EDSGN 100
Design Project #1
FINAL REPORT

Electric Toothbrush Redesign

Introduction to Engineering Design
EDSGN 100 Sec 24

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Executive Summary

This report discusses the objective given to us to redesign an electric toothbrush. This report contains data collected on the toothbrush and others, as well as customer assessments to help us plan what needs to be in our toothbrushes final redesign, such as a longer battery life and more efficient cleaning ability. After benchmarking other toothbrush designs, we assessed the data and came up with features to help us with the redesign process. We came up with three redesigned features of the toothbrush and then assessed those to come up with a final redesign, which then met all of our set out goals, which were better battery life, better cleaning ability, and more easily accessible batteries.

Electric Toothbrush Redesign

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1.0 Introduction

The project we were given to work on these past few weeks was to redesign a toothbrush to make it work better and perform better on the marketplace. The redesign process involved looking at the components of our toothbrush and testing to see how important each part was in our design. This process will be covered more in Section 4.0. Once we tested our toothbrush, we researched online to see what customers of our toothbrush had to say about it and how effective it was, as well as problems they experienced. These will be covered in Section 2.0. The next step in our process was benchmarking our product with others like it and seeing how each one faired, and which factors each toothbrush fared better in than others. This will be discussed in Section 3.0. Finally, after going through each of our redesigns, we assessed which redesigns were best and which features to implement into our final redesign. This will be discussed in Section 5.0.

1.1 Initial Problem Statement

The goal for our team was to take a toothbrush that was given to us and redesign said toothbrush to be a more successful product on the marketplace. We strive to meet all customer needs as well as more efficiently produce the toothbrush, making the redesign beneficial to both parties.

2.0 Customer Needs Assessment

After we were given our toothbrush and decided what we were going to do with it, we had to generate a list of customer needs that would tell us what features that certain people wanted to see implemented into their toothbrush. Since our toothbrush was designed for kids ages 2-9 and the parents that use them, we couldn’t use traditional methods of interviews and surveys to gather our answers. To make up for this fact, we looked on the GUM Brand official website as well as Amazon to look up customer reviews and what each person had to say about our initial product. We charted what the issues were, as well as things they liked to help us generate a list of customer needs in a toothbrush.

2.1 Weighing of Customer Needs

Each issue that a customer brings up is important when looking at what we need to focus on in a redesign, but not all issues are of the same importance. For our redesign, we felt that battery life and cleaning ability were our most important needs, rather than the amount of noise that was produced from the toothbrush and how it looked to a consumer. We generated a list of needs and then assigned each

need a number. This number told us how important the issue would be in our redesign of the toothbrush.

Table 1. Customer Needs List and Hierarchal Assessment of Needs Obtained from Online Reviews on Amazon and the GUM Brand Website

Customer Need	Interpreted need	heirarchy
Water gets inside the brush	Need a way to keep water out of brush	5
It would be nice to have an easier way to switch the battery	The battery is easily accessible	2
The battery doesn't last long enough	Toothbrush needs longer battery life	4
I need to clean plaque	Toothbrush must clean plaque	5
Toothbrush is slippery when wet	Toothbrush must be easy to hold	2
The bristles wear out too easily	Toothbrush needs long lasting bristles	3
It makes a lot of noise	Toothbrush must be quieter	3
I want to know how long to brush my teeth	Toothbrush needs to let users know how long to brush teeth	3
It is a little to heavy for my child	Toothbrush must be lightweight	2
It always gets knocked over	Toothbrush must be able to stay upright	1
I want the toothbrust to look cool	Toothbrush must have positive aesthetic value	1
I don't want to spend a lot of money	Toothbrush must be be cost effective	4

This table tells us what some of the customer needs were that we examined, as well as what the interpreted need was. We ran across issues such as water getting inside the brush and the need for a longer battery life. Since these were issues we ran across the most, we deemed them to be the most important issues to focus on.

2.2 Revised Problem Statement

Our initial statement only focuses on improving our toothbrush to perform well on the market, but now that we assessed the needs in our customer base and what the problems were in the initial design, we were now able to come up with what we needed to focus on. Our new redesign of our toothbrush needs to perform well on the market, as well as improve on the problems that customers had about our original design, which include features such as water getting into the brush and the battery life being poor. We feel that the best focus would be on designing a toothbrush that improves each of these qualities and makes our customer more satisfied,

3.0 External Search

Performing tests on our toothbrush and getting needs from customers only tells us what to improve with our brush, but we are not sure if these are features that are common in other electric toothbrushes on the market. We also need to know how the other electric toothbrushes in the market compare to our toothbrush. We focused our efforts mainly on benchmarking our product to the others available in the market.

3.1 Literature Review

We examined our competition and the toothbrush designs they implemented on their websites which include colgate.com, walmart.com, and target.com. We even looked at other models of our product on gumbrand.com that implemented other features such as using AA batteries instead of AAA, and making the batteries easily replacable.

