



THE WINDOW TO RELIEF

Reducing collective stress at the office

Industrial Design
Eindhoven University of Technology
Final Bachelor project

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ABSTRACT

Most of our adult life is spent working. Office work is a sedentary indoor activity which is a cause for stress. Stress is said to decrease mental and physical wellbeing and. Being in contact with nature is proven to be a good way to relief stress. To achieve the best result, this experience has to be as close to a "wild" natural environment.

The Window to Relief is an interactive ceiling light that introduces a seemingly natural experience into the workplace The system uses a sensorial pillow on the chairs of workers to measure their collective stress level. When the stress level increases, the ceiling light will provide a more intense natural experience.. The aesthetics the sound and the feel of the window with vegetation moving behind, raindrops falling and natural sunlight if found to decrease the stress of the workers at the office.



Figure 1: Working beneath the Window to Relief

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Figure 2: Visualization on the Window to Relief

INTRODUCTION

Figure 3: Exploring nature

INTRODUCTION

We live in a world with constant stimuli and “noise” around us. This is due to the environment we live in, information technology, and the way we work. This causes a lot of stress in modern people. Reducing this stress is crucial for the psychological wellbeing of office workers (Ahmad Hassan, 2018).

The majority of an adult’s life is spent at work, which happens almost exclusively indoors for people working in an office. Here there are only more stimuli and less opportunities to release your stress (Agnes E. van den Berg, 2007). When this becomes too much, the wellbeing of the workers is harmed as stress is related to severe mental and physical conditions. This will also affect their work since prolonged stress can cause a decrease in concentration and the most common reason to take on sick days (Nasar, 2014). This in turn will affect the company and their fellow employees. Therefore, reducing psychological stress experienced by office workers is a vital challenge for organizations.

In this final bachelor thesis project the stress-relieving effect nature has on humans is used to address this challenge. Contact with indoor plants during office hours is said to relief the build-up of stress (Min-sun Lee, NCBI, 2015). However, this is still a human-controlled natural attribute. Interaction with “wild” nature is said to help relief this stress even more effectively (Matsunaga, 2021). Therefore, nature is the medium through which the stress reduction will take place since this is a widely validated stress reducer.

Furthermore, collective stress related coping is said to be a more effective way to individual coping. For this reason, this kind of stress related coping is further investigated in this project.

Therefore, the design question is formulated as such: *“To what extent can a seemingly “true” natural experience in the office both reduce collective stress and be a visualization of the collective stress level as measured in the office?”*

By introducing a seemingly “true” natural experience into the office, the aim is to reduce the stress of the workers, due to our biophilic nature. The idea that humans have a inherent love for nature (William Browning C. R., 2014). Furthermore, the Window to Relief offers a visualization of the collective stress level of the office workers to help them reflect on this and take action accordingly. This combination of adaptive lighting, a natural experience and visualizing real-time stress data should help improve their individual and collective wellbeing as less stress will be experienced at the office.

RELATED WORKS

Figure 4: Nearby inspiration

RELATED WORKS

Working a job is a great part of most adult's lives. This brings positive effects to the lives of the workers, however it is also associated with negative health issues such as stress. This is the most frequent reason to take on sick days at office jobs (Nasar, 2014). Psychological stress has multiple negative effects on humans and can contribute to severe medical conditions (Bjørnstad, Patil, & Raanaas, 2016). Many physical and mental illnesses are related to chronic stress (Hansmann, Hug, & Seeland, 2007). Stress is defined as: *"A non-specific response of the body to any demand placed upon it, which arises when there is an imbalance between demands in life, such as those related to work, and the coping resources available to an individual"* (Nasar, 2014).

In recent years, the environment we surround us with has shifted from outdoors to indoors. More than 95% of an average life is spent inside (Hassan, et al., 2018). (Berg, Hartig, & Staats, 2007) States that modern-day urban environments are unsuited for the human being, as it can put excessive psychological demands on them. This is mainly due to noise, population density and the lack of nature.

Another development that contributes to rising psychological stress is the advancement of information technology. This create a high amount of stimuli to deal with throughout the day. The information technology has made us connect to a tech environment instead of the natural environment (Min-sun Lee & Juyoung Lee, 2015) (Hassan, et al., 2018). This is illustrated for example by students, who spend most of their time on online studies. This behavior has seen another big increase during the COVID-19 pandemic and is cause for excessive screen time from students and office workers (Majumdar, Biswas, & Sahu, 2020). This increase in digital activity has many negative effects on the normal activities of the brain. Excessive online behavior is associated with poor health, sleep problems, bad personal relations, and a lower quality of life (Hassan, et al., 2018).

In 2019, 94% of the US office workers reported to suffer from psychological stress at the workplace. Where 29% reported to experience excessive stress (Hansen, 2018).

Rachel and Steven Kaplan (Kaplan & Kaplan, 1989) proposes in their Attention Restoration Theory that our direct attention is finite which makes it vulnerable to depletion. When this is over-taxed, stress will occur as our brain is not able to hold concentration whilst we want it to. The theory states that: *"contact with nature indirectly relieves the build-up of stress associated with loss of fatigue"* (Matsunaga S. A., 2021).

A proven way to reduce the excessive stress is with the stress-relieving effect of the natural environment. Contact with vegetation helps to relief psychological stress (Min-sun Lee & Juyoung Lee, 2015). The calming effect of nature has been researched and verified widely in recent years. As interaction with plants is an intuitive and nonverbal activity, it can provide comfort and psychological stability. Interaction with plants is said to help with moods and enhance mental wellbeing, enhance job satisfaction, and reduce stress (Min-sun Lee & Juyoung Lee, 2015).

This is also due to the reliance humans have on nature for emotional, mental, spiritual, and physical needs (Hassan, et al., 2018). This is not only psychologically validated but also physiologically beneficial, whilst too much stress can damage the sympathetic nervous system (Min-sun Lee & Juyoung Lee, 2015).

Nowadays, many employers promote vitality in the office to counteract stress. One approach is to change the environment by for example letting in more daylight or adding vegetation (Nasar, 2014). The Project 2 report by Joost Buining and Yinying Miao states that: *“architectural elements such as providing sufficient sunlight, green space, and open space help workers to cope with stress”* (Buining & Miao, 2020). The satisfaction of employees with the work environment is mainly associated with the quality of indoor and physical aspects (Samani, Rasid, & Sofian, 2017). Bringslimark (2011) found that office workers with windowless offices have a five times higher chance to compensate by bringing in office plants compared to windowed offices. The authors suggest to implement this to make natural design for workers, spending much of their time indoors (Bringslimark, Hartig, & Patil, 2011), since indoor nature contact at work is associated with significantly less mental job related stress (Bjørnstad, Patil, & Raanaas, 2016). Research into the view out of a window associates views on vegetation with better overall health compared to office workers with a view on an urban environment. Furthermore, individuals experiencing more stress have even greater psychological benefits from views on vegetation (Ulrich R. S., 1986). This was measured by the level of alpha activity in the brain and suggested the least stress with a combination of plants and natural lighting, which had positive effects on the blood pressure and emotions (Nasar, 2014).

This domesticated, indoor nature is proven to reduce stress. However, as this is placed and controlled by humans, this is perceived to be not completely “real” nature. Therefore, the soothing effect it has on humans is less compared to contact with wild nature (Matsunaga S. A., 2021). Creating a seemingly “real” natural experience for the office is far more uncommon but is recommended to do more research into

This study by Matsunaga shows how foliage movement by wind helps reduce stress of hospital patients and staff. Furthermore, water movement caused by wind is known to decrease stress by observants and there is also evidence showing this to boost concentration.

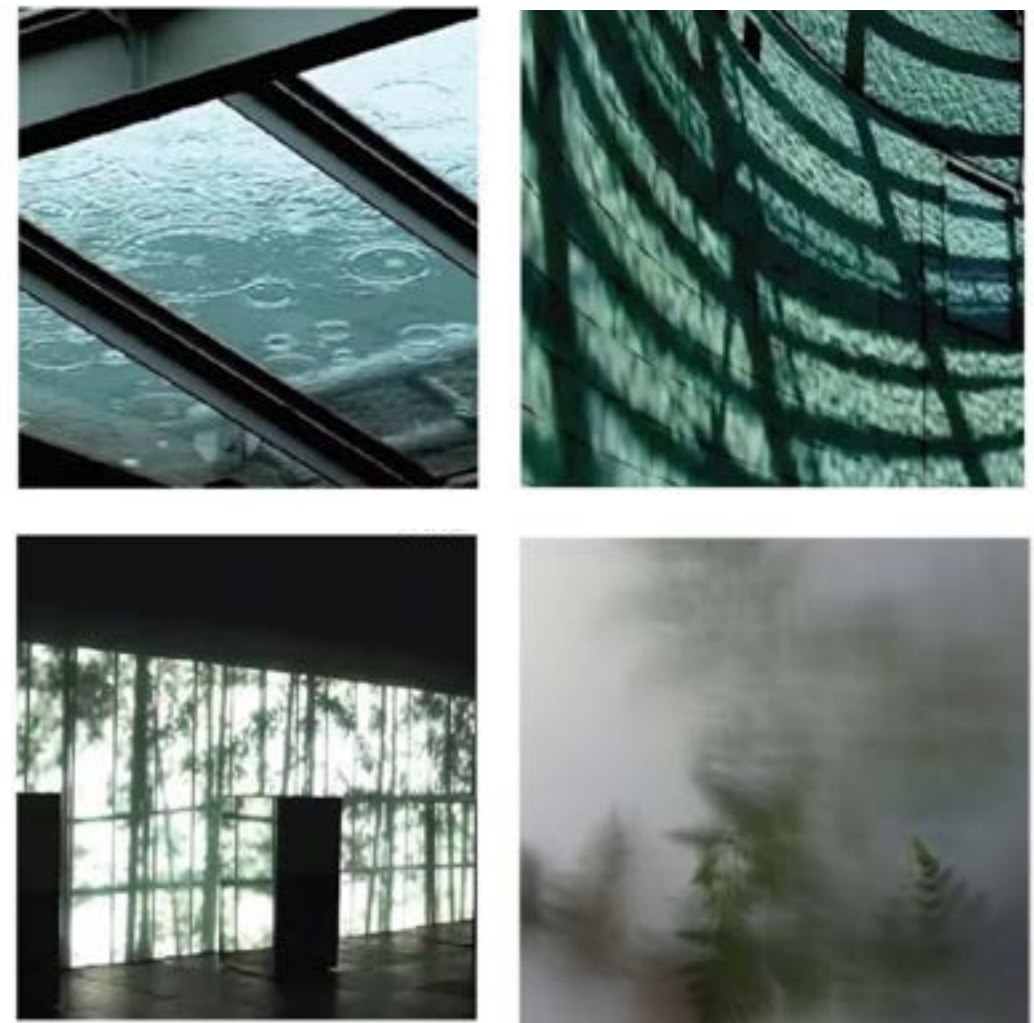


Figure 5: Matsunaga S. A., (2021). Natural exploration. Scholarspace. <https://scholarspace.manoa.hawaii.edu/bitstream/10125/75891/Matsunaga-hawii-0085A-10980.pdf>

The design as suggested in this case is placing foliage plants behind windows. As the privacy had to be taken into account, the glazing had to be matte.

The soothing effect of nature occurs due to Biophilia which is our inherent inclination to identify with nature (Matsunaga S. A., 2021). This effect is due to evolutionarily adaptation natural elements are critical for humans survival and well-being.

The restorative qualities of environments are concluded in four aspects for stress relief:

- Extent (the scope to feel immersed in the environment)
- Being away (providing an escape from habitual activities)
- Soft fascination (aspects of the environment that capture attention effortlessly)
- Compatibility (individuals must want to be exposed to, and appreciate, the environment) (Hansmann, Hug, & Seeland, 2007)

To use the benefits biophilia can offer in design, 14 patterns of Biophilic design are defined to mimic nature in design. These describe the relationship between human, the natural environment and design (Interface, 2016). *Biophilic design can reduce stress, enhance creativity and clarity of thought, improve our well-being and expedite healing* (Browning & Clancy, 2014). The 14 patterns are divided into three categories. Nature in space, natural analogues and nature of space (Browning & Clancy, 2014). These are described in more detail in the design iterations section. Furthermore, the aesthetic pleasantness of the natural environment is described in six principles where depth is considered as being most significant (Ulrich R. S., 1983).

As mentioned before, sufficient amounts of daylight or bright light are proven to be stress reducers. Furthermore, longer exposure to bright light could alleviate winter-bound symptoms due to the lack of longer periods of light during the winter months (Partonen & Lönnqvist, 2000). Nature-based installations are able to alleviate this season-bound health problems. Further studies on how to design such installations are recommended (Patil, 2014).

Similarly to vegetation and daylight, a stress-relieving effect can be achieved by forest-derived auditory stimulation, which can induce physiological and psychological relaxation effects (Jo, et al., 2019). The results affirm that natural sounds improve health, increase positive affect, and lower stress and annoyance. The natural soundscape helped to destress whilst anthropogenic sounds have an opposite effect (Buxton, Pearson, Allou, Fristrup, & Wittemyer, 2021).

Furthermore, audio is a great way to facilitate frequent shifts from the center of attention to the periphery for interactive systems. There are nowadays many interactive systems in our center of attention during the day. Therefore, it is desirable for some systems to be within the periphery, as this will not take up more attention. These systems then could come into the center of attention when this is relevant. (Bakker, Hoven, & Eggen, 2014).

When designing for a stress reduction at offices, Leffler (1997) suggests to focus on collective problem-focused stress coping. This was found to be more effective compared to individual or co-active coping.



INTRODUCTION TO THE PROCESS

According to the iterative design process a planning for the semester was made. Four iterations would be completed in this project, from which one would be a pressure cooker. Each iteration exists out of five parts, planning and requirements, analysis and design, implementation, testing and evaluation and review (Martins, 2021). These are repeated each time taking up more time to be able to go more into detail. The pressure cooker was opted for to get a feel for the project, discover some possibilities and see which kind of ideas would be fitting to the project. The further part of the planning was based on research into iterative design process planning, and experience. The process overview can be seen in Figure 7.

Figure 7: Process overview

PRESSURE COOKER

Figure 8: Pressure cooker ideation

SECOND ITERATION

The second iteration started by collecting information by visiting Ahrend, the client. Ahrend is an office furniture company who specializes in vitalizing workspaces. Afterwards, more in-depth research into the subject matter was done. Four main topics were identified into which research was done:

- the cause of stress in the office
- what are proven de-stressors
- previous projects
- planning

The identification for proven de-stressor would be the foundation for the ideation phase which followed. The chosen de-stressors were:

- (micro) breaks
- Change of environment
- Nature
- Reflection
- Breathing
- Sleep
- Exercise

IDEATION

Based on this the 50 sketches challenge was initialized (Appendix A). The ideas were both made completely by myself and in collaboration with others. Most ideas were also based on the idea of intervening when the collective stress level of the office workers would rise, which would be measured by a cushion on the chairs of the office workers. This pillow already exists.

To get a better overview of all the ideas, the most promising ideas were grouped and from this three concepts were derived and created, by combining the most important aspects of some of the ideas (Figures 10, 11 & 12). The concepts will be shortly elaborated discussed.



