Creating A High-throughput Tool for Examining the Effect of Stretch on Cell Signaling and Protein Expression

(Technical Topic)

How to Bridge the Gap Between Engineers and the Public with Effective Communication

(STS Topic)

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On my honor as a student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

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Introduction

In a world after the COVID-19 pandemic, the public is picking up the pieces of their quarantine life to understand the parts of our day-to-day that will never quite go back to normal. Some people continue to wear masks. When we catch a cold, we wonder whether it is the plague, and avoid any and all interactions with others. New technology has helped us to connect and work from home, but also has completely wiped away the boundary between traditional family time and work responsibilities. With these changes comes concern for the public opinion of the true authorities on the virus: medical professionals and scientists. A recent study from Pew Research Center compiled survey data from before and after the pandemic about public trust in medical scientists. It suggests that 22% of US adults have not too much confidence or no confidence at all in medical professionals in 2021, which is up from 15% of US adults in 2016 (Nadeem, 2022).

Based on the evidence, I am interested in asking the question: How did this breakdown of communication and trust occur? The pandemic was a source of fear and conflict that has put a spotlight of criticism on the integral actors in the resolution of the heath crisis. The medical field is one that is dependent on collective understanding and trust. This is illustrated by the mechanism of vaccines. To cite a less popular and topical example, we can examine the eradication of smallpox in the US and worldwide. Smallpox claimed the lives of millions at the eve of the 20th century and continued to do so until innovations in inoculation created the smallpox vaccine, which moved to mass production in the 1950s (*History of Smallpox Vaccination*, n.d.). Eradication of the disease was dependent on the cooperation of people globally, to trust medical professionals to administer a vaccine whose mechanics were unknown to them. After the inoculation of enough people, transmission of the disease was impeded until its extinction. This example illustrates why it is so important to earn and care for the trust of the public.

On a surface level, there are two important aspects of this problem to consider using the study of Science, Technology, and Society (STS). The first aspect to consider is the technology itself and how the public is affected by the technology or scientific ideas. Relevant technologies and scientific ideas in this study would be the COVID-19 vaccine and the general knowledge of the virus, such as symptoms and risk, transmission abilities, and quarantine requirements. The second STS actor is the group of people responsible for the creation and implementation of the technology and knowledge. Those groups would be government health agencies, the health care system, medical professionals, and medical scientists such as engineers. Understanding the reasoning behind distrust of the actors and relevant technological factors surrounding the COVID-19 pandemic has important STS implications. As expressed above, national health is a field that is dependent on trust and cooperation. Uncovering the causes of distrust can give professionals the ability to reform communication, which is not only important for national health, as it can be translated to other forms of scientific knowledge that require public trust and understanding.

The technical project will explore different design ideas for a device that will aid in the identification of disease mechanisms and possible drug solutions in tissues that stretch. One day, a drug identified as useful by this device might make its way to a patient. Then, such STS theory as explored in this paper will be integral in communicating to the patient how it was determined this drug is useful for their medical condition.

Technical Topic: Creating A High-throughput Tool for Examining the Effect of Stretch on Cell Signaling and Protein Expression

The human body is a composition of many organ systems and tissues that experience some kind of stretch, specifically the alveoli of the lungs and the chambers of the heart that pump blood. Many of these tissues rely on mechanotransduction, the translation of physical signals, like stretching, to biochemical signals that instruct cells how to behave. Understanding the details of mechanotransduction is important for treatment of conditions and diseases like lung fibrosis, heart disease, and cancer (Suki et al., 2011; Lammerding et al., 2004; Dombroski et al., 2021). Therefore, it is important to have an easy to use, translatable platform that can test a variety of test conditions efficiently. Current designs are bulky and require a lot of human monitoring and interaction. The options for imaging are not diverse, and tissue culture that is done on a stretched device takes a long time and is very inefficient.

Strain Scout is the device that my capstone team will design to make mechanotransduction experiments more high-throughput, automated, and efficient. Strain Scout will consist of three major components: a membrane on which to do tissue culture, a scaffolding that is bare enough to allow imaging and made of a material that can withstand high pressures and humidity, and a motorized component that has a user interface.

