Master Thesis

Designing a Smart User Feedback System for a Cordless Vacuum Cleaner

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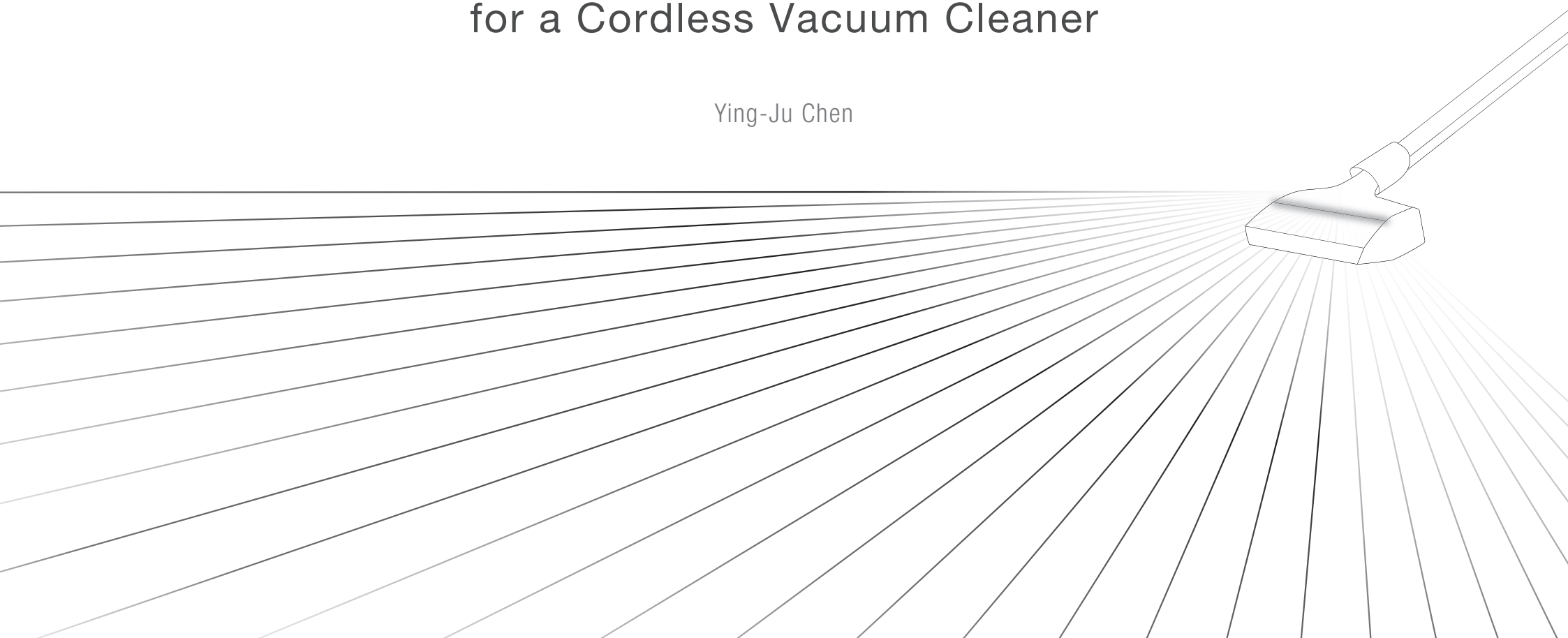

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Background & Scope

1.1. The Context of the Cordless Vacuum Cleaner

Moving Towards Cordless Vacuum Cleaners

Vacuum cleaners are becoming some of the most indispensable appliances in typical households in developed countries and have gradually replaced the way people used to clean their houses. People use them to accomplish cleaning tasks which are seen as some of the “normal” interactions at home (Shove, 2004). Empowered by the technological advancement, the design of a vacuum cleaner has been transformed from being wired to being wireless which enables the user to have the freedom of movement without the restriction of the power cord and it further enhances the level of convenience as well as the comfort level during use. Given the survey, the world vacuum cleaner market has shown fast growth over the past few years, especially regarding the cordless type. It is anticipated that the cordless vacuum cleaner will witness a huge increase and will reach another peak in 2021 (GFK, 2018), especially for the group of people without any experience in purchasing any kinds of vacuum cleaners for themselves. The cordless type is on their highest priority in general when they go for the first purchase of vacuum cleaner.

New Problems Arise from the Cordless Type

The biggest problem with the cordless vacuum cleaner is the limit in its battery life, which brings lots of inconvenience for the user. Even with the lowest power consumption setting during the whole vacuuming process, the battery can only last for a maximum of one hour and the vacuum quality is questionable. Because of the prevalence of the cordless vacuum cleaner, this problem has in recent years been attracting much attention both from users and companies. Especially for frequent users, such as people who have a larger surface area at home and for pet owners, the rundown of the battery which is considered to be a significant issue greatly affect their daily schedule. The users are unable to finish cleaning at once, and fully charging the battery is an extremely time-consuming task, at the same time the appliance cannot be used during charging. The users spend more time on recharging and cleaning than they expected. However, the current technique being sought to solve the root causes of the problem is still under development. For these reasons, companies choose to look at this problem from another perspective, “what if the cleaning workflow can be optimized through some useful manners which give the user support during the task leads to more tasks can be completed under the same amount of battery life, so that the user can not only save time but also be more productive through a smart way to live?”.

Innovation Opportunities

Due to the problems mentioned above, people are seeking an optimal solution to maximize the efficiency of cleaning from both sides, the user and the appliance, and under the same conditions. Manufacturers would like to make ordinary devices, such as vacuum cleaners are able to interact with the user by exchanging information between them, this will enable the machine to create an efficient workflow based on the user’s needs, to minimize the waste in time and effort while deciding to switch setting and to estimate duration on each task before running out of battery. In the meanwhile, given that the user also knows the machine’s operational state, they can prioritize the important tasks in the cleaning process, like emptying the dust container before vacuuming. Besides, be more flexible and convenient about arranging their busy daily schedule, so that, for instance, the time taken to recharge the battery can be used to do the grocery shopping instead.

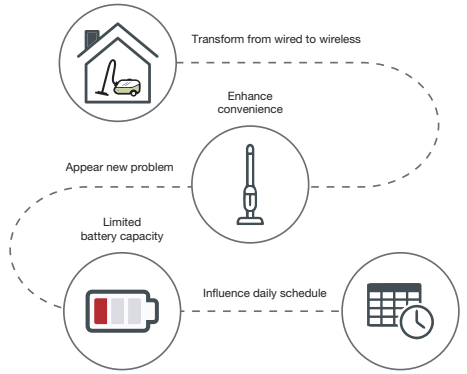


Figure 1: The Development of the Cordless Vacuum Cleaner

1.2. Project for Optimizing the Workflow

Philips & The Vision

What Philips is interested in the whole product development process is to make people's lives better through innovation. The floor care team at Philips, which focuses on the innovation of domestic appliances, would like to redesign the latest cordless vacuum cleaner, Philips SpeedPro Max, to be smart enough to react to the users' needs all the time and optimize energy utilization.

Nowadays people become busier than ever before because they focus more on enhancing their quality of life. Even though people still have 24 hours in each day, it feels as if no one has "free time" to do anything. For example, as an employee, faced with endless meetings, frequent interruptions, and urgent last-minute tasks, people can easily be busy all day without making any progress in the area of living better. For this reason, more companies offer products and services aimed at helping people to manage their time in order to be more productive (Gleick 1999), so does Philips.

In an attempt to maximize efficiency on cleaning, Philips would like to make their vacuum cleaner faster and smart enough to enable the user to use their limited time in a more useful way, such as increasing the efficiency of the work done also reducing the time taken to complete the task in hand, to reduce the cost of operation, and other factors which enhance the workflow performance as effectively as possible through innovative technology.

Project Focus

The project is to redesign the UI of Philips SpeedPro Max, in order to optimize user workflow before, during and after the cleaning task. It will be researched based on the goals below, to help in the research work towards satisfying completion.

- Find out the user's experience while using the vacuum cleaner.
- Find out the main reasons leading to a decrease in working efficiency on both sides.
- Find out what for users is the meaning of "smart" and "efficiency".
- Find out what users expect to gain from the vacuum cleaner before, during and after using it for cleaning.

The project will focus on collecting the insights, based on the following questions:

- What kinds of barriers hinder users from using a cordless vacuum cleaner? And how does that happen?
- What induces the "smart" and "efficiency" feeling?
- What kind of assistance or information do users want to have? (E.g. providing an overview, analyzing the information, guiding planning, reminding with a to-do list, notifying unexpected situations, etc.)

The information found during the interviews and questionnaire will be turned into guidelines as well as a Philips vision. By means of the advanced technology, the design will follow these guidelines to develop a digital service or product-service system.

To answer these questions and to come up with an optimal solution, the approaches mentioned in the next section will be used to help dive deeper.

Design Approaches

The project will be divided into the two stages of exploration and refinement. In the early stages of the project, the exploration, the research will be conducted using a qualitative and explorative approach. To understand the context, I shall zoom in the user's experience, such as favorable and unfavorable interaction, discovering through observation, interviews, questionnaires, and the user journey. These tools will be implemented with the users with and without experience in the cordless vacuum cleaner.

After understanding the context, to set up some vision which needs to be achieved, I shall review previous research related to the project that interests me, like what the user thinks about the smart products/technology, the interaction between sensor technology, and feedback systems. Furthermore, I will also look at the sample given by Philips and analyzed competitor's products to list the pros and cons in each case and define the possible elements that can be applied to the project.

Finally, given the innovation direction that will be set up, some sketches and simple prototypes will be made to gain insights through the user's feedback to find out which optimal concepts could be executed in the next stage of refinement.

In the refinement stage, the first concept will be designed according to insights from the research and evaluated within the target group.

The goal of the user test is to test the usability of the interface itself, also to explore the value people obtain from the new UI design, and to determine what is the user experience when the vacuum cleaner is in use. The renewed concepts keep being modified, based on the user tests, mainly on the interface and its value.

After selecting the final concept, I will try to produce a better visual design of the prototype and refined the details to strengthen the effects of my final prototype, based on the feedback I got during the manufacturing and testing the final prototypes.

CH2

Understanding “Smart” Interaction with Domestic Appliances

2.1. Being “Smart”

What is "Smart "

There are lots of products described as smart and fill our daily lives. People may not always be aware of them, but everyone uses smart technologies to make their life better every day, such as safeguarding the house, using real-time traveler’s information at a station, and watching TV shows when they come out. However, what does “smart” mean for the user? What kind of experience will have a feeling of being smart?

According to the Cambridge Dictionary (2019), one of the definitions of this word could mean being able to think “quickly” or” intelligently” in difficult situations. As people are busy and we only have 24 hours in a day, making a smarter plan to manage people’s daily routine in a useful way becomes a ritual. In an attempt to maximize the efficiency of their daily routine, increasing importance and attention is being placed on the workflow. However, without sufficient information and careful consideration, the user is hard to figure out what to do to make themselves more efficient and productive in executing the task.

Workflows can be simply optimized by the decisions we make. We make decisions every day and even every minute in our daily lives. The relevant research estimated that an adult makes about 35,000 remotely conscious decisions each day (Sahakian & Labuzetta, 2013). However, how can we make smart decisions? We took some times to carefully consider the available information and how we experience and understand from similar situations.

For example, before you decide to follow the cleaning schedule on a busy day, you will think whether the vacuum cleaner is usable at a given time, and how much time the cleaning task will take. However, making decisions based on knowledge and experience cannot always lead to “smart” decisions. When we face unknowns and uncertainty, most of the time, we just guess and assume things, such as the level of dirtiness in one’s house which we cannot easily perceive dust and dirt which are far too small. In this way, we will be easily guided to another direction and end up with unsatisfactory results, and even finding ourselves feeling a little stupid sometimes, like not making the good distribution of our time.

Technology may be able to give us some support during the process. It can receive and analyze known and unknown information and integrate that to give us a clear vision of what the outcomes could be and how we can achieve or avoid such outcomes, which will enable us to become smarter.

Being Smart through Technology

Empowered by technological advancements, today’s consumer products are changing. For instance, sensor technology is able to provide huge amounts of data every minute and even turn invisible information to the visible one. According to the survey, 90% of the world data (information) has been generated in the past two years (Marr, 2018). This technology is capable of analyzing data and deducing conclusions, and using these analyzed data to make the appliance adapt automatically and modify human behavior to best fit the environment, which help people make sense of all this information more quickly. Through implement this new technology on the physical products, it enables these products to be filled with processing, sensing and communication abilities. Thus, the appliance becomes smarter, like being context-aware, proactivity and self-organized, and is able to make decisions based on different contexts and even try to anticipate the user’s activities and choices. That is why some appliances are described as smart because they are devices that are not ignorant about their environment and context (Schmidt et al., 2001). For example, June Oven is a good example of applying sensor technology. The oven is able to track the internal temperature and automatically recognize the presence of food through an internal camera. The oven can do the cooking for the user and also provide a satisfactory outcome, a well-cooked meal. These smart appliances use the sensor data to make basic assumptions on context awareness, based on these specific sensor values they

acquire from the current situation. In a certain situation, specific sensor data is frequently similar to sensor data in the same situation at different times. In this way, the appliance is able to predict the current situation or even forecast a situation. It is also capable of anticipating, thinking and reasoning about what to do next to support humans to live better and easier.

Furthermore, we all have tasks that we need to complete repetitively in our lives whether that is multiple times per week or a few times per year. Based on these regular data in a certain context, the machine can develop smarter processes for repeated tasks, which helps one accomplish more in less amount of time. The machine can take on the repetitive tasks so that people focus on intelligent demanding work, such as creating a strategy. In that way, humans can do what they do best (Parasuraman et al., 1997).

Nowadays, “smart” is seen as the focal point of the advertisement strategy in typical households, which have enhanced features that go beyond basic functionality. When people are choosing a vacuum cleaner to help with cleaning task, they will consider the functionality as well as others, such as whether it can make their lives better and easier.

How to “Talk”

To get smarter at the cleaning tasks, we need to gather the required information to determine the most efficient approach to performing tasks. Workflow optimization also enables people to draw the best strategy out of existing habits as well as the environment. Thus, successful information exchange and automation support from the machine play a key role in the process.

Successful information exchange is determined by the ability of the machine to understand the user’s needs and other information in a certain context, as well as deliver the information and data in a timely fashion so that, the time required for the decision making can be shortened. For example, a smart vacuum cleaner is able to give you real-time feedback on battery life when the appliance is in use. Besides that, given the users also understand the current situation, users can prioritize different tasks in the cleaning process, based on the importance, like cleaning the dirtiest place before running out of battery, also be more flexible with their daily schedule, like taking into account the time needed to recharge the battery which can also be used to do grocery shopping. Good communication between both sides will enhance efficiency during the cleaning task.

Furthermore, informative communication in an interactive and dynamic way will lead to successful interaction between the appliance and the user. For example, diverse light and sound which come with specific human behavior allow the vacuum cleaner to communicate a range of messages during key moments and allow the user to understand the machine, such as a display shows “I need the power. ” when the battery is low or the unit is trapped under furniture. The interactive use of information seems to positively influence the quality of communication but also the user’s attitude to coping with the problem due to the emotional connection. People will then feel less annoyed about the problem they face and, instead, have more patience and feel guided to solve it.

Finally, we said people use machines, rather than machines use people. The balance between the user and the machine automation over tasks is important. The machine sometimes takes control away from the users and leads to a higher level of convenience for them. However, people want to feel a sense of control over the tasks. Giving too much authority to the machine is hard for the user to develop an emotional involvement. The appropriate support from the machine makes humans labor more valuable and enables the user to feel in control. Thus, the authority between these two roles has to be a perfect balance between choice and automation of actions while designing in this way (Bhamra, 2011).

2.2. A Case Study: Dyson V11

This section will use the Dyson V11 Absolute as an example (Figure 2). Dyson is the biggest competitor for Philips and their new design, the Dyson V11, which is the first one implemented an LCD screen on the appliance itself that allows the user to monitor usage, greatly enhances the user's cleaning experience.

The case study is conducted by analyzing reviews from websites, such as the Dyson official website, Amazon, and youtube videos, but also look into some literature study about consumer behavior and UI design to understand how they think of this design and drive the user to get where they want users to go in a more efficient way.

Figure 2: Dyson V11 Absolute (TNW, 2019)

New Characteristics

The Dyson V11 Absolute was announced on March 21, 2019. According to Dyson (2019b), the Dyson V11 has the highest suction power of all cordless vacuum cleaners and smart features, like intelligently optimizes suction power and service life.
The main characteristic of the product is the LCD screen that gives real-time feedback to the user. It informs the user when the device needs maintenance, such as cleaning the filter or emptying the dust container. It also shows the level of charge left and how long the vacuum cleaner can still be used before it has to be recharged. In addition to the conventional cleaning modes, Dyson has added a new mode, the Auto Mode (Figure 3). This mode is able to detect the resistance of the brush bar, after which it informs the motor and battery to adjust the suction power to best fit the floor material.

LCD SCREEN

Shows current performance, including selected power mode, remaining run time, filter maintenance reminders and blockage reports.

SHOWS REMAINING RUN TIME

Lets you know how much battery power is left in each mode, to give you more control of your clean.

MAINTENANCE ALERTS

Reminds you to clean filters for optimum performance, and informs you of any blockages and how to clear them.

Figure 3: The indicator of the Dyson V11 Absolute (JOHN LEWIS & PARTNERS, 2019)

User Reviews

One of the issues is that consumers perceive the Dyson V11 to be similar to its predecessor, the V10. As one user commented on the Dyson website: “Evolution, not revolution”. One of the major complaints from the consumers is that the battery is still not replaceable. With previous models, users experienced that the battery can break down after a few years, after which they had to buy a new vacuum cleaner. However, some people did seem to have a more positive attitude towards the new design. The main improvement is that they can keep track of the amount of power that is left. Moreover, consumers appreciate that the Dyson V11 now has an auto mode that changes suction power to adapt to different floor materials, thus, improving the otherwise manual operation and thus increasing the convenience. (Dyson, 2019b).

Becoming Smart

One of the features of the Dyson V11 is the new battery indicator which enhances the level of flexibility in consumer’s daily life and the efficiency of the cleaning task. As the total energy consumption varies with different power modes, the indicator shows three battery icons of different sizes. The size of the battery icon relates to how long the vacuum cleaner can be used during cleaning, which decreases when the suction power increases. It also shows the actual run time of the battery during the use phase. The time will change, based on which power mode and brush is used. Given the fact that consumers are able to know the ongoing operational state of the Dyson V11, they can perceive the diminishing battery level and feel in control through the real-time feedback received from the battery indicator. The energy consumption then becomes visible (Fisher, 2008). It not only enables consumers to make appropriate arrangements in their daily schedule, like recharging the appliance beforehand so that the cleaning workflow is optimized.

Feedback is successful if it captures the consumer's attention and closely links up with specific actions and their effects (Fisher, 2008). Changing the suction modes gives immediate feedback with regards to the battery life, and thus shows a direct impact. The feedback steers the consumer towards thinking about how to assign the cleaning task in each mode because battery life is an important attribute for the users as we can see from the reviews.

However, the icon and information on the display related to battery life are still limited, such as icons not being clear enough to link up with different battery capacity.

As the Dyson V11 aims to find out the perfect balance between satisfying cleaning performance and battery usage, which are the main concerns with the users. Another feature in the Dyson V11 is the auto mode with it. The users do not need to manually adjust the suction power to fit different material floor during the use phase. The vacuum cleaner can help out with making the judgment and automatically switch to the most suitable suction mode, which saves time and energy on the switching process while the appliance is in use. However, the user is still able to change the suction power if they want to. The research mentioned that users want automation but would like to make some setting of context-aware functions themselves (Koskela et al., 2004). It has to be a balance between choice and automation of actions while designing in this way (Bhamra, 2011). The Auto Mode takes control away from the users, which leads to a higher level of convenience for them. The ability to manually change modes is still possible with the Dyson V11; therefore, a sense of control is given back to the user.

Furthermore, domestic interactions are part of habits and routines (Shove, 2004). People are used to keeping using the suction mode they are used to unless there is a reason to need to change, such as to clean the carpet well needs stronger suction. The auto mode enables the user to continue with their habitual behavior. In addition, the user still gets the optimum result that they desire.

Recommendations

As the Dyson V11 aims at having the balance between cleaning performance and battery usage, another thing Dyson can do is to look at their Boost Mode. Dyson has foregrounded the energy-efficient option, by making access to all modes similar. However, it could have a better balance if they background the energy-inefficient option, Boost mode. This can be done by adapting the functionality of the button. For instance, using the Eco Mode and the Auto Mode can be done by clicking the button once. If the consumer wants to use the Boost Mode, they have to press the button for a longer period of time. Research has shown that users are less likely to use an option if they need to put in more effort (Pierce, 2010). The idea is to make it harder, but not impossible, for the consumer to use this mode. Furthermore, people often choose a suction mode and only change it if there is really a reason to do. They will use Boost mode when they really need to do a deep clean. Thus, it will be a more feasible way to make a balance between performance and battery usage.

CH3

Analyzing the Vacuuming Experience: Philips SpeedPro Max

3.1. Overview of Existing Characteristics

The latest vacuum cleaners from Philips, SpeedPro Max, which is advertised as the fastest and most effective cordless vacuum cleaner in the domestic market. The main characteristic is the 360 ° nozzle with LED lighting, which collects dust and dirt from all sides and is suitable for different types of floor materials (Figure 4).

Figure 4: Philips SpeedPro Max (Philips, 2019a)

User Reviews

Philips SpeedPro Max has launched to the market for a while, the reviews are mainly retrieved by the Philips official website as well as an e-commerce website, such as Amazon (Philips, 2019 b; Amazon, 2019).

Most users give positive comments on the performance such as its suction power, the display of battery life, and LED light which illuminates the floor to reveal dirt and dust on the floor as you clean. At the same time, the users have provided some suggestions for the product. They mentioned charging battery still requires a long time. To charge 10%, it approximately requires 30 minutes, therefore, the user had to wait for at least a few hours for the appliance to fully charged.

In addition, with the maintenance aspect, the users considered there to be a large amount of improvement, to maintain the device. The users would like to make sure that they maintain it properly, such as charging without the device being used, and take more responsibility on regular cleaning of the rollers and filters to expend the product's life.

Insights from Reviews

In this stage of research, based on the reviews, I found some key insights. They are battery issues, weight, and maintenance.

Firstly, the battery can last the entire cleaning task most of the time if the battery is fully charged. However, to a fully-charged battery is a time-consuming task, so that, users have to make sure there is enough battery life before vacuuming. The frustrating experience could appear when users plan to use the appliance and found it is unavailable due to its insufficient battery life. In addition to frustration, it also brings inconvenience to the experience.

Furthermore, there is a lack of information related to the maintenance of the appliance. Without understanding the state of appliance, this gives the user a sense of loss in control. Even worse, it makes the operation more complicated to use and even sometimes brings unnecessary frustrating into the experience.

3.2. Preparation for User Test

The main goal of this user test is to identify the area of improvement regarding first-time use of the Philips Speed Pro Max.

Research Question

"While using Philips SpeedPro Max at home, what is the common problems related to usability and user experience?"

To know the usability of the Philips Speed Pro Max, I divided the entire user experience into three different phases, preparation, usage, and finish. With the assistance of specialised tests, the main problem in each phase can be identified.

- Preparation phase: Get ready for the cleaning task
- Use phase: The vacuum cleaner is in use.
- Finish phase: Return the appliance to storage

The user test will focus on the control panel, where in my point of view has the most to improve, which is ideal for my study. Furthermore, the goal is to determine the level of knowledge in the topic of:

- The control of the vacuum cleaner with the physical controller
- The definition of the items displayed on the screen
- The method to find information related to the vacuum cleaner
- The method to gain insights into the state of the vacuum cleaner

Target Users

I recruited the target users for the test, based on the criteria mentioned in table 1 and the details of the participants will be mentioned in the table as well.

Criteria:

- Do not own a Philips SpeedMax Pro
- Have experience with the cordless vacuum cleaner

Characteristics:

- Potential users of Philips SpeedPro Max
- Different background study

	Participant 1	Participant 2	Participant 3
Gender/Age	F/25Y	F/26Y	F/41Y
Nationality	German	Dutch	Dutch
Occupation	Master Student	Working in the business field	Housewife
Background	Marketing	Business	N/A
Experience	Own one at the moment	Yes, a little	Own one at the moment

Table 1: Details in Participant Selection and information

Materials

- A Philips SpeedPro Max and its cable charger
- Soils which represent the real dust to enable the user to vacuum
- A laptop is used to record audio and video during the test and interview
- A phone is used to take photographs during the test
- Pen and paper to record insights from observations

Environment Setting

Each test will take around 50 minutes and each participant will conduct the test individually. The location of the test is at their own home where they feel the most comfortable and familiar to reduce stress. The setting is shown in figure 5.

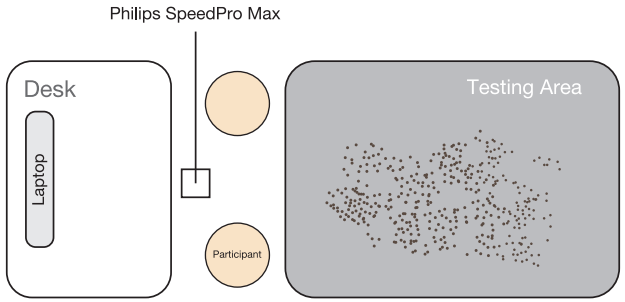


Figure 5: Visual Explanation of the Test Setup

Procedure

1. **Welcoming (1 min)**
   Welcome and thank the participant

2. **Introduction (2 min)**
   Explain the purpose of the test as well as the procedure, request for permission of using the voice and video recorded materials for research goals only, and encourage the participant to share their thoughts throughout the process

3. **Pre-test Interview (3 min)**
   Questions about personal information, the impression/experience of using a cordless vacuum cleaner, and the first impression on the Philips SpeedPro Max

4. **Performing Tasks & Post-test Interview (15 min)**
   Layout a scenario for the participants before conducting the test and ask the participants about their experience after each task with the prepared questions

5. **End of the Test (1 min)**
   Thank the participant again and request for feedback

Tasks for Performing on Control Panel

The following tables provide an overview of the tasks that have been tested during the user test and their related scenarios. These tasks are focused on the usability and the interactions with the product's control panel.

Task1: Adjusting the power setting

Figure 6: The Button Design of Philips SpeedPro Max

1. Moderate suction:
Vacuum the floor of the room with moderate suction as well as a fur carpet, which is laid with a perceivable amount of dust.

2. Lowest suction:
During the vacuuming process, there are fragile objects around the area you want to complete the clean task without damaging them.

Task2: Tracking the battery during use

Figure 7: The Battery Indicator of Philips SpeedPro Max

You are vacuuming and the battery is at 10%. You want to finish cleaning your room but also worried that it will run out of battery during use.

Task3: Checking error of the appliance

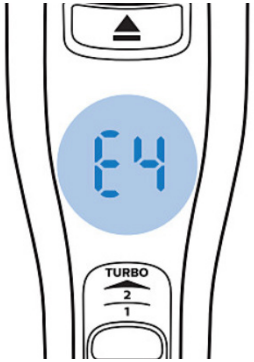


Figure 8: The Error Indicator of Philips SpeedPro Max (Philips, 2019b)

During vacuuming, an unforeseen circumstance happened and the appliance pops up a warning and you have to resolve it in a set amount of the time.

Task3: Charging the battery

Figure 9: The Charger of Philips SpeedPro Max

The appliance cannot be used because it is out of battery. You want to charge it.

3.3. The Outcome of the User Test

A total of seven problems were found during the first formal user test (See details in Appendix 10.1) and I will explain all problems individually. I locate the problems in figure 10 which provides an overview of the process that the participant experience during the tasks. The red triangle with numbers indicates where the problems occurred. Also, I summarize and explain the problems in figure 11.

Based on the result from the user test, it showed that the participants mainly had difficulties to understand the information provided and missed some important message on the control panel. This caused the participants to experience uncertainties about how to read and react.

