MyDayLight

How to design a light system for people with Autism Spectrum Disorder that supports them in self-reliance?

Graduation Project Repot for Creative Technology

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Abstract

This bachelor thesis tries to further the research and development of the project MyDayLight. MyDayLight is an ongoing project since 2014 part of Powertools. It has been done in collaboration with the Philadelphia Care Institute, University of Twente and the University of Applied Science of Utrecht.

MyDayLight helps empower adults with Autism Spectrum Disorder by giving them a tool to help them motivate themselves to do and organize household tasks. The product consists of lamps that work as alarms in light form. The user can place one of these lamps in the area where the task should happen, this way they will know which task they need to do depending on the location. They can also input their mood about doing the task. This gives them a moment to reflect on their day and the information will, later on, be used to get feedback from their caretakers.

This graduation report shows literature research on making persuasive health technology for people with Autism Spectrum Disorder as well as the process of building a working prototype for MyDayLight. Finally, this report shows the expert review done to the prototype.

The conclusion of the project is that to design a light system for people with Autism Spectrum Disorder to support them in self-reliance it is important to make the system customizable and take into account the senses sensibility of the users.

Key Words: *Autism Spectrum Disorder (ASD), empowerment, caregivers, Persuasive Health Technology*

Chapter 1

Introduction

1.1 Problem Statement

The diagnosis of Autism Spectrum Disorder (ASD) seems to be raising, the disorder begins in childhood and continues into adulthood. The center of Disease Control and Prevention of the United States [16] has reported that 1 in 68 children have been identified with ASD. The Diagnostic and Statistical Manual of Mental Disorders (DSM-5) [6] divides autism spectrum disorder into four separate disorders. These disorders are autistic disorder, Asperger disorder, childhood disintegrative disorder, and pervasive developmental disorder. This means it is a heterogeneous condition, therefore no two people will have the same exact profile.

The spectrum is large and depending on the severity of the condition, people with ASD will have different living arrangements. Heasley [7] explains that only 17% of young adults with ASD between the ages 21 and 25 live independently. With the right tools, they can achieve empowerment and feel more in control of their lives. Empowerment can allow them to be productive members of society but as well it will improve their relationship with their caretakers. One tool that can be used to achieve this goal is technology.

1.2 GP description

This report is dedicated to showing the work done within the MyDayLight project. It is a project linked to the Philadelphia care institute under the supervision of Jelle van Dijk. This is an existing and ongoing project which tries to empower and give more Independence to people with ASD or light intellectual disabilities.

The project consists of making several lamps that can be placed in different

places of the user's house. In combination with a tablet interface, the user can program reminders at specific hours of the day of tasks they need to complete in the house. The lamp will then light up at the specified moment. It will give the user a noninvasive reminder of activities they need to do, for example, household tasks. This is an improvement from for instance using their smart phones for reminders since it might cause them confusion or distraction from the other features of the phone or if the reminder is not in context with the location.

Before starting a task, the user can also indicate how they are feeling about doing the task. They can see all of this data with their caregivers and it gives both of them an easier way to reflect and discuss how the week went. Finally, the project will be evaluated in an expert evaluation.

1.3 Central Questions

The goal of this bachelor thesis is to develop further the MyDayLight project but also to evaluate it. It is also about making design decisions that support the self-reliance of its users. Therefore this thesis is trying to answer:

How to design a light system for people with Autism Spectrum Disorder that supports them in self-reliance?

To answer the main research question, the following subquestions should also be answered during the literature research, ideation, specification, realization, and evaluation phase. The questions have been divided into research and design questions.

Research questions:

- *How does the target group use MyDayLight?*
- *Does MyDayLight encourage self-reliance of people with Autism Spectrum Disorder?*
- *How do the users identify the different lamps?*
- *How do the users interact with the different lamps?*

Design questions:

- *Which are the best components to use for the product to be testable?*
- *How can the lamps communicate with the tablet application?*
- *How can a wireless charging battery be done?*

- *How can the current design of the casing of the lamps be adapted for the new prototype?*

Chapter 2

Background

2.1 MyDayLight

2.1.1 Concept

2.1.2 Appearance

MyDayLight project has had several prototypes.

Figure 2.1: Previous MyDayLight prototypes. From left to right: 1st, 2nd, and 3rd prototype.

Through all of the iterations of the MyDayLight project the design and the way of interacting with the product have evolved. But the main concept still remains since the 1st prototype. The product needs to empower its users by giving them a different type of alarm, which uses light instead of sound, and that has a scheduling tool.

The last prototype done before this research paper is composed of three lamps that are connected to an Arduino Uno which is connected to the electricity for power supply. The casing of the lamps are 3d printed and they contain

rotatory encoders and RGB LED NeoPixel rings. The lamps can be rotated and it will change colors depending to which side it is rotated, otherwise, it will remain on with a white light.

The lamps are not yet connected to the tablet application. The application is only a mock up for the moment. The application shows a day that has different lamps and each lamp represents an area. In each area, a different type of task is assigned. The tasks can be slid up and down to change the hour at which they should happen.

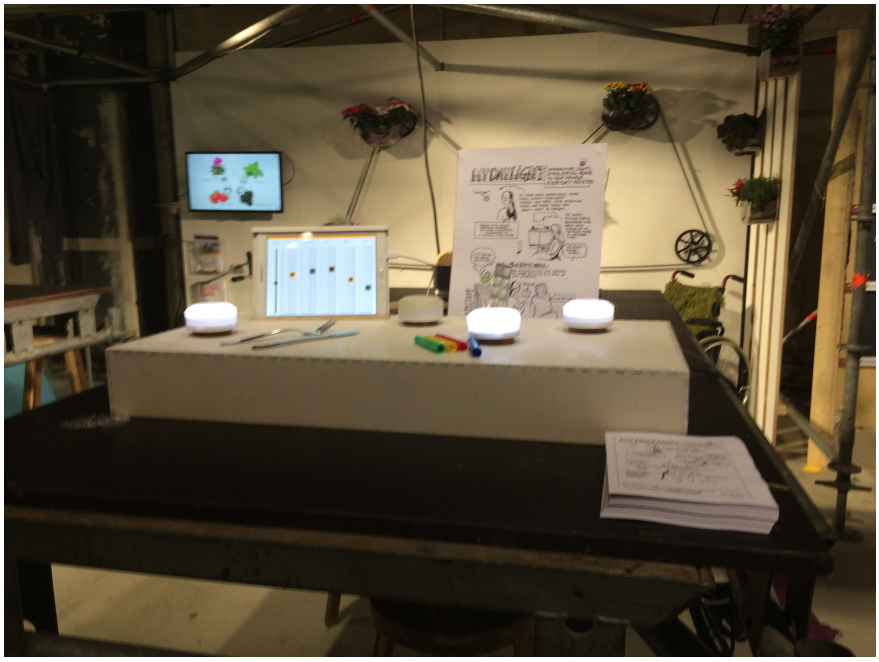

Figure 2.2: 4th MyDayLight prototype used during the Dutch Design Week.

The casing for the lamp was previously designed by Melina Kopke. It was 3d printed and includes 9 separate parts:

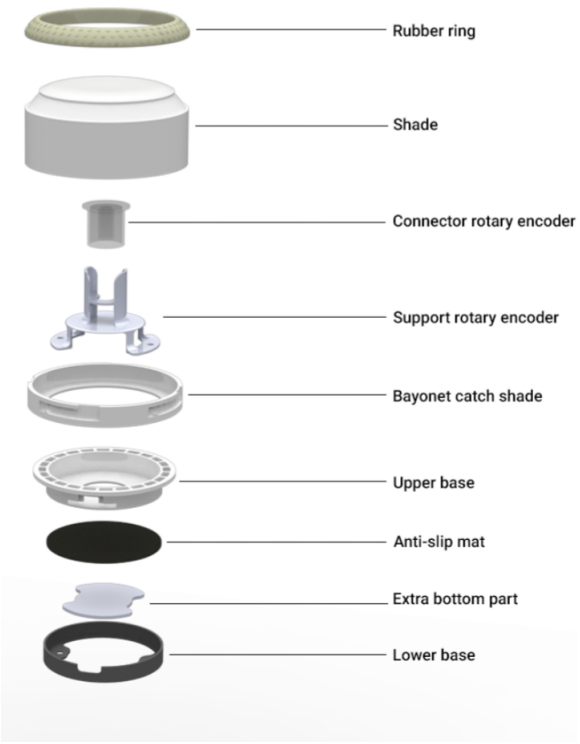

Figure 2.3: 3d printed casing parts.

One of the first ideas was to have a removable battery part so that the user could change the battery without moving the actual lamp. For this idea the lamp casing would change to have two separate compartments:

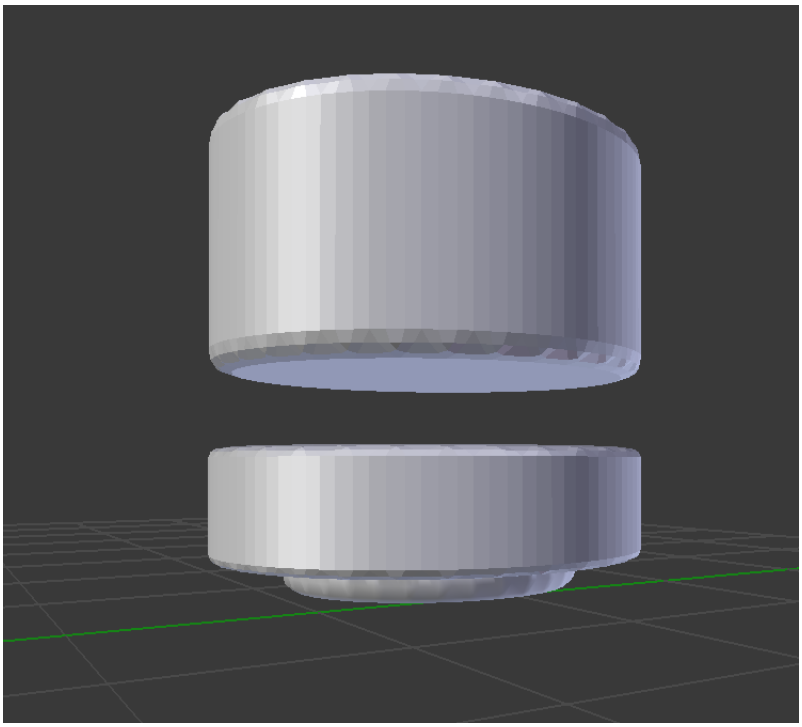

Figure 2.4: Casing modification.

2.2 State of the Art

This state of the art is being done to find what type of products are in the market for task management but as well products made specifically for people with ASD. This is being done to see in which direction the MyDayLight project could go.

