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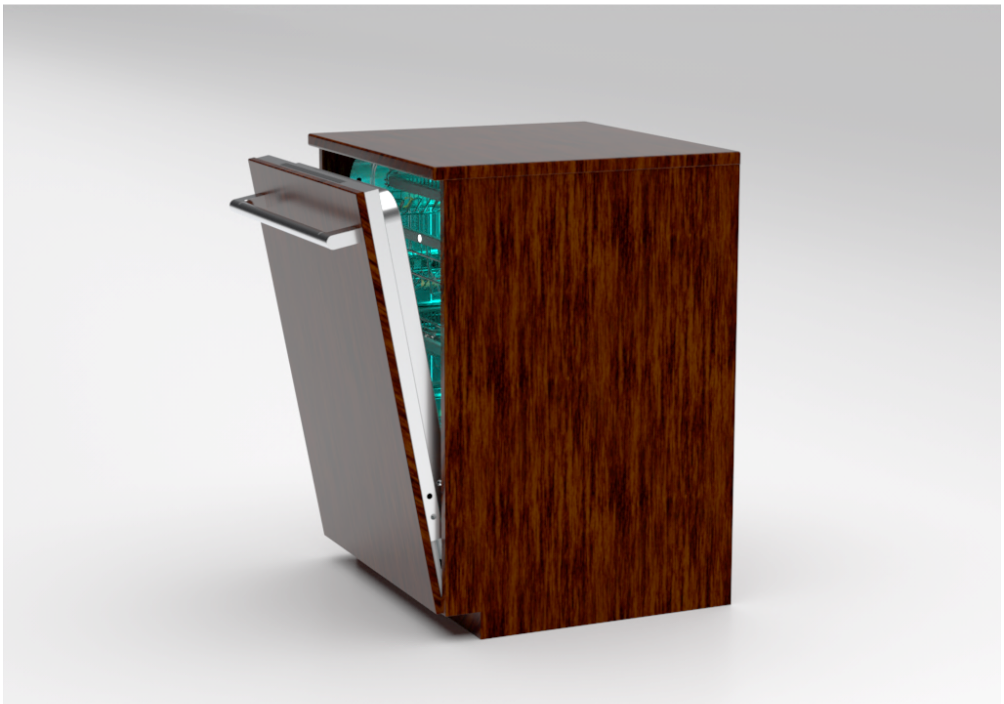

Designing a Premium Dishwasher Opening Experience

With concern to user experience, dishwashing and kitchen trends

Master's thesis in Industrial Design Engineering

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Cover: The final concept *Aurora*

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Abstract

Today, users see dishwashers as uninteresting products with little change over a long time. To increase and improve users' experience and perceived quality, a premium dishwasher opening experience was studied and designed, with regards to dishwashing and interior kitchen trends. Methods used to achieve this were interviews, user studies, benchmarking of kitchen interiors and dishwashers and a workshop. Trends and findings from benchmarking kitchens and dishwashers and the user study were used to create design guidelines. Examples of trends and findings are an increase in colours, rounded shapes, milled-in LED strips and the users considering how well the dishes are cleaned, the most important aspect of dishwashers. The final concept is a light and scent combination with a milled-in colour-changing LED strip one-third of the way into the dishwasher, a functional spotlight moving with the baskets and lights behind the basket handles to improve the perception of cleanliness and premium experience.

Keywords: design, dishwasher, product development, light, user experience, scent, perceived quality.

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Caroline Liew & Klara Lycken, Gothenburg, June 2024

Nomenclature

Below is the nomenclature used throughout this thesis.

Parts of a dishwasher

Door	The front of the dishwasher which opens by folding down
Decor panel	A matching cover used to integrate appliances like dishwashers or refrigerators into the overall design of a kitchen
Basket	The drawers of the dishwasher which can be pulled out
Lower basket	The lowest basket in the dishwasher, where plates usually are
Middle basket	The middle basket in the dishwasher, in between the lower and upper basket, for smaller tableware
Upper basket	The upper basket in the dishwasher, where glasses usually are
Top basket	The highest basket in the dishwasher, where cutlery usually are
Cutlery basket	A basket specifically for cutlery which is a small detached basket that is placed in the lower basket
Tines	The metal prongs in the baskets used to hold dishes and utensils in place during the washing cycle
Washer arm	The rotating arms splashing water on the dishes
Container	The interior shell of the dishwasher

Dishwasher functions

Auto-open	A function which opens the door of the dishwasher when a programme has finished to let out the moist air.
Push-to-open	A function which opens the dishwasher door when the user pushes on the door
Knock-to-open	A function which opens the dishwasher door when the user knocks on the front twice
Grellow	A greenish yellow colour which indicates points of interaction in ASKO dishwashers specifically

Contents

1
Introduction

This thesis is focused on the evaluation and development of the opening experience of integrated premium dishwashers for the company ASKO.

1.1 Background

The dishwasher is an appliance which cleans dishes, at home and on an industrial scale. It runs on electricity, with water, dish detergent, salt and often a rinsing aid. There are dishwashers of different sizes. Some of the smallest ones are meant to be placed on the counter. The standard consumer dishwasher is 60 cm in width, while there is also a thinner one with 45 cm in width. Both are meant to be placed beneath the counter or integrated with the cabinets in the kitchen. From there, they also increase in size on the industrial scale. A major advantage of using dishwashers is that they save up to four times as much energy and also save six to eight times of water usage, in comparison to washing dishes by hand [Energimyndigheten, 2017]. However, the production of dishwashers also uses these resources, so the actual gain is smaller than the values from Energymyndigheten.

Another advantage of using dishwashers are that they can relieve households from a time-consuming chore and hide dirty dishes. Because of this, the dishwasher is a greatly appreciated product among users. However, since its introduction, there have been relatively few changes in its design which might cause some users to consider it an uninteresting product.

ASKO is a premium brand for kitchen appliances, including dishwashers, and has a design language based on Scandinavian design. When buying a premium appliance, the customer expects a premium experience. Therefore, ASKO wants to examine and improve all parts of their machine and all steps in the process of using them. They also strive for more user involvement in their development phase, through user research and evaluations, to ensure desired user experiences and perceptions of quality. An internal study found that hygiene and cleanliness are important to dishwasher users. The company would like to evaluate whether its current solutions fulfil these expectations and bring them closer to this vision.

A part of that process is to examine the door and the user experience, with user involvement and make design suggestions to improve the experience and user perceptions and match their preferences. The opening and door of the machine is an important part which is the first thing customers see when looking at a machine and something that users will use and interact with several times a day, every day. It is also time the dishwasher is considered a more exciting product and is, therefore, an important part to study and improve.

1.2 Aim & Objectives

The aim of the thesis was to create a plausible vision of the dishwasher opening experience, dishwashing, and kitchen trends of the future.

One objective was to explore and map current solutions and products in the Swedish market: by ASKO, by competitors and in other relevant markets. Future kitchen and dishwashing trends were also researched to ensure a long-lasting solution while providing design solutions for the dishwasher door to improve the user experience.

This process was intended to result in answers to the following research questions:

- **What are the upcoming trends in kitchen design and its usage?**
- **How do users perceive ASKO's dishwasher interactions?**
- **What aspects of dishwasher use are important for users?**

The project deliverables was divided into three parts:

- **Mapping of current and future trends in the kitchen and dishwasher industry**
  The first part of the objective was to explore the kitchen industry and make well-informed predictions about what the future might hold. This was essential for designing a dishwasher for future needs and conditions.
- **Design guidelines for dishwasher opening experience development**
  A list of requirements and guidelines concluded from user research, observations and testing to facilitate the creation of a dishwasher door fit for future kitchens.
- **A visionary design solution for a dishwasher opening experience**
  With the help of insights from earlier activities and the design guidelines, a design solution for a premium dishwasher front door was generated to explore what the future of dishwashing may look like.

1.3 Limitations

Since ASKO is a premium brand and the aim of this project was to predict and find a solution appropriate for the future of the industry, this project did not consider the financial aspects or the technical feasibility of design solutions.

2

Aurora – the final concept

The project has included trend analysis and user studies to explore and identify how the opening experience of a dishwasher could be enhanced. It has resulted in a design concept which merges the use of light, colour and scent to deliver a premium and user-centric interaction with the machine, see Figure 2.1. The study highlighted several requirements for improving the user experience and the final concept *Aurora* centres around two main aspects: ease of use and hygiene.

A central part of the design is the moment the door opens after a finished washing cycle. The user is met with an aquamarine light emerging from an LED strip inside the machine accompanied by a fresh scent that briefly fills the air, signalling a sense of cleanliness. When the door is opened further, the aquamarine light turns white while the user discovers additional features. Inside the dishwasher are added lighting elements in the shape of two moving spotlights and handle lights.

Placed at the top of the container, the movable spotlights shine directly on the baskets regardless of how far out they are pulled. This function is possible by the integrated proximity sensors in the baskets which detect the basket's position and adjust the angle of the spotlights. The lights inside the basket's handles provide the user with adequate work lightning as well, as it is directed toward the basket. In addition to this, a part of the light shines through the front of the handle, highlighting the handle itself. These added lighting elements provide the user with an excellent working light to admire their sparkling clean dishes.

Aurora includes a cleaning mode for cleaning the inside of the dishwasher, e.g. the filter or salt lid. This works by tilting the spotlights to be directed at the container's floor and can be activated either automatically by removing the bottom basket or manually through the usual program menu. Inside the door is a pressure sensor that detects when the bottom basket is lifted off.

Two main trends identified from the trend analysis are included in the design. Firstly, the LED light is embedded into the container's surface, mimicking modern kitchen and display cabinets. Secondly, all the baskets are equipped with a soft close feature which minimises rattling of the items placed in the baskets. This is found in a majority of today's furniture and kitchen cabinets.

For more details about the concept, see Section 5.5.

Figure 2.1: Images of Aurora.

3

Methods and theories

This chapter presents the methods and theories used in the project. They were used to gain insights and in the development.

3.1 Methods

Here the general outline and theory concerning the methods used in this project is presented.

3.1.1 Interviews

Interviews are a method which consists of meeting people to gain insights [Åsa Wikberg-Nilsson et al., 2015]. These people can be either users giving insights on attitudes, experiences preferences, opinions and motivations. It is good to observe users and note their comments during interviews [Åsa Wikberg-Nilsson et al., 2015]. Interviews can have different levels of structure. There are unstructured interviews that have no interview template. There are also structured interviews where the questions are formulated according to what one wants answered. Furthermore, there are semi-structured interviews which are in between the other levels. This means that there is some freedom and some structure. It's a good idea to pilot-test one's interview template before using it. Smaller changes can also be made after an interview, if the questions prove not to be ideal [Dodgson and Trotman, 2022]. However, this can be mitigated by putting in thorough work while planning the interview and considering what the aim of each question is [Dodgson and Trotman, 2022]. Being prepared is one of the most important aspects of conducting an interview.

3.1.2 Observations

An observation, as the name suggests, means to observe something to gain insights [Åsa Wikberg-Nilsson et al., 2015]. These can be to discover unknown problem areas or the user's needs. Participant observation is a kind of observation where a researcher will ask to observe a part of a user's daily life or while they perform a task. It is important to document their actions to be able to discuss them later [Åsa Wikberg-Nilsson et al., 2015]. There are other types of observations and ways to categorise observations. For example, there are work dairies, in which the participants self-report, there is applied ethnography, which combines methods such as interviews and observations and there is "fly on the wall", where the participant records themselves [Cash et al., 2015]. An advantage to applied ethnography is that it creates many insights and data but that is also its disadvantage since it is difficult to document all of it.

3.1.3 Workshop

To simultaneously utilise a group of people's creative potential, a workshop can be used [Åsa Wikberg-Nilsson et al., 2015]. These people can be experts, users or other people. The most important aspects to create a successful workshop is to define the purpose and aim before planning [Åsa Wikberg-Nilsson et al., 2015]. The general outline of a workshop starts with introducing the topic and the plan for the session. Then one introduces the topic and the general current situation. Then the problem areas are combined with a free ideation. Then the creative phase and lastly presenting solutions and then concluding the session.

3.1.4 KJ analysis

A KJ analysis is a method for analysing data [Scupin, 1997]. It is done by making separate notes for each piece of information. Then shuffling all the notes and then sorting them into groups by moving related notes closer together until groups are formed. These groups are given headlines and then the relations between the notes are noted.

3.1.5 UX-curve

The UX curve is a user experience evaluation tool used to evaluate the user's experience over time [Kujala et al., 2011]. The user is given a template which they fill in by drawing a curve representing how negative or positive their experience is. This means that they draw a graph where the horizontal represents the passing time and the vertical represents the positivity level of the experience.

3.1.6 Brainstorming

Brainstorming is an ideation method which aims to create as many and varied ideas and solutions as possible [Åsa Wikberg-Nilsson et al., 2015]. There are four rules which should be followed, 1) Do not criticise, 2) Aim for wild and crazy ideas, 3) Try to evolve and combine the ideas and 4) Aim for quantity. The sessions work by trying to come up with ideas that answers an aim or resolves a problem.

3.1.7 Braindrawing

Braindrawing is a method which applies the same rules as brainstorming but also utilises drawing as a creative stimulus [Åsa Wikberg-Nilsson et al., 2015]. It is done by defining a question or context and then asking all participants to sketch for a defined amount of time. Then the participants change places and continue drawing on someone else's drawing. This continues until everyone has drawn at all the stations. After the sketching, the drawings are gone over and discussed within the group. Then the ideas are categorised. One benefit of this method is the lack of or shared ownership of ideas.

3.1.8 Speedstorming

Speedstorming is an ideation method which utilises quick sessions to ensure focus on the task [Åsa Wikberg-Nilsson et al., 2015]. The general outline of the method is that a few different problem or ideation areas are prepared and then the participants switch between which they ideate on in very short sessions.

3.1.9 Personas

Personas are fictive users which are used to condense insights by creating an archetype [Åsa Wikberg-Nilsson et al., 2015]. It can help designers gain more empathy for the user personas. To create a persona, the context has to be researched and insights on the users created. Then these insights must be contextualised and pattern recognised. Then personal details should be added to the persona, for example, a name. Use a scenario, a short story from the persona's life, to create further understanding. The last step is to validate the persona to make sure that it is believable. One's prejudice and society's norms can be challenged by changing the gender or the age of the persona.

3.1.10 Design development

To design is to go through different activities to reach a solution and a designer needs knowledge of many different subjects, such as materials, usage, function, semantics and manufacturing [Åsa Wikberg-Nilsson et al., 2015]. Design development projects are complex problems and therefore require adjusted methods for each project since each project is unique [Åsa Wikberg-Nilsson et al., 2015]. One of the main tasks is to understand the context of and users in the design problem if the design should comply with the emotional, cognitive and physical needs of the user. User-centred design is a term describing design which focuses on fulfilling the needs and preferences of the users in the context [Åsa Wikberg-Nilsson et al., 2015]. The design development process is usually an iteration of planning, exploring, creating and prototyping.

3.2 Theories

In this section, the theoretical framework utilised in this project is presented.

3.2.1 Senses

Humans interpret the world around us through the five main senses: audition, vision, olfaction, taste and touch [Ludden et al., 2006]. Information collected from the senses impacts how we experience, value and relate to products. When designing with the senses in mind, it is important to consider all senses since they work together to create a unified understanding of a product, with each sense influencing the others.

Congruity and incongruity
Previous experiences with products form expectations of how a similar product might look, feel, sound or smell [Ludden et al., 2006]. For example, one might think of a couch as soft and fluffy and expect a soft-looking couch to feel just that. When a person's expectations align with their experience, it is called *congruity*. However, if it turns out that the couch is made out of stone – and not soft cushions – the person will likely be surprised when taking a seat on the couch as their expectations and visual information do not match up with the haptic sensation. This sensory conflict is called *incongruity*. Mindfully designing for incongruity can spark interest and curiosity in the user, while an unsuitable combination of contradictory experiences can cause negative emotions. It is therefore important to have a clear goal when designing with the senses in mind, along with considering all senses and how they impact each other in a specific context.

3.2.2 User experience

User experience (UX) is a broad subject with many definitions [Hassenzahl, 2011]. One general description of UX is "enhancing user satisfaction by improving the usability, accessibility and pleasure provided in the interaction with the product". User experience is the result of a complex cluster of feelings, thoughts, and actions [Hassenzahl, 2011] that are influenced by e.g. societal and cultural factors, a person's memories and expectations, the product itself and its context, and how the experience is shaped over time.

One way to illustrate user experience is by using the UX pyramid, a framework for categorising UX levels [Ralph, 2017]. It is based on Maslow's hierarchy of needs with the lower and broader half of the pyramid represented by basic features such as functional, reliable and usable. The top half consists of more subjective attributes like convenient, pleasurable and meaningful at the very top. The pyramid is used to assess how well a product fulfils each level and as a guide for reaching the top of the pyramid and the desired goal of creating a meaningful design. By keeping the upper levels in mind, one can design products that users want to engage with and enrich and improve people's lives.

3.2.3 Ergonomics

Ergonomics is a term defined as the optimisation of the human-product interaction [Åsa Wikberg-Nilsson et al., 2015]. It can be divided into physical, cognitive and organisational ergonomics. One important aspect of physical ergonomics is anthropometrics, which describes all forms of human length and angle measurements [Åsa Wikberg-Nilsson et al., 2015]. By using anthropometrics effectively, one can design products that fit as many body shapes as possible.

Vision is considered the most dominant of the human senses [Berlin and Adams, 2017]. Glare, reflections and contrast are three important light parameters to consider when designing ergonomic and functional lighting to facilitate good vision. Glare can occur in situations when a person is exposed to too bright and excessive light, which can result in an uncomfortable experience or impaired vision. Reflection is affected by the surface material and finish. For example, polished steel will cause more reflections than matte plastic. Reflections can on one hand create interesting effects, while on the other hand be bothering when used incorrectly. Contrast is defined as the difference in luminance between two surfaces. Too high a contrast between light in a work environment can cause problems, while a contrast between colours can be beneficial to differentiate parts or indicate functions.

4

Execution

In this chapter, the execution of the project will be described. The project's process consisted of two phases with three main activities running in parallel, as seen in Figure 4.1. The three main deliverables are represented in green. The concept development activity included ideation, prototyping and refinement based on the user studies. This activity resulted in a final design concept for the dishwasher door opening experience.

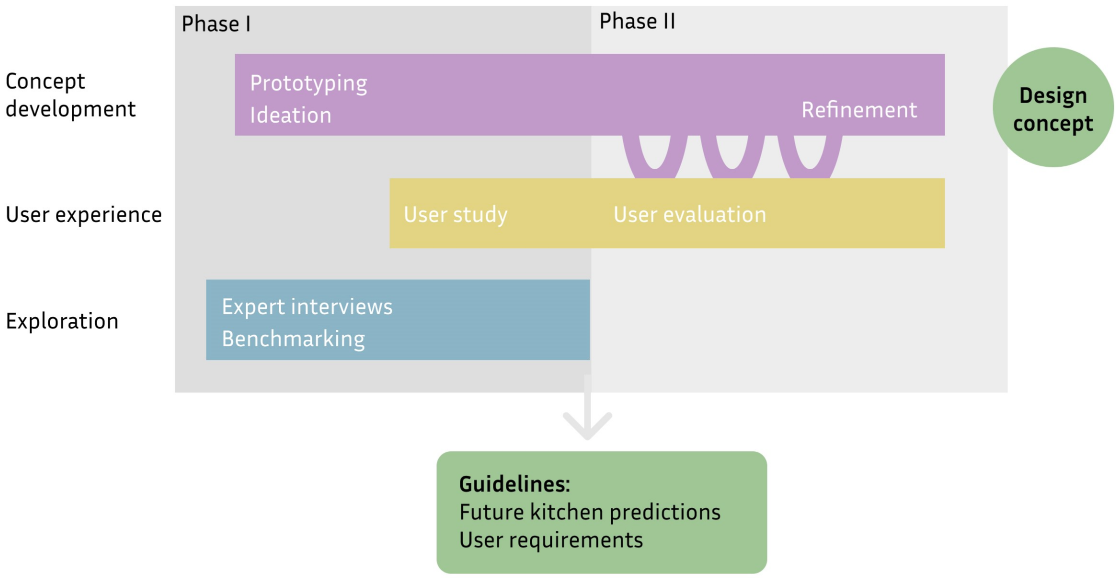


Figure 4.1: A visualisation of the process, with the two phases.

The user experience activity consisted of user involvement through studies and evaluations to understand how users perceive current dishwasher doors, lighting, scents and the proposed concepts. They were also involved in a workshop to both evaluate and ideate on the concepts. The user involvement and design and ideation were iterated, as is common in design development processes. Through the exploration activity, a study of the kitchen industry was performed to explore the market and future kitchen trends. It included benchmarking of dishwashers on the market and kitchen interiors and expert interviews with trend experts. Other product categories were also benchmarked as inspiration for the ideation.

Phase I, the pre-study, resulted in a list of guidelines concerning future kitchen trends and insights from the user study. The guidelines were used in Phase II, the development phase, as a base for the remaining design process, which resulted in the final concept, seen in Chapter 2 and Section 5.5.

4.1 Benchmarking

During the benchmarking process, stores and a fair were visited and some interviews were held to understand dishwashers and the current and future kitchen trends.

4.1.1 Kitchen and appliance stores

Several kitchen and home appliance stores were visited in Gothenburg. The main purposes for visiting kitchen stores were to 1) investigate current kitchen trends by analysing the displayed product range, and to 2) study handles and opening mechanisms of kitchen cabinets. Most of the study was done by observing the lighting, opening the cabinets, feeling the materials et cetera. In some instances, an additional conversation with the store staff was held to understand customers' needs more thoroughly. Five kitchen retailers were visited, see Appendix A.1 for the list of stores.

While the kitchen stores had dishwashers in the showrooms, a comprehensive study of the dishwasher market was required to gain insights from a broader range of dishwashers. For this, three home appliance stores were visited, see Appendix A.1. Whereas the study at the kitchen stores was exploratory, the study of the dishwasher market was structured and included a form, see Appendix A.2, with predefined properties and features to analyse. Among the chosen characteristics were the type of opening mechanism and the experience of using it, sensory experiences such as smell, sound and texture, and the first impression of the dishwasher. The force of opening the door was also measured with a dynamometer, see Figure 4.2.

4.1.2 Other stores

Four stores selling only interior design were also visited; Designtorget, Bolia, Vallgatan 12 and Slettwoll. In these stores, materials, colours, shapes and the opening of cabinets and closets were examined to benchmark the current kitchen trends and gain inspiration for the ideation phase. At three car stores, the opening of doors and compartments was explored and evaluated for inspiration.

4.1.3 Stockholm Furniture Fair

A visit was made to the 2024 Stockholm Furniture Fair to examine kitchens and other interior designs. There were five kitchen retailers at the fair. All the kitchens and many other interior design exhibitions were inspected and tested, by opening cabinets, dishwashers, and other appliances and feeling the textures and materials. Observations of the shapes and colours of exhibitions were also made. Lighting, lighting effects such as reflections, and sounds were also examined. The sounds of opening and closing doors were studied, mostly at interior exhibitions. The lighting was examined at both interior exhibitions and lighting-focused exhibitions. The examination was made for inspiration and understanding of current kitchen and design trends.

4.1.4 Expert interviews

Three expert interviews were held with people who are knowledgeable of current and upcoming interior and kitchen trends. The purpose of these interviews was to gain more in-depth insight into trends and predictions for their future development. The experts were asked which current and upcoming trends they could notice regarding kitchen layout, colour and material, lighting, cabinet opening mechanisms, kitchen appliances and kitchenware. The full interview guide can be seen in Appendix A.3. Afterwards, the results were analysed using a simplified version of a KJ analysis. This method was chosen since it is a very effective way of sorting, creating an overhead understanding and facilitating the drawing of conclusions. The version used in this project skipped marking relations and was done digitally using the software Figma.

Figure 4.2: Measuring the opening force with a dynamometer.

Figure 4.3: At the Stockholm Furniture Fair.

