TALLINN UNIVERSITY OF TECHNOLOGY
SCHOOL OF ENGINEERING
Design and Technology Futures

"SleepFlow": Improving the Sleep Hygiene of rotating shift workers in office work environment.

"SleepFlow": Unehügieeni parandamine rotatsioonivahetustes kontoritöötajatel

MASTER THESIS

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Tallinn, 2021

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THESIS TASK

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Thesis topic:

"SleepFlow": Improving the Sleep Hygiene of rotating shift workers in office work environment

"SleepFlow": Unehügieeni parandamine rotatsioonivahetustes kontoritöötajatel

Thesis main objectives:

1 Support the worker to prepare for the night shift.
2 Guide the worker on the activities to do during the night shift to support their sleep hygiene.
3 Instruct the worker on what to do after the night shift to come back to the regular sleeping schedule.

Thesis tasks and time schedule:

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2.	DESIGN RESEARCH	29.10.2020
3.	Design concept	10.12.2020

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Abstract

The increase in the number of companies that require night shift workers due to globalized services demanding 24 hours desk work is impacting the work industry and the way many people live. "Nearly one-quarter of all workers have shifts that are not during the daytime, and more than two-thirds of these workers have problems with sleepiness and/or difficulty sleeping" (NHLBI, 2005), such alterations are diagnosed as Shift Work Sleep Disorder (SWD).

This thesis focuses on rotating shift desk-based type of work that has effects at the level of physical health, social interactions, and professional life (Wright, 2009, Hu, 2008). Additionally, companies face difficulties to support the health of shift workers due to the lack of solutions addressing this issue.

This thesis proposes a design solution to support and enhance the sleep hygiene of rotating shift workers in desk-based office work environments. The individual's biological clock, his/her behaviors, and the environment, are factors influencing the sleep hygiene of rotating shift workers. By adjusting the environment and guiding the behaviors, the worker's adaptation to rotating shift work can be supported. That includes supporting the worker on preparing for the night shift, guidance on the activities during the night shift to support sleep hygiene, and instruction on what to do afterwards to return to a regular sleeping schedule.

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List of abbreviations

- SWD: Shift Work Disorder.
- EEG: Electroencephalography
- NREM or Non-REM: Non-Rapid Eye Movement sleep
- REM sleep: Rapid Eye Movement sleep
- SH: Sleep Hygiene
- ES: Excessive Sleepiness
- CRSD: Circadian Rhythm Sleep Disorder
- SHI: Sleep Hygiene Index

1. INTRODUCTION

The nature of our body is to being awake during the day and to being asleep at night. However, several companies and services such as such as hospitals, firefighters, police, office workers, factories etc. require continuing working at night. Due to the increase of globalized services demanding 24-hours desk work, the sleeping schedules of many people have been altered. In fact, "Nearly one-quarter of all workers have shifts that are not during the daytime, and more than two-thirds of these workers have problems with sleepiness and/or difficulty sleeping." (NHLBI, 2005).

The development of this thesis research initiated from a personal interest in the field of sleep medicine. Simultaneously, I enrolled in a company as a rotating shift worker (for nine months) were I rotated within a month between morning, brunch, evening, and night shifts.

As the research progressed, I came across several articles related to the decrease on the sleep quality in rotating shift workers and the myriad of diseases related to sleep deprivation and lack of a sleep pattern. Having the personal experience, and the opportunity to identify several issues at observing my colleagues, this field became a fascinating terrain for the development of my master's thesis project.

I then formulated the research question for this research: How can a design solution support or enhance the sleep hygiene of rotating shift workers? It is worth bringing clarity that, from the broad range of types of work which operate based on rotating shifts, the focus here will be on desk type of work which requires twenty-four hours of operations and workers have to work eight hours shifts moving between morning (7:00 to 15:00), evening (16:00 to 00:00), and night (23:30 to 7:30).

The existing solutions related to sleep were also analyzed and three categories were formulated: tracking sleep, inducing sleep, and focused on the workspace environment. Nevertheless, there is a lack of solutions focused on the shift-work type of work to support the worker´s adaptation to nocturnal work and to improve their sleep hygiene.

For the development of this document literature review was conducted in order to collect evidence about the research topic and the relevance of the study. Autoethnographic analysis to understand in depth the nature of Rotating Shift type of work, interviews to understand the way people deal with night work, and Design research where mapping tools were applied to understand the field of study from different angles and identify pain points/opportunities. A systemic approach was relevant to evaluate the way people are currently behaving, what are the different factors of influence and where are the opportunities for the design field.

This thesis proposes a design solution to support and enhance the sleep hygiene of rotating shift workers in desk-based office work environments. The individual's biological clock, his/her behaviors, and the environment, are factors influencing the sleep hygiene of rotating shift workers.

By adjusting the environment and guiding the behaviors, the worker's adaptation to rotating shift work can be supported. With the implementation of such solution, companies will have a healthier worker who is better prepared to perform his or her tasks and in the long run save time and money. From the worker's perspective, their sleep hygiene will improve, therefore upgrade the quality of their lives, prevent diseases, and support them in the search for balance.

1.2 PROBLEM STATEMENT, THE PROBLEM SPACE.

Our body is used to being awake during the day and to being asleep at night. Nevertheless, countless companies continue to work at night, such as hospitals, firefighters, police, office workers, etc. The increase in the number of companies that require night shift workers due to globalized services demanding 24 hours desk work is impacting the work industry and the way many people live. In fact, "Nearly one-quarter of all workers have shifts that are not during the daytime, and more than two-thirds of these workers have problems with sleepiness and/or difficulty sleeping." (NHLBI, 2005).

If we take into consideration the rotating shift work, there is an alteration in the sleep schedule which affects the performance of the subject, the lack of a stable sleep pattern shifting randomly from the morning, to evening and night shift affects his/her life and health in a general manner. Due to the ever-changing schedule, shift workers tend to be less active and have a poorer diet, also, the biological clock or circadian rhythm suffers alterations, which results in a permanent deficit of sleep, chronic fatigue, gastrointestinal disorders, loss of appetite, nervous disorders, impoverishment of the social and family relationships, loss of friendships, difficulties in having a satisfactory sex life among other effects. In other words, the rotating shift work has effects at the level of physical and mental health, interactions within the family, relationships with friends and (Wright, 2009, Hu, 2008), and professional life. Often, the main motivation for night shift workers is the higher pay rates overnight-work, even though many other aspects of their lives suffer. Nevertheless, some people see other benefits such as having a quieter work environment, finding it easier to focus on their tasks, or even having more freedom or independence at work.

The consequences of lack of sleep affect the performance of a person, which results in a reluctance to carry out tasks, fatigue, depression, anxiety, stress, reflexes are reduced

so that the risk and severity of having an accident increase dramatically. Normally in the absence of sleep, irritability and impulsivity are increased. Productivity is negatively affected.

Rotating work also has repercussions on the individual's eating behavior, influencing the eating schedule and habits. Often, rotating shift workers when waking up have no appetite and, when they feel hungry, they are working and not able to satisfy this need.

Psychological problems are much more frequent among night shift workers than among the general population. This is not only due to the physical disorders caused by the lack of a regular schedule to rest and eat, but it is mainly due to the difficulty they have to lead a satisfactory social life.

Even knowing the negative impact of nocturnal work, it is crucial within the way our world functions, the workforce is required around the clock for many businesses to run. In the endeavor of companies to operate 24 hours, they face difficulties to support the health of shift workers due to the lack of solutions addressing this issue. Often, companies fail at scheduling too many nights in a row for the same worker, not giving him/her enough time off after the shift to recover from a night of work before the next morning or evening shift, not providing an adequate environment for night shift type of work and not having effective training concerning sleep quality, the last two are just the result of a lack of solutions available in the market.

The quality of our sleep is determined by the concept of *sleep hygiene* which is the set of behaviors, the environment in which we live, and the biological characteristics of every individual and how these in conjunction impact sleep. Our sleep hygiene is influenced by several aspects of our lives, it involves everything we do, where we live, and our biological constitution. The diet we decide to have, the environment around us, how active we are, and our biological clock are ruling its quality.

In the case of night shift workers, their bodies are required to function in an unnatural manner when having to work at night and sleep during the day, this pattern affects their sleep hygiene which has an impact on their physical, mental health and social interactions.

Even more dramatic is the case of rotating shift workers, in which case the sleep pattern is constantly changing due to the work schedule moving between morning shift, evening shift and night shift. Rotating shift workers find it hard to prepare for the shift. It is difficult to sleep before, at least for too long when the person comes from a pattern of a night of sleep and day of waking state.

The desk-work environment is the same as the one used during daytime hours with few differences such as allowing to turn lights on or control the screen's brightness. Working at night brings different conditions such as quieter office environment, darkness, lower temperatures and commonly feelings of exhaustion. The desk work environment which has been designed for daytime work does not help the night worker to keep awake when it has not been designed or thought through from the perspective of working at night. People then find it difficult to be awake during the night of work, it is challenging to operate in a way that is disconnected to our nature and in an environment, which is set for daytime work.

In addition to the extreme condition in which the body of a night shift worker is put through, there is an almost inevitable feeling of alienation from the rest of the company. In a common case scenario, during the night shift, there are fewer interactions with colleagues and most of the office workers are away. This does not only happen on a company scale, but the surrounding world also keeps functioning during daytime and nighttime workers are rendered isolated, rotating shift workers find it hard to have a "normal" life which inhibits them from a balanced and healthy being.

In addition to the array of challenges to which a rotating shift worker is put through, there is also a direct impact on our sleep patterns from the use of electronic devices. Blue light exposure when we use screens blocks melatonin release causing insomnia. Further, access to a high amount of information at all hours such as social media scrolling at late hours keeps people awake/busy/entertained at any time, which can affect their sleep patterns.

After a night or work, the person usually faces difficulty sleeping during the day which is influenced by the biological clock, the environment, and other aspects such as family or duties. The impaired performance and difficulties to have a healthy life result in a Shift Work Disorder (SWD). The SWD is intertwined with sleep deprivation, associated with a wide array of health complications such as diabetes, hormonal disorders, migraine, obesity, etc. At a mental health level, a person suffering from SWD is not capable of having a normal performance, the interactions with others are limited and the perception of his/herself is impacted negatively. This disorder results in a general feeling of instability, lack of motivation, and lowers self-esteem which affects the mental health of an individual. The interactions with others are fundamental for the wellbeing of any individual, these are limited due to the different work schedule which does not facilitate encounters with others. Also, interactions are affected by the SWD when the person lacks energy resulting in diminishing self-esteem.

There is a lack of education around sleep hygiene and how different factors can be tackled to support the sleep hygiene of the rotating shift worker. Although there are tips for night workers, some are very difficult to comply with and information is scattered around. There is a lack of solutions that can support shift workers to cope with fatigue and improve their sleep hygiene. Solutions are required, from the design field (in this case) there is a call for a contribution. Currently, although there are many advances in the field of sleep which have helped us understand why it happens and what occurs in our bodies, this remains a mystery, what sleep medicine understands well is the effects on our body when sleep deprived.

Given the importance of sleep, there are tips suggested by the World Sleep Society to maintain its hygiene, but they are difficult to maintain, especially for workers who rotate in shifts including nighttime. Here we find a paradox on what people are supposed to do and what they are willing or capable of doing, when our lifestyles do not support the standards to have good sleep hygiene.

Given the relevance of this matter, there is a field of study and opportunities for solutions which combine design and technology.

1.3 RESEARCH QUESTION

How can a design solution support or enhance the sleep hygiene of rotating shift workers?

The focus of this project will be on how to support or enhance the sleep hygiene of rotating shift workers. It is worth bringing clarity that, from the wide array of types of work which operate based on rotating shifts, such as nurses, builders, factory operators, miners, etc. The focus here will be on desk type of work which requires twenty-four hours of operations and workers have to work eight hours shifts moving between morning (7:00 to 15:00), evening (16:00 to 00:00), and night (23:30 to 7:30).

The development of the research question for this project is the result of two facts, number one, research on the field of sleep medicine where the Shift Work Disorder (SWD) (Shift Work Disorder Symptoms, 2020) has become a relevant topic, there is more awareness concerning the negative effects of the rotating shift type of work and the implication this has on the physical health, mental health and in the social interactions for the worker (D B Boivin, 2014).

The second reason is personal, when starting the research, I was working as a rotating shift worker, there I experienced the effects of rotating shift type of work and especially the night work on my health, also had the opportunity to see it in my colleagues, talked

about it, analyzed how people are dealing with it in different ways and the opportunities from the design field to propose solutions to this situation.

There are several solutions focused on **tracking**, **inducing** sleep, and for the **workspace**: from acupressure mats, weighted blankets, smart lighting products, noise-masking sleep buds or phone apps for sleep, meditation and relaxation, lightboxes, etc. Nevertheless, there is a lack of solutions focused on the shift-work type of work to support the worker and to improve their sleep hygiene.

Many products and services have been developed to improve the sleep quality of people, and which can be used by rotating shift workers. However, there is still a gap when it comes to a dedicated solution for rotating shift workers to support the improvement of their sleep hygiene.

Given the increasing demand for rotating shift workers due to globalized businesses, and the importance to find ways to support or enhance the sleep hygiene of rotating shift workers, the research question of this document becomes a matter of public health. Additionally, the gap in the existing solutions related to the field of study becomes an opportunity for design solutions.

1.3.1 Personal experience in the Field of study

The selection of this thesis topic started from personal experience, I worked as a rotating shift worker for nine months. The work environment was friendly and comfortable, there was a certain level of freedom in the usage of time during the shift and also flexibility to set the shifts or to request a shift to be swapped if possible, the atmosphere at the office was very positive and people were friendly, this made the experience very positive and helped me to cope better with the rotating shift work, especially with the nights. The shift slots were morning (07:00-13:00), brunch (10:00-18:00), evening (16:00-00:00), and night (11:30-07:30), the nature of the work was in front of a computer at a desk, concentration and attention to details were very important.

Having the opportunity to be involved in this type of work while researching sleep (a field of study which I was driven to), I was able to identify the challenges faced when sleep deprivation is required for work and helped me to narrow down a relevant research question for the development of my thesis project. The beginning of this research was from a personal experience, supported by desktop research, and finally became a fascinating field of study full of opportunities.

2. METHODOLOGY

- Desktop study: Review the literature in order to collect evidence about the research topic and the relevance of the study.
- Autoethnography: To understand in depth the nature of Rotating Shift type of work, influence on sleep quality, on health and work environment analysis.
- Observation of work colleagues during night shifts and the company's approach to rotating shift work.
- Interviews to understand the way people deal with night work BEFORE-DURING-AFTER.
- Design research:
  Mapping tools were applied to understand the field of study from different angles, identify pain points and opportunities.
  Systems thinking to evaluate the way people are currently behaving, what are the different factors of influence and where are the opportunities for the design field.

2.1 Desktop research (theoretical background)

2.1.1 Understanding sleep

The human body cannot live without sleep, sleep is necessary, ideally, a daily occurring phenomenon to which its main characteristic is privation from awaking decreased responsiveness to external stimuli and easy to reverse. To sleep for our organism represents vital functions where brain wave activity, breathing, heart rate, and body temperature changes occur and fulfill a whole complex adjustment of the biological system and a fundamental stage to support our natural physiological processes. Adequate sleep is directly tied to a healthy cardiovascular system, lowering our blood pressure while keeping our heart in good condition (Walker, 2017). Sleep is not only a mechanism of physiological repair where energy is recovered to be in good condition for the next day, but it also allows new information acquired during the day to be integrated, therefore it enables to consolidate learning and is a vital process for our performance while awake. Sleep is the most crucial activity we can perform to reset our brain and physical health on a daily basis (Walker, 2017).

2.1.1.1 Two-process model of sleep regulation

The architecture of sleep-in healthy adults is ruled by the Two-process model of sleep regulation (Borbély, 1982) was proposed almost four decades ago and is still a prevalent model in sleep research medicine. Here come to play two main systems, the circadian rhythm or circadian pacemaker (Process C) (Alexander A. Borbély, 2016) which is a

twenty-four-hour rhythm (circa, meaning "around", and diam, meaning "day" (Walker, 2017)) being the main mechanism that controls the timing of sleep, the sleep patterns. The circadian clock is located in the middle of our brain called the suprachiasmatic nucleus ((SCN) composed of 20,000 brain cells) it communicates its daily rhythms to every organ in our body, not only controlling when you want to be awake and when you want to sleep but also when to eat, drink, controls our moods and emotions, the amount of urine we produce, our body temperature, metabolic rate, and the secretion of several hormones (Walker, 2017).

Our circadian rhythm is stimulated by the sunlight being this the main factor in supporting this twenty-four-hour cycle. Nevertheless, daylight is not the only signal taken by our brain for our biological clock resetting, our brain also uses external factors such as food, temperature fluctuations, physical activity, and even regularly timed social interactions (Walker, 2017).

The location of the suprachiasmatic nucleus in our brain is right above a crossing point of the optic nerves coming from our eyeballs, this nucleus uses the light information received to reset its cycle (Walker, 2017). This rather small part of our brain also controls our core body temperature fluctuations, our body temperature decreases as the time for sleep approaches, then it rises overnight, no matter if we are asleep or not these variations occur independently.

These variations also vary from person to person, every human has an individual biological pattern and a different peak of wakefulness. For some people, the peak arrives early in the day and their desire for sleep early at night, these are known as "morning types" (40 percent of the population). Other people are known as "evening types" (30 percent of the population) preferring to go to bed late at night and waking up later in the morning. The remaining 30 percent are the types who are in between morning and evening type. These peak wakefulness types or chronotypes are popularly known as "morning larks" and "night owls" and are determined strongly by genetics. Usually a "night owls" finds it challenging to fit in a regular work schedule forcing its genetic tendency to wake up early in the morning and having trouble falling asleep early at night, therefore being chronically sleep-deprived. In this regard, the working schedule ideally should be set considering the chronotype of the worker and in that way making life easier for the person, supporting a healthier lifestyle, and also getting the best results in terms of productivity (Walker, 2017).

Our circadian rhythm communicates the signal between night and day through a hormone known as Melatonin. This hormone is triggered in response to darkness and indicates to several regions of the brain that is time to prepare for sleep, is what makes

us feel sleepy, and facilitates the process of falling asleep, but not necessarily what makes us fall asleep. Melatonin is commonly known as "the hormone of darkness" and "the vampire hormone" due to it being released soon after dusk. Once sleep is happening, melatonin slowly decreases in concentration through the night until the morning hours come and the sunlight enters the eye indicating to the suprachiasmatic nucleus to stop releasing melatonin (Walker, 2017).

The second component of the Two-process model of sleep regulation is the sleep-wake homeostasis (Process S) or sleep pressure (Walker, 2017) is regulated by an internal biochemical system through a neurotransmitter called Adenosine which generates drive for sleep as a function based on the amount of time elapsed since the last sleep episode. This process represents a sleep debt, increases during wakefulness, and declines during sleep (Alexander A. Borbély, 2016). The accumulation of the hypnogenic (sleep-inducing) substance in the brain generates a homeostatic sleep drive.

The two-process model of sleep regulation is moderated by the circadian drive for arousal and generates the sleep-wake cycle, which is directly influenced by our genes, behavioral aspects like our diet, physical activity, sleep or eating schedule, etc., and by the environmental aspects such as temperature, noise, and light.

The sleep cycle or sleep-wake cycle is a daily biological pattern of alternating sleep and wakefulness, roughly eight hours of nighttime sleep, and sixteen hours of daytime wakefulness in humans. Electrophysiological recordings from the suprachiasmatic nucleus suggest that the process S and process C interact continuously (Alexander A. Borbély, 2016).

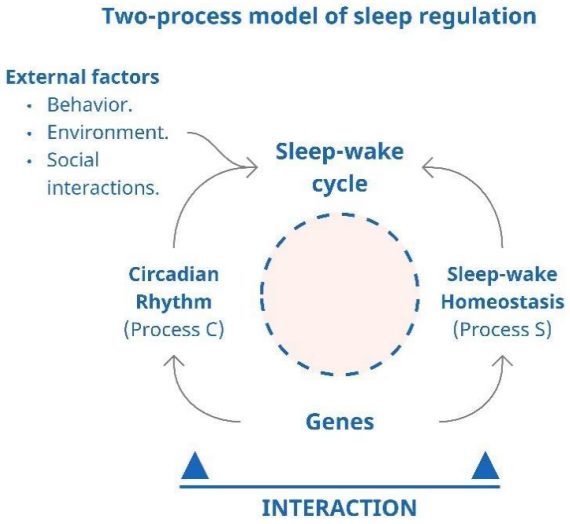


Figure 1 Elements of the two-process model of sleep regulation, figure made by the author

The figure above is a representation of the concepts discussed earlier. The two-process model of sleep regulation the sleep-wake cycle is ruled by the relation between our circadian rhythm and the sleep-wake homeostasis. Is a constant interaction of two separate systems that are ignorant of each other yet usually aligned (Walker, 2017).

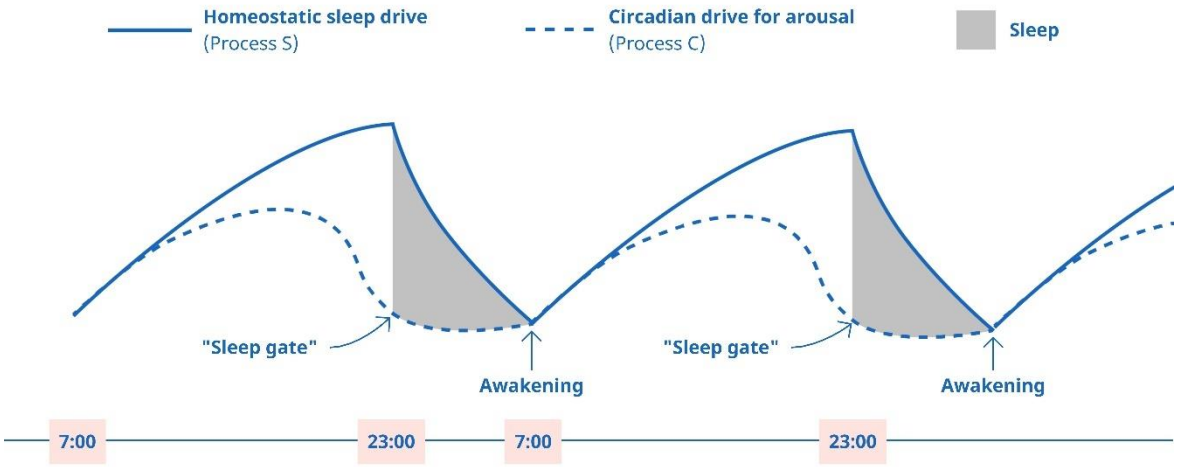


Figure 2 Two Factors Regulating Sleep and Wakefulness (Walker, 2017)

The figure above is a representation of forty-eight hours of time where the relation between Process C and Process S is displayed graphically as a constant fluctuation and relation of two systems to enable the sleep gate to occur, the sleep period and the awakening process. It is a fascinating intrinsic rhythm within an hour body in which the distance among the curved lines reflects the desire to sleep. As the Process S (sleep drive) gathers adenosine throughout the day, Process C (wake drive) has its peak moment and eventually starts to decline, lowering activity levels in our brain and generating a strong desire for sleep (Walker, 2017).

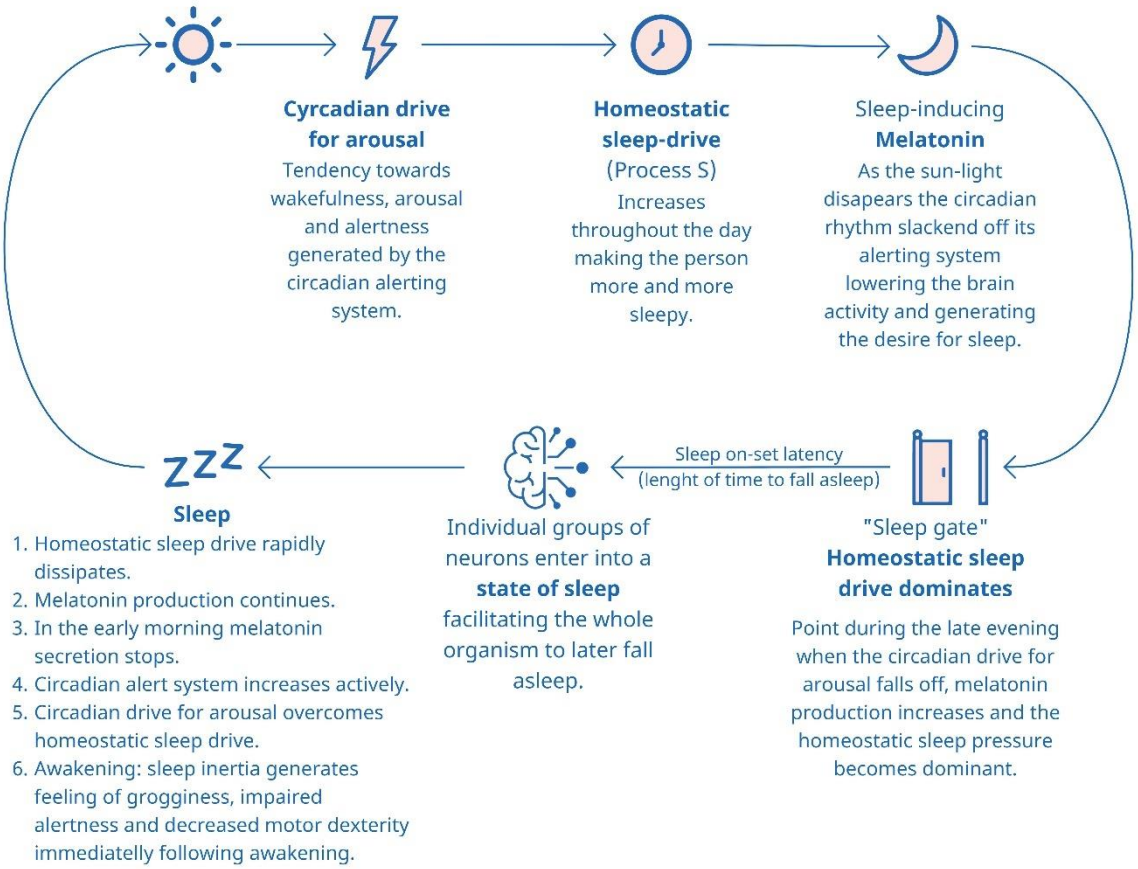


Figure 3 Sleep fluctuations through a day, figure made by the author

The figure above illustrates what are the fluctuations of sleep during a day, the relation between the Two-process model of sleep regulation as time passes by, and how on each stage a different system is dominantly facilitating the sleep-wake cycle to occur.