Previous to this thesis, other students interviewed Philadelphia institute caretakers of people with ASD. In the interviews done, the caretakers and the patients showed the current way they deal with task management. At the moment the caretakers write on a piece of paper all of the household tasks that the patients need to do. This method is not effective since it does not remind the patients that they need to do a specific task at a specific time. It also, as said by one of the patients, makes them feel like they do not have any control in their lives and that they are being treated as children. At the moment, the patients do not have much say in what goes onto their to-do list.

Task Management

Google Calendar Google Calendar is a good tool to schedule appointments or tasks to be done. It can also send a notification when the time for the next task is approaching. It is a calendar format in which the user can add events or tasks at specific moments of the day or just during a specific day. Calendars can be shared with different levels of authority, therefore in the most open case, everybody with an access to the calendar can also edit it. It is highly customizable since each calendar or activity can have a different color, location time and duration.

Trello Trello is a website and application organization tool for project management. Trello uses the Kanban paradigm as a model of organization. Boards can be created to organize tasks by them and inside each board lists and cards can be made. It is also possible to share a board with multiple people all of whom would be able to edit the board and subsequent cards. This is a good feature for the case of ASD patients and caretakers since they would both be able to add tasks. It has a calendar view since a deadline can be applied to the card. But Trello is not very developed in the reminder section.

Mango Health Mango Health is an application for smart phones which gives notifications on when the user needs to take a certain medication. It also tracks daily the mood of the user. The user can input in the application which medicines they need to take and when. When using Mango Health, the user outsources medication management to the application.

Reflection

Spiritual Me This application helps the users calm down by meditating and reflecting on their day. The application can be used daily and different exercises can be chosen. The first task asked is to indicate the mood of the user, this is done by clicking on a smileyometer. After the first task, the user indicates an attribute of themselves that they would like to change. This is followed by several meditation exercises such as breathing. At the end of all of the exercises, the user is asked which attribute they see improving in themselves and again how they are feeling, this is to show if their mood improved. These last two features are used in and attempt to reflect and give self-confidence to the user.

Filisia Filisia is a form of creative therapy for people with additional needs. The users can interact with 2 to 6 modules for different activities such as sensory exploration, memory training, or storytelling. The product was designed with therapists and actual users. The modules save the data recorded while using them, this data is then used to reflect with therapists. This last feature is very similar to MyDayLight, the design is also similar.

Leka Leka is a robotic ball made for children with special needs. It helps them to motivate, learn and play. By using lights and images in a screen Leka helps these children to do their daily routines such as brushing their teeth. This concept is very similar to MyDayLight, the only difference is that is is targeted to children, therefore, the interactions include more games and more child-friendly actions.

2.2.1 Conclusion

To understand better how these different projects relate to each other, a radar chart has been made to compare them:

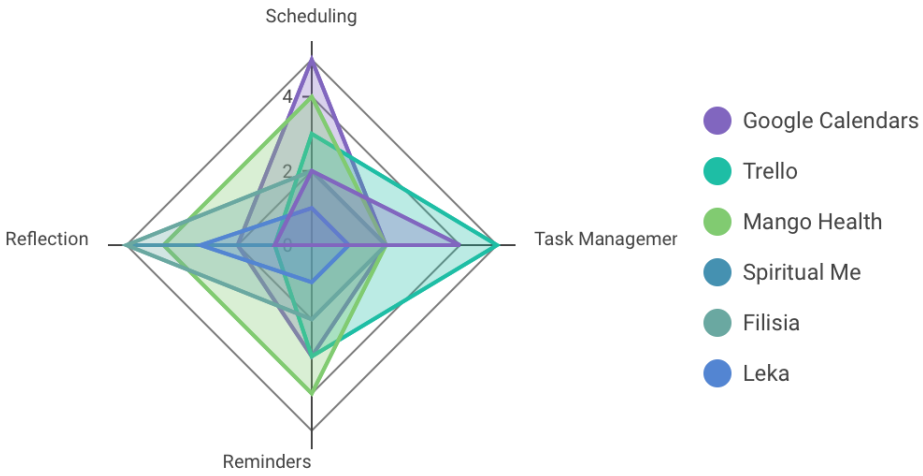

Figure 2.5: Radar Chart of the related work.

The radar chart was made rating each related work from 1 (very bad) to 5 (very good) in four different categories These categories are, scheduling, reflection, task management, and reminders. They were chosen since this are the main characteristics related to the MyDayLight concept.

The first things that can be seen are that none of the discussed projects rank 5 in every category. The ones the rank the highest in the overall categories are Mango Health and Trello. In the only point, Mango Health is laking is in task management, this is because it is a very specified application Trello, on the other hand, is lacking in reflection, this is because it is a task management oriented platform.

MyDayLight needs to succeed in all four categories. It is a mixture of Mango Health and Trello since MyDayLight tries to incorporate a persuasive health technology with a task management system. By using a calendar input system

in the graphical user interface, MyDayLight scores high in the task management and scheduling categories. Since the user can also input their mood and see it afterward, MyDayLight can also score high on reflection. Finally, by being able to add new alarms both from the graphical user interface as well as from the lamp itself, MyDayLight also scores high on reminders.

2.3 Literature Research

2.3.1 Empowering people with ASD

To know how people with ASD can be empowered it is important to discuss in more detail what ASD is and how it affects people. ASD is defined by Autism Speaks [1] as "complex disorders of brain development". Even though ASD is a broad spectrum, some symptoms are similar when it comes to the four different disorders, this can be seen in the graph provided by Autism Speaks [1]. The DSM-5 [6], Lord et al. [13] and Militerni et al. [15] all agree that people with ASD tend to have communication problems, social deficits and repetitive behaviors. Since it is a spectrum, each person will have mild to severe symptoms.

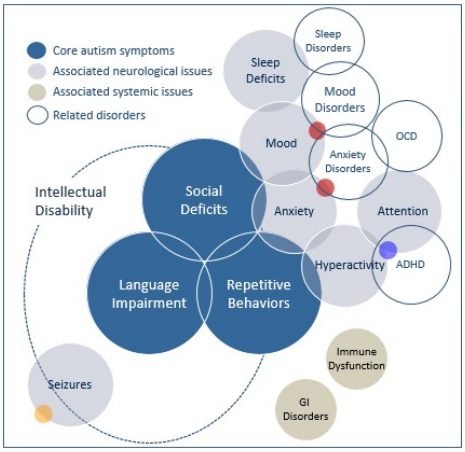

Figure 2.6: Autism Speaks [1] graph showing the different symptoms of ASD.

The symptoms of ASD vary from person to person, but it is important to understand the symptoms to improve them. The DSM-5 [6] explains that communication problems in people with ASD can manifest themselves as inappropriately responding in conversation or as misreading nonverbal interactions. This impacts their social skills. It may be difficult for them to build and sustain friendships. This is also tied to them having a bigger chance of suffering from anxiety and depression problems according to Kim et al. [11]. The second symptom that can be seen is repetitive behaviors. The DSM-5 [6] explains that people with ASD tend to have routines, are sensitivity to change and intensely focused on random items. Militerni et al. [15] also adds that these behaviors are complex and reflect a cognitive inflexibility. A less known symptom, as mentioned by Crane et al. [5] is sensory sensitivity. This means that people with ASD might have unusual responses to sensory input. Crane et al. explains, it is difficult for them to process sensory information and stimuli such as sight, sounds, smells,

tastes and movements. This sensitivity can be expressed by painful, unpleasant or confusing experiences as mentioned in Autism Speaks [1]. Depending on the severity of these symptoms they might be treatable or at least the person with ASD can learn how to live with the symptoms.

To conclude, the main factors involved in empowering people with ASD are helping people with ASD improving in their most prevalent symptoms. These symptoms are communication difficulties, social deficits, repetitive behaviors and sensory sensitivity.

2.3.2 Relationship between caretakers and ASD patients:

When it comes to helping, people with ASD can find themselves with a whole community willing to help. This might include family members, friends but also caregivers. Having a child with ASD can have a big impact on the family, especially the parents as mentioned by Phelps et al. [18], Bellando and Lopez [3] and Krauss et al. [12]. Phelps et al. [18] lists the impacts of having a child with ASD, one of the biggest is physiological implications. The parents interviewed by Phelps et al. [18] mentioned that they gained more empathy in their daily life but they were more likely to having depression because of the diagnosis of their child. Phelps et al. [18] continues by mentioning that the family nucleus is also affected by the diagnosis. Phelps et al. [18] claims it can be stressful for the parents, but also for the siblings, especially since they can be jealous of the attention that is being given to their sibling with ASD. Phelps et al. [18] explains, that families with children with ASD also face social implications since there is still a lack of knowledge on what ASD means and how to deal with it.

Children with ASD need to receive therapies that can be costly, but this external help is essential. Phelps et al. [18] reports that having services and specialized caretakers for children with ASD decreases stress levels of the family, it also gives normality to the family life. Phelps et al. [18] claims these services also allow the child to participate in activities they enjoy. Non-family caretakers can provide appropriate and specialized management to the case of the child. Bellando and Lopez [3] claim that the first step to having a successful caretaker intervention is clearly defining the role of the caretaker in the situation.

In many cases when children with ASD become adults they live semi independently. This means that they live by themselves but from time to time a doctor, nurse or a non-family caretaker comes to help them with their daily activities. Krauss et al. [12] reports that living apart from the family gives the adult with ASD opportunities to learn new valuable skills. Krauss et al. [12] also mentions that these adults also seem to have an increased confidence and independence from living in such conditions, they learn how to be more independent and responsible.

To conclude, having a child with ASD is a big impact for the family. But with

the right support system it is easier to face. Nurses or non-family caretakers can be the bridge between school, doctors and families. Clearly defining the role of the caregiver is essential. Finally, adults with ASD living semi-independently feel more empowered than living with their parents.

2.3.3 Effective assistive technology

Technology can also be used to empower people with ASD. One of the most important factors to take into account is using and working with the caretakers and family members of people with ASD who act as a support system. As Hendricks and Wehman [8] mentions, professionals need to carefully plan for instance transitions from adolescence to adulthood to achieve the empowerment of the person with ASD. This is important since the caretaker and family have the most knowledge of the unique case of the person with ASD. People with ASD can be included even earlier on in the design process. Burleson et al. [4] claims that it is important to include the user by using co-design approaches to design assistive technology. This gives a bigger sense of control to the users. Burleson et al. [4] explains that in this case the assistive technology is not being imposed on the users but they are also deciding what it will contain. Both Hendricks and Wehman [8] and Burleson et al. [4] suggest the inclusion of the users and stakeholders in the design and organization process.

