



INDIAN INSTITUTE OF TECHNOLOGY GANDHINAGAR

Project Report

ES-201: Introduction to Design and Innovation

Team Benefits

Product Name: Vibristly

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1 Introduction

1.1 Premise of the Problem Scenario

“Brushing our teeth” is the first thing that we do in the morning after waking up. Our day simply begins with the sight of a toothbrush and toothpaste. And guess what if that does not happen smoothly? It spoils our mood in the early morning hours itself and the effect is carried for the entire day. There are some issues associated with the conventional brushing which directly or indirectly affect us, but often remain unnoticed. Let us look at some of the problems associated with brushing our teeth.

Carrying a toothbrush kit to the washroom after waking up, is not something which every one cherishes, especially when you are not at home. Moreover, it is quite difficult to find a proper hygienic place to keep the contents of your brushing kit, particularly your toothbrush away from microbes and germs. Hence, there is a need to design something which ensures that your toothbrush is protected from all kinds of dirt and germs.

Moreover, while brushing, we are not able to keep track of time, which apart from being late, sometimes also results in over brushing or brushing for less than the recommended time. Therefore, there needs to be a solution which updates a user about the optimum brushing time everyday.

Applying toothpaste to your toothbrush properly is also something which we miss owing to sleepiness early in the morning, and this task becomes more complicated when you are travelling. Hence, an inbuilt integrated mechanism for dispensing toothpaste directly to your toothbrush would really help.

After every use, the bristles of the toothbrush become a breeding place for bacteria, viruses, and germs, so there should be a cleaning agent for bristles,

which is embedded with the brushing kit itself.

Also, after a few months, the cleaning action of the bristles becomes ineffective, and so the toothbrush requires timely replacement. But why to add to the plastic waste on this planet by unnecessarily throwing away the body of the toothbrush which is still usable? We can simply replace the upper portion of the toothbrush on a bimonthly basis and change the body of the toothbrush once in a year as per requirement.

After analysing these problems associated with brushing our teeth, we came to an understanding that these tasks can be performed in an easy, hassle-free and productive way. We, therefore, decided to try to find solutions to these issues and design an ideal brushing model, so that all of us can have a good start of the day. We, the team "Benefits", then took up the task of providing a hassle-free brushing experience to the user.

1.2 Potential User Group

Brushing is something which is common for everyone, irrespective of age, gender, social status or health requirements. We would like to design something which works with milk teeth as well as permanent teeth. Our product, in general, will be something which can be used by both children as well as adults because dental hygiene will be our topmost priority. But, concurrently solving the time-related issues associated with brushing might make our product affordable to only some of the sections of the society.

1.3 Problem Statement

To solve the issues associated with the ordinary way of brushing, and ultimately provide "Hassle Free Brushing Experience" to a user.

2 Acknowledgements

We would like to express our deepest gratitude to all those people who helped us reach till this stage and complete this project.

- We would firstly like to thank Professor Manasi Kanetkar for giving us the opportunity to work on this problem.
- We would like to acknowledge all the users who took survey for us and gave an insight of the general public opinion on the issue.
- We are grateful to all the experts whom we consulted to seek their advise regarding the problem. Special thanks to Prof. Umashankar Singh (*biologist*), Dr. Kajal (*dental student*), Dr. Sonmit Singh (dentist) and Dr. Nitin Gupta (dentist).
- We are really thankful to our project mentors: Prof Sagar, Prof. Franklin and Prof. Hatim for their help and support in modeling and documentation work.
- We are also thankful to the Tinkerer's lab and Manufacturing lab staff for allowing to use the lab facilities while working on the prototype.

3 Research

We tried to get an in-depth analysis of the entire brushing process and tried to figure out all the problems associated with brushing our teeth. Our research was aimed at getting an opinion of the diversified group of people.

The Research Methodology followed by us involved the following stages:

- a. Preliminary Study
- b. Problem Identification and Formulation
- c. Data Collection ad Processing
- d. Literature Study
- e. Analysis
- f. Conclusion and Suggestions

The different research methods used by us were as listed below:

- Fly On the wall - We silently observed people while they were brushing. We tried to figure out the problems faced by them while using a toothbrush by closely observing their facial expressions and body language. It resulted into a more reliable data based on practical observations.
- Questionnaire: We floated a survey form containing a series of questions related to the brushing process. This helped us to not limit our data to close proximity places, and we were able to get perspective of people from far off places as well.
- Personal Interview and Field Visit: We interviewed some of the students and Professors of our institute to seek their views on the issue. We also visited some of the public places in Gandhinagar and Ahmedabad to get a general public opinion. This enabled to get structured data from users as well as subject experts.

