Toothbrush Redesign

EDSGN 100 - Section 24
Team 1 - 10/18/13

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Executive Summary

This report presents the redesign of an Oral B Type 3744 electric toothbrush. The original design featured a large plastic case, a moderately heavy motor, and a 2-minute timer. Our redesign focused on creating a lighter and more cost effective product. By removing the timer, using a smaller motor, and utilizing only one battery, we have effectively reduced the weight of our product.

Toothbrush Redesign

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1.0 Introduction

The goal of our redesign is to provide the consumer with a more ergonomic toothbrush and to reduce the mass of the product to ensure a more comfortable experience.

We began our project with an analysis of our toothbrush. We took measurements on power, vibration noise, vibration frequency, voltage output, and weight. Recording these measurements, we benchmarked them against eight similar toothbrushes.

The problem for our redesign project centered around size and weight. In order to figure out a solution to the problem, we began with a dissection of our toothbrush. Using a dremel, we cut the toothbrush apart in order to see the different parts. The major issues were a heavy plastic body, a large motor, a two-minute timer, and two AA batteries in series.

This report expands on the customer needs assessment, external research, and concept generation and selection that went into redesigning our electric toothbrush.

1.1 Initial Problem Statement

Our toothbrush needs to be redesigned for the purpose of our choice.

2.0 Customer Needs Assessment

The consumer needs were very elaborately collected through different methods of sampling that minimized the sampling and non sampling biases so the sample size could include the most accurate account of toothbrush consumer needs of Penn State University, University Park students and staff members. The age range was between 18 and 56 and included both men and women.

The first method that was utilized was systematic sampling. Systematic sampling is a method of selecting sample units using a fixed interval of selection. We began by dispersing ourselves at different locations throughout the campus. We located one team member each at the HUB, Pollock Commons Building, Pollock and Mifflin Road intersection, and White Building. Each of us selected approximately every twentieth person that walked on the path by our work station and followed our script and questioned them appropriately. This method minimized volunteer bias because we selected the sample size and it's harder to have non response bias.

The second method we used was simple random sampling. We began this method by generating a list of all of the room numbers in Mifflin, Hartranft, and Stuart Halls. Then we used a random number generator to select 20 rooms so the sample size was sufficient. Once the room numbers were selected, we knocked on the subject's room and followed our script and questioned them appropriately. The problem we faced with this method was that some subjects did not respond when their door was knocked on. This required us to reselect another number to find another subject. The sample script is located below.

Questioning Locations:
Charles: Pollock-Mifflin Intersection
Franz: Pollock Commons
Ian: White Building
Zach: HUB
Ask about every 20th person until sample size has been reached
Introduction:

- What are qualities that you look for when you purchase a toothbrush?
- What is the number one important quality you want in your toothbrush?
- What toothbrush do you use and why?
- Out of the following, what top three characteristics do you look for most in your brush.
  - Brush Size
  - Design
  - Lightweight
  - Grip
  - Body Size
  - Battery Life
  - Cost

2.1 Weighting of Customer Needs

It is key to properly organize and weigh customer needs. This ensures that the proper amount of attention is given to each need according to its importance. We weighed them according to number of times that need was mentioned as top in our surveys. Each percentage represents how many times the need was considered most important out of a count of fifty interviews.

Table 1 Initial Customer Needs List

Lightweight- 26%
Cost- 20%
Smaller body- 18%
Long battery life- 14%
Better grip- 10%
Smaller brush head- 8%
Cool design- 4%

Table 2 Hierarchy List of Customer Needs with Descriptions

1. Lightweight 1.1 More ergonomic 1.2 Less plastic is used
2. Cost 2.1 Cheaper to buy 2.2 Parts must be less expensive to buy and assemble
3. Smaller body 3.1 Easier to handle 3.2 Easier to maneuver when being used
4. Long battery life 4.1 More efficient system 4.2 Requires less battery disposal
5. Better grip 5.1 Won't fall when being used 5.2 More comfortable usage
6. Smaller brush head 6.1 Can access smaller crevices easier 6.2 Teeth get cleaner
7. Cool design 7.1 Make customers more interested to purchase brush 7.2 Maximum profit can be achieved easier

Making our toothbrush design lightweight was our number one priority because it accomplishes many things. First of all, we wanted to decrease the motor size which also only requires one battery to operate. This makes the brush itself easier to handle because it will be smaller while being lightweight. It also decreases the amount of plastic used which will save money and reduce the footprint on the environment because more toothbrushes can be created with the same amount of plastic in theory. This also relates to our second highest priority, cost.

