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## 1. Introduction

This is the Report of Smart Sleep group 02 second semester 2012-2013, consisting of Bas Bakx b1.2, Cas Zeegers b1.2 and Heleen Willard b1.2 and coached by René de Torbal. Our design challenge for semester was to create a new product in the environment of sleep. We chose to focus on the moment after being waked, to make becoming active a more pleasant moment. In this report we will talk about our process this semester, with the chapters design, users and technology. We will end with a personal reflection of every groupmember to show our development.

### 1.2 Abstract

A lot of students have trouble with getting up in the morning; some have no motivation or energy due to long hours, others might be stressed because of, for example, upcoming exams or deadlines.

In your sleep you can sense sounds that happen in your sleep environment unconsciously. When a sound is played you will hear it and remember it, without being conscious. Many people link certain sounds to certain feelings and emotions, because of this some sounds will remember you of a happening or feeling that is linked with it. This is a way of classical conditioning.

The Pablob plays sounds when you are asleep that will provide a relaxed or energetic mood before you wake up. The function of the sounds depend on your schedule of the next day which Pablob will read directly from your smartphone or computer.

In the Pablob we combine your personal conditioning with unconscious sensing in the sleep.

## 2. Objective

In our perception, the main goal of the theme is creating an improvement in a sleep situation. The focus in the project process will be on creating an improvement in waking up. This improvement will be a one-off device with the following requirements. It has to be functional and in the field of design adjusted to the users' sleep environment.

To achieve our goals a clear process structure is needed. In the research phases investigations will show the possibilities in influencing the human being during sleep, in conditioning and learning new specification (as in sensory information) during sleep and in linking senses with memory during sleep. The research in sleeping stages will give us an elaboration of the human being's sleep rhythm.

In the specification phase, when a direction is chosen, the concept will be formed and found. User test will give us which exposure during sleep (in a certain sense) will be linked to which feeling when waking up.

In field of design there will be collaboration with users. Their form and senses will be used to create a design that will be adjusted to their sleep environment.

In the building phase the tasks and the full concept will be clear. The final prototype of the project will be made and will bring in feedback on the full concept.

The project will result in a device that let the user wake up better through exposure of influences during the sleep. The device has to combine conditioning with unconscious sensation during the sleep.



## 3 Users

### 3.1 Project Focus

#### 3.1.1 Target group

The target group of the project consists of students and young adolescents. We chose this group, because we wanted to counter a problem that is close to our own life and behavior.

We divided sleeping problems of students and young adolescents in three sleeping stages: Going to sleep, sleeping and waking up.



Figure 1: Pressure Cooker

#### 3.1.2 Pressure Cooker

In our “pressure cooker” we chose to solve a problem in waking up. We made a device that gives the user every morning a new game to play. When the alarm rings, the user will be able to play the game. The user has to become active to be able to play the game and when he or she solves the game he or she is ready to start the day. Because the games wake the user in their brain activity and physical activity the user can start the day active and motivated.

We presented the concept to students two times: the first time as a concept description and the second time with a prototype of the concept. The first time students gave us the advice to had a social cohesion in the concept (link it with social media and social behavior) and gave us ideas of fitting games for the device. The second time we presented the prototype students told that they liked the idea that the concept was a separate device (so not a smartphone application). In an application the concept becomes “just another function of your smartphone”. Students were likely to test the device, but we had to start with the next phase of our project.

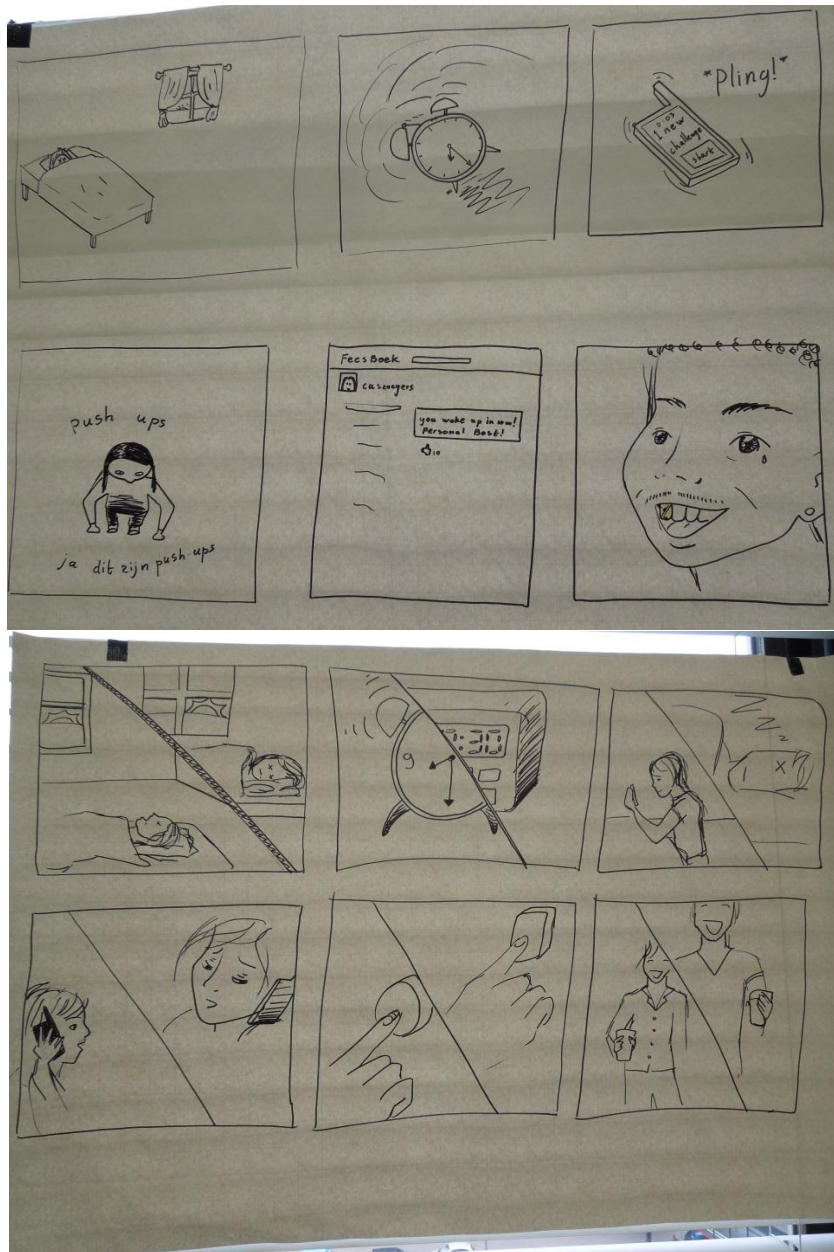


Figure 2: scenarios

## 3.2 User Research Approaches and Findings

### 3.2.1 Research

The research was divided in the three sleeping stages: Going to sleep, sleeping and waking up. After quick individual research we chose two directions to focus on: temperature regulation and conditioning during sleep. We developed concepts in temperature regulation what led us to Temp. The concept development in conditioning during sleep led us to Speaker Clock. After developing the two concepts we specified the research on the concepts. Eventually we chose to develop the concept of conditioning during sleep.

#### 3.2.1.1 Sleeping

The focus was on regulation of body temperature. The warmth-cycles in the body regulate the functions in the nervous system and vice versa. The sleep rhythm of a person depends on the rhythm of the warmth-cycles.<sup>5</sup> How does this regulation of sleep phases work?

