Electric Toothbrush Redesign

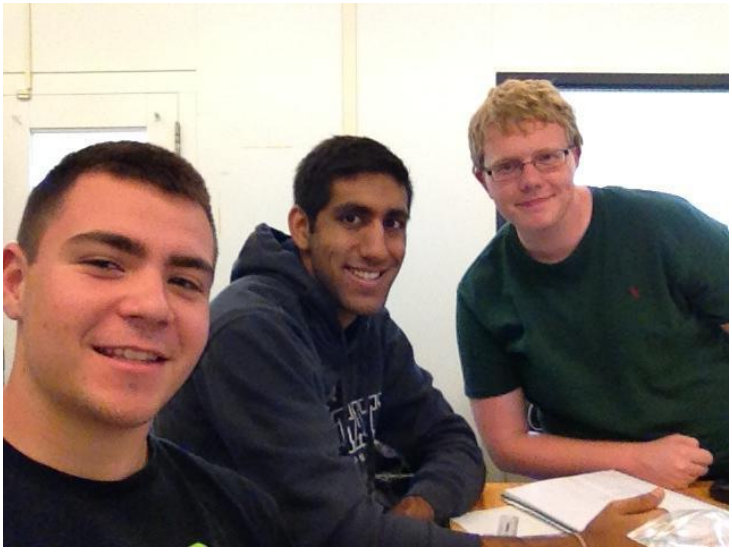
EDSGN 100

Section 024

Team 5

Submitted to Professor Sven Bilen

17 October 2013



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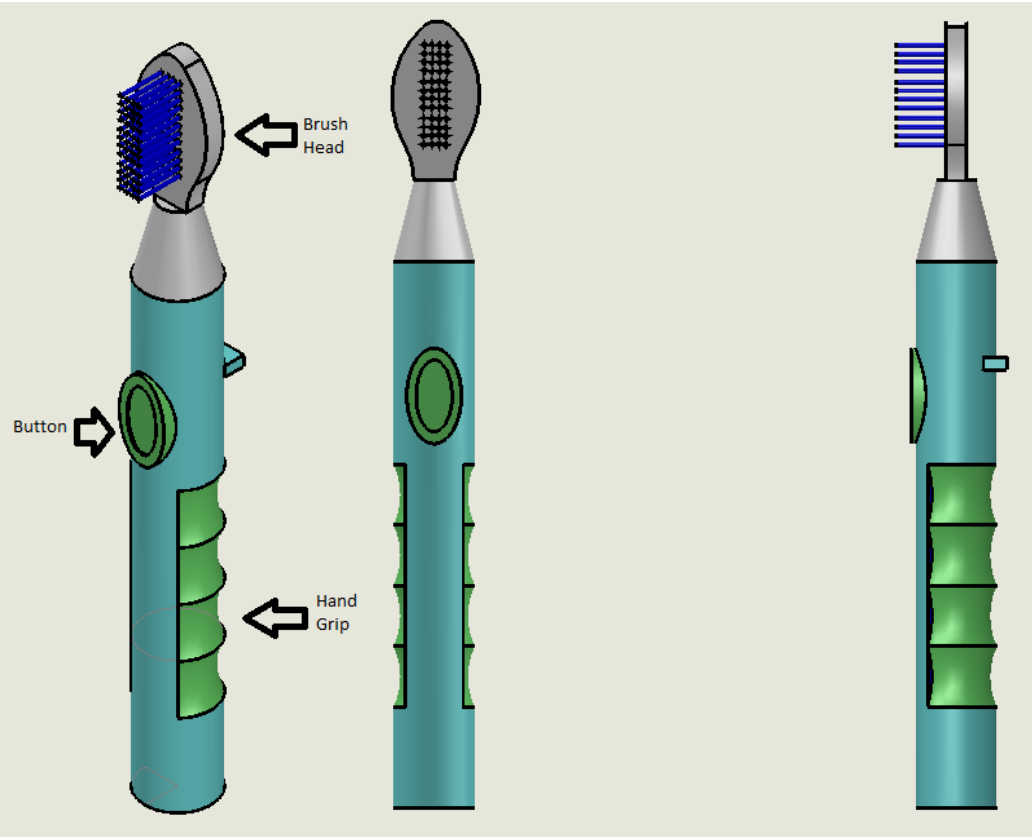
Our Design



The final design of our electric toothbrush has rubber on the button and the finger grips, shown in the picture in green. The entire white section is detachable, allowing other attachments to be added in its place.