2.1.1.2 Sleep Architecture

The sleep architecture will be explained in a very general way as is not the intention of this document to go deeply into neuroscience. With the EEG technology scientists have been able to identify different stages and sleep cycles and conclude that healthy adults have ninety-minutes sleep cycles where NREM or non-REM (Non-Rapid Eye Movement) and REM (Rapid Eye Movement) sleep across the night where different brain states take place (Walker, 2017).

During the NREM sleep also known as light sleep, there is little to no eye movement, muscle atonia and dreams are rare. During REM sleep or deep sleep, there is rapid and random eye movement, high-frequency brain waves, muscle paralysis, and frequent and vivid dreams. The way our brain moves from one state to another every ninety

minutes during the night varies as the sleep time progresses. As can be seen in Figure 4: Hypnogram: The architecture of sleep, during the first half of the night a major part of our ninety-minutes cycle is spent in NREM sleep, as the night continues the majority of time is consumed in REM sleep (Walker, 2017).

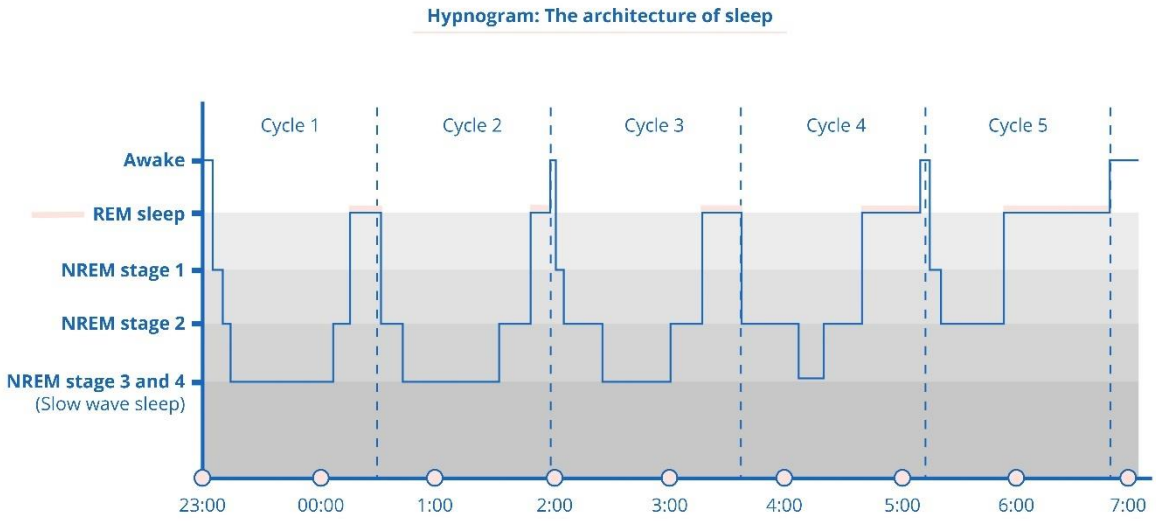


Figure 4 Hypnogram: The architecture of sleep (Walker, 2017).

What a person experiences during NREM sleep is a great display of neural collaboration where thousands of brain cells unite in a synchronic manner. During REM sleep also called paradoxical sleep, the brain waves resemble an awakened brain yet with a dormant body. In REM sleep fast electrical brain frequencies return in different parts of the brain in the same way it happens while we are awake. During this state signals from our memories are played out, this is the state when our information processing takes place (Walker, 2017).

A fascinating analogy on how this process occurs was described by Matthew Walker in his book Why we sleep: NREM sleep as a reflection (storing and strengthening those raw ingredients of new facts and skills), and REM sleep as integration (interconnecting these raw ingredients with each other, with all past experiences, and, in doing so, building an ever more accurate model of how the world works, including innovative insights and problem-solving abilities).

The more science can uncover the complexity of sleep, the more we are aware of its importance and the relation to every performance factor during our waking state, the impact it has on our health in the present, and how much it defines the quality of our life.

2.1.2 SLEEP, SHIFTING PARADIGM

Sleep is defined as a daily occurring phenomenon where the privation from awaking state is its main characteristic. Formerly there was little knowledge about what happened while we slept, it was considered as an unknown state with very low brain activity, a state facilitated by a dormant brain.

Back in the 1950s and 1960s with the development of Electroencephalography (EEG) scientists began measuring brain activity while we sleep. This brain wave activity was expected to be slow or lazy, the surprise came when they discovered that while we sleep there is an outstanding electrical activity in our brain with absolute neuronal synchrony (Walker, 2017). Sleep was then considered a complement to the waking stage where physiological functions and changes (breathing, body temperature, heart rate, etc.) occur with variations in the brain activity (through the various sleep stages).

The understanding of the importance of sleep is not based on knowing what happens while we sleep but rather on knowing what happens when there is sleep deprivation. Nevertheless, sleep is still poorly considered as a performance factor. Some of the causes of poor sleep are anxiety, depression, lack of concentration, impaired performance, drowsiness, cardiovascular diseases, mental health problems, etc.

Sleep is underrated, in fact, 35% of American adults are not getting enough sleep on a regular basis, which is equivalent to around 84 million adults ((CDC), 2016). The sleep hygiene of college students is very poor, 44% experience depression, 80% feel overwhelmed, 50% struggle with anxiety, and 16-24-year-olds are 80% more likely to be in a drowsy driving accident (Cunningham, College students are not getting nearly enough sleep, 2019). There is a lack of sleep education in schools and even doctors do not train it.

As sleep medicine develops there is a constant rising of awareness in relation to the importance of sleep. This is the sleep paradigm of today where sleep epidemiology is widely studied and has gained prevalence in the scientific and medical field (Jane E. Ferrie, 2011). We know what happens if we do not sleep enough, therefore understanding how important it is. Here we are facing a paradox: people are told what should be done and how to act in a general way, but to apply rigid rules in a world where we all have varying schedules does not work. We live in different parts of the world and we have different circadian rhythms. When giving instructions to people related to the length of sleep, diet, physical activity and social life, the individual characteristics and lifestyle of the person should be considered.

This is why it is important to consider a sleep re-education where the concept of Sleep Hygiene has high potential to provide benefits and to inform people how from their behavior, they can influence their sleep schedule, create relaxing rituals, prevent from sleep stealers like alcohol and caffeine, to exercise regularly and to have a healthy diet. From the perspective of the environment consider the temperature for sleep, the noise, light, mattress, pillow, the use of electronic devices, and finally to understand and learn from their own biological Clock ruled by the circadian rhythm. With sleep re-education and providing the tools for people to be informed, every individual could find ways to navigate their life and achieve better sleep quality.

The understanding of sleep hygiene as a tool to improve the quality of our lives is then a great tool to support people who have to live a life in an unnatural manner such as shift workers, especially those who have to work at night and suffer the effects of sleep deprivation.

2.1.3 SHIFT WORK SLEEP DISORDER (SWD)

Sleeping well has benefits such as improving memory capacity, reflexes, attention span, humor, more energy and have a greater willingness to learn, in fact, sleep is a vital function to support the way we perform during our waking state, but what happens if the work schedule does not allow the person to have a regular sleep pattern and the person is rendered sleep deprived? This will be discussed in this chapter.

Due to the importance of adequate sleep, there has been a World Sleep Day celebration established and promoted by the World Sleep Society and the World Association of Sleep Medicine since 2008, to prevent the risks associated with sleep disorders. A sleep-deprived person will have an impaired performance, sleep loss affects productivity, physical and mental health, poor sleep affects the life of a person in a general way. According to a study by the University of Cambridge that focused on the habits of more than 21,000 British employees, the factor that most affects productivity is lack of sleep.

On World Sleep Day, the importance of preserving circadian cycles during the healthy sleep of the human being is emphasized, while respecting the biological clocks that are often altered in our daily lives by environmental, behavioral, and social factors. Circadian rhythm constitutes the human biological clock that regulates important physiological processes of the organism, which repeat every 24 hours. Given the importance of this course of action occurring during sleep and discussed in the previous sub-chapters, it is worth analyzing what happens in our body while a person is sleep-deprived and how this potentially generates sleep disorders.

There is a long list of diagnosed sleep disorders . About fifty to seventy million Americans suffer from a chronic sleep problem and one in three adults does not get the recommended amount of interrupted sleep to protect their health (NHLBI, 2013). Alertness is low considering the severity of the problem.

This research focuses on Shift Work Disorder (SWD), but first, let us define what is shift work. Shift work is work that takes place on a schedule outside the traditional 9 am – 5 pm daily. It can involve evening or night shifts, early morning shifts, and rotating shifts. Many industries rely heavily on shift work, and millions of people work in jobs that require shift schedules (SleepFoundation.org, What is Shift Work? 2020).

Shift work is prevalent in industrialized societies where different companies require to function twenty-four hours a day either acting on global markets, providing vital services for society or keeping heavy industry machinery running. The necessity of including night work harms the sleep pattern, which causes physiological sleepiness, affects the performance, increases the risk of accidents, and the possibilities of suffering from cardiovascular disease and certain forms of cancer (Wright, 2009).

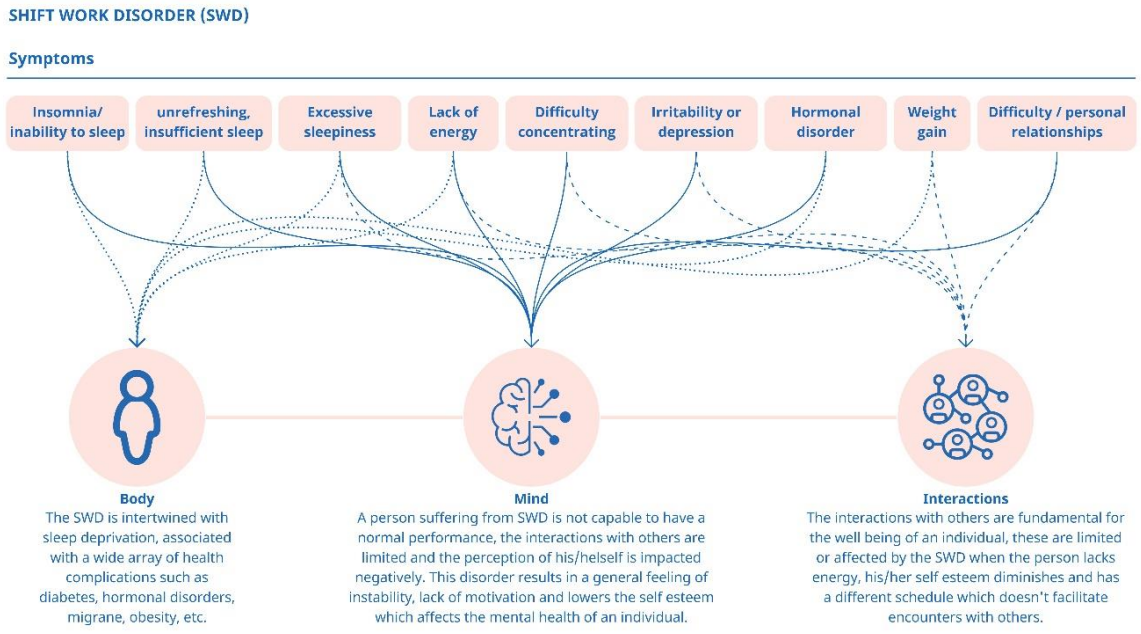


Figure 5 Symptoms of Shift Work Disorder and the relation to Body, Mind, and Interactions. Figure developed by the author.

Figure 5 illustrates how the symptoms of SWD relate to physical health, mental health, and how it has an impact on the interactions with others. The main health problem is caused by a disturbed sleep pattern, at least ¾ of the shift workers are affected as being proved by EEG analysis that their day sleep is 1 to 4 hours shorter than night sleep. Night shift workers suffer a greater sleep loss than evening workers and slow rotating

shifts (e.g., at least 3 weeks per shift schedule) schedule while rapid shift rotation is related to greater reduced total sleep duration (Wright, 2009).

The way rotating shifts happen has an impact on the severity of the impact on sleep. In case of rapid counterclockwise rotation, the sleep pattern is affected immediately before the night shift, in the case of clockwise rotation, the effect is less severe due to the natural tendency of the circadian clock to delay to a later hour. Before a counterclockwise rotation, 80% to 90% of workers can nap before the night shift, in contrast to 40% to 60% before a clockwise rotation. To nap before the night shift lessens the expected impairments of sleep deprivation (Wright, 2009). There is no clear scientific statement whether rapid rotating shift or slow rotating shift is less harmful, some experts have argued that a rapidly rotating schedule is more rational since it minimizes the time spent in a desynchronized state, while others could argue for longer runs (more consecutive days) of shift work that provide an opportunity to achieve a degree of synchronization (Robert L Sack, 2007).

The desynchronized state mentioned above relates to a misalignment between our internal circadian physiology and the required work schedule which is the main cause of induced sleepiness and sleep disruption (Robert L Sack, 2007). Differentiation among a "normal" and pathological response to shift work is yet not clearly defined, resulting in an underrecognized disorder in the clinical research field (Schwartz, 2010).

The misalignment caused by the night work is because our circadian rhythm (Process C) and the sleepiness signal of adenosine (Process S) are independent (Walker, 2017) systems which in normal sleeping conditions interact in an aligned way supporting the person to have a healthy sleep pattern. By remaining awake, the brain is not able to drain the adenosine concentration which keeps growing in concentration. This would mean that the longer we are awake the sleepier we would feel, but what happens is that our circadian rhythm keeps operating as if it had been sleeping, rising at seven in the morning (for "morning larks" chronotype). The circadian rhythm continues its fluctuation of fall and rises based on the time of the day, not considering if we have slept or not (Walker, 2017).

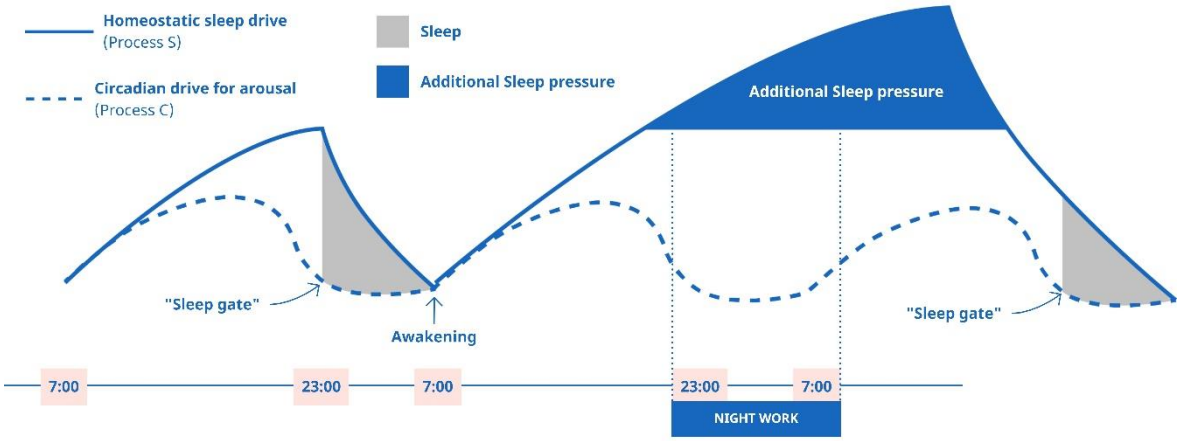


Figure 6 Night work, Additional Sleep Pressure (Russell Rosenberg, 2011)

In Figure 6 is represented how the Circadian drive for arousal continues its behavior in a rhythmical way while the adenosine produced by the Homeostatic Sleep drive grows in concentration as we remain awake. The longer the distance among the two curves, the bigger the desire to sleep. This is why the end of the night shift between 5-6 am is the hardest hour to remain awake and lucid (Walker, 2017).

Having a comprehension of the relation between the Two-process model of sleep regulation and sleep deprivation, it is understandable why workers suffering from SWD can fall asleep involuntarily at work or driving back home after a night shift. Working on atypical shifts has important socioeconomic impacts as it leads to an increased risk of accidents, workers' impairment, and danger to public safety, especially at night (D B Boivin, 2014).

Shift Work Disorder is a public health matter which requires solutions to support rotating shift workers, especially night shift workers on having a better sleep quality or what is becoming a more popular concept, better *sleep hygiene*.

2.1.4 SLEEP HYGIENE

Sleep Hygiene (SH) is a list of Behaviors, environmental conditions, and other aspects related to sleep, like our internal clock (Process S and Process C) which determine the sleep-wake cycle. These factors can be adjusted to serve as a treatment for patients suffering from sleeping disorders (Wyatt, 2003).

Sleep Hygiene is formed by a collection of elements which define the quality of our sleep. For example, healthy diet and exercising / physical activity are vital sleep influencers. In conjunction, these define whether we have or not adequate health (Walker, 2017). Good sleep hygiene practices, together with the application of circadian

principles, can improve sleep quality, alertness, performance, and safety in shift workers and jet travelers (Phyllis C. Zee, 2010).

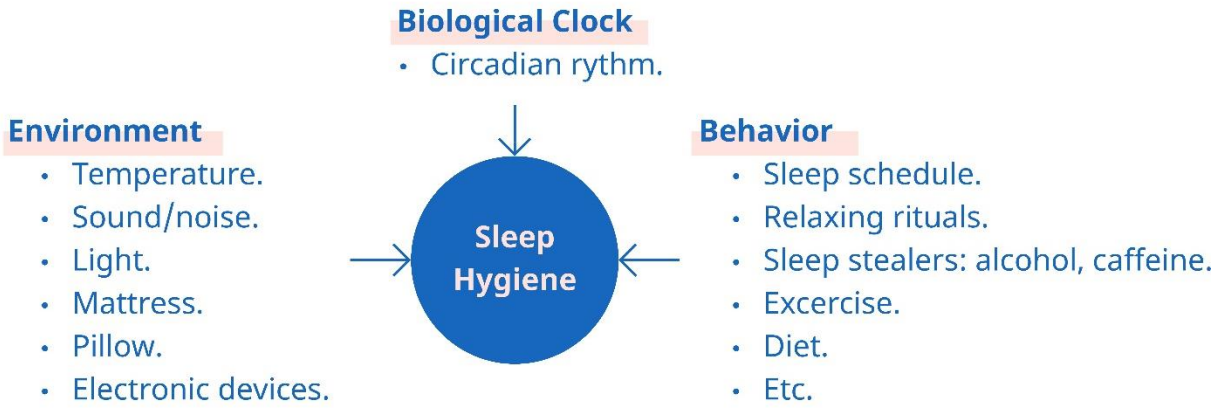


Figure 7 Influencing factors on the Sleep Hygiene. Figure developed by the author

Figure 7 shows how three main factors influence sleep hygiene: our biological clock regulated by the circadian rhythm; environmental factors such as temperature, sound/noise, light, the type of mattress or pillow we have and the use of electronic devices before sleeping and our behaviors such as how active we are, our sleep schedules, diet, the consumption of alcohol, caffeine, and what type of relaxing rituals we establish before sleep.

There is an increasing global health concern in relation to sleep. Sleep hygiene has become a tool to promote healthy sleep to the population (Leah A. Irisha, 2015), it represents a valuable strategy for disease prevention and a way leading to sleep re-education.

2.1.4.1 Sleep Hygiene Index (SHI)

The Sleep Hygiene Index (SHI) is a tool which includes 13-items designed to self-report the practice of sleep hygiene behaviors during day-to-day life (David F. Mastin, 2006). *Each item is rated on a five-point scale ranging from 0 (never) to 4 (always). Total scores range from 0 to 52, with a higher score representing poorer sleep hygiene. SHI has shown adequate reliability and validity* (Sungkun Cho, 2013).

Number	Question	*always*	*frequently*	*sometimes*	*rarely*	*never*
SHI-1	I take daytime naps lasting two or more hours					
SHI-2	I go to bed at different times from day to day					
SHI-3	I get out of bed at different times from day to day					
SHI-4	I exercise to the point of sweating within 1 hour of going to bed					
SHI-5	I stay in bed longer than I should two or three times a week					
SHI-6	I use alcohol, tobacco, or caffeine within 4 hours of going to bed or after going to bed					
SHI-7	I do something that may wake me up before bedtime (for example: play video games, use internet, watch television, eat)					
SHI-8	I go to bed feeling stressed, angry, upset or nervous					
SHI-9	I use my bed for things other than sleeping or sex (for example: watch television, use or phone or eat)					
SHI-10	I sleep on an uncomfortable bed (for example: poor mattress or pillow, too much or not enough blankets					
SHI-11	I sleep in an uncomfortable bedroom (for example: too bright, too stuffy, too hot, too cold, or too noisy)					
SHI-12	I do important work before bedtime					
SHI-13	I think, plan, or worry when I am in bed					

Table 1 Sleep Hygiene Index (SHI) table (David F. Mastin, 2006).

The sleep Hygiene table is a valuable tool to identify how the behavior and environment impact sleep hygiene. It also potentially helps to identify circadian clock alterations.

2.1.5 Sleep Hygiene and Rotating Shift Work

To have good sleep hygiene it is essential to have patterns in our sleep schedule, diet, physical activity, etc. It is fundamental to keep rhythms that align with our physiological processes, but what happens to the sleep hygiene of Rotating Shift workers?

Rotating shift work includes day, evening, and night shift, or two of the three shifts. "Nearly one-quarter of all workers have shifts that are not during the daytime, and more than two-thirds of these workers have problem sleepiness and/or difficulty sleeping." (NHLBI, 2005) Night and rotating shifts have been studied most because they are potentially the most problematic to shift workers (McGovern, 1991).

Many shift workers are unable to tolerate a sleep/wake routine of daytime sleep and nocturnal activity (McGovern, 1991) which is understandable considering the functioning of the two-process model of sleep regulation and the unbalance created by a night of sleep deprivation. The ability to cope with rotating shift work depends on many variables such as age, gender, biological rhythms, job satisfaction, attitudes about shift work, physical health, and environmental variables like type of shift schedule worked, social support (McGovern, 1991), domestic responsibilities, commuting time and distance to and from work, and environment pollution like noise and light that interfere with promoting and maintenance of sleep. The noise is the main environmental disturbance that interferes with daytime sleep (Tepas, 1982).

Another crucial aspect of coping with shift work is related to a person's genetic chronotype. Morning types have an earlier rise and fall in their circadian rhythms, evening types have a later rise and fall, due to this it is common that evening types prefer the night shift and are better able to adapt to it. Morning types experience a greater disturbance when the rhythms constantly change (McGovern, 1991).

2.1.5.1 Interventions for Rotating Shift Work to promote Sleep Hygiene

The selection of the appropriate interventions for a certain group of rotating shift workers should be proposed based on a clear understanding of the work environment and the specific worker population. After having analyzed the nature of the work and identified potential problems, strategies have been compiled to tackle the worker´s intolerance to shift work with the objective of promoting worker´s adjustment to shift work and protect them, also their families, and the society (McGovern, 1991) from the appearance of Shift Work Disorder.

The following list of items is a compilation of recommendations to consider when setting rotating shift work in order to help the worker to adapt easier and to avoid or lessen the effects of the Shift Work Disorder.

- Circadian rhythms adapt easier to forward rotation of shifts (day, evening, then nights) than backward rotations (day, night, then evening) (Rose, 1984). Our circadian rhythms can be delayed easier than be advanced (McGovern, 1991).
- Higher temperatures during the day improve performance and at night when temperatures drop there is poorer performance (McGovern, 1991).
- Tasks demanding high memory or higher levels of complexity tend to get worse throughout the day (McGovern, 1991).
- The length of the shift should be set based on the physical and mental load of the tasks to be performed. Night shifts should be shorter than morning or evening shifts. In the case of work requiring high physical or mental load, it may be necessary to reduce the length of the shift to 7 or 6 hours (P. KNAUTH, 1982).
- After night shifts the workers should have days off so the sleep dept can be a relief (Minors, 1981).
- Assessment of night work environment related to the adequacy of light, ventilation, temperature, and noise control should be considered as these might contribute to increased fatigue and discomfort (McGovern, 1991).
- Breaks scheduled during the shift should be considered to promote physical activity in workers, provide the time to eat meals at adequate scheduled times, and to socialize to maintain alertness. Equally, such criteria suggest that it may

be necessary to reduce the length of the shift to 7 or 6 hours if the physical or mental load of the task is very high (P. KNAUTH, 1982).