Becoming sleepy is a reaction on an increase of the body temperature. During the sleep the temperature of the body increases till half of the required sleep. The body temperature is at this point at its maximum and starts decreasing again. The decrease of body temperature regulates an increase of activity in the body. In an ideal situation an individual wakes up when the body temperature reaches its minimum. At this point the activity in the body has its highest capacity. When the minimum is reached the body temperature starts increasing and the cycle "starts" again.

<sup>5</sup> Carol Orlock, "Inner Time: The Science of Body Clocks and What Makes Us Thirsty" (June 2000)

The warmth “sensor” of the body is in the brain. The brain measures the temperature of the blood and anticipates with the certain temperature. On which scale is it possible to influence the blood temperature and in which parts of the body the blood can be influenced the most?

Next step would be finding research of temperature regulation on body parts. We expect the head, the neck and hands and feet would be the main parts of possible temperature regulation, because of the design of winter clothing (scarfs, gloves, caps etc.).

### 3.2.1.2 Waking up

In the stage waking up the focus was on learning to wake up better. People can condition themselves to do an activity regularly: it becomes a habit. People can strengthen previous acquired memories during the sleep.<sup>1,3</sup> But is it possible to let people learn in the sleep to wake up better?

People can learn a new behavior, with partial trace conditioning between tones and odors during sleep.<sup>1</sup> Thus, human can link sensory information

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<sup>1</sup> Anat Arzi, Limor Shedlesky, Mor Ben-Shaul, Khitam Nasser, Arie Oksenberg, Ilana S Hairston, Noam Sobel, “Human can learn new information during sleep”. Nature Neuroscience Vol. 15 no. 10 (October 2012). 1460-1467  
[http://www.nature.com/neuro/journal/v15/n10/full/nn.3193.html?WT.ec\\_id=NEURO-201210](http://www.nature.com/neuro/journal/v15/n10/full/nn.3193.html?WT.ec_id=NEURO-201210)

<sup>3</sup> John D. Rudoy, Joel L. Voss, Carmen E. Westerberg, Ken A. Paller, “Strengthening Individual Memories by Reactivating Them During Sleep”. Science Vol. 326 no. 5956 (20 November 2009). 1079  
<http://www.sciencemag.org/content/326/5956/1079.full>

to each other<sup>4</sup> and can link sensory information to memory during their sleep.<sup>1</sup> The REM sleep is the best phase to expose the sensory information to humans.<sup>1</sup> In this phase the brain is almost as active as when you are awake.<sup>4</sup>

In the user test we wanted to find how concrete the conditioning during sleep can be. The results (see User test: Conditioning during sleep) showed that with conditioning during sleep with sounds only gives an abstract outcome. We found that dance music and rhythms, played during the sleep, gives an energetic mood in the morning.

Classical music and self-selected music increases the feeling of relaxation and decreases the feeling of anxiety and stress.<sup>2</sup> In combination with research, that proves you humans can link sounds to memory during the sleep<sup>1</sup>, and our own user test (User test: Conditioning during sleep) it is

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<sup>4</sup> Tadao Hori, Yoshio Suhita, et al. “Proposed Supplements and Amendments to ‘A Manual of Standardized Terminology, techniques and Scoring System for Sleep Stages of Human Subjects’, the Rechtschaffen & Kalas (1968) standard”. Psychiatry and Clinical Neurosciences 55 (2001). 305-310  
<http://jsr.jp/oshirase/association/paper/JSRS-computer-comm-criteria.pdf>

<sup>1</sup> Anat Arzi, Limor Shedlesky, Mor Ben-Shaul, Khitam Nasser, Arie Oksenberg, Ilana S Hairston, Noam Sobel, “Human can learn new information during sleep”. Nature Neuroscience Vol. 15 no. 10 (October 2012). 1460-1467  
[http://www.nature.com/neuro/journal/v15/n10/full/nn.3193.html?WT.ec\\_id=NEURO-201210](http://www.nature.com/neuro/journal/v15/n10/full/nn.3193.html?WT.ec_id=NEURO-201210)

<sup>2</sup> Elise Labbé, Nicholas Schmidt, Jonathan Babin, Martha Pharr, “Coping with stress: The Effectiveness of Different Types of Music”. Applied Psychophysiol Biofeedback 32 (2007). 163-168  
<http://ruby.fgcu.edu/Courses/ndemers/sciproc/coping%20with%20stress.pdf>



possible to wake up relaxed and calm when one is exposed to classical music during the sleep.

### 3.2.2 User test: Conditioning during sleep

Once we knew our users (students and young adults) could be influenced while they were sleeping, we wanted to find out how concrete the thoughts of a person could be adjusted by us. For example: can we make someone think about a dance club simply by playing it to them during their REM sleep?

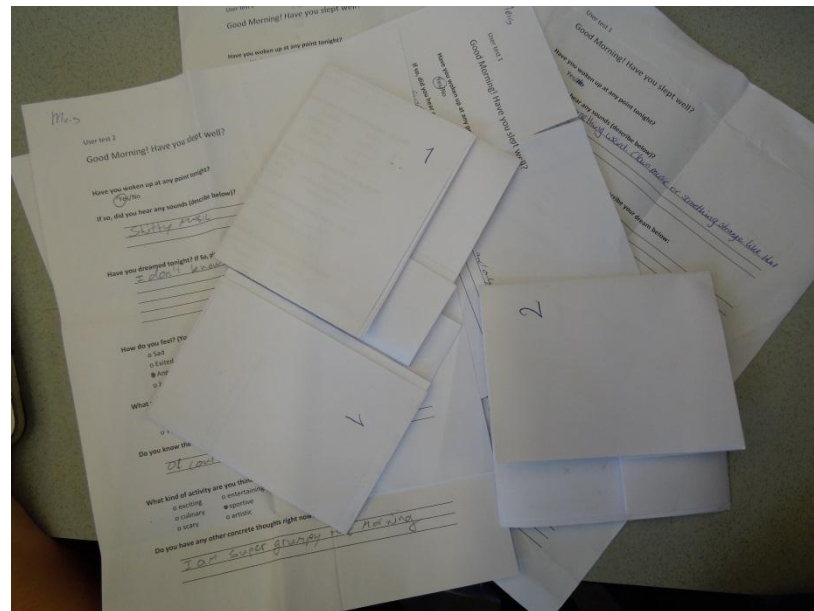


Figure 3: Usertest Results

#### 3.2.2.1 Execution

To test the aforementioned questions we designed four sound files each of 7.30 hours long, one dance music, one Efteling music, one pirate sounds and one ambient city sounds. The sounds were designed to play during the REM phases of a typical sleep of 7.30 hours long. Each sound file also got a small questionnaire made to be bundled with it (appendix 1).

The Efteling and dance music were put on a cd together (hereafter referred to as CD 1) and the pirate and city sounds on another (CD 2). 12 test subjects were selected, 6 of them received CD 1 and the remaining 6 received CD 2, they were asked to sleep for 7.30 hours and play one of the tracks during this sleep, then they were to play the other track during their 7.30 sleep the next night. Each CD was bundled with two matching sealed questionnaires that the test subjects were asked to open and fill in as soon as they woke up.

#### 3.2.2.2 Hypotheses

We expected that, when presented with Efteling music, we could make people think about the Efteling, dance music would make subjects think about a dance hall, pirate sounds about pirates and sailing and city sounds about a city. We expected people would think pretty concretely about what we presented them with when they woke up.

