

theranos

The blindness of venture capital

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All group members have contributed equally to this project.

Grochevaia, Nadja

nadejda@student.chalmers.se

Liu, Jerry

lijerry@student.chalmers.se



CHALMERS

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Introduction

This essay gives a brief introduction to the rapid rise and fall of the healthcare technology company Theranos: a privately held multi-billion dollar medtech startup that managed to obtain a \$9 billion dollar valuation at its height, followed by an inevitable bankruptcy two years later. Our goal is to investigate the intricacies behind the plot that enabled Theranos to achieve such a high valuation without having a working product to show for, while at the same time endangering the lives of innocent people. We will also discuss the potential upside and pitfalls of venture capital.

1 Background

Theranos was founded in 2003 by Elizabeth Holmes, who at the time was 19 years old. From an early age, she had a vision of one day changing the world; a dream of a new technology that could perform advanced laboratory analysis on a tiny amount of blood, in the convenience of your home and at a fraction of the cost. This revolutionary healthcare innovation was inspired by Holmes' inherent fear of needles and the tragic loss of her uncle, the latter being greatly exaggerated as a key component of the image she tried to purvey[1].



1.1 Elizabeth Holmes

The founder and former CEO of Theranos, Elizabeth Holmes, was born in 1984. Holmes knew at a very young age that she wanted to become a billionaire. Her innovative nature compelled her to pursue the field of science; she even tried to build her own time machine at the age of seven. In 2002, during an internship at the Genome Institute of Singapore, Holmes spawned the idea for Theranos and a year later, she filed a U.S. patent for her so called "drug delivery and adjusting dosage system". In 2004, Holmes left Stanford to start her own company, then called Real-Time Cures, and changed the description of her patent to "portable blood testing device", later named Edison. Around that time, a new company name came about: the amalgamation between "therapy" and "diagnosis", which ultimately became Theranos. During Holmes' years as CEO, she became incredibly famous, hosting multiple talks and was featured in dozens of magazines. It was also at this point in time when Holmes' obsession with Steve Jobs became glaringly apparent; she started to mimic the Silicon Valley megastar in every aspect of life, from clothing to managing style, and even the manner he carried himself. In 2014, Holmes took a spot on the Forbes list of the 400 richest Americans and was dubbed the world's youngest self-made female billionaire and genius. Shortly after, Holmes and Theranos was charged with fraud for drastically overstating the company's medical testing technology. Following these events, Holmes settled and relinquished control of Theranos in 2018 [1].

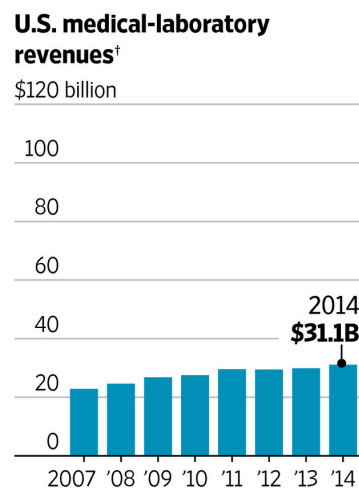
2 Funding

For the idea to become reality, Elizabeth Holmes was in need of backers and capital, and where else in the world could you find such risk-willing appetite for college dropouts, other than Silicon Valley. Back in 2003, during the inception of the company, Theranos' primary source of funding was from family members and friends. Holmes managed to persuade a celebrity attorney, two former secretaries of state and the ex-CEO of Wells Fargo to join the company, all of whom were appointed to serve on the board. These individuals in turn used their influence to recruit other wealthy investors. The Theranos investor list consisted of university alumni and distinguished military veterans, from whom Holmes received \$700 million dollars in funding. The money, on the other hand, was never reported in any financial statements, since Holmes never hired any accountants to produce audited financial information.

