ENRICHING THE AUTONOMOUS *RITUAL* KITCHEN WITH EMBODIED INTERACTIONS.

Future cooking with Gaggenau

Nuria Nicolau i Torra

Design for Interaction · Mater Thesis

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Designing Sous, an autonomous concept for the future kitchen based on embodied interactions to enhance the pleasures of Human-Food interactions and enable the Home Chef.

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The more you know, the more you can create. There is no end to imagination in the kitchen.

- Julia Child

Investigate, explore, always aim to go a bit further when doing things.

- Paco Roncero

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Domestic kitchens are the heart of modern households, a space that embraces social gatherings and, most importantly, where pleasures associated with interacting with food arise while cooking and eating. Nevertheless, the way technology is being introduced in this context moves away from this ritual aspect of kitchens as it focuses on a relatively rational side, focused on efficiency and functionality to fix undesired problems.

The goal of this project has been approaching the introduction of autonomous agents in domestic kitchens in a celebratory way, emphasizing the positive aspects of Human-Food interaction with a particular focus on culinary creativity. Speculative design has served to set the mindset in the near future and design according to a scenario where kitchen appliances will be more intelligent and capable of gathering more information from the cooking process. The project has been executed with a strong focus on theoretical and user-context research, resulting in the design of a concept that conveys a potential solution for the challenge mentioned above.

Sous, the cooking assistant designed in this thesis, responds to the following Design Goal "Gaggenau users should feel like Home Chefs when cooking in their kitchens". Feeling like a Home Chef involves being the leader of the (domestic) kitchen, feeling in control, exploring creative opportunities, and having a certain level of culinary knowledge. The design revolves around celebratory technologies based on principles of autonomy and embodied interactions, the theoretical background from this project. Sous is a wearable that allows Home Chefs to understand in depth the preparations being cooked by providing real-time feedback about doneness or sensory aspects, among other information. With this, the aim is that Home Chefs would enjoy more the cooking process while ensuring the best result for the dishes they cook.

The collaboration created when Home Chefs cook with Sous aims to maximise human capacities while maximising the possibilities of technology to ensure both entities' autonomy and richness of interactions.

EXECUTIVE SUMMARY

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INTRODUCTION

This chapter is an introduction to the project, with a brief description of the process followed and the relevant concepts to know before reading the report.

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1

INTRODUCTION

This project revolves around domestic kitchens' future and how autonomous technologies can help to shape them. Kitchens are a space where we spend time daily, such as cooking or eating, but are we really aware of their influence on our lives at home?

Kitchens play an essential role in modern households and in our everyday lives (Xu, Dong, & Zhu, 2019). Originally their purpose relied on food preparation. Nevertheless, the food itself can be perceived as a social facilitator — cooking and eating encourage social relations — which influenced kitchens to become spaces to gather around others (Ceccaldi, Huisman, Volpe, & Mancini, 2020). Kitchens can be understood from two perspectives, the rational kitchen — focused on efficiency — and the ritual kitchen — centered on social relations and the pleasures of cooking and eating (van den Eijnde, 2020). For the last decades, kitchens have been innovations hubs, especially regarding food storing and preparing processes. This reveals that modern kitchens have reached high levels of functionality and spatial distribution. Nevertheless, its celebratory character has been put on a side (Xu, Dong, & Zhu, 2019).

In the project, the introduction of autonomous agents and embodied interactions (EI) in the context of domestic kitchens is done to reach the celebratory character above-mentioned. This means designing for the pleasures of cooking instead of aiming to fix undesired problems in a corrective perspective.

EI are relevant for the project as they focus on humans' richness of actions and sense-making capacities. This is especially useful in the context of domestic kitchens, where humans interact with the environment, other people around, and with the food being prepared. Moreover, the introduction of EI can enhance the feelings of freedom and control.

On the other hand, autonomy can be studied from the perspective of Human-Agent collaborations (HAC), where the relationships established between users and smart agents are designed to be sustainable over time (Cila, 2022). This is achieved by pursuing a balanced division of tasks that considers each entity's capacities, as well as ensuring collaboration towards a shared-intention.

EI and autonomous agents' theory have one point in common, which is augmenting human capacities. In this project, this is targeted by aiming to maximize intellignet agents' capacities.

Scope

The project follows a Speculative Design approach that focuses on the near future, 5-7 years from now. This has had an impact on the final concept designed. Sous, the cooking assistant developed, has been approached at a conceptual level to speculate about the future role of autonomous agents in domestic kitchens. Hence, only the relevant aspects to make the concept more understandable have been brought to a tangible level, such as interactions or information visualization.

Aspects concerning an instead product design approach, such as technical specifications have been left outside the scope. Nevertheless, all the technology that would be embedded in Sous has been defined ensuring feasibility.

PROBLEM STATEMENT

The project outlines three major challenges that arise when reflecting about the future of domestic kitchens and the position of Gaggenau.

Preserving users' freedom. By introducing new autonomous technologies people's role in the kitchen appears to be threatened as smart agents aim to reduce our involvement throughout the cooking process. Nevertheless, these technological innovations can also enhance the experience. The project aims to find a solution that achieves balancing users' autonomy in the context by designing an autonomous system based on embodied interactions as those trigger skilled actions and engagement.

Recovering the ritual character of the kitchen. The development of human culture has had a major impact on how our kitchens are designed, from the appliances used to the experiences in this space. This project approaches the challenge of designing new technologies that recover the ritual side of the kitchen and leaving the rational part on a secondary level.

Gaggenau's user group. The brand's target customers poses a challenge due to its complexity. The *social diplomats* focus on the ritual kitchen, prioritizing the meals' social component rather than cooking. However, the *aesthetic explorers* aim to expand their cookings skills. The solution has to comprise the main expectation of the user, having personalized luxury experiences in their kitchens.

ASSIGNMENT

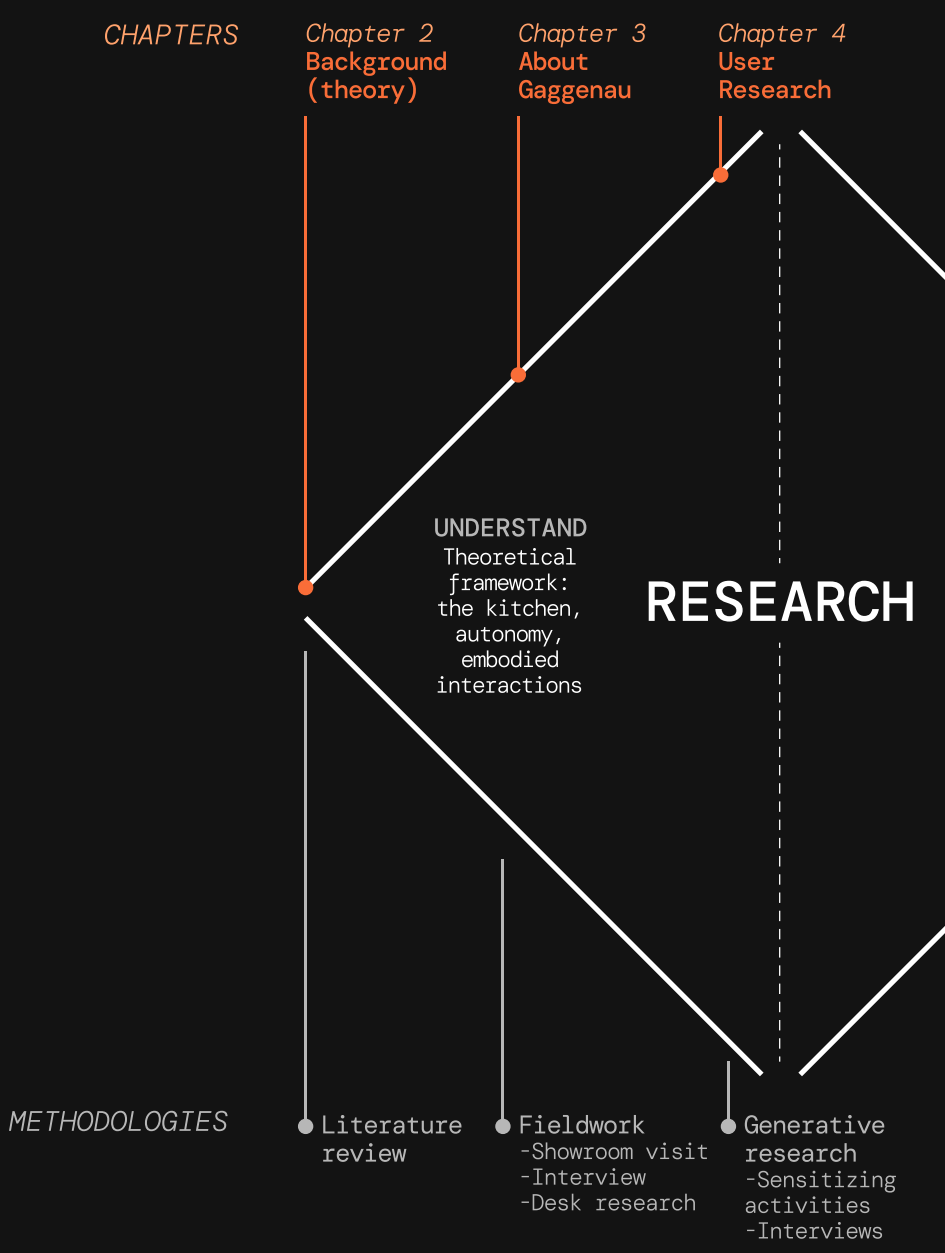
The design solution is envisioned as a concept for the future kitchen that besides the aforementioned problem responds to the following question, how can Gaggenau add new value to the cooking process? Hence, the solution should be aligned with the brand's values while understanding the kitchen as a ritual space, finding the balance between the addition of autonomy and embodied interactions. According to this, the final solution follows an holistic approach to the kitchen, thus not focusing on individual elements but the overall dynamism of the space when cooking.

Designing a concept can be rather abstract. Being a project from the Design for Interaction master it has been decided to set the focus on the interactions between the user and the final solution, as well as the experience created around it. Consequently, technical aspects and specifications from a product design perspective have been approached with a lower level of detail while still taking feasibility into account.

PROJECT OVERVIEW

The Double-Diamond approach has been followed to carry out this project, where the first diamond involved the research phase and the second has focused on the concept's design (Norman, 2002). The Double-Diamond Model implies initially diverging to expand the knowledge over a specific topic or context, in this case the kitchen, autonomy and embodied interactions, as well as the user group; followed by a converging phase to arrive to a problem statement, although in this project the outcome of the first diamond has been the Design Goal and design requirements. The second diamond starts with expanding the possible solutions and finally converging with the selected concept.

Throughout the project different design methodologies have been employed in order to execute each of the above mentioned phases. The description and outcome of each of these methodologies can be found on the specified chapters.



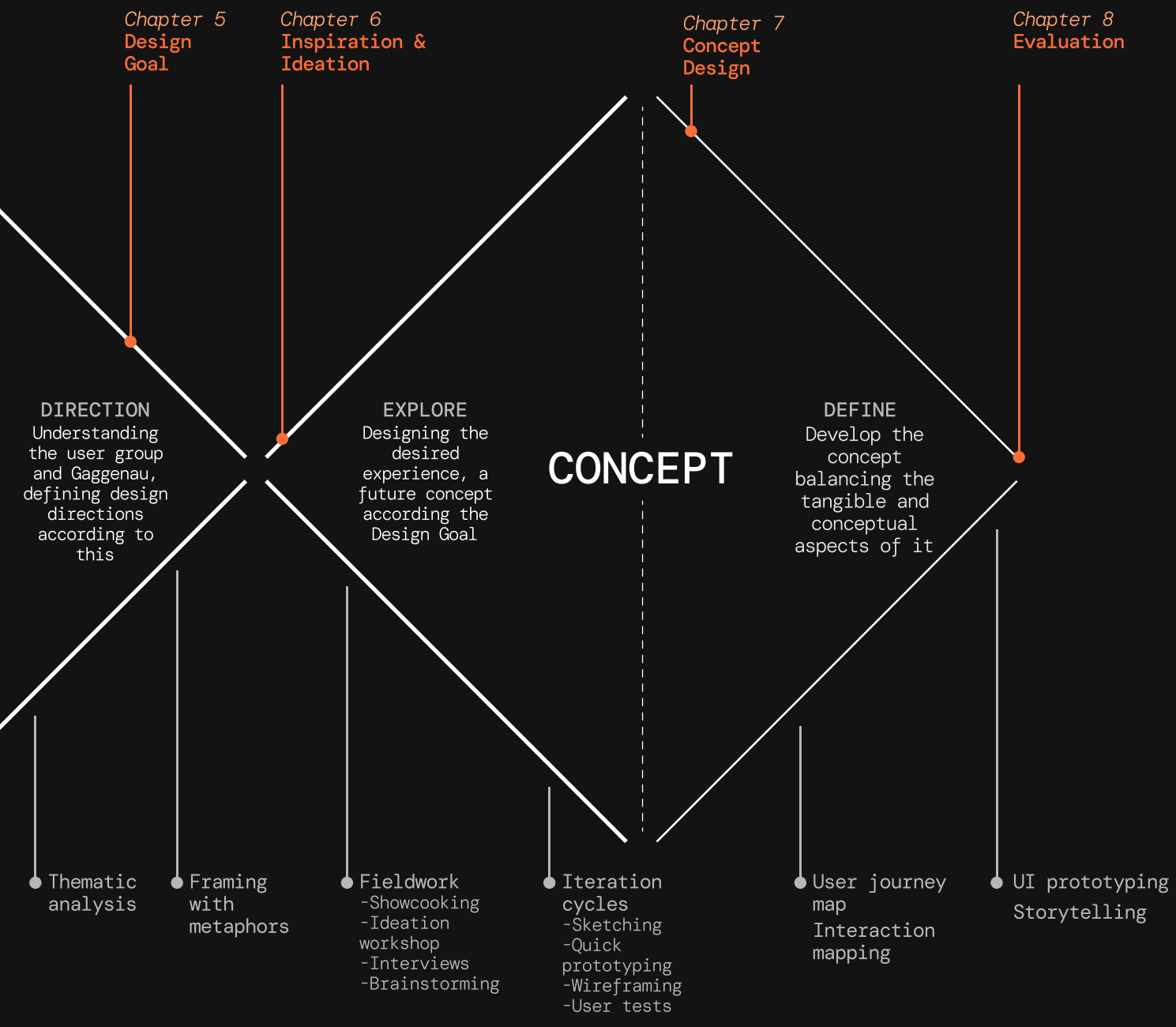


Figure 1. Double-Diamong Model applied to the project

PROJECT PHASES

RESEARCH PHASE

The first phase of the project has focused on research to dissect the theoretical concepts and determine the requirements of the context and its user. The first step has been carrying out a literature review to understand the concepts of ***autonomy*** and *embodied interactions (EI)*, and dissect their current implications in the context of domestic kitchens. Moreover, from the literature review a framework has been established with the guidelines to determine how the concept should be designed according the theoretical perspectives of autonomy and EI.
Secondly, research about Gaggenau has been conducted to identify the values and differentiating attributes of the brand. Finally, user research has been carried out, which informed the specific design requirements of the customer group and domestic kitchens according Gaggenau's standards.

The research phase has concluded with the definition of the Design Goal, Interaction Vision and the Future Scenario. These three concepts ground the starting point for the following phase: conceptualisation.

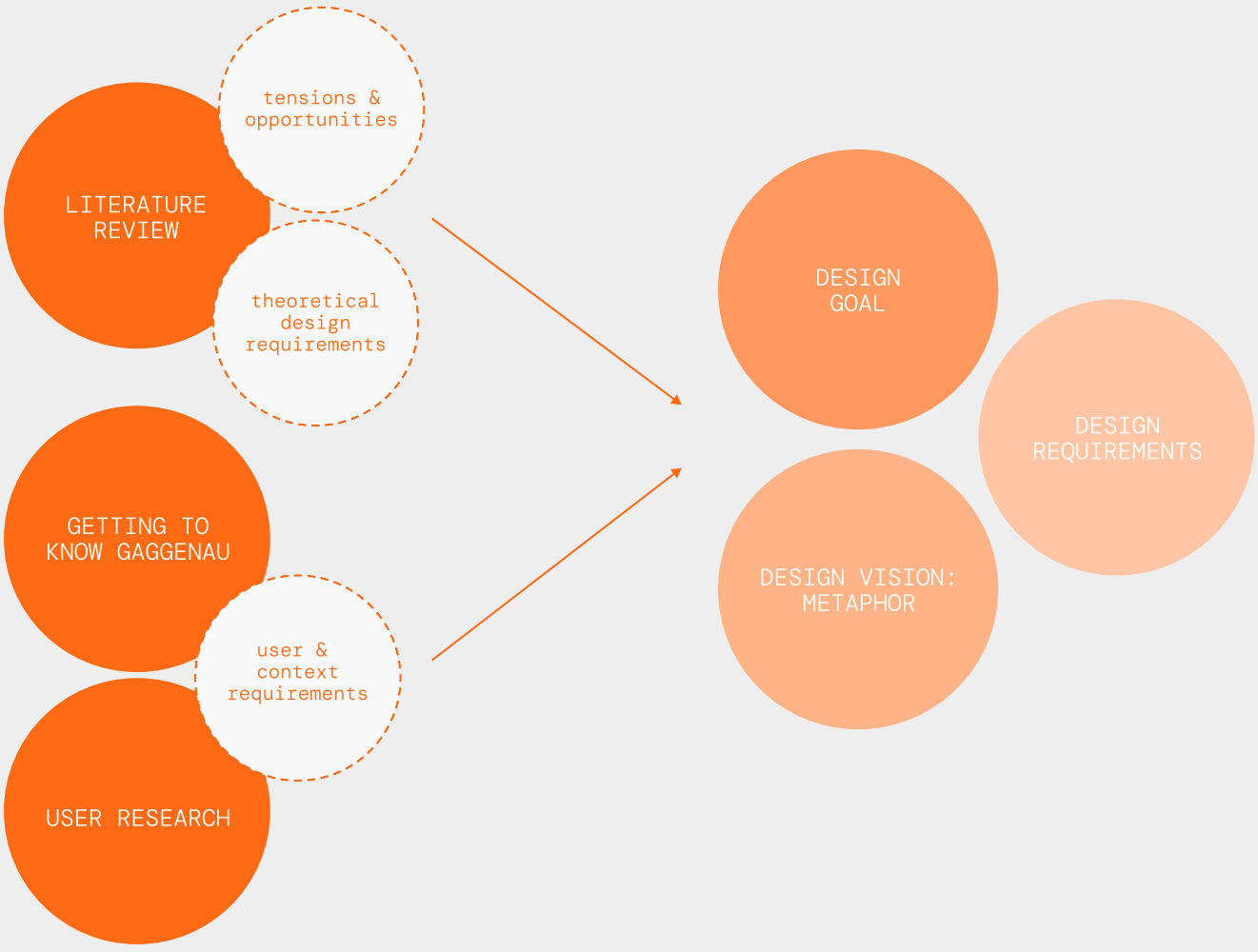


Figure 2. Diagram of the process followed on the research phase

CONCEPT PHASE

Based on the insights gained and design directions defined during the research, the second phase of the project comprises the end goal, designing a concept for the future kitchen based on EI and autonomy that focuses on the ritual approach. To develop the concept the initial step included different inspiration activities to gather potential ideas for the later stages. Subsequently, the ideation process began with the aim of exploring different concepts that could convey all the targeted functionalities and experience.
After analysing the initial ideas, the most adequate one was selected and explored further via three iteration cycles, each of which intended to approach the development of the concept in a more holistic way. The final step has been refining the concept by detailing all its functionalities, interactions, and behaviour which lead to the final concept design.

To conclude the project, this phase has been followed by an evaluation which intended to validate the concept from the perspective of the Design Goal as well as the theoretical and design requirements.

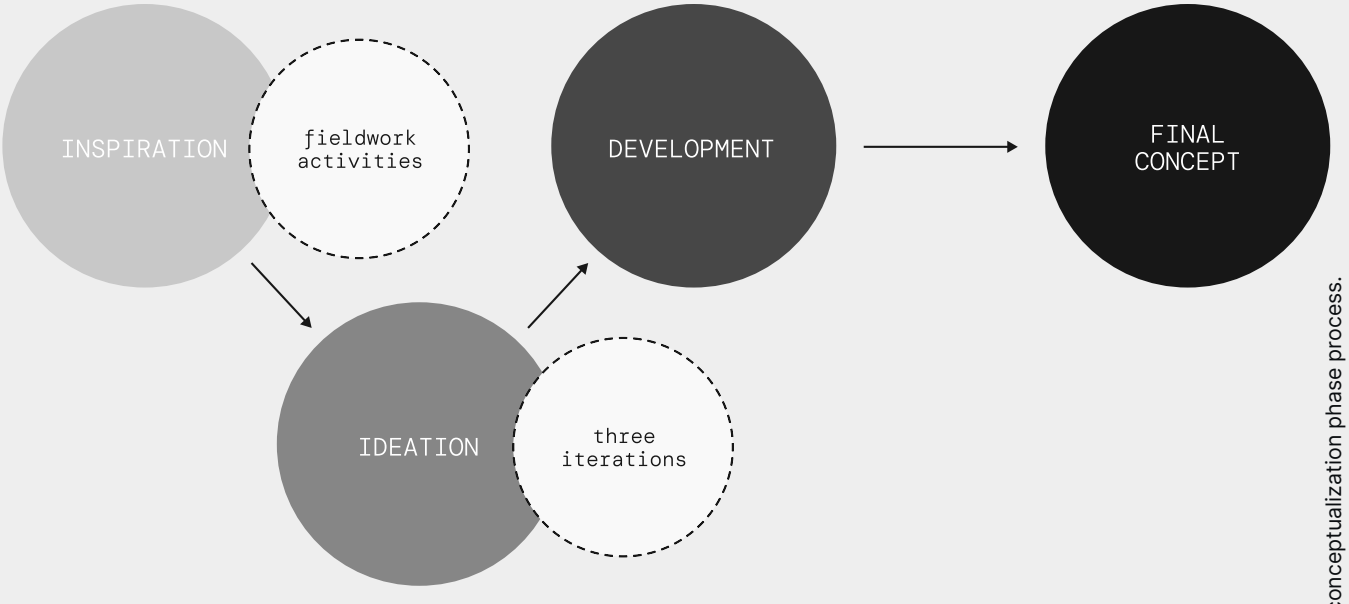


Figure 3. Diagram of the conceptualization phase process.

GLOSSARY AND ACRONYMS

Automatic.
A thing (or process) that operates a monotonous task repeatedly without needing constant supervision. Automatic products use sensors to perceive the environment but are unable to interpret it and decide which action to take.

Autonomous.
A human or non-human able to make its own decisions and act according to those without external intervention.

Celebratory (technology).
Technology with the aim to enhance the positive aspects of a situation.

Corrective (technology).
Technology that focuses on fixing undesired problems that arise in a specific context.

Embodied interaction.
Interactions based on the idea that humans interact with the world around them through their bodies (by doing) instead of purely from their minds (by knowing). These interactions support the idea that by using our bodies our sense-making capacity augments.

Human-Agent Collaboration.
Socio-technical system in which humans and smart agents engage in flexible relations to achieve their individual and collective goals.

Smart agent.
Intelligent products capable of sensing the environment and respond to it through diverse actions autonomously without the intervention of humans.

Ritual kitchen.
Socio-ritual kitchen approach that focuses on the pleasures associated to the activities that take place in this context: eating and cooking. Understands the kitchen as homes' social-hub.

Rational kitchen.
Efficient kitchen approach that focuses on standardization and reducing the active involvement of users in the kitchen with the aim to ease their role in the context.

Home Chef.
The term Home Chef refers to Gaggenau's users in this project, as this is the aimed experience for them. Hence, both terms are used as synonyms.

Sous.
In the lasts chapters of the report the noun Sous refers to the concept developed. The terms (autonomous) agent and system are employed then as synonyms of Sous.

EI.
Embodied interaction

HAC.
Human-Agent collaboration

HCI.
Human-Computer interaction

HFI.
Human-Food interaction

BACKGROUND *(THEORY)*

This chapter presents an analysis of the existing literature on autonomy, embodied interactions and the kitchen, grounding the theoretical approach of the project.

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KITCHEN EVOLUTION

Throughout history kitchens have continuously evolved mainly conditioned by new technological innovations. While since prehistoric the role of this space has been central to households — where food is prepared — it is the fact that it hosts most domestic social gatherings that makes kitchens be considered the hub of daily life or the *so-called* heart of the house (Kerr, Tan, & Chua, 2014). In order to understand the relevance of this context and envision its future, it is crucial to be aware of its past. The following analysis provides an overview of the main changes and events from the first open-air kitchen in prehistoric communities until modern kitchens of the 21st century.

PALEOLITHIC
2.6M ya

In nomadic tribes, the first kitchens appeared with the creation of bonfires used to cook the hunted animals, it was the only space with permanent equipment and the heart of the community (Charytonowicz & Latala, 2011).

Family having dinner in the prehistoric.
Source: Pinterest

ANTIQUITY
3000 BC

With the construction of the first houses, the bonfire was moved inside and this is when the kitchen was converted into a space itself but still multi-use, being the source of light, warmth and protection (Studio Hausinc, 2016). All domestic social relations took place in the kitchen. In richer households servants were responsible for cooking, so kitchens were separated from the rest of the living areas reserved for the home's owners (Charytonowicz & Latala, 2011).
Utensils used for cooking became more specialized and the bonfire evolved to a simple stove made of bricks.

MIDDLE AGES
5th century

During this period homes were divided in the working area — kitchen — and the living areas because of the increase of servants cooking, and the fact that the hearth used to cook generated a lot of smoke (van den Eijnde, 2020, Studio Hausinc, 2016). However, in most of the households the kitchen was still the central point of the house.

Enligsh kitchen from the s.XII
Source: Medium

LATE MODERN PERIOD

19-20th centuries

The introduction of electricity improved food storage conditions and the development of new appliances for food preparation (Charytonowicz & Latala, 2011). Electricity started a race towards the rational kitchen, having one goal in mind; making the kitchen efficient, functional and reducing the role of human beings. The disappearance of servants in most households lead to housewives taking the lead in cooking, which also contributed in the development of the rational kitchen, aiming to ease their lives and reduce their role in cooking tasks (van den Eijnde, 2020). All this encouraged developing new concepts based on electricity, as the kitchen presented in the World's Fair in Chicago on 1893. Other examples are the modern-functional Frankfurt Kitchen (1926) and the Casa Electtrica (1930) (van den Eijnde, 2020).

