



**BIOMEDICAL
ENGINEERING**

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dentomatic

Automatic Tooth Brushing/ Mouth Cleaning Device for People with Disabilities

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Executive Summary

- Many of the elderly in the nursing homes are not able to perform the simple task of brushing teeth, due to the loss of fine motor control caused by aging.
- Due to the overwhelming number of tasks required of nursing aides, **dental care is often considered to be low priority**, as the consequences of not doing so are not immediate.
- **The resulting treatments and surgeries add up to be expensive** for the patient or insurance provider.
- Lack of treatment may result in a much poorer quality of life, as it creates difficulty eating, trouble speaking, and self-consciousness.
- **Dentomatic is a device that brushes teeth automatically**. With water flow in and out, a dynamic brush head, and computer software that formats brushing to the users needs and specific mouth shape, this device will adequately and efficiently clean teeth.
- The convenience of this device will result in **increased dental care to the elderly in nursing homes, reduced number of procedures to pull teeth, reduced dental care procedure costs, improved quality of life for the elderly, and increased time for nurse's aides to focus on more immediate tasks**.

Clinical Need

The problem of **bad oral hygiene** in the elderly (65 years and older) arises from a variety of factors:

1. Physical disability with the user, which prevents the person from properly and regularly brushing their teeth. This can be due to the user having a condition such as arthritis that compromises their strength and fine motor skills.
2. Amount of over the counter drugs elderly consume. Many of these drugs cause dry mouth, which slows the cycle of saliva and lets food particulates "sit" on the teeth.
3. Those that live in nursing homes require the assistance of a caregiver in order to have their teeth properly brushed. This can be problematic since the quality of the oral cleaning hinges on how well the caregiver brushes the teeth, and caregivers are often underpaid and unmotivated to do this job well.

Some studies also showed that **oral infections such as periodontitis can lead to other systemic diseases**, such as cardiovascular disease, bacterial pneumonia, diabetes mellitus, and low birth weight. It is proposed that this is due to the metastatic spread of infection from the oral infections as a result of transient bacteremia (bacteria in the blood).

Description of Market

Our goal is to make a device suitable for the elderly who were vulnerable to poor daily dental care. The elderly homes offer an environment with numerous stakeholders a single device can be shared with. Due to the potentially high manufacturing costs we foresee in building the device, the **high-end nursing homes** are our target customers. These homes have greater incentive to purchase the best products in health care management.

- In 2006, 68% of dental expenditures came from elderly out-of-pocket.
- The baby boomer population is our elderly target for the next generation (1945-64).
- *This group has typically done better than the generation before financially, thus out-of-pocket costs will reduce due to maintained private insurance and elderly population will increase, putting more weight on insurance providers.*
- From the span of 2000 to 2035, the elderly population will grow from 12% to 20%.
- Boomers already account for 37% of all dental expenditures in the US, about \$20 billion.

What Makes dentomatic Novel?

Currently, there are **no products in the market that does what Dentomatic does**: provide a completely hands-free automatic teeth-brushing experience, while retaining the thoroughness of the electric toothbrush. The closest marketplace competition to Dentomatic is the electric toothbrushes that minimize the work to be done by the patients and the elderly. One patent that comes close to what Dentomatic is trying to achieve is the automatic hands-free brush that has been developed and patented in China. This brush contains some problems that we are trying to avoid:

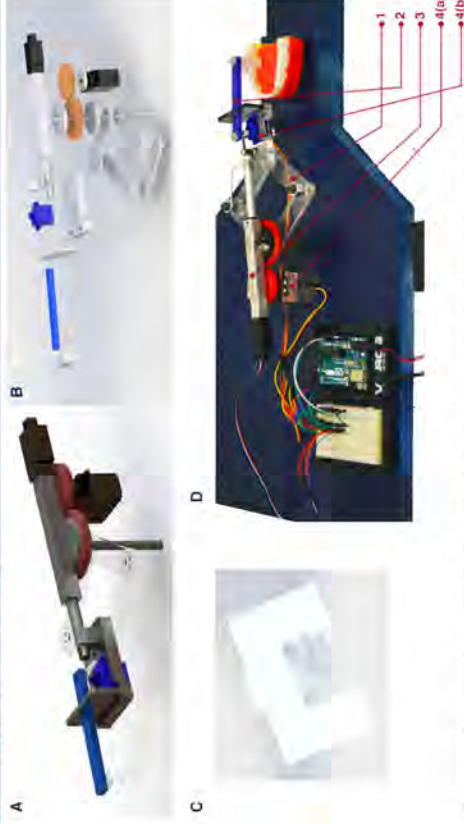
- a) the brush is very invasive
- b) the brush requires the top and bottom of the teeth to be perfectly aligned

Therefore, people with weak gum, uneven teeth, or malocclusion cannot use this brush, which is most of the cases for the elderly who are our main target users.

Anticipated Regulatory Pathway

- Composed of pantograph and toothbrush = **Class I FDA approved devices**
- **510(k) route** in trying earn the FDA approval
- Claim that our device is substantially equivalent to both the manual toothbrush and the pantograph
- **Toothbrush**: the material that composes the device as well as the function of the toothbrush head is extremely similar to that of a manual toothbrush
- **Pantograph**: approved by the FDA for dental use

Description of Design



* (A) Assembled CAD model, (B) Exploded view of the CAD model, (C) Brush-head details, (D) Picture of the prototype.

1. **Pantograph**: Translates the motion of the linear actuator and the rotational motor to the delivering end, the brush.
 2. **Toothbrush**: Delivers the motion of the pantograph. Has a brush head that is made of PDMS which is flexible and can provide pressure on the teeth from all sides, swivels 360 degrees, has nylon bristles, and has three sides of bristles for brushing of all sides of the teeth at.
 3. **Linear Actuator**: Provides in-and-out motion for the pantograph/ brush.
 4. **Rotational Motor**: (a) Provides rotational motion for the pantograph/ brush.
(b) Provides oscillating motion for the brush.
 5. **Water Pump**: Irrigates water from the tank (Not shown in picture).
- The final product has to provide dental care for the elderly, meaning that our **device must be gentle**, but still be able to provide thorough cleaning.

- Potential Hazards:

1. Resistance from the patients with dementia from having a tooth brush in their mouth
 2. Interference from the patients with the operation (move around, bite down on the brush)
- **Method of cleaning and sanitizing the device** itself is required.
- **Efficiency of the device**: the product should be able to remove plaque and other food particles, and must fit the majority of mouth sizes and shapes.

Estimated Production Cost



The production cost (manufacturing cost) is composed of (a) raw material cost, (b) labor and tooling cost, and (c) factory expenses. The percentage breakdown of the manufacturing cost is shown in the pie chart (figure on the right). The **raw material cost** is estimated to be **\$150.34 per device**. Each component will be purchased in bulk, and bulk material cost has been calculated from unit purchase assuming an exponential factor of 0.95 (i.e. bulk cost = unit cost^{0.95}). According to the model, the **total manufacturing cost** is estimated to be **\$300.68 per unit**, with **\$72.16 labor and tooling cost**, and **\$78.18 factory expenses**.

* Chang, Kuang-Hua "Cheaper & Product Cost Estimating - Product Manufacturing and Cost Estimating Using Excelise: The Computer Aided Engineering Design Series"

Acknowledgements

This group would like to thank Dr. Conrad Zapanta, Dr. Mark Carl Miller, and our TA Madeline Cramer for their guidance and support throughout the year.