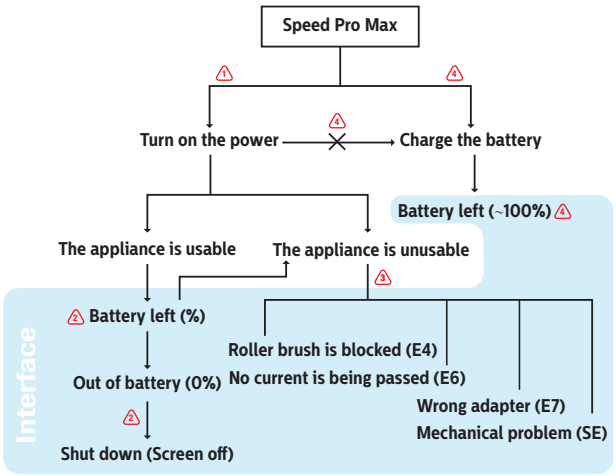
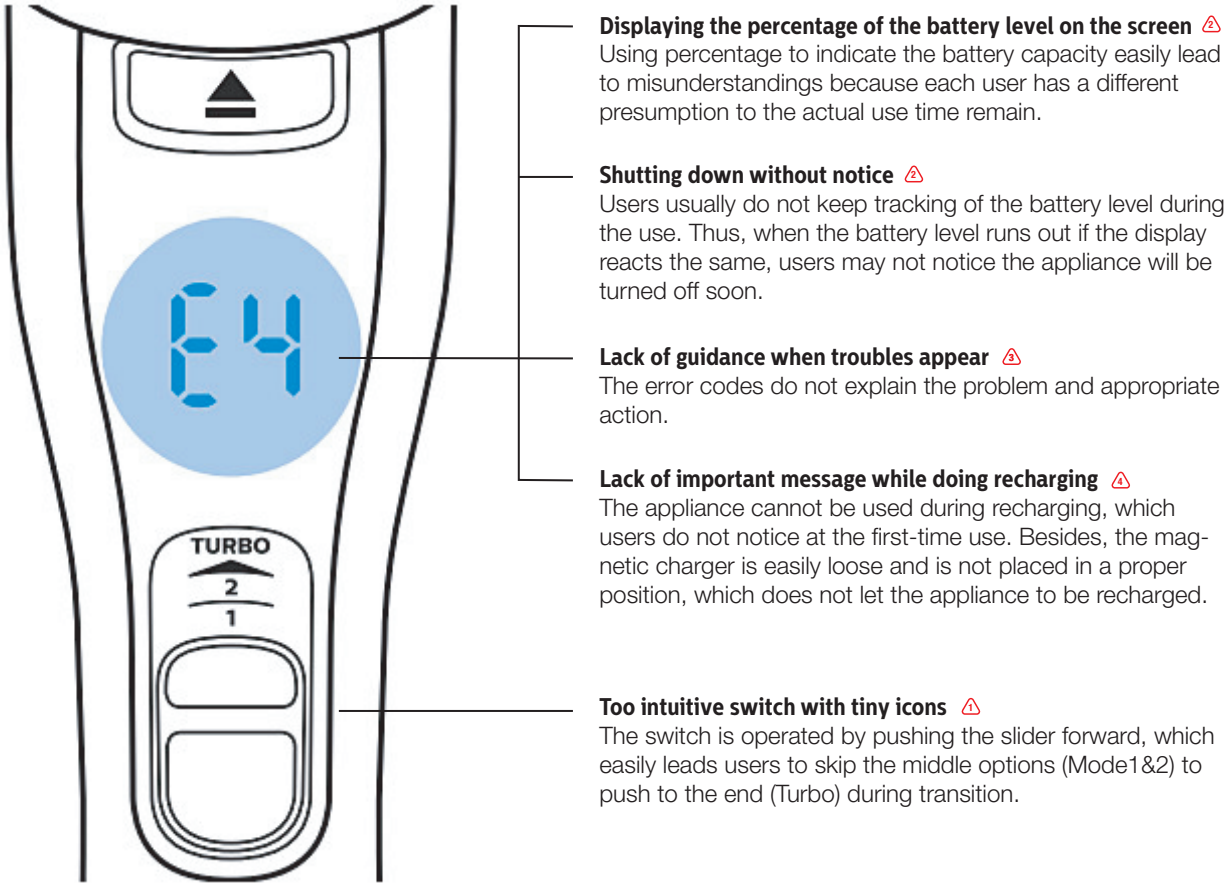


Figure 10: The Task Flow on Interface



Displaying the percentage of the battery level on the screen
Using percentage to indicate the battery capacity easily lead to misunderstandings because each user has a different presumption to the actual use time remain.

Shutting down without notice
Users usually do not keep tracking of the battery level during the use. Thus, when the battery level runs out if the display reacts the same, users may not notice the appliance will be turned off soon.

Lack of guidance when troubles appear
The error codes do not explain the problem and appropriate action.

Lack of important message while doing recharging
The appliance cannot be used during recharging, which users do not notice at the first-time use. Besides, the magnetic charger is easily loose and is not placed in a proper position, which does not let the appliance to be recharged.

Too intuitive switch with tiny icons
The switch is operated by pushing the slider forward, which easily leads users to skip the middle options (Mode1&2) to push to the end (Turbo) during transition.

Figure 11: The Problems on Control Panel

3.4. Conclusion for Problem Statement

In conclusion, the following elements on the control panel show a significant room for improvement:

- Adjust the power setting
- Interpret the level of the battery
- Understand the differences in battery life between each mode
- Understand the codes indicated on the screen indicate
- Understand how to resolve the errors when they occur
- Inform the user whether the appliance is being recharged
- Acknowledge during charing the appliance's unavailable

Problem Statement

On this stage of research, all issues relating to the operation of the control panel are boiled down into three main problems.

- Button Design
  The users have difficulties to adjust the suction power setting through the current switch design on the control panel because the interaction of the switch is too intuitive and only has little feedback during adjustment, so the current design cannot assist the user when they want to choose the mild suction mode (Mode1; Mode 2). Furthermore, the icons to indicate three different modes (Mode1; Mode 2; Turbo) are tiny in size, which makes it difficult to read and during the transition between power settings. It is crucial for users to read the current setting. In conclusion, the switch does not provide enough assistance during the process of switching.

- Nontechnical Language
  The way in which the control panel communicates with the user is unclear and difficult to understand. For example, 'E4', 'E6', 'E7', 'SE' does not explain thoroughly and do not mean anything to users. Users are confused about the condition of the appliance at that specific moment. Besides, showing the battery level in percentage is not useful for the user. They usually take some time to understand the information, such as the duration which the appliance is still usable. This way of communicating lacks a connection between both parties, which leads to ineffective communication.

- Insufficient Instruction/Information
  The instructions and information are not always sufficient during doing recharging or maintaining the appliance. This way the participants do not always know what is the appropriate action.

CH4

Exploring & Discovering the User Journey in Vacuuming

4.1. Preparation for User Journey

The adequate interaction between the user and the vacuum cleaner is critical during the design stage. Furthermore, to enhance the user experience, interviews are particularly useful in terms of getting to know their motivations, goals, habits and pain points behind an interaction. To have clear and in-depth answers for the research outcome supported by a wide spectrum of data, a well-prepared interview will be helpful to look into what is the user's need.

Setting Up

Before starting the interview process, I divided the entire cleaning process into almost the same as the process of analyzing the existing product mentioned in chapter 3.2. The difference was that I included the motivation phase this time, which we can see whether the product meets the user's goal and discover opportunities to their expectation.

- Motivation phase: Aware that you need to clean the house
- Preparation phase: Get ready for the cleaning task
- Use phase: The vacuum cleaner is in use.
- Finish phase: Return the appliance to storage

The interview will be conducted through both skype and face to face and take between 5-10 minutes. The main questions are listed out below.

- What do you normally do during the cleaning process?
- Why do you want to clean the house? How to achieve your goal?
- What is the current problem brought from the vacuum cleaner? What is the user experience with the cordless vacuum cleaner? How do you resolve the issue?
- What is your ideal cordless vacuum cleaner? And why?
- What is the meaning of "smart" and "efficiency" for you?

The insights which gain from interviews will be used to develop a questionnaire (See details in Appendix 10.2). From the questionnaire, the major concern related to the use of vacuum cleaner will be identified.

Determining the Focus on Exploration

The information which gains from the interview and questionnaire will be organized and transformed into a user journey mapping.

- The needs and insights for each cleaning phase are different. The user journey mapping can provide additional information about when these situations happened, which moment the user needs support from the vacuum cleaner and the solution. Furthermore, it provides a clear overview of all touchpoints, which are seen as opportunities to improve the user experience.

- Understand how the user experience is crucial, also which elements influence their decision-making process and what kind of information they need when the specific problems occur.

The user insights are key to reach the optimal solution, therefore, the conclusion will be drawn with key points identified throughout the process. Afterward, technological feasibility will be looked into. In the end, with Philips vision in mind, a product-service system will be developed.

Main Target Users

Based on the current situation introduced in previous parts, the target group mainly focus on people who are responsible for housework at home, like a housewife, couple and single workers, who are busy in either children or jobs. However, due to the popularity of cordless vacuum cleaner among the group without the experience in purchasing any kinds of vacuum cleaners, therefore, the target group also includes young people above the age of 22 when they are able to purchase the appliance and be independent on their daily living.

34Y Female, Housewife

I am busy with taking care of children and doing housework. All I do is to provide a better living environment for my family. I am happy to do anything for my family, but I still wish to have time for my own hobbies. Thus, I will plan my daily schedule to be more productive.

26Y Male, PhD Student

My time is mostly occupied by the study, and cleaness affect my focus with study, also cleanness makes me happy. However, cleaning is a time-consuming task, so I make cleaning distribution. Before I start, I will think where I have cleaned and what I did last time to make everywhere have almost the same cleanness.

Goal
Input
Gain
Pain

Figure 12: Persona - Jeanet & Tim

User Journey Mapping

To gain insights on the use of a cordless vacuum cleaner, the interaction between the user and the appliance is mapped out with information containing the desirability of each individual experience. It is supported by interviews and the questionnaire conducted earlier. In addition, the solution to each problem is provided as well. All the information we gain from the user journey mapping pushes me to think deeply about how I can use experience design to have a positive impact on my target users. The entire user journey includes four phases which mentioned before starts from motivation, preparation, use phase to the finishing phase. The use phase is the most interesting part which shows a lot of miscommunication between the user and the appliance (See details in Appendix 10.3).

Figure 13: Storyboard

4.2. Highlights in User Journey

The highlight is the most common concerns and goals in each individual phase from the user, which the information are gathered during the interview and questionnaire stages. These insights provide the bedrock for future design.

★ Meaning of Cleaning Task

Awareness towards the hygiene of the living space is the most common reason to initiate the cleaning process. However, during the research, there are other contributing factors. First, people view cleaning as a stress-relieving method, so during a high-intensity situation, people may use cleaning as a tool to relax and let off some steam. Secondly, when the focus is needed a clean workspace removes any unnecessary distraction, therefore, enabling an improvement in the efficiency. Finally, self-image plays a part as well, because your home is a representation of you, therefore, keeps it at an orderly manner leads to a positive impression to guests.

On the other hand, there is multiple causes lead to people abandoning the idea of cleaning. To begin with, the lack of time, cleaning is seen as a hugely time-consuming process, and in today's time, people are generally busy and equip with a packed schedule, therefore spare time is a rarity. Furthermore, the noise created during the cleaning process, when people finally finished with work, it is generally late in the evening, therefore, the noise created is going to not just affect the user, but also his or her neighbors, especially in the city with the most common type of housing as apartment, and the neighbors are at arm's length, this may lead to unwanted complaints. At last, with the combination of both factor listed above, cleaning is being painted with a negative image, and thus, people usually desert the idea of cleaning or at least postponing it as long as possible until it is absolutely necessary.

- "When I feel anxious, I will clean my room, then I can feel better."
- "I think the room can show one's personality."

★ Getting Ready to Vacuum

Simple and quick are the expectations during this phase. Therefore, the users are inclining to spend some time on the development of a cleaning strategy in order to find out the most suitable option for them.

During the planning stage, the first difficulty most users face is the selection of the nozzle. This is due to the lack of knowledge in the function of different types of nozzles. Therefore, they either take assumption base on their previous experience to make the selection or use the manual to help with the decision making the process.

Secondly, the limitation of the battery, therefore, sometimes the users have to distribute the cleaning process into multiple phases. In general, they organize each individual phase by the level of dirtiness of the location, level of importance, for example, is it a high foot traffic area or the use of the space. Further relevant research and study will be present in chapter 4.3.

- "If the battery is at 10%, I will do a fast cleaning on the area I frequently passed by."

★ Knowing the ongoing state of the appliance

The peaks in the user journey mostly appeared in the use phase, due to the sense of control, which the user value greatly during the cleaning process. The sense of control the user experiences directly related to the level of confidence in using the appliance. However, with the current product, the users cannot react to the condition of the appliance appropriately, because of the lack of information provided by the appliance. This can easily lead to a frustrating experience and lost in faith with the product at the end. Furthermore, as mentioned before, cleaning and organizing are helpful tools for stress relief, but unknown interruption during use can easily deprive the benefit of the actions. Instead, it may further indulge the user's frustration even if it took place during the simplest task. For example, lack of battery life and accumulation of hair on the nozzle, these will lead to the appliance being out of service for the duration of charging and reduce suction power. To prevent this from happening, the users try to adapt their lives to suit the appliance and discover the optimal way to cooperate with the appliance from their past experience, such as recharge after it been used twice and keep it in a good working condition, which increases their confidence during usage, as well as complete the goals been laid out. One of the goals could be the removing dust when complete a sense of achievement is rewards to the user.

- "I feel betrayed when the appliance is unusable due to unknown reasons."
- "I feel happy when I perceive the clean floor brought from my efforts."

★ Returning a well-prepared appliance

From the research, a sense of relief is experienced when the cleaning process is completed. However, at the same time, people generally forget to take care of the appliance or reluctant to spend time maintaining it. Maintenance is seen as an unimportant action, therefore, they usually put it in the back of their minds and move on to the more important tasks. Busyness makes people lazy as well as careless. Even though people understand a few minutes of maintenance lead to a well-functioning appliance when the next cleaning session occurs, but they still classified it as a low priority. As a result, malfunction will occur in the future cleaning process, such as battery insufficient or additional time is required because the dust container is overloaded, which reduces the suction power.

> ▶ "When I want to use and battery is low, I would like to blame the person who didn't charge after last-time use."

Implications User Journey

The problems mostly are initiated by mental exhaustion due to the lack of adequate information during each period. From the research, most people spend some time to "understand" the vacuum cleaner after that they are able to develop their own unique way of interacting with the appliance. Furthermore, the cleaning task is seen as a time-consuming and complicated task, which leads to less enjoyment and demotivation to clean, especially for busy people after a long day. However, the "cleaning" process and result make the user feel good. To conclude, insights found in the user journey will be addressed to develop a product-service system which helps the user to enhance their efficiency on the work done.

- Nowadays, people understand the appliance and current situation from past experience. The understanding of the situation is the main factor contributing to the speed of the decision-making process, such as the level of dirtiness in a room and the appliance state. This point provides an interesting insight on how to support the user to be more engaged in the cleaning task.

- Perceiving the dirtiness is gone and the "clean" outcome is the opportunities that will have the biggest impact on users and their overall experience.

- The influence of external inputs could be considered while redesigning the user experience. For example, the hygiene factor as a motivation to use the vacuum cleaner, there are also external inputs to motivate this cleaning behavior, such as leaving a positive impression or releasing the stress from the job. These users want to personally benefit from the cleaning behavior.

4.3. What a Busy User Needs/Wishes

What a Busy User Needs

The previous section has already shown the result of the user journey which provides insights on the journey and shows the decision-making process during the cleaning task. Besides that, solutions and ideal assistants which have mentioned by users during mapping journey will be helpful to create a product-service system. Based on these insights, I go back to see which focus points most users care about or want to gain during the task.

★ Feeling “Clean Enough”

Busy workers set their cleaning goal according to the amount of time they have. Most of them complete the cleaning at once, which includes tasks, such as mopping and vacuuming, which reduces the amount of time required because they don’t have to split the tasks into multiple time slot or stages. On the other hand, when they have less time, they prefer to save time by prioritizing important area to clean. Furthermore, due to lack of time, their goal will just want their house to be relatively clean and tidy, rather than every little thing has to be perfect, which can be called minor cleaning. When the goal is to do minor cleaning, users, firstly, think about when/where/what/how they cleaned last time. By knowing the level of cleanliness and the importance of each area, they prioritize the tasks to make a proper cleaning plan which best fits their current situation.

> ▶ “If I were busy, I would use turbo mode to clean the high-traffic area, which can prevent cleaning twice on the same area.”

★ Adapting to Users

Most users have experienced insufficient battery with the appliance which disturbs their daily schedule, which is annoying and frustrating, especially for busy people. Instead of one aiding the other, the relationship between user and appliance is quite the opposite, which is experienced by the user. This makes more mental exhaustion during use. To prevent the situation from happening again, they increase the maintenance frequency to once per use , which includes recharging and emptying the dust container. However, due to a busy life, they sometimes forget, therefore, a reminder could be a good tool to aid the user and enhance the efficiency of work done. Popping up a reminder with the appliance information at the right moment and is important. If a reminder appears at the wrong moment or irrelevant information is presented, it will not help the user. Furthermore, they will ignore, so that, the message does not accomplish its main task, which is reminding users of doing something.

> ▶ “When I want to use the vacuum cleaner and find out it is not usable, I feel betrayed and it makes my life harder .”

★ Being Supported by Vacuum Cleaner

Whether the problem is a user error, a bug or technical issue, it is not important to users, they just want to know what happened with the appliance and how to resolve this issue, so that, they are able to continue their work. Therefore, the simplest things in daily life affect their day in a negative manner. Not understanding the state which the appliance is in gives the user a feeling of being out of control because they do not know how to react to this situation. This experience is extremely uncomfortable because of the tension between the desire for control and lack of ability to resolve the issue, which enhances the stress and frustration during the cleaning process. Thus, providing some information about the state which the appliance is in can make them feel more confident during use because they know where they can actually make a real contribution to increasing the performance of the appliance, rather than wasting time and efforts trying to resolve the issue. It enables the user to do more with less effort.

Conclusion of the User's Needs

Given the outcome from the research, user test and user journey mapping, I came out with a few requirements for the development of main functions. Therefore, during the redesign stage, the basic needs of my target group will be fulfilled.

- Measuring battery:
  Knowing how long the appliance is still usable

- Switching suction power setting:
  Fitting to any kinds of situation

- Showing errors(warning):
  Indicating what is wrong on the appliance state in the conduct

What a Busy User Wishes

To keep the possibility of further development with the product, the following content will show which are the user wishes.

The ability to track and record both the location of the appliance and the surrounding environment information, which is able to make the context more controllable and further engage the user in the cleaning tasks. Furthermore, provide assistant to the user at the right moment through the method of pop-up notice, warning or reminder, with the help the user can resolve the issue in a timely manner, which has a side benefit of stress relief. For example, a reminder the user to charge the appliance after use, and the right moment for the message to be delivered is when the power button has been switched off. In this way, users can always have a well-prepared appliance well-prepared for the next time use. In addition, after a while, the user will begin to develop a habit related to use of the appliance, which in a way make he or she a more efficient user.

Based on the reviews gain from the user tests of the current product, there is another problem been identified, which is the weight of the head unit. Thus, how to achieve the user's cleaning goal in an efficient way is important. For example, informing where is dirtier could help shorten the time of using the appliance, so the user with arthritis is able to complete the task and also have good energy utilization, which minimizes the problems brought from its limited battery.

Conclusion of the User's Wishes

I have laid out four directions which are worthy to be considered into the redesign. To decide whether it is appropriate to include them, are base on the relative helpfulness towards effective communication.

- Transform abstract information like dirtiness into a format, which is understandable to the user. This enables the user to understand the situation which the appliance is in during the cleaning process.

- Provide real-time feedback in a dynamic or interactive manner, which assists the users to understand the current situation. This enables the user to change their behavior and adjust the inputs towards the appliance.

- Provide guidance during the decision-making process, which on the user's ability, expectation, and available resources. By this, the complexity of the work is reduced, which is ideal for the user.

- Provide suggestion or constraints to achieve high efficiency, but at the same time without bringing annoyance.

CH5

Exploring Redesign Concepts

5.1. Setting the Design Goal & Design Charateristic

To successfully redesign the Philips SpeedPro Max, it is important to set a clear goal to achieve through the redesign. To achieve the goal, having a clear set of requirements and wishes for the redesign is important as well. The design requirements and wishes are the descriptions of the interaction between the user and the appliance. The list of the requirements and wishes we would like to include in our final redesign will be described in chapter 5.3.

Deisgn Goal

"To allow the user to easily acknowledge the states of the appliances, and at the same time to determine the appropriate action during the daily use at home."

Interaction Vision

I want the interaction between the user and the appliance to be like the guest and the chef in a "teppanyaki" restaurant (Figure 14). Guest can order the dish prepared by the table chef. No matter the dish guests order, the chefs will cook all the delicious food around the table where guests sit around and are able to see the cooking process.

Figure 14: The Context of Having a Meal in a "Teppanyaki" Restaurant (ComerJapones, 2014)

Interaction Characteristics

Having a clear direction about characteristics users want to experience through the redesign will be helpful in making a meaningful emotional connection between the user and appliance. Besides that, based on these characteristics, setting up a few requirements for prototypes, which enables this new design to actually achieve the desired effect.

- Supported
  Guests save time on making a well-cooked meal because they are supported by a professional chef.
- Confident
  Guests are able to order and adjust dishes to meet personal preference by directly informing the chef.
- In Control
  Guests perceive how the chef prepares their meal.
- Involved
  Guests are able to communicate with the chef during the cooking process.
- Guided
  The meal is provided step by step from entree to dessert to make guests have a completed dining experience.
- Easy
  The menu is designed in a simple and understandable way, which makes the ordering process easy.

Desired Interaction

Combining the intended target group, our vision, and our results, I came up with the desired interaction qualities for the redesign.

- Supported
  Users get help from the vacuum cleaner to achieve their cleaning goal and expectation in an efficient way.
- Confident
  Users should know what to do instantly and be sure that is the appropriate action to take.
- In Control
  Users get all the information they want to know during cleaning.
- Involved
  Users are able to give any input they want towards the vacuum cleaner. At the same time, the appliance will react to the input given and give feedback in return.
- Guided
  Users know how to take action when they have difficulties.
- Easy
  The operational process is intuitive which will relative ease during usage.

Requirements & Wishes

Based on the desired interaction, I have set up a few requirements for concept selection and prototypes to make sure to have the desired effect.

Requirements

1. The difficulty in understanding the appliance state perceived by the users should be less. (Support)
2. User should know what they should do without a doubt, at every moment during usage. (Confident)
3. Uses know whether the appliance is usable or not. (In control)
4. Users have a clear message on the appliance state whatever they do. (Involved)
5. Users are able to know how to solve the problem by following the given information. (Guided)
6. Without having a guess, assumption, and assistance, users should understand the information given. (Easy)
7. Users should immediately understand how to interact with the physical and digital elements. (Easy)

Wishes

1. Through observation, I can see users be more excited about engaging in vacuuming and feel empowered by the appliance.
2. The body language and facial expressions of the users should show positive emotions during usage.

5.2. Conceptualization

Inspired by users' requirements and experiences on existing products, two main concepts are defined to redesign both physical and digital parts. The physical design should be decided prior to the digital part, so that, the size and shape can be well defined to have a clear overview of the interface.

Exploring Physical Redesign

The main direction is to keep familiarity for users. The physical part is planned to be changed as little as possible, so that, users can spend the least effort to adapt to the new design. Thus, the blueprint of the cordless vacuum cleaner in the future generation of Philips product has been decided to only change the structure of the motor which makes the appliance extend a bit longer about 3cm (the orange part shown in Figure 15). This extension gives opportunities to place the interface on the top of the handle if the handle moves backward for 3 cm. Since this design is expected to be applied in a new vacuum cleaner in Philips, the following physical redesigns will be based on this requirement.

First of all, a simpler operation process is considered. It was originally planned to integrate the interfacial controls and power supply to only one button (Figure 16). However, due to the limitation of the current technique, this development is time-consuming and would lead to a high cost. Therefore, I decided to divide the functions into one touchable screen for interfacial control and one physical button for power supply.

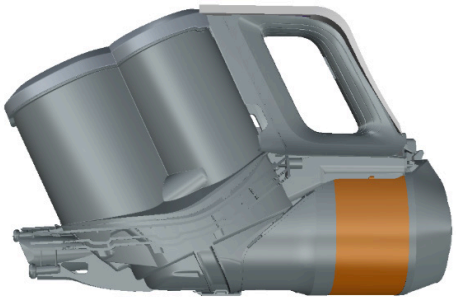


Figure 15: The Future of the Cordless Vacuum Cleaner in Philips

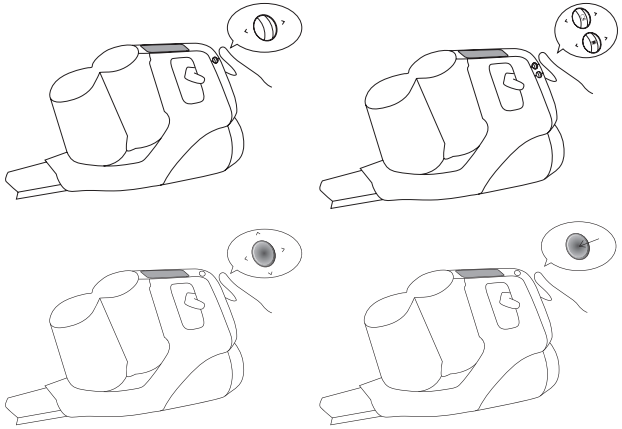


Figure 16: Exploration of Button Controlling

Figure 17 shows possible positions for the touchable screen. It was mainly explored in the head component of the vacuum cleaner. In this way, users may have a clear overview of this screen while using the appliance, which makes users easier to navigate different functions. However, due to the limitation of vision field and construction and to minimize the change of the physical part, position 2 was chosen finally.

To have enough space to place a touchable screen on the top of the appliance, the right part of the head components needs to be extended. Considering the convenience to users, the possible solutions for setting a touchable screen were also investigated, shown in Figure 18.

Due to the future architecture of the cordless vacuum cleaner, the final decision is to extend the right part of the head components for 3mm and make the screen area wider (Figure 19). Instead of a slider to switch on/off the power, a pressed round button is replaced, and a touchable digital screen will be used to control different functions and provide the information. After decided the physical part, I started to look into the possible direction of digital redesign and then came out with two concepts.

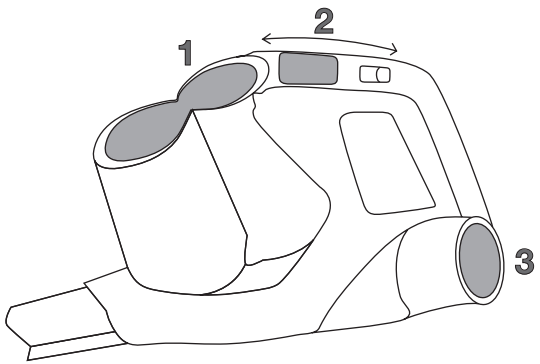


Figure 17: Consideration of Screen Position

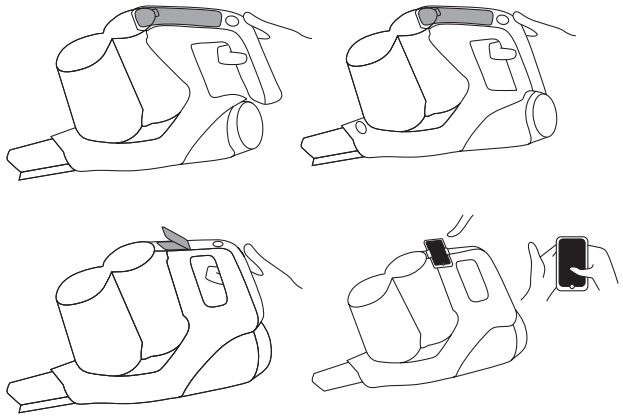


Figure 18: Exploration of Interface Adjustment

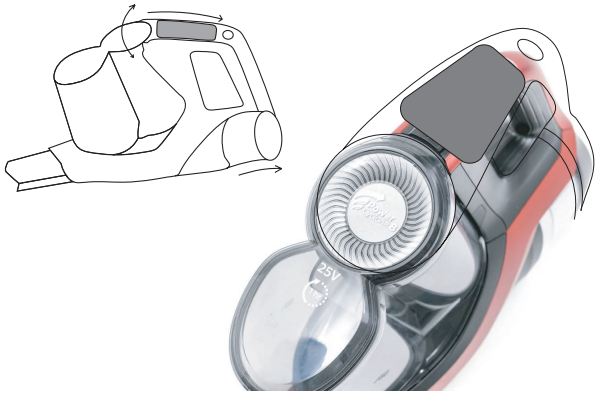


Figure 19: Final Decision of Physical Design

Exploring Possible Direction of Digital Redesign

After the modification of the physical part is fixed, the digital redesign is considered. Three concepts were proposed based on different functionalities that users want to have a future product, as mentioned in chapter 4.5.

The first one mainly focuses on the preparing phase (Figure 20). All the information related to the appliance is categorized and prioritized based on its importance and necessity before vacuuming. More important and necessary information will be firstly shown on the screen. In this way, users can be immediately well informed and able to judge whether the appliance is in good condition to use.

The second exploration is to improve the satisfaction of users during use of the appliance (Figure 21). The symbol expression not only addresses information, but also humanizes the appliance to give users the feeling of friendliness. These symbols can help users check the appliance state before and after the use, and then remind the user to let the appliance be ready for the next time. In addition, if something goes wrong and the users have no clue how to solve, the appliance is able to provide information to guide users on how to do step by step.