The concept of smart kitchen arose during this period, conceiving it as a kitchen that made its inhabitants lifes easier and limitted their involvement in cooking tasks (Mocrii, Chen, & Musilek, 2018). In this context, the first kitchen robots appeared to allow the user to prepare a meal in simple and quick steps. (Fonseca et al., 2019).
The isolated situation of women in kitchens lead to rethinking the distribution of the house, giving place to the open kitchen, where the so-called work space — kitchen — and the areas reserved for entertainment and socializing merged. The Willey House designed by Frank Lloyd Wright in 1934 was one of the first examples of this composition. This recovered the multi-functional and ritual role of the kitchen lost in the middle-ages (Sikora, 2017).

1926 Frankfurt Kitchen.
Source: The NY Times

Thermomix add from 1971.
Source: Vorwerk

21st century

RENAISSANCE

15th century

During the 15th century French cuisine influenced the perception of dinner, becaming more sophisticated and considered an opportunity to build social relations (Studio Hausinc, 2016). Technologically wise two innovations shaped kitchens between the 15-19th centuries. First, the improvements on ventilation systems allowed moving kitchens far from the living areas (Charytonowicz & Latala, 2011). Secondly, in 1742 Benjamin Franklin invented the cast iron stove which provided a more efficient heating system and permitted using different cooking utensils to prepare a wider range of dishes. During this period, kitchens were considered uniquely as working areas (van den Eijnde, 2020).

The banquet of the Monarchs
by A. Sanchez Coello
Source: Wikipedia

The evolution of the kitchen's role and distribution shows how although being the heart of households, its use and nature have changed throughout time. It started being a ritual kitchen, a gathering point for where almost all domestic activity took place. With technological improvements it was slowly separated from the living area, and became a working space. The Industrial Revolution accelerated the transition to the ritual kitchen, focusing on efficiency and diminishing the role of human beings. However, during the last decades it slowly regained its ritual component, becoming a space where families share their time mainly during meals. Although the social side regaining relevance, current kitchens designs remain centered on efficiency and functionality.

AUTONOMY

The first concept to dissect is autonomy, more specifically the autonomy embedded in everyday objects that surround us, especially at home. In the following sections can be found an analysis of this category of products — smart agents — as well as an overview of how human-agent collaborations can take place. Moreover, the main challenges that arise when designing autonomous objects will be described.

Stacey (2017) defines autonomy from an ethical perspective as the state or condition of self-governance, or leading one's life according to reasons, values, or desires that are authentically one's own. Autonomous or intelligent agents are those capable of sensing the environment and respond to it through a wide variety of actions without needing the intervention of a human being. In other words, the smart behavior embedded in these entities allows them to make their own decisions as a result of their perception of the world (Rozendaal, Boon, & Kaptelinin, 2019). While this type of products is becoming more and more popular in our lives, automation is still the norm in digital objects. An automatic entity operates a specific task without needing human supervision, nevertheless, it can not interpret the environment and decide what actions to perform on its own (Mocrii, Chen, & Musilek, 2018). Automation makes objects act according to our indications, as opposed to autonomy which allows them to be more reactive and adapt to user's needs and behavior.

This project has an holistic approach to the kitchen, conceiving it as one space with a specific intention and purpose, instead of a combination of individual appliances. From this perspective, it is relevant to understand the concept of the "*smart home*" that appeared in the 1930's with the introduction of automatic domestic appliances and the promise of providing unprecedented levels of luxury, relaxation and indulgence (Mocrii et al., 2018). A more pragmatical and contemporary vision about the goal of smart homes comprises the following benefits for the user: feeling in control of their homes, personalizing the context, being modern and impressing others, having a peace of mind, optimization and simplifying daily tasks (Coskun, Kaner, & Bostan, 2018). To accomplish these promises, smart homes are equipped with sensors that perceive the world around them, the capacity of interpreting its current state and act according to it to please its inhabitants, plus allowing remote control. According to Yang & Newman (2013) understanding the intention of the user and learning from their behavior and routines is essential in order to provide customized experiences that fulfill individual needs .

Human-Agent collaboration

Smart homes are networks of appliances connected to each other — Internet of Things (IoT) — meaning that individual agents interact with each-other, as well as interacting with the people around them and the environment where they are embedded; thusly merging digital and physical worlds (Kounelis et al., 2014). This project comprehends that the function of the kitchen is to help the user during the tasks carried out in there, and therefore it can be considered a Human-Agent collaboration. This thought is aligned with Kounelis et al. (2014) conception that smart environments have to support and not substitute human beings, guaranteeing human agency and their capacity to make free-will decisions. Mimicking human behavior diminishes the potential that agents have. In order to augment people's reasoning, learning and decision-making abilities, smart products should be designed with the aim of augmenting humans capabilities by maximizing the possibilities that new technologies offer (Cila, 2022). Human-Agent collaborations are symbiotic relationships where both sides are perceived as partners. In order to create sustainable relationships, it is helpful to see it from the perspective of human-human collaborations, since the essence of both partnerships is the same, for it to be successful individuals need to have a *joint end* or *shared intention* for which they will coordinate their actions (Blomberg, 2015; Sebanz, Bekkering, & Knoblich, 2006). According to Cila (2022) there are three elements essential to have favorable human-human collaborations which can be extrapolated to human-agent collaborations. Firstly, *commitment to joint activity*, while individuals can have different intentions a joint end is needed as well as an agreement on the division and proceedings to perform tasks. Next, *mutual responsiveness*, meaning that individuals need to be responsive to each other's actions and intentions and it has to be intelligible for both sides. Lastly, *commitment and mutual support*, meaning that collaborating individuals should

be willing to support and aid the other to play its role in the joint action. Agents need to use positive politeness and be able to request help to humans when needed, but offer help in form of recommendations avoiding imperative orders.

In the field of human-agent collaborations there are two concepts that provide a deeper understanding on how to build relations that conserve both sides' autonomy; Objects with Intent (OwI) and Human Agent Collectives (HACs).

Objects wit Intent: A category among autonomous agents, described as intelligent ordinary products that empower humans by complementing them in some tasks (Rozendaal, 2016). OwI are equipped with autonomy and the ability to communicate with human-beings in a way that enables negotiation which enhanced the feeling of shared control. The underlying idea is that humans act indirectly to the world, they need specific tools or objects to carry out many actions, which means that these artifacts mediate according to user's intentions which empowers them by widening their possibility of actions (Rozendaal et al., 2019). When mediation occurs, it is essential that users's intentionality is properly understood by agents to support their learning process and encourage a long-lasting relationship (Suchman, 2007).

Human Agent Collective: Jennings et al. (2014) conceive HACs as socio-technical systems in which humans and agents engage in flexible relations that allow them to accomplish both their individual and collective goals. The collaborative aspect of this relation relies on the role of the user as a conscious data gatherer, informer and processor which enhances the autonomous behavior of agents. The second relevant concept is flexibility, understood as the possibility of altering the leading role between users and agents according the situation's nature.

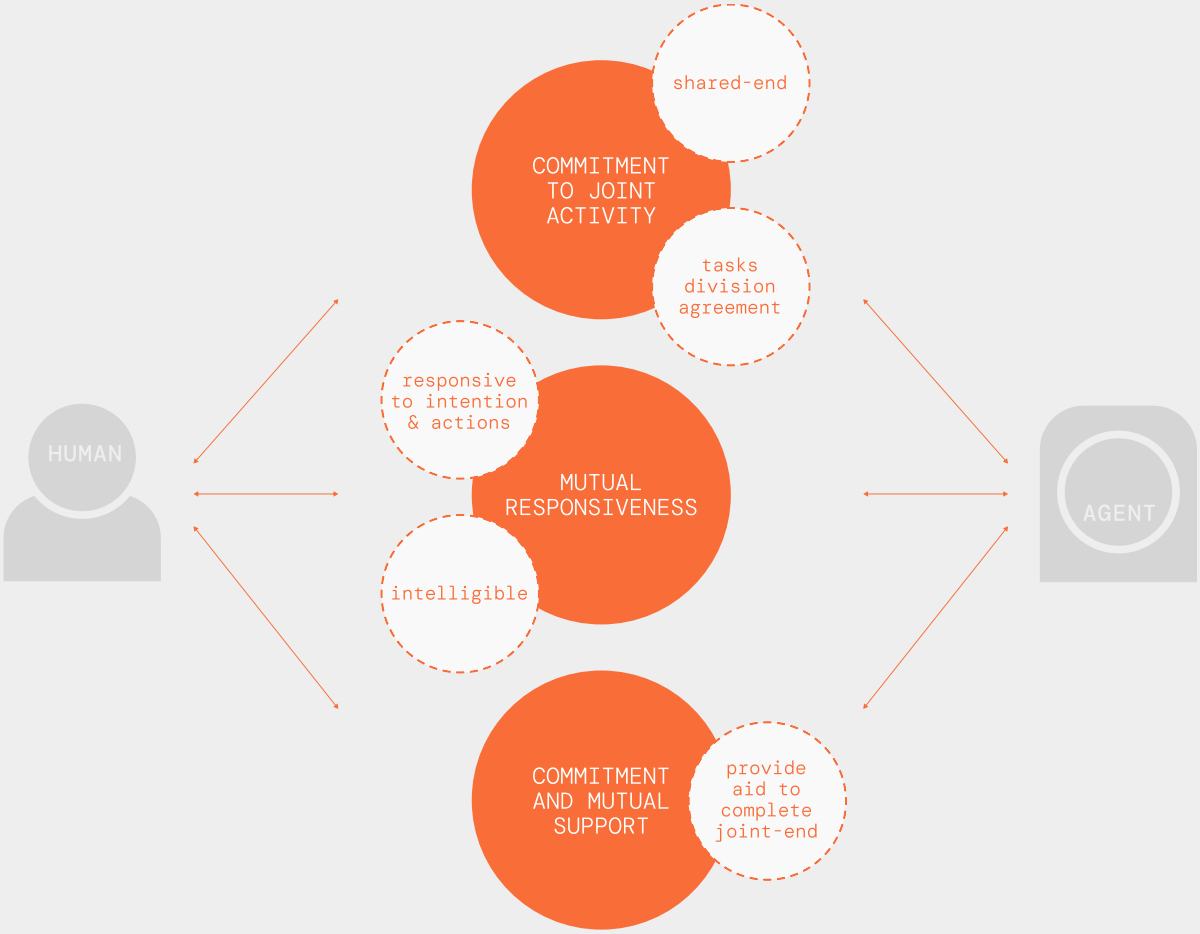


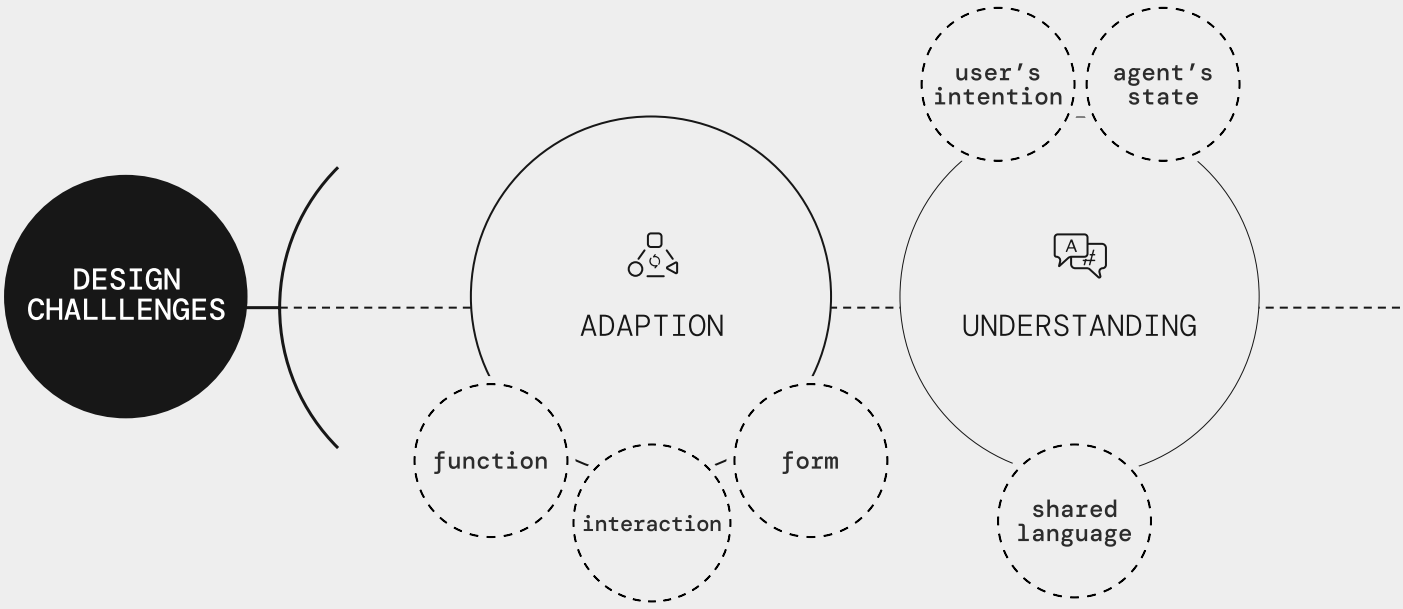
Figure 4. Elements to stablish a sustainable Human-Agent collaboration

Design challenges

Achieving the promising benefits of autonomous environments is not as easy as it might seem. While the technology to develop smart products is available and studies reveal society's willingness to introduce them in their households (Alan et al., 2016; GFK, 2018) four main aspects that challenge their design have been identified: adaption, understanding, trust and flexibility.

Adaption: Being successfully integrated in our homes is essential for smart agents to operate properly, thus they have to be adapted to the environment requirements, but also to users' routines and values. Agents should adapt to their inhabitants and not the other way around (Forlizzi & Disalvo, 2006). If this is achieved, they can be considered house-trained, this adaptation processes is conceived as domestication (Berker, Hartmann, Punie, & Ward, 2006). The ultimate goal is that products are easy to use and visually attractive while respecting the complexity of domestic routines. Auger (2014) describes three processes of adaption in order to design house-trained agents. Functional adaptation, understanding the environment and grounding an object's function according to technological possibilities, not merely replicating human behavior. Form adaptation, suggests that the shape of smart agents needs to be coherent to the present time and domestic environments. And thirdly, interactive adaption is the result of considering the functionality, and both the user and its context.

Understanding: A basic attribute from any relationship is mutual understanding, therefore users need to understand smart agents and vice-versa. The first idea to highlight is the fact that to achieve reciprocal understanding a shared language has to exist, the type of interactions used to transfer information have to be intelligible by both parties or it could generate frustration, diminish product's functionalities and affect the relationship (Yang & Newman, 2013). On the side of autonomous agents, it is crucial that they are able to interpret the environment and also understand the actions of the user to predict and act (Suchman, 2007). On the other hand, operating with the artifact has to be easy, and therefore the interface (front-end design) has to be comprehensible.
On top of this, to build sustainable and trustful relationships users need to be aware of the devices' learning process and their current status (back-end design), which can be enhanced through adding responsiveness to the artifacts and providing intelligible feedback (Bonanni, Lee, & Selker, 2005; Forlizzi & Disalvo, 2006; Kounelis et al., 2014).



Flexibility: Authors identify two types of flexibility in the subject of autonomous agents, the first approach refers to altering the level of autonomy from this artifacts while the second is associated to allowing different types of behaviors (Yang & Newman, 2013; Alan et al., 2016).
Alan et al. (2016) claim that flexibility regarding the level of autonomy increases users' feeling of control and contributes to creating meaningful relations as the responsibility for the actions is shared between the user and agent. Flexibility from this perspective involves the possibility of switching agents from autonomous to manual mode, or deciding who takes the lead in certain tasks depending the situation.
On the other hand, the second approach to flexibility in smart agents relies on enabling them to identify and interpret different types of behavior such as differentiating routine from sporadic tasks or understanding that activities that some days are pleasurable, due to certain circumstances other days might be undesirable (Yang & Newman, 2013). Progresses in Artificial Intelligence (AI) can improve this flexibility, since AI provides agent's with the learning ability needed to identify and process use and behavioral patterns. An example of this, is the smart home development carried out by MIT researchers, capable of recognizing occupants while they move around the space (Matheson, 2018). However, allowing users to manually indicate which actions should not be learned by the system is also perceived as a strengthener of human-agent collaborations (Yang & Newman, 2013).

Trust: Probably the least obvious but most complex attribute among the described in this section, since it involves all the above-mentioned. Authors in the field of IoT define trust as the level of confidence that users have to ensure an entity specific tasks, which means that if this level is positive, users believe that the outcome of the action will match their expectations and intentions (Kounelis et al., 2014). There is a second level of trust, known as trusting intention, it is the extent to which the user is willing to rely on the artifact to mediate his intentions and act on its behalf (Neisse, 2012). Engaging and establishing sustainable long-time relations with an object relies to a large extent on the trust levels that the user has with it. Although fully trusting a product from the first day can be difficult, studies show that trust can be built over time when the stated conditions are present: understanding, flexibility and adaptation (Yang & Newman, 2013).

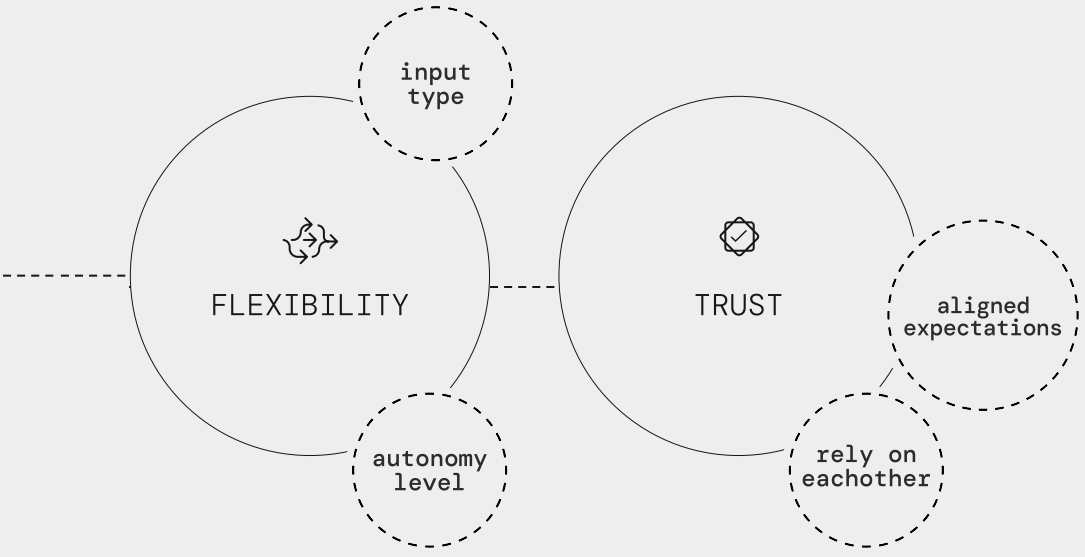


Figure 5. Autonomous agents' design challenges

EMBODIED INTERACTIONS

In order to understand the origin of EI it is necessary to comprehend the cognitive theory in which they are grounded — embodied cognition (EC) — and how improvements in the field of Human Computer Interaction (HCI) have lead to these type interactions. In the following section these concepts will be dissected and the definition of EI will be explained.

Embodied cognition

Cognition, according the Oxford Dictionary is the process by which knowledge and understanding is developed in the mind. Traditional cognition theories understand the mind as the processor of the environment, which perceives the inputs from the environment and instructs the body to perform output actions (Klemmer, Hartmann, & Takayama, 2006). This approach sees the body as irrelevant regarding the understanding of the world manifesting that cognition is not influenced by our bodies. Traditional cognitions considered that the body is separated from the mind (see Figure 6).

Opposed to this point of view, EC dissolves the division between mind and body and conceives cognition as the relation between body-mind and the environment (Foglia & Wilson, 2013). In EC, the body gains a central role in shaping the mind and contributes to understanding the environment, with the conception that we think through our bodies. According to Wilson (2003) and Suchman (2007) cognition is situated, which means that activity takes place in the context and requires both perception and action through the combination of mind-body. In other words, the idea behind *situated coginition* is that our knowledge or perception of the world is inherently conditioned by the social and cultural context where it takes place since. We are not isolated, hence our learning processes are tied to specific places and interactions.

Autonomy in EC

Among diverse EC theories, enactivism arises with a more radical approach to cognition. McGann et al. (2013) define enactive cognition theory as:

> *"The mind is seen not as inhering in the individual, but as emerging, existing dynamically in the relationship between organisms and their surroundings." (p.203)*

The concept of autonomy gains relevance in enactive cognition, understood as the capacity of bodies to be self-individuating by generating and maintaining themselves through constant structural and functional changes and being adaptive to their environment (Jaegher & Froese, 2009). Autonomy makes bodies capable of sense-making, and enables them to interact with the environment in terms of the consequences that these interactions can have for their own identity conservation (Jaegher, Di Paolo, & Gallagher, 2010).
After unpacking the enactivist conception of autonomy, for this project it has been found relevant to analyze what social cognition is and what defines a social interaction. The first concerns cognition involving others, understanding them, but also understanding with them (Jaegher et al., 2010). This becomes relevant to the project as the aim is to design sustainable relationships between humans and smart agents, which can be understood as social interactions.
Social interaction is the regulated coupling between two or more autonomous agents. Thus, for this interaction to be social the autonomy of each individual should not be diminished nor the regulating control of it should rely only on one of them (Jaegher et al., 2010). For the project, it is relevant to keep this idea as a priority as the introduction of smart agents in the domestic kitchen should not threaten human's autonomy in the tasks that take place in this context.

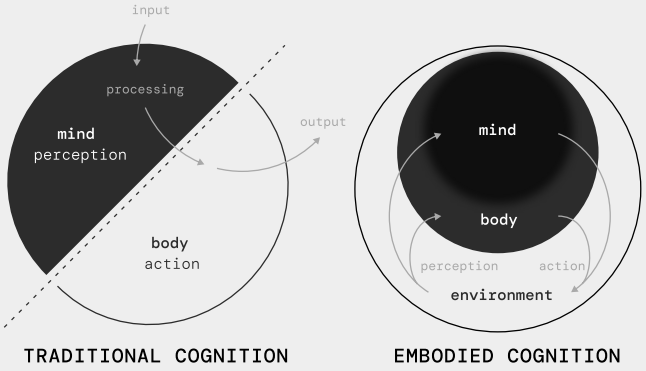


Figure 6
Traditional cognition vs Embodied cognition

Ubiquitous Computing

The history of HCI stands out due to its ongoing evolution. In this project HCI becomes relevant for how the interactions with computers have been changing according the improvements in these

devices. With the first computers users provided input using sets of punched cards and the output received was a line printer, the richness of action was very poor and the interaction can be considered symbolic. When computers started to process words and numbers, interactions with these devices became textual and language-based, where our grammar and communication skills where exploited more (Dourish, 1999). With the introduction of visual computing the modern concept of interface was born, as well as the devices linked to it such as the mouse coupled to the on-screen cursor to allow navigation. Graphics shown on screen became richer and metaphoric elements started to be used in computing (e.g folders to save documents, trashbin to delete files and windows for each program running). Dourish (1999) claims that all this contributed to enhancing human skills and enhanced our interactions with computers.
While computers have changed exponentially since that time both in terms of form and functionality, the way in which we interact with them has remained mostly unchanged. *Ubiquitous computing*, a concept developed by Mark Weiser in the 80' becomes relevant to argument the needs of a new paradigm of interactions in the field. Computer boundaries are fading, being harder to identify by users as interfaces are becoming invisible in our environment due to their embedding in everyday objects (Malaka & Porzel, 2009; Weiser, 1999). Regarding interactions, Malaka and Porzel (2009) argument that *ubiquitous computing* requires acting from our intuition and natural embodied forms of interaction that respect our mental models and help users understand the meaning of the objects.

Embodied interactions

EC theories claimed the relevance of the body to enhance our sense-making abilities; and ubiquitous computing pointed out the need of designing new interactions that considered the richness of human skills to relate with the autonomous and smart agents that surround us. These two perspectives are what make relevant the introduction of EIs in this project. Authors understand EIs as those that allow humans relate to the world around them through their bodies — *doing* — instead of purely from their minds — *knowing* (Klemmer et al., 2006). The idea is that we create and communicate meaning through interacting with objects (Dourish, 2001). Among the field of EIs an interesting concept described by Frens (2017) are rich interactions, a product centric perspective that focuses on the idea that the appearance and shape of an object, as well as the actions with it should allow the user to depict its functionality.

According to Dourish (1999), two terms need to be dissected to understand EIs: *social computing* and *tangible computing*. *Social computing* highlights the relevance of the context where the action occurs since it influences it and makes it meaningful. Hence, with computer boundaries fading as they become more ubiquitous, ensuring their adaption to the context becomes relevant. Secondly, *tangible computing* refers to exploring the wide range of skills that humans can employ to interact with computers. Most of the time, done through physical objects (i.e., mouse, keyboard...). In contrast, Dourish claims that our abilities can be maximized by interacting with the objects themselves, merging in this way digital and physical worlds.
A second set of relevant concepts is the following: *coupling* and *intentionality*. Wensveen et al. (2004) refer to *coupling* as the connection between users' actions and the product's functions. When these two aspects are correctly connected, their interaction feels intuitive. *Coupling* is essential in EIs as it means that users are coordinated with objects and can maintain a relationship through time (Dourish, 1999). Additionally, *coupling* or balancing both digital and physical worlds is necessary. In this way, as stated by Van Campenhout et al. (2020), interactions can "feel physical as well as digital." *Intentionality* describes the relationship between two entities. Engaging with the world around us helps users understand how the elements of a system can become meaningful during the course of action (Dourish, 2001). Hence, *intentionality* connects what is done (action) and what is meant (purpose).

For the project, the idea of *coupling* will be considered when designing the relationship between users and the agent. In the final concept, despite involving the digital world, interactions should feel physical and adapted to the context of domestic kitchens and the activity of cooking. Regarding *intentionality*, in the project it will be introduced by understanding the intelligent agent as the bridge to ensure it. The agent should support users carry out the required actions (cooking steps) to achieve their purpose (dish).

ANALYZING THE KITCHEN

The following analysis examines modern kitchens in terms of autonomy and embodied interactions, as well as identifying potential future directions from this context.

The description of modern kitchens from MIT researchers Bonanni, Lee & Selker (2005) enlightens the pragmatic approach to this space; "domestic kitchens are technological complex laboratories where multiple users carry out different tasks with numerous tools, work surfaces and appliances" (p.1). Technological interventions in the context reflect it mainly as a working space rather than a social hub to strengthen relationships. Corrective technologies that aim to improve uncertainty (i.e what to cook), efficiency (i.e reduce time or food waste) or nutrition (i.e control caloric intake) have the highest presence (Kerr, Tan, & Chua, 2014). Augmented fridges with embedded intelligence are a clear example of these technologies. Samsung's (2021) Family Hub fridges allow users to remotely control them, see what food is inside or receive suggestions on what to cook. Another example of is the adaptive kitchen designed by Reichel (2011) that assists people to cook complex dishes at home by providing a clear structured recipe by tracking the user's performance.