4.2 User studies

In the first phase of the project, several existing machines were evaluated and tested by users and in the later phase, several user evaluations of ideas and concepts were made. In the first user study and the first light and scent study, the participants were chosen based on convenience sampling from the company perspective while also ensuring a variety in age and gender. The participants in the pilot study and informal evaluation were chosen based on convenience sampling from the authors' perspective and were all young adults in their 20s. The project followed the GDPR act by not collecting any private or personal information which could be used to identify any user or interviewee.

4.2.1 User studies of current machines

An evaluation of four existing machines was made with users. This evaluation included a small semi-structured interview about dishwasher opinions and use and a participant observation while they performed two tasks making it an applied ethnography. There were nine participants in the official user study and two in the pilot studies leading up to it. All participants had a dishwasher at home. The pilot studies were made to test the questions, assignments and format of the later official study. In the two pilot studies, the same machine was used, which was not in the official study. This machine was chosen out of convenience and was a budget Cylinda dishwasher. In the official study, two ASKO machines were used, one integrated push-to-open and one detached machine with a regular handle. The two other machines – a push-to-open Bosch and one knock-to-open Miele – were both integrated. The arrangement can be seen in Figure 4.4.

Figure 4.4: The arrangement in the official user study. The dishwashers in the line-up are, from left to right, the detached ASKO, the push to open Bosch, the push to open ASKO and the knock to open Miele.

The general format of the studies began with some general questions, before having the participant try out and test a dishwasher. These questions were mostly to gain some understanding of how the user used their own dishwasher. During the following testing, the participants would be given two different assignments to complete: to load the machine with two place settings of dishes and to unload them. The dishes used in the official study can be seen in Figure 4.5. After each assignment, they would be asked to fill in a UX curve describing their experience as the assignment went on. It was chosen to gain an understanding of what parts of the process of using a dishwasher are currently the most negative and positive. They were encouraged to comment and think out loud. Afterwards, the participants would continue to evaluate the dishwasher and they were asked probing questions about mostly lighting and sound. In the official study, each participant tried out two machines. The testing was also observed and both observations and comments from the participants were annotated. After the testing, the users were asked some more questions. In the official study, these were a comparison between the two tested dishwashers. The introductory questions, the UX curve form and the comparing questions can be found in the Appendix D.1. After the study, comments and observations were analysed through a simplified KJ analysis, similar to the one used after the expert interviews and by comparing pictures of how the users placed the dishes in the dishwasher.

Figure 4.5: The arrangement of dishes (a total of 21 items) for the first user study.

In the first pilot study, the first assignment, to load the dishwasher, was done with sticky hands. This was achieved by using hand lotion. A NASA-TLX form was also used in combination with the UX curve to evaluate mental and physical demands. Neither of these steps was included in the second pilot study.

4.2.2 User studies of colour and scent

To determine how coloured lighting and scent can impact the perceived hygiene factor of a dishwasher, several user-involved tests were conducted including an initial pilot study with one participant. The first official study of coloured lighting and scents included nine participants, two of whom were the authors, seven different scents, one LED light strip and an ASKO dishwasher. The scents as seen in Figure 4.6 ranged from fragranced laundry detergent to chlorine and were selected based on their hygienic and/or fresh scent. A full list of the scents can be seen in Appendix D.3.1. The scented solutions were poured into drinking glasses so that their names or packaging would not impact the participants' perception of the scents. The participants were each asked to smell the contents of the seven glasses and order them according to how *hygienic* they found the scents. The highest-ranked scent was brought over to the dishwasher with the LED light inside and the participant was asked to choose a colour on the light that best fit that particular scent. The colours available, as they are represented on the remote used to control the LED strip and the LED strip in the dishwasher can be seen in Figure 4.7. They were then asked to order the seven scents based on *how much they would like them in a dishwasher*. The most preferred scent from this round was once again paired with a fitting colour of the LED light. The reason behind pairing a scent with a colour was to investigate which were suitable together and which may cause incongruity (refer to section 3.2.1 for an explanation of incongruity) for the user.

Figure 4.6: The seven scents used in the first scent study, poured in glasses. Their original packaging was not visible during the test.

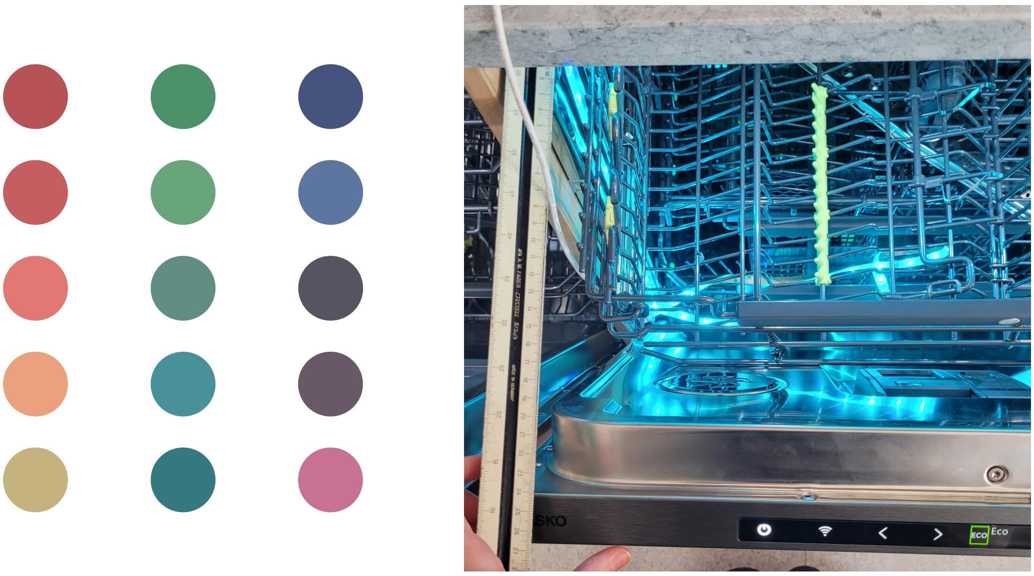


Figure 4.7: Here are the colours possible to choose between, except white, as they are represented on the remote used to control the LED strip. To the right, the LED strip in the dishwasher can also be seen. The measuring of a good position of the change of light colour can also be seen in the picture to the right.

The results were compiled in a table and can be seen in Appendix D.3.2. Three scent winners were declared that were in general perceived as both hygienic and fitting in a dishwasher context. These three scents were taken on to a second study involving four participants to investigate the scent and colour combinations further. A fourth, new scent, *Hav* (English: Sea), was added since it was missing from the first test. The second study had the same basic outline as the first study but had a looser structure.

4.2.3 User study on lighting placement

To investigate and determine where the lighting in the dishwasher should be placed and how it should act in a opening scenario, a user study with four participants was made. Two different suggestions for the LED light strip's placement in a dishwasher were shown to each participant. The first option had the light strip in the front of the container, right inside of the door frame. The second option had the light strip in between the front and back end of the container. The participants were asked to comment on the suggestions, select the preferred option and choose which colour of the light they liked the best, for colours see Figure 4.7.

4.3 Ideation and refinement

4.3.1 Ideation

The first ideation session was done in an iterative manner where both parties drew and thought of ideas for a period of time and then the ideas were discussed. This method was inspired by and based on the methods brainstorming, braindrawing and speedstorming, which are described in Sections 3.1.6, 3.1.6 and 3.1.8. After the discussion, new ideas or refinements were done for another period of time and so the sessions went on. After some sessions, the ideation was divided into several different areas, such as lighting and sounds.

4.3.2 Informal evalution

In preparation for the workshop, which is later described in Section 4.3.3 and in Appendix E, the first ideas were informally evaluated by several users to condense them into four more defined concepts. Two longer informal individual interviews and one shorter informal group interview with four participants were held to gather more insight into the user's thoughts and criticism of the ideas and simple concepts.

4.3.3 Workshop

A workshop was held together with five participants from ASKO's R&D department to further develop four selected concepts and to brainstorm new ideas. The four concepts, a number of selected requirements and six personas were presented to the participants and their task was to generate ideas with this information in mind. The presentation and instructions for the workshop can be found in Appendix E.

4.3.4 Refinement & Prototyping

Refinement of ideas and concepts was done both during the workshop earlier mentioned and through sessions similar to the ideation, where suggestions and alternatives were discussed and evaluated before continuing ideating. Ideas for lighting were also tested in dishwashers, with and without dishes to see the lighting effects. Different placements, such as on the edge of the dishwasher and around baskets were tried out to observe and evaluate the effects in conjunction with the user evaluations. For the placement, comparisons to the previous benchmarking were also made to ensure compliance with kitchen trends. Different angles in relation to the opening of the door were also tested. They were tested so that the light would change at a natural angle and to minimise the risk of the users opening the door and using the dishwasher without functional white lighting. This testing can be seen in Figure 4.7. For the moving spotlight, how far the different baskets should be pulled out for it to move was also tested by measuring the angles and how far out the baskets were.

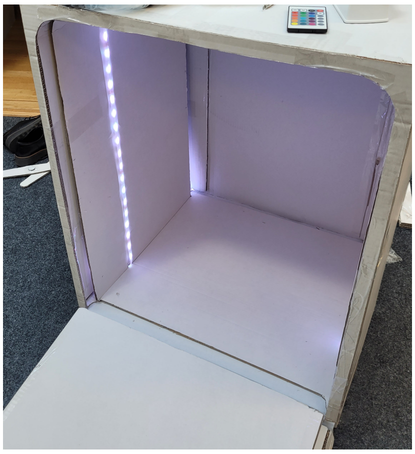
In the beginning of the project, a cardboard prototype was made to gain a better understanding of the product and its attributes. Later, more details such as the holders for the baskets were added, as seen in Figure 4.8. The prototype was then used during the workshop to test ideas and placements, as can be seen in Figure 4.9. Some aspects of the final concept were also applied to the cardboard prototype at the end of the project. The LED strip was added and the container was covered in aluminium foil to imitate the reflective, stainless steel surface since it would affect the effect of the lighting in the dishwasher.

Figure 4.8: This shows the cardboard prototype early in the project, with the basket holders.

(a) In this picture, prototyping with white light can be seen.

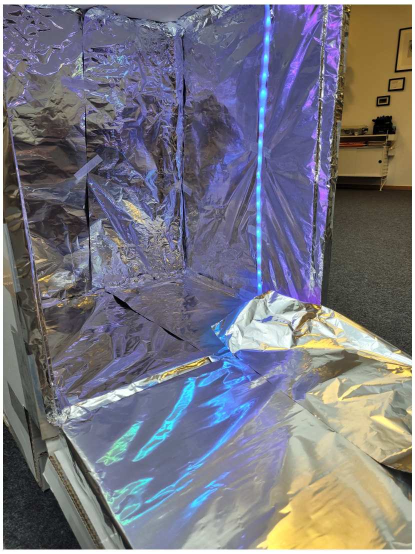
(b) In this picture, prototyping with white light can be seen.

Figure 4.9: In these pictures, prototyping in the cardboard dishwasher with an LED strip can be seen. This was done in during the workshop and at other times.



(a) Here the cardboard prototype can be seen with the LED strip placed on the side and around the interior.

(b) Here the prototype can be seen in the beginning of the process of placing aluminium foil on the internal surfaces.



(c) Here, the LED strip and shiny internal surface are fully applied before the baskets were added.

(d) Here, the LED strip and shiny internal surface are fully applied with baskets added.

Figure 4.10: These pictures show the application of the final concept on the cardboard prototype and its stages.

5
Results

In this chapter, the results from the activities earlier described will be presented. The trends from the benchmarking and expert interviews as well as the user study and development process will be included. The chapter concludes with a presentation of the final design concept.

5.1 Kitchen trends

The kitchen trends were identified using trend expert interviews, informal interviews and benchmarking at stores and benchmarking at the Stockholm furniture fair. Here they are presented and divided into six different areas.

5.1.1 Colour & material

The most common theme regarding colours was a clear rise in red and pink shades. This can be seen in Figure 5.1. The trend experts agreed that colour is on the rise, especially red, pink and cornflower blue. Inspiration comes from the 80's and the recently dominating trend of all-white is disappearing. The current norm, according to the trend experts, is beige kitchens, while the kitchens with stronger colours are bolder and will probably rise in popularity in the future. Today, it is the more daring customers who choose strong colours for their kitchens. There were also strong blues, greens and yellows, as well as pastel colours. At the fair, the Bauhaus colour combination of yellow, red, blue and black was seen several times.

The trend of natural wood, which can be seen in Figure 5.1, and stainless surfaces also seem to be up and coming according to both the observations made and the experts in the expert interviews. However, there is also a wood shortage which influences prices in the industry. The increasing price and association with sustainability will probably mean that wood will stay popular and perhaps even increase in popularity. Some customers may choose different kinds of wood imitations because of the increased price.

Another popular surface material, according to both the benchmarking at stores, the Stockholm Furniture fair and the trend experts, is stone. Especially stone composites made with grounded stone are on the rise. The material is easy to maintain and customise to one's desires.

5.1.2 Shapes

Considering shapes, there seems to be a rise in round and rounded shapes, especially several round shapes in combination with each other. Cone-like shapes were also seen relatively often. The experts agree that rounded shapes seem to be on the rise, such as the edge of countertops or sides of kitchen islands, as can be seen in Figure 5.1. However, one trend expert stated that round shapes are less practical for the user, which may influence people's choices. They use more space in a rectangular environment, create less countertop space and create less usable space in case of downward rounded edges.

5.1.3 Lighting

There seems to be a trend with LED strips in kitchens, especially milled into a surface, such as a cabinet wall. This was seen in both stores and at the furniture fair and an example can be seen in Figure 5.1. At the fair, many different kinds of lighting effects, reflections and ”cosy” lighting could be found for interiors more generally. These could apply both warm and cold light although warmer light was more common. The lighting effects could for example be holes in a lamp shade creating a light pattern on the surrounding surfaces.

The trend experts agree that LED strips are popular and believe that they are normally used as decorations and milled in or somehow hidden. One of them also said that LED strips are frequently used in display cabinets and that younger people are generally more interested in decorative lighting compared to older people who focus on functional lighting instead. Another expert said that the industry seems more focused on decorative lighting rather than function and that there is a knowledge gap for functional lighting. The industry seems to care more about the appearance of the lamp and fitting rather than the light emitted. They also said that ”naked”, uncovered light sources are popular, which could also be confirmed during the benchmarking.

5.1.4 Cabinet doors

Regarding cabinet doors, the number of drawers per unit seems to have become less in recent years in comparison to traditional kitchens with five to six drawers on top of each other. Today, there are cabinets below the counter divided into two or three drawers. For this type of kitchen design, there are decor panels for dishwashers imitating these drawers with vertical grooves on the surface. The number of drawers in kitchen cabinets has reduced so much that there are also big, single-drawer cabinets with smaller inner drawers, as can be seen in Figure 5.1. It is also popular to have part of the frame showing between the cabinet doors. When these are not aligned with the cabinet's surface, it creates space between the cabinet doors. This is utilised in some cabinets to create the very popular trend of integrated handles so that users grip the door where the space is to open the doors. Other integrated handles are notches or ledges on the upper side of the doors, which can be seen in Figure 5.1. Some exhibitions are also completely free from handles and utilise solutions such as push-to-open but this is less common than integrated handles. However, some kitchen exhibitions do use push-to-open in combination with other solutions.

One of the trend experts said that leaving out the top cabinets is popular when designing kitchens and that more solutions to support this have become available and probably will continue to increase. These solutions are, for example, to place fridges, freezers or dishwashers in drawers under the counter. Other aspects of kitchen design mentioned by the experts are that cabinet bases are sometimes removed to gain a clean and straight line, display cabinets with windows have made a comeback and the kitchen islands are still very popular. An example can be seen in Figure 5.1. The kitchen island trend started as a TV-cook inspired cooking surface but is now becoming a social space instead. The main size of dishwashers is 60 cm. Even in the smaller kitchen, 60 cm dishwashers are often chosen over a 45 cm dishwasher since standard cabinets are 60 cm, according to one of the experts.

Tableware has gradually become larger in recent years, although the experts do not think that the size will continue to increase. The increased size has led to larger cabinet sizes but all tableware does not fit in all cabinets since tableware and other products no longer follow the earlier used standards. They are produced by new, non-tableware-specialised companies and in other cultures, without the Swedish standard tableware sizes. Many people also use tableware or cutlery sets differently, for example by mixing and matching from different sets.

5.1.5 Handles & fittings

Generally, there are not a lot of surface-mounted handles in the kitchen exhibitions since the earlier mentioned integrated handles are so common, although they are still in use. The experts believe that handles are making a comeback, although they also think that clean, smooth doors with integrated handles, or even completely handleless, are still popular. One expert, however, said that integrated handles are less robust and that the trend is starting to lose popularity. Another expert said that handleless solutions are also losing popularity. Some of the experts mentioned that the now popular auto-open dishwasher function is causing damage to doors and wooden surfaces due to the water steam emerging from the opening. The function is used, in part, for sustainability reasons.

One type of handle that is gaining traction is the T-shaped handle, which can be seen in Figure 5.1. It can be explained as something in-between a regular handle and a knob. Among the handle types decreasing in popularity, one example stands out: the full-length, t-bar handle which has been very popular in previous years. There is a strong interest in authentic materials such as metals and wood materials. Some types of handles, such as leather-bound handles have been stable in popularity for a long time and will probably continue to be so. One of the experts stated that handles and fittings are often chosen more for their looks than their practicality or usability.

5.1.6 Miscellaneous

In general, norms and trends seem to have become wider and less defined with social media and more information channels, allowing different and unique styles into the spotlight, as observed by trend experts. Before, the published magazines defined what was in style. Now, many different trends can be found on the internet. Trends are also changing faster than before. There used to be a two-year cycle where trends first showed up at the Milan Furniture Fair and could be found in stores here two years later. Now, industry fairs and magazines are no longer the only players in trendsetting. This makes trends harder to predict. One expert mentioned that this means that people with little or no knowledge in the area can do anything that gains traction online and people will start asking for it in stores. The standard customer, however, is usually a lot more careful than the trend and exhibition kitchens which make the more extreme versions to inspire the clients. Customers will often apply a less extreme version of what they find in exhibitions, and the transition of new trends into people´s homes takes some time. The amount of time will be different for different clients.

Another trend mentioned by a trend expert in the interviews was that people care the most about those parts which can be seen. For instance, the decor panel will be more important than the dishwasher's inside. Many prioritise having an integrated dishwasher. They said that there is a trend of people wanting more flash for their money in order to show off. For example, some may choose sustainable or high-quality materials, but only where the material can be seen. The economic situation is currently challenging for many people and one expert suspects that it will cause the recently increased restaurant meals to stabilise and perhaps even decrease. This would mean that people will cook more at home again.

The trend experts also said that people want to wash as much as possible, not only tableware or kitchen tools, in their dishwashers. This has also been observed in internet trends such as dish-washing your computer keyboard. They also said that people are interested in the practical function when choosing a dishwasher, for example, ergonomic functions, top baskets, sliding door installations and how quiet it runs. Ergonomic functions, such as Electrolux's *Comfort Lift*, are more popular amongst the older generation. Other functions, such as Neff's *Slide & Hide* oven door are not very popular but considered luxurious by those who chose them. The experts said that people want a simple kitchen although they also want appliances with more functions than they will ever use. There is an attitude among customers where many functions and programs feel luxurious and like a status symbol while few feel basic and cheap.

Figure 5.1: This image board shows many of the different trends found in the kitchen trend benchmarking. In the lowest picture, natural wood and many of the trend colours, such as blue, pink and red can be seen. There is also the kitchen island and rounded edges. Above, T-handles and embedded LED strips can be seen. Then there is a drawer in a drawer and at the top, there is natural wood with integrated handles and naked, rounded lights. The bottom picture is used with permission from Puustelli.

5.2 Evaluations of current dishwashers

The benchmarking of dishwashers on the market and the first user studies led to many insights on dishwashers in general and people's opinions on them. In this section, these insights are divided into eight different areas, some of them with subcategories. These insights were then used to create the guidelines and a baseline for the ideation. The results and observations from the comparison of pictures of placement and the UX curves can be found in Appendix D.1.3.

5.2.1 Opening of dishwasher door

A general insight was that many dishwashers have very inert doors and the opening requires a fair amount of strength. This was found both during the benchmarking of dishwashers and the first user study. Some users would like the door to be able to stop at all positions or angles and others would like it to stop at certain predetermined positions, like car doors usually do. Both these solutions can be found on the market. Some machines on the market also have an issue with the door springing up from the bottom position, which users find frustrating.

Some users would like the door to close itself when it is nearly shut and make it possible to slam it closed. One user said it should feel like a magnet. A similar feature can be found in most of Siemens's dishwashers. However, this function may cause conflict with the function to leave the door slightly open, depending on how small the gap can be for the door to stay open. Machines with the auto-open function usually open like this, with a small gap in different sizes for different machines, as seen in the benchmarking. Some users in the study preferred smaller gaps since the open door can be an obstruction when working in the kitchen. However, some users preferred larger gaps to lessen the risk of steam damage on surrounding surfaces.

Users have varied opinions about the automated opening mechanism such as push-to-open and knock-to-open. They generally prefer push-to-open before knock-to-open and push-to-open solutions which don't need to be pushed as hard. Yet, some prefer traditional handles over motorised solutions. This is usually motivated by the wait that comes with the motorised solutions tested, as well as the sound of the opening mechanism. Speed seems to be one of the most prioritised aspects of the opening mechanism according to the participants. The advantage of the motorised solutions is that they enable clean, smooth cabinet doors. Push-to-open features also allow the user to open the dishwasher with something other than their hands, such as pushing the door open with their hips.

Miele's knock-to-open solution has an arm which pushes out the door. To open the door completely, the user needs to pull hard on the door to release it from the arm, which can cause frustration and disturbance. This was observed both during the benchmarking and the first user study. Some users also thought that it was a children's lock and aesthetically unpleasing. The main drawbacks of the knock-to-open function, found in the user study, are the sound and the lack of speed.

5.2.2 Basket experience

In both the benchmarking and the user study, some dishwasher baskets were found to be inert and lax, which is an unfavourable experience. However, some users would like some inertness at the beginning of the pull-out motion to create a robust feeling. Many think that lax or rattling baskets feel less robust. Users appreciate the baskets that can be fully protracted. During the benchmarking, it was found that many top baskets for cutlery, can not be seen when standing next to the machine and therefore may not be noticed by the user.

Most baskets have some kind of handle, some are only the same thin metal rod as the rest of the basket and others are wide and thick, often in plastic. This was seen both in the user study and in the benchmarking. In the user study, it was also found that one user did not like the rounded grip of the Bosch dishwasher. However, people generally think the thicker handles are more comfortable but that the thinner, plastic covered handles look better. They think that the uncovered handles are especially uncomfortable. Both the benchmarking and the user study also found that handles with a smooth surface were the most comfortable and liked, compared to handles with some kind of texture.

5.2.3 Material and colours

The opinions of the dishwasher's looks are very varied. Some users are uninterested in it and are more concerned with other aspects. Nevertheless, many users do have opinions regarding the dishwasher's appearance. Some users like the design of Miele's dishwasher with thicker frames the best, while other users thinks that it looks plasticky and old. Several users, however, think that the light colours of that machine make it look more spacious, which is considered a good quality. Still, some users dislike the light colours since they regard them as cheap rather than premium and remind them of products from the 80's.

People also preferred the use of fewer different colours, as in the other machines, rather than the many colours of Miele, since they think it looks more exclusive and premium. For example, the looks of the integrated ASKO machine were generally appreciated by the user, with thinner handles and a clean design, that however could be considered basic. The users thought that the darker shade of grey was better as well. One user said darker colours creates a larger contrast between the dishes and the interior of the dishwasher. The smaller logo of the integrated ASKO dishwasher was also preferred over the larger logotype of Miele. Metal surfaces generally give a premium impression, according to the users. The Bosch dishwasher in the study, however, was viewed as more traditional and old-looking by users.

Considering the colours, many machines in the benchmarking and the machine in the user study used accent colours. Different brands use different colours. ASKO uses grellow (SV:grul). Miele uses orange. Bosch uses red. Siemens uses blue and Beko uses purple. In the user study, the participants appreciated the use of colour to denote functions in the dishwasher. They also liked the red accent colour of Bosch.

