# Relay

Rock 'n Sleep

Eindhoven University of Technology,
Bachelor College Major Industrial Design

DPB100 Project 1 Design
Vital Change

2019/2020, Semester B
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# Introduction

This report is about Project 1 with the theme ‘Vital Change’. We aimed to design a productto improve the current situation regarding sleep deprivation. This report explains our process during this semester regarding our taken steps, discussions, and plans for the future. We reflected on our past developments and established new steps to take, based on user tests and research.

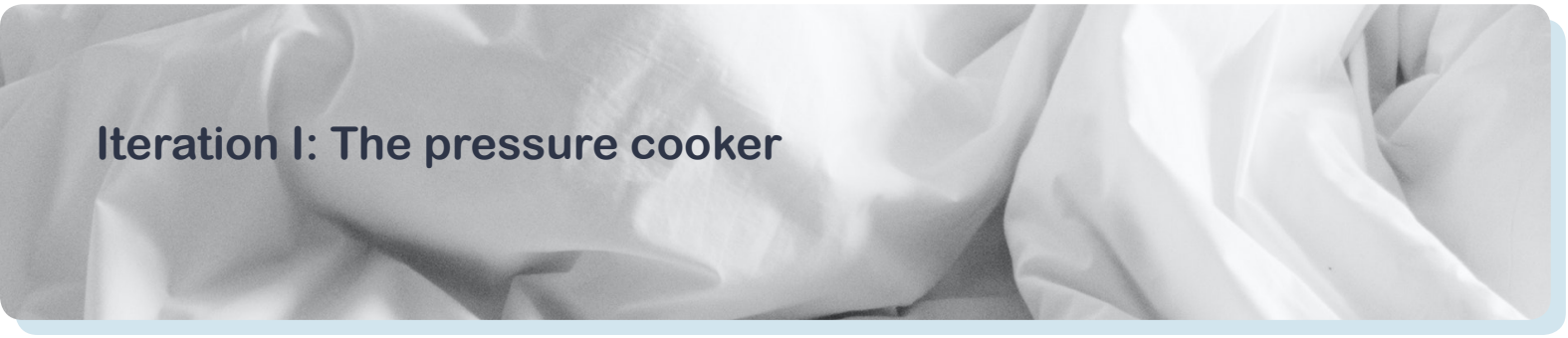
Vital Change in designing contains a product, service, or system designed to help people with their health and way of living. Our main focus landed on mental health since this subject spoke to our professional vision the most. Our established target group is 16-25 years old, who struggle with sleep deprivation caused by external or internal stress. ‘Sleep deprivation’ is defined by people sleeping at least one hour a week at least less than the eight recommended hours you should sleep every night (Jones, 2017).

# Project Goal

Our group has one main goal during this project: finding a solution to the question ‘How do we get people with the age of 16-25 and with sleep deprivation because of stress falling asleep so that they will not have sleeping issues anymore?’ We want to achieve this goal because this is a long-lasting problem, many people are dealing with it and if nothing is done about it, it can cause insomnia and much worse physical and mental health problems (American Sleep Apnea Association, 2017), which we want to prevent. It can affect your daily behavior the bad way of being tired all day instead of active, and that is the reason why tackling this problem will solve a lot of problems.

# Process

Our process consists of different iterations which we will be talking about in the next chapters. All of our iterations exist of ideation or brainstorming part, doing a test, research or processing some information, and then implementing the knowledge we got from that in the design as a solution for the problem. The outcome of every iteration is a basis for what we want to do in the new iteration so that we make our product stronger and more reliable in each iteration.



# Iteration I: The pressure cooker

## *Introduction*

In the pressure cooker, by defining our interests and what is a healthy lifestyle precisely, by ideating based on this brainstorming and by validating the idea we came up with, we got our first idea.

## *Goals*

The goal of the first iteration goes through a design process in a very short time. Another goal the pressure cooker had, was getting to know each other and our interests. We wanted to reduce stress in our target group and make someone's lifestyle healthier.

## *Methods*

### Defining and ideation

We started this pressure cooker by defining what a 'healthy lifestyle' meant for us. All of the things we wanted to brainstorm about, we formulated into a question for ourselves so that we could all give answers. We also made mind maps to get our visions clear (figure 1-4). We then continued to write down all the existing products, services, or systems already providing an option to improve our lifestyle, to what is already on the market, and what could help us. We also discussed the people we wanted to design for and how they would fit in the directions we found interesting.

By combining what we had written down we came up with our idea. We thought about what it could do, how it would help people, how it would look, what it would be made of, and when you would use it, to get an overall image of what it would be. To make it even more visual for ourselves, all of the group members made a sketch, we saw that everyone thought the same(figure 5-8).

### Research and validation

To test if our first concept would work and what people in our target group would think of it, we interviewed a person from our target group(see appendix 'A. Iteration I: Portrayed concept' and 'B. Iteration I: Interview with the participant'). We received some great feedback regarding size, color, extended features, and interpretation.

*Results*

Due to talking to each other and brainstorming, we decided that we all had the same interests for mental health. Also, we made the decision that we did not want to make an application for electronic devices. Our interests lie also in wearables, which could do a lot of measuring in health. We do not want to design for elderly people, because that did not interest us.

The concept we came up with was a design aimed to relieve stress during the day. Our target group would be between 16 to 30 years old because we figured this age group struggles the most with stress from external factors such as academic/work or sport pressure. We also recognized the problems of this age group ourselves. It is scientifically proven that lowering your heart rate decreases stress and reduces panic attacks. Lowering your breathing tempo is also proven to reduce your heart rate. Therefore, our design, this pulsating ball would measure your (irregular) breathing tempo, synchronize with the tempo of special foam being able to form to your hand, aimed to get the most natural feel so you wouldn't be distracted by the form of feel by the ball. It could also be inside your clothes.

by pulsating at a given rate, slowly reduce and regulate the tempo, resulting in helping you to hang on a tempo for your own breathing tempo, eventually reducing the breathing tempo, heart rate, and stress. This stress ball can be used everywhere since its relatively small and tangible. It can be used throughout the day to get a few 'zen' moments when the user would be in the workplace, university, or right before going to sleep. The stress ball would be made of special foam being able to form to your hand, aimed to get the most natural feel so you wouldn't be distracted by the form or feel by the ball.

The feedback we got from our interview with the user was that the product should be small and subtle including a down to earth color, making sure it would not be too awkward or uncomfortable to be used in public spaces. The product integrated into clothes is also a great option making it even more subtle and with the breathing instrument attached around the chest area. Maybe a wireless connection to connect the product with (noise-canceling) headphones could help, so that relaxing sounds from the product can be used in public spaces too. We learned from this that our concept needed some more validations and research to make it work in the end.

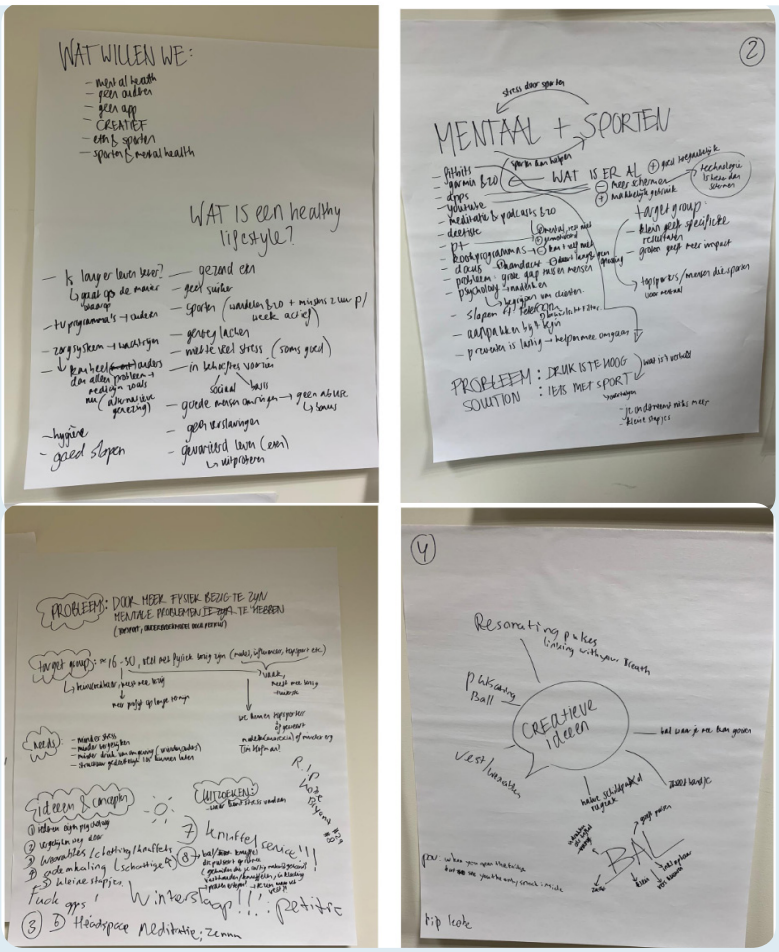



*Figure 1-4, The results of our first brainstorm meeting including a mind map and basic questions we wanted to answer.*

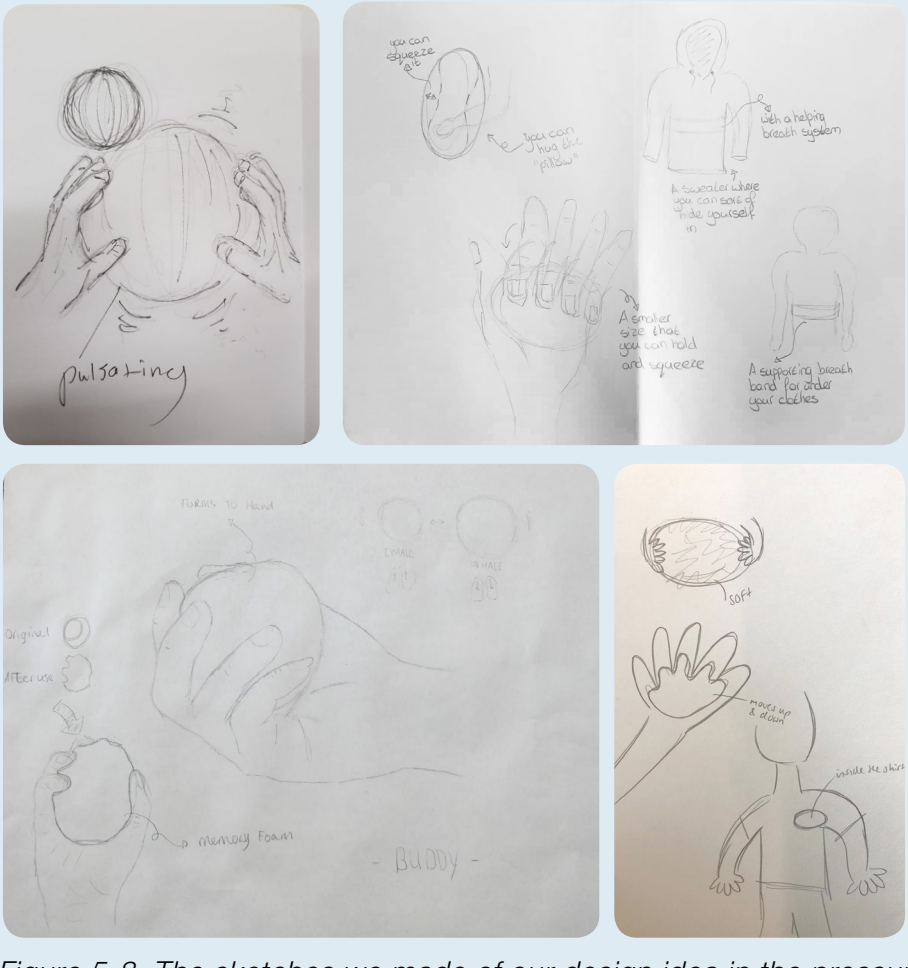
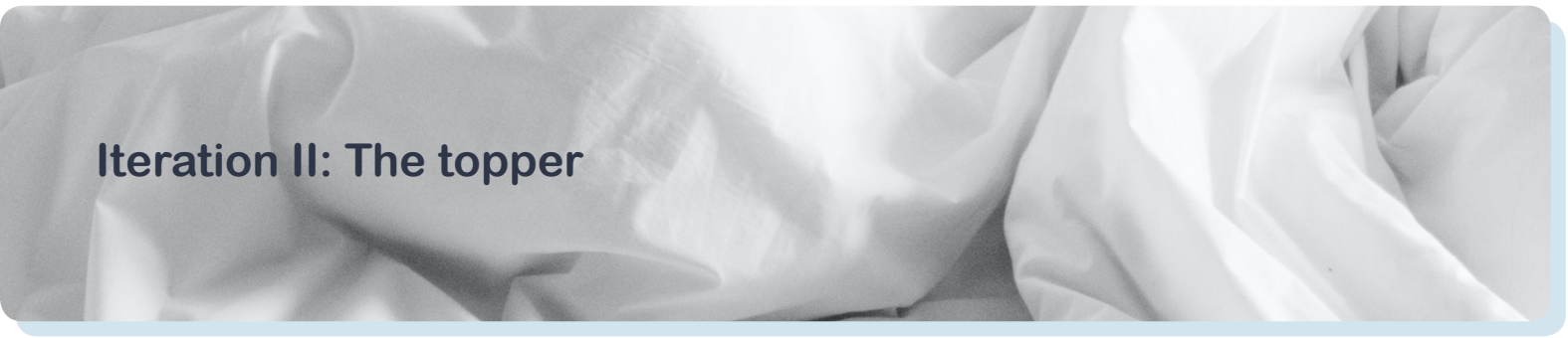



*Figure 5-8, The sketches we made of our design idea in the pressure cooker.*



# Iteration II: The topper

## *Introduction*

This iteration, we started the design process all over and began with doing more research on different directions, brainstorming, we ideated in another direction than we were used to and we did a physical and digital user test to make conclusions on our new idea. .

## *Goals*

Our goal is to come up with new ideas than in the pressure cooker. A second goal is to gain more knowledge of our target group by evaluating their problems and needs by doing a user test. We want to give this project more structure in times of having planning and tasks. We want to come up with a working solution for getting our target group to sleep.

## *Methods*

### Structuring the project

We started by preparing our vision and goals for the upcoming semester. Our qualities, our weaknesses, what we'd like and dislike, what we wanted to improve during this project, what goals we'd like to achieve. We then proceeded to make planning for the upcoming weeks and global task division and decide who would be responsible for what deliverable.

### Brainstorming about directions

We were advised to get back to the drawing board and forget the past idea for a moment. This was not just on the initiative of the coaches but also on our own. We started again by coming up with health problems. Again did we looked at what was already out there and focused eventually on three groups (Mental health, Food, and Insomnia). We did this by creating a mindmap(figure 9). These directions were established by combining our visions. We wanted to focus on a lot of research this week to enhance our knowledge regarding these three topics, so we decided to do all research in each of the three directions and come up with five to ten ideas in each direction.

### Deciding our direction

After having done all our research and creating ideas, we all sat together. We discussed per direction what each of us came up with so that we knew per category what was the input and the knowledge now. We wrote down the interesting ideas per direction (figure 10-13), individually, when the others were talking about their ideas. After this, we needed to choose individually the three best ideas per direction. We discussed them and saw some of the same ideas which were chosen by each of us. We looked into each category to determine which ideas had most of our interests, and by doing that we came out in the direction 'Insomnia'.

That is when we chose a specific target group, for better and more specific results. With that in mind, we chose a target group who fitted also our interest.

Then we wanted to agree on a product. We looked at the ideas we found the most interesting in the direction we chose, which were a projector, wearables like a pajama or a bed/mattress which could move. We also thought about product sets, like a blanket with a pillow and pajamas, but that would be too much at once. When we wanted to choose one out of these three main ideas we liked, we were stimulated by our project coach to set up a question instead of instantly thinking out of a product. We would first need to find information on the question before determining a product so that our product would be better substantiated. Our main question was: How can we decrease people's stress in bed when they want to fall asleep?

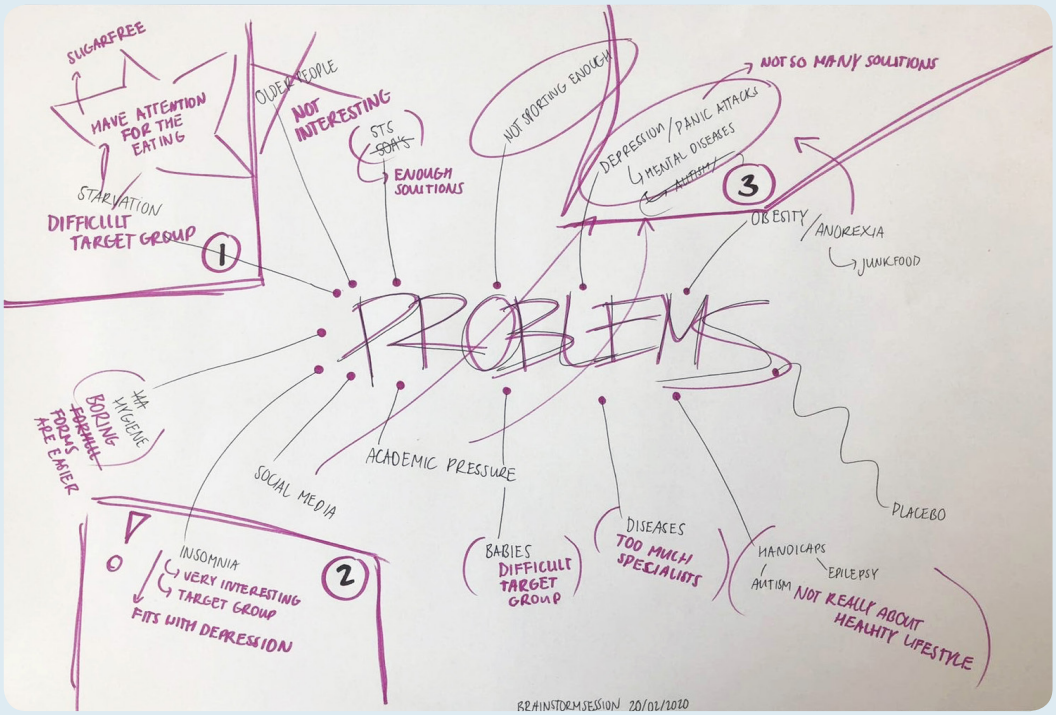
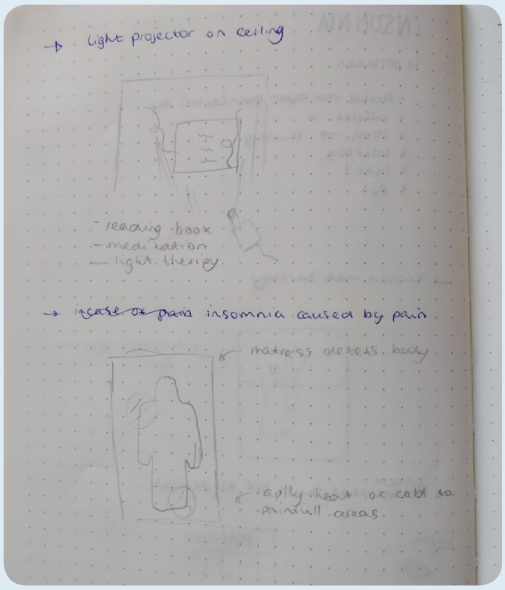
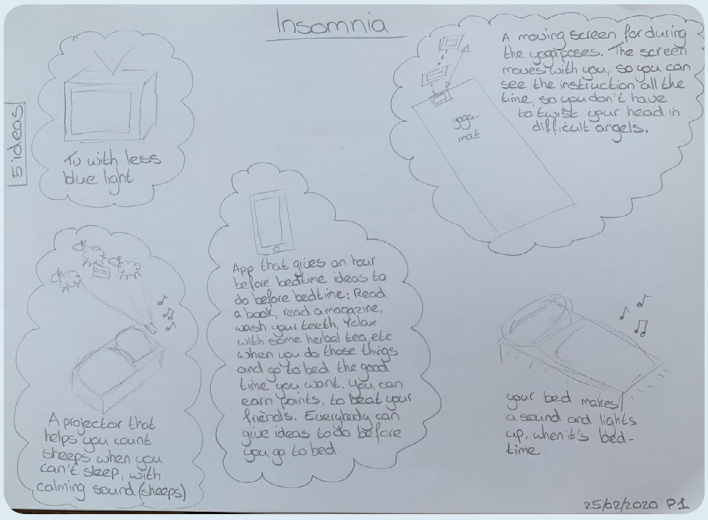



