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By **JERRY HIRSCH**
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Capitalism 2015: In corporate finance today, the theme is "Go where the money is." For Elon Musk, CEO of Tesla, SolarCity and SpaceX, the place to hunt for cash isn't Wall Street or even Silicon Valley. It's Washington, D.C.

ELON MUSK: A RAT IN SPACE



MUSK'S OWN STAFF CALL HIM: "A LIAR"

Elon Musk's Space Dream Almost Killed Tesla

By Ashlee Vance

Illustrations by The Red Dress

SpaceX started with a plan to send mice to Mars. It got crazier from there.

In late October 2001, Elon Musk went to Moscow to buy an intercontinental ballistic missile. He brought along Jim Cantrell, a kind of international aerospace supplies fixer, and Adeo Ressi, his best friend from Penn. Although Musk had tens of millions in the

bank, he was trying to get a rocket on the cheap. They flew coach, and they were planning to buy a refurbished missile, not a new one. Musk figured it would be a good vehicle for sending a plant or some mice to Mars.

Ressi, a gangly eccentric, had been thinking a lot about whether his best friend had started to lose his mind, and he'd been doing his best to discourage the project. He peppered Musk with links to video montages of Russian, European, and American rockets exploding. He staged interventions, bringing Musk's friends together to talk him out of wasting his money. None of it worked. Musk remained committed to funding a grand, inspirational spectacle in space and would spend all of his fortune to do it. And so Ressi went to Russia to contain Musk as best as he could. "Adeo would call me to the side and say, 'What Elon is doing is insane. A philanthropic gesture? That's crazy,'" said Cantrell. "He was seriously worried."



The group set up a few meetings with companies such as NPO Lavochkin, which had made probes intended for Mars and Venus for the Russian Federal Space Agency, and Kosmotras, a commercial rocket launcher based in Moscow. The appointments all seemed to go the same way, following Russian decorum. The Russians, who often skip breakfast, would ask to meet around 11 a.m. at their offices for an early lunch. Then there would be small talk for an hour or more as the meeting attendees picked over a spread of sandwiches, sausages, and, of course, vodka. After lunch came a lengthy smoking and coffee drinking period. Once all of the tables were cleared, the Russian in charge would turn to Musk and ask, "What is it you're interested in buying?" The big windup may not have bothered Musk as much if the Russians had taken him more seriously. They viewed Musk as a novice when it came to space and did not appreciate his bravado. "One of their chief

designers spit on me and Elon because he thought we were full of s---," Cantrell said. Team Musk returned empty-handed.



In February 2002 the group returned to Russia, this time bringing Mike Griffin, who had worked for the **CIA's venture capital arm, In-Q-Tel**; NASA's Jet Propulsion Laboratory; and was just leaving Orbital Sciences, a maker of satellites and spacecraft. Musk was now looking for not one but three missiles and had a briefcase full of cash, too. They met with Kosmotras officials in an ornate, neglected, prerevolutionary building near downtown Moscow. The vodka shots started—"To space!" "To America!"—and, a little buzzed, Musk asked point-blank how much a missile would cost. Eight million dollars each, they said. Musk countered, offering \$8 million for two. "They sat there and looked at him," Cantrell said. "And said something like, 'Young boy. No.' They also intimated that he didn't have the money." At this point, Musk had decided the Russians were either not serious about doing business or were just determined to part a dot-com millionaire from as much of his money as possible. He stormed out of the meeting.

The team went out into the snow and dreck of the Moscow winter, hailed a cab, and drove straight to the airport. The Russians were the only ones with rockets that could possibly fit within Musk's budget, and they were too difficult to deal with. "It was a long drive," Cantrell said. "We sat there in silence looking at the Russian peasants shopping in the snow." The somber mood lingered all the way to the plane, until the drink cart arrived. "You always feel particularly good when the wheels lift off in Moscow," Cantrell said. "It's like, 'My God. I made it.' So, Griffin and I got drinks and clinked our glasses." Musk sat in the row in front of them, typing on his computer. "We're thinking, 'F---ing nerd: What can he be doing now?'"

At which point Musk wheeled around and flashed a spreadsheet he'd created.

"Hey, guys," he said, "I think we can build this rocket ourselves."





SpaceX made history on Sept. 28, 2008, when its Falcon 1 became the first privately developed, liquid-fueled rocket to orbit earth.

Source: NASA

SpaceX made history on Sept. 28, 2008, when its Falcon 1 became the first privately developed, liquid-fueled rocket to orbit earth.

Source: NASA

Just a few months before, in June 2001, Musk had turned 30. "I'm no longer a child prodigy," he told his college sweetheart and new wife, Justine, only half joking. Musk had emigrated from South Africa in 1988 and had made millions off two Internet companies, Zip2 and PayPal. Now, he was expected to act like a stereotypical dot-com rich guy and start some other Web service. Musk, though, wanted more. As a child, he had dreamed of rocket ships and space travel, devouring Heinlein, Asimov, and Douglas Adams. For most people, a triumph in Silicon Valley would be the goal. For Musk, it was a stepping stone.

The changes in his attitude and thinking were obvious to friends, including a group of PayPal executives who gathered in Las Vegas one weekend to celebrate the recent sale. "We're all hanging out in this cabana at the Hard Rock Cafe, and Elon is there reading some obscure Soviet rocket manual that was all moldy and looked like it had been bought on EBay," said Kevin Hartz, an early PayPal investor. "He

was studying it and talking openly about space travel and changing the world.”

Elon and Justine decided to move south to begin their family and the next chapter of their lives in Los Angeles. Unlike many Southern California transplants, they were drawn by the technology. The mild, consistent weather made it ideal for the aeronautics industry, which had been there since the 1920s, when Lockheed Aircraft set up shop in Hollywood. Howard Hughes, the U.S. Air Force, NASA, Boeing, and a mosaic of support industries followed suit. While Musk’s space plans were vague at the time, he felt confident that he could recruit some of the world’s top aeronautics thinkers and get them to join his next venture.



Illustrations by Paul Faassen; Photo: Courtesy Maye Musk

Musk started by crashing the Mars Society, an eclectic collection of space enthusiasts dedicated to exploring and settling the Red Planet. They were holding a fund-raiser in mid-2001, a \$500-per-plate event at the house of one of the well-off Mars Society members. What stunned Robert Zubrin, the head of

the group, was the reply from someone named Elon Musk, whom no one could remember inviting. “He gave us a check for \$5,000,” Zubrin said. “That made everyone take notice.” Zubrin invited Musk for coffee ahead of the dinner and told him about the research center the society had built in the Arctic to mimic the tough conditions of Mars and the experiments they had been running for something called the Translife Mission, in which there would be a capsule orbiting earth carrying a crew of mice. It would spin to give them one-third gravity—the same as Mars—and they would live there and make babies.