However, some thought the red, rubbery details were protection for transportation. This also applied to the grellow details in the ASKO machines, according to one user. The grellow colour was generally liked by the users. They thought that it was calmer than the red and orange. Some users thought that the orange colour felt non-premium and messy.

Many users expressed concern regarding the cleaning and ageing of different materials and colours. They worry that white and light materials will age badly and therefore appreciate stainless steel and durable materials. Despite liking the rubber materials holding things in place, one user worried that it would turn yellow with time, especially if you have your own water supply and iron-rich water.

5.2.4 Loading the baskets with cutlery, plates and glasses

Users generally appreciate densely wired baskets. In both the user study and the benchmarking, it was found that it was easy to miss the top cutlery basket in many dishwashers with one. Most users like the flexibility of changing the baskets to work with different tableware. However, they also see several drawbacks to today's solutions. For example, the folding holders for glasses risk falling down, are difficult to place in the correct position and the solutions take up a lot of space.

Plates and bowls
The most difficult thing to load in the user study was the small bowls. They use up a lot of space and if they are loaded too tightly, users worry that they will not be properly cleaned. Flexible holders help reduce this problem by creating larger gaps. Different users put the small bowl in very different places in the dishwasher. One user shared their experience that if the plates are loaded from the back and forward, the basket may become back-heavy. It is therefore better to allow the users to load plates from side to side, making the weight more evenly distributed. The users also appreciated the possibility of loading larger plates.

Cutlery and utensils
The participants in the user study wish to load and unload the dishwasher easily and quickly. Many users consider the possibility of carrying the cutlery away from the dishwasher to their cutlery drawer when unloading the dishwasher an advantage. This is enabled by a cutlery basket. While the placing of cutlery is usually clear, the placement of kitchen tools is more difficult. Many users do not know where to place them and they often do not fit with the cutlery. Many cutlery baskets have a cover with a grid for placing the cutlery individually so that they won't stick together during the wash cycle. These covers were a source of much frustration for the users. This caused frustration since some models of cutlery are too large for the holes and may not fit, or will not be easily unloaded. During the user study, several covers fell off during the loading or unloading of the dishwasher. Many users said that removing the cover was one of the first things they did with a new dishwasher.

Some users like the cutlery basket since they think it is fast to unload while other users think that it takes too long and prefer the top basket. Some would have liked the top basket more, had it included the function to sort the cutlery by type. For example, placing forks next to each other when loading the machine. However, they did not believe this to be possible in their household because of differences in loading habits among family members. Furthermore, many users thought that it was unnecessary to have both the cutlery and the top baskets in the dishwasher. However, their opinions on which one should be left out differed. Some users found it difficult to place the cutlery in the top basket since each piece of cutlery must fit perfectly between the tines. Users also said that they would like to be able to remove or fold down the tines so that other items could be placed there.

Glasses

Many users feel unsure and concerned while loading wine glasses and other fragile items in their dishwashers since they worry that the glasses will fall over and get damaged. Many glass holders only give support in a single direction. There are softer rubber holders that give support in several directions to keep the stem in place. These are very appreciated by the users. However, one user did not like them since the stem of the glass needs to be pushed into the holder and several users noted that it takes more time. There are a number of different designs for these softer rubber holders. Some look like smaller rubber tool holders, while some are like rubber claws holding the glass in place, and some create a smaller passage through flat rubber. The different versions were seen both during the user study and during the benchmarking in both the lower and upper baskets.

Beneath many of the glass holders, there were tines. Sometimes they made the placement of glasses more difficult by getting in the way, while in some cases they stabilised the glasses. Especially the small rubber tines were appreciated. When folding down the glass holders, there is seldom any feedback to the user that they have reached the correct position. This causes the users to press them down with unnecessary force. One exception is the Miele dishwasher in the user study whose glass holders click when in the correct position. This is both heard and felt haptically.

In the Bosch dishwasher included in the user study, the wine glasses used could not fit in the glass holders of the upper basket because of the placement of the top cutlery basket. This caused a great deal of frustration among the participants. This machine was also equipped with glass holders in the lower basket. However, some users did not want to place their glasses next to plates or the most soiled dishes. In several dishwashers, the glasses were hanging freely from the holders without touching the basket below, making users worry that the glasses would knock into each other. Another thing which caused concern was the lack of space between the glasses when placed in the dishwasher. Having glasses pressed against each other made the users doubt the glasses' safety as well.

5.2.5 Interface

Concerning the interface, some users prefer physical buttons while other users prefer touch buttons or screens. One advantage of the physical buttons is the haptic feedback of pressing something down. However, one user suggested using haptic feedback in the touch buttons, similar to the iPhone home button. Many dishwashers with touch buttons have some kind of audio feedback when the buttons are pressed. This is usually a high-pitched beep.

The users prefer the interface placement to be on top of the door, rather than on the front. This was also seen as a physical ergonomic advantage during the benchmarking since front displays are not visible when standing upright directly next to a machine and therefore require bending down to see the display properly. Some users like to be able to see all programs and functions at the same time to have a better overview, while other users prefer a cleaner and more minimalistic interface. Especially if they are also easy to understand and use. This was a usual reason for the participants to like the ASKO dishwashers since they are minimalistic and simple. Many found Miele's rather complex interface more difficult to use. However, they liked the display of the Miele dishwasher. Regarding what should be shown on the display, or somehow communicated to the user, some user would like to see how much time is left on the wash cycle while some consider that unnecessary information.

5.2.6 Sound

Sound was found to be an important aspect for the users to perceive a dishwasher as a premium appliance. The sound of the mechanism of the auto-opening function can be too loud and disturbing according to many users. This is also true for the motorised opening solutions, such as knock-to-open and push-to-open. For the knock-to-open solution, there is a motorised arm which causes a loud sound which most users heavily dislike. With Bosch's push-to-open, there is a locking mechanism which makes a relatively high-pitched and loud sound both before and after the door is let go. Many found the sound disturbing and reminded them of a motorised safe. Some users even thought that the dishwasher was broken or soon to be broken. Even the quieter motorised opening sound in the user study had a beep to mark the opening of the dishwasher, which was disliked by a user. According to some users, the most important audio aspect was the opening sound while other users thought that the cycle sound level being kept as low as possible was more important.

5.2.7 Light

Many users think that lighting is very important. However, one user thought that it did not matter at all. One dishwasher in the user study had to be turned on to enable the interior lights to light up when opening the door. This was considered a bad trait by the users, who prefer when the lights turn on automatically, regardless of the machine being turned on or not.

Some users thought that there should be more lighting in the back of the dishwashers' container. This would also facilitate cleaning the container or filter etc. The users generally said that the position of lighting was a larger problem than the brightness of it. Concerning the temperature of the light, one user generally preferred warm lighting but thought that white light is a fitting colour for functional lighting, helping to complete a task such as unloading the dishwasher.

5.2.8 Miscellaneous

The most important feature of a dishwasher, according to the users, is that it properly cleans the dishes. Other important aspects are quiet dish cycles, a large capacity and that the appliance is easy to use. However, aspects such as good lighting and functions like soft close in the baskets would be appreciated as well. One of the users thinks that using the dishwasher will always be a tedious and negative experience, regardless of improvement made to the appliance. Another user thought the appearance of the cover of the dishwasher very important.

Regarding dishwasher maintenance, many users noted that the salt lid was very difficult to open in both the integrated ASKO dishwasher and the Bosch dishwasher. One user said that they would have liked the refilling of salt to be placed in the door next to the refilling of dish detergent. Another user thought that the dish detergent lids were difficult to use. Generally, the users were pleased with the design of the filters at the bottom of the dishwashers' container. One user also noted that they would have liked to be able to dismantle the wash arm and split it into two parts to more easily clean its inside.

5.3 Design guidelines

The prestudy, including the benchmarking and the user study, resulted in a set of design guidelines. The complete list can be found in Appendix B. They were divided into eight different areas: General; Opening; Pulling baskets; Loading baskets; Materials, looks, and colours; Lighting; Sounds and Interface.

The general area included guidelines on the main function of the dishwasher, to clean the dishes, the cleaning of the dishwasher and ease of use. These guidelines can be seen in Table 5.1. The opening area was focused on ergonomic and user experience factors for opening the dishwasher door. The third area, pulling baskets, included guidelines on how pulling the baskets out should feel and include examples such as *Should feel comfortable to grip* and *Should not be hard to pull*. Loading baskets, the fourth area, was focused on the placement of the tableware in the dishwasher to lessen the user's worry and make the tasks of loading and unloading easier and quicker. For example, *Tableware should be stable and not risk falling or getting damaged when placed in the dishwasher*.

The fifth area, materials, looks and colours focused on the appearance of the dishwasher. In this area, there were guidelines for giving users a premium impression, following the ASKO design language and with the kitchen trends identified in section 5.1. The most important aspect on lighting is that it should reach the entire inside and facilitate the use of the dishwasher. The sound should generally be quiet but also help give the users a premium impression. The last area, interface, included guidelines such as *Should be easy to understand* and *Should be placed on top of the door*.

1 General	1.1 Enable easy cleaning of the dishwasher
	1.2 Should clean the dishes
	1.3 Should be easy to use

Table 5.1: The general guidelines from the list of guidelines.

5.4 Development and concept evaluations

5.4.1 First ideas

The first ideas were simple ideas, general ideas and full dishwasher concepts. Some of them were used to create the first concepts. The ideas were divided into possible concepts and other freestanding ideas. They can be found in Appendix C.1.

5.4.2 Informal evaluation of first ideas

The informal evaluation led to the four concepts used in the workshop; *Tor, Karusell, High Tech*, and *Lådhiss*. The comments and opinions from the users which motivated the decision can be found in appendix D.2.

5.4.3 Workshop

The workshop that was held to ideate, refine and evaluate the four concepts resulted in the choice to move forward with the natural experience and lighting-focused concept *Tor* that worked with different human senses such as vision, smell and sound. One idea that came up during the workshop was to focus on the hygiene aspect of the dishwasher experience since it is one of the most important elements for a user. It was decided to take the essence of the *Tor* idea and evolve it into a concept focused on the sensory experiences of cleanliness. More results and details from the workshop can be found in Appendix E and Appendix D.2.1.

5.4.4 Scent and light study

The first light and scent study resulted in the choice to continue with the following three scents, based on the results that can be seen in Appendix D.3.

- Lemon or *Citron*
- Soap or *Såpa*
- Forest or *Skog*

After, it was decided that the very similar scents, Soap and Forest, should be combined and the scent missing from the first study, Sea or *Hav*, should be included in the next study. In that study, it was found that aquamarine-coloured light worked well with all three scents.

When testing the placement and amount of the lights, it was found that an embedded LED light strip would be suitable to integrate into the dishwasher. It illuminates the container well, according to the users, and is in line with current kitchen trends. It was also decided to implement moving spotlights where the current lights are, as well as lights in the basket's handles. These light sources facilitate ergonomic and efficient use of the dishwasher.

5.5 Aurora – the final concept

The final concept for improving the user experience of an ASKO dishwasher is a design based around lighting and scent and how they are combined to offer a premium and elevated interaction with the machine. The concept stems from the *Tor* concept but builds on how the senses can be impacted to create the feeling of cleanliness and hygiene. It was evident from the user study that one aspect that the user values the most is that the dishwasher cleans the dishes properly. ASKO's dishwashers have excellent cleaning abilities including a hygiene program option. This concept aims to amplify the feeling of cleanliness through the use of lighting, colour and scent.

Aurora offers a combined light and scent experience when opening the dishwasher door after a finished cycle. The user is met with a teal-coloured light and a fresh scent of their choice. The teal light then transitions into a white glow. The dishwasher is also equipped with an elevated lighting effect through an LED strip around the inside container, moving spotlights on the upper side of the container and lights in the baskets' handles.

In addition to this, the dishwasher's baskets have a soft close function. It works both in the basket's innermost and outermost position and softly slows down its speed. This minimises the rattling of the items placed in the baskets and offers the user a more luxurious experience while aligning with current kitchen trends.

5.5.1 Lighting

The lighting segment of the final concept includes three different light elements – embedded LED strip, two moving spotlights and handle lights – that work together to create a premium user experience. Inspired by the kitchen and interior trends of today, the idea mimics display cabinets while incorporating a more technological touch.

Light strip
The LED light is inspired by modern kitchen and showcase cabinet lights. It is embedded into the inside container of the dishwasher and is placed flush with the container's surface and runs along the inside container of the dishwasher in an upside-down U-shape, see Figure 5.2. It is placed 16 cm – about a third – into the container from the edge of the door and is 2,5 cm wide.

This light illuminates the entire inside of the dishwasher and provides the user with a decorative element and a premium feel. The first time the door is opened after a cycle – either by the user or by the auto opening function – the light shines in a teal colour to enhance the sense of hygiene, see Figure 5.3. This was the shade that from the user study was generally considered the most hygienic and most suitable for a dishwasher. The teal colour is active until the door is opened ten cm and then gradually fades into a white colour until the door is 25 cm open, see Figures 5.5 and 5.6. After that, the LED light stays white until after the next cycle is run.

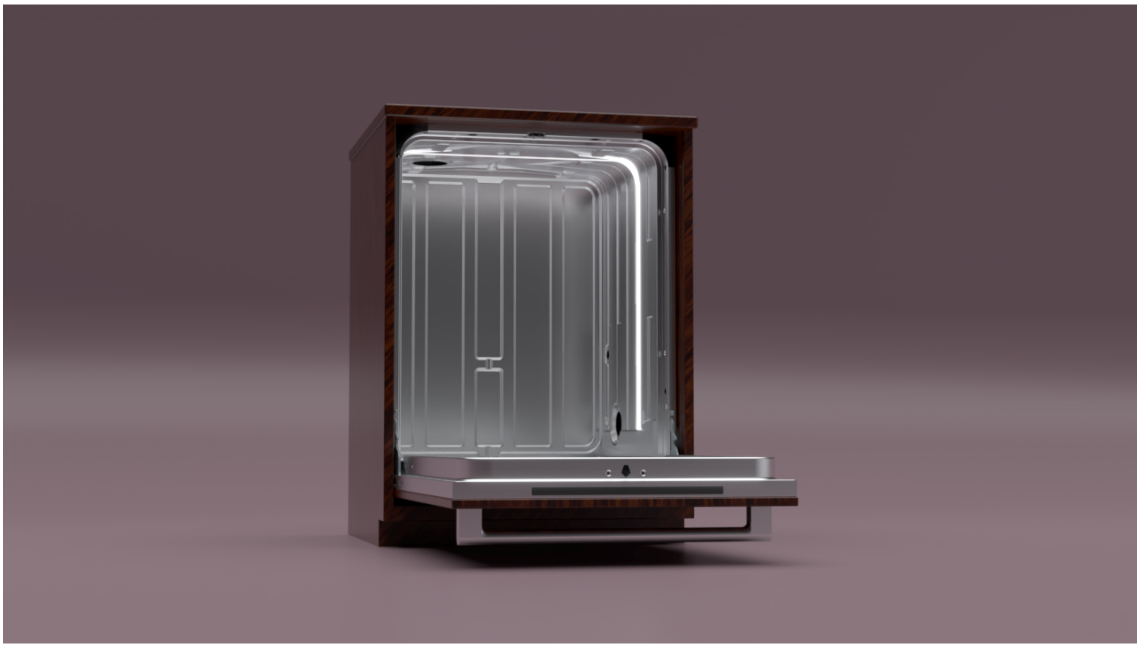


Figure 5.2: The placement of the LED strip inside a fully integrated dishwasher with a wooden cabinet. The white colour is activated when the door is opened past 10 cm.

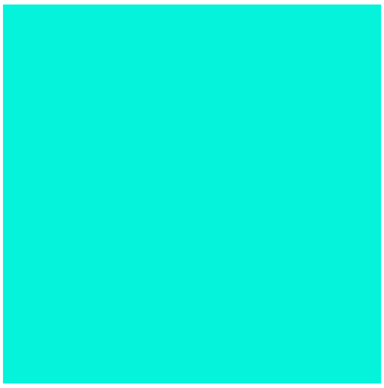


Figure 5.3: The teal colour is represented by the RGB colour code (5, 242, 219).

Moving spotlights

ASKO's current dishwasher has two fixed lights on the top of the inside container that are directed downwards. In the final concept, these two lights are tilting and illuminating the baskets as the user moves them in or out. When all baskets are in their starting position inside the machine, the spotlights are pointing downwards. When the user pulls out a basket, the light tilts and provides the user with a working light to facilitate loading and unloading. If multiple baskets are pulled out, the spotlights will illuminate the one furthest out. These lights shine in a white colour.

The user study showed that users find it difficult to clean the inside of the dishwasher because of the lighting being too low. The final concept includes a cleaning mode where the two spotlights tilt inwards to illuminate the dishwasher's container. This makes it easier for the user to for instance clean the filter or top up salt. The cleaning mode works in two ways: automatic and manual. The user usually remove the lower basket in order to better reach the entire container. When the lower basket is pulled out and removed from the door, the spotlights will automatically turn to point directly at the floor where the filter and salt compartment are located. This is enabled by a pressure sensor in the door which senses whether the basket's wheels are resting on the track or not. If the user prefers to control the spotlights themselves, a manual cleaning mode will be available in the settings menu. It allows the user to either activate the cleaning mode while the lower basket is still in its track or deactivate the cleaning mode with the lower basket removed.

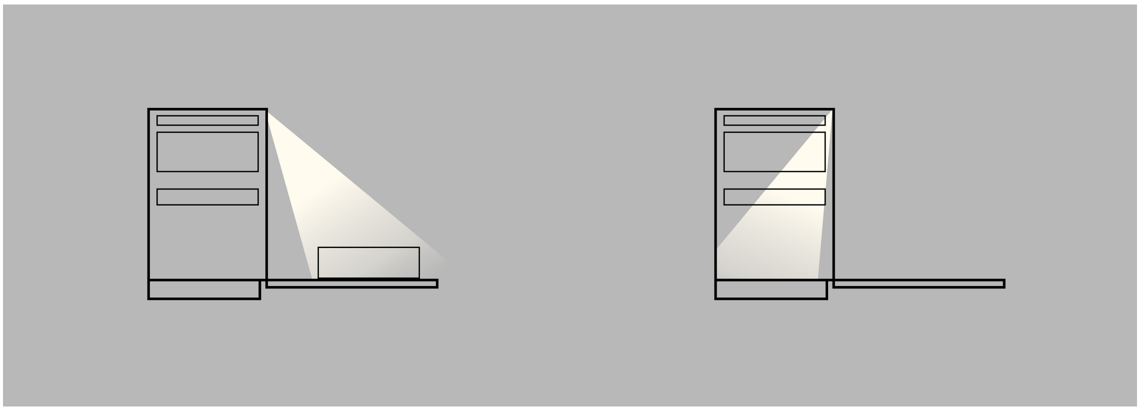


Figure 5.4: This figure shows the cleaning mode, which concentrates light on the bottom of the machine and is automatically activated when the lower basket is removed from the dishwasher.

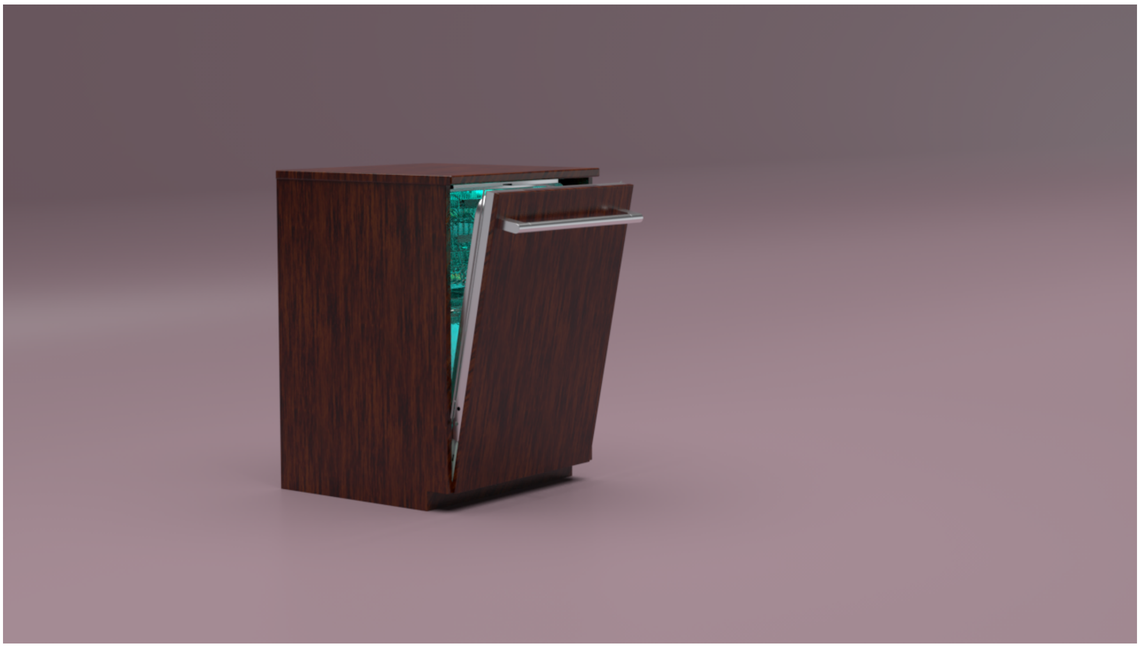


Figure 5.5: The door opens and the LED strip shines in an aquamarine colour.

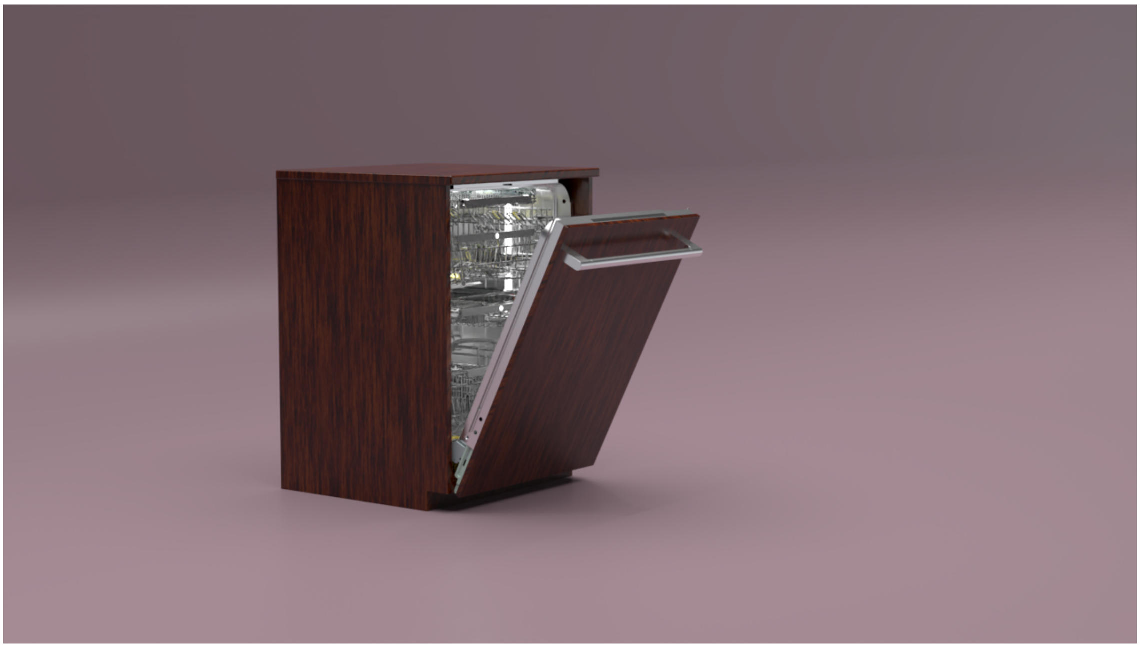


Figure 5.6: The door opens further and the spotlights and handle lights turn on. The LED strip shifts into a white colour.

Figure 5.7: A fully opened door.