Executive Summary

When we first began the project we first laid out a plan of how we would take apart the brush. We did this so we could carefully extract components during the teardown process. We did not damage them in the process so we could examine them later when redesigning the brush. We were very careful in this process which allowed us to reassemble and disassemble it a multitude of times allowing us to fully understand what went in to the toothbrush, and also allowed us to improve on its design. We ultimately redesigned the handle of the toothbrush to be better for the customer.

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1.0 Introduction

Our toothbrush was the UP and UP brand electric toothbrush, this is part of Targets generic version products. It is an oscillating toothbrush with a single double A battery as its power source. The brush is a very simple design that's very powerful and effective.

1.1 Mission Statement

To redesign the electric toothbrush so that the customer is able to use it more effectively.

2.0 Customer Needs Assessment

The most crucial aspect of the redesign was obtaining the customer needs. In order to make a product that sells, one must first know what the consumer wants in a product. The customer needs were assessed in two ways: Polled family members and reading online reviews for various toothbrushes. The demographics for the poll tended to be males and females between early twenties and mid to late teens along with parents aged from late forties to mid-fifties. The online reviews were from a full range of people, but nearly everyone who reviewed a product online tends to have an extreme opinion regarding an item. People who are moderately satisfied and dissatisfied typically do not post online reviews. Only when someone is extremely enthusiastic or dissatisfied with a product do they tend to post online comments. Through these methods of gathering customer needs, we were able to deduce that people, above all, want a toothbrush that has great cleaning power, but also is comfortable and affordable. The full interview script can be found in Appendix A

2.1 Weighting of Customer Needs

While it is important to try and have the toothbrush to best fit the customer needs as possible, a trade off must always be made. To have the toothbrush be more powerful, it must also be louder. To have to optimal toothbrush, we have to take into account the opportunity cost of each item that gets placed in the toothbrush and see which combination results in the best overall toothbrush.

Table 1. Initial Customer Needs List Obtained Individual interviews and online reviews

Affordable
Cleans well
Long lasting/durable
Easy to hold
Aesthesis
Light weight
Portable
Battery easy to replace
Quiet

Table 2. Hierarchal Customer Needs List Obtained from Individual Interviews and online reviews

1. Affordable
F.1 meets a price range of $20.00
4. Easy to hold handle/ grip
2. Cleans well
F.1 Cleans teeth
F.2 Cleans and strengthen gums
3. Long lasting/durable
F.1 Be protected against falling
F.2 Waterproof
5.1 Light weight
F.1 Must also have a worthy grip
5.2 Portable
5. Quiet
6. Battery easy to replace
7. Aesthetics

Table 1 provided numerous answers to what the consumer looked for in a toothbrush, while table 2 broke down the responses into more specific categories. By reading table two, we can see that the consumer looks for approximately seven areas when buying a toothbrush, these areas include being affordable, cleaning well, durable, aesthetically appealing, easy to hold, having the battery easy to replace, and having the toothbrush run quietly. By analyzing what the customer wants and weighing each of the needs we can more accurately makes a toothbrush that satisfies the consumer. Using table 2, we can see that the consumer cares much more about the price of the toothbrush then the look of the toothbrush. Rather than spend money and increase the price of the toothbrush to take it look nice, we know that the consumer would rather buy a less expensive, while less aesthetically appealing, model.

2.2 Revised Problem Statement

After observing what the customer values highest in a toothbrush, it is obvious that items such as affordability and grip are valued much higher than other categories such as aesthetics. Seeing as how the toothbrush already falls below the price point that consumers are willing to pay, the next most important category is the handle, and more specifically the grip. Seeing this, the revised problem state is: To redesign the toothbrush so that the grip is superior and the overall handle is more comfortable to hold.

