Inclusive Artifact Analysis and Inclusive Design Playbook

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Part 1: In-Depth Analysis

Over the past couple of decades, automatic soap dispensers have become critical sanitation devices in public restrooms in the United States. The touchless functionality of these soap dispensers, patented by Guey-Chuan Shiau in 1989 and pictured to the right, is instrumental to preventing the transmission of infectious disease (Shiau). Although the initial design utilized photoelectric sensors, modern soap dispenser designs are powered by radar-based sensors, photo sensors, and passive infrared sensors. However, despite their many benefits, automated soap dispensers are not necessarily inclusive across all axes of human diversity and oppression. In particular, the unequal adoption of soap dispensers across the world has exacerbated issues regarding wealthism, colorism, racism, and disablism in modern society.

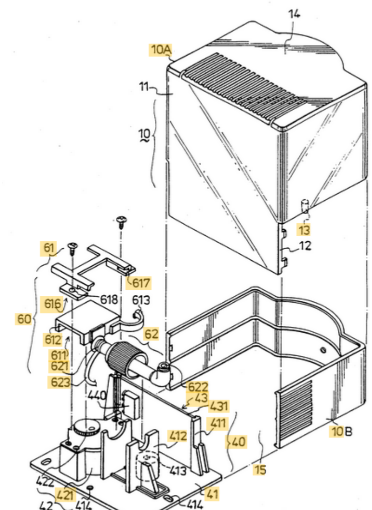


FIG. 2

While soap dispensers have been widely implemented in the United States and other industrialized countries, there are still significant barriers that prevent them from being utilized in developing countries. For example, Chennai International Airport in India offers soap bars in their public restrooms as they are a much more affordable option. Even though soap dispensers may seem more trivial than other more advanced technologies, the consequences of having ineffective and unsafe sanitation materials have proven to be deadly during the COVID-19 pandemic (Rodriguez). This clear disparity in wealth, as shown through the incredibly large gap in GDP ("GDP per capita") and the unequal access to sanitation devices such as automated soap dispensers, contributes greatly to the widening divide of resources that are available to people across the world and perpetuates a vicious cycle of marginalization based on wealthism.

Even in places where automatic soap dispensers are used, many users still face challenges with operating them. The exclusive design of these automatic technologies can contribute to racism and colorism. In 2017, Twitter user Chukwuemeka Afigbo shared a video of an uncomfortable encounter that he had with a soap dispenser, accompanied by the caption: "If you have ever had a problem grasping the importance of diversity in tech and its impact on society, watch this video.” His 45-second video first showed a lighter skinned person easily receiving soap from the automated dispenser on the first try, and then demonstrated how the same dispenser did not recognize his darker skinned hand. To emphasize his point, when Afigbo placed a white paper towel on top of his hand and waved it underneath the soap dispenser, he was able to operate it successfully (@nke_ise). To this day, the tweet has been shared almost 170,000 times and viewed over 8.9 million times. It serves as another example of the casual racism that people of color encounter in society. This could be due to a lack of diversity on the team that created the soap dispenser, as they evidently did not think to test the device on people of all skin tones (Lazzaro). Designers often design for themselves, neglecting the needs of users who don’t fit their idea of an “average” intended user and leading to the exclusion of large groups of people. Not only does this soap dispenser example indicate how implementing photoelectric sensors (light-based sensors that cannot effectively detect changes in shadows when people have darker skin) can further colorism and racism in society, but it also highlights the broader issue of diversity, more specifically the lack thereof, in technical fields.

Automatic soap dispensers also physically exclude many communities, which perpetuates disablism and introduces yet another societal barrier for people with disabilities. For example, people with limited dexterity in their upper limbs and people whose heights are statistically lower than average may struggle with accessing soap dispensers. To make soap dispensers more accessible to wheelchair users, the Americans with Disabilities Act of 1990 requires soap dispensers to be placed no lower than 15 inches and no higher than 48 inches from the floor (McMichael). However, these measurements do not work for users of all heights, and soap dispensers that are located above counters may still be difficult to reach for wheelchair users or children. Both the placement and method of interaction of a soap dispenser can determine how inclusive it is for people with disabilities. While there have been efforts to mandate accessible placements of soap dispensers, current control mechanisms such as infrared and photo sensors are extremely limited and there are few efforts to innovate in this space. Long term consequences of these exclusive designs can include discomfort for people who must reach farther than they are comfortable and an inability for users who cannot access dispensers at all to sanitize their hands, which can contribute greatly to the spread of infectious disease.