Despite the benefits of technological innovations in the kitchen regarding performance, they can also enhance learning and communication as well as considering emotional interactions (Bonanni et al., 2005; Siio et al., 2007; Xu, Dong, & Zhu, 2019). Accordingly, celebratory technologies that focus on inspiration, appreciation and motivation should also be considered (Kerr et al., 2014). One of the main directions in this line of thought is sharing recipes, an example is the Living Cookbook concept by Terrenghi et al. (2007) that encourages the creation and sharing of recipes with family and friends, the system records videos of the cooking process to provide a deeper and funnier experience.

This reveals that while innovation in the kitchen is growing, a shift in the approach has to be made in order to exploit the possibilities of this domestic space, maximizing its functionalities while welcoming social encounters to make the overall experience more enjoyable.

The terms "smart kitchen" and "smart appliances" are increasing in popularity but the reality is that most technological interventions from the past decade have brought automation to our lives. According to the functions of these innovations, such as cooking robots, or allowing remote control, it can be inferred that the objective is to diminish the role of the user and simplify the tasks to cook, they are mainly corrective technologies (Grimes & Harper, 2008). In other words, it can be said that technologies that aim to fix users' problems are making the kitchen more automatic but not autonomous.

By going from the automatic kitchen to the autonomous kitchen, the relationships between users and appliances can be enriched, as well as providing personalized experiences that fit each household's inhabitants needs.

According to Kim & Maher's work (2020), the (embodied) interactions that take place in the kitchen are metaphorically dissected in the following analysis:

- *Direct control over the object.* Users operate on the object directly to accomplish a specific task, the agent (or system) is considered a device. Here, users actively control the environment and the information exchange with their interactions. An example of this is the kitchen robot Thermomix (2020), "the do-it-all kitchen appliance that makes accomplishing more possible". Thermomix allows users to perform actions such as chopping ingredients or cooking a whole dish by using the controls on its touch interface.
- *Performing tasks by automation.* Actions in which an interactive agent performs a task without human control as a result of an interpretation of the external conditions, the agent is metaphorically considered a robot. The Neo Smart Jar designed by Ske Labs represents this category, when filling it with a specific ingredient such as rice, the jar provides nutritional information about it and automatically places an

order to the user's desired supermarket when it is running out of content (Onbyz, 2017).

- *Performing tasks by assistance.* Activities done by users with an active intervention of an interactive system, hence the leadership is shared. Metaphorically these systems are friends. Amazon's smart assistant, Alexa, embedded in the speaker Echo Dot is an example. The user interacts with Alexa by voice control, and it can be used to cook a specific recipe. While the user carries out the tasks, Alexa indicates the steps.

According to the project's aim to understand the kitchen as a Human Agent Collective, the main focus will be on tasks performed by assistance, although the other two will also be considered for specific tasks.

Thanks to technological innovations in the kitchen cooking is decreasing in complexity, and now elaborating an ambitious meal can be done by just gathering all the ingredients and performing a sequence of clicks. The richness of EIs that a chef employs to master a recipe is completely non-existent in many modern domestic kitchens with the introduction of agents that substitute human-beings' skills such as intuition, manual ability or creativity. This decreases our natural capacity to use our bodies for sense-making.

The introduction of richer interactions can exploit the capacities of human-beings when operating with the autonomous kitchen, and ultimately achieve what Gaggenau wants for their users, to feel like home chefs and enjoy the meals at home.

Following a recipe from the fridge. *Source: Samsung*

Cooking with a Thermomix. *Source: The New York Times*

TENSIONS

The analysis of the existing literature on the fields of the kitchen, autonomy and embodied interactions has helped in grounding the main tensions that this project aspires to address. These tensions are understood as opportunities for improving the context of domestic kitchens, and subsequently opportunities for innovation. Two predominant tensions have been ascertained: integrating embodied interactions in an autonomous environment and bringing back the ritual kitchen while considering its rational side.

Integrating embodied interactions in an autonomous environment.

At first glance from an interaction viewpoint, autonomy and EI could be seen as opposite concepts. EIs empower humans by strengthening their sense-making capacities and consequently enhancing their freedom and feeling of control. On the contrary, autonomous appear to threaten users feeling of self-sufficiency. Nevertheless, these two approaches complement each-other, and according Coskun, Kaner & Bostan (2018) work the main challenges to address are: keeping user's feeling of achievement, guarantee freedom and pleasure when cooking while providing guidance, secure user's decision-making abilities, guiding users through new types of interactions and enabling participation in the context. Additionally, this tension highlights the need of identifying and clearly defining the roles of humans and agents.

The rational-ritual kitchen

Although the central role of kitchens in households is still alive, innovations in this context are pointing to a functional and corrective direction where the objective is efficiency and reducing users' involvement in chore tasks. Moreover, modern lifestyles encourage this direction as time is limited and people seek for solutions that ease domestic tasks. In spite of this, kitchens still held most of the social encounters at home and therefore this space should regain its ritual side. Celebratory technologies that embrace the positive aspects of the food experience can be a starting point to redefine the kitchens of the near future. Gaggenau's complex target group (see *Personas* in pages 40-41 for details) reinforces the need of conveying both rational and ritual approaches, where users can feel like chefs and explore while cooking but also use the space as a social hub. To achieve this balance, celebratory technologies can embrace the pleasures, whereas embedding rational elements can help users delegate specific tasks to achieve the desired results.

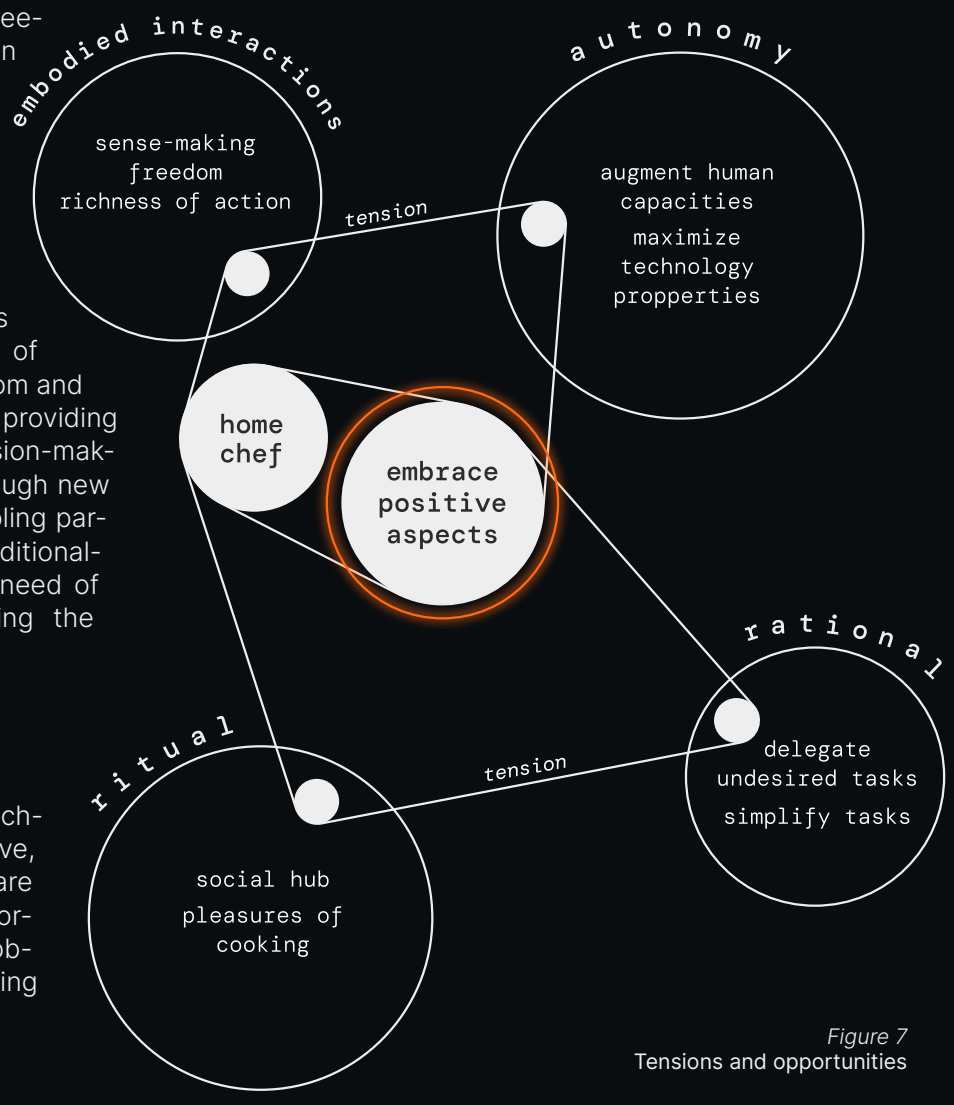


Figure 7
Tensions and opportunities

GUIDELINES
FOR DESIGNING THE AUTONOMOUS KITCHEN WITH EI

Grounded on the literature study performed throughout the previous sections the following "Guide for designing the autonomous kitchen with EI" has been elaborated.
The aim of this guide is to summarize in eight principles the main aspects that should be considered when designing an agent that will be part of a human-agent collaboration in order to make this partnership sustainable and long-lasting. The guidelines convey the main challenges of designing smart agents and principles from EI, both adjusted when possible to the context of domestic kitchens.

1
UNDERSTAND THE HOME CHEF AND THE KITCHEN AS COLLABORATIVE PARTNERS.
The user -Home Chef- and the kitchen should have a joint end.

2
AGENTS SHOULD BE ADAPTED TO THE DOMESTIC KITCHEN
The smart system has to be adapted to the context, and therefore the shape and interactions are conditioned to it.

3
GUARANTEE MUTUAL INTELLIGIBILITY
Humans should understand the state and learning process of the agent, and the agent should be able to understand user's intentionality and behavior. Language should be common.

4
AUGMENT USERS CAPACITIES, MAXIMIZE AGENTS' CAPACITIES
Avoid mimicking human behavior, understand the capabilities of technology to empower users by accomplishing goals that could not be achieved otherwise.

5
GUARANTEE MUTUAL TRUST ACCORDING TO TASK DELEGATION
The division of tasks should guarantee that humans trust agents in their performance, and shared responsibility

6
FLEXIBILITY IN AUTONOMY LEVEL AND INPUT TYPE
The level of autonomy from the system should be possible to regulate by users, as well as being able to provide input manually.

7
GUARANTEE BOTH ENTITIES' AUTONOMY
Throughout the interactions, both sides have to preserve their autonomy.

8
UNDERSTAND RICHNESS OF HUMAN BODIES' INTERACTIONS
Use the most adequate interactions for the context and scenario, consider the richness of humans' possible actions.

IMPLICATIONS FOR THE PROJECT
These guidelines will be used in the later stages of the project: ideation and conceptualization. These eight conditions will influence the final concept, serving as references to guide the design process. Finally, evaluating the concept will include assessing the achievement of those, as their accomplishment will indicate the design of a successful HAC for domestic kitchens.

ABOUT GAGGENAU

This project is possible thanks to the collaboration with Gaggenau. Knowing the brand in depth to share its values and design requirements has been essential.

Contents

3

THE BRAND

Born in 1683, Gaggenau has evolved from a smelting plat in Rotenfels (Black Forest, Germany) to the world's leading brand of kitchen appliances. In 1931 Gaggenau began to produce innovative and economical solutions for private kitchens, starting with gas and coal ovens. From that moment onwards, and especially after 1956, Gaggenau initiated a kitchen revolution lead by the passion for cooking which inspired the custom-designed fitted kitchen with sophisticated and easy-to-use appliances (Gaggenau, 2016). Until the present, its mission has remained intact, providing exclusive culinary culture and sophisticated lifestyle for their customers, home chefs, guaranteeing the best quality in their products.

Understanding the needs

Gaggenau's approach to innovation focuses on discovering the needs of the context and their customers, and from there, providing a perfect solution that might be a new concept for the private kitchen (i.e. the introduction of the first fitted kitchen in the 50's or the first downdraft ventilation in 1972). Designers, engineers and cooks all take part in the process of designing new concepts for the private kitchen.

Quality

Since 1683 Gaggenau's DNA has remain unchanged based on an ongoing quest for authenticity and uncompromising quality. The brand's develops their appliances under the premise of perfection, thanks to their careful attention to detail and the involvement of hand-made processes during the production of the products.

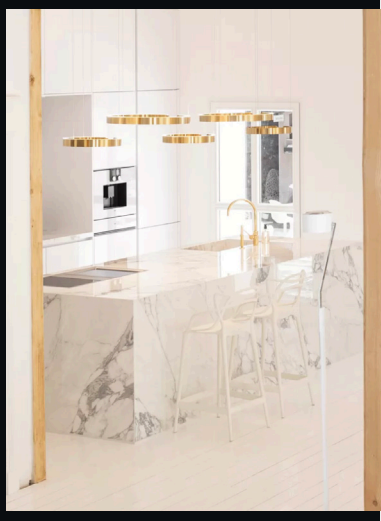
Home chef

The idea behind a home chef is that they create, take risks and try out new combinations, and the brand wants to support this process and eliminate all the possible inconveniences. The experience aimed for is that, regardless of one's cooking abilities, available time or ingredients, Gaggenau's customers feel like chefs and their creations are the best.

Why this partnership

The purpose of this project is to conceptualize a new idea for the connected kitchen that provides an enjoyable experience in this context, which is considered the households' hub of life. According to this, Gaggenau's values of innovation and quality make the company a perfect fit. Moreover, the brand's essence is fundamental when conceiving this context: If the kitchen is the heart of the house, Gaggenau is the soul. Finally, Gaggenau's openness to the evolution of cooking and eating experiences towards the future allowed the aim of this project of exploring possible perspectives from a speculative — while still realistic — point of view.

GAGGENAU IS THE DIFFRENCE

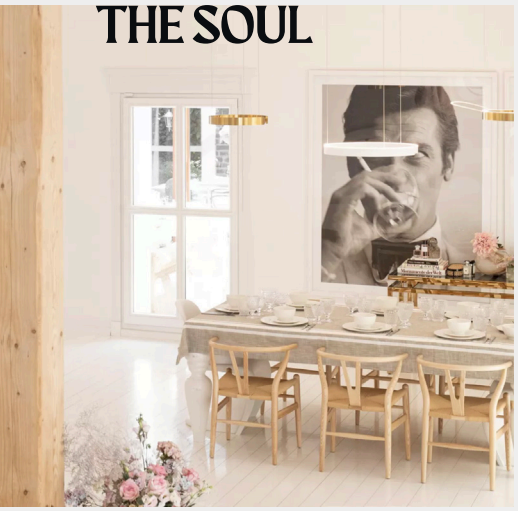


Wine climate cabinet.
Source: Gaggenau

Cutting vegetables.
Source: Gaggenau

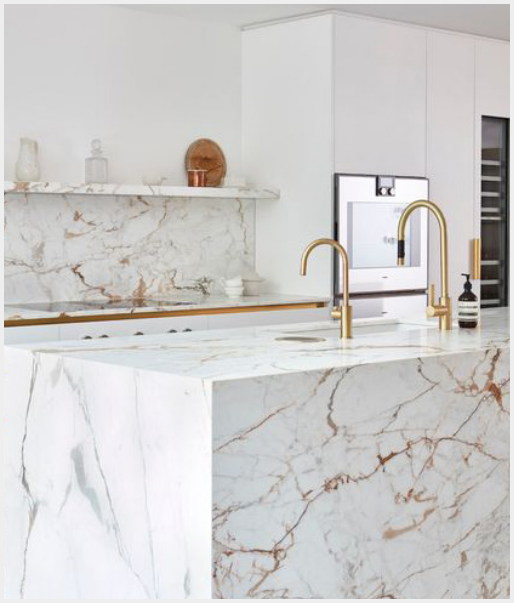
Nadia Damaso in the kitchen.
Source: Gaggenau

IF THE KITCHEN IS THE HEART, GAGGENAU IS THE SOUL



Luxury kitchen in Cologne.
Source: Gaggenau

Series 200 cooktop.
Source: Gaggenau



Gaggenau is the difference.

What does this actually mean for the brand? Gaggenau provides exclusivity, the best materials and usability, as well as refined aesthetics, however, the most essential aspect is the fact that their appliances can be adapted to any kitchen, there are no restrictions. This is the most valued aspect from their customers. Regarding the appliances, they are easy and intuitive to use, guarantee precision and their look&feel evoke high-quality. Currently Gaggenau has products used for *cooking* — cooktops and ventilation system, ovens, coffee machines and *sous-vide* drawers — but also for *food storage* — fridge, freezers and climate wine cabinets — and *cleaning* — dishwasher and embedded automatic cleaning systems in other appliances. This allows customers to purchase the full kitchen, the brand's goal.

Diverse kitchen styles with Gaggenau appliances.
Source: Gaggenau on Pinterest

INSPIRING THE AMBITIOUS PRIVATE CHEF, CREATING THE KITCHEN OF DISTINCTION

Appliances ecosytsem

The appliances ecosystem from the brand comprises a large range of products that altogether are the perfect equipment for the home chef (see Appendix B). Something relevant from the range of appliances is the wide variety of accessories that are included in order to allow the home chef explore different techniques and be creative at home while cooking. Examples of this are the steam oven, the pizza stone for the oven or meat thermometer. Next to this, precision is desired by the home chef, and therefore Gaggenau's appliances are designed to allow users control in detail, for example modifying the light and temperature of every shelf from the wine cabinets or adjusting the fridge's light, temperature and humidity.

Interactions

The interactions are designed in a way to evoke quality on one hand, and on the other simplify the tasks. All the appliances have embedded screens where users can define the settings and visualize the current state of the device. There are predefined settings that guide users when cooking a specific meal or storing a specific product.

HomeConnect

A relevant feature to mention is the HomeConnect app, a system that integrates automation in Gaggenau's kitchens by allowing remote control of the appliances. Customers enjoy this as it gives them more control, knowledge but also it is something to show off. There are two main characteristics of this system that make it especially relevant for Gaggenau's target group. Firstly, the fact that it can be connected with third-party services (Alexa, Sonos, Philips Hue or IFTTT) makes it possible to link the kitchen with other areas of the house, creating multi-sensory experiences where music or lights are involved. Secondly, when appliances are connected to HomeConnect, the app reads both software and hardware status and in case of malfunctioning it is automatically managed by customer-service.

Induction cooktop settings interface.
Source: Gaggenau

Defining oven's settings.
Source: Gaggenau

PERSONAS

***Based on information provided by Gaggenau.**

Craft conneisseurs.
Source: Vogue

Chef Isaac Carew at home.
Source: YOU Magazine

AESTHETIC EXPLORER

Name	The Kellers
Age	45-48
Job	Art dealer / Architect
Status	High-income
Location	Berlin
Tech	Apple devices, smart lighting
Family	Married, 2 kids (7-9 yo)
Hobbies	Cooking, traveling, outdoors sports

The Kellers are a sophisticated and creative marriage, always willing to explore this through their home, by decorating it with craft furniture and honest materials that reflect their personality. Their kitchen is the most important room, where they spend time creating new recipes and expanding their cooking techniques thanks to the quality appliances they own. Aesthetics are important, both in what they create and use. They are skilled home chefs, who like to spend time together in the kitchen and share this moment with their kids, especially on the weekends. They both occupy the role of cooking and planning family encounters, and enjoy surprising each other with new ideas.

Having busy lives because of their jobs and family responsibilities, their time spent cooking is very appreciated, this moment should allow them freedom of expression.

Gaggenau's modular cooktop.
Source: Gaggenau

Gaggenau's modular cooktops are versatile, high-quality and enhance creativity, the aesthetic explorer's qualities.

SOCIAL DIPLOMAT

Name	Nina
Age	53
Job	CEO Fashion business
Status	High-income
Location	London
Tech	iPhone, Alexa, smart TV
Family	Divorced, children not at home
Hobbies	Fashion, yoga, self-care

Nina, the social diplomat, is a perfectionist and ambitious woman working in the fashion field. She spends most of her time working and when being at home she enjoys doing some yoga or meditation to relax. However, she conceives of her house as a social-hub, where she hosts networking events, parties or family meals. In this occasions, she aims to impress them with her opulent and refined design-home, as well as with the delicious and sophisticated food and drinks that are served. Despite this, her role in the kitchen is secondary, as she usually has her staff prepare the meals or hires professional chefs/catering for bigger events. In case she prepares a meal for herself, she uses precooked elaborations.

She stands out for her social intelligence and in her parties, the kitchen always becomes the meeting point, this is why she wants it to be inviting and enhance relationships.

The social diplomat.
Source: Architectural Digest

Gaggenau's wine cabinets represent the elegance and opulence that define the social diplomat.

Wine cabinet by Gaggenau.
Source: Gaggenau

Guests at a home party.
Source: lonny.com

IMPLICATIONS FOR THE PROJECT

The collaboration with Gaggenau implies introducing the values and essence of the brand when designing the final concept, with special detail on interactions. The idea of the Home Chef introduced by Gaggenau will be used as a reference for the aimed experience to design. However, in later stages of the project the concept of the Home Chef will be expanded. Finally, the user group will be defined according the personas illustrated in this chapter. Nevertheless, it will center around the aesthetic explorers as they are the ones more interested on the pleasures of cooking.

USER RESEARCH

In order to empathize and understand Gaggenau's target group needs and wishes, user research has been conducted. This chapter focuses on the user study, the process and results.

Contents

4

RESEARCH PURPOSE

The literature review carried out in the second chapter served as a basis to ground the user research. While the theoretical study has provided answers to what challenges need to be addressed and how to do it, the aim of this user study is to get more in-depth knowledge about the target group's experiences in their kitchens. Consequently, the results of the activities will be used as inspirational material to define the Design Goal. The focus is on the emotions and feelings that the concept should trigger, as well as the nature of the collaborative partnership between the user and the kitchen (see Figure 8).

Figure 8. User Research structure: research questions and metrics

Scope and focus of the research

Focus represents the specific experience area aimed to be fully understood. Considering the scope, the larger field of experience, enables having a wider perspective (Sanders & Stappers, 2013). Domestic kitchens frame the scope of the research, and the focus comprises four topics: the cooking process, eating at home, domestic social relations and the use of digital devices in the context (see Figure 9).
In order to understand the wide range of activities and social relations in the context, two scenarios have been studied. Firstly, routine in the kitchen (everyday cooking and eating). Secondly, gatherings with guests such as friends or family. In this way the insights obtained from the research will provide a more realistic overview of the eating and cooking experiences of the user group, as well as allowing to consider celebratory technologies and not only seeing the pragmatic side of this context (Grimes & Harper, 2008).

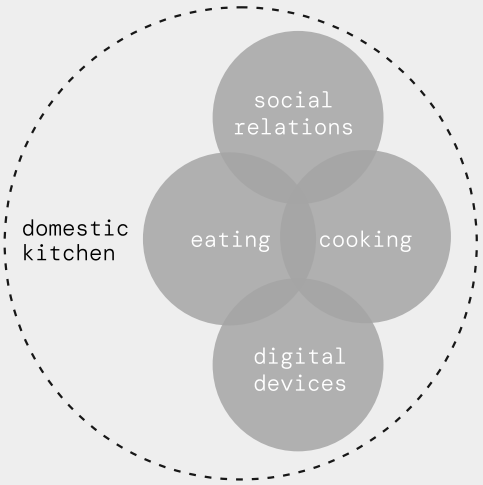


Figure 9. User Research scope and focus topics

USER DESCRIPTION

The user research aims to provide a deeper understanding of the user group. The following portrait of Gaggenau's target customers is based on the literature review and information provided by the brand itself. This facilitates defining the research activities and emphasize in-depth information about personal experiences, instead of demographics or their general lifestyle already known.

Gaggenau's customers can be defined as people who want to have the best, especially at home since they enjoy where they live a lot. Having the best is not enough, this should also fit their refined and aesthetic taste. Things should be however they want and they are not willing to compromise on their preferences. They care about details and perfection should be accomplished, this means having the best materials, beautifully designed spaces and the newest innovations. Since they have busy lives and work occupies a big part of their days, they value their house a lot and expect it to encompass pleasant experiences.

A distinguishing characteristic of Gaggenau's customers is their passion for cooking. The way this user understands cooking is from a cultural-aesthetic perspective, where creativity has a key role, instead of perceiving it as a mere operational and survival-based process (Park, Kim, & Leifer, 2017). Consequently, the pleasures associated to food processes, especially cooking, serving and eating, are desired by Gaggenau's customers, who are willing to explore in this field. In the literature review it has been stated that kitchens are the heart of modern homes (Bonanni, Lee, & Selker, 2005; van den Eijnde, 2020) and this becomes especially relevant for the target group. As a consequence, their kitchens need to fulfill both aesthetic and functional requirements, having appliances that allow them to cook the highest quality products with the certainty that the result will be the best. **Therefore, it is really important for the user group to be able to improve their cooking skills, explore new techniques but especially, focus on the pleasures of the moment.**

Social life becomes also relevant to understand this user group in more depth. Firstly, there are the natural social relations that take place between members of the household, most of the times held in the kitchen (Sikora, 2017). Furthermore, hosting social reunions is something that they especially enjoy, it is an occasion to share their house with people they care about. Food is used as a social facilitator in many occasions (Ceccaldi, Huisman, Volpe, & Mancini, 2020), meaning that most of this social encounters revolve around meals. In these situations, the pride of owning such unique and luxury spaces grows and the hosts like to delight the guests with their cooking abilities.

Gaggenau's customers characteristics have been used to create a profile (see Figure 10) that allowed selecting participants for the user research carried out in the project.

Although reaching out to the exact target group has been complex due to its lifestyle and busy schedules, there are two attributes that have been considered essential when defining the requisites:

- The social status should be high-income working adults.
- Participants should own a fully equipped kitchen.

Further criteria has been included in the user profile used for participant selection (see Figure 10):

- *General*: Adults, any gender, high-income, employed
- *Specific*: mid-high tech experience, cook and/or eat at home, spend time with family and have a preference for high-quality, aesthetic and luxury products.

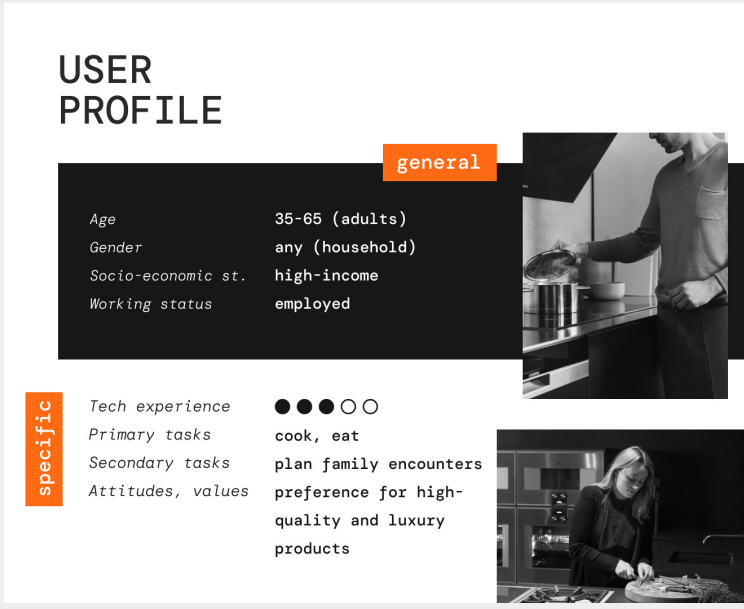


Figure 10. User Profile for participant selection

METHODOLOGY

The user research is grounded on generative methodologies since they center on gaining deeper understanding of the users' motivations. Hence, the aim is to design from their values and not from a usability perspective. Moreover, this approach empowers participants by considering them experts about the field, with the capacity to bring relevant contributions to the design (Sanders & Stappers, 2013).

