Prospectus

PAPR Mask – The COVID-19 Approach
(Technical Topic)

Face Coverings as a Political Statement
(STS Topic)

By

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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

The Covid-19 pandemic has taken a serious toll on humanity since it was discovered in December 2019. According to the CDC, more than 40 million people have become infected with Covid-19, and complications from this disease have led to the death of over 1 million people (Center for Disease Control, 2020). However, Covid-19 does not stand out from other pandemics in these categories. In fact, it is estimated that the H1N1 pandemic infected more people and the cholera pandemic showed a higher death toll (Center for Disease Control, 2019). Instead, the Covid-19 pandemic poses a complex socio-technical problem because infected people can spread the disease without showing any symptoms.

Armed with this information, lawmakers and health experts have grappled with how to slow the spread of the pandemic. At one extreme, if people severed all communication with others for the length of the viral incubation period, the spread of the pandemic would stop. Even asymptomatic hosts could not spread the virus if people stopped interacting. However, this approach is unrealistic. At the other extreme, if people continued operating normally, the pandemic would run rampant and overwhelm hospitals, like in New York City (Gonzalez & Nasseri, 2020). To strike a balance between these two extremes, the CDC encourages three behaviors: maintain a distance of 6 feet from others, wash hands thoroughly and often, and cover the nose and mouth with a mask when around others.

This third recommendation has come under intense scrutiny during the past few months and has encouraged innovation in the realm of mask design. Recent studies have shown that common mask types, like the surgical mask, the cloth mask, and the cotton mask, do not protect the wearer from particles leaking into gaps between the mask and the face. These masks also do not filter virus particles as effectively as other types of masks, like NIOSH-certified N95 masks.

To solve these problems, I am designing a slim, powered mask, capable of filtering as effectively as hospital-grade respirators. This mask will be comfortable, easy to breathe through, and attractive.

However, even an effective mask will not end the Covid-19 pandemic. In order for mask-wearing to reduce the risk of transmission, people must actually comply with the CDC guidelines. To understand why some people choose to neglect these guidelines, we must understand the social implications of mask-wearing in the United States. These social implications differ widely between the two major political parties in the United States, and I will investigate this difference using the concept of interpretive flexibility from the Social Construction of Technology.

Technical Problem

Masks in the Covid-19 era serve two physical purposes: to protect others from the wearer and, to a lesser extent, to protect the wearer from others. Protect, in this context, means to block droplets and particles containing the virus which causes Covid-19, and recent studies have shown that the level of protection varies widely from mask to mask. Effective protection depends on filtration capacity, facial fit, comfort, and even aesthetics.

There are four common mask types available. The first is a simple cloth face covering. This primitive mask type can be made of cotton, polyester, and many other materials, and they can include ear loops or head attachments. Cloth coverings are easy to make, washable, and reusable, and they helped remedy the shortage of commercially available masks at the outset of the pandemic (Food and Drug Administration, 2020). Although a cloth masks are better than nothing, they do not protect as effectively as other masks because they fit loosely and they filter

primitively (Fischer et al., 2020). The second common type of mask is a surgical mask. These simple, disposable masks are effective at blocking large droplets, but they share the same problems as many cloth masks: they fit loosely, and they filter primitively. A loose-fitting mask is like an undersized wine cork; the wine will simply leak around the cork. Primitive filtering means that these masks work like common kitchen strainers. They simply block particles that collide with the fibers of the mask material. This means that only a very tightly woven material will effectively intercept incident particles (Godoy, 2020). Ineffective filtration and fit could lead to viral transmission even when masks are worn.

The third common type of mask is a medical-grade respirator. These masks are often called by their classification, like N95, N99, or N100. According to the National Institute for Occupational Safety and Health (NIOSH), an N95 respirator is guaranteed to filter at least 95% or airborne particles when fitted properly (Center for Disease Control, 2020). These respirators filter in a more complex way than typical masks because they hold electrostatic charge. This charge attracts incident particles, making filtration more likely. However, pulling air through these masks is more difficult than with a cloth or surgical mask, making them uncomfortable to wear. They also tend to be difficult to fit to a variety of faces because the material is rigid. Since breathing is more difficult with this type of mask, people will be less likely to wear it in the first place. This is problematic because unmasked people can unknowingly spread the virus without ever showing symptoms.

The last, and least common type of mask is a half-face respirator. Often referred to as "gas masks," these respirators have undergone significant fit and filtration testing. Although they are effective, they look aggressive, and it is very uncommon to see them in regular use. The aesthetics matter in this case because face coverings must be worn at all times to prevent viral

spread. If someone feels that they look ridiculous in a mask, they are less likely to wear it consistently. This poses a problem similar to the N95 because people without masks can easily spread the virus without ever knowing that they are infected.

The mask design proposed in this project solves the four shortcomings of common mask types: poor fit, ineffective filtration, obstructed breathing, and overlooked aesthetics. To effectively fit a variety of faces, our mask will use silicone closures and CPAP sizing. Silicone is very pliable, so it can adapt to many facial contours. CPAP masks come in a variety of sizes and attach via a universal port. We will leverage this commonality to accommodate people of many ages and sizes.

In terms of filtration, our mask will solve two problems. First, our design will harness the electrostatic power of N95 material. This will provide at least 95% protection from airborne particles, a marked improvement over cloth or surgical masks. Also, our design will filter exhaled air as well. Since this virus can spread from patients without symptoms, filtering both inhalation and exhalation will be extremely important.

