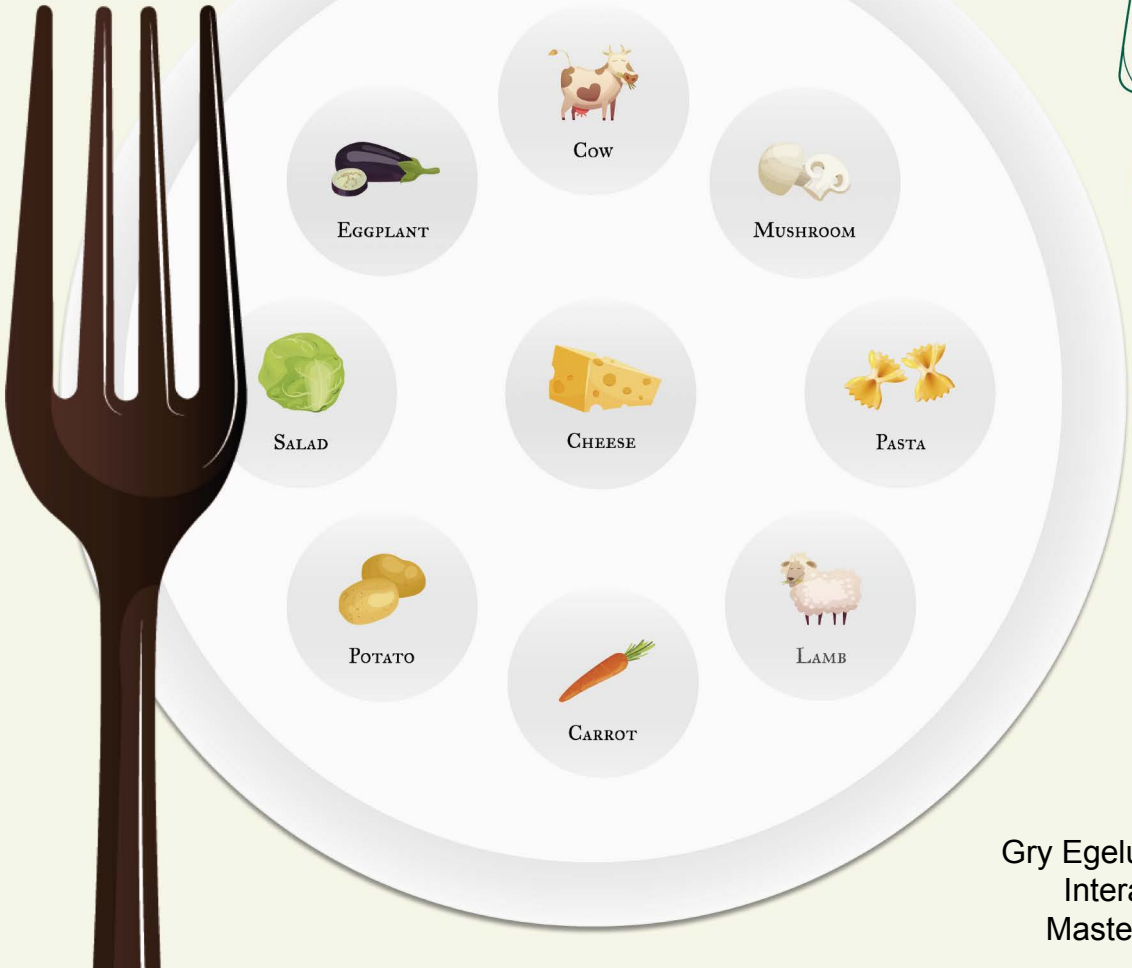
Put a gaffel in it!

A tangible user interface turning families food preferences into inspiration for new dishes



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Interactiondesign,
Master thesis 2022

Abstract

Danish families with children are living with time scarcity and resort to the coping strategy of meal planning, when dealing with the question of what to have for dinner. During meal planning families experience issues such as lack of participation and motivation from children, pickiness, and the feeling of being overwhelmed by existing solutions for finding new dishes. Therefore, families are cooking convenience food, even though it goes against family values such as eating healthy and varied food.

Analysis of existing research, showed that the field of discovering new dishes is limited within HCI and that the existing research focuses on how to output dishes, from recommendation systems, based on digital user preferences as input. As tangible user interfaces (TUIs) have proved to be engaging for children, the focus was therefore to create a TUI. From several iterations of concept development a single concept “Put a gaffel in it” was selected and evaluated through a field study with two families for one week. Qualitative and quantitative data was collected throughout the study in three different sessions as semi-structured interviews, along with a dairy for self-reported data.

The data concluded that the TUI “Put a gaffel in it” can facilitate the process of discovering new dishes by; (1) making all family members participate (2) making an exciting and less overwhelming process, (3) minimize conflicts regarding preferences, (4) providing a new dish based on the chosen ingredients to families in order to potentially expand their meal base.

Resume

Igennem dette projekt har fokus været på at udforme et Tangible User Interface som skulle facilitere processen; at udforske nye retter for at udvide basen af retter med afsætning i familiers madpræferencer. Fra initierende interviews var det tydeligt, at danske familier med børn havde problemer omkring tidspres, manglende deltagelse og motivation fra børnene, børnenes kræsenhed og at det var overvældende at bruge eksisterende løsninger til at udforske nye retter. En analyse af eksisterende research viser, at feltet kun er udforsket i begrænset omfang indenfor HCI og at det research der findes, fokuserer på hvordan der gives output i form af retten fra recommender systemer baseret på digitale brugerpræferencer som input. Dette stemmer ikke overens med faktummet af, at mange af problemerne omhandler børnene, hvor en TUI kan være mere egnet som brugerpræference input. Derfor var fokus i dette projekt på at skabe en TUI for input af brugerpræferencer, og dette blev udforsket gennem flere iterationer af konceptudvikling. Dette resulterede i konceptet “Put a gaffel ind it”; et koncept hvor familiemedlemmer hver især skal stemme på ingredienser de kan lide i løbet af en uge, ved at putte en gaffel i ingredienser som derved bliver fundamentet for familiens nye ugentlige ret.

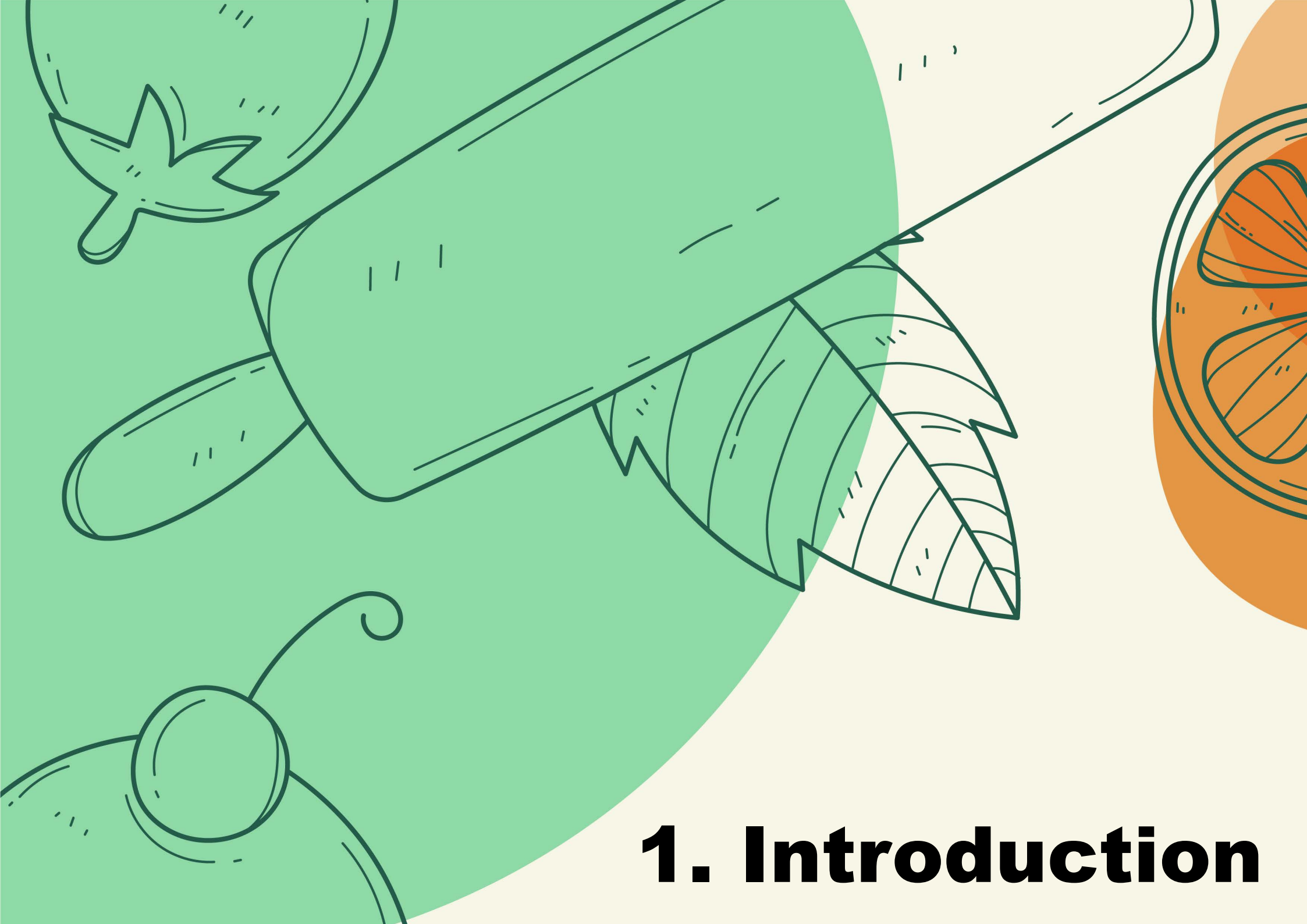
Konceptet blev evalueret i et feltstudie over en uge, gennem en high-fidelity prototype som var udviklet til formålet. Feltstudiet undersøgte brugen af prototypen i to danske familier med formålet at få en ny ret i slutningen af ugen når den ugentlige madplanlægning fandt sted. Data bestod af både kvalitativ og kvantitativ data, og var indsamlet gennem tre forskellige sessioner som var formet som semi-struktureret interviews, og en dagbog til at indsamle selv-rapporteret data fra deltagerne.

Data viste, at en fysisk prototype med tangible input hjælper med at få børn til at deltage og gør at prototypen bliver lagt mærke til. De præsenterede begrænsede ingredienser på et mid-level giver tilstrækkelig mulighed for at udtrykke præferencer til en færdig ret, men ved at bruge flere granulariteter kan det gøre oplevelsen mere udforskende og spændende.

Det kan være svært at svært at præcisere det optimale antal af mulige præferencer, eftersom der er stor diversitet mellem familiemedlemmer. Skiftet af ingredienser som sker hver dag på ikke-stemte ingredienser, blev en motiverende faktor da familiemedlemmerne var spændte over de nye valg hver dag. Den individuelle og løbende interaktion viste sig at reducere problemer omhandlende konflikter, overvældethed og tidspres. Det viste sig også at for at familien skal prøve en ny ret, skal der være elementer af “tvang” eller “pres”, da de ellers vil falde tilbage til convenience retter.

Derfor kan det konluderes at konceptet “Put a gaffel in it” kan facilitere processen at udforske nye retter, ved at få alle familiemedlemmer til at deltage, herunder også børnene. Den kan derudover gøre processen mindre overvældende, skabe rum for færre konflikter mellem familiemedlemmer angående præferencer og gøre processen mere spændende. Det endelige resultat er en ny ret som potentielt kunne udvide familiers base af retter.

Table of content



1. Introduction

1. Introduction

Food practices in households include a set of routines for making meals including planning, purchasing, preparation and consumption [1]. Meals are spread throughout the day and in numerous societies the most important of these meals is dinner. Dinner is the meal that brings families together [2], it is a meal that requires planning and therefore deciding on what to cook for dinner is an inevitable challenge faced everyday or week [3].

In families where both parents work full-time, the time after work to plan dinner is scarce. Besides the time scarcity, families are facing a challenge of uncertainty when planning what to eat for dinner, i.e. meal planning [2]. This uncertainty is embodied by a lack of motivation for planning, a lack of inspiration for finding new dishes, and conflicting preferences between family members. These challenges within uncertainty leads to the cooking of convenience food; cooking and eating the same dishes every week, or having a fixed set of meals to choose from (meal base) [1]. Convenience food imposes a problem against family values such as eating healthy and varied food, but also against the aspiration to introduce the family to new styles and flavors of food. These problems arise as families often chooses to cook what is convenient and readily available at home [1].

Through initial interviews (further elaborated in *Section 3.5*) all of these issues were confirmed, but it was also apparent that the process of making meal plans is challenging due to childrens of the family not being motivated to participate and being more picky i.e. being very careful about choosing or accepting flavors of food and therefore have a seemingly limited set of preferences. Further the parents have a wish for introducing new dishes, they have tried solutions for discovering new dishes, primarily applications and websites. These are, however, perceived as overwhelming due to their many choices and features.

Current HCI research within the field of discovering new dishes (further elaborated in *Section 2.3*), mainly focus on preference based recommendation methods and how to output these recommendations. All existing products, both research prototypes and consumer products, within this field feature a digital input and the majority also have digital output. This presents an opportunity to explore a physical product with a tangible input.

Based on these family challenges and a lack of research on tangible interactions, within the context of discovering new dishes, a need for investigating and facilitating the process of discovering new dishes, based on family members preferences through a physical design, has emerged.

With these issues in mind, this master thesis sets out to alleviate several challenges within the field of discovering new dishes; Existing digital solutions are overwhelming in the number of features and suggestions, no current research examines the use of tangible inputs for recommendation systems within the context of discovering new dishes, discovering new dishes and expanding the base of conveniences dishes is problematic in a family context as children are picky and lacks the motivation to participate in the process because of boredom and critique.

Based on these challenges this master thesis focuses on answering the following question:

How can a tangible interaction design, focusing on families' food preferences, facilitate the process of discovering new dishes for meal expansion?

2. Background

2. Background

This section provides a background of related work regarding time scarcity and coping strategies within the subject of food practices, along with meal planning and expansion of the convenience meal base.

2.1 Time scarcity in food practices

Time scarcity i.e. the perception of not having sufficient time to achieve everything planned during the day, is a rising issue in industrialized societies, due to socio-cultural trends such as; employed parents, pressure on productivity at work, the fulfilling of various roles, and wanting to be effecient with spare time [4]. Focusing on people's food practices, research shows that the time scarcity is a contributing factor to an increased intake of fast- and snack food [5]. If people value a healthy dinner and are unable to cope with the time scarcity, these experiences can lead to chronic stress, which has been associated with increased intake of unhealthy snacks, sugar-sweetened beverages and a decreased consumption of vegetables and fish. Research further shows that in order to deal with time scarcity, people change their food practices as they are using food choice coping strategies i.e. a special behavior to deal with fatigue and stress around their food practice.

Five identified coping strategies in the literature are; (1) skipping dinner, (2) include family members in the cooking process, (3) cooking convenience food, (4) avoid serving food which potentially leads to conflicts between family members as negotiations can be time consuming, and (5) meal planning and shopping lists [5].

Through this projects' conducted interviews (further elaborated in *Section 3*) it was evident that families are using meal planning as a coping strategy to deal with the time scarcity issue, and therefore further focus was set on this coping strategy.

