

EVE

COLOPHON

STUDENTS

Myrte Thoolen (Pre-Master) s159864

Bram de Vogel (B3.2 FBP) s114960

PROJECT COACH

Jun Hu

CLIENTS

Sebastiaan Overeem

Kempenhaeghe Center for Sleep Medicine

University of Technology Eindhoven

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A B S T R A C T

This report details the combined work of Bram de Vogel (B3.2 Final Bachelor) and Myrte Thoolen (Pre-Master) in semester 1 2015-2016. We developed the "Eve" Sleep Diary concept within the context of the project Tools for Medical Professionals and the project track Sleep in particular.

The design challenge in the project was to develop a new sleep diary for use in the treatment of patients with insomnia. For our final concept, we designed "Eve," a hybrid physical-digital sleep diary. Eve aims to improve the sleep logging experience for insomnia patients and to provide medical specialists with more quality and quantity of patient sleep data, significantly benefitting the treatment.

Within this report, you may find an extensive description of the "Eve" Sleep Diary, description and analysis of the original problem, the design process as well as future development (recommendations). We have also added individual reflections regarding the project and our individual growth as designers.

EXECUTIVE SUMMARY

An improved version of the current sleep diary that is used in several sleep disorder institutes. Current sleep diaries consist of pen and paper. Worrying is that with the current technological developments no digital or physical sleep diary is yet developed. Especially a combination of mainly a subjective measurement with an objective measurement of sleep. This report shows a first development of a subjective sleep measurement tool that is not on the market yet.

INTRODUCTION

A BRIEF INTRODUCTION TO THE PROJECT

This project was a collaboration between Industrial Design students Bram de Vogel (B3.2 Final Bachelor) and Myrte Thoolen (Pre-Master). Working within the Sleep track of DPF 201 Tools for Medical Specialists, the aim of our project was to design a so-called "Sleep Diary 2.0". This design was to be an improved version of the current sleep diary used at certain sleep institutes to help treat insomnia patients.

Insomnia patients suffer from a sleep disorder that is characterized by troubles in falling asleep and staying asleep that results in a poor quality of

the day through daytime sleepiness and a lack of energy. Insomnia is a disorder that is not caused by medical problems, but it is related to subjective experiences of both the quality and quantity of sleep that causes the problem (Schutte-Rodin, Broch, Buysse, Dorsey, & Sateia, 2008).

Through discussions with Sebastiaan Overeem, Md. PhD., somnologist at Sleep Medicine Centre "Kempenhaghe", it became clear that there was a direct need to improve upon the current sleep diary. Sleep diaries are used by patients to log their sleep experience as well as other sleep-related factors and activities.

The sleep diary contains useful information for medical staff regarding their patients' sleep experience. For a period of over two weeks, the patient uses this diary to log sleep information, e.g. bedtime, total sleep time, time of awakening etc. This subjective way of sleep measuring is therefore, at Kempenhaghe, an integral component in the treatment of various sleeping disorders. The more information about their patients' sleep is available, the better patients can be diagnosed and treated.

Although the importance of data extracted from the diary is clear, the diary itself was in need of improvement. The current diary used by Kem-

penhaeghe is lacking in sleep-related information and the information that is available is not always trustworthy. The latter is due to a number of patients not filling in the diary in a timely manner, i.e. logging their sleep hours or days later. On the contrary, the diary is meant to be used in the morning immediately after awakening. This ensures that the sleep experience is logged precisely as the patient experienced it. Filling it in at a (much) later moment may result in a recorded sleep experience that can have been tainted by other events or emotional states during the day, resulting in an inaccurate diary entry.

The current diary consists of an A4-sized book which has to be filled in each morning using a pen. Overeem stated that many patients found this a boring, dissatisfying and laborious task to accomplish. He suggested that this may be the reason why patients were not filling in the diary on time. Moreover, since the diary was non-digital, the staff at Kempenhaeghe could only review the data whenever a patient came for an appointment. The diary had to be scanned in and converted to digital format for further analysis. Switching to a digital format would therefore save valuable time and allow for earlier analysis and optimized care.

Considering the importance of the sleep diary and its current flaws, the project goal became designing a new "Sleep Diary 2.0". This new sleep diary would have to address the current diary's shortcomings of incomplete and inaccurate (non-digital) data in a way that would motivate and stimulate patients to log their sleep properly.

We decided upon an approach combining physical input with a digital component. The physical input (for logging essential sleep time) would serve as the first step, with a low threshold for the user to interact with in a fast, tangible and enjoyable way. The digital component with Graphical User Interface would serve as a second step to collect additional detailed, sleep-related information and proceeds to send this data back to the sleep institute. We believed that through this approach we would be able to design a product that would stimulate continued, proper use through an inviting and pleasant interaction (and therefore benefit the treatment), as well as gather enough data in a digital format.

This approach culminated with our design concept of Eve, a new, subjective sleep diary which aims to help provide efficient and accurate treatment of insomnia patients.

Below you may find the original project description as provided by ID Education. Our project was developed within the focus topic / track four: Sleep.



How to improve the health of people? Especially in an ageing society health and improving (ones own) health becomes ever more important. Many societal challenges are evident in this area. This squad mainly concentrates on developing tools for medical specialist. Topics will be:

1) **BABY @HOME**

This project aims at designing intelligent products, systems and/or related services for enhancing comfort and bonding of newborn children at home or in hospital environments. In case of a hospital the aim is to create a home-like, natural environment supporting a healthy development of the baby and its parents.

2) **MEDICAL SIMULATION**

Medical simulation is an important topic because medical professionals and patients need to be trained to perform medical interventions in a setting that is safe for the trainees and patients.

Subtopics are: Blood drawing simulation / infusion simulation, CPR simulation, Baby simulation, Diabetes simulation

3) **SQUEEZE TO FIT**

The specialized hand-physiotherapists of the 'Hand center' in Eindhoven diagnose and treat patients with all kinds of hand injuries. Injuries range from tendon and nerve damage to amputated fingers. The physiotherapist goal is to get as much as (painless) possible movement back into the hands of their patients. There is a need for tools that help them achieve their goal.

4) **SLEEP**

Subtopics are:

Night watch: design the physical casing for a form to measure sleep related signals during the night.

Disappearing armband. Health monitoring smart armbands, tend to look very cheap and tacky. Could we make this watch physically and cognitively disappear by using different technologies? Or could we design it so nice that it becomes a jewel and a means of personal expression.

Self-Monitoring Experience. This project will evaluate the user experience of self-monitoring health related behaviors using wearables and

apps. Does monitoring influence the behavior itself? And how?

Narcolepsy App. This project aims to support the design and evaluation of an application for monitoring narcolepsy related symptoms.

Longitudinal sleep quality assessment. Evaluating the usefulness of inter night sleep quality reports in assessing sleep quality. This project is going into some depth in empirical research methods relating to evaluating the sleep experience.

DESIGN CHALLENGES

+ Creating intelligent products, systems and services in the above described fields

+ How to design sensor and actuator systems in an unobtrusive way. The challenges lie in designing these systems such that they do not interfere with the tasks needed. For example sleep sensors should not disturb sleep

+ How to assess the effectiveness of the chosen solutions in the (medical) context.

PROCESS DESCRIPTION

This sleep project was a collaboration between Industrial Design students Bram de Vogel (B3.2 Final Bachelor) and Myrte Thoolen (Pre-Master).

The first five weeks of this semester we were still working individually on our projects. Although we were working within the same squad on the same project, we were not really aware of each other and we pursued our own, individual directions.

Both of us had already had separate meetings with Jun Hu, our project coach, and Sebastiaan Overeem, somnologist at Kempenhaeghe and since this semester connected to our faculty. Bram had discussions with Overeem regarding his take on the project, yet Overeem was unsure about this and could not verify Bram's research conclusions based on his own expertise and experience. Myrte was talking to Overeem in order to find out what was needed within the world of sleep health, during which discussion Overeem eventually mentioned the need for a new sleep diary. This would become the main direction within our project.

Eventually, Hu and Overeem came with the suggestion that it might be beneficial for both of us if we could start working together. This would benefit Bram, who was looking for an improved or different project direction, as well as Myrte, who was

unsure to proceed with an ID project here and who needed a teammate. Hu suggested that working together shouldn't impact both of our individual assessments, as long as we stated clearly what each of us learned and did during the project.

Although we had a late start with the project, our collaboration soon took off and we eventually managed to come up with multiple iterations and tangible demonstrators during the Demo Days.

PROCESS

During the process, we held regular, weekly meetings with both our coach Hu as well as Overeem. This enabled us to continually receive feedback upon our progress that would enable us to further improve our concepts. Myrte and I tried to meet every day that we were available, which was dependent on the time schedules of our different electives as well as other personal commitments.

Overeem wanted us to come up with our own, original ideas, to "run wild." Therefore, he did not want us to contact and interview insomnia patients before working on concepts. He believed this would steer us too much, plus the administrative procedure for getting access to patients under

treatment would be an arduous task that would further consume valuable time.

We had initially wanted to present a fully-functional physical demonstrator during the Demo Days. However, Hu advised us that we should not compromise the concept for technology and preferred we spend additional time on user testing. While this meant that we were unable to work out the prototype as we had originally intended, it did bolster the strength and validity of our concepts.

DESIGN APPROACH

We used an iterative design approach within our process and worked closely together, especially during the earlier stages of the project.

- + We analyzed the existing sleep diaries and researched sleep literature;
- + We brainstormed using post-its to come up with major problem areas and focus points;
- + We implemented lessons learned from our mutual elective Exploratory Sketching and used sketching as an ideation tool;
- + Through a visual analysis of existing sleep and health devices and apps we got further insights and inspiration for the new sleep diary;
- + We designed our final interactions based on

acting out with physical objects, as well as a suggestion of our coach to look into the pins interaction model of a light timer;

- + We created paper prototypes and user tested these prototypes;
- + Based on those results we created a new, laser cutted iteration, which we also began testing;
- + We developed more refined demonstrators with electronics plus an app mockup for the Demo Days;
- + Throughout the whole process, we discussed our progress and process with our coach and the client.

The background of the image is a dark blue gradient with several out-of-focus circular light spots in shades of yellow, orange, and red, creating a bokeh effect. The text is positioned in the lower-left quadrant.

RESEARCH

COMBINED RESEARCH INTO INSOMNIA AND THE
SLEEP DIARY

WHAT IS INSOMNIA?

Insomnia is a sleep disorder that is characterized with troubles in falling asleep, staying asleep, waking up too early in the morning and feeling tired upon waking that results in a poor quality of the day through day-

time sleepiness and a lack of energy. Insomnia is a sleep disorder that affects in about 33–50% of the adult population of the United States making it a serious problem requiring effective treatment (Roth & Ancoli-Israel, 1991). Another study from 2008 shows the average per country in Europe, in which the Netherlands contain an average of 14% of insomnia patients. Insomnia increases with the age, wherein the age of 50- 54 years is the most common age predominantly composed of women (Narayanan, Potthoff, Guether, & Kanitscheid,

2008).

Insomnia is a disorder that is not only caused by medical problems, but it is related to subjective experiences of both the quality and quantity of sleep that causes the problem (Schutte-Rodin, Broch, Buysse, Dorsey, & Sateia, 2008).

Insomnia is characterized on its duration and is categorized into two types, acute insomnia, and chronic insomnia.

ACUTE INSOMNIA

Acute insomnia, also known as short-term insomnia, is a sleep disorder that features a poor quality of sleep for a period less than a month. This

disruptive sleep occurs due to life circumstances such as illness, stress, tensions because of school or work, or other environmental problems. This type of sleep disruption will resolve without any treatment.

CHRONIC INSOMNIA

Patients with chronic insomnia have accompanying daytime damage of cognition, mood and overall performance over a period for months or years. Chronic insomnia can be caused due to underlying psychological problems. People with chronic insomnia have an increased risk of depression, anxiety, and even immune diseases (Taylor, Lichstein, & Durrence, 2003).

EFFECTS OF INSOMNIA AND THE IMPORTANCE OF SLEEP

Sleep is functional and essential for individual and societal well-being, physiological balance and long-term health and mental functioning. Partial sleep deprivation is associated with adverse health and safety consequences. Poor sleep is associated with accidents, long-term ill health, and mortality. (Chatzitheochari & Arber, 2009) (Åkerstedt, 2006)

Patients with insomnia usually awaken not feeling refreshed, which takes a toll on their ability to function during the day. Although insomnia can affect people at any age, it is more common in adult females than adult males. Insomnia can sap not only the mood of patients but also their health, work performance and quality of life.

The CDC (Centers for Disease Control and Prevention) have declared insufficient sleep “a public health problem,” with an estimated 50 -70 million Americans suffering from a sleep- or wakefulness disease in 2006. 30% of American adults sleeps less than 6 hours per night on average, compared to a recommended adult average of 7-8 hours (Centers for Disease Control and Prevention, 2015). Sleep Disorders and Sleep Deprivation: An Unmet Public Health Problem. Washington, DC: The National Academies Press; 2006. A 2008 survey within

France, Germany, Italy, The Netherlands, the UK and Spain found that between 14% (NL) to 27% (FR) of these countries’ populations suffered from insomnia (Narayanan, Potthoff, Guether, & Kanitscheid, 2008).

Insomnia and associated sleep deprivation have been linked to a wide spectrum of consequences. These include a higher risk of obesity by 21%, strokes by 22%, diabetes by 25% and coronary heart disease by 35% (M. Heffron, 2014). Additionally, sleep deprivation increases the change of deadly incidents (Laugsand, et. al, 2014), may shrink one part of the frontal cortex (E. Sexton, et. al, 2014), higher risk of weight gain and obesity (M. Spaeth, et.al, 2013 and)(A. Mitchell, et.al, 2013), faster cell aging and cell regeneration (American Academy of Sleep Medicine, 2015), etc. etc.

In the US alone, so-called “drowsy driving” due to a lack of sleep was responsible for 72000 crashes, 44000 injuries, and 800 deaths in 2013 (National Highway Traffic Safety Administration, 2013) It is thought that these numbers are underestimated with a more likely number of 6000 fatal crashes per year in the US due to sleepiness behind the steering wheel. Not only car drivers are at risk: for example, in 2013 five people in a plane crash caused by fatigue of the pilot due to acute sleep loss

(Williams, 2014).

