EDSGN 100

Design Project #1

FINAL REPORT

Arm & Hammer Spinbrush Redesign
Introduction to Engineering Design
EDSGN 100 Sec 024

Team 6

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Executive Summary

The design of the Arm & Hammer Spinbrush was closely observed and tested to determine the quality of its structure and function. The objective was to improve upon the electric toothbrush in some way as to make it more desirable towards consumers. Once the toothbrush was tested and consumers were polled, the most important customer need that was to be changed in order to make the toothbrush more desirable was cost. This was done using less packaging materials and thinner plastic on the body parts of the toothbrush. These cost changes lower the overall cost in the toothbrush enough for customer needs to be settled.

Arm & Hammer Spinbrush Redesign

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1.0 Introduction

The given toothbrush in need of a redesign is the Arm and Hammer Spinbrush, an electric toothbrush meant to capture adult customers. The mission is to find the customer need that is of the utmost importance, and redesign this Spinbrush in order to meet the needs of the customers to a highest extent. The Spinbrush must undergo tests of the motor and noise level, be taken apart to have the parts evaluated, and compared to different brands of electric toothbrushes. Once the toothbrush is taken apart and evaluated, a wide array of concepts are generated of ways to improve the quality of the Spinbrush and comply more with customer needs which are determined through polls and surveys. The next sections to follow explain the path to choosing the new redesign feature of the electric toothbrush based on customer needs and the generation of ideas of those involved in the project.

1.1 Mission Statement

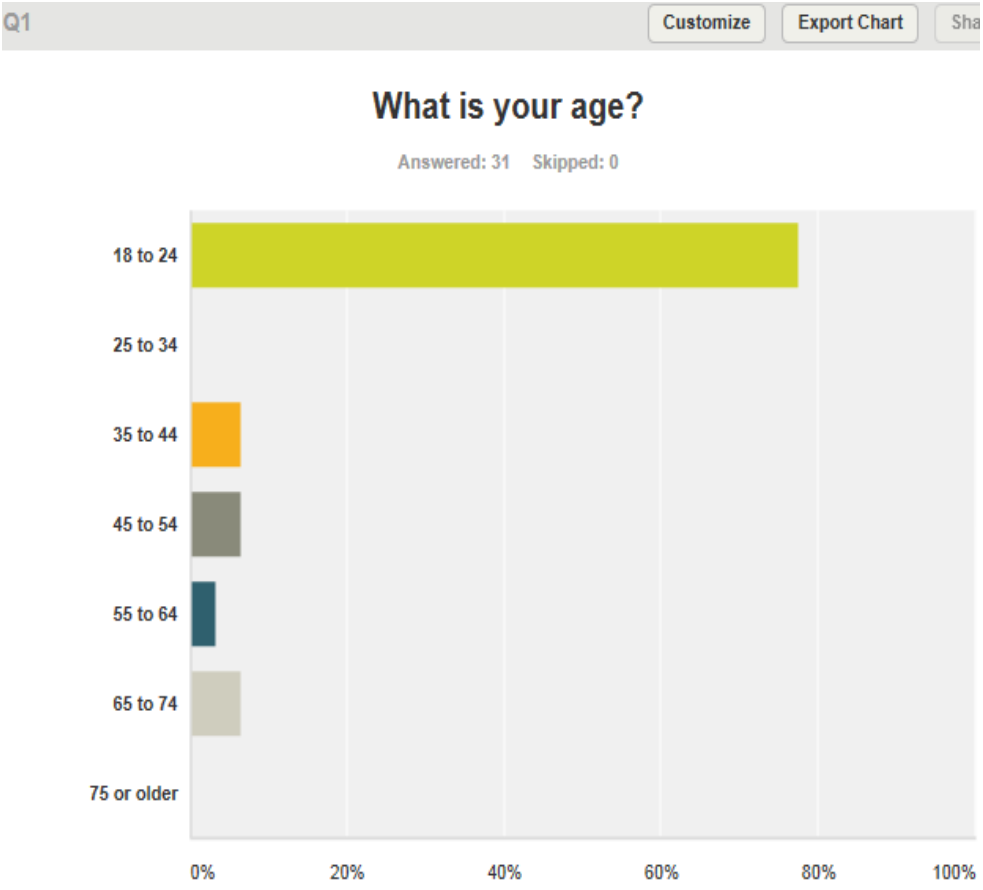
During a recent strategic meeting, the board of directors decided to fund a newly redesigned electric toothbrush to take full advantage of opportunities in the current market scenario. The task of the group is to redesign the toothbrush by examining current market trends and applying them to the redesign project.

