Prospectus

Robotic Word Search Solver ("Lonely Robo")
(Technical Topic)

The Engineer's Effect on Health Risks Associated with Medical Technology

(STS Topic)

By

Sean Wolfe

11/19/19

Technical Project Team Members: Wade Hisiro, Nicholas Mohammed, Christopher Truong, Joshua Laney

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Signed: _____

Approved: _____ Date _____
Sean Travis Elliott, Department of Engineering and Society

Approved: _____ Date _____
Harry Powell, Department of Electrical and Computer Engineering

STS Research Paper Prospectus

The Engineer's Effect on Health Risks Associated with Medical Technology

Introduction

This thesis centers itself around the following research question: What can engineers do to minimize the health risks associated with medical technology? As the baby boomers of our population reached old age, we experienced a growth in the demand of medical technology. This growth in demand coincides with a boom of technological innovation brought on by the age of information. Not to mention, the allocation of venture capital funds towards medical technology highlights our society's demand for such innovation. In 2018, venture capital firms invested more than $2.9 billion in medical technology (PricewaterhouseCoopers, n.d.). Governments and prestigious academic entities in our society also note the importance of working to solve medical conditions through engineering. Of the 17 Sustainable Development Goals proposed by the UN, "Good Health" sits at third on the list ("Sustainable Development Goals (SDGs)," n.d.). In addition, the National Academy of Engineering lists three medical problems in their array of Grand Challenges: "Advance Health Informatics", "Engineer Better Medicines", and "Reverse Engineer the Brain" ("Grand Challenges—14 Grand Challenges for Engineering," n.d.).

While the engineering of medical devices has been propped up by our society, several STS factors complicate this process. For example, engineers must make sure to secure the health information from potential adversaries in the case of machines that keep record of health informatics. At the same time, the health data is often crucial to the

performance of the medical device. In addition, dilemmas could arise from medical professionals disagreeing with the decisions made by certain medical devices. Medical professionals and patients must be used to aid engineers in the design of these devices to help prevent these scenarios. Not to mention, there is a growing distrust towards AI by patients, who feel that they know more about their medical condition than a black-boxed algorithm (Longoni & Morewedge, 2019).

Another key STS factor to consider is the ruthless competition that drives American innovation. We live in a country where the first to patent and first to market a specific technology obtains a substantial advantage over other competing groups working to develop this specific technology. In order to secure the patent in their name, many engineers and entrepreneurs rush through the development of the device and bank on their idea (and perhaps even a fraudulent demonstration) to acquire the interest of venture capitalists. When the innovation applies to the medical field, fraudulent promises warrant deeper consequences. Rather than disappointing users that want a working Snapchat, disappointed users could include patients whose lives depend on the promises of the medical device. While engineers racing to success understand the ruthless competition presented by capitalism, they must also weigh the heightened consequences of delivering defective medical technology.

The answer I propose to the central research question is that the use of medical professionals and patients in the design phase of these medical devices can help engineers mitigate the health risk of their inventions. Medical professionals are also needed to call out stubborn engineers who are creating faulty technology.

STS Framework

I plan to answer this research question utilizing both sociology of scientific knowledge and historical case studies as my STS frameworks. The Sociology of Scientific Knowledge (SSK) will be applied to explore the dangers (or benefits) of the social acceptance and fervor around innovative ideas in our country. Schools of empirical scientific thought argue that a technology's ability to perform its intended functionality defines its success. However, the SSK framework stipulates that the social context of our society shapes the usage, acceptance, and success of a particular technology ("Sociology of scientific knowledge (SSK)—Sts wiki," 2017). Suppose technology "A" performs worse than technology "B", but technology "A" has a higher social acceptance. Even with "A's" inferior performance, it will prevail over Technology "B" according to the SSK theory. In terms of medical technology, the social acceptance of technology becomes a determining factor in terms of success and usage. Medical technology requires the acceptance of patients, their friends/family, and most of all their doctors before its empirical performance is considered.

Historical case studies will illustrate both positive and negative instances where medical technology was socially accepted as described in SSK. The negative and detrimental case will demonstrate a case where medical professionals are not used in the development of medical devices. In this case, fallacious innovation is lauded by the media and venture capital community, and catastrophe ensues. After that, two other cases propose a more positive form of SSK. In these two cases, the social figures that prop up a medical device are actually the medical professional themselves. The medical professionals guide the engineers throughout their development of the medical device,

and are able to socially validate the medical invention to our society through public test data.

The Case Study for the Negative Instance of SSK

As mentioned before, the restless competition of securing the right to develop the business around the product raises the probability of flaws in the performance of American ideas. When this product is a medical device, these flaws potentially threaten the lives of users. For example, Elizabeth Holmes of Theranos accumulated billions of dollars in venture capital investment for a blood analysis tool that never once worked. Her charismatic presence, board of previously successful business heads, and phony demonstrations swindled some of the country's top regulatory agencies and venture capitalists, until an engineer on the inside used the media to bring the company down. John Carreyrou's *Bad Blood: Secrets and Lies in a Silicon Valley Startup* presents a lengthy, detailed account of Elizabeth Holmes and Theranos (Carreyrou, 2018). This resource will allow me to acutely analyze this debacle through the lens of SSK. Carreyrou mentions interviews, news articles, documentaries and videos. All of these primary resources will also be utilized for the case study.

