VISUALISING COLLECTIVE STRESS IN THE WORK ENVIRONMENT

Physical representation to enhance stress awareness

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ABSTRACT

Stress has always been present in the work environment and recently, more attention is drawn to this stress. The aim of this research is to see which aesthetic parameters are appropriate to visualise collective stress in the open office environment.

To research which parameters are more suitable to visualise collective stress, participants with different occupations and different nationalities were interviewed. The quantitative data, gathered by using a questionnaire, was analysed using a boxplot for graphically displaying summary statistics. The qualitative data from the interviews was analysed using a thematic analysis approach.

From this, it was concluded that the appearance is rather personal. Multiple parameters are suitable to visualise collective stress depending on the individual. However, a natural coupling between certain movements and general stress perception could be concluded.

Keywords

Collective stress; Data visualisation; Work-environment; Aesthetic parameters; Movement.

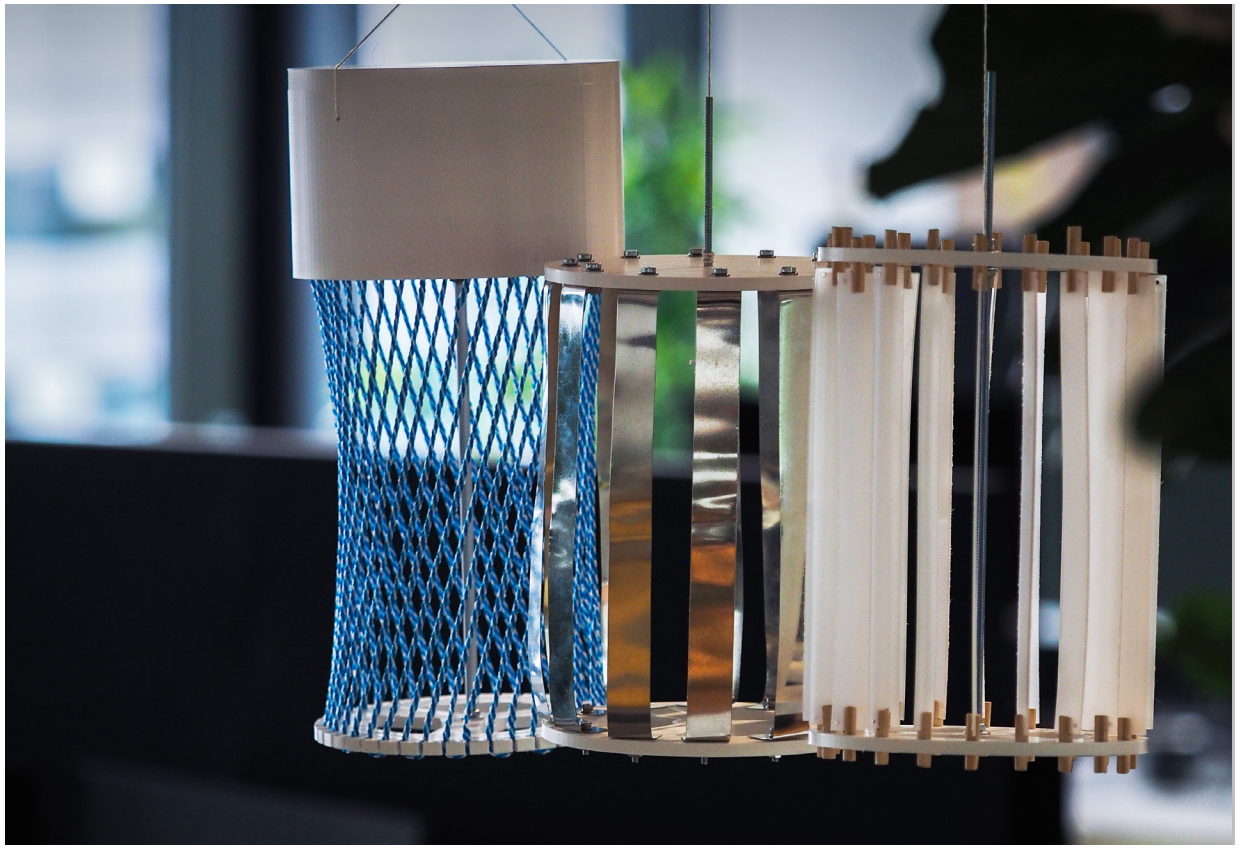

Figure 1: Healix, a visualisation of collective stress

INTRODUCTION

Nowadays, more and more employees are dealing with increased workloads. In 2020, it was discovered that 1.2 million Dutch employees cope with burnout symptoms. According to 34% of these employees, high work pressure is identified to be the underlying cause [18]. As a result, the increased workload has a detrimental impact on all the people involved.

High workload pressure over time can lead to long-term stress which as a result can have serious negative consequences since it impairs 'efficiency, drive, and creativity [14]. Additionally, it influences the mental health of the employees. For instance, there is a link between stress, due to work, and depression [9]. Moreover, issues with mental health can have ramifications on physical health. For example, It is believed that there is a relationship between stress and cardiovascular disease [14].

All these issues can cause problems for businesses; for example, being unable to work due to illness, having a burnout, or other reasons resulting in employees being forced to stay at home. These irregularities in work rhythm cost companies massive amounts of money. The total amount of sick leave in the year 2020 in the Netherlands, was 13 million, where 3.2 million people stayed home due to work stress [17]. But, more importantly, it lowers the quality of life for employees who are subjected to such stress and its consequences. It is vital that the stress level, primarily the collective stress level, in a work environment becomes more apparent. This paper, therefore, seeks to come closer to the following research question: "Which aesthetic parameters are suitable to visualise collective stress in the work environment?".

In order to draw a conclusion from the research question, three artifacts that visualise the disturbance collective stress can cause in an office environment through movement were designed. The disturbance created by stress in the work environment is shown by either; core rotation, resulting in wires getting twisted around each other, pressure, resulting in metal slats getting bent, and turning, resulting in slats being able to turn open and closed.

To research which parameters of the artifacts are the most suitable to visualise collective stress, multiple interviews were conducted. During these interviews, participants were first asked to answer some general questions related to stress and its collective visualisation. General information about stress perception Is needed to answer specific questions regarding materials, movement, and positioning in the work environment. Following this, a questionnaire needed to be filled in that is specifically created for the three different aesthetic artifacts. Lastly, to have security in obtaining valid answers from participants, the choice was made to ask open questions of the questionnaire at the end of the research in the form of an interview.

Participants consisted of people with different occupations and different nationalities. The quantitative data, gathered by using a questionnaire, was analysed using a Boxplot for graphically displaying summary statistics. In order to analyse large amounts of qualitative data properly, the method of thematic analysis was used.

Our research question is:

"Which aesthetic parameters are suitable to visualise collective stress in the work environment?"

RELATED WORK

Firstly, studies about organisational culture in the work environment are discussed to better understand the design context. Following, calm technology is introduced as a way to inform the user in a non-obtrusive way. After this, designing biofeedback is analysed as a way to improve self-awareness. Lastly, the advantages of physical information visualisation compared to digital visualisation are mentioned. Following this, two collective visualisation projects were analysed through benchmarking.

1. Organisational Culture

To design in the office environment it is first crucial to understand the context and its organizational culture. Organizational culture, like an organization's personality, is defined as a set of shared underlying assumptions about an organization regarding what is valued, how people should behave, and beliefs about what is "normal" within the organization [10]. Office environments can differ by cultural attributes such as hierarchical/flat, cold/caring, top-down/participative, rigid/relaxed, micromanaged/autonomous, etc. Within Organizational Culture it is studied how workers, who felt that their company cared about them, had a higher commitment, lower stress and burnout risk, and overall better well-being [10]. In other words, caring about the employees' health and improving their stress level by creating awareness can be seen as one of the keys to creating a healthy and successful working environment.

2. Designing calm technology for the periphery

Calm Technologies are considered devices that can both inform and calm the user. Nowadays, information technology (cellphones, email, and TV) provides intrusive and bombarding information. Calm technology can be a useful tool in stress visualisation. In this way, the artifact informs the employees in a non-intrusive and natural way by creating a natural coupling [25] between the artifact and the collective stress perception. One suggestion to achieve this complex goal was provided by Mark Weiser and John Seely Brown in 1995 in Designing Calm Technology [21]. According to the authors, the solution relies on how the designed artifact engages the users' attention. Calm technology smoothly moves back and forth between the periphery and the center of our attention, where the periphery is intended to be what we are attuned to without attending to explicitly [21].

By placing an artifact in the periphery, the employees can focus on more things rather than if the artifact had been placed on the desk and, by letting the user decide whether to give attention to it, he or she takes control over the situation, without being dominated by the visualisation.

3. Designing Biofeedback

One first step in individual stress visualisation has been taken by Bin Yu. In Designing biofeedback for managing stress, the researcher focuses on Biofeedback in the context of stress management and relaxation training. Biofeedback, also referred to as Bio-Mirror, "is a mind-body technique that brings unconscious physiological processes under conscious control" [25], and it's proven to be a useful instrument to improve self-awareness, enhance self-regulation, and facilitate self-reflection for improving health. The biofeedback systems can be categorized into five types: GSR (Galvanic Skin Response), HR (Heart Rate), Respiratory Rate (RR), HRV (Heart Rate Variability), and Multi-modal Biofeedback.

4. Physical information visualisation

Recently, interest in visualisation beyond digital has risen [9], and within the field of HCI, tangible interaction is today well established. However, the possibility of physically visualising data has mostly been disregarded. In Physical and tangible information visualisation [27] Yvonne Jansen provides a contribution to the understanding of the benefits of emerging physical data visualisations. The main principle for such representations is to augment the physical world "by coupling digital information to everyday physical objects and environment" [20]. Tangible interfaces have been characterized through four proprieties that distinguish them from digital ones: physical embodiment, physical representation, physical manipulation, and spacial configuration [19]. By exploring the physicalisation of existing digital visualisation instruments, it was discovered how physical visualisations allowed to leverage the capability that users train throughout their life by simply interacting with their surroundings. Hence, the main goal is to remove bottlenecks in communication between the user and the data representation.

BENCHMARKING

Stress is one of the most common work-related problems [3] and it is becoming a more popular research theme also within design research. One example of a study in this area of design research study is the analysis from Elvitigala et al [4], who designed a sensor implemented in shoes that allowed tracking the stress levels of users throughout the day. The user got feedback, either through an interruption (music changes), a notification (suggestions), or contextual changes, (desktop background that changed). The StressShoe (Figure 2) was designed to increase the awareness of a user's stress level. The results of the research showed that it indeed helped to increase awareness. What Healix and StressShoe have in common is the aim to achieve contextual changes. However, the difference between Healix and the StressShoe is that StressShoe is an individual stress visualisation, whereas Healix is a collective visualisation.

Moreover, there are multiple self-tracking devices on the market that track stress for instance smartwatches. These products are focused on individual stress tracking and visualisation, and are not aimed at collective stress. Conversely, an example of a collective stress visualisation is the ClockViz (Figure 3), from Xue et al [23], in which stress is represented by a zen garden where the sand is flat when the environment is relaxed, and raked when it is stressed. In this way, the data remain anonymous and are displayed on a highly visible office object, the clock. Another collective visualisation was designed by Xue, AffectiveWall (Figure 4) [24]. AffectiveWall is a visualisation where individuals in the office could see how everyone was doing individually and also collectively. The idea behind AffectiveWall was to start the conversation between different employees about their stress level and to reflect on it [24]. In this second case, anonymity is removed.

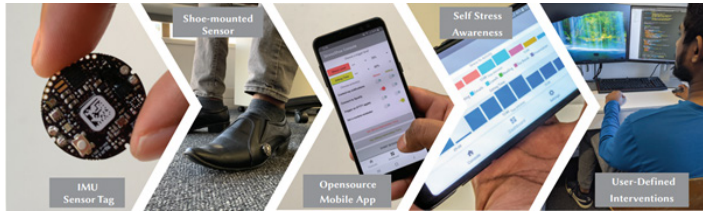

Figure 2: StressShoe by Elvitigala et al. (2021).

Figure 3: ClockViz by Xue et al. (2017).

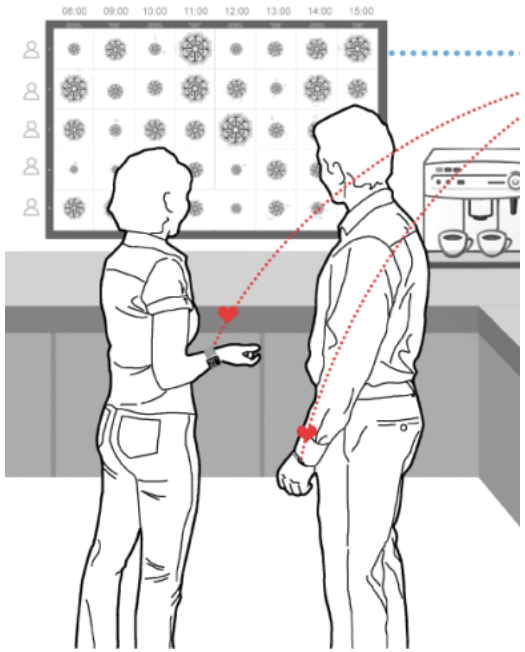

Figure 4: AffectiveWall by Xue et al. (2019).

DESIGN PROCESS / ITERATIONS

Understanding the often negative effects of long-term stress exposure in the work environment has led to the initial motivation for raising awareness around stress variation. Awareness plays a substantial role in taking the proper action at the fitting moment. Subsequently, studies indicate allowing stress to go untreated often results in harmful effects as a consequence [5]. The initial direction was directed toward developing a tangible design artifact that combines stress awareness on the one hand, and an overall non-imposing yet not insignificant interaction on the other. In order to spark creativity, roughly 131 sketches were made with this design direction in mind. From these sketches, corresponding groups were formed based on subject, design structure, underlying emotion, and possible positive and negative consequences the design brings.

Natural visualisation

In a workshop about high-quality materials in design, a first attempt had been made to create a physical visualisation of stress, where visual elements of waves, e.g. water, sand, or lines crossing each other gathered from the sketching analysis, have been an inspiration source (Figure 5). The result of the workshop was a twisting design consisting of two rings of cardboard covered in a wood-pictured paper, that served as connection points for wires (Figure 6). To further investigate the look of a natural visualisation nature-wise, a second prototype was made from natural materials entirely (Figure 7). Although coming closer to the natural look, with natural meaning; ”existing in or derived from nature; not made or caused by humankind”[13] had been achieved, the visualisation of the twisting wires could be improved in smoothness if desired. Creating a prototype of natural materials provided insight into the possibilities of the restrictions natural materials impose on visualisation precision. Furthermore, natural colours are perceived as colours that exist in living organisms, where the colours sometimes function as blending in their natural surroundings, creating unawareness of their presence [19]. Camouflage appears to be the single most important evolutionary force behind mammalian colouration [19]. As a result, an encounter with the aesthetic or colour of the design in this stress visualising artifact may not be determined solely on itself, but rather on its surroundings, either blending in or standing out. Choices of the followed design iterations have been based on this understanding.

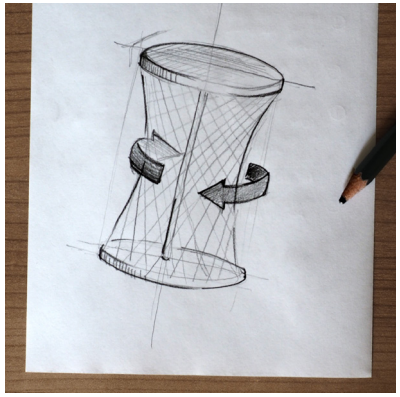

Figure 5: Final concept sketch

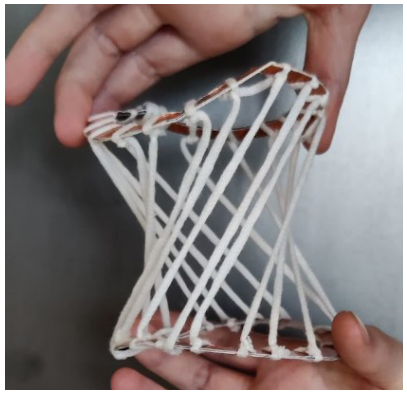

Figure 6: Workshop result

Figure 7: Natural material exploration

Lampshade

During the midterm period, the following iteration of the workshop prototype was imagined; a tangible design that visualises collective stress in the work environment that maintains a natural aesthetic in relation to its surroundings while implying balance or imbalance based on measured stress levels. The natural aesthetic is achieved in this scenario by designing a lamp that can be hung from the office ceiling, among other lamps. The imbalance is obtained by the lamp’s lampshade being able to function as a changing visualisation depending on the collective stress levels measured. Once stress levels in the work environment are low, the strings in the lampshade hang straight in parallel. According to Hübner and Fillinger’s research, who investigated perceptual balance appreciation, pictures containing a ‘single-element’ are perceived as the most stable and thus balanced visualisation [6]. As straight lines visualise only one single element of aesthetic difference, one may conclude this position is perceived as balanced by the user. Next to that, Hübner and Fillinger found that multiple-element pictures, on the other hand, covered the entire range of stability [6]. This means that the multiple-element aesthetics of the lampshade in its twisted position corresponds to the degree of imbalance. In conclusion, the artifact has one position that is perceived as balanced, namely the straight lines, followed by a degree of imbalanced positions depending on the amount of twisting. Due to the artifact’s ability to rotate its core, creating an approximate spiral shape, and ranging from the most extreme stress levels to no stress levels measured, the term ‘Helix’ has functioned as an inspiration source. The artifact is eventually given the name Healix, which stands for healing the work environment by creating awareness. In order for the artifact to work accurately, it was the intention to use heartrate, heart-respiratory rate, and heart-rate variability measuring pillows. Every employee would sit on these pillows during the day, after which an average is calculated continuously. Healix would be able to visualise the collective measured stress levels from this data. However, due to the pillows not giving continuous data over large periods of time, no valid research could be performed. The company providing these data measuring pillows had been contacted about this issue, which led to an intern design iteration process.