This begs the question: how was this possible? It seems that nobody really has a good answer, but most people agree that Holmes had charisma, outstanding networking skills and an intelligent demeanour; qualities which helped her to quickly raise seed money for Theranos. Despite Holmes' clear display of leadership, some large venture capitalists were still hesitant towards investing in Theranos, due to her unwillingness to share information about the technology and the lack of support from the scientific community via peer-reviewed research. Also, the members of the board lacked both medical and science experience. The secrecy behind Edison was a key component that made this grand fraud possible. Holmes acquired talented engineers and forced them into strict non-disclosure agreements. She even kept the employees isolated from each other, in order to prevent information leakage, and critics who disputed the product were immediately fired[2].

2.1 Investment Case

In a graph published by the Wall Street Journal in 2014 the U.S. medical laboratory revenue was estimated to be \$31.1B. An attractive market that Theranos wanted to be a part of. The goal of the company was to introduce the user-friendly and affordable Edison machines into drug-stores and pharmacies around the U.S. for the purpose of capturing market shares. The appeal was that the Edison machine could perform a large number of blood tests at more convenient locations. Previously, these test were only available in expensive hospital laboratories.



2.2 People

When investing in a company one tend to look at its structure as well as the members of the board. In Theranos' case it was the 19-year-old Stanford dropout, Elizabeth Holmes, who dressed solely in black turtlenecks with a burning passion to disrupt the status quo. A common back story for some of the biggest names in Silicon Valley: Bill Gates, Mark Zuckerberg and Steve Jobs, the latter whom obviously inspired Holmes' sense of fashion. For some investors it was reasonable to invest millions of dollars in a product that lacked

scientific support, but it is most likely a risk you are willing to take when you fantasize of even greater revenue.

3 Financial Time Line

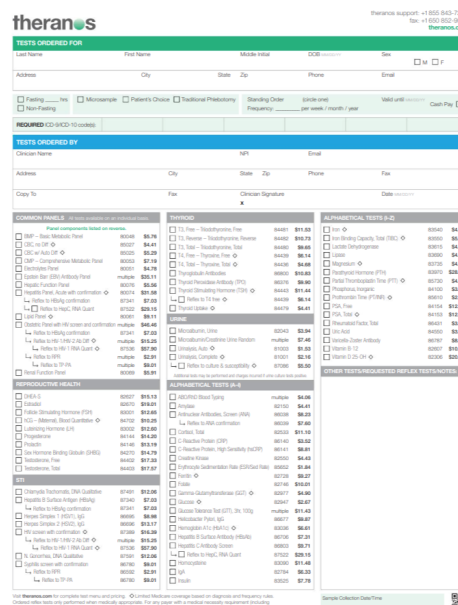
Since foundation in 2003, Theranos got through its first round of funding in 2004 with an valuation of \$30 million. From early on Elizabeth was able to secure well-known people such as Henry Kissinger, Betsy DeVos, and Rupert Murdoch on the board. Having acquired the former U.S. Secretary of State on the list of investors meant that the company’s credibility grew immensely in the public eye. This lead to Theranos achieving a valuation of almost \$200 million after raising \$43 million in capital in 2007. Three years later the company was valued at \$1 billion after further rounds of funding[3]. In 2013 Elizabeth Holmes announced Theranos to the world and unveiled their website. A year later with over \$400 million in funding the company was valued at \$9 billion dollars. In the following two years, the company lost two of its big partners and all of its rights, an event we will investigate and also how one as an investor could have navigated this better.

4 Debunking

When investing in ideas and promising startups, one tend to think of the possibilities and not the limitations. What Theranos promised was a majorly disruptive technology with massive implications on the current way of blood testing. In hindsight, it is not difficult to see the red flags and realize where it all went wrong. Although, at the time it might not have been that obvious. According to interviews with former employees, the company had specific routines in place to trick investors on their visits. Theranos employees would take blood samples from investors and run them on third-party machines, whilst taking them on guided tours, and nobody suspected anything since the test results were consistently accurate[4].

