Bringing **valuable insights to office environments** by visualizing health–data

From sensor data to value proposition

Industrial Design - Eindhoven University of Technology
Msc. Design Leadership and Entrepreneurship

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Prologue

This project is a graduation project of Industrial Design, MSc. Design Leadership and Entrepreneurship part of the Eindhoven University of Technology. This report describes both the process of tackling a technologic-centric challenge and creating a more matured version of Kickoff Lab

Technology-centric business challenge

Bringing design strategy to a technology-centric challenge is what this report describes. Through a business design method there is explored how one can exploit a sensor-equipped chair within the European / Dutch market.

Through exploring the business landscape, evaluating the technology, interviewing experts, and developing a new value proposition the project sketches a concept has been designed which is applicable to the European Market. Additionally opportunities and risks are identified as well.

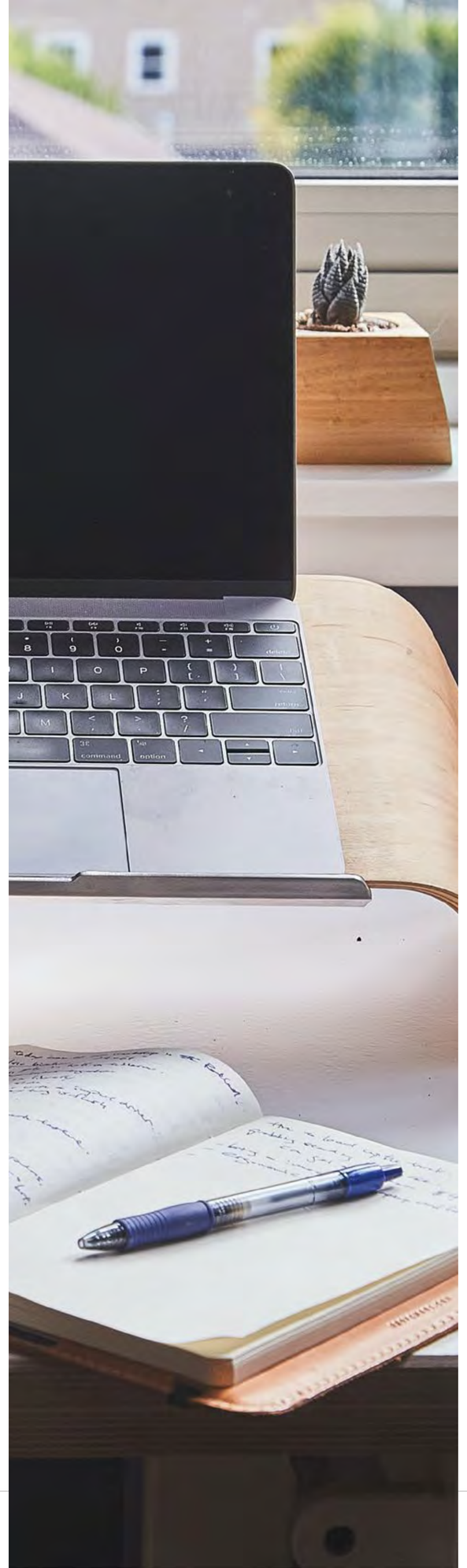
Kickoff Lab

Kickoff Lab is founded in 2018 as a side-business with Martijn Dekker and Cyril Mengin, both Industrial Design students from the Eindhoven University of Technology. The company started without a direction, and our assignments mainly focused on software development. Over the last year, we decided that we are aiming to work full-time on the business in 2021 and develop it in a more matured company ready for new assignments in 2021.

The report describes the process of creating a future-ready Kickoff Lab

Ethical considerations

In the project, cushions are used which measure several health-related indicators. If spoken about real-time, the data is still delayed and referred, and within a time window. Participants' information is being stored anonymously at a secure server, which is only accessible through username and password combination. Every participant gave consent; At all points, participants' were free to remove the cushion from their chair;



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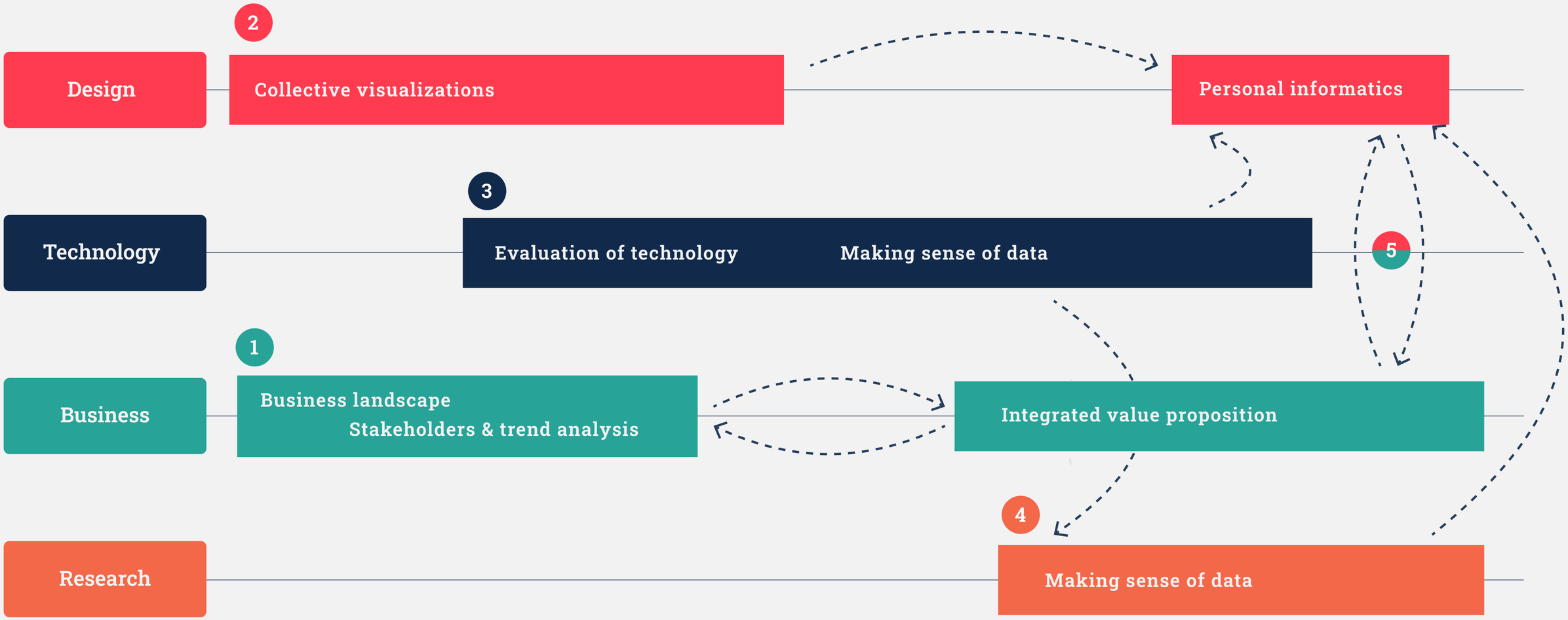


Design business challenge

Introduction

For a solid start, there is explored how the landscape is shaped around the project. Several factors and people are identified which are essential in the project. Besides, current ongoing trends are analyzed to build upon later in the project.

Direct related project stakeholders

The project was initiated by Jun Hu, who is currently working together with Biyong Zhang (alumni Eindhoven University of Technology) to measure and visualize health-related data in office environments. Jun proposed doing a project in collaboration with Biyong's co-owned company; Hangzhou Bobo based in Hangzhou (China).

One of the products this company is known for is its sensor-equipped chair cushion. This cushion measures several health-related parameters from the human body. It thus could provide insights for any persons using this sensor. Jun has the availability of ± 20 sensor-equipped cushions which can measure above mentioned parameters from individuals.

In the project, several other researchers from the Eindhoven University of Technology are involved, which all played a role in the project's current scope. They are mentioned in the 'direct related-project stakeholder' – a map with their related expertise in figure 1.

Design brief

Below mentioned details are gathered from personal meetings with Biyong. These sessions didn't follow any pre-structured interview method, but mainly discussed and deepened the knowledge to create a solid base for the project.

As mentioned above, Hangzhou Bobo is developing a sensor which can be implemented in, for example, an office chair. This sensor can measure several health-related data and thus can provide an employee with direct feedback and insights. Refer to image on the next page for an overview with more detailed information about the collected data.

Hangzhou Bobo is currently pre-occupied with creating a relationship with SUNON a Chinese office equipment producing company within China. For this partnership, there is an integrated value proposition for the sensor detailing the design and technology. This proposition is solely focused on the Chinese market and therefore not adapted to any countries outside of China. As indicated by others, companies operating in different market networks (e.g. Europe and China) need to adjust their strategies to be successful, as the context can differ both on a cultural level (Lampert & Schoemaker, n.d.) as on a more strategic level (Jansson et al., 2007).

Thus, it is necessary to change the current proposition into an adapted one for the European market; this, therefore, includes exploring the business landscape in Europe and defining new (design) directions for using the data in office environments in the EU.

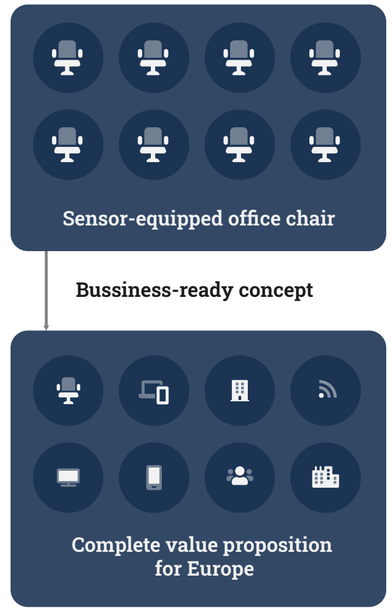


Figure 2: From sensor-equipped office chair towards a fully integrated value proposition

Figure 1: Direct related project stakeholders

Figure 3: Hanzhou Bobo's sensor integrated within office chair

Sensor-equipped office cushion

Measured (health) data:

1. Presence of a person
Measured (health) data:

2. Heartrate
Beats per minute

3. Respitatory rate

4. Heartrate variability
The variation in the time interval between consecutive heartbeats in milliseconds. An indicator for being relaxed or stressed.

5. Sitting position
How did one sit at their chair?
Centered, too much to the left, etc.

Design business challenge

Project setup

The main challenge focusses itself around a challenge which comes from the industry. The importance here is finding the right design and taking into account that it is an operating company. As a result, it is essential to create the right value for the target and user group and consider whether the company can deliver the solution and has the resources to do so.

There is chosen to keep these importance's into the mind by balancing the disability, feasibility, and viability during the project, following the 'three lenses of innovation' by IDEO (IDEO, 2016).

Moreover, as a central-thought-model, business-design has been chosen to keep the user-centricity during the process and bridge the gap to business viability, as design from a more value-driven design does not necessarily mean that customers are willing to pay for it (Board of Innovation, n.d.-b). Besides, it helps in creating solutions which are ensuring that each stakeholder is ready to enter into the new business model and is getting more value than they are giving (Board of Innovation, n.d.-a)(Faljic, 2019)(Bland et al., 2020).

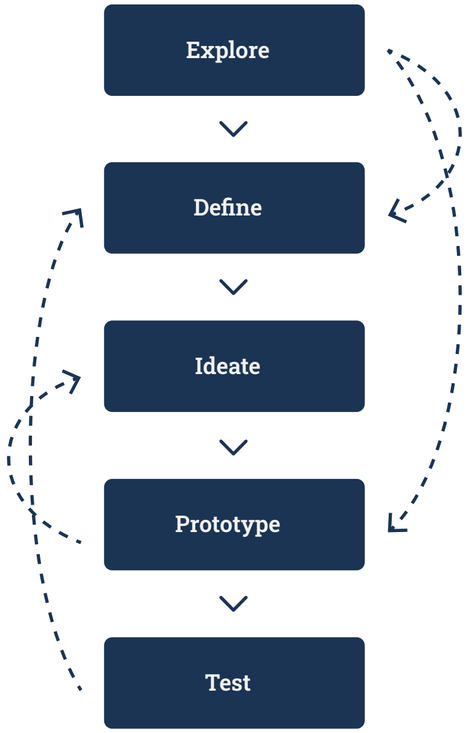


Figure 5: Business design cycle - importance to evaluate every step with relevant stakeholders

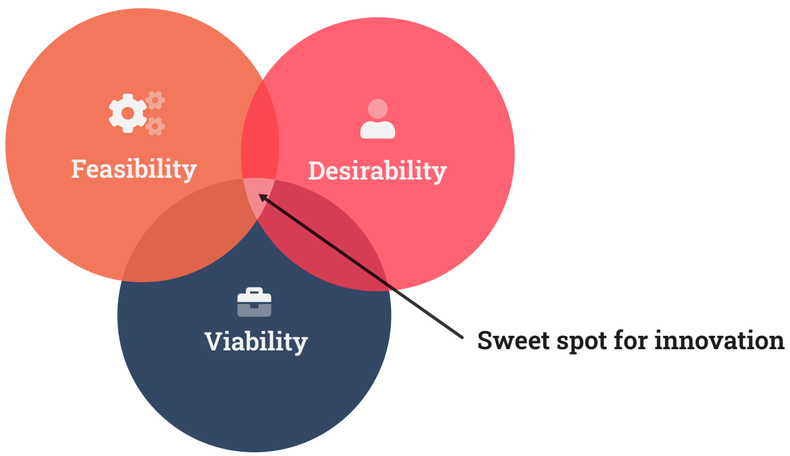


Figure 4: Three lenses of innovation (IDEO, 2016)

Business design landscape

To better understand the issue at hand, in-depth (desk) research has been executed to deepen the business landscape knowledge. Below, there is given a summary for every stakeholder related to the sensors, and office context. To further exacerbate the industry's current trends, an trend analysis has been done by analyzing the top five office-equipment producing companies in Europe to research on which segment and trends their product range is focusing.

Hangzhou Bobo

Provider of the vitality technology in the case of this project.

Office equipment producers

The top 15 most earning office equipment producers in Europe have been researched to explore their profiles and trends they are focusing on (OfficeRepublic, 2017)

Main operations

Office-equipment producers in the Netherlands and Europe offer similar offerings of essential office-equipment articles, from complete desks for single employees, meeting rooms articles, and equipment with a more social function. Their normal operations focus on producing these offerings and offering customized and uniquely designed office layouts for their customers. Insights from later in the process are also added to this map, further deepen the insights found during this stage.

Related trends

Health and vitalazing offices

At all companies, vitalizing the office is their focus. Overall all companies mention the importance for employees to move during their work, either by moving on your chair or walking more through the building. Except for Vitra, they all support a healthy office by offering adapted office layouts. At Koning+Neurath, they mention for example; "But while we're at work, we can help our bodies stay in good shape by regularly changing position, or standing up for meetings and phone calls."