3.0 External Search

We live in an age of technology. Nearly all the information one could ever need can be found on the internet, so one would be a fool for not using this invaluable tool. There are hundreds of different

kinds of toothbrushes on the market, some with LCDs and others with toothpaste that comes out of a hole in the center of the brush head. To buy each variation of a toothbrush would not only cost excess money, but it would also waste valuable time. Using the internet, we can see what consumers all over the world think about new ideas regarding toothbrushes without ever having to leave our seat.

3.1 Literature Review

While people flock to stores to buy the latest new smartphone or gadget, the same can not be said for toothbrushes. Toothbrushes that have been try to introduce new ideas to the market tend to fail. Even if the reviews are good, such as on Amazon, people don't like the idea of having a lcd on their toothbrush, and therefore the sales of toothbrushes with new concepts are typically low. Rather then spending thousands researching and devolving a new concept for a toothbrush, simply using the internet to see that people don't like the idea of change when regarding a toothbrush can save money, and more importantly, time.

3.2 Patent Search

Various aspects of the redesigned toothbrush have already created utility patents. To avoid copyright infringement, one must give credit to the patent.

Table 3. Art-Function Matrix for Toothbrush

FUNCTION		**ART**	
	Interdental power arm	Rotation driving unit	Partial rubber around handle
Accessory head	US 8522797 B2		
Vibrating Head		WO 2001043586 A1	
Grip			EP 2142139 A1

3.3 Benchmarking

In order to see whether our toothbrush has a chance of selling well in the market, it must first be compared to the competitor's products. If the toothbrush lacks in every area when compared to another toothbrush currently in the market, it is obvious that our toothbrush won't sell as well, and therefore we need go back and rethink some ideas. On the other hand, if the toothbrush outranks all the other competitors, then it is ready to go on the market. This type of test is done by benchmarking the redesigned toothbrush against the competitor's toothbrushes.

Table 4. Benchmarking of Four Products

Feature	Up&Up(Benchmark)	Spin Brush	Colgate 360	G.U.M. /2272R
Packaging	5	2	4	3
Aesthetics	3	5	4	3
Cleaning	5	2	5	3
Convenience of on/off switch	5	5	4	5
Battery location	4	3	3	1
Ease of switch use	3	3	3	3
Handle	2	2	5	3
Quality	3	1	5	3
Safety	2	5	4	4
Attachments	5	1	1	1
Weight with batteries	4	2	2	3
Environmental friendliness	3	2	4	3

3.4 Design Target

The external searched proved to be an invaluable tool in determining what the design target will be. We originally assumed that for the optimal toothbrush redesigned, we would have to completely redesign the toothbrush. After reading about how many companies lost millions of dollars by introducing a unique toothbrush to the market, only to learn that people are not interested in buying a non-typical toothbrush. Using what received positive reviews from other toothbrushes, and seeing what received negative reviews on our toothbrush online, we are now able to confidently implement the best design ideas. Knowing that the grip of the Up & Up was what received the poorest reviews, and seeing that toothbrush grips are very important to the consumer, it is apparent that fixing the grip of our toothbrush is of utmost importance.

3.6 Global Issues

This product should only be sold in developed countries, because most 2nd and third world countries still brush their teeth with natural materials such as twigs and various roots, or often do not brush at all. This toothbrush should also only have a small test launch in some other countries, such as The United Kingdom, because many such countries do not value oral health as much as other nations, and as such do not regularly brush their teeth. Other than those two factors, there is no cultural reason why this toothbrush should not succeed in foreign markets.

3.8 House of Quality

To access the house of quality, please follow this link:

http://www.personal.psu.edu/rwm5541/house.pdf

3.7 Product dissection

Before design concepts can be fully generated, one must break down the toothbrush into the individual components. Seeing as how the interdental power-arm is connected to all accessory heads, changing the structure of this part, would in effect result in a change of nearly all accessories. Dissecting the product allows us to see the function of each component, to see if we can maximize the overall efficiency of the toothbrush.