Aesthetic artifacts

The research direction of Healix has shifted from putting an emphasis on raising awareness about collective stress to putting emphasis on demonstrating how to best visualise collective stress through design. Aesthetics can be viewed as criteria for the effects a visualisation has on the user. Therefore, due to performing research on three different aesthetic artifacts, one might come closer to the question which aesthetic parameters are the most suitable to visualise collective stress in the office environment. All three artifacts have the same base, namely a white top and bottom frame connected through a small aluminium rod. The middle part differs in aesthetics and movement, one artifact visualises stress by twisting its core (Figure 8), one by compressing its body (Figure 9), and the last one by turning its slats (Figure 10). The materials used for each artifact are perspex plastic and wood, nylon

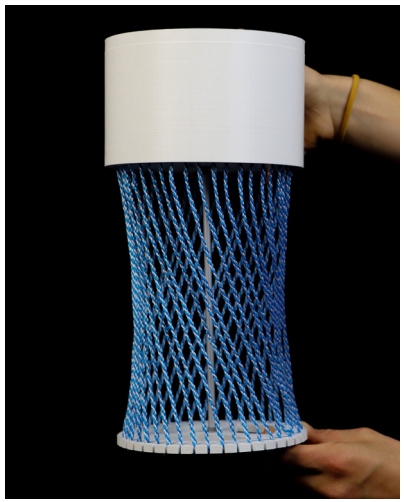

Figure 8: Twisting Healix

Figure 9: Bending Healix

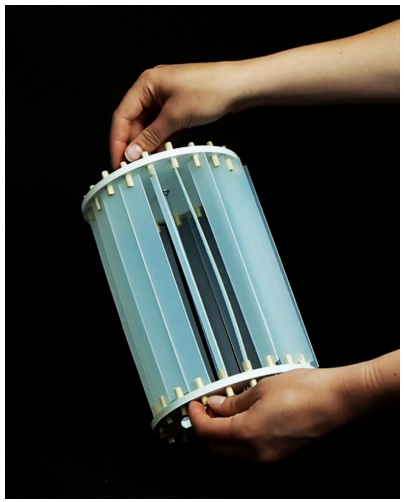

Figure 10: Turning Healix

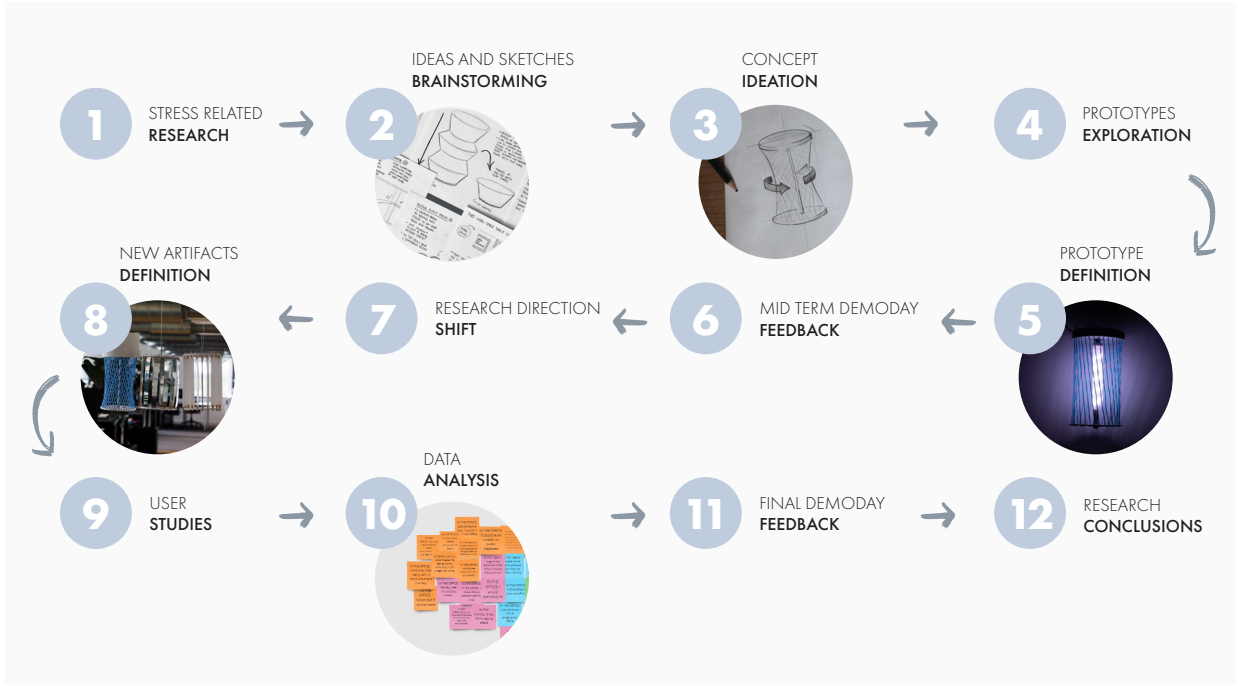

Figure 11: Representation of the design process

wire, and aluminium plates respectively. The choice for these materials is made to create three different styles in the office environment that could be perceived as natural on the one hand, but visualise balance or imbalance on the other, as was explained previously. The artifact with plastic slats can be perceived as a blending design among other plastic lamps hanging from the ceiling, where the wood matches with wooden e.g. closets or desks in the office if applicable. Of course, every office environment is different aesthetic-wise, and therefore a blending visualisation would differentiate in each office environment. The prototype containing aluminium plates can be imagined in an open office containing a vast amount of electronic, or metal aesthetic equipment. On the contrary, the artifact containing blue wires could be used in a more playful and less boundary-imposing office environment, such as in e.g. Google offices [7]. The overall process is shown in Figure 11.

FINAL DESIGN

Healix is able to create awareness about the collective stress levels in the open office environment through the use of a natural visualisation. The artifact is due to its sleek design and customisability able to be positioned in any given open office, resulting in directly being incorporated into the current environment. Due to the practice of movement, Healix is able to modify into different positions depending on the measured collective stress level. The movements included in this research are either twisting, bending, or turning. The choice for these three types of movement is made due to the possibility of creating an applicable third-dimensional visualisation around the artifact at all times. Depending on the visualised stress level in the office, employees are able to take action accordingly. As earlier described, research performed by the Limeade Institute concluded that caring about the employees' health and improving their stress levels by creating awareness can be seen as one of the keys to creating a healthy and successful working environment [10]. Therefore, the visualisation can be seen as an additional effort for employers or supervisors to show heart to their employees' feelings of stress and performance pressure. More importantly, negative consequences of long-term stress exposure can be prevented timely, by talking to colleagues and finding a manner to reduce stress individually.

Underlying Design Principles

Various underlying design principles are implemented within Healix relating to contrast, balance, emphasis,

hierarchy, and movement. Within the design, white was chosen as the top and bottom base colour to create contrast with the middle section, which represents collective stress. Next to that, contrast plays an important role outside of the design. The intention for Healix was to blend the aesthetics in the environment in such a way that it would be perceived as natural and become one with its surrounding. Within and outside of the design, the opposite effect of contrast has thus been implemented.

Next to that, it is important the blended artifact could convey balance or imbalance in relation to measured stress levels. The chosen manner to do so is by creating symmetrical and asymmetrical visualisations through movement. Symmetrical in this case can be understood as the twisting Healix being able to visualise straight lines, the slats of the turning Healix being positioned at an identical angle, and the bending Healix representing its plates as straight and unbent, all in a 360 degrees cylinder in their balanced position. Asymmetry occurs once a form of stress is measured in the office. The twisting Healix twists its strings over a 360 radius, making it an asymmetrical visualisation from one standing position; the users' eyes to the visualisation. The same is true for the turning Healix, as the individual angle of each slat, over a 360 degrees radius differs in the position from one point. The bending Healix however, adds a dimension to this principle by covering specific parts of its other plates which are different for the top and bottom of the artifact.

The hierarchy within the three Healix research artifacts is differently divided. In the twisting artifact, the colour blue is intended to pop out from the white, which in its turn would blend in a colourful office. The perspex slats together with their wooden attachment pieces in the turning artifact create less difference in the design hierarchy compared to the white base, and could therefore be implemented in multiple different offices aesthetic-wise. The metal plates in the bending artifact directly distinguish themselves from the base aesthetic-wise, as the material flares when light falls on it, whereas the white PLA plastic does not. The three artifacts' scheme is shown in Figure 12.

Technology & Realization

The decision was made to create one artifact, the twisting Healix, completely functional, while the other two artifacts were used to conduct research using the wizard of Oz technique. This choice was made because the remaining two artifacts' functionality could be precisely matched with this technique once completed. The mechanism

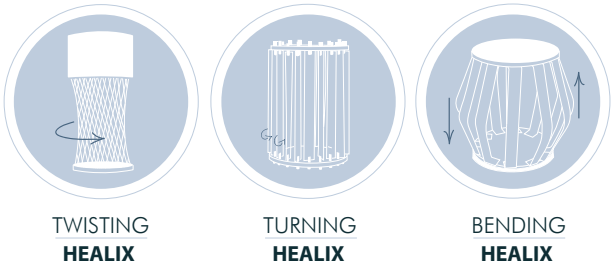

Figure 12: Visualisation of Healix's movement direction per artifact

within the twisting artifact has been iterated reflecting on the midterm design, in order to let the strings twist further in the high-stress level position. This is achieved by using the metal rod that comes up when the artifact starts twisting as a resistance object when sliding in and out the cap on top of the servomotor. The functioning of this mechanism is realized by 3D printing the square-shaped cylinders that slide into each other, followed by clicking the mechanism into the covering 3D printed casing using white PLA filament. The SG90 Digital servo motor is connected to a 6Mhz ATMEGA328P Arduino Nano microcontroller using jumper wires. In order to prevent short circuits, the Arduino Nano is placed on a perforated grid and taped to the printed casing.

The servo motor is controlled and programmed using the Arduino computing program, which causes the strings of Healix to twist accordingly. In the user test, the servo's pointer had been programmed to be able to turn 180 degrees in a time period of 6 seconds. As a result, the artifact's wires start in the straight balanced position, followed by the wires starting to twist to the extreme position of high-stress levels measured. The artifact would stay in this position for one second and twists back to the initial position. Although the artifact is programmed in this manner for the user test to show the potential range of stress levels, the visualisation, in reality, would unpredictably turn back and forth.

Lastly, the top and bottom bases of the three artifacts are modeled in both Fusion 360 and Inventor (Autodesk suite), in order to precisely draw attachment points for the 3 different materials and moving features. For example, in the top casing of the functional twisting Healix, it had been taken into account to leave an opening for powering the Arduino Nano with a battery and adjusting the speed of the twisting servo during the final Demoday.

VALUE PROPOSITION

Healix's target group is aimed at open-plan office workers. As the business world is becoming more digital, offices are becoming more abundant throughout the world resulting in office spaces undergoing some changes over the last century. Offices started off with an open plan, where workers' desks were lined up in big open rooms to fit as many of them as possible and save space [16]. Around the 1950s alterations started to appear in the office spaces as the well-being of employees became more crucial to companies. These changes consisted of partitions placed between desks to give employees more privacy and fewer distractions. However, after these alterations were made it became clear that these closed offices also had their own flaws and therefore companies reverted to open offices. This was done as open office plans increased creativity, communication, and teamwork between co-workers, which was more viable in the open office plan [1]. The perks that arise from these open offices do come at the cost of distractions and privacy. Employees who work in an open office environment often experience higher levels of stress or a lack of productivity [1]. Despite this, companies are still making the shift to open-plan offices as it is seen as the better solution. Healix is therefore designed to create more awareness of the increase of stress levels that arise in open-plan offices and aims to help employees improve their working environment.

Value proposition and business model canvas

When analysing Healix from a business perspective by creating a business and a value proposition canvas, it is apparent Healix's solution aims to cover a lot of issues being faced in the workspace environment. Additionally, it brings value to a multitude of stakeholders consisting of employees at open offices, employers/management and Marketing and HR. The artifact is able to visualise the overall collective stress level in the work environment, which, by creating awarness, can lead to an increase in productivity and efficiency levels in the workspace. Due to its non-intrusive behaviour, employees are able to utilise Healix as a reflection moment and change their own behaviour or even help others change theirs.Not only on the main work floor is Healix a useful tool. Higher up the hierarchy chain are managers and supervisors able to analyse and use Healix's visualisation to improve the overall wellbeing of their employees. When for example an overall increase of stress levels resulting in burn-outs can be seen, employers are able to see this

change and take action. Healix's visualisation allows employers and employees to create the most efficient and productive work environment for themselves whilst also communicating this to others. Lastly, the importance on the awareness of stress in the office environment can be utilized by the Marketing and HR department. To put a focus on the current issues being faced in the work environment and to decrease the level of taboo, it can create further value and attract new employees and business opportunities. The Value proposition and business model canvas can be found in Appendix A Figure A10-11.

ETHICAL CONSIDERATIONS

Intention

The intention of Healix is to break the current taboo of collective stress awareness in the office environment through visualisation. Healix allows employees to have a reflection moment and aims to improve the current situation in the office.

Potential unethical situations

Potential unethical situations that could occur because of Healix are mainly stress-related. Healix aims to visualise collective stress in a non-intrusive way, however, an employee can view Healix's visualisation as an additional stress factor. By seeing the overall collective stress level rise, an employee can become more stressed due to emotionally connecting with their colleagues when this person was not stressed in the first place. Next to that, a consequence of Healix visualising high stress-levels, can result in users trying to counteract the visualisation. This could lead to an increase in stress as a result of the need to complete stressful tasks quickly in order to return the visualisation to its balanced state. Both of these situations result in enhancing the employee's stress level, instead of creating awareness and potentially reducing it, which is what Healix originally is designed and intended for. Another potential unethical situation that can occur was found during the interviews. Due to the wide variety of cultural backgrounds of participants in this research, it came to light that different cultures have different opinions on visualising and displaying stress levels. In certain cultures talking about stress or displaying it, is seen as a tool that can be used against them. When an employer either sees a lack of stress level, he or she might wonder if their employees are doing enough. Additionally, if an employer sees a rise in stress level, and if it became apparent that this is being caused by a certain individual or multiple individuals, it can result in the employer reconsidering if they hired the right person. Lastly, another potential unethical situation that can occur is a lack of anonymity. Healix is designed for an open office environment with multiple employees. Should an situation arise in which a lot of employees are absent, the anonymity factor of Healix decreases as there are less users being able to influence the data. This can result to it becoming evident which employee is the main influencer of Healix, instead of a collective stress value influencing Healix. Healix is therefore not designed to be used in an office environment with a small quantity of employees.

METHODOLOGY

Participant

People with experience in open offices were recruited through personal networks. The study has been executed with eight participants (3M/5F) between the age of 20-30 from different nationalities. The nationalities were Dutch, Italian, Czech, Mexican, German and Ukrainian. All the participants were 'regular' employees without a managing function. The ethics committee at Eindhoven University of Technology approved the study. An informed consent form was utilised to describe the ethical regulations and the experiment to the subjects. Participation in the study was entirely voluntary and without compensation.

