

Meztli Sabina Morales Sanchez

Design of a Tangible User Interface for Task Management at Home

Master's thesis in Interaction Design

Supervisor: Anders-Petter Andersson

June 2019

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This thesis is the finale of a Master's Degree in Interaction Design in the Department of Design at the Norwegian University of Science and Technology.

The thesis is the product of initial research carried out from August 2018 and finishes with the development of a prototype in May 2019.

I would like to thank my supervisor Anders-Petter Andersson for inspiration and for being available for guidance and feedback. I would also like to thank my husband for providing emotional support and his programming skills that made me feel confident enough to embrace a challenge like this.

Finally, I want to say thank you to the participants who opened their houses and allowed me to know a bit about their life.

Abstract

The aim of this thesis was to design a tangible user interface (TUI) for the management of tasks at home. There are multiple existing solutions that families already use to organise their activities and chores at home. Yet, these solutions are either physical tools that can be used by all the family members, or they are digital apps that provide further connectivity. One of the objectives of this project was to create a product that is tangible and therefore can be used by all members, but also connected through the internet and thus can be accessed from anywhere.

The design was built upon a literature review of how TUIs can help in promoting collaboration. Furthermore, the user investigations consisted of online social media and market research, as well as house visits and interviews. Finally, the prototype was built taking advantage of Radio Frequency Identification (RFID) technology and a Raspberry Pi thanks to their flexibility as tools for quick prototyping. The physical prototype consists of a magnetic board, RFID-tagged tokens and an RFID box which provides the internet functionalities. The product is capable of receiving task via email, allow users to interact with the tasks via the graspable tokens, and can also display the status of the tasks online by connecting to a Google Keep account. The final prototype hopes to decrease the limitations of existing analogue boards for task management, as it adds digital functionalities to a tangible product. This thesis hopes to serve as an example of how blended interaction can be used to add computational functionalities to everyday objects. The contents of the prototype itself, are laid out in detail, allowing others to replicate, modify and improve the product.

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1. Introduction

1.1 Project Description

Many people face challenges when trying to organise their activities both at work and in their personal life. In particular, families with one or more children often have the need to organise and manage the tasks and schedules of people with very different needs and skills. Similarly, many parents face challenges when trying to get their children involved in the house chores, a situation that can cause arguments and stress for all family members. Every family has different ways of dealing with this situation, and many families already use digital and analogue tools to help them in keeping track of their family activities. In this report, some of these existing products are reviewed in a search of understanding the benefits that both digital and analogue tools give their users. These insights will then help in the development of a product that can help families solve the same problems. As part of the process to design a solution, this project also explores the advantages of using tangible user interfaces (TUIs) for collaboration. Since TUIs can have benefits when trying to involve all members of a family. Additionally, as part of a user-centered design process, house visits and interviews help in understanding the way families already organise their chores and activities. This thesis aims to prototype a product that takes all of these elements into consideration and that can support families in the management of tasks and chores at home.

1.2 Keywords

Token-based Interaction, Radio Frequency Identification (RFID), Near Field Communication (NFC), Internet of Things (IoT), RFID-based Interaction, post-WIMP, Tangible User Interface (TUI), Graspable user interfaces, Blended Interaction, Task management, Household Task Management, Tangibles for Collaboration

1.3 Abbreviations and Terms

TUI - Tangible User Interface

GUI – Graphical User Interface

WIMP – Windows, Icons, Menus, Pointers

HCI - Human Computer Interaction

IoT – Internet of Things. An interconnection of devices through wired or wireless technology

NFC - Near Field Communication

RFID - Radio-Frequency Identification

DIY - Do It Yourself

App - Application, typically used for small programs running on portable devices.

Raspberry Pi - Small pocket sized computer capable of manipulating electronic devices.

Arduino - Project and user community that designs and manufactures single-board microcontrollers and microcontroller kits

YouTube - Video-sharing website that allows users to upload, view, rate, comment and share videos

Google Keep - Note-taking service developed by Google

Python - OSI-approved open source programming language

1.4 Project Goals and Research Questions

This chapter describes the goals and defines the research questions for the thesis. This project's main goal is to design and prototype a smart product that can support families in managing their tasks and chores at home. Different analogue and digital solutions that serve this purpose already exist. Moreover, this project aims to explore ways in which bridges between the digital and physical world can be created. The following research questions help in guiding the research and development activities needed to build a prototype and to keep the users' needs in mind.

RQ1: What other similar solutions exist?

Whenever we have the intention of designing a new product or service, it is essential to understand the state of the art and gain as much as possible from others' failures and successes. A brief review of existing solutions is to be conducted. The review looks for digital and analogue products or services that families are already using to manage their personal and family tasks.

RQ2: How can we make this product suit collaborative activities?

To answer this question, a review of the literature provides with an understanding of the ways in which teams organise their tasks and promote collaboration in different contexts. Later on, interviews and observations give insights into how families organise their chores. These observations guide further design decisions that are then prototyped.

RQ3: How can we embed this product into a home environment?

It is also important to consider how this tangible solution can fit in the specific context of use. Since the interface is designed with a home environment in mind, rather than being a tool for the office or other environments. To answer this question, it is essential to observe and get to know the key spaces in people's homes as well as their habits and patterns when using these spaces. This information provides inspirational to prototype embodied interactions that can blend into a home environment.

RQ4: How can we input users' data items in a way that it is convenient for them?

Since this product is intended to help people manage different bits of information that come to their minds at different moments during the day, it is expected that these information items will arise when the person is away from the tangible interface (e.g. at school, at work, during a walk or while being in a different room). Hence, one of the challenges of this development is to find a for the user to save these bits of information and capture them to deal with them later. How can we help the user sending data items remotely? What kind of wireless technology can support this activity? To answer this question, interviews with the users provide insights into their organisation activities and preferences, that are then used to brainstorm solutions and to build the prototype.

2. Background

This literature review is divided in three chapters that are described as follows.

- **Task Management in the Family:** To understand the context of use of the product, this review sheds light into certain family and home organisation behaviours. However, the main source of insights about the user needs, came from the observations made during the chapter 3.1 *Inspiration - Understanding User Needs*. This literature review describes how many families with one or more children have to manage the task and schedules of people with very different needs and skills. Making this activity challenging and sometimes not ideal for a screen-based solution.
- **Tangible Interfaces for Family Collaboration:** This master project builds on knowledge acquired during the course *IMT4215 Specialisation Project* where a literature review helped in finding specific tools and technologies that can be used to create tangible interfaces following the *Tokens and Constraints* approach by Ulmer et al. (2005). The objective of such research was to find and create flexible and low cost tokens that could have assigned data to them for physical prototyping. Leading to results that are used in the development of the prototypes for this project. Some of the findings from the *IMT4215* project's literature review are summarised in this chapter and some of the tools that were analysed in such document are used during the prototyping phase (3.3 *Implementation - Making*).
- **Smart Environment:** Finally, this review explains the benefits of giving users physical representations of their tasks (taking advantage of inherent cognitive capabilities), without losing the power of digital computing.

2.1 Task Management in the Family

The way in which we organize and deal with all the things we have to get done on a daily basis is a common area of interest that has created a thriving market of publications and mobile App development. A number of best-selling authors have been focusing on developing different methods and techniques to help people manage their time and to prioritize their activities (Allen, 2015) (Covey, 1989) (Zahariades, 2016). While these authors' work is based on practical experience rather than theoretical foundation, they do help us understand the increasing

interest that exists for learning to cope with information overload and for managing the multiple and diverse types of tasks we face outside of a working scope. This means that the interest towards improving one's productivity is not reserved for the corporate world or one's job schedules. People are often interested in improving their task management even when they are at home. For instance, when taking care of the tasks needed for personal projects or the management of household tasks that involve the whole family. In that sense, people might not have the objective of improving their family's productivity, but they do want to improve their relationships with their family members while decreasing the stress of a busy and messy life. During the observation and inspiration phase of this project (*chapter 3.1*), I got to hear multiple comments about how parents find relieve in keeping their kids' activities scheduled and organised.

Some researchers have also found that there is an increasing number of people worrying about how to deal with all the commitments one has to manage on an average day (Bellotti et al., 2004). This thriving market has motivated researchers to try and find scientific foundations to explain the success of personal productivity books. For instance, the researchers Heylighen and Vidal (2008) argue about how recent insights in psychology and cognitive science support Allen's (2001) proposed method for enhancing personal productivity and reducing stress caused by information overload. His popular productivity method, called "*Getting Things Done*" (Allen's, 2001), has as its main objective, to get everything that is bothering us out of our mind and into a trusted external system so that we can focus on what we are actually doing at the moment, rather than trying to remember tasks, plans and commitments for later. In the context of this project, that trusted and external system helps alleviate the stress that parents have when trying to manage all the family's task and schedules.

2.1.1 Household Task Management

Household work or household task designation can often create friction within the members of a family. It is generally a person in authority that has to assign tasks or chores to younger family members and this situation can create conflict for a variety of reasons. For instance, depending on the assignment of chores, children can feel in disadvantage or think there is a certain favoritism towards other siblings (Labrot, 2002). This can result in conflict between parents and children, between siblings or even between couples.

Researchers who study children's and adolescents' perceptions of fairness in the distribution of chores (Thomson, 2007; Lerner, 1974) are often aware that family members can perceive the work that is the result of a team effort, in which individuals work cooperatively, as more fair. *“The perception of being a unit, separate individuals belonging together as members of a team, elicits the justice of parity in which each member shares equally in the outcomes.”* (Lerner, 1974, p.539). Similarly, during the inspiration phase of this project (*chapter 3.1*), I got to hear matching comments from mothers who perceived an improvement in their relationships with their families when they put in place methods to treat the house tasks as a team effort.

Another interesting insight I got from the literature is that although the increase in the amount of women who work and contribute to the household has generated a more equitable allocation of house tasks, the division of task is still done by women. In other words, even when all members of the family spend time doing the house chores, the division of such chores is still the wife's or mother's responsibility (Bird, Bird and Scruggs, 1984). I found this particularly interesting because it matched the comments I listened during the social media observation and the market research (*See 3.1.1 Social Media and Market Research*). Where mothers made comments regarding being the responsible one for organising the family's activities. Additionally, when reading the product reviews within this Market Research (*Appendix A*), I found that these home organisation tools are always used by women. It appeared to me that it is consistently the women the ones assigning the tasks within the family, even if they are employed. This situation guided me to consider married women and mothers as the main user profile.

2.1.2 Task Management for Teams and Collaboration

One of the most popular ways of organising team tasks in modern organisations is the Kanban Board. In Kanban Boards, cards are used to represent work items and columns are used to organised stages of a work process. In the Kanban method, items first get collected and placed on the left column, and the progress is shown by moving the cards from left to right (Wikipedia, 2018). The basic columns that can be used on Kanban board are: "to-do", "doing", and "done". This structure is often used for agile or lean software development but it has also been used to manage personal tasks (Benson and Barry, 2011). Kanban Boards have been found to improve the communication and collaboration in teams at the beginning of a project or when a team starts to coordinate work together. A study by Oza, Fagerholm and Munch, (2013) showed that

Kandan Boards helps team members to collectively identify and surface any missing tasks and hence to keep the pace of the work harmonized across all the team. Having said that, this very simple layout to organise tasks might not be useful for larger teams or more complicated development. Yet, its simplicity could be ideal for house or children task management. In chapter 3.1.3 *Similar Solutions* I list some examples I found people use to work with kids and their chores. Many of them had a very simple layout, similar to a Kanban board with "to-do" and "done" columns.

2.2 Tangible Interfaces for Family Collaboration

Many of the latest trends in technology seem to fit in one of two categories; they are either creating digital worlds for users to enter, or they are enriching the real world with digital functionality. This project, as well as many others, is motivated by the idea of keeping the richness and situatedness of physical, real-world interactions in our interactions with technology. In other words, to embed computing in environments and practices that humans already know and getting rid of the limitations that flat screens and graphical user interfaces (GUI) are giving us.

Although interfaces composed of windows, icons, menus and pointers (WIMP) are still the main way in which we interact with computers, the idea of creating other kinds of interaction styles is nothing new. There have been multiple efforts over the last three decades to develop interaction styles that diverge from a WIMP interface. (Shaer & Hornecker, 2009). As Ishii and Ullmer (1998) conclude, graphical user interfaces sometimes *“fall short of embracing the richness of human senses and skills people have developed through a lifetime of interaction with the physical world.”*

In the case of an interface that is intended to be used by all members of the family, it is also worth mentioning that having a tangible interface can lower the threshold of participation and consequently promote collaboration from family members that could otherwise be excluded. For instance, elderly or children. This notion is also supported by Marshal, P. (2007, p.164) who explains: *“As interaction with tangible interfaces is assumed to be more natural or familiar than with other types of interface, they might be more accessible to young children, people with learning disabilities or novices, lowering the threshold of participation.”* In this sense,

different theoretical points of view, can lead us to consider tangibles as a possible tool for collaboration, exploration, and playfulness of the task (Schneider et al., 2011).

2.2.1 How Can Tangible Interfaces Support Human Tasks

There are multiple reasons why tangible interfaces have attracted the attention of human–computer interaction (HCI) researchers along the years. To begin with, there is always a certain effort that needs to be made when one operates a new system. However, if said system draws upon known affordances and pre-existing skills from our everyday interaction with the real world, that effort is often reduced. Hence lowering the threshold for engaging with the system (Norman, 1988; Hornecker and Buur, 2006; Jacob et al., 2018).

In like manner, another reason is that tangible user interfaces (TUIs) can take advantage of the connection that exists between body and cognition. Klemmer, Hartmann, and Takayama, (2006) through their overview of embodiment (from psychology, sociology, and philosophy), conclude that TUIs facilitate tangible thinking, which means thinking through bodily actions, physical manipulation, and tangible representations. A common example of this is epistemic actions, where humans first manipulate objects to better understand the context of the task, rather than directly solving the problem in hand.

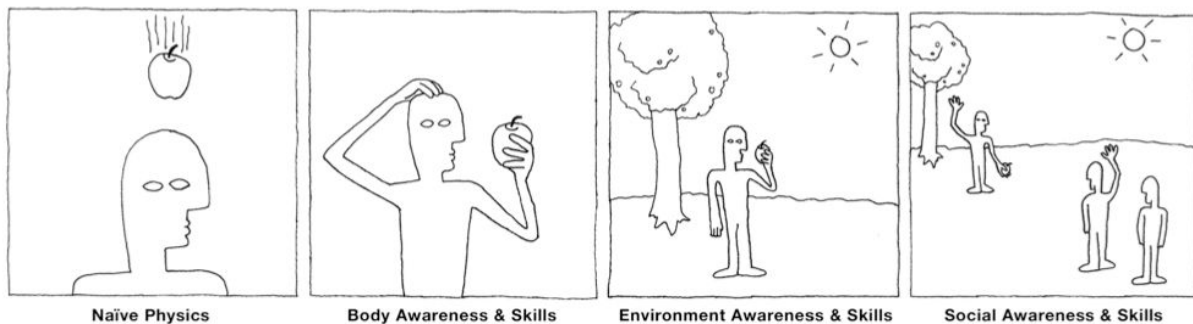


Figure 1. The four themes of reality (from Jacob et al, 2008, p.203)

Another reason why TUIs might be attractive for researchers and developers alike is their parallel feedback capabilities. Tangible interfaces can work both as tangible representations of digital information and as controls. This duality creates a situation in which users can touch and manipulate data with their hands, and also use these physical representations of digital information as input and output devices. TUIs can give users a specifically rich type of feedback loop, where a physical haptic feedback informs users in real time, that a manipulation has taken

place. In contrast, graphical user interfaces (GUIs) make a clear distinction between input (e.g. keyboard and mouse) and output devices (e.g. monitor) Ishii, H. and Ullmer, B. (2000).

2.2.2 Qualities of Tangibles for Managing Tasks and Collaboration

In particular, tangibles have certain characteristics that are relevant to this project and offer design cues that could be used when deciding the physical structure of the interface.

- **Tokens and Constraints**

There is an interactive approach that was first presented by Ullmer, Ishii and Jacob (2005) and that is particularly relevant for this project. The tokens+constraints approach combines the use of physical tokens which can be used to reference digital information and physical constraints which can be used to provide structure for the tokens. These constraints help by limiting the space where tokens can be placed, for instance, indented slots, racks or stacks. This approach is especially valuable for this project because we have the need to constantly move and organise a set of items from basket (tokens) into different categories and priorities (constraints).

- **Tangible Representation / Thinking Props**

Tangible interfaces allow us to create a physical representation of data. In the context of this project, that data is each of the tasks that the user has to do. By using physical tokens to represent tasks, and constraints to limit the number of tasks that can be placed in a certain area, we can help the user to think about the tasks as items that cannot be all done at the same time. Diverse studies have found the use of physical tokens as helpful to support cognition (Zhang and Norman, 1994).

“Actions such as pointing at objects, changing their arrangement, turning them, occluding them, annotating and counting, may serve as epistemic actions that decrease the mental workload of a task by drawing upon resources that are external to the mind” (Shaer and Hornecker, 2009, p.100).

