TiltACurl: Design Analysis and Manufacturing

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Abstract

As hair styles and hair trends are dramatically changing over time, modern hair styling tools were developed to provide a quick method to alter the way one's natural hair looks. With the fast and easy approaches to styling hair with modern technology, such as a hair dryer diffuser and hair curling iron, the risk of damage to the hair is greatly increased due to the intense high heat applied directly to the hair. This project analyzes the design of a hair styling product that serves as a healthier for hair alternative to hair dryer diffusers and hair curling irons to dry and curl hair. The TiltACurl is a hair styling tool meant to work alongside a hair dryer to prohibit the overheating of hair while acting as a curling tool to curl hair at temperatures lower than that of a curling iron.

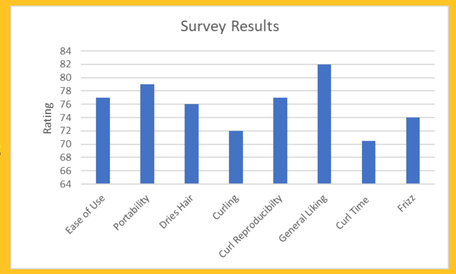
Project statement

This project is based on the initial prototype design of a new hair styling product, the TiltACurl, which was created to provide a healthier and efficient alternative to hair dryer diffusers and hair curling irons by combining the beneficial aspects of both while providing solutions to the harmful effects. In this project, design modifications based on engineering concepts of heat transfer, as well as user feedback, will be considered to enhance its effective use of curling and drying hair. The product will also be considered for manufacturing, comparing the manufacturing process of injection molding and 3D printing. Material selection, as well as a cost analysis of the TiltACurl will be studied to prepare the product for mass production.

Methods

User Feedback

As the TiltACurl is a consumer product, user feedback was considered in part with an engineering analysis to optimize the design of the product. Over the course of the project, the product was tested with volunteer users to collect feedback based on the different aspects of the product as well as answers to provided survey questions. The lowest scoring categories resulted to be curling and short curl time. Comb-like spikes were added to the product to increase the effective curling and design changes were made based analysis to decrease curl time.

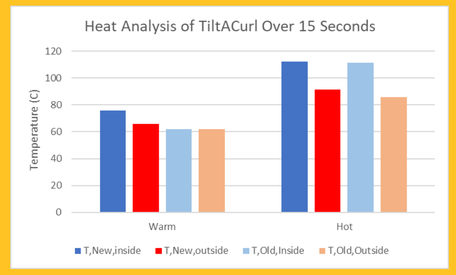


Engineering Analysis

As the TiltACurl is used in hand alongside a hairdryer, the outer surface of the product will need to remain under the temperature that skin will feel pain, 45°C. Theoretical calculations of transient heat conduction for convection over a surface were conducted to confirm that the inner surface reaches temperatures high enough to quickly set curls in hair while the outer surface remains under 45°C after a single use.

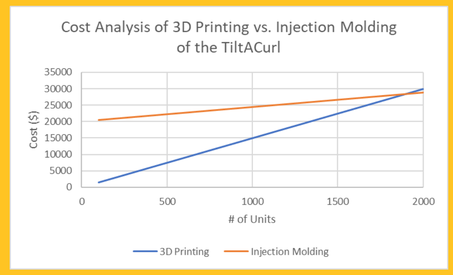
Design Changes

As curl time was a low scoring aspect of the TiltACurl and the outer surface temperature of the product was found to remain under 45°C after a single use, an increase in the air temperature inside the product to set curls in hair quicker was found to be viable. This was done through the design change of decreasing the number ventilation holes on the product. Through development and experimentation, an increase in the air temperature inside the product was verified while the temperature on the outside remained constant.



Cost Analysis

Through quotes received from injection molding companies, the price for a mold base was around $20,000 with a cost of a little over $4 per part. For 3D printing, the combined labor and material cost resulted to be $15 per part. The breakeven number of parts at these costs resulted to be around 1900 parts. For mass producing through 3D printing, the hidden cost of time must also be considered as the time to produce one part is about one day.



Conclusions

Material Selection: Polypropylene will provide the best qualities for this product as it performs well in high heat and moisture conditions, as well as being relatively cheap for manufacturing. Polypropylene is also used in many modern hair styling products.
Cost Analysis: The breakeven number for justifying injection molding compared to 3D printing as a means of mass producing is around 1900 parts. An additional benefit to injection molding is a lower production time compared to 3D printing.
Final Design: The desired outcome of the final design was to improve user experience of the product through an increase in effective curling and a reduction in curl time. After testing the new design all desired changes were met, ultimately increasing the ability of the TiltACurl to serve as a healthy tool to style hair.

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