Perfect sleep

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Degree Project for Master of Fine Arts in Industrial Design
Lund University School of Industrial Design, Department of Design Sciences
In collaboration with Electrolux Healthy home department

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ABSTRACT

FOREWORD

At the time for the starting point of this master thesis, the Electrolux Healthy Home department where at a high extent looking into how a system of products that could communicate with one another could give the user a better experience in the home. Products that where looked into for coupling where for example an air purifier with a robotic vacuum-cleaner, maybe also coupled with any other product that could give the customer a better experience in the experience area "well-being".

This project aims to investigate how the experience of the future smart home could look like in relation to sleep. What does perfect sleep mean to people and how could Electrolux – with their air and water products – find a system (or product) that could help people sleep as well as possible. What is needed for a perfect night's sleep? The project is investigating the whole experience of sleep, falling asleep, sleeping and waking up from different perspectives but with an emphasise on user needs.

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1. INTRODUCTION

1.1 Background
This thesis is conducted for Electrolux Healthy Home department, with the design director Martin Alexanderson as an external supervisor. Electrolux Healthy Home department consists of Electrolux air and water products; such as air conditioners, air purifiers, dehumidifiers and heat pumps. The majority of the time has been spent in the design department at Electrolux head quarters in Stockholm, where global design is also situated for other departments within Small Appliances (Floor Care) and for Major Appliances (Kitchen, Laundry and Dish Care.)

1.2 Assignment
The assignment and focus for this project has been the concept of "perfect sleep". What does perfect sleep mean for people and how can Electrolux air and water products create a system where these products help people sleep better? What benefits and value can a connected healthy home situation bring to the users of Electrolux air care devices in a sleeping context?

1.3 Goal & Purpose
The objective for Electrolux is to better under-

stand and investigate future opportunities in the area of Healthy Home using smart and/or connected PACS (Products/Accessories/Consumables/Services) in the digital world of IoT. The project is aiming to be a step in supporting the digital transformation and sustainable thinking of Electrolux as a company and brand.

1.4 Research objective
The research for this thesis has been focused around these objectives:

- What does perfect sleep mean?
- What parameters (environmental & individual) affect your sleep?
- What can IoT and personalization bring in form of value to the sleep situation?
- What products do we use which affects our sleep?
- How does other smart home solutions work?
- How do want the interaction to be with our smart home products?
- Which products should be a part of an ecosystem created to provide perfect sleep?
- What stories of human behaviour, needs, desires & aspirations can we build this system around?

Eco System
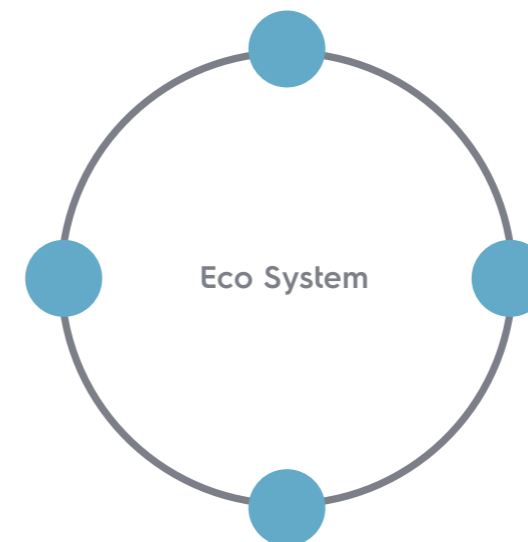
1.5 Methodology
The thesis is conducted with a research phase, ideation phase, synthesis phase and a development phase. The research phase started with understanding Electrolux as a brand and the strategic direction for the future, focusing on Electrolux Healthy home and the projects that have been done in the area of connectivity and sleep. Time was also spent understanding the target group for Electrolux Healthy Home, framed from a persona and different consumer benefit areas.
Desktop research was done looking into sleep from a general but mostly from an indoor environmental context, also drawing from research conducted or ordered by Electrolux. An analysis on current and future shifts and trends was conducted with the help of desktop research and trend report material retrieved from Sofia Andreasson, Trends Researcher at Electrolux. A market analysis was conducted from a broad perspective, looking at different type of products with the promise of improving sleep. Some sleep measuring products was tested in order to get a better understanding of their function. Some market research was also done in the area of smart homes, to get an understanding of the most promising technology for tomorrow and what is being used today. The research phase was used to start building concept and laying a foundation for a deeper look into different target groups. To build concepts a questionnaire was sent out to employees at Electrolux and consumer insights material provided from Mathilda Velevska, Insight For Consumer Experience Manager at Electrolux, was drawn from. Interviews with children's families and a children's doctors was also conducted. Prose scenarios were fabricated from these investigations, based on the Electrolux consumer benefit areas but circled into more defined users. Some concepts were combined into a final conceptual scenario, and a product family with a supporting application was developed in order to visualize the concept. To develop the physical product and the application some user testing and scenario acting was conducted.

RESEARCH QUESTION

How might we improve the sleep experience
through a digital and connected home?

2. INTRODUCING ELECTROLUX HEALTHY HOME

> *Electrolux is a global leader in household appliances and appliances for professional use, selling more than 50 million products to customers in more than 150 markets every year.*
> *The company focuses on innovations that are thoughtfully designed, based on extensive consumer insight, to meet the real needs of consumers and professionals.*
> *The Electrolux Purpose is to make a positive, everyday difference in people's lives and for our planet. It's a natural extension of their vision to be the best appliance company in the world, in the eyes of our customers, employees and shareholders.*
> *Electrolux healthy home department wants to promote health and well-being and make life easier for people. As a company we want to give people opportunities for more fulfilling lives by empowering them and also lead the way in sustainable living.*

Martin Alexanderson, 2017

PURPOSE
Calm & Uplifted
Alert & Dynamic

PEACE OF MIND

**Perfect Comfort
My Sanctuary**

PROTECTION

Healthy for Life
Healthy Happy Kids

2.1 Product portfolio

Electrolux Healthy Home department consist of air and water products for the consumer market such as air conditioners, air purifiers, dehumidifiers and heat pumps. Besides from households the products are also sold to hotels and offices.

Home care is a rapidly growing product category within Electrolux and now holds an 11% share of the group sales. The growth is primarily driven by a higher demand in emerging markets.
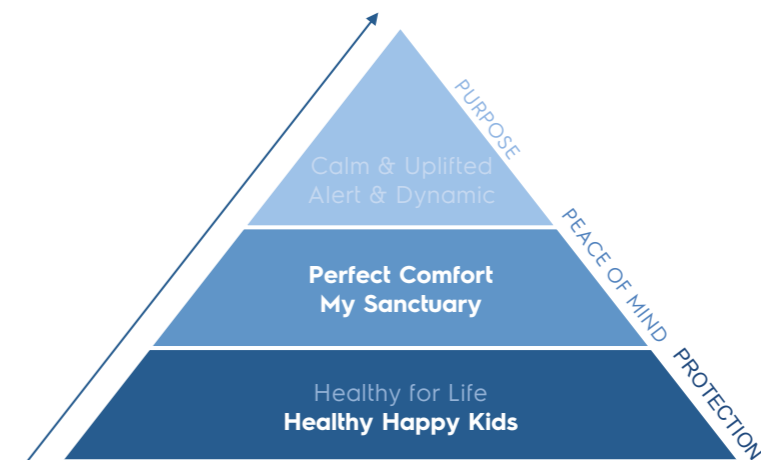
2.2 Strategic direction

The digital universe is growing and is estimated to have expanded to ten times the size in 2020 compared to 2013 measured in zettabytes (Life in 2050 – Megatrends shape our future, Dr. Ulrich Eberl, Siemens).
It is safe to say that digital is changing our world and Electrolux needs to change with it.
Internet of Things and connectivity are enablers that can help create more meaningful experiences within the homes and we already now see how "smart home" solutions are getting more and more accessible for the end consumer. Electrolux wants to focus on the full experience rather than the traditional product categories in order to follow these shifting mind-set and behaviours. (Simon Bradford, Design VP at Electrolux, 2017).

2.3 Consumer benefit areas

Within the Electrolux healthy home department there are different CBA's, consumer benefit areas. Consumer benefit areas represent the high-level benefits for a specific innovation focus area that Electrolux can deliver to customers. They are based on consumer insights and are created to address the needs of the consumers. They should provide focus and purpose for both long and short-term innovation pipeline and help to evaluate and prioritize their plan for new products, solutions, technologies and stories. The 3 consumer benefit areas that Electrolux is focusing on are: Healthy happy kids, Perfect comfort and My sanctuary. Healthy happy kids are focusing on the kids as the end consumer, but with the parents as buyers. Health and safety are inevitably very important in the kid's room, ensuring that the air quality is good during sleep and play. The perfect comfort benefit area is focusing on effortlessness and balance, the users should be able to be focusing on what matters the most and not have to care about the air quality and climate. It should just be right and not disturb the day-to-day life. The perfect sanctuary CBA is focusing on the feeling of the pure and clean home. Coming home should make you feel relaxed, knowing that the home environment is comfortably calm and refreshing. Your home should be an oasis in the city and make you feel connected with nature.

2.4 Persona

The Electrolux Design Group has one common persona that is being used to create a common and broad target for the different departments. The Electrolux persona is a self-reliant individual, living in a big city, who knows what she wants and loves to try new things. She cares about the aesthetics of her home and chooses products that are flexible and that helps her doing things in her own way. She is digitally confident and likes to explore new things. A balanced lifestyle for her is as much about the body as it is about the mind.

2.5 Demographics

Displayed on the map are some of the emerging markets for Electrolux Healthy Home. The cities displayed on the map are New York (USA), Sao Paolo (Brazil), Milan (Italy), Dubai (United Arab Emirates), Shanghai (China), Seoul (South Korea) and Tokyo (Japan). 88% of the consumers today are living in big cities. 91% are living in partnership and 57% are living in houses.

3. SLEEP

People spend one-third of their life sleeping, 12-14 h/day during infancy and 7-8 h/day during adulthood. Sleep is a very important factor for overall health and well-being, but it is usually a random experience with little control or understanding about the importance of surrounding conditions. Sleep in itself is complex and can be hard to directly measure. In the definition of quality of sleep you separate the restfulness and continuity of sleep from how fast you are able to go to sleep (sleep onset latency). Yet the factors affecting these are strongly linked. There is also a big difference between quality of sleep and duration since they do not necessarily have to be linked.

LIGHT   SMELL   NOISE   TEMP   AIR   HUMIDITY
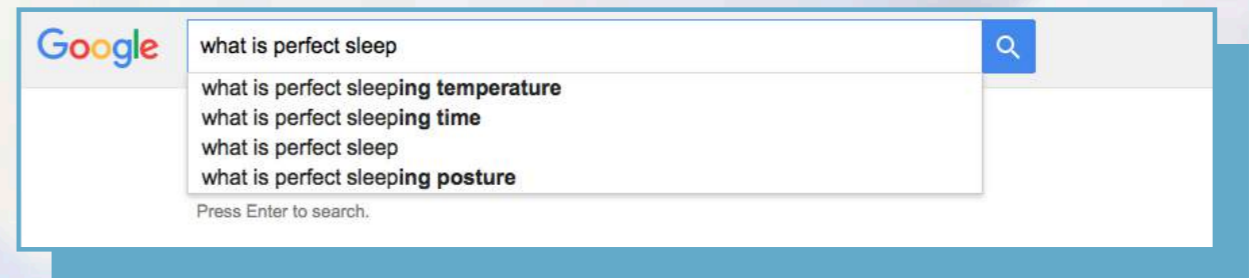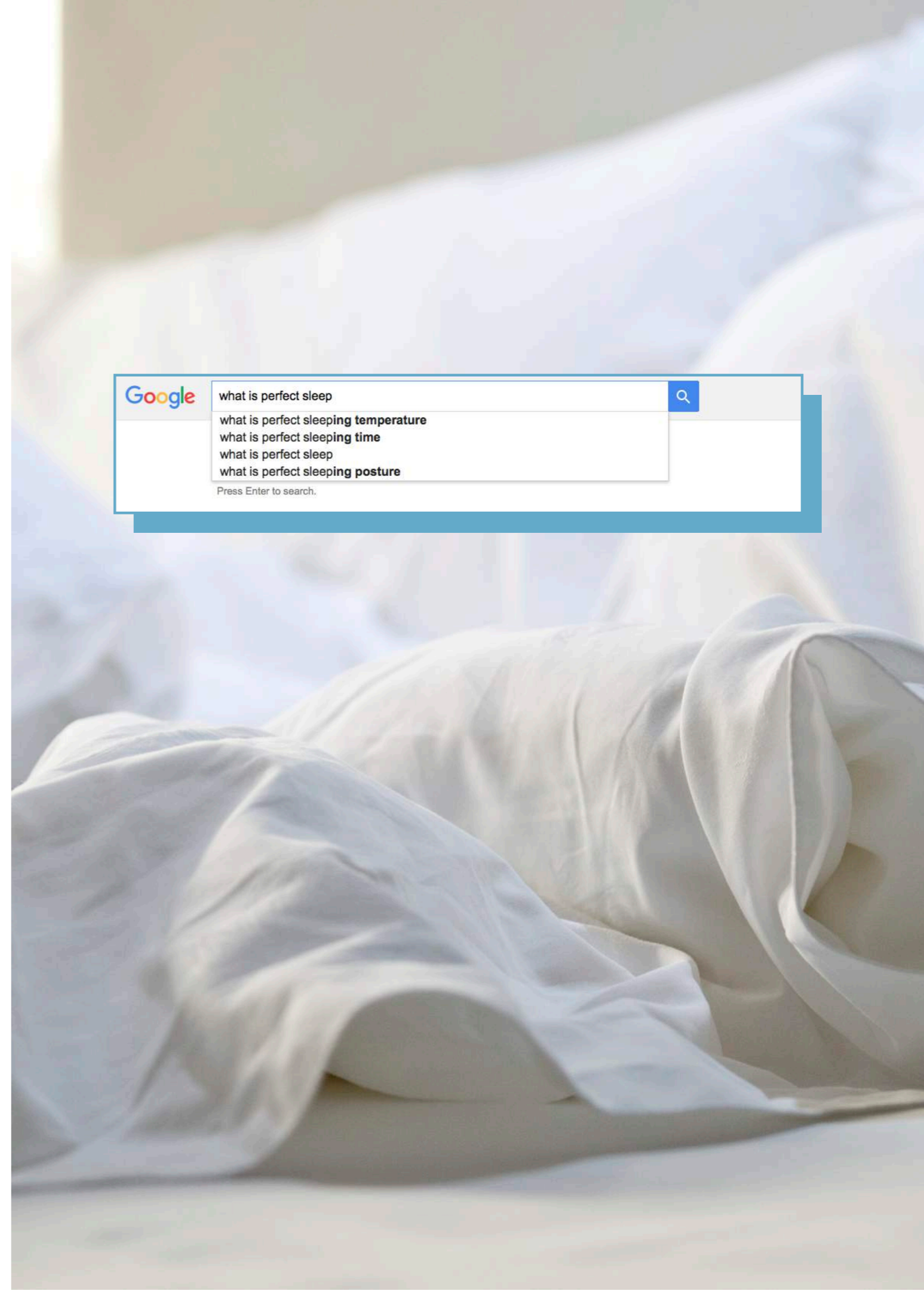
3.1 Sleep environment

The environment in the room you sleep in at night has a big impact on your sleep quality. The primary factors that are measurable are temperature, humidity, air composition, pollution, light, smell and noise. Temperature & humidity. Regarding temperature, there is no single best temperature/humidity combination since of the influence of bed, mattress and clothing design as well as cultural differences. Insulation and ventilation in the room also needs to be taken into consideration when looking at temperature. Thermal zones can be defined but needs to take these factors into considerations. In general, ambient temperature shows no negative effect on sleep quality at 22.5-25°C when sleeping covered and 28-32°C when uncovered. Humidity also affects the body's experience of temperature; changes from 0% to 100% humidity can vary the thermal comfort zones by 1.5°C. Therefore we cannot define one single best temperature for sleep. Furthermore, different populations have different preferences, when acclimatized to hot conditions the population prefer higher ambient temperatures than colder countries. One

study also found that women prefer a slightly warmer room (average of 3°C). Dampness is found to have a negative impact on sleep, maybe due to the mould growth causing irritations in the airways, or microbial VOCs. (S. Norman et. al, Sagentia, December 2016 – January 2017)
There is evidence that changing temperature across the course of the night can assist in good quality of sleep – a "fall-rise" ambient temperature linked to measurement of the body temperature. Mostly for avoiding waking up in the middle of the night drowned in sweat, due to either ambient changes or personal parameters such as hormones, sickness etc.
Also heating up the feet before bed promotes the fast onset of sleep. This is due to that the body needs to drop down in temperature before sleep, a heat loss that mostly is achieved through the extremities hands and feet. If these are too cold it's hard to drop down in temperature, since the temperature is deciding the degree of dilation of the blood vessels. The temperature, or more specific the degree of dilation of the blood vessels in the skin of the hands and feet, is therefore the

best physiological predictor for the rapid onset of sleep. (K. Kräuchi et. Al. 1999)

Air composition & pollution: As it comes to air composition and pollution factors as co2, high levels of VOCs (especially fungal or microbial) show correlation with poor sleep. In some studies with children, particulate pollution lowers sleep quality due to increased snoring. In adults snoring are more strongly associated with illnesses and personal physiology than indoor air quality factors. Other important external factors that impact snoring include road noise and levels of nitrogen dioxide.
Strong links have been found between worsening of quality of sleep during times of peak particle pollution. This is evidenced mostly since of the lowering quality of breathing linked to particulates, most strongly affecting asthmatics. Good ventilation and air velocity is strongly linked to good sleep, sleeping with an open window might although bring other issues causing bad sleep. Factors coming from the outside such as noise, pollution and pollen limit many people from

sleeping with an open window.

Noise and sound: The National sleep Foundation (in the United States) recommends noise levels below 40 dBa. In studies participants find it very hard to achieve sleep when levels are above 70 dBa. Studies have also showed that there is little to no acclimatization when sleeping in a noisy environment, meaning that the negative effects are constant and not declining after a while.
The use of white noise when sleeping is popular among some people. Either using a small fan with the sole purpose of generating that ambient noise, or buying a more advanced sound machine with a range of white to pink and also brown noise. You might not be aware of the disturbance of your sleep caused by a sound since going from deep to light or even to a state of wakefulness is usually not remembered the next day. (Harlid, 2017).

The most important thing regarding sleep is just to give yourself enough of it

To monitor your sleep can bring a lot of stress to the patient
Somebody who actually slept fine can get a harder time sleeping if the app tells you that you did not get enough of deep sleep for example.

- Richard Harlid,
specialist within sleep medicine, Aleris

3.2 Personal factors

Other than the environmental parameters that can be found and measured in the room is the parameters relating to the person and their physical and mental state.
Stress, depression and pain related diseases are a factor that is strongly related to poor sleep, insomnia and restlessness. (L. Mallon et. al., 2014)
Other factors that are strongly linked to sleep are alcohol and caffeine intake, food intake in general and how active your lifestyle is. Also the time you exercise during the day has an effect on your sleep. So your lifestyle in general has a big impact on your sleep quality and is possible to

change; however we are all also born with different prerequisites.
These prerequisites can be both physical (for example if your nostril canals are shaped in a way that makes you snore) and mental (how prone you are for worrying and causing sleepless nights). It is also personal how many hours of sleep you need per night and some people do not sleep any REM-sleep (Harlid, 2017). Eight hours of sleep per night is a good "thumb rule" but research can not pinpoint the exact amount of sleep needed for different age groups. (National Sleep Foundation, 2017).