3.2 Patent Search

We also examined different patents on electric toothbrushes that used features similar to our product. US 6000083 A which was published on Dec 14, 1999 is an electric toothbrush that uses a kind of motor that improves the power that is generated. It also includes the idea we want to implement which is two separate bristle heads performing two different motions. US 6178579 B1 published on Jan 30, 2001 discusses the design of an electric toothbrush as well, discussing the general shape. US 6189693 B1 and US 6360395 B2 are patents that continue in explaining the features in patent US 6000083 A.

3.3 Benchmarking

After conducting our own assessments of our model, we were given the data of six other toothbrushes and ranked each brush using the several qualities that we developed in Section 2.1.

Table 2. Benchmarking of Seven Electric Toothbrushes

	Battery accessibility	Battery Life	Cleaning ability	Grip	Bristle Durability	Quietness	Timer	Lightweight	Aesthetics	Cheapness
GUM	2	4	3	2	4	3	1	4	5	4
Colgate 360 Optic White	4	3	5	4	3	5	1	3	4	3
Oral B type 3744	2	3	4	5	4	4	5	2	3	2
Arm and Hammer Spin Brush	2	3	4	3	4	3	1	3	2	3
Colgate NAEGMBDOPBAG	3	2	4	3	2	3	1	5	3	5
Oral B Pulsar	2	3	3	4	3	3	1	5	4	4
Up and Up	4	5	4	2	2	4	1	1	3	2

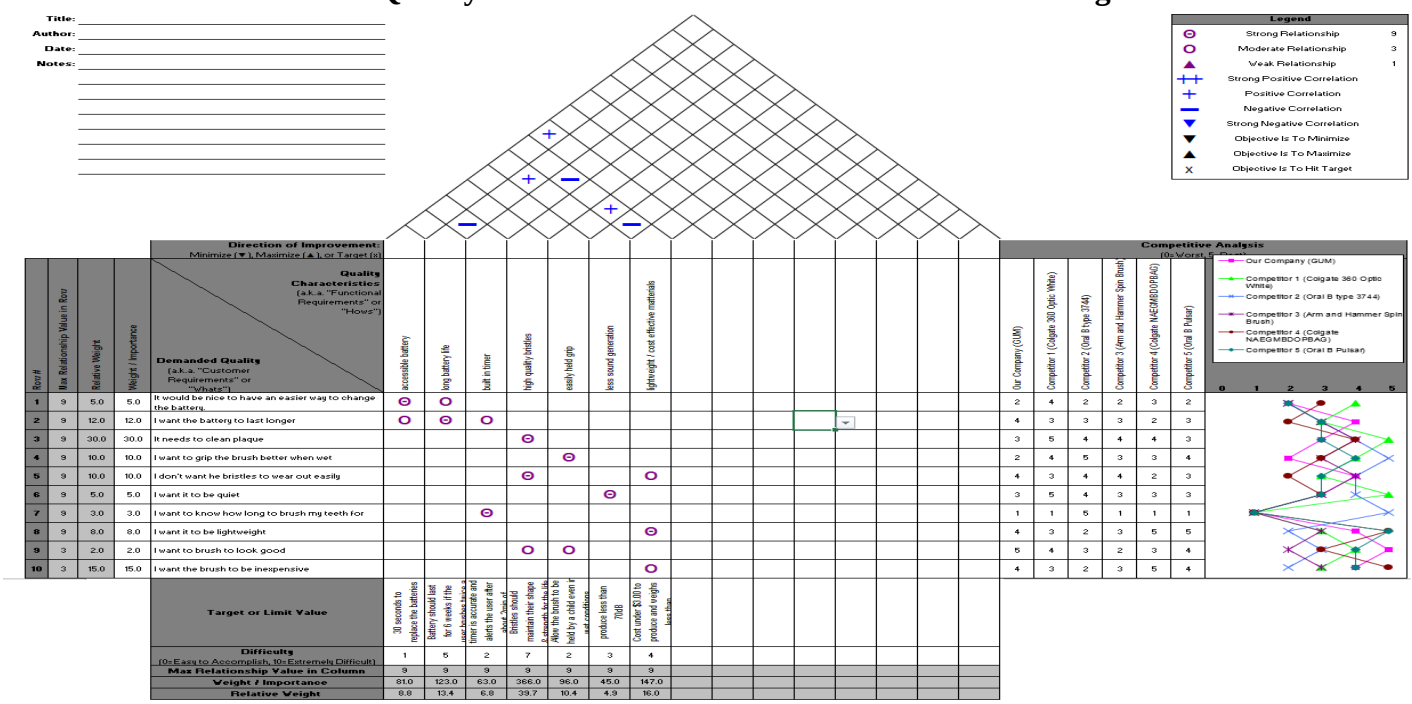
The table listed only gives the rankings of each feature of each product, but does not include the weights of each feature. This step allowed us to effectively measure how each toothbrush compared to the others in the specific categories.