Material

During the study the following materials have been used to execute the study: notebook for writing down findings, informed consent form for ethical regulations, printed questionnaire created using Google forms, procedure: study protocol and questions for the semi-structured interview, the three research artifacts: twisting, bending and turning Healix.

Procedure

The user study started with an explanation of the procedure and the ethical regulations, if the participant accepted the ethical regulations and the procedure, the participant signed an informed consent form (appendix D). The study started with open questions about stress in general in relation to the office environment. After the first global interview was finished, the participant saw the three different research artifacts for the first time without an explanation of what it was or how they worked. Their initial thoughts about each artifact were written down. Then the aim of the research project was explained and the focus was shifted towards each artifact in particular. The three artifacts' movements were shown and following this, questions about the aesthetics and the movement of the artifacts were asked. After the three different artifacts had been discussed, the second part was finished. In the third part, the participants were asked to fill in a questionnaire with general questions about the different artifacts, (Appendix E). When the participant was done, the last part started, which consisted of another semi-structured interview about the three different artifacts and their preference. The first questions were based on the answers the participants had given in the questionnaire. The reasons behind the questionnaire answers gave the most insights. The interview continued with general questions about the appearance and the movement of the three artifacts and what they preferred. The interview ended with general questions regarding the concept itself and its placement in the office environment. The overall time the whole user study lasted was between 30 till 45 minutes per participant.

Data Analyse

The quantitative data of the questionnaire were analyzed using a boxplot. The boxplot was used for showing summary statics for each question, making the difference in the summary statics for every question more visible. The bar chart was used for visualising the individual preferences of each participant. The qualitative data was also used as an explanation for the gathered results of the quantitative data. A thematic analysis (Appendix A - Figure A12) was conducted based on the qualitative data. The transcripts of each participant were analyzed and highlighted in coding for each part of the interview. Inductive reasoning was used for finding the themes. The inductive reasoning was done individually by each group member. The individually defined themes were compared and summarized to be validated and prevent bias. These themes allowed us to analyze the different aspects of the artifacts.

RESULTS

During the thematic analysis, negative, neutral, and positive comments about the movement, placement and aesthetics were found. Possible suggestions for new movements or aesthetics were also obtained. Additionally, themes regarding natural coupling, visual elements representing stress and recognizable elements were discovered. The thematic analysis can be found at the following link: https://miro.com/welcomeonboard/

Artifact 1: Twisting Healix

The artifact with the strings was described as an art piece by several participants, P3 mentioned that 'It would be cool if it is gigantic in the middle of the office, from ceiling to the floor, it would have a huge impact'(#P3). Other participants could envision it standing on their desk if it would be more miniature-sized. P6 for instance thought that it would be nice to have the artifact placed on the windowsill. Responses also depended on how fast and how many times the artifact was moving. P1 would like to see it on the desks if it was static, but if it required movement, rather would have it hanging from the ceiling or standing in a bookcase.

All the participants could imagine the artifact in an office environment. However, several suggestions about the current aesthetics were discussed. P7 added the amount of twisting could be increased. Next to the aesthetics, the twisting movement of this artifact was in general positively received. P3 got the feeling of looking at a fountain, 'just sitting and watching it, it is relaxing in some way'(#P3). P5 enjoyed how smoothly it twisted. The movement's pace, on the other hand, was a point of contention. P7 mentioned that the speeds was good. Meanwhile, P4, P5, P6 said that the pace should be slower. P8 thought it would be nice if the movement is updated daily. On the other hand, P2 thought that it would be better if the movement was constantly updated throughout the day very slowly.

Artifact 2: Bending Healix (metal plates)

The second artifact reminded several participants of different objects. P1 said 'It looks like something from the kitchen. 'Something that will cut my fingers, like blades'(#P1). P6 thought 'It looks like torturing someone, it feels strong'(#P6). The shape reminded P4 of a barrel. P6 liked how the metal reflected the sunlight, but found it disrupting that it was not straight due to the previous movement, also P8 agreed on this. P7 did not like how it looked; 'Normally I like metal, but not in this case. It is a too strong material, too difficult to bend, it is not smooth. It reminds me of a cage'(#P7). However, the contrast between white and silver, in general, was positively received. P4 found it an interesting concept, by stating 'I have not seen much in this direction, very interesting'(#P4). P1 found it difficult to imagine it in the office environment, 'I do not like this, it looks ugly if you ask me'(#P1). Meanwhile, P5 thought that it fitted very well in the office environment. P8 thought that it could fit in the work environment, but more close to the exit door. P3 would place it next to the exit door if it was bigger explaining; 'As a big piece, not as a table piece. The bigger it would be, the bigger effect it would have with the sunlight and the reflection'(#P3). The reaction to the movement of the artifact was diverse; 'I like it, original movement', 'it is not something that you expect that it does this movement.'(#P2). P8 said 'The movement is not natural, you have to force it, it is annoying'(#P8). For the same reason, P6 does not feel like it represents stress 'I can imagine that when there is a lot of stress the thing bends, and that feels weird to me'(#P6). P7 mentions that 'the power of stress feels for me what is needed for pushing it down'(#P7). Also, P1 is positive about the movement: 'the movement is good for expressing stress'(#P1)

Artifact 3: Turning Healix (plastic plates)

The third artifact was seen as a unity due to the colour of white plastic with the wood by P1. P5 said: 'I like this the most, it is clean, the materials that are used are nice.''(#P5) The first reaction of P8 was: 'I love it, it is super nice, the colours, the materials, just everything.''(#P8) P3 found that it was more a 'regular thing, something that you would not notice in the office. More part of the furniture.''(#P3) Where P1, P4,P5, P6, P7, P8 could image it be in the office, because of its aesethics. P3 could not. P2 mentioned that 'I would not look at it, because it is not eye-catching.''(#P2) P8 imagined hang from the ceiling as P6 and P7 were if a light was inside. P4 could also image it as a dividing screen. P4 mentioned about the movement: 'I like it, it is nice and more interpretable. Less clear what it is meaning, it has both options. I think that is good'.'(#P4) P1 said 'it conveys something about being open and close. It can be interpretable both ways, either I am open to talk because I am not stressed or I am stressed please talk to me.' '(#P1) P2 mention that 'the movement is satisfying, especially if it is done gradually.''(#P2) P3 found that the movement made the artifact more interesting to look at then in the static state. P7 mentioned that 'if it is done one by one in sequence it is satisfying. I love the way it can move infinite, very nice and very beautiful.'(#P7) Also for P7 the pace of the artifact opening up gradual would say more about the amount of stress level then the two states. 'Also I guess that the pace of the open/closing can say something about the stress level.'(#P7)

Artifacts in relation to stress

The Boxplot in Figure 13 (on the following page) shows that the opinion of the individual participants were quite scattered over the scale. Only with the first question about the first prototype almost everyone agreed that using strings makes people aware of the stress level. Most participants relate the not twisted state with relaxation and the twisted state as stressed. P1 mentioned that 'the strings are twisted just as your head is when it is stressed, in a knot.'(#P1) P5 mentioned the complete opposite: 'when everything is in order (twisted state) it feels less stressed. The other configuration is too chaotic for my OCD.''(#P5) The mean for using twisting as an effective way to represent stress (Q4) is 4. P7 mentioned that 'It is easy to connect the string to stress''(#P7). The second prototype had a median of 4 for making people aware of the stress levels throughout the different states. The association with stress was for the second prototype mostly inclined towards the bended position. P6 mentioned that 'you need the power of stress to shrink the prototype''(#P6). Overall the participants thought that using the second artifact was an effective way for showing stress. The answers to questions about the third prototype are the most scattered. All of the questions are answered at least one time with a maximum. P4 mentioned that 'you have a lot of different interpretations, it has the open and close, the transparency''(#P4). In the quantitative data this is visible, people associate the closed and the open state with both stress and relaxation. The closed state was a mostly associated with stress and the open state with relaxed. P8 stated that one possible interpretation was that human behaviour when you are stressed, you are blocked, so closed. And then the open when you are more relaxed.' P1 said that 'closed meant I am not stressed, so you do not need to talk to me and open I am stressed talk to me'.'(#P1) To the questions if the artifact made people aware or was an effective way for representing stress, the answers different a lot.

Overall comments on the three artifacts

Additionally, there were general comments in relation to stress. For example, P3 mentioned that: 'The movement is the most important factor for the visualisation of the stress, more than colour or shape''(#P3). Further, P6 felt that the movement of the third artifact did in fact express the stress level: 'For the last one, it was hard to say what the opening and closing meant, but the movements made an impression of the stresslevel'(#P6). P4 mentioned that 'the type of turning is good for representation of stress. I prefer the panels as they are more calming. The strings, however, are kind of nagging''(#P4). P2 stated that the coupling between material and movement happened because of your past experiences with it. 'The coupling of movements of certain materials happen because of your past experiences. Therefore you guess what they will do'(#P2). P7 mentioned that they were able to couple

the second prototype with stress: 'The power is the representation of the stress, a strong material, without the shiness or reflexitness''(#P7).

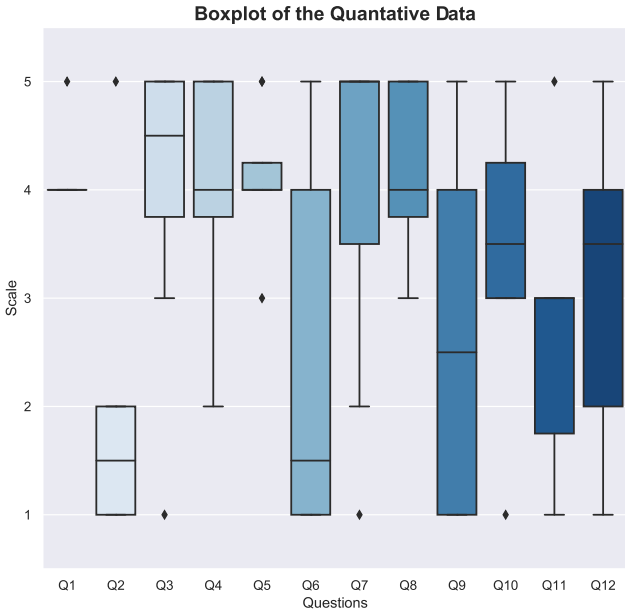

Figure 13: Boxplot of the quantitative data

Boxplot description: questions 1 to 4 are about Twisting Healix, Questions 5 to 8 are about Bending Healix, and Questions 9 to 12 are about Turning Healix. The first question for each Healix artifact regarded the awareness level of Healix, the second and third questions were related to the configuration and if they would couple a stressed or relaxed state to the artifact. The last questions were about the effectiveness of the representation.

DISCUSSION

This research aims to investigate which aesthetic parameters are most suitable to visualise collective stress in the work environment. To do so, three artifacts were developed with different aesthetic parameters (using twisting strings, turning slats and bending metal plates). Qualitative data was collected by having interviews with participants. Quantitative data was collected through a scale questions in a questionnaire. From the data, it is hard to say which aesthetic parameter concerning the appearance is the best to visualise collective stress. Participants reacted very differently to the same artifact concerning appearance. For instance, P8 loved the third artifact meanwhile P3 found it a regular object. The participants had no specific reasons behind their preference, meaning that this preference is rather personal and multiple parameters are suitable to visualise collective stress depending on the individuals who are working in the office. The research revealed that certain movements could be coupled with stress. Mostly because of the associations participants made with the movement. P2 and P3 mentioned that, for them, the tension and pressure were the two links between stress and the artifacts: The same tension that was felt due to stress could be easily associated with the twisting and pressure movements.

Interpretations and Metaphors

The subliminal meaning, or interpretation about an appearance, movement, or state, is something that should be communicated explicitly if you want to convey the message to the user. Users will always see a subjective and personal meaning behind it, based on their own previous life experience. However, it seems from the results that certain movements are interpreted by multiple people in the same way. As can be seen in the boxplot most participants associate the same state with relaxed and the other state with stressed. Especially with the twisting Healix there is an overall clear distinction between what the two states are associated with to people. The tension in the strings is associated with stress and the 'loose' strings is mostly associated with relaxed. When the participant were asked the reason behind this link, P1 said: 'the strings are twisted just as your head is when it is stressed, in a knot'. P2 mentioned that the tension in the strings was the connection to stress tension. This is in line with the results of the research from Hübner and Fillingers [6], where one single element of aesthetic would be perceived as balance and multiple as unbalanced. Therefore when you are visualising stress it is important to think about the metaphor and connections that the artifacts might arise in the user. Between the three presented artifacts, two of them suggested tension and pressure as a representation of stress, the strings that twisted and the metal plates that are bent. In the third artifact, one can either see through the artifact or not, which resembled as being open or closed off due to stress. The tension as a metaphor for stress applied even to the quantitative data analysis. The turning Healix was less clearly interpreted by the participants. The metaphor of being open and closed is something that turned out to be more linked to the participants' personal state and experience, where there is more room for own interpretation concerning what this personal state meant of being open or closed. In the data, this own interpretation is also visible.

Movement

During the user studies it was also discovered how the different parameters of a movement could influence its interpretation. The movement parameters, meaning the movement variables, were discovered through the user studies and later analysed. Such variables will be now explained in relation with the three different artifacts. Regarding the twisting Healix, the movement variables are the twisting speed, meaning the amount of time the artifact took to switch from the two limit configurations (6 seconds during the user test), its possible acceleration, and lastly the twisting radius, meaning the twisting grade of the core. Most of the participants did state that the twisting speed was too fast and they would have preferred a slower feedback, such as a daily feedback. Others would have preferred a continuous movement in order to see the collective stress level being represented in real time.

Emotion framework

After having analysed the movement from a quantitative point of view, it is interesting to study the emotional meaning that movements can convey. Having said that, the movement-emotion connection in physical data visualisation is still quite an unexplored field, this conclusion is based on the user studies finding. Particularly insightful was how two different movements such as tension, which refers to something being pulled, and pressure, which refers to something being pressed or pushed, could be both easily coupled with the same visualisation subject, stress. Based on this statement, we can affirm how the movement is implicitly connected to the force behind it. Disregarding the force direction, both the movements, tension, and pressure, were implicitly connected to a high-intensity force. Consequently, such a force could naturally be associated with the stress high intensity. Conversely, the turning movement is more easily associated with a gradual and constant force. While pressure and tension brought at their limit, can eventually cause breaking point, turning does not. This assertion is proved by P7's statement regarding the turning Healix, 'I could only image it as a way to lower the stress, not as a visualisation'. (#P7). Additionally, P3 suggested making the plastic plates of the turning Healix move faster and in a jittery way, which could better visualise a high-stress level. Consequently, it can be concluded how different movements can naturally convey emotion and sensation based on their force-intensity and nature.

Personal preferences

In interviews data there was a large amount of personal preferences concerning the appearance of the artifacts.

Moreover, participants had different preferences for sharing their stress to the office itself. P2 explained that they were not comfortable sharing their stress level with people in the office, because it could be used against them. P1 and P5 did not have trouble with sharing their stress level as long it was anonymous. For other participants, it did not matter. The results are aligned with the related work Organisational Culture since office environment and, consequently, the employees' working experience can differ by several cultural attributes, such as having a cold/caring work environment culture. The appearance of the artifact that is designed should also fit the office environment. When the participants were asked to change any part of artifacts, the changes were mostly related to the aesthetics and dimension. For the twisting Healix, the colours of the strings would have been preferred to be changed, because they were too distracting, 'I do not like the strings, the blue/white is too much for my eyes, too busy' (#P4). P1 could not imagine the bending Healix in the office, whereas P2 and P3 could. An assumption was made that these differences are due to a different office conception based on the users' experience. These research findings provide insights into which aesthetic parameters should be taken into account when designing for an open office. This research shows that appearance is not the most important factor to take into account, but the metaphor that is used to express stress in movements is. The appearance of Healix should be adapted to suit the environment in which it is used. A user study where the prototype is tested in the office should determine if Healix does indeed help to create awareness over the overall collective stress level.

Limitations

One of the study's limitations was that whilst the first artifact worked perfectly and turned automatically, artifacts two and three did not. Using the Wizard of Oz technique, the artifacts' configurations changed during the interview, resulting in answers about the movement of those two artifacts being mostly based on the imagination of how they would automatically move rather than being able to actually experience the artifacts functioning. For more insights into the movements, it would be beneficial to let the all the artifacts would function.Furthermore, the participants that were interviewed are not completely representative of a group of the working community. Despite all of them having worked in an open office environment and being from different backgrounds, their ages were between 19-30, which does not make them representative of the entire working community. Therefore the results cannot be generalised, but could be used as an initial point for future research. Additionally, applying the use of the above-stated stress measuring data pillow would have given insightful information regarding the users' feelings associated with collective stress visualisation. Since the participants could not experience the collective representation, the question related to stress visualisation were answered based on the participants' assumptions and not empirical facts. Lastly, the three artifacts were not tested in an open office to see which worked the best in its intended environment. The participants imagined the prototypes working in the open office environment in which they have previously worked. Despite open offices do have the same concept, they can look very different, also concerning the number of people who are working in that office.