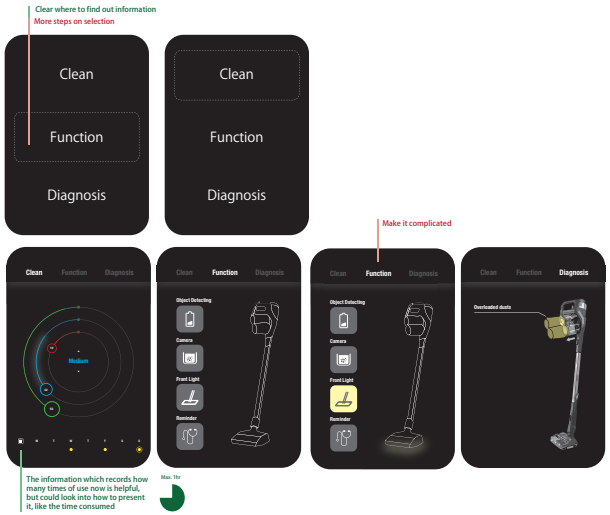


Figure 20: The Exploration of Information Categorization

Figure 21: The Exploration of Usability Enhancement

The last exploration mainly focuses on interaction during use. While users are vacuuming, they are able to get real-time information according to their movement and immediately adjust their behavior to fit the current situation the best (Figure 22). For example, users can get the feedback about the variation of the level of dust during vacuuming, so that they are able to know whether the floor becomes clean and they can move on to the next area.

The first and second images in figure 22 show the users can know how the dust accumulates in their home by combining with the technology of detecting the dust. The small greyish points represent the dust. When users do not clean from time to time, the points accumulate and this area will become whiter. The red dot, representing the location of the appliance, shows the movement of the appliance during usage. By tracking its movement, the appliance will act as an eraser to erase dust points from the dust map. This idea can be further applied to different target groups by showing the image in a different way. For example, people who only want to do minor cleaning, the first image in figure 16 is suitable. However, for pet owners of allergists who want to clean as perfect as they can, the second one which fills the background of the map layer by layer is more suitable because they can see whether the appliance reach as deep as it can, such as the dead angle.

After surveying users' opinions, the idea of the dust map came into favor with users since it can help users the most when doing the cleaning task. Therefore, I will focus on developing this concept. Meanwhile, I will also include some elements from other concepts to make the dust map much better.

Figure 22: The Exploration of Real-time Feedback During Use

Selected Direction: Creating a Dust Map

As a busy person, how to keep the home clean is always one of the most bothering things. They prefer using their limited time to clean the most important area indeed. It is how the idea “dust map” came. To use dust map, users are able to know which area should be cleaned the most and which area can be skipped out of their limited time.

Similar to robot vacuum cleaner, with smart sensors, such as camera and image recognition, the appliance is capable of searching for the area to clean through locating itself. Meanwhile, it can establish the size of the room and estimate the cleaning time. Inspired by the latest mapping technology applied in the robot vacuum cleaner, I will use it as a starting point to build my system.

In my system, users can create the map by themselves and the appliance will collect data to predict or explain the level of cleanliness at home. The first challenge is the limitation of indoor tracking technology. To conquer it, users need to map their surroundings by themselves for the first time. After the initial map has been established, users can locate themselves on the map and keep tracking the movement during usage for each cleaning.

Furthermore, the dust may spread differently based on their own property.Lighter dust can be brought to the corner, under the sofa, and deep inside the carpet by the wind or the footstep. Conversely, the heavier one may stay at the original place. The spread and accumulation of the dust are greatly affected by that human behavior and the airflow (Figure 23). Therefore, it produces another challenge that how to related the real situation of cleanliness to the virtual map.To reflect authenticity, a dust sensor developed by Philips will be set in the appliance. This dust sensor can determine the amount of picked up in specific area. Through combination of this dust data with the location data, the appliance can calculate and determine the regularity of dust accumulation. In this way, the dust accumulation according to the location can be predicted and shown on the map.

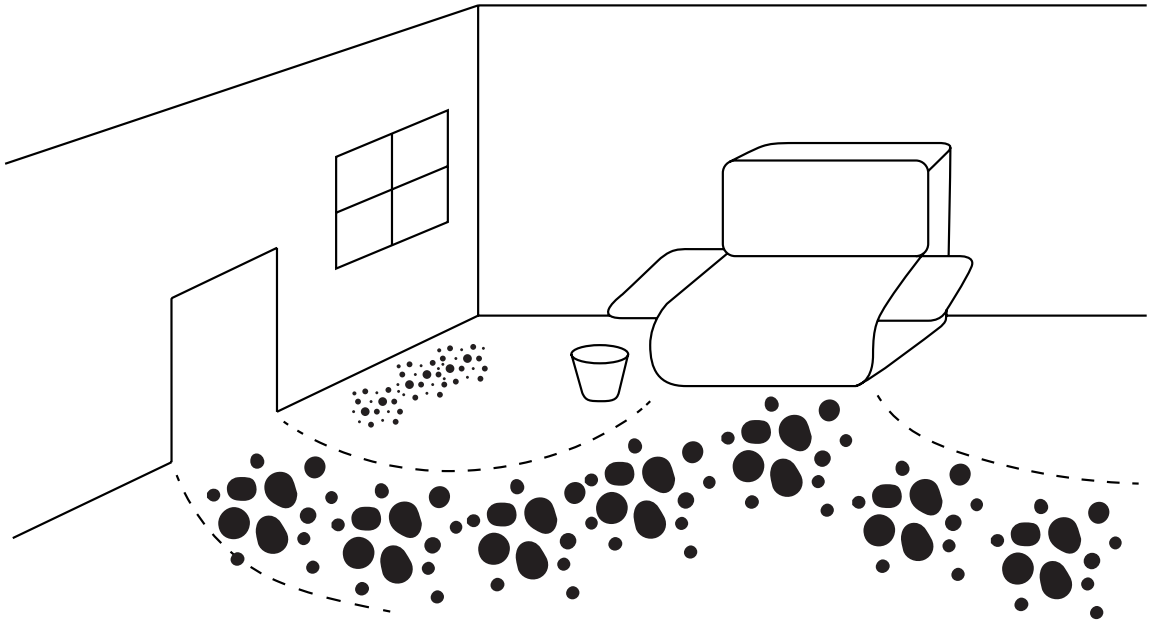


Figure 23: The Dust Distribution at Home

5.3. Concept Development

Concept 1

The main goal is to make information clearer and more transparent. It increases the convenience and efficiency to use the appliance. In concept 1 (Figure 24 & 25), users have a right to decide what should be mainly shown on the screen to be able to track during cleaning. They draw the room shape by themselves and are warned by the appliance when something goes wrong on the appliance in a more subtle way. Besides, all the information will be shown on the same page to make users easier to find it at first glance. To be well informed, users can be at ease during the cleaning task.

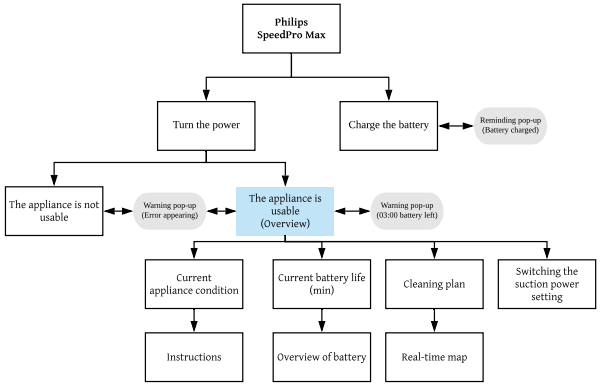


Figure 25: The Task Flow of Concept 1

Figure 24: Digital Interface of Concept 1

Concept 2

This concept targets on giving feedback clearly on cleaning, It lets users' effort recognizable and at the same time strengthens the cleaning motivation to enhance the efficiency of work done (Figure 26 & 27).

Cleaning task is thought as a time-consuming and complicated work, which brings less enjoyment. Through gamification, it makes cleaning tasks more interesting that the users feel they are playing the game during cleaning, such as collecting dust as points to get a higher score, which is inspired by the Pac-Man game. It motivates users to take the cleaning action without any stress and the feeling of exhaustion. In addition, this concept strengthens control through the appliance like a Home console.

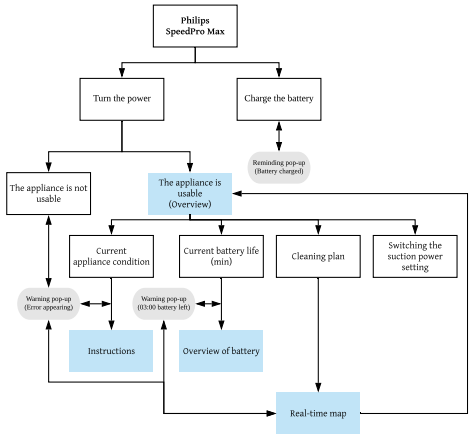


Figure 27: Digital Interface of Concept 2

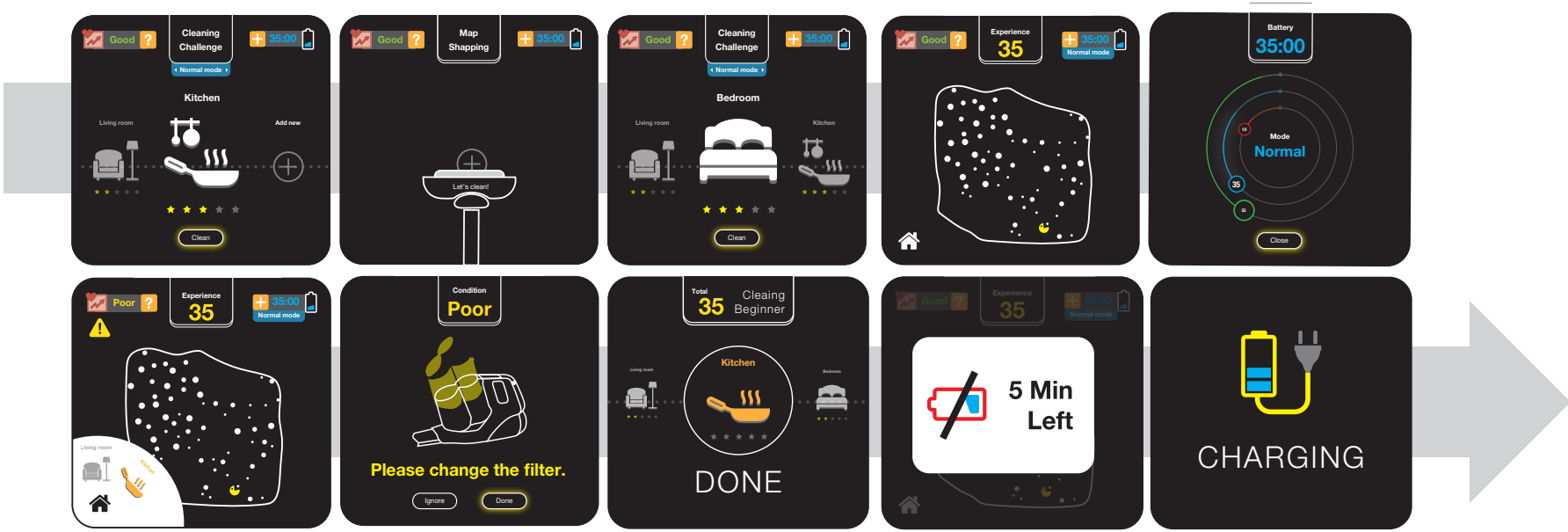


Figure 26: Digital Interface of Concept 2

5.4. Preparation of Concept Selection

Based on the requirements mentioned in chapter 5.1. as the criteria to select a concept, I interviewed 3 participants and understood their reasons. The primary goal of this user test is to identify the strong and weak points in terms of experience and interaction with each concept and make the final direction accordingly. The learnings from this testing stage will provide a profound understanding of which feature of each concept must be included or excluded in the new design. Lastly, the two concepts are converged into a new design as my final direction.

Research Questions

1. What concept is experienced best?
2. What are the strong and weak points of each individual concept?

Approaches

The approache for the user test will be a scenario-based-tasks in combination with a pre-test and a post-test interview. In order to compare the differences between concepts, both concept cards will be presented together for letting participants point out the favorite and unfavorite parts during the post-test interview.

Focus Aspects

The research questions will be answered for the following aspects. In addition to the aspects listed below, the overall experience will be included as well.

1. Tracking cleanliness condition during use

   You know there is functionality about mapping the room shape and you have a guest room at home. However, there is no option for it, so you want to create a new item.

   Your schedule is full but it seems like your last cleaning occurred a long time ago, so you want to go for fast cleaning of the dirtiest parts at home.

2. Tracking battery life during use

   You want to finish your room cleaning but you are also wondering how long it can be used in each mode.

3. Tracking the appliance condition during use

   During vacuuming, an unforeseen circumstance happened and the appliance pops up a warning and you have to resolve it in a set amount of the time.

4. Tracking recharging condition

   The appliance cannot be used because it is out of battery. You want to charge it.

5. Experience throughout the entire process

Context

The test was conducted in the participants' own living, which was a safe and familiar place for them, in order to make the participants more engaged in the scenario. Afterward, a small bag of candy was offered to all participants.

Participants

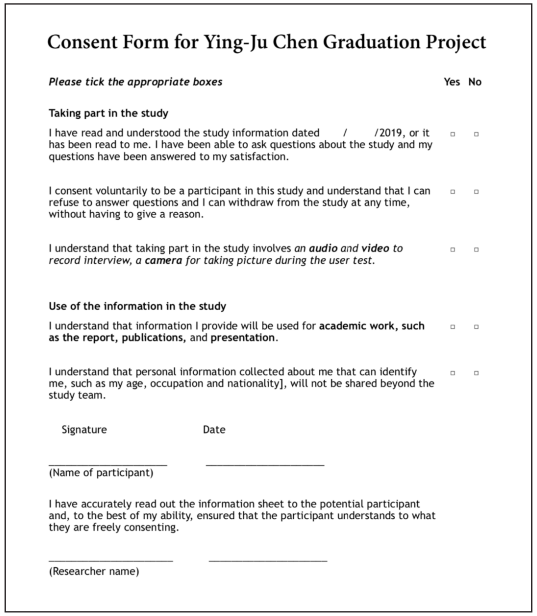
The concept was conducted with four users, two students from TU Delft and two workers, who are in the target group as well. The target group includes people within the age around 25-45. The data of participants will be shown below.

	P1	P2	P3	P4
Gender/Age	F/22Y	M/22Y	F/30Y	F/41Y
Nationality	French	Dutch	Italy	Taiwanese
Occupation	Student with income	Student	Full-time working	Part-time working & Wife
Experience	No, but want to have one	Yes, had one before	Yes, a little	Yes, has one now

Table 2: The Data of Participants

Materials

- A Philips SpeedPro Max and its cable charger
- A consent form is to agree with using their information during the test (Figure 28)
- Prototypes components (Figure 29)
- Some candies are to thank their participation
- A laptop is used to record audio and video during the test and interview
- A phone is used to take photographs during the test
- Some pen and empty papers are to do drawing exercise and record insights from observations



Consent Form for Ying-Ju Chen Graduation Project

Please tick the appropriate boxes **Yes No**

Taking part in the study

I have read and understood the study information dated / /2019, or it has been read to me. I have been able to ask questions about the study and my questions have been answered to my satisfaction. ☐ ☐

I consent voluntarily to be a participant in this study and understand that I can refuse to answer questions and I can withdraw from the study at any time, without having to give a reason. ☐ ☐

I understand that taking part in the study involves *an **audio** and **video** to record interview, a **camera** for taking picture during the user test.* ☐ ☐

Use of the information in the study

I understand that information I provide will be used for **academic work, such as the report, publications,** and **presentation.** ☐ ☐

I understand that personal information collected about me that can identify me, such as my age, occupation and nationality], will not be shared beyond the study team. ☐ ☐

Signature Date

_____ _____
(Name of participant)

I have accurately read out the information sheet to the potential participant and, to the best of my ability, ensured that the participant understands to what they are freely consenting.

_____ _____
(Researcher name)

Figure 28: Consent Form

Figure 29: Prototype for the Concept Testing

Procedure

The test took around 40 minutes in total. Here will show the procedure and its details.

1. Welcoming (1 min)

   Welcome and thank the participant

2. Introduction (5 min)

   Explain the purpose of the test as well as the procedure, request for permission of using the voice and video recorded materials for research goals only, and encourage the participant to share their thoughts throughout the process

3. Pre-test Interview (3 min)

   Questions about personal information and the impression/experience of using a cordless vacuum cleaner. Given their impression/experience, what kind of problems they have perceived?

4. Drawing Exercise (5 min)

   Ask participants to draw their room shape in and out of their room through observation and imagination respectively to find out the difference between the manual and automatic drawing.

5. Performing Tasks (15 min)

   Layout a scenario for the participants before conducting the test

6. Post-test Interview (10 min)

   Interview the participants about their experience after each concept, given the prepared questions. At the end of this phase, the two concepts are presented next to each other to do the comparison on the overall experience from several points of view:

   - What concept gives the best overview of all the different functionality?
   - What concept has the best overall interaction?
   - What concept would you buy?
   - What concept makes you feel most engaged?
   - What concept informs you best about battery/ the level of cleanliness/appliance condition/ recharge?
   - Which type of warning do you like the most?

7. End of the test (1 min)

   Thank the participant again and request for some feedback

Figure 30: Concept Testing

5.5. Concept Test Results

This section will show the main insights from the test. The two concepts are presented with their pros and cons listed in a table. The positive and negative sides of each task are shown which constantly refer back to the design goal and interaction vision. Each interaction characteristic is represented by a letter: A=Supported, B=Confidence, D=In control, E=Involved, F=Guided, G=Easy, so that, it is clear what is missing in the current concept and which direction needs more focus during the next stage. Before looking into individual problems, the overall experience in both concepts will be summarized.

In general, both provided clear and adequate information to help the user do the cleaning task in a more efficient way. However, there are some parts in both concepts which are still confusing to the participants. Firstly, switching the suction power setting is unclear in where this is done and how to operate it, which causes the user to be unaware of the fact that the appliance has three different suction modes. Because of this, the graph to show the overview of the battery becomes unclear as well. The green and red circle respectively represent silent and turbo mode, for the participants it is hard to associate these colors with their functions.

Concept 1

Figure 31 shows the feedback from participants during the test (See details in Appendix 10.4). All the information is clearly presented on the home page. People are able to get the information they want to know immediately. In addition, this concept focuses on user initiative: people can decide to take the actions they want, based on the information they gain, which gives more authority to the user and brings a strong feeling of control. At last, the design tends to be more serious and technical, which makes the information more trustworthy. However, the layout of the screen has not been organized well yet, which brought a bit of chaos during navigation.

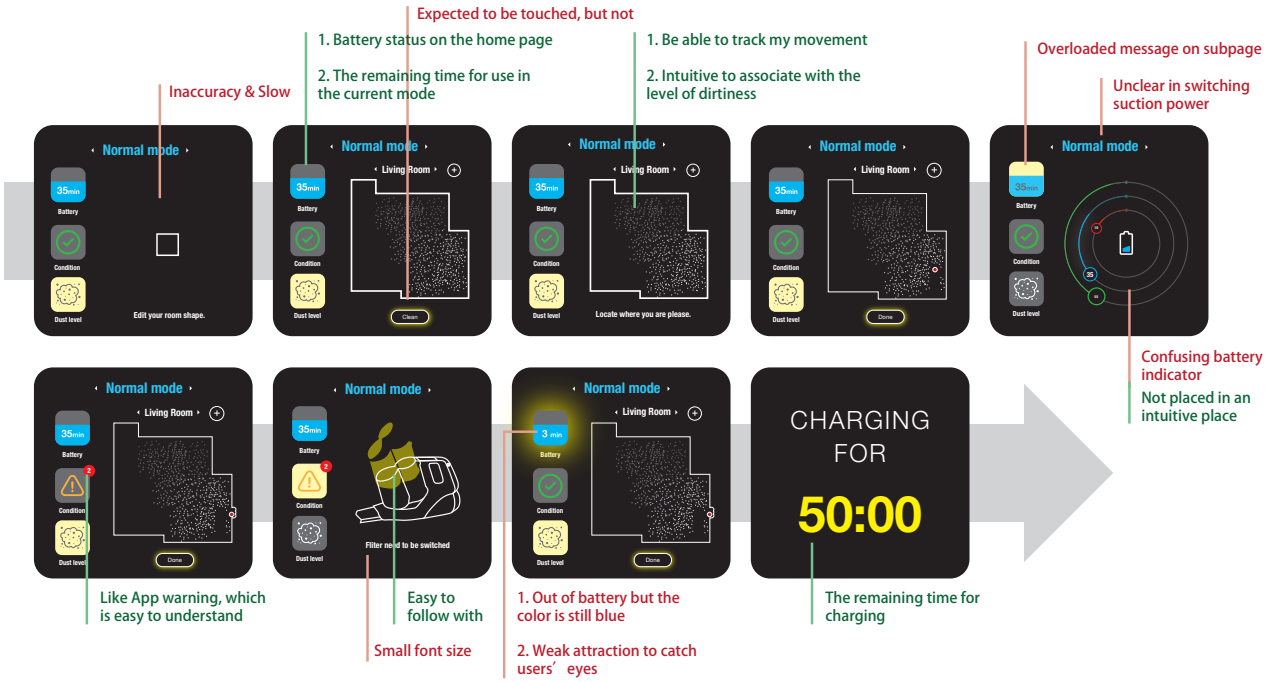


Figure 31: Problem Locating of Concept 1

Concept 2

In figure 32, this concept got more positive comments than the first one in general (See details in Appendix 10.5), which gives feedback in a direct way, so that, participants are able to immediately know what to do and how to do it. In addition, the concept gives a friendly feeling during use, which shortens the invisible distance between the user and the technical product. The navigation process is smooth here. Even though there are many pages to be navigated through, participants still know what the focus is on each page and how to access the page.

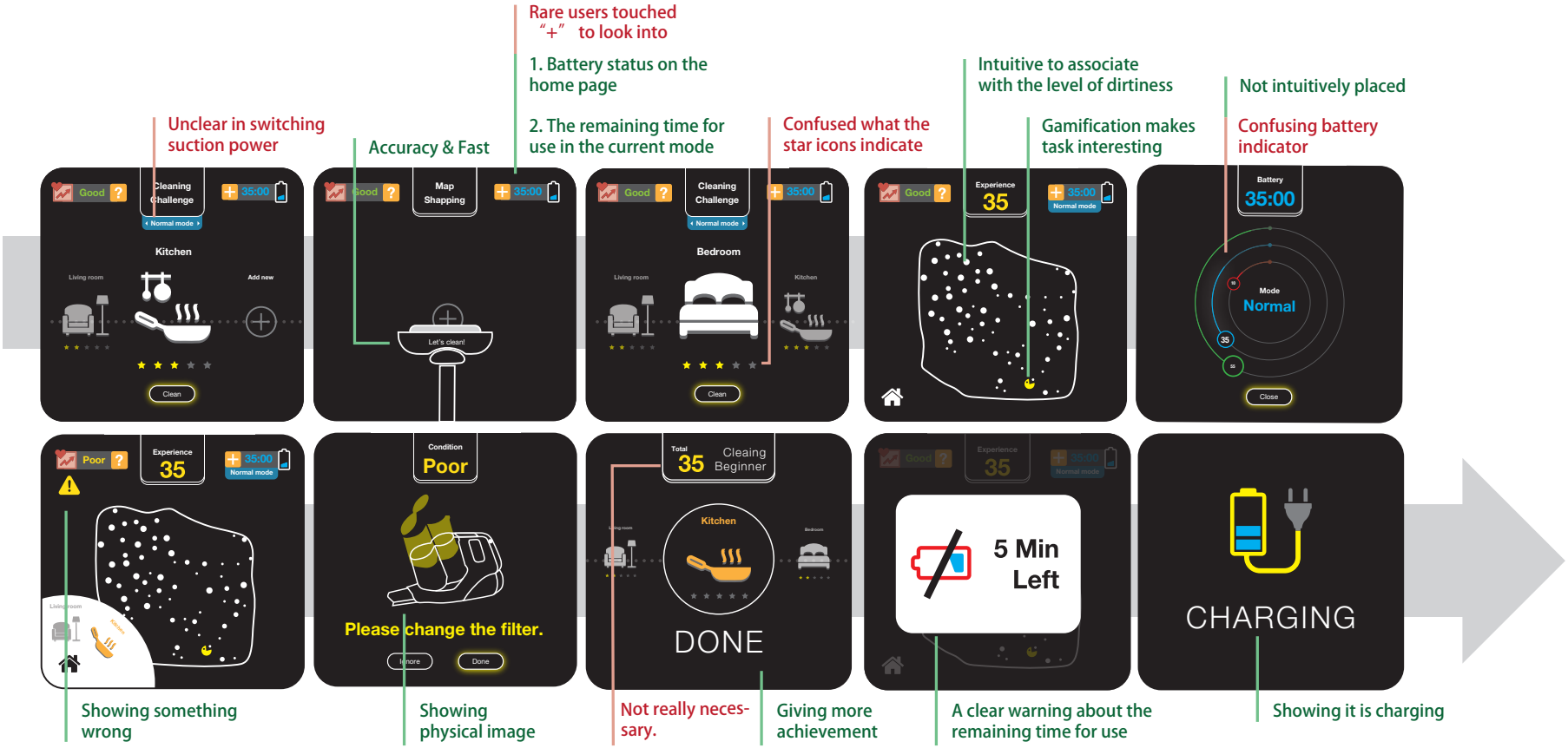


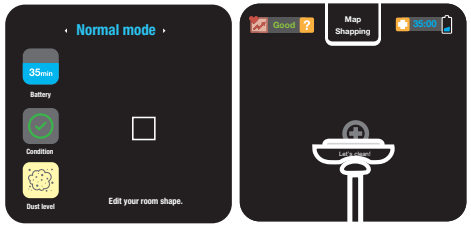
Figure 32: Problem Locating of Concept 2

Results Comparison

During the test, it is important to keep in mind that the participants did not fully cover the target groups. For this reason, it might not be reliable to draw conclusions upon their subjective preferences. However, the answers relating to the understandability are based on objective experiences. Therefore, it can be seen as important in comparing the effectiveness of the two concepts.

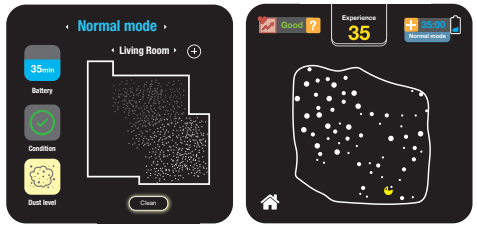
Task 1: Mapping the room shape

The image on the first and second concepts clearly shows the map is drawn by users themselves and appliance, respectively. Both groups mentioned that they prefer that the appliance automatically detects how to map a room, which makes it more accurate and trustworthy.



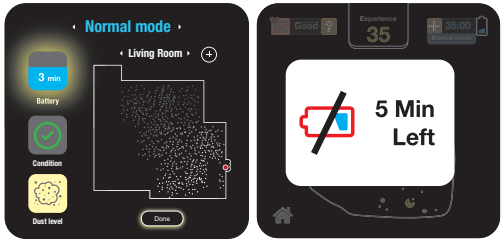
Task 2: Tracking cleanliness condition

Most participants mentioned that providing this information is the most helpful during the cleaning task. It is intuitive and easy to recognize the visualization of dirtiness. Concept2 got more compliment because it provides a game feeling during cleaning. It makes cleaning not boring. Next to that, the layout of the screen is more understandable, so it has better usability. However, 3/4 still go for concept 1, where more realistic gradient dots are shown.



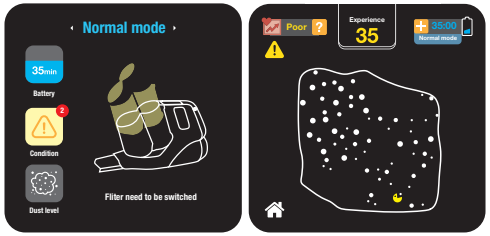
Task 3: Tracking battery life

A pop-up reminder to show the appliance will be out of battery soon is more popular among all users. Which is deemed more clear and attention-grabbing than the blinking battery icon.



Task 4: Tracking appliance condition

Comparing with a small warning icon appearing on the screen, users prefer concept 1 because the icon is bigger to provide a clear view and more like a notification that they are used to seeing on the app on their phone.



Task 5: Tracking recharging condition

Information to provide whether the appliance is successfully charged is helpful for users. However, concept 1 gives more information about the status, which enables the user to track the current situation of the appliance. This gives more flexibility in arranging the daily schedule of use.

Executive Summary

This section shows an overview of the most important strengths and weaknesses of both concepts.

+ More realistic dust distribution:
The way to present dust is like closer to reality.

+ Subtle warning:
A warning to change filter is more subtle by presenting it like an app notification, which prioritizes the importance of unfinished work.

- Overloaded information provided on unimportant subpages:
In addition to the home page, users are also able to know battery and appliance condition on any pages.

- Indirect feedback:
The display gives indirect feedback which can only be discovered appliance condition by actively touching.

- Unclear interactivity:
Some elements in the screen are expected to be interactive, but they are not.

+ Automatically tracking room shape:
With fewer steps to create a room map, but higher accuracy

+ Easy navigation:
Quickly understood how all screens relate to each other and how to interact with it.

+ Gamification:
The task is seen as a game, which adds positive feeling during the use.

+ Direct reminder:
The pop-up easily catches attention.

+ Direct feedback:
The idea of collecting behavior and showing big “done” give achievement.

- Not trustworthy due to gamification:
Due to gamification, it makes the task not serious anymore.

5.6. Conclusion

In conclusion, concept 1 is considered as the most trustworthy concepts and concept 2 is considered as the most friendly concept. Both concepts have their own strengths and weaknesses. Even though participants gave a lot of compliments for concept 2, they still prefer to use concept 1 due to trusting that one more. Thus, concept 1 presents a more promising design direction and is therefore used as a starting point for the next iteration. This iteration will be a redesign which combines concept 1 with the strengths of concept 2.

