SITBIT

Tracking & improving posture for people with spinal cord injuries

Eindhoven University of Technology
DPM110 Social Inclusion & Physical Rehabilitation

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Client
Adelante Healthcare Group

adelante haal het beste uit jezelf

PREFACE

This report will share the process of creating a product which improves the posture of people with a spinal cord injury, during the first semester of the Industrial Design master at the Eindhoven University of Technology. The project stemmed from our mutual interested in personal healthcare, behavioral change and tangible solutions which we saw fit for this design project. This design project has been a challenge that has tested our current skills and has helped improve these in order to grow as a designer and engineer.

The journey throughout the whole semester was informative with some minor setbacks, nonetheless very enjoyable and helpful for future projects. We started this project by making our vision clear. For this project we wanted to create an intuitive wearable which gives the user direct and easy feedback, we saw here some design opportunities. With this project and report we hope to bring you new insights on designing for people with a spinal cord injury.

Fig. 1: Final prototype Sitbit

CONTENT

1 | INTRODUCTION

Many wheelchair users are facing physical discomfort caused by prolonged sitting (Monette Michele, 1999). Bad seating position and posture cause pressure ulcers and back pains due to the relatively fixed position and potential intense load in the lower body (Wu Yaqun, 2009) (Tay Shih Kwang, 2009). Especially in the case of spinal cord injuries (SCI), the damage to the spinal cord causes different changes in body functions, which vary from numbness to paralysis (Spinal cord injury, 2019). Their lower-body provides them with limited feedback when they sit in undesired postures, which is more difficult for them to move proactively (Gorgey, 2014). A schematic overview of the problem is shown in fig. 2.

Based on the observation of Jean Mindel, people with low thoracic-level (T9-T12) and sacral-level (S) injuries still have sufficient muscle activity to move their upper-limbs and maintain sitting balance (Minkel, 2000). While they are able to assume good posture, they tend to forget to. Therefore, a reminder for changing postures is necessary.

In this project, we investigated the intuitive design to generate the reminder for the wheelchair users with spinal cord injury, which could lead to a behavior change in a long-term run.

The project was in collaboration with i2-CoRT, which brings together stakeholders with various backgrounds to promote rehabilitation technology innovation (interreg, 2018). One of the stakeholders of the i2-CoRT project has been developing a sensor mat, which can measure the factors contributing to the pressure ulcers and back pains. Using the data from the sensor mat, we were able to develop the Sitbit system.

The Sitbit system includes the sensor mat, wearable, phone application for the users and dashboard for the therapists. The data from the sensor mat is collected and can be analyzed to create a personalized feedback system. Based on the data, the wearable gives the users real-time feedback, which enables them to be aware of their seating problems and autonomously decide to change their posture. It could simplify the function - no overwhelming data and distractions. The phone application and the dashboard take full advantage of the data collection, which makes the progress visible and available to the patients themselves and the therapists. This also enables more efficient communication between the patients and therapists.

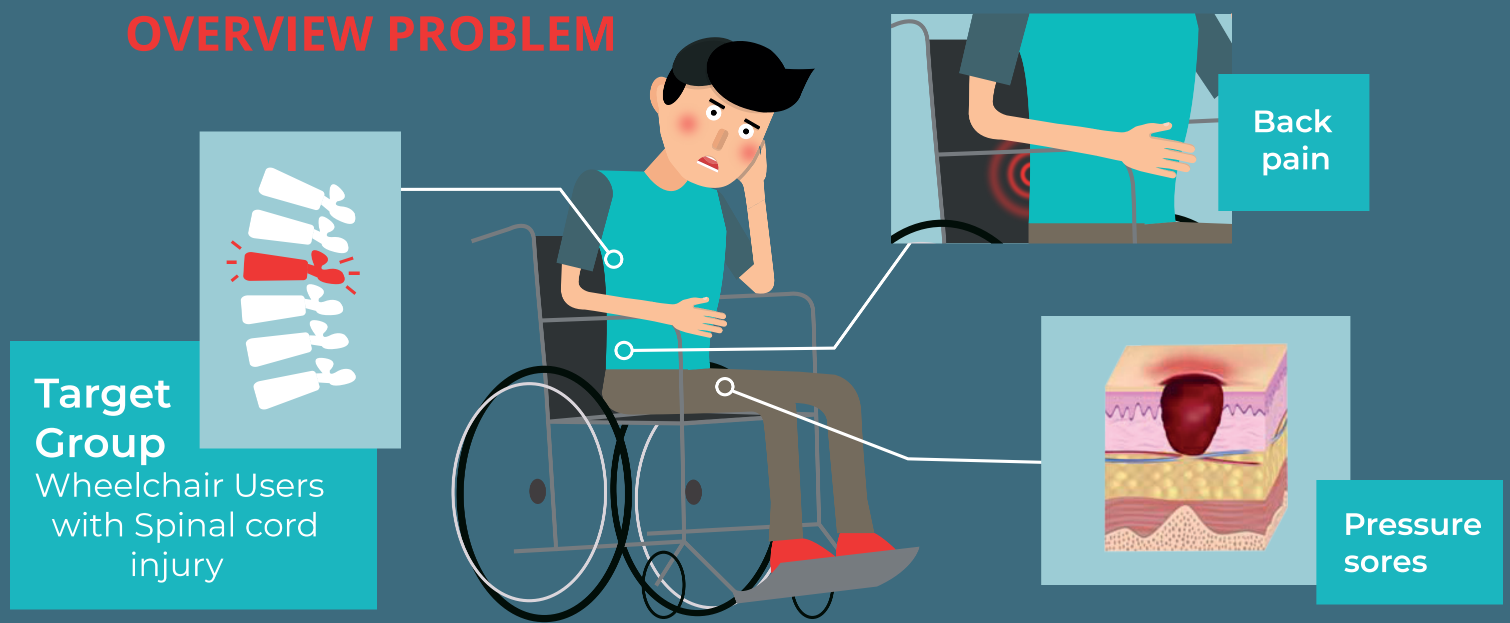


Fig. 2: Overview problem statement

2 | THEORETICAL BACKGROUND

The aim of this project is to help people in a wheelchair prevent and treat pressure sores and back pains by adapting new seating behavior. They need to be reminded of their posture and need to move to make sure they aren't developing problems. It is important that the user will immediately react when he/she is notified about the problem, especially when they already have (starting) pressure sores.

In the transtheoretical model of behavior change it is stated that to successfully adapt new behavior a person goes through 6 stages: precontemplation, contemplation, preparation, action, maintenance and termination (Prochaska, 1997). In the precontemplation stage the user is not intending to take action, they are unaware of the needs for change. Within the contemplation stage the user is aware of the possibilities for change but does not intent to change yet. In the preparation stage the user has the intention to change in the immediate future. The action stage is when a person is actively making modifications within their lifestyle. During the maintenance stage the user is working on preventing a setback in behavior, but they do not use tools to help as frequently as before. The termination stage is when a new behavior is adapted and integrated without the temptation to fall into old routines (Prochaska, 1997). The first three stages are before the actual change has been made, the therapist at Adelante make the user aware of the pros and cons of changing their behavior. The design opportunities lie in the stages after that, to help with taking action and maintaining taking action upon the problem and to make sure that they continue with doing that, because otherwise it would have major effect on their health and personal well-being.

To persuade the user into taking the action there is need for motivation, the ability to perform the task and a trigger to perform the behavior (Fogg, 2009). As the therapists at Adelante mentioned the ability to change is there: they can lift their legs with their hands and push themselves up in the chair to relieve pressure. They also can correct their posture when needed. The motivation to do so is also there, that is also something the therapists at Adelante work on, if the patient does not improve their behavior they will be more dependent on doctors and will lose autonomy. The problem is that moving can be forgotten because the patients do not feel the lower part of their body, therefore the trigger is important. A successful trigger has three components: they are noticeable, they are associated with the target behavior and the trigger happens when we have the ability as well as the motivation to do the task (Fogg, 2009). Spam, pop-ups, beeps and other email alerts are the triggers a computer system gives to the user, unfortunately they rarely convert to behavior and are seen as irritant (Fogg, 2009).

In order to remind the patients to change their sitting posture, a wearable is designed to give instant feedbacks. Meanwhile, it is significant for the users to gain overview of their progress in changing postures and monitor their health, as well as for the therapists to collect frequent data of their patients (Munos, 2016).

As described by Bernard Munos et al, the mobile technology combining wearables and integrated mobile apps could be promising in the healthcare industry. The authors explored the potentials of the mobile health ecosystem, focusing on the technology innovation, data optimization, commercial platform integration, clinical implementation and regulation, as well as the broad societal implications. They emphasize the great opportunity in the use of wearable technologies for healthcare because the development of new technologies could continually improve the size, weight and cost of future wearables. They also mentioned that this kind of mobile health ecosystem provides the users with the transparency of the data collection and fully control over their own data, which will make the communication between patients and therapists more efficiently.

3 | RELATED WORK

After getting a better understanding of the situation and problem, it was decided to look further into already existing products on the market. Exploring these solutions will help in developing a clear overview of what is already being used for this situation and where further improvements can be made. As stated in the previous chapter, people with spinal cord injury can develop problems like pressure ulcers, deformation of the spinal cord and moist which further advances the ulcers. To prevent the problems mentioned above, various solutions have been created which tackle different aspects of the problem. The solutions have been grouped in three categories which range from foam or gel pad protections to applications for on the mobile phone that help you relieve pressure or change posture. The most important solutions are pictured in this chapter, the full research is stated in appendix 4.

PREVENTING PRESSURE SORES

THE FOOT ELEVATOR BY POSEY

The first product (fig. 3) is a foam/gel protection designed and manufactured by Posey which can be placed around the high risk areas. The foot elevator has a washable material and relieves pressures around the foot while patient is laying down (Posey, n.d.). This company has various products which are in line with the Posey foot elevator. Not only do they have protections made out of foam, but also gel protections for around the elbows (fig. 4) (Posey, n.d.).

Fig. 3: Posey foot elevator. (Posey, n.d.)
Fig. 4: gel protection for elbow (Posey, n.d.)

WHEELCHAIR CUSHION

Ride Designs specializes in wheelchair cushions and backs (Ride Designs, 2018). They provide a variety of customizable cushions which prevent moisture buildup, pressure ulcers and improve sitting stability (fig. 5). What makes these cushions so special is that they are breathable, lightweight, simple and adjustable (Ride Designs, 2018). They are made from spacer mesh cover fabric. The cushions are not fixed, they can be adjusted in a later stage by inserting CAM wedges (Ride Designs, 2018). Several other companies created similar cushions. Fig. 6 & 7 show examples of these other cushions.

Fig. 5: Wheelchair cushion (Ride, 2018)

Fig. 6: Shift cushion (turner, 2014)

Fig. 7: Amovida cushion (Wild Design, 2018)

WEARABLES FOR LIFE TRACKING & POSTURE CHANGE

BELLABEAT

Fig. 8 & 9 show the Bellabeat. The Bellabeat is both a wellness tracker and a fashion piece. This product tracks the wearer's sleep, stress levels and the reproductive health which will then be send to the Bellabeat application (BellaBeat, 2018). The application shows in depth details and a summary about the tracked measurements and visualizes this in different menus (BellaBeat, 2018). The Bellabeat itself does not use any buttons or screens and is completely focused on the aesthetics

Fig. 8: BellaBeat companion app (BellaBeat, 2018)
Fig. 9: BellaBeat wearable as bracelet (BellaBeat, 2018)

VALEDO

Valedo (fig. 10 & 11) is designed for those who have problems with their lower back. It has video game like interactions which you need to follow to complete the exercise. By playing the different games you will collect points and lose back pain (Valedo, 2010). In order to play the game, a device is attached to the person's back in which smart sensors are located. These sensors store data which can later be accessed through the companion app (Valedo, 2010).

Fig. 10: Valedo therapy in action. (Valedo, 2010)
Fig. 11: Valedo therapy companion app (Valedo, 2010)

MISFIT

Like the BellaBeat, Misfit (fig. 12) focuses on a fashionable item to wear everyday. The misfit tracks the amount of steps taken, distance, sleep cycle and its duration (Misfit, 2011). All the measurements from the misfit are send to a corresponding app (fig. 13) where users see an overview of the above mentioned items. Next to tracking, users can also log food intake and weight or even connect to a social community (Misfit, 2011). There are various bracelets and necklace options to wear the misfit in.

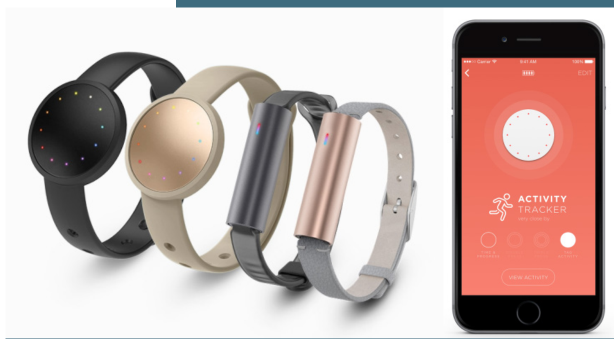


Fig. 12: Misfit Shine 2 & Misfit Ray fitness (Misfit, 2011)
Fig. 13: Misfit fitness application. (Misfit, 2011)

UPRIGHT POSE WEARABLE & APPLICATION

The upright pose wearable can be attached to the body (the upper-back) with an adhesive sticker and senses your posture (fig. 14). It gives feedback by vibrating when the user needs to correct his or her posture. The wearable interacts with an application, called the UPRIGHT GO mobile app (Upright, 2018). This app includes tutorials, tracks progress and shows your daily overview. The app uses a character to show the user how his or her posture is at that moment and how it can be changed (fig. 15).

Fig. 14: Wearable UPRIGHT (Upright, 2018)
Fig. 15: Application UPRIGHT (Upright, 2018)

SYSTEMS FOR POSTURE CHANGE

DARMA CUSHION

Darma developed products with sensors to measure heart rate, breathing rate and heart rate variability (Darma, 2017). One of these is the Darma cushion which can monitor sitting time and posture (Darma, 2017). Vibrations in the cushion alert users to change posture and an accompanying app shows how. The app also gives exercise examples to stretch the upper body and shows progress overview (Darma, 2017). Fig. 16 &17 show the system of the Darma cushion (Darma, 2017).

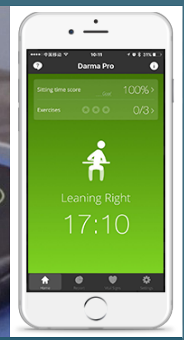



Fig. 16: Darma cushion (Darma, 2017)
Fig. 17: Screens Darma cushion app (Darma, 2017)

THE VIRTUAL SEATING COACH

This system consists of an app for patients in an electric wheelchair and a web portal for clinicians (Permobil, 2016). It is developed to learn patients to change the position of their wheelchair to the optimal seating position. The web portal allows clinicians to adjust their approach per patient (Permobil, 2016). The system uses a timer as input. After a certain amount of time the patient needs to reposition. The app shows how much time is left in the current position (Permobil, 2016). Fig. 18 & 19 show the system.