- A health monitoring program should be developed or applied to track the worker´s ability to tolerate shift work. Periodic interviews could be scheduled to ask workers about their adjustment to the night work schedules (McGovern, 1991).
- Education and counseling that explain how circadian rhythms work and are affected by night work are necessary as most people are not aware of the complexity of adapting to a shift work schedule which includes night work. In this regard also family members should be instructed about the importance of social support (McGovern, 1991).
- To have regularity on bedtime and mealtime is important since these factors serve as synchronizers to facilitate the adjustment to a new schedule. Also, to maintain a regular schedule during days off minimizes circadian rhythms disorders.
- Bright light therapy has shown positive results for accelerating the adjustments in some people. Well, timed exposure to bright light can help to reset the circadian clock by as much as 6 hours (Raymond, 1988b).
- Early starting morning shifts (05:00 or 06:00) usually shorten the sleep duration and increase fatigue before work compared to later starting morning shifts. Late finishing afternoon and night shifts shorten the sleep duration after work. Self-rated fatigue was highest for morning shifts beginning before 0600 hours and lowest for morning shifts beginning between 08:21 and 10:00 hours (P. KNAUTH, 1982).
- The shift change times should provide some flexibility to the worker. The shift schedule planning should have few nights in succession and include at least two free days off (P. KNAUTH, 1982).
- The worker's sleep chronotype should be considered when setting the work schedule. The sleep chronotype suggests the timing or set point of an individual's circadian rhythm (Frei, 2018). There are three types of chronotypes according to Steve Frei in his book *Making Night Shift Work: A Practical Guide for the Night Worker,* 1. Early birds are the people who wake up early, feel best in the morning, and get tired in the early evening, 2. Night owls are the people who struggle to wake up early in the morning, and get tired in the late evening, and 3. Common sparrows are those who are in between. To define the sleep chronotype of a person the Morningness-eveningness chronotype questionnaire can be implemented (Frei, 2018).

- The Karolinska Sleepiness Scale (KSS) can be implemented at the beginning of the night shift to measure the subjective level of sleepiness at that particular time. With the KSS the worker indicates the level that represents the psycho-physical condition felt in the last 10 minutes (Shahid A., 2011).

2.1.6 BIOHACKING

Biohacking is a do-it-yourself (DIY) merging science for body modification with technology. Biohackers are driven to explore cybernetics, personal data acquisition, and encourage the development of privacy rights and open-source medicine. The biohacking community has brought discussions related to cultural values, medical ethics, safety, and compliance in transhumanist technology (K.Yetisen, 2018).

Biohacking is a broad term that can cover a wide range of activities, from science experiments with other organisms to sleep tracking and dietary changes, to adapting the biological constitution of a human body (Samuel, 2019) by different sources of modification.

Biohackers experiment usually outside labs or traditional laboratory spaces and institutions to perform the trials on their bodies, often to improve their physical and cognitive performance with the use of technology (Samuel, 2019), a technology that is accessible to anyone.

To measure the state of their bodies, biohackers often quantify themselves with the help of wearable devices. Collecting data of their body's mechanical functions enables them to optimize them to accomplish the desired outcome (Samuel, 2019).

A more extreme subset of biohackers is known as grinders, who go as far as implanting devices or computer chips in their bodies. Such implants enable them to open doors, monitor their glucose levels subcutaneously (Samuel, 2019), among other functionalities.

One good example is the Elon Musk initiative with his company Neuralink, they are designing a neural implant (called the Link) to enable the control of a computer by just thinking about desired actions. This, by inserting micro-scale threads in certain areas of the brain which control movement and that are connected to the Link. This information is transmitted to the Neuralink app which then controls iOS devices, keyboard, and mouse.

Considering that biohacking is any action to modify or improve our performance, this concept has the potential to be linked to the SWD with the purpose of improving sleep hygiene or facilitating the worker's adaptation to night work.

2.1.6.1 BRIGHT LIGHT EXPOSURE DURING NIGHT SHIFT

The solar light-dark cycle is the main environmental factor in synchronizing the circadian rhythm in most living organisms to the twenty-four-hour day, humans are not the exception.

Studies with bright light exposure in humans proved a dramatic suppression of melatonin secretion (Lewy AJ, Wehr TA, Goodwin FK, Newsome DA, Markey SP, 1980), along with a circadian phase-shifting effect on the circadian rhythm (Czeisler CA, 1986).

The light intensity of illumination is measured in units of lux or watts. Lux is an International System unit of illumination or intensity based on the spectral characteristics of the human vision (photoreceptors). One lux is equal to the light received from a candle which is one meter away from the eye, the light intensity (lux) lowers as the light source is moved further from the eye. Watts is the International System unit of power which indicates the intensity of light emitted per square meter (Robert L Sack, 2007).

A light source with higher intensity produces major effects on the circadian rhythm. Bright light exposure (3000-10,000 lux) has been proven to generate strong circadian phase shifts; even lower intensities (50-600 lux) can produce phase shifts when the subject is living in a darker environment (Zeitzer JM, 2000).

Light exposure does not have to be continuous to affect the circadian rhythm. Alternating exposure to bright light and dim light has been proven to produce a similar effect concerning phase shifting as continuous light exposure (Gronfier C, 2004).

The phase resetting response to light exposure is more effective at the beginning of the light exposure period (Robert L Sack, 2007).

Such findings brought the opportunity to propose the use of timed light exposure as a treatment for Circadian Rhythm Sleep Disorder (CRSD) (Robert L Sack, 2007) which can also be implemented for night workers.

"For a night worker, circadian alignment can be achieved with bright light exposure during the shift and avoidance of bright light (with dark or amber sunglasses) toward the latter portion of the work period and during the morning commute home" (Phyllis C. Zee, 2010). Wearing dark glasses or blue-light blocking glasses during the morning

commute on the way home improves adaptation to the nocturnal work (Crowley SJ, 2004).

It has been proven that being exposed to light, including artificial light from a bright desk lamp or regular overhead lamps, triggers alertness on the brain and improves the worker's performance (Yoon IY, 2002).

2.1.6.2 Banking sleep

Banking sleep refers to periods of extended sleep before a phase of sleep deprivation. Studies have proven that extended sleep reduces sleep drive and improves mood and performance, which brings the possibility that sleep does not happen only with an accumulated sleep need, but extended sleep can provide a reserve of sleep, which could be used in subsequent waking periods (Vyazovskiy, 2015).

Sleep extension enhances the capacity to tolerate periods of total sleep deprivation (Arnal PJ, Sauvet F, Leger D, van Beers P, Bayon V, Bougard C, Rabat A, Millet GY, Chennaoui M, 2015), due to lower levels of sleep pressure in the initial phase of sleep deprivation, resulting in a longer period of comfort for the sleep-deprived individual (Vyazovskiy, 2015).

One week of sleep extension improves resilience on factors like performance and alertness during periods of sleep restriction and ease the recovery thereafter. Studies suggest that the recovery from sleep restriction is slower than recovery from total sleep deprivation (Tracy L. Rupp, 2009). Overall, several neurobehavioral factors in subjects who obtained an excess of sleep were recuperated faster than in the case of individuals who did not (Rupp TL, Wesensten NJ, Bliese PD, Balkin TJ, 2009).

The extent to which an individual is affected by sleep restriction, and the capacity to reverse those affections is directly linked to the amount of nightly sleep obtained prior to the sleep restriction period. This suggests that the underlying sleep debt is accumulated long-term (Tracy L. Rupp, 2009).

2.1.7 The existing solutions (solution space)

There are several solutions addressing the field of sleep, for this project the collection of concepts for the existing situation have been grouped under three categories: **Sleep monitoring, Sleep inducing** and focused on the **Workspace or environment**. (see Appendix 2 The SOLUTION SPACE map)

Sleep Monitoring/Tracking	Sleep induction	Workspace
• Bed/mattress wearable device. • Wearable: ring, wrist bands, belt, smart watches. • Mobile applications. • Service for sleep assesment and sleep quiality improvement. • Smart Sleep system: Phillips.	• Accupressure mat. • Weighted blankets. • Ear buds. • Technology enhanced meditation. • Sleep and wake-up light. • PEMF (Pulsed electromagnetic field) to perform brainwave entrainment.	• Biosensors. • Computer vision algoritms. • Fatigue technology. • AI technology. • Blue light: Therapy and blocking. • Light therapy. • Eye saver technology. • Heated desks.

Table 2 Solution space categories. Figure developed by the author

Sleep Monitoring/Tracking

The solutions under this category serve the purpose of monitoring sleep. By measuring the time slept, the physiological variations in the body while sleeping, the sleep cycles, sleep disruptions, and some even track the environmental conditions. In most cases, the user receives feedback in the form of data.

Sleep monitoring solutions have been developed as wearable devices, mobile applications, and digital services. By monitoring sleep these solutions provide an overview of the sleep characteristics, some of them to educate people and help them improve their sleep quality. Depending on the solution, some can be more accurate as might be the case of wearable devices which by tracking the body fluctuations can provide an array of variations happening in our body while we sleep. Other solutions use the phone microphone as a tool to track the noises we make during sleep or the environmental noise pollution and based on that provide statistics of sleep quality.

Sleep Induction

The solutions under this category focus on inducing sleep. there is a wide range of solutions from acupressure mats, weighted blankets, noise-masking earbuds, meditation apps, and smart lights which by relaxing the body stimulate the secretion of different substances helping the person to fall asleep. In addition to what has been included in the map (see Appendix 2 The SOLUTION SPACE map), several practices contribute to sleep induction such as essential oil's aromatherapy or white noise machines which help to block noise that might disturb the sleep.

On a more high-tech note, NeoRhythm is a PEMF (Pulsed electromagnetic field) wearable device that uses electromagnetic fields to perform brainwave entertainment. Through

brain stimulation, it synchronizes brainwave frequencies with the resonance of predetermined frequencies to accomplish a specific state of mind, in this case, sleep.

EEG (Electroencephalography) technology has also been applied to wearable devices as is the case of Muse, which provides *technology-enhanced meditation* by tracking brain signals that are processed to interpret mental activity and later translates them into guiding sounds of weather to help the person find focused calm during meditation, in their portfolio, they offer *Go-to-Sleep Journeys* as guided meditations.

Workspace solutions

The solutions under this category focus on the workspace, not only for shift workers but for the computer-based type of work and its environment. The collection of products analyzed here proves that technology is implemented to improve the quality and conditions in the workspace.

Several BIOSENSORS are currently used to analyze human behavior and/or corporal state or physiological changes, especially when it comes to high-risk types of work these tools have increased safety standards and efficiency. The following list displays how technological advancements have been applied to the work environment.

- Eye tracking technology: eye tracking algorithms to monitor eye-closure duration, eyesight focus and head pose to detect fatigue and distraction.
- Screen-based Eye Trackers.
- Eye Tracking Glasses.
- VR Eye Tracking.
- Electroencephalography (EEG) Headsets: Measuring electrical activity from the brain reflects how the neuronal electrical impulses in the brain are associated with different cognitive processes.
- Facial Expression Analysis: Facial coding to measure human emotions through facial expressions.
- Electrodermal activity (EDA/GSR): measures the electrical activity conducted through sweat glands in the skin. Giving an indication of the intensity of an emotion experienced.
- Electrocardiogram (ECG/EKG): measures Heart Rate Variability.
- Electromyography (EMG): measures the electrical activity produced by muscles contractions.

There are also several solutions related to daylight simulation for the workspace. Research has shown the effects of light exposure on our body, there is still a debate on whether light exposure contributes to better cognitive performance or not. A study

(Ahuva Y. Segal, 2016) conducted has shown no variation in the cognition when exposing people to light during daytime work. Other several studies have proven light exposure to be of support for the circadian rhythm variations by supporting sleep-deprived individuals increasing their levels of vigilance, cognition and also to improve mood (Henri Comtet, Light therapy with boxes or glasses to counteract effects of acute sleep deprivation, 2019).

Products like Luminette, a wearable "lightbox" where a light beam enters the eye simulating the sun, or Needlite an office desk lamp, app synced that simulates daylight are solutions that use light therapy as a treatment against winter fatigue and SAD (Seasonal Affective Disorder).

There are several solutions focused on tracking, inducing sleep, and for the workspace: from acupressure mats, weighted blankets, smart lighting products, noise-masking sleep buds or phone apps for sleep, meditation and relaxation, lightboxes, etc. Nevertheless, there is a lack of solutions focused on the shift-work type of work to support the worker and to improve their sleep hygiene.

2.3 Desktop research conclusions

- The more science can uncover the complexity of sleep, the more we recognize that it is a crucial performance factor, the influence it has on our health and influences the overall quality of our life.
- The increased global interest concerning sleep has positioned the concept of Sleep Hygiene as a tool to promote a better sleep quality to the population.
- The importance of sleep has gained awareness, sleep medicine specialists recognize the need for a sleep re-education addressing disease prevention.
- Broad understanding on the factors which affect the Sleep Hygiene can be an effective way to improve the sleep hygiene of any person, especially of those who go through periods of sleep deprivation such as rotating shift worker.
- The genetic chronotype of rotating shift workers should be taken into consideration when assessing Sleep Hygiene practices.
- Many factors contribute to the improvement of Sleep Hygiene in rotating shift workers such as behavioral aspects (diet, physical activity, socializing, etc.) and environmental aspects (at home and at work).
- Biohacking techniques can be applied to improve the rotating shift worker’s adaptation to the night shift.
- Timed bright light exposure during the night shift improves the worker’s performance when working at night.

- Blue light blocking glasses used at the end of the night shift and during the commute home enable the body's melatonin release, therefore has a positive influence on the daytime sleep.
- Banking sleep before the night shift reduces exhaustion during the night shift improving the worker's performance and accelerates the recovery period.
- There is a gap of improvement from the perspective of design solutions addressing rotating shift type of work to enhance the worker's sleep hygiene.

3 DESIGN RESEARCH

3.1 Systems thinking

Humans live in a systemic way, *"everything in real world is connected to everything else with variations in the levels of intensity in connections…"* In *The design way* chapter 3, the authors explain the importance for designers to be able to have a *systemic way of thinking* thus identify and enhance the essential connections which take part in real life. The author explains that the *systemic design* is based on *relations* built between elements of a system and how they are *connected* (Stolterman, 2002).

Designers should be able to think and learn about the human condition and how it is affected. Designers must go through a change of *mindset* which defines the standpoint from which to approach the inquiry and enables access to different schemas. They should wear the "right" *lenses* that help them make the case of study clearer and analyze the system from different perspectives (Stolterman, 2002).

When designers envision a systemic situation, they make use of different tools to visualize them through the representation of form, structure, and process. Any description of a system requires the development of defined (framed) categories through which the system is analyzed. These categories enable designers to develop paradoxes as an emerging whole (Stolterman, 2002).

There are several tools which help designers to explain, describe, understand, and create paradoxes around the system inquiry (Stolterman, 2002). In this project, systems thinking approach was used to evaluate the way people are currently behaving within the field of study, what are the different factors of influence and where are the opportunities for the design field.

3.1.1 The problem space tool

The problem space tool developed by the Stanford University was used to have a broader understanding around the topic of study. The case of study is then analyzed

from different arenas such as implications, systems, experiences, products, technologies, and data, which are interconnected and expand the scope for design interventions.

3.2 Interviews

Interviews are used as a tool to understand the field of study with the selected segment, in this case, a computer-based type of job where the employee has to be in front of the computer processing a constant flow of information, required to be efficient and accurate in his/her decisions. Often, employees enroll in different types of projects related to the company which can be research, creative work, or even data analysis.

Six interviews were conducted, the questions were formulated to understand how the workers prepare for the night shift, how they cope with the night shift, and how they recover from it.

3.3 Sleep Hygiene Index (SHI)

The Sleep Hygiene Index (SHI) was applied to understand the state of the Sleep Hygiene of the rotating shift workers selected. Seventeen rotating shift workers take part on the exploration of this tool.

3.4 Objectives

Support or enhance the sleep hygiene of rotating shift workers.

- Support the worker to prepare for the night shift.
- Guide the worker on the activities to do during the night shift to support their sleep hygiene.
- Instruct the worker on what to do after the night shift to come back to the regular sleeping schedule.

3.5 Description of the work done

3.5.1 Company Night shift training

When started to work as a rotating shift worker the company offered a one-session training to support the adaptation to the night shift. As the work schedules are set one month in advance, it is easy to know when the night shift will happen with the purpose to organize a resting time beforehand, this also facilitates communication to a partner or family so they can support in the preparation for the night shift.

In the training, the workers were briefly explained about the different types of sleep chronotypes, the duration of sleep cycles, and guidance on how long and when to sleep before a night shift.

The trainer was aware of the difficulties when trying to sleep during the day before the night shift, he gave suggestions of having an early morning rise (7:00 or 8:00), an active day (exercise, cook, socialize), and sleep for one or two sleep cycles if possible before the night of work. Before the pre-work sleep, he recommended doing all the usual bedtime rituals such as brushing teeth, washing face, wear pajamas, make the room dark, keep the phone away, when having struggles to sleep he proposed to meditate, take melatonin, or practice yoga.

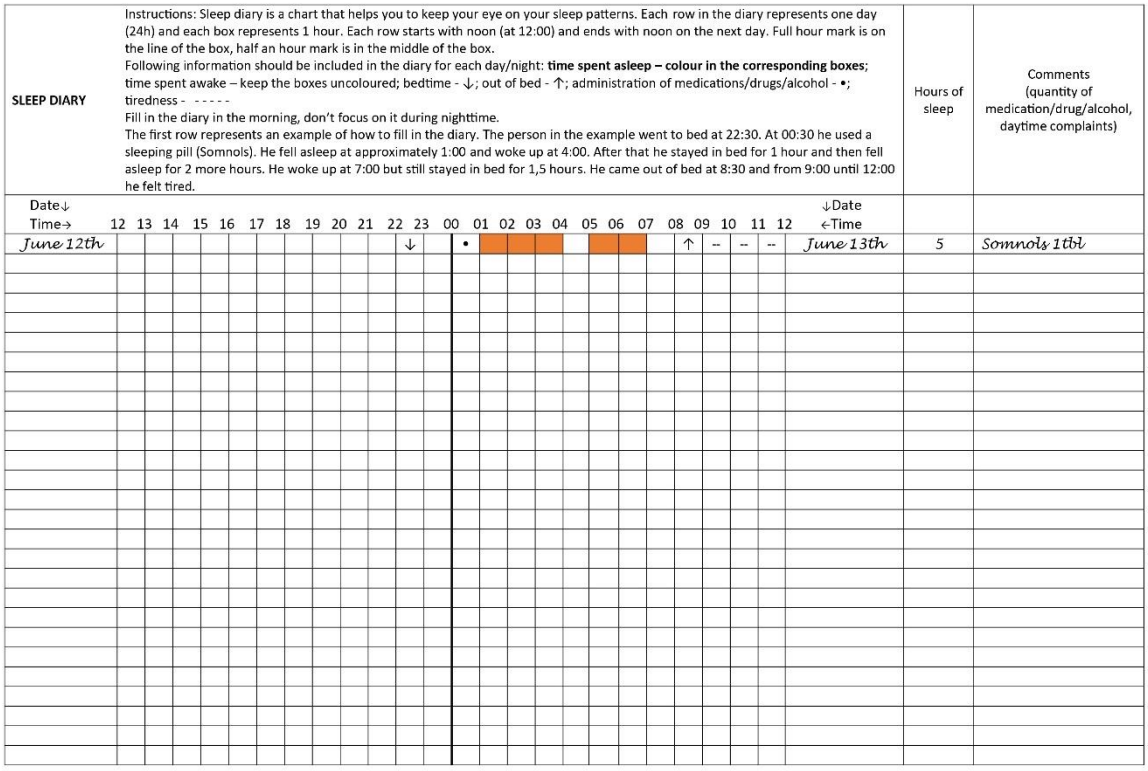
The company acknowledges the fatigue caused by the night shifts and offers a sleeping room; the night shift trainer talks about napping as a way to cope with extreme fatigue, a 10 to 30 minutes powernap, or a coffee-nap were options to be able to make it through the night.

In terms of diet, he instructed to eat a "small meal" before the night shift and to have a night-lunch, light food such as soups, smoothies, a small portion of a heavy meal, or fruits and nuts as snacks. He highlighted the risk of gaining weight due to sugar intake after half of the shift has passed, recommended to avoid energy drinks, and drink coffee after 2:00. Instead, drink plenty of water or green tea.

The work environment was also mentioned, the company uses the f.lux app in the computers to block blue light from screens and prevent this from affecting the eyes and disrupting sleep. Background music was also brought up, to stand using the height-adjustable desks and to take turns to move around the office.

After the first night shift, it was suggested to go home wearing sunglasses, have breakfast, sleeps for eight hours, wakes up, does the usual "morning" routine, and to go for a walk. To come back to a normal sleeping schedule, he recommended to sleep from 9:00 to 13:30, have an active afternoon, and finally go to bed at 23:00.

The following table was given to the workers to track their sleeping times.



SLEEP DIARY	Instructions: Sleep diary is a chart that helps you to keep your eye on your sleep patterns. Each row in the diary represents one day (24h) and each box represents 1 hour. Each row starts with noon (at 12:00) and ends with noon on the next day. Full hour mark is on the line of the box, half an hour mark is in the middle of the box. Following information should be included in the diary for each day/night: **time spent asleep – colour in the corresponding boxes**; time spent awake – keep the boxes uncoloured; bedtime - ↓; out of bed - ↑; administration of medications/drugs/alcohol - •; tiredness - - - - - Fill in the diary in the morning, don't focus on it during nighttime. The first row represents an example of how to fill in the diary. The person in the example went to bed at 22:30. At 00:30 he used a sleeping pill (Somnols). He fell asleep at approximately 1:00 and woke up at 4:00. After that he stayed in bed for 1 hour and then fell asleep for 2 more hours. He woke up at 7:00 but still stayed in bed for 1,5 hours. He came out of bed at 8:30 and from 9:00 until 12:00 he felt tired.	Hours of sleep	Comments (quantity of medication/drug/alcohol, daytime complaints)

Date↓ Time→	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11	12	↓Date ←Time		
June 12th											↓		•									↑	--	--	--	June 13th	5	Somnols 1tbl

Figure 8 Sleep diary. Source: company (anonymous)

3.5.2 Field work (Autoethnography)

The field work was developed based on autoethnography, a research method where the researcher's autobiographical data is used to analyze and interpret the context of study based on personal beliefs, behaviors, and perspectives (Chang, 2008).

Having the opportunity to be involved as a rotating shift worker, I was able to identify the challenges faced when sleep deprivation is required for work, how a company supports this type of work and what is the work environment setup during different times of the day.

As a rotating shift worker, to have a healthy life becomes challenging, to keep balance in physical health, mental health, and also to have social interactions require a lot of planning and awareness and being constantly tired due to the sleep dept makes decision-making processes difficult.

The office environment was used twenty-four hours, it allowed flexibility to some extent, such as height-adjustable desks, chairs, and monitors. We also had yoga balls available or bean bags for sitting. There were a few different rooms where people could choose freely where to sit in every shift. The lights where turn on for the whole room, reason why some people usually chose their workstation based on the light conditions, which

were set by some other colleague who had turn the lights on or off, usually with the consentient of other people around. People also chose their workstation based on who were the people around and the noise conditions.

The overall atmosphere in every night shift was different based on the people who were working. Sometimes there was music playing in high volumes, or there were groups of friends working together so people talked and laughed. Some of the workers were more outgoing than others, they took breaks to walk around the office talking to others, jumped around or went to the games room to play with the foosball or slack line. Some other nights were extremely quiet, and every person was sitting silently in their own station, these were the hardest ones for me, it was boring, and I felt more tired.

The common area around the kitchen was a comfortable space where to have a snack, drink tea or coffee. The company usually provided food for making sandwiches and some fruits, these elements varied depending on the day of the week. For example, during weekends everything was pretty much finished since it was stocked on Mondays. Every worker had the possibility to store their own food in drawers and fridges (had to be labeled with the name of the person), it was just a matter of planning for lack of food to never be a problem.

From a personal level as a rotating shift worker, I faced several of the symptoms of Shift Work Disorders (SWD) such as having troubles to sleep before the night shift and knowing that not being able to sleep in the afternoon/evening was going to make my night shift a hard one, causing anxiety and tension.

During the shift, I went through different stages of exhaustion and tried different things to make it easier to cope with. For example, I tried not to change my eating schedule when I had a sequence of night shifts, ate before the shift as if it was a late dinner, then had a very small snack during the shift, and at around 6 am taking a break to eat as if it would be my breakfast. Also, I did not drink coffee after 1 am and usually had only one cup, after that only tea. Active breaks were also crucial, I stopped to stretch and also constantly changed my body posture by working sitting, standing up position (thanks to the height-adjustable desk), and also changing the regular desk chair to a yoga ball.

Another very important aspect from my experience was to be able to work with colleagues with whom I had made friends, this was a great motivation and also helped a lot to keep awake, to connect and interact with people was very important to make the night shift bearable and fun.

The company had an agreement with a taxi operator company, we had access to ordering a car to take us to the office before the night shift and to take us home after the night shift. This service could be used not only with night shift related times, but also when leaving the office after evening shift or when coming to morning shift. This service contributed to improve the working conditions since we did not have to worry about commuting, got home much faster and lowered the risks of accidents caused by driving after a night of work.

After the night shift, I went straight home, got ready for bed doing my usual night-time rituals, made the room dark, and tried to ensure a quiet environment. Usually, I slept six hours whilst I slept around eight hours during the night. Waking up was confusing and often had lost sense of time and had a headache. In the afternoon I was not able to be productive and, in the night (after the last night shift), I was able to fall asleep easily.

In addition to my personal experience, I was able to talk with my colleagues about the way they cope with the rotating shift work, I also observed how people behave during the night shift and at a company level had the chance to see how it is handled, how the office environment is used and where are the gaps of opportunity for design solutions.

3.5.3 Interviews

The purpose of the interviews was to understand how rotating shifts specially the night shift affects the patterns and quality of sleep-in shift workers, also to Identify how shift workers prepare for night shifts, feel during the night shifts and how do they come back to a "normal" night/sleep and day/wake routine. Overall, to understand how others cope with the rotating shift work.