- **Guiding Through Indentation**

Another advantage of working with physical objects to represent data items, is that we can express the compatibility of these objects through their shape in relation to the shape

of the constraints. By using indentation to “explain” the compatibility of the elements, the user does not need to make logical deductions, as the physical syntax is read directly by human perception instead (Scaife and Rogers, 1996).

- **Embodied Cognition**

Theories on situated and embodied cognition suggest that people deal with the complexity of the real world by interacting with it. This interaction includes the entire body and different sensors like eyes, ears, touch and the motor system (Heylighen and Vidal, 2008). It is by performing actions and observing its physical effects that we can make sense of our environment. This concept makes emphasis on the formative role that the physical environment plays on any cognitive processes and provides an argument for using physical objects to help in the comprehension of any given interface and interaction.

- **Awareness of others’ actions**

Flat screens, compared to tangible interfaces, can present the disadvantage of having just two dimensions to communicate the status of the system, making it harder for two or more people to observe the interface and interact with it at the same time. TUIs can make use of a third dimension and hence improve the awareness of others’ actions whenever gestures take place, potentially leading to increased collaboration. (Tuddenham, Kirk and Izadi, as cited in Schneider et al., 2011)

2.2.3 Sample of Tangible User Interfaces

One example of tangible interface that uses some of the characteristics previously mentioned to its advantage is The Marble Answering Machine (*see Figure 2*). Although this interface was first made by Durrel Bishop only as a concept sketch, it turned out to be a very often mentioned piece or work, regularly used as inspiration for the development of tangible interfaces. Bishop’s machine uses the Token+Constraint interaction approach and spits out a marble (token) each time someone leaves a voice message. The messages can be played by putting a marble in a small dent (constraint). That way the answering machine is guiding users through indentation. Additionally, the order of the marbles indicates the order in which the messages arrived, which is an example of how tangible representation of data items can be used.

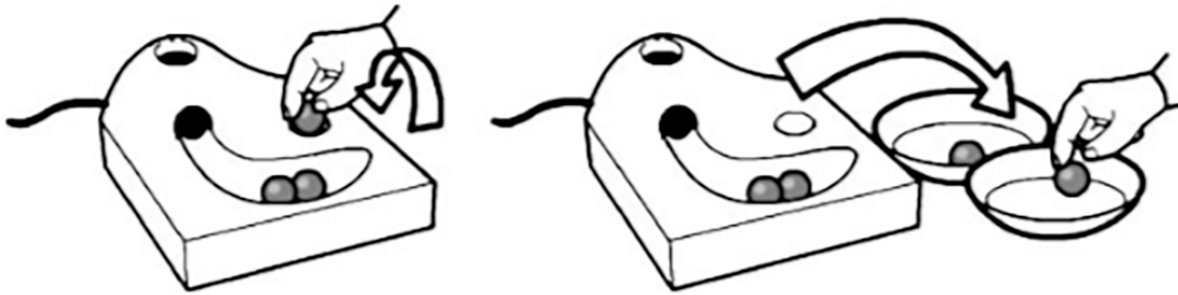


Figure 2. Conceptual drawing of the marble answering machine by Durrell Bishop (from Döring et al., 2009, p.320)

2.3 Blended Interaction

Continuous technological advances have contributed to the line between the tangible and the digital becoming more flexible. Wireless technologies and cloud-based system have propitiated a growth of devices interconnected through the internet and always talking to each other, also known as the Internet of Things (IoT). This evolution is taking us from a traditional mobile computing where the interfaces are limited to certain devices with screens, to an interconnected environment that embeds technology into everyday items (Gubbi et al., 2013). Following this trend, it is not hard to imagine that we will continue to develop products and services that allow us to interact with augmented objects in our house even when we are away from home.

Taking into account that one of the objectives of this development is to help people manage their tasks at home, and that we cannot assume that those “tasks” will come into people’s mind when they are at home and in front of the tangible interface, I needed to make sure I can provide a way of collecting tasks that is not location-dependent. Hence, one of the challenges is to find a way in which the user can save these bits of information and capture them to deal with them later. That is where wireless technologies come into play. One of the aspirations of this project is to build an interface that is not only tangible, but also smart and connected through a continuous network. As mentioned in chapter 1.4 *Project goals and research questions*, RQ4 is: *How can we input users’ data items in a way that it is convenient for them?*. Which means that first I need to provide a way of capturing task items anytime, anywhere, and later allow them to interact with that data, physically.

Therefore, by giving users the opportunity of manipulating physical representations of their tasks, we can take advantage of inherent cognitive capabilities without losing the power of digital computing. As Hurtienne and Habakuk (2013) describe: “The goal of blended interaction is to leverage users’ knowledge about the real-world while preserving the power of digital computing.” (see *Figure 3*)

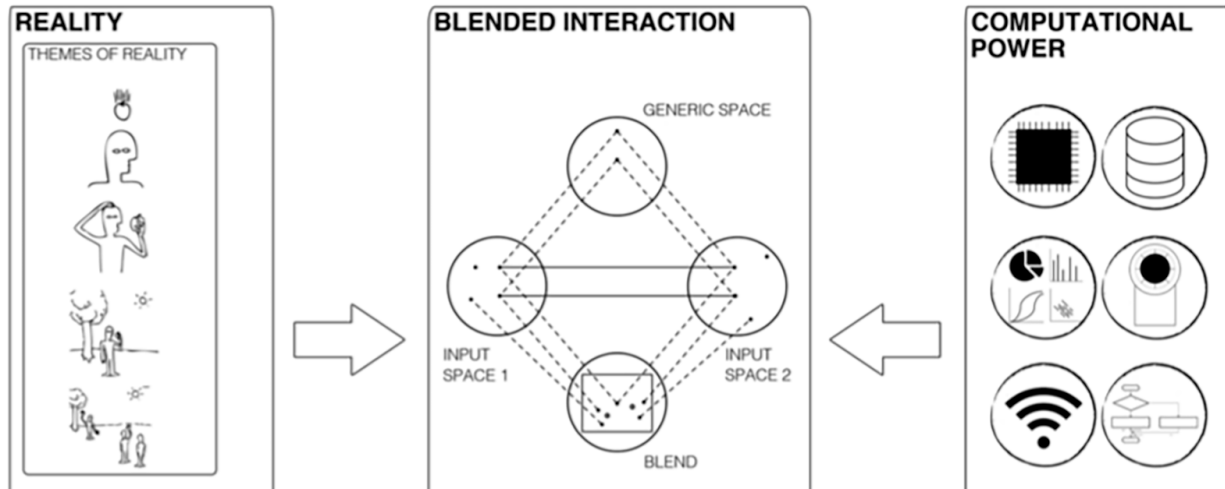


Figure 3. Visual overview of Blended Interaction (from Jetter, Reiterer and Geyer, 2013, p.1149)

3. Methods

This chapter describes the methodology that was followed to gain an understanding of the users' needs, to build the interface prototype and to test the concept design.

Design Process

For this development, a user-centred design methodology guided the choice of activities to gain insights about the users' behaviours and inform the system's requirements. IDEO (2015) suggests three main phases to tackle design challenges with a focus on users: **Inspiration**, **ideation** and **implementation** (figure 4). The inspiration process starts by gathering a lot of information about the users and their needs (diverge). Then during ideation, that information is analysed to make sense of it (converge), which opens the possibility to start generating design ideas (diverge). Finally, the final phase consists of testing such ideas to refine the prototype (converge)

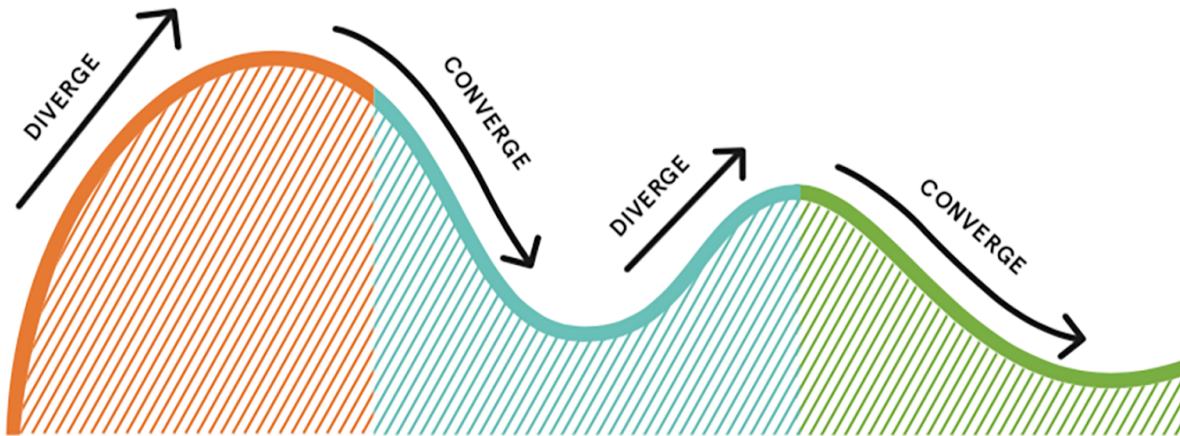


Figure 4. **Inspiration**, **ideation** and **implementation** process (from IDEO, 2015, p.13)

These phases are not meant to be a perfectly linear process, but by making sure we include all of them, it is that we can build empathy with the people we are designing for. Hence the phases are to be revisited throughout the process as we learn more about the product and the context of use.

3.1 Inspiration - Understanding User Needs

This phase is about understanding people better and it is mostly considered as a divergent phase of the process (*see figure 4*). During the initial observation, we as user researchers can define the audience and identify the problems to tackle. Before building anything, it is important to get out and talk to people to learn about their hopes and desires as well as their problems and pains.

3.1.1 Social Media and Market Research

Self-publishing online platforms were very useful for me during this phase of the process when it was needed to understand user's needs and behaviours, as well as to discover who the target user exactly was. YouTube¹ played an essential role at this initial research stage, as it gave me access to people's personal videos which were essentially monologues about the topic I was trying to understand. On these videos, people go for about 5 to 20 minutes talking about their house organisation needs, their schedules, their pains when managing family activities or their motivations to find organisation tools. They also show their houses while explaining their thought processes when creating home organisation spaces and systems. Such access to people's lives on video turns out to be incredibly valuable as it is similar to taking part of a *Guided Tour* activity (IDEO, 2015, p.64). I watched a total of 30 videos and captured key quotes, recurring organisation tools and gain insights about people's task management behaviours for them and their families. Out of the total sample, 10 videos are shortlisted under *Appendix A* where I also listed their key comments. These key comments were used to capture insights and to brainstorm system's requirements based on those. Thanks to having access to all this video material, it was possible to get clues about how people organise their tasks at home. During this observation, I found out that the term "home command center" is commonly used as part of a trend of house organisation and family task management. A home command center consists of a dedicated space, generally it being a wall, where different organisation tools are placed for all the family to see and use (*see Appendix A5*).

An online search using "home command center" keyword gave me hundreds of results on blogs, DIY tutorials, YouTube videos, Pinterest² boards and even books which teach you how to build

¹ YouTube - Video-sharing website that allows users to upload, view, rate, comment and share videos. [online] Available at: <https://www.youtube.com>

² Pinterest - Social media web and mobile platform that can function as a "catalogue of ideas" [online] Available at: <https://www.pinterest.co.uk/>

your own command center, as well as ready made products sold on Amazon³ and Etsy⁴ (*see Appendix A2 for a shortlist of these products*). These findings gave me an initial validation regarding the existence of a need for task organisation dashboards at home. It was important however, to keep in mind that what people decide to upload on YouTube or any other social media, could be a filtered truth or a semi-truth, hence it was essential to visit family homes in person to see if similar organisation spaces exist. Subsequent home visits and interviews confirmed that families try to recreate these designated organisation areas even if they are not at the same level as the ones portrayed by people online .

The social media and market research also shed light into the type of user that would most probably be interested on a task manager at home. Most of these tutorials and products were made and targeted towards women between 25 - 45 years old, who are married and have kids. Many of them were Stay-at-Home moms, which meant they had a lot to handle and organise at home. Others did not have children yet but worked from home and therefore spent a lot of time indoors. It was possible for me to get all of this information because on the videos I found, women explain everything about their lifestyle and how they use the “command center” to organise their family. I also read the product reviews on the products sold online, that way I knew who is buying and what they like or dislike about these organisation boards (*see Appendix A2 for a shortlist of these products*). This information lead to include these user profiles as part of the personas.

3.1.2 Home Visits and Interviews

After gathering information online, it was time to go out and talk to people. I decided to conduct interviews at participants’ houses with the objective of observing their home environment and common areas in search of organisation elements. These interviews were semi-structured and aimed at understanding the organisation routines and habits of the users during an average day. In particular, the interviews helped me to understand how people go about managing their common tasks at home, the communication between family members, what tools are used and where those tools are located at home.

³ Amazon - Multinational technology and e-commerce company. [online] Available at: <https://www.amazon.co.uk/>

⁴ Etsy - E-commerce website focused on handmade and vintage. [online] Available at: <https://www.etsy.com>

The participants recruited for this interview were between the ages of 28 and 34, aiming at married women or couples living together with children. This particular target group usually have busy days where keeping track of the daily activities can be difficult. The decision to focus on this user group was based on the observations made on social media and market research (see *Appendix A for a shortlist of video sources*). A total of five households were observed, seven people answered questions; five women and two men. Out of the five households, four were married couples and three couples had children. Three of the women were full-time moms and two of them had part-time jobs. The interview guide (*Appendix C*) was semi-structured and aimed at collecting information about the way participants organise the house chores or family activities, how they communicate these to the other members of the family, what tools are used and where do they keep those tools. These insights helped by guiding design decisions, helped to feed the user persona and to know what other similar solutions people use to organise their tasks.

Participants were asked to draw a simple floor plan of their homes to explain what kind of activities take place around certain key areas and they were asked to show any tools they had to organise their house activities (*photos of some of these tools can be found in Appendix D*). These visits revealed that three of the houses had physical organisation tools in their house, all of them in the kitchen. Some houses had these tools in two different areas and some had all of them together. Recurring objects in such areas were: calendars, note pads, chalkboard, time schedules, inspirational quotes, family photos, mail containers, useful phone numbers (see *Appendix D: Interview findings*). Additionally, five out of seven people mentioned the use of digital tools to keep track of certain house chores like buying food or fixing problems around the house. The digital tools mentioned were: Google Keep⁵, Google Calendar⁶, iOS Calendar⁷, Android Memos, Trello⁸ and iOS Notes. People who use digital tools for house tasks, also mentioned that they use these Apps whenever they remember something, and this happened at random moments during the day. As part of the questionnaire, I wanted to know what were the

⁵ Google Keep - Note-taking service developed by Google. [online] Available at: <https://www.google.com/keep>.

⁶ Google Calendar - Google Calendar is a time-management and scheduling calendar service developed by Google. [online] Available at: <https://calendar.google.com/calendar>.

⁷ iOS Calendar - Calendar is a personal calendar app made by Apple Inc. that runs on both the macOS desktop operating system and the iOS mobile operating system.

⁸ Trello - web-based project management application. [online] Available at: <https://trello.com>

reasons why they preferred to use digital tools. The answers were mainly related to: enjoying the sharing functionalities, and the fact that they can access old to-do lists that have been stored.

3.1.3 Similar Solutions

As part of the inspiration phase, it is important to have a look at what other similar solutions people already use to organise their tasks at home. The following products and services were mentioned during the interviews or were found during the social media and market research.

3.1.3.1 Digital Solutions

- Google Keep: Note-taking service developed by Google where you can capture notes, share them with others, and access them from your computer, phone or tablet.

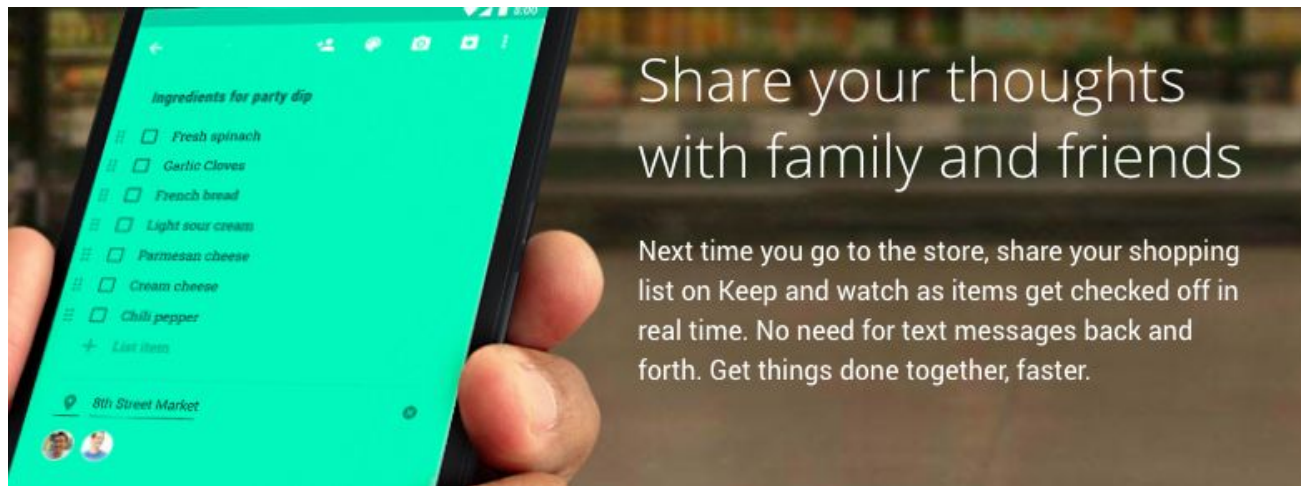


Figure 5. Google Keep shopping list example (from <https://www.google.com/keep/>)

A recurring comment during the interviews, is that people like Google Keep because they can share a to-do list with other people and also they can keep those lists saved and search for them later. People also mentioned that they do not have a specific time to use this App, they use randomly during the day whenever they remember something that needs to be added. Participants said that they like this App because of its simplicity and its collaboration possibilities.