When it was time for dinner, Zubrin placed Musk at the VIP table next to himself, the director and space buff James Cameron, and Carol Stoker, a planetary scientist for NASA. Musk loved it. “He was much more intense than some of the other millionaires,” Zubrin said. “He didn’t know a lot about space, but he had a scientific mind. He wanted to know exactly what was being planned in regards to Mars and what the significance would be.” Musk took to the Mars Society right away and joined its board of directors. He donated an additional \$100,000 to fund a research station in the desert.

Musk’s friends were not entirely sure what to make of his mental state at that time. He’d caught malaria while on vacation in Africa and lost a tremendous amount of weight fighting it off. Musk stands 6-foot-1 but usually seems much bigger than that. He’s broad-shouldered, sturdy, and thick. This version of Musk, though, looked emaciated and with little prompting would start expounding on his desire to do something meaningful with his life. “He said, ‘The logical thing to happen next is solar, but I can’t figure out how to make any money out of it,’” said George

Zachary, an investor and close friend of Musk's, recalling a lunch date at the time. "He started talking about space, and I thought he meant office space like a real estate play." Musk had already started thinking beyond the Mars Society's goals. Rather than send a few mice into earth's orbit, Musk wanted to send them to Mars.

"He asked if I thought that was crazy," Zachary said. "I asked, 'Do the mice come back? Because, if they don't, yeah, most people will think that's crazy.'" Musk said that the mice were not only meant to go to Mars and come back but they also would come home with the baby mice, too.

Musk built a network of space experts and brought the best of them together at a series of salons—sometimes at the Renaissance hotel at the Los Angeles airport and sometimes at the Sheraton in Palo Alto. Musk had no formal business plan. He mostly wanted them to help him develop the mice-to-Mars idea or at least to come up with something comparable. Musk hoped to hit on a wondrous gesture for mankind—some type of event that would capture the world's attention, get people thinking about Mars again, and have them reflect on man's potential. Scientists showed up from NASA's JPL. Cameron was there again, along with Griffin. No one on the planet knew more about the realities of getting things into space than Griffin, and he was consulting for Musk. Four years later, he would be running NASA.



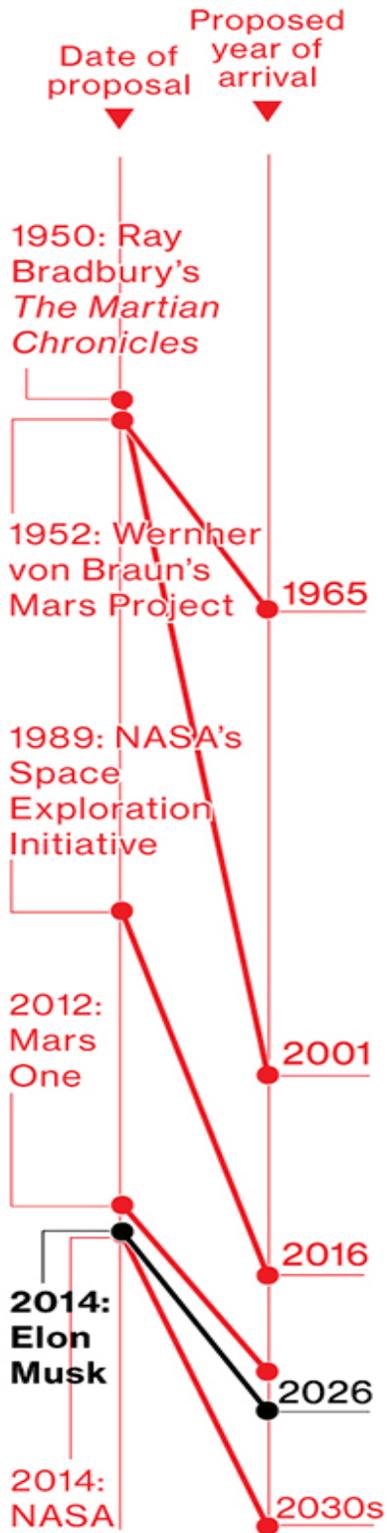
The experts were thrilled to have another rich guy appear who was willing to fund something interesting in space. They happily debated the merits and feasibility of sending up the mice. But the discussion turned to a different project, the “Mars Oasis.” In this scenario, Musk would buy a rocket and use it to shoot what amounted to a robotic greenhouse to Mars, a space-ready growth chamber for plants that could open up briefly and scoop in some of the Martian regolith, or soil, and then use it to grow a plant, which would in turn produce the first oxygen on Mars. Much to Musk’s liking, this plan seemed both ostentatious and feasible.

Musk wanted the space greenhouse to have a way to send a video feed to earth, so people could watch the plant grow. The group also talked about mailing kits to students around the country who would nurture their own plants simultaneously and notice, for example, that the Martian plant could grow twice as high as its earthbound counterpart in the same amount of time. Musk’s enthusiasm for the idea started to inspire the group, many of whom had

grown cynical about anything novel happening in space again. There were immense engineering challenges that would need solving. Getting Martian soil into the structure seemed not only hard to do physically but also problematic because the regolith would be toxic. For a while, the scientists debated growing the plant in a nutrient-rich gel instead, but that felt like cheating. Even the optimistic moments were awash in unknowns. One scientist found some very resilient mustard seeds and thought they could possibly survive a treated version of the Martian soil. "There was a pretty big downside if the plant didn't survive," said Dave Bearden, a space industry veteran who attended the meetings. "You'd have this dead garden on Mars."

The main thing troubling the space experts was Musk's budget. Following the salons, it seemed like Musk wanted to spend somewhere between \$20 million and \$30 million on the stunt, and everyone knew that the cost of a rocket launch alone would eat up that money and then some. Musk, however, had his own plans. He'd been devouring books he'd borrowed from Cantrell and others. They included *Rocket Propulsion Elements*, *Fundamentals of Astrodynamics*, and *Aerothermodynamics of Gas Turbine and Rocket Propulsion*. According to Musk's calculations, he could undercut existing launch companies by building a modest-size rocket that specialized in carrying smaller satellites and research payloads to space. In June 2002 he founded Space Exploration Technologies, or SpaceX. He was on his way to Mars.

Red Planet Ambitions



DATA: NASA, MARS ONE, NATIONAL SPACE SOCIETY, CNBC

SpaceX's first headquarters was in an old warehouse at 1310 East Grand Ave. in El Segundo, a suburb of Los Angeles. It had 75,000 square feet of open space and several receiving bays, allowing Musk to drive his silver McLaren F1 sports car right into his office. It was a sparse, hangarlike building with a dusty floor and curved ceilings. During the first week of SpaceX's operations, delivery trucks showed up with laptops and printers and folding tables. Musk walked over to one of the loading docks, rolled up the door, and offloaded the equipment himself. Desks were eventually interspersed around the factory so the computer scientists and engineers designing the machines could sit with the welders and machinists building the hardware. In aerospace, this was daring. Traditional aerospace companies separate engineers and machinists by thousands of miles.

