



# The Engineer

Follow  
Elon Musk  
on a journey from  
South Africa  
to  
Mars

Erik Nordeus

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# Preface

The history of *The Engineer - Follow Elon Musk on a journey from South Africa to Mars* began in 2006 when I read a book about peak oil. The idea behind peak oil is that the world sooner or later will run out of oil because oil is a finite resource. Most books written on the subject are within the doomsday category. The book I read argued that when there's no more oil we would be forced to return to a 19th century society. Horses would be the main mode of transportation because the alternatives, such as electric cars, wouldn't make a difference because they weren't good enough.

Peak oil terrified me. The first night I had nightmares about how the world would look like without any vehicles. How would we deliver food? How would we build houses? How would we transport injured people? I watched every day how the price of oil climbed to record levels. But when the 2008 credit crisis hit the world, the price of oil decreased from \$150 per barrel, and nightmares about derivatives replaced my nightmares about peak oil.

Fast forward to late 2012. One dark autumn night I watched a video on YouTube where the entrepreneur Kevin Rose interviewed a guy called Elon Musk. I had never heard of him or his companies before. At the end of the interview, Elon mentioned that he worked with the Hyperloop - a fifth mode of transportation, where the other modes are

train, boat, road, and aircraft. This sounded interesting to the engineer in me, so I needed to learn more about him.

After reading a few articles, I realized that Elon was well aware of peak oil. He had even designed an electric car that could replace a gasoline car. The book I had read about peak oil was wrong! To learn more about Elon, I searched for if someone had written a biography. The only books I found were those biographies where the author has copied only what's available on Wikipedia. I began reading more articles and watching more videos, and I realized it existed so much information I might as well write a real biography.

But this is not just a book about Elon as it has several other purposes. Elon himself said, "I think you have to enjoy what you are doing. Otherwise, it is hard to do it. There are three things you look for. You have to look forward in the morning to doing your work. You do want to have a significant financial reward. And you want to have a possible effect on the world. If you can find all three, you have something you can tell your children."

I believe this book may have a positive effect on the world. The first purpose with the book is to motivate young people to become engineers. It has been estimated that Europe will lack 500 000 engineers by 2020, and I believe the solution is inspiration.

During my first year in engineering school, each student had to read a book on the Nobel Prize. I don't recall the purpose; maybe someone thought we would become more motivated? But the book had almost the opposite effect - we became less motivated. The characters in the book were no

role models we could find any inspiration from. Elon, on the other hand, is a true role model. Will Elon ever get a Nobel Prize? If he doesn't get it, will he be sad about it? He might, but then he jumps into his Tesla Roadster, drives to the airport, boards his private jet, flies to the nearest spaceport where he enters a rocket on its way to a new civilization on Mars. That's inspiring.

The second purpose with this book is to motivate engineers to become entrepreneurs and tackle the larger, more expensive, and difficult problems. I believe there are professional engineers who have great ideas, but they don't know they can build a company from those ideas. If Elon can build two Internet companies, a rocket company, a car company, and a solar company - why can't you?

Another purpose is to explain the why of things. The problem is that not everyone understands Elon and his companies. How can you convince someone to buy an electric car if he or she at the same time believes the supply of oil is infinite? Elon himself said, "If you could explain the why of things then that makes a huge difference to people's motivation."<sup>353</sup> So someone has to explain why we need to move away from a society dependent on oil. Why do we need to build rockets and colonize Mars? Elon has tried to explain everything by giving countless interviews, but it's difficult to understand the big picture from articles and videos. I hope that you who read this book will soon understand the big picture behind Elon.

I also believe the author of a biography on Elon has to be an engineer. I've read articles by non-engineers (I

suspect) that confuses different topics. One example is that several articles argued that Elon became interested in electric cars to save the environment. But that's not true. Elon became interested in electric cars because the world is running out of oil. During one interview, he had to hang up the phone because the journalist couldn't understand the difficult topics. But don't worry - you don't need to be an engineer to read this book.

I've used 457 sources to write this biography. The goal is that everything in the book is as truthful as it can be in an unofficial biography. But since it's after all rocket science, some factual errors may exist. If you find an error, I'm happy to correct it as soon as possible.

Several conflicts have happened throughout Elon's life, including divorces and angry employees. When describing these conflicts, I've tried to be as neutral as possible by including the views from both sides.

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# Introduction

*“I think we’re going to the Moon because it’s in the nature of the human being to face challenges. It’s by the nature of his deep inner soul. Yes, we are required to do these things just as salmon swim upstream.”*

Neil Armstrong

*“All our dreams can come true, if we have the courage to pursue them.”*

Walt Disney

A dictionary defines an engineer: “A professional practitioner of engineering, concerned with applying scientific knowledge, mathematics, and ingenuity to develop solutions for technical problems. Engineers design materials, structures, and systems while considering the limitations imposed by practicality, regulation, safety, and cost. The word engineer is derived from the Latin roots *ingeniare* [to contrive, devise] and *ingenium* [cleverness].”<sup>391</sup>

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This is a book about the beginning of a journey. Elon Musk is the main person in the journey through a roller-coaster life. His journey includes everything from Winston

Churchill's adventures in British colonies to demolished sports cars. From failed marriages to German scientists escaping from the Red Army. From the oil industry to the Burning Man festival.

Elon has been described as the Steve Jobs of heavy industry, as a modern version of the scientist Nikola Tesla, and as the Henry Ford of rockets. There's a high probability that the British Secret Intelligence Service has a file on him. As the files of other James Bond villains, it describes secret rocket launches in the Pacific Ocean. But Elon doesn't own a white cat - he's more of a dog person. Maybe the most comparable persons are the great explorers who voyaged across the globe. They had an entrepreneurial spirit, were a little crazy, tried what no one else had tried, and thought what no one else had thought.