Smart technologies to support workforce

The integration of smart technologies is mentioned by two of the researched companies. They both try to connect their existing line of articles to the internet, to provide valuable insights to their customers. For example, Ahrend works together with selected partners to offer a smart platform for integrating 'smart' technologies in the office, such as occupancy heatmaps or the detection of broken desks.

3rd level parties providing technology

Added at a later stage. For example, Ahrend outsources their smart technology offerings to 3rd parties who maintain their technology (please refer to the interview with Ahrend to view more detailed information about this insight).

Thus, it indicates these companies' interest to work with outside partners to offer more services to their customers. SUNON working together with Hangzhou Bobo shows a similar interest.

Companies

SME and large companies (more than >50 employees) generally focus on their normal operations in the sector they have offerings. These companies are typically focused on their workforce's health (Papagiannidis & Marikyan, 2020). One interesting trend currently ongoing is that companies are going to be focusing on monitoring and measuring in their spaces obsessively; "Companies monitor and

measure obsessively, [...] both in and outside the workplace. Organizations use the data to predict performance and importantly, to anticipate people risk. "(PWC, 2018)

C-level executives and team managers

Currently, c-level executives are responsible for the company's day-to-day operation and decide where money flows. Executives indicate in recent research by Deloitte that they rank both reducing costs (rank 3), and prioritizing well-being (rank 8) in their top ten priority list (Deloitte, 2020). Besides, they also identify that they will 'implement new technologies' to transform the current workflow. (Deloitte, 2020)

Human resources department

The human resources department is, in general, responsible for the full workforce. They support an employee during their total stay at the company. In this process, they have a focus on supporting employees in their health and wellness. McKinsey&Company indicate that HR focus will increase focus on this topic, by taking responsibility in improving the working well-being and promoting worker-wellbeing. They suggest that they will be hiring more experts in workforce and health (Lund et al., 2020).

Employees

The employee is part of the companies system, and each one of them executes specific tasks to bring the company further. Thus, they prioritize bringing a certain quality of work (rank 1), and increasing innovativeness (rank 3). Besides they are on a higher level more focused on 'improving worker well-being' (rank 3). Thus, prioritizing their health more than their executives prioritize their employees' health. (Deloitte, 2020)

Company doctor

"Companies can engage a company doctor, usually through an occupational health and safety service, to give advice and support on improving working conditions." (ArboNed, 2020).

Insurances

Insurances provide companies with the means to protect themselves against staff dropout. Companies pay a certain amount a month, which in return gives them a protection for employees which could dropout and still need to be paid.

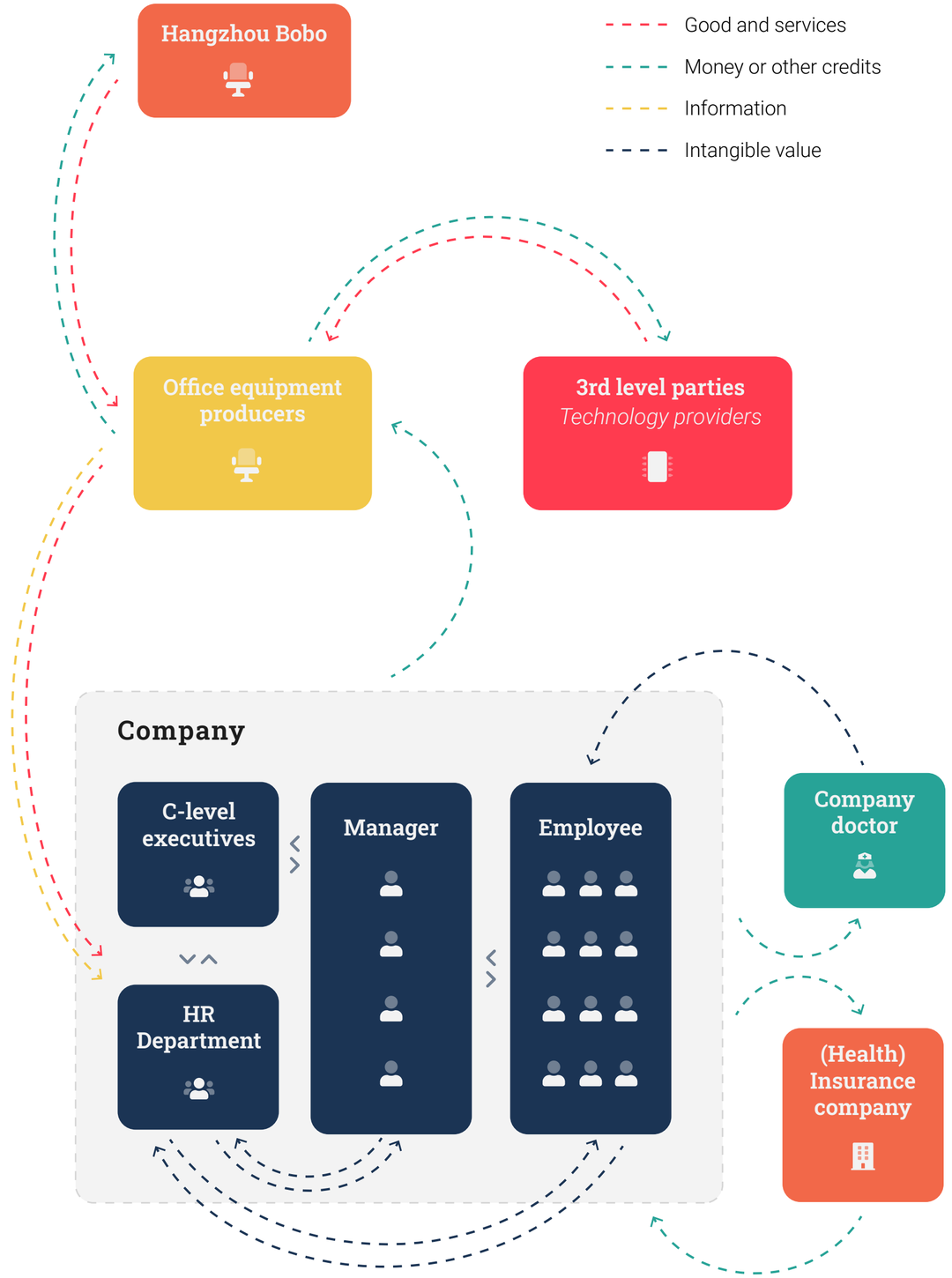


Figure 6: Stakeholder map & value flow model identifying all stakeholder relevant to the project, and related value streams between those stakeholders

Recap

Opportunities

At the beginning of the project, an effort was made in a single iteration to identify possible areas where the sensor could add value. An additional one of these areas stood as most potential and several visualizations where created.

Three levels of visualizations were identified on which any technology could add value, namely: Firstly, on an individual level: the tech can generate insights into a person's well-being level or productivity levels.

Secondly, on a collective level: where one visualization shows merged data of multiple individuals (for example, working together in one room or department).

Thirdly, combining the data of multiple collectives can generate insights into the entire office or company.

In addition to these areas, several opportunities for giving valuable insights are identified, further elaborated on in figure 7

Visualizations

Additionally, the design opportunity for teams described in the last section was explored, and several visualizations were designed to give insights to this group. From earlier research, there were three takeaways generated which collective visualization should take into account; namely:

☑ Main takeaways

1. Visualizations should not try to display factual data as this can be inaccurate. Use abstract visualizations.
2. Three states of stress should be taken into account
   a. *Everyone feels stressed*
   b. *Few members feel stressed; thus, there is an uneven workload*
   c. *Nobody is stressed.*
3. Try to change the context as less as possible

Based on these takeaways, the following possibilities for visualizing the perceived stress levels were identified: visualize data as abstract geometrical figures, use metaphors which people associate with stress or visualize data more detailed and group users, but still keep a certain abstractness.

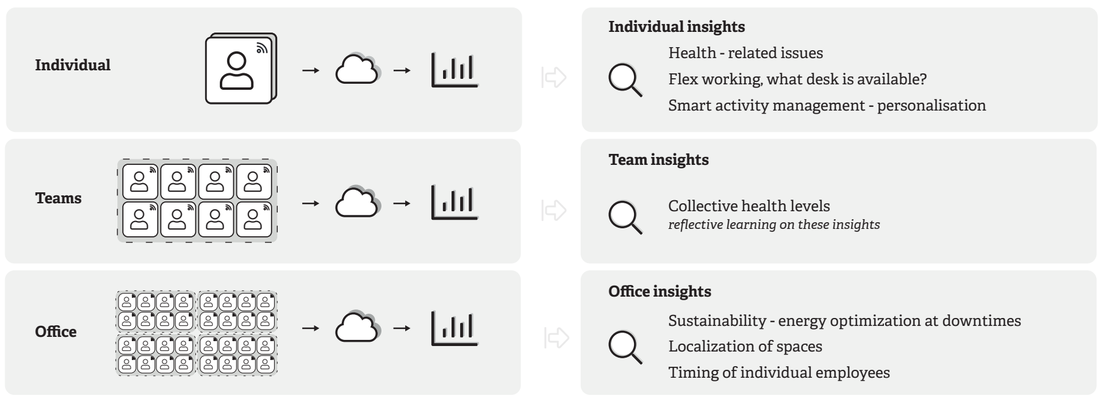
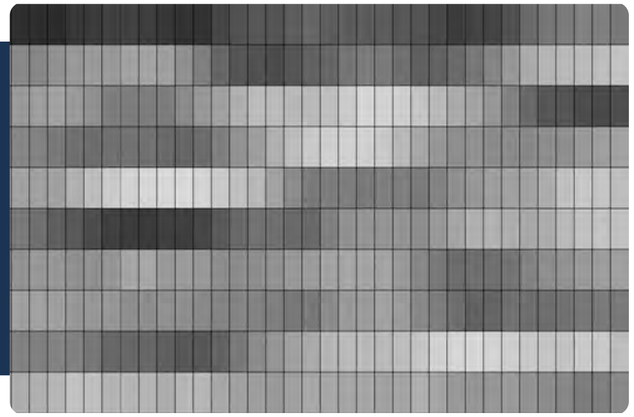


Figure 7: Opportunities identified to provide value inside office spaces

Visualizations

Abstract

Every block indicates one person their stress related levels measured over one hour. Visualizations display thus a week worth of data.



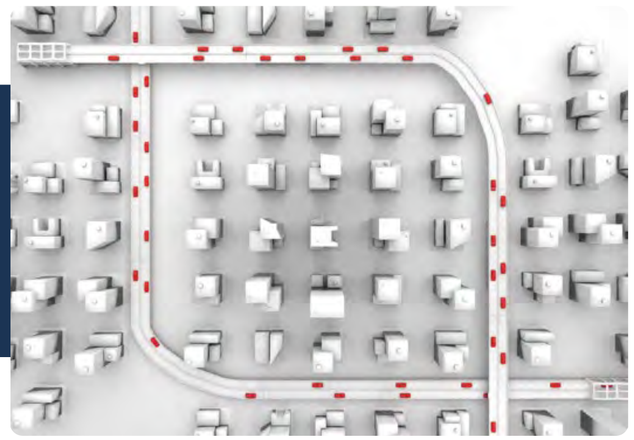
Aggregate and grouped

Bar visualization. Data is mapped per day, where in this picture five working days are visualized. In this visualization it is apparent that there has been stress for multiple days as on the third day the red bar has the biggest size.

After this day, people are slowly starting to recover from the stress, consequently, increasing the size of the green bar.

Metaphor - cityscape

Visaulizes traffic jams as methaphor for stress, the more cars are getting on the road, the more people are stressed.



Collective visualizations

Opportunities

All the directions are evaluated through expert opinions. Two sessions were conducted with Monroe Xue, a PhD'er focusing on collective health visualizations (Xue et al., 2017, 2019) from the Eindhoven University of Technology, and Biyong Zhang, expert due to his expertise with his company, to discuss and reflect upon the visualizations. Insights are elaborated upon per visualization.

Based on the above insights, there are several takeaways: data visualizations must have a versatile time range, which helps users reflect both on a short term and long term base. Colours have immense importance; they can negatively influence the user and help understand the data more quickly. Additionally, more aggregated data can be useful, for example, managers or c-level executives in a company.

Abstract

1. The **time dimension** of the mosaic visualization is the most valuable of this visualization. Because users can see an extended range of days, it is possible to both reflect upon their stress levels on a short term and long term base.

2. Due to **colour usage** and the **number of people** listed, it might be hard to discover who you might be.

3. Due to the greyness, it looks like a 'misty' landscape. The **greyness adds to an extra layer of negativeness** to the already negative message of too much stress.

Aggregate and grouped

1. There is a **low learning effort** due to the **colour usage**. It is clear that green means relaxed, and red means worse. Besides the **colours are also less 'stress-full'** in comparison to the grey shades.

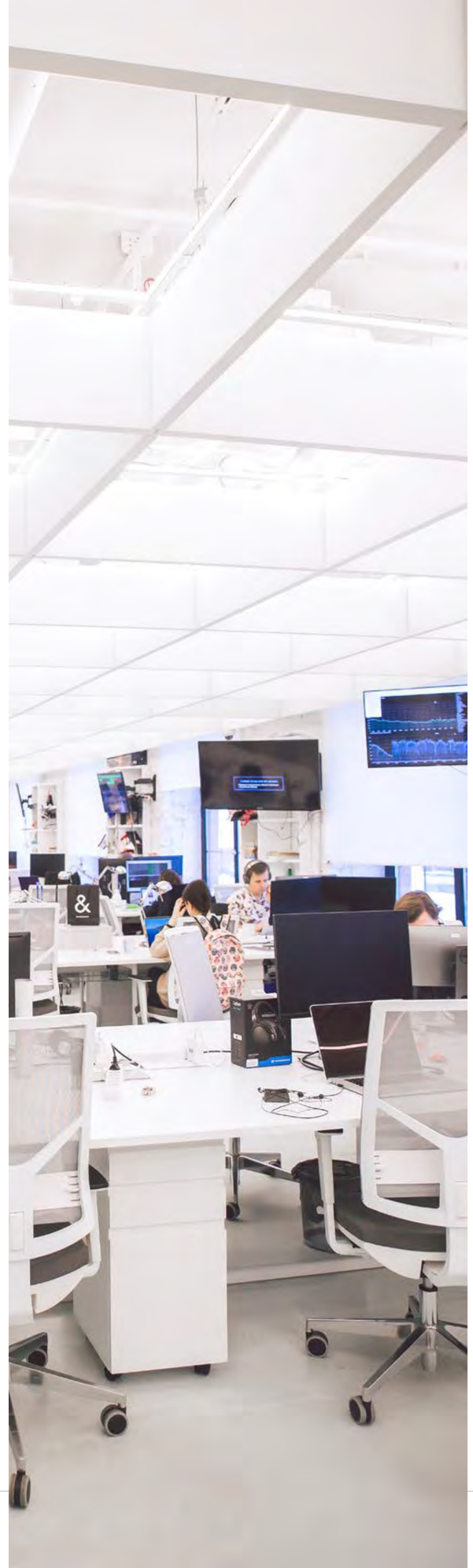
2. It is essential to **inform people** about the meaning of the visualization. What does it mean if they are in, for example, the green or orange zone?