*Figure 9, The mindmap with the different directions and discussing points after starting all over.*







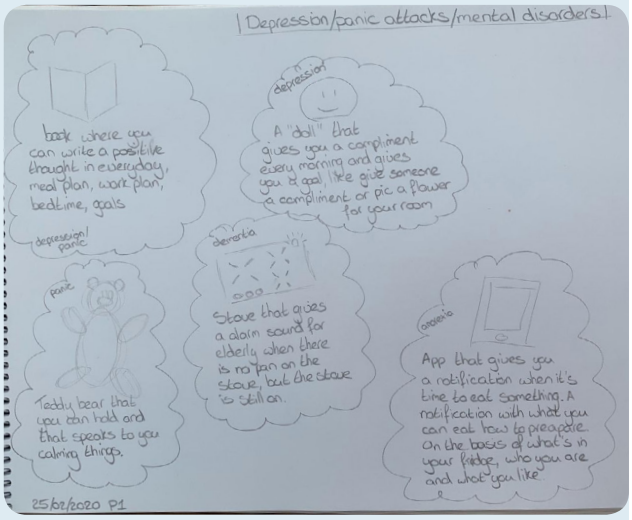




*Figure 10-13, Ideas per direction we came up with.*

### *Questionaire & user test*

All these products we had come up with would focus on your breath, which would decrease your heart rate and your stress in bed, like in our first iteration. But we wanted to find out in what way this would work, by trying to confirm our assumptions and ideas and fill out the blank by creating a questionnaire aimed at our target group. We all made some questions and discussed them to make a final questionnaire and a user test. When we were establishing what our user test would look like exactly, we also tried on ourselves what we wanted to do, to make sure that we knew what to do in the user test exactly and that we gathered info that was important. Therefore, Kim tested Britt with a jacket (simulating a blanket) on her and her fry with pasta salad to simulate weight on a blanket, but also she put a jacket on Britt's head and tried to move that slowly to see how Britt would react(figure 14 and 15). This worked out the way we wanted to, so that would be our test. Of course, we also made an ERB and consent form to get to know more about the ethical aspects of designing and to let the participants sign and see their rights (see Appendix 'C. Iteration II: Consent form & ERB form').

So, we made a questionnaire with some questions to determine how bad the case of the sleeping issues was per person, but also the reasons for the sleeping disorder precisely and what they had already done about it. Next to these questions who everybody could answer via the internet, we also include some questions which could be answered only if we did the user test in person. Those were questions we would answer ourselves by asking the participants at the moment they were experiencing a test or right after, what they thought about it. We tried to make the question as open as they could be, just to receive a reaction naturally. We sent the questionnaire right away to our target group so that we could evaluate the results with the ones from the user test on the next Thursday (see 'D. Iteration II: Questionnaire of the user test').

We sent the questionnaire to our target group online. We were supposed to do the user test with 5 people, but unfortunately, due to a lack of participants in time, we performed the test with 3 participants. The original amount of five people was chosen because of the scientific research that showed that with testing five different people you would not get more results than we already would have (Nielsen, 2000).

In the user test, we simulated a bed (figure 16) so that we ould do our usertest in a convinient plase, the univerity. We took all the equipment for a good 'real' user test with the participant, for example, a pillow and a sleeping bag, but also an air mattress (figure 17). We first explained to the participants why we were doing this and what we were going to do and let the participants fill in the first questions of the questionnaire, till they saw the questions which were related to the physical user test. We told them to lie in the bed and to relax. We gave them the 4-7-8 breathing exercise (figure 19) (see 'E. Iteration II: Breathing exercise of the user test') and put on a heart rate sensor and a tight sport band around their chest. After they had done this for two minutes, we changed the band to their belly and did the same, and after that without a band. Then, we used a Wizard of Oz technique by putting weight on their blanket (a jug) and rolling that slowly over the whole body (figure 18). We also moved their pillow a little bit. After all those tests we asked what they found of it and if they would fall asleep from it and noted it down in their questionnaire. We asked which method they liked the most and if there were some other things they wanted to tell us.

The Thursday after we sat together, to evaluate the outcomes of the user test and the questionnaire(see Appendix 'H. Iteration II: Conclusions of the user test'). We wrote down all the most common answers and answers that were remarkable and brainstormed about how we could include this information in what kind of design we would make. We went through different possibilities and the ideas we had before and tried to implement all the findings in a design.

### *Finalizing*

We came up with an idea and sketched it to make it more visual. After having this idea we focused on our mid-term deliverables: the pitch, posters, the report, and the prototype. We set some deadlines for the things we want to establish and who is responsible for it. We tried to give everybody the task they would learn from and helped each other by evaluating what we had made and giving some feedback.

We came up with the topper 'B-asleep' because that fitted best with our information and sketched our prototype, with all the features we wanted it to have because of the outcomes of the user-test. These features were the following: A topper could be rocking so that you fall asleep, it could move slowly. It can also be foldable so that you can sleep everywhere like you want to sleep, the technology in it could be connected to something that would measure your heart rate so that it could stop moving when you would sleep, also to save energy. Besides that, it could have settings for the technology to make the movements personal and it could deliver sound in the technology that could give you breathing exercises or cam sounds. When we thought about how this would work exactly we came up with the topper who has areas that can blow up.

### *Results*

For this project, we chose the direction Insomnia. We decided that our target group became people of 16-25 years old (because this is our age, we know their problems, and this is the period in which there is a lot of stress about school, and work) suffering from insomnia minimal once or twice a week, caused by stress (like thinking constantly about a test they have to make the next day), meaning they would sleep a minimum of one or two hours in the night less than the recommended eight hours.

Things that stood out in our test were that everything that felt like sleeping like a baby, like rocking, worked in falling asleep. Also, the breathing techniques worked out well after a time of practicing these. We also noticed that the way of sleeping is different for each person and the parts of the body they like things on (like the weight). Things we noticed furthermore is that most of the people have already tried much, also breathing exercises and that they work sometimes.

During the evaluation of the user test, we already had some things we could do better in the next user test. For example, doing the breathing exercise a few times before the real user test. Because now after three times doing breathing exercises with the prototype, the user found the third time the best, because they had the breathing technique under control. And informing them about chest and belly breathing? Or that we just need to put one question in a question box and not two at once, even though it is a follow-up question because people forget two answers one of these two. We learn from it.

We came up with the topper 'B-asleep' because that fittest best with our information and sketched our prototype, with all the features we wanted it to have because of the outcomes of the user-test. These features were the following: A topper could be rocking so that you fall asleep, it could move slowly. It can also be foldable so that you can sleep everywhere like you want to sleep, the technology in it could be connected to something that would measure your heart rate so that it could stop moving when you would sleep, also to save energy. Besides that, it could have settings for the technology to make the movements personal and it could deliver sound in the technology that could give you breathing exercises or cam sounds. When we thought about how this would work exactly we came up with the topper who has areas that can blow up.


*Figure 14-15, Testing within our group if the test we had in mind for our user-group would work.*

*Figure 16, Our simulation for a sleeping  place.*

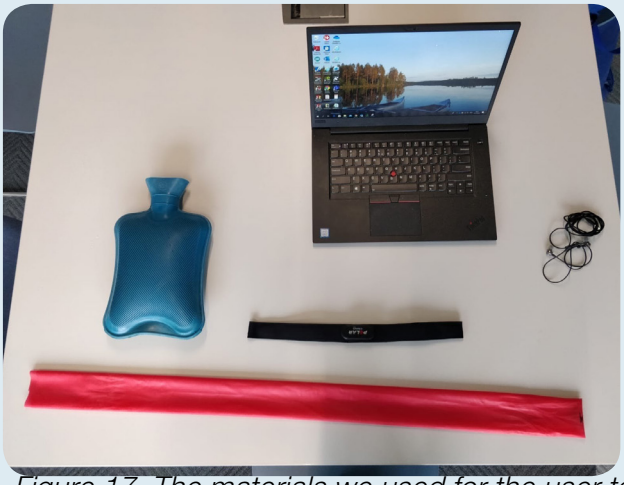
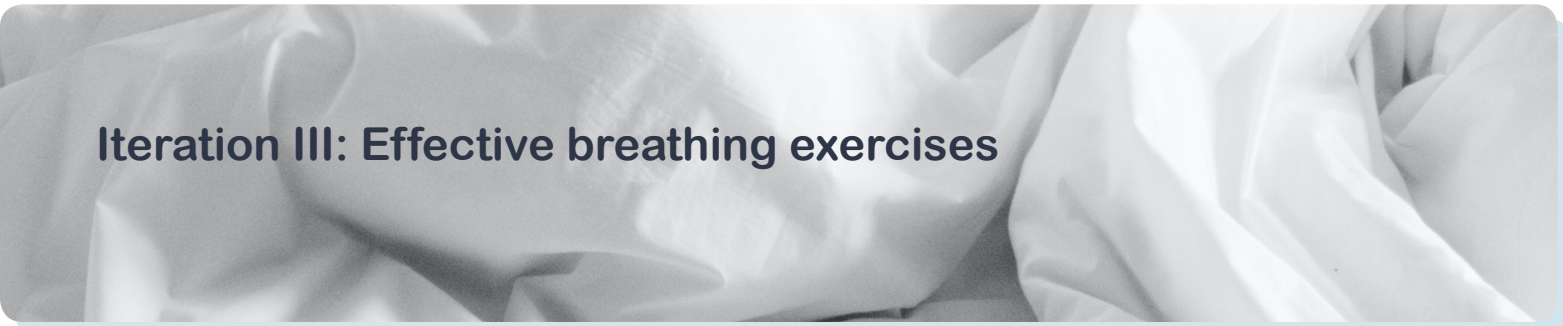


*Figure 17, The materials we used for the user test.*

*Figure 19, Participant doing the breathing exercise.*

*Figure 18, rolling with a jug over a participant to see how they react.*



# Iteration III: Effective breathing exercises

## *Introduction*

Because of the Coronavirus, we go in a new direction: designing in a digital way. In this iteration, we are going to do more research in-depth on the aspects of our design. To establish this we are doing a user test with our target group and make conclusions from it.

## *Goals*

The goal of this iteration is to come up with solutions to do our project digitally from now and already thinking about the steps we want to take after this iteration. A second goal we want to achieve is getting to know our target group more to see which breathing exercises work for them. The third goal is to get more information about materials, how babies and toddlers sleep and fall asleep, and what exists already that looks like our prototype.

## *Methods*

### Research

Because of the Coronavirus, we first decided to come up with different solutions to go further with our project. From those ideas, we made plans and divide them into the next three iterations. We divided tasks for different research subjects: materials for our design, the sleeping behavior of babies and toddlers, what exists already that looks like our prototype, what kind of breathing exercises there are and how they work, but also how we are going to perform the user test we had in our heads: a sleeping diary for our users in which we let them test different breathing exercises in their own bed.

### The sleeping diary test

In the next meeting, we discussed outcomes by telling all the bullet points and read each other's materials. We discussed what we wanted to do exactly in the future and in the user test and made a format for all the participants, with on it: how it would work, what they needed to do exactly, how long the test would take and we looked for all the breathing exercises that needed to be in there, to get it all clear. We all gave feedback on the first template and sent our acquaintances a message to know how many people would help us. Our starting point would be five participants (for the same reason as in iteration II), but the more the better. Eventually, we had eleven participants. We adapted the format for the participants and sent it to them. Of course, we also made a consent and ERB form (see appendix 'F. Iteration III: Consent form & ERB form') and checked these with our project coaches. To make sure of the anonymity of our participants, we sent the sleeping diaries via WhatsApp, because this has end-to-end-encryption. We would give all the diaries a participant number and put them into One Drive, and we would know ourselves from which person that diary would be. After the test, we read all the results and drew some conclusions. We thought about how this would influence our design and made that decision based on the tests.

We also divided tasks for the postponed midterm demo-day now that the deliverables were a bit different than we thought at first, so we discussed the tasks and prepared them.

## *Results*

From the research we did, we found about the materials that using memory foam as the material for the mattress topper provides room for the moving sensors underneath. The topper would have ventilating properties since memory foam toppers are traditionally made from a mix of memory foam and cold foam. This is to provide back pressure since memory foam alone will let you sink through the bed (van Leen, 2017).

About the sleeping behavior of babies, we know now that they sleep on their back to prevent SIDS (sudden infant death syndrome), babies like being completely strapped in because they have no control over their limbs which messes with their balance and gives them a feeling of falling, babies like being rocked, depends on if they are strapped in or not, but even if they are it depends on the baby. That rocking needs to be in a very slow and consistent tempo and babies calm down and stop moving immediately after they are carried. Kuroda and colleagues at RIKEN determined that the calming response is mediated by the parasympathetic nervous system and a region of the brain called the cerebellum (Latin: little brain) (Bergland, 2013).

About the sleeping behavior of toddlers, we found out most of the factors lead back to psychological problems. The sleep problems are caused by different factors than with babies. Starting with a sleeping structure is a good idea, and there are many tricks to let them better fall asleep, like the standard extinction: when the parents bring their toddler to bed sleepy but awake and do not pay attention to them anymore.

Furthermore, something that exists already was the anti decubitus mattress, which is for people that are paralyzed to prevent bedsores. This mattress works also with air that blows different parts up. This mattress has another goal then our problem, but maybe we could dive into it more to see if it works for our target group.

We decided to test one breathing exercise per day seven days long because this would be a not too long period for people to do the user test, but we could test a lot of exercises in this way. There were some evening questions right before the exercise and some in the morning after. These were about things they did, eat or the breathing exercises. We wanted the participants to live their usual life, and test how these exercises were working then, but one thing was sure: the questions were not allowed to be answered via the mobile phone, to prevent that they would be awake because of their phone (see appendix ‘G. Iteration III: Sleeping diary format’).

We have noticed that there were some people we could have reminded more to do the exercises in the evening (conclusions see appendix ‘H. Iteration III: Results of the sleeping diary test’). There were many participants who forgot a few days of doing the exercise and did not do all the exercises in the end. Therefore we could not take the exercise they found the best into account. Also, all the participants had really different habits like drinking alcohol during the day or their bedtime. But the thing we found from all the tests that were completed was that the exercise with calming music on the background (6) was the most appreciated. Therefore we decided to change our design in the mattress we already had, but with the function to play calming music, with the mattress moving in the rhythm of the music. From our test results, we could conclude the chosen calming music was not anonymously. That’s why we give our users the option to pick out their own music while using our product.

# Feedback evaluation (Midterm Demo Day)

After the midterm demo day, we have gotten a lot of feedback from peer reviewers, our coaches, and our second assessor.

We sat together and we evaluated all of this feedback and made some changes for the rest of our project. The main adjustment is that we are going to look more in detail on the differences between sleep deprivation and medical illness insomnia and decide for which of the two we are actually designing. Insomnia is a disease that is hard to cure without medicine or some medical therapy, whereas sleeping problems are more common and represent the earlier stages of insomnia.

We established a set of new sub-questions regarding different aspects of our concept.

- What is the difference between insomnia and sleeping problems and on which of these concepts do we want to focus and why?
- What exactly is being in a 'relaxed state' of mind and body?
- What technological mechanism would represent the desired moving motion in our topper the best and can we think of a different technical realization than u using air chambers?
- What kind of knowledge or information do we want to retrieve from specialists and doctors and in what way could they help us progress?

In the previous iterations, we noticed we hadn't paid enough attention to the Business & Entrepreneurship aspect of our design and the Technology & Realization aspect. We will start the oncoming iterations with research regarding our sub-questions, a technical realized prototype, and later on, the business aspect of our design. Also, for the Demo Day deliverables we got the tip to use a voice-over.

# Iteration IV: The big research

*Introduction*

After receiving feedback during the Midterm Demo Day, we got a lot of new questions and features to think about. Therefore, we researched and thought about a lot more aspects of our design, and reviewed them with some experts.

*Goals*

Our goal for this iteration is to find new information via the internet and experts about: which technical system would be the best, what the difference is between sleep deprivation and insomnia, what relaxation is precise, what the Anti-decubitus mattress can deliver us, the relation between mental sides and physical sides of sleeping problems, the heart-rate when you are asleep and the aesthetics of our product, to make well-argumented decisions for our design.
Methods

*Research*

We started out by evaluating which themes we needed to do research based on our feedback. After that, we divided the themes and papers between the group members based on who wanted to learn what and who was interested in which subject. Most of the categories were researched by searching on the internet for information about that subject, but for instance, for the aesthetics, Kim made an exploratory sketch to explore the possibilities.

*Being the user*

After doing this research, we discussed what we had found and adapted our design based on that information. For the technical system, we needed to make a decision on a system with the air chambers, as we had for the Midterm, or for a more mechanical way with motors. We discussed the pros and cons but still were doubting about the two techniques. Therefore, we made a persona and a customer journey map to all crawl into the skin of our user and depict how the two systems would feel. We lie in bed, discussed, and vote on which system it would be.