One of the most important things to consider while designing an assistive technology is to prevent product abandonment. This is when users stop using a product. According to Phillips and Zhao [17], product abandonment of assistive technology can lead to decrees in independence, increase in costs and in functional activities of the user. Phillips and Zhao [17] also mention the four factors that are the most significantly related to the abandonment of such technologies. These factors are: not involving the user in the selection process, the device is not easy to get, the device does not work properly and changes in the user needs or priorities. Therefore assistive technology should prioritize the involvement of the need of users as mentioned previously. The best way to do that is to have a personalized device and involvement of the family as Iovannone et al. [10] suggests. Hume et al. [9] suggests using self-monitoring features, this makes the user reflect on their current situation which will help them improve. Another example is video modeling. This type of features removes the feeling of control from a third party such as a teacher or caretaker and instead gives it to the user, as explained by Hume et al. [9].

To conclude, the most important way to make and effective assistive technology is to include the users and stakeholders through the design process. For instance by making co-design workshops with people with ASD and their caretakers. It is equally important to prevent product abandonment. This will be achieved by the above mentioned but as well by making personalized devices and by prioritizing the needs of the users.

2.3.4 Target User

The target user of this project are adults with ASD who live semi-independently. From research done as well as talking with experts and proxies the following personas were developed to represent the target users:

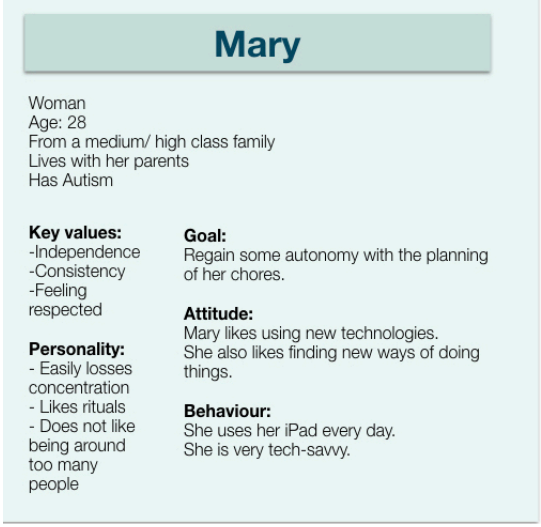

Figure 2.7: 1st persona.

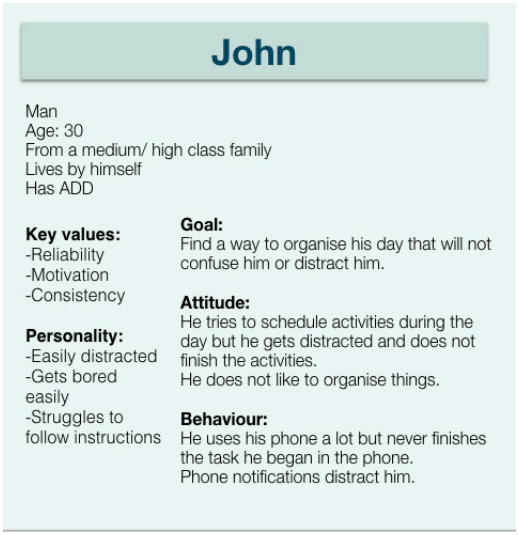

Figure 2.8: 2nd persona.

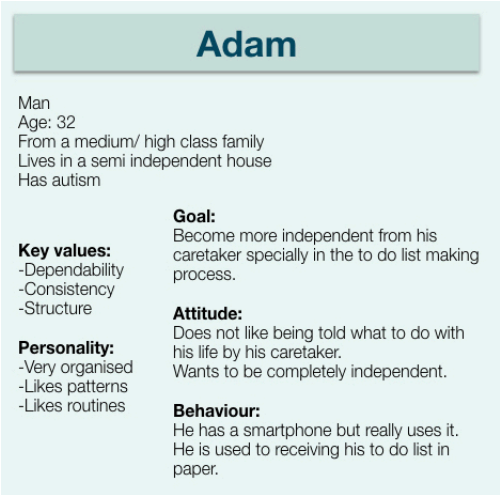

Figure 2.9: 3rd persona.

2.4 Conclusions

From the research done it is possible to answer how technology can be used to empower people with ASD. One of the most important factors in empowering people with ASD is for them to live semi-independently. It is important for them to have the right support system, whether it is their family or caretakers. To improve the relationship of caretakers and people with ASD it is important to help the latter communicate better. A way to achieve this is by clearly defining the role of the caretaker. In terms of assistive technology, it is essential to prevent abandonment. To prevent it, the technology should be customizable to each individual case and it should include the user and its support system in the design process. Personalization is especially important with users with ASD since each individual case is unique and their treatment should be as well. The sensory sensibility of people with ASD should be respected. Finally, they should be able to decide how to organize things themselves since they have a preferred specific pattern they want things to be done. These findings apply both in how to treat someone with ASD and how to design a product for people with ASD.

To improve MyDayLight, the product should be continued with the above-mentioned facts in mind. As well, it should combine the features of the related work. It should have a scheduling feature, task management, reminders and a good reflection system.

Chapter 3

Methods and Techniques

3.1 Stakeholders of the Thesis

The stakeholder map on the right analysis the different stakeholders interested in this thesis, project, and process. The stakeholder map was used to visualize these relationships since it gives a quick visual overview of the situation. Bellow is a detailed description of each stakeholder:

- ***Jelle van Dijk*** *is the client and supervisor of this project and thesis. He has the highest interest on the project since he has work on it since 2014 and he wants to further the project as far as possible.*
- ***Richard Bults*** *is the coordinator for the thesis and he deals for instance with the scheduling and deadlines of the thesis.*
- ***Angelika Mader*** *is the second supervisor fo this thesis.*
- *The people that previously contributed to the* ***MyDayLight project*** *are interested in the project since this project is based on the previous work they did.*

Figure 3.1: Stakeholder map.

- *Part of the **Powertool research group** was involved in the project by having two meetings in which feedback was given to this and other projects.*
- *The **experts** who reviewed the project are also potential clients and users of the project. They expressed high interest in the project. One of them is also willing to collaborate further.*
- *The **clients and users** of this project have high interest in the project working as well as high power in steering its direction.*

3.2 User Study

3.2.1 Literature Research

A literature research was done for this thesis to analyze the target user, make personas but to also answer several questions relevant to the project. The questions that needed to be answered where:

- *Which factors are involved in empowering people with ASD?*
- *How can effective assistive technology be designed?*
- *How can technology facilitate the relationship between care-takers and ASD clients?*

The first question tries to find concrete factors on how people with ASD can be empowered but it also answers what is ASD. The second question is broader and it asks which are the factors make an effective assistive technology. The final question was formulated after doing a literature matrix for the first two questions. The literature matrix can be seen in the Appendices C. To finalize the literature matrix and to find the necessary literature this search terms where used: *Autism Spectrum Disorder (ASD), empowerment, caregivers, and persuasive health technology.*

This literature research helped define further the questions for this thesis. It also helped in making guidelines on how to build the prototypes.

3.2.2 Personas

The personas were made from information from the literature research, conversations with Jelle van Dijk and from the expert review. They are used to get an overview of who are the type of users of the project.

3.3 Project Phasing

3.3.1 Planning

This project followed the Creative Technology Design Process [14]. The project went through Ideation, Specification, Realization, Evaluation and Reflection which correspond to the chapters 4-7 of this report. This phases were also used as iterations during the different prototypes.

3.4 Evaluations

3.4.1 Powertool Research group feedback

During the project, the different prototypes were showed to the supervisor and client but also during two meetings of the Powertool's research group. Powertool is the bigger project MyDayLight is part of. All of the projects in Powertool try to empower people with disabilities. The members of the research group are doing similar projects to MyDayLight. Therefore they provided, in an informal setting, feedback on how to improve the prototype and in how to conduct the expert review.

3.4.2 Expert Evaluation

At the end of the project, an expert review was conducted.

Participants

The participants were two men who both have Aspergers. Both of the participants work in a technology workshop lead by Edwin Dertien, called ASSortiMENS [2]. ASSortiMENS [2] is located in Oldenzaal and it is a workshop for people with ASD. Both of the participants have a technology background by working in the workshop and volunteered for the evaluation after talking to Edwin Dertien.

Setting/ Context

The evaluation was done in an informal setting. The goal of the evaluation was to test the interaction of the prototype as well as getting feedback from experts and clients on how to improve the prototype.

Task/Activity

The project's goal was explained to the participants as well as how to use the Prototype 3. They were then asked several questions about the concept, design, and interaction of the prototype. These questions can be seen in the Appendices. Finally, they interacted with the prototype.

Data gathering

Two people were present to do the evaluation. One was conducting the evaluation as well as making notes and the second person was dedicated to writing notes of the evaluation. The notes can be seen in the Appendices.

Data processing

After the evaluation, the notes were used to make a summary. The summary can be found in the Appendices.

Chapter 4

Ideation

4.1 MyDayLight concept

MyDayLight is an ongoing project since 2014. Therefore the concept of what the product was going to be already existed. The concept is to have around 10 movable lamps. These lamps are used as light alarms. The lamp should also have a way to input the mood of the user before doing the task. These concept was used for this thesis as well.

The requirements that still needed to be figured out were: how to make the device stand alone, that it can be used without connecting it to the computer. For this to happen it was important to figure out the best way to power the lamps as well as which board to use. The lamp should also be connected to the Internet so it can receive the input of a tablet or a graphical user interface. Finally all of the hardware components needed to fit in the current design of the casing with minimal changes to it.

Figure 4.1: Concept and casing.

All of the components that needed to be chosen were chosen by doing research and by trial and error.

4.2 Interaction

The user needs to be able to interact with the lamp in several ways. These actions were decided from the client's demands The main actions that the user should have were:

- *When the light alarm is on, the user should be able to indicate how they are feeling from two specific moods.*

Figure 4.2: Colors of different moods.

- *The user should be able to tick off that they are done with the task.*
- *The user should be able to add a new task to the lamp.*
- *When the light alarm is on, the user should be able to indicate how they are feeling from two specific moods.*

The flowing flow chart shows the interaction scheme the lamps need:

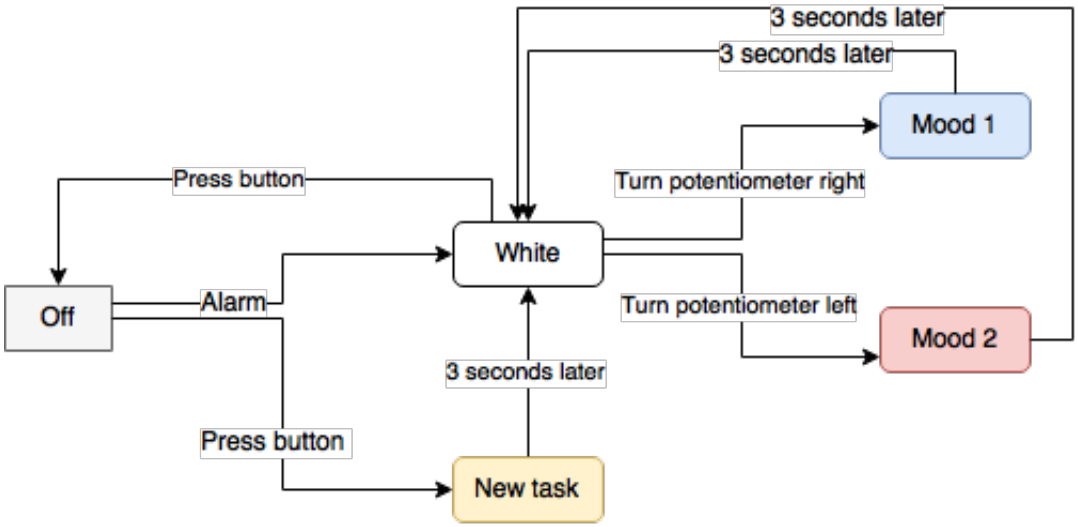

Figure 4.3: Interaction flow chart.