2.0 Customer Needs Assessment

Customer needs were collected by a survey created online. The customer survey was executed online in order to successfully collect customer needs while also having them in an accessible place in which data can be organized. The customers were asked to rank four components of electric toothbrushes in order of most importance to them to least importance and their results were tallied online by SurveyMonkey.com

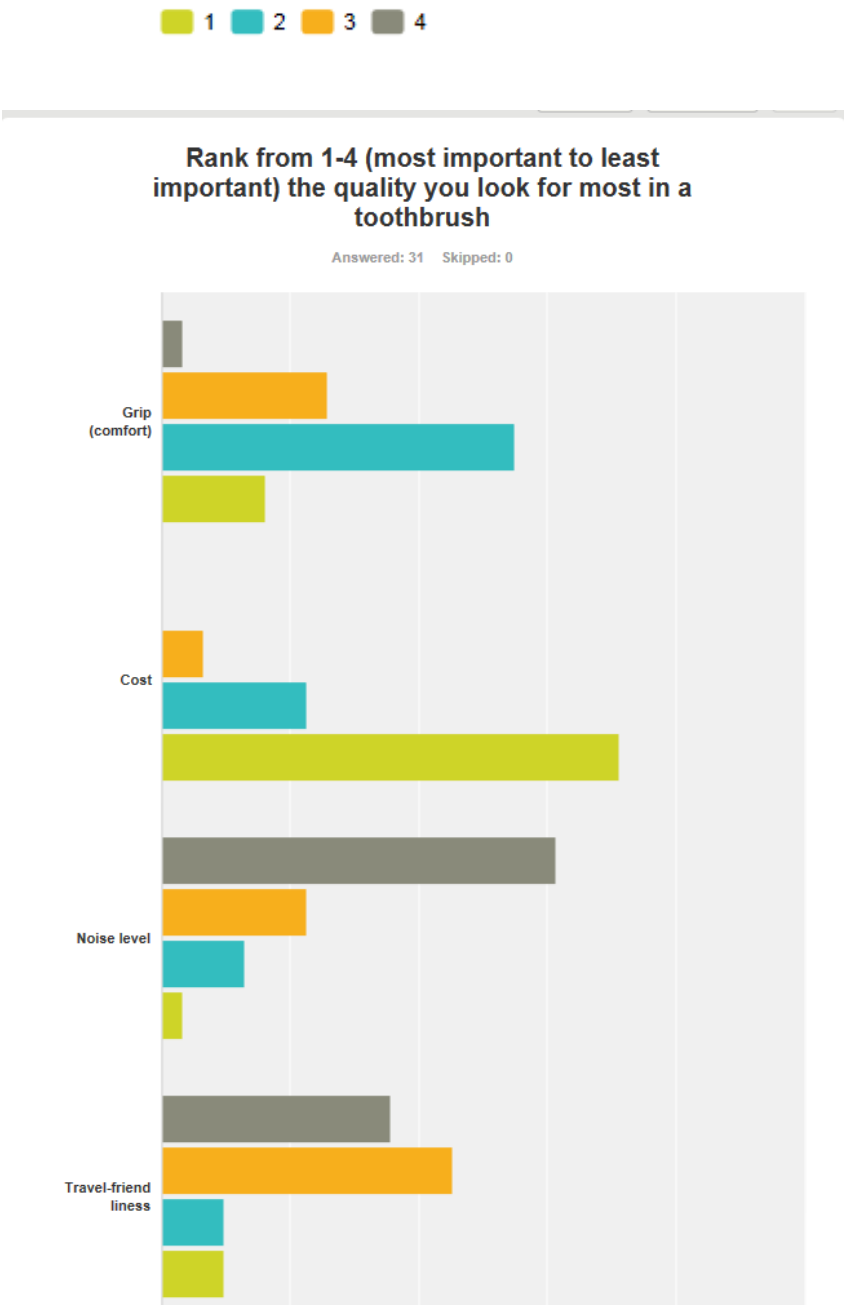
According to chart 1, the majority of information gathered by the survey was collected by customers who are between the ages of 18 to 24. Even though the majority were young customers, the survey also received a wide variety of ages that ranged from 18 years to 74 years old. This allowed for interpretation of needs among a wide variety of buyers.

Chart 2.1: Responses to Customer Needs Survey by Age



According to chart 2, the customers ranked cost as their number one priority that they look at while purchasing a toothbrush. Comfort, noise level, and travel friendliness could not compare to the importance of cost. Due to the open ended questions, it was discovered that noise level and travel friendliness plays a minimal role in choosing an electric toothbrush.

Chart 2.2: Ranking of Toothbrush Qualities



The comments are as follows:

Showing 29 responses

Cost is most important because I don't want to spend a lot of money on a toothbrush. I travel a lot, so travel-friendliness is very important, and grip is the more important to me than the noise it can make, because I don't by electronic toothbrushes anyway.
10/7/2013 11:16 AM View respondent's answers

weakness in hands makes the grip very important
10/7/2013 11:12 AM View respondent's answers

Bc I'm a poor college student
10/7/2013 11:10 AM View respondent's answers

I ranked them this way because I don't like spending a lot of money on a tooth brush as long as it gets the job done!
10/7/2013 11:08 AM View respondent's answers

Cost is most important factor since I do not want to be spending much money on a toothbrush that is frequently replaced. Grip is also "important" since I dont' use it much for the function but more to play around with. Travel-friendliness is not as important as toothbrush size are relatively small when packing. And noise level never bothered me when brushing my teeth, it is just not something I think about.
10/7/2013 11:02 AM View respondent's answers

According to the graph and comments about further customer needs, data also supports the claim that cost is more important by the percentage of data collected from the surveyors.

