BSc Creative Technology

Translating data from wearable sensors in an understandable way to motivate older adults

Vera Schockemöhle
s2397277

Supervisor: Dr. Femke Nijboer
Critical observer: Sefora Tunc

July, 2022

Department of Creative Technology
Faculty of Electrical Engineering,
Mathematics and Computer Science

UNIVERSITY OF TWENTE.

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Vera Schockemöhle*

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Abstract

Over the last century, the elderly population and the number of patients with chronic diseases has increased. Both numbers are related to each other since many older adults are suffering under chronic diseases such as type 2 diabetes, heart disease, different types of cancer, depression and anxiety, and dementia. However, the majority of these diseases can be prevented or treated with enough physical activity and a healthy lifestyle. Many older adults feel unmotivated ti increase their physical activity. One possibility to support and coach them are wearable devices. With the aid of this technology, the activity can be measured and presented to the older adults to motivate them. However, most activity trackers or coaches are not design for this target group and their needs. The common applications visualize the data in 2D with numbers and diagrams but a meaningful visualization, with which older adults can be motivated, is missing.

This bachelor thesis describes the process of developing a meaningful data visualization for older adults with the aid of a wearable sensor. The sensor used for this research is the Mox sensor, developed by Maastricht Instruments.

This final design consists of the final prototype, a controller box and a manual. The design of the prototype is an artificial flower, which can bloom depending on the activity of the user. Furthermore, integrated fiber optic cables combined with an LED, makes the prototype visually attractive and allows it to change colors based on the users progress.

The design was tested by three participants over at least 24 hours. The results show that the design can lead to a higher activity level of the participants, at least for a short term. Furthermore, we concluded that a 3D visualization is more convenient compared to a 2D visualization for this kind of target group and that the modern design together with integrated fiber optic cables makes the user curious and interested in the design. Additionally, a personal goal option in combination with an easy understandable controller keeps the user independent and encourage him or her to start an interaction.

Keywords: data visualization, wearable sensors, 3D visualization, older adults, motivation, pharaon

*Email: v.schockemohle@student.utwente.nl

Acknowledgement

I could not have undertaken this journey without my supervisor, Dr. Femke Nijboer and my co-supervisor Sefora Tunc. Thank you for your feedback and support during this project. Furthermore, I would like to express my deepest gratitude to those who are responsible for the European Pharaon Project. I am also extremely grateful for the support from Maastricht Instruments and their experts, who have provided me with the Mox sensor and additional data sets.

Thanks should also go to my classmates and Konrad for their editing help and input during my Ideation phase. Lastly, I would be remiss in not mentioning my family, friends, dog, and especially my partner Matze. Their belief in me has kept my motivation high during this process and gave me emotional support.

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1 Introduction

1.1 Introduction

Life expectancy and the elderly population have increased over the last century and with it the number of diseases [1][2]. In 2010, 15% of the Dutch population were over 65 years old. In 2021 this number has increased to 20% (3.457.535 people)[3] [4]. From this part of the population, 80% have at least one, and 68% have two or more chronic conditions [5]. Some common diseases are type 2 diabetes, heart disease, many types of cancer, depression and anxiety, and dementia [6] [2].

Fortunately, research shows that most of these diseases can be prevented. Physical activity or a healthy lifestyle can reduce the risk of suffering under chronic conditions in the future [6]. However, many older adults are not aware of their physical activity or not motivated enough to improve their activity level [7]. Wearable technologies could address this problem. This type of technology can give the users deeper insights about their physical behavior, enables feedback and gives suggestions for improvement [8].

However, many physical activity trackers or coaches today are not developed and tested for the older part of the population relating to the data collection as well as the data visualization [7]. The data that needs to be collected for older adults is not completely the same as for younger users. For instance, the tracking of activities like running, workout time or riding a bike, will not provide enough accurate data to improve older adults activity level [9]. Also, older adults may engage in different types of physical activity at different intensity levels. For example, activities like sitting, slowly walking or lying down are important to consider when collecting data from older adults [10].

One possibility to collect data about such physical activity, are wearable sensors, in particular accelerometers. For this research, the MOX sensor from Maastricht Instruments will be used to collect the necessary data. The MOX sensor is an accelerometer-based activity logger, which measures and records high resolution raw acceleration data up to 7 days [11]. With the aid of IDEEQ software and algorithms, human physical activity can be classified and quantified. The MOX sensor, including software and application, was especially developed for older adults and can therefore recognize slower tasks, such as slow walking or sitting. Currently, the application MISS Activity is visualizing these tasks and divide them into steps and minutes of activity. However, the data visualization can still be improved or redesigned, since it is simplistic, a smartphone is needed to visualize the data and it does not motivate the user for keep using it.

Furthermore, it is important how this data can be visualized to motivate and address the older adults needs. For instance, users seem less open to new technology if the user has to rely on friends, family or researchers to help them with device issues [7]. Therefore, the data visualization needs to fit within the target group's environment and should not be burdensome or limit the user's independence [7].

The goal of this research is to investigate how the data, collected by the MOX sensor, should be visualized to motivate older adults, to keep using it. This project is part of the PHArA-ON project (www.pharaon.eu, Grant agreement ID: 857188), which provides support for Europe's older adults. By the integration of digital services and technology, the project wants to enhance the independence, safety, and capabilities of older adults [12].

1.2 Research Questions

How can the data, collected by the MOX sensor, be visualized to motivate older adults, to keep using it.

The subquestions are:
- How is data currently visualized?
- How familiar are older adults with wearable devices?
- How likely would older adults use wearable devices as a motivation for their physical activity?
- How would older adults like the data to be visualized or made audible or touchable?

1.3 Report structure

This report is structured in nine different chapters to explain the development process. It starts with the introduction, which is followed by the state of art. The state of the art includes an overview of the currently available information about data visualizations for older adults and further literature review. The third chapter focuses on the methods and techniques that are used in the project. The following four chapters follow the steps of Creative Technology Design Process, which is discussed in chapter 3. In chapter 4 the ideation is conducted, which describes the first requirements, ideas and concepts. At the end of this chapter, one idea is chosen to be worked out further in the fifth chapter: specification. Here the first prototypes are presented. The final design of the visualization is presented in chapter 6: realization. This design is then evaluated by the stakeholders in chapter 7: evaluation. In chapter 8, Future work for this project will be discussed. The conclusion will be drawn and answers will be given to the research questions in chapter 9.

2 State of the Art

Due to permanent development and research, sensors have been successfully implemented in different personal wearable devices. Smartphones, smart rings, watches, fitness trackers, and wristbands are already used to track our physical movement, health status, and behavior. In addition, body mounted sensors can support healthcare by sending biological data about the patient [13] [8]. Together with diagnostic and monitoring applications, data cannot just be collected but also processed to identify a person's physical activity [14] [13]. In the field of healthcare, it can be helpful to collect biological data about patients like body temperature, heart rate, brain activity and muscle motion, to improve treatment [8]. This data can be analyzed to provide clinically relevant health metrics and monitor health status [7]. Some common data collection devices nowadays are mobile computing devices such as smartphones and accelerometers.

Smartphones or other mobile devices like smartwatches have become a constant companion for most people. These devices are part of our social environment and implemented in our daily lives. Within these devices, several sensors have been implemented to measure data like footsteps and vital signs to provide information about activity and behavior [4]. For instance, sensors like accelerometers are able to collect more detailed data about the user's behavior, such as the change in velocity of the user over time (SI unit: m.s-2) [15]. With the collection of this data, users behavior and activities like sitting, standing and lying can be detected and measured as well [16]. Therefore, different wearable sensors can be more suitable than others, depending on the type and accuracy of the required data. Wearable sensors like smartphones or fitness trackers are already able to collect a lot of data about the user's behavior. But if the detection of simpler physical activity tasks are required, specific accelerometers are more suitable.

In this chapter the current state of sensors, their data collection as well as their visualization, regarding physical activity, will be reviewed. Furthermore, the relation between physical activity and the prevention of chronic diseases will be discussed and the subquestion of how data is currently visualized will be answered.

2.1 Prevention of chronic diseases

The prevention of suffering from a chronic disease in later life can be achieved through several ways. One effective way is the improvement of lifestyle and physical activity. Already in 2016, 72% of all global deaths were caused by non-communicable diseases [17]. The risk of suffering from such a disease depends on different factors. These factors can be modifiable and non-modifiable. Non-modifiable risks cannot be changed by the person such as age, ethnicity, or genetics. Whereas modifiable risks can be influenced and are mainly dependent on lifestyle, physical activity, regular exercise, diets, social engagement, spirituality, and stress management. These modifiable disease risks are mainly associated with physical inactivity [17]. A healthy lifestyle and good physical activity can contribute to improving life quality and life expectancy. Already a basic level of daily physical activity can have several health benefits. Most of these benefits are connected to a reduced risk of suffering from diseases. Some of them are, for instance, contributing to lower blood pressure, having a good cholesterol level, preventing cancer, improving sugar tolerance, and preventing diabetes [16] [18]. Therefore, physical activity can help to prevent and reduce the risk of suffering from a chronic disease in late life.

Furthermore, previous research has also shown that treatment was more successful with physical activity included after a chronic illness was diagnosed. In many cases of chronic diseases, it can work as a natural treatment and has a similar effect as other medical treatments. For instance, contrary to medication like beta-blockers to reduce blood pressure and heart rate, physical activity helps the physiological system of the body to work at an optimal level and has no harmful secondary effects [17]. It can also improve the insulin response as a treatment for diabetes (T2D) [19]. Furthermore, it can help to increase myocardial strength, oxygen delivery and decrease myocardial oxygen demand of the body [17]. Altogether, physical activity has a positive influence for the prevention of chronic diseases as well as for the treatment.

This literature review gives an overview of different sensors and their capabilities as well as advantages and disadvantages when collecting data of physical activities. Furthermore, it shows what should be considered when visualizing this data for target user's and why this motivation for more physical activity is important to improve life quality. This information will be used to evaluate the future prototype.

2.2 Data Collection and Data Visualization

In this section, already existing data collection and visualization technologies will be analyzed, since data visualizations can help to motivate and change people's behavior. Therefore, the purpose of this section is to understand existing ways of collection and visualization of data and gain deeper insights in possible designs and their strengths and weaknesses. The selection of the technology discussed in this section is focused on data collection and visualization regarding health. The state of the art is divided in data collection and data visualization. The collection will focus on common sensors and wearable devices, whereas the data visualization part will focus on applications and physical data visualizations, which are able to adapt their shape.

2.2.1 Data Collection

Data about human activity can be collected with the aid of different sensors. In this section, already existing sensors, their function and their application area will be investigated.

Ambient Sensors
With the usage of only one kind of sensor, some data, and information about users' behavior cannot be collected or is not accurate enough. To gain more specific data and to prevent failures in identifying users' behavior, sensors can be combined. A successful combination can be for instance ambient sensors together with wearable sensors. Some examples of such technology are motion sensors, which can detect users to open the door for them, switch the light on or can control smart ventilation systems [14] [20]. Furthermore, ambient sensors are often used to monitor users' behavior in their own home environment (Figure 1). With the combination of wearable sensors and specific data analysis procedures, it is possible to monitor vital sign data and track motions. In emergency cases, it is possible to detect falls even if the user does not wear any wearable devices [14]. In addition, the combination of ambient and wearable sensors can find its application in the field of rehabilitation (Figure: 1) [14].

In conclusion, research has shown that the installation of ambient sensors is useful when data, about a user behavior interacting with a specific environment, should be collected. Furthermore, the most successful method of implementing ambient sensors to gain accurate data, is the combination with other wearable sensors.

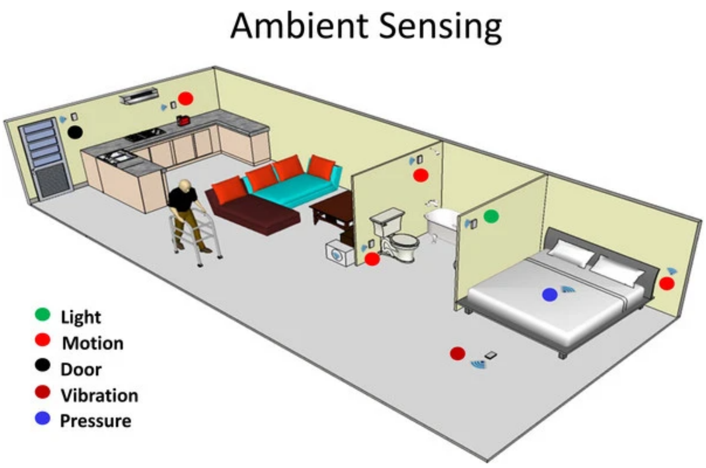


FIGURE 1: Example of ambient sensors in a patient home [14]

FIGURE 2: Passive Infrared Sensor for motion detection (PIR sensor) [21]

The PIR motion sensor can be installed to detect whether a human has moved in or out of the sensors range. They can often be found within devices and gadgets at home or in businesses. The sensor itself is small, inexpensive and does not need much power [21].

FIGURE 3: Light Dependent Resistor (LDR) [22]

Another example of an ambient sensor is a light dependent resistor (LDR)(Figure: 3).

The LDR is made of exposed semiconductor material and cadmium sulphide. Dependent on the incidence of light, the electrical resistance changes. The LDR sensor can be useful when the detection of light is needed. This can be for instance light based burglar system, a phone screen, or an alarm clock at home [22] [23].

Ambient sensors are implemented within the user's home environment. They can also be combined with each other to provide additional context information. Even the interaction with key objects can be recognized with the usage of RFID tags, placed on key objects or items. However, ambient sensors mostly collect data about human behavior indoor [24].

Wearable Sensors and devices

The second category of sensors are wearable sensors, which are used to recognize human activities in- and outdoors. These types of sensors are integrated within different fields. Consumer wearable sensors are developed for healthier decisions, medical wearable sensors for a better quality of life and defense wearable sensors are developed especially for soldiers. The field where wearable sensors are implemented is broad [24][25]. Therefore, we will focus on sensors, which are implemented within wearable devices to serve humans for healthier decisions. Most common sensors, which are integrated within wearable devices can be seen in Figure 4.

	Galaxy watch 4	Galaxy Fit2	Apple Series 3	Oura Gen3
				
Accelerometer / Activity detection	X	X	X	X
Barometer Gyroscope Geomagnetic sensor	X	X	X	
Ambient light sensor	X	X	X	
Samsung BioActive sensor	X			
optical heart rate (PPG), Respiratory Rate	X	X	X	X
Advanced heart rate functions (RHR, HRV, DHR, WHR)				X
electrocardiogram (ECG)	X		X	
bioelectrical impedance analysis sensor (BIA)	X			
GPS	X		X	
Altimeter	X		X	
Body Temperature				X

FIGURE 4: Overview of included sensors of the Samsung Smartwatch Galaxy watch 4 , the Samsung Fitness band Galaxy Fit2 and the Apple Smartwatch Series 3 [26] [27]

Smartwatches and fitness bands, such as the Galaxy Watch 4, Galaxy Fit2, Apple series 3 or the Oura gen3 are equipped with these sensors to detect and monitor specific human behavior as well as environmental factors, as explained below [28] [27] [29].

- Accelerometer/Activity detection: monitor user motion and general activity
- Barometer Gyroscope Geomagnetic sensor: detects the direction of the device
- Ambient light sensor: allows to adapt and adjusts the brightness of a screen's backlight according to the surrounding light level, in order to improve battery life and ease of use
- Optical heart rate (PPG): measures the heart rate
- Advanced heart rate functions: Resting Heart Rate (RHR), Heart Rate Variability (HRV), Daytime Heart Rate (DHR), Workout Heart Rate (WHR)

- Electrocardiogram (ECG): allows to track the heart rate and check the sinus rhythm, offering effective heart monitoring as well as blood pressure.
- GPS: location of the device
- Altimeter: measures the height and air pressure of the current location

When comparing wearable sensors and ambient sensors, some data parameter collected by the sensors, are ending with the same information (movement of a person, activity, etc.). The main disadvantage of wearable sensors are their obtrusiveness because the user is required to carry the wearable device all the time. However, the advantage of wearable and mobile sensors are their ability to capture activity data in both indoor and outdoor settings for days [24]. Therefore, wearable sensors have potential when data about user's daily behavior, need to be collected and monitored. Furthermore, the most important sensor, which should be included when collecting activity data, is the accelerometer.

2.2.2 Data Visualization

Technology and users data visualization can be used to motivate users and to change their behavior for different purposes. Intille [4] mentions here a new class of just-in-time persuasive interfaces. That means, for instance, the adoption of powerful mobile computing devices, which can visualize and translate the user's data into audio or bright liquid crystal display (LCD). Therefore, one big advantage of using wearable sensors, together with applications, is the immediate feedback on vital signs. Especially for patients who would otherwise spend hours at doctors' offices to monitor and check their health status, this can be a significant improvement and provide access to continuing healthcare. With the presentation of data to the user at points of decision, the behavior of the user can change [4].

Furthermore, to make this strategy as effective as possible, four main components should be considered when designing a visualization. First, the information should be as simple and as understandable as possible. Second, the timing of the feedback is important. Thirdly, the place where the feedback will be received should be considered and for the last, the strategy of presenting should not irritate the user [4].

Altogether, to create a visualization, which can motivate users to change their behavior, the type and translation of the feedback should be considered. Furthermore, the data visualization and the collected data must be adapted to the target group and their needs.

2.2.2.1 Applications

The data collected by wearable devices are visualized in different ways. Most common today is the visualization with the aid of an application. Applications are downloadable via smartphone and tablet. The collected information is sent from the wearable device to the application, so that the user can get visualized feedback in real time. This section will investigate how the data of Smart Home, and Health and Fitness applications, is visualized.

Smart Home Applications
Smart home applications are designed to display and visualize data about different sensors or systems installed within the home environment.

FIGURE 5: Bosch Smart Home application [30]

The Bosch smart home application is connected to a controller, that means that even without an internet connection, the smart home system can still work. Furthermore, the data is visualized dependent on the connected system. The main menu shows all connected systems and with further clicks, more information about each system is visible (Figure 5). The connected systems can be, for instance, the security-, heating- or ventilation system. The visualization itself is simple and easy to use. As seen in Figure 5, the data and settings are divided in categories, where for instance, the temperature can be set with the aid of a circle. The color of the circle is either red or blue depending on warm or cold temperatures. Adaption can be made to personalize the menu [30].

Health and Fitness Applications

Many companies have developed their own fitness tracking products including data visualizations. The data is collected with the aid of wearable sensors, such as smartphones or smartwatches. The data is accessed, visualized, and controlled through apps (Figure 6, 7, 8, 9, 10).

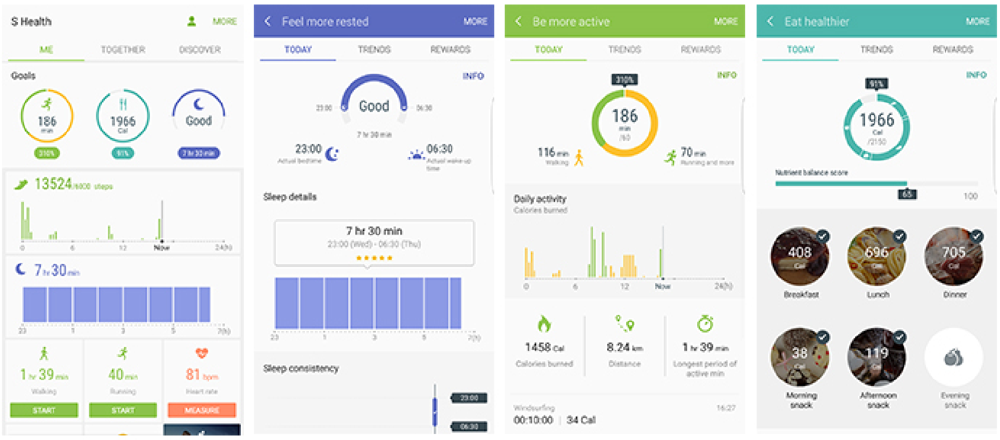


FIGURE 6: Samsung health 5.0 (App) [31]

The Samsung Health as well as Apple Health application give an overview of daily activity and specific sport activities (running, walking, or biking etc.) through icons, circle and bar charts. Furthermore, if collected data contains errors, it can be partly adapted manually. The application is also able to be personalized to a certain level. Goals can be selected and changed. For instance, footsteps per day, time of activity or weight. It also has the possibility of sharing progress to a community and gives examples for workouts.

FIGURE 7: Apple Health (App) [32]

Similar to Samsung, Apple Health also collects data about users' behavior. Apple tries to keep the user motivated through an activity ring (Figure 7), which the user has to complete to achieve their goal. The user can also receive a medal for exercises, listen to personal coaches or can participate in activity competitions [27].

The visualization of physical activity itself is displayed as diagrams or numbers with different colors. The main visualization of the daily activity is visualized as an activity ring (for Samsung also a heart) with inner circles, which is completed when the user has reached the goal of activity (Figure 7).

FIGURE 8: Garmin Connect (App) [33]

Compared to the applications of Samsung and Apple, the Garmin Connect app looks alike. Even the visualization of the collected data and the data itself is similar. But besides the features of the others, Garmin Connect also developed a digital coach for pregnancy [33]. However, Garmin Connect, Samsung Health and Apple Health, all these applications need a Smartphone to visualize the collected data. Furthermore, for all applications, a lot of data is visualized but physical activity like sitting or lying is not. The visualizations are always displayed as diagrams with different colors and numbers.