- Trello: Web-based project management application that is based on the use of boards. A board is a list of lists, filled with cards where you can write all the details of the task. This

application is often used in project management with the columns to-do, doing and done, where the cards are moved to the corresponding column along the progress.

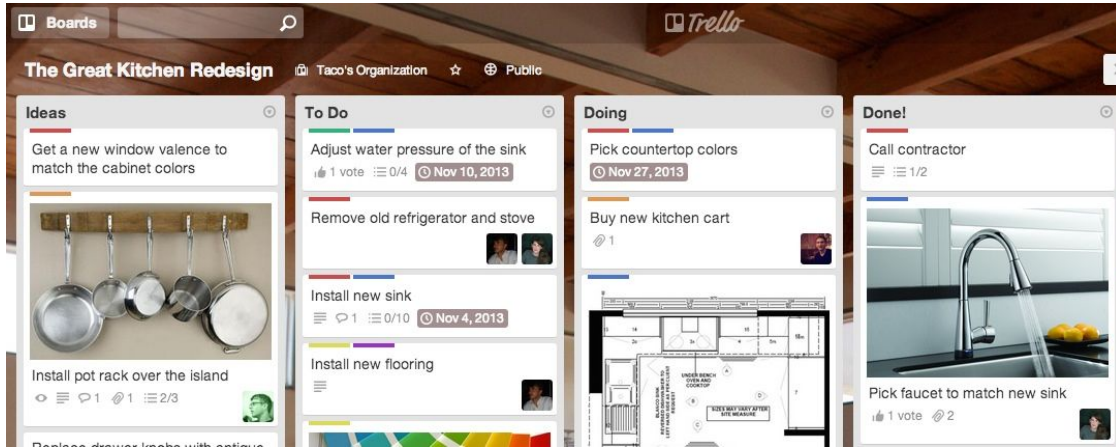


Figure 6. Trello Project management layout example (from <https://trello.com/en-GB/tour>)

3.1.3.2 Analogue Solutions

- **Magnet Board:** Consists on a magnetic surface with drawn or printed areas to place the tokens. Tokens are made with magnets which have a chore printed or written with a marker. Colours are sometimes used to differentiate each family member or the type of activity. Areas can be used to represent priority, working process or family members. The magnets can be flipped to show the task has been done, or the magnet can be moved into a “done” delimited area.



Figure 7. Magnet- based systems. *FamilyDoDots* on the left and a magnet board on the right (from Appendix A6)

Magnet boards are already a very common way of implementing chores and home organisation systems, which has created room for businesses to offer their own solutions. For instance, FamilyDoDots⁹ is a membership-based product which helps families to keep their chores organised through a magnetic board that keeps track of their tasks. On this board, each family member starts the day on *level one* and progresses every time they complete a chore. The progress is marked by flipping the magnet so that it shows the black side instead of a colour (see *figure 7*). Parents are encouraged to give privileges to the children once they complete their responsibilities and move to *level two* on the system. This product comes with all the tools you need to put the system together, including pre-printed responsibility dots and customizable white blank dots.

Other similar magnet-based boards are more simple and make use of magnets with pre-assigned task. These magnets can have the task written or drawn on top, and can be assigned to family members by placing them under their name. The second example on figure 7, is part of a board that uses this method. On this board there is a section to store all the possible tasks, a second section that works as a queue for tasks that “*Need to get done today*” and a third section for each family member to keep their assigned tasks.

- To Do Jar: Another way of using the to-do/done arrangement, is to make labels for each of the tasks and stick those onto wooden sticks that can be switched between two jars (see *figure 8*). A general suggestion for to-do Jars is to have a jar for each family member.

⁹ FamilyDoDots - Membership-based chores system. [online] Available at: <http://familydodots.com/>



Figure 8. to-do Jar (from Appendix A3)

3.2 Ideation - Making Sense and Brainstorming

At this second phase of the process, it was time for me to start making sense of everything I learnt during the *Inspiration* activities. After understanding people's problems, many ideas were generated and design opportunities were identified. These ideas could then be tested and refined (IDEO, 2015).

3.2.1 Finding Themes

As suggested by IDEO (2015), patterns and themes were likely to emerge after the observation activities. It is important to spot them and make sense of them so that we can take better design decisions. For instance, in this case, the social media and market research revealed that people have dedicated areas where to keep organisation tools at home. Once I visited some houses to interview people, I was able to observe some of the same patterns. I observed that most people kept this dedicated area in the kitchen and often as part of the wall (*Appendix D*), which is consistent with the narrative found on YouTube videos (*Appendix A*). I found that in some houses, people keep all the tools together, and some others had a couple of areas for this. For instance, the kitchen and the hallway. Recurring objects in such areas are: calendars, note pads, chalkboard, time schedules, inspirational quotes, family photos, mail containers and useful phone numbers. Participants explained to me how these tools are used to keep track of things they need to buy or do, but acknowledged that they are not always consistent with their use.

Something else I found out during the interviews, is what digital tools are people using to keep track of things to do with their families. I did not get any information about digital tools from watching the vlogs but the people I interviewed kept mentioning some of the same tools. I also got to know what people like about them and what they do not like, how often they use them and where they are when they use them. All of the participants who mentioned the use of a digital tool to keep track of tasks, said they use it at random times during the day, and whenever they remember a task. Hence, it was important for me to keep this in mind when creating a solution which would be always placed at home and could stop people from saving those tasks that come up to their minds when they are away from home.

Finally, I also heard some of their motivations for adopting organisations systems at home, and some of the pains that these systems are trying to solve. To make sure these comments are not lost after the house visits, I took some of those comments to create insights for the product development.

3.2.2 How Might We

Based on IDEO's *How Might We* suggested activity (2015, p.85), some key comments from the social media, market research and interviews, were used to identify problems and then were rephrases to turn them into opportunities for design. As IDEO states (2015, p.85):

"A properly framed How Might We doesn't suggest a particular solution, but gives you the perfect frame for innovative thinking." The resulting questions from following table helped during the brainstorming session when it was time to generate ideas about what the system could do.

Comment	Insight	How might we...
It is not only for me, it is for all the family to look at and use.	Mothers want a tool to use with the family	Support family collaboration?
I use Google keep memos like once per day at random moments.	People come up with ideas or to-do's at random moments during the days.	Allow people to record a task on the go? Implement an item queue or pre-assigned tasks?

Something great about command centers is that you can customise it according to your family needs	Families want to be able to use their personalised activities	Implement an item queue or pre-assigned tasks?
I can easily search all the old notes, I can access it on my computer or phone, i can set reminders, I can share the notes. (About Google Keep)	People like the ability of saving and sharing the lists.	Keep a record of the to-do lists?
One of the responses we heard from the parents is that they love that the board tells the kids what to do instead of the parents telling them.	Parents want a tool to support them in keeping track of tasks and liberate them from the responsibility of having to tell the kids what they have not done.	Show the kids the activities they still have to do?
Some families like to keep their command center on the side of the fridge, others might want to have it on a mudroom or entryway	Families want to have the organisation tools in the busy areas of the house without using too much space	Place the board in a space where the family spends a lot of time without affecting their limited space?

3.2.3 User Personas

User personas are part of the methods for designers to get a solid understanding of their users. Personas can be considered of value if they are based on research rather than imagination. Different research activities can be used to feed the personas and so that they describe attributes from real users (Baxter, Caine, and Courage 2015).

After the initial observation on social media and market research, preliminary user personas were created (see Appendix D). These personas were updated after the interviews and whenever something relevant about the user was discovered. Based on the findings from the user interviews and the preliminary market research, two user personas were developed; 2 married women. One of the married women had children and the other did not. Even though husbands are thought to be part of the users, gender alone was not enough differentiator to justify creating a third persona.

The personas describe users' motivations as well as their frustrations when trying to organise their household and making everyone be part of the chores. These user personas work as summaries of the insights from user research and are useful tools to inform the requirements of the system. Both personas describe people who feel they are not getting enough help from their families in keeping the house tidy. They also feel they are the only person in the house who is interested in keeping track of what needs to be done rather than being a combined effort. They wish all the family felt part of the activities that make home loving enjoyable. Based on several comments made by the target users and collected during social media and market research, I understood that users would like the product to inform their family members what to do, rather than being them who tells them.

3.2.4 User Scenarios

Based on the findings from the user interviews and social media and market research, user scenarios were created. According to Preece, Sharp and Rogers (2015), scenarios can be considered as an informal narrative description of human activities that allows exploration and discussion. For this activity, it was important to preserve some of the behaviours observed during the inspiration phase, to make sure users' key activities were understood and considered when creating the new product.

User Scenario

Katie is a mom of three: a 7 year old, a 10 year old and a 13 year old. Katie and her husband, James, like to involve the kids in the tasks of the house. Each child have daily and weekly tasks assigned to them, depending on their skills and time available. Katie likes to have a system to support her in assigning the tasks to both her kids and also her husband. Having a system in which everyone can see what has been done and what has not, is really useful for Katie and James, since they do not like to keep remind the kids about the things they have pending, as this can cause arguments. Besides the daily and weekly recurring tasks that the family is used to do over and over again, like cooking, cleaning rooms, doing laundry or walking the dog, there are times in which new tasks arise. For instance, fix the kitchen table, buy a gift for grandma or cancel the newspaper subscription. Katie and her family need a way of keeping track of all these tasks and that can be used by each of their children without having to use a tablet at all times. Katie and her husband have considered buying one of the different boards for children's chores that are available online, but they are not sure if once they get it they will keep using it.

3.2.5 Brainstorming

After finding themes and defining what the users need, it was time to have a divergent activity again and to start brainstorming possible solutions. At this first brainstorming session, the goal was not to get the perfect idea, but to get plenty of ideas. This session was guided by the general question: *What could this product do?*. As well as the specific questions obtained from the activity in 3.2.2 *How Might We*. Furthermore, it was already known who the persona is, what are her problems and what she needed the system to help her with. Therefore it was possible to give many ideas of what could the system do for her, without worrying too much about what is possible or feasible to make. This brainstorming session took place with the help of two participants. Post-Its were used to help with the idea collection, as well as pen and paper, magnets and a whiteboard. Magnets were useful at this stage of the process to help explain an action and then write down each possible functionality on one of the paper pieces. It was important that each idea was understood by all the participants so that we could build on top of each other's ideas. Even though this first brainstorming session was not planned to be visual, it was evident that drawing was necessary to explain some ideas. Therefore by the end of this session, we had a few sketches of how the layout of the interface could end up looking (see figure 9).

3.2.6 Bundle Ideas

After generating as many ideas as possible, it was time to match the ideas that were similar to each other and bundle them together. Besides having a few groups of ideas that are very similar to each other, I realised that some ideas needed to have a higher priority because they were necessary to give the users the basic functionality. These more important ideas were grouped under a main category, whilst the rest of the ideas were grouped as “*Secondary functionalities*” and “*Unrealistic*”.

3.2.7 Getting Visual

Once the ideas were bundled together and priorities were decided, I took some of the quick sketches made during the brainstorming and draw them again to continue exploring them by acting different scenarios and activities the user could do. In this case, scenarios were used to describe envisioned situations and the magnets allowed to act these situations and understand them better. It is highly valuable for designers to use quick physical sketches of the product

being built and to “explore by doing” in a way that we can experience different interaction solutions along an iterative process (Buchenau and Suri, 2000).

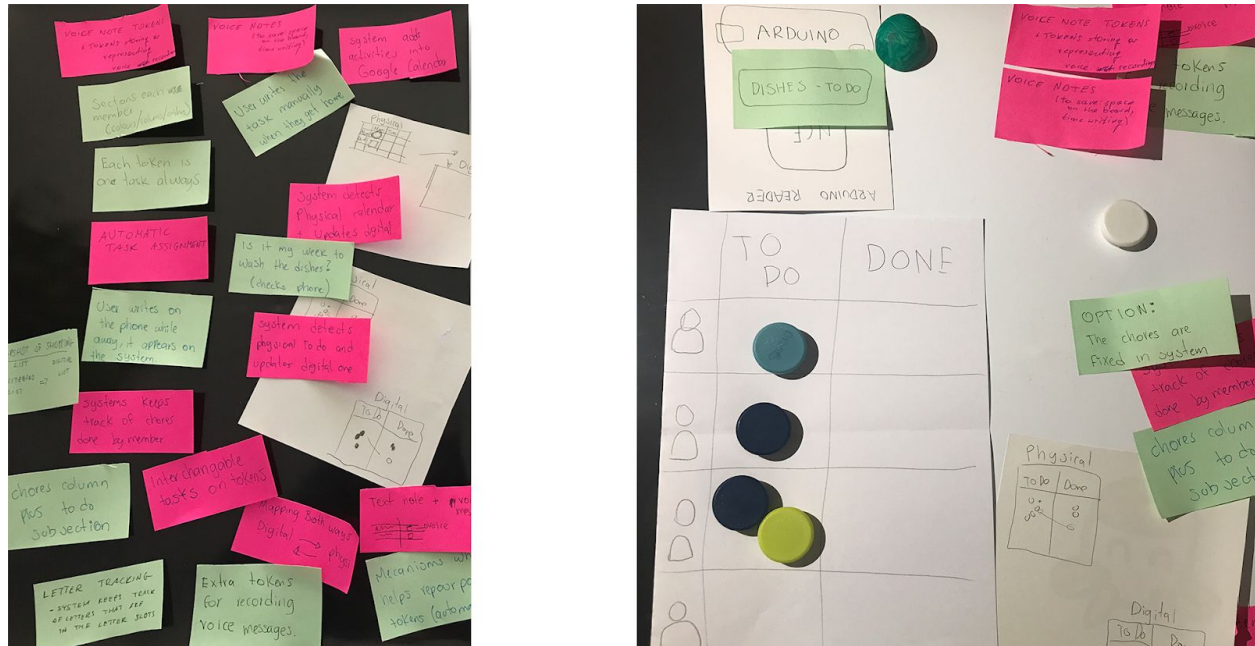


Figure 9. Left: Pool of solutions after brainstorm session. Right: layout and action exploration using pen, paper and magnets.

3.2.8 Product Requirements

After the exploration sessions, I was able to choose the main functionalities that needed to be prototyped. I also had a general idea about their order of priority, since I did not have the time to build for all of them. To create the product requirements, it was useful to keep in mind the solutions that already exist (3.1.1 *Similar Solutions*) and also a list of questions from the activity 3.2.2. How Might we question. Consequently, the product requirements that were considered a priority at this point were:

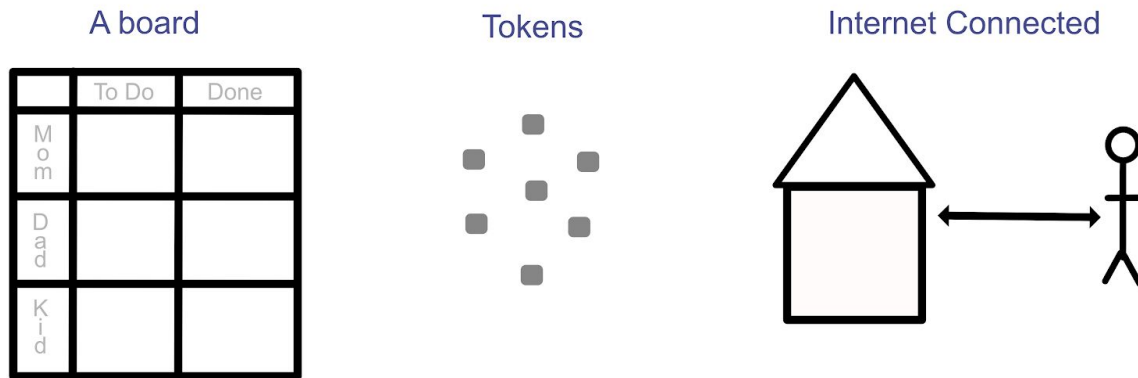


Figure 10. Main elements of the product.