2.2 Meal planning

Meal planning is the activity of deciding what to eat for dinner ahead of time for a set amount of days [6]. This has the potential of alleviating time scarcity as time is focused on the meal planning activity. On the opposite end of the spectrum is choosing dinner every day, the daily fatigue after work and lack of motivation, potentially inhibits focus, which in turn will make each dinner choice take longer. Another risk is resorting to fast food that long term has a negative impact on health. An upside to choosing dinner day by day is the freedom and room for spontaneity, which can be lost when doing meal planning. The family must know in advance which days they will be cooking from home and the amount of people to feed.

Besides alleviating time scarcity, meal planning provides the benefits of minimizing chaotic mealtimes and the negatives from it, along with social benefits such as enhanced well-being [6]. Also it encourages home cooked meals which can lead to increased health. [7]. Despite the positives, families still lack time and skills for making meal plans [6] [8]. One study found that even though 86% of their respondents agreed that weekly meal plans have a lot of benefits, only 46% of them create meal plans ahead of time [9].

Even though meal planning is a coping strategy of time scarcity, people still tend to use time scarcity as an argument for not creating meal plans along with poor planning- and cooking skills. However, research on families meal planning activities is sparse and additionally no literature on the cohesion between a certain type of family and approach to meal planning seems to exist. Most research seems to focus on meal planning of diets for diabetics [7].

Dishes for meal plans can be divided into two categories; performative (well planned and made based on recipes) and everyday (convenience food) [10]. Even with a wish for introducing new dishes to the meal plan, discovering new dishes for expanding the meal base can be challenging, as there is not enough time, inspiration or motivation.

Additionally, if having guests, people tend to cook performative dishes instead [10] [1].

A lack of inspiration for choosing dishes for meal plans can arise due to uncertainty, e.g. uncertainty about what people have in their refrigerator, or from being overwhelmed by the amount of recipes online [2]. At the same time the lack of variety in the convenience dishes irritate people, as they do not like to eat from the same base of dishes every week along with the fact that goes against personal values regarding health, variety and ingredient choice [1].

2.3 Discovering dishes

A traditional way of discovering dishes is through cookbooks. However, this has been digitized through websites and smartphone applications [11]. These offer a set of new functionalities such as setting preferences for ingredients, type of dinner, diets, eating style etc. Based on these choices, recipes are presented. Other functionalities include saving, liking, and rating dishes. Furthermore, some apps offer a meal plan solution, as you select recipes, resulting in an overview for the dishes of the week. Although a lot of applications and websites are available for use [12], it was evident through initial interviews (further elaborated in *Section 3.5*) that families feel overwhelmed by the many choices the applications and websites are offering, and therefore disregards them.

An alternative way of discovering dishes for dinner is through foodboxes [13]. When choosing a menu with foodboxes a category is selected, e.g. healthy, vegetarian or quick, and afterwards specific dishes are picked from a list of curated dishes that falls under the selected category. The fitting amount of ingredients are sent home along with the recipes, ready to cook. The delivery time, price, and amount of work to complete the meal differs depending on the choice of foodbox provider. However, issues reported regarding foodboxes are the prices and the lack of spontaneity.

The additional cost is mainly because of the curated dishes (inspiration) and delivery of ingredients, while lack of spontaneity is also mentioned as a general challenge with meal planning.

However, when using foodboxes, the spontaneity challenge can be more difficult to manage due to the unfamiliarity of the dishes, along with a potential need for special ingredients, not necessarily available in the local shop.

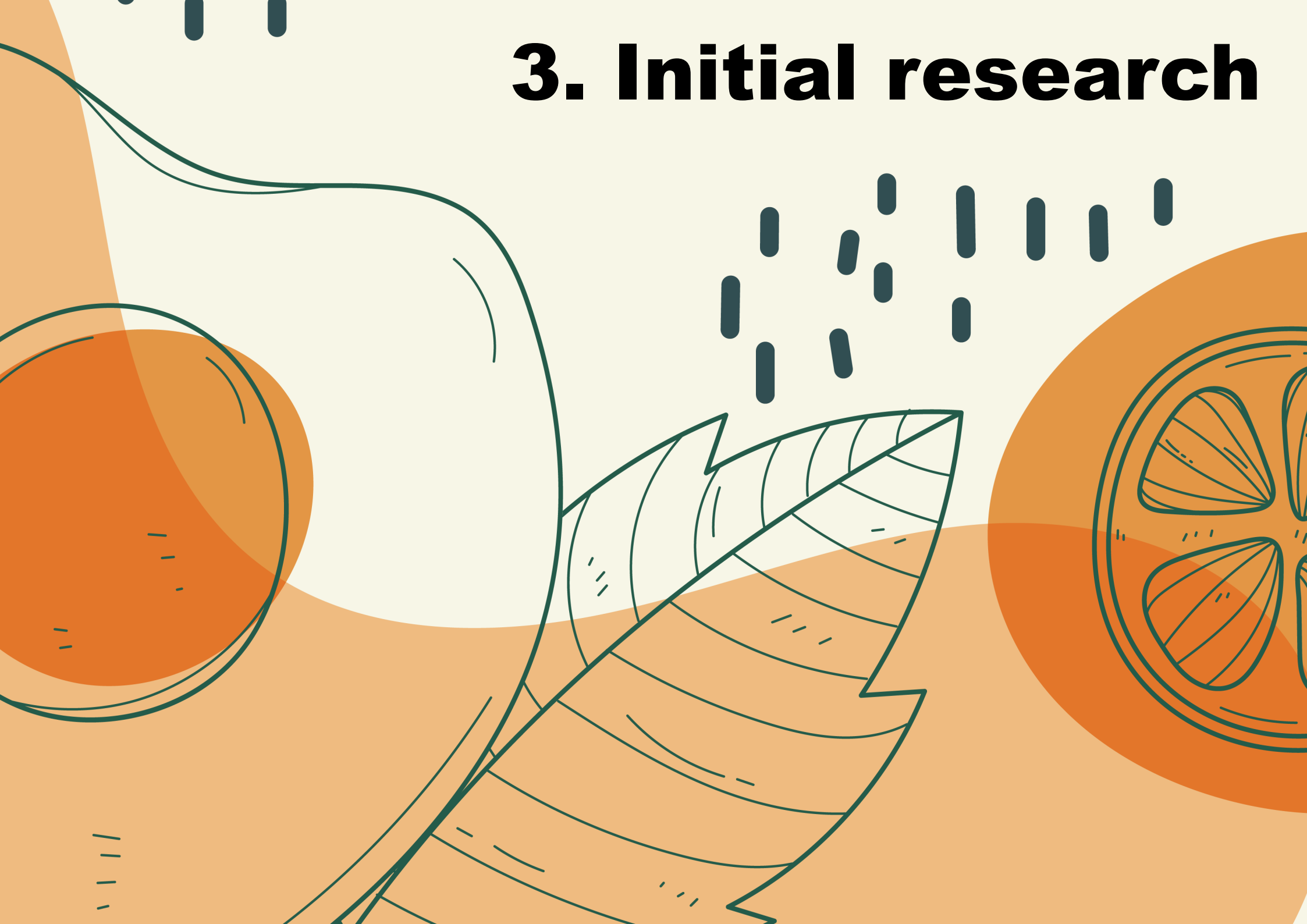
Besides the commercially available products, it is interesting to examine what existing HCI research on discovering new dishes is focusing on. As with meal planning the research within this field is limited, but it is primarily focused on recommender systems [1] [10]. Recommender systems focus on turning data on users along with their preferences into predictions of future likes and interests of the user [14]. In [1] a digital user profile with selected preferences is created in a mobile application. This user profile is then used as input to a physical printer that produces new recommended dishes on-demand, whenever the user tears the latest recommendation of the printer a new one is printed. A digital interface is also present in [10] where a touch screen is present in the kitchen. The interface features a couple of recommended dishes that are aimed to inspire the user, and also the ability to share inspiring dishes with users in social groups. Common for these two products is a focus on digital input, but a physical presence in order to output recommendations.

Current HCI research, within the field of discovering new dishes, is limited and lacks a focus on products that provide a tangible interface for inputting preferences to a recommendation system. Furthermore the products that are used within the field of discovering dishes are all digital. This presents an opportunity to investigate a physical product with a tangible interface (TUI). A physical product will always be accessible and conspicuous, reminding the user of the interaction with the product, compared to websites and applications where the interactions are hidden and need to be actively searched for.

Research has shown that TUIs enable more playful interactions, provide better means for exploration, better conditions for learning and in particular for children it is easier to use and more engaging [15] [16].

These potential benefits of TUIs become increasingly relevant for this project, as initial interviews (further elaborated in *Section 3*) revealed that discovering new dishes in a family setting is difficult due to lack of motivation and participation by the children.

3. Initial research



3. Initial research: Meal planning as food practice

This section describes initial user research regarding food practices and meal planning in Danish households with children.

3.1 Purpose and target group

In order to further design for food and meal practices, an investigation of the problems and challenges described in the previous section regarding time scarcity, meal planning and discovering new dishes was initiated. In order to limit the scope of the project, a target group was chosen. The choice was on Danish households consisting of two full-time working parents with children. The choice of full-time working parents was based on the fact that time scarcity is a rising issue among full-time working parents due to the parents being busy with work, minimizing the time to do chores (e.g. dinner, cleaning etc.) during weekdays [4].

The choice to focus on families with children was based on the fact that the food practices becomes more complicated and time scarcity is more prevalent in this type of family constellation [4], due to reasons such as employed parents, childrens spare time interest, childrens pickiness [17] and the fact that some coping strategies are not sufficient when having kids, e.g. skipping dinner.

3.2 Participants

The participants consisted of three families. The three families each consisted of two full-time working parents (age 29-46) with children (age 1-17). Family 1 (F1) consists of two parents and three children, family 2 (F2) consists of two parents and three children, and family 3 (F3) consists of two parents and two children.

3.3 Procedure

The interview was set up as a semi structured interview. The focus in the interview was families current food choice practice; if they eat dinner together as family, how they choose what to eat (meal planning), how much time they have for planning/preparing, personal values of food choice, lack of inspiration for choosing dishes and if and what actions they have tried in order to deal with food choices. Each interview was held as a joint interview, as all family members in a single family were interviewed at the same time.

3.4 Data collection and analysis

All interviews were audio recorded and manually transcribed. Each transcription was coded using keywords through a summative content analysis [18], followed by a process of categorizing and grouping quotes and codes together in several iterations to uncover themes in an affinity diagram created in miro (see *Figure 3.1*).

3.5 Findings

Meal planning process

In order to cope with time scarcity during weekdays, all three families create meal plans for seven days ahead. Usually, the meal plan is created in the weekend and takes between 15 and 30 minutes to finalize.

Choosing dishes

When choosing dishes for the meal plan, parents in the families describe that they choose from their meal base (convenience food), for instance one adult in family 3 expressed;

“Well… we.. we re-use a lot of dishes.. We have some go-to dishes, which we vary a little in” - P1, F3

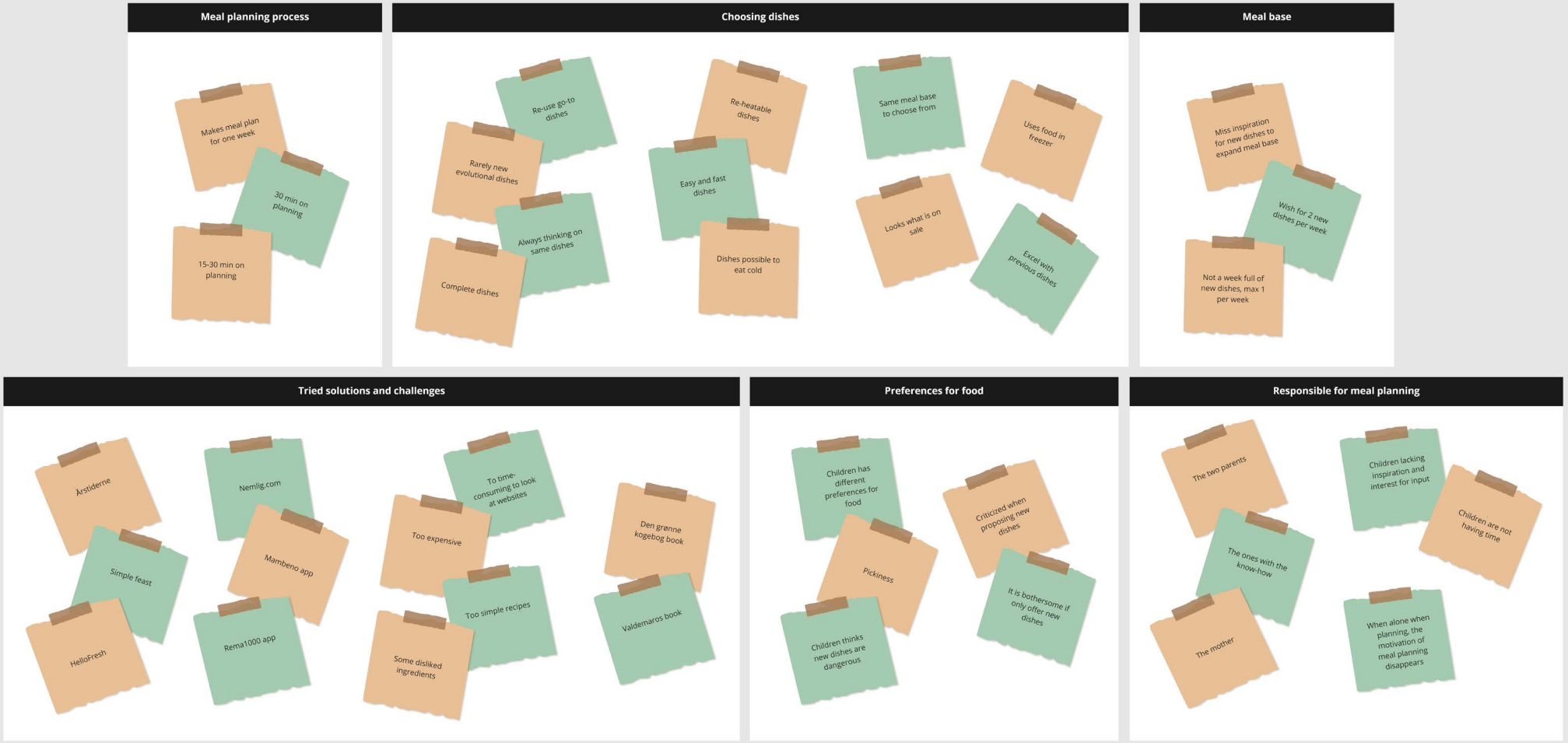


Figure 3.1: Affinity diagram of initial interviews created in Miro.

Two families choose dishes based on offers at the store, previous meal plans, and what is available at home eg. in the freezer or refrigerator;

"Most often we look in the freezer to see what can be used, or we look after offers in the stores, if anything could end as a dish" - P2, F2

Making meal plan as whole family

When planning which dishes to include in the meal plan, there was a tendency across all families towards the children not taking part in the making of the meal plan. This challenge was due to the children not being motivated to propose dishes as they found the process of meal planning boring, or the fact that they felt criticized for their meal proposals;

"Well, I just can't think of anything" - C3, F1

"It is boring" - C1, F1

"You are so annoying (B1) when you suggest steak and bearnaise, you know I do not like the sauce" - C3, F2

Additionally, the parents expressed a wish regarding making meal plans as a whole family and not alone in order to be motivated for the planning process. Without the other family members participating, the parents just resort to convenience dishes;

"I think it [meal planning] is hard to do alone, and then I just do not bother… then it is easier just to make meatballs [convenience food for the family]" - P1, F1

Meal base too small

Two families expressed that they did not feel their meal base was big enough. However all three families wished for an expansion of the base, by discovering new dishes, for instance one parent in family 1 expressed;

"You could imagine a kind of catalog, which you could look into with the most popular dishes you made before.. And say; "now we take number 24 again because it was so good or a version of it" … because it is always the same dishes you focus on" - P2, F1

Current solutions to expansion of meal base

All three families have actively tried solutions to discover new dishes for their meal plans.