- Desk Research: We got to know about the current challenges and the latest technology prevailing by reading some research papers and articles.
- Market Research: We talked to some of the shopkeepers selling toothbrushes in order to understand what are things people usually look for while buying a toothbrush. We also looked into the reports published by some of the leading toothbrush brands.

3.1 User Profile

- Age: Brushing is an activity that is common to all age groups.
- Our targeted user group was people in the age group of 15-25 years, which means most of them are students. But we also tried to interact with different sets of people as much as possible so as to involve people of different age groups. Gathering data from people of different age groups helped us identify various age-related issues associated with the brushing process.
- Sex: Brushing has nothing to do with gender. Hence the survey and data analysis conducted by us were totally independent of the gender of the user.
- Sections of Society: Our toothbrush will have an embedded digital clock, hence it will be difficult to make it affordable for all sections of the society.
- Education and Work Profile: Our product is mostly concerned to help hostel students, as they are the ones who need to carry toothbrushes and toothpaste every day to the washroom. But, apart from the hostlers, we are also targeting people who need to travel frequently.

3.2 Interaction

- The task under Consideration: Brushing your Teeth

- Time Required for the task: Ideally, one should brush teeth twice a day, with each duration of brushing being around 2-3 minutes. But most of the people are not able to have a sense of time while brushing. Hence, one of our value propositions is the track of time.
- Let us look into the various steps involved with the brushing process
 - The first task is to carry your toothbrush and toothpaste safely to the washroom.
 - The next task is to ensure that your toothbrush is clean enough to be put in your mouth, and then you need to apply toothpaste on your toothbrush in a proper manner.
 - Further, you need to make sure that your toothbrush does not come in contact with the dirt and germs lying near the washbasin
 - Then comes the brushing part that is to brush your teeth for an appropriate amount of time as suggested by dentists to have a good dental health. We also need to make sure that our bristles are in good condition so that they can help with the proper cleaning of teeth.
 - Finally, to make sure that after the use, the brush is clean enough to be fit for use next time.
- Ergonomic issues - The ergonomic issues which we found were mostly related to Physical Ergonomics.
 - The dimensions of a toothbrush play a very important role in the cleansing effect of a toothbrush. Further, the body of the toothbrush should be such that it ensures proper grip for the user and suits both the left-handed as well as the right handed users. Moreover, the weight of toothbrush also needs to be accounted for.
 - The motion of bristles in a proper manner, covering all areas inside the mouth is essential. Hence, the appropriate angular orientation of the toothbrush head is must. The bristles should be able to reach

the posterior teeth, the gumline and interproximal spaces and should also be soft enough to prevent gum bleeding. Moreover, the bristles should be suitable for use for different kinds of teeth.

- The Cognitive issues are mainly concerned with maintaining good dental health. A healthy smile and a healthy body is what everyone looks for. Further, to some extent the attraction factor and the cost factor also contribute.

3.3 Literature Study

- As a very first step, we tried to know about the history of a toothbrush. We tried to understand how the way people brush their teeth has changed over time. Thus, we got to know about the evolution of a toothbrush.
- We read some research papers and articles based on the analysis of a toothbrush as a product. We looked at the different reports about surveys conducted regarding toothbrushes. This made us understand the challenges associated with brushing in a better way.
- We analysed the reports published by some of the leading toothbrush manufacturers. This helped us in getting familiar with the latest trends and technology and get a rough idea of the Market scenario.
- We read several articles about dental hygiene and healthy brushing practices written by leading dentists across the globe. This helped us understand the hygienic challenges associated with the current brushing techniques.

3.4 Existing Solutions with pros and cons

- **Electric Toothbrush** - It represents the latest and technically advanced toothbrush model existing in the market today. It cleans teeth by making predefined automatic bristle movement in all directions. But, it is very

expensive and hence not affordable to most of the people. Also, it can not properly access all areas of our mouth resulting into improper cleaning of teeth.