*Usertesting with experts*

After we made new decisions, we wanted to test our product this time with another audience than our users, but with experts who could give us advice from other perspectives. We set up a mail (see appendix 'I. Iteration IV: Mail and answer'.) with all of the newest features of our product and some questions on what they found about it and some more general questions. We searched for researchers in our area and sent it to them with the question if they wanted to answer our questions or maybe wanted to answer them in a meeting with us. We got one answer via the mail with prof. dr. S. (Sebastiaan) Overeem, general physician/somnologist and also a researcher on the TU/e and we did an interview with Jana Thomas, a Ph.D. student at Radboudumc, Nijmegen and currently researching the relationship between chronic sleep deprivation and the development of Alzheimer's disease. With the feedback and answers we got from them, we changed some features and got more feeling for what was so unique in our design. From Jana, we got some more interesting papers about the features we had in our product like how stress was related to sleep, how a rocking movement and sound affect your sleep, and your memory. We investigated them and made some last adaptations on our design for this iteration (American Sleep Apnea Association, 2017).

*Results*

For each of the themes for research, we got some important results. For the technical system, we found out that the noise of air-filling chambers was as hard as whispering with the AS-M001 Nagomi. Also, we found out that a lot of massage chairs worked with electrical motors and wheels in different corners which can turn (Futurescoop, 2019). For the difference between sleep deprivation and insomnia, we found that insomnia is much worse than sleep deprivation. Insomnia is often caused by a stressful event. You have to think of people who stare awake all night at the ceiling. Medication is often involved and the health problems are enormous. You can often not change it yourself, it takes doctors, while sleep deprivation is something you cause yourself by choosing to go later to bed, for instance, because of work or school. You can change this yourself by re-prioritizing sleep above all else or planning power naps, but if you do not change it, it can become insomnia (American Sleep Apnea Association, 2017). About the relaxation, the important parts we found are that the body moves towards a state of physiological relaxation where blood pressure, heart rate, digestive functioning, and hormonal levels return to normal levels. It is a combination of a relaxing mind and body (Scott, 2020). When the sun goes down and darkness occurs, the pineal is ''turned on'' and makes melatonin, which causes sleep. Taking extra melatonin during the day may reset your biological clock in an undesirable direction (SleepFoundation.org, 2020). The heart rate variability increases during relaxing and recovering activities and decreases during stress. The heart rate variability (HRV) is the variation in time between consecutive heartbeats (Firstbeat, 2019). About the anti-decubitus mattress, we found that the movement can go as slow as we want, but that we need to take into account the weight of the person (Medipoint, w.d.). A conclusion about the mental and physical side of sleeping problems is that preventing mental issues can prevent physical health issues. Also, when you are physically not well, it can badly affect your mental state, which brings you in a cycle (Erten-Uyumaz, 2018).

Based on these outcomes, we changed our target group from insomnia to sleep deprivation, since we want to prevent insomnia, and since insomnia is much more complex. Also, we decided that our product needs to have a function where you can set your weight because of the pressure. About the aesthetics, we decided that we just kept the form of a topper, since this is the most convenient for over your mattress and the other forms do not have a certain added value over the uniqueness of the concept. Also, people stay mostly with what they are comfortable with and definitely in bed, since sleeping must feel comfortable.

We chose for the mechanical system for the technical side, with motors and wheels like a massage chair, since most of our group members would have liked that better when we imagined it as Bo(figure 21 and 22).

From prof. dr. S. (Sebastiaan) Overeem the key learning point was that our concept was still a bit too vague for showing it to the public. He could not answer a lot of our questions because of this. From Jana Thomas, we noticed that there were already some products regarding this on the market, or to make people just awake (the Smart Sleep of Philips), but that the combination of the music and the rocking movement was really unique about our concept and interesting.

From the papers and websites she gave to us, we found that when you rock a bed on a frequency of 0.25 Hz, it is proven to facilitate the transition from waking to sleep and increases the duration of the stage N2 sleep. In this same research, the level of auditory stimulation was around 37 dB, which worked for the same goal (Bayer et al., 2011). Also, the vestibular stimulation (the rocking movement) stimulates the N2 stage for two hours, but not if it was moving the whole night. This is true for rocking on the pitch and roll axis(figure 23). Also, the memory performance is better when the rocking was applied, but there was no difference between rocking for 2 hours or for the whole night (Omlin et al., 2018). Besides, you need a bit of stress during the day to be tired at the end of the day (van Reeth et al. 2000), but the surplus of stress which causes no sleep, we take from our users by our working concept. Based on this information, we decided to use the same frequency (0.25 Hz) for our movement (and music on the same rhythm) and the same axis' of movement, the same sound level (37 dB), and stop these two elements after two hours.

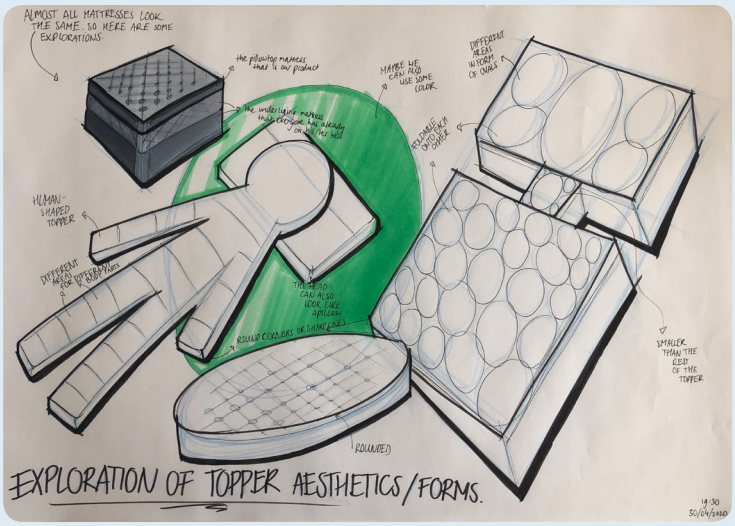



Figure 20, The research of the aesthetics of our product.

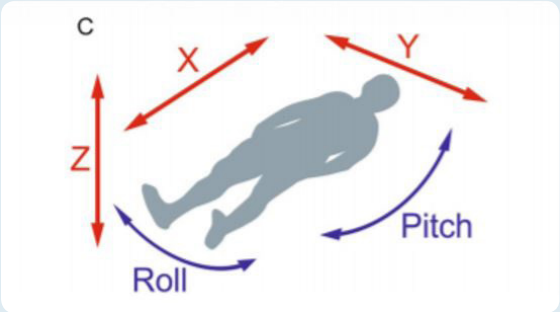



Figure 23, The axis' of movement.

## Customer Journey Map, B-asleep

Project 1, 01/05/2020

**Scenario**

Bo is a 22 year old student, with a busy live. She wants to have a good bed rest, with no stress before she finally falls asleep.

**Goals & Expectations**

Bo is a fulltime student with a side job, and is sporting. This makes her feel stressed when she wants to sleep and makes her awake in the middle of the night.

| Problem | Attempt 1 | Attempt 2 | Attempt 3 | Attempt 4 | Solution |
|---|---|---|---|---|---|
| **Customer goals** Sleeping fast with no stress and no midnight awakenings. | **Customer goals** Going earlier to bed. | **Customer goals** Buying a new matress. | **Customer goals** Going later to bed. | **Customer goals** Doing meditation and putting on some calming music. | **Customer goals** A good matress which rockes and has calming music in it. |
| **Customer thoughts and emotions** Stressed and tired. | **Customer thoughts and emotions** Hopefull and stressed. | **Customer thoughts and emotions** Less money, stressed and tired. | **Customer thoughts and emotions** Hopefull. | **Customer thoughts and emotions** Bored and tired. | **Customer thoughts and emotions** Happy and wide-awake. |
| **Opportunities** Doing less. | **Opportunities** Sleeping earlier and being earlier up. | **Opportunities** Sleeping better. | **Opportunities** Late to bed and later out bed. | **Opportunities** Destressing from the busy days. | **Opportunities** Sleeping at the best. |

Figure 21, The persona we made to make a choice for a technical system.

## Bo Driessen

'A dream, falling asleep with no stress.'

**Background**

Study: Medicine
Location: Amsterdam
Age: 22 years old
Sports: 3 times a week in the gym
Home: studenthouse with 5 room mates
Job: two nights a week in a restaurant

**Attributes**

- Student income
- Little experience with meditation.
- Inexperienced with products for meditation or not falling asleep.
- During the week she tries to sleep at 23:00, in the weekend most of the time it is 01:00.
- Wants to sleep every night eight hours.
- Knows a little bit about meditating and sleeping, by her own research.

**Customer needs**

- Guidance with meditation
- No stress during bedtime
- Feedback after sleeping
- Good mattress
- Simple tool

**Bio**

Bo is a student. She has to study every day in the university from 9 am till 5 pm. On Tuesdays and Thursdays she has to work in a restaurant from 6 pm till 10 pm. With this job she has a normal student income to pay her rent. She lives in a student home with 5 other people, 3 boys and 2 girls. Sometimes a student home can be pretty noise. She tries to go to bed during the week at 11 pm. This means that after she gets home from work, she immediately has to go to bed. She tries to sport 3 times a week, the only time she has for sporting is after the university, due to this most of the time when she goes sporting it is around 8 pm. This late night sporting and going to work ensures that she is not feeling tired when she is laying in bed, what goeses that she is thinking a lot about how her day went. Every night she can't sleep due to the thinking about her day, what she has to do tomorrow and a lot more stress thoughts. Sometimes she is tired and falls asleep immediately, but wakes up in the night and can't fall asleep anymore, due to the overthinking. What causes being tired during the day.
Bo wants to sleep every night well, having a eight hour bed rest. Why? Because she thinks this will help her being less tired during the day. She has done already a little research about sleeping techniques, meditation and breathing techniques. She tried some of them, a few techniques helped her a little, but after a couple of days trying it, it didn't worked anymore. With a product that you can hold or have with you and maybe something what makes calming sounds, she thinks she can fall asleep more easily.

Figure 22, The customer journey map we made to make a choice for a technical system

# Iteration V: Technology and Realization

## *Introduction*

To make our product more realistic, we needed to dig deeper into how to make our design work technologically. That is why we focused on building our prototype in this iteration.

## *Goals*

The goal of this iteration is to present the technology behind our concept, and knowing how our product is set up from the inside. All during online work.

## *Methods*

### Means

We wanted to create a demonstrator to represent our aimed purpose. Due to the current situation, we were a bit limited in our supplies and options to create a lifesize model. We chose to channel our effort in time into a SolidWorks representation and a small scale model to demonstrate the movement of the pillowtop mattress.

### The system

We came up with a way to make surfaces rise and drop down n a comfortable way, like in massage chairs, using turning servo motors and pear-shaped elements. This looks like how the system in massage chairs is. Using this technique we were able to represent our rocking movement. In the earlier stages of this technique, we also considered using the pear-shaped elements turned by the servo motors to lift up certain elements in the mattress to function more as a massage oriented mattress. After the research and some meetings, we concluded the desired movement to be rocked from side to side and top to bottom.

### Representation

Our link with music is a big part of what separates our concept from others, by synchronizing the movement with desired soothing music, we can induce an even more relaxed state for the user. Based on our research in the section prior to this iteration, we concluded we should aim for a frequency of 0.25 Hz for our movement and 37 dB as our sound level for the soothing music. The technical realization of this idea was simple for now. All we needed as a demonstrator was a mattress, push buttons and servo motors with pear-shaped elements attached to show how our product would work. We chose three buttons representing the pre-programmed movements on the music. One button would actuate the top to bottom movement, the second one would actuate the side to side movement, the last button would actuate both movements following each other up.

### Material

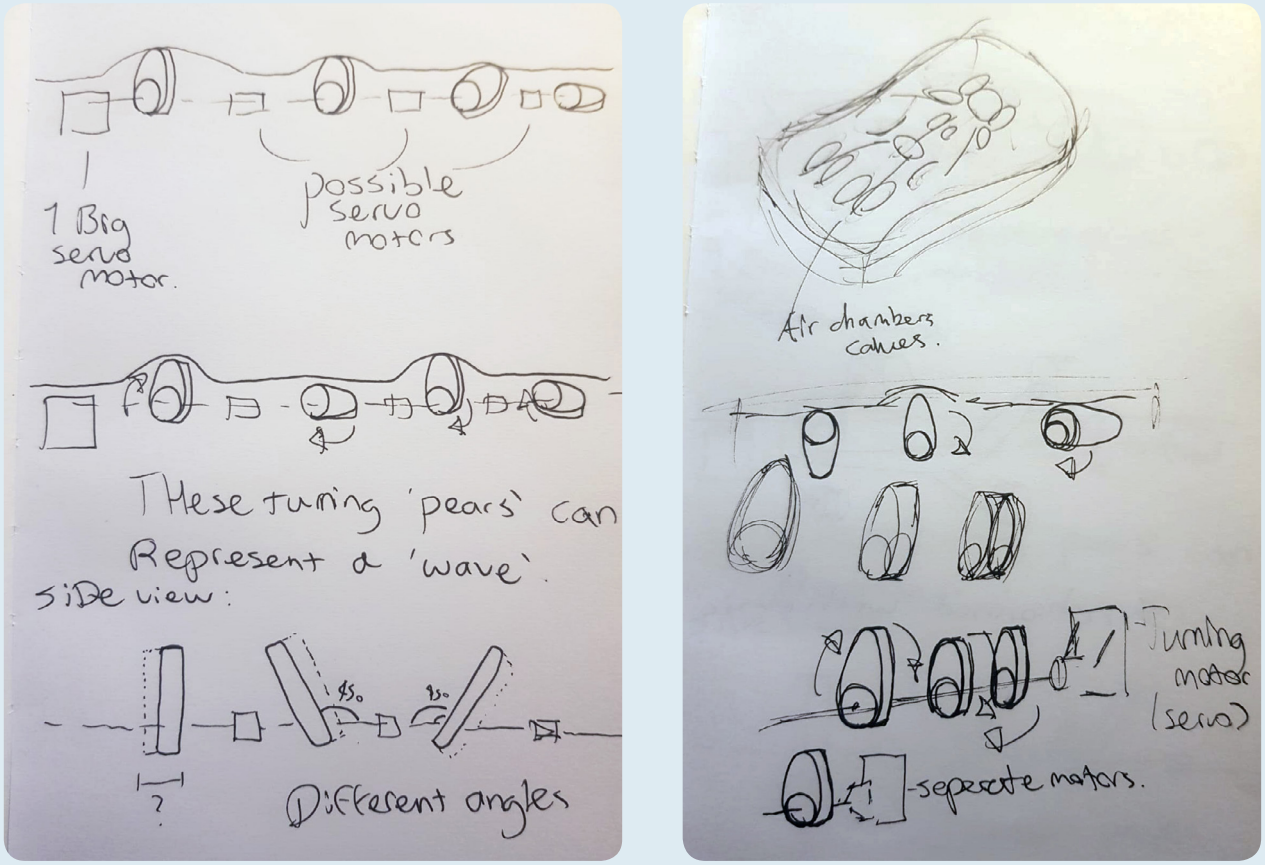
For our product, we will be using an aluminum frame due to the low weight resulting in a transportable product. The motors and pear-shaped elements will be hinged at this frame resulting in a foldable concept as seen in the pictures below. These hinges can be loosened and secured, so that the frame is steady while laying on it.

*Results*

Eventually, we came to a demonstrator. An Arduino breadboard including three buttons being able to control four servo motors attached beneath a low-fi bedframe enabling these motors to move the mattress on top. As seen in the attached video, our servo motors attached with the pear-shaped element on the x- and y-axis result in the desired movement. (Figure 23)

The code controls the servo motors(see appendix ‘J. Iteration V: Arduino code’). It will enable you to activate the first (self-assigned) two servo motors which can ,when attached with a pear-shaped element as seen in the pictures, lift and drop your mattress. The speed and ratio can be varied when the delay and the desired angle of the servo motors are different.

Furthermore, SolidWorks is made and adapted to all the changes in our product.



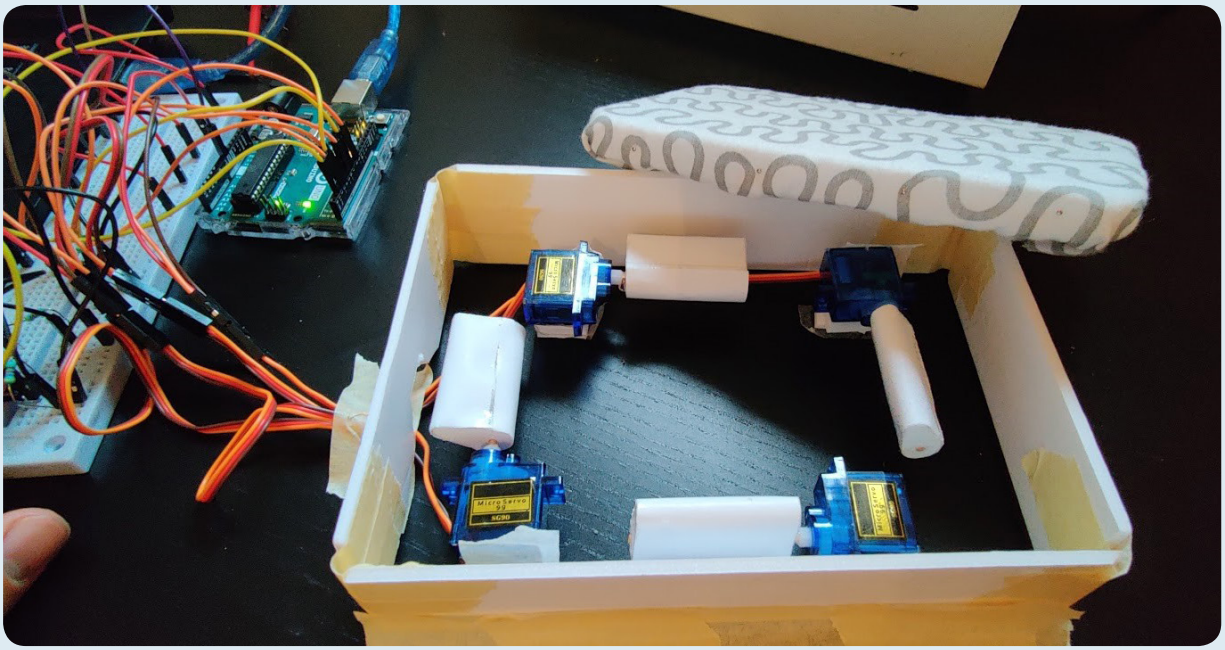



*Figure 23, sketches and protoype*

# Iteration VI: Being entrepreneurs

*Introduction*

Now, it was time to dig into the business side of our design. How are we going to get profit with this design and what do we need to do before we get that?

*Goals*

The goal of this iteration is to find a way to get users to buy our product and to get more insights into how we need to deal with the business around our design.

*Methods*

To explore our business side we first decided to make a value proposition canvas so we could make a business model canvas after (figure 24, 25 and 26). While making this and filling those in, we noticed some elements of our design that we had not thought of before. When certain elements came by, we discussed it within the group and made a decision based on how the customer would like it (by going back into the persona) and what was possible based on money. Also, we made a picture of the costs and benefits to see the eventually costprice. Within doing this, we noticed that we had to think about ways to make it cheaper.