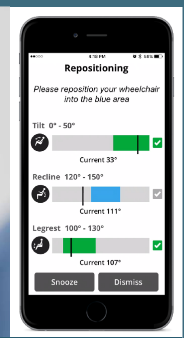



Fig. 18: Virtual seating coach in use (Permobil, 2018)
Fig. 19: Screen virtual seating coach (Permobil, 2018)

SENSIMAT

David Mravyan & Will Mann created a mat which measures pressure and an application which shows these measurements on a phone (fig. 20 & 21). The app shows the pressure distribution, how many times the user moves and it reminds the user to move whenever he/she is in the same position for a long time (Mravyan & Mann, 2004). Lastly, all the data from the mat are send to the healthcare provider who then can track the user's improvement and help him wherever needed (Mravyan & Mann, 2004).

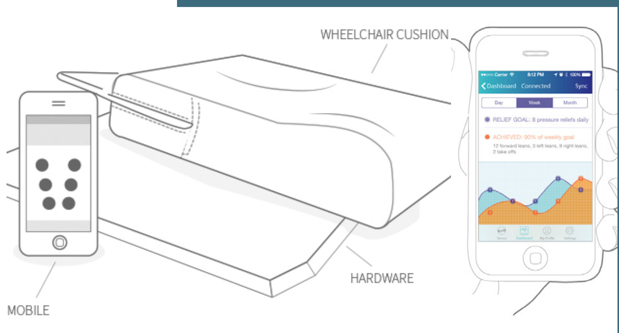


Fig. 20: Overview SENSIMAT system
Fig. 21: Screen SENSIMAT application

PREVENTING PRESSURE SORES

After the benchmark research, it became clear that there are a lot of cushions, protections and systems available which prevent pressure ulcers, moist buildup and back pain relieve. These products vary from very simple foam protections to systems for posture change. However, there is not one solution that encompasses all three categories. The benchmarks that use systems to prevent formation of pressure ulcers, by using an application and a cushion, give real-time reminders when the pressure is building up or the user needs to change from position. Nevertheless, it does not use a small and fashionable wearable which could make the whole system more personal and aesthetically pleasing. It is the other way around for the wearables in this research. The wearables from this research are aesthetically pleasing, but do not give real-time feedback which could be beneficial for the user. Finally, the solutions in the "preventing pressure ulcers" category do not have the interesting aspects (real-time feedback and aesthetically pleasing exterior) of the other two categories and are quite simple. This gap between the three categories is an interesting market opportunity which needs to be researched further.

4 | THE USER

The target group for this project are people in a wheelchair who have a spinal cord injury and need to learn new behavior towards their posture in a wheelchair. A wrong posture in the wheelchair and too little physical activity can lead to pressure sores and back pains. It is important that this can be prevented, as well as treated. Therefore it is essential that wheelchair users continue moving their legs and lower back, this to relieve pressure on their upper legs and butt. The project focuses on two target groups: people that are still in the revalidation process of their injury and need to learn to use the wheelchair and people that are in wheelchair for a longer period of time that have developed problems that need to be treated and prevented in the future.

TARGET GROUP 1

Person who is at the end of the revalidation process after the spinal cord injury. This person has to learn how to deal with the wheelchair and how to maintain healthy. The physical therapist at Adelante notices that the person is at risk of developing pressure sores, because the person is not moving in the wheelchair enough. In order to prevent this the Sitbit can be introduced and used.

TARGET GROUP 2

Person that is in a wheelchair for a longer period of time. This person is starting to develop back pain or pressure sores or already has the earlier mentioned. The therapists at the 'Zitpoli (department at Adelante that focuses on seating and seating problems)' notice this problem and will use the Sitbit to help reduce the pressure sores/ back pains faster and prevent them in the future by learning new behavior towards wheelchair seating.

EMPATHY MAP

As a tool to dive deeper into the feelings and needs of the user an empathy map was made (Empathy Map, n.d.). This empathy map (appendix 1) was based on personal stories of wheelchair users and the therapists at Adelante. The most important points derived from that empathy map were that independence for the user is important, as well as fear of a more deteriorating situation. Being in a wheelchair is also a visible handicap, more emphasis on this is not wanted. Concluding, the solution needs to make sure that the person does not look "sick", nor should it look like a medical device. It is also important that the autonomy of the user is taken into account to prevent further deterioration.
The process of helping both target group 1 and target group 2 is similar, however the process of target group 1 is slightly different than the process of the latter. The system needs, therefore, to adapt to the specific needs of the user. Adelante already developed a pressure matt, which can detect pressure sores and wrongly distributed pressure. This matt will be used as input data for the project.

As a final point, there are a few requirements which need to be implemented into the project, namely:

- Should not look like a medical tool
- Is adaptable to the user and the different needs of different users
- Can be used independently

PATIENT JOURNEY

In order to understand the process of patients who go through the process at Adelante and what he/she deals with, we made a patient journey for the 'Zitpoli' at Adelante (fig. 22). This patient journey is made in collaboration with the i2CoRT project and shows the process for people who are in a wheelchair for a longer period of time and have developed a seating problem.

Within this patient journey there is a step by step overview of how a revalidation process looks like. Looking at the full process it can be concluded that the whole process takes a lot of time, once problems are detected. The process takes about 6 months to fully recover at the 'Zitpoli', therefore a solution is needed to make sure that those problems will not develop.

Patient Journey

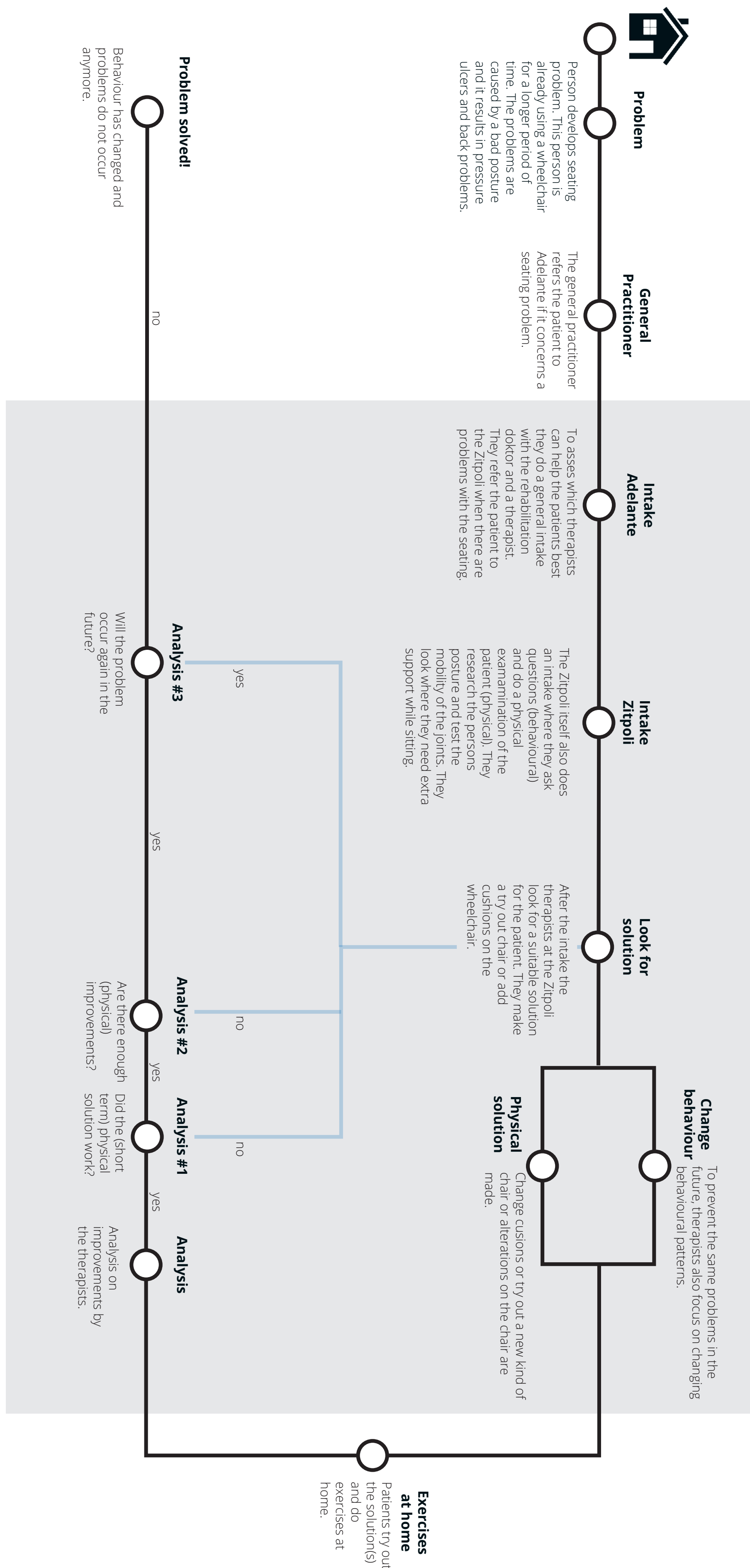


Fig. 22: Patient journey Zitpoli Adelante

5 | # DESIGN PROCESS

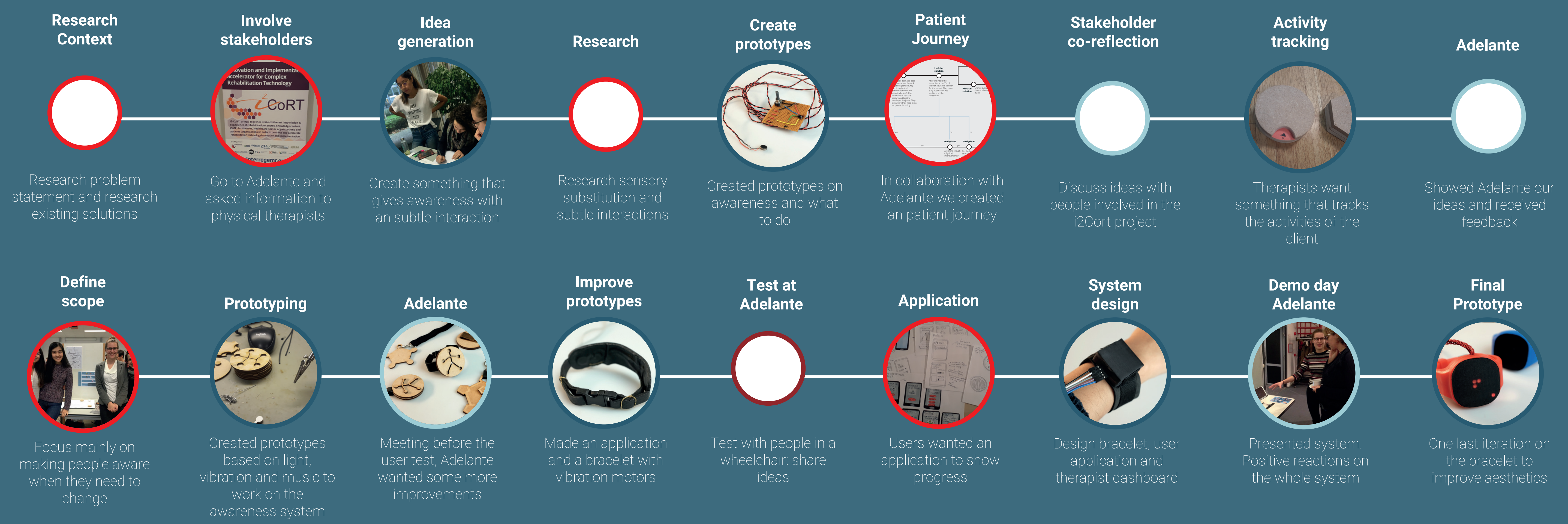


Fig. 23: Process overview Sitbit

PROCESS OVERVIEW

Within this project the 4 staged design process as described in the thesis of Rens Brankaert is used (Brankaert, 2016).The four stages are: Exploration, Design, Evaluation and Implementation (fig. 23). The exploration phase is about finding the needs and opportunities for the user (and other stakeholders). Within the design phase ideas which match to the needs and opportunities are created. Those ideas are tested within a real-life context within the evaluation phase. In the implementation phase you will look at strategies and approaches to getting the concept into the market (Brankaert, 2016).This process was chosen because it enhances a hands on approach with close collaboration with the user and client. During the project there were 4 big iterations within the project, most of the iterations were operated within the exploration, design and evaluation phase. The implementation phase was difficult because of the sensitive subject and sensitive user group, which were not available for elaborate testing.

Among the project there was close collaboration with our client, Adelante to test our hypotheses. The information the therapists at Adelante, together with their volunteers gave were used as next steps in the project.

Exploration Design Evaluation Implementation

USER INSIGHTS

During the user test (protocol in appendix 2) at Adelante different aspects of the project were tested. The main insights that were gained from that is that an app is desired, because this means they do not have to bring another thing along. They can also see their personal progress on an app. The test persons also mentioned that a phone can be turned off or the notifications can be put out. They mentioned that a bracelet should not interfere with pushing the wheelchair, is it might get stuck between the chair. Based on those insights the system was created. The system was proposed at the Demoday at Adelante, they had some feedback on the intuitiveness of the LEDs and on the direction of the LEDs in the bracelet. This was integrated in the bracelet prototype that was shown at the Final Demoday.

ITERATION 1

This iteration is mainly focused on getting familiar with the user, context and client (Adelante) by researching the users' problems and by visiting the rehabilitation center in Hoensbroek. The ideas derived from this were immediately embodied into physical prototypes and showed to the client. The idea consisted out of different wearables (fig. 24 & 25) that gave a notification when the posture wasn't right, one was a matt for on the back and shoulders of the patient which gave a notification via vibration motors, the other was a small wearable that would give the user a small notification via light. They reacted positive on the ways the physical artifacts were used as a means of making the user aware of their posture. To dive deeper into the user context a Patient Journey was made in collaboration with the i2CoRT project. The patient journey was used as a tool to frame our project within the existing rehabilitation process.

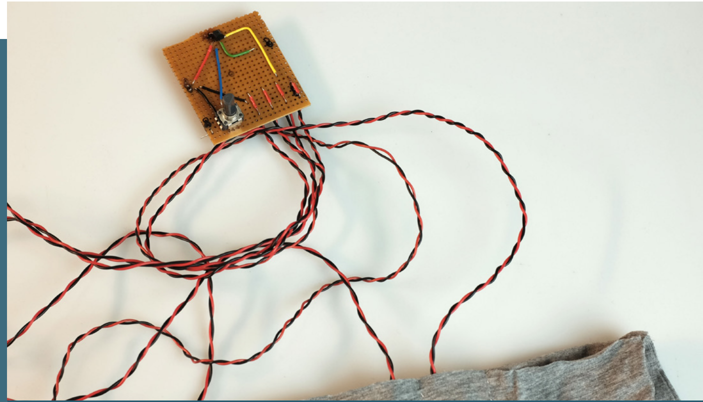


Fig. 24: First iteration 1

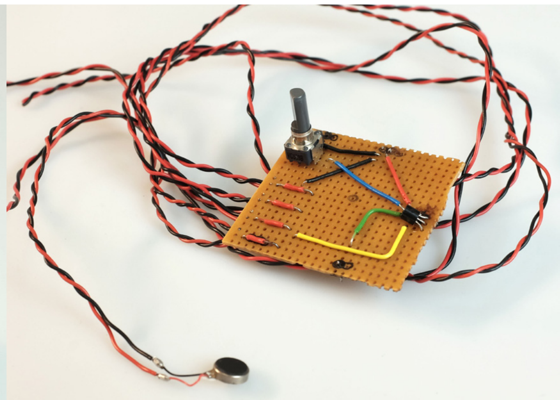


Fig. 25: First iteration 2

ITERATION 2

The second iteration was focused on defining a more narrow scope. To evaluate the concept a meeting with an occupational therapist and a physical therapist at Adelante was made. They told that the tracking of activities is important within the rehabilitation process to see when and during what activity bad or good seating behavior occurred. At this point in the project the 3 ideas (wearable, matt on the back and activity tracking) were combined and discussed (fig. 26 & 27), but it was too broad to address all those things within one project. The decision was made to solely focus on making people aware and look for a right wearable to make people aware in an intuitive way.

