

Dental Hygiene

Background Report

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DISCLAIMER

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1 BACKGROUND

1.1 Introduction

Our project consists of creating a Dental Triturator. This machine is used by dentist to shake and mix a capsule made up of amalgam and glass ionomer sealant. This capsule contains liquids and metals used for teeth fillings. The problem with current Dental Triturator is that they require electricity. Our client frequently has trips to third world countries to give dental services to those in need. The problem is some of the places they go to do not have electricity. Our job is to design and create a Dental triturator that does not require electricity to mix the dental capsules. This new Dental triturator¹¹ will help improve the lives of many people in third world countries.

1.2 Project Description

The following is the original project description provided by the sponsor. "A dental triturator is used to mix the components of dental capsules before certain dental procedures and they are usually powered by electricity. When dental hygiene students travel internationally, often times there is no electricity and/or the powered triturations are not compatible with international outlets. Collaboration between NAU's Dental Hygiene (DH) Dept. and NAU Mechanical Engineering Dept. (CHHS and CEFNS) have created this Spring 2017 capstone project for 3-5 mechanical engineering students to create a human powered mixer that can shake a capsule for 10 seconds".

1.3 Original System

The original system for this project is a dental triturator. A dental triturator is used to mix a capsule filled with amalgam and glass ionomer sealant. The capsule is mixed for a certain time and frequency to ensure that the filaments are properly mixed. This sealant is then used to fill cavities or holes in teeth.

1.3.1 Original System Structure

The dental triturator is made up gears and rotational components that convert electrical energy to shake the capsule in a semi-linear motion. There are metal bands that act as arms to hold the capsule in place. The structure closely resembles a cube shape and has a safety cover over the arms where the capsule is placed. The triturator only allows one capsule at a time to ensure the device is working properly. The internal components are some kind of metal or alloy and the covers and buttons are plastic.

1.3.2 Original System Operation

To see how the dental triturator operated, we needed to see it in action. We observed the triturator while it was shaking a capsule. We noticed that the motion was not directly linear but almost a figure eight motion. It was not a circular motion since a circular motion would not work for the capsule. The motion of the device was quick and the capsule was shaken for 10 seconds. The capsule was then put into a tool and the components were squeezed out as a liquid. If the triturator does not do its job correctly then the capsule components remain unmixed and it cannot be used.

1.3.3 Original System Performance

The function of the dental triturator is to shake a capsule at 4000 rpm for 10 seconds. When we observed the triturator, we timed it for 10 seconds but could not directly measure the rpm's. The capsule calls for 4000 rpm but we estimate that the triturator may not always reach this requirement. Each capsule weighs around 2 grams and the triturator weighs on average 5 kilograms. The power requirements for the triturator are 220V and 50Hz. A small amount of power is used for the buttons and lights so the majority of power is directly converted to the capsule. The triturator has a high efficiency since it is small and there aren't so many parts.

1.3.4 Original System Deficiencies

The only deficiency with the dental triturator is that it is dependent on electricity. The Dental Hygiene Department wants a triturator that can be easily transported and used in countries that may not have electricity.

2 REQUIREMENTS

This project requires us to re-engineer a dental triturator that is manually or battery operated. The current dental triturator is run on electricity and this resource is not always available in other countries. The Dental Hygiene Department wants a triturator that can be run off of manual power such as a hand crank or little electric power such as small battery. The triturator needs to have the same function as the original so that the user can do their job properly. The triturator will be re-engineered using these requirements so that it can produce the proper results for the Dental Hygiene Department.

2.1 Customer Requirements (CRs)

There are many requirements that come into consideration with this project. This section contains all the customer requirements that are based off of what they need out of this design. Lightweight, Easy Transportation, and Shaking the capsule for 10 seconds are the top customer requirements so we gave them a ranking of 5 out of 5. The triturator will be a lightweight so the user can carry it onto a plane, bus, or car. Also, it will fit in a bag for easy carry. The triturator will have shaken a capsule for 10 seconds in order for the filling to be used, so this must be ranked highest.

Reliability and Easy Operation are the next customer requirements with a ranking of 4 out of 5. This project is not meant for a single person so we are going to make it easy to operate for any person who uses it. Our team wants the triturator to work every time and will make sure that we develop a reliable design to satisfy our customer.