Reducing the amount of plastic and size of the brush will make the toothbrush more cost effective. If a consumer can buy a better brush for a cheaper cost, the demand will increase on the market and this will maximize our profit. Each individual part must be purchased at a cheaper price for our company to be able to make a maximum profit on the brush.

Making the brush more energy efficient is also a necessity especially if we want to only have one battery in the shell. This will make it so the consumer will not have to change the battery as frequently and this will save them money overtime. This is a motive for the consumer to purchase a more cost effective toothbrush.

A smaller toothbrush body will make the brush easier to handle and more pleasurable to use while in usage. The maneuvers required to brush one's teeth will also become much easier which will make the consumer want to buy the brush and recommend it to more potential purchasers.

A better grip on the brush will also increase the comfort and brushing experience of the consumer. This will make it so that the brush is dropped less often and it can be rotated easier. A thin rubber casing will be added around the plastic shell so that even when the brush becomes wet, it will not be slippery.

A smaller brush head will make it so that the multitude of small crevices in the users mouth can be accessed easier so a cleaner mouth can be attained. If the consumer sees results with this brush when it has a smaller head, demand will increase and so will toothbrush sales.

A cool design will improve the form of the product but it does not affect the function of the toothbrush. This is last on the list of priorities because the brush must work properly before a nice design can be added. However, it is important for sales because certain age groups value the actual functionality of the brush (e.g. children) and want their brush to look nice or have their favorite television character on it.

3.0 External Research

External research was conducted in order to gain insight on the original toothbrush. Information was gained through the use of a Bill of Materials, benchmarking, patent research, as well as a product dissection.

3.0.1 Bill of Materials

Table 3: Bill of Materials of Original Toothbrush

Part #	Part Name	QTY	SOP Effect	Function	Mass (g)	Material	Manuf. Process	Dimensions (cm)	Cost
1	Motor	1	No	spins the brush head	32.66g	plastic, metal	metal assembly	5x2x1.5	≈$1.00
2	Brush head	1	Yes	moves bristles to brush	3.63g	plastic	assembly line	5.5x2x1	≈$14.95
3	Battery case	1	No	holds battery	4.54g	plastic	assembly line	3.5x2.5x2.5	<$.10
4	AA battery	2	No	powers motor	47.17g	steel, conducting	assembly line	5x1.5x1.5	≈$3.50

						metal			
5	Metal rod	1	Yes	pops off battery case	.91g	metal	assembly line	4x(1x1)mm	<$.10
6	Circuit board + spinning rod	1	No	controls motor	7.26g	plastic, metal	assembly line	11x1.5x1	≈$2.00

3.0.2 Internet Sources:

www.walmart.com
www.amazon.com
www.google.com

3.1.3 Patent Sources:

https://www.google.com/patents/US8479341?dq=electric+toothbrush&hl=en&sa=X&ei=14dkUrQclMjgA47MgPAJ&sqi=2&pjf=1&ved=0CDcQ6AEwAA#backward-citations

3.1 Patent Search

Table 4: Patent Search

Cited Patent	Patent Date	Publication Date	Applicant	Title
US7464430	Jan 3, 2006	Dec 16, 2008	Ehsan Filsouf	Electric Toothbrush
US20060037197	Aug 12, 2005	Feb 23, 2006	Hawes Christopher M	Hand held appliances
US20080280248	Sep 30, 2005	Nov 13, 2008	Idmos Plc	Dental Electrode Assembly
US20090130636	Jun 19, 2006	Apr 9, 2009	Xiusolution Co., Ltd.	Method and system for managing oral hygiene

3.2 Benchmarking

Measurements on weight, power, battery life, sound, and oscillation frequency were recorded for our toothbrush. Scales, tachometers, multimeters, and decibel meters were used in these measurements. As shown in figure 2, a benchmark was done against eight competitor toothbrushes, based on the recorded measurements.