A mix-method has been chosen for the study. First, a sensiziting activity to encourage participants' self-reflection about the scope of the project. Followed by an interview to gain deeper understanding about personal experiences in the kitchen.
Participants from 8 households have been part of the user study, four of those in Spain and the rest in The Netherlands. Participants were all adults and (co)owners of the house. To provide them with all the information, participants have been contacted by email where the Consent Form was also attached (see Appendix C.1).

Photo safari

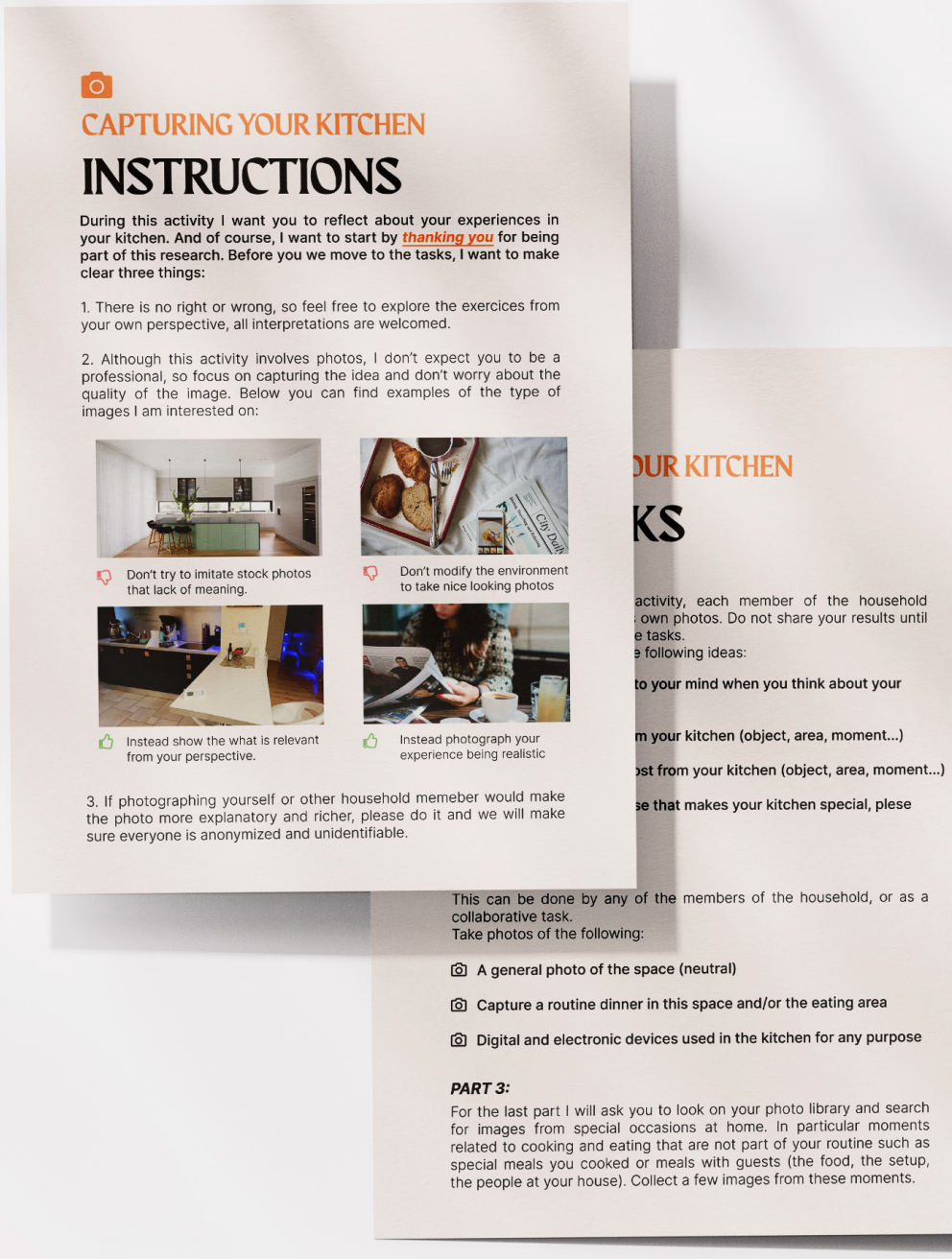
In this method, popular in the field of service design, participants are encouraged to capture (with photos) their own experience according to the given instructions, helping researchers gain a first understanding about the scope of the project (Technology Strategy Brand, 2015). The structure has been based on the method *cultural probes* defined by Gaver, Dunne & Pacenti (1999), that allows participants of the research to carry out the tasks without feeling intimidated by the researcher. Therefore, insights about their everyday situations are obtained more naturally.
For this activity, instructions about how to approach it have been given to participants, highlighting the idea that they can explore it freely and that the images should capture realistic experiences and not ideal situations. Next to this, a list of tasks (which photos to take) has been provided, divided in three parts: personal experience, general overview, special occasions (see Figure 11). The first part, personal experience, has to be carried out individually in order to emphasize the personal perspective of the space, while the others can be performed as a collaborative task by the household participants.

Interviews

To conclude with the research, within a week of the photo safari, follow-up interviews have been conducted to obtain a deeper perspective on how the user group experiences their own kitchens (see Appendix C.3). These interviews have been based on the material provided during the sensitizing phase with the photo safari. Semi-structured interviews have been chosen as the method since they allow exploring in depth participants' experiences by posing questions specific to the focus topics, as well as giving participants the chance to explain their answers from the first activities (Adams, 2010). These interviews combined close and open-ended questions and had a duration of 30min. approximately, which took place online via videocall. As the project aims to design for the whole household, it has been decided to conduct the interviews with both members of each home together, to observe and analyze the unique family dynamics and perception of their kitchens.

Thematic analysis

Drawing conclusions from the user study has been done following a thematic analysis in order to generate the main themes (Braun & Clarke, 2006) (see Appendix D). The aim of this analysis is to break down and cluster the behavioral qualitative data gathered during the research activities: images from the photo safari, interview transcripts and personal notes. The first step has been **spreading all the data** by grouping the photos and transcribing each interview. Secondly, the data has been analyzed and **grouped and coded** using affinity diagrams that helped creating meaningful associations between different participants' answers. This has been followed by an **inductive process to define the themes**, which have been concluded from the data itself, and not imposing preconceived ideas or expected themes. Themes comprise beliefs, patterns or needs discovered from the data. The following section of the chapter dissects the results from the study. The analysis has been mainly semantic, meaning that the data has been analyzed verbatim as originally expressed by the participants, without introducing personal opinions or interpretations.



CAPTURING YOUR KITCHEN

INSTRUCTIONS

During this activity I want you to reflect about your experiences in your kitchen. And of course, I want to start by *thanking you* for being part of this research. Before you we move to the tasks, I want to make clear three things:

1. There is no right or wrong, so feel free to explore the exercices from your own perspective, all interpretations are welcomed.

2. Although this activity involves photos, I don't expect you to be a professional, so focus on capturing the idea and don't worry about the quality of the image. Below you can find examples of the type of images I am interested on:

Don't try to imitate stock photos that lack of meaning.

Don't modify the environment to take nice looking photos

Instead show the what is relevant from your perspective.

Instead photograph your experience being realistic

3. If photographing yourself or other household memeber would make the photo more explanatory and richer, please do it and we will make sure everyone is anonymized and unidentifiable.

UR KITCHEN

KS

activity, each member of the household own photos. Do not share your results until e tasks.
e following ideas:

to your mind when you think about your

m your kitchen (object, area, moment...)

ost from your kitchen (object, area, moment...)

se that makes your kitchen special, plese

This can be done by any of the members of the household, or as a collaborative task.
Take photos of the following:

A general photo of the space (neutral)

Capture a routine dinner in this space and/or the eating area

Digital and electronic devices used in the kitchen for any purpose

PART 3:

For the last part I will ask you to look on your photo library and search for images from special occasions at home. In particular moments related to cooking and eating that are not part of your routine such as special meals you cooked or meals with guests (the food, the setup, the people at your house). Collect a few images from these moments.

Figure 11. Instructions given to participants to do the Photo Safari activity

RESULTS

Seven themes arose from the user research analysis: functional aesthetic, use patterns, pleasing others, socializing hub, cooking as a pleasure, precision and detail, technology (see Table 1 for the summary). These themes cover the different perspectives and events that belong to the overall personal experience in the kitchen according the participants.

THEME	EXEMPLARY QUOTE
Functional aesthetic The space has to be comfortable and practical, but aesthetics are a priority	*For me the kitchen we designed could not be more beautiful, but another thing that I wanted was it to be functional, have a lot of space and all the appliances that I wanted.* *Something special from our kitchen are the small details such as the plugs hidden below the cupboards. It's not frequent to see this but it's really useful.*
Use patterns Meals are different in workdays and weekends, but also when receiving guests	*I also really like it when it's in the weekends when you just take a bit more time for cooking.* *We always try to prepare food that is more special when guests come, I think in advance about what they would like.*
Pleasing others Cooking for the dining guests is highly enjoyed	*What I really like, above all, is cooking something that the others will like and enjoy eating*
Socializing hub Families and guests gather around in the kitchen often	*I'd say [our kitchen] it's really familiar, we spend more time in kitchen together than in the living room.* *I like is having this open space [open-kitchen], so I can interact with guests all the time.*
Cooking as a pleasure Cooking is considered by some participants a pleasurable activity that triggers relax and inspiration	*I like the concept of mixing ingredients and then arriving to a delicious result.* *This [the kitchen] is a place where you relax while cooking.*
Precision and detail Being focused is required to obtain good results in the kitchen	*[cooking] requires a certain concentration, being aware of the cooking techniques, achieving the detail.* *You can't cook a pasta and focus too much on the others because you might overcook it.*
Technology Electronic devices are mainly introduced in the way of appliances, kitchen robots and sometimes for entertainment purposes	*The robot [Thermomix] is fantastic. You can do what you want, fast, easy and simple* *I always have the iPad around with the recipes, it is easy to use while cooking.* *[while cooking] With television I can be watching the news or listening to music, it's a distraction and relaxing.*

Table 1. Summarized view of the themes concluded from user research.

Overview of kitchen.
Provided by H7

Overview of the open-kitchen.
Provided by H8

Table setup for a meal with friends
Provided by H1

Functional aesthetic

This theme conveys the main characteristics that users seek in their kitchens. All participants mentioned that when designing this space they prioritized making it visually appealing above everything else. However, guaranteeing its practicality and functional character is also a priority, expecting to feel at ease and having enough space to cook and eat comfortably. In other words, they want to have a kitchen adapted to their needs and preferences, both aesthetically and functionally, a kitchen they can be proud of. Participant H1.01's perception of the kitchen clearly reflects this idea:

> *"For me the kitchen we designed could not be more beautiful, but another thing that I wanted was it to be functional, have a lot of space and all the appliances that I wanted. H1.02"*

Use patterns

Use patterns encapsulates the diverse ways in how the kitchen is used according to the occasion. Routine in weekdays asks for simple dishes and the time spent both cooking and eating is reduced, since people are tired or need to complete other duties. Whereas during weekends, families spend more time together, the meals tend to be more elaborated, as well as increasing the enjoyment while cooking. It becomes a moment home chefs are looking forward to.

> *"I also really like it when it's in the weekends when you just take a bit more time for cooking. H6.02"*

> *"During weekdays we don't use the kitchen too much. But on the weekends breakfast is the best moment, we take it easy and enjoy a lot this moment. We go over how the week's been. H5.01"*

Besides these occasions, there is a third type in which the kitchen is also used differently. When receiving guests such as friends or family, the whole setup is more complex, food is carefully chosen and an extra effort is put in making special dishes. This affects the food, how the table is set and in general the whole experience in the kitchen.

> *"We always try to prepare food that is more special when guests come, I think in advance about what they would like. Also the aesthetics of plating are more refined. In general I don't mind working a bit more in this moments, even for the cleaning part. H1.01"*

Pleasing others

Most participants shared the idea that serving others is the best part about cooking, it is what encourages them to cook complex recipes or spend more time in the kitchen. The fact that others like what you have prepared, generates a positive feeling that is highly appreciated by home chefs according to the participants:

> *"When people eat what you've cooked is super satisfying, if they like it is the best. H1.01"*

> *"What I really like, above all, is cooking something that the others will like and enjoy eating. H5.01"*

The surprise effect is one of the main ingredients users like to add when cooking for others. Although it is something less relevant in simple and routine meals, in special occasions cooks aim to surprise the diners with the meal, and sometimes even hiring private chefs or caterings for this.

> *"With hiring an external catering, the idea was to surprise guests, serve something that everyone would like but that it's more special than what we could cook ourselves. H5.02"*

> *"When we receive guests, we want it to be something pleasant, beautiful and different, live it as an experience too. H1.02"*

Socializing hub

This theme captures the essence of the kitchen as the heart of the house, or the socializing hub, as most of the encounters between family members take place in there. It is also an area where different activities can be done, and participants claimed that they tend to spend a lot of time in there because it is comfortable.

> *"I'd say [our kitchen] it's really familiar, we spend more time in kitchen together than in the living room. H3.01"*

> *"Most of the times we sit all night in the kitchen. We go don't go to the living room. So after dinner, we read the papers or chat in there. H6.01"*

Participants found especially relevant the distribution of the kitchen in order to allow social interactions. Four of the households mentioned choosing a kitchen island in order to avoid the feeling of isolation when cooking, and making it possible to talk with others in these situations. This has been found one of the most important things to enhance the cooking experience and make it more enjoyable.

> *"We wanted to have some stools and a bar so someone can be having a wine and accompanying you while you cook, this is the real beauty of this kitchen. H1.01"*

Table setup for a meal with friends
Provided by H2

Cooking as a pleasure

This theme highlights the positive aspects of cooking mentioned by the participants. In all the households, there is usually one person who has the home chef role, the one who enjoys cooking the most. Participants who claimed to specially like it, described the activity as fun, pleasing and relaxing.
Regarding the main pleasures associated to cooking, the above-mentioned theme of serving others was mentioned together with the idea of being able to create delicious dishes. Specifically four participants remarked how exciting it is to go from raw ingredients to surprising dishes and exploring new combinations.

> *"I like the concept of mixing ingredients and then arriving to a delicious result. H5.01"*

> *"What I like the most when cooking is the smells of food, seeing the colors of the ingredients. H1.02".*

> *"When you eat after cooking it, if it is good it is like a prize. H3.02"*

> *"I love seeing how something so simple as a piece of meat and some veggies can become a beautiful dish H6.01"*

Regarding the inspiration sources there are two positions. While some of the participants like to use recipe books that help them discover new

possibilities and guarantee a good result, others prefer following their intuition and exploring freely.

"At the beginning of the week we go over the week meals together, we use recipe books to choose and plan our meals. We like trying out new ideas. H2.01"

"I like to invent things myself, not to following recipes and just let my intuition guide me on what to do. H4.01"

Precision and detail

Participants reflected on the theme precision and detail, which captures the notion that cooking is an activity that requires these two attributes. In order to obtain a perfect result, something aimed at by the participants, all the steps from the cooking process need to be carried out precisely and wisely as stated by H3.02:

"[cooking] requires a certain concentration, being aware of the cooking techniques, achieving the detail. H3.02"

This theme entails a contradiction with the aforementioned theme, socializing hub, as participants found difficult to focus on cooking techniques while interacting with others. Nonetheless, high-quality results and having the chance to socialize are two things the user group is not willing to compromise.

"You can't cook a pasta and focus too much on the others because you might overcook it. H2.01"

"Cooking has to do with sharing moments and with socializing with other people and in the end, I don't want to be just cooking, this is also important. H1.01 "

During the research, there have been found two main solutions for guaranteeing these aspects. On one hand four participants mentioned using kitchen robots (i.e. Thermomix from Vorwerk) due to its excellent performance and the good results obtained, and because it allows multitasking. On the other hand, some participants choose to hire caterings, private chefs or just buy precooked dishes from well-known restaurants to make sure that the food served will taste good, but specially to ensure that they can focus on their guests.

"[hiring a private chef with guests] we didn't want to spend time cooking. We wanted to be with the people who came and enjoy it. H3.02"

"Being served at home [private catering] makes you forget about preparing everything, you can enjoy the meal without worries and feel special at your own house. H6.02"

"[when having guests] Sometimes we buy food if it's something more special, we can surprise them more and it's also easier for me. H1.01"

Technology

The last theme, technology, encompasses the use of appliances and electronic devices in the kitchen. Regarding the first, participants explained how they like owning a wide variety of appliances as this allows them to use different cooking techniques and explore more. Something that was shared among all the participants is the fact that they are willing to invest in high-quality products, as they want to have the best results but look for the options that ensure easy usage. Those who own a kitchen robot use it mostly in a daily basis, while the more special appliances such as steam ovens or *teppanyaki* grills are used in meals where more effort is required.

"The robot [Thermomix] is fantastic. You can do what you want, fast, easy and simple. H3.01"

Using electronic devices for entertainment purposes was mentioned by three participants, nevertheless, since it is a minority sub-theme, it is not considered to have a main role in the kitchen.

"[while cooking] With television I can be watching the news or listening to music, it's a distraction and relaxing. H4.02"

Waiter serving food in a private lunch.
Provided by H6

DESIGN GOAL

The user study, together with the conclusions fom the literature review have made it possible to delineate a design goal and its requirements, which sets the ground for the future ideation phase

Contents

5

SPECULATING THE DESIGN GOAL

Design goal

The insights concluded from user research have made it possible to define the Design Goal; **Gaggenau's users should feel like Home Chefs when cooking special meals in their kitchens**. The aim behind it is breaking with the current trends in HFI, and shift to enhancing the pleasures of cooking through a celebratory approach. The Design Goal focuses specifically on special meals, as it is when cooking becomes a ritual and therefore the idea of the Home Chef gains relevance.

Speculative design

A speculative approach has been followed when determining the Design Goal. By using Voro's future cones (Dunne & Raby, 2013; Montgomery & Woebken, 2016) the speculative *preferable future* has been defined. This means defining a scenario that is feasible according to laws of physics, but deflected from the projected future. According to HFI trends, the probable future awaits an increase of automation in kitchens and a reduction of users' involvement in the cooking process. However, the preferred future depicted for the project sees cooking as a pleasurable activity in specific moments, where technology is used to enhance this celebratory aspect.

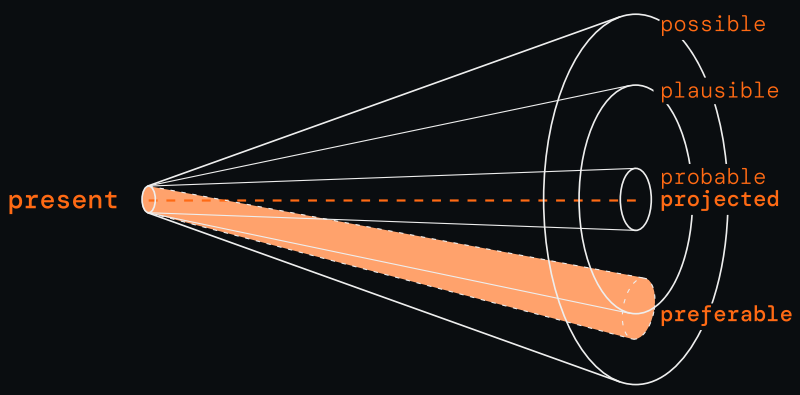


Figure 12
Voro's future cones diagram.

DESIGN VISION: METAPHOR

The metaphor of a **professional kitchen** has been used as the inspiration source to give more depth to the Design Goal. This has allowed creating a vision on how the concept should feel as well as its nature. Moreover, it has helped shape the vision of the **Home Chef** which will be dissected in this chapter.

The first idea to dissect is that professional kitchens are composed by a team, where the leader is the executive Chef, but there are many other cooks that are essential when preparing a dinner-service. In domestic kitchens, the user study has underlined the idea that there is usually one member of the household who takes the cooking role (Home Chef), and therefore they are the ones compared to professional Chefs. Regarding the team, in domestic kitchens the appliances (and occasionally other humans) are the ones that should take the role of assistants, whose performance is indispensable. The appliances should follow the Home Chef's orders, and act upon its intentions.

In order to ensure a team success, communication is critical. In this context, the Chef interacts with the rest of the team, but also the members cooperate with each-other. Hence, in the domestic kitchen this sense of team should be present, the diverse appliances should form a network and collaborate according the Home Chef's orders.

Thirdly, the cooking team is the Chef's support team who ensure its will, and help, guaranteeing that even when the Chef is not fully involved, the result will match its expectations. The same should happen in domestic kitchens, where appliances should act as the support team of the Home Chef, who should be able to multi-task without jeopardizing the cooking process.

The concept should evoke feelings of **collaboration**, **leadership**, **trust**, **precision** and **enjoyment**.

Figure 13
Future metaphor illustration.

THE HOME CHEF

The idea of the Home Chef reflects a personal vision constructed as a result of an inspiration process that helped to understand the implications from the figure of a professional Chef. The inspiration process has been grounded by analyzing various sources such as interviews with Michelin-awarded chefs, the book of the renowned restaurant Sublimotion (Roncero, 2020), as well as the documentary "El Bulli's footprints" (de la Cuesta, 2021) and the Netflix serie's Chef's Table (Gelb, 2015). According to these sources, pleasing and surprising dining guests is the ultimate purpose of a chef, who gains self-validation and pride when this is achieved. This highlights the positive aspect of conceiving food as a gift. Regarding what distinguishes a chef, three main attributes have been ascertained: creativity, knowledge of the culinary world and sense of control. At the end, a (Home) Chef is the leader of the kitchen, who controls all the processes involved to provide a perfect dining experience, and this is possible thanks to experience, knowledge and applying creative thinking.

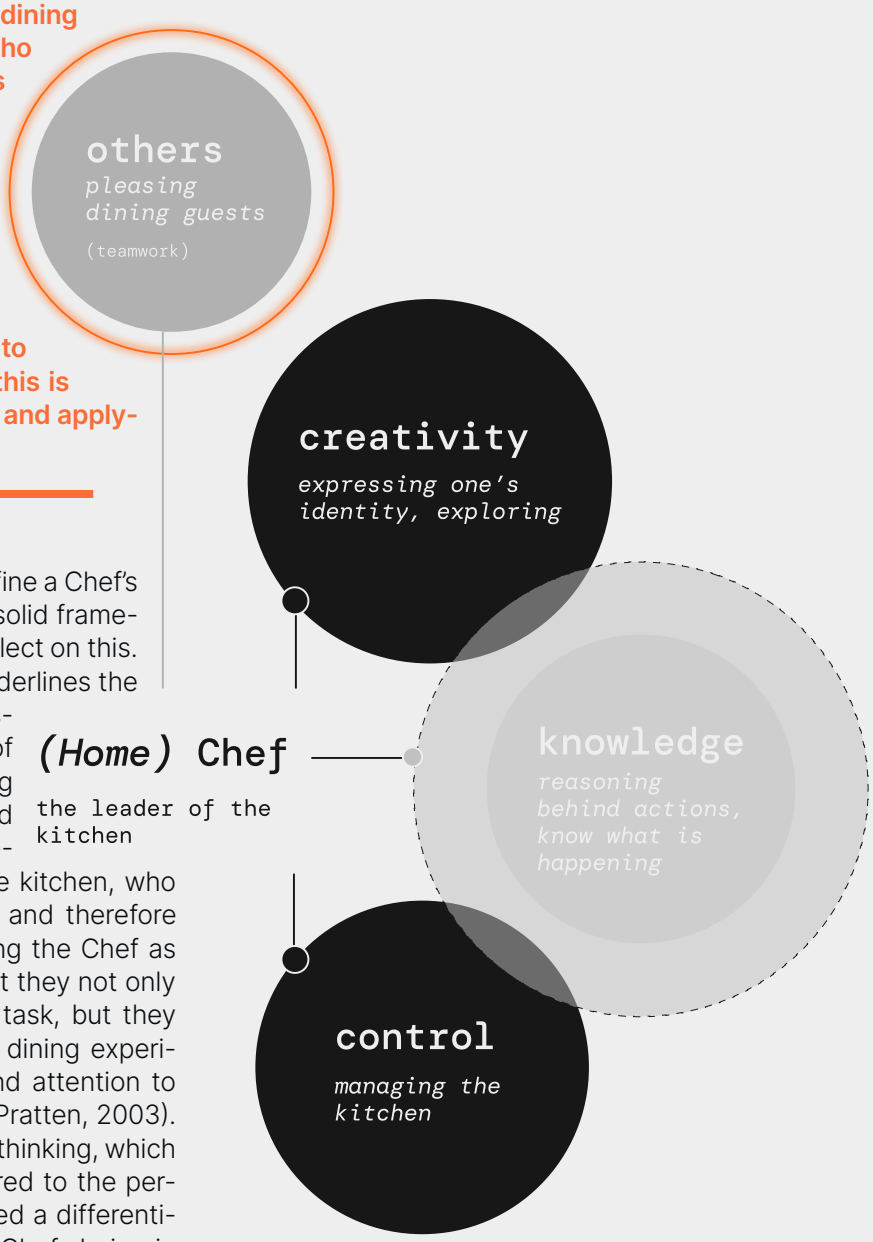


Figure 14
Diagram of the *(home)* chef attributes.

Although there is not an objective way to define a Chef's competencies, and therefore there is not a solid framework on this, there are a few authors that reflect on this. The study carried out by Zopiatis (2010) underlines the most important competences of a successful Chef in the following order: knowledge of culinary flavors, managerial skills (organizing and supervising), decision making skills and cost management. These competencies reflect the role of a Chef as the leader of the kitchen, who needs to supervise the overall functioning and therefore have good communication skills. Considering the Chef as the kitchen manager reinforces the idea that they not only cook, actually this might no be their main task, but they have the responsibility to provide the best dining experience to their guests. For this, discipline and attention to detail are essential (McBride & Flore, 2019; Pratten, 2003). A recurrent topic on the literature is creative thinking, which although perceived as less relevant compared to the personal vision described above, it is considered a differentiating characteristic of Chefs. The notion of Chefs being in constant evolution and seek for innovation is shared among authors, having culinary knowledge is what allows it, as well as being what enhances guests trust in them (McBride & Flore, 2019). Finally, there is the notion that what makes a good Chef is the capacity to cook from flavors and not recipes, using its intuition to create new combinations and surprise whoever eats that dish (Pratten, 2003).