#### 3.2.2.3 Results

Figure 1 shows the most important results the questionnaires provided us with.

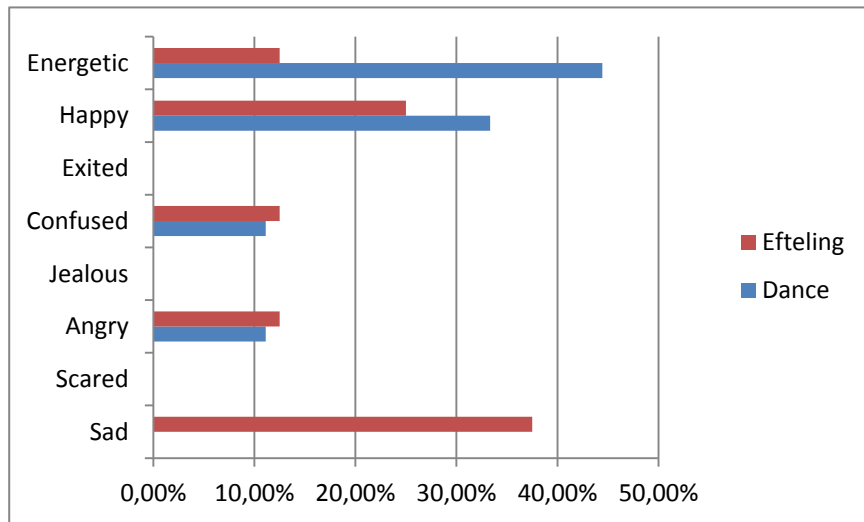


Table 1

### 3.2.2.4 Conclusion

From the full results we can conclude that provoking specific thoughts is very hard. There are no conclusive pointers towards making people think about a specific place. What does surprise however is the correlation between the sounds and feelings subjects indicate, dance music seems to make them wake up more energized and happy than usual while the classical and moody music (Efteling and ambient city sounds) made them comparatively sadder when waking up.

Other research <sup>2</sup> confirms a link between music and emotion; we also know individuals can be very much influenced in their sleep<sup>[1]</sup>. What we can conclude of our research is that music generally associated with

<sup>2</sup> Elise Labbé, Nicholas Schmidt, Jonathan Babin, Martha Pharr, "Coping with stress: The Effectiveness of Different Types of Music". Applied Psychophysiol Biofeedback 32 (2007). 163-168  
<http://ruby.fgcu.edu/Courses/ndemers/sciproc/coping%20with%20stress.pdf>

energy (dance music) influences many to wake up energetic as well. Music that people have linked to a lot of energy in their minds will also cause them to link it during their sleep, waking up more energetic than during a quiet night's sleep.

### 3.2.2.5 Evaluation

Looking back at our research reveals that some things went wrong. CD2's questionnaire had a lot of open questions, which didn't give us conclusive results, they were hard to compare.

We also did not offer a reward to our test subjects apart from our gratitude, in hindsight a simple gift for test subjects to look forward to could have increased the likelihood of them performing the test in a timely manner significantly. This resulted in some tests only being filled out after a week with us asking for it several times and even some test subjects not delivering their tests at all.

Some other factors were also out of our hands, our research had a lot of outside variables we couldn't control (temperature, food intake, social contact etc. etc.) that can alter the test results. This could have been solved by performing the tests in an isolated environment. Sadly we could not get the means to have people in a closed off space for as long times as we required for our testing.



### 3.2.3 User test Form and Design: Finishing stage concept

In our concept touching and pushing the prototype is a very important action. The user has to feel comfortable touching Pablob and has to like the way it looks. The LEDs in the prototype have to give a spread lights effect and have to be invisible for the users (they only see light). To achieve this, we did the user test to know what the users' preferences are.

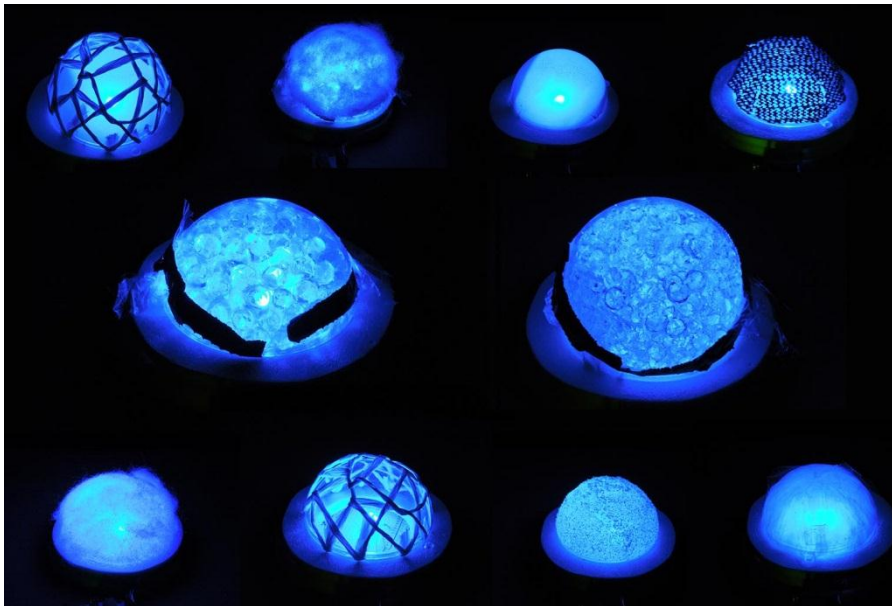


Figure 5: User tests

#### 3.2.3.1 Execution

Which material is nicest to touch and which one provides the best light-effect. Those qualities are tested separately so the test-group would not be influenced by the other qualities. The user tested the feeling of the

materials in a dark room, so that they would not be influenced by the looks. In the part of testing the best light-effect users were only allowed to look, and not feel, the test prototypes. This part was also tested in a dark room, so the users could not be distracted.

We chose several materials to test and put them on and in half plastic balls to simulate the surface of Pablob. For the feeling part of the test we used sand, an anti-slip tablemat, wool, tights, a poncho, string and the plastic balls. For the part where users test the looks we used string, wool, an anti-slip tablemat, gel balls, broken gel balls, a poncho, sand, tights, gel balls + string, gel balls + anti-slip tablemat, gel balls + wool, gel balls + sand blasted plastic and broken gel balls + sand blasted plastic.

We asked eight individuals of the target group to rate the materials and material combinations (separate in feeling and the way it looks) between zero and five. In the first part zero was not comfortable ascending to five, the most comfortable. In the second part zero was a not liked light effect ascending to five, the most liked light effect.

We wrote down the grades for every quality of every material and the feedback we received. We processed the grades so we could combine them of the feeling and the looks and use our optimal material for Pablob.

### 3.2.3.2 Hypotheses

We expected users would grade wool as most comfortable in the feeling part and sand as most liked light effect in the part about the looks. We think when we combine the grades of the two parts the anti-slip tablemat will have the best result.



Figure 5: Usertest Setup

We processed the results of the feeling-test to make a clear table of the results. Table 2 shows the given grades and the average of the grades. Table 3 shows the average grade of every material. As the figures shows the feeling of the tights was the most comfortable in contrast with the

other materials. The feeling of sand was the least comfortable of all tested materials.