As a conclusion of the concept testing, the following list carries the characteristics that this converged concept should have.

- **A simple layout design** which guides the user to perform different tasks, by providing only what is necessary and visualizes how options relate to each other.
- **Large font size for better readability** is great important during vacuuming. The font size will be as big as possible without deleting essential information. Finally, readability for colorblind people was will be adapted accordingly.
- **A homepage** that shows a clear overview of all the appliance conditions.
- **Feedback of each appliance condition** on the home page to communicate with users all the time.
- **Automatic room tracking** that provides more accurate information to strengthen the trust towards the appliance.
- **A clear and strong reminder** during certain situations or errors, such as out of battery. This is to grab the user's attention and give a feeling of urgency to the message.
- **A subtle notification** to non-urgent information, such as filter switching. This gives the user a nudge to bear this information in mind, rather than be on high alert.
- **Improving the design for suction settings** by guiding the user to know where the three suction settings are and how to adjust it.
- **Improving the graph design in the overview of battery** in the overview of the battery which shows the different battery life within each mode.
- **Strengthening the postive feeling** during and after the cleaning task, making the task more engaging for these users.

CH6

Developing & Evolving the Redesign Proposal

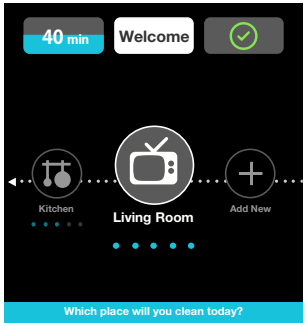
6.1. Converged Concept

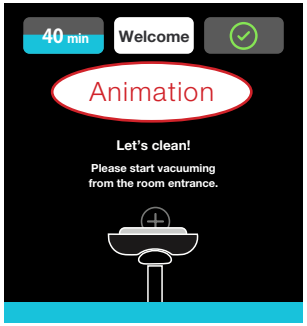
Introduction of Converged Concept

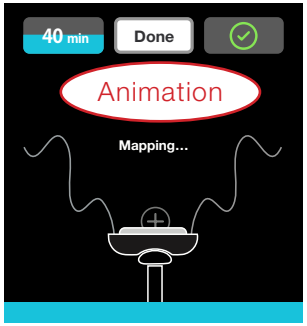
After selecting the final direction, the prototype was built up, and, to test and refine the details, a better visual design was provided to it. Before describing the first round of iteration, the overview and general build-up of the converged concept will be presented on the following pages.

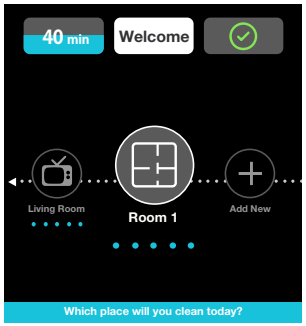
Task A - Mapping

Users create a room map by moving around the vacuum cleaner which is able to track the movement of use.



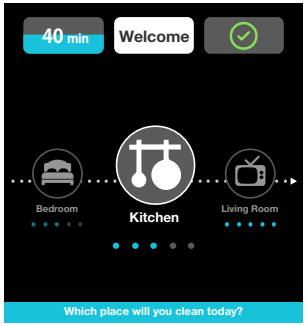


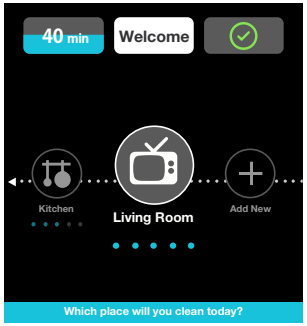


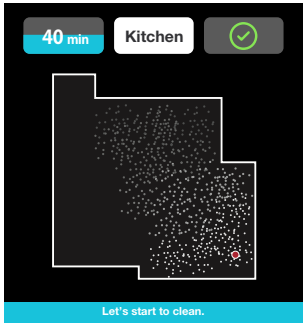


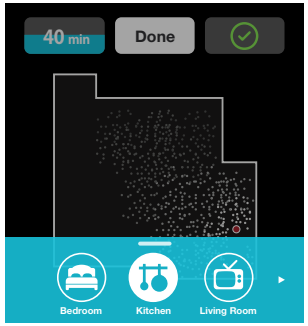
Task B - Following the map to clean their room

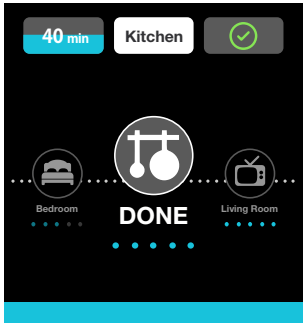
Users can have an overview of their home level of cleanliness by looking at the blue-dot indicator in the homepage, so that they also get a suggestion from the appliance on which place should be cleaned. After that, a dust map created by the appliance is presented. The grey dots representing dust can be removed by following the movement of the use of the appliance. At last, when users feel the work is done and tap the "Done" button to stop tracking, feedback on the cleaning activity is given.





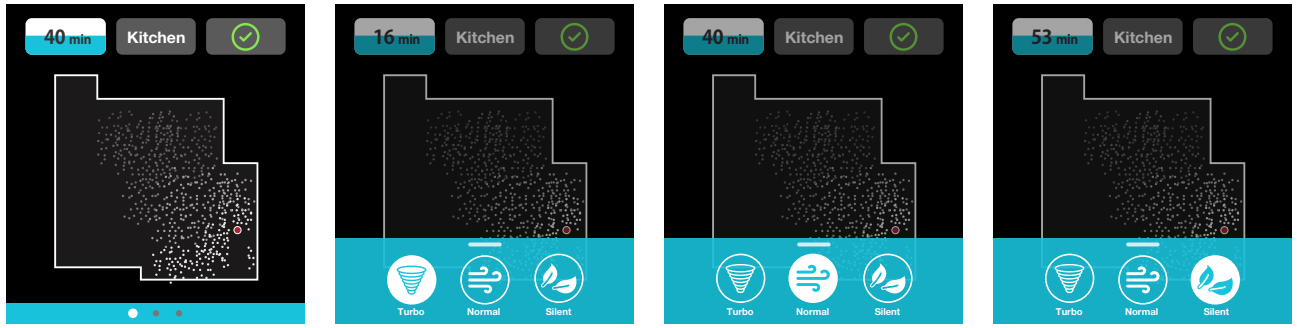






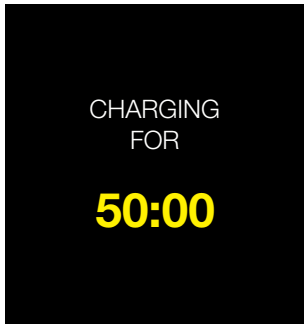
Task C - Switching suction power setting

Users can choose among three different levels of suction power and switch from one to the other at any time.



Task F - Tracking recharge

Users know whether they have successfully recharged.

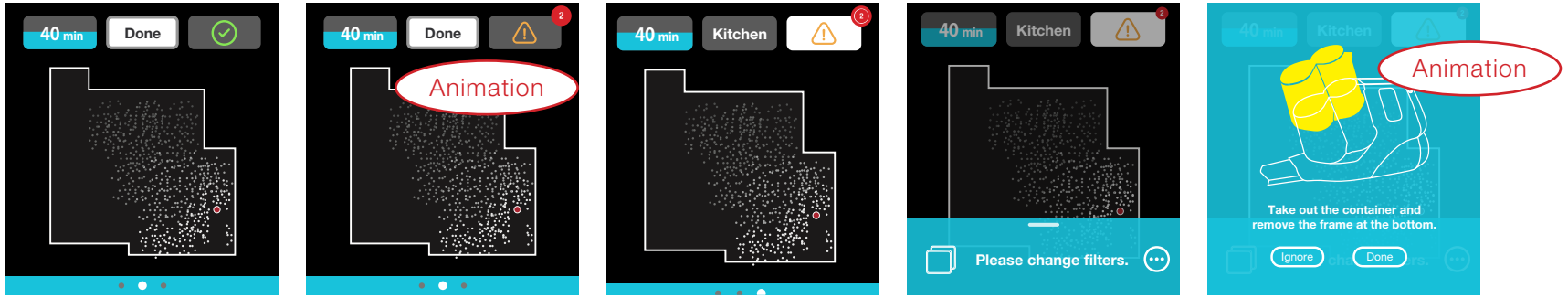


Task D - Tracking battery life

Users know how much battery is left, and, if a state of insufficient battery occurs, they get a strong warning from the button getting red and flashing.

Task E - Tracking appliance condition

As problems occur, users are informed through an animated red icon, and can check how to solve problems with an animated graph providing a short description.



Hierarchical Task Analysis

The task flow displayed below (Figure 33)shows the process of using the appliance from beginning to end. It represents how the menu is structured and all the functionalities that can be carried out. Those can be accessed either from the home page or by following only two steps in the menu. Additionally, from each screen of the application users can access to any functionality with one or two simple clicks. In this way, users do not need to figure out where they are located and can easily know how to enter the functionality they are looking for.

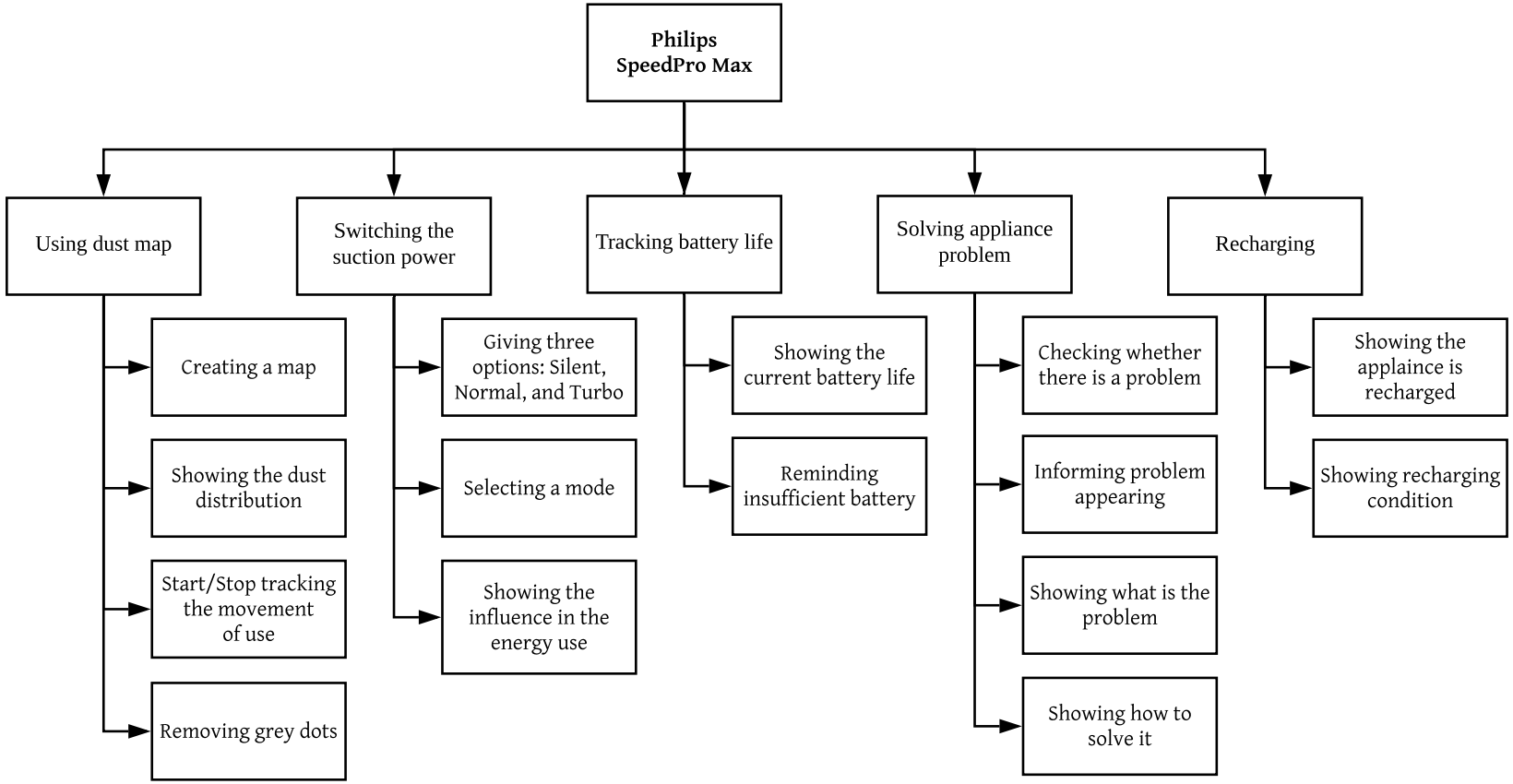


Figure 33: Task Flow of Converged Concept

6.2. Evolution of Prototype

Before the user test with the actual users, a usage inspection is conducted on the converged concept in the form of a cognitive walkthrough where four students used an interactive prototype for iPhone 6. This is performed on six different tasks that covered all the appliance's core functionalities. The usage inspection is useful to filter out problems that can interfere with the user test.

Approaches

This method is considered particularly effective because it allows foreseeing whether the potential users can easily understand and carry out different tasks within the converged design. To analyze each task, the four questions mentioned by David Travis (2010) in an article, The 4 questions to ask in a cognitive walkthrough, are considered particularly adequate. The questions are as follows:

- Will users understand how to start the task?
- Are the controls obvious to notice?
- Will users know the control is the correct one?
- Was there feedback to indicate you completed (or did not complete) the task? Will the user try and achieve the right outcome?

Next to that, to grip on the good direction in the design process, a self-evaluation will be conducted to refer back to my interaction vision and design goal.

Results of 1st Iteration

The prototype includes all the pages needed for the six tasks, so that participants could go through all the tasks and point out the problems. However, the prototype fidelity affected the test a little bit. Some elements like the animation, the sliding page were missing in the version, which had a negative influence on participants' experience, and even made the using process complicated. Also, participants could not give their feedback on these missing parts.

To summarize the feedback of the usage inspection, the main problems were analyzed based on their universality and severity (See details in Appendix 10.6). The results were as follows:

- Without enough text to explain icons on the home page, users will be confused about what these icons mean during navigation. This will be solved by adding texts on the buttons that explain what the button does. Next to that, the ellipsis icon showed at the bottom bar leads to misunderstanding. Users feel it means the page can be slid. Using arrows works better to help them understand the bar is clickable and can provide more information.
- To turn off the functionality of the map tracking, users have to take an extra step, which is not intuitive. To solve this problem, I change the time of page transition to make the using process more smooth.
- The instructions to guide users on how to map are not well elaborated. To improve it, the instruction will add the goal of this action and highlight the keywords in the long sentence. Secondly, the instruction to guide users on how to use the dust map is too small, failing to attract the user's attention. It can be improved by enlarging the font size.
- The connection between energy consumption and the use of suction power is weak, so that users do not know where to adjust suction power setting. To solve this issue, the current suction mode will be shown on the battery icon. This also helps to solve another problem about using a background color to represent the current suction mode.

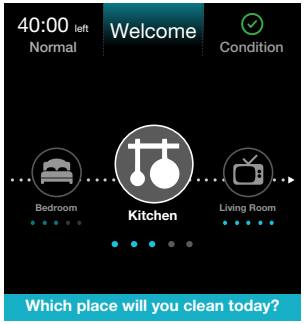
Self-Evaluation

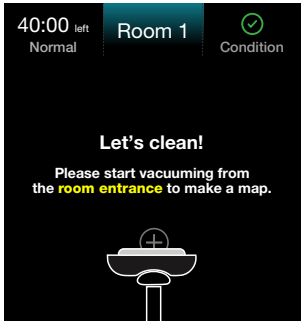
In general, the user experience of this prototype is a bit complicated due to the reasons mentioned above. More explanation is necessary during testing.

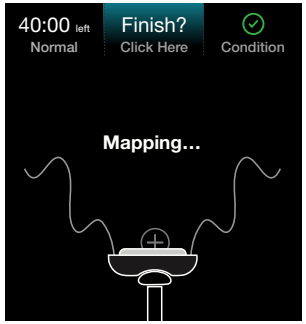
2nd Iteration

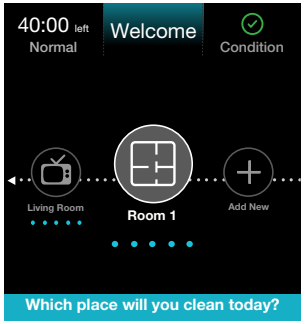
After the 1st iteration, I did some revision, based on the results and feedback. The 2nd iteration will help look into other potential problems, especially from the point of guiding the users to the touchpoint of each functionality, for instance, whether users are able to associate the right action with the outcome they expect to achieve?

Task A - Mapping

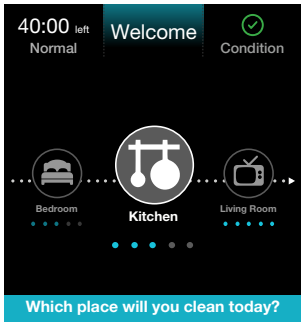


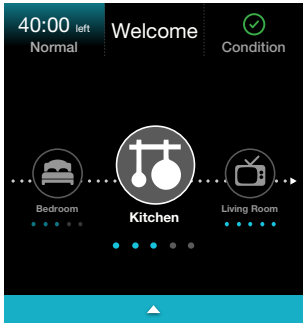


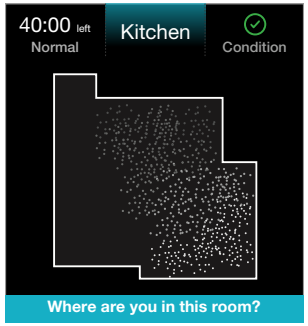


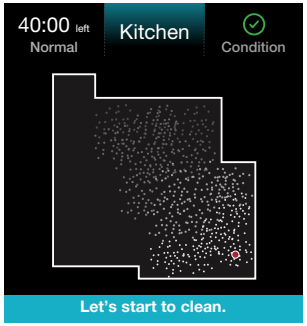


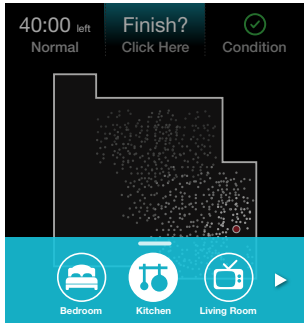
Task B - Following the map to clean their room

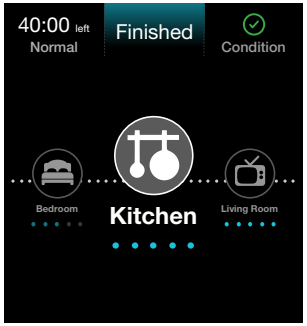




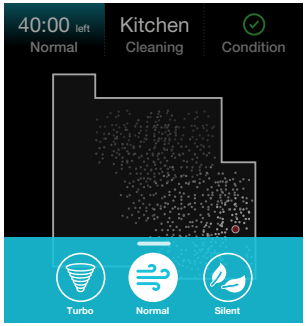


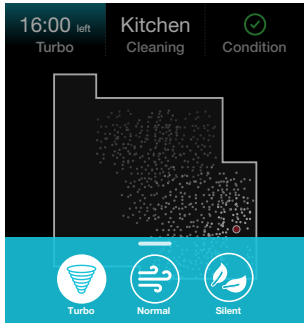


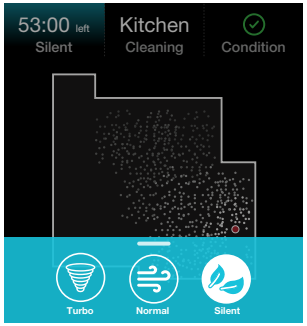




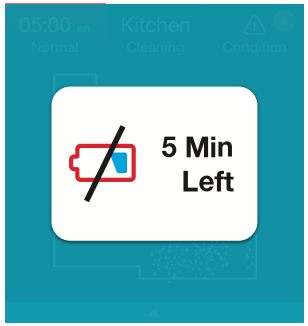
Task C - Switching suction power setting



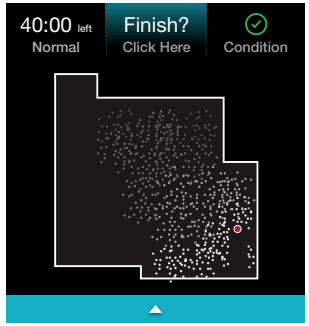


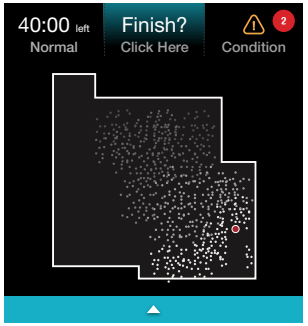


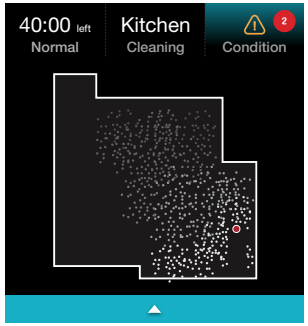
Task D - Tracking battery life

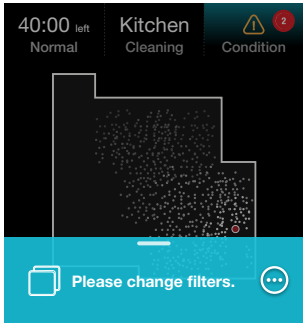


Task E - Tracking appliance condition

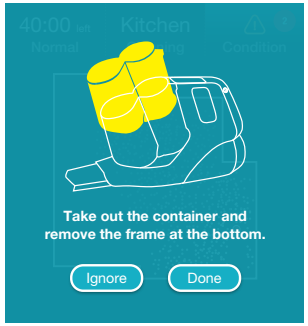


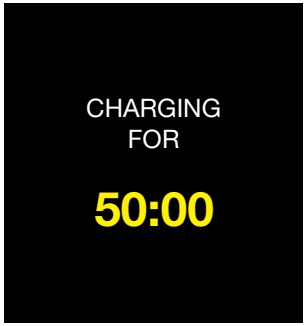






Task F - Tracking recharge





Results of 2nd Iteration

The second prototype is similar to the first one, but with the following differences: more text to explain what the buttons have to be used for and enlarged font size to make these words more evident. Besides, some animation, such as sliding pages, are also added to make more clear on their functionality. However, due to the limitation of the software, some animation cannot be shown on the phone screen. Thus, participants were informed that all buttons are only activated by a click and the way of working was explained. However, as some pages should be connected to the appliance, I was not able to show how the interface and the appliance interact with each other, which affected prototype fidelity.

To summarize the feedback from the 2nd iteration, the main problems were analyzed based on their universality and severity (See details in Appendix 10.7). The results were as follows:

- The five-point icon which is an indicator of showing the level of cleanliness in the homepage was not informative enough. As a consequence, I changed to a round progress bar.

- The word "Normal" which referred to the suction mode and placed under the battery indicator was confusing. Users thought it meant battery condition, rather than the name of the suction mode. This can be solved by renaming the name of the suction mode, such as "Classic". Also, it could be considered to separately place it.

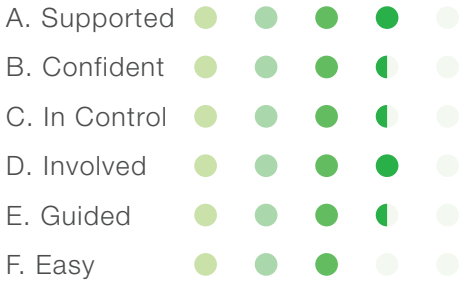
- The instruction placed at the bottom of the screen was still ignored by most users, mostly because of its position. Thus, it was solved by placing the instruction on the upper part of the screen.

- Users were unlcear how to map. To have a better understanding, the leading words were elaborated to make it more infographic

- The menu was placed underneath the "Welcome" button, which was not coherent because they had a different purpose to exist in this interface, so they should be designed individually and separately for improvement.

Self-Evaluation

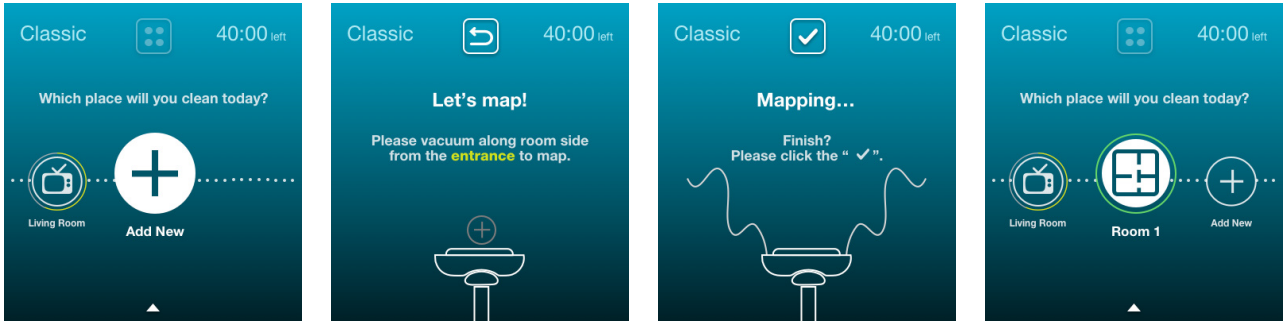
It can be perceived that users have a better understanding of how to use this interface due to more instructions provided. At the same time, the complexity of interface design increases at the same time, so the visual design will be rethought in the next phase of iteration.



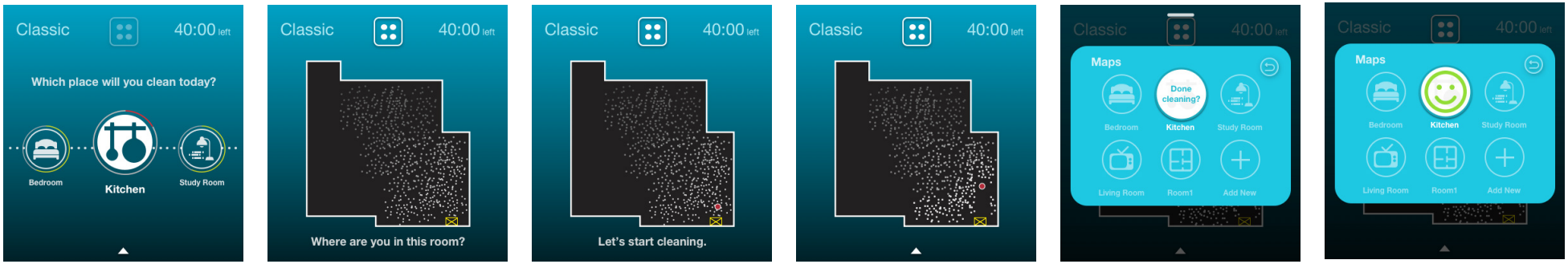
3rd Iteration

Compared to the 2nd iteration, more elements of the setting and visual design were improved this time, based on the results and feedback. The 3rd iteration focuses on the overall experience, for instance, whether the user is able to immediately know what/how to do in between tasks and whether the process is smooth during the transition.

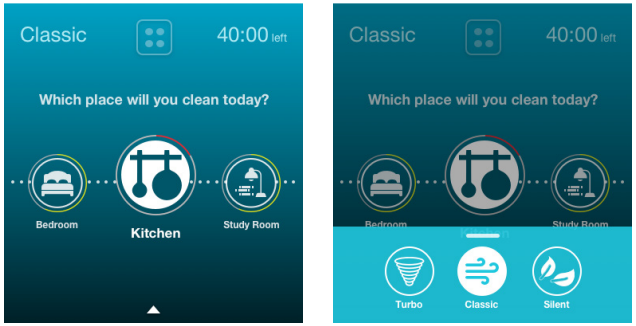
Task A - Mapping



Task B - Following the map to clean their room

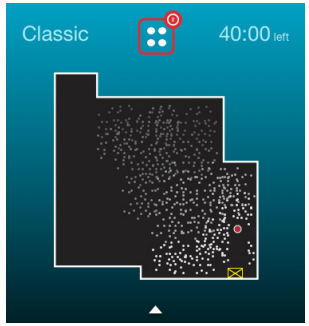


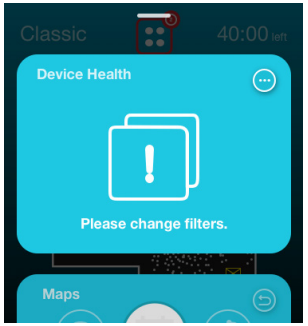
Task C - Switching suction power setting

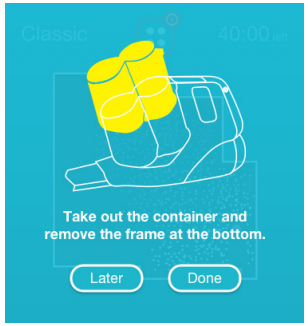


Task D - Tracking battery life

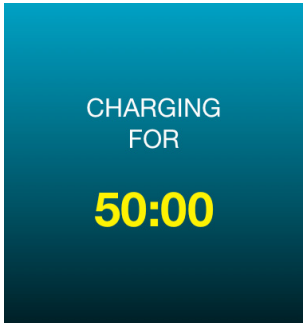
Task E - Tracking appliance condition







Task F - Tracking recharge



Results of 3rd Iteration

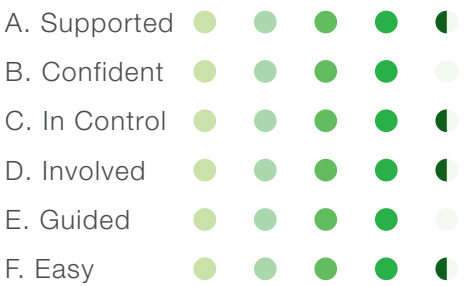
The third prototype focuses on making each functionality accessible in an easier way through improved visual design. Due to the higher complexity of the second prototype, the information shown on the screen was prioritized and organized, based on their importance. Most tasks did not lead to complaints, but some details have to be adjusted.

