Disabled Individual Mug Research and Development

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Abstract

Today thirty thousand people ranging from children to adults are rushed to emergency rooms across the United States for finger amputations (“30,000 Finger Amputations”). In addition, thousands of veterans seek care from the Veterans Administration for loss of fingers and toes (Marchione). All of these people who have any form of hand defect or amputation struggle with everyday tasks. Specifically the product designed in this project is a coffee mug to accommodate disabled individuals with only one finger, however it is suitable for any form of hand disability. The goal of this project was to make one of many everyday tasks easier and more convenient for disabled individuals in hopes that it would be a step in the direction of disabled people living a more normal life. In order to design a coffee mug that would accommodate a disabled person five important attributes were chosen to focus on and expound ideas upon. These attributes were appearance, portable, flexible, durable and user friendly. The ideas for each attribute were then ranked and the best ideas were compiled to create the design for the final product of the coffee mug. The final product is composed of two handles - one larger for the stub and one smaller for the finger. The mug uses double wall stainless steel for insulation purposes and has textured plastic on the outside to enhance grip ability. It is also constructed of washable material and a lid, however due to cost restrictions the lid was dropped.

Keywords: Product Design Process, Disabled, One Finger, Mug
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Have you ever picked up and drank from a cup of coffee or tea? Although this act may seem to be a trivial part of your day, disabled individuals struggle to complete this simple task. Our project addresses the difficulties that holding a coffee mug creates for disabled individuals with one finger. Although this disability may not seem prevalent, 90% of work related amputations involve the loss of one or more fingers. (Marchione, 2012) Due to a substantial lack of research and development in this area many disabled individuals are left with a need for better suited mugs.

Literature Review

The initial stages of the research and development of the disabled mug involved reviewing existing disabled and normal mugs to develop a better understanding of the current options available to consumers as well as discover where our product could improve on the attributes currently offered. Initial research into disabled mugs showed that a prominent strategy was to use gripping material and modify the handles (Infant Mug, 2015) (Inset Grip, 2012). Additionally the four patents reviewed as preliminary research revealed four different grip modifications. An inset grip (Inset Grip, 2015) was utilized for individuals that had difficulty gripping a flat cylinder however this concept did not work for our conditions as it required all five fingers. A one finger grip (Cup used for people with fingers disabled) utilized one finger grip to hold the mug, however it appeared to be greatly unstable and limited potential usage to select fingers. A promising method involved modifying the handles to fit the user’s need as shown by the infant mug where two handles were utilized for stability, and the cup handle which is shaped to fit the user’s hand. These ideas inspired a modified two handle grip in our design
process. Additional attributes that were taken into consideration included insulating material, convenient dimensions, and modularity.

**Design Process**

The design process allows for a team to methodically work through a problem and come up with the best possible design to solve a problem. As a team we were able to work through the design process that we learned in our engineering design class. We identified the problem, defined the problem, developed the possible solutions, selected the best possible solutions, modeled the solution, and communicated the solutions. However, we were not able to test, evaluate, and refine the solution because of time constraints and limited resources.

The first part of the design process is to identify the problem. The problem given to our team was to design a coffee mug that a person with a hand disability could use, specifically a person with only one finger and one stub. From this we develop a mission statement. In our mission statement we determined that our coffee mug would be lightweight, insulated, and designed for disable individuals with one finger and one stub. Our key goals were to get the product in manufacturing within six weeks and hold a 20% share of disabled cups on the market within one year. The markets we focused on were disabled individuals and individuals that wanted to purchase a coffee mug. Assumptions we made were that the coffee mug would be held by disabled individuals, would be lightweight, would insulate the beverage, would be machine washer safe, and would include a lid. Stakeholders include disabled users, retailers, caregivers,
retirement/nursing homes, veteran organizations, hospitals, and other assisted living environments.