Table 3. Benchmarking of Electric Toothbrushes with Weighted Factors

	Battery accessibility	Battery Life	Cleaning ability	Grip	Bristle Durability	Quietness	Timer	Lightweight	Aesthetics	Cheapness	
GUM	2	4	3	2	4	3	1	4	5	4	
Colgate 360 Optic White	4	3	5	4	3	5	1	3	4	3	
Oral B type 3744	2	3	4	5	4	4	5	2	3	2	
Arm and Hammer Spin Brush	2	3	4	3	4	3	1	3	2	3	
Colgate NAEGMBDOPBAG	3	2	4	3	2	3	1	5	3	5	
Oral B Pulsar	2	3	3	4	3	3	1	5	4	4	
Up and Up	4	5	4	2	2	4	1	1	3	2	
											Sum
Sensitivity Rank	5%	12%	30%	10%	10%	5%	3%	8%	2%	15%	
GUM	0.1	0.48	0.9	0.2	0.4	0.15	0.03	0.3	0.1	0.6	3.26
Colgate 360 Optic White	0.2	0.36	1.5	0.4	0.3	0.25	0.03	0.225	0.08	0.45	3.795
Oral B type 3744	0.1	0.36	1.2	0.5	0.4	0.2	0.15	0.15	0.06	0.3	3.42
Arm and Hammer Spin Brush	0.1	0.36	1.2	0.3	0.4	0.15	0.03	0.225	0.04	0.45	3.255
Colgate NAEGMBDOPBAG	0.15	0.24	1.2	0.3	0.2	0.15	0.03	0.375	0.06	0.75	3.455
Oral B Pulsar	0.1	0.36	0.9	0.4	0.3	0.15	0.03	0.375	0.08	0.6	3.295
Up and Up	0.2	0.6	1.2	0.2	0.2	0.2	0.03	0.075	0.06	0.3	3.065

This table takes the sensitivities of each factor and then calculates then when we sum the weighted scores. The weighted scores tell us which toothbrush ranked better that the others. These scores allowed us to take features of highly rated toothbrushes that we liked so that we could then implement it into our design. We also designed a house of quality to determine which features were related to others and which to include in our new redesigns.

Table 4. House of Quality of Electric Toothbrush Features and Rankings



The House of Quality shows what features are important and how they are related to each other in terms of redesign. After comparing the weighted scores of the toothbrushes, the rankings were as follows:

1. Colgate 360 Optic White
2. Colgate NAEGMBDOPBAG
3. Oral B type 3744
4. Oral B Pulsar
5. GUM
6. Arm and Hammer Spin Brush
7. Up and Up

Our toothbrush ranked 5 out of 7 which meant we needed to redesign our brush so that it is enjoyed by customers and works.

3.4 Design Target

After doing lots of external research, we learned that in the market our toothbrush was somewhat ineffective and did not compare to other electric toothbrushes in terms of quality. This let us come up with what features to focus on in our redesigns.

4.0 Internal Search

Internal search is testing our product and examining the components to ensure that it works as intended. We wanted to make sure that our toothbrush was the best on the market and that it satisfied our customer base, so we had to come up with redesigns that fit our toothbrush and made it work better than before.

4.1 Concept Generation

Since we now have decided what qualities make the best toothbrush, we decided to lay out all of our ideas graphically to mix and match the best qualities of the redesign.