Group segment: Shift workers.
Nature of the shifts: 8 hours rotating shifts.
Type of shifts: Morning shift (7:00-15:00), Evening shift (16:00-00) and Night shift (23:30-7:30).
Gender: Men and Women.
Age range: 20-35 years old.
Time as shift worker: between two months to 2 years.
Nature of the work: Computer based type of job where the employee has to be in front of the computer processing constant flow of information, required to be efficient and accurate in his/her decisions. Often, employees enroll in different types of projects related to the company which can be research, creative work or even data analysis. The company provides a certain amount of freedom for the employees to set their work schedule and to divide the time slots between the different tasks they are meant to

perform and when to take their break. These distributions are accomplished in consensus with the other workers who are taking part in the same shift.

3.5.4 Sleep Hygiene Index (SHI)

Seventeen rotating shift workers took part on the application of the SHI tool, this tool brings valuable insights to identify the main pain points which are affecting the sleep hygiene of these rotating shift workers.

3.6 Description of the results

3.6.1 Ideal journey map to promote Sleep Hygiene in rotating shift workers

Based on the theories discussed in desktop research, the interventions for rotating shift work to promote sleep hygiene, the observations in the field of study and the understanding on how people are dealing with the rotating shift work currently, a map of the ideal journey to promote SH in night shift workers was developed (see appendix 8 Ideal journey map to promote Sleep Hygiene in rotating shift workers).

This map encompasses a timeline in which different actions take place. These actions are grouped in layers related to sleeping time and length, diet recommendations, physical activity, and the environment (at home and in the office). These factors were placed in a particular way to support the SH in a context of sleep deprivation and lack of sleeping patterns as is the case of rotating shift work.

Worker's behavioral aspects were included, also environmental factors to look upon at home when having the intention to promote sleep. At a company level, decisions related to worker's number of night shifts scheduled in a row, time given to recover from nocturnal work and the office's environment to promote the SH of their workers.

This map was build considering the actions taking place BEFORE the night shift, DURING the night shift and AFTER the night shift. In other words, it includes tips and facts to help the worker to prepare for the night shift, to cope with the night shift and to recover from it.

The development of this map was important for the project, it gave a broad understanding of the myriad of actions within a timeframe which can be implemented to support the worker's SH and the adaptation to night shifts. Comparing this *ideal journey* to the current situation, enabled the identification of pain points throughout the current journey which become opportunities for design interventions.

3.6.2 Sleep Hygiene and Rotating Shift Work

To have adequate Sleep Hygiene (SH) it is important to generate patterns that support the physiological processes of sleep. These patterns enclose our behavior for what is relevant to consider the decisions made in terms of diet, how active the person is, the environment for sleep and how this has a direct influence in the SH and therefore an impact on performance factors, mental and physical health and even in disease prevention.

As an outcome during the desktop research, interviews, and field work, it is challenging for Rotating shift Workers to have good Sleep Hygiene when it is not possible to have a pattern in their sleep schedule. As discussed previously, this unusual work time affects the circadian rhythm processes to occur in a natural way therefore the capacity to have an adequate performance is limited, the person is very prone to feel constantly exhausted, his or her interactions with others are limited, and the risk factor from suffering from disease increases.

Lacking pattern in their sleep time increases the worker's probability of suffering from Shift Work Disorder symptoms. Felling exhausted makes it harder to improve the SH since constant tiredness will stop the person from being more active, able to plan, have a healthier diet, or even to have a positive approach towards life and his or her work.

Considering that the night work and rotating shift work is very important for many businesses, the Sleep Hygiene and the different factors affecting it can be considered as a valuable tool to support the shift workers on mitigating the impact that the sleep deprivation and the constant sleep pattern changing has on his/her health.

3.6.3 Sleep Hygiene Index (SHI)

To analyze the results of the Sleep Hygiene Index (SHI) *each item is rated on a five-point scale ranging from 0 (never) to 4 (always). Total scores range from 0 to 52, with a higher score representing poorer sleep hygiene.* (Sungkun Cho, 2013)

Seventeen rotating shift workers took part on the application of the SHI tool, the following table displays the results.

Number	Question	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11	#12	#13	#14	#15	#16	#17	Total
Age		21	21	21	23	23	24	25	25	25	26	26	26	27	30	32	32		
SHI-1	I take daytime naps lasting two or more hours	2	2	1	2	1	1	2	0	1	0	2	2	3	2	1	3	1	26
SHI-2	I go to bed at different times from day to day	4	4	3	4	2	1	3	2	4	3	3	3	3	2	4	4	3	52
SHI-3	I get out of bed at different times from day to day	4	4	2	4	3	1	3	2	4	3	3	3	3	2	4	1	3	49
SHI-4	I exercise to the point of sweating within 1 hour of going to bed	0	0	2	1	0	0	1	1	1	1	0	1	0	1	0	1	1	11
SHI-5	I stay in bed longer than I should two or three times a week	3	3	2	3	2	1	3	1	1	3	2	3	3	0	4	3	4	41
SHI-6	I use alcohol, tobacco, or caffeine within 4 hours of going to bed or after going to bed	2	2	1	3	2	0	3	0	2	1	2	4	1	0	4	0	1	28
SHI-7	I do something that may wake me up before bedtime (for example: play video games, use internet, watch television, eat)	1	1	3	2	2	3	3	2	4	3	3	3	4	2	3	4	4	47
SHI-8	I go to bed feeling stressed, angry, upset or nervous	1	1	2	2	1	2	2	2	0	3	2	2	3	1	2	3	2	31
SHI-9	I use my bed for things other than sleeping or sex (for example: watch television, use or phone or eat)	4	4	0	0	1	2	2	2	1	2	2	0	4	0	2	1	4	31
SHI-10	I sleep on an uncomfortable bed (for example: poor mattress or pillow, too much or not enough blankets	0	0	0	0	2	0	1	0	0	1	1	0	2	0	1	3	1	12
SHI-11	I sleep in an uncomfortable bedroom (for example: too bright, too stuffy, too hot, too cold, or too noisy)	0	0	0	1	1	0	1	1	0	2	2	0	2	0	0	1	2	13
SHI-12	I do important work before bedtime	2	2	2	2	2	1	1	3	3	1	0	2	3	0	2	1	3	30
SHI-13	I think, plan, or worry when I am in bed	1	1	2	3	1	3	3	3	0	4	2	2	4	2	2	3	4	40
Total		**24**	**24**	**20**	**27**	**20**	**15**	**28**	**19**	**21**	**27**	**24**	**25**	**35**	**12**	**29**	**28**	**33**	

Table 3 Results of the Sleep Hygiene Index (SHI)

The total values at the bottom line of the table show that the SHI of this group of workers is in a range of 12 being the best one and 35 being the poorest one. The medium SHI value is 24.18 which means that the SHI result leans towards medium quality of sleep hygiene (see Appendix 4 Sleep Hygiene Index results)

These results lead to the conclusion that the main problem affecting the sleep hygiene of this group of rotating shift workers is a lack of pattern when it comes to times to go to bed, to get out of bed and also the activities performed before going to bed which might affect the quality of sleep as it can be to be exposed to screens, do important work which might then cause worry or generate feelings of anxiety.

3.6.4 Interviews

3.6.4.1 Mapping the journeys

To generate an understanding around how the rotating shift workers are dealing with the night shift work, each person's journey was mapped out (See appendix 8 Interview's journey maps).

In each of these journey maps was highlighted every action whether it was affecting positively or negatively their sleep hygiene. These evaluations were made based on the information previously mapped in the *Ideal journey map to promote Sleep Hygiene in night shift workers* (See appendix 7) and were marked in red the ones negatively affecting the SH and in blue the ones improving the SH.

Having each journey mapped, a matrix was created to analyze what were the common behaviors under each category to come to conclusions by identifying patterns (See appendix 9 Interview's matrix of co-relation).

3.6.4.2 Pattern identification

The figure below displays a set of Sleep Hygiene statements mapped in the *Ideal journey map to promote Sleep Hygiene in night shift workers* (See appendix 7) and how these relate to the journey of the people interviewed.

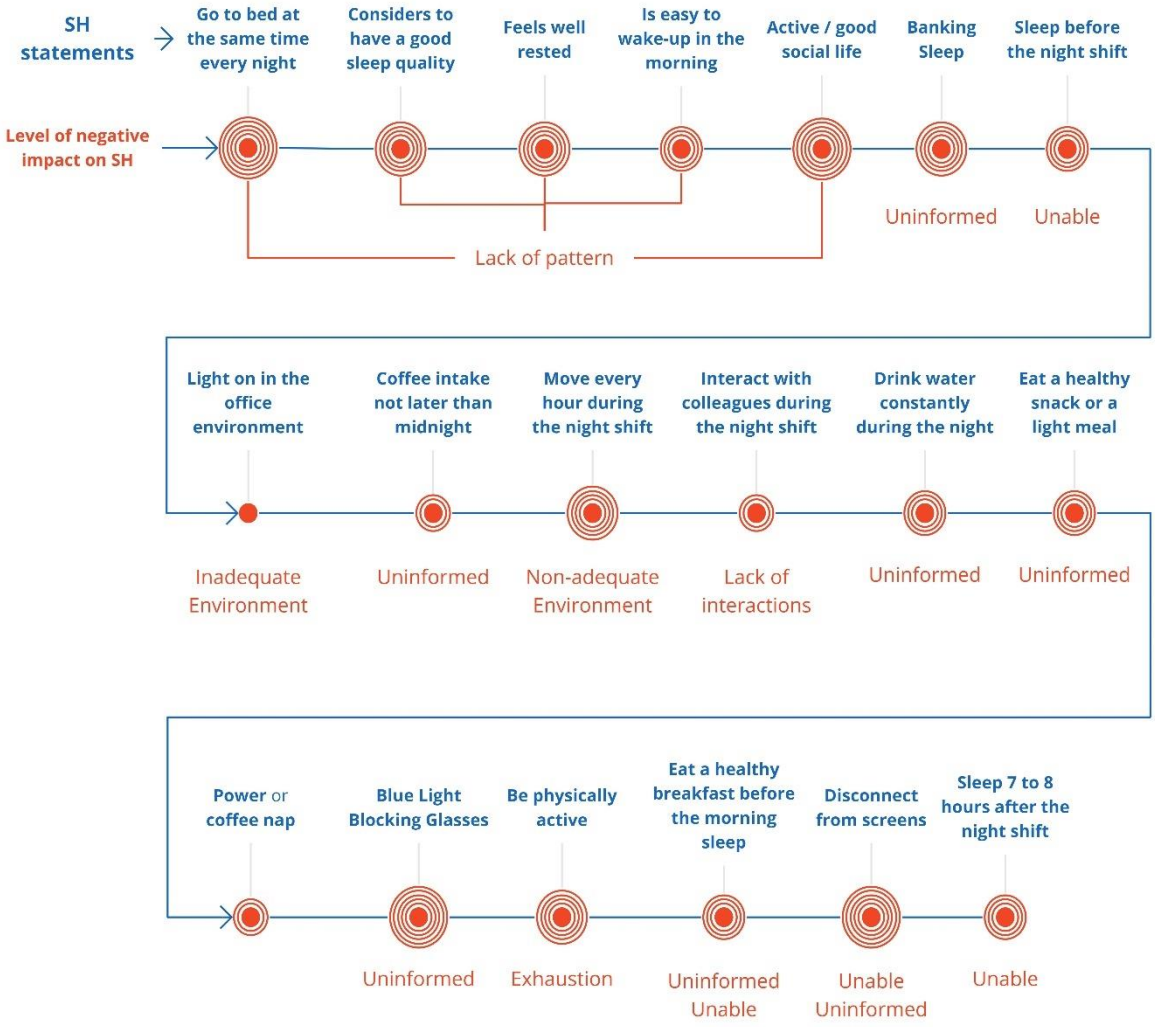


Figure 9 Pattern identification from interviews. Developed by the author

The red dot and rings around each SH statement reflect the level of negative impact on the SH based on the amount of people interviewed, who did not comply with such statement; one the dot representing one person, and every ring around it adding one person to it.

There is a general negative influence on the SH due to the **lack of pattern** in relation to sleeping times and waking times. People also have a negative personal perception of

their sleep quality and have difficulties to be physically and socially active. *"…If I had a better planning, it would help" (Mo). "The quality of my sleep is not the same because my body can't get used to a certain schedule. Sometimes I have to sleep during the day when there is light and it is not so easy, and during the wintertime sometimes you don't even see the daylight/natural light for two or three days and this starts to affect" (Nia). "…it is hard to have a routine where I can do my activities if one day, I have morning shift but the next one brunch shift, then I have to do my activities before work" (Kate).*

Only one person applies the concept of banking sleep, most people are unaware or unable of doing it.*"…every night shift is very different, the days preceding the night shifts, let's say two days before…have a very strong impact on how the night shift is. Imagine I have not been rested in like two days before the night shift, or if I have slept very well, your body is going to find it so hard" (Andrew).*

All the participants prefer to have lights on when working at night, but the office lights are not thought through from the perspective of night work or considering the potential benefits of light therapy to the worker's performance. *"I like to have lights on when I am watching the screens…" (Janus). "…the lights should be better, during the night shift I have lights on around me…sometimes the room is dark when people turn the lights off and the only lights are from the screens and this makes your eyes very tired" (Nia).*

There is no area in the office environment for people to perform physical activity and to take active breaks. Some people do not move because they lack motivation, to move is not advised by the company. *"…usually, the best is to stand up once in a while and walk around" (Andrew). "…I don't have enough physical activity anymore in my life, so I am trying to put this habit again into my daily life, but it's hard" (Kate).*

During nocturnal work there is a lack of interactions, most of the company is absent and the ones present are tired, this makes it harder to cope with the night. *"No way you can have a team meeting at night. So, the chances of being more productive than you normally would be are halted because the whole company is not here at night" (Janus).*

Additionally, interactions with people outside the work environment are limited, *"I lost contact with most of my friends since everyone had a different schedule and they just couldn't count on me for meetings, also when receiving messages or things happening during the day I missed it because I was asleep" (Lea)."…some days my boyfriend has to wait several hours for me to wake up when I have had a night shift or when I leave to morning shift I don't see him and even some times the next day I have evening shift and I can't see him until midnight" (Nia).*

People are uninformed in relation to the adequate diet to support their SH. There is no guidance on what to eat or about the importance of eating (at least something small) during the night shift. One worker considers that adequate food or guidance on what to eat should be provided by the company.

To take a power or coffee nap is not the healthiest option when it comes to benefiting the SH but can support the worker to perform his/her work and help to prevent mistakes that could affect the company. Some people find it risky due to the probability to oversleep.*"… maybe for like 30 minutes, as a power nap if it is that serious" (Andrew).*

People are unable to disconnect from screens due to work requirements. They are also uninformed in relation to the negative influence on the SH of phone use right before sleeping, or just unable to stop using it when in bed. *"…I have to come to work and spend 8 hours in front of three screens"*. *"…the all-night-long screen light makes my eyes very tired"* (Mo). *"I should try to decrease my screen time would be very helpful, the blue light emitted from screens tricks the brain and makes it think that is daytime. I even have a blue light filter, it helps a bit but is still not enough, what I should do is to turn it off and fight the temptation"* (Mo).

"Is not the same as a normal work schedule when you have time to do other activities after work and disconnect your mind from it, in this case, you have to work, disconnect quickly and then force yourself to sleep, this is hard for your body." "…I just look at the phone for a bit and eventually fall asleep" (Nia).

People are unable to sleep too long during the day (after nocturnal work), not covering the sleep depth. People who can sleep 8+ hours still report to feel exhausted after waking up. *"…having to sleep during the day is never the same as during the night. There is noise from everyone else who is awake and a lot of light which is never totally covered by the blackout curtains" (Lea). "After two months of starting night work I had gained a lot of weight, started to suffer from migraines, and had hormonal disorders" (Lea). "…the day has started; the sun is shining, and the body doesn't understand why it needs to sleep instead of doing something"* (Kate).

People expressed to have a general feeling of exhaustion. Some people feel their body in an abnormal state. *"…the body does not catch up on sleep if doesn´t get it over night. Even with a better pay rate, the night shift is something I would not go through if it were my choice" (Lea). "…There is a certain way I feel, I feel feverish.It has a turn on your health definitely" (Andrew). "Usually, after the night shifts, it takes me a few days to feel good again, to come back to feel well because it affects my organism, my stomach goes crazy, my eating and sleep schedule rotate, everything changes" (Nia).*

From analyzing the patterns created by the overlap of the different journeys and the comparison to the *ideal SH journey*, it is noticeable that people are in a general manner **uniformed** about the actions which can be implemented to improve their SH. There are also gaps of improvement from the company's perspective when it comes to **education** and **work environment** (light conditions and space for active breaks) to support the worker's SH.

3.6.5 Observations in the field of study

During the observations in the field of study it was possible to identify that people make use of their workstation and environment in different ways during the shift, some night workers preferred to be in a dark room while some others preferred the lights on, some people made use of the adjustable height desks changing the body posture during the shift from sitting down on a regular desk chair to standing up, some people used a desk chair while others used bean bags or yoga balls for sitting or just alternated among those options. During the night shift, people used more comfortable clothes (like sweatpants) and also used blankets to cover themselves.

During the night shift, people were quieter than during daytime shifts, but some people played upbeat music on a speaker which changed the office´s atmosphere. Some people chose to sit next to a friend colleague, so they had the chance to also talk for moments.

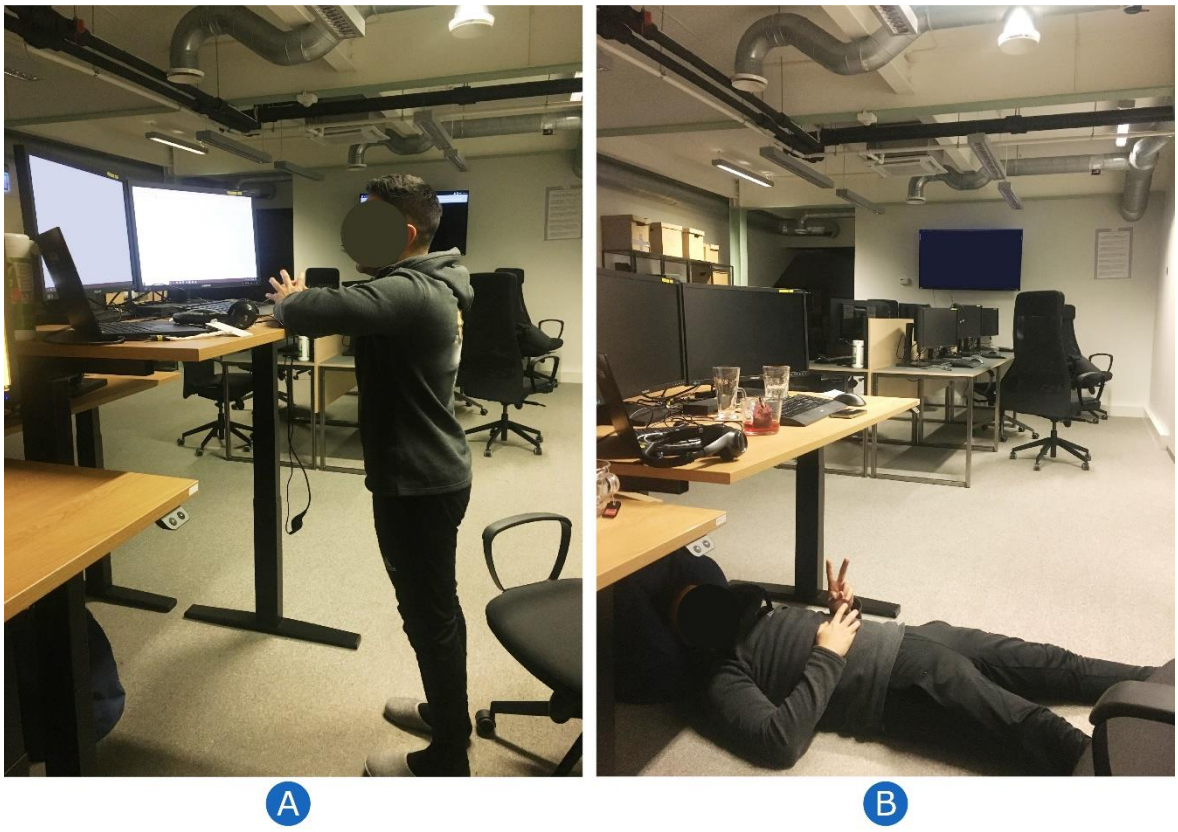


Figure 10 Night shift, standing desk and resting. Source: company (anonymous)

Figure 8 shows how the height adjustable desk is used in different ways during the night shift. In picture A the worker has increased the height after being in a sitting position for a few hours and in picture B the worker is taking a break under the desk. Usually, the last two hours of the shift was when people expressed to be very exhausted and found it hard to focus or to be productive.

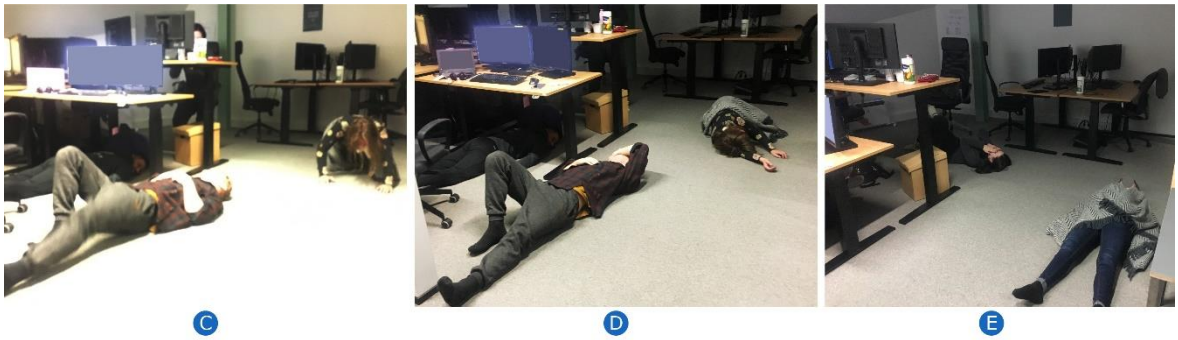


Figure 11 Last two hours of night shift. Source: company (anonymous)

In picture 9 is shown how people behaved when they were very exhausted. A funny mood came, people walked around the office trying to engage in conversations with their co-workers. In this case, one worker proposes to do push-ups to two more people, they willingly try but everyone ends up laying on the floor, with blankets, laughing, and completely exhausted.

Also, people were asked how they keep themselves awake during the night shift and these were some of the responses: "Walking helps", "Washing my face with water", "Walk the dogs outside for 5-10 minutes", "Just chatting with a friend helps me to keep awake", one person also commented: "We need a stretching bar here".

People find different ways to adapt to the night shifts, body posture vary among the shift or from person to person, environmental conditions such a light and sound vary based on the mood or on the specific needs at a certain moment, people prefer to work next to a somebody with whom to talk, this makes the shift more fun and keeps active, some people need to take breaks to stretch or walk around, caffeine intake is also very common among the workers, some people take two or three coffees during the night and some others take tea. People's needs are diverse during the night shift therefore the work environment should consider these variations to support the worker´s adaptation process to shift work and to have a positive impact on sleep hygiene.

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3.6.6 Design Research conclusions

- The lack of patter in their sleep times generates a feeling of chronic exhaustion in most of the workers. This affects their social life, and they have the tendency to be less physically active.
- Rotating shift workers are unaware of the actions that can be taken to improve their adaptation to night shift and to support their sleep hygiene.
- The majority of workers are unaware of the influence of caffeine on their sleep hygiene when taking it too late during the night shift.
- The workers are unaware of the type of food which supports their adaptation to night shift and that supports their sleep hygiene.
- Rotating shift workers are unaware of the concept of Banking sleep as preparation to cope better with the nocturnal work and as a support to recover from it.
- The majority of workers are unaware of the influence of light on their performance and on their sleep hygiene.
- None of the workers used blue light blocking glasses at the end of their night shift and during their commute home.
- The majority of workers prefer to work during the night shift with lights on, but the office’s light environment does not allow personalized light settings.
- Preferences regarding the intensity of lights in the workstation during the night shift, are individual and can vary as the shift progresses.
- Workers have the tendency to vary their physical posture during the night shift. E.g., sitting on a chair, standing up, sitting on a yoga ball, etc.

- The work environment lacks systems and elements which enhances or support the worker's sleep hygiene and the adaptation to nocturnal work.
- Physical activity and active breaks are fundamental to improve the worker's adaptation to nocturnal work and to improve their sleep hygiene. Nevertheless, the office environment lacks dedicated spaces for such activities and scheduled times to perform them.
- Interactions and socialization during night shift support the worker's adaptation to nocturnal work.
- Socialization practices are negatively affected by the rotating shift work, especially by the night shifts. Even though the work environment considered for this study offered some level of flexibility to their workers, there were not systems to promote interactions between workers during the night shift.
- The worker's chronotype influences his/her capacity to adapt to nocturnal work. This should be considered when setting the worker's schedule.
- The workers consider that the number of night shifts in a row should not exceed three and the company must provide extra time to recover from the nocturnal work.
- The last two hours of the night shift are the most challenging. Workers expressed to feel extreme exhaustion and consider themselves to be more prone to making mistakes.

3.6.7 Design brief

The design brief is defined considering the results from the desktop research and from the design research. The following statements are considered as crucial to be included in the design concept and serve as a guide for the design phase of the project.

- The design proposal must inform* the rotating shift workers on the actions that can be taken to improve their sleep hygiene, optimize their adaptation to nocturnal work and accelerate the recovery from it.
- The concept must inform* the worker on what to do before the night shift (support the preparation for nocturnal work).
- The solution must inform* the worker on what do during the night shift to support the adaptation to the nocturnal work.
- The design solution must inform* on what to do after the night shift (support the recovery process).
- The design should allow user to create his personalized approach / case generate a personalized user journey based on the worker's monthly scheduled shifts, his/her behaviors, and the individual sleep chronotype.

- The concept must propose a solution for the work environment to implement light therapy as a tool to support the worker's adaptation to nocturnal work.

