

Inclusive Apparel Design Framework for Accommodating Clothing Needs of People with Different Levels of Reach, Dexterity, and Mobility Capabilities

Sunhyung Cho, Iowa State University

Elena Karpova, University of North Carolina at Greensboro

Since the passage of the Rehabilitation Act in 1973, scholars and apparel manufacturers have worked on addressing apparel needs of people living with disabilities (PLWD). The major focus has been on developing functional garments, ignoring the preferences of PLWD for aesthetically pleasing clothing (Cho & Morris, 2018). Purely functional clothing that does not conform to ‘normal’ garment appearance is not widely adopted by PLWD who feel stigmatized (Wingate et al, 1986). Further, scholars did not prioritize the commercialization of the developed prototypes. As a result, most apparel design solutions would be challenging to mass produce because of (a) high product costs and (b) relatively low demand due to limited population size of people living with specific types of disabilities (Carroll & Gross, 2010). To solve this issue, a holistic design approach is required to ensure clothing for PLWD meets their needs *and* can be mass produced (Kosinski et al., 2018; Martins & Martins, 2012).

Inclusive Design vs. Universal Design. Despite having the same goal of satisfying the needs of populations with diverse abilities, the foci of the inclusive design and universal design approaches are different. Universal design is based on the “one-size-fits-all” concept (Homes, 2018, p. 56), which is less applicable to apparel in comparison to other products. Inclusive design (ID) is based on the idea that “it is not always possible for one product to meet the needs of the entire population” (University of Cambridge, 2017, para 2). Instead, ID focuses on clearly defining diverse needs in a population and then strategically dividing the population into several segments based on the identified needs. Therefore, ID framework was adopted in this study because it offers a more relevant approach in the apparel context than universal design.

Inclusive Design. ID framework offers useful principles to guide designers when developing products for people with a wide range of physical capabilities. The two key ID strategies include (Keates & Clarkson, 2003; Waller et al., 2015):

1. *Understanding user diverse capabilities* is critical for designers to not inadvertently exclude groups of people from being able to use the product. Design exclusion happens when a group of people with specific needs is not able to use a product because the effort required (usability of the product) exceeds the range of the users’ capabilities.
2. *Responding to user diverse capabilities* with informed design decisions. The ID philosophy encourages designers to systematically respond to user diversity and address the needs of specific group(s) of people with specific capabilities while, at the same time, increasing product usability for people with full range of capabilities.

Inclusive Apparel Design Framework. In this study, we proposed Inclusive Apparel Design Framework (IADF), which is based on the Inclusive Design Cube model. The cube model illustrates the benefits and applicability of inclusive design principles for various motion, cognitive, and sensory user capabilities (Keates & Clarkson, 2003). Clothing use primarily depends on the two types of user capabilities: (a) reach and dexterity and (b) mobility (Watkins

& Dunne, 2015). The capability of using hands and arms is essential for a person to put on and take off clothing items. For pants, hosiery, and shoes, the capability of using legs and feet is also very important. Dexterity affects the wearer's ability to use garment closures, pockets and other functional design features. Mobility is also closely related to the usability of apparel products, which should work well with any assistive tools such as a wheelchair or a walker (Waller, et al., 2013). In this study, we focused on addressing the following capability types associated with the use of apparel products: (a) reach and dexterity and (b) mobility.

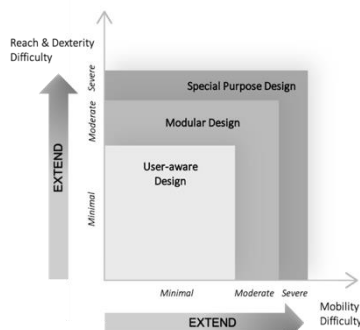


Figure 1 Inclusive Apparel Design Framework for users with different physical

IADF was developed to inform apparel design strategies.