Table 5: Toothbrush Benchmarking

		Toothbrushes															
		A (reference)		B		C		D		E		E		E		E	
		Oral B		Target		Spin Brush		Colgate OW		G.U.M		A&H		Bulsar		Colgate NAE	
Benchmark Criteria	Weight	Rating	Weighted Score	Rating	Weighted Score	Rating	Weighted Score	Rating	Weighted Score	Rating	Weighted Score	Rating	Weighted Score	Rating	Weighted Score	Rating	Weighted Score
Weight	30%	2	0.6	4	1.2	4	1.2	3	0.9	3	0.9	3	0.9	5	1.5	3	0.9
Power	20%	5	1	2	0.4	4	0.8	4	0.8	3	0.6	3	0.6	2	0.4	2	0.4
Battery Life	10%	3	0.3	5	0.5	1	0.1	3	0.3	4	0.4	2	0.2	3	0.3	3	0.3
Sound	20%	2	0.4	4	0.8	3	0.6	5	1	2	0.4	3	0.6	4	0.8	4	0.8
Oscillation Freq.	20%	4	0.8	5	1	3	0.6	5	1	2	0.4	3	0.6	3	0.6	3	0.6
			0		0		0		0		0		0		0		0
			0		0		0		0		0		0		0		0
			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	3.10		3.90		3.30		4.00		2.70		2.90		3.60		3.00	
	Rank	2		3		1		4		6		4		5		6	

3.3 Product Dissection

In order to determine how our toothbrush currently works and what parts are essential to the design of the product, we performed a product dissection. Using a dremel saw, we cut apart our toothbrush into its basic components. As seen in figure 3, the basic components include: two AA batteries, a detachable head, plastic body, a motor, a circuit board, and a removable battery case.

Figure 3: Product Dissection

3.4 Product Target

Using what we learned from the external search, we determined the target market of our redesign to be nearly all ages.

4.0 Internal Search

The internal search includes how we generated and selected concepts.
We used creativity techniques from Mycoted to help us generate concepts. We used a Pugh chart and decisioning to pick from our list of concepts.

4.1 Concept Generation

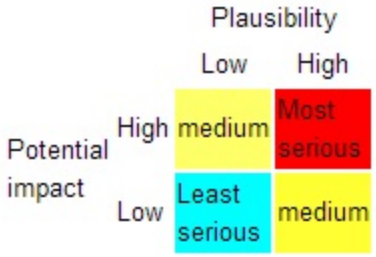
To generate concepts, we used three different professional brainstorming methods. We researched methods individually to find ones we found appropriate. The source of our research is www.mycoted.com. From this site, we looked through a large list of brainstorming methods and read many examples to make our choices. Our methods are “Circle Time”, “5 W’s and an H”, and “Assumption Surfacing”.

Circle time refers to any moment that a group of people are together for an activity that involves everyone and makes sure to never exclude anyone. Circle time is also called group time. Mycoted’s “Circle Time” is a method with a particular procedure that mainly involves sitting in a circle in chairs or on cushions and using an object that signifies the holder’s ability to speak without interruption. For our project, the speaker shared their idea for a concept to solve the weight and size problem with our toothbrush. No negative feedback was allowed in response to the speaker’s concept idea. This promoted idea production without fear of judgement to make sure that every concept thought of was spoken and heard.

“5 W’s and an H” is a simple method that asks each participant six questions. The questions are,

“Who?”, “Why?”, “What?”, “Where?”, “When?”, “How?”. Each participant generates an idea and explains the details by answering these questions. The questions are meant to be like a checklist used to verify your idea to be worth mentioning.