Chart 1. Head Redesign

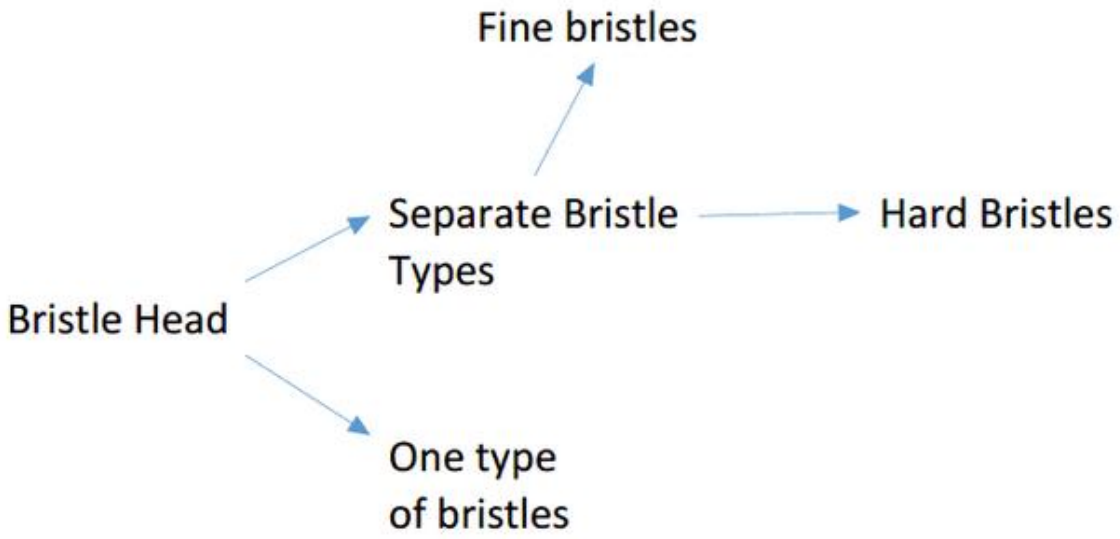


Chart 2. Spin/Vibration Qualities Redesign

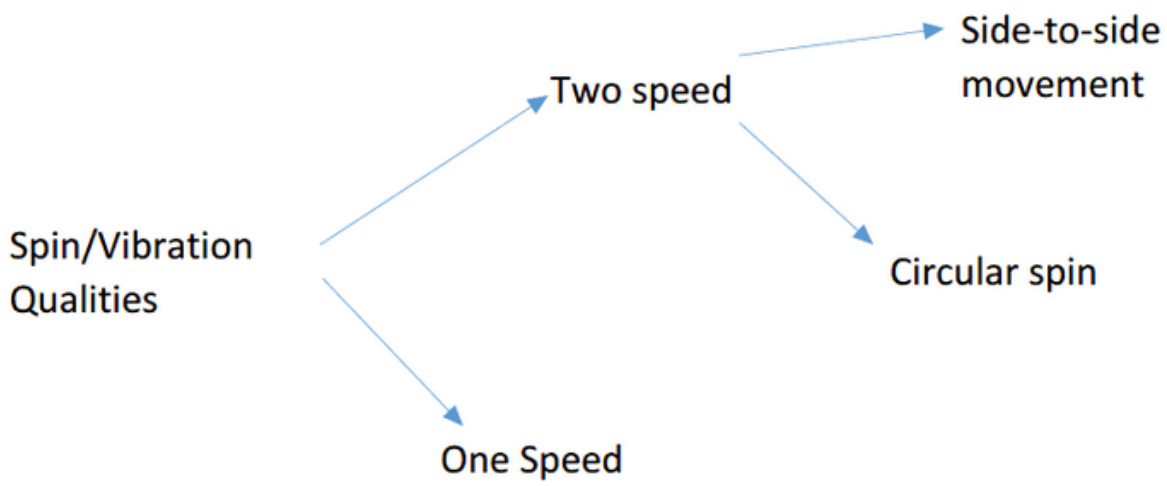


Chart 3. Battery Type Redesign

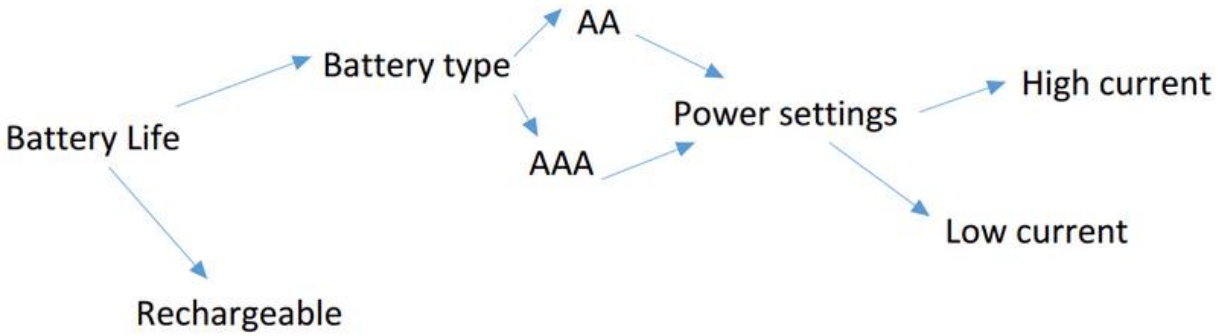
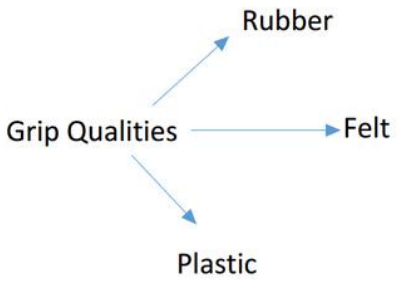
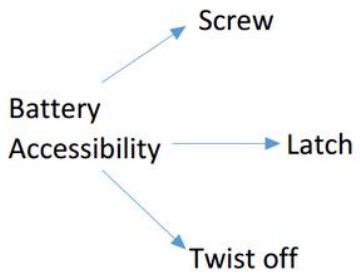


Chart 4. Grip Qualities Redesign & Chart 5. Battery Accessibility Redesign





Each of these tables shows the different problems that we focused on and the different solutions that we came up with to fix our toothbrush. The redesigns we focused on were fixing the head of the electric toothbrush, the type of cleaning that the toothbrush does in terms of movement, the battery life, the grip of the toothbrush, and how accessible the batteries are. We felt these redesigns would work the most effectively with our toothbrush after assessing how our toothbrush performed overall.

