|  |  |
| --- | --- |
| Cover Image | *Elon Musk: Tesla, SpaceX, and the Quest for a Fantastic Future* Ashlee Vance  HarperCollins |

|  |
| --- |
| This document is overwritten when you make changes in Play Books.  You should make a copy of this document before you edit it. |

# *56 notes/highlights*

*Created by Tarang Shah*  – Last synced March 2, 2016

## *4         ELON’S FIRST START-UP*

|  |  |  |  |
| --- | --- | --- | --- |
| |  |  |  | | --- | --- | --- | |  | *What kept the employees’ spirits up were the continuous improvements Musk made with the Zip2 software.*  Early tech founder  October 6, 2015 | [68](http://play.google.com/books/reader?printsec=frontcover&output=reader&id=qvW0BAAAAEAJ&source=books-notes-export&pg=GBS.PA68) | |

|  |  |  |  |
| --- | --- | --- | --- |
| |  |  |  | | --- | --- | --- | |  | *Early on in the Zip2 venture, Musk acquired an important confidant, who tempered some of these more dramatic impulses. Greg Kouri, a Canadian businessman in his mid-thirties, had met the Musks in Toronto and bought into the early Zip2 brainstorming.*  Role of a mentor/elder person at the beginning  October 6, 2015 | [68](http://play.google.com/books/reader?printsec=frontcover&output=reader&id=qvW0BAAAAEAJ&source=books-notes-export&pg=GBS.PA68.w.0.0.0.3) | |

|  |  |  |  |
| --- | --- | --- | --- |
| |  |  |  | | --- | --- | --- | |  | *Kouri, who had done a number of real estate deals in the past and had actual business experience and skills at reading people, served as the adult supervision at Zip2. The Canadian had a knack for calming Musk and ended up becoming something of a mentor.*  Role of mentor 2  October 6, 2015 | [69](http://play.google.com/books/reader?printsec=frontcover&output=reader&id=qvW0BAAAAEAJ&source=books-notes-export&pg=GBS.PA69) | |

|  |  |  |  |
| --- | --- | --- | --- |
| |  |  |  | | --- | --- | --- | |  | *While Musk had exceled as a self-taught coder, his skills weren’t nearly as polished as those of the new hires. They took one look at Zip2’s code and began rewriting the vast majority of the software. Musk bristled at some of their changes, but the computer scientists needed just a fraction of the lines of code that Musk used to get their jobs done. They had a knack for dividing software projects into chunks that could be altered and refined whereas Musk fell into the classic self-taught coder trap of writing what developers call hairballs—big, monolithic hunks of code that could go berserk for mysterious reasons*  Engineering before the startup makes it big.  October 6, 2015 | [71](http://play.google.com/books/reader?printsec=frontcover&output=reader&id=qvW0BAAAAEAJ&source=books-notes-export&pg=GBS.PA71) | |

|  |  |  |  |
| --- | --- | --- | --- |
| |  |  |  | | --- | --- | --- | |  | *This was a welcome change from Musk’s approach, which had been to set overly optimistic deadlines and then try to get engineers to work nonstop for days on end to meet the goals. “If you asked Elon*  October 1, 2015 | [71](http://play.google.com/books/reader?printsec=frontcover&output=reader&id=qvW0BAAAAEAJ&source=books-notes-export&pg=GBS.PA71.w.0.0.0.1) | |

|  |  |  |  |
| --- | --- | --- | --- |
| |  |  |  | | --- | --- | --- | |  | *how long it would take to do something, there was never anything in his mind that would take more than an hour,” Ambras said. “We came to interpret an hour as really taking a day or two and if Elon ever did say something would take a day, we allowed for a week or two weeks.”*  Optimistic Deadlines and their accuracy  October 6, 2015 | [71](http://play.google.com/books/reader?printsec=frontcover&output=reader&id=qvW0BAAAAEAJ&source=books-notes-export&pg=GBS.PA71.w.0.0.0.2) | |

|  |  |  |  |
| --- | --- | --- | --- |
| |  |  |  | | --- | --- | --- | |  | *Years later, after he had time to reflect on the Zip2 situation, Musk realized that he could have handled some of the situations with employees better. “I had never really run a team of any sort before,” Musk said. “I’d never been a sports captain or a captain of anything or managed a single person. I had to think, Okay, what are the things that affect how a team functions. The first obvious assumption would be that other people will behave like you. But that’s not true. Even if they would like to behave like you, they don’t necessarily have all the assumptions or information that you have in your mind. So, if I know a certain set of things, and I talk to a replica of myself but only communicate half the information, you can’t expect that the replica would come to the same conclusion. You have to put yourself in a position where you say, ‘Well, how would this sound to them, knowing what they know?’”*  Musk reflecting on the days of running his first company zip2  October 6, 2015 | [76](http://play.google.com/books/reader?printsec=frontcover&output=reader&id=qvW0BAAAAEAJ&source=books-notes-export&pg=GBS.PA76) | |

|  |  |  |  |
| --- | --- | --- | --- |
| |  |  |  | | --- | --- | --- | |  | *Employees at Zip2 would go home at night, come back, and find that Musk had changed their work without talking to them, and Musk’s confrontational style did more harm than good. “Yeah, we had some very good software engineers at Zip2, but I mean, I could code way better than them. And I’d just go in and fix their fucking code,” Musk said. “I would be frustrated waiting for their stuff, so I’m going to go and fix your code and now it runs five times faster, you idiot. There was one guy who wrote a quantum mechanics equation, a quantum probability on the board, and he got it wrong. I’m like, ‘How can you write that?’ Then I corrected it for him. He hated me after that. Eventually, I realized, Okay, I might have fixed that thing but now I’ve made the person unproductive. It just wasn’t a good way to go about things.”*  Work of employees may seem of less quality than what you build, but if the employee is worth being an employee, you should let go and not fix his work, but indicate the flaw that you see and suggest improvements which the employee can choose to add, or maybe not.  October 20, 2015 | [76](http://play.google.com/books/reader?printsec=frontcover&output=reader&id=qvW0BAAAAEAJ&source=books-notes-export&pg=GBS.PA76.w.0.0.0.2) | |

|  |  |  |  |
| --- | --- | --- | --- |
| |  |  |  | | --- | --- | --- | |  | *Musk, the dot-com striver, had been both lucky and good. He had a decent idea, turned it into a real service, and came out of the dot-com tumult with cash in his pockets, which was better than what many of his compatriots could say. The process had been painful. Musk had yearned to be a leader, but the people around him struggled to see how Musk as the CEO could work. As far as Musk was concerned, they were all wrong, and he set out to prove his point with what would end up being even more dramatic results.*  "in your face" proving a point  October 6, 2015 | [76](http://play.google.com/books/reader?printsec=frontcover&output=reader&id=qvW0BAAAAEAJ&source=books-notes-export&pg=GBS.PA76.w.0.0.0.4.0.1) | |

## *5         PAYPAL MAFIA BOSS*

|  |  |  |  |
| --- | --- | --- | --- |
| |  |  |  | | --- | --- | --- | |  | *So while Musk could be found on television talking like the rest of the self-absorbed dot-com schmucks, he behaved more like a throwback to Silicon Valley’s earlier days, when the founders of companies like Intel were willing to take huge gambles on themselves. Where Zip2 had been a neat, useful idea, X.com held the promise of fomenting a major revolution. Musk, for the first time, would be confronting a deep-pocketed, entrenched industry head-on with the hopes of upending all of the incumbents. Musk also began to hone his trademark style of entering an ultracomplex business and not letting the fact that he knew very little about the industry’s nuances bother him in the slightest. He had an inkling that the bankers were doing finance all wrong and that he could run the business better than everyone else. Musk’s ego and confidence had started heading toward the levels that would inspire some and leave others thinking of him as pompous and unscrupulous. The creation of X.com would ultimately reveal a great deal about Musk’s creativity, relentless drive, confrontational style, and foibles as a leader. Musk would also get another taste of being pushed aside at his own company and the pain that accompanies a grand vision left unfulfilled*  Risking a lot to start in an industry you know little about, but believing in the idea and yourself execute it.  October 20, 2015 | [84](http://play.google.com/books/reader?printsec=frontcover&output=reader&id=qvW0BAAAAEAJ&source=books-notes-export&pg=GBS.PA84.w.0.0.0.1) | |

|  |  |  |  |
| --- | --- | --- | --- |
| |  |  |  | | --- | --- | --- | |  | *Musk assembled what looked like an all-star crew to start X.com. Ho had worked at SGI and Zip2 as an engineer, and his peers marveled at his coding and team-management skills. They were joined by a pair of Canadians with finance experience—Harris Fricker and Christopher Payne. Musk had met Fricker during his time as an intern at the Bank of Nova Scotia, and the two really hit it off. A Rhodes scholar, Fricker brought the knowledge of the banking world’s mechanics that X.com would need. Payne was Fricker’s friend from the Canadian finance community. All four men were considered cofounders of the company, while Musk emerged as the largest shareholder thanks to his hefty up-front investment. X.com began, like so many Silicon Valley operations, at a house where the cofounders began brainstorming, and then moved to more formal offices at 394 University Avenue in Palo Alto.*  The team at X.com, Musk's second startup.  October 20, 2015 | [85](http://play.google.com/books/reader?printsec=frontcover&output=reader&id=qvW0BAAAAEAJ&source=books-notes-export&pg=GBS.PA85) | |

|  |  |  |  |
| --- | --- | --- | --- |
| |  |  |  | | --- | --- | --- | |  | *From the outset, there were personality clashes as well. Musk had become a budding superstar in Silicon Valley and had the press fawning over him. This didn’t sit that well with Fricker, who’d moved from Canada and pegged X.com as his chance to make a mark on the world as a banking whiz. Fricker, according to numerous people, wanted to run X.com and do so in a more conventional manner. He found Musk’s visionary statements to the press about rethinking the entire banking industry silly since the company was struggling to build much of anything. “We were out promising the sun, moon, and the stars to the media,” Fricker said. “Elon would say that this is not a normal business environment, and you have to suspend normal business thinking. He said, ‘There is a happy-gas factory up on the hill, and it’s pumping stuff into the Valley.’” Fricker would not be the last person to accuse Musk of overhyping products and playing the public, although whether this is a flaw or one of Musk’s great talents as a businessman is up for debate*  Clashes at the beginning, root bieng Musk's over hypeing and bloating facts, which may have been the right way to go about things...  October 20, 2015 | [85](http://play.google.com/books/reader?printsec=frontcover&output=reader&id=qvW0BAAAAEAJ&source=books-notes-export&pg=GBS.PA85.w.0.0.0.3.0.1) | |

