



**Elon Musk: Tesla, SpaceX, and the Quest for a Fantastic Future
(Biography written by Ashlee Vance, 2015)**

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“Blue Origin’s New Shepard space vehicle successfully flew to space, reaching its planned test altitude of 329,839 feet (100.5 kilometers) before executing a historic landing back at the launch site in West Texas.”

and: “...Bezos [founder of Blue Origin], asked about Musk’s comments in a conference call, suggested New Shepard’s landing was at least as difficult as SpaceX’s unsuccessful attempts to date to land a Falcon 9 first stage on a ship.” [SpaceNews, Dec. 2, 2015]

These news got me interested in reading Elon Musk’s Biography because I was sure that SpaceX would be the first to achieve this “stunt” – what happened?

“Do you think I am insane” is the first sentence in chapter 1, referring to Musk’s goal to colonize space, in particular Mars. This pledge is symbolized by a poster hanging on the way to his office in “Musk-land”, in Hawthorne, 1 Rocket Road, California, the SpaceX headquarters, showing a green Mars colonized by human beings.

„Mankind is a multi-planetary species“ (Elon Musk)

The book continues to list Musk’s three main technological activities considered to “change the world” for the good of mankind: SpaceX rockets, TESLA (electrical powered cars, together with his interest in “Ultra Capacitors” for energy storage) and Solar City (solar generators, “...the sun will come out tomorrow”). This is well in line with Musk’s credo “...to strive for greater collective enlightenment”.

The following chapter describes in detail Musk’s origins and his cumbersome way through a painful youth, his various start-up activities (Dungeon & Dragons games, ZIP2, X.com) and how he achieved to sell the PayPal online banking company to ebay for \$1.5 B in 2002, leaving him enough money (\$250 M) to start SpaceX.

In the biography the “early” Musk is characterized as a “do or die” guy “who never gives up”, a “confrontational, know it all” who conceived the possibilities of the Internet, however no CEO material”.

After his move from Palo Alto to Los Angeles in 1995 he felt a “call for space”. After brief visits with the Mars Society (Zubrin), the Mars Foundation and the plans for either establishing a “Mars Oasis” or sending mice to Mars and bring them back alive, and after the Russian Space Agency turned Musk down for letting him have three converted ICBM rockets for his plans by asking \$8 M for one ICBM rocket (he simply walked out of the meeting room in Moscow), Musk decided in 2002 to start his own commercial space company (SpaceX, initially at El Segundo, L.A.) and help exploring space with a cheaper and more

flexible approach (“...hey guys, we can build the rocket ourselves” – “...and make as much parts as possible in-house).

Another reason was, it seemed to Musk that NASA had no actual plan to explore Mars and appeared to be too inflexible and bureaucratic to achieve something soon.

For engineers familiar with the space-business it is very interesting to read the story how the Falcon-1 was created from scratch – and how the SpaceX people were not spared from the trial and error experience either. However the span between acquiring the first potential customer (Department of Defence, TACSAT1) without having a functioning product in 2004 until the first successful flight in Sept. 2008 - after three failed launches (see Falcon1-4 on Youtube: <https://www.youtube.com/watch?v=eGHWheEM-ww>) - was quite an achievement and required a lot of “midnight oil burning”.

During this time the financial cover also stretched very thin and the Falcon1-flight # 4 was the last chance to avert SpaceX’s financial collapse. In particular, 2008 was the year of “pain and suffering” with the company’s “near death” experience and a lot of personal suffering for Elon Musk.

Despite, in mid 2008 the earlier announced more powerful Falcon 5 was replaced by the Falcon 9 together with the Dragon capsule to enter the NASA commercial contracts round of bidders selection for ISS resupply flights (Commercial Orbital Transportation Services - COTS). SpaceX got accepted and earned a \$1.5B contract from NASA. This financial shot helped the Falcon 9 to finally become an US built global workhorse with a price tag of \$60 Mio per flight which even cannot be met by government supported Russian launch vehicles in this category.

