Fall 12-1-2012

Accommodating Face Mask for Those with Hearing Impairments

Anushka Khanna
Case Western Reserve University

Emily Hauser
Case Western Reserve University

Rashi Shukla
Case Western Reserve University

David Yo
Case Western Reserve University

Adam Portugali

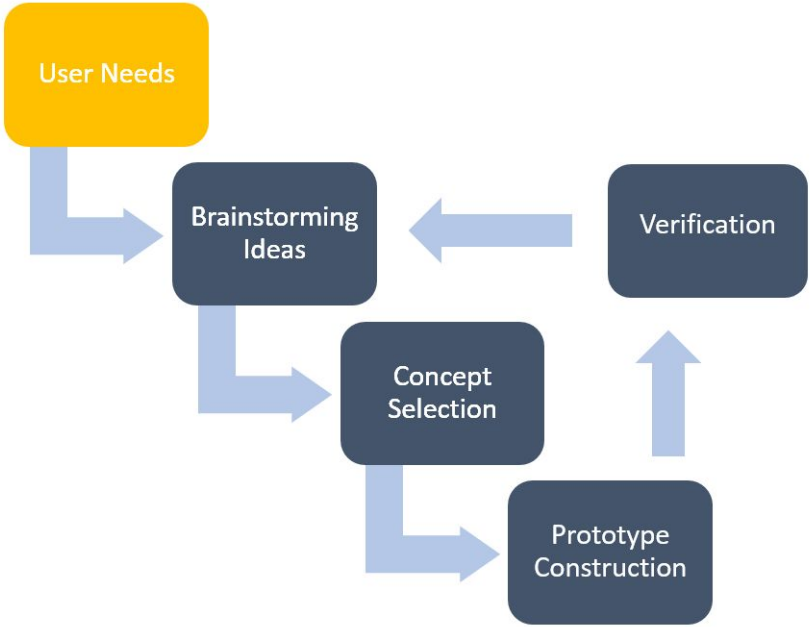
Accommodating Face Masks for Those with Hearing Impairments

By: Anushka Khanna, Emily Hauser, Rashi Shukla, David Yo, and Adam Portugali

CASE SCHOOL OF ENGINEERING
CASE WESTERN RESERVE UNIVERSITY

Introduction

- As COVID-19 continues to persist, masks have become integrated in daily life
- Facial obstructions present challenges users with disabilities
  - Users with hearing impairments
  - Detection of seizure, strokes or other facial cues

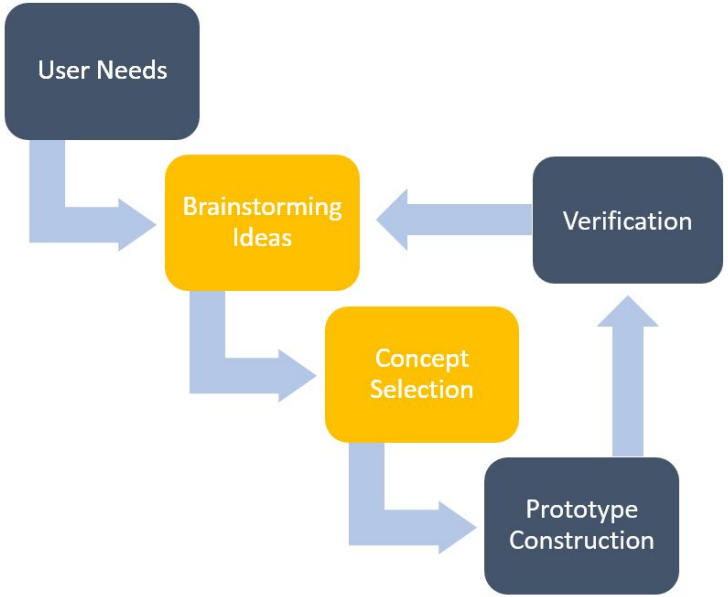


Needs Statement

For our current mask project, we are looking into user needs given the current COVID-19 pandemic and widespread use of masks by all populations. By focusing on individuals with disabilities (specifically those with hearing impairments), we aim to make masks more accessible, safer, and easier to use for those affected.