SpaceX planned to do a lot of things differently. Instead of assembling parts from thousands of suppliers, the company would build as much machinery as it could in-house. This included things like a mobile launchpad and—most ambitiously—rocket engines. Wherever possible, SpaceX would be faster, cheaper, and better than its competitors. It would launch multiple rockets each month, make money off each one, and never need to become a huge contractor dependent on government funds. SpaceX's first rocket would be called the Falcon 1, a nod to *Star Wars' Millennium Falcon*. At a time when the cost of sending a 550-pound payload into orbit started at \$30 million, Musk promised that the Falcon

1 would be able to carry a 1,400-pound payload for \$6.9 million.

The proposed timeline for upending the aerospace industry was comically short. One of the earliest SpaceX presentations promised the first complete engine by May 2003, a second engine in June, the body of the rocket in July, and everything assembled by August. A launchpad would be ready by September, and the first launch would take place in November 2003, or about 15 months after the company started. A trip to Mars was naturally slated for somewhere near the end of the decade. "Elon has always been optimistic," said Kevin Brogan, an early SpaceX recruit. "That's the nice word. He can be a downright liar about when things need to get done. He will pick the most aggressive time schedule imaginable assuming everything goes right, and then accelerate it by assuming that everyone can work harder."

Musk [sought out](#) young overachievers, personally calling top students in aerospace programs and recruiting them over the phone. "I thought it was a prank call," said Michael Colonno, who heard from Musk while attending Stanford. "I did not believe for a minute that he had a rocket company." Once the students looked Musk up on the Internet, selling them on SpaceX was easy. As word of SpaceX's ambitions spread, top engineers with a high tolerance for risk from Boeing, Lockheed Martin, and Orbital Sciences fled to the upstart, too.

Throughout the first year at SpaceX, one or two new employees joined almost every week. Brogan was employee No. 23 and came from TRW, a soon-to-be-shuttered aerospace player, where he'd been used to various internal policies blocking him from doing work. "I called it the country club," he said. "Nobody did anything." Brogan started at SpaceX the day after his interview and was told to scrounge around the office and find a computer to use. "It was go to Fry's and get whatever you need and go to Staples and get a chair," Brogan said.

One of the first projects was the construction of a gas generator, a machine not unlike a small rocket engine that produces hot gas to power pumps. Tom Mueller, another TRW veteran, Tim Buzza, a defector from Boeing, and a couple of young engineers assembled the generator in Los Angeles and then packed it into the back of a pickup truck and drove it out to Mojave to test it. A desert town about 100 miles from Los Angeles, Mojave had become a hub for aerospace companies such as Scaled Composites and XCOR.

The SpaceX team borrowed a test stand from XCOR that was just about the perfect size to hold the gas generator. The first ignition run took place at 11 a.m. and lasted 90 seconds. The generator worked, but it let out a billowing black cloud that settled right over the airport tower. In the days that followed, SpaceX's engineers perfected a routine that let them do multiple tests a day—an unheard-of practice at the airport—and had the gas generator tuned to their liking after two weeks of work.

Elon Musk's Planetary and Galactic Empire

A guide to the past, present, and future of SpaceX and Tesla

- 1 2001: Musk travels to Moscow hoping to buy an intercontinental ballistic missile
- 2 2001: Joins Mars Society in Los Angeles
- 3 2002: SpaceX founded in an El Segundo (Calif.) warehouse
- 4 2002-2003: SpaceX rocket engines tested in Mojave, Calif., McGregor, Texas, and Stennis Space Center, Miss.
- 5 2003: Musk founds Tesla Motors, headquartered in Palo Alto
- 6 2008-2015: SpaceX launch sites
- 7 2009: SpaceX moves to larger headquarters in Hawthorne, Calif.
- 8 2014: Tesla begins construction of battery Gigafactory outside Reno

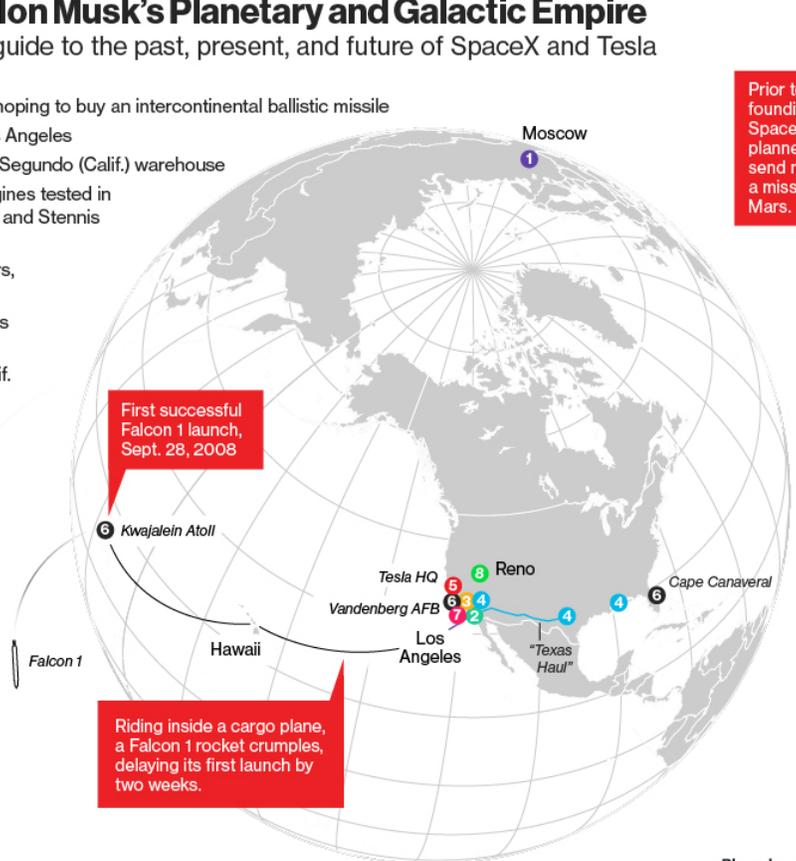
Prior to founding SpaceX, Musk planned to send mice on a mission to Mars.

SpaceX has made six resupply missions to the International Space Station for NASA.



First successful Falcon 1 launch, Sept. 28, 2008

Riding inside a cargo plane, a Falcon 1 rocket crumples, delaying its first launch by two weeks.



Source: Bloomberg research

Bloomberg Graphics

The SpaceX team made a few more trips to Mojave and some other spots, including a test stand at Edwards Air Force Base in Southern California and another in Mississippi. While on this countrywide rocketry tour, the SpaceX engineers visited a 300-acre test site in McGregor, Texas, a small city near the center of the state. The site was a leftover from another billionaire, Andrew Beal, a real estate and finance whiz in Texas, who had folded his aerospace startup after pouring millions into the massive test facility. The SpaceX engineers really liked this spot—and the three-story concrete test stand Beal had left there—and talked Musk into buying it.