To summarize the feedback of the usage inspection in 3rd iteration, the main problems were analyzed based on their universality and severity (See details in Appendix 10.8). The results were as follows:

- To understand faster how to map, the instructions should be more infographic. Accordingly, the picture linked to instruction was improved to provide more information. For example, a vacuum cleaner moving forward to the door is shown.
- The yellow icon which showed on the map and represented the location of the room entrance was changed into white, and the instruction was considered to move to the top of the map.
- The way to access the suction setting was a bit unclear, however, users were still able to find it after the first time. Thus, this problem was decided not to change on this phase until the result from the user test in the next phase.

Self-Evaluation

The comments toward the third prototype changes seem more positive. This prototype is perceived as easier to use, according to what most users said.



CH7

Presenting the Final Redesign

7.1. Final User Test

To evaluate whether this design is experienced positively by potential users, a user test will be conducted. It aims to identify points for improvement regarding the interaction and experience of the product.

The process of user test will be elaborated on the following pages, which contain test set-up, the information about the participants involved, the procedure of conducting the test, the results, and the conclusion. After this user test, a final redesign will be made based on the input of this last user test.

Research Questions

The primary goal is to identify the points for improvement for the converged concept.

1. What problems arise when using the converged concept?

2. Does the converged concept solve the problems as stated in the design brief?

Approaches

The method is similar to the user test of the current product and concept selection. It will be a scenario-based-tasks in combination with a pre-test and a post-test interview. In addition, participants are given a questionnaire after the test. The questionnaire allows to precisely evaluate the converged concept based on specific aspects relating to usability.

Focus Aspects

The research questions will be answered in terms of the following aspects, consisting in an extensive overview of the tasks that have been tested during the user test and their related scenarios.

1. Tracking cleanliness condition during use

   You know there is functionality about mapping the room shape and you have a guest room at home. However, there is no option for it, so you want to create a new item.

   Your schedule is full but it seems like your last cleaning occurred a long time ago, so you want to go for fast cleaning of the dirtiest parts in this room.

2. Tracking battery during use

   You want to finish your room cleaning but you are also wondering how long it can be used in each mode.

3. Tracking the appliance condition during use

   During vacuuming, an unforeseen circumstance happens and the appliance pops up a warning and you have to resolve it in a set amount of time.

4. Tracking recharging condition

   The appliance cannot be used because it is out of battery. You want to charge it.

5. Experience throughout the entire process

Environment Setting

The test was conducted in a quiet meeting room in order to make the participants able to get into the context which has been set by the author. Afterward, a small bag of candy was offered to all participants as a way to thank them for their participation.

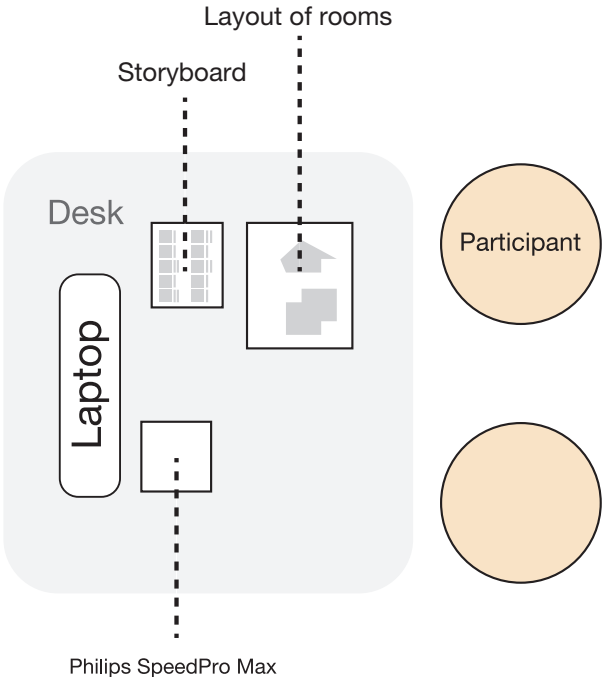


Figure 34: The Setting of Environment

Participants

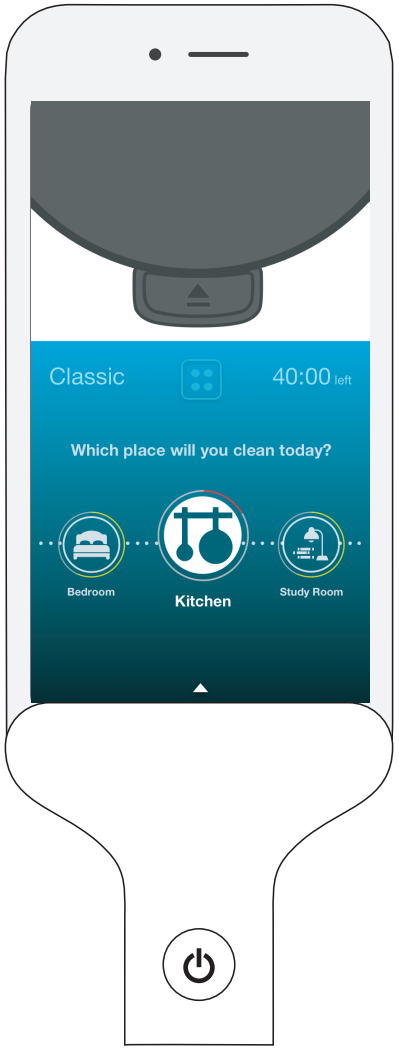
The converged concept test was conducted with seven people. Except for the second participant (P2), the rest of them are in the target group. The target group is people between the age of 25 to 45, especially a family member who is in charge of the cleaning. They are European or people who have been living in the Netherlands for over 10 years. The data of the participants will be shown below (Figure 35). The opinions and suggestion from P2 will be kept in mind, as they can be helpful to improve the final design.

	Gender/Age	Nationality	Occupation	Composition of Family Members	Experience	Cleaning Style
P1	F/45Y	Taiwanese	Part-time job & Wife	Husband, young kids*3	Yes, own one	1/wk
P2	F/65Y	Dutch	Full-time work & Wife	Husband, daughters*2, and pets*2	Yes, own one	3~4/wk
P3	M/37Y	Dutch	Full-time work & Father	Wife, young kids*3, two pets*2	Yes, owned one before	everyday
P4	F/41Y	French	Part-time job & Wife	Young kid*1	No, a little experience in try-out	1~2/wk
P5	F/35Y	Spanish	Part-time job & Wife	Husband, young kids*2	Yes, owned one before	1/wk
P6	M/45Y	Dutch	Full-time work	Husband	Yes, own one	2/wk
P7	F/45Y	Italy	Part-time job & Wife	Husband, young kids*2	No, a little experience in try-out	everyday

Figure 35: The Data of Participants

Materials

- A Philips SpeedPro Max and its cable charger
- Two sheets of paper showing a specific room layout and storyboard (Figure 36)
- Prototypes components
- A consent form to agree with the information used during the test
- Some snacks to thank their participation
- A laptop is used to play the sound of suction during the test, record audio and video during the test and interview
- A phone is used to take photographs during the test
- Some pen and empty papers to do the exercise and record insights from observations



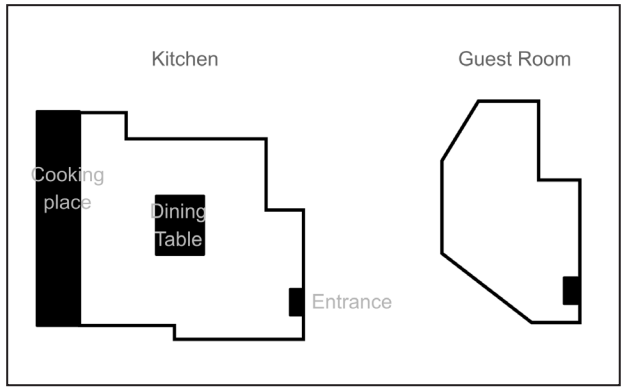


Figure 36: Prototype for the Usert Testing

Procedure

The test took around 50 minutes in total per person. Below the procedure and its details are described.

1. Welcoming (1 min)

   Welcome and thank the participant

2. Introduction (5 min)

   Explain the purpose of the test as well as the procedure, request for permission of using the voice and video recorded materials for research goals only, and encourage the participant to share their thoughts throughout the process

3. Pre-test Interview (3 min)

   Questions about personal information and the impression/experience of using a cordless vacuum cleaner.

   The question includes:

   - What do you do? What is the composition of your family members?
   - Who is responsible for the cleaning? How often do you clean? How do you clean?
   - What type of vacuum cleaner do you use?
   - Given your impression/experience, what kind of problems have you perceived/experienced?

   Before starting to perform tasks, the last step is to lay out the scenario, which is helpful to make the test smooth and coherent. It starts from reading storyboard, showing the context they are in, and explain what this new appliance can do. For example, "The new device is able to generate a map of the house to better understand the geography of the rooms and house in general, and keep a track of the cleanliness of the room to provide better feedback while cleaning."

   .

5. Performing Tasks (15 min)

   Layout a scenario for the participants before conducting the test.

6. Post-test Interview (10 min)

   Interview the participants about their experience after each concept, given the prepared questions. At the end of this phase, they are asked to fill a post-test questionnaire which has two parts, questions about using the interface and the Likert scale about their experience rated from 1 to 7.

   - What is the most understandable/confusing part of each functionality?
   - What is the most helpful part for you throughout the cleaning task? And why?
   - What do you like best about the interface? And why?
   - What do you feel useless about the interface? And why?
   - How is the overall experience in using this redesign?

7. End of the Test (1 min)

   Thank the participant again and request for some feedback

Figure 37: Coverged Concept Testing

7.2. Results from the Final Test

The following paragraph shows the results of the user test. For these results, three different datasets were analyzed.

The first set of data comes from scenario-based tasks. The results for this part are displayed in lists, with positive and negative performances shown per task, indicated with the number of participants. These results were gathered from video recordings and observation sheets. The lists also show different quotes to strengthen positive and negative insights.

The second part of this section shows the results of the post-test-interview. These insights were collected from videos and interview sheets. The data in this section is also displayed in tables, but only with quotes since the interview had open questions and it shows the insights best.

The last part of this section shows results from the post-test-questionnaire present in a graphical way. The post-test-questionnaires consisted of questions with a Likert-scale to evaluate whether my design goals and interaction vision were achieved. The graphical representation of this data shows an overview of all answers with the average scores.

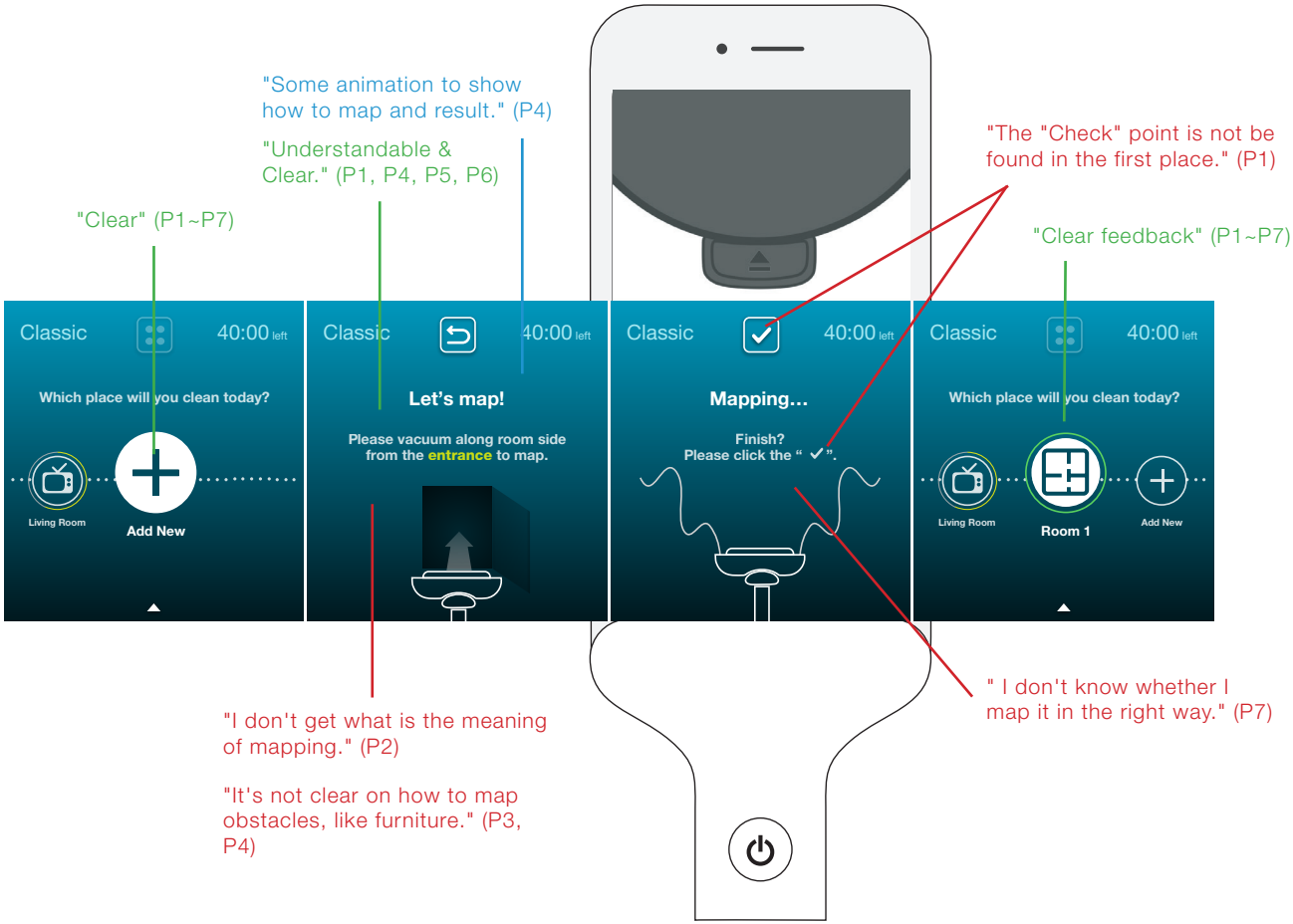
Observation Results

Task1: Mapping the room shape	
+ 6/7 knew how to map without assistance. + 6/7 knew how to navigate the pages. + 6/7 knew they successfully mapped. - 3/7 did not read instruction to understand how to map and need to be reminded of the instruction exsiting. - 3/7 did not know what to do after they finished mapping.	+ “Oh! I added one new map of the room on the homepage” (P1) - “(The participant tapped the button "Add new" to enter the mapping page) Hmm.. then what I should do now?” (P7) - “I will map like this way. What's the next step?” (P5)
Task2: Tracking cleanliness condition	
+ 6/7 understood the grey dots represent dust. + 7/7 notice the dots are removed on the map. - 2/7 need verbal assistance to understand how to locate themselves at the beginning.	- "The color code (bright vs. shaded) of the dust is unclear for me." (P3)
Task3: Tracking battery life	
+ 6/7 knew the remaining time of use will be different in each suction mode. + 7/7 were able to find out where to change the suction setting after trying and guessing. - 7/7 were unsure where to change suction modes for the first time.	+ - “I guess…I can change the suction here.” (P1)
Task4: Tracking appliance condition	
+ 7/7 noticed there was an error happening. + 7/7 knew where and how to get more information about the error + 7/7 knew what the problem was and how to solve it.	+ "This part is quite clear for me." (P3)
Task5: Tracking recharging condition	
+ 7/7 noticed the interface change. + 7/7 understood what the remaining time referred to.	

Interview Results

Task1: Mapping the room shape

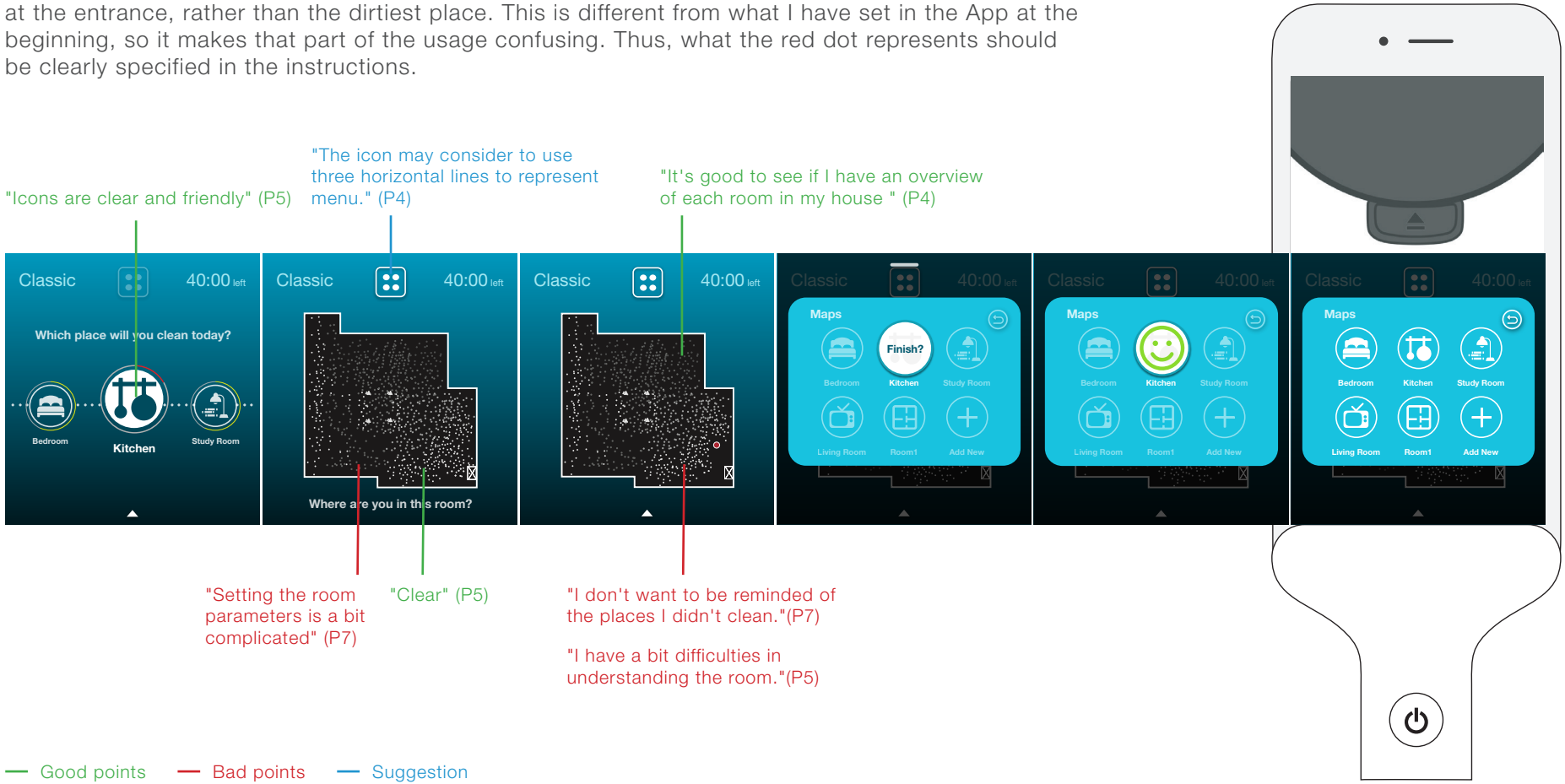
The main reason participants are confused about this task is that it is hard for them to imagine what it would be like, in reality, to map the room for the first time. One of the participants suggested that an animation showing how to map can improve the current situation.



— Good points — Bad points — Suggestion

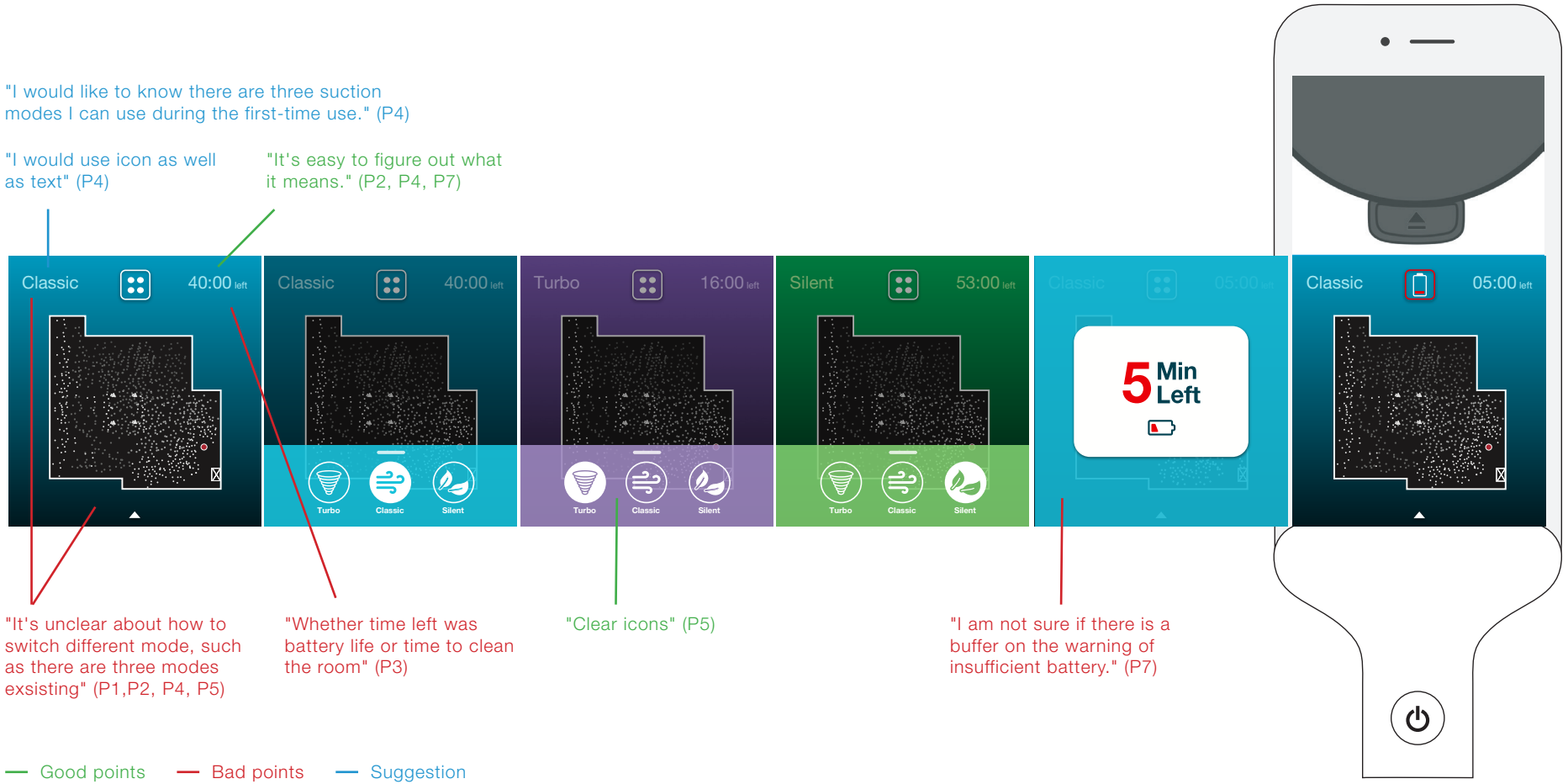
Task2: Tracking cleanliness condition

Most participants are curious about how this functionality works. The main problem here is that people are unclear that they have to locate on the start point of vacuuming. Besides, the test is conducted in two situations, the kitchen and a guest room. They also mention there are various situations, such as when they bring the vacuum cleaner to another room for cleaning, they may start at the entrance, rather than the dirtiest place. This is different from what I have set in the App at the beginning, so it makes that part of the usage confusing. Thus, what the red dot represents should be clearly specified in the instructions.



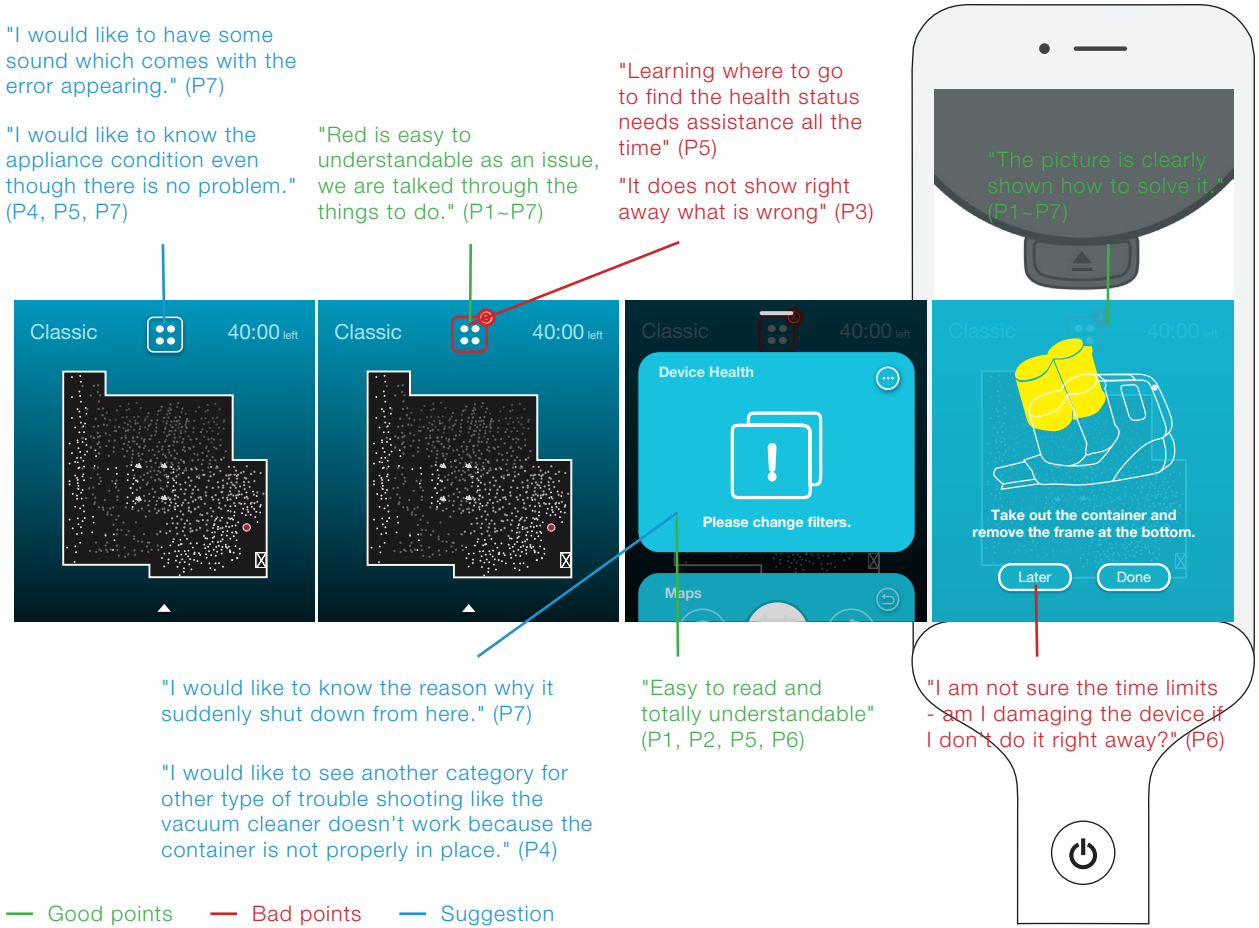
Task3: Tracking battery life

In general, most participants are able to keep track of the battery life and just one participant misunderstood on the time left. The main problem is that participants are confused about where to adjust suction settings, which is not obvious for them.