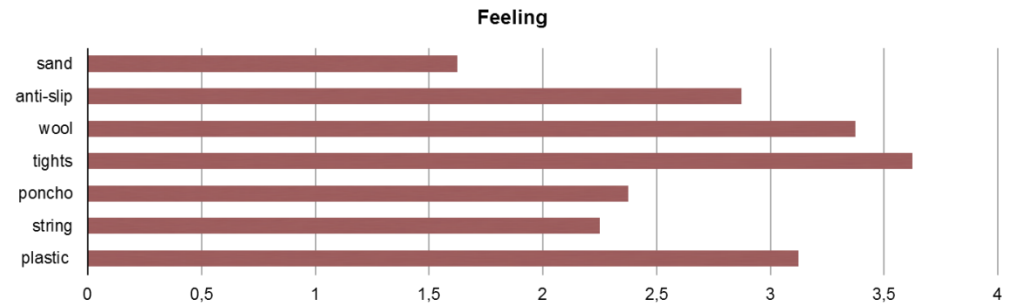


Table 2

material									average
sand	3	1	2	1	1	1	2	2	1,625
anti-slip	2	2	4	4	4	2	3	2	2,875
wool	2	3	3	4	5	3	4	3	3,375
tights	4	3	5	4	3	3	3	4	3,625
poncho	2	2	2	2	3	3	2	3	2,375
tights	2	3	1	3	3	2	1	3	2,25
plastic	3	3	4	2	2	2	4	5	3,125

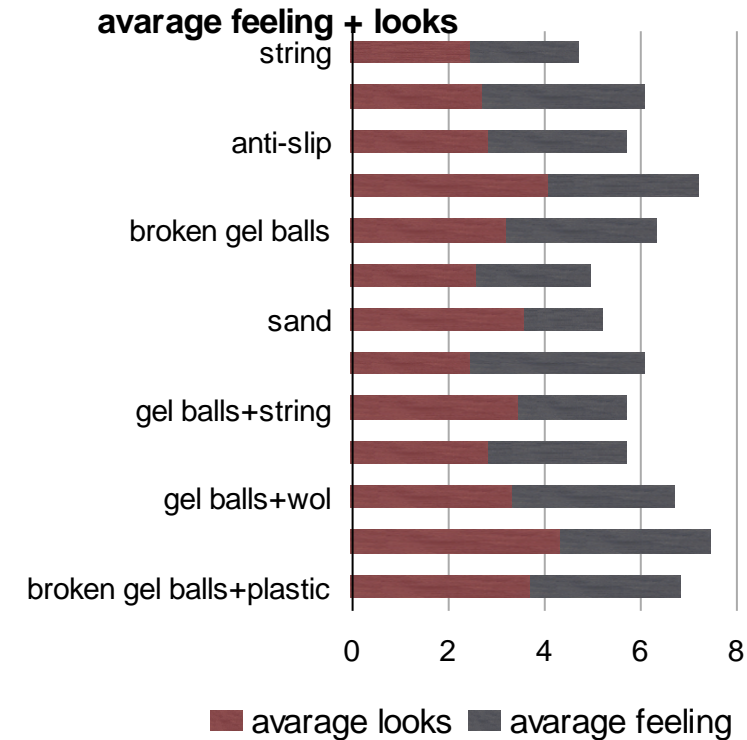
Table 3

We processed also the results of the looks-test to make a clear table of the results. Figure 3 shows the given grades and the average of the grades. The conclusion of this result shows that the looks of the gel balls in combination with the sand blasted plastic gives the most likely light-effect (referring to the users). The light-effect with the strings and the light-effect with the tights gives the least liked light effect.

looks									
string	2	3	4	3	3	2	1	2	
wool	4	3	4	2	1	1	4	3	
anti-slip	2	4	3	2	4	2	3	3	
gel balls	4	5	5	4	5	4	2	4	
broken gel balls	3	5	1	5	3	3	3	3	
poncho	3	4	2	4	2	1	1	4	
sand	4	5	5	3	4	2	3	3	
tights	3	3	3	3	2	2	1	3	
gel balls+string	2	3	5	4	5	5	2	2	3,5
gel balls+anti-slip	1	4	3	4	2	2	3	4	2,875
gel balls+wool	3	3	3	3	4	3	4	4	3,375
gel balls+plastic	5	4	4	4	5	4	4	5	4,375
broken gel balls+plastic	3	3	4	5	4	4	4	4	3,75

Table 4: Look Grades

We combined the result of both test to see which combination of feeling experience and light-effect experience are the most appreciated by the users. The feeling and the looks have for us to design Pablob the same importance (feeling : looks = 1:1). The combined results are showed in Figure 4. We can conclude from Figure 4 that the gel balls + the sand



blasted plastic is the most liked combination for users combining feeling and looks. The feeling and look combination of the string is the least liked by users.

### 3.2.3.4 Conclusion

The feeling of the tights was the most comfortable in contrast with the other materials. The feeling of sand was the least comfortable of all tested materials.

The looks of the gel balls in combination with the sand blasted plastic gives the most likely light-effect (referring to the users). The light-effect with the strings and the light-effect with the tights gives the least liked light effect.

The conclusion of the test is that the combination of gel balls with the sand blasted plastic gives the best material for Pablob.

The structure of Pablob is sand blasted plastic with the content of gel balls and broken gel balls. We added the broken gel balls, because this was the best way to manage the gel balls would stay in the right position.

### 3.2.3.5 Evaluation

To make the results even more reliable, we could improve some aspects of the user test. We should have used the final shape of Pablob instead of the plastic ball. The shape could have an influence for the light-effects and the feeling of it. We did not use the final shape, because the final shape was not ready when we did this user test.

The prototypes for the test were not finished well. The user could be distracted by, for example, the glue on it.



Figure 7: Gel Balls



Figure 6: Stocking

## 4 Technology

We had 3 parts of technology, we had the Temp-prototype, the Speaker Clock and Pablob-prototypes. Temp was the first one we made, and with the knowledge of Temp we made the Pablob-prototypes.

### 4.1 Temp.

To make the technique of this prototype it was very important to start with a plan. It should get warm in the neck at right moments. It should be controlled by a simple button. And it should have its own energy-source, because you cannot wear it when there is a power lead.

For the electronic-parts we used several techniques.

1. an Arduino
2. piece of fabric that can heat up when it receives 5 volt
3. a button
4. batteries in a holder

We wanted a system that would start a cycle of 24 hours when the button was pushed. It should warm up on the moments the max of the temperature should be changed. But for this demo-product we shorted it to 2 minutes. So when you are wearing the collar and you pushed the button, you can feel it warms up and cools down. Before we began to build the electronics, we made a sketch of the circuit.

We first used a LED instead of the heating element so we could see when the signal was HIGH or LOW.

The first part of programming was the button. We had to search at the internet and made it work. We found on the internet how to light the LEDS and how to put a delay in it. We found out about the if() and else() to make the code complete. With that knowledge we build the code for the prototype. The name of this code is Code Temp.