Jeremy Hollman, a young engineer, soon found himself living in Texas. Hollman exemplified the kind of recruit Musk wanted: He'd earned an aerospace engineering degree from Iowa State University and a master's in aeronautical engineering from the University of Southern California. He'd spent a couple of years working as a test engineer at Boeing dealing with jets, rockets, and spacecraft. At 23, Hollman was young, single, and willing to give up any semblance of having a life in favor of working at SpaceX nonstop, and he became Mueller's second in command.

Mueller had developed a pair of 3D computer models of the two engines he wanted to build. Merlin would be the engine for the first stage of the Falcon 1, which lifted it off the ground, and Kestrel would be the smaller engine used to power the upper, second stage of the rocket and guide it in space. Together, Hollman and Mueller figured out which parts SpaceX would build at the Los Angeles factory and which parts it would try to buy. For the purchased parts, Hollman had to head to various machine shops and get quotes and delivery dates for the hardware. Quite often, the machinists told Hollman that SpaceX's timelines were nuts. Others were more accommodating and would try to bend an existing product to SpaceX's needs instead of building something from scratch. Hollman also found that ingenuity got him a long way. He discovered, for example, that changing the seals on some readily available carwash valves made them good enough to be used with rocket fuel.

In addition to building its own engines, rocket bodies, and capsules, SpaceX designed its own

motherboards and circuits, sensors to detect vibrations, flight computers, and solar panels. On a radio, SpaceX's engineers found that they could reduce the weight of the device by about 20 percent. And the cost savings were dramatic, dropping from the \$50,000 to \$100,000 for the industrial-grade equipment used by aerospace companies to \$5,000 for SpaceX's unit.

Even as they were trying to figure out Falcon 1, Musk was planning to build something he was calling the BFR, aka the Big Falcon Rocket or Big F---ing Rocket. It would have the biggest rocket engine in history. Musk's bigger, faster mentality amused and impressed some of the suppliers that SpaceX occasionally turned to for help, like Barber-Nichols, a Colorado-based maker of rocket engine turbo pumps and other aerospace machinery. Bob Linden, a Barber-Nichols executive, remembers dealing with him. "Elon showed up with Tom Mueller and started telling us it was his destiny to launch things into space at lower costs and to help us become spacefaring people," he said. "We thought the world of Tom but weren't quite sure whether to take Elon too seriously. They began asking us for the impossible. They wanted a turbo pump to be built in less than a year for under \$1 million. Boeing might do a project like that over five years for \$100 million. Tom told us to give it our best shot, and we built it in 13 months. He was relentless."



The SpaceX facility in McGregor, Texas.

Source: SpaceX

After SpaceX completed its first engine at the factory in California, Hollman loaded it along with mounds of other equipment into a U-Haul trailer, hitched it to the back of a white Hummer H2, and drove it down Interstate 10 from Los Angeles to the test site in Texas. Amid rattlesnakes, fire ants, isolation, and searing heat, the group fastened their prototype engine to the stand, filled it with liquid oxygen and kerosene, hid in a bunker behind a dirt berm, and fired it, for all of 0.1 seconds. The bad news was it would need a lot of work. The good news was it didn't blow up. (That would happen later, and the engineers had a term for that, a "rapid unscheduled disassembly.") After that first successful burn, the employees christened the site by drinking a \$1,200 bottle of Rémy Martin, left over from SpaceX's inaugural party, out of paper cups.

Over the next years, the trek from California to the test site became known as the Texas Cattle Haul. SpaceX engineers would work for 10 days straight in Texas, come back to California for a weekend, and then head back. To ease the burden of travel, Musk sometimes let them use his private jet. "It carried six people," Mueller said. "Well, seven if someone sat in the toilet, which happened all the time."

Musk, of course, wasn't just building rockets. In 2003, about a year after he started SpaceX, Musk helped found Tesla Motors, which planned to sell an electric sports car. Musk had spent years pining after a good electric car, and though he had committed \$100 million to SpaceX, he would now put an additional \$70 million into Tesla and end up as the company's

CEO. It was a decision that would almost break both companies.



Stills from *Iron Man 2*

As he prepared to begin filming *Iron Man* in early 2007, director Jon Favreau rented out a complex in Los Angeles that once belonged to Hughes Aircraft, the aerospace and defense contractor started about 80 years earlier by Howard Hughes. The facility had a series of interlocking hangars and served as a production office for the movie. It also supplied Robert Downey Jr., who was to play Iron Man and his human creator, Tony Stark, with a splash of inspiration. Downey felt nostalgic looking at one of the larger hangars, which had fallen into a state of disrepair. Not too long ago, that building had played host to the big ideas of a big man who shook up industries and did things his own way.

Downey had heard about a Howard Hughes-like figure who had constructed his own industrial complex about 10 miles from the *Iron Man* set. Instead of visualizing how life might have been for Hughes, Downey could perhaps get a taste of the real thing. In March 2007, he visited SpaceX's headquarters in El Segundo and wound up receiving a personal tour from Musk. "My mind is not easily blown, but this place and this guy were amazing," Downey said.

To Downey, the SpaceX facility looked like a giant, exotic hardware store. Enthusiastic employees were zipping about, fiddling with an assortment of machines. Young white-collar engineers interacted with blue-collar assembly line workers, and they all seemed to share a genuine excitement for what they were doing. "It felt like a radical startup company,"

Downey said. After the initial tour, Downey came away pleased that the sets being hammered out at the former Hughes factory did have parallels to the SpaceX operations. "Things didn't feel out of place," he said.

The men walked, sat in Musk's office, and had lunch. Downey appreciated that Musk was not a foul-smelling, fidgety, coder whack job. What Downey picked up on instead were Musk's "accessible eccentricities" and the feeling that he was someone who could work alongside the people in the factory. When he returned to the *Iron Man* production office, Downey asked that Favreau be sure to place a Tesla Roadster in Tony Stark's workshop. "After meeting Elon and making him real to me, I felt like having his presence in the workshop," Downey said. "They became contemporaries. Elon was someone Tony probably hung out with and partied with, or more likely they went on some weird jungle trek together to drink concoctions with the shamans." Musk later had a cameo in *Iron Man 2*.

Musk enjoyed his rising profile. He and Justine bought a house in Bel Air. Their neighbors were Quincy Jones, and Joe Francis, the creator of the Girls Gone Wild videos. Musk and some former PayPal executives produced *Thank You for Smoking* and used Musk's jet in the movie. While not a carouser, Musk took part in the Hollywood nightlife and its social scene. "We had a domestic staff of five; during the day our home transformed into a workplace," Justine wrote in a magazine article for *Marie Claire*. "We went to black-tie fundraisers and got the best tables at

elite Hollywood nightclubs, with Paris Hilton and Leonardo DiCaprio partying next to us. When Google co-founder Larry Page got married on Richard Branson's private Caribbean island, we were there, hanging out in a villa with John Cusack and watching Bono pose with swarms of adoring women outside the reception tent."