3.2 The sleep cycle

Our sleep consists of different phases that are looped throughout the night. The moment we fall asleep we are in the lightest stage of sleep - NREM1 - and are then most likely to be woken up by a disturbance in the surrounding environment. This disturbance could for example be a noise but even a change of smell can bring you to a woken stage. The brain is actively seeking changes in the surroundings, a mere survival mechanism inherited from our ancestors. The second stage is NREM2, a lighter form of sleep, followed by NREM3, what we usually refer to as deep sleep. During the last stage, NREM3, we are least likely to be woken up by a disturbance in the surroundings. However a disturbance can make us go from deep to light or even a state of wakefulness without us remembering this in the morning. During the cycle some of us also go

into REM (Rapid Eye Movement) sleep, known as the dream stage of sleep. Although some people can't get any REM sleep, they are usually as alert as others but get a declined learning ability (Harlid, 2017).
Each cycle lasts for about 90 minutes and you should pass through about 5-6 of them during a night. But the cycles are not constant, as we go through the night the time we spend in the different stages begin to shift. Normally we tend to spend more time in REM sleep during the last cycles of the night. But whether we get more or less of NREM or REM sleep also seem to be affected on the actual time, independent on what time you went to bed. This means that the ones going to bed later in the evening are more likely to get more REM sleep than the ones going to bed early.

NREM1 – *falling asleep*
NREM2 – *light sleep*
NREM3 – *deep sleep*
REM – *rapid eye movement*

3.3 Measuring sleep

You can measure sleep in different ways. The most reliable methods usually involve measuring brain activity (EEG), eye movements (EOG), heart rhythm (ECG) and additional measure such as pulse oximetry. This complex and expensive method is called Polysomnography and also usually involves over 22 electrodes, making the study quite invasive. Actigraphy is a more low-cost alternative usually worn as a watch-like device, for example "Fitbit". These devices are useful for studying how fast you are able to go to sleep and how many hours you spend in bed, but struggle to differentiate between the different stages of sleep due to the lower quality of the

information collected.
For a more holistic study you can also measure factors in the bedroom environment. Sensors can be used to measure light, ambient temperature, noise, motion and air quality. If the sensors are embedded in the mattress surface they can also measure body temperature and position/body movements.

The Aura by Withings is an example of a product that uses an additional strap with embedded sensors that you put under your matrass. This is an un-invasive way of getting breathing and heart-rate data to get a better reading of sleep.

4. TREND RESEARCH

4.1 Society

Looking at the future society we will see a further development of the urbanisation, globalisation and due to this an increase of pollution and climate change. More and more people will live in cities, therefore noise will be a bigger issue then before. We will also live more collectively and/or more compact due to the lack of space. We will also see a demographic change where the population is aging. The digital transformation will of course have a big impact on our lives and society as a whole. Are we seeing a counter reaction to this state of always connected and the stress it brings us?

4.2 Behaviour

Boredom: In the WGSN lifestyle futures report from 2016 the concept of boredom is explored, from a benefit perspective and how it is trending. According to the article, people in this connected world are more boredom-prone these days. Research also suggests that we should welcome boredom rather than banishing it through connectivity. For example, a 2013 study from the University of Lancashire found that boredom leads to increased creativity. We need to bring in downtime to increase our uptime. If we never reset our brains, just like computers they will fill up with stuff, until they start running slower and slower. However – today we are using tech to save ourselves from boredom. At the moment we wake up, we reach for our phones. We stare down our screen on our daily commute and scroll through Facebook before we sleep. As the article states: "When the International Center for Media & the Public Agenda asked 1,000 students in 10 countries to go unplugged for the day, more than half gave up within the first two hours. In a UK study, 18 of 42 people chose to give themselves electric shocks rather than sit in solitude for 15 minutes." This is not only suggesting how tech is killing boredom, but also how intolerant we have become of it. With researchers and experts telling us how important downtime is for our brains to function properly, we can see a shift happening. As writer Ana Veciana-Suarez puts it: "…(boredom) as the catalyst to creativity, as the pathway to invention, as proof that slowing time and delaying duty is a luxury in a hyper-connected world." In art and design we can also see this trend growing. For example, in 2014 and

again later in 2016, the conceptual artist Marina Abramovic set up installations that required visitors to sit at a table and count rice for hours on end. The podcast "Sleep with me" is another example of a concept solely built on being boring that has gained a lot of popularity, ranked as one of the top 50 most popular podcasts. The reaction can also be seen in the design of tech, where products act as a reaction against machines with too many options.

Self-improvement: big data, smart tech and different smart home solutions are all enablers for tracking and following your overall health and well-being. In a Stylus macro trend report – "Product Rhythms" – published in may 2016, it is stated that consumers are seeking out to enhance their well-being in multiple ways. Through stimulating energy and flow, encouraging disconnection and helping them better their performance. An example of this is energized experiences, where devices that make tasks seem less complicated and distraction-free energize the user and enhance their sense of flow. Another example is tools for detachment, where technology is being used to achieve digital downtime. The third example is 360-degree monitors, where connected devices and the Internet of things are turning smart homes and cars into doctors, monitoring our health and vital signs. The view of health in the business of tech is also becoming more holistic or "360-degree", where emotional factors rather than just physical is getting an upswing.

4.2 Technology

In the recent years we have seen a big progression of health-tech to help you monitor and track your physical activity, diet and sleep.

Behavioural nudge – By monitoring daily routines devices of today and the future can understand behavioural patterns and compare it to personal goals. By prompting and making giving suggestions at the right moment devices can help the user to make better decisions and hopefully contribute in a better physical and emotional well-being.

Emotional response – Artificial Intelligence is getting smarter and smarter and is learning to spot the users feelings by determining the tone of voice. Other technologies like face trackers can also read users expressions and determinate emotions. By assessing the

users emotions devices of the future can bring relevant content suited to the situation. Over time devices can by these tracking methods learn about the users personality and then personalize the interaction by its own machine learning

abilities.

Contextual experience – By using information as location, time, previous behaviour and weather, internet-enabled devices can deliver more appropriate experiences.

Adaptive machines – By using smart algorithms, large data sets and connected devices the individual devices within an home eco-system can share data around user behaviour and collaborate towards more efficient operations.

Shared Awareness – individual data can be used to enable a seamless flow of communication between people. This opens up towards a more integrated world but also a more connected family.

Programmable Lifestyle – Sites like IFTTT today makes it possible to customize how your devices act when certain scenarios occurs. Devices are also able to choreograph their work together based on our specific needs.

Open Source Access – Systems are getting connected and information access is democratized.
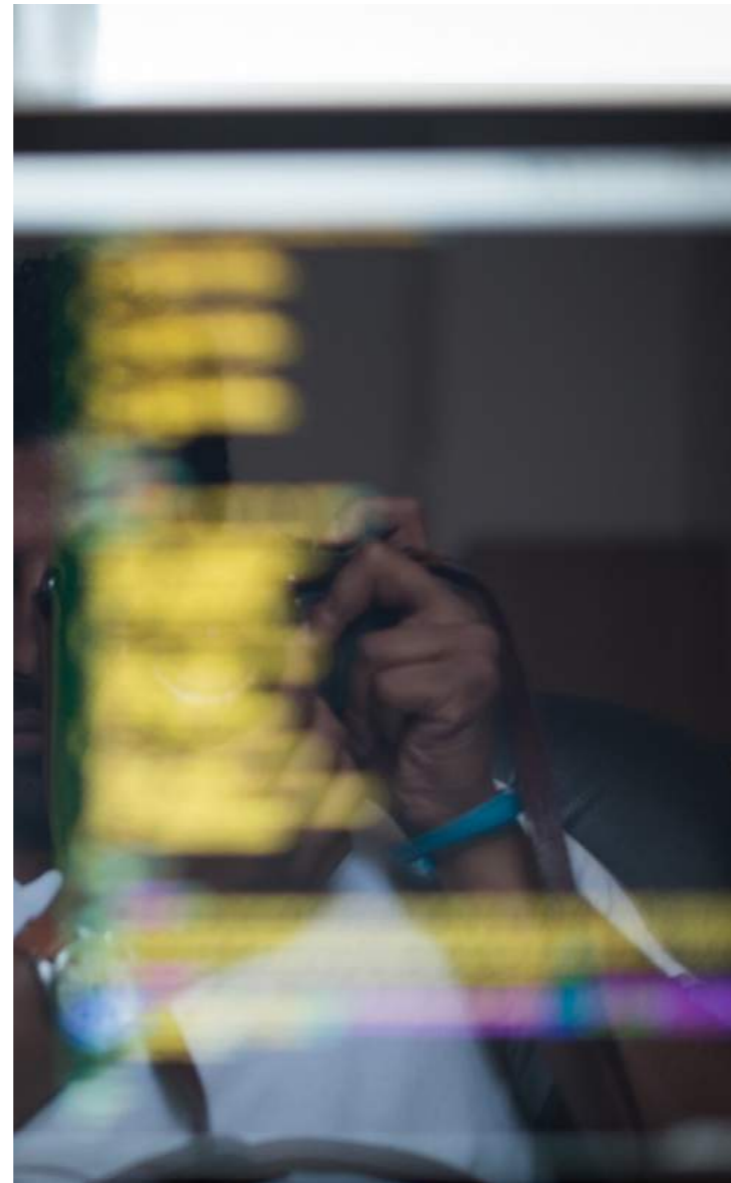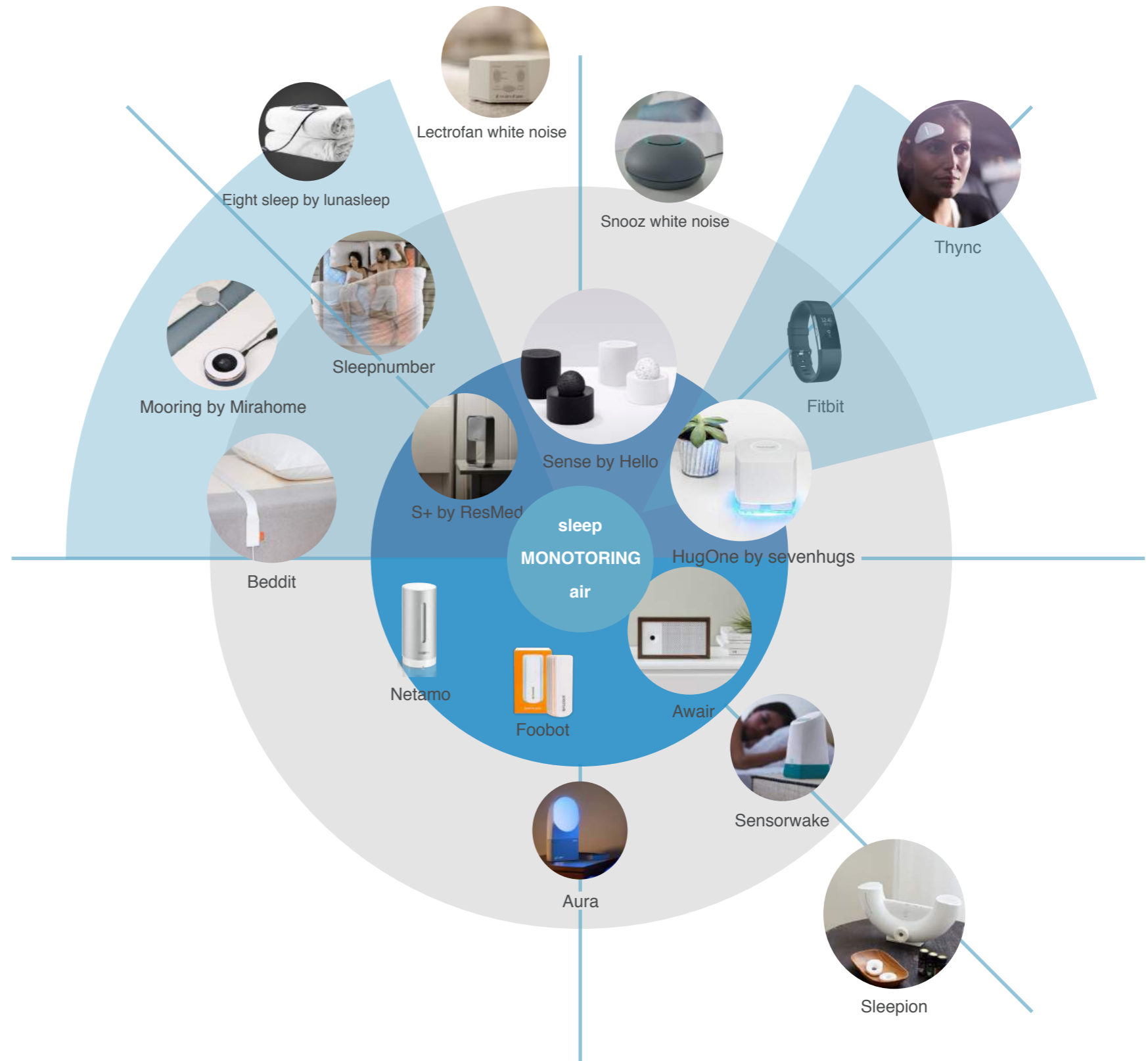
BOREDOM
BRING IN DOWNTIME TO ACHIEVE UPTIME

Counting rice, installation by the
conceptual artist Marina Abramovic, 2014

5. MARKET ANALYSIS

5.1 The sleep economy

A market analysis was conducted to better understand what is being used today to improve sleep. The products that were found were analysed according to whether they measured both sleep and air and which senses they where enhancing. It was found that the products measuring air and sleep all needed to be paired up with your phone. The S+ by Resmed for example needs to be paired up with your phone throughout the night, and you need to use your phone to control it. Some of the products also got bad reviews concerning a confusing interface that were giving more information than needed (mostly concerning the sleep data from the application). The devices are mostly measuring sleep through actigraphy (motion), the Aura by Withings is an example of a product that uses an additional strap with embedded sensors that you put under your mattress. This is an non-invasive way of getting breathing and heart-rate data to get a better reading of sleep. This band is however not measuring your own body temperature which would be interesting in an ecosystem of Electrolux air care products. Sense by hello is only using actigraphy, movement analysis, with the help of an addition device that clips on to your pillow. The S+ by Resmed measures movements using ultra low power radio waves, a more advanced technology that picks up on both movement and breathing.

Lectrofan white noise

Eight sleep by lunasleep

Snooz white noise

Thync

Sleepnumber

Mooring by Mirahome

Fitbit

Sense by Hello

S+ by ResMed

sleep MONOTORING air

HugOne by sevenhugs

Beddit

Netamo

Awair

Foobot

Sensorwake

Aura

Sleepion

5.3 Smart home solutions

More and more things around us are getting smart. By smart we mean that they are able to speak to other devices and that they are internet enabled. But this does not per say mean that they are smart though. What is needed to be focused on regarding this new market segment is the value they bring to the user - the experience. To the right some examples of smart home prod-

ucts are displayed. Voice are currently and predicted to continue to lead regarding controlling of the smart home, biggest on the market are now *Google Home* and *Amazons Alexa. Sonos speakers* are an example of a popular smart speaker. *Philips hue* has long led the market regarding smart lights but are recently getting competition from *IKEA*'s smart lights "trådfri".
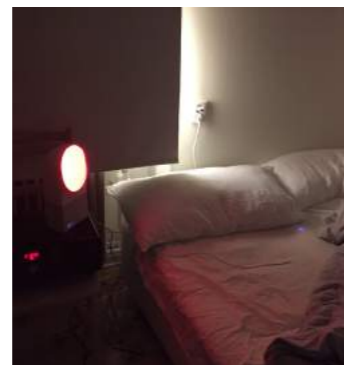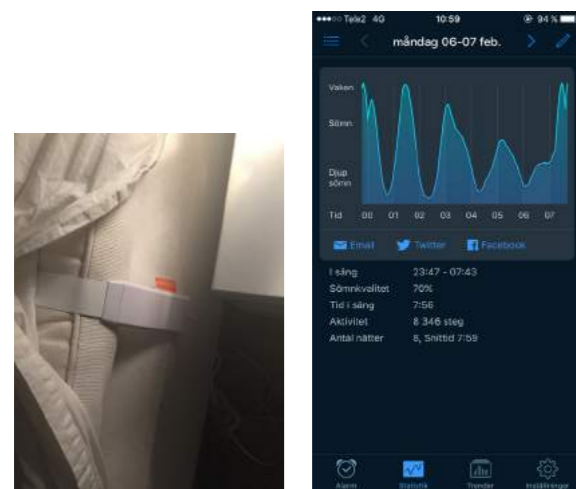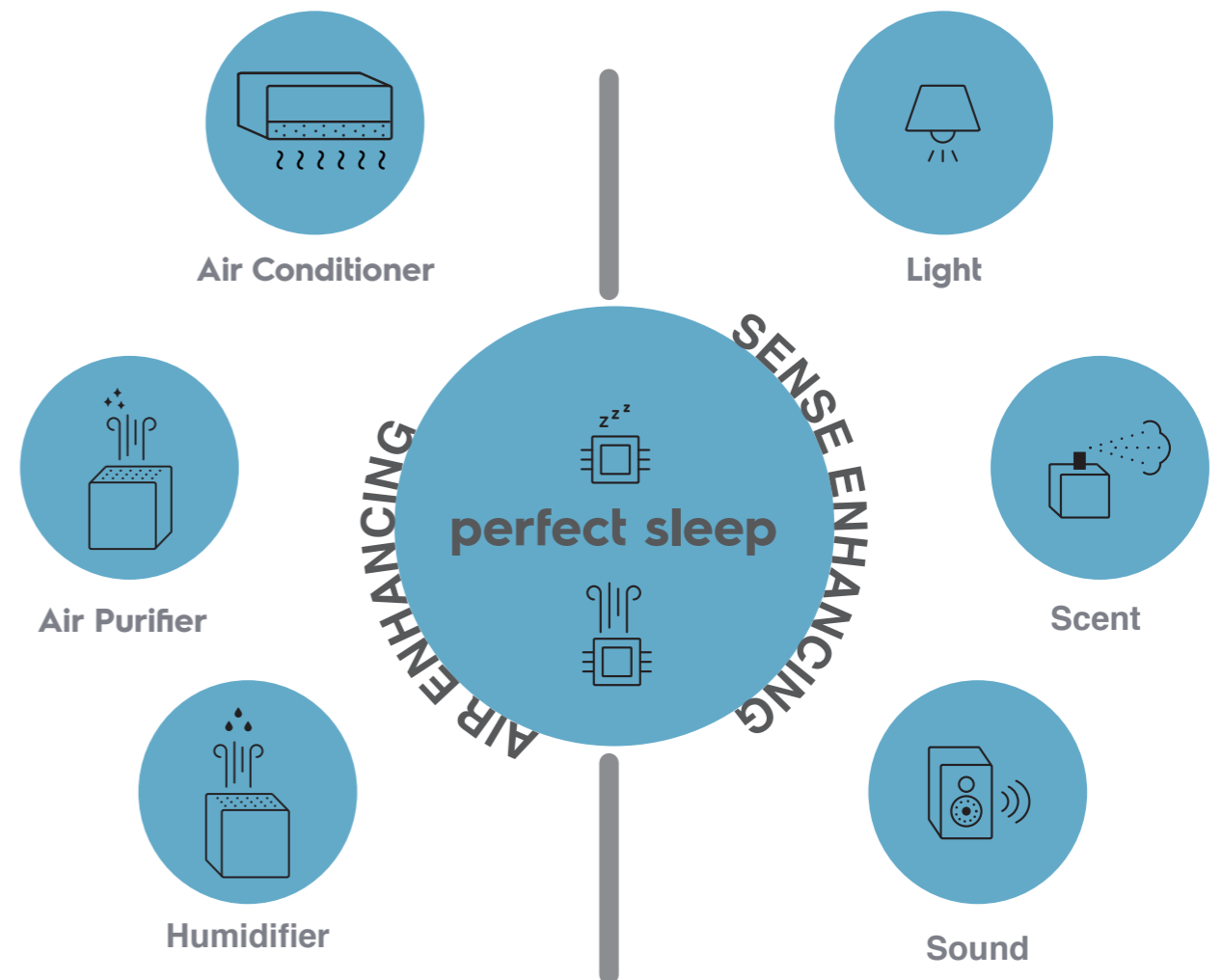

5.2 Testing of sleep products

During the project some sleep products where tested. Lectrofan, a white noise machine, where tested during a longer period of time to test the benefits of sleeping with controlled white noise. The noise functioned well for relaxing but a more advanced test would be necessary to review the "drowning-effect" it might have had on other

disturbing noise in the environment.
The app Sleep Cycle where tested to get readings of sleep. Aura by Withings where tested regarding the comfort of the strap that goes under your sheets and Beddit where also tested to get sleep readings.