*The information will be taken from the Ideal journey map to promote Sleep Hygiene in night shift workers.

3.7 Design concept

The set of guidelines proposed in the design brief leads to consider three main components for the design concept: 1. Information, 2. Personalization, and 3. Work environment adaptation.

The first component is a set of information required to guide the rotating shift workers on actions to take which can improve their SH. The second component is a personalized worker's guide which relates to the actions to take before, during, and after the night shift, and which is powered by AI integrating the worker's sleep chronotype, behaviors, and work schedule. The third component is related to the work environment, where a set of guidelines is developed for the company to support the worker's adaptation to nocturnal work. Light therapy is a potential element to include in the workstation as a way to support the worker's adaptation to nocturnal work. Additionally, guidelines for the company to provide active breaks and a dedicated space to perform physical activity at work.

Figure 12 Design concept components. Developed by the author

The design concept proposal aims to generate a personalized Sleep hygiene (SH) smart solution to inform and guide Rotating shift workers on the correct behaviors which can improve their SH in periods of sleep deprivation. Additionally, to guide the company for improving their work environment thus support the worker's adaptation to nocturnal work.

3.7.1 System components

The following information is to explain in detail the logic of the design concept. The system proposed is explained in detail in relation to its components and the elements of the system. Additionally, the tools used to build the architecture of the platform or interface, the company's guidelines suggested, and finally the design concept interface.

3.7.1.1 System components overview

The system component overview is defined by three main blocks:

First, from the perspective of the rotating shift worker: a digital platform will Teach behaviors and will support those behaviors aiming to improve their SH. It will serve as a real-time guide in relation to actions to take in every given moment.

Second, from the company's perspective: guidelines with a set of best practices will support the shift scheduling process and the shift length definition. Also, recommendations for the work environment in relation to a dedicated office space to perform physical activity, energy-boosting food could be provided, and the implementation of smart workstation solutions such as smart lighting solutions or height-adjustable desks.

The third component powered by AI is the one blending together the previous two blocks and powered by machine learning is able to improve with time as data is added into the system.

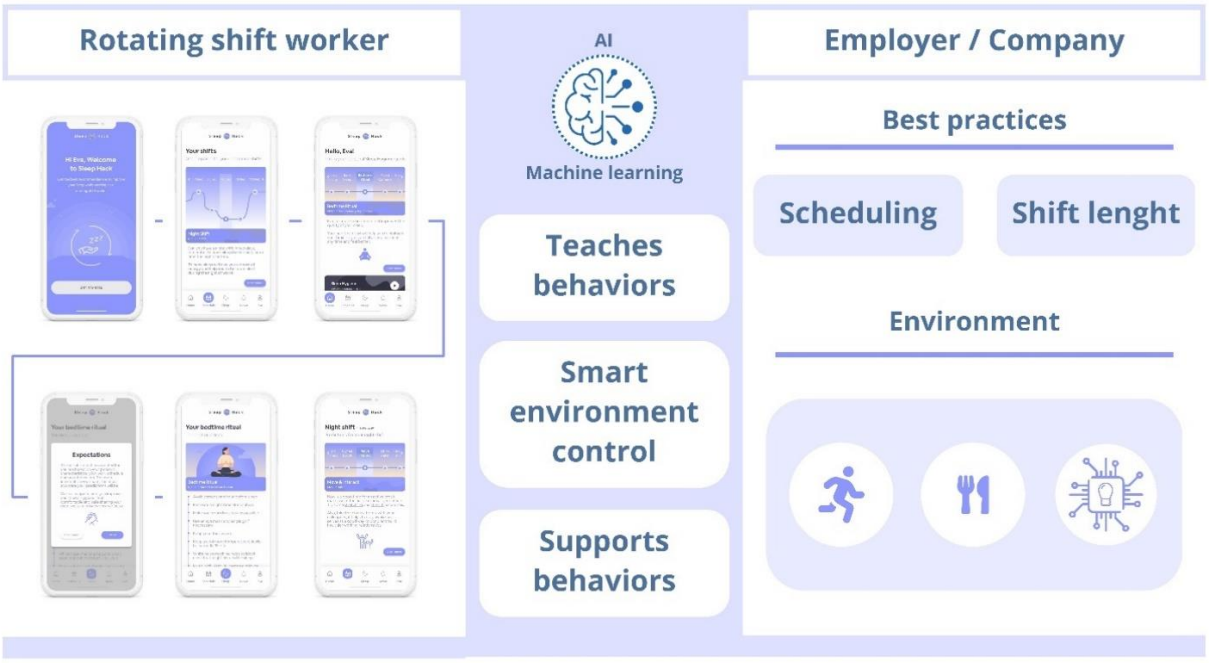

Figure 13 System components overview map. Developed by the author

3.7.1.2 Elements of the system

The elements of the system are constituted by the input, the data processing synergy, and the output.

The input is formed by all the data required to enter into the system for it to generate the desired output. In this case, has been defined as:

- Sleep chronotype is defined by the Morningness-Eveningness Questionaire which the users answer when onboarding the platform. By the system knowing the sleep chronotype of the user, will generate predictions based on the moments of increased alertness or sleepiness. For example, in the case of early bird chronotype, the person tends to do better with the evening sleep option before or after the night shift as opposed to the night owl chronotype who tends to better with the morning sleep option (Frei, 2018). In the case of a common sparrow, either option can be tested to see which one adapts better.
- The personal calendar is defined by the monthly shift schedule provided by the company. The platform considers the worker's sleep chronotype, maximum of nights to work in a row, and recommended recovery periods and automatically sets the shifts for all the workers. This information is automatically loaded into the system to generate the worker's monthly work journey supporting his/her SH.
- The lifestyle habits where the worker can input information related to dietary restrictions or preferences, physical activity and can also pair his/her wearable device to provide additional data concerning physiological fluctuations at all times.
- Sleep time is manual input data where the users provide the times when they went to sleep and when woke up. This helps the system to generate an understanding of the amount of time slept, the times when this happened, and to estimate the sleep debt thus generate strategies to support the SH of the worker.
- The bedtime ritual is information provided to the user as tools to induce and improve the quality of sleep. The user chooses a specific bedtime ritual which is then loaded into the system for it to learn what are the behaviors of the person before bed. It then generates the work SH journey considering such data and can also estimate beneficial modifications.
- The feeling before the shift is defined by using the Karolinska Sleepiness Scale (KSS) to measure the subjective perception of sleepiness at the start of the night shift. Based on how prepared the user is for the night shift and on how he or she

feels, the system will create a set of predictions to improve alertness and to support their SH.

The input data is analyzed by smart system algorithms powered by AI or machine learning that by using processes of deep learning can build neural networks which are small blocks of information connected thus facilitating a data processing synergy.

By the processing of the input data the system generates:

- Awareness about the expectations of the recommendations generated by the system. The accuracy of the insights given by the system depends on how much data the user inputs, this is important to convey to the users so they can act thus have a better experience.
- The system will generate a personalized monthly journey with tips related to physical activity, diet, and sleep quality to support the worker's SH and rotating shift work adaptation. This, by generating a set of recommendations of what to do before the night shift in preparation for the period of sleep deprivation, what to do during the night shift to increase alertness and to prepare for the day-time-sleep, and finally tips on what to do after the night shift.
- Additionally, the system is connected to an infrared camera that tracks eye movement and facial features, AI algorithms analyze this information and predict the worker's state of mind. If AI detects that decrease of alertness, increases light brightness through the smart light system connected to the system. In such a scenario, the worker's brain would be biohacked by blocking melatonin release the drive for arousal is stimulated.

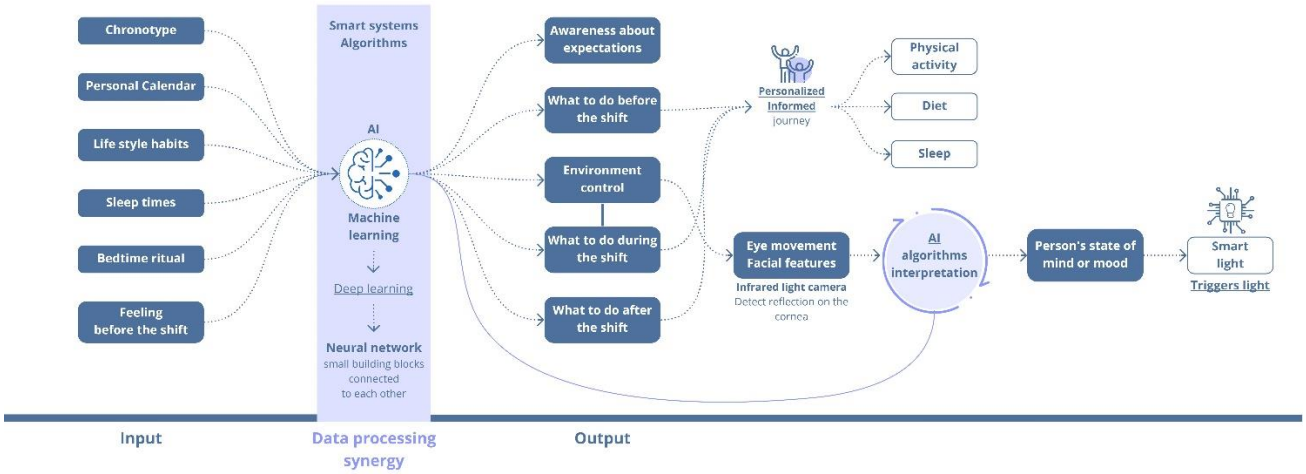

Figure 14 Elements of the system map. Developed by the author

3.7.1.3 Shorthand

A shorthand is a tool used to structure flows of information withing an interface. The flow is as important as the interface or wireframes and help to set specific sequences of actions that lead the user through the app as they try to accomplish their tasks (Singer, 2009).

"Flows are made out of individual interactions. A screen offers some possibilities, and the user chooses one. Then something happens, and the screen changes. It's an ongoing conversation" (Singer, 2009).

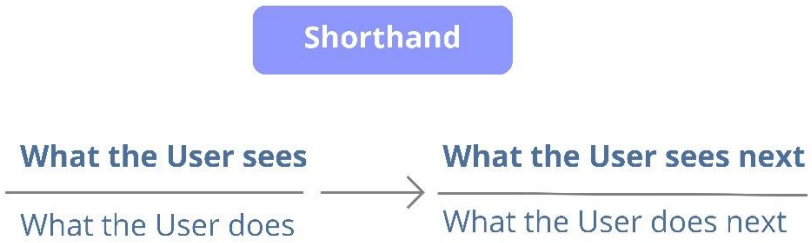

Figure 15 Shorthand structure (Singer, 2009).

The shorthand's structure is based on the logic displayed in the Figure 15; the information displayed enables the user to generate an action which then leads to a new set of information where the user had more possibilities of interacting.

This tool was applied to have a clear understanding of the information to place in the platform and how to structure it. This gave a clear structure to the interaction the user would have withing the platform and was used for the development of the wireframes (see appendix 10).

3.7.1.4 Company's guidelines for night work

Guidelines with a set of best practices involve different departments of the company. From the management to define the shift's length and support the shift scheduling process. Human resources to keep track of the worker's health. To recommendations for the work environment concerning dedicated office space to perform physical activity, energy-boosting food could be provided, and the implementation of smart workstation solutions such as smart lighting solutions or height-adjustable desks.

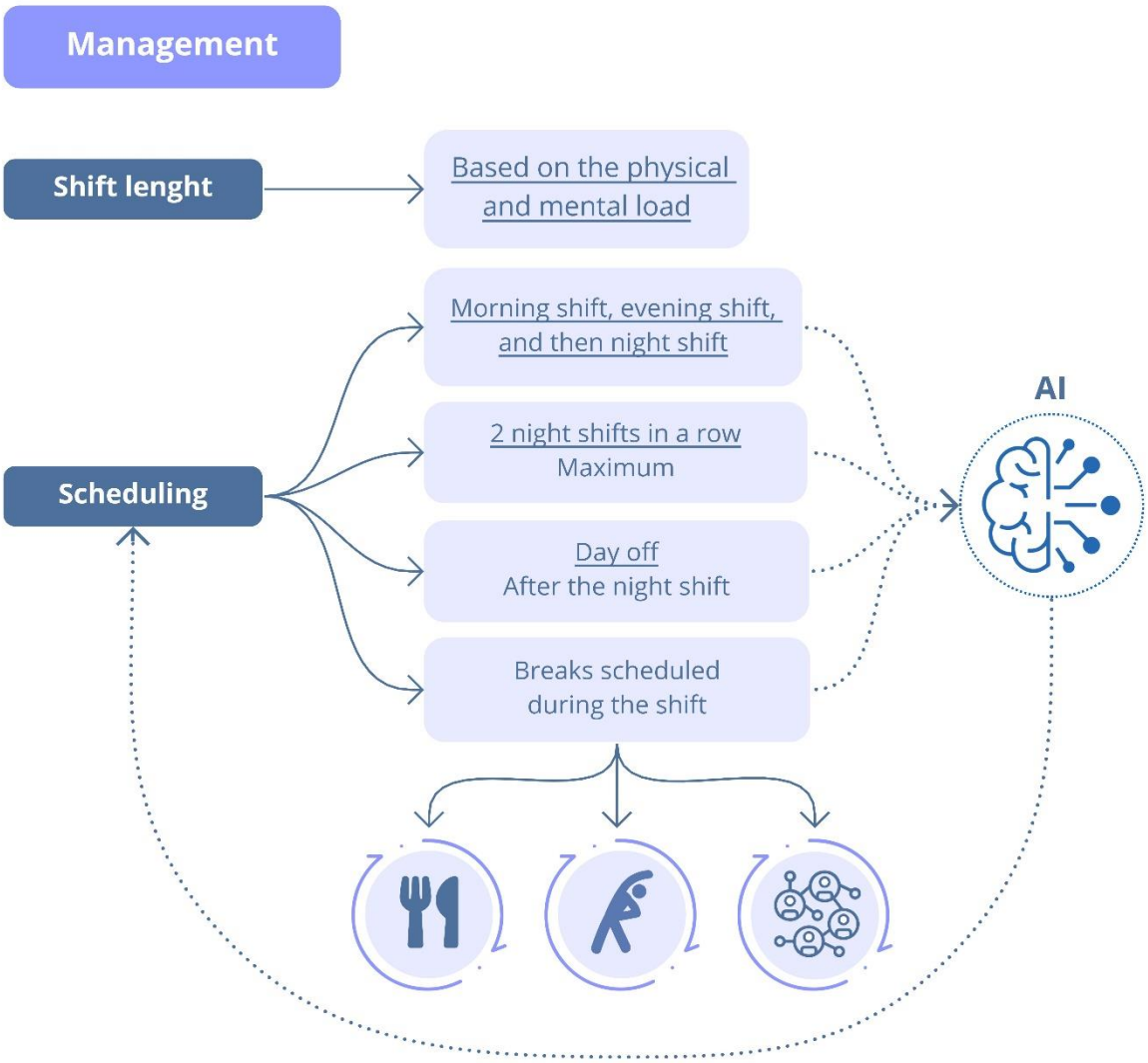

Figure 16 Company's guidelines for night work, management. Developed by the author

From the management perspective, the shift length should be based on the physical and mental load of the task to perform. Night shifts should be shorter than morning or evening shifts. In the case of high physical or mental load, it may be necessary to reduce the length of the shift to 7 or 6 hours.

The scheduling process must consider that our circadian rhythms can be delayed easier than be advanced, thus plan morning shift, followed by evening shift, and then night shift. Ideally, a maximum of two-night shifts should be scheduled in a row and provide a day off after nocturnal work for the worker's recovery.

Breaks must be automatically scheduled during the shifts considering the worker's sleep hygiene and the tasks to perform. These work pauses would deem eating meals at adequate times; the food is recommended to be provided by the company to ensure

balanced nutrition for their workers. Active breaks to promote physical activity should be scheduled during the shift, and space and time to socialize which increases worker's alertness.

The scheduling process is automatically generated by smart systems algorithms that set the staff's monthly schedule considering the company's requirements and the worker's sleep hygiene.

The human resources department should keep track of the worker's ability to tolerate shift work and, if needed, provide support to promote adaptation to rotating shift work.

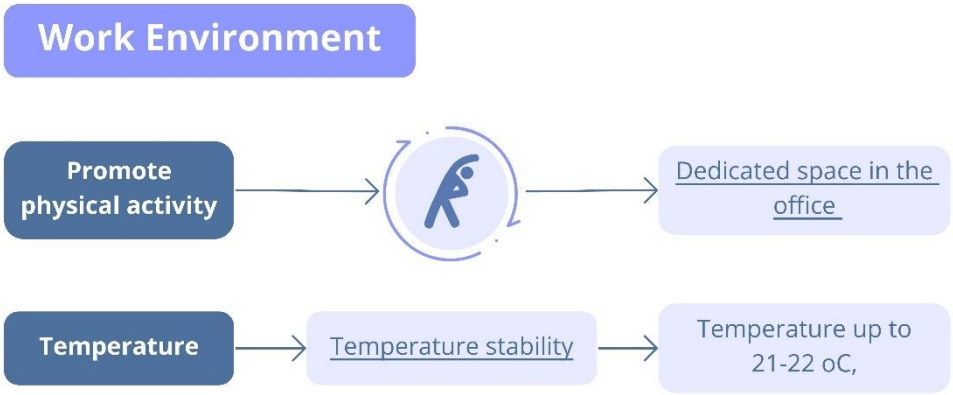

Figure 17 Company's guidelines for night work, Work Environment. Developed by the author

The work environment must also be adapted to support the worker's adjustment to nocturnal work.

The company should provide a dedicated space to perform physical activity during working hours. Active breaks are important to promote alertness and to improve the worker's SH.

The office's temperature is another environmental factor that influences productivity; thus, companies should guarantee temperature stability. At night when temperatures drop there is poorer performance, performance increases with temperature up to 21-22 degrees Celsius.

In terms of furniture, height-adjustable desks (see figure 18) enable the worker to work while sitting or standing up which can increase alertness and serve as ergonomic support.

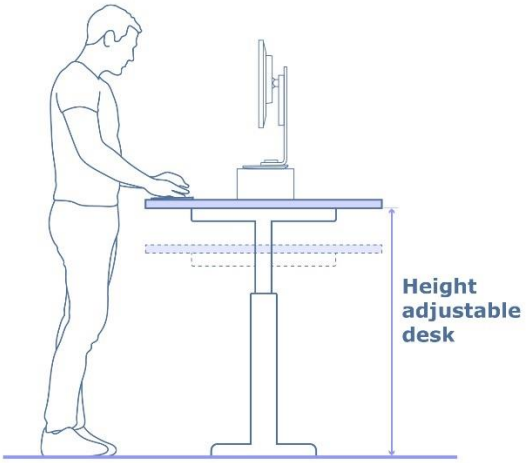

Figure 18 Height adjustable desk.

The company must provide different seating options (see figure 19) such as stability balls and office chairs. Given these possibilities, the workers can vary their posture during their shifts, this helps to change body posture, support the worker's adaptation to the tasks, and to prevent back pain.

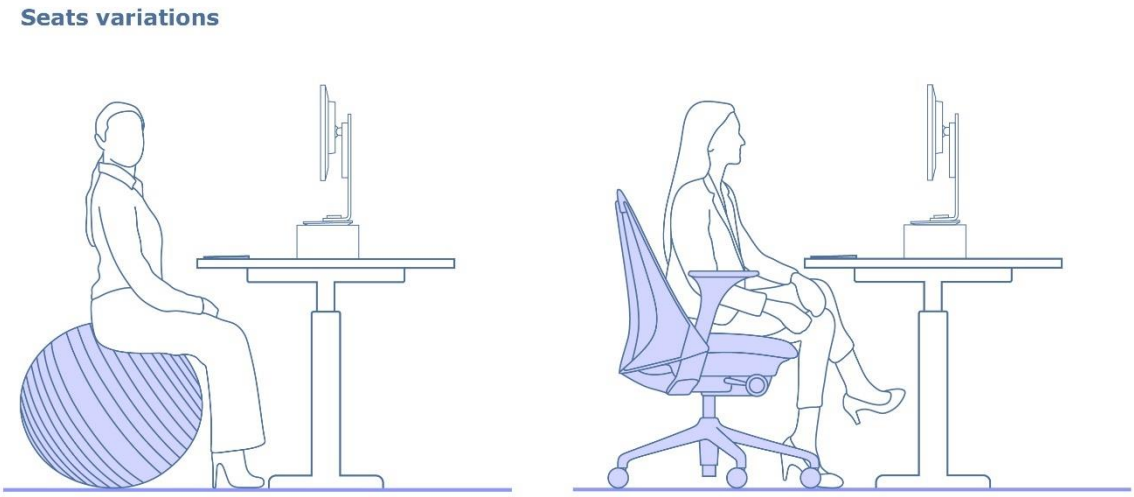

Figure 19 Seats variations

As previously discussed in this document, bright light therapy has shown positive results for accelerating the adjustment to nocturnal work in some people and to support the recovery from the sleep deprivation period.

Existing technology such as a SMART LIGHTING SYSTEM (see figure 20) can be implemented in the work environment. This system is connected to the built-in infrared camera in the monitor, smart systems algorithms analyze the information collected and increase light brightness as a decrease of the worker's alertness is detected.

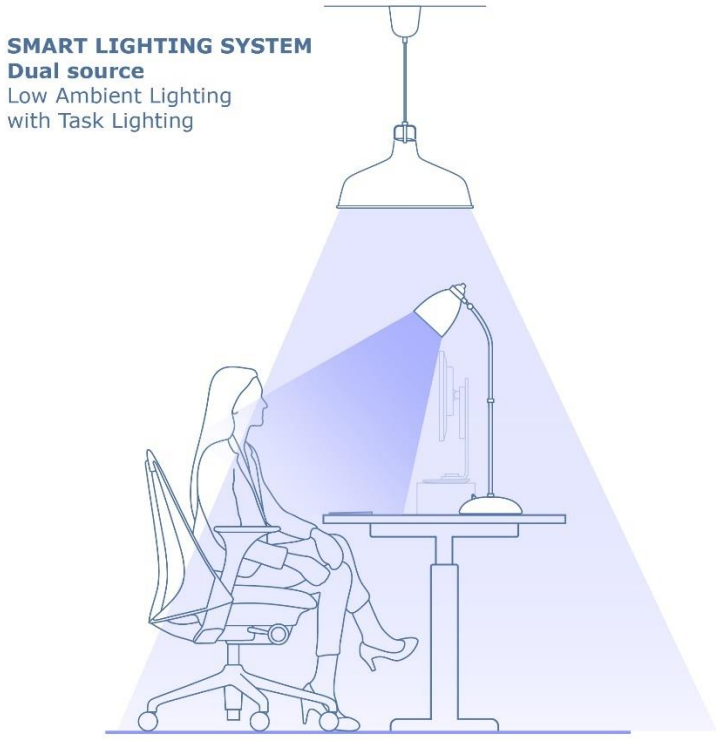

Figure 20 Office lighting, SMART LIGHTING SYSTEM.

A dual source of light composed of low ambient lighting which will impact the general office's atmosphere and a task lighting which is directed to the individual worker and generates a dedicated lighting atmosphere based on the person's needs in every given moment to promote alertness and to improve the worker's sleep hygiene.

3.7.1.5 SleepFlow Interface

The following information is a display of how the information would be communicated to the rotating shift workers. The digital platform aims to teach and guide behaviors to improve and support the worker's SH and adaptation to nocturnal work.

To illustrate the usability of the platform the *story of Eva* will be narrated:

- Eva joins a company as a rotating shift worker.
- She is set with her company's devices and platforms and soon accesses SleepFlow where she will get the best recommendations to improve her Sleep while working as a rotating shift worker (see figure 21, A).
- Eva pairs her wearable smart device which will sync the data to SleepFlow. The more information provided, the more accurate the system´s predictions will be.
- Eva automatically receives her month's personal work schedule. SleepFlow considers her sleep chronotype, the maximum of nights recommended to work in a row, and the recovery periods to automatically set the shifts for Eva and for

all her co-workers. She knows exactly what her working times will be and has the possibility to plan her life around it (see figure 21, B).