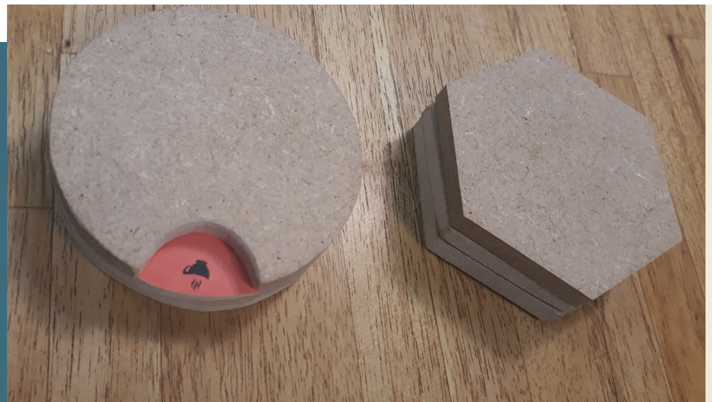


Fig. 26: Second iteration 1

Fig. 27: second iteration 2

ITERATION 3

This iteration was focused towards a user test at Adelante to test the prototypes and the ideas (fig. 28 & 29). Two small iterations on the prototypes were made to create artefacts that would communicate and make the ideas experienceable. At Adelante a phone application, bracelet with vibration, wearable with lighting and a wearable with musing was shown. The people in the wheelchair that participated in the test only wanted an application and not a wearable. They did not want a wearable because that would be inconvenient when pushing the wheelchair, but they did mention that they wanted a smartwatch. The results were contradictory. The users said they only wanted an application, but this contradicted the fact that in research notifications on applications do not work very well to change the behavior of a person.

Fig. 28: Third iteration 1

Fig. 29: Third iteration 2

ITERATION 4

The position and usefulness of an application were discussed and looked for ways were an app would be used for insight in progress and contact with therapist. Notifications on a phone as a trigger did not seem a good idea, because it will be one of the tons of notifications a person during the day. Therefore a system was designed with a bracelet (fig. 30 and later fig. 31) as trigger, but it also provides information on how to change. Additionally an app to see personal progress and a therapist dashboard was created which are all connected to the input data of the pressure matt of Adelante. The feedback on this system during the demo day at Adelante and the Final Demoday was mostly positive.

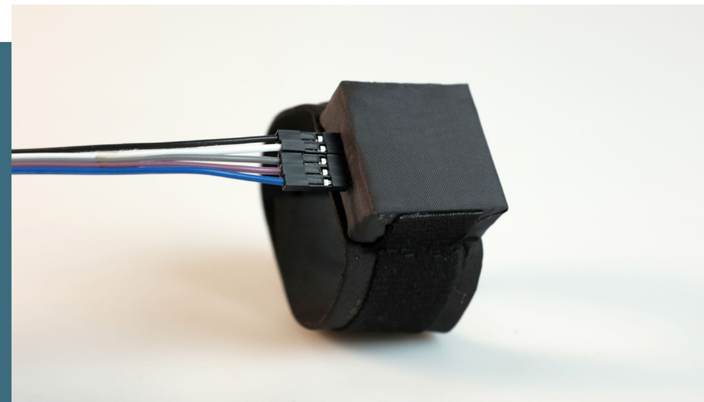


Fig. 30: Fourth iteration 1

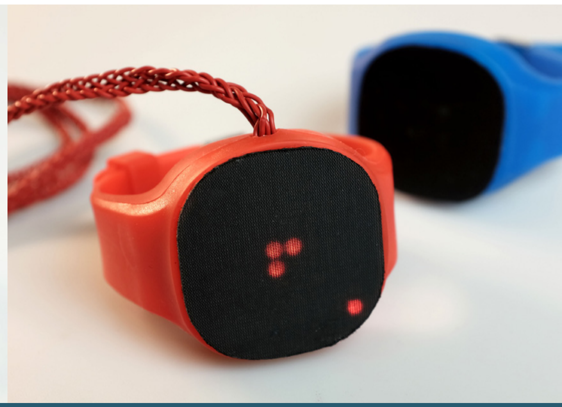


Fig. 31: Fourth iteration 2

6 | THE CONCEPT

The design process resulted in the “Sitbit” system. Fig. 32 shows an overview of all elements that together form this system.

CONCEPT OVERVIEW

The input for Sitbit will be provided by a sensor mat, currently being developed by other members of the I2Cort project. The mat will cover the wheelchair seat so that users will be sitting on top of it. This allows built-in sensors to measure factors that can increase the risk of pressure ulcers and back pain. The most important risk factors include high temperature, moist and an unbalanced distribution of pressure on the buttocks. Although the mat is currently being developed, it is likely that it will be equipped with sensors that can measure these specific factors.

The input from the sensor mat is used in three other elements of the Sitbit system. The first and most important element is the wearable, developed for the wheelchair user. The wearable is similar to a watch; it is designed to be worn around the wrist. When the mat senses that the user needs to change posture, the wearable vibrates to draw attention. The built-in display shows four dots representing the user’s buttocks. These dots should be centered as shown in fig. 32 but are located elsewhere in the display to indicate where the problem area is at that moment. The user needs to make sure that all dots become centered again by moving the problem area towards the center. One accomplished, the display will automatically turn off to be as unobtrusive as possible.

The second element of the Sitbit system is an application, meant as an extension on the wearable. The homescreen of the app shows the same four dots as on the display so that users will be reminded about their posture when opening the app. The main function of the app is providing users with an overview of their progress through time. Graphs show several aspects, for example how many successful improvements are made during a day, week or month. The app has two other important functions. In the settings menu, users can turn notifications of both the app and the wearable on or off. A chat window gives users the opportunity to ask questions to their therapist in between sessions.

The chat window within the application is linked to the fourth element of the Sitbit system; a dashboard for therapists. By logging in to a web portal, therapists can monitor the progress of their patients. This enables them to personalize their plan of approach. By using the built-in sessions window, therapists can answer patient’s questions or give advice without the need of an appointment.

WEARABLE

DESIGN

The final prototype (fig. 35 & 36) of the wearable is made of a silicone strap and casing. This material was chosen because it has better grip on the skin than leather or other fabrics. This was done to make sure that the strap will stay in place when users are manually moving their wheelchair. The case contains an LED matrix and a vibration motor covered with plexiglass and a black plastic foil. The plexiglass protects the matrix and the black foil covers the electronics and gives the prototype a more finished look. The wearable comes in two colors: blue and red. More colors can be added in the future.

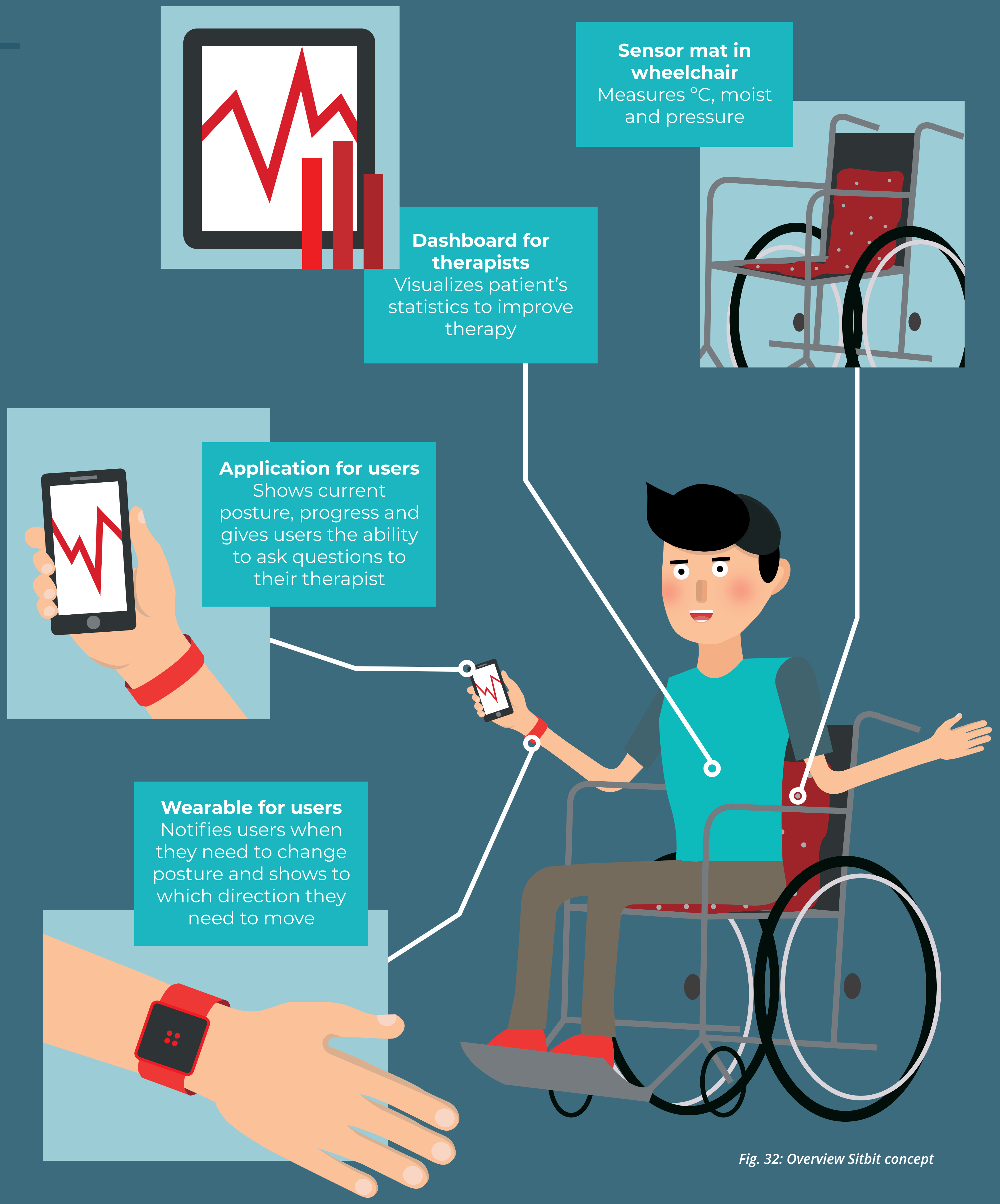


Fig. 32: Overview Sitbit concept

SOFT- AND HARDWARE

The LED matrix and the vibration motor in the casing are connected to an Arduino. As there is no input signal from the sensor mat yet, it was decided to mimic this by using a joystick. As fig. 35 shows, the wearable is still connected to a box that includes all wiring and the joystick.

For the LED matrix the MaxMatrix library (Kin-Chung Au, O., 2013) is used to drive all the LEDs in the matrix. The code of the prototype can be best explained by fig. 33 and is stated in appendix 3.

The LED matrix is represented by the black circles with in the center four red dots which are lighted. To effectively run the code the X- and Y- coordinates of the joystick within the matrix are needed. One of the main problems we encountered during previous codes is that the red dot, which represents the joystick, was never fully able to go diagonal. This needed to be fixed, since we wanted to demonstrate fluent and logical movements throughout the matrix. The solution for this problem is to restrict the area of movement to the paths shown in fig. 33. All paths can be seen as a triangle where the code calculates the angle between 0 degrees and it's respective path. The angles are capped to 0, 45, 90, 135 and 180 degrees for the upper half, whereas the lower half is inverted. If the angle is not one of the previous mentioned angles the code will not show the red dot, instead the code will search for the nearest path to set the red moving dot on.

Because of the relatively large amount of components in the functional prototype, a breadboard is being used to connect all the wiring. In the following picture the wiring of both the joystick and LED matrix used for this prototype, is shown.

The vibration motor gets driven by an Arduino. Vibration motors are known to have voltage spikes due to the rotation of their windings (Learning about Electronics, 2018). In order to protect the Arduino, a diode and a capacitor are placed in parallel between the motor and the Arduino. The diode makes sure that the voltage spikes can't reach the Arduino, the capacitor takes the voltage spikes up (Learning about Electronics, 2018). The circuit as shown in fig. 34 also contains a transistor to amplify the current to 75mA as the Arduino alone would not provide enough current for the vibration motor (Learning about Electronics, 2018). To prevent all components from damage caused by too much current, a resistor is placed in series to the base of the transistor (Learning about Electronics, 2018).