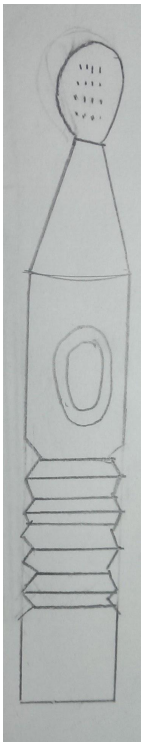
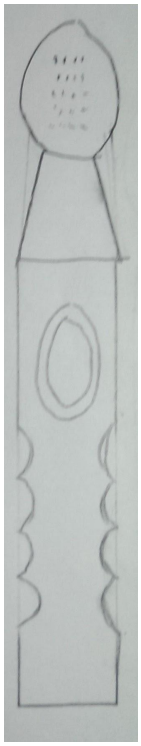
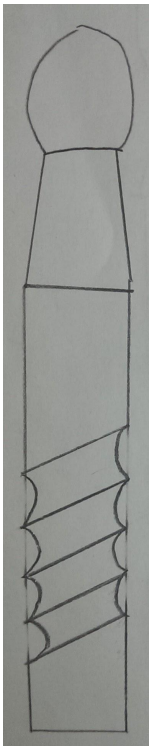
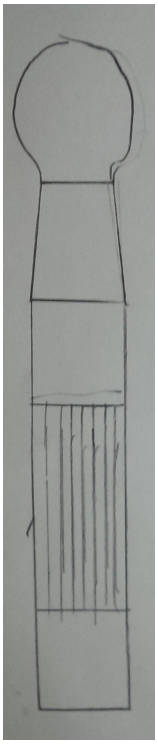
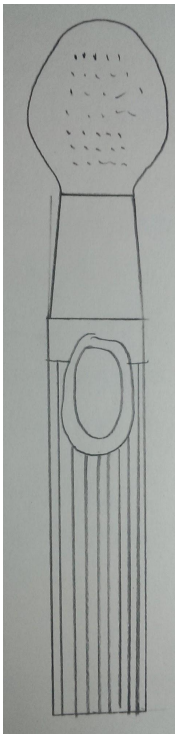
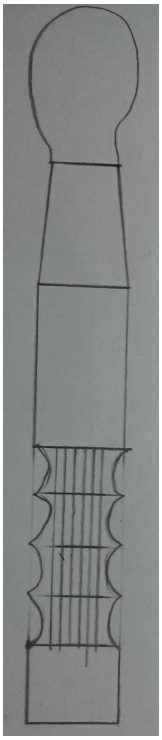
Part	**Description and function**
Replaceable brush head (3)	Vibrating bristles clean teeth
Interdental power arm (1)	Attachable arm used for interdental accessory heads
Floss heads (21)	Floss strings to clean between teeth
Sulcus tips (2)	Plastic bristles used to strength gums
Gum stimulator (1)	Hard plastic cone to remove plaque
Outer Shell (1)	Handle used to grab toothbrush and store internal section. Also has the power switch located in the center
Internal Section (1)	Section holding the motor, switch, circuit, and battery.Has a rod at the top that spins with the motor.
Battery Cover (1)	Twistable cap used to cover the battery while in use

4.0 Internal Search

Within our group, we had various discussions regarding potential modifications to the Up and Up electric toothbrush design to better improve the grip for the use by the consumer. The two main needs that we addressed were the uncomfortable grip of a flat plastic surface, as well as the fact that the brush is very slippery, especially when wet.

4.1 Concept Generation

Our initial IDEO Brainstorm gave us 5 different concepts that all seemed to improve the handle of the brush as it currently existed. These are shown below, with descriptions on the next page. The Morphological Chart can be seen in Appendix B.

1. 
2. 
3. 
4. 
5. 
6. 

1. The addition of ridged texture to the sides of the brush. This would be a minor modification of the shell to essentially remove the smoothness of the sides to increase the friction of the handle. The ridges are achieved by alternating the radius of the outer shell from 1 to .9 6 times along the handle. The image shown is a front view. The ridges go the entire way around the brush.

2. Adding full finger depressions to to the brush. This would consist of four finger sized slots that go three quarters of the way around the circumference of the brush. This would give a more comfortable position for the fingers, as well as reducing the possibility of it slipping away from the fingers. The slots are not present on the front of the brush. The image shown is a front view, showing the visibility of the slots on the sides, but not being present on the front.

3. Having finger depressions that are "handed." What this means is that the slots are angled to facilitate a specific hand (left or right). This increases the comfort compared to the horizontal slots, but limits itself to only right handed individuals. The image shown is a back view to better show the slots. Like concept 2, these slots do not extend to the front, but only the sides and back.