4.2 Concept Selection

We selected our designs based off the concepts we generated and that we felt worked best with our toothbrush. Our best concepts will be discussed as redesigns later on in this section.

<u>Bristle Head</u>

Things to consider in redesign:

- Are there different types of bristles on the head? Hard vs. soft? Fine vs. large?
- Is the head replaceable?

The ideal bristle head can efficiently clean, is durable and can be replaced. Looking at customer needs and our sensitivity chart, the bristle head is the most crucial part of the toothbrush. If the toothbrush does not clean plaque efficiently then it will not sell on the market.

<u>Spin/Vibration Qualities</u>

Things to consider in redesign:

- Do certain bristles move at different speed?
- Do bristles vary in direction?
    - Side-to-side? Oscillating? Circular?

For optimal cleaning, the different bristles should move in certain directions. For instance, the heavy bristles could oscillate and the fine bristles could move in a circular motion. A combination of the two speeds and directions would allow for the best cleaning.

Battery Life

Things to consider in redesign:

- Are the batteries rechargeable or replaceable?
- What type of batteries
  - AA or AAA?
  - How is the current through the toothbrush?

For our redesign, obviously we would like to make our battery last as long as possible. Changing from AAA to AA could prove useful, as AA provides more power. The current through the AA battery is greater than the AAA, which leads to a higher power.

Grip Qualities

Things to consider in redesign:

- What material is used for the grip?
  - Rubber?
  - Plastic?
  - Felt?
  - Combination of three?

Grip is important when the toothbrush becomes wet. We want to minimize how slippery the brush will become when affected by water. A combination of the materials would work the best in the redesign. The bigger the brush, the more rubber will be needed to allow for extra support. Felt really isn't necessary, but would look cool.

Battery Accessibility

Things to consider in redesign:

- How do you access the battery compartment?
  - Unscrewing?
  - Using a latch
  - Twist off

The most important things to consider when accessing the battery is how long does it take and does it close water-tight. A latch would most likely be the fastest way to access the batteries and as long as it keeps water out of the batteries it can be utilized.

Selection:

1. Toothbrush with dual head. Two bristle types: fine and hard, as well as two spin types: oscillating and circular motion. The hard bristles will oscillate and the soft will spin.

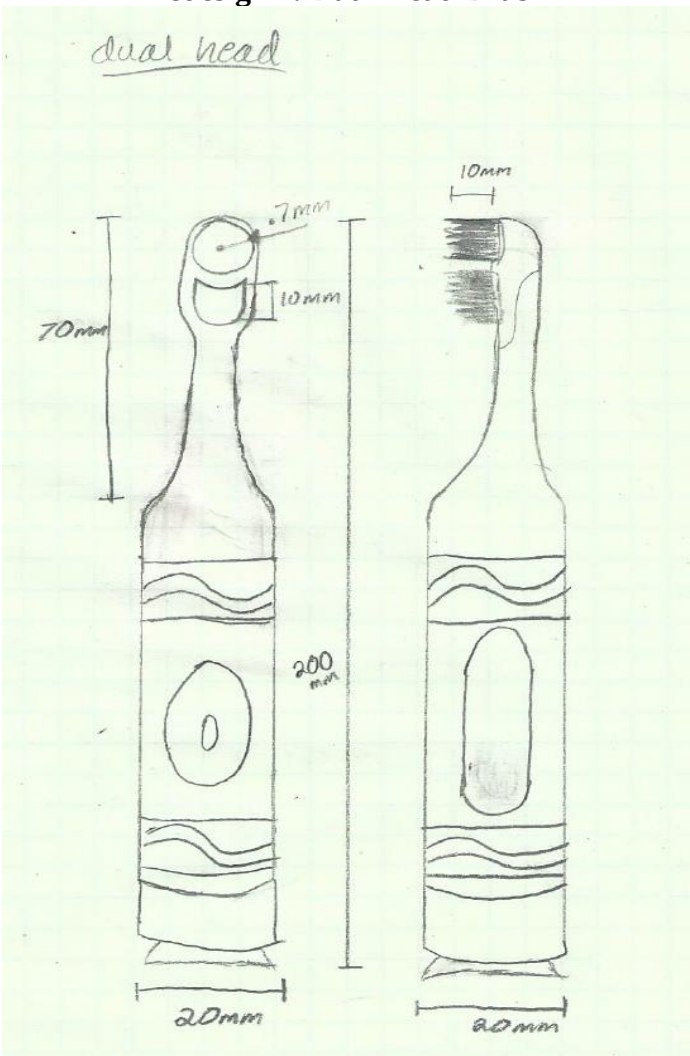
2. Use AA batteries instead of AAA. This means a bigger battery compartment to create better power to the spin. This will require a new shaft and grip. The grip will be composed of more rubber than previously to reduce the slipping from hands.