6. SYNTHESIS

6.1 The ecosystem of perfect sleep

After conducting research on sleep and the controllable environmental factors affecting sleep, the insights was concluded into an ecosystem for perfect sleep. In the middle of the system are the sensing of sleep and air parameters, enabling a reactive system towards the ambient environment and the personal factors of the user. To the right in the system are the air enhancing devices, provided by Electrolux, in this project focused on the air purifier, air conditioner and humidifier. These products could of course be interchangeable dependent of the geographical/environmental need of the user. To the right in the system are the sense enhancing parameters, being light, scent and sound. These parameters could be created in different ways and with the help of different products – all dependent on the individual need and preferences of the user. The sound in this ecosystem could for example be created with a white noise machine, a speaker or a smart phone. The enabler in this scenario is that the products should be Wi-Fi combatable, in order to link the ecosystem together. However these products – on the sense enhancing side – doesn't have to be provided by Electrolux.

6.2 Brain mapping

In order to start thinking about concept and to structure the findings, a brain mapping was conducted and structured into objectives and hypotheses. The objectives – being questions and knowledge gaps – where structured under who, what, when, where, why and how. A question could for example be "how would people like to interact with the system?" and the goal would for that be "to understand the current possibilities within technology and how a desired interface might look like". The hypotheses are assumptions that where made so far in the project, and they where structured under attitude, behaviour and feature related hypothesis. A hypothesis under the behaviour related category could for example be that "most people use their phones

as alarm clocks."
The research method of formulating objectives and hypotheses was performed in order to gain insight about what further research needed to be conducted in the project.
In a classic user research method process the objectives and hypothesis should then be followed by methods (how do we plan to fill the gaps in the research), conduct (gather this data), and synthesise (to answer the research question and to prove or disprove the hypothesis). However, since my research question still was very broad in at this stage, I jumped straight into concept generation in order to narrow the project down and to make some demarcations.

6.3 Concept generation

From the hypotheses formulated in the previous step, design ideas and concepts were developed. Inspiration was also drawn from previous research and the environmental controllable factors that were found; being light, smell, noise, temperature, air and humidity.
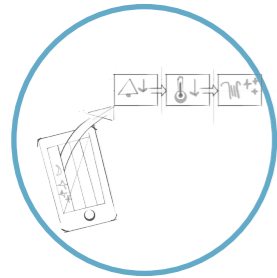
6.3.1 Perfect sleep mode
The "perfect sleep mode" concept is concentrated to an application on your smartphone. The application is a collection of "modes" where you can compose your home environment. Other modes that the user would create could be "dinner mode", "movie night" or maybe "evening reading". Under each mode you can set up different factors such as temperature, light and smell. When a certain ambience is needed you can create these modes through a push of a button in the interface.
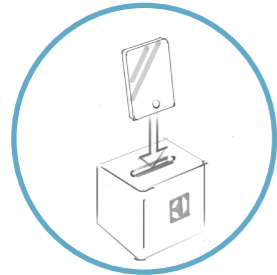
6.3.2 Tech-free zone
The "tech-free zone" concept is inspired by the "late night scrolling" behaviour. What if the controlling hub for your smart home system also could act as a "safety box" for your smart phone, protecting you from radiation and help you to hide away from any distraction.
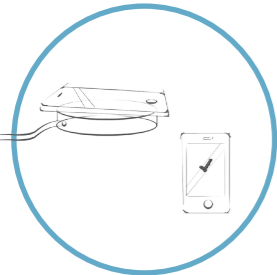
6.3.3 No phone checkpoint
The "checkpoint could help teenagers "lay off" their smartphone in the bedroom and help the parents feel in control. The checkpoint would act as a touch point to distance the user from the smart phone.
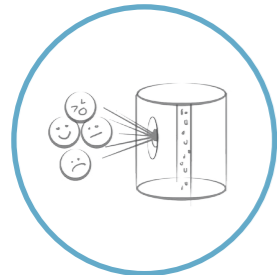
6.3.4 Mood relevant wake-up experience
This concept is playing with the idea of using facial expression recognition technology in order to detect the morning mood of the user and by that adapt the course of actions the system sets in. The user could configure the different modes so that a "feeling recognition" could be followed by your preferred ambience/course of action (sound, temperature, light, extra strong coffee etc.)
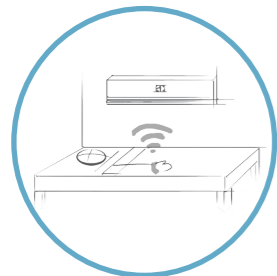
6.3.5 Adaptive temperature
This concept is retrieved from a concept generated at an Electrolux hackathon (Product Council September 2016). The idea is to measure the body temperature of the user continuously in order to be able to create a reactive system with the air conditioner in the bedroom.

6.3.6 Scent pods
Scent pods could be sold as a consumable to either an air purifier or a humidifier. The scent pods could have different scents for different modes/preferences, as for example eucalyptus scent in order to help open the airways for an allergic individual.
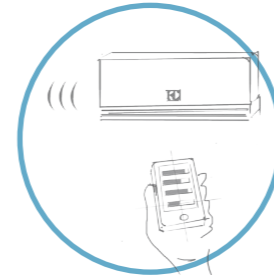
6.3.7 Adaptive AC sounds for sleep
During the research phase sound and colour of sound was explored in relation to sleep. Colour of noise refers to the power spectrum of the noise signal, and especially white, brown and pink noise have been found to function as an inducer for sleep and act as a "cushion" for other incoming disruptive noise. Since an air conditioner already is emissive of noise, this concept is building on the idea of making that noise customizable.
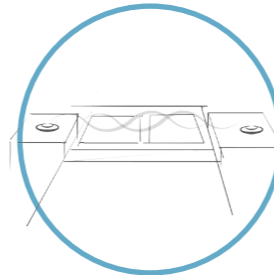
6.3.8 Active noise cancellation
This concept is instead looking at sound as a negative factor in the environment – classing it as noise – and exploring how it could be eliminated. Active noise cancellation is a technology on the rise, where a lot of research is being developed and where we already see implementations. By recording and analysing the incoming disruptive noise, a counter noise (the exact same waves but reversed) can be produced and eliminate the disruptive noise. This could ensure the user of a totally quiet sleep zone – a sanctuary for sleep.
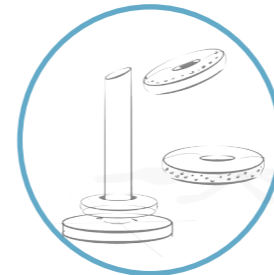
6.3.9 Modular sleep kit
The modular sleep kit is pressing the boundaries for what an air-enhancing product could be. Could an air conditioner or an air purifier be portal? Could the bed zone be cut off from the rest of the environment (like a tent), paving for a smaller and more localized air-enhancing kit?
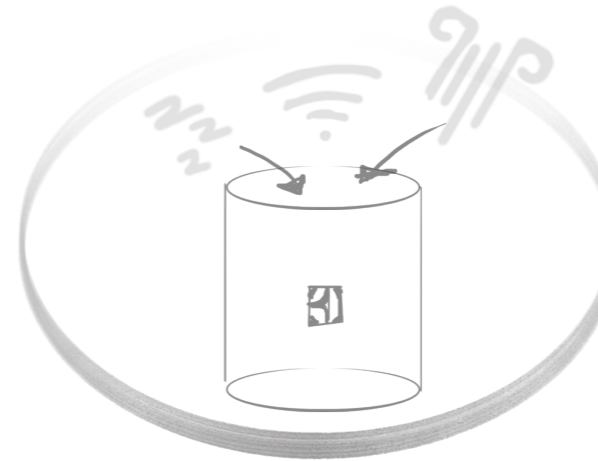
6.3.10 Measuring sleep and air
This concept is focusing on the bedroom hub for the system. How would the user like to interact with the system? What should be measured? What consumer benefits could be created when connecting the sleep cycle with the ambient environment and the air parameters in the bedroom?

6.4 Choice of concept

After generating a series of concepts an evaluation was done in order to make further demarcations for the project. The concepts where evaluated after the level of innovation, how relevant they where for Electrolux as a company and finally also from a personal view – where I could contribute as a designer. The choice landed on concept nr 6.3.10, measuring sleep and air. This concept felt most relevant for Electrolux and here I could also continue to look at concept 6.3.2 tech-free zone and concept 6.3.5 adaptive temperature.
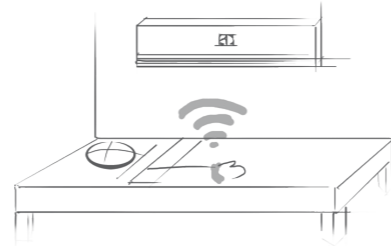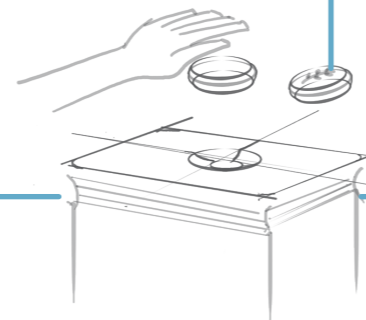
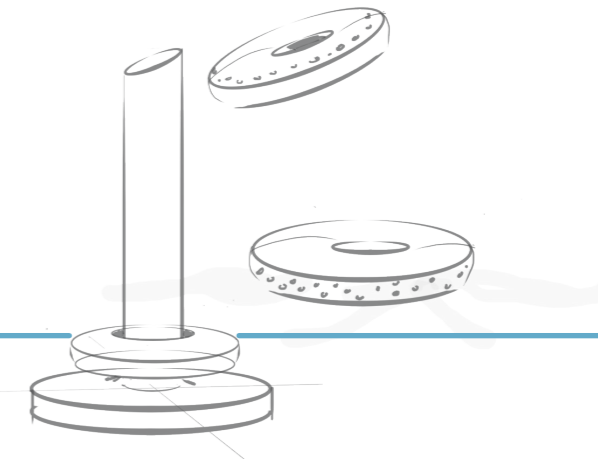**RELEVANT FOR ELECTROLUX**

6.3.10 Measuring sleep and air
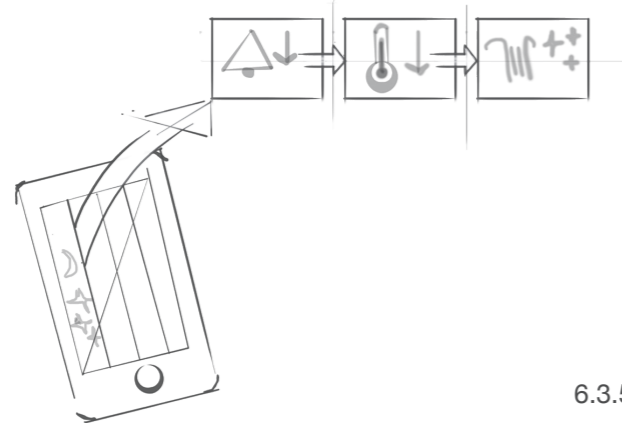
6.3.1 Perfect sleep mode

6.3.5 Adaptive temperature

NOT INNOVATIVE

INNOVATIVE
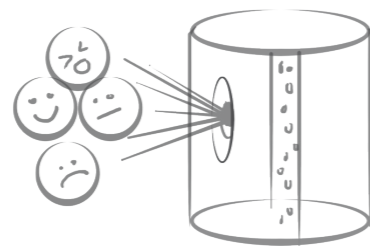
6.3.3 No phone checkpoint

6.3.6 Scent pods

6.3.9 Modular sleep kit
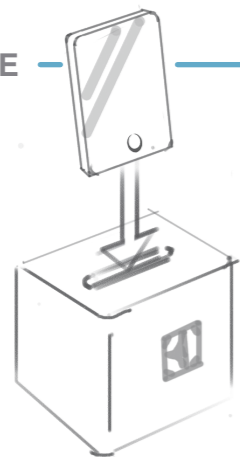
6.3.2 Tech-free zone

6.3.4 Mood relevant wake-up experience

6.3.7 Adaptive AC sounds for sleep
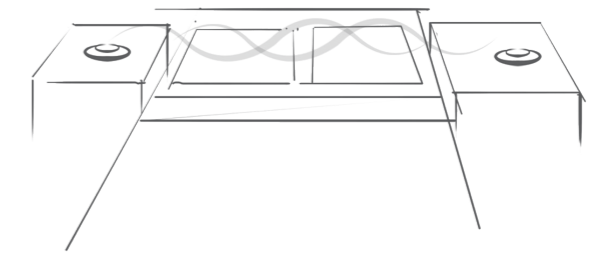
6.3.8 Active noise cancellation

IRRELEVANT FOR ELECTROLUX

BRIEF

Create an ecosystem for measuring air and sleep
in order to better control the air / temperature
along with the sleep experience in the bedroom.

Motivation

⊹ **By creating an system for measuring air and sleep the
possibility to connect existing Electrolux air products
potentially brings rooms for new solutions.**

⊹ **With the new possibilities connected to smart homes,
novel scenarios could be created.**

7. USER RESEARCH

Looking at the Electrolux persona and the Consumer Benefit Areas for the Electrolux Healthy Home department already narrowed down the target audience for this project. However, further exploration was needed in order to investigate different potential for a more specific target audience.
With the Electrolux persona and the CBA's as a starting point, some user research was conducted and some already conducted user research made or ordered by Electrolux was looked at and then used to create different user scenarios.

7.1 Interviews with families with young children

Since small children families are among the group of people who gets the least amount of sleep, some extreme user interviews where conducted in the homes of the families. The format of the interviews where semi structured and general questions where asked about the routines around bedtime, during the night and in the mornings.
The children in the families were between 1-2 years old but some of the families also had older children aged around 4 years old.
During the interview with Arthur's family the parents where also asked to sketch up a timeline. The timeline stretched from when they got home and until they left home again in the morning. They where asked to pinpoint activities but also to assign moods to these activities. This was done in order to get a general impression of the regular night and morning routines in the life of the family.

The biggest pain point found within Arthur's family was the noisy outdoor environment. The family wished they could sleep with an open window but didn't do this since the noise from the street would be disruptive of their sleep.
When talking to Hedda's parents, they remembered certain aspects as more problematic during their child's first year. They found it hard to know when their baby was soundly asleep after their bedtime routine, and when they could leave the bedroom without risking her to wake up. When she was a baby they also took notes on the phone to keep track of sleep routines and hours.
Selma's mother talked about the importance of the night light for the night peace in the family. Selma often woke up during the night but could most often fall asleep without the help from the parents if they would leave the light on.

Hedda 1 years old

My wife took notes on her phone to keep track of her sleep routines and hours when she was a baby.

It is hard to know when it is safe to leave the nursery after putting her to bed. Is she soundly asleep?

Selma 2 years old

Both children sleep with a night light. We leave it on all night in case they wake up, which they do every night.

Arthur 2 years old

We wish we could open the window (during night) but the street outside is so noisy it would disrupt our sleep.

You can't plan your whole life around certain nap times, routines can only be kept to a certain extent.

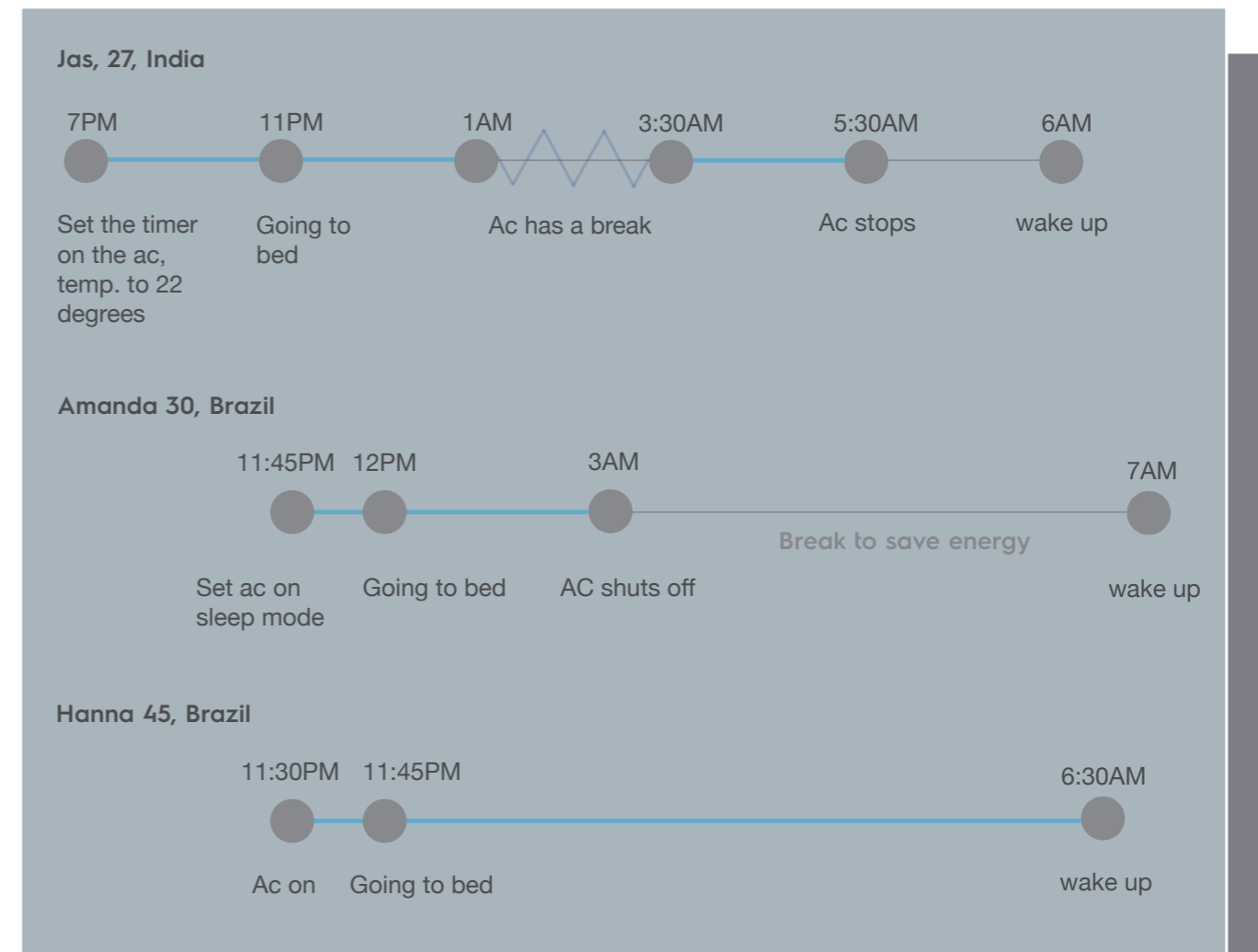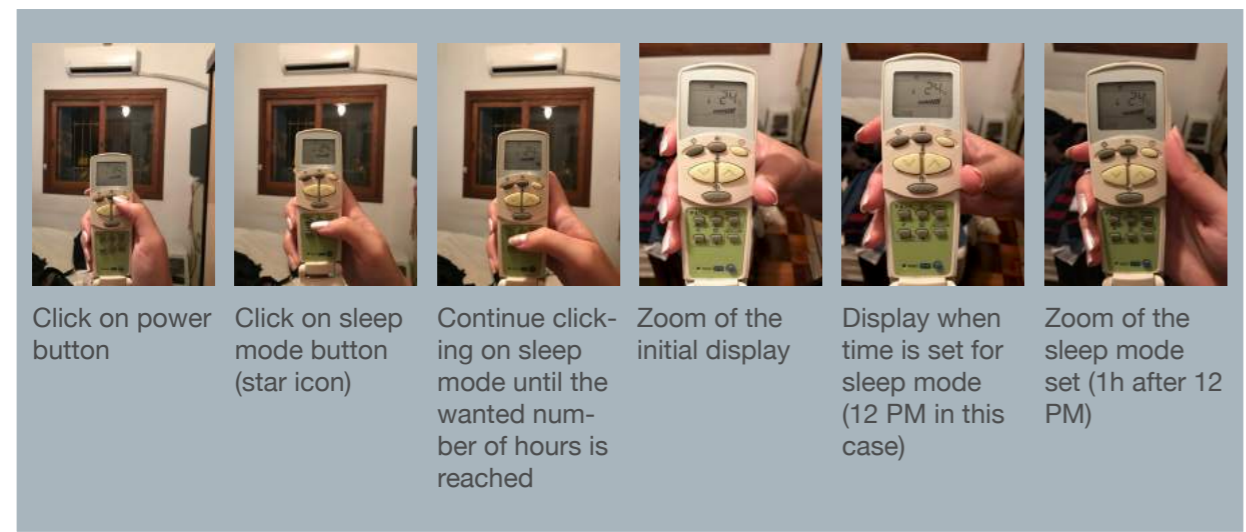## 7.2 Interview with a children's doctor