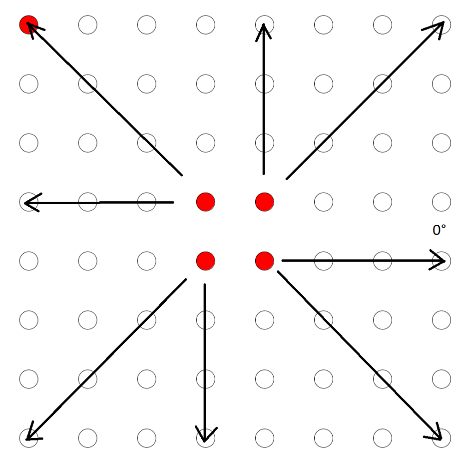


Fig. 33: LED matrix wearable

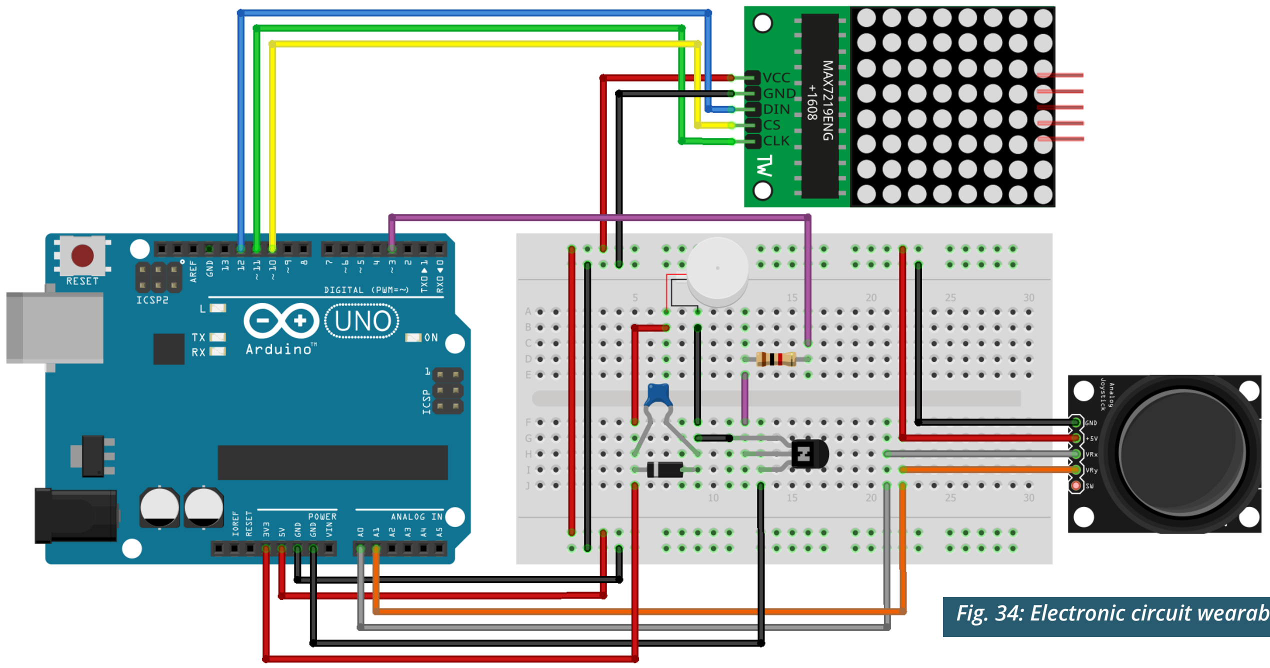


Fig. 34: Electronic circuit wearable

Fig. 35: Final prototype wearable (picture by Twycer / fotografie voor bedrijven)

Fig. 36: Final prototype wearable

Fig. 37: Application in use

APPLICATION

A mockup of the application was made in Adobe XD. To use the application, users need to set up an account first (see fig. 38). Once finished the home screen will appear, displaying the wearable and the aforementioned four dots (see fig. 39). The home screen shows a menu at the bottom; the navigation of the app. The menu shows four options; progress, Adelante, personal and settings. When clicking the progress button, the screen in fig. 40 shows up. The screen shows the amount of successful improvements, the duration since the last notification and the total amount of notifications. These can all be seen per day, per week and per month. The weekly and monthly overviews are visualized in graphs. The Adelante button brings the user to the chat window (fig. 41), allowing them to communicate with their therapists in between sessions. The chat window shows the account's name and picture which can be altered by clicking the personal button in the menu (the screen in figure 42 will pop up). The last button in the menu leads to the screen in figure 43; settings. Users can turn notifications of both the app and the wearable on and off. Although it is recommended to keep the wearable on, users should also be able to visit silent places like a cinema without getting disturbing notifications.

Users can go back to the home screen by clicking the Sitbit logo in the center of the menu.

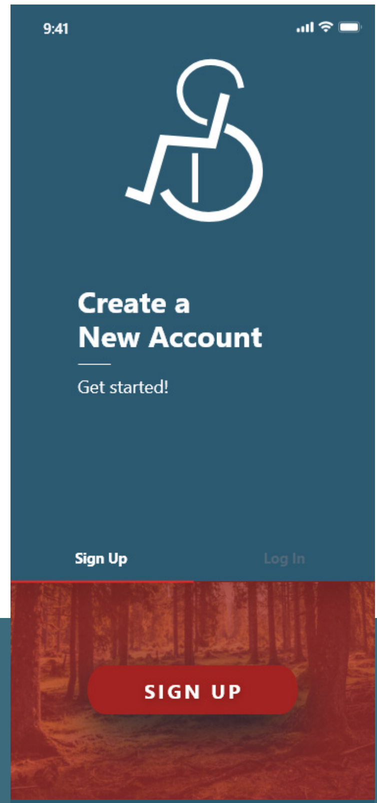


Fig. 38: Setup account screen

Fig. 39: Home screen

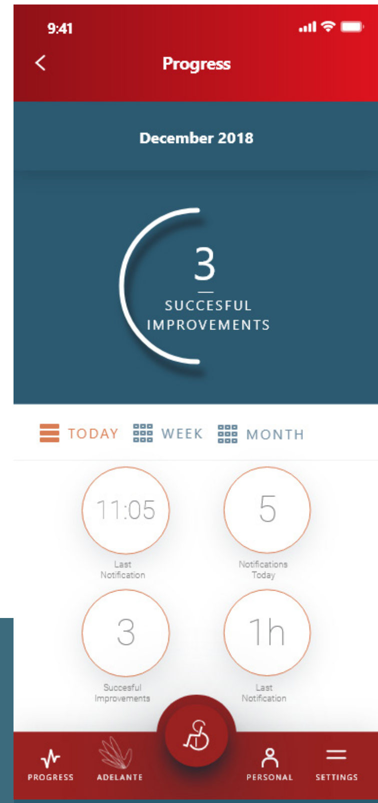


Fig. 40: Progress overview screen

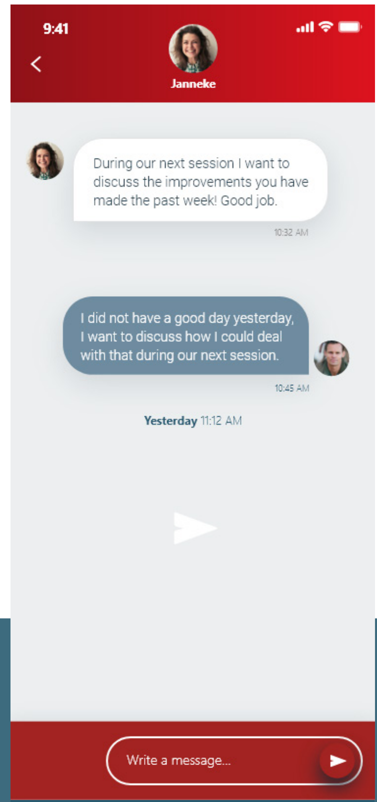


Fig. 41: Chat window screen

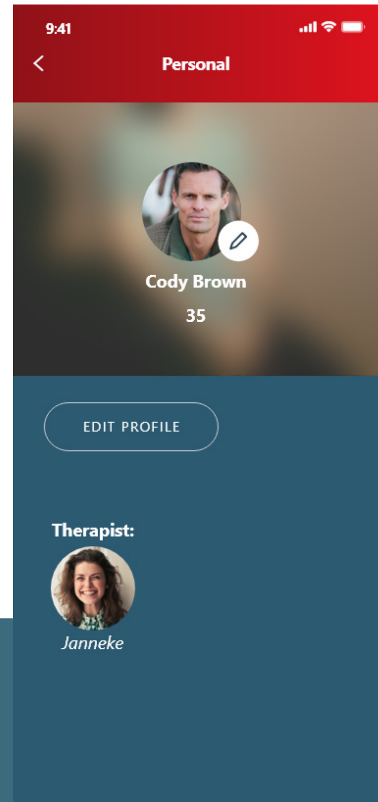


Fig. 42: Personal account screen

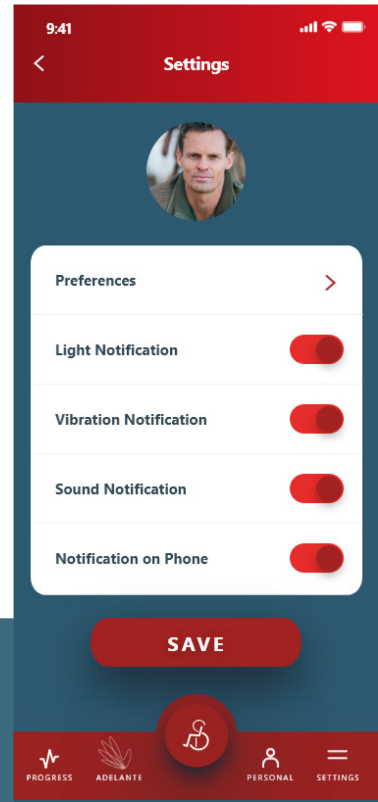


Fig. 43: Settings screen

DASHBOARD FOR THERAPISTS

A mockup of the dashboard for therapists was made in Adobe XD. When therapists log in to the dashboard, the home screen as shown in fig. 44 will show up. Therapists can choose between four options: patients, progress, calendar and sessions. These options are also shown in the navigation pane on the left side of the screen. By clicking the first option, patients, therapists can see an overview of all patients and their progress, shown in fig. 46 and fig. 47. The progress overview shows the same information as the overview in the application. Therapists can also see the overall progress (fig. 45) of all patients by clicking the option progress in the menu. The next option is the calendar (fig. 48), where therapists can schedule appointments. The last option of the menu is sessions (fig. 49). Questions and remarks that users send via the app will be shown here. This enables therapists to see what they should include in the next session. They can also reply with a message that will be shown in the application of the patient.