The last customer requirements are Quality, Cost, and Easy Maintenance with rankings of 3 out of 5. Aesthetics is also a requirement with a ranking of 2 out of 5. The triturator will have a few different parts and they may break or need to be changed in a few years. Maintenance on the device can be done by anybody and the parts will be easy to locate. The team will stay under budget by developing a triturator with low cost parts and fabrication. The quality of the parts have to be good and will have a lifespan of at least 1 year of moderate use. Aesthetics are ranked last since we do not need a good looking design in order for it to work.

2.5 House of Quality (Hu)

The house of quality shows our customer requirements and appropriate weightings. We completed the weightings for each requirement with the approval of our customer.

| | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S | T | U | V | W |
|----|---|--------|-------------------------|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | House of Quality (HoQ) | | | | | | | | | | | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | | | | | | | | | | | |
| 3 | Client Approval: Email | Weight | Engineering Requirement | | | | | | | | | | | | | | | | | | | | |
| 4 | 1. Quality | 3 | | | | | | | | | | | | | | | | | | | | | |
| 5 | 2. Reliability | 4 | | | | | | | | | | | | | | | | | | | | | |
| 6 | 3. Cost | 3 | | | | | | | | | | | | | | | | | | | | | |
| 7 | 4. Easy Operation | 4 | | | | | | | | | | | | | | | | | | | | | |
| 8 | 5. Easy Maintenance | 3 | | | | | | | | | | | | | | | | | | | | | |
| 9 | 6. Lightweight | 5 | | | | | | | | | | | | | | | | | | | | | |
| 10 | 7. Shake capsule for 10 seconds | 5 | | | | | | | | | | | | | | | | | | | | | |
| 11 | 8. Easily Transportable | 5 | | | | | | | | | | | | | | | | | | | | | |
| 12 | 9. Aesthetics | 2 | | | | | | | | | | | | | | | | | | | | | |
| 13 | | | | | | | | | | | | | | | | | | | | | | | |
| 14 | Approval | | | | | | | | | | | | | | | | | | | | | | |
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Figure 1. House of Quality



Amy Nicole Smith <Amy.N.Smith@nau.edu>

Feb 13 (4 days ago) ☆



to Keenan, me, Rodrigo ▾

Your list looks correct to me. Lightweight and transportable are definitely the top priorities. I don't have any comments as of now.
Thanks for keeping me updated.
Amy

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Figure 2: Client Approval

3 EXISTING DESIGNS

Existing designs are devices on the market that have a similar system to our ideal device. The paint shaker shakes paint in the same way we need to shake our dental capsule. The egg beater uses manual power to mix all the cooking ingredients. The Sawzall blades moves in the same motion we need to move our dental capsule. The team has to create a project that shakes the dental capsule in 10 seconds and 4000 rpm.

3.1 Design Research

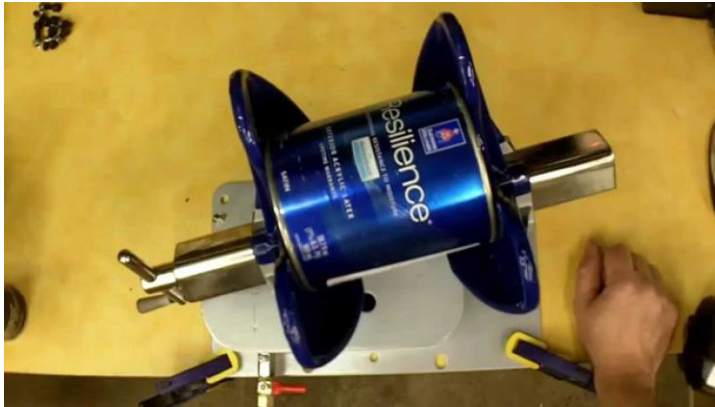
Team have done the research by an examining similar systems and the web. For the examining similar systems portion of this report the team used the electrical dental device. After extensive research, the team choose three existing devices that are similar to the same system used by the electrical dental titrator.

3.2 System Level

A dental capsule machine is a device that mixed the components of the capsule. Nowadays, it can be found in every dental clinic. The team choose three different devices which are pain mixer, egg beater, and sawzall. First, paint mixer will provide the necessary semi-linear motion which needed in the project. Second, egg beater provides the concept of using the manual method. Finally, the sawzall provides the missing key of the back and forth movement that is needed for the success of this project.