If you want to describe the companies Elon has founded with one theme, you can say that they improve the world with the help of innovative technologies. This is exactly what our world needs.

The history of mankind begins about 50 000 years ago. We know little of the first 40 000 years, except at the end of them, we had learned to use the skins of animals. Then we emerged from our caves to construct other kinds of shelter. 5 000 years ago, we learned how to write and how to use a cart with wheels. Now began the acceleration of technological progress. Within only a few hundred years, we invented the steam engine, electric lights, telephones, cars, and airplanes. In the last few years, we developed penicillin, television, and nuclear power.<sup>19</sup>

Then something happened. Everyone forgot the larger problems and began to focus on the smaller problems. The computer in a modern phone is more powerful than the computer in the craft that landed on the Moon, but we are only using the power to fire birds against pigs and to watch pictures showing what our friends ate for breakfast. Was it that future we wanted? In a famous speech, the former US President John F. Kennedy said, "So it is not surprising that some would have us stay where we are a little longer to rest, to wait. But this city of Houston, this State of Texas, this country of the United States was not built by those who waited and rested and wished to look behind them. This country was conquered by those who moved forward."<sup>19</sup>

We are no longer moving forward with ever-greater speed, we are moving slower. The Concorde could fly across the Atlantic Ocean in three hours, and the commercial said, "The world is now a smaller place." But with the decommissioning of the Concorde in 2003, the world is now a larger place. We're not just flying slower, other modes of transportation are also moving slower. The US state of California ordered a bullet train that would be one of the slowest bullet trains in the world at the highest cost per mile.

The world has not just become a larger place; we are also destroying the world. One explanation to why we no longer are moving faster is because we are using expensive, dirty, and sometimes dangerous energy sources. We are not only using nuclear power plants, we are a world dependent on oil. The problem is that oil is a finite natural resource

we are running out of, and we may begin to run out of it as soon as 2020. Unless we want to start using horses, we need to design technology that doesn't rely on oil.

The question is why we are focusing on the smaller problems and forget the larger ones. One of the reasons might be that it's complicated and more expensive to build an electric car, while it's less expensive to build yet another Facebook clone. Another reason might be that we are satisfied with what we have. We don't have to replace the world's oil dependency today. But what happens when we need to? What if we need to leave the planet because something has happened or will happen to it. Then we have to trust that someone has the answers to these larger problems no one cares about today.

But someone who cares about these larger problems is Elon. He knows how we can replace our dependency on oil. He knows how we can colonize Mars and escape to the red planet if something happens to Earth. To yet again make the world a smaller place, he has designed an aircraft that's faster than the Concorde.

The difference between Elon and other pundits is that he realizes his ideas. To save the world from its oil dependency, he's creating companies with exactly that purpose. To be able to escape to Mars, he has already begun building the rockets needed. To make the world a smaller place, he will release the technology for free. The rest of the world needs to just sit back and enjoy the ride.

# Sand Hill Road

You can find several stories about the engineer Elon Musk. One of them took place on and around the Sand Hill Road in California. It goes like this:

A 28-year-old Elon wanted to buy a new car. The price of the car wasn't important because he didn't need to think about money anymore. He had just made \$22 million from selling his company.<sup>327</sup> His garage had already included a 1967 Series 1 E-type Jaguar, which is considered to have the best car design ever made. Now he wanted the fastest car he could find.

A magnesium silver McLaren F1 met his requirements. The British made McLaren F1 is essentially a road-ready version of a racing car from the Formula One World Championship. With a top speed of 231 mph [372 km/h], it set a record in 1998 as the fastest road car in the world. It only takes 3.2 seconds to reach 60 mph [100 km/h].

It was a close call when Elon bought his dream car. The fashion designer Ralph Lauren tried to buy the same one, but Elon signed the deal one hour earlier.<sup>263</sup> When McLaren began selling it, the fortunate customers paid one million dollars to get one. But since only 106 cars were ever manufactured, the price today can be as high as four million dollars. Elon bought number 67.<sup>10</sup>

A large black truck delivered the McLaren F1 to Elon's home. He was now famous in Silicon Valley, so a film crew behind the documentary *Silicon Valley Gold Rush* followed each step. Like a boy before Christmas, Elon jumped around the truck while the car was unloaded. The first person who walked by said, "Is that a McLaren F1? Oh my God. That's unbelievable." Elon was happy. "Wow, I can't believe it's actually here," he said. "That's pretty wild man. Just three years ago, I was showering at the YMCA and sleeping on the office floor, and now I got a million dollar car."<sup>27</sup>

Enthusiasts described the McLaren F1 as the purest super car ever manufactured. This may sometimes be a drawback with owning one because enthusiasts chase them like a paparazzi chasing a movie star. "I lined up next to one at a light in Palo Alto a few months ago," a proud enthusiast said. "I think it was the one that belongs to the X.com/PayPal founder guy [Elon Musk]. Made my day."<sup>9</sup>

Seeing the car in Silicon Valley wasn't anything unusual. The region has the largest density of McLaren F1 in the world. "I'm more excited about seeing this car than I have ever been about anything else," another enthusiast said. "Nothing else compares at all. As he [Elon Musk] braked for the 90-degree right to get on the freeway, the rear diffuser popped up exposing its gold foil covered underside. That sent a chill up my spine – go ahead – laugh all you want. When he decided he'd had enough of me tagging along beside him he practically disappeared down the FWY. Considering he's got about five times the power

of my car, I just let him go.”<sup>111</sup>

In 2000, Elon drove his McLaren F1 along Sand Hill Road. Located in California, the Sand Hill Road has the same appeal as Wall Street in New York. Venture capitalist companies flock to the road, and it provides easy access to the Stanford University and Silicon Valley. During the height of the tech bubble – when the difference between being the next big thing and looking like it didn’t matter – the commercial real estates on Sand Hill Road were more expensive than almost anywhere else in the world. The prices were so high it would be less expensive to live on Manhattan in New York. It was impossible to find vacant office spaces or any legal places to park. Those who could afford to live in the area accepted the cost of parking tickets as part of the high price of living there. But money wasn’t a problem for most people. You could hear comments like, “Let’s call our team Gold Rush because we all want to make a lot of money.”<sup>167</sup>