Knowledge

Knowledge is the bridging concept that makes creative thinking and sense of control possible. Flavor (ingredients functionality, recipe development...) and techniques (cooking skills, food presentation skills, use of appliances...) comprise the culinary knowledge that a Home Chef should have in order to run a kitchen and organize the overall cooking process (Birdir & Pearson, 2000). This is especially necessary when defining how and why things should be done, having in mind how the elaborations should taste and look. However, it is important also during the ongoing actions, so the Home Chef can readdress the process if needed, for instance if an ingredient is missing or the recipe should be modified.

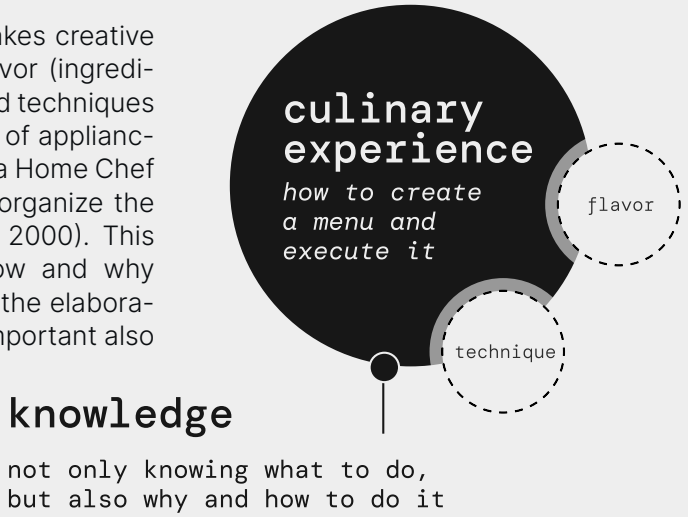


Figure 15
Chef's knowledge diagram.

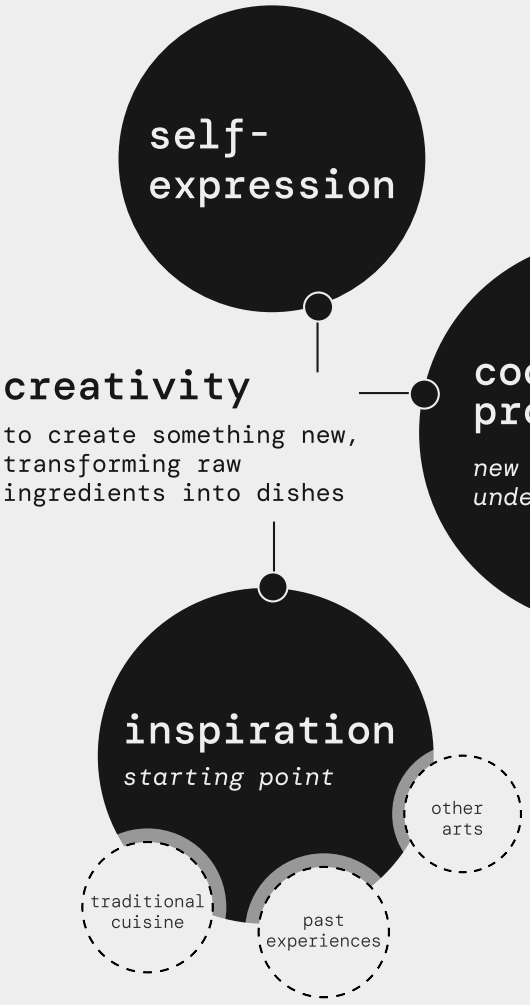


Figure 16
Chef's creativity diagram.

Creativity

Creativity can be understood as the act of creating something new, which in the culinary context applies transforming raw ingredients into a dish presented to dining guests. On one hand, there is the belief that creativity has to do with radically transforming how ingredients are used, cooking techniques, food presentation or even the dining experience (Horng & Hu, 2008; Page, 2017). Nevertheless, another conception argues that creativity is nothing more than refining and improving traditional cuisine, and for this, experience and knowledge are required (Lin & Baum, 2016). Authors and professional Chefs believe that creativity is a way to express one's personal style and ideas, and the fact that past experiences and other sources of inspiration are used to trigger creativity in this context are a clear example of this (Horng & Hu, 2008). According to Page (2017) it is through our outer senses that we perceive the world around us, but we can enhance our creativity by making use of our inner senses (instinct, intuition, insight imagination and inspiration) to perceive our inner world and express our desires and likings. A final concept to have in mind, is that the environment in which one is cooking can influence creative thinking, and this also applies the social context (Lin & Baum, 2016).

Control

Home Chefs lead their kitchen, which means that they have the responsibility to control everything that takes place in there (Zopiatis, 2010). While the formal definition of control focuses on one's position of making the decisions, in a kitchen it has further connotations. Being a chef implies multi-tasking and not only focusing on cooking, but according to the personal vision of a Chef, there are three moments throughout the cooking process where the involvement needs to be direct in order to ensure the sense of control. First, when defining the menu as the food served is the essence of the experience and therefore it should be stablished according the Chef's vision. Second, coordinating and supervising all the members of the team. Meaning that a Chef should be able to delegate tasks and be aware of what is happening in every moment, the Chef's orders are followed by everyone. Third, the dining experience for the guests should be ran by the Chef, who guarantees the perfect result. This enhances the Chef's pride and positive feelings by pleasing the diners.

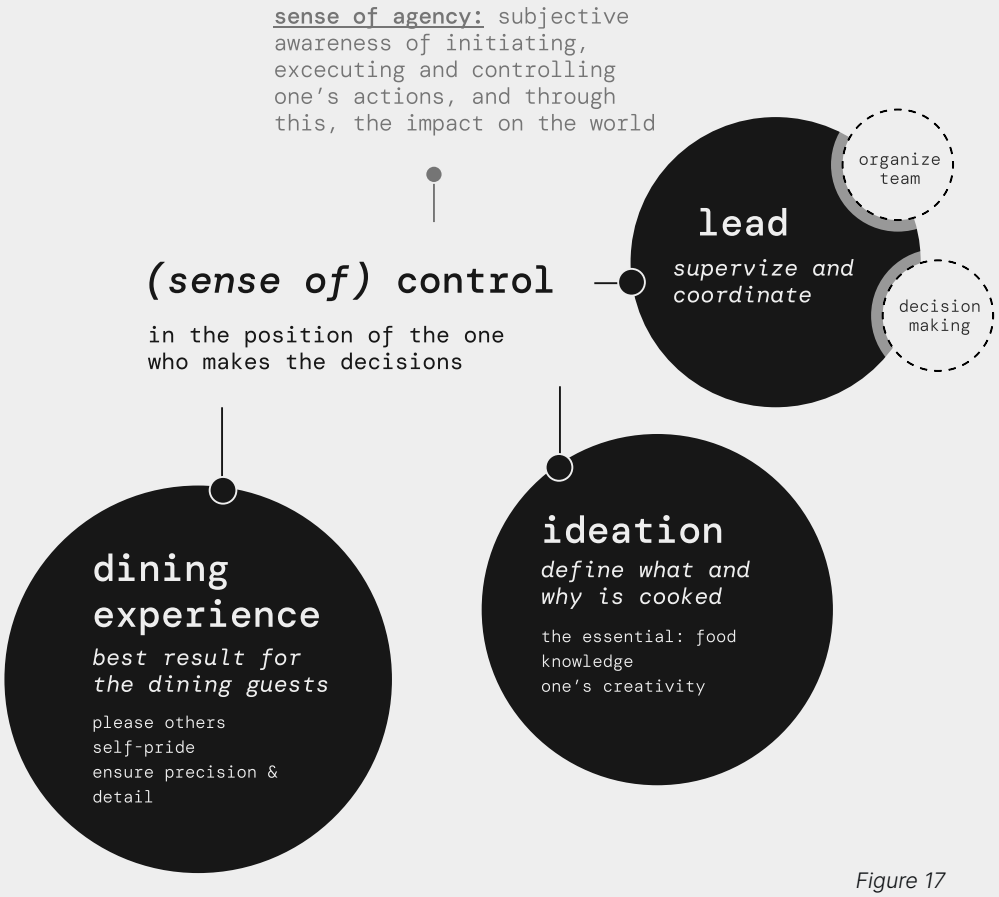


Figure 17
Chef's sense of control diagram.

DESIGN REQUIREMENTS
ACCORDING THE CONTEXT AND USER NEEDS

The following design requirements have been stipulated according the results from the user research which emphasized the nature of the context and the user group needs, desires and lifestyle. Moreover, these have been combined with the Design Goal presented in the previous section.

1
PRACTICAL AND EASY TO USE
Moving around the kitchen and interacting with the products in it should be intuitive and practical.

2
ALLOW DIFFERENT USE-MODES
The kitchen is used differently depending on the occasion, therefore the space and its autonomy should be adapted to users' needs in each situation

3
GUARANTEE THE PERFECT RESULT
A Home Chef should cook with precision and detail, the kitchen should support this and ensure the quality of the result.

4
ENHANCE CREATIVITY
Creativity is one of the main attributes of a chef, therefore the concept should encourage and stimulate it to make the users feels like a Home Chef.

5
SENSE OF CONTROL
A Home Chef should be in control of its kitchen, therefore regardless of the autonomy level of the agents, users should feel in control.

6
ACCESSIBLE KNOWLEDGE
Knowledge about what is happening in the kitchen as well as what steps to carry out should be available for the Home Chef in order to make decisions.

7
SUPPORT MULTI-TASKING
The kitchen should enable multi-tasking without compromising the result, specially socializing with others as it is the heart of the house.

8
SURPRISE OTHERS, AND ONESELF
Serving food to others and pleasing them is considered one of the main pleasures of cooking, this should be embraced. Moreover, the Home Chef should also experience this.

IMPLICATIONS FOR THE PROJECT

The Design Requirements exposed in this section will be considered during the final concept's design process. While the Design Guidelines provide a baseline for the general concept, these requirements can be used to make decisions regarding specific details from features and functionalities. They would also serve as a good starting point to define usability aspects, but in this project this aspect is aproached in a general way as it is not part of the scope.

INSPIRATION & IDEATION

The different activities and ideas employed to set the ground for the concept definition can be found in this chapter. It starts with the defintion of Design Directions and concludes with the ideation process.

Contents

6

DESIGN DIRECTIONS

Defining the main design directions has allowed setting a stage for the ideation phase, using these directions as inspiration and areas to exlore. The directions have been based in the findings from the research phase, and analyzing the cooking process and the opportunities for enhancement (see Appendix E). Moreover, the introduction of the two theoretical perspectives, EI and autonomy, has also been considered a design direction.
The intention is to combine all four directions and design a concept that conveys their most relevant aspects.

Grant Achatz and a co-chef plating a dessert in Chhef's Table.
Source: Netflix

AUTONOMY LEVEL

This directions explores the autonomous behaviour of the kitchen focused on providing the **needed knowledge**, **triggering creative thinking** and guaranteeing **precision and detail**. However, the idea is to allow regulating the **kitchen's role on decision-making** (autonomy level) regarding this topics.

Allow multi-tasking (i.e. socializing)
Delegating
Home Chef is in control always

CREATIVITY

The idea behind this direction is that Gaggenau users' creativity should be triggered when cooking in their kitchens as a way to **own the recipe**, encourage **self-expression** and **exploring**. The aim is to introduce **creative opportunities** throughout the whole cooking process, from ideation to serving.

Refine and combine existing recipes
Try out new combinations
Surprise
Find inspiration

EMBODIED INTERACTIONS

The approach to EI in this design direction focuses on using the body to **sense the cooking process**, trigger intuition and support **making informed decisions**.

Learning by doing
Sense-making
Richness of actions
Pleasures of coking

KNOWLEDGE

As culinary knowledge is essential for a Chef to succeed, this direction focuses on making this **information accessible** by displaying it **non-intrusively**, in a way that supports the Home Chef's **decision-making process**.

Flavor and technique
Doneness
Steps
Organization

Paco Roncero and Grant Achatz are two clear examples of how succeeding in the kitchen requires creativity that comes from their expertise. Moreover, Roncero and Achatz are referents of how using senses when cooking and eating helps achieving better results.

Paco Roncero testing one of his creations in his kitchen-lab.
Source: El País

Inspiration process

Prior to starting the ideation process, different inspiration activities were carried out to gather insights on potential functionalities and relevant touchpoints between the agent (kitchen) and humans (Home Chef). The first activity was an inspiration workshop — with 5 cooking enthusiasts — that aimed to ascertain their different perspectives about personal creativity in the kitchen, as well as the possible benefits of having a smart system helping on that (see Appendix F.1). Secondly, Gaggenau's showroom in Amsterdam was visited to participate in a cooking demonstration carried out by a professional chef (see Appendix F.2). This activity allowed observing in context how professional chefs cook and use their senses to make decisions throughout the process. Later, interviews were conducted with the chef that cooked at Gaggenau's showcooking and a chef from the Michelin-starred restaurant Cocina Hermanos Torres, for the purpose of understanding better their viewpoint regarding creativity and inspiration in the kitchen. Finally, several recipes were analysed in order to see how a smart agent could intervene in triggering creative decisions as well as guaranteeing the optimal result with precision and detail (see Appendix F.3).

Gaggenau's chef during a showcooking.
Source: own image

DEFINING THE *SOUS* CHEF

The metaphor employed for the design vision was retrieved to develop further the project's concept. Initially, the essence of the professional Chef was translated to domestic environments with the Home Chef idea — knowledge, creativity and control. Despite well known Chefs such as René Redzepi (*Noma*), Dabiz Muñoz (*DiverXO*) or Dominque Crenn (*Atelier Crenn*) are the visible faces of their restaurants, there is a team who makes possible serving the amazing meals to diner guests.

Professional kitchens are organised hierarchically being the *Executif* Chef the leader ("Chef roles in a modern kitchen," n.d.). Although the rest or roles might vary depending on the restaurant, the following positions tend to be the basic ones. The second in-command is the *Sous* Chef who is an intermediary between the *Executif* Chef and the diverse cooks in lower ranks. The *Sous* Chef is also responsible for the smooth running of the kitchen and takes on the leading role in the absence of the team "leader". Below, there are all the Chefs *de partie* who are in charge of specific areas or types of preparations such as *rotissier*, *saucier*, butcher, *entremetier* or *patissier*.

In domestic kitchens there is also an existing hierarchy, although it is composed by fewer levels. When setting the Design Goal (see page 54), the comparison between the *Executif* Chef and the Home Chef was already established. Home Chefs are the leaders of their own (domestic) kitchens. At home, appliances could be seen as Chefs *de partie*, who instead of focusing on a specific area or type of preparation, have their own functionality. For example, the fridge is responsible for keeping ingredients cold while the cooktop heats up pans and pots. In this case, each appliance is responsible for the preparations carried out with it, but they form a "team", and the combination of their specific "skills" enables the Home Chef to prepare a meal. **In domestic kitchens the role of the Sous Chef is lacking, and this projects aims to introduce this figure by designing a smart agent — central hub — that supports the Home Chef when preparing special meal.**

Clare Smyth at Core's kitchen with her team.
Source: Eater

Home Chef with its team of appliances.
Source: applianceretailer.com

THE ROLE OF THE *SOUS* CHEF (OR AGENT)

According "Chef roles in a modern kitchen" (n.d.)and Gelb (2015) the following responsabilities fall on a *Sous* Chef:

- Take the leading position in the absence of the *Executif* Chef
- Assist the *Executif* Chef throughout the process
- Guarantee that the food served to the guests has the best level of quality
- Assist in plating
- Collaborate with the *Executif* Chef when exploring new recipes

Translating the role of the Sous-Chef in domestic environments has been done by exploring the wide range of possible touchpoints among the collaboration. As a result, the following are the responsibilities of the system:

f.1 **Provide culinary knowledge of the cooking process:** This means that the system should support the Home Chef being informed throughout the process about the doneness of the ingredients, to make decisions based on one's culinary preferences, and personal experience. In this case the system operates as the intermediary between the appliances — or Chefs *de partie* — and the Home Chef.

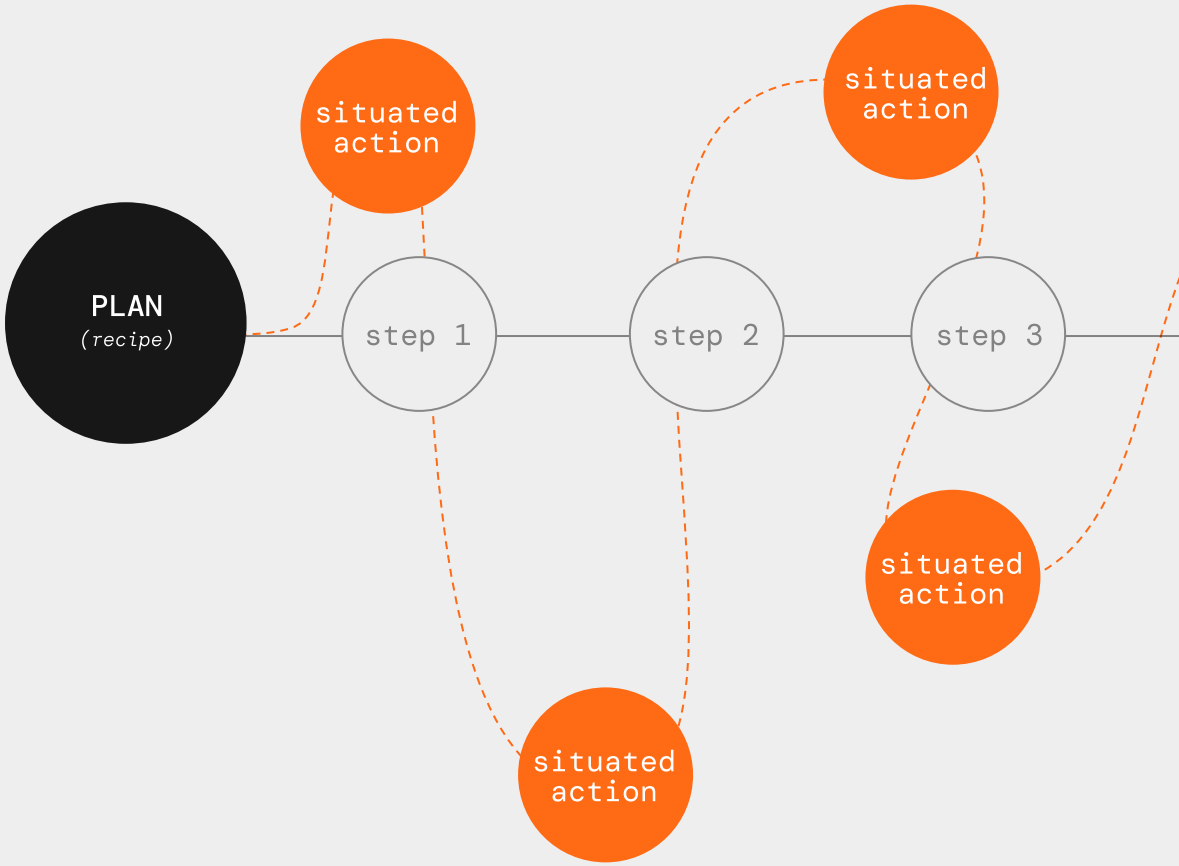
f.2 **Trigger creativity:** To celebrate cooking, the system will enhance users' creativity throughout the different stages of the process in a way that leaves room to individual explorations by means of broad suggestions. As in real life, *Sous* Chefs are involved in the ideation of recipes, helping the *Executif* Chef explore new directions.

f.3 **Guarantee the best result:** This involves notifying the user in case the end-result is threatened as well as providing insight to help the Home Chef cook more precisely. *Sous* Chefs take upon the leading role when needed, but also help in supervising the cooking process in order to serve the best meal to dinner guests.

PLAN AND SITUATED ACTIONS

Plan
Defining the *plan* implies setting a desired goal according one's preconceptions. In other words, it means defining the steps and actions that need to be carried out from the initial state to arrive to the desired outcome or solution. However, according to Lucy Schuman (Suchman, 2006), in real life the *plan* only points out and orients actions towards the aimed direction, as the events of the unpredictable environment can effect the smaller steps of the general *plan*.

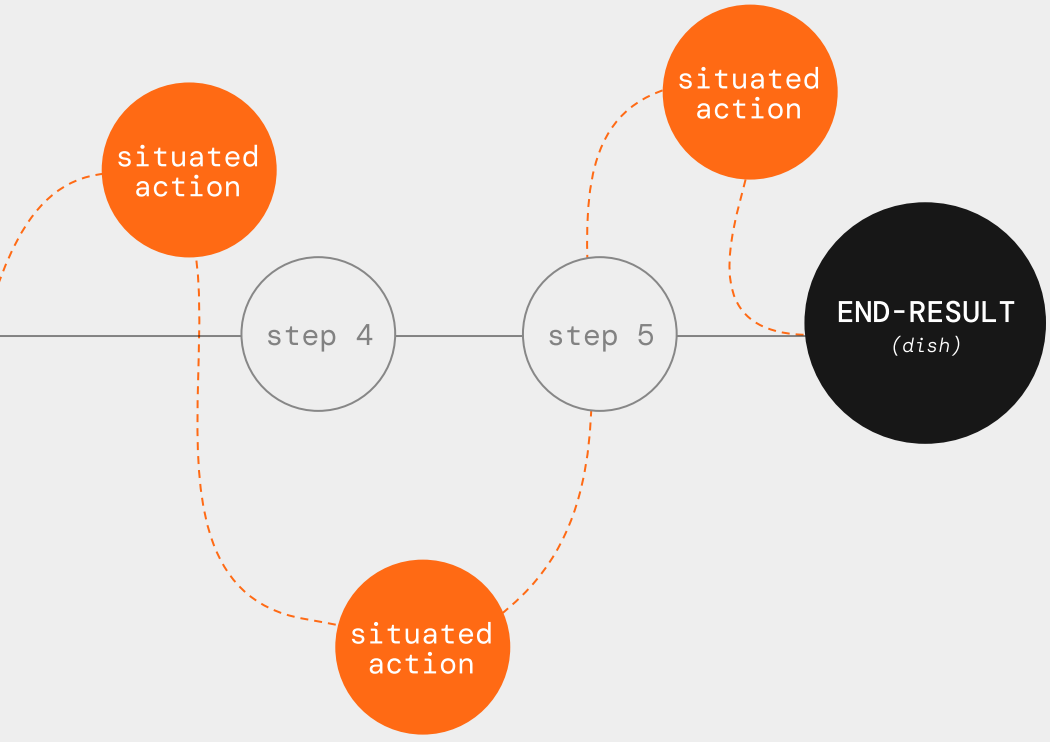
Situated actions
Situated actions are those that take place as a cognitive reaction to the events of the unpredictable environment when executing a plan. In other words, responding to unexpected circumstances implies leaving the initial plan and using the embodied skills that one has, and these are *situated actions* (Baurley, Petreca, Selinas, Selby, & Flintham, 2020; Suchman, 2006). The idea behind situated actions is that we can not plan and know the different possibilities and setbacks that might occur in a certain situation until we are involved in it.



In the kitchen context, the *plan* is the dish or recipe that has been selected to be cooked (Figure 18). The initial recipe is the goal aimed for, nonetheless, while executing it, the predefined steps might need modifications and improvising - *situated actions* - as cooking depends on many unpredictable factors. Obvious examples are for instance having to replace an ingredient or utensil that is not available. However, ingredients' temperatures, origin, environmental conditions or type of appliance owned, can lead to results that differ from the original recipe. It is here where the Home Chef will need to be creative and use its culinary knowledge to react and achieve the best result.

Another way to see the difference between plan and situated actions in the kitchen is the fact that cooks always add their personal preferences when following a recipe, slightly modifying the result. While a recipe is the plan that contains the explicit culinary knowledge, it is impossible to capture in there the embodied knowledge that conveys how one's preferences are achieved while cooking (i.e. how salty or spicy one likes food, the preferred doneness of a certain ingredient or how finely chopped one wants their steak tartar). All these small decisions are also *situated actions* (Baurley et al., 2020).

By introducing the figure of an autonomous or smart Sous Chef the aim is to support the Home Chef in the above mentioned situated actions. While the Home Chef has the role of deciding the plan or in other words, the menu, the Sous Chef will assist in sensing the process. Nevertheless the approach is celebratory, meaning that instead of acting from a perspective of solving uncertainty, it will provide culinary knowledge that encourages the Home Chef to explore and be creative.



In the diagram it can be seen how the situated actions deviate from the initial plan. All these actions can be carried out by employing embodied knowledge that can not be captured in recipes according to the chefs interviewed on the inspiration activities.

Figure 18
Diagram of the plan and situated actions in the kitchen.

THE PARTNERSHIP

The team formed by the Home Chef and the smart agent can be considered a HAC when analysed from the perspective of autonomous agents theory. Consequently, prior to defining the details of the concept it is important to establish the terms of this partnership by dissecting each party's role and the tasks' distribution.

Human (Home Chef)

According to the Design Goal, the Home Chef is the leader of the kitchen and therefore is the one who has the ultimate control over all the preparations taking place in this space. Hence, the role of the human is **coordinating and controlling the cooking process**, and most importantly, carrying out all the steps from the **cooking** process, from ideation, cooking and serving the dishes.

Agent

The agent's role is basically to **support the Home Chef** achieving the best result by guaranteeing precision and detail, as well as triggering the human's creativity.

For each of these roles several tasks are assigned. On the human's side there are mainly the tasks associated with making personal decisions while the agent's tasks focus on helping humans perform their functions by extending their capacities. The following diagram illustrates the distribution of tasks for each side of the partnership and how these are connected to each other (see Figure 19).

Establishing a shared-intention is crucial to guarantee the success of the partnership. In this context, the shared-intention or joint-end is the dish that the Home Chef has decided to cook. Despite being determined by the human, it is necessary that the agent has a clear understanding of it. Thusly, it can be said that the agent mediates according to the human's intention. Besides the shared-intention, both entities from the partnership have their own individual intentions which do not have to be the same. Regarding the user, it can slightly vary depending on the occasion, but it can be said that the intention when cooking is to create a dish to please and surprise the dining guests. On the other hand, the individual intention of the agent is to track the preparations to obtain the best result possible both from a creative and technical perspective.