Therefore, a typical interaction with a lamp would be: there is an alarm, therefore, the lamps turns on to white, then the user can indicate their mood by turning the lamp right or left. The lamp changes to the color of the chosen

mood and after 3 seconds it goes back to white. If the user is done with the task they can indicate so by pressing the lamp. The lamp will then go off. If the user would like to create a new task they can do so by pressing the lamp again and the loop restarts. This can also be seen bellow in the use case scenario:

Main Success Scenario	Step	Description
U: User S:System	1	U: User adds household task reminder in their tablet.
	2	S: At the specified time the light in the lamp will turn on.
	3	U: The user goes to the area of the lamp.
	4	U: The user tells the lamp, by turning it to the left or to the right, how they feel about the activity.
	5	S: The lamp changes the color to show the input given.
	6	S: The lamp sends the information to the tablet.
	7	S: The tablet saves the information and shows it in a weekly view.
	8	U: The user and their caretakers see and discuss the progress made that week.

Figure 4.4: Use Case Scenario.

For the interaction, other possibilities were also considered. For instance having the mood as a mandatory interaction. This means the user would not be able to turn the lamp off unless the mood was added to the lamp. This was later on disregarded. Other things that were considered were how long the press of the button and turning the lamp should last so that the lamp does not register a mistake.

Chapter 5

Specification

The hardware requirements for the project MyDayLight include:

- The lamps need to be programmable through Wi-Fi.
- The lamps need to be easily charged without moving them to location.

For this to be accomplished, the current design of the casing of the lamps will be modified to incorporate the new hardware, it will be slightly wider. As well, the Arduino UNO previously used was replaced by a Genuino MKR1000 with ESP8266 Wi-Fi, it will allow the lamps to communicate via Wi Fi. The Genuino MKR1000 also includes a battery module that can be used with an lipo rechargeable battery.

5.1 MoSCow

The action points that needed to be taken during the project were decided after meetings with the client of this project as well of researching the possibilities. The user should be able to have a setup as shown bellow with the different lamps.

Figure 5.1: Setup of lamps in the house.

From the previously mentioned information the following MoSCoW actions were decided:

Most Include	Should Include	Could Include	Wont Include
WiFi connection Lamp to App	Redesign 3d casing	Arduino sleep mode	Graphical User Interface
Rechargeable battery	Tap lamp for new task	Signal lamp needs to change battery	
Lamp light up when scheduled task is due		Removable rechargeable battery	
Rotate lamp to say how the user is feeling		Wireless chargable battery	
Make 10 working lamps			
3d print 10 modified casings			

Figure 5.2: Table showing the Most include, should include, could include and won't include of the project.

Chapter 6

Realization

6.1 Prototypes

6.1.1 1st Prototype

The first prototype made consists of a light reminder made out of an Arduino UNO, breadboard, led, button and a tiny RTC module. The goal of this prototype was to experience using the lights in a house. This helped in figuring out which would be potential problems and uses for the lamps.

This prototype can be programmed in Arduino to a specific time in which the light will go off. Afterward, a button can be pressed to turn off the light. It can be used connected to a laptop or with an USB electricity plug.

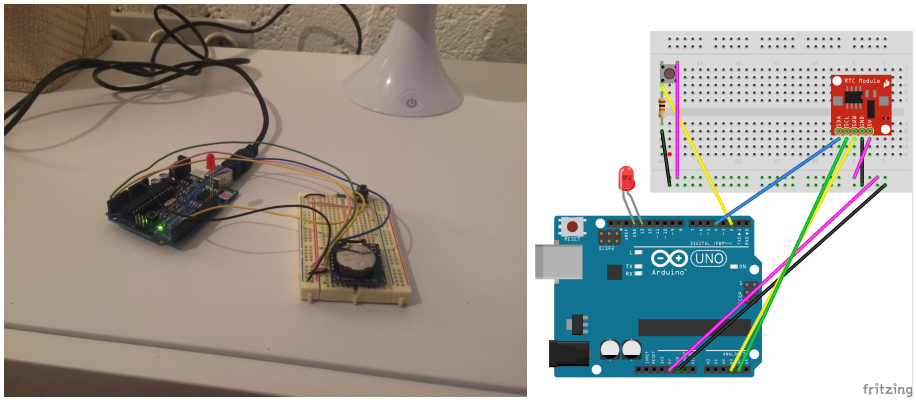

Figure 6.1: First prototype and its schematic view.

For this prototype, all of the hardware parts need to be upgraded. But, it helped to understand better the importance of the lamp being movable. It also

showed that, ideally the lamp should not be used for reminding someone to take medication or tasks that need to happen immediately after the alarm. Since the lamp is not always visible and it is a gentle reminder it can be easily ignored.

6.1.2 2nd Prototype

The second prototype consists of a light reminder made out of a Genuino MKR1000, breadboard, Adafruit Neopixel 16 ring, button, potentiometer and a lipo rechargeable battery. The goal of this prototype was to further the development of the previous prototype to be able to test it. Another goal of this prototype is to use it to determine which type of interaction the user should have with the lamp as well as testing the hardware.

This prototype can be programmed in Arduino to a specific time in which the light will go off. It can be used connected to a laptop or with only connected to the lipo rechargeable battery.

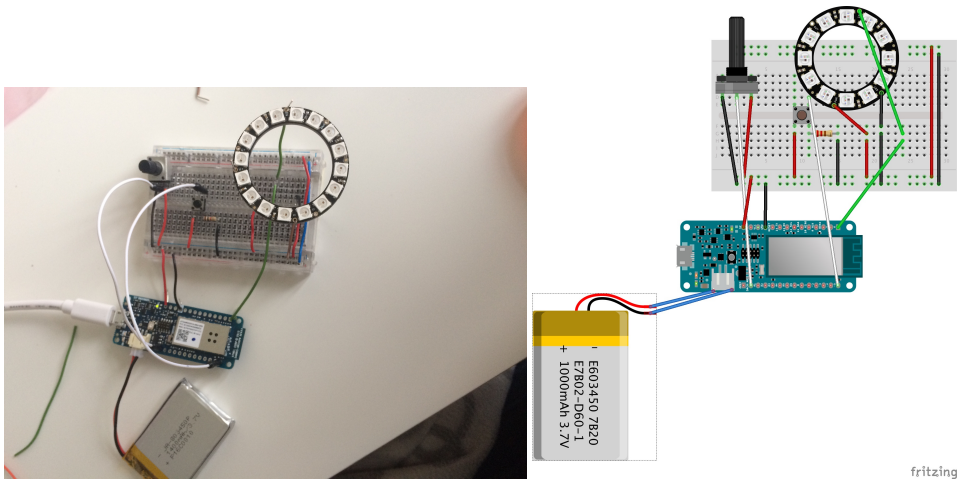

Figure 6.2: Second prototype and its schematic view.

Some of the issues encountered in the previous prototype were fixed for this one. Since the Genuino is connected to a lipo rechargeable battery, the prototype can be easily placed anywhere. The Genunio contains an RTC module, therefore, it is no longer necessary to use a separate module. The time counter is therefore more accurate now. The size of the Genuino is one third of the size of the Arduino UNO which allows this prototype to be smaller and more portable. The red LED has now been replaced by a Neopixel ring which allows the lamp to have any color or pattern wanted. As well a potentiometer was added to show how the user is feeling about doing the task.

There are several things that could still be improved for the next prototype. One of the biggest problems of this prototype is that it can only be programmed once. The Arduino needs to be connected every time if a new reminder will be added. It also can only be changed in the code.

6.1.3 3rd Prototype

In this prototype, the code issues were fixed. The hardware stayed the same. Now several alarms can be programmed. Timers can also be set through the console of processing. Finally, Arduino and processing are being used together to send and save in a text file the sensor information of Arduino into processing. Also, it is now possible to set the alarms through processing. This exchange can be seen bellow:

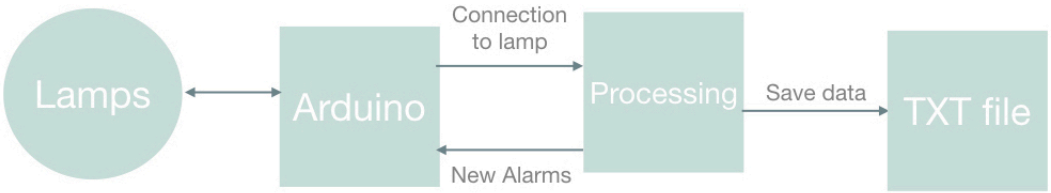

Figure 6.3: Flow chart of lamps.

The potentiometer and button were replaced by an encoder with a pushbutton. This reduces the number of sensors used to one instead of two separate ones. The casing of the lamps previously designed and 3d printed are being used. But the casing is to small for the cables, therefore the cables, battery and board are inside of a small laser cut box.

Figure 6.4: Final Prototype.

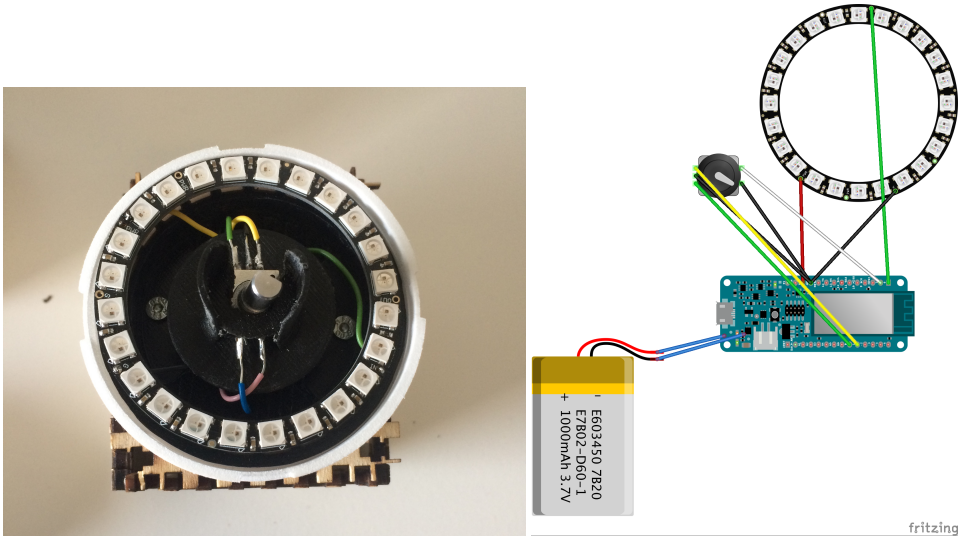

Figure 6.5: Hardware of prototype and its schematic view.

