



Mask Design Research at the Time of COVID-19

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This position paper is about engaged, interdisciplinary, design scholarship and the roadblocks in the journey. The research developed with the rise of COVID-19. Previously unaffected populations became aware that barrier face coverings (i.e., masks) were a useful tool to fight virus transmission. The presentation chronicles about a year of mask design (ca. March 2020 to March 2021). It is divided in three sections: the rise of public mask use recommendations, the growth of improvised PPE to alleviate the crisis in the global supply chain, and the development of a DIY respirator with an individualized fit and a removable filter.

The paper starts with a March 30, 2020, article in *The Washington Post*, which asked, “Should we all be wearing masks?” within a piece entitled “CDC considering recommending general public wear face coverings in public.”¹ The US’ Centers for Disease Control and Prevention (CDC) was not alone in its approach. Many asked this question at the time and before lockdowns began. For many decades, scientists and public health officials had worried that mask wearing would give the public a false sense of protection.² A 2006 report by The Institute of Medicine of the National Academies of Sciences, Engineering, and Medicine entitled *Reusability of Facemasks During an Influenza Pandemic: Facing the Flu* pondered the reuse of masks during supply shortages and noted that the design of such devices mattered.³ The authors of the 2008 scientific paper “Professional and Home-Made Face Masks Reduce Exposure to Respiratory Infections among the General Population” concluded that “[a]ny type of general mask use is likely to decrease viral exposure and infection risk on a population level, in spite of imperfect fit and imperfect adherence, personal respirators providing most protection.”⁴ A popular “all-or-nothing” viewpoint (i.e., if we cannot be 100% sure of the efficacy of masks for public use, we cannot endorse them) may have impacted public health policies but it was evident, by early 2020, that mask hesitation aimed to tackle a supply chain crisis and keep certified respirators for health professionals. Misinformation led to lasting confusion, mistrust, increase viral exposure and infection, and lost lives globally as many countries followed CDC advice.

The second section focuses on the rise of improvised PPE to alleviate the supply chain crisis when demand far outpaced the supply for certified respirators. It critically observes early “sew” and “no-sew” masks posted on US and Canadian governmental websites and addresses common flaws and possible design improvements for increased filtration efficacy and fit to allow proper eyewear use. It points out that government agencies, journalistic sources in recognized publications, and non-journalists on social medial platforms presented a myriad of mask models with the conspicuous absence of scientific data. Conversely, many engineers published scientific works but their understanding of fibers, fabric structures, and surface treatments was deficient. They also ignored the lack of standardization in household fabrics, which made their results unreplicable. The efficacy of improvised PPE was, and remains, hard to assess due to a lack of standardized materials and poor fit.⁵ This makes them difficult to test to insure a proven and replicable level of efficacy. Unlike N95 filtering facepiece respirators that are evaluated, tested,

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and approved by the National Institute for Occupation Safety and Health and medical masks that must adhere to regulations by the US Food and Drug Administration, non-medical masks are neither certified nor regulated.⁶ What was needed yet not provided was standardized filtering materials available for use by the public during a lockdown and the ability to create an effective individualized face-mask seal that could be tested on a personal respirator.

The third section describes the processes involved in the development and diffusion of an (uncertified) DIY respirator. Its materials, a shoestring and two plastic yogurt containers, are available during lockdowns. It is reusable, sanitizable, and accommodates fog-free eyewear. A toothpick method can capture a wearer's facial contour and transfer it to a container. This serves a variety of faces of different genders and races. During the production process, one is able to test the quality of the face-mask seal. The design accommodates a removable filter distanced from the mouth and nose, which aims to keep the filter dry and clean to increase its efficacy and expand its life.⁷ Without the filter touching the face directly, it may also help to address problems like contact dermatitis. The removable filter allows different materials to be used as scientific knowledge evolves. A standardized and regulated medical mask is suggested as default filters but a review of the literature going back to 1910 identifies pre-synthetic solutions and proposes contemporary biodegradable filtering solutions to be considered by scientists.

¹ Joel Achenbach, Lena H. Sun, and Laurie McGinley, "CDC considering recommending general public wear face coverings in public," *The Washington Post*, March 30, 2020, https://www.washingtonpost.com/health/cdc-considering-recommending-general-public-wear-face-coverings-in-public/2020/03/30/6a3e495c-7280-11ea-87da-77a8136c1a6d_story.html.

² For "sense of complete security," see Charles F. McKhann, Adelbert Steeger, and Arthur P. Long, "Hospital infections: A survey of the problem," *American Journal of Diseases of Children* 55, no. 3 (1938): 595, doi:10.1001/archpedi.1938.01980090127015. For "false sense of protection," see Institute of Medicine, *Reusability of Facemasks During an Influenza Pandemic: Facing the Flu* (Washington, DC: The National Academies Press, 2006), 6, <https://doi.org/10.17226/11637>.

³ Institute of Medicine, xi, xii.

⁴ Marianne van der Sande, Peter Teunis, and Rob Sabel, "Professional and home-made face masks reduce exposure to respiratory infections among the general population," *PLoS ONE* 3 (7) (2008): 1, <https://doi.org/10.1371/journal.pone.0002618>.

⁵ Anne Bissonnette, "Improving Improvised PPE: A Custom-fitted, Low-cost, and Reusable DIY Respirator with a Removable Filter," *The International Journal of Designed Objects* 15 (2) (2021): 53, doi:10.18848/2325-1379/CGP/v15i02/53-69.

⁶ *Ibid.*, 54-56.

⁷ Centers for Disease Control and Prevention, "Guidance for Wearing Masks," COVID-19, CDC (website) under "Medical procedure masks (sometimes referred to as Surgical Masks or Disposable Face Masks)," updated February 18, 2021, accessed March 23, 2021, <https://www.cdc.gov/coronavirus/2019-ncov/prevent-getting-sick/cloth-face-cover-guidance.html>.

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