Sleep loss and associated performance impact on workers have also been linked with more far-reaching tragedies, like the Bhopal chemical disaster, the nuclear meltdowns at Three Mile Island and Chernobyl as well as the grounding of the Star Princess cruise ship and the Exxon Valdez oil tanker. (source: National Center for Biotechnology Information <http://www.ncbi.nlm.nih.gov/books/NBK19958/>)

Outside of health and safety risks, sleep deprivation also affects the economy as a whole. People sleeping less than six hours per night (or more than nine hours) have the highest risk of extended absence from work due to sickness (Lallukka, et al., 2014). The financial cost of sleep deprivation in the USA alone has been estimated at \$63 billion a year in lost productivity and health care bills (American Academy of Sleep Medicine, 2011).

Considering the wide spectrum of consequences wrought by sleep deprivation on both individual and societal level, combined with a large amount of people suffering from insomnia and aforementioned sleep deprivation, it becomes obvious there is a clear and urgent need for measures to tackle insomnia.

OBJECTIVE *vs.* SUBJECTIVE SLEEP ASSESSMENT

Sleep assessment and monitoring can help people to understand the quality of their sleep, their sleep behavior and the relation between these two. Through the monitoring and subsequent analysis of these factors, the cause of a sleeping disorder like insomnia may be identified and a proper treatment program composed.

A distinction is made between subjective and objective sleep monitoring:

OBJECTIVE SLEEP ASSESSMENT

Objective sleep assessment is based on objective measurements through brain activity, heart activity, muscle movement, and airflow, which are mainly performed in sleep laboratories. Types of objective sleep measurements include EEG (electroencephalography) using electrodes placed on the body, EMG (electromyography) using an electrode inserted into the skin, EOG (electro-oculography) using electrodes placed around the eyes, or video observation during sleep.

SUBJECTIVE SLEEP ASSESSMENT

Subjective assessment of sleep quality can help determine whether further treatment for a sleep complaint might be warranted. An example of subjective sleep assessment is keeping a sleep diary.

Subjective and objective sleep data are not invariably correlated. For example, complaints of poor sleep are not always confirmed through objective measurement in the sleep laboratory. This discrepancy indicates objective data may not always be the optimal, sole approach moving forward and that it is important to evaluate the sleep through the perspective of the patient.

Additional research methods, usually after a first sleep assessment, include lumbar puncture, blood analysis (usually for determining effective medication dosage) or a neuropsychological evaluation (source: <http://www.kempenhaeghe.nl/slaapprobleem/32/5/68/0/0/Diagnostiek-slaapstoornissen/> and (Espie).

THE SLEEP DIARY AS SUBJECTIVE SLEEP ASSESSMENT TOOL

As written earlier, there are different assessment and treatment methods available for diagnosing and treating insomnia. A big part of this process involves understanding and establishing the sleeping patterns of the patient.

Since many people with insomnia overestimate their sleep disruption and underestimate their actual sleep time, a 2-week sleep diary is a helpful subjective assessment tool as it assists the sleep clinician to estimate the severity of the problem, especially the night-to-night variability and the presence of sleep-influencing habits (E. Carney

& Posner, Cognitive behavior therapy for insomnia in those with depression, 2016). An objective sleep assessment tool might not provide the optimal results in this case since the patient's' sleep experience can differ from reality / recorded sleep data.

An essential component of insomnia assessment is, therefore, the sleep diary. A sleep diary is a record of sleep details filled in by a patient, usually over a period of two weeks or more. Sleep diaries are the standard in assessing insomnia to record sleep patterns, the variability of the nights, maladaptive habits, difficulties and overall sleep efficiency (Saddichha, 2010).

KEMPENHAEGHE SLEEP DIARY

✓ S. CONSENSUS SLEEP DIARY

The sleep diary has been hailed as the “gold standard” for subjective sleep assessment, despite the lack of a standardized format. Although a generally accepted sleep diary format is non-existent, there is widespread agreement that a sleep diary should commonly be included in insomnia research.

Kempenhaeghe utilizes their own, proprietary format which differs from e.g. the Consensus Sleep Diary. The Kempenhaeghe format of sleep diary consists of a linear time bar divided into blocks of a quarter hour. Users can record their sleep experience (time awake, time asleep, bedtime etc.) and provide written commentary.

The Consensus Sleep Diary was jointly developed by insomnia experts at the Insomnia Assessment Conference in 2005. This team of experts decided to create a standardized, consensually agreed upon sleep diary upon noting the lack of a standard format in current sleep diaries. This diary consists of a comprehensive questionnaire with various questions regarding sleep time and other key factors (E. Carney, et al., 2012).

Both diaries share a paper-and-pen approach to

user input. The Kempenhaeghe Diary takes a minimal visual approach, whereas the Consensus Sleep Diary has no real visuals to speak of. However, the Consensus Sleep Diary has a much wider range of questions to be answered and is thus able to provide a more comprehensive overview of sleep and related factors to clinics.

In their study, the authors of the Consensus Sleep Diary noted that multiple participants voted for a more visual approach of the quantification of sleep (time), like a clock face, and they requested a more simplified concept. Another important result of the study was that participants might prefer an electronic / digital version of the sleep diary over a paper diary.

Overeem indicated that while he believes the current Kempenhaeghe Sleep Diary is better for simply filling in sleep time, he would like to integrate certain aspects of the Consensus Sleep Diary into the new Sleep Diary 2.0.



PROBLEMS WITH THE EXISTING SLEEP DIARY

Dr. Sebastiaan Overeem, a doctor at Kempenhaeghe Sleep Institute, indicated several issues and causes in the treatment of patients with insomnia. Patients with insomnia have to fill in a sleep diary from which a specific treatment is drafted. The experience of the patient is useful in the treatment of insomnia. This sleep diary has lagged behind in its development, according to Dr. Sebastiaan Overeem. Currently, the Kempenhaeghe institute uses a paper sleep diary, which the patient should be filled in every day with a pen. Several issues have been raised during this treatment with a paper version of the sleep diary.

The main two existing problems are:

Patients are not filling in their sleep diaries

Patients forget to fill in their sleep diaries. Without a filled-in sleep diary, the medical staff does not

know how (well) the patient is sleeping. Without detailed sleep data, they cannot establish patterns and causes and properly diagnose and treat insomnia patients.

Patients are inaccurately filling in their sleep diaries

When patients forgetting to fill in their sleep diary, they fill in their diary randomly without thinking about it. Without an accurate sleep diary, the medical staff may have a skewed image of how the patient is doing. Without accurate data, they cannot establish actual patterns and causes and properly diagnose and treat patients.

We determined the following underlying problems:

The sleep diary takes time and effort to fill in.

Filling in the diary is not something that is done quickly. Moreover, you have to take the time to

fill it in, which not everyone may want to do at all times. Additionally, the task is boring to do. These factors may result in people refusing, postponing and / or forgetting to fill in their diaries.

The patient has to accurately remember all relevant times and time spans related to his / her sleep.

Even when patients earnestly try to consistently record their sleep using the sleep diary, their subjective experience may make it difficult to ascertain whether their sleep experience matches "reality" (i.e. patients may think they were awake for a long time, when this may not have been the case).

Sleep diaries rely solely on pen-and-paper input, without any form of digitization.

The diary should be digitized in order to improve the reliability of the data and provide clinicians with better and earlier access to their patients' subjective sleep experience. It also means patients don't have to painstakingly fill out a lot on paper each morning.

RESEARCH CONCLUSIONS

Insomnia is a sleep disorder that is characterized with troubles in falling asleep, staying asleep, waking up too early in the morning and feeling tired upon waking. Insomnia is a disorder that is not only caused by medical problems, but it is related to subjective experiences of both the quality and quantity of sleep that causes the problem.

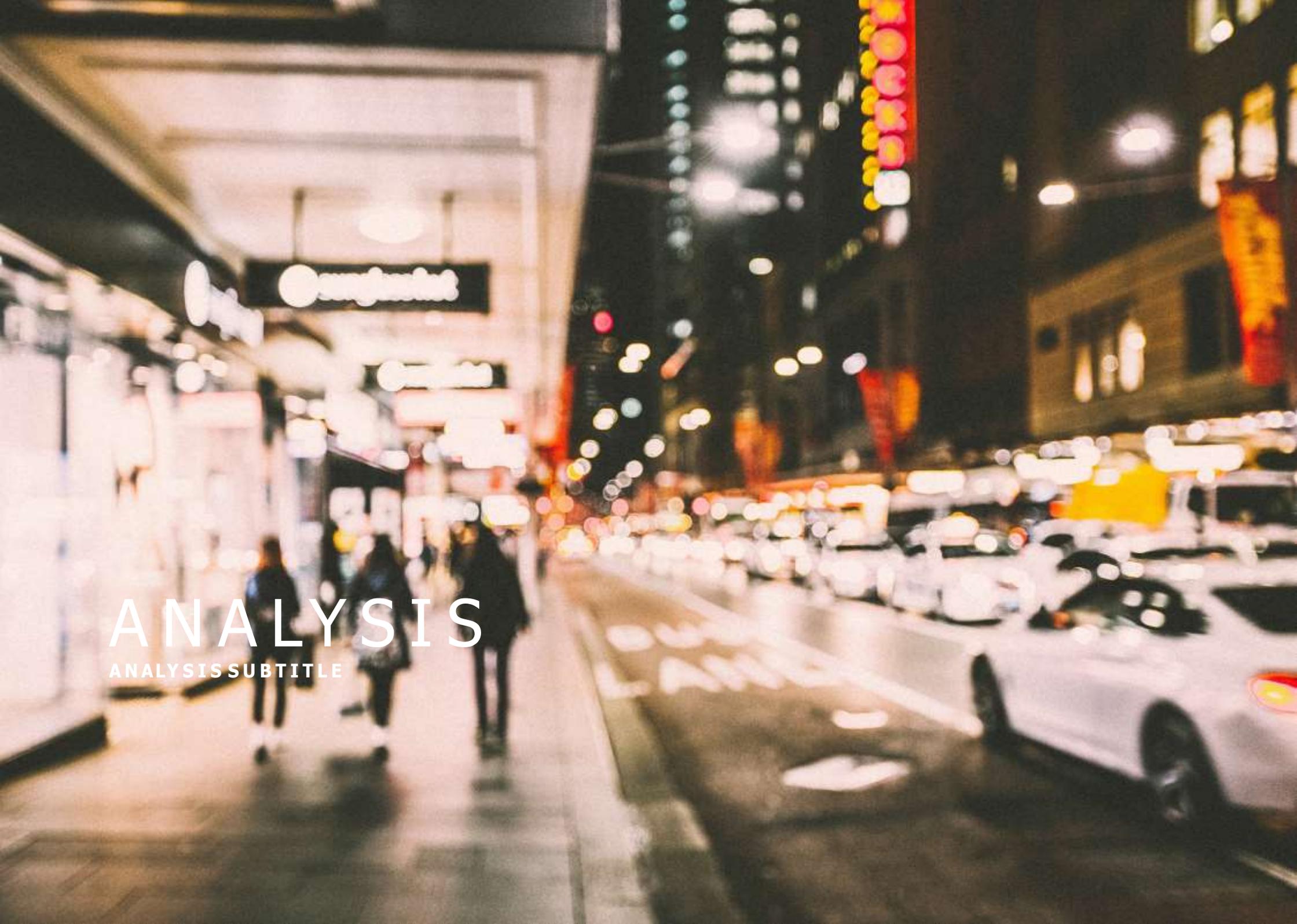
A significant portion of the population is affected by insomnia and resulting sleep deprivation. Poor sleep can result in severe physiological and mental health consequences and affects society and economy as a whole as well.

The sleep diary is a subjective sleep assessment tool and an essential component of determining insomnia. There is currently no standardized for-

mat of such a sleep diary. Our two main points of reference for the sleep diary are the Kempenhaeghe Sleep Diary and the Consensus Sleep Diary.

The team behind the Consensus Sleep Diary stated in their report that some participants suggested that alternate graphical formats, such as clock faces or time charts, would be more useful. Some argued for an electronic format, which will ultimately make use of new technologies (E. Carney, et al., 2012).

Through an evaluation of the Kempenhaeghe Sleep Diary with Sebastiaan Overeem, Md. PhD., we determined that the main problem is that patients are not, or inaccurately, using the sleep diary.



ANALYSIS

ANALYSIS SUBTITLE

MI



CONSUMER HEALTH-
AND SLEEP TRACKERS:
TREND ANALYSIS

JAWBONE



ResMed

In recent years, there has been a development in measuring and evaluating sleep patterns and habits. A concern and interest in health has created a growing awareness of sleep. Sleep is increasingly seen as an important aspect of the 'healthy living' lifestyle of this century. People are more and more curious about their own body and are willing to do anything for it. They use technology to collect specific data about themselves for personal interest and growth.

Developments in 'big data' create more possibilities in trends such as healthcare at home, which focuses on personalized healthcare. Patients can be monitored, treated and coached to health by virtual care at any place and any time of the day (mann, 2015). Most of the consumer products capable of tracking sleep are wearables (actigraphy), a market that grew by 223,2% in the second quarter of 2015. The major companies in this field are, in order of total units shipped, FitBit, Apple, Xiaomi and Garmin (Nusca, 2015).

We analyzed the existing market for consumer products capable of monitoring one's sleep in order to understand what's already out there and what our opportunities are.

WEARABLES

APPLE WATCH

The Apple Watch is maybe the most expensive consumer wearable on the market capable of tracking sleep. It can track your sleep, heart rate and steps taken. Apple's Healthkit software enables third-party developers to design extra apps that give you further insight from the data generated by the Apple Watch.

FITBIT

Sleep tracking is one of the features of the FitBit. The FitBit keeps track of the steps the customer take over the course of the day and how active he/she is overall. It will track the movements overnight, including the times to get up and move around, or when the customer awake tossing and turning in bed. This device is synchronized with a mobile app. This mobile app shows a complete report of the sleep quality. It won't diagnose sleep issues.

JAWBONE UP

The jawbone up is a wearable that only pays attention to sleep. It will also track the steps and the activity level, and even makes it easy to log food and drink to keep track of diet. The Jawbone Up can track how many hours the customer slept, and pays



attention to the overnight activity.. The Up is synchronized with a mobile app to figure out what the root cause of the sleep issue may be.