By this time, SpaceX was looking like a real aerospace company. It had built and tested its engines and completed a full rocket body. All Musk needed now was to fire the thing into the sky and see what happened.



Justine Musk by the pool of the Bel Air home she shared with Elon.

Photographer: Lauren Greenfield/Institute

Under normal circumstances, SpaceX might have launched its rockets from the nearby Vandenberg Air Force Base. The site has several launchpads to pick from, but none of the current tenants—Boeing, Lockheed, and the Air Force—were all that interested in helping an Internet executive get to space. Locked

out locally, SpaceX decided to try Kwajalein Island—or Kwaj—the largest island in an atoll between Guam and Hawaii and part of the Republic of the Marshall Islands. The U.S. Army had used it for decades as a missile test site. Gwynne Shotwell, then SpaceX's vice president for business development, looked up the name of a colonel at the test site and sent him an e-mail. Three weeks later she got a call back from the Army saying they would love to have SpaceX fly from the islands.

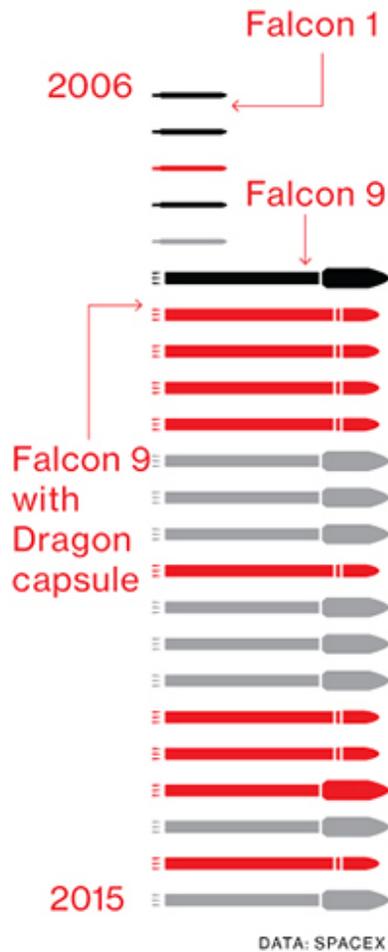
To get to Kwaj, the SpaceX employees either flew on Musk's jet or took commercial flights through Hawaii. The main accommodations were two-bedroom affairs that looked more like dormitories than hotel rooms, with their military-issued dressers and desks. Over the course of several months a small team of people cleared brush on nearby Omelek Island to create a launch site and converted a double-wide trailer into offices. The work took place in soul-sapping humidity under a sun powerful enough to burn the skin through a T-shirt. The SpaceX team started at sunrise, around 7 a.m., and went until 7 p.m. "One or two people would decide it was their night to cook, and they would make steak and potatoes and pasta," Hollman said. "We had a bunch of movies and a DVD player, and some of us did a lot of fishing off the docks." For many of the engineers, this was both a torturous and magical experience. "At Boeing you could be comfortable, but that wasn't going to happen at SpaceX," said Walter Sims, a SpaceX tech expert who found time to get certified to scuba dive while on Kwaj. "Every person on that island was a f---ing star, and they were always holding seminars on radios or the engine. It was such an invigorating place."

Time and again, the rocket would get rolled out to the launchpad and tipped vertical for a couple of days, and then technical and safety checks would reveal a host of new problems. As soon as they could, the engineers returned it to the hangar to protect it from the salty air. Teams that had labored separately for months back at the SpaceX factory—propulsion, avionics, software—were thrown together on the island and forced to become an interdisciplinary whole. “It was like *Gilligan’s Island* except with rockets,” Hollman said.

Finally, on March 24, 2006, the engineers had fixed enough bugs to launch. The Falcon 1 stood on its square launchpad and ignited. It soared into the sky and started to shrink against the vast blue expanse. In the island control room, Musk paced as he watched the action, wearing shorts, flip-flops, and a T-shirt. Then, about 25 seconds in, a fire broke out above the Merlin engine, and suddenly this machine that had been flying straight and true started to spin and then tumble back to earth. The Falcon 1 ended up falling directly onto the launch site. Most of the debris went into a reef 250 feet from the launchpad, and the satellite cargo smashed through SpaceX’s machine shop roof and landed more or less intact on the floor. Some of the engineers put on their snorkeling and scuba gear and recovered the pieces, fitting all of the rocket’s remnants into two refrigerator-size crates.

Tallying Up The Launches

- Test flight
- NASA
- Commercial



DATA: SPACEX

After the crash, there was a lot of drinking at a bar on the main island. Musk wanted to launch again within six months, but putting together a new machine would require an immense amount of work. Musk had vowed publicly that he would build a working rocket, but people inside and outside the company were doing back-of-the-envelope math and could tell that SpaceX likely could afford only one more attempt. 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 Branden Spikes, head of IT for SpaceX. "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."

Meanwhile, SpaceX had put another group of engineers on a new project to develop the Falcon 9, a nine-engine rocket that would serve as a possible replacement for the retiring space shuttle. SpaceX had yet to prove it could get to space successfully, but Musk was already positioning the company to bid on big-ticket NASA contracts.

In mid-2008, SpaceX prepared its fourth rocket for launch. Typically, the body of the Falcon 1 traveled to Kwaj via barge. Maybe it was "go fever," which is how rocket people describe the manic decision-making that can characterize a launch, but this time around Musk and the engineers were too excited and desperate to wait for the ocean journey. Musk rented a military cargo plane to fly the rocket body from Los Angeles to Hawaii and then on to Kwaj. This would have been a fine idea except the SpaceX engineers forgot to think about what the pressurized plane would do to the body of the rocket, which is less than an eighth of an inch thick. As the plane started its descent into Hawaii, strange noises came from the cargo hold. "I looked back and could see the stage crumpling," said Bulent Altan, the former head of avionics at SpaceX. "I told the pilot to go up, and he did." The rocket was buckling from the increasing air pressure like an empty water bottle.

Altan saw that the SpaceX team on the plane had about 30 minutes to do something about the problem before they would need to land. They pulled out their pocketknives and cut away the shrink wrap that covered the rocket. They found a maintenance kit on the plane and used the wrenches to open up some nuts on the rocket that would allow its internal pressure to match that of the plane's. When the plane landed, the engineers divvied up the duties of calling SpaceX's top executives to tell them what happened. It was 3 a.m. Los Angeles time, and one of the executives volunteered to deliver the news to Musk.

It looked like three months of work to fix the rocket. The body had caved in several places, and the baffles placed inside the fuel tank to stop the fuel from sloshing had broken. Musk ordered the team to continue on to Kwaj and sent in a reinforcement team with repair parts. Two weeks later, the rocket was fixed. "It was like being stuck in a foxhole together," Altan said. "You weren't going to quit and leave the person next to you behind."