Figure 5.8: When the baskets are pulled out, the spotlights tilt to constantly illuminate them.

Moving the spotlights in synchronisation with the baskets is enabled using proximity sensors. A total of ten receivers are mounted on the machine, seven of which are mounted on the baskets, two on the container's rails and one in the door. The placement of the receivers can be seen in Figure 5.9.

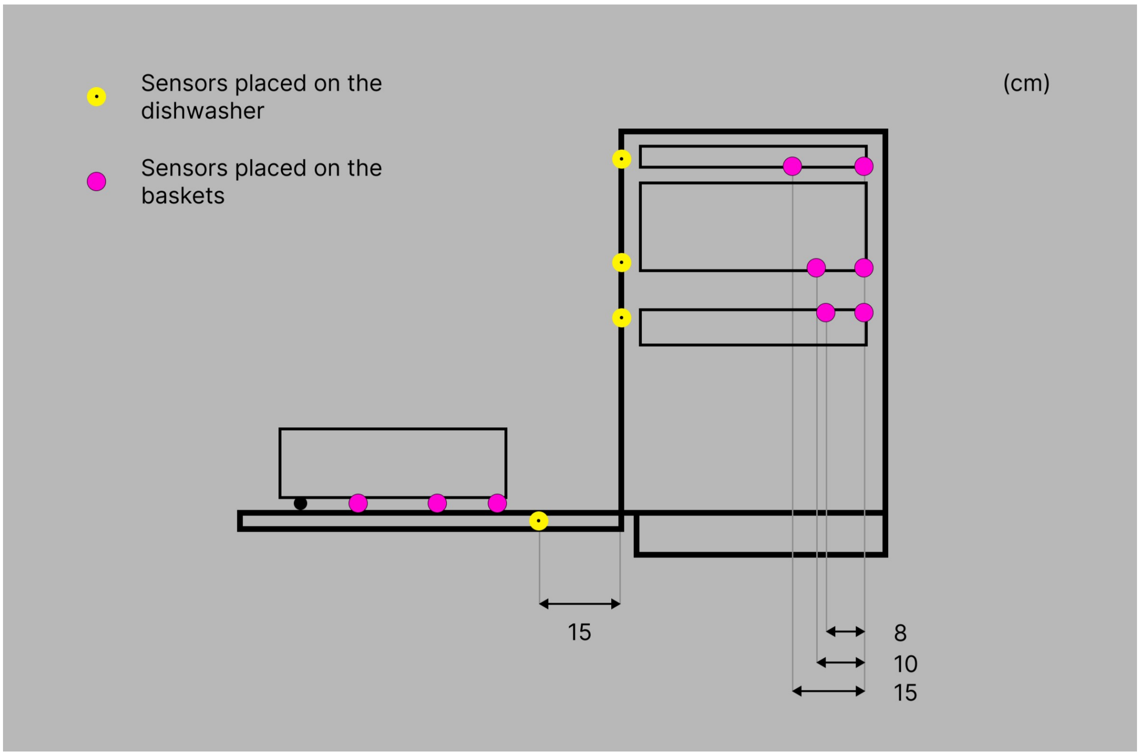


Figure 5.9: This figure shows the placement of the sensors on the dishwasher. The measurements are defined so the spotlights shine on the baskets in the best direction possible.

For each receiver that passes by another receiver, the spotlights turn so that the lights shine directly on the basket. Because of the different distances between the baskets and the spotlights, the lower basket will need three receivers to achieve a smooth movement of the lights. These are placed inside the basket's wheels. For a four-basket dishwasher, the upper and middle baskets will only need two receivers each, placed inside of the baskets' rails.

Handle lights

In addition to the LED strip and the spotlights, there are also lights in the baskets' handles. The purpose of these lights is to illuminate the baskets from the front and to highlight the handle itself. According to the benchmarking and the user study, users can struggle with noticing the top basket. Lights in the handles aim to make it easier to spot all the baskets, especially for new users.

The handle lighting consists of one light source that directs the majority of the light towards the basket and its contents. The remaining light shines through an opening in the front-facing surface of the handle. This opening is in the shape of the ASKO logo in a see-through, frosted material.

Figure 5.10: The three lights on the handles of the lower basket.

5.5.2 Scent

Aurora has the option to add a scent to enhance the sense of hygiene and clean dishes. The first time the door is opened after a cycle, the user is met with a fresh scent which is sprayed out in a thin cloud from the top of the door. The fragrance is sprayed out for only a short moment right when the door is opened and consists of an alcohol-based fragrance extract that does not leave an oil film on its surroundings.

Three different fragrance extracts are envisioned to be available for selection: Citron, Skog and Hav, as seen in Figure 5.11. Citron (English: Lemon) is a citrus scent based on lemon-scented dish soap. It reminds one of the freshness of lemon and cleaning supplies. Skog (English: Forest) is a woody fragrance that combines the scents of green soap and woody laundry detergent. It transports one to pine forests and mossy woodland. Hav (English: Sea) is a fresh and watery scent and brings to mind the coast and the ocean. Hav is inspired by freshly scented dish soap and laundry detergent. These three scents were considered the most hygienic and pleasing to the people who took part in the user study, however, the citrus scent was the most popular fragrance among the participants. Offering several scents allows users to choose their favourite scent and swap them out whenever desired.

Figure 5.11: Illustrations for the three scents *Citron*, *Skog* and *Hav*, matching the existing graphic design of ASKO's dishwasher gel packaging.

The fragrance extracts would be delivered in small packages which are added to the dishwasher through an opening next to the detergent and rinse aid dispenser. The extract is then carried to the top of the dishwasher door where a small amount of the fragrance is sprayed out right next to the locking mechanism piece. Once sprayed in the air, it dissipates with the water steam that escapes through the opening right after a finished cycle.

5.5.3 Opening moment

The opening of the door after each washing cycle is the moment when light, colour and scent are combined. The user study showed that aquamarine is generally considered the freshest colour to implement inside a dishwasher. The three most popular scents among the participants, i.e. Citron, Skog and Hav, also proved to fit in combination with the aquamarine colour and not risk causing any incongruence. The aquamarine and the three scents are inherently regarded as hygienic on their own, but the freshness is amplified when integrated simultaneously into the interaction with the dishwasher. The opening moment can be broken down into three sub-events as presented below.

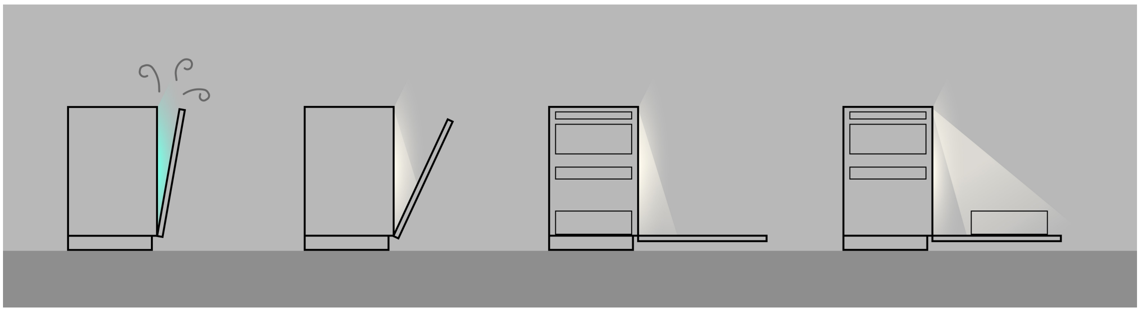


Figure 5.12: This picture shows the stages of the opening from Stage 1 to the left, to Stage 3 to the far right.

Stage 1
After each washing cycle, the dishwasher door will either be opened automatically through the auto-open function or manually by the user. The auto-open function opens the door approximately ten centimetres to stand ajar. This is also the position where the multi-position hinge allows the door to settle into a semi-fixed state, which works similarly to how car doors have several semi-fixed positions. Up to this point, the LED light strip will shine in the aquamarine colour. The lights in the handles will also light up. As soon as the door is opened, the fragrance extract will be dispensed through an opening at the top surface of the door and dissipated through the air.

Stage 2
In the next stage, the user opens the door further. Between being ten to 25 centimetres open, the aquamarine light will fade into a white colour. The two spotlights will also turn on to illuminate the dishwasher further.

Stage 3
When the user opens the door fully and pulls out the baskets, the two spotlights will tilt to light up the baskets wherever they are positioned on their rails.

6
Discussion

Through the methods, activities and analysis made during the project, it was possible to answer the three research questions and create a design solution to improve the user experience at the opening moment.

6.1 Research questions

What are the upcoming trends in kitchen design and its usage?
"*What are the upcoming trends in kitchen design and its usage?* ", the first research question is fully answered in 5.1. Some of the most distinct trends are the introduction of more and stronger colours, rounded shapes, milled-in LED strips and a culmination of the increasing size of tableware. There are also more wood and composite materials. It is important to note that the trends are more difficult to predict and are changing faster than before. The norm is also wider and more diverse than before.

Since the way the trends work has changed, the predictions are both more difficult to make and more uncertain. It is very difficult to say for how long this prediction will stay true, and if some aspects of the exhibitions will never be seen in the consumers' households. It would have been preferable if these predicts could be said to apply for an exact amount of time. However, that does not seem to be possible. Some of these trends are made based on the global financial situation, which in itself is very difficult to predict. For example, that people will begin to cook at home more again and therefore create more dishes. If the economic situation improves again soon, it is likely that some will start eating out and ordering takeout. The world of politics may also impact the trends. As one expert mentioned, there is currently a lack of wood due to several ongoing wars in the world. More conflicts or other political uncertainties would cause a greater shortage of wood while peace may resolve the current issue.

One of the trend experts said that customers usually choose their appliances before the rest of the kitchen when designing a kitchen. This could mean that design choices made in the dishwasher or other appliances could impact how people choose to design their kitchen. This would make these trends and predictions even more uncertain if bolder dishwasher and appliance designs were made.

How do users perceive ASKO's dishwasher interactions?
The second research question," *How do users perceive ASKO's dishwasher interactions?* " has many answers, including some contradictions from different users, which can be seen in 5.2. Overall, the users were positive. Since different ASKO dishwashers have different opening mechanisms, mainly push-to-open or pulling the door open, both of them were evaluated. Many users liked the ASKO push-to-open better than that of Bosch, but they also felt that pulling the door open required quite a lot of strength. However, one user disliked the opening beep sound with the push-to-open solution. Many also took issue with the delay in the motorised solution. Regarding the baskets, they liked the denser baskets and the looks of the thinner handles of the ASKO dishwasher despite it being less comfortable to hold on to. The users also liked the flexible solutions for the holder, although some of them were not found by the users during the tests. Many users also liked the interface of the ASKO dishwasher, although they preferred it when it was on top of the door and some would have preferred physical buttons. Opening the salt lid was considered a large issue. The users were also very positive about the appearance of the ASKO dishwasher, including the the dark grey and grellow colours. In conclusion, the users perceived the interaction with the ASKO dishwasher positively but had some complaints.

Based on the complaints received during the user study, the overall design and construction of the ASKO dishwasher should be kept. However, some smaller changes could be made. For example, to see if the comfortability of the thinner handles could be improved, if the existence of the flexible holders could be made clearer to the users or if all user interaction points could be placed on top of the door. The downside to the last suggestion would be that it would require another screen to communicate with the user while it was running. More user studies on the subject would be needed to gain a better understanding of the users' needs and preferences to improve the product line further. Preferably, there would be a small-scale user study accompanying each design change to ensure the improvement. However, this is probably not economically feasible to do.

What aspects of dishwasher use are important for users?
The third research question, "*What aspects of dishwasher use are important for users?*" can be answered with the cleanliness of dishes, that the dishwasher works and that it is easy to use. Those are the most important aspects to the users but many users also consider other aspects essential as well, such as lighting or appearances. However, the users have very contradicting opinions on aspects such as the last examples. This means that many of the found aspects may not apply to all users but the three most important do and therefore answer the research question. Hygiene and cleanliness are a key factor since that is a dishwasher's main function. The hygiene factor was a major motivator for the design choices made at the end of the project, both in the design of the last user studies and in the final concept.

The fact that ease of use is also an important factor for the users is natural since it is a key element for all designs. The fact that they want it to just work, and for a long time, is not very surprising either. Dishwashers cost a lot of money and are just one of many appliances in most homes. The last two aspects might be fulfilled by having a very simple dishwasher since fewer components would mean fewer components that could possibly break and a simple solution would be easier to understand for users. However, more components and more complicated and refined designs could also help the upkeep and make the dishwasher last longer.

6.2 Results

This project resulted in a large quantity of information, guidelines and a final concept through benchmarking, user studies and concept refinement.

6.2.1 Phase I: benchmarking and guidelines

This project gathered a lot of information about current dishwashers, user-dishwasher interactions, and trends. Most of it was very useful for the development.

Benchmarking of current dishwasher
The benchmarking of current dishwashers was a large part of the project and used up a lot of time. However, the greatest gain from it was the understanding of the product and what was currently on the market which is important but could, for example not be used when creating the guidelines. It was still useful for the ideation since it showed what holes exist on the market.

Benchmarking of kitchens
The kitchen trends were difficult to predict and although a collection of trends could be made, how they will be used and for how long is harder to tell. The experts and the findings from what could be observed in stores and exhibitions seemed to agree. With the faster trend changes, those trends may fall out in a few years. The timeline and the trends which are not even showing on the horizon yet are the most difficult thing to predict. The goal was that the many different methods would make predicting these things possible, however, this project did not create any confident predictions on those subjects. The fact that the trends are most uncertain and diverse is also information that can be used in design development for kitchens. Perhaps setting a trend would be easier now.

Benchmarking of other products
The benchmarking of other products, such as other home appliances and cars, was used as inspiration during the ideation. A large number of the findings from the car industry are related to many different types of handles. However, designing handles had been excluded from the development since it focused on integrated dishwashers with no handles on their own and have to work with different handles. Some handle-related aspects found could therefore not be used in the development phase. Many interesting functions were found in the other appliances and they were used as inspiration both for functions and placements. Looking at other appliances is also important since it hopefully makes a more coherent kitchen.

User study
The user study results gave vital insights for this project. However, there were many contradictions. It is possible there would have been even more contradictions between users if the sampling size had been larger. Additionally, some insights may not have affected the design process but could still be very valuable to the company. One user was negative about lighting before the tasks but had changed their mind

by the end of the interview and user test when they had gotten the chance to try a dishwasher with lighting. In general, many users said that they would like a dishwasher to just do the job of cleaning dishes and be simple, but they also appreciated the extra functions of more complicated dishwashers.

Overall, the contradictions between the users make the results more difficult to use since the opinions are subjective but also based on their personal experience and preferences. This makes insight on the general opinions difficult to gain. Perhaps there is no general opinion among the users on some subjects. However, this also means that trade-offs are required during the design process.

Guidelines
Since the guidelines were based, mostly, on the findings from the user study, they apply to a larger part of the dishwasher than the design development focused on. This means that many guidelines are not relevant to the final concept. For example, the final concept will not impact the cycle sound level or how tableware is placed in the dishwasher.

Some of the limits in the guidelines are also based on the testing done for the refinement of the final concept rather than the user study. This means that it is based on the opinions of a smaller sample size and could therefore possibly not comply with the general opinion. This means the results could have been different if a more extensive test had been made. However, the guidelines are a good start to gain some insights for the dishwasher development process.

6.2.2 Phase II: final concept

Considering the aim and objective of the thesis, the final concept does fulfil the goal of creating a visionary design solution for a dishwasher opening experience. It is based on the pre-study of kitchen trends and user experience and includes these aspects to create an improved user experience for the future of dishwashers.

The final concept builds on the idea that mindful use of light, colour and scent creates a premium user experience on several points. The concept builds the user's sense of ASKO being a luxury, trend-aware, hygienic and high-performing brand. It meets the following requirements from the design guidelines in Appendix B:

- It should enable easy cleaning of the dishwasher
- The Baskets should be clearly visible to the user
- The baskets should not rattle the tableware when pulling/pushing the basket
- It should comply with current and future kitchen trends
- The light should reach the entire inside
- The light should facilitate use of the dishwasher
- The lighting should turn on automatically when the door opens
- It should give users a premium, exclusive and clean impression

Comparing the final concept to the guidelines, one may notice that the concept does not fulfil all the identified requirements. This was a conscious choice made at the beginning of the development process. The guidelines include many diverse elements that would simply be too difficult to condense into a single design. It was decided that the ideas during the ideation process were not required to meet all the criteria, but rather have a distinct theme or purpose. The final concept therefore aims toward the theme of ease of use and hygiene and meets a selected number of requirements in the guidelines. The guidelines are a result of their own and can be used during the future development of dishwashers or other kitchen and household appliances.

The final concept could be further developed in different ways. For example, a more detailed and comprehensive prototype should be developed to determine any details that could not be covered in this project. The prototype created in the project did not include the spotlights, the lights in the baskets' handles or the scent spray dispenser due to limited time and components available. The different elements of the design were tested on their own, but a prototype complete with all the important aspects would be needed to understand how they impact each other. Moreover, a study of how the concept is perceived in an at-home context is necessary to fully understand how the design impacts the users' impression of quality and cleanliness.

6.3 Process

Since the activities during the prestudy phase required a lot of time and documentation, the later activities had less possible time and thus made the project process front-heavy. Even though the user evaluations only started after the completion of phase I, the ideation started early in the project. This, however, meant that the iterations with direct user feedback on the ideas began in the second half of the project. Despite that, several iterations could be done, although perhaps not as many as would be ideal. A large number of iterations are important since direct feedback is needed to create a good final concept. Only a good understanding of the context is not enough since different people have different preferences and the designer could be an outlier.

The problem or solution space remained large and open for a long time in the project. The four concepts in the workshop were very diverse and this could have contributed to a feeling of time constraint at the end of the project. Deciding to use the workshop to gather feedback for deciding which area to continue in probably meant that that decision was delayed. When working with stages it is important to start with the next one and not wait them out to save time.

However, the two phases made the planning less complicated by creating a simpler project model. They were always supposed to be done in conjunctions, but it is possible it would have been beneficial to start the user evaluations earlier, pushing the later activities of user studies into phase I, see Figure 4.1. It would probably have meant that the early ideation would have been more effective. Now, it was mostly inspired by the benchmarking of kitchens, dishwashers and other products.

Since both the user study and the workshop were held with and at ASKO, regular communication was very important. It was also very good for understanding the product and many other aspects of this project.

6.4 Methods

The study involved a user study in which the participants were asked to load and unload a dishwasher with dishes and kitchenware. The test could not reflect a real at-home use scenario for several reasons. Firstly, due to time constraints, the study could not involve letting the participants run a full cycle of the dishwasher. Secondly, the dishes and kitchenware used were completely clean and dry. In a real-life context, they would likely be dirty when loaded into the machine and damp when unloaded. Furthermore, the users were asked to load two place settings, a total of 21 items, into the machine which did not fill the baskets as dishwashers normally have a capacity of 12-14 place settings. An exploration of how users experience fully loading the dishwasher would have been of interest. Because of limitations in time and available kitchenware, this was not covered by the user study. The user study may have had a different result, had the study accurately reflected a real-life scenario.

The scent study results may have been influenced by the coloured glasses since associations between colour and scent are usual. They may have influenced the light colours chosen by the users later. The glasses, however, were chosen to be different colours to make it easier to document the results and to distinguish them.

During all user studies, convenience sampling was used, which could have affected the results by creating bias. For example, all participants lived in the same province. However, most of the participants did not know each other and would not have contact. Hence, they were not likely to have discussed it with each other and increased bias. Another aspect that may have created bias would be that the participants may have been uncomfortable acting as they would have with their dishwasher at home since they were in a vulnerable position and knew the two study conductors were observing them. This could have caused participants to act more according to what they consider the norm in dishwasher use.

Visiting the 2024 Stockholm Furniture Fair created interesting and inspiring insights into upcoming interior trends. Witnessing the artistry and craftsmanship sparked the later ideation of the project. Being able to speak to the artists and company representatives also gave the project a deeper understanding of new trends, different materials and manufacturing processes. However, considering that this was the first furniture fair that the authors visited, it could be difficult to know which of the exhibits are trend-driven, upcoming interior pieces and which are independent art. Many of the exhibitions at the fair were still in line with the previously identified trends in kitchen and interior stores. The Stockholm Furniture Fair was therefore also an effective method to confirm findings.

A physical, proof-of-concept prototype of a dishwasher was made during the project in order to explore the shape of an actual dishwasher and to test ideas. The creation of a cardboard mock-up on a low detail level proved to be a beneficial approach during the development process. It sparked creativity and facilitated the ideation process.

6.5 Sustainability and ethics

The final concept aims to increase the user's perception of clean dishes and a hygienic dishwasher. This does not however improve how clean the dishes actually are. ASKO's dishwashers do have excellent cleaning abilities, but what if the dishwasher would not properly clean for some reason? The design proposal is not intended to fool the user into a false sense of safety of believing that the dishwasher is hygienic if it actually is not. It could risk creating an incongruence between perceived quality and actual quality, making the user put less trust in the ASKO brand. However, as long as the dishes come out clean, and the perceived hygiene and the actual hygiene align, the design proposal strengthens the relationship between the user and the product.

Sustainability-wise, the final concept uses more resources than current dishwashers, both through the inclusion of more lighting and the scent. It can be argued that the potential sustainability gain from the final concept is smaller than the resources that it uses since the only potential sustainability gain would be increased use and trust in dishwashers. That use would also have to replace hand-washing dishes. The increased use of resources such as materials and energy would be caused by the added components. The scent is also meant to be refilled which results in an increase in resources used during the entire lifetime of each dishwasher with this design solution. This is also true for the added energy consumption that comes with added lighting.

However, there are other gains which justify the existence of this concept. It could improve users' experiences and relationships with their household appliances and the ergonomic aspects of the functional light can help lessen the detrimental effects of strain. Improved user experience, usability and ergonomics can also lead to more inclusive products, facilitating use by the elderly or people with cognitive impairments. This would be a good development for society but the more than standard price for the product is still limiting for those with a smaller budget, which can be common among elderly and people with disabilities. Making premium products can be considered promoting consumerism, although they are also supposed to and expected to last longer than their cheaper counterparts. This can also be considered an ethical dilemma since it would mean that those with more funds can buy longer-lasting and more expensive products than those with less funds. This can then lead to more costs for those with fewer resources and contribute to financial inequality. However, the increased lifetime will mean less waste.

This thesis involved user studies and user observation, which could lead to risk to the user's privacy. Although all involvement in these user studies will be completely voluntary and anonymous, there is still a slight risk that this project will lead to the gathering of their personal information and create a risk of other people accessing it. During the project, efforts have been made to ensure the anonymity of user study participants and interviewees.

6.6 Potential future studies

Areas related to this thesis that would be interesting to study more are many. For example, one could study the ethics of creating the impression of something that may not be true, in case of malfunction. Kitchen trends and how interior trends change over time could be another area to study more since it is very complex and has many challenges. Extensive studies on how people interact with dishwashers and are impacted by dishwasher design could make dishwasher development more effective. How this final concept would be perceived by the users and tests with a high-fidelity prototype would facilitate the continued refinement of Aurora. More studies and work on the manufacturability of the concept could also be of use. More development could be made with the other concepts presented in Appendix E and create a more mobility ergonomic dishwasher design.

7
Conclusion

The main kitchen trends identified were rounded edges, more natural wood and colours, especially red and pink tones, and embedded LED strips in display cabinets. It was also clear that the trendsetting and trend life cycle has changed and become more uncertain. The main findings regarding dishwasher use and opinions were that users' most prioritised aspect was the cleaning of dishes and ease of use. It was also clear that interior lighting played a part in how many users valued different dishwashers. A wide set of guidelines for dishwasher design could be generated.

The final concept is a light and scent combination with a milled-in colour-changing LED strip one-third of the way into the dishwasher, a functional spotlight, moving with the baskets and lights behind the basket handles to improve the perception of cleanliness and premium experience. It was found that aquamarine and the three scents were considered clean and hygienic.