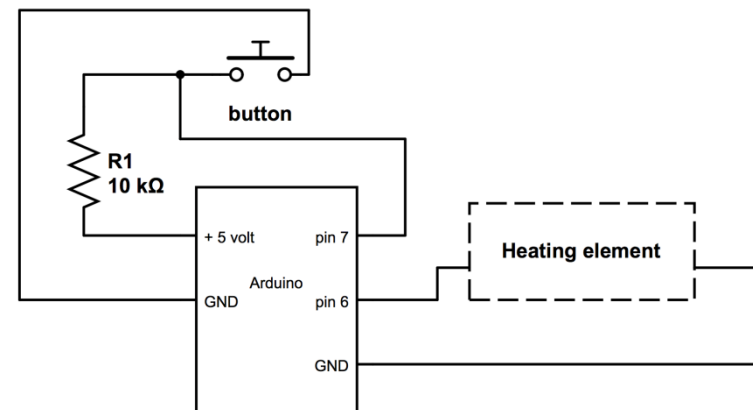


Figure 8: Temp. Circuit

## 4.2 Pablob

### 4.2.1 Pablob 1

Before we started to make our first working prototype of Pablob we talked about all the things that Pablob should do. We wanted to make a first demo-model, so we could easily explain what our prototype was and show it works. We choose to make a prototype that could play music, gives light and has an alarm in it. For this prototype we had a button, an Arduino Uno, some blue LEDs and a piezo.

The button had 4 little pins on it. These can be seen as 2 wires with the ends sticking out of the button. When the button is not pressed, the two wires do not make any contact. But when the button is pressed, the 2 wires make contact and both of the wires have current flowing through them. We used this because we liked the feeling of it. Pushing the alarm-clock in the morning inspired us for pushing the Pablob, because it is a simple movement which feels natural. In the morning you do not want to search or focus to do the right act to silent the alarm.

The Arduino Uno is a microcontroller board based on the ATmega328 ([datasheet](#)). It has 14 digital input/output pins, 6 analog inputs, a USB connection, a power jack, and a reset button. You can program when and which pin gets voltage. In this way is the base of a lot of prototypes. We used this to

The piezo buzzer is a small piezo which has a little plate in it which vibrates. How much it vibrates depends on the voltage. It does not produce a pretty sound, but it can make every tone you want to make.

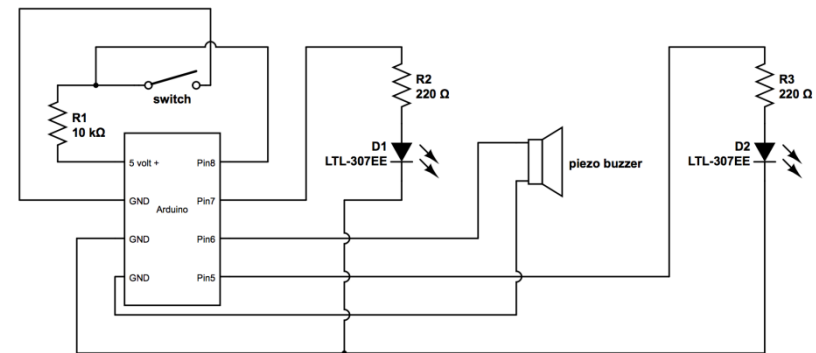


Figure 9: First Prototype Circuit

A LED is an abbreviation of light-emitting diode. This means that the current can only flow in one direction through the led, from the long pin to the shorter pin.



We wanted our prototype to be controlled by only one button. The slamming part should be the only input of the prototype, so every input should change the function of the prototype. We made a model to have an idea how this prototype should work.

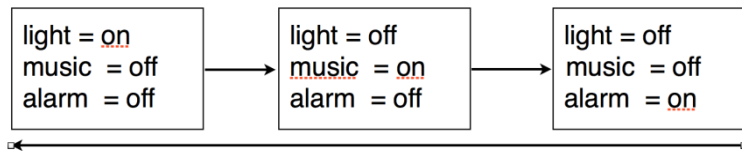


Figure 10: Function Model

This is the model that shows how the prototype should work. Every arrow represents a push on the button. There are 3 stages of the prototype, in one stage it is only a lamp, in the next stage it only produces music and in the last stage the alarm starts. And when the alarm is pushed silent, it starts over again.

To make this, we started to make a plan of the electronics. We used the Pins +, 5, 6 and 7 as output and pin 8 as input.

Having this, we only needed to make a code. First we had to figure out how to program a piezo-buzzer. The second step was the programming of the button. This is something we did before with the code for Temp, so that was not really a big problem.

To program the LEDs we just had to give a HIGH or a LOW signal for their pins at the right time, so that was also not a big problem.

Now came the tricky part. We needed to put it all together in one big working code. We needed to make a code that includes all the different states of the prototype with the button as only input. We began with Code 1.

We tried to adjust it so that it would make the buzzer play when the light was out. This worked. But we could not reset the loop whenever we wanted. We asked a fellow student B. Jakobs, who knows a lot of arduino, to help us with this program. He told us that what we wanted was impossible with arduino. Arduino can only do one think at the time. The thing with a button is that the Arduino must see when the button is pushed and remember it.

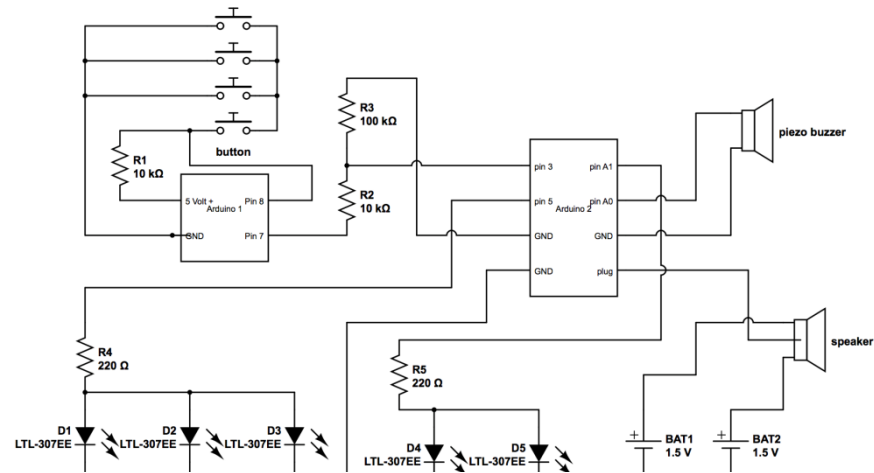


Figure 11: Final Prototype Circuit

Pushing the button makes the voltage change just for a moment, that's why he needs to remember it till the point where he must control it there was a voltage-switch. But when the piezo buzzer is playing the arduino cannot check it the button has been pushed. So in that way, the program will be stuck. So, as a solution, we now used a switch instead of a button. When a switch has been pushed, the 2 wires in it keep having contact till the switch is pushed again. In that way, the arduino just need to control if the voltage it receives is HIGH or LOW and does not need to remember something.

With the switch we could continue the programming. And the second problem appeared, the Arduino could again not control of the switch was pushed when it was playing its alarm. We did some research and found out about the While-function. In that way, every time we put while in the programming the Arduino would check it the switch was pushed. For the alarm we made a third loop. At every end of the loop the Arduino checked if the switch was pushed. If the switch was pushed, it would start again at the loop().

For the piezo buzzer we first noted which notes were there to play. We wanted to make it recognizable for everybody that there was music played so we chose one of the most famous songs, The Final Countdown of Europe. We looked up some music sheets and programmed the song with the correct notes and delays. The code for this prototype is Pablob 1.

#### 4.2.2 Pablob 2

For our next prototype, we wanted to fix the sound. The sound of the piezo buzzer was horrible and we wanted real music. We bought a Sparkfun MP3-shield for our Arduino and applied it to the Arduino.