“Assumption Surfacing” is a technique used to make assumptions more clear. Users go through an ordered procedure to understand which assumptions need to be taken more seriously. First, we picked a choice made and asked ourselves why we feel it’s for the best. Next, we listed the assumptions that we felt guided that choice and created a counter-assumption for each. Then, we went down the list and removed any assumptions we felt were ineffective when matched with a counter-assumption. After that, we evaluated each of the remaining assumptions in terms of high or low potential impact and plausibility. Lastly, we plotted the assumptions like so:

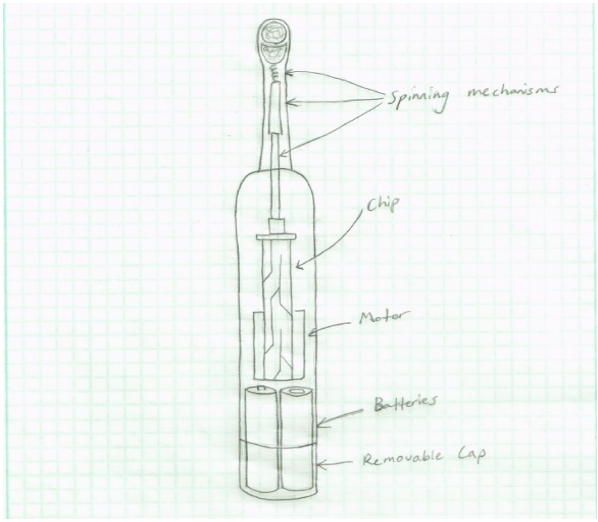
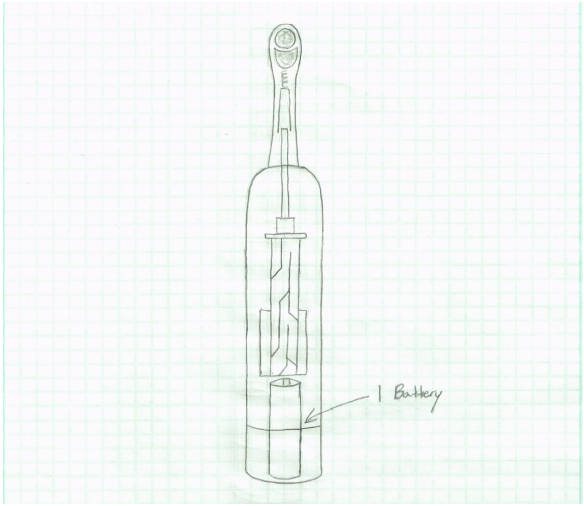
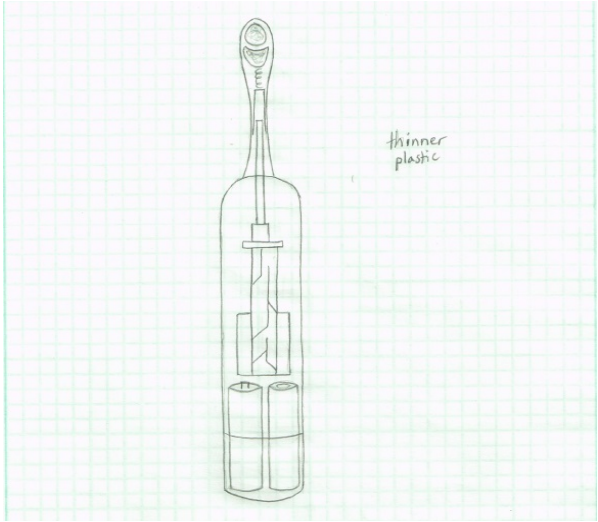