*Results*

Examples of things we thought more of were the selling point, namely via our own website or maybe via shops for beds in the future, but also we thought more of how to have profit in a long way and reduce the costs by buying our own 3D printer for the pears.

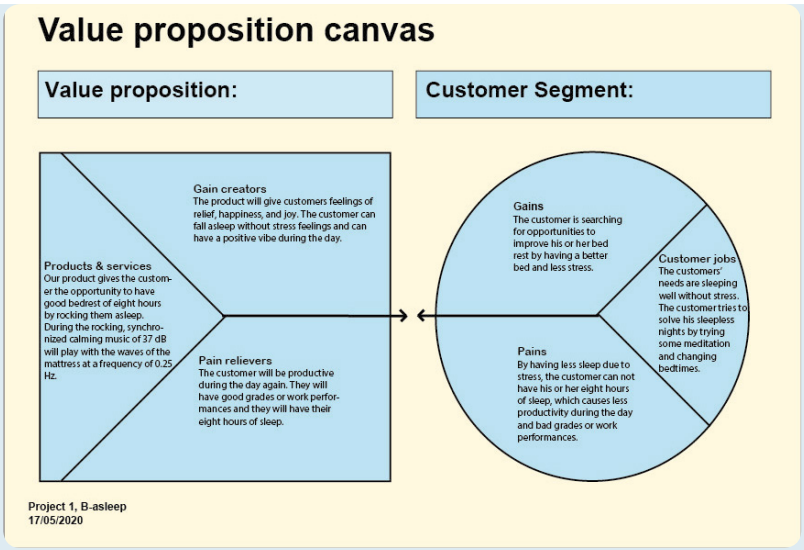



*Figure 24, The value proposition canvas.*

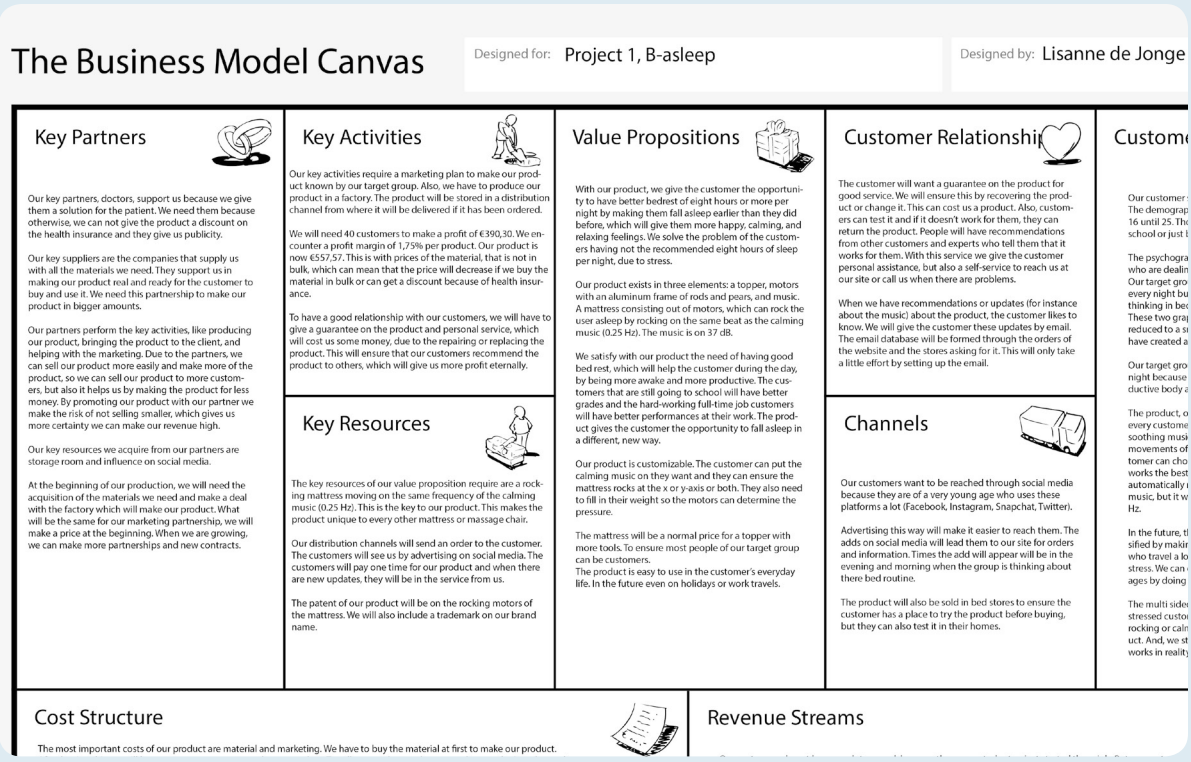



*Figure 25, The business model canvas.*

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 1 coil of 75dm | adhesive spray | | | | | |
| 3D printer kopen | €244,50 | €44,50 | €11,50 | | | | | https://www.123-3d.nl/3D-printers/Anet-A8-Plus-p15704.html |
| | | L200cm, w90cm, dikte3cm | | | | | | |
| cold foam | | €27,00 | €54,00 | €108,00 | €135,00 | €270,00 | €540,00 | https://www.schuimwinkel.nl/koudschuim-schuimrubber-sg-40-hr-40-medium-spepel.html |
| | | L200cm, w90cm, dikte3cm | | | | | | |
| memory foam | | €25,20 | €50,40 | €100,80 | €126,00 | €252,00 | €504,00 | https://schuimrubberfabriek.nl/op-maat/traagschuim/sg50-op-maat/ |
| hinges | €11,96 | €47,84 | €95,68 | €191,36 | €239,20 | €478,40 | €956,80 | https://www.kippcom.nl/nl/nl/Producten/Bedbenodelen-Normelementen/Scharnieren/K0580-scharnieren-aluminium |
| | | L40mm, w30mm, d10mm | | | | | | |
| aluminium frame, flat staff | | €1,54 | €3,08 | €6,16 | €7,70 | €15,40 | €30,80 | https://www.aluminiumopmaat.nl/aluminium-staf/aluminium-platstaf.html |
| | | 2meter | 4meter | 8meter | 10meter | 20meter | 40meter | |
| fabric | | €11,90 | €23,80 | €47,60 | €59,50 | €119,00 | 238 | https://www.destoffenkraam.nl/stoffen/katoen-1/poplin-wit-kn16750-001/ |
| panel | €78,95 | €78,95 | €157,90 | €315,80 | €394,75 | €789,50 | €1.579,00 | https://www.bol.com/nl/p/raspberry-pi-7-inch-touchscreen-display/9200000058306993/?bltgh=uPw7CEQ_P31aE |
| cord | €1,99 | €1,99 | €3,98 | €7,96 | €9,95 | €19,90 | €39,80 | |
| | | 1meter | | | | | | |
| elastics | | €2,70 | €5,40 | €10,80 | €13,50 | €27,00 | €54,00 | https://www.textielstad.nl/fournituren/band-en-lint/elastiek/bandelastiek-zacht-30mm-wit-17269.html |
| remote control | | €7,29 | €14,58 | €29,16 | €36,45 | €72,90 | €145,80 | https://www.bol.com/nl/p/universele-philips-afstandsbediening-voor-alle-philips-televisie-s/9200000083728754/? |
| fan | | €3,99 | €7,98 | €15,96 | €19,95 | €39,90 | €79,80 | https://www.allekabels.nl/koeler/214/1085667/koeler-40-x-40-mm.html?gclid=Cj0KCQjwwr32BRD4ARIsAAJNF_1 |
| | | | | | | | | |
| | | 1 bed without own printer | | | | | | |
| only material | | €1.211,72 | | | | | | |
| salaries | €85,65 | €1.297,37 | | | | | | |
| ads on Instagram (1 month) | €513,80 | €1.310,22 | | | | | | https://intelligentonline.nl/instagram-adverteren-kosten/ |
| costs site (1 year) | €10,00 | €1.320,22 | | | | | | |
| margin of profit (70% in total) | €23,06 | €1.343,32 | | | | | | |
| | | 1 bed with own printer | | | | | | |
| only material | | €439,48 | | | | | | |
| salaries | €85,65 | €525,13 | | | | | | |
| ads on Instagram (1 month) | €513,80 | €537,98 | | | | | | |
| costs site (1 year) | €10,00 | €547,98 | | | | | | |
| margin of profit (70% in total) | €9,59 | €557,57 | | | | | | |
| | | users needed for profit | | | | | | |
| margin of profit with 40 buyers | | €390,30 | | | | | | |

*Figure 26, The picture of the costs and benefits*

# Iteration VII: Validation of the final design (for now)

## *Introduction*

To do some last adaptations and come back to the opinion of our target group, we wanted to do one last user test with all of the features of our design and find out what our users would think of it, and maybe what they would change.

## *Goals*

The goal of this iteration is to get insights into the opinion of our users and do the last adaptations on our product to satisfy that same customer.

## *Methods*

### Setting up the questionnaire

To get our final feedback from the future users, we made a google form questionnaire with questions with all of the features of our product (the looks, the user interface, the material, the foldableness, the price and if they would see themselves lie on it) and asked the opinion from the ones who filled it in. Because we got the advice multiple times during the Midterm Demo Day to also include people from 16-25 without having sleep deprivation (for instance because they can get it later or just because of more broad opinions and publicity), we also asked people next to our target group from 16-25 to fill in our form. We tried to keep this as anonymous as possible and began with a consent form and only asked about themselves if they were part of our target group by asking if they suffered from sleep deprivation. And to get as many answers as possible, we contacted these people via our own Whatsapp contacts and sent the survey in groups with people from this age.

### Processing the answers

A few days after this survey was sent out, we all read all the answers and concluded the most important answers. Furthermore, to get a clear overview of the answers we translated to Jupyter Notebook in Python and processes the data so that we could create a visual in which we could see clearly how many people would buy and from which category(see appendix ‘L. Iteration VII: Price evaluation in Python’). We discussed all these results and based on the feedback that we got, we changed some last features.

After this, we again divided tasks for the Demo Day deliverables based on our own learning goals and interests.

## *Results*

The last user test was answered by 56 people from which 72% fell not within our target group, but 28% did (see appendix ’K. Iteration VII: Questionnaire’). The most important things we found from this test were that they found the looks of the topper clean and comfortable (figures 27 and 28), especially because there is a sheet that is going on top of it. Only this would mean that a power plug would get in the way. Also, the logo was a bit unreadable. About the user interface (figure 27) there was also said that it was inconvenient to read while it was on the side and not handy because of the sheet. A lot of people came up with a remote control or an app. Also, because it was a tablet now, they were afraid it would break, or that it would be too small. It was not clear that it was a user interface at first, it looked more like a label. Furthermore, some people asked if they could upload their own music. Of the material, most of them do not have much knowledge, but to most of them, it sounded quite nice, since it is comfortable. A lot of people were afraid that you would feel the aluminum frame and that that would make it less comfortable. One person named the heat that the motor could produce and that he/she was afraid it would result in a burning topper.

Also, someone mentioned that memory foam was not so eco friendly. About the topper being foldable most people answered that it was a nice feature for taking it to vacation, but not to a friend for just one night. It needed to be as compact as possible and the hinges needed to be well tightened and loosened. Some people found it awkward to bring it with them. About the price: a lot of people found the topper quite expensive for being a student.

Here we saw that we should have asked the question differently because most of the people who answered our questionnaire were people who are not in our target group and they answered that they would not buy it, but at the explanation, they said it was worth the price if they would have sleep deprivation(figure 29). Therefore, we should have asked them if they had sleep deprivation if they would buy it then. If the product would have good service and you could test it first, but it was also proven to help, they would buy it faster. The maximum that people wanted to pay was lying on 300. Most of the people would see themselves lie on the product, but there were a few that we're scared of the electricity we would use or that they would feel seasick.

The product adjustments we made are as follows. The power plug would come on a low point, so it would not be in the way of the sheet. The logo would be adapted with a new name and slogan since we wanted to have a new design identity with the same three colors and we wanted to fit it all together with the product. The user interface would be a remote control on the side connected with a cord to the topper which you can take off the topper and stick it on the topper. This would have a small screen with no intense lightning and four arrow buttons around an okay button on which you could set your weight, your preference of soothing music, and the axis or axis' of movement that you like. Also, there would be updates for new soothing music. We kept the materials the same, with the reasoning that you could interpret memory foam as sustainable since this topper had to have a long lifetime, so that is has a sustainable life. For the heat, we wanted to install a cooling system. The aluminum frame would be only on the very sides so people would not feel it when they lie in the middle. For being foldable we would make it as compact as possible and give the motors a level on which they can lie flat too, so you could fold the topper a few times, at least so it can be transported with a car. The awkwardness would disappear after the product has had more publicity, as with all innovation products. We went into the price again to make it cheaper and things we came up was a deal with the health insurance, and we would buy the materials in bulk so it would be cheaper in the end. Also, we want to provide an excellent service: you can test it at home and bring it back and get your money back if it does not work for you, but we also wanted to let experts write good recommendations and prove it works. To prevent the fear of electricity, we would make sure there is a safety button to turn the topper off.

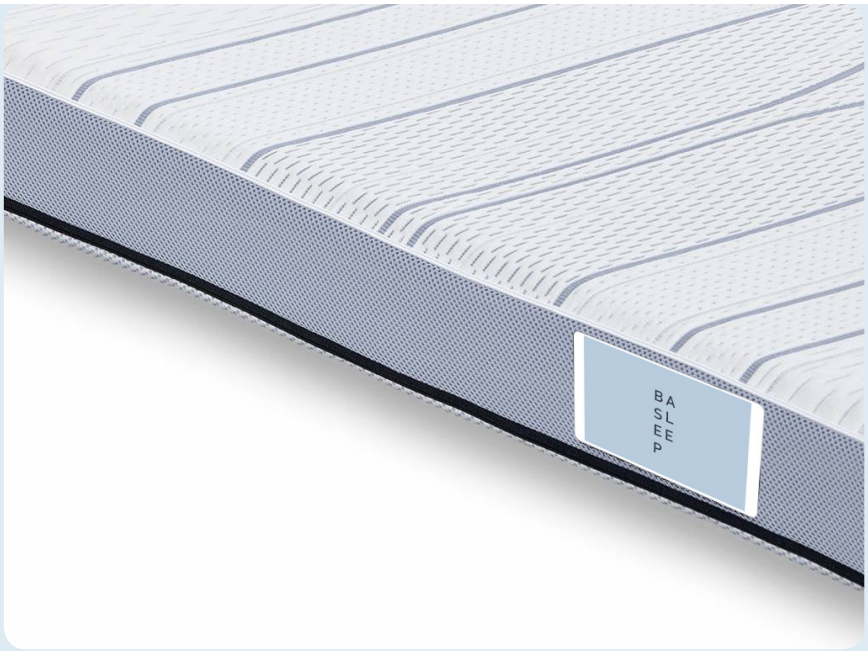



*Figure 27, The looks of the topper with the panel.*

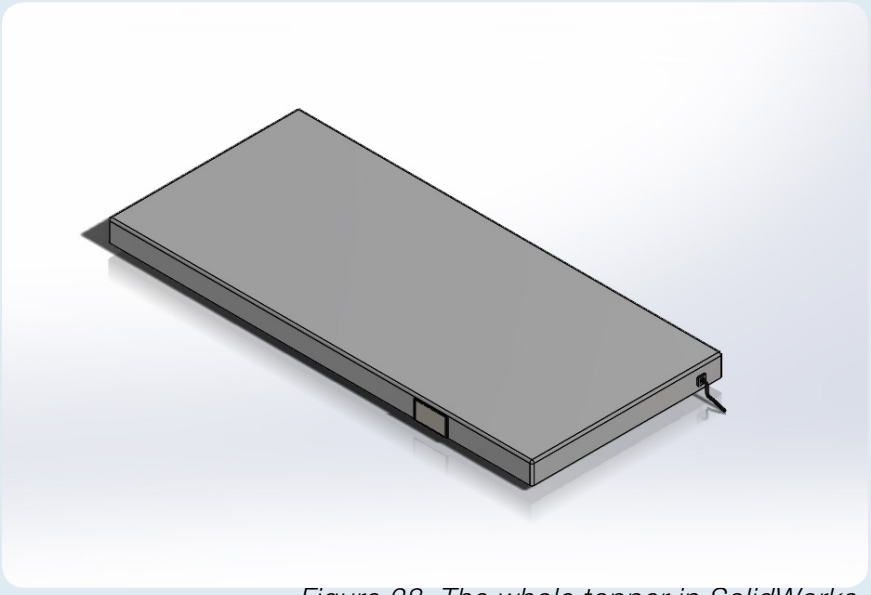
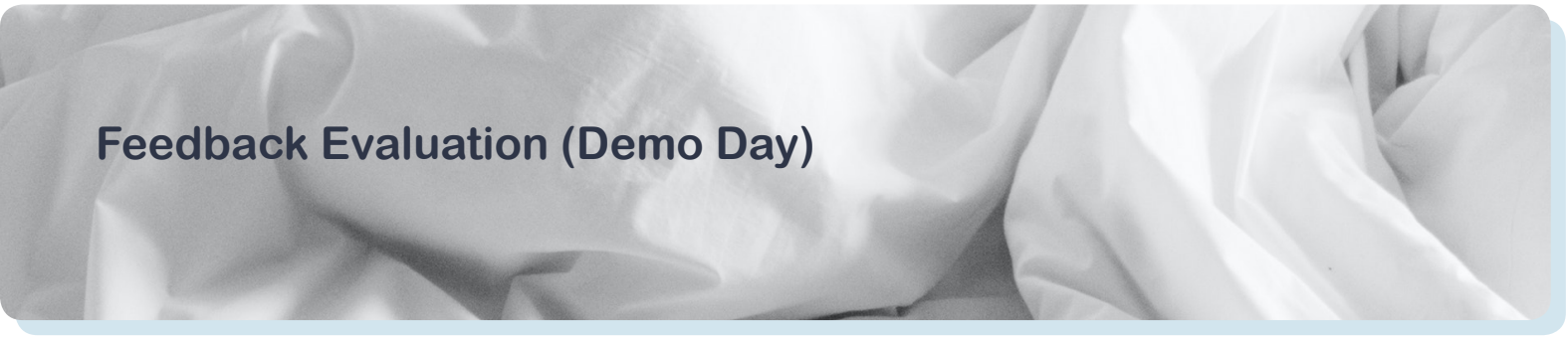


*Figure 28, The whole topper in SolidWorks.*


*Figure 29, The visualization from Python about the buyers of our topper*



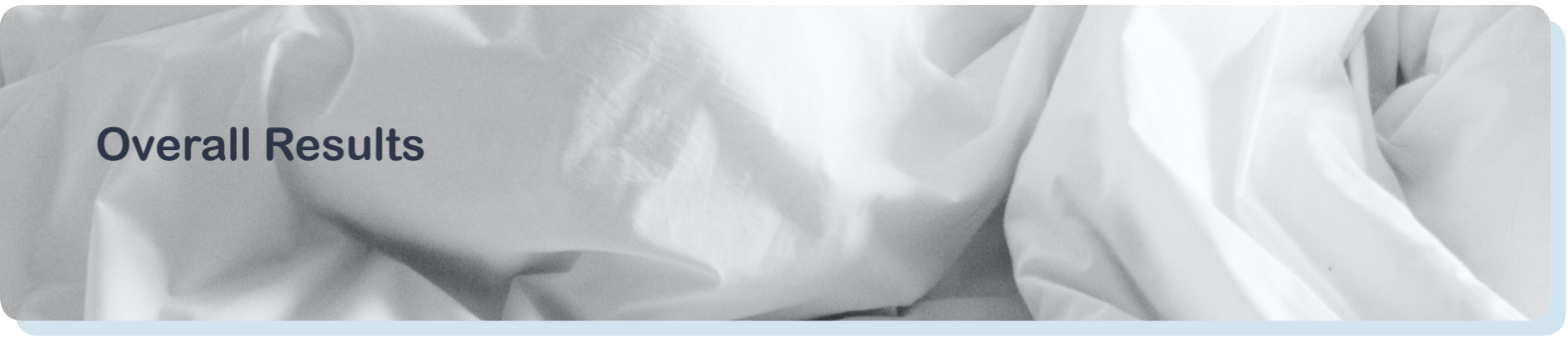
# Feedback Evaluation (Demo Day)

During the Demo Day, we got again the feedback from our coaches and other members of our theme, our second assessor, and some peer reviews from students of other themes. We discussed them within the group and reflected on them.