Making the MP3-shield work was very hard we tried to get a QuickStart guide from the website, but everything was outdated and did not work. We mailed an expert to help us out and made an appointment with Peter Peters. Together we read all the errors of the code again and tried to figure out what was wrong. We found out that some definitions had to change. So we found a very complicated code, but it was not hard to work with. In this code you could give orders in the serial input with letters. In that way, we could work in a not too hard way with this MP3-shield.

We also wanted to control this prototype with a button, so we needed an extra Arduino to fix that.

Before we started to build we made a sketch of the circuit so it was clear what had to be done.

The model was still the same, first only light, then it should play music and in the end there should be an alarm. This means that we could copy a big part from the previous code.

We made the code for the first Arduino, the Arduino for the buttons. We used the first code, CODE1. That already showed as a basic. While making it we used an extra led to see if the signal to the second Arduino was HIGH or LOW. Code Pablob 2 button is the code we used.

For the prototype we wanted 4 buttons. So we put 4 buttons parallel. When the Pablob would be pushed, all 4 of the buttons would give a

signal. Every signal would change the voltage from HIGH to LOW and when 2 signals were received the signal of pin7 would go HIGH and then immediately go LOW. To solve this problem we put a delay in the code. Now only one signal per second could change the voltage of pin 7.

We combined the Pablob 1 code with the MP3-shield quick-start code.

This is the most important part of the programming:

### Code Pablob 3:

```
if (reading == HIGH) {  
  
    for(int fadeValue = 255 ; fadeValue >= 0; fadeValue -=5) {  
        // sets the value (range from 0 to 255):  
        analogWrite(5, fadeValue);  
        analogWrite(A1, fadeValue);  
        // wait for 30 milliseconds to see the dimming effect  
        delay(30); }  
    digitalWrite(5, LOW);  
    digitalWrite(A1, LOW);  
    parse_menu('p'); // get command from serial input  
    parse_menu(Serial.read());  
    parse_menu('1'); // get command from serial input  
    delay(10000);  
    parse_menu('p'); // get command from serial input  
    noTone(A0);  
    while (reading == LOW) loop();  
    while (reading == HIGH) quitloop();  
  
    }  
else {  
    parse_menu(Serial.read());  
    digitalWrite(5, HIGH);  
    digitalWrite(A1, HIGH);  
    noTone(A0);  
    while (reading == HIGH) loop();  
}
```

We also had some problems with the MP3-shield receiving the HIGH or LOW signal from the Arduino 1. The problem was very simple; we did not put the ground in the MP3-shield but in the Arduino 1. In this way, the MP3-shield was always receiving a HIGH signal.

This is how it works: First the code looks is the signal is HIGH or LOW. If the signal is LOW, it goes to the else(). There is a While, so when the signal changes to HIGH it starts again with the loop and then goes to the HIGH part of the loop, the if (reading == HIGH). This loop starts with the lights fading out. Then there is a p, this is a pause/play code. When the song was op pause it starts playing, and when there was no song playing nothing happens. After that the MP3-shield receives a 1, this starts the song. When the song is already started, there happens nothing. So in those 2 steps the music starts, does not matter if it had already started or not. Then there is a delay of 10 seconds, so the music plays for 10 seconds. After that delay there is a p signal, this means that the music is put into pause, so the music stops. Right after that there is a While and the arduino checks if the input-signal has changed. If it has, it will start the loop again. If it has not, the quitloop() loop will start. This is the alarm-loop. This loop will repeat till the input-signal changes and when it does, the programs starts at the loop() again.

## 5. Design

### 5.1 Initial concepts

#### 5.1.1 Temp.:

The first of the concepts was Temp, it was a scarf focussing on uniting two of your most important sleep cycles quickly. These two cycles are your “temperature cycle” and your “biological clock”. When you, for example, take a plane to another time zone your sleep pattern becomes disoriented, known as jetlag you will sleep very badly and be very drowsy for a long time. This jetlag occurs because of the two cycles being out of sync, because while the biological clock adjusts itself relatively quick (a matter of days), the temperature cycle takes far longer (weeks).

We decided Temp should be near a place where a lot of blood flows and close to the brain, because the body’s “thermometer” resides there. Temp, being a scarf, was close to the carotid, one of the main arteries of the human body, the main link between the heart and brain. Using a heating pad that was integrated in it it could, during the day, shift your blood temperature at specific times. This way the two cycles would start coinciding again.



Figure 12: Initial sketches



Figure 13: The Temp.



Figure 14: Form Exploration



Figure 15: Speaker Clock

### 5.1.2 Speaker Clock:

The other main concept was a type of alarm clock. Users would be able to input future activities they were looking forward to. The clock would take these activities, and play associated sounds to the users. This way when the users wake up, they would be thinking about their activities in a seemingly spontaneous manner. When users woke up they would leap out of bed, energised and encouraged by the knowledge of things to look forward to.

The clock would take advantage of conditioning, the link humans lay between certain activities and certain sounds are central in this idea. Just like the look of a well-cooked steak triggers people to get hungry.

For this concept tests were conducted to find out which shapes people would find pleasing, and based on this a first rough prototype was made.

Most of the surveyed people liked the speaker shape (leftmost on the picture) the most. It looked friendly and visualised the idea of sound in our wake up solution. We decided to base the first iteration of our concept on the chosen shape. Together with it visualising sound it should also visualise time, which caused us to integrate a clock into the speaker.

This left us with the final shape of the Speaker Clock: a functioning clock capable of reminding users of why they should wake u happy each morning.

## 5.2 Concept development

After both concepts were presented in a Pecha Kucha presentation during the themedays the second concept was chosen to be worked out, because it received more enthusiasm from the crowd.

### 5.2.1 Shape

We did not want to give our product a meaningless shape. It was going to be an object standing next to your bed, on the nightstand, we didn't want it to be just another thing to put on there next to a lamp and clock. After consulting with a Chris Nederhorst, a sleep expert, we got the advice to integrate other functions next to our desired function, for example; the device could be integrated into a pillow.

Because we felt our current shape didn't accommodate for it being a true multifunctional device that would fit into any bedroom we decided to reshape it. We kept on experimenting with different shapes and gradually developed towards a pebble shape, which shaped the first prototype.

#### 5.2.1.2 Prototype 1

We carved and sanded down foam to create a pleasant, natural shape. We vacuum formed this shaped using Vivak (PET-G) which created a hollow shape in which the electronics could be housed. To obscure the electronics inside and diffuse the light that would be placed inside we sandblasted the housing. For the first prototype we decided to use a simple piece of painted foam as bottom. A LED was used to give indication of an ON and OFF status



Figure 16: First prototype



Figure 17: First prototype mould



### 5.2.1.3 Prototype 2

With the experience from making the first prototype we progressed toward the second and final prototype. Because we wanted the shape to be as attractive to interact with as possible we wanted to adjust the shape. To invite hand presses we decided to add a hand impression into the pebble shape.

To achieve the optimal imprint we asked 50 people to hit a piece of clay with an open hand

This was carried over into the final mould for the prototype. After a pleasant shape to hold was made we made a handprint on the foam and carved out the shape. The final shape was vacuum formed again.

We made another, smaller, cast to fit inside the first one, this created a double wall which was filled with gell balls, as a usertest pointed out to be the best looking and feeling. To accompany the whole a small wooden platform for everything to sit on was made, resulting in the beautiful prototype known as “Pablob”.