For this final prototype, three lamps were made.

Figure 6.6: Final Prototype lamps.

The interaction with the lamps has stayed the same, the difference now is that the casing is being used. The user can turn the lamp to change the mood as well as pressing the lamp to turn it off or on.

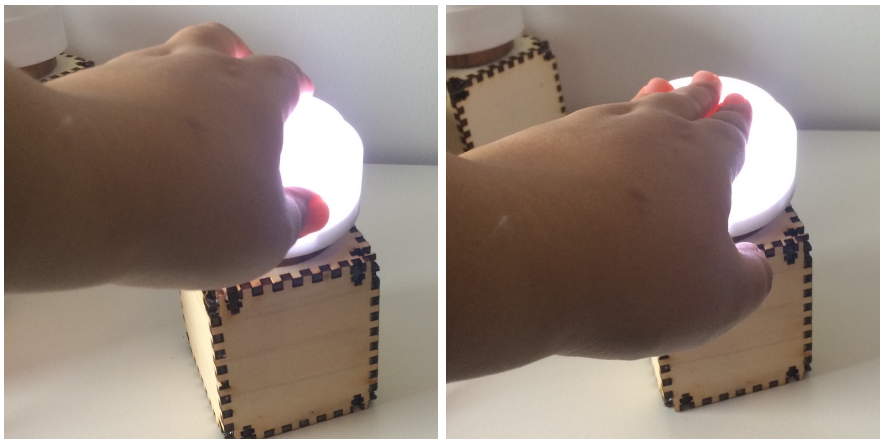

Figure 6.7: Turning and pressing the lamp.

At the moment there are two moods the user can choose. Turning to the left results in the lamp turning blue, and turning to the right red.

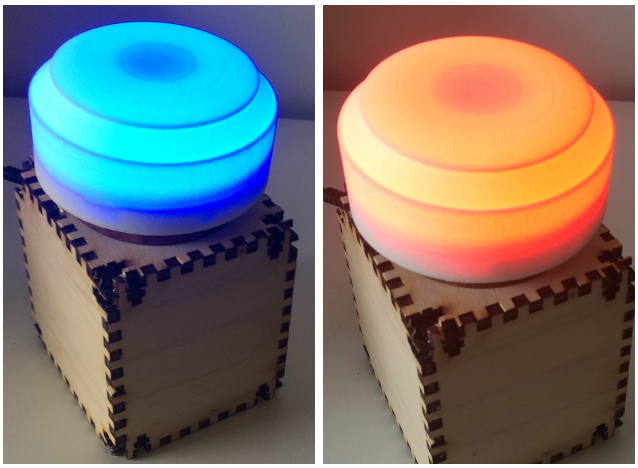

Figure 6.8: Turning and pressing the lamp.

6.1.4 Bigger picture

When the graphical user interface is made, the lamps will be able to be connected via WiFi to the tablet. Alarms would be made from the tablet. It would also save all of the sensor information and show it in a visualization or just saved in a text file. The lamps would be able to be identified by an id. This can be seen in this flow chart:

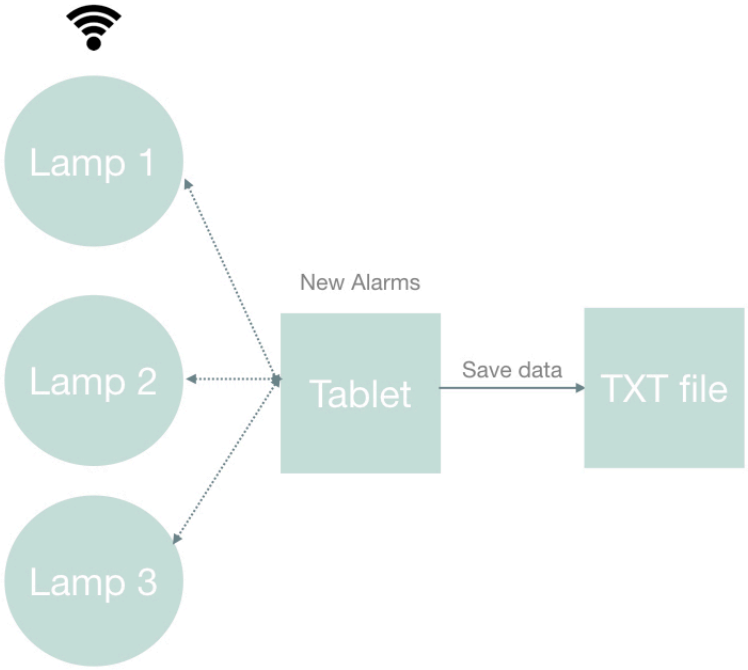

Figure 6.9: Flow chart of lamps and tablet system.

Chapter 7

Evaluation and Reflection

7.1 Expert Reviews

An expert review was done to get feedback on the latest prototype done.

7.1.1 Participants

The two participants were two men who have Aspergers. They work in a technology workshop dedicated for people with ASD. Both of them are very knowledgeable in technology and they live independently.

Both of the participants expressed the difficulty they experience doing the laundry. They both mentioned that they can get very distracted and forget about doing the laundry or they forget to take the clothes out of the washing machine.

Both mentioned that the lamps or this type of persuasive technology would only work if the client is willing to try it. The older the client is the less likely they will be to embrace change. It is easier to incorporate such a system in the lives of children. This is also related to, as they mentioned, they need to do things their way. One of the participants mentioned that he has authoritarian issues. As soon as someone asks him to do something, he will not want to do it. The decisions need to come from them, not other people.

7.1.2 Setting and Context

The expert review was done in a room with the two participants and two people conducting the review. It was done to get the target users to give feedback on the prototype.

The questions asked were mainly about the concept, design, and interaction of the prototype, The main questions asked were:

General system questions:

- How would you use the system?
- What would you use the system for?
- How many lamps would you use?
- How would you identify the different lamps?

Specific system questions:

- Would you add your mood
- How would you prefer charging the lamps?
- How would you interact with the lamps?

7.1.3 Task and Activity

The interviewers asked the two participants the questions mentioned previously. Afterward, the participants were able to try the prototype and ask their own questions about it.

7.1.4 Data Gathering

The notes taken during the review can be seen in the appendices.

7.1.5 Data Processing

The resume done from the notes can be seen in the appendices.

7.1.6 Results

The results of the expert review confirmed the literature research done as well as assumptions made about the prototype and its target users. The feedback received can be divided into three sections, concept, design and interaction.

Concept

Both of the participants liked the concept of the project. Especially one of the participants who is even interested in buying such a system and testing it for a longer period of time.

The participants agreed and said that they would mainly use the lamps for daily activities such as doing the laundry. It would be specially useful for tasks that do not happen every day but for example weekly activities. Since they would use it for precise weekly activities they would use one lamp for each activity and they would prefer to have only one alarm in each lamp. The lamp

would have one purpose only. They would also leave one lamp in a specific place since they would like the lamps to become part of their routine. One of the participants mentioned that his ideal scenario would be that the system becomes so much part of his routine that five minutes before the lamp goes off he would already be in the place to do the task and the lamp would become a backup plan. This also means that the lamp would be semi-permanently located in one place.

The amount of lamps they would use would depend on how big the house where they are going to be used is. Both of the participants live in small apartments. One of the participants said that the living room and the kitchen are in the same area of his apartment. The other participant said that his washing machine is in the bathroom. Therefore in this type of places they would use no more than three lamps. One of the participants said that it would be overwhelming having so many lamps. He would like the system to become a sustainable part of his routine.

Some thing that worried them of the concept itself was the data sharing. They would want to have full control of who can see this information. Other general remarks were that the lamp could be used as a wake-up alarm and that people who are deaf could benefit from it.

Design

Since ideally the lamps would be in the same place in a semi-permanent way the sticky bottom part of the lamp is very useful. In a final product version of the project, the lamp should be possibly waterproof since the lamps might be near water or humid areas such as in the kitchen or bathroom. It should also be made out of a cleanable material.

Interaction

The common theme that came up in the review were the senses. People with ASD are sensitive to the senses. They can be triggered by things as sounds, light or touch and it is difficult for them to calm down after it.

For the lamps, it is important to take this into account. For instance one of the participants is triggered by light and because of this, his house is very dark. He mentioned that the lamp was still fine for him but it was in the border of him being fine with it and potentially being annoyed by it. For him, the ideal would be to be able to control the brightness of the lamp to suite his preferences and limits. In most of the features of the lamp, the ideal would be for the user to choose what they prefer. For instance one of the participants mentioned he would prefer using a spectrum of red and green to identify his mood since for him those colors represent good or bad. Especially having a non-binary mood

input system.

The participants strongly advised not using sound as a method of catching their attention. Both of the clients have problems with repeating sounds such as alarms. That type of sounds can trigger them. One of the participants compared it to having the light as a gentle reminder of please do if you want a certain task. While the sound needs immediate action, will frustrate them and it is obliging them to do somethings. It becomes an obligation.

With the last sense relevant to the project, touch, they mentioned that the final product should have a smooth material so that the client is not triggered by it. The grip the lamp currently has is unnecessary.

The input of mood should not be mandatory since it will frustrate the client.It could be voluntary and become a sort of mood diary. It should maybe include a nonbinary mood entry and also a neutral mood.

In more practical matters, they said that the time to press the button should be shorter and it should have a bigger press area of a whole 2-3 cm. For the battery the best solution would be to replace the battery since they would not be willing to change the lamp of location, the lamp could blink or light in a different color to change the battery.

7.2 Reflection

7.2.1 All stakeholders

This project affects not only the clients with ASD or light intellectual disabilities but also their support group, their caretakers, and families. Therefore they are also stakeholders of the project and each group is affected by different possible ethical problems. Another stakeholder that is important to consider is people without any disabilities who choose to use the product. Lastly, the other stakeholder of this project is the University of Twente and Powertools which are the two collaborators of the project.

The first group that is involved and will have the most consequences of the project are the clients with ASD or light mental disabilities. The goal of the project is to change the way this stakeholder organizes their daily household chores. Therefore if the project is successful with that goal, it will have an impact on the wellbeing of the clients. It will change their day to day behaviors and habits. It will also bring the clients happiness.