Methods

- Brainstorming concepts
- Utilizing a weighted decision matrix to select the best concept
- Construction of verification plan and protocols



Concept Selection

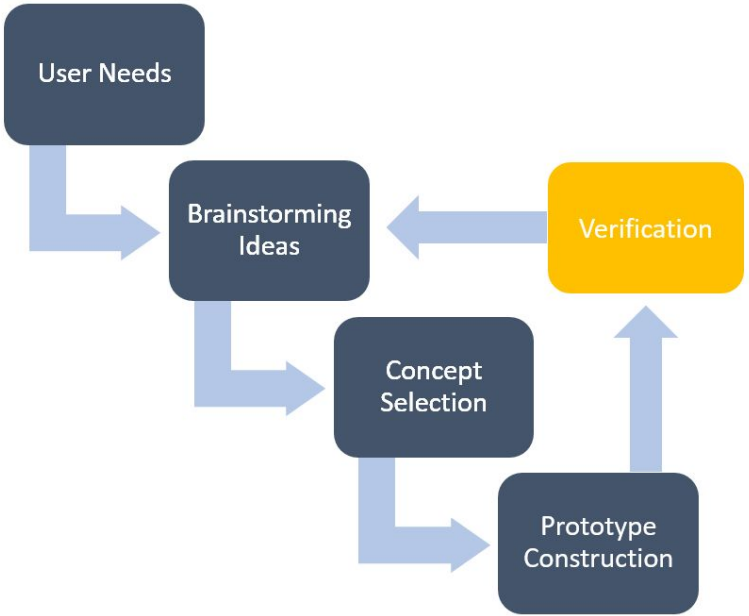
- First decision was between three (3) different types of masks.
- We ultimately decided to follow through with the third design with the clear window because it optimized viral protection and visual accessibility while minimizing discomfort.

Concept Selection

	Pro	Con
	• Good Viral Protection • Adjustable	• Limits lip reading • Diminished airflow • One time use
	• Mouth is visible • Blocks droplets from entire face • Durable	• Does not filter air • Bulky
	• Mouth is visible • Separation of straps from ears • Adjustable	• Diminished airflow • Durability/Reusability

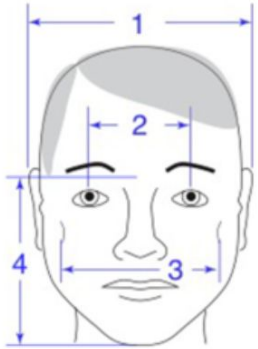
Methods Cont.

- Factors that must to be tested and evaluated for the mask include:
  - **Fitting, Viral Protection, Materials, and Accessibility**



Fitting

- Proper fit is essential for effectiveness of viral containment
- Obtain dimensions for mask via average population head sizes
- Testing in-person over a wide variety of head sizes