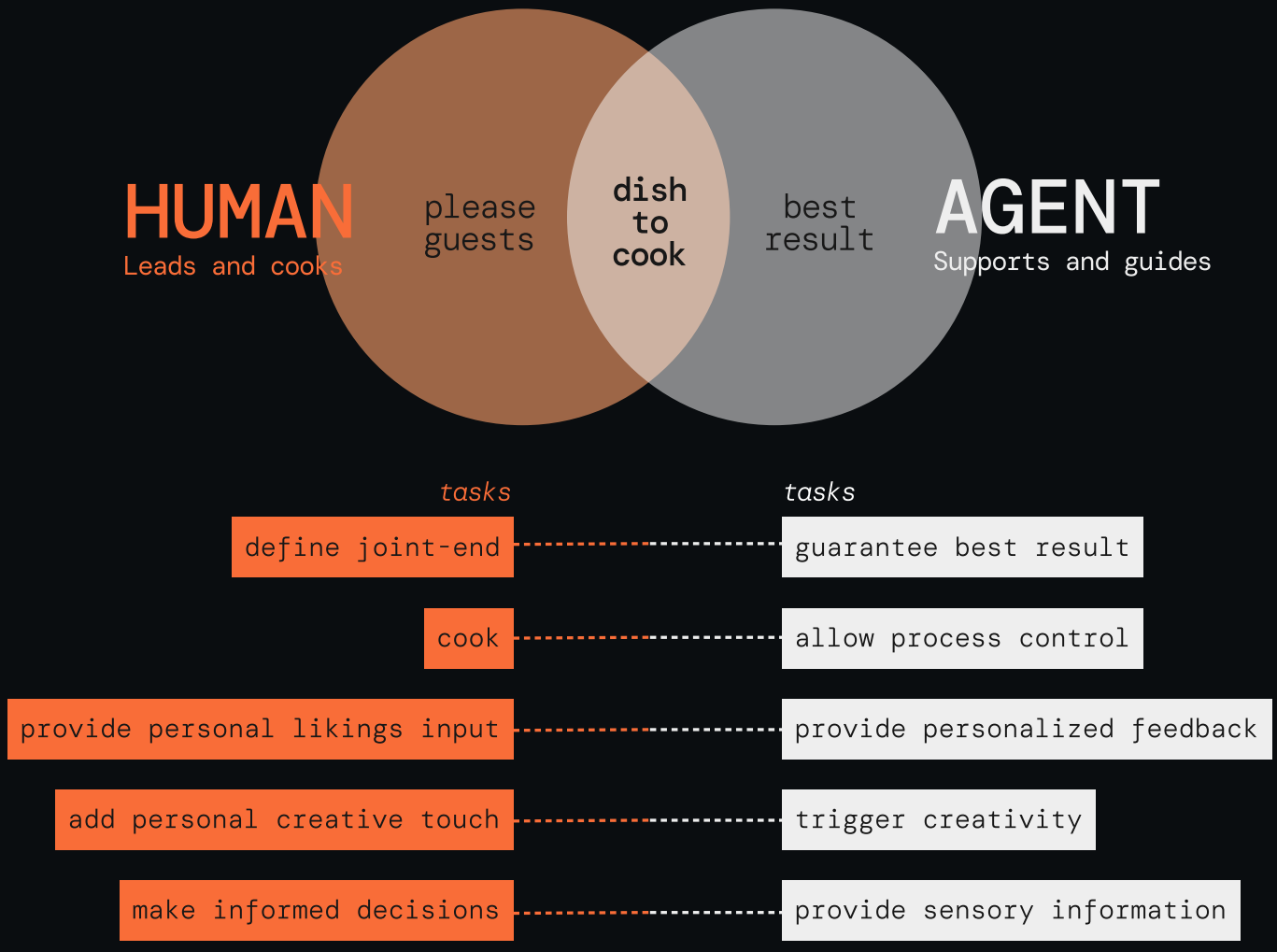


Figure 19
Human-Agent Collaboration applied to the project.

THE SPECULATED FUTURE

As it has been previously stated, this project explores the future context of domestic kitchens from a speculative approach. While a celebratory perspective has been defined for the preferable future (Dunne & Raby, 2013), to develop the concept some of the ideas comprised in a more corrective projected future have also been considered (see Figure 20). The reasoning behind this decision is the fact that in order to have a domestic kitchen that fulfils the user's needs and desires in its totality, both the rational and ritual side need to be combined as explained in the first section (see page 34). In other words, this project aims to build on the rational kitchen by designing a ritual intervention.

In consonance with the current trends and new developments that Gaggenau and other domestic appliances providers are pursuing, a future scenario has been defined to set the stage for the concept.

The defined scenario revolves around technological advances that illustrate the projected future for domestic kitchens. The main idea behing the considered innovations is that **appliances will be more smart** and part of a network of connected everyday objects. This makes possible to design a concept like Sous (see Chapter 7) as its functioning is based on some of the technolgies described in this section.

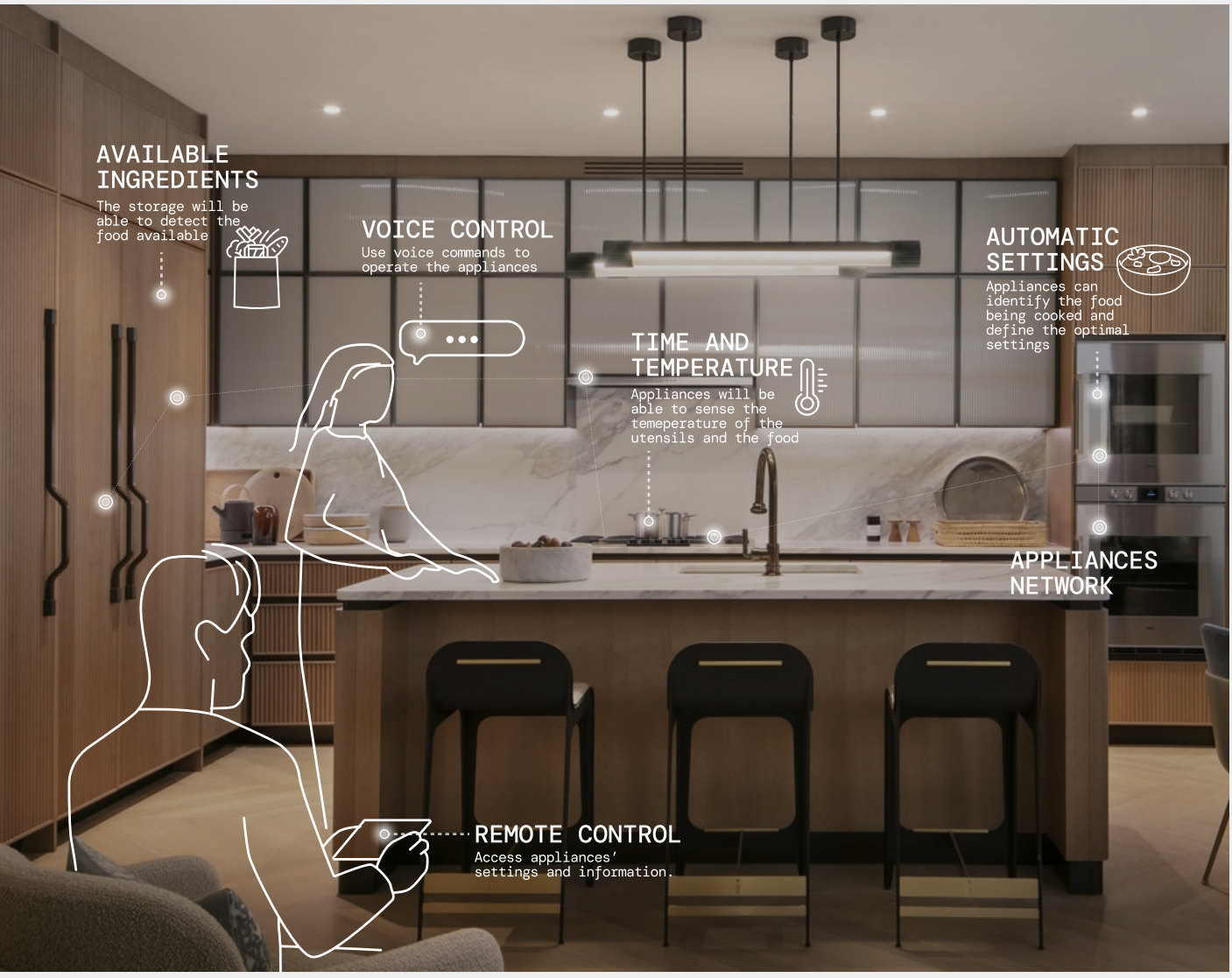


Figure 20 Speculated future scenario infrographic.

New ways of controlling appliances

Making appliances smarter is closely associated to making them controllable remotely, as it is currently done with the BSH Group app Home Connect ("Home Connect app," 2021). This means that in the future, remote control will be even more inherent in kitchen appliances. Another feature that is slowly gaining relevance is the possibility to operate domestic appliances by voice, either directly interacting with them or through third party products such as Siri or Alexa. Again, this is something that Gaggenau is already exploring in the present, as the 400 series oven offers the possibility to open-close its door via voice commands through Alexa. Hence, it is likely that in the future users will be more used to and comfortable with using this these type of interactions.

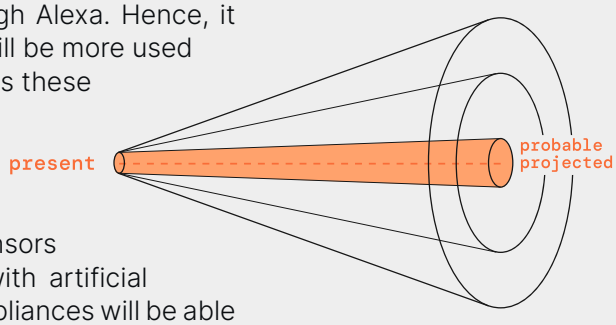


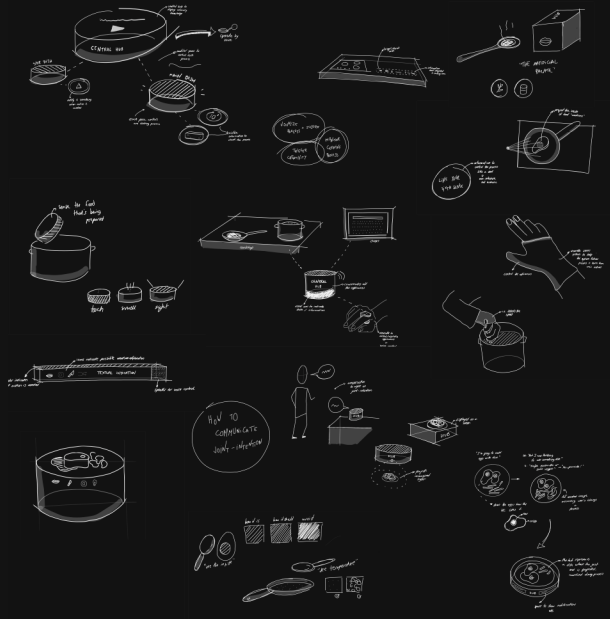
Figure 21
Voro's proejcted future cone.

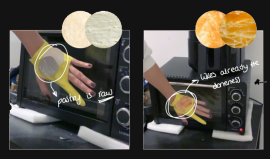
Better capacities to sense the environment

Thanks to the introduction of sensors and computer vision together with artificial intelligence, domestic kitchen appliances will be able to sense and interpret new aspects of the environment, as well as being more precise. The following examples illustrate the future. The future kitchen will know which ingredients are available as well as what can be done with these according the appliances owned (Sakthisudhan, Mohanraj, & Sundararajan, 2019; Samsung, 2021). Furthermore, it can be assumed that computer vision technologies used currently in smart fridges will be implemented in other appliances, hence these will be able to identify what is being cooked in them, and consequently adjust the settings for an optimal result. Something already being explored in Gaggenau oven's. Lastly, adding new sensors means expanding the variables that can be sensed. Temperature (from the appliances, utensils and food) is one of the variables to assume that in the future will be easier to detect, something that is remarkably helpful to determine ingredient's doneness (Breville, 2019; Hestan, 2017).

CREATIVE PROCESS

The aim of this project has been, since the beginning, designing a new concept for the future of domestic kitchens where autonomy and embodied interactions are introduced to bring to light the ritual side of cooking. This section shows an overview of the different design activities executed to get to the above-mentioned concept. The activities have been addressed with the aim of finding a balance between designing in a conceptual level and defining certain elements in a rather tangible perspective. To find the right balance the decision was the following; the overall idea should be conceptual and ritual, while the specific interactions with the agent should be specified and designed in more detail.
In the next chapter, Concept Design, these two levels of design will be dissected in more detail.





EXPLORATION

0 ***goal.*** translate abstract ideas to tangible interactions.

0 ***method.*** *brainstorming* and *drawstorming* sessions.

0 ***insights.*** focus on a wearable to let the user always be informed, plus a central hub.

1st ITERATION

1 ***goal.*** validate the main concept by focusing on the communication aspects, validate the information shown and if the system is capable of triggering creativity and helping the user be in control and stay informed.

1 ***method.*** functionalities ideation session / user test with storytelling and a low-fidelity (lo-fi) prototype.

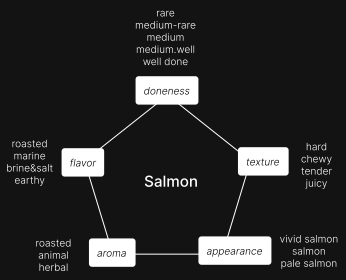
1 ***insights.*** the idea of the wearable is well received. People like the idea of using sensory information but it should be easy to understand. Having a central hub + a wearable might not be needed, they are not really cooperating.

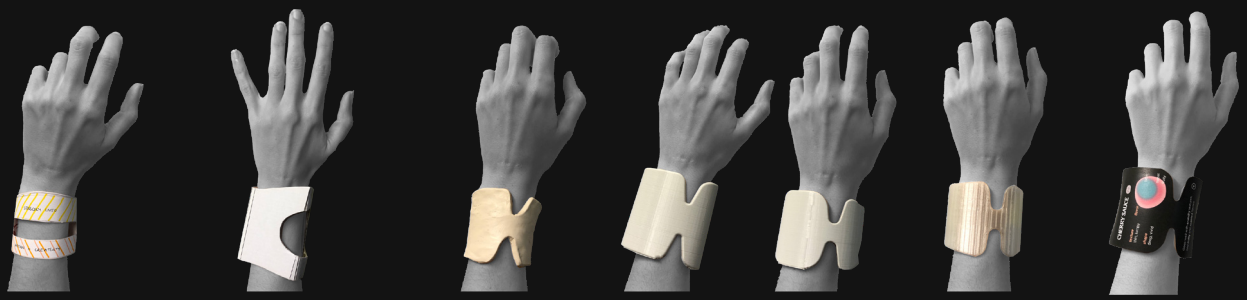
goal. Aspects or questions to answer and explore

method. Design activities

insight. Conclusions and results

The creative process started with a brief ideation process using the method of *drawstorming* where different concepts were explored. This phase ended when choosing a wearable as the tool to allow the Home Chef to be informed and to control the process, with the wearable being the interface through which the system communicates. The ideation was followed by an iteration process with three cycles, each of them including a wider range of functionalities until the final concept was reached. Each of these iterations involved ideation, quick prototyping and evaluating the ideas either by testing it with participants or by analysing its characteristics according the design requirements (see page 59) and rules for designing autonomous agents with EI (see page 35). The third iteration's result corresponds to the concept presented in the following chapter. Its evaluation will be described in further detail later in the report.





2nd ITERATION

2 **goal.** test better the comfort of using a wearable as the main touch-point with the agent and validate the sensory information approach.

2 **method.** shape&usability tests using lo-fi prototypes (handmade) / UI wireframes for user testing.

2 **insights.** the sensory information is much helpful now as it helps inspire people, but there should also be basic information and guidance throughout the process for the best result. Visuals should accompany the information to make it easier to understand and process.

3rd ITERATION

3 **goal.** refining the shape, the visual information and the interactions with the wearable.

3 **method.** lo-fi prototypes (3D printed) / haptic user test with lo-fi prototype / visual information user test with digital prototypes.

FIRST ITERATION

The starting point for the first iteration was the idea of using a wearable to help Home Chefs increase their awareness when cooking, and a connected central hub to provide further information about the dish being prepared: time, ingredients...

Goal

- Validate the main concept by focusing on the communication aspects.
- Validate if the information shown triggers users creativity, enhances feeling in control and informed.

Method

- **Ideation session:** first step to define the potential functionalities for both the wearable and central hub, and how to connect both devices.
- **Idea evaluation:** 5 participants were explained the idea using storytelling (sketches and a storyboard), while 2 others took part in a user test where the use of the concept in context was evaluated. For the test a lo-fi prototype was made, with different prompts used to emulate the information of the system throughout the process (see Figure 22). The facilitator of the test enacted the system in regards of the voice control feature.

Conclusions

Main spects to consider for future iterations.

- People liked the idea of a wearable that helps you cook better and control cooking process. Central hub not needed, people ignored it.
- Receive suggestions to coordinate the cooking process (times, techniques...).
- Showing the complete recipe is not needed, but in some cases providing “chefs tips” could help.
- Sensory information helps making decisions, but it has to be more understandable
- Feedback from the wearable considered non-intrustive. Refine moments of intervention and frequency.
- It lacks a creative aspect or triggering inspiration.

SECOND ITERATION

The second iteration aimed to develop further the use of a wearable to enhance the experience of cooking. better the comfort of using a wearable as the main touch-point with the agent and validate the sensory information approach

Goal

- Validate the **comfort of using a wearable** as a cooking assistant
- Validate **sensory information** shown, communication aspects
- Add elements to **trigger creativity**.

Method

Instead of making one general prototype, the goal was validating individual aspects.

- **Shape:** First, inspiration was seeked by creating a visual mood-board. Secondly, sketches, paper and cardboard prototypes were been done to refine the shape and finally tried during cooking sessions to validate their usability.
- **Sensory information:** An exercise to refine the information displayed by the wearable has been executed. Leading to a shift from literal sensory information to a pentagram of sensory data to helps understand the state of an elaboration.
- **Interface:** Wireframes for the interface of the wearable have been designed and discussed with four participants to evaluate their perception about the information depicted (see Figure 23).

Conclusions

The evaluation of the different parts revealed the following conclusions.

Figure 22
Photos from the user test and the lo-fi prototype used for it.

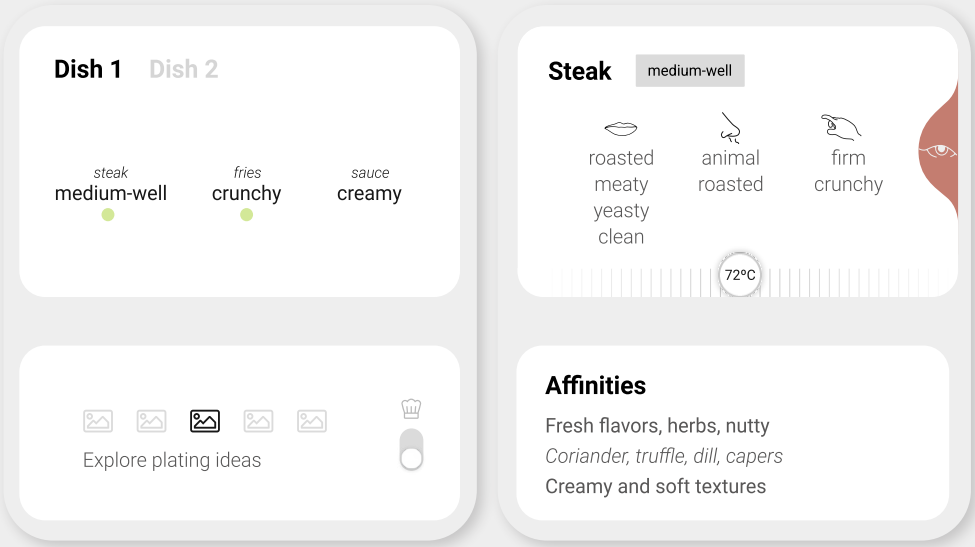


Figure 23
Wireframes used to test the concept with participants on the second iteration.

- Each sensory variable has a different evolution and impact on decision-making, it should be represented accordingly.
- People specially liked the idea of using sensory information in a new way, triggered imagination.
- Regarding the affinities, allow the option to have wider or more detailed suggestions.
- People missed having access to rational information from the preparations and appliances to more feel in control.
- Having freedom to make own decisions is positive, but people missed suggestions on optimal doneness or cooking steps.
- Having the wearable in the wrist was seen as comfortable and not interrupting the cooking process.
- A wearable guarantees easy accessibility to the information.

THIRD ITERATION

Tthe third and final iteration carried out in the project conveys all the conclusions from the previous ones and aims to refine the concept to achieve the Design Goal.

Goal

- Definine the final shape
- Design the interventions from the system and their visualization
- Define the interactions with the wearable

Method

The concept has been divided in different parts in order to refine the overall idea.

- **Shape:** Lo-fi models of the wearable (clay, 3D printing) were made to define the final shape. The goals were to have the information sections dividided by the shape, make it aesthetic yet comfortable.
- **Information shown:** Digital sketches were done to refine the sensory information in terms of categories and graphic representation. The idea of doneness was explored as the main element to trigger feeling in control.
- **Autonomy levels, settings:** Information architecture diagrams were used to explore the different modes of the system and how to adjust them manually.
- **Feedback:** In this iteration the haptic feedback has been tested by creating a lo-fi prototype with vibration motors (see Figure 24). Three participants tested it while working to evaluate the non-intrusive character of this type of interaction.

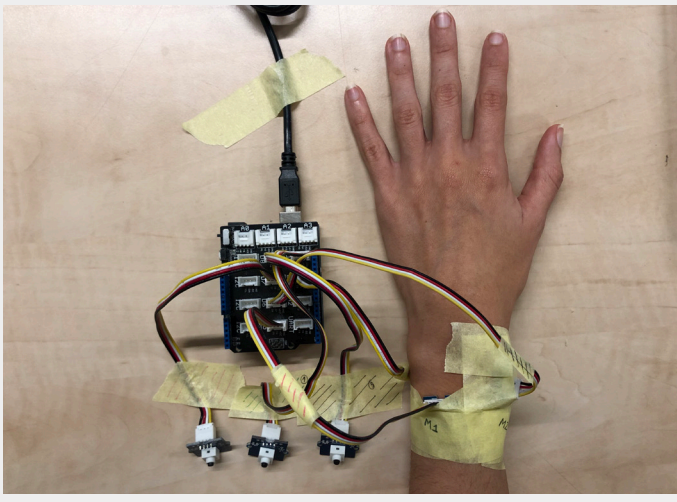


Figure 24
Lo-fi prototype made to test haptic feedback.

**Furhter details of each iteration can be found in the Appendix G.*

CONCEPT DESIGN

The “Concept Design” chapter revolves around the idea developed in this project. The following sections detail the different aspects of the concept.

Contents

7

SOUS, COOKING ASSISTANT

Sous is a cooking assistant that helps its owner to focus on the pleasures of cooking and enjoy this activity while guaranteeing the best result. Sous is a smart wearable that augments users' skills in the kitchen triggering their creativity and helping achieve the best results by displaying the needed information when cooking. It is connected to an app that contributes to a more personalized experience. It is important to highlight that despite being an autonomous agent, Sous has an assisting character, being the support in the kitchen that provides the needed culinary knowledge for the Home Chef to feel in control.Nevertheless, the ultimate decisions rests with the user.

Main functions

According to the design guidelines defined in the second chapter of the project, an autonomous agent with EI has to maximise human capacities instead of mimicking human behaviour, and it has to embed both rational and ritual sides of the kitchen, with special emphasis on the second (see page 34). These ideas have established the ground to define Sous' functionalities (see Figure 25).

Providing the cooking process' overview

This is the first functionality, executed purely from the wearable. The aim is to provide an overview of the different ongoing preparations. This is part of where the innovation lies, as instead of showing rational and numeric information the system translates this data into a comprehensible value: ingredients' doneness. By displaying this on the screen the Home Chef can make informed decisions when cooking.

Helping sense the process.

The second functionality aims to expand the user's capacities on tasting the food that is being prepared, an essential step according to professional chefs. Home Chefs are encouraged to taste the food using their inherent senses, but Sous provides a deeper level of sensorial information to bring the experience to a higher level. This makes up for the lack of culinary experience that Gaggenau's users might have. By using the wearable to sense the preparations the Home Chef can discover a deeper layer of information: how textures, flavours, and shapes are in the food being cooked, as well as exploring new food affinities.

Personalization

An essential aspect of Sous is the fact that it learns from the user's behaviors, by gathering insights on how it cooks. Also, users can provide their personal likings and experiences using the app. Making the experience more personalized by providing suggestions based on the users' preferences increases the value of the partnership.

Why a wearable

Three main reasons lead to the decision of embodying Sous in the form of a wearable. Firstly, it guarantees that user will always have the information accessible throughout the cooking process, even if multi-tasking might take place. Secondly, it is a way to provide non-intrusive feedback that can be adjusted to each situation and, if wanted, only the Home Chef will be aware of it. Finally, a more metaphorical idea is understanding that the wearable consists of the Home Chef's tool; in the same way that professional Chefs own their knifes or *kitchen-jacket*. By putting on the wearable, the user is communicating to the system the willingness to cook a special meal. Furthermore, the action of putting it on is also a way to trigger to encourage oneself feeling like a real Home Chef.

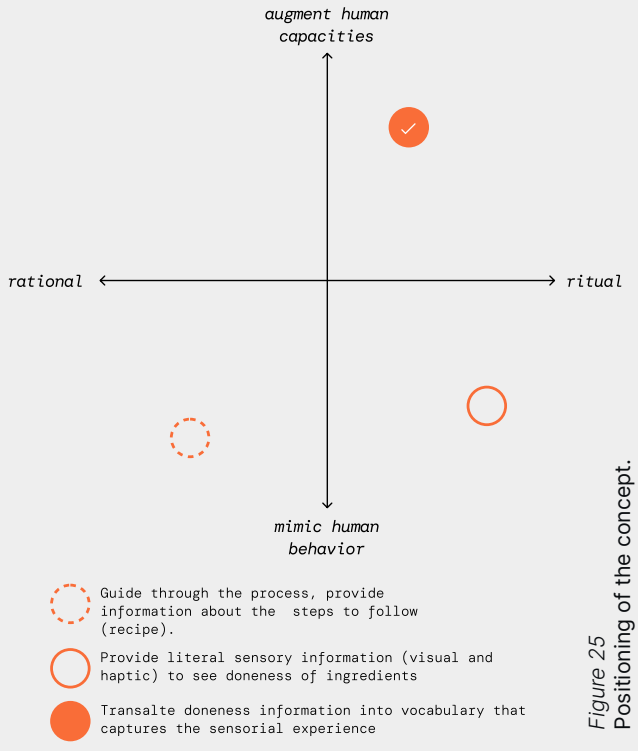


Figure 25 Positioning of the concept.

Figure 26
Sous' main parts

Cooking while reviewing sensory information on the wearable.
Background source: Pexels

SOUS'S DESING

Wearable's shape

The shape represents union. On one hand it symbolises the partnership between Sous and the Home Chef, an essential collaboration to get the best result when cooking. On the other hand, it represents the fusion of the ritual and rational sides of the kitchen. While the first one, ritual, is more predominant (bigger area of the screen), Chefs also require precision and detail (smaller area of the screen) to create amazing dishes.

