Elon Musk and Tesla

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Chapter 3

Launching SpaceX

After eBay bought PayPal in 2002, the thirty-one-year-old Elon Musk was wealthy beyond his dreams. With the $180 million he received he could have retired, traveled the world, sponsored numerous charities, or even built a mansion on a private tropical island. But Musk was still interested in the "important problems" he imagined in 1994 when he graduated from Wharton—the Internet, clean energy, and space. Musk had already conquered the Internet with Zip2 and PayPal, and his clean energy plans were still in the future. Motivated by his childhood fascination with launching rockets, Musk decided to pursue space exploration by founding the Space Exploration Technologies Corporation, or SpaceX.

A Great Photograph

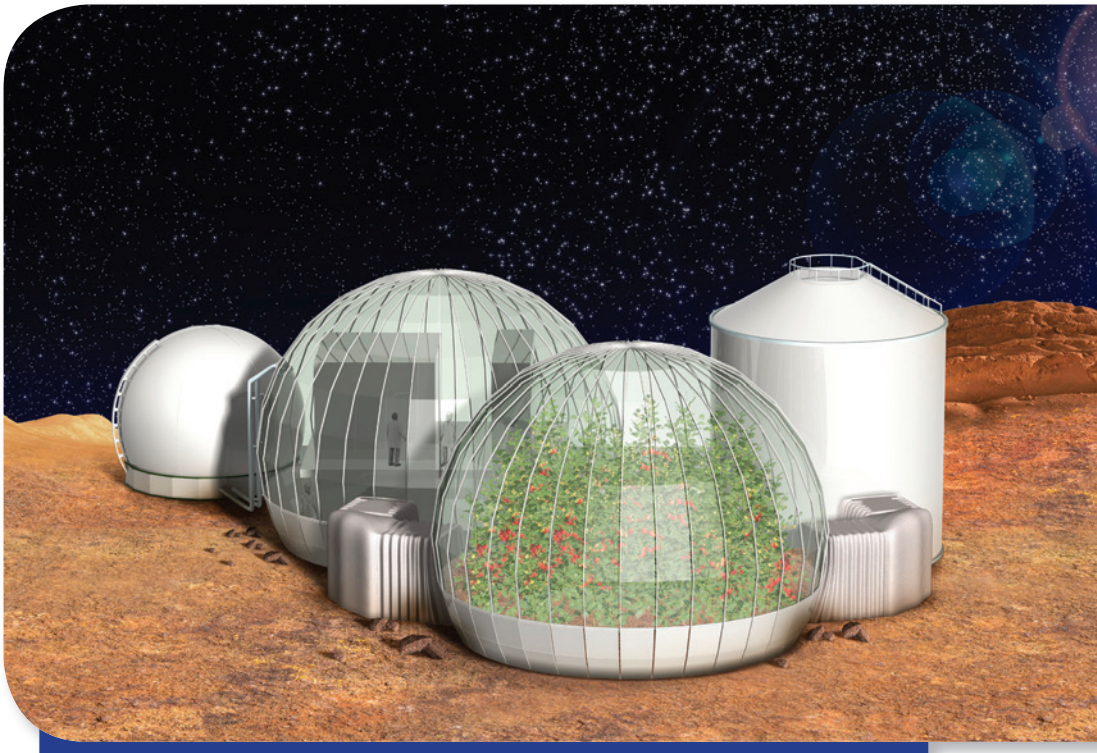
When asked why he created SpaceX Musk tells a story. He describes how he stayed up late one night in 2001 searching NASA's website for information about possible future missions to Mars. Musk was interested in such missions because he had conceived of a project called the Mars Oasis. He wanted to send a small greenhouse to Mars with seeds planted in a nutritious gel. The seeds would sprout into living plants, temporarily establishing life on the Martian surface. As Musk later described it: "You'd wind up with this great photograph of green plants and red background—the first life on Mars, as far as we know, and the farthest that life's ever traveled. It would be a great . . . shot, plus you'd get a lot of engineering data about what it takes to maintain a little greenhouse and keep plants alive on Mars."[34]

Musk started to price out the Mars Oasis and discovered that building a space capsule for his Martian greenhouse was relatively inexpen-

sive. However, he would have to rely on NASA to take the greenhouse to Mars. And this dream was quickly deflated when he realized NASA had no plans for missions to Mars. Musk describes his reaction: "At first I thought, jeez, maybe I'm just looking in the wrong place! Why was there no plan, no schedule? There was nothing. It seemed crazy."[35]

Founding SpaceX

As someone who refused to take no for an answer, Musk decided to buy his own rocket to launch a space capsule carrying the Mars Oasis. However, the least expensive American rocket cost around $130 million. Since that was more than two-thirds of his PayPal money, Musk sought a cheaper way to carry out his goal. He traveled to Russia several times in 2001 and 2002 attempting to buy old Soviet intercontinental ballistic



Musk's vision for the Mars Oasis included greenhouses similar to the structure pictured at the center of this artist's rendering.