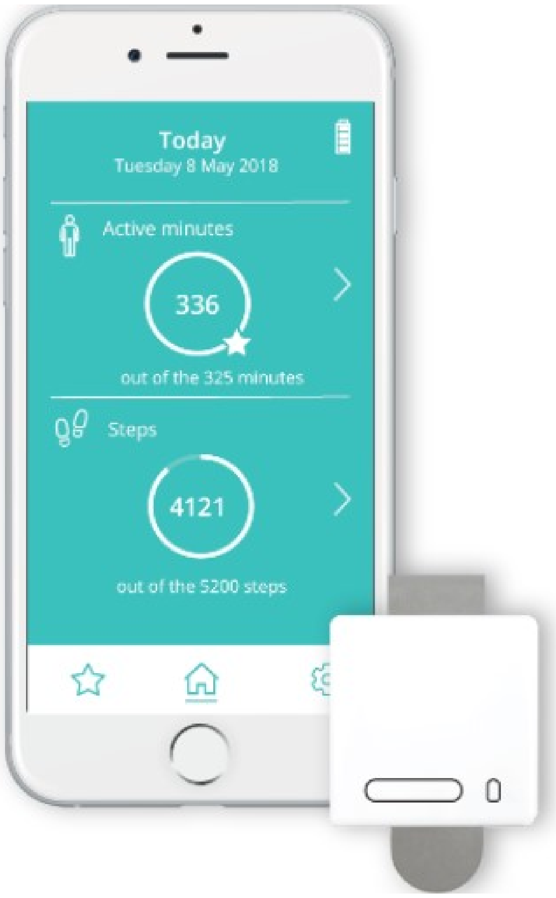


Figure 9: Miss Activity in combination with the MOX sensor [11]

The application MISS Activity was developed for the MOX sensor, a validated accelerometer-based activity logger. The sensor can measure and record high resolution raw acceleration data. Together with a software, human physical activity can be processed, classified and quantified. The MISS application as well as the software is adapted to older adults' activities and can be installed on the smartphone. The visualization of the data is simple and displays the number of steps and activity minutes including circle diagrams. Furthermore, like the previous apps, personal goals can be indicated.

FIGURE 10: Application of Oura ring [34]

The Oura ring is a smart ring, which measures human data with sensors on the inside of the ring (Figure 10). The collected data is almost the same as for the mentioned smartwatches. The sensors are able to monitor sleep, activity, recovery, temperature, heart rate and stress. The ring is designed in a comfortable and timeless way, which makes it easier for the user to wear it 24/7. The application focuses on sleeping and activity behavior, but also on "readiness", which shows the user how much the body can take on. The main three daily scores are displayed as half circles (Figure 11).

Conclusion Data Visualizations

The applications for wearable devices and how they display the data is always in 2D. For fitness applications, the daily goal is mostly represented as activity level, which is visualized through circle/heart, this design method also serves as motivation for the user to complete the visualization and their goal. Further information is displayed as different diagrams and numbers. Furthermore, the majority of fitness application users are younger and therefore, almost all apps (except for Miss Activity) are designed for this part of population. Main reason for that is the fluffiness of the need of a healthier and sporty lifestyle.

2.2.2.2 Physical Data Visualizations

While the previous digital visualizations are focused on diagrams, numbers, and colors, there are many options left unexplored in the field of physical data visualization. Physical visualizations can also give information through, for instance, light, vibration, number of items, pictures, shapes, or maps. Some examples of these physical visualizations can be seen below.

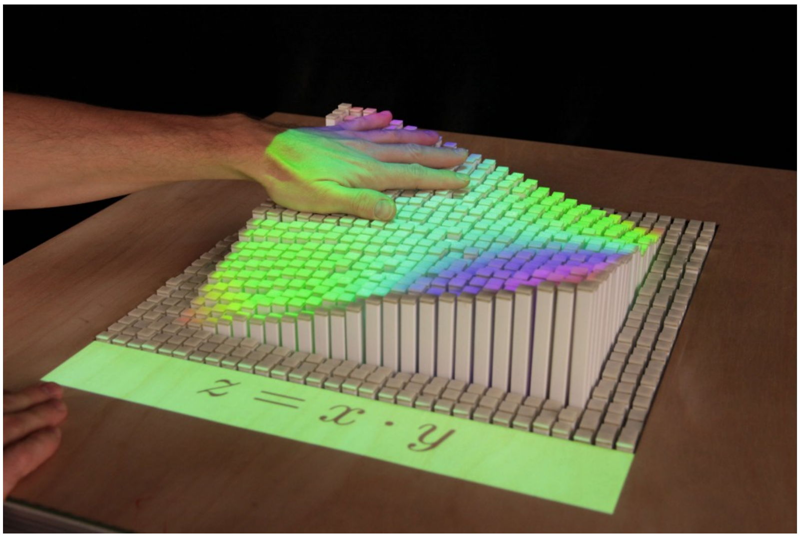


FIGURE 11: Tangible Data Visualizations [35]

This visualization of a math formula combines a 3D bar chart with light to let the user experience the data (Figure 11). This can lead to a better understanding, remembering and imagining of the data [36]. The visualization can change its shape but is limited in the amount of displayed variables the same time. For instance, the color and the 3D bar chart indicates the height, which is calculated with the aid of a formula.

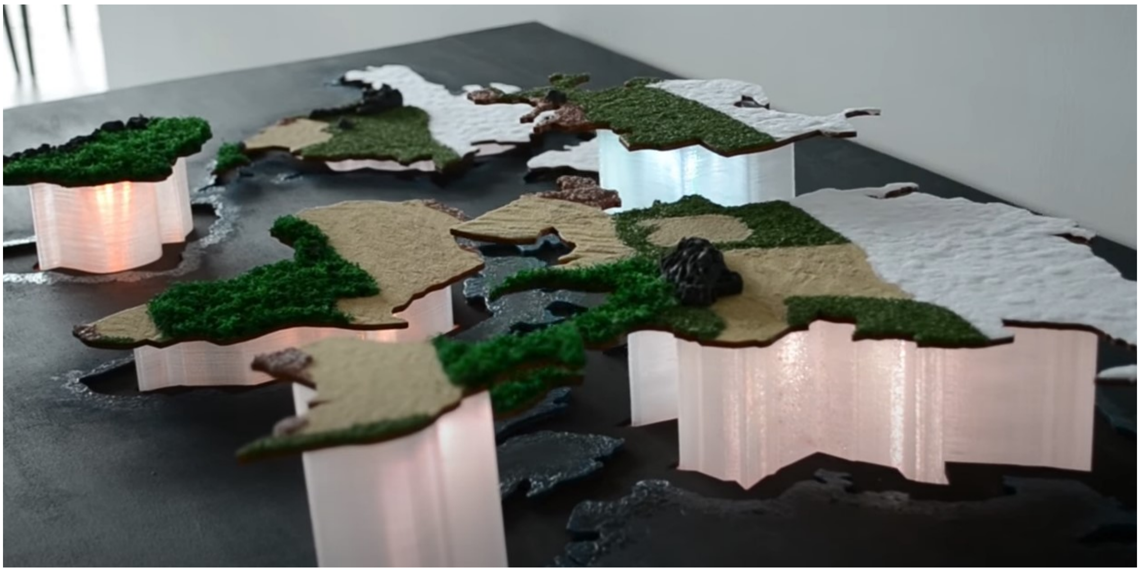


FIGURE 12: Table of Continents [37]

Figure 12 is an example of a physical visualization of a map created by students from the University of Twente. Depending on a data set, the continents are able to move and integrated LED's can represent a second chosen variable like CO2 level or GDP per country.

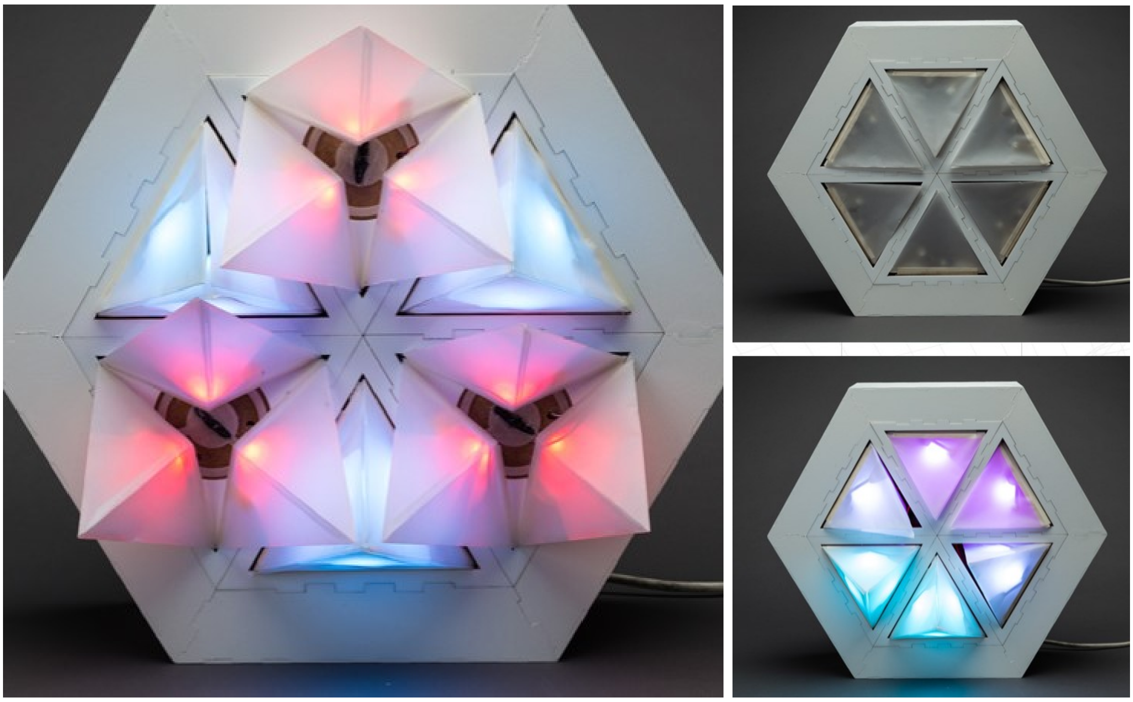


Figure 13: Shape changing interface - visualization of company data [38]

The shape changing interface in Figure 13 was designed to visualize office data, such as worker attendance, into live action. The goal of this visualization was to create a creature, which adapts to the data by moving and changing shape and color. If, for instance the work environment is quiet, the visualization becomes inactive and backs down. Whereas the movements get faster when the office environment is bustling. Different colors represent different team members, to show if they are in a meeting, present, sick, or on vacation. Furthermore, the visualization can react to physical attendance by for instance, opening up greet or taking on the color of the employee's clothes [38]. An advantage of this visualization is that the data can move and therefore, the user can interact and experience the data with it differently. The feedback from physical data visualization motivates the users and make them curious to interact with.

2.3 Discussion and Conclusion

We have reviewed literature about data collection and data visualization. The common sensors to collect human data, are nowadays wearable and ambient sensors. Different wearable sensors are integrated within wearable devices, such as smartwatches or fitness bands. This allows the user to get information and feedback about health status and physical activity. The visualization of the data should be simple and understandable, the feedback should have the right timing and place, and the presenting strategy should not irritate the user. Taking all that into account, the user can be motivated by fitness visualizations, to improve their physical activity and therefore prevent and treat chronic diseases of older adults.

What we found in the state of the art is, that most fitness trackers nowadays are designed in a similar fashion. The data is digitally visualized with diagrams, circles, numbers and colors. Furthermore, for all applications the usage of a smartphone is necessary. The fitness applications of Apple and Samsung also try to visualize all information collected by the sensor even if it is possibly irrelevant for the user. Except for the pregnancy coach of Garmin Connect and some adjustable goals as well as exercises, the applications are not adaptable for diverse groups of the population, such as older adults. Whereas almost all fitness applications and devices are designed and programmed for target users with higher activity background, only the Miss Activity application by Maastricht Instruments is tailored to older adults, by taking their possibly lower activity actions and level into account.

Apart from digital visualizations, when designing for older adults, physical visualizations have a great potential to motivate the user. The physical visualizations are mostly limited in the amount of data displayed at the same time but they can have a bigger influence on the user than digital data visualizations, since they can display data in a meaningful way that is not limited to 2D visualization methods. The user can experience the data through more senses, such as seeing, feeling, hearing, or smelling. Data can be visualized in a way that increases understanding through physical interaction, as Tufte explained in his book, "An especially effective device for enhancing the explanatory power of time-series displays is to add spatial dimensions to the design of the graphic, so that the data are moving over space as well as over time." [39] [35]. Furthermore, these kinds of visualization also indicate a higher potential for users with less interest in technology [36].

The background research showed that there are sensors like the Mox sensor, which are tailored to older adults. However, the visualization of the data can be improved. The current Mox visualization is based on an app which is similar-looking to other already existing applications but with less options. Furthermore, a translation of the data, from the Mox sensor, into a 3D visualization might be a better fit.

3 Methods and Techniques

3.1 Design Method

This section will describe the methodology used. First, the Creative Technology Design Process will be discussed as the main methodology for this project.

3.1.1 Creative Technology Design Process

The Creative Technology Design Process is a design process developed for the Creative Technology bachelor's program at the University of Twente. This design process will be used as main process for this graduation project. The design method is based on a combination of Divergence-Convergence and Spiral models of design practice. Creative Technology has similar content with several design principles, such as Industrial design, Human-Media Interaction, Graphic design, Interaction Design, Engineering Design, and more. Therefore, the Creative Technology Design process also integrates steps and methods from these fields [40].

As shown in Figure 14, the design process consists of four phases: Ideation, Specification, Realisation and Evaluation. First, the ideation phase is about identifying the problem. During this phase, different brainstorming techniques will be used to collect ideas, which will be further investigated. The Ideation phase of this project contains different brainstorming techniques, such as brainstorming itself, sketches and a survey with questions to identify user needs and requirements. During the specification phase, user scenarios and interaction analysis help to identify the user needs and gain deeper insights. Within the realization phase, first prototypes will be built and tested. During the last phase, the evaluation phase, user testing with a followed questions will take place. Furthermore, it will be evaluated if all the requirements from the ideation phase are met.

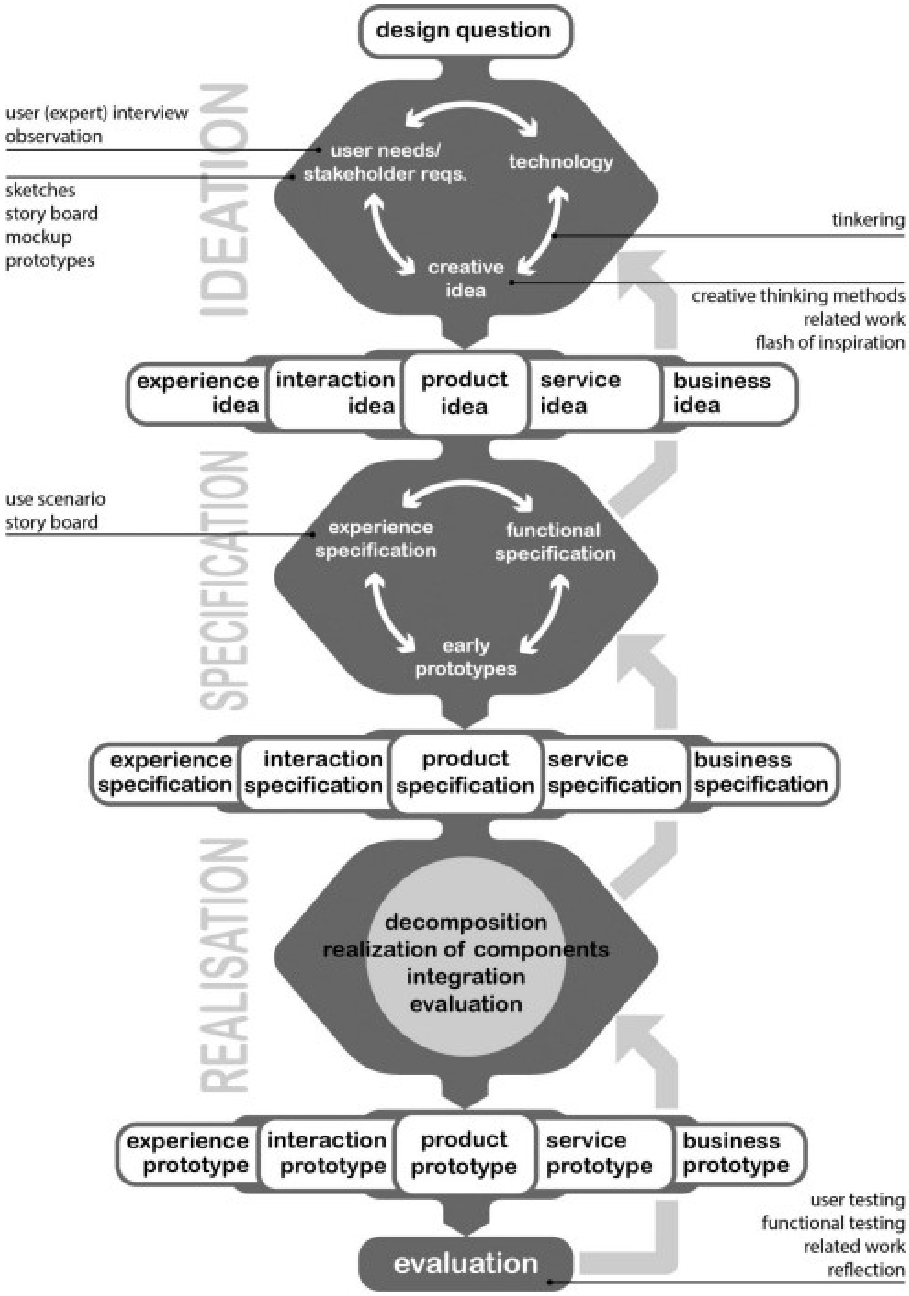


Figure 14: Creative Technology Design Process [40]

3.2 Ideation

Within this section, the stakeholders, their motivation and interests will be identified. For that, questionnaires were held. Furthermore, a stakeholder analysis, together with literature research, will help to define a first set of requirements for prototyping. Afterwards, the MoSCow method will help to order the requirement according to their importance.

3.2.1 Stakeholder Analysis

Within the process of the development of a product, several stakeholders are involved. Some stakeholders are influencing a product directly, others indirectly. Therefore, it is important to identify all stakeholders within a project, their needs, and how they have influence on a product.

One possibility of performing a stakeholder analysis is the usage of a stakeholder map. When creating such a map, three steps must be followed [41].

Step 1: Identify your stakeholders
Step 2: Prioritize your stakeholders
Step 3: Understand your key stakeholders

After following these steps, a stakeholder map can be created. One example of such a map can be seen in Figure 15.

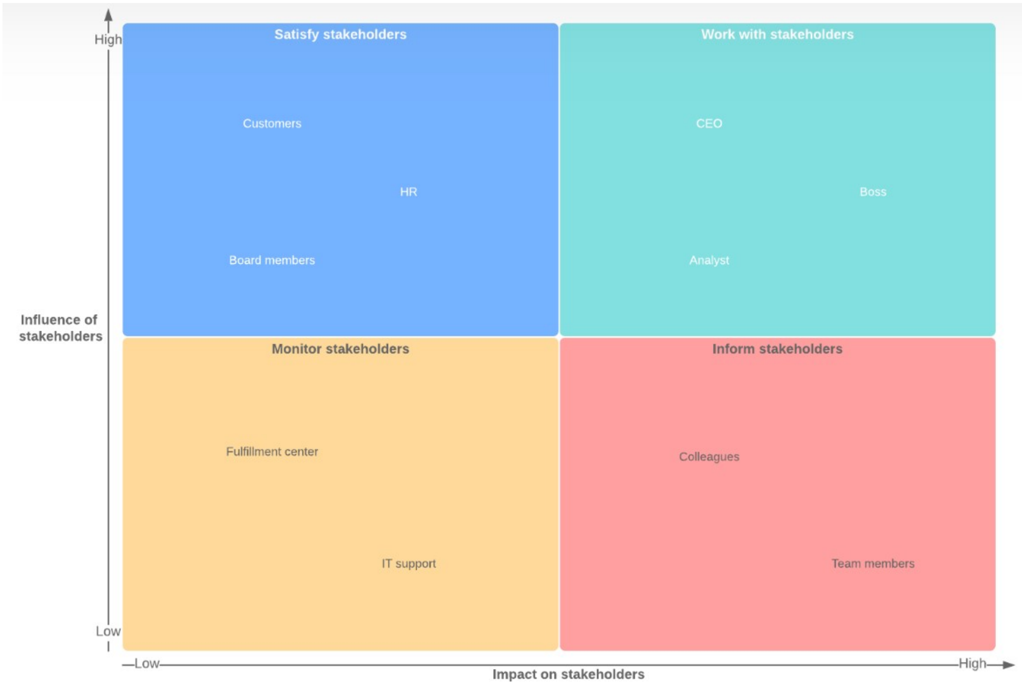


FIGURE 15: Example of stakeholder map by Lucid Content Team [41]

3.2.2 Survey

When the stakeholders are identified, the next step is to gain more detailed insights about the users [42]. To do so, questionnaires about demographics, as well as physical behavior and social environment will be used. The questionnaires also allows to get an better understanding of the target users and their needs. Furthermore, they also included questions about the users interaction and knowledge about technical and wearable devices.

3.2.3 Brainstorming

Brainstorming is a technique, which can help to create and generate a lot of new and different ideas through an open group discussion. During the brainstorming session, every participant of the group should think aloud and come up with as many ideas as possible.

During the brainstorming session, it does not matter how bizarre or illogical an idea looks or sounds [43].

For this project, creative technologists will be asked to participate. During the first round, each of the student will write down as many ideas as possible within a set amount of time. Afterwards, these ideas will be discussed and critiqued. The participants will vote for the top five ideas. These five ideas will be developed and discussed further. During the last round, The participants will vote for the best three ideas. These ideas will be worked out further.

This kind of brainstorming session is called rapid ideation. The usage can help to avoid typically brainstorming problems where many ideas are already shot down before a participant is even able to share the idea. This can happen when ideas for instance to early confronted with critique.

3.2.4 Expert opinion

The three chosen ideas from the brainstorming session will be presented to experts from Maastricht Instruments [11]. To do so, a paper prototype for each idea will be developed and presented in an interview. The experts will consult me how to proceed with the ideas with respect to the technology and user group.

3.2.5 Prototyping and Iteration

For the development of the prototype, the first step will be the visualization of the data and the basic design of the product itself. For that, different designing choices will be compared depending on material, size, electronic components and feasibility. With the aid of several iteration phases, weaknesses of the prototype will be analysed and addressed.

3.3 Specification

With the start of the specification phase, the three ideas from the brainstorming session will be presented to an expert. Based on that, one concept will be chosen to be further developed. Furthermore, the first requirements, set in the ideation phase, will be adapted and personas will be created based on the results of the questionnaire. With the aid of these personas, the main functionalities of the prototype will be tested within user scenarios.

3.3.1 Requirements

Within the specification phase, the final requirements will be set. Furthermore, the requirements are divided into functional and non-functional requirements [44].

3.3.2 MoSCow

After developing requirements for the product, the requirements need to be prioritized. Within this project, this will happen with the aid of the MoSCow method. The MoSCow method prioritize requirements with the aid of categories. These categories includes must haves, should haves, could haves and will not haves [45].

3.3.3 Personas

Personas will be developed to get a better understanding about the target group [46]. These personas will be fictional characters, based on literature research and the survey from the ideation phase.