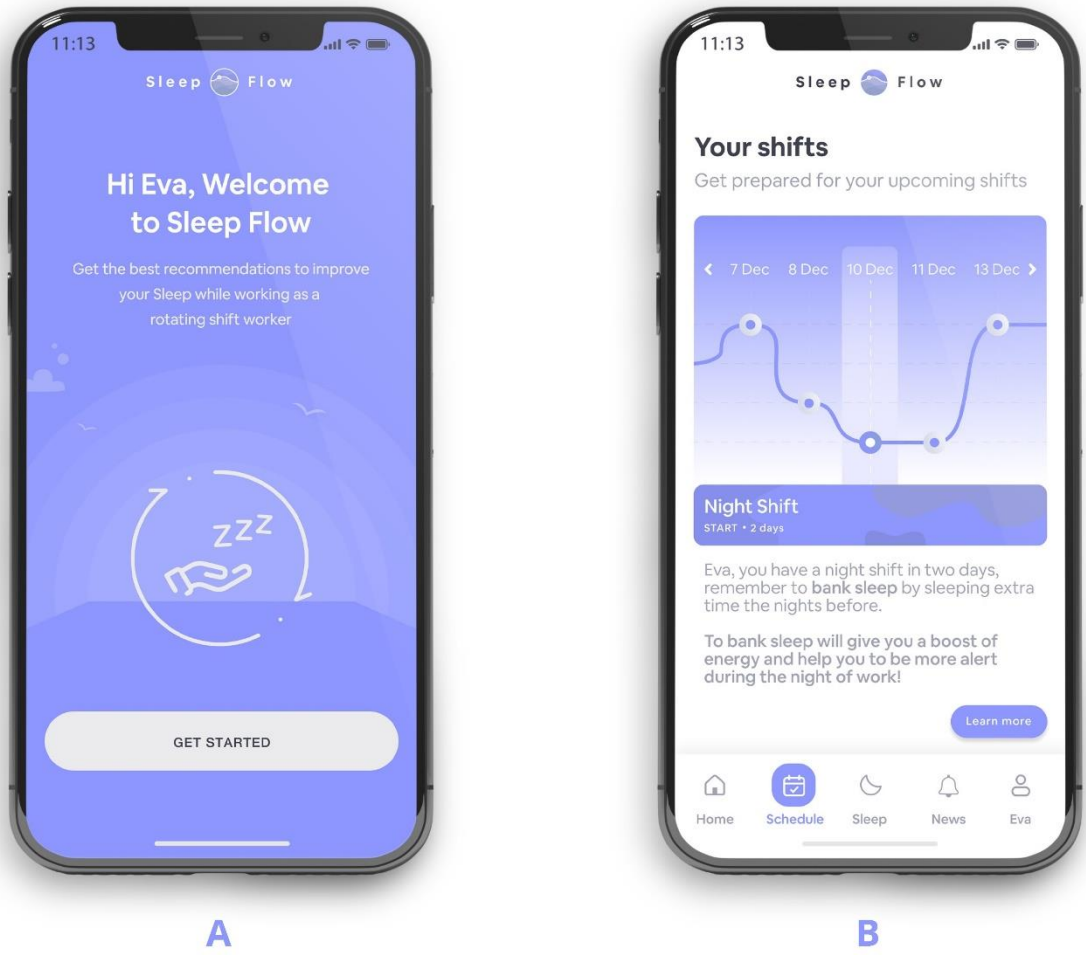

Figure 21 Interfaces A – B. Developed by the author

- Eva receives real-time recommendations to support her Sleep Hygiene. She has in power the personal monthly journey of her rotating shift work with tips to prepare for the upcoming shifts. One week before her night shift SleepFlow recommends to bank sleep and she can learn more about it if she wishes (see figure 22, C).
- Is soon bedtime and Eva knows exactly what to do to improve her sleep quality. With the instruction of SleepFlow, she has created her personal bedtime ritual, uses it every time she needs to sleep, even in the mornings after a night shift (see figure 22, D and figure 23, F).

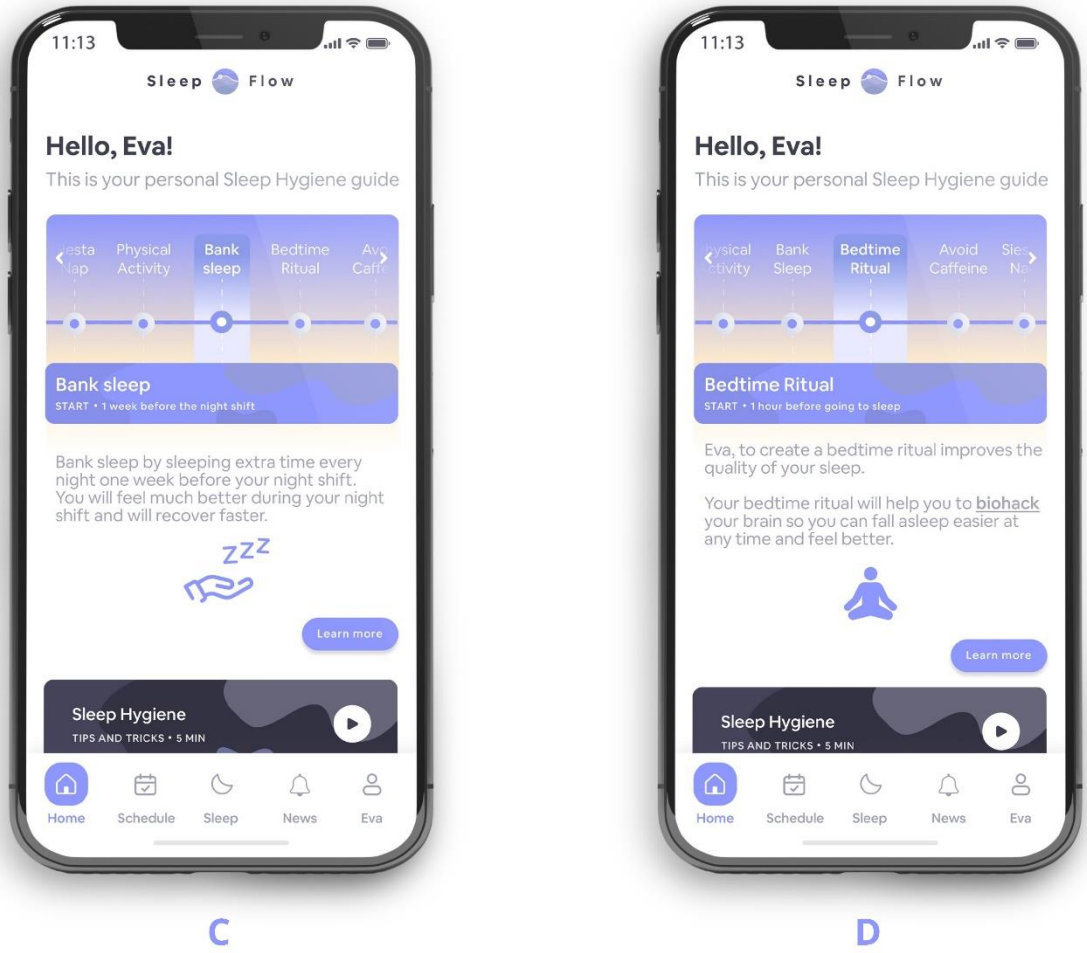

Figure 22 Interfaces C – D. Developed by the author

- Eva knows that the accuracy of the insights given by SleepFlow depend on how much data she inputs. She has clear expectations! (see figure 23, E).

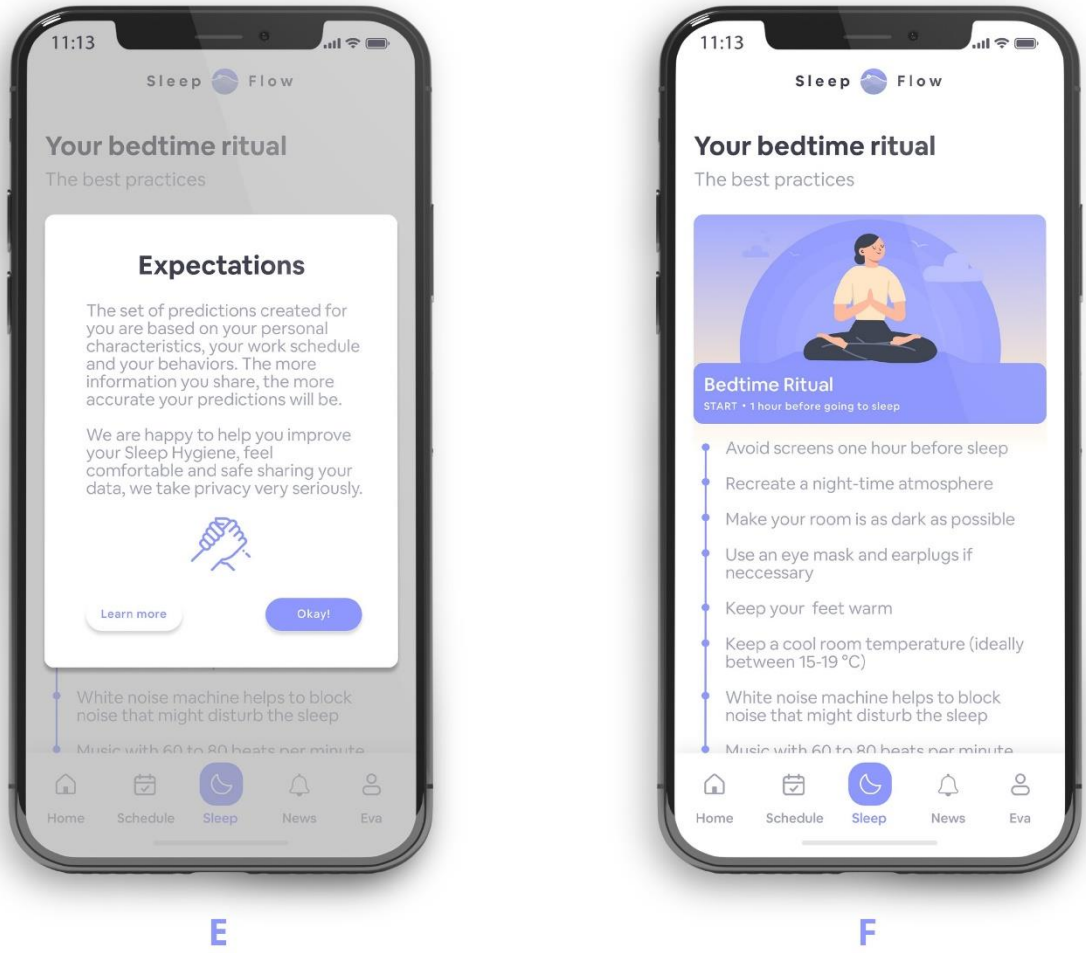

Figure 23 Interfaces E – F. Developed by the author

- Is the morning before a night shift and SleepFlow suggests not to drink caffeine at breakfast or during the day. Caffeine blocks the effect that Adenosine has on our body. Eva knows that Adenosine is the hormone that makes her feel tired, by avoiding caffeine she will feel the necessary sleep drive to be able to sleep before her upcoming night shift.

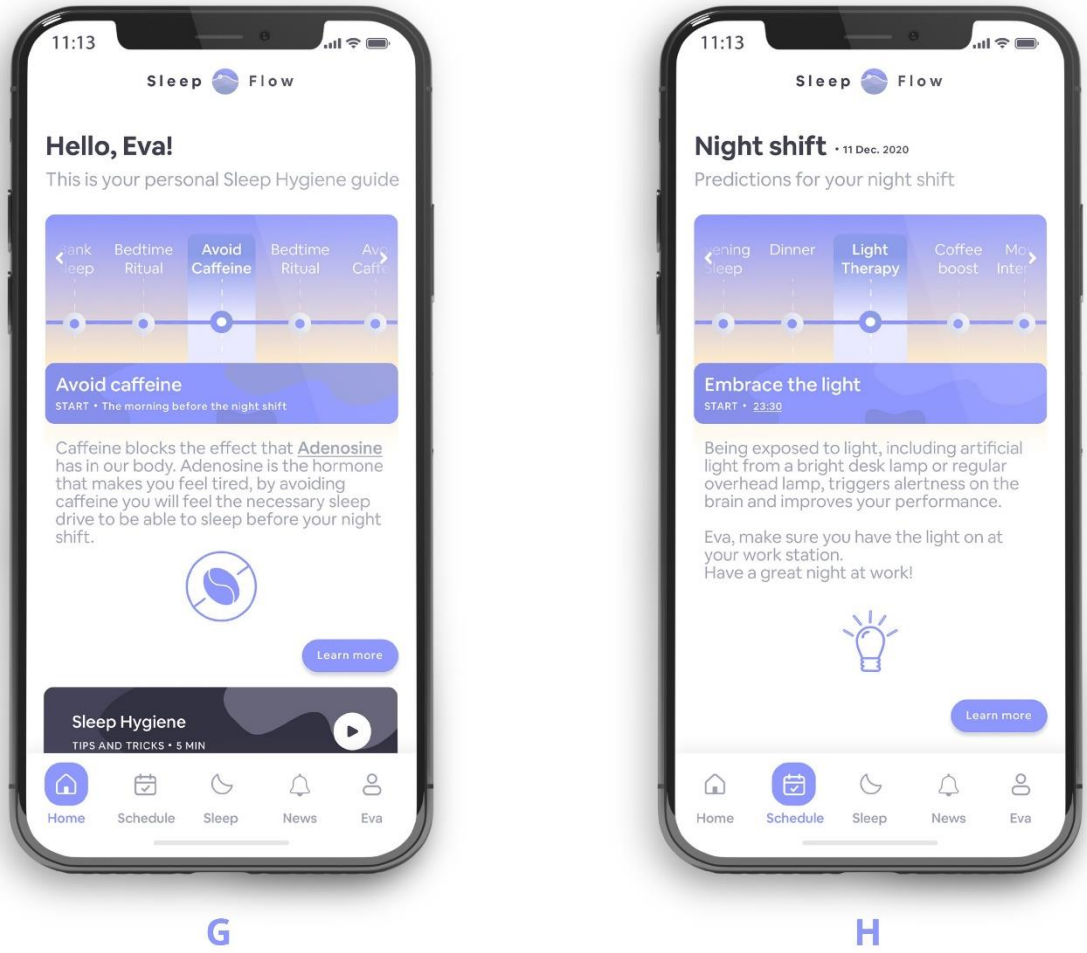

Figure 24 Interfaces G – H. Developed by the author

- Once Eva is logged in on her work computer at the start of her night shift, she answers the Karolinska Sleepiness Scale (KSS), that way SleepFlow knows how tired she feels before the shift and can adapt her journey to support her on making it through the night of work in the best way possible. Her sleep hygiene journey will be real-time up to date based on every input (See figure 25).

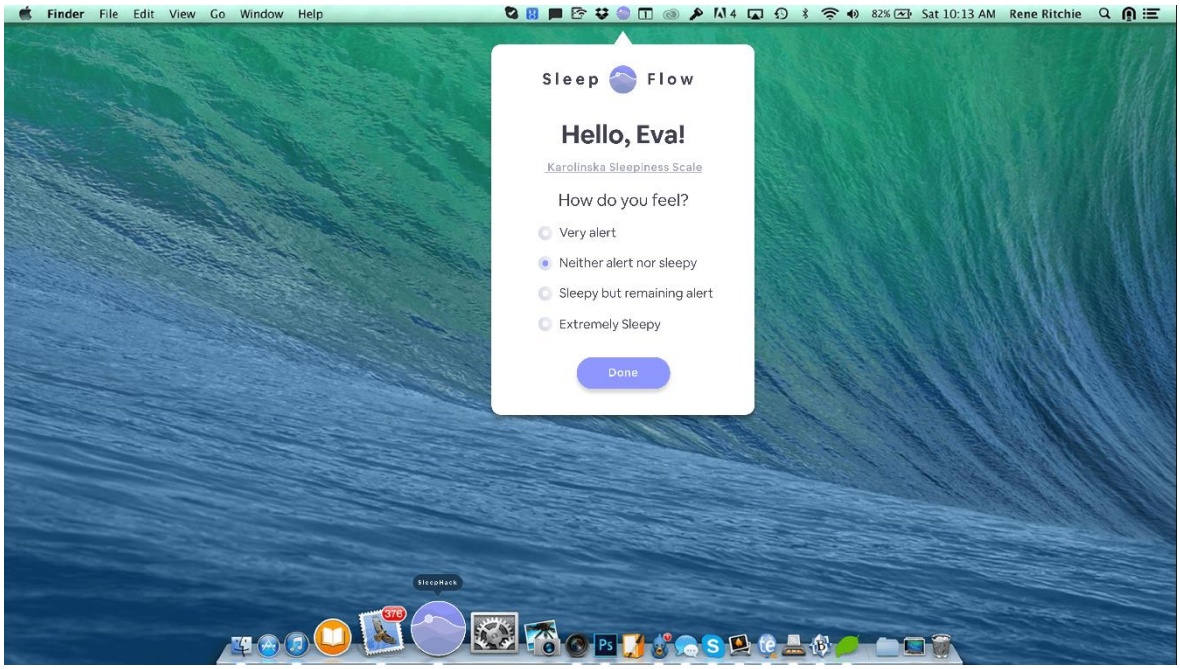

Figure 25 Interface, Karolinska Sleepiness Scale (KSS). Developed by the author

- As Eva is focused on her shift tasks, SleepFlow is working in the background tracking Eva's eye movement and facial features, AI algorithms analyze this information and predict Eva's state of mind. The system detects that Eva is falling asleep and increases light brightness through the smart light system connected to SleepFlow. Now Eva's brain has been biohacked! Her melatonin release has been blocked and her drive for arousal stimulated.
- The system reminds Eva when is the right time to take coffee during her night shift, SleepFlow informs her that caffeine intake after midnight would affect her morning sleep (see figure 26, I).

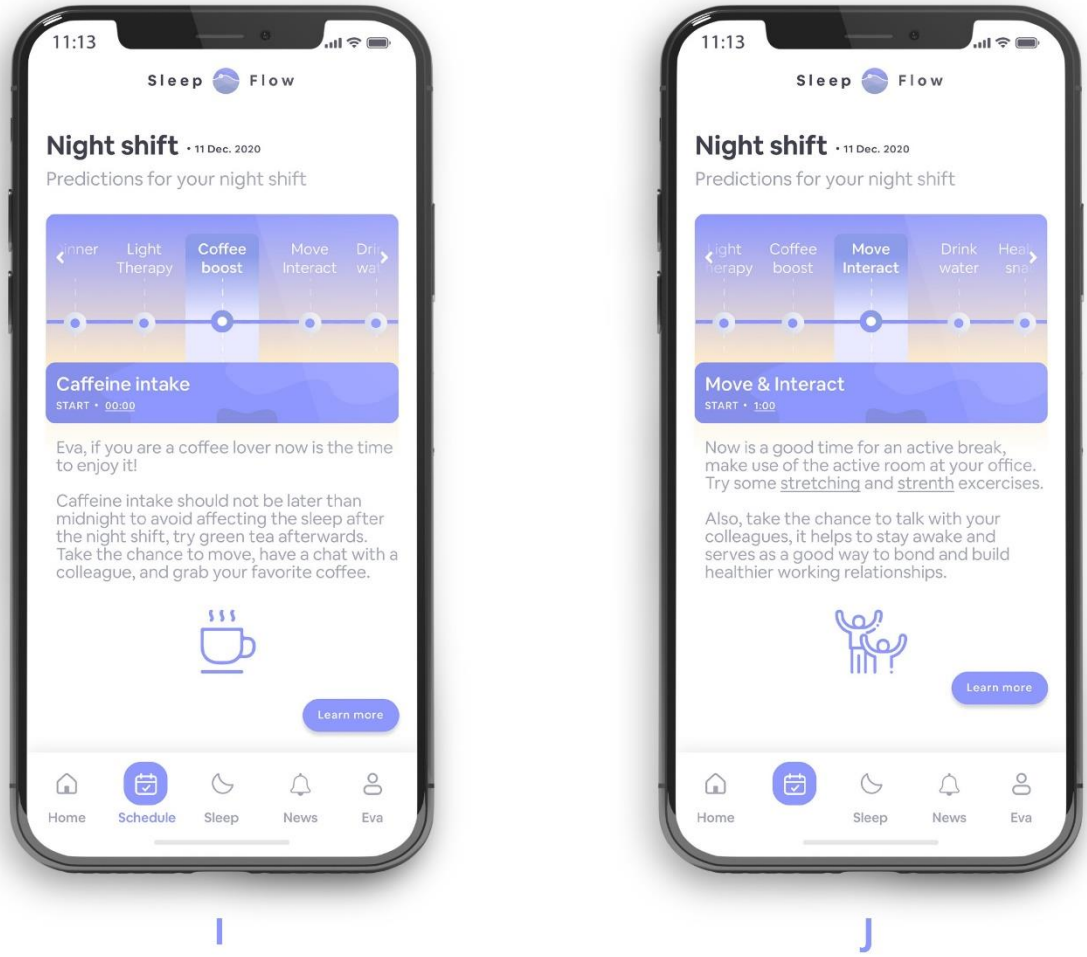

Figure 26 Interfaces I – J. Developed by the author

- SleepFlow reminds Eva to take active breaks every hour. Sometimes she walks around the office and talks to a colleague...and sometimes she goes to the physical activity corner in the office to do some stretches and push-ups. These breaks help Eva to interact more with her colleagues during the night shift and to feel more alert (see figure 27).

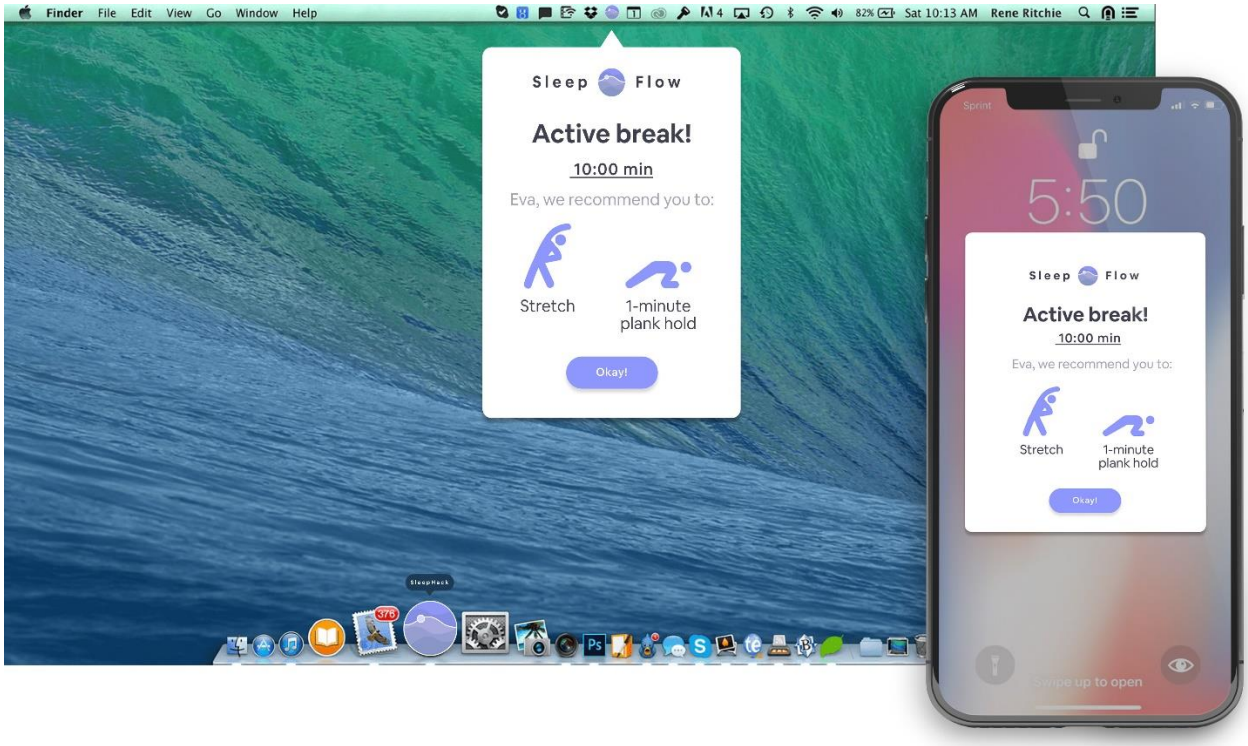

Figure 27 Interface, Active break notification. Developed by the author

- Eva can easily access her Sleep Hygiene journey from her computer and phone. She can expand and navigate through it to see the predictions generated.

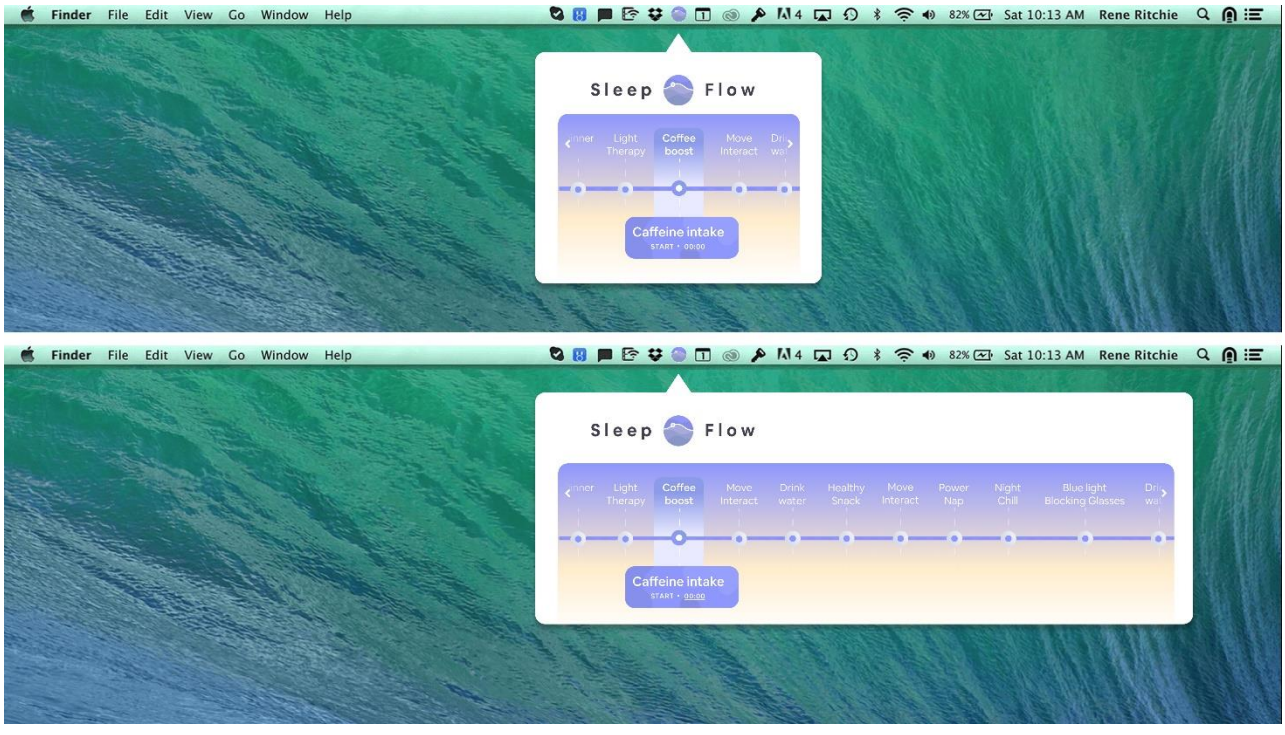

Figure 28 27 Interface, SH journey navigation. Developed by the author

With the implementation of SleepFlow, companies will have a healthier worker who is better prepared to perform his or her tasks, in the long term save time and money.