## *6         MICE IN SPACE*

|  |  |  |  |
| --- | --- | --- | --- |
| |  |  |  | | --- | --- | --- | |  | *His fears that mankind had lost much of its will to push the boundaries were reinforced one day when Musk went to the NASA website. He’d expected to find a detailed plan for exploring Mars and instead found bupkis. “At first I thought, jeez, maybe I’m just looking in the wrong place,” Musk once told Wired. “Why was there no plan, no schedule? There was nothing. It seemed crazy.” Musk believed that the very idea of America was intertwined with humanity’s desire to explore. He found it sad that the American agency tasked with doing audacious things in space and exploring new frontiers as its mission seemed to have no serious interest in investigating Mars at all. The spirit of Manifest Destiny had been deflated or maybe even come to a depressing end, and hardly anyone seemed to care.*  We wanted flying cars but instead got 140 characters.  December 29, 2015 | [103](http://play.google.com/books/reader?printsec=frontcover&output=reader&id=qvW0BAAAAEAJ&source=books-notes-export&pg=GBS.PA103.w.0.0.0.4) | |

|  |  |  |  |
| --- | --- | --- | --- |
| |  |  |  | | --- | --- | --- | |  | *Mueller had helped Musk fill out that spreadsheet around the performance and cost metrics of a new, low-cost rocket, and, along with the rest of Team Musk, had subsequently refined the idea. The rocket would not carry truck-sized satellites like some of the monster rockets flown by Boeing, Lockheed, the Russians, and others countries. Instead, Musk’s rocket would be aimed at the lower end of the satellite market, and it could end up as ideal for an emerging class of smaller payloads that capitalized on the massive advances that had taken place in recent years in computing and electronics technology. The rocket would cater directly to a theory in the space industry that a whole new market might open for both commercial and research payloads if a company could drastically lower the price per launch and perform launches on a regular schedule. Musk relished the idea of being at the forefront of this trend and developing the workhorse of a new era in space. Of course, all of this was theoretical—and then, suddenly, it wasn’t. PayPal had gone public in February with its shares shooting up 55 percent, and Musk knew that eBay wanted to buy the company as well. While noodling on the rocket idea, Musk’s net worth had increased from tens of millions to hundreds of millions. In April 2002, Musk fully abandoned the publicity-stunt idea and committed to building a commercial space venture. He pulled aside Cantrell, Griffin, Mueller, and Chris Thompson, an aerospace engineer at Boeing, and told the group, “I want to do this company. If you guys are in, let’s do it.” (Griffin wanted to join but ended up declining when Musk rebuffed his request to live on the East Coast, and Cantrell only stuck around for a few months after this meeting, seeing the venture as too risky.) Founded in June 2002, Space Exploration Technologies came to life in humble settings*  Getting people together and beginning a new company - spaceX  December 29, 2015 | [113](http://play.google.com/books/reader?printsec=frontcover&output=reader&id=qvW0BAAAAEAJ&source=books-notes-export&pg=GBS.PA113.w.0.0.0.4.0.1) | |

|  |  |  |  |
| --- | --- | --- | --- |
| |  |  |  | | --- | --- | --- | |  | *Musk had soon transformed the SpaceX office with what has become his signature factory aesthetic: a glossy epoxy coating applied over concrete on the floors, and a fresh coat of white paint slathered onto the walls. The white color scheme was intended to make the factory look clean and feel cheerful. Desks were interspersed around the factory so that Ivy League computer scientists and engineers designing the machines could sit with the welders and machinists building the hardware. This approach stood as SpaceX’s first major break with traditional aerospace companies that prefer to cordon different engineering groups off from each other and typically separate engineers and machinists by thousands of miles by placing their factories in locations where real estate and labor run cheap.*  Defining culture through work place/environment  December 29, 2015 | [115](http://play.google.com/books/reader?printsec=frontcover&output=reader&id=qvW0BAAAAEAJ&source=books-notes-export&pg=GBS.PA115.w.0.0.0.1) | |

|  |  |  |  |
| --- | --- | --- | --- |
| |  |  |  | | --- | --- | --- | |  | *SpaceX would build its own engines and then contract with suppliers for the other components of the rocket. The company would gain an edge over the competition by building a better, cheaper engine and by fine-tuning the assembly process to make rockets faster and cheaper than anyone else. This vision included the construction of a type of mobile launch vehicle that could travel to various sites, take the rocket from a horizontal to vertical position, and send it off to space—no muss, no fuss. SpaceX was meant to get so good at this process that it could do multiple launches a month, make money off each one, and never need to become a huge contractor dependent on government funds.*  The beginning of spacex  December 29, 2015 | [115](http://play.google.com/books/reader?printsec=frontcover&output=reader&id=qvW0BAAAAEAJ&source=books-notes-export&pg=GBS.PA115.w.0.0.0.3) | |

|  |  |  |  |
| --- | --- | --- | --- |
| |  |  |  | | --- | --- | --- | |  | *Musk felt that the space industry had not really evolved in about fifty years. The aerospace companies had little competition and tended to make supremely expensive products that achieved maximum performance. They were building a Ferrari for every launch, when it was possible that a Honda Accord might do the trick. Musk, by contrast, would apply some of the start-up techniques he’d learned in Silicon Valley to run SpaceX lean and fast and capitalize on the huge advances in computing power and materials that had taken place over the past couple of decades. As a private company, SpaceX would also avoid the waste and cost overruns associated with government contractors. Musk declared that SpaceX’s first rocket would be called the Falcon 1, a nod to Star Wars ’ Millennium Falcon and his role as the architect of an exciting future. At a time when the cost of sending a 550-pound payload started at $30 million, he promised that the Falcon 1 would be able to carry a 1,400-pound payload for $6.9 million.*  Disrupting the incumbents  December 29, 2015 | [116](http://play.google.com/books/reader?printsec=frontcover&output=reader&id=qvW0BAAAAEAJ&source=books-notes-export&pg=GBS.PA116) | |

|  |  |  |  |
| --- | --- | --- | --- |
| |  |  |  | | --- | --- | --- | |  | *Bowing to his nature, Musk set an insanely ambitious timeline for all of this. One of the earliest SpaceX presentations suggested that the company would complete its first engine in May 2003, a second engine in June, the body of the rocket in July, and have everything assembled in August. A launchpad would then be prepared by September, and the first launch would take place in November 2003, or about fifteen months after the company started. A trip to Mars was naturally slated for somewhere near the end of the decade. This was Musk the logical, naïve optimist tabulating how long it should take people physically to perform all of this work. It’s the baseline he expects of himself and one that his employees, with their human foibles, are in a never-ending struggle to match. As space enthusiasts started to learn about the new company, they didn’t really obsess over whether Musk’s delivery schedule sounded realistic or not. They were just thrilled that someone had decided to take the cheap and fast approach*  Timeliness for Falcon 1, the first space X rocket 🚀  January 19, 2016 | [116](http://play.google.com/books/reader?printsec=frontcover&output=reader&id=qvW0BAAAAEAJ&source=books-notes-export&pg=GBS.PA116.w.0.0.0.3) | |