The fourth and possibly final launch for SpaceX took place on Sept. 28, 2008. SpaceX employees had worked nonstop shifts for months to reach this moment. They had been separated from their families, in exile on their tiny, hot outpost—sometimes without much food—for days on end as they waited for launch windows to open and dealt with the aborts that followed.

In the late afternoon, the SpaceX team raised the Falcon 1 to its launch position. It stood tall, looking like a bizarre artifact from the future as palm trees swayed beside it and a smattering of clouds crossed through the spectacular blue sky. By this time, SpaceX had turned each launch into a major Web production, so there was a worldwide audience. The Falcon 1 was not carrying real cargo this time; neither the company nor the military nor NASA wanted to see something else blow up or get lost at sea, so the rocket held a 360-pound dummy payload.

Musk, back in Los Angeles, tried to distract himself from the mounting pressure by going to Disneyland with his brother Kimbal and their children, but by 4 p.m. he was back in SpaceX's L.A. control room, watching the feed. As the rocket rumbled and then climbed higher, the employees inside SpaceX's headquarters let out raucous cheers. Each milestone that followed—clearing the island, engine checks coming back good—was again met with whistles and shouts. After the first stage fell away, the second stage fired up about 90 seconds into the flight and the employees turned downright rapturous, filling the webcast with their ecstatic hollering. "Perfect," said one of the talking heads. The Kestrel engine glowed red and started its six-minute burn. "When the second stage cleared, I could finally start breathing again and my knees stopped buckling," said James McLaury, a machinist at SpaceX.

The fairing opened up around the three-minute mark and fell back toward earth. And, finally, around nine minutes into its journey, the Falcon 1 shut down just as planned. After six years—about four-and-a-half

more than Musk had once planned—the first privately built, liquid-fueled rocket had reached orbit.

“Everyone burst into tears,” Kimbal said. “It was one of the most emotional experiences I’ve had.” Musk left the control room and walked out to the factory floor, where he received a rock star’s welcome. “Well, that was freaking awesome,” he said. “As the saying goes, ‘The fourth time is the charm,’ right?”



The Dragon capsule in orbit, Jan. 14, 2015.

Source: SpaceX

The afterglow, however, soon faded. SpaceX, like Musk's other company, Tesla, was facing a major cash shortage. SpaceX had the Falcon 9 efforts to support and had also greenlighted the construction of the Dragon capsule, which would take supplies and, one day, humans, to the International Space Station. Historically, either project would have cost more than \$1 billion to complete, but SpaceX would have to find a way to build both machines simultaneously for a fraction of the cost. The company had dramatically increased the rate at which it hired employees and moved into a much larger headquarters. SpaceX had a commercial flight booked to carry a satellite into orbit for the Malaysian government, but that launch and the payment for it would not arrive until the middle of 2009. In the meantime, SpaceX simply struggled to make its payroll. Just when it figured out how to fly a rocket, SpaceX was going broke.

As bad as they were, the financial problems did not compare to the collapse of Musk's personal life. Not long after moving to Los Angeles, Musk had lost his 10-week-old son, Nevada Alexander, to sudden infant death syndrome. "I'm not sure why I'd want to talk about extremely sad events," Musk told me. "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." Musk went on to have five more sons with Justine—twins and triplets—but their relationship broke apart in 2008, and Musk filed for divorce. Justine soon began documenting the divorce on a blog, and the press was all too happy to merge the personal details into stories of Musk's financial woes.

Reporters seemed to take a special pleasure in attacking Tesla. The electric car maker had suffered through numerous product delays, management changes, and cost overruns. After five years and tens of millions of dollars, there was still no Tesla available to buy. A website called the Truth About Cars began a "Tesla Death Watch" in May 2008 and followed up with dozens of entries throughout the year. The blog captured Tesla's engineering issues and Musk's feud with Tesla co-founder Martin Eberhard, who'd been forced out of the company.

"I was just getting pistol-whipped," Musk said. "There was a lot of schadenfreude at the time, and it was bad on so many levels. Justine was torturing me in the press. ... It hurt really bad. You have these huge doubts that your life is not working, your car is not working, you're going through a divorce and all of those things. I felt like a pile of s---. I didn't think we would overcome it. I thought things were probably f--ing doomed."

When Musk looked at the numbers, it looked like only one company would survive. "I could either pick SpaceX or Tesla or split the money I had left between

them," Musk said. "That was a tough decision. If I split the money, maybe both of them would die. If I gave the money to just one company, the probability of it surviving was greater, but then it would mean certain death for the other company. I debated that over and over." In the meantime, the economy was worsening, and spacecraft and sports cars seemed out of place in a time of near-record unemployment.



Riley and Musk at the premiere of *St. Trinian's 2* in London in 2009.

Photographer: UPPA/Zuma Press

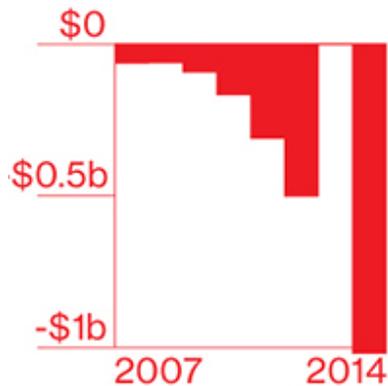
The brightest light in Musk's life at the time was Talulah Riley, a 22-year-old British actress he had started dating and would later marry. She viewed Musk's life as Shakespearean tragedy. Sometimes Musk would open up to her, and other times he retreated into himself. Riley spied on Musk while he read e-mail and watched him grimace as bad news poured in. "You'd witness him having these conversations in his head," she said. "It's really hard to watch someone you love struggle like that." Because of the long hours that he worked and his eating habits, bags formed under his eyes. "He looked like death itself," Riley said. "I remember thinking this guy would have a heart attack and die. He seemed like a man on the brink."

Burning through about \$4 million a month, Tesla needed to close another major round of funding to get through 2008 and stay alive. Musk had to lean on friends just to make payroll from week to week as he negotiated with investors. He sent impassioned pleas to anyone he could think of who might be able to spare some money. Bill Lee, a wealthy friend, invested \$2 million in Tesla, and Sergey Brin, co-founder of Google, invested \$500,000. Kimbal had lost most of his money during the recession but sold what investments he had left and put it into Tesla as well. The company had set the prepayments that customers made for the Roadsters aside, but Musk now needed to use that money to keep the company going. Soon those funds were gone, too. These maneuvers worried Kimbal. "I'm sure Elon would have found a way to make things right, but he definitely took risks," he said.

In December 2008, Musk heard a rumor that NASA was on the verge of awarding a contract to resupply the space station. SpaceX's fourth launch had put it in a position to receive some of this money, which was said to be in excess of \$1 billion. Musk reached out through back channels in Washington and found out that SpaceX might even be a front-runner for the deal.

