

**Human Powered Dental Mixer (Dental Triturator)
Background Report**

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1 BACKGROUND

1.1 Introduction

Dentists use a machine that is called a Dental Triturator to mix dental formulations. The formulation is placed inside a capsule and shaken by the dental Triturator till the formulation is completely and thoroughly mixed up. When the formulation is thoroughly mixed, it is then used by the dentist to cater for the need of the patient that the dentist wants to help in fillings. The main reason why the machine is used is because, there is a lot of vigorousness that is needed so that the formulation can be thoroughly mixed up together.

The main purpose of this project is to make a man Powered Dental Mixer that can be operated manually by the dentist and still perform the same function that the Dental Triturator functions. The Dental Triturator uses electricity. The man Powered Dental Mixer will not use electricity and will be powered by the human hand effort. There are also several shortcomings that come with the current Dental Triturator that makes it to be no-useful during some of the times. The new model is supposed to overcome the shortcomings. A customer survey has revealed some of these challenges that customers would seek to get addressed on top of the main purpose which is to make a device to be human powered. This report seeks to address them to the fullest so that the customers of the new model can feel comfortable with the device.

This project was triggered as a result of some students that were traveling abroad to places where there was no electricity and they needed to carry out their dental work. Given this challenge, the NAU's Dental Hygiene Department and NAU Mechanical Engineering Department (CHHS and CEFNS) decided to create a man Powered Dental Mixer that would effectively address this challenge and enable these travelling students to do their work effectively.

1.2 Project Description

The main original statement of this project was 'create a human powered mixer that can shake a capsule for 10 seconds.' This statement is adopted from the joint collaboration of NAU's Dental Hygiene (DH) Department and NAU Mechanical Engineering Department (CHHS and CEFNS). Following the original project description provided by the two departments, the challenge was given to the students so that they can develop the prototypes for the human powered mixer. The instruction was that the new device should be a completely new model and not a reverse engineered form of the existing model device.

The original statement was altered from what it was following considerations on the users of the device. Typically, the students are the clients that needed to be served by the device. However, when the idea of a new model was brought up, there was the need to make more customization measures that would make the device to be even more ideal to the users. It happens that the electrical component was not the only challenge that this model was facing. The suggestions that were put across were all with the aim of helping the dental hygiene students travelling internationally to be more comfortable in their work. The criterion for what was done is relatively for the benefit of the students. However, there was a realization that a device should be made such that it does not limit the users to student. It was decided that it would be good if the

model was able to cater for even some outside parties that could be interested in the device due to the nature of their working conditions.

1.3 Original System

Our system is basically a design of a completely new product. There is therefore little or no similarity between our new model and the currently existing models. The only possible similarity is the functional role that the new and the older design will be performing. The working mechanism will work in the capsule, which is the same as was in the older model.

The original design takes several forms but they relatively take the form of the sample that is represented below.



Figure 1: Dental Hygiene mixer.

The sample above has an outer molding that is made of plastic which can be said of most of the existing design. On the upper compartment that has a glass covering is the compartment where the capsule is placed into. In the above device, the capsule is the red cylinder that is held between two holders. These two holders are connected to some inner mechanism that vibrates when the device is in working. On the fore side is a scale that seems to read '10'. Ten seconds is the basic time that a capsule is usually shaken for before it is removed. A dentist therefore usually sets the time on this screen.

The process starts with the preparation of the capsule. The capsules are then placed in between the two holders that are as above. The compartment is then closed with the transparent lid. The dentist then sets the ten seconds time that the capsule is supposed to be shaken for. The dentist then sets it on. The capsule is shaken for the ten seconds and the machine then stops after the ten second. The dentist then retrieves the capsule and goes ahead to take care of the patient.

In the new device that we propose to make the only feature that may be there are the holders that will hold the capsule, the power system will be different and the mechanism of timing will also be different. It will be a completely new device that will be made after the re-engineering process has been done.

1.3.1 Original System Structure

The most vital part of the original system is the mechanism that causes the vibration of the capsule. This same part led to the formulation of the problem statement of this project. It is the part that the project seeks to replicate with the aid of a human powered effort as a substitute to the electrical component that makes the device that we have in this project.

In the original system, there is a power cable that connects the power source to the device. This electrical cable is connected to the motor of the device. The motor is driven by the electrical current causing an oscillatory motion to the axle that is connected to the motor. This axle is connected to a mechanical manipulation to the two hooks that are supposed to hold the capsule from the outside. The mechanical manipulation are made in a way that the two hooks can move to and from on a fixed range [1]. The two hooks also moves out of phase. This means that as one of the hooks moves to the North, the other is moving to the South and the as the first is moving towards the South, the other one is moving towards the North. This incoherent motion helps the device to be able to mix the contents of the capsule well. In the span of the ten seconds that the capsule is taken, there is usually a total mix up f the contents of the capsule completely. The new device needs to be able to provide this shake up in ten seconds through the mechanisms that will be used for it.

