Designing a Wearable Air Filtration Device to Block Coronavirus Transmission

(Technical Paper)

Manipulation of Scientific Expertise by Different Stakeholders

(STS Paper)

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On my honor as a University 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

Globally, the COVID-19 pandemic has affected almost 50 million people to date with 1.2 million deaths (*COVID-19 Map*, n.d.). It spreads primarily through respiratory droplets when an infected person sheds the virus by coughing, sneezing, and/or talking (CDC, 2020). As a result, our capstone team is designing a wearable filtration system that overcomes the limitations of traditional masks being utilized today such as surgical and cloth masks. Compared to current solutions, our apparatus provides superior filtration and comfortability for the user.

Back in January of 2020, information was scarce regarding this virus. Research into the methods of how COVID-19 spreads from person-to-person had to be conducted in order to determine the best ways to combat the virus. Scientific research gradually shed more light on the virus. The world began to utilize face masks to mitigate its spread as it was found that it spread by respiratory droplets. Masks have been proven to be quite effective in mitigating the spread, hence our capstone group's goal of designing a new wearable apparatus that is even more effective at preventing transmission of COVID-19. As the year 2020 is coming to an end, there is still so much that is unknown regarding this virus. The expertise of the scientific community has been utilized to gain new knowledge of the virus and formulate solutions to mitigate it. However, that expertise has been interpreted in varying ways by different stakeholders to propose distinct policy decisions regarding the pandemic in the United States and the world. Therefore, it is important to explore how the scientific community's expertise has been utilized by stakeholders during the COVID-19 pandemic, such as politicians, and the reasons

why they were utilized in their respective distinct ways, to mitigate this problem of manipulation of scientific information produced by science experts.

My STS research investigates the frameworks of actor network theory in the context of political polarization, experiences, and value proposition to investigate the how and why behind the manipulation of scientific expertise during the COVID-19 pandemic. A better understanding of this topic may assist the institution of science to undergo less politicization and more effectively solve scientific problems in the United States and the world.

Technical Topic

The COVID-19 pandemic continues to affect thousands of people in the world every day. The main objective of this project is to mitigate the spread of this virus by designing, building, and optimizing a wearable air purification system. My team, in collaboration with Dr. Alexander Klibanov, is constructing a device that optimizes a filter to block COVID-19 sized particles. Cost and weight are two primary factors that are being taken into account to ensure that it is accessible to a vast majority of the public and comfortable for the user. A face shield will be incorporated into the apparatus and designed so that it is protective and does not introduce glare. The fan will be implemented with air flow optimized so that the size and weight are appropriate and the design is able to provide the user with sufficient amount of properly filtered air. Battery packs will be implemented in regards to appropriate location, weight, and battery life.

After an initial prototype is constructed, the filtration system functionality will be validated and potential further expansion of features will be investigated. We will

test to make sure that the filtered air is up to standards with regards to filtration of particles of interest, such as COVID-19, by the filter. The air flow rate will be measured repeatedly to ensure that it is adequate for the user to inhale. A testing system with our filter (experimental group) and other current solutions being utilized today (e.g. surgical masks) will be performed to investigate how effectively the different groups can filter particles similar in size to COVID-19, such as smoke and salt aerosol particles. Resource requirements include procurement of fans, a filter with 99.97% filtration efficacy, a baseball cap, a plastic sheet for the face shield, and the use of 3D printers in order to fabricate certain in-house designed components for integration of the various parts of the apparatus.

The public uses mostly cloth, surgical, and N95 masks to mitigate the spread of COVID-19. However, these masks have certain drawbacks that make them only partially effective. For example, cloth and surgical masks do not create a tight seal with the face, allowing small particles to move in and out of the mouth and nose of the user. A surgical mask also only filters 60 percent of 0.3-micron particles (Nick Fox, 2020). Besides the filtration aspect, these masks are also uncomfortable to wear especially for long periods of time. Because they constantly cover our nose and mouth, they can cause overheating of the face and difficulty in breathing (Li et al., 2005). These limitations of current face mask solutions highlight the need for a new design that overcomes these limitations at an affordable cost. By doing so, coronavirus transmission will be greatly reduced while reducing discomfort to users.

My responsibilities within the team include continuing research into the different components of the filtration system. This includes researching into the physical concepts revolving the fan such as air flow rate and static pressure,

deciding on the proper parts to implement, and procurement of the components with cost in mind. My group has started designing the filtration system. In addition to participation in the overall design process, I primarily optimize the implementation of the face shield. I am also responsible for figuring out the details for testing the filtration system.