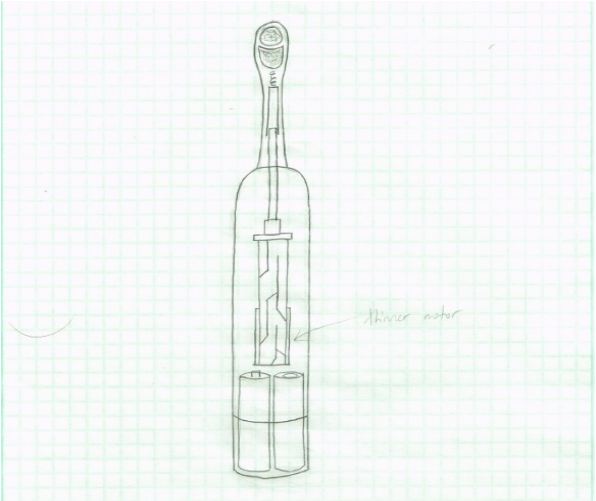
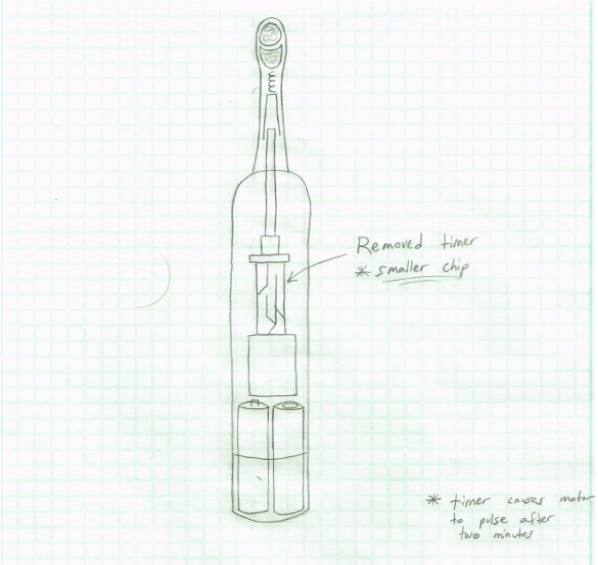
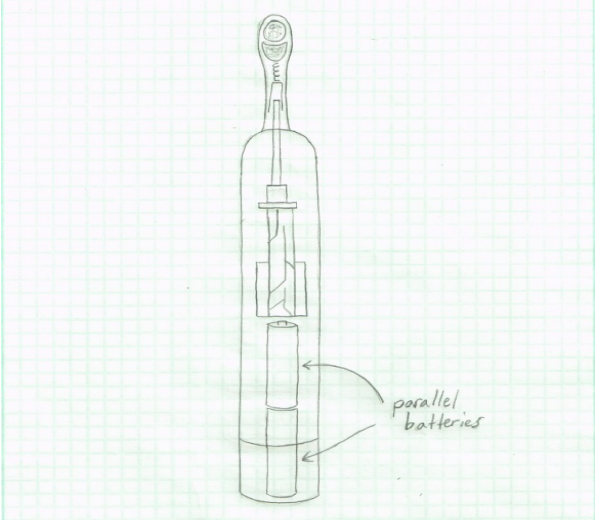
(This image is an example from www.mycoted.com/Assumption_Surfacing.)

This showed us which assumptions are the most/least serious and which are more/less important to be evaluated further, respectively.

These techniques were valuable for helping us create and judge our concepts. Through these methods, we created five concepts for our weight and size problem. They each provide a similar solution but have widely varying costs. These costs are discussed and evaluated in our concept selection section.

Table 6: Concept Generation

Original	
1 Battery	
Thinner Plastic	

Small Motor	
Remove Timer	
Parallel Batteries	

4.2 Concept Selection

We used a pre-made Pugh chart to help us decide which concepts would best solve our problem. Our criteria is composed of details that are related to our problem. They are specifications that all generally wanted to be low in quantity. These specifications are weighted based on our order of consumer needs.