In 2004 NASA selected Musk's company SpaceX to take over deliveries between Earth and the International Space Station (pictured).

Relief Not Elation

In 2004 Musk signed a $15-million-dollar contract with the Department of Defense to use a Falcon 1 to deliver an experimental military satellite called TacSat-1 into orbit. The satellite was designed to provide ground imagery to military commanders waging war in Afghanistan, Iraq, and elsewhere. Due to technical problems the launch never took place, and the mission was canceled. In the years that followed, SpaceX attempted several other unsuccessful launches for the military.

After another failed mission in August 2008, Musk badly needed a win: Critics had already pronounced SpaceX dead. Musk got his victory on September 28 as the Falcon 1 rode a long column of burning fuel out of the atmosphere and into the history books; it was the first successful orbital launch of any privately funded and developed liquid-propelled rocket. After three major failures costing millions of dollars and threatening the existence of SpaceX, Musk told reporters: "That was freakin'

awesome. It's great to have this giant monkey off my back. It's been six years of extremely intense effort and some pretty heart-wrenching episodes during prior launches. The emotion I feel is much more relief than elation. . . . It really gives a huge kick in the [groin] to the naysayers."[41]

Going Up in a Dragon

Even as Musk celebrated his victory, engineers at SpaceX were working intensely to build and develop the Falcon 9 launch vehicle. The second-generation Falcon was 173 feet (53 m) in length, nearly two-and-a-half times the size of the Falcon 1. It was also much more expensive, with an expected cost of around $55 million per launch. However, Musk did not have to finance this rocket himself. Development of the Falcon 9 was paid for by NASA's Commercial Orbital Transportation Services (COTS) program. This program was created in January 2006 with the goal of funding private companies to deliver crew and cargo to the International Space Station.

"Throwing away multimillion-dollar rocket stages every flight makes no more sense than chucking away a 747 after every flight."[39]

—Elon Musk.

In 2006 COTS provided SpaceX with $278 million to fund three Falcon 9 demonstration flights. If these were successful, SpaceX would receive an additional $1.6 billion for twelve missions to the ISS. For these missions SpaceX would have to do more than build dependable rockets. The company would also have to provide a spacecraft, a vehicle designed to enter outer space, travel to the ISS, and return safely to Earth. So while one team of SpaceX engineers worked on the Falcon 9, another developed the spacecraft that Musk named Dragon.

While Musk mocked the 1960s Russian rocket engines used by Orbital Sciences, he looked back to the sixties when designing Dragon. Unlike NASA's sleek Space Shuttle, which resembles a large passenger jet, the Dragon looks like the type of space capsule that carried American astronauts into orbit in the mid-1960s. Resembling a shuttlecock used in badminton, the Dragon was a blunt-nosed capsule around 12 feet (3.7 m) wide. Musk did not care what the Dragon looked like; he just wanted to make sure it had a window so astronauts, including himself, could

would have to carry people, food, water, oxygen, and shelter. Most important, the spacecraft would need to carry fuel that would make up about 80 percent of the vehicle's weight. A nuclear- or electric-powered space vehicle might solve the fuel problem, but no such entity currently exists.

A Million People on Mars

Musk is not bothered by seemingly insurmountable problems. He believes a colony on Mars will be functioning by 2040, and tens of thousands or even a million people will live there. Musk explained the logistics of such a mission:

> If you could take 100 people at a time, you would need 10,000 trips to get to a million people. But you would also need a lot of cargo to support those people. In fact, your cargo to person ratio is going to be quite high. It would probably be 10 cargo trips for every human trip, so more like 100,000 trips. And we're talking 100,000 trips of a giant spaceship.[50]

Life on Mars would be somber. The planet is often enveloped in massive dust storms, and Martian residents would be subjected to dangerous levels of cosmic radiation. Mars dwellers would most likely live in underground caves in very confined quarters; they would never feel the sun or wind on their skin. Earth would be visible only through a high-powered telescope. Despite the drawbacks Musk believes people will pay good money, up to a million dollars, for a one-way ticket to Mars. And he wants to be there with them. As Musk stated in 2013: "Space travel is the best thing we can do to extend the life of humanity. . . . I will go if I can be assured that SpaceX would go on without me. . . . I want to die on Mars, just not on impact."[51]

> "I want to die on Mars, just not on impact."[51]
>
> —Elon Musk.