SleepFlow will help Rotating shift workers to improve their sleep hygiene, therefore improve the quality of their lives, prevent diseases, and support them in the search for balance.

3.7.2 Further development

The design concept proposed is an illustration of the service functioning. As a way to prove the concept, extended testing of the proposal should be conducted placing relevant inputs related to the SH of the rotating shift worker.

In the thesis research several factors that influence the SH of rotating shift workers were mentioned. Nevertheless, there are some theories that require deeper research development to come to a consensus, thus have clarity on how affects the SH o rotating shift workers. As is the case of specific dietary recommendations.

Company management discussion must be conducted to test the feasibility of the guidelines proposed to support the rotating shift worker's SH.

Consultation with a sports specialist must be conducted to define the specifications for the office's physical activity corner.

5. SUMMARY

Our body is used to being awake during the day and to being asleep at night. Nevertheless, countless companies need to keep operating at night and therefore nocturnal and rotating shift work is required.

When a person works as a rotating shift worker there is a direct alteration on his/her sleep schedule, commonly placing the worker under a state of sleep deprivation. The consequences of lack of sleep influence the performance of a person, which results in a reluctance to carry out tasks, fatigue, depression, anxiety, stress, reflexes are reduced so that the risk and severity of having an accident increase dramatically. Such symptoms result in Shift Work Sleep Disorder (SWD).

This thesis proposes a design solution to support and enhance the sleep hygiene of rotating shift workers in desk-based office work environments. The individual's biological clock, his/her behaviors, and the environment, are factors influencing the sleep hygiene of rotating shift workers. By adjusting the environment and guiding the behaviors, the worker's adaptation to rotating shift work can be supported. That includes supporting the worker on preparing for the night shift, guidance on the activities during the night shift to support sleep hygiene, and instruction on what to do afterwards to return to a regular sleeping schedule.

The concept is illustrated by solution schemas (system maps), wireframes of a digital platform, user journeys and company guidelines to support the sleep hygiene of rotating shift workers.

5.1 Kokkuvõte

Meie keha on harjunud päeval ärkvel olema ja öösel magama. Sellegipoolest peab lugematu hulk ettevõtteid jätkama tööd ka öötundidel ning seetõttu on nõutud öine ja roteeruvate vahetustega töö.

Roteeruvate vahetustega töötaval inimesel on muutuv unegraafik, mis viib ta tihtipeale unepuudulikkuse seisundisse. Unepuudulikkus mõjutab inimese sooritusvõimet ning põhjustab näiteks vastumeelsust ülesannete täitmisel, väsimust, depressiooni, ärevust, stressi ja nõrgendab inimese reflekse, mis omakorda suurendab õnnetusjuhtumite ohtu ja nende tõsidust. Selliste sümptomite tagajärjel tekib niinimetatud "vahetustega töö unehäire" (ingl. k. *"Shift Work Sleep Disorder"*).

Käesolevas lõputöös pakun välja disainlahenduse rotatsioonivahetustes töötajate unehügieeni toetamiseks ja parandamiseks kontoritöö keskkonnas. Inimese bioloogiline kell, tema käitumine ja keskkond on rotatsioonivahetustes töötaja unehügieeni

mõjutavad tegurid. Keskkonda kohandades ja käitumist suunates saab toetada töötaja kohanemist vahetustega tööga. See hõlmab töötaja toetamist öiseks vahetuseks ettevalmistumisel, juhendamist töövahetuse ajal unehügieeni toetavate tegevuste osas ning juhiseid selle kohta, mida teha pärast öist töövahetust tavapärase unerütmi juurde naasmiseks.

Antud kontseptsiooni illustreerivad lahendusskeemid, digitaalse platvormi ekraanivisandid, kasutajateekonnad ning juhised ettevõtetele rotatsioonivahetustes töötajate unehügieeni toetamiseks.

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7. FIGURE LIST

8. TABLE LIST

9. APPENDICES LIST

10. APPENDICES

Appendix 1 Structure for Interviews

Interviews

BEFORE THE SHIFT
Since when have you been working in shift work type of job?
How do you think that the rotating shifts type of work affect your life?
Do you think that having rotating shifts including night shifts has affected your sleep quality?
What do you think about the night shifts?
How many night shifts do you have every month and how many of those in a raw?
How do you get ready for the night shifts?
What are the benefits or advantages of night shift work?
What are the disadvantages of night shift work?

DURING THE SHIFT
Do you have any kind of structure for the project times during the night shift? E.g., When do you take a break, eat or how much coffee do you drink?
How do you usually feel during the night shifts?
What is the most usually thing that happen to you or how your body feels?
Do you feel tired sometimes?
What do you do when you feel tired?
What is in your mind once the shift is over?

AFTER THE SHIFT
What do you do when you get home after your shift?
How many hours do you sleep after the night shift?
Do you feel well rested after sleeping during the day? Do you feel different?
What happens with your sleep pattern after the night shifts?
How do you think your sleep could improve after the night shifts?
Is there anything that you think could help you to sleep better?

Appendix 2 THE PROBLEM SPACE map

Due to the size of this map, it is provided as an individual file linked to this document.

Appendix 3 The SOLUTION SPACE map

Due to the size of this map, it is provided as an individual file linked to this document.

Appendix 4 Sleep Hygiene Index results

Number	Question	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11	#12	#13	#14	#15	#16	#17	Total
Age		21	21	21	23	23	24	25	25	25	26	26	26	27	30	32	32		
SHI-1	I take daytime naps lasting two or more hours	2	2	1	2	1	1	2	0	1	0	2	2	3	2	1	3	1	26
SHI-2	I go to bed at different times from day to day	4	4	3	4	2	1	3	2	4	3	3	3	3	2	4	4	3	52
SHI-3	I get out of bed at different times from day to day	4	4	2	4	3	1	3	2	4	3	3	3	3	2	4	1	3	49
SHI-4	I exercise to the point of sweating within 1 hour of going to bed	0	0	2	1	0	0	1	1	1	1	0	1	0	1	0	1	1	11
SHI-5	I stay in bed longer than I should two or three times a week	3	3	2	3	2	1	3	1	1	3	2	3	3	0	4	3	4	41
SHI-6	I use alcohol, tobacco, or caffeine within 4 hours of going to bed or after going to bed	2	2	1	3	2	0	3	0	2	1	2	4	1	0	4	0	1	28
SHI-7	I do something that may wake me up before bedtime (for example: play video games, use internet, watch television, eat)	1	1	3	2	2	3	3	2	4	3	3	3	4	2	3	4	4	47
SHI-8	I go to bed feeling stressed, angry, upset or nervous	1	1	2	2	1	2	2	2	0	3	2	2	3	1	2	3	2	31
SHI-9	I use my bed for things other than sleeping or sex (for example: watch television, use or phone or eat)	4	4	0	0	1	2	2	2	1	2	2	0	4	0	2	1	4	31
SHI-10	I sleep on an uncomfortable bed (for example: poor mattress or pillow, too much or not enough blankets	0	0	0	0	2	0	1	0	0	1	1	0	2	0	1	3	1	12
SHI-11	I sleep in an uncomfortable bedroom (for example: too bright, too stuffy, too hot, too cold, or too noisy)	0	0	0	1	1	0	1	1	0	2	2	0	2	0	0	1	2	13
SHI-12	I do important work before bedtime	2	2	2	2	2	1	1	3	3	1	0	2	3	0	2	1	3	30
SHI-13	I think, plan, or worry when I am in bed	1	1	2	3	1	3	3	3	0	4	2	2	4	2	2	3	4	40
Total		**24**	**24**	**20**	**27**	**20**	**15**	**28**	**19**	**21**	**27**	**24**	**25**	**35**	**12**	**29**	**28**	**33**	

The total values at the bottom line of the table show that the SHI of this group of workers is in a range of 12 being the best one and 35 being the poorest one. The medium SHI value is 24.18 which means that the SHI result leans towards medium quality of sleep hygiene.

According to the accumulated values of each of the SHI items, the SHI-2 (I go to bed at different times from day to day) has the highest value, followed by SHI-3 (*I get out* of bed at different times from day to day), then SHI-7 (I do something that may wake me up before bedtime (for example: play video games, use internet, watch television, eat)), then SHI-5 (I stay in bed longer than I should two or three times a week), followed by SHI-13 (I think, plan, or worry when I am in bed), SHI-8 (I go to bed feeling stressed, angry, upset or nervous) and SHI-9 (I use my bed for things other than sleeping or sex (for example: watch television, use or phone or eat)) are at the same level, followed by SHI-12 (I do important work before bedtime), then SHI-6 (I use alcohol, tobacco, or caffeine within 4 hours of going to bed or after going to bed), then SHI-1 (I take daytime naps lasting two or more hours), SHI-11 (I sleep in an uncomfortable bedroom (for example: too bright, too stuffy, too hot, too cold, or too noisy)), SHI-10 (I sleep on an

uncomfortable bed (for example: poor mattress or pillow, too much or not enough blankets) and the index with lowest value was SHI-4 (I exercise to the point of sweating within 1 hour of going to bed).

Appendix 5 Results of interviews

Andrew / Full time worker

BEFORE THE SHIFT

Since when have you been working in shift work type of job?

- Never worked before during night shifts.
- Have been working for almost six months.

How do you think that the rotating shifts type of work affect your life?

- I have not had too many night shifts, so it has not been a big problem, I usually have two- or three-night shifts very month in a raw, he considers that is not much but still has a weird effect on his body, it affects his sleep patterns.

Do you think that having rotating shifts including night shifts has affected your sleep quality?

- It does affect your sleep patterns, but in his case since he does not have too many night shifts, he still has a time when his body is used to sleep.
- My body is used to sleep at around 2 am, so is very tough to work over night, is a struggle to keep awake.
- I love to sleep a lot; I usually sleep around six or seven hours.

How many night shifts do you have every month and how many of those in a raw?

- Two or three nights every month and they are usually in a raw.

How do you get ready for the night shifts?

- He tries to follow the technique thought in the company and sleep before the night shift but is very hard to sleep 5 hours before the shift, he manages to sleep maximum two hours in the evening before the night shift.
- Is usually hard to sleep during the day, so he manages to sleep only two or three hours, not five. He ends up rolling in bed, "to sleep five hours during the day is almost impossible".

What are the benefits or advantages of night shift work?

- Advantages of night shift: More money/incentive.

What are the disadvantages of night shift work?

- "It has a turn on your health definitely, I believe you need sleep and the best time to sleep is at night. Night is when I prefer sleeping, not day. If you cannot sleep it really messes up. There is a certain way I personally feel, I feel feverish"

DURING THE SHIFT

Do you have any kind of structure for the project times during the night shift? E.g., When do you take a break, eat or how much coffee do you drink?

- I take breaks, usually the best is to stand up once in a while and walk around. I do not like coffee, there is a way I feel when I drink coffee, but I do not have a choice and it has to be a lot, I have to get coffee to keep myself awake. But sometimes maybe when I am well rested and not stressed, I can go on without the coffee, I try to listen to music, one or two things by the side to keep you awake. My type of music is African kind of songs with a lot of beat.
- When there is bright light is hard to sleep, when the lights are dim is better for your brain.
- I usually have eating before I leave home, so do not eat during the night shift.

How do you usually feel during the night shifts?

- Every night shift is very different, the days preceding the night shifts, let us say two days before…have a very strong impact on how the night shift is. "Imagine I have not really been rested in like two days before the night shift, or if I have slept very well, your body is going to find it so hard."

What do you do when you feel tired/falling asleep during the night shift?

- "…there is an opportunity for you to sleep to take a nap, maybe for like 30 minutes, like a power nap if it is that serious."

What is in your mind once the shift is over?

- "Just go to bed" 8:54

<u>AFTER THE SHIFT</u>

What do you do when you get home after your shift?

- I hit the bed; I eat breakfast when I wake up.

How many hours do you sleep after the night shift?

- I would sleep around five hours.
- When there is very bright light is hard to sleep, the brain is more active thinking that is day.

Do you feel well rested after sleeping during the day? Do you feel different?

- My body feels different, is not the same as sleeping during the night but is more or less ok, not so bad.

How do you come back to the normal sleep time?

- To come back to the normal time, you sleep again that night if you do not have a shift anymore. I get home at 8, sleep until 1 and then you wake up and when there is that night you go to sleep at around 1 or 12 am. Is ok for me to fall asleep, I sleep soo fine, straight up. Except if I have people around me moving, I am hearing sounds…even if the lights are on, I can fall asleep.

How do you think your sleep could improve after the night shifts?

- For me to come back to the normal sleep time is easy. But maybe if I had to do nights shifts for a long time, let us say a whole week it would be hard, but if is not that long is fine, I do not find it hard to sleep.

How would you rate your sleep quality?

- My sleep quality is very good.
- What I am not used to is to wake up very early. I prefer to sleep until 8 but if I have morning shift is very hard. My favorite shifts are brunch and evening.
- My hardest shift is night, but it is ok because there is incentive.

Mo / Full time worker

BEFORE THE SHIFT

Since when have you been working in shift work type of job?

- One and a half months.
- I worked at a bar before, the shifts were from 5pm to 2am.
- Since it was a fixed work schedule it was easy to set a sleep pattern.

How do you think that the rotating shifts type of work affect your life?

- Sometimes affects in a good way and sometimes in a bad way. Sometimes works for what you have planned in that particular week, for example this week I had brunch shifts so I felt like I had no time for myself, after 6pm I am already tired and cannot do much after work.
- Sometimes I have morning shift after a brunch shift the day before and that is hard for me.

Do you think that having rotating shifts including night shifts has affected your sleep quality?

- I have not got a proper rest for at least a month and also know that my sleeping quality has been bad before. I have spent three or four hours lying in bed just scrolling on my screen, then I wake up next morning and my eyes are still tired, I have to come to work and spend 8 hours in front of three screens.

What do you think about the night shifts?

- For me it is easy to come to the night shifts because you have the whole day before to sleep, for me it is easier to wake up in the afternoon than in the morning, I struggle to wake up in the morning. For example, wake up at 5pm, have breakfast and also eat something at 9 or 10.

How do you get ready for the night shifts?

- The night before I go to bed at around 3 or 4 am, then I wake up at around 5pm, have breakfast, I eat something else later and then go to the night shift.
- I usually eat two times during the day, for me it is enough.
- Noise or people talking does not bother him while asleep.

What are the benefits or advantages of night shift work?

- For me is easy because I am not a morning person, I cannot think about any other benefit.

What are the disadvantages of night shift work?

- Staring at the screen for 8 hours makes my eyes more tired during night shifts than during morning shifts because when is day you have natural light coming

through the windows, so the all-night-long screen light makes my eyes very tired.
- He uses an application on his computed which regulates the screen brightness and color depending on the time. In this case it was around 6pm and his screen looked totally yellow, this helps his eyes to get less tired.

DURING THE SHIFT

Do you have any kind of structure for the project times during the night shift? E.g., When do you take a break, eat or how much coffee do you drink?

- Depending on the day I set my work routine. Depends on how I feel.
- I do not ring food for the night shifts, I just drink coffee.

How do you usually feel during the night shifts?

- I feel sleepy. I do not really have a sleeping pattern, but I feel sleepy.

What do you usually do when you feel tired during the night shift?

- Nothing, I just try to stay awake.
- I have only taken a nap once because I was not feeling well, but I never take a nap for feeling tired.

What is in your mind once the shift is over?

- Sleep.

AFTER THE SHIFT

What do you do when you get home after your shift?

- Literally go to bed. Sometimes I find myself sleeping with shoes on, I think that will sleep like for five minutes and end up waking up at 5pm.

How many hours do you sleep after the night shift?

- More than 10 hours.
- I go to bed at 8 am and wakeup at 5 or 6 pm sometimes.
- It is easy for me to sleep during the day, I can sleep whenever I want.

Do you feel well rested after sleeping during the day?

- I feel fine, this is why I say that coming to night shifts is easy for me. But for example, after brunch shift, I go home after 6 and then I start to look stuff in social media, then cook dinner and then watch YouTube, open like 20 tabs and watch all of it, then eventually is 2am. I cannot sleep at home; my brain suddenly is very active. Then when I get to work, I feel very sleepy.

What happens with your sleep pattern after the night shifts?

- He does not have a sleep pattern.

Is there anything that you think could help you to sleep better?

- I should try to decrease my screen time would be very helpful, the blue light emitted from screens tricks the brain and makes it think that is daytime. I even have a blue light filter, it helps a bit but is still not enough, what I should do is to turn it off and fight the temptation.
- The screen use is like an addiction, nowadays you even get these phantom vibrations, it is difficult.

- You also have to be careful about the sleep cycle, so you get enough of them and do not wake up in the middle of it and feel very tired.
- If I had a better planning, it would help. The other day I had to wake up in the morning, when I say morning, I mean like 11 am, that day was very difficult because I only slept like 4 hours and had to be awake the whole day.
- I do not follow the recommendations from the night shift training, I do not even set any alarm. Is hard to follow these suggestions because work is not the only thing in our lives.

Lea / Full time worker

BEFORE THE SHIFT

Since when have you been working in shift work type of job?

- Has been working in the shift work since 2017. When she was working in India it was in a company based in USA, reason why all the workers had to be in evening shift (17:00-2:00) or night shift. The periods of time for these shifts were usually 8-10 months night shift and 3-4 months as evening shift.

How do you think that the rotating shifts type of work affect your life?

- It has affected deeply her health. After two months of starting her shift work type of job she had gained a lot of weight, started to suffer from migraine, had hormonal disorders (linked to weight gain and facial hair).
- These types of work also affected her social life. Lost contact with most of her friends since everyone had a different schedule and they just could not count on her for meetings, also when receiving messages or things happening during the day she missed because she was asleep. Her closest friends and family remained but it was still hard to keep up. For instance, when there was a family meeting, she had to prepare for that one week in advance so that she would have enough sleep during the previous days and be able to participate and be socially engaged.

Do you think that having rotating shifts including night shifts has affected your sleep quality?

- It has definitely affected it. Especially when was working in her previous job she was never well rested and she and her work mates could never sleep 7 or 8 hours during the day, the average was 5 hours, and this is not enough.
- Having to sleep during the day is never the same as during the night. There is noise from everyone else who is awake and a lot of light which is never totally covered by the blackout curtains.
- The longest the periods of night shifts, the hardest is the effect on the health.
- The body does not catch up on sleep if you do not get it over night.

What do you think about the night shifts?

- Is understandable that companies need it but is very harsh on the body, is something that she does not want to go through.

How many night shifts do you have every month and how many of those in a raw?

- Around 4 or 5 but usually two in a raw.

How do you get ready for the night shifts?

- She sleeps in the morning before the night shift, for example instead of waking up at 6:30 she would sleep until 11:00.

What are the benefits or advantages of night shift work?

- Better pay, but other than that is so bad for the health and social life that is not worth it.

What are the disadvantages of night shift work?

- The health is harmed.
- The social life is affected.

DURING THE SHIFT

Do you have any kind of structure for the project times during the night shift? E.g., When do you take a break, eat or how much coffee do you drink?

- Yes, she knows that she will get very tired at around 3am, so she tries to divide her tasks in a certain way so she would be able to take a nap if needed.
- When she is feeling very tired, she would take a nap. She has taken the nap of one hour because she thinks is better than a shorter one, but lately tried to drink a coffee, then take a power nap (20-30 minutes) and she felt much better after that.
- From her experience she knows that coffee is better to drink during the day and tea during the night, it helps to keep awake (caffeine) and is less harsh on the stomach.
- She tries to have a light environment for work and watch documentaries of funny videos to keep awake.

How do you usually feel during the night shifts/ how does your body feel?

- Her sight starts to be blurred.
- Migraine can appear after a few days of having night shift.

What do you do when you feel tired?

- To take breaks is very helpful.
- Drink tea.
- Take a nap.

What is in your mind once the shift is over?

- To go home to sleep.

AFTER THE SHIFT

What do you do when you get home after your shift?

- Usually brush teeth and go to bed right away.

How many hours do you sleep after the night shift?

- Usually 5 hours, she is not able to get 7 or 8 hours of sleep.

Do you feel well rested after sleeping during the day? Do you feel different?

- Is never the same to sleep during the day, the body is still tired, and some migraine might start for her.

What happens with your sleep pattern after the night shifts?

- Is very difficult to come back to normal, it usually takes her one or two weeks to come back to the normal sleep schedule.
- To come back to normal sleep schedule, she does some physical activity. She tries to go for long walks that would exhaust her body so that she will be able to fall asleep the next night.
- I feel very tired, have very low energy to perform simple tasks like making lunch. Is very helpful to have a partner who can support you in this type of things.

How do you think your sleep could improve after the night shifts?

- Doing physical activity.

Is there anything that you think could help you to sleep better?

- To have a normal schedule (office hours).

Nia / Full time worker

<u>BEFORE THE SHIFT</u>

Since when have you been working in shift work type of job?

- Seven months.

How do you think that the rotating shifts type of work affect your life?

- Is very difficult, it affects a lot. Considering that you are single it affects your eating schedule, sleeping schedule and the times when you do certain activities…specially during the wintertime when by working in rotating shifts sometimes you do not even see the day light/natural light for two or three days and this starts to affect you a bit.
- If you are living with your partner there is a stronger impact because your partner is also affected by your schedule and this can be very frustrating. For example, some days my boyfriend has to wait several hours for me to wake up when I have had a night shift or when I leave to morning shifts, I do not see him and even sometimes the next day I have evening shift and I cannot see him until midnight. So, we cannot see as often as we wish even though we live together. The rotating shifts can be very chaotic.
- It affects eating schedules, sleep patterns and social interactions.

Do you think that having rotating shifts including night shifts has affected your sleep quality?

- The quality of my sleep is not the same because my body cannot get used to a certain schedule. Sometimes you have to sleep during the day when there is light, and it is not so easy. When I have had a few days (4 or 5) with the same shift my body starts to get used to it, but then it changes so the body gets tired or stressed and even if you sleep a lot you never feel rested.

What do you think about the night shifts?

- There are many factors, first of all I think night shifts are necessary for the nature of the work, economically are beneficial because you get a better pay. But physically is something that I do not want, I do not want to face that…if I take them is because they are part of my responsibility and economically are good, but they affect me a lot. Usually after the night shifts it takes me a few days to feel good again, to come back to feel well because it affects my

organism, my stomach goes crazy, my eating and sleep schedule rotate, everything changes. If I could I wouldn't take them.

How many night shifts do you have every month and how many of those in a raw?

- Normally 4 but I have had months of 6-night shifts. Usually 2 in a raw but once I had 3 and asked to the company to not do it again because at the third night I went back home feeling sick and couldn't even hold myself up on my feet, I thought that I was just exaggerating but with the time I have noticed that during the first night is something you can cope with, in the second night I start to feel dizzy and bad, even if I sleep before the shift.

How do you get ready for the night shifts?

- I try to sleep at least two hours before the night shift. But it depends on my previous day's schedule because sometimes my brain is very active until 12 am and our night shift starts at 11:30. In that case I just lay down or watch something that reliefs the stress and ideas in my mind.
- I also make food because I get hungry at around 3 am.
- When I get to work, I try to have artificial lights directly on my desk because otherwise my head starts to hurt, and I feel more tired.
- I try to work standing up because this helps me to fight tiredness.
- I listen to music and even dance.
- If I am sitting next to a friend is also good to have conversations, is like if we are encouraging each other to keep awake and make the shift nicer. My responsibility is to keep awake and perform all my tasks.
- I have taken naps but interestingly it has happened to me that I have needed to take naps at 8am or 3pm because I am exhausted, luckily these naps have been one hour long. But during night shifts is very rare that I take a nap because I might not wake up or if I do it will be very stressful, also during the nights we are not some many at work so nobody will cover my activities if I am not there.

What are the benefits or advantages of night shift work?

- For the company is economically good to be able to cover 24 hours service.
- Economically is good because we receive almost double pay.
- For our emotional and physical health, I do not see any benefit, even if you prepare for the night shift it affects a lot. I have noticed that when I started working it was easier to cope with the nights but as time passes by, becomes harder because my body is struggling to adapt to the constant changes of rotating shifts. There is no pattern on the shifts that we get.
- It would be ideal that morning, brunch, and evening shifts were grouped monthly, but for night shifts (in the case of having four/month) is necessary that they are distributed as far from each other as possible, so you do not do them all at once and the body has time to recover…and when you get a night shift, take a day off and the next shift is an evening shift, so the schedule starts to change gradually. E.g.: Morning, then brunch, then evening and night and it also comes back from night, to evening, brunch and then morning. Give time to the body to get used to a certain schedule.

<u>DURING THE SHIFT</u>

Do you have any kind of structure for the project times during the night shift? E.g., When do you take a break, eat or how much coffee do you drink?

- Lights on around me, happy music, speak with others, work standing up, I do not read much because it makes me tired. I avoid any activity boring or

monotonous activity which can make me tired. Sometimes I watch funny videos because helps me to keep awake.
- I drink a lot of water. From my university time I got used to drink a lot of water and it helps.

How do you usually feel during the night shifts?

- First my stomach is affected, I feel a heavy stomach, I am thirsty, my eyes and tired and I am heavily prone to sleep. My whole body is telling me that I should go to sleep. My stomach is so heavy that I cannot control it.

What is in your mind once the night shift is over?

- Finally! Oh yes, great!
- Usually until 4 or 5 am I can cope, but from 5 to 7 am is a torture is like your brain is wait for the minutes to pass by quickly and when finally, is 7:30 am you just say "thanks!".
- When I get home event though I am exhausted, it usually takes me 30 minutes or one hour to fall asleep because my mind is still thinking about work. Is not the same as a normal work schedule when you have time to do other activities after work and disconnect your mind from it, in this case you have to work, disconnect quickly and then force yourself to sleep, this is hard for your body.