Figure 18: Second Prototype Process



Figure 21: Final Prototype Shape



Figure 20: Final Prototype



Figure 22: Final Prototype

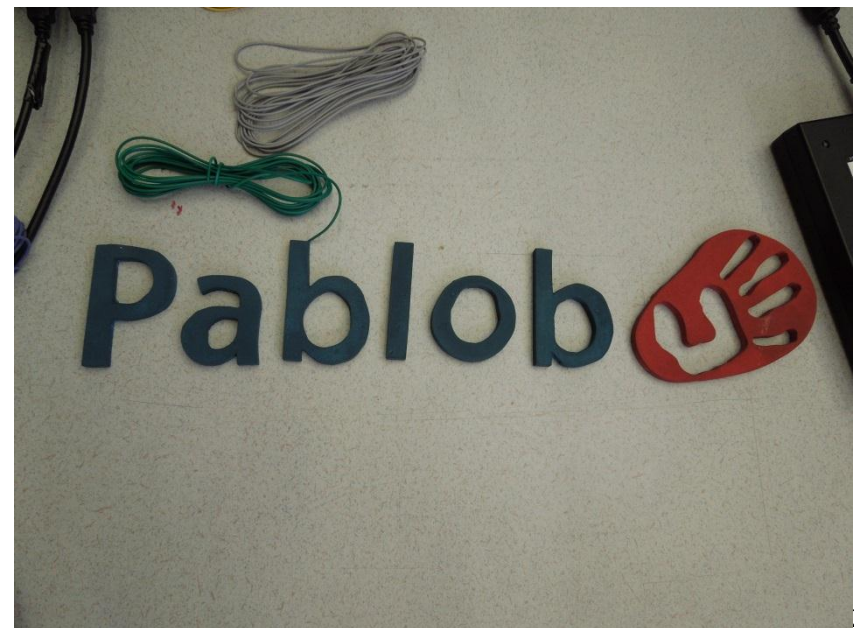


Figure 19: Pablob Logo

### 5.2.1 Sound

Our first course of action to discover what sound we were going to use was to commit a usertest, we needed to know how concrete the thoughts were that we could encourage people to think about. It turned out that it was very hard and unlikely to be able to influence users concretely, but controlling basic moods proved more viable. This gave us cues as to what sounds to choose<sup>1</sup>.

Because our target group was students and young adults we decided to work with sounds that we expected to have effects on them:

- Dance music for energy because of the energetic setting it is usually found in and its dynamic nature.

- Calm classical music to evoke a relaxed mood, it is generally not associated with stress but with being calm and sitting back, it has a sweeping and calming nature.

Ideally the sounds should be chosen per person, individual conditioning works best to evoke certain moods<sup>2</sup>.

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<sup>1</sup> John D. Rudoy, Joel L. Voss, Carmen E. Westerberg, Ken A. Paller, "Strengthening Individual Memories by Reactivating Them During Sleep". Science Vol. 326 no. 5956 (20 November 2009). 1079  
<http://www.sciencemag.org/content/326/5956/1079.full>

<sup>2</sup> Elise Labbé, Nicholas Schmidt, Jonathan Babin, Martha Pharr, "Coping with stress: The Effectiveness of Different Types of Music". Applied Psychophysiol Biofeedback 32 (2007). 163-168  
<http://ruby.fgcu.edu/Courses/ndemers/sciproc/coping%20with%20stress.pdf>

## 6 Evaluation and Discussion

Our goal was let people wake up better. We achieved this with the concept conditioning during sleep. It was a very risky choice, but we are glad we made this decision. We encountered that there is little knowledge about the subject conditioning within this study and that projects about waking up are rare. We gave the project's theme a perspective, which was also new for the theme's coaches and experts.

We had to emphasis on the research in the first phase, because little was known about our direction. This enabled us to combine well-founded aspects with our own insights and perspectives.

We learned a lot in the process and beside we achieved our project goals; we also achieved many individual goals in this project. We gave each other the possibility to develop our own goals and we divided tasks in a way everyone would have their benefit.

A clear structure, clear tasks and clear goals were very important within our project process. It gave us the opportunity to work motivated and hard on the tasks to achieve our goals. Unfortunately, Camiel chose to quit with the project after problems with the study and problems with his motivation. We tried to keep Camiel in the group, but eventually we couldn't help him. We didn't take Camiel into the report, because he didn't contribute in the project (because of his earlier mentioned problems).

A point of discussion can be the target group we chose. We wanted to keep the target group close to us. Our target group consisted students and young adolescents. If we had taken a much broader target group, the concept could give solutions in more and different scenarios. With this benefit we would have the opportunity to elaborate the concept more.

Reflecting on the process of the project and the results, we have achieved our goals. We shared our visions and insight, what led to good discussions, more knowledge and a good relationship between the remaining group members.

## 7 Reflection

### Heleen

#### T&C

There were a lot of discussion in our group, our visions were very different. This made working together sometimes very uncomfortable. Mostly this discussions were not about important subjects, which made them very time-consuming. Just stopping with the discussion was the best solution.

I have been the leader of the group for a period. I learned a lot that period. I felt very responsible for the group and it's achievements. It was in the period that the tensions in the group were very uncomfortable. I learned to be a neutral leader in the group. Everybody should feel comfortable with you as a leader, otherwise you are not good leader. I learnt to make the final decision when there was a lot of discussion with thinking about the benefits of the group, en ignore your own preferences.

#### ideas and concepts

This semester ideas and concepts was one of the most important competency. I enjoyed generating ideas and building on previous ideas. Thinking out of the box is something you have to practice, so that is what we have done in Q3. I learned how to begin very broad, en specify in every step but never forget what was the original idea.

#### integrating technology

Before I started building technology for the main project I followed the assignment Creative Electronics. That means that I knew the theory of a lot of electronically elements and knew how to draw circuits. I made a few prototypes this semester. To do this I had to gain a lot of information first.

I looked for codes on the internet to learn how to make my own. I also had some experts-meeting when I was really stuck. I found electronics very hard and frustrating when it did not work. But when it did work, I always felt very proud and that compensated all the stress.

#### mathematical and descriptive modeling

To develop this competency I organized a questionnaire. To do this i read some information in the first place. When I received the questionnaires back I put them in excel and tried to find the link between the several questions. On the internet I looked up which functions might be useful. I made several tables and applied functions like the t-test. I did not find any relative connections between the answers, but it was a fun and instructive practice. When I reflect on it I would have changed a few things. I would have made the subject of the questionnaire less obvious by putting some 'fake' questions in it. And the questions would have been more concrete, now I used a lot of 'possible' and 'mostly', so I did not have direct answers. Next time I would make better and more direct answers.

#### self-directed and continuously learning.

The whole development of integrating technology was about challenging myself. This felt very productive, I am a perfectionist so in everything I see a challenge I am willing to accomplish. It is very important for me find a balance in these challenges. There is no time to make everything perfect so priorities had to make set. I trained myself in making goals so I did not have to put time in time-consuming details, what I normally would have done.



### **form and senses**

I made the design for Temp this semester. I wrote down what was important and started to design with those ideas. I chose the material and created the first prototype. I learnt to think about the human body, what was comfortable. I also explored several materials to learn what they were capable of. In the user-test about form and senses I learnt what most people think is comfortable. This is something I would use in the future when I am choosing materials.

Graphic design was also a part that I wanted to develop. I made some illustrators to help with the explanation of the concepts. I learned working with Illustrator and Photoshop. Getting used with these was hard and frustrating, but fun when you master it.