The main discussion point of our design was that the actual movement and sound were not tested in reality, in the form so that we would know it would work exactly like we wanted, apart from that both the sound and movement are proven to work with falling asleep. Of course, due to COVID-19, there were limited opportunities in testing this, but we could have given our users a bit more of the feeling by letting someone move their mattress or swing them while they listen to the music we use in our product. So, this is a discussion point on our design which we will take away in our next design projects. Furthermore, the sheet that is going on top of the topper was discussed, so that remote control would be a little inconvenient on the side. Therefore we invented the remote control with a cord so you can grab it while lying in bed, but also stick it to your bed frame in a holder. Next to this, the sound and weight of the motors are things that we could have looked into more. A tip that was given to us is that we could also consider deals with employers for buying our product for their employees because if they can fall asleep again with our product, they could win also much more profit by having more active employees.

For the deliverables itself, we came across the point that we should have prioritized some information over other information to talk a bit slower and leave silence at some points to let the watcher take some time to think about the concept. Also, with our poster, we tried to give an easeful feeling, but we could have explained a bit more about our concept and what it is.

But, after all, we were and are very proud to present what we have done and put our priorities in and we have also gotten a lot of compliments about our learning by doing and testing our assumptions. Lastly, we have learned how to respectfully work with each other in a communicative way to motivate each other.



# Overall Results

By going through all the iterations, we came up with a final result: The Relay (figure 33). It is an interactive pillowtop mattress for one person with a length of 200 cm, a width of 90 cm and a thickness of 10 cm which uses the combination of soothing music (on 37 dB) and rocking movements (of 0.25 Hz) on the same rhythm to make people of 16-25 who suffer from sleep deprivation because of stress at least once a week and sleep at least one hour less than the eight recommended hours on that nights, fall asleep. It works as follows: the user lays in bed, set his or her weight (to determine the pressure the motors have to exercise), preference of soothing music and the axis of movement (left to right, top to bottom or both)(figure 23) on the connected remote control, connected to the side with a wire, and the user will hear the music through the speakers of the topper (figure 30). The four preprogrammed motors in the topper will turn the rods, connected to the motors on the sides of the topper on the same beat, which makes the multiple pears of aluminum connected to the rods also turn, to simulate a rocking movement. The user falls asleep, and after two hours, the movements and sounds slowly stop, for saving energy and because it is scientifically proven that these two hours are enough to let you fall asleep. To make sure you can fall asleep everywhere, the aluminum frame with the motors is connected with hinges and the motors have a certain position in which they can lie flat so that you can fold it and transport it with you (figure 31). This foldable feature is also the reason why it is a topper, instead of a mattress because you can put it on top of your mattress with elastics, and in this way, it can be more compact than a mattress. Furthermore, it is connected to the power grid by a power plug and the motors have a safety button and a cooling system so the user does not have to be afraid for the electricity or too much heat. The topper itself is made out of a layer of memory foam and a layer of cold foam (figure 32) for being comfortable, and it is padded with padding fabric. Also, there are updates for new music every once in a while.

The price for the Relay is now estimated at approximately five hundred euros and it is provided with excellent service. It will be sold on the product's website and promoted on social media. It will be recommended by experts which will test it and prove that it works. When you are a customer you can test it yourself and if it does not work for you, you bring it back and you will get your money back.

To give a little more insights on the name, slogan and colors (figure 34) we want to tell you that we used three colors that give the message of the word ''soothing'' (Eiseman, 2017, p. 141-143) and the name stands for Relaxation, lay from lay in bed and ''delay'', a word which is often used in music to indicate that it is going on a slower pace, even as your heart rate when a user is using our product. Our slogan is ''Rock 'n Sleep'', a derivative of ''Rock 'n Roll'' since our product uses music and rocking to get the user fall asleep. All our designed deliverables have the same ''soothing theme'' to give a clear design attitude.

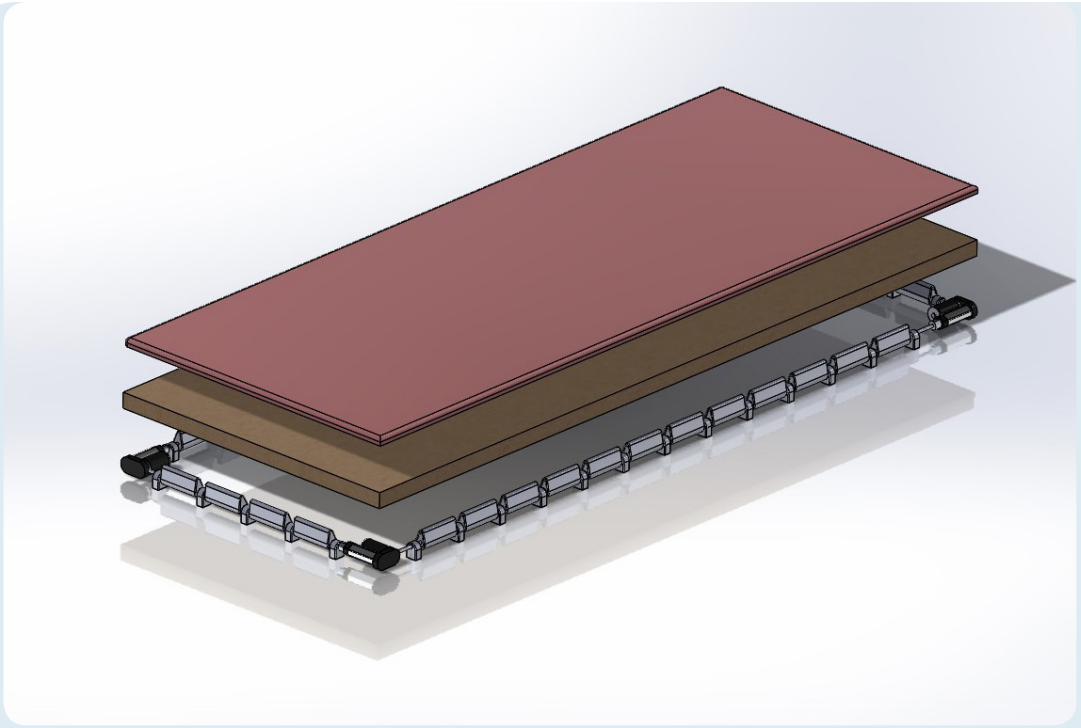


*Figure 32, the multiple layers of the Relay.*

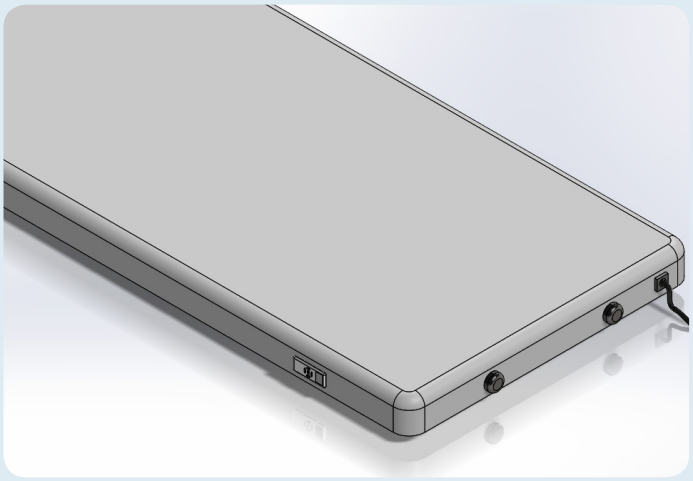


*Figure 30, A raw image of what our product looks like.*

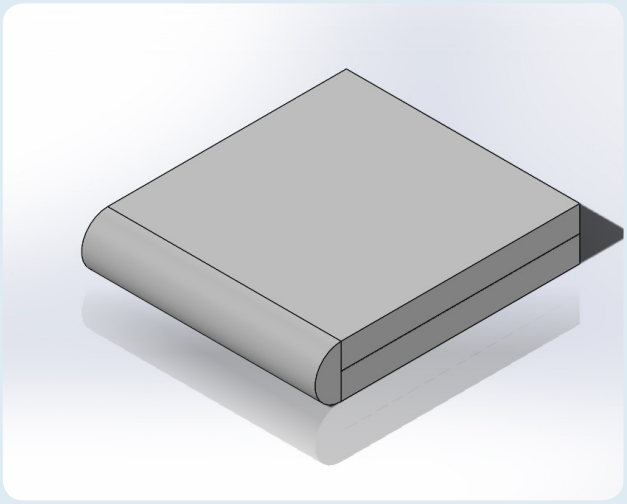


*Figure 31, Our product folded.*

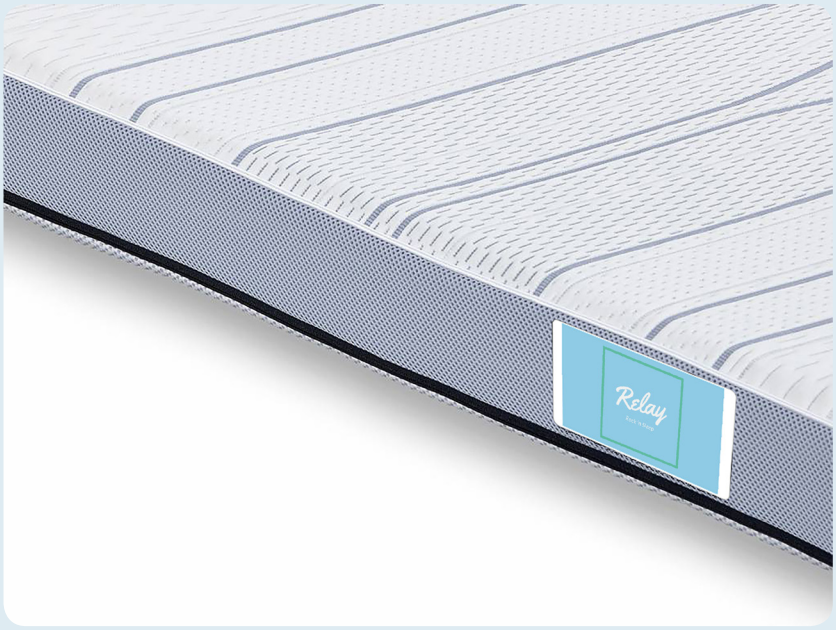
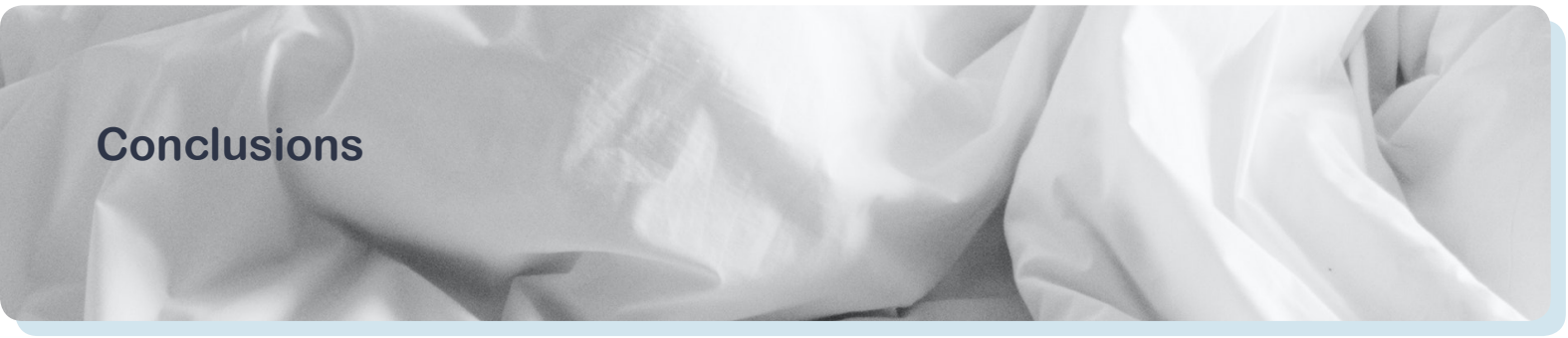



*Figure 33, The looks of our product.*


*Figure 34, Our product transparently with our logo*



# Conclusions

Our goal of this project was to find a solution on the question ‘How do we get people with the age of 16-25 and with sleep deprivation because of stress (sleeping at least one hour a week less than the eight recommended hours you should sleep every night) falling asleep so that they will not have sleeping issues anymore?’ Of course, we do not know for sure if we reached that goal since we did not test our final product directly on our users, but due to all the research we have done, we added features like the rocking and the music which should help because they are proven to help with falling asleep. Also, our design is designed to take away the stress of not getting into sleep, to get the user more active during the day since the user is not missing a lot of sleep and it is designed to prevent that the sleep deprivation goes further to older age and increases the physical and mental health issues. Because of this and all the iterations and the learning experiences we got from those as a group, we are very satisfied with our outcome and how we dealt with the situation around COVID-19.

To still find out if we have answered the question, we also have set up some points to look at if we would have more time to investigate. For this product, doing a user test to work the technical concept out as a real product to look at comfort, seasickness, and precise dimensions would be important, but also making a more precise plan for updates since the motors are preprogrammed on the music. Another feature that would deserve more attention is the process to let it be foldable and how exactly that would go, even as how we should implement a cooling system and what effects that would have. We would look more into the deal with the health insurance to let people pay less for the product, and we would look into the product to see if we can tape off the movement and music after a period of using it, so people do not get addicted to the product like to medicine now. This also would make the topper more sustainable since it then could be reused for someone else.

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# Task division

As explained in our group reflection, despite our knowledge regarding the importance of a strong structure, planning and organized task division, we had shifted quite a bit in our responsibilities. This went quite smoothly due to the direct and quick communication regarding who was capable of what job and who 'liked' to complete which task. In every meeting, Kim or Lisanne would write everything down, we all discussed the tasks of every member and we all made new tasks and deadlines. Also we always read all of the materials that others made and gave feedback on it, so we could improve it.

We all together worked on the ideation, user test and evaluation of our pressure cooker idea, including the preparation for the short presentation, to get the most ideas. Prior to a meeting with the coaches, we prepared what we liked and disliked on academic level and what we wanted to improve during this project. Based on that meeting we established our first concrete task division and end responsibles' for our deliverables for the midterm demo day.

Kim and Lisanne were assigned to the poster and the report, while Britt would prepare the pitch and Dapper would take responsibility of the prototype. This was because Kim and Lisanne wanted to learn about the application Illustrator for making the posters, Dapper would focus more on making a prototype with Britt and Britt find it hard to present something in her own way. Dapper and Lisanne would make a first draft of the report by writing the introduction and Iteration I and II when they were done to get a clear view already from what was done.
After the 'back-to-the-drawing board' brainstorming session we decided to come up with five ideas each and do research regarding our topics. Everyone completed this task. All the meetings we had to discuss something, we did with all of us to come to an agreement. Kim made a visual mind map during that meeting to get it all clear.

After our research and brainstorming we developed an idea and Britt had material for our first prototype. Kim and Britt prepared this user test qua materials and the four of us established questions we wanted to be answered by our participants. Dapper would prepare the ERB and consent form of this user test, this would unfortunately be completed later. Kim and Britt performed the user test as described in 'Questionnaire and user test' in our report.

Then we worked on the midterm deliverables. Britt started with making a design for the report, because she wanted to learn how to deal with inDesign, she and Kim supplemented the report and Kim made it more structured by following the restrictions, because she can work very detailed. We all made conclusions together regarding our second Iterations' results, so that we would all agree on the point where we were with the design. Then we performed  research about different topics we divided. Every member shared their information and research regarding the divided topics. Britt researched the sleeping behavior and environment of babies and toddlers, and spoke with an expert. Furthermore, Britt researched some information regarding user testing; the necessities and different digital platforms and techniques and looked at existing products. Kim researched different breathing techniques and made already a draft format for our sleeping diary user test. Dapper gathered information regarding the possible material of our prototype and real life design. Lisanne set up the clear version for the participants of our sleeping diary test, which was then checked by the rest of the members.

Dapper set up the ERB and consent forms and made sure they were checked for the upcoming sleeping diary user test and the user test from iteration II, while informing himself with information regarding privacy protection and collected some contact information for possible experts who could provide us with information regarding insomnia for our project. These people were then contacted. Lisanne also made already a persona and empathy map, so we could use that in a later iteration and because she wanted to dig more into the user. Britt afterwards looked for similar material to be used in our iterations for our prototype, while Kim worked on the third iteration of the report. Everyone contacted users for the test, received the tests and read those materials to tell the others about it. They were collected in a separate private onedrive created by Britt. Britt also made an excel file in which all the results were clear with an average of each exercise of the sleeping diary test.

Lisanne and Dapper completed the group reflection, which was later checked by Kim and Britt. Kim also checked the reference of a necessary scientific paper in the report and completed reporting the third Iteration. Dapper worked on the task division part. Britt completed the report by making it as short and strong as possible and by making it visually appealing in her inDesign format.

For the postponed midterm demo day, we already had a pitch, posters and a prototype, but since we made it before we had done iteration III and since the deliverables were a bit different, we divided tasks to adapt those: Dapper and Kim would make the video with the explaining because they would want to visualize things and earn more edit skills, Britt would adapt the pitch and Lisanne and Britt would make sure of the posters. We would all look at the deliverables and give each other feedback, so we would be very ready for the midterm demo day.