3. As individuals can't see data about themselves, it might be more applicable for **managers**, as the visualization shows **aggregated data.**

Metaphor - cityscape

1. It is **ambient**; it will perform in the office environment as a **canvas**. The visualization won't grab too much attention and won't make a stressful situation even more stressful.

2. Individual users might have difficulty understanding their stress levels, as **their information is not visible.**



New design

Two visualizations are proposed which should help employees and managers to reflect up their stress status. These visualizations build upon the already identified takeaways.

Additionally, in these visualizations, the aspects of the COVID-19 epidemic are considered. Several researchers and companies indicate that office and work life will permanently change, and people will be working more remotely. (Ahrend, 2020) (Boland et al., 2020). While all employees indicate that they will enjoy their work at home, there is the risk of becoming disconnected to the company and your colleagues. As employees work more from home, it could be challenging to report any inconveniences they might have with their work.

In both visualizations, the main element visible is the stress visualization itself. It is an abstract representation, which tries to summarize one's arousal level. Every horizontal row represents a single employee or user, and every vertical row a single day. The colour indicates one's performance level based on the Yerkes-Dodson Law (Cohen, 2011), which describes the relationship between arousal levels and performance levels (figure 8). In the visualizations, the colour is based around this principle. Due to this colour differentiation, it is immediately clear if the pressure is too high. Thus, employees directly reflect upon these strains. Besides, almost four weeks of data are visible so that trends will be visible in the data.

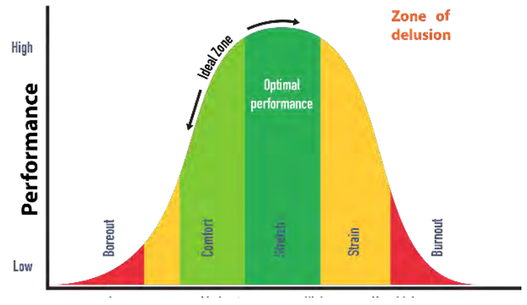
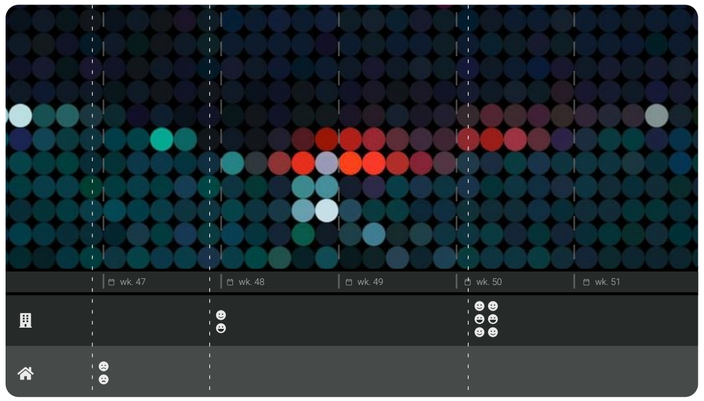


Figure 8: Yerkes-dodson law (Cohen, 2011) - describing the relationship between pressure and performance

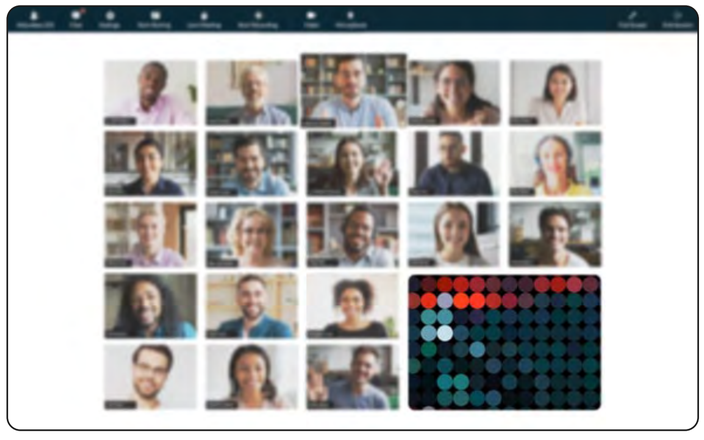


Collective visualization

Visible in the office on a central screen and accessible online.

In addition to the main performance visualization, the interface adds the possibility for employees to indicate their emotions. These emotions are ordered based on whether they were send at home or at the office space.

Those additions make the visualization a twitch more personal, as employees whom are sitting at home and vice versa, are able to view how their colleagues are feeling.



Video call visualization

Health visualization is visible in every voice call online (e.g. in Microsoft Teams)

The video call visualization is the main visualization displayed in the call window of any online meeting.

It gives employees the means if they ought to find it important to reflect upon the data visualized.

Validation

A validation is held to review the designed interfaces and evaluate possible users their opinion. Two young professionals were asked to review the interfaces in an open discussion session. A set of topics and questions were set up to prepare the discussions beforehand (full-set of questions see appendix D). The topics discussed were their first thoughts on the system after detailed description, in what kind of setting could the interface be useful, and at what point in time could this be helpful?

During the session, notes were taken, and the conversation was transcribed after the session. The session was analyzed through thematic analysis a widely used method within the design world to find themes and patterns within interviews (Braun & Clarke, 2006).

The following themes are identified:

Acceptance

Identifying individuals

One of the first though of both interviewees was that the chance of identifying an individual was high. One participant said it never could be anonymous, and chances are to determine who belongs to which row. Another said that if there is one red dot in the system, it is not desirable to know who that is. Additionally, both said that if 50% of the team were red, it would be impossible to solve the situation, and colleagues should take responsibility themselves.

Office culture

One of the interviewees mentions that office culture needs to be ideal before you can reflect upon the data together. “what’s way more important here is the culture of what organization you’re working in,” […] in the ideal world. You don’t have a shitty manager. You can just have a open conversation with him or fellow team members

Personal reflection

Both participants mention it might be more helpful as a personal tool: “on a personal level I can really see this works. If I could see my own data in a personal system, I think that can really help as input for myself.”

Tool for evaluation

One participant mentioned that the tool would be ideal for evaluation after a project. If one can identify stressful periods, you can reflect upon that period with your team, and improve future projects’ situation.

Aggregation of data

Both participants said that the tool could be useful if it aggregates the data into an average score for the full team. “ I guess it could be useful to get a rating of how the full team is doing.”

Main takeaways

Both participants had positive opinions about the central screen visualization. The visualization within a video call was evaluated as useless, as it would only be a distraction during a meeting.

Nevertheless, there are several areas where the tool could be more useful. One could look at the potential of visualizing data on a more personal level or create a tool that supports managers and employees at the end of the project to reflect upon the stress levels during the project.

Evaluation of technology

Current state

As within any technology-centric project, it is crucial to know how the technology functions. Hangzhou Bobo's sensors are provided within a cushion. Inside a little bag, attached to the cushion, is the main electronic board powered by a power bank of 10.000mAh. The total battery length is plus-minus five days. The cushion has a setup process through WeChat which connects to the full package to a Wi-Fi network. At this point, the sensor will always connect automatically to the last connected Wi-Fi network, and send its data to a managed server.

Before this project, there hasn't been anybody who worked with this specific sensor model, and thus, no information was known on how to interface with the data. The following sections try to elaborate on all the possibilities for future reference.

Output sensor data

The sensor outputs its data automatically to a managed server , which stores and analyzes the data. The database's data is fully anonymized and only accessible if one knows every cushion's unique id. Every four seconds, the data is being processed and send.

One can access the data by accessing an open-API interface protected by an access-token, which currently supports two ways of retrieving data:

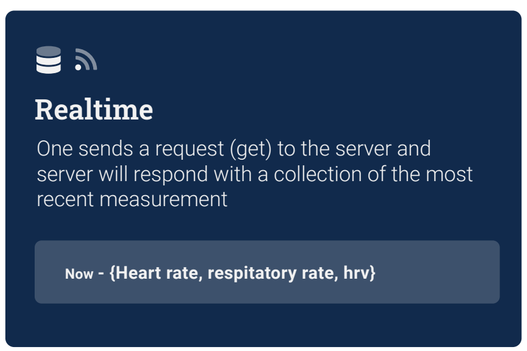


Figure 9: Data currently available through the open-API of the sensors, return results are simplified.

Exploring data

A quick low-fi prototype is created within Processing (Processing Foundation, 2020)1 to explore the measures. This prototype provides a small written library to pull real-time data, from a given sensor, from the server. This software has been developed to prototype with the available data quickly. One group of Industrial Design students from the Eindhoven University of Technology has been successfully using this software to power their visualization and prototype.

Additionally, a software package within Processing has been created which extends on the above example and gives developers and designer the means to view the data inside a simple graphical interface2. Several different ids can be added to the system. At the start of the program, the software will automatically start to collect data, and add this to single plots for every single id. While the program is running, the software saves the measurements to look back at the data from the program's start.

Software accessible at:

https://github.com/MatthijsHoekstra/example_cushionAPI/releases/

https://github.com/MatthijsHoekstra/plotter_cushionAPI/releases/

```
15:42:40 -- Added cushion -- SN: BBFE031200032451
SN data: BBFE031200032451 -- data -- status code: 400 , heartrate: 65 , HRV: 389 , Respitory rate: 17
SN data: BBFE031200032451 -- data -- status code: 400 , heartrate: 63 , HRV: 389 , Respitory rate: 18
SN data: BBFE031200032451 -- data -- status code: 400 , heartrate: 64 , HRV: 389 , Respitory rate: 18
SN data: BBFE031200032451 -- data -- status code: 400 , heartrate: 61 , HRV: 389 , Respitory rate: 20
SN data: BBFE031200032451 -- data -- status code: 400 , heartrate: 59 , HRV: 389 , Respitory rate: 17
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Figure 10: Get realtime data, updates automatically when cushion has new data.

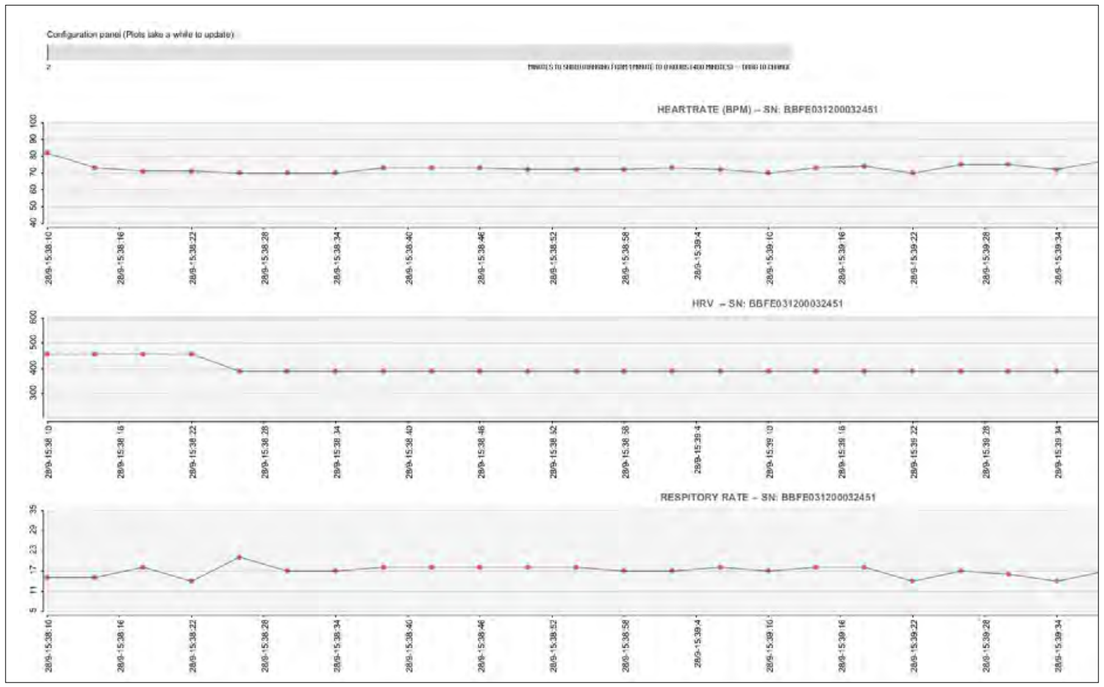


Figure 11: Visualize BPM, HRV and respitatory rate within graphs, updates automatically.

Figure 12: Track multiple different cushions by adding them to a dynamic list, updates automatically.

Adapating technology stack

While the open-API in combination with the Processing sketches gave the possibility to explore the data real-time it did not provide the flexibility to analyze the data in a more complex manner (e.g. get all measurement of the last work week, get the mean of all heart-rate and HRV measures for the previous workday, etc.).

To extend the possibility to prototype with the data, there is researched how one can change the current technology stack to integrate more options with the currently available data. From both a business and designer perspective, extending the means to query the data more flexible creates the possibility to experiment and prototype more efficiently with the data. If more advanced aggregations with the data are possible, and thus, decreases the time needed to deploy new tests or functionalities.

As the data stored is the easiest identifiable on its timestamp, a time-based database is the most convenient solution. Several open-source solutions support time-based data and provide functions to aggregate the data (InfluxData, 2020a; Linux Foundation, 2020; The PostgreSQL Global Development Group, 2020). In this project, InfluxDB (InfluxData, 2020a) is set up, as it provides a SQL-based method to get and write data, is written explicitly for time-based IoT data, and has an easy setup process.

Advised to use with the InfluxDB platform are Grafana (Grafana Labs, 2020) and Telegraf (InfluxData, 2020b). These two platforms provide the means to visualize the data stored in the InfluxDB (Grafana) and collect data from given endpoints (for example, the open-API, for example, a get real-time data request from cushions) at set intervals (Telegraf).

All these platforms were deployed on a remote virtual machine, which ran within a protected environment to protect potential users and participants' data. Telegraf is set up to collect data from the given id numbers from the real-time API every four seconds. Telegraf would write the measurement into the InfluxDB database, which was identifiable by a participant code, and id number. Consequently, the measures would appear in real-time within the setup Grafana dashboard .

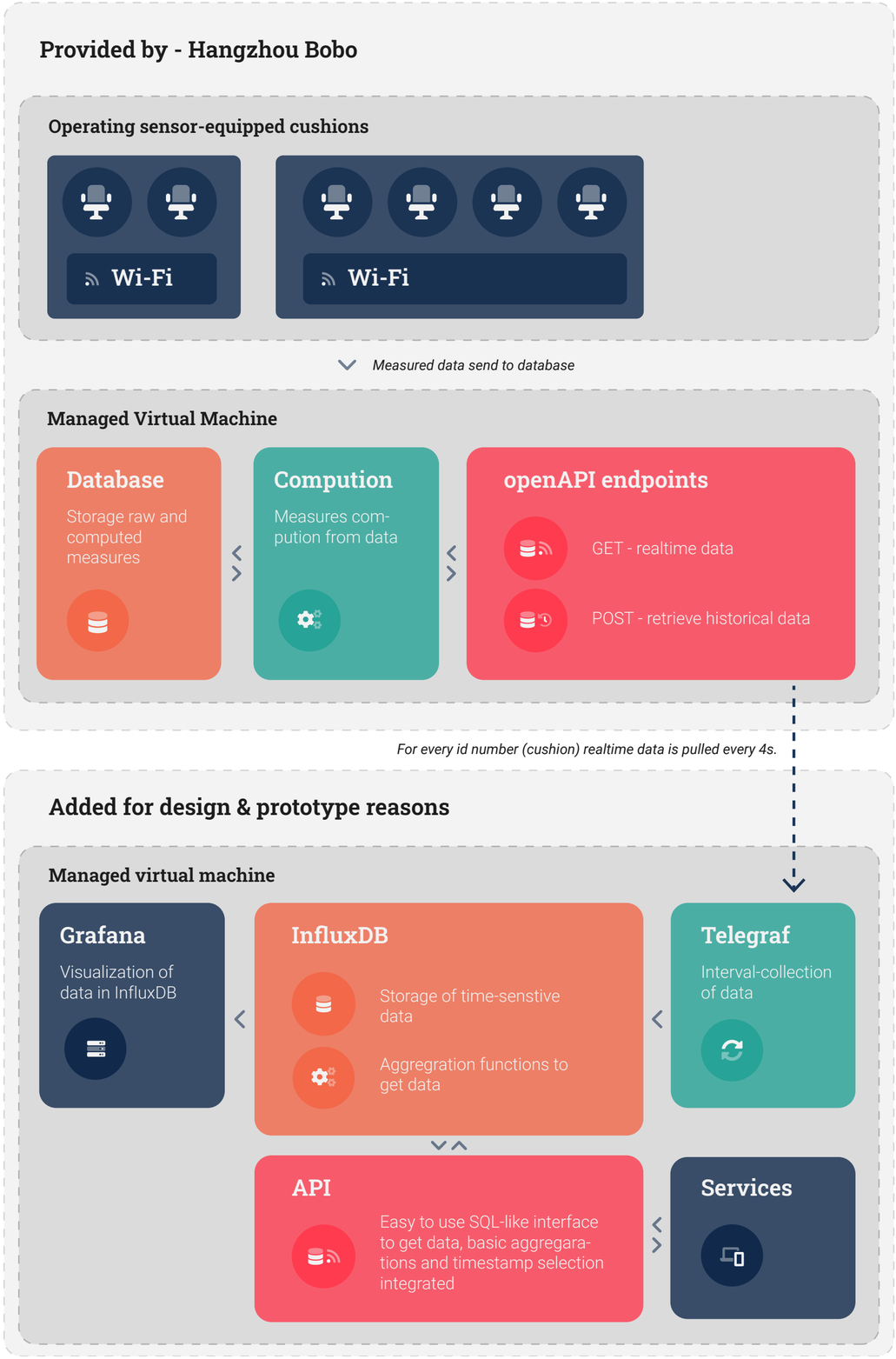


Figure 13: Complete technology stack used in the project

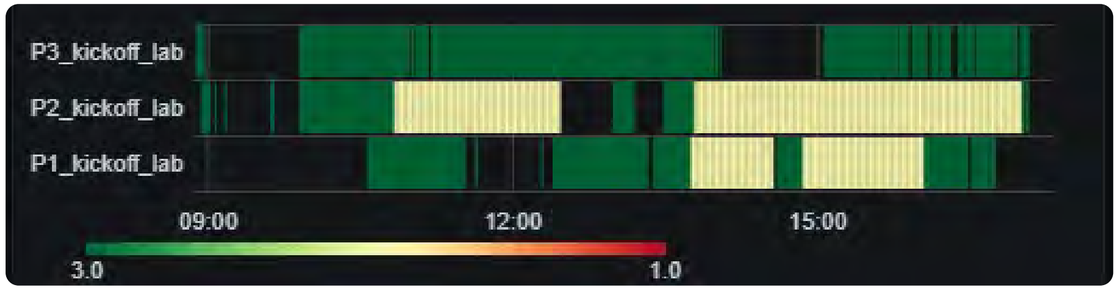
Making sense of data

Grafana test setup

While the data was evaluated by looking at data of a day within the Processing sketches, it did not give enough insights into how the data changes over the days.

As the new setup support visualizing time-sensitive data, there was chosen to deploy a dashboard which displays the data collected by the sensor. Three people (including myself) were working full-time in the space. Therefore it gave enough opportunity and insights to evaluate the data further.

Through a period of 2 months, the sensors were thoroughly evaluated through the usage of the dashboard. The main elements of this dashboard continuously changed. The end version included a moving average of the measured heart rate, a one-day average of the HRV displayed over four weeks, the 7-day trend line of average HRV, and coloured min-max graph of moving average of the heart rate. The respiratory rate was removed after two weeks, as almost no variance was detected within this data.



Discussion

A discussion with both participants is held to validate the data visualized. This discussion was about all parts of the dashboard and experiences with the sensor. There is no specific procedure followed.

Topics identified through a thematic analysis of the discussion:

Resolution of data

The interviewees both mentioned that the moving average data visualized per minute is not valuable at all. One should try to visualize the trends in the data.

Data correctness

Both interviewees discussed that the heartrate seemed accurate. One of them said: “My heart rate was higher when I came in cycling on my bike”. Both of them identified that it was hard to say anything about the HRV, they don’t know the exact measure, and therefore it seemed for them that it was all over the place, and hard to conclude upon. Another interesting insight was that they both identified that the sensor has a peak in the data when sitting down. This should be further evaluated in future research, and data might need to exclude.

Effect of perceived stress on measured heartrate variability

From the stakeholder analysis, the evaluation of the sensor-equipped cushion measures and the interview session with Ahrend (please refer to …) it became apparent that the heart rate variability measures are most valuable. Consequently, research is conducted to study whether there is a relationship between perceived stress and the measured heart-rate variability. A generalized rule for predicting a user's perceived stress would mean more insightful data visualizations.

Introduction

The heart-rate variability (HRV) measures give an objective indication of somebodies health being (Campos, 2017). Even though several research pieces concluded that one could indicate one's perceived stress with HRV measures, it is unknown whether there is a relationship between perceived stress and the measured heart-rate variability in this sensor's case. At the start of the research, there is expected that there is a relation between the HRV and perceived stress. When ones perceived stress increases, the HRV drops.

Method

Design

The study used a repeated-measures experimental design to investigate the relationship between one's perceived stress level and measured heart-rate variability. The measurement ran for every participant for two full weeks, thus ten workdays. Perceived stress levels were measured via a self-reported stress scale (Bartenwerfer, 1969). The questionnaire was accessible through an online-platform accessible through both desktop and mobile. Heart-rate variability was measured through the sensor-equipped cushions. An opportunity sample was recruited (N=16) from both the Eindhoven University of Technology and Hangzhou Bobo. The recruited participants were only required to do full-time work from their (home) office.

Materials

The study used a self-reported question stress scale (Bartenwerfer, 1969). Participants rated how ones perceived their current stress level on the scale. The questionnaire was accessible through an online-platform available on both desktop and mobile. On submitting the inputted measure (slider fully up, perceived stress = 1.0, slider fully down, perceived stress = 0.0 – linear scale for all positions in between) is sent to a secure database with a timestamp.

The heart-rate variability is collected automatically by the sensor-equipped cushion and send to the same secure database with the corresponding timestamp of submitting.

Procedure

EEvery participant received a sensor-equipped cushion at the start of the project, connected to their preferred Wi-Fi network. Participants were advised to work according to their schedule, not to influence any of the results. After every working block (morning block (8:00 – 13:00, afternoon block (14:00, 18:00), and evening block (19:00 – 23:00)1) the participants were asked to reflect upon that block of working (plus-minus 3-4 hours of work) and indicate their perceived stress level during that working session.

During the research, all participants were monitored. Through a custom-designed webpage ; the count of every critical measure in the studies was being calculated on a per-day base. If a participants cushion failed (most often empty battery), they would receive a message to change their battery pack. If the participant worked in a particular block but did not submit their perceived stress, one received a reminder through their specified platform (e.g. Whatsapp, E-mail, etc .).

To analyze the relationship between the measured heart-rate variability and the perceived stress, all

the submitted survey data (N=220) is pulled from the database. Based on the data's timestamp, there is a time range defined of 3 hours before submitting the perceived stress level. The mean of the HRV measures in that time range is returned from the database. If there are not HRV levels, the measurements are automatically dropped. Obvious errors in the measurements are dropped (HRV error measurement, submission submitted in the morning, etc.). As a result, a total of 180 submissions and measured HRV levels (N=180).

[1] One participant occasionally worked in the evening due to personal preference.

Results

Linear regression was run to understand submitted perceived stress on measured heart-rate variability. To assess linearity, a scatterplot of perceived stress and heart rate variability was plotted. Visual inspection of the plots indicated a slight linear relationship between the variables. Residuals were independent, as assessed by a Durbin-Watson statistic of 1.589. There was heteroscedasticity evaluated by visual inspection of a plot of standardized residuals versus standardized predicted values. The data was square transformed to remove heteroscedasticity. After visual inspection, homoscedasticity and Residuals were normally distributed as assessed by visual inspection of a normal probability plot. One outlier was detected with a Casewise diagnostics test. It was decided not to remove the datapoint as it seemed like a genuine datapoint.

The prediction equation was: √(perceived stress)= -0.02302+0.001020*measured hrv. The measured HRV statistically significantly predicted the perceived stress, F(1, 177) = 11.07, p < .002, accounting for 5.89% of the variation in perceived stress with adjusted R2 = 5,45%. An extra point on the scale of HRV leads to a 0.001020 increase in perceived stress. Predictions were made to determine perceived stress levels for people with their measured HRV; please refer to table 1 for results.

Discussion