After visiting some families a phone interview was conducted with Cecilia Chrapowska, children's doctor at Karolinska. This interview was done in order to get some broader insight in the recommendations of young children's sleep. Cecilia explained that there would be a bigger need for tracking the bedtime when the child is about 2-3 years old, when it is possible to have a more set time for naps and bedtimes. Before that it is very personal how much sleep the child needs. Different methods also work differently for different families, often dependent on the habits and routines that are specific for that family. Chrapowska also stressed that measuring a childs sleep could cause more stress rather than doing any good for the parents. She stated that letting the parents themselves keep track of the sleep hours is very different from assigning the task to a device.

7.3 An air conditioned night

Since the chosen ecosystem would include an air conditioner some research was done in order to understand how the current scenario look like when using an air conditioner in the bedroom. Three different time lines where drawn up for three different users, where two of the users used the timer on the air conditioner in order to get a "fall and ri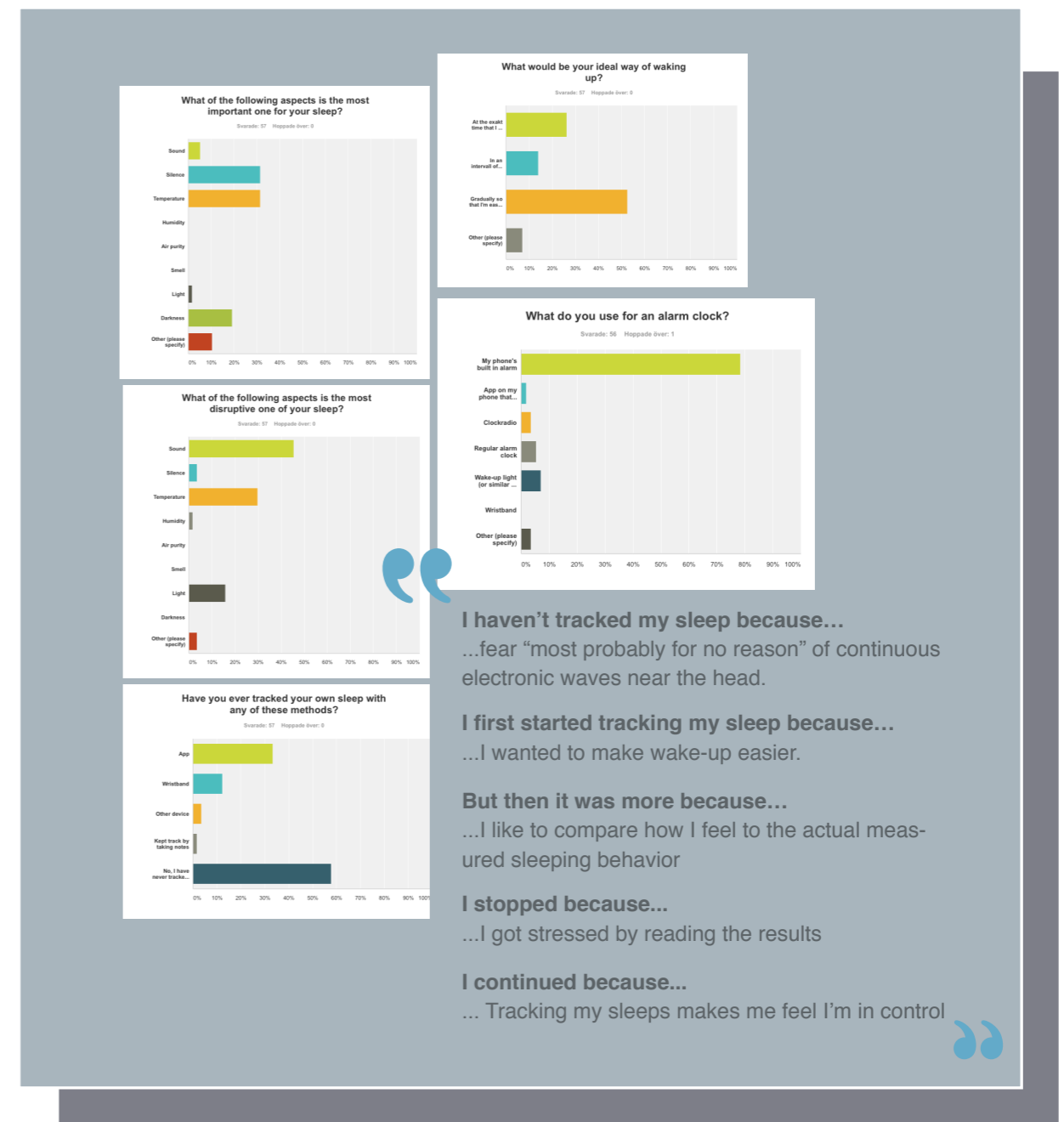se" temperature curve during the night. This was in both cases done in order to get a comfortable temperature during the night, but also to decrease the cost. The time lines where drawn up after talking to users with a long experience of sleeping with an air conditioner in the bedroom. A closer look was also taken on the interaction with a remote when setting the air conditioner in "sleep mode".

Click on power button

Click on sleep mode button (star icon)

Continue clicking on sleep mode until the wanted number of hours is reached

Zoom of the initial display

Display when time is set for sleep mode (12 PM in this case)

Zoom of the sleep mode set (1h after 12 PM)

Jas, 27, India

7PM — Set the timer on the ac, temp. to 22 degrees

11PM — Going to bed

1AM — Ac has a break

3:30AM

5:30AM — Ac stops

6AM — wake up

Amanda 30, Brazil

11:45PM — Set ac on sleep mode

12PM — Going to bed

3AM — AC shuts off

Break to save energy

7AM — wake up

Hanna 45, Brazil

11:30PM — Ac on

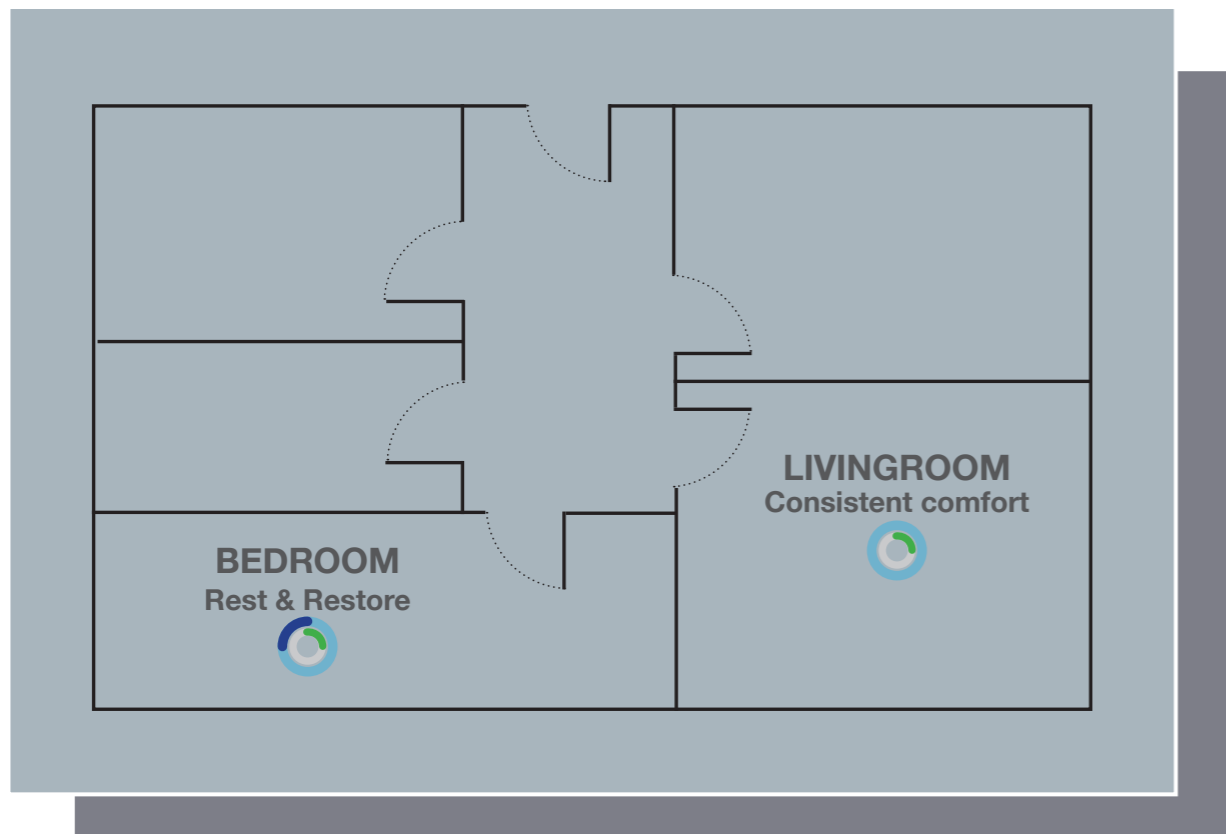11:45PM — Going to bed

6:30AM — wake up

7.4 Questionnaire

A questionnaire was sent out to employees within the Electrolux office. Answers where retrieved from a group of 60 people with an average age of 37. Amongst the respondents the most common nationality where Swedish (23) and Brazilian (16), but many other nationalities where also represented. The other nationalities amongst the respondents where: Danish, Finish, Belgian, French, British, Italian, Spanish, German, Singaporean, Egyptian, Chilean, Chinese, New Zealander and Canadian. 31.7% of the respondents answered that temperature is the most important aspect for their sleep. 46.7% of the respondents answered that sound is the most disruptive aspect for their sleep. 79.7% of the respondents used their phone as an alarm clock. 53.3% of the respondents thought that the ideal way of waking up would be gradually but at an exact set time. Some more open questions where also prosed regarding the respondents experience with tracking sleep, their motivation to do it or lack of it. Some of the respondent felt a fear of continuous electronic waves near their head and hadn't used any device for tracking sleep for that reason. The motivation for those who had tracked their sleep was in many cases an aspiration of making the wake-up process easier. Some also wanted to track their sleeping behaviour in order to improve it or to compare it to how they actually felt. Some respondents stopped tracking their sleep since the readings where stressing them out while some continued because following their readings made them feel in control.

I haven't tracked my sleep because…
…fear "most probably for no reason" of continuous electronic waves near the head.

I first started tracking my sleep because…
…I wanted to make wake-up easier.

But then it was more because…
…I like to compare how I feel to the actual measured sleeping behavior

I stopped because...
…I got stressed by reading the results

I continued because...
… Tracking my sleeps makes me feel I'm in control

LIVINGROOM
Consistent comfort

BEDROOM
Rest & Restore

"My home needs to be a place, almost like a sanctuary. I work in the city. I have to deal with the trials of the city, commuting in and out. When I come home I need to be safe."

Female / CPC / F
New york

"A comfortable environment is an environment you're not think-ing about. If it's causing you a problem, you are going to start worrying about it."

Male / Expat / CPC / PRF
Dubai

"I would want the air in the bedroom to be fresh, pure. The climate must be the best pos-sible, so you can have a good night of sleep and wake up fit for work next day. But we don't have a way to improve it right now."

Female / SA / F
Sao Paulo

"I have this PM 2.5 app on my mobile phone to check the air quality outside."

Male / SA / PF
Shanghai

7.5 Electrolux consumer insights

A meeting with Mathilda Velevska, Insight For Consumer Experience Manager at Electrolux, was held to discuss the already conducted market research regarding measuring air. Velevs-ka provided research reports, including reports on insight stories from costumers from different demographics, retrieved from home visits, and

some statistics regarding their costumer segment in the Healthy Home category.
Some relevant quotes was drawn from the re-ports and the different perspective the costumers had on their living room compared to the bed-room was noted.

8. PROSE SCENARIOS

Prose scenarios where built based on the user research, exploring solutions for pain points and benefit opportunities for the different consumer benefit areas within the Electrolux Healthy Home department.

The Electrolux consumer benefit areas here categorize the user groups that were investigated. The different target groups, families, the "self-improver", the city dweller and pollen allergies are derived from a composition of the Electrolux user, survey results, the trend research and interviews.

The prose scenarios were made to investigate and ideate around the benefits of a smart connected home. After speaking to a childrens doctor I stepped away from the family scenarios and finally chose to focus on a rather broad grouping, city dwellers and couples.

The couples scenario where decided to be included in the final concept because of the insights regarding different temperature preferences in a bed sharing scenario, but also because of the insight that the Electrolux healthy home consumer most likely lives in a partnership.

The "City Dweller" scenario - based on the stressed city person - where also included because of the strong link between the generalised Electrolux persona.

8.1 Healthy happy kids

Infants
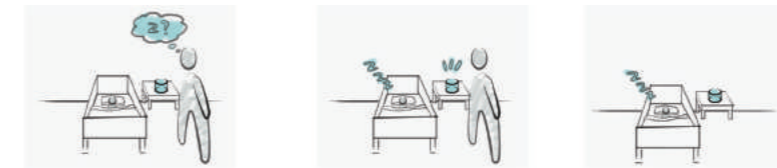
"Soundly asleep" feedback. Letting you know that the child is in deep enough sleep for you to leave the room.
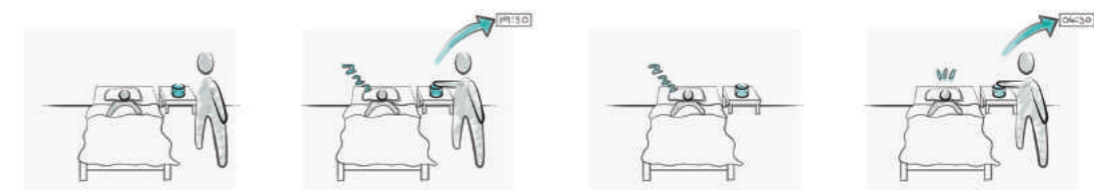

Lullaby mobile. Used to induce sleep and kicks in if the child wakes up during the night.
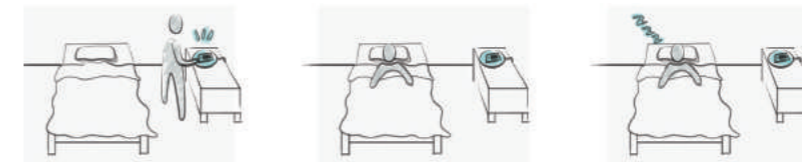
Small children

Tracking sleep as an enabler to control the night light after the child's sleep/awake.

Tracking nap hours.

Teenagers

Mobile checkpoint to create a distance from the user and the phone.

8.2 Perfect comfort

The self improver

Breathe with me. Detecting high pulse and prompting and guiding the user to do a breathing exercise.

Couples

Two different temperature preferences - one bedroom. Using a complementary accessory to either cool or heat one user.

8.3 My sanctuary

Pollen allergic

Can I sleep with an open window? Feedback regarding the current pollen readings based on your specific allergy.

Pollen calendar. Planning your week after the readings.

Eucalyptus scent to open the airways.

City dweller

Your bedroom as a tech-free zone.