Together with Elon in the car sat his friend and co-worker Peter Thiel. They were on their way to the famous venture capital firm Sequoia Capital where they would brainstorm fund-raising strategies. Thiel sat in one of the two passenger seats. The driver in a McLaren F1 is sitting in the middle of the car in a seat personally customized for each owner. Slightly behind the driver, there are two passenger seats on each side of the driver’s seat.<sup>8,123</sup>

“So what can this do?” Thiel asked Elon after a fifteen-minute demonstration of the car.

“Watch this,” Elon replied and floored the gas pedal.

The McLaren F1 has no traction control because the car is designed for maximum performance, so the car began to spin after a lane change. Elon did what he could to avoid the other cars driving on the same road while he at the same time tried to control the spinning car. After some terrifying seconds, the McLaren F1 slammed into the embankment of the road. The car lifted from the ground and began rotating like a discus flying through the air. They finally crashed down on the ground.<sup>328</sup>

When the dust cleared, Thiel heard how Elon laughed. Thiel asked him why he laughed when he had just wrecked his new dream car. “You don’t know the funny part, it wasn’t even insured,” Elon replied.<sup>328</sup> It’s unclear exactly why he laughed. One reason might have been the shock from the traumatic event that had just happened. Another reason can be explained with the new word “muskitude,” defined as a supercilious attitude caused by having made too much money too young.<sup>301</sup> It might have been a combination of both.

Elon and Thiel survived the crash without any major injuries. “The first woman who saw us thought we were dead, and the whole thing felt like a roller coaster gone a little bit out of control,” Thiel said.<sup>8</sup> Before the emergency services arrived to the scene, Thiel opened the gull-winged door, stepped out of the car, and hitchhiked a ride to not miss the meeting with Sequoia Capital. Elon also hitchhiked a ride to the meeting once a tow truck arrived to the scene.

Despite the dramatic accident, the McLaren factory



could repair the damaged car. The car's main body had survived, but the front and the suspension were damaged. After the brief detour to the workshop, Elon began using the McLaren F1 as his daily driver to and home from work.

Another unfortunate McLaren F1 driver was the British comedian and actor Rowan Atkinson, also known as Mr. Bean. His black McLaren F1, number 61, has crashed twice. Luckily he survived the accidents without any major injuries, but his insurance company had to pay the most expensive insurance payout ever recorded in Britain.<sup>6</sup> In favor of Atkinson's driving skills, he has driven the car since 1997, covering a distance of 37 000 miles [60 000 km]. It's probably a world record among McLaren F1 owners.<sup>7</sup>

While Atkinson competes with other sports cars on a racetrack, Elon never participated in a race with his car. Elon, however, once tried to see how fast he could drive it on an airstrip, and he pushed the McLaren F1 to speeds of 215 mph [346 km/h].<sup>4</sup>

In 2007, Elon felt he had to sell his beloved McLaren F1. As the manager of a company manufacturing environmental friendly cars, he wanted to improve his image. "It was an environmental decision," he said. "My McLaren F1 was a great car. It was a work of art, really, but it's not good for the environment and I didn't want people always writing that I have a high-performance gasoline sports car, so I decided to sell it."<sup>69</sup>

Number 67 wasn't more safe with its new owner. After six months of winter storage in a garage, the new owner wanted to take it out for a spin. A passing onlooker

alerted the driver that smoke came out of the rear engine compartment. As the owner jumped out, the fire spread quickly, destroying large parts of the car. Since the car is a collectibles item, the McLaren factory had to save it yet again. But there's no need to feel sad for the owner while the car was repaired – the owner had one McLaren F1 in reserve.<sup>5</sup>

So who said it was dull to be an engineer?

# The Electric Stars

There was a time when more electric cars drove on the roads than there were cars powered by fossil fuels. In 1900, electric motors powered 34 percent of the cars in New York, Boston, and Chicago. A steam or a combustion engine powered the other cars.<sup>385</sup>

Manufactured in the late 1800s, the first electric cars were quiet, clean, and could be charged in the home.<sup>59</sup> The torpedo shaped electric car, *The Never Satisfied*, was the first vehicle to reach a speed over 62 mph [100 km/h]. Those who saw the record thought they were going to die if they traveled so fast. While Henry Ford mass produced gasoline cars, his wife Clara Ford drove a 1914 Detroit Electric with a range of 80 miles [130 km] and a speed of 20 mph [32 km/h].<sup>218</sup>

Around 1920, the gasoline cars began to outnumber the electric because they were easier to refuel. In most smaller towns in America, the gasoline car arrived before electricity. The gasoline car was also less expensive. You could buy three of Ford's Model T for the price of just one electric car.<sup>59,329</sup> Several car manufacturers have since then again and again tried to sell electric cars. But all models failed. They didn't always fail because the cars were expensive, slow, ugly, or had a limited range – they could also fail because the auto manufacturers wanted them to fail. The best example is General Motors's EV1.