Figure 9: Low-fi prototype

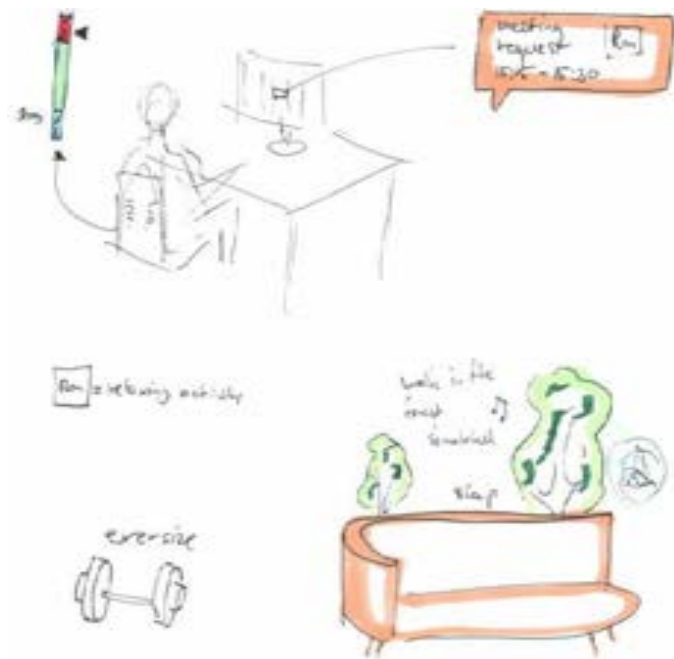


Figure 10: Relax meeting

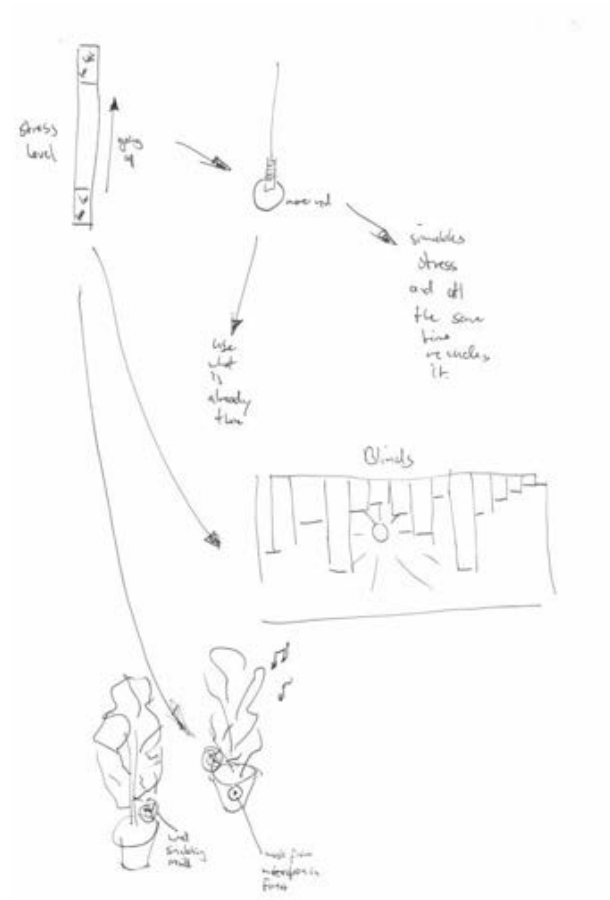


Figure 11: Nature inside

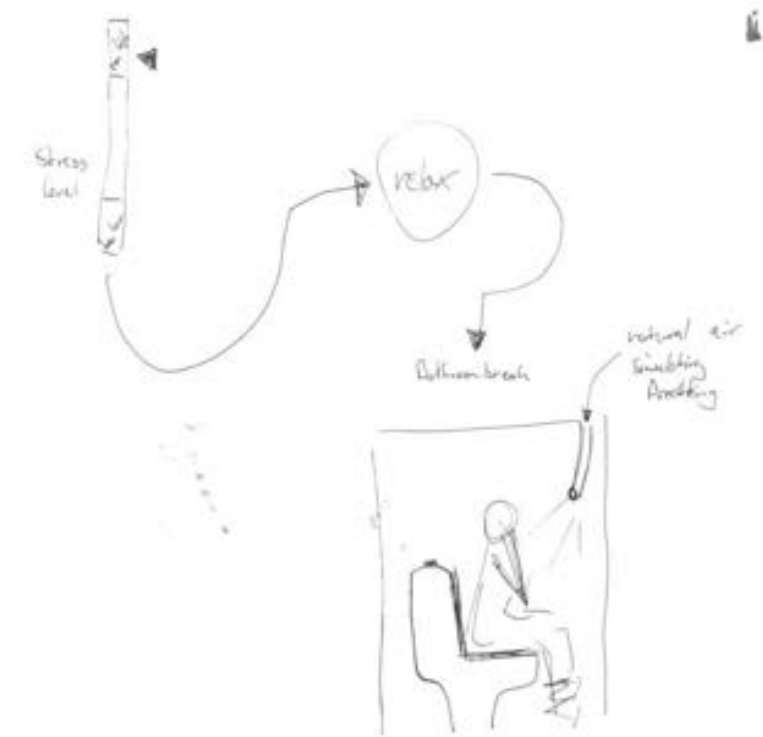


Figure 12: Private relax

The concept relax meeting is based on the idea that relaxation during work is not culturally accepted in westerns countries. To still enable people to do so, Relax meeting sends an anonymous meeting request to a person who's stress level is high. Now this person can go to a room to relax, whilst his colleagues think he is in meeting. In this room a forest environment could for example be simulated to help relax as is illustrated in the sketch.

Natural inside is based on the idea of creating something which would be both a visualization of the collective stress level in the office and simultaneously reduce the collective stress of the workers. The reduction of the stress is done by introducing a seemingly natural experience into the office. For example by opening up the blinds of making plants move in a breeze when the collective stress level is high.

For private relax, a moment was chosen, which everyone experiences at the office and where there is no distraction by work, the toilette. In the toilette a device would be stationed to help relax. For example a wind generator to help have a calm breathing pattern.

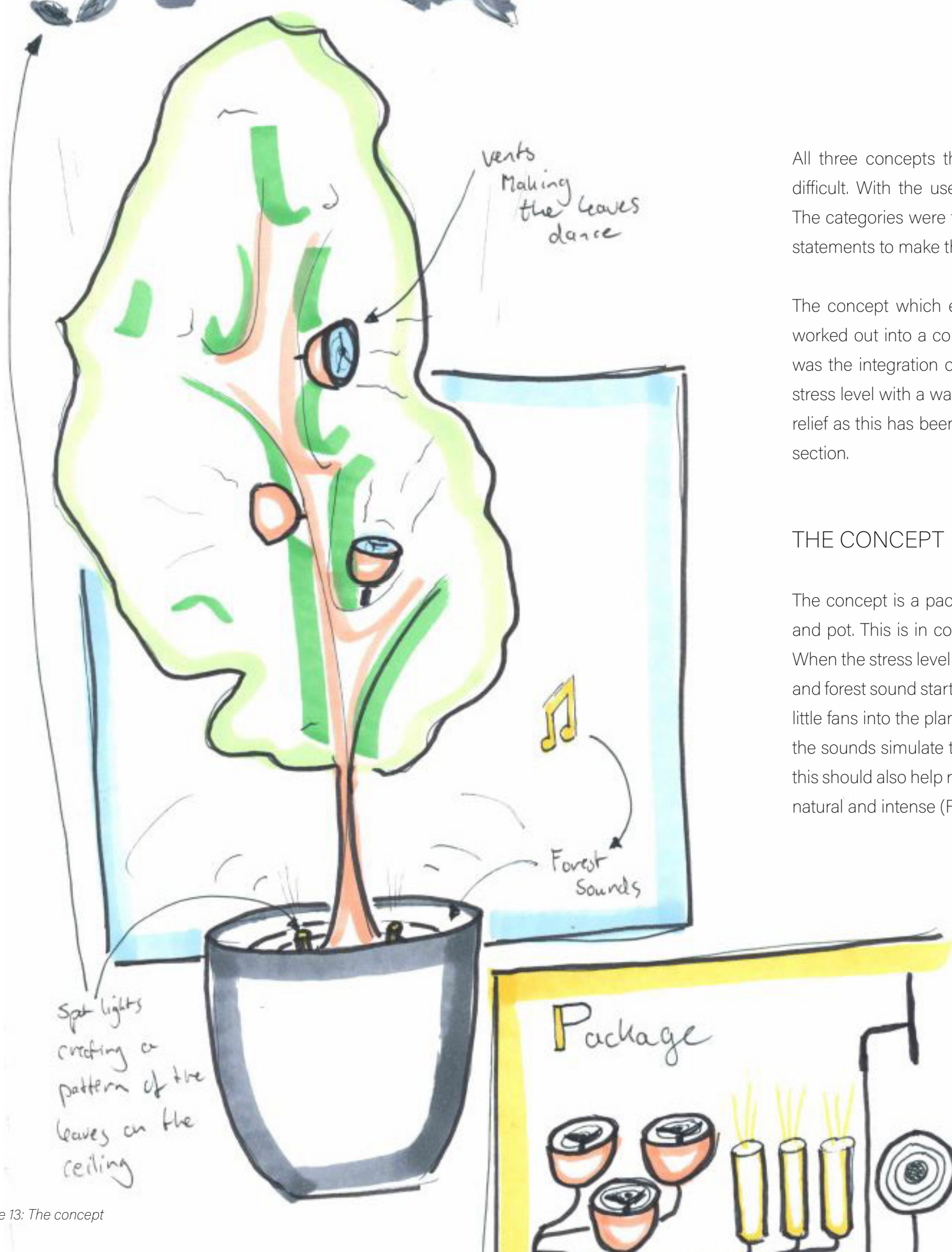


Figure 13: The concept

All three concepts thought to be interesting and therefore choosing one was difficult. With the use of a decision matrix, one idea was picked (Appendix B). The categories that were used in the matrix were mostly based on my own statements to make the most coherent concept combined.

The concept which eventually came out on top was natural inside, which was worked out into a concrete product. The main point which made this interesting was the integration of simultaneously presenting a visualization of the collective stress level with a way of reducing this. Furthermore, nature was chosen as stress relief as this has been proven to do this well, as is described in the related works section.

THE CONCEPT

The concept is a package of products which should be added to an office plant and pot. This is in connection with the cushion which measures the stress level. When the stress level rises, the plant will slowly start to move like a breeze picks up and forest sound start to come from the pot of the plant. This is achieved by placing little fans into the plant and a speaker into the pot. The intensity of the breeze and the sounds simulate the amount of collective stress measured in the office, whilst this should also help relief stress because the nature experience seems to get more natural and intense (Figure 13).



Figure 13: Smaller fan implementation



Figure 14: Larger fan implementation

IMPLEMENTATION

This concept was made into a low-fi prototype to be used for testing. Three parts had to be made, the plant, the fans and the speakers. Multiple fans were tested. Eventually the biggest one was found to be the best as this one made the most leaves. The smaller fans create almost to no movement of the leaves (Figures 13 & 14). A plant and speaker were collected to complete the prototype.

TESTING

The main objective of the user test was to find out more about the effect the moving foliage has on stressed user (Figure 15). The test and results are more described in detail in the methodology and results section. The most important results are summarized here:

- The users that were actually stressed did not notice the soft bird sounds, the others did.
- The foliage movement was experienced as calming by some.
- Bird sounds were experienced as calming.
- Telling the workers they are working hard instead of having too much stress did not help to create more stress.

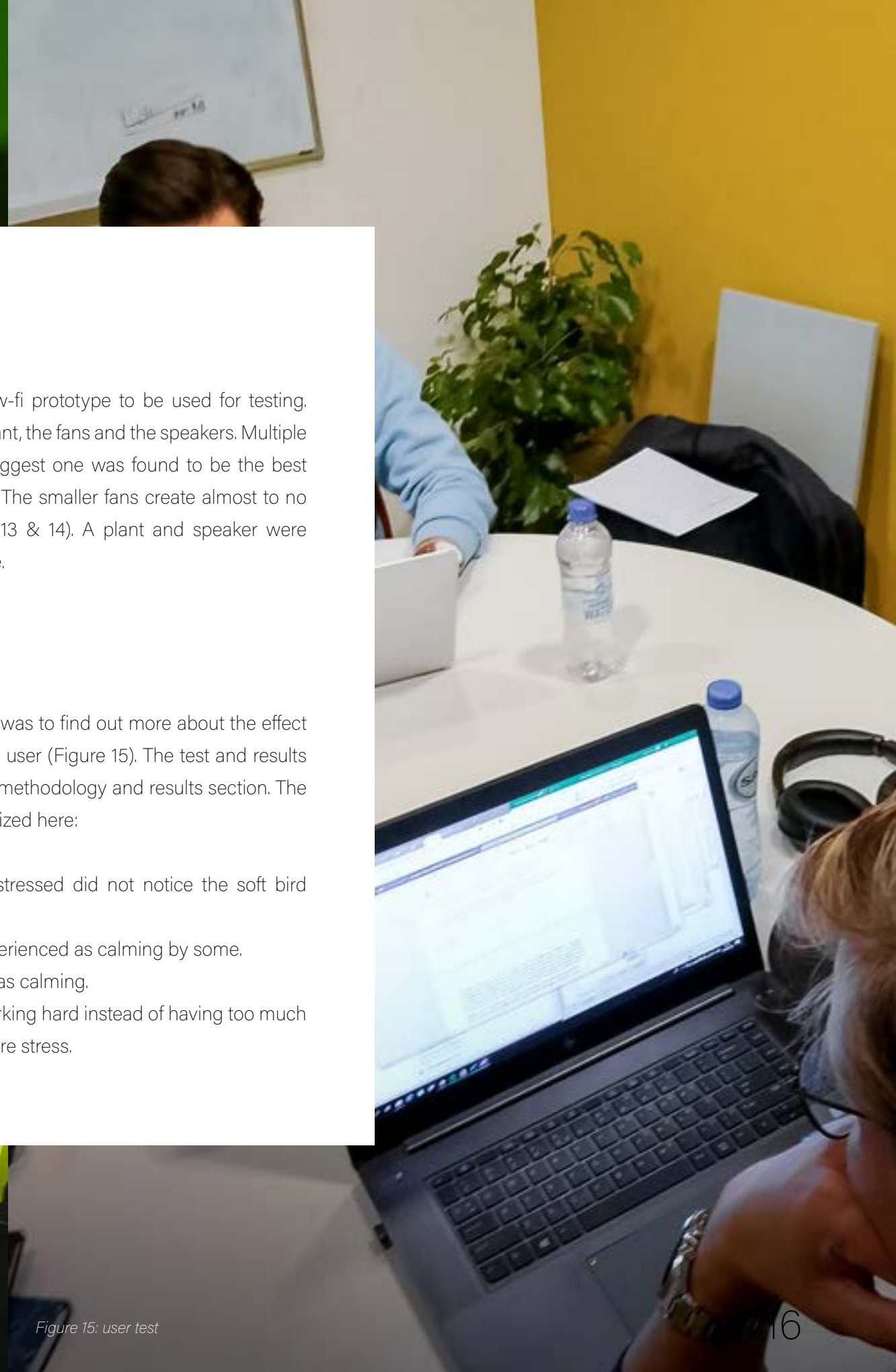


Figure 15: user test

EVALUATION

The results of the user test were evaluated and translated into design objectives. These combined with the evaluation of this iteration resulted in these objectives:

- Use nature as main de-stressor.
- Make something which presents a visualization of the collective stress level and reduces it when the stress level rises.
- When users are more stressed they need a more intense experience to be notable as they are more focused.
- Bird sounds are experienced as calming.

THIRD ITERATION

The third iteration started again by making the planning and requirements. Further research was done into more specific areas concerning the design objectives as defined in the prior iteration. The main topics were:

- Nature and its general effect on humans
- The effect of natural movement on stress
- The effect of nature sound on stress
- Prior projects

The main findings can be summarized as follows: humans experience stress due to the amount of stimuli to take in daily. Nature reliefs the build-up of stress caused by the aforementioned. The more natural the experience is, the better it reliefs stress. The most revitalizing natural experiences have four characteristics:

- Extent
- Being away
- Soft fascination
- Compatibility

Here soft fascination is considered to be essential (Hansmann, Hug, & Seeland, 2007). Wind generated movement in for example foliage or water makes a experience more natural and has a positive effect on stress as is described in the related works section.

These findings combined with, the cumulative knowledge gathered from prior research and the user tests, were translated into new design objectives, being:

- Create new environment/experience (being away)
- Make it immersive (extent)
- Make it Attractive (soft fascination)
- Use nature sounds
- Stimulate taking a break by simulating stress level

IDEATION

Based on these objectives, ten improved concepts were worked out (Appendix A). From this the best three ideas were further worked out (Figure 16, 17, 18). The concepts and their considerations will be shortly elaborated on.

The HIT desk is a zone in a flex office for stressed people, which is called high intensity working area (Figure 16). This is based on two prior described principles, namely, being surrounded and being in a new environment. At this desk the different working spots are separated by plants, moving in the wind (fans), based on the stress level of the people sitting at the table. This should simulate a natural experience, much more than for example some plants in the office. When the workers are done with their high intensity task (stress), they can go to another area.

This concept is a lot like meeting to relax, which is a concept described prior in the process. The difference is that in the "relax room" there are plants, sounds and projections simulating a nature experience, also by using wind (Figure 17).

The window to relief brings a seemingly extensive nature experience into offices (Figure 18). It is a lightbox, simulating a matte window with plants moving in the wind behind it. This should give the impression of having a window in the office with real nature behind it. Also vague nature sounds are incorporated, like they are coming from outside. The wind moving the plant and the sounds will pick up when the collective stress level of the workers rises, to calm them again by making the nature experience more intense. This is also a reflection moment for the workers as they see their collective stress level rise which will make them aware of it and could help them take action.