FUTURE WORK/ENVISIONING

In the original study setup, it was intended for Healix to be tested in an open office environment. However, during this study, this has not been achieved. It is still believed that there is a benefit in testing Healix in an office environment, as it allows for a more accurate user test and the ability to see if Healix indeed is able to increase the stress awareness level of office employees. A suggestion would be to clearly look at which version of the Healix would be most appropriate within the office culture to optimize the collected data. Therefore, doing research on office culture and the specific office where the designers are designing for is suggested, as this can help guide the designer in the direction to visualise stress in an optimal way. Additionally, an interesting direction to dive deeper in, would be to research if participants perceive this collective visualisation as a collective or as an individual visualisation. During the interviews, the participants mentioned several times what Healix would mean for them as individuals but not as a collective. Therefore, it is believed that it can be interesting to do a focus group with a company using Healix, in which the meaning of the representation of Healix is discussed and how a group utilises the feedback given by Healix. Another direction for further research would be investigating how something negative can be visualised in a positive way. Stress is something that can be viewed as positive until a certain threshold, from then on it can be perceived as something negative. Representing a negative variable in a negative manner can aggravate the situation. In this case, this would mean that visualising stress as a phisical object is able to make the user even more stressed. Therefore, investigating how this can be shown in a positive manner would benefit Healix. An example that could be given is, instead of Healix representing stress, it could represent relaxation. Lastly, an interesting direction would be to study the psychological connections between movements and emotions as it was discovered that certain movements can be naturally connected to certain sensations better than others. This could then be used as a new way to further research how movement can be used as a metaphor of stress.

CONCLUSION

Due to an increased workload and high work pressure, more and more employees cope with burnout symptoms and chronic stress [18]. Making them aware of these issues, can help to be conscious of their stress state. This research aimed to discover which aesthetic parameters are suitable to visualise collective stress. In order to investigate this, three artifacts with different aesthetic parameters were created. Quantitative and qualitative data were obtained through questionnaires and interviews respectively. From the results, it became apparent that appearance is dependent on both personal preference and the office culture. When it comes to movement as an aesthetic parameter, it was alleged there is a coupling with stress through metaphors, as well as connecting and linking personal interpretations. The artifacts were not tested in an office, therefore the suggestion is to test and select each design artifact based on the particular office culture, and use them for numerous days when performing research about stress awareness. In such a manner, this study could serve as an initial step towards the development of collective stress visualisations that effectively represent collective stress and help people become more conscious and aware of the stress level in an open office environment.

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CONTRIBUTION OF TEAM MEMBERS

Every group member has been actively involved in both project completion and report writing. This was done by proofreading the entire document and offering assistence in both writing and other required tasks.

The contribution concerning the report chapters are divided between the person who wrote the inital set up and framework of the chapter. Others assisted in editing and rewriting or placed necessary comments.

Erina Böck

Project

- Ideation sketching
- High-quality materials workshop
- Programming data measuring pillows
- Constructing questions for research
- Conducting interviews & questionnaire
- Analysing questionnaire results
- Assembly final prototype
- Conducting thematic analysis interview answers
- Photostudio shooting pictures + video
- Value proposition canvas

Report:

- Introduction
- Related work and Benchmark
- Methodology
- Results
- Discussion
- Future work and Envisioning
- Conclusion

Susan Draaijer

Project

- Ideation sketching
- High-quality materials workshop
- Vitality hub visit High Tech Campus Eindhoven
- Assembly midterm prototype
- Electronics midterm prototype
- 3D modeling mechanism and top cover Fusion 360
- 3D print 3x Healix base and mechanism
- Electronics final prototype
- Assembly final prototype
- Conducting thematic analysis interview answers
- Photostudio shooting pictures + video
- Editing video midterm & final Demoday

Report:

- Introduction
- Design process/iterations
- Name of final design - Healix
- Visualisation Healix turning directions

Lara Potma

Project

- Ideation sketching
- Assembly midterm prototype
- Electronics midterm prototype
- ERB form together with approval
- Constructing questions for research
- Assembly final prototype
- Analysing research results
- Photostudio shooting pictures + video
- Editing pictures for visualisation
- Conducting thematic analysis interview answers
- Business model canvas and value proposition canvas

Report:

- Abstract
- Introduction
- Value propositions
- Ethical considerations
- Conclusion
- Acknowledgments

Anna Zambrini

Project

- Ideation sketching
- High-quality materials in design workshop
- Vitality hub visit High Tech Campus Eindhoven
- Assembly midterm prototype
- 3D modeling functional twisting Healix, and the two bases in Inventor
- Conducting interviews & questionnaire
- Assembly final prototype
- Conducting thematic analysis answers interviews
- Photostudio shooting pictures + video
- Visualising poster midterm & final Demoday
- 3 additional visualisations twisting, turning, bending Healix

Report:

- Related work and Benchmark
- Discussion
- Future work
- Visualisation process
- Template editing