As for Tesla, Musk made a last-ditch effort to raise all the personal funds he could. He took out a loan from SpaceX, which NASA approved—Musk did not want to mess up his chance for a contract—and earmarked the money for Tesla. He went to the secondary markets to try to sell some of his shares in [SolarCity](#), a solar panel installer where he served as chairman. He lucked into about \$15 million that came through when Dell acquired a data center software startup called Everdream, founded by Musk's cousins, in which he had invested.

Tesla's cash flow ...



...and its stock price



DATA: COMPILED BY BLOOMBERG

Musk finally put together about \$20 million and asked Tesla's existing investors—since no new investors materialized—to match that figure. The investors agreed, and on Dec. 3, 2008, they were in the process of finalizing the paperwork for the funding round when Musk noticed a problem. VantagePoint Capital Partners had signed all of the paperwork except for one crucial page. Musk phoned Alan Salzman, VantagePoint's co-founder and managing partner, to ask about the situation. Salzman told Musk that the firm had a problem with the investment round because it undervalued Tesla.

Salzman asked Musk to come in the following week at 7 a.m. to present to VantagePoint's top brass and explain the deal. Not having a week of time to work with, Musk demanded to come in the next day, and Salzman refused, forcing Musk to continue taking on loans. "The only reason he wanted the meeting at his office was for me to come on bended knee begging for money so he could say, 'No,'" Musk theorized. "What a f---head."

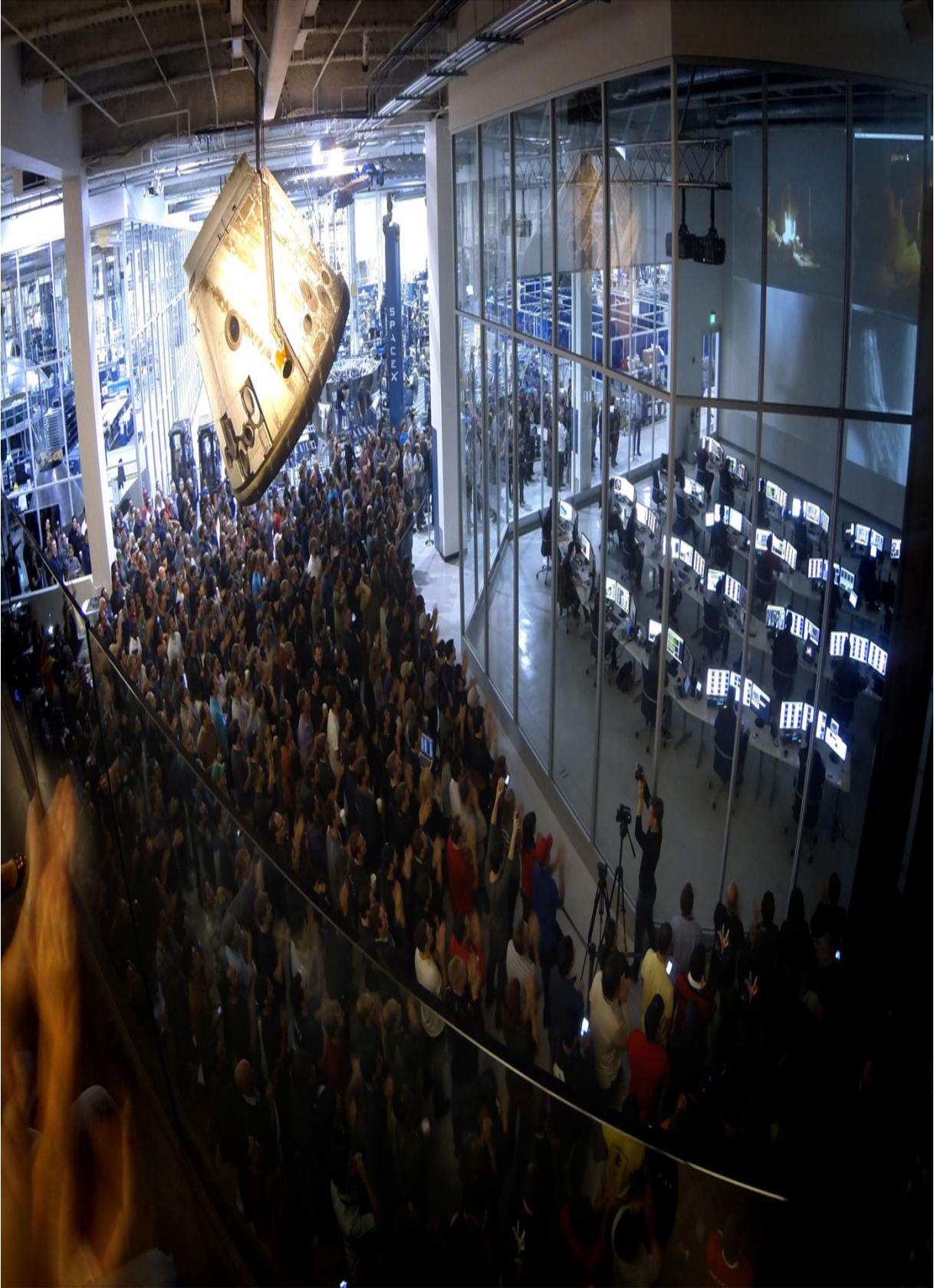
VantagePoint declined to speak about this period, but Musk believed that Salzman's tactics were part of a mission to bankrupt Tesla. Musk feared that VantagePoint would oust him as CEO, recapitalize Tesla, and emerge as the major owner of the carmaker. It could then sell Tesla to a Detroit automaker or focus on selling electric drivetrains and battery packs instead of making cars.

In response, Musk took another huge risk. Tesla recharacterized the funding as a debt round, knowing that VantagePoint could not interfere with a debt deal. The tricky part of this strategy was that venture capital investors, such as Draper Fisher Jurvetson, are not structured to do debt deals. Persuading their backers to alter their rules of engagement for a company that could very well go bankrupt in a matter of days would be tough. So Musk bluffed. He told the investors that he would take another loan from SpaceX and fund the entire round—all \$40 million—himself. The tactic worked: The investors handed over \$20 million. "When you have scarcity, it naturally reinforces greed and leads to more interest," Steve Jurvetson said. "It was also easier for us to go back to our firms and say, 'Here is the deal. Go or no go?'"

In the meantime, at SpaceX, Musk and top executives had spent most of December in a state of fear, but on Dec. 23, 2008, SpaceX received a wonderful shock. The company won a \$1.6 billion contract for 12 NASA resupply flights to the space station. Then the Tesla deal ended up closing successfully, on Christmas Eve, hours before Tesla would have gone bankrupt. Musk had just a few hundred thousand dollars left and could not have made payroll the next day.