Figure 16: HIT desk



Figure 17: Relax meeting

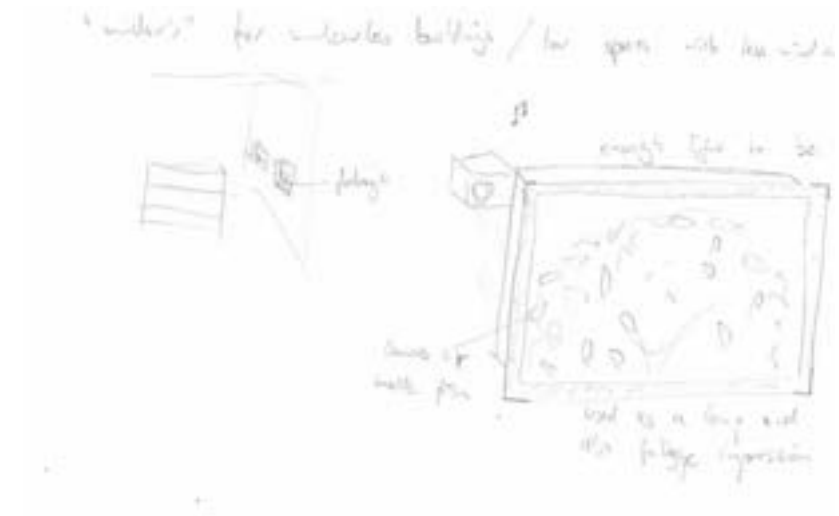


Figure 18: Window to Relief

To choose one, a decision matrix was filled in using the same categories as before as the design challenge was still valid (Appendix B). The result was in favor of the window to relief, however this was not satisfactory without a good reasoning. Therefore other squad students were asked about their opinion on the concepts. Eventually the choice was made simpler and could be divided into two different kind of solutions. The meeting to relax was more a cultural projects, as this focusses on the social acceptance of taking a relax break at work. In this case nature is only a tool, whilst the window to relief and HIT desk focus on the direct influence of nature. The difference in window to relief and HIT desk are that the first is more of an abstract visualization simulating a seemingly more natural experience, whilst HIT desk is a "in your face" natural experience. With this reasoning a pros and cons list was made to finally end on the window to relief as concept.



Figure 19: Inspiration: the sight i wake up to



IMPLEMENTATION

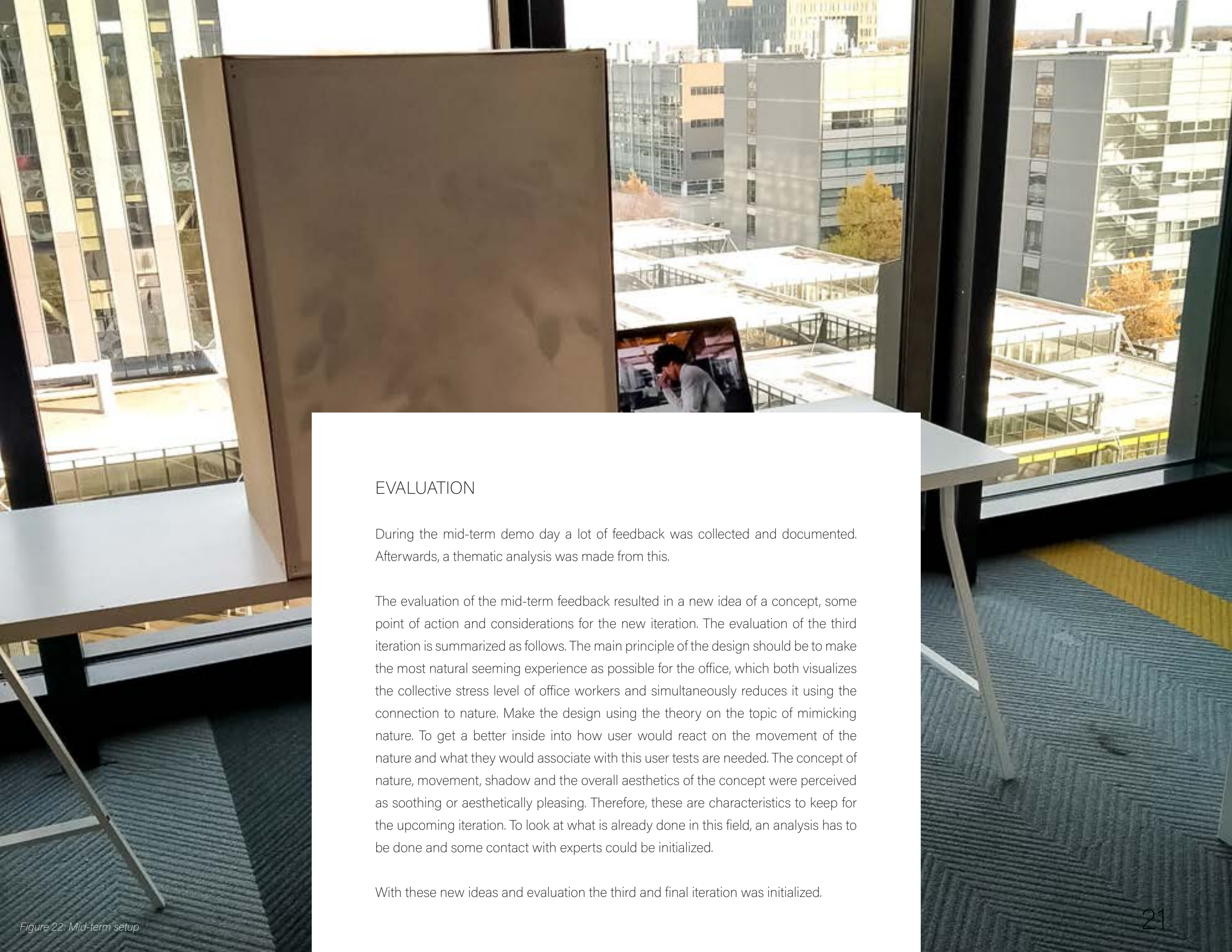
The prototype will be a frame with the canvas on the front and wood on the sides. Inside there should be plant, a light shining from behind the plant on the canvas, fans moving the plant and a speaker making forest sounds. Before realizing this, Technical drawing and requirements were made. The dimensions were chosen to be equal to that of a small window. The frame had to be quite deep, to make a plant fit in it and put a light behind it to create a shadow in the canvas. This was all realized into a working prototype.

The fans were the only thing not going as planned for the prototype. The small fans which were hooked up to a circuit did not create enough airflow to make the foliage move. Therefore, there was opted for a usual cooling fan.

Figure 20: Detail of The prototype



Figure 21: *The Window to Relief*



EVALUATION

During the mid-term demo day a lot of feedback was collected and documented. Afterwards, a thematic analysis was made from this.

The evaluation of the mid-term feedback resulted in a new idea of a concept, some point of action and considerations for the new iteration. The evaluation of the third iteration is summarized as follows. The main principle of the design should be to make the most natural seeming experience as possible for the office, which both visualizes the collective stress level of office workers and simultaneously reduces it using the connection to nature. Make the design using the theory on the topic of mimicking nature. To get a better inside into how user would react on the movement of the nature and what they would associate with this user tests are needed. The concept of nature, movement, shadow and the overall aesthetics of the concept were perceived as soothing or aesthetically pleasing. Therefore, these are characteristics to keep for the upcoming iteration. To look at what is already done in this field, an analysis has to be done and some contact with experts could be initialized.

With these new ideas and evaluation the third and final iteration was initialized.

FOURTH ITERATION

The fourth iteration started with defining requirements and making a planning. The requirements are combined in the design question for this iteration: *To what extent can a seemingly natural experience using shadow and movement both reduce collective stress in the office and be a visualization of the collective stress level as measured in the office?* Furthermore, 6 design requirements were made, to which the design should adhere to:

1. To the most extent adhere to Extent, Being away, Compatibility and soft fascination
2. To the most extent adhere to the 14 patterns of biophilic design
3. Incorporate natural movement simulating the stress level and relief stress simultaneously
4. Be aesthetically pleasing/soothing
5. Be a complete designed (intelligent) system
6. Be interesting to business (simple and attractive solution with different configurations)

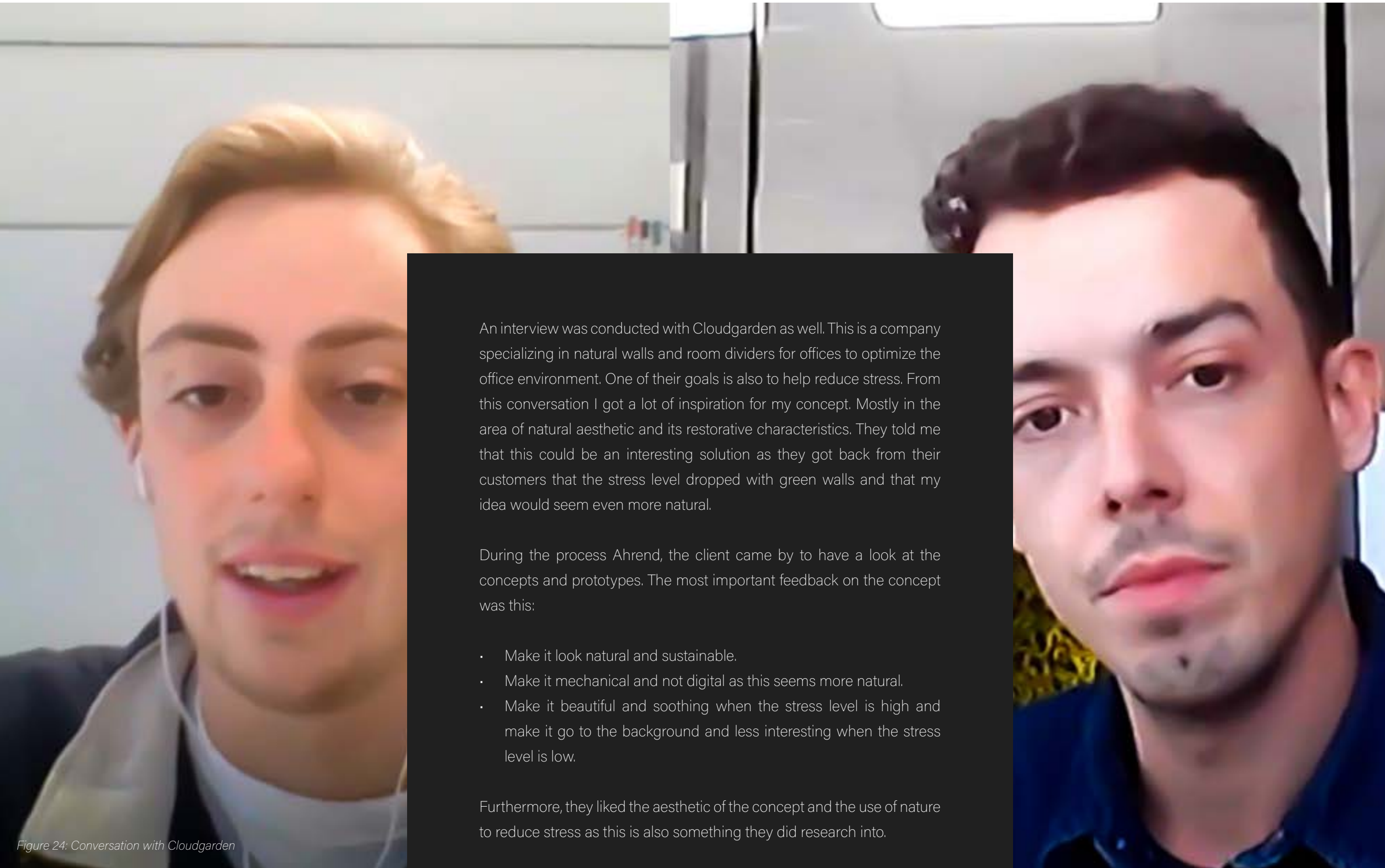
With this in mind the initial planning was revised and improved where necessary.



Some research objectives were defined to start new research, both book research as well as talking to experts and users. These objectives were:

- What exactly in nature makes it soothing (attractive)
- What prior work is done in this area and what can I learn from it

With these objectives in mind, three experts/companies were approached, all from the mid-term feedback and my own experience. Bart Bongers, doing an internship at Philips signify, Cloudgarden, a company specializing in green walls for offices and Ahrend as my partner. First of all, Bart was contacted, he didn't want to give away too many details about the project as this was all confidential. However, he told me about the 14 patterns of biophilic design helping to create a natural experience in design and said to do empirical research on nearby nature to get a better feeling for it.




An interview was conducted with Cloudgarden as well. This is a company specializing in natural walls and room dividers for offices to optimize the office environment. One of their goals is also to help reduce stress. From this conversation I got a lot of inspiration for my concept. Mostly in the area of natural aesthetic and its restorative characteristics. They told me that this could be an interesting solution as they got back from their customers that the stress level dropped with green walls and that my idea would seem even more natural.

During the process Ahrend, the client came by to have a look at the concepts and prototypes. The most important feedback on the concept was this:

- Make it look natural and sustainable.
- Make it mechanical and not digital as this seems more natural.
- Make it beautiful and soothing when the stress level is high and make it go to the background and less interesting when the stress level is low.

Furthermore, they liked the aesthetic of the concept and the use of nature to reduce stress as this is also something they did research into.

Figure 24: Conversation with Cloudgarden



Besides doing expert interviews, a user test protocol was made to test some of the uncertainties in the design. The test consisted of two parts. First test is about what people feel and associate with more or less movement of the leaves and accompanied sound. The second test was about what kind of movement of the leaves would increase or decrease the stress level of the workers and to define a movement threshold. More on the method is explained in the method section.

The most important findings are described as: there were certain movements perceived as being calming, others not significantly. Furthermore, movement over a certain threshold was associated with taking a break. This could be implemented when the stress level would be way too high and an intervention is needed to reduce this again. Furthermore, most users indicated not to immediately understand that the stress level was connected to their stress level. Therefore the users thought it to be good to tell the users link between the stress level and the movement to make it a clear reflection moment for them.

Further Book research was conducted into the topics:

- Biophilic design
- Nature in office environments
- Attractiveness of nature

The main findings will be summarized here. Biophilic design helps to reduce stress, boost creativity and well-being. There are 14 patterns of biophilic design which show the relationship between human, nature and design. By using these, the benefits of biophilia can be experienced through design. Biophilia is the human nature to love living natural systems. More on the patterns is explained in related work. For this project these are relevant:

- Visual Connection with Nature: Conveys a sense of time, weather and other living things
- Non-Visual Connection with Nature: hearing, feeling, smelling, tasting
- Non-Rhythmic Sensual Stimuli:
- Indoor: kinetic facades (facades with moving elements that can be seen from corner of the eye), interactive design displays
- Outdoor: swaying grasses, falling water and the buzz of passing insects
- Presence of Water
- Dynamic and Diffused Light
- Connection to Natural Systems Awareness of natural processes, especially seasonal and temporal changes characteristics of a healthy ecosystem
- Biomorphic Forms and Patterns
- Material Connection to Nature
- Complexity and Order
- Prospect An unblocked view
- Mystery
- Risk / Peril

These patterns are all incorporated in some form into the project. More on this can be found in the related works section.

Furthermore research was done into the topic of human attraction to nature. These six characteristics were found to conclude this. Therefore these should also be incorporated into the project as much as possible (Hansmann, Hug, & Seeland, 2007).