More than a tool

The wearable has been designed by understanding it not only used as a tool but also as an accessory of the Home Chef's outfit. This fits the target group and its desire to stand out and show-off with the dining guests. The design makes it is easy to put it on and off, as well as being a non-intrusive object.

Serving a glass of champagne while checking the dashboard
Background source: Pexels

CHARGING DOCK

Integration in the space

A charging dock has been designed in a way that is integrated in the kitchen, as Sous is part of it as any other appliance. This is achieved by giving users the possibility to install it in their preferred position, either on the worktop or the wall. The aim is to evoke the idea that Sous is always accessible and ready to be used to support to Home Chef while cooking.

Charging dock installed on the worktop.
Background source: The Block Shop

Multi-purpose

Being part of the space involves adapting to the use of Sous. For this reason, the shape of the charging station makes it possible to place the phone when cooking. In this way, the overall experience with Sous is supported, as accessing the phone to explore the app is easier.

Light feedback

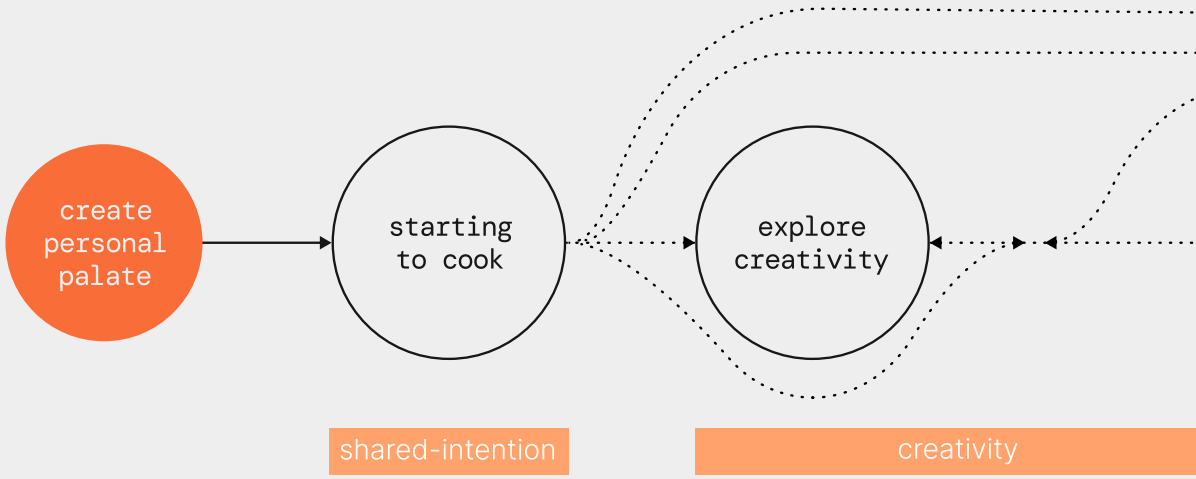
The design pretends to stick to Gaggenau's minimal style and the wearable. However, lights have been introduced to provide non-invasive feedback. The front white light indicates the charging state. While the perimeter orange light is active when the phone is on the dock and the system detects that the Home Chef can use Sous' app to know more about the cooking process.

Charging dock placed on the wall.
Background source: Espresso Design

Charging dock with the phone attached.
Background source: Architonic

USER JOURNEY

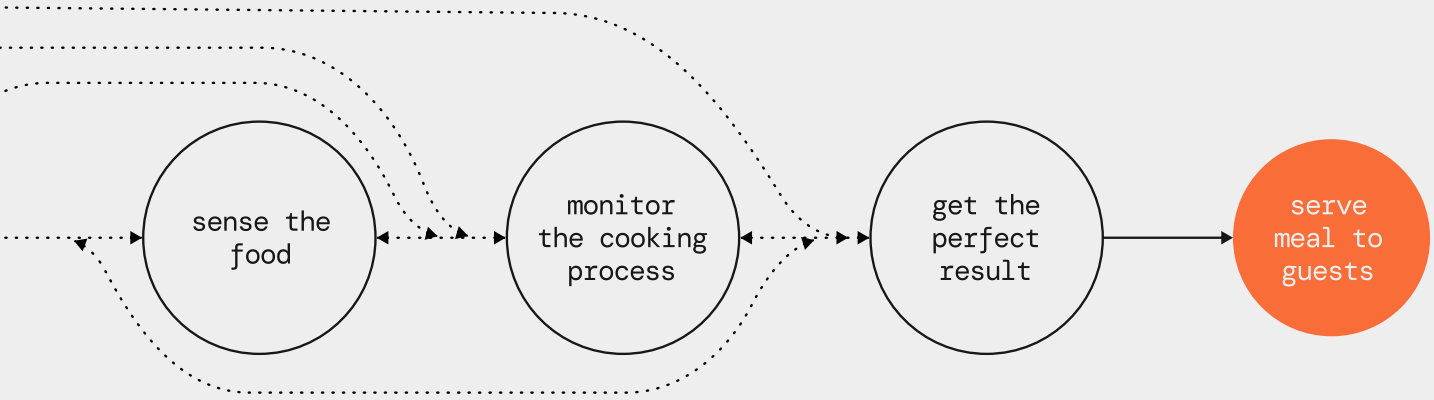
This section dissects the journey users go through when cooking with Sous. To capture the essential situations in the kitchen where Sous brings a special added value, instead of creating a journey based on the standard cooking process (ideation → procurement → preparation → cooking- > plating → serving), the journey has been defined according to the moments in which the Home Chef feelings arise (sense of control, knowledge, and creativity). The step of aligning the shared-intention has also been found relevant as it is the starting point when cooking with Sous. The journey ends with serving the meal to the guests, which conveys the ultimate goal of cooking: pleasing others.



GOAL	The cooking experience is connected to the user's life, by creating a personal palate where memories of enjoyed culinary experiences can be stored, as well as desired explorations.	In this step, the Home Chef shares with the agent the meal that will be cooked, the shared-intention. Both entities should agree and understand the end-result to collaborate throughout its preparation.	When the system identifies opportunities to add a creative personal touch, the Home Chef will be notified through the wearable. This encourages the Home Chef to explore different results.
INTERACTIONS			
HUMAN-AGENT	*take photo* *save images*	*conversation to decide shared-intention* *provide feedback when intention is understood*	*notify creative opportunity* *describe opportunity* *ask for inspiration*
HUMAN-FOOD		*prepare the ingredients* *cook using appliances and utensils*	
AGENT-FOOD	*interpret the food on the images*	*appliances know available ingredients* *appliances detect what is being cooked in them*	

Parts of the journey map

Steps. They represent the diverse situations that take place throughout the cooking process while using Sous. It is not linear, the steps can take place in a different order and times, this is just a simplification.
Home Chef: The feeling or purpose of each step.
Goal: A short description of the step.
Interactions: All the interactions that take place between the different entities in the kitchen. The visualisations below this area include the most relevant interactions, those that make the concept unique.



knowledge

feeling in control

The Home Chef can use the wearalbe to sense the preparations. This provides deeper sensorial information to understand the process and explore new directions. This does not substitute tasting the food with one's inherent senses.	The agent supports monitoring the cooking process by indicating the doneness of the different preparations. This allows the Home Chef to multi-task, either by cooking multiple preparations simultaneously or to do other activities like socializing.	As the system and the Home Chef work together to get the best result, through the wearable the user will be notified in case an action needs to be fulfilled to guarantee precision and detail.	Ultimately, the Home Chef wants to please and surprise its guests, serving a perfect meal both regarding its taste and appearance.
visualize sensorial information *indicate affinities* *use wearable to scan food* *activate sensing mode*	*visualize cooking progress (doneness)* *delegate role* *indicate autonomy level*	*notify required action* *describe action*	*provide plating inspiration*
sense food (smell, touch, try, see)			*plate the ingredients* *serve the dish*
sense odour *sense appearance*	*predict doneness*		

AGENT'S INTERVENTIONS

Being an autonomous agent, the system is able to sense the cooking progress executed by the Home Chef, process it and respond. These responses can be understood as interventions that the agent does in order to guarantee the best result in the kitchen. Designing the interventions has been done while ensuring their non-intrusive character. To be beneficial for the user, they should not interrupt any activity that the Home Chef might be undertaking. It is important to mention that the interventions described in this section are only those that come from the autonomous feedback of the agent and not the information provided when the user manually requests it.

Sous' interventions are composed by two elements. The first, when, relating to the timing of the intervention *when* cooking. The second, *how*, relating to the mode of communication.

WHEN

This category comprises the diverse situations throughout the cooking process in which the agent might intervene.

- *Required steps*: this type of intervention refers to the actions that the Home Chef has to execute to succeed in the preparation of a dish (see Required Steps in page 88). The agent will only intervene if the action has not been completed at the right time.
- *Creative opportunities*: these interventions consist of the moments when the system identifies a possibility for the Home Chef to be more creative, or in other words, to explore new outcomes for a recipe (see Creative Tips in page 88).
- *Defining appliances' settings*: only when the user manually activates the full autonomy mode, the system will be able to intervene by modifying appliance's settings in the optimal way. Although the system will be capable of doing this autonomously, the user will always be informed after the action is completed.

HOW:

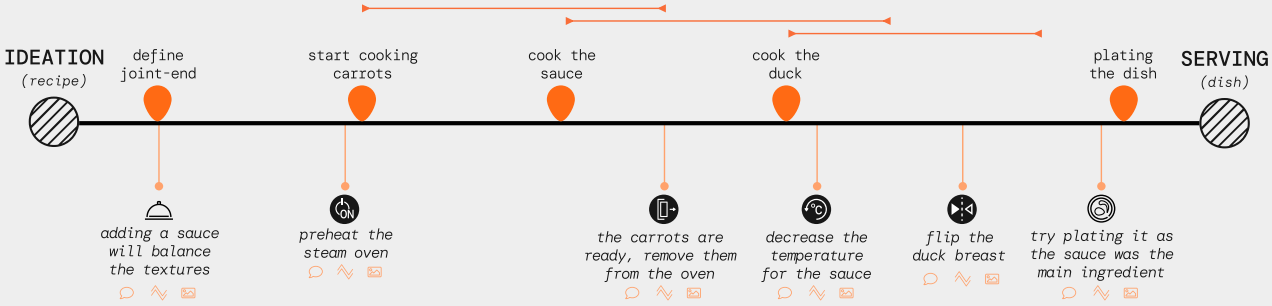
This category comprises the different types of interactions that the system employs to communicate with the user.

- Voice: Interacting with conversational agents is becoming more frequent in domestic environments, and also in the kitchen such as with the Home Connect app ("Home Connect app," 2021). The fact that users are getting more familiar with this type of human-agent interaction is what lead to introducing voice control in the concept. Among the interventions done by the agent in this way, it is important to differentiate two scenarios. On one hand, the shared-intention alignment will always be done in a conversational way, reinforcing the idea of collaboration between the agent and the Home Chef. However, when the system needs to intervene to communicate a specific action, it will do it as a basic voice command. Afterwards, only if the user wants to more information it could lead to a conversation.
  For these interventions the user can choose between three modes. *Full-voice* mode where the system will communicate every type of suggesstions. *Mid-voice* mode where only required steps will be communicated. *Silent* mode where voice interactions will be omitted.
- Haptic: Embedded in the wearable there is a vibration motor which activates each time an action is required. This is a non-intrusive type of interaction that does not interrupt any activity nor disturb if there is more people sharing the space.
- Visual: On the screen of the wearable a brief description of the intervention will always be displayed, by allowing the user to get back to it and process it. By providing a simplified explanation of the action using icons or a short text users can scan the information quickly almost without interrupting the cooking process.

The following diagrams visualize how and when the system would intervene in different recipes, voice mode and scenarios.

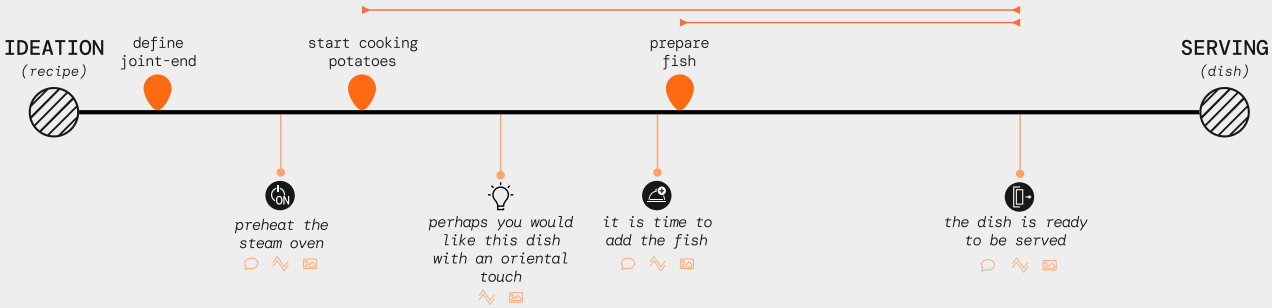
SCENARIO 1.

The recipe is duck with roasted carrots. In this case the wearable is in full-voice mode since the Home Chef is cooking in the kitchen.



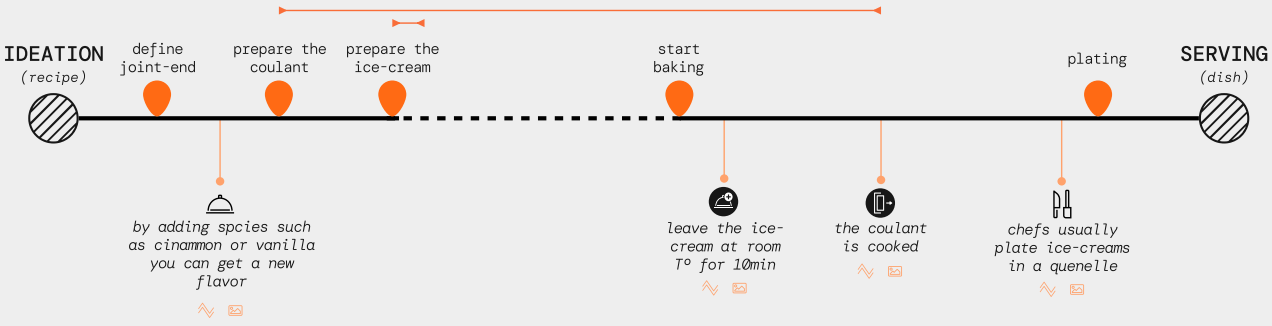
SCENARIO 2.

The recipe is sea bass with roasted potatoes.In this case the Home Chef is enjoying a drink with the guests while the food is being cooked in the oven, this is why the mid-voice mode has been activated.



SCENARIO 3.

The recipe is chocolate coulant with mint ice-cream. As it is the dessert the Home Chef is having dinner while waiting to bake the coulant last minute. To avoid disturbing the guests the voice is off in silent mode .



Legend

cooking step · ongoing preparation · intervention · creative tip · required step · voice · haptic · visual

Figure 27
Infographic of different scenarios and system interventions.

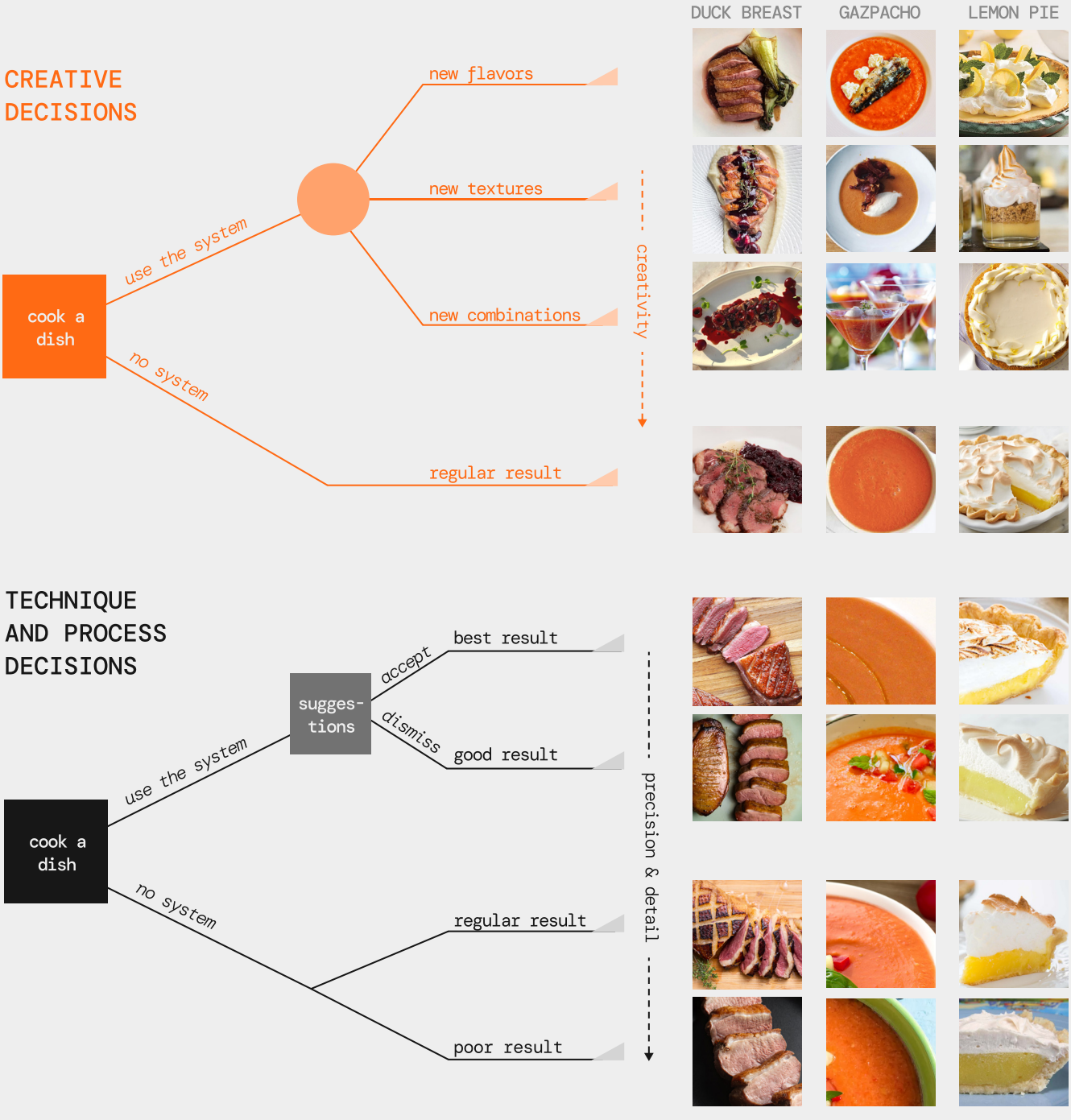


Figure 28
Creativity and process decision diagram

DECISION-MAKING PROCESS

In previous sections of this report, it has been highlighted a key idea regarding who has the power of making decisions among the HAC stablished between Sous and the Home Chef. Except for the occasions in which the full-autonomous mode is activated (see page 101), the Home Chef owns the leading role and consequently is in charge of making all the culinary decisions.

This section unfolds the positive effect of the wearable regarding the decisions made by the user. According to the design goal and main functionalities of the agent, Sous can influence both creative and technique decisions.
The underlying idea is that if the Home Chef would cook alone, the result could either be regular or even poor depending the technique of the Chef. However, when collaborating with the system throughout the cooking process, the end-result would be upgraded in the following ways:
In terms of creative decisions, by following the suggestions given by the system the Home Chef would be able to get to new and unexpected outcomes, which can include new flavours or textures, but also new combinations to plate the food. In relation to the decisions that involve cooking techniques, when collaborating with the agent the result would always be good as the system suggest the appropriate cooking processes and doneness. Even when the user ignores the optimal doneness for an ingredient or a possible alternative. Being always aware of the food's current state allows the Home Chef to make informed decisions according to its personal judgment. Nevertheless, if the suggestions are followed, the best result for the dish can be guaranteed.

The infographic on the left illustrates the comparison of the potential outcomes for three different dishes — duck breast, gazpacho, and lemon pie — depending on if it has been used the system or not (see Figure 28).

INFORMATION GUIDE

The information expressed by the agent can be divided in two main categories. One refers to actions that the user can or should perform, while the other comprises sensorial data as a means to trigger inspiration.

ACTIONS

Among the actions that the Home Chef may need to execute, two types can be distinguished. On one hand, *creative tips* comprise possibilities of adding a personal touch to the dish that is being cooked, as well as suggestions on how to cook specific foods. Secondly, *suggested steps* include the actions to be performed according to the cooking process to get the best result. Nevertheless, these indications remain suggestions and a form of support that the Home Chef can decide to follow or omit.

CREATIVE TIPS

		(examples)
Ingredient	Explore new flavour or texture combinations by adding or changing ingredients.	*Pumpkin soup: When blending the ingredients, spices can be added to enhance the flavour.*
Inspiration	Inspirational methods to trigger the user's creativity and encourage self-exploration	*Flammkuchen: How could you rethink this recipe to make it more playful?*
Technique	Try a new technique for an unexpected or optimal result for an ingredient or dish.	*Gazpacho: By blending the ingredients for longer with olive oil you will get a better texture.*
Plating	Provide tips or suggestions on how to plate food more creatively and visually attractive.	*Duck breast: Instead of thinking about the breast as the central element, use the sauce for that.*

Table 2. List and examples of creative tips

SUGGESTED STEPS

Turn on	When needed for a preparation, the system will indicate to turn on a specific appliance.	*Brownie: In the right time, it will be indicated to preheat the oven*
Turn off	When needed for a preparation, the system will indicate to turn off a specific appliance.	*Roasted chicken: When the tenderness, or doneness, is the adequate, turn off the cooktop.*
Increase temperature	When needed for a preparation, the system will indicate to increase the temperature.	*Fries: If the oil is not warm enough for a crunchy result, increase the intensity of the cooktop.*
Decrease temperature	When needed for a preparation, the system will indicate to decrease the temperature.	*Hollandaise sauce: if the temperature is too high it may jeopardise the result.*
Take out of appliance	If *turn off* is not possible, it will indicate to take out preparation from appliances.	*Ice cream: Take it out of the fridge to get it in the right serving temperature*
Add ingredient	If detected the need to add an ingredient for the optimal the cooking process.	*Risotto: Add now the butter before finishing the rice to get the creamy result.*
Flip or mix	If needed to flip the preparation to succeed in the cooking process.	*Salmon: Flip it to get a uniform doneness.*
Check	If the system can not fully interpret the food or needs a validation from the user.	*Pasta: Check the doneness as it varies for each type of pasta*

Table 3. List and examples of possible suggested steps from Sous

SENSORY INFORMATION

The system translates literal sensory data (visual appearance and odour) into a higher level of information. This helps Home Chefs better understand the preparations being cooked and stimulate their creativity. The wearable displays five classes of sensory information (Patterson & Aftel, 2017), which combined lead to interesting flavour and texture affinities to be explored by the user.

SENSORIAL CLASSES

		(i.e. for a brownie)
Doneness	The level or degree of cooking that has been completed for a specific ingredient, it conveys different sensorial values such as temperature, visual appearance and texture. Each ingredient has a specific optimal doneness to enhance its flavour, therefore this value is used to decide when an ingredient is cooked enough.	*raw* *fudgy* *cakey*
Flavour	Is the combination of smell and taste. These two senses work closely as they have the same sensorial root in our brain, therefore it is by merging their perceptions that we are able to determine flavour. Moreover, it is a crucial aspect when cooking, which has to be validated throughout the whole process to guarantee that the diners will eat a pleasing dish.	*sweet* *roasted* *nutty*
Texture	It refers to an ingredient's physical presence, but also how it feels in the mouth when eating it. Moreover, texture has a direct effect on how the flavour is perceived.	*soft* *moist* *thick* ...
Shape	It refers to the overall impression of what is being cooked or eaten, most of the times it involves its physical appearance.	*dark brown* *shiny* ...
Affinity	Professional chefs use this idea when creating their dishes to make sure they are balanced. In this context, affinity refers to ingredients that due to its flavour and/or texture harmonise well.	*nuts* *berries* *creamy textures* *crunchy textures* ...

Table 4. Sensorial classes communicated by Sous.

UI DESIGN: JOINT-INTENTION

Scenario

Aligning the shared-intention by conversing with the agent is the first step prior to cooking. This can take place for example while setting the kitchen space to cook.

UI design

This step is of high relevance as it is the moment where both parts of the partnership have to agree and understand the end-result, or in other words, the meal that is going to be prepared. To help the user follow the process that the agent is carrying out while processing this information, besides the conversation, on the wearable it can be read what Sous is understanding throughout the talk.

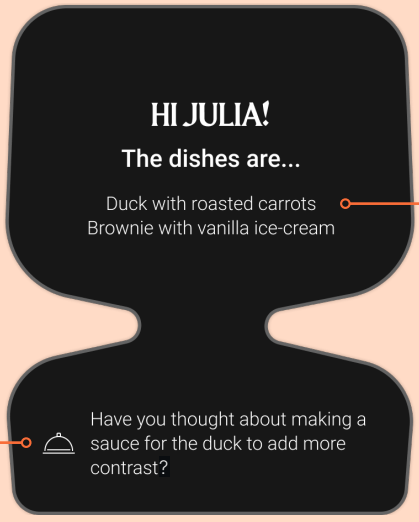
(The whole flow of interactions can be found in the Appendix I.1)

Figure 29
Aligning joint-intention in a Gaggenau kitchen

UI FEATURES

Conversation starter

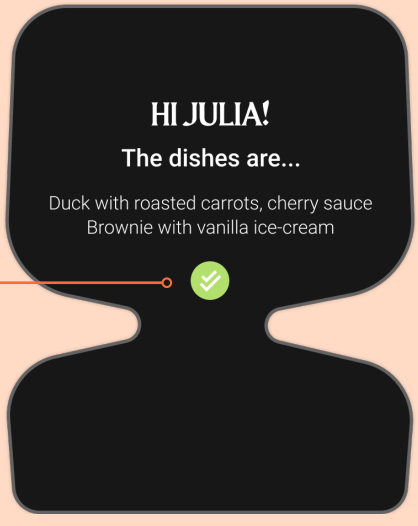
Starting the conversation
When turning on the wearable, it automatically sets on the mode to align the shared-intention by displaying a question on the screen.



Suggestion during the conversation

Indicate the menu
Throughout the talk, on the screen it can be read the dishes as the system has interpreted them.

Creative tip
It is possible that during the alignment of the end-result the system identifies a creative opportunity, which will be communicated.



Shared-intention is aligned

Confirmation feedback
It is important that both sides understand the end-result. This is why once the Home Chef and the agent are successfully aligned, visual and voice feedback to indicate it will be provided.

UI DESIGN: SENSING

Scenario

While the Home Chefs are expected to use their own senses to taste the preparations while cooking, the wearable can be used to get deeper information about the dishes being prepared.