APPENDICES

Appendix A: Extra figures

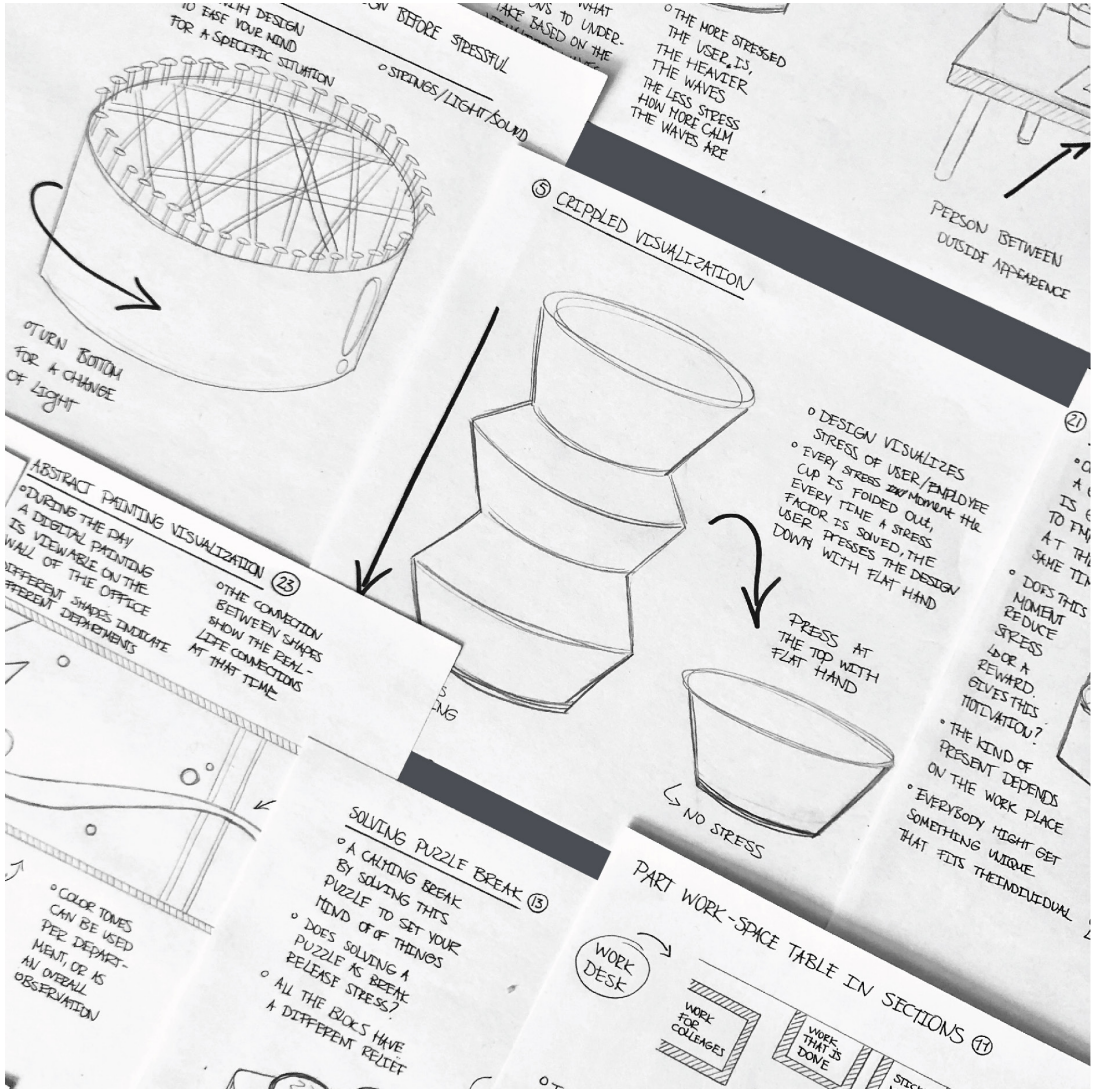

Figure A1: Section of 131 ideation sketches

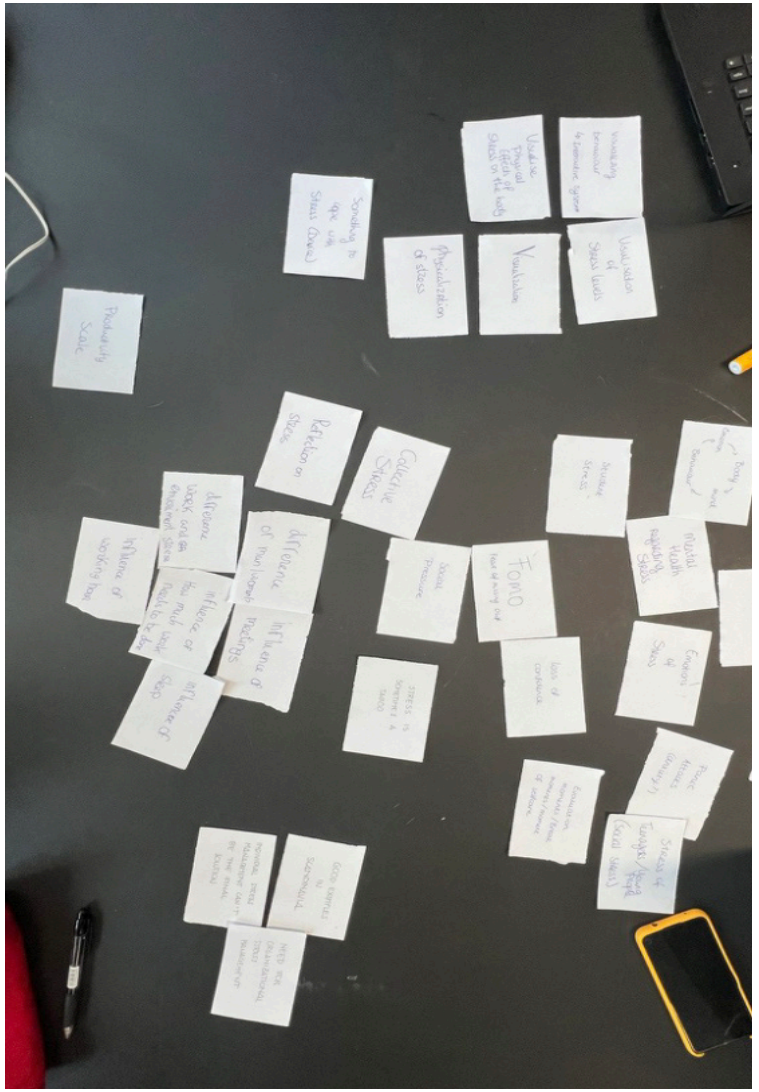

Figure A2: Corresponding groups formed from all created sketches

Figure A3: Relaxed configuration renders

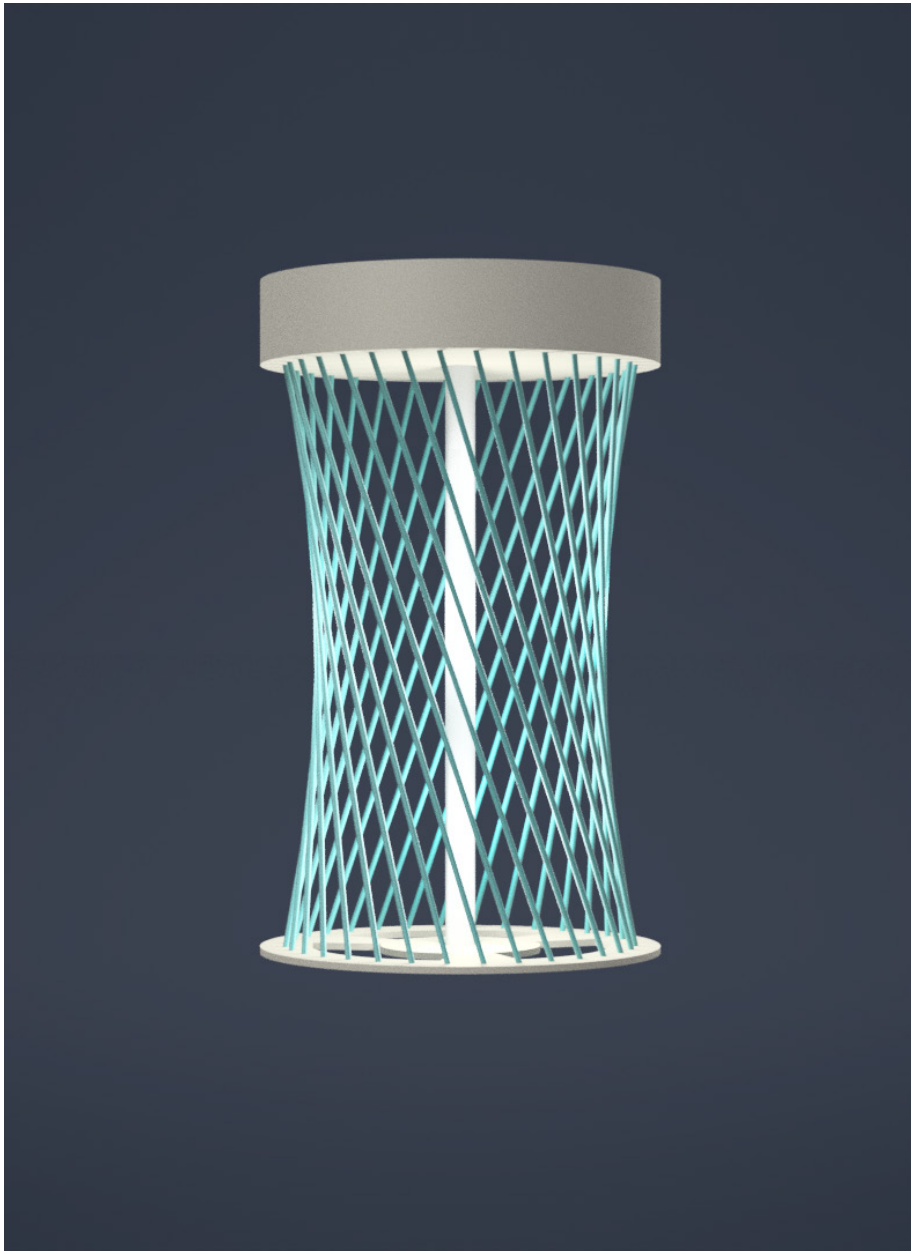

Figure A4: Stressed configuration renders

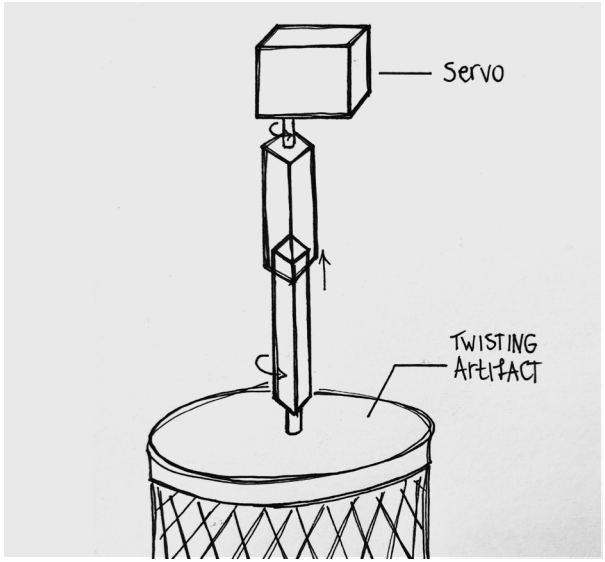

Figure A5: Twisting Healix mechanism scheme

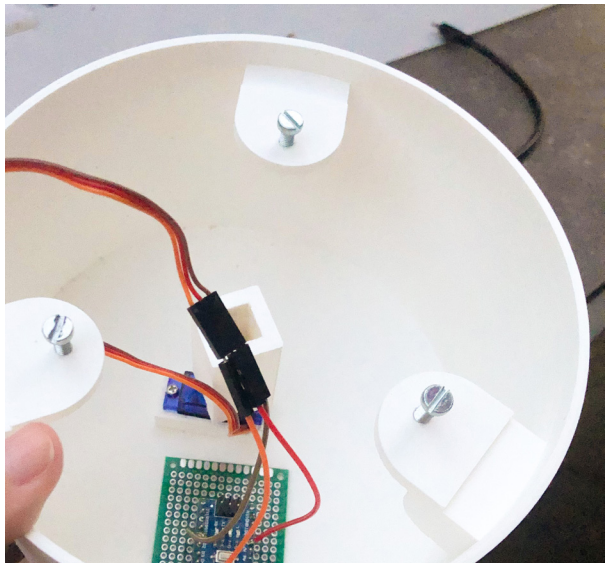

Figure A6: Twisting Healix mechanism

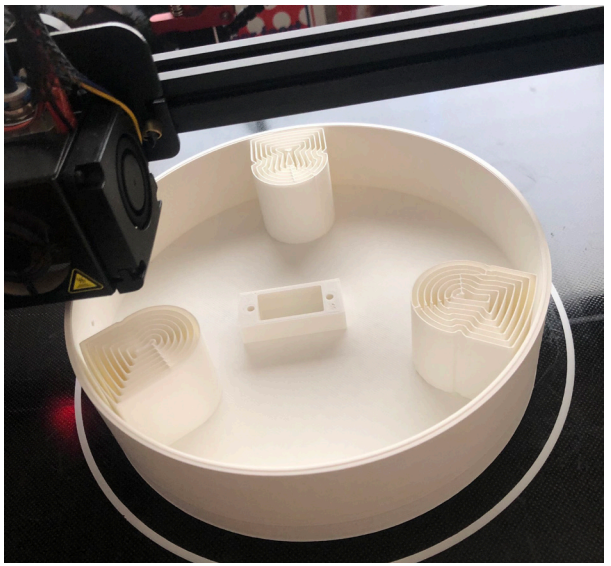

Figure A7: 3D printer

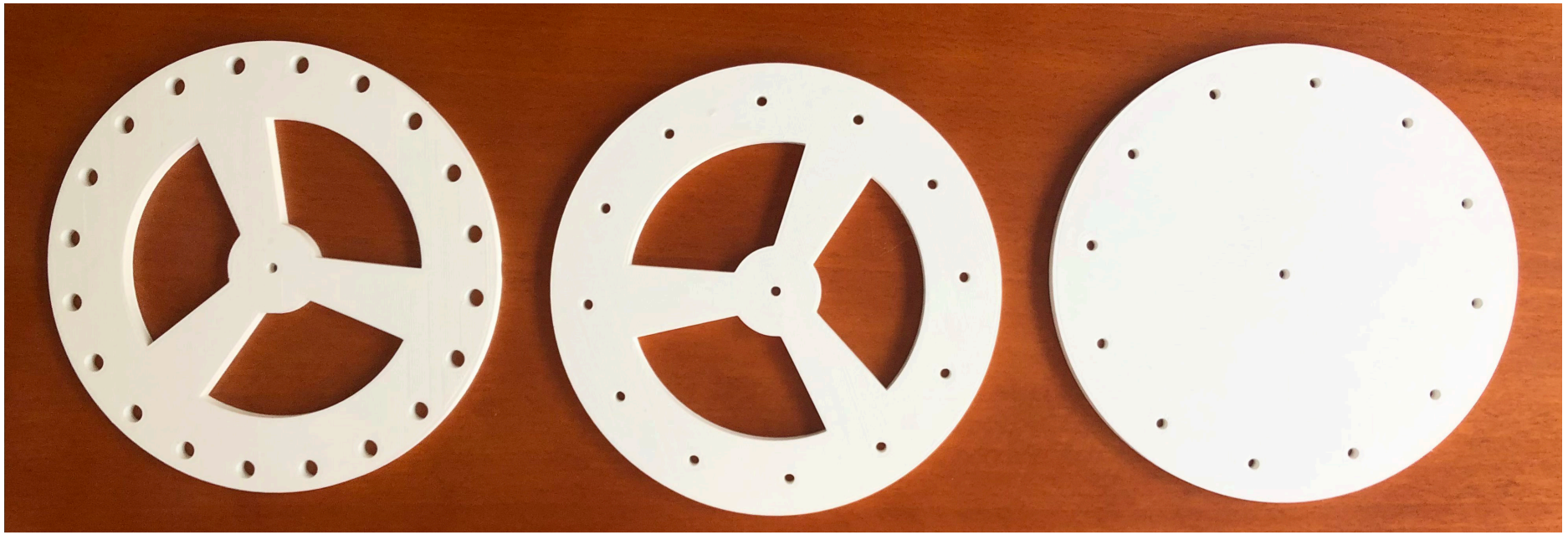

Figure A8: 3D printed bases

Figure A9: The three Healix in an open office environment

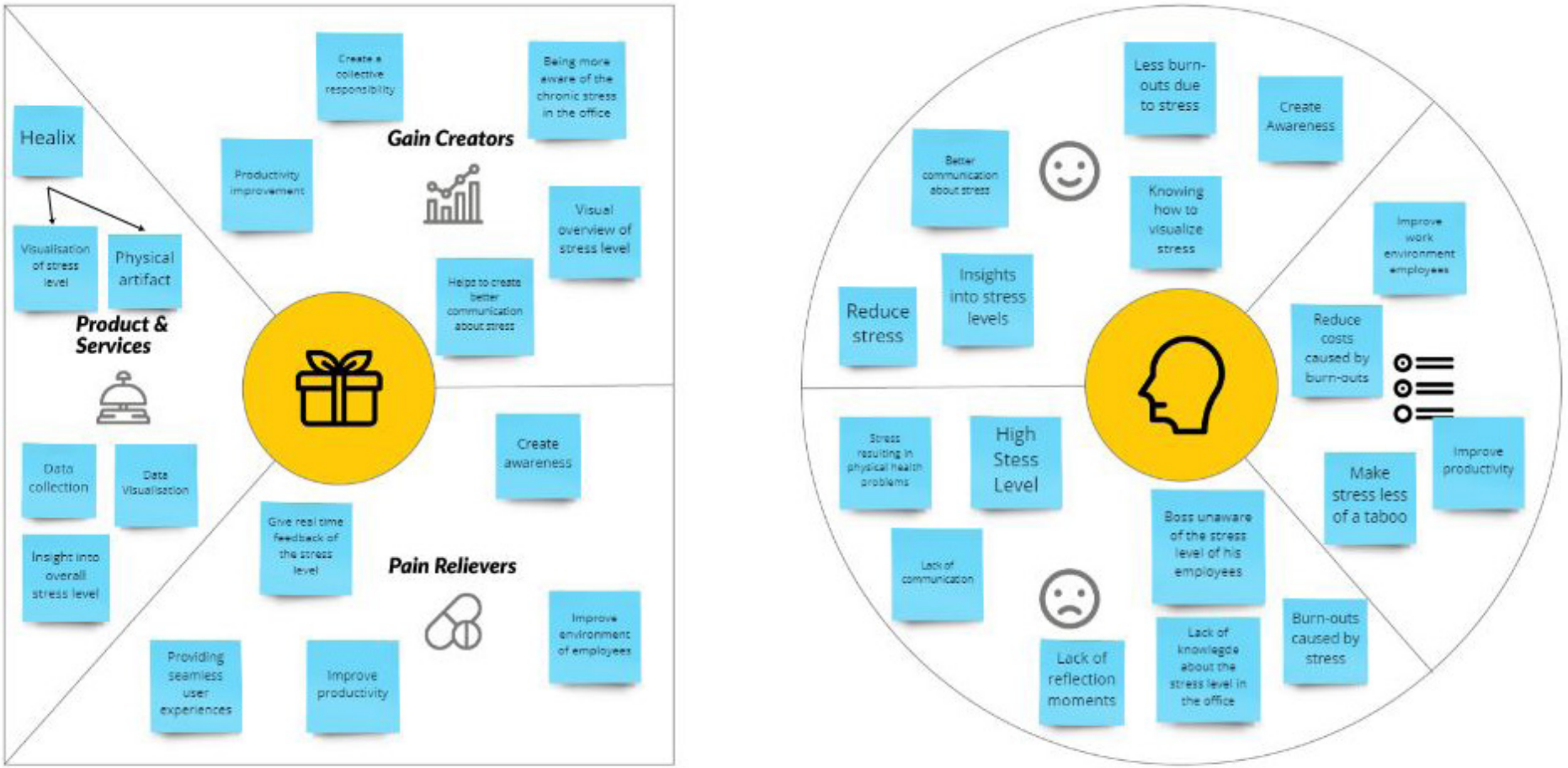

Figure A10: Value proposition canvas

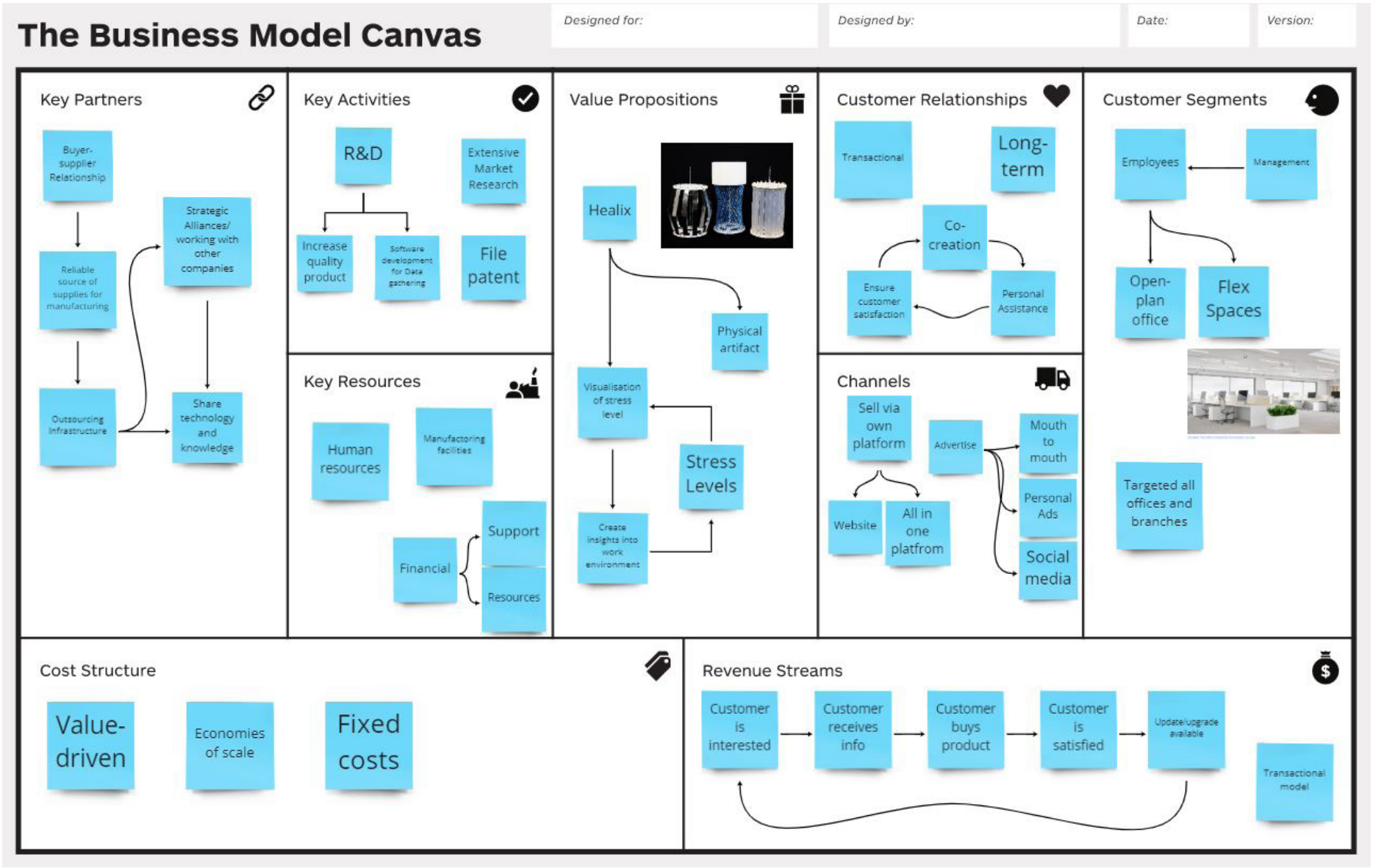

Figure A11: Business model canvas

Figure A11: Thematic analysis on Miro

Appendix B: Extra background research for the initial reserach

Biofeedback

Stress management through light

In recent years, stress has become more prevalent within the office environment, affecting workers' physical and mental health and, consequently, companies. Despite this increase in prevalence, awareness of this issue still lacks the attention it requires.A first step in individual stress visualisation has been taken by Bin Yu. In "Designing biofeedback for managing stress" he focuses on Biofeedback in the context of stress management and relaxation training. "Biofeedback", also referred to as Bio-Mirror, "is a mind-body technique that brings unconscious physiological processes under conscious control" [1], and it's proven to be a useful instrument to improve self-awareness, enhance self-regulation and facilitate self-reflection for improving health.The biofeedback systems can be categorized into five types: GSR (Galvanic Skin Response), HR (Heart Rate), Respiratory Rate (RR), HRV (Heart Rate Variability) and Multi-modal Biofeedback. Among the different case studies, attention was drawn to DeLight: a biofeedback system that studied how light could represent physiological information but also promote relaxation [2]. DeLight is an HRV biofeedback system that represents the IBI (Inter Beat Interval) and HRV data through light parameters such as colour, brightness, hue, and saturation. It visualises the IBI data by varying the diffusion of brightness between the centre and ambient lights and, at the same time, by changing the light colour, it shows the effects of breathing regulation. During inhalation, the heart rate increases, and, therefore, the brightness is shifted from the ambient lights to the centre light, closer to the body. Vice versa, when the user exhales, the brightness is transferred back to the ambient light. The research hypothesis states that light brightness could be naturally associated with the user's breathing flow and could help relaxation. By comparing DeLight to a traditional digital data visualisation, the user study was conducted on 20 participants [2] proving the system as effective: the users showed a slower heart rate, SCR (Skin Conductance Responses), which represents user arousal, stayed at a low level, breathing regulation was successful, and HRV was improved.There are two main differences between the described case study and Healix: firstly, the twisting lamp represents collective and not individual stress levels, secondly, since the designed artifact will be introduced in a working environment, less intrusive light solutions will be considered.Having said that, the case proves the effectiveness of stress visualisation through light.

Light and stress

How does dimming the light in the office environment influence the stress level?

(Day)light has an important influence on stress [3]. In the study 'The effects of light exposure on the cortisol stress response in human males' it was found that bright white light increases the release of cortisol in comparison with soft white, red, and blue light. Releasing a lot of cortisol can indicate that the person is stressed [4]. In the research of J.Oh, no significant difference was found between the two groups concerning their stress level indicated by HRV in relation to the changes in the hue, brightness, and saturation of the indoor environmental colours[5]. Because of this contradiction of results, it is possible that light triggers different indicators of stress. For instance, bright white light increases the release of cortical, while it does not necessarily influence the HRV level of someone.

Extra background research references

1. Yu, B. (2018). Designing biofeedback for managing stress. Technische Universiteit Eindhoven.
2. Yu, B., Hu, J., Funk, M. and Feijs, L. (Under Review) Delight: Lighting Biofeedback for Stress Management Personal and Ubiquitous Computing
3. Wolrd Health Organization. (2020, October 19). Occupational health: Stress at the workplace. Retrieved 6 April 2022, from https://www.who.int/news-room/questions-and-answers/item/ccupational-health-stress-
4. Schabracq, M. J., Winnubst, J. A. M., & Cooper, C. (2002). The Handbook of Work and Health Psychology (2nd ed.). Wiley.
5. Oh, J., Lee, H., & Park, H. (2021). Effects on Heart Rate Variability of Stress Level Responses to the Properties of Indoor Environmental Colors: A Preliminary Study. International Journal of Environmental Research and Public Health, 18(17), 9136. https://doi.org/10.3390/ijerph181791365.