|  |  |  |  |
| --- | --- | --- | --- |
| |  |  |  | | --- | --- | --- | |  | *And then all of a sudden none of this seemed to matter. Justine had given birth to a son—Nevada Alexander Musk. He was ten weeks old when, just as the eBay deal was announced, he died. The Musks had tucked Nevada in for a nap and placed the boy on his back as parents are taught to do. When they returned to check on him, he was no longer breathing and had suffered from what the doctors would term a sudden infant death syndrome–related incident. “By the time the paramedics resuscitated him, he had been deprived of oxygen for so long that he was brain-dead,” Justine wrote in her article for Marie Claire. “He spent three days on life support in a hospital in Orange County before we made the decision to take him off it. I held him in my arms when he died. Elon made it clear that he did not want to talk about Nevada’s death. I didn’t understand this, just as he didn’t understand why I grieved openly, which he regarded as ‘emotionally manipulative.’ I buried my feelings instead, coping with Nevada’s death by making my first visit to an IVF clinic less than two months later. Elon and I planned to get pregnant again as swiftly as possible. Within the next five years, I gave birth to twins, then triplets.” Later, Justine chalked up Musk’s reaction to a defense mechanism that he’d learned from years of suffering as a kid. “He doesn’t do well in dark places,” she told Esquire magazine. “He’s forward-moving, and I think it’s a survival thing with him.” Musk did open up to a couple of close friends and expressed the depth of his misery. But for the most part, Justine read her husband right. He didn’t see the value in grieving publicly. “It made me extremely sad to talk about it,” Musk said. “I’m not sure why I’d want to talk about extremely sad events. It does no good for the future. If you’ve got other kids and obligations, then wallowing in sadness does no good for anyone around you. I’m not sure what should be done in such situations.” Following Nevada’s death, Musk threw himself at SpaceX and rapidly expanded the company’s goals. His conversations with aerospace contractors around possible work for SpaceX left Musk disenchanted. It sounded like they all charged a lot of money and worked slowly. The plan to integrate components made by these types of companies gave way to the decision to make as much as practical right at SpaceX. “While drawing upon the ideas of many prior launch vehicle programs from Apollo to the X-34/Fastrac, SpaceX is privately developing the entire Falcon rocket from the ground up, including both engines, the turbo-pump, the cryogenic tank structure and the guidance system,” the company announced on its website. “A ground up internal development increases difficulty and the required investment, but no other path will achieve the needed improvement in the cost of access to space.”*  March 2, 2016 | [118](http://play.google.com/books/reader?printsec=frontcover&output=reader&id=qvW0BAAAAEAJ&source=books-notes-export&pg=GBS.PA118.w.0.0.0.4.0.1) | |

|  |  |  |  |
| --- | --- | --- | --- |
| |  |  |  | | --- | --- | --- | |  | *Some members of the Texas crew honed their skills to the point that they could build a test-worthy engine in three days. These same people were required to be adept at software. They’d pull an all-nighter building a turbo pump for the engine and then dig in the next night to retool a suite of applications used to control the engines. Hollman did this type of work all the time and was an all-star, but he was not alone among this group of young, nimble engineers who crossed disciplines out of necessity and the spirit of adventure. “There was an almost addictive quality to the experience,” Hollman said. “You’re twenty-four or twenty-five, and they’re trusting you with so much. It was very empowering.”*  Multidisciplinaryness - how early space X engineers did everything that had to be done  December 29, 2015 | [127](http://play.google.com/books/reader?printsec=frontcover&output=reader&id=qvW0BAAAAEAJ&source=books-notes-export&pg=GBS.PA127) | |

|  |  |  |  |
| --- | --- | --- | --- |
| |  |  |  | | --- | --- | --- | |  | *According to Musk, its first rocket would launch in “early 2004” from Vandenberg Air Force Base, carrying a satellite called TacSat-1 for the Department of Defense. With this goal looming, twelve-hour days, six days a week were considered the norm, although many people worked longer than that for extended periods of time. Respites, as far as they existed, came around 8 P.M . on some weeknights when Musk would allow everyone to use their work computers to play first-person-shooter video games like Quake III Arena and Counter-Strike against each other. At the appointed hour, the sound of guns loading would cascade throughout the office as close to twenty people armed themselves for battle. Musk—playing under the handle Random9—often won the games, talking trash and blasting away his employees without mercy. “The CEO is there shooting at us with rockets and plasma guns,” said Colonno. “Worse, he’s almost alarmingly good at these games and has insanely fast reactions. He knew all the tricks and how to sneak up on people.”*  Counterstrike within a company! Reminds of AcYut 😂 b  December 29, 2015 | [129](http://play.google.com/books/reader?printsec=frontcover&output=reader&id=qvW0BAAAAEAJ&source=books-notes-export&pg=GBS.PA129.w.0.0.0.2) | |

|  |  |  |  |
| --- | --- | --- | --- |
| |  |  |  | | --- | --- | --- | |  | *The only way to keep up with all of this work was to do what SpaceX had promised from the beginning: operate in the spirit of a Silicon Valley start-up. Musk was always looking for brainy engineers who had not just done well at school but had done something exceptional with their talents. When he found someone good, Musk was relentless in courting him or her to come to SpaceX. Bryan Gardner, for example, first met Musk at a space rave in the hangars at the Mojave airport and a short while later started talking about a job. Gardner was having some of his academic work sponsored by Northrop Grumman. “Elon said, ‘We’ll buy them out,’” Gardner said. “So, I e-mailed him my resume at two thirty A.M ., and he replied back in thirty minutes addressing everything I put in there point by point. He said, ‘When you interview make sure you can talk concretely about what you do rather than use buzzwords.’ It floored me that he would take the time to do this.” After being hired, Gardner was tasked with improving the system for testing the valves on the Merlin engine.*  Hiring @spacex Musk  December 29, 2015 | [131](http://play.google.com/books/reader?printsec=frontcover&output=reader&id=qvW0BAAAAEAJ&source=books-notes-export&pg=GBS.PA131.w.0.0.0.3) | |

|  |  |  |  |
| --- | --- | --- | --- |
| |  |  |  | | --- | --- | --- | |  | *As the new hires arrived, SpaceX moved beyond its original building to fill up several buildings in the El Segundo complex. The engineers were running demanding software and rendering large graphics files and needed high-speed connections between all of these offices. But SpaceX had neighbors who were blocking an initiative to connect all of its buildings via fiber optic lines. Instead of taking the time to haggle with the other companies for right of way, the IT chief Branden Spikes, who had worked with Musk at Zip2 and PayPal, came up with a quicker, more devious solution. A friend of his worked for the phone company and drew a diagram that demonstrated a way to squeeze a networking cable safely between the electricity, cable, and phone wires on a telephone pole. At 2 A.M ., an off-the-books crew showed up with a cherry picker and ran fiber to the telephone poles and then ran cables straight to the SpaceX buildings. “We did that over a weekend instead of taking months to get permits,” Spikes said. “There was always this feeling that we were facing a sort of insurmountable challenge and that we had to band together to fight the good fight.” SpaceX’s landlord, Alex Lidow, chuckled when thinking back to all of the antics of Musk’s team. “I know they did a lot of hanky stuff at night,” he said. “They were smart, needed to get things done, and didn’t always have time to wait for things like city permits*  Jugaad and getting things done  November 22, 2015 | [132](http://play.google.com/books/reader?printsec=frontcover&output=reader&id=qvW0BAAAAEAJ&source=books-notes-export&pg=GBS.PA132.w.0.0.0.1.0.1) | |

|  |  |  |  |
| --- | --- | --- | --- |
| |  |  |  | | --- | --- | --- | |  | *Musk had tried to find contractors that could keep up with SpaceX’s creativity and pace. Instead of always hitting up aerospace guys, for example, he located suppliers with similar experience from different fields. Early on, SpaceX needed someone to build the fuel tanks, essentially the main body of the rocket, and Musk ended up in the Midwest talking to companies that had made large, metal agricultural tanks used in the dairy and food processing businesses. These suppliers also struggled to keep up with SpaceX’s schedule, and Musk found himself flying across the country to pay visits—sometimes surprise ones—on the contractors to check on their progress. One such inspection took place at a company in Wisconsin called Spincraft. Musk and a couple of SpaceX employees flew his jet across the country and arrived late at night expecting to see a shift of workers doing extra duty to get the fuel tanks completed. When Musk discovered that Spincraft was well behind schedule, he turned to a Spincraft employee and informed him, “You’re fucking us up the ass, and it doesn’t feel good.” David Schmitz was a general manager at Spincraft and said Musk earned a reputation as a fearsome negotiator who did indeed follow up on things personally. “If Elon was not happy, you knew it,” Schmitz said. “Things could get nasty.” In the months that followed that meeting, SpaceX increased its internal welding capabilities so that it could make the fuel tanks in El Segundo and ditch Spincraft.*  Contractors and dealing with slow ones  December 29, 2015 | [133](http://play.google.com/books/reader?printsec=frontcover&output=reader&id=qvW0BAAAAEAJ&source=books-notes-export&pg=GBS.PA133.w.0.0.0.2) | |

|  |  |  |  |
| --- | --- | --- | --- |
| |  |  |  | | --- | --- | --- | |  | *The failure was another crushing blow to SpaceX’s engineers. Some of them had spent close to two years shuffling back and forth between California, Hawaii, and Kwaj. By the time SpaceX could attempt another launch, it would be about four years after Musk’s original target, and the company had been chewing through his Internet fortune at a worrying rate. Musk had vowed publicly that he would see this thing through to the end, but people inside and outside the company were doing back-of-the-envelope math and could tell that SpaceX likely could only afford one more attempt—maybe two. To the extent that the financial situation unnerved Musk, he rarely if ever let it show to employees. “Elon did a great job of not burdening people with those worries,” said Spikes. “He always communicated the importance of being lean and of success, but it was never ‘if we fail, we’re done for.’ He was very optimistic.”*  Optimism  December 9, 2015 | [144](http://play.google.com/books/reader?printsec=frontcover&output=reader&id=qvW0BAAAAEAJ&source=books-notes-export&pg=GBS.PA144.w.0.0.0.0.1) | |