3.3.4 Interaction Scenario

Together with the personas, an interaction scenario will describe possible interactions with the product. Therefore, the scenario will help to focus on who your users are, what their goals are and how they would interact with the product [47].

3.3.5 Functional Architecture

The functional architecture of the prototype will be visualized as a logical flow chart to understand the steps behind the prototype and the code [48].

3.4 Realization

After the specification phase, a first high-fidelity prototype of the chosen concept will be developed.

3.5 Evaluation

During the evaluation, three participants were asked to interact with the design. First, the participant got a short introduction with the aid of a manual of the product and it's concept. During the actual test, each participant used the design for at least 24 hours. The activity progress (the data from the Mox sensor) has been entered with the aid of the controller box, at least three times a day.

After the user tests, the participants were asked to answer some questions regarding the prototype. This will help to identify possible strength and weaknesses of the product for further research.

4 Ideation

4.1 Stakeholder Analysis

To gain a better understanding of all stakeholder within this project and to achieve an overview of their influence, a stakeholder analysis was developed. Furthermore, with the aid of this analysis, misunderstandings between stakeholders, within this project, can be prevented.

4.1.1 Identifying the Stakeholders

For the stakeholder analysis, three steps will be applied. The first step is to identify the stakeholders for this project [41]. Therefore, the following list will include all persons and companies who are somehow affected by the project:

- University of Twente
- PHArA-ON Project
- Future Users (older adults)
- Research Participants (older adults)
- Maastricht Instruments
- Supervisor and Co-supervisor
- NFE
- Roessign Research and Development

4.1.2 Prioritizing the Stakeholders

The second step is to prioritize the stakeholder depended on their influence on the product. For that, a stakeholder map has been filled out (Figure:16). The stakeholder map is divided in two columns and two rows. The x-axis represents the Influence/Interest and the y-axis the power of the different stakeholders.

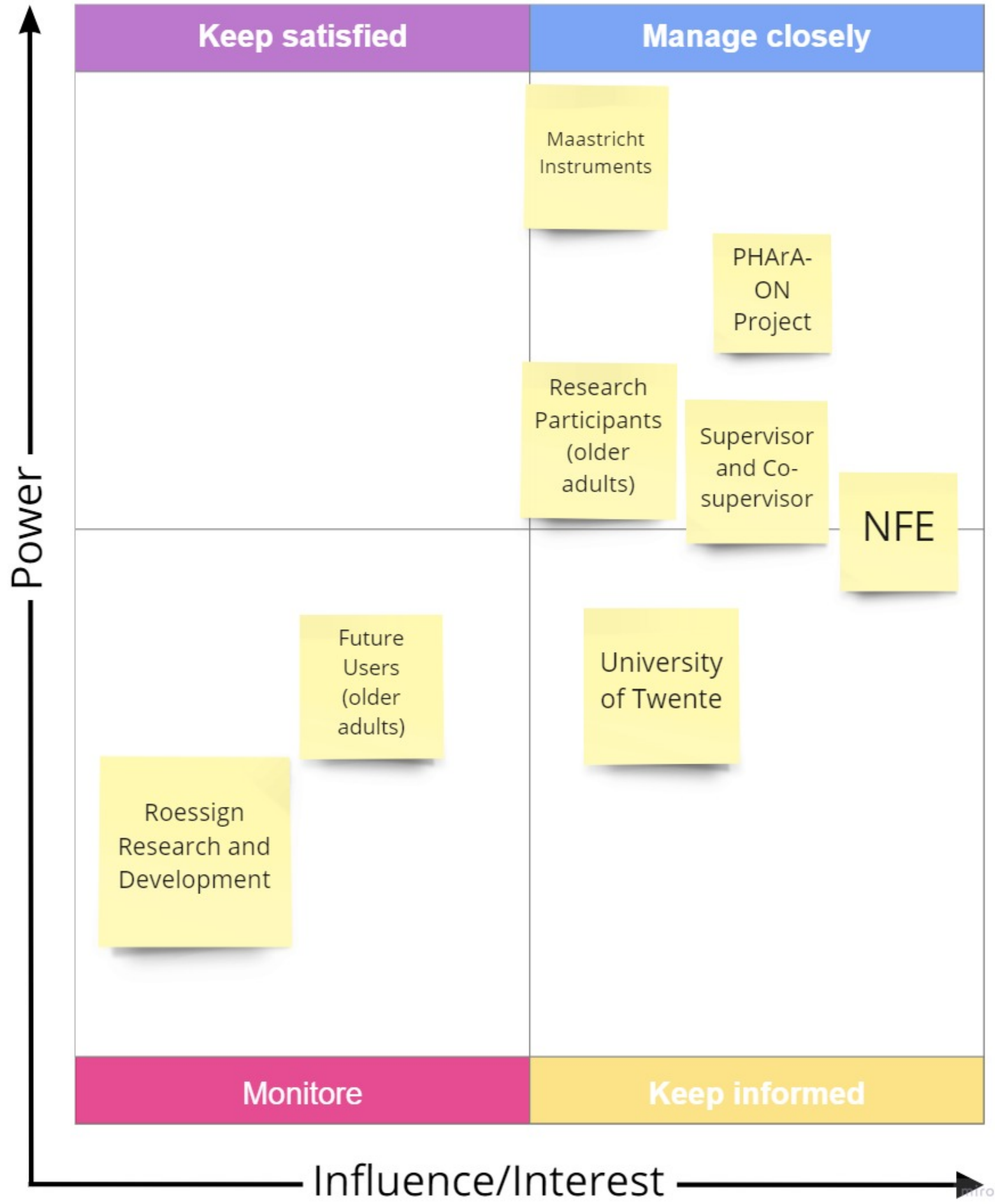


Figure 16: Stakeholder Map

4.1.3 Understanding the Stakeholders

The third step includes the understanding of the key stakeholders. The key stakeholders for this project are Maastricht Instruments, since they are the developer of the MOX sensor and the application Miss Activity. Therefore, they have the highest power and a high interest for the product. Furthermore, NFE who, among other things, are responsible for the recruitment of participants and therefore have the highest influence and interest on the product. However, another important stakeholder are the research participants, since they are part of the design and evaluation process of the product. To get a better understanding of this type of stakeholders, a survey has been conducted and the results have been analyzed.

4.2 Survey

As part of the PHArA-ON Project, a survey has been conducted by the University of Twente and NFE. Since the collected information of the survey is relevant for this project, the data from the survey has been analysed. The results have been used to answer the subquestion on how familiar older adults are with wearable devices. Furthermore, the survey helps to check how open older adults are for using wearable devices as a motivation for physical activity.

4.2.1 Setup

The survey was divided in two different questionnaires. The first questionnaire had 59, and the second 56 participants. Before the questionnaires were analyzed, all data has been anonymized.

The first questionnaire included demographic questions like gender, age, education, work, etc.. Furthermore, the questions from the second questionnaire were asked to get deeper insights about the participant's lifestyle, such as their physical behaviour, their social environment and their knowledge and usage of technical devices.

4.2.2 Results

In relation to the demographic questions, the survey showed that most participants were female, widowed or married and had an average age of 83 years (Figure: 18, Top Left). Furthermore, the majority of the participants had a middle or higher educational degree. Since the average age is high, almost all participants have been already retired. Only a few wrote that they still have another part time job.

When the participants were asked about their social environment, many answered that they live alone. However, most of them also mentioned, that they have family and friends with whom they can talk.

Furthermore, almost all participants connected the benefits of exercises with their health. They said that exercises would be good for their health status (Figure: 17.

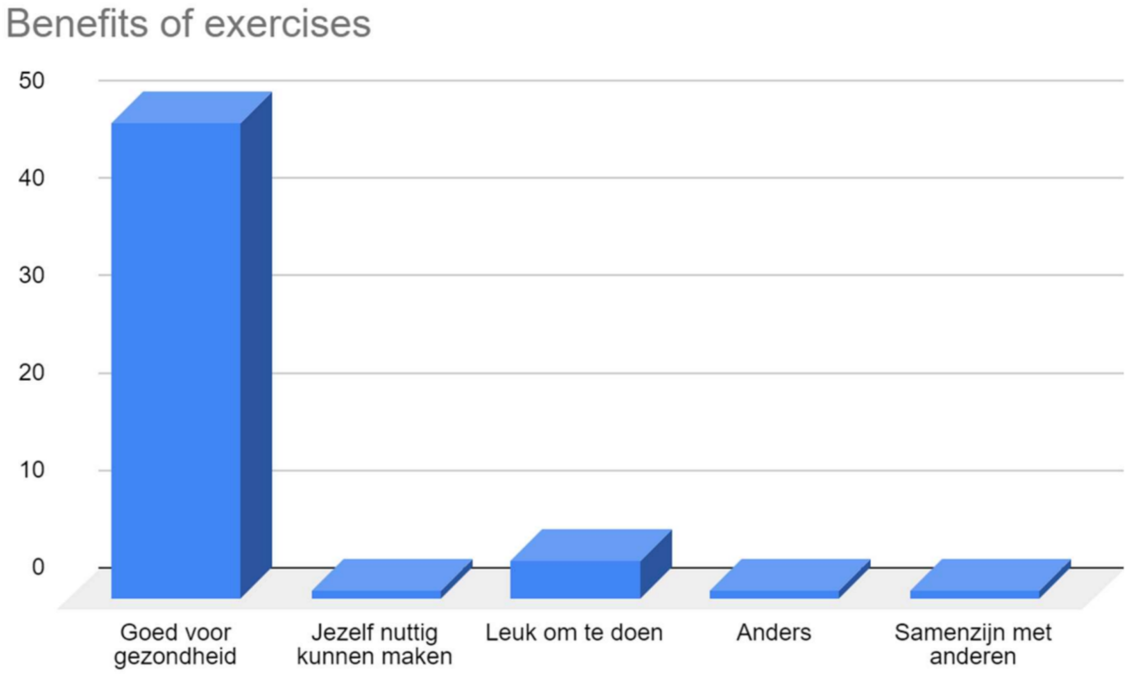


Figure 17: Benefits of exercises

Regarding the technical knowledge of the participants, the participants answered that almost all had at least one technically device, such as a smartphone, tablet or computer (Figure: 18). However, their capabilities of using these devices is limited. Most answers show that the participants had no or mediocre skills. Many participants indicated that the reason why they have a technically device is the desire to stay in contact with others or to search for news (Figure: 19).

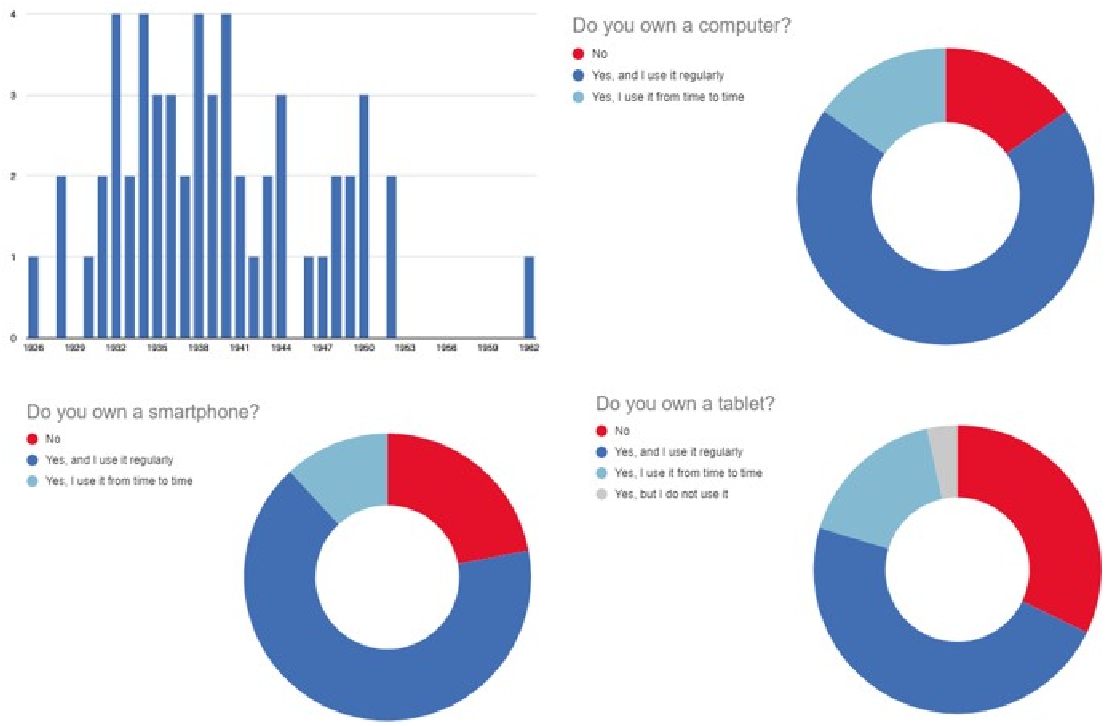


FIGURE 18: Top Left: average age of participants, Top Right: Having a computer , Bottom Left: Having a smartphone, Bottom Right: Having a tablet

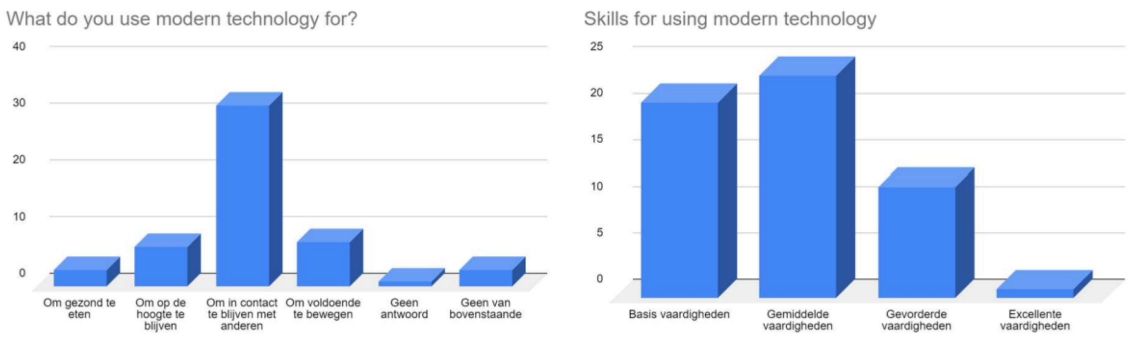


FIGURE 19: Left: Reason of technology usage, Right: Skills of technology usage

4.2.3 Conclusion

From the survey can be concluded that many target users do know about the benefits of physical activity. However, a large number of users does not have devices, such as a smartphone, computer or tablet. Since the current Mox visualisation is based on an app, the needed interaction with wearable devices, such as smartphones, can be an obstacle for the users. The target user information from the survey will be translated into two personas (see section 5.3.1 in specification) and will be used as an input for the brainstorming session.

4.3 Brainstorming

For the brainstorming session, the rapid ideation method has been selected. Four creative technologists were asked to participate since they are trained to generate new and innovative ideas. The age of the participants was between 20 and 25 years old. Three were female and one male. The session was held online. Before the start of the session, a whiteboard canvas with the aid of the online tool "Miro" was prepared to collect all ideas and thoughts generated by the participants. The whole session was divided in four steps for the introduction and in three rounds of the procedure and the brainstorming itself. (Figure: 21):

4.3.1 Introduction of the session

To give the participants an overview of the topic, the target group and an understanding of what is going to happen, an introduction took place. This introduction included four different steps.

Step 1: The first step was to explain the participants the project, the target group and to gave them insight in the different characteristics of older adults. For that, an example persona together with the MOX sensor, the Miss Activity application and an explanation of the project were provided (see Figure: 20). Three of the four participants were already informed about the target group since they already worked with them as part of their graduation project. After the explanation and introduction, questions were answered.

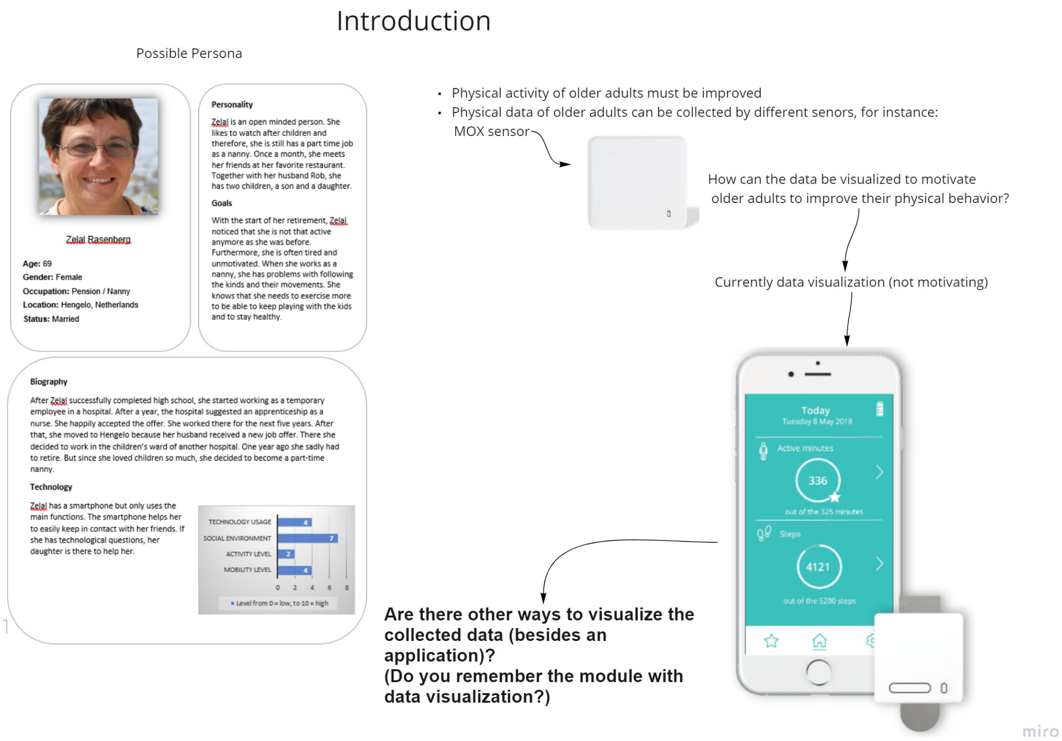


FIGURE 20: Introduction of the target group and sensor

Step 2: Within the second step of the introduction, the brainstorming rules were explained (Figure: 21).

Step 3: The third step included an introduction of the online tool Miro and how to work with it. The participants received a link to a prepared document. After the registration,

a short tutorial about the tool followed and questions were answered.
Step 4: The fourth step was to keep an overview of the duration of the session. Therefore, a timer was set for each round.

4.3.2 Procedure

With the clarification of the goal, the target group and the process, the brainstorming started. The brainstorming itself was divided in three different rounds.

Round 1: The participants have 10 minutes to fill in the columns with as many ideas as possible (Figure 21).

Round 2: After the 10 minutes, each idea has been discussed and questions have been clarified. For that the participants presented their ideas individually. While doing so, advantages, disadvantages, motivational background and feasibility, of the idea, have been discussed (Discussion notes). When all ideas were clear, every participant had two votes to vote for the top five ideas. The top five ideas can be seen in (Figure 21). In the end of this round, the top five ideas were written down.

Explanation of top 5 Ideas:
Artificial plant: An artificial plant or flower, which growth is dependent on the activity progress of the user.
Plant pot: A plant pot, which can show emotions and needs, similar to a tamagotchi. It can remember the user to be more active. Otherwise, the plant pot would get sad.
Magic Mirror: A mirror which can display the activity progress with circles around the mirrored person and gives motivational messages.
Photo frame: The user can use a picture of their motivation. The visibility of the picture is connected to the activity progress. If for instance, 100% of the users goal is reached, the picture will be 100% visible.
Floor mat: Every time the user comes home or left their home, the floor mat remembers the user of their progress and how much activity the user still have left to do to reach their daily goal.

Round 3: The concepts of the five ideas has been worked out further for a better understanding of each idea. During this round, the main focus of the discussion was on the feasibility of the idea.

For that, improvements and further thoughts were documented. Afterwards, based on the new insights, a final selection was made and each participant had only one vote. The final round of the brainstorming session resulted in three ideas. These three ideas will be worked out further within this project (Figure 21).

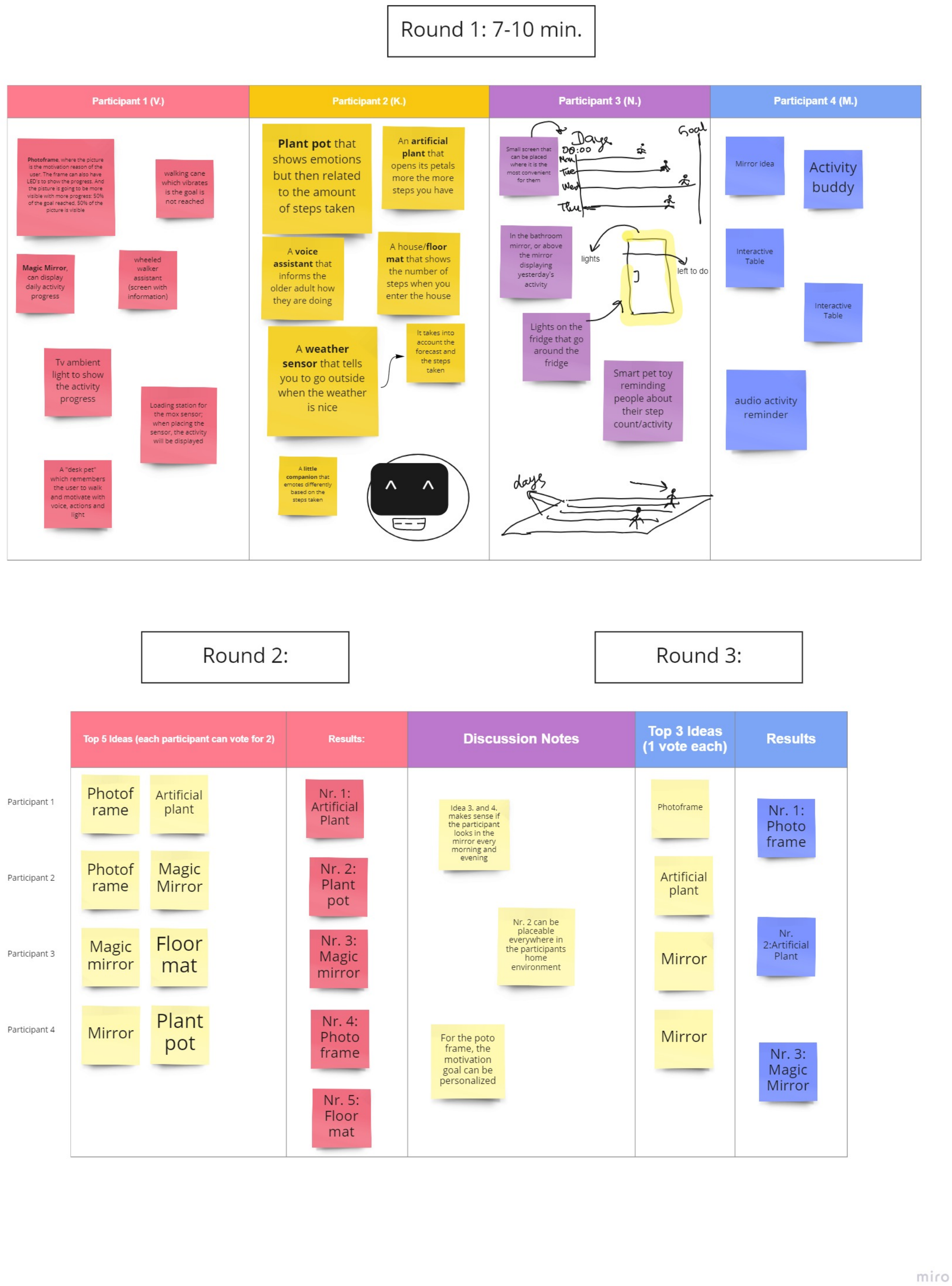


Figure 21: Brainstorming session with the website Miro

4.3.3 Results

With the aid of a brainstorming session, three final ideas were generated for this project. The results can be seen in Figure 22, 23, 24.