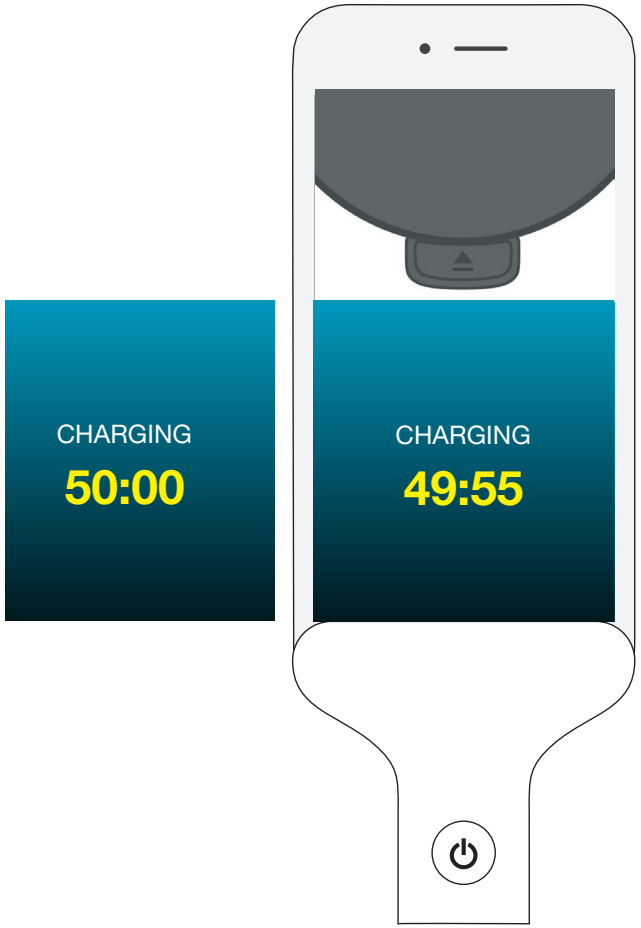
Task4: Tracking appliance condition

The process of knowing the error and how to solve it, is intuitive for most participants. However, they want to see the huge difference in the level of emergency of each problem.



Task5: Tracking recharging condition

The screen clearly conveys the information which all participants feel helpful.



Questionnaire Results

The questionnaire is structured in questions related to each interaction characters. The table shown on this page visualizes the results of the post-test questionnaire. The colors represent the different ratings provided by the participants on a 7-point Likert scale.

The green color indicates an answer that is optimistic about the concept, whilst a red answer indicates discontent with the device (see Legend below).

The results are displayed by means of the color codes, to provide information about every single participants' answer and to allow the reader to make a comparison at a glance.

Except for the scores from Participant 5 (P5) who gave the lower score in general in the questionnaire, nearly all questions were rated over 4 and most of them were rated around 6, which means that the current design provides the user experience that I wanted to convey through my redesign. To further enhance the user experience, the insights from the test will be used to modify and improve the interface used in the final redesign.

Legend

1	2	3	4	5	6	7

P = Participants

		P1	P3	P4	P5	P6	P7
Supported	Q11. You feel that you get help from the vacuum cleaner to achieve your cleaning goal and expectation in a faster way.	7	4	5	3	7	7
Control	Q2. You are able to know whether the appliance is usable or not.	6	7	7	7	7	6
	Q4. You get all the information you want to know.	7	6	6	3	7	7
Confident	Q6. You know what you should do without a doubt, at every moment during usage.	7	5	6	2	6	7
	Q7. You know what to do instantly and are sure sure that is the appropriate action to take.	7	6	7	2	7	7
Involved	Q5. You got a clear message on the appliance state whatever you do	7	4	7	3	7	7
	Q8. You are able to give any input you want towards the vacuum cleaner. At the same time, the appliance will react to the input given and give feedback in return.	7	6	7	5	6	7
Guided	Q9. You know how to take action when you have difficulties.	7	6	2	3	7	6
	Q10. You know how to solve the problem by following the given information.	7	7	7	7	7	7
Easy	Q1. You immediately understand how to interact with the interface.	6	6	7	5	7	4
	Q3. Without having a guess, assumption, and assistance, you understand the information given.	7	4	7	3	7	5
	Q12. The operational process is intuitive, which feel relativly ease during usage.	7	6	7	3	7	6

7.3. Conclusion

This paragraph first shows the main conclusions from the different dataset results: the scenario-based tasks, the post-test-interview, and the post-questionnaire. Furthermore, two research questions, which were asked at the beginning of this chapter, will be answered here. Finally, a list of characteristics that the final redesign should have is provided.

1st Research Question

What problems arise when using the converged concept?

To answer it, I looked at the interaction of both physical and digital parts. Furthermore, there are some limitations during the test, which will be mentioned on the next page.

Using the Physical Part of Interface

Most participants barely look at the interface during the use unless they want to change any functionality. In most situations, the vacuum cleaner was being moved around during the entire process, so notifications are easily ignored by them. Adding haptic design, such as vibration, may not be suitable to implement, as it might interrupt the cleaning task and feel out of control. Thus, the redesign can get the benefit of sounds implementation, for example when the vacuum cleaner has some problems appearing.

Next to that, the operating positions of the participants were observed. Most participants operated the system by one hand with standing position and elbow slight flexion, meaning that the interface was readable at maximum 65cm (DINED anthropometric database, 2004), which is the length of the arm of the people between the age of 20 to 60.

Using the Digital Part of Interface

All the participants agreed that the interface is simple and easy to use. Most tasks were completed by participants themselves, except for three tasks which needed a moderate level of verbal assistance during the test, offering them some room for improvements.

1. Mapping the room shape:
   This task was confusing for most participants, mainly because it was not clear how it worked with the appliance.

2. Locating the vacuum cleaner:
   Participants were unclear that they had to locate on the start point of vacuuming. What the red dot represented should be clearly mentioned through instructions.

3. Understanding the dust map:
   One participant misunderstood the meaning of dots on the map. Besides, another participant mentioned the dust map was dominant that the appliance seemed to force her to remove all the points from the map, which made her feel uncomfortable.

4. Adjusting the suction modes:
   In this task, there were two directions which should be improved. Firstly, participants were not informed that there were three suction modes available, so they were not aware that those could have been adjusted. Furthermore, the access point of suction was not obvious.

Limitations in the Final User Test

- **Cannot show animation and sound effect through prototypes, such as sliding pages and GIF file.**

  The software, Sketch, which only can do page transition by a click and the App, Sketch Mirror, which comes with this software does not support GIF file, so the actual interaction cannot present to participants. To make up this point, some screens were shown from the laptop to make participants understand what they should be like.

- **Cannot actually test the effect of some functionalities.**

  Some functionalities are mainly used during the use of the vacuum cleaner, such as tracking the movement of use. However, without actual operation, it is hard to imagine how it would be.

2nd Research Question

Does the converged concept solve the problems as stated in the design brief?

Problem1: Button Design

The ordinary switch design is intuitive, but only has little feedback during adjusting the suction setting, which makes users easily fail to stop on the middle option. This is not the case anymore. Besides, the ordinary switch combines with the functionality of activating the motor and adjusting the suction, but the final redesign separates these two functionalities, thus the problem is solved. However, the new button to adjust suction modes raises another problem, which should be further improved in the future.

Problem2: Nontechnical Language

Users are confused about the condition of the original appliance at that specific moment, such as when an error appears. This is not the case here. Given the scores from Q2 & Q10 in the questionnaire and the result from the interview, all the participants showed that they are able to know whether the appliance is usable and understand what the problem is.

Problem3: Insufficient Instruction/Information

Users did not always know whether they were doing the appropriate action or what they were supposed to do. This is not the case here anymore, but still, there is room for improvement. Given the scores from Q7 & Q9 in the questionnaire and the result from the interview, most participants showed that they were able to perform the tasks without assistance. However, one to two participants gave a lower score, which meant the experience during navigation was still not satisfactory enough.

7.4. Final Redesign

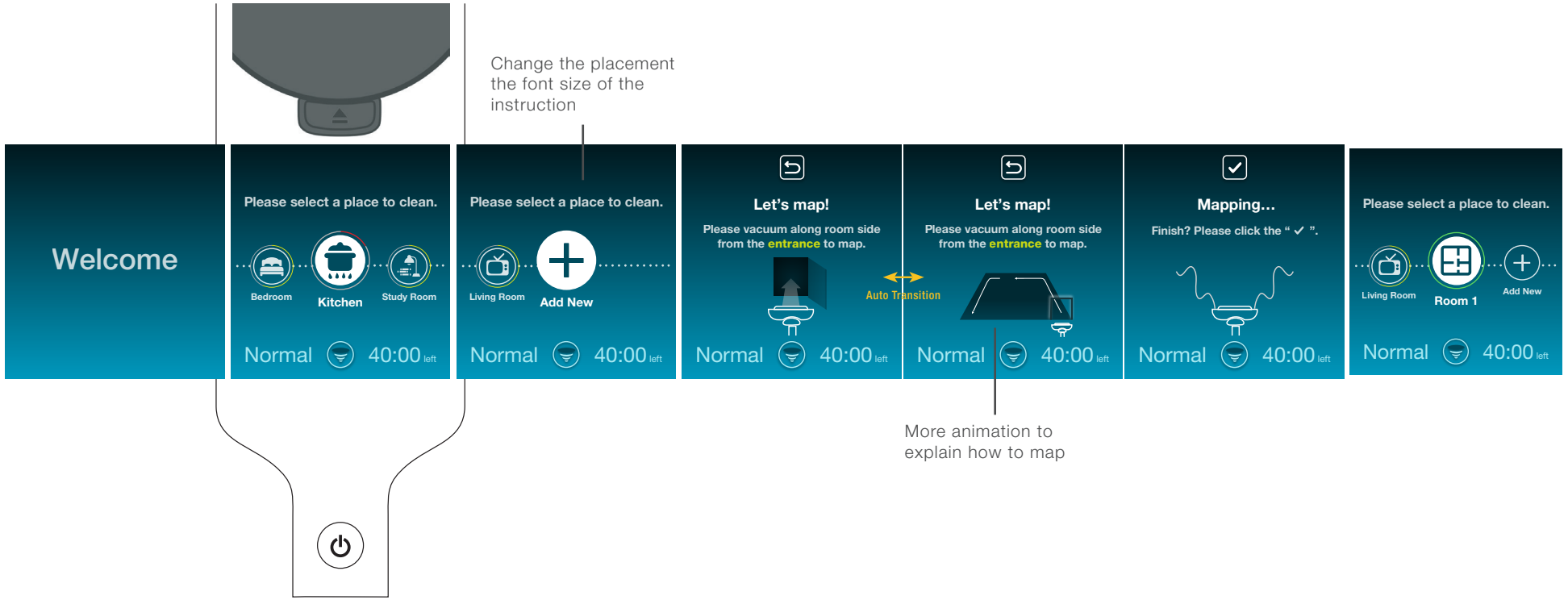
Here the final redesign of the interface will be presented. The first part will give a view of how the physical redesign looks like. Furthermore, the main improvements which come from the analysis are displayed and will be explained below the image. The yellow lines on each image explain how the screens transit in between. At last, the task flow of the interface will be provided.

Button & Interface redesign

The button is a round button which is responsible for switching on/off the power to activate the motor of the appliance and the screen. The screen set on the appliance is a touchable screen and the size is 56*62 cm.

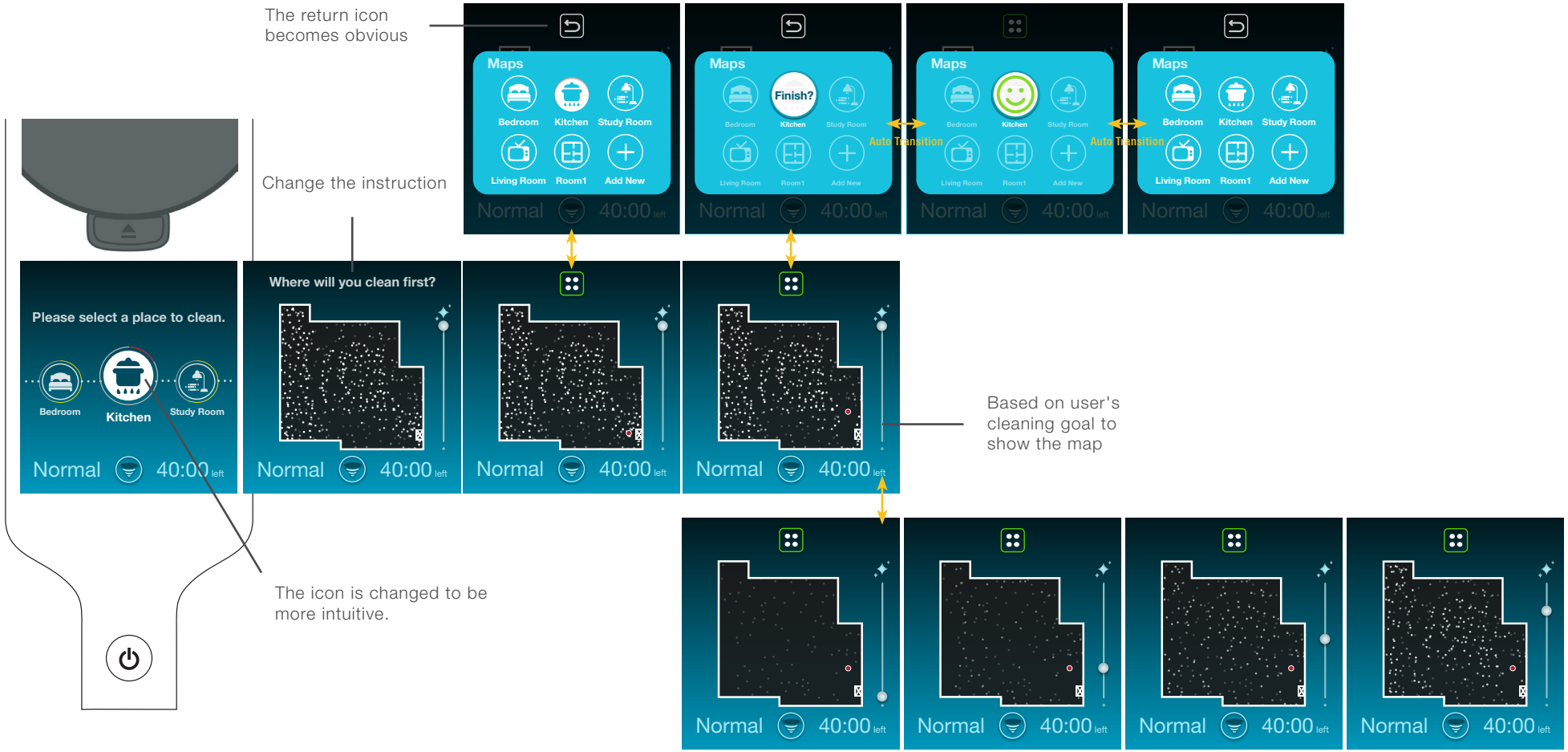
Mapping the shape of rooms

Two changes were made in this task. The first one was the placement of the instruction, which was shifted to the top of the screen. In this way, users will not easily ignore them. The other change was the animation to teach users how to map. Due to the distance between the user's eyes and the placement of the small interface, I made the information infographic.



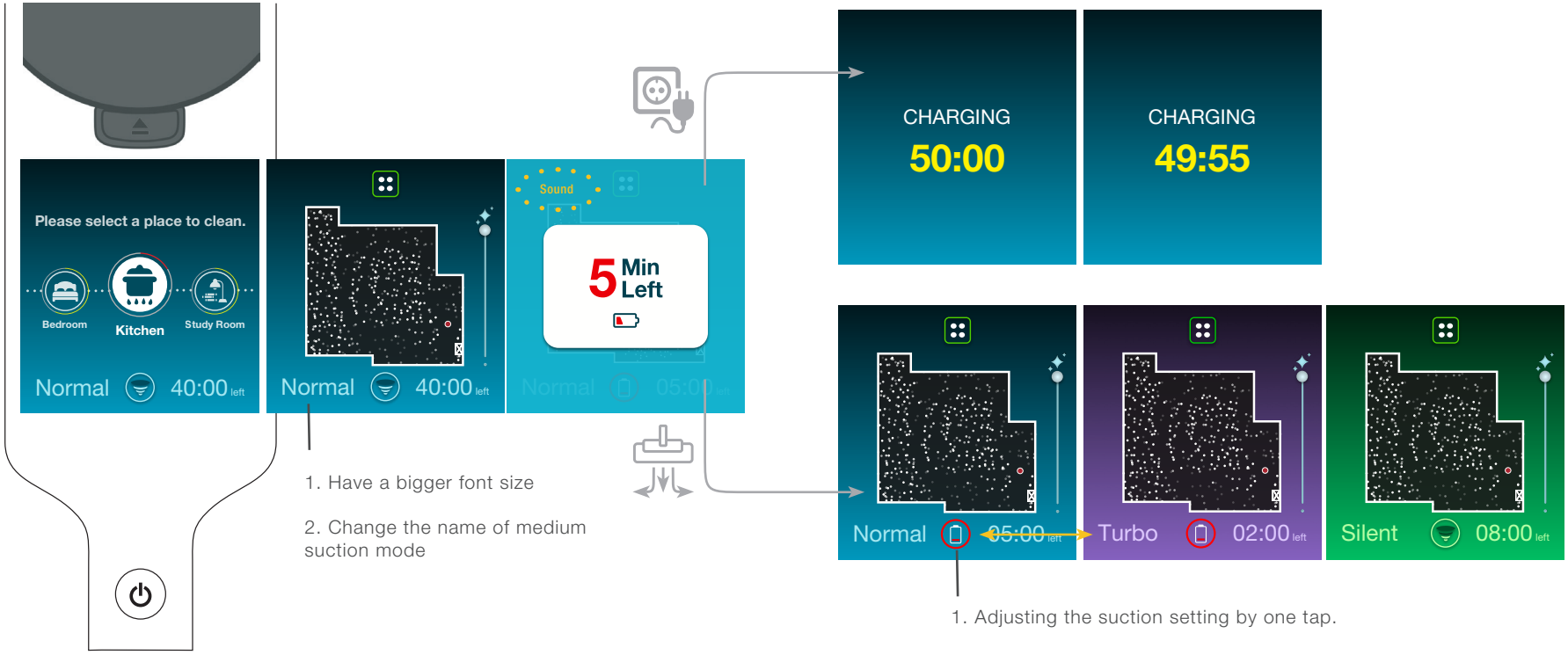
Tracking the level of cleanliness

Four changes were made to this task. The first one was the kitchen icon, which was made more intuitive and matching the industrial standard. The second change was the instruction itself, which was confusing for users. The third one was the return icon made easier noticed during use. At last, a user mentioned the dominant feeling brought from the appliance, which made her uncomfortable. To improve this, I firstly explored other alternative ways, but the dot map was still the most understandable. Afterward, I added a new setting for the map to adjust the display of the map to meet the user's cleaning goal.



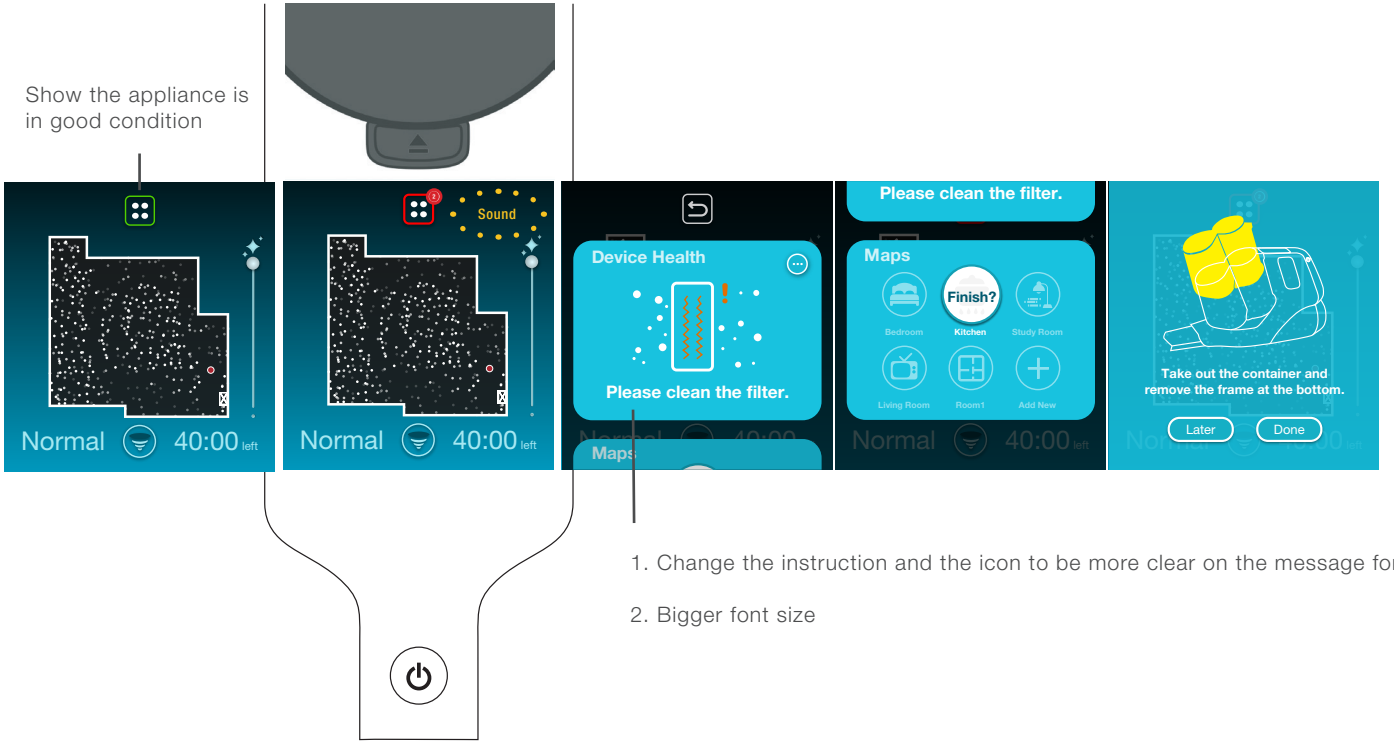
Tracking the battery condition

Few parts were changed in this task. The first one was to make the text of indicators big enough to be seen. Furthermore, the way to adjust the suction setting now can be done by tapping on the suction icon placed between the battery and suction indicator. Because of the position of this icon, using "Normal" as the name of medium suction mode was considered again because it was easier to associate with the suction mode in this situation and also in line with what Philips usually provides. At last, the icon of the insufficient battery was moved to the place where showed the suction icon.



Tracking the appliance condition

Two parts were changed in the task of tracking the appliance condition. Firstly, given half users mentioned they would like to have an indicator to know the appliance condition, even when it was good. Thus, the frame color of the menu icon was changed to green when the appliance was in good condition. Furthermore, I made the instruction itself more clear on what to do for maintenance.



1. Change the instruction and the icon to be more clear on the message for maintenance.

2. Bigger font size

Hierarchical Task Analysis

The task flow displayed below shows an overview of how the process of using the interface works from beginning to end. When the power is on, the screen will show a welcoming page first, and automatically jump to the homepage which can access to all functionalities.

To let the user be able to know the appliance condition during use, the appliance will inform the user when something goes wrong by messages in two ways. The messages are divided into two parts, based on the emergency of the events. Not emergent events will be shown as a notification, and emergent events will be displayed as a pop-up. In this diagram, the pop-up screens for emergent events are marked by the grey block, such as warning an insufficient battery. The detailed list of event classification will be provided below.

- Emergent events: The events which make the appliance unusable should immediately be resolved, called “Error” in this diagram, such as insufficient battery, roller brush is blocked, no current is being passed, wrong adapter, mechanical problem, etc..

- Not emergent events: The events do not make the appliance unusable, but influence the vacuuming experience, such as the cleanliness of filter, dust container, and brush.

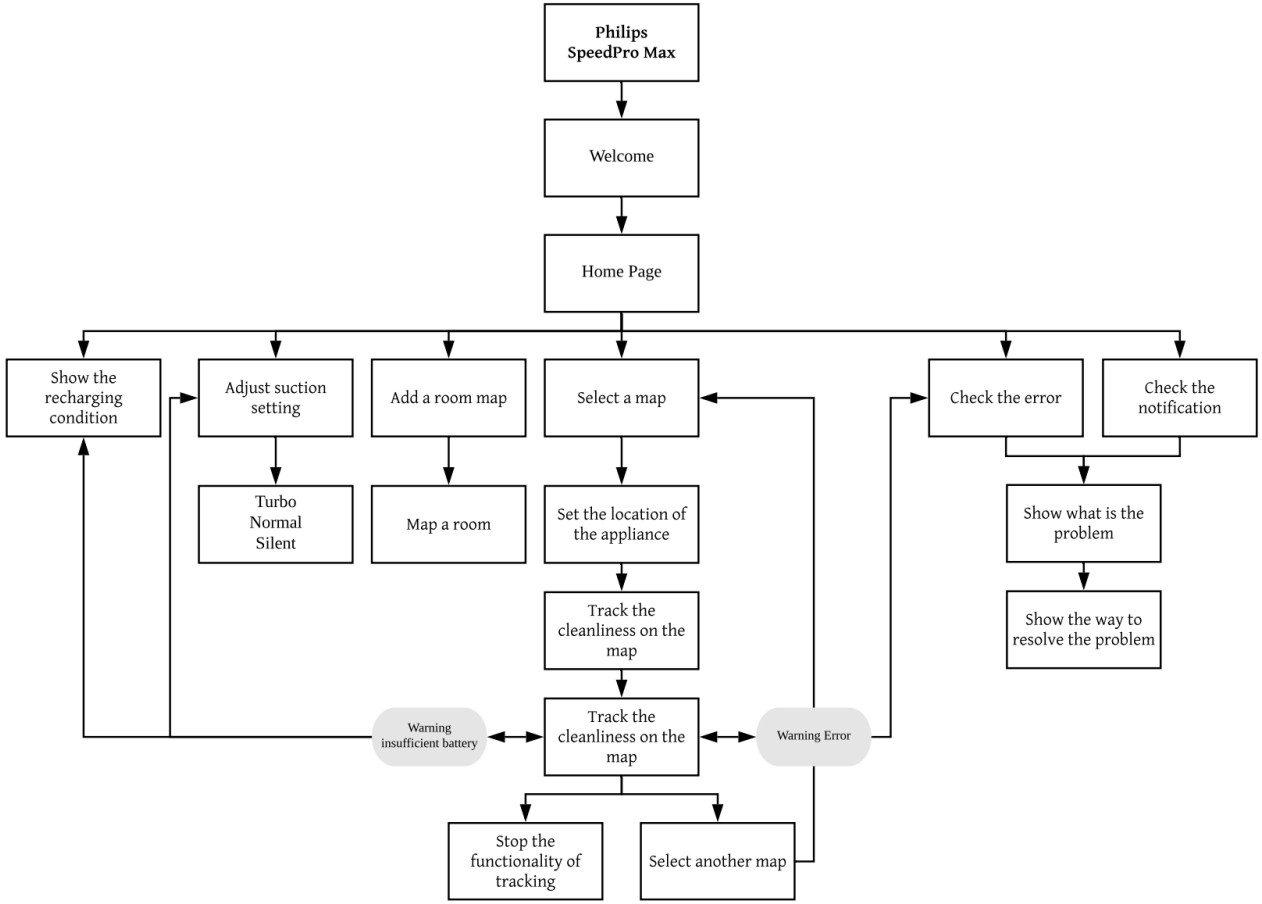


Figure 37: The Task Flow of the Final Redesign

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Evaluation & Recommendation

8.1. Evaluation

The final evaluation is to reflect on the design brief, whether the final redesign improved the original design.

The results from the analysis of the original product in Chapter 3 consisted of three main problems and a design goal. These three questions formed the base of the redesign direction. To evaluate the improvements of the final redesign, the evaluation will be elaborated, based on these questions.

Button Design

During the user test of the original product mentioned in Chapter 3, participants could not always adjust the suction setting in one time due to the slider switch of the original design. To make users more controllable, the functionality of adjusting suction setting was redesigned to be controlled by a digital controller interacted in a different way. The placement of this digital controller and the interaction was designed through careful consideration, such as how to make the user able to reach the controller without the assistance from the other hand, and adjust the suction in one step.

According to the feedback from the final user test, the redesign was made before the final user test was an improvement, but not sufficient because the suction was done in two steps, rather than one step. Now, in the final design, the suction is done by a tap on the touch screen, and the physical switch is only used to switch on/off the motor by a press. It is then further improved.

Nontechnical Language

Users were not always clear about the condition of the original appliance during use. For example, the display of the original design showed the battery in percentage terms, which might create a little gap between the user's expectation and the actual-time use because everyone had a different percentage definition about the remaining time. This was improved by showing the remaining time for replacement, which used human language to make the information more understandable. Furthermore, due to the high price of this appliance, maintenance and problem solving were seen as an important matter for users. However, the error code of the original design, such as 'E4', 'E6', 'E7', 'SE', did not mean anything to users, so they didn't know how to take action. This was improved by showing these messages in a way of notification or pop-up. During the user test, both ways (notification & pop-up) to showing the messages were appreciated by the participants.

Insufficient Instruction/Information

Without further explaining how to perform actions or proceed, users easily felt lost during use, especially while conducting complicated tasks. The use of the touch screen allowed the addition of textual and visual explanation to clarify, for example, the modes and the procedure of cleaning the filter, which was helpful for users. In the final user test, all participants appreciated the image and icons shown on the screen, which was clear and understood at a glance. However, the new functionality, mapping the room was unfamiliar for all users and still confused a few participants. This can be further improved in the future.

Design Goal

The design goal is “to allow the user to easily acknowledge the states of the appliances, and at the same time to determine the appropriate action during the daily use at home.” Given that there is a communication gap between the user’s cleaning goal and the existing ability of the appliances, the final redesign provides all the necessary information about appliance on each page with corresponding texts and icons to minimize such gap. Moreover, to be able to use the time and efforts and the limited battery of the appliance in an efficient way, the redesign provides new features that suggest the user how to clean, so that their cleaning goal can be achieved under these limitations. However, the attitude of users towards this new feature is not entirely ly positive. Few users mentioned it was helpful for the cleaning tasks, but not necessary. Next to that, they also mentioned that it was hard to imagine how it actually works without using the appliance at the same time, so I will leave this result open and recommend to validate its usefulness in the future. When I reflected on the design goal, I think it has been met. The final design shows a clear hierarchy and users are able to understand what these indicators mean, what the functions are designed for, and how they are used, which improves the communication problem from both sides.