The framework specifically focuses on accommodating people with different levels of reach/dexterity plotted on the Y-axis and mobility capabilities shown on the X-axis (Figure 1). The enclosed square reflects the entire population coverage with respect to physical capabilities: larger the area of the square corresponds to greater apparel product inclusivity. IADF addresses three levels of difficulty when using apparel products: (a) minimal, (b) moderate, and (c) severe. Depending on the level of difficulty in using apparel products, we adopted the inclusive design cube terminology to describe respective design strategies: (a) user-aware design, (b) modular design, and (c) special-

purpose design. *User-aware design* aims at “pushing the boundaries of 'mainstream' products to include as many people as possible” (Keates & Clarkson, 2003, p. 92). For example, a top with a zipper is very popular and used in various types of garments because of its use simplicity and convenience; however, this design feature may exclude some populations with low hand motion and sensory capabilities. *Modular design* minimizes “the difficulties of adaptation for particular users” (Keates & Clarkson, 2003, p. 92). It offers changeable design features, thus, making the product usable by people with moderate level of difficulties who would not be able to use a standard zipper in our example. Garment design with a magnetic zipper will include people with moderate difficulties due to dexterity limitations while increasing product usability for users who have no difficulty using a standard zipper. *Special-purposed design* is intended for developing products for “specific users with very particular needs” (Keates & Clarkson, 2003, p. 92). It is based on personalized design features for individuals who have severe difficulties using apparel. For example, a special design suit might address specific needs of a person with an amputated leg. This garment design is only suitable for this specific and limited population (people with an amputated leg) and might not be adopted by other population segments (Figure 1).

The greater inclusivity can be achieved by designing products usable by as wide population segments as possible. The proposed Inclusive Apparel Design Framework promotes inclusive design with the goal to develop products that satisfy needs of diverse user groups. The framework can be a useful tool for designers to: (a) identify population segments' distinct capabilities and apparel needs and (b) choose appropriate design strategies when focusing on people with different levels of difficulty in using apparel.

References:

- Carroll, K., & Gross, K. (2010). An examination of clothing issues and physical limitations in the product development process. *Family and Consumer Sciences Research Journal*, 39(1), 2-17. <https://doi.org/10.1111/j.1552-3934.2010.02041.x>
- Cho, S. & Morris, K. (November 2018). Developing baseline design criteria for people with lower body mobility impairments using inclusive design. *2018 International Textile and Apparel Association (ITAA) Annual Conference*, Cleveland, OH, USA.
- Holmes, K. (2020). *Mismatch: How inclusion shapes design*. MIT Press.
- Keates, S., & Clarkson, J. (2003). *Design exclusion*. In J. Clarkson, R. Coleman, S. Keates, & C. Lebbon (Eds.), *Inclusive design* (pp. 88–102). London, UK: Springer-Verlag
- Kosinski, K., Orzada, B., & Kim, H. S. (2018). Commercialization of adaptive clothing: Toward a movement of inclusive design. *2018 International Textile and Apparel Association (ITAA) Annual Conference*, Cleveland, OH, USA.
- Martins, S. B., & Martins, L. B. (2012). Ergonomics, design universal and fashion. *Work*, 41(SUPPL.1), 4733–4738. <https://doi.org/10.3233/WOR-2012-0761-4733>
- University of Cambridge. (2017). *Inclusive design toolkit*. <http://www.inclusivedesigntoolkit.com>
- Waller, S. D., Bradley, M. D., Hosking, I., & Clarkson, P. J. (2015). Making the case for inclusive design. *Applied Ergonomics*, 46, 297–303. <https://doi.org/10.1016/j.apergo.2013.03.012>
- Waller, S. D., Bradley, M. D., Langdon, P. M., & Clarkson, P. J. (2013). Visualising the number of people who cannot perform tasks related to product interactions. *Universal Access in the Information Society*, 12, 263–278. <https://doi.org/10.1007/s10209-013-0297-0>
- Watkins, S. M., & Dunne, L. (2015). *Functional clothing design: From sportswear to spacesuits*. Fairchild Books.
- Wingate, S. B., Kaiser, S. B., & Freeman, C. M. (1986). Salience of disability cues in functional clothing: A multidimensional approach. *Clothing and Textiles Research Journal*, 4(2), 37-47. <https://doi.org/10.1177/0887302X8600400206>