The first idea was a photo frame, with implemented background LED's. The photo can be a personal photo of the user, which helps him or her to stay motivated to improve their physical activity. This can be, for instance, a picture of their grandchildren or a place they want to visit again.

The picture will only be fully visible for the user when he or she reached their activity goal. If the user has reached for instance 10% of their goal, only 10% of the picture will be visible. If 50% of the goal is reached, 50% of the picture will be visible and so on.

For this progress, the background LED's can be used in two different ways. Either the LED brightness makes the picture visible or the number of the implemented LED's. Furthermore, an additional LED stripe can be attached to the frame to show another second variable of the MOX sensor. This can be for instance the footsteps of the user.

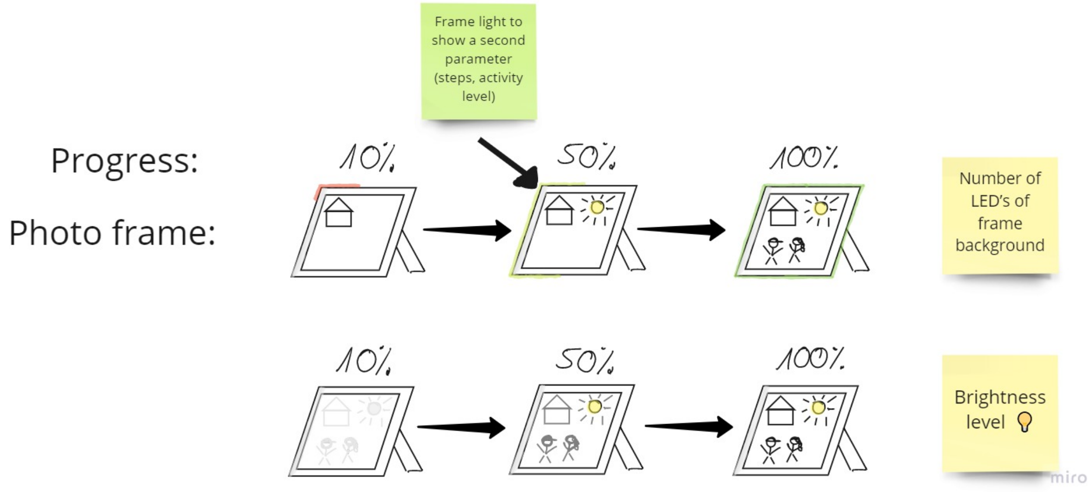


FIGURE 22: Photo Frame Idea

The second idea was an artificial plant, which growth process indicates the activity goal process. The flower itself will be opened up completely when the user reached 100% of their activity goal. Similar to the first idea, additional LED stripes can be attached to the flowerpot to make a second variable visible.

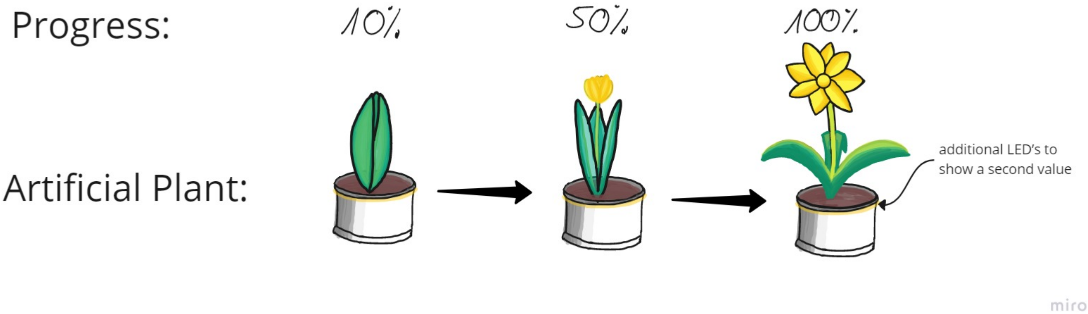


FIGURE 23: Artificial Plant/Flower Idea

For the third idea, a participant came up with a magic mirror. The magic mirror can not just be used as a mirror but also as a screen. The screen is attached to the background of the mirror and is visible through the mirror. When the user looks in the mirror, their activity progress can be displayed as a circle around their head.

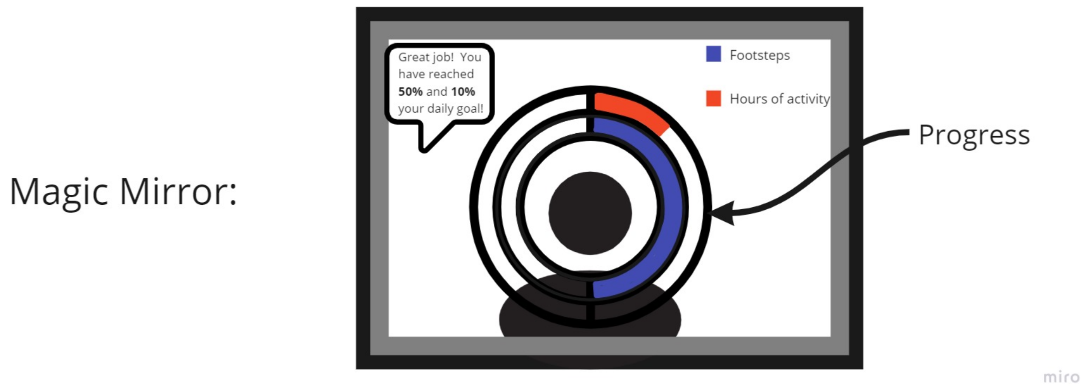


FIGURE 24: Magic Mirror Idea

4.4 Expert opinion

The three ideas from the brainstorming session were compared in terms of their advantages, disadvantages and potential. For that, two experts from Maastricht Instruments were asked to participate in a feedback session. The session was held online. During the session, the three final results from the brainstorming session were presented.

The two are experts within the field of instrument development, and engineering and evaluation. Furthermore, both have a good understanding of the target group and their needs, since they are already developing for that type of users.

4.4.1 Idea 1: Photo frame

The results of the feedback session included possible weak and strength points but also new possibilities of the ideas (see Figure 25). The experts mentioned that the photo frame idea is suitable for the target group and can be easily integrated within every household. However, the photo frame idea could become boring after some time, since the participants will always expect to see the same picture. Furthermore, additional LED's could be to bright and distract the user from the main goal. To solve the first problem, a setup of different pictures, where randomly one picture will be displayed, could be added to keep the users interested.

While discussing this possibility, another idea came to mind. The integration of an reward system could potentially help to motivate the user. The user could earn rewards while they are physically active. These rewards can be used to for instance, buy new pictures for the photo frame.

4.4.2 Idea 2: Artificial Plant/Flower

When discussing the artificial plant idea, the experts saw high potential. They pointed out that the idea is suitable for the target group, since many older adults like flowers and the product would be easy to place in every house or apartment, which can be more motivational than the other two ideas. The flower or plant can also lead to a friendly competition when users see a flower of another user and compare the growth progress.

However, there could be a risk if the same flower appears every day because the user could get bored. Nevertheless, an artificial flower or plant is simple and easy to understand for this group of target users.

4.4.3 Idea 3: Magic Mirror

The experts considered that for instance the Magic Mirror idea could be too futuristic for the target group of older adults.

4.4.4 Conclusion

From the feedback it was possible to get a new view on the different ideas and their advantages and disadvantages 25. When considering all advantages of the three ideas, the main points can all be collected and realized within only one idea, the artificial flower/plant. The artificial flower/plant is therefore most convenient to realize for this project, since it has the highest potential to be developed into a successful product when considering older adults as final end users.

	Advantages	*Disadvantages*	*Possibilities*
Photo Frame	- can be easily integrated within every household	- could become boring after some time (same picture) - additional LEDs could be too bright and distract from the main picture	- setup of different pictures to keep the product interesting - integration of a reward system
Artificial Flower/ Plant	- suitable for the target group (could be most motivational) - friendly competition between users - can be easily integrated within every household	- could become boring after some time (same flower)	- making the flower more interesting - additional LEDs (flower pot)
Magic Mirror	- directly visualization with the aid of a chart	- could be too futuristic for older adults	

FIGURE 25: Feedback Results, advantages, disadvantages and possibilities

4.5 Prototyping

As in the previous section mentioned, the artificial flower idea shows the highest potential to be further developed. Therefore, several steps has been made to create the first prototype.

First, a mindmap and scetches have been drawn to develop and collect ideas. Furthermore, possible methods and electronic parts, which were considered suitable, were tested. The most convenient and feasible methods have been used to create the first prototype.

4.5.1 Mindmapping

While searching for possible realisation ideas, a mindmap has been developed. The first branches are divided in "Activity Progress", "Connection to the Mox sensor", and "Keeping it interesting/motivating". The yellow circles are the second points that need to be considered. Furthermore, the purple and red points are possible realization ideas, where the purple circles correspond to the first ideas tested for the prototype.

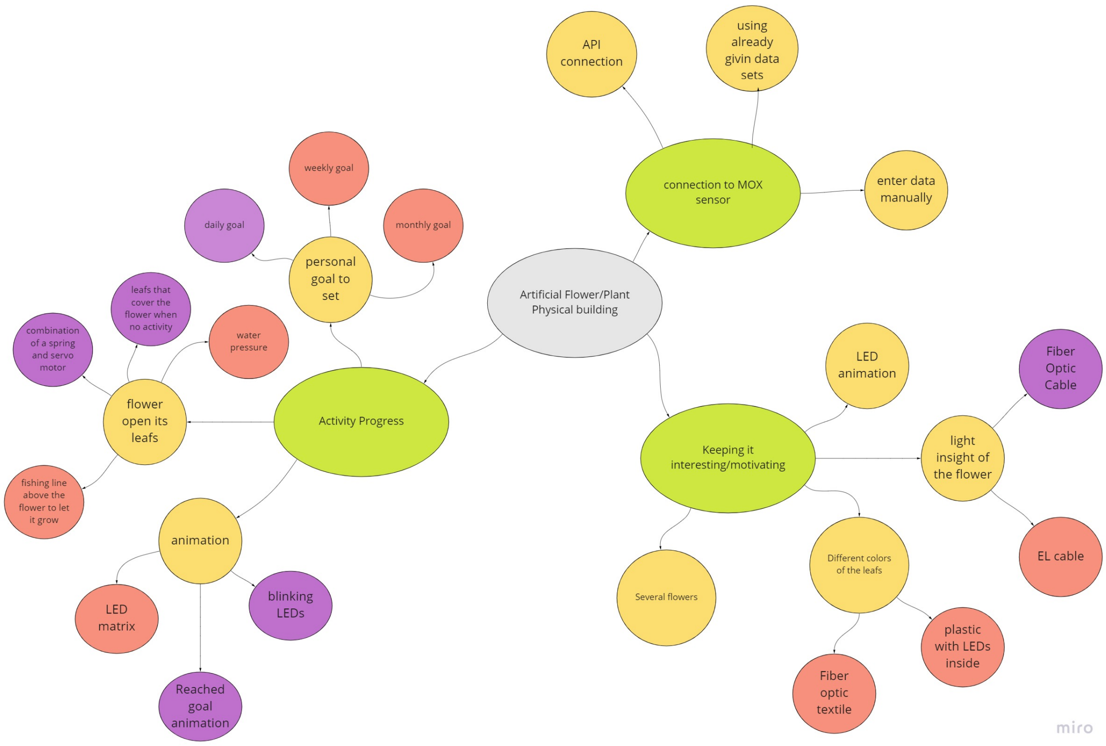


Figure 26: Mindmap Brainstorming

In order to bring all the different ideas together, sketches have been drawn. The scetch shows how the ideas were connected to design the first prototype.

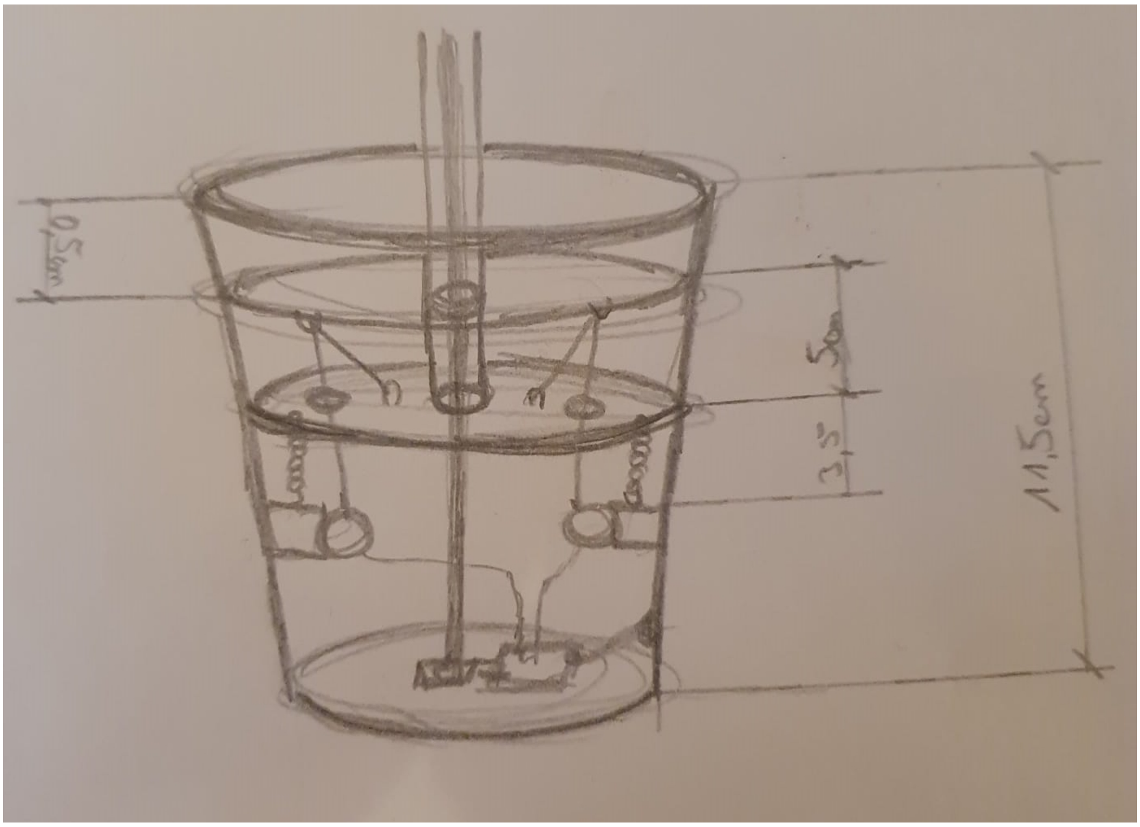


Figure 27: First sketch of prototype

4.5.2 Test of parts and methods

With the aid of mindmapping and sketching, a first approach of the prototyping has been made. Within this section, different methods and electronic parts have been tested to compare and estimate their feasibility.

Opening of the flower
First step was to let the flower open up and close again. To do so, an artificial flower petals (textile) has been used. For the opening, a plastic bottleneck has been cut out and used as a cover to get the flower in the right position.

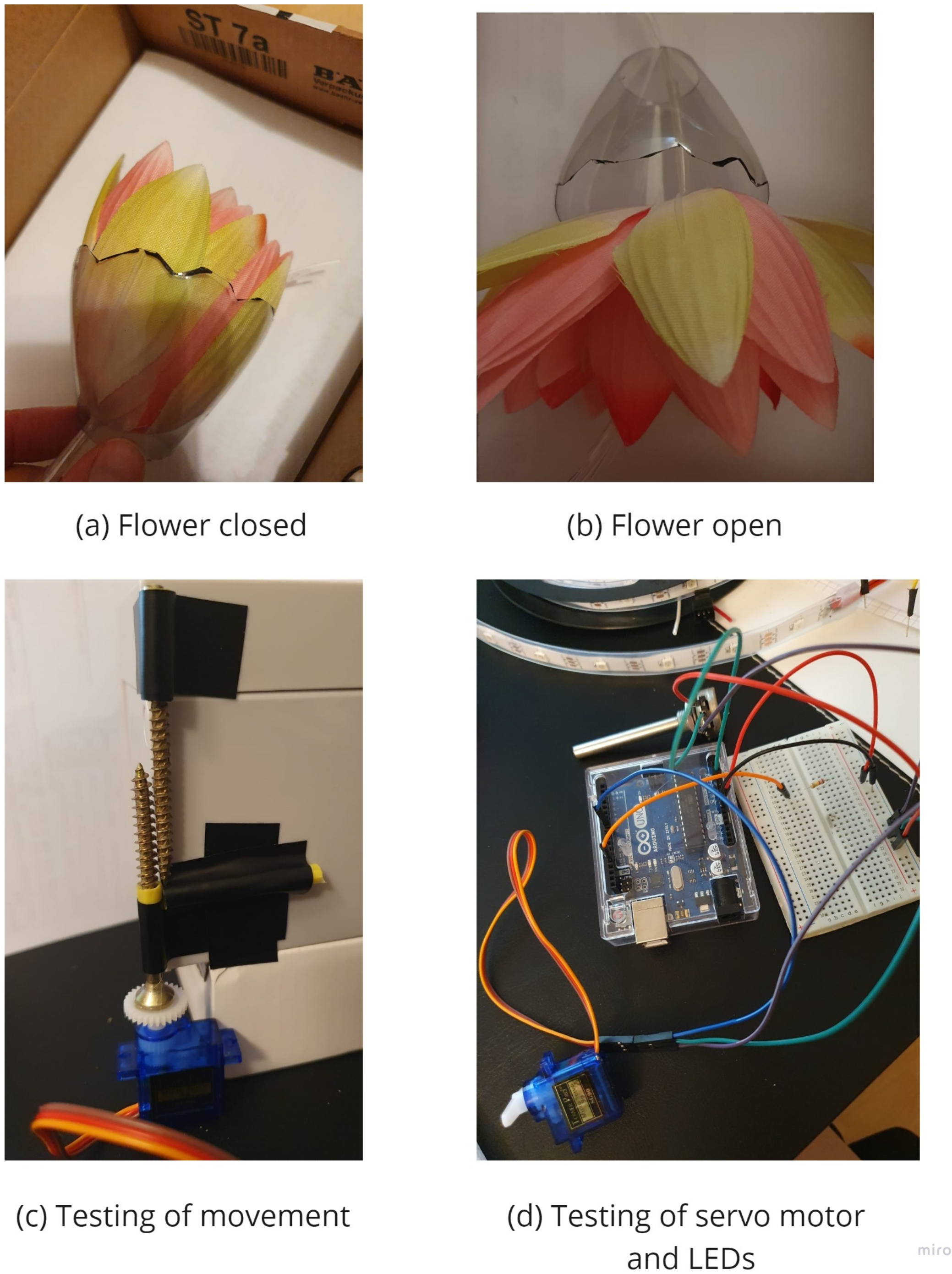
Movement of the flower
Second step was to find a way to move the flower up and down. Therefore, two different movement methods have been tested during the first test (Figure 28).

The first method was a self made gear shift with drive line in parallel. But the pressure of the threads was not enough to achieve a constant movement. An improved version of this method can be a threaded rod together with a stepper motor (mostly used for 3D printers), since these types of motors are accurate and easy to control.

However the second tested method was a combination of a servo motor and a spring. While testing, this method was more convincing considering feasibility. Only the accuracy needs to be improved. To test a second variation of this method, another 5V DC motor together with furling fishing line was used. Since these kind of motors are cheap and have short delivery times Therefore, this method was used for the next tests (see subsection First Iteration).

	Mini gear motor, self-made	Spring in combination with servo motor
Image	(see "Figure 29c -Testing of parts" below)	
Advantages	- can be more accurate	- no electric energy necessary for the closed flower - cheap
Disadvantages	- electric energy is always necessary - long delivery times	- servo motor is not accurate enough
Conclusion	It was not possible to create enough pressure between the threads to lift the flower equally (self-made). Maybe a threaded rod together with a stepper motor can solve this problem.	Worked well but not accurate enough. Another motor could solve this problem.
Possible solution		Change the servo motor to wheel motors and bigger (several) spring(s)

Figure 28: Comparison movement methods



(a) Flower closed (b) Flower open

(c) Testing of movement (d) Testing of servo motor and LEDs

Figure 29: Testing of parts

Flower design
The product needs to be visual attractive and still interesting even if the user interacts with it on a long term. Therefore, the inside of the flower consists of fiber optic cable in combination with LEDs (Figure 30).