The client's privacy will also be compromised since they will input how they feel about doing a certain task into the lamp. They will be the ones to decide whether or not they want to share this information but ideally, they will share

it with their caretakers.

One of the biggest ethical problems the project faces is that it will steer the behavior of the users. As previously mentioned the goal of the project is to change the way the clients organize their daily household chores. The clients themselves chose which chores they want to do and when. But in comparison to the current way of organizing chores the lamps will be more invasive and will more bluntly steer the behavior of the clients. Currently, the caretakers make a to-do list on paper of the tasks the client needs to complete. If the clients do not read the paper they will not remember to do the tasks. In the other hand, the lamps will send notifications in light form to the client implying that the client needs to do a task in a very precise area of their house. If the client does not want to do the task and do not interact with the lamp the information will be saved in the system and can be seen in the tablet by the client and possibly their caretaker.

The second most important stakeholders of the project are the caretakers. The project will also have an impact on their wellbeing and the way they interact with their clients. Since the to-do list will now be made by the client instead of the caretaker, the caretakers will lose some control over what the clients do as household chores. This in combination with the reviewing of the client's results will change the relationship the client and the caretaker have. They will interact in a slightly different way. In difference to before they will now be aided by a tablet to review how the client did during the week and with this information, they will be able to see how the client can improve in the future. If the project is successful, it will be easier for the client and the caretaker to communicate since they will have the visual support mentioned earlier. In interviews previously done to the caretakers they said that using such a system allowed them to have an easier and deeper conversation with their clients since they had a starting point of conversation with the tablet.

In the current state of the project, the family of the clients are not as involved as the caretakers, but the families might also be affected. They might want to be more involved in the client's life and the decisions they are making through the lamps. Especially, they might want to have access to the results of the client which might be trespassing the privacy of the client since it will include much more detailed information the family did not previously have. This can lead to the family making decisions of the client basing themselves with the results of the application.

For the families as well as for other people that are not part of the immediate scope of the project will hopefully change their expectations on how people with certain disorders can live independently or semi-independently. This might lead to a wider acceptance of people with ASD and light intellectual disabilities, therefore an easier integration for them into the community and society.

The people that are not part of the current target group might use it as well, it could also be useful for them to organize their own household tasks but the feedback mechanism might not be as interesting for them since it is made for a caretaker to review. For instance, a parent might use the product with the feedback mechanism with their child but the second part might not be interpreted properly which might cause tension and misguided actions.

This stakeholder might also not know how the lamps work and misuse them. They could be used as a light wake up alarm clock or as a light show, by just programming different lamps to set off at certain moments. This last scenario happened with a previous prototype of the lamps was being tested with the clients.

In a more negative scenario, the lamps functions could be exploited. If someone hacks the lamps they will have access to private information about the client. This information could be used against the client if for instance on a particular day they said they were not feeling good about doing a certain activity. If hacked the setup of the lamps could also be changed and disrupt the day of the client, this might be dangerous if for instance, the user programmed one of the lamps to remind them to take medicine.

7.2.2 Main stakeholders

As mentioned previously the main stakeholder of the MyDayLight project is people with ASD or light mental disabilities that live semi-independently. They are also the ones who will be the most severely affected by the project. Some of the changes they will encounter will be related to their behavior, habits, expectations and opportunities.

The main behaviors that will change are how much independence and how empowered the users are of their own lives. The way the user organizes their house will potentially change to accommodate and use the 10 small lamps. This also entails a change in the way the user plans chores in the house. Ultimately the product will change how the user interacts with their caregiver. Before the product, the caregiver had much more control on the activities the person with ASD was going to do. This will allow the user to have more independence by making more decisions themselves. But, with the lamps the caregiver will have a better picture of how the user is doing, therefore if the client did not want to do a certain task the caregiver will be able to see it when before if the user wanted, they could potentially lie to the caregiver of having done the task.

The habits of the user will also change since a new technology, which they will use every day, is being introduced to them. Their day will change and they will relay much more in the lamps to now what to do next. They will now be steered into having a specific behavior or doing certain tasks.

Hopefully, the user's expectations will also change, mainly in what it means to live semi-independently and independently. The product is trying to make it easier for them to obtain empowerment and independence, therefore, it will hopefully change the dynamic on how it is perceived and done. What is expected from people with ASD will also change as well as what they expect from their caregivers. With the product, the caregiver will be there more for support and advice rather than actually planning the day to day of the users.

Ultimately, MyDayLight will help people with ASD to learn how to be more responsible and independent which Krauss [12] shows that living independently is very beneficial for the personal growth of people with ASD, it is much more beneficial than staying in their parents' home. If the product is successful it will have severe and long-lasting changes in the users' lives.

The likelihood of the user benefiting and especially adopting the product is difficult to predict. One of the reasons is because the prototype has only been tested by a couple of users. Another reason is that the DSM [6] shows that it is difficult for people with ASD to embrace change. The user needs to be willing to try something new and that can be hard considering their condition. It is also difficult to design a product for people with ASD since the condition is complex and depending on the person they will have a different level of severity of symptoms which will change their willingness to change or even understand how to use the product, as explained in the DSM [6] .

7.2.3 Preventive Measures

One of the best ways to make sure people with ASD adopt the product is by making it easy to use and include personalization. This are characteristics that also correspond to techniques to avoid technology abandonment, as Phillips and Zhao [17] explain this means that the client stops using the product after a certain time period. The positive consequences of the project will not happen unless the client uses it constantly for a long period of time.

For the behavior steering, it is important to include the client, caretakers, and families in the design of the product. The early stages of the project included co-design workshops to brainstorm and decide together which behaviors are important to address and how. The user should have control over those decisions while still improving their behavior. Another important factor is to also include the clients and caretakers in the testing phase, they will ultimately be the ones to know if the product is successful or not and whether they are interested in using it.

The privacy is an important ethical problem the project faces, but because of time constraints, this will not be inside the scope of the project. But it should

be addressed during future work of the project. For the time being to respect the client's privacy, their real names will not be used while writing about the project, the data will not be publicly shared and the testing will be planned in advance and approved by both the caretakers and the clients.

Chapter 8

Conclusion

The expert evaluation confirmed the findings of the literature research. No two people with ASD are alike. Their symptoms may vary in type and severity. To successfully design for them it is important to include them in the design process since, ultimately they are the ones who know best what they want and need.

As well it is important to prevent the abandonment of the product. The persuasive technology is not going to be successful unless the user uses the product for an extended period of time. The most important factor to take into account to achieve this is to have a highly customizable product. The product should be able to adapt to the changing needs and wants of the user. In the case of MyDayLight, the user should be able to choose things like:

- The colors of the lights.
- The brightness of the lights.
- Who can see their data.
- How many lamps the user will use.
- How many alarms each lamp will have.
- Where the lamps will be placed.
- Adding a mood or not.

In the design aspect, the best board to use for MyDayLight is the genuino MKR 1000. It can connect to the Internet and it has a port for a lypo rechargeable battery. That is the ideal battery to use since it is small, movable and easily chargeable.

For the interaction of the lamp what was chosen was to have four different stages. The lamp is off, on, in mood 1 or mood 2. The user can decide if they add their mood or not and they can add a new task by just pressing the lamp.

Chapter 9

Discussion and Future

In the future, one of the most important things to do is to test the product for several weeks in the house of a client. To do this what is still missing is:

- Connect lamps to a graphical user interface.
- Modify casing to fit the board, battery and encoder.
- Make a custom board so that the cable management is easier.

The online platform IFTT could be used to program different alarms using Google calendars and

Some other features could also be included in the interaction with the lamp. For instance:

- Implement a snooze button to skip an alarm.
- Show how much battery is left in the battery.

As well, it would be important to check the ventilation of the lamps. At the moment it is not a problem but maybe while using the lamps in a long term they might heat up.

It would also be interesting to explore different target users, since this product could be beneficial to a lot of different people. For instance people who are deaf could use it.

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Appendices

Appendix A

Project schedule gantt chart

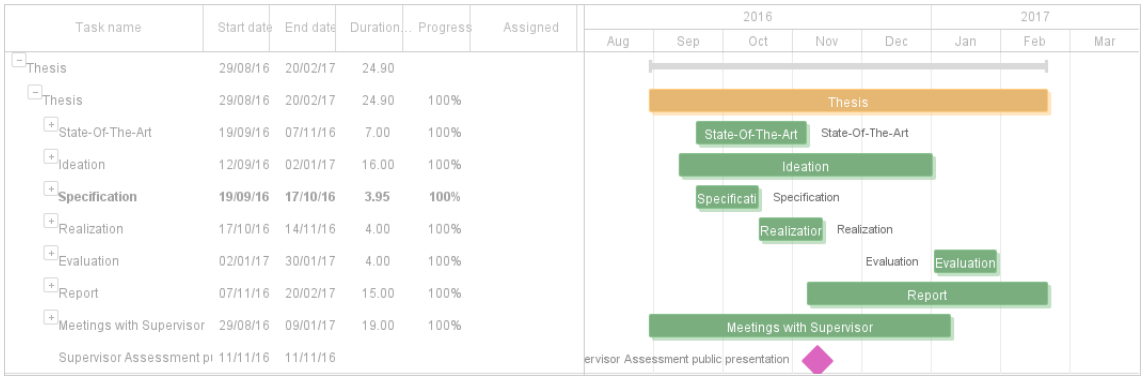

Figure A.1: Project Schedule.

Appendix B

Question mind map

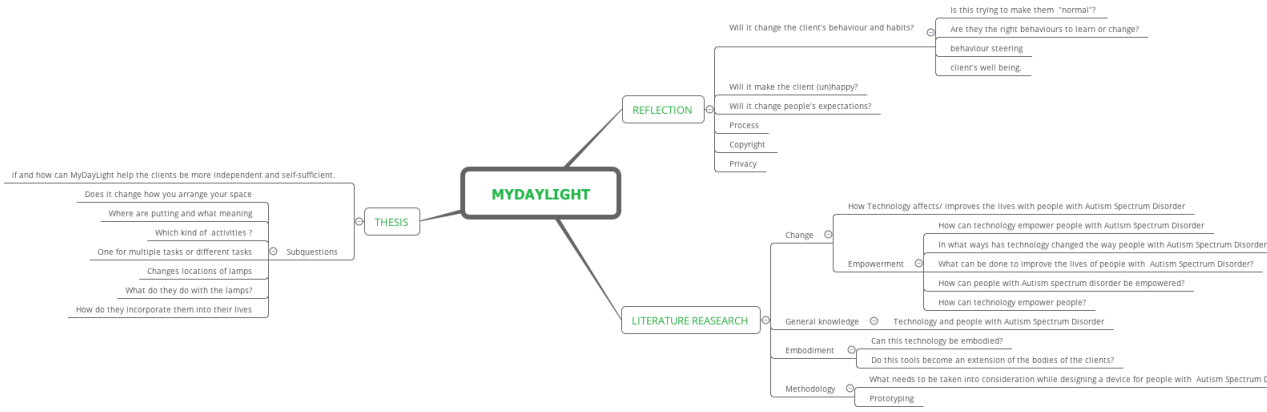

Figure B.1: Questions mind map.