XIAOMI MI BAND

The Xiaomi Mi Band features largely the same functionality of aforementioned competitors like FitBit or Jawbone, but manages to couple this to the very low price tag of just \$16. This has led the Chinese brand to become “the dark horse of the wearables market”: its entry-level price means more people may opt to buy a Mi Band and sales (3,1M in second quarter of 2015) are expected to further grow since the product has only been on

sale in US and the EU since June 2015 (Leswing, 2015).

PHYSICAL DEVICES

HELLO SENSE

Sense is a sleep tracking device. The product consists of the device for on the bedside and a pillow clip-on. The clip tracks movements and sends these data to the bedside device that tracks temperature, light sound and allergen particle data. Via a mobile application it is possible to see all the relevant sleep data and the current status of the bedroom (Hello, 2015).

S + RESMED

S+ is a sleep monitoring device that monitors sleep habits by measuring breathing patterns and body movements throughout the night. It analyzes light, noise and temperature levels in bedroom environments using bio-motions sensors. This information will be translated into daily sleep scores and charts of sleep patterns and habits. The physical device send real-time data to a mobile app. S+ contains a number of features; relax to sleep (sound synchronize with breathing patterns), daily sleep score, S+ mentor, sleep charts and smart alarm (Resmed, 2016).





SLEEP APPLICATIONS

SLEEP CYCLE

This app “sleeps” under the customer’s pillow, where it analyzes the nighttime motion and calculates the best wake up time. The app make use of sleep cycle theory by using the accelerometer of the iPhone to record sleep habits and to wake up at the right time (Sleep Cycle, 2014).

SLEEP TIME+

A mobile app containing a combination of sleep tracking and a smart alarm clock by using the phone sensors to measure the sleep quality. The mobile app contains a wake-up function at the optimal and lightest sleep phase. User’s have to place

the phone in the bed for optimal measurements. It analyses the movements during the night and graphs the sleep cycles. The mobile app makes use of soundscapes, natural sounds stimulating sleep (Azumio).

SLEEP GENIUS

A mobile app developed by neuroscience, sleep and sound experts. Sleep Genius is based on helping NASA astronauts with their sleep. The techniques used in Sleep Genius are taken directly from research that was done to get NASA astronauts asleep in their unaccustomed weightless conditions in space. Sleep Genius uses scientifically based algorithms of music and sounds in order to provide a better night of sleep. In addition, to the sleep

mode there is also a special alarm clock function waking the user gradually. Besides these features, a power nap feature is also available that makes the power nap, even more, enjoyable (Sleep Genius, 2015).

The interest in new sleep-related technologies is a positive development in society. Sleep is increasingly perceived as important by the general public and it also proves to be healthier. In terms of basic sleep needs and functions of sleep, we have a much better understanding of the profound impact of sleep loss on vigilance, mood, and performance, both affecting children at school and in adults in the workplace (M. Morin & A. Espie, 2012).

A remark to this positive development is that sleep apps and smart sleep devices were not developed for people already suffering from insomnia. These devices and apps are designed for healthy people to remain healthy and it ultimately improves their sleep; they won't help people who already suffer from abnormal sleeping patterns. Although the data from these devices are becoming increasingly precise, they are not nearly accurate enough to match the quality of sleep clinics. In sleep clinics, research is done in laboratories using objective measurements.

Insomnia patients who are tracking sleep with one of these sleep monitoring devices might be informed with false reassurance (Sleep Health Foundation, 2015). These devices can encourage anxiety by too much thinking about sleep, which leads to more sleep disruptions finally creating a vicious cycle with negative effects for patients with insomnia.

TRACKERS, SLEEP APP IMAGES HERE!

TREND RESEARCH CONCLUSIONS

Sleep monitoring devices are increasingly popular. These devices give people an understanding and review of their sleep and wake patterns to improve their overall sleep. Different devices have conquered the current market, from wearables to mobile apps.

A remark to all these consumer products is that these have not undergone scientific evaluation. Most of the data of the current sleep monitoring devices would not accurately reflect a poor quality of sleep. This is because they are based on movements instead of brain wave activities and other body indicators (eye movements and muscle

tension) measured in a laboratory. People with a sleep disorder might be informed with false reassurance. These devices can encourage anxiety by too much thinking about sleep, which leads to more sleep disruptions.

A solution for a home sleep monitoring device for patients with a sleep disorder is not yet available. The current devices are not accurate enough and create anxiety by showing false and incomplete data. In addition to the sleep monitoring devices, there are also no devices that focus on the subjective measurement such as the experience of the patient.

DESIGN & ATMOSPHERE RESEARCH

We investigated the design, atmosphere and feeling that the new Sleep Diary should give. Since we were designing for people under treatment, we wanted to give the design a calming, soothing and serene feeling.

We searched for timetelling devices and other products that met our earlier mentioned keywords. We discovered interesting new approaches to light, shapeshifting, and colourshifting.

Moving forward, we were interested to see if we could apply an overall metaphor, e.g. sunrise / sunset, the crescent of the moon, the path of the sun and the moon along the sky, the sands of time etc.

Additionally, we looked into devices with original, intuitive interaction models and products that integrated smart phones in a clever way.





Looking at the main problems with existing sleep diaries, combined with our research on consumer-grade sleep trackers, we were able to identify several design opportunities for the new Sleep Diary 2.0:

RELIABILITY / TRUSTWORTHINESS

A sense of reliability will improve the subjective measurement for both the patient as the doctor. Adding smart constraints will make a positive contribution to the reliability of the subjective sleep measurement.

EXTERNAL MOTIVATION

Utilize external (social) motivation to support their path towards recovery. Physical, sensory triggers, such as sound, light, vibration and movements are technological triggers that influence the external motivation. Peer pressure, competition, and family are social structures that could also be used towards that purpose.

SENSE OF COMMUNITY

A problem people with sleep disorders face is that they may feel alone in the process as if they're one of the few struggling. A sense of community and interaction with other patients may help them to find support and feel better about themselves.

PATIENT - DOCTOR INTERACTION

Overeem mentioned that sometimes months may pass before he meets a patient again at Kempenhaeghe. It may be interesting to look at ways to allow patients and doctors to communicate and interact with each other in the meantime.

Based on the situation explained earlier, the design should answer the following questions:

1. How can we motivate users to use the design "Sleep Diary 2.0" consistently and properly?

The main flaw of the existing sleep diary is that patients were not (accurately) filling in the sleep diary. The design should motivate patients to regularly and accurately record their sleep.

2. How can the design accurately record the patient's sleep (patterns, relevant moments)?

In the existing sleep diary, the patient was solely responsible for providing the data with which Kempenhaeghe has to work to treat the patient. In addition to stimulating patients to regularly use the design, we may need to look at ways to gather objective sleep data.

3. How can we make it easy for patients and doc-

tors to review the collected sleep data?

Currently, patients do not immediately get feedback or an overview on the data they are recording on their sleep habits. This may make it harder for them to see if they are making progress and does not encourage them to continue recording their sleep. Additionally, doctors rely on information that is only provided on a few specific moments by the patients. It may be advantageous for them to be able to request the sleep data whenever is necessary and provide short feedback that may help the patient in turn. We need to look at ways to visualize and explain data and patterns and extract useful information from raw data.

4. How can the design improve patient - doctor communication / interaction?

Months may pass before the doctor and patient meet again. However, small checkups in the meantime may be beneficial to provide timely feedback to the patient and keep him / her motivated to continue tracking. Additionally, the doctor may be alerted timely when the patient's status significantly worsens. We need to look at ways to improve patient - doctor communication and interaction, without burdening either party with unnecessary "spam."

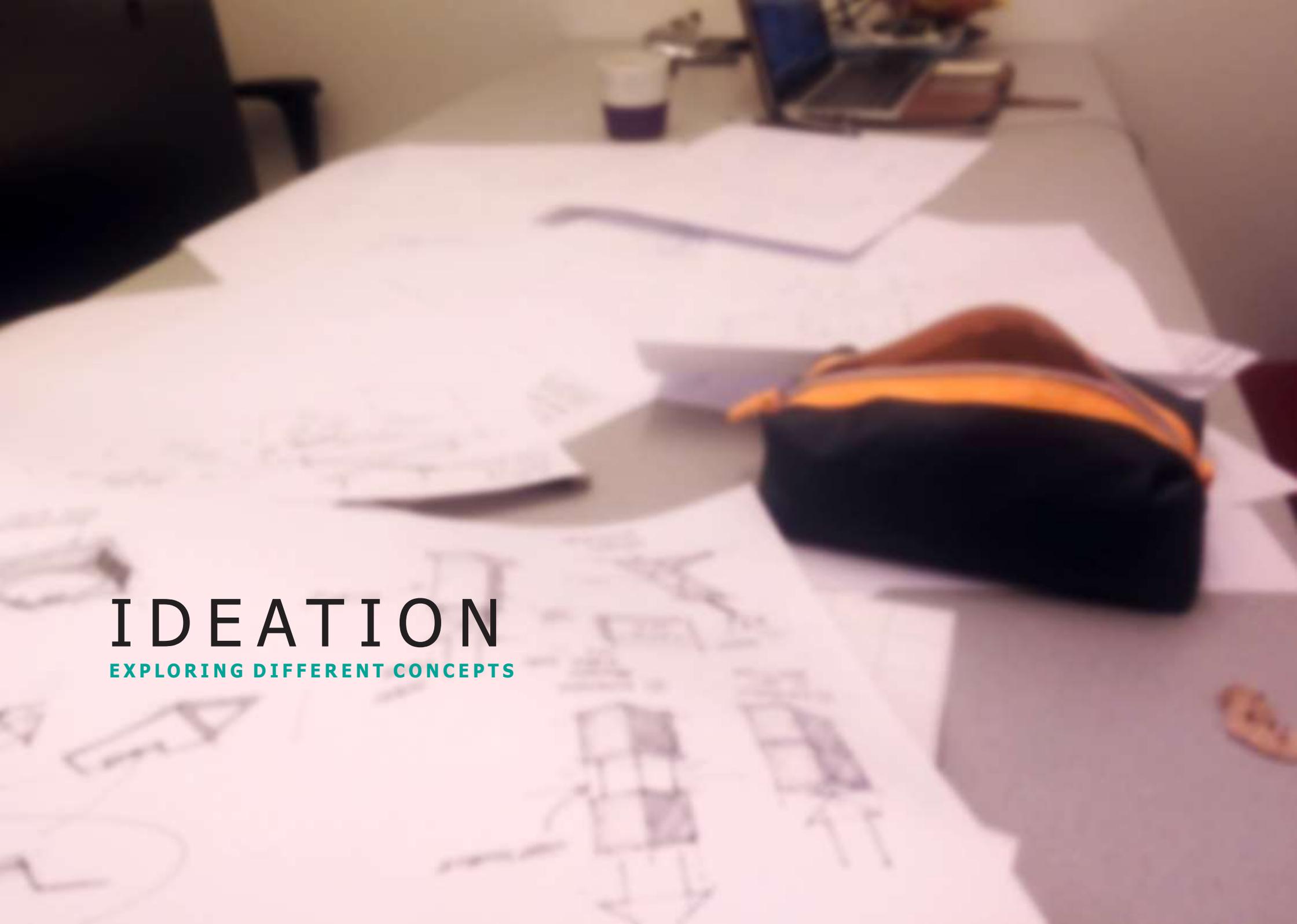
ANALYSIS CONCLUSIONS

A combination of physical and digital interaction is not new, many trends make this development visible. There are already many different examples of products containing this combination, strong example already mentioned earlier such as the Fitbit and S+ Resmed. Especially sleep monitoring products, that will improve the sleep quality of customers, contain this powerful combination. However, the current sleep monitoring devices are not accurate enough for people with a sleep disorder, because they are based on movements instead of brain wave activities and other body indicators (eye movements and muscle tension) measured in a laboratory. A qualified measurement uses different measurement techniques to be as specific as possible to measure the quality of sleep. The current sleep diary does not make use of these 'new' technologies or an amalgamation thereof.

A lack of new technology causes repeated use of the current sleep diary consisting of pen and paper in which the patient colors his/her sleep and awake time. There is no digitization involved in

this process of filling in the diary. This makes the current sleep diary time-consuming and an effort to fill in. Furthermore, the patient has to accurately remember all relevant times and time spans related to his/her sleep. Besides these negative aspects of the current sleep diary, the reliability is the most important issue. A sense of reliability will improve the subjective measurement for both the patient as the doctor. Thereby this improvement will also trigger the (external) motivation of the patient.

A solution for a subjective sleep monitoring device, both physical or digital, is not yet available for patients with a sleep disorder. In the current treatment, the sleep diary comprises only a paper version. The challenge is to design from the point of view of these missing and existing products in terms of sleep monitoring, operational and usage problems of the patients and the physicians. This forces to look at the current advantages and disadvantages and take these as a starting point, while the goal is to design a realistic product within five years.

A photograph of a desk covered with architectural sketches and papers. In the foreground, there are several sheets of paper with hand-drawn diagrams and sketches of buildings. A black and orange bag is resting on the desk to the right. In the background, a laptop and a cup are visible on the desk. The overall scene suggests a creative or design workspace.

IDEATION

EXPLORING DIFFERENT CONCEPTS

DESIGN FOCUS AREAS

Current trends, technological developments, and interesting design possibilities result in a specific design area for further development of the concept.

Based on the analysis (the design questions and possibilities), our respective PDPs, and our personal interests, we determined that it would be preferable to have both a physical and digital design elaboration; with the physical part used mainly for sleep diary input and the digital part as the support of the diary itself. These insights and data led to five major areas that were identified for taking into account for the further development of concepts.

1. PHYSICAL AND DIGITAL UNITY

A complete, seamless experience integrating both the physical and digital parts of the sleep diary. A unified design language in terms of visual, material and interaction design. The design should integrate into the bedroom environment and be able to monitor the sleep experience of the patient. This integration of 'physical and digital' should increasingly attract the attention of the patient. A clever integration of the mobile phone should benefit the total experience of the product. The current paper version does not draw the attention of the

patient, reducing the accuracy of completing the diary. The physical part will be provided with the main functionalities, as in previous studies has been shown that the display of the mobile phone is not beneficial to sleep. The main input will, therefore, focus on the physical device and should include a suitable and adapted display, which does not adversely affect sleep.