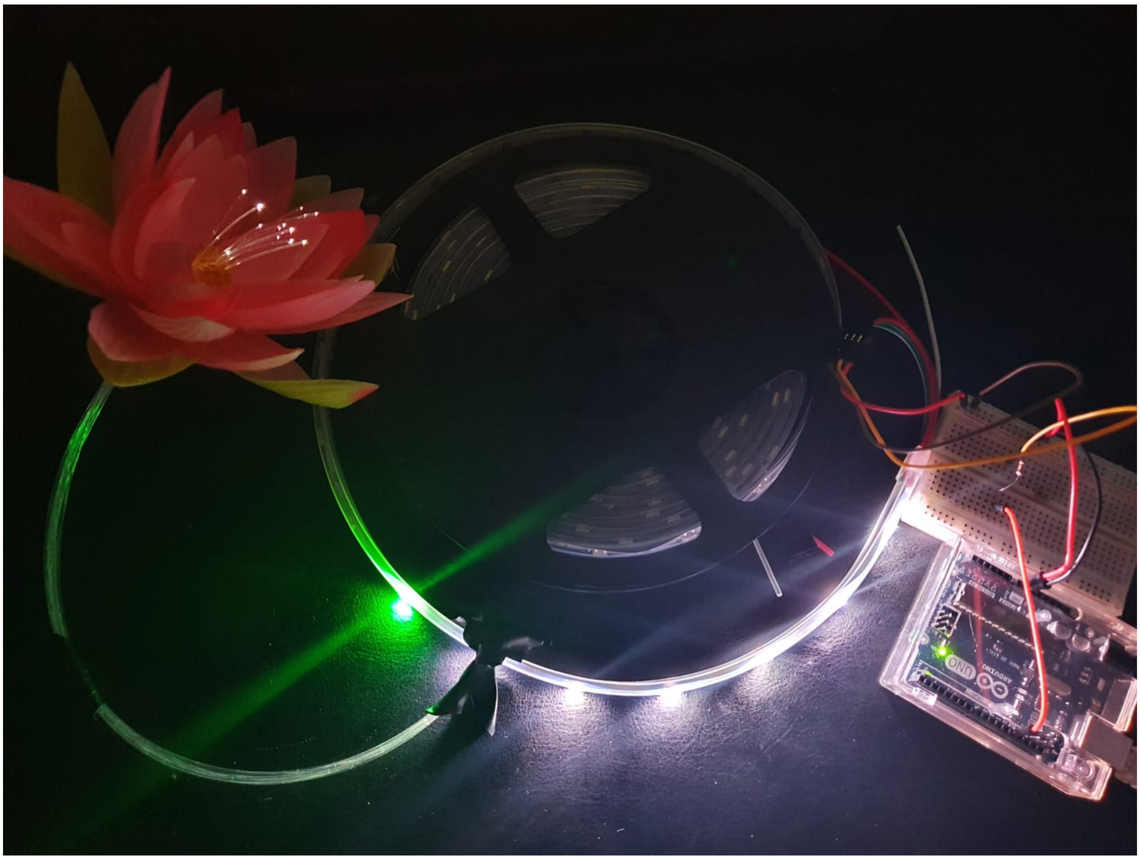


FIGURE 30: First test of LED's in combination with Fiber Optic Cable

MOX Sensor - Data Usage

The MOX sensor is supposed to be connected to the product. Initially the idea was a bluetooth connection to the used arduino UNO with the aid of an HC-05 6-Pin bluetooth module. The MOX sensor should connect to the arduino and transmit the raw data to the arduino. However, for this project, it was not possible for the MOX sensor to transmit raw data. The sensor itself was simply not able to transmit these kind of data.

To be able to still meet the goal of testing the usability of the product, another way of using the data from the MOX sensor has been developed (Figure: 31). An interface will be developed to be able to still use the data from the participants. The participant will be able to enter their progress over the interface. The flower will use this data to visualize the data accordingly.

FIGURE 31: Demo controller

4.5.3 First Iteration - Prototype

The result of the first prototyping can be seen in Figure 32. There are still some points that need to be improved, which will be discussed in the further sections.

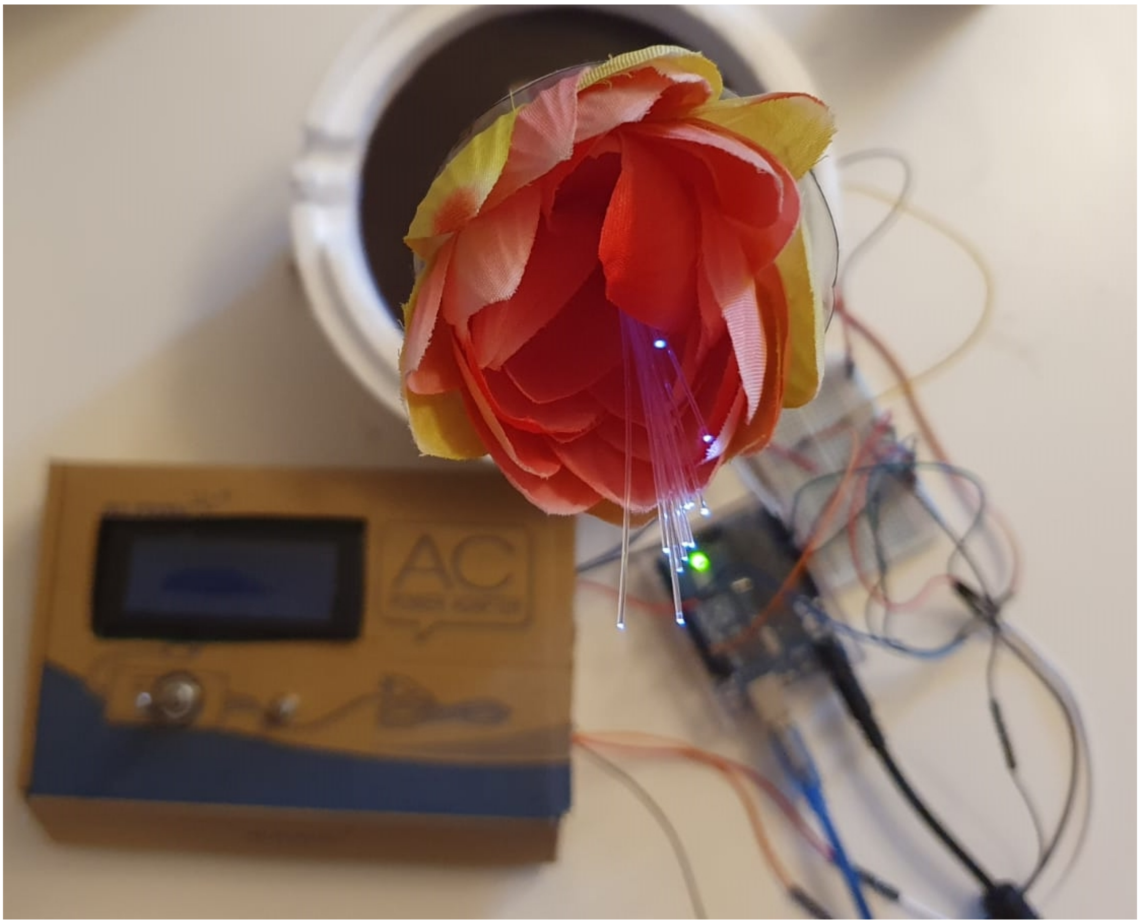


FIGURE 32: Flower (closed) prototype

4.5.4 First Iteration - Conclusion

From the first iteration, new requirements resulted. While improving the prototype, the following parts need to be considered:

- Visual attractiveness

The prototype needs to become more visual attractive to the participants to make them curious about the product and keep them interested

- Improvement of movement

Stronger motors and a spring will help to make the movements of the flower more accurate. Furthermore, the movement should be slower to make it more look like a real flower growing.

- Demo controller needs to be more stable

When testing the prototype together with the participants, the demo controller needs to be more stable. Therefore, for the next prototype, the controller will be made out of wood.

-Demo controller manual

To avoid confusion and make it as easy as possible for the participants to interact with the controller, a manual will be written. Furthermore, the interface will be similar to the interface of the Miss activity application, to make it easy for the participants to copy their data.

4.6 Second Iteration

For the building of the second prototype, a new case made of two flower pots will be used. To get a new overview of the parts and the measurements, a new scetch has been drawn. And the new motors have been tested in combination with the springs.

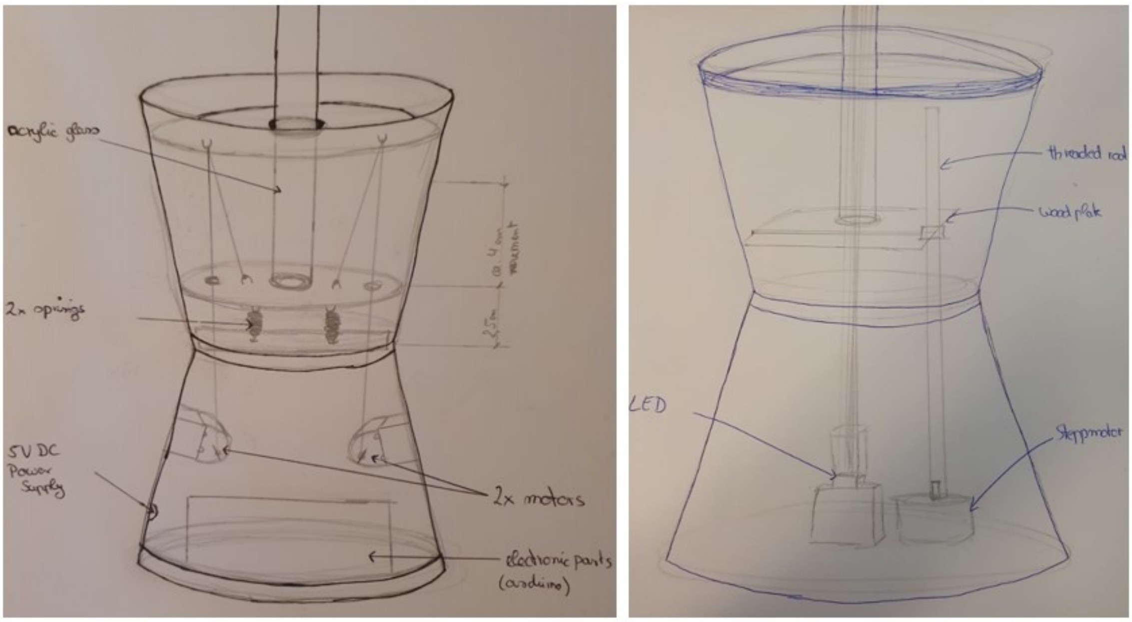


Figure 33: Left: New design with motors, Right: New design with stepper motors

While building the second prototype some new points came up. The design of the prototype has been improved and with it the placement of the different electronic and hardware parts. The new motors used for this prototype were 3v-6v motors with an amp of 0,2 and 18000-35000 U/min.

However, tests showed that the motors were not precise enough to move the flower exact to a certain position. Furthermore, the movement was to fast and unrealistic when considering the flower should be compared to a real flower which is growing. Therefore, the sketch has been improved (Figure: 33). The method of a threaded rod in combination with a stepper motor, which was already mentioned in Figure 28 as a possible solution, has been tested successfully. This new method proved to be very accurate and precise. Therefore, this method has been used for the second iteration to improve the movement of the prototype.

4.6.1 Second Prototype

For the second iteration, the improved prototype together with the manual has been shown to an older adults. The concept of the prototype including the controller has been explained and questions were answered. The participant was asked to follow the manual and set example values of physical activity. As a personal activity goal, 50 min of activity per day was set.

FIGURE 34: Second Iteration, test of prototype

4.6.2 Second Iteration - Conclusion

During the testing, the participant had problems reading the manual. Therefore, the size of the font must be adapted. The instructions on the manual were clear but an explanation of stopping the flower must be added. Furthermore, the fiber optic cable should change its color based on the input physical activity value. Overall, the physical interaction between the flower and the participants worked without any errors or problems.

5 Specification

5.1 Requirements

Based on information gathered through the ideation phase, it is possible to set a number of different requirements, which the prototype, the controller box and the manual must fulfill. These requirements were divided in functional and non-functional requirements. Functional requirements have an impact on what the system must do to be successful. Non functional requirements however do not have an impact on the functionally of the product but on how it will perform. Furthermore, non functional requirements are important for the usability of the product.

Functional Requirements

- FR1: The visualization should show at least one physical activity variable.
- FR2: The flower has to move/open/close.
- FR3: The flower has to communicate with the Mox sensor.
- FR4: The flower must visualize two variables from the MOX sensor.
- FR5: The time the flower needs to be completely open should take at least one minute.
- FR6: The controller box needs to be made out of solid material

Non-Functional Requirements

- NFR1: At least 65% of the participants should agree that the data visualization fits inside their home environment.
- NFR2: At least 65% of the participants should see the design not only as a burden for them but as a motivation.
- NFR3: The majority of the participants should confirm, that opening of the flower motivates the user to reach their physical activity goal.
- NFR4: The interaction with the product should be simple, so no advanced technology knowledge when using the product is necessary.
- NFR5: At least 65% of the participants should confirm that the artificial flower is visual attractive.
- NFR6: 65% of the participants should be able to interact with the flower after reading the manual.
- NFR7: At least 65% of the participants confirm that the size of the manual is readable.
- NFR8: At least 65% should agree that the flower made them curious.

5.2 MoSCow

The next step after the requirements are set, is he prioritizing of the requirements. For that, the MoSCow method will be used. MoSCow stands for Must have, Should have, Could have and Won't have. The prioritizing of the requirements, after these points, can improve the amount of effort which is needed for each requirement. Furthermore, it helps to focus on the important requirements of the product and make the project more manageable.

Therefore, a table has been created to get an overview of the prioritized requirements:

Must Have	Should Have
FR1: The visualization should show at least one physical activity variable. FR2: The flower has to move/open/close. NFR2: At least 65% of the participants should see the design not only as a burden for them but as a motivation. NFR3: The majority of the participants should confirm, that opening of the flower motivates the user to reach their physical activity goal NFR6: 65% of the participants should be able to interact with the flower after reading the manual.	FR3: Flower has to communicate with the Mox sensor. FR5: The time the flower needs to be completely open should take at least one minute. FR6: The controller box needs to be made out of solid material. NFR1: At least 65% of the participants should agree that the data visualization fits inside their home environment NFR4: The interaction with the product should be simple, so no advanced technology knowledge when using the product is necessary NFR5: At least 65% of the participants should confirm that the artificial flower is visual attractive. NFR7: At least 65% of the participants confirm that the size of the manual is readable. NFR8: At least 65% should agree that the flower made them curious.
Could Have	**Won't have**
FR4: The flower must visualize two variables from the MOX sensor.	miro

FIGURE 35: Table MoSCow analysis

5.3 Personas

To understand the needs, goals and expectations of different target users, two personas were created.

5.3.1 Persona 1

Zelal Rasenberg

Age: 66

Gender: Female

Occupation: Pension / Nanny

Location: Hengelo, Netherlands

Status: Married

Personality

Zelal is an open minded person. She likes to watch after children and therefore, she is still has a part time job as a nanny. Once a month, she meets her friends at her favorite restaurant. Together with her husband Rob, she has two children, a son and a daughter.

Goals

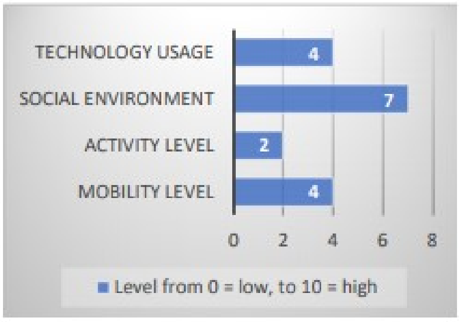
With the start of her retirement, Zelal noticed that she is not that active anymore as she was before. Furthermore, she is often tired and unmotivated. When she works as a nanny, she has problems with following the kinds and their movements. She knows that she needs to exercise more to be able to keep playing with the kids and to stay healthy.

Biography

After Zelal successfully completed high school, she started working as a temporary employee in a hospital. After a year, the hospital suggested an apprenticeship as a nurse. She happily accepted the offer. She worked there for the next five years. After that, she moved to Hengelo because her husband received a new job offer. There she decided to work in the children's ward of another hospital. One year ago she sadly had to retire. But since she loved children so much, she decided to become a part-time nanny.

Technology

Zelal has a smartphone but only uses the main functions. The smartphone helps her to easily keep in contact with her friends. If she has technological questions, her daughter is there to help her.



5.3.2 Persona 2

Amos van der Rest

Age: 73

Gender: Male

Occupation: Pension

Location: Den Haag, Netherlands

Status: Widower

Personality

Amos is a more introverted person. He likes to watch TV and meet his friend Alfred. Together with him, he works on an oldtimer car project. His wife Juli died seven years before. Together with her, he has a son, Michal. Michal lives further away and has his own family

Goals

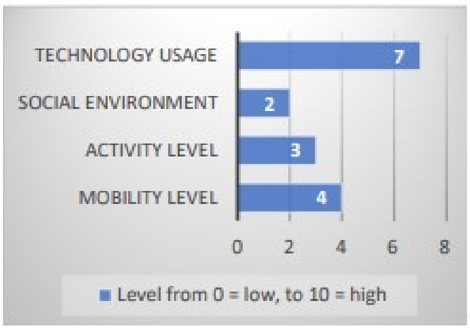
When his wife died, Amos started to spend more time alone. Therefore, his activity level was decreasing drastically. Now, when he wants to work with his friend on their car project, he recognizes, that he is not flexible anymore. Furthermore, when he works on the project for more than an hour, he noticed, that he has no stamina.

Biography

After Amos finished high-school, he started working for his father's repair and assembling shop. When he turned 21, he met his wife Juli on a friend's party. They married when he was 23. At 30, his father had to sell his shop. Afterwards, Amos worked as a metalworker until his retirement.

Technology

Amos knows all the basics about technological devices. Since his son lives further away, he mostly contacts him via his smartphone, tablet, or laptop. If he has questions about technical problems, he always googles them first. He likes to spend time on exploring the digital world. If he cannot figure something out, he asks Michal or his neighbor's son Jeff.



5.4 Interaction Scenario

To get a better understanding of the users' motivations and needs within context, two user interaction scenarios have been created. These scenarios help to understand how possible users will interact with the design and how they would use it.

5.4.1 Interaction scenario: Persona 1

After waking up at 8:00 AM, Zelal makes herself ready to start her day. While dressing up, Zelal attaches the Mox sensor to her trousers. At 9:00 AM, Zelal starts her job as a nanny for three children. The mothers bring the children to Zelal, so Zelal can work at home. At 10:00 AM, Zelal is checking her minutes of activity via the MISS activity app. After checking her progress she asks the children if they want to help her to bloom up the flower. Together, they are using the controller box, Zelal shows the children how she can set the value with the aid of the rotatable button. The children and she are watching the flower growing slowly and changing its light. Then the flower stops moving. One of the children asks Zelal why the flower is not completely open. Zelal answers that she did not achieved her daily goal of activity today and that she has to walk and play to make the flower completely bloom. After hearing that, the children want to help her let the flower bloom. Therefore, they suggest to dance together with Zelal. Zelal agreed but after the lunch break and a afternoon nap. Zelal prepared the lunch and during the children's nap, she cleaned the house a bit. At around 15:00 PM the children were all awake. Zelal kept her promise and together they had a beautiful dance hour. Together they checked Zelal's activity progress with the Miss activity application and this time Zelal allowed one child to enter the new value. They saw that still 5 minutes of activity were missing until Zelal reached her daily goal of 70 minutes. Therefore another child suggested to go for a little walk. The children and Zelal walked down the street and back. A refresh of the Mox sensor connection to the Miss activity app made clear that Zelal had reached her daily goal. Zelal and the kids turned the rotatable button until the maximum and saw the flower completely bloomed. The children and Zelal celebrated the achieved goal. Zelal promised the children that they will achieve tomorrow‘s goal as well. When the children were picked up by their moms and dads, at 16:30, Zelal cleaned the room and rotated the button of the flower back to reset it to default. Zelal is happy since she started to use the artificial flower in combination with the Mox sensor, she feels more alive than before. In addition to that is she able to keep up with the kids again. This is a great relief to her since she already considered to give up her part time job as a nanny but now she wants to take care of children as long as she can.

5.4.2 Interaction scenario: Persona 2

Amos starts his day at 9:00 AM with a cup of coffee and a nourishing breakfast. While he eats, he is scrolling through the news with his tablet. After the breakfast he puts on his working jacket and attaches the Mox sensor to his trousers. At around 10:30 he is going in his garage where he is working on a special car. Before he starts devoting himself to the project, he opens the Miss Activity app with the aid of his phone. The app already collected 6 minutes of activity. Therefore, he walks over to his workbench where he placed the artificial flower. Since he spensd more time in his garage than in his house, he thought this place is more convenient for the flower. Amos enters the value of 6 activity minutes with the aid of the controller box and the rotatable button. The flower color changes from red to green and moves up a bit. After the first interaction with the flower, Amos starts working on his car project. At around 1:00 PM he goes back in to kitchen making some food. Afterwards he checked the time since his friend wanted to join him in the garage in the late afternoon. He realised that he still has some time left before his friend wanted to come over. Therefore, he checked his activity progress again and gave the new value as input for the flower. Currently he achieved 50% of his daily goal of 55 minutes. Because he wants to have the flower completely open before his friend comes over, he decided to go for a walk. During the walk he realised that from week to week he has more stamina and can walk a longer distance. Last week he already changed his daily goal from 50 to 55 minutes. Furthermore, breathing the fresh air and listening to the nature made him feel more alive and relaxed. He also recognized that he makes less mistakes when working on his car project. When he came back to his house, he made another coffee and checked his progress again. The app shows that he achieved his daily goal of 55 minutes. He is happy and proud. While he drinks his coffee, he watches the flower growing. Later on, his friend Alfred arrives. Amos proudly presents the bloomed artificial flower to Alfred. Alfred is curios about the flower and both starting speculating about how the movement of the flower and the color changing works. Since Amos knows that Alfred also started complaining about some health issues, he suggest Alfred to also buy an artificial flower together with a Mox sensor. If both would have a flower, they could motivate and challenge each other. Alfred considered that as a great idea.

5.5 Functional Architecture

For a better understanding of the logic behind the circuitry of the prototype, the following flow chart has been developed. Additionally, the following technical drawing shows the measurements of the prototype and gives an overview of all parts.