Elizabeth's case closely ties to the theory of the sociology of scientific knowledge (SSK). While developing her blood analysis tool, the media lauded her as "the next Steve Jobs" ("Will Theranos Founder Elizabeth Holmes Actually Go to Jail?," 2019). The

snowballing fervor around the potential of her technology and her confidence garnered a strong social acceptance. This acceptance grew to the point where many overlooked the validity of her invention. The research will involve a deep dive into this scenario. Further analysis will be performed on the key social interactions that allowed Elizabeth to persuade the public to initially accept her technology. These interactions include a puff piece written about her by a senior writer at Fortune Magazine ("This CEO's out for blood | Fortune," n.d.) and an opportunity to give a TED Talk in 2014 (Elizabeth Holmes, Theranos CEO at TEDMED 2014, n.d.). These boosts from the media gave her the social acceptance mentioned by the SSK framework.

Along with the boosts from Fortune and TED that helped Elizabeth achieve artificial success, my research will explore the social acceptance influenced by a desperate investing company, Walgreens. Rather than demanding extensive test results that backed up Elizabeth's device, Walgreens gave Elizabeth the benefit of the doubt because they did not want her to take her business idea to the competitors like CVS (Carreyrou, 2018). Even when Elizabeth turned down a demand for a comparative study and a request to visit her lab, Walgreens felt that they could not risk losing this deal to CVS. This aspect of the case study will illustrate that the economic pressure of our society also led to a premature social acceptance of Elizabeth's technology, which directly ties into the SSK framework.

Case Studies for two positive instances of SSK

After performing a historical case study of Elizabeth Holmes' company Theranos , the SSK framework will look into two case studies where the social acceptance of medical technology takes a positive role. During the "development" of the Theranos' prime invention, Elizabeth never committed to oversight and guidance by medical specialists. This led to a false approval of her technology by experts in other fields. A contradicting example is realized in IDx, a medical technology company based in Coralville, Iowa.

IDx-DR, the main product of IDx, is an AI-driven diagnostic system that analyzes images of the retina for signs of diabetic retinopathy ("IDx-DR US," n.d.). Rather than closing their whole testing process to the public, they present data on their website that chronicles the results of their system in various tests. Their system was tested on 900 different subjects at 10 different sites, achieving a success of 87% (Abràmoff et al, 2018). The test itself is published in a digital health journal. Two of their leaders are medical consultants that they used to help them create their product. In addition. both consultants are experienced MDs that helped them develop the system through all phases of IDx-DR's development.

Rather than just placing the accuracy of the test results performed on their site to acquire business clout, this company placed their entire testing methodology in a paper on their website. This website and paper will be used as resources to analyze how IDx was able to foster social acceptance through the consulting of medical professionals. As described by the SSK framework, this social acceptance effectively shows the success of their diagnosing system.

In addition to IDx-DR, another positive case study will be realized in the startup MaxQ AI (AI, n.d.). With headquarters in both Andover, Massachusetts and Tel Aviv, Israel, this company aims to leverage artificial intelligence to help doctors diagnose patients with time sensitive and life threatening conditions. An example use case they proclaim is analyzing a CT scan to determine the severity of a stroke in a matter of minutes. Rather than marketing their product as a device that can be a deciding factor in diagnosing patients, this startup still acknowledges that doctors possess the final say when it comes to diagnosing the patient. Not to mention, their company lists several medical researchers and professionals as part of their "Medical Advisory Board" on the company website. At the same time, MaxQ does not try to garner social acceptance through fraudulent demonstrations or business. They simply list the functionality of their product as goals rather than boasting a robust algorithm.

Where the IDx case study boasts a finished product with test results, MaxQ AI presents a situation earlier in the development stage. The analysis of this company will utilize the company's web pages, media appearances, and their appearances at medical or AI conferences ("RSNA 2018: MaxQ AI Machine Learning Showcase Presentation—YouTube," n.d.). These resources will allow me to acquire a better understanding of the role the medical specialists at MaxQ AI play in the development and testing of the product. These resources will also allow me to gauge the perception of this technology by patients, doctors, government officials, and other experts in the medical field. Throughout this inspection of MaxQ AI, the overall framework of SSK will be used to highlight the company's focus towards getting their product socially accepted by the medical community and patients.

Wrapping Up

While the empirical performance of a medical technology lets the engineer know when their product meets its designed functionality, society ultimately determines whether this designed functionality cooperates with patients and medical professionals. While certain medical innovations can gain momentum through venture capitalist fervor or media attention, their success ultimately comes down to the social acceptance of the medical community. This phenomenon, known as SSK, will be demonstrated by three case studies. The case study of Elizabeth Holmes and Theranos will illustrate a case where the engineer acquired considerable media and financial appreciation, but ultimately failed to involve medical professionals in her design. The other two cases, IDx-IR and MaxQ AI, will exemplify companies that understand the importance of having their device socially accepted by the medical community.

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