To make Strain Scout more high-throughput than previous models, the team plans to explore stereolithography to print a membrane with an assortment of wells that can separate it into a variety of independent testing environments. The goal is to make the membrane out of PDMS (polydimethylsiloxane) using PDMS prepolymer as it is a material that is known to be biocompatible. Additionally, we need to design a well pattern that will distribute the force of strain across the membrane as equally as possible.

The team will explore several scaffolding design ideas that use a minimal amount of material and have clips that both apply as much controlled stain as possible as well as maneuver the membrane closer to the imaging platform. The team will research a material or combination of materials that is able to be sterilized in the autoclave and will not be affected by high temperature, pressure, and humidity.

The collection of design ideas that compose Strain Scout will ideally improve the platform’s usability and will open a window in the world of biological mechanical signals and will be easily translatable to people who are not trained in a wide variety of niche scientific topics. Medical scientists such as biomedical engineers can then begin to more rapidly and efficiently characterize mechanotransduction. This will lead to a more educated approach to drug testing, which will also be made more efficient and measurable with Strain Scout.

Science, Technology, and Society (STS) Topic: How to Bridge the Gap Between Engineers and the Public with Effective Communication

There are many resources that identify a breakdown in communication between the public and medical scientists over the period of COVID-19. Authors articulate that there have been an abundance of threats to trust, such as conflicting messages, questionable treatments, political interference, and pseudoscience propagation (Baker, 2020). A poll conducted by NORC through the University of Chicago reveals the public’s ideas about the players in the medical field. While there is a high percentage of people surveyed that have trust for doctors and nurses, at 85% and 84% respectively, there are few that have trust in the health care system as a whole (64%), government agencies (56%), or pharmaceutical companies (34%) (NORC, 2021). As the reader will know, some of these actors were the most important parts of the creation and execution of a plan to overcome the pandemic. The most relevant of these groups being pharmaceutical companies, which were responsible for the production and dissemination of the vaccine. Several other life-threatening diseases such as hepatitis B, pertussis, meningitis, and influenza are controlled by drugs that are produced by such actors (Miller & Sentz, 2006). If the public discredits drug companies, there could be negative implications in the future for both chronic and infectious health crises, which could lower the standard of living and life expectancy of Americans.

Therefore, it is important to understand the reason behind such low trust in the variety of groups associated with medicine and the health of United States citizens. The problem needs to be explored through a duality of perspectives: from a technological standpoint and from a societal standpoint. Was there something about COVID-19 technology and scientific knowledge itself that caused people to have pause? If so, what was it? As medical professionals, can we communicate the technology in a better way? Was there something associated with the scientists themselves that the public did not trust which affected the view of the product? These questions are integral in creating a foundation for future communications between engineers and the public.

STS framework

To examine how the breakdown of communication between medical professionals and the public occurred during the COVID-19 pandemic, I will be exploring the case through two STS frameworks, Social Construction of Technology (SCOT) and the Sociology of Scientific Knowledge (SSK). SCOT originated in the 1980s and is used to (1) identify technological change in society and (2) extrapolate and characterize the relationship between technology and society (Bijker, 2001). SSK takes a more specific approach to the social effect on the creation of technology. The major idea of SSK is that the creation of technology and science is dependent on the collaboration of a group of intellectuals (Mukerji, 2001). For example, pursual of scientific knowledge could be affected by the morals and political leanings of involved labs and scientists. An inherent assumption and tenet of both SSK and SCOT is that society shapes the growth and progress of technology and scientific development.

Application of Frameworks and Methods of Investigation

SCOT will be used to determine if there were factors of COVID-19 scientific knowledge that caused people to question its validity, and then to identify what propagated the doubt. On the flip side, SSK will be used to identify people involved in the creation of new technology and what about those people caused individuals to question the intentions of medical professionals. The combination of these two STS frameworks will offer a comprehensive perspective of the actors involved in the COVID-19 response and how they affected the societal view of related scientific knowledge and people.

Conclusion

In conclusion, the objective of my thesis is to determine the cause of the lack of trust between the public and medical professionals such as medical engineers in order to improve the efficacy of communication. Understanding public interpretation of COVID-19 related technology, scientific ideas, and related groups will create a foundation upon which a new system of communication and transparency can be built. Increased trust will not only improve the collective health of the nation, but the concepts learned will be easily translatable to other forms of scientific knowledge that require public trust and understanding.

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