

**Project Rewind, Smart Studio**

**Concept design for supportig rest or sleep in public environments**

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## Abstract

Rewind is a Master's project that focuses on how to support sleeping in public environments. With focus on interdisciplinary methods the project's aim was to investigate the conventions of sleep and to develop a conceptual framework that could inform the design of a device that could support sleeping in public environments. The starting point was to allow sleep to have its own space and form both conceptually and physically in a public environment, like for example in an office where sleep is not allowed even though it may be needed. Sleep should be allowed to take place and should shape the character of the room so that sleep becomes accepted and that our need for it is acknowledged. One aim of this project was therefore to find the obvious and natural design that motivates sleeping in public and that makes it accepted. Results from interviews showed that important aspects to consider were safety and sound input. The concept that was the result of the designwork was called Augmented sleep. The most important design idea in Augmented sleep was that environmental sounds was used as input to a biofeedback system so that the user could control the sound input by relaxing. Most important conclusions from discussions performed in focus groups were that they would prefer a personal device and that it is questionable to create a device where the users have to trust a system that takes over bodily functions. Design methods, artistic methods and methods in human-computer interaction have set the frames for the work.

## Sammanfattning

### Design av koncept för att stödja vila eller sömn i offentliga miljöer

Rewind är ett examensarbete som fokuserar på möjligheten att stödja sömn eller vila i offentliga miljöer. Med fokus på tvärvetenskapliga metoder, är projektets mål att undersöka konventionerna kring sömn och utveckla ett konceptuellt ramverk för design av en utrustning som stödjer sömn eller vila i offentliga miljöer. Utgångspunkten har varit att tillåta sömnen ta utrymme och form både konceptuellt och fysiskt i en offentlig miljö, till exempel på ett kontor, där sömn vanligen inte är tillåtet även om det finns ett behov. I detta arbete ska sömnen tillåtas ta plats och forma karaktären av rummet så att sömnen och behovet av vila blir accepterad. Ett mål för projektet har därför varit att hitta en självklar form som motiverar offentlig vila. Intervjuresultat visade att viktiga aspekter att ta hänsyn till var säkerhet och ljud. Konceptet som var resultatet av designarbetet kallas Augmented sleep. Den viktigaste idén rörande Augmented sleep var att miljöljud används som input till ett biofeedbacksystem så att användaren kan kontrollera ljudinput genom att slappna av. De viktigaste resultaten från diskussioner i fokusgrupper var att de föredrar en personlig utrustning och att det är möjligt att ifrågasätta skapandet av ett verktyg där användaren måste lita på ett system som tar över kroppsliga funktioner. Designmetoder, konstnärliga metoder och metoder i människa-datorinteraktion har satt ramarna för arbetet.

## Thanks

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# Concept design for supporting rest or sleep in public environments

## Introduction

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Rewind is a project in the Smart studio, at the Interactive Institute in Stockholm. The starting point was to allow sleep to have its own space and form (both conceptually and physically) in a public environment, for example an office where sleep is not allowed even though it may be needed. Sleep should be allowed to take place and shape the character of the room so that sleep becomes accepted and our need for it is acknowledged. The project is about the form that motivates sleeping in public and which makes it accepted.

Rewind is a project about sleep and is characterised by interdisciplinary thinking. It has been important for the creative process to gain information and inspiration from different areas. The literature study involved studies in areas such as: napping, sleeping, public health, sleep in art, sleep stages, the sleep environment, products supporting sleep or wake and technology for human-computer interaction that is relevant for Rewind. It has been important to develop a broad understanding for areas related to sleep to be able to find an innovative and motivating area to start a project around. Members in workshops have been people in an interdisciplinary co-ordinated group. Members represent areas such as art, industrial design, computer programming and human-computer interaction. Important in interdisciplinary collaboration is communicative competence [7] as a lack of it can both produce difficulties to understand each other and misinterpretations. The interdisciplinary collaboration can be an ingredient in a method for generating innovative ideas. That is an important underlying opinion that forms this project. It is common that human-computer interaction project groups need competence from different areas.

The results of the Rewind project is a concept for a product, or a mobile environment that will be a place for reducing stress and enjoying rest that increase energy. The motivation behind the project is that being “burnt-out”, stressed and lacking enough sleep is becoming a major health risk. A short rest during the day is an often forgotten way to gather one’s energy in a stressful society.

For example, a tired person should be allowed a half-hour’s rest or a short sleep by stepping into an environment that supports the transition from sleepiness to wakefulness; where the room adapts to the individuals tiredness. It could also be a wearable (portable) product with a corresponding function. By creating this favourable environment for a catnap we give the bed, sleep and the public space a new meaning.

## Physiology

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### The public health

Lack of sleep has become a public health problem and the subject is current in today's debate about stress and being burnt out. One fifth of all reported sickness are caused by psychological illness [12]. The Swedish insurance company SPP's statistics show that depression and getting burnt out are the most common reasons for long-term reported sick leave. The stressed person usually does not listen to the signals of the body, and is working even though the body says no. Eventually symptoms like indispositions, headache, and dizziness occur. Being burnt out then might result in chronic sleepiness, sleep disorders, chronic pain, aggressiveness and depression. A life in a 24-hour society with too much stress often includes lack of sleep. Today the life awake is worth a lot. The rest and sleep is regarded as taking too much time and is often connected with passivity, laziness, inefficiency, and something that is almost shameful. The fast effective work and a sleepless society have reached high priority in many groups of professions. This status of sleeplessness complicates the possibilities to demand different working hours and working conditions. According to Swedish medicine statistics from 1999, the sale of prescription of soporifics and tranquillisers were 4.4% of sold prescriptions [28]. This is one of the three largest separate groups of sold prescriptions and it means 3217 sold 1999.

### Sleep

#### The sleep regulation

The need for sleep is very individual. It is reported that long sleepers tend to be more introverted and creative, while short sleepers are more extrovert and concrete [23]. This is, of course, a generalisation, but it might give a hint of the correlation between personal characters connected with sleeping habits and needs. The differences in the need of sleep stem from the interplay between the:

- autonomic nervous system balance
- homeostatic drive for sleep
- circadian rhythm

#### *Autonomic nervous system balance*

The autonomic nervous system controls activity from the body's glands and organs. A subdivision of this system is the parasympathetic nervous system. The parasympathetic nervous system affects one or a few organs at a time. Contrary to the sympathetic system which activates the internal organs, the parasympathetic slows down body processes. These two subparts of the autonomic nervous system together create a balance for the internal organs.

Stimulation of the parasympathetic activity in the autonomic nervous system (ANS) causes signs of sleep, both behaviourally and on the EEG pattern (measuring brainwaves). On the other hand sympathetic activity will disturb sleep. Sleep disruptions caused by the endogenous influences include fear, anxiety, worry, muscle tension and pain. Exogenous causes of sleep disruptions include ingestion of stimulants, heat and sudden and intrusive noise.

There are two characteristics that are especially relevant to sleeplessness. First, the fact that stimulus causes autonomic responses. If you repeatedly associate the sleep environment, your bedroom or bed with for example worries, anxiety or unsuccessful attempts to sleep, insomnia might be a fact. The second thing is that once being awakened by a stimuli that causes sympathetic arousal it will take some time to get back to relaxation or sleep. The response does not disappear directly.

### *Homeostatic drive for sleep*

The homeostasis is the name of processes that maintains the balance in the body, between all the complex systems. The homeostatic process contains both the behavioural adjustments and the physiological adjustments [27]. The regulation of body temperature is an example of a homeostatic process where the physiological process of perspiration cools the body down. The behavioural part is that you probably move to a shady or cooler environment to adjust the temperature. The homeostatic mechanisms also help to regulate sleep in general and the specific stages of sleep. For example it compensates for the lack of a specific sleep stage from a bad night's sleep. If you have a lack of say, REM sleep (rapid eye movements or dream sleep), a 20 minutes nap will contain lots of REM sleep to compensate for the debt. A general sleep debt will probably cause a debt of slow wave sleep and a nap will then generate stage 3 or 4 sleep (deepest sleep stages).

The hypothalamic regulation of sleepiness can be compared to the motivational states of sex, hunger and thirst that produce behaviours to reduce the specific drive. The drive to sleep is connected to the behaviour of less activity. The point is that the purpose of sleep is not to reduce sleepiness but to satisfy the *underlying* reasons why a person sleeps. This brings us to the different theories of why we sleep and research has not got the complete answer to this question. For example one theory explains that we sleep because neurochemicals are resynthesised and growth hormone secreted during sleep [1]. Evidence supports this theory but it fails to link sleep to the activity the day before. An extension to this theory suggests that "sleep has a specialised restoration function within the brain" where noradrenalin is important for REM sleep and serotonin for non REM sleep. Another theory is explaining sleep as an evolutionary behaviour. Further reading about this can be found in [1].

### *Circadian rhythm*

Circadian rhythms are biological rhythms with regular changes over periods of 24-26 hours [23]. The sleep-wake cycle is a circadian rhythm, usually said to be 24.9 hours long [1]. The sleep-wake rhythm is controlled by on one hand the inner biological clock and on the other hand by so called *zeitgebers*, environmental cues like light, eating and the clock. Even without the environmental cues such as light and knowing what time it is, the circadian rhythm seems to move on with the 24.9 hours rhythm. This was showed in a experiment with a man who was set to live in a cave with no external cues and still kept the 25 hour rhythm. This is a proof that we also have internal biological clocks. The endogenous mechanisms, SCN (supra-chiasmatic nucleus) and the pineal gland, together control the circadian rhythm and are reset by light. Light impulses are transported through the eyes, along the optic nerve into the brain. Some of the impulses reach the SCN which neurones have a circadian pattern. The SCN neurones regulate the pineal gland's production of melatonin, which makes us tired at certain times during the evening.

The human being is very adaptable and since the introduction of electricity we have changed our rhythm and can be awake later in the evenings. A great miscorrelation though between the inner clock and the environmental cues will cause a disturbed sleep-wake pattern. One example is jet lag, when the timing of zeitgebers like light and meals are different from what the body's inner clock expects. It is possible to prevent jet lag by being exposed to bright light (light therapy) at certain times when your biological clock signals that you should sleep in contrary to the environmental clock. People working at night shifts are also affected by the disturbed circadian rhythm.

The temperature rhythm correlates with the circadian rhythm and is often used as a marker of the later. A fall in body temperature is correlated with drowsiness and rising temperature with arousal. In the experiment with the man in the cave the temperature cycle didn't follow the change in the sleep-wake cycle and therefore seems to be another separate endogenous clock.

### **Effects of external stimuli while sleeping**

According to some older studies it seems that we, to a certain amount, are susceptible to external stimuli during REM sleep and slow wave sleep [5]. Stimuli such as as sound, sensory stimuli and

light can affect the content of the dreams. By waking up subjects from a specific sleep stage and ask what they dreamt of, their reports showed stories associated with the external stimuli. The literature, however, gives no convincing proof of how external stimuli affects the dream content. What we know for certain is that external stimuli cause awakening. As mentioned above, exogenous autonomic activity will cause sleep disturbance. Sometimes this is not unwanted, for example when night time drivers or shift workers get tired it could be danger to their lives. Tests with light, temperature and sound have succeeded in keeping drivers awake.

### *Temperature*

The temperature in the environment affects the amount of the subjective sleepiness. Studies in regulating the temperature during a simulated truck driving gives proof for the hypothesis that temperature reduction counteracts sleepiness [14]. When the subjects were exposed to recurrent reductions of temperature (in 2 or 4 minutes cooling periods) it does not seem to exist a tendency for continuing development of sleepiness. The wakefulness stabilises at a constant level and with rise in the temperature the sleepiness returns. The temperature during the tests were changed between + 18°C and 28°C with a changing of 10°C/minute. Observe that there seems to be a difference in how body temperature and room temperature (see Circadian rhythm) affect sleepiness.

### *Sound*

In public spaces it is common with a lot of sounds. To develop a prototype that supports sleep or rest in a public environment, it is probably necessary with noise reduction to be able to fall asleep. Sound can of course be used to wake up. Depending on the frequency of the sound it is more or less wakening. Low frequency noise and monotonous irregular sounds can cause sleepiness [15]. High frequency sounds and time variable sounds in intervals are wakening.

A 4 seconds long sound signal repeating in intervals, 1, 2 and 5 minutes, have an effect of wakening. Tests [15] with this were made with 60 and 70 dBA; 70 dBA was more wakening. The rise of the amount of alpha waves triggered the sounds when they reached a level considered as a high level of sleepiness. For drivers it is important to make the sound clear and discernible among other sounds. The sounds also have to be varying to avoid getting used to them.

### *Light*

As indicated above (see Circadian rhythm), light is an important factor to sleep since our sleep-wake cycle (circadian rhythm) is reset by light [1]. It is possible to relieve jet lag by light and it has positive effects on mood for persons suffering seasonal affective disorders like depressions appearing in the darker months of the year [1].

A more concrete example of how light affected truck driver's sleepiness [13] during a test will now follow. Two different light systems were tested at their pause. One system was a light box with full colour fluorescent tubes (2000 candela/m<sup>2</sup>, 1000 lux) placed in front of the driver on the steering wheel. The other system was a cap with two bulbs with reflectors, which lighted the eyes. (The luminance during the light exposure was 2500 candela/m<sup>2</sup>, 600 lux.)

After 30 minutes of exposure, at five times plus control test, results were given showed a significant difference between light and no light for the cap. The light cap delayed the development of sleep for two hours after the exposure. The light box proved to be less effective. The drivers themselves didn't think they were affected.

What is always said to be important in light therapy is the intensity of light. At least a couple of thousands lux is necessary to gain positive effects.

## How to fall into a good night's sleep

There are no simple answers to how to fall asleep in the best way since it is very individual. The conditions for sleep are many. However some general tips are sometimes suggested. To fall asleep easily the external stimuli from the environment, described above, have to be as preferable as possible. It is also good to know what to eat and not to eat before going to sleep. A big meal is not to recommend, but a light meal at least two hours before sleep is all right to eat. Going to bed hungry will cause disturbed sleep. For example bananas, avocados and peanut butter include the amine acid tryptophan, which is activating the parasympathetic nervous system that calms the body down [17]. Regular exercise, meditation and a comfortable sleeping environment and bed/seat will give good sleep.

## Polysomnography

Polysomnography is made at a sleeping lab or with a portable device at the patient's home. It is used for identifying and evaluating sleep disorders with analyses of sleep stages, circadian rhythm (see below), movements and behaviours in sleep [23]. Polysomnography includes

- EEG for measuring brainwaves.
- EOG for eye movement recording.
- EMG for recording of muscle activity from the chin or neck. EMG from the legs identifies movement disorders.
- Respiratory measures for identifying breathing disorders during sleep.
- Temperature measures for identifying circadian rhythm.