AFTER THE SHIFT

What do you do when you get home after your shift?

- I usually wash my face, teeth, drink water and go to bed. Usually reading helps me to sleep but after the night shift I avoid it because my eyes are tired, my body is exhausted…I just look at the phone for a bit and eventually fall asleep.

How many hours do you sleep after the night shift?

- Since I live with my boyfriend is hard to sleep all the hours I would need to sleep. Is usually 6, 7 or 8 hours but I honestly wake up and feel that I could sleep a lot more.

Do you feel well rested after sleeping during the day? Do you feel different?

- I do not feel well rested, I do not want to do anything, I do not even want to move and if I have another night shift coming is even worse. Sometimes I sleep a bit more before the night shift but usually 7 hours are enough for my brain.

How do you come back to the normal sleep time after the night shifts?

- Is very difficult but I try to regulate it. I cannot force my body to sleep immediately…what I do is to go to sleep very late. Let's say the first night after the shift I would try to go to bed at 3 am, the second day at 2 am and the third one -when the next day I have to work- I try to make it to bed at 12, but it all depends on how my body feels. Sometimes I have a morning shift and my body does not let me fall asleep until 4 am and then I have to be at work for 7 am and I am exhausted.

Is there anything that you think could help you to improve the sleep quality of people who work in rotating shifts?

- To set the shifts that they are gradually changing, is not so feasible though.

- Extent the evening shift until 2 or 3 am and the night shift start it earlier. Because the hardest hours are from 2 am to 6 am, try to cover them, find a way.
- The furniture should all be high adjustable, the lights should be better…sometimes the room is dark when people turn the lights off and the only lights are from the screens and this makes your eyes very tired.
- Food which provides energy.
- Training about nutrition related to the night shifts. I try to eat healthy, but this is not helping me to cope with the night shifts.
- The company could be more flexible. For example, if you have had a night shift the arrival time for the upcoming shift could be more flexible. Depending on how you are feeling, be able to come a bit late, notify the company about it but have such a possibility.
- Make activities during the night, for instance a meeting at 4am to check out how we are feeling, how the night workers are coping with it.

Kate / Part time (75% of full time) worker

BEFORE THE SHIFT

Since when have you been working in shift work type of job?

- 9 months working at.
- Have been working in shift work before for 6 months.

How do you think that the rotating shifts type of work affect your life?

- Firstly, on sleep, when having night shifts is hard to stay awake specially after 3 or 4 am when you have no energy, but you have to push yourself.
- Also, the rotating shifts make it difficult for the body and mind to understand why is so changing.
- I try to schedule my work according to my study and social life, based on this is set non available hours and it has worked out so far so I can meet my friends and study.

Do you think that having rotating shifts including night shifts has affected your sleep quality?

- I started to sleep worse, I have more sensitive sleep right now.
- The rotating shifts have completely changed my life. I have to plan my personal life around my work, is hard to have a routine where I can do my personal activities if one day, I have morning shift but the next one brunch shift, then I have to do my personal activities before work. I prefer to wake up early, do all my stuff and at 12 be done and take it easier during the rest of the day.

What do you think about the night shifts?

- Is fine if I can sleep before is totally fine.
- I like it because is quiet and I can concentrate more on my activities.
- I prefer nights because they are calm and quiet, there is less stress around me.
- Is not good to have three nights in a raw, I have had this and is really difficult, on the third night I could not even understand where I am and what I am doing, I had to sleep all day and then come back to work, I would say that three nights is the maximum. But some people have five nights in a raw and they are fine with it, it depends on the person.

How do you get ready for the night shifts?

- I like to sleep before. I go to sleep at around 6 until 10:30.
- After night shift I am either going to sleep or living my own life and then going to sleep at around 5 or 4pm.

What are the benefits or advantages of night shift work?

- Quiet.
- Double pay.

What are the disadvantages of night shift work?

- Your body and mind hurt.
- Sometimes is difficult to manage all your things in the right way. After night shift you come home, you need to sleep but I have heard of other people who say that they cannot simply sleep…the day has started, the sun is shining, and the body does not understand why is needs to sleep instead of doing something.
- If you live with your partner then you come back home when you are coming back, you do not see each other…or he comes back from work and you are sleeping before the night shift.
- I like flexible schedules; the rotating shifts have that benefit that you can always change and not have to be fixed to a certain routine that might get boring or too rigid.

<u>DURING THE SHIFT</u>

Do you have any kind of structure for the project times during the night shift? E.g., When do you take a break, eat or how much coffee do you drink?

- If I feel very tired during the shift and my eyes are closing, I would rather go to sleep for 30 minutes then I would try my best to be up until 7am. But some people say that they prefer to not sleep because when they wake up, they feel worse, but for me a power nap is better, helps me to recover.
- I am trying to get rid of coffee, it does not help me, it makes me sleepier.
- I do not like eating during the night.

How do you usually feel during the night shifts?

- My body feels alright, nothing changes.

What do you do when you feel tired?

- Take a nap.
- If I cannot take a nap I go to the kitchen and drink a cold glass of water, this makes me feel that I am awake again.
- I prefer to have lights in the room, is better for my eyes. If I only have three screens working in darkness would make me feel worse.

What is in your mind once the shift is over?

- To call a taxi.

<u>AFTER THE SHIFT</u>

What do you do when you get home after your shift?

- From September until the beginning of December I had classes starting from 8am, sometimes I had night shifts and I went to school after the shift. I could not sleep, had breakfast at the office and went to school and then home at around 12pm.

- This was really tough. When the shift was over, I thought "oh, well I'm fine, I will survive" but when it gets close to 8 am in the morning and the class is starting, you start to lose your mind and cannot concentrate. In those moments I just left the class because I could not stay anymore. "I talked to my teacher that sometimes I have to work over night, and they understood and said that is fine if I go home to rest".
- When I started working (2 months of work), after the night shift I used to go swimming, it was good that I did physical activity in the morning, then I lived my own life and went to bed at around 4 or 5pm. I felt better but at some point, I stopped because I felt that my body cannot do it anymore, I am feeling very exhausted, not feeling good. But I regret about this decision because now I am feeling even worse, I do not have enough physical activity anymore in my life, so I am trying to put this habit again into my daily life, but it is hard.
- I decided to the physical activity in the morning because if I did sleep in the morning and woke up at 2pm I feel that my whole day is cut, I feel that I would just go to the gym and then the day is over…if I would go to the gym I would come back home to rest, go to meetings and then I would go to sleep. I would feel that my day is still day.
- I am this kind of person who feels that when the morning is started, I cannot sleep, I rather do something during the day and go to bet at around 4pm. Even if I have another night shift, I do this. If it is my last night, I would go to sleep at around 7,8 or 9pm depending on how I am feeling and what I have to do during that day.

Do you feel well rested after sleeping during the day? Do you feel different?

- I feel well rested after sleeping during the day.
- I also tried to not sleep at all between night shifts, but it was worse to not sleep at all, I try to sleep at least three hours.
- The best options of which I have tried, the best one is to go to sleep at around 4 and do some physical activity during the day.

What happens with your sleep pattern after the night shifts?

- If I have two nights is difficult to come back to normal sleep hours, the body cannot understand that you want to sleep at 6 but it is actually time to work. Is hard but manageable.

Is there anything that you think could help you to sleep better?

- Maybe to take vitamins.
- Listen to relaxing music.
- Meditation.
- I had a lot of stress some months ago and when I was looking for the reason of why I am so stressed out I realized that are the night shifts which are affecting me.

Janus / Full time worker

<u>BEFORE THE SHIFT</u>

Since when have you been working in shift work type of job?

- Three months.
- I have done previously shift work when I was up until the night.

How do you think that the rotating shifts type of work affect your life?

- It does affect my life but not in the most catastrophic way, I do not know how much it affects my life, but I am sure it does to some extent.

Do you think that having rotating shifts including night shifts has affected your sleep quality?

- Sure. Yes, I think so.

What do you think about the night shifts?

- They are not the worst thing; they are not the best thing. But I know that my work quality is worse during the night. I make more mistakes.
- I know my threshold is until 4 am and everything after that time is miserable. Because even in my days off I go to bed very late, so I know that 4am is my limit. In my free days I do not have a certain time when I go to bed.

How many night shifts do you have every month and how many of those in a raw?

- 4 or 5 every month, 2 or 3 in a raw.

How do you get ready for the night shifts?

- I do what we were thought during the training, I sleep in the evening before the shift from 7pm to 11pm, two sleep cycles before the shift, I try to get that.
- I eat dinner before sleeping.

What are the benefits or advantages of night shift work?

- None, cero compared to normal shifts.

What are the disadvantages of night shift work?

- You cannot concentrate as well.
- Make more mistakes.
- Less productive overall.
- Not focused at all.
- No way you can have a team meeting at night. So, the chances of being more productive than you normally would be are halted because the whole company is not here at night.

<u>DURING THE SHIFT</u>

Do you have any kind of structure for the project times during the night shift? E.g., When do you take a break, eat or how much coffee do you drink?

- I do not have a structure; I just do not sleep.
- I have never been in a situation when I am so tired that I need to take a nap.
- I am bad at sleeping in strange places like car rides or planes. If I would take 15 minutes break during the night shift and go to sleep, I would probably sleep until the end so there is no point.
- I like to have lights on when I am watching the screens, I do not mind talking. When the morning comes, I wish it would still be quiet, so no shift would come before I leave, people come and start talking and take away my sleep, I am energized because of that.

What do you do when you feel tired?

- I read stuff online, nothing too serious.

<u>AFTER THE SHIFT</u>

What do you do when you get home after your shift? / How many hours do you sleep after the night shift?

- Usually, I go to bed and sleep for like 4 hours if I have another night shift coming.

Do you feel well rested after sleeping during the day? Do you feel different?

- If I sleep or not after the night shift either way is horrible.

What happens with your sleep pattern after the night shifts?

- If I sleep during the day will be hard to fall asleep at night.
- To come back to normal, I sleep for 24 hours. I get to bed at 8am, I sleep for a few hours, the wake up, lay down to watch something and then go back to bed. Just the first day after the night is very hard, but after 24 hours is ok.

How do you think your sleep could improve after the night shifts?

- Not having dreams. But that is a different issue.

Is there anything that you think could help you to sleep better?

- I do not have time to exercise at the moment.

Appendix 6 Summary of interviews

Andrew and the shift work:

Andrew has been working for six months as a rotating shift worker, he usually has two- or three-night shifts in a month which he says is not a big problem but still has a *"weird"* effect on his body, it affects his sleep patterns.

Andrew usually goes to sleep at around 2 am and sleeps six or seven hours every night and refers to a struggle to keep awake during the night shift.

Before the night shift Andrew struggles to sleep, *"It is usually hard to sleep during the day", so he manages to sleep only two or three hours. He ends up rolling in bed, "to sleep five hours during the day is almost impossible".*

The advantage and motivation of the night shift for him are better to pay, as a disadvantage he says *"It has a turn on your health definitely, I believe you need sleep and the best time to sleep is at night. The night is when I prefer sleeping, not day. If you cannot sleep it messes up. There is a certain way I feel, I feel feverish"*

During the night shift, he takes breaks *"…usually the best is to stand up once in a while and walk around. I do not like coffee, but I do not have a choice it has to be a lot, I have to get coffee to keep myself awake. Sometimes maybe when I am well rested and*

not stressed, I can go on without the coffee, I try to listen to music. My type of music is African kind of songs with a lot of beats."

Andrew does not eat during the night shift; he usually eats before leaving home to work. For him *"every night shift is very different, the days preceding the night shifts, let us say two days before…have a very strong impact on how the night shift is. Imagine I have not been rested in like two days before the night shift, or if I have slept very well, your body is going to find it so hard."*

When he is very tired during the night shift, he considers the option to take a nap *"… maybe for like 30 minutes, as a power nap if it is that serious."* When the night shift is over the only thing in his mind is to go to bed, which is what he does once he gets home and eats breakfast after waking up. He sleeps around five hours when the lights are dim, when there is bright light is hard to sleep.

After the daytime sleeping his body feels abnormal, *"is not the same as sleeping during the night but is more or less ok, not so bad"*. To come back to the normal sleeping schedule, he sleeps from 8:00 until 13:00, and then that night he goes to sleep at around 00:00 or 1:00. *"Is ok for me to fall asleep, I sleep very well, straight up is the environment is quiet"*, he finds easy to fall asleep and to come back to the regular sleeping schedule since it is just a few night shifts.

Andrew rates his sleep quality as very good, what he finds hard is to wake up early, *"I prefer to sleep until 8 but if I have morning shift is very hard. My favorite shifts are brunch and evening. My hardest shift is night, but it's ok because there is an incentive"*.

Mo and the shift work:

Mo has been working as a rotating shift worker for one a half month, he has no previous experience as a night shift worker but has worked in a bar where the shifts were from 17:00 to 2:00.

For Mo, working as a rotating shift worker requires extra planning to have social events, when he has the evening shift and finishes work at 18:00 he feels there is no time for himself, he is already tired and cannot do much after work. When he has a morning shift after a brunch shift the day before he finds it hard to wake up.

Mo says that his sleeping quality has not been adequate before starting to work as a rotating shift worker, but it has gotten worse, and has not had proper sleep for at least a month. He thinks that fixed shifts helped him to have a sleep pattern.

Another aspect affecting his sleep quality is that he spends three or four hours lying in bed just scrolling on his phone screen, then he wakes up the next morning and his eyes are still tired *"…I have to come to work and spend 8 hours in front of three screens"*.

He thinks is easy to work during the night as he is not a morning person and has the whole day before to sleep, he goes to sleep the night before at around 3:00 or 4:00 *"…for me it's easier to wake up in the afternoon than in the morning, I struggle to wake up in the morning. For example, wake up at 17:00, have breakfast, and also eat something at 21:00 or 22:00."*

Staring at the screen for 8 hours makes his eyes more tired during night shifts than during morning shifts because when is daytime there is natural light coming through the windows*,"…the all-night-long screen light makes my eyes very tired"*. To mitigate this, he uses an application on his computed which regulates the screen brightness and color depending on the time of the day. At the moment of the interview, it was around 18:00 and his screen looked very yellow, this helps his eyes to get less tired, he says.

During the night shift he sets his work schedule depending on how he is feeling, he usually feels sleepy and to keep awake drinks coffee.

After the shift he goes to sleep right away, *"…Sometimes I find myself sleeping with shoes on, I think that will sleep like for five minutes and end up waking up at 5 pm."* He sleeps around 9 or 10 hours, for him is easy to sleep during the day, and wakes up feeling well.

Mo considers that to improve his sleep quality he should decrease the time he spends in from of screens, *"…the blue light emitted from screens tricks the brain and makes it think that is daytime. I even have a blue light filter, it helps a bit but is still not enough, what I should do is to turn it off and fight the temptation. The screen use is like an addiction, nowadays you even get these phantom vibrations, it's difficult."*

If he had better plan it would help, he does not follow the recommendations from the night shift training given in the company, he does not use an alarm. *"Is hard to follow these suggestions because work is not the only thing in our lives."*

Lea and the shift work:

Lea has been working as a shift worker since 2017, initially, she was working from India for a company based in the USA, the reason why all the workers in this company had to be on the evening shift (17:00-2:00) or night shift. The periods for these shifts were usually 8-10 months night shift and 3-4 months as evening shift.

This type of work affected deeply her health. After two months of starting her shift work type of job she had gained a lot of weight, started to suffer from migraines, had hormonal disorders (linked to weight gain and facial hair).

Her social life was also affected, lost contact with most of her friends since everyone had a different schedule and they just could not count on her for meetings, also when receiving messages or things happening during the day she missed because she was asleep. Her closest friends and family remained but it was still hard to keep in contact. For instance, when there was a family meeting, she had to prepare for that one week in advance so that she would have enough sleep during the previous days and be able to participate and be socially engaged.

Lea´s sleep quality has been affected by the night work, especially when was working in her previous job she was never well-rested and she and her workmates could never sleep 7 or 8 hours during the day, the average was 5 hours, and this is not enough *"…having to sleep during the day is never the same as during the night. There is noise from everyone else who is awake and a lot of light which is never totally covered by the blackout curtains."*

She thinks that the longest the periods of night shifts, the more harmful is the effect on the health, and from her experience, the body does not catch up on sleep if she doesn´t get it over night. Even with a better pay rate, the night shift is something she would not go through if it was her choice.

To prepare for the night shift Lea sleeps in the morning before the night shift, for example, instead of waking up at 6:30 she would sleep until 11:00.

During the night shift, she knows that will get very tired at around 3 am, so she tries to divide her tasks in a certain way so she would be able to take a nap if needed. She has taken a one-hour nap because she thinks is better than a shorter one, but later tried to drink a coffee, then take a power nap (20-30 minutes) and she felt much better after that. From her experience she knows that coffee is better to drink during the day and tea during the night, it helps to keep awake (caffeine) and is less harsh on the stomach. She tries to have a light environment for work and watch documentaries of funny videos to keep awake.

When she is exhausted her sight starts to be blurred, migraine can appear after a few days of having a night shift. To lessen the negative effects of the night shifts, Lea takes breaks, drinks tea, and takes a nap if necessary.

After the night shift she usually brushes teeth and goes to bed right away, she can sleep a maximum of 5 hours during the day and does not get adequate rest, after waking up the body is still tired and sometimes migraine might start for her.

To come back to a normal sleeping schedule, it usually takes her one or two weeks, she does some physical activity, goes for long walks that would exhaust her body so that she will be able to fall asleep the next night. She has a general feeling of being tired, has very low energy to perform simple tasks like making lunch. For Lea is very helpful to have a partner who can support her.

Nia and the shift work:

Nia has been working as a rotating shift worker for seven months, she thinks that it has negatively affected her eating schedules, sleep patterns, and social interactions*. "The quality of my sleep is not the same because my body can't get used to a certain schedule. Sometimes I have to sleep during the day when there is light and it is not so easy, and during the wintertime sometimes you do not even see the daylight/natural light for two or three days and this starts to affect*

Nia lives with her partner and considers this as a bigger challenge since the changing schedules also affect him, she says, *"…some days my boyfriend has to wait several hours for me to wake up when I have had a night shift or when I leave to morning shift, I don't see him and even sometimes the next day I have evening shift and I can't see him until midnight. So, we cannot see as often as we wish even though we live together. The rotating shifts can be very chaotic."*

Nia understands the necessity of shift work for the nature of the work, but physically is something that she does not want to go through, *"…if I take them is because they are part of my responsibility and economically are good, but they affect me a lot. Usually, after the night shifts, it takes me a few days to feel good again, to come back to feel well because it affects my organism, my stomach goes crazy, my eating and sleep schedule rotate, everything changes."*

Nia usually has two-night shifts in a row, in one occasion she was scheduled for three nights, at the third night went back home feeling sick and couldn't even hold herself up on her feet, *"I thought that I was just exaggerating but with the time I have noticed that during the first night is something I can cope with, in the second night I start to feel dizzy and bad, even if I sleep before the shift."*

For Nia, it would be ideal that morning, brunch, and evening shifts were grouped monthly, for night shifts (in the case of having four in a month) they should be

distributed two nights in a row and as far from each other as possible giving time to the body to recover. After a night shift, take a day off and the next shift should be the evening shift, so the schedule starts to change gradually. E.g., Morning shift, then brunch shift, then evening shift and night shift and it also comes back from the night shift, to evening shift, brunch shift, and then morning shift.

Before the night shift Nia tries to sleep at least two hours, it depends on her previous day's schedule, sometimes her brain is very active until 00:00 and the night shift starts at 23:30, when she is not able to sleep just lays down or watches something that reliefs the stress and ideas in her mind. She also makes food for the night; she knows that will get hungry at around 3:00.

During the night shift Nia tries to have artificial lights directly on her desk, this prevents her from getting a headache and from feeling exhausted. She also works standing up, listens to happy music, and even dances*, "If I am sitting next to a friend is also good to have conversations, is like if we are encouraging each other to keep awake and make the shift nicer." Nia tries to avoid activities that involve reading or monotonous activities, sometimes she watches funny videos to keep awake, also drinks water constantly "…from my university time I got used to drink a lot of water when I was up doing homework, and it helps."*

On occasions of extreme exhaustion, she has taken one-hour naps, interestingly it has happened during the morning shift at around 8:00 or during brunch shift at around 15:00. During night shifts are very rare for her to take a nap because she might not wake up or it would be very stressful, as during the nights there are not as many workers as during the daytime. The last two hours of the night shift are the hardest, she is heavily prone to fall asleep, her eyes are tired, she feels thirsty and with a heavy stomach *"My stomach is so heavy that I can't control it."*

When she gets home after the night shift, even though she is exhausted, it usually takes her 30 minutes or one hour to fall asleep because her mind is still thinking about work. *"Is not the same as a normal work schedule when you have time to do other activities after work and disconnect your mind from it, in this case, you have to work, disconnect quickly and then force yourself to sleep, this is hard for your body."* To read helps her to fall asleep but sometimes her eyes are too tired for reading, she then looks at the phone for a while and eventually falls asleep.

Nia finds it difficult to come back to the normal sleeping schedule, *"I can't force my body to sleep immediately…what I do is to go to sleep very late. Let us say the first night after the shift I would try to go to bed at 3:00, the second day at 2:00 and the third*

one (when the next day I have to work), I try to make it to bed at 00:00, but it all depends on how my body feels. Sometimes I have a morning shift and my body doesn't let me fall asleep until 4 am and then I have to be at work for 7 am and I am exhausted."

Nia considers that for the night shift the office´s light conditions can be improved, adequate food can be provided, training about nutrition related to the night shift, and also to make activities during the night, for instance, a meeting at 4:00 to check out how everyone is coping with the night.

Kate and the shift work:

Kate has been working as a rotating shift worker for nine months, the constant change in her work schedule has harmed her physical and mental health.

The rotating shifts have completely changed her life, she now has to plan her personal life around work, *"is hard to have a routine where I can do my activities if one day, I have morning shift but the next one brunch shift, then I have to do my activities before work."*

Kate can cope with the night shift if she manages to sleep before, nevertheless, when having night shifts is hard to stay awake especially after 3:00 or 4:00 when is exhausted, but still has to push herself. Her sleep quality has been dismissed considerably, and her sleep is more sensitive after started to work as a rotating shift worker.

Kate usually has two or three night in a row, when she has three nights is challenging *"…on the third night I couldn't even understand where I am and what I am doing, I had to sleep all day and then come back to work, I would say that three nights is the maximum."* During the nighttime, the office is very quiet, Kate enjoys having a less stressful environment and a better pay rate.

To prepare for the night shift Kate usually sleeps before from 18:00 to 22:30, during the night shift she does not drink coffee, does not eat and in case of feeling very tired, she drinks a glass of cold water or takes a power nap of 30 minutes.

After the night shift Kate either goes to sleep or goes on with her day as usual and goes to sleep at around 18:00 or 17:00, it can be hard to sleep during the *day "…the day has started, the sun is shining, and the body doesn't understand why it needs to sleep instead of doing something."* Kate is also a student, on many occasions, she went from the office to university, *"…when it gets close to 8:00 and the class is starting, you start to lose your mind and can't concentrate. In those moments I just left the class."*

When Kate started working, after the night shift she used to go swimming, at some point she stopped because felt that her body could not do it anymore, she was exhausted. She regrets this decision, by not going to exercise after the night shift is feeling even worse, she does not have enough physical activity anymore in her routine. If it is her last night shift, she would go to sleep at around 19:00 to 21:00 depending on how tired she is feeling.

Kate has tried different ways to cope with the night work, she has slept in the morning after work, she has tried not to sleep at all but her best option is to exercise in the morning, do other activities during the day, and go to sleep at 16:00 when having another night shift or between 19:00 to 21:00 when is the last one.

She has suffered from stress due to shift work and tries to improve her sleep quality by taking vitamins, listening to relaxing music, and meditating.

Janus and the shift work:

Janus has been working as a rotating shift worker for three months, he thinks it does affect his sleep quality, but he is not sure to what extent. He knows that his performance is not the same overnight, he makes more mistakes. His threshold is at around 4:00 *"…everything after that time is miserable. Because even on my days off I go to bed very late, so I know that 4:00 is my limit. In my free days, I do not have a certain time when I go to bed."*

Janus works four to five-night shifts every month, two or three in a row. To prepare for the night shifts he does what the company thought during the night shift training, he eats a light dinner and sleeps from 19:00 to 23:00.

He does not see any benefit by working during the night, but knows the disadvantages as he cannot concentrate well, makes more mistakes, can´t focus, is less productive, and also is unable to have team events since the majority of the company is absent.

During the shift, Janus does not have any structure, tries not to sleep since is hard for him to sleep in strange places, and also thinks that would sleep through what remains from the shift. It feels more comfortable to have lights on when working as he is watching screens, to keep awake he does not mind talking or reads light articles online. When the morning shift staff comes, he would rather the office to keep quiet since he gets energized and loses his sleep.

After the night shift Janus sleeps for around four hours, having slept or not after the night shift, he feels horrible. If he sleeps for too long it will be very hard to sleep at night when wanting to come back to a regular sleep schedule. In that case, he gets to

bed at 8:00, sleeps for a few hours, wakes up, watches something, and then goes back to bed. The first day after the night shift is hard but after 24 hours he feels recovered.

Appendix 7 Ideal journey map to promote Sleep Hygiene in rotating shift workers

Due to the size of this map, it is provided as an individual file linked to this document.

Appendix 8 Interview's journey maps

Due to the size of this map, it is provided as an individual file linked to this document.

Appendix 9 Interview's matrix of co-relation

Due to the size of this map, it is provided as an individual file linked to this document.

Appendix 10 Shorthand map

Due to the size of this map, it is provided as an individual file linked to this document.