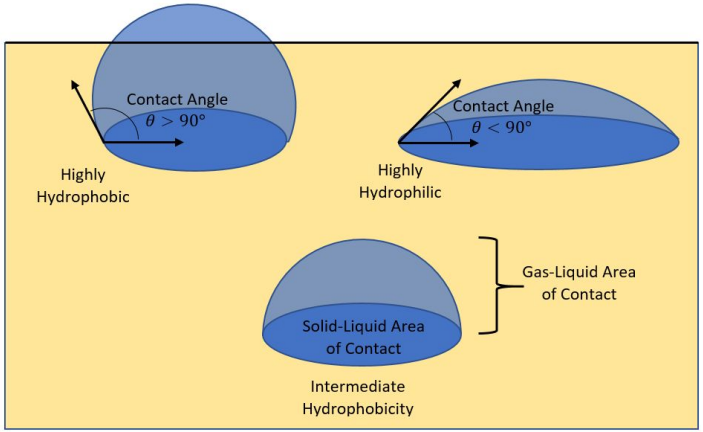
Average Head Sizes

inches

	Percentiles	1st	5th	50th	95th	99th
1	Head breadth. The maximum breadth of the head, usually above and behind the ears.					
	Men	5.5	5.6	6.0	6.3	6.5
	Women	5.2	5.4	5.7	5.9	6.2
2	Interpupillary breadth. The distance between the centers of the pupils of the eyes (the eyes are looking straight ahead).					
	Men	2.2	2.3	2.6	2.8	2.9
	Women	2.2	2.2	2.4	2.7	2.8
3	Face breadth (bzygomatic). The breadth of the face, measured across the most lateral projections of the cheek bones (zygomatic arches).					
	Men	5.0	5.2	5.5	5.9	6.1
	Women	4.8	4.8	5.0	5.5	6.1

Viral Protection

- Contact Angle (Goniometer)
  - Hydrophobic or Hydrophilic properties
  - inner most layer: skin sensitive (cotton)
  - Middle and outer layers: filtration and water-resistant (polypropylene)
- Medical Mask Droplet Test
  - # of droplets entering or exiting the mask's filtration layers
  - Determines mask protection efficiency



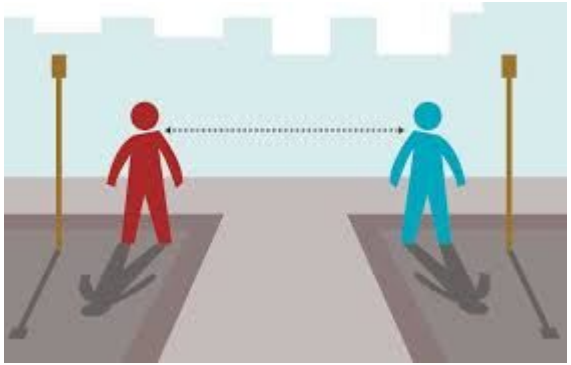
(Source: Wyatt Becicka)

Materials

- Dynamic Mass Flow
  - Evaluate breathability
- Skin Irritation Test
  - Analyze prevalence of skin irritation based on material
- Fog Test
  - Analyze translucent materials with the least amount of fogging
- Washability
  - Effectiveness after washing

Accessibility

- Ensure visibility of user's mouth
  - Adjustable sizing and material choice
- Testing auditory and visual comprehension at different distances
  - 80% comprehension expected to pass



Testing Criteria

While experiments are ongoing, we hope ideal results to include:

- Ideal contact angles - greater than 90^{o} for two outer layers (hydrophobic), less than 90^{o} for inner (hydrophilic)
- At least 80% word comprehension of from a 30 ft distance.
- Improved skin irritation and breathability
- High reusability; Ability to wash five times without significant reduction in performance
- **Controls:** N95/surgical and homemade cloth masks

Discussion

We will be discussing significance of our results and how we addressed them during our Live Q&A:

- We've been focusing on user needs through in-depth research and first-hand examples
- Critical to understand patient needs in direct context with the pandemic
- One size fits all challenge