N95 material tends to make breathing more difficult because it filters more effectively. To help the user breathe normally, our design will incorporate blower-style fans. These fans will pull air into the mask through the N95 material, creating a more favorable pressure environment for breathing. In other words, the fans will make the mask much more comfortable to breathe through.

Lastly, our design will pay close attention to the aesthetics of the mask. An unattractive mask will not solve the problem at hand because people need to wear masks at all times to

effectively slow the spread of the virus. Our goals for the mask's aesthetics are to keep the profile close to the face, to avoid head straps, and to design with neutral colors.

Conceptually, we will create the mask in four ways. First, we will use 3D modeling software and UVA's rapid prototyping capability to generate prototypes. Then, we will use fluid dynamic analysis to analyze the pressure environment created by the fans. It is not yet established how much pressure will make the mask feel comfortable, but we will combine this analysis with human trials to determine the necessary fan power. Third, qualitative assessments will be considered from students concerning the look, feel, and form of the mask. These will be important because they will indicate whether people will wear the mask consistently. Last, we will conduct Bitrex testing to confirm the filtering capability of the mask as a whole. Bitrex testing involves aerosolizing an extremely bitter substance in the vicinity of the mask wearer. If the mask wearer can detect the bitter substance, the mask is not effectively filtering the air. Using these four evaluation methods, our group will determine the efficacy of our design.

STS Project

In the wake of a heated presidential election, previously uncontroversial topics divide the nation along party lines. One such divisive topic is the treatment of the Covid-19 pandemic, and more specifically, wearing masks during the pandemic. Current understanding suggests that people make decisions about masks based on personal interpretation of available information (Dastagir, 2020). In fact, it has been shown that individuals who argue against masks usually cite one of five reasons: negative feelings while wearing a mask, medical issues, distorted science, personal freedom, and government conspiracy (Jarry, 2020).

Although these reasons help explain, on a personal level, why some people choose not to wear masks, they do not help explain the political split concerning mask use. All of the above categories should affect both sides of the political spectrum equally, yet there still exists a large difference in opinion about masks. According to the Pew Research Center, only 29 percent of those who "lean Republican" believe that masks should always be worn in public places, as opposed to 63 percent of those who "lean Democrat" (Pew Research Center, 2020). Since masks reduce the likelihood of transmission and people can transmit Covid-19 without knowing they are infected, people need to wear masks in public places. To this point, Dr. Anthony Fauci, the director of the National Institute of Allergy and Infectious Diseases, said that even "a small percentage of people who don't comply can have an impact on the entire population." (Rozsa, Janes, Weiner, & Achenbach, 2020). If we can understand why large groups of Americans choose not to wear masks, we can more effectively solve the complex socio-technical problem of the Covid-19 pandemic.

I argue that those who lean Republican and those who lean Democrat feel differently about wearing masks because they interpret the physical object of the mask differently. On the one hand, Democrats tend to see wearing a mask as an expression of civic duty. They feel that it is their obligation to their neighbors to protect them. Republicans, on the other hand, tend to see wearing a mask as a submission to an overbearing authority. They argue that "making individual decisions is the American way" and that masking decisions should be no different (Rozsa, Janes, Weiner, & Achenbach, 2020).

To frame this argument, I will draw on concepts elucidated in the Social Construction of Technology (SCOT). SCOT takes particular interest in how relevant social groups, or stakeholders, interpret technologies in different ways. This concept is called interpretive

flexibility. These interpretations, in turn, inform how designers will revise the dominant technology in a process called design flexibility. SCOT also argues that technologies eventually reach a state of design closure and stabilization once enough relevant social groups believe that the technology suits their needs better than competing designs (Johnson 2005). This study will specifically focus on the first two concepts associated with SCOT because masks have not reached a state of design closure or stabilization.

To support my argument, I will analyze evidence from a number of primary sources. First, I will analyze the Pew Research Center's poll data regarding the link between political leaning and masking opinions. They have conducted a number of studies which will validate the differences between the two political parties. Also, I will analyze public statements and actions of prominent political leaders on both sides. These figures serve as a mouthpiece for their respective parties, so their opinions tend to align with the portion of the population they represent. Last, I will analyze the wealth of interviews and public statements that news outlets have conducted with everyday citizens. Since the beginning of the pandemic, people have spoken openly on the news about masking, and I will analyze those interviews in which the subject's political leaning is exposed.

Conclusion

This project will deliver two separate but related products. First, the Technical Project will provide a comfortable, safe, attractive mask intended to better serve the community during the Covid-19 pandemic. It will improve upon existing mask designs, like the surgical mask, the cloth mask, and the N95 respirator. The STS Project, on the other hand, will offer better understanding about how people interpret the technology of masks. Masks have become a political statement in a time of stark division between the political parties of the United States.

This understanding will help explain why people choose not to always wear masks in accordance with the CDC guidelines.

These two projects will help to solve the complex socio-technical problem of the Covid-19 pandemic in different ways. The Technical Project will encourage more people to wear masks because it will be more comfortable and more attractive than existing designs. It will also protect more effectively than common surgical and cloth masks. This will slow the spread of the virus, and help solve the socio-technical problem. The STS Project, on the other hand, will provide a greater understanding of the choice to wear a mask in the first place. To wear a mask means to make a political statement in today's world. We must understand these statements if we are to expect everyone to wear a mask.

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