## The sleep stages

We sleep in cycles of 90-100 minutes with different characters of the sleep within this time. The sleep cycles are divided into five different stages: REM, stage 1, 2, 3, and 4. The sleep starts with stage 1 to 4, up to 3 and 2 (see figure1). The cycles end with REM sleep, except the first. The stages are often referred to the different brain activity measured by electroencephalography (EEG). The brain activity appears differently in the different sleep stages. The EEG filters out these different frequencies and amplitudes from our brain that characterises the sleep stages where some frequencies/amplitudes appear more in some sleep stages. The EEG pattern is therefore based on frequency and amplitude. The frequency is given in cycles per second (cps) or Hertz (Hz) and the amplitude in MicroVolts ( $\mu\text{V}$ ). The brain waves during sleep are often called alpha- (8-13 cps), delta- (less than 4 cps) and theta (4-7 cps) waves. EEG patterns during sleep are shown in see attachment 1.

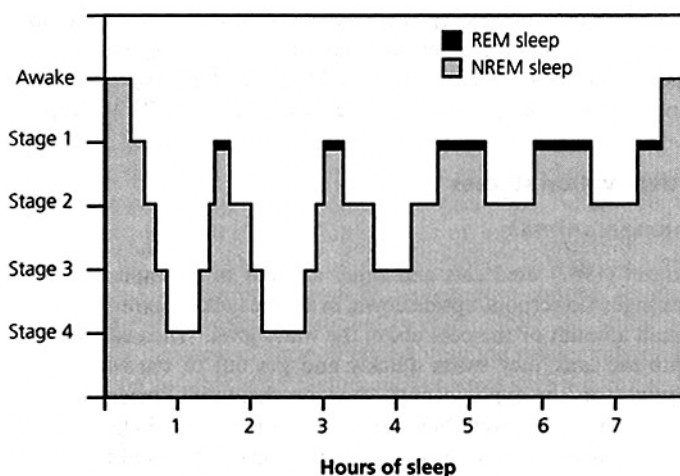


Figure 1. The sleep cycles. From [Bentley, Awareness].

### *Sleep onset*

A relaxed person who is trying to fall asleep has a great amount of alpha waves, which is between 8-13 cps [23]. When falling asleep the alpha waves slowly disappear and so do blinking and rapid eye movements (from wake). A decrease in chin muscles and frontal scalp activity appear.

### *Stage 1 and REM sleep*

Stage 1 is considered as drowsy sleep and it is easy to wake up. During this stage less logical thoughts appear, a feeling of falling or flying and dreamlike feelings sometimes mixed with the external environment. Stage 1 sleep lasts between 1-10 minutes and is about 5 % of a night's sleep [17]. The heart rate slows and muscles relax. Brain waves slow down from faster to slower alpha waves down to theta waves [1]. Compared with the other sleep stages, sleep stage 1 is recognised by the absence of K-complexes, sleep spindles and delta activity (see below). Depending on the movement of the eyelids it is possible to separate stage 1 sleep from REM sleep. Stage 1 sleep has slow eye movements (SEMs) particularly at sleep onset. The eyeballs are slowly oscillation from one side to another, mostly horizontal. The EEG pattern of stage 1 contains activity of mixed frequencies and low voltage.

REM sleep is popularly called "dream sleep" because of the rich dream content. After waking up from REM sleep we often remember the dreams. As in stage 1 sleep, the EEG pattern for REM sleep also contains activity of mixed frequencies and low voltage. The difference is that during REM sleep we can observe rapid eye movements (REMs). There is also typical sawtooth-shaped waves that may be present. The activity range is between 4-7 cps, and that range is called theta waves. Also characterising REM sleep is the general loss of muscle activity. All muscles except the involuntarily controlled (heart, lungs, and other organs) are paralysed. It is unknown why this muscle inhibition is taking place. A theory is that it is preventing the person from living out his dreams, because of the rich dreaming. REM sleep occurs most frequently at the end of the night.

### *Stage 2*

Stage 2 sleep lasts about 20 minutes and is about 50% of a night's sleep [17]. During stage 2 sleep, heart rate and blood pressure and body temperature continue to fall. Quiet sounds do not wake us. The presence of sleep spindles and K-complexes define stage 2 sleep together with the absence of slow wave sleep. Sleep spindles are bursts of EEG waveforms, with a mean frequency of 11.5-16 cps and duration of at least 0.5 seconds. The amplitude is usually not more than 50 $\mu$ V in adults. K-complexes are EEG waveforms that show high voltage. It is usually less than 1.5 seconds in duration but can be either slow (long contoured) or sharp. Sleep spindles often follow a K-complex. The K-complexes occurs either spontaneously or in response to external stimuli. The probability of waking up is greater several minutes after a K-complex.

### *Stage 3 and 4*

Sleep stages 3 and 4 are also known as delta waves and slow waves sleep. The delta wave frequency is less than 4 cps, usually ranging between 0.1 and 3.5 cps. For sleep specialists the slow waves (the frequencies below 2 cps) are the most interesting ones. Delta activity is the slowest EEG activity and is maximal over the central and frontal cortex. It occurs over the entire scalp during the slow wave sleep. It is difficult to be waked up from stages 3 and 4 and if so the person seldom remember any dream content. Stage 3 sleep lasts for only a few minutes (about 7 % of a night's sleep) while stage 4 lasts for about 30-40 minutes (about 11 % of a night's sleep) [17]. Sleep stage 4 is when the metabolic rate is at the lowest. During these stages sleep talking and sleep walking can occur. This might seem contradictory since we are in the most relaxed state. Research can not yet explain much of these phenomena.

### *Comments for Rewind*

For Rewind we are interested in creating a prototype that supports rest and if possible, sleep. The vision is that the prototype will be inspiring enough so that it is possible to fall asleep. We can't

consider the project unsuccessful if people do not, since the conditions for sleep are individual. With the background of napping and our approach to rest vs. sleep we will probably work mostly with sleep stages 1 and 2. Note that napping also can produce stage 3 and 4 sleep if the person has a sleep debt.

## Napping

Napping is usually regarded as short sleep, 20-30 minutes, but sometimes longer. A short daytime sleep can have positive effects for both the person with sleep debt and the recreated. A nap might also have negative effects like reduced alertness after waking up, “sleep inertia”, because of being waked up from slow wave sleep. Increased alertness, mood and performance are some of the advantages of napping [8]. The effects however, depend on a number of aspects:

- the duration of the nap
- how long the person has been awake before the nap
- what time in the day the nap is taken

Test results showed that a 20-minute nap in bed at 12.20-12.40, after 8 hours of sleep at night (at 00.00-08.00), gives positive effects in 1-2 hours [8]. For example subjective sleepiness was reduced, but napping at this time is less effective than later naps [8]. The reason is that it does not coincide with the biological rhythm that causes sleepiness in the afternoon so the afternoon sleepiness occurs regardless of this extra sleep and naps at noon. Timing naps at this time has also been shown to improve sleepiness, subjective ratings of performance level and EEG arousal level [10]. It did not enhance the performance level.

A 20-minute nap in bed, at 14.00-14.20, after eight hours sleep at night (at 00.00-08.00), reduces subjective sleepiness, increases performance and self confidence regarding performance and reduces alpha activity during 3 hours after the nap [9]. Motivation also increases and fatigue decreases.

Resting in a semi-reclining chair in 20 minutes, compared to the case just above, includes no subjective increase in performance [9]. An improvement in mood has been reported by subject resting (not falling asleep) for 1 hour. The timing of the naps affects the effectiveness of the nap, the post-nap sleepiness levels and the time of sleep deprivation effects [18]. The effects can either be delayed or immediate depending on the timing of the nap. Tests were arranged with a nap at 15.00-17.00 and 19.00-21.00 after a prior night of wakefulness and a day with 13 minutes of waking and 7 minutes of resisting sleep. As in earlier tests described above this also shows the importance of the timing of the naps for best results. It was also shown that an abrupt waking can affect sleepiness or alertness.

It should be observed that those tests that support the results above, are comparing bed napping with resting (no nap) in a resting chair. The results would therefore indicate that napping is better than resting. Other tests have shown that resting also improves mood compared with no rest. The subjects had one hours nap or rest and both conditions showed positive changes in mood [4]. The subjects felt less sleepy and tired.

## Relaxation

There are many different kinds of techniques recommended for relaxation and a few are shortly described here.

### *Meditation*

In meditation one focuses the attention on one single thing, for example on breathing, on a sound or one word to relax. A pioneer in mind/body medicine finds that meditation, as described in [38], “can be broadly defined as any activity that keeps the attention pleasantly anchored in the present moment. When the mind is calm and focused in the present, it is neither reacting to memories from the past nor being preoccupied with plans for the future, two major sources of chronic stress known to impact health.”

Even if there are different techniques of meditation [38]; “All the meditation techniques can be grouped into two basic approaches: Concentrative meditation and Mindfulness meditation. Concentrative meditation focuses the attention on the breath, an image, or a sound (mantra), in order to still the mind and allow a greater awareness and clarity to emerge. This is like a zoom lens in a camera; we narrow our focus to a selected field. The simplest form of concentrative meditation is to sit quietly and focus the attention on the breath. Yoga and meditation practitioners believe that there is a direct correlation between one's breath and one's state of the mind. As you focus your awareness on the breath, your mind becomes absorbed in the rhythm of inhalation and exhalation. As a result, your breathing will become slower and deeper, and the mind becomes more tranquil and aware.”

Mindfulness meditation, according to Dr. Borysenko, "involves opening the attention to become aware of the continuously passing parade of sensations and feelings, images, thoughts, sounds, smells, and so forth without becoming involved in thinking about them." It is common to first learn concentrative meditation where you focus and then open up the sphere of the meditative focus to let thoughts be caught more freely, but still in a meditative state. In Mindfulness meditation you let the thoughts, emotions and physical reaction come and go without judging or getting involved with them. As in all types of meditation the focus of breathing is important.

#### *Yoga*

In yoga methods for breathing is used, stretching and visualisation for gaining a relaxed mental and physical state which can improve your sleep [17].

#### *Peripheral vision*

This is a method where you start focusing on a point above your forehead so that you have to look up. By focusing intensively enough there will be a tunnel vision. Then try to broaden your field of vision, still looking at the same point. This is said to cause relaxation because of activation of the parasympathetic nervous system [31].

#### *Energy bubble and float above yourself*

One method to gain relaxation is projecting an energy bubble around oneself and imagining that stressful things are bouncing on the bubble away from yourself. Another way of getting relaxed is to imagine that oneself is floating out of the body, the higher the more relaxing. It could also be used for coping with, for example, stressful situations and memories [31].

## Sleep in art and design

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This section will exemplify different approaches to sleep in design, architecture, art which include literature, music and a short history of the bed and sleeping environment.

### The bed

Neither the construction nor the design of the bed has changed much over the years. The sleeping environments have probably changed more. Nowadays people sleep in everything from tents to bunks in space. Pilots for example can take a nap on the aeroplane and we are not always sleeping at home, but in hotels, at the bus or train, or at a rest area at work.

The first beds were probably heaps of leaves covered with animal furs used by the cave men [11]. They slept together to keep warm and safe. Even today in some parts of the world mattresses are filled with hay or leaves but also feather is used. Waterbeds were already used by the nomads in Persia. Goatskin was filled with water to isolate from the cold. The Japanese people have slept in futons for over 4000 years. The Romans slept in cradles divided in two, where one was filled with water and one had a mattress. They were lulled to sleep in the water and then lifted by their servants to the mattress. At the end of the Middle ages the rich built solid beds with walls and sliding doors. For Ludwig XIV the bed was very important for his life and he even held court from the bed. He owned 413 luxurious beds. With the industrial revolution the bed constructions were improved and the helical spring was found. During the 1940's synthetic rubber was found which were used for the first mattresses of latex. During the 1950's latex was replaced by polyurethane and is what is used for foamed plastic mattresses today.

The history of bed in short: [41]:

- **10000 years ago.** Man started to sleep on primitive beds.
- **3400 B.C.** Egypt pharaohs discover the advantages with lifting up the bed from the floor. Tutankhamon had a bed made of ebony and gold. Common people slept on palm leaves bent over in the corner of a room.
- **Roman Empire.** The first really luxurious beds with mattresses filled with hay, wool and feather. They were decorated with gold, silver or bronze.
- **Roman Empire.** The first water beds.
- **Renaissance.** The mattresses were filled with straw or pea-shells, sometimes feather and were covered with velvet or silk.
- **Late 18<sup>th</sup> century.** The first cotton mattress and iron casted bed. The bed was now unattractive for bugs.
- **1865.** The first helical spring constructions for beds were patented.
- **1930's.** Stuffed mattresses made of helical springs became common.
- **1950's.** Foamed plastic mattresses and pillows were introduced on the market.
- **1960's.** Modern waterbeds were introduced. Adjustable beds became popular.
- **1980's.** Airbeds were introduced.

### Sleeping in seats

In Rewind napping and resting in public spaces will probably mean sleeping in seats and not beds. Anyone trying to sleep on a flight knows that it is often difficult. It is difficult because the angle between the vertical plane and the plane supporting the back is too small. In fact sleep angles greater than 40° will give good sleep efficiency and fewer awakenings [21]. The less angle the poorer the sleep.

## Design for sleeping in public environments

Here I will shortly present three of the most diverse solutions for sleeping in public environments that I found during the research phase. These will serve as examples of how different public environments creates opportunities for the design for sleeping.

### *Jennie Pinneus*

Jennie Pinneus, (education from Beckman's school of design) wants to point to one of today's most threatening health issues – stress. She has created a cocoon to rest in, in a public place [33]. It is a fine example of design and function.

### *Capsule hotel*

In 1977 an entirely new concept of a hotel was introduced in Japan, the so-called Capsule Hotel. These 3.3 square metres big sleeping capsules was designed by Kisho Kurokawa and manufactured by the well known furniture manufacturer Kotokubi. The capsules are stacked on to each other in the corridors. The hotel only accepts men and it is common that Japanese businessmen stay there after a long day of work or nightlife. In the first capsule hotels you were only allowed to stay for one night and while checking in you switch your shoes for a key to a safety box to wear around you wrist. The capsules include sleeping space, TV, radio, alarm clock and in some a coin fax machine and some space for studies. Today there are a lot of facilities connected to the hotel such as sauna, karaoke, massage, bath and fitness.

### *Sleeping in outer space*

There are a few ways that sleeping is arranged in space depending on the different requirements of the mission. The crew sleeps in their seats, in sleeping bags, in bunks or by tethering oneself to the walls [40]. They separate between one and two shift sleeping. At the one shift work everybody sleep simultaneously. One will wear a headset communicator to be able to get reached for warning or emergency.

The sleeping bag contains a support pad, a movable pillow and head restraint and six adjustable restraining straps [39]. On the side that is attached to the wall there are three helical springs on the straps. The helical springs relieve loads on the crewmembers. The sleeping bags are made of special material and are perforated for thermal comfort. The crewmembers are also provided with sleeping kits with eye covers and earplugs.