3. A small toothbrush to reduce materials and thus reduce the cost. Make a small latch accessible battery compartment with AAA batteries. This bristles will be all one type of medium hardness and the grip will be mostly plastic.

5.0 Detailed Design

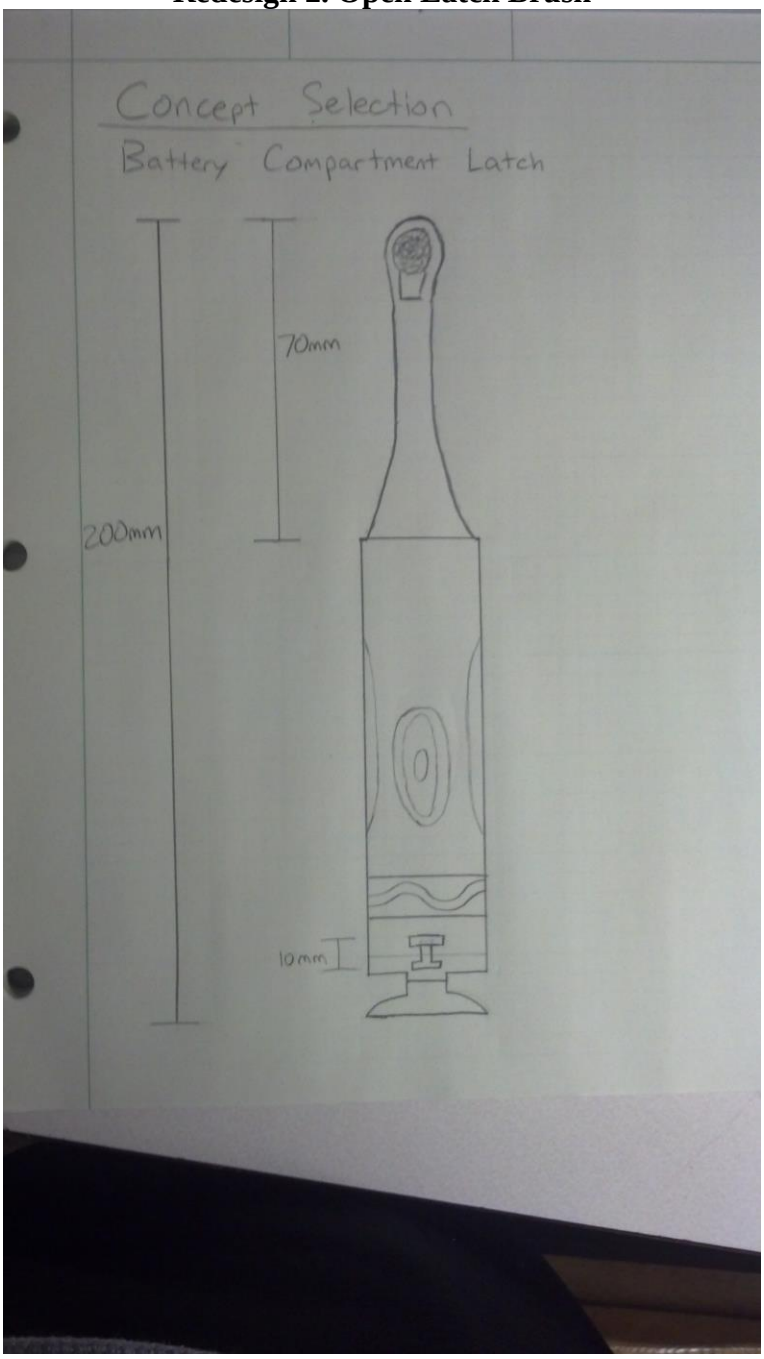
The three redesigns we chose are in Section 4.2. We felt that these redesigns focus on certain aspects that we want most in our final redesign to help make it the best possible product.