At the 1990 Los Angeles Auto Show, General Motors revealed an electric concept car: the Impact. Because of the name, you could hear comments like, “What’s next, the Ford Whiplash?” General Motors announced at the same time how the Impact would become a vehicle for the mass market. The California Air Resources Board realized this new generation of electric vehicles could solve the state’s problem with pollution. The same year, they passed the Zero-Emission Vehicle mandate. It said that if a car manufacturer wanted to sell cars in California, some cars must be free from exhaust. California was a large market, so the car manufacturers didn’t have any other choice than to begin selling electric cars.<sup>330</sup>

The Impact evolved into the EV1 [Electric Vehicle 1]. It became the first modern mass produced electric car – 1 117 were manufactured between 1996 and 1999. The EV1 had two seats, a futuristic shape where the rear wheels were almost covered, it was developed in California, and was supposed to be the first in a series of electric vehicles. The next car in the series would be called EV2, the next EV3, and so on. “This is going to represent a great step forward for people in terms of commuting to work, from work, if you don’t have to go more than 120 miles [190 km] a day,” the CEO of General Motors explained when he introduced the car.

Several celebrities enjoyed driving the EV1. The only sound they could hear from the car was a slight hum and the quiet clicks from the brakes. Because there was no lag between pedal and power, the EV1 owner and actor, Mel

Gibson, thought he drove the same car as the superhero Batman. “With no gears to complicate acceleration, you get that launched sort of feeling, a childish giddiness called the EV smile,” a driver said.<sup>330</sup>

Another famous EV1 driver was Alexandra Paul, who played a lifeguard in the television series *Baywatch*. “Mine [EV1] was forest green, got 70 miles [113 km] on a charge, and handled like a Porsche,” she said. “A couple years later, improved battery technology in the EV1 allowed me to get 100 miles to a charge and then 120 miles to a charge. It was my only vehicle, and served 95 percent of my driving needs. When I needed to go farther, I borrowed a Toyota Prius.”

Paul had previously owned two other electric cars. She had taken an interest in them ever since the oil tanker *Exxon Valdez* struck a reef in Alaska and 500 000 barrels of oil spilled into the sea. “I was very much on my high horse about it, until I realized that I was part of the reason that the Exxon Valdez was out there in the first place – my car needed gasoline as much as the next person’s to take me from one place to another in my daily life,” she said.<sup>379</sup>

The actor and director, Peter Horton, wanted to join the other celebrities. “I decided to go electric,” he said. “I had seen those sleek, sort of George Jetson EV1s shoot by me with surprising speed on the freeways. I thought, fine, I’ll get an EV1.” But Horton couldn’t find one. General Motors had removed them from the market.<sup>229</sup>

According to General Motors, the EV1 failed. They didn’t believe the car would bring in any profits to the company because the EV1 would never appeal to anyone

else than a small group of technology enthusiasts and environmentalists. But before the car was removed from the streets, 4 000 people had written on a list how they wanted to order the EV1. General Motors called these people and began the conversation with describing the car's limitations. So when they came to the bottom of the list, it had shrunk to 50 people. The private individuals who supported the EV1 wondered if it really was a wise idea to sell a car by describing the limitations. This is how one of the supporters recalled a discussion with General Motors:

“What’s wrong with the batteries? The ones in my car seem to work fine,” an EV1 owner asked.

“Do you know how much it costs to replace those batteries? A lot,” a General Motors representative replied.

“Yeah, but doesn’t it cost a lot to replace a transmission or an engine in a traditional car?”

“Not as much as you’d think. An engine’s only a couple hundred.”

“That’s because you mass produce them?”

“Well, that and other factors.”

“If you mass produced the batteries, wouldn’t their cost come down?”

“Yeah, but we’re not.”<sup>229</sup>

The final kill to the electric vehicle in California came when General Motors, Chrysler, and several auto dealers sued the California Air Resources Board. In April 2003, California killed the electric car mandate. They thought the batteries were not yet good enough to be a competitive alternative to the gasoline car.

Another technology shift happened at the same time. With one billion dollars, the US Government announced it would support the shift to hydrogen fuel-cell vehicles.<sup>330</sup> Elon Musk is not a fan of fuel-cells and nicknamed them “fool-cells.”<sup>328</sup> “If car companies can’t figure out anything else to do they give a technology that is always ten years into the future and something people don’t quite understand,” Elon said. “People say, ‘They are doing something for sustainable transport, but we don’t understand it and it’s ten years away.’ And then ten years go by and nothing happens.”<sup>366</sup>

General Motors didn’t sell the EV1, the customers leased it for \$250 to \$500 per month. When General Motors canceled the EV1 program, they told the owners they had to turn them in or they would face legal consequences. Some owners wanted to keep their cars, so they fought back. But nothing helped. General Motors called the police who carried away the last supporters who blocked the truck that transported the last EV1 away from the roads in 2004.<sup>330</sup>

The now heartbroken EV1 owners held a funeral for the cars. You could hear a musical piece with Scottish bagpipes and each owner held a speech. “What the contractors and critics of electric vehicles have been saying for years is true; the electric vehicle is not for everybody. Given the limited range, it can only meet the needs of 90 percent of the population,” an owner said.<sup>330</sup>

A group of EV1 supporters traveled across the country to find out what had happened to their cars. They heard a rumor that the cars had been transported to the General

Motors proving ground in Arizona. With a rented helicopter, they flew over the area and found the now crushed cars. “The EV1 had to be forcibly taken from people, and then the cars were sent to some car graveyard where they were squashed, while the customers held a candle-light vigil,” Elon said. “Now, when was the last time you heard of someone holding a candle-light vigil for a product, let alone a General Motors product? How blind do you have to be to not realize that that is something you should be pursuing, not destroying? It’s astounding incompetence. Mind-blowing incompetence. How foolish. Where would GM be today if it had done the EV2 and EV3?”<sup>197</sup>