The three or four rigid sleep stations are equipped with a cotton sleeping bag, personal stowage provisions, a light and ventilation inlet and outlet in each of the tiers. The light is a fluorescent fixture with an on and off position. The sleep station for three persons weighs 205 pounds and is made of plastic honeycomb panel. The four persons sleep station weighs 173 pounds and is made of metal.

The crew normally sleeps 8 hours a day excluding the 45 minutes period of preparing for bed and another 45 minutes of getting ready for the day.

## Art

Sleep has been a popular subject in art for a long time. The surrealists were inspired by dreams, the unconsciousness, where Dali is one of the most famous examples. In Sweden the two artists Thomas Liljenberg and Leif Elggren have worked with dreams and sleep in their artistic expressions for years. Art pieces such as the books *Experiment with Dreams* and *The Answers and music for example sounds from a sleeper* – a CD called *Zzz...* (Stockholm 1996. CD, Firework Edition Records 1002). For more information, see [32]. At the hotel *Künstlerheim Luise* in East Berlin, 32 artists got an assignment to design the interior of a hotel room. The artist Peter Buechler [34] has used that possibility for an installation with fluorescent letters in front of the bed. By searching for meaningful combinations you are falling asleep. On another wall a fluorescent area leaves a shadow of yourself under a few seconds. The science fiction author

William Gibson, known for coining the term cyberspace, has written a novel called *Fragments of a Hologram Rose*. It is a visionary story about a boy with difficulties to fall asleep and what he experiences then. A lot of music is also inspired by sleep and inspiring to sleep. New Age and similar movements have developed special music for relaxation. This stereotypic music is often based on slow rhythm, ambient sounds and sounds from the nature such as waves, wind, fire or singing birds. Over all it is of course very individual how music affects us and is regarded as relaxing.

## Human computer interaction

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There are several areas in human-computer interaction that are relevant for Rewind. Some of them are therefore described below to show what background theories and concepts of technology Rewind is inspired by and based on.

### Wearable computing

With ideas of creating an environment that inspires for sleep or rest in public places it is close to think of using wearable computing. Wearable computing is wearable and portable computers mounted on clothes, headgear, glasses or similar [37]. Steve Mann is one of the pioneers and has worked with visual manipulation and video for wearables. There is also something called Wearable Audio Computing (WAC) [36] where sound is the primary modality for interaction, for example using sound to handle information and communication. The sound environment might be used to control information about our environment and balance it between periphery and focus of attention. For Rewind sound could be an interesting parameter to work with since that is one of the things to handle when trying to fall asleep in a public environment.

### Presence

Presence is a term used in many different ways to describe the sense of presence of people or environments, or of yourself in a virtual or real environment [35]. The definitions relevant for the Rewind project is called

- Presence as transportation
- Presence as immersion

Presence as transportation is divided in two subgroups, "You are there" and "It is here". "You are there" is sometimes used as a synonym for virtual presence and is about feeling present in a computer-generated environment. It is here means that the persons react directly to what they see or hear in a mediated experience as if what they see and hear is present in their own environment instead of making an interpretation or a representation of the impressions.

Presence as immersion is a term usually used for virtual reality experiences. It means that people get perceptually and psychologically immersed in the environment and the senses are reacting to the virtual world's stimuli. The term immersion is both defined as a psychological state and a technological description [25]. The psychological state of immersion is connected to how isolated one is from the physical environment and how the perception is reacting in the virtual environment as if it were responding to the real environment. The greater immersion the more sense of presence [35]. When it is used as a description of a technology, it means that it "...describes the extent to which the computer displays are capable of delivering an inclusive, extensive, surrounding and vivid illusion of reality to the senses of a human participant." [25]. The term is more technical and factors that affect this immersion is for example display quality and resolution, the quality of the feedback from movements and navigation and if the view is panoramic or narrow.

These definitions of presence and immersion are interesting for Rewind. When you sleep you are totally "immersed" in your dream or sleep. It might be interesting to create a mediated environment that merges wake with sleep and erases the borders between them.

### Peripheral awareness

As information load now gets greater in new media technology, different approaches to handle this are ongoing. The problem is often that much information demands attention and people has

no possibility to control it. All the time we get information about what is going on around ourselves. Steps in a corridor, your husband snoring in another room, sound from cups and plates in the kitchen. That is what we call awareness of what people are doing and what is happening around us in the environment. A lot of this awareness is peripheral, meaning that it is not in focus of our attention but recognised in the periphery. The fact that human vision is constructed in that way could help us handling today's big information flow. A way of doing that is to make symbolic representation of information or creating a system that allows sensing certain information as peripheral awareness. AROMA [24] is a system that exemplifies this well. It supports peripheral awareness of persons over distance with colour representation of people presence and room activity at work.

## **Calm Technology**

Calm technology is a term coined by Weiser and Brown at Xerox Palo Alto Research Lab [42] and is used in ubiquitous computing. Calm technology is about moving information from the centre of the vision to the periphery to reduce load on the cognitive ability [43]. Calm technology enables the users to control the information environment and choose which information to keep in focus and which to sense in the periphery.

The issue of calm technology is interesting for Rewind since we have to decrease the attention to the periphery to be able to fall asleep. But paying attention to the information in the periphery could also be important to feel secure in the environment.

## **Products and technology**

During the research phase, different technologies for sleep and rest were investigated to get a broad insight on what is already existing on the market. Some of them are presented here.

### **Biosensor technology**

*Sensors for polysomnography (EEG, EOG, EDA, EMG, breathing, pulse)*

Sensors for polysomnography, e.g. for brain activity, muscle activity, eye movements, breathing and pulse. These sensors are applied before sleep and make it possible to identify for example the sleep stages.

*EEG circuit from Circuit Cellar*

This is a circuit that filters out brain wave activity [46]. It is not medically approved, but very interesting to try out especially since it opens up wireless biofeedback possibilities.

### **Telemedicine**

*CardioPocket*

Built in ECG sensors in a pocket wallet send heart rate signals via mobile phone to a station with physicians analysing the medical data [48]. This is interesting technology for Rewind since it is a portable use of biosensors.

### **Products supporting awakening with light**

*SunRise Clock*

SunRise [44] is a watch that wakes you up with a simulated sunrise. The lamp starts to shine 30 minutes before wake up time and gradually the light's growing strength is waking you up.

### *SolarMax*

SolarMax [44] is a peaked cap made with two lamps pointing at each eye. The light intensity can be varied from 500-2500 lux. It is possible to set a timer to turn off the light after 15-60 minutes. SolarMax is used to relieve the effects of jet lag.

*Light boxes* with light intensity up to 10000 lux for lighting therapy, jetlag and seasonal affective disorders (SADs) like depression.

## **Biofeedback systems and relaxation tools**

### *MindSurfer*

MindSurfer [51] is a relaxation and biofeedback system and software with 3-D graphics and sounds, which are controlled by brainwaves. Either you move in one of the available 3-D environments or soundscapes by relaxing. It is like a game where the goal is to move to a certain place in the environment by relaxing or changing the sound with the brainwaves to a sound comfortable enough to fall asleep to.

### *ProComp/Biograph*

A biofeedback system and software [52] to use for sound and visual feedback from sensors like pulse, EEG, EMG, GSR and more.

### *IBVA*

IBVA [47] is much like ProComp except that it only uses EEG.

### *Brain Ball*

Brain Ball [50] is an art project that twists the concept of a game and the concept of relaxation. A ball on a table is controlled by the brainwaves to make a goal on the other competing person's side. Here you are winning by relaxing.

### *brainLight*

brainLight [49] is a product for relaxation and mental training. It is based on optical and acoustical signals, which are said to affect the human nervous system. The blinking light and the ticking sound are blended with for example the sound of waves. The frequency of the ticks are set to correspond to the frequency of alpha-, beta-, delta-, and theta waves. The light and sound frequencies are therefore said to control the brainwaves to a relaxed state. Observe that this is not a biofeedback system.

## **Napping support**

Circadian Technologies [45] have several products that support napping, for example napping chairs and adjustable light. I have tried to reach them for more information without success.

## HCI methods

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### Interview technique

Since there are little literature and research about sleeping in public places, the pre-study contains interviews with people. The purpose with the interviews was to be informed of the sleeping habits of people especially outside the home environment. To get qualitative information interviews are preferred instead of fill-in forms. There are a number of different interview techniques ranging from structured to open.

The open and half-open interview [16] gives the respondent's subjective experience of a phenomenon. The scientific approach to interviewing is to systematically analyse the subjective answers. Other scientific methods often try to work with objective data. Interviews should be separated from observed data. The first case is a description of ones behaviour while the later is an actual observation of that behaviour.

An open interview circulates around one widely formulated question. In the open interview you search for the respondents opinion of the meaning of a phenomenon. It means that the interviewer is also offered a possibility to understand how the person's inner context relates to the phenomena. The respondent defines and delimits the phenomena. The more structured the interview is the greater possibilities to receive quantitative data. A structured interview can hold alternatives for the answers, much like in fill-in forms. In the structured interview the respondent gives her opinion of what the interviewer finds meaningful. It has also got predefined questions and follow up questions.

Suitable for the prestudy in the Rewind project is something in between structured and open interview. It is very important for us to hear the subjective opinions but there are predefined questions.

#### *Interview analysis*

The validity of interview analysis is based on some basic concepts such as; Interview data should be analysed so that the meaning of the entirety is well kept [16]. The raw data should be related to the theoretical understanding already collected. The entire corpus should be analysed thoroughly and the synthesis of these parts should form a higher understanding of the phenomena on a more abstract level. The analysis validity is also dependent on internal subjectivity and external validity. Internal validity means the interviewer and the respondent's relation to each other. The interviewer should have an ability to understand the phenomena from the respondent's point of view and be able to seize the meaning that the respondent gives of the phenomena.

In Intervjumetodik, Lantz [16], seven principles for qualitative work with interview data are suggested as a general model. The first principle states that it is important that the different parts from the interview forms an inner pattern free from logical contradictions. The second principle is about the iterative nature of the analysis process. The process involves switching between analysing the internal parts and the whole until an inner pattern appears of the data. This is done by reading a transcription from the interview to get a global understanding of what was said. After that you work with parts from the interview and then put it in relation to the whole interview. As mentioned above this continues until an inner pattern appears. The third principle is to search for consistency in the data and try to understand contradictions from the respondent's answers. The fourth principle is the autonomy of the interview, that it should be understood without any other information such as the respondent's behaviour or non-verbal information. The interpretation of the interview is only based on what is said during the interview. The fifth principle points out the importance of the interviewers theoretical understanding of the phenomenon studied. The sixth principle states that there is no unprejudiced analysis of an interview. The interviewer will always influence the interview situation and on the work with the data. The last principle points out that the analysis should increase the understanding of the phenomenon's meaning and be valid.

These principles could be used for the iterative process in analysing the interview data. In short, the analysis is about reducing data in an iterative process to get a more abstract meaning of the data. To find a model for the phenomena based on data and to relate the theoretical understanding and then to examine the conclusions critically.

## Focus group studies

Focus group discussions are relatively new as a method for research in disciplines as social science [30]. Before the 1980's focus groups has mainly been used as a method for market analysis. Today it is widely spread and is getting more and more used for different areas of research.

A focus group is a group of people, at least four and a moderator. The goal with a focus group is to focus a discussion on a given subject for 1-2 hours. The point is to let the group members discuss with each other where the role of the moderator is to keep the discussion going between the other group members. The focus group discussion should not be like a one-to-one interview where the interviewer gets answers directed to him. Here the purpose is an interaction between the members where they are allowed to state questions to each other and answer them. The moderator only direct the conversation so that the areas of interest are discussed and let everyone get his voice heard. In focus group discussions the central issue is the advantage of group interaction and it is important for the moderator to be conscious about his purpose in relation to the members of the discussion, since it affects the discussion. In focus group discussions comments that are specific and personal are more reliable than comments about how others might react or are believed to relate to different subject areas.

An advantage with a focus group discussion is that it can be easier to get less biased answers since the interviewer plays a more drawn back role. On the other hand there are a dynamic group interaction where people have to fit in. It is a risk that some personalities have more difficulties to get themselves heard in this kind of method.

There are several different suggestions for analysis of focus group data [30]. It is common to do a content analysis from the earlier stated purpose with the study. Content analysis is mainly based on the different areas of discussion, the interaction between the members, argumentation and underlying opinions. To be able to handle the material collected through video or sound recordings it demands some form of transcription. Different methods handle the transcriptions in different ways. In scientific research it is important do to this carefully, while a market analysis might demand other priorities in the analysis.

Analysis is, to put it shortly, "coding the material, divide it into entities and search for trends and patterns" [30]. It means that the content is labelled after different topics within the focused question ("ethics of gene manipulation of food") or the way they express themselves about the topic (for example "fear"). The labels are then collected for a search for trends and patterns in the discussion.

In Sequential analysis one is interested in the structure of the discussion; the sequential order of contents, patterns of associations of subjects and the context of the conversation. The meaning of an utterance is dependent on its placement in the sequence [30]. It means that it becomes important to study not only what is said, but also when it is said because it affects the meaning of what is said.

If the members of the group discuss something they can easily relate to they might start to develop the subject in their own way. In a narrative analysis method one is focused on the member's narratives, both the structure and the content. It is a good way of getting to know more about how the subject relates to different questions and their underlying believes.

There is also a possibility to analyse the material without a complete transcription. The analysis can be made based on the video tape or sound tape together with a short transcription. If the discussion was summarised before the end this should also be transcribed. This method is best

suited for structured focus groups. There is also a note-based analysis, which is mainly based on field notes from the discussion. This method is not suited for scientific research.

## Methods for design

Design and product development is not regarded as science, but scientific knowledge is often used for the process [19]. Design is often future and action oriented and is characterised by work through development and interdisciplinary collaboration is often a must

“Development work means a systematic way of using scientific and other knowledge, new ideas, to create new products, systems, processes...” [19].

In one book about design and product development the different phases are described as three general steps [19]:

- Conceptual design, ideas are developed, tested and decided.
- Main design, the development of the product.
- Detail design, where the product finally is specified.

Also used for Rewind are the following four different processes [19]:

- The artistic process
- Information process
- Negotiation- and decision process
- Solving the design issue

### *Creative methods*

Design and art projects often involve a creative process. Creative thinking is a confusing term used in many different contexts. Creative in its simplest form means creating something that didn't exist before [2]. We often associate “creative” with not being *simple* or *obvious*. The result is something *new* and *unexpected* or we think of it as an alteration. Edward de Bono [2] is talking about creative thinking as lateral thinking and is working with methods for changing conventional conceptions. His ideas of lateral thinking originate from self-organising information systems and the human perception. Lateral thinking is “a way of solving problems with untraditional or seemingly illogical methods” [2] or a way of finding out many possibilities and ideas instead of just choosing one line of action. What de Bono really means by the term is that lateral thinking is “a number of systematic methods for changing and creating new ideas and terms”.