Redesign 1. Dual Head Brush



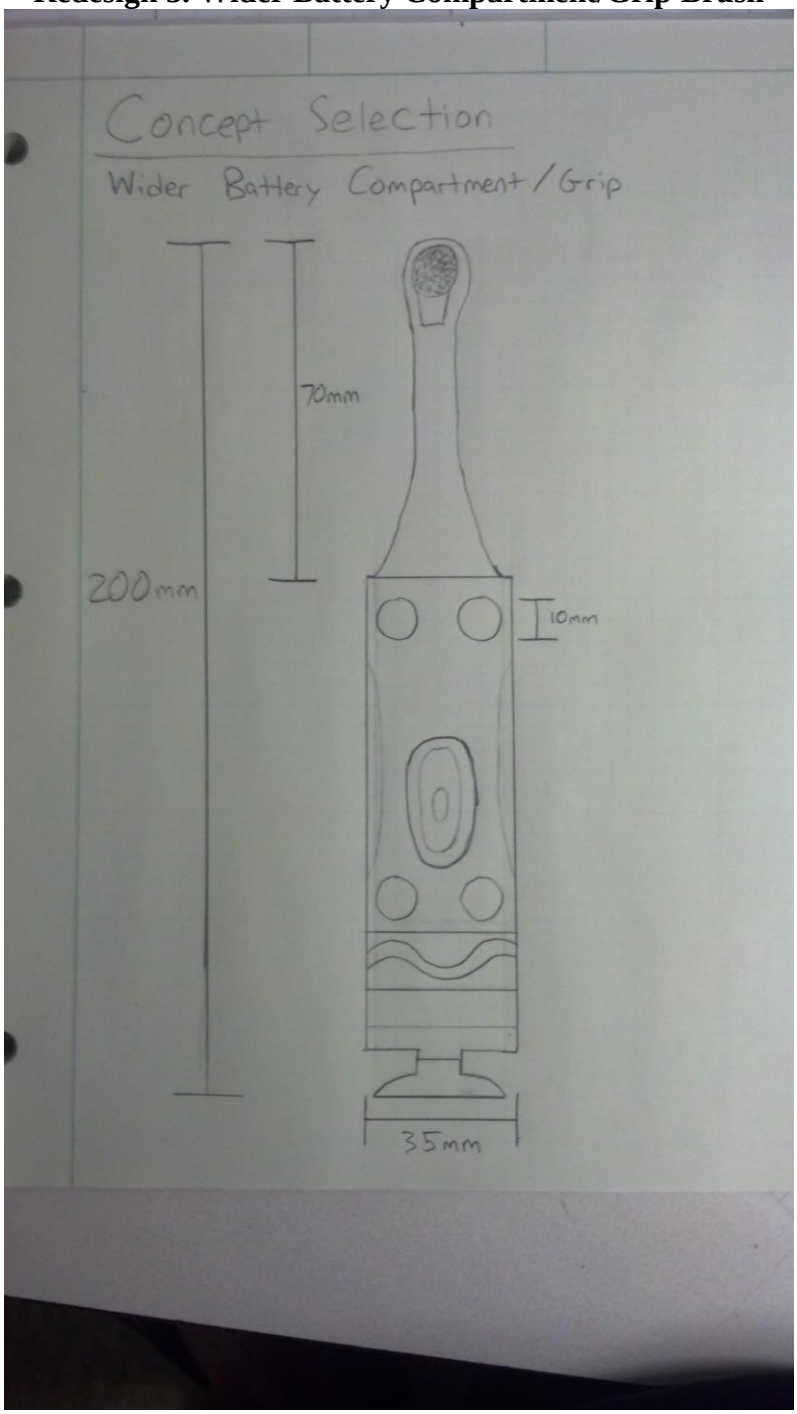
The toothbrush head contains two sets of bristles to help clean efficiently, one set that oscillates and the other that circulates. It also includes a detachable and replaceable head.

Redesign 2. Open Latch Brush



To make batteries more accessible for the consumer, a latch on the side of the handle will allow for quick access to the batteries.

Redesign 3. Wider Battery Compartment/Grip Brush



The toothbrush uses AA batteries instead of AAA which means the batteries will last much longer. The shaft will have to be bigger to hold the batteries, so a more comfortable grip was designed.

These toothbrush redesigns were then ranked the same way that the earlier benchmarking data was collected with scores and weights for each factor.

Table 5. Weighted Scores and Rankings of the Three Redesigns

	Battery accessibility	Battery Life	Cleaning ability	Grip	Bristle Durability	Quietness	Timer	Lightweight	Aesthetics	Cheapness
Dual Head Brush	3	3	5	3	3	3	1	4	5	3
Wider/Grip Brush	3	5	3	4	3	2	1	2	5	2
Open Latch Brush	5	3	4	2	3	3	1	4	5	3