- Complexity
- The complexity is structured to establish a focal point
- There is a moderate to high level of depth that is clearly defined
- The ground surface has even or uniform length textures that are relatively smooth
- A deflected or curving sightline is present
- Judged threat is negligible or absent



Figure 26: Ahrend (n.d.). Biophilic design. Ahrend. Retrieved January 10, 2020, from <https://www.ahrend.com/en/expertise/biophilic-design/>



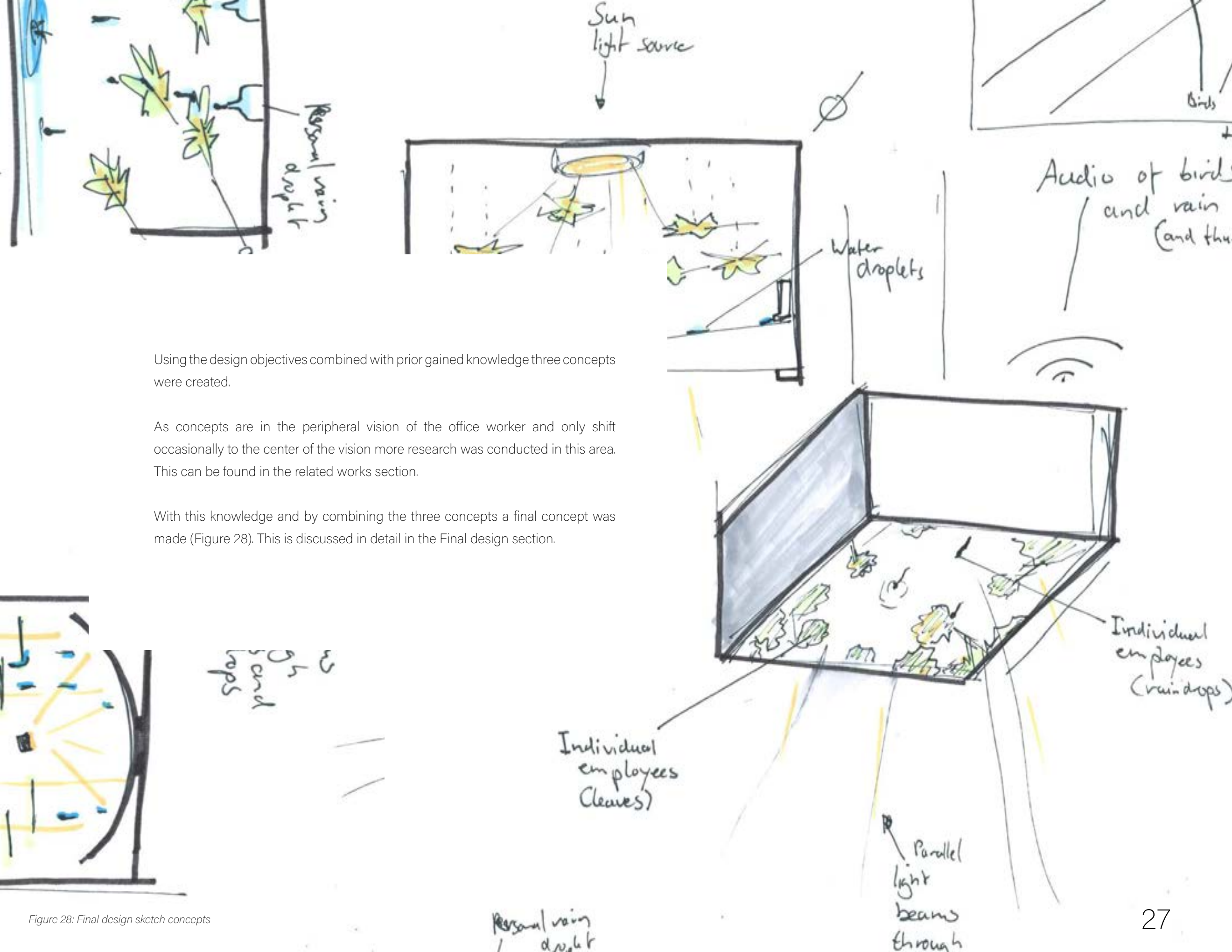
Figure 27: Co-design session

IDEATION

A co-design session was needed to get external input as letting go of the original idea was hard. The objective was to get more ideas inside the defined scope of the process and get user input into what would help them relief stress using nature and what this would look like. The co-design session was based on the method of issue cards. More on the method is elaborated on in the method section. With the method used, the outcome of the co-design session would be a complete concept using nature as a stress reducer and simulator of the collective stress level. Each concept would be based on design principles and multiple individual ideas. The results are elaborated on in the results section.

In total ten co-creation sessions were conducted (Figure 27). All final designs were gathered and a thematic analysis was made of all the different features and characteristics of the designs. These were translated into design objectives. These being:

- The visualization of the collective stress by showing all individual stress levels in a similar form factor (for example: multiple trees combined are a forest)
- Multiple time periods. Different layers in the design respond differently to the collective stress level by taking up more or less time
- Intervene when the collective stress is too high by going over a certain threshold
- The use of movement and shadow



Using the design objectives combined with prior gained knowledge three concepts were created.

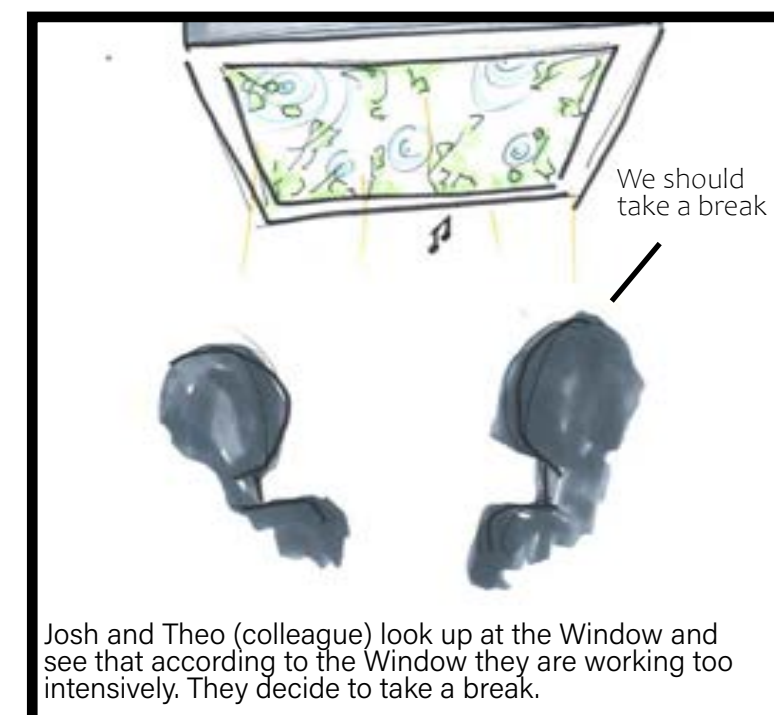
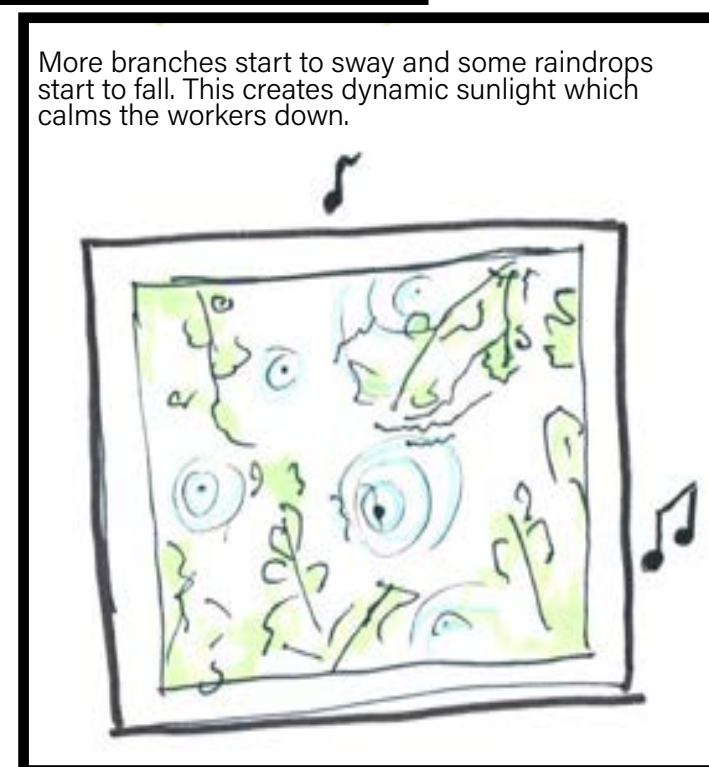
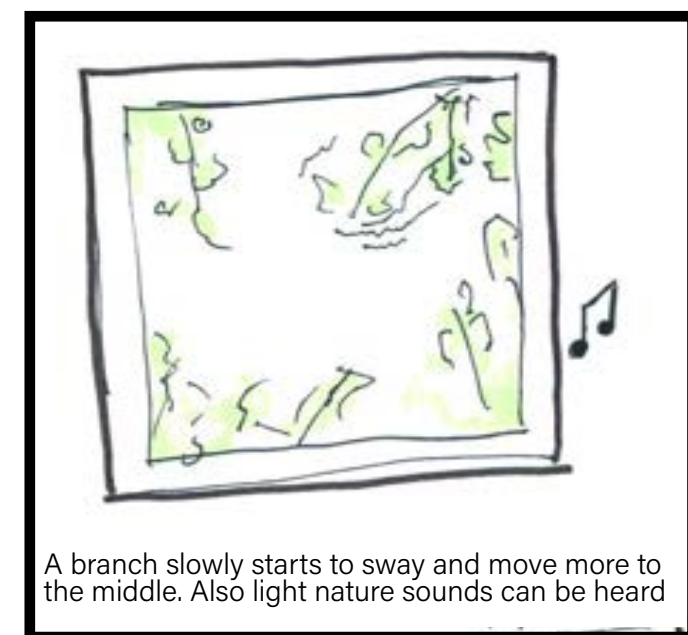
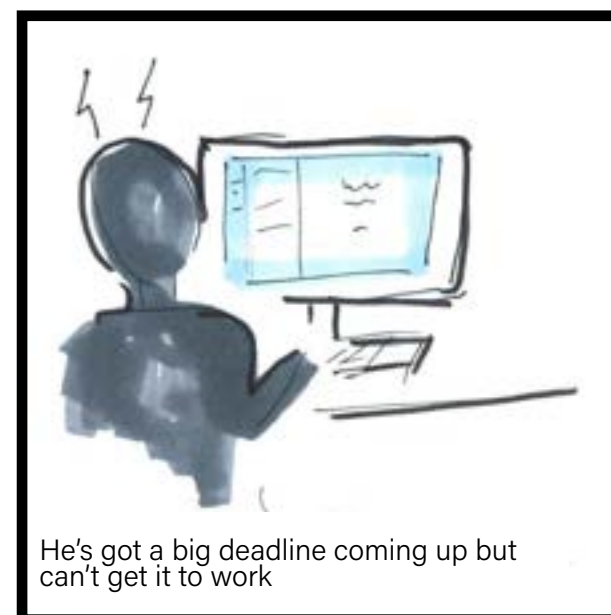
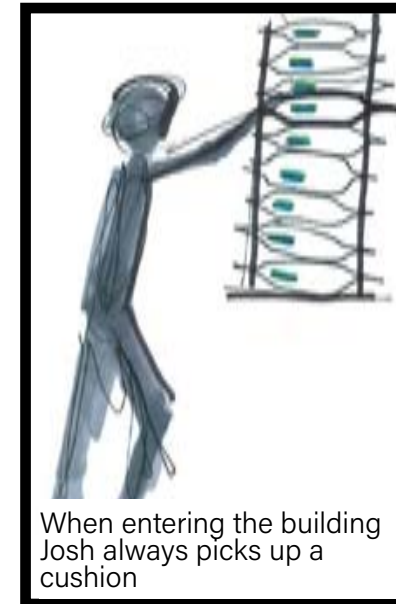
As concepts are in the peripheral vision of the office worker and only shift occasionally to the center of the vision more research was conducted in this area. This can be found in the related works section.

With this knowledge and by combining the three concepts a final concept was made (Figure 28). This is discussed in detail in the Final design section.

Figure 28: Final design sketch concepts

FINAL DESIGN

Figure 29: Window to relief Visualization






FINAL DESIGN

The window to relief is a way to help office workers relief their stress by both creating a seemingly natural experience for the workplace and by giving the office workers a reflection moment on their collective stress level. As nature is a proven stress reducer and the more natural the experience seems, the faster it helps relief stress, this is used to calm office workers. The window to relief is a "natural" light panel simulating a ceiling window through which you can look to the outside. Behind the window there is a seemingly natural world. With foliage moving, raindrops falling, birds chirping and natural sunlight. This "world" is there to help the office workers de-stress and concentrate better, leading to a better collective wellbeing.

Each individual's stress level is measured by a cushion on their chair. All stress levels of a department or office are gathered. Each cushion is linked to a branch in the window to relief. When an individual's stress level goes up, the associated branch will slowly start to move more to the middle of the window. This subtle movement and dynamic lighting created by the leaves have a calming effect on the office workers.

A blurred background image showing a person's silhouette in the foreground, looking out a window at a bright, cloudy sky. The person's head and shoulders are visible on the right side of the frame, looking towards the left. The sky is filled with soft, white clouds. The window frame is visible as a dark horizontal line across the middle of the image.

All branches together can be seen as a tree, which forms the visualization of the collective stress level. When office workers notice many branches swaying and are closer to the middle they could have a reflection moment on their collective stress level being high. It is up to them to take action. As the collective stress level rises, so does the volume of the bird sounds. This is necessary as you notice less when having more stress. When the collective stress level (the average of all stress levels) is very high over a longer period of time, it starts to rain softly and the bird sounds stop as the rain sounds take over. This makes the nature experience more intense and more natural whilst both having a more calming effect. When the collective stress level is over a threshold, an intervention is needed to help calm the office workers. The goal is then to move the window from their peripheral vision to the centre of their attention. In order to achieve this, the light in the window starts to flicker and thunder sounds can be heard. This intense experience triggers a response of reflection and is often perceived as a sign to stop work for a moment and take a break for example.

Figure 31: Someone looking up at the Window

Figure 32: Looking up at the Window



DESIGN PRINCIPLES

When the final design was made, it all had to be worked out to a working prototype. This was done by doing research into building techniques, creating drawings, testing, and by talking to experts.

The main design objective for the window to relief was to create the seemingly most natural experience possible to help the office workers to release stress. The design is therefore based on the 14 principles of biophilic design, the natural restoration principles and natural attractiveness characteristics. These are the biophilic patterns that were used (Browning & Clancy, 14 patterns of Biophilic design, 2014):

- Visual Connection with Nature: (rain, thunder and wind)
- Non-Visual Connection with Nature: (bird, rain and thunder sounds)
- Non-Rhythmic Sensual Stimuli: (falling water and water ripples)
- Presence of Water (rain)
- Dynamic and Diffused Light (sunlight, dynamic through leaves, water and diffused by glass)
- Connection to Natural Systems: (change in weather)
- Biomorphic Forms and Patterns (shape of leaves and rain drops)
- Material Connection to Nature (wooden outside)
- Complexity and Order (complexity and order of leaves)
- Prospect An unblocked view (seemingly depth by not seeing the end)
- Mystery (vague view)



Figure 33: Frame



Figure 34: Working of the lighting solution

TECHNOLOGY AND REALIZATION

The first thing the final prototype was built around was a light source emitting light mimicking sunlight as much as possible. When sunlight hits the earth, the light beams are parallel (negligible on an angle). Therefore, a light source had to be created which would emit parallel rays. An old TV antenna dish was used as this is made to do exactly the same, however with a TV signal. When a light source emits light into a parabolic object whilst being exactly at the focal point, the returning light will be parallel. The TV antenna dish was covered in reflective film to make it reflect the light. To match the colour of the sunlight a light source with the same warmth was chosen, this being 5900k.

Another aspect of sunlight which is challenging to mimic, is that it travels through the sky, which gives the light different characteristics when it hits the earth due to particles scattering the light. Therefore, opalescent glass was chosen through which the light will shine. Opalescent glass shares the same characteristics as the micro particles through which sunlight gets scattered in the sky. This effect is called the Tyndall effect (Gregersen, n.d.). Therefore, this was used as the glass panel in the bottom of the box which also functions as water reservoir.

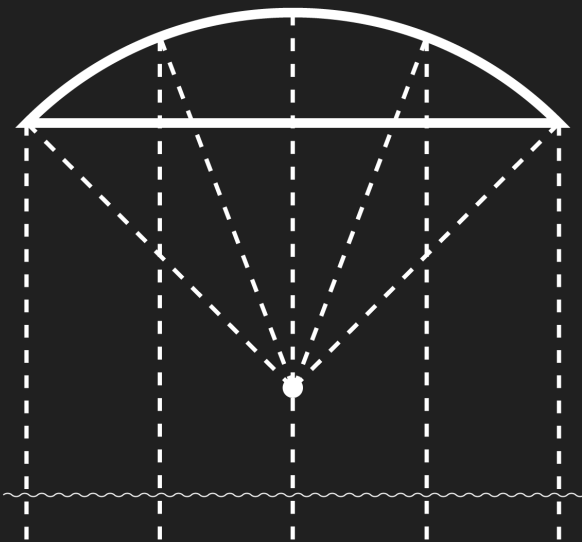


Figure 35: Technical illustration of the lighting solution

For the branches behind the window a construction was made using servomotors and hinges to make them move (Figure 36). When mounting a branch directly to the servomotor, the torque would become too big. Therefore, a hinge was used to which the branches were attached to be moved by a servo. This system was mounted by a quick release system to be able to show also the possibility of there not being branches. This is further explained in the Value proposition section.

