DESIGN OF A DENTURE CLEANER FOR ELDERLY IN NURSING HOMES
REQUIREMENTS

Cleaning
1.1 The denture cleaner is able to clean two dentures (i.e. upper and lower denture) at the same time
1.2 The denture cleaner is able to clean removable complete dentures
1.3 The denture cleaner is able to clean removable partial dentures
1.4 The denture cleaner cleans all sides of the denture
1.5 The denture cleaner cleans 90 percent of the dirt on the denture
1.6 The denture cleaner removes food residue and dental plaque
1.7 The denture cleaner is able to clean with vinegar in order to remove tartar
1.8 The denture cleaner does not damage the dentures
1.9 The denture cleaner does not harm acryl or porselain materials
1.10 The denture cleaner does not harm metal parts
1.11 The maximum temperature for the fluid is 80 degrees
1.12 The denture cleaner has place for two dentures with a maximum 8,41 x 6,82cm (W*L)

Use
2.1 The denture cleaner can be easily filled with fluid
2.2 The fluid can be easily disposed in the sink
2.3 The denture cleaner can not flip over or move
2.4 The cleaning is performed overnight
2.5 The denture cleaner makes sure the denture is not soaking longer than 2 hours
2.6 The denture cleaner makes sure that the denture is stored dry after cleaning
2.7 The denture cleaner does not make more noise than 60 decibels
2.8 The denture cleaner's cleaning process does not conflict with the guidelines of Ivoren Kruis
2.9 The denture cleaner fits into the daily routine of the nurse.

Appearance
3.1 The denture cleaner is nonobtrusive
3.2 The denture cleaner fits into the environment of the elderly
3.3 The denture cleaner fits on a nightstand, the maximum measurements are: 200*300 (L*W)
3.4 The denture cleaner fits in the product portfolio of Dental Robotics

Costs
4.1 The denture cleaner is sold for a price between 50 and 100 euros
4.2 The denture cleaner is produced for maximum price of 25 euros

