

Duke University Trinity College of Arts & Sciences

SPACE EXPLORATION TECHNOLOGIES

& ELON MUSK:

founding, failures and successes,

funding, and future

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Math 89s: Mathematics of the Universe

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Elon Musk's little known first company Zip2, an online yellow pages' database intended to help bring newspapers to the digital age, was acquired by Compaq in 1999 for \$307 million in cash and \$34 million in stock options. Musk made \$22 million from the sale. He could have bought an island and retired at the age of 28, but instead, he went on to co-found PayPal. In early 2002, he sold the company to eBay for \$1.5 billion and walked away with \$180 million in his pocket. He hadn't yet turned 31 (Bloomberg Business, 2014). Again, he faced the choice of retiring and buying a chain of islands. But islands didn't appeal to him; space did.

“Initially, I was trying to figure out why we had not made more progress since Apollo. In the 60s we went from basically nothing. Nothing ever put anyone into space to putting people on the moon...And yet in the 70s and 80s and 90s we've kind of gone sideways,” Musk stated in 2003, on the founding of Space Exploration Technologies, more commonly known as SpaceX.

In the last fourteen years, SpaceX has gone from having only one investor (Musk himself) to being awarded billion-dollar contracts with NASA to resupply the International Space Station (ISS), competed against rival private space companies Sierra Nevada and Boeing, and worked toward the ultimate goal of bringing human life to Mars.

Founding: Mars Oasis

Elon Musk's initial motivation for founding SpaceX came from a desire to explore the possibility of life on Mars, an endeavor he termed Mars Oasis. “We'd put a small, robotic land rover on the surface of Mars with seeds and dehydrated nutrient gel. They would hydrate upon landing and you'd have plants growing in a Martian radiation, gravity conditions. And you'd also be maintaining, essentially, life support systems on the surface of Mars” (Musk, 2003). The project would put a mini-greenhouse on Mar's surface. Through growing crop samples in “an

enclosed chamber filled with treated Martian” soil, it would be possible to test the feasibility of survival off the Martian land (Space Frontier Foundation, 2001). Additionally, the mission could also test the “production of oxygen and rocket fuel from the Martian atmosphere”.

Musk was frustrated by the lack of technological advancement in the space sector in the decades following the 20th-century Space Race with the Soviet Union. He felt one of the largest problems was the lack of innovation of the rocket design since it was first introduced in the mid-1900s (Bloomberg Business, 2014), as well as a lack of funding for space programs. “That funding can be garnered by really marshalling public support” and that Mars Oasis would be able to garner this support because the public “tend[s] to respond to presidents and superlatives. This would be the furthest that life has ever traveled and the first life on Mars. So pretty significant” (Musk, 2003). A private mission pioneered by SpaceX could cost “about \$15 to \$30 million, which isn’t a lot of money, but its about a tenth of what a low-cost NASA mission would be.”

Failures and Successes

In the beginning, Musk was the only investor in SpaceX, with the understanding that he wouldn’t be able to garner investor support until he could demonstrate success (Musk, 2009). By 2006, he had contributed \$100 million of his own dollars, over half of what he made from his sale of PayPal (Wayne, 2006), into his company.

Unfortunately, the early years of SpaceX saw only failures. After four years of work and preparation, the company launched its first rocket, Falcon 1, in 2006. An engine fire started upon liftoff, and after not even a minute in the air, the engine lost power and the rocket came crashing back to the ground. The company determined the cause of the failure in the first flight to be flaws in the quality of materials used to build the rocket, and tried again in 2007 with better parts

(Musk, 2009). However, Falcon 1 failed yet again, and a third launch in August of 2008 fared just the same (SpaceX). But in September 2008, SpaceX successfully managed to send Falcon 1 into orbit (Musk, 2009). This success changed the tide for SpaceX.

Funding and Profitability

What started out as one single billionaire's vision for human travel to Mars has grown into a profitable, private industry in the wake of NASA's space shuttle program. Contrary to common belief, SpaceX has already become profitable and has made a name for itself in the space exploration industry. SpaceX has moved beyond just travel to Mars. Its main source of funding has been through contracts it holds with NASA to haul cargo and astronauts to the International Space Station. In its fourteen years since founding, it has managed to transform into a billion-dollar company with a slew of investors eager for each innovation SpaceX has up its sleeves.

