extraordinary items	-3.69	-0.62	-2.36	-6.93	-4.68
Earnings per share (diluted) excluding extraordinary items	-1.66	-2.53	-3.69	-0.62	-2.36

Source: Tabulation of publicly available data.

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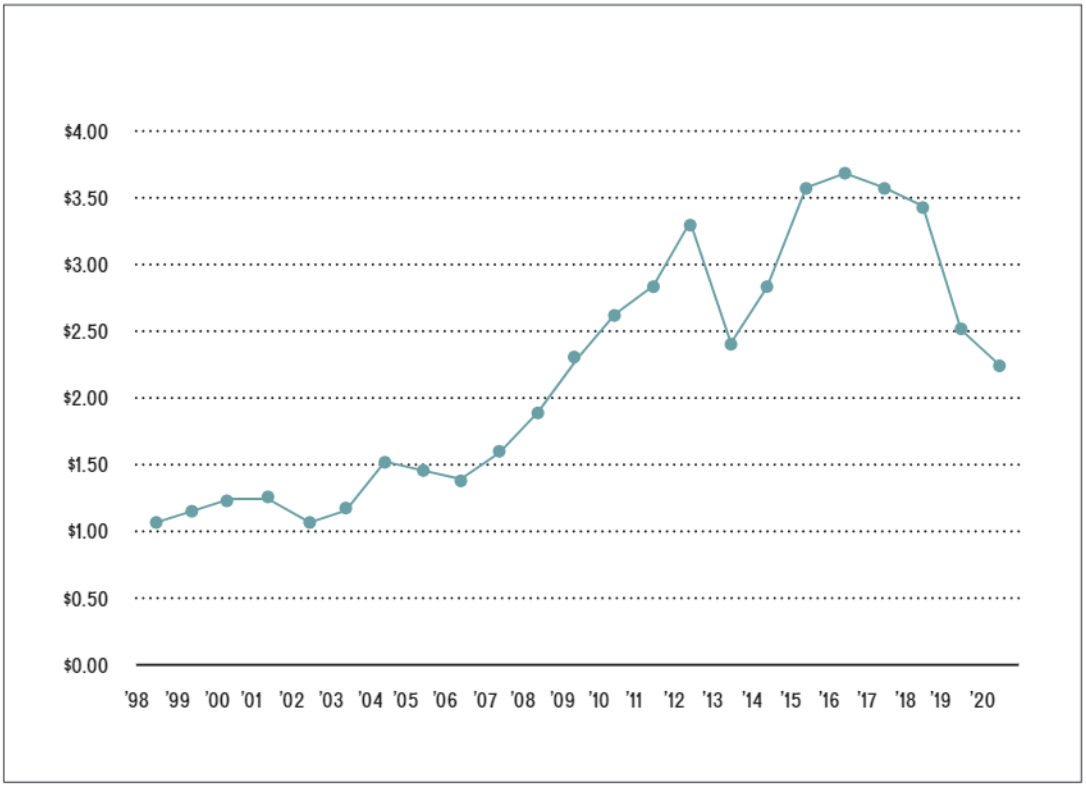
EXHIBIT 3 U.S. Retail Average Annual Gasoline Prices (Dollars per Gallon), 1994–2016



Source: Depiction of data from U.S. Energy Information Administration (EIA).