	1	2	3	4	Total	Average Ranking
Grip (comfort)	**16.13%** 5	**54.84%** 17	**25.81%** 8	**3.23%** 1	31	2.84
Cost	**70.97%** 22	**22.58%** 7	**6.45%** 2	**0%** 0	31	3.65
Noise level	**3.23%** 1	**12.90%** 4	**22.58%** 7	**61.29%** 19	31	1.58
Travel-friendliness	**9.68%** 3	**9.68%** 3	**45.16%** 14	**35.48%** 11	31	1.94

Cost had an overall average of 3.65 while the next highest rank (comfort) was ranked with a 2.84. This is a wide range which can lead to an obvious decision that cost is the most important factor of the Spinbrush that can be changed.

2.1 Revised Problem Statement

By examining market trends from a customer survey, a trend arose. The data showed a huge interest in the cost of a toothbrush and a fairly high interest in the comfort of a toothbrush. This showed that the new design must be both cost effective and comfortable.

3.0 External Search

From the information gathered through customer needs, an external search was then conducted in order to compare one product to other successful products on the market. This external search is also important to view current design patents so that the new product will not violate those current patents, but rather combines them into a product with higher customer satisfaction.

3.1 Literature Review

Online websites were utilized in the literature review to find a price range for the original design of the A & H Spinbrush. Prices for data sheet 1 were collected from the following sources:

"Arm & Hammer Spin Brush Pro Whitening Powered Toothbrush, 1ct." *Walmart.com*. N.p., n.d. Web. 18 Oct. 2013.

"Crest Spinbrush Pro Whitening Powered Toothbrush, Medium, 1 Brush." *Crest Spinbrush Pro Whitening Powered Toothbrush, Medium, 1 Brush*. *Kmart.com*. N.p., n.d. Web. 18 Oct. 2013.

"Professional Spinbrush Prowhitening Battery Powered Toothbrush Soft Tooth Dental." *EBay*. N.p., n.d. Web. 18 Oct. 2013.

"Spinbrush Prowhitening Battery Powered Toothbrush, Soft (Colors May Vary)."*Amazon.com: Health & Personal Care*. N.p., n.d. Web. 18 Oct. 2013.

3.2 Patent Search

A patent search was then conducted to examine the main components of an electric toothbrush. From this process, the four main components of the toothbrush were determined and their functions explored as well. This aspect of the design process helped transition the project into the concept generation phase by collecting previously created ideas to aid in brainstorming new, unique concepts. This not only fosters originality in the redesigned product, but also provides a starting point for generating new ideas based off of older ones.

Table 3.1: Art-Function Matrix for Electric Toothbrush

FUNCTION		**ART**		
	Central Bristle Rotation	Transmission Rod	Dual Battery Cover and Circuit Connector	Houses On/Off Switch and Power Wires
Toothbrush Head	US 5974615			
Toothbrush Body		US 5524312		
Battery Cover			US D527185	
Toothbrush Handle				US CN202682086 U

3.3 Benchmarking

Based on the benchmarking of actual values for the eight toothbrushes, the Arm and Hammer Spinbrush has technical properties that are either standard or very close to standard. This is especially impressive considering its substandard cost. These observations, however, are not consistent when considering the relative benchmarked values. The Arm and Hammer Spinbrush is clearly lacking relative to its competition and must undergo improvements in cost, noise and cleaning level in order to be more competitive.

Table 3.2 Benchmarking of Eight Products

Feature	**A&H Spinbrush (us)**	**Oral B (Team 1)**	**Oral B Pulsar (Team 2)**	**Colgate (Team 3)**	**(Team 4) Oral B Kids'**	**Up & Up (Team 5)**	**GUM (Team 7)**	**Colgate 360 (Team 8)**
Cost	$5-$8	$12	$6.79	$5-$7.79	$5-$15	$9	$6	$8.50
Noise Level	71.4 dB	70.425 dB	69.4 dB	73.59 dB	71 dB	60 dB	70 dB	30.125 dB
Battery type/Life	2 AA/ 4.44 hr	2 AAA/ 2.55 hr	1 AAA/ 6 hr	2 AAA/ 3.572 hr	2 AAA/ 2.07 hr	1 AA/ 14.4 hr	2 AAA/ 2.55 hr	2 AAA/ 3.614 hr
Oscillation Frequency	54.17 Hz	79 Hz	5.78 Hz	N/A	43.53 Hz	155.5 Hz	24.97 Hz	95 Hz
Weight	112.5 g	140.7 g	33.6 g	73.48 g	83.7 g	N/A	95.3 g	107 g