WISHES
1. The denture cleaner is as easy as possible to clean
2. The denture cleaner is as small as possible
3. The denture cleaner removes tartar as much as possible
4. The denture cleaner removes adhesive paste on a denture as much as possible
5. The denture cleaner cleans as much of the contamination as possible
6. The denture cleaner helps the caretaker remind to clean the denture
APPENDIX B
ALUMINUM ORIENTATION TEST
APPENDIX C
ALUMINUM ORIENTATION TEST
APPENDIX D
TESTS WITH STANDARD TEST
<table>
<thead>
<tr>
<th>Test type</th>
<th>Test number</th>
<th>Date</th>
<th>Type of bath</th>
<th>Time (sec)</th>
<th>Liquid</th>
<th>Dirt*</th>
<th>Temp before</th>
<th>Temp after</th>
<th>Temp raise</th>
<th>Upper / Lower</th>
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<tbody>
<tr>
<td>A - Testing with real 'dirt'</td>
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<td>x</td>
<td>x</td>
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<td>B - 'Dirt test'</td>
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<td>3</td>
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<td>Syrup</td>
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<td>Syrup</td>
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<td>6</td>
<td>13-03-2019</td>
<td>Jeken 300 Water</td>
<td>300</td>
<td>Syrup + Peanut butter</td>
<td>17,6</td>
<td>19,9</td>
<td>2,3</td>
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<td>7</td>
<td>13-03-2019</td>
<td>Jeken 300 Water</td>
<td>300</td>
<td>Syrup + Peanut butter</td>
<td>17,6</td>
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<td>8</td>
<td>15-03-2019</td>
<td>Jeken 300 Water</td>
<td>300</td>
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<td>10</td>
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<td>300</td>
<td>Yoghurt + Peanut butter (more yoghurt) + pigment</td>
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<td>Purpose of test</td>
<td>Remarks</td>
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<tr>
<td>At dentist bus of G. Franken to see how the existing ultrasonic cleaner works with real dirty dentures</td>
<td>Did not clean well, only ink was getting off a bit.</td>
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<td></td>
<td>No good pictures, really quick test before standard test. Came off too easy</td>
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<td></td>
<td>No good pictures, really quick test before standard test. Ok for testing, but hard to apply an even amount everywhere</td>
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<td></td>
<td>Got off easier than expected</td>
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<td>Thicker application, because it came off too easy</td>
<td>Was a little bit harder, but not convinced</td>
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<td></td>
<td>Works really well</td>
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<tr>
<td>Expect that yoghurt dries out easily and in combination with peanut butter is is also sticky.</td>
<td>Worked really well, looked like real dirt</td>
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<tr>
<td>If yoghurt and peanut butter works fine, why not only use yoghurt is that is easier? Did not test before separate</td>
<td>Yoghurt only is more easy to clean, but it comes off in flakes. With peanut butter is better.</td>
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<td>Because of the pigment it is easier to see on photos where the dirt is.</td>
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<td>Open bath, temp off</td>
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<td>Open bath, temp off</td>
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<td>Control test</td>
<td>Closed bath, other colour powder</td>
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<td>Other position because it are two parts</td>
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<td>Closed bath</td>
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<td></td>
<td>Closed bath, unsure if dirt was dry enough</td>
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<td>Orientation 1, denture 1</td>
<td>5x water</td>
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<td>Orientation 2, denture 2</td>
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<td>Orientation 3, denture 1</td>
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<td>Orientation 4, denture 2</td>
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<td>More water, denture at bottom</td>
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<td>More water, denture at top</td>
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<td>Transducer fell off 5sec after stopped (5min)</td>
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<td>transducer fixed with spanband, looks like nothing is happening</td>
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<td>nothing happened</td>
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<td>Finally worked!</td>
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<td>Side and bottom</td>
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<td>did not happen too much, believe its because lijmklem was fixed there</td>
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<td>did not happen much, but water warmed up a lot, transducers and generator were also very hot</td>
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<td>tested for 3 minutes, then the wire came off</td>
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<td>Went good for 5 minutes, had the feeling that it worked well in periods.</td>
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<td></td>
<td>Tested for one minute, then the wire came off</td>
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</tbody>
</table>
A - Real dentures

A1 - Lower

A1 - Upper
B - Dirt test

**B1**

1.

2.

3.

**B2**

1.

2.

3.

**B3**

1.

2.

3.

4.
C - Existing baths

**C1a - Jeken**

1

B

A

2

3

4

**C1b - Jeken**

1

B

A

2

3

4

**C1c - Jeken**

1

B

A

2

3

4
D - Parameters

D1 - Control test

D2.1 - Water + soap

D2.2 - Water + denture cleaner
D3 - Amount of dentures: Lower

1 2 3 4

B A B A

D3 - Amount of dentures: Upper

1 2 3 4

B A B A

D4.1 - Time 3600 sec.

1 2 3 4

B A B A
D4.2 - Time 1800 sec.

D5.1 - Temp 50 degrees (5.4)

D5.2 - Temp 70 degrees (5.5)
D6.4 - Orientation 4

D7.1 - Water amount, low position

D7.2 - Water amount, high position
APPENDIX E
TEMPORARY FIXATION OF A PIEZO
IDE Master Graduation
Project team, Procedural checks and personal Project brief

This document contains the agreements made between student and supervisory team about the student's IDE Master Graduation Project. This document can also include the involvement of an external organisation, however, it does not cover any legal employment relationship that the student and the client (might) agree upon. Next to that, this document facilitates the required procedural checks. In this document:
• The student defines the team, what he/she is going to do/deliver and how that will come about.
• SSC E&SA (Shared Service Center, Education & Student Affairs) reports on the student's registration and study progress.
• IDE's Board of Examiners confirms if the student is allowed to start the Graduation Project.