SANCTUARY?
removing distraction and stress

RE-BRIEF

Create a physical control-point / air measuring
hub that acts as a tool for detachment
and
supporting pads for reactivity and measuring
to support
the connected "Electrolux bedroom experience",
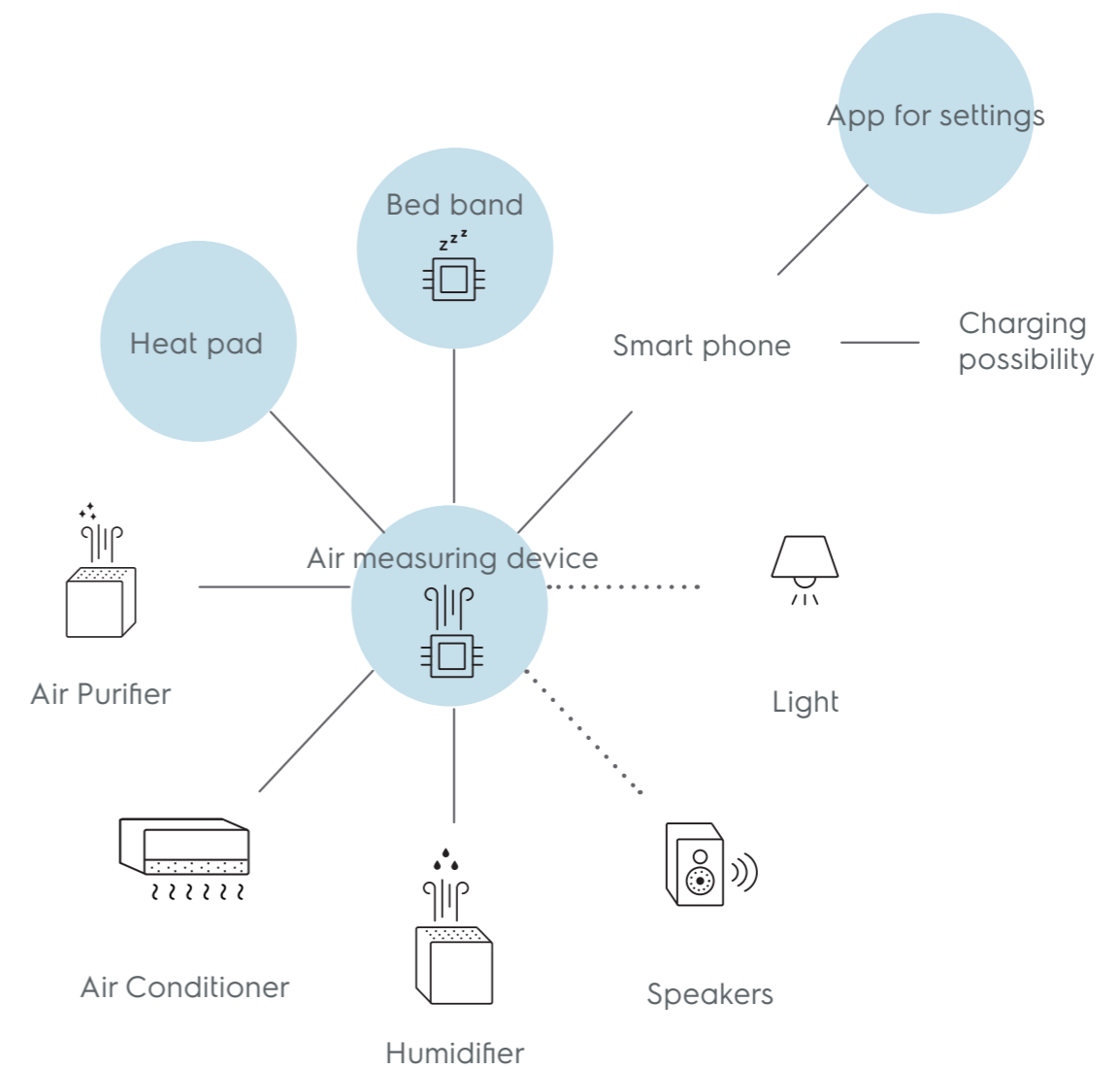creating the feeling of a "tech-free zone".

Motivation

- Differentiating this system to other sleep/air systems
  would not only lie in connecting existing Electrolux air
  products but also in making the measuring device into
  a control point that also acts as a tool for detachment.

- The system also differentiate itself by being flexible
  and possible to personalize by connecting your
  chosen products.

9. CONCEPT DEFINITION

9.1 Final ecosystem

To the right the final chosen ecosystem is displayed. The system is centred around the air measuring device. The kit also consists of a heat pad- enabling the temperature to be reactive to two users - and a bed band that is measuring the users sleep and body temperature. An application is also included for settings. Other from this are devices included that are capable of pairing with the system - air products from Electrolux and environmentally enchaining products as light and speakers.

App for settings

Bed band

Heat pad

Charging possibility

Smart phone

Air measuring device

Air Purifier

Light

Air Conditioner

Speakers

Humidifier

AIR MEASURING / CONTROL POINT

+ sensing air parameters
+ informative through gesture control
+ control point for the bedroom ecosystem

APP

+ advanced settings
+ ratings for learning
+ pairing up the system

HEAT PAD

+ local heat source
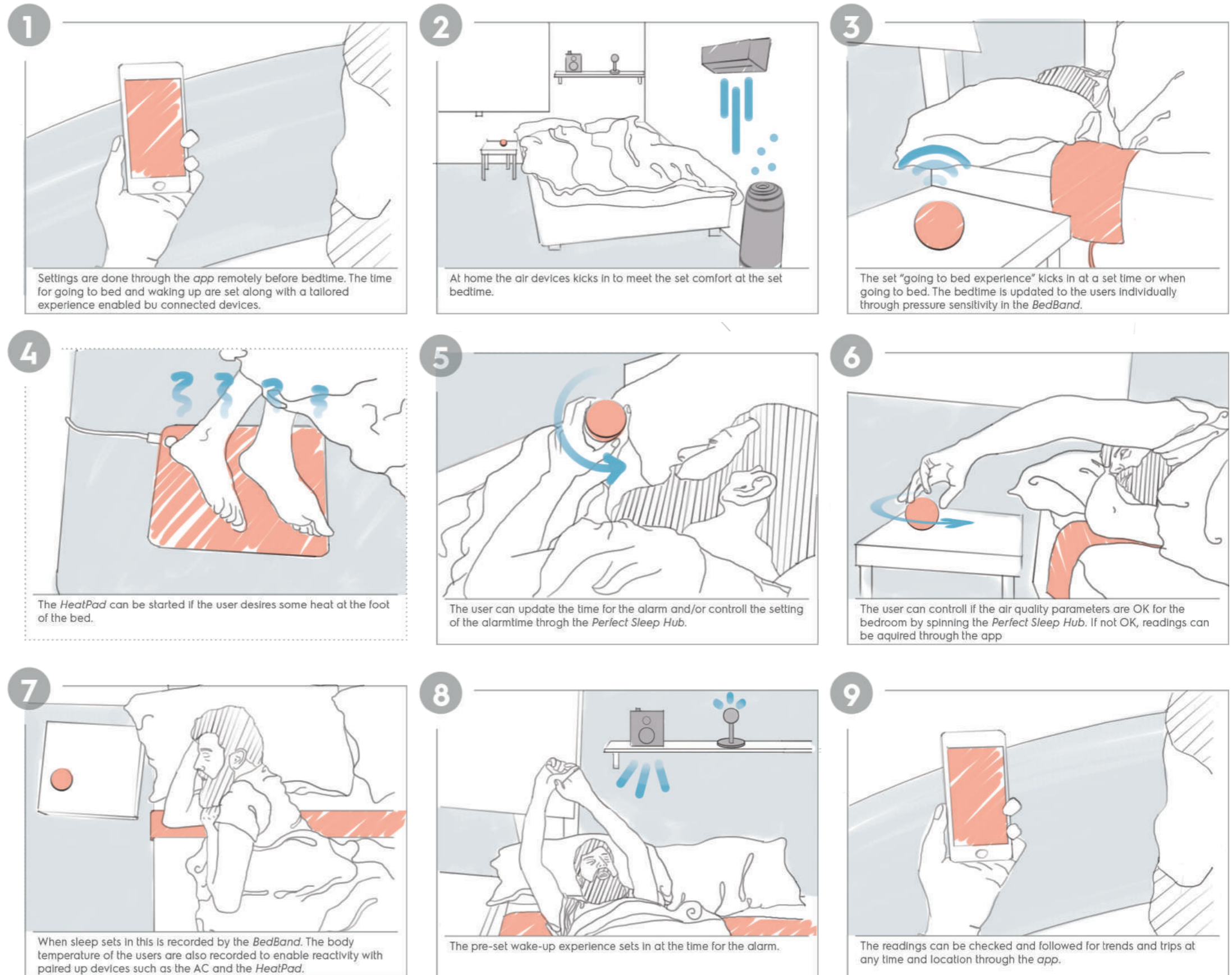+ wi-fi enabled for reactivity with air products

BED BAND

+ measures sleep
+ measures body temperature
+ user detection through pressure sensors
+ wi-fi enabled for reactivity with air products

9.2 A starting kit

Here is an overview of the different products included in the start kit for the ecosystem of your bedroom.

9.3 Final scenario

A scenario was drawn up in order to clarify the function and usage of the system. The scenario stretches from evening until the morning after.


1 Settings are done through the *app* remotely before bedtime. The time for going to bed and waking up are set along with a tailored experience enabled by connected devices.

2 At home the air devices kicks in to meet the set comfort at the set bedtime.

3 The set "going to bed experience" kicks in at a set time or when going to bed. The bedtime is updated to the users individually through pressure sensitivity in the *BedBand*.

4 The *HeatPad* can be started if the user desires some heat at the foot of the bed.

5 The user can update the time for the alarm and/or controll the setting of the alarmtime throgh the *Perfect Sleep Hub*.

6 The user can controll if the air quality parameters are OK for the bedroom by spinning the *Perfect Sleep Hub*. If not OK, readings can be aquired through the app

7 When sleep sets in this is recorded by the *BedBand*. The body temperature of the users are also recorded to enable reactivity with paired up devices such as the AC and the *HeatPad*.

8 The pre-set wake-up experience sets in at the time for the alarm.

9 The readings can be checked and followed for trends and trips at any time and location through the *app*.

10. PHYSICAL DEVELOPMENT

10.1 An Electrolux product

At this point in the project a choice needed to be made regarding the aesthetics of the products. The products within the Healthy Home range today are designed to blend into the home more than having an expression of their own. But during talks with colleagues at the Electrolux Healthy Home department - and when attending a workshop - I got the impression that this is about to change, making the products fit into a home more in the way the furniture does, rather than blending into the walls. Therefore the decision was made to find inspiration of my own for the physical development for the products.
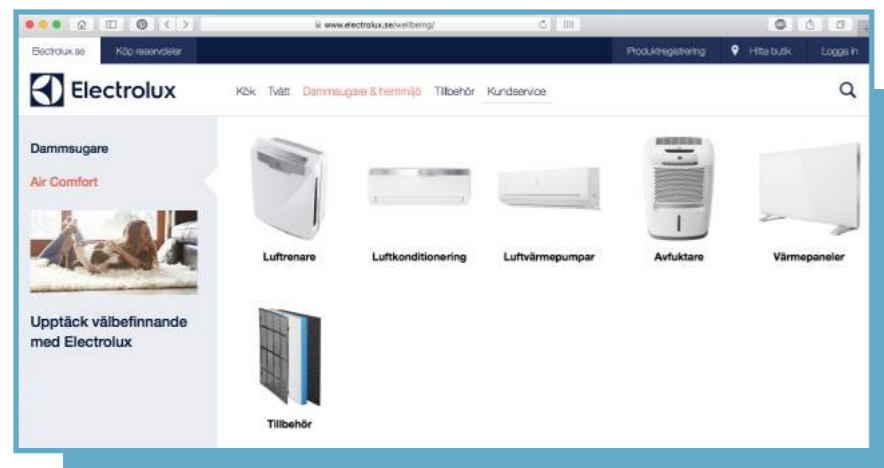
10.2 Inspiration

In order to frame an aesthetic intent some words where noted down. The words then acted as a guide for the following form development.

SOFT

CALM

WARM

ZEN

COMFORT

QUIET

SANCTUARY

COSINESS

ASSURING

10.3 The pads

A visit to the Danish textile company *Kvadrat* was made in order to look at different fabrics and to talk about the different qualities and characteristics. Since the goal was to use the fabric on both the pads and the control point the fabric needed to facilitate different needs.

The technical aspects was not in focus but the assumption was made that the product needed a fixed power source (rather than using a battery solution) since similar products functioned this way. The choice to have a magnetic connection was made since this solution would also function well with the control point. A form development was made for this magnetic connection, different forms where explored with the help of 3D printing. The reason behind focusing on *Kvadrat* was that Electrolux previously used their fabrics for inspiration and also because my perception of their wide range.

The choice to look into fabrics from the company Kvadrat in particular was made because of range and style but also since their fabrics could be found on existing Electrolux mood boards regarding CMF.

MAGNETIC CONNECTION

Development of the pads

For the fabric prototypes help was gotten from a tailor. By sketching and rough mock-ups a solution for the magnetic connection was developed.
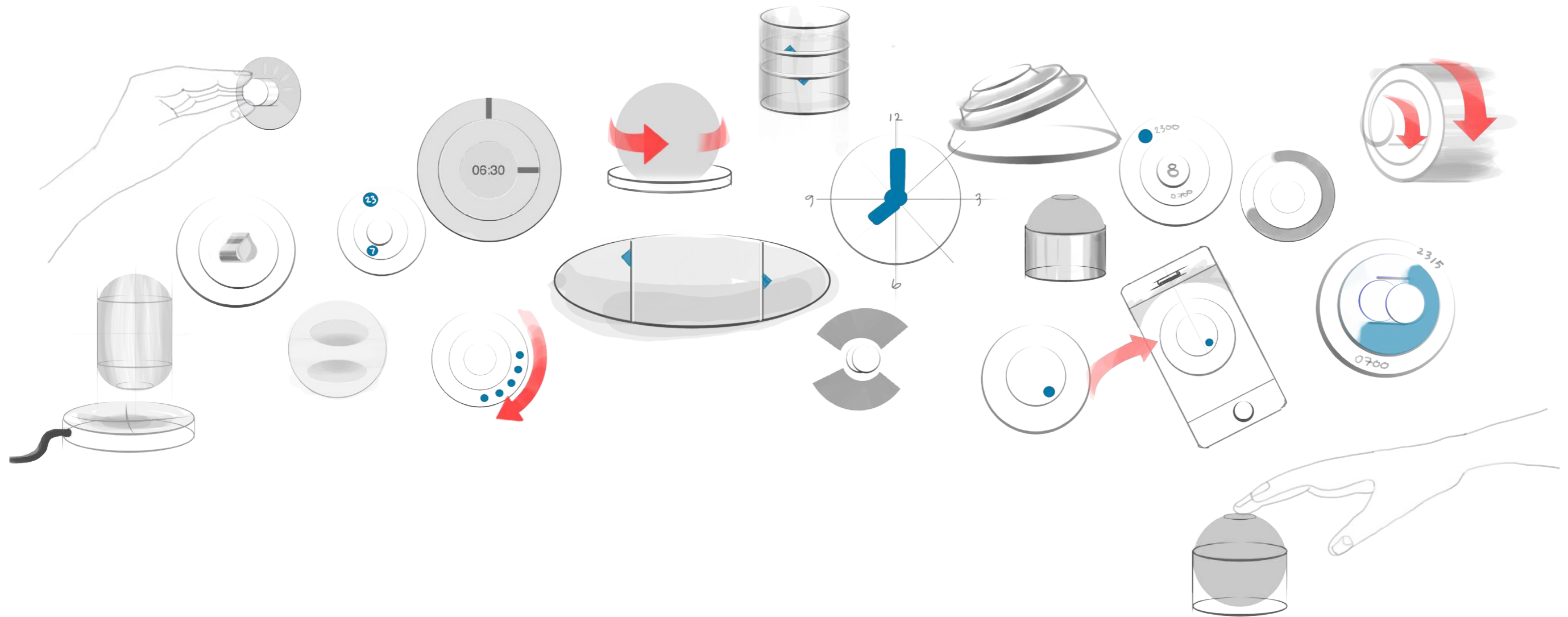
10.4 The hub

Different ideas where explored concerning a
physical interface. The main inspiration was to
have the interface as simple as possible .

THE SEMIOTICS OF A WHEEL
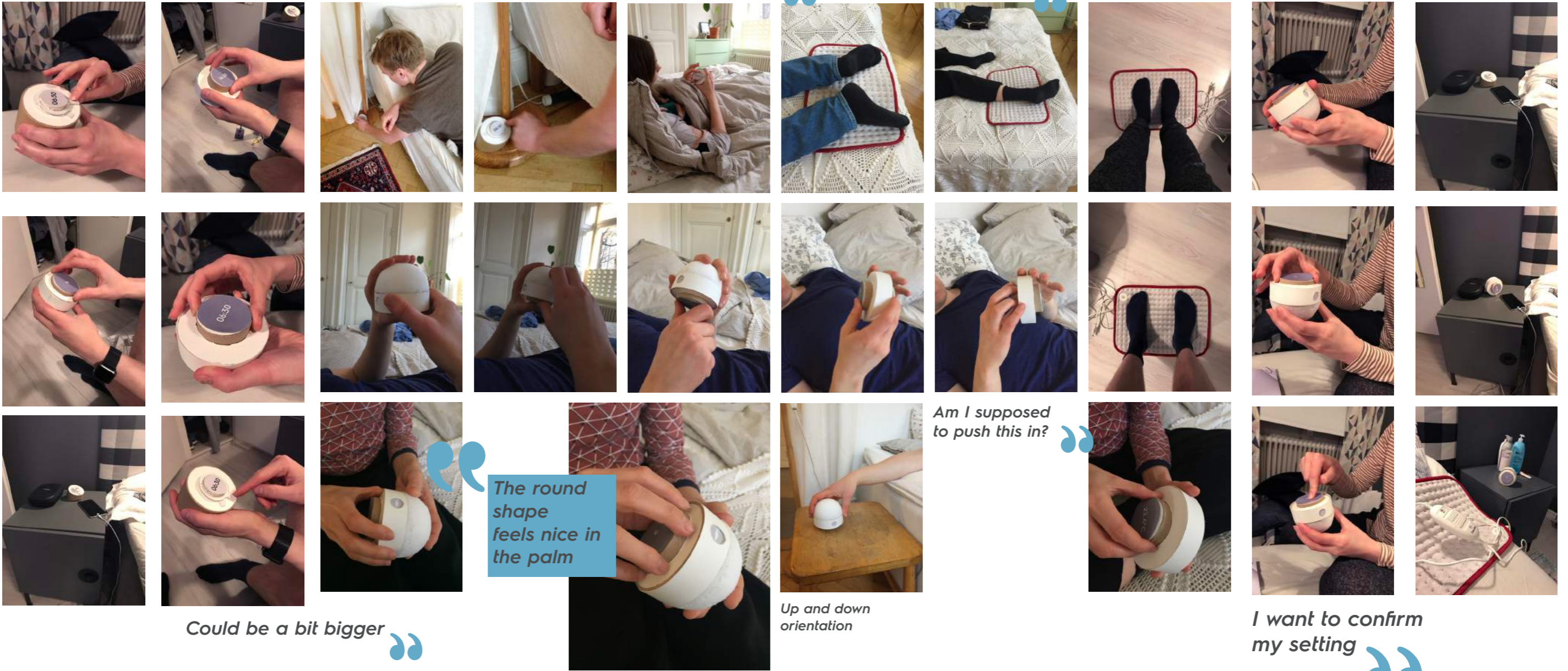**different settings – one control point**

SKETCH MODELS

Three different ideas where chosen and some rough sketch models where made in order to be able to evaluate the concepts.
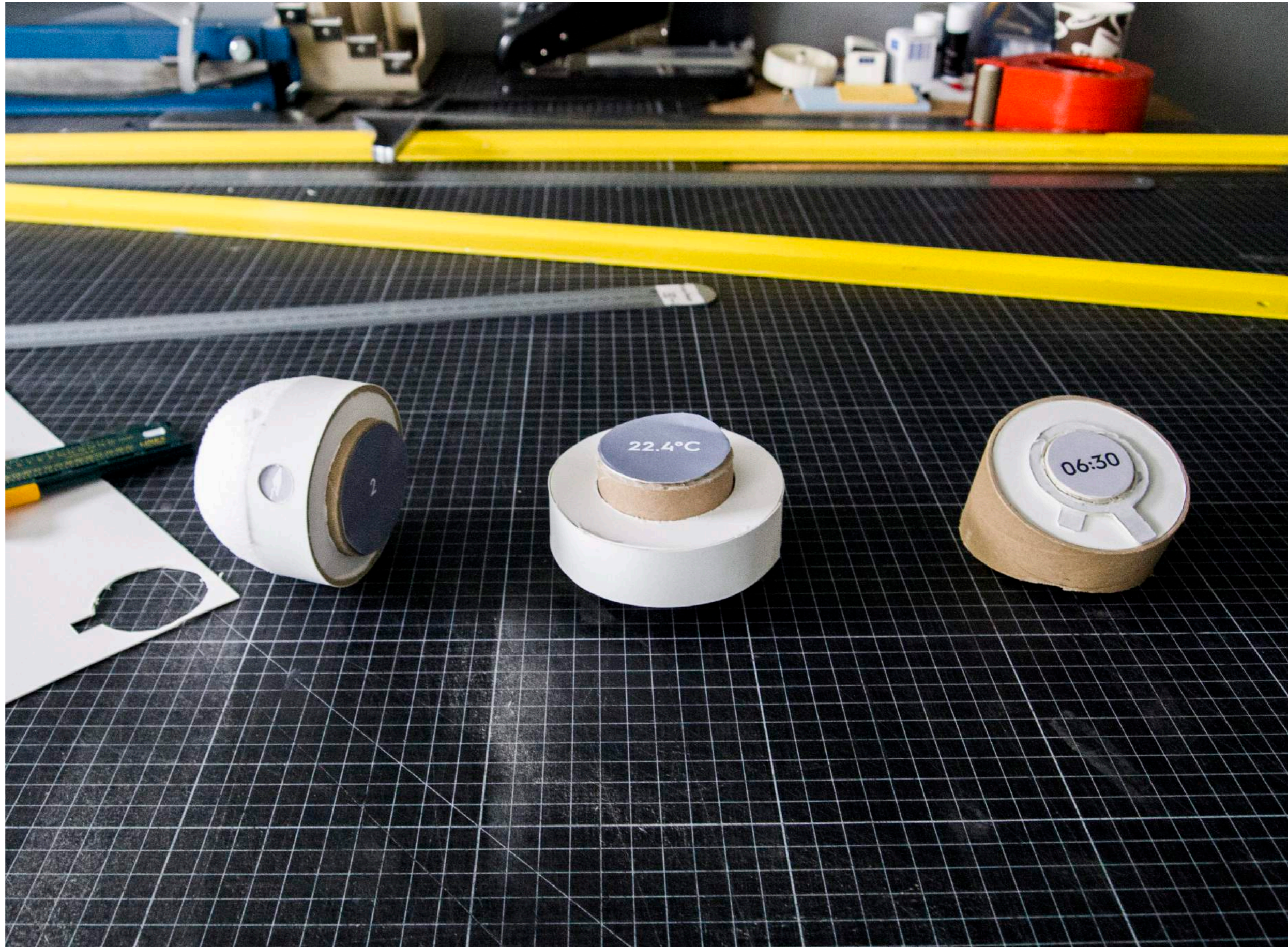
Alarm and clock, the same thing?