Appendix C: Arduino code

```
#include <Servo.h>

Servo myservo;
int pos = 0;          // variable to store the servo
position

void setup() {
  myservo.attach(9);  // attaches the servo on pin 9 to
the servo object
}

void loop() {
  for (pos = 0; pos <= 180; pos += 1) { // goes from
0 degrees to 180 degrees
    // in steps of 1 degree
    myservo.write(pos);               // tell servo to go to
position in variable 'pos'
    delay(6);                         // waits 6sec for the
servo to reach the position
  }
  delay(5000);
  for (pos = 180; pos >= 0; pos -= 1) { // goes from
180 degrees to 0 degrees
    myservo.write(pos);               // tell servo to go to
position in variable 'pos'
    delay(6);                         // waits 6sec for the
servo to reach the position
  }
   delay(1000);                       //wait 1 sec and
repeat loop
```

Appendix D: Empty consent form for the interviews

Subject information for participation in scientific research

HEALIX

Official title: Which aesthetic parameters are suitable to visualize collective stress in the work environment?

Introduction

Dear Sir/Madam,

You are asked to take part in a scientific study.
Participation is voluntary. Participation requires your written consent. Before you decide whether you want to participate in this study, you will be given an explanation about what the study involves. Please read this information carefully and ask the investigator for an explanation if you have any questions. You may also discuss it with your partner, friends, or family.

1. General information

Situation	Example passage
- Study-initiated	This study has been designed by the collective stress group and is being carried out by Industrial Design students from the Eindhoven University of Technology.

2. Purpose of the study

Currently, we are doing a research project about collective stress visualization in the office environment. We have developed Healix, which is a physical representation of the stress level found in this environment. Healix is a lampshade that focuses on increasing the overall awareness of employees of their office environment/surroundings. In this research, we are aiming to discover which different parameters of Healix are preferred. The research looks at the parameters of the strings/wires, twisting degree, and overall shape of Healix.

3. What participation involves

During the study, the following will happen:
Three different artifacts are presented, and the subject will be asked to give their opinion about them after interacting with the artifacts first. After the initial interaction and initial thoughts, they will be asked to fill in a short questionnaire. Following this, a small interview will be held based on their answers in the survey and to gain further data.

4. What is expected of you

In order to carry out the study properly, it is important that you follow the study instructions.

It is important that you contact the investigator:

- if you no longer want to participate in the study.
- if your contact details change.
- if you have any further questions about the research

5. If you do not want to participate or you want to stop participating in the study

It is up to you to decide whether or not to participate in the study. Participation is voluntary.
If you do participate in the study, you can always change your mind and decide to stop, at any time during the study. You do not have to say why you are stopping, but you do need to tell the investigator immediately.
The data collected until that time will still be used for the study.

If there is any new information about the study that is important for you, the investigator will let you know. You will then be asked whether you still want to continue your participation.

6. End of the study

Your participation in the study stops when

- you choose to stop
- the end of the entire study has been reached
- the investigator considers it best for you to stop
- The Eindhoven University of Technology, the government or Ethical Review Board, decides to stop the study.

The study is concluded once all the participants have completed the study.

7. Usage and storage of your data

Your data will be collected, used, and stored for this study. This concerns data such as your filled in questionnaire and recorded data from the interview. The collection, use, and storage of your data are required to answer the questions asked in this study and to publish the results. We ask your permission for the use of your data

Confidentiality of your data

To protect your privacy, your data will be given a code. Your name and other information that can directly identify you will be omitted. The data that is used for the research will only contain the code, not your name or other data with which you can be identified. The data cannot be traced back to you in reports and publications about the study.

Access to your data for verification

Some people can access all your data at the research location. Including the data without a code. This is necessary to check whether the study is being conducted in a good and reliable manner. Persons who have access to your data for review are *Erina Böck, Susan Draaijer, Lara Potma and Anna Zambrini and the coaches Matthijs Hoekstra and Jun Hu*. They will keep your data confidential. We ask you to consent to this access.

Retention period of your data
Your data must be kept for 15 years at the research location.

Storage and use of data in other research
Your data may also be of importance for other scientific research in the field of *collective stress*. To this end, your data will be stored for 15 years. You can indicate on the consent form whether or not you agree with this. If you do not agree with this, you can still participate in the current study.

Withdrawing consent
You can withdraw your consent to the use of your personal data at any time. This applies to this study and also to storage and use for future research. The study data collected until the moment you withdraw your consent will still be used in the study.

More information about your rights when processing data
For general information about your rights when processing your personal data, you can consult the website of the Dutch Data Protection Authority.

If you have questions about your rights, please contact the people responsible for the processing of your personal data. For this study, that is:

- Erina Böck e.i.n.bock@student.tue.nl
- Susan Draaijer s.h.m.l.draaijer@student.tue.nl
- Lara Potma l.a.potma@student.tue.nl
- Anna Zambrini a.zambrini@student.tue.nl

If you have questions or complaints about the processing of your personal data, we advise you to first contact the research location or research team.

8. Any questions?

If you have any questions, please contact the study team
If you have any complaints about the study, you can discuss this with the investigator. If you prefer not to do this, you may contact the Vitality squad leader. All the relevant details can be found in **Appendix A**: Contact details.

9. Signing the consent form

When you have had sufficient time for reflection, you will be asked to decide on participation in this study. If you give permission, we will ask you to confirm this in writing on the appended consent form. By your written permission you indicate that you have understood the information and consent to participate in the study. The signature sheet is kept by the investigator. Both the Investigator and yourself receive a signed version of this consent form.

Thank you for your attention.

10. Appendices to this information

A. Contact details of researchers
B. Informed Consent Form

Appendix A: contact details for Healix

Researchers: Industrial Design students in the Vitality squad researching Collective Stress in the office environment at the Eindhoven University of Technology

- Erina Böck e.i.n.bock@student.tue.nl
- Susan Draaijer s.h.m.l.draaijer@student.tue.nl
- Lara Potma l.a.potma@student.tue.nl
- Anna Zambrini a.zambrini@student.tue.nl

Appendix B: Subject Consent Form

Healix - *Which aesthetic parameters are suitable to visualize collective stress in the work environment?*

- I have read the subject information form. I was also able to ask questions. My questions have been answered to my satisfaction. I had enough time to decide whether to participate.
- I know that participation is voluntary. I know that I may decide at any time not to participate after all or to withdraw from the study. I do not need to give a reason for this.
- I give permission for the collection and use of my data to answer the research question in this study.
- I know that some people may have access to all my data to verify the study. These people are listed in this information sheet. I consent to the inspection by them.

- I □ **do**

  □ **do not**

  consent to keeping my personal data longer and to use it for future research in the field of Collective Stress.

- I □ **do**

  □ **do not**

  consent to being contacted again after this study for a follow-up study.

- I want to participate in this study.

Name of study subject:
Signature:

Date: __ / __ / __

I hereby declare that I have fully informed this study subject about this study.

If information comes to light during the course of the study that could affect the study subject's consent, I will inform him/her of this in a timely fashion.

Name of investigator (or his/her representative):
Signature:

Date:__ / __ / __

The study subject will receive the full information sheet, together with an original of the signed consent form.

Appendix E: Questionnaire

Project 3; Healix

Currently we are doing a research project about collective stress visualization in the office environment. For this study, we developed Healix; a physical representation of the collective stress level. Healix is a lampshade that focuses on increasing the overall stress awareness of employees in their office environment/surroundings. The goal of this study is to determine which Healix parameters are preferred. The study looks at the string/wire parameters, twisting degree, and the overall shape of Healix.

Twisting of the Strings

1. Does the twisting make you aware of the stress level?

Mark only one oval.

	1	2	3	4	5	
Not at all	◯	◯	◯	◯	◯	Completely

2. What does the 'loose' position mean for you?: stressed or relaxed

Mark only one oval.

	1	2	3	4	5	
Relaxed	◯	◯	◯	◯	◯	Stressed

3. What does the 'twisted' position mean for you?: stressed or relaxed

Mark only one oval.

	1	2	3	4	5	
Relaxed	◯	◯	◯	◯	◯	Stressed

4. Do you see the twisting as an effective way to represent different levels of collective stress?

Mark only one oval.

	1	2	3	4	5	
Not at all	◯	◯	◯	◯	◯	Completely

Shrinking of the Metallic Plates

5. Do the prototype different states (stretched out, shrinking in) of the artefact make you aware of the stress level?

Mark only one oval.

	1	2	3	4	5	
Not at all	◯	◯	◯	◯	◯	Completely

6. What does the 'stretched out' state mean for you?: stressed or relaxed

Mark only one oval.

	1	2	3	4	5	
Relaxed	◯	◯	◯	◯	◯	Stressed

7. What does the 'shrinking in' state mean for you? stressed or relaxed

Mark only one oval.

	1	2	3	4	5	
Relaxed	◯	◯	◯	◯	◯	Stressed

8. Do you see stretching and shrinking as an effective way to represent different levels of collective stress?

Mark only one oval.

	1	2	3	4	5	
Not at all	◯	◯	◯	◯	◯	Completely

Turning of the plastic Lamellen

9. Do the two different states (open and closed lamellen) of the artefact make you aware of the stress level?

Mark only one oval.

	1	2	3	4	5	
Not at all	◯	◯	◯	◯	◯	Completely

10. What does the 'closed lamellen' state mean for you?: stressed or relaxed

Mark only one oval.

	1	2	3	4	5	
Relaxed	◯	◯	◯	◯	◯	Stressed

11. What does the 'open lamellen' state mean for you? stressed or relaxed

Mark only one oval.

	1	2	3	4	5	
Relaxed	◯	◯	◯	◯	◯	Stressed

12. Do you see the closing and opening as an effective way to represent different levels of collective stress?

Mark only one oval.

	1	2	3	4	5	
Not at all	◯	◯	◯	◯	◯	Completely

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Google Forms

Appendix F: Interviews

Participant 1

Individual initial interview, general about stress:

What does stress mean for you in the office environment?
Depends; stress in the work environment is related to deadlines and get stuff done in time
Real stress is when you are out of the work environment and can not stop thinking about work and do not relax anymore from the moment you are doing something relaxing

Do you feel like that stress is an issue within the office environment?
Collective feeling of stress is when people are stress, Tension, people do not talk to each other and you feel that it will burst

Do you feel that stress is a taboe in the office?
People like to talk about it but it is difficult to start talking about. When everyone feels that there is stress people stop talking, cause you have the feeling that it will escale. Do not talk about the stress. If one persons has stress and perhaps you are trying to point it out then. But everyones is stressed; everyone is interdiependent and then talking will escale

How do you feel about your stress level being measured while working?
It does not say anything, it does not matter, i track it with a stress tracker. Not have the feeling that he is stressed even when the Miband is saying that he is stressed. More the feeling that the data is incorrect.

How do you feel about your stress level being shown in a collective stress visualisation? (data is still anonymous)
Depends stress is privacy related, i like to talk about it sometimes, but i need to be open then. It comes with waves, sometimes i do want to talk about it and then i do not. Depends also about where the stress comes from either private or work. Work easier to talk about in environment. But private stress is not what you want to talk about it at work
Depends on the context, there was a point in the student team that everything was gone wrong. Everyone is stressed because one part fucked it up, so everyone is stress. There are certain days that everyone is stressed, people already feel that their is stress, a slap in their face.
In the open workspace less interested if you do not know the person.

Showing the prototype for the first time
What's your first impression of the three prototypes:

- What does the twisting of the strings evoke in you?
  - Fun water machine
- What does the stretching of the metallic lamellen evoke in you?
  - Blade from a kitchen machine
- What does the turning of the plastic lamellen evoke in you?
  - Filter of a car

Explanation of the projects aim; so collective stress artifacts

Prototype 1 (strings):

1. **Appearance**
    1. **How do you feel about the material?**
        i. A bit lose, get the feeling that the top part can turn. It is nice blue with white, is a contrast. Looks the most soft, playful one
    2. **Do you feel that this fits a work environment?**
        i. I can make guesses, it looks like a piece of an art.
    3. **Could you image this hanging in the a working environment?**
    4. **Where do you prefer to have it in the office? Close by the desks, coffee machine, exit door etc.**
        i. If it is static then fine on the desks
        ii. Bookcase in the side of the office
        iii. In the middle of four desks
2. **Movement**

. **What do you think of the movement?**
Repetitive movement i think of a heartbeat, it twists the strings get twisted just like your mind sometimes

Prototype 2 (metal plates):

3. **Appearance**
    1. **How do you feel about the material?**
        i. It will cut my fingers, it looks like blades
    2. D**o you feel that this fits a work environment?**
        i. Not really fits in the environment, it looks ugly if you ask me. I do not like this, not put on the desks
    3. **Could you image this hanging in the a working environment?**
    4. **Where do you prefer to have it in the office? Close by the desks, coffee machine, exit door etc.**
        i. Maybe on the side, or in the side of the office environment → but not in the environment
4. **Movement**

. **What do you think of the movement?**
Breathing, it could show how many beats in a minute. The movement is good for expressing, about conveying the stress. Will work just as fine. Overall is the aesthetics appeal, strange looking. More silicone base perhaps. More dense will make it better,

Prototype 3 (plastic plates):

5. **Appearance**
    1. **How do you feel about the material?**
        i. I like the material, sad part of the wooden part (just the little finishes), general tip small things will make designers talk about it.
            1. The colour white/plastic is more a unity. Less eye-catching, less conveyed to it. Static white plastic. It could blend more in a certain space than the other two
    2. **Do you feel that this fits a work environment?**
        i. This one could fit in an work environment. If it is a light shade.
    3. **Could you image this hanging in the a working environment?**

4. **Where do you prefer to have it in the office? Close by the desks, coffee machine, exit door etc.**
    i. I would put it on the table
6. **Movement**
    a. **What do you think of the movement?**
    Will it be a pattern or all at once?

No rhythmic movements, It conveys something about open/close. It will say something I open up for stress. It can be both ways (closed: I am not stressed, so you do not need to talk to me or I am stressed talk to me). Either means I want to talk cause I am not stressed or I am stressed do not talk to me.
Making movement it:
Do not image it now. All about how it looks when it moving

2) REFLECTION INTERVIEW
Questionnaire

1. In a knot like as in a stress. Also the tension with the tension of the strings

4. It can go both ways, it depends on which part you are looking. Less easy to see the collective part

9. It can go both ways, more meanings behind it. Maybe do something with colour of the light in the middel what means something. A flicker lamp means
Combine the different parameters, difficult to make meaning behind it

Interview questions after the questionnaire has been filled in:

Asking "why" of the questions of the questionnaire?

Appearance

- **Which parameters did you feel that expressed/showed stress the best?**
    - Metal is hard material → not relaxing, metal regadrelss of their state
    - The lamel clean, relaxing material. Not hard not ugly → not a opinion
    - The blue and white, it depends on the colour a lot(red will look odd), the material has two states, it is still soft.
- **Would you create a different prototype/combination based on the parameters that were shown?**
    - **Would you add or remove something of the artifact?**
        - Different feeling if the 'blades' are more closer to each other
    -
- **How did you perceive the metal/plastic/strings as material?**
- **Which material did you express stress the best?**
    - And why?
        - Strings → softnesses but the tension.

Movements

- **What did you think about the different movements of the artifacts?**
- **Are there any other movements that you would suggest for expressing stress?**
    - **Would you add/replace/remove one of the current directions?**
-
- The movement of going up and down. Maybe a fabric, make it about the movement.
- New movement: twisting one is really nice, not a new movement. The strings does the job.
- Which direction did you find natural coupled to stress?
    - I can find stress everything if i look enough. But with the strings have the feeling of having tension.
-

General
How did you perceive the coupling between the material and the movement?
Do you see these concepts work in the office environment? (With the adaptation the user made)
If it hangs from the ceiling: consequently moving i will ignore it, but over a longe rperiode of time i will notice ,

- **Hanging will make it better for the collective. How well do you notice change?**
    - How often is it changing?

Do you feel that such an artifact would distract you too much while working?
Or that you are going to activate try to influence the artifact?
You can not influence the stress, so do not stress. Perhaps take offf the tracker
Not breathing exercises, it will not help the stress lower. Just fix the deadline then it will go down. Handed deadline then just relaxed. I will ask other for help if others are relaxed, but also when others are stressed you have the feeling that you are not alone (however i will less easily talk to someone about it)

Participant 2 and 3

First Interaction with the prototype

Individual initial interview, general about stress:

What does stress mean for you in the office environment?

Participant 2: certain discomfort related to a lot of work or personal relationship

Participant 3**:** a kind of fear, or social fear inside the including people in the office + the work you should do. The amount you should do

Do you feel like that stress is an issue within the office environment?