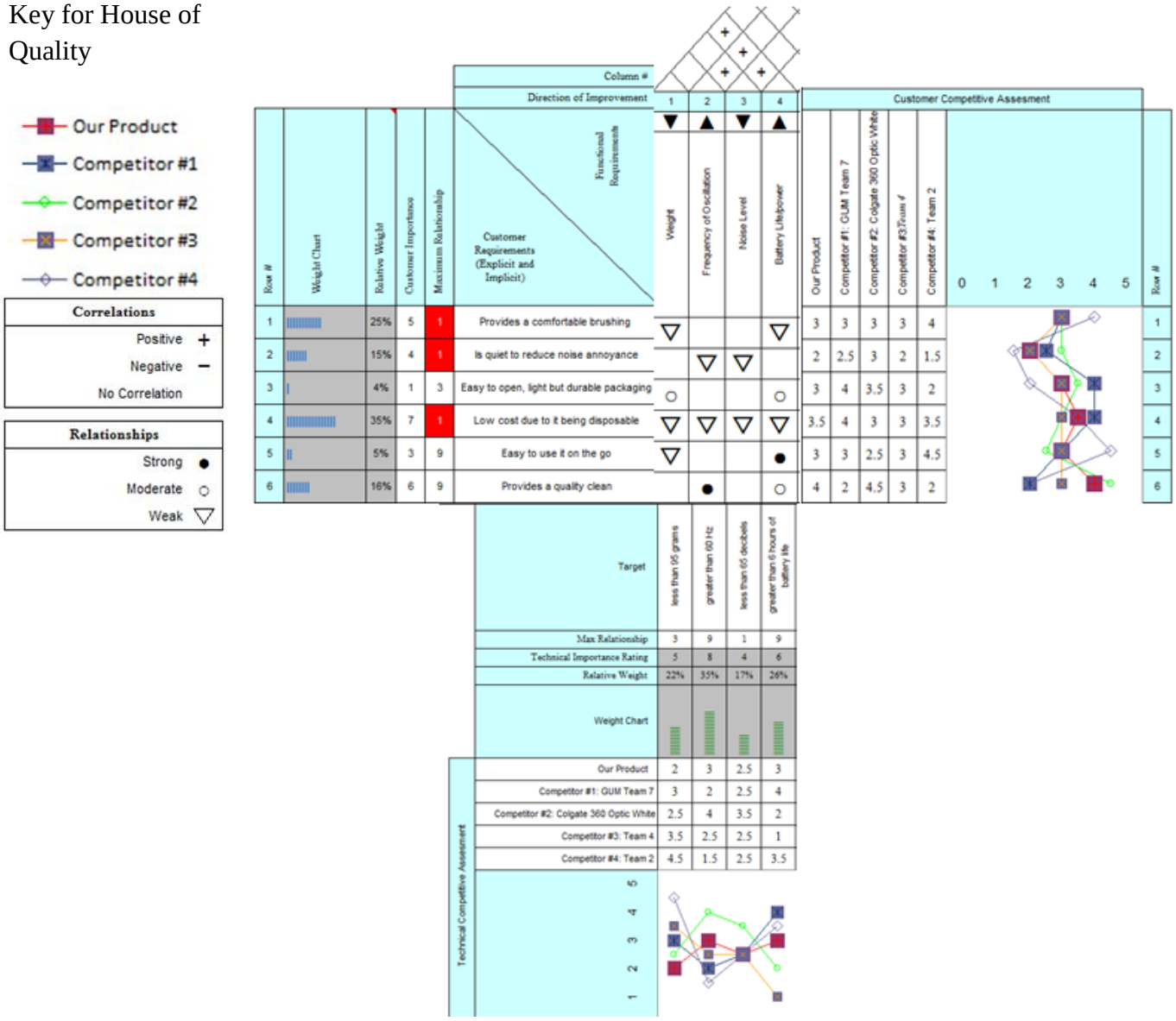
Table 3.3 Relative Benchmarking of Eight Products

Feature	A&H Spinbrush (us)	Oral B (Team 1)	Oral B Pulsar (Team 2)	Colgate (Team 3)	(Team 4) Oral B Kids'	Up & Up (Team 5)	GUM (Team 7)	Colgate 360 (Team 8)
Cost	Used as Constraint	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Noise Level	3	3	3	2	3	4	3	5
Battery type/Life	3	2	5	3	2	4	3	4
Oscillation Frequency	3	4	1	N/A	3	5	2	4
Weight	2	1	5	4	3	N/A	3	2

3.4 House of Quality Analysis

In order to fully apply the benchmarking process, a house of quality was used in order to organize and rank similar products. This method of organization gives a clearer picture of what standards any designed products should meet and what technical aspects must be adjusted and how they must be adjusted in order to meet these requirements for optimal profits.

Key for House of Quality



Through external search and benchmarking, it was found that in order to improve the standing of the Spinbrush in the market, the design must provide for a lightweight, cheap toothbrush which also has a method of improving cleaning ability without creating significantly higher cost. With these new requirements, the process of generating possible alternative concepts began.

3.5 Global Considerations

The major area of concern for this product is in developed countries or developed areas of an emerging country. With, this in mind, international culture does not generally have a large effect on preferences of tooth brushes. The populace in these areas is typically most concerned with a comfortable and effective clean, preferably at a low cost. As countries worldwide increase interaction and growth, oral hygiene is relatively uniform in standard methods of cleaning. With this in mind, the Spinbrush's redesign will be appropriately oriented towards all major consuming and developed cultures.

3.6 Product Dissection

From the product dissection, it was determined that there are three main components of the toothbrush: the head, body, and battery case. The head houses the bristles and a transmission shaft that powers the bristles, since it is connected to the motor. The body contains a gear system that connects the transmission shaft to the motor, as well as the motor itself and part of the circuit that provides electrical energy to the motor from the battery. The battery case holds the battery and the electrical circuit, thus completing the circuit between the batteries and motor.