I get stressed by looking at the time if I wake up in the middle of the night, but I still want to know.

It is usually my feet that are cold

The round shape feels nice in the palm

Could be a bit bigger

Up and down orientation

Am I supposed to push this in?

I want to confirm my setting

Simple user tests

In order to evaluate the sketch models I wanted to get them in the hands of potential users. Other than letting the persons act out a scenario and interact with the models some general questions where asked concerning sleeping habits and preferences. The mock-up with a round bottom where liked because it had a nice feel to it in the palm and the people found it easy to understand how to interact with it. Inspiration for the further development was also drawn from these tests, for example the fact that some wanted to confirm their settings by pushing the wheel in.

Top surface in need of element of interest

Smoother transition between main body and turning wheel.

1. 2. 3.
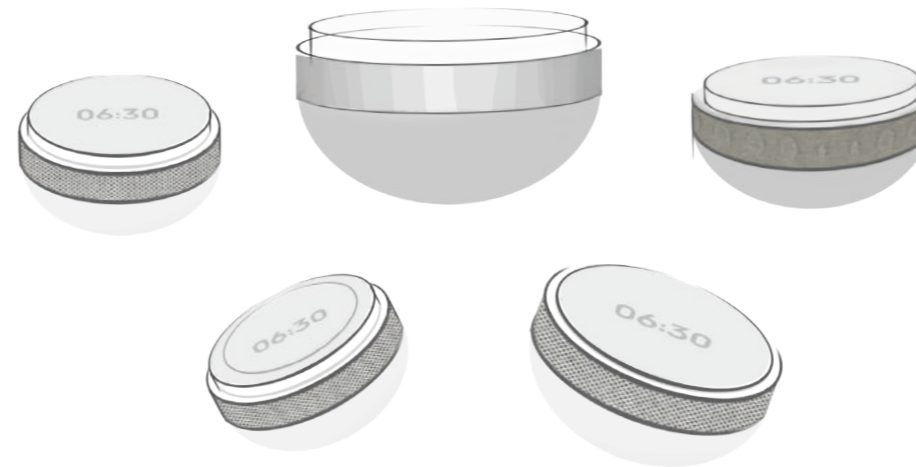
Chosen concept

The chosen concept was further explored and developed. 3D printing was used to find the right dimensions and sizing, The intent to use fabric on the control point was due to making the products feel connected - like a family. The fabric was tried as a display but the decision to have it on the charging plate instead was made due
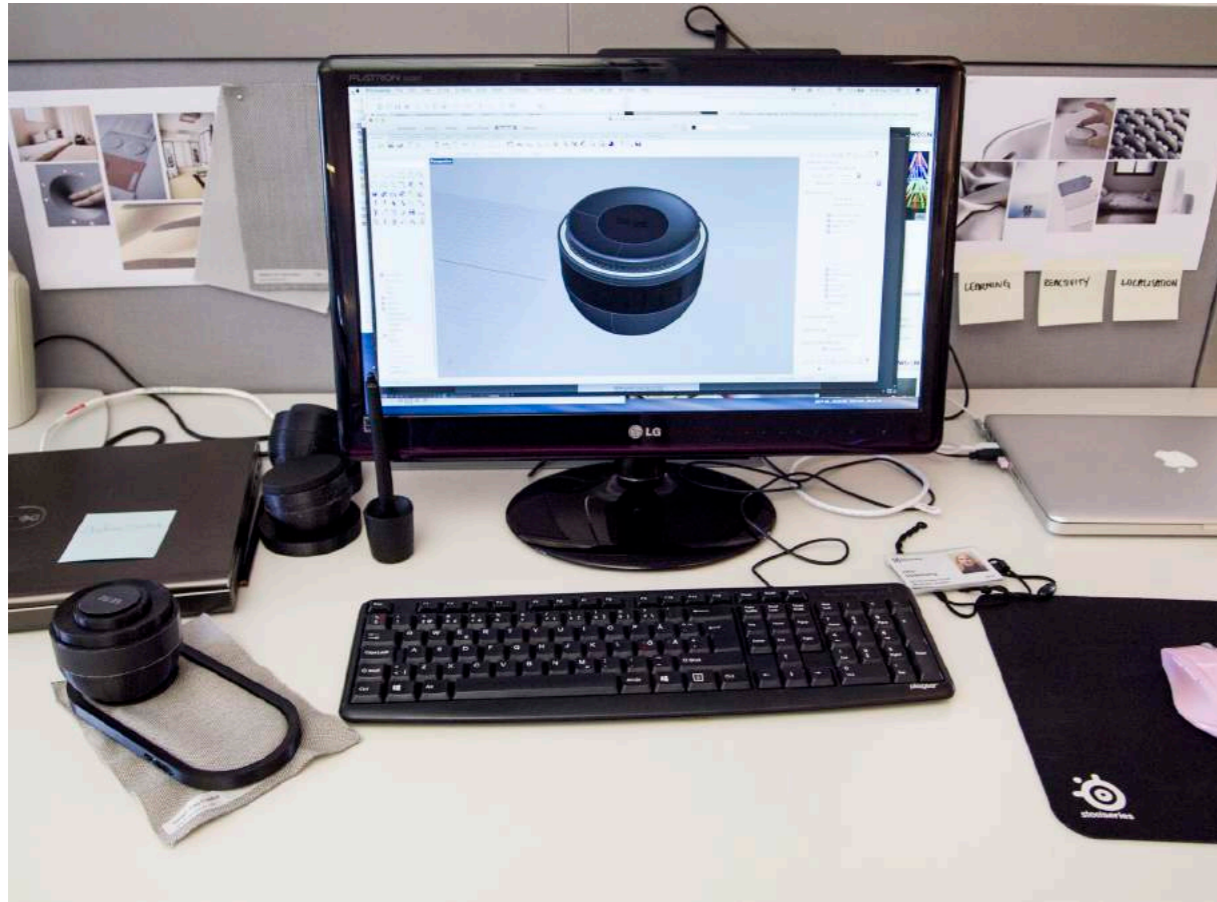
to making the manufacturing easier. Having the fabric on the device itself could also risk getting the fabric dirty since you would interact with it daily. Having the fabric of the plate also had a nice resemblance of a bed - making the device "rest" on a soft surface.
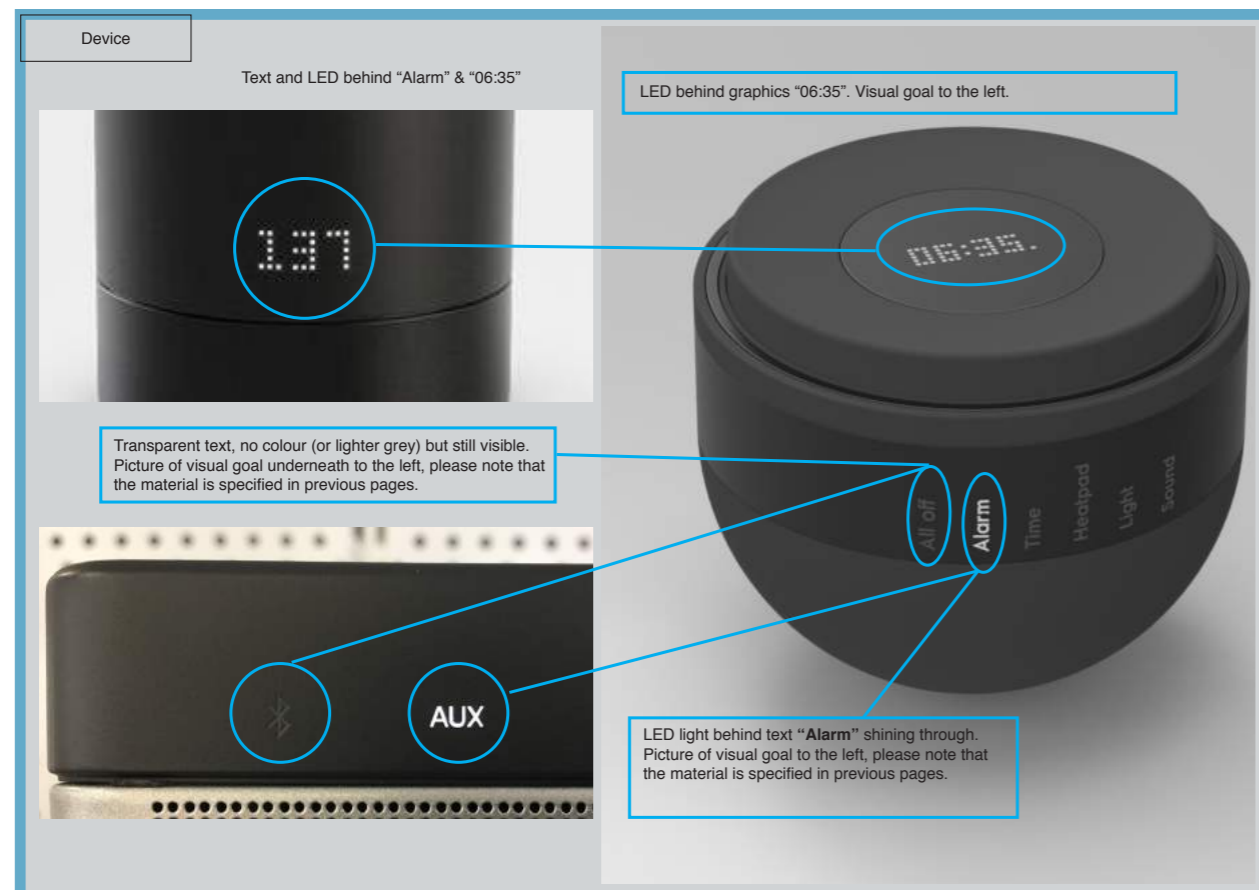
ABS coating 1:

1. Semi-matte silky plastic

For this sample I would like the end result to be as close to the sample as possible, both colour, texture and level of gloss.

ABS coating 2:

2. matte soft touch coating. Less shiny than material nr. 1.

For this sample I would like the end result to be as close to the color as possible, however I would like to have it as matte as possible with a soft touch coating. So please note that this is only a sample for the color, not for the texture or level of gloss.

3D CAD & specification for the model

When the dimensions were set the final CAD drawings and the final detailing where made. Since a final model where to be produced by a model making company in Shanghai some slides were made to specify the different parts, the printed text and logos and the finish (CMF).

Charging dock

Bottom view: Recessed screws

PANTONE®
PQ-CoolGray7C

silkscreen printed

Ai. file with vectors provided separately.

Invisible magnet inside for connection with "connection" A

Connection A, specifications on separate sheet.

Charging dock

ABS coating 2

ABS coating 2

fabric

ABS coating 1

screws

ABS coating 1:

1. Semi-matte silky plastic

ABS coating 2:

2. matte soft touch coating. Less shiny than material nr. 1.

Screen printed grapic element on fabric, the vectors are specified in the .Ai document and placement are specified in the 3D file **js-elux2textupdated.stp**

Device

Text and LED behind "Alarm" & "06:35"

LED behind graphics "06:35". Visual goal to the left.

Transparent text, no colour (or lighter grey) but still visible. Picture of visual goal underneath to the left, please note that the material is specified in previous pages.

LED light behind text **"Alarm"** shining through. Picture of visual goal to the left, please note that the material is specified in previous pages.

AUX

All off   Alarm   Time   Heatpad   Light   Sound

Connection

For this part I need 3 copies of A and 2 copies of B.

ABS coating 2:

2. **2. matte soft touch coating. Less shiny than material nr. 1.**

Invisible magnet inside B and A to be able to connect

A x 3

B x 2

COLOUR, MATERIAL & FINISH

The colour and material choices where based on the earlier frame of aesthetic intent in the form of words. Words like calm, quiet and zen personally for me aligned well with darker colours. Matte surfaces gave a soft and warmer impression and feel to the product. Including fabric also in the charging dock gave a softer impression and almost made the tray resemble a bed where the device could rest.
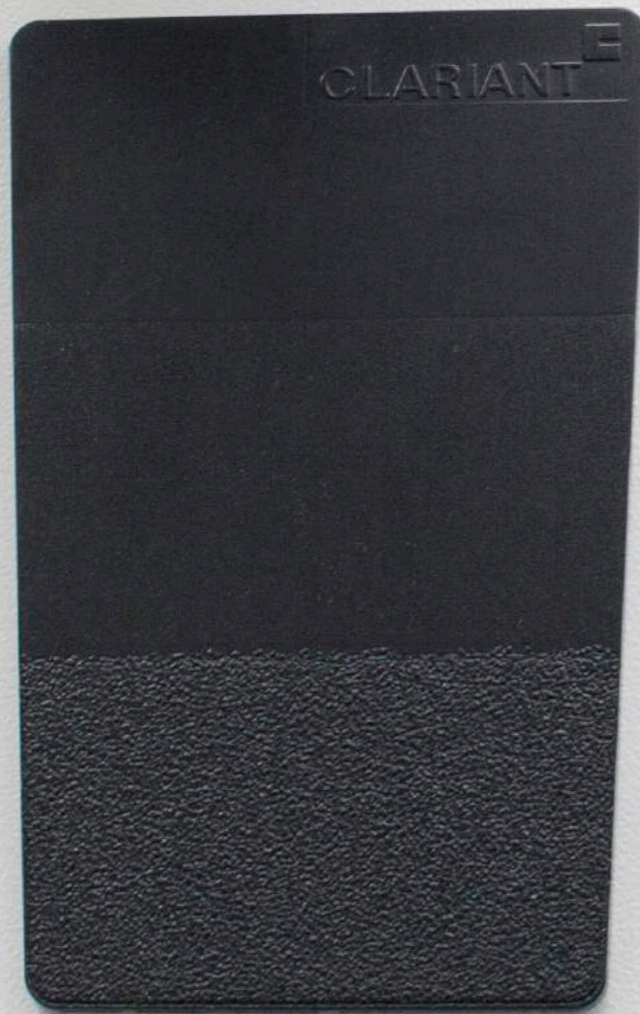
Ginger 2 by Kvadrat   152
www.kvadrat.dk