4.1 Capillary blood contents

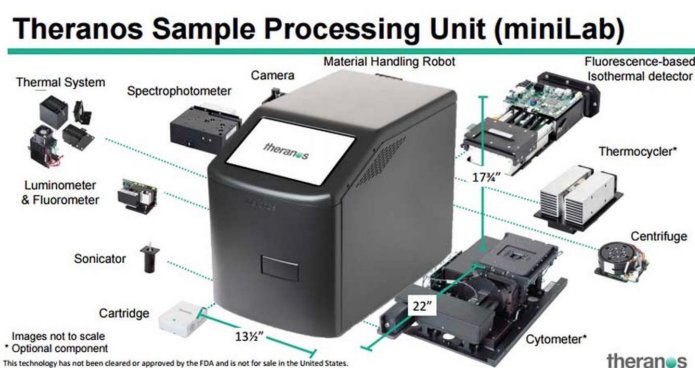
The early focus of the company was running tests on minuscule amounts of blood from fingersticks. But problem with that was primarily performance; it is virtually impossible to perform a large number of tests on an insignificant amount of blood. Since there are only a finite number of blood cells in a single drop of blood, the probability of detecting certain diseases diminishes due to the sample size i.e. one cannot simply extract enough infected cells from a sample that small. The inaccuracy renders the test results useless. These fingerstick samples only contain capillary blood, which is a mixture of blood from arterioles, veins and capillaries



and it contains some interstitial and intracellular fluid. These samples sufficed for certain tests like sugar level for diabetics but didn't provide the accuracy obtained from larger venous samples. The small volume of capillary blood samples also makes it more exposed to contaminants in the results, reducing the accuracy further. Despite all this, the company still marketed their product of only requiring only droplets of blood in an advert released 2016. Their machine was supposedly able to handle up to 200 tests shown in the test-sheet, a remarkable number of tests in a single machine with the size of an oven[5].

4.2 The problem of the innovation

The idea behind the user-friendly portable blood-testing device was not pioneered by Holmes and Theranos. In fact, years prior to the launch of Edison, innovations made by engineers within the field of microfluidics lead to the invention of a similar device but with fewer selected tests. The limiting factor of the device was its overall size. The small form factor exposes adjacent parts in the device to noise e.g. the spectrophotometer



was likely to interfere with the luminometer due to components being densely packed (see Figure). The Apple looking product wouldn't work, where it would sometimes literally fall apart and the regularisation of the temperature was persistently off. Theranos' engineers tried to work out the solutions but were fired while mentioning their concerns.

her business endeavours, coupled with complete disregard of technical capabilities and scientifically sound solutions, lead Theranos to its inevitable demise. The managing directors at Theranos seemed ignorant of several basic limitations and believed that any problem could be resolved, in spite of efforts to explain the impossibility of the Edison prototype from the employees. Another problem with Theranos business idea was that diagnostic blood test results were handed to patients directly without any reading from medical professionals. Initially, it seemed like a well-thought-out idea, since there is a large part of the population that do not have access to universal healthcare. However, the technology still lacked a user interface that would eliminate the need for analysis by a professional. In order to provide a full spectrum of care, diagnostics would have to be combined with an AI that take a patient's medical record and current health status into account, to produce an accurate reading. The health of an individual is not completely reflected in the test; one have to take a contextual approach and try to understand to what extent a person's life choices affect the overall diagnosis.

Despite all these complications, Holmes still managed to raise several billions in venture capital and attain a highly profitable business contract with a well-established drugstore chain, Walgreens in the U.S. Unbeknownst to the general public, the inaccurate blood test results produced by Edison threatened the lives of countless patients[6].