The following methods are examples of interest for the Rewind project.

### *Six Thinking Hats*

A method where you choose one of six differently coloured hats which each represents a different kind of thinking. This method is limited by time and is used to force us to think of a problem in different ways and to get an idea of the different points of views. White hat: facts and information, red hat: emotions, intuition, impulses and reactions, black hat: critical judgements, limitations, yellow hat: optimism, advantages, green hat: creative thinking, new ideas, possibilities: blue hat: about the thinking process used, organisation.

### *Provocations*

A method for consciously thinking differently through provoking the thinking with thoughts that do not feel natural is called “Provocations”. The provocations can be formulated sentences that are the complete opposite to what we usually think about the problem. It can also be for example pictures, sounds, situations and assumptions.

## Methods for the Rewind project

Research methods often differentiate between qualitative and quantitative methods. Qualitative methods give qualitative data, like for example subjective data. Quantitative methods give quantitative data that is possible to analyse in a statistical way [20]. For the Rewind project mainly qualitative methods, such as interviews, will be used. Other relevant methods for Rewind are brainstorming and workshops. The structure and methods for the project work is summarised below.

- Workshop, brainstorming. The method was chosen to feed ideas into the concept development from interdisciplinary areas.
- Literature study/background research. Very important in order to get a broad understanding of the area.
- Specialist interview. Specialist interviews were needed especially for deepened answers about the clinical aspects of sleep.
- Attitude/behaviour analyses of public sleep and sleep in general. Semi-open interviews. Since no literature with a similar approach as Rewind was found, semi-open interviews were chosen as a method to be able to analyse attitudes and behaviours in relation to sleep.
- Workshop, brainstorming with studio members. An other kind of workshops in order to gain interdisciplinary input for Rewind in a later stage.
- Creative process during the whole pre-study.
- Focus group study. The method was chosen to get critical comments on the concept. Focus group studies are suitable for this purpose as the group members interact with each other and the moderator does not bias the discussion as much as in a traditional interview.

## Interview study

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### Purpose with the interviews

The purpose with the interviews was to gain information and inspiration in those areas of interest where little or no literature or earlier studies existed, and in order to enable design decisions for the concept of a prototype supporting sleep or rest in a public space. The main area of interest was to investigate peoples attitudes regarding sleeping, their own sleeping and others, especially focusing the questions on public spaces. Important was also to investigate in what way public environments affects sleeping and sleeping habits. The interview was also performed in order to support the process of making decisions about whether the prototype should be designed as a wearable or as an environment (room).

### Subjects background and interview method

Five adults, between 24 and 34 years of age, were interviewed, two women and three men. Subjects were chosen in such a way that they represented average people possibly with stress or sleep debt linked to their life situation. Two of the subjects had one or two children, where one of those who had children was home for baby care. One of the women worked as a research assistant. Her education was in psychology. Two of the male subjects worked in the IT-business as a system architect and interface programmer. One subject was a student in politics at a university. All subjects had at least one time in their life had problems when their sleep was affected. These problems ranged from stress and occasional sleep debt to severe insomnia.

The first interview is considered as a pilot interview. Some questions gave all about the same answers. The content from some questions and the structure of the questions were therefore slightly modified for the second interview. The material from all interviews was possible to use for the analysis.

The interview was prepared with predefined questions, although questions were added during the interview in order to follow up on subject's answers to main questions. Therefore the interviews can be considered as semi-open interviews. The interview started with a short introduction about the purpose with the interviews, what main areas the questions would be about and the respondent's ethical rights. Each interview ended with a part that was an open discussion during which I told the respondent more about the project and The Interactive Institute. The respondents gave spontaneous comments and ideas on the project.

Each interview lasted for about one hour and was recorded with MiniDisc. Each interview was transcribed in a modified way and the transcript material was considered to be the raw data that was analysed later. The conversation was thus written down so that it is possible to follow the whole interview from the paper transcript. Sounds were excluded and sentences were not transcribed exactly from the whole interview. When sentences were transcribed word for word this was marked specifically in the documentation. When the sounds or pauses were considered as especially important for the interpretation of the interview this was also marked in the paper transcript.

Different categories of interest were identified from the raw data.

- How the respondents fall asleep
- How the respondents relax
- How the respondents define rest and sleep
- What signals does a sleeping person give, including the respondent
- The respondents attitudes to sleeping in public spaces
- Ideas that came up during the interview

All identified sequences of raw data were marked according to which category it belonged to. In the next phase data in the different categories were clustered in separate documents for each category. Data that belonged to several groups were included in all documents in which they suited. The different categories of clustered data were first analysed separately and then also in relation to each other. These findings finally resulted in a number of general conclusions drawn from the interviews.

## Results from the interviews

The interviews showed three main categories of interest: the importance of safety and confidence during sleep, influences from external stimuli in the sleeping environment and attitudes regarding sleeping. I will also describe the respondent's definition of rest.

### Resting vs. sleeping

Two subjects explained that a good rest necessarily does not include sleep. A good rest can be about being able to shut out thoughts, physical comfort, silence and darkness. One person stated that resting without sleeping is best done in another environment than at home, because then it is easier to not think and talk about work. At least one of the following variables is fundamental for relaxation for all subjects: variation from the usual tasks, variation from the usual thoughts and variation from the usual physical environment

According to the subject with insomnia, good sleep is when she feels that she has had enough deep (slow wave) sleep and does not wake up too often during the night. Another respondent defines good sleep as the sleep you get when you go to bed early. He feels more rested the next morning if he went to bed early than if he went to bed late, even if he slept the same amount of hours in both cases.

### Falling asleep

The presence or absence of thoughts plays an important part in the process of falling asleep. In public places the awareness of the environment and people in the surroundings have a disturbing effect on deep rest or sleep. People are not able to focus inwards and are not able to stop having mental control over the surroundings. The difficulties to fall asleep in public places are therefore not only caused by physical discomfort. The thoughts play a central and protective role to prevent people from losing their connection to the outer world in a possibly unsafe situation. At home the presumptions are different. People are more confident in their own home. It is a predictable space where they know the physical environment, sounds and the family members' habits. The environment itself isn't as unpredictable and unsafe as the public space. Difficulties in falling asleep depend to a larger extent on the individual him or her self. The respondent with insomnia believed that so called, sleep-disrupting thoughts are central to insomnia. She is very conscious about her problem and this in it self causes problems when she thinks about it while trying to fall asleep. Another problem is that she thinks about what consequences the sleep debt will cause. She said, it is important that sleeping does not feel like an achievement. That it does not come in focus, because if you do not succeed in falling asleep it will feel as a failure and accelerate the negative spiral.

Different methods for relaxation were identified from the interviews. The respondent with insomnia had used several methods to reach a relaxed state. She explained that the methods used were only effective in the beginning of use. After a while they became worn-out because she, while using the method, became aware that she was using it because she has problems with relaxing/falling asleep.

According to the subjects, relaxation can be:

- to shut out the outer world and to be focused inwards, for example in a noisy environment.
- To focus on happy memories, recollections/visual pictures, pleasant thoughts or thoughts in general.

- Meditation
- Not trying to control the thoughts

## **The sleeping and resting environment**

### *Public environments*

All subjects have fallen asleep or have been resting in a public environment: at trains, boats, subways, cars, parks, hospitals, at the movie, at a friend or relative, at work, at seminars and buses. The degree of relaxation varies and all subjects defined the state as *relaxation* or *rest* in public environments. Only few occasions of *sleep*, often involuntarily, occurs in public spaces. For example: at work or at a long distance train.

A number of different environments like subway or parks are regarded as difficult to sleep in, even though it is not too rare to fall asleep in those particular ones. Subjects mentioned those environments as difficult but possible to sleep in. It is difficult because of the lack of silence and feeling safe, among others. At the same time subject exemplifies some of these environments *causing* sleep, for example the train and park.

The subjects had a very stereotype mindset of what sounds and environments they believe is causing sleep, such as trains (the sounds from trains). It is difficult to say how much the questions directed the respondent towards this stereotype picture and how much they really believed this to be the fact.

One opinion is that it is tiring to read difficult articles or doing the same thing over a long time. Reading for this person does not have the same effect at bedtime when she gets activated by reading. This person has general difficulties to fall asleep. However, another respondent mentioned reading as a way of falling asleep and he also gets tired at libraries. Common for all respondents is that monotony makes people feel tired, whether it is from monotonous sounds (see below), monotonous work or monotonous movements as at trains and boats. Physical fatigue is also causing sleep. For example a visit at a museum according to one subject is tiring because of all the impressions and strong light. The cinema is also an example of a public place that causes sleepiness because of the darkness and the relaxing situation.

External factors that affect the possibility to sleep in a public environment in a negative way are according to the subjects, light, comfort and sounds from the environment including the sounds from people in motion. There are however, individual differences between the subjects. When talking about sleeping environments at home there seems to be less tolerance to external factors that affects the sleep in a negative way since it is possible to control the environment as desired. The conditions in public places include lack of control over the environmental conditions. The tolerance for external negative factors is therefore higher at the cost of sleep.

### *Light*

Four of the subjects find it important with a dark sleeping-environment at home. For three of them it is very important and for one it is more important than quietness. Two of the interviewed persons also mentioned that they arrange the light conditions when resting in a public environment such as on the train.

### *Comfort*

For two of the respondents it is very important with comfort while sleeping. They are very sensitive for how the bed feel, for example the material and softness. Sleeping in public environments is partly difficult because you often have to sit and have no place for stretching out your legs and lean your head. Aeroplanes have little space for the legs and the seats cannot be set down enough to be comfortable. As for aeroplanes, trains, buses and other places where you have to sit and rest the support for the head is one of the biggest problems.

### *Sound*

Three respondents agreed on the importance of having a quiet sleeping environment, while two found it less important. One of them often falls asleep to music. In fact there are a number of sounds that they all think are tiring and it is of course very individual. It is possible to conclude from the interviews that all experience that monotonous sounds makes them feel tired. Even though the stimulus is different for different people like traffic sounds, train sounds, monologues like when you just have to listen without being involved in a discussion (seminars, preaching, stories) or just hearing a voice. All mentioned the sounds from a moving train. Four of them got tired of other people talking (monologue) for different reasons. On one hand it is the fact that you are passive and not involved in a discussion yourself and on the other hand it might be because you are sitting still and are not activated.

Irregularity in the sound environment causes arousal that draws attention. For example one respondent had worked at kindergarten. Waking up from a nap at kindergarten when the children start to speak intensively was a very wakening sound. Others mentioned traffic and aeroplanes. Sounds from people's presence (moving, walking) in the environment are experienced as distracting and make it hard to relax.

One respondent believed that music or sounds could affect her negatively because of the associations she makes. She thought that the sounds could destroy the function it was meant to have, for example relaxing, since she sometimes associates the sounds to something negative. She had tried meditation and experienced this negative association with the sounds they played there, which was disturbing.

### *Temperature*

Four of the five subjects agreed on the importance of having a cool room temperature in order to sleep (at home). They found it hard to sleep when the sleeping environment was warm and they rather preferred a cool room to sleep in. They tried to arrange for a cool sleeping environment if possible.

### *Safety and confidence*

One of the main issues regarding sleeping in public environments concerns safety. Feeling safe is fundamental to make it possible to fall asleep, whether it is at home or somewhere else. The respondents talked about both confidence and safety. Being able to sleep in public environments depend on both of these factors. Confidence springs from yourself and affects the possibility to sleep in public. Feeling safe is in a higher degree than confidence dependent on external factors in the environment. Safety can also be seen more objectively, that the actual safety in a particular environment depends on external factors.

All subjects think that if people they do not know are present in the sleeping environment, they might feel threatened and unsafe. Some subjects were more afraid of getting robbed than hurt by other people while sleeping. The feeling of not being safe is also caused by not knowing who and what is around when sleeping. For example, too much sound and sounds that indicate movements in the environment are disturbing. Safety is achieved when a friend or relative to the subject is near, either awake or sleeping. One subject thinks that safety is achieved by having possibilities to control the environment. Control is then for example, the possibility to control light, sound, but most importantly to control if people are getting in or passes by, by locking the door to the sleeping place. Safety for the subjects is about the sleeping environment in general: if the environment is predictable and safe by experience. I will therefore emphasise the importance of the feeling of having control over the sleeping environment. The significance of knowledge of what usually happens in the environment should not be underestimated.

### *Peoples presence in the sleeping environment*

The awareness of other people's presence in the sleeping/resting environment affects the ability to sleep in two important ways. A familiar person who is close by creates a feeling of safety, a feeling of being watched over while sleeping. Unfamiliar people often make it difficult to sleep. Not knowing who is there and if it is a person that can be trusted is problematic. One subject suggested a cage to be in that could be locked. I suggested something to wear and she then mentioned that Muslim women wear a cloth over the head. She meant that if you know that others can not see if you are sleeping or not, this would probably create a feeling of safety. That you wouldn't be as vulnerable if people think you are awake.

It seems that problems to sleep among other people (in public places) exist for all subjects because they feel a lack of safety. At least one of the subjects believed that the problems is caused by the knowledge of possibly being observed by others especially when people sit beside or in front of oneself. Sleeping is therefore impossible for this subject while resting is possible. Other subjects only care if people can see them sleeping, if it is not appropriate to sleep at that time or place. Not because of the fact that someone is seeing them.

### **Attitudes and sleeping habits**

None of the subjects said directly that they currently were in need of a place and time to sleep in the daytime. However, all subjects had at least one time in their life had problems when their sleep was negatively affected. These problems, as already mentioned, ranged from stress and occasional sleep debt to severe insomnia.

All subjects were unanimous in their answers that they were not in immediate need of any scheduled or extra time for *sleeping* in the daytime. This is probably because of their current life situation where three of them are at home most time of the day. Both subjects that work in the IT-business meant that it is difficult to take time for a daytime rest since there is no time left for it and it is also difficult to slow down at this time. However, both of them were positive to daytime *rest* or a pause from their usual tasks. This rest does not have to include sleep. It is more important with a variation in tasks and of physical environment. The two subjects were only positive towards short sleep or rest at work if there is an easy way to learn how to sleep effectively. One of them later stated that he is principally against daytime napping since he believed it would disturb nighttime sleeping. He is also against encouraging sleep at work since he does not think people should be encourage staying at work more than necessary and that it is better to go home if too tired. He means that fatigue indicates that something is wrong.

The two subjects in the IT industry do not think there is internal status in working hard and sleeping little, as media sometimes states. They agree on that they trust that the company takes its responsibility for the employee's health. The fact remains that many working in this business experience periods with great lack of sleep.

Four subjects had rested at work at least once and two of those more than that. The reason why it was possible for them to rest at work was that it was socially accepted to rest in public and as long as they felt they weren't affecting others' habits, rest (with closed eyes) felt comfortable. Some of the subjects had also involuntarily fallen asleep at work. Sleeping at work can cause feelings of guilt for not working, but one subject especially emphasised that it is guilt towards himself. He feels ashamed if he falls asleep at work, that he is neglecting work. Seeing other people sleeping at work makes him wondering if they feel alright. He never distrusts his fellow-workers, thinking that they do not do their job and are lazy when sleeping.