STS Topic

In an ideal world, science is separate from politics. In reality, science and politics are inextricably tied together in both positive and negative senses. To make numerous policy decisions, science experts are called upon regularly by the federal government for advising on scientific issues. However, the expertise provided by science is interpreted through different lenses of stakeholders that seemingly serve their own beliefs and interests (Sarewitz, 2004). Therefore, it is important to gain a greater understanding of the how and why behind the specific utilizations of scientific expertise to advance political agenda. This exploration will help to shape the language of science in such a way that it still retains the necessary uncertainty that revolves around science while guiding interpretations of the knowledge towards a single point instead of multiple. The long-term goal is to deduce implementable solutions that mitigate the manipulation of scientific expertise for different stakeholders' goals and agendas. This will allow for science as an institution to become less politicized and more neutral, and more effectively address national issues that are scientific in nature.

Science experts have been critical in advancing the front on learning more about COVID-19 during this pandemic. Even though their expertise has been used

for certain productive policy decisions to mitigate the spread of this virus, there has been disagreement with regards to how to combat this virus in the times ahead due to mischaracterization of knowledge. One such topic involves herd immunity. Scientists have suggested that the pandemic would eventually come to an end when herd immunity is reached (Medley, 2020). Widespread use of vaccines would allow the population to reach this point. However, some politicians have characterized herd immunity as a solution to ending the pandemic by natural means instead of waiting for a vaccine solution. The low-risk population would be exposed to the virus and eventually protect the vulnerable population due to high levels of immunity. The science community has expressed concern to say the least because this simply would not happen in reality (Alwan et al., 2020). This mischaracterization by certain stakeholders is potentially dangerous in fact. Unfortunately, this concerning phenomenon is not helped by the fact that science is inherently full of uncertainties. This core characteristic of science invites politicization and potential undermining of public trust on science (Kreps & Kriner, 2020). Therefore, it is necessary to explore the reasons behind misguided interpretations of these situations in order to find solutions that can help science be trusted and utilized without distortion.

One framework that I believe is critical to explore this subject effectively is actor network theory in the context of political polarization. The current administration has repeatedly sought to encourage the reopening of the economy and return to a state that resembles the pre-pandemic time. Data has illustrated that residents in Republican counties were less likely to follow a stay-at-home order compared to residents in Democratic counties (Painter & Qiu, 2020). Political

factors may play a partial reason in explaining this difference. By certain metrics, conservatives have been found to place less importance on COVID-19 compared to Democrats and Independents (Iii et al., 2020). In addition to the politics framework, experience of the pandemic first-hand also needs to be considered. Simply, conservatives may have less experience related to the pandemic than democrats for example. Because of the uncertainty that surrounds scientific explanations and models regarding COVID-19, it is prone to political manipulation in such a way that support for science-based interventions are weakened (Kreps & Kriner, 2020). This is especially so because policy decisions that end up being inappropriate may have serious consequences due to the scientific knowledge that was used to implement the policies possibly changing over time. Another important framework that should be taken into account is value proposition. Looking at environmental controversies in general such as climate change, there are advocates and opponents. Each stakeholder will lobby for the action that advances their value propositions and/or interests (Sarewitz, 2004). In regards to COVID-19, according to Alex Stevens, government leaders may very well listen to scientific evidence but only hear the ones that suit their purposes (Stevens, 2020).

The goal is to analyze the precise factors that may be in play when it comes to the manipulation of scientific expertise and how that plays out through networks. Although concrete conclusions will be challenging to deduce, it is still important to investigate this topic if society wants science to have a more productive role in guiding effective policy decision making. Stakeholders include the science community, the politicians, lobbyists, the citizens of the country, and even news networks. To learn more about the timeline of this pandemic, documents published

throughout the pandemic may be researched. To explore the different stakeholders, published papers and various news articles could be investigated. Congressional hearings may also prove very useful in gathering the specific information that different politicians present or request from federal agencies' leaders involved with COVID-19. The main question that needs to be answered is regarding how and why exactly is scientific expertise manipulated in the context of the COVID-19 pandemic by different stakeholders. This will be looked through the different frameworks mentioned.

Next Steps

- It can be argued with sufficient evidence that scientific expertise has been utilized and shaped to fit a stakeholder's beliefs and interests during various environmental controversies and the COVID-19 pandemic.
- Therefore, I will continue to do more research into specific instances of where expertise is manipulated with COVID-19 and investigate the factors through the frameworks.
- It is also important to research the backgrounds of the stakeholders to better understand their motives and beliefs, which may affect their interpretations of science and policy decision making.

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