3.2.1 Existing Design #1: Paint Mixer

This is a gas powered paint mixer. If paint is left alone the ingredients will separate. This is why paint must be mixed before use. This paint mixer requires 3.2cfm at 70psi pressurized air to shake the paint in a semi-linear motion. This relates to our project because we must shake the capsules in a semi-linear motion.



<https://i.ytimg.com/vi/o4QIBHXVEPs/maxresdefault.jpg>

3.2.2 Existing Design #2: Egg Beater



<https://www.oxo.com/egg-beater-304>

This existing design is the most related design to the team's project requirement. This is called egg beater from XOX. In the description it says they have combined the idea of the egg beater and the smooth movement crank from a fishing rod.

3.2.3 Existing Design #3:Sawzall



<http://toolguyd.com/blog/wp-content/uploads/2013/09/Milwaukee-M18-Fuel-Sawzall-Recip-Saw.jpg>

The sawzall is an existing design that is used to cut different materials. The reason the sawzall is relevant to our project is because the movement of the Saw is back and forth. This is the same movement we need in our project.

3.3 Subsystem Level

In this section the team describes the system and subsystems of the existing designs we found. Each system and subsystems is explained how they work and why they are relevant to our project design.

3.3.1 Subsystem #1: Paint Mixer

The paint mixer has multiple sub-systems. They consist of the base, the air motor, and the Air feed system.

3.3.1.1 Existing Design #1: Base

The base is a really important in this model because it holds the whole system together. In this particular model the base needs to be very sturdy because a gallon of paint weighs 11.3 pounds. When the paint is shaken it emits a tremendous moment and force that the base has to withstand.

3.3.1.2 Existing Design #2: The air motor

The air motor is the most important subsystem in this item. The air motor converts the power of air into a kinetic energy. This kinetic energy is then used to shake the paint.

3.3.1.3 Existing Design #3: Air feed system

Air feed system is important because it allows the source of energy to enter the Paint mixer. There is a valve to manage the intake of the air on the motor. There is also a filter to keep trash from entering the motor.

3.3.2 Subsystem #2: Egg Beater

Egg beater contains several subsystems which are a plastic handle, crank, and beaters.

3.3.2.1 Existing Design #1: Handle

A plastic handle is attached to the crank with a carved stainless steel block. The plastic handle is a source that is used to generate human energy into kinetic energy. This is done by rotating the handle using human power to make the egg beater work. The dental capsule machine needs an electric source to function.

3.3.2.2 Existing Design #2: Crank

Crank is the most important subsystem in the egg beater, and without it the entire device cannot function. The most significant thing about the crank is the faster the crank rotates, the faster the beaters will rotate, and that's why it is related to this team's project.

3.3.2.3 Existing Design #3: beaters

Beaters are the conclusion of the device, because they beat the eggs. And they are made of stainless steel. The function of the beaters is achieved by rotating them in a high circular speed movement. The team has decided to change the movement of the beaters from a circular way to a back and forth way. With this method, the team will find a key of success to the project design (dental capsule machine).

3.3.3 Subsystem #3: Sawzall

The sawzall has a few main subsystems. The main ones are the Electric motor, the ANC gear drive, and the blade.

3.3.3.1 Existing Design #1: Electric motor

The electric motor needs to be powerful. The sawzall conducts heavy duty cutting therefore the saw has to have lots of force and torque in its motor to accomplish its goals.

3.3.3.2 Existing Design #2: ANC Gear Drive

The ANC Gear drive allows for the power of the electric motor to be converted into the back and forth motion of the saw.

3.3.3.3 Existing Design #3: The Blades

The blade is the simplest of the subsystems, but essential for the purpose of this device. The blade is what is used to cut the materials

References:

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- [2] *Gas Paint Mixer*. Digital image. N.p., n.d. Web. <https://i.ytimg.com/vi/o4QIBHXVEPs/maxresdefault.jpg>
- [3] *Sawzall*. Digital image. N.p., n.d. Web. <http://toolguyd.com/blog/wp-content/uploads/2013/09/Milwaukee-M18-Fuel-Sawzall-Recip-Saw.jpg>