2. EASY, FUN AND FAST

A satisfying, quick and effortless experience of recording subjective sleep. The patient gets out of bed and has to perform a small task to achieve his goal, completing the sleep diary. Simplicity is a key element in the design. An attractive and easy-to-use design that is attractive to use with targeted feedback by playing with light. The interaction design will form a unity between the physical and digital. This makes the product easier to understand and faster in its control.

3. FEEDBACK AND FEEDFORWARD

A clever design that uses a thought-out interaction model to ensure continued usage and implements functionalities for subjective sleep monitoring. The device will attract the attention of the patient in order to promote the completing of the sleep diary. Feedforward plays a major role hereby. Feed-

back, however, will control and encourage the user responding to the user's input.

4. MEANINGFUL DATA

Engaging, easy-to-understand overview of the sleep data, useful for both patient and doctor. The paper version gives a clear insight into the patient's sleep data. Is it intended that the patient can see his data back over the past week? Research shows that this affects the patient's thoughts about sleep and finally influences the behavior of filling in the diary (Sleep Education, 2013). Will this affect the input behavior of the patient? In addition, the data of the patient is not digital. This information should be scanned after which calculations can be made in the computer that give the doctor an insight into the sleep patterns of the patient. This is not time-efficient.

5. SOCIAL AND PERSONAL

A friendly and caring experience surrounding the treatment and process. Engage with friends and / or family. Keep in touch with the doctor and / or with a sleeping "community." It will give the user the feeling of unity, which they can share similar experiences and can ask questions to the doctor.

FIRST CONCEPTS ITERATION

The first weeks were devoted to brainstorm sessions. Several iterations are done to come up with a first, strong concept direction. From the design focus areas different concepts have emerged of which two are developed for the midterm presentation.

In this phase, the physical and digital unity was the central starting point of the concept development. The mobile phone was meant as activating functionality. The user activates the system by bringing his mobile phone in physical contact with the physical product. The sleep data can be filled in on both the mobile phone and the physical product, but the general information can be completed on the physical device and the most detailed information can be completed on the mobile app.

MODEL 1

The first model is designed by Bram. The physical model is a vertical, cylindrical component made of wood. The inside of the cylindrical device is open, so there is space for the mobile phone. The sleep data may be entered in both the mobile component as the physical component. Data exchange between these both components makes it possi-

ble that they will show the same information. The sleep data on the physical prototype is projected on the ground surface by means of a light projection. The completed data of the sleep diary is circularly displayed using light reflection. The same circular representation is displayed on the mobile application as it is removed from the prototype.

MODEL 2

The second model is designed by Myrte. The physical model has a rectangular shape with a special cut out for the mobile component. This concept consists also of a circular representation of time. The mobile phone should be placed on the physical component whereby the system is activated. The circle on the physical model will give light and display the sleep data using an integrated LED system. But it is also possible to change the sleep data on this model by touching the circle and interact with it. This concept contains the possibility of completing the sleep data on both the mobile component as the physical model. The sleep data will also be displayed on both components by exchanging the data. A special feature is that the physical component can only be used when the mobile component touches, and thus activates, the physical component.

Both models have advantages and disadvantages that emerged through feedback after our mid-term presentation.

ADVANTAGES

Consistency is highlighted by the design enhancing the interaction;
The design emphasizes the consistency by showing the relationship in interaction. The physical and digital element forms a unity in shape and functionality. The mobile phone 'activates' the physical device by touching it. The sleep data to be recorded will be completed by the mobile phone with more specific data that affect sleep such as the consumption of alcohol or caffeine.

DISADVANTAGES

Patients are exposed to the light of mobile devices if they take them to their bedroom;

Studies have suggested that electronic devices with self-luminous "backlit" displays can affect evening melatonin, which might result in delayed sleep (10). Mental activity and light exposure promote wakefulness. Physical and digital unity will stimulate people to bring the mobile phone into the bedroom. Stimulation wakefulness is the op-



posite of the purpose of this project.

The interaction design of both models is not obvious enough;

The shape of the models does not show the functionality and interaction of the product. The interaction may not be intuitive or obvious enough.



SECOND CONCEPTS ITERATION

The midterm presentation defined an annotation about the interaction design of the chosen models. The functionality does not match with the interaction.

After and during the midterm presentation questions raised

Should the time be displayed linear or circular?

What has a more positive influence on the use of the user?

Is it unpleasant for people to hide their mobile phone while using the product?

What is the most important interaction of the product?

These questions can be answered after doing research. Different approaches were not defined in the first concept iteration.

CIRCULAR VERSUS LINEAR TIME

Research about personal savings has shown that people who applied circular time savings method provided higher personal savings estimates, compared to people who applied linear time savings method (Tam, L., Lee, H., Dholakia, U., 2010). Thus, a circular representation of time has a positive influence on people. This can be translated to the

sleep diary in which time is the key element. Registering their sleep and awake time should be a positive incentive to constantly keep track of the sleep diary. A design advantage of the circular representation of time is that the circle circumference is larger than a linear representation of time. This results in a smaller area that is required for the physical product. A circular representation of time provides more benefits than a linear representation. In this case, the circular representation is selected for further development of the second concept.

MOBILEPHONE

People want to do everything with their phone. A product that hide the mobile phone is unpleasant for the user. They want to see their notifications, messages and other important information on their mobile phone. Hiding this display is experienced as negative. On the other hand, it is important to stimulate a minimal usage of the mobile phone in the bedroom. The display of the mobile phone affects the sleep quality (Rensselaer Polytechnic Institute, 2012). Two interesting starting points for further concept development.

INTERACTION

The most important interaction of the product is

to fill in the sleep data. Simplicity and efficiency are the key principles of the interaction design. It should be easy to understand and fast to use in contrast to the current sleep diary.

THREE CONCEPTS

The concept is a circular product that appears at the bedside of the patient (sketches). The circular representation of time has been chosen because of the many advantages. The patient records his sleep and awake time on the physical product to 'draw' this on the device. The 'in bed' time is determined by a sensor which is located in the bed of the patient. The 'in bed' time indicates the area that should be filled in by the patient on its improved, physical sleep diary. A time indication is given to stimulate the remembering of last night, which makes it easier and more efficient to complete the sleep diary. The time indication will be visible with LEDs to create a more clear and attractive design. An interaction model is made to define the actual functionalities. The sleep time is displayed with a blue LEDs, the awake time with a green LEDs, and the off-bed time with white LEDs.

Three concept developments, including the previous interaction model, are elaborated. All three are based on the same concept but contain a different

interaction model and interface design. Previously described, the concept is a dichotomy; an approach combining physical input with a digital component (mobile app). The physical input (for logging essential sleep time) would serve as the first step, with a low threshold for the user to interact with in a fast, tangible and enjoyable way. The digital component that consists of a mobile app with Graphical User Interface would serve as a second step to collect additional detailed, sleep-related information and proceeds to send this data back to the sleep institute.



1. PINS

The second concept elaboration consists of 24 pins, which can be pressed and pulled. The pins stand, in zero position, a few centimeters (5 cm) up. Each pin visualizes half an hour. In order to indicate a specific time, the pin will need to be gently bent back or forward. The time will be visible on the display, which is located in the middle of the circle.

When the patient wakes up and sits down on the edge of the bed, the circular product lights up. The pins are in the zero position. The patient records the sleep time by pushing the pins completely down. The awake time is recorded by keeping the pins in the current position. The product knows that this

part consists of the awake time. In this way, it is a smart device, helping the patient by filling in the awake time.

2. RING DIAL

The first concept elaboration consists of a rotating ring on the top of the product, with a hole for the finger on one side of the upper area. The ring can be rotated in order to record the sleep time and awake time by placing the finger in this hole. When the user presses harder in the hole, the sleep time will be recorded. During the rotation of the ring, the time will be visible on a display at the center of this ring.

3. FLEXIBLE SURFACE

The third concept elaboration consists of a flexible ring on the upper surface of the product. This flexible circle can be pressed, after which it bent out of shape. The surface that is pushed lights up. The sleep time is recorded. The awake time is recorded by keeping the surface in its current shape. This concept consists of the same user interaction principle as the second concept elaboration but has a different interaction design. It does not consist of moving pins, but from a solid surface which can be formed.

The validation of the different interaction designs

should have to be tested with different users. These user tests should show what the best concept is to develop and elaborate further in the final concept iteration. It will focus primarily towards validating three interface ideas. The 'ring dial' concept is regarding the interaction design an entirely different concept than the concepts of the 'pins' and 'flexible surface'.



MOBILE APPLICATION

All three of the concepts are synchronized with a digital component, a mobile application. This mobile app shows a similar interaction design, the circular timeline. By bringing the interface design of the physical product close to the interface design of the digital product will create a better understanding of the total interaction. This strengthens the unity between the physical and digital what was one of the focus areas.

The mobile app has as the main feature to support the physical product. The main input is entered in the physical product. The patient can view the completed diary of the last night on the mobile app. The additional information and data can be filled in on the mobile app. Additional information may consist of the consumption of caffeine, alcohol or medicines and doing sports.

HOME

The mobile app opens with the home screen. This consists of a menu with two choices: complete today's diary and review last night.

COMPLETE DIARY

The 'complete your diary' screen consists of an

overview of the last night. The icons of the additional information are around this overview. The patient can drag these icons into the circle to indicate what additional information is applicable.

REVIEW LAST NIGHT

On the 'review last night' screen the completed diary of last night is visible.

ALARM

The 'alarm' screen shows the time of the alarm. This time can be adjusted, then the visualization of the clock adapts to the time.

DOCTOR

The 'doctor' page consists of two elements: 'request your data' and 'ask your doctor'. There is a possibility to retrieve the data of recent weeks and there is a possibility to ask questions to the doctor.

SETTINGS

On the settings page, the patient preferences may be indicated. These are the preferences of the color of the sleep diary, which is related to the sleep time, wake time and the in bed time.





USER TEST

A user test is done to evaluate three different concepts, interaction models, to found out the best final concept.

PURPOSE

This test has been set up as a way to validate and receive feedback on our three, current concepts. We wish to know if we are correctly answering our design questions. Through active participation by the test persons in the session, we hope to gain additional insights in the way they perceive time and maybe learn things we didn't know beforehand.

The test is designed to evaluate three different interactions for completing the sleep diary. To finally found out the best interaction model for the sleep diary.

We want to actively involve the test person because in this way we may be able to gather more feedback compared to a research where only one-sided questions are asked.

RESEARCH QUESTIONS

- How do people currently think about (periods of) time (representations)?
- Do people prefer a circular time representation over a linear time representation?
- Do people prefer a touch-based interface over a more physical interface (model)?

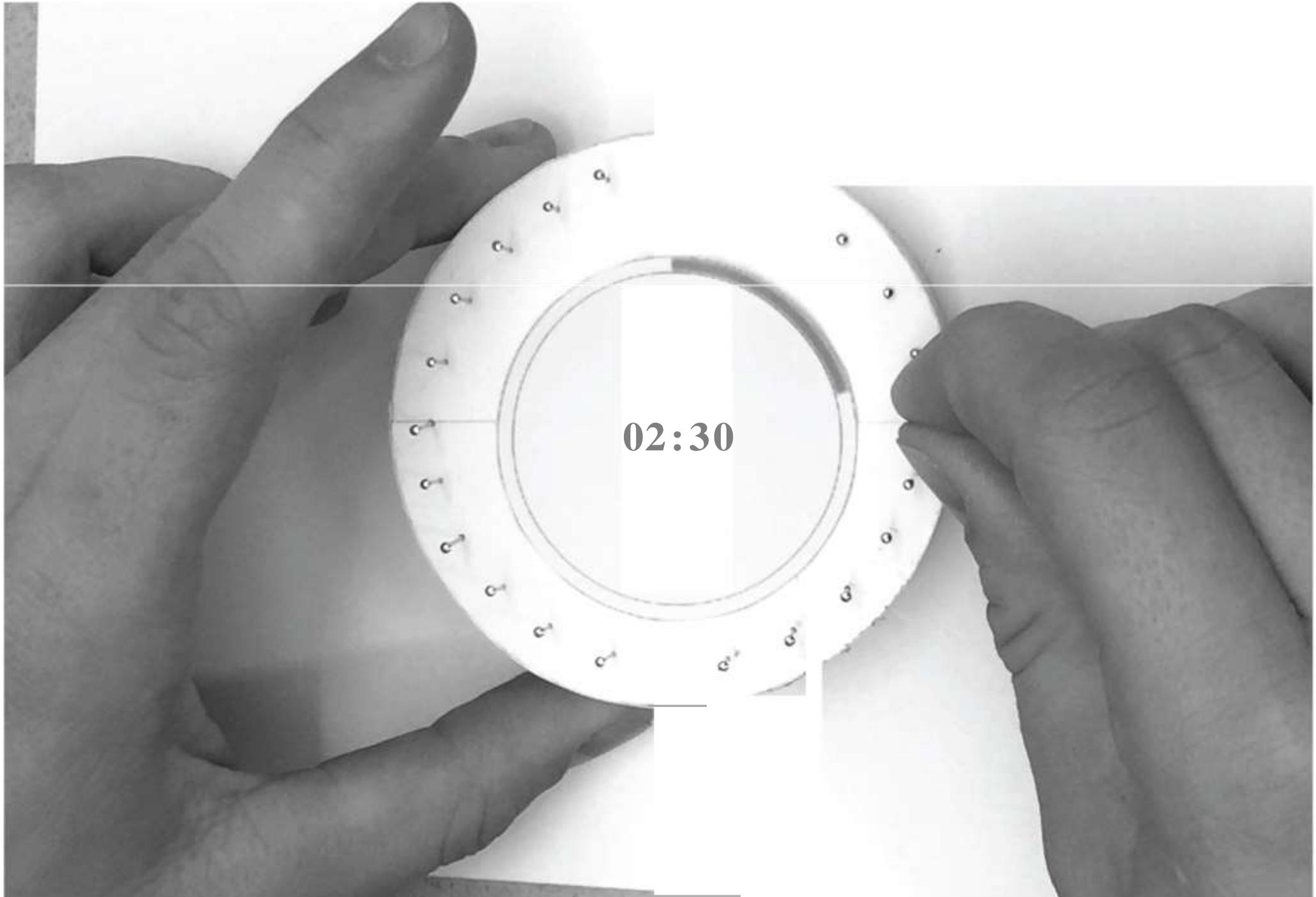
HYPOTHESIS

We believe people will prefer the circular time representation. Several research papers seem to

confirm this bias towards circular time representation over linear representation. We are still unsure whether people will prefer a touch-based interface over a more physical interface. We hope that the results of this test will help us determine

TEST PERSONS

Although our main project revolves around a product for people suffering from insomnia, this test is focused primarily towards validating our interface ideas. Therefore, it is not necessary to test on insomnia patients. The test will take place on the University of Technology in Eindhoven with students as the obvious test persons.