When engineers and designers do not think about the impacts of technology, their creations can not only inconvenience but deeply harm marginalized people. The inaccessibility of proper sanitation supplies in developing countries has become a serious problem during the COVID-19 pandemic, and this also uncovers the larger issue of the lack of inclusion in a variety of technologies. Exclusive soap dispenser designs can easily contribute to problems surrounding wealthism, colorism, racism, and disablism, harming marginalized communities and preventing them from breaking existing cycles of inequity. In the following parts of this analysis, we introduce metrics of inclusive design and propose recommendations for how to make the design of automatic soap dispensers more inclusive.

Part 2: Artifact Comparison

Most facilities that have automatic soap dispensers also offer a variety of other automated and touchless sanitation technologies, which include **automatic paper towel dispensers**, **automatic faucets**, and **automatic hand dryers**. All aim to limit resource consumption and prevent the spread of infectious disease, and rely on similar sensor mechanisms for activation.

Based on Nielsen's heuristics for usability and the axes of oppression we identified in Part 1, we propose 3 metrics of inclusive design by which we can analyze these touchless sanitation technologies.

Multiple Control Mechanisms

This metric measures how many ways a design can be accessed and controlled. Currently, all automatic sanitation technologies are operated by various types of motion sensors, meaning that the user must reach their hand either below (or in the case of some modern hand dryers, into) the device. However, this means that they are all physically exclusive to people with limited dexterity in their upper limbs or people whose heights are significantly shorter than average, as users need to place their hands very close to the device itself.

Appropriate Sensing Mechanisms

This metric measures the degree to which a design utilizes a variety of sensors to detect human activity / motion, as well as how logical the placement of the sensor is. Currently, automatic faucets rely on proximity sensors, which detect the physical changes of an object rather than changes in color, making them more reliable than light sensors ("Technical Explanation for Proximity Sensors"). Similarly, hand dryers often utilize infrared sensors which do not depend on changes in light or color, making them slightly more inclusive than the photoelectric sensors utilized in automatic soap dispensers. Automatic paper towel dispensers vary in the type of motion sensor that they use, but one inclusive option is the passive infrared sensor which detects a person's skin temperature when it interrupts emitted infrared wavelengths. Additionally, as the sensor for a paper towel dispenser is usually on the side of the device facing the user as opposed to the soap dispenser sensor being placed on the underside of the device, the chances of the sensor being unable to detect a person's shadow is significantly lower. However, most devices still employ only one sensor.

Scalable and Sustainable

This metric measures how well the design functions when created at a low cost, whether it implements new or expensive technology, and whether it needs to be replaced often. Although automatic faucets are usually powered with domestic electricity, they have been redesigned to function on rechargeable batteries or two 6-volt lantern batteries to be better suited for places without reliable power sources. Additionally, the proximity sensors used in automatic faucets are usually reliable and sustainable because of the absence of mechanical parts and lack of contact between the sensor and the sensed object. All automatic sanitation devices do not require extreme amounts of electricity to support operation, but many developing countries do not have the means to provide these technologies at scale.

Inclusiveness Matrix

In this matrix, **x** means that the technology has satisfied this metric.

	Towel	Faucet	Dryer	Soap
Multiple Control Mechanisms				
Appropriate Sensing Mechanisms	x	x		
Scalable and Sustainable				

Part 3: Design Recommendations

To make touchless sanitation technologies more inclusive, our overarching recommendation for usability is for designers to implement additional control mechanisms such that users can choose which method of interaction is easiest or best for them. Another recommendation regarding the scalability and sustainability of these devices is to utilize robust sensors and dispensers that are made with inexpensive materials. We discuss some design ideas and share some low-fidelity prototypes to illustrate how these can be incorporated.