11. DIGITAL DEVELOPMENT

11.1 Wire frames

Alongside with the physical development of the products, wire frames where sketched in order to think on paper regarding the building of the application. Different frames where considered for different settings and how the general flow would work was taken into consideration.
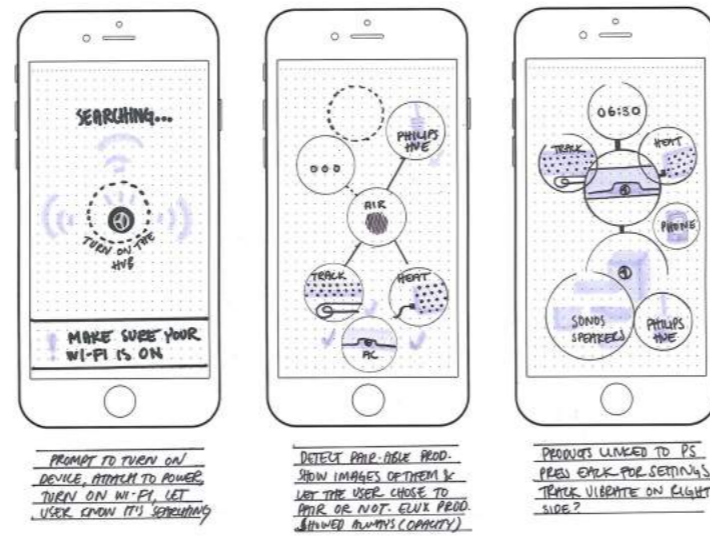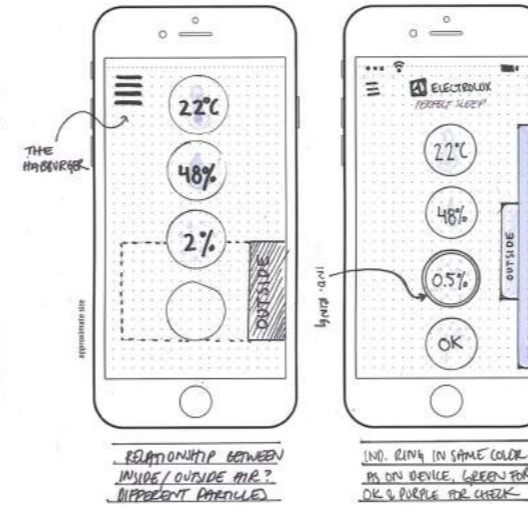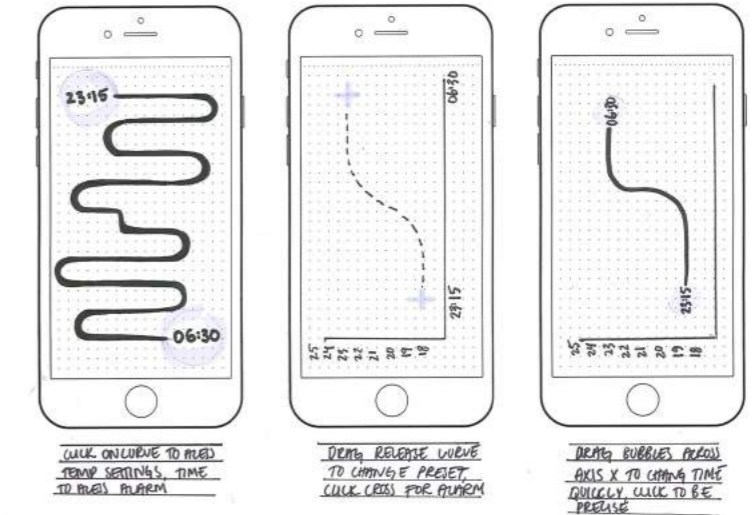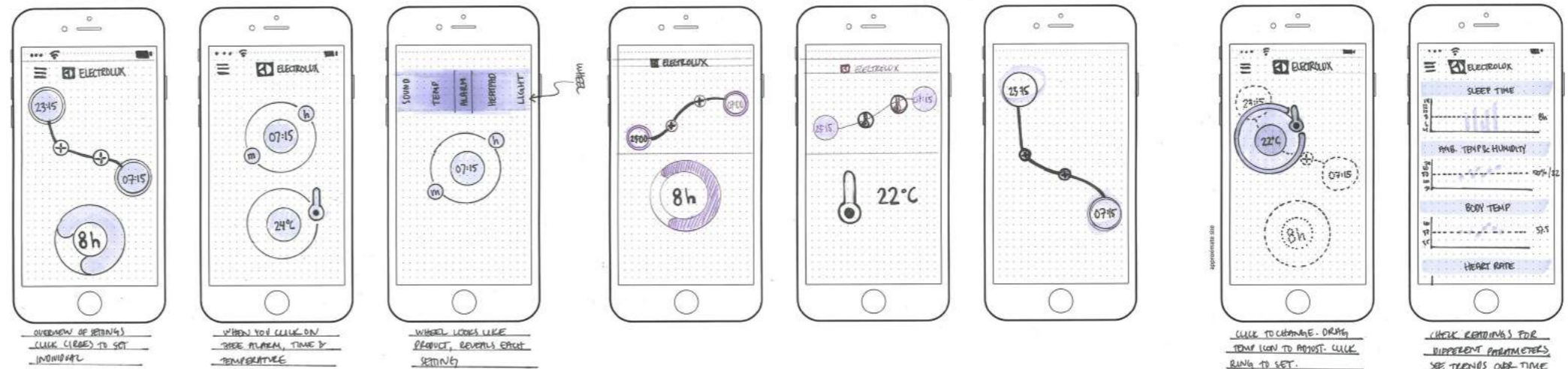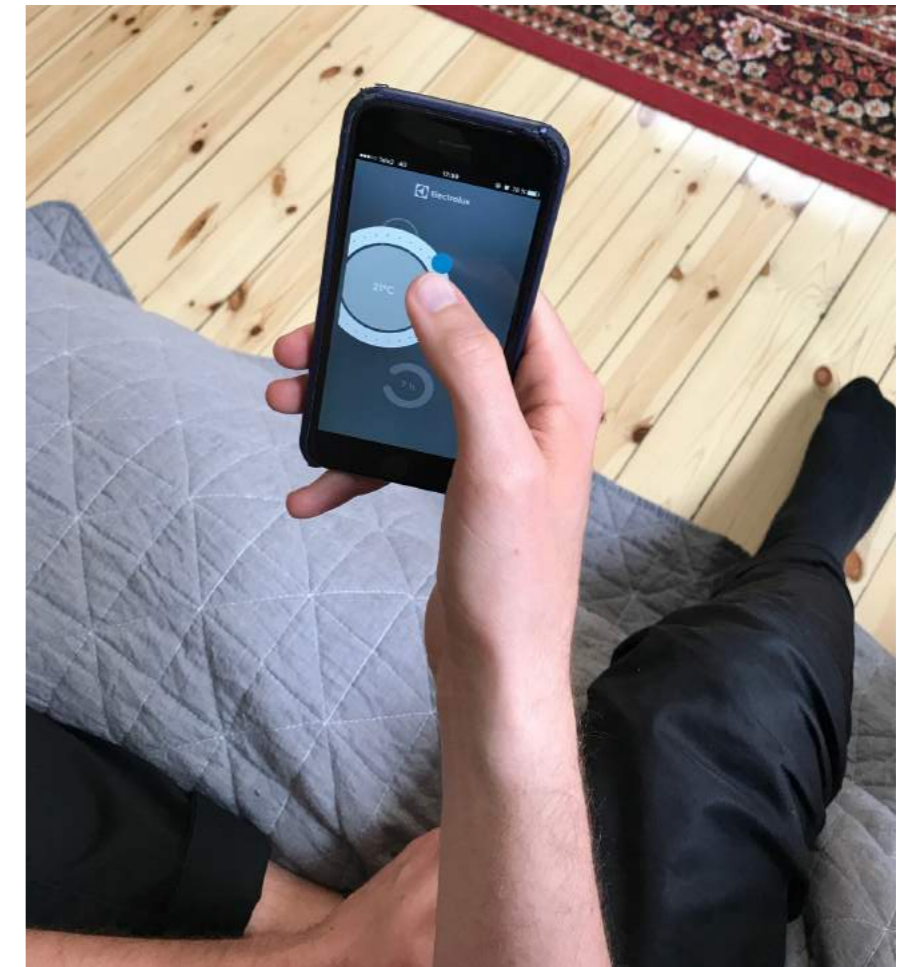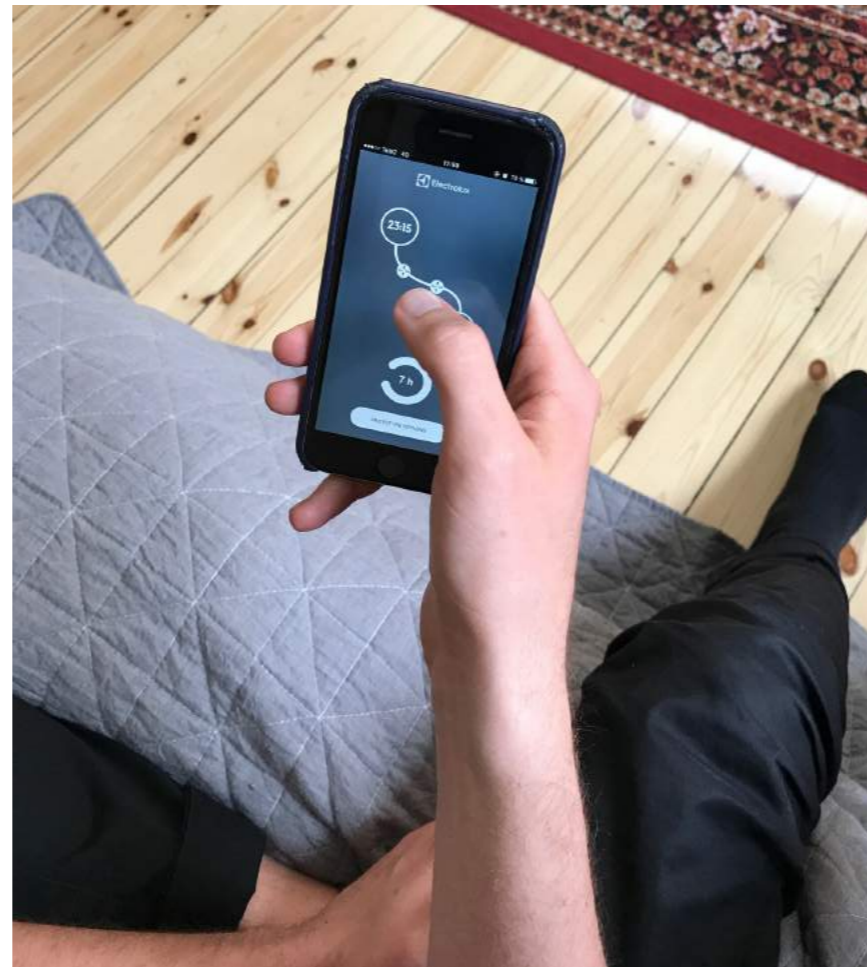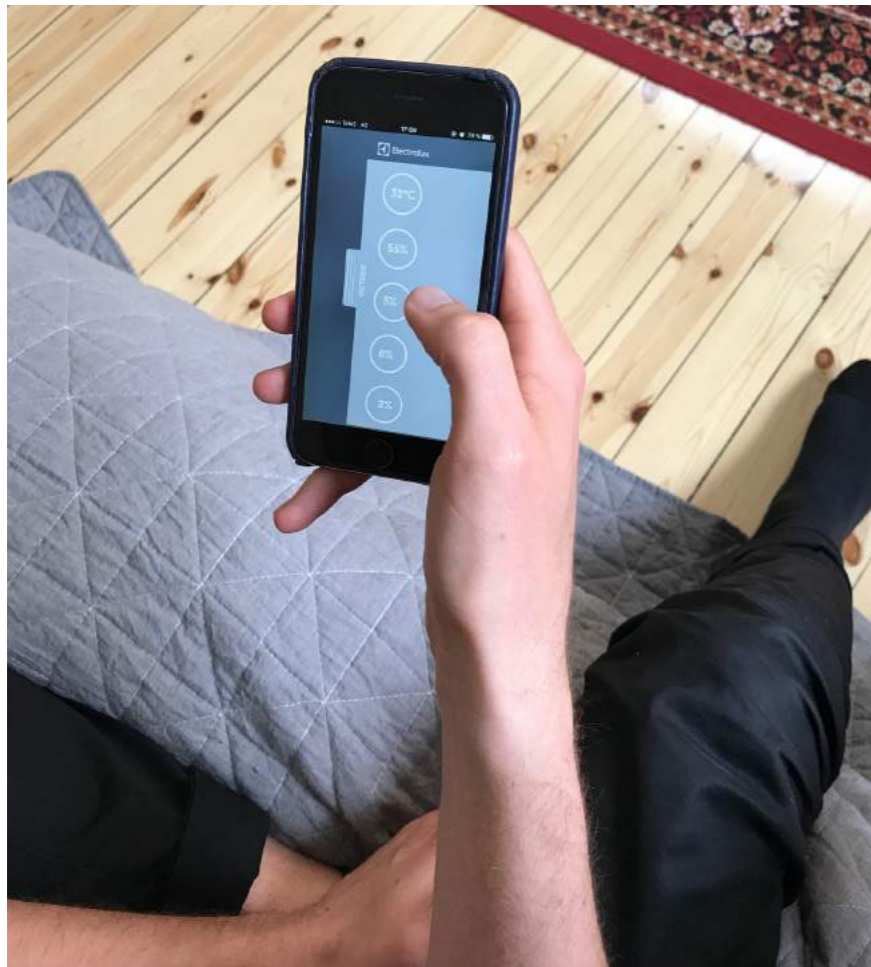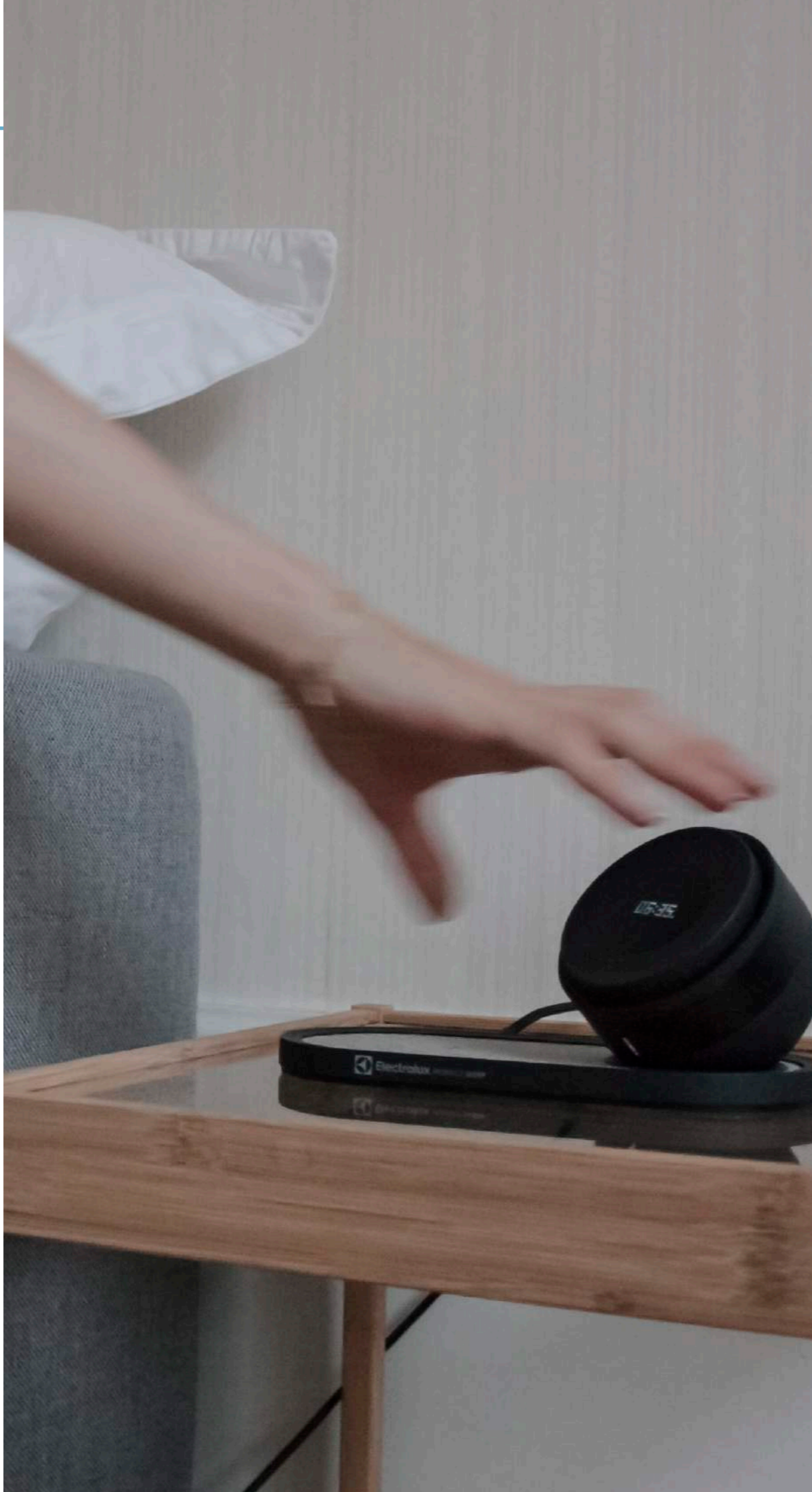
11.2 Prototype

A prototype of some frames was made in the
program InVision in order to quickly try the usa-
bility of the concept. Some flows were tried out
and it was noted where the test persons would
click on the screen.

12. RESULT
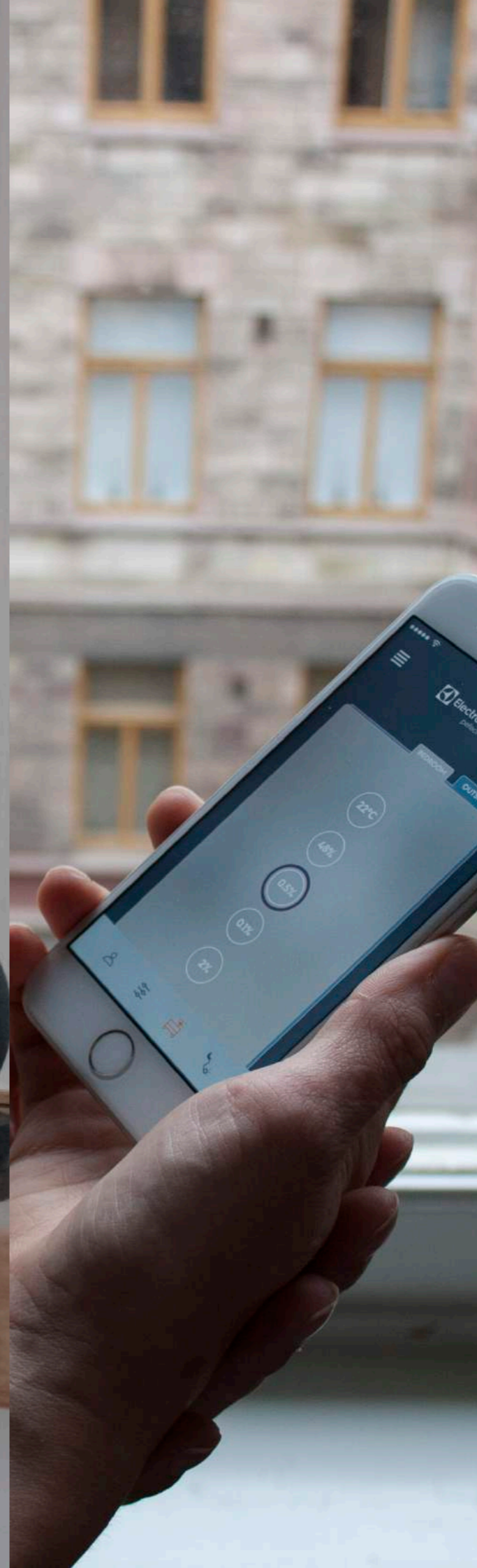
Reactive to other Electrolux air products in order to create perfect cleanness, temperature and humidity.

Pairable with other sense enhancing, wi-fi enabled products such as light and speakers.
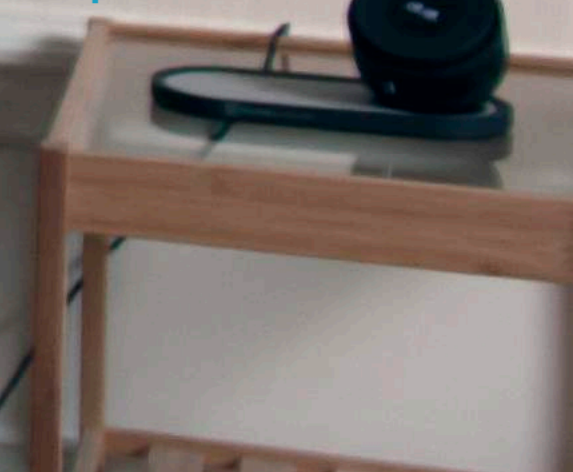
Measuring body temperature

Measuring heartbeat

Pressure sensitivity in order to locate different users based on bodyweight.

Reactive/ on demand heating

Surface to charge smart phone

PHYSICAL INTERACTION BY MOVEMENTS

1. Choosing

2. Setting

3. Confirming

Magnetic connection

This image shows the magnetic connection in the back of the induction tray. Induction deliberate the user to integrate with the device and to make the settings without the fuss of cords.