To simulate real rain, a system was made to move the water upwards and release it. This was done by using the opalescent glass as a water reservoir. The water was pumped through a pipe network through multiple holes in the TV antenna dish where it would be released into the water reservoir again. The water pump is activated when the collective stress level is above 7 and will pump more water each step the collective stress level rises. (The code for the branches and the rain can be found in Appendix H)

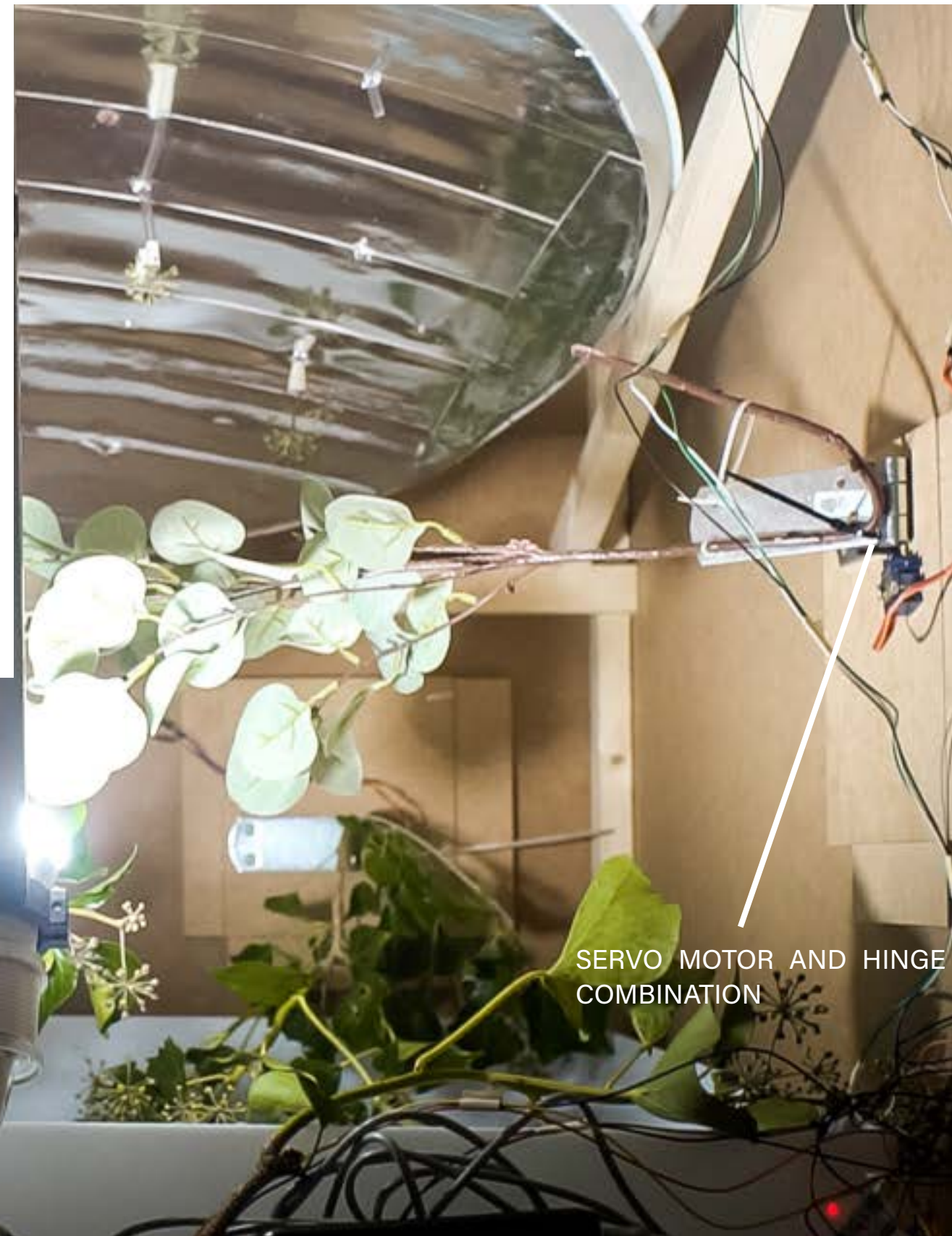


Figure 36: The inside of the Window



On the input side of the project, the collective stress level was measured using a cushion. This cushion was not used in the demo as peers who worked with it said it to be unstable and they were unable to work with it properly. However, the imagined use will be explained here.

The cushion has multiple vibration sensors in it which measure the heart rate, heart rate variability (HRV) and respiratory rate. The HRV is needed to determine the stress level. A low HRV score indicates stress of the nervous system whilst a high HRV indicates a relaxed state (Kim, Cheon, Bai, Lee, & Koo, 2018). The cushion's output however works on an inverse scale. The output is a score between 250 and 550. The lowest value, 250, indicates a relaxed state, whereas the highest value, 550, indicates a high level of stress. To read out the cushion, it first needs to be connected to a local network using an app. Then, it can be connected and read out by the code in processing (Appendix H). To get a more constant HRV value, a moving average was used in the code. To get usable data a mapping between the cushion's output and HRV was created. The final output, being between 250 and 550, could be mapped to a 1 to 10 scale in Arduino IDE. This gave all stress levels as used in the code for the demo.

However, as mentioned due to the unstable nature of the cushion the connection with the window was not made.



Figure 38: Interaction with the Window to Relief

VALUE PROPOSITION

Figure 39: Demo day setup



Figure 40: Tomas Vykruta (2019). Why CEOs Should Avoid the Open Office Trend <https://tom-vykes.medium.com/why-ceos-should-avoid-the-open-office-trend-google-got-it-wrong-50537621f5a3>

VALUE PROPOSITION

The window to relief offers a wide variety of values to multiple stakeholders. The main aim of the product is to improve the wellbeing of office workers by reducing collective stress. Improving the individual wellbeing of employees will indirectly result in a positive effect on the working atmosphere and thus, on employers and co-workers. Therefore, this section is divided into the two most important stakeholders, the user and the customer. The user being the office worker and the customer being the employer they work for.

OFFICE WORKER (THE USER)

The Window to Relief is made for office workers. It helps them to relief the build-up of stress and to revitalize. This will be beneficial for their mental and physical well-being as prolonged stress has severe effects on both.

The added benefit from this lighting solution is the light tricks the brain into thinking the sun is shining. This effect reliefs stress, boost productivity and helps office workers suffering from winter-bound symptoms during the decreasing photoperiod. This was explained in further detail in the related works section.

OFFICE EMPLOYER (THE CUSTOMER)

The employer of the aforementioned office worker is the customer for the window to relief. The product is appealing to the customers since it promises an improved wellbeing among employees and a boosted concentration. Stress is the most common cause for sick days. Thus, reducing the amount of prolonged stress will bring benefit to one's work. Furthermore, the willingness to operate of the workers will also be increased by the social exchange effect. This states that employees will be more motivated to deliver good work when their employer noticeably invests in their wellbeing (Bruvold, 2010).

PRODUCT OFFER AND CONFIGURATIONS

The Window to Relief can be bought in multiple configurations. The basic model only consists of the window and the lighting. As this is a true to life sunlight lighting solution, which in itself will boost productivity and wellbeing in the office. Especially for people suffering from winter-bound symptoms.

One can opt to add the branches or/and the rain still without this being connected to the cushions. The branches and rain will just follow a randomized patterns which is made to be soothing.

The complete package includes the cushion, which delivers the optimal experience to the users of the window to relief. First of all, the window will real time respond to the collective stress level making it most effecting at reducing this. Furthermore, the office workers are now able to reflect on their collective stress level and are able to take action accordingly. And lastly the stress level of the office workers is tracked and can be evaluated by the company they are working for. To for example create a better working environment which could then lead into more productive employees.

BUSINESS PLAN

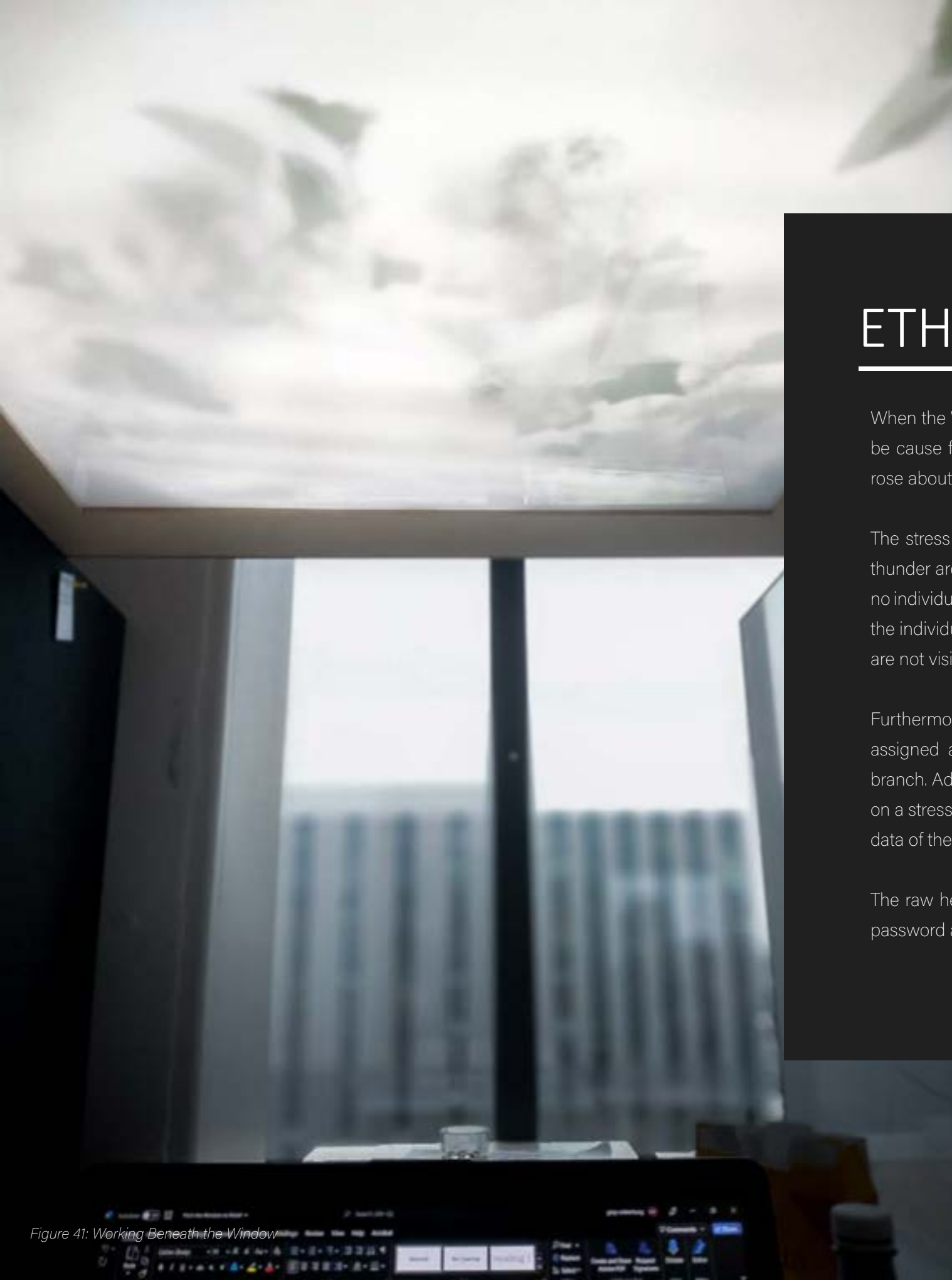
The window to relief primary targets organizations with an office. It has a B2B business model, meaning it will be exclusively sold to companies. This frequently leads to larger orders, however also a higher consideration time. The configuration with only light will be the cheapest one but adding the foliage or water will not increase the price by large amounts as this triggers the customer to opt for a better option more easily.

An important activity for the window to relief is to create a sustainable image , as this will add to the natural feel of the product. Therefore, most elements of the product were recycled and are recyclable. This is due to the construction of the window. The exclusion of glue form the making process makes it easily to detach and ready to repurpose. For example, the TV antenna dish wasn't fit anymore for its original purpose, however it did work for the window to relief.

OPPORTUNITY

The last couple of years, working from home became a popular trend, especially since COVID-19 made its appearance to the world. More people are forced to create an in-home working space, which frequently raises challenges, such as missing lighting regulations. Therefore, this growing target group offers interesting market opportunities for the future. The window to relief simulates day light, reduces stress and boosts productivity, thus improves one's working comfort.

The different configurations are relevant for this market as well, however a smaller form factor is needed. The first option being a good lighting solution simulating daylight could be interesting for home workers as well. Furthermore, the configurations with the branches and the water could also be calming for an individual, however this could also be intrusive as there is no collective stress level only direct feedback on the individuals feedback.



ETHICAL CONSIDERATION

When the Window to Relief is in use, data related to stress is collected. This could be cause for an unethical situation. During user test and the process questions rose about the anonymity of the data. This is guaranteed in multiple ways.

The stress related data is visualized in a collective manor. The rain, sounds and thunder are only activated based on the average collective stress level. Therefore, no individual data is visualized. The branches are the only parts that move based on the individual stress level. To not make this intrusive of the privacy, most branches are not visibly separated.

Furthermore, each day, when the office workers enter the building, they are assigned a new pillow, guaranteeing no possibility of discovering a personal branch. Additionally, some branches are made to follow random paths, not based on a stress level. This combined should guarantee the privacy of the stress related data of the office workers.

The raw health data is stored anonymously at a secure server. A username and password are needed to access this server to guarantee privacy.

METHODOLOGY

Figure 42: Prototype used for user testing



METHODOLOGY

In this methodology section the methods used to validate the design are elaborated on. First the user tests will be described, followed by the co-design sessions.

FIRST USER TEST

Before doing the first user tests, a protocol was made based on the user research planning model. To test this, first a pilot was done to work out most flaws. With the feedback gathered from this, the test protocol was improved to have more specific goals.

Objectives

In this user test the main goal is to validate the product concept, find improvements and most importantly is to find what effect the foliage movement and nature sounds have on the users.

Participants

The participants were selected by purposive sampling, as this is a good strategy for qualitative research and to have quick access to a variety of users. To assure this variety, students with different ages, genders and backgrounds were chosen. With the age ranging from 18 to 26. Three people were selected for this research. Participants were asked to sign the informed consent form and were compensated with a snack.



Figure 43: User testing setup

Procedure

For this test the users will be placed in an environment most like an office environment, however, with the least amount of other stimuli to influence the results of the test. During the test he or she will just work on their laptop, doing a demanding task.

The concept, plant with attached electronics, will be placed in sight of the user but not too obvious to not give away the experiment.

The test consists of three parts. This is based on the experience prototype method, ensuring a gradual build-up of interactions. between each part of the study the users are send away to make sure they are unaware of the changes to the setup. Each part lasted for ten minutes. During the first part of the experiment the system will be turned off as control. During the second part the wind through the leaves is tested. This is done by placing a ventilator under the plant to make the leaves move. During the third part the nature sounds are tested. The sound mentioned is the recording of a forest with birds played from a speaker in the plant.

Afterwards the users are asked about their experience, followed by the explanation of the concept, followed by additional questions and input on the concept all with a standard questionnaire and additional questions. This was recorded to be able to later evaluate it. The participants were anonymized in the recording.

Data analysis

The recording of the interview was analyzed using a thematic analysis. The results can be found in the results section.

SECOND USER TEST

Objectives

The goal for this user test was to find out two things. First, what people feel and what action they associate with more or less movement of the leaves and accompanied sound. And Secondly, whether they understand the link between the stress level and the foliage movement and accompanied sounds.

Participants

For this test voluntary response sampling was used to have a variety of users and because a combination of qualitative and quantitative research was used. 12 participants responded.

The test was done anonymously. Only the researcher knew who did the test, without knowing which test belonged to the specific person.

Procedure

Prior to the test, a pilot test was conducted using the same format as the final test. Some minor adjustments were made.

For the test, videos were made of the prototype with different foliage movement. Six videos of about two minutes. All having different movements in the range of no motion to what was considered more than too much. This was “too much” was validated by asking peers when making the video’s. The movement was mapped to a value ranging from 0 to 2.