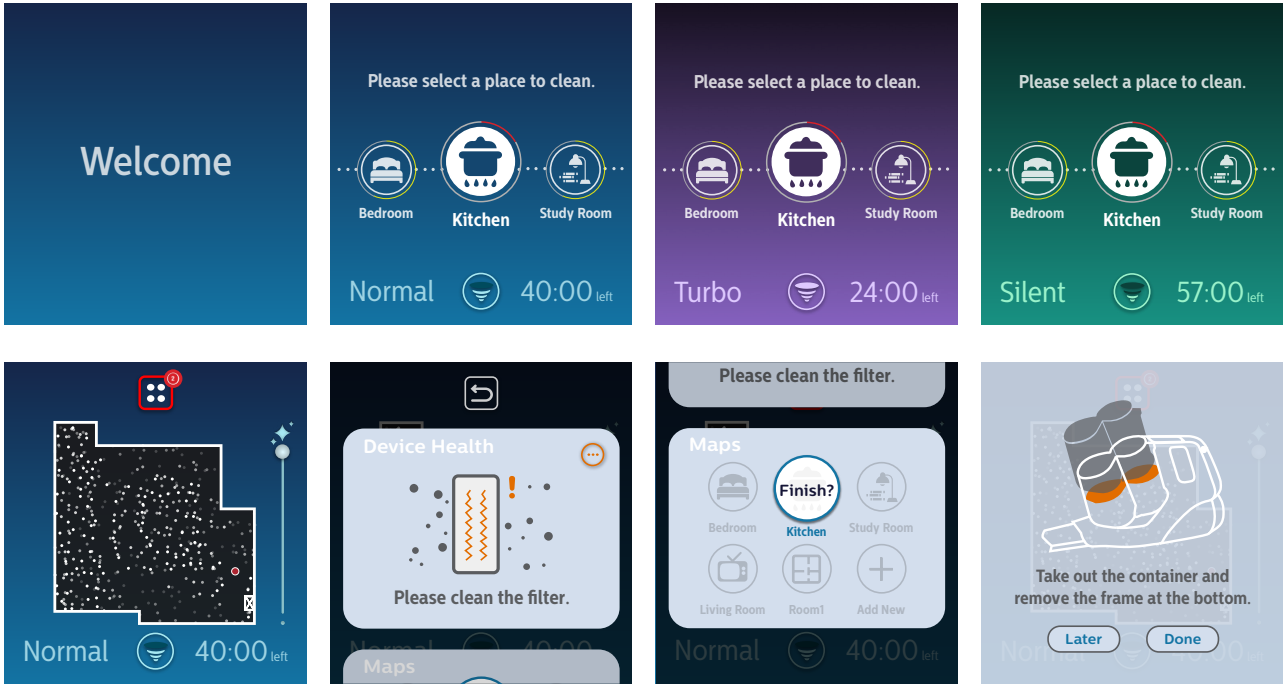
At last, Inspired by the Philips vision, enhancing workflow performance as effectively as possible through innovative technology, the final redesign convey a strong vision of where Philips could be in the future. By adding sensor and touch screen, the final redesign is able to minimize the waste in time and effort of users during the cleaning task, such as deciding where to clean before running out of battery, and changes the way of cleaning the house to meet the user’s expectation and goal.

8.2. Recommendation

During the project, few extra functions were added to the interface, but not all of them can be practically used in the ongoing project in Philips, such as mapping and tracking the cleanliness. However, some elements in the final redesign can still be used, such as the process of error warning, given that Philips focuses on the maintenance at the moment. To create further insights on the maintenance, more direction can be given into additional matters, such as whether users still have spare filters at home that they can change when it needs.

Furthermore, given that the new features of this redesign (mapping and tracking the cleanliness) may need the setting of new sensors on the appliance, it can be relevant to take the ‘cost’ factor ’ into consideration when making design decisions because this could potentially become an issue with respect to the production. Nevertheless, it is recommended to still consider implementing these features because they provide more cleaning feedback for the user.

At last, to tailorize even further the Philips experience from the interface, the icon, color, and font can be made coherent with other Philips media platform, such as the official website. The images shown on this page are examples.



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CH10

Appendix

10.1. The Outcome for the User Test of Philips SpeedPro Max

From on the user test, I have collected key insights a few at this stage of the research. The following pages show the results and insights of the tasks performed for the control panel.

Observation	Quotes
Task1: Adjusting the power setting	
+ none of the participants had trouble with switching the suction power to turbo mode. - 2 out of 3 cannot switch the suction power to the lowest setting at the first try.	“I need more attention and better proprioception while switching to the lowest mode, so that, I will not over switch and then adjust again.” “These tiny icons which indicate the suction level is hard to see in the dark.”
Task2: Tracking the battery during use	
+ Participants behave differently when they notice the battery is insufficient and reduces at a fast rate. - 3 out of 3 did not track the battery during the entire task. - 3 out of 3 were uncertain about how much time they can actually use the appliance. - 3 out of 3 did not prepare well when the appliance turned off.	“1% left!? Let’s clean it faster.” “I was shocked when the appliance shut down because I was too focusing on vacuuming.” “I like the screen shows battery, it is helpful for me to decide what to do.” “Hm…10%? I guess I can use 15 minutes, but it is only usable for 2 mins…The reason could because of the use of Turbo mode.”
Task3: Checking error of the appliance	
- 3 out of 3 did not understand the meaning of each code.	“What does this mean?” “I would probably google ‘E4 Philips SpeedPro Max’ or check the manual.” “I didn’t put the dust container well and it did not show error!? So what will be counted as an error?”
Task4: Charging the battery	
- 3 out of 3 were uncertain about how much time they need to spend on recharging. - 2 out of 3 tried to turn on the suction power when the appliance connected with cable charger. - 1 out of 3 did not connect the appliance to the charger properly on the first try.	“I assumed I put there for recharging 1 hrs, it will have 20%, rather than 10%” “Um? It did not work with cable?” “Oh, I did not find that the magnetic part did not successfully connect with the appliance.”

10.2. Questionnaire for User Journey

User Journey in Cordless Vacuum Cleaner

Hello!
This survey is about your experience of using vacuum cleaning to clean the house.
The questionnaire divides the entire cleaning process into four phases to conduct.

Q0. How old are you?

○ 21~30 ○ 31~40 ○ 41~50 ○ 51~60

1st Phase - Motivation

This phase is about the moment of knowing you need to clean the house.

Get cleaning awareness through routine or incidents

Q1.1. What makes you feel good in this phase?

- ○ A. Nice-looking room makes my day happy
- ○ B. Regular cleaning makes the next cleaning easier and faster
- ○ C. Being healthier
- ○ D. Nice-looking for visitors
- ○ E. Nothing I can think of
- ○ F. Others _____

Q1.2 The importance of these items is...

Please make the priority on the items you only chose on the last question.
List out from the MOST important to NOT important.

A. Nice-looking room makes my day happy

B. Regular cleaning makes the next cleaning easier and faster

C. Be healthier

D. Nice-looking for visitors

E. Others (The Item you added on the last question.)

Q1.3 What hinder you doing cleaning tasks at home?

- ○ A. Busy makes the task processed with lower priority
- ○ B. Cleaning is not a flattering task
- ○ C. Nothing I can think of
- ○ D. Others _____

Q1.4 The severity of influence is...

Please make the priority on the items you only chose on the last question.
List out from the MOST serious to NOT serious.

A. Busy makes the task processed with lower priority

B. Cleaning is not a flattering task

C. Others (The Item you added on the last question.)

2nd Phase - Preparation

This phase is about getting ready for the cleaning task.

Checking the appliance state | Attaching components | Choosing a proper brush | Making a to-do list

Q2.1 What makes you feel good in this phase?

- ○ A. A feasible plan really fits my expectation and schedule
- ○ B. Nothing I can think of
- ○ C. Others _____

Q2.2 What makes you feel "NOT" so good in this phase?

- ○ A. Find out battery life cannot last until finishing the cleaning task
- ○ B. Heavy components bring inconvenience while attaching
- ○ C. Too many components makes task complicated
- ○ D. Think a proper cleaning distribution
- ○ E. Nothing I can think of
- ○ F. Others _____

Q2.3 The severity of influence is...

Please make the priority on the items you only chose on the last question.
List out from the MOST serious to NOT serious.

A. Find out battery life cannot last until finishing the cleaning task.

B. Heavy components bring inconvenience while attaching.

C. Too many components makes task complicated.

D. Think a proper cleaning distribution

E. Others (The Item you added on the last question.)

3rd Phase - Use

This phase is about using vacuum cleaner.

Choosing power setting | Switching on the power | Vacuuming around | Reaching as detailed as it can | Switching brushes

Q3.1 What makes you feel good in this phase?

- ○ A. I see dusts sucked into the machine and found they are gone
- ○ B. Nothing I can think of
- ○ C. Others _____

Q3.2 What makes you feel "NOT" so good in this phase?

- ○ A. Too much noise from the strongest power mode
- ○ B. The noise from the appliance sounds different from the past
- ○ C. Maneuver the obstacles
- ○ D. Hitting fragile objects
- ○ E. Suddenly shut down with unknown reason
- ○ F. Out of power without notice
- ○ G. Hairs are stuck on the brush
- ○ H. Components are loose
- ○ I. Too many components makes task complicated
- ○ J. Nothing I can think of
- ○ H. Others _____

Q3.3 The severity of influence is...

Please make the priority on the items you only chose on the last question.
List out from the MOST serious to NOT serious.

A. Too much noise from the strongest power mode

B. The noise from machine sounds different from the past.

C. Maneuver the obstacles

D. Hitting fragile objects

E. Suddenly shut down with unknown reason

F. Out of power without notice

G. Hairs are stuck on the brush

H. Component is loose

I. Too many components makes task complicated

J. Others (The Item you added on the last question.)

4th Phase - Finish

This phase is mainly about making everything go back to its original place.

Check the result | Clean dust bucket and brush | Return obstacles to the original place | Check battery life and recharge | Store the product | Clean ourselves

Q4.1 What makes you feel good in this phase?

- ○ A. The cleaning task is done.
- ○ B. Nothing I can think of
- ○ C. Others _____

Q4.2 What makes you feel "NOT" so good in this phase?

- ○ A. While cleaning components, dusts spread around
- ○ B. Maneuver the obstacles
- ○ C. Nothing I can think of
- ○ D. Others _____

Q4.3 The severity of influence is...

Please make the priority on the items you only chose on the last question.
List out from the MOST serious to NOT serious.

A. While cleaning components, dusts spread around

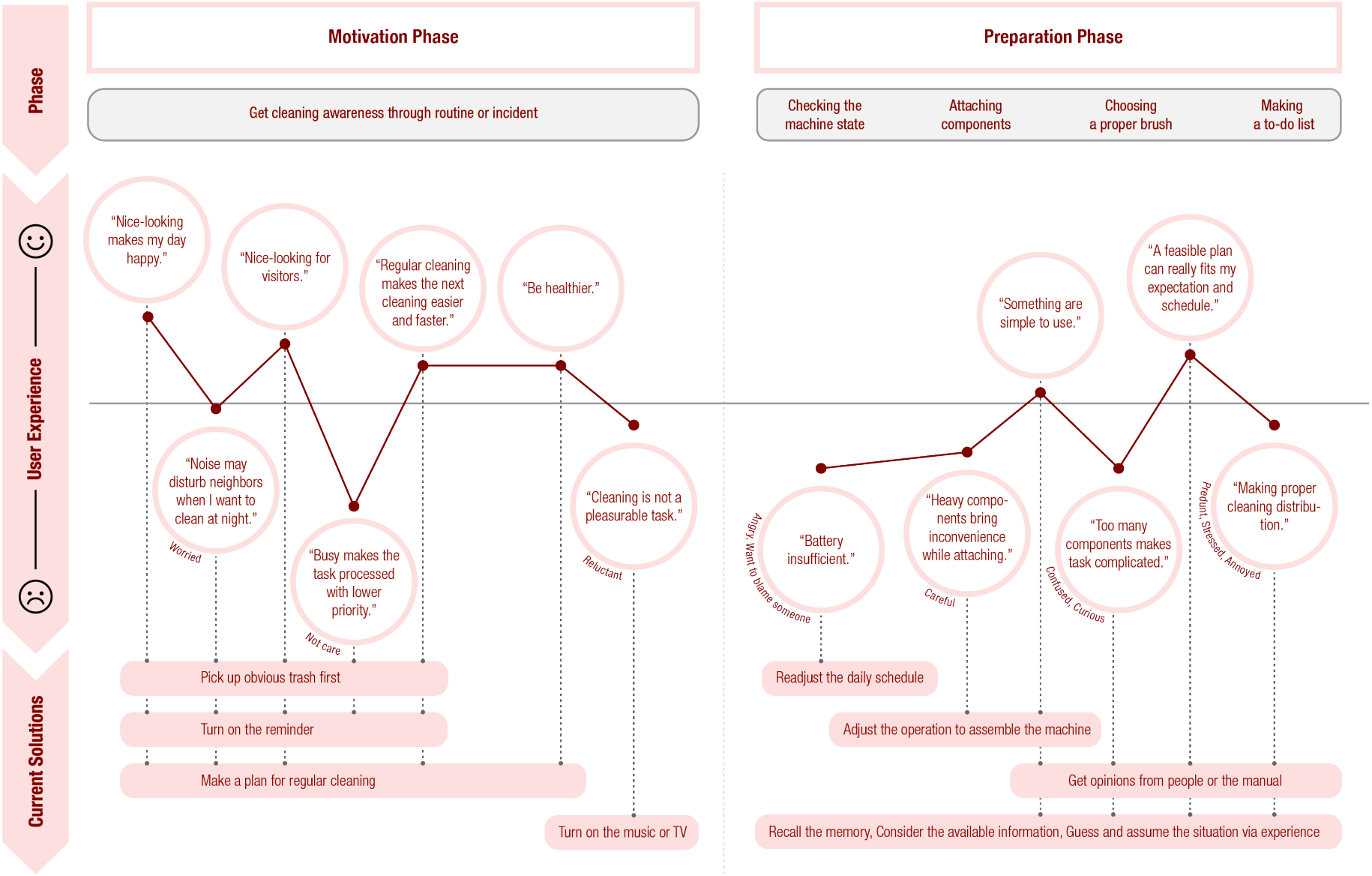
B. Maneuver the obstacles

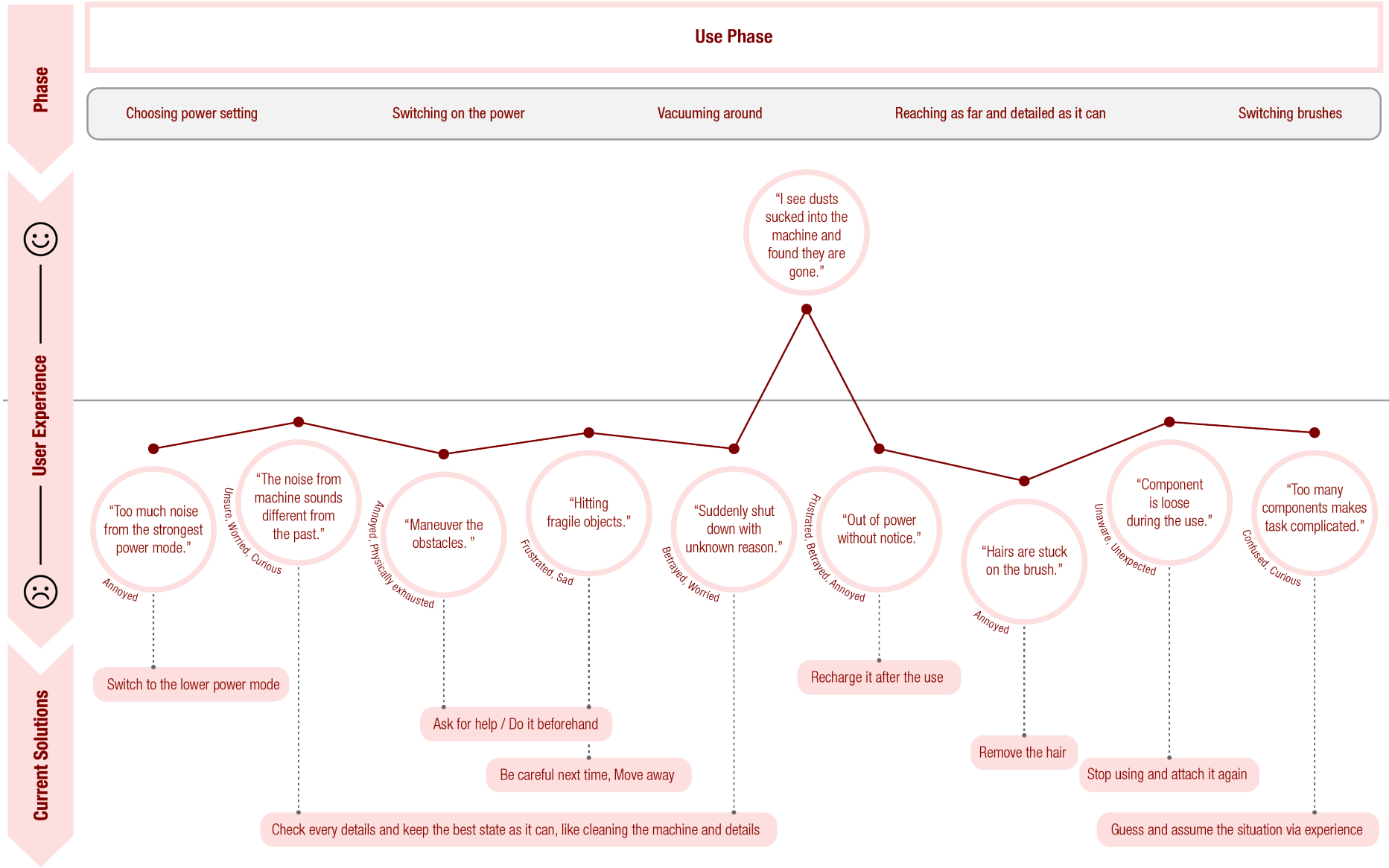
C. Others (The Item you added on the last question.)

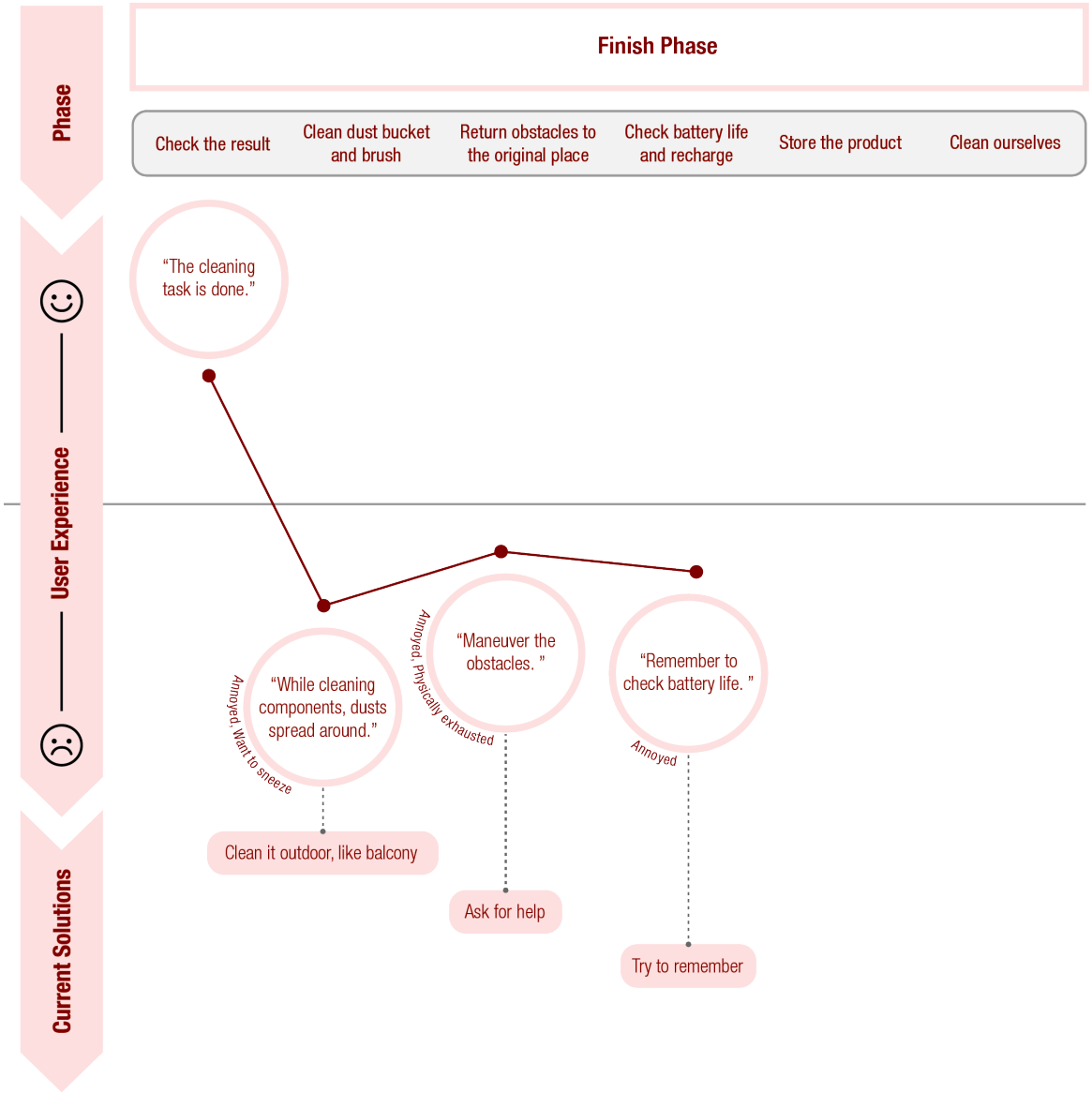
Completed!

Thanks for your time and effort in completing this questionnaire!

10.3. Questionnaire for User Journey




Phase
User Experience
Current Solutions
Use Phase
Choosing power setting
Switching on the power
Vacuuming around
Reaching as far and detailed as it can
Switching brushes
"I see dusts sucked into the machine and found they are gone."
"Too much noise from the strongest power mode."
Annoyed
"The noise from machine sounds different from the past."
Unsure, Worried, Curious
"Maneuver the obstacles. "
Annoyed, Physically exhausted
"Hitting fragile objects."
Frustrated, Sad
"Suddenly shut down with unknown reason."
Betrayed, Worried
"Out of power without notice."
Frustrated, Betrayed, Annoyed
"Hairs are stuck on the brush."
Annoyed
"Component is loose during the use."
Unaware, Unexpected
"Too many components makes task complicated."
Confused, Curious
Switch to the lower power mode
Check every details and keep the best state as it can, like cleaning the machine and details
Ask for help / Do it beforehand
Be careful next time, Move away
Recharge it after the use
Remove the hair
Stop using and attach it again
Guess and assume the situation via experience


Phase
User Experience
Current Solutions
Finish Phase
Check the result
Clean dust bucket and brush
Return obstacles to the original place
Check battery life and recharge
Store the product
Clean ourselves
"The cleaning task is done."
"While cleaning components, dusts spread around."
Annoyed, Want to sneeze
"Maneuver the obstacles. "
Annoyed, Physically exhausted
"Remember to check battery life. "
Annoyed
Clean it outdoor, like balcony
Ask for help
Try to remember

10.4. The Outcome for the Concept 1 Testing

Observation	Quotes
Task1: Mapping the room shape	
(A-) 4/4 Comparing with the actual room shape and everyone's manual drawing, they showed the difference.	(C-) "I assumed my room was supposed to be like a square, rather than a rectangle." (C-) "I miss this furniture in my drawing." (C-) "There is not enough space to include the furniture in this room shape. I limited myself."
Task2: Tracking cleanliness condition	
(A+) 4/4 could recognize the dots represented the level of dirtiness.	(A+, E+) "I understand clearly what the dots and the gradient colors mean. Whiter dots means more dust, right? I will mainly focus on cleaning that part." (D+) "The appliance is able to keep track of where I have already cleaned." (D-) "When I finished cleaning and clicked 'Done', nothing really happened, which gave me less of a feeling of achievement."
Task3: Tracking battery life	
(B+) 4/4 recognized the remaining time of use in the current suction mode. (B-) 2/4 could not recognize the appliance would be out of battery soon. (F-) 4/4 were unsure where the switch of suction modes was. (A-) 2/4 The overview of battery condition is confusing and 1/4 is able to understand it by herself.	(C+) "It is nice to see the battery status on the home page." (B-) "I didn't directly understand when it was out of battery, it showed blue color, rather than red." (F-) "I did not immediately know where to switch the mode." (A-) "What is this graph indicating? I just know blue means the remaining time of the current suction mode."
Task4: Tracking appliance condition	
(B+) 4/4 recognized the warning when it appeared. (B+, E+) 3/4 knew what the problem was and how to solve it. (F-) 2/4 showed that they payed more attention to reading the instructions.	(A+) "It is like APP warning " (A+) "The error with numbers is easy to understand." (E+, F+) "It is clear and easier to follow the sign." (B-, E-) "I'm bad on mechanical stuff, so I need more details about how to remove the filter and put on a new one." (B+, F-) " The instruction is short and clear but the font size of instruction is too small."
Task5: Tracking recharging condition	
(C+) 3/4 knew the appliance was being charged.	(C+) "I know it means it will take 50 minutes to charge."

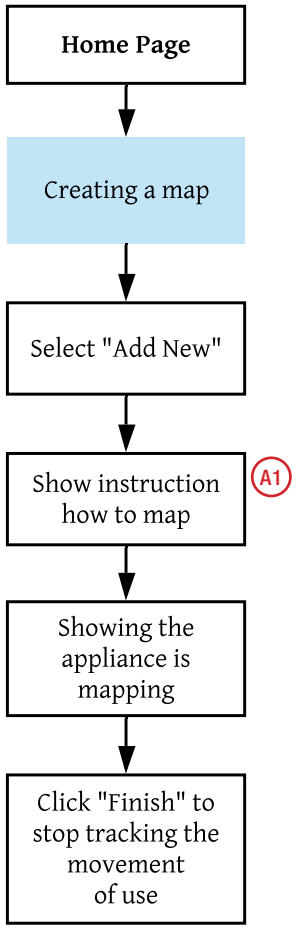
A=Supported, B=Confidence, D=In control, E=Involved, F=Guided, G=Easy

10.5. The Outcome for the Concept 2 Testing

Observation	Quotes
Task1: Mapping the room shape	
(D+) 3/4 They showed their interest in knowing what their room shape actually looks like.	(D+) “Drawing by the appliance is faster and more accurate because the appliance was adjusting to space’s irregularities.”
Task2: Tracking cleanliness condition	
(D+) 2/4 They are interested that they are engaged in this game-like map, like a player in a game. (A+) 3/4 could recognize that the dots represented the level of dirtiness. (A-) 3/4 could not recognize the meaning of the star icons.	(A+, D+) “Interesting. I will collect as many as I can.” (A+) “It is more efficient if the appliance is able to keep track of where the dirt is.” (A-) “I guess the star icons mean how clean my room is?”
Task3: Tracking battery life	
(B+) 3/4 recognized the remaining time of use in the current suction mode. (B+) 3/4 recognized the appliance might be out of battery soon. (F-) 4/4 were unsure about where to switch the suction mode and even did not perceive it, so that, they could not see the remaining time of use is different in each mode.	(C+) “The appliance is able to work for another 35 mins. ” (B+, F+) “A clear warning about the appliance: will shut down in 5 mins. ” (A-) “I guess the red circle means the charging time?” (F-) “I guess I can switch the suction settings here? It is not super clear how to change it.”
Task4: Tracking appliance condition	
(B+) 4/4 recognized the warning when it appeared. (B+, E+) 4/4 knew what the problem was and how to solve it.	(B+) “I saw this warning, so I will click here to look into it.” (E+) “The physical image associated with the problem.” (B-, E-) “I’m bad with mechanical stuff, so I still don’t know the detailed procedure on how to remove the filter and put on a new one.”
Task5: Tracking recharging condition	
(C+) 4/4 recognized the appliance was being charged.	(C+) “I know it is recharging.”

A=Supported, B=Confidence, D=In control, E=Involved, F=Guided, G=Easy

10.6. Feedbacks from the 1st Iteration



Task A

Problem

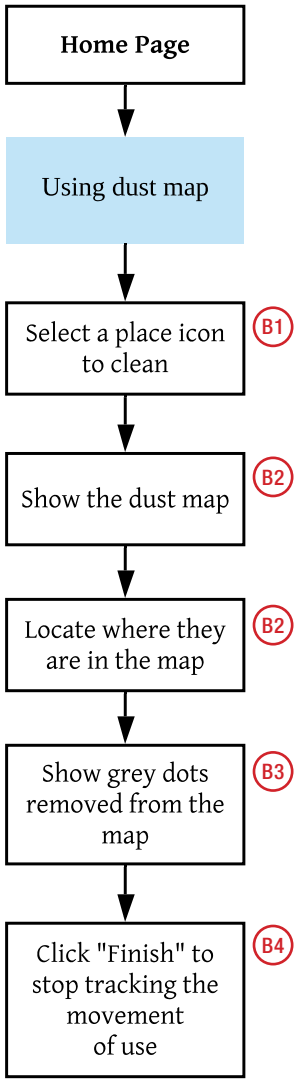
A1. People did not know how and why they do mapping. (4/4)

"I don't know why I have to vacuum from the entrance."