Stress is an issue in the office, different level but also their, their is an amount that put you to work. Without the stress you do not things, but too much is unhealty

I think it is an issue; stress motivates you to do more, but the fear that you are not managing is stress

Do you feel that stress is a taboe in the office?

It depends on relationship how powerful relationships have a influence. Depending on who you boss is you express it to them, but overall you do not talk with someone of a higher hierarchical.

I think that people start talking about it, it is a trend. It is a evaluation of teamwork and how projects are done nowadays. Including the methodology and stuff. Team corporation stuff you start caring for your teammates.

How do you feel about your stress level being measured while working?

I would not believe it, it will be sceptiocal; i think it could be manipulate. If it is implanted in the company i would not trust it. It could also be seen as a weakness; where it is competitive. That could be used against you; not get a promotion

I will be secptiol. Assess your stress perhaps, which is not good,

How do you feel about your stress level being shown in a collective stress visualisation? (data is still anonymous)

I think it is interesting

Better then individual, but not sure if i want to see it. It could influence me, the stress level is super high today i would stressed as well.

Would it help if you can see that others are not stress? Will it help you to talk with people about your stress?

I will start delegate stuff, i think that the stresslevel measurements could be counterproductive. If i was my boss i would use it

I will not give away my work, then i have the feeling i am not dealing with it.

Showing the prototype for the first time

What's your first impression of the three prototypes:

- **What does the twisting of the strings evoke in you?**
    - *Visual inclusion. If i move a bit then everything moves, it forces you to see it*
    - It will grab my attention. When i want to distract myself i will look at it
- **What does the stretching of the metallic lamellen evoke in you?**
    - *Less attractive, more hard and cold*
    - Less eye cathing
- **What does the turning of the plastic lamellen evoke in you?**
    - Regular thing, something i do not notice, lamp or something

Explanation of the projects aim; so collective stress artifacts

Prototype 1 (strings):

1. Appearance
    1. **How do you feel about the material?**
        i. I get the feeling that i want to make it more tensed
        ii. It stressing me out, it is not static, more difficult; give it more form
    2. **Do you feel that this fits a work environment?**
        i. in someones desks, son or daughter made it. Not in a useful tool
        ii. I can envision it in a tempore office. I prefer to work is more progressive, so then yeah
    3. **Could you image this hanging in the a working environment?**
    4. **Where do you prefer to have it in the office? Close by the desks, coffee machine, exit door etc.**
        i. It depends, art exhibition, huge piece of art
        ii. Middle of the desks; perhaps also in by the coffee machine
2. Movement

. **What do you think of the movement?**

It is something that you watch,

Like watching a fountain, sit and watch it. It is relaxing in someway.

Prototype 2 (metal plates):

3. Appearance
    1. **How do you feel about the material?**
        i. It would be cool if it is huge, in the entrance of the office. The sun on it will reflect, other way then the other material. It is raw
        ii. Is less subtle than the other, but you still watch in it.
    2. **Do you feel that this fits a work environment?**
        i. I can see it, a bit more boring
    3. If it was bigger then yeah.
    4. **Could you image this hanging in the a working environment?**
    5. **Where do you prefer to have it in the office? Close by the desks, coffee machine, exit door etc.**
        i. Make it smaller and then put in on someones desks
        ii. It looks also like a cage, but also on the desks
4. Movement

. **What do you think of the movement?**

I like it, original movement, surprising movement

It is not something that you expect that it does this movement

Prototype 3 (plastic plates):

5. **Appearance**
    1. How do you feel about the material?

i. *I do not like it, it feels cheap. The wood and the plastic → looks like elementary school work*
ii. Very normal, part of the furniture

2. **Do you feel that this fits a work environment?**
   i. I will not look at it, not eyecatching
   ii. Less attractive one, not put in an office
3. **Could you image this hanging in the a working environment?**
4. **Where do you prefer to have it in the office? Close by the desks, coffee machine, exit door etc.**

6. Movement
   a. **What do you think of the movement?**
   It is satisfying
   The movement makes it more interesting. Not so cool as the other one (blades), because then the whole dimension change.

2) REFLECTION INTERVIEW

Appearance

- **Which parameters did you feel that expressed/showed stress the best?**
  - **T**he tension of all the prototypes express stress very well. Also the chaos can represent stress well but not in this cases
  - *The movements are the most factors for the expression of the stress. More then colour or shape.*
- **Would you create a different prototype/combination based on the parameters that were shown?**
  - **Would you add or remove something of the artifact?**
- **How did you perceive the metal/plastic/strings as material?**
- Metal is the best to represents stress. A tension chord could represent but their is more open interpretation then with the metal more intuitive.
- *Metal can fitt in the work envoriemtn. Before seeing the prototyupes i would say strings where the best but after seeing the prototypes i would say the metal is best.*
- **Which material did you express stress the best?**
  - **And why?**
- *I will make it more stimulation, more different parameters , do something with light.*

Movements

- **What did you think about the different movements of the artifacts?**
- *Vibration.*
- Not particular movement, but more the sense. For instance the chaotic movement for stress, slower more relaxing.
- **Are there any other movements that you would suggest for expressing stress?**
  - **Would you add/replace/remove one of the current directions?**
- **Which direction did you find natural coupled to stress?**

General

How did you perceive the coupling between the movement and the movement?

Because of your past experience you know the movements of certain materials. Or what you guess they will do
I like that the breaking more then the strings, because it can break forever and then it not go back anymore, better to it. Too much pressure will make sure that you talk about it

Do you see these concept work in the office environment?(With the adaptation the user made)

Do you feel that such an artifact would distract you too much while working?
I will be distracted, i will look at it, even in the long term perspective i will look at it. It is not that it is distracted, subconseuqtly you will look at it (metal). It depends on where it is. Happening very slow. More once a day or contuinitly very slow

I think you see the weather in the computer, maybe see it once a day and someday you just do not look it. I like if it was digital and not a physical artifact. It looks to me more to an art, it is not a tool a widget is more fitted. One per building i would compare that, if it per office it does not represents the collective. One per building is not representative individual, but one per floor will be comparing more like and the office. The work environments will be used as a weapon.

Per office is more representative, it depends on the scale. The distruction of the stress is very scarted if you have a big building. The bigger scale the more stable the state would be. Because average it will be the same.

Or that you are going to activate try to influence the artifact?
Depending on how the stress is measured. But yes i will try to influence it, people will find a way to trick it. It is useful for you, but not to communicate. But indidivudal it can be useful

It will subconsciously influence me and how i do, if you just place it somewhere. It will be so different, when you tell people what it means.

Questionnaire

I feel that it is compled to stress, the twisting feels like more stress even

The other movement (twisted state) when everything is in order it feels less stressed. Then when the other one where it is chaotic. Seeing it messy feels more stress ful. If it is a metophoner for stress with strings. Not inclusive with OCD. Beautiful to see the change

It is supper intuitive that it is stressed.
It looks like a material that seems to brake, very tensed. Strong bars, expected form is that is straight

It does not feel like stress, not a good representation. Spiral ones perhaps more.

It is not associating with stress, not related. More a open interpretation

The rytime can give you an impression of the stress.

Participant 4

Individual initial interview, general about stress:

What does stress mean for you in the office environment?

A lot of tasks, a lot of people running around, deadlines, follow up deadlines. Things breaking last minute, you need to fix it, a lot of work in short time. Personal stress, i get stressed if others are stressed. Personal environment sometimes on the characters, their people who bring it indirectly while other use the stress to hide from the issues. Very personal, but people do get influenced by others who is stressed. I assume that others get stressed as well.

Do you feel like that stress is an issue within the office environment?

Definitely, it is an issue. It does not go away, their is an increase in the workload, people are working more, do more taks and have more the feeling that they need to do more(live up to expectation), a lot of compotionion. Comparing yourself to others, influencers. Just general basic stress level is increaeds which we find normal. You are more relaxed if ou are not doing any of these mentioned above, especially when you are at holiday. But back home it is full on. Being relaxed, 0 relaxed and 100 super stress. Normal at a holiday it will be a 5/10, but on average days at home 20/25, work till 50/60

Do you feel that stress is a taboo in the office?

It is used a way to justify yourself, to brag. ‘I am so stressed, i have so many thing to do’, it is seen as begging productive, people use it as an excuse. I am already to busy so i can not help right no. People will do less things in long term perspective. People are proud to be stressed, it is a social economic problem. If you are not stressed, you are not perspective. It depends on the generation. Talk about productive then stress. Much more research are done about habits that improve the productive. mental/emotional health, going to the right therpatis → younger generation. In new company people are more conscious about their environment. Also in the universities a bit more leaned back,(you do not need an excuse to skip class, while in germany can not leave class(need a sick note from the doctor to skip class). Work culture is very important. Fear that it will be used against.

How do you feel about your stress level being measured while working?

I already do it, i like it. I am not good with emotion, to busy to realise how stressed you are, seeing it back in some kind of data is useful for me.

How do you feel about your stress level being shown in a collective stress visualisation? (data is still anonymous)

I think it can help for some people, to sympathise. There is a personal and a collective view, for the person self. The visualisation depends on the positive or negative visualisation. It is not useful to visualise negative in a negative way. It should be something that grabs your attention, back to relaxing methods.

Showing the prototype for the first time

What's your first impression of the three prototypes:

- **What does the twisting of the strings evoke in you?**
    - I like the shape of it, the tightness does have a restraining type of feel. Like a body being knotted,
- **What does the stretching of the metallic lamellen evoke in you?**
    - Reminds of a barrel. It seems unneat. It seems messy
- **What does the turning of the plastic lamellen (in an open way) evoke in you?**

- I like this more, elegant, airy. I don't think threatening feeling, very calming feeling in both sides. It does not feel bad in either states. Japanese kind of feel, minimlizing. Just chill

Explanation of the projects aim: so collective stress artifacts

Prototype 1 (strings):

1. **Appearance**
    1. **How do you feel about the material?**
        i. I do not like the strings, the blue/white is too much for me eyes, too busy. Not good for my ADHD. A monocolour would be nice. The thickness give characterics. Different pattern. Pure attetack
    2. **Do you feel that this fits a work environment?**
        i. Very top heavy. What is the size?
        ii. If it this size, with transplant strings → desks size
        iii. But a bigger size, standing.
    3. **Could you image this hanging in the a working environment?**
    4. **Where do you prefer to have it in the office? Close by the desks, coffee machine, exit door etc.**
        i. Kind of cool a big more gigantic. In the middle of the office, from ceiling to the floor. Very huge impact. It would be fun as a desk lamp in a smaller size.
2. **Movement**

What do you think of the movement?

The movement way slower, 10% of this sweet. More creeping change, the movement is too fast, grabs too much attention. It should be in your periphery. It should not make the intervention with your work. I think it is not apprentice when every 5 minutes you are told you are stressed

Prototype 2 (metal plates):

3. **Appearance**
    1. **How do you feel about the material?**
        i. It is a really interesting concept, i have not see much in this direction, very interesting.
        ii. Different conceptualize, thinner, i do not see it much in a stress environment
    2. **Do you feel that this fits a work environment?**
        i. Grab attention in a slow way. Because of the metal reflection and the light reflection. It is very chunky. I think it is a great art piece when it is bigger. It just reminds of a barrel.
        ii. As a big piece yaeh, not as a table piece. The bigger it would the bigger effect it would have → looks more nice
    3. **Could you image this hanging in the a working environment?**
    4. **Where do you prefer to have it in the office? Close by the desks, coffee machine, exit door etc.**
        i. Depends a bit on the floor plan
            1. Center, a place where people walk by a lot,
            2. Gang, near the kitchen, toilets.
            3. It has the bragging effect
4. **Movement**

. **What do you think of the movement?**

I think is an interesting one, it looks like a cocktail umbrella (parapultje as kind), the japanese type of lampignons. It is a nice from, as a bigger from it would be more effect, A cluster could also be aesthicly pleasing. It is frosting that it does not go all the way back. It is art topic which it could be interesting, but more if it was broken completely, more damage then this. I like this more, elegant, airy. I don't think threatening feeling, very calming feeling in both sides. It does not feel bad in either states. Japanese kind of feel, minimlizing. Just chill

Prototype 3 (plastic plates):

5. **Appearance**
    1. **How do you feel about the material?**
        i. I like it more, i like the wooden influence, the transparent, the airness, this is my favourite one
    2. **Do you feel that this fits a work environment?**
        i. I think that it fitness really wel, it more universale in a way. You have a lot of different interpretations, it has the open en close, the transparency. Nice message, very personal and also every panel could be a person. It could be a plan instead of a circle. To divide the work place (a screen),
    3. **Could you image this hanging in the a working environment?**
        i. It could be longer, but for it hanging it should be bigger etc. To see the influence.
    4. **Where do you prefer to have it in the office? Close by the desks, coffee machine, exit door etc**.
        i. It could be on a table, or public displaced
6. **Movement**
    a. **What do you think of the movement?**

    I like it, a lot, it is nice and more interpretable. Less clear, has both option. I think that is good, also if it is about personlizatoin. More with automotizmen. Personally like that is chaotic. More satisfying if it is done more gradually.

2) REFLECTION INTERVIEW

Interview questions after the questionnaire has been filled in:

Asking "why" of the questions of the questionnaire?

Appearance

- **Which parameters did you feel that expressed/showed stress the best?**
    - Type of turning is a good representation of stress. The panels i just prefer them are more calming. The strings it is still kind of nagging. The panel is more i like turned.
    - The strings are most linked with the stress, most compelled. It mades me more stressed
        - Metal: maybe more rubbery material, i will accept it more. Perhaps thinners strips, it would have more movements. The idae of damage just turns me off

- **Would you create a different prototype/combination based on the parameters that were shown?**
    - **Would you add or remove something of the artifact?**
        - Perhaps change the panels to the shrinking one, also the metal could also be used in the panels. Subtle subconscious of design view.
- **How did you perceive the metal/plastic/strings as material?**
- **Which material did you express stress the best?**
    - **And why?**

Movements

- **What did you think about the different movements of the artifacts?**
- **Are there any other movements that you would suggest for expressing stress?**
    - **Would you add/replace/remove one of the current directions?**
- **Which direction did you find natural coupled to stress?**

General

How did you perceive the coupling between the material and the movement?

Do you see these concept work in the office environment?(With the adaptation the user made)

I am not too sure, that should be tested in a work environment. It could be image that it is a nice art piece. I do not it depends a lot of different aspects. Some companies could be interested.

Do you feel that such an artifact would distract you too much while working?

It would depend, the strings/panels will be the least distraction in the office environment, The metal one the most. (it will have the most effect, most attention seeking)

Or that you are going to activate try to influence the artifact?

Definitely I will play with it, breathing exercise. It is fun to manipulate your data.

Participant 5

1. **First Interaction with the prototype**

Individual initial interview, general about stress:

What does stress mean for you in the office environment?

Basically all work is stress. It depends. Doing stuff i did not before, makes it more stressed. Doing new things. I get stressed if others are stressed. Very sensitive to others emotions. Ofcourse you bring stress from prive tot work

Do you feel like that stress is an issue within the office environment?

I think it is a really issue

Do you feel that stress is a taboe in the office?

It is getting less a taboe, it is a small firm there is a big difference. People are getting more used to talk about. I do not have problems talking about it but others do

How do you feel about your stress level being measured while working?

I think be nervous at first. If it was not just me but the entire office(but the data used for a good cost and depends on the collective where I am; are it friends/ or boss)

How do you feel about your stress level being shown in a collective stress visualisation? (data is still anonymous)

I would not have a problem with that, that is fine

Showing the prototype for the first time

What's your first impression of the three prototypes:

- **What does the twisting of the strings evoke in you?**
    - It looks cool, i feel that the strings are unstable.
- **What does the stretching of the metallic lamellen evoke in you?**
    - It looks like a cool design. Space thing
- **What does the turning of the plastic lamellen evoke in you?**
    - I like this the most, it is clean, the materials that are used are nice .Calmness one. The other two are a bit distracting

Explanation of the projects aim; so collective stress artifacts

Prototype 1 (strings):

1. **Appearance**
    1. **How do you feel about the material?**
        i. The contrast between the colours is too much. Should be less. Blue is for me not the calmness colour, maybe a warmer toon.
    2. **Do you feel that this fits a work environment?**
        i. Yeah it could definitely be in a work environment
    3. **Could you image this hanging in the a working environment?**
    4. **Where do you prefer to have it in the office? Close by the desks, coffee machine, exit door etc.**
        i. Higher place, in the middle of the workspace area. Visible for everyone
2. **Movement**

. **What do you think of the movement?**

The movements should be slower for the work environment otherwise too distraction. I like how it goes smoothly

Prototype 2 (metal plates):

3. **Appearance**

1. How do you feel about the material?
    i. I like that it is minimalistic. It is super simple. I like the proportion. Maybe the light reflection can be distraction.
2. Do you feel that this fits a work environment?
    i. Yeah, no problem
3. Could you image this hanging in the a working environment?
4. Where do you prefer to have it in the office? Close by the desks, coffee machine, exit door etc.
    i. Looks more for a piece by the door by the entrance. Kind of a scultplure

4. **Movement**

What do you think of the movement?

the movement is less elegant than the frist one, Maybe it is better as a visuazlation of the tension in the office.