The participants were send an online survey containing these video’s. They were told what setting they would be in and asked to work on something whilst playing each video. After each video they were asked how they felt by the use of the attractiveness scales of the user experience questionnaire. The order was randomized for each participant. After each video they were also asked what action they associated with the video and why.

At the end of the survey the users were informed about the idea and function of the concept. After the explanation they were asked whether they had figured this already out for themselves and whether it would be good to give this information to the end user before using the concept.

Data analysis

The quantitative data, being the data gathered from the user experience questionnaire was visualized using graphs combining all the participants. This was evaluated by looking for significant patterns. The qualitative data, being the rest of the data was analyzed using a thematic analysis. The results can be found in the results section.



Figure 44: Video setup



Figure 45: Video output

CO-DESIGN SESSION

The co-design session is included in the methodology as co-designing with users is also a form of getting input and validation from them about the concept.

Objectives

The goals of the co-design sessions was to get new ideas and gather design input from the user. Mostly on what would help them relief stress using nature and what this would look like.

Participants

The participants were selected by purposive sampling as I wanted a degree of skill in sketching and complex thinking. Ten co-design sessions were done.

Procedure

For the co-design sessions, the issue cards method was used, being described as: Support the conversation around complex matters by breaking down the subject into physical cards. The co-design session started with each participant drawing something natural and interactive with the stress level of office workers. These are the steps they had to follow:

1. Do this based on 2 of the green cards. Sketch the idea in 3 minutes. The green cards all had a principle of biophilic design on them.
2. Now explain the idea to your neighbor and pass your sketch on to them.
3. Now add 1 or 2 of the purple cards and make a better new sketch in 2 minutes. The purple cards had a reason for attractiveness in nature on them.
4. Is it possible to add stimulation of other senses (sound, light, touch, taste, smell)
5. Now make 1 for the individual stress level, 1 for a combination of individual and collective stress level and 1 for the collective stress level.

In the end the final designs were discussed with me.

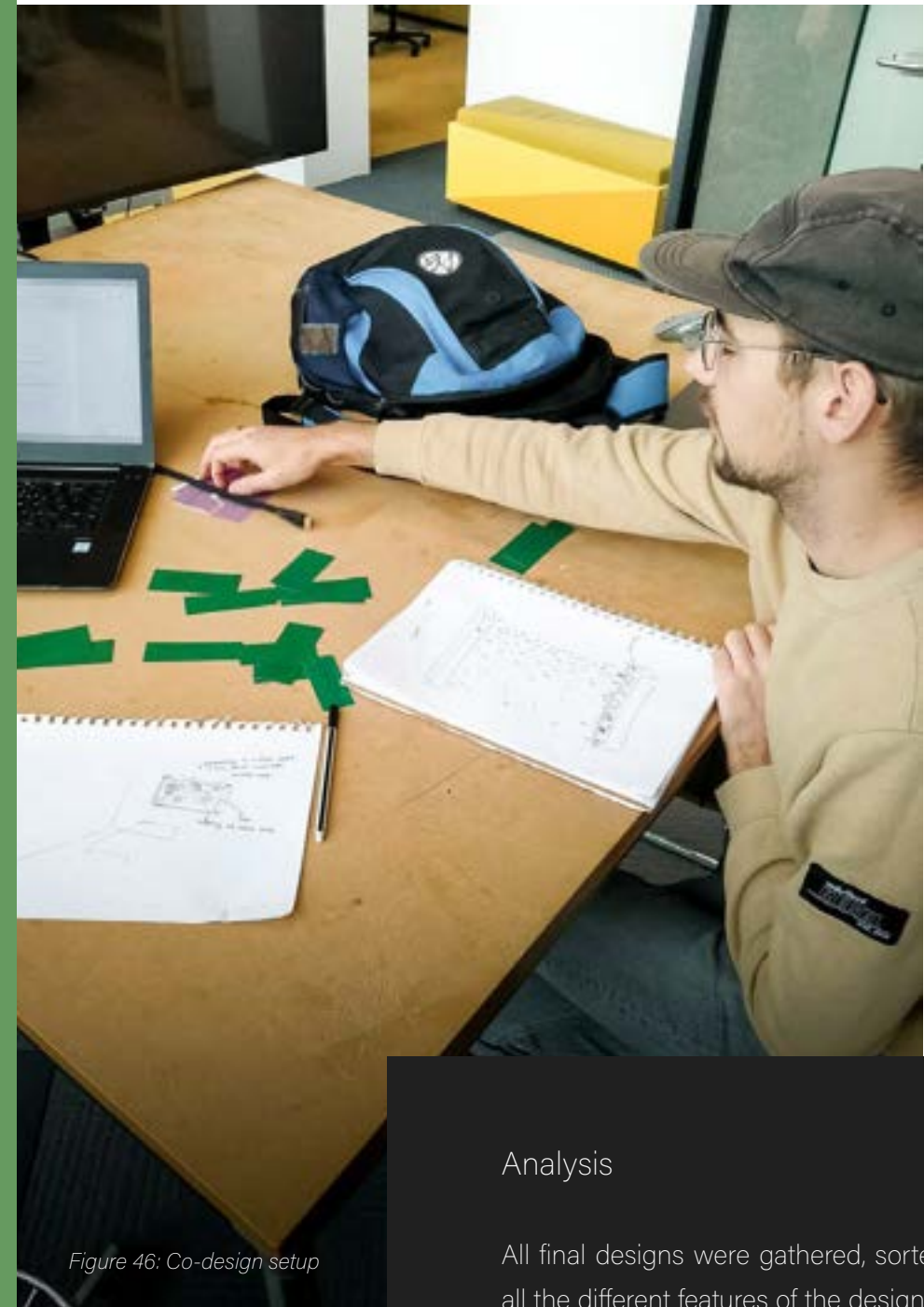


Figure 46: Co-design setup

Analysis

All final designs were gathered, sorted and all the different features of the designs were extracted. This set was analyzed thematically. These were translated into design objectives.

6

4

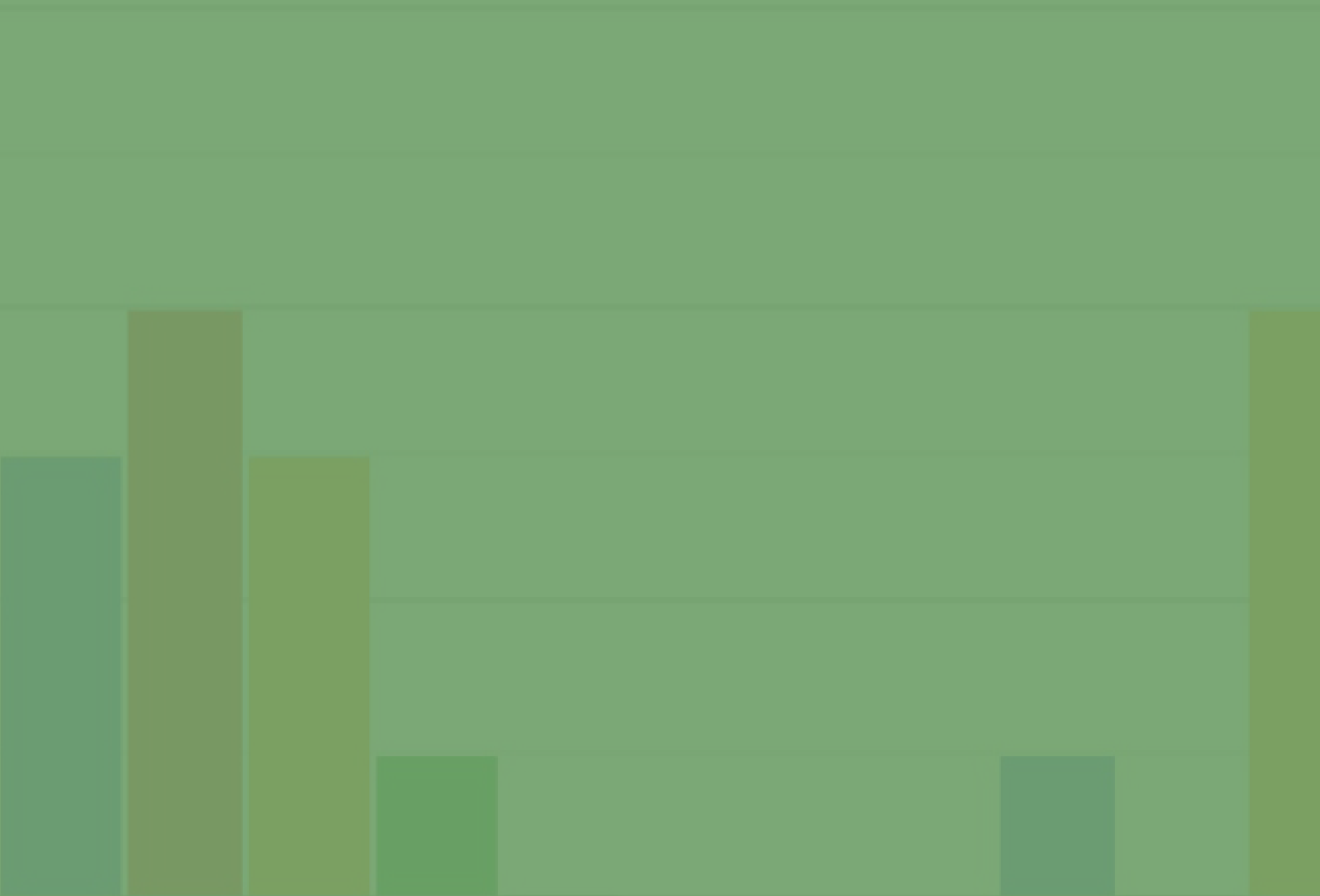
2

0

RESULTS

stressed

relax



RESULTS

FIRST USER TEST

After the test, the users were asked a predefined and extended set of question, which was recorded. A thematic analysis was used to evaluate and process this, from which the results were derived. The main findings were:

- The users that had to imagine they were stressed noticed more of the movement and bird sounds, whilst the user that was actually stressed noticed less.
- Bird sounds were experienced as calming.
- The movement of the plant was experienced by some as calming, others didn't notice.
- Telling the workers they are working hard instead of having too much stress did not help to create more stress.
- The fan made too much noise.

Some features that users had varying response to were:

- Signalling to workers that they are stressed by increasing foliage movement. This could help relax or make more stress.
- The intensity of the movement of the plant.
- These results were translated in design objectives as can be read in the iterations section.

SECOND USER TEST

The second user was quantitative, and tested the attractiveness part of the user experience questionnaire. The most important results are given here:

- The most soothing movement was from level 0.5 to 1/1.5 as described in the method section.
- Going to no movement and going over a level 2 was perceived as causing more stress.

The most important findings of the qualitative part are described as:

- The overall aesthetic of the videos was received as soothing.
- A slight change in movement was generally not associated with a specific action.
- The movement going over a level 2 was associated with the need for taking a break.
- Most users indicated not to immediately understand that the stress level was connected to their stress level. Therefore the users thought it to be good to tell the users link between the stress level and the movement to make it a clear reflection moment for them.

CO-DESIGN SESSION

The results of the Co-design session are now structured chronologically with short descriptions of the most important aspect that were extracted from the designs. These aspects were used for evaluation after the co-design session.

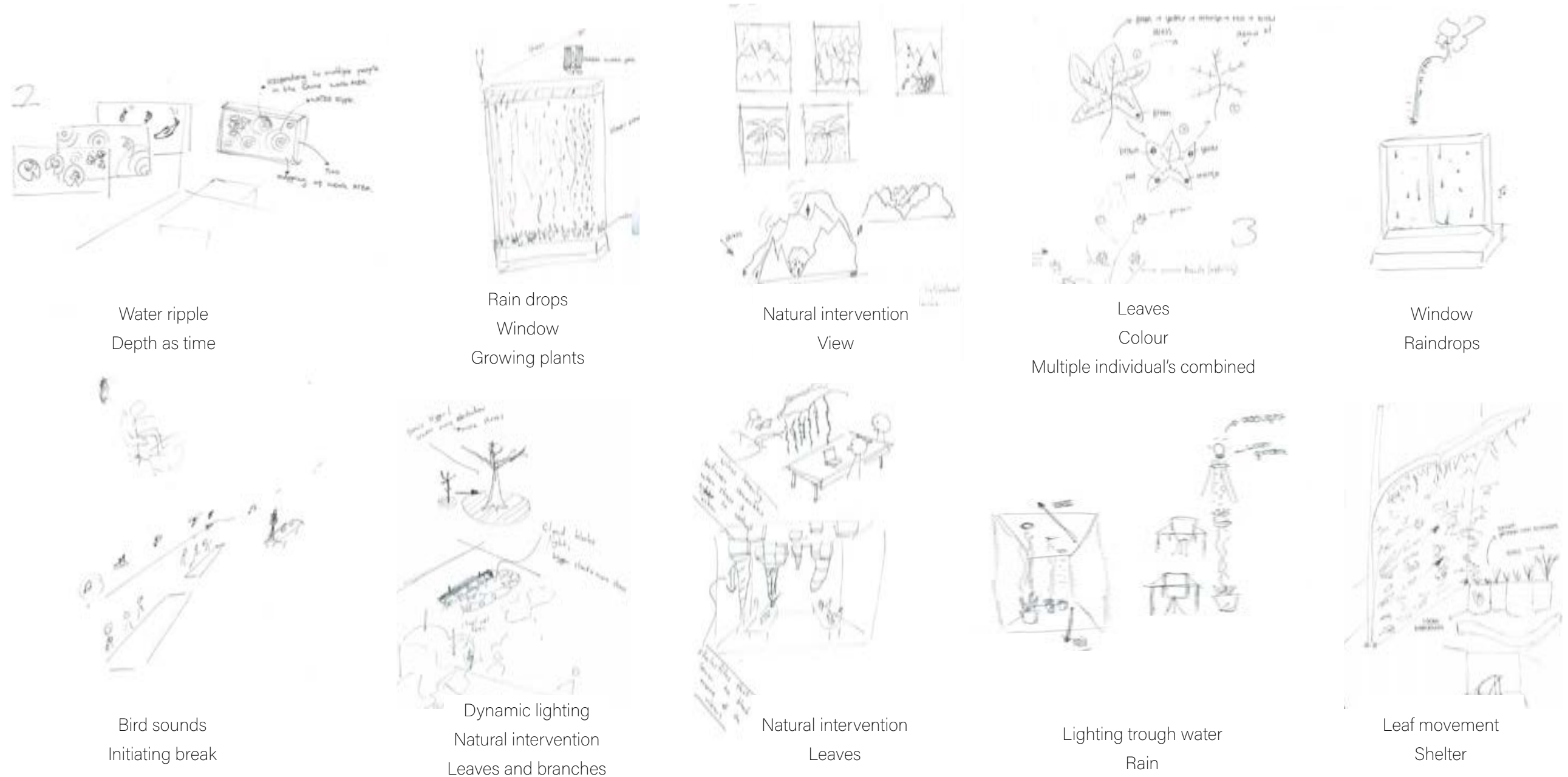


Figure 48: Co-designs

DISCUSSION



DISCUSSION

The design challenge of this project is formulated as: "To what extent can a seemingly "true" natural experience in the office both reduce collective stress and be a visualization of the collective stress level as measured in the office?"

The window to relief uses the soothing effect of nature and natural movement to help relief collective stress. From user tests and validation, a calming effect is confirmed for the aesthetic, leaf movement, and natural sounds of the window. Furthermore, the design is based on the 14 patterns of biophilic design, the principle of attractiveness in nature, and the characteristics of restorative nature. These principles have been validated in previous research to help relief stress.

The natural sounds were validated to be calming. However, users with higher levels of stress did not notice soft bird noises. Therefore, when the stress level rises, those sounds should also increase in volume.

Different foliage movements were tested. Some were experienced as soothing whilst others were experienced as stressful. The soothing movements were implemented into the design. An interesting finding about the stressful movement was the association that was linked to this. The users associated this movement with having to take a break. This was not expected but useful as this proved that an intrusive natural intervention could be interesting when the office workers have to take a break due to too high stress levels.

The aesthetic was received as soothing by the majority of the users as a result of the second user test. Furthermore, most experts also saw the aesthetics of the window to relief as its main selling point. Especially the rain with accompanied water ripples was experienced as very pleasant. During demo day, some people took a seat beneath the window and said to be fascinated by it and wanted to "just sit there and watch". As soft fascination is one of the four characteristics of restorative nature and considered to be the most important, this could implicate the restorative effect of the rain and ripples. However, to be able to validate it, this should be tested.