THIRD CONCEPTS ITERATION

Based on the feedback of our first user test, we decided to move forward with both rings and pins prototypes.

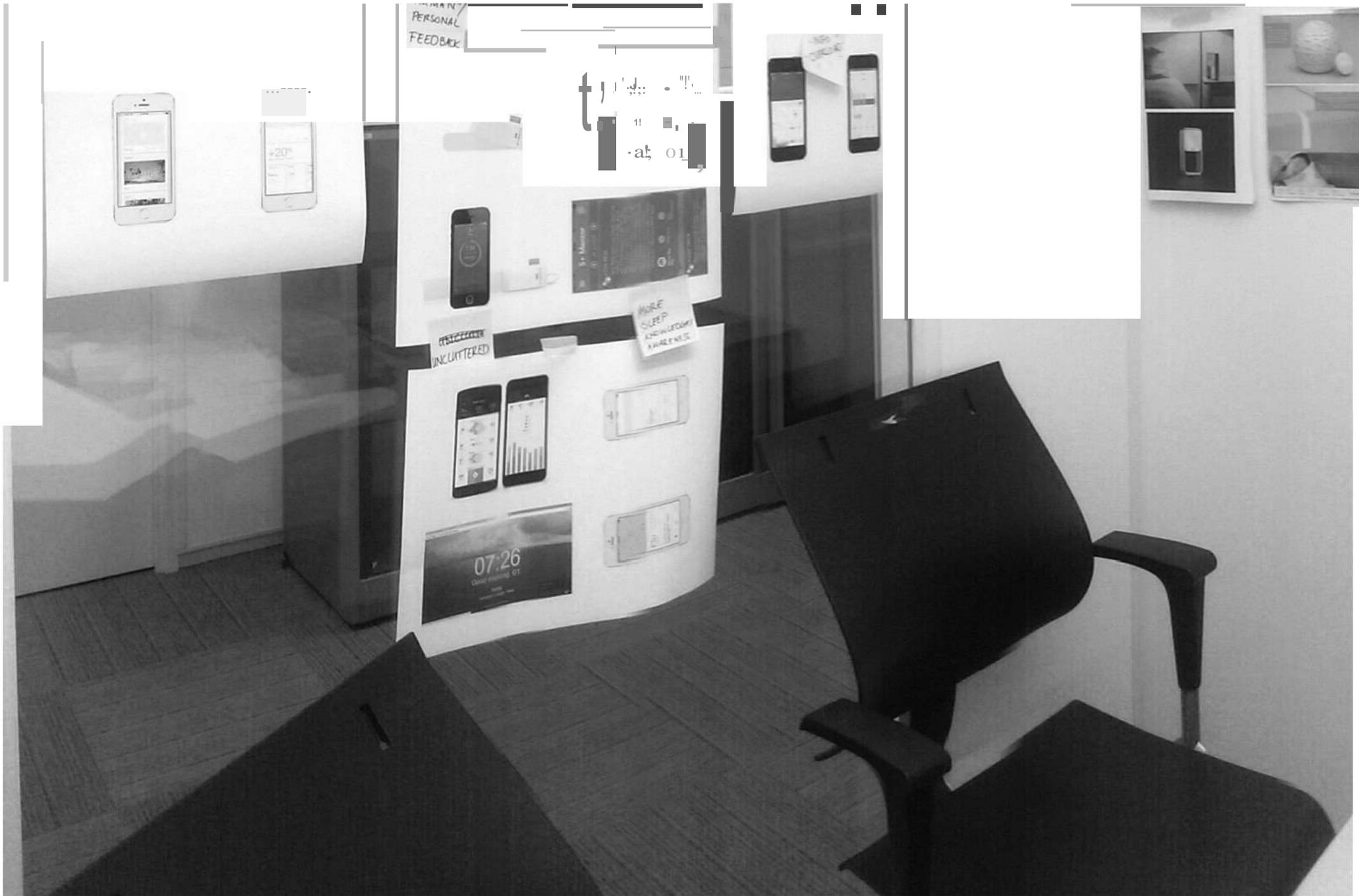
We wanted to further test these two prototypes through more refined prototypes.

These prototypes were designed in Solidworks, lasercutted and painted. The overall appearance is more resembling of an actual product than the previous cardboard models, are sturdier and less fragile and therefore easier to test.

We adapted the previous user test for these prototypes and began testing them. Unfortunately, we didn't have enough time to finish testing before the end of the project.











EVE

FINAL CONCEPT



VISION

EVE IS A COMPREHENSIVE AND PERSONAL (SUBJECTIVE) SLEEP MEASURING EXPERIENCE TO AID IN THE TREATMENT IN INSOMNIA PATIENTS ”

Sleep, like air, food and water, is one of the necessities in our lives. It is essential for our mental and physiological well-being. Not only is it pleasurable and satisfying when you wake up feeling refreshed after a good night's sleep, your nightrest greatly benefits almost any part of your body.

However, in our modern-day, 27/7 society a significant amount of the population finds it hard to get enough rest during the night. A considerable percentage of the population suffers from insomnia, which means that they have trouble falling and staying asleep, waking up too early in the morning and feeling tired upon waking up. The percentage of people with insomnia varies around the world, from 14% in the Netherlands up to 33-50% of adult Americans in some surveys.

The consequences of insomnia and poor sleep can be severe and should not be underestimated. The odds of obesity, strokes, diabetes, cardiovascular disease, but also mental issues like depression rise dramatically when your body's sleep needs aren't being met. When you aren't well-rested the risk of being involved in serious incidents increases likewise. Fatigued workers call in sick more often, re-

sulting in large-scale economical losses in lost productivity, totaling up to \$63 billion in the US alone. The prevalence of sleep deprivation has become such that the US Centers for Disease Control and Prevention has called it a public health problem.

Sleep clinics like Kempenhaeghe treat people with various sleeping disorders, including insomnia. An integral component of their insomnia treatment is the subjective sleep assessment tool called the "sleep diary". Over a period of two weeks patients use this diary to log their sleep experience and related factors.

However, Kempenhaeghe encountered several issues with their current sleep diary, with patients not using the diary as intended. The large A4 paper forms form for many patients an arduous chore to fill in each morning after yet another sleepless night. As a result, the diary is sometimes unable to provide clinicians with the correct data needed to swiftly diagnose their patients and provide them with the optimized, personalized care they need.

We wish to help insomnia patients in their process to get better sooner, to help them win back a good night's rest. We wish to provide them and their clinicians with the best tools to aid their treatment.

In order to do just that, we designed Eve.

Eve is the sleep diary that integrates with patients' morning rituals, instead of forcing notes on paper forms.

Eve is the sleep diary that is pleasant to use, instead of a daily chore.

Eve is the sleep diary that doesn't look like a bland, medical tool.

Eve is fast, easy-to-use and fully digital.

Meet Eve. The sleep diary for the 21st century.

Have a nice eve.

CONCEPT

The approach of combining physical input with a digital component (mobile application) is further developed and elaborated. The physical input (for logging essential sleep time) would serve as the first step and most important step, with a low threshold for the user to interact with in a fast, tangible and enjoyable way. The physical prototype, with its cylindrical shape, will be placed on the bedside of the patient. When the patient awakes because of the alarm clock, the device will light up for visual attention. The physical input consists of an easy to use approach by registering only the sleep and awake time of the patient. The in bed time is objective

measured with an external sensor that lies under the bed. This sensor information (in-bed time) will be set by the smart device and visualized by LEDs. As a result, the patient knows the area to complete his sleep and awake time.

The digital component that consists of a mobile application with Graphical User Interface would serve as a second step to collect additional detailed, sleep-related information and proceeds to send this data back to the sleep institute. The additional detailed sleep information may consist of the consumption of caffeine, alcohol or medicines and body movements (sports).



PHYSICAL PROTOTYPE

Both physical demonstrators were designed in Solidworks for easy and precise assembly out of laser cutted wood and perspex. Required electronic components were also modeled in Solidworks in order to see if everything would fit together nicely.

The app was designed using Photoshop and made interactive through InVision. Initially, we wanted to have a show-and-tell interactive experience using a fully-coded HTML / CSS webapp, but time constraints meant we had to find another way.

Since the waiting queues for 3D printers were too long compared to (commercial) laser cutters, we decided to forgo 3D printing the parts for our demonstrators and opted to prototype using the laser cutter. We did not want to build the design by hand because we were aiming to bring a certain degree of polish to the exhibition. Furthermore, laser cutting meant that components could be manufactured much quicker than through a manual process.

The electronics were prototyped using an Arduino and various components and modules which are listed below. The dimensions of these components were precisely measured to ensure they would fit

within the outer shells of the demonstrators.

The outer, wooden edges of the demonstrators were sanded by hand and stained with wood stain to achieve a more glossy, premium effect that would set us apart from other laser cutted demonstrators at the Final Exhibition.

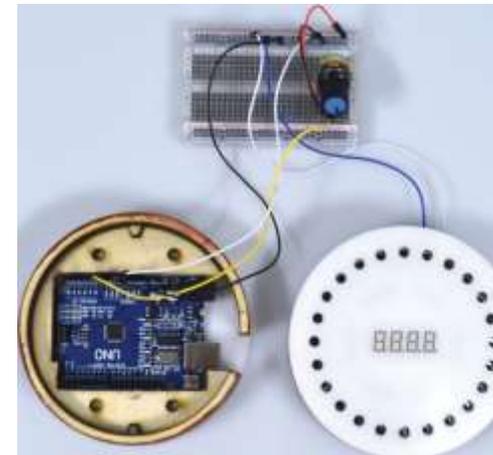
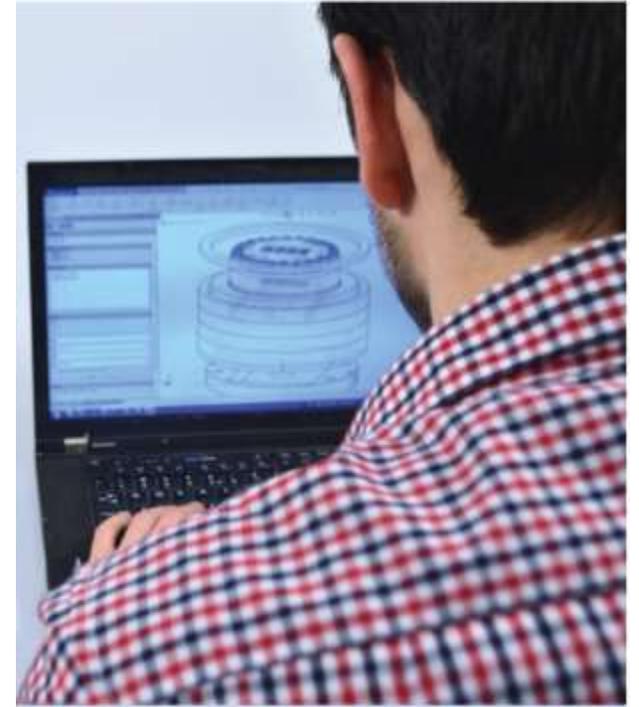
MATERIALS

- Housing / shell components
- 9mm Wood (beach)
- 3mm Wood (beach)
- 4mm wooden sticks, round (beach)
- 3mm Perspex, opal white, translucent
- (Wood) stain / wood dye for treating and dyeing / staining the wood

ELECTRONIC COMPONENTS

- Arduino Uno for powering everything and making the prototypes interactive
- 24-bit RGB LED Ring (NeoPixel) for use as time indication
- 5mm pushbuttons
- Breadboard for linking all components together
- Jumper wires
- 10K potentiometer to control the LED Ring

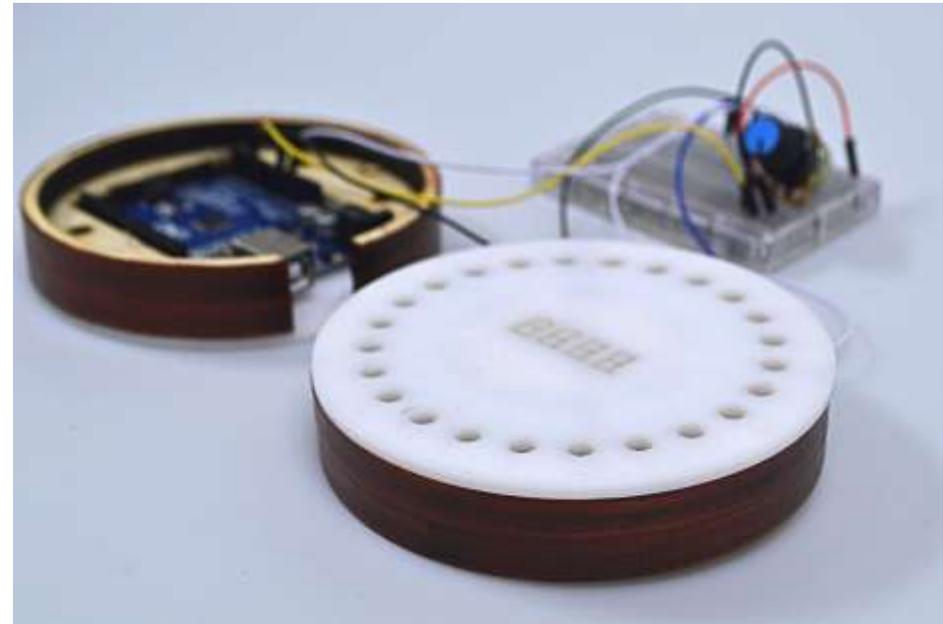
The electronic components that we had wanted to



integrate into the demonstrators:

- Alps 24 Pulse rotary encoder for reading the movement of the ring in the Ring prototype
- KYX-3461BS 7-segment 4-digit LED display for displaying time. We had actually managed to implement a partially working display, but the sheer volume of jumper cables meant we were unable to integrate this into the demonstrator housings.
- MAX7219 driver for 7-segment LED displays would have allowed us to easily implement the LED display in a proper way, without a large cable volume and through an easier programming interface.
- ESP8266 module for connecting to the internet through WiFi
- OR W5100 Arduino Shield for connecting to the internet through LAN

The technology of the physical product was complicated. Both the concept with the pins as the concept with the turntable are elaborated.