- **Toothbrush Sanitizer** - It involves killing of the bacteria lying in the bristles of a toothbrush with the help of ultraviolet light or by using steam and dry heat. Like the electric toothbrush, it is also very expensive and the use of ultraviolet light might have some side effects as well.
- **Toothbrush with a head-cap** - It is used by most of people because of its low-price. Although it prevents the toothbrush from coming in contact with external entities, it cannot treat the germs already lying in the bristles due to accumulation of water in the bristles after every use.
- **Mouthwash** - It is a very good replacement of a toothbrush due to its simplified cleaning action. It can access all areas of your mouth and ensure better cleaning. But, it can cause health issues if swallowed inside.

4 Value Proposition

"To design a tool for a person to brush his teeth."

Interaction issues solved

- **Hygienic brushing:** The disinfectant helps in keeping the brush germ free. Hygienic brushing prevents bad breath, tooth decay and gum diseases.
- **Track of time:** The clock attached on the toothbrush container enables users to keep a watch on time while brushing. This helps them time the brushing process appropriately.
- **Replacement of bristles:** When the toothbrush bristles are worn out, a new head can be installed on the toothbrush. This saves the the money of buying a new brush altogether and also helps in reducing the waste disposal.
- **Disinfectant:** Disinfectant is filled inside the container. This provides a hygienic storage area for the toothbrush. Suction cups and centre of mass concept help in holding the device in an upright position, thus protecting it from germs on the surface.
- **Stability (Centre of Mass):** A magnet attached to the bottom of the toothbrush helps in attaching it to a round container which balances itself when given a jerk. This protects the toothbrush from falling on the surface and encountering germs.
- **Suction cups:** Suction cups attached on the bottom of the container firmly attach it to the surface, thus preventing it from toppling. This prevents the disinfectant from spilling over.

Adjectives and Keywords

- Comfort

- Usability
- Economically viable
- Sustainability
- Cleanliness
- Easy-to-use
- Easily accessible

5 Ideation

5.1 Multiple Ideas based on keywords

- **Track of Time:** To give the user a sense of time while brushing, we thought of embedding a digital clock with a toothbrush. But looking at the high-cost associated with the installation of a digital clock, we tried to find out some other alternatives like LED flickering at an interval of 3 minutes, a dial of an old watch or a timer because our aim was simply to alert the user about the optimum time of brushing. We also thought of integrating a sand timer with the toothbrush holder.
- **Hygiene:** Throughout the project hygiene was our topmost priority. To protect the bristles from dust and germs floating in the air, we thought of covering the head of the toothbrush with a plastic head cap. in order to avoid unhygienic conditions created by accumulation of water in the toothbrush, we thought of a mechanism for drying the bristles thoroughly after every use. We then came to the idea of putting some kind of disinfectant, which could treat bacteria and germs lying in a toothbrush, into a toothbrush bottle. We also considered spraying a disinfecting agent on the surface of bristles before and after every use.
- **Economic Viability and Environmental concerns:** After having a discussion with the dentists, we got to know how timely replacement of your toothbrush is important for maintaining dental hygiene. But nobody would like to take out Rs 40 (This is an average estimated cost. this value may vary based on multiple factors) every month for a toothbrush. We then came up with the idea of designing a replaceable head for a toothbrush. We also thought about developing a wooden body for a toothbrush in order to reduce usage of plastic in our model.
- **Stability:** It is very important to ensure that your brush is kept upright while not in use so that it does not come in contact with the bacteria and

viruses lying in the wash area. We therefore tried to develop a model which could stand on its own, based on the concept of lowering of Centre of Mass of the toothbrush. But, looking at the issues regarding the heaviness We then thought of attaching a toothbrush with another heavy object such that the toothbrush can be detached from it as and when required. We got multiple options for accomplishing this task like using a magnet, screw mechanism or using a magnet and piece of iron. We also came up with the idea of using suction at the bottom of the toothbrush so that it can stand on its own.

- **Integrated Toothpaste Mechanism:** In order to solve the problem of carrying a toothpaste to the washroom everyday, generally faced by hostellers we thought about various mechanisms for integrating toothpaste with the toothbrush itself like syringe mechanism, piston mechanism etc.