# Individual reflections

Britt Joosten

Until now I have been very happy with project 1 and the direction 'Vital change'. I want to design for people who need it most, in my opinion people with health problems. I feel like I am designing for a target group that i'm happy with and can relate to ( people of our age (16-25) suffering from insomnia due to stress). I also feel like this specific target group doesn't have a lot of existing (tangible) solutions which motivates me even more in this project.

Immediately at the start, we learned how to do a pressure cooker. You get a week to go through a whole design process, you have to make quick decisions which for me is difficult, because I'm a perfectionist and want to have every detail in every decision well thought out. I have learned a lot from this technique, sometimes just making a quick decision can lead you in the wrong direction. But at least you learned that this direction will not work and start again with your design cycle. We also learned new approach for a project from one of our coaches which was setting up a main question for yourself ('How can we help our target group cope insomnia due to stress from their bed'), and only do research or build prototypes that help you find the answer to this main question or parts of the question. In previous projects I always came up with a product, something tangible to

I do feel that we, as a group, were making quick decisions which is good for our design process. But I sometimes got the feeling that we were finishing deadlines just to check them of our to do list, not to make/design something with a good backing or reasoning. In my opinion it had a lot to do with time and planning. As I sad I am a perfectionist, so I want every detail/decision in the design process to be well thought out and good. I think I need to share this side of me more and don't let time get in the way of that. For me there is a difference in finishing a deadline early to just be done with it and finishing a deadline just in time/late but having a idea/product your happy with and with a good reasoning. I Think I have made it clear to my team, the remainder of the project we were more focused on substatioating our choices.

In meetings I feel like I'm sometimes lacking the confidence to really say what I want, being more in the background. Sometimes just agreeing with group decisions to prevent debating and bickering which leads to nothing. In previous projects I have been more dominant in group discussions. I have been addressed to my 'dominant' behaviour in those groups, which I think is the reason for me to have taken a step back. I also think it's because we are with multiple dominant people in one group. I have realised that I prefer the way I was (more dominant), so I need to work on that.

I know that I'm a type of person that likes to wait until the very deadline is due, to do my work. But in a group project this concept doesn't work, because your group members rely on what you do. I always finished my tasks in time, but with more stress then needed, and with less quality. The last quartile I have been really working on this trying to divide big tasks in smaller ones, and I have been doing a bit better. And now because of quarentaining I have started and delivered most of my work days before the deadline which for me is a great improvement. I think because I don't have to travel to uni and don't have long days I have more energy/persistence to do so, so I will keep this up.

What I also learned from qurantining is a new form of comunicating and user testing, which will become very handy in the future.

The group dynamic has been great with everyone outside the project. But within the project (tasks, meetings deadlines etc) there were some problems with a member lacking input. I have had the exact same problem in previous project and still regret not doing enough about it then. That's why I'm happy I did this project. I've tried to stimulate in many different ways, I've learned that being nice isn't always the most effective way, but . And I've learned that you just sometimes need to be hard to let someone really know what needs to happen.

I have been working on my goals in this project, I am writing pitches and delivering pitches, working with adobe programs. I took a lot of creativity and aestethics tasks, I think because of that I took the safe route. I know I am still struggeling with writing (reports etc), so I need to focus on that more.

To conclude everything for this semester, I have learned the importance of making quick decisions and not to think in solutions. But I also learned that, we as a group, are going to need to find a balance between thought out decisions and quick decisions. I've learned that it can be good, sometimes better, to be 'dominant' in group meetings. My planning and making deadlines have become significantly better, I am going to keep in that way. And I have been working on my pdp goals.

This project one has been an interesting experience. An experience containing expectations, lets downs, surprises and a lot of learning points. As described by my coaches; this project is Industrial design. Later on, in the project, I realized the importance of the 'why?' question, and in this case, why I want to study Industrial Design. I experienced quite a shift in motivation for this project and our direction in Iterations, just like a change in the team dynamics. Both were not really in 'my favor' and were experienced as suboptimal. I tried to find out why I lost motivation for the project and how I 'lost' my leading role in the team (questioning the fact I ever had one). A few weeks prior to the start of this project I took an initiative with myself to be more assertive, confident and leading in academic and non-academic situations. I started as a chairman of a committee and wanted to improve this skill in multiple areas, such as this project. Unfortunately, I experienced this as a slow process, which I'm not bringing myself down for, but it wasn't exactly developing according to plan. I had disappointed my group by not completing my tasks in time resulting in them naturally losing faith in me, my competence, discipline and ability to help them. While these tasks might have been small and I experienced myself still valuable with regard to creative input and discussions, it was more about the principle and attitude of me not being motivated and strict enough to myself and towards this project. After a long conversation with the coaches, I received great tips and a wake-up call helping me to focus on small steps to make towards the greater goal of becoming more disciplined. I've noticed some small positive progress regarding my sleeping rhythm and ability to put in the necessary work I had to, to pass my courses and deliver my work for this project. Especially in the second half of the project I noticed myself being more disciplined, keeping up with my tight schedule and being able to put in work when necessary. I realized that I had to assign more value towards my own deadlines instead of those established by the university. I think the main reason I experience these deadlines different is because of the difference in consequences with the two. The consequences of missing/failing a deadline ordered by the University are more severe, direct, on short notice and more severe in the short and long term. However, due to my other courses I have discovered how it feels to be directly awarded for hard work and the actual effect of keeping up with your own deadlines improves the overall result of your assignment and changes the entire vibe, feeling and experience of studying completely.

You approach studying, courses and assignments so much differently when following your own tight well structured planning, which sounds like the single most obvious observation someone could make, but for someone to realize this, they have to experience it for themselves instead of hearing it from others. I think I am on my way to grow and progress in this matter.

I think every single person can spend time at something they like to do when they're feeling good, but putting in work in tasks or assignments when you're feeling down while it has nothing to do with your vision or identity, that really shows character, attitude, and dedication. I have noticed myself finding joy in completing tasks even if these tasks do not bring me joy directly, which is a really useful tool and skill for the (near) future, since it will help me work productively on tasks I might not initially enjoy.

I was really happy with the randomized grouping in Vital Change and with the coaches we received. The two different coaches Joost and Jim are very different from each other vision wise, but both strongly invested in the same goal; to help and guide our squad in the most personal and professional way possible. Being exposed to two coaches with quite different visions and approaches to design, helps each of us to form a broader, more in-depth vision of our own. The advice I received regarding educating and informing myself about the visions of my 'role models' on academic and nonacademic levels sounded like really great advice, unfortunately, due to deadlines and academic stress I have not been able to put this advice into practice, but I definitely will. Starting with my favorite music composer Ludovico Einaudi. It is something passing time has taught me everyday, the value of forming an unique identity becomes bigger and bigger every single day. Questioning your own ambition, motivation and vision is an exhausting but interesting process.

This study has been exposing me to all the other possibilities and opportunities regarding design and creating.

After getting used to this way of educating myself I will start with reading about Designers to form a more professional vision instead of a personal one. This order will work for me, since I'm more invested in my personal vision and progress right now, rather than my academic and professional one.

To get back at what this project has taught me, I have not yet formed a clear answer which aspect of this project (or which aspect of Industrial Design) I value the most.

I quickly realized after starting this project that I have a 'creating oriented' mindset, assuming a large portion of ID students have this too, it was really weird to realize a lot of people do not think in 'creating', resulting in a weird familiarity when working in different teams with people with the same goal and mindset towards creating like yourself.

The project has taught me, just like other courses, the difficulty of stepping away from an idea. For me personally, it's quite a challenge to forget an idea when you've nearly convinced yourself of how great it might be if worked out properly. It is a skill I want to master since it feels a bit limiting right now to be stuck at an idea instead of moving forward. I want to find balance between believing in myself and my ideas and being able to step away from them and being open for new ones.

I expected to be more influenced, moved and invested in the overall message and purpose of our concept and design. When I reflect on how I valued this project I notice myself not being as moved as I thought it would. My vision might not be 'helping-people' oriented as I expected it to be during this project. My vision does not have to include or revolve around helping people or designing for others. However, I want my designs to be useful, maybe useful for me and maybe more intended for me to express my ideas and creativity, feelings and emotions. This project showed me I value these types of aspects of designing more.

We noticed in our teamwork how we progressed as a team. For example, the fact that after the midterm demo day we sat together and revisited our learning goals and expertise areas, on our own initiative instead of on advice from the coaches. This showed immediate adoption of our knowledge and experience in this project and the value of valuing each others ambitions.

I'm where I want and maybe need to be at this study and I feel like I can develop all the right needs for me to express and grow into the person and designer/creator I want to be. I'm more than curious what the oncoming projects and years will bring. I will be actively learning, educating myself and constantly growing and improving on both academic and non-academic level. Furthermore, I will focus on keeping the recently developed attitude and mindset towards disciplined working.

An always fluent vision and identity is something to be aware and cautious of, functioning as a guideline which can be communicated towards others, represent what you stand for and be used mainly as a direction to live and create by.

Kim Keereweer

*In this first project I was immediately satisfied with our subject because we tried to solve a major problem called sleep deprivation which many persons I know are dealing with multiple nights a week, which means that a solution would make their lives much better. With the attitude on trying to find this solution, I have already learned much about design, research processes, integration, collaboration, organization, and planning.*

Firstly, about the design. When we started our project, we began designing with a brainstorm about a product. We first wanted to pick an idea with logical mind-thinking, but one of our project coaches told us that it would be better if we get more knowledge about a problem and how to solve that first. So, different than in earlier projects, we set up a problem and began researching it by doing a user test with our target group. I took together with another group member the responsibility for this test. After this, we took conclusions of our user test and came up with the product that would fit best. I noticed that this method was much more useful to come to an idea of a product, instead of 'product-thinking', because now it was based on information we gathered ourselves, in perspective of our target group. In further parts of our project, we did the same by gathering information via user tests and then adapting our design. Because I learned this, I definitely want to implement the technique of first getting to know aspects of the problem and/or the solution before implementing something in the design, in my further projects. Because it makes your design stronger.

Our group also did various research processes. By doing these processes, I learned that there are various ways of doing research, especially by dealing with COVID-19. In the project of From Idea to Design, we divided research subjects and then told each other what we found. This project, after the first brainstorming we had chosen three areas in which we would do research, all the four of us, to come up with ideas and to know more about these subjects. Also, in our fourth iteration we had interviews with experts about our product and their opinion on it and for choosing a technical system we tried to crawl into the user's skin to make a decision by being the persona. By using new ways, we found different results, because every person looks in another way and comes up with new ideas. I will definitely keep thinking wider in all kind of the design processes than just what I know like doing just internet research so that you can find more and more diverse and trustable information.

Furthermore, in this group, I have also learned about my role as a group leader and how to stimulate people to work. Within our group, in the first weeks we experienced some difficulty between team members because deadlines were not met. After discussing this multiple times with each other and the coaches, and finding out motivation and communication were and are key, I noticed that this can be prevented by giving everyone the tasks he or she is interested in and give him or her the possibility to speak up and share how much time they have in general. Also, agreements need to be set clear and based on how a person is, you need to remind them every once in a while to what they need to do. Using those methods helped us during the project and further than this, there were no problems at all: everybody worked as hard as they could to get the best out of the project. Therefore, I will use this techniques in further projects but I will also take time to get to know the work attitude of others and adapt my behavior to them.

Lastly, I have always been strict in my organization and planning. At the beginning and after the Midterm of this project we made a planning with or group. Since a design process is very fluid in what you can do to investigate and depends on in which situation you are, you cannot plan everything and just keep yourself onto it. Of course, because of COVID-19 we also needed to change a few things in our planning, for instance, getting to know multiple ways to make an online prototype in SolidWorks or to do an online user test, to get that information we need, but in a different way. From this, I have learned that making a planning is useful to create an idea of the time you have for something and to create a red wire in what you want to reach, but that you do not have to stick to it too much. You can change it when the project asks for that. So, in the future, I will keep this into account and be less strict to myself.

So, from the first ten weeks of my project I already learned that 'problem-thinking' instead of 'product-thinking' can make your design stronger, that there are multiple ways to do research and to get information, that collaboration works only with good communication and motivation because of a person's interests and that planning can be the red wire in your project, but can be changed due to circumstances. These learning points I will use in further projects and future goals I have for new projects are exploring other ways of realizing a product like with 3D-printing or laser-printing since this was not possible with the current circumstances and designing in a different squad like ''Crafting Everyday Soft Things'' to explore my interests more and see the difference between design projects with different subjects.

Lisanne de Jonge

This semester I started with my first project. A project with the theme of Vital Change. My team exists in a total of four people. A good amount in my opinion, so you can get more easily in contact with each other with a meeting. We are developing a prototype for people between 16-25 years old. People that do not have good bedrest due to stress. We have made a prototype of a mattress topper which moves on the calming music from the topper. It moves due to motors on each side of the mattress that is moving in the axis. The calming music and rocking of the mattress will distract the person from thinking about their stressful problem thoughts.

At the start of the project, I could not make a well-designed attracting poster. I had not made an empathy map before. During this project, I learned with some help from the internet how you can make an empathy map. With the persona I had made I was able to fill this in the correct way in. I wanted to make this empathy map because my goal for this semester was to implement the user more in the design process. Due to the coronavirus, we were not able anymore to meet with participants in real life. With this map, I could imagine what the participants would think. Why I and my group mates would know this? Because with this knowledge, we can improve our prototype. With a better prototype, we can test it better with new participants and we can show our idea better during the demo day.

About the new skills, I learned to make an attractive poster. With help from my groupmate, I made a well-designed poster. With my little knowledge about the Adobe Illustrator program, we could make together a poster. She was very good at the astatic part. This helped me very much in learning how you can make a poster attractive, my PI&V goal. Because I got other insights on how to look at a poster. Due to this new knowledge, I have gathered for making posters attractive I have more knowledge in the creativity and aesthetics part. This can help me in my next projects two and three, to help my groupmates or to make by myself a poster for the group.

During this project, we had to make a planning at the beginning of the semester. To give our coaches some insights about how we wanted to work. I made this planning. I learned from this to make a planning at the beginning of your project and not to make it for one week, but for the whole semester. This will help me in my own program to plan in advance, but also in projects two and three for my groupmates.

In this project, I wrote the draft midterm report. I can write down a text in not a very long time. This helped my group mates in making the beginning of the report because that is often a difficult point: How to begin with your report? After writing it my groupmates controlled the text and made new chapters. In the end, I helped with the missing parts. What did I learn from this experience? I can help my teammates by writing the beginning of the report because I can write easily a text. This will help me in project two and three, writing at a fast pace the report and for the final report of project one.

During the project, we had to divide the tasks. Dividing the tasks helps with working more efficiently during a project. I helped with making the task division. We made a task division and we made people responsible for the task. This helped us to make our deadlines because you feel more the urge to finish everything on time. I learned to divided tasks during a project more. This can help to work faster. Why did I want to learn that? So, I can use this type of task division in the next projects, for a faster work pace.
, so I can make a good prototype to test with participants. In the next quartile, I would like to learn that.
To conclude, so far, I have learned new skills that I could not do before for my PDP. This helped me in making me as a designer better, by improving my expertise areas. To reach my future designer vision.

I think I am a hard-working person in the group, who finishes her work on time. I help in this project by doing stuff on time, creating new ideas/insights, and making the poster, sleeping diary and report. Creating new ideas/insights with my groupmates helped me with thinking more out of the box. A difficult point for me in the past, but during this quartile, I learned to think more out of the box. Why? So, I can make more interesting prototypes in future projects. For new better prototypes to test with my participants.

Overall, I think that the project went well. The cooperation between the group members was good, a little bumpy after a while, due to the problem that someone did not make his deadlines a couple of times. But eventually, we talked about it in the group and with the coaches. This helped the person to realize the problem. I learned from this problem that you must stay in touch with each other. You must stay in contact with your group mates, even if you can do it only online. This makes the work go faster and with better results.

I am happy to see what we have reached. We have made a prototype with the resources we have, during this crazy time. We made a good-looking poster and we have written a good report. All with good communication(online). But I am happy if we do not have to spend so much time behind our desks anymore. I like being a designer that you can work in a lab or workshop place, where you can work offline.

What I missed to learn was making the prototype. My goal for this semester was to learn how to make a high-fidelity prototype with the help of my groupmates. Due to the coronavirus, I could not make a prototype in Vertigo with my groupmates. I wanted to learn this

# Appendix

## *A. Iteration I: Portrayed concept*

This is the way we portrayed our concept to our participant :
‘’We want to design a product synchronizing with someone’s heart rate and breathing/respiration to create a stabilized heart rate resulting in a more relaxed state of being throughout the day.

The customizable ball formed product from adjustable proportions or a specific material adjustable to your own hand, would be used in different situations throughout to day. The product would synchronise with the persons irregular breathing and conduct the breathing to a more regular tempo resulting in a more relaxed state of being, reducing stress. The design would pulsate and expand resulting in the person’s heart rate being tempted and influenced by the products frequency. When the product would be located close to the wrist, reading the heart rate would be easier than somewhere else on the body, except from around the chest area. That’s why we also came up with a way of implementing this design in a wearable around your chest, yet again focusing on synchronizing and so stabilizing the breathing and heart rate of the person.’’

## *B. Iteration I: Interview with the participant*

Q1: How many times per week are you stressed or do you suffer from panic attacks?
A1: I am stressed two times per week, I suffer one time per month from a panic attack I think.

Q2: How do you feel at that moment/What symptoms do you have then?
A2: I am not properly breathing then, I have shortness of breath and I breathe high. Such a panic attack takes nearly half an hour. And then, there are too many things going around in my head. I have shaking hands, and I am not thinking clearly. Such situations you cannot feel coming.

Q3: Is there any specific reason for the occurrence of these moments?
A3: They happen mostly at the end of the day, you’re out of energy, but the attack itself costs a lot of energy too. Sometimes during the stress, you already notice that you are stressed. The stress is accumulated at a panic attack and a lot of things that has happened suddenly come out. You are already feeling less than good for a while.

Q4: Then, about the form of our intended design: would you keep this shape? What form would you find nicer?
A4: Perhaps I would rather have not a perfect sphere, but an oval, which can lie in your hand palm, so you do not feel that there is actually something. Therefore it also needs to be light. You should be able to squeeze it.

Q5: Would you like a customizable form, special to your hand more?
A5: Yes.

Q6: What is your opinion on the color?
A6: Make it gray, or another subtle color.

Q7: Should the ball also give (calming) sounds?
A7: Yes! Or chill, nature sounds, in a quiet room, or waves, because you can sync those with your heartbeat/breathing. Oh and maybe a tip: when I have a panic attack and someone says breathe with me, with a quiet breathing, that helps. So the ball should vibrate as quick to calm someone with heavy breathing.