MOBILE APPLICATION

The physical product is synchronized with a mobile app. The biggest challenge was to design an interface that matches the physical product in form and function. The mobile app should act as support for the physical product. The main functionality of the mobile app is the addition of the completed data in the physical device. The physical component acts as the main input of the sleep data. The mobile application is used for more specific information about the night, such as the consumption of alcohol or caffeine, use of medication and sports.

The mobile app is, compared with the previous elaboration, adapted in design and functionality. The previous design did not fit to the shape, material, and the overall design of the physical product. An adaptation of the design has been made in order to form a unity between the physical and digital.

MOBILE APP SCREENS

HOME

The home screen consists of an interface with two main functionalities of the app: complete today's diary and review last night.

COMPLETE DIARY

The 'complete your diary' screen consists of an overview of the last night. The icons of the additional information are around this overview. The patient can drag these icons into the circle to indicate what additional

information is applicable for that specific night. .

REVIEW LAST NIGHT

On the 'review last night' screen the overview of the completed diary of last night is visible. The patient has a possibility of visualizing only the sleep time and the awake time. The moon icon shows the total sleep time and the man icon shows the awake time. The total hours of both sleep and awake time will be visible when pressing one of these icons. From this screen, the patient can easily complete the sleep diary.

ALARM

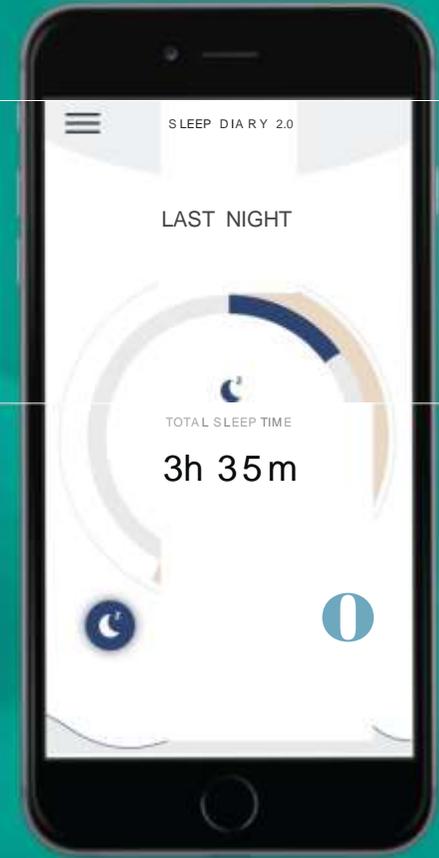
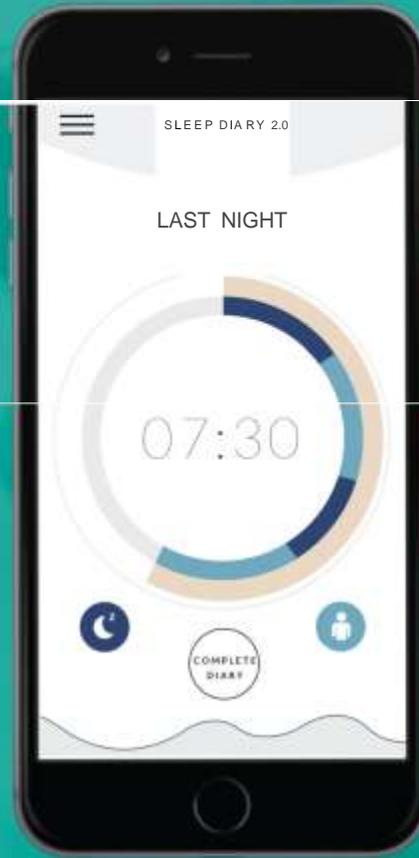
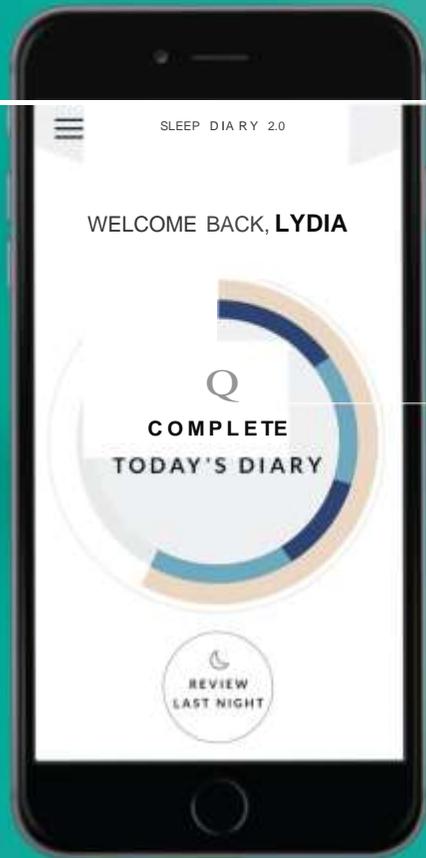
The 'alarm' screen shows the time of the alarm. This time can be adjusted by moving the circular timelines, then the visualization of the clock adapts to the time. The clock is composed of two circular time lines, one for the hours and one for the minutes. If the alarm is set to the correct time, the patient can set a light that will shine when the alarm goes on.

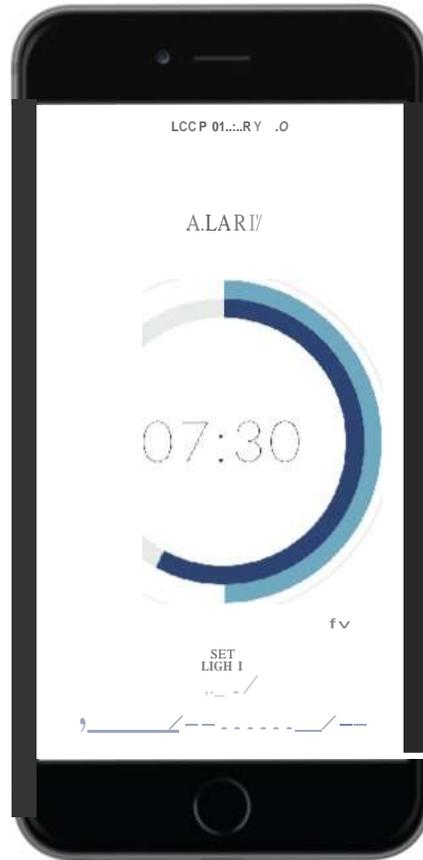
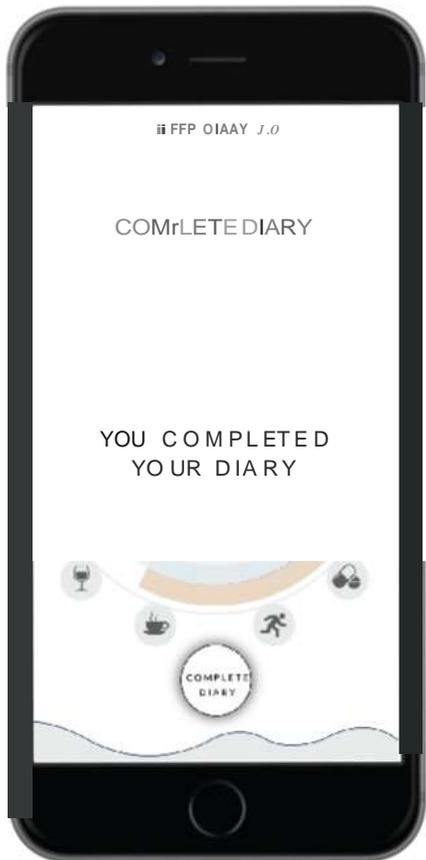
DOCTOR

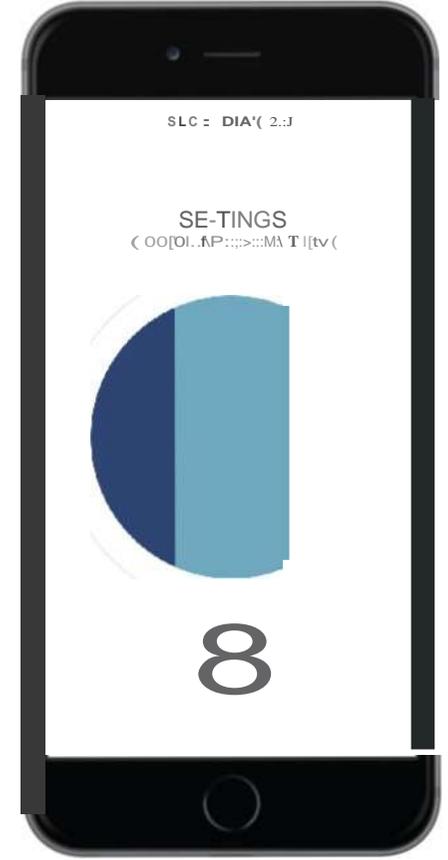
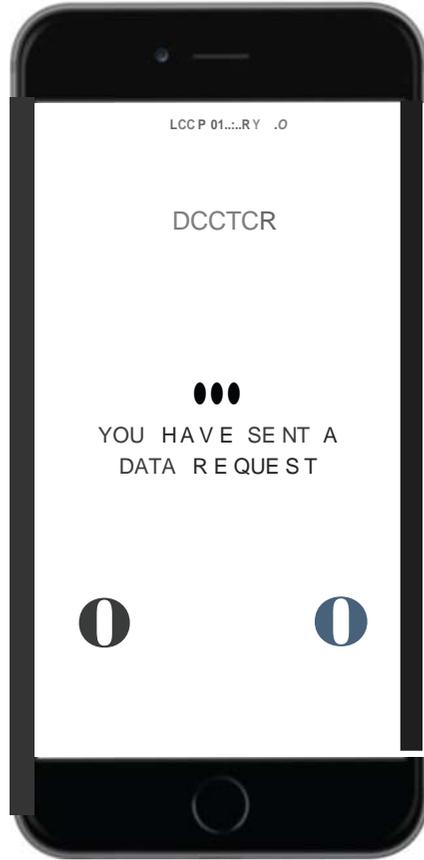
The 'doctor' page consists of one element: 'request your data'. There is a possibility to send a request to the doctor to review the data of recent weeks.

SETTINGS

On the settings page, the patient preferences may be indicated. These are the preferences of the color theme of the sleep diary, which is related to the colors of the sleep time, awake time and the in bed time.







DEMO DAY



The demo day was dominated by showing the project where we have worked on over the past five months. The process up to the final prototype was exhibited to the outside.

The responses from visitors were positive. 'A simple solution of an actual problem', was a reaction of a visitor. Other interesting reactions: 'A strong

combination between a physical product, which invites the user and the mobile phone, used daily by everyone', and 'It is good to complete the main interaction on the physical product, because you do not want to encourage patients with sleep disorder to use their phone for the most important interaction and to stimulate to bring the mobile phone to the bedroom. This has negative effects on sleep, what is commonly known'.

Three women stood by our table and found it an interesting product. We asked them what concept they found more interesting and stronger in its interaction. One woman said: "It is difficult to make a choice between these two prototypes. In my opinion, the prototype with the pins is better for the elderly and the prototype of the ring dial is better for younger people. Perhaps there need be no choice and both products are placed on the market?."



DEVELOPMENT

PROPOSED PROGRESS AFTER THIS SEMESTER

PROPOSED NEXT USER TEST

It is essential within a user-centered design project to remain testing and validating concepts and keep receiving and implementing user feedback into the design (process).

Every further stage of this project should be validated and feedback implemented. There are several user tests we propose to do next.

Finish Second Iteration prototype testing. Continue and finish testing of the existing and running user test. We did not yet have sufficient test persons to finish this test, but it should eventually be finished nonetheless.

1. TEST THE DEMO DAY PROTOTYPES.

A similar format to our previous user tests may be used to test these prototypes. Test the InVision mock-up as well. Make sure to include additional questions regarding light and materials used and the integration of physical and digital.

2. TEST THE NEXT ITERATION PROTOTYPES

(See: Proposed next iteration). Also test these prototypes on actual insomnia patients with the assistance of Kempenhaeghe and Sebastiaan Overeem, Md. PhD, if possible. Test a better working / interactive version of the app as well.

3. USE THE SLEEP DIARY YOURSELF FOR THE RECOMMENDED 2-WEEK PERIOD.

Find out any pitfalls and shortcomings that still

need to be addressed.

4. SET UP A CLINICAL TRIAL WITH THE HELP OF KEMPENHAEGHE AND OVEREEM.

The device and app need to be fully operational and communicating with each other. This will be one of the final stages of the "beginning" and may finally validate the product and its impact / benefit.

PROPOSED NEXT ITERATION

The current prototypes have several issues that should be improved in the next iteration:

PHYSICAL DEVICE

More interior space / volume to accommodate electronics: currently, the volume inside our round prototypes does not allow much room for extra wires and components.

- + Increase the size of the prototype, this may then also allow for a place to put down the phone;
- + Use an Arduino Nano, or similar, if possible to save space compared to the Arduino Uno.
- + Use extra-small breadboards or solder components onto PCBs to save space
- + Use special prefabricated drivers / components to save time and space (e.g. driver chip MAX7219 for the LED display);
- + See if 3D-printing components is possible. Due to a combination of time constraints and waiting queues for 3D-printers, we resorted to laser cutting wood. Although this is perfectly fine, 3D-printed components may offer similar structural integrity at a smaller footprint and allow for easier assembly.

Easier, sturdier access to inside of device: currently our prototype either has to be completely sealed and become inaccessible for debugging, or it does offer access to the electronics at the expense of structural integrity.

+ Design the next prototype in such a way that allows for easy, non-destructive access to the (removable) electronics. 3D printing components may allow for more degrees of freedom regarding the construction of the prototype.

Additional working components: due to time constraints, we were unable to get all aspects of our product working in time. This shouldn't be too difficult or time-consuming.