The study hypothesized that there is a relation between HRV and perceived stress. When the measured HRV increases, the perceived stress lower. While the perceived stress was statistically significantly predicted by the linear regression, the prediction equation contradicts the research's set experimental hypothesis as the relationship is inversed. These findings do not correspond with well-known facts about the HRV. If one HRV decreases, their perceived stress should decrease (Campos, 2017; Harvard Medical School, 2020; McDuff et al., 2014; Taelman et al., 2008). There hasn't been any research which validates or explains such an outcome.

Therefore there is concluded that there is a probable cause for the above result. The participant group is probably too small, and there might have been a confounding variable, which could have resulted in the anomalous results. As the technology is experimental, it is advised to thoroughly research the calculation of the HRV and determine whether it is valid.

In the future, the research that can be rerun to investigate whether the small sample group (N=16) is the problem. Otherwise, there can be concluded that measured HRV is too personal to find a generalized rule. Thus, it is advised to look at trends in the users' data to detect any negative or positive trend in the measured HRV and inform users based on the trend prediction.

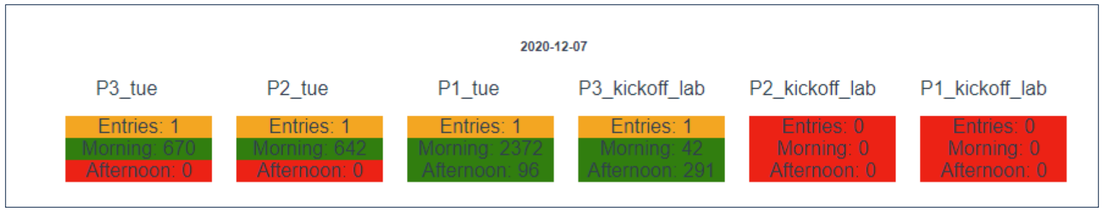


Figure 14: custom-designed web-page ; the count of every critical measure in the studies was being calculated on a per-day base. One day row shown in figure.

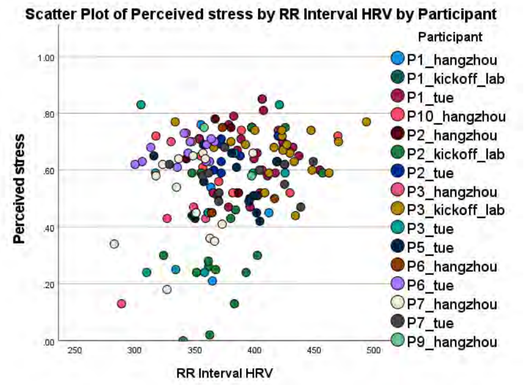


Figure 15: Non-transformed perceived stress plotted against the measured mean HRV of a 3hour window. Heteroscedacity visually identified

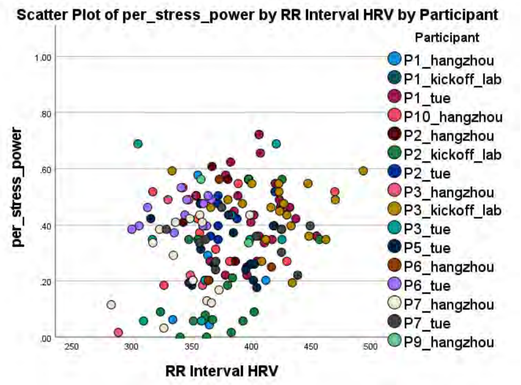


Figure 16: (perceived stress)[2] plotted against the measured mean HRV of a 3 hour window. Slight linear relationship between variables. Homoscedacity visually identified

			95% Confidence interval for Difference	
HRV	**(per_stress)²**	**per_stress**	**Lower Bound**	**Upperbound**
300	0.28	0.53	0.48	0.58
325	0.31	0.56	0.52	0.59
350	0.33	0.58	0.55	0.60
375	0.36	0.60	0.58	0.62
400	0.39	0.62	0.60	0.64
425	0.41	0.64	0.61	0.67
450	0.44	0.66	0.62	0.70
475	0.46	0.68	0.62	0.72

Table 1: Predictions of (perceived_stress) [2] - calculation of perceived stress - with confidence interval of perceived stress

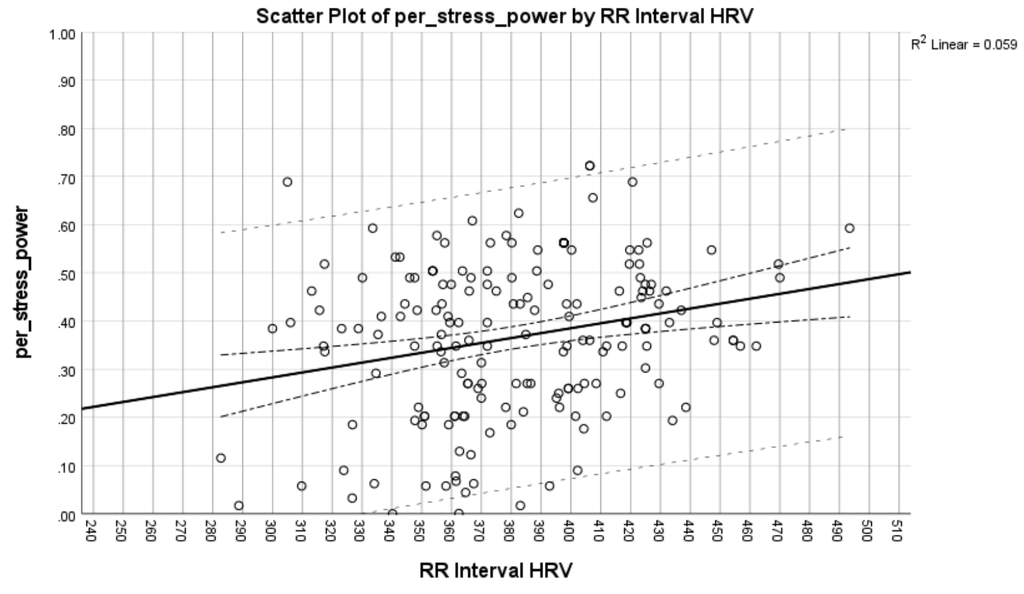
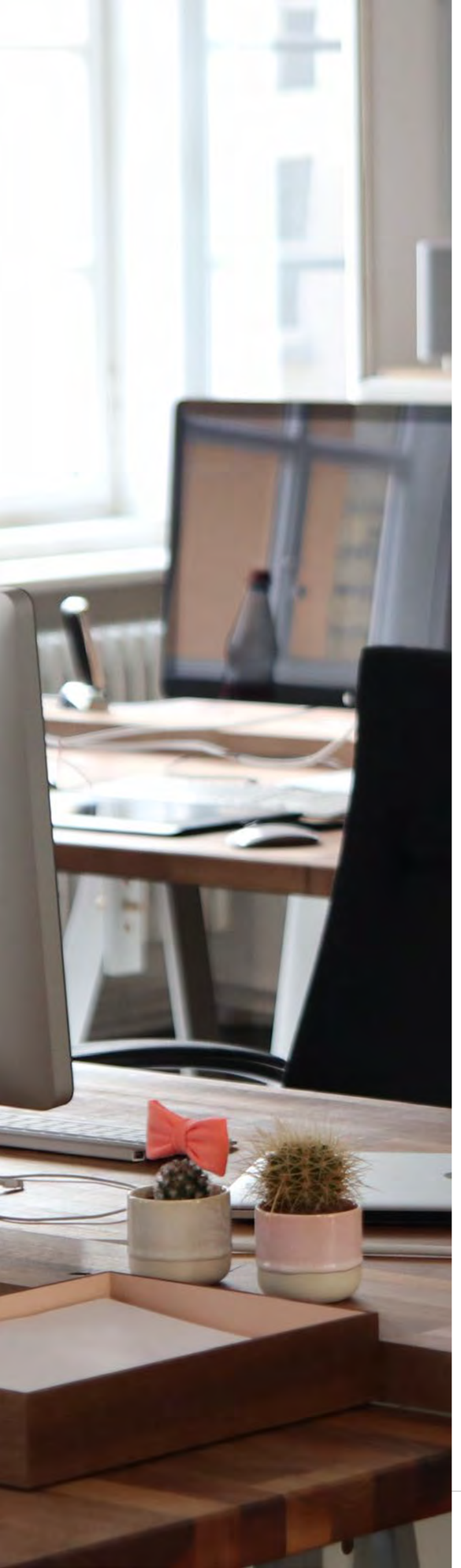


Figure 17: Linear regression scatter-plot. Measured HRV against (perceived stress)[2]. 95% Confidence interval for Difference plotted, with upper and lower bound.



Validating thoughts

Several employees from office equipment companies (Linkedin; Koninklijke Ahrend BV, Kinnarps BV, and Vitra BV) were approached to validate and deepen the knowledge already known. There was a successful connection with one designer from Ahrend, Ronald Schipperen, who was willing to consult in planning in a meeting with their innovation manager, Gerard Huiskes and one of their longest-running chair designers in the company; Kees de Boer.

A set of topics and questions were set up to prepare the three separate interview sessions beforehand (full-set of questions see appendix C). The session started with an introduction from both sides. The sensor and aim of the sensor were introduced, and Ahrend introduced their company and services. Besides, during the opening, more in-depth questions were asked about the sensor and its functionalities and Ahrend's vital offerings. More in-depth topics were discussed after the introduction. The first topic is more sector-focused on what trends are currently developing in the sector, Ahrend's vision on integrating smart technologies in the office, and the impact of COVID-19 on (home) office and workspaces. The second topic discussed was about the current value proposition of Hangzhou Bobo, and the extended one, developed during the first phases of the project, subjects discussed where; collective visualizations, vitality within the office, and energy-saving propositions.

During the session, notes were taken, and the conversation was transcribed after the sessions. The sessions were analyzed through thematic analysis, a widely used method within the design world to find themes and patterns within interviews (Braun & Clarke, 2006). All the sessions were combined within one analysis to find similar themes between the three interviewed. Different colours were given to the interviewees' statements to identify possible relationships between views and one role.

Four main themes are identified, namely (ordered from most statements to least statements): strategy and value proposition, data and privacy, feasibility and technology requirements, and user experience of one using a sensor-equipped chair.

Strategy and value proposition

Change in working

COVID-19

Office as social hub versus home office as a personal workplace

Gamification

Home for individual measurements, games in the office on a chair to improve social connection through leader-boards. Additionally, one could challenge others to be more active on a slow day

Collection of additional data

There is a trend seen that adding additional sensors is very cheap. Is there a possibility to collect more data from the cushion (temperature data, light intensity)? The collection of more data might reveal information which generally won't be found.

Data access (API)

Companies might be interested in combining data collected from the sensors into their available data sources. They are willing to pay extra.

Data ownership

3rd party companies, should give Ahrend access to the data; it is not a one-way partnership.

3rd party collaboration

Ahrend participates with 3rd parties to integrate new 'smart' technologies in their chairs.

Data and privacy

Security and privacy collective visualization

Due to the nature of the data, data is very private-sensitive. Due to new laws (GDPR), you can't visualize collective data anymore. By collecting so much data, it is always possible to find an individual inside the data.

Legal

It is important to research companies policies (e.g. in governmental institutions, it is not allowed to collect any data). Besides, who is liable when wrong advice is given if there any advises given?
Acceptance of user
Outside of work, users accept data is collected, but data-collection by the employer is a sensitive topic. Stress data is private data and thus sensitive data which one should carefully handle. Value of the data is very important, what can insights does it give me as a user? Transparency about the data usage should also be clear, and there should be discussed that data is never used within the decision-making process.

Office culture

There is social control by the employer; they might not support you vitalizing during work. Therefore, it is also essential to support change in the work floor, and indicate the importance of supporting office culture—numerous researches demonstrate the importance of moving during work. Still, the most important is that the employer supports a small break.

Awareness of user

Employees are very aware of their data and privacy. It is important to be transparent and indicate where data is flowing and who is using the data. Make sure there are no weird in-between servers of other companies.

Home versus office environment

As more employees will start working at home, it is even more important to indicate what is being done with the data. As employees are at even more sensible in giving data to their employee.

Feasibility and technology requirements

Modularity

“We focus on using technology which are easily added to a furniture object and which are easily upgradeable”, as the development of technology goes faster than the development of furniture you want to upgrade furniture at a later stage, and thus, make the technology as modular as possible.

Connectivity

Sensors must connect with a separate network outside of the intranet of companies. Companies IT departments do not allow other companies to be on their internal network.

Energy usage

Energy usage is very important, as one does not want to charge their device continuously. One should look into alternatives of power, for example, power over Wi-Fi.

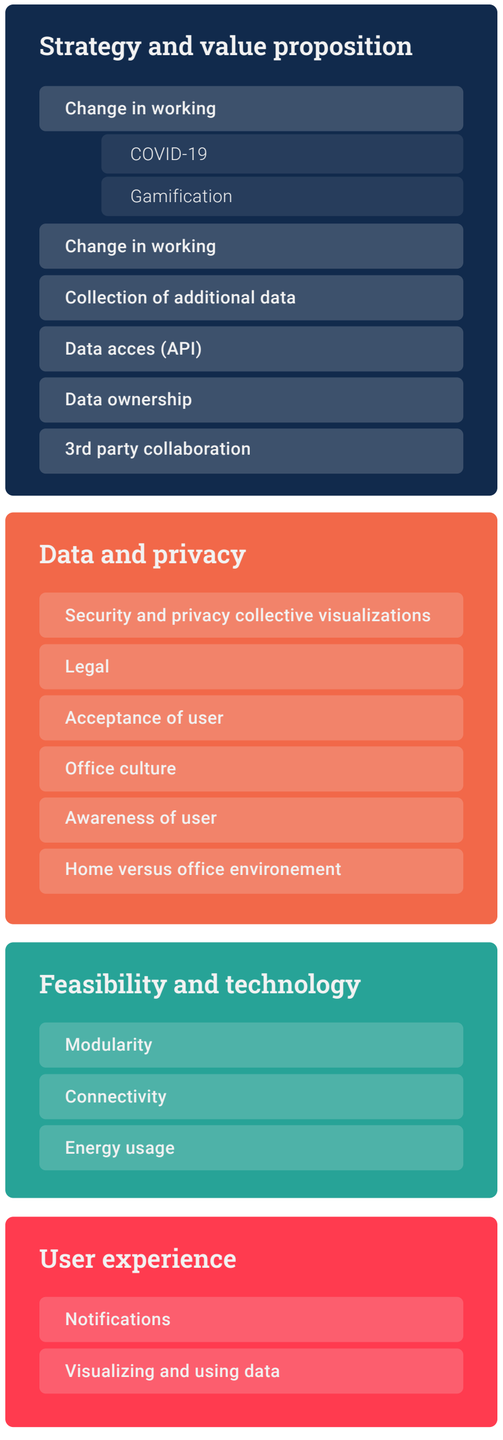
User experience

Notifications

There are too many notifications, users are notification-tired. One could nudge a user another way (coloured light, small vibration, change colour in the room), but don’t force users to change. Nudging should also occur on a personal level, instead of on a collective level.

Visualizing and using data

It is important that users can use the system whenever they want. “We facilitate objects and environments to be inspirational to create more movement”. One should provide insights and analysis when people want to look at their data; it is important to get feedback on what you are doing.

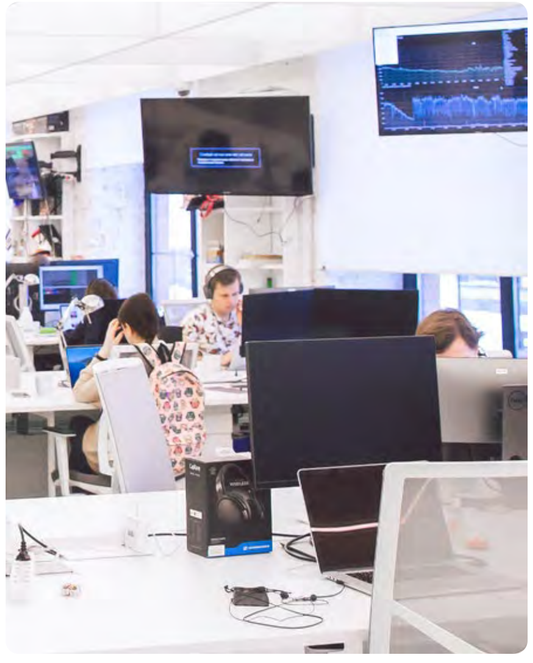


Making decisions

As mentioned in the interview with Ahrend, and earlier done research, the initial concept was to visualize data more collectively. While the idea provides enormous amounts of value to employees as they reflect upon the teams’ performance and stress level together, it is currently not desired and feasible to implement such visualization. As indicated in the interview data, data of individual users can always be linked back to individuals, personal data can’t be visualized because of EU-wide laws (General Data Protection Regulation (GDPR), 2016), and it is doubtful whether users would accept such visualization in their workspace.

As indicated in both the validation of the collective visualization and the interview with Ahrend, it seems that it is too early to visualize collectively (see design ‘collective visualization’ – section) due to negative thoughts by the user about negatively influencing a their position within the company (lack of transparency, sensitive data, etc.).

Therefore, it was decided to focus on a personal informatics platform to let people adapt to measuring their well-being data during their work. As said before, collective visualizations provide value in the office, but employees currently do not desire them.



Integrated value proposition

"A personal **data-driven vitality** *app, helping you in being more* **self-aware of your well-being** *during work."*

Personal informatics app

As a final result, a personal informatics app is designed, which helps employees manage their vitality within the office space.

The products consist of a vitality platform connected your sensor-equipped office chair. This sensor measures several different parameters related to your well-being in the office; fatigue levels, sitting position, sitting duration, heart-rate and respiratory rate. While an employee is working, the office chair will automatically collect and send the data to the vitality platform. When an employee is willing to look at their data, as they might are not feeling well, or are interested in their vitals, one can open the connected app and see in one glance whether there is anything wrong with their vitals. If an employee is interested, one can go one layer deeper in the app to see a detailed overview