Indication light

The indicator light is included to be able to give the user immediate feedback regarding the state of the air in the bedroom. However - the indicator light only shows if you perform the gesture programmed to prose the inquiry. In the scenario, a simple spin was suggested to be the default setting. It is also desirable that the values set to determine whether the air is interpreted as "good", "OK" or "bad" by the device is originally set by the user. This puts the user in control even though a default can be prosed. In this way, a more personalised range can also be set dependent on for example allergies or temperature preferences.
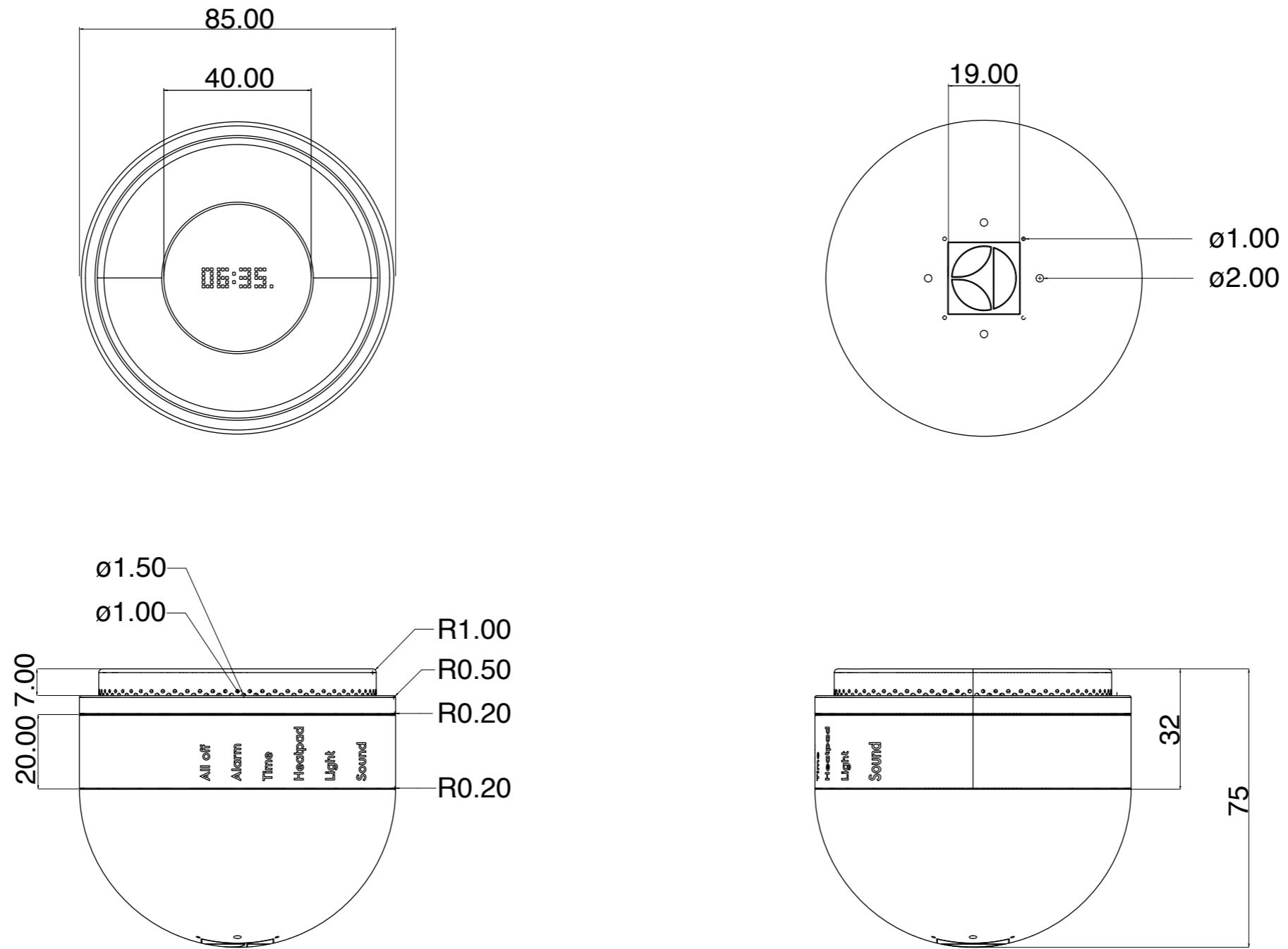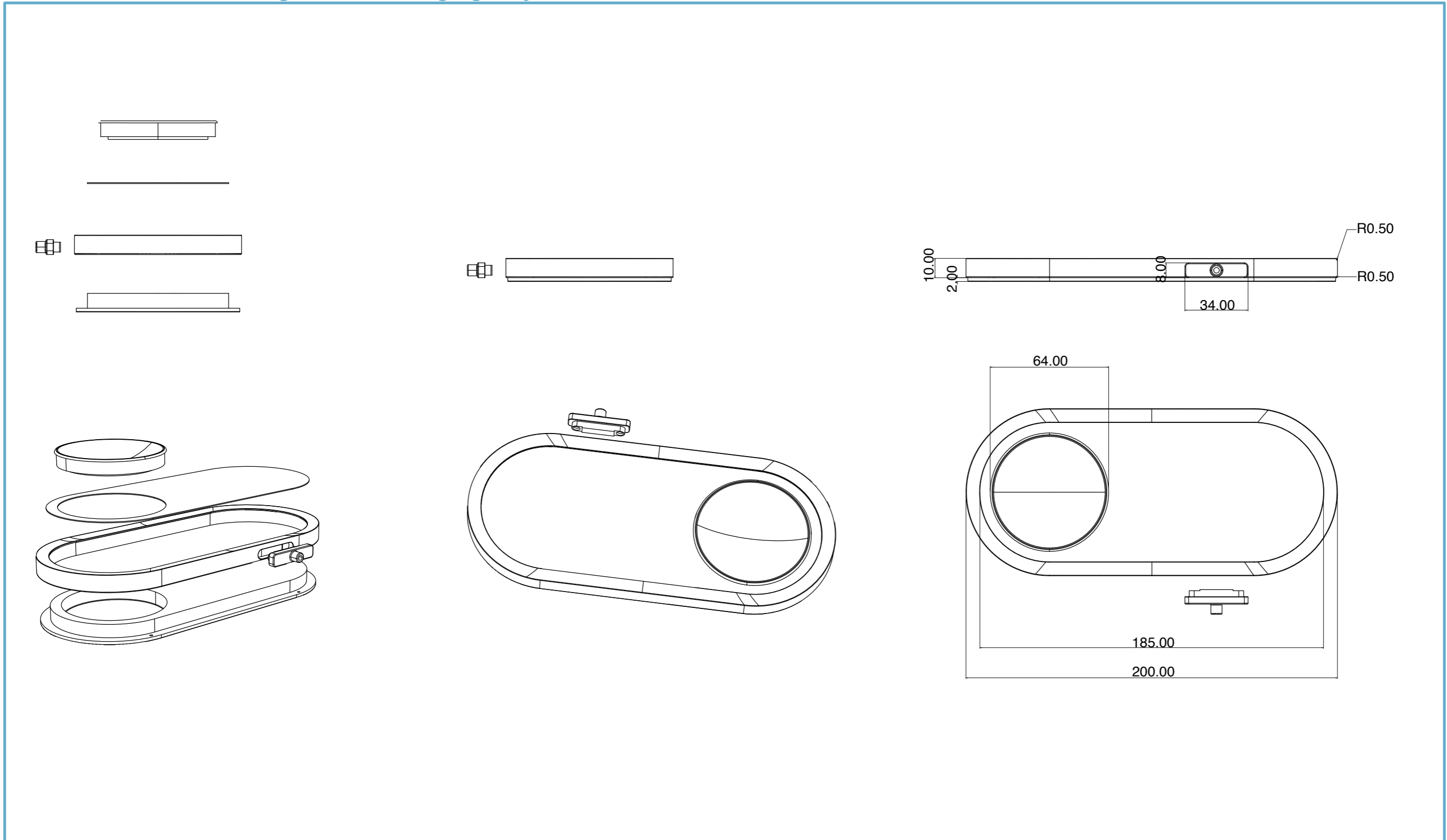
Air flow & sensors

The device holds sensors to measure the air quality in the room by different parameters; temperature, particles (cleanness) and humidity. The air is circulating the device with the help of a small fan, and inlet and exit holes are located at the top and bottom of the device to enable the flow.
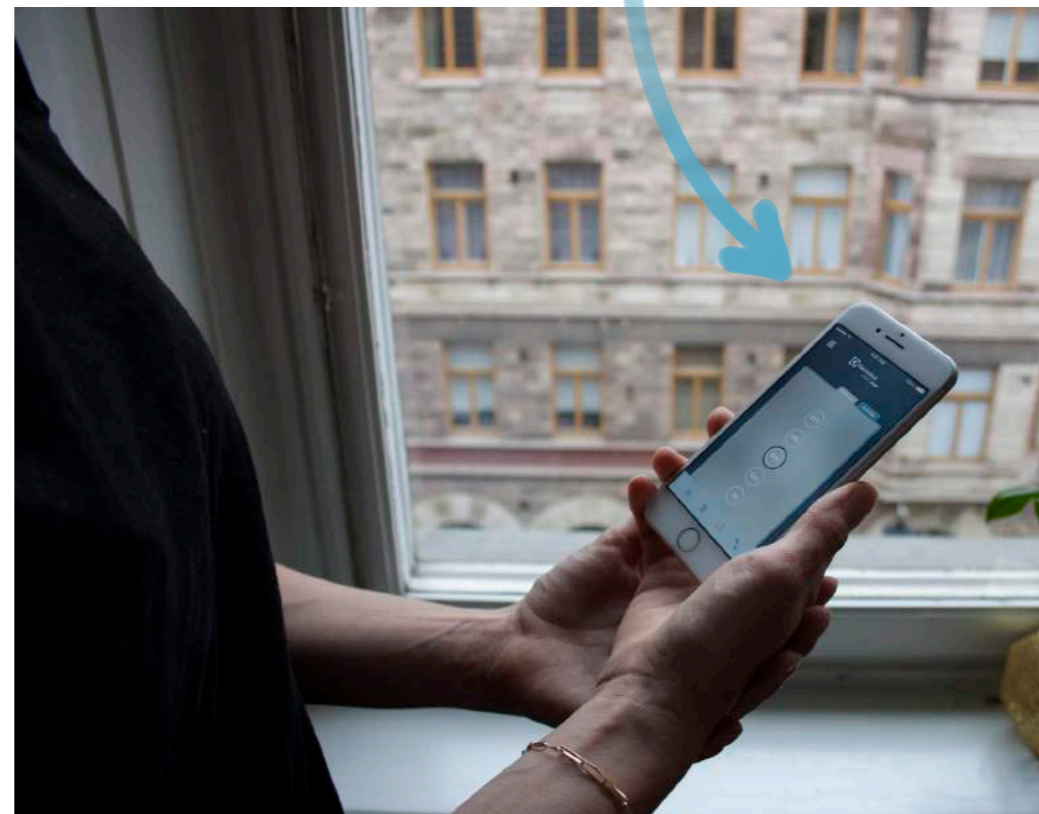
Drawing #1. The device
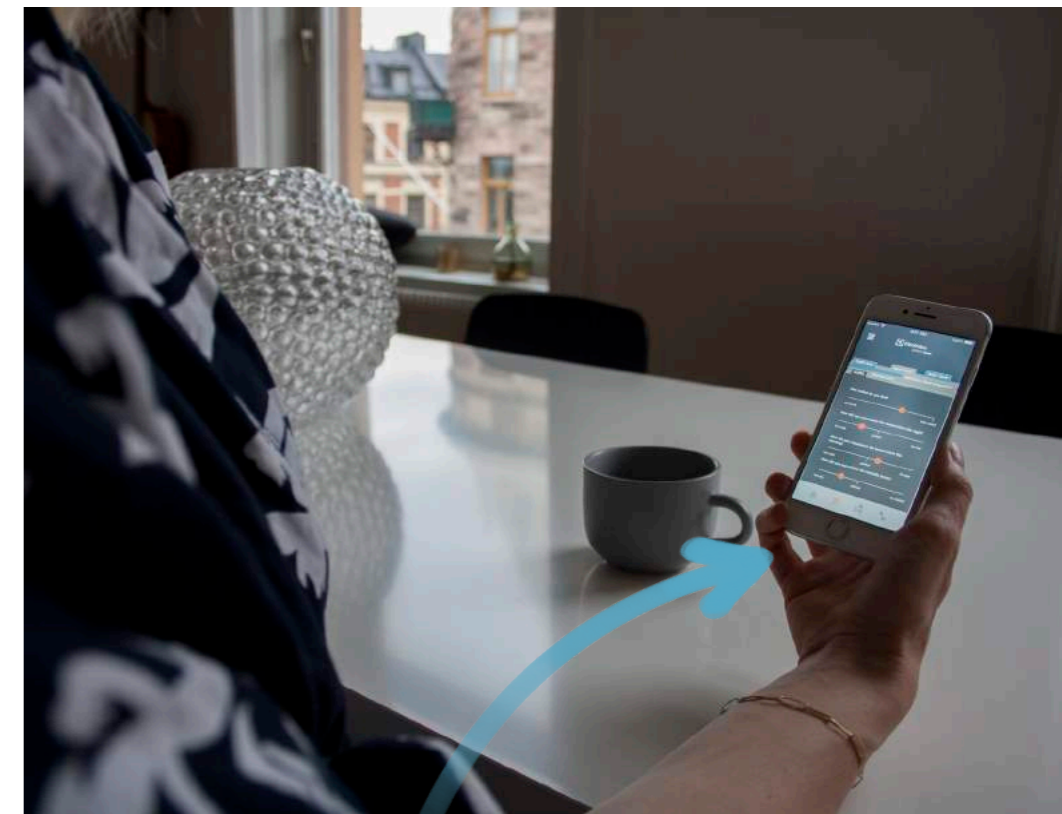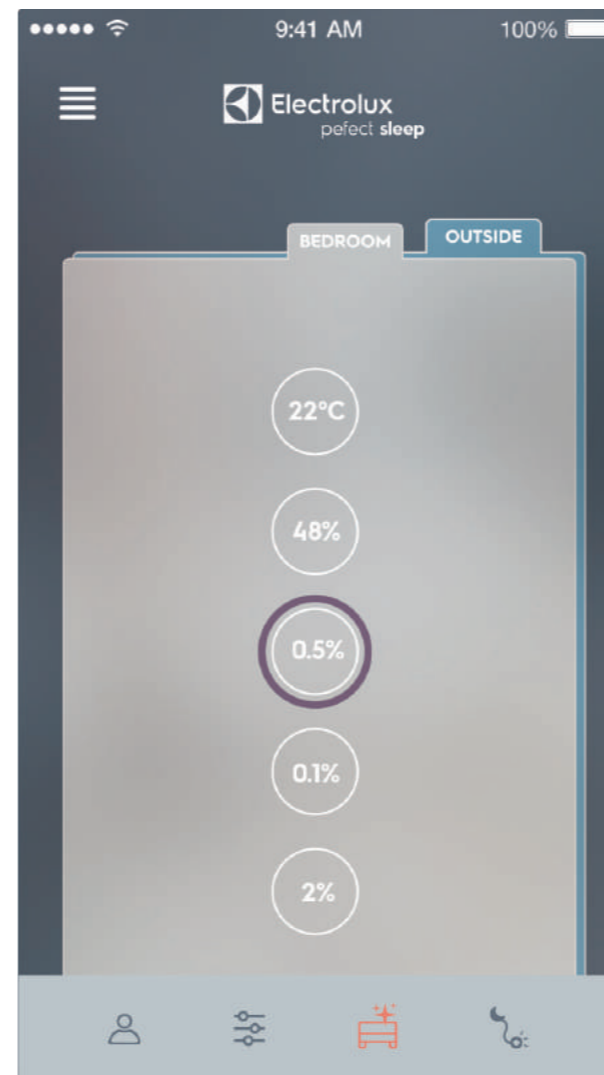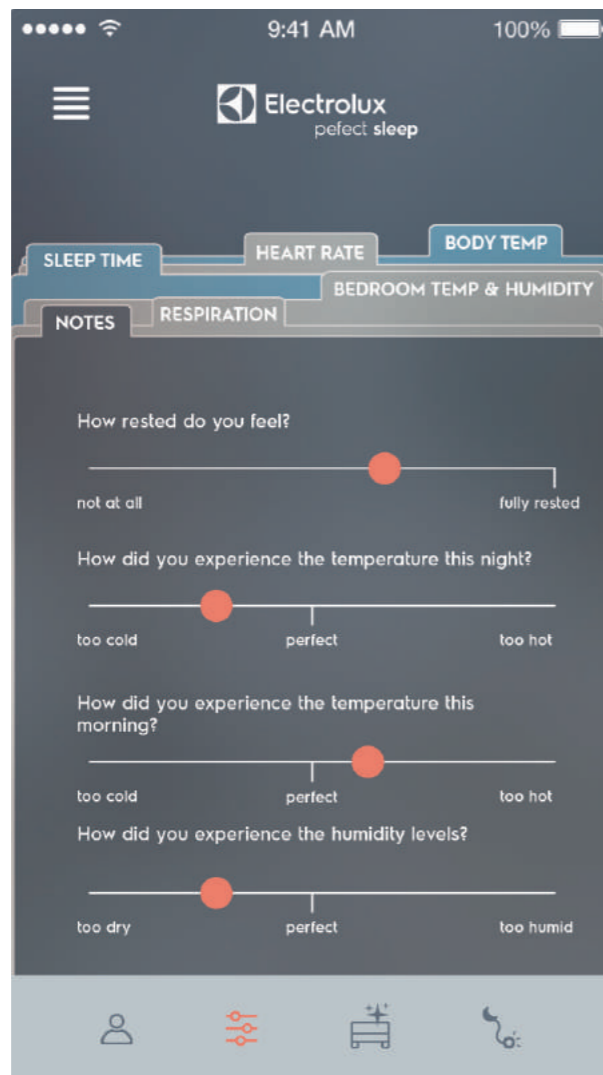
Drawing #2. The charging tray

**Check bedroom air readings
in case of purple light after asking the hub (gesture)**

Set bedtime & wake-up experience

Rate your settings for a learning system

13. DISCUSSION

This project started with a broad subject – sleep. Sleep is a rather complex, intimate and personal subject. Everybody has an opinion, experiences and preferences regarding sleep, but even so we do not exactly know what is going on in our brains while we sleep. Sleep is a highly natural and could be a very uncomplicated event – you are tired ergo you sleep - but even so many people faces a line of difficulties in relation to sleep.

During the project I have debated the interaction between sleep and connectivity. You could say that many of the modern sleep issues are subsequent to connectivity, which is why it in many senses could be seen as a contradiction in terms to tie them together in order to create better sleep for people.

The aim of this project was not to reach the phase of a ready to produce product. Therefore a lot of more development and testing can be done, the result should more be seen as a visualisation of the concept rather than a finalized product.

The least amount of time was put into the development of the bedband and the heatpad. The decision to have magnetic charging connections for them is debatable since unplugging them wouldn't happen on a daily basis. The optimum solution would also not include cords but further investigations would have to be made to see if cordless would be possible. Batteries require charging but with enough of time in between the charging/changing occasions and with a simple and easy to use solution – maybe batteries could be a better option.
The fabric on the pads would of course need to be developed into removable, washable covers. The products are intended to be placed under

the sheets in the bed but would need to be washable for sanitary reasons.

Regarding the design choices of the device, the design hierarchy of the air holes on top of the device could have been higher in order to communicate that it is an air-measuring device. It could also be made clearer in the design how the air travels trough the product to measure it. Important regarding the device would also be to develop the touch and feel of the wheel where settings are done. The experience of turning and pressing the wheel would be crucial since the physicality is key to the product. The weight of the device and feel of the surface would also be important factors for further development.

Regarding the application solely three different frames where developed for three different scenes in the scenario. This was done because of time limitations but also in order to visualize some important scenes from the scenario. The next step for the development would be to continue to sketch on the entire flow of the application and to do continuous testing along the way.

Looking back it would had been interesting to do separate trend and user research for each emerging market for the Healthy Home department. Even so, to do a separate research chapter for seven cities (New York, Sao Paolo, Milan, Dubai, Shanghai, Seoul and Tokyo) would have been too time consuming for this project. The consumer insights derived from the marketing department was indeed sourced from different countries but it would have been interesting to continuously separate the different markets and to do a summary and research section for each.

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14.3 Verbal referenses

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THE END

Thank you!

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