Voice activation, a mode of interaction that has become ubiquitous on modern smartphones, is one of our suggested design changes. With voice control enabled on sanitation devices, users no longer need to rely on motion sensors to detect the presence of a human hand. Instead, the device can respond to a wake word, similar to saying “Hey Siri” followed by a command to an iPhone. However, we recognize that voice activation is not perfect – it may dispense at unwanted times when it mistakenly recognizes the wake word, it may be awkward in context, and it may not be fully inclusive for people with cognitive disabilities.

Another recommendation that we propose is to utilize a pedal or other contact-based control mechanism. Although this will make the mechanism no longer “touchless,” activating the device by foot maintains the same degree of sanitation as motion sensors. While this design does not require voice activation, it will not be as inclusive for people with mobility impairments or for wheelchair users. We also encourage designers to use motion sensing mechanisms that are not light-dependent, such as proximity sensors.

The scalability of sanitation technologies is also paramount to their inclusiveness. As mentioned in Part 1, soap dispensers and other automatic devices are frequently implemented in public areas in the United States, but have significantly lower rates of adoption in less affluent countries. Similar to how it is possible to create foot-operated hand washing stations from limited materials, we advocate for designs that can construct soap, paper towel, and hand drying technologies with less expensive and fewer materials so that these can be scaled for use in communities with less resources. One existing example of a foot-operated soap dispenser and faucet combination is pictured to the right, where users can step on pedals to release soap and water, respectively. As it is constructed with minimal materials, such as large plastic jugs, PVC pipes, a basin to catch the water, and wood beams, it is scalable and easy to construct in communities that may not have access to the same high end resources utilized to build most modern automatic sanitation devices.

While these design recommendations may not be universal on their own, they can be combined to greatly increase the inclusivity and usability of touchless sanitation technologies.

Part 4: Design Philosophy (Individual)

Notions of universal design aim to account for diversity by encouraging designers to create products and environments that are usable by all without needing adaptation ("Universal Design"). As discussed in class, universal design can be thought of as a "one size fits all" philosophy, in which diversity is considered and largely accounted for, but not celebrated. The Center for Universal Design at North Carolina State established seven principles of universal design, which include equitable use, flexibility in use, and tolerance for error. On the other hand, inclusive design shifts the emphasis "from designing *for* people to designing *with* people" (Leahy), including end users in the design process from start to finish. Though these two design processes sound similar, the book *Mismatch* establishes a clear differentiator between universal and inclusive design by acknowledging that universal design focuses on "attributes of the end result… [while] inclusive design… recognizes and remedies mismatched interactions between people and their world" (Holmes).

To me, as a designer and engineer, inclusive design means designing interactions, products, and environments that reflect the lived experiences, needs, and wants of end users. Before taking

HCDE 298, I had some experience in universal design and inclusive design from participating in research in the HCDE department, as well as working on projects focused on accessibility. I was familiar with involving users in the design process and conducting user interviews as well as usability tests, but never understood how widespread, systemic, and generational the consequences of non-inclusive design could be. This course has helped me better understand how design is intertwined with every aspect of our lives, and has broadened my horizons for how I can make a difference at both personal and community levels.

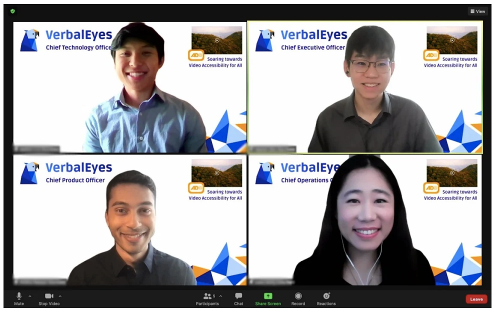
In my future work in designing for humans, I look forward to continuing my current practices as well as pushing for greater degrees of involvement and inclusion of marginalized communities. This includes following equitable outreach and user research practices so that individuals feel understood, valued, and respected. Some view diversity as an impediment and some view it as an asset. While thinking of diversity as something that can bring about positive change in a company or product is more constructive than neglecting it entirely, I believe that this still points to how modern society tends to commodify and exploit diversity rather than celebrate and uplift underrepresented communities (Czepanski). As designers and engineers, we must focus on the intangible value that we are bringing to people rather than the material value that we can gain from marketing or selling an inclusive product.