## *7         ALL ELECTRIC*

|  |  |  |  |
| --- | --- | --- | --- |
| |  |  |  | | --- | --- | --- | |  | *Once they’d finished building a second car a few months later, the engineers at Tesla decided they needed to face up to a massive potential flaw in their electric vehicle. On July 4, 2005, they were at Eberhard’s house in Woodside celebrating Independence Day and figured it was as good a moment as any to see what happened when the Roadster’s batteries caught on fire. Someone taped twenty of the batteries together, put a heating strip wire into the bundle, and set it off. “It went up like a cluster of bottle rockets,” Lyons said. Instead of twenty batteries, the Roadster would have close to 7,000, and the thought of what an explosion at that scale would be like horrified the engineers. One of the perks of an electric car was meant to be that it moved people away from a flammable liquid like gasoline and the endless explosions that take place in an engine. Rich people were unlikely to pay a high price for something even more dangerous, and the early nightmare scenario for the employees at Tesla was that a rich, famous person would get caught in a fire caused by the car. “It was one of those ‘oh shit’ moments,” Lyons said. “That is when we really sobered up.” Tesla formed a six-person task force to deal with the battery issue. They were pulled off all other work and given money to begin running experiments. The first explosions started taking place at the Tesla headquarters, where the engineers filmed them in slow motion. Once saner minds prevailed, Tesla moved its explosion research to a blast area behind an electrical substation maintained by the fire department. Blast by blast, the engineers learned a great deal about the inner workings of the batteries. They developed methods for arranging them in ways that would prevent fires spreading from one battery to the next and other techniques for stopping explosions altogether. Thousands of batteries exploded along the way, and the effort was worth it. It was still early days, for sure, but Tesla was on the verge of inventing battery technology that would set it apart from rivals for years to come and would become one of the company’s great advantages.*  Risk management, research for extremely important aspects like a battery explosion.  December 30, 2015 | [176](http://play.google.com/books/reader?printsec=frontcover&output=reader&id=qvW0BAAAAEAJ&source=books-notes-export&pg=GBS.PA176) | |

|  |  |  |  |
| --- | --- | --- | --- |
| |  |  |  | | --- | --- | --- | |  | *About a year later, after many tweaks and much work, Tesla had a pencils-down moment. It was May 2006, and the company had grown to a hundred employees. This team built a black version of the Roadster known as EP1, or engineering prototype one. “It was saying, ‘We now think we know what we will build,’” Tarpenning said. “You can feel it. It’s a real car, and it’s very exciting.” The arrival of the EP1 provided a great excuse to show existing investors what their money had bought and to ask for more funds from a wider audience. The venture capitalists were impressed enough to overlook the fact that engineers sometimes had to manually fan the car to cool it down in between test drives and were now starting to grasp Tesla’s long-term potential. Musk once again put money into Tesla—$12 million—and a handful of other investors, including the venture capital firm Draper Fisher Jurvetson, VantagePoint Capital Partners, J.P. Morgan, Compass Technology Partners, Nick Pritzker, Larry Page, and Sergey Brin, joined the $40 million round. \**  The first ready to mfg prototype(more than just a working prototype which was built in Jan 2004) led to the third major round of funding. Musk had led two earlier rounds (6.5 mil out of a total 7mil and 9/13 mill after the first working prototype)  December 30, 2015 | [178](http://play.google.com/books/reader?printsec=frontcover&output=reader&id=qvW0BAAAAEAJ&source=books-notes-export&pg=GBS.PA178.w.0.0.0.1) | |

|  |  |  |  |
| --- | --- | --- | --- |
| |  |  |  | | --- | --- | --- | |  | *Quite often, the Tesla engineers brought their Silicon Valley attitude to the automakers’ traditional stomping grounds. There’s a break and traction testing track in northern Sweden near the Arctic Circle where cars get tuned on large plains of ice. It would be standard to run the car for three days or so, get the data, and return to company headquarters for many weeks of meetings about how to adjust the car. The whole process of tuning a car can take the entire winter. Tesla, by contrast, sent its engineers along with the Roadsters being tested and had them analyze the data on the spot. When something needed to be tweaked, the engineers would rewrite some code and send the car back on the ice. “BMW would need to have a confab between three or four companies that would all blame each other for the problem,” Tarpenning said. “We just fixed it ourselves.” Another testing procedure required that the Roadsters go into a special cooling chamber to check how they would respond to frigid temperatures. Not wanting to pay the exorbitant costs to use one of these chambers, the Tesla engineers opted to rent an ice cream delivery truck with a large refrigerated trailer. Someone would drive a Roadster into the truck, and the engineers would don parkas and work on the car.*  Get stuff done fast, traditional ways of doing things don't matter. Jugaad, without any quality compromises.  December 30, 2015 | [181](http://play.google.com/books/reader?printsec=frontcover&output=reader&id=qvW0BAAAAEAJ&source=books-notes-export&pg=GBS.PA181.w.0.0.0.1) | |

|  |  |  |  |
| --- | --- | --- | --- |
| |  |  |  | | --- | --- | --- | |  | *Throughout these early years, the engineers credited Eberhard with making quick, crisp decisions. Rarely did Tesla get hung up overanalyzing a situation. The company would pick a plan of attack, and when it failed at something, it failed fast and then tried a new approach. It was many of the changes that Musk wanted that started to delay the Roadster. Musk kept pushing for the car to be more comfortable, asking for alterations to the seats and the doors. He made the carbon-fiber body a priority, and he pushed for electronic sensors on the doors so that the Roadster could be unlocked with the touch of a finger instead of a tug on a handle. Eberhard groused that these features were slowing the company down, and many of the engineers agreed. “It felt at times like Elon was this unreasonably demanding overarching force,” said Berdichevsky. “The company as a whole was sympathetic to Martin because he was there all the time, and we all felt the car should ship sooner.”*  Eberhard - the practical engineer VS Musk the ?\_\_\_\_\_\_\_\_?  February 23, 2016 | [182](http://play.google.com/books/reader?printsec=frontcover&output=reader&id=qvW0BAAAAEAJ&source=books-notes-export&pg=GBS.PA182.w.0.0.0.1) | |

## *9         LIFTOFF*

|  |  |  |  |
| --- | --- | --- | --- |
| |  |  |  | | --- | --- | --- | |  | *T HE FALCON 9 HAS BECOME SPACEX’S WORKHORSE. The rocket looks—let’s face it—like a giant white phallus. It stands 224.4 feet tall, is 12 feet across, and weighs 1.1 million pounds. The rocket is powered by nine engines arranged in an “octaweb” pattern at its base with one engine in the center and eight others encircling it. The engines connect to the first stage, or the main body of the rocket, which bears the blue SpaceX insignia and an American flag. The shorter second stage of the rocket sits on top of the first and is the one that actually ends up doing things in space. It can be outfitted with a rounded container for carrying satellites or a capsule capable of transporting humans. By design, there’s nothing particularly flashy about the Falcon 9’s outward appearance. It’s the spaceship equivalent of an Apple laptop or a Braun kettle—an elegant, purposeful machine stripped of frivolity and waste.*  How the Falcon 9 looks like  January 17, 2016 | [228](http://play.google.com/books/reader?printsec=frontcover&output=reader&id=qvW0BAAAAEAJ&source=books-notes-export&pg=GBS.PA228) | |

|  |  |  |  |
| --- | --- | --- | --- |
| |  |  |  | | --- | --- | --- | |  | *On launch days, the white Falcon 9 breaks up the blue and green landscape, pointing skyward and leaving no doubt about its intentions. About four hours before a launch, the Falcon 9 starts getting filled with an immense amount of liquid oxygen and rocket-grade kerosene. Some of the liquid oxygen vents out of the rocket as it awaits launch and is kept so cold that it boils off on contact with the metal and air, forming white plumes that stream down the rocket’s sides. This gives the impression of the Falcon 9 huffing and puffing as it limbers up before the journey. The engineers inside of SpaceX’s mission control monitor these fuel systems and all manner of other items. They chat back and forth through headsets and begin cycling through their launch checklist, consumed by what people in the business call “go fever” as they move from one approval to the next. Ten minutes before launch, the humans step out of the way and leave the remaining processes up to automated machines. Everything goes quiet, and the tension builds until right before the main event. That’s when, out of nowhere, the Falcon 9 breaks the silence by letting out a loud gasp. A white latticed support structure pulls away from its body. The T-minus-ten-seconds countdown begins. Nothing much happens from ten down to four. At the count of three, however, the engines ignite, and the computers conduct a last, oh-so-rapid, health check. Four enormous metal clamps hold the rocket down, as computing systems evaluate all nine engines and measure if there’s sufficient downward force being produced. By the time zero arrives, the rocket has decided that all is well enough to go through with its mission, and the clamps release. The rocket goes to war with inertia, and then, with flames surrounding its base and snow-thick plumes of the liquid oxygen filling the air, it shoots up. Seeing something so large hold so straight and steady while suspended in midair is hard for the brain to register. It is foreign, inexplicable. About twenty seconds after liftoff, the spectators placed safely a few miles away catch the first faceful of the Falcon 9’s rumble. It’s a distinct sound—a sort of staccato crackling that arises from chemicals whipped into a violent frenzy. Pant legs vibrate from shock waves produced by a stream of sonic booms coming out of the Falcon 9’s exhaust. The white rocket climbs higher and higher with impressive stamina. After about a minute, it’s just a red spot in the sky, and then—poof—it’s gone. Only a cynical dullard could come away from witnessing this feeling anything other than wonder at what man can accomplish*  How a Falcon 9 launch feels like  January 17, 2016 | [228](http://play.google.com/books/reader?printsec=frontcover&output=reader&id=qvW0BAAAAEAJ&source=books-notes-export&pg=GBS.PA228.w.0.0.0.3) | |