All families have tried cookbooks, but realized that often those recipes took too long in everyday life;

"But.. often you think "that could be delicious".. But then it takes a long time to cook.. And if it something that requires a lot of time, then it is not doable in the everyday life" - P2, F2

Two families have tried different smartphone applications, in order to cope with the challenge of discovering new dishes. The families express that they feel too overwhelmed by the many options of searching for dishes along with an overwhelming amount of results based on the search, leading to the process being too time consuming as it is hard to keep the focus on the task. One parent in family 3 expressed;

"You can find a lot of websites that inspire you, but if I have to look it all through and not know what to search for.. I need it to be thrown in my face, else it would be too time consuming" - P1, F3

Lastly, one family tried foodboxes, however they felt they were too expensive, inflexible regarding guests and spontaneous appointments and the recipes were too simple as the dishes were too close to their convenience dishes, tasted too boring and were not inspiring. For instance one parent in family 3 expressed;

"It has been too expensive and too simple.. And then you think "okay I can make this better myself" - P1, F3

Children's preferences for food

Some concerns expressed by the parents regarding discovering new dishes were centered around children's preferences for food, as they "do not like new food". This complicated the process of choosing new dishes for meal planning, as the family has many preferences regarding ingredients and dishes to take into account;

"They [the children] do not like anything new, it is dangerous" - P2, F1

Further, the pickiness of children was also expressed by the kids themselves as one of the children expressed;

"Everytime, without failure, there is always somebody that doesn't like lasagne, somebody that doesn't want tartlets, and then there is somebody that doesn't fancy potatoes and gravy. There are always complaints." - C3, F2

Parents also express a challenge by introducing new dishes, as the children have a need for familiarity, otherwise they will critique the new dishes that are introduced. Furthermore, as time is scarce, the families express no time for adopting more than one new dish per week. Therefore the amount of new dishes that can be introduced is limited due to time and since the parents do not wanna be criticized too much;

"I can feel in this family, that you can not have a week with 2-3 new dishes, it is probably max 1 new dish a week that you can present… because you get criticized when suggesting new and young dishes" - P2, F2

Summary of findings

All families experience time scarcity, and use meal plans as a coping strategy. However, the families face challenges when deciding on dishes for their meal plan, mainly regarding discovering new dishes, which discourages the meal planning process. First, the parents are left to themselves during meal planning due to lack of motivation from the children. This lack seems to stem from the children's thoughts on the process being boring, not inspirational and further the feeling of critique of suggestions from siblings. When choosing dishes, the parents tend to pick from their meal base, as they know those dishes are liked by the entire family regardless of preferences. Secondly, with a wish from the parents to introduce new dishes, either from wanting to be healthier or eat more varied, they are troubled by the children's food preferences as they often are afraid of tasting new dishes or ingredients due to pickiness. Due to the process being challenging, all families had tried solutions to discover new recipes; cookbooks, smartphone applications and foodboxes. However, dishes in cookbooks seem to be too time-consuming, smartphone applications give a too overwhelming amount of choices to choose from and finally food boxes are too expensive and contain too simple dishes for the families.

The highlights in the background section along with findings from the initial interviews imply a need for further investigation of how to help families expand the meal base with four points in mind, making sure that: (1) all family member participate in the process, (2) all family members' food preferences are taken into account and 3) it must not be to overwhelming and time consuming, 4) the concept gives suggestions on new dishes based on the family's preferences to expand the families meal base.

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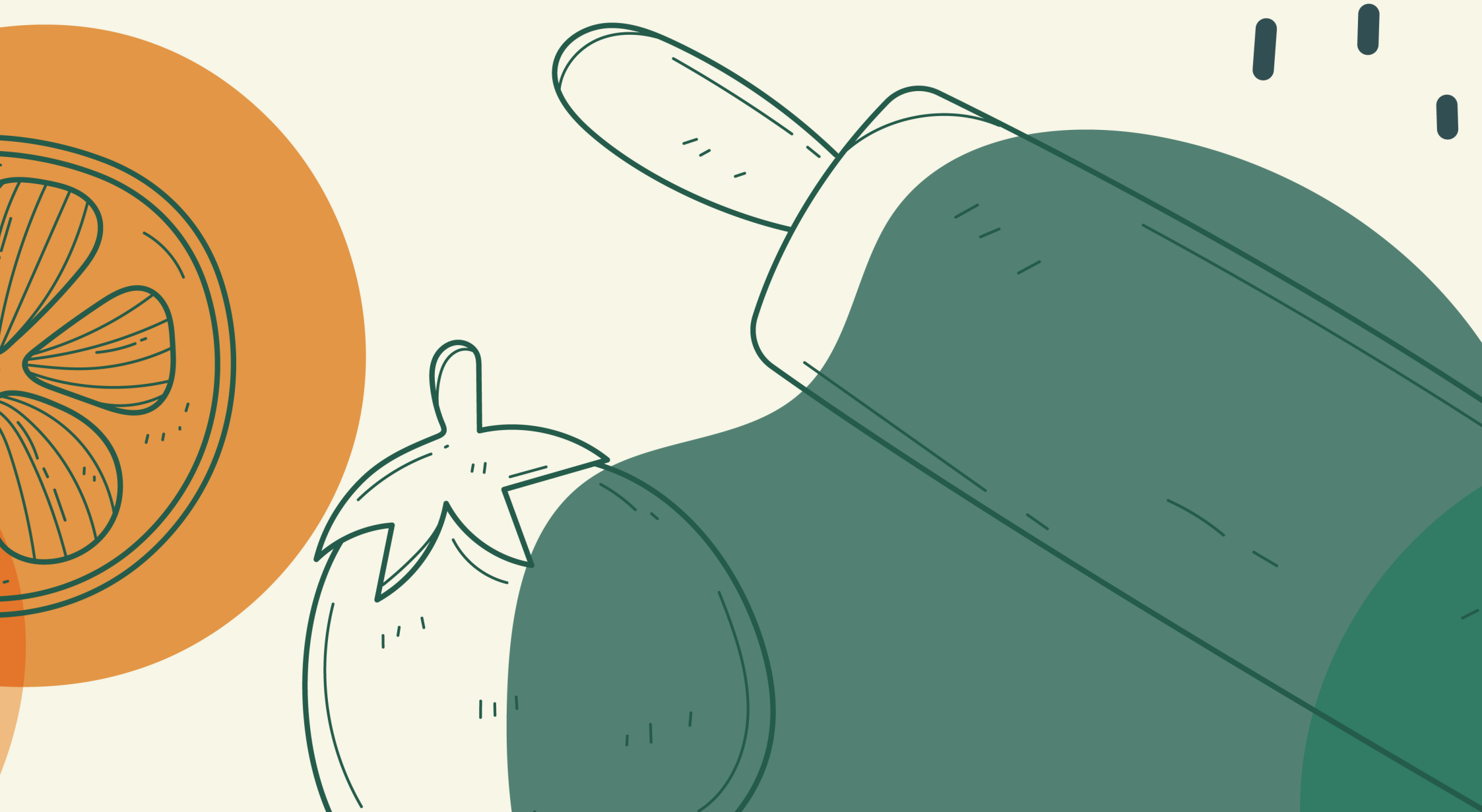
4. Ideation and concept



4. Ideation and concept

This section describes the ideation process including focus and concept ideas, along with the chosen concept.

4.1 Focus

An ideation process was conducted to further explore how to help families expand their meal base. As all family members' food preferences should be taken into consideration, it was chosen that the concept should focus on the family members selecting preferences as input. Through this focus, the challenge of children's pickiness could potentially be solved, as the children can express what they like and prefer, through their participation.

Further, as the concept should be able to suggest new dishes for the family based on the preferences, it was chosen that the concept should print a dish on a receipt as output. The choice of a receipt printer as output was heavily inspired by the study of the physical printer described in *Section 2.3.*

Another inspiration from *Section 2.3*, is the TUIs that children are perceiving more playful along with them enabling exploration and making systems easier to use. Furthermore, exploring physical tangible products for discovering dishes adds to current research. Therefore, creating TUIs was also an important focus point.

4.2 Concept ideas

The focus points were used in the ideation process when exploring concepts for interaction and selection of preferences. Concepts were explored through brainstorming, sketching and combining ideas on paper in several iterations. This resulted in multiple concept ideas, as seen on *Figure 4.1*.

The concepts differ in different aspects, namely; how cooperative the process is for the family, the amount of preferences available in the process, how preferences are input to the system, and whether the interaction is continuous or one-time throughout the process.
The game concepts are highly cooperative and require the entire family to sit together one time throughout the week, in order to select between all the preferences to make a shared set of preferences as input to their new dish. These concepts have potential to be fun and minimize criticism as the games have a fixed set of rules to follow. However, the rules can also be a con, as the family has to learn them, along with them all having to participate at the same time.
The remaining concepts are all continuous interaction concepts where the family can interact and select between all preferences whenever they individually have time. The building concept invites building together, but can be used individually, whereas the tamagotchi concept invites for an individual interaction. The concept forks invites to individual use, but stands out by being the only concept, where a limited set of preferences are available, thereby minimizing the risk of being overwhelmed. Further concept explanation can be seen in *Appendix 1*.

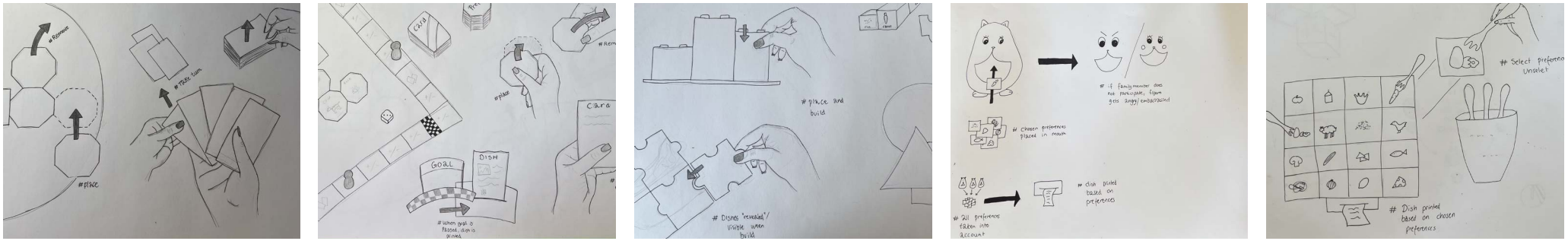


Figure 4.1 Concept ideas from ideation phase - (1) Cardgame, (2) Boardgame, (3) Building, (4) Tamagotchi, (5) Forks.

4.3 Choice and refinement

Choice

By considering the pros and cons from the concept ideas, a concept was chosen and further refined with more details.

The concept “forks” was chosen as it complemented the findings presented in *Section 3.5*. From the findings it was important to ensure that the concept facilitates that all family members can participate and express their preferences for food in order to influence the weekly new dish. Here the concept “forks” is giving each family member the possibility to give individual votes for preferences they like, which will influence the new dish at the end of the week when meal planning. Further, by giving the family the choice of voting for ingredients the week up to meal planning, the possibility of participating is potentially higher, as the family members can participate when having time.

As all family members mentioned the feeling of getting criticized for proposals of dishes, it is important to focus on a concept which can facilitate a process with minimal risk of criticism.
Criticism is avoided in the “forks” concept as family members do not interact with each other, the set of rules makes the votes equal for all participants, and the system is unbiased and based on probability from the number of votes. It is further important to make sure the family is not overwhelmed by too many options, as findings revealed that too many options is an issue when using applications and websites. This issue is overcomed in the concept “forks” by limiting the amount of preferences to a set amount, instead of the family having all possible preferences in front of them.

Refinement

Aesthetics

The concept consists of a physical plate with fields that each presents one ingredient (preference). Further, it consists of a container for color tagged forks, but it also acts as the dish receipt printer.

The act of voting

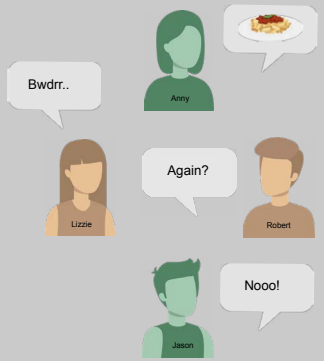
The concept revolves around each family member voting on ingredients they prefer in the seven days leading up to the next meal planning session. Voting is done by placing a fork in an ingredient. This is inspired by the process of eating at a dinner table - having a plate of food and putting a fork into what we would like to eat. One ingredient can be selected multiple times, and for each selection the ingredient field will grow, to signal its importance. Each family member is assigned color-coded forks, where the exact amount of forks is chosen by the family.

The votes on ingredients should be given, whenever a family member has time, thereby being a continuous interaction with the concept. As long as an ingredient has a vote in it, it is locked and cannot change. The ingredients which do not have any votes would change to a new ingredient at the start of the next day.

A family member can shift their votes to a new ingredient by moving their forks from one ingredient to another - however if the ingredient, which is no longer chosen, has no other votes on it, it will change to a new ingredient. If all presented ingredients are voted for, there will be no change and thereby no new ingredients to choose. Any ingredient with votes is used to select a new dish based on probabilistic calculations once the week has passed.

The selected dish is then printed as a receipt containing general information of the dish, alongside a way to gain more information if needed. If no ingredients are chosen at all, no new dish will be printed to the family. See *Figure 4.2* for visualization of use in context (storyboard).

1



For a long time the family has struggled when meal planning, as they always feel they choose the same dishes every week.

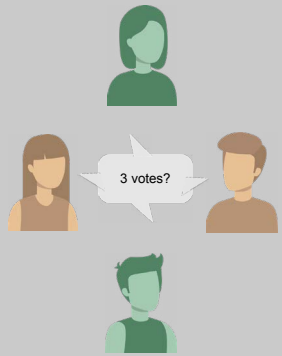
2

Therefore, Robert and his family decide on using a new product called “put a gaffel in it”; a new way of getting inspiration for dishes.

3

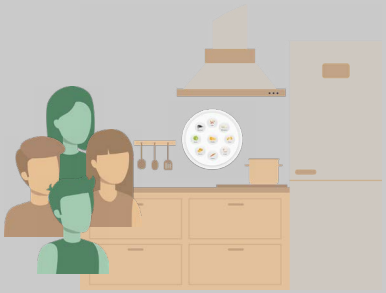
The family agrees that the product should be placed in the kitchen where every family member has a chance to pass by and participate.

4



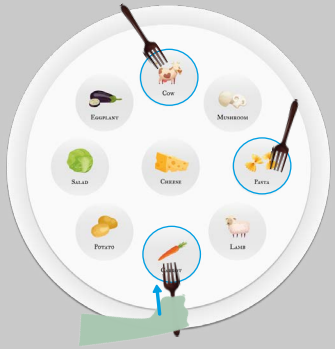
The family has to vote for ingredients they like. They agree that each family member has three votes to use each week.