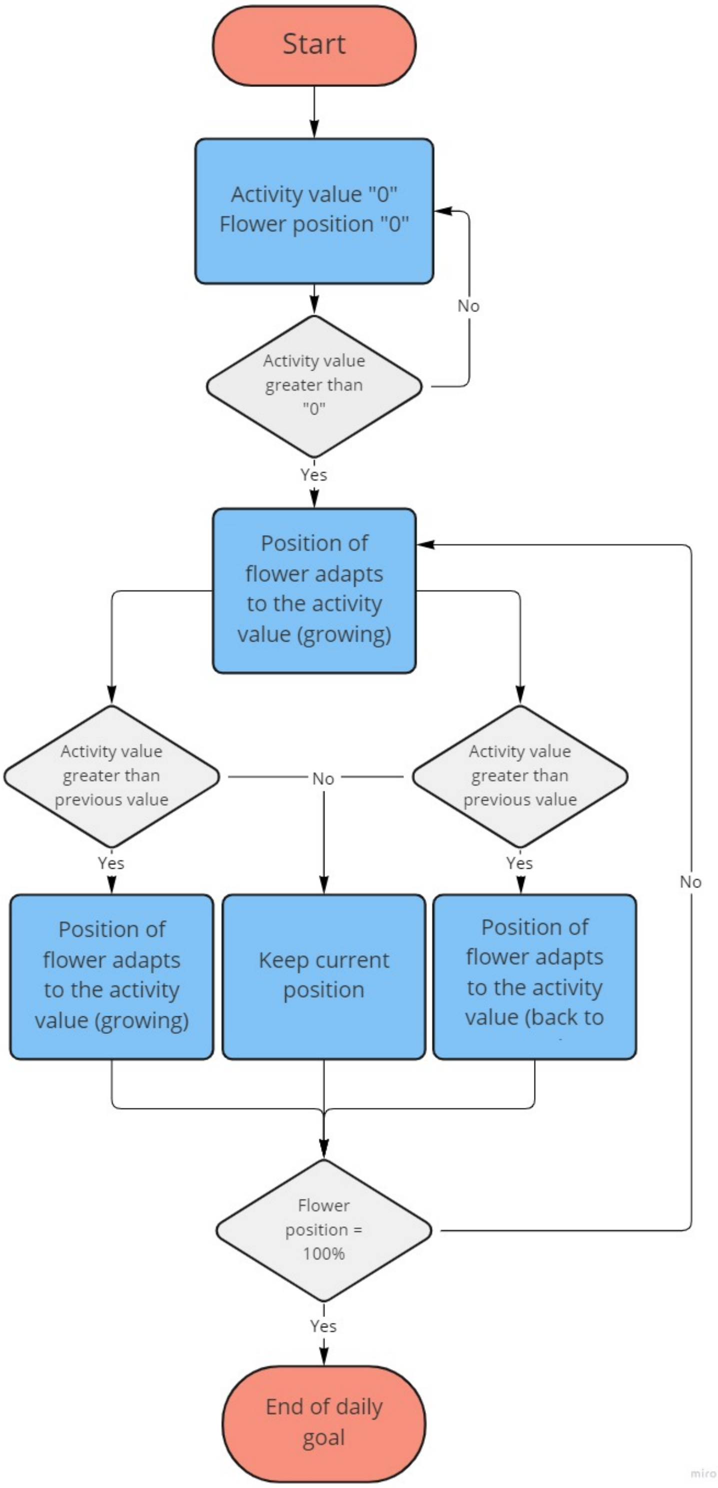
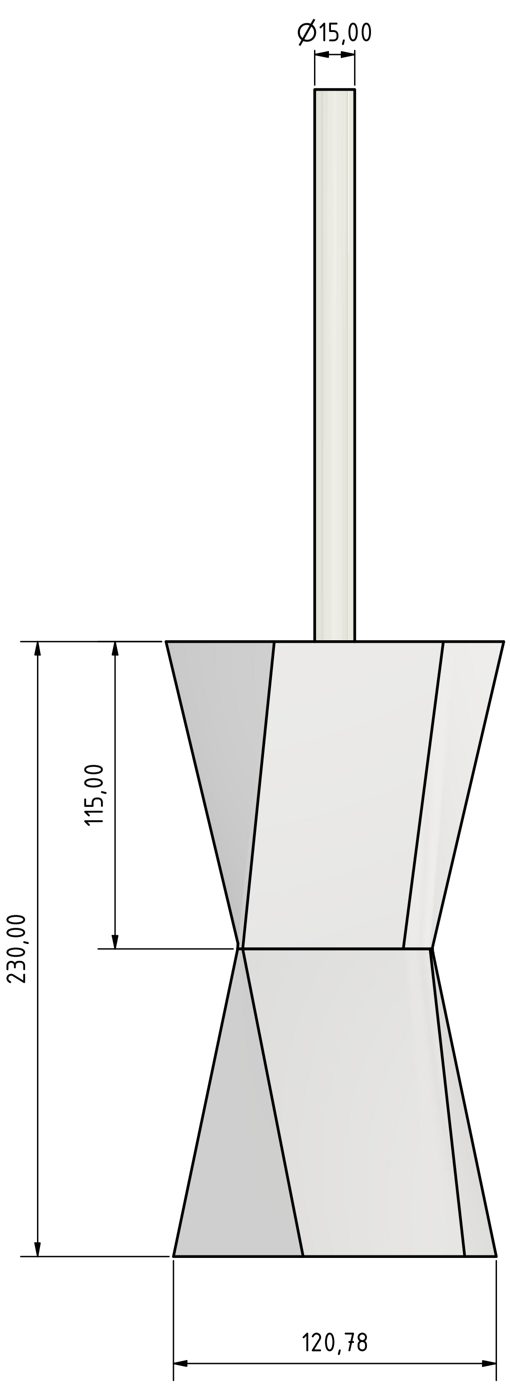
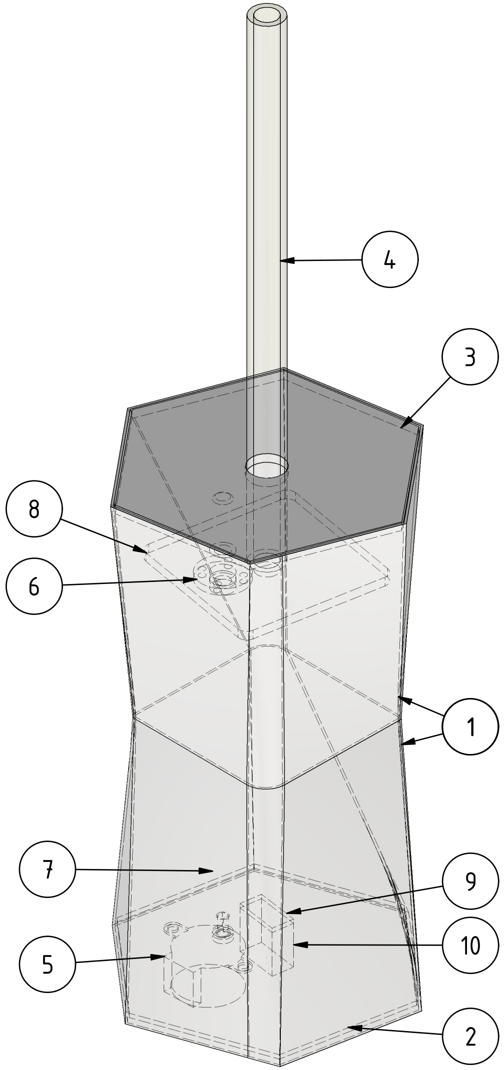


FIGURE 36: Logic flow chart





PARTS LIST

ITEM	QTY	PART NUMBER	DESCRIPTION
1	2	Flower pot	
2	1	Bottom plate	
3	1	Top plate	
4	1	Tupe	
5	1	Step Motor	
6	1	Nut	
7	1	Lead screw	
8	1	Elevator plate	
9	1	Led	
10	1	Spacer	

DRAWN Vera Schockemöhle	26.06.2022	
CHECKED		TITLE Bachelor Thesis - Artificial flower
QA		
MFG		
APPROVED		SIZE A3 · DWG NO flower all parts · REV
		SCALE 1 / 2 · SHEET 1 OF 1

6 Realisation

Together with all the information and feedback from the previous chapters, a final prototype has been developed. The realisation of the prototype and the controller box will be discussed within this chapter. Therefore, the technical hardware, the electronic hardware and software will be listed.

6.1 Technical Hardware

The prototype was made out of different components. These components consist of different materials and parts.In following section, these parts will be further explained and listed.

6.1.1 Material

For building the prototype, different material has been used. Two plastic flower pots were put together to create the case or "artificial flower pot". The stabilization for the threaded rod as well as the two plates for the top cover and movement were made out of wood. The plate for the movement is attached to a thread. The thread can be screwed on top of the 8mm threaded rod. The threaded rod was glued together with the motor. To connect the different parts hot glue and superglue has been used.

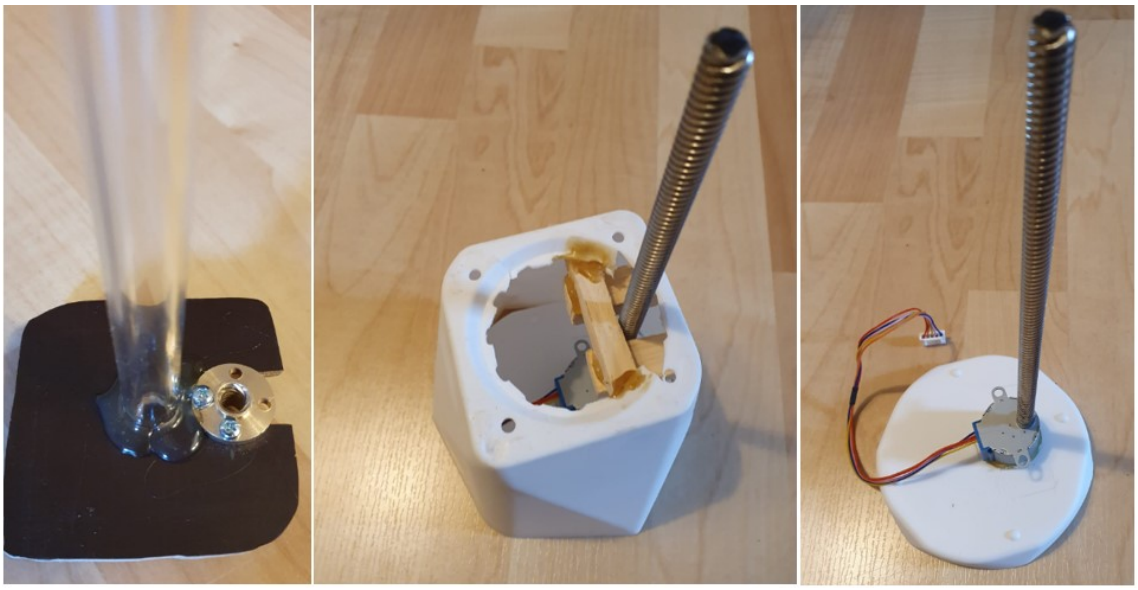


FIGURE 37: Left: Movement plate, Middle: Stabilization construction, Right: Threaded rod with stepper motor

6.1.2 Technical drawings

To give a better view of the different components within the flower pot, the prototype has been drawn with the aid of inventor. The first picture shows the flower pot from the outside and the second shows the inside of the flower pot (Figure: 38).

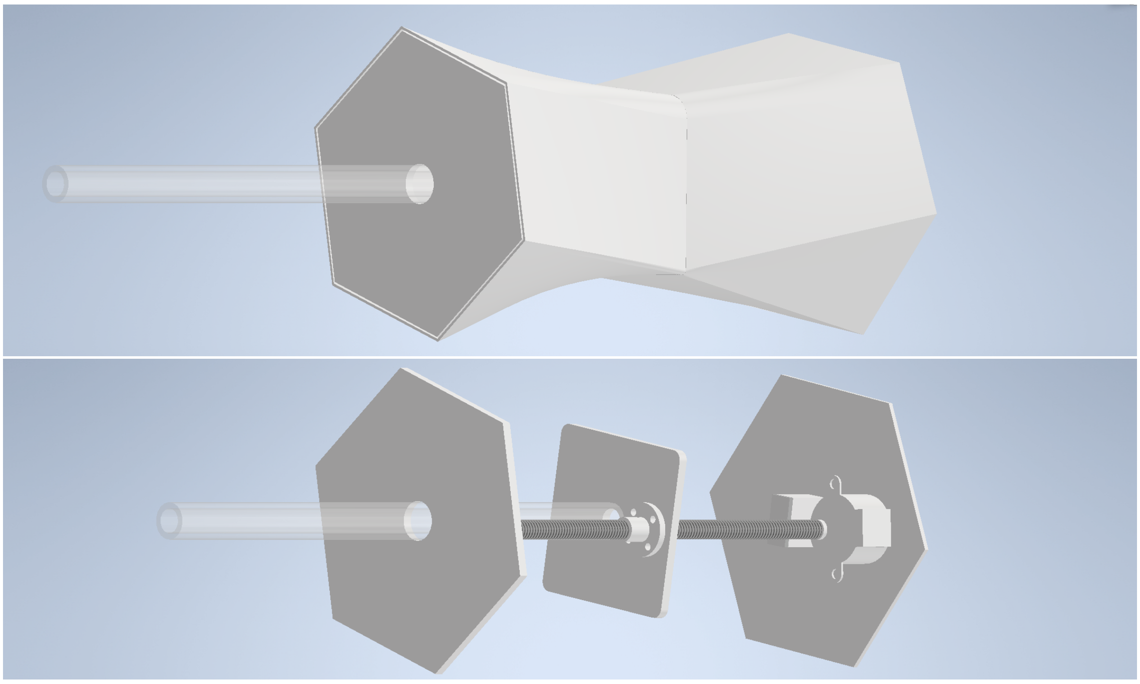


Figure 38: Technical drawings 3D (Inventor)

6.2 Electronic Hardware

The electronic hardware were placed inside the flower as well as inside the controller box. The main parts which came into use were an arduino UNO, a stepper motor, a LED, a potentiometer and a power supply.

6.2.1 Arduino UNO

To combine and control all different electrical components, an arduino UNO was implemented within the circuitry. The arduino UNO consists of an E/A-board, a micro controller and has analog and digital in-/outputs.

6.2.2 Circuitry

To give an overview of the circuitry of the electric parts, a circuit diagram has been created with the program fritzig (Figure: 39).

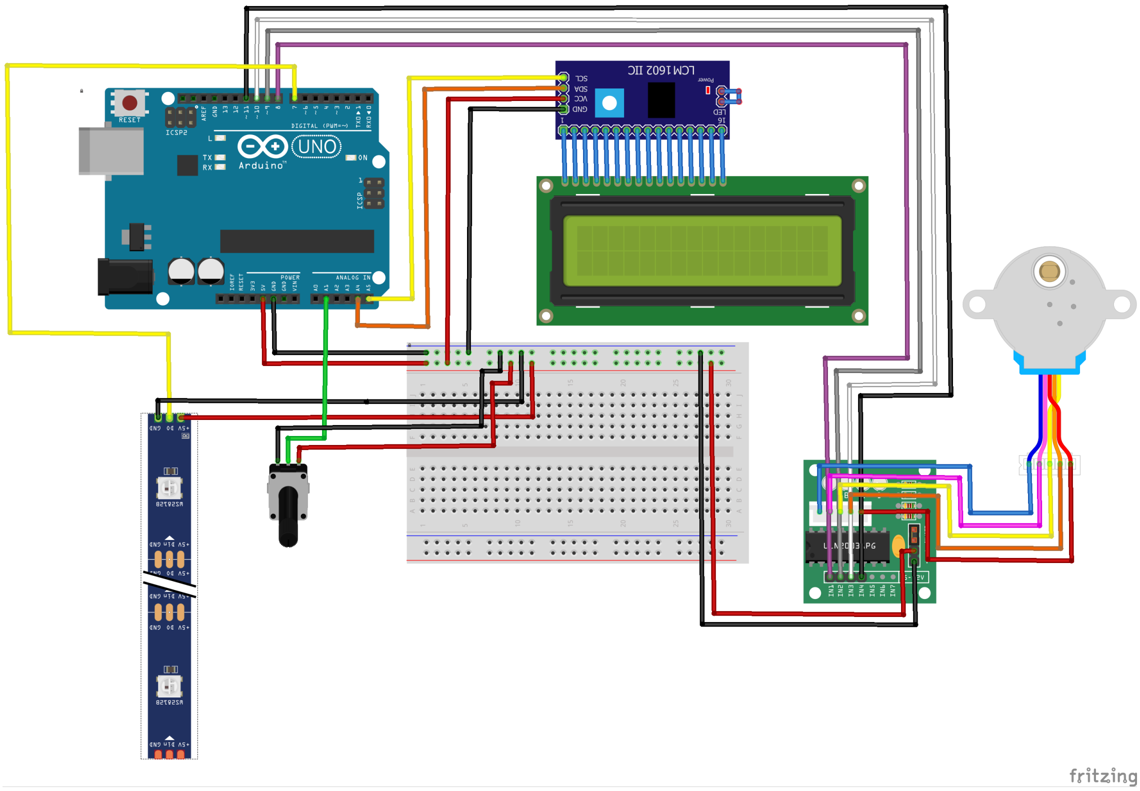


FIGURE 39: Project circuitry

6.2.3 Potentiometer and LCD display

To let the participant input their daily progress, a potentiometer has been used. It is a linear, rotary, 10k Ohm potentiometer. With 2x16 LCD display combined with an I2C driver board, the participant was able to see the data input and output by the flower (flower position). Together with the potentiometer, the user was able to input their daily progress on an easy an precise way.

6.2.4 Stepper motor

The motor which has been used is a 28BYJ-48 stepper motor together with a ULN2003 5V driver board. The advantages of this motor type is the possibility to control the speed of the rotation. Therefore, it was possible to set the position of the flower very precise.

6.2.5 LED and fiber optic cable

The LED inside of the flower is used to light up the fiber optic cable. It is addressable by the arduino board and can change to every color.

6.2.6 Power supply

The power supply is a simple 9V DC supply. It is used to power the arduino UNO. All other electrical components, including the LCD display and the LED, were powered by the arduino.

6.3 Software

The code for the project was written with the aid of the arduino software. The current version 1.8.19 was used. For the an implementation of the stepper motor, the LCD display and the LED, the following libraries were used: AccelStepper.h, LiquidCrystal_I2C.h and FastLED.h. Also parts of the sample codes and commands from the libraries were reused for the final code (see Appendix B, Figure: 43).

6.4 Manual

Manual

Start:

1.
- Please make sure that, before connecting the power supply with the product, the rotatable button is completely turned to the left.

2.
- Connect the power supply with the controller box.
- After around 3 seconds, the LCD display should be on.

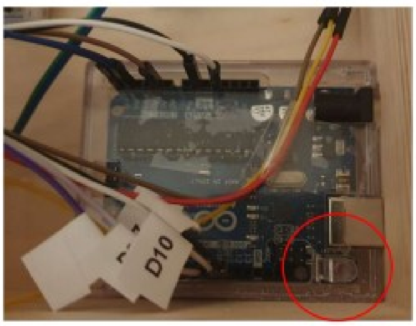
3.
- The LCD display should show two values now.
- The value above is labeled with "Physical Activity" and shows the manually set value. The second value below is the position of the flower, which adapts its value automatically.

4.
- For the next step, please turn the rotatable button until the first value displays your current activity value.
- Now please have some patience. The flower is growing and adapting to your progress (This can take a few minutes).

Shutdown:

5.
- To shut down the flower, please turn the rotatable button left until the first value shows a "0". Now, wait until the value of the flower position adapts to this value and shows a "0" as well.
- Now you can disconnect the power supply.

6.
- **Note:** If something is not displayed as mentioned in the manual, please press the „Reset" button inside of the controller boy and make sure to turn the button parallel back to its original position (entirely left).



← Reset Button

7 Evaluation

After the realization of the prototype, an evaluation session was conducted. The evaluation session will help to understand the current design strengths and weaknesses.

Therefore, the functional and non-functional requirements will be evaluated doing a technical and a user test.

7.1 Technical Evaluation

In the following and the 7.2.1 Technical test results section, the prototype will be controlled and compared to see if the functional requirements apply (Figure 41). The requirements of the prototype are the following:
- FR1: The visualization should show at least one physical activity variable.
- FR2: The flower has to move/open/close.
- FR3: The flower has to communicate with the Mox sensor.
- FR4: The flower must visualize two variables from the MOX sensor.
- FR5: The time the flower needs to be completely open should take at least one minute.
- FR6: The controller box needs to be made out of solid material like metal or wood etc..

7.2 User Testing

Before the start of the session, the participants were informed about the project and an informed consent was signed. As a daily activity goal 50 minutes of activity were set for the participants [49]. Furthermore, the average age of the participants was 79 years old, where two were female and one male. Each participant tested the design for at least 24 hours (see Appendix C). The activity level of the participants differed from 20% (low activity) to 100% (high activity).

After the introduction, the flower, controller box and manual were presented to the participant (Figure 40). The participant was asked to read the manual. Right after that the participant was asked to set a sample value of 30 activity minutes to test if the participant understood the manual.

In the following 24 hours, the participants were asked to enter the values form the Miss Activity app with the aid of the controller box (at least) three times a day.

FIGURE 40: Prototype presented to the participant

At the end of the user testing, a questionnaire in person was conducted with the option for follow up questions. Through this, it was possible to gain more information besides the listed questions. The first part included demographic questions. The second part were questions abut the prototype, the controller box and the manual (see Figure 44 in Appendix B).

Questionnaire:
To get a better understanding of the results and main findings, the questions will be further explained.
Q1: Does the design suit within your home environment? Where would you place the design?

The first question was to get insight if the user likes the design and if he or she would place it within their home environment.
Q2: Did you achieve your daily goal? How did you feel about seeing the flower? How did it motivate you?

The second question was to control if the previously set goal is realistic. This could have impact on further motivational questions since an unrealistic goal is demotivating and could be seen as a burden.
Q3: What do you think about the design choice that the opening of the flower refers to your activity progress? Would it motivate you to be more active?

To understand if the artificial flower contributes to a better physical activity behavior, the third question was asked. Furthermore, this question should help to understand if the participants see opening of the flower as a motivation.
Q4: How did you like the interaction with the flower?

The next question was to check whether the participants were able to input the values with the aid of the controller box.
Q5: How do you like the design of the flower?

This questions was asked to gain information whether the participants like the design and size of the prototype.

The questions 6,7 and 8 were connected to the usability of the manual. The users should be able to interact with the flower after reading the manual.
Q6: After reading the manual, were you able to interact with the flower?
Q7: Was the manual readable?
Q8: Did you understand the manual?

7.3 Test results

This chapter includes the results of the comparison of the prototype to the functional requirements and the answers of the participants to the questionnaire.