|  |  |  |  |
| --- | --- | --- | --- |
| |  |  |  | | --- | --- | --- | |  | *The SpaceX hiring model places some emphasis on getting top marks at top schools. But most of the attention goes toward spotting engineers who have exhibited type A personality traits over the course of their lives. The company’s recruiters look for people who might excel at robot-building competitions or who are car-racing hobbyists who have built unusual vehicles. The object is to find individuals who ooze passion, can work well as part of a team, and have real-world experience bending metal. “Even if you’re someone who writes code for your job, you need to understand how mechanical things work,” said Dolly Singh, who spent five years as the head of talent acquisition at SpaceX. “We were looking for people that had been building things since they were little.” Sometimes these people walked through the front door. Other times, Singh relied on a handful of enterprising techniques to find them. She became famous for trawling through academic papers to find engineers with very specific skills, cold-calling researchers at labs and plucking possessed engineers out of college. At trade shows and conferences, SpaceX recruiters wooed interesting candidates they had spotted with a cloak-and-dagger shtick. They would hand out blank envelopes that contained invitations to meet at a specific time and place, usually a bar or restaurant near the event, for an initial interview. The candidates that showed up would discover they were among only a handful of people who been anointed out of all the conference attendees. They were immediately made to feel special and inspired. Like many tech companies, SpaceX subjects potential hires to a gauntlet of interviews and tests. Some of the interviews are easygoing chats in which both parties get to feel each other out; others are filled with quizzes that can be quite hard. Engineers tend to face the most rigorous interrogations, although business types and salesmen are made to suffer, too. Coders who expect to pass through standard challenges have rude awakenings. Companies will typically challenge software developers on the spot by asking them to solve problems that require a couple of dozen lines of code. The standard SpaceX problem requires five hundred or more lines of code. All potential employees who make their way to the end of the interview process then handle one more task. They’re asked to write an essay for Musk about why they want to work at SpaceX. The reward for solving the puzzles, acting clever in interviews, and penning up a good essay is a meeting with Musk*  Hiring at space X  January 17, 2016 | [234](http://play.google.com/books/reader?printsec=frontcover&output=reader&id=qvW0BAAAAEAJ&source=books-notes-export&pg=GBS.PA234.w.0.0.0.1) | |

|  |  |  |  |
| --- | --- | --- | --- |
| |  |  |  | | --- | --- | --- | |  | *He interviewed almost every one of SpaceX’s first one thousand hires, including the janitors and technicians, and has continued to interview the engineers as the company’s workforce swelled. Each employee receives a warning before going to meet with Musk. The interview, he or she is told, could last anywhere from thirty seconds to fifteen minutes. Elon will likely keep on writing e-mails and working during the initial part of the interview and not speak much. Don’t panic. That’s normal. Eventually, he will turn around in his chair to face you. Even then, though, he might not make actual eye contact with you or fully acknowledge your presence. Don’t panic. That’s normal. In due course, he will speak to you. From that point, the tales of engineers who have interviewed with Musk run the gamut from torturous experiences to the sublime. He might ask one question or he might ask several. You can be sure, though, that he will roll out the Riddle: “You’re standing on the surface of the Earth. You walk one mile south, one mile west, and one mile north. You end up exactly where you started. Where are you?” One answer to that is the North Pole, and most of the engineers get it right away. That’s when Musk will follow with “Where else could you be?” The other answer is somewhere close to the South Pole where, if you walk one mile south, the circumference of the Earth becomes one mile. Fewer engineers get this answer, and Musk will happily walk them through that riddle and others and cite any relevant equations during his explanations. He tends to care less about whether or not the person gets the answer than about how they describe the problem and their approach to solving it. When speaking to potential recruits, Singh tried to energize them and be up front about the demands of SpaceX and of Musk at the same time. “The recruiting pitch was SpaceX is special forces,” she said. “If you want as hard as it gets, then great. If not, then you shouldn’t come here.” Once at SpaceX, the new employees found out very quickly if they were indeed up for the challenge. Many of them would quit within the first few months because of the ninety-plus-hour workweeks. Others quit because they could not handle just how direct Musk and the other executives were during meetings. “Elon doesn’t know about you and he hasn’t thought through whether or not something is going to hurt your feelings,” Singh said. “He just knows what the fuck he wants done. People who did not normalize to his communication style did not do well.”*  Musk's Interviewing style  January 17, 2016 | [235](http://play.google.com/books/reader?printsec=frontcover&output=reader&id=qvW0BAAAAEAJ&source=books-notes-export&pg=GBS.PA235.w.0.0.0.2) | |

|  |  |  |  |
| --- | --- | --- | --- |
| |  |  |  | | --- | --- | --- | |  | *This is not a problem for SpaceX’s new facility in Hawthorne. The building’s address is 1 Rocket Road, and it has the Hawthorne Municipal Airport and several tooling and manufacturing companies as neighbors. While the SpaceX building resembles the others in size and shape, its all-white color makes it the obvious outlier. The structure looks like a gargantuan, rectangular glacier that’s been planted in the midst of a particularly soulless portion of Los Angeles County’s sprawl.*  SpaceX building and office description. Much longer and elaborate multi-page description follows.  January 19, 2016 | [237](http://play.google.com/books/reader?printsec=frontcover&output=reader&id=qvW0BAAAAEAJ&source=books-notes-export&pg=GBS.PA237.w.0.0.0.2) | |

|  |  |  |  |
| --- | --- | --- | --- |
| |  |  |  | | --- | --- | --- | |  | *A typical aerospace company comes up with the list of parts that it needs for a launch system and then hands off their design and specifications to myriad third parties who then actually build the hardware. SpaceX tends to buy as little as possible to save money and because it sees depending on suppliers—especially foreign ones—as a weakness. This approach comes off as excessive at first blush. Companies have made things like radios and power distribution units for decades. Reinventing the wheel for every computer and machine on a rocket could introduce more chances for error and, in general, be a waste of time. But for SpaceX, the strategy works. In addition to building its own engines, rocket bodies, and capsules, SpaceX designs its own motherboards and circuits, sensors to detect vibrations, flight computers, and solar panels. Just by streamlining a radio, for instance, SpaceX’s engineers have found that they can reduce the weight of the device by about 20 percent. And the cost savings for a homemade radio are dramatic, dropping from between $50,000 to $100,000 for the industrial-grade equipment used by aerospace companies to $5,000 for SpaceX’s unit*  Building stuff in-house vs outsourcing, critical for cost saving and getting the price down for components.  January 19, 2016 | [240](http://play.google.com/books/reader?printsec=frontcover&output=reader&id=qvW0BAAAAEAJ&source=books-notes-export&pg=GBS.PA240.w.0.0.0.3) | |

|  |  |  |  |
| --- | --- | --- | --- |
| |  |  |  | | --- | --- | --- | |  | *It’s hard to believe these kinds of price differentials at first, but there are dozens if not hundreds of places where SpaceX has secured such savings. The equipment at SpaceX tends to be built out of readily available consumer electronics as opposed to “space grade” equipment used by others in the industry. SpaceX has had to work for years to prove to NASA that standard electronics have gotten good enough to compete with the more expensive, specialized gear trusted in years past. “Traditional aerospace has been doing things the same way for a very, very long time,” said Drew Eldeen, a former SpaceX engineer. “The biggest challenge was convincing NASA to give something new a try and building a paper trail that showed the parts were high enough quality.” To prove that it’s making the right choice to NASA and itself, SpaceX will sometimes load a rocket with both the standard equipment and prototypes of its own design for testing during flight. Engineers then compare the performance characteristics of the devices. Once a SpaceX design equals or outperforms the commercial products, it becomes the de facto hardware.*  How spacex convinced their customers(nasa) that cheaper components doesn't mean lower quality/performance  January 19, 2016 | [241](http://play.google.com/books/reader?printsec=frontcover&output=reader&id=qvW0BAAAAEAJ&source=books-notes-export&pg=GBS.PA241.w.0.0.0.1) | |

|  |  |  |  |
| --- | --- | --- | --- |
| |  |  |  | | --- | --- | --- | |  | *There have also been numerous times when SpaceX has done pioneering work on advancing very complex hardware systems. A classic example of this is one of the factory’s weirder-looking contraptions, a two-story machine designed to perform what’s known as friction stir welding. The machine allows SpaceX to automate the welding process for massive sheets of metal like the ones that make up the bodies of the Falcon rockets. An arm takes one of the rocket’s body panels, lines it up against another body panel, and then joins them together with a weld that could run twenty feet or more. Aerospace companies typically try to avoid welds whenever possible because they create weaknesses in the metal, and that’s limited the size of metal sheets they can use and forced other design constraints. From the early days of SpaceX, Musk pushed the company to master friction stir welding, in which a spinning head is smashed at high speeds into the join between two pieces of metal in a bid to make their crystalline structures merge. It’s as if you heated two sheets of aluminum foil and then joined them by putting your thumb down on the seam and twisting the metal together. This type of welding tends to result in much stronger bonds than traditional welds. Companies had performed friction stir welding before but not on structures as large as a rocket’s body or to the degree to which SpaceX has used the technique. As a result of its trials and errors, SpaceX can now join large, thin sheets of metal and shave hundreds of pounds off the weight of the Falcon rockets, as it’s able to use lighter-weight alloys and avoid using rivets, fasteners, and other support structures. Musk’s competitors in the auto industry might soon need to do the same because SpaceX has transferred some of the equipment and techniques to Tesla. The hope is that Tesla will be able to make lighter, stronger cars*  Friction stir welding - Technology advancements at spacex.  January 19, 2016 | [241](http://play.google.com/books/reader?printsec=frontcover&output=reader&id=qvW0BAAAAEAJ&source=books-notes-export&pg=GBS.PA241.w.0.0.0.4) | |