5



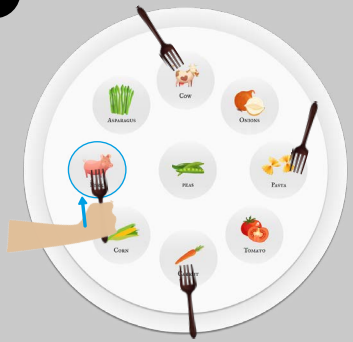
Robert’s family is excited to use the product and immediately took a look at today’s presented preferences.

6



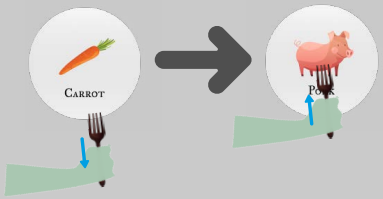
Anny immediately saw three ingredients she prefered and decided to vote on them by putting a fork into each.

7



The next day Lizzie saw that the ”not voted for ingredients” had changed and now the possibility to vote for pork had risen. Therefore, she decide to vote on pork.

8



Anny looked at the available ingredients and realized that she also wanted to vote for pork, but since she already used all her votes, she moves her fork from carrot to pork.

Figure 4.2: Storyboard

9

Now the ingredient carrot shifted to broccoli, as there were no longer any votes for carrot.

10

After a few days of voting all possible ingredients were now voted for, and therefore the family would not receive any new ingredients.

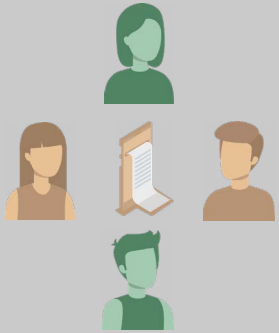
11

Because of this, Jason chose to withdraw one vote, in order for the ingredient to change so he could explore other possibilities.

12

Robert was challenged on deciding on ingredients, but now, as Jason has moved a fork, the ingredient fish appeared, which he really likes. Therefore, he uses a fork and votes on fish.

13



Now one week has gone, and a receipt with details of the new dish is printed for the family. All family members gather around the product, excited to see what dish is proposed and they have to cook in the upcoming week.

Preferences

Each preference is represented as mid-level ingredients. The ingredients are presented as fields with a picture and the name of the ingredient. The choice of mid-level ingredients are chosen, as preferences for food can be divided into a range of granulations; from full dish level to atomic ingredient level (see *Figure 4.3*). It can be difficult to come up with new dishes based on full dishes (which potentially are convenience dishes) that are new to the family. On the other hand, if using atomic level, it can be hard for family members to express if they want an ingredient or not. An example could be pasta that is essentially made from egg and flour, so if a family member wanted pasta they would have to pick egg and flour instead. Therefore, a mid-level of ingredients are used as preferences in the concept.

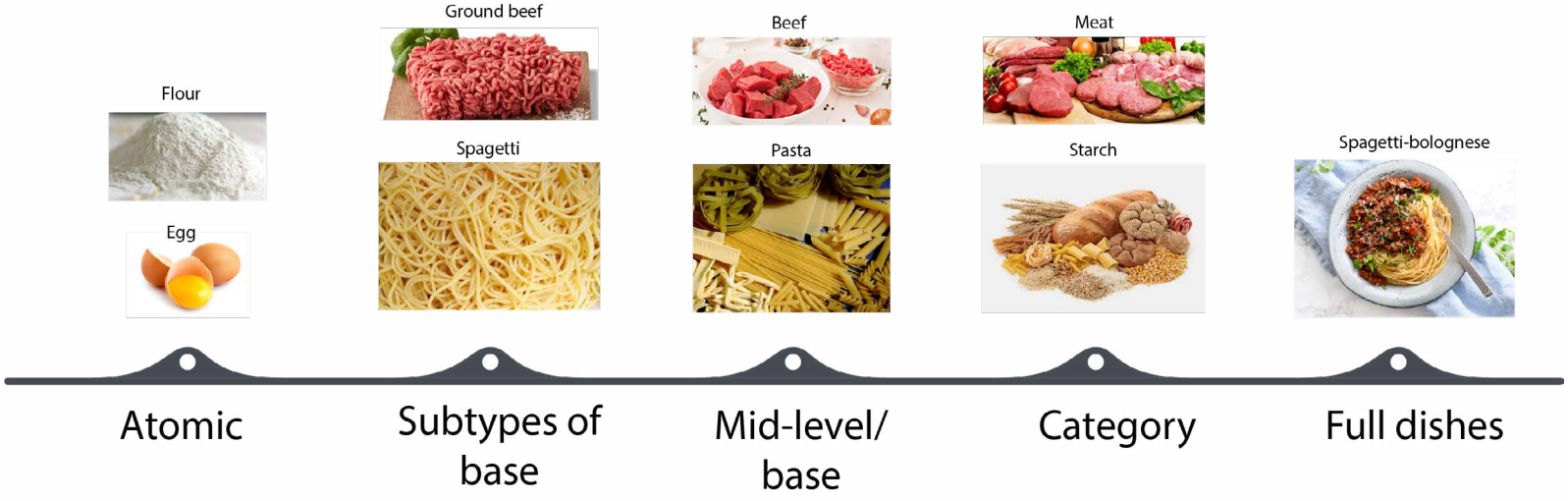


Figure 4.3: Scale for granularity of ingredients.

The end product is envisioned as a porcelain plate, where the middle acts as an interactive screen where forks can be attached as magnets. Besides the plate, the product features a printer encased in wood, which also serves as a container for the wooden forks. The choice of wood as a material is based on the fact that wood is becoming popular in Danish homes as it adds a natural, warm and rustic look to a minimalistic interior [19].

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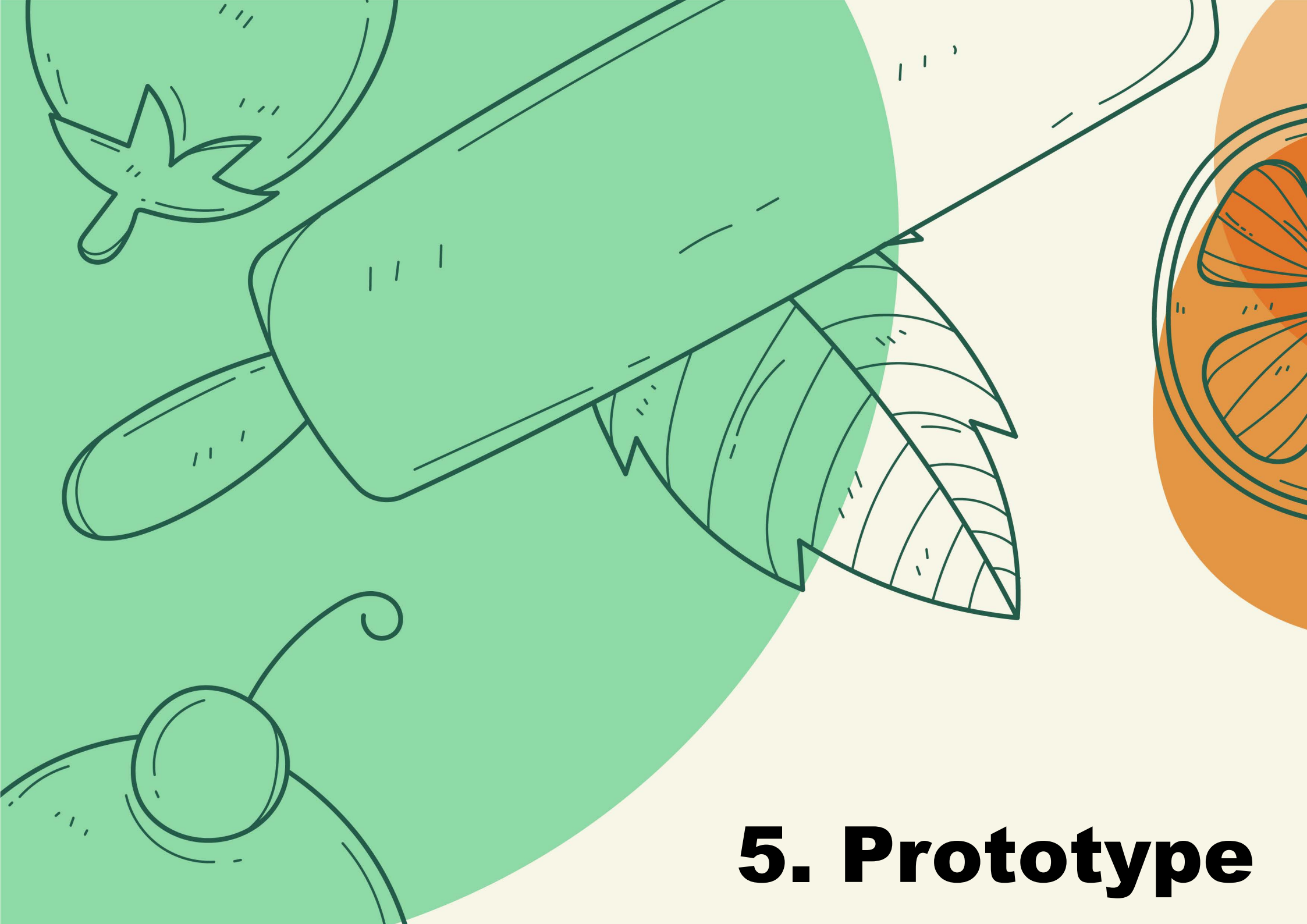


5. Prototype

5. Prototype

This section describes the process of building a high-fidelity prototype for evaluation.

5.1 The final prototype

In order to evaluate the concept, a high fidelity prototype was built. It was chosen to build a high fidelity prototype in order to get as close as possible to the original concept and due to the fact that the field study required a prototype that was durable and functional to the point where it could be placed at the families for a week at a time without need for maintenance. The prototype consists of a plate of foam core with eight displays, each displaying one ingredient as text (see *Figure 5.1*).

Figure 5.1: High-fidelity prototype.

Each ingredient can get three votes, through the use of color-coded forks. Each family member is given two same-colored forks to use for voting during the week. Conceptually the family had to choose the amount of votes, but for the prototype two votes were given in order to make it possible that some ingredients were not voted for.

To see the prototype in action, a video can be seen scanning the following QR code:

5.2 How it works

Initializing of data

When the prototype is powered on, it will start by initializing the hard-coded data (see *Figure 5.2*), which consists of 11 different recipe urls, 39 named ingredients, a recipe-ingredient matrix (further explained later in this section), and eight lists of possible ingredients; one for each display. Once data has been initialized, the ingredient for each display is set according to the current weekday and the possible list of ingredients for each individual display. Finally a random seed is set for upcoming probability calculations.

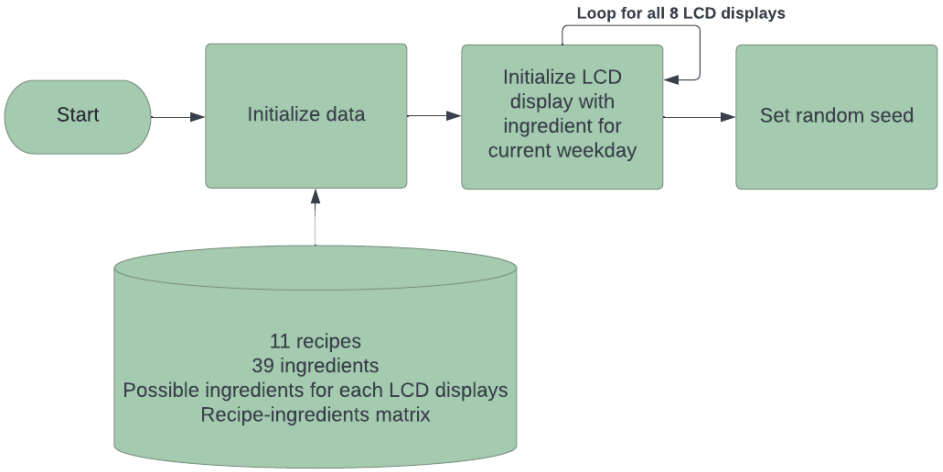


Figure 5.2: Sequence diagram for initialization of data.

State of LCD displays

The following logic flow (see *Figure 5.3*) runs in a continuous loop while the prototype is powered on and after initialization has finished. This flow is run for each of the eight displays/available ingredients, but for simplicity the example just considers the case for one. A check is made whether any active votes are present on this display/ingredient, if that is the case then continue to display this ingredient and run the loop again. If no active votes are present a check is made if the current displayed ingredient matches the ingredient that should be displayed for the current weekday.
If that is the case we keep displaying the ingredient, otherwise we exchange the displayed ingredient with the ingredient matching this weekday.

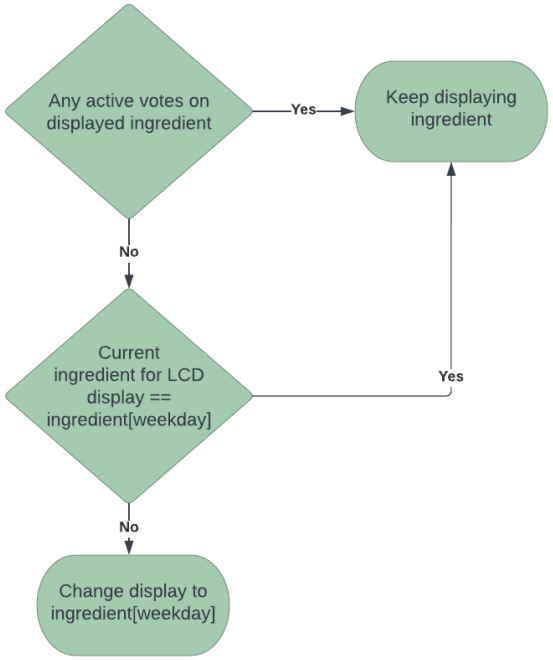


Figure 5.3: Flowchart for state of LCD displays.

Probability and selection of specific dish

When the “give recipe” button is pressed on the prototype an algorithm will select a matching recipe url which can then be used to generate a QR code that the user can scan.

The algorithm uses a matrix *X* which is a *m x n* matrix where *m = 39* and *n = 11*. The matrix describes the relationship between the 39 ingredients and the 11 recipes by having either *1* or *0* in each cell representing if the ingredient is present in a dish.

Eg. $x_{0,0} = 1$ means that ingredient 0, is present in recipe 0. Besides the matrix, the algorithm also uses an array of 11 numbers (see *Figure 5.4*) where each number represents the points that are active for each recipe. The points for recipe 0 is the sum of active votes(y_i) of the eight active ingredients(i) that are used in recipe 0(x_{k0}).

An example could be as follows:
Ingredient 1 has two active votes, ingredient 2 has zero active votes, and ingredient 3 has three active votes. First the active votes for ingredient 1 is calculated: $i = 1$ and $y_1 = 2$. Pretend that ingredient 1 is used in recipe 0 then $x_{k0} = 1$ so the active votes for ingredient 1 is $2 * 1 = 2$. For ingredient 2: $i = 2$, $y_2 = 0$. Pretend that ingredient 2 is used in recipe 0 then $x_{k0} = 1$ and the active votes for ingredient 2 then becomes $0 * 1 = 0$. For ingredient 3: $i = 3$, $y_3 = 3$. Pretend that ingredient 3 is not used in recipe 0 then $x_{k0} = 0$ and the active votes for ingredient 3 is $3 * 0 = 0$. The sum for these three ingredients for recipe 0 would so far be $2 + 0 + 0 = 2$.