Staying with Kimbal in Boulder, Colo., for the holidays, Musk broke down in tears as the SpaceX and Tesla transactions processed. "I hadn't had an opportunity to buy a Christmas present for Talulah or anything," he said. "I went running down the f---ing street in Boulder, and the only place that was open sold these s----- trinkets, and they were about to close. The best thing I could find were these plastic monkeys with coconuts—those 'see no evil, hear no evil' monkeys."

Antonio Gracias, a Tesla and SpaceX investor and one of Musk's closest friends, had watched all of this transpire; 2008 told him everything he would ever need to know about Musk's character. "He has the ability to work harder and endure more stress than anyone I've ever met," Gracias said. "What he went through in 2008 would have broken anyone else. Most people who are under that sort of pressure fray. Their decisions go bad. Elon gets hyperrational. He's still able to make very clear, long-term decisions. The harder it gets, the better he gets."



SpaceX employees watch a Falcon 9 launch from headquarters in Hawthorne, Calif., on Nov. 28, 2013.

Source: SpaceX

Today, the headquarters of SpaceX is on One Rocket Road in Hawthorne, a few miles from Los Angeles International Airport. It's 550,000 square feet and painted a blinding white. Near the back, enormous sheets of metal arrive and are transported to two-story-high welding machines, to be turned into rockets. Over to one side, technicians in white coats make motherboards, radios, and more electronics. Others are in a special, airtight glass chamber, building the capsules that dock with the International Space Station. Tattooed men in bandanas blast Van Halen and thread wires around rocket engines. There are fuselages lined up and ready to be placed on trucks; others await coats of white paint. Everywhere, there are bodies in motion around a variety of bizarre machines. It is difficult to take in the entire factory at once.

On the wall leading up to Musk's cubicle on the first floor of the SpaceX headquarters are two posters of Mars. The one on the left is Mars as it is today—a cold, barren red orb. The poster on the right shows a Mars with a cheery green landmass surrounded by oceans. The planet has been heated up and transformed to suit humans.

For all his swagger, Musk can be surprisingly shy and awkward in person. Like a lot of engineers, he will pause while searching for exact phrasing, and he'll often wander down a scientific rabbit hole without offering any lay translations along the way. He expects you to keep up; there's no small talk.

He can also be disarmingly sincere. "I would like to die thinking that humanity has a bright future," he says, while chatting at his cubicle and making his way through a cup of cookies-and-cream ice cream with sprinkles on top, just passed to him by an assistant. "If we can solve sustainable energy and be well on our way to becoming a multiplanetary species with a self-sustaining civilization on another planet—to cope with a worst-case scenario happening and extinguishing human consciousness— then I think that would be really good."



Musk at the opening of the Tesla showroom in Newport Beach, Calif., on July 1, 2010.

Photographer: J. Emilio Flores/The New York Times/Redux

His once-failing companies are thriving. SpaceX flew a supply capsule to the International Space Station, brought it safely back to earth, and soon plans to begin flying humans and building reusable rockets. Tesla Motors delivered the [Model S](#), a beautiful, all-electric sedan that took the automotive industry's breath away. Musk is also the chairman and principal shareholder of SolarCity, which has become the largest installer of solar panels.

Most CEOs have handlers, but Musk usually moves about on his own, in his usual black T-shirt and designer jeans. During one interview in Los Angeles, Musk walks me out of the SpaceX facility, and we hop into his Model S sedan to zip over to the Tesla design studio, a couple of buildings away. We talk as he makes his way around the studio's main floor, inspecting prototype parts and vehicles. At each station, employees rush up and give him updates. He listens intently, processes, nods, and moves on. Tesla's design chief, Franz von Holzhausen, wants Musk's take on some new tires and rims for the Model S and seats for the Model X. He seems unmoved. He tells him he'll think about it and then walks toward the source of the loudest noise—a workshop deep in the design studio where Tesla engineers are building the scaffolding for the 30-foot decorative towers that go outside the company's charging stations. "That thing looks like it could survive a Category 5 hurricane," Musk says. "Let's thin it up a bit."

Currently, SpaceX sends up about one rocket a month, carrying satellites for companies and nations. The company can undercut its U.S. competitors—Boeing, Lockheed Martin, Orbital Sciences—on price by a wide margin. It also offers U.S. customers a peace of mind that its rivals can't. Where competitors rely on Russian and other foreign suppliers, SpaceX makes its machines from scratch in the U.S. Its \$60 million per launch cost is much less than what Europe and Japan charge and trumps even the relative bargains offered by the Russians and Chinese, who have the added benefit of cheap labor and decades of government investment.

To date, SpaceX has flown satellites for Canadian, European, and Asian customers and completed about two dozen launches. Its launch manifest stretches out for a number of years, and SpaceX has more than 50 flights planned, which are all together worth more than \$5 billion. The company remains privately owned, with Musk as the largest shareholder. SpaceX is profitable and is estimated to be worth \$12 billion.

The Falcon 9 has gone from a fantasy to SpaceX's workhorse. It's 224.4 feet tall, 12 feet across, and weighs 1.1 million pounds. It's powered by nine engines arranged in an "octaweb" pattern, with a center engine surrounded by eight others. The engines power the first stage of the rocket, which bears the blue SpaceX insignia and an American flag. The shorter second stage is the one that does things in space. It can be outfitted with a rounded container for carrying satellites or a capsule capable of transporting humans. There's nothing particularly

flashy-looking about the Falcon 9. It's an elegant, purposeful machine.

These days, SpaceX sometimes uses Vandenberg Air Force Base to send up Falcon 9s. Were it not owned by the military, the base would be a resort. The Pacific Ocean runs for miles along its border, and its grounds are wide open shrubby fields amid green hills. Nestled into one hilly spot just at the ocean's edge are a handful of launchpads. On launch days, the white Falcon 9 breaks up the blue and green landscape, pointing skyward and leaving no doubt about its intentions.



Source: SpaceX

On Sept. 29, 2013, about four hours before a launch, the Falcon 9's fueling process begins by filling the tanks with some 46,000 gallons of liquid oxygen and 29,600 gallons of rocket-grade kerosene. Some of the liquid oxygen vents out of the rocket and is 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 in SpaceX's mission control chatter on headsets and cycle through their launch checklist as they move from one approval to the next. Ten minutes before launch, the machines take over. Everything goes quiet, and the tension builds until, out of nowhere, the Falcon 9 breaks the silence with a loud gasp.

A latticed support structure pulls away from the fuselage. The T-minus-10-seconds countdown begins. At the count of three, the engines ignite, and the computers conduct a last health check. Four enormous metal clamps hold the rocket down, as computing systems ensure that the nine engines are producing sufficient downward force. At zero, 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 process. It is foreign, inexplicable. About 20 seconds after liftoff, the spectators a few miles away hear and feel the Falcon 9's full rumble. It's a distinct sound—a sort of staccato crackling that makes pant legs vibrate. After about a minute, the rocket is a red spot in the sky, and then it's gone. **B**

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