STUDENT DATA & MASTER PROGRAMME
Save this form according the format "IDE Master Graduation Project Brief_familyname_firstname_studentnumber_dd-mm-yyyy". Complete all blue parts of the form and include the approved Project Brief in your Graduation Report as Appendix 1.

family name  Folders  given name  Francis
initials  F
student number  4279417
street & no.  Jacoba van Beverenlaan 21
zipcode & city  2613HJ Delft
country  The Netherlands
phone  0620685616
email  francis@folders.nl

Your master programme (only select the options that apply to you):
IDE master(s):  IPO  DHI  SPD
2nd non-IDE master:  
individual programme:  
give date of approval:  
honours programme:  
specialisation / annotation:  

SUPERVISORY TEAM **
Fill in the required data for the supervisory team members. Please check the instructions on the right!

** chair  Sander Minnuye  dept. / section:  DE - MD
** mentor  Henk Cruydis  dept. / section:  DE - AM
2nd mentor  Daan Donkhof
organisation:  Dental Robotics
city:  Delft  country:  The Netherlands

Chair should request the IDE Board of Examiners for approval of a non-IDE mentor, including a motivation letter and c.v.
Second mentor only applies in case the assignment is hosted by an external organisation.
Ensure a heterogeneous team. In case you wish to include two team members from the same section, please explain why.

IDE TU Delft - E&SA Department // Graduation project brief & study overview /// 2018-01 v30
Page 1 of 7

APPENDIX | 29
Procedural Checks - IDE Master Graduation

APPROVAL PROJECT BRIEF
To be filled in by the chair of the supervisory team.

chair: [Signature] date: 14.01.2016

CHECK STUDY PROGRESS
To be filled in by the SSC E&S (Shared Service Center, Education & Student Affairs) after approval of the project brief by the Chair.
The study progress will be checked for a 2nd time just before the green light meeting.

- Master electives no. of EC accumulated in total: 27 EC
- Of which, taking the conditional requirements into account, can be part of the exam programme: 27 EC
- List of electives obtained before the third semester without approval of the BoE

name: [Signature] date: 10.11.19

FORMAL APPROVAL GRADUATION PROJECT
To be filled in by the Board of Examiners of IDE TU Delft. Please check the supervisory team and study the parts of the brief marked **
Next, please assess, disapprove and sign this Project Brief, by using the criteria below.

- Does the project fit within the (MSC) programme of the student, taking into account, if described, the activities done next to the obligatory MSC specific course(s)?
- Is the level of the project challenging enough for a MSC IDE graduating student?
- Is the project expected to be doable within 100 working days/20 weeks?
- Does the composition of the supervisory team comply with the regulations and fit the assignment?

Content: 

Approve: N
Disapprove: N

Procedure: 

Approve: N
Disapprove: N

comments:

name: [Signature] date: 4.2.2019

IDE TU Delft - E&S Department // Graduation project brief & study overview // 2018-01-x30

Initials & Name: F. Folkers
Student number: 4299417
Title of Project: Design of a denture cleaner for elderly in nursing homes

Page 2 of 7
Design of a denture cleaner for elderly in nursing homes

Please state the title of your graduation project (above) and the start date and end date (below). Keep the title compact and simple. Do not use abbreviations. The remainder of this document allows you to define and clarify your graduation project.

**INTRODUCTION**

Please describe, the context of your project, and address the main stakeholders (interests) within this context in a concise yet complete manner. Who are involved, what do they value and how do they currently operate within the given context? What are the main opportunities and limitations you are currently aware of (cultural- and social norms, resources (time, money,...), technology, ...).

Oral hygiene is very important for your overall health. When your mouth is poorly maintained you can get bad breath and infections may occur. Poor oral care is a major concern among elderly, especially in nursing homes. Older people struggle to take good care of their teeth because they sometimes do not know how and on the other hand they are not capable anymore. In addition, care workers in a nursing home often do not have time for proper oral care.