In December 2008, SpaceX was awarded handsomely following its successful launch of Falcon 1 with a \$1.6 billion contract with NASA for its Commercial Resupply Services (CRS). This contract involved twelve missions using SpaceX's "Dragon" capsule launcher aboard its other rocket, the Falcon 9. At the same time, a rival company Orbital was awarded a contract valued at \$1.9 billion with NASA for eight missions with Orbital's Cygnus, also within the CRS program (Foust, 2016). SpaceX prides itself in its ability to accomplish the same feats as its competitors at a lower cost. Here, SpaceX is able to complete more missions than its competitor with less funding. On January 10th, 2015, SpaceX's Falcon 9 rocket successfully delivered 5,200 pounds of supplies to the ISS (Lippert, 2015).

SpaceX also has the chance to be one of the private firms to carry astronauts and passengers into space. Since 2011, when NASA officially ended its space shuttle program, the United States has relied on Russia to transport its astronauts into space. A single flight to the ISS costs about \$70 million per person (Kramer, 2015). In January 2015, NASA awarded contracts to SpaceX and Boeing in the new Commercial Crew program. These firms were to use the contracts to develop the passenger capabilities of their launch capsules in order to make trips to the ISS significantly less expensive by 2017 (Kramer, 2015). According to a Bloomberg Business interview with Musk in 2014, Musk estimated a trip to the ISS on SpaceX's Dragon capsule would cost around \$20 million. Boeing received \$4.2 billion for the program, while SpaceX, confident it could carry out the same results for far less, received \$2.6 billion (Kramer, 2015).

By March 2015, SpaceX held contracts with NASA worth \$4.2 billion. Its list of investors included Founders Fund, Draper Fisher Jurvetson, Valor Equity Partners, and Capricorn. The Pentagon had said it expects to certify SpaceX for the transport of military payloads. And SpaceX is now able to offer cheaper rocket and satellite launches than when NASA and the military were in charge (Lippert, 2015).

With SpaceX's growing success at launching satellites, Google's hopped into the market. Together with Fidelity Investments, they invested \$1 billion into the company, giving them 10% stake. Wanting "to beam the Internet to hard-to-reach regions of the planet so it can take in more advertising revenue" (Lippert, 2015), Google's interest is in SpaceX's ability to send satellites into space for \$60 million, a fraction of the \$225 million it costs United Launch Alliance, SpaceX's main competition, a joint venture of Lockheed Martin and Boeing.

In January 2016, SpaceX was awarded another contract with NASA through the Commercial Resupply Services 2 program in an unspecified amount. This new contract involves

at least six missions running from late 2019 through 2024 transporting cargo to and from the ISS (Foust, 2016).

Distinguishing Factors

What separates SpaceX from its competitors isn't just its innovative design abilities—both SpaceX's Dragon capsule for delivering people and supplies is much like Boeing's CTS-100 design. It isn't its amount of funding—SpaceX typically receives less in contracts than its competition. What separates SpaceX is its ability to provide the whole package: its ability to provide innovative designs on a variety of different services all while lower cost than its other competitors. And, it's the unwavering, ingenious mastermind it has running the company in Elon Musk.

“What SpaceX has been very successful at is taking...off-the-shelf technology, stuff that was developed by NASA, say, fifty years ago, and streamlining it. In that way, he's kind of the 'Henry Ford of Space', because Henry Ford didn't invent the automobile, he just figured out a way to make the automobile, you know, commercially viable,” technology and business journalist Max Chafkin said of Elon Musk (Bloomberg Business, 2014).

As seen by his constant pursuit of future innovations, Elon Musk is not motivated by wealth. After selling PayPal, he could have lived out the rest of his life happy and stress-free on an island somewhere. Musk is motivated by advancing technology for future benefit. And he has absolute confidence and believe in all his endeavors, evidence by his investment of all his earnings into his projects when needed without a second thought. After watching failure after failure of his Falcon 1 rockets, Musk maintained that before the third failed launch: “I'd talked to everyone working on the project. I said that if flight four failed we'd do flight five, and if flight

five failed we'd do flight six. I would never give up on something as long as I believed there was a reasonable chance of success" (2009).

On top of that, SpaceX is valued for its versatility and its low-cost. SpaceX is the only private space firm, out of Orbital, Sierra Nevada, Boeing, and Lockheed Martin, to hold a contract with NASA in both its Commercial Resupply *and* Commercial Crew programs. And it is able to compete against its competitors while receiving billions less in funding.

Future Potential

Although SpaceX has had other things to focus on outside of travel to Mars, exploration of the planet is still a core goal for the company. "Gwynne Shotwell, SpaceX's chief operating officer, says the first step, manned flights to the planet, could begin in 15 years" (Lippert, 2015).