"I thought it could start mapping anywhere in the room."

Brief Conclusion

In the functionality ‘mapping’, it is still unclear the purpose to map and where is the start point, which is the focal point of this task. The instruction does not elaborate well to tell users how to do. Also, due to the long sentence of instruction, users cannot immediately catch the keywords.



Task B

Problem

B1. People were confused about the indicator which is to show the level of cleanliness. (4/4)

"I saw these points, but I was not sure what it indicated."

B2. People did not perceive there were some instructions at the bottom. (4/4)

"The font size is too small. I think it should be obvious to grab my attention if they are important message."

B3. People did not know they could get information underneath the bottom bar. (4/4)

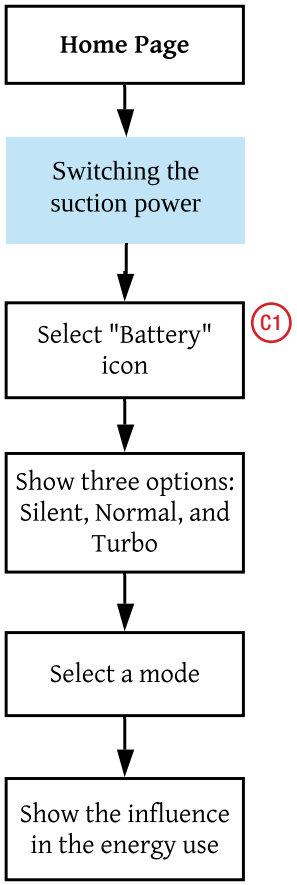
"I thought it was only for pages can be slid."

B4. Users took extra steps to stop tracking the movement of use. (4/4)

"When I want to finish vacuuming, I have to click the "Map" icon and then click the "Done". It's not intuitive.

Brief Conclusion

The usability of the application is still not desirable enough because the user interface is not yet intuitively designed that it guides the user successfully to know what they can/should do.



Task C

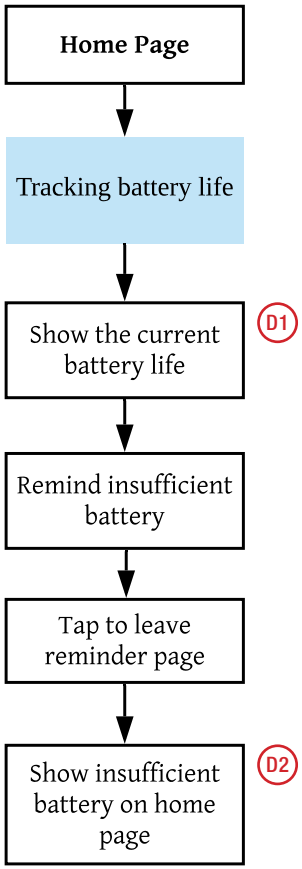
Problem

C1. The battery icon was hard to associate with suction power setting. (4/4)

"Hmm...yes I will try to click here to find out suction power setting, but it's a weird connection."

Brief Conclusion

Without enough text to explain the icon, it makes users confused. Besides, only fewer people can make an association between energy consumption and suction power. Both reasons make the task harder.



Task D

Problem

D1. The time which showed on battery icon was confused. (2/4)

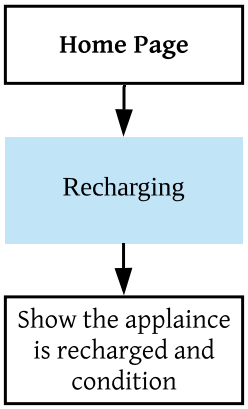
"I thought it meant fully cleaning the kitchenl took 40 minutes."

D2. The background color of the battery icon was confused when it was out of battery. (2/4)

"The blue background color is still presented while the appliance will be out of battery soon, which is a bit weird."

Brief Conclusion

Using different colors to represent each suction mode should be carefully considered, especially when there is not enough explanation on the icon, which easily confuses users. This battery icon also conveys battery information, so the meaning of color will be different from the point of battery.



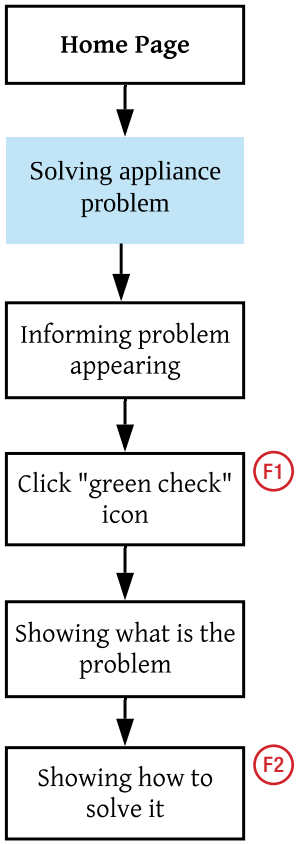
Task E

Problem

No complaints.

Brief Conclusion

During the test, users are able to complete the task without any assistance.



Task F

Problem

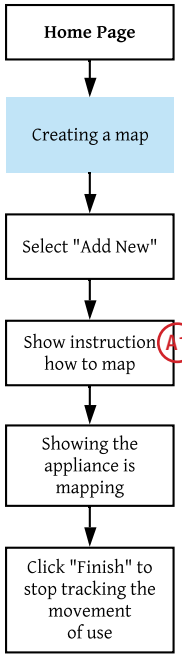
F1. The meaning of green icon was unclear. (4/4)
"I assumed it meant the level of cleanliness in this room. Also, when I finished vacuuming, I wanted to click this icon."

F2. People did not know they could get information from the bottom bar. (4/4)
"I will call this message again from the status icon, rather than the bar at the bottom."

Brief Conclusion

Most users did not have much complaints about task F. The green icon is the main problem on the user interface design which is not intuitive enough for the target group. The problem of bottom bar still appears.

10.7. Feedbacks from the 2nd Iteration



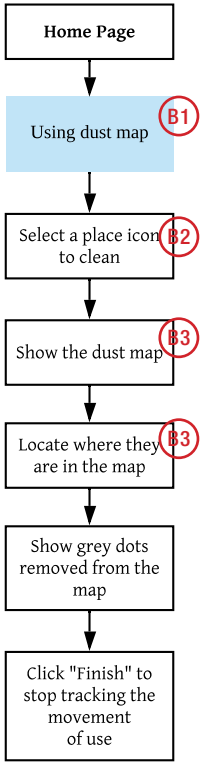
Task A

Problem

A1. People did not know how to exactly map at the first-time use. (4/4)
"I don't know the way of mapping is like drawing a frame or painting the area."

Brief Conclusion

Mapping is important in this task, but users have no idea how to map without further information.



Task B

Problem

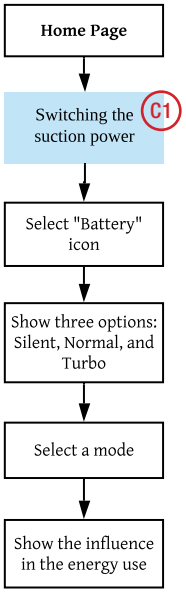
B1. Inappropriate setting to access the map menu. (2/4)
"I do not know why the "Welcome" can be as a button to enter in the map menu."

B2. People were still confused about the indicator which is to show the level of cleanliness (4/4)
"I didn't notice there is an indicator with five blue dots, but what does it mean?"

B3. People still did not perceive there were some instructions at the bottom. (4/4)
"I am used to ignoring the message at the bottom and the text is too small to grab my attention."

Brief Conclusion

Enlarging the font size and providing more instruction enhance the usability of the application. However, it still has some space for improvement, such as icon design and how to deal with too much information presented at the same time.



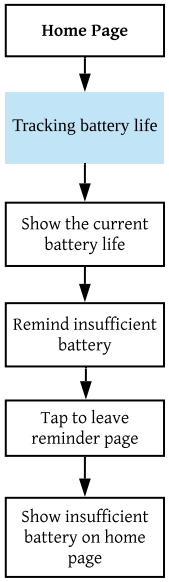
Task C

Problem

C1. The use of words to represent the suction mode is confusing. (4/4)
"Hmm...I am not sure what the word, Normal, refer to here. It can be interpreted from the point of the level of cleanliness."

Brief Conclusion

To keep the layout of the screen simple, only the keywords are presented on the screen. However, the words choosing is important, so that users are able to associate with.



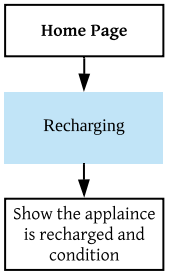
Task D

Problem

No complaints.

Brief Conclusion

Placing a word "left" next to the usable time, which make it clear that it means battery life.



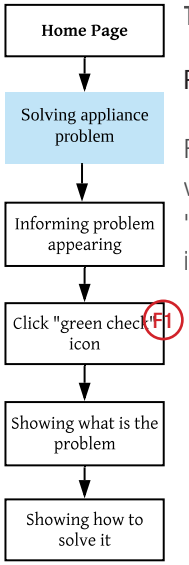
Task E

Problem

No complaints.

Brief Conclusion

During the test, users are able to complete the task without any assistance.



Task F

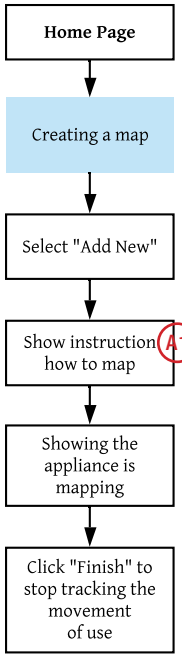
Problem

F1. The meaning of green icon was unclear. (4/4)
"I am not sure what kind of condition it refers to."

Brief Conclusion

When the keyword is unclear, only showing an icon cannot precisely convey what it indicates. More instruction to explain could solve this situation.

10.8. Feedbacks from the 3rd Iteration



Task A

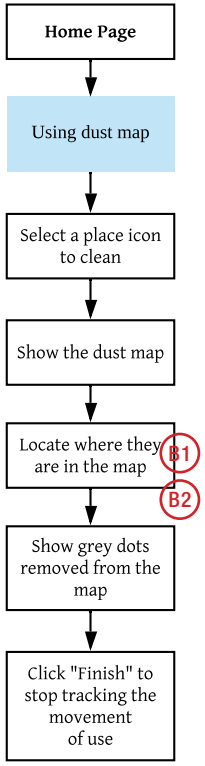
Problem

A1. People had better a understanding of how to exactly map at the first-time use, but still took a while to understand it. (2/4)

"It's clear on instruction, but it could be more infographic."

Brief Conclusion

Whether the user is able to map, which more depends on the user's character. Some people have more patience to read instructions, and others like to have some icon or images to guide them without thinking.



Task B

Problem

B1. Some people still did not perceive instructions at the bottom. (2/4)

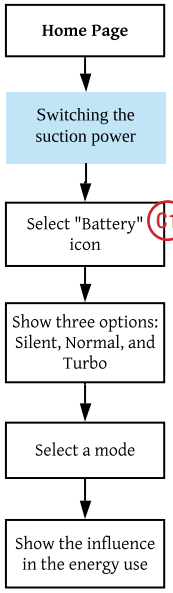
"I saw it after you reminded me to look around."

B2. The yellow color used on the icon of entrance confused users. (3/4)

"I assumed yellow here had already shown where I am, so I didn't need to locate anymore."

Brief Conclusion

The yellow color used on the icon makes the entrance special, so it misleads the user. The darker background contrast



Task C

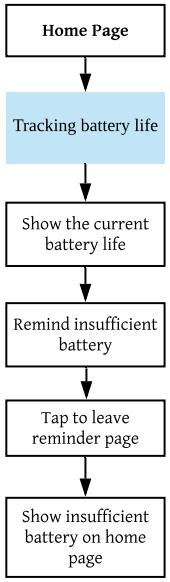
Problem

C1. They doubted where to access the suction setting is for the first time. (4/4)

"Hmm...I guess it's here?"

Brief Conclusion

Users are unsure about where is the right way to access the suction setting at the first-time use, but they can find it. After the first try, users are able to remember where is the setting.



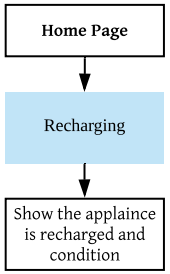
Task D

Problem

No complaints.

Brief Conclusion

The battery indicator is seldom seen as the cleaning time needed for this place.



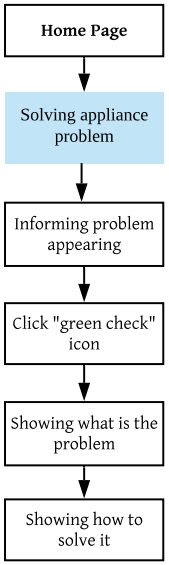
Task E

Problem

No complaints.

Brief Conclusion

During the test, users are able to complete the task without any assistance.



Task F

Problem

No complaints.

Brief Conclusion

During the test, users are able to complete the task without any assistance.

IDE Master Graduation

Project team, Procedural checks and personal Project brief

This document contains the agreements made between student and supervisory team about the student's IDE Master Graduation Project. This document can also include the involvement of an external organisation, however, it does not cover any legal employment relationship that the student and the client (might) agree upon. Next to that, this document facilitates the required procedural checks. In this document:

- The student defines the team, what he/she is going to do/deliver and how that will come about.
- SSC E&SA (Shared Service Center, Education & Student Affairs) reports on the student's registration and study progress.
- IDE's Board of Examiners confirms if the student is allowed to start the Graduation Project.

USE ADOBE ACROBAT READER TO OPEN, EDIT AND SAVE THIS DOCUMENT

Download again and reopen in case you tried other software, such as Preview (Mac) or a webbrowser.

STUDENT DATA & MASTER PROGRAMME

Save this form according the format "IDE Master Graduation Project Brief_familyname_firstname_studentnumber_dd-mm-yyyy".
Complete all blue parts of the form and include the approved Project Brief in your Graduation Report as Appendix 1 !

family name	Chen
initials	Y
given name	Ying-Ju
student number	4715357
street & no.	Lisztstraat 44 k1
zipcode & city	2625 BK, Delft
country	The Netherlands
phone	+31619492931
email	irene80604@gmail.com

Your master programme (only select the options that apply to you):

IDE master(s):	IPD ★ DfI SPD
2nd non-IDE master:	
individual programme:	- - (give date of approval)
honours programme:	Honours Programme Master
specialisation / annotation:	Medisign
	Tech. in Sustainable Design
	Entrepeneurship

SUPERVISORY TEAM **

Fill in the required data for the supervisory team members. Please check the instructions on the right !

** chair	René van Egmond	dept. / section:	HICD
** mentor	Ianus Keller	dept. / section:	DCC
2nd mentor	Loek Canton		
organisation:	Philips Consumer Lifestyle		
city:	Drachten	country:	The Netherlands
comments (optional)			

Chair should request the IDE Board of Examiners for approval of a non-IDE mentor, including a motivation letter and c.v..

Second mentor only applies in case the assignment is hosted by an external organisation.

Ensure a heterogeneous team. In case you wish to include two team members from the same section, please explain why.

Procedural Checks - IDE Master Graduation

APPROVAL PROJECT BRIEF

To be filled in by the chair of the supervisory team.

chair René van Egmond date 18 - 03 - 2019 signature

CHECK STUDY PROGRESS

To be filled in by the SSC E&SA (Shared Service Center, Education & Student Affairs), after approval of the project brief by the Chair.
The study progress will be checked for a 2nd time just before the green light meeting.

Master electives no. of EC accumulated in total: EC

Of which, taking the conditional requirements into account, can be part of the exam programme EC

List of electives obtained before the third semester without approval of the BoE

YES all 1st year master courses passed

NO missing 1st year master courses are:

name date - - signature

FORMAL APPROVAL GRADUATION PROJECT

To be filled in by the Board of Examiners of IDE TU Delft. Please check the supervisory team and study the parts of the brief marked **.
Next, please assess, (dis)approve and sign this Project Brief, by using the criteria below.

- Does the project fit within the (MSc)-programme of the student (taking into account, if described, the activities done next to the obligatory MSc specific courses)?
- Is the level of the project challenging enough for a MSc IDE graduating student?
- Is the project expected to be doable within 100 working days/20 weeks ?
- Does the composition of the supervisory team comply with the regulations and fit the assignment ?

Content: APPROVED NOT APPROVED

Procedure: APPROVED NOT APPROVED

comments

name date - - signature

Initials & Name Y Ying-Ju Chen Student number 4715357

Title of Project Designing a smart user feedback system for vacuum cleaners

Personal Project Brief - IDE Master Graduation

TU Delft

Designing a smart user feedback system for vacuum cleaners

project title

Please state the title of your graduation project (above) and the start date and end date (below). Keep the title compact and simple. Do not use abbreviations. The remainder of this document allows you to define and clarify your graduation project.

start date 18 - 03 - 2019

05 - 08 - 2019 end date

INTRODUCTION **

Please describe, the context of your project, and address the main stakeholders (interests) within this context in a concise yet complete manner. Who are involved, what do they value and how do they currently operate within the given context? What are the main opportunities and limitations you are currently aware of (cultural- and social norms, resources (time, money,...), technology, ...).

The vacuum cleaner is one of the most indispensable appliances in a typical household. It is essential for people to accomplish cleaning tasks and therefore it is also seen as one of the “normal” interactions at home (Pierce, 2010). Empowered by technological advancement, the design of a vacuum cleaner transforms from wired to wireless which enables the user to have the freedom of movement without restriction of the power cord and further enhances the convenience as well as comfort level during use. However, the battery capacity for the wireless machine is limited. For frequent users, such as people who have a larger surface area at home and pet owners, the rundown of the battery is always annoying. Therefore, it has become an important and inevitable issue that we have to use the minimum resource to gain maximum efficiency (Pierce, 2010).

Make people’s lives better through innovation is what Philips pursues in the whole product development process. The floor care team at Philips which focuses on the innovation of domestic appliances would like to make ordinary devices, such as vacuum cleaners, to be smart enough to correctly adjust the context-related information and suggest the user how to achieve maximum efficiency of given tasks under limited battery power. This goal may be achieved through integrating the latest technology, like sensor technology, IoT, or machine learning. For instance, June Oven is a good example of integrating IoT which connects the user and the oven through a network to let both of them be able to "talk" to each other, and can also be remotely controlled by the user. Through this integration, it not only saves our time and cost of electricity bill but also gives us a satisfying outcome, a well-cooked meal. Thus, Philips would like to optimize the user’s workflow in vacuuming through the latest technology so that more tasks can be efficiently completed under the same amount of battery power. The project will mainly focus on the market in Germany where the household sector is one with the fastest growing (Fisher, 2008).

space available for images / figures on next page

Initials & Name	Y	Ying-Ju Chen	Student number	4715357
Title of Project	Designing a smart user feedback system for vacuum cleaners			

introduction (continued): space for images

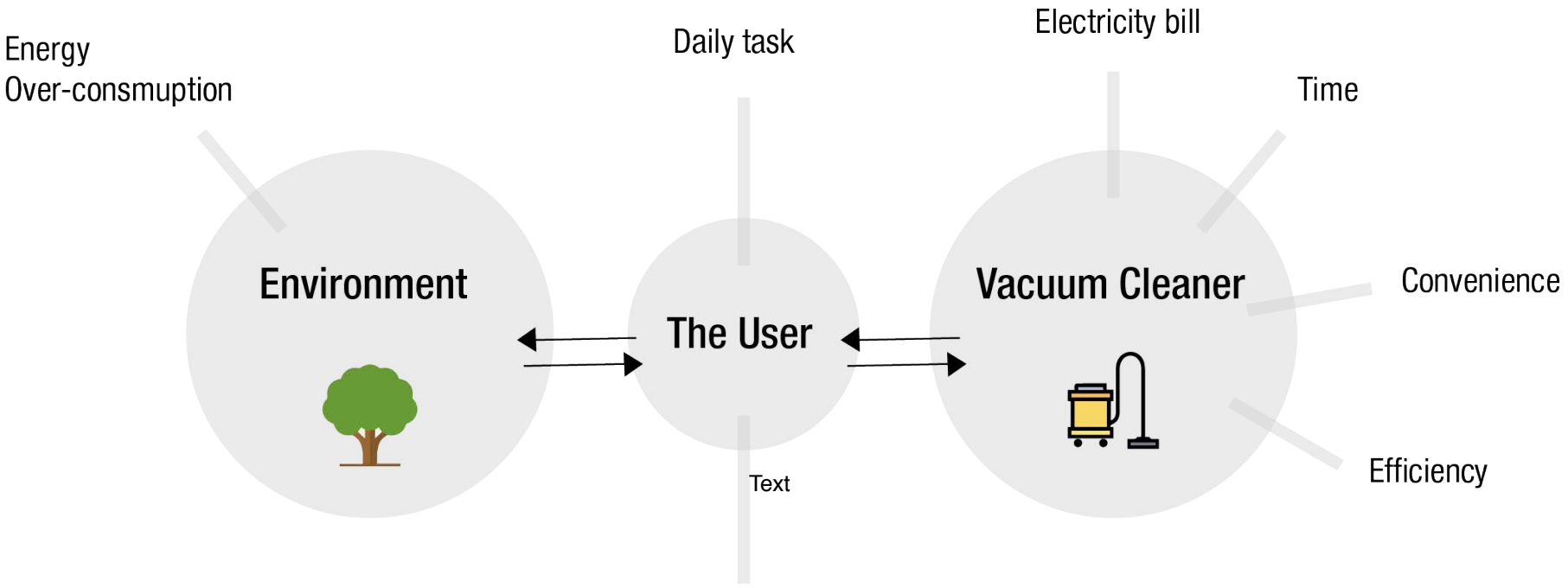


image / figure 1: The concerns of the user, product, the environment

image / figure 2: The existing products and potential direction on redesigning the UI of vacuum cleaner

Initials & Name	Y	Ying-Ju Chen	Student number	4715357
Title of Project	Designing a smart user feedback system for vacuum cleaners			

Personal Project Brief - IDE Master Graduation

PROBLEM DEFINITION **

Limit and define the scope and solution space of your project to one that is manageable within one Master Graduation Project of 30 EC (= 20 full time weeks or 100 working days) and clearly indicate what issue(s) should be addressed in this project.

The biggest problem with the cordless vacuum cleaner is the limit in battery life, as well as the possibility of the loss of power during the usage. Even with the lowest power consumption setting during the whole vacuuming process, the battery can only last for a maximum of one hour and the vacuum quality is questionable. Fully charging the battery is an extremely time-consuming task. Thus, people start to look for alternative ways to solve this problem, like buying a second vacuum cleaner or spare batteries to be switch during vacuuming process, and keeping charging the battery at all the time for stand by. However, these extra behaviors cause additional new environmental issues. It leads to questions, " How to prevent the rise of the new environmental problems without negatively affecting our "normal" domestic interaction? " and " How can we optimize the workflow of vacuum under limited battery life so that we can save not only our time as well as money from monthly electricity bills but also our only one planet, the Earth? ".

ASSIGNMENT **

State in 2 or 3 sentences what you are going to research, design, create and / or generate, that will solve (part of) the issue(s) pointed out in "problem definition". Then illustrate this assignment by indicating what kind of solution you expect and / or aim to deliver, for instance: a product, a product-service combination, a strategy illustrated through product or product-service combination ideas, ... In case of a Specialisation and/or Annotation, make sure the assignment reflects this/these.

The main goal is to redesign UI of the Philips vacuum cleaner to optimize the user's workflow before, during and after vacuuming.

1. Make consumption, like energy, visible to inspire the users to reflect on their use of resources and take responsibility.

2. Inform users clearly about what they are doing and to assist the users to make proper decisions based on their needs.

3. Act automatically based on environmental or social benefits without raising awareness affecting user behavior.

Initials & Name	Y	Ying-Ju Chen	Student number	4715357
Title of Project	Designing a smart user feedback system for vacuum cleaners			

PLANNING AND APPROACH **

Include a Gantt Chart (replace the example below - more examples can be found in Manual 2) that shows the different phases of your project, deliverables you have in mind, meetings, and how you plan to spend your time. Please note that all activities should fit within the given net time of 30 EC = 20 full time weeks or 100 working days, and your planning should include a kick-off meeting, mid-term meeting, green light meeting and graduation ceremony. Illustrate your Gantt Chart by, for instance, explaining your approach, and please indicate periods of part-time activities and/or periods of not spending time on your graduation project, if any, for instance because of holidays or parallel activities.

start date 18 - 03 - 2019

05 - 08 - 2019 end date

PROJECT WEEK		TIME	LITERATURE STUDY	ANALYZE EXISTING PRODUCT/ SAMPLE	USER RESEARCH	IDEATION	FINAL CONCEPT	1ST PROTOTYPE & USER TEST	2ND PROTOTYPE & USER TEST	FINAL DESIGN	FINALIZE REPORT
1		2019-03-18									
2		2019-03-25									
3		2019-04-01									
4		2019-04-08									
5		2019-04-15									
6		2019-04-22									
7		2019-04-29									
8		2019-05-06									
9		2019-05-13									
10	Midterm	2019-05-20									
11		2019-05-27									
12		2019-06-03									
13		2019-06-10									
14		2019-06-17									
15		2019-06-24									
16		2019-07-01									
17	Green Light	2019-07-08									
18		2019-07-15									
19		2019-07-22									
20		2019-07-29									
21	Defense	2019-08-05									

The project is divided into two cycles: Exploration and Refinement
1st Cycle: Exploration (10 wks)
1) Literature study: Review previous researches around this topic, like the interaction between sensor technology and the user with feedback systems and how the user thinks about the sustainable product.
2) Analyzing the sample and similar product: Look at the build-up, hierarchical task analysis, and the user flow. List out the pros and cons of each case, and possible elements that can be applied in the feedback systems.
3) Perform user research: To explore people's motivation and workflow to use a vacuum cleaner, like which is seen as an important point to them during operation.What kind of information they would like to obtain when the machine is in the operational state. How they normally operate the machine and what kind of troubles they have experienced.
4) Ideation: To explore the ideas. Some sketch and simple prototypes will be made to gain insights through the user's feedback.
2nd Cycle: Refinement (10 wks)
- The first concept will be designed according to the research, and evaluate among the target group. The goal of the user test is to measure the usability of the interface itself, explore the value people obtain from the new feedback system setting, and people's experience when they operate the vacuum cleaner through sensory technology.
- The renewed concept will be modified based on the first user test, mainly on the interface and its value.
- The final design will be performed based on the previous insight and evaluation.

Initials & Name	Y	Ying-Ju Chen	Student number	4715357
Title of Project	Designing a smart user feedback system for vacuum cleaners			

MOTIVATION AND PERSONAL AMBITIONS

Explain why you set up this project, what competences you want to prove and learn. For example: acquired competences from your MSc programme, the elective semester, extra-curricular activities (etc.) and point out the competences you have yet developed. Optionally, describe which personal learning ambitions you explicitly want to address in this project, on top of the learning objectives of the Graduation Project, such as: in depth knowledge a on specific subject, broadening your competences or experimenting with a specific tool and/or methodology, ... Stick to no more than five ambitions.

A design that helps people to decrease their consumption of both time and resources attract me. As a newcomer in the Netherlands, I adopt in this green society and developed a sense of belonging with the environment. The Dutch and their mentality are deeply geared towards protecting their environment. This is apparent in the amount of effort they put in their daily life anywhere, even when developing advanced technology. I appreciate how they contribute themselves to the sustainable field. As technology growing rapidly, people always pursue the smartest and efficient product. However, we usually ignore that we have only one earth, and our resource is limited. Therefore, it has become an important and inevitable issue that we have to use the minimum resource to gain the highest efficiency. Insufficient information provided easily leads the user without a deeper understanding of the outcomes from their behavior. I am interested in making a connection between the user and the product to give them sufficient feedback from their behavior through sensor technology to encourage people to care the environmental issue, reflect themselves and take more responsibility. The design is undoubtedly the most useful tool to find a way to communication among the user, the environment and the product. I believe that focusing on user-centricity will give my design a broad scope to make human behavior's different, rather than just "copy and paste" from the current products.

Before the project I also experience some mandatory and elective course related to sustainable design, like EI and Sustainable Consumer Behavior, inspire me to work on this field. I believe that during the project, I will have a deeper understanding of the need of the user and find out the balance between the technology and the environment through literature study and practice my prototype in the real situation. Furthermore, I will know how to apply the research method I learned from TU Delft into the real case. About the technical skills, I will have further understand how different sensor technology influence people feeling and how to use it on my prototype guide my design strategies to the right direction though conducting usage inspection and executing user test on my own.

In the future, I would like to keep working on information technology design, especially the design focused on the users themselves. It will be good if I can still cooperative with the companies which create amazing products and focus on enhancing the experience between products and the user to broaden my horizons and further specialize what I am good at.

FINAL COMMENTS

In case your project brief needs final comments, please add any information you think is relevant.

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