Bothered by the fact that it does not go back completely?

Not bothered by that. I like the shape. I am not sure if people would notice, if the metals are still bend,

Prototype 3 (plastic plates):

5. **Appearance**
    1. **How do you feel about the material?**
        i. Calmness, use of the wood/transparancy.
    2. **Do you feel that this fits a work environment?**
        i. Definitely image in the center where everyone can see it
    3. **Could you image this hanging in the a working environment?**
    4. **Where do you prefer to have it in the office? Close by the desks, coffee machine, exit door etc.**
6. **Movement**
    a. **What do you think of the movement?**
        Does it light up more when it opens up?

Distracted that you can see the inside pool of the lamp, the shape of the bottom base should be full. The inside perhaps should be also wood. It can be a nice effect, gradual can be nice effect.

2) REFLECTION INTERVIEW

Interview questions after the questionnaire has been filled in:

Asking “why” of the questions of the questionnaire?

Appearance

- **Which parameters did you feel that expressed/showed stress the best?**
    - Strings is the best participants with the twinsting movement.
- **Would you create a different prototype/combination based on the parameters that were shown?**
    - **Maybe prefer different colour of the strings. The strings are the best option.**
    - **Would you add or remove something of the artifact?**
        - The plastic in the metal one, now it is matching with the construction inside,
        - The plastic one can play nice with the light
- **How did you perceive the metal/plastic/strings as material?**
- **Which material did you express stress the best?**
    - **And why?**

Movements

- **What did you think about the different movements of the artifacts?**
    - The pressing one, and the stretched out. Is like the best in my head for that.
- **Are there any other movements that you would suggest for expressing stress?**
    - Maybe the intensity of the lighting, i can see that working. The office light is stressed intensive the light. Then people can see it.
    - **Would you add/replace/remove one of the current directions?**
- **Which direction did you find natural coupled to stress?**

The strings with the twisting is the most coupled to stress.

General

How did you perceive the coupling between the material and the movement?

Do you see these concept work in the office environment?(With the adaptation the user made)

Do you feel that such an artifact would distract you too much while working?

It would depend on the intensity of the lighting and the movements(should be way slower). Consequently and slowly changing

Or that you are going to activate try to influence the artifact?

I think if the whole office had a bad feeling. Perhaps people will change their tone of speaking. I think it could help behave nicely. I think it might help talking about stress.

Participant 6 and 7

Individual initial interview, general about stress:

What does stress mean for you in the office environment?

P6: The causes are when you have too much work and you have the feeling that you can not handle everything, but you want to. You also have private problems.you can also sense the stress of others, when others are stressed you get stressed too. I can feel the influence of others a lot, my mood is influenced by others

P7 i get stressed when i do not have all the information. Then have the feeling that you do not know what to do exactly. I have the feeling that i needed to be stressed to be product, i can be good for me. It is difficult to know where the limit is

Do you feel like that stress is an issue within the office environment?

I think it is an issue, not enough attention to it. You need to take time to think about your stress, but there is not enough time for that. You need to pay attention to it *definitely*

Do you feel that stress is a taboe in the office?

I don't feel that it's a taboe, it also depends on the person

I have the feeling that you can tell it to friends, but in the work environment you have some responsibilities and you need to look professional

How do you feel about your stress level being measured while working?

Yeah

How do you want to measure it? I would like to see the results, sometimes you have the feeling that you are stressed and then i want to see if i am exactly stressed.

How do you feel about your stress level being shown in a collective stress visualisation? (data is still anonymous)

P6: depends on the quantity of the people. Stress is an individual problem. I don't think that it is the right way to see it as a collective problem. It is very subjective. Talking about it helps. I find it hard to think about to talk about stress in the work environments. I think it can help a lot if everyone participate in it.

P7 agrees with the subjective problem. For me i need to speak out loud about the problems i am experience, because then i am reconsidering it. Talking to people i trust about it. If all the people participate i think that it might be useful to globally think about the results

What's your first impression of the three prototypes:

- **What does the twisting of the strings evoke in you?**
- P6: i like this one, the movement is really smooth. Also because of the material
- *P7: i like the movement. But i do not like the material (shiny rope). The composition is very nice, i like the strings*
- **What does the stretching of the metallic lamellen evoke in you?**
- P6: i like it, but the material. Visualise nice with the light/reflection
- *P7: it looks like torturing someone. It feel strong*
- **What does the turning of the plastic lamellen evoke in you?**
- P6 : because you can not see through. In the second place
- *P7: i like this one, it's a bit transparent. I like the material and colours, i am not sure about the movement yet. This one is most aesthetically nice*

Explanation of the projects aim; so collective stress artifacts

Prototype 1 (strings):

1. **Appearance**
    1. **How do you feel about the material?**
    2. P6: it is smooth, because it is not a strong material. It moves following gravity. When it swifts, it starts straight then bend, nice movement it is kind of relaxing. The colour is kind of bright, perhaps pastel blue.
    3. *P7: i like the material, because it is not stiff, it can bend. For me the robe: the colour and the shiness, makes me nervous. I like the material, but i do not like the shinnes of the colour of the rob at all. Feels to artisiscs*
    4. **Do you feel that this fits a work environment?**
    5. Yeah as a lamp or something
    6. *Yeah, because at my work i always look at my screen. Then it will be nice, if it would work*
        i. *It will be better to looking into the screen. It is a nice break(physical watching something calming)*
    7. **Could you image this hanging in the a working environment?**
    I will not looking at it when it is hanging, i do not pay attention to the lamp
    I always pay attention to the ceiling, i will notice it , but it depends. Not imagine it hanging from the ceiling. I can image it in a bigger dimension in a common area
    8. **Where do you prefer to have it in the office? Close by the desks, coffee machine, exit door etc.**
    9. *Next to the computer, vensterbank(next to the flower)*
    10. On the the desks, i image it a little smaller standing somewhere. Perhaps on the floor
2. **Movement**

. **What do you think of the movement?**

P6: i think it slower, it is nice and without the sound. It is nice, i liek taht it gets smaller when it is stressed

P7: more rotation would be interesting, the speed is okay. More rotation till the end, more swmithc. Changing the direction, more smooth more rotation it would be nicer for me. For me it works

It is easy to connect the string to stress, if i would apply the data collected if their is a lot of stress. A lot of rotation

Prototype 2 (metal plates):

3. **Appearance**
    1. **How do you feel about the material?**
    2. P6 it is nice of the reflection and stuff. I think it is disrupting that it is not straight, because it not perfelcty shining. I like the contrast between white and silver.
    3. *Normal i like the material, but not this case. It looks too much like a cage. You picked a too strong material.* It is hard to bend. *It is not smooth, too difficult too much noise.*
    4. **Do you feel that this fits a work environment?**
    5. *Maybe for a different purpose, but not for this. I can image that is really small and then i can push it down.*
    6. Probably not. Maybe smaller
    7. **Could you image this hanging in the a working environment?**

8. **Where do you prefer to have it in the office? Close by the desks, coffee machine, exit door etc.**

4. **Movement**

What do you think of the movement?

I do not feel that it represents stress, i can image that when there is a lot of stress the thing bend and that feels weird to me. So the bend can be for me relax.

P7: the power of stress feels for me that when it pushs down. Feels opposite for me

Prototype 3 (plastic plates):

5. **Appearance**
    1. **How do you feel about the material?**
    2. P6: i like the colours, i would like to see it through it. For me the wood the light is nice. The colours are in balance, very neutral.
    3. *P7: I like the materials and the colours. It feel calm and neutral. The wood makes me feel at home, more cozy. I can image it at home.*
    4. **Do you feel that this fits a work environment?**
    5. yeah , as a lamp, because it is not transparent the light does not bother you much.
    6. *It would be nice if there would be a light inside. And then the change of the light.*
    7. **Could you image this hanging in the a working environment?**
    8. Maybe it hanging, maybe some together a composition
    9. *I can image this hanging from the ceiling, make it a kind of light shape*
    10. **Where do you prefer to have it in the office? Close by the desks, coffee machine, exit door etc.**
6. **Movement**
    a. **What do you think of the movement?**

    P6: all at once. I think it is nice, also because their is not a direction. You can just move them a bit smooth

    P7: one by one,in sequence. I love the way it is infinite. The movement of the plates as well as the movement of the entire aritefact. At the same times nice sequence never ending, very nice very beautiful. I would use it before going to bed, i would go to sleep with. 'Always the same, but never the same'

2) REFLECTION INTERVIEW

Interview questions after the questionnaire has been filled in:

For the last one, it was hard to say what the opening and closnig makes you know of the stresslevel more the movement made an impression

I also had a problem with that one as well. I can only image it as a way to lower the stress, not as as visualisation. It will be very relaxing for me, more a cure then a visualisation

For me it is because the material, you need to the power of the stress

Because of the tension, it is kind of the link

I can feel that the rope is stretched, and also because it is not straight. Normal shape is the straight, so relaxed and then it is out of balance, when it is twisted

Out of balacne, when it is twisted

Stretch and stressing is completed

Asking "why" of the questions of the questionnaire?

Appearance

- **Which parameters did you feel that expressed/showed stress the best?**
    - P6: i like the movement of the strings, when i think about thinking of representing stress i think of the twisting, also the white and blue and one colour would be better
    - *P7: i can image(the strings), elastics material i can image there, that you can stretch is more. Because then you can go further, maybe something*
- **Would you create a different prototype/combination based on the parameters that were shown?**
    - **Would you add or remove something of the artifact?**
    - *I would like the colour, the top can be wooden, the proportion is out of balance(first prototype), you want some contrast to see the strings. But more the composition fo the third. grey/green colour*
    - The wood
- **How did you perceive the metal/plastic/strings as material?**
- **Which material did you express stress the best?**
    - **And why?**

Movements

- **What did you think about the different movements of the artifacts?**
- **Are there any other movements that you would suggest for expressing stress?**
    - **Would you add/replace/remove one of the current directions?**
- **Which direction did you find natural coupled to stress?**

General

How did you perceive the coupling between the material and the movement?

P6: the one with the lamellen, i think that is nice, i can not image another matieral, the second, i can image something else,. I miss the smooth sensation, one where it can return ot it original position(with out the bedding)

P7, i can image material(in the third prototyupe), the second one, for me the power is the representation of the stress, a strong material, without the shiness or reflexcigtness.

Do you see these concept work in the office environment?(With the adaptation the user made)

P6: because it is collective, you do not know(would it be helpful to ask someone),. The situation i would feel like that i am not stress really, but get the feeling that i am not really stress but just have the feeling that i am stressed.

P7 i wold like it all the time, you can see it all the tiem. But if it is stretched would make me more stressed. I am not sure, how it is suppose to help us in the office environment. Because of the taboe. But i do not know how to act when i see that their is much stress. Often i am stressed, just because i am stressed and the rest is relaxed and then i am the only one with stress it would make me more stressed.

Do you feel that such an artifact would distract you too much while working?

P6:i do not think it is dsicration. It does not draw that much attention. It depends a lot on how it fitts in the surrounding.

P7: i would pay attention to it.

Or that you are going to activate try to influence the artifact?

P6: No i will be not

P7: perhaps the first day, just try to have some fun. Because it depends on the rest is feeling, but in some time people will not paying attention to it. At the end it will be part of the environment.

Participant 8

Individual initial interview, general about stress:

What does stress mean for you in the office environment?

I want to preferom in an excellence way. I feel the stress of the others. Because i feel the stress that i need to work with them and them with me. I do not mix private with work environment, it is completely seprate. Not the attention to mix the stress

Do you feel like that stress is an issue within the office environment?

I feel like that it is an stress issue. Defintitliy in some countries there is a lot of stress

Do you feel that stress is a taboe in the office?

It depends. May idea of work is very structured oragnize, you have your role.
You do not tell your feels to your surpoise. But in smaller orgaiation it is different, the opposite

How do you feel about your stress level being measured while working?

It is like the same issue of measuring everything. It has drawbacks, it can influence if you are measured. And it has some positive parts.

How do you feel about your stress level being shown in a collective stress visualisation? (data is still anonymous)

Nice, that would be nice, also nice for group works. I think it would help

Showing the prototype for the first time

What's your first impression of the three prototypes:

- **What does the twisting of the strings evoke in you?**
  - It is quite like crossing yoru eyes
- **What does the stretching of the metallic lamellen evoke in you?**
  - The metal is stressing me
- **What does the turning of the plastic lamellen evoke in you?**
  - I love it. It is super nice, the everything the colours, materials. The combination of the materials

Explanation of the projects aim: so collective stress artifacts

Prototype 1 (strings):

1. **Appearance**
    1. **How do you feel about the material?**
        i. I like the colours, I like it when it is tense, when it is not is insignificant.
    2. **Do you feel that this fits a work environment?**
        i. Yes i think it can fitt the work environment. The blue is quite relaxing colour. When it is tensed it is super nice
    3. **Could you image this hanging in the a working environment?**
    4. **Where do you prefer to have it in the office? Close by the desks, coffee machine, exit door etc.**
        i. In the common area. Probably not from the ceiling more on a base in the corner where it is standing
2. **Movement**

. **What do you think of the movement?** Nice and cute

I prefer it not moving. Just crossed is perfect, moving is quite insuigifcant. For me it is more stressful to see things moving. I can not study with music or anything.
Probably i would see it daily adapting the movement.

Prototype 2 (metal plates):

3. **Appearance**
    1. **How do you feel about the material?**
        i. I don't like it. I like the metal, but not when it curved or something. In this case, i am also thinking about a lamp
    2. **Do you feel that this fits a work environment?**
        i. Yess, in the cantine or cordorer. Not in the real office where people are working
    3. **Could you image this hanging in the a working environment?**
        i. More suitable to hang then the other, or also maybe on the floor
    4. **Where do you prefer to have it in the office? Close by the desks, coffee machine, exit door etc.**
4. **Movement**

. **What do you think of the movement?**
It is not natural. It is a movement you have to force, it is annoying.

Prototype 3 (plastic plates):

5. **Appearance**
    1. **How do you feel about the material?**
        i. I like the combination of the wood and the plastic. Very neutral.
    2. **Do you feel that this fits a work environment?**
        i. Yes definitely. In an office; maybe also a couple of them or more on a shelf next ot each other .
    3. **Could you image this hanging in the a working environment?**
    4. **Where do you prefer to have it in the office? Close by the desks, coffee machine, exit door etc.**
6. **Movement**
    a. **What do you think of the movement?**
    You can just move parts of them, according the number of the plastes that is twisting. I find it interesting. Gradually.

2) REFLECTION INTERVIEW

Interview questions after the questionnaire has been filled in:

Asking "why" of the questions of the questionnaire?

3. I like the twisting position, stress is negative and the twisting is something positive.
It is true gives a true of the environment on how the environment is evolving, but not stress.
The idea of pressure that relates to the the power you need for un twisting
Human behaviour when you are stressed, you are blocked, so closed. And then the open when you are more relaxed

Appearance

- **Which parameters did you feel that expressed/showed stress the best?**
    - The shape and the refer to the circular/squared. The the roundshape for the collective is representable. Also the material
- **Would you create a different prototype/combination based on the parameters that were shown?**
    - I would putt the plastic plates in the benign one and the metal one for the turning.
    - Would you add or remove something of the artifact?
- **How did you perceive the metal/plastic/strings as material?**
- **Which material did you express stress the best?**
    - **And why?**

Movements

- **What did you think about the different movements of the artifacts?**
- **Are there any other movements that you would suggest for expressing stress?**
- **Would you add/replace/remove one of the current directions?**
- **Which direction did you find natural coupled to stress?**

I would say the one with turning on the axes. Daily turing

General

How did you perceive the coupling between the material and the movement?

I think that the metal blades would be usable for the turning.

Do you see these concept work in the office environment?(With the adaptation the user made)

yesss

Do you feel that such an artifact would distract you too much while working?

Not distracting, but because it a collective representation. You can act to improve the environment. If others are stressed you can say something this is nto going well, so take some actions.I see some purpose in this, the aynomies way to make people aware of what is happening in the group. Cause sometimes you can not talk about it.

Or that you are going to activate try to influence the artifact?

Yes ofcourse the first time try to influence.