The visualization of the collective stress level to offer a reflection moment to the office workers has successfully been done in the demo. However, as tested during the second user test, this has to be explained to the office workers to be able to reflect on it as they did not understand this intuitively. In order to not cause more stress, this should not be explained as a stress visualization but as a visualization of their work intensity. This insight was a result from the second user test. The intuitive interaction of the window could be experienced differently over time. However, this has to be tested to be validated.

Besides these proven aspects there are still uncertainties in the design. The point that caused the most debate was the implementation of the thunder into the window when the collective stress level has risen over the highest threshold. The results of the user test showed that an obtrusive intervention like thunder caused the association to take a break. This is a beneficial association as this is necessary in this state of stress to reduce it. Also the research into peripheral vision resulted in the implementation of this feature as this is the moment of moving from the peripheral vision into the center, which supports the intervention. However, multiple experts, including the client, Ahrend, thought this to be too intrusive. The thunder takes up a lot of attention, which can be a potentially stressful experience as found during user tests. This is only avoided when moving out to take a break. But some workers may need to finish their work, before a deadline for example. Therefore, this is an aspect that should be further explored, preferably with real-life office workers.

To test the attractiveness of the complete system, the Attrakdiff method could have been used. However, due to the website domain not being available, the owner not responding and time limits this was not done. This method however, could be used in future studies.

Future works

The most important step for future works is to test whether an extensive natural experience for the workplace like the window to relief actually has long term effects on the reduction of the collective stress in a real environment. Due to time limits and scarcity of reliable testing equipment, this was not be possible to execute.

CONCLUSION

Figure 50: Conclusion

CONCLUSION

This project focused on finding to what extent a seemingly “true” natural experience in the office could both reduce collective stress and be a visualization of the collective stress level as measured in the office? Reducing the stress level is a vital action for offices as prolonged stress has severe effects on office workers, both mentally and physically. Furthermore, it will also affect the office they are working for as it is cause for less job satisfaction and more sick days. To counteract this, nature is used in this project.

Interaction with a natural environment has widely been validated to relief the build-up of stress. However, previous research has mostly focused the effect of a single natural attribute on individual stress levels. This project, on the other hand, further investigates the possibilities and effects of a more true-to-life natural experience and introduces a way of collective stress related coping. By creating a more natural experience compared to for example an indoor plant, the stress relief will be more effective. This was found based on the research into natural design principles and user tests. And by offering a reflection moment the office workers will be more aware of their collective mental states. It is however their responsibility to take action.

Therefore, further research could focus on how such true-to-life natural experience could benefit office workers in the long term, and see if this collective stress related coping will also help reduce stress in the long term.

ACKNOWLEDGEMENTS

First of all, I would like to thank Jun Hu for being a critical and supportive coach who offered exactly what I need at the right moments.

The Vitality squad for the motivating atmosphere and for all the organized workshop and meetings even during these difficult times.


Ahrend for offering an inspiring insight into their domain.

And lastly thanks to all my friends and family for all the support.

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Window to relief

Imagine you are working in an office. There is a deadline coming up soon. Besides you a room divider is placed as can be seen in the photo below. In the following videos, you will see what would be happening on the room divider besides you. After watching the videos, you are asked some questions about how it made you feel. Please use headphones for the videos, but don't turn up the sound too much.

 **giepvalk@gmail.com** (not shared) [Switch accounts](#)



Next

Clear form

Figure 51: User test format

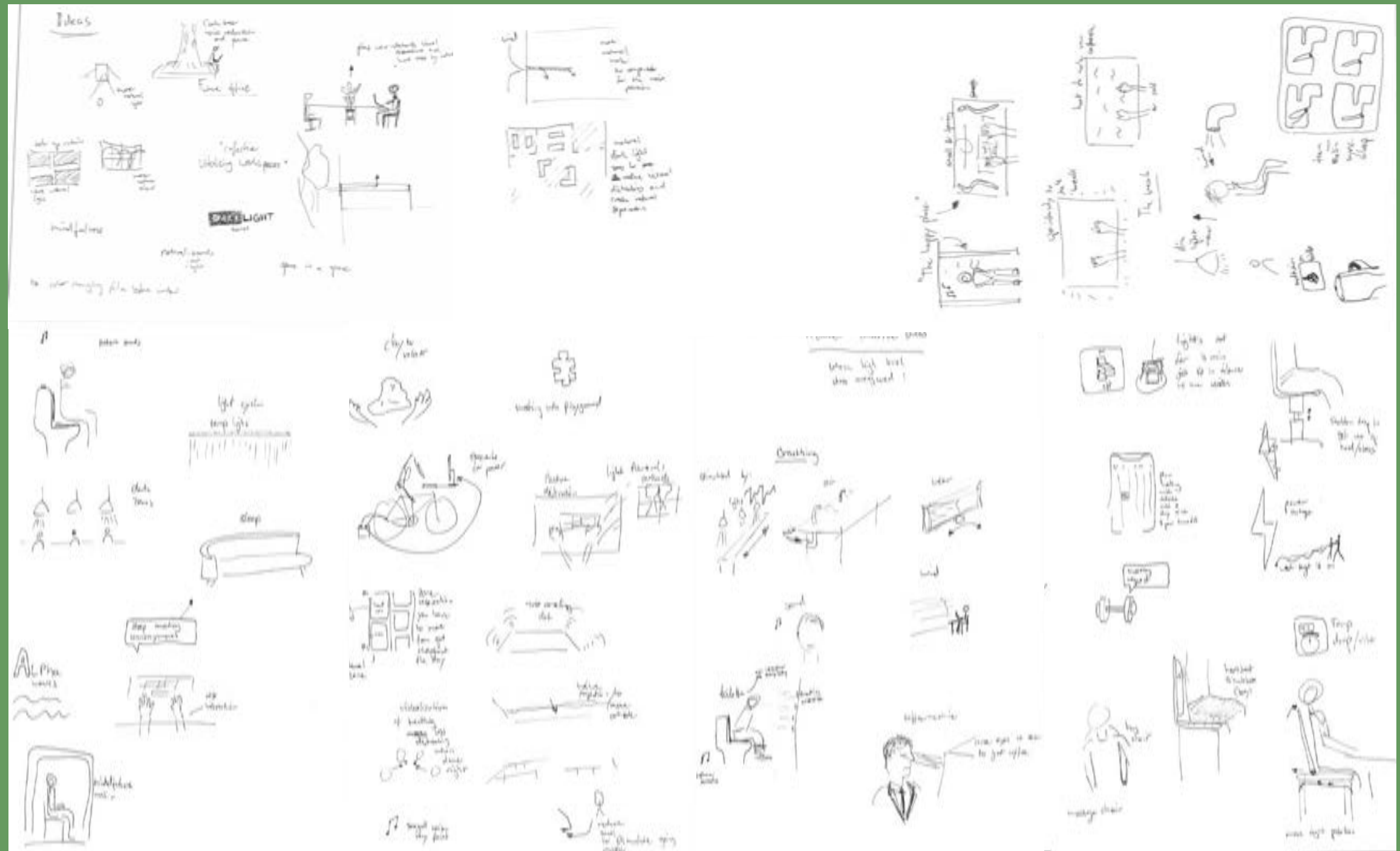
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APPENDIX A: SKETCHES



APPENDIX B: DECISION MATRICES

Criteria	Unobtrusive	User decides	attractive	Interaction	Intergratability	business possible	feasibility	Adhering to PI& purpose	collective score		
Weight											
Meeting request to relax	3	4	3	4	5	4	4	1	4	1	33
Self time at toilette	3	3	1	3	4	3	4	1	4	1	27
Natural simulation and destimulation	5	1	5	3	5	5	4	5	5	4	42
combination of three and five	4	4	4	5	2	3	3	4	4	3	36


Criteria	Unobtrusive	User decides	attractive	interaction	intergratability	business possible	feasibility	Adhering to PI& purpose		score
Weight										
Relax mex	3	4	4	5	2	5	3	5	3	34
Organic di	5	5	4	4	4	5	4	5	4	40
Window	4	3	5	4	4	5	5	5	5	40

APPENDIX C: Demo-day deliverables

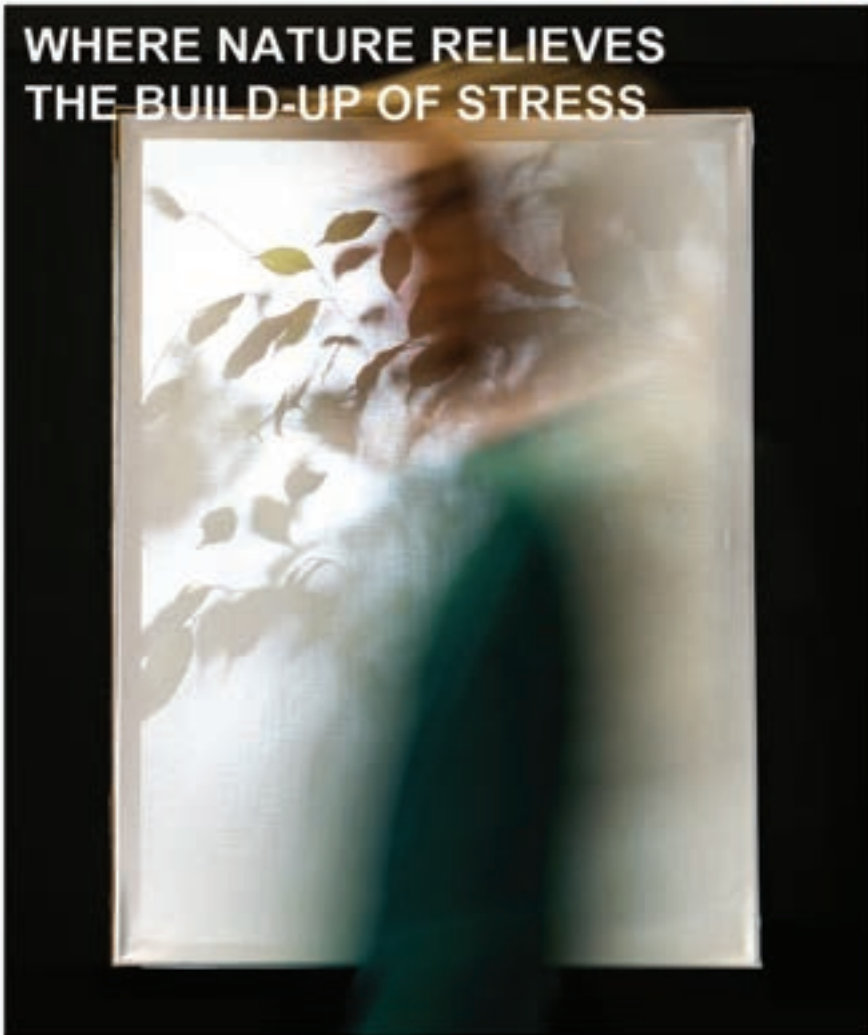
LINK TO DEMO DAY VIDEO:

<https://www.youtube.com/watch?v=LyBSLiVZAYE>

APPENDIX C: Demo-day deliverables



WHERE NATURE RELIEVES THE BUILD-UP OF STRESS



LESS COLLECTIVE STRESS
WINDOW TO RELIEF

STUDENT NAME:
GIEP VALKENBURG

COACHES:
JUN HU
RHYS DUNDAS

SEMIESTER:
FSP

How much time do you spent in nature and how does this make you feel? While office work is a sedentary indoor activity, being in contact with nature can reduce stress and boost concentration. The Window to Relief is an interactive light panel that introduces nature into the workplace in a seemingly natural way. When the stress level of the workers increases, measured by a sensorial pillow on the chairs, the natural experience will get more intense. The aesthetics the sound and the feel of the window with vegetation moving behind it in the wind will decrease the stress of the workers at the office.



A NATURAL EXPERIENCE TO RELIEVE STRESS



LESS COLLECTIVE STRESS
WINDOW TO RELIEF

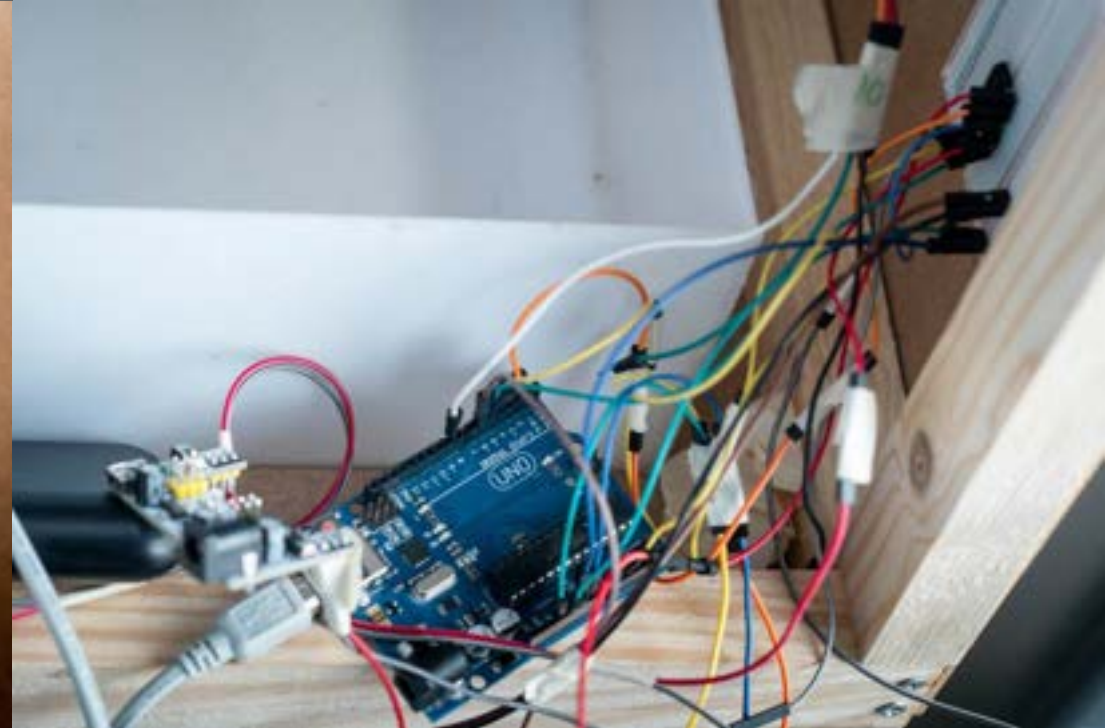
STUDENT NAME:
GIEP VALKENBURG

COACHES:
JUN HU
RHYS DUNDAS

SEMIESTER:
FSP

How much time do you spent in nature and how does this make you feel? While office work is a sedentary indoor activity, being in contact with nature can reduce stress and boost concentration. The Window to Relief is an interactive ceiling light that introduces a natural experience into the workplace. When the collective stress level of the workers increases, measured by a sensorial pillow on the chairs, the natural experience will get more intense. The aesthetics the sound and the feel of the window with vegetation moving behind, raindrops falling and natural sunlight will decrease the stress of the workers at the office.

APPENDIX D: DEMONSTRATOR PICTURES



APPENDIX E: METHOD MATERIAL

Questionnaire test 1

- 1. What were your first impressions of the product?
 - 2. Did you intuitively know what to do? What are the elements that caused you to (not) understand the product?
 - 3. Is the product attractive to you? If you would walk past it, would you want to investigate it or would you walk on?
 - 4. Would this be a product that you would want to use multiple times or only once?
 - 5. What do you think the design goals of this product are?
 - 6. Do you think this is a good product to address these design goals?
 - 7. What would you say your stress level was at every part of the test?
 - 8. Would you say the product affected this?
 - 9. How did every part of the test affect you ?
- After explanation
- 10. What are your first thoughts on the concept?
 - 11. What improvements would you like to see?

Additional questions

stressed	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
rushed	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
distracted	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
chill	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
concentrated	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
relaxed	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Issue Cards

Support the conversation around complex matters by breaking down the subject into physical cards.

ALSO CALLED
Challenge Cards, Trigger Cards



WHAT IS IT

Issue cards are used to promote discussion, to suggest new avenues of exploration, to structure thinking, and to spark ideas. They can be especially useful when the group feels stuck, or is unable to move away from familiar thinking. The basic concept behind issue cards is to isolate a specific element into each card, and then use the cards as starting point for a 1:1 or group conversation. An issue card can contain an insight, a picture, a drawing, a feature, a keyword, a description, etc. based on the specific need. They act as prompts to suggest new interpretations of a problem and induce considering a different perspective; they can be used in many different ways, from identifying priorities to discussing relationships or simply facilitating the conversation.