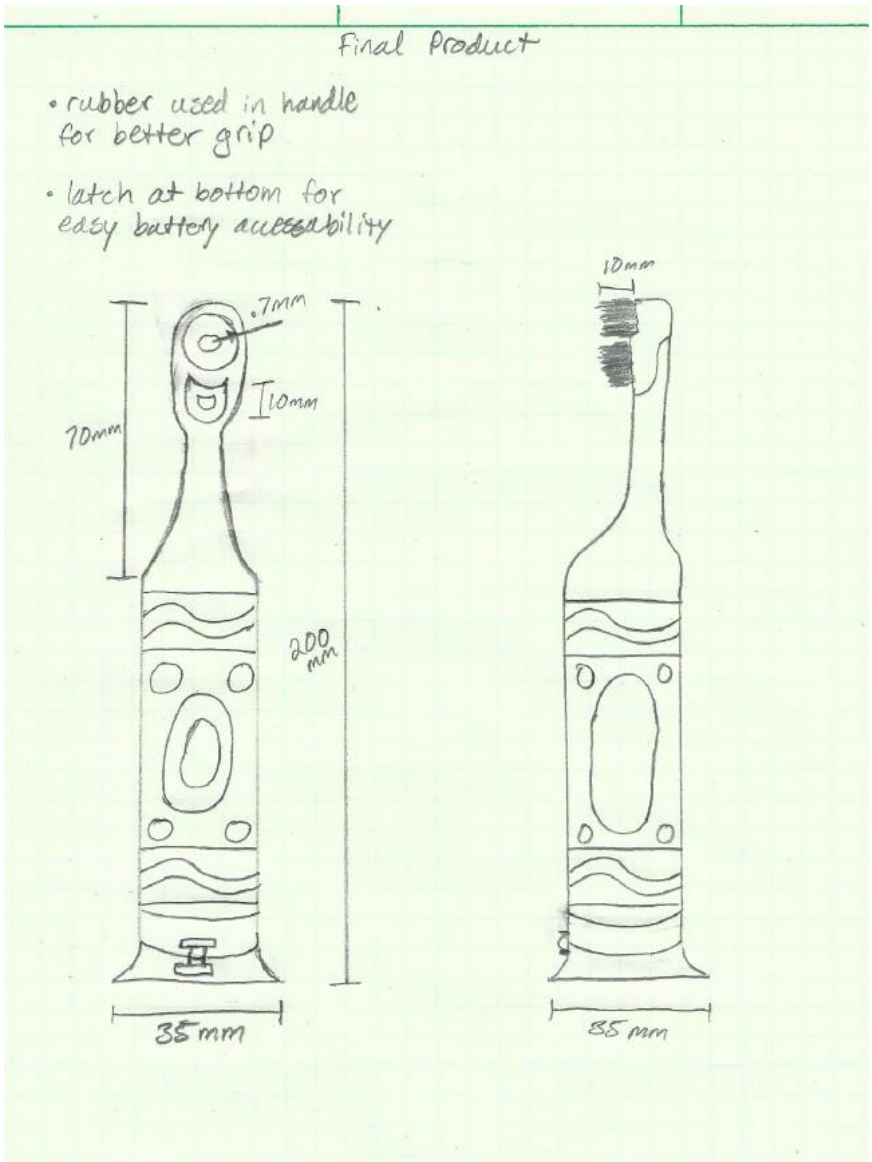
We now compared our redesigns with the same category of needs as before. To see which toothbrush redesign was the most effective, we needed to weigh each category and then sum the result.

	Battery accessibility	Battery Life	Cleaning ability	Grip	Bristle Durability	Quietness	Timer	Lightweight	Aesthetics	Cheapness	
Dual Head Brush	3	3	5	3	3	3	1	4	5	3	
Wider/Grip Brush	3	5	3	4	3	2	1	2	5	2	
Open Latch Brush	5	3	4	2	3	3	1	4	5	3	
											Sum
Sensitivity Rank	5%	12%	30%	10%	10%	5%	3%	8%	2%	15%	
Dual Head Brush	0.15	0.36	1.5	0.3	0.3	0.15	0.03	0.3	0.1	0.45	3.64
Wider/Grip Brush	0.15	0.6	0.9	0.4	0.3	0.1	0.03	0.15	0.1	0.3	3.03
Open Latch Brush	0.25	0.36	1.2	0.2	0.3	0.15	0.03	0.3	0.1	0.45	3.34
Weighted Rankings											
Dual Head Brush	1										

Wider/Grip Brush	3										
Open Latch Brush	2										

After coming up with the rankings for the redesigns, our group decided to drop the third idea of a wider grip brush with new batteries since it was the lowest ranked of the three. For the final design, however; we decided to incorporate the dual head brush qualities along with the latch brush qualities.

Final Design: Dual head and Latch



6.0 Conclusion

The final design of our toothbrush incorporated all the concepts generated based on customer needs, external and internal assessment, and weighing all the last concepts to choose the best few. We believe this redesign will be more successful in the market place meanwhile it will save the producer money. When generating the concepts, we took in to account all important issues a consumer might have with this brand of toothbrush, and improved them to the best of our ability. Through extensive comparison we choose the best features to incorporate and overall created a new product to meet our mission statement.