Attitudes towards seeing other people sleeping in public were similar. Depending on which context a person is seen sleeping in, an overall judgement of the person and why he is sleeping in that particular place is made. A seemingly homeless person causes feelings of compassion, while a person looking like he is satisfied signals positive feelings. Persons sleeping in public also signal that they do not want to be disturbed.

## **The respondent's ideas and comments on the project**

One of the subjects believed that there is a contradiction in using biofeedback since you have to use will power to be able to get the correct biofeedback response. The device will be connected to an achievement, that you are actively trying to fall asleep. She thinks it goes too much in the same direction as insomnia: the thoughts are affecting the ability to fall sleep.

## **Conclusions**

The following criteria for design springs from the interviews. These criteria have also affected different questions for design. More about the bigger questions for design during the concept development in chapter Questions for design.

### **Rest vs. sleep**

The need for daytime sleep seemed less important than the need for rest or just a pause from the normal activities. It has therefore been important to consider if it is really necessary to design for the person falling asleep. The concept should in the first place support a stimulating rest. What rest meant for the respondents was described in different ways, but it seems to be important to change task and physical environment. The design of the system could be a virtual environment that creates the same safety and predictability as at home, or an environment that is associated with relaxation. The resting person might not need support for passive rest. A motivating activity in the created environment could be good as well.

### **Safety**

The interviews showed that feeling safe is the most important criteria for sleeping in public environments. A prototype that supports rest or sleep in public environments must therefore be designed so that people feel safe. Since other people can both cause unsafety and can provide safety depending on if they are strangers or a familiar person, there are different suggestions for design:

- A familiar person is always connected to the person's sleeping device and has the possibility to watch over him or her.
- Subjects said that movements from people draw attention and cause unsafety. A sleeping alarm as a part of the sleeping device can be sensitive for fast movements close to the sleeping person or can sense if someone comes too close. The alarm could also be connected to valuable devices, and could cause an alarm if someone tries to steal it from the sleeping person.
- Since screening and a locked space around oneself can maintain a feeling of safety, this might be something to consider for the design.

To design so that the users feel safe, the users should have control over the sleeping environment. Control means a possibility to control what happens in the surrounding and a possibility to control whom is there.

### **Comfort and ergonomics**

Comfort while resting in public environments seems to be a problem if a person really wants to rest there. In most of the public environments mentioned in the interviews you have to sit while resting/sleeping. The most important in order to be comfortable is that the head is supported so that it does not fall down. In an optimal situation for sleep the seat must lean at least 45 degrees [21]. The material the person is enclosed by should preferably be soft.

### **Attitudes and sleeping habits**

The answers showed that there are strong conventions around sleeping in public environments. It seems as if these conventions prevent the respondents from doing what they feel or would need. The working climate for the subjects in the IT business is an important factor for how they behave at work. To be able to sleep at work it has to be socially accepted there, otherwise a feeling of guilt will occur. A difficult issue for design is to try to break these conventions otherwise a device/environment for it will not be used. How to best do this depends on the type of public environment and the attitudes of the people in that environment. The attitude towards seeing other people sleeping in public places is dependent on the context the person is sleeping in.

It is hard to conclude whether the respondents need a public place for rest or not. One conclusion is yes, they need this kind of environment since all of them have at least occasional sleep debt and four of them had fallen asleep for example at work. On the other hand the majority of the respondents do not believe they are in an immediate need for extra daytime sleep and they would not therefore need any public place to rest in. It is difficult to predict how a public sleeping environment would affect conventions of sleep and need for sleep. Regardless of the needs we believe it is interesting to raise the questions.

### **Sound, light and motion**

The majority of the respondents prefer a quiet sleeping environment. Sounds in the public environment clearly affect sleeping and resting. The sounds give information, on both a subliminal and conscious level, about what is happening in the surrounding. It gives peripheral awareness of the environment. People judge the environment from the sounds when trying to relax. Sounds therefore become very important for safety reasons. Sounds from people's presence (moving, walking) in the environment are experienced as distracting and make it hard to relax.

Music or sounds can affect people negatively because of the associations they make. No sounds are neutral and we always associate them to something and create a meaning to what we hear. This can destroy the function the sound was meant to have, for example relaxing. If using sounds, the sound-scape should be composed carefully in order to minimise unwanted associations.

Preferable, but not necessary, is to design something that covers the eyes. Other suggestions will be described under Concept – Augmented sleep.

### **Comments on the interview situation**

The interviewer always affects the interview situation to some degree. I recognised that since I have my own hypothesis about for example where people have slept in public environments, I have probably directed the answers to a certain degree towards some of the exemplified environments. Some subjects had greater difficulties to relate to the questions and therefore needed more guidance to be able to answer. Four of the subjects seemed motivated and enthusiastic during the interview situation. The fifth told me that he felt a little bit nervous and thought it was difficult to give exhaustive answers. This person however, gave important contributions to the results regarding attitudes and sleeping at work.

## Concept development

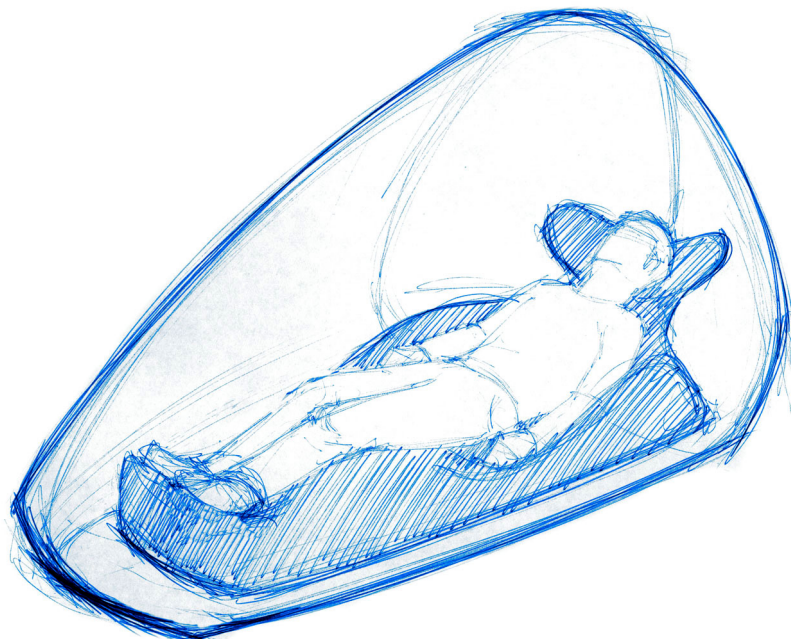
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### Design issue – Public sleeping

As a result from the first workshop we found it interesting to work with napping in public places. As stated in the introduction, the starting point with the idea was to allow sleep to have its own space and form, both conceptually and physically, in a public environment like for example in an office where sleep is not allowed even though it may be needed. Sleep should be allowed to take place and shape the character of the room so that sleep becomes accepted and our need for it is acknowledged. The aim of the project is to design the form that motivates sleeping in public and which makes it accepted.

The goal with Rewind was thus that the project should result in a product, or a mobile environment that was supposed to be a place for reducing stress and enjoying energy producing rest. The motivation behind the project was that being “burnt-out”, stressed and lacking enough sleep is becoming a major health risk. A short rest during the day is an often forgotten way to gather one’s energy in a stressful society. The goal of the project was changed, because of time limits, from developing a product to developing a concept for public sleeping.

We thought, for example, that a tired person should be allowed a half-hour’s rest or a short sleep by stepping into an environment that supports the transition from sleepiness to wakefulness; where the room adapts to the individuals tiredness. We also thought that it could be a wearable or portable product with a corresponding function. By creating this favourable environment for a catnap we wanted to give the bed, sleep and the public space a new meaning. Figure 2 is a sketch by Mathias Nordström that was made to serve as inspiration for the design of a sleeping environment for Rewind.



*Figure 2. A sketch for inspiration - a mobile sleeping environment. Sketch by Mathias Nordström.*

## Design issue – Cocoon vs. wearable

Since sleep should be allowed to take place and shape the character of the room so that sleep becomes accepted and our need for it acknowledged, an important design issue has been to decide the size of the environment that should support rest or sleep in public environments. There are many questions to take in to consideration since different solutions will visualise the concept in different ways. It is important to carefully consider the factors that will affect the interpretation of the concept.

One of these issues is the size. I started to investigate the concept of a mobile environment to sleep or rest in. An environment to place in a public space, for example at work, at busy meeting spots or at a shopping centre. This could be a natural way to pause in the busy urban life.

An advantage of a cocoon is that people probably feel relatively safe, since they can lock it. On the other hand it might not feel safe because no one can see if the resting person is feeling well or need emergency help. In a cocoon the visitor will not be disturbed by external stimuli like sounds, motion, etc., since it is easier to build for an optimal environment for sleep. The mobile environment can also be designed ergonomically and comfortable and people can lie down, which is preferable for sleep. An inconvenience of a cocoon is for example that it is more difficult to arrange for hygiene. Another disadvantage is that it might be misused for other purposes than rest. Problems would arise if people used it for drinking, doing drugs or other inappropriate activities. It would also be relatively difficult to move a mobile environment compared to a wearable or portable device. It demands space. A cocoon might be visually interpreted as a statement of a new architectural function in the public space, but a wearable would probably signal much clearer what function it actually has, as it can be seen easily on the person using it. A wearable can occupy any space question the use of it for sleeping, while a cocoon would question the function of a *particular* public space. The two design alternatives also have different power to diffuse a “sleeping culture”. The future of a cocoon might be “sleeping cafés” or “resting cafés”, where people allow themselves to collectively rest in public. The future of a wearable would rather become a “sleeping community” of people, a life style as we see people using a walk-man or in-lines.

A wearable would definitely be mobile and portable. It would be easy to bring everywhere and there are no limits to which public environment it could be used in. A wearable could also be individual. You can have your own device adjusted for your own needs and taste. You do not have to be somewhere else than you usually are and you do not have to look up where to get the rest. You have a device in your pocket. The device could also be manufactured for the public, for example at long distance trains. A disadvantage of a wearable though, is that it is more difficult to design for comfort than in a cocoon. It is uncertain if people would feel safe enough using a wearable when they are not in a room that they can lock and from which they can physically shut out the surroundings. Depending on the design the device wont send the message that it is designed for public environments only. It could probably also be used at home. How important is it that it is a device for public environments?

After contemplating these advantages and disadvantages, we decided to go for a wearable device that supports rest. We thought that the advantages of mobility and the possibility to have your own device were strong arguments for deciding on a wearable. We believe this concept has more potential for the future than a cocoon.

A starting point for the projects at The Interactive Institute is to create mostly interactive solutions. This means that the solution is responsive to its surrounding. The surrounding might include parameters from individuals, states of an environment or of a system like for example peoples movement, activity on the Internet or speech, to mention just a few. The idea for Rewind was therefore not only to create a physical environment. This environment should be sensitive to the individual’s sleepiness and adjust itself to this. For the concept Rewind we are interested in being able to detect the sleep stages and wake the sleeping person up when it is optimal, according to the sleep cycles in order to give alertness and to prevent sleep inertia (see page 10, Napping). Already from the start we considered using light, colours, sound, temperature and other

modalities that would be controlled by a persons wakefulness or sleepiness. Lights can be used to wake a person up and darkness can be used to support sleep. Colours can be used in an artistic way to create a favourable state of mind. Composing sounds or to provide silence, depending on the level of sleepiness, can be used for both waking up the person or to help her falling asleep.

## **Design issue – Usability vs. artistic approach**

In the Smart Studio at the Interactive Institute the workflow is highly interdisciplinary. The Smart Studio emphasises the artistic approach in many projects and an open work method. The visions are often far beyond what is possible to accomplish today, but they also explore the potential of new technology with an artistic approach. This is a quote from the Smart Studio's preliminary Studio Description:

### ***Vision***

*Our vision is not of a material or definitive nature. Rather, we see our vision as a part of our daily work in the studio. It may be described as a search for no specific goal. We allow one situation to lead to another. Our work could just as easily result in a question as well as start with one. The vision of the Smart studio is never to stick to one path and to uphold chaos, always.*

### ***Mission and scope***

*In principle, our work is based on the three concepts we have mentioned here, art, technology and science. As we have already described, these concepts may be derived from different paradigms and traditions. This is where our identity lies. In addition, we have chosen to limit our area of work to such things, which concern matter, space and critical reflection.*

*This gives us an array of methods, practices, theories, empirical material etc. In practice, this means that we work on projects, which are characterised by experimental, critical thinking. The projects should act as an example and be loaded with knowledge derived from our various disciplines. Because our results act as an example they should be bearers of questions and ideas. In that way, they will act as a catalyst for discussion rather than a functional, practical solution.*

*To maintain critical thought, to find different questions and assumptions as well as to run an enterprise which surprises both ourselves and those around us, we do not reject any method, any subject or any question as long as it can lead to a thought-provoking, reflective debate or vital results.*

At the Smart studio, as described above, it is not always the goal or final item that is important. The process itself is a part of the research, result and vision in order to find new interesting directions in new media, science, art and technology. The methods used are not downright, but are suited and developed for each project. For a longer excerpt from the Studio description, see Attachment 2.

With the background of the Smart studio's visions and methods of work it is easier to understand the progress of the Rewind project. We have dealt with the different aspects of different disciplines and tried to find an interesting solution from these merged areas. It is very much a way of thinking, similar to only a few other institutions in the world.

I believe there are limitations and possibilities in both artistic thinking and usability thinking. The intention has been to combine the possibilities with both ways of thinking. A problem with this kind of interdisciplinary thinking is that usability vs. artistic thinking in many ways are opposites even if they can be used together. We are not interested in designing a product that there must be a common need of. We believe that there is an attitude that is wrong in the society about people's wellbeing. The hectic life has its problems but is also intriguing and fascinating and in many ways fantastic. We are interested in making the public environment even more appealing for people to be in. That it can be a place not only to be on the move in, but that the large areas also can be used for passivity, calmness and rest. We do this because we find it interesting and not because there are a request for this kind of product. We want to visualise questions regarding the conventions of

sleep. This could be done in a quite extreme way. We believe it is necessary to keep this open-minded thinking because there is a greater chance to reach new, interesting ways of looking at the society, technology, art and media.

Questions and conventions that we want to visualise through this item:

- The way of designing the public urban environment. How the urban environment is unidirectionally designed for mostly functional use in activities. There are no good alternatives for resting and relaxation.
- There is little acceptance for people being passive in public. There are strong values around passivity in urban environments. A passive or sleeping person is often interpreted as if something is wrong with him. In the conceptual idea of Rewind we want to allow sleep or rest when it is needed and desirable, wherever it is.