The board:

- The board needs to be placed vertically so that it does not use surface space.
- The board needs to have limited areas to display tasks or chores for each family member.
- The board needs to have a “basket” section, where task can wait before being assigned.

The tokens:

- Some tokens need to have predefined tasks that are used constantly.
- Some tokens will be single use and will be created after a new task is added by a family member.
- Each token must have both a visual property to communicate people its content, and a tag so that it can communicate to the computer its content.

Internet connected:

- The system needs to provide the possibility for someone who is away from home, to know what tasks have been done.
- A person who is away from home should be able to record or send a task to the system at any time.
- The system must keep track of who has done which activity.

3.3 Implementation - Making

According to IDEO (2015), this third phase is all about bringing our solutions to life. After all the ideas that were generated, here is where we can figure out how to bring the best ones to real life and how to maximize its impact in the world. In the case of this project, *implementation* consisted of building three prototypes that were refined after each feedback session. In this chapter I briefly describe the context of building the prototypes as well as I introduce the general tools and technologies that this project focuses on. The characteristics of each prototype and a description of each feedback session can be found in the next chapter, 4. Results.

3.3.1 Prototyping

The intention is to build a basic version of the system as early as possible and tweak it as new insights arise. As a user-centered design is characterised by iterative processes and a focus on the users, the iterations of the system were tested at different stages to inform the final prototype. These iteration consisted of three rounds of feedback where participants shared their first impressions of the prototype, as well as gave opinions about that was clear or confusing. Each round of feedback allowed for further refinement of the interface and the system.

3.3.2 Technology

This project builds on previous work done during the course IMT4215 Specialisation Project where I explored different tools and materials to build interaction prototypes that help embedding technology into everyday items. There are clearly multiple ways of creating bridges between the digital and physical world, nonetheless, I have focused on Token-Constraint approach presented by Ullmer, Ishii and Jacob (2005). In this approach, Tokens consist of small geometric objects that can represent digital information and Constraints are limited areas that are mapped to trigger computational interpretations. During the literature review done for IMT4215 Specialisation Project, I found out that this type of interaction is often implemented with the use of RFID technology. Where an RFID reader can function as the constraint and the RFID tags as the Tokens. Thanks to RFID tags being so small, they make it possible to have computational elements embedded into all kinds of objects.

3.3.2.1 RFID Technology

RFID (Radio-frequency Identification) is a wireless communication technology used to wirelessly identify tagged items with the use of radio signals. RFID tags are small chips that contain an antenna and can be read by an RFID reader when they are in close proximity. On top of being quite small, RFID tags have the advantage of being cheap, making them an ideal tool for prototyping different types of tangible interactions. In the context of this project, RFID tags allow us to tag physical objects and to connect them to digital information, creating a relationship between the physical and the digital that can be used to create solutions for the users.

3.3.2.2 Microcontrollers

In the context of creating prototypes with IoT functionalities, microcontrollers are a popular tool since they are economical and can be used for data collection, sensing and actuating the physical world. Microcontrollers are small computers with a single board, these computers are made by different manufacturers being Arduino¹⁰ and Raspberry Pi¹¹ some of the most popular ones. Depending on the requirements of the project, one can choose a specific microcontroller, as some of them have wireless Local Area Network (LAN), Bluetooth, and sensors that can be attached to add extra functionality. One of those sensors, can be an RFID reader, like in the case of this project.

¹⁰ The Arduino UNO. Store.arduino.cc [online] Available at: <https://store.arduino.cc/arduino-uno-rev3>

¹¹ Raspberry Pi. Raspberrypi.org [online] Available at: <https://www.raspberrypi.org/products/>

4. Results

This chapter contains a description of the prototypes that were built, as well as the feedback I got from participants and the improvements that such feedback inspired. The results are divided in three iterations.

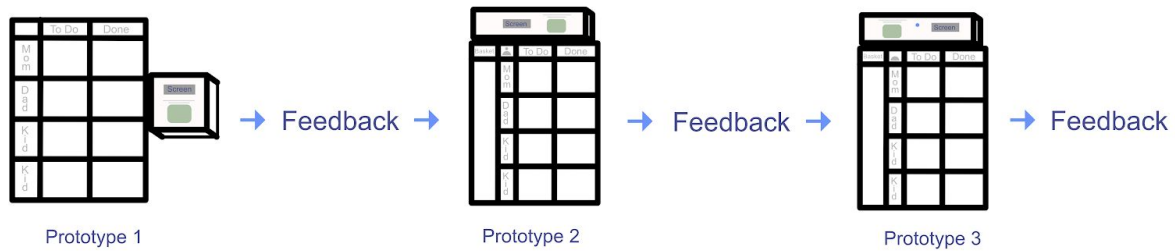


Figure 11. Iteration sets.

4.1 Iteration I

The intention of the first prototype was to generate more ideas and to discover problems with the concept when presenting it to users. At this point, the system was only able to read the tag and to give feedback to the user by displaying the word *DONE* on a screen. No internet connection was being used and given the conditions of the interface and the RFID box, I do not consider this to be a usability test, but rather an opportunity to explore the board together with the RFID box concept.

The prototype consisted of three main parts: a magnetic board, a set of tokens that represent tasks, and a box which gives feedback regarding the action being tracked or recorded. The board was made using a wooden board covered with magnetic whiteboard sheets and ribbon to create sections within the board. Everything was put together with tape rather than glue so that the layout could be rearranged cheaply and the pieces could be reused after the feedback. The tokens were made using polymer clay, magnets, tape, pen and paper. Each token had an RFID tag attached to it and covered by a piece of paper with a task written on it (see Figure 12). Each RFID tag had the same task written on it as a text record so that it could be read by the RFID

Box . The RFID box was made with a cardboard box, a small screen, an Arduino UNO, an NFC reader and printed paper to communicate its constraints (*see figure 13*).

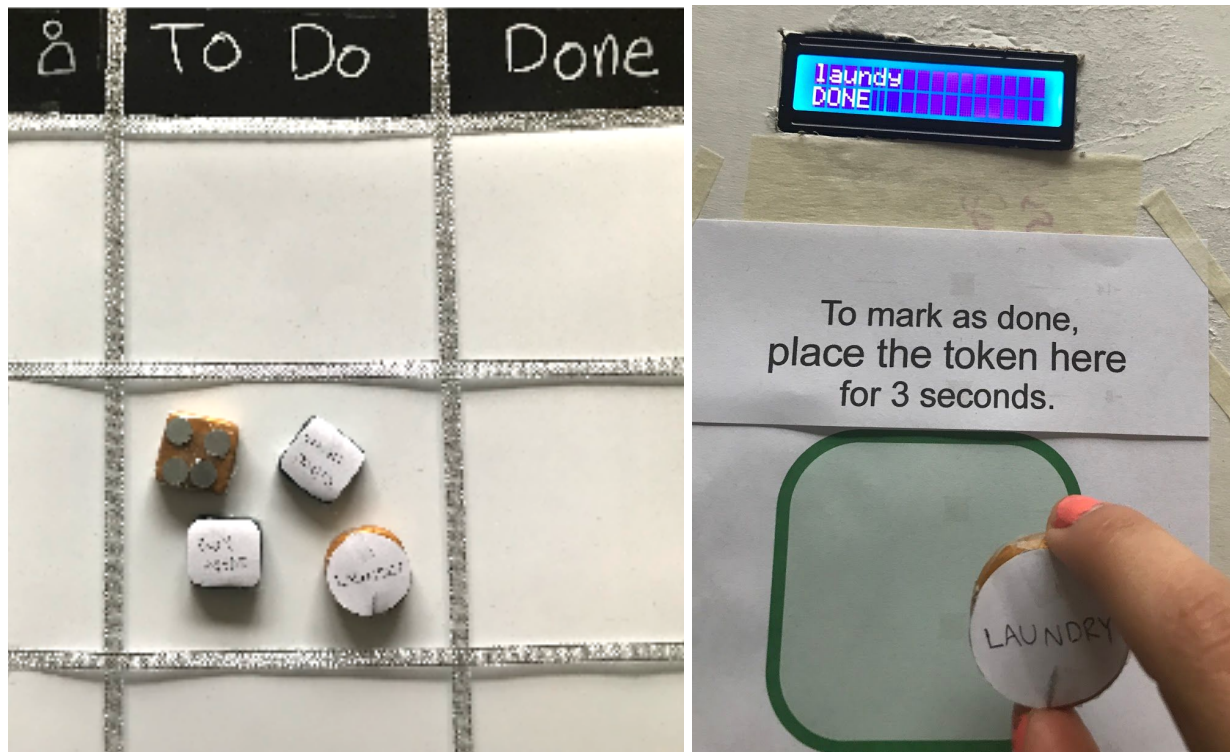


Figure 12. Left: Board and tokens. Right: RFID Box.

4.1.1 Technology Used

The RFID box was built using an Arduino UNO connected to an Adafruit PN532 NFC/RFID Controller Shield and a LCD 1602 Display with i2c adapter with the help of an Arduino Screw Shield V2 to easily connect the shield and the screen to the Arduino.

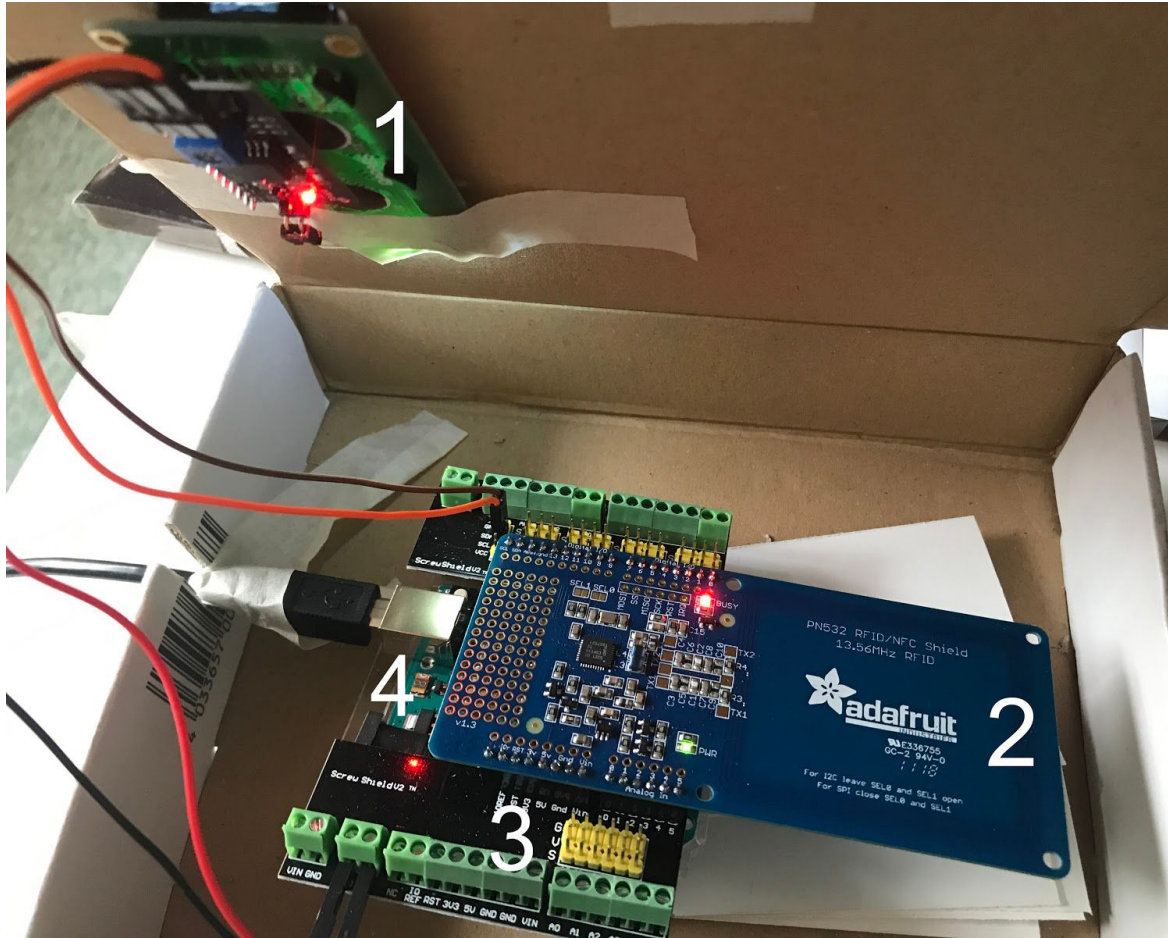


Figure 13. RFID Box.

1) LCD 1602 Display with I2c adapter 2) Adafruit PN532 RFID Shield 3) Arduino Screw Shield V2 4) Arduino UNO

Following the Adafruit Tutorial for NFC Shield¹², the Adafruit Library¹³ was installed and the examples were used to create a program to read NTAG tags. The tags were formatted to NDEF format so that they could work with Android Phones and be written using an Android App called NFC Tools. For this prototype, the program was only able to read the tag and display its content followed by the word *DONE*. My intention was to have some sort of feedback working to show the user that their actions could be saved and then explain how that data could be used later, even though at this point there was no system recording anything after the tag was read. I also wanted to figure out if the action of moving the task from the column *to-do* onto the RFID box,

¹² Adafruit PN532 RFID/NFC Breakout and Shield
Radio Frequency ID and Near Field Tutorial. [online] Adafruit.com. Available at:
<https://learn.adafruit.com/adafruit-pn532-rfid-nfc/shield-wiring>

¹³ Adafruit NFC Library. [online] Github.com. Available at: <https://github.com/adafruit/Adafruit-PN532>

and then to the *done* column would feel troublesome to someone using it for the first time (see figure 14). And finally, I wanted to hear comments participants would have after explaining the connectivity possibilities of this product.

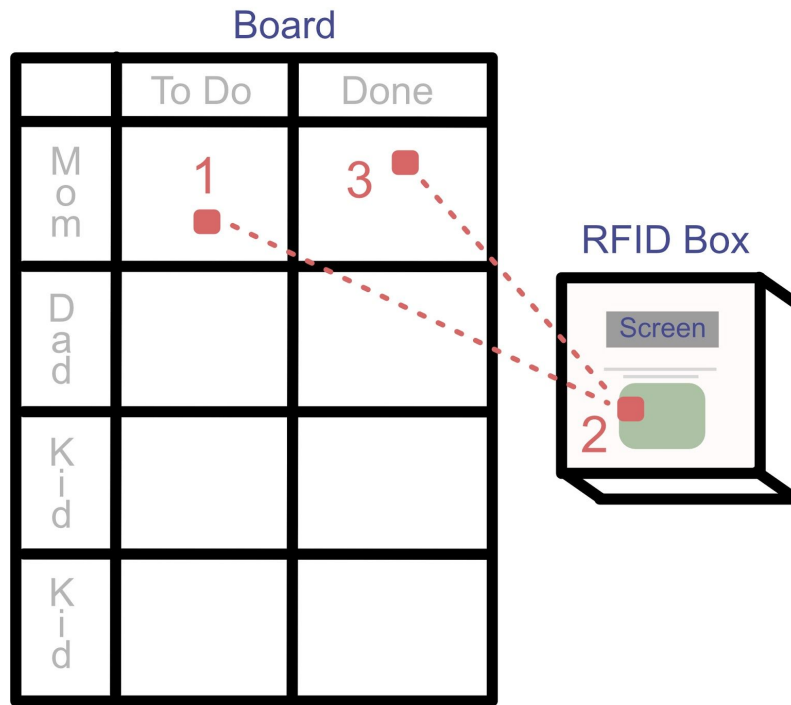


Figure 14. Movement of the token needed to mark a task as done in Prototype I.

To have the program working, it was necessary to modify the existing the NTAG reading example¹⁴ so that we could extract a NDEF record from NDEF message. To connect the LCD screen, an online tutorial¹⁵ was used. The tutorial explains how to connect the LCD screen with I2C Adapter to Arduino and also provides library¹⁶ for doing so.

¹⁴ Ntag2xx_read example sketch. [online] Github.com. Available at:

https://github.com/adafruit/Adafruit-PN532/blob/master/examples/ntag2xx_read/ntag2xx_read.pde

¹⁵Using LCD Displays with Arduino. [online] Dronebotworkshop.com. Available at:

<https://dronebotworkshop.com/lcd-displays-arduino/>

¹⁶ NewLiquidCrystal library. [online] Bitbucket.org. Available at:

<https://bitbucket.org/fmalpartida/new-liquidcrystal/downloads/>

4.1.2 Feedback Session

The first feedback session using a prototype was intended to generate more ideas and discover problems with the concept. The consent form used for this session can be found in *Appendix B* and the questions guide in *Appendix E*. The questions were useful to start a conversation about the prototype and to get participants talking. I presented the prototype to four participants. I started by asking first impressions of the prototype to figure out what would be their best guess before me explaining it. Participants understood the layout of the board and grabbed a token, proceeded to touch the RFID box with it and then place it under the *done* column.

Once I was able to observe their first guesses at using it, I proceeded to explain the purpose of the product and its possibilities to hear comments and suggestions.