APPENDIX F: INFORMED CONSENT FORMS



CONSENT FORM FOR PARTICIPATION IN RESEARCH

Department of Industrial Design Eindhoven University of Technology

The purpose of this form is to inform you of the nature of the research conducted at the vitality squad of the department of Industrial Design and to ask for your informed consent to participate.

Your participation in this experiment is strictly voluntary. You may choose not to participate, and you may withdraw at any time during the experiment. If there are any hesitations about participating or you have any questions about the research, please feel free to ask the project leader.

You will be asked to participate in a concept user test. During and after this test we will ask you some questions about the experience. There will also be an observer who will observe how you interact with the prototype in the test. We think this will take about 10 minutes and there will be no health risks.

The audio and/or video of this experiment will be recorded and notes will be taken. All data obtained in this experiment will be processed and reported anonymously. More information about this study has been explained to you by the researcher.

All research conducted at the vitality squad of the department of Industrial Design adheres to the Code of Ethics of the NIP (Nederlands Instituut voor Psychologen - Dutch Institute for Psychologists).

I, (NAME) Katharina F. B. O. J., have read and understood this consent form and have been given the opportunity to ask questions. I agree that I participate in research conducted by the research group Human Technology Interaction of the Eindhoven University of Technology.


Participant Signature

30-09-2021
Date



CONSENT FORM FOR PARTICIPATION IN RESEARCH

Department of Industrial Design Eindhoven University of Technology

The purpose of this form is to inform you of the nature of the research conducted at the vitality squad of the department of Industrial Design and to ask for your informed consent to participate.

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All research conducted at the vitality squad of the department of Industrial Design adheres to the Code of Ethics of the NIP (Nederlands Instituut voor Psychologen - Dutch Institute for Psychologists).

I, (NAME) Maria Morge, have read and understood this consent form and have been given the opportunity to ask questions. I agree that I participate in research conducted by the research group Human Technology Interaction of the Eindhoven University of Technology.


Participant Signature

30-09-2021
Date



CONSENT FORM FOR PARTICIPATION IN RESEARCH

Department of Industrial Design Eindhoven University of Technology

The purpose of this form is to inform you of the nature of the research conducted at the vitality squad of the department of Industrial Design and to ask for your informed consent to participate.

Your participation in this experiment is strictly voluntary. You may choose not to participate, and you may withdraw at any time during the experiment. If there are any hesitations about participating or you have any questions about the research, please feel free to ask the project leader.

You will be asked to participate in a concept user test. During and after this test we will ask you some questions about the experience. There will also be an observer who will observe how you interact with the prototype in the test. We think this will take about 10 minutes and there will be no health risks.

The audio and/or video of this experiment will be recorded and notes will be taken. All data obtained in this experiment will be processed and reported anonymously. More information about this study has been explained to you by the researcher.

All research conducted at the vitality squad of the department of Industrial Design adheres to the Code of Ethics of the NIP (Nederlands Instituut voor Psychologen - Dutch Institute for Psychologists).

I, (NAME) Wendy Buijs, have read and understood this consent form and have been given the opportunity to ask questions. I agree that I participate in research conducted by the research group Human Technology Interaction of the Eindhoven University of Technology.


Participant Signature

30-09-2021
Date

APPENDIX G: RESULTS DATA

Time stamp	How did the beginning of the video make you feel?	How did the beginning of the video make you feel?	How did the beginning of the video make you feel?	How did the beginning of the video make you feel?	How did the beginning of the video make you feel?	How did the beginning of the video make you feel?	How did the beginning of the video make you feel?	How did the beginning of the video make you feel?	How did the beginning of the video make you feel?	How did the beginning of the video make you feel?	How did the beginning of the video make you feel?	How did the beginning of the video make you feel?	How did the beginning of the video make you feel?	How did the beginning of the video make you feel?	How did the beginning of the video make you feel?	How did the beginning of the video make you feel?	How did the beginning of the video make you feel?	How did the beginning of the video make you feel?	How did the beginning of the video make you feel?	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APPENDIX H: CODE WINDOW TO RELIEF

```
#include <Servo.h>
```

```
Servo servo1; // create servo object to control a servo
```

```
Servo servo2; // create servo object to control a servo
```

```
Servo servo3;
```

```
int speedPin = 5;
```

```
int dir1 = 4;
```

```
int dir2 = 3;
```

```
int servoPos1;
```

```
int servoPos2;
```

```
int servoPos3;
```

```
int potmeter = A0;
```

```
int currentLevel;
```

```
int delayTime = 1000;
```

```
int array1[] = {0, 0, 1, 6, 3, 6, 3, 4, 6, 3, 14, 15, 17, 12, 20, 25, 22, 24, 34, 36, 34, 34, 31, 37, 40, 41, 43, 44, 44, 44, 41, 37, 43, 47, 46, 52, 53, 50, 51, 55, 55, 55, 56, 54, 58, 59, 62, 61, 60, 63}; //define array
```

```
int array2[] = {0, 40, 40, 40, 50, 60, 80, 90, 60, 80, 70, 0};
```

```
void setup() {
```

```
    Serial.begin(9600);
```

```
    servo1.attach(9);
```

```
    servo2.attach(10);
```

```
    servo3.attach(6);
```

APPENDIX H: CODE WINDOW TO RELIEF

```
pinMode(potmeter, INPUT);
pinMode(speedPin, OUTPUT);
pinMode(dir1, OUTPUT);
pinMode(dir2, OUTPUT);
```

```
digitalWrite(4, HIGH);
digitalWrite(3, LOW);
```

```
}
```

```
void loop() {
```

```
  // put your main code here, to run repeatedly:
```

```
  int potValue = analogRead(potmeter);
```

```
  Serial.print("potValue");
```

```
  Serial.println(potValue);
```

```
  /*int numReads = 100;   // number of samples
```

```
  int senseSum = 0;      // sum of sensor readings
```

```
  for(int k = 0; k < numReads; k++) {
```

```
    senseSum += analogRead(A0);
```

```
    delay(1);
```

```
  }
```

```
  int senseAve = senseSum / numReads;
```

```
  Serial.println(senseAve);
```

```
  delay(1000);
```

```
  */
```

```
  int stresslevel = map(potValue, 0, 690, 0, 9);
```

```
  if (stresslevel != currentLevel)
```

```
  {
```

```
    Serial.print("Stresslevel");
```

```
    Serial.println(stresslevel);
```

```
    switch (stresslevel) {
```

```
    //moving average anders teveel schommelen
```

APPENDIX H: CODE WINDOW TO RELIEF

```
case 0:
    moveServo(30, 0, 10);
    setPump(0);
    break;
case 1:
    moveServo(35, 0, 15);
    setPump(0);
    break;
case 2:
    moveServo(40, 5, 15);
    setPump(0);
    break;
case 3:
    moveServo(45, 20, 18);
    setPump(0);
    break;
case 4:
    moveServo(55, 30, 20);
    setPump(0);
    break;
case 5:
    moveServo(60, 55, 23);
    setPump(0);
    break;
case 6:
    moveServo(65, 60, 25);
    setPump(0);
    break;
case 7:
    moveServo(75, 70, 30);
    setPump(0);
    break;
```

APPENDIX H: CODE WINDOW TO RELIEF

```
    case 8:
        moveServo(85, 85, 28);
        setPump(125);
        break;
    case 9:
        moveServo(90, 90, 25);
        setPump(250);
        break;
}
currentLevel = stresslevel;
}

delay(1000);
}

void moveServo(int valServo1, int valServo2, int valServo3)    //in stapjes niet tien graden per keer
{
    //for(int i; i <= 40; i++) {
    servo1.write(valServo1);
    servo2.write(valServo2);
    servo3.write(valServo3);
    //delay(delayTime);
    //}

    Serial.println();
    Serial.println("In moveServo met de waardes:");
    Serial.print("valServo1: ");
    Serial.println(valServo1);
    Serial.print("valServo2: ");
    Serial.println(valServo2);
    Serial.print("valServo3: ");
    Serial.println(valServo3);
}
```

APPENDIX H: CODE WINDOW TO RELIEF

```
void setPump(int pumpSpeed)
{
  Serial.println();
  Serial.println("In setPump met de waardes:");
  Serial.print("pumpSpeed: ");
  Serial.println(pumpSpeed);

  if (pumpSpeed == 0)
  {
    digitalWrite(dir1, LOW);
  }

  else
  {
    digitalWrite(dir1, HIGH);
    analogWrite(speedPin, pumpSpeed);           //in stapjes zodat niet teveel water in 1 keer
  }
}
```

APPENDIX H: CODE CUSHION BY MATTHIJS HOEKSTRA

```
import java.text.SimpleDateFormat;
import java.util.*;

//-----
//
// Interfacing with the LightSit cushions
//
// Functions:
//
// - getHealthData()
// - getHistoryData()
// - saveHistoryToCSV()
//
// Written by: Matthijs Hoekstra - matthijs.hoekstra@live.nl

//-----

//Necessary: HTTP-Requests-for-Processing - https://github.com/runemadsen/HTTP-Requests-for-Processing - Findable in libraries
import http.requests.*;

Map<String, Cushion> cushion = new HashMap<String, Cushion>();
int lastMeasureTime = 0;
int timeBetweenMeasurements = 10000;

String accesstoken = "7949657846cf44a5be37e3979f6b97ba"; //Please do not share

String snCushion1 = "ADA004EE000946A7";

//For example second cushion: - uncomment next line
//String snCushion2 = "BBFE031200032451";

int heartRate;
int HRV;
```

APPENDIX H: CODE CUSHION BY MATTHIJS HOEKSTRA

```
int breathRate;

void setup() {
  //Create for P1 (participant 1) a cushion (SN: <snCushion1>) with accesstoken and no debug information
  cushion.put("P1", new Cushion(snCushion1, accesstoken, false));

  //Create for P2 (participant 2) a cushion (SN: <snCushion2>) with accesstoken and no debug information - uncomment next line
  //cushion.put("P2", new Cushion(snCushion2, accesstoken, false));

  //Additionally you can get the history of a cushion, execute this only in setup or once every while
  cushion.get("P1").saveHistoryToCSV("2021-12-01");

  //In addition you can also access the history data within processing
  JSONObject historyJSON = cushion.get("P1").getHistoryData("2021-12-09");

  if (historyJSON.getInt("status") == 200) {

    int numberOfMeasurements = historyJSON.getInt("n");
    JSONArray data = historyJSON.getJSONArray("data");

    println("Received history from sn: " + cushion.get("P1").sn + " from date: \"2021-12-01\" with " + numberOfMeasurements);
    println("First measurement of the series: ");

    println(data.getJSONObject(0));
    int sumhrv = 0;
    for (int i = 0; i < numberOfMeasurements; i++){
      int hrv = data.getJSONObject(i).getInt("hrv");
      sumhrv += hrv;
    }
    int averageHeartRate = sumhrv/numberOfMeasurements;
    println(averageHeartRate);
```

APPENDIX H: CODE CUSHION BY MATTHIJS HOEKSTRA

```
} else {  
    println("no data at: 2021-12-01 \n");  
}  
}
```

```
void draw() {  
    if (millis() > lastMeasureTime + timeBetweenMeasurements) { //Make sure we only get data every 4 seconds  
        lastMeasureTime = millis();
```

```
        // int[] dataP1 = cushion.get("P1").getHealthData(); // return int[] with size 4 - containing statuscode, heartrate, HRV, beats per minute
```

```
        // println("SN data: " + snCushion1 + " -- data -- HTTP status code: " + dataP1[0] + " , heartrate: " + dataP1[1] + " , HRV: " + dataP1[2] + " , Respiratory rate: " + dataP1[3] + "\n"); //
```

Received data

```
        //if (dataP1[0] == 200) { //HTTP CODE 200 - means everything OK and there is data  
        //    heartRate = dataP1[1];  
        //    HRV = dataP1[2];  
        //    breathRate = dataP1[3];  
        //}
```

```
        //For example second cushion: -- uncomment next section
```

```
        //int[] dataP2 = cushion.get("P2").getHealthData(); // return int[] with size 4 - containing statuscode, heartrate, HRV, beats per minute
```

```
        //println("SN data: " + snCushion2 + " -- data -- status code: " + dataP2[0] + " , heartrate: " + dataP2[1] + " , HRV: " + dataP2[2] + " , Respiratory rate: " + dataP2[3]); //Received data
```

```
        //if (dataP2[0] == 400) { //HTTP CODE 400 - means everything OK and there is data
```

```
        //    int heartRate = dataP2[1];  
        //    int HRV = dataP2[2];  
        //    int breathRate = dataP2[3];  
        //}
```

```
}
```

```
        //Do something with the data here
```

APPENDIX F: REFLECTION

When comparing this project with my previous FBP, I can say that I have developed many of my shortcomings this semester. To avoid the same shortcoming, I formulated five learning goals at the beginning of the project. The intention of the goals was to get better at: planning, documenting, meetings, gathering feedback and programming. The execution of these goals is discussed at first.

Furthermore, I will elaborate on the improvements and learning activities of the design research process which is followed by the implementation of the expertise areas in the design. I will end on how this project has helped shape my Professional Identity and vision and how they have shaped the project.

Predetermined learning goals

My personal goals were to be more structured and more in control of the process. This is how I achieved this:

Planning

Before starting the design process I made a concise planning based on the iterative design process and checked by my coach. By consistently checking and updating this planning I managed to keep an organized and structured process. This has helped me a lot during the process as there were no days of not knowing what to do. Furthermore, this made it possible to check how far I was in the process and what still had to do.

Documentation

To keep track of what I did, I made a document containing everything I read, made, tested and thought. This was structured per week. Besides that I filled two sketchbooks with all the ideas and drawings. Doing both was very valuable as it made it easy to recall my decisions and have a clear view on the process. Furthermore, I made a summary of each week on Friday before meeting up with my Coach. This consisted of bullet point of the most important activities, findings and idea.

Meetings

Each coach meeting I prepared by indicating where I was on the planning, by elaborating on my progress that week (summary) and by preparing questions of uncertainties about the process or project. This way the feedback I got was very valuable and could immediately be applied. Furthermore, having a coach meeting every week forced me to have something to present every week and be able to explain how this contributed to the process.

Feedback

To get more feedback on the project multiple activities were performed. First of all, multiple user test were done to get inside into their response to my ideas. Furthermore, ten Co-design session were used to get me out of a tunnel vision and get more input from others. And lastly regular feedback from my coach, peers, friends and family was asked for consistently checking the process and my decisions. This helped me to validate my ideas and revise them when they did not met the targets. This is an important learning activity as I used to base my ideas mostly on my own view on the subject.

Programming/electronics

By starting early on in the process with programming and working with electronics, I made sure not to avoid this and to have enough time to execute this. To achieve this, I made sure to work on a related task every two weeks, just to get comfortable with it. As this is one of my less developed skills, the startup was slow. However, due the initial effort, progress was made. By taking one step at the time a consistent progress was realized. With the help of others, most major setbacks were overcome. Eventually I made a complete working system with every aspect I intended to make.

APPENDIX F: REFLECTION

Design research process

I am aware that I am not naturally organized and can be chaotic. With the use of the planning, documentation, regular prepared meeting, the squad structure and by requesting feedback from others I realized a structured process. Furthermore, to have a viable process I used tools and methods to validate each step. I did not regularly work with tools and methods before, due to a lack of interest and others being in charge of this. Therefore, my prior knowledge on these was not extensive. By consistently looking for useful tools and methods and by help from my coach I managed to understand, use and implement these. A valuable learning activity is that I now see the added value validated tools and methods can bring to the process.

Expertise areas

This project I focused more on improving my less developed expertise areas. These being, User & Society and Math Data & Computing. User & Society was improved by gathering more useful input from user by doing multiple user tests and co-design session. This was further improved by the use of the previously mentioned methods, like the user experience questionnaire and issue cards session. Math Data & Computing was developed by practicing with programming and electronics and by working with different qualitative and quantitative data as gathered from the user tests and co-design sessions.

Professional Identity and vision

The core values of the project intend are very coherent with my vision. As I believe that the connection between human and nature is very valuable for our being. This has always been the core of my vision. However, I wasn't able to define exactly what and why it was important. Due to research and findings during the project and by discussing this with others a more concrete vision is realized.

My professional identity has also developed. By working organized and structured I was much more in control of the process. This teaches me that working like this is important for achieve my goals. Furthermore, the implementation of input from others into the project was a valuable lesson and one that I will use more in the future.

When looking back at the project it is clear that it has greatly contributed to my development as a designer.