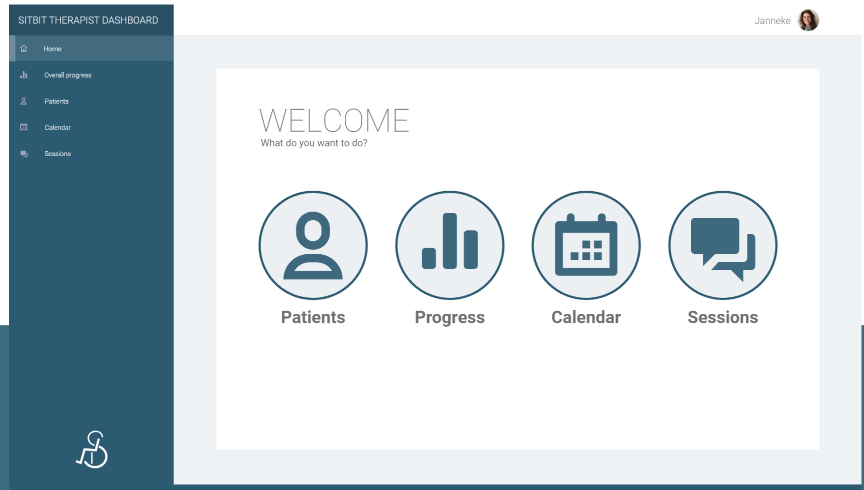


Fig. 44: Home screen dashboard

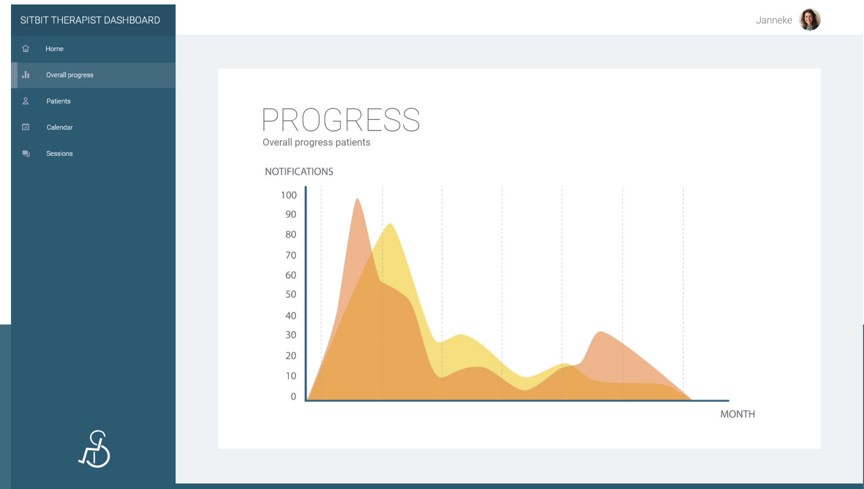


Fig. 45: Overall progress all patients screen dashboard

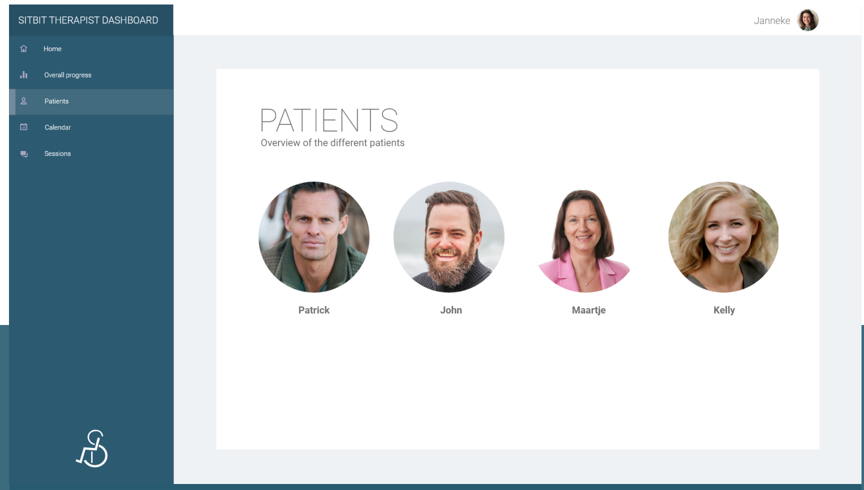


Fig. 46: Patient overview screen dashboard

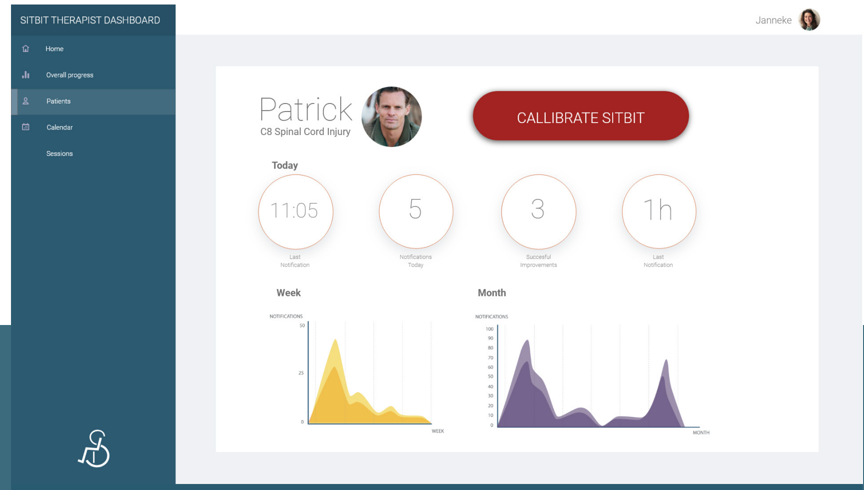


Fig. 47: Progress overview per patient screen dashboard

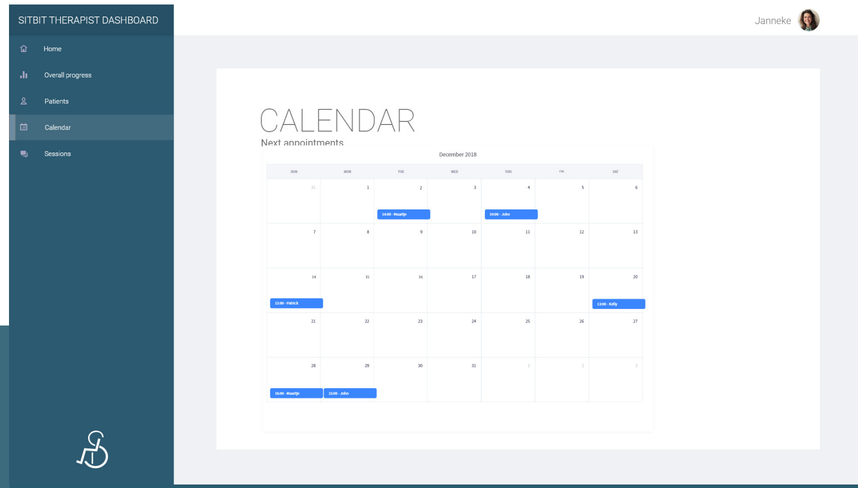


Fig. 48: Calendar screen dashboard

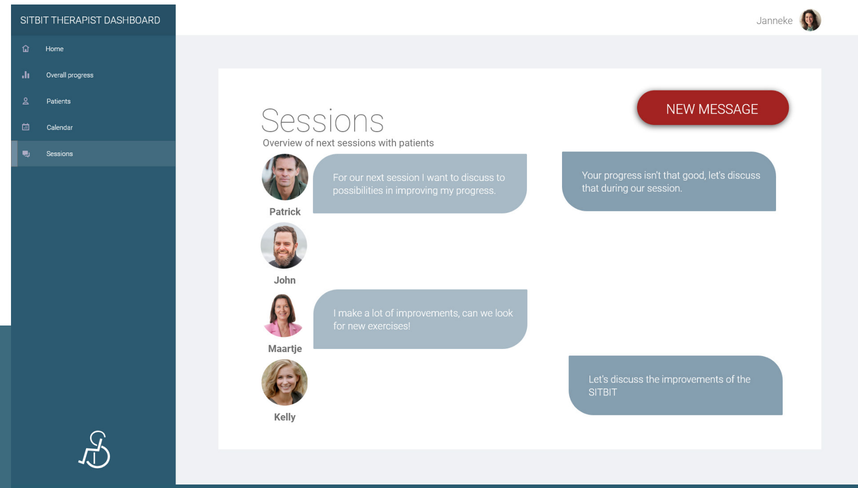


Fig. 49 : Sessions screen dashboard

7 | FUTURE

This report presented our system design for posture change and intervention, however there is still extensive space to explore further.

In the end of the process the different products that were used for the Related Work and the Benchmark were used to map out the position of the Sitbit in relation to the other products. In this overview only the products that could be used to treat the problem. In the picture (fig. 50) this matrix is shown, a lot of products do work on the prevention of pressure sores or other pains and also a lot focus on to change the behavior. The reason the Sitbit scores highest on behavior change is that the Sitbit gives an immediate trigger that is easy to act upon, this was lacking in the Darma and the Upright. The Darma cushion gives feedback by vibrations in the cushion, this cannot be sensed by all people with a spinal cord injury, the upright only looks at the position of the upper back, and does not take the buttocks and upper legs into account.

As smart devices such as phones and watches are becoming increasingly prevalent, the discussion about combining the Sitbit display with the smart screens can not be ignored. In order to give prioritized and distinct intervention signals, the smartphones or smart watches should be able to block other notifications and give priority to the Sitbit display. The user will not be able to use the smartwatch until their posture is changed correctly.

Another possible direction could be implementing artificial intelligence (AI) into the system. As bad postures could be connected with specific activities and environments, AI could intervene before undesired sitting positions happen. This pre-intervention could lead to more awareness and better behavior change.

Lastly, future students can take one step back and do a more detailed study on what the patients actually need. Since we only conducted one user test with only three participants, the conclusion we drew could be unreliable. A smartwatch seems like the best solution for now, but a more elaborated user study on the possibilities could give new insights.

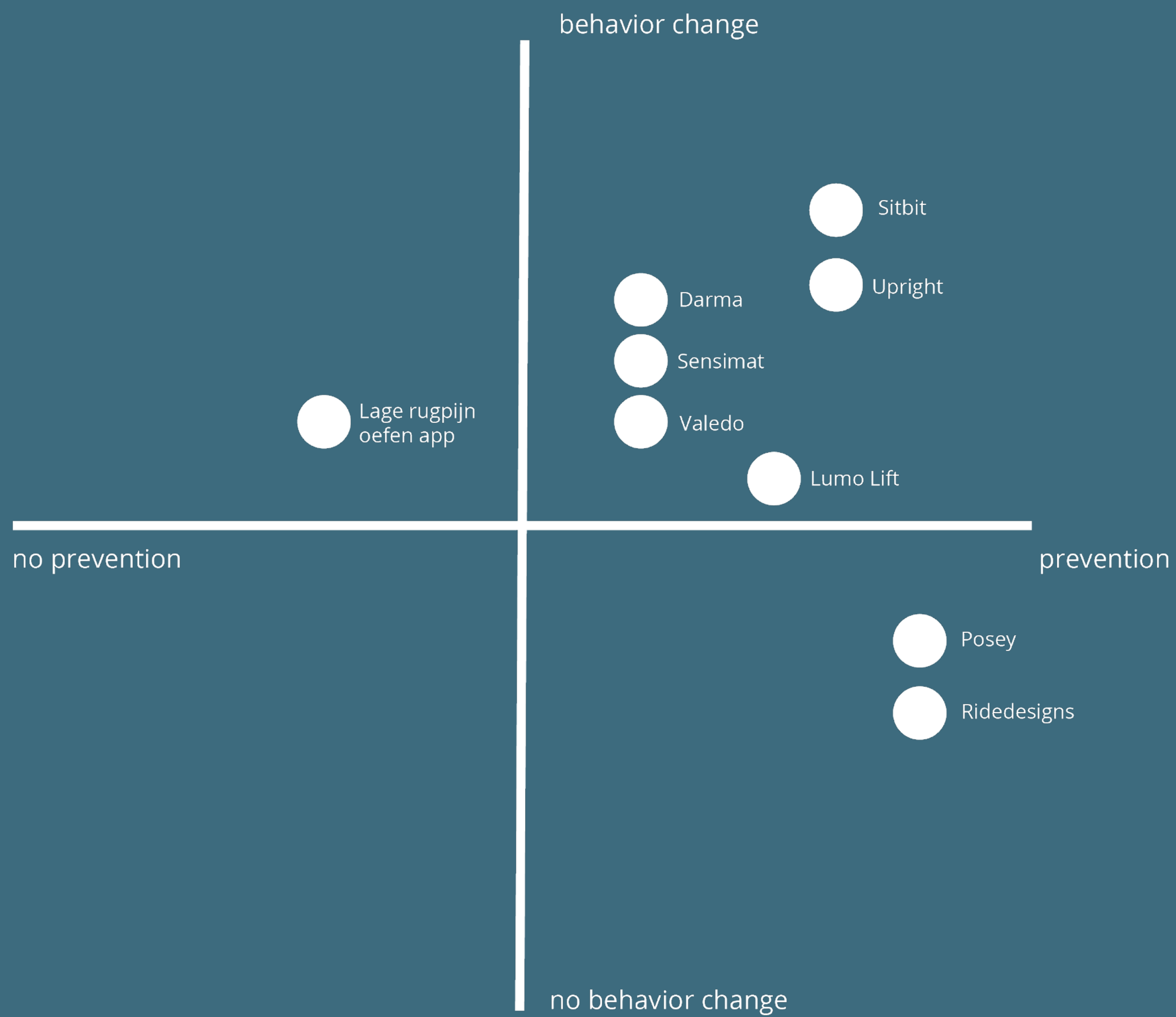


Fig. 50: Patient overview screen dashboard

8 | DISCUSSION

Although the participants in the user test opted for only a phone application which can provide them with posture changing reminders, this result could be unconvincing and not representative for all wheelchair users due to the inadequate amount of participants. We took this result into consideration and eventually integrated the phone application into an entire healthcare system with the wearable as core. It needs to be indicated that the function of the phone application works in the background of the system, only giving the user a summary of the data and a way to contact the therapists, instead of a direct intervention to the users. We believe that the intervention given by phone applications could be easily ignored and lost among other notifications based on personal experience, common cognition and research. Nevertheless, more research needs to be actuated, on the effectiveness of phone apps and wearables in changing people's health-related behaviors.

As stated in the theoretical background, the Sitbit facilitates as trigger for improving sitting posture and prevention of pressure ulcers. To change behavior on the long term, we aim to lessen the amount of notifications from the wearable over time. Unfortunately, we did not have the chance to test whether the decreasing amount of notifications leads to behavioral change.

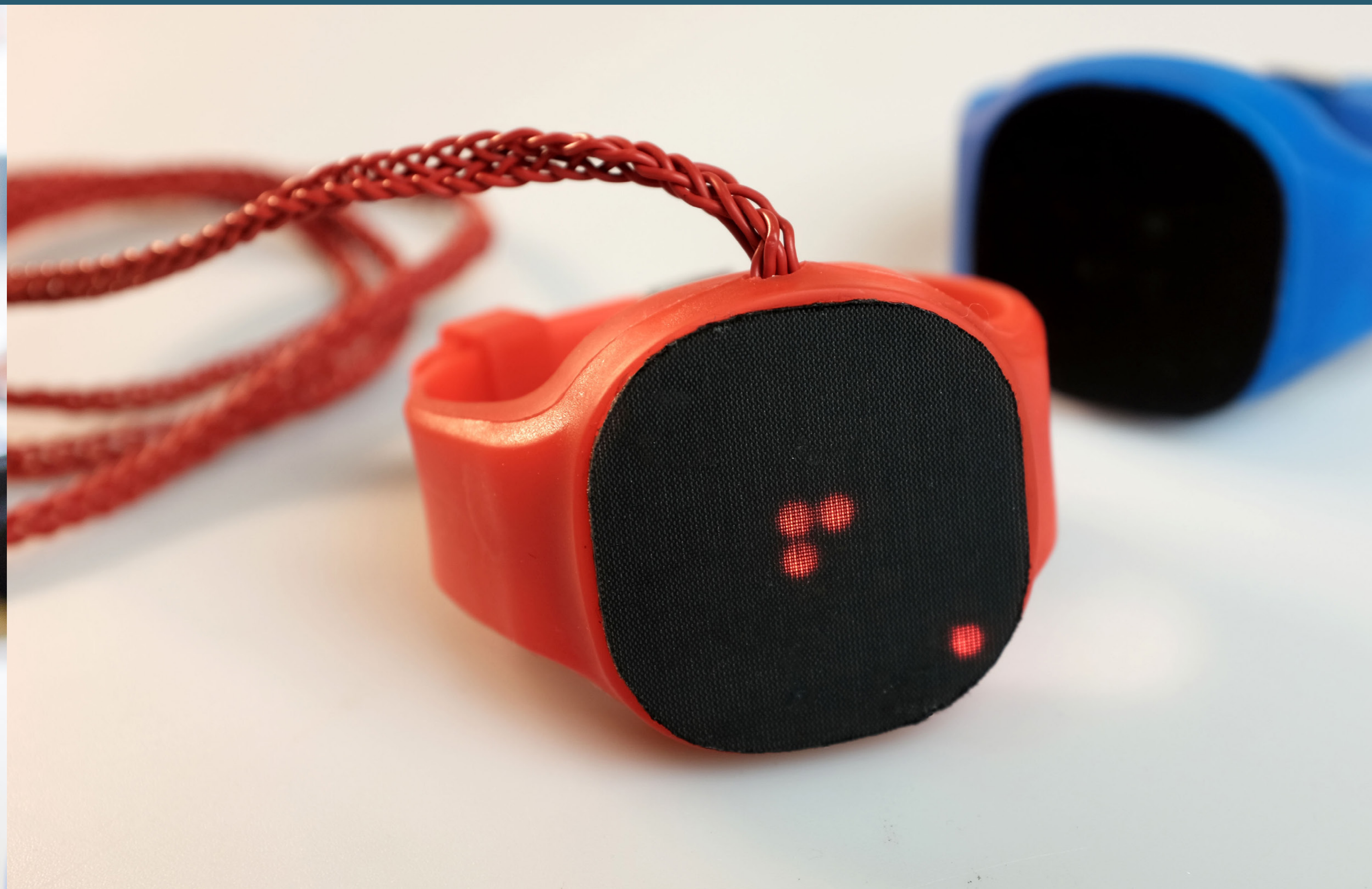
Regarding the display in the wearable, we developed three different ways to demonstrate which direction the users should move when they sit in a bad position. During the Demoday, the visitors could understand the meaning of the display well after we explained it. However, we did not examine the intuitiveness of the displays. In our opinion, there is a large amount of possible ways to design the display. Thus, it will be meaningful to test the intuitiveness of the current and other possible displays and apply them in future iterations.

9 | CONCLUSION

This report is written to explain and explore the process of the Sitbit for people with a spinal cord injury. We started this project by asking ourselves how we could design an interesting and helpful solution for people with a spinal cord injury. Through the theoretical background and related work we concluded that creating a personalized wearable and real-time feedback giving system would be an interesting market opportunity. Similar to these results is our own vision which next to the outcomes, include creating intuitiveness, behavioral change and tangibility. Altogether, we gained knowledge about creating innovative solutions for people with a spinal cord injury and we met most of our design objectives for the final product.
Via several researches it was possible to acquire new information about the issue at hand, the consequences and the solution. This information has been applied early on in the project and ever since, hence the many iterations. After every iteration we analyzed and evaluated the prototype looking back at past results, old and new knowledge in order to create a new iteration. On the ground of earlier research, we already met some design objectives such as tangibility and personalization. The results of the user test were implemented in the final system (Sitbit) which include real-time feedback, personalization, tangibility and a wearable. However, the final result did not encompass intuitiveness and behavioral change, which were design objectives, due to lack of time.
Since we only conducted one user test with three participants it can be said that the results from the user test are not representative for other patients with a spinal cord injury. More user tests should be conducted in which we experiment more with tangible and intuitive solutions.

Fig. 51: Visitors of the demoday testing the Sitbit wearable

Fig. 52: Sitbit wearable



10 | ACKNOWLEDGEMENTS

We hereby want to acknowledge the people that helped us during our design process. We could not have done our project without these people.

First of all, we would like to express our sincerest gratitude towards our project coaches Daniel Tetteroo and Panos Markopoulos who gave us valuable feedback during squad meetings. We would like to thank Daniel Tetteroo specifically for his guidance and support when needed.

We would also like to thank our client Adelante for providing us with valuable feedback and for providing us with participants for our user test. Especially Richard Geers, who guided us throughout the process, we would also like to thank him for his time and for welcoming us multiple times in Hoensbroek. Next to this we also want to thank therapists Janneke Goossens and Evelien van der Sloten for giving us feedback from the therapists' perspective.

Finally we want to thank Bruna Goveia da Rocha for helping us with the patient journey.