Issues found:

- **Deficient feedback:** It was taking too long for the screen to give feedback after the token touches the RFID reader. The program was working in a way that the screens displayed the content of the tag only when the tag is either moved away, or after 3-4 seconds. Hence, participants who only tapped the reader got a better experience than the ones who tried to hold the token longer.
- **Inadequate instruction:** The wording of the instructions on the RFID box was adding to the previous issue, since I used the word “place”, it was giving the impression that one must hold the token against the reader until something happens.
- **Interface continuity:** The shape of the box was not helping for it to look like part of the board.
- **Linguistic clarity:** Since the tokens were made with pen a paper, some of them were not very easy to understand quickly enough, forcing the users to stop and try to read them rather than scan the interface as a whole.

4.2 Iteration II

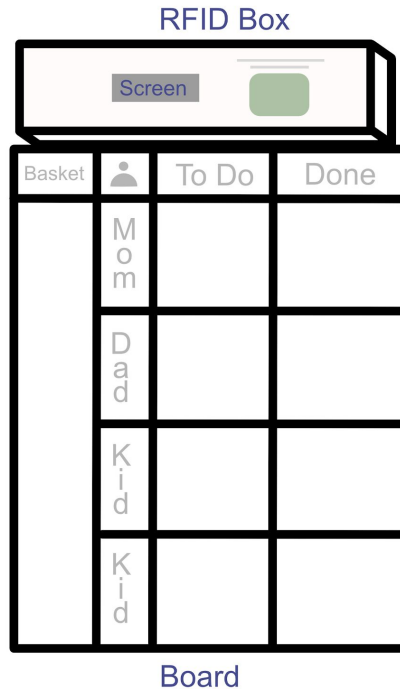


Figure 15. Prototype II.

4.2.1 Improvements

- In the first prototype, the RFID box was perceived as not part of the interface by some of the participants, therefore I tried to change its shape from a square that is placed next to the board, to a rectangle that can be placed on top of the board (see figure 15).
- A “Basket” column to place tasks before assigning them was added (see figure 15).
- The functionality of capturing a task remotely via email was added.
- The instructions in the RFID box were improved by changing the wording and the inclusion of a commonly known *contactless*¹⁷ icon.
- A button was added to switch between reading and writing mode.
- The task-tokens were updated to be all the same shape and size, plus icons were added to make the common tasks easier to read and understand.

¹⁷ Contactless payment are systems that use radio-frequency identification (RFID) or near field communication for making secure payments.

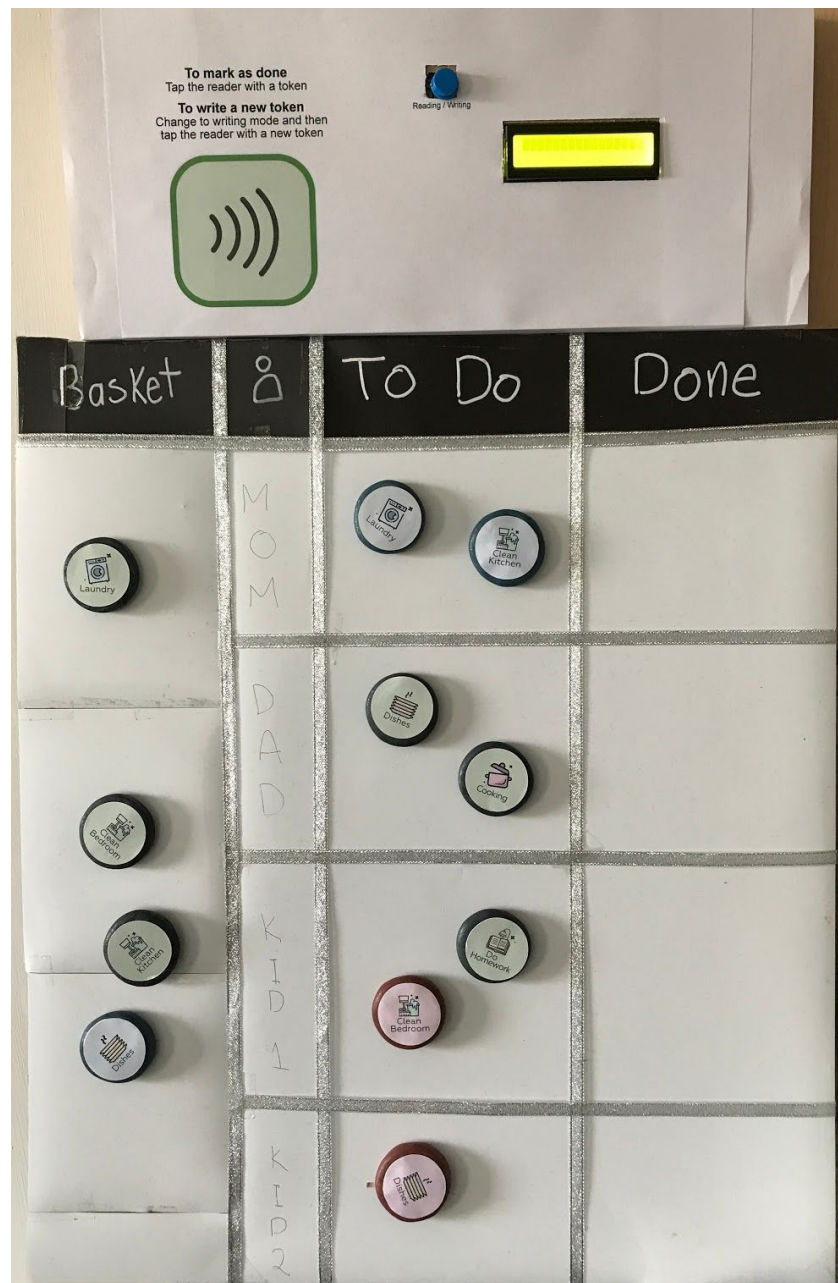


Figure 16. Board, tokens and RFID Box in Prototype II

4.2.2 Internet Functionalities

One of the challenges of me doing a physical product to keep track of tasks, is the fact that people sometimes come up with tasks when they are away from home (as discussed in 3.1.2

Home Visits and Interviews). Hence an important challenge to tackle in this project was to add internet connectivity to an otherwise analogue task board. For this second iteration, I started adding internet to the prototype with the intention of allowing users to send data to the device, from wherever they were. The need to have internet, forced me to completely discard the prototype used during the first iteration, and make another RFID box with new components. Besides the internet connection, access to libraries in Python¹⁸ guided the decision to switch to using a Raspberry Pi, rather than Arduino as in the first prototype.

The first internet functionality that added was the possibility to send tasks to the board via email. To do this, the user needs to send an email with one or more tasks to an email address I created for this purpose. The program is written in a way that after 20 seconds, the Raspberry Pi checks for emails and then adds the tasks to a queue, at which moment the user can proceed to write to tasks into a rewritable token. To also have a visual of the content of the task, these writable tokens were made with whiteboard sheets, hence we can write on the front of them (see *figure 17*).



Figure 17. Sending an email creates a task in the queue that can then be written into a rewritable token.

¹⁸ Python - OSI-approved open source programming language. [online] Python.org. Available at: <https://www.python.org>

4.2.3 Feedback Session

Even though the prototype was not ready to perform a usability test, I was still interested in seeing how far could the participants get in using the interface without any explanation other than the couple of lines of instructions written on the RFID box.

For this round of feedback, five participants were asked to approach the prototype without any introduction to its functionality or purpose. After I got some of the first impressions, I proceeded to explain how to send a task via email and how to write a token. Three out of five participants were able to use the RFID box to mark tokens as "done" and place them into the *done* column without me explaining anything.

Positive comments:

- "Maybe if I don't see the children during the day, when I come home, I can see what the children have done during the day. And everyone knows that people have done. "
- "I like that the magnets have images, so I understood right away. I like that you can see what the other person has done!"
- "I like that it is a good interface for children, they don't need to go on a website. "

Issues found:

- **Visibility of system status:** Before the users scan a token or click the button, the screen is giving no clue about the current state of the system. Some participants tried to use the button multiple times in an effort to figure out what was the current state. In other words, the screen was not communicating correctly the system status.
- **Confusing feedback messages:** Similar to the first issue, when the button is clicked and the mode is switched to *writing*, the following phrase appeared on the screen: "Basket is empty, add some tasks" which was very confusing for all the participants, since I was using the word "basket" for both the column on the left of the board, and the queue of tasks coming from an email. Hence, reading "Basket is empty" and looking at the column basket having tokens in it, did not make sense.
- **Feedback timing on screen:** When a token is being marked as done, the content of the token appears on the screen, followed by the word *DONE*. This message was clear for all the participants but two of them missed it the first time, since it disappears too soon.

- **Having all the board surface detecting:** One participant mentioned that it would be great if the board could detect the changes by itself, without the need of an RFID box. I noted this comment because it matched my initial supposition: I was suspecting that the extra step of using the RFID box could be perceived as troublesome (*see Figure 14. Movement of the token needed to mark a task as done in Prototype I*). However, it is worth mentioning that later on during the third iteration, I received comments stating the opposite. These contradictory participant perceptions are hence discussed in chapter 5.5 *Further Work*.

4.3 Iteration III

4.3.1 Improvements

- Online board status functionality added: each task which is in to-do or done, has now a note representation on Google Keep.
- Family member identification
 - Tangible: The tokens are colour coded by family member.
 - Digital: Each token has a label to be related to one family member.
- Visibility of system status: now the screen shows “Create tag: *{text}*” or “Ready to read”, depending if it is in writing or reading mode, instead of the text that was confusing for participants in the last feedback session.
- Feedback messages: “Queue is empty, add tasks via @”, instead of using “Basket is empty”, which was confusing in the last iteration.

4.3.2 Board Status Available Online

Since one of the value propositions of this project was to add digital functionalities to an otherwise analogue board, in this iteration I began adding the possibility for users to see the status of the board, online. After researching a few different ways of making this possible, I went with Google Keep since there was an existing library for easily integrating the program with Google Keep Notes (*Appendix G: The Program*) for a full list of the libraries used. With this new functionality, every time a movement is registered on the physical board, a note is created on Google Keep which shows the status of the task, i.e., to-do or done. The to-do and done notes can be distinguished by labels and colours to identify their status. Additionally, every note has a

label with the name of the family member, allowing members of the family to see what has been done and by whom. To avoid members using other person's tokens, the tokens are colour coded and each member should use only their own (see figure 18).

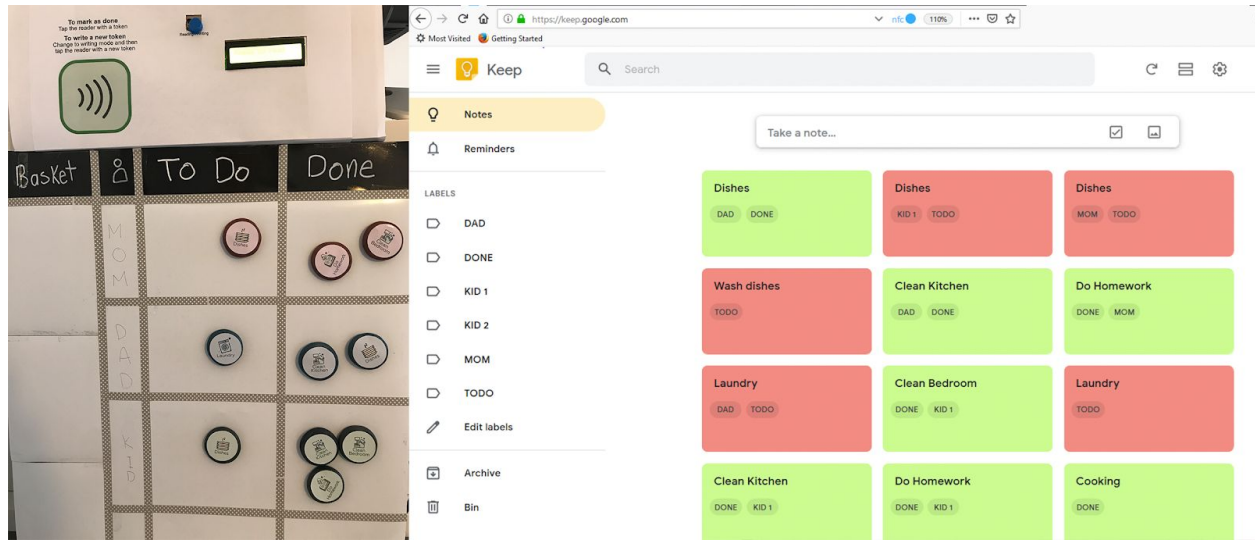


Figure 18. The Board and the Board Status Online via Google Keep.

4.3.3 Technology Used

For the third prototype, I continued using the Raspberry Pi as in the second prototype. To make the connection between the board and Google Keep, the program is using an unofficial client for Google Keep API¹⁹. Whenever a new task is created, a note that contains the task is also created on Google Keep. The notes have a label and a background colour to easily identify the status; to-do: red and done: green. A more detailed explanation of how the program works can be found under *Appendix G: The Program*. The RFID box in this prototype contained: a Raspberry Pi 3²⁰, a PN532 RFID Reader/Writer Module, an LCD Screen 1602 with I2C backpack, a bi-directional Logic Level Shifter and a Push-Button. A more complete explanation of how these components are connected can be found in *Appendix G: The Program*.

¹⁹ Unofficial client for the Google Keep API - GitHub repository. Available at: <https://github.com/kiwiz/gkeepapi>

²⁰ Raspberry Pi 3 - Single-board computer with wireless LAN and Bluetooth connectivity. Available at: <https://www.raspberrypi.org/products/raspberry-pi-3-model-b/>

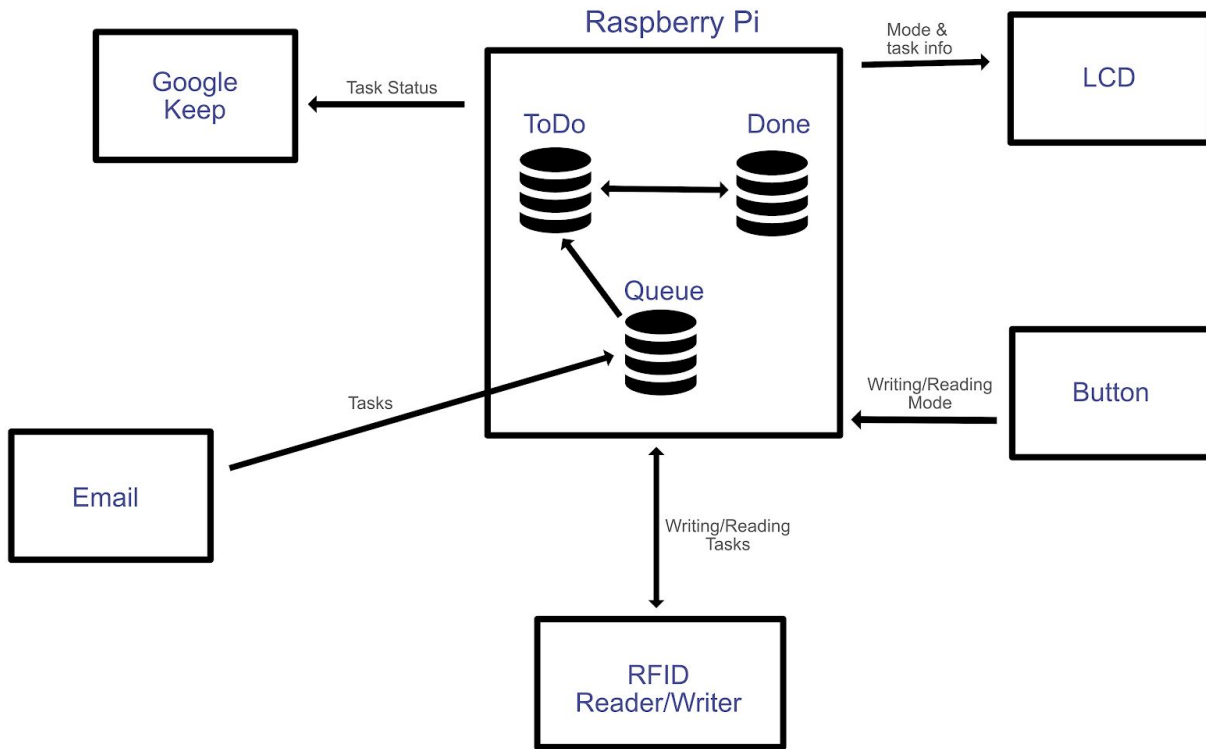


Figure 19. Diagram of the program used for Prototype III

4.3.4 Feedback Session

For this round of feedback, four participants were asked to approach the prototype without any introduction to its functionality or purpose. After I got some of their first impressions, I proceeded to explain how to the tasks that are marked as done on the board and then appear in digital form on Google Keep. Then I asked them to mark a couple of tasks as done, and started asking questions about their impressions and suggestions, using the guide found in *Appendix E: Feedback Session - Semi-structured Interview*.