Rewind defies the conventions around sleep. In an urban society there is little space for rest except at home. The public space is mainly for activity such as work, transportation and entertainment. Few places are designated for rest. Restaurants, coffee shops and spas might be relaxing to visit but there is still a sort of activity. In the summer time parks and other calm environments with elements of nature in the city is used for relaxation, but there are with few exceptions no designed spaces for resting. Whether we let a physical space take the form of a public space or we design a wearable that let you use the present urban environment for relaxation, we want to open up for an unexplored use of the urban city.

## **Augmented sleep – safe and sound**

From previous research, the interview study and other inputs to the project, different conceptual solutions for Rewind have been developed. What I will present in this report, in this chapter, is one of them that reached the furthest and that is more user oriented than the other ideas.

Augmented sleep is an idea that takes advantage of the characteristics of the public environment and uses it to create a favourable atmosphere to fall asleep in. Augmented sleep is a concept mainly based on the sounds in the present environment. Urban environments are often very noisy. The background is to use these sounds as a nice experience to the resting situation and to make the sounds more adapted for relaxation. Augmented sleep will produce a filter between you and the environment that will adjust itself to your level of relaxation. If you are in the mood for relaxing the surrounding sound-scape will appear more and more abstract until you fall asleep when it will be quiet regardless of the noise around you (see Attachment 3).

### **Public environments**

Augmented sleep could be used almost anywhere one wishes, since it is portable. It will however, be designed so that it is most suitable for public spaces and the characteristics of those environments, especially noisy environments. Since Augmented sleep use surrounding sound it won't be so active at home where it is usually more quiet. Of course this is a design issue and it could be designed to be adaptable to quiet environments too. The device could also be designed for better comfort while resting in public places, especially for sitting.

Augmented sleep could for example be used at trains. As one of the interviewed said:

*“You could make some device that could hang on the trains. I imagine something that in the first place has to do with sight and sound, but maybe is something soft and enclosing. Most people need something over oneself to be able to sleep, a blanket or something. Perhaps you could add a sort of sound, a monotonous sound to follow.”*

## Safety

Since the sounds in the public environment can help the relaxing person to consciously or unconsciously judge if it is safe, Augmented sleep will interpret the sounds in a similar way that you would have done if you heard them. Augmented sleep will take care of the safety around you and wake you up if needed or let you use your own judgement of the situation by letting the sounds in as they are, if the system regards the situation to be unsafe. You are not supposed to feel that you have to rely on the technology. This technology will not make the environment less safe than it already is. A motion detector could interpret fast movements near you, something you probably would react on if awake. At trains and buses there are a lot of movements around, but Augmented sleep would only react on fast movements or movements very close in front of you. For safety reasons expensive items could be tagged in order to cause an alarm if disappearing. Any alarm function could also be set at your own choice.

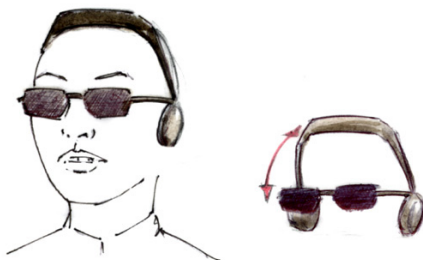
## Sound experience

The user will be in an augmented sound environment and therefore experience the public environments in a new way and use the sound actively to fall asleep. The purpose is not only to rest, it is also to experience something different and to open up a new world of sound based on the place you are in. For Augmented sleep to be interesting more than the first time of use, it is probably very important with variation. The experience in Augmented sleep will therefore never be the same since it depends on the situation you choose to relax in. I will not go deeper into how the sounds will be manipulated, but the idea is to create an abstract musical experience while resting, based on the sounds in the environment. The sounds could for example be real-time processed and manipulated through different filters with pitch, rhythm, tempo, amplitude, character, phrasing, etc. Also read more about the music ideas in the section, Further development.

## Design

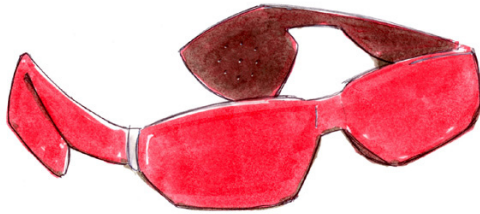
Mathias Nordström (student at Konstfack, Stockholm) made a number of idea sketches as design proposals for realisation of a prototype.

*Sketch 1: Shades and earphones.*



The shades and earphones (sketch 1) is a slim and foldable product. As shown on the sketches it is discrete. It would demand a characterising design to give the product its own meaning. The EEG sensors could be placed under the foldable piece on the forehead. Multifunctional shades that provide darkness while trying to rest, otherwise responsive to the light conditions, for example.

*Sketch 2: Shades and earphones in one piece.*



The construction shown in sketch 2 with shades and earphones in one piece is the most slimmed one. The microphones and earphones are integrated in the shades and can be fold as ordinary glasses. This solution would also require a band on the forehead for the EEG sensors.

*Sketch 3: A sleeping cap.*



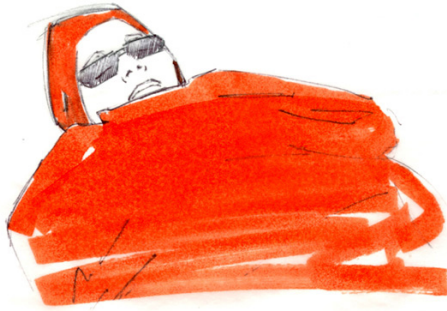
Sketch 3 shows a soft sleeping cap with integrated shades and earphones and microphones. This version has more space for the sensors than the previous ideas, but not as slim as the previous. It could also cause problems with hair between the sensors and the skin.

*Sketch 4: A pullover with hood.*



The concept shown in sketch 4 is a pullover with a hood that gives a lot of room for needed technology. Since it is an ordinary cloth it becomes important to design this to give the cloth its own character according to the concept of Rewind.

*Sketch 5: A blanket with a hood.*



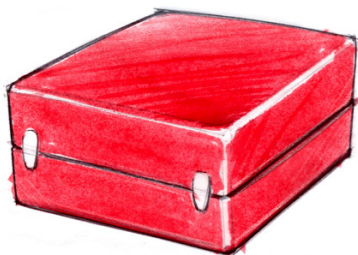
Sketch 5 is a blanket with a hood, a comfortable piece that has its potential to become a symbol for the Rewind concept in both public and other places. This idea might provide a sense of privacy with the blanket to hide behind. It is inviting by its design and signals that it is made for rest and therefore contributes to the discussion that sleep should be allowed where and when it is needed.

*Sketch 6: A hood.*

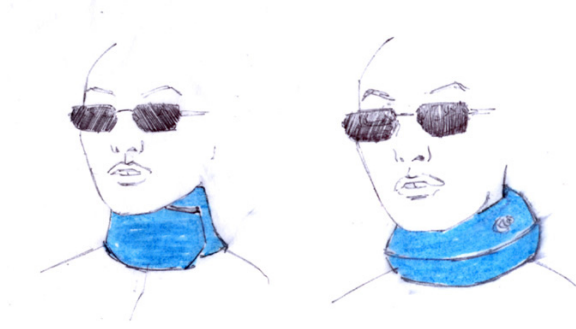
The design of sketch 6, a hood, provides support for the neck and has lots of room for integrated technology. The cloth could be worn together with one's ordinary clothes and maybe become a street fashion symbolising the Rewind concept.



*Sketch 7: The sleep kit.*



The sleep kit (sketch 7) is a solution to keep your sleep outfit in. The kit should be designed as a symbol of sleeping in public places. A disadvantage with the extra carrying.

*Sketch 8 & 9: Neck support.*

The idea of sketch 8 and 9, is focused on neck support that would satisfy an important need to be able to sleep in other places than the bed. The concept of Augmented Sleep is not incorporated in this piece. When technology for detecting sleep improves this might although be an interesting solution. Easy to attach and wear. It could be designed to suit different tastes. The second idea (sketch 9) is an inflatable version that gives extra neck support.

## Technical research

### Sound

There are some different solutions for arranging the sounds. The sounds from the environment can be recorded in real-time with a small stereo microphone. The sizes of stereo microphones are very limited when it comes to small sizes or so called mini-microphones. These are mainly used for vocals and different instruments in mono in musical arrangements or for reporters in television. A relatively cheap and small microphone from Sony, ECM-717, can be used at least for a low budget prototype. Stereo can also be provided by two mono mini-microphones attached to preamplifiers, arranged with one stereo-plug for the computer stereo input.

The sounds will be manipulated in a program that makes real-time processing of sounds possible. At present solutions for PC will be the most suitable because of the biosensors available in the Smart studio. The real-time sound program for PC is called PD, a freeware downloaded from the Internet. It is also possible to use Max for Macintosh, but it is more expensive and we haven't got the necessary biosensors for Mac. PD is a real-time graphical programming environment for audio and graphical processing. It resembles the Max/MSP system for Mac, but it is simpler and more portable and has some features not shown in Max/MSP – via the GEM package. PD can be used for simultaneous computer animation and computer audio. PD documents are called patches. The patches are made of four different kinds of boxes: object, message, number and computer. These have different functionality and can be programmed in many ways to create real time audio.

Once the audio has been processed in PD it needs to be played back. Since the sound environment for Augmented sleep should be controlled, so that the user hears the surroundings completely through earphones, there must be a solution that shuts out all sounds from the outside.

On the market there exist active hearing protections that can be connected to stereo or that has built-in radio. The sort that has a stereo plug could be used for Augmented sleep, but the design is unfortunately very bad. The hearing protections are far too large to design into a slim wearable and it is probably difficult to rest with it on, since you can not lean your head on the side in a comfortable way.

Another possibility is in-ear monitoring. These are small monitors, with a combined function of an earplug and earphone. The level of ambient noise reduction varies depending on what sort of system that is used. Generic monitors soften the sound at least 10 dB. Custom fitted monitors are recommended for optimum performance. Extra silencing material might be needed for the cloth for even more ambient noise reduction.

The wished solution should be slim and built in so that the technology is nearly invisible. Regular headphones reinforced with silencing material could also be a solution. Further research on this is necessary.

## Biosensor technology

To realise this concept the most difficult part is to do the analysis of sleep. For a first prototype, we would start with trying to automatically identify if a person is sleeping or not and also to identify REM sleep. In consultation with Professor Torbjörn Åkerstedt and Jens Nilsson at IPM, Karolinska Institutet, a solution has been proposed in order to suite this project. Sleep research and analysis has not come so far that it is possible to automatically, clinically and in real-time, identify the sleep stages and if a person is sleeping or not. For us it is not necessary to do this analysis clinically. It is enough to do a generalisation in order to be able to visualise the concept and to use the device.

To be able to do this generalisation we need three different sensors: EEG for brain activity, EMG for muscle activity and EOG for eye movements. EEG gives the main information to be used for identification of sleep stages, especially the REM stage. The EOG gives information about two things, slow eye movements (SEM:s) that indicates that the subject is in the transition from being awake to falling asleep, and rapid eye movements (REM:s) that is typical during REM sleep. During REM sleep all muscles are paralysed. This can be confirmed from the EMG sensors. Without the EMG it can be difficult to separate a REM stage from a wake state, or at least from sleep stage 1. So, REM might be identified through identifying the combination of low delta activity, low EMG and frequent rapid eye movements.

According to Nilsson we could be able to approximate if a person is sleeping or not and if a person is in the REM stage in a way that is suitable for the Rewind device. He believed that this could be obtained through skilled programming and with enough knowledge about sleep and biometrics. It is for example necessary to be able to identify the presence of artefacts, arousals and movements by other means as these aspects will probably disturb the equipment in its analysis of EEG, EOG and EMG.

## EEG

Measuring EEG is reliable for establishing sleep disorders [22], but the analysis also includes subjective estimations made by the person interpreting the visual data from the brain activity. For clinical purposes this visual interpretation is done according to Rechtschaffen and Kales standardised rules for visual estimation of sleep. EEG is basically the electrical activity caused by groups of neurones firing. In many recordings the data obtained is the difference in voltage between two different sensors. Analysis of EEG demands high competence and accuracy. The placement of the electrodes is one of the most important issues for scientific reliability of EEG measurements. For our purpose it is acceptable with EEG measured from the forehead according to Nilsson. For best result it is necessary to place the electrodes at the same place every time it is used since a calibration otherwise might be useless. Different placements of the electrodes from time to time produce different potentials and then a calibration for one recording might not be useful for another. During slow wave sleep it is common with EEG artefacts in the EOG, since the EEG frequency and power leaks to mainly EOG channels. Transient EEG phenomena such as K-complexes and spindles can also leak to the EOG channels. When there are eye blinkings when a person is awake, or when a person has rapid eye movements during REM sleep, these can cause artefacts on the EEG screen. It is important to be aware of these artefacts to get the analysis correct.

To get the characteristics of the brain activity and in this case the sleep, it is necessary to filter the EEG signal. The theta, alpha and delta activity is the EEG activity for sleep. There are different kinds of filters to sort out the right frequencies. We are recommended to use 0,3-32 Hz. bandpass filter for Rewind.

Approximately 10-15% of the population is not producing alpha activity according to Nilsson. It is more difficult to identify if these persons are sleeping or not in real-time because the alpha waves indicates a relaxed state before sleep, and more specifically one can say that the brain cortex in the occipital region no longer gets visual information as during wake and alert. Instead one must identify the disappearance of beta and appearance of theta waves, coupled with fewer blinkings and possibly also with slow eye movements (rolling eyes). We have to take into consideration how to deal with this for the prototype of Augmented sleep. The recommended

sample frequency of *at least* 100 Hz, but preferably 200 Hz might be used as well (multiples of 2, as 256, 128 Hz, would be the ideal).

## EMG

During REM sleep, EMG per definition equals 0, but the paralysis of the muscles that occur during REM varies from person to person *close to* 0. For best results each user should sleep with the device on one night, prior to the test, in order to calibrate it. For best results EMG is measured bipolarly, sub-mentally under the cheek. Here there are least disturbing artefacts. We can be quite sure that the person has reached REM sleep when the lowest EMG is recorded in combination with a lot of EOG activity. Occasional twitches during REM sleep should be disregarded. The recommended sample frequency for EMG is 200 Hz with a filter for 5-50 Hz, according to Nilsson.

## EOG

EOG activity during REM can be very similar to when a person is awake. It is therefore necessary to add the data from EMG to the analysis. We were told that the sensors that are used for EEG could also be used for EOG. The same analysing screen in the software, that we use for the EEG is also possible to use for EOG. EOG should be filtered for frequencies of 0.1-10 Hz, but after sleep onset it is possible to filter for frequencies of 0.3-10 Hz. Recommended sample frequency is 100 Hz. The body gives a mixed range of frequencies. If no filtering were done it would be impossible to identify the different frequencies that characterises different aspects of sleep.

## Focus group study

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### Purpose with the focus groups

The purpose with the focus study was to receive comments on the concept, especially related to the use of biosensors and conventions on sleep.