|  |  |  |  |
| --- | --- | --- | --- |
| |  |  |  | | --- | --- | --- | |  | *Asked about his approach, Musk said, I certainly don’t try to set impossible goals. I think impossible goals are demotivating. You don’t want to tell people to go through a wall by banging their head against it. I don’t ever set intentionally impossible goals. But I’ve certainly always been optimistic on time frames. I’m trying to recalibrate to be a little more realistic. I don’t assume that it’s just like 100 of me or something like that. I mean, in the case of the early SpaceX days, it would have been just the lack of understanding of what it takes to develop a rocket. In that case I was off by, say, 200 percent. I think future programs might be off by anywhere from like 25 percent to 50 percent as opposed to 200 percent. So, I think generally you do want to have a timeline where, based on everything you know about, the schedule should be X, and you execute towards that, but with the understanding that there will be all sorts of things that you don’t know about that you will encounter that will push the date beyond that. It doesn’t mean that you shouldn’t have tried to aim for that date from the beginning because aiming for something else would have been an arbitrary time increase. It’s different to say, “Well, what do you promise people?” Because you want to try to promise people something that includes schedule margin. But in order to achieve the external promised schedule, you’ve got to have an internal schedule that’s more aggressive than that. Sometimes you still miss the external schedule. SpaceX, by the way, is not alone here. Being late is par for the course in the aerospace industry. It’s not a question of if it’s late, it’s how late will the program be. I don’t think an aerospace program has been completed on time since bloody World War II.*  Musk reflecting on his own optimistic timelines(refer earlier highlight about Falcon 1 timeline in the chapter - mice in space)  January 19, 2016 | [245](http://play.google.com/books/reader?printsec=frontcover&output=reader&id=qvW0BAAAAEAJ&source=books-notes-export&pg=GBS.PA245.w.0.0.0.1) | |

|  |  |  |  |
| --- | --- | --- | --- |
| |  |  |  | | --- | --- | --- | |  | *Dealing with the epically aggressive schedules and Musk’s expectations has required SpaceX’s engineers to develop a variety of survival techniques. Musk often asks for highly detailed proposals for how projects will be accomplished. The employees have learned never to break the time needed to accomplish something down into months or weeks. Musk wants day-by-day and hour-by-hour forecasts and sometimes even minute-by-minute countdowns, and the fallout from missed schedules is severe. “You had to put in when you would go to the bathroom,” Brogan said. “I’m like, ‘Elon, sometimes people need to take a long dump.’” SpaceX’s top managers work together to, in essence, create fake schedules that they know will please Musk but that are basically impossible to achieve. This would not be such a horrible situation if the targets were kept internal. Musk, however, tends to quote these fake schedules to customers, unintentionally giving them false hope. Typically, it falls to Gwynne Shotwell, SpaceX’s president, to clean up the resulting mess. She will either need to ring up a customer to give them a more realistic timeline or concoct a litany of excuses to explain away the inevitable delays. “Poor Gwynne,” Brogan said. “Just to hear her on the phone with the customers is agonizing.”*  Work based timeline expectations  January 19, 2016 | [246](http://play.google.com/books/reader?printsec=frontcover&output=reader&id=qvW0BAAAAEAJ&source=books-notes-export&pg=GBS.PA246) | |

|  |  |  |  |
| --- | --- | --- | --- |
| |  |  |  | | --- | --- | --- | |  | *There can be no question that Musk has mastered the art of getting the most out of his employees. Interview three dozen SpaceX engineers and each one of them will have picked up on a managerial nuance that Musk has used to get people to meet his deadlines. One example from Brogan: Where a typical manager may set the deadline for the employee, Musk guides his engineers into taking ownership of their own delivery dates. “He doesn’t say, ‘You have to do this by Friday at two P.M .,’” Brogan said. “He says, ‘I need the impossible done by Friday at two P.M . Can you do it?’ Then, when you say yes, you are not working hard because he told you to. You’re working hard for yourself. It’s a distinction you can feel. You have signed up to do your own work.” And by recruiting hundreds of bright, self-motivated people, SpaceX has maximized the power of the individual. One person putting in a sixteen-hour day ends up being much more effective than two people working eight-hour days together. The individual doesn’t have to hold meetings, reach a consensus, or bring other people up to speed on a project. He just keeps working and working and working. The ideal SpaceX employee is someone like Steve Davis, the director of advanced projects at SpaceX. “He’s been working sixteen hours a day every day for years,” Brogan said. “He gets more done than eleven people working together.”*  How to get work done, when the time lines are ridiculous  January 19, 2016 | [246](http://play.google.com/books/reader?printsec=frontcover&output=reader&id=qvW0BAAAAEAJ&source=books-notes-export&pg=GBS.PA246.w.0.0.0.4) | |

|  |  |  |  |
| --- | --- | --- | --- |
| |  |  |  | | --- | --- | --- | |  | *One example from Brogan: Where a typical manager may set the deadline for the employee, Musk guides his engineers into taking ownership of their own delivery dates. “He doesn’t say, ‘You have to do this by Friday at two P.M .,’” Brogan said. “He says, ‘I need the impossible done by Friday at two P.M . Can you do it?’ Then, when you say yes, you are not working hard because he told you to. You’re working hard for yourself. It’s a distinction you can feel. You have signed up to do your own work.” And by recruiting hundreds of bright, self-motivated people, SpaceX has maximized the power of the individual.*  An amazing way to make people feel great about tight deadlines. People do it for themselves, not for you. Make them feel like that.  January 19, 2016 | [246](http://play.google.com/books/reader?printsec=frontcover&output=reader&id=qvW0BAAAAEAJ&source=books-notes-export&pg=GBS.PA246.w.0.0.0.4) | |

|  |  |  |  |
| --- | --- | --- | --- |
| |  |  |  | | --- | --- | --- | |  | *One of Watson’s top discoveries at SpaceX was the test bed on the third floor of the Hawthorne factory. SpaceX has test versions of all the hardware and electronics that go into a rocket laid out on metal tables. It has in effect replicated the innards of a rocket end to end in order to run thousands of flight simulations. Someone “launches” the rocket from a computer and then every piece of mechanical and computing hardware is monitored with sensors. An engineer can tell a valve to open, then check to see if it opened, how quickly it opened, and the level of current running to it. This testing apparatus lets SpaceX engineers practice ahead of launches and figure out how they would deal with all manner of anomalies. During the actual flights, SpaceX has people in the test facility who can replicate errors seen on Falcon or Dragon and make adjustments accordingly. SpaceX has made numerous changes on the fly with this system. In one case someone spotted an error in a software file in the hours right before a launch. SpaceX’s engineers changed the file, checked how it affected the test hardware, and, when no problems were detected, sent the file to the Falcon 9, waiting on the launchpad, all in less than thirty minutes. “NASA wasn’t used to this,” Watson said. “If something went wrong with the shuttle, everyone was just resigned to waiting three weeks before they could try and launch again*  Testing at spacex  January 23, 2016 | [251](http://play.google.com/books/reader?printsec=frontcover&output=reader&id=qvW0BAAAAEAJ&source=books-notes-export&pg=GBS.PA251.w.0.0.0.3) | |

|  |  |  |  |
| --- | --- | --- | --- |
| |  |  |  | | --- | --- | --- | |  | *From time to time, Musk will send out an e-mail to the entire company to enforce a new policy or let them know about something that’s bothering him. One of the more famous e-mails arrived in May 2010 with the subject line: Acronyms Seriously Suck: There is a creeping tendency to use made up acronyms at SpaceX. Excessive use of made up acronyms is a significant impediment to communication and keeping communication good as we grow is incredibly important. Individually, a few acronyms here and there may not seem so bad, but if a thousand people are making these up, over time the result will be a huge glossary that we have to issue to new employees. No one can actually remember all these acronyms and people don’t want to seem dumb in a meeting, so they just sit there in ignorance. This is particularly tough on new employees. That needs to stop immediately or I will take drastic action—I have given enough warnings over the years. Unless an acronym is approved by me, it should not enter the SpaceX glossary. If there is an existing acronym that cannot reasonably be justified, it should be eliminated, as I have requested in the past. For example, there should be no “HTS” [horizontal test stand] or “VTS” [vertical test stand] designations for test stands. Those are particularly dumb, as they contain unnecessary words. A “stand” at our test site is obviously a \*test\* stand. VTS-3 is four syllables compared with “Tripod,” which is two, so the bloody acronym version actually takes longer to say than the name! The key test for an acronym is to ask whether it helps or hurts communication. An acronym that most engineers outside of SpaceX already know, such as GUI, is fine to use. It is also ok to make up a few acronyms/contractions every now and again, assuming I have approved them, eg MVac and M9 instead of Merlin 1C-Vacuum or Merlin 1C-Sea Level, but those need to be kept to a minimum. This was classic Musk. The e-mail is rough in its tone and yet not really unwarranted for a guy who just wants things done as efficiently as possible. It obsesses over something that other people might find trivial and yet he has a definite point. It’s comical in that Musk wants all acronym approvals to run directly through him, but that’s entirely in keeping with the hands-on management style that has, mainly, worked well at both SpaceX and Tesla. Employees have since dubbed the acronym policy the ASS Rule.*  Acronyms Seriously Suck - The ASS rule and how Musk handles internal communication redundancies  January 23, 2016 | [252](http://play.google.com/books/reader?printsec=frontcover&output=reader&id=qvW0BAAAAEAJ&source=books-notes-export&pg=GBS.PA252.w.0.0.0.1.0.1) | |