- + Design and implement rotary encoder into the prototype;
- + Implement an LDR in order to measure when the lights go out
- + Integrate a bed sensor in order to measure when the patients are in and out of bed.
- + Implement a 7-segment LED display (preferably using a driver like the MAX7219)
- + Implement a servo plus gear system in the Ring Prototype in order to reset the position of the Ring when the diary has been filled in;
- + The Ring itself should rotate using a planetary gear system, with rollers for even smoother, more controlled motion and reduced friction;
- + The buttons on the Pins prototype should be soldered and working. This will take some time but shouldn't be very hard;
- + If possible, there should be a pin / button me-

chanism on the Pins prototype. This mechanism should allow the pin to travel a certain distance downwards on clicking. On clicking again, the button should be released. This will require some clever engineering, springs, and 3D printing. Be aware of the limitations in accuracy of 3D-printing regarding smaller components and look at ball-point click mechanisms for inspiration;

- + Connect the Arduino to the internet using the ESP8266 WiFi module or an Arduino ethernet shield. Upload data to a data stream service like data.sparkfun.com and setup a custom, private server in order to ensure privacy.

Design for “mass prototyping” and testing: eventually we would want to test the product in a clinical test. This means testing on multiple persons and will thus require multiple (working and reliable) prototypes.

- + Design for easy assembly. Create a manual for the production (tools) and assembly (methods) so that other people may also be involved;

- + Make sure that faulty components can be easily accessed and repaired.

APPLICATION

Refine visuals and UI of app: keep refining the (graphic) design and interface until the app is perfectly in line with the physical device.

- + Transition from a mock-up to a working app: The current app is still an InVision mock-up, which is perfect for testing, but cannot be used in a clinical test.

- + Use web technologies for fast cross-platform prototyping. For example, use Bootstrap framework for the UI design, AngularJS for interactivity and actual programming and a service like native.io to package everything into an installable, native app for iOS or Android.

- + Design the (web) application from the side of the clinic. Right now we have designed the app for the patient’s side only. The side of the clinic should likely look very different, with a stronger emphasis on data visualization and a patient (dossier) database.

FUTURE PROCESS

The project, so-called 'sleep diary 2.0', is a project that became larger and more comprehensive than previously thought. A further development of the process is necessary to create a well-developed final product.

To get a better understanding of the future process current design directions are listed:

1. PHYSICAL AND DIGITAL UNITY

A complete, seamless experience integrating both the physical and digital parts of the sleep diary. A unified design language in terms of visual, material and interaction design. The design should integrate into the bedroom environment and be able to monitor the sleep experience of the patient.

2. USER INTERFACE / INTERACTION (MODEL)

A clever interface design that uses a thought-out interaction model to ensure continued usage and implements functionalities for subjective sleep monitoring. A satisfying, quick and effortless experience of recording sleep. The physical device and the mobile app should have a continued user interface design.

3. USER EXPERIENCE (MODEL)

An attractive and easy-to-use design that is fun to use with positive feedback. A caring, personal experience.

4. MEANINGFUL DATA

Engaging, easy-to-understand overview of the sleep data, useful for both patient and doctor. The paper version gives a clear insight into the patient's sleep data. Is it intended that the patient can see his data back over the past week? Will this affect the input behavior of the patient? In addition, the data of the patient is not digital. This information should be scanned after which calculations can be made in the computer that give the doctor an insight into the sleep patterns of the patient. This is not time-efficient.

5. SOCIAL INTEGRATION

A friendly and caring experience surrounding the treatment and process. Engage with friends and / or family. Keep in touch with the doctor and / or with a sleeping "community." It will give the user the feeling of unity, which they can share similar experiences and can ask questions to the doctor.

The future process of this project is made up of three of the five design directions, namely user interface of the mobile app, meaningful data that is send to the doctor and the social integration. These issues are partly addressed but not yet solved.

CONCLUSION

Insomnia is a sleep disorder that is characterized with troubles in falling asleep, staying asleep, waking up too early in the morning and feeling tired upon waking. Insomnia is a disorder that is not only caused by medical problems, but it is related to subjective experiences of both the quality and quantity of sleep that causes the problem. A significant portion of the population is affected by insomnia and resulting sleep deprivation. Poor sleep can result in severe physiological and mental health consequences and affects society and economy as a whole as well.

The sleep diary is a subjective sleep assessment tool and an essential component of determining insomnia. There is currently no standardized format of such a sleep diary. Our two main points of reference for the sleep diary are the Kempenhaeghe Sleep Diary and the Consensus Sleep Diary.

Through an evaluation of the Kempenhaeghe Sleep Diary with Sebastiaan Overeem, Md. PhD., we determined that the main problem is that patients are not, or inaccurately, using the sleep diary.

A combination of physical and digital interaction is

not new, many trends make this development visible. There are already many different examples of products containing this combination. However, the current sleep monitoring devices are inaccurately for people with a sleep disorder, because they are based on movements instead of brain wave activities and other body indicators (eye movements and muscle tension) measured in a laboratory. A qualified measurement uses different measurement techniques to be as specific as possible to measure the quality of sleep. The current sleep diary does not make use of these 'new' technologies or an amalgamation thereof.

A lack of new technology causes the repeatedly use of the current sleep diary consisting of pen and paper in which the patient colors his/her sleep and awake time. There is no digitization involved in this process of filling in the diary. This makes the current sleep diary time-consuming and an effort to fill in. Furthermore, the patient has to accurately remember all relevant times and time spans related to his/her sleep. Besides these negative aspects of the current sleep diary, the reliability is the most important issue. A sense of reliability will improve the subjective measurement for both the

patient as the doctor. Thereby this improvement will also trigger the (external) motivation of the patient.

Looking back at the questions we asked ourselves, at the end of the project we can now answer our design questions.

1. How can we motivate users to use the design "Sleep Diary 2.0" consistently and properly?

The main flaw of the existing sleep diary is that patients are inaccurately filling in the sleep diary. The design should motivate patients to regularly and accurately record their sleep. A physical component next to the bedside will influence the user's behavior because it is responsive by giving light and sound. An easy-to-use approach is chosen to create an approachable design. Besides this approach there is also chosen for an interaction and interface design that is matched with each other, whereby created a strong unity which makes it easier and satisfying in its interaction.

2. How can the design accurately record the patient's sleep (patterns, relevant moments)?

In the existing sleep diary, the patient was solely responsible for providing the data with which

Kempenhaeghe has to work to treat the patient. In addition to stimulating patients to regularly use the design, we have implemented ways to gather sleep data both subjective as objective. The most important data registrations of the sleep data are subjective, the experiences of the patient's sleep. An objective measurement tool is chosen for creating a certain area that helps the patient completing the diary easier and more efficient.

3. How can we make it easy for patients and doctors to review the collected sleep data?

Currently, patients see immediately an overview of the data they are recording on their sleep habits. This may make it harder to think objectively of their last night of sleep. It will influence their recording behavior according to Overeem. The final concept uses, as a starting point, the sleep data as not visible to the patient. The patient is, on the other hand, able to send a request to the doctor to view his/her data. Additionally, doctors rely on information that is only provided on a few specific moments by the patients. It may be advantageous for them to be able to request the sleep data whenever is necessary and provide short feedback that may help the patient in turn. The physical and digital component make it possible to immediately send the obtained data from the patient to the

doctor. The patient's data is digitized, allowing the doctor to have an understanding of this information at any time. The data visualization of the data that is sent to the doctor is an interesting starting point for future development.

4. How can the design improve patient - doctor communication / interaction?

Months may pass before the doctor and patient meet again. However, small checkups in the meantime may be beneficial to provide timely feedback to the patient and keep him / her motivated to continue tracking. Additionally, the doctor may be alerted timely when the patient's status significantly worsens. The final concept shows a possibility to ask questions to the doctor. Moreover, Overeem thought that a patient - doctor communication was not necessary for this project direction. Also, this design question is interesting for future development.

REFLECTION INDIVIDUAL DEVELOPMENT AS DESIGNERS

MYRTE THOOLEN PRE-MASTER STUDENT

This 'sleep' project was my first project on the faculty of Industrial Design. I graduated at the University of applied Sciences, Communication and Multimedia Design. I did my final bachelor project at Philips Design, working on an improved interaction design of the interventional X-ray Suite to make the interventional X-ray system more efficient and easier in its use for the physician. During this final bachelor project, I learned different design approaches and processes, implementing technology and working individual. But this study did not bring enough satisfaction to me, so I wanted to continue studying at the University of Technology in Eindhoven.

PROCESS AND PROGRESS BEFORE COLLABORATING

I did not know what to expect during my first project at the faculty of Industrial Design. The first five weeks of this semester I was still working individually while it is not usual to work individual as a pre-master student. In these weeks, the project was not yet defined. Multiple meetings with Overeem and Hu, where many issues were discussed, came to an undefined problem. I believe in design

as a development of a physical and mental connection between the user and the product. With this vision in mind, I came with the suggestion about designing a physical product, which have lead to the 'sleep diary 2.0' project.

In the fifth week of this project, Hu and Overeem came with the suggestion that it might be beneficial to start working together with a student that is already familiar with the process and the daily routing of the faculty. This was a positive turn in the project for me. I thought it would be difficult to be thrown into the deep in a new environment, with new approaches, and expectations.

MY ROLE IN THE DESIGN PROCESS

The first weeks, with an extra project member, were devoted to defining the problem in consultation with Overeem. The 'sleep diary 2.0' was our major focus during this design project. We started with general investigations such as talking with an expert (Overeem), implementing desk research, evaluating current products and trends, and starting with the first brainstorm. After three weeks of working together, I went to China to work on the workshop 'Social interaction in public spaces'. Therefore, the project was 'paused' with a small individual set of tasks. Working in China was a unique opportunity to gain insight into the way of working

at the faculty and to practice a design project. I used these learning opportunities and experience in my project.

Creativity: Conceptualization

Designers should develop a response to the changing customer needs through product innovation and matching choices in look and feel, materials and technology. The conceptualization should adjust to customer needs and innovations. To think about concept directions and solutions is a skill I am already familiar with.

Research: User focus and research

I believe in design as a development of a physical and mental connection between the user and the product. At the beginning of the project, I wanted to do user research through interviews and questionnaires. Overeem discouraged this because he wanted us to come up with our own, original ideas. Therefore, he did not want us to contact and interview insomnia patients. He believed this would steer us and the administrative procedure would be an arduous task that would further consume valuable time. By creating test models and user test protocols, I implemented a user-focused approach in the design process.

Integrating technology

Integrating technology is an important aspect in the design process. I wanted to learn more about implementing technology so I mainly focused on this. The technology was complex and the short period of time also had an influence on the overall effect of the final implementation of the technology. The small prototype in combination with a lot of jumper wires became a problem. In one prototype we needed to connect 24 buttons, this results in a plurality of jumper wires. The decision was made to deliver an esthetical prototype with the global interaction.

Prototyping: Cardboard modeling

An elective during this project was 'cardboard modeling', building prototypes out of foam board and cardboard. I implemented my learned knowledge about this technique in the first phase of the design process. This made it possible to evaluate look and feel and to create real prototypes for user tests.

Aesthetics: Mobile interface and overall design

The mobile application is one component of the whole prototype. The interface of the mobile app had to be designed. Together we examined the functionality and design by making a wireframe.

My role was to develop it into a mobile interface design.

Critical evaluation

A critical evaluation during the design process is in my opinion very important. Each concept iteration should be critically analyzed to develop a strong final prototype. I am a perfectionist and very critical, so I constantly ask questions to think about the user, main goals of the project and the focus of the project.

WHAT I LEARNED

Altogether, I have taken note of the way of working at the faculty. This is not very different compared to my previous study, but it is more detailed, extended and 'real'. Working with a professional makes the process more tangible and valuable. I learned to work with a professional and experienced as positive. The design choices were aligned with each other, which I found difficult in the beginning because the professional is not a designer. But after several meetings I learned to deal with this and the collaboration was valuable and comfortable. Secondly, I have learned to implement (elective) skills such as creative programming, cardboard modeling, and exploratory sketching. I realized that it is important to

integrate the learned skills into the design process to come to a more valuable and a solid final result. Another side of this story is the planning part. During the process, I learned that making a thoughtful planning, such as a gantt chart, is essential. Finally I have discovered my vision and identity during this project. I see design as a development of physical and mental connections with a strong balance between technological efficiency, usability and design, which has been expressed in this project.

FUTURE

An industrial designer must possess many different skills. During my previous study, I have been able to develop many professional skills. But this design project allowed me to realize that there is still much more to learn. Technology is important in the design process, particularly for testing the prototype, and for evaluating the operation of the prototype. In this project, I could work on my technological development, but it can still be improved. My 3D elaborative skills could also be improved for next projects. Secondly, I want to do a more iterative process during the next projects where I can integrate my learned skills more and more. Besides skills, I find it also very important to implement user research in the process. I believe in design as a development of a physical and mental connection between the user and the product. It was, however,

difficult to come into contact with insomnia patients. For the future, I would place the user even more central in the entire design process, even though it is not the "real" user.

A half-year project goes fast. This project consists already of fewer weeks making it important to create a good planning. Normally I am quite good in planning projects, but this project was more difficult because of the slow start. In the future, I want to make a better planning, even though the project is delayed by certain circumstances. It is the job of a designer to respond to any situation. This will be a point of improvement for the future.

The collaboration with Bram de Vogel was a partnership that immediately worked. We completed each other; both were highly motivated and able to work on our own tasks to create a valuable final concept.

I learned so much of this project that I prefer working on products and services that really help people or improves their lives, especially focused on healthcare. Within healthcare, there are great possibilities and challenges for innovation.

BRAM DE VOGEL

FINAL BACHELOR STUDENT

ORIGINAL PROJECT GOAL

After a couple of false starts, I intended to finally graduate from my Bachelor. I wanted to run a good, individual project, with academical depth, user testing and growth in my technological skills. I had chosen this project because of my own interest in sleep and the opportunity to make a difference in someone's life. Additionally, I wanted to create a tangible product through an iterative design process with academic depth. It had to be a something that I could show to people, a worthy graduation project.