While General Motors manufactured the EV1, Toyota manufactured 1 480 electric RAV4 EV. 500 of them were still rolling on the roads as late as 2012. One famous RAV4 EV driver was the actor Tom Hanks, famous from the movie *Forrest Gump*. He began to search for an electric vehicle in 2003, and since the EV1 didn’t exist anymore, he had to buy the RAV4 EV. “When the car companies collectively, and, to some, diabolically, decided to take these cars back, the electric vehicles disappeared,” Hanks said. “But not mine. I have the pink slip. I own that car, and it is still driven every day, albeit by one of my crack staff of employees. My electric car recently crossed 50 000 miles [80 000 km] on the odometer with its original battery but without so much as a splash of gasoline.”<sup>191</sup>

In addition to the RAV4 EV, Hanks bought an eBox, which is an electric Toyota Scion xB. The car actually looks like a box and may not win a design price, but Hanks



liked it. “There are three electric cars sitting on the Moon, and now another one in my garage,” Hanks said. “The eBox makes even more sense in Los Angeles than in the Taurus-Littrow Valley of the Moon. I can drive all weekend, hauling dogs and helping my friends move, and the only reason I’ll need to stop at a gas station is for beef jerky and lottery tickets.”<sup>192</sup> Ironically, it was engineers from General Motors who came up with the best design for the electric Lunar Rover that drove around on the Moon.<sup>348</sup>

AC Propulsion was responsible for converting the Toyota Scion xB to the electric eBox. Alan “Al” Cocconi, thus the AC in the company name, founded the company in 1992. Cocconi had earlier worked with the now crushed EV1. He designed the first prototype in his garage. But as General Motors didn’t believe in the EV1, he decided to make a better car on his own.

Cocconi bought a Piontek kit car, converted it to electric power, and renamed it to tzero. “We designed it to show that ultimate performance is available for electric vehicle technology,” Cocconi said. The plan was that the tzero would be the first in a series of the next generation environmental friendly vehicles. The name tzero originates from the engineering term  $t_0$ , which indicates the first measurement of time in a sequence of several measurements, where  $t_1$  is the next measurement, and so on.

It was the tzero that convinced Hanks to buy an eBox. “I drove their tzero electric sports car a few years ago, so when they put the same technology in a four-door I wanted one for myself,” he said.<sup>219</sup> The yellow tzero wouldn’t win

a design competition, it had no safety systems, and it was expensive. But it was fast. When the car competed with a famous sports car, the Dodge Viper, the tzero had a better acceleration.<sup>33</sup>

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Elon has always liked cars. He has owned, among others, a 2007 Porsche 911 Turbo, a Hamann BMW, an Audi Q7, the 1967 Series 1 E-type “bad girlfriend” Jaguar, and of course the McLaren F1.<sup>4</sup> He used the Porsche as a family car. Two of his children could sit in the tiny back seat.<sup>190</sup> But electricity didn’t power any of these cars.

Cars are the type of transportation that consumes the most oil. Out of the 20 million barrels of oil consumed each day in the US, cars are using 25 percent, light trucks are using 18 percent, heavy trucks are using 16 percent, and airplanes are using 6 percent. When there’s no more oil to fill the gasoline vehicles, then we have no other choice than to choose another type of fuel. Elon’s prophecy is that peak oil will happen in 2020, so he believes a majority of all new cars manufactured in year 2030 will be pure electric. 20 years after that, a majority of all cars on the roads will be pure electric.<sup>360</sup> “There may be something cooler than a car in 20 years, but the most likely outcome is that we’ll still have cars and they’ll be predominantly electric,” Elon said.<sup>316</sup>

Alternatives such as ethanol or fuel-cells are not good enough compared with the electric alternative. Ethanol may work in countries where there’s plenty of room to

grow the plants that will be turned into ethanol, but not in other countries. “Domestic ethanol as the primary solution will definitely not work for the world’s most populous countries, such as Japan, China, India, Pakistan, Indonesia,” Elon said. “Those countries are either breaking even on domestic food production or are net importers. If you argue that ethanol is to be grown elsewhere and shipped, where are the vast tracts of unused arable land?”<sup>248</sup>

Electricity is the best alternative because electricity is like cash – it can be generated in many ways. You can power an electric vehicle by generating electricity from coal, wind, solar, water, oil, natural gas, geothermal, or nuclear power.<sup>359</sup>

Electric vehicles are also energy efficient to use. Let’s say you produce electricity in a coal power plant. If you calculate the CO<sub>2</sub> per mile if an electric vehicle is charged with electricity from the coal power plant, the electric vehicle will release less CO<sub>2</sub> per mile compared with a hybrid car. This is because even without clean electricity production, it’s very efficient to produce power at a power plant. “What’s important to appreciate is that even if the power is 100 percent coal-generated, the CO<sub>2</sub> per mile is still better than a gasoline engine,” Elon said. “The electric motor is incredibly good at turning energy into motion. Mostly what you’re doing with a gasoline engine in a car is generating heat.”<sup>57</sup>

In 2003, Elon went to a lunch in Los Angeles organized by Harold Rosen.<sup>199</sup> With them was also JB Straubel, who first heard of Elon when he attended a Stanford University

speech where Elon talked about SpaceX.<sup>214</sup>

At age 14, Jeffrey Brian Straubel, known to all as JB, discovered a discarded electric golf cart. He decided to rebuild it. To find the parts needed, he convinced his mother to drive as far as 50 miles [80 km] in search for batteries, tires, and electric motors. “He was passionate about it,” his mother said. “He wrote to the manufacturers for information. He worked on it every day, all day long, all evening long, until he got it to run. JB was born to be an engineer. He was always passionate about anything that had wheels and required engineering.” To motivate himself, he watch the movie *October Sky*. “I watch it every year or so,” he said. “It’s inspirational. I always come out of it wanting to work harder.”<sup>213,215</sup>