Positive Comments:

- “I like that everybody can see the activities and if someone lies, everyone can see that they lied. Then children cannot lie about doing the chores cause everyone can see.”
- “I like that we include children and mom and dad, not only children. And they can see that it is not only them.”
- “There will be less reason to argue because you can see what needs to be done. And we don’t have to be reminding them. Will be more objective and less emotional.”

- “It improves the family atmosphere because mom doesn't need to remind all the time about their activities.”
- “I like that I need to move the token to the reader, I like to grab the token and move it to mark it as done. It feels like I’m doing something, otherwise it's too effortless. It would need to have more feedback, so that I know that I have done something”

Issues found:

- **Error recovery:** The system does not have a way to undo any actions. One participant mentioned: “What if the kid moves the token by mistake? I don’t know how to fix it.” and also some participants on this testing session, and the passed ones, liked to explore the interface by performing certain actions and it would be better to have an option to go back.
- **Incoming task notification:** It would be better to have a notification to let the user know that a task has been sent by email and it is waiting in the queue. Currently the only way to see that a task has been sent, is once you click on the button and change to “writing”.
- **Token colours:** One participant mentioned that the difference in colour between each participants’ group of tokens was not enough. She thought it would be easier for family members to get confused and use other person’s tokens. Since the results on Google Keep depend on people using only their own tokens, it is important that they do not mix them.

During this feedback session, it was getting harder for me to get the participants to talk about issues with the interface, contrary to the first and second rounds of feedback, where the issues were very obvious. Nevertheless, I started getting more functionality suggestions.

Participants suggestions:

- **Time sensitive tasks:** Two participants mentioned they would like to have a way to add a due date to their tasks. Additionally, they would like to have some kind of reminder sent to them. As an example, one person mentioned a task that happens once per week, like taking out the trash.

- **Flexible layout:** Another participants asked:”what if you have another kid? The layout of the people could be flexible to add more people.”
- **More content in each token:** It was also mentioned that it would be useful to have more details about the tasks inside the token. For instance, if the task is the laundry, it could contain the instructions to program the washing machine. This situation is further discussed in chapter 5.5 *Further Work*.

5. Discussion

This chapter will first discuss the use of IDEO's design kit and the experiences I had while working alone, learning about the users and towards the final prototype. Then I will point out certain limitations and functionalities that could be useful for the target users.

5.1 IDEO's Method

Even though IDEO's design kit (2015) is intended to be used to solve social changes and it is ideal for projects related to social innovation and community initiatives, that does not mean it is not a great tool for other types of projects. Because of this, even when I might not have exploit of all the benefits of this kit's design-thinking approach, I did gain a lot from using it in this project.

IDEO's field guide and tool kit focuses on human-centered design, guiding you in the process of understanding, and generating empathy for the people you are designing for. I chose this kit because of its clear and concise how-to approach, which helped me to identify each next, tangible step. Firstly, I took advantage of its three main phases (Inspiration, Ideation and Implementation) to guide my design process and to make sure I did not jump into planning technology solutions before listening to people. Secondly, I used some of the suggested activities in this book and applied them during the Ideation phase, which helped creating a link between learning and doing. Personally, I was not used to spending this much time in the process of making sense of observations, as I tended to jump from a quick observation into building and prototyping. For instance, a key part of the Ideation phase was the activity called "*How might we*" which helped me in understanding exactly what users need, by forcing me to come up with questions based on direct quotes from people. A chapter from this book that was not as useful for me in this particular project, was the Implementation one. IDEO's focus for the Implementation chapter is to help designers and creators to launch a product or service into the market, as it contains tools to help finding funding or getting sustainable revenue. Therefore, what I did was to adapt the activity sequence to fit my situation and limitations, and hence the Implementation section in this thesis was used to iterate and to get feedback.

Another reason why I felt I was not getting the most out of these activities and out of this book, was the fact that this was a solo project. I did not have a team to brainstorm with, and to add on

top of each other's design ideas. I can imagine a project like this would get a great benefit from having two or more people designing together. To that end, I would like to keep this book and use these methods in future projects. Specially when I have at least one other team member to help me in coming up with more ideas and interesting solutions.

5.2 Getting to know my users

This thesis started with a slightly different objective as at the beginning the idea was to make a task manager for personal use. However, as I started learning about the benefits of tangible interfaces, I realised that most the strengths of TUIs are related their use as collaboration tools. Additionally, during the market research I found that most, if not all, task managing tools for the home are used by the whole family, rather than individually (*see 3.1.1 Social Media and Market Research*). I also realised that people who buy and find these task managing boards useful, are people who have children, since they deal with a more chaotic day to day life (*see Appendix A4. Key quotes from social media and market research*). Therefore I decided to focus on families as they would be the ones who could benefit from a product like this, rather than people living alone. After all, a mobile app is often enough for people living alone, as they do not need to share their tasks with anyone and they do not need to know what other people have done.

5.4 Limitations

In this section, I will discuss some limitations regarding the prototype development and testing:

- **Developing the prototype:** Lacking a programming background myself, I underestimated the time it would take to program the Arduino and the Raspberry Pi programs. Even though I got help from my husband who is a software engineer, it made the development a lot less straightforward, as I was trying to learn programming and electronic basics as well as building the prototype. Because of this, a functional prototype with the core functionalities came quite late into the process. It was only in Iteration III that I had a product that could both receive new tasks and also feed the Google Keep, leaving me with very little time to do proper usability testing.
- **Usability testing:** based on the feedback sessions I was able to get great insights about what seemed useful and what was confusing for the users, these insights certainly helped me while building the prototype. However, if having more time, a more structured usability test performed on the working prototype would have provided quantitative data

and a stronger evidence of the products' usability and benefits. In the end, without a usability test, I cannot confirm or deny if the current solution is "usable" or not.

- **Insights from children:** Given the fact that families are the type of users I am focusing on, it would have been useful to include children in the feedback sessions. However, because of time restrictions, I had to prioritise and focus on the user group that is generally in charge of assigning tasks, which tends to be the women (*as discussed in 2.1.1 Household Task Management*).

5.5 Further Work

Some of the situations I noticed could be improved, based on personal observations and also on users' feedback are:

- **Child behaviour research:** The current report does not include research regarding the effectiveness of this kind of systems for improving and managing behavior and creating independence in young family members. The decision to create this product is based on the fact that similar products already exist in the market and they seem to work for many people. Therefore, expanding the literature in this subject would be useful to provide a stronger background about the product's benefits.
- **Storing information of tasks done:** During the research activities described in 3.1.2 *Home Visits and Interviews*, one of the topics I wanted to touch with participants was their use of digital tool to manage household tasks. Something I was trying to figure out, was the benefits they saw in using digital apps. The answers I got were related to their ease of use, the fact that they can share the to-do lists, and the possibility of seeing old notes and to-do lists saved in the app. Therefore, I think it would be useful for the users if this product could store data about the tasks. For instance, how many times has one particular member cleaned the kitchen? Or see if they remembered to water the plants everyday of the week. After all, having access to all this information would bring this product closer to its digital competitors in terms of benefits. Making it a stronger example of blended interaction: "The goal of blended interaction is to leverage users' knowledge about the real-world while preserving the power of digital computing." (Hurtienne and Habakuk, 2013).
- **Integrated reading surface:** Since the initial layout planning, I pictured an ideal situation in which the token's location could be read from behind the whole board. In other words, the tasks could be mark as done just by moving the token to the *done*

column, without having to perform the extra step of moving it to the RFID Box. This could possibly allow a more fluid interaction, but I did not have the opportunity to build for it and test it. One of the participants from the second feedback session did mention that would be better to have the board detecting the movements without having to use the RFID Box. However, two participants from the third feedback session, also commented that they like and prefer to have the extra step of using the RFID Box. One participant said that having that extra step means that children cannot mark activities as done by mistake. For instance, they cannot lie about having done their homework, and then pretend they moved the task by accident when confronted. Another participant said that she likes that she needs to grab the token and move it to the read, as it makes her feel like she is “doing something”, and she is not sure if without the movement she would get enough feedback of having done something (*4.3.4 Feedback Session*). In the end, it would be useful to find a technological solution to allow this board to read the position of the tokens at all times, and then test it with families to see if this simplification actually improves their experience or not.

- **Creating new recurring tokens:** An issue that has not been discussed yet but would be useful to clarify if this product was to develop any further, is the creation of new recurring tokens. The board would ideally come with a set of pre-printed task tokens, similar to what FamilyDoDots ²¹ does with its system (*3.1.3.2 Analogue Solutions*). Additional recurring tokens could be made by the users with the help of stickers and tokens that come with the package (*see figure 20*). The RFID could be added to the tokens as a sticker or they could also be pre-encapsulated inside the token itself.

²¹ FamilyDoDots - Membership-based chores system. [online] Available at: <http://familydodots.com/>



Figure 20. Pieces included in the FamilyDoDots Kit. (from <http://familydodots.com/product/the-dodots-family-system>)

- **The token content:** A system like this could benefit from storing more information in each of the tokens, rather than only a couple of words. For instance, a description about the task, a list of sub-tasks about how it needs to be done, where the tools needed for it are stored, etc. This information could be displayed on a bigger screen whenever the user needs it, rather than only displaying the name of the token. This would further expand the value of the product, as it could help children in learning how to do things around the house.
- **Error recovery:** The system does not have a way to undo any actions. Some participants liked to explore the interface by performing certain actions and it would be better to have an option to go back (4.3.4 Feedback Session).

6. Conclusion

This thesis aimed to design and prototype a product that could support families in managing their tasks and chores at home. One of the challenges of this project was to have a tangible interface that stays at home, but also provide some of the functionalities that users enjoy when using their mobile apps. Therefore, I considered useful to first get a grasp of all the different tools that families are already using to organise their tasks at home. Only then I could think of contributing by adding functionalities, extend the capabilities of existing tools, or adding bridges between different concepts that already exist.

To answer the *RQ1: “What other similar solutions exist?”*, first I conducted a market and social media research, and then a series of interviews and house visits. These observations shed light into the way people organise their tasks at home and the tools they use. In regards to the market and social media research, a list of books and ready made products were listed under *Appendix A2* and *A3*, as well as a shortlist of videos and images where people explain how they organise their family activities. The findings from the home visits are listed under *Appendix D*, where some photos I took at people’s houses display the tools they use to organise. Additionally, the interviews at people houses allowed me to get familiar with the digital tools they use to organise task and chores. These digital tools are listed and explored in chapter *3.1.1 Similar solutions*. Many of the design decisions that gave birth to the prototype in this project, came from these observations. For instance, the layout, the use of magnets, the use of colour coding per family member, the decision to use Google Keep, etc.

The second research question, “*How can we make this product suit collaborative activities?*”, lead me to first do a review of the literature to get a grasp of the methods that other kind of teams use to manage tasks. For instance, teams that work with agile or lean software development (*2.1.2 Task Management for Teams and Collaboration*). During this review I found that a Kanban Board can help team members to collectively identify and surface any missing tasks and therefore to keep the pace of the work harmonized (Oza, Fagerholm and Munch, 2013). Considering that a layout similar to the Kanban Board is the one I observed on most of the boards families already use at home, I thought it would be a good layout to start with (see *A5. Recurring elements observed on home organisation dashboards* and *3.1.3.2 Analogue*

Solutions). In a similar matter, during the literature review I found information about how TUIs can take advantage of a third dimension to improve the awareness of others' actions, potentially leading to increased collaboration (Tuddenham, Kirk and Izadi, as cited in Schneider et al., 2011). In the case of this project's task board, the use of graspable tokens and a column-based layout that is visible for everyone, are some elements that make this product more suitable for collaboration. Particularly in comparison to using a screen-based application to organise the tasks, where the children of the family could be left out of the activity. It is therefore, no surprise that so many of the families who already use tools for task management, use boards with magnets and similar layouts. Additionally, comments received during the feedback sessions with the prototype, confirmed upto certain degree, that people perceive this product to be useful in that regard, e.g., *"Maybe if I don't see the children during the day, when coming home, you can see what the children have done during the day. And everyone knows that people have done."* (4.2.3 Feedback Session). Furthermore, the addition of colour coding and labels to the tokens, which helps distinguishing members' tasks, is another way of supporting collaboration. After observing different products and services that families use in their houses, I realised that many of them use colours to identify each person's tasks. These observations and some others are listed under 3.1.3.2 *Analogue solutions*. In conclusion, this product suits collaborative activities by providing third dimension awareness of others' actions, by helping family members to collectively identify what everyone has done, and by helping them spot any missing tasks even without a face to face interaction.

To answer the 3rd research question, *"How can we embed this product into a home environment?"*, this thesis' 3.1 *Inspiration* chapter describes the activities used to understand the way in which people use tools to organise their tasks at home. The key findings from online and in-person observations were then taken into account to create the prototypes. For instance, most families keep their organisation tools in the kitchen or in a nearby hallway and always vertically. Because of this, I knew I had to create an interface that could be placed vertically and hence the tokens needed to be magnetic. Furthermore, contrary to an office environment, house tasks are mostly repetitive, which means pre-made tokens with standard activities would be more useful than having to create them from scratch. Accordingly, many of the products that are already being sold to organise house chores, have these pre-made token-like items. These existing products that are already being sold, can be found under 3.1.3.2 *Analogue solutions* and Appendix A2. *Ready Made Products*.

To answer the RQ4: “*How can we input users’ data items in a way that it is convenient for them?*”, the first thing I needed to do was to listen to people. In chapter 3.1.2 *Home Visits and Interview*, I describe the process I took to understand how families manage their common tasks by visiting their houses and talking to them. Some families use mobile applications to communicate and keep track of the things they have to do and are common to the household. For instance, if there are things they need to buy they would use Google Keep or they would text their partner to remind them. Everyone I talked to, agreed with the fact that these task ideas or communication needs arise at different times during the day (3.1.2 *Home Visits and Interviews*). For example, the father can be at work when he remembers that they need to book the flights for the family holiday. If he could only use the task board once he arrives at home, he might have forgotten by then. Because of this, one of the prioritised requirements for this product, was as follows: “A person who is away from home should be able to record or send a task to the system at any time.”(3.2.8 *Product Requirements*). As a result, the first solution this project proposes is the ability to send the tasks by email and having the systems store these data items. Once the father gets home, he can assign the tasks to a physical token and place it on the board. The second solution is regarding the management of the existing task and tokens on the board. How can someone who is not at home get to know if the laundry has been done?. What the prototyped product proposed is to feed the changes made on the board, into Google Keep via an API. That way anyone would have access to it, wherever they are. For instance, mom can be upstairs and she can see if the kids have marked their homework as *done* without going to the kitchen to see the board. She would just need to access their Google Keep account from her mobile phone or tablet.

In conclusion, even though these solutions were prototyped in a very basic form, they allow us to contemplate the multiple possibilities that open for us as interaction designers if we decide to explore the connection of existing analogue products and digital tools that we might already use. In the same way, this thesis provides an example of blended interaction, where an existing analogue solution has been given certain characteristics that were previously reserved for digital tools. As Hurtienne and Habakuk (2013) describe: “The goal of blended interaction is to leverage users’ knowledge about the real-world while preserving the power of digital computing.”

Therefore, by looking at this design process, we can observe how it is possible to create something *smart* out of a simple item that exist in our houses. As it has been shown, one way of doing so, is with the use of RFID tags that help in creating a digital representation of a real object. Thanks to RFID tags being so small, that means they make it possible to have computational elements embedded into all kinds of objects.

Finally, the contents of the prototype itself, have been laid out in detail in *4.3 Iteration III* and *Appendix G: The Program*, allowing others to replicate, modify and improve the product. The Appendix contains details about the way the components are connected inside the RFID box, a list of the libraries used and a link to the GitHub²² repository where the final program is available.

²² GitHub - Developers platform to discover, share, and build better software. Available online at: <https://github.com/>

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Appendix

- A. Social Media Analysis and Market Research
- B. Consent Forms
- C. Interview Guide
- D. Interview Findings
- E. Feedback Sessions: Semi-structured Interview
- F. Personas
- G. The Program

Appendix A: Social Media and Market Research

This Appendix contains:

- The sources of products and DIY tutorials showing what kind of tools are used to organise tasks at home.
- Key quotes gathered from these sources.
- A list and images of recurring analogue tools found in these sources.