1.3.2 Original System Operation

The basic necessity for this device to work is electrical power that will power the system. This is also the basic reason why there is a need to build another design to replace the existing one. The rest of the requirements for the model can be described as secondary as they are not a vital part of the design that needs to be built. The device sued between 2-5 volts of power that powers the timer and the vibration mechanism.

This device is not majorly customized for the dental use only. This can be seen from the intervals of time that the device can range along. There are not many dental capsules that need more than ten seconds to make a total mix up. There are other devices that also need shake up to implement mixing and the dental application just happens to be one of them. If this device was specifically made for the dental use, it would not have been important to have all the bulk that the current device has. This is why this device needs the customization of the period that the capsule will be shaken [2].

There are several model formats that the build of this device takes as per the market. This is dependent majorly on the roles that are to be played by the device and the place where it was made it. However the basic component of the hooks is consistently standard. These hooks are made so that they can cause a shaking motion of the capsule when it is placed in the gap. All the other makes are secondary to the primary function of the device.

1.3.3 Original System Performance

The current device operates at a period of 10. This means that the capsule makes ten oscillations per every second. With this kind of periodic time, the ten seconds that are given to the capsule are enough to have mixed up the contents of the capsule thoroughly. The standard capsule that is placed within the gap holds about 20 grams of the dental formula. This weight does not pose any challenge is at an almost negligible significance to the hooks that holds the capsule. As far as the performance of this device goes, there is absolute efficiency when it is used for the dental work in a clinic. However, if it needs to be transferred to another place and there is a need to have the same power as the one that it normally uses, the efficiency may be cut into two to give a fifty percent efficiency.

1.3.4 Original System Deficiencies

One of the deficiencies of this device is low adaptability. The device is not able to function if there is no electrical power. This makes it to become useless if there is no power that can power it to do the function that it is supposed to do. The other deficiency is the weight. This device is relatively heavy. If one is transferring their workstation o another locality, they may encounter a lot of challenge, as this device is not all that flexible to duce to the weight aspect. This device is also relatively clumsy. The shape of the device is blocky and this makes it to present a challenge when one is seeing to transport it to another place. If the devise has less challenging edges and be less big, it would be easier to transport. The challenges that are outlined above are a result of the needs that the travelling student needs to overcome as they are traveling to other places for their work.

2 REQUIREMENTS

2.1 Customer Requirements (CRs)

The first customer requirement that triggered this project is to make the dental mixture to become a man Powered Dental Mixer. This means that the electrical component should be replaced so that the device runs on human effort. A mechanical system that is run by the human should be able to provide the same amount of power and the same amount of power as it was producing when it was using the electrical component. The mechanical system that utilizes the hand should also be able do the mixing in the same time that the electrically powered mixer was using there before.

The other customer requirement is making the man powered dental mixer to be lighter. The device is currently so heavy that it is difficult for the students to carry especially if they are negotiating through vast distances on rough terrain. The main reason for the redesign process is to make the device to be usable by students as they are travelling internationally doing their dental hygiene work. With a heavy device, it will be hard for them to get to the destination that they want without getting too tired to work. This is why we seek to have it made lighter for the travelling students.

The other customer requirement is that the device should be durable. It so happens that the working of this device entails vibrations that are used to shake the capsule that is used to make the dental formulae. This makes this device to wear out as the parts are shaken and the current devices do not have a very long life span. It is therefore required that the new device should last for some time before it becomes necessary to replace it. The time that the customer stated is about five years.

The other requirement is that it should have a transparent compartment. This is to enable the student to have a view of the process that is happening in the device. This could be done through the use of transparent glass on the outside.

The other requirement is the size of the device. The current device is too large and the customers are really having a hard time in the transportation. This is especially the students who have to carry these devices over long distances as they carry out their work. A large object is clumpy to carry. A small device should therefore be developed so as to allow for proper transportation of the device effectively and easily.

Weighing of the customer needs was done in a scale of 1 to 5.

Table 1: Relative weight of the customer requirements

Customer requirement	Weight of customer requirement
Use of man power to power the device	5
Light weight	4
Smaller in size	3
Be durable	2
Transparent compartment	1

2.2 House of Quality (HoQ)

Table 2: House of Quality

	Weight								
Customer Requirement									
Use of man power to power the device	5								
Light weight	4								
Smaller in size	3								
Be durable	2								
Transparent compartment	1								
6.									
7.									
8.									
9.									
10.									
[add or remove CR rows, as necessary]									
Absolute Technical Importance (ATI)									
Relative Technical Importance (RTI)									
Target(s), with Tolerance(s)									
[add or remove T/T rows, as necessary]									
Testing Procedure (TP#)									
Design Link (DL#)									

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Our team held on a brainstorming session to look at the various possible alternatives for the designs that we could develop. In looking for alternatives, we were not completely in the dark as there are some people who had tried to do the designs previously. We tried to reason out on the line of reasoning that these designers were thinking along though we could only get so far. After we have evaluated the exiting designs, we went ahead and made our prototypes that we deemed could possibly be developed into real concepts to dot eh function for which we intended.