Good oral care is necessary for people with their own teeth, but also for people with a denture, what a large number of people have in nursing homes. This is because infections can easily occur. Food can be easily trapped between the teeth and will rot as the person does not feel this himself.

The current way of cleaning a denture is by hand and putting it in a cup with water for the night. However, by hand is time consuming and they can sometimes not reach all dirty pieces. Also, some elderly do not have the strength or coordination to do this themselves.

Dental Robotics is a start-up company located in YesDelft. They have designed a toothbrush that make sure your teeth are clean within ten seconds and they are cleaned better than with regular toothbrushing. Dental Robotics will bring the toothbrush on the market for elderly in nursing homes and they will start on short-term with executing pilots in nursing homes. In order to serve all elderly in nursing homes, with or without teeth, Dental Robotics is interestest in expanding their product portfolio with a device to clean dentures.

Their product portfolio will expand to three products in order to enable care facilities to deliver better oral care in less time for all elderly:
1. Toothbrush - for elderly with teeth
2. Gum cleaner - for elderly without teeth
3. Denture cleaner - for elderly without teeth

My graduation project will be completely about the third product: the denture cleaner. The starting point will be ultrasonic cleaning, as this technique shows promising features. In theory it should be able to get into all the difficult corners and clean really good. However, existing ultrasonic cleaners are not adapted to denture cleaning and are therefore not working good enough.
introduction (continued): space for images

image / figure 1: An existing ultrasonic cleaner which has been tested with a denture

image / figure 2:

Title of Project  Design of a denture cleaner for elderly in nursing homes

Initials & Name  F. Folkers  Student number 4279417
The main focus of my graduation project will be the functional aspect of the product, making sure it cleans dentures in a proper way. In order to set the focus on this part, it is predetermined for example where the product will be used (on a nightstand), what is the maximum duration of the cleaning (five minutes) and how many dentures can be cleaned at the same time (two, so the upper and bottom set of teeth can be cleaned at the same time).

Dental Robotics already performed some test with ultrasonic cleaners. These are available on the market however these are not specific for dentures and have some limitations resulting in that they do not work properly for denture cleaning. But the results are promising in a way that the technique is very suitable for denture cleaning. The advantage of ultrasonic cleaning is that it is able to get into all the difficult corners and holes so it is able to also clean ‘inside’ of the denture, the part where it is placed to the mouth, and between the teeth. Therefore is decided to do specific research into ultrasonic cleaning and use this principle in the design.

Main topic:
- Functionality: How you can clean dentures using an ultrasonic bath? What are the parameters? What types of filth are on dentures and what is needed to remove all this filth? How to place or move the dentures so that they are cleaned most efficiently?

Side topics:
- Aesthetics: Aesthetically pleasing and fit into the surrounding of where the product will be placed.
- User scenario: What is the desirable user scenario for both elderly and care takers?

Design a denture cleaner, using an ultrasonic bath, which is used by elderly or caretakers that fits the environment of the bedroom in nursing homes in an obtrusive way. The goal is to improve the cleaning effectivity and reduce the cleaning time of dentures.

The design process will be iterative, starting with a design that is the easiest to produce and later on expand to improved versions with more features. During the process (a) working prototype(s) will be made. One important aspect of the product will be the manufacturability, in all choices this has to be taken into account.

First will be investigated why it is hard to clean dentures and what kind of filth is on the denture. Then an extensive research will be performed into ultrasonic waves and cleaning. Subsequently, I will quickly switch to designing an ultrasonic bath and making it work. Using multiple iteration I try to improve the concept and in the end hopefully create a working prototype including aesthetics.

Needs for the product: 1- Cleans two dentures at the same time. 2- Can also be used for partial dentures. 3- Cleans bacteria, fungi and food from dentures completely. 4- Cleaning takes 5 minutes maximum. 5- Easy to dispose water. 6- Robust, will not fall off nightstand.