Straubel has always enjoyed the sound of silence. He can drive for hours without listening to music. This might be the reason to why he became fascinated by machines powered by electricity. “Electric vehicles don’t make much noise,” Straubel said. “When they do, something is not right.” Among other projects, he worked with unmanned electric airplanes, he converted a Porsche 944 to electric drive, and he constructed an electric bicycle nicknamed *the Red Bike*. He was also a fan of the EV1 and you can see him, or his unknown twin, driving it in the documentary *Who killed the electric car?* “I was talking to anyone and everyone to promote the idea that electric vehicles had turned a corner,” Straubel said. “I told them that with new battery technology, they could go much, much farther than anyone thought was possible.”<sup>213,215</sup>

Armed with two engineering degrees from Stanford University, Straubel joined Rosen Motors where he met Harold Rosen who was one of the founders. Rosen had previously worked within the space industry and he's considered to be the father of the geosynchronous satellite. Straubel and Rosen left Rosen Motors and founded Volacom where they helped the company Scaled Composites – the same company that won the Ansari X Prize.<sup>39</sup>

Straubel and Rosen sat now at the lunch table together with Elon. The topic of the day was space, but they also talked about general topics. Elon mentioned how he came to California to work on a new battery technology for electric vehicles, and how he became interested in them before global warming became a hot topic. Maybe they laughed when Elon said he talked about cars with girls he dated. “And we talked about lithium-ion and what that meant for electric vehicle range.” Elon said. “The EV1 had a range of about 120 miles [190 km] or so with nickel metal hydride and so if you did a direct substitution of lithium-ion for nickel metal hydride, which has directly two times the energy density you get to around a 240-250 mile range, which would be acceptable to people.”<sup>199</sup> It's true because nearly eighty percent of all Americans drive less than 40 miles [64 km] a day.<sup>59</sup>

They began talking about AC Propulsion. Straubel, who had friends working at AC Propulsion, mentioned that the company developed early prototypes of electric sports cars, and the performance of these cars was good. After Elon told him he wanted to learn more, Straubel arranged

a meeting with AC Propulsion so Elon could drive the tzero.

Despite the car's disadvantages, Elon liked the ideas behind the tzero. He said it was a really awesome vehicle. For several months, Elon tried to convince AC Propulsion to accept funding from him to commercialize the tzero by creating an electric sports car for the mass market. But AC Propulsion was a small company. They wanted to tinker and experiment with their vehicles before they commercialized it, so they declined the offer. AC Propulsion also declined to sell a tzero to Elon and convert his Porsche to electric drive.<sup>199</sup>

What Elon could do was to buy an eBox. While Hanks liked the car, Elon didn't like the idea to convert the Toyota Scion xB. The basic vehicle cost \$20 000, the electric conversion cost \$45 000, so you had to pay \$65 000 for the final vehicle. "Who wants to take an ugly \$20 000 car and buy it for \$65 000?" Elon asked. "That's not a very viable strategy. I wouldn't want to drive it. My wife certainly wouldn't want to drive it. I said, 'Look, I wouldn't even drive an electric Scion if it was free.' I mean, it's OK as a car, but come on."<sup>4,209</sup>

Elon told AC Propulsion that if they didn't want to manufacture an electric vehicle for the mass market, then he would do it on his own. "Do you want to meet Martin, Marc, and Ian?" AC Propulsion asked Elon.<sup>199</sup>

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Martin Eberhard was born in 1960 in California and at age thirteen, he drove his first car. With a degree in

computer and electric engineering from the University of Illinois, he had founded several companies.<sup>209</sup>

In 1996, Eberhard co-founded NuvoMedia together with Marc Tarpenning. He was born in 1964 in California and earned a degree in computer science from the University of California. After graduating, he spent the next five years in the oil-rich nation of Saudi Arabia where he worked at Textron - an American company involved in a wide range of products, including electric golf carts.

It was when he was working in Saudi Arabia that Tarpenning discovered the oil industry's darker sides. "The amount of treasure that is sent to the Middle East to supply our oil addiction is astonishing," he said. "And it doesn't necessarily do good things there and it doesn't do good things for us, and that got me thinking that oil is not so great."<sup>453</sup>

In 2000, Eberhard and Tarpenning sold their company to Gemstar for \$187 million.<sup>71</sup> Now they wanted to create a new company. "We knew we wanted to solve a real problem," Tarpenning said. "We just couldn't do another network widget." They researched a wide range of major problems, including water scarcity and income inequality. "So we looked at these big problems, and there are a lot of big problems out there, but the one that we took was oil," Tarpenning said.<sup>453</sup>

The reason why they thought oil was the major problem is because oil causes several other problems, including global warming, political problems, and economical problems. "If you can reduce your dependency on oil everything

gets easier,” Tarpenning said.<sup>453</sup>

When US refused to sign the Kyoto Protocol on climate change, Eberhard was embarrassed, and he was concerned about how US had to import oil from troublesome countries. This was when primarily US troops for the second time in twelve years invaded Iraq.<sup>205</sup> “To me, the only way that I can be successful at something is to work at something I actually care about,” Eberhard said. “This time around, the something meaningful I care about was oil consumption. It was clear to me that we had to do something about our oil consumption, both from a global warming perspective and from a national security perspective.”<sup>355</sup>

To calm his nerves, he tried to buy an electric car. But he realized he couldn’t find one to buy. “So I was considering some of the electric cars that were on the market,” Eberhard said. “I didn’t particularly like them, but I thought about maybe I would convince myself to get one. And just about when I had talked myself into that, they disappeared from the market.” He realized not a single car company in America tried to design a decent electric car.<sup>200</sup>