The dissection allows the conclusion that all of these parts are important due to their high level of interconnectivity. Without one piece, none of the others would work, meaning that the redesign would be able to vary only certain components of these parts, but not their overall function since the toothbrush wouldn't work if the functions were altered. It was also determined that there were non-essential aspects of the toothbrush as well. For example, the plastic on the body was overly thick, thus increasing manufacturing and retail prices, when it isn't necessary to do so. The non-essential aspects of the toothbrush could possibly be eliminated in the future to reduce costs and appeal to the customers' desires.

4.0 Internal Search

After finding out information about other products on the market through the external search, an internal search must be led in order to determine how to best redesign the product. This allows for the ability to pick out the factors that are best in the product and also the factors that are unfavorable.

4.1 Concept Generation

<u>Original Concepts:</u>

Comfort

1. People buy grips for their toothbrushes- (include one on the toothbrush)
2. Change the size of the handle
3. Change the shape of the handle
4. Change texture

Cost

1. Less packaging - less battery?
2. Change thickness of plastic-(a lot of waste?)
3. Change type of plastic

Noise Level

1. Securing gears in place -reduce rattling
2. Insulation

Travel Friendliness

1. More compact
2. Folds up
3. Separates into parts

Head Functionality

1. Bristles firm but not rough
2. Durability
3. Shape of head

These concepts were broken down into most important by the team members in order to get customer needs. The concepts chosen were:

- Comfort
- Cost
- Noise Level
- Travel Friendliness

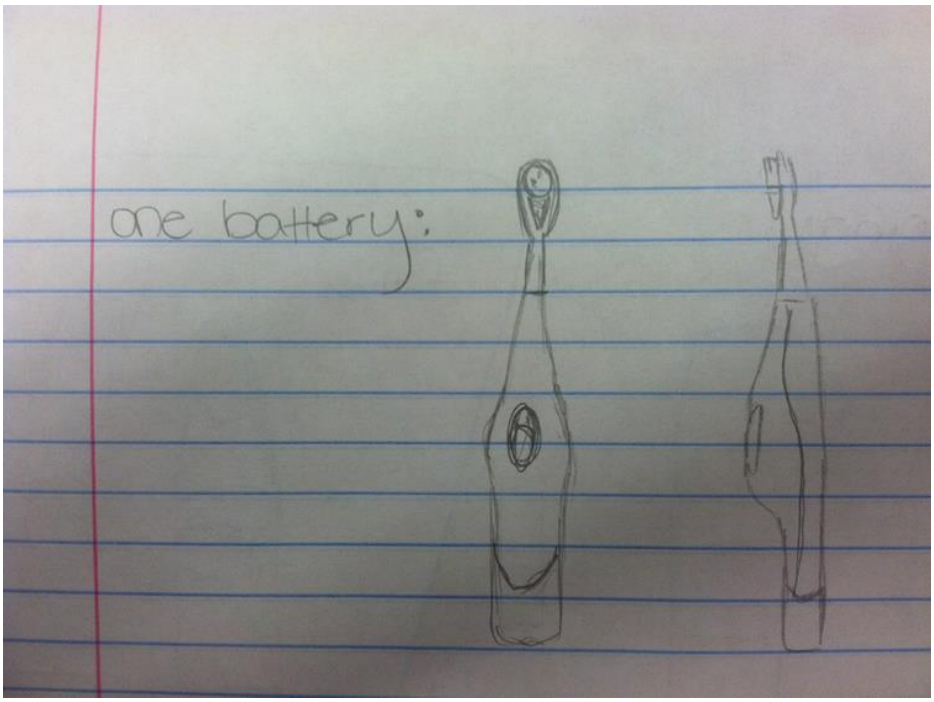
While collecting customer needs through an online survey, the concepts needed to be developed in a more in-depth manner.

- Comfort: size, weight, texture, hand-shaking, shape of handle, grip
- Cost: one battery, grip material, thickness of plastic, less packaging, type of plastic
- Noise Level: insulation, reinforce the gears, compartments
- Travel Friendliness: compactness, folds up, separates into different parts

After receiving the customer needs and analyzing the results (results shown in section 2.0), it was concluded that cost was the most important concept to change about the toothbrush.