Fig. 53: Final prototype Sitbit wearable

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Fig. 54: Logo Sitbit system

REFLECTIONS

REFLECTION MARIT PROPER

Overall I have good feeling about this project, I liked the collaboration with my group members, enjoyed the project subject, had the opportunity to work with a client and I am satisfied the outcome of the project. For me it was a long time ago since I last participated in a group project (my design research project in 2016), so I had to get used to working in a design team again.

Role within the team
During a project in a team I am most of the time the person who keeps the overview and makes sure that the design activities match the goals and what possible next steps could be. This project I had, especially during the first part of the project, a facilitating role towards guiding the design process. Because the group was more multidisciplinary than I expected (different backgrounds from different universities) this was needed to start with the right design activities and a hands on iterative design process. Together with Emma I was facilitating in design activities and creativity techniques to get the project started, throughout the further process we were the driving factors in managing the process. This learned me how to get other people along with design thinking and creativity techniques.

Collaboration
The collaboration went well, despite the sometimes different (strong) opinions that were within the team. The discussion helped to make the concept more clear and helped with making the design decisions. The practical work in the project was contributed over teams of two most of the time (while one group worked on the electronics, the others worked on the aesthetics). This worked really well in a way that everyone worked on different parts of the project, this was especially good for the group members that were starting ID since this semester.

Personal contribution and learning points
As stated before I was keeping the overall design process in mind, I chose the design process, which was the same I used during my FBP. I chose this process for this project as well because, even though the original process is developed for design for dementia, as it enhances a hands on approach by making and evaluating constantly. In the end we had a reflective and iterative process. During the mid and final demo day I also mapped out the whole process and used this to reflect upon the process. During the process there was made room for everyone to work on different parts of the project, this to make sure that everyone learned about the different parts of the competency framework. Because I had a facilitating role in the project I sometimes felt more like a teacher than a student because I had to explain a lot of design related things, but this made me also more critical towards the things I usually 'just do' by asking the 'why' question more often. In the future I have to take into account during the process that my head goes faster than my hands. I have to take the time to also execute my ideas and accept that that takes time.

In the beginning of the process I worked on the patient journey, which was something new for me to map it out like this, during next projects I will use this more, as it gives a good overview and insight from the users' perspective. Next to this I also worked on several prototypes throughout the process, within the team we decided to make teams of two to tackle different design problems with. I worked for example on making a wearable with small vibration motors in it as well as creating a bracelet that gave notifications when a person wasn't sitting in the right way. On the bracelet I worked together with Haoyu, she worked on the esthetics of the bracelet and the bracelets itself, I soldered and programmed the first version of this bracelet.

I also made the user application and the therapist dashboard in Adobe XD. Which learned me how to create interactive UX designs for an phone application and a website.

During the project I improved many handy design skills, such as the adobe programs, programming and Arduino. Because of the versatile nature of the project I had the opportunity to improve many handy design skills, such as the adobe programs, programming in Arduino and a little bit of SolidWorks. The collaboration with the client did not go as expected. First they were enthusiastic about our ideas, but a few weeks later they weren't and after that I had the feeling the only way we could please them was to create an application, which we didn't. After that I had the feeling they lost interest in our project, which was unfortunate. I have learned firsthand that trying to innovate is not always easy, when a client does not see the opportunities, it is not easy to persuade them into doing things another way. When something like this happens next time I will open up the dialogue more on the why from their side in the hope to prevent this and to come to a mutual agreement. Because the client was far away and we were with 4 in the group, we divided the meetings so we did not have to go with all of us every time we needed to go there. This was looking at time management and money a good idea, but in the end I think that it is important for me to go to every meeting to keep the overview and to connect the right dots. Now I sometimes had the feeling that I was missing some pieces of the whole story because someone else went to the meeting.

Within the report I mainly wrote on the theoretical background, the user chapter, the process chapter and I looked at mapping out different products on the market compared to our designed system.

REFLECTION SAMANTHA GALVEZ VARGAS

Looking back at the semester and this design project, I can conclude that this project has been a very valuable experience for me as a designer and person. During the project we went in depth in several expertise areas (EA) such as User & Society (US), Math, Data & Computing (MDC), Technology & Realization (TR) and Creativity & Aesthetics (CA) as defined by. Some examples where we included the above mentioned EA's are as follows. We have worked on our product while keeping the desires and needs of our client and target group in mind. For the final system I have created an algorithm of high performance. Next, we have created and demonstrated an excellent prototype using the right technologies. Finally, the Sitbit has had several iterations where every time a lot of attention went into the aesthetical part of the product.

Professional skills
As a result of this multidimensional project I was given the opportunity to expand my professional skills to a new level. The development of my Communicating and Reflecting skills stand out the most to me. I have learned how to communicate with different stakeholders on a professional level. Next to this, I have refined my presenting skills during the mid-term and final demo day thanks to insightful feedback from my project group. I have learned through this project that reflecting is a great tool to learn from my experiences in the past and how I need to proceed as a designer in the future. Reflecting on my overall competence as a designer, I have acquired new knowledge and skills in all the EA's, since I was part of all the processes. There are still some areas where I can improve like CA, MDC and using scientific information. However, my teamwork, communicating, collaborating skills and the areas TR, US is where I excel as a designer.

Collaboration and role in my team
The collaboration in the project group is something I have enjoyed. The atmosphere surrounding the group was informative and supportive with a lot of communication by means of meetings and email. Each member had her own expertise's which made it easier to learn something new. However, to get to this point of collaboration some minor issues were at hand at the beginning of the semester. Due to some miscommunication some members felt the amount of pro-activeness was not fairly divided. At the end of the first quartile this has been talked through and solved. It was overall a very good collaboration with some minor hiccups in the beginning of the semester.

Looking at my role in the team it can be said that I was the technical realizer. I made sure the technical problems were solved and made for presenting. I also helped my team in solving issues with my creativity, my enthusiasm of exploring ideas and my ability to discuss/refine ideas with them. Due to my background I was able to help my team with programming and developing hardware. I felt I could be more leading in the team as this is something I am good at, nevertheless I got more pro-active and leading after the first quartile when I felt more at ease.

A big part of my contribution in the design process and deliverables has been the technical side of the project as I mentioned earlier. I have programmed and made the prototypes for the mid-term demo day, one of the three prototypes for the user test and the final prototype, because this was one of my learning goals. I have worked and done research on the aesthetical part of the wearable which was later tested in a user test by me and a fellow team member. I am very proud of my pro-active attitude and ability to give new input, creative ideas and asking the right questions which made the team re-think about certain aspects.

Personal goals
Thinking back of my personal development plan (PDP) I set a few short and long term goals for myself. I wanted to determine which master track I want to follow, explore my vision and interests as designer and I wanted to make all my projects look aesthetically pleasing. The Sitbit has received many compliments about the design which I am very proud of. Through this project I learned that healthcare is not my area of interest. By analyzing my interest and reflecting on past decisions I came to the decision to follow the RDD track in the Play & Learn squad. I am very proud to say that all my goals have been achieved.

In order to achieve my learning goals I had to have a learning process. Considering my different background, the first semester has been one big learning experience. Through research, asking

questions and observations I got to understand the vision and way of doing things at the TU/e. By working on processes I am not used at, ensured that I became more confident as designer and it has thought me that my technical skills are very valuable. Unfortunately, there are two missed opportunities for learning. One of the things I still would have loved to learn is how to 3d print and the program solid works. Due to lack of time and importance I was not able to do this. For a next project this will be on my to-do list.

Conclusion
As final words, I want to continue learning on how to be a full-fledged Industrial designer as this was my first semester at the TU/e. I already know that healthcare is not for me, but this was only possible by working on a project that encompasses healthcare. There is still a lot to explore within the EA's and Play & Learn squad. My following steps will be to put my new insights into use in future projects.

REFLECTION HAOYU DONG

Collaboration process:
In this project, we worked in a four-member-group with four different backgrounds. At the beginning of the semester, we shared our academic skills and personal goals, which is a good start to find out the way we can collaborate. In general, we worked in a way that everyone can fulfill their personal learning goals by helping others and learning from others' advantages. Nevertheless, there were some circumstances where we had distinct ideas and discussed intensely, and where we have to sacrifice our own interests and make full use of what we are already good at. But everything went well based on the consensus of seeking common ground while reserving differences, which makes our concept rich in content. This also allows us to express and exchange our ideas, as well as improve our teamwork skills in interdisciplinary environment.

Furthermore, we usually separated the tasks and worked in small teams. Then we set up a deadline to finish the tasks, and meet to discuss the progress and problem. Usually we would switch the tasks after the meeting and improve what have been done. Since the transport to Adelante is time consuming and expensive, we also have planned in advance - every time only two of us need to visit our clients. This division of labors can save time and maximize the work efficiency. Meanwhile, it allows team member to involved in various aspects of the whole design process to develop our skills in various expertise.

Additionally, we are punctual and respect others' time, which in my opinion is essential to teamwork. Setting up weekly goals helps us to keep up to schedules.

Individual contribution:
In the early stage of the project, we separate the research tasks, then we did brainstorm together to summarize the research results, and find possible problems and design opportunities. Then, I focused on researching deeply on the wearable technologies and existing healthcare products. I also contact Qi Wang, former PhD student in TU/e, and studied her posture correction garment design project.

After we decided to design a wearable, I put effort into prototyping the wearables and focused on expertises in creativity and aesthetics, and the technology and realization. I made the very first iteration of the prototype using 3D print, the example prototypes showing how user could wear them, the bracelet with vibration motors based on what Marit made, as well as the functional prototype with LED Matrix. I also helped making the final prototype which integrating the LED Matrix and vibration motor.

Personal learning goal and Learning process:
Since I was taking the bachelor electives Creative Programming during the first quarter, it would be a good opportunity to apply the knowledge into practice in this project. Therefore, my main goal was improving my skills in the expertise of technology and realization. As expected, I was able to work on the code and electronic part of the vibration bracelet and the final functional prototype with my teammates. Although I am new hand in this expertise, I am really enthusiastic about it and willing to learn more. Have not taken Creative Electronics, yet I already started the book - Getting Started in Electronics.

Moreover, as this is the very first project in TU/e, it is essential for me to adapt to the new system. I was willing to acquire the information of the basic design process as well as the area of healthcare design. On the one hand, I observed and learnt from my teammates. At the beginning of the project, I mainly follow their leads and schedules; after a while, I got better understanding of the project and was able to comment more on the design process. In my opinion, it is significant to find out my personal design methods based on the general design process. On the other hand, I read papers and design reports to obtain basic theoretical and background knowledge about physical rehabilitation innovation and healthcare design. I also went to the rehabilitation center and talked with the therapists, which gives me a deeper understanding of the role the designers should take in the industry. This project allows me to grasp knowledge about health-related technologies and the huge potentials to change traditional healthcare industry. During the project, it was realized that design for behavioral change is an crucial aspect of our concept. We took this chance to gain more insight of this area: we read papers and attend the behavioral change workshop, then we integrated the workshop result in our concept.

Besides, thanks to the i2-CoRT project, we were able to be involved in a large design project with different stakeholders, and I was able to work on the patient journey based on the requirement of our client - Adelante. I also developed my presentation skills by showcase our project on the Demoday in Adelante.

Regarding to the five expertises, first of all, I mainly developed my professional skills in Technology & Realization and User & Society, which is also the expertises that I am willing to focus in my future study. Secondly, I improved my former skills and abilities in the expertise of Creativity & Aesthetics. Then, we analyzed the market positions of our design by doing benchmark research. We also got positive feedback during the Demoday in Adelante about the possibility to launch the system. The experience I believe could help me further develop my skills in Business & Entrepreneurship. As for Math, Data & Computing, we did not actually implement it into our project. However, we created the concept of using the data from the sensor mat as the input to our system, as well as sharing open data platform to promote the mobile healthcare industry. We also explored the possibility to combining artificial intelligence into our system, which also integrated the new knowledge from the elective - Designing Intelligence in Interaction.

Individual contribution to deliverables:
I worked on the introduction, theoretical background, future work and discussion to the deliverables. Writing these parts helped me to gain a more general review of our concept.

Missed opportunities for learning:
It is meaningful for us as student to cooperate with company and professionals in this area. However, there was not so many chances to directly communicate with the patients. Without direct contact with patients, it is difficult for us to raise a convincing concept and test our design.

In my case, the language is a barrier. We had teleconference with the therapists and engineers from Adelante, and also visited Adelante rehabilitation center for several times. Unfortunately, they preferred to talk in Dutch sometimes, which makes it more difficult for me to get a first-hand information. Although my teammates are willing to translate and convey the main idea afterwards, this is a pity that I can not fully participate in some activities.

Acknowledgement
This design project is a good start for my Master study. I have struggled a lot, yet learnt a lot. Hereby, I would like to appreciate the patience and support from Daniel Tetteroo, as well as the excellent teamwork of my teammates.

REFLECTION EMMA REILING

Professional skills
Looking back on the project, the first aspect that comes to mind is the great collaboration within the team. Everybody seemed to naturally take their desired role without any problems. Haoyu and Samantha took a more wait-and-see approach, Marit and I took a more leading role. Marit and I seem to have a better overview of the design process and mostly initiated the steps that were taken. This was done in good consultation with Haoyu and Samantha and they seemed to like this way of working too. We all worked very efficiently; our meetings were structured and to the point and the atmosphere was good. We all respected each other's opinions and had constructive discussions and evaluations. One of these evaluations led to an important step in the process; we realized we had to improve our communication within the team. We usually agreed on a task division verbally, without writing it down for everyone to see. We started to write minutes during meetings and we filled in a schedule together so that everyone knew what to do and where we were in the process. I want to continue doing this during my next project as it helps me to structure the project correctly.

As already mentioned, one of my main responsibilities during this project was managing the design process. Although I took this role in former projects as well, I learned a lot. During my bachelor, I knew only one design process and adjusted it myself if necessary. Marit taught me different and more standard approaches used at TU/e like the one we used for this project. I will definitely use these approaches in future projects as it allows me to work in a more structured way and to further develop my professional skills.

Expertise areas
For me, user and society turned out to be one of the most important expertise areas during this project. We constantly tried to work from a user perspective. I liked this way of working; I believe that putting yourself in the place of the user will lead to better designs. My contribution to this was conducting research to spinal cord injuries, the benchmark study, helping with the patient journey and the user test at Adelante. Unfortunately, this test did not go as planned. Employees of Adelante took the lead and asked for more information than we were supposed to give. Although we were fully prepared and had a decent protocol, we still gave the information as we were too insecure to say no. To practice and to prevent this from happening again, I want to do more user studies in future projects. This will be my personal learning goal for next semester.

My personal learning goals for this semester were mainly on technology and realization and on math, data and computing. I wanted to further develop my prototyping skills (electronics and programming) and I wanted to learn how to use a 3D modelling program like SolidWorks. I succeeded for the first goal. I created some of the earlier iterations, shown in figure 55 and 56. Although it took me some time to create them, they turned out the way I wanted them to be.

Unfortunately, the second goal was harder to reach. I underestimated 3D modelling, I thought it would be an easy switch from 2D programs like Adobe Illustrator to 3D programs like SolidWorks. I watched tons of tutorials, asked for help from fellow students and spend several hours trying to create a prototype. I realized I was slowing down the iteration process and decided to complete the 3D model that I was working on in my spare time. Although not used within the project, I'm still proud of the end result, shown in figure 57. I will continue practicing with 3D modelling because I believe that obtaining this skill will make me a better designer.