Eventually nice to have: 1- As small as possible. 2- Can also be used to store denture overnight. 3- Easy to fill with water. 4- Removes Kukident, 5- Batteries instead of cable power.
**PLANNING AND APPROACH**

Include a Gantt Chart (replace the example below - more examples can be found in Manual 2) that shows the different phases of your project, deliverables you have in mind, meetings, and how you plan to spend your time. Please note that all activities should fit within the green net time of 30 EC = 20 full time weeks or 100 working days, and your planning should include a kick-off meeting, mid-term meeting, green light meeting and graduation ceremony. Illustrate your Gantt Chart by, for instance, explaining your approach, and please indicate periods of part-time activities and/or periods of not spending time on your graduation project, if any, for instance because of holidays or parallel activities.

**Denture research:** Current way of cleaning dentures, talk with target group, talk with denture expert(s)

**Ultrasonic research:** Ultrasonic waves & ultrasonic cleaners

**Ideation 1:** how to create an ultrasonic bath; what are the components, determine what are the parameters etc.

**Prototyping & validating 1:** First ultrasonic bath, can I make it work?

**User scenario:** for elderly and caretakers

**Aesthetics:** What does fit in the environment & with Dental Robotics

**Prototyping & validating 1:** Keep on with making it work, validate use

**Final design:** Determine final principle, aesthetics and use scenario, will follow from last ideation/prototyping/validating.

**Detailing:** Finalizing the design, if possible, create a working prototype.

**Report:** Start already in the beginning of the project with making visuals for the report and keep this up to date. Set fixed timeslot every week to work on text.

The aim is to use the three iterations, but due to if the prototypes will work it can be less or more. This will be discussed in the mid-term evaluation as well.
MOTIVATION AND PERSONAL AMBITIONS

Explain why you set up this project, what competences you want to prove and learn. For example: acquired competences from your MSc programme, the elective semester, extra-curricular activities (etc.) and point out the competences you have yet developed. Optionally, describe which personal learning ambitions you explicitly want to address in this project, on top of the learning objectives of the Graduation Project, such as: in depth knowledge on a specific subject, broadening your competences or experimenting with a specific tool and/or methodology, ... Stick to no more than five ambitions.

When I started searching for a graduation assignment, I knew what I wanted to do during my graduation: completely design a technical product but did not know what kind of product I wanted to design. During an earlier internship I realized that maybe a start-up is a right company for me, because it is a young and freer environment. Therefore, I started looking for a graduation project at start-ups. Via YesDelft I came in contact with Dental Robotics, they wanted a graduate intern who could design a cleaning device for dentures using ultrasonic techniques. So, the focus will be on the technical development, but I can also design the aesthetics of the product. An ideal combination for me and I believe that as a designer you need to be able to design all kinds of products, therefore denture cleaning is a challenge to me.

Competence to show I am good in: planning
I really like to plan projects to have clear for myself and others what I will do when and when I will deliver stuff. Although it is a little bit harder with an iterative process, I really want to show that I can work with deadlines I set for myself and complete a full project in 100 days.

Competence to show I am good in: visual and oral presenting in a clear way
As I said above, I like to have everything clear for myself, also with presenting. I would like to present all the technical information in a way everyone understands with the help of clear and nice visuals.

Competence to further develop during graduation: try, fail, learn and try again
Sometimes I tend to try something only after I have completely thought it through. The big challenge for me in this project is to quickly test things and have the courage to just try it out. And when it does not work? Learn from it and try again.

Competence to further develop during graduation: devote to deep dive
When looking into a topic I sometimes do not understand the phenomenon exactly. When this happens, my motivation will become less, and I will get a little bit stuck in the process and lot of time will get lost. During my graduation I want to take a deep dive in the topic of ultrasonic waves and I ask from myself to really devote to that. When I do get stuck, I must take immediately action and search for an expert who can help me.

FINAL COMMENTS

In case your project brief needs final comments, please add any information you think is relevant.

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