From an employee their perspective, the platform provides the means to reflect more insightful on their working habits around vitality. Several researchers are indicating the importance of vitality in the office. An employee, for example, should switch their position once every 30 minutes (University of Waterloo, n.d.), change their position, or do a short walk as this can relieve any neck and lower back pain (Buckley et al. Secondly, having a proper sitting position is equally as important as sitting wrongly on a chair, can result into musculoskeletal injury, also known as Repetitive Strain Injuries (RSI). Lastly, while self-reflecting stress surveys exist, there is no means to measure fatigue levels over a more extended amount of time, without any considerable increase of effort.

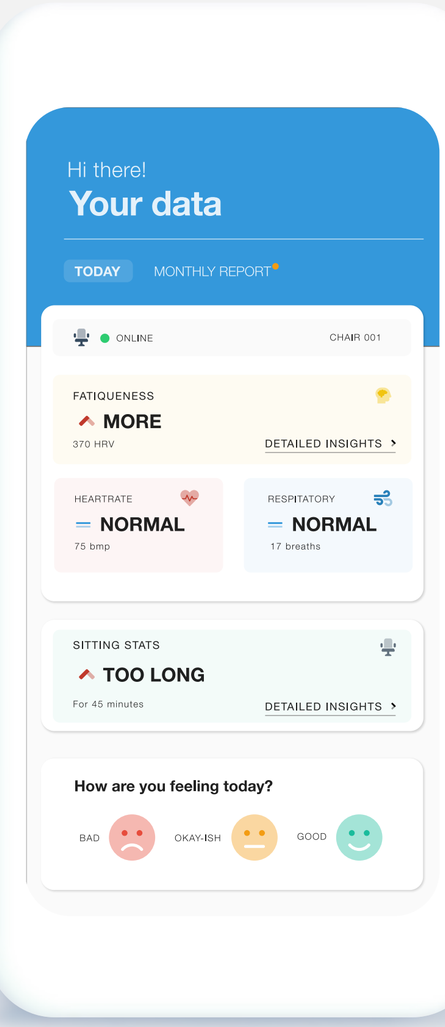
From an employer standpoint, the platform provides means for an employer to support their employees with a vitality platform so that the full workforce can be more vital. Currently, around 20 per cent of the working force in the Netherlands experiences the last phase of too much fatigue at work; namely burnouts. While employers try to lower this number by adapting their employees' tasks, there is less focus on informing people about their fatigue levels during their work, and proactively tackling problems (TNO, 2020).

Personal informatics app

Main elements

1. **See your current day**
2. **Get a report of the last 4 weeks**
3. **Compare and see details**
4. **Compare yourself against the office**
5. **Set goals and improve yourself**

In use



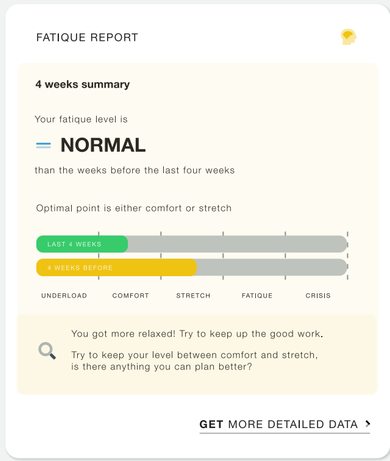
Start screen

One can discover in one look at their current statistics on wellbeing.

Main elements:

1. Four indicators about wellbeing
2. Insightful information about trends in the data, looks anything off?
3. Possibility to dive deeper in your on well-being stats

Four weeks-reports

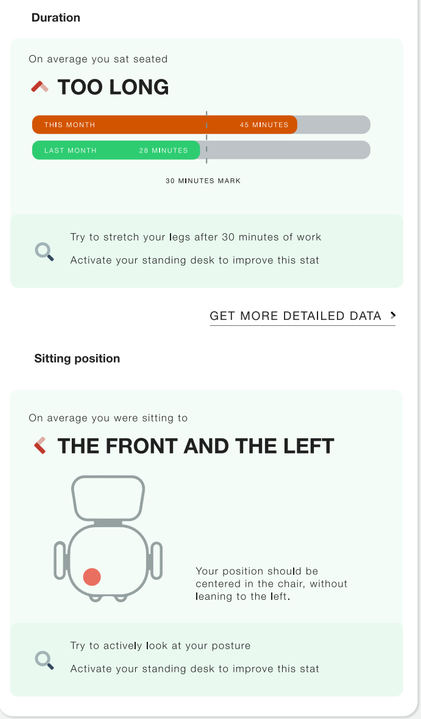


Fatigue level

These levels indicate your current fatigue levels in the office.

Main elements

1. Insightful indicator, which indicates your zone according to the Yerkes-Doson law (Cohen, 2011)
2. Compare your results with the last month, and directly make yourself aware of changes
3. Hints to improve your fatigue levels

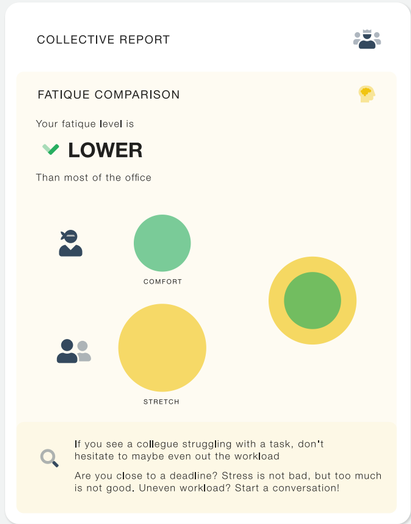


Sitting report

Discover your sitting behavior. Did you follow the base rule 30 minutes standing and sitting rule? And did I correctly position myself on my chair?

Main elements:

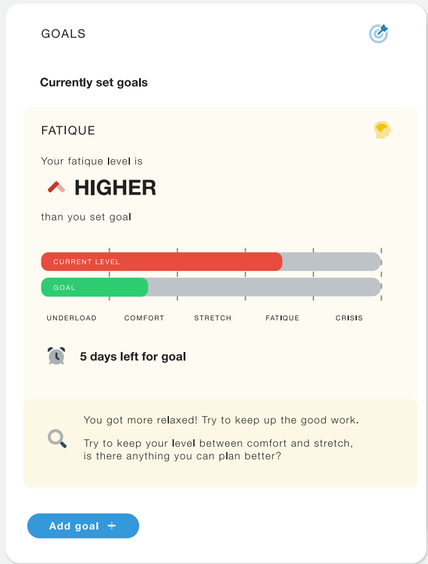
1. On average how long was I seated?
2. Comparison with last month to check improvement or degradation.
3. Visualization of sitting position in chair.
4. Insightful hints based on your data, to indicate what one should do to keep going or to improve oneself.



Collective report

View your health-level against the department's aggregated result. From this module, an employee might want to challenge others to be more vital during the day.

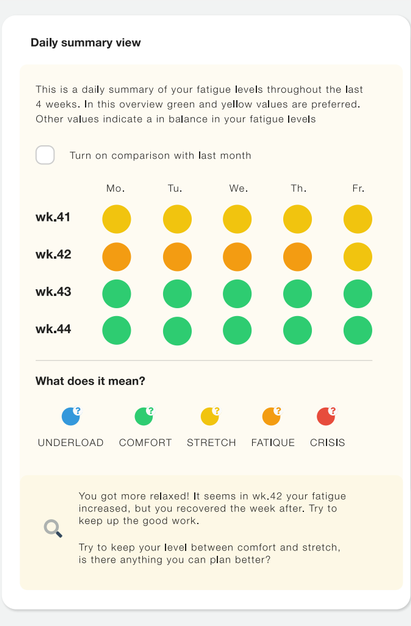
Goals



Goal overview

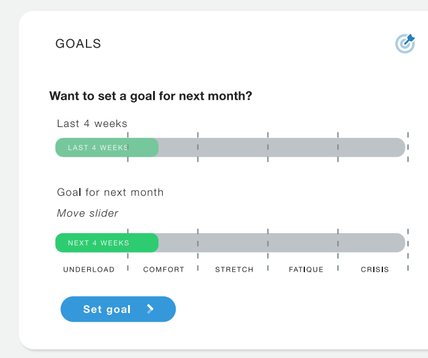
View your personal goals and reflect upon those in the goal overview screen. Follow whether your wellbeing is improving towards your set goal

Detailed insights



Collective report

View your health-level against the department's aggregated result. From this module, an employee might want to challenge others to be more vital during the day.



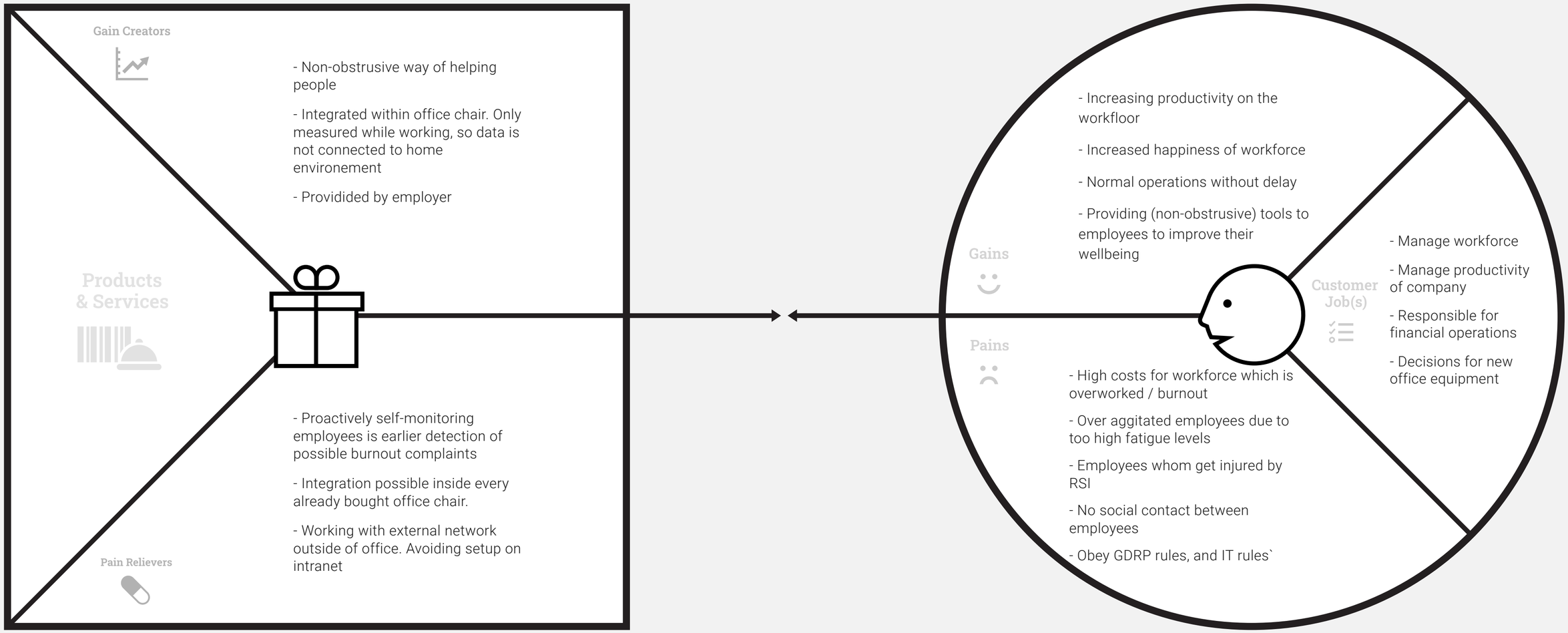
Set goals

In the report section you can set your goal. Is there a certain value I want to work towards?

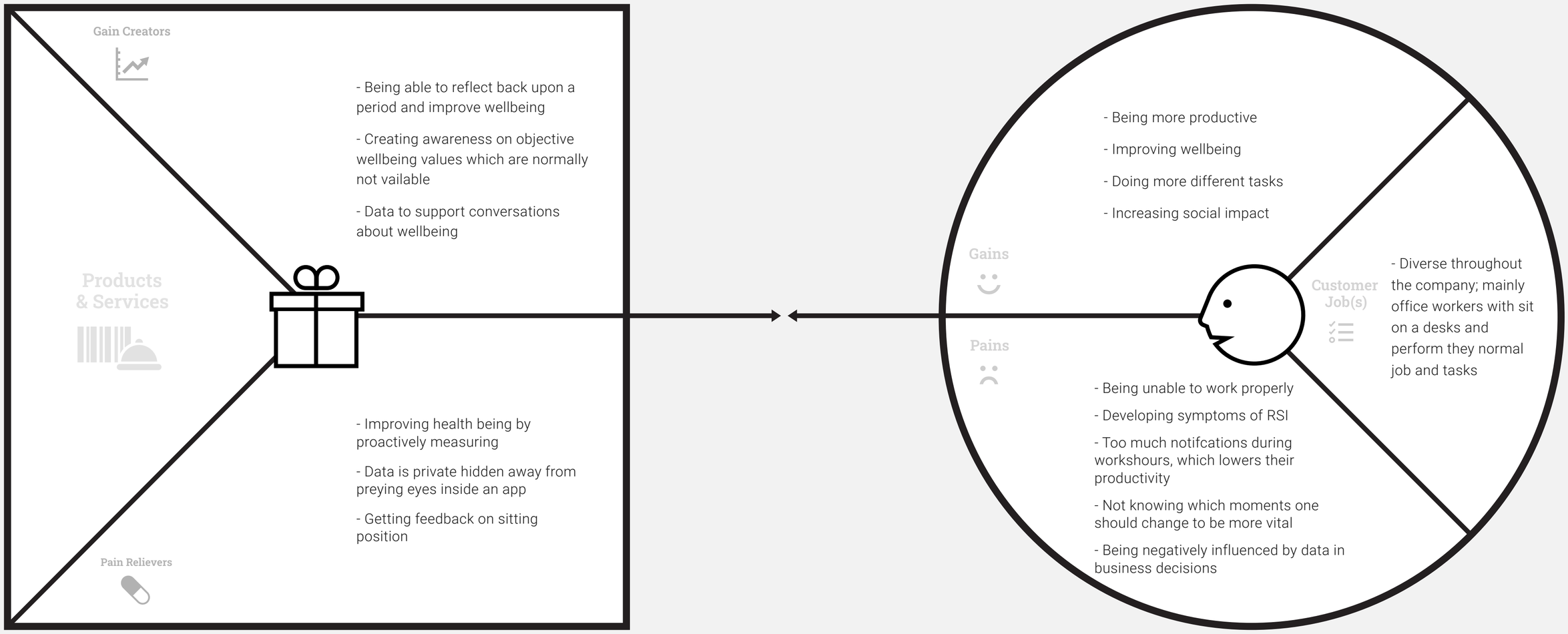
Customer pains & gains

Too further detail and summarize the value proposition: two Value Proposition Canvases are developed. The proposition canvases outline the customer profile, the value which is created and thus shows the problem-market fit (Osterwalder et al., 2015)

C-Level executives and managers



Employees


Gain Creators
- Being able to reflect back upon a period and improve wellbeing
- Creating awareness on objective wellbeing values which are normally not vailable
- Data to support conversations about wellbeing
Products & Services
- Improving health being by proactively measuring
- Data is private hidden away from preying eyes inside an app
- Getting feedback on sitting position
Pain Relievers
Gains
- Being more productive
- Improving wellbeing
- Doing more different tasks
- Increasing social impact
Customer Job(s)
- Diverse throughout the company; mainly office workers with sit on a desks and perform they normal job and tasks
Pains
- Being unable to work properly
- Developing symptoms of RSI
- Too much notifcations during workshours, which lowers their productivity
- Not knowing which moments one should change to be more vital
- Being negatively influenced by data in business decisions

Competitors

By closely determining the competition of the current value proposition, a clear understanding of the value of the combination of both the sensor-equipped cushion and the informatics were derived. Several companies with their products were identified, which could help companies and employees in measuring vitality levels. This overview is depicted in table 2

		Sit position and duration	Fatigue detection	Accuracy	Data storage and reports	Non-intrusive measuring
On the go	Elite HRV	✗	✓	✓	✓	✗
Wearables	Whoop strap	✗	✓	✗	✗	✗
	Apple watch	–	✓	✓	✓	✗
Office chair	Aeron[1]	✓	✗	✓	✓	✓
	Axia[2]	✓	✗	✓	✗	✓
	Chair + app[3]	✓	✓	✓	✓	✓

[1] Herman Miller
[2] BMA ergonomics
[3] Project's value proposition

Table 2: Competition current value proposition

EliteHRV is the first device and platform reviewed. EliteHRV offers a product that can be put around the finger, determining the HRV, and giving insights based on this measured HRV. They claim only to need two minutes of measurement to assess your well-being. This method, unfortunately, does not help with sitting duration and position.

Two devices are identified in the wearables group, the apple watch, and a static strap, the Whoop strap. Both need to be worn on the user's body, which is an intrusive way of measuring; as users need to put the strap around their body to measure their HRV.

Several other sensor-equipped office chairs are on the market, which measures similarly, but fail to provide insights to the employee other than sit position and duration.
While all the products help the employee with their vitality and the employer with managing vitality levels, none of them provides a complete package in an already available product within the office environment. Combining both sensor and app creates a way for employees to manage their vitality levels, while employers provide a privacy friendly and non-intrusive measurement device.

Porter's 5 forces

By closing researching the business climate one can determine the competitiveness of the business , and determine the potential profitability. In appendix B the calculation of each force can be found.

Validation

A validation is held to review the designed interfaces and evaluate possible users their opinion. Two young professionals were asked to review the interfaces in an open discussion session. A set of topics and questions were set up to prepare the discussions beforehand (full-set of questions see appendix …). The topics discussed were their first thoughts on the system after detailed description, in what kind of setting could the interface be useful, and at what point in time could this be helpful? Both of the participants felt healthy at the point of the interview, so they were asked to imagine they would have stress or physical issues.

During the session, notes were taken, and the conversation was transcribed after the session. The session was analyzed through thematic analysis (Braun & Clarke, 2006).

Topics identified:

Tool for evaluation and evidence

Both interviewees identified that the tool is for personal usage. Nevertheless, they say that the tool can be used as evidence towards your boss if something is going on in the data. “This could be a tool to show to my manager when I want it, to support that I am stressed.”

Heartrate data

One interviewee was critical about the heartrate. It seemed to him that a ‘higher’ heartrate is dangerous to say. “Be careful with heart rate higher. What does that mean? Where does it come from? Many people make false conclusions on that.” The other interviewee added: “The app should be designed that I do not draw wrong conclusions”. Extra attention should, therefore, be put into designing insights which support people in their conclusion making. Another way to help people in concluding is to give a workshop to inform them before the start of deploying the sensor in an office building

Trust in employer

Both of the interviewees had doubts whether the data was kept away from their employer. “ Like, I wouldn’t trust that I’m actually in control of data on this”. There should be extra care at the onboarding process that the employee knows that the data is sent to a 3rd party and can’t be accessed by the employer.

Awareness

The interviewees both mentioned that the app would create awareness into both their mental and physical status. “For sure if the app is there I would look at it to discover whether there is anything wrong with my data” and “It creates a certain awareness which I might not have had before”

Discussion and future

While the project's result is clear and gives a well-substantiated direction for deploying the sensor within the market, more insights gathered during the projects that did not fit the current value propositions. These insights and directions can still be precious. Therefore, several options to extend upon this report are listed below.

Road ahead

Post-COVID-19 epidemic

This report is written during the COVID-19 epidemic. Currently, big chances are ongoing with the employees' opinions on where they want to perform their work in the future. More and more employees' now start indicating they would like to spend more days working from their home office (Boland et al., 2020). Office equipment producers, like Ahrend, also indicate they are working on visions where the office is a more a social hub, and where people work home 50% of their time. While the sensor would then more be a home measurement tool, one could deploy the office chair in the 'new' office as a gaming chair where little games can be played on. This would add an extra value to the chair, which is not yet exploited by other companies, giving 'the social hub' a bit more socialness.

Proposed extra functionalities