Q8: Would you use the ball in the public?
A8: I would not use it in public. But if it was without sound and it would be small, such as a stress ball format, than I would give it a try I think. But I think it also depends on who you are to find it uncomfortable. If something would fit in a clothing piece, it would help also.

Q9: Would you really be less stressed by this?
A9: Yes, I think I would be.

Q10: How often would you use the ball?
A10: I think as many times as I have stress or feel that coming.

*C. Iteration II : Consent form & ERB form*

| Part 1: General Study Information | | |
|---|---|---|
| 1 | Project title and project number | Project 1 Vital Change |
| 2 | Researcher name and email | Dapper Bruijn (bruijndapper@gmail.com) |
| 3 | Supervisor(s) | Joost Liebregts, Jim Steenbakkers |
| 4 | Faculty/department | Industrial Design |
| 5 | Research location | TU/e |
| 6 | Research period (start/end date) | January 2020 – June 2020 |
| 7 | Funding agency | - |
| 8 | [If Applicable] Study is part of an educational course with code: | DPB100 |
| 9 | [If Applicable] Proposal already approved by external Ethical Review Board: Add name, date of approval, and contact details of the ERB | |
| 10 | Short description of the research question | Due to a project 'Vital Change' for the study Industrial Design, we, Lisanne de Jonge, Britt Joosten, Kim Keereweer & Dapper Bruijn have started a research to design a solution for people from the age of 16-25 who are having trouble getting sleep due to stress and thinking about things you need to do. |
| 11 | Description of the research method | We researched the effect of a moving blanket and pillow or a weighted blanket, by using the Wizard of Oz technique representing our idea |
| | | by moving the pillow and blanket ourselves and ask complementing questions. We will also put out a questionnaire online asking people the conditions of their insomnia and the supposed origin of the person's insomnia. |

| | | | |
|---|---|---|---|
| 12 | Description of the research population, exclusion criteria | We will contact 5 participants that we know will fall into our target group : aged 16-25 year old with issues falling asleep due to stress or other external factors. Nex to this we will put the questionnaire online for anyone who feels the problem is relatable and wants to fill it in. | |
| 13 | Description of the measurements and/or stimuli/treatments | We will ask the participant questions during the movement of the blanket and pillow. We will also ask questions regarding their well-being during some breathing exercises. | |
| 14 | Number of participants | 5 (3), we were unfortunately only able to find 3 participants for the real-life user test. | |
| 15 | Explain why the research is socially important. What benefits and harm to society may result from the study? | This research will enhance our knowledge regarding the effect of breathing techniques on people who struggle to relax, destress and fall asleep. This knowledge will be used to form a better product/service/system to help people fall asleep easier. Decreasing global insomnia and enhancing people's sleep will increase the general physical and mental well being of the users. Since sleep is extremely important for rest and recovery of the physical body and stress. | |
| 16 | Describe the way participants will be recruited | Participants we already know will be asked if they would like to participate in research regarding this subject. After signing the consent form the test could start | |
| | | and the online questionnaire could be filled in. | |
| 17 | Provide a brief statement of the risks you expect for the participants or others involved in the research or educational activity and explain. Take into consideration any personal data you may gather and privacy issues. | The data is anonymized in the online google forms questionnaire, since there will not be asked to a name, only age and gender. | |

## Part 2: Checklist for Minimal Risk

| | | Yes | No |
|---|---|---|---|
| 1 | Does the study involve participants who are particularly vulnerable or unable to give informed consent? (e.g. children, people with learning difficulties, patients, people receiving counselling, people living in care or nursing homes, people recruited through self-help groups) | | x |
| 2 | Are the participants, outside the context of the research, in a dependent or subordinate position to the investigator (such as own children or own students)? | | x |
| 3 | Will it be necessary for participants to take part in the study without their knowledge and consent at the time? (e.g. covert observation of people in non-public places) | | x |
| 4 | Will the study involve actively deceiving the participants? (e.g. will participants be deliberately falsely informed, will information be withheld from them or will they be misled in such a way that they are likely to object or show unease when debriefed about the study) | | x |
| 5 | Will the study involve discussion or collection of personal data? (e.g. name, address, phone number, email address, IP address, BSN number, location data) or will the study collect and store videos, pictures, or other identifiable data of human subjects?. Please check the FAQ's on the intranet. If yes: please follow the procedure. Make sure you perform a Data Protection Impact Assessment (DPIA) and make a Data Management Plan if necessary and let the data steward check it. Please attach these documents with this form (see part 5; enclosures) | | x |
| 6 | Will participants be asked to discuss or report sexual experiences, religion, alcohol or drug use, or suicidal thoughts, or other topics that are highly personal or intimate? | | x |
| 7 | Will participating in the research be burdensome? (e.g. requiring participants to wear a device 24/7 for several weeks, to fill in questionnaires for hours, to travel long distances to a research location, to be interviewed multiple times)? | | x |
| 8 | May the research procedure cause harm or discomfort to the participant in any way? (e.g. causing pain or more than mild discomfort, stress, anxiety or by administering drinks, foods, drugs) | | x |
| 9 | Will blood or other (bio)samples be obtained from participants (e.g. also external imaging of the body)? | | x |
| 10 | Will financial inducement (other than reasonable expenses and compensation for time) be offered to participants? | | x |
| 11 | Will the experiment involve the use of physical devices that are not 'CE' certified? | | x |

| Important: |
|---|
| If you answered all questions with "no", you can skip parts 3 - 4 and go directly to part 5. Check which documents you need to enclose and continue with signature and submission.<br><br>If you answered one or more questions with "yes", please continue with parts 3 – 5. |

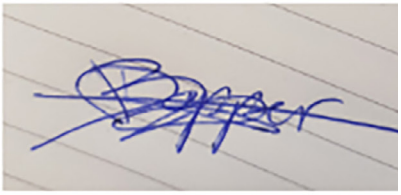
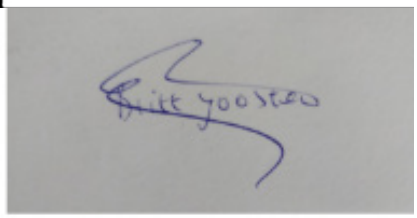
## Part 3: Study Procedures and Sample Size Justification

| | | |
|---|---|---|
| 1 | Elaborate on all boxes answered with "yes" in part 2. Describe how you safeguard any potential risk for the research participant. | Not applicable |
| 2 | Describe and justify the number of participants you need for this research or educational activity. Also justify the number of observations you need, taking into account the risks and benefits | |

## Part 4: Data and Privacy Statement

| | | |
|---|---|---|
| 1 | Explain whether your data are completely anonymous, or if they will be de-identified (pseudonymized or anonymized) and explain how. | |
| 2 | Who will have access to the data? | Only the researches will have access to the data. |
| 3 | Will you store personal information that will allow participants to be identified from their data? See VSNU draft. | ■ No<br><br>☐ Yes, and I declare I will follow the general data protection regulation (GDPR). |
| 4 | Will you share de-identified data (e.g., upon publication in a public repository)? | ■ No<br><br>☐ Yes, and I will inform participants about how their data will be shared, and ask consent to share their data. I will, to the best of my knowledge and ability, make sure the data do not contain information that can identify participants |

## Part 5: Closures and Signatures

| | | |
|---|---|---|
| 1 | Enclosures (tick if applicable):<br><br>☑ Informed consent form;<br><br>☑ Informed consent form for other agencies when the research is conducted at a location (such as a school);<br><br>☐ Text used for ads (to find participants);<br><br>☐ Text used for debriefings;<br><br>■ Approval other research ethics committee;<br><br>☑ The survey the participants need to complete, or a description of other measurements;<br><br>☐ Any other information which might be relevant for decision making by ERB;<br><br>☐ Data Protection Impact Assessment checked by the privacy officer<br><br>☐ Data Management Plan checked by a data steward | |
| 2 | Signature(s)<br><br>Signature(s) of researcher(s)<br><br>Date: 15/04/2020<br><br>Signature research supervisor (if applicable)<br><br>Date: |  <br>  <br>  <br>  |

## *D. Iteration II: Questionnaire of the user test*

The questionnaire we made:https://docs.google.com/forms/d/e/1FAIpQLScYg5xPUe6gctCXudBtnL9mTWi-yVTQ5XQmR12WosLxPvy1R_A/viewform?usp=sf_link

## *E. Iteration II: Breathing exercise of the user test*

4-7-8 Breathing technique (Healthline, 2019)

1. Allow your lips to gently part.
2. Exhale completely, making a breathy whoosh sound as you do.
3. Press your lips together as you silently inhale through the nose for a count of 4 seconds.
4. Hold your breath for a count of 7.
5. Exhale again for a full 8 seconds, making a whooshing sound throughout.
6. Repeat 4 times when you first start. Eventually work up to 8 repetitions.

## *F. Iteration III: Consent form & ERB form*

*Subject Consent Form*

Stress and insomnia
Due to a project 'Vital Change' for the study Industrial Design, we, Lisanne de Jonge, Britt Joosten, Kim Keereweer & Dapper Bruijn have started a research to design a solution for people from the age of 16-25 who are having trouble getting sleep due to stress and thinking about things you need to do. This questionnaire has a few questions about your own experience and then some about solutions we came up with.

- I have been given information and I understand what this research is about. I was also able to ask questions. My questions have been answered to my satisfaction. I had enough time to decide whether to participate.
- I know that participation is voluntary. I know that I may decide at any time not to participate after all or to withdraw from the study. I do not need to give a reason for this.
- I know that I do not have to answer questions I don't want to answer.
- I know that some people can access my data. These people are B.J.H. Joosten, L.J.J de Jonge, K.R. Keereweer, D.C. Bruijn.
- I consent to gathering and usage of my data for scientific publication and additional research on my data.
- I consent to being pictured during this research. I know that I won't be shown as recognizable in these pictures if I don't want to. I know that there is a possibility that these pictures are seen by the assessors of subject DPB100 Project 1 of Eindhoven University of Technology. I know that I have the right to make these pictures be removed at all times.
- I understand that the transcript of this diary will be translated to English. I know that I can get a copy of the transcript and the translated transcript.
- I consent to my data being stored at the research location for another 5 years after this study.
- After the questionnaire I have the right to decline the use of certain answers for the research.

I want to participate in this study.

Name of study subject:
Signature: Date: __ / __ / __

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I hereby declare that I have fully informed this study subject about this study.

If information comes to light during the course of the study that could affect the study subject's consent, I will inform him/her of this in a timely fashion.

Name of investigator (or his/her representative):
Signature: Date:__ / __ / __

---

| Part 1: General Study Information | | |
|---|---|---|
| 1 | Project title and project number | Project 1 Vital Change |
| 2 | Researcher name and email | Dapper Bruijn (bruijndapper@gmail.com) |
| 3 | Supervisor(s) | Joost Liebregts, Jim Steenbakkers |
| 4 | Faculty/department | Industrial Design |
| 5 | Research location | TU/e |
| 6 | Research period (start/end date) | January 2020 – June 2020 |
| 7 | Funding agency | - |
| 8 | [If Applicable] Study is part of an educational course with code: | DPB100 |
| 9 | [If Applicable] Proposal already approved by external Ethical Review Board: Add name, date of approval, and contact details of the ERB | |
| 10 | Short description of the research question | Due to a project 'Vital Change' for the study Industrial Design, we, Lisanne de Jonge, Britt Joosten, Kim Keereweer & Dapper Bruijn have started a research to design a solution for people from the age of 16-25 who are having trouble getting sleep due to stress and thinking about things you need to do. |
| 11 | Description of the research method | We researched the effect of a moving blanket and pillow or a weighted blanket, by using the Wizard of Oz technique representing our idea |
| | | by moving the pillow and blanket ourselves and ask complementing questions. We will also put out a questionnaire online asking people the conditions of their insomnia and the supposed origin of the person's insomnia. |

| | | | |
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| 15 | Explain why the research is socially important. What benefits and harm to society may result from the study? | This research will enhance our knowledge regarding the effect of breathing techniques on people who struggle to relax, destress and fall asleep. This knowledge will be used to form a better product/service/system to help people fall asleep easier. Decreasing global insomnia and enhancing people's sleep will increase the general physical and mental well being of the users. Since sleep is extremely important for rest and recovery of the physical body and stress. | |
| 16 | Describe the way participants will be recruited | Participants we already know will be asked if they would like to participate in research regarding this subject. After signing the consent form the test could start | |
| | | and the online questionnaire could be filled in. | |
| 17 | Provide a brief statement of the risks you expect for the participants or others involved in the research or educational activity and explain. Take into consideration any personal data you may gather and privacy issues. | The data is anonymized in the online google forms questionnaire, since there will not be asked to a name, only age and gender. | |

## Part 2: Checklist for Minimal Risk

| | | Yes | No |
|---|---|---|---|
| 1 | Does the study involve participants who are particularly vulnerable or unable to give informed consent? (e.g. children, people with learning difficulties, patients, people receiving counselling, people living in care or nursing homes, people recruited through self-help groups) | | x |
| 2 | Are the participants, outside the context of the research, in a dependent or subordinate position to the investigator (such as own children or own students)? | | x |
| 3 | Will it be necessary for participants to take part in the study without their knowledge and consent at the time? (e.g. covert observation of people in non-public places) | | x |
| 4 | Will the study involve actively deceiving the participants? (e.g. will participants be deliberately falsely informed, will information be withheld from them or will they be misled in such a way that they are likely to object or show unease when debriefed about the study) | | x |
| 5 | Will the study involve discussion or collection of personal data? (e.g. name, address, phone number, email address, IP address, BSN number, location data) or will the study collect and store videos, pictures, or other identifiable data of human subjects?. Please check the FAQ's on the intranet. If yes: please follow the procedure. Make sure you perform a Data Protection Impact Assessment (DPIA) and make a Data Management Plan if necessary and let the data steward check it. Please attach these documents with this form (see part 5; enclosures) | | x |
| 6 | Will participants be asked to discuss or report sexual experiences, religion, alcohol or drug use, or suicidal thoughts, or other topics that are highly personal or intimate? | | x |
| 7 | Will participating in the research be burdensome? (e.g. requiring participants to wear a device 24/7 for several weeks, to fill in questionnaires for hours, to travel long distances to a research location, to be interviewed multiple times)? | | x |
| 8 | May the research procedure cause harm or discomfort to the participant in any way? (e.g. causing pain or more than mild discomfort, stress, anxiety or by administering drinks, foods, drugs) | | x |
| 9 | Will blood or other (bio)samples be obtained from participants (e.g. also external imaging of the body)? | | x |
| 10 | Will financial inducement (other than reasonable expenses and compensation for time) be offered to participants? | | x |
| 11 | Will the experiment involve the use of physical devices that are not 'CE' certified? | | x |

| Important: |
|---|
| If you answered all questions with "no", you can skip parts 3 - 4 and go directly to part 5. Check which documents you need to enclose and continue with signature and submission.<br><br>If you answered one or more questions with "yes", please continue with parts 3 – 5. |

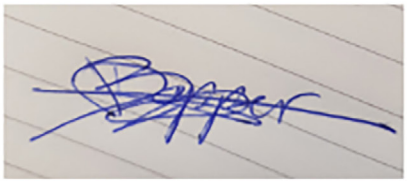
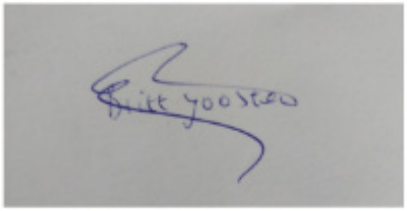
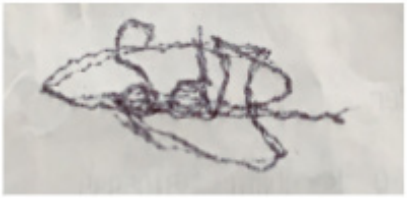
## Part 3: Study Procedures and Sample Size Justification

| | | |
|---|---|---|
| 1 | Elaborate on all boxes answered with "yes" in part 2. Describe how you safeguard any potential risk for the research participant. | Not applicable |
| 2 | Describe and justify the number of participants you need for this research or educational activity. Also justify the number of observations you need, taking into account the risks and benefits | |

## Part 4: Data and Privacy Statement

| | | |
|---|---|---|
| 1 | Explain whether your data are completely anonymous, or if they will be de-identified (pseudonymized or anonymized) and explain how. | |
| 2 | Who will have access to the data? | Only the researches will have access to the data. |
| 3 | Will you store personal information that will allow participants to be identified from their data? See VSNU draft. | ■ No<br><br>☐ Yes, and I declare I will follow the general data protection regulation (GDPR). |
| 4 | Will you share de-identified data (e.g., upon publication in a public repository)? | ■ No<br><br>☐ Yes, and I will inform participants about how their data will be shared, and ask consent to share their data. I will, to the best of my knowledge and ability, make sure the data do not contain information that can identify participants. |

## Part 5: Closures and Signatures

| | | |
|---|---|---|
| 1 | Enclosures (tick if applicable):<br><br>☑ Informed consent form;<br><br>☑ Informed consent form for other agencies when the research is conducted at a location (such as a school);<br><br>☐ Text used for ads (to find participants);<br><br>☐ Text used for debriefings;<br><br>■ Approval other research ethics committee;<br><br>☑ The survey the participants need to complete, or a description of other measurements;<br><br>☐ Any other information which might be relevant for decision making by ERB;<br><br>☐ Data Protection Impact Assessment checked by the privacy officer<br><br>☐ Data Management Plan checked by a data steward | |
| 2 | Signature(s)<br><br>Signature(s) of researcher(s)<br><br>Date: 15/04/2020<br><br>Signature research supervisor (if applicable)<br><br>Date: |  <br>  |
| | |  <br>  |

## *G. Iteration III: Sleeping diary format*

Sleeping diary

**Print this diary out (if you can't don't try to use your phone to much before bedtime**
*How the sleeping diary works. Every day you will have to answer a few questions before you go to sleep. After answering these questions you can start with the exercise to fall asleep. In the morning after you wake up we ask you to answer a few questions about what you think of this breathing exercise. If a exercise does not comfort you, you can stop at all times. This sleeping diary takes 7 days.*

*Kind regards for helping in our research for developing a product for a better bedrest.*
*From Dapper Bruijn, Kim Keereweer, Britt Joosten and Lisanne de Jonge.*

Begin questions:
- What is your daily sleeping time and weekend sleeping time?
- Which position do you sleep?

**Day 1, 31-3-2020**
Evening questions:
1. How stressed are you at the moment? 1 Not at all to 10 very much.
   1 2 3 4 5 6 7 8 9 10
2. What time is it?

   ---
3. Did you take medication? (What for?)

   ---
4. Did you drink alcohol today? How many glasses?

   ---
5. Did you drink any caffeine drinks(cola, caffe, etc)? How many?

   ---
6. Did you set an alarm?