|  |  |  |  |
| --- | --- | --- | --- |
| |  |  |  | | --- | --- | --- | |  | *The guiding principle at SpaceX is to embrace your work and get stuff done. People who await guidance or detailed instructions languish. The same goes for workers who crave feedback. And the absolute worst thing that someone can do is inform Musk that what he’s asking is impossible. An employee could be telling Musk that there’s no way to get the cost on something like that actuator down to where he wants it or that there is simply not enough time to build a part by Musk’s deadline. “Elon will say, ‘Fine. You’re off the project, and I am now the CEO of the project. I will do your job and be CEO of two companies at the same time. I will deliver it,’” Brogan said. “What’s crazy is that Elon actually does it. Every time he’s fired someone and taken their job, he’s delivered on whatever the project was.”*  Getting things done. Nothing is impossible 🙅 and believe in it.  January 23, 2016 | [253](http://play.google.com/books/reader?printsec=frontcover&output=reader&id=qvW0BAAAAEAJ&source=books-notes-export&pg=GBS.PA253.w.0.0.0.2) | |

|  |  |  |  |
| --- | --- | --- | --- |
| |  |  |  | | --- | --- | --- | |  | *It is jarring for both parties when the SpaceX culture rubs against more bureaucratic bodies like NASA, the U.S. Air Force, and the Federal Aviation Administration. The first inklings of these difficulties appeared on Kwaj, where government officials sometimes questioned what they saw as SpaceX’s cavalier approach to the launch process. There were times when SpaceX would want to make a change to its launch procedures and any such change would require a pile of paperwork. SpaceX, for example, would have written down all the steps needed to replace a filter—put on gloves, wear safety goggles, remove a nut—and then want to alter this procedure or use a different type of filter. The FAA would need a week to review the new process before SpaceX could actually go about changing the filter on the rocket, a lag that both the engineers and Musk found ridiculous. On one occasion after this type of thing happened, Musk laid into an FAA official while on a conference call with members of the SpaceX team and NASA. “It got hot and heated, and he berated this guy on a personal level for like ten minutes,” Brogan said. Musk did not recall this incident but did remember other confrontations with the FAA. One time he compiled a list of things an FAA subordinate had said during a meeting that Musk found silly and sent the list along to the guy’s boss. “And then his dingbat manager sent me this long e-mail about how he had been in the shuttle program and in charge of twenty launches or something like that and how dare I say that the other guy was wrong,” Musk said. “I told him, ‘Not only is he wrong, and let me rearticulate the reasons, but you’re wrong, and let me articulate the reasons.’ I don’t think he sent me another e-mail after that. We’re trying to have a really big impact on the space industry. If the rules are such that you can’t make progress, then you have to fight the rules. “There is a fundamental problem with regulators. If a regulator agrees to change a rule and something bad happens, they could easily lose their career. Whereas if they change a rule and something good happens, they don’t even get a reward. So, it’s very asymmetric. It’s then very easy to understand why regulators resist changing the rules. It’s because there’s a big punishment on one side and no reward on the other. How would any rational person behave in such a scenario?”*  Dealing with bureaucracy and regulations. Why regulators are generally scared(albeit personally) to amend any old standing regulation/law  January 23, 2016 | [253](http://play.google.com/books/reader?printsec=frontcover&output=reader&id=qvW0BAAAAEAJ&source=books-notes-export&pg=GBS.PA253.w.0.0.0.4.0.1) | |

|  |  |  |  |
| --- | --- | --- | --- |
| |  |  |  | | --- | --- | --- | |  | *To put things more bluntly, ULA has turned into an embarrassment for the United States. In March 2014, ULA’s then CEO, Michael Gass, faced off against Musk during a congressional hearing that dealt, in part, with SpaceX’s request to take on more of the government’s annual launch load. A series of slides were rolled out that showed how the government payments for launches have skyrocketed since Boeing and Lockheed went from a duopoly to a monopoly. According to Musk’s math presented at the hearing, ULA charged $380 million per flight, while SpaceX would charge $90 million per flight. (The $90 million figure was higher than SpaceX’s standard $60 million because the government has certain additional requirements for particularly sensitive launches.) By simply picking SpaceX as its launch provider, Musk pointed out, the government would save enough money to pay for the satellite going on the rocket. Gass had no real retort. He claimed Musk’s figures for the ULA launch price were inaccurate but failed to provide a figure of his own. The hearing also came as tensions between the United States and Russia were running high due to Russia’s aggressive actions in Ukraine. Musk rightly noted that the United States could soon be placing sanctions on Russia that could carry over to aerospace equipment. ULA, as it happens, relies on Russian-made engines to send up sensitive U.S. military equipment in its Atlas V rockets. “Our Falcon 9 and Falcon Heavy launch vehicles are truly American,” Musk said. “We design and manufacture our rockets in California and Texas.” Gass countered that ULA had bought a two-year supply of Russian engines and purchased the blueprints to the machines and had them translated from Russian to English, and he said this with a straight face. (A few months after the hearing, ULA replaced Gass as CEO and signed a deal with Blue Origin to develop American-made rockets.) Some of the most disheartening moments of the hearing arrived when Senator Richard Shelby of Alabama took the microphone for questioning. ULA has manufacturing facilities in Alabama and close ties to the senator. Shelby felt compelled to play the role of hometown booster by repeatedly pointing out that ULA had enjoyed sixty-eight successful launches and then asking Musk what he made of that accomplishment. The aerospace industry stands as one of Shelby’s biggest donors and he’s ended up surprisingly pro-bureaucracy and anticompetition when it comes to getting things into space. “Typically competition results in better quality and lower-priced contracts—but the launch market is not typical,” Shelby said. “It is limited demand framed by government-industrial policies.” The March hearing in which Shelby made these statements would turn out to be something of a sham. The government had agreed to put fourteen of its sensitive launches up for bid instead of just awarding them directly to ULA. Musk had come to Congress to present his case for why SpaceX made sense as a viable candidate for those and other launches. The day after the hearing, the air force cut the number of launches up for bid from fourteen to between seven and one. One month later, SpaceX filed a lawsuit against the air force asking for a chance to earn its launch business. “SpaceX is not seeking to be awarded contracts for these launches,” the company said on its freedomtolaunch.com website. “We are simply seeking the right to compete.” \**  Opening up the government and competing against companies who have deep roots in the government people's(senators/mp, ministers etc) pockets, very similar to big traditionally politically linked companies in India, like Birla, Ambani etc  January 24, 2016 | [263](http://play.google.com/books/reader?printsec=frontcover&output=reader&id=qvW0BAAAAEAJ&source=books-notes-export&pg=GBS.PA263.w.0.0.0.4) | |

## *10         THE REVENGE OF THE ELECTRIC CAR*

|  |  |  |  |
| --- | --- | --- | --- |
| |  |  |  | | --- | --- | --- | |  | *Following the price increase, Tesla had a safety recall. It said that Lotus, the manufacturer of the Roadster’s chassis, had failed to tighten a bolt properly on its assembly line. On the plus side, Tesla had only delivered about 345 Roadsters, which meant that it could fix the problem in a manageable fashion. On the downside, a safety recall was the last thing a car start-up needs, even if it was, as Tesla claimed, more of a proactive measure than anything else. The next year, Tesla had another voluntary recall. It had received a report of a power cable grinding against the body of the Roadster to the point that it caused a short circuit and some smoke. That time, Tesla brought 439 Roadsters in for a fix. Tesla did its best to put a positive spin on these issues, saying that it would make “house calls” to fix the Roadsters or pick up the cars and take them back to the factory. Ever since, Musk has tried to turn any snafu with a Tesla into an excuse to show off the company’s attention to service and dedication to pleasing the customer. More often than not, the strategy has worked.*  January 30, 2016 | [281](http://play.google.com/books/reader?printsec=frontcover&output=reader&id=qvW0BAAAAEAJ&source=books-notes-export&pg=GBS.PA281.w.0.0.0.2) | |

|  |  |  |  |
| --- | --- | --- | --- |
| |  |  |  | | --- | --- | --- | |  | *According to Lloyd, Tesla initially aimed to make about ten thousand Model S sedans per year and had budgeted around $130 million to achieve this goal, including engineering the car and acquiring the manufacturing machines needed to stamp out the body parts. “One of the things Elon pushed hard with everyone was to do as much as possible in-house,” Lloyd said. Tesla would make up for its lack of R&D money by hiring smart people who could outwork and outthink the third parties relied on by the rest of the automakers. “The mantra was that one great engineer will replace three medium ones,” Lloyd said.*  January 31, 2016 | [286](http://play.google.com/books/reader?printsec=frontcover&output=reader&id=qvW0BAAAAEAJ&source=books-notes-export&pg=GBS.PA286.w.0.0.0.2) | |