Table 7: Concept Selection

		Concepts															
		A		B		C		D		E		F		G		E	
		Original		1 Battery		Thinner Plastic		Smaller Motor		Remove Timer		Parallel Batteries		(blank)		(blank)	
Selection Criteria	Weight	Rating	Weighted Score	Rating	Weighted Score	Rating	Weighted Score	Rating	Weighted Score	Rating	Weighted Score	Rating	Weighted Score	Rating	Weighted Score	Rating	Weighted Score
Weight	30%	5	1.5	7	2.1	6	1.8	7	2.1	5	1.5	5	1.5		0		0
Width (base)	20%	5	1	7	1.4	5	1	5	1	5	1	7	1.4		0		0
Length	10%	5	0.5	5	0.5	5	0.5	6	0.6	7	0.7	3	0.3		0		0
Cost	30%	5	1.5	6	1.8	4	1.2	3	0.9	8	2.4	5	1.5		0		0
Pieces	20%	5	1	7	1.4	5	1	5	1	5	1	6	1.2		0		0
			0		0		0		0		0		0		0		0
			0		0		0		0		0		0		0		0
			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	5.50		7.20		5.50		5.60		6.60		5.90		0.00		0.00	
	Rank	5		1		5		4		2		3					
	Continue?	No		Yes		No		Yes		Yes		No		No		No	

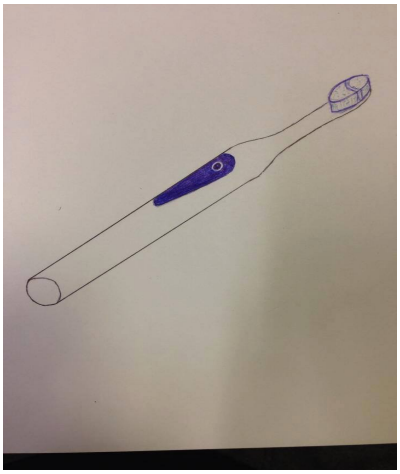
We used the Total Score to determine which concepts would be best. Through our results, we determined the ideal concepts to use are 1 battery, remove timer, and smaller motor.

5.0 Final Design

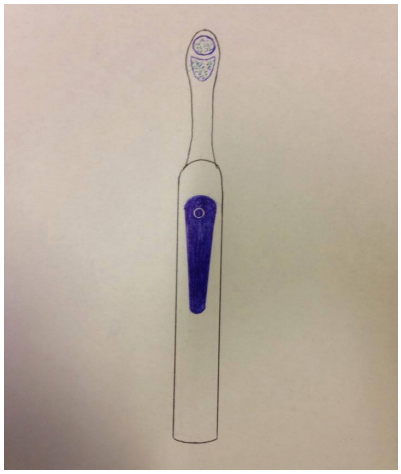
The final design for our project is a combination of three of our design concepts. We removed one AA battery, used a smaller motor, and removed the timer to make the chip smaller and cheaper. This allowed for a significant drop in the weight, size, and predicted cost of our product. Our design still utilizes a push-to-activate button, as well as a detachable head. In order to accommodate the single AA battery, a sliding compartment has been created on the underside of the toothbrush body. This also saves money on production by taking away the detachable battery case.