2.3 Design Research

Our research for designs that have existed in the past of this nature was informed by the internet. This is the only possible source where we could get this sort of information, as there is not a lot of research that is done on this topic to warrant a book or a journal to be written. We therefore went to the internet and typed the search words, 'man Powered Dental Mixer.' There are several results that are given by the above search category. Some of them are generic and we studied closely the ones that had information that had close relation to what we were seeking to get. Among the results that we got, there are two particular ones that we will discuss below as the best ones that we could be able to trace from the Internet.

2.4 System Level

The design that was gotten area all operated manually. They therefore meet the criterion for the engineering requirement that we had set as a pre-requisite for the working of the device. There is one of the designs is developed commercially while the other one has remained a prototype that never relay went into any sort of production due to its limitations.

2.4.1 Existing Design #1: Mixacap dental triturator

The mixacap was developed by Benjamin Lowry who lives and practices dental engineering in Idaho. The mizacap is cordless and can be used in virtually any place on the earth. It can be moved easily from one room to another or even taken on a mission trip by a dentist. This device seemed to be in line with the needs of the customers that we seek to serve. To operate this device, a screw is turned that is on the side of the device and as the screw is turned it causes the holder of the capsule to vibrate and therefore the dental capsule is mixed. The challenge with this prototype is that it cannot compete against the electrical triturator as it uses a lot of effort and needs some degree of patience to use it something many people cannot afford.

2.4.2 Existing Design #2: Maxine Janis

Maxine Janis' triturator was made in 2013. This triturator operates through a system of gears that are encased in a glass casing. This device is operated by a hand turning on an effort lever. The effort lever causes a motion of gears. The gears are made in such a way that there is a multiplication of the effort as the gears turns each other. The final gear is connected to a device that keeps oscillating the holder of the dental capsule. As a result, the capsule is moved up and down and this makes it to mix up the contents that it holds. The bigger challenge with this device is that it is so bulky and heavy that it hard to move it about.

2.4.3 Existing Design #3: motor and pestle

This is perhaps the most rookie method of mixing dental formulae. It was the one that was used before the emergence of the fancy capsules and the dental mixing machines. This method relies purely on having the dental formulae on the motor and then it is mixed up with a pestle until the user is satisfied that the mixer has blended into each other completely. The only shortcoming with this method is that it causes a lot of wastage of the amalgam. It is also cumbersome and leads to a lot of wastage f the dental formulae.

2.5 Subsystem Level

In our design process, we were seeking to address some of the challenges that are seen in the above existing models. There were however, little or no connections between the designs that we made and the existing models. After extensive deliberations, we settled on two major designs that we deemed to be ideal for our project. To the best of our knowledge they seemed to address the challenges that came with the previous models that already exist in the market.

2.5.1 Subsystem #1: Sprigged rod

In this system, there is a rod that is inside a spring. On one end, the rod has a flexible cord that is vertical and holds the capsule. The spring is depressed towards the flexible chord by screwing a tightening bar on the opposite side. As the spring gets depressed, it depresses the flexible chord so that it becomes a little tilted. The spring is then released from the hold that has been put on it and as a result the, flexible chord bounces back, as it bounces back, it makes the capsule to move to and from making it to mix. The spring that continues to be depressed and released by the flexible chord for some time until all the mixing of the capsule has been done.

2.5.2 Subsystem #2: Sprigged box

In this prototype, the operation is based on the impulsive force that is transmitted by a string. A plexus box has two springs on either side of the box. The two springs are connected by a metal rod that that is attached on the lower side of the spring on one side and on the upper side on the other side of the other spring. This argument ensures that if the spring is depressed on one side, it will expand on the other side. When the spring is released from a depression, it makes an oscillatory motion to and from. A capsule is attached to one so the protruding sides of the metal rod. This will make it to move to and from as the rod is directed by the two connected springs. To continue the oscillatory motion the depression can be enhanced as it is in press and within the time interval, the capsule will be completely mixed.

3 REFERENCES

- [1] H. Feldner, S. Logan and J. Galloway, "Why the time is right for a radical paradigm shift in early powered mobility: the role of powered mobility technology devices, policy and stakeholders", *Disability and Rehabilitation: Assistive Technology*, vol. 11, no. 2, pp. 89-102, 2015.
- [2] D. Adaire, "Classification of Dental Instruments". *Arkansas Tech University*. Retrieved 2017-01-12
- [3] "Kaeser Compressor Applications". *Compressed Air Systems*.
- [4] M. Kazemi, A. Rohanian, A. Monzavi and M. Nazari, "Evaluation of the accuracy and related factors of the mechanical torque-limiting device for dental implants", 2013.