Because it took some time before we could do the user test at Adelante, there was not much time left for the last iterations and the final concept. Therefore we decided that everyone should do the part on which they had the most advanced skills. For me this meant working on creativity and aesthetics. I did all graphic design; the poster, infographic, layout of the application and layout of the report. I made sure that the whole system worked as one concept and I wrote the concept chapter in the report. I also took care of the final iteration of the wearable; I developed the prototype with the silicone strap. I am proud of the final result and I am happy to see that all elements have the same style and colors.

The last expertise area is business and entrepreneurship. I worked on this area throughout the whole project; I was responsible for the contact with Adelante and went there several times. Working with Adelante and within the I2Cort project was a challenge sometimes. Besides that it took some time before getting in contact with them, they seemed to have a preconceived idea of what they wanted; an application. We struggled with choosing the right direction for our prototype (our vision or theirs), especially after the user test. We decided to note all positive aspects of every idea and turn that into an ecosystem. Looking back at that moment, I am glad it happened. I think I will encounter this more often in the future and I now know it is just part of being a designer. A major learning moment!

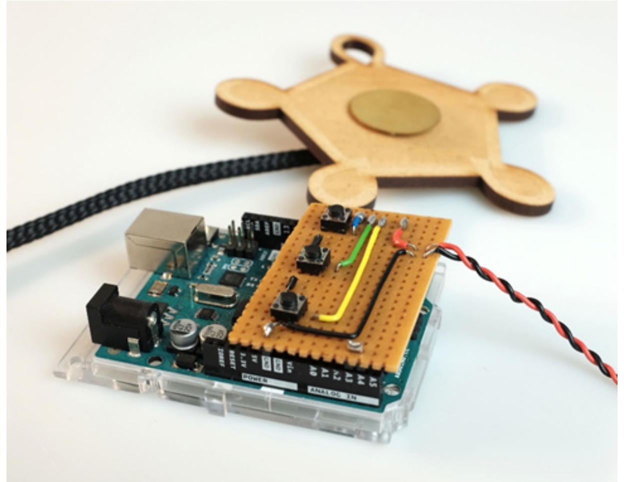
Fig. 55: Early iteration 1

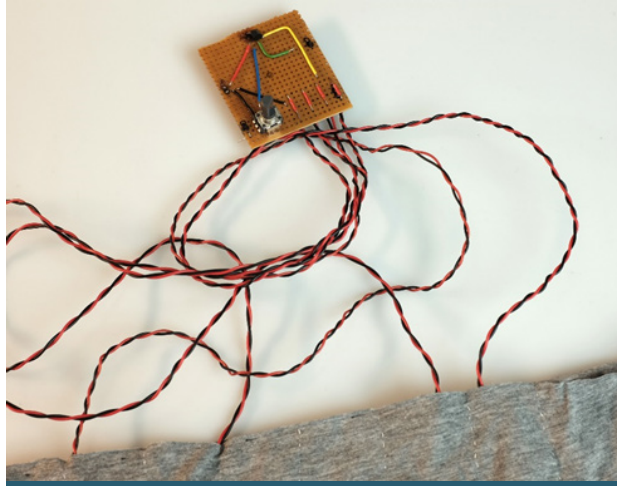
Fig. 56: Early iteration 2

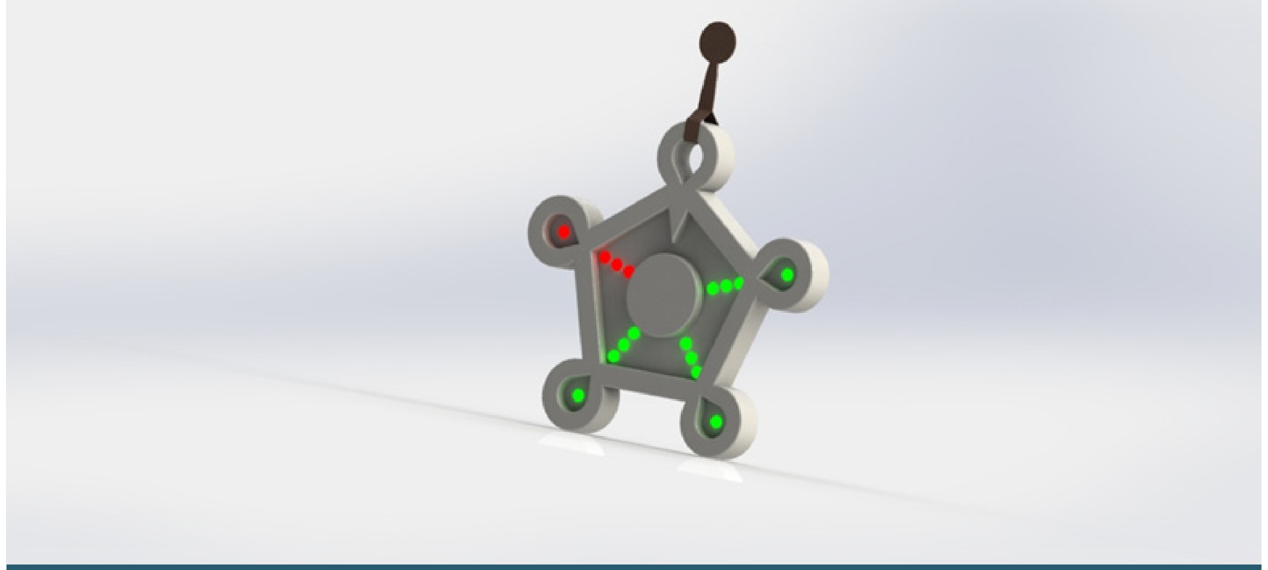
Fig. 57: 3D model prototype

APPENDICES

APPENDIX 1 - EMPATHY MAP

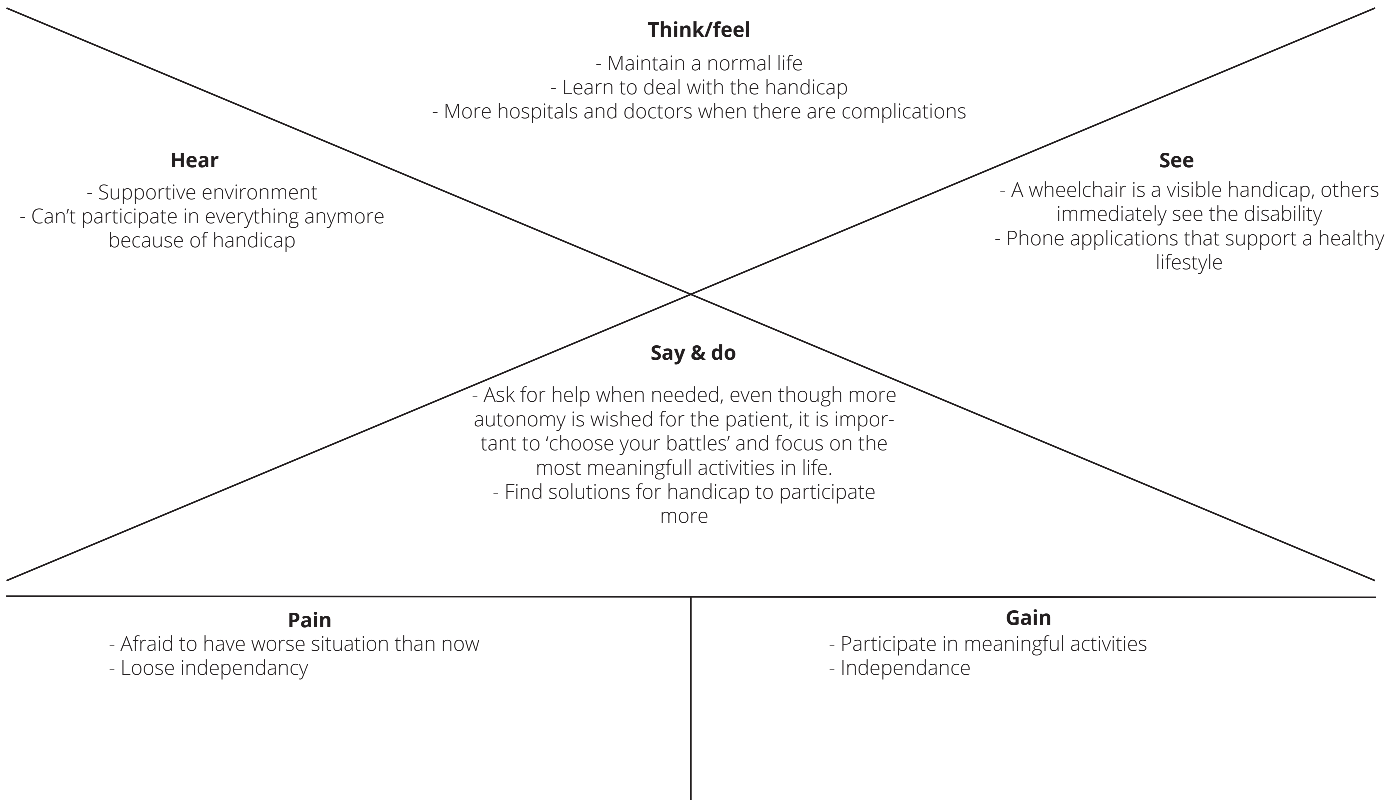

Fig. 1: Empathy map

APPENDIX 2 - USER TEST PROTOCOL

Introductie
We beginnen de user study met het introduceren van onszelf, wat we in deze studie gaan doen en waarom.

"Wij zijn designers die vanuit de technische universiteit in Eindhoven een oplossing zoeken om de houding van mensen in een rolstoel te verbeteren. Bij de zitpoli hebben we gemerkt dat veel problemen die patiënten ondervinden (deels) voorkomen zouden kunnen worden door het aannemen van een andere zithouding. Wij zijn aan de slag gegaan met een device waarmee mensen zich bewust kunnen worden van hun huidige zithouding en geattendeerd kunnen worden op momenten dat zij een andere zithouding aan zouden kunnen nemen die misschien beter is voor hun lijf. Verder wordt deze sessie verdeeld in 3 verschillende fases. In de eerste fase gaan we kijken naar de voordelen en nadelen van verschillende manieren om het apparaat te dragen. De tweede fase bestaat uit het testen van de ontworpen apparaten en in de laatste fase kijken we nog even terug op de sessie en de ontworpen apparaten. Bij elke fase geven we aan op welke aspecten gelet moet worden."

De introductie wordt geëindigd door de sessie leider en de eerste fase wordt ingeleid.

Fase 1:
In deze fase worden de functionele prototypes aangekaart door de sessie leider. In dit deel van de studie testen we of de deelnemers de manier waarop deze prototypes hen suggereert om van houding te veranderen, snappen.

"We laten jullie 4 functionele prototypes zien die gebruik maken van geluid, licht intensiteit, vibratie en een app om jullie te attenderen dat een andere houding beter is voor jullie lichaam. Nadat jullie alle functionele prototypes hebben vastgehouden ga ik jullie wat vragen stellen over deze prototypes. In deze fase mogen jullie letten op de technologie/functies van het prototype en niet op het uiterlijk, want dit is nog niet het eindproduct."

Nadat alle deelnemers de prototypes hebben gezien en vastgehouden stelt de sessie leider de volgende vragen per prototype:

"Begrepen jullie in welke richting je zou moeten bewegen?
Snap je direct wat je zou moeten doen?
Welke vond jij het fijnst? Waarom?"

De observer is ook hier weer bezig met het maken van aantekeningen over de houding van de deelnemers tegenover de prototypes.

Fase 2

Na afloop van fase 1 kan er een pauze worden ingelast als de deelnemers dat willen.

Het doel van deze fase is om inzicht te krijgen in de voor- en nadelen van de prototypes die zijn ervaren door de deelnemers. Het gaat dus voornamelijk om of de deelnemers een zichtbaar of onzichtbaar apparaat willen dragen. De eerste fase bestaat uit een focusgroep discussie over de verschillende manieren waarop het apparaat gedragen/gebruikt kan worden.

"Ik zal nu een korte uitleg geven over fase 2. In deze fase kijken we samen naar verschillende manieren waarop het apparaat gedragen/gebruikt kan worden. Dit doen we door middel van voor- en nadelen.

Zoals jullie al zien hebben we 5 vellen op tafel gelegd met ieder 1 idee, een vak voor voordelen en een voor nadelen. Jullie kunnen voor- en nadelen per prototype op een post it schrijven en plakken binnen de vakken. De manieren zijn als volgt: light intensity, vibration bracelet, app and music. Jullie zullen de bedachte ideeën allemaal anders ervaren (een man wil waarschijnlijk geen ketting dragen) en dat is prima.” (Waar moeten ze in deze fase op letten?)

De deelnemers krijgen aan het begin van de fase roze (nadelen) en groene (voordelen) post its. Elke kleur representeert een voordeel of een nadeel. De deelnemers mogen zelf de post-its op de vellen plakken. De sessie leider gaat elk idee af en zorgt ervoor dat ze zo neutraal mogelijk is. Er mogen geen vooroordelen plaatsvinden door het gebruik van positieve of negatieve woorden. De deelnemers plakken zelf post-its op de vellen. De observer maakt aantekeningen over de discussie en de redenen waarom de deelnemers de genoemde punten goed of juist slecht vonden.

Fase 3:
Na afloop van fase 2 kan er een pauze worden ingelast als de deelnemers dat willen.

Tijdens de eerste en tweede fase hebben wij gerichte vragen gesteld over de functies van de prototypes. De laatste fase is bedoeld om een wat algemener beeld te vormen van deze sessie en de prototypes. Dit proberen we te bereiken door ook in deze fase een focusgroep discussie te houden.

“Om deze sessie af te sluiten wil ik het met jullie nog hebben over deze sessie.
Wat vonden jullie ervan? Was het interessant en wat was dan precies interessant?
Wat was volgens jullie het leukste prototype? Waarom?
Welk prototype vonden jullie het beste? Waarom?
Welk prototype vonden jullie het slechts? Waarom?
Welk prototype vonden jullie het makkelijkst te interpreteren?
Zouden jullie een verder ontwikkelt prototype in het dagelijks leven willen gebruiken? Waarom wel/niet?
Hebben jullie nog tips en suggesties om de bestaande prototypes te verbeteren?
Hebben jullie nog een andere manier waarop het apparaat gedragen/gebruikt kan worden?
Denken jullie dat het eindproduct nuttig zal zijn?”

De sessie leider rondt de discussie wanneer ze ziet dat de deelnemers zijn uitgesproken. Ze bedankt de deelnemers voor hun coöperatie en geeft elke deelnemer een bloemetje of een chocoladereep.