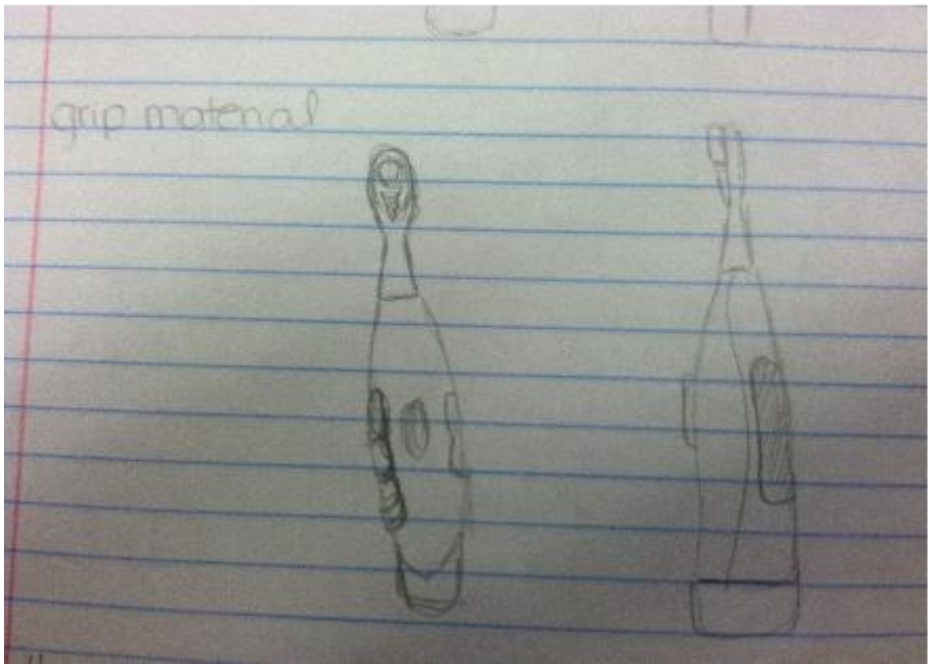
1.) One battery:

If the redesign switched to utilizing one battery, that would reduce the amount of plastic used in the handle and reduce the amount of batteries. This would allow the cost to decrease.



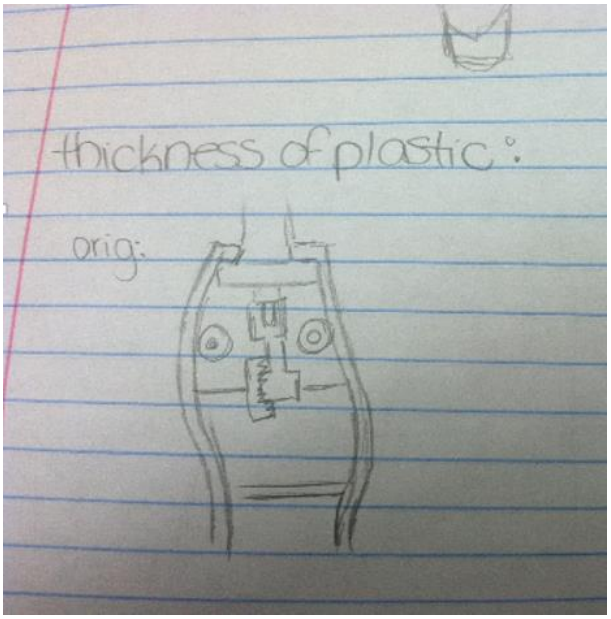
2.) Grip material:

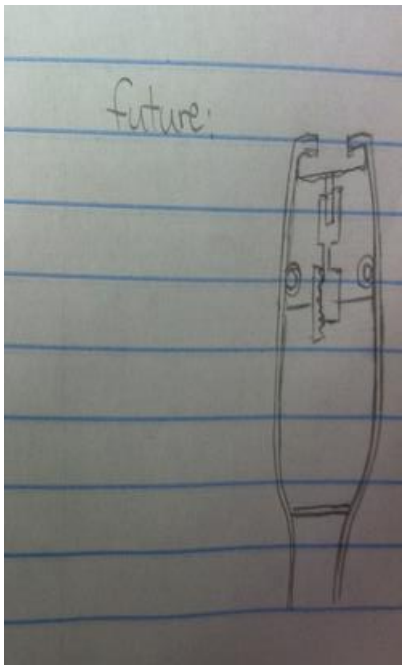
If the type of plastic was changed to a more rubbery material, the cost may decrease depending on what material was used. This would also help with the comfort aspect of the new design.



3.) Thickness of plastic:

If the redesign changed to use a thinner plastic, less plastic would be used making the product cheaper. Since the Spinbrush is a “disposable electric toothbrush”, it is not supposed to be made to last years and years. The original design was very sturdy, causing it to be more expensive. This is too sturdy of a toothbrush for people who usually use it and throw it out after the batteries die.





4.) Less Packaging:
If the redesign had reduced packaging, the product would obviously be cheaper because the customer's money would not be spend on access plastic and paper that is just used to protect the toothbrush while it is traveling and on the shelves.

4.2 Concept Selection

Following the concept generation, the ideas created were assigned letters for the final concept selection. Overall concepts were created through the combination of these letters, with each one being tailored to a different function. For example, a final concept was created with cost in mind and included the combination of ideas like using less packaging, decreasing the thickness of the plastic, creating a compact toothbrush model, and changing the handle shape. Five concepts were created and then inserted into the concept generation matrix for evaluation. Below is the key for the concepts in the matrix.