This report is written during the COVID-19 epidemic. Currently, big chances are ongoing with the employees' opinions on where they want to perform their work in the future. More and more employees' now start indicating they would like to spend more days working from their home office (Boland et al., 2020). Office equipment producers, like Ahrend, also indicate they are working on visions where the office is a more a social hub, and where people work home 50% of their time. While the sensor would then more be a home measurement tool, one could deploy the office chair in the 'new' office as a gaming chair where little games can be played on. This would add an extra value to the chair, which is not yet exploited by other companies, giving 'the social hub' a bit more socialness. One direction that hasn't been explored during this project is adding extra functionality to the already existing sensors stack. Currently, the rise of machine learning models means we can detect patterns we cannot detect. Innovations like keystroke dynamics analysis (Intense Solutions, n.d.), which detects a person through their typing behaviour, find patterns that seemed impossible before. As everybody is unique, it might be valuable to research this direction and discover whether one can detect somebodies identity based on their 'unique' pressure, and thus identify non-intrusive

Additionally, non-intrusive ways of indicating an employee are not yet implemented in the current design. One could research whether there are any sensors, or additional tangible products, which could nudge the employee just enough to take action during their work already.

Collective versus individual visualization

As already mentioned in the 'making decisions' it seems that it is currently not yet desired to show your boss and colleagues your data (while anonymized it might still be possible to identify somebody). Both in the user validation of the collective visualization and the interview, it was mentioned that trust and culture in the office are essential in visualizing such data. Therefore, it might be an interesting direction to explore further how one can open up office cultures, and let them a full office environment reflect together upon their stress data without influencing any future business decisions.

Partnerships

To deploy these sensors at a scalable level and improve the vitality of as many employees as possible; it is crucial to find channels to deploy the sensors within office chairs. Currently, the most beneficial route is to set up partnerships with already well-established office equipment producers, as they have the channels to roll out these sensors. As office-equipment producers are from nature producers of static articles, they trust 3rd party companies (Ahrend is an excellent example who work with 3rd parties) as their technology providers. One should look to get ground in Europe and the Netherlands by partnering with these companies to run a pilot test at their customers to improve the current value proposition further.

Challenges technology

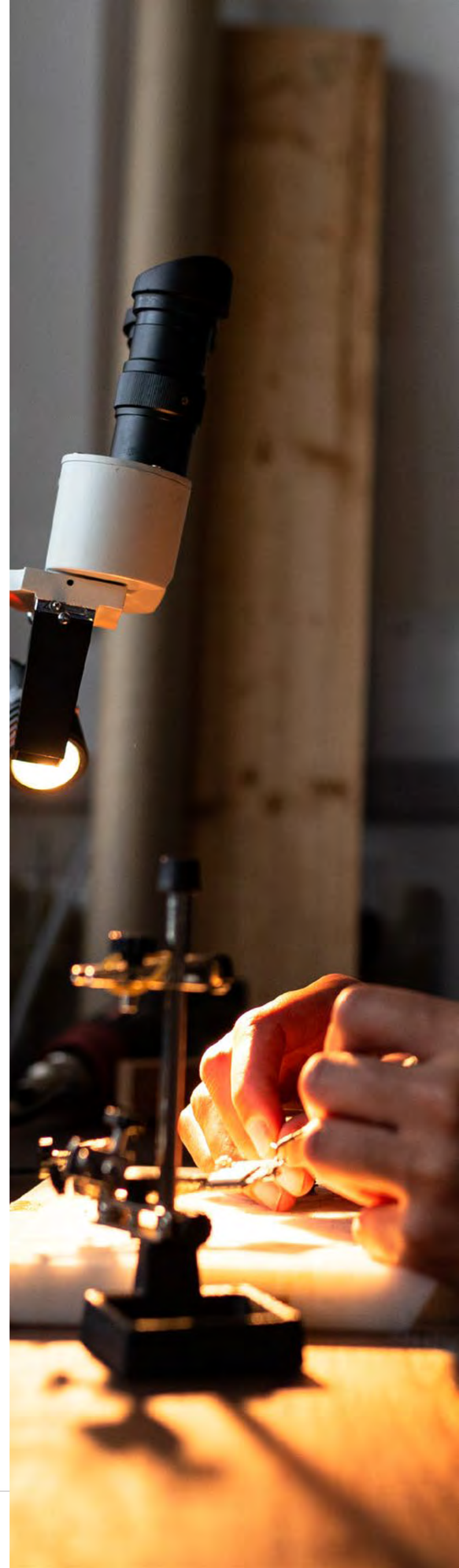
Measured HRV versus real-life perceived stress

As already indicated at the end of the research to find a relationship and predict perceived stress levels, a correlation was found. Unfortunately, this correlation was inversed, and not according to the hypothesis set at the start of the research.

As the measured HRV is one of the most valuable parts of the value proposition one could extend upon the research done in this project and see whether there are any other methods to give employees an indication of their fatigue levels.

Firstly, as already indicated, one can look at the data trends, if data trends down, one can suggest that an employee might feel more fatigued.

Secondly, one can extend the research already done. Several methods exist to adjust or create stress status by, for example, a first-person shooter game (Bouchard et al., 2012) or memory card game (Admon et al., 2013). Therefore, research can be developed to adapt to participants' stress levels, forcing participants' measured HRV to go down. One could research whether groups can be found by certain induced stress levels. If so, a generalized rule can be created, and the visualization can improve.



Requirements technology

Several methods and technologies used in the setup and functioning of the sensors are currently not usable in office environments in Europe.

Connectivity

Currently, the sensors connect to a Wi-Fi network and send the measures to the cloud. While this works fine in home-environments, most companies IT departments do not want you to connect to their corporate Wi-Fi networks. Therefore the sensor must connect to a network outside of the companies' one.

Several other options of connectivity are currently available. Short-range options (like Bluetooth, Zigbee, RFID) are not possible as a gateway should still be implemented in the office environment. Long-range options which are currently available are LPWAN and cellular. Only cellular crosses of all criteria for connection, as LPWAN only support a limited amount of 'messages' per day limited by size. As the sensor continuously collects data, this data must be sent to the cloud, which is only possible by connecting the sensor to the cellular network. It is therefore highly advised, to connect the sensor in the future to cellular networks (3G – 4G – or 5G)

Modularity of the system

As can be read in the overview section of the analysis of the interview with Ahrend, modular technology is crucial in a partnership. "We focus on using technology which are easily added to a furniture object and which are easily upgradeable", as the development of technology goes faster than the development of furniture you want to upgrade furniture at a later stage, and thus, make the technology as modular as possible. It is an insight which probably changes the current design of technology. As it was not a focus point during the project, it should be researched in the future, how the technology can be modified so it can be retrofitted within every office chair cushion. The battery and main processing board should be as modular as possible.

Besides, measuring more parameters (for example, temperature) on every chair could discover hidden things in office spaces. One should possibly research whether additions can be made to the main processing board to extend the set of data collected. An example of this could be integrating temperature, humidity and air quality sensors in the at the main processing board. If modularity is taken into account, one can offer comprehensive data collection in a home office environment to better the working environment of a user. Adding modularity to the setup means that electronics can be updated at a later stage, and more value can be offered.

kl

Kickoff Lab

Bringing design strategy to technology-centric challenges

Founding our own company for the future.

The current section is not connected to the project described in the rest of the project. While it is a typical case of bringing design-strategy to a technology-centric challenge, I reflect and describe on developing Kickoff Lab into a company which is ready for the future. This is a process together with two others with whom I'll run the company in the future. As it was one of my goals during this semester to position Kickoff Lab in the market, it is included in this report.

Kickoff Lab is founded in 2018 as a side-business with Martijn Dekker and Cyril Mengin, both Industrial Design students from the Eindhoven University of Technology. The company started without a direction, and our assignments mainly focused on software development. Over the last year, we decided that we are aiming to work full-time on the business in 2021 and develop it in a more matured company ready for new assignments in 2021.

Positioning Kickoff Lab

Who are we, and what for service do we provide?

In several sessions, we tried to examine further who we are, our identity and values, and what kind of work we want to do in the future.

After several sessions where we tried to find a name for the company that describes what we like (after 50 different names further), we settled with Kickoff Lab. A place where ideas can get started and where experimentation is key to success.

While we all have very different profiles, we all love to do (highly) technology-centred projects. From this we all have different ways of achieving our set objective within a project. We found three factors that describe every project we do and how we tackle them.

Figure 18: Idea generation session

kickoff lab brings design strategy to technology–centric challenges

Figure 19: Kickoff Lab's main mission statement

Target ↑

Through research and rapid validation, we target the problem at hand. Clearly defining boundaries from the unknown, with a practical and realistic mindset.

Process ↺

We set up the design process that fits your project with a bias for action; exploring and validating opportunities and perspectives – all while keeping you involved.

Connect ✣

From corporate meeting rooms to the workshop floor – we bring together the tools, partners and expertise needed to ensure success.

Figure 20: Kickoff Lab's three factors that describe every project and process

How do we brand ourselves?

In addition to a well-defined and positioned mission and identity statement, it was essential to professionalize ourselves for the future. To present ourselves to the outside world we brainstormed (see picture ….) and designed our brand DNA – a full summary of colours, fonts, and logo are to use when communicating.

Besides, to further define our brand, and communicate ourselves to the outside world, we designed our portfolio, including our mission and identity statement and projects we did. The project section tries to display a complete picture of all services we could offer .

Titles

Almost before we knew it, we had left the ground.

Almost before we knew it, we had left the ground.

Almost before we knew it, we had left the ground.

Almost before we knew it, we had left the ground.

Sub-titles

Almost before we knew it, we had left the ground.

Almost before we knew it, we had left the ground.

Almost before we knew it, we had left the ground.

Body

Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Suspendisse sed nisi lacus sed viverra tellus.

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Logo

kl kickoff lab

kl kickoff lab

Color palette

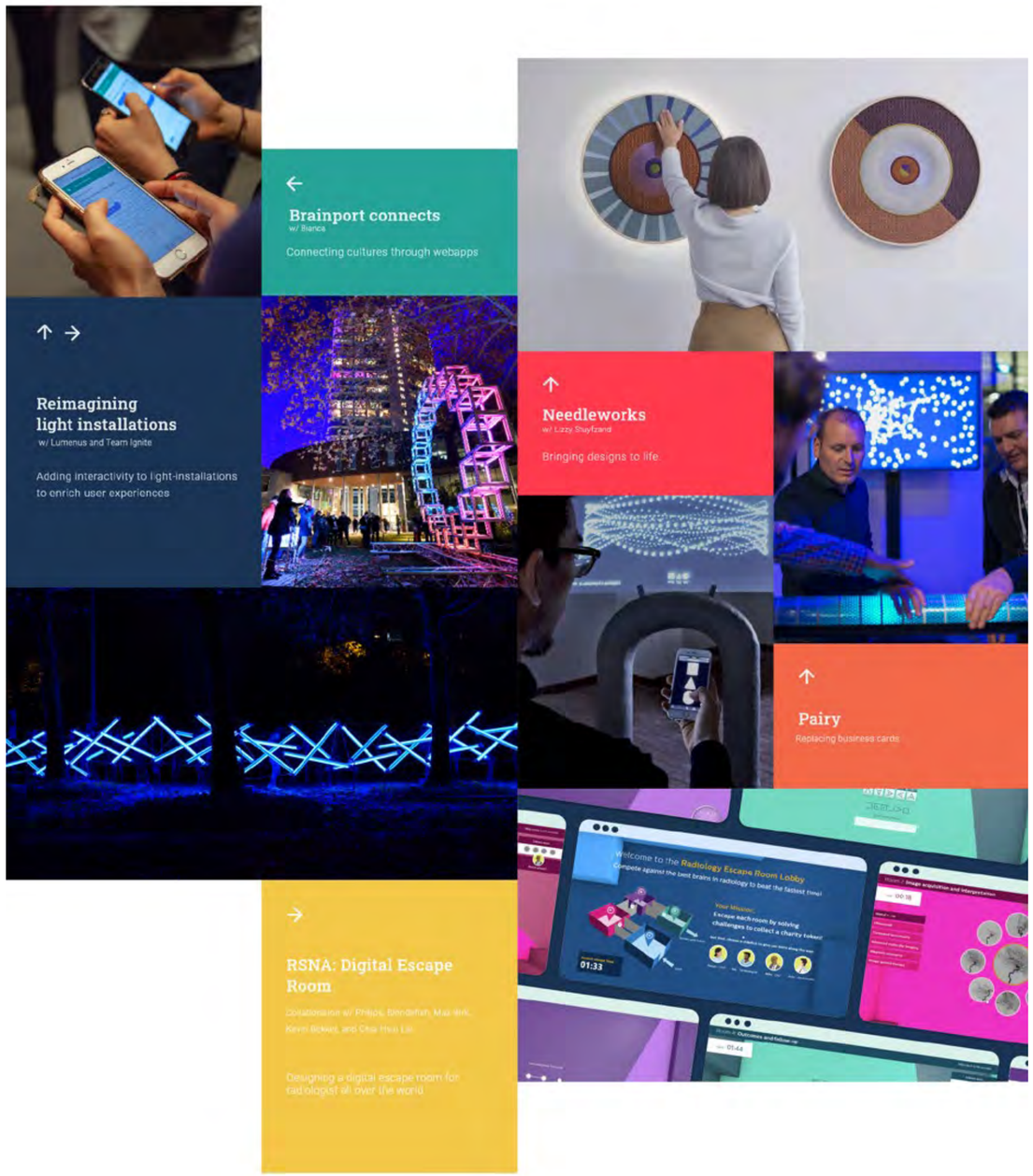

Figure 21: Projects overview - portfolio

Positioning Kickoff Lab

The reason for founding the company was our first client Bianca Serba. The project ran within the Effenaar's (Eindhoven's most prominent event venue) Fieldlab Social Cohesion project. Together with Irina Serban and Studio Lot de Haan, we worked on a web-application which improved social cohesion between ex-pats and Dutch locals. Kickoff Lab acted as a technical partner and realized, Brainport Connect; the web-application should provide more cohesion. In between 2018 and 2020, small assignments have been done to extend our portfolio further.