Now once these points have been calculated for all recipes an example of this point list could be as illustrated in *Figure 5.5*. The next step in the algorithm is to convert these points into percentages in order to select something through means of probability. First the total points are calculated by summing the entire list. Then for each element the percentage chance is calculated as *(points / total points) * 100* and rounded down. These percentage chances then replace the existing points in the list, a random number is picked between 0 and 100 and the algorithm loops over each element.

If an element is 0, such as the first one in the illustration, that element is skipped as there is no chance this recipe can be selected. For the next element (30 in the illustration) it is checked if the *random number* is less below that percentage chance, if that is the case the recipe on that index of the list is chosen. Otherwise the number is added to a *totalPassed* variable and continues. Next time a number is found in the list a check is performed on whether the *random number* is between the *totalPassed* variable (30 in the case where 43 is reached in the

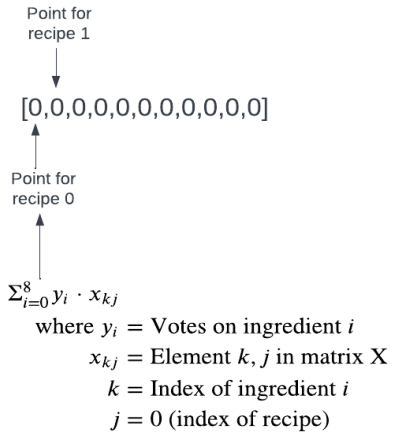


Figure 5.4: Calculation of point for all recipes.

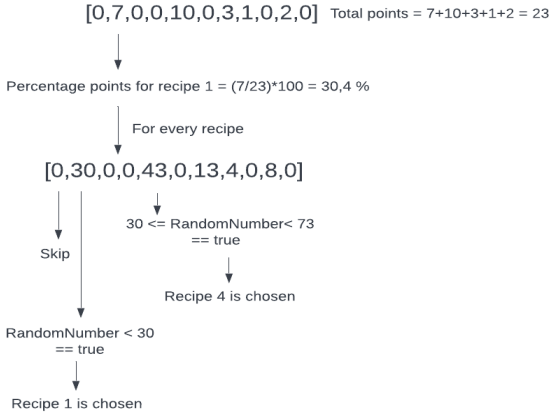


Figure 5.5: Probability and selection of recipe.

illustration) and the new *totalPassed* (*43 + 30 = 73* in the illustration) if that is the case then the recipe on this index is chosen. Otherwise it just continues as before with a new *totalPassed*. This continues until a recipe has been chosen or the end of the list is reached, in which case the last recipe with a percentage change is selected.

5.3 The building process

Arduino mega

The prototype is built up around an arduino mega, which is coded using the programming language C++ through arduino studio. The code can be found in *Appendix 2*.

LCD displays

The displays should conceptually show the ingredients along with their names. However, in the prototype it was chosen to use LCD displays which only display text (see *Figure 5.6*). The choice on LCD displays was taken to reduce the cost of the prototype while still maintaining the ability to evaluate the concept.

The displays are used with I2C modules in order to simplify the connection to the arduino mega. Since the I2C modules can only be distinguished through eight unique addresses, there is a limitation in the prototype of eight displays.

Female headers input for forks

Conceptually, the fork should be placed on the field of the ingredient with no limitations of the placement within the field. However, the prototype is limited by having three defined slots (total of 24) for each ingredient to put forks into, which eases the implementation significantly (see *Figure 5.6*). Each input module was built by using female pin headers, a 10K pull down resistor and wires. The forks were created from foam core, duct tape and connected male pin headers and were color coded.

Dish container

Conceptually, the output should consist of a printer which would print out a receipt. However, to reduce cost it was replaced with a button that activates the dish selection algorithm, and showing a QR code on an monochrome OLED display (see *Figure 5.6*). The OLED display was also connected through an I2C module and the QR code would present a link to the recipe.

Conceptually, the system should be able to print the receipt based on a set timer (eg. every saturday).
However, in the prototype it was chosen that it should be activated by a button, in order to evaluate the prototype with different families regardless when they are meal planning. Further functionality of the container is to hold the forks.

Stand

In the original concept the plate should be wall mounted but with a limited testing period it was decided that a table stand was a better alternative for the prototype (see *Figure 5.6*). This also had the effect of making the prototype more sturdy and semi-hiding the electronics.

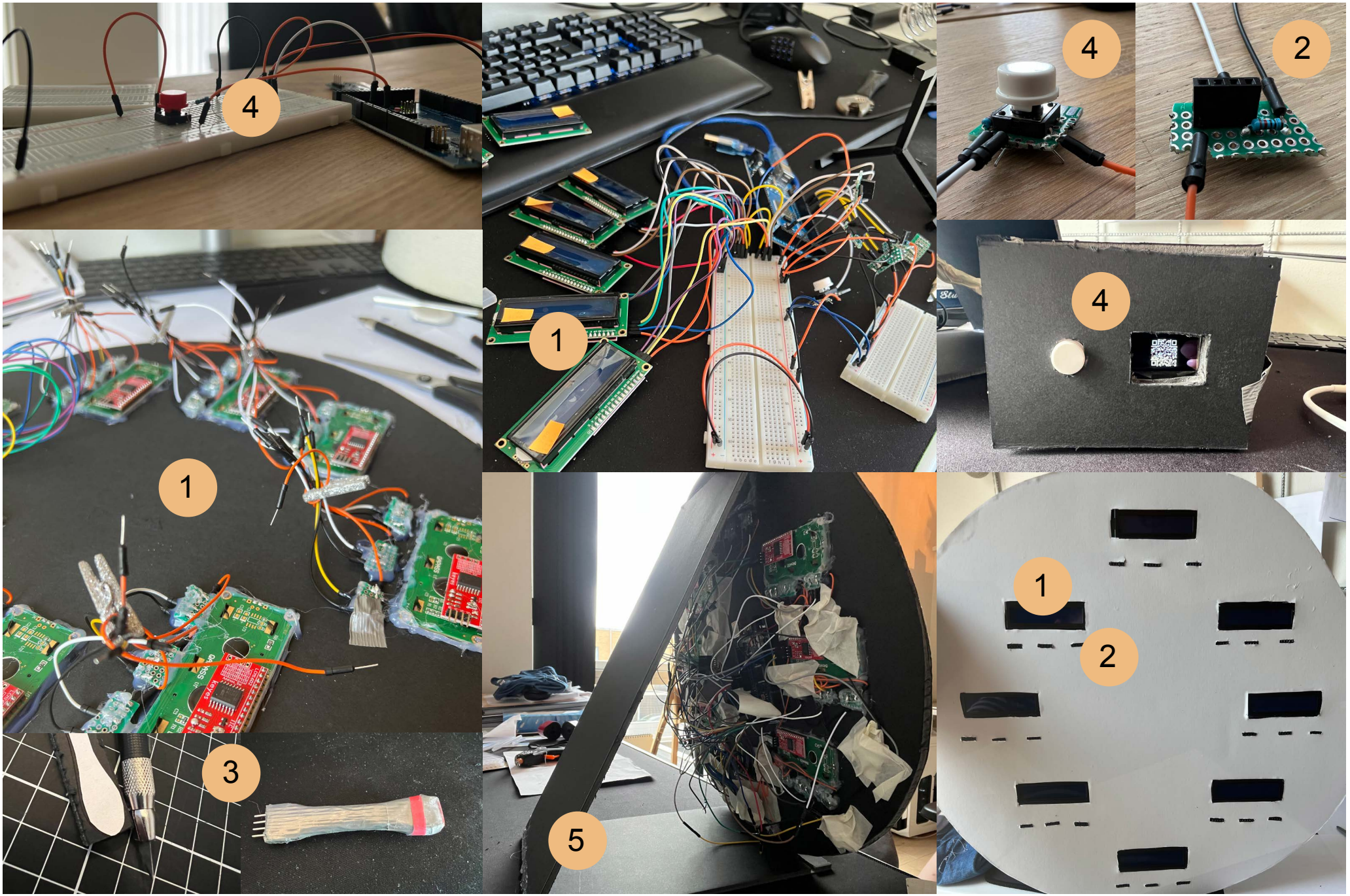


Figure 5.6: Prototype where (1) displays, (2) input for forks, (3) forks, (4) output button and OLED display, (5) stand.

6. Field study

6. Field study

This section describes the conducted field study with two Danish families.

6.1 Purpose

A field study was conducted in order to evaluate the concept through the constructed prototype. Since the context of the product is dependent on the users' daily activities at home and the anticipated interaction happens when users are having time and become aware of the product, a field study [20] over time was chosen. This enables the possibility to investigate how the product would be used in its real context, as the concept is meant to be used in the week leading up to meal planning.

The purpose of the field study was to get insights into the experience and interactions with the concept. Main focus of the inquiry was to investigate whether the concept could make the process of finding new dishes for families' meal plans more enjoyable, accessible and less overwhelming and how the tangible aspect of the product contributes to these factors. Another focus of the inquiry is on whether dishes, based on preferences, makes sense for the families, and if it overcomes the challenge of choosing dishes due to the pickiness of children.

6.2 Participants

Two of the three families from the initial interview were chosen to evaluate the concept. Family 3 was left out of the study, due to limitations of the prototype, as the children in that family are not able to read.

6.3 Procedure

The setup for the evaluation consisted of an introduction-, midterm- and follow up sessions.

All sessions were held as joint sessions, where all family members in a single family were introduced and interviewed at the same time.

The introduction session consisted of an explanation of the concept, the setup of the prototype along with a few questions around placement and the family's anticipation of the upcoming week. After the introduction session, the families had to decide which member had which color of forks and then the families tried the prototype for one week in their homes. In the middle of the week, the families were contacted and questioned about "how their current experience was", "how it differs from their anticipation from the introduction meeting" and "if the placement of the prototype has changed since the introduction meeting". Lastly, a follow up session in the form of a semi-structured interview was held in order to get insight into the experience of the prototype.

6.4 Data collection

The data consisted of qualitative data from summaries and transcriptions of each interview, along with quantitative and qualitative data from a diary. All meetings and interviews were audio recorded and manually transcribed. Further, each family was given a log/diary (see *Appendix 3*) to write in each time they interacted with the prototype. These diaries were based on the experience sampling method [21], in order to gather self-reported data from each family member. Questions were split between qualitative and quantitative inquiries. The qualitative questions; "*what did the family member do*?", and "*how did they experience doing it?*" were asked to gauge the perceived interaction. The quantitative questions; "*when?*"(date and time), "*duration?*" created a basis for analyzing participation metrics of children vs. parents, and what total time was spent interacting to get a new dish for each family.

6.5 Data analysis

As with the initial interviews, each transcription was coded using keywords through a summative content analysis [18], followed by a process of categorizing and grouping quotes and codes together in several iterations to uncover themes in an affinity diagram created in miro (see *Figure 6.1*).

High visibility

During the introduction meeting, family 1 placed the prototype in their dining room (see *Figure 6.2*), with the anticipation that most family members would pass by everyday;

"Well, everyone pass everyday" - P1, F1

When asked in the midterm meeting, the family expressed that the placement of the prototype worked well, as they all passed by daily;

"The placement are great. Everyone passes daily and are reminded to look for new ingredients" - P2, F1

Family 2 placed the prototype in their living room (see *Figure 6.3*), as they were sure all family members would pass;

"The living room is inevitable to pass" - P1, F2

When asked in the midterm meeting, the family expressed that the placement of the prototype was perfect, as all family members passed by multiple times a day, and thereby noticed it;

"The dining table is a great placement, as you notice it" - P1, F2

Continuous use

Looking at the self-reported data in Figure 6.4 and Figure 6.5, it indicates that both families have had continuous interaction with the prototype during the week, as all family members have reported interactions at different days during the week. When following up, both families expressed that by having a physical device, it was clearly visible for the family members and drew attention to the device;

"All family members had continuous participated, because when the children has passed the prototype and seen meat as choice they thought "damn there is pork I have to change my vote", because it was placed in the living room, which draw their attention to it" - P1, F2

"We have interacted with the prototype during the week, and mostly around dinner time because of the placement" - P1, F1

The continuous use can be due to several reasons; their ability to vote for ingredients they like, the playful element of forks or the physical and tangible aspect. By having a physical product, the family is "forced" to notice it, compared to a digital solution where the choice of using it is more "hidden". This therefore indicates that having a physical prototype and placing it in a room where people pass by invites to continuous use of it.

Having aesthetical troubles

Family 1 expressed in the follow up sessions, that due to the aesthetics of the prototype (and vision of it), they would have a hard time using it in the future, as it does not fit into their interior and expressed a need for a digital solution;

"Well there is something aesthetically by having something placed in the room, which not necessarily fit it… it demands a lot of space and if you have decorated your home, it is not sure it fits in" - P1, F1

"It could have been a television screen… but who wants that in their home?" - P2, F1

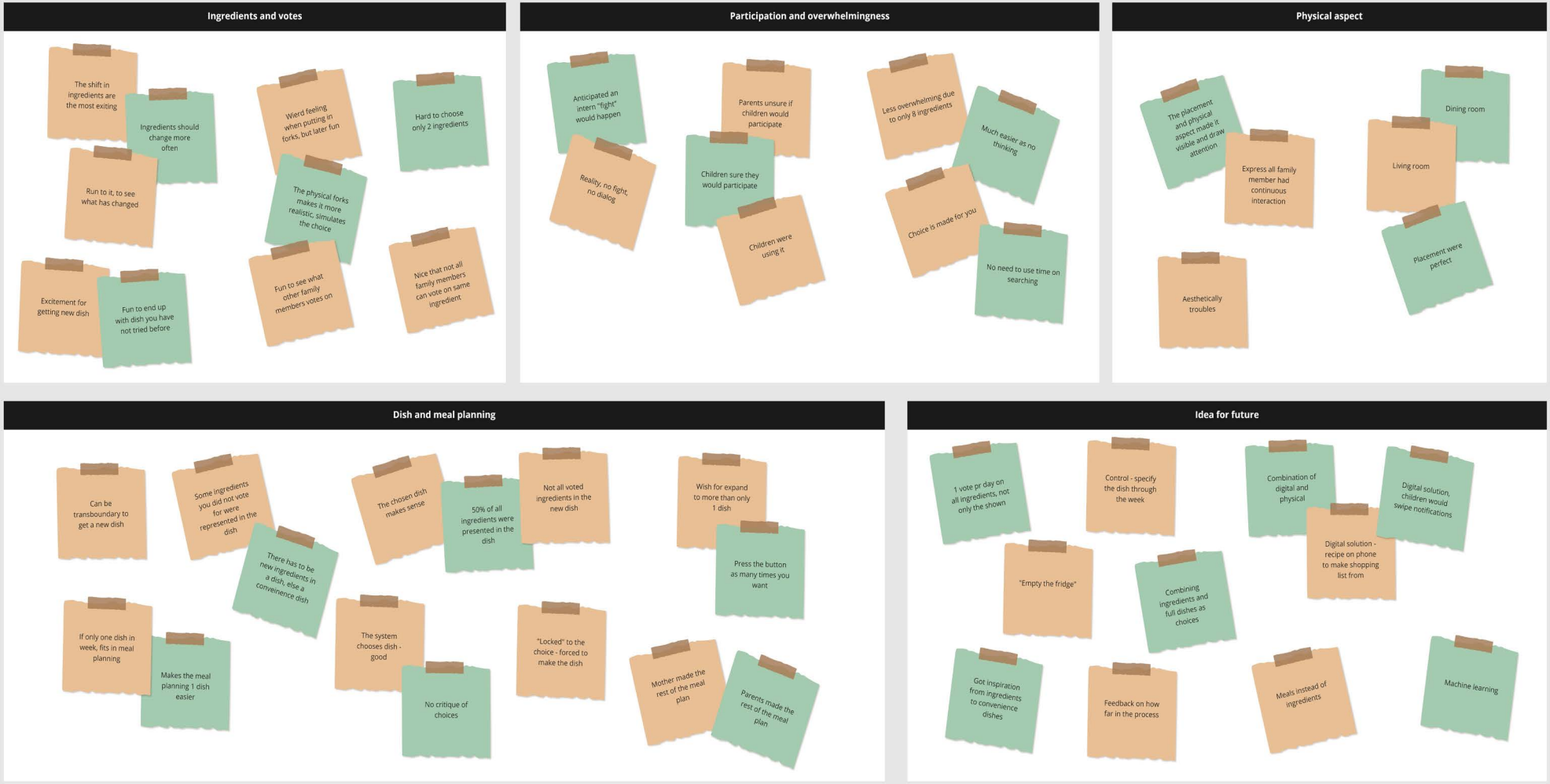


Figure 6.1: Affinity diagram of data from field study created in Miro.