But it doesn’t stop there: On May 22, 2012 the Falcon 9 successfully delivered and docked the first commercial Dragon transport carrier to the ISS. Falcon “Heavy” – with 27 Merlin engines - was announced together with the Dragon V2 vehicle for a crew of 7 to finally make the trip to Mars. SpaceX is currently building its own launch site/SpacePort in Brownsville, Texas.

The next step will be to fly astronauts to the ISS under NASA contract in 2017.

According to the author Ashlee Vance Musk’s ultimate goal is “turning human beings into interplanetary species”.

Therefore it really is the more astonishing that Blue Origin (another COTS competitor) won the race for “soft-landing” a launch vehicle returning from orbit to be used again. I think it will be just a question of (a short) time until SpaceX pulls even, in particular since an earlier quote from Musk about Jeff Bezos (the Blue Origin founder) said “...his patent [for landing a rocket with retro-nozzles] is completely ridiculous” – could Musk have been wrong in this case?

TESLA

One chapter is devoted to the development of the TESLA Motor enterprise which was started in 2003. The TESLA motor company founding was another astonishing feat despite the warning that the last successful car-factory start-up was in 1924 by Chrysler. Again Musk was way ahead of his time - even before Fukushima and the ever growing green-movements – because he wanted “to change the energy equation of the country”.

In 2005 Musk and his team of only 12 engineers completed the design of a brand new all electrical car prototype and was able to attract additional investors. Musk’s strategy was to start with a high-end

production line (\$ 90,000 per car) to come down later with mass production (\$ 50,000) seemed to work, but then the problems started: time- and delivery delays mounted and by 2007 Musk had spent \$125,000 M instead of the original planned \$25,000 M.

Yet Musk's earlier SpaceX strategy was successful also in the TESLA case: hire as much expert talent as possible and team them with young enthusiastic engineers, develop and build as much as possible "in-house" and worry about every technical and financial detail yourself and solve problems with quick decisions without long discussions.

The book quotes Musk and his co-engineers as having invented the "iPhone" of cars, i.e., the first all-electric, computer controlled car competing successfully with the established automobile industry with a product which is "fun to drive, easy to handle and wanted by the public".

In 2013 the TESLA Model-S was nominated as car of the year by the US Consumer Reports with the highest grade ever achieved (99 of 100 points). The Model S Sedan was praised as "a love child of Aston Martin and Maserati".

Solar Energy

Together with the Rive brothers Musk entered the Solar Energy market in 2006 (SolarCity), "...the Sun hits the Earth in 1hr with enough energy to cover 1 year of the worldwide energy consumption". With the by-out of Silevo Cells, by the end of 2015 Solar City delivered 2 GWatts produced by solar cells of their own (in-house) produced solar panels.

Elon Musk's approach challenging two big established industries, the space- and automobile industry has the flavor of Pascal's wager: If you believe you are always better off than not believing, and so far, he won. It looks like his success will be lasting, taking the urgent concerns of the current climate-change conference (Paris, Dec 2015) and the VW emissions scandal (California, Sept 2015) into account.

The book has an interesting chapter on the high speed HyperLoop surface transportation system also (see Youtube <https://www.youtube.com/watch?v=haJD6gPZwGo>).

In summary one has to give credit to Musk for his visional approach to try to "fix the Earth" and reach out to other planets in order to secure the survival of humankind.

The author Ashlee Vance delivered an excellently researched book and was able to take a deep look into Elon Musk's past and current intellectual world. He describes "the unified field theory of Musk" as "all components of his businesses to be interconnected in short term and long term", like solar-, battery- and aerospace-industry .

The book gives also an interesting insight in how Silicon Valley start-ups work and provides in my opinion a reliable peek into how our future might a look like in the years to come.

It is required reading (- and fun to read) for technical and ecological oriented engineers. It definitely is worth your while reading the book and it might be worthwhile to keep it on your bookshelf (or on your kindle) and read it again 20 years from now.