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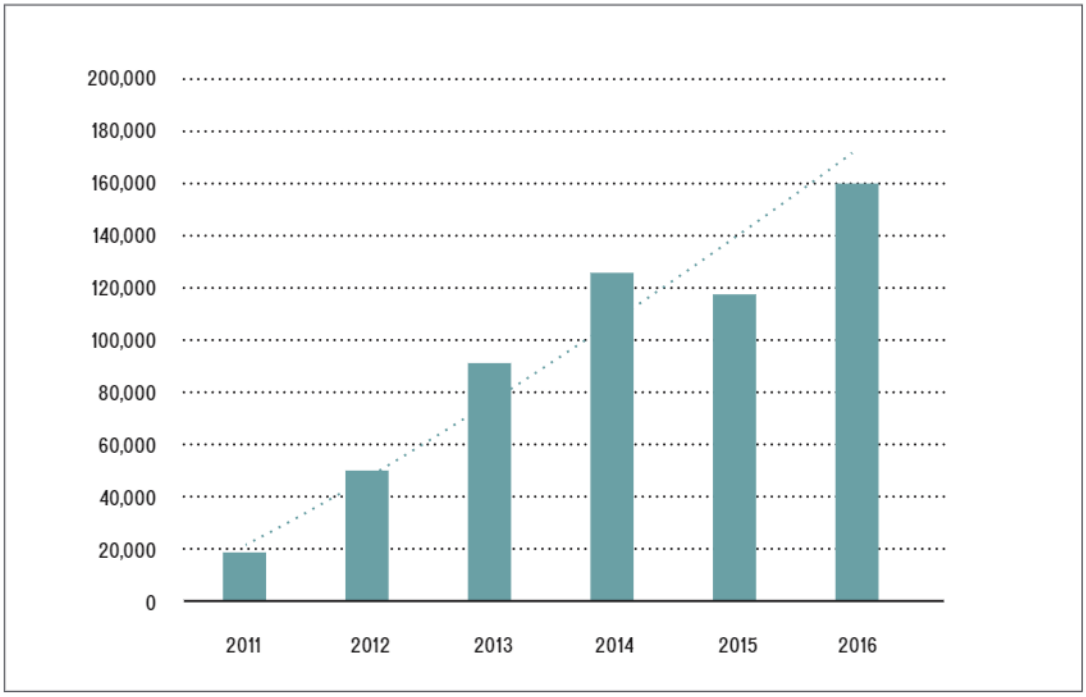
EXHIBIT 4 Battery Electric Vehicles (BEVs) Sales in U.S., 2011–2016



Source: Depiction of data "U.S. Electric Vehicle Sales Soared In 2016," *Forbes*, February 5, 2017. Dashed trendline added.

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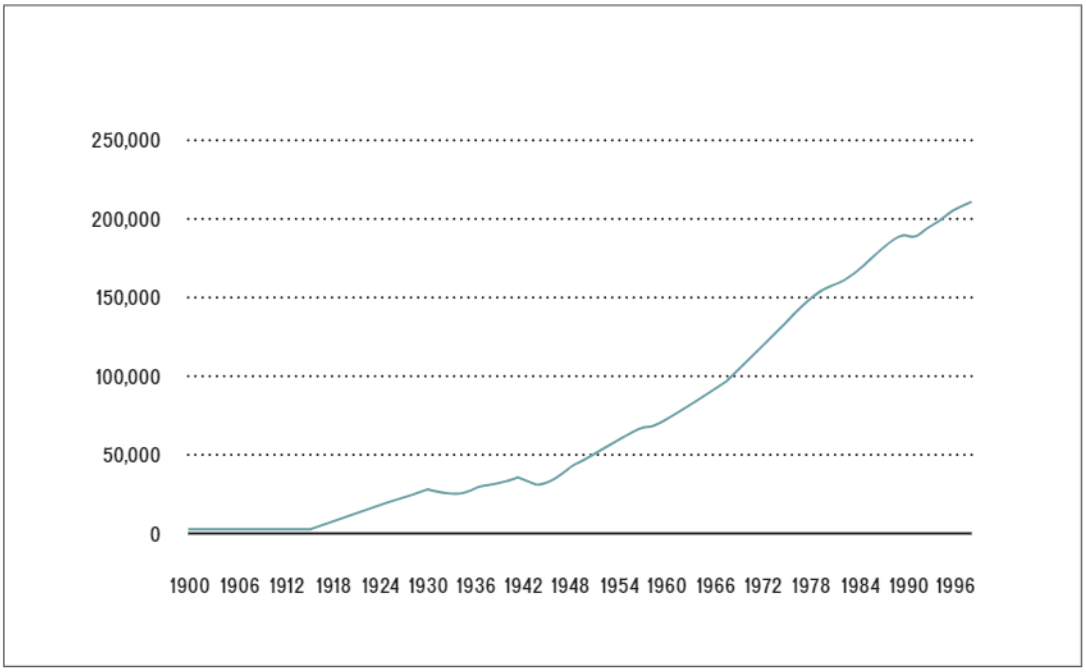
EXHIBIT 5 Total Number of Motor Vehicle Registrations (ICE) in the U.S., 1900–1998 (in thousands)