APPENDIX 3 - CODE WEARABLE

Fig. 2: Code wearable part 1

Fig. 3: Code wearable part 2

APPENDIX 4 - BENCHMARK STUDY

Upright pose wearable & application

The upright pose wearable can be attached to the body (the upper-back) with an adhesive sticker and senses your posture. It gives feedback by vibrating when the user needs to correct his or her posture. The wearable interacts with an application, called the UPRIGHT GO mobile app (Upright, 2018). This app includes tutorials, tracks progress and shows your daily overview. The app uses a character to show the user how his or her posture is at that moment and how it can be changed (Figure 4: Wearable UPRIGHT, (Upright, 2018), Figure 5: Screens UPRIGHT GO mobile app (Upright, 2018)).

Figure 4: Wearable UPRIGHT (Upright, 2018)

Figure 5: Screens UPRIGHT GO mobile app (Upright, 2018)

Lumo Lift wearable & application

The Lumo Lift is similar to the Upright pose. It is a wearable that can be attached to the body by using an adhesive sticker. In contrast to the Upright pose, this wearable is attached just underneath the collar bone. The wearable interacts with an application, called the Lumo Lift app (Lumo Bodytech Support, 2018). The app counts the amount of steps that were taken per day, the estimated distance, the estimated burned calories and most importantly, good posture minutes (Lumo Bodytech Support, 2018). When starting the application for the first time, the user is asked to set a Target posture. The wearable will track how many minutes the user is in this position, the application shows an overview (Figure 7: Screens Lumo Lift mobile app (Lumo Bodytech Support, 2018)).

Figure 6: Lumo Lift wearable

Figure 7: Screens Lumo Lift mobile app (Lumo Bodytech Support, 2018)

Alex + posture habit changer wearable & application

The Alex+ posture is similar to the systems mentioned above. It consists of a wearable (Figure 8: Wearable ALEX+ (ALEX, 2018)) that the user needs to place on the back of the neck and an application (Figure 9: Screens ALEX+ mobile app (ALEX, 2018)). This system is especially designed to improve posture of the neck-area, mostly for people that are spending quite some hours behind their computers. The application tracks posture, gives alerts when the user needs to change position, shows statistics and progress, includes a coaching program and notifies the user when he or she has been inactive for too long (ALEX, 2018).

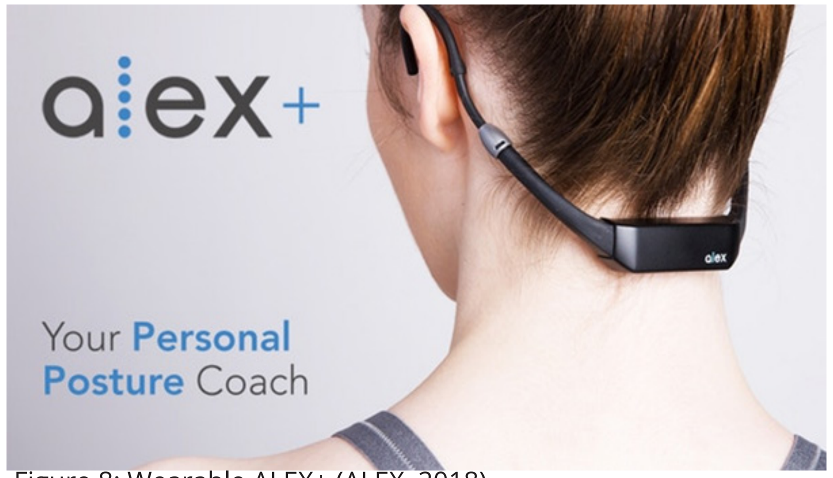

Figure 8: Wearable ALEX+ (ALEX, 2018)

Figure 9: Screens ALEX+ mobile app (ALEX, 2018)

Nekoze – Improve your posture
Application for Mac only. The app uses the camera of the Mac to watch the user. When the user needs to change posture, the application shows a warning on screen to remind the user (see Figure 10: Nekoze application for Mac (Katsuma Tanaka, 2018) (Katsuma Tanaka, 2018).

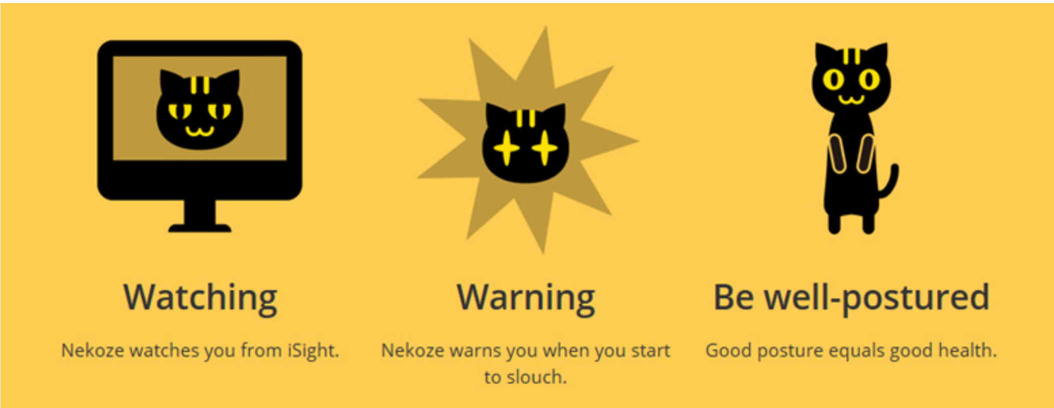

Figure 10: Nekoze application for Mac (Katsuma Tanaka, 2018)

Lage rugpijn oefen app
This application serves as a tool to help people do exercises at home to improve low backpains. It is designed as a weekly training schedule. The app provides audio files that talk the user through an exercise. These exercises are also shown in a video for the user to check if they are doing it correctly. Because of the format of the application, users can see their progress and look back at exercises that they did before (Vloothuis, 2017). The format of the application could serve as inspiration for the wheelchair seating app, but the exercises are not doable for patients that are wheelchair-bound. Figure 11: Lage rugpijn oefen app screens (AudioFysio, 2018) (AudioFysio, 2018) shows an overview of the different screens of the application.

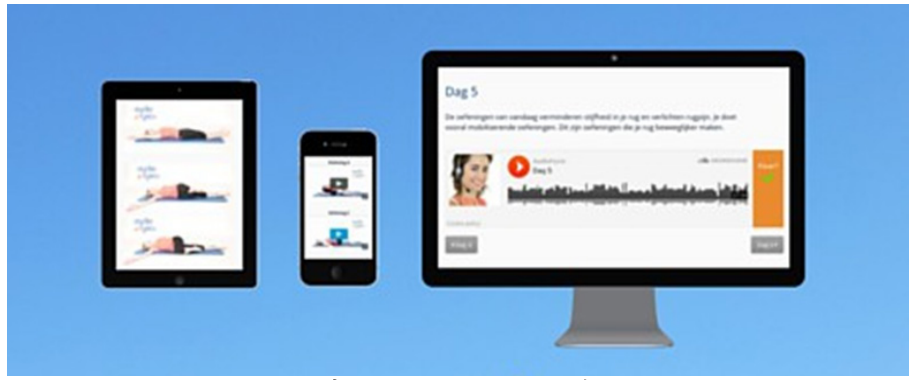
Figure 11: Lage rugpijn oefen app screens (AudioFysio, 2018)

Darma fiber optic sensor
Darma developed optic sensors that can measure several health-related aspects, such as heart rate, breathing rate and heart rate variability (Darma, 2017). The sensors are used in a range of products with the Darma cushion being the most interesting for this benchmark study. The cushion is equipped with sensors that monitor sitting time and posture (Darma, 2017). Vibration motors in the cushion notify the user when something needs to be changed. An accompanying application shows what needs to be changed, gives exercise examples to stretch the upper body and shows a progress overview (Darma, 2017). As this product is very similar to the seating mat that will be used at Adelante, this product might be interesting to take a further look at. Especially because the stretching exercises are mainly aimed at the upper body, patients with spinal cord injuries might be able to do these as well. Figure 12: Screens darma cushion app and (Darma, 2017) Figure 13: Darma cushion (Darma, 2017)show the system of the Darma cushion (Darma, 2017).

Figure 12: Screens darma cushion app (Darma, 2017)

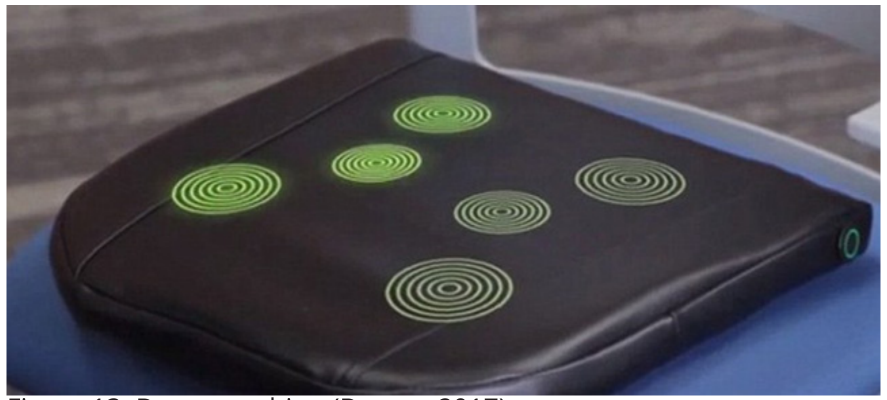
Figure 13: Darma cushion (Darma, 2017)

The virtual seating coach

The virtual seating coach is a system consisting of an application for patients in an electric wheelchair and a web portal for their clinicians (Permobil, 2016). The system is developed to learn patients how they should change the position of their wheelchair in order to have the most optimal seating position and thus posture (Permobil, 2016). The connecting between the web portal and the application allows the clinicians to monitor the patients at all time and to adjust their plan of approach per patient (Permobil, 2016). The virtual seating coach uses a timer as input for the system. The clinician can set a certain amount of time after which the patient needs to change their posture, the application shows the patient how much time is left in their current position (Permobil, 2016). Figure 14: Overview system virtual seating coach (Permobil, 2018) (Permobil, 2018)shows the system in one picture.

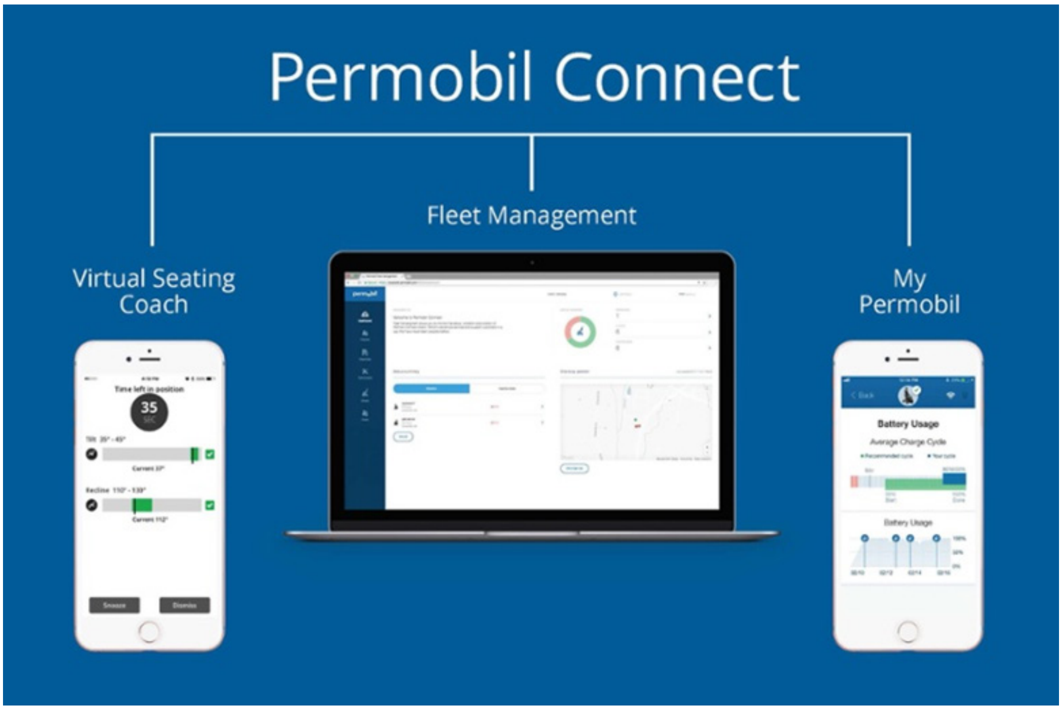

Figure 14: Overview system virtual seating coach (Permobil, 2018)

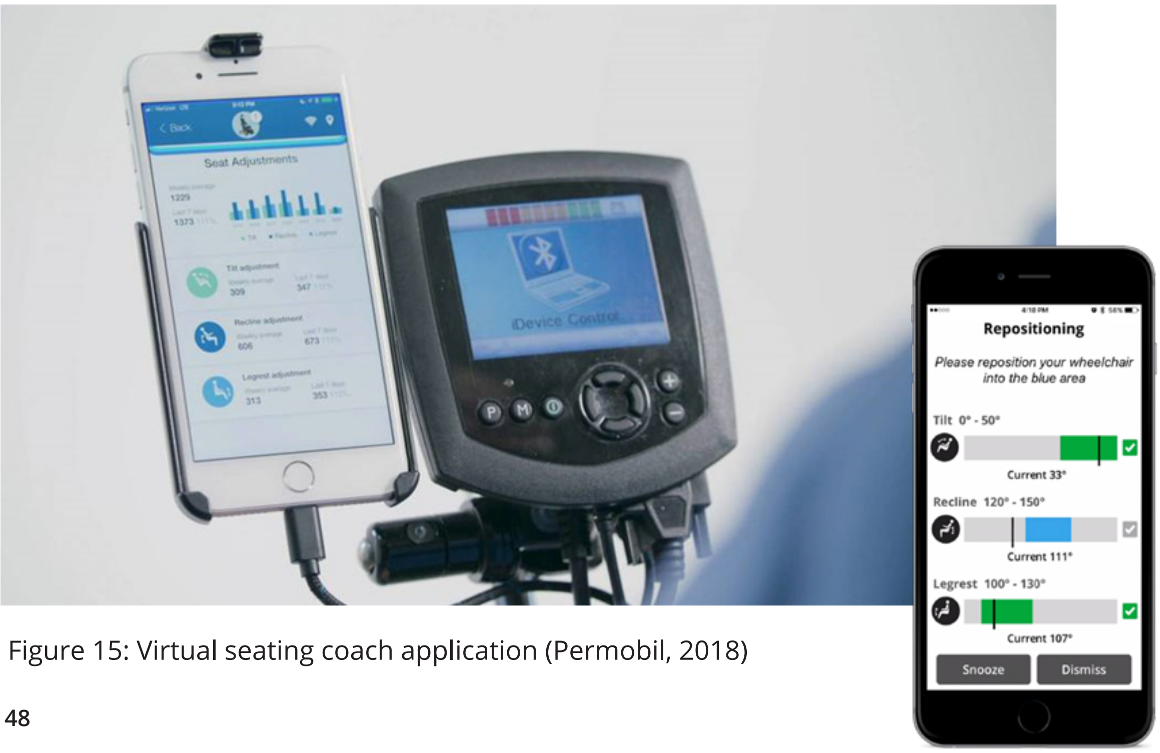

Figure 15: Virtual seating coach application (Permobil, 2018)