Figure 6.2: Placement of prototype for Family 1.

Figure 6.3: Placement of prototype for Family 2.

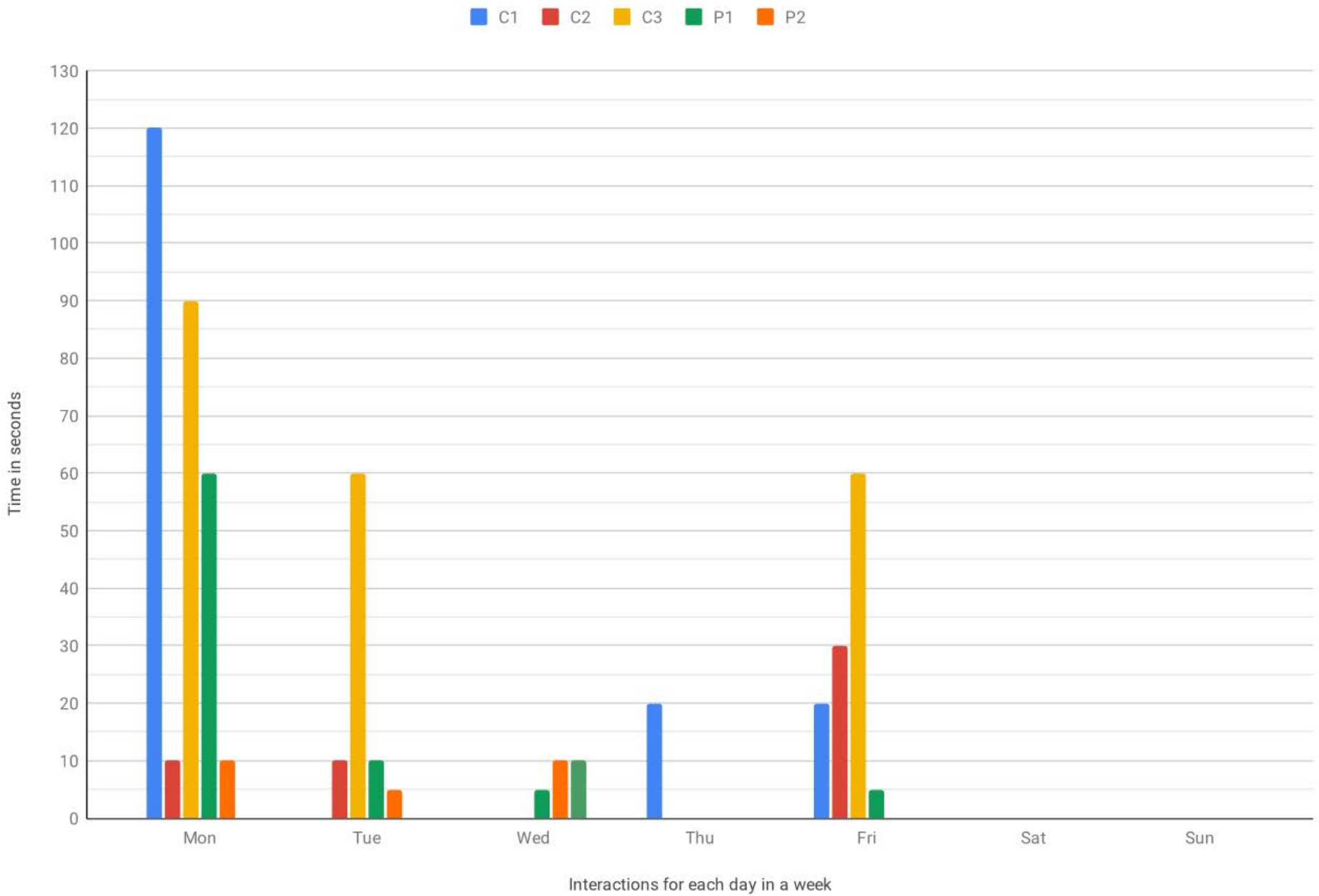


Figure 6.4: Self-reported interactions during the week and their duration for family 1.

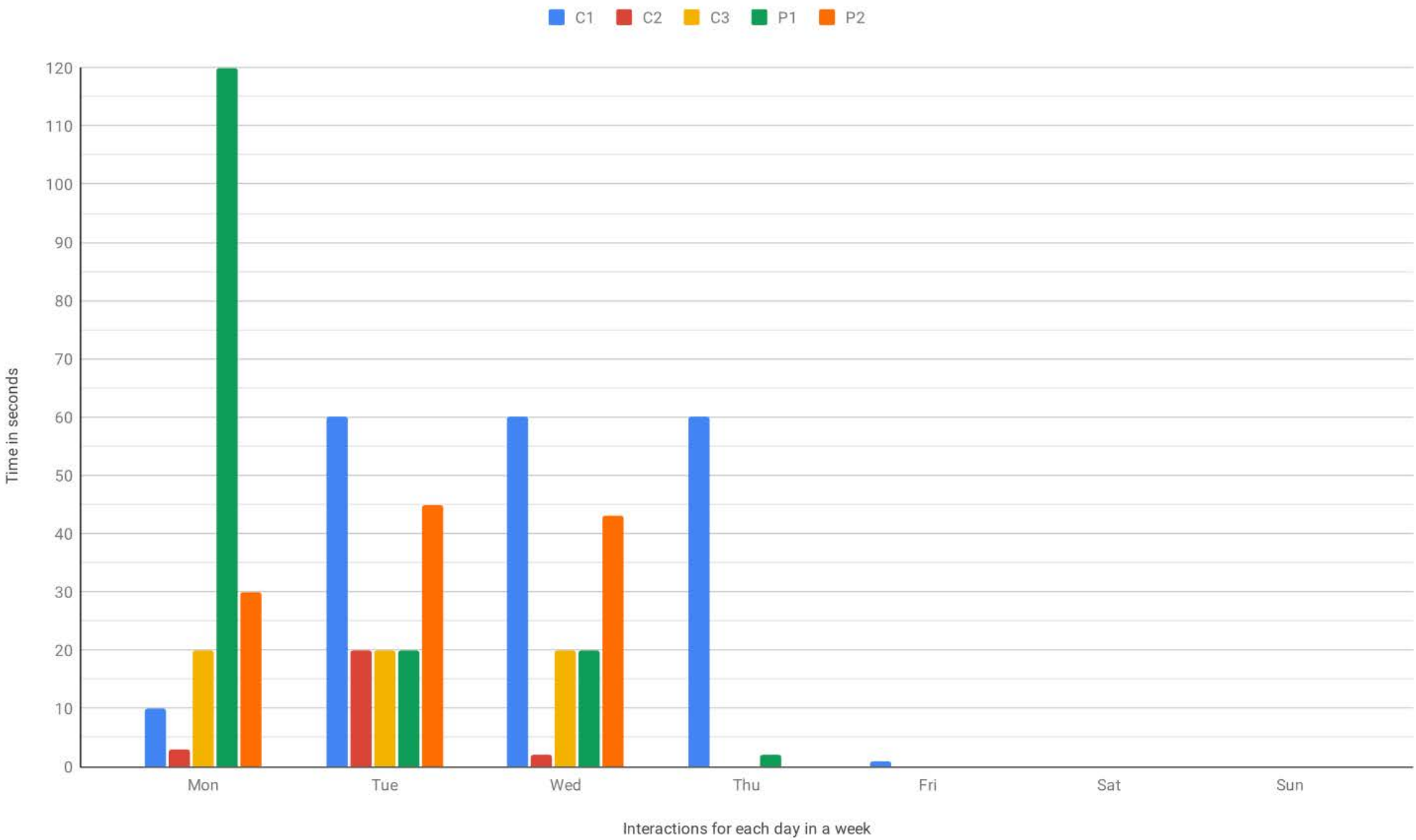


Figure 6.5: Self-reported interactions during the week and their duration for family 2.

Expecting a fight

In the introduction meeting, family 2 anticipated that there would be an intern fight between family members, as their preferences for food vary a lot. The anticipation were regarding a fight between the family members preferring meat and the ones preferring vegetables;

"Hmmm.. I think there would be a intern fight between meat and vegetables" - P1, F2

However, when asked in the mid-term meeting, the fight they anticipated did not happen, as all family members were voting at different times without talking about their choices;

"We experience no fight.. We actually just vote when having time, people have not talked to each other about their choices… we only looked at others' votes.. no dialog at all" - P1, F2

Children were participating

When asked about family 1's anticipation at the introduction meeting, the parents were questioning the children's participation for the upcoming week;

"I am not sure that the children actually are gonna interact with the prototype" - P1, F1

However, the children were sure that they would participate during the week;

"I am sure that we are gonna use it" - C3, F1

When asked in the mid-term meeting, the parents expressed that the children, opposite of their anticipation, were very interested in the prototype;

"The childrens are very interested, what is new is exciting" - P2, F1

"I think it is very funny to see and vote for ingredients" - C3, F1

It was further evident from the self-reported data, that both families were actively using the prototype, and that the children participated equally as much as the parents (see *Figure 6.6* and *Figure 6.7*).

Voted the first three days

The graphs on *Figure 6.4* and *Figure 6.5* show that most interactions were made in the first three days for both families, which indicates that interaction decreased as more ingredient options became locked by votes. For both families no interactions happened at the last two days, which indicate that the family already had chosen the liked ingredients, and no ingredients on the last days were interesting enough to shift votes for. Further it can be due to some family members not being home;

"One family member were not home one day, and therefore no interactions happened"- P2, F1

Efficient interaction

The total time spent interacting with the product over the week for each family (see *Figure 6.6* and *Figure 6.7*) indicates that the process of choosing ingredients was efficient, which is also the expression received through the follow up interview;

"It is so much easier to do it in this way, as I do not need to come up with any dish by searching on the internet" - C3, F1

Average time between each participant seems to fluctuate and no apparent correlation is noticed between children and parent interaction. When comparing family 1 and family 2's time used on interactions, it seems like family 1 uses more time on interacting the first time, whereas family 2 are using less time on the first interaction. It further seems that overall time for interactions in family 1 is decreasing as days go by whereas family 2 the tendency is either increase of consistency in times used.

Family members in family 1(F1)	Gender	Number of entries	Total time used on entries	Average time used on entries
C1	M	3	320 sek ≈ 5,3 min	106,6 sek ≈ 1,7 min
C2	F	3	50 sek ≈ 0,8 min	16,6 sek
C3	F	3	210 sek = 3,5 min	70 sek
P1	F	5	90 sek = 1,5 min	18 sek
P2	M	3	25 sek ≈ 0,42 min	8,3 sek
Total:		17	695 sek ≈ 11,6 min	40,9 sek

Figure 6.6: Self-reported data collected and calculated through diary for family 1.

Family members in family 2(F2)	Gender	Number of entries	Total time used on entries	Average time used on entries
C1	F	4	131 sek ≈ 2,18 min	32,75 sek
C2	M	3	25 sek ≈ 0,4 min	8,3 sek
C3	M	3	60 sek = 1 min	20 sek
P1	F	4	162 sek ≈ 2,7 min	40,5 sek
P2	M	3	118 sek ≈ 1,9 min	39,3 sek
Total		17	496 sek ≈ 8,18 min	29,2 sek

Figure 6.7: Self-reported data collected and calculated through diary for family 2.

Less overwhelmed family

Both families agreed on the process being less overwhelming and much easier, due to the limited amount of ingredients presented;

"Yes [to question about it being less overwhelming] - there is only 8 options" - P2, F2

"Sure, it is easier as you do not need to think of anything" - C3, F1

The process also limited the cognitive load, as the family expressed no need for thinking or searching for new dishes as the choice is made for you;

"Well, it is much easier as I do not have to figure out what to search for, it is a choice that is made for me" - C3, F1

This therefore indicates that choosing between a limited set of ingredients is less overwhelming for the family, than using the applications and websites they have tried in the past.

Excitement of getting new dish

At the introduction meeting, both families expressed that they were excited about using the prototype and getting a new dish at the end of the week;

"We are just excited to get a new dish" - P1, F1

"I just think we are excited for trying the product and getting a new dish" - P1, F2

Further, in family 1, one parent expressed the excitement of getting a new dish by being impatient and therefore wanting to press the button even though the rest of the family wanted to wait;

"I asked a lot - "can I press the button to get the dish now?" but then P1 says "no"..." - P2, F1

When following up, the families were also excited about making the chosen dish;

"I think it such a good choice, I am so excited to make it" - P1, F2

"I'm excited to see if everyone will like the dish" - P2, F1

Excitement for shifting ingredients

At the mid-term meeting, family 2 expressed that they were enjoying using the concept, and that all family members are exiting each morning to check what has changed;

"We have a great time, we are very excited every morning to see what has changed since yesterday" - P2, F2

This was also true when following up, as both families describe that the most exciting were when the prototype shifted ingredients. In family 1, one child ran into the dining room every morning to see what has changed;

"You (C1) has expressed to us, that you thought it was very exciting and sometimes ran to the prototype to see what choices there were" - P1, F1

However, both families express a need for it to change more often, due to the fact that both families wanted to use the product for more new dishes, maybe a few times a week;

"It takes a whole week to make one dish.. Sometimes things have to go faster.. The question is also if it need to change more often, for example in the morning and evening to ensure new choices" - P2, F1

Putting forks into ingredients was fun

The idea of putting forks into ingredients were expressed as making the process more fun, but also more realistic as it simulates the choice;

"I think it is more realistic.. It simulates that you actually have a choice" - C3, F2

"It is a bit odd… but after some time became fun" - C3, F1

Further, parents in family 2 also expressed that they found it funny and interesting to see what the children actually voted for;

"I think it was funny to see how different we voted, as me and C1 were voting on very similar ingredients compared to P2, C2 and C3 which were voting on meat and cream" - P1, F2

This indicates that by making a TUI, the process of voting for ingredients was deemed fun by the children and also facilitated insights into each family member's preferences.

Hard to select ingredients

The graphs based on the self-reported data of the time for each interaction seen on *Figure 6.4* and *Figure 6.5* indicates that interaction time varied on a personal level, which indicates that some choices for preference were harder to make than others.