Another equally important aspect of inclusion is supporting people from underrepresented communities in becoming designers and engineers, something I have had the honor to help with through being a teaching assistant for the Allen School's Early Fall Start course and a discrete mathematics workshop designed for first-generation college students and transfer students in the Allen School. This past year, I have been a teaching assistant for CSE 440 (Human-Computer Interaction) and have introduced accessibility principles to computer science and engineering students who may not have learned of them otherwise. I will continue to be a teaching assistant for CSE 440 next year, and I am grateful to have the opportunity to share my passion for accessibility and inclusive design with others. I hope that learning about these principles will inspire them to work towards greater equity in their work and workplaces.

Part 5: Commitment (Individual)

To mitigate potential harms and to prevent the perpetuation of oppression through both low and high technology devices, I will commit to (1) being conscious of my own implicit biases, (2) prioritizing and respecting the lived experiences of marginalized communities, (3) working with interdisciplinary teams, (4) thinking about potential misuses of technologies and whether the benefits outweigh the costs, (5) critically analyzing how inclusive their designs are to all users, and (6) supporting people where they currently are. While these are my own personal commitments, I believe that these can also be followed by other engineers and designers who are hoping to celebrate diversity and inclusion both through their work and with their actions. This part will address my concrete plans for following a few of the commitments listed.

All of these commitments cannot be followed in isolation, and abiding by these commitments alone will not solve all issues with inclusion. Rather, these are proposals for gradual steps we must take to begin working towards a more inclusive society together. As we progress, we must reflect and iterate on previous practices or designs so that we are constantly growing and learning. Over the past couple of quarters, I have been working on an automated audio description project called VerbalEyes (team pictured to the left), and I have incorporated these commitments into VerbalEyes and our interactions with the blind and visually impaired community. Through this project, I have had the opportunity to build on my computer science background as well as focus more on human-computer interaction and human centered design principles. I led our efforts in seeking out research grants to compensate interviewees for their time, in conducting outreach efforts and interviews with people across the world to gain a comprehensive understanding of the issues facing end users, and in ensuring that we are consistently working with the blind and visually impaired community through our project iterations. I plan to continue working on VerbalEyes over the summer and beyond, and I hope to make our design and user research even more inclusive in the future.



Furthermore, I am committed to supporting people where they are by combating inequality regarding food insecurity, unequal access to education, cost prohibitive medical care, and more. As the Chair of UW ACM this past year, I have spearheaded our inaugural fundraising efforts for a variety of local Seattle-based nonprofit organizations. By holding one week-long fundraiser in each academic quarter, we raised $3460 for three organizations: University District Food Bank (supporting their Packs for Kids program, which provides free meals to children in the Seattle Public Schools system), Code.org (supporting 600+ active students, 9 active teachers, and 1350+ projects), and Seattle Children's Hospital (supporting their Uncompensated Care fund, which helps them provide medical care for children regardless of the family's ability to pay). Moving forward, I am committed to expanding these fundraising efforts through UW ACM as next year's Chair, and I am excited to continue encouraging the UW and Allen School community to take collective action to make an even larger impact.

I am making these commitments to myself so that I can improve my quality of work, be more intentional about the impact that I can make, and feel proud of the work that I am doing. I am also making these commitments to others – while I am an Asian American woman and can both speak to and design for my own experiences, I will also dedicate myself to understanding and amplifying the voices of marginalized groups so that their needs can be addressed and respected. Lastly, I am making these commitments to future generations. The work that we are doing today is laying the foundation for the work that we will be doing tomorrow. There is no better time than now to reaffirm and take action on our dedication to inclusion and diversity.

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