5.2 Shortlisted and Consolidated ideas

5.2.1 Mock up-1: Toothbrush with disinfectant

- The keywords associated with this mock-up are hygiene, stability and track of time
- There is a holder with cap for keeping the toothbrush after every use and this holder is filled with a disinfectant, which acts like a bactericidal agent for cleaning the bristles. There is a one way gate mechanism inside the holder, above the disinfectant which ensures that only the bristles comes in contact with the disinfectant. This also restricts the flow and spilling of the disinfectant from the holder.
- There is a suction attached at the bottom of the holder, which provides stability to the holder so that the bristles remain dipped in the disinfectant properly, and also ensures that the disinfectant does not spill out from the container. There is also a digital clock integrated with the container which

gives a user a sense of optimum duration of brushing.



Mock Up 1

5.2.2 Mock up-2: Toothbrush with a Steady Base

- The keywords associated with this mock-up are Stability, Economic viability and Sustainability
- The toothbrush consists of detachable base which is very heavy in comparison to the toothbrush. This is done in order to prevent toppling of the toothbrush by lowering the centre of mass of the combined body, which ultimately prevents the toothbrush from coming in contact with the dirt lying on the floor. The toothbrush can be attached or detached from the base object with the help of magnet used at its bottom. Another additional purpose served by this model is that such a structure of the base makes it look very attractive and appealing, especially to children.
- The upper portion of this toothbrush has a replaceable head, which reduces the cost of changing the worn-out bristles every time. Reusing the same toothbrush body cuts on the plastic waste generated, and therefore this is an environment friendly solution.



Mock Up 2

5.2.3 Mock up-3: Integrated Toothpaste Mechanism

- The keywords associated with this mock up are Usability, Comfort and Sustainability.
- This model has an integrated toothpaste dispensing mechanism with the toothbrush. The toothpaste is pushed towards the bristles of the toothbrush with the help of a simple piston mechanism. As soon as the sufficient amount of toothpaste reaches the bristles, the holes for meant for allowing the flow of toothpaste through it get closed by means of a locking mechanism. This enables the user experience the comfort of not requiring to carry toothpaste everywhere.
- The auto-dispensing mechanism also ensures that the toothpaste is applied on the bristles in a proper manner, and thus prevents the wastage of toothpaste due to spill-over on ground. There exists a replaceable head on the upper portion of the toothbrush which ensures minimum usage of plastic while replacing a toothbrush.



Mock Up 3

5.3 Chosen concept and reasons

We have combined these three prototypes into two final concepts keeping into mind two sets of target user groups. We have tried our best to integrate all possible features so as to give a pleasant brushing experience to a user.

- The first concept is based on maintaining the hygiene of the toothbrush by immersing its bristles in a disinfectant filled in the container. The movement of bristles in and out of the disinfectant will be controlled by one way gate mechanism such that the disinfectant does not spill or leak out of the container. The use of disinfectant in the container will help make the brush germ free efficiently in a cost effective manner. The container will be provided stability with the help of suction cups attached to its bottom. Suction pumps will be the most suitable because of their light-weight property, low cost and the flexibility associated with the material. A digital clock embedded with the container will help the user to keep a track of time while brushing.
- The second concept is based on providing stability to the brush with the help of a solid base by lowering the centre of mass of the combined body. We have used a round hemispherical base at the bottom of the toothbrush which makes the toothbrush look eye catching. Magnets have been used to make the brush detachable from the base

6 Final Solution

6.1 Final Dimensions

a. Prototype 1

- Length = 175mm
- Base diameter = 16.5mm
- Maximum Width = 12mm
- Head Length = 30.2mm
- Diameter of Ball = 75mm

b. Prototype 2

- Length of Holder = 160mm
- Top Diameter = 35mm
- Bottom Diameter = 60mm
- Diameter of a suction cup = 20mm

6.2 Choice of Materials

- **Body:** Polypropylene and Polyethylene - These materials have the desirable thermal, physical and mechanical properties at room Temperature. The material also has a sufficient amount of flexibility that is required while brushing.
- **Bristles:** Nylon-6 - This material can easily be converted into fibres to make bristles for a toothbrush. Nylon-6 is the earliest material used for the manufacturing of bristles. It is very easy to clean Nylon by simply rinsing with water.
- **Removable head:** Polypropylene

- **Base:** HDPE (High density Polyethylene) Plastic Resin hemisphere (density 0.94-0.97 g/cm³) and Neodymium Magnets. This material is suitable for preparing the base of our prototype because it has sufficiently high density to bring the Centre of Mass (COM) of the combined system (brush and base) at an appropriate distance from the platform so as to provide stability to the prototype.