   ---
7. How awake do you feel now?
   wide awake awake, but a little tired sleepy

8. Have you had a big meal or a big workout 2 or 3 hours before bedtime?

   ---

Exercise 1:
4-7-8 Breathing technique (Healthline, 2019)

1. Allow your lips to gently part.
2. Exhale completely, making a breathy whoosh sound as you do.
3. Press your lips together as you silently inhale through the nose for a count of 4 seconds.
4. Hold your breath for a count of 7.
5. Exhale again for a full 8 seconds, making a whooshing sound throughout.
6. Repeat 4 times when you first start. Eventually work up to 8 repetitions.

Morning questions:
1. How many minutes did you think it took for you to fall asleep?

   ---
2. What time is it?

   ---
3. How did you fall asleep?
   easily after some time with difficulty

(Why did you fall asleep with difficulty?)

4. How many times did you wake up during the night? Did you try the exercise again?

---

5. How long did these awakenings last?

---

6. What occurs these awakenings?

---

7. How awake did you feel when you woke up?
wide awake awake, but a little tired sleepy

8. Do you want to note anything that interfered with your sleeping?

---

9. Did the exercise worked destressing? Why?

---

10. Did the exercise make you drowsy?

---

11. Was the counting helpful? Why?

---

12. Which number would you give this exercise? (1 bad to 10 excellent)
1 2 3 4 5 6 7 8 9 10

13. Why?
---

**Day 2, 1-4-2020**

Evening questions:
1. How stressed are you at the moment? 1 Not at all to 10 very much.
1 2 3 4 5 6 7 8 9 10
2. What time is it?

---

3. Did you take medication? (What for?)

---

4. Did you drink alcohol today? How many glasses?

---

5. Did you drink any caffeine drinks(cola, caffe, etc)? How many?

---

6. Did you set an alarm?

---

7. How awake do you feel now?
wide awake awake, but a little tired sleepy

8. Have you had a big meal or a big workout 2 or 3 hours before bedtime?

---

Exercise 2:
Three part breathing exercise

1. Take a long, deep inhale.
2. Exhale fully while focusing intently on your body and how it feels. Think slowly about your feet getting heavier, your legs, but, belly, etc.
   ^If your thoughts are going to something else, bring them back to your body.^
3. After doing this a few times, slow down your exhale so that it's twice as long as your inhale. Still can't fall asleep? Ty it one(or eve 2) more times.

Morning questions:

1. How many minutes did you think it took for you to fall asleep?

---

2. What time is it?

---

3. How did you fall asleep?
   easily after some time with difficulty

(Why did you fall asleep with difficulty?)

---

4. How many times did you wake up during the night? Did you try the exercise again?

---

5. How long did these awakenings last?

---

6. What occurs these awakenings?

---

7. How awake did you feel when you woke up?
   wide awake awake, but a little tired sleepy

8. Do you want to note anything that interfered with your sleeping?

---

9. Did the exercise worked destressing? Why?

---

10. Did the exercise make you drowsy?

---

11. Did it help to focus on your thoughts? Why?

---

12. Which number would you give this exercise? (1 bad to 10 excellent)
    1 2 3 4 5 6 7 8 9 10

13. Why?

---

**Day 3, 2-4-2020**

Evening questions:

1. How stressed are you at the moment? 1 Not at all to 10 very much.
   1 2 3 4 5 6 7 8 9 10
2. What time is it?

   ---

3. Did you take medication? (What for?)

   ---

4. Did you drink alcohol today? How many glasses?

   ---

5. Did you drink any caffeine drinks(cola, caffe, etc)? How many?

   ---

6. Did you set an alarm?

   ---

7. How awake do you feel now?
   wide awake awake, but a little tired sleepy

8. Have you had a big meal or a big workout 2 or 3 hours before bedtime?

   ---

Exercise 3:

Diaphragmatic breathing exercise

!Take an extra pillow with you in bed!

1. Lie on your back and bend your knees over a pillow.
2. Place one hand flat against your chest and the other on your stomach.
3. Take slow, deep breaths through your nose, keeping the hand on your chest still as the hand on your stomach rises and falls with your breaths.
4. Next, breath slowly through pursed lips.
5. Eventually, you want to be able to breath in and out without your chest moving.

Morning questions:

1. How many minutes did you think it took for you to fall asleep?

   ---

2. What time is it?

   ---

3. How did you fall asleep?
   easily after some time with difficulty

(Why did you fall asleep with difficulty?)

   ---

4. How many times did you wake up during the night? Did you try the exercise again?

   ---

5. How long did these awakenings last?

   ---

6. What occurs these awakenings?

   ---

7. How awake did you feel when you woke up?
   wide awake awake, but a little tired sleepy

8. Do you want to note anything that interfered with your sleeping?

9. Did the exercise worked destressing? Why?

---

10. Did the exercise make you drowsy?

---

11. Did it help to focus on your breath? Why?

---

12. Which number would you give this exercise? (1 bad to 10 excellent)
1 2 3 4 5 6 7 8 9 10

13. Why?

---

**Day 4, 3-3-2020**

Evening questions:

1. How stressed are you at the moment? 1 Not at all to 10 very much.
1 2 3 4 5 6 7 8 9 10
2. What time is it?

---

3. Did you take medication? (What for?)

---

4. Did you drink alcohol today? How many glasses?

---

5. Did you drink any caffeine drinks(cola, caffe, etc)? How many?

---

6. Did you set an alarm?

---

7. How awake do you feel now?
wide awake awake, but a little tired sleepy

8. Have you had a big meal or a big workout 2 or 3 hours before bedtime?

---

Exercise 4:

Alternate nasal breathing exercise

1. Sit with your legs crossed on your bedside.
2. Place your left hand on your knee and your right thumb against your nose.
3. Exhale fully and then close the right nostril.
4. Inhale through your left nostril.
5. Open your right nostril and exhale through it, while closing the left.
6. Continue this rotation for 5 minutes, finishing by exhaling through your left nostril.

Morning questions:

1. How many minutes did you think it took for you to fall asleep?

---

2. What time is it?

---

3. How did you fall asleep?
easily after some time with difficulty

(Why did you fall asleep with difficulty?)

4. How many times did you wake up during the night? Did you try the exercise again?

---

5. How long did these awakenings last?

---

6. What occurs these awakenings?

---

7. How awake did you feel when you woke up?
wide awake awake, but a little tired sleepy

8. Do you want to note anything that interfered with your sleeping?

---

9. Did the exercise worked destressing? Why?

---

10. Did the exercise make you drowsy?

---

11. Did it help to focus on where your breath is going? Why

---

12. Did you find it better to sit up than a exercise lying in your bed? Why?

---

13. Which number would you give this exercise? (1 bad to 10 excellent)
1 2 3 4 5 6 7 8 9 10

14. Why?

---

**Day 5, 4-4-2020**

Evening questions:

1. How stressed are you at the moment? 1 Not at all to 10 very much.
1 2 3 4 5 6 7 8 9 10
2. What time is it?

---

3. Did you take medication? (What for?)

---

4. Did you drink alcohol today? How many glasses?

---

5. Did you drink any caffeine drinks(cola, caffe, etc)? How many?

---

6. Did you set an alarm?

---

7. How awake do you feel now?
wide awake awake, but a little tired sleepy

8. Have you had a big meal or a big workout 2 or 3 hours before bedtime?

---

Exercise 5:
The Papworth method

1. Sit up straight, perhaps in bed if using this to fall asleep.
2. Take deep, methodical breaths in and out, counting to 4 with each inhale — through your mouth or nose — and each exhale, which should be through your nose.
3. Focus on your abdomen(belly) rising and falling, and listen for your breath sounds to come from your stomach.

Morning questions:

1. How many minutes did you think it took for you to fall asleep?

---

2. What time is it?

---

3. How did you fall asleep?
easily after some time with difficulty

(Why did you fall asleep with difficulty?)

---

4. How many times did you wake up during the night? Did you try the exercise again?

---

5. How long did these awakenings last?

---

6. What occurs these awakenings?

---

7. How awake did you feel when you woke up?
wide awake awake, but a little tired sleepy

8. Do you want to note anything that interfered with your sleeping?

---

9. Did the exercise worked destressing? Why?

---

10. Did the exercise make you drowsy?

---

11. Did you find it better to sit up than a exercise lying in your bed? Why?

---

12. Did you find it helpful to focus on your breath? Why?

---

13. Which number would you give this exercise? (1 bad to 10 excellent)
1 2 3 4 5 6 7 8 9 10

14. Why?
---

**Day 6, 5-4-2020**

Evening questions:

1. How stressed are you at the moment? 1 Not at all to 10 very much.
   1 2 3 4 5 6 7 8 9 10
2. What time is it?

---

3. Did you take medication? (What for?)

---

4. Did you drink alcohol today? How many glasses?

---

5. Did you drink any caffeine drinks(cola, caffe, etc)? How many?

---

6. Did you set an alarm?

---

7. How awake do you feel now?
   wide awake awake, but a little tired sleepy

8. Have you had a big meal or a big workout 2 or 3 hours before bedtime?

---

Exercise 6:

Put on some calming music: Click on the first one you see in your results.
   a. buddhist music b. sedative music

Morning questions:

1. How many minutes did you think it took for you to fall asleep?

---

2. What time is it?

---

3. How did you fall asleep?
   easily after some time with difficulty

(Why did you fall asleep with difficulty?)

---

4. How many times did you wake up during the night? Did you try the exercise again?

---

5. How long did these awakenings last?

---

6. What occurs these awakenings?

---

7. How awake did you feel when you woke up?
   wide awake awake, but a little tired sleepy

8. Do you want to note anything that interfered with your sleeping?

---

9. Did the exercise worked destressing? Why?

---

10. Did the exercise make you drowsy?

---

11. Which music did you prefer? Why?

---

12. Do you prefer listening music over the other exercises? Why?

---

13. Which number would you give this exercise? (1 bad to 10 excellent)
1 2 3 4 5 6 7 8 9 10

14. Why?

---

**Day 7, 6-4-2020**

Evening questions:

1. How stressed are you at the moment? 1 Not at all to 10 very much.
1 2 3 4 5 6 7 8 9 10
2. What time is it?

---

3. Did you take medication? (What for?)

---

4. Did you drink alcohol today? How many glasses?

---

5. Did you drink any caffeine drinks(cola, caffe, etc)? How many?

---

6. Did you set an alarm?

---

7. How awake do you feel now?
wide awake awake, but a little tired sleepy

8. Have you had a big meal or a big workout 2 or 3 hours before bedtime?

---

Exercise 7:

Box breathing

1. Sit with your back straight, breathe in, and then try to push all the air out of your lungs as you exhale.
2. Inhale slowly through your nose and count to 4 in your head, filling your lungs with more air with each number.
3. Hold your breath and count to 4 in your head.
4. Slowly exhale through your mouth, focusing on getting all the oxygen out of your lungs.

Morning questions:

1. How many minutes did you think it took for you to fall asleep?

---

2. What time is it?

---

3. How did you fall asleep?
easily after some time with difficulty

(Why did you fall asleep with difficulty?)

---

4. How many times did you wake up during the night? Did you try the exercise again?

---

5. How long did these awakenings last?

---

6. What occurs these awakenings?

---

7. How awake did you feel when you woke up?
wide awake awake, but a little tired sleepy

8. Do you want to note anything that interfered with your sleeping?

---

9. Did the exercise worked destressing? Why?

---

10. Did the exercise make you drowsy?

---

11.Do you prefer meditation sitting or lying?

---

12Did you find the counting helpful? Why?

---

13. Which number would you give this exercise? (1 bad to 10 excellent)
1 2 3 4 5 6 7 8 9 10

14. Why?

---

The final questions: Which breathing exercise did you find the best? (1=best to 7=bad)
1 2 3 4 5 6 7 8 9 10

If you have chosen 5, 6 or 7. Do you think it can be, due to the fact that you have done for a couple of days already breathing exercises?

---

Thank you very much for participating! Did you find the 4-7-8 breathing exercise helpful? You can install the app Breathe(Apple) or Prana Breath: Calm & Meditate(Google play).

*Make photos in daylight*

→ whatsapp your answer back to us. If you have any additional things you can always app it to us.

## H. Iteration III: Results of the sleeping diary exercise

| person | Exercice 1 | Exercice 2 | Exercice 3 | Exercice 4 | Exercice 5 | Exercice 6 | Exercice 7 | | Type of music |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 6 | 4 | 3 | 4 | 6 | 8 | 6 | | Buddhist music |
| 2 | 8 | 6 | 8 | 4 | 7 | 9 | 8 | | Buddhist music |
| 3 | 3 | 3 | 2 | 6 | 1 | 5 | 3 | | Sedative music |
| 4 | 6 | 8 | 8 | 5 | 7 | 7 | 5 | | Sedative music |
| 5 | 6 | 8 | 4 | 4 | 6 | 9 | 6 | | Calm spotify |
| 6 | 4 | 5 | 6 | 5 | 5 | 7 | 6 | | Piano music |
| 7 | 4 | 8 | 8 | 4 | 6 | 7 | 4 | | Sedative music |
| 8 | 6 | 4 | 7 | 5 | 6 | 9 | 4 | | Buddhist music |
| 9 | 7 | 4 | 7 | 6 | 6 | 3 | 6 | | no music |
| 10 | | | | | | | | | |
| 11 | | | | | | | | | |
| Average | 5,6 | 5,6 | 5,9 | 4,8 | 5,6 | 7,1 | 5,3 | | Sedative music & buddhist |
| | | | | | | | | | |
| Total participants | 11 | | | | | | | | |
| completed tests | 9 | | | | | | | | |

## I. Iteration IV: Mail and answer

Answers
https://drive.google.com/file/d/1dlj_9m78akNdUEx7Tn98PKBbEDCZ3Gec/view?usp=sharing

## J. Iteration V: Arduino code

```
#include <Servo.h>            //Servo library needed to control the servo motors

const int servo1 = 0;         //Creating integers for the servo motors
const int servo2 = 1;
const int servo3 = 2;
const int servo4 = 3;

const int pin_servo1 = 9;
const int pin_servo2 = 6;
const int pin_servo3 = 5;
const int pin_servo4 = 3;


const int buttonPin1 = 2;     //Assigning buttons to the arduino
const int buttonPin2 = 4;
const int buttonPin3 = 7;

int pos = 0;                 //Creating position and state integers
int state = 0;
int buttonState1 = 0;
int buttonState2 = 0;
int buttonState3 = 0;


Servo servo[4];              //Creating servo's enabling to be controlled

void setup() {

  Serial.begin(9600);

  pinMode(buttonPin1, INPUT);       //Indicating the buttons as information input
  pinMode(buttonPin2, INPUT);
  pinMode(buttonPin3, INPUT);

  servo[servo1].attach(pin_servo1); //Assigning different servo's to the right pins
  servo[servo1].write(0);

  servo[servo2].attach(pin_servo2);
  servo[servo2].write(0);

  servo[servo3].attach(pin_servo3);
  servo[servo3].write(0);

  servo[servo4].attach(pin_servo4);
```

```
  servo[servo4].write(0);

}


void loop() {                             //Where the magic happens :

  buttonState1 = digitalRead(buttonPin1); //Creating 'buttonSate(n)' which will
  buttonState2 = digitalRead(buttonPin2); //read the values of the buttons
  buttonState3 = digitalRead(buttonPin3);


  if (buttonState1 == 0) {                //Whenever the button is pressed,
                                          //indicating a value of 0, the servo motors
                                          //will be ordered to move

    for (pos = 0; pos <= 90; pos += 1) {//Ordering servo motor 1 and servo motor 2 to
      servo[servo1].write(pos);          //keep positioning themselves 1 degree to
      servo[servo2].write(pos);          //their original position (0 degrees)
                                         //Untill they reach the position of 90 degrees

      delay(20);                         //The speed of which the servo motors turn,
                                         //and the bed will turn
    }
    for (pos = 90; pos >= 0; pos -= 1) {//Yet again, the movement of the servo's
      servo[servo1].write(pos);          //resulting in them positioning themselves
      servo[servo2].write(pos);          //1 degree 'back' to its original position
                                         //from 90 degress untill they reach 0 degrees.
      delay(20);
    }
 }

  if (buttonState2 == 0) {//Same movement, two different motors. A different button

      for (pos = 0; pos <= 90; pos += 1) {
      servo[servo3].write(pos);
      servo[servo4].write(pos);
      delay(20);
    }
    for (pos = 90; pos >= 0; pos -= 1) {
      servo[servo3].write(pos);
      servo[servo4].write(pos);
      delay(20);
    }

 }

  if (buttonState3 == 0) {//The two previous movements combined with yet
                          //another button functioning as actuator
      for (pos = 90; pos >= 0; pos -= 1) {
      servo[servo1].write(pos);
      servo[servo2].write(pos);
      delay(20);
    }

    for (pos = 0; pos <= 90; pos += 1) {
      servo[servo1].write(pos);
      servo[servo2].write(pos);
      delay(20);
    }

    for (pos = 0; pos <= 90; pos += 1) {
      servo[servo3].write(pos);
      servo[servo4].write(pos);
      delay(20);
    }
    for (pos = 90; pos >= 0; pos -= 1) {
      servo[servo3].write(pos);
      servo[servo4].write(pos);
      delay(20);
    }
  }
}
```

## K. Iteration VII: Questionnaire

The questionnaire we made:

https://docs.google.com/forms/d/1tj2EnN7tB5cHr9cBFLPxu2fBmsJH9BOUU1sE4zDhx3g/prefill

## L. Iteration VII: Price evaluation in Python

In [1]:
```
import numpy as np
import pandas as pd

# next command ensures that plots appear inside the notebook
%matplotlib inline
import matplotlib as mpl
import matplotlib.pyplot as plt
import seaborn as sns  # also improves the look of plots
sns.set()
plt.rcParams['figure.figsize'] = 10, 5  # default hor./vert. size of plots, in inches
plt.rcParams['lines.markeredgewidth'] = 1  # to fix issue with seaborn box plots; needed after import seaborn

from sklearn.linear_model import LinearRegression  # for linear regression
from sklearn.cluster import KMeans  # for clustering
from sklearn.tree import DecisionTreeClassifier  # for decision tree mining
from sklearn.metrics import accuracy_score, confusion_matrix, mean_squared_error
from sklearn.model_selection import train_test_split
```

In [2]:
```
df_validation = pd.read_excel('datasets/Validation.xlsx')
df_validation.set_index('User',inplace=True)
df_validation.columns = ['In our target group', 'Buying the product']
df_validation.head()
```

Out[2]:

| User | In our target group | Buying the product |
|---|---|---|
| 1 | Yes | No |
| 2 | No | Yes |
| 3 | Yes | No |
| 4 | No | No |
| 5 | Yes | Yes |

In [3]:
```
df_validation_Q2 = df_validation[df_validation['Buying the product'] == 'Yes']
df_validation_Q2.head()
```

Out[3]:

| User | In our target group | Buying the product |
|---|---|---|