4. Adding a portion of rubber to the back of the brush. This allows the surface of the handle to give somewhat with a cushion effect that is more comfortable to the hand. Rubber also has a very high friction coefficient, and so would improve the grip. The image shown is a rear image. The section with vertical lines is the rubber section. The section is only on the back of the brush, ad as such this design assumes a certain orientation of the brush

5. Adding a full rubber shell on top of the plastic one. This would allow the user to hold the brush in any position without losing the friction of the grip. In the image shown, the section with vertical lines has the rubber shell. Unlike concept 4, this shell goes the entire way around the brush.

6. The concept was not developed at the initial stage. It was developed after comparing the concepts,

which is further detailed in section 4.2. The concept is a combination of 2 and 4. The slots are identical to the ones described in concept 2, however a rubber shell is also along the skin of the finger grip. The image shown is a rear view.

4.2 Concept Selection

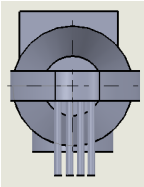
These concepts fell into two main categories. One was a modification of the shape of the shell of the brush in some manner so as to be more comfortable to hold, as well as potentially reducing the slipperiness of the grip. The other category was the addition of a rubber grip to the handle to reduce slipping, as well as giving some flexibility to be more comfortable.

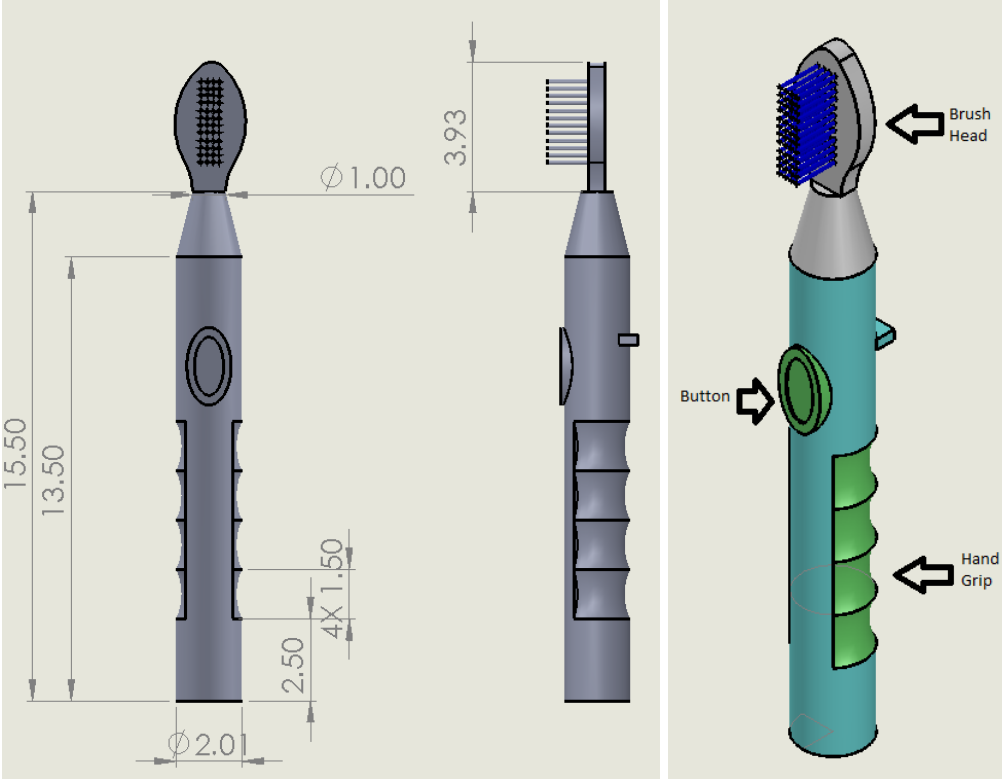
To evaluate the concepts that were generated, Pugh Charts were used to rank the different concepts. The first chart is shown in Appendix C.