6.3 Prototyping

a. Prototype 1

- We prepared a CAD model of the toothbrush and the replaceable head using Autodesk Inventor. The body of the toothbrush is thin and it has a round flat base where the magnet is to be attached. The head of the toothbrush has a small hole where the replaceable head can be attached.
- The replaceable head has a flat base with evenly spaced small holes covering the entire surface. The bristles are to be attached on these small holes.
- The CAD models were given for 3D printing and we started working on the rest of the components of our product.
- We grinded a coin (made of magnetic material) to reduce its diameter to the size of the base of the toothbrush. Then we attached it to the base of the 3D printed toothbrush with help of a strong adhesive.
- To develop the base for the toothbrush, we first cut a season ball into two halves. Then we made a hole nearly equal to the size of the neodymium magnet in the cork of the ball. The neodymium magnet was hammered into the hole to firmly fix it in the cork.
- With the components (hemispherical base and toothbrush) being prepared, we started testing the device. The coin attached at the bottom of the toothbrush was strongly attracted by the magnet fixed in the

hemispherical base. Thus, the toothbrush was able to stand in an upright position. We tried giving jerks to the entire setup and observed that the base was able to balance itself and restore its original upright position.

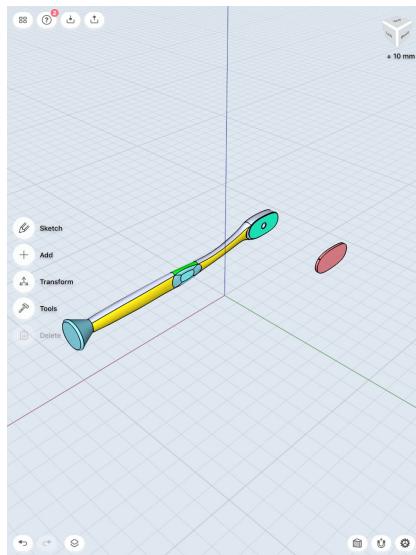


Figure 1: CAD model



Figure 2: Making of the CAD model



Figure 3: 3D Printed Model



Figure 4: Grinding the coin



Figure 5: Cutting the season ball



Figure 6: Final Prototype

b. Prototype 2

- We designed a CAD model of the cylindrical container for the toothbrush. The container has a hole of the size of the head of the toothbrush on the top. The container has a small hole at the bottom from where the disinfectant can be filled in the container. A compartment in the container acts as a barrier and prevents the disinfectant from spilling out.

- A circular compartment is present at the center of the curved surface where we attached a small clock.
- We also fixed a piece of rubber on the top of the container. This piece helps in maintaining the toothbrush at a fixed position when placed inside the container.
- We attached suction cups at the bottom of the container to firmly attach it to the platform/surface on which it is kept. This prevents toppling of the container and prevents the disinfectant from flowing out of the container