PROCESS AND PROGRESS BEFORE COLLABORATING

Initially I set out to work on my own. I ended up with a sizeable amount of research papers on sleep, resulting in a project direction and preliminary concept to tackle social sleep perception and "sleep machismo". When discussing my research results and concept with Sebastiaan Overeem, however, he could not immediately corroborate my claims from his own experience. I became unsure of the value and relevance of my work so far and was considering how to proceed from there and

how to turn around my project. My coach Jun Hu strongly suggested working together with someone else in order to spend less time searching and more time designing. About five weeks after the start of the semester, I decided to team up with Myrte Thoolen and work together on the sleep diary project.

MY ROLE IN THE DESIGN PROCESS

Within our design process I was the person who was most familiar with the ID design process. In the beginning I took some initiative with multiple brainstorming methods in order to quickly produce concepts. After we had created a final concept, I became responsible for modelling and designing the physical prototypes. This was mainly because Myrte's Macbook cannot run Solidworks. I worked on the very beginning of the mobile app with which Myrte proceeded and designed the lion's share of the app. Since designing in Solidworks for laser-cutting is significantly different from designing for 3D printing, this took more time than expected. Therefore I was unable to start the Arduino prototyping myself and Myrte worked on that. I did, however, research how we could get the prototype to actually work and selected and implemented the right components into the design. At the end I got to experiment a little bit with the Arduino

when implementing my own Arduino into the second demonstrator for the Demo Days.

WHAT I LEARNED

I got back into the proper workflow for Industrial Design. This semester and the project have proven to be the turnaround I had been hoping for.

I discovered that while I have enough skill to work on all aspects of the industrial design process, from research, ideation and conceptualization, to prototyping and presenting, I work better with a team mate. Myrte and I formed a strong, motivated team that was able to work and iterate quickly. We had good communication with our coach and client. We received quick and valuable feedback which allowed us to move quicker. This showed me the importance of good communication, something I still had to learn for this semester.

Although I was hesitant about doing the user tests at the expense of available prototyping time, I did appreciate it in the end. The results of the user test strengthened the foundation of our concept, which is something that I will definitely keep on doing.

FUTURE

It is highly likely that I will not pursue my Msc at the faculty of Industrial Design. Currently I am

still considering either Strategic Product Design in Delft, or Innovation Management here in Eindhoven. Therefore, it is hard to say which lessons I learned this semester I will incorporate in my master's education. I will

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APPENDIX

UserTestConsentForm

Project: Tools for Medical Professionals, Sleep Track

Students: Myrte Thoolen, Bram de Vogel

Project Coach: Jun Hu

INTRODUCTION

We are Myrte and Bram, both students Industrial Design (ID) at the University of Technology Eindhoven (TU/e). We are currently working on a "sleep diary" for Kempenhaeghe Sleep Institute as part of the project Tools for Medical Professionals here at the TU/e.

The Sleep Diary is meant for patients under treatment for sleep disorders, in this case insomnia. They will use the Diary to keep track of their sleep. The data generated by the Diary will be used by specialists to better diagnose and treat the patients.

TEST PURPOSE

In this test you will try out various Sleep Diary prototypes. The main purpose is to validate the interaction models of the prototypes. Your participation and feedback will enable us to improve the Diary and our final concept and may eventually aid patients suffering from insomnia.

CONSENT

By signing this document, you agree that your responses and interactions during the test may be monitored and/or recorded. You may be asked for verbal and written feedback throughout the test and you agree that your feedback may be recorded, copied, cited or used otherwise in our project. The test results will be anonymized and anonymously processed and analyzed.

If you have any questions left, do not hesitate to ask them. You may keep a copy of this form and feel free to contact us afterwards.

PARTICIPANT SIGNATURE

MYRTE / BRAM SIGNATURE

Date:

Name:

Signature:

User Test Questionnaire Date: _____ # _____

The test will consist of three parts, wherein you will interact with the various concepts / prototypes. After each part, you will be asked to fill in the relevant part of this questionnaire.

PROTOTYPE 1: RING DIAL

- I immediately understood how the device / interaction worked.
Strongly disagree 0 1 2 3 4 5 Strongly agree
- I was able to fill in my sleep time easily.
Strongly disagree 0 1 2 3 4 5 Strongly agree
- I was able to fill in the time I was awake easily.
Strongly disagree 0 1 2 3 4 5 Strongly agree
- I was able to tweak / correct my sleep time easily.
Strongly disagree 0 1 2 3 4 5 Strongly agree
- The product worked as I expected it to.
Strongly disagree 0 1 2 3 4 5 Strongly agree
- It did not take much effort to complete the task / fill in the Diary.
Strongly disagree 0 1 2 3 4 5 Strongly agree
- I found the overall interaction quick.
Strongly disagree 0 1 2 3 4 5 Strongly agree
- It felt 'right' to fill in the Diary in this way.
Strongly disagree 0 1 2 3 4 5 Strongly agree
- I enjoyed filling in the Diary / using this concept.
Strongly disagree 0 1 2 3 4 5 Strongly agree

Write down a positive and negative aspect of this concept.

Positive:

Negative:

User Test

The test will consist of three parts, wherein you will interact with the various concepts / prototypes. After each part, you will be asked to fill in the relevant part of this questionnaire.

PROTOTYPE 1 (RING) TASKS

- You slept from 23:30–03:00
- You were awake between 03:00–04:30
- You slept from 04:30–07:00
- You made a mistake: you actually were awake from 03:00 – 04:00 and then slept until 07:00.

PROTOTYPE 2 (PINS) TASKS

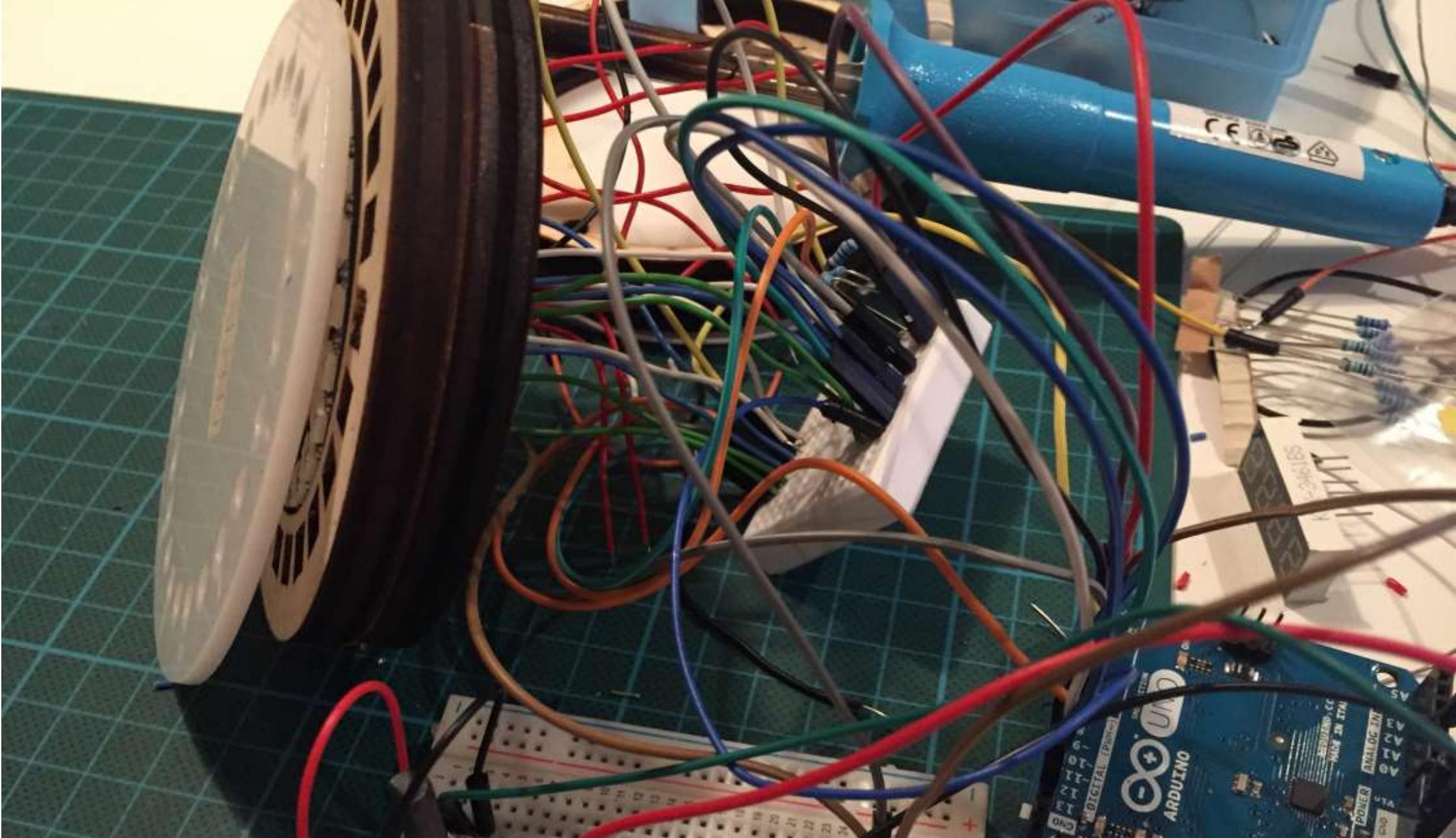
- You slept from 00:00–02:30
- You were awake between 02:30–03:00
- Correct your input: You were awake from 02:30–03:30
- You slept from 03:30 – 08:00.

PROTOTYPE 3 (FLEXIBLE SURFACE) TASKS

- You slept from 00:00–03:00
- Correct your input: you slept from 00:30–03:00
- You were awake between 03:00–04:00
- You slept from 04:00–07:00



TECHNOLOGY
INTEGRATION OF TECHNOLOGY

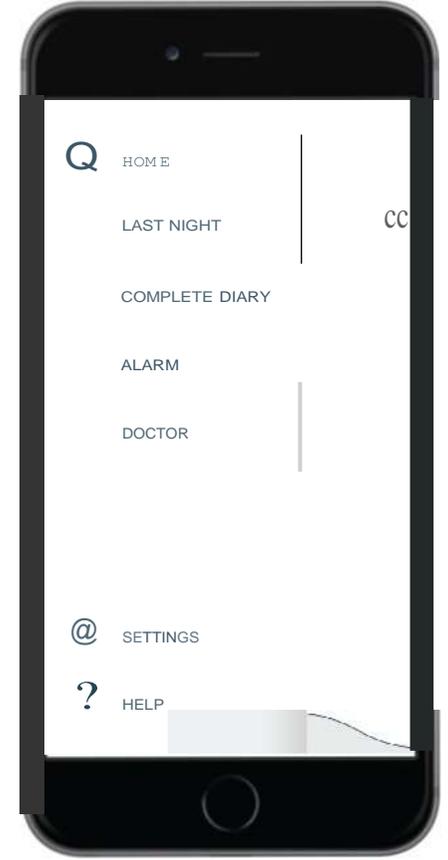
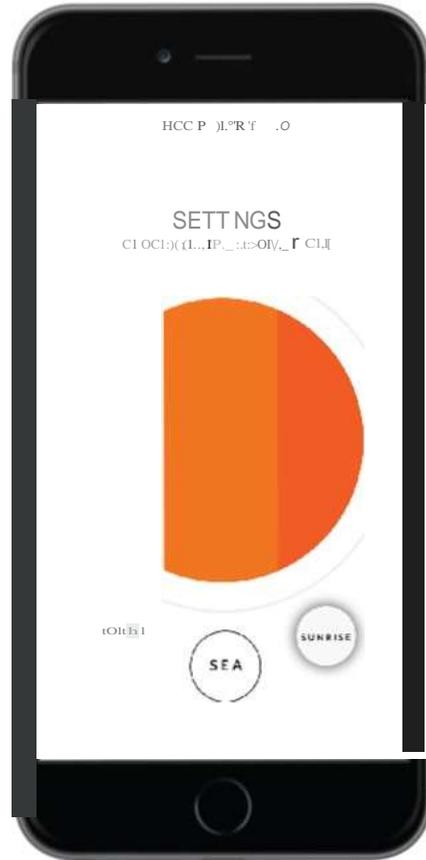


TECHNOLOGY ISSUES

AN OVERLOAD OF WIRES

FINAL MOBILE APPLICATION





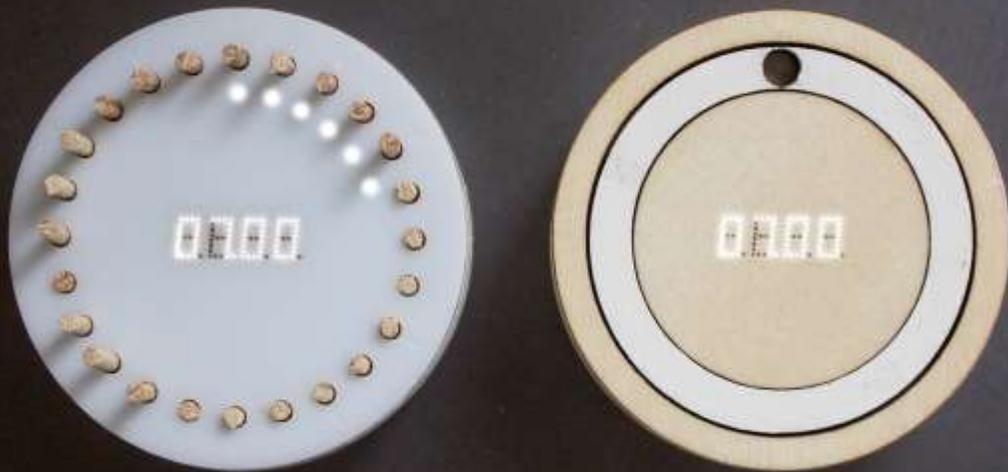
DEMO
DAY
MATERIAL



EVE | SLEEP DIARY 2.0

Sleep clinics like Kempenhaeghe provide their patients with sleep diaries, which they can use to track their sleep. Current sleep diaries consist of A4-sized papers that the patients have to fill in every morning. Those diaries are vital for doctors to understand the sleeping patterns of their patients and provide proper care and treatment. However, patients were often not filling in their diaries properly or accurately. This is largely due because the paper diaries were not engaging, a hassle to fill in.

EVE, the Sleep Diary 2.0, is an improved version that stimulates persistent usage through a fast and engaging experience. A two-fold approach is designed, consisting of a physical product on the nightstand and a mobile app. The physical product is used for fast input each morning, while the app is used for more detailed input.



Department of Industrial Design
Eindhoven University of Technology