7.3.1 Technical test results

After testing the functional requirements using the final prototype, it can be seen that that the prototype met most of the requirements.

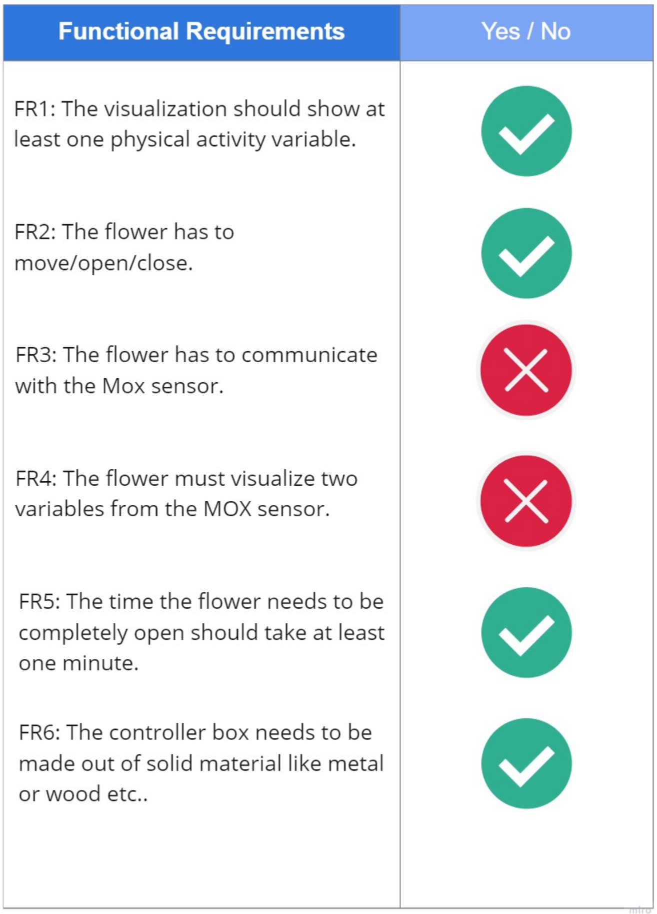


FIGURE 41: Results Functional Requirements

For the requirements, all functional "must haves" and most "should haves" are met. Only one "should have" requirements and one "could have" were not implemented. The first includes the communication of the Mox sensor to the flower. However due to technical difficulties, that was not possible. The second requirement describes the visualization of a second variable such as footsteps or progress in percentage. This implementation was due to time concerns also not possible to realise.

7.3.2 User test results

To test the non-functional requirements, the answers from the participants were analysed (Figure: 42).

Figure 42: Results Non-Functional Requirements

The analysis of the non-functional requirements and the answers of the questions gave deeper insights on the usability are realisation of the design.

Q1: All participants agreed that the design can be placed within their home environment and it was always a place where they can often see the flower. Two out of three participants, both females, agreed on the kitchen as the bust suitable place. The other male participant even considered placing the flower in his garage where he is working most time of the day.

Q2: To see if the users were motivated to achieve the set goal of 50 minutes of activity, their progress was controlled at least three times per day. However one participant had difficulties in attaching the Mox sensor to the trousers, since the Mox sensor needs to be placed in a certain position and not all trousers/clothes had the same high of the waistband. Therefore, this test had to be repeated.

Q3: For the participants the design contributed to a higher activity level than normal. Two participants even started to make additional walks and compared their progress to each other.

Q4: Three out of three participants agreed on the fact that the interaction with the flower was intuitive and easy to understand.

Q5: The participants mentioned that the design choice of a flower was interesting and motivating. Furthermore, the possibility to touch it made it alive. Most of them referred flowers with good memories and a possibility to identify themselves with the design. Also one said that the fiber optical cable recollected her to a lamp from the 90s. However, the size of the flower could be a bit smaller and the covering part could be more colorful.

The interaction itself was seemed as easy and interesting and all participants were interested in how the movement of the flower works.

Q6, Q7, Q8: Furthermore, no participant had difficulties in setting a certain value and the manual was readable and understandable. Only one participant had difficulties in interacting with the flower, after reading the manual, without any questions.

8 Conclusion

To come up with a suitable and motivating design for older adults, I have applied different methods within the creative technology design process. First, a literature review to collect data and information about already existing visualizations and a survey, to get deeper insights of the target user and to create personas. After that, a brainstorming together with an expert opinion helped to identify a suitable design for the target group. To realise the idea, a prototype has been developed and improved through several iteration phases. Later on, the prototype has been tested with three participants to determine its usability and technical feasibility.

Based on these insights, each research question will be answered before the main research question will be addressed. Therefore the first four questions are the following:

How is data currently visualized?
Currently the data of wearable devices is visualized with the aid of smartphone applications. The data is analysed through charts and numbers. These apps are motivating and coaching with mostly a geometrical form which needs to be completed through exercises (circle, heart, etc.). The Miss Activity application for the Mox sensor makes also use of this motivational strategy. Furthermore, with the possibility to set a personal goal for steps and activity in minutes, the app can be adapted to personal needs and expectations. Since the majority of activity coaches and motivational applications is visualized similar, there is a high potential for alternative and adapted solutions for older adults.

How familiar are older adults with wearable devices?
The results from the survey made clear that many older adults do not have wearable devices or do not regularly interacting with them. Furthermore, for the majority of the older adults, their performance skills when using smartphones, laptops or tablets correspond to a self-reported low or medium level based on the survey conducted with 59 people.

How likely would older adults use wearable devices as a motivation for their physical activity? The data from the survey show that almost all participants were aware that a good physical activity level is related to their health. Where the results from the evaluation support that older adults would like to use wearable devices but only with a motivating design, and if they wearable device come without complicating instructions or a lot of extra work.

How would older adults like the data to be visualized or made audible or touchable?
The participants were interested and excited to have data visualized in 3D so they can touch it. In addition, the participants showed a positive reaction on the design if it remembers them of things they already know. For instance all were familiar with flower and some even reminds the fiber optic cables from lamps from the 90s. Furthermore, a 3D visualization makes the data more accessible. All participants understood directly the correlation between the flower and their activity. Furthermore, without knowing the exact data but only seeing the flower, the participants were able to say if they have reached their goal or if they still have to be active. The results from the evaluation also showed that the interaction and the input of the data through a rotatable button was an easy exercise for the participants. Through a slow movement reaction of the artificial flower, the older

adults showed no fear but indicated interest and curiosity.

The purpose of this research was to investigate how data from the Mox sensor can be visualized to motivate and coach older adults to keep using it. Based on the analysis conveyed, it can be concluded that a 3D visualization can have a bigger impact on users. Especially for this target group it has a bigger impact on the motivational aspect since many older adults are not very familiar with wearable technology and applications. Therefore, a 3D visualization is more convenient compared to a 2D app based visualization.

Based on this concept, an artificial flower has been developed, which growth progress is linked to the activity progress of the user. The results indicate that the majority of the target group has a positive connection to flowers, where the participants adapted this mindset while interacting with the artificial flower. Furthermore, the simplistic design of the flower suits in most households. The modern design together with integrated fiber optic cables makes the user curious and interested in the product. A personal goal option, together with an easy understandable controller allows the user to stay independent and encourages the user to start an interaction.

9 Discussion Future Work

The following chapter will reflect on the strengths and weaknesses of this research. Therefore, related work will be compared and analysed to this project and suggestions for future research will be made.

The resulted design of this research is one possible solution for motivating older adults. The prototype and therefore the design choice of a flower was well accepted by the participants. However, there is still room for improvement for the prototype as well as for the research process.

9.1 Related work

Previous studies has also already focused on similar designs too motivate people to change their physical behaviour and/or decrease their health issues. The designs are also inspired by nature flowers, called Bloom-e [50] and Flowie [51]. Whereas the Bloom-e design also focus on a 3D realisation. The goal of the Flowie design, is similar to the goal of this project. Finding new ways of motivating older adults to increase their activity level with the aid of technology. Both studies and designs are also facing the limited previous research within this field.

The Bloom-e design is more aiming to train a person's ability to attend to the present moment non-judgmentally and with full awareness. But the visualisation itself is based on a real flower with several blooms and a color changing flower pot, which can be visually more attractive. Furthermore, the flower showed a positive affect on users regarding chronic pain and depression. The Flowie design focus on a similar background as this research. Whereas this project is using the Mox sensor, an accelerometer, which can sense different movements, the Flowie's sensing capability is limited to a pedometer, which can collect data about footsteps. The final prototype of Flowie was a 2D screen, placed in a wooden frame. It's user interface consist of three views, a general overview, a daily overview and a weekly overview. To have the possibility to see the personal progress of the day as well as of the week can also have a positive influence on the motivational part of the design. Furthermore, for the design of the final prototype, the easy interaction between the design and the user was an important factor. The design was described as easy to use, clear and appealing.

However also this design had its limitations. Due to the limited sensing capabilities of this design and a lack of the right timing for motivational cues, the physical activity of the users did not increase.

This research as well as the Flowie design would benefit of a longitudinal user study within this field.

9.2 Prototype

The designed prototype comes with limitations and therefore with recommendations for future work. Also during the evaluation phase possible suggestions and improvements were made. During the tests some participants had difficulties in attaching the Mox sensor to their clothes. A false position of the Mox sensor can also lead to wrong results regarding the daily activity.

The flower prototype was made of different parts. These parts were connected to each other in a way that it was still possible to separate them again to fix possible bugs. Therefore the design can still be improved. Furthermore, to make the design more interesting for the user, the flower pot could include several different flowers, which could open one by one until the daily goal is reached.

To support the motivational part of the prototype, additional LED's or sound can be added to generate a unique goal animation if the user has reached his or her goal. Furthermore, the prototypes intended goal was an automatic connection to the MOX sensor to be able to regularly update the activity progress. Since it was not possible at the current time, it is important to consider for future work and what impact it has on future users.

9.3 Research process

For the research process, some methods should be considered to be improved for future research. Furthermore, some factors could have been influenced the research process. First of all, due to deadlines, time constraints could have negatively impact this study. Therefore, it should be considered to use longitudinal studies for future research.

During the background research, a further research on intrusive and extrusive motivational methods could be added to achieve more physiological background regrading this topic.

The results of the brainstorming session could also be extended. With the aid of different brainstorming techniques and more participants, the results could be quantitatively and qualitatively improved. This also counts for the design process. A combination of the creative technology design process together with, for instance, a co-creation session could have a positive influence on the research process.

The participants for the evaluation process were recruited in the same environment and could therefore be biased. This could have influenced the answers and therefore the results of the evaluation phase. Furthermore, for future research, the sample size should be considered higher to get more reliable results. However, instead of used evaluation method, other evaluation methods, like a SUS analysis, could have a positive impact on the quality of the results.

During the evaluation phase, it was also obvious that the capabilities of the target group were different. Therefore, the design and the evaluation was developed for users with low but also higher capabilities. If the target group would be more focused, the design and the research process could have been design more precise for a specific part of the target group.

Even if the ideation phase is lacking in depth, the prototype was well executed. However, the research topic on using technology to motivate and coach older adults for more physical activity, is still a new field and more research on this topic is necessary.

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10 Appendix

10.1 Appendix A

PlusBus-onderzoek

Vragenlijst Informatiebijeenkomst

nationaal ouderen fonds
UNIVERSITY OF TWENTE.
Roessingh Research and Development
AdSysCo
MAASTRICHT INSTRUMENTS

Deze vragenlijst gaat over u. We gebruiken deze vragenlijst om:

- uw contactgegevens na te vragen voor het onderzoek,
- beter te begrijpen wie aan het onderzoek meedoen,
- te controleren of u deel kunt nemen aan het onderzoek (min. 65 jaar oud en in het bezit van een emailadres),
- uw voorkeuren met betrekking tot het onderzoek na te vragen.

Het invullen van de vragenlijst duurt ongeveer 10 minuten.

Naam & contactgegevens

Naam: ____

Straat & huisnummer: ________________________________

Postcode: ____

Woonplaats: ____

Telefoonnummer: _____________________________________

Email-adres: ____

Persoonlijke gegevens

Geboortejaar: __________

Geslacht: ☐ Man ☐ Vrouw ☐ Anders

Hoogst genoten opleiding:

☐ Geen
☐ Basisonderwijs
☐ Middelbaar voortgezet onderwijs (vmbo, mavo, mulo, lts etc.)
☐ Hoger voortgezet onderwijs (havo, vwo, mms, etc.)
☐ Middelbaar beroepsonderwijs (mbo, meao, mts, etc.)
☐ Hoger beroepsonderwijs (hbo, hogeschool)
☐ Universiteit
☐ Doctoraal
☐ Anders, namelijk: ________________________________

Huwelijkse status:

☐ Getrouwd ☐ Gescheiden ☐ Vrijgezel
☐ Weduwe/weduwnaar

Werk situatie:

☐ In loondienst ☐ Zelfstandige ☐ Werkloos
☐ Gepensioneerd ☐ Vrijwilligerswerk

Woon situatie (1):

☐ Thuis ☐ Aanleunwoning/serviceflat
☐ Verzorgingstehuis ☐ Anders, namelijk: ___________________

Woon situatie (2):

☐ Met partner ☐ Met familie/vrienden ☐ Alleen

Woon situatie (3):

☐ Landelijke omgeving ☐ Stedelijke omgeving

Gebruik PlusBus

Wat is de naam van uw PlusBus?

☐ Buurtbus Hilversum (Hilversum)
☐ DomstadPlusBus (Utrecht)
☐ PlusBus Barneveld (Barneveld)
☐ PlusBus033 (Amersfoort)
☐ Uit Bus Vechtdal (Ommen)
☐ Zender Express (IJsselstein)
☐ +Bus Utrechtse Heuvelrug (Driebergen)

Hoelang maakt u al gebruik van de PlusBus?

_______ jaar

Hoe vaak gaat u mee met de PlusBus, er vanuit gaande dat hij rijdt?

☐ 1 keer per week
☐ Meerdere keren per maand, maar minder dan 1 keer per week
☐ 1 keer per maand
☐ Meerdere keren per kwartaal, maar minder dan 1 keer per maand
☐ 1 keer per kwartaal
☐ Meerdere keren per jaar, maar minder dan 1 keer per kwartaal
☐ 1 keer per jaar of minder

Motivatie

Wat is uw belangrijkste reden om mee te doen aan dit onderzoek?

☐ De uitjes die voor het onderzoek georganiseerd worden
☐ Interesse in de nieuwe diensten voor de PlusBus
☐ Een bijdrage leveren aan het onderzoek
☐ Betrokkenheid bij uw PlusBus
☐ Anders, namelijk: ____

____

Zou u een online eet- en kookhulp willen gebruiken?

☐ Ja ☐ Nee ☐ Misschien

Zou u bij willen houden hoeveel u beweegt met een smartphone applicatie en een sensor?

☐ Ja ☐ Nee ☐ Misschien

Zou u na uitjes van uw PlusBus berichten uit willen wisselen met de andere deelnemers via de website van uw PlusBus?

☐ Ja ☐ Nee ☐ Misschien

Gebruik van moderne technologie (computer, smartphone, internet etc.)

Heeft u een computer?

- ☐ Ja, en ik gebruik hem regelmatig
- ☐ Ja, en ik gebruik hem af en toe
- ☐ Ja, maar ik gebruik hem niet
- ☐ Nee

Heeft u een tablet?

- ☐ Ja, en ik gebruik hem regelmatig
- ☐ Ja, en ik gebruik hem af en toe
- ☐ Ja, maar ik gebruik hem niet
- ☐ Nee

Heeft u een smartphone?

- ☐ Ja, en ik gebruik hem regelmatig
- ☐ Ja, maar ik gebruik hem weinig
- ☐ Ja, maar ik gebruik hem niet
- ☐ Nee

Waarvoor gebruikt u op dit moment moderne technologie?

- ☐ Om gezond te eten *(bijv. online recepten of digitaal voedingsdagboekje)*
- ☐ Om voldoende te bewegen *(bijv. stappenteller of smartphone applicatie)*
- ☐ Om in contact te blijven met anderen *(bijv. Facebook of WhatsApp)*
- ☐ Om op de hoogte te blijven *(bijv. digitale nieuwsbrief of nieuws websites)*
- ☐ Geen van bovenstaande

Hoe zou u uw vaardigheden voor het gebruik van moderne technologie (computer, applicaties/programma's, internet etc.) omschrijven?

- ☐ Basis vaardigheden
- ☐ Gemiddelde vaardigheden
- ☐ Gevorderde vaardigheden
- ☐ Excellente vaardigheden

Hoe denkt u in het algemeen over nieuwe technologieën (computer, applicaties/programma's, internet etc.)?

- Als ik zou horen over een nieuwe technologie, zou ik manieren zoeken om ermee te experimenteren.

Helemaal mee oneens	Een beetje mee oneens	Neutraal	Een beetje mee eens	Helemaal mee eens
☐	☐	☐	☐	☐

- Van mijn leeftijdsgenoten ben ik meestal de eerste om nieuwe technologieën uit te proberen.

Helemaal mee oneens	Een beetje mee oneens	Neutraal	Een beetje mee eens	Helemaal mee eens
☐	☐	☐	☐	☐

- Over het algemeen ben ik terughoudend in het uitproberen van nieuwe technologieën.

Helemaal mee oneens	Een beetje mee oneens	Neutraal	Een beetje mee eens	Helemaal mee eens
☐	☐	☐	☐	☐

- Ik vind het leuk om te experimenteren met nieuwe technologieën.

Helemaal mee oneens	Een beetje mee oneens	Neutraal	Een beetje mee eens	Helemaal mee eens
☐	☐	☐	☐	☐

Interviews

Aan het begin én aan het eind van het onderzoek interviewen we deelnemers over hun kwaliteit van leven (duur: 30-40 min). Hiervoor is een beperkt aantal plaatsen beschikbaar.

Zou u het leuk vinden om deel te nemen aan deze interviews over uw kwaliteit van leven?

☐ Ja ☐ Nee

Nieuws

We willen we u graag op de hoogte houden van de ontwikkelingen in het onderzoek. Dit kan bijvoorbeeld gaan over de PlusBus-locaties die meedoen en de uitjes die we georganiseerd hebben.

Hoe we deze informatie aan gaan bieden weten we nog niet.

Hoe zou u deze informatie het liefst ontvangen?

☐ Per post
☐ Per email

Einde van deze vragenlijst

PlusBus-onderzoek

Vragenlijst startbijeenkomst

Naam: ________________________________

nationaal ouderenfonds   UNIVERSITY OF TWENTE.   Roessingh Research and Development   AdSysCo   MAASTRICHT INSTRUMENTS

Deze vragenlijst gaat over hoe u aan de studie begint met betrekking tot:

- Uw kwaliteit van leven
- Uw tevredenheid met uw sociale leven, voedingspatroon en hoeveel u beweegt
- Uw tevredenheid met de PlusBus

Het invullen van de vragenlijst duurt ongeveer 25 minuten.

Kwaliteit van leven
Kruis aan wat het beste past bij uw gezondheid VANDAAG

Mobiliteit
☐ Ik heb geen problemen met lopen
☐ Ik heb enige problemen met lopen
☐ Ik ben bedlegerig

Zelfzorg
☐ Ik heb geen problemen om mijzelf te wassen of aan te kleden
☐ Ik heb enige problemen om mijzelf te wassen of aan te kleden
☐ Ik ben niet in staat mijzelf te wassen of aan te kleden

Dagelijkse activiteiten (
bijv. werk, studie, huishouden, gezins- of vrijetijdsactiviteiten
☐ Ik heb geen problemen met mijn dagelijkse activiteiten
☐ Ik heb enige problemen met mijn dagelijkse activiteiten
☐ Ik ben niet in staat mijn dagelijkse activiteiten uit te voeren

Pijn / klachten
☐ Ik heb geen pijn of andere klachten
☐ Ik heb matige pijn of andere klachten
☐ Ik ervaar zeer veel pijn of ongemak

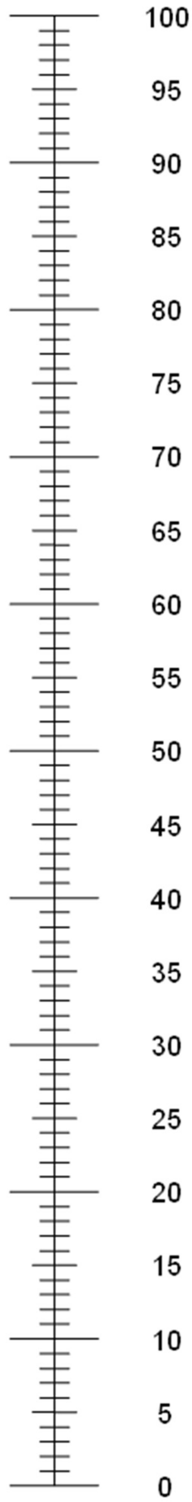
Stemming
☐ Ik ben niet angstig of somber
☐ Ik ben matig angstig of somber
☐ Ik ben erg angstig of somber

De beste gezondheid die u zich kunt voorstellen

Gezondheid

- We willen weten hoe goed of slecht uw gezondheid VANDAAG is.
- Deze meetschaal loopt van 0 tot 100.
- 100 staat voor de beste gezondheid die u zich kunt voorstellen.
  0 staat voor de slechtste gezondheid die u zich kunt voorstellen.
- Markeer een X op de meetschaal om aan te geven hoe uw gezondheid VANDAAG is.
- Noteer het getal waarbij u de X heeft geplaatst in onderstaand vakje.