The next step was to gather raw data from customers. Information could be gathered through one-on-one interviews of a single customer, a focus group of experts, a survey, a field study, and an internal search. Our team took to the internal search due to limited resources and time. After we gathered the raw data we had to organize the needs into a hierarchy that used the analytical hierarchy process to determine the value or weight of each need. The needs were sorted into three categories: attributes, constraints, and features or functions. Constraints and features or functions were removed from our needs. Then, the attributes were organized into their own categories with a first and second layer. Our first layer attributes include portable, user friendly, durable, appearance, and flexible. Through the analytical hierarchy process (AHP), each first layer attribute was ranked against each other on a scale of one to nine (one is equal importance and nine was extremely more import). Then through a table comparison a total score was found and so each attribute had a certain weight of importance that went along with it. Our weights showed that user friendly was the most important (0.310), portable and flexible were tied for second (0.207), durable was third (0.241), and appearance was last (0.0345). The AHP was used again to rank the second layer attributes to determine their weight. The second layer attributes’ actual weights were found by multiplying the weight in their category by the weight
of the first layer that they were under. All of the customers’ needs were neatly organized with the value of importance for us to use and help continue our design process.

After we identified the problem and gathered customer needs, we began the concept generation process. During this process we clarified the problem, searched externally and internally, and explored systematically. We had to change the customers’ needs into tangible and usable data. Our group combined the ideas of the concept classification tree and concept combination table to create our concept compatibility chart. The chart included five general topics that each of the concepts we came up with could be placed under. The categories were usable by disabled, insulates, lightweight, reliable over lifetime, and lid. Then a concept from each category was combined to create a design concept. We came up with sixteen possible design concepts from our concept compatibility chart.

Following the AHP and concept compatibility chart, we narrowed sixteen possible designs down to just the best combination through the concept selection process. The concept selection uses concept screening and scoring to narrow down the designs. We used plus signs, zeros, and minus signs (plus signs mean that the criteria being compared is better than the base. Zeros mean it is equal to the base and minus signs mean that it is worse than the base) to compare a base concepts or designs to the other designs. This comparison compares specific selection criteria from the concept compatibility chart. Then the plus signs, zeros, and minus
signs are combined to find a net score. The net score is then ranked to determine the top rank. In our rank we had several first place ties and so we used concept scoring to compare the top five of our concepts to find the best solution. The concept scoring gave each selection criteria a weight and then a rating from one to five (one meant that it was much worse than reference and five meant that is was much better than reference) was used to find the weight score and total score. Weight and rate were multiplied together to find the weighted score. The sum of all of the weighted scores were used to find the total score and the one with the highest score was ranked first.

**Design Result**

Our number one rank include two handles (one larger/one smaller), a stainless steel double wall, gripping plastic, washable material, and a slide lid. After reviewing our concept that was ranked first, we agreed it was the best concept and decided to develop it, however we did not include the lid due to time and material constraints.

If the customers were not satisfied with the design or it did not pass testing and evaluation, it would go through the design process again to refine it in an attempt to develop the best possible solution. The design process is a way to organize and systematically rank needs and designs to come up with the most effective end result. Our end result was much different than what we expected however, due to the design process we believe that it is the more effective and practical implementation.
Conclusion and Summary

The coffee mug design created in this project is intended to make an everyday task, drinking a cup of coffee, easy and convenient for a disabled person. Not only does this project help disabled people live a more normal life but can expand the market for products designed for disabled individuals. By implementing the design process a coffee mug prototype for a disabled individual was successfully created. The design process included the following steps utilizing the analytical hierarchy process to organize attributes. A concept tree was then developed to determine each possible design. Each design was reviewed and evaluated in a concept screening table to determine which model had the highest ranking meaning it is the design that bests fulfills all the criteria of the AHP chart. The five key or important features of the AHP chart were appearance, portable, flexible, durable and user friendly. The model from the concept tree that received the highest ranking was then created using Solidworks software. Also a clay model of the coffee mug was molded and functioned as the prototype for the product. A final design of two handles, one larger for the stub and one smaller for the finger was decided upon. The cup is built with a double wall stainless steel design for insulation purposes and has textured plastic on the outside to enhance grip ability. It is also constructed of washable material and if more time was allotted a slide lid would also have been constructed. If this project was to be performed again it would have been more effective to interview people with hand disabilities to observe and understand the extent of how debilitating a hand or finger disability can be. Also there were difficulties with communication, learning the design process, and visualizing different ideas. Despite these obstacles the task of designing a coffee mug for a disabled individual with only one finger was successfully completed.
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