From this matrix, it was possible to continue forward and create a new one with the full finger slot and some rubber combined. This concept was then compared with the remaining initial concepts to evaluate it. The resulting Pugh Chart is shown in Appendix C

Through this, we came to the conclusion that the best concept would be the combination of the horizontal finger slots and the sectional rubber.

5.0 Final Design



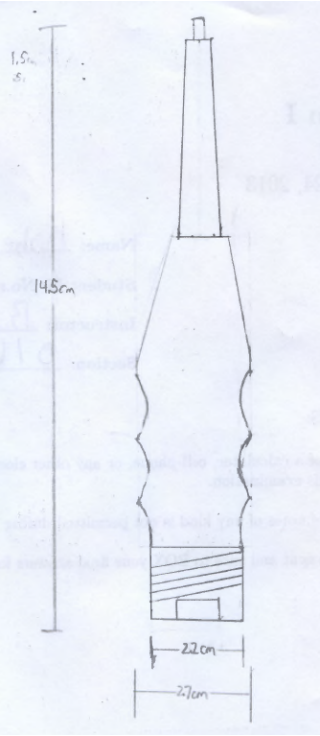


The final design of the brush is shown above. All shown dimensions are in centimeters. The finger slots go three quarters of the way around the circumference of the brush. Each slot is 1.5 centimeters tall and goes into the shell approximately .25 centimeters deep into the shell. The slots also have a rubber layer on top of the plastic. In the isometric image, any section that is light green has a layer of rubber on top of it.

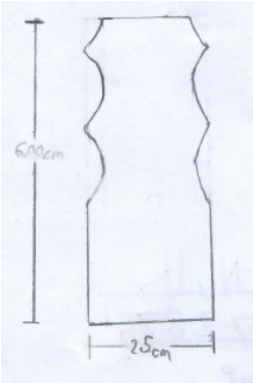
5.1 Design Drawings

All of the following dimensions are in centimeters.

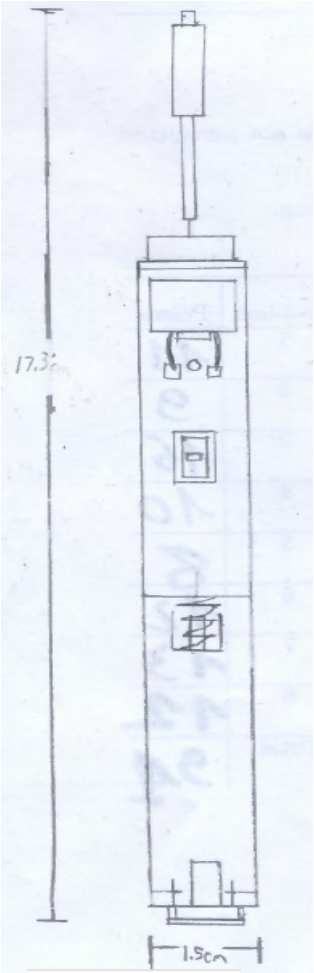
:



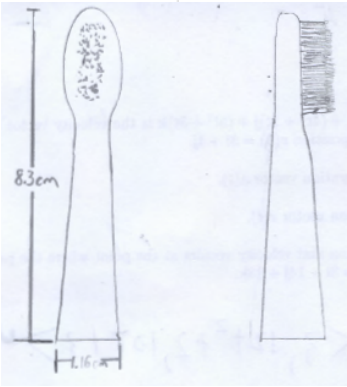
Outer Shell



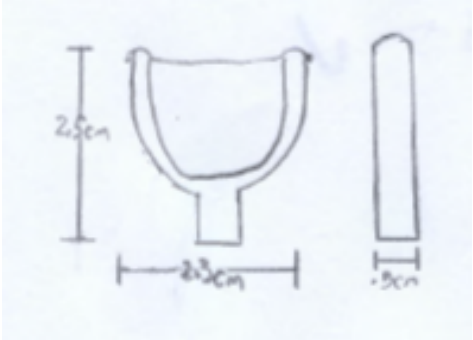
Battery Cover



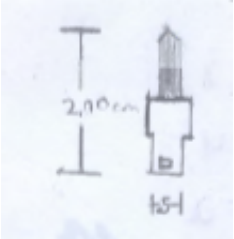
Internal Mechanism



Brush Head



Floss Head



Gum Stimulator

5.2 Bill of Materials

Number	Name	Qty	Function	Mass (grams)	Material	Dimensions (cm)	Cost ($)
1	Brush Head	4	vibrates at top of devices to rub bristles against teeth	4.55	Plastic and nylon bristles	8.2x1.54	0.90
2	Outer Shell	1	protects the internal mechanism as well as being a handle	8	molded plastic with rubber insert	13.5x2	0.10
3	Spin Rod	1	Is spun by the motor within the shell to vibrate the attachment	2	Metal and Plastic	3x.1	0.25
4	Motor with circuit	1	A circuit powered by a battery powers a motor that spins the Spin Rod. There is a simple switch in the center	5	wire, motor, and simple metal	1x2	0.15
5	Inner Shell	1	Holds the battery, motor, circuit, and spin rod within the batter	5	molded plastic	1.5x10	0.10
6	Power Arm	1	Attaches on top of device to vibrate a variety of tools	3.55	2 pieces of molded plastic snapped together	6.4x1.5	0.07
7	Floss Head	21	Goes onto power arm to rub in between teeth for cleaning	.4	molded plastic and nylon	2.2x2.6	0.10
8	Sulcus Tips	2	goes onto power arm for specific cleaning	<.01	Molded Plastic	1.8x.7	0.07
9	Gum Stimulator	1	Goes onto Power arm to vibrate and stimulate gums	<.01	Molded Plastic, Rubber	2.3x.5	0.05
10	Battery Cover	1	completes outer shell at bottom, allows battery removal/installation	3	molded plastic	4x2	0.07

5.3 Instructions for Assembly

1. Snap motor into the inner shell

2. Solder wires onto motor, switch, and battery slot

3. Slide the total internal mechanism into the outer shell, lining the two protrusions at the back of the battery slot with the slots on the shell

4. Twist the battery cap onto the bottom.

5. Place a brush head onto the top of the shell, and lock into place by turning the head clockwise.

5.4 Improvements of the Design

The modified design has two main benefits over the original. These are the finger depressions and the rubber coating. The finger depressions give the hand that is holding the brush a specific place to rest. This is more comfortable that holding onto a flat surface, since it now matches the contours of the human hand. This modification also prevents slipping, since the ridges between the depressions are more difficult to slip past. The rubber insert goes right into the finger area. Rubber is much more flexible than plastic, and as such it will "give" slightly to the pressure of the grip. This is much more comfortable to hold, since there is not a hard plastic surface pressing against the skin. The rubber also greatly reduces the chance of slipping, since rubber has a very high coefficient of friction.

6.0 Conclusion

The final design of the toothbrush is completely different then what the original idea of the toothbrush redesign. Through interviewing customers, and researching online reviews we determined that the grip, not the price, was the real problem. No single redesign concept was prevalent in the redesign; it was a combination of multiple redesign ideas that resulted in the final product. The product

meets all customer needs, and also it still falls in a reasonable price range of under twenty dollars. The most unique feature added to the design is the multi-grip handle; the back of the toothbrush has rubber coated finger depressions which allow for a comfortable, yet stable grip.

References

. N.p.. Web. 17 Oct 2013. <http://www.target.com/p/brushpoint-rechargeable-oral-care-system/-/A-14129553

. N.p.. Web. 17 Oct 2013. <http://www.amazon.com/dp/B00EXJ5DA6?psc=1>.

Appendix A: Customer Needs Interview Script

The following questions were asked of the 5 individuals:

1. Do you like how your current toothbrush feels in your hand? If not, what would you change?

2. How wet are your hands when you brush? Do you often find your grip slipping?

3. How often do you drop your toothbrush?

4. What do you want your toothbrush to do in addition to cleaning your teeth?

5. How easy do you find it to clean your toothbrush when necessary?\

6. How much would you pay for a decent electric toothbrush?

Here are each individuals responses. Note that most have been shortened to have the main point of their response

Person 1

1. It mostly feels good, also it kind of hurts to hold it for a long time. I would change the handle to fit my hand better.

2. My hands are fairly dry. I brush when I wake up and before I shower in the evening. My grip is

sometimes a little slippery, but I am happy with it.