A1. Books

1. *Command Center. Household and family at a glance with pin board, calendar, menu plan and Co* (2018). Frech Verlag GmbH. Available at: <https://www.amazon.co.uk/dp/3772478034>
2. *Organize your Family Command Center with a Personal Organizer*. [ebook] Available at: <https://www.amazon.co.uk/dp/B079DM1FGB>

A2. Ready Made Products

3. *Large Chalk Calendar, Chalk Message Board, Cork Board & Mailbox Command Center with Mason Jar and Key Hooks*. Available at: <https://etsy.me/2VZZjJt>
4. *Mead Organizher Command Center, Undated*. Available at: <https://www.amazon.co.uk/Mead-Organizher-Command-Undated-WUN40238/dp/B01HDVPM38/>
5. *Magnetic Dry Erase Refrigerator Calendar, Conversion Chart & To Do Grocery List, Best Supplies For Smart Planners*. Available at: <https://www.amazon.com/Magnetic-Dry-Erase-Refrigerator-Calendar-x/dp/B076J1QJNJ/>
6. *Magnetic Chore Chart - Kids Chore Chart* available at: <https://etsy.me/2Uzk8db>
7. *Family DoDots*. Available at: <http://familydodots.com/>

A3. Videos

8. *ULTIMATE FAMILY COMMAND CENTER*. [video] Available at: <https://www.youtube.com/watch?v=RVctCpRyP-o>
9. *How to: Create a FAMILY COMMAND CENTER*. [video] Available at: <https://www.youtube.com/watch?v=YJb2SUIhhEo>

10. *FARMHOUSE COMMAND CENTER | HOME ORGANIZATION*. [video] Available at: <https://www.youtube.com/watch?v=AZ2PUkVUxcY>
11. FAMILY COMMAND CENTER || Home Organization Ideas with DOLLAR TREE Items. [video] Available at: <https://youtu.be/QWGVK5Bwwis>
12. DIY | Chore Charts (cute and easy!!). [video] Available at: https://www.youtube.com/watch?v=ybVvxLC5_Jo
13. CHORES AND FAMILY STORE EXPLAINED. [video] Available at: <https://www.youtube.com/watch?v=Uh-mxcooxcE>
14. My Cleaning & Organization Schedule + Tips for a Clean Home! | Blair Fowler. [video] Available at: <https://www.youtube.com/watch?v=7pU6vCJ7dY4>
15. Family DoDots Review. [video] Available at: <https://www.youtube.com/watch?v=t3CXHVxkhu8>
16. DIY Family Chore Chart - Custom Family DoDot System - Homeschool Family Chore Chart. [video] Available at: https://www.youtube.com/watch?v=aeFIE4kC_-o
17. Never Make Another Chore Chart Again! Studio 5 - Channel 5. [video] Available at: <https://www.youtube.com/watch?v=7fvoi8B7UBk>

A4. Key quotes from social media and market research

“For me a command center is more than a place to put your keys and drop your mail... it is a central place to keep track of the system and schedules that I use for my home”

“One of the responses we heard from the parents is that they love that the board tells the kids what to do instead of the parents telling them”

“It is not only for me, it is for all the family to look at and use”

“Our lives were very chaotic and we were exhausted, our kids were fighting and not motivated to do anything”

“Some families like to keep their command center on the side of the fridge, others might want to have in a mudroom or entryway”

“Something great about command centers is that you can customise it according to your family needs”

“It makes me feel better to have sparkling (kitchen, sink, table, surfaces)”

“One of the hardest things for me is in the morning to make sure everybody is ready and they have done their routine.”

“It is a very important thing for me that the kids know that it is a team effort.”

“It helps me to keep organised and sane”

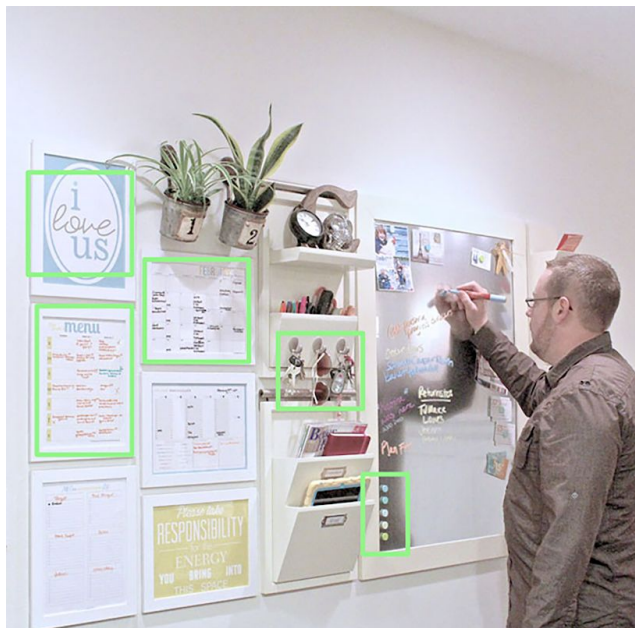
“I need to lead like an organised clean life or I go crazy”

A5. Recurring elements observed on home organisation dashboards

To better understand the context in which organisation tool are used at home, I made a list of the items that are often put together when creating an organisation area in a house.

The observations from house visits were also taken into account for this list, such images can be found under *Appendix D: Interview Finding*.

- A clock
- Magnets
- Chalkboard
- Hooks
- Mail Containers
- Cork board
- Weekly Food Menu
- Inspirational Quotes
- Pen and Paper for Notes
- Pre-made magnets for recurring tasks
- To-do list
- Kids' morning and bedtime routines
- Weekly cleaning schedule



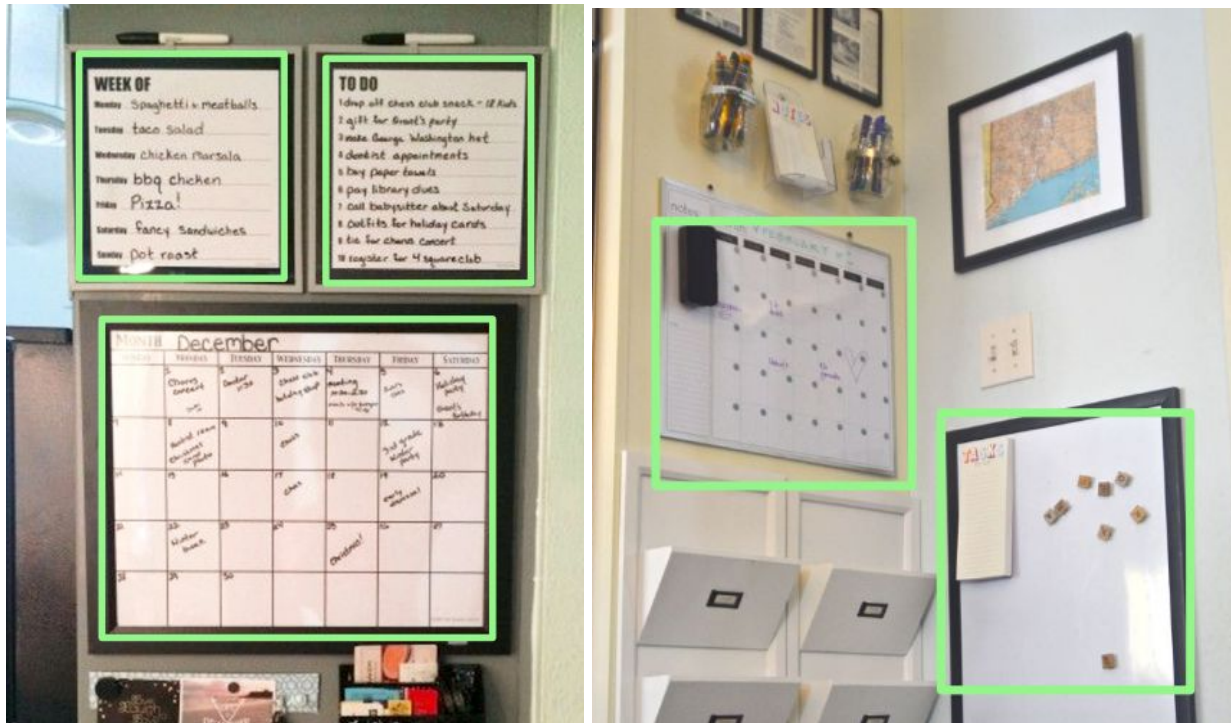


Figure 21. Identifying recurring elements in home organisation systems (from Appendix A)

Appendix B: Consent Forms

Consent form - Interview

This interview is being conducted as part of a master's thesis in interaction design from the Norwegian University of Science and Technology (NTNU). Please read each part of this description so that you can fully understand what will be asked of you.

Goals and Purpose: The goal of this interview is to gain understanding of common family organisation tools and activities. The information gathered will be used to create an organisation dashboard for the home and your answers might be printed as part of the documentation of its development.

Voluntary: You may stop and withdraw from this interview at any point. Your information will be excluded from the report if you decide to withdraw from this interview.

Confidentiality: None of the information that you will provide will be able to be traced back to you, all information will be anonymous. These results will only be used for the purpose of this project. I might ask to take photos of certain objects in your house but you will know whenever I am doing so and in the case that these photos are used in the report, no personal information will be visible on them.

Contact Information: If you have any questions or concerns, feel free to contact Meztli Morales at meztlism@stud.ntnu.no.

By signing your name below, you are consenting to take part in this interview:

- I have been given sufficient information about the interview and project
- I acknowledge that participation is voluntary
- I understand that the interview consists of tasks and questions
- I have the right to not answer questions or to stop at any point
- I have been informed that all information I provide will be kept anonymous

Signature

Date

Consent form - Tests

This activity is being conducted as part of a master's thesis in interaction design from the Norwegian University of Science and Technology (NTNU). Please read each part of this description so that you can fully understand what will be asked of you.

Goals and Purpose: The goal of this activity is to gain understanding of common family organisation tools and activities as well as to generate ideas to incorporate into the main prototype built for this project.

Voluntary: You may stop and withdraw from this activity at any point. Your information will be excluded from the report if you decide to withdraw from this test.

Confidentiality: None of the information that you will provide will be able to be traced back to you, all information will be anonymous. These results will only be used for the purpose of this project. I might ask to take photos of you or your hands while you interact with the prototype.

Contact Information: If you have any questions or concerns, feel free to contact Meztli Morales at meztlism@stud.ntnu.no.

By signing your name below, you are consenting to take part in this interview:

- I have been given sufficient information about the activity and project
- I acknowledge that participation is voluntary
- I have the right to not answer questions or to stop at any point
- I have been informed that all information I provide will be kept anonymous

Signature

Date

Appendix C: Interview Guide

Introduction

Hello, thank you for letting me be here today. I will be asking you a few questions about your house and taking notes. I am working on a device that could help people organise their tasks at home and that is why I am asking to meet you at home. I would also like to take some photos but I will ask you before doing so.

I will also ask a couple of questions about the way you organise your tasks on a daily basis and I don't expect you to be a super organised person or to have a perfect answer for everything. There are no right or wrong answers here, and I am not here to judge how you organise your house. Even if you think you are not as organised as you wish you were, that is also useful for me.

Questions	Answers
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Ice Breaker Questions

- Gender and Age - Marital Status	
- How long have you been living here?	
- How many people live here?	
- What do you do (working/studying)?	

Home Questions

- I want to ask you to broadly draw a map of the layout of your house (floorplan). It doesn't need to be very accurate.	
- Where do you spend most of your time at home?	
- Is it the same for the other members of the household?	

Task Management Questions

- Do you use any mobile apps to organise your personal tasks?	
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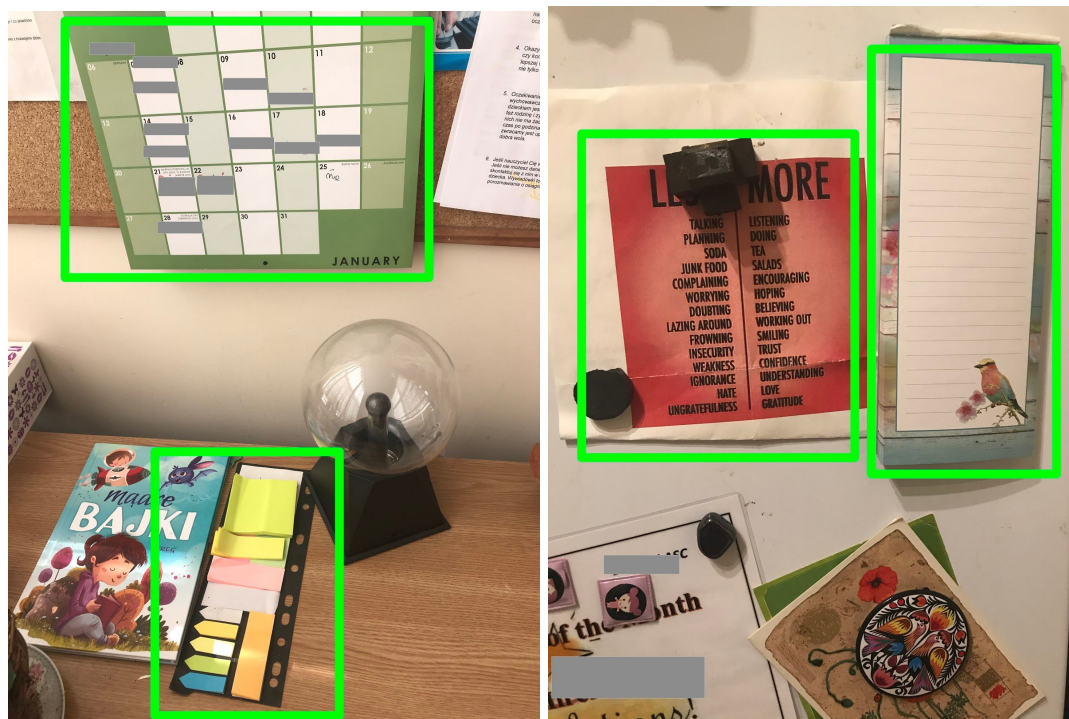
- How often do you use it? (morning, night, several times per day)	
- What do you like about these apps?	
- What don't you like about those apps?	
- Do you use pen and paper to write down things you have to do? Is it in a dedicated notebook or random paper?	
- If there are any tasks that are common to the household (buying milk, taking the trash out) where would you write it down? (talk about these tasks)	
- When there is new mail (letters), where do you put them for other people to find it? (use the floorplan)	
I'm going to show you some examples of houses which have something called "command centre" - If you had something like this in your house, where would you place it?	

Summary and Wrap-up

- Take Photos	
- Do you have any questions?	

Appendix D: Interview Findings

Home visits revealed that people have dedicated areas to keep organisation tools at home. These are some of the photos containing those objects. All personal information on them has been covered to protect the privacy of the participants. These photos show some of the same items that were identified as part of the house organisation areas during the activities in *3.1.1 Social Media and Market Research*. For instance, calendars, to-do lists, schedules, note taking, inspirational quotes and reminders. The last two photos show the use of Google Keep for house tasks and a cleaning rota that uses dots to mark each person's contribution.



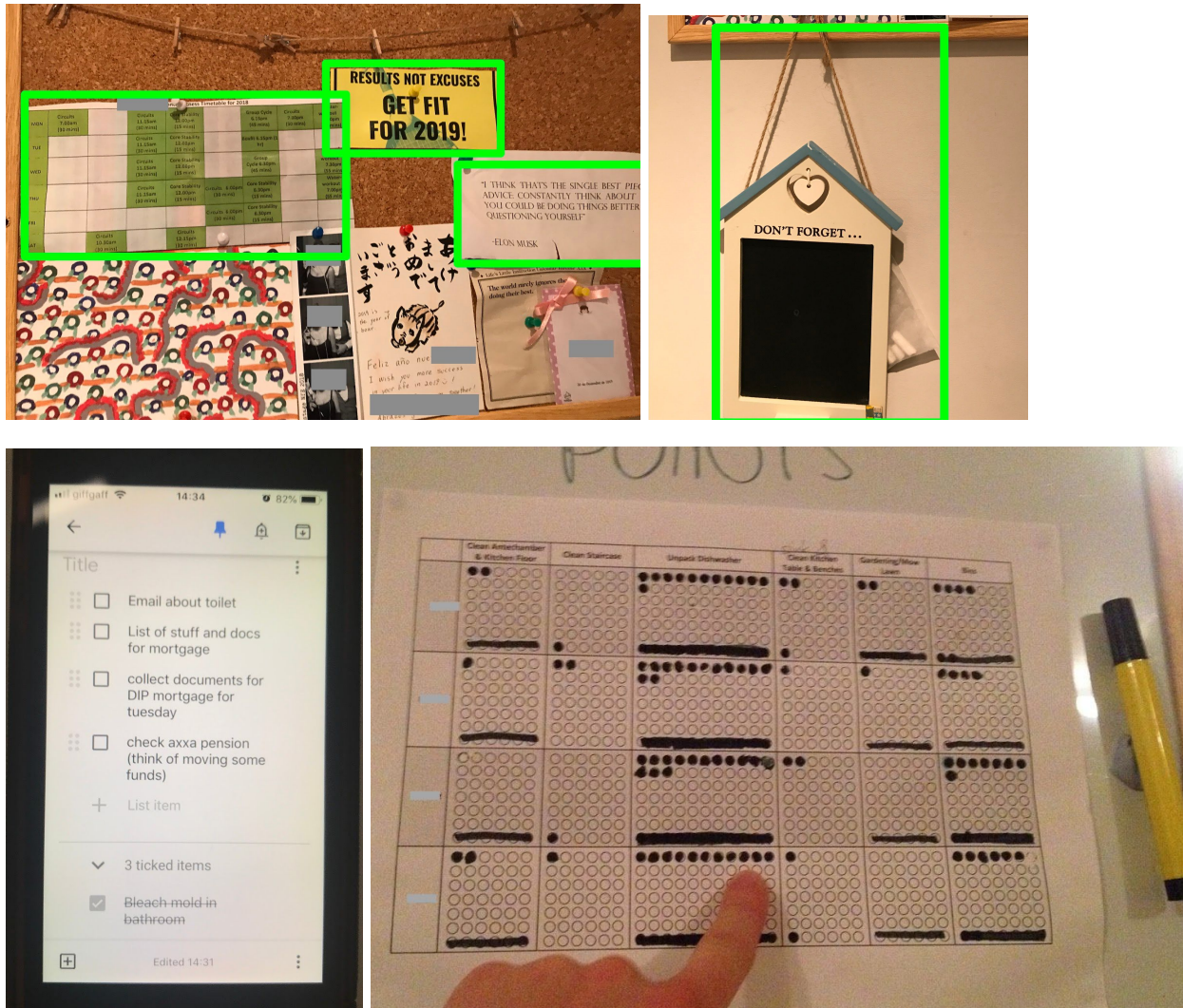


Figure 22. Set of photos taken at people's houses during the activities for 3.1.2 Home Visits and Interviews.