### **Design and research-processes**

Doing research is very important in the first period of this project. During that period I had my 100 hours assignment, this means that in that period I was the least attended. But I did a lot of research in my last project, so I did not miss a lot of development. Looking up useful information is also something that you need to practice. Scanning the text, judging the reliability, all kinds of things I have become better at this semester.

### **User**

This semester created a few user-tests. By this I learned different ways to approach the users by doing different tests. It was very interesting to investigate a target-group, see how they live and what they like. Making the test showed me the steps you have to make. Thinking what you wanted to know, how you were going to receive that information and how

to make sure that the information was reliable. This can be done by taking all the other influences away of the test. The environment of the user-test should be as neutral as possible. It was also very important that the test-person did not know what the test was about. Getting in that level of scientific testing was very interesting. The best way to do the test was with double blindness. It was a pity that we did not do this this semester, double blindness is when the test-person and person taking the test do not know what the test is about. I would really like to do that in the near future, with a big group of testing-persons.



## Cas

### Teamwork and Communication

I was team leader in the first phase of the project (we divided the project in research and concept development stage, specification stage and building stage). I learned to be responsible for the project: setting a clear structure, clear tasks and goals and leading the group. First I had some difficulty in directing the other students, but when the team positions and individual characterizes were clear I could fulfill my role as team leader.

We encountered problems in teamwork. Camiel was not motivated enough to participate in the project process. First step to solve this was talking about the problem with the project group and coach (including Camiel). Second step (there was no improvement visible in the case) was taking Camiel's lack of interest into account and give him smaller tasks and give him the task to come up with a plan for improvement. He didn't come with a plan and after the SDL-weeks he chose to quit with the project and the study. I learned that if someone stays unmotivated you can't help the person anymore. It is better to go on with, in this case, the project and don't take the certain person into account in tasks and decisions.

### User Focus and Perspective

In this project I set up user tests for the first time. It is very difficult to set up a user test with the right conditions. A good test should exclude all other influences on the tested user than the influence you want to test. Also it should exclude the vulnerability to fraud. Researchers made a certain hypotheses with their expectations. It is possible they interpret the results to their own perspective. The best way to prevent this vulnerability to fraud is making the test double blind: the users don't know why they

have to test something and authorized, unfamiliar with the purposes of the test, control the test (collecting results, make conclusion etc.).

I learned to set up user test with its best possible conditions. We encountered the problem that users had to take one of the user tests themselves. We had to test the user when he or she is asleep. If we would attend the test the user's sleep situation would change in such amount the user couldn't behave like usually. We chose to give the users instruction, through what they could take the test themselves. User didn't do the test, didn't follow the instruction right or didn't give the testing materials back.

Having informal conversations and discussions with people of the target group enabled me to get honest and reliable feedback on our project. If people expect you will directly use the feedback, they often tell you what they expect you want to hear.

### Design and Research Process

I made a plan of how a good design process would look like. The process had to include three stages: research and concept development stage, specification stage and building stage. I managed the first stage to set up this clear structure with tasks and goals. I learned to stay calm and reflect on the situation if a task isn't done or a goal isn't achieved. You have to discuss and reflect with the concerned people of the certain situation to find what exactly went wrong and why.

I wanted a well-founded concept and project process. To achieve this I wanted to include scientific research reports in the project decisions and concept development. My task in research was to find scientific reports about waking up and conditioning during sleep. I learned how to filter reliable scientific reports from unreliable reports.

### **Form and Senses**

I have learned to take the five senses into account in forming the concept. The sounds of the Pablob had to be adjusted to the user's hearing. The user should hear the sounds during the sleep, but shouldn't get awake of the sounds' volume and frequency. The shape of Pablob explains how to use it. The hand-shaped form in the prototype should guide users to press on it. Taking the sense sight into account, I did a user test to find out which looks should be the best for the Pablob. The senses taste and smell don't have a functional aspect in Pablob, so I didn't take these into account when forming the prototypes.

### **Ideas and Concepts**

I learned to fulfill a concept. A concept has to have a clear description, function and use and clear arguments of development. I also learned that not every aspect of the development can be explained with arguments. To add your vision and identity in the concept you have to make decisions based on own preferences.

### **Integrating Technology**

I think the function of an arduino in building circuits is devious. A technic circuit can work on its own. I think the logics of building a circuit suits me better than linking a circuit with arduino and program the functions of each circuit part separate. I learned this when assisting Helena with building the technology. Next semester I will look at the possibilities of building a free-standing circuit.

I never worked at Vertigo before this project. I now know where I can find certain machines and what machines I need for a certain adaption. I also learned how to sand-blast plastic and to vacuum plastic on a shape.

### **Social Cultural Awareness**

After chosen the direction of conditioning during sleep I doubted if users would accept the idea of being influenced unconscious. Users aren't aware of what happens during the sleep and have no control on the conditioning. Users could think of controlled training or "brainwash" activities, but people of our target group didn't mentioned this and had no problem with being influenced unconscious. The purpose of waking up better is the most important for the users. The target group didn't doubt the process of achieving this goal.

## Bas

**SD&CL:** Self-directed learning proved very important this semester, because we tended to split up tasks it was important for each of us to be able to work independently. Like any semester we were very much set upon ourselves to create a good project, but with good coaching and some experts that helped us, I think we succeeded in directing ourselves in developing effectively as designers.

**IT:** By creating prototypes we developed our technological skills. At the end we created two functional prototypes, the trial and error that came with this has learned me a lot about making and creating to develop a concept instead of sticking with thinking and brainstorming all the time.

**I&C:** At the start of the semester we were faced with the always challenging task of creating something (in this case something to do with sleep). By first getting to the root of sleep and dividing it into bite-sized portions for each of the group members to tackle, I think we had a very effective ideation process. Above all I learned that sometimes choices have to be made, while I hate seeing good concepts go to waste I realise that sometimes they can't be kept and integrated, they have to be separated and put on a backburner to be developed independently.

**F&S:** One of the main things I wanted to do this semester was create. Instead of thinking and studying, researching and brainstorming, I really wanted creating to be central in the design process. By creating a functioning prototype in the first week we made a good step towards realising this wish. By doing form explorations and asking others on how objects should look and feel I think I made a very valuable step in this

competency. The form and senses decisions we made in this project were always meaningful and well argued.

**UF&P:** As mentioned in the last competence users were a very important focus of our project. We did two very useful usertests, we processed the results (included in this report) and learned a lot not only about how to set up a good usertest, but also about what to do with results sprouted from this test. Instead of just assuming preferences we decided to prove them, sometimes leading to surprising results.

**DBP:** Our product has always been under the guise of: "this has to be sold to someone". We always kept ourselves to a specific user group and made a product that is interesting to them and would be useful in a home. I even had a talk with Hans 'd Achard, where we found out how important it is to work out every aspect of a product exhaustively before it can be meaningfully be implemented into a company.

**D&RP:** Even though I tried to limit myself in researching in this project. By dividing the areas of sleep and only exhaustively researching one of them our design process was meaningful and had a clear direction. I consulted several sources not limiting to google:, experts, books, magazines and databases were also part of it.

**T&C:** Teamwork was remarkably tougher this semester than last semester for me. By having a unmotivated teammember that eventually quit the study I was challenged with keeping the focus on the project. Clashing visions were a big part of our process and learned me a lot about working in a team.