### Method

Because of the time limits of the project the focus study was limited to two group discussions with four persons in each group and were planned to last for about one hour each. The focus study was in an open structured form with a number of predefined topics for the persons to talk about. Some questions were also formulated in order to serve as follow-up questions if the discussion headed the wrong way. The focus group discussion was recorded on video for future analysis.

Each group consisted of two men and two women. Each group had at least two people with a common background. In the first group two persons knew each other and in the other group two persons had met before.

A summary of the plan for the discussions:

- Presentation of the members and me
- Purpose with the discussion, ethical rights
- Short background information about the Smart studio and The Interactive Institute
- Picture for inspiration – a man sleeping at a train
- Explanation of the concept and discussion around it
- Biosensor technology – explanation of biosensor technology
- Discussion about biosensor technology with predefined questions, pictures
- The group members have the possibility to try EEG sensors and biofeedback

The discussions started with a presentation of the members and of myself and some background information about the Smart studio and The Interactive Institute was given. The purpose of the discussion and what was expected from them was explained. A picture of a man sleeping at a train was shown to the members in the beginning of the discussion for inspiration and they made associations to it. The purpose with this introductory picture was that they should get a common ground in order to be able to interact easier during the following discussion. The next step was to explain the Rewind concept and the technology behind it, especially about biosensors and biofeedback. Future possibilities with biosensor technology were then discussed with the members. The meeting ended up with the members trying EEG sensors in a biofeedback system.

An analysis was performed using a modified transcription method. Notes were taken during observations of the video recordings of the discussion in such a way that it was possible to follow the dialogue between the persons by reading the notes. The overall content was written down from each contribution to the discussion. Less effort was made to transcribe word for word because of the time limits of the project. The data was then clustered and labelled after similar topics so conclusions could be drawn about the content of the discussion. These different topics that developed during the discussion were identified as; conventions around sleep, needs for sleep, areas of usage of the concept, areas of usage for (biosensor) technology and control.

## Results

Group number two developed a discussion that was more about attitudes (attitudes towards the technology and attitudes towards sleep) than group number one did. Group number one, on the other hand, focused more on conventions of sleep and what need they believed they would have of a product like Augmented sleep. It was easier for group number two to relate to possibilities with the technology and they could criticise it in a constructive manner. The members in both groups could relate to the picture of the man sleeping at the train. It opened up the discussion in a good way, especially in the first group, since they emphasised the meaning of the conventions of sleep at several times during the discussion. They believed that there are strong norms in our society that does not allow daytime sleep. They compared countries with siesta and the Japanese culture. What they think is necessary in order for the Swedish culture to incorporate this kind of product, is to dedicate physical places where it is regarded as alright to sleep. The second group also reflected on different aspects of sleeping in public, such as the fear of not waking up when it is time to get off, or feeling insecure.

The members of group number one could relate very well to the initial picture shown on a man sleeping at a train. They explained that they think there is a need for a place and for time to rest at daytime. They compare habits in our society to the habit of having siesta in other countries and say that sleep is not accepted in that way in our society. They do not think it is possible to change conventions like that quickly and today we have conventions that stop us from taking a nap at for example work. The group members therefore think that it would be easier to adapt the idea of Augmented sleep (sleeping at public places) if such a space were created at a fixed place. They also reflected on why there are no places to rest in big cities. They agree on that there is a need for those places and wished that special zones for rest were established. They had doubts about the concept of using sound in Augmented sleep for falling asleep. One mentioned that being in a quiet place is probably the best way for falling asleep. They also believed that being comfortable is important for sleeping well and that Augmented sleep has not taken that into priority.

They could see several areas of usage for biosensors integrated in products used in daily life. They were, for example, interested in getting a print out of their brain activity during sleep in order to see whether they had slept good or not. Somebody said that she would like to get a diagnosis of how tired she was, to see if she needs rest. They then discussed if it really is good to trust that diagnosis instead of listening to one's own body signals. They reflected on if a dependence on technology would develop when one stops to listen to signals from the body. They do not consider it frightening that products might use biosensor technology. They said that they would trust the use of it if larger companies developed them. But in general, they want to have more control over what the product does if it includes taking out signals from the body. One of the group members said that he would prefer a product like Augmented sleep to be personal. That nobody else could use the personal information that might be saved there. They were also doubtful about attaching technology to something as natural as sleep. They said that it is important that there is a meaningful function behind the technology, that it fulfils a need.

One of the female group members wished there would be a product that warned her just before her period, since she always forgets when it is time and her mood goes down. She would also like to have a product that warns her when the blood sugar level is too low in order to prevent fatigue. One of the members explains that he believes that the society and discussions among people would be different if one could see for example another person's hormone levels while talking to her. He says he would for example take greater consideration if someone reacts strongly on a subject if he could see that it depends more on hormone levels (the period for example) than the subject itself. This group didn't talk much about other possibilities than direct functional for the use of Augmented sleep, but one person said that he would rather use it to explore sound than to support sleeping.

The second focus group discussed different possible areas of use for the concept of Augmented sleep. They also discussed possibilities with biosensor technology. One of the group members thought that Augmented sleep could be used at libraries because how it handles sounds. He meant that it could create a good balance between silence and the surrounding sounds. He thought that it is too quiet with ear moulds. To use Augmented sleep would then make the surrounding sounds abstract so that it would give a notion of what is happening in the surroundings without being

disturbing. Two of the group members have worked as nurses and thought that the product could be used in order to help patients with problems to sleep. There are many new sounds at hospitals that one might not be used to. They said that the patients get a lot of sleeping pills and that it would be good if there was a substitute for it. Another area of usage they saw was for being awoken. They asked if it is possible to switch the functions of the sounds. To increase the volume of the sounds if somebody were to fall asleep, for example a driver. One person thought that biofeedback could be good to use if it could be used for learning. To get feedback about when one had the best ability to learn.

The scepticism they had was against creating something that should work as an external system for the body. They thought, for example, that it would increase the insecurity in public environments because one has to trust the technology. One person also meant that the body itself is so good at judging risks in the surroundings that it would be unnecessary and difficult to create a system that tries to imitate this. This person was also sceptic towards the continuous search for new products for the market.

The concept was also discussed shortly from a possible artistic approach. One person saw an interesting scenario; that the user gets a musical experience based on his mental state. He suggested to work with musical features, such as tempo, ritardando and different phrasings to reinforce the calmness in the character of the sounds when a person relax. He thought it would help for meditation. He also reflected upon the effect of differentiating sight and hearing if a one-second delay was attached to the sound. Since sight and hearing work together to judge the environment this might cause a delayed reaction on something that causes sound. For example if somebody drops a book on the floor you'd react to the sound. If you instead only saw the book falling and heard the sound one second later, you might have the time to reflect on what you saw and not get disturbed or frightened by the sound.

There were different opinions in the group regarding if they would like to use technology that senses the signals from the body. One of them said that she wouldn't voluntarily check a value from the body as long as she was healthy. Another saw no limitations in using technology that for example measured the pulse during training or similarly. If the use of this kind of technology was clinical only, they agreed that it was all right to use it. On the other hand one of them mentioned that it is often better to realise oneself that something is wrong, for example feeling stressed, instead of letting it go so far that a machine has to tell you.

The group reflected on if the biosensor technology could be frightening if misused. They were not afraid of this, but they wondered what would happen if the system reveals that somebody has a disease that the person himself/herself or no one else knows about. They meant that this information might be misused. One example is if someone is employed and has to wear something that captures valuable data about the employee. One thought it would be bad if bio data were used as cookies on the Internet. That people are logged regarding personal qualities and needs based on clinical facts.

## **Conclusions**

### **Conventions and reflections on sleep**

A conclusion from the focus group discussions is that the concept will demand time in order to get accepted if incorporated in society. According to the discussions Augmented sleep, as a product for helping people to rest, would probably not be used if the concept were not adjusted to the current conventions around sleep. Since they believed it would be easier to accept the concept of Augmented sleep if there were fixed places to use it in, this is something to take into consideration. The choice of a wearable was very much based on the opposite namely letting the physical location be of less importance for getting rest.

## User needs and areas of usage

The group members often came back to a discussion in which they questioned *why* we would need a product based on the concept of Augmented sleep. The first group agreed on that there is obviously a need for sleep or daytime rest for example at work. This was also exemplified during the discussion.

The overall impression from the discussions is that there is some scepticism towards the concept, since the group members couldn't see sleep as a natural area of usage for the concept of Augmented sleep. My interpretation is that the first group agreed on that there is a need for daytime sleep and rest in public spaces (for example at work), but they meant that the conventions around sleep inhibit them and that there are no room for sleep under these conditions. They had difficulties in understanding how sounds can be used to help a person to falling asleep or resting as suggested in Augmented sleep. Both groups saw several areas of usage for the biosensor technology used in Augmented sleep, for example in the care of sick people, for drivers and for recreation.

Both groups were also sceptical about attaching oneself to a system that takes over functions that the body has, for example in a nervous environment the senses are working actively to judge how safe it is. If a person wears a system with the function of doing this judgement, they believed it would be difficult to trust that the systems abilities were superior to the brain capacity.

It was difficult to make the group members think of the concept as a tool for making surrounding sounds into musical experiences. I believe it is on the one hand due to their background and on the other hand due to the fact that I had personal interests in that direction. Those group members that were interested in music also showed a greater interest for the concept from this point of view.

In the beginning of the discussions the group members found it hard to understand the concept until I had explained enough about biofeedback technology. It therefore took a while before they could reflect on the future possibilities with the technology and understand how sounds can be used in biofeedback. It was easier for the first group to relate to the concept and I believe it is because I explained the background better to them than to the second group.

A majority of the members in both groups did not find biosensor technology threatening for their integrity if incorporated in different devices. They just wanted to know how the data would be used and by whom.

I think it is very important to be aware of how to describe the concept to focus groups. Since I personally believed that it would be more interesting if the concept was developed into an interactive sound generator, I might have biased the focus discussion slightly.

## Technology

The group members were afraid of the dependency a product might cause if they have to trust a system that takes over bodily functions. They wouldn't trust that a system is able to judge how safe an environment is. They think that our own senses are superior in judging that. I believe that I therefore have to questions the use of biosensors. What happens if we create a need that in the long run develops a dependency where people stop trusting what their own bodies tell them?

There are different criteria that might have to be fulfilled before they feel that they would use a device like Augmented sleep. Group members would prefer that the device was personal. If biosensors would be used they felt that they would not take the risk that the system was not cleared when the next person starts to use it. It is important to have control. They said that if they know how the data will be handled and by whom, they could judge whether to trust it or not. They also meant that they would trust larger companies that they already have confidence in. It would be very important to design Augmented sleep in an obvious way so that it is easy to understand how the data is handled. The consequences they are afraid of are that personal data will be used for other purposes than intended. This does not only concern Augmented sleep but the use of

biosensor technology in general. For example they are afraid that an employer uses information when employing people, that companies log people on the internet based on body data or that a person's disease is revealed through this kind of apparatus. It raises questions for the future about how we are going to handle this kind of data, when medical records are saved on computers connected to networks.

The group members could easily see different areas of use for biofeedback technology, despite their critical point of view.

The group members related to the concept of Augmented sleep from the assumption that it actually would help people to fall asleep or rest. But when we talked about the fact that the sounds with the biofeedback system would provide this help they had more difficulties to relate to the concept. Since they had little experience on biofeedback and its output it is probably difficult to understand its possibilities. On the other hand we have no evidence that Augmented sleep would help people to rest and it is therefore interesting to hear if they believe it would work. Some of them were sceptical towards using sounds when falling asleep and they suggested providing silence instead.

Some of the women mentioned that they would like to have a product that predicts their period or a product that show the blood sugar levels, when they are tired and need food.

### **Art**

Especially one person, who is a professional musician, pointed out that he thought this concept was more interesting to develop as a musical installation rather than a usable product. He didn't see why people would need a product for sleeping and he saw more opportunities as a musical application.

## Discussion

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### The process and methods of Rewind

The process of developing the concept Augmented sleep for Rewind has been a very open process where the concept has had the right to develop in any direction. It is difficult to work in a project where the subject investigated is too broad for too long time. I have learned that it is important to limit the scope of a project more. There has to be limits in a project and within them an open process can be allowed. To let a project take too many directions without evaluating ideas will end up in a scattered result. In Rewind we felt that we didn't find a good enough idea that would visualise the concept. Therefore we continued to seek and no prototypes were made.

The background research (including literature study and expert interviews) was very important because it gave a broad range of facts about sleep to the project. The research also served as inspiration for the development of the concept and opened our eyes for possibilities and unexplored areas regarding sleep. But, the research also made it difficult to focus, as it was difficult to choose how to continue when so much information was available about one subject. The interviews gave an understanding for attitudes and behaviours regarding sleep in public spaces. The result was interesting for the development of the concept, but not as much for the more artistic ideas that are not presented in this report. The focus groups made me realise that, that particular method probably is perfect for product development, especially when there is a prototype that the members of the group have experienced or can experience during the focus discussion. The focus group method wasn't really suitable for the concept of Rewind. The focus group members regarded the idea only as a practical product that would facilitate sleep and it was difficult for them to understand that it could be a tool for enjoyment or reflection. Those kinds of experiences are very individual and it is impossible to predict what the result of a focus group discussion will be.

The workshops were very important for me in the project, since it was a possibility for me to discuss ideas with other people that were interested in the topic. These workshops gave input both in the form of ideas and constructive critic and they were more suitable for the project than the focus group study. I feel that the people in the workshop understood the approach better and I could therefore listen to their opinions in another way. Of course it is very good for a concept to be evaluated by different people, also outsiders, but in this case I believe that it would have been better to let people evaluate a finished concept.

At one workshop I had to brief the whole group with background information before the discussion could start. If I had had a fixed project group this type of workshop wouldn't have been necessary. At another workshop prior knowledge by the participants was not needed. The members were supposed to come up with innovative ideas freely without other frames of reference than public sleeping. In that kind of workshop my background knowledge, as the concept developer, would probably have created unwanted boundaries and not as imaginative ideas.

### Potential conflicts and possibilities between artistic methods vs. usability

The Smart studio at the Interactive Institute is a melting pot for different areas of competence. At the Smart studio different methods are used ranging from artistic methods to HCI methods. This is also the way we have been working with Rewind. These merging areas sometimes cause conflict but do at the same time give room for innovative thinking. The basic approach is to attack a subject from a new and interesting point of view. It has sometimes been difficult to meet different demands from the Smart studio and KTH on the same time. At the beginning of the project, the starting point was to ask open questions about new ways of thinking about sleep. The research has mainly been based on curiosity and a strong interest for sleep. Early in the process we decided that the central theme for Rewind should be to question the conventions around sleep. This approach differs from the approach taken in usability research, where the focus is more on user needs than philosophical questions about a phenomenon. But even in our case we are

motivated by the fact that a big amount of the population suffers from sleep difficulties of some kind. The difference is that our purpose is to clarify and visualise this through concept design, instead of satisfying a general need for sleep. This does not mean that the result, from an approach that is not about usability specifically, can not be usable. That might be one result, but the result can also be something completely different, that is essential to the phenomenon investigated.