While not petting his Siamese cat, Eberhard cruised around in California. He saw how wealthy people, including actor Clint Eastwood, drove the environmental friendly Toyota Prius only because they cared about the environment. The gasoline price was in 2003 low, so they didn’t drive it to save money.<sup>196</sup> “Every time I get into my Prius, I feel like I’m demonstrating my point of view on national security,” the talent agent, Ari Emanuel, said when he replaced his Ferrari with a Prius.<sup>346</sup>



When the Prius drivers returned home, they also had a Porsche or a similar expensive gasoline car parked in their garage. Eberhard realized a market existed for a sports car with the same performance as a Porsche and at the same time was more environmental friendly than the Prius – a *Porschius* as he called it.<sup>345</sup> The average income of the EV1 drivers was above \$200 000 per year. Since they couldn't drive the EV1 anymore, maybe they would buy a Porschius? Or maybe they needed an electric motorcycle? But the market for such a bike wasn't as interesting as the market for electric cars.<sup>453</sup>

The Prius had both a battery and a gasoline engine, but the battery couldn't charge when the owner parked the car. "Without plug-in capability, a hybrid is just a gasoline powered car with some fancy hardware," Eberhard said. He nicknamed the Prius *dork mobile*. Elon had the same ideas. "You could have the entire country driving the Prius and we'd still be addicted to oil," Elon said. "When you create a hybrid, you're designing an amphibian – and an amphibian is going to be a worse fish than a fish, and a worse mouse than a mouse or whatever creature you want to pick."<sup>197</sup> Elon nicknamed the Prius *gas-guzzling hog*.

Eberhard and Tarpenning examined the electric car market, mainly with the help of a Google search and by ordering brochures on eBay. They came to the same conclusions as Elon had when he did a similar market research. Electric power is the future because electricity gives you the highest efficiency and performance compared with other alternatives.<sup>345</sup> Hydrogen fuel-cells, natural gas, hybrid

technologies, and diesel were all dismissed as competitive alternatives.<sup>196</sup> “What surprised me was that electric cars were substantially more efficient than everything else out there,” Eberhard said.<sup>205</sup>

The tzero did not only convince Elon, it also convinced Eberhard he could design a true electric sports car. He had earlier invested money in AC Propulsion – they had lost several contracts and were about to go bankrupt – and he also drove the tzero as a daily driver during three months. “The company was about to go out of business,” Eberhard said. “When I saw them, they had five employees left and were not paying salaries. I paid their rent and commissioned them to build a car.”<sup>223</sup>

The drawback with the tzero wasn't the speed - it was the 60 miles [100 km] range. To increase the range, Eberhard told AC Propulsion to replace the old batteries with thousands of lithium-ion batteries – the same battery as in a laptop or a mobile phone. Eberhard used these batteries at NuvoMedia where he and Tarpenning developed the RocketBook – an early e-book reader similar to the Kindle and the iPad. Before Amazon developed the Kindle, NuvoMedia negotiated with the CEO of Amazon, Jeff Bezos, if Amazon wanted to invest in their company. But Eberhard didn't agree to Bezos's demands.<sup>411</sup>

The RocketBook's batteries lasted for 20 to 24 hours. When they installed the new batteries, the device became lighter but had the same performance.<sup>344</sup> It turned out AC Propulsion already experimented with the same batteries, and the new batteries worked as expected. The tzero's

range increased to 300 miles [480 km] and the acceleration improved to 0-60 mph [0-100 km/h] in 3.6 seconds.<sup>196</sup>

In the summer of 2003, Eberhard co-founded Tesla Motors together with Tarpinning. When they founded the company, they chose between if they should name the company after the scientists Nikola Tesla or Michael Faraday.<sup>350</sup> They agreed on Tesla Motors. Another fan of Tesla is Elon, who even contributed with financial aid to a future Tesla museum. JB Straubel is also a fan of Tesla and one of his favorite biographies is *Wizard: The Life and Times of Nikola Tesla* by Marc J. Seifer.<sup>215</sup>

Born in 1856, Tesla became a productive scientist, and has given name to the units of magnetism, which are units of tesla [T]. At the end of his life, he went a little crazy. He became fascinated by the pigeons in the park and he designed death-rays that would end all wars. “Tesla’s problem was that he wasn’t entirely sane, and that got worse later in his life,” Elon said. “Retaining sanity is important.”<sup>128</sup>

In 1943, Tesla died poor and alone in a hotel room. The reason why he was poor was that he could build his inventions in his brain – he almost never made the physical products – so he couldn’t make any money. When he finished the design in his head, he became bored, and moved on to the next idea. “I need no models, drawings, or experiments,” Tesla said. “I could picture them all as real in my mind. I do not rush into actual work. When I get an idea, I start at once building it up in my imagination. I change the construction, make improvements and operate the device in my mind. It is absolutely immaterial to me

whether I run my turbine in thought or test it in my shop.”

Tesla and Elon are quite similar to each other. As children, both of them read many books and made experiments. Both studied physics and they moved from other countries to the US. While Tesla decided not to join the military by living in the forest for a year, Elon moved to Canada to avoid joining the military.

In February 2004, the founding team behind Tesla finished writing a business plan. Their idea was to license the electric powertrain technology from AC Propulsion and to use an existing car manufacturer to build the rest of the car. What they needed now was money, lots of money, so they began looking for outside investors.