Figure 4.1: Idea Generation Key

KEY		
A = One Battery	G = Compact	J = Insulation
B = Grip Material	H = Fold up head	K = Reinforce Gears
C = Less Packaging	I = Separates into Parts	L = Compartmentalize
D = Decrease Thickness of Plastic	M = Handle Shape	
E = Form Fit Bristles	N = Shaking Stability	
F = Bristles Strength	O = Replaceable Grip	

The concept matrix evaluated the ideas based on five of the major components identified in the customer needs section: cost, comfort, noise level, travel friendliness, and head functionality. Each final concept was given a rating from 1-5, with 5 being the best and 1 the worst. The ratings were based on the original design of the toothbrush, which had a baseline at 3 for each category. After the ratings were completed, the top two designs were selected and combined into two more concepts, which were rated in level two of the concept generation matrix. From this final grading, it was decided that Concept CDGE (Less packaging, decreasing the thickness of plastic, more compact model, and form fitting the bristles to teeth) was the concept that would be further developed, as it scored the highest out of all the concepts in the matrix. Below is the finish concept generation matrix.

Figure 4.2: Concept Generation Matrix

		LEVEL	ONE									LEVEL	TWO		
		CDGM		BOJEF		ADIGO		CDKE		EFNK		COMBO	CDKM	COMBO	CDGE
Selection Criteria	Weight	Rating	Weighted Score	Rating	Weighted Score	Rating	Weighted Score	Rating	Weighted Score	Rating	Weighted Score	Rating	Weighted Score	Rating	Weighted Score
Cost	40%	5	2	1	0.4	3	1.2	4	1.6	2	0.8	3	1.2	4.5	1.8
Comfort	20%	3	0.6	5	1	4	0.8	3	0.6	5	1	4.5	0.9	3.5	0.7
Noise Level	15%	2	0.3	4	0.6	2	0.3	4	0.6	4	0.6	3	0.45	2	0.3
Travel Friendliness	13%	3.5	0.455	2	0.26	5	0.65	3	0.39	2	0.26	3.5	0.455	4.5	0.585
Head Functionality	12%	3	0.36	5	0.6	3	0.36	4	0.48	5	0.6	3	0.36	4	0.48
	Total Score	3.72		2.86		3.31		3.67		3.26		3.37		3.87	
	Rank	1		5		3		2		4		2		1	
	Continue?	COMBINE		NO		NO		COMBINE		NO		NO		YES	

5.0 Final Design

The final product consists of the original Arm & Hammer Spinbrush design, but with less packaging, a decrease in the plastic thickness, and form fit bristles, with the overall model being more compact as well. It embodies the main requests communicated by the customer needs survey, as it will be cheaper and more travel friendly than the previous model.

5.1 Design Drawings and Parts List

Figure 5.1: Various views of design in and outside of packaging with focus on changes