A conflict between these two ways of thinking arise, when one aim is to satisfy the needs of a certain target group and a second aim is to, at the same time think freely about how to clarify the question that is in focus in more interesting ways. When the user is in focus a number of other possibilities are lost. I believe there is a contradiction between usability methods that starts with people's needs and the creative methods used at the Smart studio, that starts with a question in any area, where a user is not the focus. Usability methods often refer to user groups and universal design, where everybody are the target group. The design takes into account as many people as possible. In art on the other hand you have the freedom of choice to not think pleasing any target group of people. Art can be as narrow minded as the artist wishes.

As the project proceeded a number of ideas developed about conventions of sleep of a more imaginative character. It has been difficult to present those ideas as a master's project at KTH and the artistic approaches are therefore not visible in this report, but they have been central methods used during the whole work with Rewind.

The Smart studio has its history in co-operation with CID (Centre for User Oriented IT design) and the work was then based on developing "smart things", as was also the studio's name. The smart things were prototypes based on innovative thinking about functionality, usage and design. As time went by the studio's ideology became more focused on artistic approaches and on being critical to our society and on trying to work with extreme ideas. I believe that HCI and usability is getting new meaning at the Smart studio. Starting with user needs and designing prototypes according to those are not as central as it was before. It is also because the Smart studio is not working towards commercial interests and is not developing products. However, some projects are closer to that approach and in those cases usability is more important.

The easiest way for the user to interact with a media isn't necessarily the best way to present or visualise the concept. Sometimes the conceptualisation has to get first priority instead of usability. I think that usability methods is suitable for the Smart studio in cases when interfaces are developed that require advanced interaction and when it is important to make sure that the user acts in a certain way. There can be a potential conflict between artistic and usability methods. For example, in BrainBar, people are served a drink according to their stress levels measured with EEG. You get the drink "you deserve", which means that if you are stress you will get a drink with calming herbs. If you are calm you will get an uplifting drink. The thing is that you do not get that information, whether you are served a "calmer" or an "activator". The interaction might have been clearer with feedback to the users so that they had a possibility to know what type of drink their EEG activity caused during the interaction. But it is a conscious move from the developers to hide that information to the users in order to create a discussion and mysticism around the event. I think that this example clarifies the conflict of an artistic intention and the effects on usability. It is relevant to discuss the issues of HCI research more at the Smart studio, because people working there have a lot of competence in the area, and it is possible to take advantage of this competence more than what is done today.

## **Future research areas and future development of the concept**

Rewind is in many ways an example of an interdisciplinary work process where the main isn't to develop a usable product. As the Smart Studio works with physicality, objects, space, without being commercial, it has its main goal to in an unconventional way do research in areas where art and science meet, together with new media and technology.

The Rewind project will be evaluated and decisions will be made of how to continue. A possible step in the future would be to evaluate the different ideas in the concepts that have been developed and to make a prototype. The topic we have been working with in Rewind is relatively unexplored. There are different possible directions for the project. One direction is to work further

with the questions of rest and sleep, activity vs. passivity in public spaces. It might be of interest for health care to develop alternative tools for rest, since sleep disorders are common. The Rewind concept is not fully developed for a certain user group. Depending on the directions of the project the concept has to be modified. The concept Rewind has not reached its full potential. The work process of Rewind is an example of how the ideas you start with can end up in something completely different, since the process is to find interesting solutions and ideas on the way. It would also be interesting to continue with the idea of a interactive real-time composer. We have worked with an alternative view at the subject of public sleeping in order to inspire users to think differently about sleep. The concepts are a result of an open and experimental attitude. It is wishful to visualise the concept in a prototype in the future.

Some potential research areas: Artistic and scientific methods for concept development. Alternative methods merging those polarities in concept design, innovations, product development. What are the benefits and losses? How would such a method work out? Another interesting area to investigate further is multimedia as tools for relaxing, especially biofeedback in multimedia and product development. Augmented audio media spaces and real-time audio processing with binaural recording techniques are also possible areas to develop further.

## Sound

The concept of Augmented sleep can as I already mentioned, be developed in different directions. It could be realised as a concept providing sleep and rest in public environments. At many workplaces it could be a tool for resting and taking a pause. Outside it could be an oasis in the stressed and hectic city atmosphere. Another application area is for resting at home. The bed has not changed much for decades, so this is a challenging area to develop the concept for. What I personally think is the most interesting though, is not to use this concept for practical needs, but to further investigate the effects of experimenting with sound and the experience of sound in a more general sense.

During the 20<sup>th</sup> century the traditional view of music has rapidly changed partly because of the fact that new musical instruments has developed based on new technology. A completely different philosophy of music has evolved when electronic music instruments were developed. Today the computer is often a natural instrument for creating sounds and compositions. Harmony and structure was important ingredients in earlier music but in the modern era people started to experiment with indeterminacy and totally new sound-scapes created electronically or by using sounds already existing around us. Sounds that already exist around us, not created by instruments, were now also material that was used for composing music. The development towards using sounds from principally any material or source around us for compositions has roots from France and Pierre Shaeffer who coined the term *musique concrète* [3]. The activity in studios in Darmstadt and Cologne during the 50's has been important for the development of electronic music where Karlheinz Stockhausen among others worked. The term for electronic music; *elektronische musik* has been a term for the era there. Today though, the translation of that phrase - electronic music of course has a much wider meaning. Another wide term that tells us a lot about how sounds are used is *electroacoustic music*.

Another important person in the modern music history is John Cage. He took the definition of composition a bit further by his random compositions. Cage used indeterminacy to create music beyond himself and his own limitations. He said in 1952:

*“It is thus possible to make a musical composition the continuity of which is free of individual taste and memory (psychology) and also of the literature and ‘traditions’ of the art...[3]”*

For Cage it was important to explore, and he believed every person has his own limitations that prevent us from discovering new aspects of for example music. He therefore tried to break these borders by letting sounds act randomly in different ways. It might be easy to think that anyone could do this music. Yes, in a way it would be possible, but Cage set the conditions for the randomness and thereby created it in his own way. Cage has raised a lot of questions by his way of experimenting with the sounds that needs to be addressed in the future.

Today the issue of interaction and real-time processing of sounds and devices has grown. Already during the middle of the 20<sup>th</sup> century, artists started to experiment with this. For example Merce Cunningham and his interactive dance choreography performed by Merce Cunningham Dance Company in 1965. The dancers triggered photocells, theremins, compositions by Cage among others and video projections by Naum Jun Paik.

Because of the development of 20<sup>th</sup> century's modern music, I find it very interesting to further explore the impression of what music is. Therefore I find it interesting to develop the Augmented sleep concept further as a musical instrument. – A real-time electroacoustic-music composer.

I fancy the idea of using the environment to create music. But it is not as simple as just recording the surrounding sound scape. It is a real-time “concert” that you yourself are creating by choosing what direction to go or what place to visit. What you hear in the place will be real-time manipulated and represented. You will experience the place you are in through this filter in a completely distorted and hopefully interesting way. I do not see that it is necessary to attach this instrument to EEG as in the early concept of Augmented sleep. Then it was a concept about sleep. Now it is a concept about sound. Of course it would be interesting to investigate how it would work if EEG is attached. You could then use the instrument for example in stressful environments. If you are very stressed, the noise around you would be filtered out and manipulated to help you enjoy the sounds around you in a different way. The sounds depend on how you feel in the environment.

With Augmented sleep I would work with the indeterminacy of the sounds in different environments which are not controllable. The only way to control it is by moving in different directions and in different places or acting in the environment in a way that creates sounds. The device would work in the same way as described earlier. The difference is that you are not connected to EEG and you would not necessary have to sleep to feel that it is enjoyable. A promising line for this investigation is to use a binaural recording technique. The sound is recorded with microphones placed in the ears, to pick up the sounds in the space as the ear do. When played back the sounds it will create a realistic three-dimensional sound. This will try the limits of the recording technique since there is a risk that the three-dimensionality disappears when the sounds are processed.

Since I find the quote from Cage above very true, I believe that the challenge is to try to create ideal presumptions for the sounds to be created from randomness of the environment. The question is how these inevitable limits are to be developed. What manipulations of the sounds are justified?

With this concept you do not need to question the use of EEG. The privacy issue is not relevant in the same way. This is an experience you voluntarily put yourself in. It is not to be used in a practical way in the first hand, even though that might be a positive side effect. I would like to emphasise that art does not excuse the use of intrusive technology, but it could be a different tool to visualise something with another purpose. I believe that art has the freedom to visualise a concept in a way that is not desirable if it is going to be used in a practical way. This might explain, not excuse the choice of technology.

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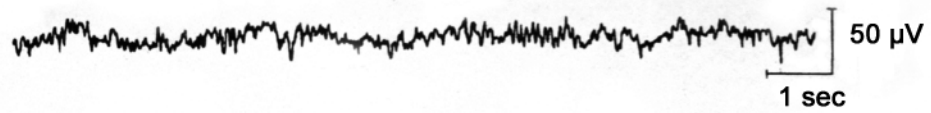
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All web references refer to information published between September 2000-April 2001, when they were visited.



## Attachment 1

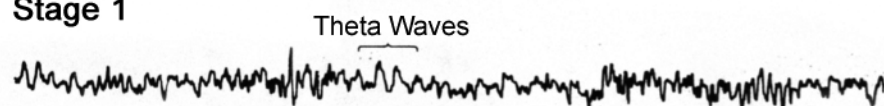
Awake - low voltage - random fast



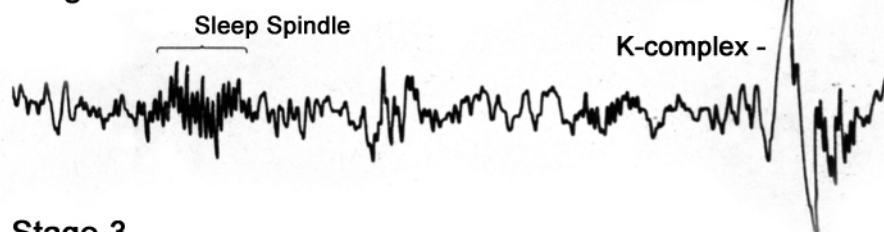
Drowsy - alpha waves



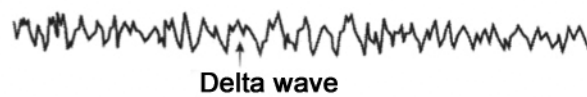
Stage 1



Stage 2



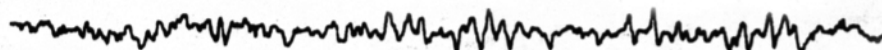
Stage 3



Stage 4



REM Sleep



*The EEG pattern of the sleep stages. Figure from Bentley [1] and Orr, Pressman [21].*



## ***Attachment 2***

An excerpt from the Smart studio's Studio description:

### **SMART STUDIO**

#### **Short Description**

As one of the Interactive Institute's seven research studies, the Smart studio is working to integrate art and technology in inter-disciplinary research projects. The studio work is characterised by our plan to find ways into technology in an artistic and social context. Out of this has been born an enterprise which, at the same time, combines visionary new-thinking with every-day interest.

#### **Background**

The Smart studio is involved in matters which concern art, technology and research. An exchange of ideas between these different fields allows movement between different spheres, the finding of new synergies and the creation of our own values. However, concepts such as art, technology and research run the risk of becoming shallow and losing strength in a context such as ours. The words are bigger than the thoughts. That is why we consider it important to express how we define these concepts.

By the word art we mean three different things. Contemporary visual art, in other words the visual tradition which has been growing since the 1960s and which has its roots in the ideas of Marcel Duchamp. Product design where concept and critical reflection are given as much priority as practical interpretation. Architecture which gives a sense of space rather than just a building.

It is not our intention to develop new technology. From our perspective, technology consists mainly of a technical application in a reflective inter-disciplinary context. Technology which creates new possibilities whether from existing solutions or not.

For us, research means critical reflection and the application of scientific methods within theoretical design, social science and behavioural science, for example.

We act within all the areas mentioned here. That means that our work goes far beyond the scientific community. And as a result, we come across, not just within our group but also in the outside world, completely different ideologies, concepts, conventions and authorities.

For us, this means participating in a number of relevant conferences, artistic exhibitions and public discussion.

#### **Vision**

Our vision is not of a material or definitive nature. Rather, we see our vision as a part of our daily work in the studio. It may be described as a search for no specific goal. We allow one situation to lead to another. Our work could just as easily result in a question as well as start with one. The vision of the Smart studio is never to stick to one path and to uphold chaos, always.

#### **Mission and Scope**

In principle, our work is based on the three concepts we have mentioned here, art, technology and science. As we have already described, these concepts may be derived from different paradigms and traditions. This is where our identity lies. In addition, we have chosen to limit our area of work to such things which concern matter, space and critical reflection.

This gives us an array of methods, practices, theories, empirical material etc. In practice, this means that we work on projects which are characterised by experimental, critical thinking. The projects should act as an example and be loaded with knowledge derived from our various disciplines. Because our results act as an example they should be bearers of questions and ideas. In that way, they will act as a catalyst for discussion rather than a functional, practical solution.

To maintain critical thought, to find different questions and assumptions as well as to run an enterprise which surprises both ourselves and those around us, we do not reject any method, any subject or any question as long as it can lead to a thought-provoking, reflective debate or vital results.

### **Goals**

For this enterprise, we do not believe in pre-set goals, rather directions and attitudes. Just not knowing where we are going is, in itself, a goal. However, we believe it is very important to maintain an aspect of quality in all we do. Assessment criteria, when it comes to quality, are difficult to express when, like we are doing, you are following a side-track. That is why one of our goals is that our results should reach an audience, be subject to criticism and be discussed openly. One goal is to inspire others to think along different lines.

Finding small and original business concepts is another of our goals. We must stick to the side-track the whole way even when it comes to spin-off effects from our projects.

Another high priority is that those of us who work here should feel comfortable working here. The Smart studio is not an institution. That means that the organisation, the enterprise are the product of the individuals who work here rather than the product of a superimposed superstructure.

### **Success Criteria**

To be noticed in the research community, the art world and by the general public. That our results are thought-provoking.

### **Focus Areas**

The area the Smart studio focuses on concerns participating in the debate regarding art, technology and science. This means that we are actively employed in creating an exchange of ideas and co-operation with the players working in these different fields. Along with art institutes, we are able to work towards a greater interest in technology. Along with technical institutes, we promote our own special idea about technology, i.e. its critical potential. In the science community, we have the chance of providing an artistic attitude to knowledge. We place great importance on these ideas and work actively to promote them.

...

### Attachment 3

This is a visualised overview of how Augmented sleep works.