We extended our portfolio during the last half-year (July – December 2020) by doing three significant assignments to expand our portfolio further. Firstly, we were part of a team which deployed the Eindhoven University's Dutch Design Week website in two weeks. Secondly, together with Philips, Blondefish, Max Birk, Shiu Liu, and Kevin Bekker, we designed a digital escape room for the digital RSNA conference (one of the world's biggest radiology conferences). Lastly, we supported Lizzy Stufyzand in creation of two touch-senstive panels part of the project: NEEDLEWORKS.

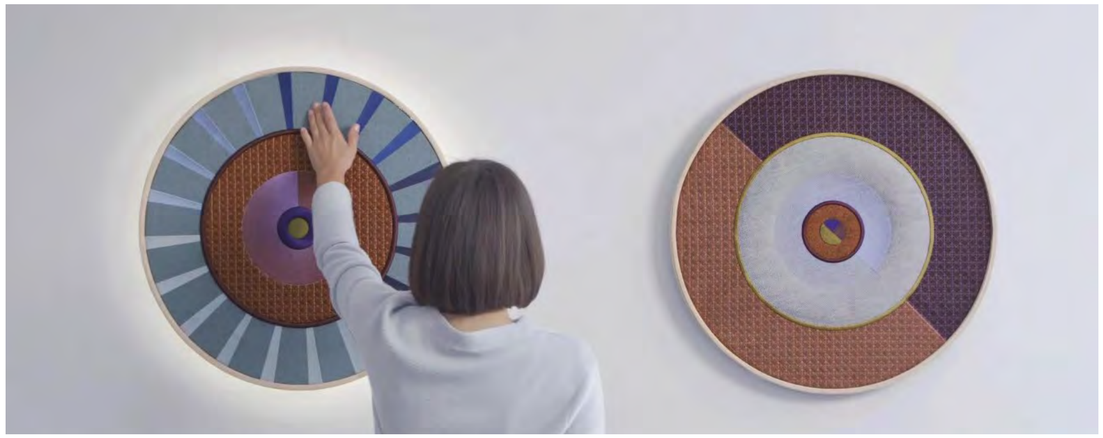

Figure 22: N E E D L E W O R K S - Design by Lizzy Stuyfzand - realization by Kickoff Lab

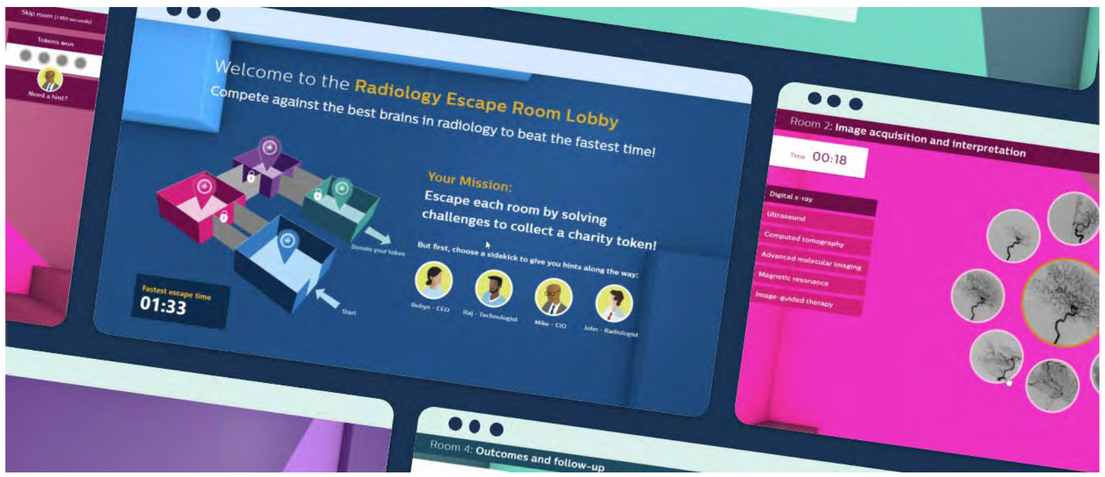

Figure 23: by Philips, Blondefish, Max Birk, Shiu Liu, and Kevin Bekker: a digital escape room for the digital RSNA conference

The future

Public roam

In the last year, we set out to professionalize our company, and be ready for 2021. With our professionalized mission statement, we successfully signed our first client for the new year; PublicRoam, a company trying to provide safe Wi-Fi to public institutions. Together with Public Roam, we are improving the user journey to connect to one of their Wi-Fi networks.

N e e d l e w o r k s by Lizzy Stuyfzand

Additionally, we are working together with Lizzy Stuyfzand in launching our first product onto the market. In an earlier project, we collaborated with Lizzy in creating two high-fi prototypes of her design; LUMI & SANA. Two touch sensitive embroidered panels, which control either light or sound. Currently, we are researching the possibilities to launch these panels to the market. Kickoff Lab will be fully managing the development cycle of these panels till launch.

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Appendix

Appendix A - consent form

Subject information for participation in scientific research

Empirical research
Evaluating subjective and objective stress levels

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
- Final Master's Project	This study has been designed by and is being carried out by Matthijs Hoekstra at TU Eindhoven, under the supervision of Jun Hu. The researchers are paying for the costs of this study.

2. Purpose of the study
The researcher plan to generate insights in how people perceive the visualization of their health-data in an office environment. Data is collected through the usage of an sensor-equipped cushion, a stress-indicator survey and a post-interview session.

3. What participation involves
During the study, the following will happen:
- a structured, onboarding instruction will be done before the sensors are installed
- objective data is collected by the sensors
- subjective data is collected by your input in the subjective stress survey

At the beginning of the study and before the sensors are installed, this consent form will be presented following an onboarding instruction. These sensors will remain here for the duration of the study, which is 2 weeks. After these 4 weeks, the sensors will be removed from your work environment.

4. What is expected of you
In order to carry out the study properly it is important that you follow the study instructions. These instructions will be provided to you during the instalment of the sensors.

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 think there is something wrong with the equipment
- If you feel uncomfortable with your data being displayed in the office environment

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 four weeks from its start date
- the investigator considers it best for you to stop
- TU Eindhoven, 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 personal data will be collected, used and stored for this study. This concerns data such as your movement around your desk, the sound threshold of the environment, and the movement of your chair. The collection, use, and storage of your data is 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. Data can only be traced back to you with the encryption key. The encryption key remains safely stored in the local research institute. If the data that is sent to the sponsor 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: the Ethical Review Board of TU Eindhoven that monitors the safety of the study, and the investigator of the study, Roy van den Heuvel. 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 one year at the research location TU Eindhoven.

Storage and use of data
Your data may also be of importance for other scientific research in the field of sedentary behaviour interventions. To this end, your data will be stored for one year. 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 person responsible for the processing of your personal data. For this study, that is:

Matthijs Hoekstra [TU Eindhoven] See Appendix A for contact details.

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

Appendix A - consent form

Any questions?
If you have any questions, please contact the research team.

If you have any complaints about the study, you can discuss this with the investigator. 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 participation 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.

16. Appendices to this information
A. Contact details
B. Details onboarding interview
C. Informed Consent Form

Appendix A: Contact details

Researcher:
Matthijs Hoekstra
+31 6 45947585
m.j.hoekstra@student.tue.nl

Research coach:
Jun Hu
j.hu@tue.nl

Appendix B: Subject Consent Form

Empirical research
Evaluating subjective and objective stress levels

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**
  want to participate in this study.

Please cross a box, and sign on next page.

Appendix B - Porter's five forces

Bargaining power of suppliers	Level of force (10 = high)
Monopolistic position of suppliers	0
Suppliers limited by patents or special technology	4
Suppliers vertically integrated with competitors	4
Overall bargaining power of suppliers (average)	2-3

Threat of new entrants	Level of force (10 = high)
Start-up costs for entering the market	2
Threat of a disruptor presenting a low-cost alternative to existing products	2
High profit margins that could encourage new entrants	6
Ease/difficulties of penetrating existing channels to market	5
Loyalty of customers to existing suppliers	2
Marketing costs to reach customers	4
Overall threat of new entrants (average)	3.5

Threat of substitutes	Level of force (10 = high)
Ease of switching to an alternative product or service	2
Easy access to alternative products or services	2
Low cost of alternative products or services	2
Overall threat of substitutes (average)	2

Power of buyers	Level of force (10 = high)
Size of buyers versus size of suppliers	8
Limited number of buyers	8
Difficulties of getting "listed" at buyers	8
Sensitivity of buyers to price changes	8
Ease of switching to new suppliers	4
Overall power of buyers (average)	8

Internal rivalry	Level of force (10 = high)
There is an oversupply of capacity within the market	2
There is a lack of loyalty amongst customers	2
There are only a small number of suppliers, each fighting for a significant market share	2
Customers have low profit margins and seek out low-cost suppliers	0
Overall internal rivalry (average)	1.5

Appendix C - Agenda Ahrend

Agenda

1. **Introductie**
    1. **Wat doe ik?**
        1. *Onderzoek naar de integratie van sensoren in bijv. kantoorstoelen*
        2. Visualisaties gebaseerd op stress 'levels' van medewerkers
            1. Op een privacy vriendelijke manier
        3. Extra mogelijke value-propositions naar mogelijkheden voor sensoren in kantoorstoelen / kantoor omgevingen
2. **Wat doet Ahrend?**
    1. *Hoe gaan jullie te werk en wat maakt jullie uniek binnen de sector?*
    2. *Wie zijn jullie klanten en waarom?*
    3. *Wat is jullie huidige selectie van producten? Wat leveren jullie aan jullie klanten?*
3. **Sector-gerelateerd**
    1. *Wat voor trends zijn er gaande binnen jullie sector en wat betekent dit voor jullie?*
        1. e.g. vitaliteit, duurzaamheid
    2. *Hoe is jullie visie op de integratie van 'smart'-technologies in het kantoor en wat voor innovatie is er op het moment?*
        1. *Bijvoorbeeld jullie "Social distancing app - Smart office" - product*
        2. *Zijn er nog andere voorbeelden waar jullie mee bezig zijn? Zo ja, waarom?*
    3. Zijn er veranderingen zichtbaar in hoe mensen nu tijdens COVID en eventueel na COVID? (Veranderingen aan bijvoorbeeld specificaties van een kantooromgeving)
4. **Wat is jullie opinie over volgende onderwerpen en cases binnen kantooromgevingen?**
    1. *Deze suggesties zijn nog helemaal open, en zijn een paar voorbeelden van mogelijke waarde proposities*
    2. **Visualisaties**
        1. Het visualiseren van stress-levels op een centrale plek in het kantoor. Data wordt geanonimiseerd, en kunnen dus niet geïdentificeerd worden.
        2. Aanwezigheid visualisaties met betrekking tot bijvoorbeeld flexplekken
        3. Overzicht van hoe bepaalde ruimtes gebruikt worden, doordat informatie beschikbaar is over waar mensen wel en niet zitten
    3. **Vitaliteit**
        1. Persoonlijke informatie over zit houding op stoel en stress gerelateerde informatie
        2. Kort beweegmoment toevoegen aan de dag (via notificatie) van een medewerker als deze persoon te lang op zijn stoel zit (e.g. doormiddel van het spelen van een spel via een andere stoel)
    4. **Energie besparing**
        1. In de trend van 'slimme' kantoren zorgen dat lampen / verwarming worden uitgeschakeld als er niemand in een bepaalde kantoorruimte zit

Appendix D - Interview collective & informatics

 # Experiences with the raw data / sensor

1. Summary of what you think of the data?
2. Which moments stood out in the data?
3. When would you find this system useful? Are there specific moments with were useful?
4. How did this experience change anything in how you look at your own biological data?
5. Are there any specific moments you looked at the data?

 # Collective visualizations

Centrally in the office

1. What are the first thought on this system?
2. In what kind of setting could this be useful?
3. Anything negative about visualizing it in a teams chat like this?
4. At what point in time could this be nice

In teams meeting

1. What are the first thought on this system?
2. In what kind of setting could this be useful? Specific moments?
3. Anything negative about visualizing it in a teams chat like this?
4. Did above interfaces change anything in how you think about displaying your stress data in the office?

 # Individual visualizations

Summary of full app

1. What are the first thought on this system?
2. Any thought on visualizing your live data?
3. How do you perceive the report page?
4. Individual versus collective visualization?
5. Are there any specific moments you would use the setting goal function?
6. Why would / wouldn't you want to share your moments to people?
7. Report