Appendix C

Literature Matrix

	A	B	C	Conclusions
1. Which factors are involved in empowering people with ASD?	Professionals need to carefully plan for instance transitions from adolescence to adulthood. [7]	Using Co-Design approaches to de- sign the assistive technology [3]	Using self-monitoring, video modeling, and individual work systems. These approaches have in common the removal of stimulus control from a teacher or interventionist to an alternative individual- controlled stimu- lus. [8]	The people that are affected by the situation should be included in the design and planning process. In this case the caretakers and the client who has ASD, they are the ones with the most knowledge of the situation. This is especially useful when designing assistive technology. The most important part is to involve the client, so
2. How to deign an effective assistive technology	Four factors were significantly related to aban- donmentlack of consideration of user opinion in selection, easy device procurement, poor device performance, and change in user needs or priorities. These findings suggest that technology- related policies and services need to emphasize consumer in- volvement and long-term needs of consumers to reduce device abandonment and enhance consumer satis- faction. [16]	These core el- ements are (a) individualized supports and ser- vices for students and families, (b) systematic instruction, (c) comprehensi- ble/structured learning envi- ronments, (d) specialized cur- riculum content, (e) functional ap- proach to prob- lem behavior, and (f) family involvement. [9]	Practitioners will likely customize programs to meet the individ- ual prompting needs of each student.	The client needs to be included and as well the device should be personalized for them. Their support sys- tem should be involved such as their family members or caretakers.
3. How can technology faciltate the relationship between care- takers and ASD clients?	One problem, in- ability of children to participate in the routine. Less than half the caregivers have solutions with AT for it. Re- search indicates caregivers have large misconceptions about what AT is and receive minimal support from their early intervention providers in understanding	It is difficult which therapy or method to use since each case is very unique. Ir can also be difficult to notice which therapy actually worked. Data is an important part in making a decision on the child and technology can help with capturing and deciphering it. Design considerations: understand the domain, make changes invisible, the easier the better, customizability is critical. Design challenges: difficulties relying on input of children, hardware for on body sensing, ethical and privacy issues. Changes are very difficult for people with autism who rely on a strict routine. The caregivers might be from very different backgrounds so the technology needs to be easy to use and to understand. Since each case is very unique the technology should support this and have a tailored aspect to it.	Only 13.4 percent caregivers feel competent in using AT. Motor inabilities such as postural misalignment or positioning limitations were the most frequent caregiver-reported problems but deficits in self-help/independence were also frequently reported. These problem activities/routines were similar to those reported by caregivers of children with autism. Early intervention providers play instrumental roles in teaching caregivers about assistive technology use. When providers and caregivers work together to use assistive technology, caregivers report feeling competent particularly in identifying solutions for facilitating their children's involvement in activities/routines and in using assistive technology to do so. It is important to include caregivers in the design process or to at least explain them directly how the technology can be used. That caregivers who had received more training and information felt more competent suggests that information and training activities are 1 strategy to use to increase caregivers' competency. Good and extensive training is important.	The three articles agree on the fact that changing children's routines, specially children with ASD, is a very difficult thing since they always follow a strict routine, so if changes are made to the AT they should be minor changes. A big problem with AT and caregivers is that the majority of caregivers do not know about the AT solutions or they do not understand how to use them properly. This is one of the reasons why they should be included early on in the design process. They should also receive extensive training on how to use AT since the ones that felt the most comfortable using them where the ones to receive the most training. As well, since each child's case is unique the AT should support that and be adaptable and customizable.

Appendix D

Expert Evaluation Notes

D.1 Resume

D.1.1 Background:

- 2 clients talked to us

  Both have Aspergers

  They work in Edwin workshop dedicated for people with ASD

  They are both very knowledgable in technology

  Both of them live independently

- Both clients were very interested in the project

  Especially Jean

- For both it is difficult to do laundry since they can get very distracted and forget about it.

- Both mentioned that this type of persuasive technology would only work if the client is willing to try it. The older the client is the less likely they will be to embrace change. It is easier to incorporate such a system in the lives of children.

- Mark mentioned that he has authoritarian issues. If someone asks him to do something he will not do it at all. Therefore any decisions need to come from him

- Mark gets very tired after social interactions so he naps after having one.

  He can easily loose his patience when he is trying to explain something to someone

- Jean would be interested in testing the product for a long period of time as well as buying such a product.

D.1.2 Concept:

- How many lamps they would use depends on how big the house is

  Both of the clients live in a small apartment.

  For Mark the living room and kitchen are in the same area

  For Jean, his washing machine is in the bathroom

- Both said they would use the lamps for daily activities such as doing the laundry.
- They would only have 1 alarm in each lamp
- They would leave 1 lamp in on specific place since they would like the lamps to become part of their routine
- They would also use just one alarm per lamp
- It would be specially useful for tasks that do not happen every day but for example weekly doing the laundry. sJean said he would not use more than 3 alarms. It would become overwhelming having so many lamps. And he would like it to become a a sustainable part of his routine.
- The lamp would have one purpose.
- The ideal scenario for Jean would for it to become so much part of his routine that 5 minutes before the lamp goes off he would already be in the place to do the task and the lamp would become almost as a backup plan. This means that Jean would also like to have the lamps in a semi permeant way in the area it is placed.
- The data sharing worried both of the clients
- The lamp could also be used as a wake up alarm.
- Having a central lamp would be completely unnecessary
- Possible to have a push notification option on phone to know one lamp is on.
- Could also work for people who are deaf (or a combination of both deaf and asd)

D.1.3 Design:

- Since ideally the lamps would be in the same place in a semi permanent way the sticky bottom part of the lamp is very useful.
- near water or humid areas such as in the kitchen or bathroom the washing machine of Mark is in his bathroom so the lamp could get wet there.

- In a final product version of the project, the lamp should be possibly waterproof since the lamps might be
- The lamp should also be made out of a cleanable material

D.1.4 Questions:

- **Explanation:**

  It is a lamp alarm. You can use how many you want, today here I have 3. DEMO when you are going to do a task you can add your mood and then it will go back to the alarm. You can also add a new task by pressing on the lamp.

- **Demographics:**

  Do you live by yourself?

  Do you currently reflect on your mood during the day?

  If so, how do you reflect?

- **Expert Evaluation General:**

  How would you use the system?

  What would you use it for?

  How many would you use?

  How would you identify the different lamps?

- **Expert Evaluation specific:**

  Interaction

  Mood

  Do they add their Mood?

  Do they change their mood?

  Charge

  Any feedback?

D.1.5 Interaction:

- Senses:
- The clients are sensitive to the senses, they can make them uncomfortable and disturb them. Afterwards it is difficult to calm down.
- Types relevant:
- Light
- Mark is easily triggered by light. Because of this he prefers having his house dark.

- He mentioned that the lamp was still fine for him but it was in the border of him being fine with it and it potentially being annoyed by it.
- For him the ideal would be to be able to control the brightness of the lamp to suite his preferences and limits.
- Jean would use a spectrum of red and green to identify his mood since for him those colors represent good or bad.
- Both would appreciate a non-binary mood input system
- Sound
- Both of the clients have problems with repeating sounds such as alarms
- This type of sounds can trigger them.
- For the lamp itself both said it should not have a sound.
- Jean compared just having the light as a gentle reminder of please do if you want a certain task. While the sound needs immediate action, will frustrate them and it is obliging them to do somethings. It becomes an obligation.
- Mark said that if someone tells him to do something he will most definitely not do it. The initiative needs to come from him.
- Touch
- The final product should have a smooth material so that the client is not triggered by it .
- the grip is unnecessary and might trigger certain clients.
- 3d print rough and difficult to clean
- The input of mood should not be mandatory since it will frustrate the client.
- It could be voluntary and become a sort of mood diary.
- It should maybe include a non binary mood entry and also a neutral mood.
- Button
- The time to press the button should be shorter
- The button should have a bigger press area of a whole 2-3 cm.
- Battery best solution to replace battery since they would not be willing to change the lamp of location
- the lamp could blink or light in a different color to change the battery

D.2 Notes 1

aspergers client to interested laundry interested distracteda

alarm problem
no sound
not to bright
beeping not block it obligations
aspergers lightly corose border sound annoyed
live in the dark
ddependshow big house is
small house
2 one kitchen
j would use red green since is the colors that for him represent good or bad
maybe having a scale of color from red to green
not just a binary mood input.
daily stuff
1 alarm w
weekly stuff laundry
3 alarms at most
routine
1 purpose
not move lamp
become a routine
perfect situation
backup plan situation ideal
routine
fixed
changing spot
on leaving on own

when client working on routine
willing to do
children more
m2 35
authoritarian issues
motivation
mood diary
sticky good
careful about data
no opinion
personal with diary
how often annoyed about light
easiest time to press shorter
green red
wake up alarm

wake up problem h 1
naps s social interaction
patience teaching
feedback on
button not working possible
change button a whole areea 2-3 cm shorter
timer blinking to save change battery
not practical
water proof it
central
grip not necessary
3d print rough and difficult to clean
cleanable material
sometimes don't want to see the lamp
push notification option in app.
maybe for people who are deaf
combination with
idea great

D.3 Notes 2

25 January 2017 testing prototype

We initially explained it to two people with autism (both of them have Asperger). They think it might help them, because it is not so obtrusive (such as a phone alarm), its just a light (sound is a no-go!). You cant block out noise, but you can block out light.

How many lamps? Mark: Depends on the size of your house. Maybe 2 is good? (1 for the kitchen, 1 for the laundry)

Jean: If its not in the routine, its a problem. So for weekly stuff and the laundry. Not more than 3, because otherwise it would be too much sensory input. One lamp for one alarm, one purpose only. Simple and clear.

Location of the lamps?
They would probably not move the lamp around, but leave it in the same place. In the ideal situation, it helps to establish a routine, ultimately. Once the routine is there, the lamp can be used for a different alarm, on a different location.

Would they use the how am I feeling-feature of the lamp?
Its a nice addition, maybe not everyone will use it but it is nice as a kind of diary (logging). Be careful with where the data is stored, to whom the data is provided.

Maybe even shorten the time you need to press it to acknowledge that you fulfilled the task. No blinking. The idea of a wake-up light would be cool as well. A stable and steady rhythm seems very important.

Pressing mechanism
The light should go off after three seconds of pressing, not only after releasing the pressure on the button.