4.3 FDA

In early 2015 Theranos received FDA approval on their machine for the test of herpes simplex virus - type 1 (HSV1)[7]. It's a widely common virus with an estimated 3.7 billion people under the age 50 being infected globally according to the World Health Organization[8]. The test relies on chemiluminescent immunoassay, a method based on enzyme labeled antibodies that breaks down the molecule which emits light in the process. Looking at what the approval itself says, although for a novel disease, could conveys some information on what actually occurs inside the machine. One interpretation is that Theranos have successfully built a machine capable of injecting a chemical into the sample to then register the light emissions and process the data. This proves what the machine actually can accomplish, but it's only one of the 200 tests advertised.

Weirdly the launch to the public market occurred before the FDA approval as Walgreens rushed to open its' first Theranos Wellness center in 2014[9]. While its' competitor Safeway choose to keep the project on hold as the results were unsatisfactory. At the end of 2015 it will reveal that Safeway made the correct choice as complaints to the FDA and CMS started coming in from ex-employees. As the story unfolded, allegations arose that the only FDA approval Theranos received had actually been tampered with[10].

4.4 Secrecy

As common with disruptive start-ups Theranos wanted to keep their technology secret. This seems to be accepted to the investors, to a certain degree. In a almost comically vague quote from Elizabeth Holmes to the New Yorker in 2014 describing their machine she said: "A chemistry is performed so that a chemical reaction occurs and generates a signal from the chemical interaction with the sample, which is translated into a result, which is then reviewed by certified laboratory personnel." This is the same year that Walgreens opened their first Theranos wellness center[11].

Two of the early big name brands that partned with Theranos was Safeway in 2011 and Walgreens in 2013. During their partnerships the two companies had opportunities to visit Theranos head office and try out the machine, but never really got to see the machine in action as they were always taken to another room while Edison did the test. Safeway asked early on for tests of the Edison at their own facilities and received varying results, as one executive received results suggesting that he had prostate cancer but when the sample was sent to another lab for retesting the results returned normal[12].

5 The fall

The unravelling of the company began around 2015, when the lies and internal pressure started to boil over, disgruntled employees started talking with outside sources about what really went on inside of the company. After a disclosure article was published in Wall Street Journal, the largest investor of Theranos sold his shares to lowest possible price even taking tax losses. The U.S Securities and Exchange Commission charged Theranos with fraud leading to the fall of the company. The fraud could have continued for years if it wasn't for the whistle blower article in Wall Street Journal.

5.1 Wall Street Journal

In October 15, 2015 writer John Carreyrou released an scathing article criticizing Theranos. With the tips from ex-employees Carreyrou did some journalistic digging on the actual accuracy of the test results. By comparing blood-results from both Theranos and a hospital he found that Theranos often predicted much higher values than what the hospital did, leading to many of the values being out of the normal range and giving the impression that the patient was sick when in fact the real test-values were completely normal. Furthermore one former senior employee stated that only a small fraction of all the tests were conducted on the "Edison machines", and that the majority of the tests were handled by competitors' equipment, which would have been a violation of the U.S. Food and Drug Administration (FDA) rules[4].

6 Summary

This story is another example of the "Fake it til' you make it" attitude venerated by the startup culture in Silicon Valley. It seemed like it didn't even matter if you literally played with people as long as it could end up with a possible successful device.

So what could you as a venture capitalist actually have done? This investment case seems to be very difficult to actually debunk, it had the eager college drop-out with an disruptive idea, multiple big name investors, like Henry Kissinger the former U.S. Secretary of State. The technology and application wasn't too far fetched as the only draw-back with capillary blood tests is a low expected accuracy. All in all it really didn't seem to be a bad investment case and could've potentially turned out to be something successful with some other leadership.

The only sign that could've tipped you off early was to maybe if you spoke with the people on the ground floor of the company, to actually talk to the employees and perhaps see what they have achieved or to study what the company are promising and comparing to what's physically possible.

The Theranos case is not over and trials are still proceeding, where the juridical decision isn't final yet. We're still about to witness the final verdict of the Elizabeth Holmes, which will be published somewhere in the near future, but you can follow the development in sources under Further reading chapter.

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