Exploring Wearable Technology: Design Attributes of Solar-Powered Book Bags Concerning Millennials

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Introduction. Developing a wearable product that incorporates solar cells is imperative to the rapidly growing mobile technological market. Solar power is energy from the sun and the energy can be harvested using a solar cell, which is "an energy generator that converts solar energy to electrical energy" (Jeon, 2010, p. 249). Consumers such as students and traveling workers have little choices in the market for portable charging products that are renewable. Technology has become increasingly mobile and with that, comes the need to power devices. Schools have transformed their curriculums to include online-based classrooms, mobile apps, and the need for portable computers. Business travelers work outside the office more than ever. These needs cause device users to be in locations without access to electricity and in a state of constant battery drainage.

Purpose and significance. The purpose of this study was to develop a product that incorporates a renewable energy source with a book bag that is both visually appealing and suited to charge high power devices based on a mixed methods research design (Figure 1) that integrated focus group interviews, online surveys, and prototyping.
The study aimed to expand the current wearable solar-powered products on the market and identify aspects of products that consumers, specifically Millennials, people born between the years 1982 and 2000 (Lancaster & Stillman, 2010), deemed most important. Overall, this research contributes to interdisciplinary work between textiles and technology, bridging the gap.
Research questions include: (a) What are Millennials' attitudes and perceptions towards wearable technology? (b) What are Millennials' major benefits/concerns for using solar-powered book bags? (c) What are effective design attributes of solar-powered book bags?

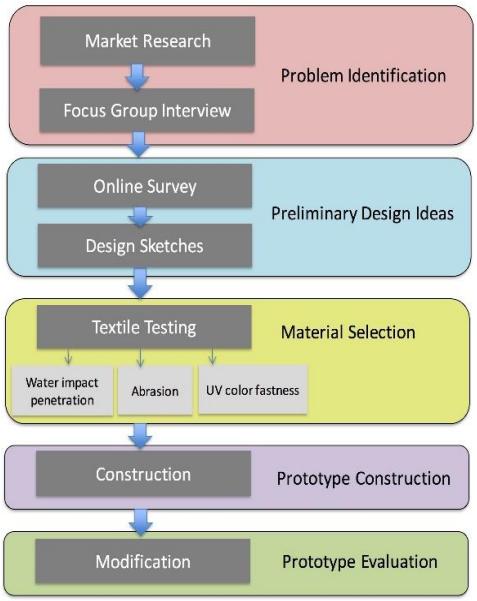

Figure 1. A design process model for solar-powered book bag

Mixed-method research design. The initial data collection was conducted through two different phases: a) focus group interviews and b) an online survey. This mixed method was chosen to first understand common thoughts around wearable technology, and then use those focus group responses to tailor the online survey. Based on the findings of the focus

groups and online survey, design attributes for solar-powered book bags were identified and implemented through prototyping. Testing of potential textiles to be used in the book bag was performed in critical functional attributes to determine the best materials for use in the final prototype. Specifically, the tests performed were AATCC Test Method 42-2000 (Water Impact Penetration), ASTM-G195 (Abrasion), and a UV Color Fastness test. Textiles tested were 400x300 Diamond Ripstop, 500 D Cordura, 1000 D Cordura, and 1680 D Traveler. Additionally, two sets of textile samples were tested in the Water Impact Penetration test, one set treated with a water repellent substance and the other untreated.

Findings and Results. The main concerns presented by the focus group were about the usefulness of wearable technology and whether the technology could be integrated easily into their lifestyles. Respondents indicated they would not use the technology if it provided little purpose or its purpose was redundant. If the user had to significantly change their lifestyle then they are less likely to utilize the technology. A total of 753 responses were useable from the online survey. The major perceived benefits were: *time saving*, *charge anywhere*, *positive environmental investment*, and *constant electricity access*. Perceived concerns were: *the size/look of the panel*, *the cost of the bag*, *speed of battery charge*, *the weight of the bag*, and *safety*. The textile testing results indicated which samples would perform better for use in a book bag. Diamond Ripstop was very susceptible to abrasion while the other samples performed significantly better. Water impact and color fastness were also factors we considered before choosing the 1680 D Traveler for the final fabric of the prototype. Almost all participants indicated they would charge their phone with the bag, closely followed by a laptop. It was found that 70% of respondents would prefer the energy to be stored in a battery rather than a direct port.

Conclusion. This study allowed us to focus our research solely on book bags and provided specific attributes to inform the design process. The textile testing allowed us to choose a material that was water resistant, abrasion resistant, and impervious to color fading; all features that are necessary for a durable book bag. Overall, this research provides an example of product development from a solid concept to a prototype. This research is significant because it demonstrates the development of a product that was driven by consumer input. Future research avenue would be exploring the capabilities of wireless charging for convenience and to minimize use of wires and cords. We also suggest further research integrating a variety of solar panels into the design of the bag, as many flexible panels can be cut to shapes to increase the aesthetics of the final product.

References

Jeon, J., & Cho, G. (2010). Fundamentals of and requirements for solar cells and photovoltaic textiles. In G. Cho (Ed.), *Smart Clothing Technology and Applications* (pp.249-265). Boca Raton, FL: Taylor & Francis Group.

Lancaster, L.C. & Stillman, D. (2010, April). *The m-factor.* Retrieved from http://tantor-marketing-assets.s3.amazonaws.com/sellsheets/1667_Mfactor.pdf