One interesting thing they did was to present Tesla in front of investors and friends they from the beginning knew wouldn't invest in the company because they invested in other areas. “We asked them if we could pitch to them this goofy car company idea we had,” Tarpenning said. “We wanted the feedback before we shot our silver bullets with the real people that might fund us.” Because of the feedback they received, they changed their business plan, including the entire distribution model.<sup>453</sup>

One of their friends they practiced in front of was Ian Wright. He had met Eberhard in 1998 when they sat next to each other on a flight between San Francisco and Tokyo. They began to talk and realized that both were interested in cars and they lived only a short distance from each other. Wright worked as a senior director of engineering at Network Equipment Technologies and was an amateur

race car builder and driver.<sup>384</sup>

Wright was also an entrepreneur and he practiced to present his business idea in front of Eberhard and Tarpenning. It turned out that Wright's idea never worked, but he thought Tesla's idea was so interesting that he joined the company. "They were keen to get me to join up because I used to build and race sports cars as a hobby in Australia," Wright said. "I knew a bit more about how cars worked than they did. The tipping point for me was when Martin borrowed the tzero from AC Propulsion, and I got to drive it. That was the thing that persuaded me – although I wouldn't want to buy that car, I could certainly see how you could make something new and interesting with electric drive."<sup>26</sup>

The NASDAQ stock market index was at an all-time low and most investors licked their wounds from the dot.com bubble. They were not interested in financing heavy industry, especially not in companies involved in environmental friendly technology when the price of oil was low. "Back then the only electric vehicles you could buy were golf carts, and the VCs couldn't imagine themselves wanting to buy one of those, so it was a very uphill battle at that time," Wright said. A few investors were interested, but only if Tesla found a lead investor.<sup>205</sup>

Eberhard had earlier met a person called Elon Musk at a conference arranged by the Mars Society. He contacted Elon by e-mail when AC Propulsion told him Elon was interested in electric cars. Elon replied with an invitation to a meeting at SpaceX.

In April 2004, after a two-hour meeting, Elon decided to invest \$6.3 million in the company Tesla Motors.<sup>196</sup> “It’s kind of crazy, who in their right mind would start a car company?” Elon asked. “But I guess I have more than my fair share of hubris. I’ll do it. I’m in, we’ll draw up the paperwork, but we have to close it in three weeks, because my wife is having twins and if we don’t get it done by then it’s not going to happen.”<sup>205</sup> Elon wasn’t the only investor, but he contributed with 98 percent of the funding. The other investors consisted of smaller venture capital firms and individuals like Eberhard.<sup>199,209</sup>

But the founders of Tesla and Elon didn’t agree on all points. The main difference was that Elon had a larger vision. While he wanted to build a company as large as General Motors, the founders wanted to build a small company. “Well, there are a few things that I disagreed in what they showed,” Elon said. “I didn’t want to be a niche sports car company. I wanted it to be something that would aim for the mass market as soon as possible.”<sup>199</sup> But Tesla didn’t have any other options. Tesla needed a deal with Elon far more than Elon needed an investment in Tesla. “You take money from the people who offer it to you,” Eberhard said. “People think I’m some kind of rich guy, but I’m not. I still clean the bathrooms in my house, I wash my own laundry, I change my children’s nappies.”<sup>196,205</sup>

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The total number of employees at Tesla was now five. Eberhard became the CEO, Tarpenning became the CFO,

Ian Wright became the VP of vehicle development, Elon became the chairman and the head of product design. Straubel joined the company and worked as an engineer for about a year before he became the CTO.<sup>199</sup>

To save the world from its dependency on oil, Tesla needed to manufacture many cars. But that would have been impossible for a newly founded company. A better idea was to begin with an expensive car that might not save the world, but it will start the snowball. Any new technology on the market is expensive: the first computers, the first mobile phones, and the first gasoline cars. “You can look at the early days of the cell phone – like when you look at the original Wall Street movie where the guy is walking around with the brick phone with a lousy signal and 30 minutes of battery time and it was really expensive,” Elon said. “In those days, if you asked people if eventually everyone would have a portable phone with the power of a supercomputer you would be told ‘no way.’ That’s how it is when you have a new technology – you have to look at where it’s headed. To quote Wayne Gretzky, ‘skate to where the puck’s going to be.’ That’s how it is with electric cars.”<sup>375</sup>

You need two things to make a technology available to the mass market and at the same time make it affordable: economies of scale and optimize the design. Usually at the third version of a product, it starts reaching mass market potential.<sup>322</sup> “Any car that we make at low volume, which is the first version of technology will be expensive,” Elon said. “It didn’t matter what that car look like. We can make

something that look like a very standard vehicle, such as a Toyota Corolla, and it would have cost \$70 000. But nobody would pay that for what looks like a mid-size economy sedan. But people are willing to pay \$100 000 for a fast sports car.”<sup>339</sup>

So the strategy Tesla had was to begin with a high-price, low-volume car. This model’s codename was DarkStar after a classic science fiction movie.<sup>272</sup> You can only charge a high price for a limited number of cars, and you can expect a customer to pay a high price for a sports car. DarkStar would prove that the customers wanted a high-performance electric car. It would also give the company credibility. The suppliers would be willing to write contracts with Tesla and Tesla could find more money from investors who now trusted the company.

WhiteStar would be phase two. That’s a mid-price, mid-volume car. The profits from the DarkStar would pay for the development of the WhiteStar. “In keeping with a fast growing technology company, all free cash flow is plowed back into R&D [Research & Development] to drive down the costs and bring the follow on products to market as fast as possible,” Elon said.<sup>247</sup>

Phase three would be the car with mass market potential. The high-volume, low-price car, with the codename BlueStar. “Our long term plan is to build a wide range of models, including affordable priced family cars,” Elon said.

Tesla thought it would cost \$25 million before they could deliver the first DarkStar, but in the end, they would need \$140 million. “We hugely underestimated the chal-



lenge – the complexity of supply chains, of manufacturing, of the battery design. It was like working through a maze,” Straubel said.<sup>59</sup> “Pretty much everything went wrong,” Elon added. But no one outside of the company knew what was happening because Tesla developed the DarkStar in secret. “Silicon Valley is a great place to run a secret car company,” Eberhard said. “Nobody expected something to sprout up in Northern California, so no one came looking.”<sup>272</sup>