Right now, the lamps actually only work when you press on the tiny spot in the middle of the button, instead of pressing the whole area of the button with your hand. Therefore, the sensitivity of the button should be increased.

Charging?
Power lines are not practical, just changing batteries (so the lamp can stay in the same place) would be better. Maybe use an (annoying) blinking alarm for changing batteries. Measure the charge level of the battery in order to program such a thing.
Waterproof casing for using it in the bathroom (shower?).

The rubber grip
Not so much added value, only maybe for the turning, but it does not affect the pushing (which is the most important feature of the prototype).

Material and construction
Make the button out of a smoother material than this one, it should be easy to clean. Maybe make the prototype a little smaller, the box could be at least halved. In a later stage, you could disregard the wooden box altogether.

The wooden box has some parts that are too tiny and shouldnt be laser-cut like that. Its not stable.

Conclusion
The concept is promising: the idea is great, it could definitely work. Note: it might also be something for deaf people?

Appendix E

Code

E.1 Arduino code

```
/*
Sleep RTC Alarm for Arduino Zero with RGB LED, encoder,
multiple alarms library + processing arduino handshake+ internet


Demonstrates the use an alarm to wake up an Arduino zero from Standby mode

NOTE:
If you use this sketch with a MKR1000 you will see no output on the serial monitor.
This happens because the USB clock is stopped so it the USB connection is stopped too.
**To see again the USB port you have to double tap on the reset button!**
*/

#include <Time.h>
#include <TimeAlarms.h>


#include <Adafruit_NeoPixel.h>
#ifdef __AVR__
#include <avr/power.h>
#endif

// Which pin on the Arduino is connected to the NeoPixels?
// On a Trinket or Gemma we suggest changing this to 1
#define PIN            6

int encoderSwitchPin = 7; //push button switch
```

```
// How many NeoPixels are attached to the Arduino?
#define NUMPIXELS      24

// When we setup the NeoPixel library, we tell it how many pixels, and which pin to use to s
// Note that for older NeoPixel strips you might need to change the third parameter--see the
// example for more information on possible values.
Adafruit_NeoPixel pixels = Adafruit_NeoPixel(NUMPIXELS, PIN, NEO_GRB + NEO_KHZ800);

int delayval = 500; // delay for half a second

/*Encoder*/
int encoderPin1 = 0;
int encoderPin2 = 1;

volatile int lastEncoded = 0;
volatile long encoderValue = 0;
int oldEncoderValue = encoderValue;

long lastencoderValue = 0;

int lastMSB = 0;
int lastLSB = 0;


unsigned long resetTime = 0;

int state = 0; // 0 = off, 1 = white, 2 = blue, 3= red, 4= yellow

unsigned long startTime;
unsigned long buttonTime = 4000000;
bool previousPress = LOW;


/* Change these values to set the current initial time */
const byte seconds = 0;
const byte minutes = 30;
const byte hours = 8;

/* Change these values to set the current initial date */
const byte days = 9;
const byte months = 1;
const byte years = 17;


void setup() {
```

```
Serial.begin(9600);//initialize serial communications at a 9600 baud rate
establishContact();  // send a byte to establish contact until receiver responds

/* Encoder */
pinMode(encoderPin1, INPUT);
pinMode(encoderPin2, INPUT);


digitalWrite(encoderPin1, HIGH); //turn pullup resistor on
digitalWrite(encoderPin2, HIGH); //turn pullup resistor on

digitalWrite(encoderSwitchPin, HIGH); //turn pullup resistor on


//call updateEncoder() when any high/low changed seen
//on interrupt 0 (pin 2), or interrupt 1 (pin 3)
attachInterrupt(0, updateEncoder, CHANGE);
attachInterrupt(1, updateEncoder, CHANGE);

/* Lights*/
pixels.begin();
pixels.show(); // Initialize all pixels to 'off'
pixels.begin(); // This initializes the NeoPixel library.

/* Time+ */
setTime(hours, minutes, seconds, months, days, years); // set time to 8:29:00am Jan 9 2017

Alarm.timerOnce(2, alarmMatch);
Alarm.alarmRepeat(8, 31, 0, alarmMatch); // 8:30am every day
Alarm.alarmRepeat(8, 32, 0, alarmMatch); // 8:30am every day

resetTime = 0;
}

void loop() {
Serial.println(encoderValue);
delay(1000); //just here to slow down the output, and show it will work  even during a delay

String val = "";

if (Serial.available() > 0) { // If data is available to read,
val = Serial.readString(); // read it and store it in val
if (val.equals("A") == false) {
int h = val.substring(0, 2).toInt(); //hours
int m = val.substring(3, 5).toInt();
int s = val.substring(6, 8).toInt();
```

```
Serial.print("hours:");
Serial.println(h);
Serial.print("minutes:");
Serial.println(m);
Serial.print("seconds:");
Serial.println(s);

Alarm.alarmRepeat(h, m, s, alarmMatch); // 8:30am every day
}

}

/*This prints the time every second*/
digitalClockDisplay();
Alarm.delay(1000); // wait one second between clock display

if (state == 0) {
/*If it is state 0 the lights will be off */
for (int i = 0; i < NUMPIXELS; i++) {

// pixels.Color takes RGB values, from 0,0,0 up to 255,255,255
pixels.setPixelColor(i, pixels.Color(0, 0, 0)); //

pixels.show(); // This sends the updated pixel color to the hardware.

}

if (digitalRead(encoderSwitchPin)) {//button is not being pushed
} else {//button is being pushed
Serial.print("New task added at");
state = 1;
}
}

else if (state == 1) {
// For a set of NeoPixels the first NeoPixel is 0, second is 1, all the way up to the count

/*If it is state 1 the lights will be white */
for (int i = 0; i < NUMPIXELS; i++) {

// pixels.Color takes RGB values, from 0,0,0 up to 255,255,255
pixels.setPixelColor(i, pixels.Color(150, 150, 150)); // Moderately bright white color.

pixels.show(); // This sends the updated pixel color to the hardware.
}
```

```
/*Encoder Potentiometer*/
if (encoderValue > oldEncoderValue) {
state = 2;
Serial.print("blue Mood 1: turned left at ");

}
if (encoderValue < oldEncoderValue) {
state = 3;
Serial.print("red Mood 2: turned right at ");

}
oldEncoderValue = encoderValue;


/*Encoder Button*/
if (digitalRead(encoderSwitchPin)) { //button is not being pushed
} else {//button is being pushed
Serial.print("Task done at");
state = 0;
}
}

else if (state == 2) {
// For a set of NeoPixels the first NeoPixel is 0, second is 1, all the way up to the count

for (int i = 0; i < NUMPIXELS; i++) {

// pixels.Color takes RGB values, from 0,0,0 up to 255,255,255
pixels.setPixelColor(i, pixels.Color(0, 0, 150)); //

pixels.show(); // This sends the updated pixel color to the hardware.

}
delay(3000);
state = 1;

}

else if (state == 3) {

// For a set of NeoPixels the first NeoPixel is 0, second is 1, all the way up to the count

for (int i = 0; i < NUMPIXELS; i++) {

// pixels.Color takes RGB values, from 0,0,0 up to 255,255,255
```

```
pixels.setPixelColor(i, pixels.Color(150, 0, 0)); // Moderately bright white color.

pixels.show(); // This sends the updated pixel color to the hardware.

}
delay(3000);
state = 1;

}
}

void alarmMatch() {
Serial.println("Alarm: - turn lights on");
state = 1;
// For a set of NeoPixels the first NeoPixel is 0, second is 1, all the way up to the count

}

void digitalClockDisplay()
{
// digital clock display of the time
Serial.print(hour());
printDigits(minute());
printDigits(second());
Serial.println();
}

void printDigits(int digits)
{
Serial.print(":");
if (digits < 10)
Serial.print('0');
Serial.print(digits);
}



void colorWipe(uint32_t c, uint8_t wait) {
for (uint16_t i = 0; i < pixels.numPixels(); i++) {
pixels.setPixelColor(i, c);
pixels.show();
delay(10);
}
}

void establishContact() { //sends out a string to see if it hears anything back
```

```
while (Serial.available() <= 0) {
Serial.println("A");   // send a capital A
delay(300);
}
}

void updateEncoder() {
int MSB = digitalRead(encoderPin1); //MSB = most significant bit
int LSB = digitalRead(encoderPin2); //LSB = least significant bit

int encoded = (MSB << 1) | LSB; //converting the 2 pin value to single number
int sum  = (lastEncoded << 2) | encoded; //adding it to the previous encoded value

if (sum == 0b1101 || sum == 0b0100 || sum == 0b0010 || sum == 0b1011) encoderValue ++;
if (sum == 0b1110 || sum == 0b0111 || sum == 0b0001 || sum == 0b1000) encoderValue --;

lastEncoded = encoded; //store this value for next time
}
```

E.2 Processing Code

```
import processing.serial.*;

Serial myPort;  // Create object from Serial class

String val;     // Data received from the serial port
boolean firstContact = false;

PrintWriter output;

String input = "";

void setup()
{
size(200, 200); //make our canvas 200 x 200 pixels big

myPort = new Serial(this, Serial.list()[1], 9600);
myPort.bufferUntil('\n');

// Create a new file in the sketch directory
output = createWriter("sensorsArduino.txt");
}
```

```
void draw()
{
if ( myPort.available() > 0)
{  // If data is available,
val = myPort.readStringUntil('\n');         // read it and store it in val
}
// println(val); //print it out in the console

output.println(val);  // Write the coordinate to the file
}

void mousePressed() {
output.flush();  // Writes the remaining data to the file
output.close();  // Finishes the file
exit();  // Stops the program
}

void serialEvent( Serial myPort) {
//put the incoming data into a String -
//the '\n' is our end delimiter indicating the end of a complete packet
val = myPort.readStringUntil('\n');
//make sure our data isn't empty before continuing
if (val != null) {
//trim whitespace and formatting characters (like carriage return)
val = trim(val);
println(val);

//look for our 'A' string to start the handshake
//if it's there, clear the buffer, and send a request for data
if (firstContact == false) {
if (val.equals("A")) {
myPort.clear();
firstContact = true;
myPort.write("A");
println("contact");
}
} else { //if we've already established contact, keep getting and parsing data
// println(val);

//      if ( == true)
//      {                    //if we clicked in the window
///
//        // println("1");
//      }
//
//    // when you've parsed the data you have, ask for more:
```

```
//    myPort.write("A");
}
}
}

void keyReleased() {
if (key == ENTER) {
myPort.write(input);
input="";
} else if (key == '0'|| key == '1'|| key == '2'|| key == '3'|| key == '4'|| key == '5'|| key

if (input.length()== 2||input.length()== 5) {
input+=':';
}
if (input.length()<8) {
input+=key;
}
} else if (key == BACKSPACE) {
input = input.substring(0, input.length()-2);
}
println(input);
}
```