Source: Depiction of data from U.S. Census

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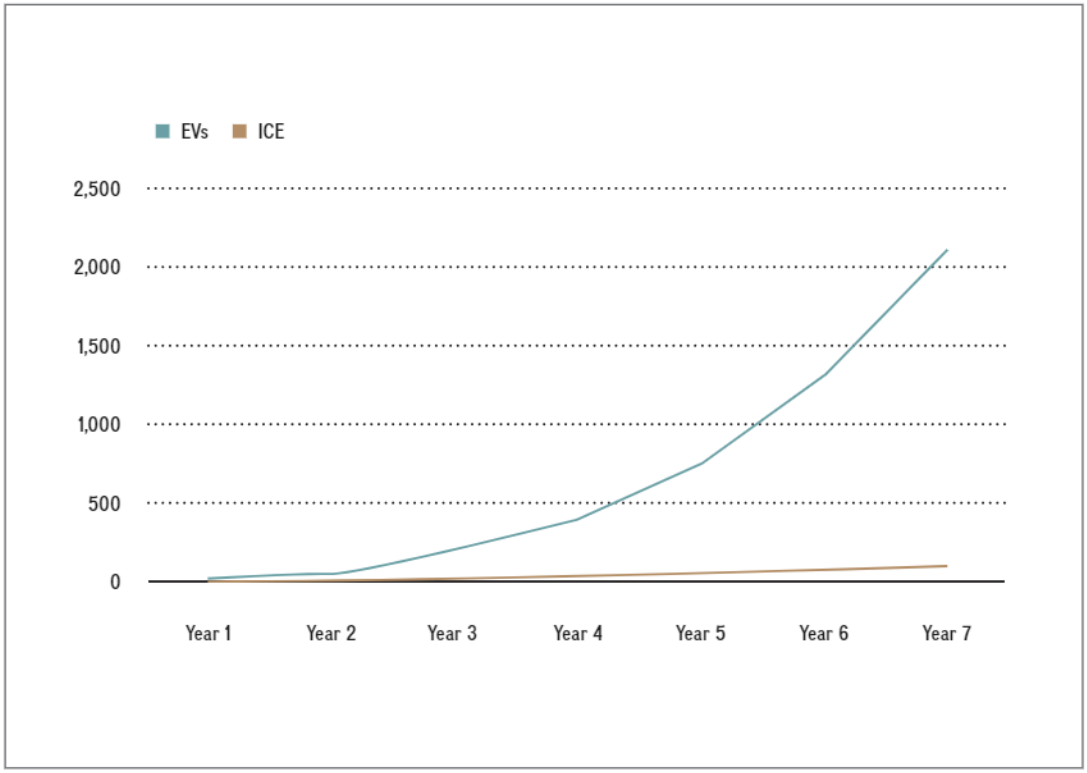
EXHIBIT 6 Comparing the Number of (ICE)* Car Registrations with that of Electric Vehicle (EV)** Sales Worldwide in First Seven Years of Respective Industry (1900–1906 for ICE Cars and 2010–2016 for EVs), in Thousands



* ICE = Internal Combustion Engine

** EV = electric vehicle (battery-electric vehicle only; hybrids, etc. are not included in count)

Source: Depiction of data from U.S. and International Energy Agency (ICE).

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EXHIBIT 7 The Six Stages of Automation (Autonomous Vehicles)

Level 0: No Automation. A human control all the critical driving functions.

Level 1: Driver Assistance. The vehicle can perform some driving functions, often with a single feature such as cruise control. The driver maintains control of the vehicle.

Level 2: Partial Automation. The car can perform one or more driving tasks at the same time, including steering and accelerating, but still requires the driver to remain alert and in control.

Level 3: Conditional Automation. The car drives itself under certain conditions but requires the human to intervene upon request with sufficient time to respond. The driver isn't expected to constantly remain alert.

Level 4: High Automation. The car performs all critical driving tasks and monitors roadway conditions the entire trip, and does not require the human to intervene. Self-driving is limited to certain driving locations and environments.

Level 5: Full Automation. The car drives itself from departure to destination. The human is not needed; indeed, human intervention would introduce more errors than fully automated driving. The car is as good or better than a human and steering wheels and pedals are potentially no longer needed in vehicle.

Source: Adapted from definitions provided by U.S. National Highway Traffic Safety Administration.

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