This is further evident from the follow up interview, as both families agreed on having a hard time selecting only two ingredients, as they liked a lot of the presented ones;

"Sometimes it was were hard to choose between ingredients" - C3, F1
"I agree with C3, it was hard to choose" - C2, F1

"Sometimes, you had to choose between things you really liked and say "okay what do I do, what should I remove my vote from, because I want something else?" - P1, F2

Limitation of votes were forcing

The limitation of not all family members being able to vote on the same ingredient, were actually well met in family 1, as they felt the limitation "forced" them to choose different ingredients and try something new;

"You can discuss if three votes per ingredient is enough.. But maybe it is smart not all family members can vote for the same ingredients.. Then someone has to pick something else and new" - P2, F1

"Sometimes only one or two ingredients were left to change, and maybe it was too few.. Of course we could change our current votes… and two times it was completely filled out, and then someone came and shifted their vote anyway" - P2, F1

This is further evident by looking at *Figure 6.4* and *Figure 6.5*. In both families, they are having fewer interactions during Thursday and Friday. Further, looking at family 1 there are only three interactions on Wednesday and one interaction on Thursday, but four interactions on Friday. This indicates that all ingredients were voted for on Thursday, and therefore it forced some of the family members to move their votes to get new ingredients, as the family also described that sometimes all ingredients were voted for, and therefore they were not able to get new ingredients;

"Once or twice it was filled out so we did not have the possibility to vote.. And then someone came and changed their vote anyway" - P2, F1

Makes meal planning one dish easier

Both families agreed that the prototype makes meal planning one dish easier;

"You can say, it makes the meal planning one dish easier" - P2, F1

However, it was noticeable that there were a further need from the family to not only get one new dish, but actually using the system for the whole meal plan;

"Now, the goal was one dish.. Maybe a solution could give one dish for everyday in the week" - P2, F1

No change in meal planner

In both families there was no change in who made the meal plan. However, the parents seems to express no need for the children to participate, as they already were participating in finding the new dish;

"It was mom and dad" - C1, F2

"I was the one making it, but they participated in finding the new dish" - P1, F1

In both families this did not seem like an issue for the parents. They were fine by creating the shopping list and deciding which days to eat what. It was the question of which dishes that they wanted input from the children for, and this prototype helped with that process at least for one dish.

Forced to make dish

Family 2 expressed that they like the way they were "forcing" or "locking" themselves to make the dish, as they thereby have the opportunity to expand their meal base;

"I think what is cool is, I would not call it a coincidence but more something you are "locked" to.. Once upon a time, we got foodboxes from Årstiderne with ingredients and recipes and we still make some of them. That time, we were "forced" to make them, because of the limited ingredients... It is kinda the same here, now we "force" ourselves to make this dish, maybe it works, maybe it does not… But it is nice to be "forced" into the new dish" - P2, F2

Getting dishes are transboundary

One parent in family 2 expressed that it can be transboundary for some of the children to get a new dish, due to new or not liked ingredients, as the chosen dish actually were containing several ingredients which were not voted for or tried avoided;

"If you think of C3, who is picky, then it can be very transboundary to make the selected dish" - P1, F2

"There were some ingredients you tried to avoid, but still ended in the dish" - P2, F1

However, family 1 discuss the need for new ingredients in dishes, in order to expand the meal base and not cooking convenience food;

"I think if you only use ingredients you have voted for, then you will get a dish you know and cook, because there is nothing new in it.. I think there needs to be something new and unknown in it" - P1, F1

The dish matched votes

Comparing the voted ingredients with the chosen dish, all family members recognized the overall chosen ingredients in the dish;

"Yes, I think it is really well chosen" - P1, F2

"I think there are about 50% of the chosen ingredients in the dish" - C1, F2

"There were a lot of the chosen ingredients" - C3, F1

"The chosen recipe reflects the chosen ingredients well" - C2, F1

However, some family members in family 2 did not feel their specific votes were represented in the dish;

"There is nothing… nothing I voted for in the dish" - P2, F2

"Well, neither beef or pork is in the dish" - C3, F2

"There are a lot of ingredients you tried to avoid that ended up in the new dish.. But at the end you got a lot of what you voted for" - P2, F1

In retrospect, the parents in family 2 expressed that even though new ingredients were in their chosen meal, they still thought the most picky child (C3) would like it;

"But C3, this is actually a great suggestion to something you like, as you like both squash, bulgur and lamb" - P1, F2

System chosen dish facilitates acceptance

It seemed like all children accepted the new dish, even though negative remarks were made on some of the ingredients within the dishes. This points to the fact that when the system makes the choice of the new dish, it seems like the children are more willing to compromise on unwanted ingredients and accept the dish, than if the parents had chosen it. Another fact that could have influence on the acceptance from the children is that the dish is new for the entire family, so everyone needs to figure out whether they like the dish or not. This creates a more equal setting that can be easier to accept for the children;

"Something, that makes it really good is the fact that none of us decided on the dish, it comes from somewhere else, then it is not like "okay then we will make this dish you decided mom", now it is something new we all try, it is new for everyone" - P1, F2

Further, it was mentioned that there was no dialog during interaction even though all family members vote and can see other members' votes, which indicates that the prototype facilitates less critique between family members;

"I did not see or heard about any conflicts regarding the choices of votes" - P1, F1

Choosing more ingredients

Family 2 discussed the idea of having one vote per day, resulting in more ingredients chosen at the end of the week;

"To vote on one ingredient each day, still shifting daily, and then collect all ingredient votes for a dish would be nice" - P2, F2

New inspiration for convenience food

One family member in family 2 also described how new inspiration for convenience food came up, while looking at the current days ingredients;

"I also think it can inspire for the other days, for example when I saw bulgur "oh, we could make this and that" - P1, F2

Emptying the fridge

Family 1 proposed that the concept also could focus on emptying the fridge by only displaying the ingredients that are in the fridge;

"You could use it as "emptying the fridge" - saying what ingredients do I have, give me a dish" - P1, F2

"Yeah so let us say that we have potato and beef, then it could come up with something that were using those ingredients" - C3, F2

Specifying a dish through the week

Other proposals were regarding control, where family 1 proposed that the dish is "built up and specified" through the week. Here making the choice of meat the first day, vegetables the next day and so on, and thereby excluding ingredients they do not want. Through this, the family mentioned they would have more control over the dish;

"Maybe you could make a system where you choose between meat on the first day.. Next day would be vegetables.. And other categories of food… by this you are locking and specifying the dish… "we do not want lamb" - well this can be controlled now" - P2, F1

Indicator on progress for dish

Further feature proposals were feedback on how far in the process of selecting preferences for a dish the family were;

"Maybe it could indicate if you were in the start of a choice, or if you have given enough ingredients for it to make a dish… like an indikator" - P2, F1

Ingredients at full dish level

Family 2 also expressed that the preferences could be at full dish level instead. This is also mentioned by family 1, but as a combination of full dishes and mid-level ingredients;

"It could be eight full dishes also, and then you voted on them" - P2, F2
"Maybe some exchange, not only ingredients but også full dishes, it would then be more exciting what it came up with" - P2, F1

Children would swipe notifications

Family 2, which were troubled by the aesthetic, proposed to make the prototype digital or even a combination of physical and digital;

"You could also think of a digital solution, as an application, and it have to pop up at least one time each day, where you have the same choice as in the physical one… or even a combination" - P1, F1

However, in the following discussion the children expressed that they would not use it, as they would swipe the notification away when getting them;

"I would honestly just swipe the notification away" - C3, F1

Learn families preferences

Lastly, the idea of the system learning about the families choices over a few months was proposed by family 2. By using the votes on ingredients the previous months, the system would be able to know what the family liked (machine learning), with no new interaction;

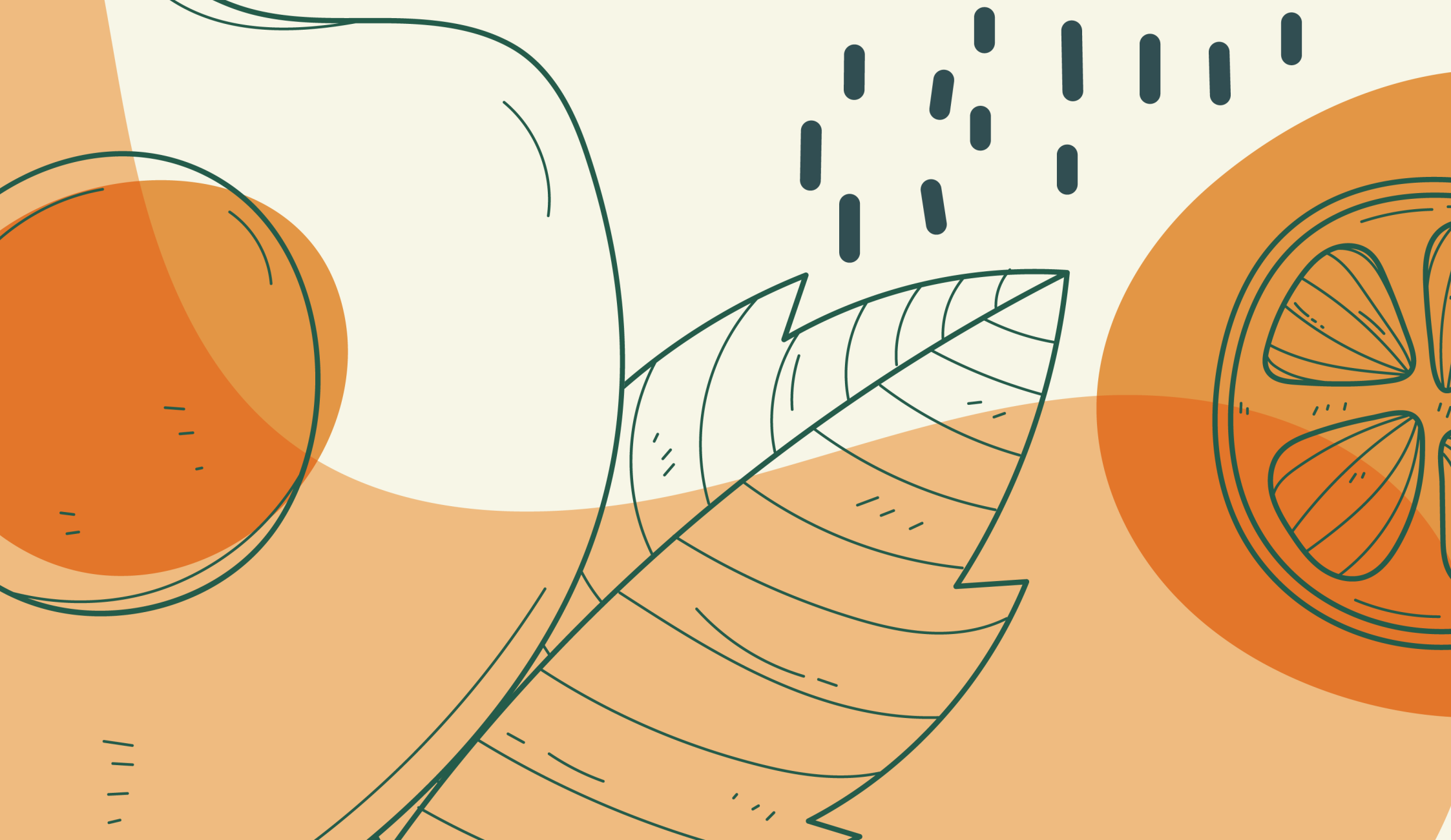
"You could maybe.. Let us say you do this for two months… then the system has empiri enough to know what we like, like it can see "okay they never voted for rice, always on beef".. Then it could propose dishes based on previous choices.. Then on Sundays we could make three dishes and choose two by overselves.." - P2, F1

Summary of findings

Both families had a good experience with the concept and used it continuously during the week. The prototype facilitated a fun, less overwhelming and easily accessible process for getting inspiration for new dishes. The few presented ingredients made it less overwhelming for the families, the shift each day made it fun and motivated the families to keep using the prototype. Furthermore, as the prototype was physical and readily available for use, the families were drawn to it, making the children use it. This was even though the parents in one family expressed they were unsure if the children would participate. The diary further shows that both families had a total of 17 entries during the week, where all family members almost interacted equally. However, the time spent on each interaction varied. All family members agreed on recognizing their shared set of votes in the chosen dish, however not all family members were able to see their choices. Despite that, the chosen dish was described as something the whole family would like anyway. Furthermore, the prototype facilitated a process with less critique as all family members had equal votes and interacted at different times thereby not talking about their choices. This is even though one family anticipated that there would be an intern fight when voting. The family further liked that it was not the parents deciding on the dish along with the feeling of getting ”forced” to create the new dish, and looked forward to making it. The families also proposed a lot of features and ways the concept could work in the future including getting one vote per day, making “emptying the fridge” functionality, progressively specifying the dish, feedback, making it digital or a combination, and adding machine learning.

Some of these findings are discussed in the following section in regards to the challenges presented from initial interviews and the related work.

7. Discussion and future work



7. Discussion and future work

This section discusses some of the findings and possible future work.

7.1 The design as a part of doing research

Through the follow up interviews, it was noticeable that both families had a lot of solutions and changes to the concept and "*what it could be in the future*". Furthermore, it also resulted in an extended understanding of the problem domain.

The findings revealed that families would like to specify a dish through the week, by choosing meat the first day, vegetables the next and so on and thereby controlling in which direction the dish would go in. If doing so, the solution would focus on finding a new dish which should be likable and where all voted ingredients should be included in the dish, which was not the intention. The idea of this concept is to provide one new dish based on the family's preferences, but having in mind that a compromise must happen in order to explore something new. The same asserts the suggestion of machine learning, as the system over time would sort out the ingredients not voted for, leading to getting preferences based convenience dishes which can be very useful if it was the goal as in [1].

Further, from the initial interview, the families for example describe their need for new dishes to expand their meal base, but only with one dish a week, as they do not have time for more, and therefore they needed to fill in the rest of their meal plan with convenience food. However, when asking about the current concept, which only provides one dish at the end of the week, both families mention their need for getting more than one dish from the system, in order to fill more than just one new dish in the meal plan. The question is therefore if the family originally needs help to find new dishes they are not able to find themselves, or if they actually want a tool to select convenience dishes based on what each family member feels like eating the upcoming week.

The initial research revealed a need for a product which could facilitate a process that produces one new dish each week, which the concept aimed at. The intention from the start has thereby been on design through research [22], as the concept is built upon gathered research. But as the families suggested many alternative features and concepts that would help them more, and further expanded the research gathered with extended knowledge about their problem domain as described above, it can be discussed whether the prototype has been functioning as a probe to facilitate a discussion to a deeper understanding about the families problems. Thereby, it can be questioned whether it has actually been research through design [22], as the designed concept has been a part of doing research, as findings also revealed deeper understanding and extension of the problem domain.

7.2 Engagement as result of novelty effect

The anticipation regarding the prototype being tangible and physically presented was that parents would be indifferent, teenagers would lean towards a more virtual approach (e.g. as a smartphone application), while the physical design with TUIs would be better suited for the younger children [15]. However, surprisingly the physical design received negative feedback from the parents of one family, while the children had a positive attitude towards the physical product and tangible input. The findings showed that the TUI prototype had a positive impact on the children's participation and excitement, contrary to the anticipation of their parents. Moreover the children expressed that a digital design would likely lower their participation. These findings contradict initial anticipation of physical and tangible versus virtual design for different age groups.