Mind on Mars

An interplanetary mission to Mars would easily be the most expensive and challenging engineering project ever undertaken. But much closer

Obstacles to a Colony on Mars

Elon Musk breezily speaks of sending thousands of people to Mars within a few decades. However, many obstacles would need to be overcome to carry out such a grand mission. People would have to survive a 150- to 300-day spaceflight and land safely on Mars. They would need the means to survive in the harsh Martian landscape, which can boil the blood of an unprotected person in less than thirty seconds.

The main problem with a Mars colony involves soft-landing a rocket on the surface of the planet, where there is little atmosphere. On Earth the atmosphere provides friction, which slows a spacecraft during landing. On Mars the atmosphere is so thin it would not slow down a craft enough for a soft landing, even if the capsule had huge parachutes.

Surviving in a colony on Mars has its own seemingly insurmountable problems. The population would need a constant supply of water, food, oxygen, and even clean clothes from Earth; the International Space Station is supplied by three or four flights a year, and it is six times closer than Mars. If 100,000 people lived on Mars, as Musk proposed, supply ships would have to leave Earth every day, travel for nearly a year to Mars—and then make the journey home.

Solar radiation is also a great risk to astronauts. People living on Mars for a year or two would have an extra risk of cancer, which could shorten their lives by fifteen years. Traveling on the Martian surface in a vehicle or working in a greenhouse would further increase exposure to cosmic radiation. Scientists compare this risk of cancer to living on Earth immediately after a nuclear war.

to Earth, Musk moved to combine his love of space with the Internet. In January 2015 he opened an office in Seattle where around sixty engineers worked to develop what are called mini-satellites. These communications satellites, which could be built on an assembly line, would weigh less than 250 pounds (113 kg) and cost around $350,000 each. By

Important Events in the Life of Elon Musk

June 28, 1971
Elon Reeve Musk is born in Pretoria, South Africa.

1981
Musk buys his first computer and learns to write code for programs and games.

1983
Musk designs a video game called "Blastar" and sells it for $500.

1988
Musk moves to Canada, his mother's native country.

1989
Musk attends Queen's University in Kingston, Ontario.

1992
Musk moves to the United States and attends the Wharton School of the University of Pennsylvania.

1994
Musk receives a bachelor's degree (BA) in economics from Wharton.

1995
Musk uses $4,000 to create Zip2, a company that converts printed media material into digital content.

For Further Research

Books

L.E. Carmichael, *Hybrid and Electric Vehicles.* Edina, MN: Abdo, 2013.

Caitlin Denham and Carla Mooney, *ROCKETRY: Investigate the Science and Technology of Rockets and Ballistics*. White River Junction, VT: Nomad, 2014.

Louise Gerdes, *Hybrid and Electric Cars*. Farmington Hills, MI: Greenhaven, 2014.

Shelley Tanaka, *Climate Change*. Revised Edition. Sydney, AU: Groundwood, 2013.

Websites

Green Car Reports (www.greencarreports.com). This website focuses on environmentally friendly cars and features videos, news, and blogs about e-car batteries, charging stations, and Elon Musk's latest vehicular ventures.

International Space Station (www.nasa.gov/mission_pages/station/main/index.htm). NASA's official website for the International Space Station, featuring photos, videos, and the latest news on landings, launches, and missions.

NASA Mars (http://mars.nasa.gov). NASA has been exploring Mars since the first spacecraft voyages took pictures of the red planet in 1965. This site covers NASA's Mars missions, technology, rovers, and the scientists behind the scenes.

60 Minutes (www.cbsnews.com/news/tesla-and-spacex-elon-musks-industrial-empire). The *60 Minutes* piece on Elon Musk, broadcast in March 2014, contains a complete transcript of the show plus extra video

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Note: Boldface page numbers indicate illustrations.