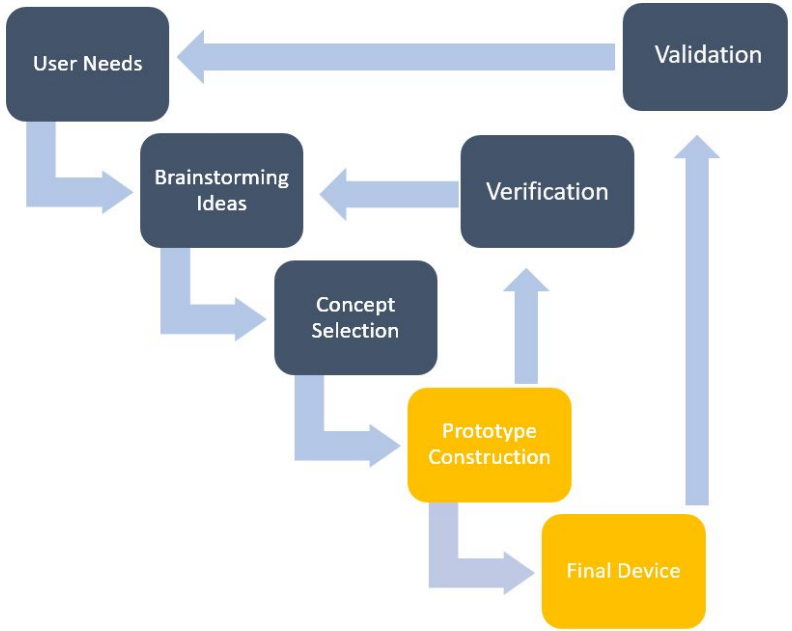
Conclusion

Moving forward…

1. Testing straps
2. Minimizing fogging and muffled sounds
3. Testing materials for comfort and reusability
4. Speech and auditory testing for accessibility
5. Complete Prototyping process

All these tests will be conducted in Spring 2021, with the ideal results set as our set goal

We expect adjustments to standards and experimentation as testing progresses in the spring



Acknowledgements

We would like to thank the following:

- NIH funding (R-25EB014774-06)
- CWRU Department of Biomedical Engineering
- Project Mentors (Dr. Matthew Williams and Dr. Colin Drummond)
- Teacher Assistant (Lin Li)

Sources

Service, CNN.com Wire. “Mask Test: Which Type Works Best at Stopping Droplets?” *The Mercury News*, The Mercury News, 1 July 2020, www.mercurynews.com/2020/06/30/mask-test-which-type-works-best-at-stopping-droplets/.

“Growth Charts - Data Table of Infant Head Circumference-for-Age Charts.” *Centers for Disease Control and Prevention*, Centers for Disease Control and Prevention, 23 Aug. 2001, www.cdc.gov/growthcharts/html_charts/hcageinf.htm.

Songer, Dr. Jocelyn. “WHO Guidance on Face Masks Changes.” MakerMask, 5 Sept. 2020, makermask.org/who-guidance-on-fabric-masks.

Kles, Keren. “Contact Angles.” *Chemistry LibreTexts*, Libretexts, 21 Aug. 2020, chem.libretexts.org/Bookshelves/Physical_and_Theoretical_Chemistry_Textbook_Maps/Supplemental_Modules_(Physical_and_Theoretical_Chemistry)/Physical_Properties_of_Matter/States_of_Matter/Properties_of_Liquids/Contact_Angles.

Chodosh, Joshua, et al. “Face Masks Can Be Devastating for People with Hearing Loss.” *The BMJ*, 1 Jan. 1970, www.bmj.com/content/370/bmj.m2683.full.print.

D. COVID-19: Face Masks and People with Disabilities., Aug. 2020,

https://www.disabilityrightsca.org/post/covid-19-face-masks-and-people-with-disabilities

Des Roches Rosa, Shannon. *Some Autistic People Can’t Tolerate Face Masks. Here’s How We’re Managing With our Son.* Washington Post, 11 May 2020, https://www.washingtonpost.com/lifestyle/2020/05/11/some-autistic-people-cant-tolerate-face-masks-heres-how-were-managing-with-our-son/ Accessed 21 Sept. 2020.

Maragakis, Lisa Lockerd. “Coronavirus Face Masks & Protection FAQs.” *Coronavirus Face Masks: Types & When to Use | Johns Hopkins Medicine*, Aug. 2020, www.hopkinsmedicine.org/health/conditions-and-diseases/coronavirus/coronavirus-face-masks-what-you-need-to-know.

Solat, Mandi. “Masks for People with Hearing Loss.” *Audiology Services & Hearing Aid Center*, www.hear2day.com/blog/masks-for-people-with-hearing-loss.