Appendix E: Feedback Session: Semi-structured interview

The following question guide was used during the three feedback sessions with a few modifications depending on the state of the prototype. After requesting the participants to “guess” the use of the board, I proceeded to explain whatever they did not manage to understand by themselves.

Introduction

Hello, thank you for letting me be here today. I will be asking you a few questions and taking notes. I am working on a device that could help people organise their tasks at home. I don't expect you to have a perfect answer for everything. There are no right or wrong answers here, and I am not here to judge how you organised you are, what I want is to get ideas to add functionality to my prototype.

-Ice Breaker Questions-

Who do you live with?	
What organisation tools do you use to keep track of family common activities or chores?	
- How many people live here?	

- Introduce Prototype -

First impressions	
what do you think this is for?	
What do you think it does?	
How would you use it?	

- Explain what the board and the RFID Box do and explain how to use it depending on the participant's first experience -

What do you like about it?	
What don't you like about it?	
What would this board need to do for you to consider it useful?	

Appendix F: Personas



Amanda Evans

User Profile: Work from Home Married

"I don't want to be the one telling my husband what needs to be done."

Technical Experience

Amanda is very comfortable with mobile devices such as smartphones and tablets. Has a laptop computer for work and personal use. Amanda has been trying to use Google Keep to remember task but forgets to update it.

Overview

Amanda is a freelance writer and spends her working hours sometimes at home and sometimes at coffee shops. She lives with her husband who also sometimes works from home as a consultant. It is the first time both of them live without their parents and they are still getting used to all the responsibilities that managing a house involves. She thinks that both she and her husband need to improve in regards of keeping the house tidy and having enough food in the fridge. Sometimes they both assume that the other person will buy something or fix something and this creates conflict between them.

Motivations

To have a tidy home.
To have a fair distribution of tasks.
To stop having discussions over who has done more cleaning.

Frustrations and pains

Husband not helping enough.
Forgetting to buy food.
Fighting about who should do the work at home

Age: 26
Occupation: Freelance Writer
Education: Bachelor Degree
Gender: Female
Marital Status: Married
Children: None
Household income: £75,000
Location: London, UK



Katie Turner

User Profile: Stay at Home

"It is a very important thing for me that the kids learn that keeping the house tidy is a team effort."

Technical Experience

She is comfortable with mobile devices such as smartphones and tablets. Shares a desktop computer with the rest of the family. Katie sometimes struggles when using children's game console or the new smart TV. Has been trying to use Google Calendar to remember family events but she cannot share it with the kids.

Overview

Katie is a stay-home-mom and has 3 children. Her husband works full time and doesn't help a lot around the house. She has been trying to get her children and husband to help more with chores and has been trying different DIY projects to track family members' tasks but hasn't yet found the right one for her family. She wants to teach her children about responsibility and have a more peaceful and tidy home. Sometimes the children fight and get frustrated when she asks for help because they feel it is unfairly distributed.

Motivations

To have a peaceful and tidy home
To keep the family organised
To get the kids feel part of the team and help in the house chores
To stop forgetting about things she has to do

Frustrations and pains

Husband not helping
Chaotic house
Children not doing their chores
Forgetting things to do herself
Stressful and chaotic schedules
Kids' fighting and lack of motivation

Age: 33
Occupation: Stay home mom
Education: Bachelor Degree
Gender: Female
Marital Status: Married
Children: 12yo girl
8yo boy
5yo girl
Household income: £80,000
Location: Manchester, UK

Appendix G: The Program

The program that was used in the last prototype, makes it possible to connect the tasks in the board, with a digital representation of it online. It parses an email account for tasks and uses the Google Keep to display the activity of the tasks. The program also allows writing and reading RFID tags with tasks and also drives an LCD screen to display feedback messages.

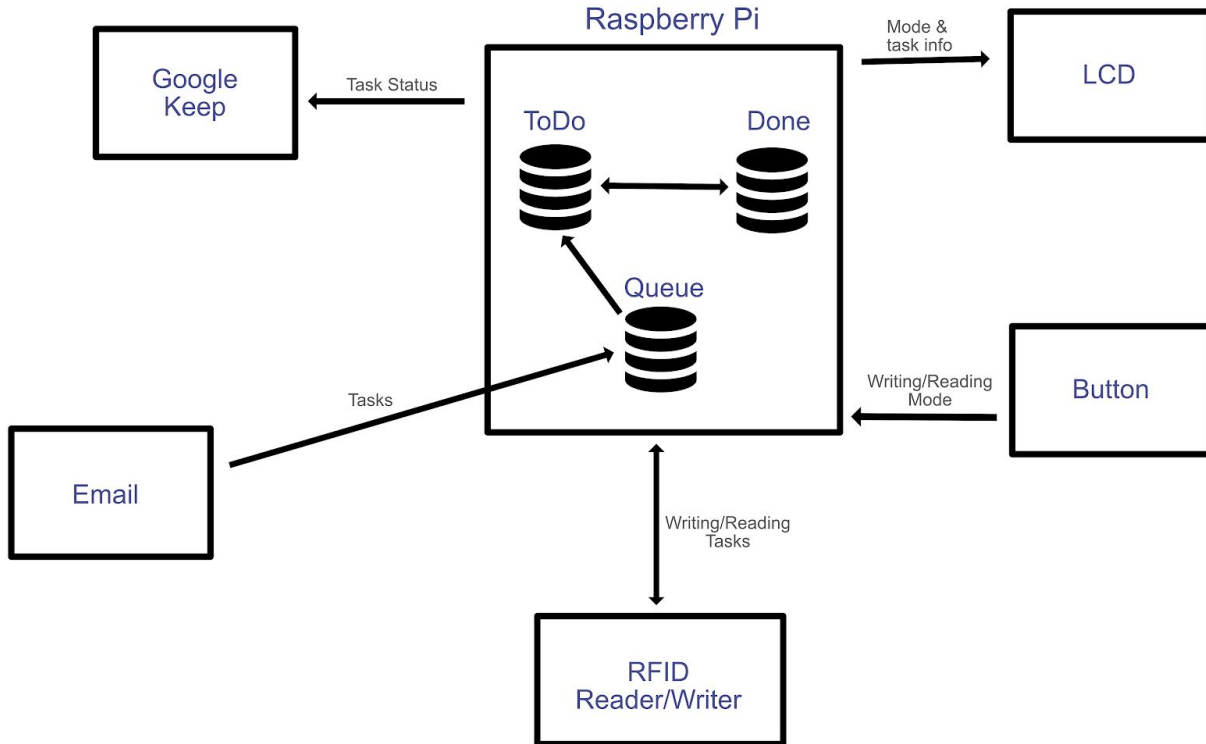


Figure 23. Diagram of the program used for Prototype III

The Raspberry Pi uses a multi-process program written in python which uses the following open-source libraries:

- To interact with the NFC reader, the program uses the `nfcpy` library²³. It also provides functionality to read and write NDEF messages which contain the task.

²³ Python module for near field communication - Stephen Tiedemann and contributors. Available online at: <https://nfcpy.readthedocs.io/en/latest/>

- To interact with the screen, an open-source repository²⁴ found on GitHub was used as a starting point with a modification.
- The button is used to switch between writing and reading mode. A python module²⁵ was used to easily read a state of a pin to which the button was connected.
- An unofficial library for the Google Keep API²⁶ was used to communicate with Google Keep server and to synchronize changes.

On Google Keep, each note is mapped to a specific RFID tag as each note has a unique ID number and so do the RFID tags. The mappings are stored locally on the device. When an RFID tag with a task is scanned and moved to another list (e.g. from *to-do* to *done*), the Google Keep note associated with the tag is looked up using the RFID tag ID. Then the note on Google Keep changes its background colour and the status of the label (see figure 24).

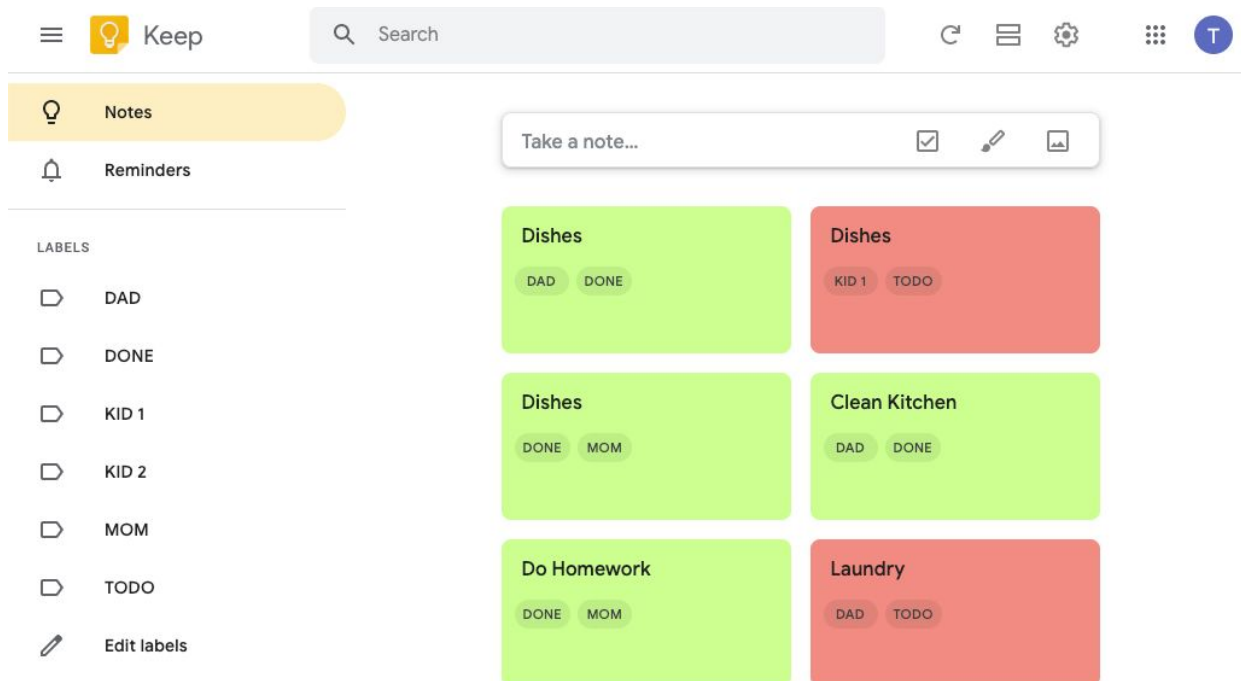


Figure 24. Google Keep visualisation of tasks.

²⁴ RaspberryPi I2C LCD Python repository - Available on GitHub at: <https://gist.github.com/DenisFromHR/cc863375a6e19dce359d>

²⁵ A module to control Raspberry Pi GPIO channels - Ben Croston. Available online at: <https://pypi.org/project/RPi.GPIO/>

²⁶ Unofficial client for the Google Keep API - Available online at: <https://github.com/kiwiz/gkeepapi>

The program used in this prototype has been preserved and can be accessed. The code can be found in the Rfid_box²⁷ GitHub Repository: https://github.com/meztliMor/rfid_box

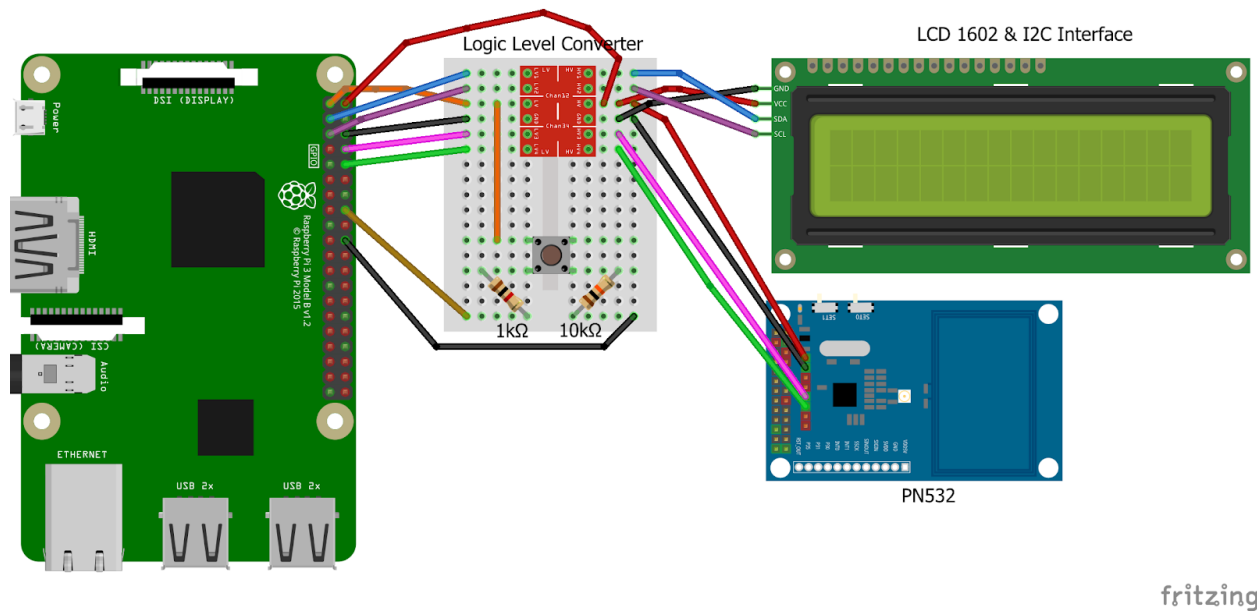


Figure 25. Graphics showing the circuit of the prototype - Made in fritzing.

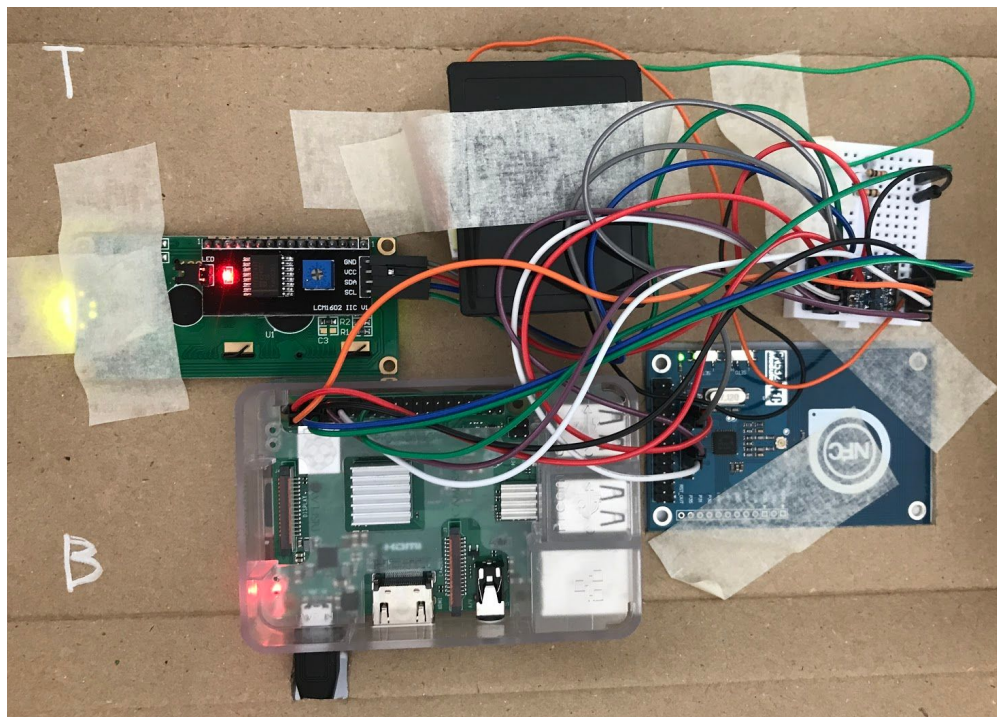


Figure 26. Inside the prototype III.

²⁷ Rfid_box - Michall3, (2019). Repository developed as a part of this Master project. Available online at: https://github.com/meztliMor/rfid_box