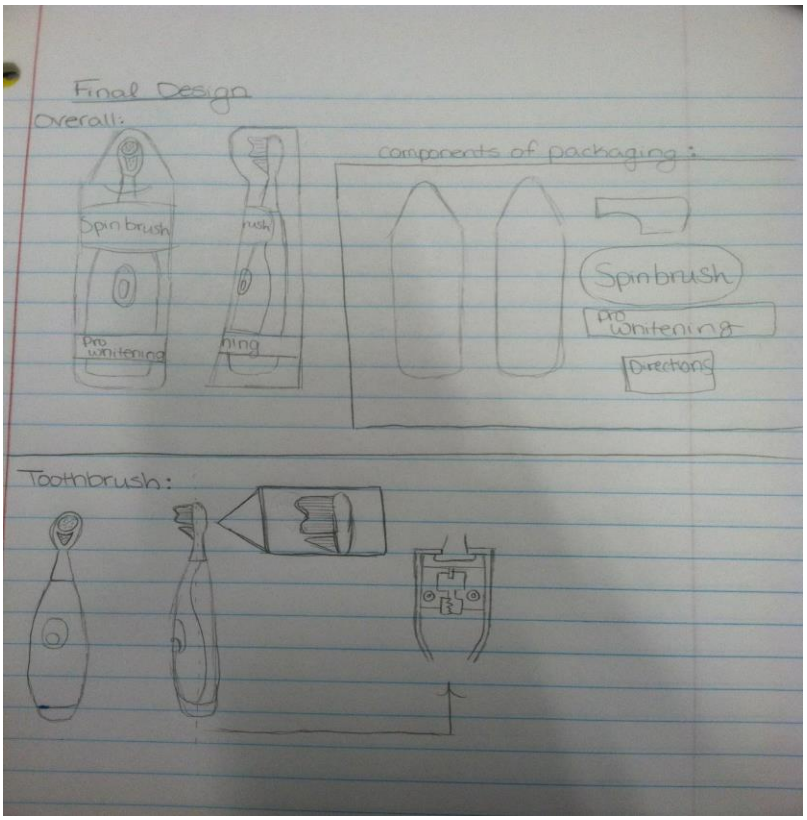
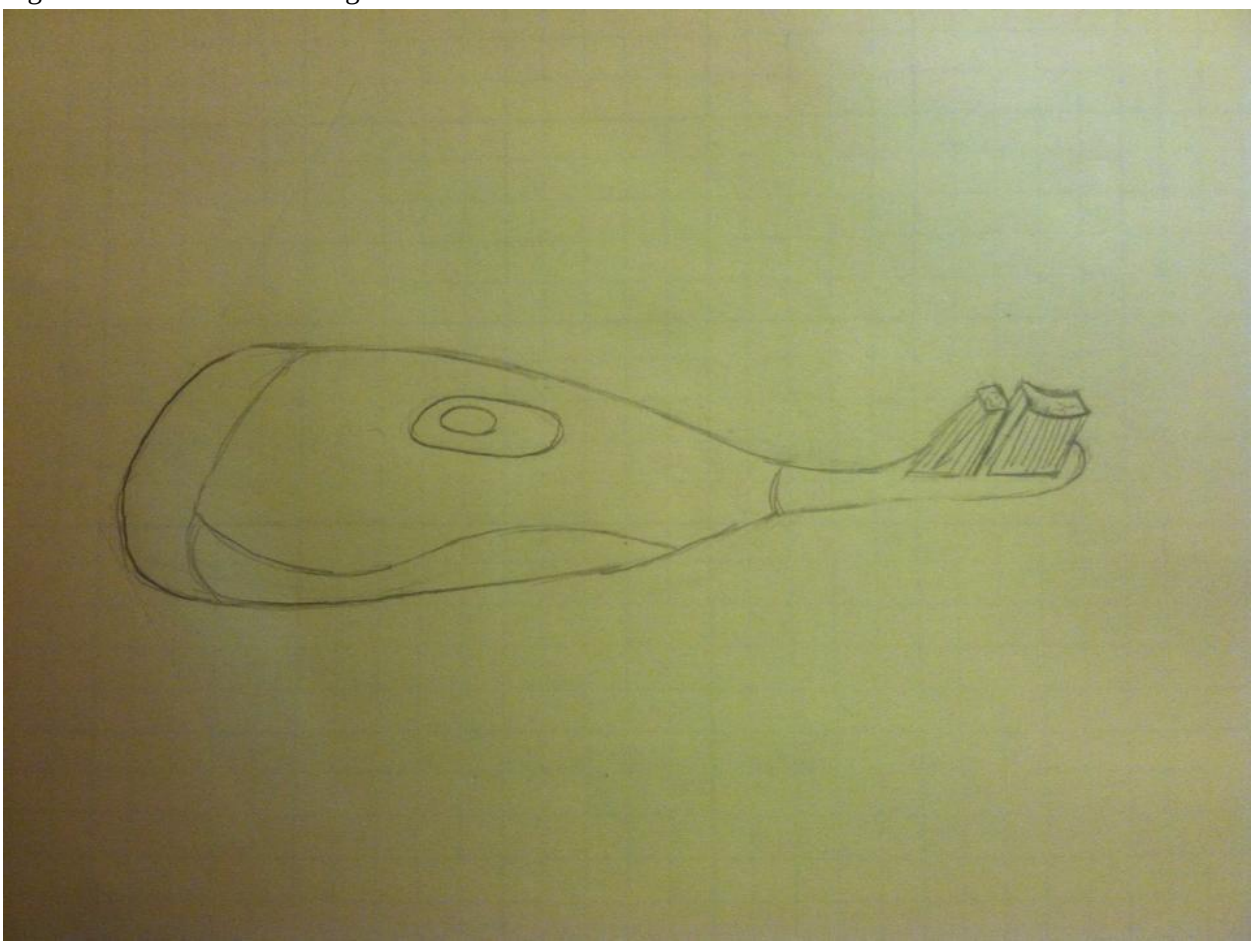


Figure 5.2: Isometric Drawing of Toothbrush



Bill of Materials

Part Number	Part Name	Qty	Function	Mass	Material	Dimensions (inches)	Cost
1	Head	1	Power bristles to clean teeth	8.6g	Plastic	2.90 x 0.50	$0.15
2	Battery	2	Power motor	22.9g	Rubber and plastic casing with chemicals inside	1.92 x 0.50	$0.20
3	Shell	1	House battery and essential	25.0g	Plastic	4.375 x 1.125	$0.20

			gear, as well as power switch				
4	Motor	1	Provide power to bristles	17.4g	Metal	1.375 x 0.75	$0.30
5	Battery Case	1	House batteries and complete battery-motor circuit	10.8g	Plastic and metal	1.68 x 1.38	$0.15
6	Metal Inner Workings	4	Connect motor to head and provide motion to bristles	1.6g	Metal	(0.54 – 1.13) x (0.125 – 0.75)	$0.07
7	Plastic Inner Workings	8	Connect motor to head and provide motion to bristles	2.3g	Plastic	(0.30 – 2.25) x (0.125 – 0.75)	$0.02
8	Packaging	1	Contain product and provide information about product	138.8 g	Cardboard and Plastic	9.00 x 1.875	$0.13

6.0 Conclusions

After the extensive redesign of the Arm & Hammer Spinbrush, a new model was developed which was cheaper, lighter, and provided a better more comfortable clean. Specifically through the concept selection of a thinner plastic shell and more compact shape, the cost of the tooth brush can be significantly reduced while also benefitting in its weight reduction. These results coincide well with the established customer needs which sought largely after low cost and mobility. The quality and comfort of the cleaning was improved by the reduction of empty space in the tooth brush and by reshaping the head of the brush to fit better with tooth shape. In regards to both product competitiveness and customer needs, the Arm & Hammer Spinbrush redesign has resulted in great improvement and will prove to be a better overall product

7.0 References

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