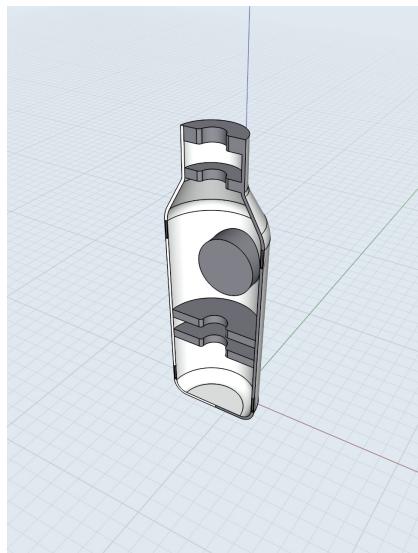


Figure 7: CAD Model

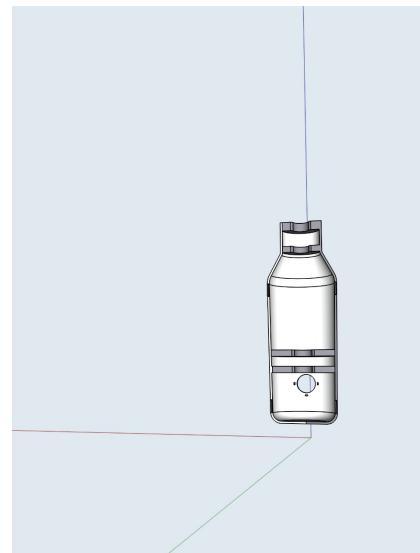


Figure 8: Interior design

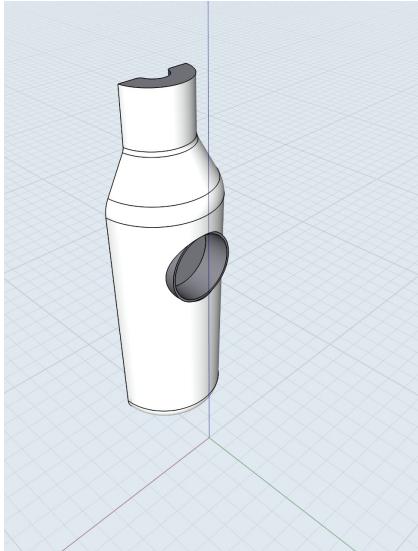


Figure 9: Hole for clock

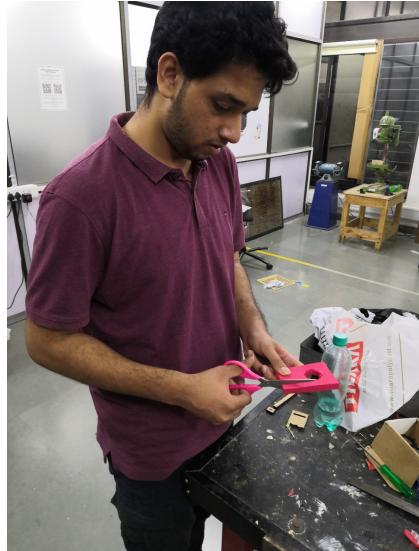


Figure 10: Cutting rubber pieces



Figure 11: Interior design

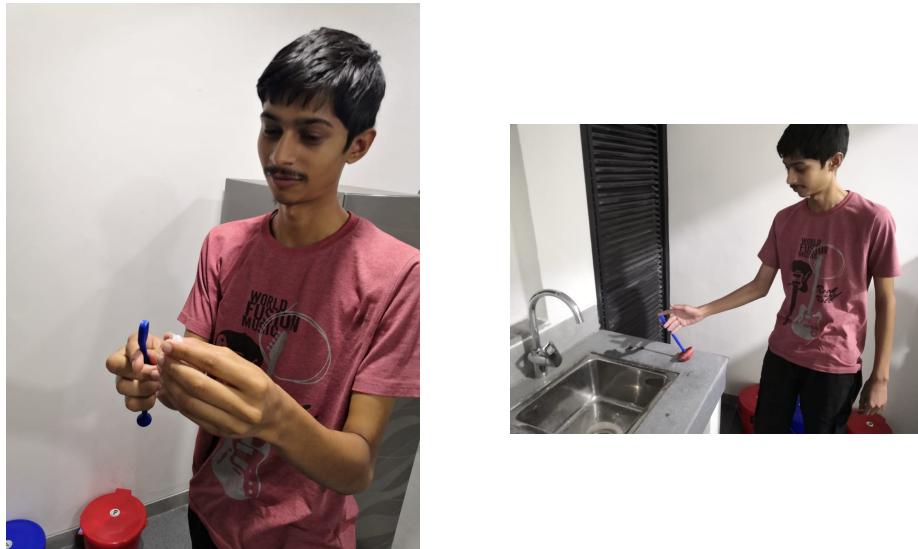


Figure 12: Final Prototype

6.4 Validation with user

- **Devanshu Thakar, Btech Sophomore, IIT Gandhinagar:**

"The way I was able to replace the head of the toothbrush was amazing. It was easy and intuitive. The "Rocking Doll" concept was also very unique and will save the toothbrush from falling. The ball at the bottom really caughted my attention. It will definitely be able to attract a user, especially children. If this product comes into the market, then I will surely recommend this product to my friends and family".