3. Maybe once a week.

4. I don't need any of that other stuff. If I wanted that I would buy a thing for it.

5. I just let it soak in a glass of water and then scrub it with a washcloth. No real problems.

6. Maybe $20 if it looks good.

Person 2

1. Oh I hate it. My hands are too big for the thin thing. I wish it had a bit more width, so my hand could actually hold on comfortably

2. In the morning I brush right after I shower, so they are very wet, but in the evening they are dry. I never really notice my grip slipping

3. About once a month

4. I wish I could put some floss thing on the end. I hate sticking my fingers in my mouth to floss.

5. I tried a few times, but it is just so much effort that I usually avoid it.

6. $25

Person 3

1. Yeah, I like it. I wouldn't change the shape really

2. My hands are wet all the time when I brush. My grip often slips around on the brush.

3. All the time, probably every other day.

4. Nothing really. Works fine as it is.

5. Do people clean their toothbrush? I just change the head and put a new one on if it gets really gross.

6. No more than $20

Person 4

1. I don't like it. Its too hard. I was it to be a bit flexible. The plastic shell hurts my hands when I apply pressure.

2. My hands are wet when I brush. My grip is terrible all of the time.

3. Every week just about

4. I wish I could clean my tongue with it, my old one did but this one doesn't have the thing.

5. I don't clean it.

6. I'd go as far as $30

Person 5

1. The sides of my brush are too smooth. My hands aren't smooth, I need some sort of texture. I want my hands to fit onto it, not grasp it.

2. My hands are dry. My grip sometimes slips around.

3. Every month or so

4. Brushing my teeth is just fine

5. I just soak it and scrub it. Isn't much trouble at all.

6. $20

Appendix B: Morphological Table

Means	Function	Concept
modifying the surface of the shell	Modify texture of brush	Add ridges to to the shell
modifying the shape of the shell	Allow for a different grip of the brush	Adding finger slots
		Adding "handed" slots
Adding a layer of new material, such as rubber, to the shell	Change the material of the brush	Adding some rubber to the back
		Adding rubber to all sides of the brush

Appendix C: Pugh Charts

Pugh Chart 1: Initial Concept Selection

		Original		Ridges		Full Finger slot		Handed Slots		Some Rubber		Lots of Rubber	
Selection Criteria	Weight	Rating	Weighted Score	Rating	Weighted Score	Rating	Weighted Score	Rating	Weighted Score	Rating	Weighted Score	Rating	Weighted Score
Comfort of grip	20%	2	0.4	3	0.6	4	0.8	4	0.8	2	0.4	3	0.6
Slickness when dry	20%	2	0.4	3	0.6	4	0.8	4	0.8	5	1	5	1
slickness when wet	30%	1	0.3	2	0.6	3	0.9	3	0.9	4	1.2	4	1.2
universitality	10%	5	0.5	5	0.5	4	0.4	1	0.1	5	0.5	5	0.5
cost	20%	5	1	5	1	4	0.8	4	0.8	3	0.6	1	0.2
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			0		0		0		0		0		0
			0		0		0		0		0		0
			0		0		0		0		0		0
			0		0		0		0		0		0
	Total Score	2.60		3.30		3.70		3.40		3.70		3.50	
	Rank	6		5		1		4		1		3	
	Continue?	No		No		Yes		No		Yes		Yes	

Pugh Chart 2: Revised selection

		Full Finger slot		Some Rubber		Lots of Rubber		New Combo	
Selection Criteria	Weight	Rating	Weighted Score	Rating	Weighted Score	Rating	Weighted Score	Rating	Weighted Score
Comfort of grip	20%	3	0.6	3	0.6	3	0.6	5	1
Slickness when dry	20%	4	0.8	5	1	5	1	5	1
slickness when wet	30%	3	0.9	4	1.2	4	1.2	4	1.2
universitality	10%	4	0.4	5	0.5	5	0.5	5	0.5
cost	20%	4	0.8	3	0.6	1	0.2	3	0.6
			0		0		0		0
			0		0		0		0
			0		0		0		0
			0		0		0		0
			0		0		0		0
	Total Score	3.50		3.90		3.50		4.30	
	Rank	3		2		3		1	