The aim of the project was to investigate how the opening moment is experienced among users. The research did, however, go beyond this and included other aspects of dishwasher use, such as loading and unloading the baskets, cleaning the filter etc. Therefore, the guidelines cover more than the initial research question. Having said that, the final concept was more niche than the guidelines and focused on a selection of the findings. This implies that the initial focus of the study, i.e. a premium opening experience, shifted throughout the project to arrive at hygiene and ease of use since those were the main points of the user study.

Possible future studies on the subject could include further developing the final concept for implementation and manufacturing, further studies on kitchen trends or more extensive user studies on dishwashers.

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Appendix

A

Benchmarking

A.1 Stores visited

Kitchen retailers

- Puustelli
- HTH
- IKEA
- Vedum
- Ballingslöv

Home appliances stores

- Elgiganten
- Electrolux Home
- Power

Car retailers

- Polestar
- Lexus
- Hedin Bil Hongqi

Interior design stores

- Nordiska Galleriet
- Designtorget
- Bolia
- Vallgatan 12
- Slettvoll

A.2 Dishwasher evaluation

Table A.1: The template used in the benchmarking of dishwashers.

Brand and model name	
First impression (1-10) Overall look (1-10) Style Integrated (Yes/No) Type of handle	
Interface	
Screen placement Interface (1-5) Number of buttons Number of steps to start cycle	
Opening	
Force (N) Angles (1-5) Type of grip Experience of grip (1-5) Sharp edges (1-5)	
Senses	
Visual Smell Sound Spatial/Haptic Texture Vibration Pain	
Other	
Plugged in (Yes/No) Overall impression (1-10) Comments	

A.3 Expert Interviews

A.3.1 Interview guide

Kan du berätta om din roll i företaget? Vad jobbar du med?

Trender

Hur upplever du att dagens kökstrender skiljer sig från tidigare?

Vilka trender kan du identifiera?

- Layouten av köket
- Förvaring, luckor/skåp
- Användningen av köket, social plats
- Matlagningstrender, hur vill vi laga mat idag? Smarta vitvaror
- Disktrender?
- Material och texturer
- Färg
- Handtag/öppningsmekanismer (se nedan)
- Ljus
- Ljud

Skulle du säga att dagens trender är mer eller mindre spretiga än tidigare?

Kan du se någon stor skillnad mellan olika grupper i samhället i vilka trender de följer?

- Några aspekter som skulle kunna gruppera dessa?
- Hur har detta utvecklats från tidigare?

Framtiden

Hur kommer framtidens kök se ut?

- Materialval?
- Storlek?
- Mängd förvaring?

Byggnadsvård/Vintage

Hur ser du på intresset för byggnadsvård eller vintagekök?

Figure A.1: The first page of questions in the expert interviews.

Har det påverkat er industri något?

Hur hanterar ni det?

Kan du se att det har påverkat trenderna på något sätt?

Hur tror du att det kommer att utvecklas?

Probing-trender

Hur stor trend skulle du säga att trä och naturmaterial är just nu och hur tror du att det kommer utveckla sig?

Många trendkök 2024 verkar vara innehålla mycket rundade former och rött? Håller du med och tror du att det kommer att säljas mycket? Kommer det hålla i sig?

Handtag

Har du sett några trender gällande specifikt handtag och öppningsmekanismer i köket?’

Hur förväntar du dig att dessa trender kommer att utvecklas framåt?

Probing; Skulle du säga att användandet av T-handtag ökar?

Probing; Skulle du säga att gömda eller integrerade handtag ökar?

Utrustning

Hur tror du att trenderna, gällande serviser, kommer att utvecklas?

Tror du att material kommer förändras?

Finish? Storlek? Asymmetriska former?

Hur tror du att trenderna gällande köksutrustning kommer att ändras?

Vitvaror

Ser du någon trend kring om kunder i hög grad väljer samma varumärke till alla sina vitvaror eller blandar?

Har du identifierat någon annan trend gällande vitvaror?

Hur tror du i så fall att denna/dessa kommer utvecklas i framtiden? Om 5 år? 10 år? 30 år?

Tror du att fler delar av olika hushållsmaskiner kommer att bli avtagbara och diskmaskinsäkra?

Figure A.2: The second page of questions in the expert interviews.

A.3.2 Results

The information gathered from the expert interviews was condensed into a KJ-analysis which can be seen in Figures A.3, A.4, A.5 and A.6.

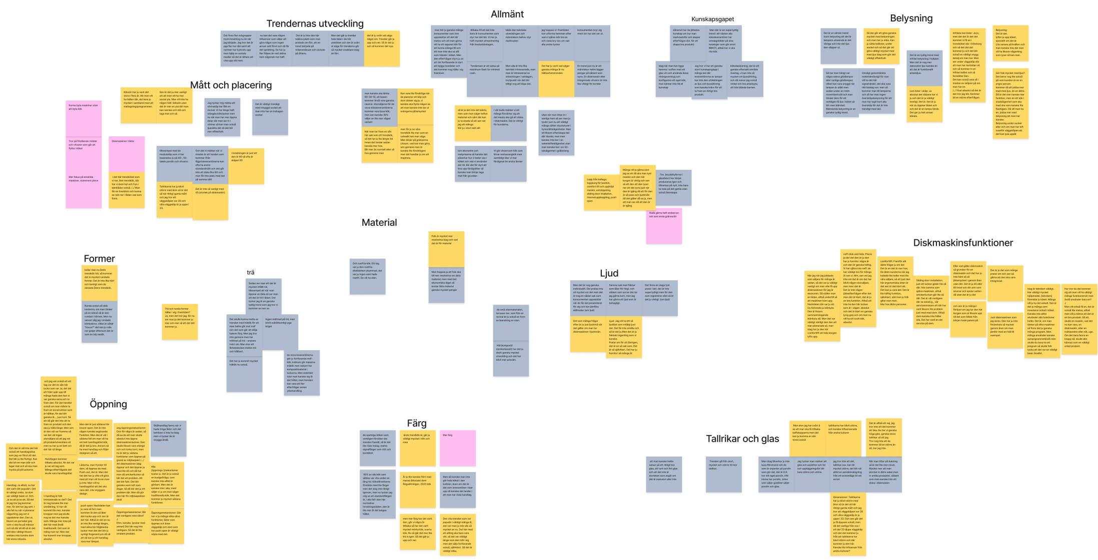

Figure A.3: The whole KJ-analysis from the expert interviews. It can also be seen divided into three parts in figures A.4, A.5 and A.6.

Figure A.4: The first part of the KJ-analysis from the expert interviews.

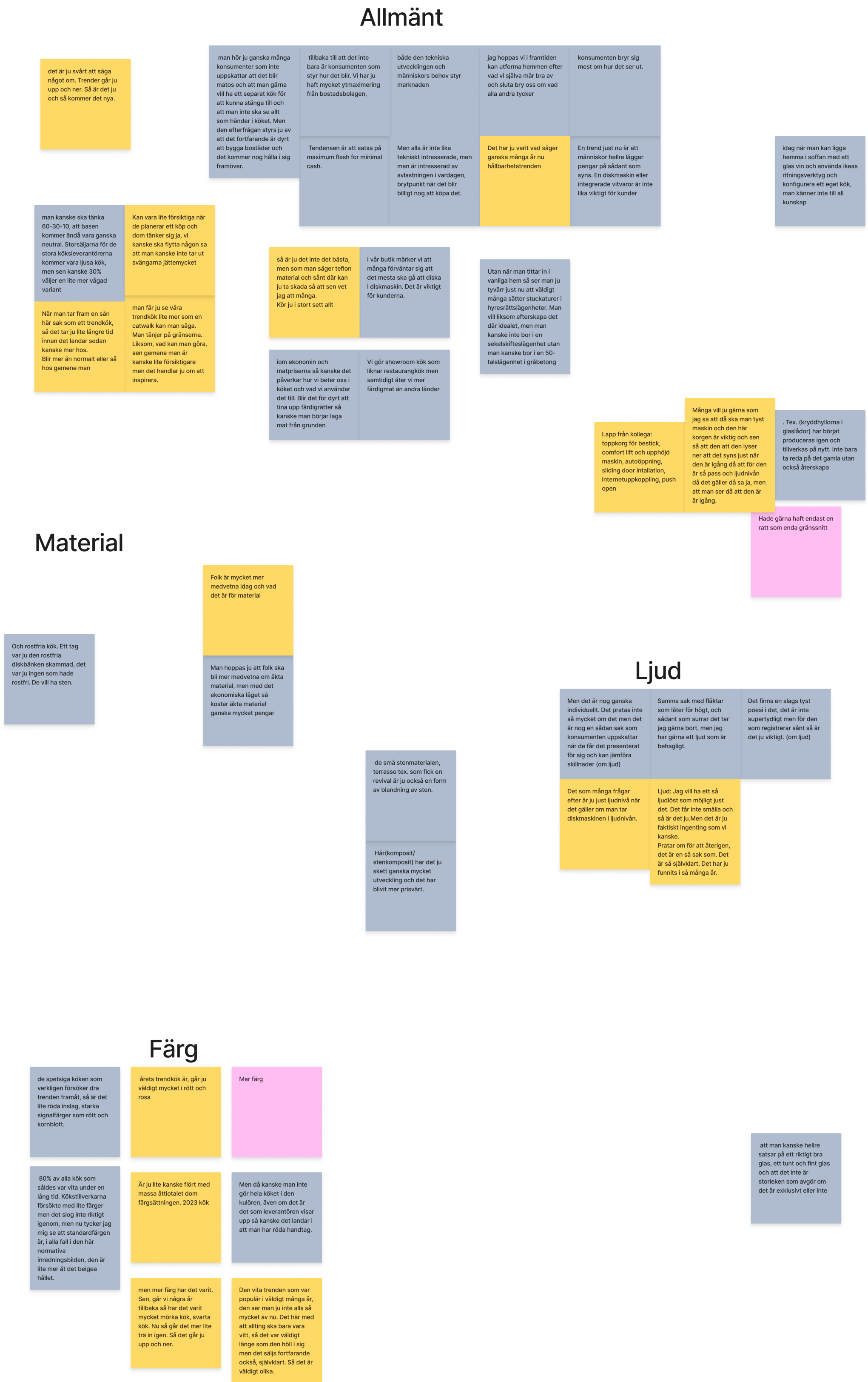

Figure A.5: The second part of the KJ-analysis from the expert interviews.

Figure A.6: The last part of the KJ-analysis from the expert interviews.

B
Guidelines

The design guidelines for the design development, divided into eight different areas, can be seen in Table B.1, on the next two pages.

Area	Requirement	Clarification	Requirement/Wish
1 General	1.1 Enable easy cleaning of the dishwasher	Concerning the filter, the spray arms and generally	R
	1.2 Should clean the dishes	According to regulations	R
	1.3 Should be easy to use	At least 80 % of people should think that it is easy to use	R
2 Opening	2.1 Should not require large amount of strength	Not over 50 N	R
	2.2 Should not require uncomfortable positions	Not too extreme angles in back, arm, wrist or fingers	R
	2.3 Should open swiftly	No slower than Asko or Bosch, preferably quicker	R
	2.4 Should not spring upward when opened	1 mm	R
	2.5 Be possible to leave slightly open	5 - 15? cm, both for ventilation and people's preference	R
	2.6 Should close easily and swiftly	Similar to Siemens	R
	2.7 Should close like a magnet	Similar to Siemens	W
	2.8 Opening mechanism should be easy to understand	At least 80 % of people should understand how to open within 10 seconds	R
	2.9 The auto opening function should not risk damaging the counter	No water or heat damage found in the counter or door after regular use of the	R
	2.9 The auto opening function should not be an obstruction to the user	The door should not extend too far out	R
	2.11 It should be possible for the door to be handleless	Integrated machines should be able to have smooth doors, in handleless kitchens	W
3 Pulling baskets	3.1 Should not be hard to pull	Should not feel like the baskets on Bosch	R
	3.2 Should not feel loose	At least 80 % of people should think that they feel stable	W
	3.3 Should be possible to pull completely out	The entire basket should be easily accessible when pulled out	W
	3.4 Should feel comfortable to grip	At least 80 % of people should think that they feel comfortable	R
	3.5 Should not rattle the tableware when pulling/pushing the basket	Mimimize the sound of the ratteling tableware primarily	R
	3.6 Should be clearly visible to the user	All baskets in the dishwasher should be visible when standing next to the dishwasher	R
4 Loading baskets	4.1 Reduce the risk of stacked plates making the lower basket back heavy		R
	4.2 Enable users to effectively load small bowls	For reference: Rörstrand Swedish Grace small bowls	R
	4.3 Enable loading of tableware of different glasses	Including big wine glasses, shot glasses, tall and wide glasses, delicate glasses	R

Area	Requirement	Clarification	Requirement/Wish
	4.4 The flexibility functions in the baskets should be easy to use	At least 80 % of people should think that they are easy to use	R
	4.5 The baskets should have a densely wired floor	Similar to Asko's	W
	4.6 It should be easy to place and unload cutlery and other kitchen tools in the	At least 80 % of people should think that they are easy to place and encounter little to	R
	4.7 Placing cutlery and kitchen tools should be easy for all household members	i.e. there should be a loading system that multiple people can follow	R
	4.8 Tableware should be stable and not risk falling or get damaged when placed in	Especially glasses and big plates and bowls	R
5 Materials, looks and c	5.1 Give users premium, exclusive & clean(sv:stilren) impression	At least 80 % of people should think that	R
	5.2 Use a monocromatic colour scheme and materials		W
	5.3 Use materials that are easy to clean		R
	5.4 Use the colour grellow to communicate functions and encourage actions by the user		R
	5.5 Use durable materials that sustain their quality over a long period of time	The materials should be in an acceptable state after 20 years of use	W
	5.6 Comply with ASKO's design language	Scandinavian design. As specified by the company	R
	5.7 Comply with current and future kitchen trends	See separate visualisation and section	W
6 Lighting	6.1 Light should reach the entire inside		R
	6.2 Light should facilitate use of the dishwasher	At least 80 % of people should think that	R
	6.3 The lighting should turn on automatically when the door opens	Within 1 second	R
7 Sounds	7.1 The machine should run quietly		R
	7.2 The door should open and close quietly	At least 80 % of people should think that	R
	7.3 The auto opening function should be quiet	Should *not* sound like Bosch's push open function	R
	7.4 The sound of the dishwasher should be pleasing to the user and give a premium	At least 80 % of people should think that it gives such an impression	W
8 Interface	8.1 Should be easy to understand	At least 80 % of people should think that the interface is easy to understand	R
	8.2 Should be placed on the top of the door		W
	8.3 Should give the user feedback	The users should be aware of when they have made changes and pressed buttons or	R
	8.4 The dishwasher should communicate cleanliness to the user		R

Table B.1: The guidelines for dishwasher design.

C

Ideation

C.1 First simple concepts and ideas

The early ideation session gave many different ideas. Some of them can be found can be found in Figures C.1 and C.2. There were some ideas for a full dishwasher redesign and other ideas which would also cause small changes. Examples of whole redesigns could be the rolling dishwasher or *snigeln*. Medium-large ideas could be adding a window in the door or having a folding door. Examples of smaller changes could be waving to the door to open it or adding a small button for opening.

After many ideation sessions, the main results were condensed into a summary with two groups, possible concepts and standalone ideas which could be used to add to concepts or be combined into concepts. The list of possible concepts can be found in Figure C.3 and the list of ideas can be found in Figure C.4. Some examples of the possible concepts are *tor*, which is an imitation of a lightning storm and *röststyrd* which is a concept for voice control. *Snigeln* is a spiral dishwasher and *Lådhissen* is made to look like a kitchen drawer. *Karusellen* is a dishwasher with rotating baskets. Examples of the ideas are soft close for the baskets, handles for the top cutlery baskets, different lighting effects, pressed patterns on the container surface and kick-to-open, which means you kick beneath the front to open the machine.

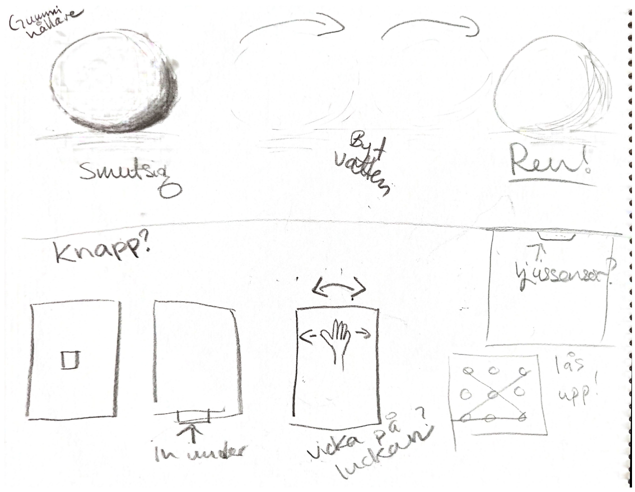

Figure C.1: Some sketches from the early ideation sessions. The upper sketches represent a rolling sphere dishwasher, in which the dishes are secured with rubber holders. It is filled with water and detergent, rolled, emptied, filled with water, rolled and then done. The lower sketches depict different ways of interacting with the door to open it. From the left, a button in the middle of the door can be seen. Then there is a button beneath the door. There is a sensor for waving on the door and lastly a swiping lock.

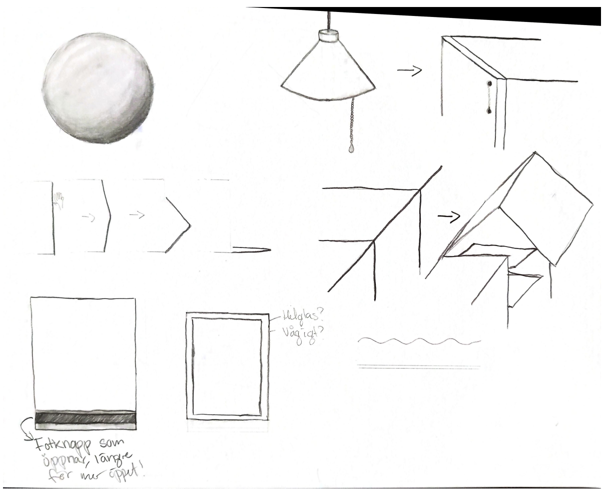

Figure C.2: More sketches from the early ideation sessions. These include a door which folds up and a folding door with a fold in the middle. There is also a foot button. The lower sketch also shows a window in the dishwasher.

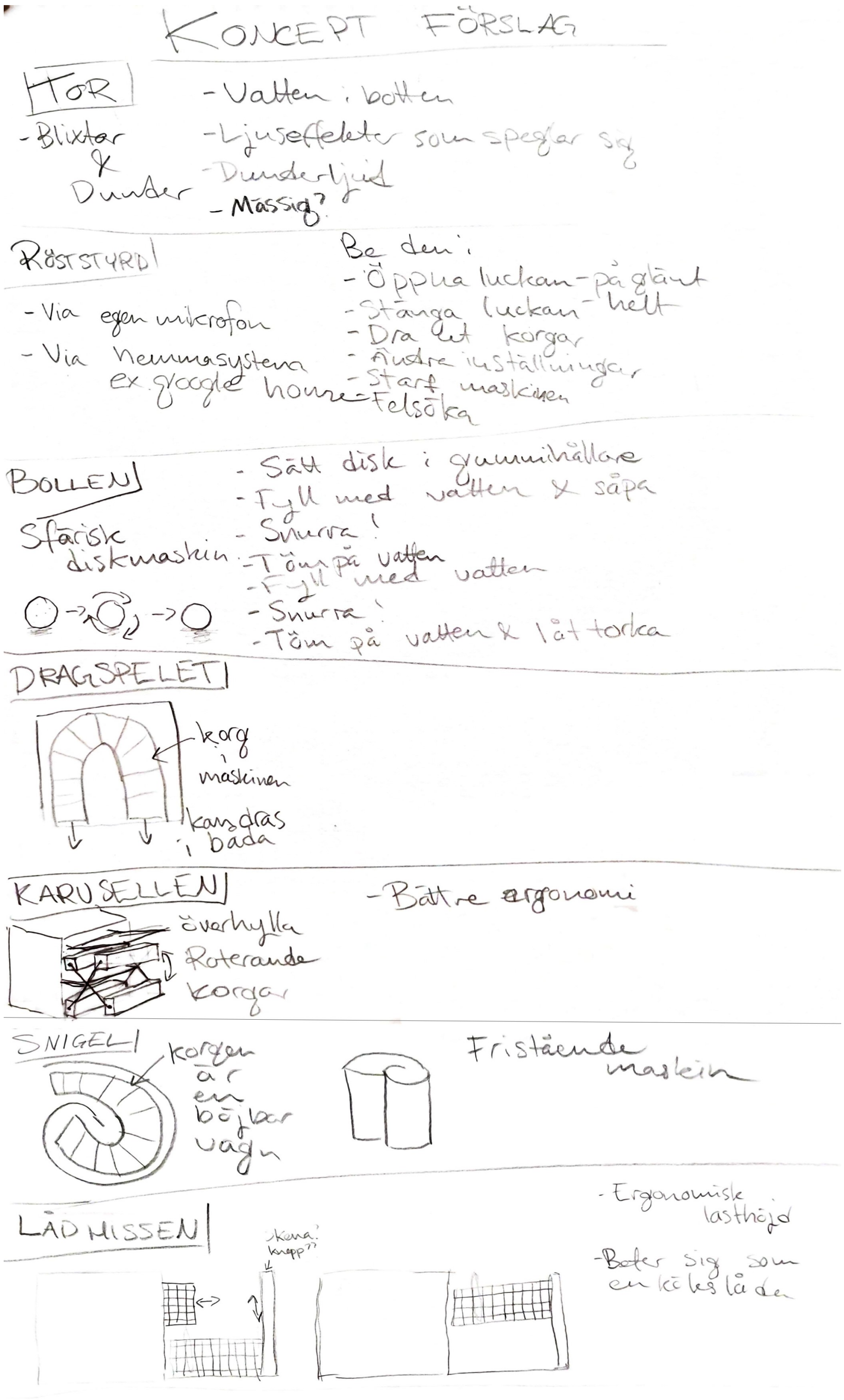

Figure C.3: Here sketches from the summary of possible concepts can be seen. The first concept is called *Tor* and includes water in the bottom, reflection, flashing lights and loud sounds. The second concept, *Röststyrd*, is voice-controlled and connects to one's home system. The third concept, the ball, rolls the dishes and water. The fourth concept, *Dragspelet*, has flexible baskets which can be pulled out on both sides. The fifth concept, *Karusellen*, has rotating baskets. The sixth concept, the snail, has a flexible basket in a swirly shape. The last concept, *Lådhissen*, is like a kitchen drawer with a lift in the door to elevate the lower basket.