With all that it has already accomplished, it's likely that SpaceX could beat NASA in accomplishing a manned mission to Mars. According to Rich Smith from the Motley Fool, "NASA was planning to attempt a manned Mars mission sometime in the 2030s...." However, the cost of such a program, to develop the technology, develop the spaceship, and conduct a successful mission, could cost as little as \$30 billion, perhaps \$100 billion, and possibly even as much as \$500 billion (Smith, 2016).

However, leading astrophysicist, Hayden Planetarium director, and host of a National Geographic talk show Dr. Neil deGrasse Tyson is doubtful of SpaceX's ability, or NASA's ability, to successfully complete a trip to Mars. He employs costs, risks, and lack of profits and explanations for his conclusions. Not only is the \$500 billion cost for such a program very within reason for such an expedition, the risk of dying through "mechanical failure, radiation, starvation, asphyxiation... and death-by-angry-Martian," and the likely lack of willing

participants to make the journey worthwhile (Smith, 2016) are all reasonable explanations for his conclusion. SpaceX would need to take all these points into consideration when deciding whether or not to put travel to Mars on its next agenda of things to accomplish. However, if anyone's successful at proving others wrong, it's Elon Musk.

On a smaller scale, SpaceX is also looking into developing and refining reusable rockets—rockets that would return to Earth on seagoing barges. If rockets were able to be reused, the cost of putting satellites into orbit could be reduced to \$200,000 to \$300,000 per flight for fuel and oxygen, compared with the \$60 million it costs to build and send a rocket into flight once. Twice in 2015, SpaceX successfully landed a first-stage booster of the Falcon 9 rocket on a drone barge in the ocean, but last December, SpaceX was able to land the booster on a landing pad in Cape Canaveral, Florida (Zhang, 2015). Innovation of this idea not only reduces the cost to put satellites in space, but it could also bring down the cost of sending astronauts and cargo into space, as well as perhaps reduce the cost of travel to Mars travel.

References

- Bloomberg Business. (2014, June 10). *Elon Musk: how I became the real 'Iron Man'* [Video file]. Retrieved from <https://www.youtube.com/watch?v=mh45igK4Esw>
- Completed Missions (n.d.). In *SpaceX*. Retrieved March 28, 2016, from <http://www.spacex.com/missions>
- Foust, J. (2016, January 14). Orbital, Sierra Nevada, SpaceX win NASA commercial cargo contracts. In *SpaceNews*. Retrieved from <http://spacenews.com/orbital-sierra-nevada-spacex-win-nasa-commercial-cargo-contracts/>
- Kramer, M. (2015, January 30). NASA's next space race: SpaceX vs. Boeing. In *Space.com*. Retrieved from <http://www.space.com/28411-spacex-boeing-nasa-space-race.html>
- Lippert, J. (2015, March 4). SpaceX profitable as Musk pulls in NASA contracts, Google cash. In *Bloomberg Business*. Retrieved from <http://www.bloomberg.com/news/articles/2015-03-04/spacex-profitable-as-musk-pulls-in-nasa-contracts-google-cash>
- Musk, E. (2009, May 30). Risky business: why Mars is more important than cosmetics and why a failed launch is also a partial success. In *IEEE Spectrum*. Retrieved from <http://spectrum.ieee.org/aerospace/space-flight/risky-business>
- Musk, E. (2014, October 8). *Opportunities in space: Mars oasis* [Video file]. Retrieved from <http://ecorner.stanford.edu/videos/381/Opportunities-in-Space-Mars-Oasis>
- Smith, R. (2016, March 27). Neil deGrasse Tyson to Elon Musk: SpaceX is "delusional" about Mars. In *The Motley Fool*. Retrieved from <http://www.fool.com/investing/general/2016/03/27/neil-degrasse-tyson-to-elon-musk-spacex-delusional.aspx?source=eptfxblnk0000004>

- Smith, R. (2016, March 6). SpaceX could beat NASA to Mars -- and do it cheaper. In *The Motley Fool*. Retrieved from <http://www.fool.com/investing/general/2016/03/06/spacex-could-beat-nasa-to-mars-and-do-it-cheaper.aspx>
- Space Frontier Foundation. (2001, September 25). MarsNow 1.9 profile: Elon Musk, life to Mars foundation. In *Space Ref*. Retrieved from <http://www.spaceref.com/news/viewstr.html?pid=3698>
- Wayne, L. (2006, February 5). A bold plan to go where men have gone before. In *The New York Times*. Retrieved from <http://www.nytimes.com/2006/02/05/business/yourmoney/05rocket.html>
- Zhang, S. (2015, December 21). SpaceX's Falcon rocket finally sticks the landing. In *Wired*. Retrieved from <http://www.wired.com/2015/12/spacex-just-landed-rocket-ground-first-time/>