UW GEZONDHEID VANDAAG =



De slechtste gezondheid die u zich kunt voorstellen

Sociaal leven (1)

Omcirkel wat van toepassing is

Hoe vaak…	Nooit	Zelden	Soms	Vaak
…heeft u het gevoel dat u op één lijn zit met anderen?	1	2	3	4
…heeft u het gevoel dat u gezelschap mist?	1	2	3	4
…heeft u het gevoel dat u bij niemand terecht kunt?	1	2	3	4
…voelt u zich alleen?	1	2	3	4
…voelt u zich onderdeel van een groep vrienden?	1	2	3	4
…heeft u het gevoel dat u veel gemeen heeft met de mensen om u heen?	1	2	3	4
…heeft u het gevoel dat u er geen mensen meer dichtbij u staan?	1	2	3	4
…heeft u het gevoel dat de mensen om u heen niet dezelfde ideeën en interesses delen?	1	2	3	4
…voelt u zich spontaan en vriendelijk?	1	2	3	4
…voelt u zich nauw verbonden met mensen?	1	2	3	4
…voelt u zich buitengesloten?	1	2	3	4
…heeft u het gevoel dat uw relaties met anderen oppervlakkig zijn?	1	2	3	4
…heeft u het gevoeld dat niemand u echt goed kent?	1	2	3	4
…voelt u zich geïsoleerd van anderen?	1	2	3	4
…heeft u het gevoel dat u kameraadschap kunt vinden als u dat zou willen?	1	2	3	4
…heeft u het gevoel dat er mensen zijn die u echt begrijpen?	1	2	3	4
…voelt u zich verlegen?	1	2	3	4
…heeft u het gevoel dat onder de mensen bent maar toch alleen?	1	2	3	4
…heeft u het gevoel dat er mensen zijn waarmee u kunt praten?	1	2	3	4
…heeft u het gevoel dat er mensen zijn waarbij u terecht kunt?	1	2	3	4

Deelnemernummer:

Sociaal leven (2)

Familie (de mensen waarmee u verbonden bent door geboorte of huwelijk)

Hoeveel familieleden ziet of spreekt u minimaal één keer per maand?

0	1	2	3 of 4	5 tot 8	9 of meer
☐	☐	☐	☐	☐	☐

Met hoeveel familieleden voelt u zich nauw verbonden, zodanig dat u ze om hulp kunt vragen?

0	1	2	3 of 4	5 tot 8	9 of meer
☐	☐	☐	☐	☐	☐

Bij hoeveel familieleden voelt u zich op uw gemak zodanig dat u met ze kunt praten over privézaken.

0	1	2	3 of 4	5 tot 8	9 of meer
☐	☐	☐	☐	☐	☐

Vriendschappen (al uw vrienden incl. de mensen in uw buurt)

Hoeveel van uw vrienden ziet of spreekt u minimaal één keer per maand?

0	1	2	3 of 4	5 tot 8	9 of meer
☐	☐	☐	☐	☐	☐

Met hoeveel vrienden voelt u zich nauw verbonden, zodanig dat u ze om hulp kunt vragen?

0	1	2	3 of 4	5 tot 8	9 of meer
☐	☐	☐	☐	☐	☐

Bij hoeveel vrienden voelt u zich op uw gemak, zodanig dat u met ze kunt praten over privézaken.

0	1	2	3 of 4	5 tot 8	9 of meer
☐	☐	☐	☐	☐	☐

Tevredenheid met voedingspatroon

Wat is voor u het belangrijkst als het gaat om eten? Selecteer 1 of 2 opties.

- ☐ Gezondheid
- ☐ Uiting van een geloofs- of levensovertuiging (bijv. kosjer of vegetarisch eten)
- ☐ Smaak
- ☐ Samenzijn met anderen
- ☐ Anders, namelijk: ______________________________

Hoe belangrijk vindt u het om gezond te eten?

Helemaal niet belangrijk	Niet belangrijk	Neutraal	Best belangrijk	Zeer belangrijk
☐	☐	☐	☐	☐

Hoe gezond eet u op dit moment?

Helemaal niet gezond	Niet gezond	Neutraal	Best gezond	Zeer gezond
☐	☐	☐	☐	☐

Zou u graag (nog) gezonder willen eten?

Helemaal niet graag	Niet graag	Neutraal	Best graag	Zeer graag
☐	☐	☐	☐	☐

Stel u wilt gezonder eten: Zou u daarbij dan ondersteund willen worden door technologie?

Helemaal niet graag	Niet graag	Neutraal	Best graag	Zeer graag
☐	☐	☐	☐	☐

Tevredenheid met hoeveelheid beweging

Wat zijn voor u de grootste voordelen van bewegen? Selecteer 1 of 2 opties.

- ☐ Goed voor gezondheid
- ☐ Leuk om te doen
- ☐ Jezelf nuttig kunnen maken (bijv. schone ramen)
- ☐ Samenzijn met anderen
- ☐ Anders, namelijk: ______________________________

Hoe belangrijk vindt u het om voldoende te bewegen?

Helemaal niet belangrijk	Niet belangrijk	Neutraal	Best belangrijk	Zeer belangrijk
☐	☐	☐	☐	☐

Beweegt u op dit moment voldoende?

Helemaal niet voldoende	Niet voldoende	Neutraal	Voldoende	Helemaal voldoende
☐	☐	☐	☐	☐

Zou u graag (nog) meer willen bewegen?

Helemaal niet graag	Niet graag	Neutraal	Best graag	Zeer graag	n.v.t.
☐	☐	☐	☐	☐	☐

Stel u wilt meer gaan bewegen: Zou u daarbij dan ondersteund willen worden door technologie?

Helemaal niet graag	Niet graag	Neutraal	Best graag	Zeer graag
☐	☐	☐	☐	☐

Tevredenheid met de PlusBus

Welk cijfer geeft u uw PlusBus op dit moment? _____

Wat zijn de meest positieve punten van uw PlusBus?

____

____

____

____

Wat zou er nog verbeterd kunnen worden aan uw PlusBus?

____

____

____

____

Kruis bij de volgende stellingen aan wat van toepassing is.

Bij mijn PlusBus is er een sterk gemeenschapsgevoel.

Helemaal niet mee eens	Niet mee eens	Neutraal	Mee eens	Helemaal mee eens
☐	☐	☐	☐	☐

Ik wil graag dat het gemeenschapsgevoel bij mijn PlusBus versterkt wordt.

Helemaal niet mee eens	Niet mee eens	Neutraal	Mee eens	Helemaal mee eens
☐	☐	☐	☐	☐

Mijn PlusBus biedt veel ondersteuning bij het gezond en fit blijven.

Helemaal niet mee eens	Niet mee eens	Neutraal	Mee eens	Helemaal mee eens
☐	☐	☐	☐	☐

Ik wil graag dat mijn PlusBus meer ondersteuning gaat bieden bij het gezond en fit blijven.

Helemaal niet mee eens	Niet mee eens	Neutraal	Mee eens	Helemaal mee eens
☐	☐	☐	☐	☐

Mijn PlusBus maakt veel gebruik van technologische middelen (bijv. online nieuwsbrief en online aanmelden voor uitjes).

Helemaal niet mee eens	Niet mee eens	Neutraal	Mee eens	Helemaal mee eens
☐	☐	☐	☐	☐

Ik wil graag dat mijn PlusBus meer gebruik gaat maken van technologische middelen.

Helemaal niet mee eens	Niet mee eens	Neutraal	Mee eens	Helemaal mee eens
☐	☐	☐	☐	☐

Einde van deze vragenlijst

10.2 Appendix B

```
#include <AccelStepper.h> // Include the AccelStepper Library
#include <LiquidCrystal_I2C.h> // Include LCD Library
#include <FastLED.h>      //Include FasLED Library

#define FULLSTEP 4
#define LED_PIN     7
#define NUM_LEDS    1
#define LED_TYPE WS2812
#define COLOR_ORDER GRB

int potPin = A1; //set A1 to Pin of potentiometer
int POTValue; //variable to read the value of potentiometer
int potColor; //set variable for the color dependend on the input of the potentiometer
uint8_t max_bright = 127; //half bright set
LiquidCrystal_I2C lcd(0x27,20,4);  // set the LCD address to 0x27 for a 16 chars and 2 line display
AccelStepper myStepper(FULLSTEP, 8, 10, 9, 11); // Pins entered in sequence IN1-IN3-IN2-IN4 for proper step sequence
CRGB leds[NUM_LEDS];

void setup() {
  pinMode(A1, INPUT); // set up the LCD's number of columns and rows:
  lcd.init(); // initialize the lcd, first show goal
  lcd.begin(16, 2);
  Serial.begin(9600);
  lcd.backlight();
  lcd.setCursor(2,0);
  lcd.print("Goal: 50 min");
  lcd.init(); // initialize the lcd display only values

LEDS.addLeds<LED_TYPE, LED_PIN, COLOR_ORDER>(leds, NUM_LEDS);
FastLED.setBrightness(max_bright);

  myStepper.setMaxSpeed(1500.0);     // initial speed and the target position
  myStepper.setAcceleration(50.0);  // set the maximum speed, acceleration factor,
  myStepper.setSpeed(1500);
  myStepper.moveTo(7000);//2038 one rund
}

void loop() {
POTValue = analogRead(potPin);
int PotPosition = map(POTValue , 0, 1023, 0 , 52); // set the goal and make it dependend on the potentiometer
int Potpercent = map(POTValue , 0, 1023, 0 ,100); // could be displayed to the the progress in percentage
int Movement = PotPosition*200; //10.000 is the distance the motor has to move the flower
myStepper.moveTo(-Movement);
myStepper.run();

lcd.setCursor(2,1);
lcd.print(PotPosition); // Prints value on PotPosition to LCD as percent
lcd.setCursor(2,3);
lcd.print(-myStepper.currentPosition()); //show flower position on screen

if (PotPosition < 49) { //If goal is not reached, LED is changing color based on progress
    fill_solid(leds, NUM_LEDS, CHSV(potColor, 255, 255));
      }

if (PotPosition >= 49) { //If goal is reached, LED is changing color
    EVERY_N_MILLISECONDS(500){
         leds[0] = CHSV(255, random8(), random8()); //change color random
       }
    }

POTValue = analogRead(potPin);
potColor = map(POTValue, 0, 1023, 0, 255);  // map the color value based on potentiometer input
FastLED.show();
}
```

FIGURE 43: Arduino Code

Informed Consent – Questionnaire

Dear participant,

My name is Vera Schockemöhle and I am a Creative Technology Bachelor student at the University of Twente. My graduation project is about translating data from wearable sensors in an understandable way to motivate older adults. That means I am researching older adults' physical behavior and how they can be motivated to be more physically active.

At the end of my research, I am trying to understand the strengths and weak points of the product. For that, I will conduct a questionnaire. The questionnaire will be filled out online with the aid of Microsoft forms.

For the research, the data will be used to evaluate the final product.

The collected data will be anonymized and saved locally. After this project (July 2022), the data will be deleted.

____

Consent

I hereby agree that I want to participate in the interview. I received a sufficient explanation of the purpose of the questionnaire and what happens with the collected data. I have read and understand the provided information and have had the opportunity to ask questions. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving a reason and without cost. I understand that I will be given a copy of this consent form. I voluntarily agree to take part in this study. With my signature, I consent that my answers can be used for this study.

Participant's signature ______________________________ Date __________

Researcher's signature _____________________________ Date __________

Contact Information: Vera Schockemöhle, Auf dem Kampe 7, 49439 Steinfeld, v.schockemohle@student.utwente.nl

Informed Consent – User testing

Dear participant,

My name is Vera Schockemöhle and I am a Creative Technology student at the University of Twente. My graduation project is about "translating data from wearable sensors in an understandable way to motivate older adults". That means I am researching older adults' physical behavior and how they can be motivated to be more physically active.

At the end of my research, I must test my prototype of a physical activity visualization. For that, I will conduct user testing. The user tests will include wearing an accelerometer, which collects data about physical behavior (walking, sitting, etc.). The collected data will be visualized by the prototype. You will be asked to perform some tasks with the prototype and afterwards, some questions will be asked.

The data will be used to test the visualization and the feedback should show if the goal of the research was fulfilled. Furthermore, another goal of the test is to find the strengths and weaknesses of the prototype.

The collected data will be anonymized and saved locally. After this project (July 2022), the data will be deleted.

____

Consent

I hereby agree that I want to participate in the user testing. I received a sufficient explanation of the purpose of the test and what happens with the collected data. I have read and understand the provided information and have had the opportunity to ask questions. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving a reason and without cost. I understand that I will be given a copy of this consent form. I voluntarily agree to take part in this study. With my signature, I consent that my answers can be used for this study.

Participant's signature ______________________________ Date __________

Researcher's signature _____________________________ Date __________

Contact Information: Vera Schockemöhle, Auf dem Kampe 7, 49439 Steinfeld, v.schockemohle@student.utwente.nl

Questionnaire – User evaluation

Age:

Gender:

Nationality:

Activity level:

1 50 100

low → high

Where would you place the design? Does the design suit within your home environment?

Did you achieve your daily goal? How did you feel about seeing the flower?

What do you think about the design choice that the opening of the flower refers to your activity progress? Would it motivate you to be more active?

How did you like the interaction with the flower?

How do you like the design of the flower?

Was the manual readable?

After reading the manual, were you able to interact with the flower?

Did you understand the manual?

FIGURE 44: Questionnaire - User evaluation

Manual

Start:

1.
- Please make sure that, before connecting the power supply with the product, the rotatable button is completely turned to the left.

2.
- Connect the power supply with the controller box.
- After around 3 seconds, the LCD display should be on.

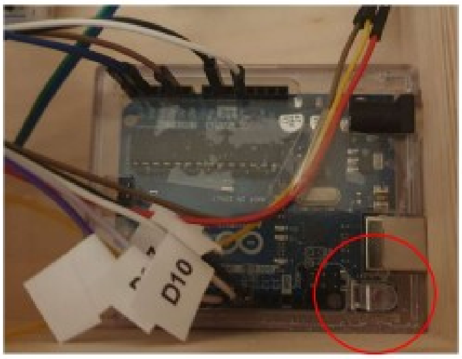
3.
- The LCD display should show two values now.
- The value above is labeled with "Physical Activity" and shows the manually set value. The second value below is the position of the flower, which adapts its value automatically.

4.
- For the next step, please turn the rotatable button until the first value displays your current activity value.
- Now please have some patience. The flower is growing and adapting to your progress (This can take a few minutes).

Shutdown:

5.
- To shut down the flower, please turn the rotatable button left until the first value shows a "0". Now, wait until the value of the flower position adapts to this value and shows a "0" as well.
- Now you can disconnect the power supply.

6.
- **Note:** If something is not displayed as mentioned in the manual, please press the „Reset" button inside of the controller boy and make sure to turn the button parallel back to its original position (entirely left).



← Reset Button

FIGURE 45: Final Manual

10.3 Appendix C

ID	MOX_NAME	TIMESTAMP	IMA_VALUE	SEDENTARY	STANDING	Low Itensity	WEIGHT_BEARING	STEPS	MEASUREMENT_ID
79222	SN16387	17-06-22 00:00:00	0	1798	0	0	0	0	O6RCX_SN16387
79223	SN16387	17-06-22 00:30:00	0	1798	0	0	0	0	O6RCX_SN16387
79224	SN16387	17-06-22 01:00:00	0	1798	0	0	0	0	O6RCX_SN16387
79225	SN16387	17-06-22 01:30:00	0	1800	0	0	0	0	O6RCX_SN16387
79226	SN16387	17-06-22 02:00:00	0	1798	0	0	0	0	O6RCX_SN16387
79227	SN16387	17-06-22 02:30:00	0	1798	0	0	0	0	O6RCX_SN16387
79228	SN16387	17-06-22 03:00:00	0	1798	0	0	0	0	O6RCX_SN16387
79229	SN16387	17-06-22 03:30:00	0	1798	0	0	0	0	O6RCX_SN16387
79230	SN16387	17-06-22 04:00:00	0	1798	0	0	0	0	O6RCX_SN16387
79231	SN16387	17-06-22 04:30:00	0	1798	0	0	0	0	O6RCX_SN16387
79232	SN16387	17-06-22 05:00:00	0	1798	0	0	0	0	O6RCX_SN16387
79233	SN16387	17-06-22 05:30:00	0	1800	0	0	0	0	O6RCX_SN16387
79234	SN16387	17-06-22 06:00:00	0	1798	0	0	0	0	O6RCX_SN16387
79235	SN16387	17-06-22 06:30:00	0	1798	0	0	0	0	O6RCX_SN16387
79236	SN16387	17-06-22 07:00:00	0	1798	0	0	0	0	O6RCX_SN16387
79237	SN16387	17-06-22 07:30:00	0	1798	0	0	0	0	O6RCX_SN16387
79238	SN16387	17-06-22 08:00:00	0	1798	0	0	0	0	O6RCX_SN16387
79239	SN16387	17-06-22 08:30:00	0	1798	0	0	0	0	O6RCX_SN16387
79240	SN16387	17-06-22 09:00:00	0	1798	0	0	0	0	O6RCX_SN16387
79241	SN16387	17-06-22 09:30:00	218	1746	0	4	0	0	O6RCX_SN16387
79242	SN16387	17-06-22 10:00:00	1266	1764	0	36	0	0	O6RCX_SN16387
79243	SN16387	17-06-22 10:30:00	1105	1776	0	22	0	0	O6RCX_SN16387
79793	SN16387	17-06-22 11:00:00	3472	278	1356	164	1506	335	O6RCX_SN16387
79794	SN16387	17-06-22 11:30:00	5393	508	816	474	1274	821	O6RCX_SN16387
79795	SN16387	17-06-22 12:00:00	6630	462	814	522	1260	783	O6RCX_SN16387
79796	SN16387	17-06-22 12:30:00	5429	0	1464	334	1798	1010	O6RCX_SN16387
79797	SN16387	17-06-22 13:00:00	2997	942	750	106	850	287	O6RCX_SN16387
79798	SN16387	17-06-22 13:30:00	3324	816	774	208	978	410	O6RCX_SN16387
79799	SN16387	17-06-22 14:00:00	6212	84	1394	322	1700	1262	O6RCX_SN16387
79800	SN16387	17-06-22 14:30:00	5166	236	1280	282	1560	851	O6RCX_SN16387
79801	SN16387	17-06-22 15:00:00	3204	82	1558	158	1716	429	O6RCX_SN16387
79802	SN16387	17-06-22 15:30:00	5868	18	1482	298	1776	1269	O6RCX_SN16387
79803	SN16387	17-06-22 16:00:00	6998	24	1182	592	1774	1355	O6RCX_SN16387
79804	SN16387	17-06-22 16:30:00	6875	32	1350	416	1760	1293	O6RCX_SN16387
79805	SN16387	17-06-22 17:00:00	5909	4	1210	584	1792	1138	O6RCX_SN16387
79806	SN16387	17-06-22 17:30:00	7465	318	856	624	1340	999	O6RCX_SN16387
79807	SN16387	17-06-22 18:00:00	5498	164	1100	536	1458	699	O6RCX_SN16387
79808	SN16387	17-06-22 18:30:00	2154	10	1682	106	1788	287	O6RCX_SN16387
79810	SN16387	17-06-22 19:00:00	4625	730	732	336	1058	589	O6RCX_SN16387
80031	SN16387	17-06-22 19:30:00	2941	1082	526	190	710	303	O6RCX_SN16387
80033	SN16387	17-06-22 20:00:00	4956	96	1372	330	1698	709	O6RCX_SN16387
80034	SN16387	17-06-22 20:30:00	1854	1426	302	70	350	138	O6RCX_SN16387
80274	SN16387	17-06-22 21:00:00	422	1798	0	0	0	0	O6RCX_SN16387
80275	SN16387	17-06-22 21:30:00	421	1798	0	0	0	0	O6RCX_SN16387
80276	SN16387	17-06-22 22:00:00	463	1798	0	2	0	0	O6RCX_SN16387
80277	SN16387	17-06-22 22:30:00	443	1798	0	0	0	0	O6RCX_SN16387
80278	SN16387	17-06-22 23:00:00	441	1798	0	0	0	0	O6RCX_SN16387
80279	SN16387	17-06-22 23:30:00	441	1798	0	0	0	0	O6RCX_SN16387
80280	SN16387	18-06-22 00:00:00	444	1798	0	0	0	0	O6RCX_SN16387
80281	SN16387	18-06-22 00:30:00	446	1798	0	0	0	0	O6RCX_SN16387
80282	SN16387	18-06-22 01:00:00	449	1798	0	0	0	0	O6RCX_SN16387
80283	SN16387	18-06-22 01:30:00	448	1798	0	0	0	0	O6RCX_SN16387
80284	SN16387	18-06-22 02:00:00	445	1800	0	0	0	0	O6RCX_SN16387
80285	SN16387	18-06-22 02:30:00	438	1798	0	0	0	0	O6RCX_SN16387
80286	SN16387	18-06-22 03:00:00	443	1798	0	0	0	0	O6RCX_SN16387
80287	SN16387	18-06-22 03:30:00	434	1798	0	0	0	0	O6RCX_SN16387
80288	SN16387	18-06-22 04:00:00	430	1798	0	0	0	0	O6RCX_SN16387
80289	SN16387	18-06-22 04:30:00	428	1798	0	0	0	0	O6RCX_SN16387
80290	SN16387	18-06-22 05:00:00	430	1798	0	0	0	0	O6RCX_SN16387
80291	SN16387	18-06-22 05:30:00	428	1798	0	0	0	0	O6RCX_SN16387
80292	SN16387	18-06-22 06:00:00	432	1798	0	0	0	0	O6RCX_SN16387
80293	SN16387	18-06-22 06:30:00	421	1800	0	0	0	0	O6RCX_SN16387
80294	SN16387	18-06-22 07:00:00	424	1798	0	0	0	0	O6RCX_SN16387
80295	SN16387	18-06-22 07:30:00	429	1798	0	0	0	0	O6RCX_SN16387
80296	SN16387	18-06-22 08:00:00	429	1798	0	0	0	0	O6RCX_SN16387
80297	SN16387	18-06-22 08:30:00	446	1798	0	0	0	0	O6RCX_SN16387
80298	SN16387	18-06-22 09:00:00	472	1796	0	2	0	0	O6RCX_SN16387
80299	SN16387	18-06-22 09:30:00	595	1780	4	14	16	12	O6RCX_SN16387
80653	SN16387	18-06-22 10:00:00	6762	80	1186	532	1700	1180	O6RCX_SN16387
80654	SN16387	18-06-22 10:30:00	5499	0	1680	120	1798	1181	O6RCX_SN16387
80655	SN16387	18-06-22 11:00:00	5399	224	1258	316	1556	844	O6RCX_SN16387
80656	SN16387	18-06-22 11:30:00	3861	1170	460	168	620	468	O6RCX_SN16387
80657	SN16387	18-06-22 12:00:00	6296	0	1404	394	1798	1190	O6RCX_SN16387
80658	SN16387	18-06-22 12:30:00	6840	102	1088	608	1694	1161	O6RCX_SN16387
80659	SN16387	18-06-22 13:00:00	5968	0	1532	266	1798	1293	O6RCX_SN16387
80660	SN16387	18-06-22 13:30:00	5981	4	1408	386	1794	1278	O6RCX_SN16387
80661	SN16387	18-06-22 14:00:00	5051	802	546	450	994	785	O6RCX_SN16387
80662	SN16387	18-06-22 14:30:00	4474	520	270	470	692	701	O6RCX_SN16387