5.1 Design Drawings and Parts List

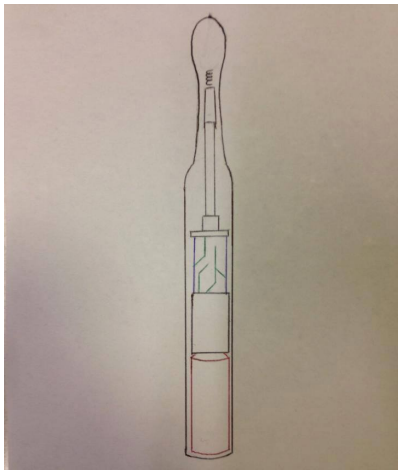
Figure 4: Final Design



Isometric



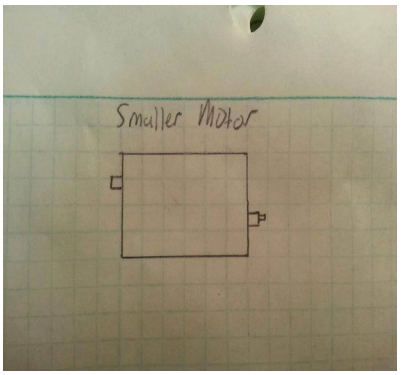
Front



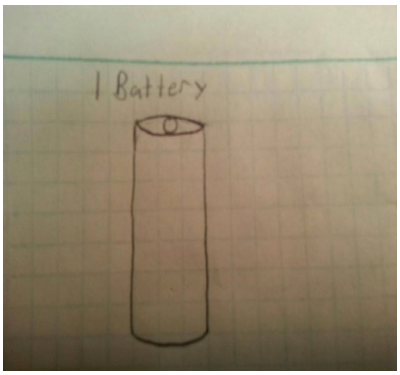
Back

5.1.1 Parts

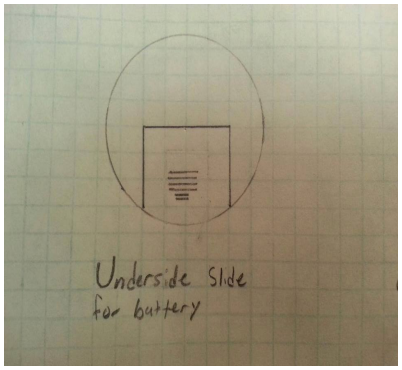
Brush



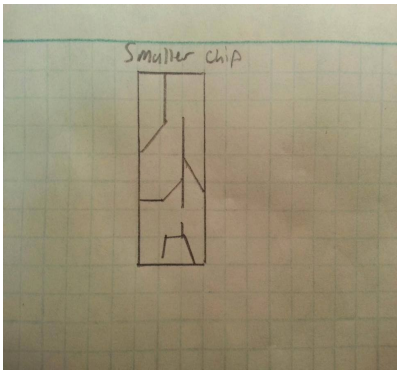
Motor



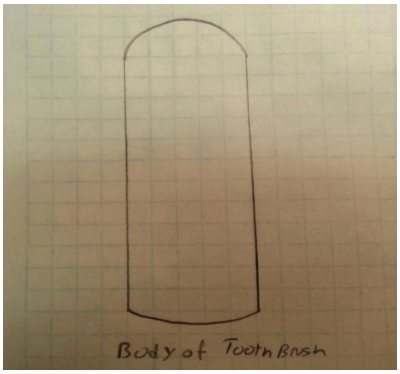
Battery



Slider



Circuit Board



Body

5.2 Bill of Materials

Table 8: Bill of Materials

Part #	Part Name	QTY	SOP	Function	Mass (est.)	Material	Manuf. Process	Dimensions (est.) (cm)	Cost (est.)
1	Brush	1	Yes	brushes teeth	3.5g	plastic	assembly line	5x2x1	$10
2	Motor	1	No	spins brush	26g	plastic, metal	assembly line	4x2x1.5	$3
3	Battery	1	No	powers motor	23.5g	steel	assembly line	5x1.5x1.5	$1.75
4	Slider	1	No	encloses battery	.5g	plastic	assembly line	2x1x.5	<$.10
5	Circuit board	1	No	controls motor	5g	plastic	assembly line	8x1.5x1	$1
6	Body	1	Yes	holds other parts	13g	plastic	assembly line	20x2x2	$2

6.0 Conclusion

Our design had three goals: reduce size, weight, and cost. All of our goals were met by implementing three of our design concepts into one final design. Reducing the size of the motor, allowed us to use one AA battery, which cut the cost of production as well as the weight of the product. Taking out the two-minute timer allowed us to reduce the size of the circuit board and cut the cost of production.

This project gave us hands-on experience on the process of designing a product from start to finish. It allowed us to work in groups and culminate different ideas using the strategies we learned in class. We were presented with an initial task, and it was our responsibility for developing solutions using the knowledge we gained through lectures.

7.0 References

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