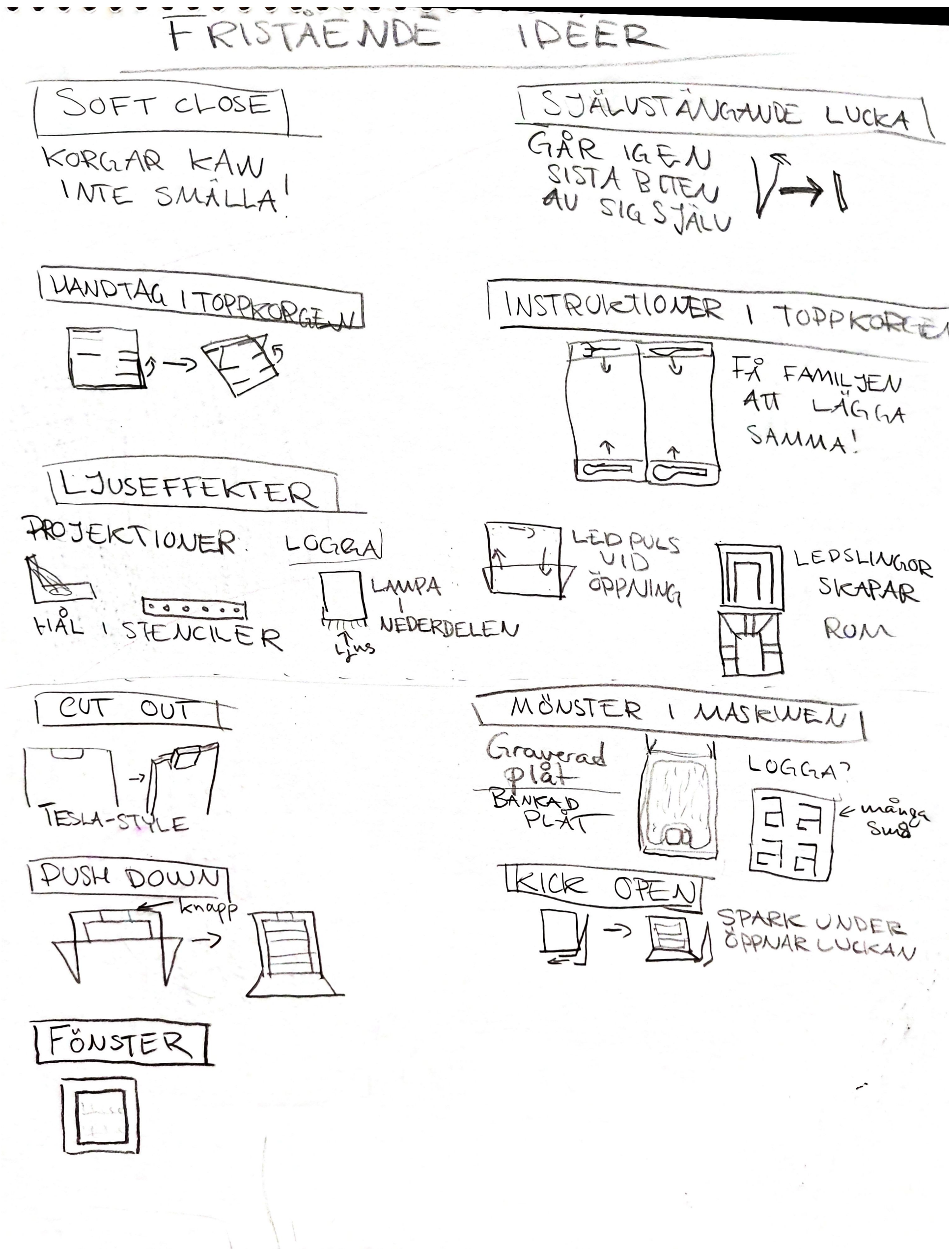

Figure C.4: These are sketches summarising ideas that could be used to combine with each other or the concept suggestions to create a concept. The first column starts with ”soft close”, to make sure that the baskets are pushed in softly. Then there is a handle for the top basket. After that, there are lighting effects such as reflections and projections. There is also the suggestion to have a cut-out handle from the door. Then there is ”push down”, where pressing a button presses the door down. At last, there is the idea of having a window in the dishwasher door. In the right and second column, it starts with the door closing itself at the last part of the close. Then there are instructions for the top basket. Thereafter, there are different patterns in the steel of the container. Lastly, there is a kick-to-open, which works like a car trunk.

D
User studies and evaluation

Several user studies were done during this project. The first one on dishwasher use, experience and impressions. Then two studies were done on lighting and scents. These studies were done to gain an understanding of the users' preferences, impressions and opinions. There were also evaluations done with users. For example, the informal evaluation and the evaluation of light placement in the dishwasher.

D.1 First user study

During the first user study, two different templates were used. One described the process, tasks and questions to be asked, which can be found in Fiure D.1.1 and Figure D.1. The other one was the template for the UX-curve which can be found in D.1.2 and the Figure D.2.

D.1.1 User study template

Frågor

Grundfrågor innan start

- Lagar du mycket mat?
- Om du har diskmaskin: Hur ofta kör du din diskmaskin?
- Undviker du att skapa disk?
- Vad tycker du om din diskmaskin? Vad gillar du/gillar du ej med den?

För maskin A

Kläm och känn

- Vad är ditt första intryck?
- Är det något som du reagerar extra mycket på?

Genomför scenario 1 – plocka i maskinen
Fyll i UX-curve

Genomför scenario 2 – plocka ur maskinen
Fyll i UX-curve

Efter scenarion

- Hur upplever du användningen? / Upplever du att diskmaskinen är tillräckligt lätt att använda?
- Skulle du beskriva upplevelsen som positiv eller negativ? Varför?
- Vilka känslor skulle du säga att diskmaskinen ger upphov till? (Ex. lättnad, frustration)
- Finns det några specifika anledningar till att du känner så?
    - Gällande ljud, ljus, textur?
- Är det något som du reagerar extra mycket på?
- Har du några andra tankar om maskinen?

Gör allt igen för maskin B

I slutet

- Vilken av maskinerna var din favorit? Varför?

Figure D.1: The questions and tasks from the first user study.

D.1.2 UX-curve template

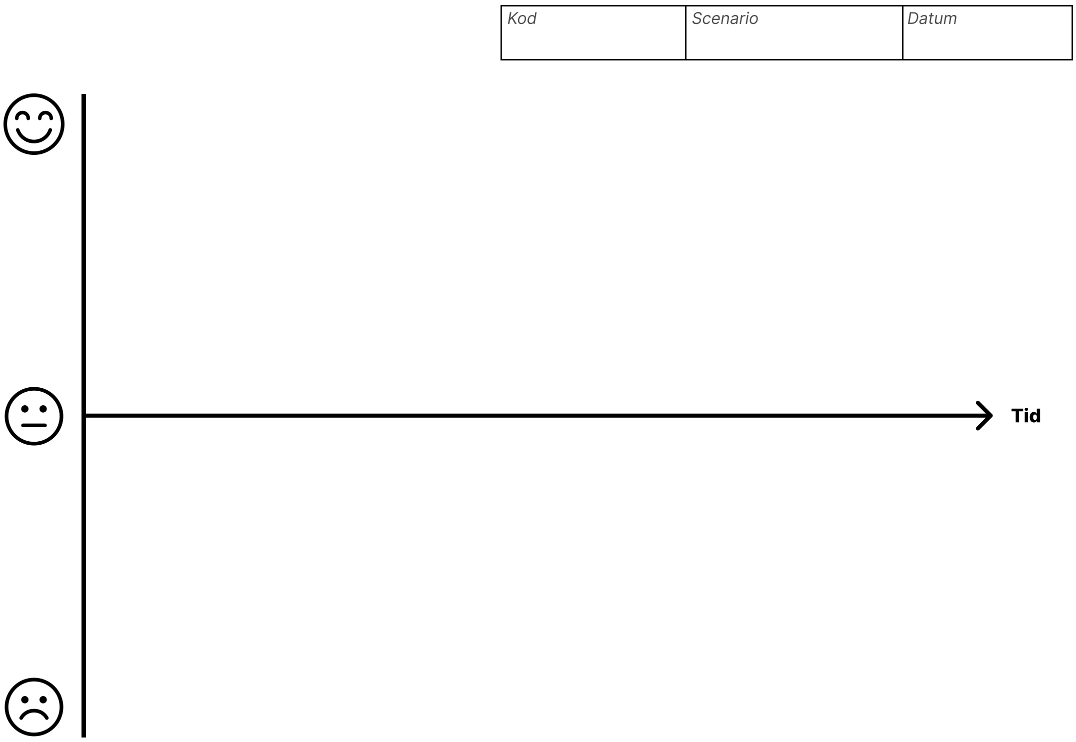

Figure D.2: The template for the UX-curves. Here smilies are used to represent the negative, neutral and positive experiences.

D.1.3 Results

The comments from the user study were compiled into a KJ-analysis, and can be found in D.3 and the pictures of placement were analysed. More zoomed-in pictures can be found in Figures D.4, D.5, D.6 and D.7. The combined results from the UX-curves can be found in Figures D.8, D.9, D.10, D.11, D.12, D.13, D.14 and D.15. The analysis of the placement of dishes can be found in Figures D.16, D.17, D.18, D.19, D.20, D.21, D.22 and D.23.

Figure D.3: The whole KJ-analysis from the first user study.

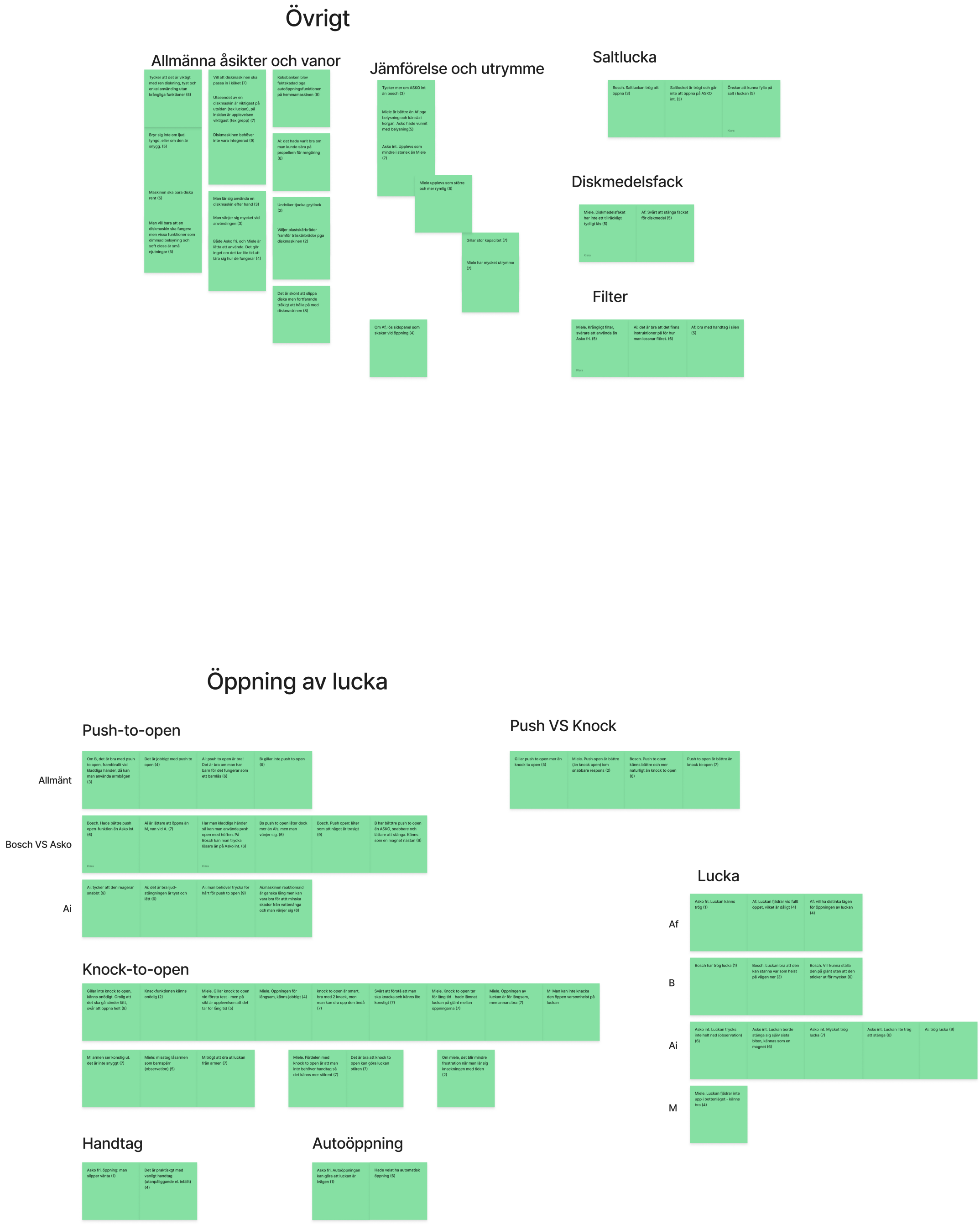

Figure D.4: The first part of the KJ-analysis from the first user study.

Figure D.5: The first part of the KJ-analysis from the first user study.

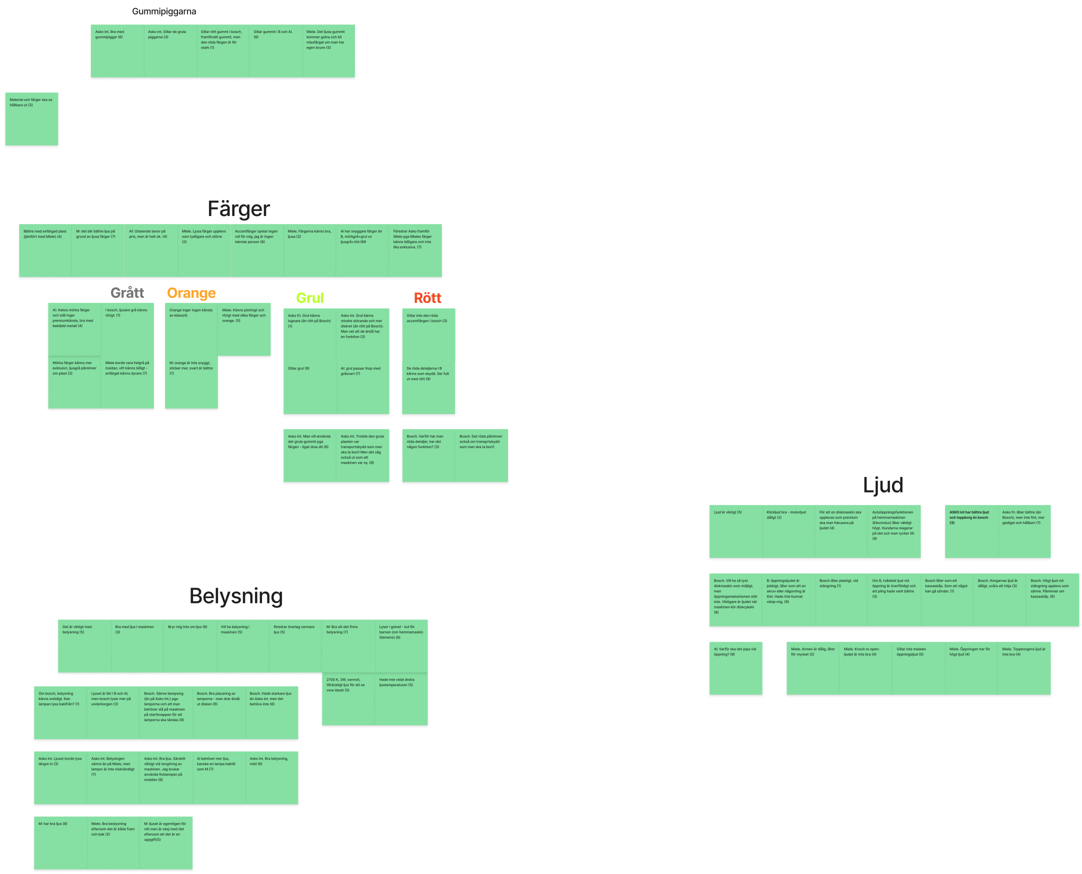

Figure D.6: The first part of the KJ-analysis from the first user study.

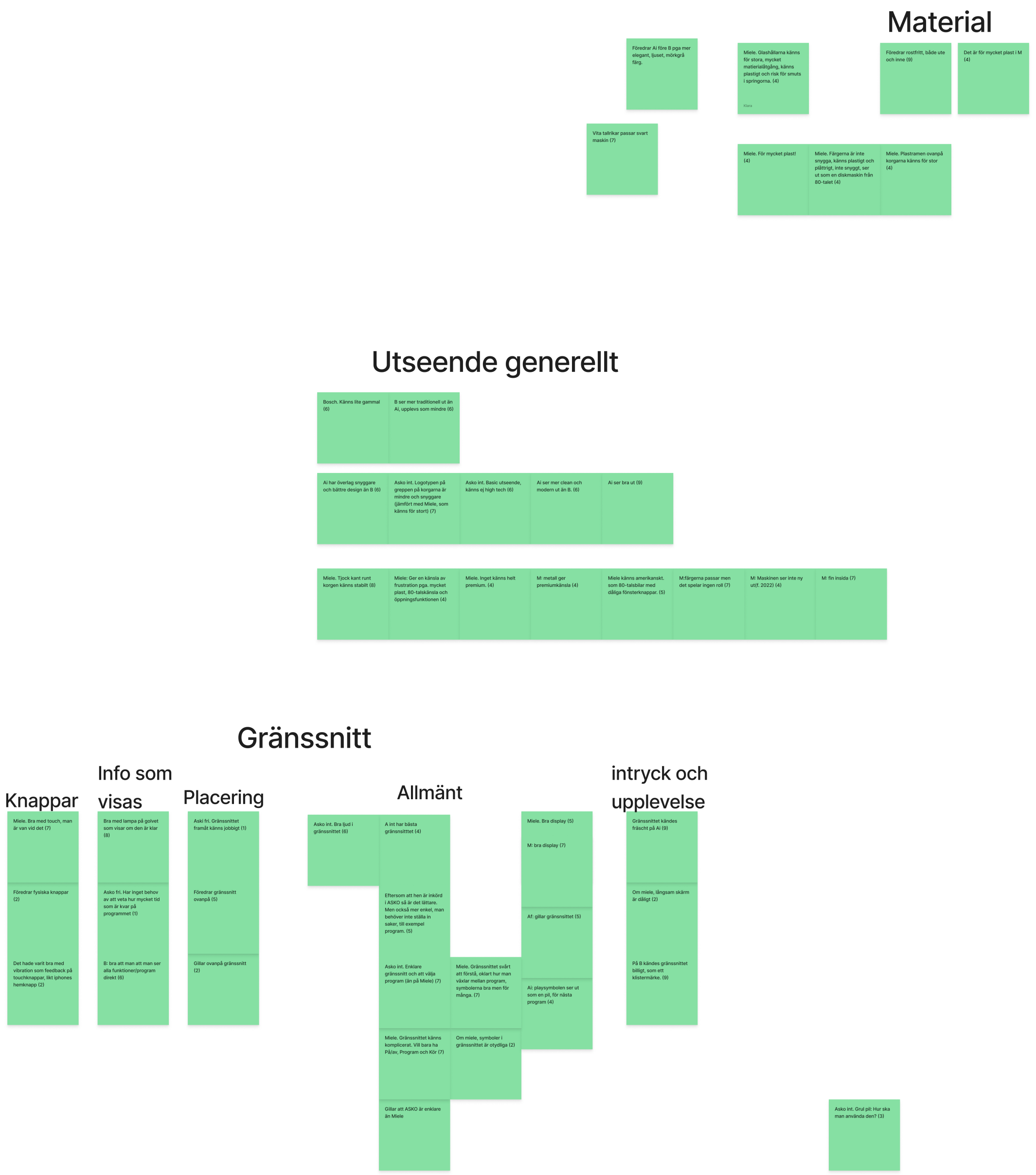

Figure D.7: The first part of the KJ-analysis from the first user study.

UX-curves

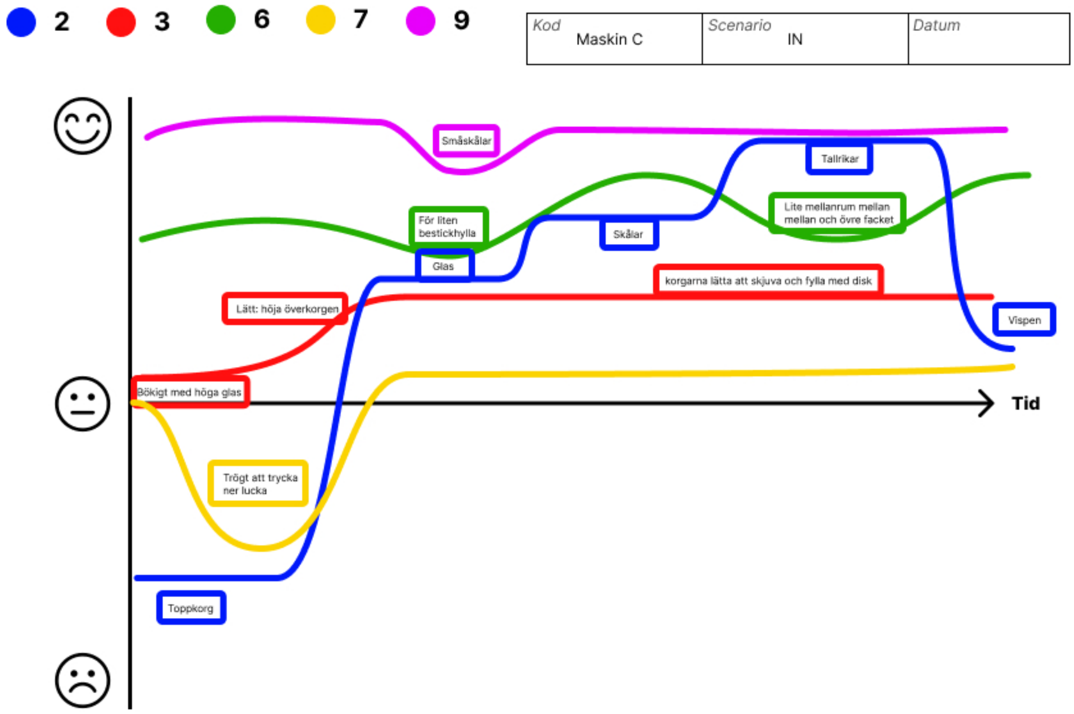

Figure D.8: The UX-curves for putting dishes into the integrated ASKO.

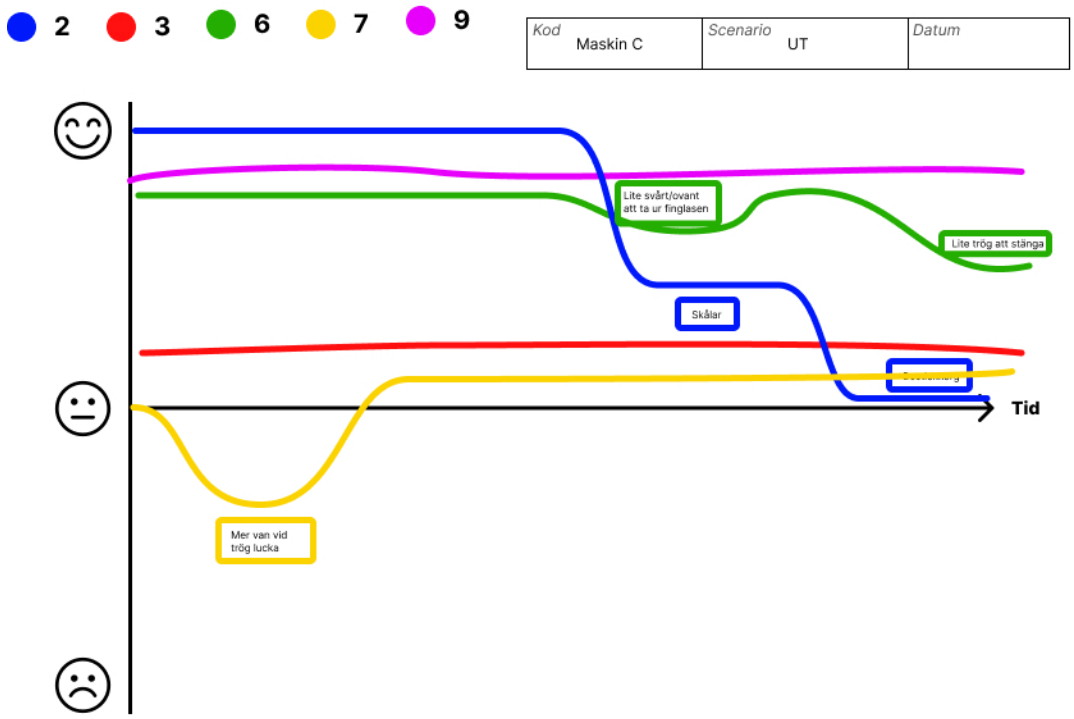

Figure D.9: The UX-curves for putting dishes out of the integrated ASKO.