|  |  |  |  |
| --- | --- | --- | --- |
| |  |  |  | | --- | --- | --- | |  | *A small team of Tesla engineers began the process of trying to figure out the mechanical inner workings of the Model S. Their first step in this journey took place at a Mercedes dealership where they test drove a CLS 4-Door Coupe and an E-Class sedan. The cars had the same chassis, and the Tesla engineers took measurements of every inch of the vehicles, studying what they liked and didn’t like. In the end, they preferred the styling on the CLS and settled on it as their baseline for thinking about the Model S. After purchasing a CLS, Tesla’s engineers tore it apart. One team had reshaped the boxy, rectangular battery pack from the Roadster and made it flat. The engineers cut the floor out of the CLS and plopped in the pack. Next they put the electronics that tied the whole system together in the trunk. After that, they replaced the interior of the car to restore its fit and finish. Following three months of work, Tesla had in effect built an all-electric Mercedes CLS. Tesla used the car to woo investors and future partners like Daimler that would eventually turn to Tesla for electric powertrains in their vehicles. Now and again, the Tesla team took the car out for drives on public roads. It weighed more than the Roadster but was still fast and had a range of about 120 miles per charge. To perform these joyrides-cum-tests in relative secrecy, the engineers had to weld the tips of the exhaust pipes back onto the car to make it look like any other CLS.*  Hacked up a prototype in a very short time to woo people who give money for the product - investors and customers  January 31, 2016 | [286](http://play.google.com/books/reader?printsec=frontcover&output=reader&id=qvW0BAAAAEAJ&source=books-notes-export&pg=GBS.PA286.w.0.0.0.3) | |

|  |  |  |  |
| --- | --- | --- | --- |
| |  |  |  | | --- | --- | --- | |  | *O’Connell had joined Tesla in 2006 to help solve some of the factory and financing issues.*  Story of O'Connell starts here, the guy who had experience of dealing with the government in terms of technicality and had a driving life mission which aligned with tesla  February 1, 2016 | [296](http://play.google.com/books/reader?printsec=frontcover&output=reader&id=qvW0BAAAAEAJ&source=books-notes-export&pg=GBS.PA296.w.0.0.0.1) | |

|  |  |  |  |
| --- | --- | --- | --- |
| |  |  |  | | --- | --- | --- | |  | *Then, while reading Businessweek, he stumbled on an article about a start-up called Tesla Motors and went to the company’s website, which described Tesla as a place “where we are doing things, not talking about things.”*  February 1, 2016 | [298](http://play.google.com/books/reader?printsec=frontcover&output=reader&id=qvW0BAAAAEAJ&source=books-notes-export&pg=GBS.PA298) | |

|  |  |  |  |
| --- | --- | --- | --- |
| |  |  |  | | --- | --- | --- | |  | *Then, while reading Businessweek, he stumbled on an article about a start-up called Tesla Motors and went to the company’s website, which described Tesla as a place “where we are doing things, not talking about things.”*  February 1, 2016 | [298](http://play.google.com/books/reader?printsec=frontcover&output=reader&id=qvW0BAAAAEAJ&source=books-notes-export&pg=GBS.PA298) | |

## *11         THE UNIFIED FIELD THEORY OF ELON MUSK*

|  |  |  |  |
| --- | --- | --- | --- |
| |  |  |  | | --- | --- | --- | |  | *Musk felt optimistic enough about Tesla’s future to talk to me about some of his more whimsical plans. He hopes to redesign the Tesla headquarters in Palo Alto, a change employees would welcome. The building, with its tiny, 1980s-era lobby and a kitchen that can barely handle a few people making cereal 21 at the same time, has none of the perks of a typical Silicon Valley darling. “I think our Tesla headquarters looks like crap,” Musk said. “We’re going to spruce things up. Not to sort of the Google level. You have to be like making money hand over fist in order to be able to spend money the way that Google does. But we’re going to make our headquarters much nicer and put in a restaurant.” Naturally, Musk had ideas for some mechanical enhancements as well. “Everybody around here has slides in their lobbies,” he said. “I’m actually wondering about putting in a roller coaster—like a functional roller coaster at the factory in Fremont. You’d get in, and it would take you around factory but also up and down. Who else has a roller coaster? I’m thinking about doing that with SpaceX, too. That one might be even bigger since SpaceX has like ten buildings now. It would probably be really expensive, but I like the idea of it.”*  Roller coaster in the workplace. Yes! please! 😂  February 3, 2016 | [335](http://play.google.com/books/reader?printsec=frontcover&output=reader&id=qvW0BAAAAEAJ&source=books-notes-export&pg=GBS.PA335.w.0.0.0.1.0.1) | |

|  |  |  |  |
| --- | --- | --- | --- |
| |  |  |  | | --- | --- | --- | |  | *To get a sense of how powerful Musk’s work may end up being for the American economy, have a think about the dominant mechatronic machine of the past several years: the smartphone. Pre-iPhone, the United States was the laggard in the telecommunications industry. All of the exciting cell phones and mobile services were in Europe and Asia, while American consumers bumbled along with dated equipment. When the iPhone arrived in 2007, it changed everything. Apple’s device mimicked many of the functions of a computer and then added new abilities with its apps, sensors, and location awareness. Google charged to market with its Android software and related handsets, and the United States suddenly emerged as the driving force in the mobile industry. Smartphones were revolutionary because of the ways they allowed hardware, software, and services to work in unison. This was a mix that favored the skills of Silicon Valley. The rise of the smartphone led to a massive industrial boom in which Apple became the most valuable company in the country, and billions of its clever devices were spread all over the world. Tony Fadell, the former Apple executive credited with bringing the iPod and iPhone to market, has characterized the smartphone as representative of a type of super-cycle in which hardware and software have reached a critical point of maturity. Electronics are good and cheap, while software is more reliable and sophisticated. Their interplay is now resulting in science fiction–worthy ideas we were promised long ago becoming a reality. Google has its self-driving cars and has acquired dozens of robotics companies as it looks to merge code and machine. Fadell’s company Nest has its intelligent thermostats and smoke alarms. General Electric has jet engines packed full of sensors taught to proactively report possible anomalies to its human mechanics. And a host of start-ups have begun infusing medical devices with powerful software to help people monitor and analyze their bodies and diagnose conditions. Tiny satellites are being put into orbit twenty at a time, and instead of being given a fixed task for their entire lifetimes, like their predecessors, they’re being reprogrammed on the fly for a wide variety of business and scientific tasks. Zee Aero, a start-up in Mountain View, has a couple of former SpaceX staffers on hand and is working on a secretive new type of transport. A flying car at last? Perhaps. For Fadell, Musk’s work sits at the highest end of this trend. “He could have just made an electric car,” Fadell said. “But he did things like use motors to actuate the door handles. He’s bringing the consumer electronics and the software together, and the other car companies are trying to figure out a way to get there. Whether it’s Tesla or SpaceX taking Ethernet cables and running them inside of rocket ships, you are talking about combining the old-world science of manufacturing with low-cost, consumer-grade technology. You put these things together, and they morph into something we have never seen before. All of a sudden there is a wholesale change,” he said. “It’s a step function.”*  About smartphones, the hardware and software Renaissance and Tony fadell  February 4, 2016 | [355](http://play.google.com/books/reader?printsec=frontcover&output=reader&id=qvW0BAAAAEAJ&source=books-notes-export&pg=GBS.PA355.w.0.0.0.1) | |

|  |  |  |  |
| --- | --- | --- | --- |
| |  |  |  | | --- | --- | --- | |  | *As Page puts it, “Good ideas are always crazy until they’re not.” It’s a principle he’s tried to apply at Google. When Page and Sergey Brin began wondering aloud about developing ways to search the text inside of books, all of the experts they consulted said it would be impossible to digitize every book. The Google cofounders decided to run the numbers and see if it was actually physically possible to scan the books in a reasonable amount of time. They concluded it was, and Google has since scanned millions of books. “I’ve learned that your intuition about things you don’t know that much about isn’t very good,” Page said. “The way Elon talks about this is that you always need to start with the first principles of a problem. What are the physics of it? How much time will it take? How much will it cost? How much cheaper can I make it? There’s this level of engineering and physics that you need to make judgments about what’s possible and interesting. Elon is unusual in that he knows that, and he also knows business and organization and leadership and governmental issues.”*  Brilliant words about ideas, intuition, solving important problems and first principles. Larry Page  February 4, 2016 | [358](http://play.google.com/books/reader?printsec=frontcover&output=reader&id=qvW0BAAAAEAJ&source=books-notes-export&pg=GBS.PA358.w.0.0.0.3) | |

|  |  |  |  |
| --- | --- | --- | --- |
| |  |  |  | | --- | --- | --- | |  | *Musk has talked about having more kids, and it’s on this subject that he delivers some controversial philosophizing vis-à-vis the creator of Beavis and Butt-head. “There’s this point that Mike Judge makes in Idiocracy, which is like smart people, you know, should at least sustain their numbers,” Musk said. “Like, if it’s a negative Darwinian vector, then obviously that’s not a good thing. It should be at least neutral. But if each successive generation of smart people has fewer kids, that’s probably bad, too. I mean, Europe, Japan, Russia, China are all headed for demographic implosion. And the fact of the matter is that basically the wealthier—basically wealth, education, and being secular are all indicative of low birth rate. They all correlate with low birth rate. I’m not saying like only smart people should have kids. I’m just saying that smart people should have kids as well. They should at least maintain—at least be a replacement rate. And the fact of the matter is that I notice that a lot of really smart women have zero or one kid. You’re like, ‘Wow, that’s probably not good.’”*  Musk justifies why smart people should have more kids 😮  February 4, 2016 | [362](http://play.google.com/books/reader?printsec=frontcover&output=reader&id=qvW0BAAAAEAJ&source=books-notes-export&pg=GBS.PA362) | |