- **Nikhil Yadav, Btech Sophomore, IIT Gandhinagar:**

"I was fascinated by the time display present on the toothbrush holder. Apart from informing me about the optimum duration of brushing, it will also save me from getting late for classes. The holder will save the brush from getting exposed to the impurities present in the external environment. The suction cups attached at the bottom of the container prevent it from falling, which is truly an amazing feature"



6.5 Fulfilling the value proposition

- The most essential value proposition "Hygiene" is completely delivered by our product. The product does not come in any kind contact with bacteria or dust particles due to the bristles being kept into a covered container. Moreover, the bristles are immersed in the disinfectant after use, which treats the bacteria already lying inside the bristles as a result of brushing.
- Since there is a digital clock attached to our product, the user will have a sense optimum duration for brushing, and the probability of the user brushing his teeth for more than required time is very low. To some extent, this will also help the user to be on time for office, meetings or classes
- The bristles of a toothbrush get worn out after a few weeks of its usage, and hence their cleansing becomes less effective. Our product has a replaceable head that can be changed whenever its bristles get damaged. This will make the timely replacement of a worn-out toothbrush affordable for everyone, and also reduce the plastic waste accumulation.

7 Conclusion

7.1 Learnings from the Course

- Initially, our understanding of design was simply limited to the knowledge of the sketches, size, shape, functioning and appearance of the product, but this course helped us to think beyond the structure and functioning of the product. We knew that while designing, a designer has to do whatever is the best for the user, but this course helped us to learn how to achieve that goal. We got to know about the physical ergonomics of the product and the cognitive ergonomics behind the product designing. We also learnt about the anthropometry aspects associated while designing a product, which makes sure that the user is comfortable while using the product. This course ultimately taught us to look at a product from the perspective of different stakeholders associated with it.
- The lab sessions apart from bringing out the designer inside us, also trained us into persons who do not hesitate to take the lead while working in a team. The lab activities really helped us improvise our communication skills which are really essential, be it any profession or any stage of life.
- Apart from all kinds of in-class learnings, the most valuable life-long lesson which we took from this course is "It's Ok to fail."

7.2 Learnings from the Project

- Although theoretical knowledge has its own importance but the entire learning process remains incomplete without the practical implementation of our theoretical knowledge.
- The project helped us understand the challenges faced by a designer while designing a product, and how to overcome those challenges by coming up with an unorthodox solution. While designing our prototype we got stuck with the joining of the toothbrush with its circular holder, and

we started looking for different mechanisms for the same. Ultimately, observing things around us very closely, we came up with the idea of exploiting the magnetic property which will also reduce the price of the product. Thus, the project enhanced our creative thinking and made us look for out of the box solutions to problems.

- The whole idea behind the project was to bring together people from different backgrounds to achieve one common goal of designing a product which provides pleasant experience to the user. We learnt to respect the opinions and ideas of different individuals and complement the beauty of the different solutions achieved with different perspectives.
- Summing up, in simple words, the project helped us get a hands-on experience to apply and test our learning from the course as a team of people from different backgrounds.

7.3 Future scope for the Project

The product we designed is very suitable for children because of its unique rocking roll mechanism, which will give children a toy to play with along with a toothbrush. Our product has the potential to actually change the toothbrush market exponentially because of its sleek design and its ability to attract those users who are very conscious about the hygiene associated with the products used by them on daily basis. In the future our main focus would be to integrate the toothpaste with our product to make the product more independent and adept.

8 References

- Brushing Your Teeth, American Dental Association,
<https://www.mouthhealthy.org/en/az-topics/b/brushing-your-teeth>
- Raw Materials in the Toothbrush,
<http://www.designlife-cycle.com/plastic-toothbrush>
- Toothbrush, How Products are Made,
<http://www.madehow.com/Volume-2/Toothbrush.html>
- <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4268624/>
- <https://www.colgate.com/en-us/oral-health/basics/brushing-and-flossing/do-i-need-a-toothbrush-sanitizer-1016>
- https://www.academia.edu/10010562/Product_analysis_TOOTH_BRUSH
- https://www.researchgate.net/publication/278047695_Ergonomics_and_toothbrushes
- https://www.academia.edu/10010562/Product_analysis_TOOTH_BRUSH