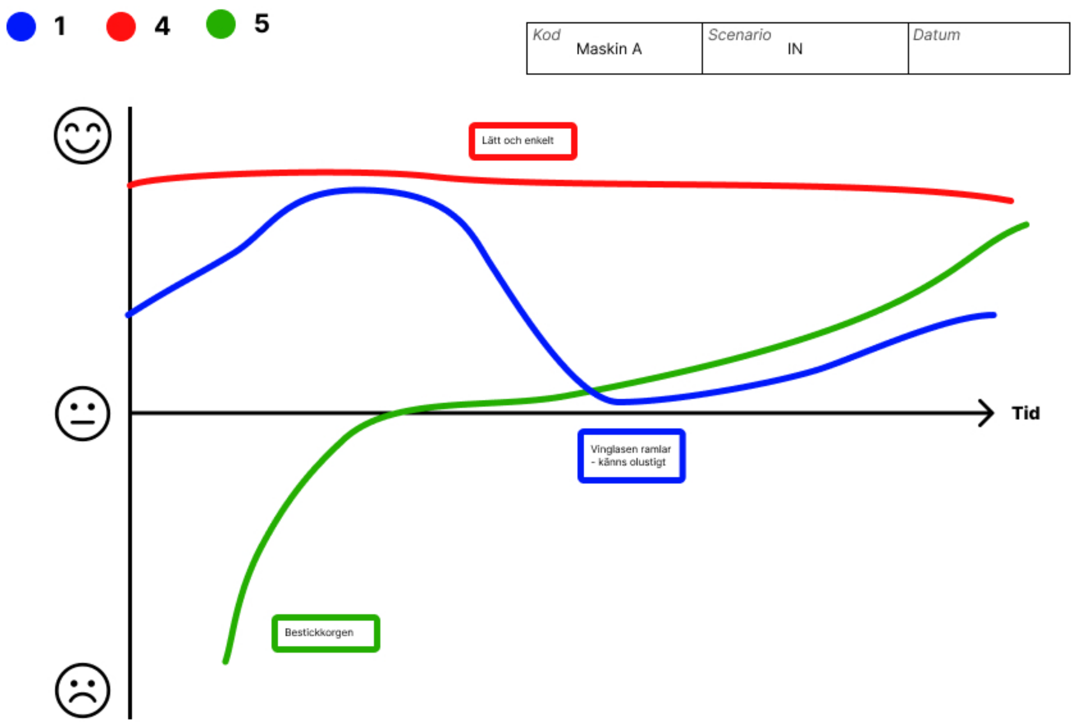

Figure D.10: The UX-curves for putting dishes into the detached ASKO.

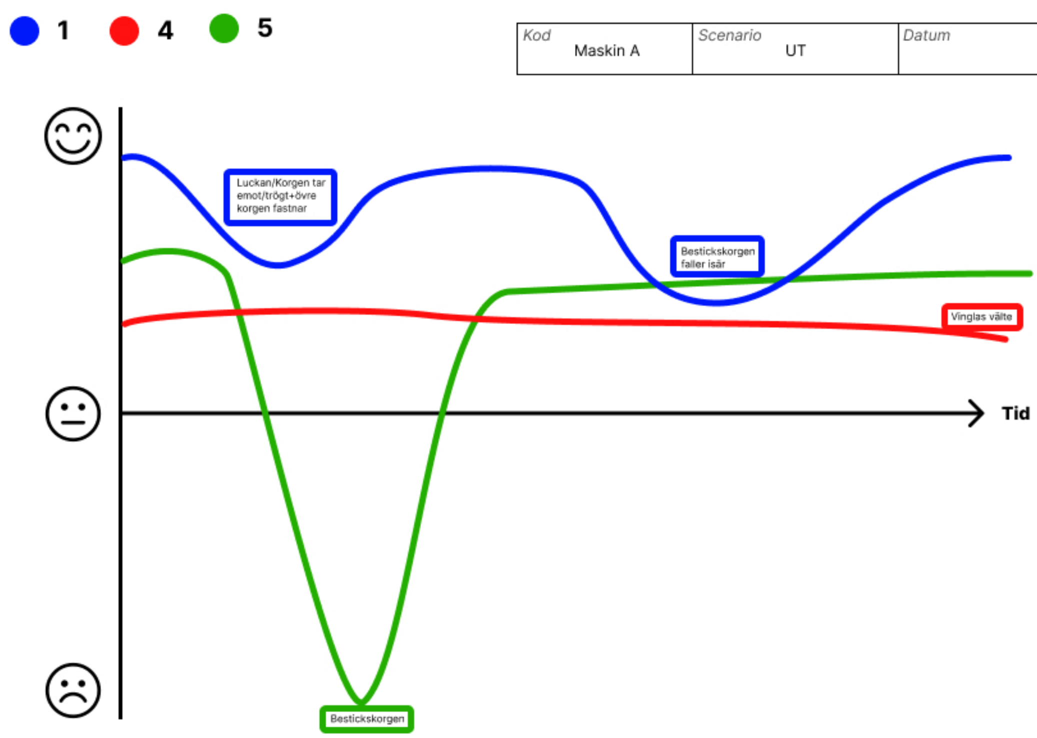

Figure D.11: The UX-curves for putting dishes out of the detached ASKO.

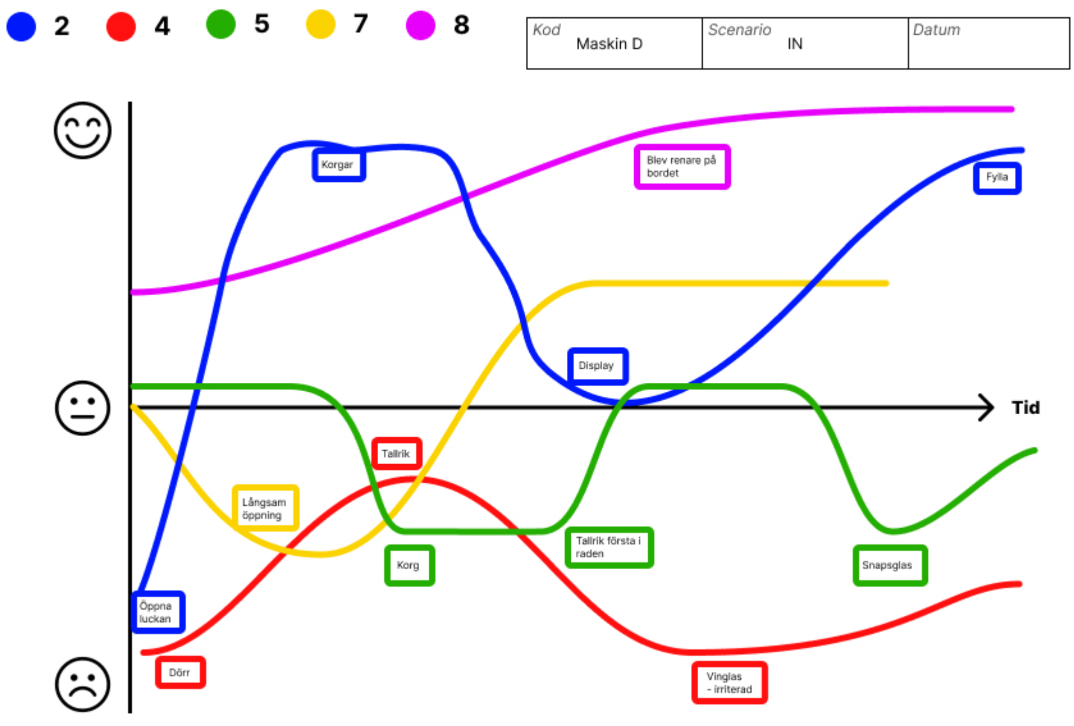

Figure D.12: The UX-curves for putting dishes into the Miele dishwasher.

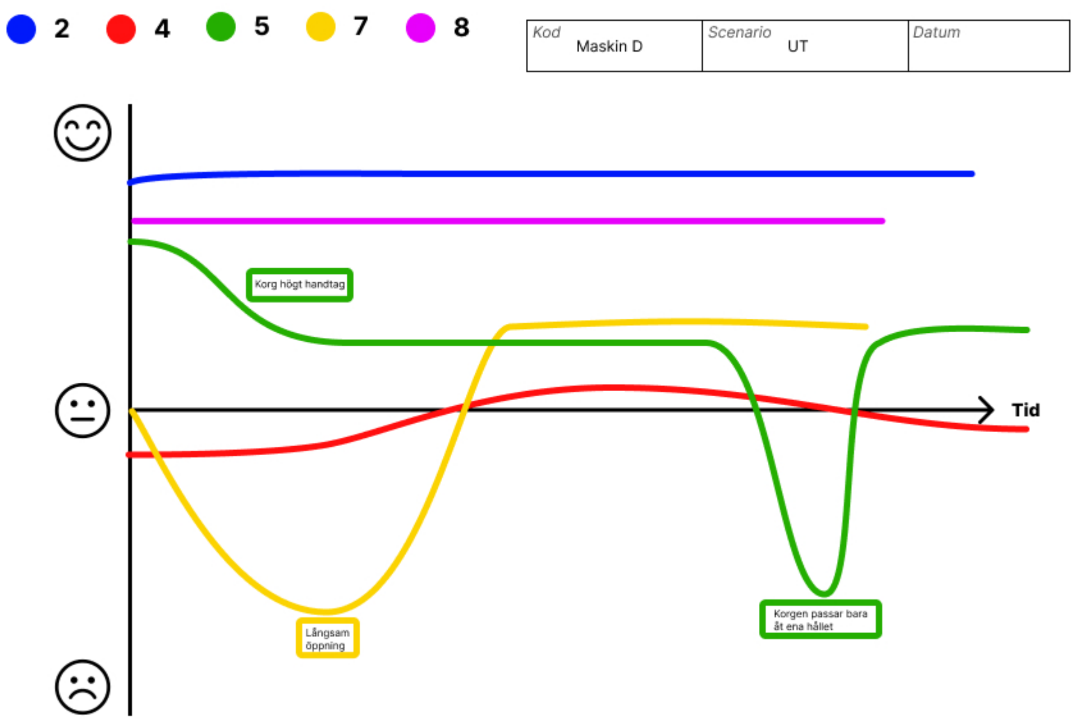

Figure D.13: The UX-curves for putting dishes out of the Miele dishwasher.

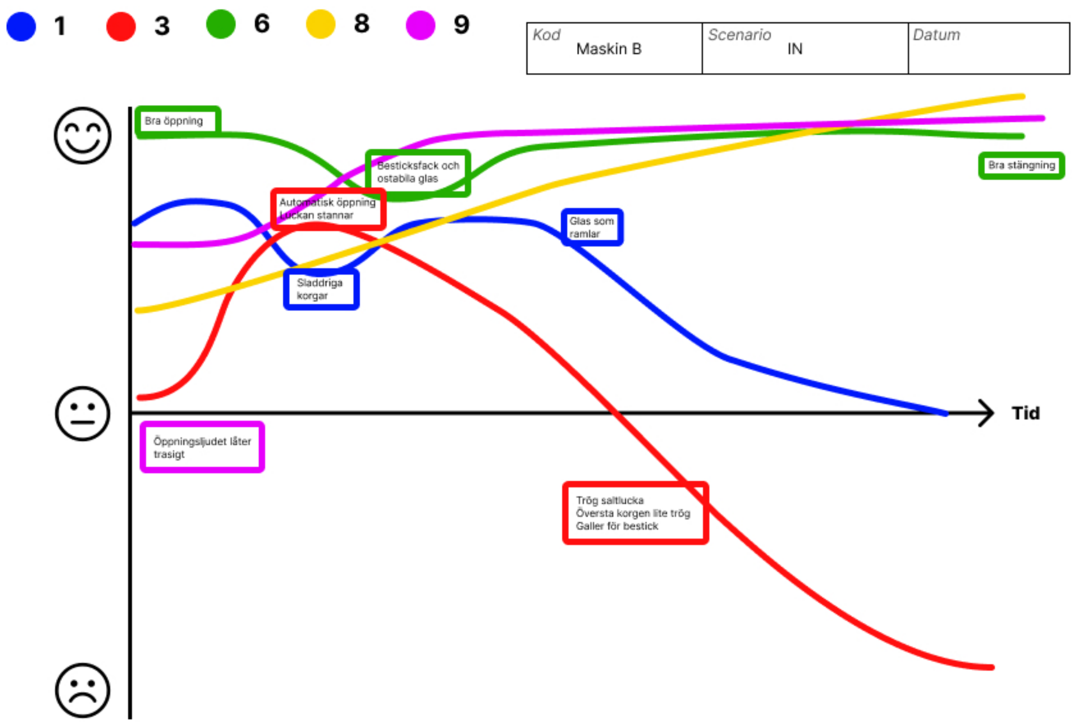

Figure D.14: The UX-curves for putting dishes into the Bosch dishwasher.

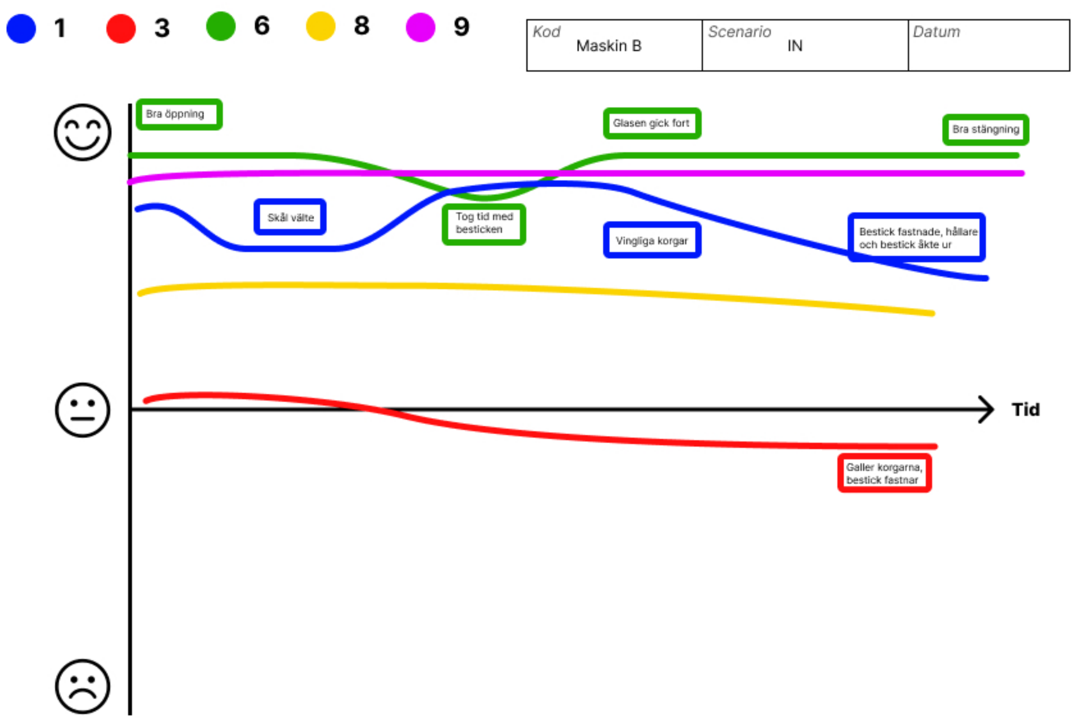

Figure D.15: The UX-curves for putting dishes out of the Bosch dishwasher.

Placement of dishes

Figure D.16: The analysis of the placement of dishes. This is the first part of eight. This shows the placement in the detached ASKO dishwasher. Here it can be seen that the lid of the traditional cutlery basket have been removed by the users and that the bowl are laid down.

Figure D.17: The analysis of the placement of dishes. This is the second part of eight. This shows the placement of dishes in the lower basket of the integrated ASKO dishwasher. Here it can be seen that cutlery is placed in both the top cutlery basket and the traditional cutlery basket, that the large bowl is sometimes placed here and that the users placed the large plates in the same place.

Figure D.18: The analysis of the placement of dishes. This is the third part of eight. This shows the placement of dishes in the higher basket of the integrated ASKO dishwasher. Here it can be seen that the users have placed the whisk here and that some users have placed the small bowls and small plates here.

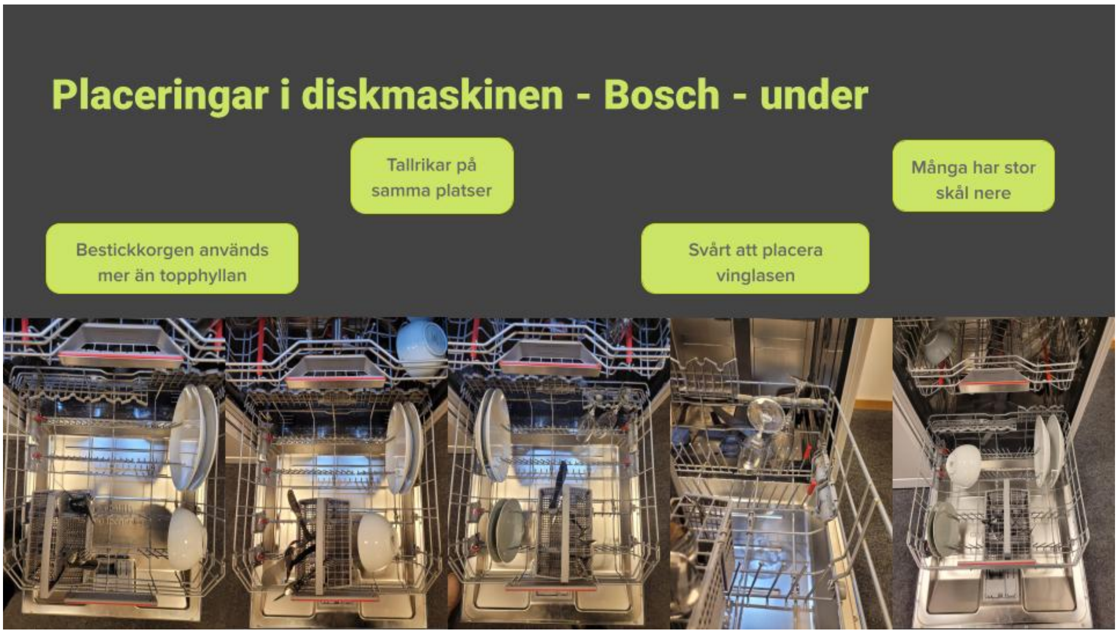

Figure D.19: The analysis of the placement of dishes. This is the fourth part of eight. This shows the placement of dishes in the lower basket of the Bosch dishwasher. Here it can be seen that the traditional cutlery basket is used more often than the top cutlery basket and that many place the large bowl here. It can also be seen that the users placed the plates in the same place and had difficulties placing the wine glasses.

Figure D.20: The analysis of the placement of dishes. This is the fifth part of eight. This shows the placement of dishes in the higher basket of the Bosch dishwasher. Here it can be seen that only the whisk and cheese slicer are placed in the top cutlery basket and that the bowls are placed both standing and laying down.

Figure D.21: The analysis of the placement of dishes. This is the sixth part of eight. This shows the placement of dishes in the lower basket of the Miele dishwasher. Here it can be seen that some users have placed the wine glasses here, many use the traditional cutlery basket and the plates are placed in the same place.

Figure D.22: The analysis of the placement of dishes. This is the seventh part of eight. This shows the placement of dishes in the higher basket of the Miele dishwasher. Here it can be seen that some users use the wine glass holder and place the big bowl here. The bowls are usually lying down.

Figure D.23: The analysis of the placement of dishes. This is the last part of eight. This shows the placement of dishes in the top cutlery basket of the Miele dishwasher. Here the whisk have always been placed, usually the cheese slicer too. Some users placed all the cutlery here.

D.2 Informal Evaluation

Information on the different concepts and ideas evaluated can be found in Appendix C.1. The *Tor* concept received varied feedback in the first informal evaluations. One user thought it felt a bit dorky, like gaming equipment with RGB LED strips. Another user thought that it was a little bit cool and powerful, but suspected that one would bore of it and that it would start to annoy you if it happened every time the door was opened. That user also thought there could be a risk of blinding with strong lights and that it may not work very well with the auto-open function. Interior brass walls could be nice if it works with the rest of the kitchen according to one of the users. The interviewee thought that it could feel innovative, exclusive and luxurious. It was also noted that a dishwasher is a tool, and therefore not something one would need a special experience from. Therefore one of the users said that they would prefer the ferris wheel, or *Karusell* before *Tor*

With the *karusell* concept, the users worried about the amount of space the mechanism would need. They worried that the solution would lessen the dish capacity of the dishwasher and that large items may not fit the rotating baskets. However, they also thought that it would be good ergonomically. They liked that it was easy to see and understand how the mechanism works.

The *Lådhiss* concept was also liked for its ergonomic factors. It was also liked for matching the kitchen drawers. However, the users said that it may be more difficult with the spill tray. They also thought that the drawer may not be too much of an obstruction since they usually stand next to the dishwasher rather than in front of the dishwasher during the loading and unloading of the dishwasher. The lift function also caused many questions from the users. How long would it take to lift the lower basket? How is it controlled? They said that it would need to be fast and that it would be good if the speed could be adjusted. Regarding the control of the lift, there were several suggestions and the users thought that the interface for the dishwasher should be on the side of the front rather than on top, since moving something up and down would be more natural to control a lift than from side to side. An issue with this concept was that it would take up more space by the lower part of the front when auto-opening since it is pulled out, rather than folded down. One user considered the lift part an add-on for the main drawer part of the concept.

The users had some mixed opinions on the prospect of putting a window in the dishwasher door. Most of them did not want to see the dirty dishes in the machine and considered being able to put dishes away one of the main advantages of a dishwasher. Some users thought that it would be cool to see the dishwasher work, but some also worried that it would be seeing a soup of dirty water. One user felt it would be unnecessary to have a window in an integrated dishwasher since it is unusual to have display cabinets on the lower level of the kitchen.

The users were generally positive about lighting. One user thought that light around the dishwasher would make it feel more alive and vivid and that it would be good to have pulses or movement to communicate that it is on. The user also thought that the light would need to on at the end of the washing cycle as well. It could be used to communicate the segment of the wash cycle. The same user also said that it would be nice to change the colour and temperature of the light. Both the individual interviewees said that several LED strips to create a spacial effect would be unnecessary in comparison with spotlights. One of them said LED strips in the baskets or in the rail of the basket could be nice. They also said that it was good with lighting in general. Another thing, that the users noted was that with a solution which includes using your foot to close or open the door, the door may be in the way to use the solution.

High tech was made by combining the kick to open with the voice control to give users alternative solutions. To this, the window was also added. *Karusell* and *Lådhiss* var relatively well-liked and kept as was. *Tor* was adjusted to more nature-inspired experiences and involved scent. It was also changed to only activating at the opening after a completed cycle since users thought that they would bore of it.

D.2.1 Workshop

The detailed results of the workshop can be found in Appendix E. The comments, ideas and evaluation of the workshop led to the decision to continue the refinement of the *Tor* concept with less dramatic lighting since participants were excited about the possibility of the natural experiences and how the concept could be used to enhance the perception of cleanliness.

D.3 Scent and Light Study

D.3.1 Scents used

A Chlorine

B Grumme liquid detergent Skog

C Yes liquid dish soap Citron

D ICA fabric softener Blomsteräng

E Grumme Såpa (pine soap)

F Mint mouthwash

G Comfort fabric softener Waterlily and Lime

H Grumme liquid dish soap Hav

D.3.2 Results: Scents

Table D.1: P: Pilot, A1: Author 1, A2: Author 2

Scents/Person	**P**	**A1**	**A2**	**P1**	**P2**	**P3**	**P4**	**P5**	**P6**	**P7**	
Hygiene factor											Avg
A Chlorine	6	3	1	6	7		3	6	6	4	4,7
B Skog		7	5	4	2		6	3	3	3	4,1
C Citron	5	6	6	2	5		5	7	2	5	4,8
D Blomsteräng	1	2	3	1	3		4	2	7	2	2,8
E Såpa	3	4	7	7	4		2	1	5	6	4,3
F Mint	2	5	4	5	6		1	4	4	7	4,2
G Vattenlija och lime		1	2	3	1		7	5	1	1	2,6
Dishwasher context											Avg
A Chlorine	4	2	1	1	2		3	1	6	2	2,4
C Citron	6	7	6	4	6		5	7	3	7	5,7
D Blomsteräng	1	4	3	2	5		4	2	1	4	2,9
E Såpa	3	3	7	7	4		2	5	7	6	4,9
F Mint	2	5	4	6	7		1	3	4	1	3,7
G Vattenlija och lime		1	2	5	1		7	4	2	3	3,1

D.3.3 Results: Light colour

Table D.2: H: Hygiene factor, D: Dishwasher context

A Chlorine	H	Purple	Yellow			
	D					
B Skog	H	Green				
	D					
C Citron	H	Yellow				
	D	Orange	Yellow	Green	Yellow	White
D Blomsteräng	H	Blue	White			
	D					
E Såpa	H	Teal	Purple	White	Purple	White
	D	Teal	Purple	White	Purple	White
F Mint	H	Teal				
	D	Teal				
G Vattenlija och lime	H	Purple	White			
	D	Purple				

E

Workshop

E.1 Execution

The workshop was held with seven participants, including the two authors. It began with an introduction to the project as a whole and continued with an explanation of the goal of the workshop: To improve the opening experience for a fully integrated dishwasher, with or without a handle. Some constraints were also described, as seen below.