The children stated that the prototype was fun and engaging to use, and findings revealed that they interacted with the prototype more than their parents anticipated. This positive engagement could possibly be explained as a result of the novelty effect experienced when only trying the prototype for a week.

A novelty effect can be experienced at two different occasions, (A) when a new system is first introduced in a context, or (B) when changes are made to an existing system [23]. In the field study the excitement and participation of the children would likely stem from type A novelty effect, which would likely wear off. This type of novelty effect could be studied further in a longitudinal study for an extended period of time.

The negative feedback from the parents and their wish for a digital solution could stem from the fact that all the administrative work around meal planning is already digitized. Consulting the calendar to decide which days to eat what, making the shopping lists, and going grocery shopping is already being aided by mobile applications, and therefore they might see more tedious and manual tasks in introducing the output of the physical device into their digitized workflow. However, it contradicts with the wish for a less overwhelming process, as it was stated that current mobile applications and websites were too overwhelming to use. Therefore it could be interesting to do a comparative study between the concept being physical and tangible (as in this concept) versus a completely virtual product, in order to see if the virtual approach also facilitates a less overwhelming process.

7.3 Alleviating overwhelmedness and time scarcity through divide-and-conquer

Initial interviews showed that the families experienced time scarcity issued when faced with the task of finding and making new dishes [4]. Further the families expressed that these tasks were overwhelming due to existing solutions providing a cognitive overload. However the findings revealed that through the continuous interactions with the prototype, that were made whenever a family member had the time, the time scarcity issues were alleviated and the process for finding a new dish was no longer deemed overwhelming. These findings indicate that when faced with tasks where time scarcity and overwhelmedness is apparent, it can be beneficial to design for a process that features small interactions, scattered over a period of time, instead of having a process with a single large interaction that needs to be planned for. Such a design principle is also known as divide-and-conquer within the field of algorithmic design [24]. Here large problems are divded into lesser problems that can be solved. The solutions of the lesser problems are then combined to form a solution to the initial large problem. In this project the large problem is ”*what new dish the family would like to have this week”*. This is then divided into the issues of ”*what ingredients each family member would like to eat this week”*. The solution to these small issues is a set of dishes that to some degree satisfies some familie members. Here a single dish is selected which solves the intial problem, as the chosen dish is what the family would like to have this week.

Further it was evident that both families did not feel overwhelmed using the prototype, as they only had to cope with eight ingredients. However, the family seems to want more than eight possible ingredients per day. Deciding on the correct amount of ingredients for a family can prove challenging as many factors affect the feeling of overwhelmedness. There has to be a limited amount of ingredients for the family to comprehend all, but also enough to be able to vote for ingredients even though some family members already have voted. Here, the age of family members also plays a role, as the cognitive load differs in different age groups. Future work could focus on examining at what stage different family members feel overwhelmed, either by investigating a higher number of presented ingredients, or even create a system the user can customize by adding/subtracting ingredients, thereby making the family themselves control when they feel overwhelmed.

7.4 Minimize conflicts through fairness

Existing research presented in *Section 2.3* focuses on providing personalized recommendations to singles or couples through machine learning algorithms. Providing personalized recommendations to individuals, as in these cases, does not need to consider fairness of the recommendation towards other people. However, in couples fairness can also be troubling as the system has to take care of multiple peop-

le's preferences. In the research, they choose to count couples as one participant, and thereby join their preferences. However, how they deal with the joint preferences are not further described.

In the case for this project a single dish suggestion is provided to an entire family, where the goal is for all participants to feel that they have a fair opportunity for their preference choices to matter in the suggestion. Therefore, suggestion fairness is further troubling to deal with compared to the existing research and their context. Throughout this project the goal was that the users should feel like they had an equal vote, but it has not been investigated when the users felt that their votes were fairly considered. Therefore it is interesting to discuss different possibilities for selecting a fair suggestion based on all the family members' votes. Especially as multiple participants expressed that their voted preferences were not reflected in the final dish, indicating a sense of injustice.

Since fairness is a complicated topic that is influenced by context and personal values, this project decided on a simple solution where all ingredients with votes had a chance to be in the final dish. More votes would give a higher chance, but not a guarantee even with max (3) votes. Other possible solutions could be to only consider the highest voted ingredient, or make ingredient votes binary to let all chances be equal. This avenue could be an interesting topic to examine further in future work to select the best algorithm for suggesting a dish based on user preference from multiple users at once. Here it would also be interesting to consider complex machine learning methods that learn about the users over time as suggested by one of the parents.

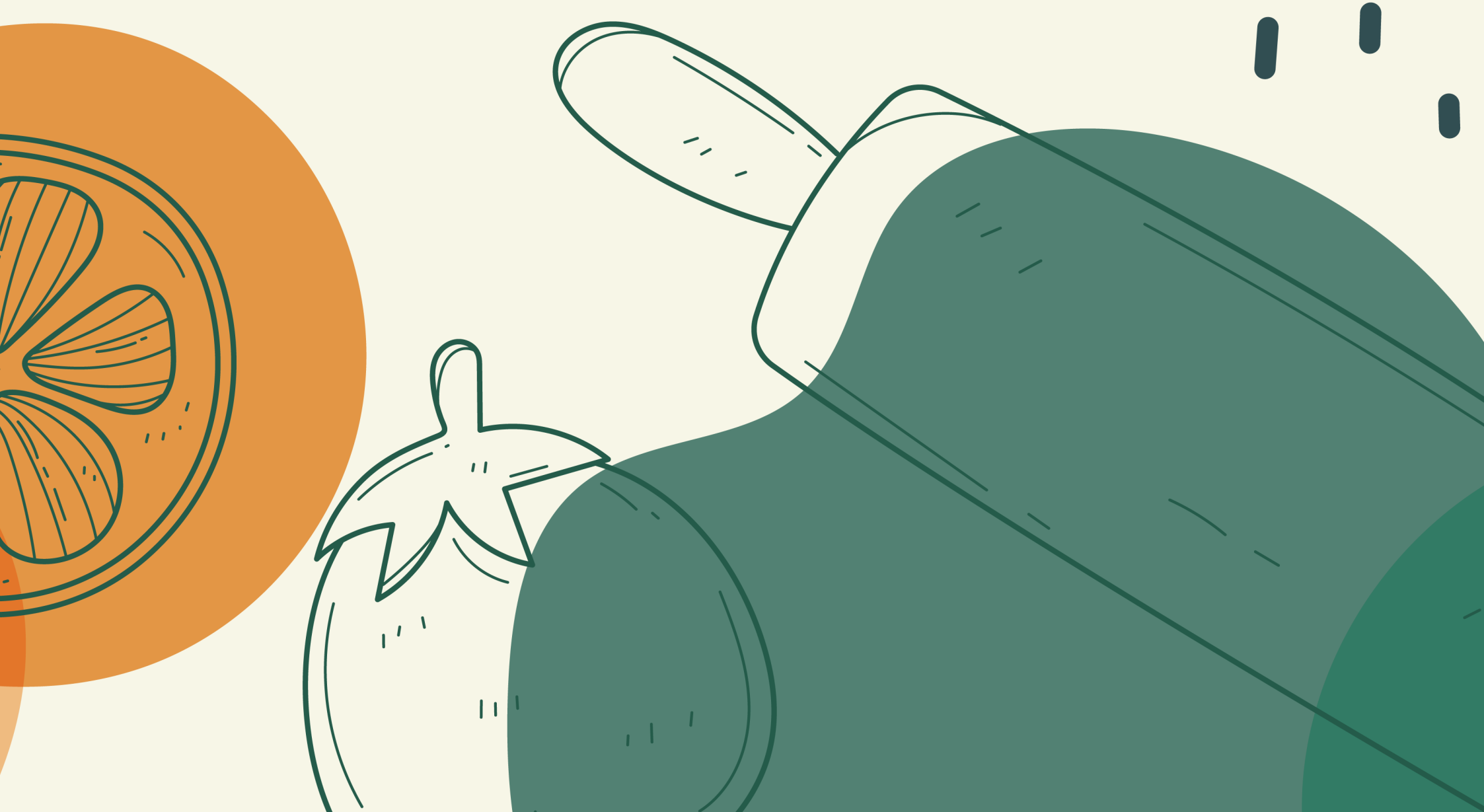
No conflicts between any family members, regarding preferences, happened during the week of each field study. The families mentions that due to the interaction being continuous, there has been no dialog, even though the family members could see each other's votes. As all family members interact under the same rules and have the same level of influence there is equality between family members (fairness) which seems to lead to no conflicts. Furthermore, despite each family member having an individual interaction, they seem engaged in reaching the shared goal of receiving a new dish, which could also be contributing to the decrease in conflicts. The previous solution of an open forum, would facilitate both negative and positive interactions between family members and it can therefore be discussed whether positive and negative interactions are better, than the "no interaction at all" seen in the field study. Future work could therefore focus on facilitating or promoting positive interaction in the process with the product.

Besides the conflict that happens between family members, the individual participants experienced personal conflict regarding which ingredients to vote for. As each person only had two votes, they had to reflect about which ingredients they chose. This reflection has the potential to lead to personal insights regarding food habits and pickiness, which ultimately could be used for beneficial change in personal relations to food. Therefore future work could be to focus on how this product could target these beneficial changes.

7.5 Explore preferences

The families had a lot of suggestions for what categories of preferences to use. As presented in *Section 4.3* preferences range from full dishes to atomic level. Both families discuss if, instead of using a mid level, a full dish level or even a combination of all levels could have been used. Therefore, future work could focus on investigating what types of levels fit in, if one level suited one age group better specifically and how the different levels affect the votes.

8. Conlusion



8. Conclusion

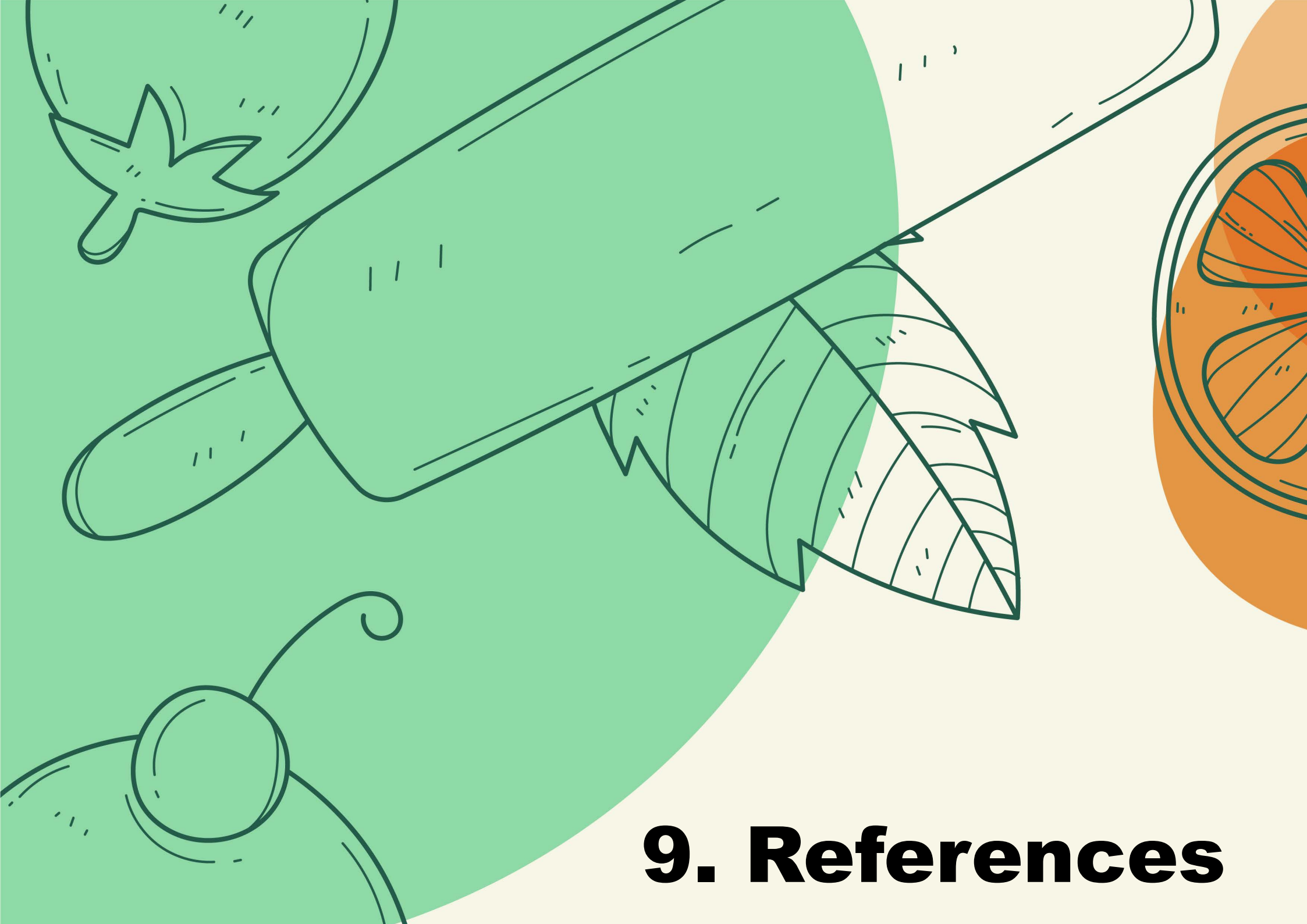
Throughout this project, the focus has been on a tangible interaction design, focusing on families' food preferences that facilitates discovering new dishes to expand an existing meal base. From initial interviews it was found that Danish families with children had issues with time scarcity, participation and motivation from children, pickiness, and feeling overwhelmed by existing solutions for finding new dishes. Analysis of existing research showed that the field was vaguely covered within HCI and that the research, which existed, focused on how to output dishes from recommendation systems based on digital user preferences as input. These digital user preferences conflicts with the fact that many of the issues revolve around children, for whom a TUI can be more suitable as user preference input.

From several iterations of concept development, with a focus on a TUI for inputting user preference, a single concept "Put a gaffel in it" was chosen. In order to evaluate the chosen concept a high-fidelity prototype was developed and used in a field study. The field study consisted of two families that were given the prototype for a week along with basic instructions for use, with the goal of providing the family with a new dish at the end of the week for their meal planning session. Qualitative and quantitative data was collected throughout the field study in three different sessions as semi-structured interviews and an ongoing diary utilizing ESM.

The data yield that the physical and tangible prototype facilitates children's participation and further that the physical representation makes the family notice it. The limited presented ingredients at mid-level gives sufficient possibility for the family members to express their preferences in order to get a new dish, but make the process more explorative and exciting if using more granularities. However, it can be challenging to decide on the optimal amount of possible preferences due to diversity in the family members. Further, the change in ingredients each day, became a motivational factor as the family members were excited about new choices.

The individual and continuous interaction reduces conflicts between family members and has shown to alleviate issues regarding overwhelmingness and scarcity. Further, it seems like there has to be elements of "force" or "urgency", in order to make the new dish, else they would fall back to cooking convenience food.

Therefore it can be concluded that the TUI "Put a gaffel in it" can facilitate the process of discovering new dishes by making; (1) all family members participate, (2) the process less overwhelming and more exiting, (3) minimize conflicts regarding preferences (4) with a result of a new dish based on the chosen ingredients, which could potentially be used for meal expansion.



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