- It should be easy to use
- Ergonomically designed
- Cabinet door should be able to smooth and handleless
- Minimise the rattling of dishes
- All baskets should be visible
- Placement of dishes should be simple for all members of the household
- Create an exclusive, clean and premium impression
- Light should facilitate use and reach the whole machine
- The sound should be comfortable and create a premium experience

After the introduction to the context, the four concepts, which were used to ideate and refine with, were described and the six personas which were presented as possible inspiration. The six personas were of different ages and interests in their households and household machines. They can be found, with age and main characteristic in the list below.

- Axel, 16 years old, lives at home
- Karin, 42 years old, with a passion for sustainability
- Kerstin, 35 years old, finds it important that things look good
- Filip, 28 years old, always after new technology
- Rickard, 52 years old, just wants everything to work
- Maj-Britt, 91 years old, lives to visit

The four concepts, which can be seen in Figures E.2, E.3, E.4, and E.5. Thereafter, the task and schedule of the workshop were introduced, as seen below in Figure E.1. The group was then divided into one group of three and one group of four for the session.

After the session, the ideas were put up on the wall so they be seen by all participants and discussed. They were placed close to the concept that they related to. At the end of the session, there was also some testing and discussion of the light in the dishwasher. The participants did some quick prototyping, putting an LED strip in the dishwasher prototype to see different colours and placements, as can be seen in Figure E.6.

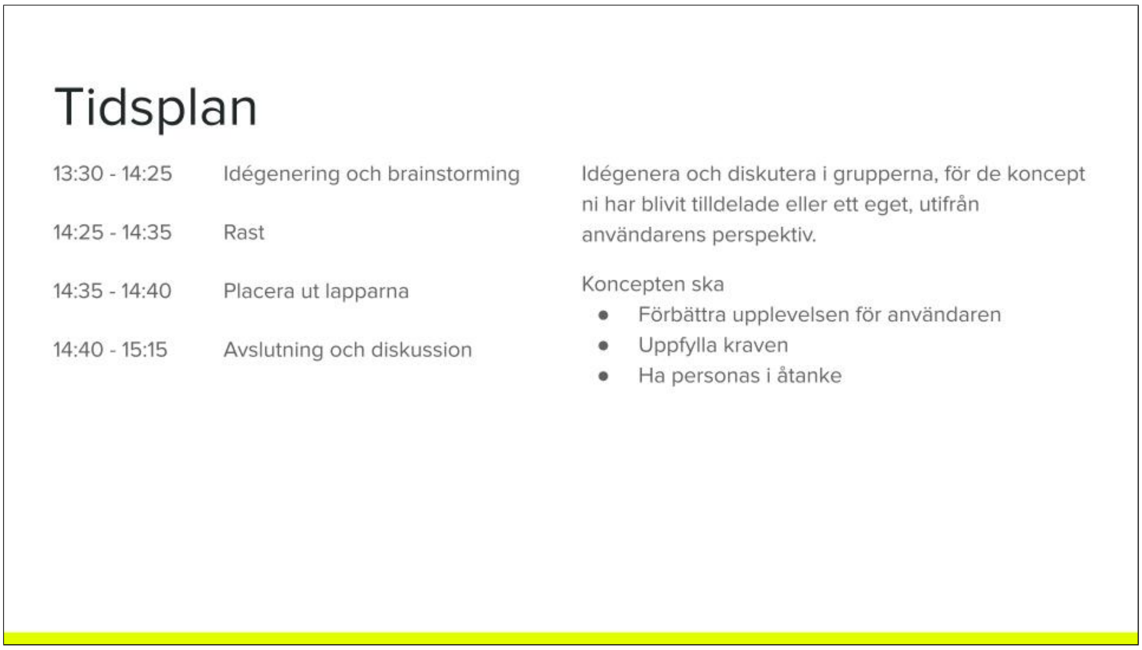

Figure E.1: The task and schedule of the workshop. The task was to ideate and discuss in the two groups.

Figure E.2: The first concept, High tech, included a completely automated, voice-controlled solution, with kick-to-open as an alternative way to open the dishwasher door. It also included a window in the dishwasher door and a large variation in lighting possibilities, so that the dishwasher could be included in a home system.

Figure E.3: The second concept, Drawers elevator, or *Lådhiss* in Swedish was inspired by the kithcen interor trend to have inner drawers so that larger cabinet fronts can be possible. This solution also has a built-in lift to lift the lower basket to facilitate ergonomic use.

Figure E.4: The third concept, the Ferris wheel or *Karusellen*, has rotating baskets to facilitate ergonomic use and make the loading and unloading more exciting.

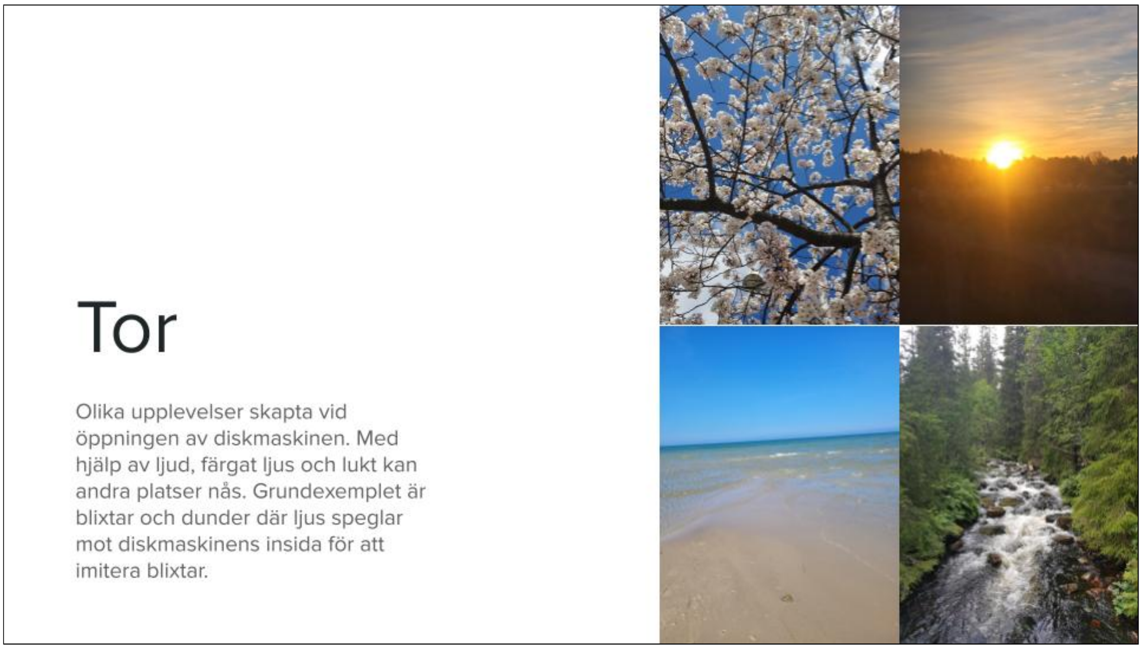

Figure E.5: The fourth concept, Tor, consists of creating nature-inspired experiences when opening the door by using sounds, light and scents.

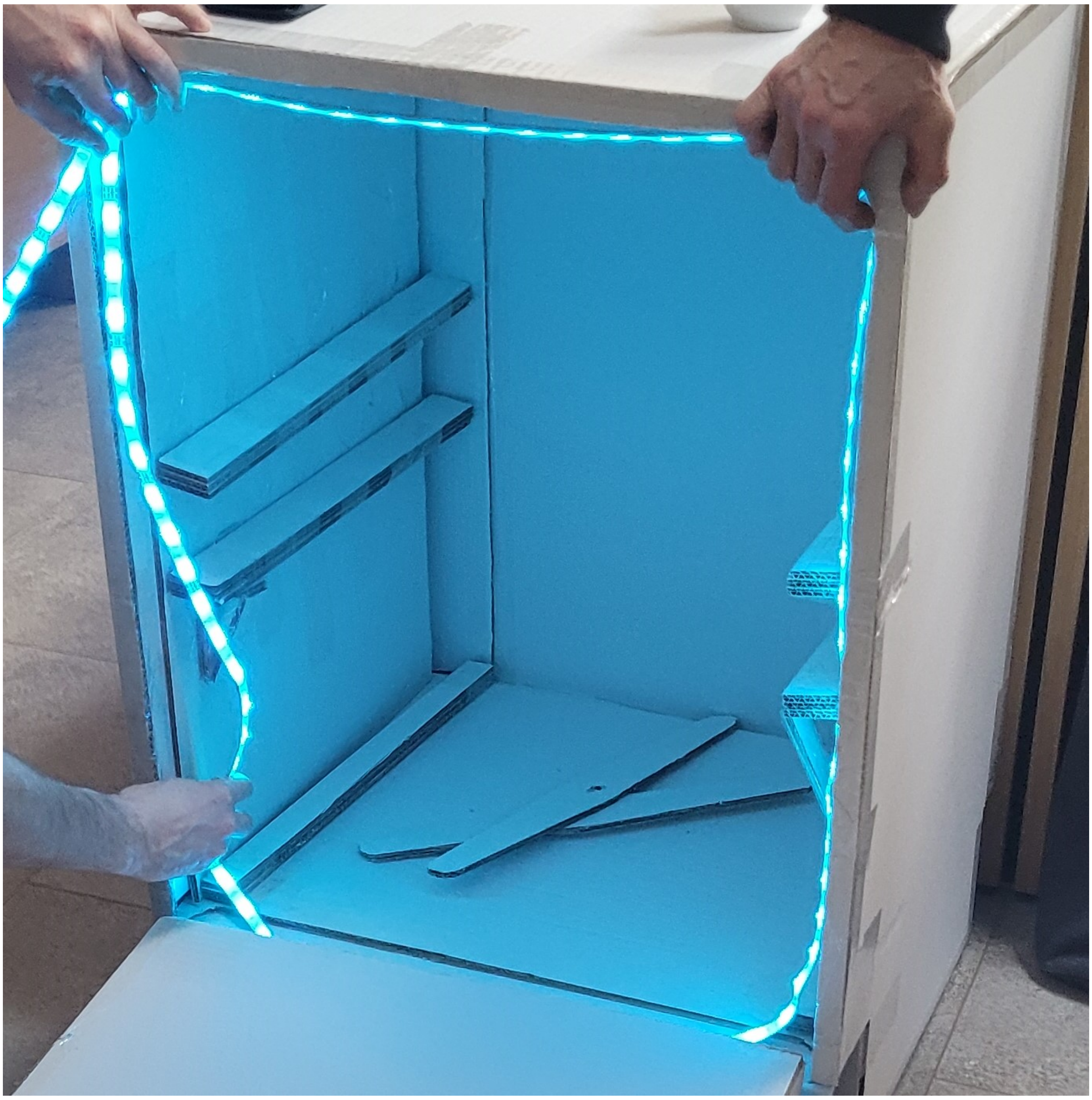

Figure E.6: A picture showing the quick prototyping done at the end of the session.

E.2 Results

The ideas and sketches which were put up on the wall and discussed with all the participants can be found in Figures E.7, E.8 and E.8. Relating to the first concept, *high tech*, there were several ideas relating to app use and gamification to try to turn the tasks involving the dishwasher into more exciting experiences and to motivate the users. One example would be having all household members collect points by doing dishwasher-related tasks and making it a competition between family members.

When ideating on the second concept, *Lådhiss*, the participants suggested cameras that film the dishes to see if they are clean, having two rotating dishwashing sets and an elevating dishwasher. For the third concept, *karusell*, many different versions of rotating dishwashers, an elevating dishwasher door and a lot of refinement to the concept were made. The refinement included how to optimise the basket system capacity-wise and how the connections should work. Concerning the fourth concept, *Tor*, many different Nordic nature experiences were discussed, as well as windows and different kinds of lighting, prisms and polarisation for example as can be seen in Figure E.9. The participants were especially excited about both the ideas relating to *high tech* and *Tor*. They were especially interested in the prospect of combining the nature-inspired experiences of *Tor* with the perception of quality and hygiene. These were the main driving forces in the decision to move forward with hygiene-focused *Tor*.

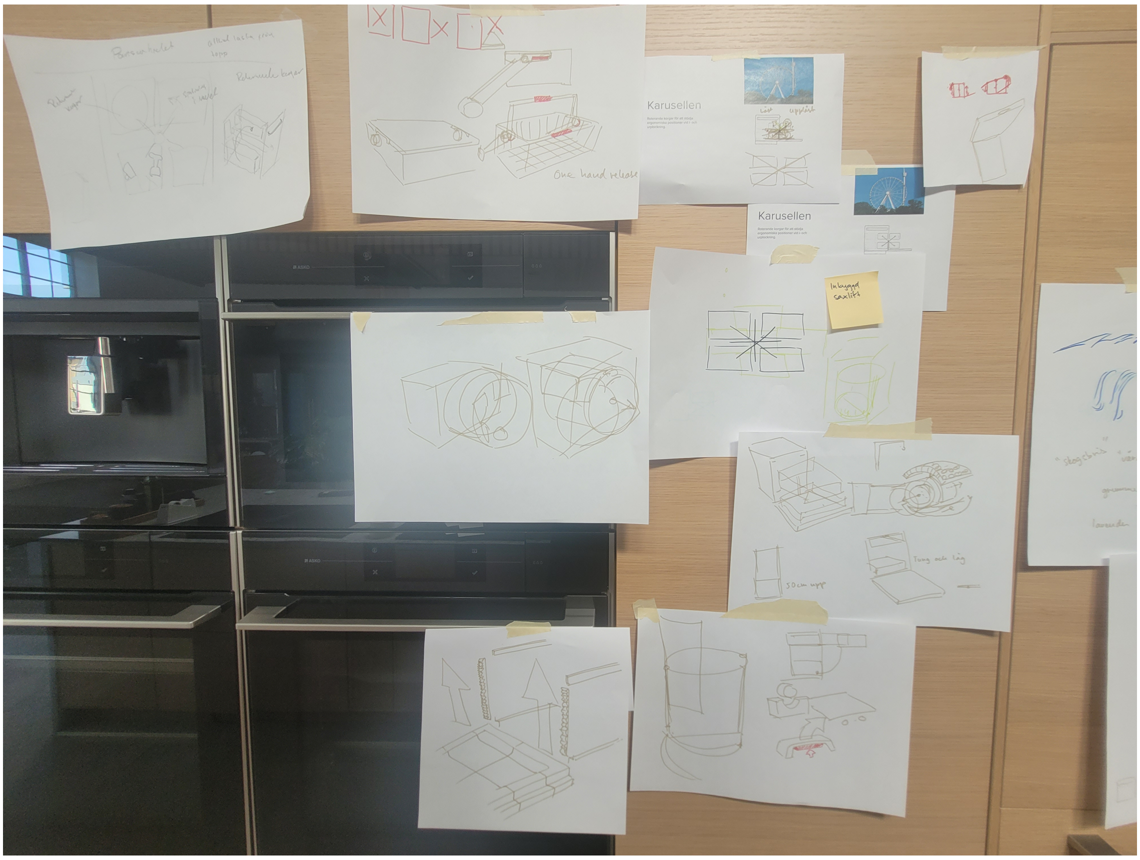

Figure E.7: The first part of the result of the workshop. This one shows ideas and sketches related to the concept *karusell*.

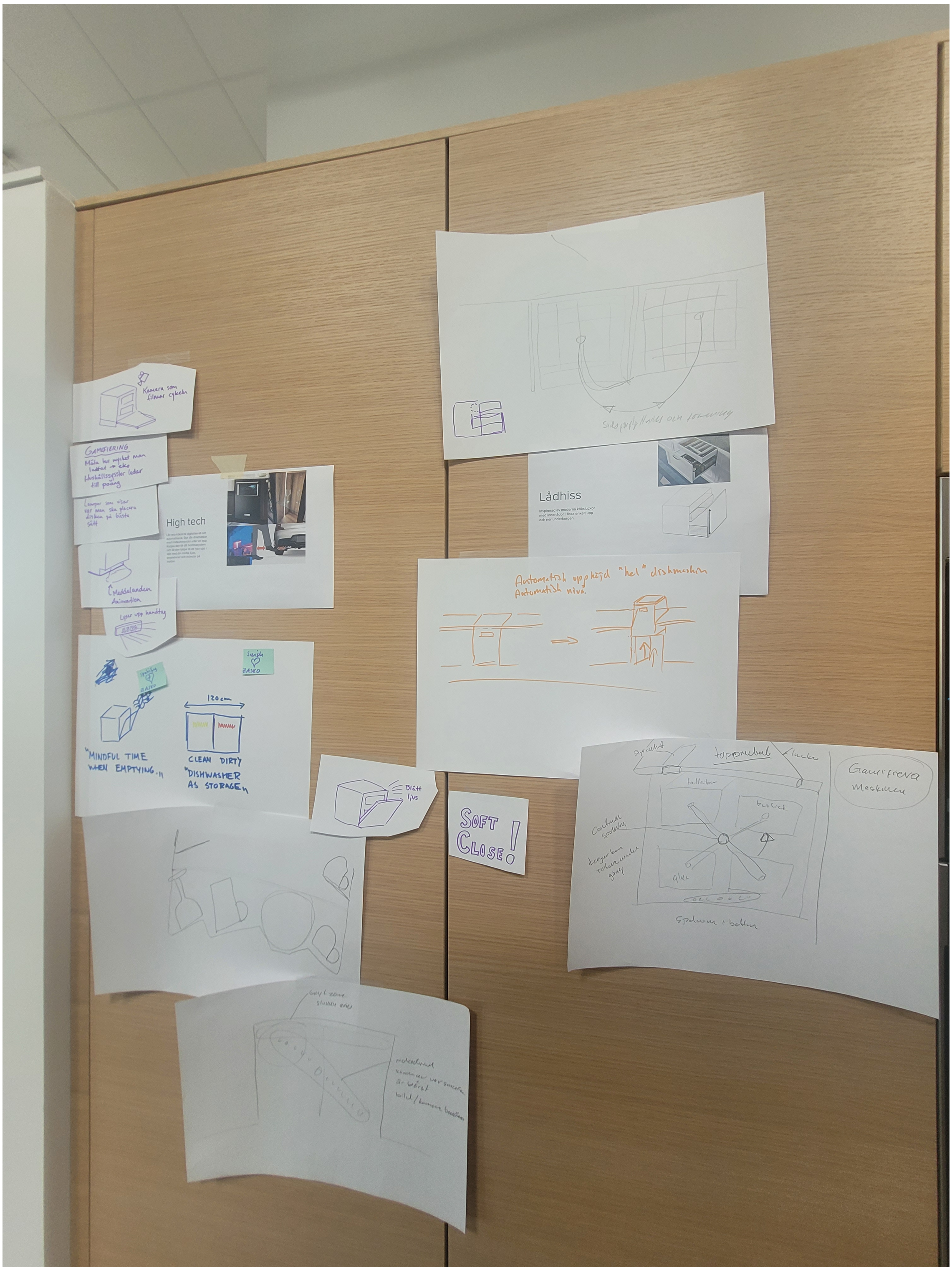

Figure E.8: The second part of the result of the workshop. This picture shows the ideas and sketches related to the concepts *High tech* and *Lådhiss.*

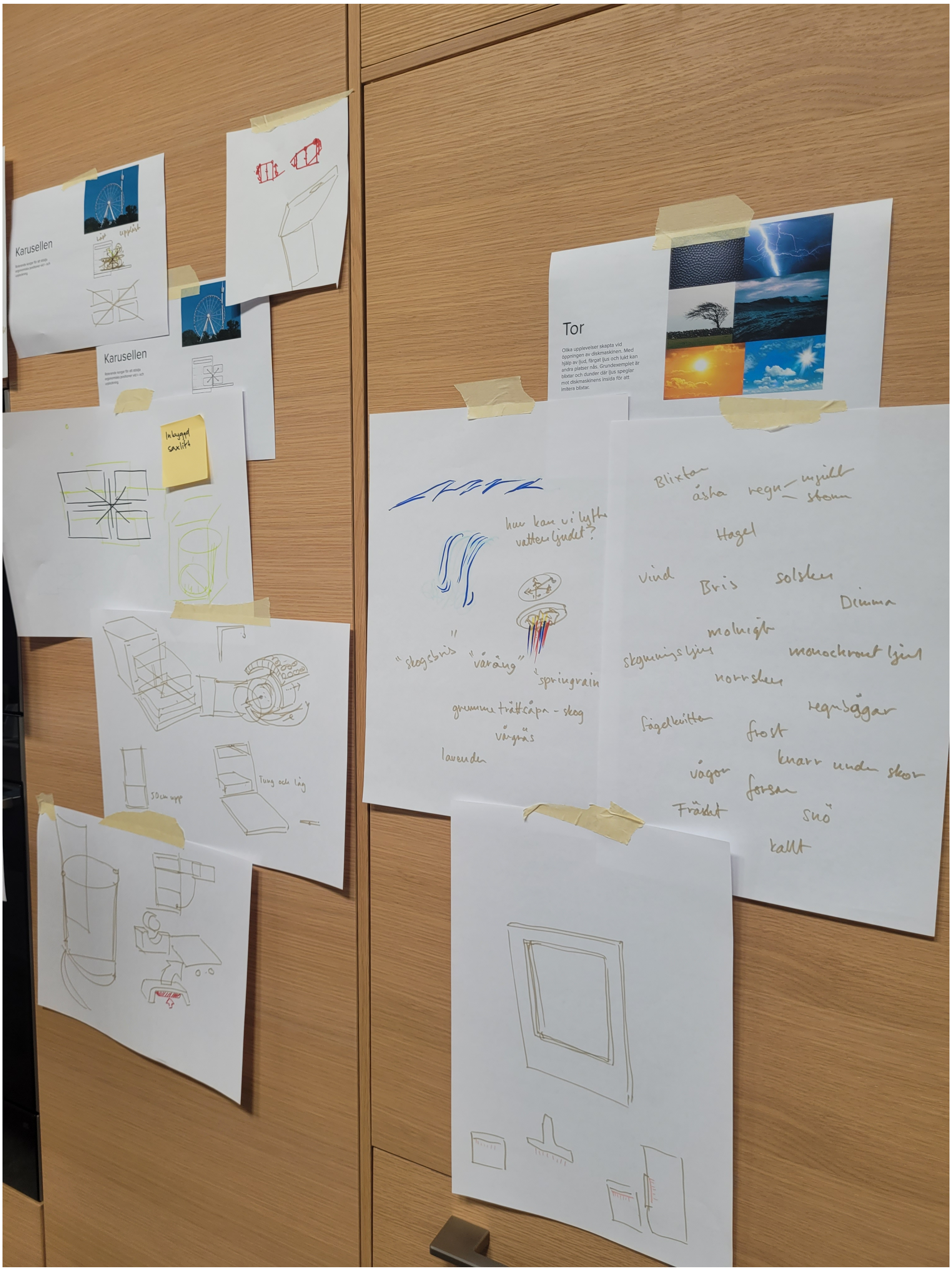

Figure E.9: The last and third part of the result of the workshop. This picture shows the ideas and sketches related to the concept *Tor* and some from the concept *Karusell*.

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