UI design

Helping the Home Chef understand the preparations from a higher sensorial level is one of the main goals of the concept. With this, the user's engagement is increased with the cooking process by being actively involved in the preparations. The information provided in this situation aims to be as broad as possible to stimulate the Home Chef's inspiration and creativity. Nevertheless, if wanted, the user can access detailed affinities according to the ingredients that are available in the kitchen.

(The whole flow of interactions can be found in the Appendix I.2)

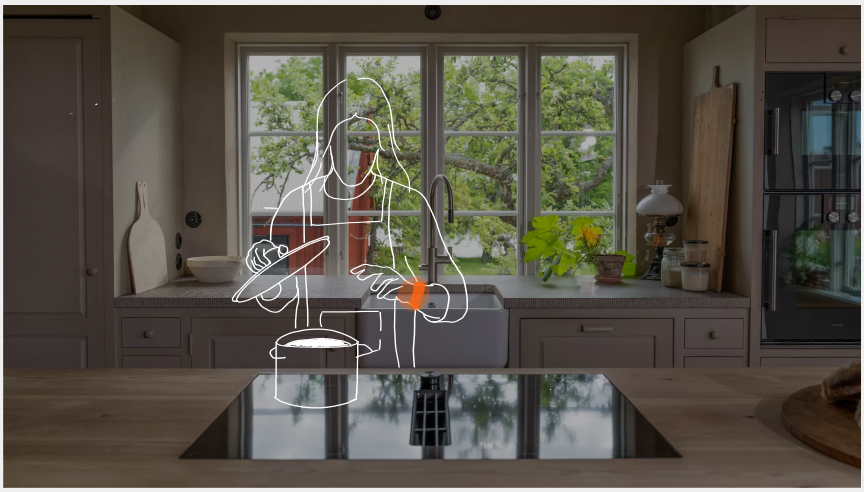
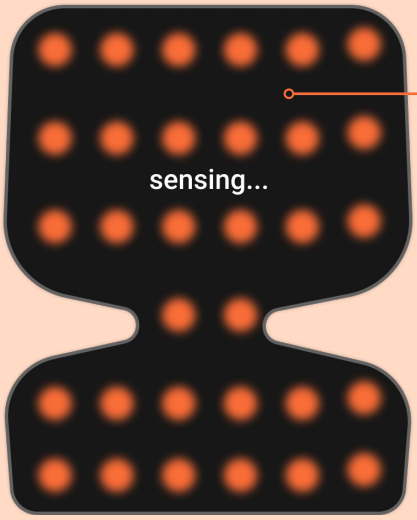


Figure 30
Sensing a preparation in a Gaggenau kitchen

UI FEATURES



Sensing process animation

Sensing animation
Keeping the user informed about the processes the agent is going through is important. This is why an animation is displayed on the whole screen to show the progress of sensing and interpreting the food once the Home Chef activates this function.

Inspiration section - ritual
The top part of the screen corresponds to the inspiration section, where the information aims to trigger users' creativity.

Main sensorial screen

Iconography & keywords
The different sensorial categories are described in keywords to ease the reading.

Guidance section - rational
The bottom area contains straightforward information to guide the process.

Temperature
Although being a basic variable, temperature is also important when sensing food. The orange line represents the optimal temperature.

Detailed affinities

Specific affinities
If wanted, the user can access to detailed affinities according available ingredients.

Flavor visualization
By introducing colors and abstract shapes, it is intented to increase the inspirational value of the data.

Broad affinities
Affinities regarding textures and flavors are provided in a wide way to give freedom to the user.

UI DESIGN: DASHBOARD

Scenario

As the wearable provides the relevant information to be in control of the process, the user is able to multi-task while cooking, for example, by socialising with the guests.

UI design

The control dashboard is designed to be easy to scan. Hence, interpreting the data shown does not interrupt any activity.

The primary information shown is the doneness of each preparation and its evolution. However, the user has the option to access a deeper level of information with details of each appliance and preparation such as the temperature or time remaining. This increases the sense of control as well as helping the user better understand the process. In this scenario, the wearable will also display the required steps or creative tips in the specific moments.

(The whole flow of interactions can be found in the Appendix I.3)

Figure 31
Home Chef socialising in a Gaggenau kitchen

UI FEATURES

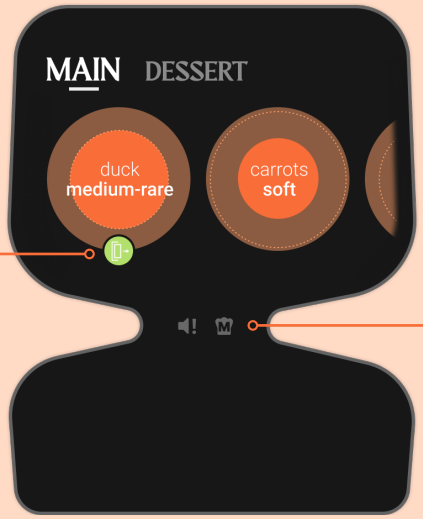
Multiple dishes
To simplify the dashboard, when different dishes are being cooked they are shown separately.

Main dashboard with general action

Doneness
Preparations doneness is the most helpful factor to make decisions, this is why it is the main information in the dashboard. The inner circle represents the current doneness, which evolves during the process. The dotted line indicates the optimal doneness according the system. Finally the outer circle indicates the maximum doneness to have a good result.

General actions
Some actions can apply to the overall cooking process. These are displayed in the bottom area.

Specific actions
If a required step is specific for a preparation, it is displayed on it.



Main dashboard with specific action

Wearable's mode
These icons indicate the current voice and autonomy modes. They can be changed by tapping on them.

Preparation details

Preparation details
By tapping a preparation on the dashboard, its details are accessed. This shows basic and rational information in a summarized way.

Doneness tips
If possible, tips and ideas about the best cooking process are explained.

UI DESIGN: THE APP

Scenario

Building the personal palate on the app can be done anytime, but a possible occasion is when being in a restaurant enjoying a dish that one specially likes.

UI design

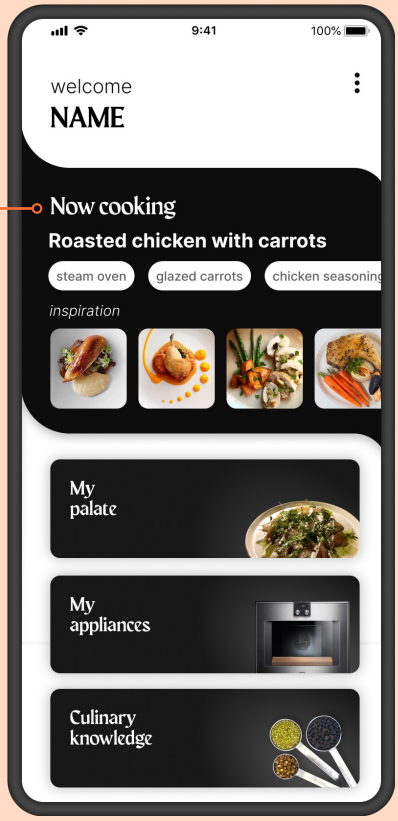
The main functionality of the app is allowing the user to create "my Palate", which contains past experiences or dishes that the Home Chef would like to explore. The interface has been designed to make this action simple and visual, but at the same time it helps the user understand the learning process of the system.
Besides this functionality, the interface on the app guides the Home Chef through the sensory categories in an educational way. Finally, it gives access to the wearable's settings.

(The whole flow of interactions can be found in the Appendix I.4)

Figure 32
User adding a photo to *"my Palate"*

UI FEATURES

Real time info
This section aims to complement the information given while cooking in real time, so that users can learn and increase their expertise on the field.
Moreover, plating inspiration for to the dish being cooked is provided.



Home screen

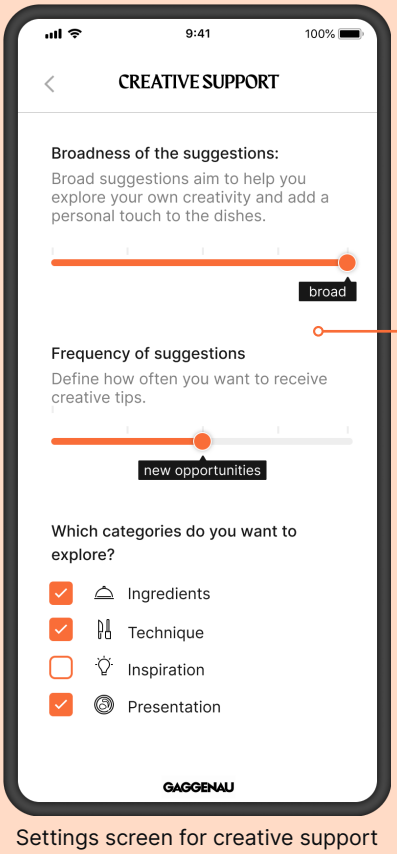
my Palate main screen

my Palate grid
Here Home Chefs can review their past experiences or dishes that would like to try.

Adding delights
This function allows adding new photos and a short description to help the system interpret it.

Tasting in detail
For each of the sensory classes, this area of the app provides a detailed description as well as examples to inspire and teach the Home Chef how to taste food.

Culinary knowledge menu



Settings screen for creative support

Creative support
This is the main section of the settings, where the user can adjust the creative tips given while cooking. This allows personalization and regulating the interventions of the system according to one's preferences or expertise.

HOW IT WORKS

In this section the functioning of Sous from a technological point of view is described. Despite being a speculative project, it has been designed guaranteeing its feasibility and technical viability. However, this part of the project is rather conceptual as the focus is on the interactions and character of Sous.

Determining the doneness

In accordance with the speculated future described in the 6th chapter (see pages 70-71), it is assumed that domestic appliances will be smarter. One of the main ideas that influences the functioning of Sous is the fact that temperature sensors will be embedded in these appliances, being able to determine both the external and internal temperature of the preparations. Combining this data with time tracking helps to determine ingredients' doneness. The individual appliances sense this information, time and temperature, and communicate it to the central system, Sous, who then translates it into a more understandable value: doneness. Hence, Sous is not only acting as an intermediary between the appliances and the Home Chef but is capable of processing the environment and expressing it in the most useful way.

Sensorial analysis

While the sensors described above are effective for determining doneness, they can not sense information regarding the remaining sensory aspects of food. As a result, additional sensors are required to provide this data to the user. In the lateral of the wearable two sensors are embedded, known as *electronic nose* and *electronic eye*. These sensors are commonly used in the alimentary sector to detect food quality or cooking state (Fedorov et al., 2020; García-Segovia et al., 2012; Xu, 2019). The *electronic nose* is a gas-analytical sensor capable of collecting odour and smell patterns replicating mammalian olfactory systems (Fedorov et al., 2020). Whereas the *electronic eye* consists of a computer vision system capable of identifying the appearance of a certain ingredient and evaluating its state. Using these sensors brings precision when assessing food since they evaluate chemical aspects. By combining the data gathered by both the electronic eye and nose, Sous is capable of providing an answer for the preparation's flavour, texture, shape, and refine the doneness.

Context-awareness

Sous is wirelessly connected to each of the appliances in the kitchen. This raises the wearable's context-awareness and has a direct influence on the information displayed on its screen. On the main dashboard, preparations are shown in order of doneness. Hence those closer to being ready will be displayed first. However, if the system detects that the Home Chef is closer to a specific appliance, the preparation being cooked on it will be presented first, easing the relevant information's accessibility.
Regarding the sensory dashboard, the user needs to activate the sensing process manually with a simple gesture (see Figure 33) and thanks to being able to detect the position, Sous will know which preparation is being analysed.

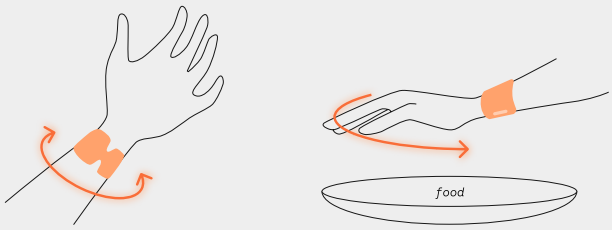


Figure 33
(left) Gesture to activate sensing process.
(right) Gesture to sense preparation.

Involving Artificial Intelligence (AI) for a better experience

Sensing the environment, or in this case, sensing the state of the preparations can be done in an automatic way. Nevertheless, the capacity of translating this data into the above-mentioned variables requires AI. Thanks to this, the specific affinities can be determined, and the optima doneness for each preparation can be expressed. Both require having a system trained with a wide database including references of multiple ingredients and preparations.
Moreover, by involving Machine Learning, the system can constantly learn to improve its performance. The user should be aware of this. The Home Chef is partly responsible for providing input to train Sous. On one hand, by learning from Home Chef's behaviour when cooking Sous can refine the given suggestions. On the other hand, the information provided on the app contributes to training the system by indicating flavours, compositions, and dishes that the Home Chef likes to consider it in future recommendations.

REFLECTION ON EI

The insights drawn in the second chapter regarding EI have been applied to Sous during the conceptualisation phase. This has been done from different perspectives, from influencing the way the user interacts with the wearable to building the character of the smart agent.

When conceptualising Sous, the premise of preserving the richness of actions associated with the cooking process was essential. This is how Sous was designed, by understanding it as an extension of the body, a tool to maximise the users' sense-making capacities by introducing somehow a new way of tasting food, like creating a new sense. In this line, designing a product adapted to the context was crucial, recovering the idea of *social computing* defined by Dourish (1999), this is how the idea of the wearable arose. Having Sous, a cooking assistant, in the shape of a wearable guarantees that the different activities that take place in this context will not be interrupted by the interactions with it thanks to its *ubiquity*.

Another relevant term that has been considered while designing the concept is *tangible computing*, which aims to explore the wide range of actions that we can do with our bodies, and somehow merge the digital and physical worlds (Dourish, 1999). Sous can be seen as facilitator of the *coupling* between the two worlds. While the physical makes the user engage with the cooking process, the digital world opens a wide range of new culinary opportunities.

Interacting with Sous is done in a natural way according to each situation. For example, to define the joint-intention the user will start a conversation, the easiest way for humans to communicate an intention. Other actions involve bodily gestures, such as activating the sense mode and scanning the preparations. This last action has been designed by a metaphorical embodiment as the gesture to allow the wearable sense the food emulates the action that humans do to smell a preparation, by directing the odour to the nose with the hand or to taste it with a spoon.

Finally, Sous aims to capture the idea from the theory of EI that argues that humans learn by doing and that we think through our bodies. The concept is designed to require the user to be present and engage in the cooking process, taste and sense the results, and ultimately have an educational perspective.

Learning by doing is achieved when cooking with Sous, thanks to the insights provided by the system about the preparations. By using Sous over time, Home Chefs would gradually increase their culinary expertise. Moreover, as the system suggests new ideas about flavours and processes helps users fulfill the desire of exploring in the kitchen without needing specific preparation or training.

Thinking through our bodies is inherently done when cooking when tasting food and assessing it based on human sensory capacities (taste, smell, sight, touch, and hearing). By using Sous, the capacity to think through our bodies aims to be enhanced as the information provided by the system helps us understand preparations in more depth and detail.

The learning processes above-mentioned take place spontaneously while cooking and gradually over time. Thus, Home Chefs can enjoy the pleasures associated with the cooking experience, feeling helped by Sous instead of feeling like they are cooking by following orders from an instructor.

Ched Fina Puigdevall cooking at Les Cols
Source: La Vanguardia

Chef Alain Ducasse cooking at Dorchester
Source: The Times

REFLECTION ON AUTONOMY

When designing Sous, different aspects from the theory of autonomous agents helped shape the concept. Firstly, the idea of understanding the Home Chef and Sous as a HAC (see pages 68-69). In addition, the design challenges defined in the second chapter and the different autonomy levels of the system have been approached.

The first question that should be answered to understand better this section is, how is the agent autonomous? According to Rozendaal et al. (2019), smart behaviour refers to the capacity of sensing the world and making own decisions to respond to it. Sous perceives the environment by sensing food preparations and the data on the app, it interprets it and responds in different ways; providing understandable information, and identifying the moments to suggest creative tips or required actions based on one's preferences and availability (see Figure 34). This autonomous behaviour, can be considered mainly passive, as the decisions from the system do not control the cooking process, but instead they result in guidance for the user. This is aligned with the idea of an Object with Intent, as well as with the main principle of EIs as Sous supports the user by maximising its capacity to sense the environment, it is conceived as a tool to operate the world (Dourish, 1999; Rozendaal, 2016).

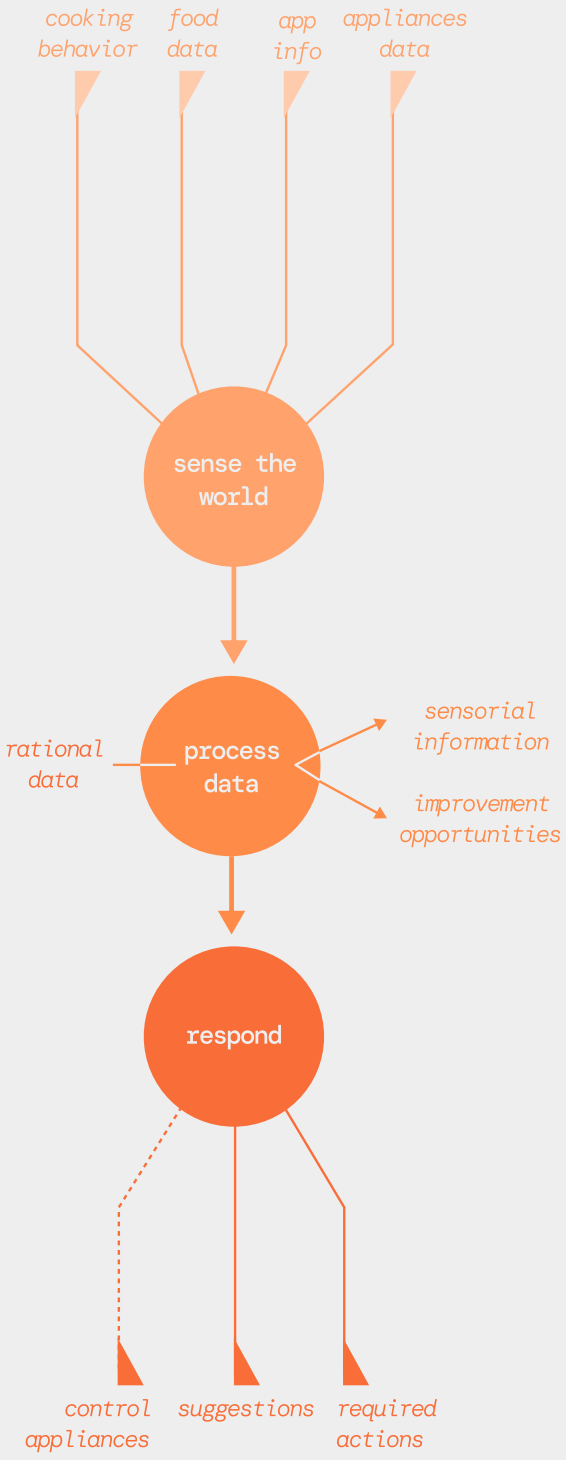


Figure 34
Representation of the autonomous behavior from Sous

Design challenges

Adaption, understanding, flexibility and trust have been defined during the first stages of the project as the main challenges when designing autonomous agents. The four aspects have been approached when designing Sous.

 *Adaption:* In terms of function the agent is not replicating human behaviour but augmenting it. The shape has been defined considering the target group and the requirements of the context, being always accessible. Finally, the interactions have been designed to be non-intrusive and suggest instead of commanding.

 *Understanding:* Firstly, the information provided by Sous is displayed to help the user understand the cooking process in more depth, adding a layer of visual information to reinforce it. Plus, involving conversational interactions makes the understanding between entities easier. Finally, the interface has been designed so that the Home Chef can always be aware of the current state from both the cooking process and the wearable.

 *Flexibility:* The user can manually determine the level of autonomy of the system. Furthermore, the Home Chef can choose the level of detail or depth from the information shown on the wearable's screen.

 *Trust:* All the previous aspects have a direct effect on building a trustful relationship. However, this is reinforced by two aspects. First, by the fact that Sous is presented as an expert that will always contribute to the best result. Secondly, the collaborative aspect as both entities work together with a shared-intention.

Autonomy levels

Depending on the Home Chef's needs three levels of autonomy are possible for Sous: zero-autonomy, regular mode, full-autonomy.

Zero-autonomy: In this case the Home Chef cooks alone, hence Sous is not involved. This is simply indicated by not putting on the wearable.

 *Regular mode:* This is the default mode described throughout the chapter. In this case the autonomy of the system relies on identifying the occasions in which to intervene to provide relevant suggestions and translate the sensed information.

 *Full-autonomy:* The user can set it manually by tapping on the "autonomy" icon on the wearable's screen. Activating this mode implies that the system will make all the possible decisions and operate on the appliances throughout the cooking process, such as adjusting the temperatures or turning them on/off. To guarantee the collaborative character, when the system makes a decision of this kind, it will be indicated on the wearable to make sure the Home Chef is aware of it.

EVALUATION

The projcet has concluded with the evaluation of the concept. This chapter describes, the process followed as well as the results obtained.

Contents

METHODOLOGY

The last stage to achieve the completion of the project consisted of the concept evaluation. The evaluation was executed bearing in mind the speculative character of Sous. Hence, validating the Design Goal — feeling like a Home Chef — has been done on a conceptual level. Moreover, the Design Guidelines concluded from the literature review were also included in the evaluation. On one hand by asking to user test's participants and on the other, by carrying out a personal assessment.

GUIDELINES ASSESSMENT

The following analysis provides a personal description about how each Design Guideline has been considered when designing Sous. Questions have been derived from each to allow participants evaluate them. These questions can be found at the end of each guideline's reflection.

Understand the Home Chef and the kitchen as collaborative partners

To approach this guideline, the metaphor of the professional kitchen was introduced, understanding the Home Chef, Sous (Sous-Chef), and appliances (specialised cooks) as a *team* that works together to get the best result under the leadership of the first.

→ *I would feel that Sous and I collaborate when cooking in the kitchen.*

Agents should be adapted to the domestic kitchen.

On one hand, the charging dock has been designed in order to be integrated in the space, and therefore make Sous part of the environment. Moreover, the fact that it is a wearable fits the requirements of the main activity done in the kitchen, cooking; with Sous the information is always accessible without having to stop any task that is being executed.

→ *Sous fits the context of a domestic kitchen*

→ *I would feel like Sous is interfering my activity while cooking*

Guarantee mutual intelligibility

First of all, the language used for the communication between the agent and the user has been defined in order to guarantee an easy scan of the information: voice/textual feedback and simplified visualisations. The fact that Sous displays real-time information allows users be aware of preparations' state. Moreover, by establishing communication between Sous and the appliances users should feel that the system is more capable of interpreting their intentions while cooking. Finally, by introducing the feature "my Palate" in the app, the Home Chef can understand better the learning process Sous follows to provide personalised experiences.

→ *I feel the information provided on Sous's screen was easy to understand*

→ *I feel Sous would accurately support/understand my decisions while cooking*

Augment users' capacities, maximise agents' capacities

These have been targeted with the introduction of the doneness value and Sous' sensing capacity (electronic eye and nose). On one hand, this augments users' capacities to understand the preparations being cooked as it provides a new way of analysing them. On the other, it is maximising agents' capacities as technology is not introduced to mimic human behaviour but to expand it. Finally, the fact that Sous provides an overview of the cooking progress helps the Home Chef achieve a higher level of detail.

→ *I feel Sous would help me to perform better when cooking*

→ *I feel that Sous' sensing capacities would help me perceive better the dish I am cooking*

Guarantee mutual trust according to task delegation

The design has been done by considering that once the Home Chef acquires Sous, it is already accepting the delegation of tasks, where Sous will be in charge of supporting the cooking process and enhancing the pleasures associated with it. However, trust is stimulated by using a communication language that the user can easily understand, plus reinforcing the idea of collaborating towards a common goal (best result) with the joint-alignment, creative tips, and required actions.

→ *I would trust Sous enough to make decisions based on the information provided by the system*

Flexibility in autonomy level and input type

By giving the possibility to manually determine the autonomy level flexibility is achieved. Regarding input flexibility, the information to allow Sous to track the cooking process is gathered automatically. However, regarding the learning process about one's preferences, the input can also be introduced manually via the app through "my Palate".

→ *(Not included in the evaluation, it has a rather theoretical approach and influences mainly usability aspects.)*

Guarantee both entities' autonomy

The fact that the Home Chef has the leading role ensures its autonomy regarding decision-making throughout the cooking process, as Sous interventions are merely suggestions (unless the full-autonomy mode is activated).

→ *(Validate achievement of feeling in control.)*

Understand the richness of human bodies' interactions

For this guideline, the introduction of different type of feedback has been introduced in order to facilitate the communication between the agent and the Home Chef according to the requirements of the context. For it, interactions that are inherent to the Home Chef's skills have been considered: conversation, textual, visuals, haptic (vibration), and gestures. All these are already integrated into most of the devices people interact with nowadays and ease the communication process while cooking as it does not interrupt the activity.

→ *I feel that interacting with Sous would be intuitive*

→ *I don't feel I need to learn new skills to use Sous/I feel that Sous supports my cooking skills*

→ *I would feel comfortable speaking to the wearable*

→ *I would feel comfortable with the gestures when sensing a preparation*

USER EVALUATION

For the evaluation, Sous was showcased to six participants and afterwards, asked their opinion about it. Participants were selected to guarantee they would fit the user group, and additionally, their enthusiasm regarding cooking was also considered. The evaluation was moderated and completed online via a video call with each participant. Different materials were shared during the call to explain the concept and subsequently evaluate. This section includes a description of the parts that constituted the evaluation (see Appendix J for more details).

PART 1. INTRODUCTION

Firstly, participants were explained the structure of the evaluation and the project's goal. Next, participants were asked to rate their current *Home Chef feeling* when cooking (sense of control, creativity, and culinary knowledge). Prior to introducing Sous, it was essential that participants changed their mindset to a speculative perspective, focusing on the celebratory side of cooking. Hence, the personal future vision was described.

PART 2. EXPLAINING SOUS

In order to help participants understand Sous, a digital prototype was made. This eased the explanation of the different functionalities of as well as illustrating how the information would be displayed on the wearable's screen. During this part, participants observed while the moderator navigated through the prototype providing the needed explanations.

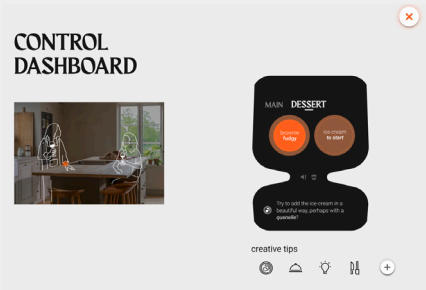


Figure 35
Screenshot from the prototype.

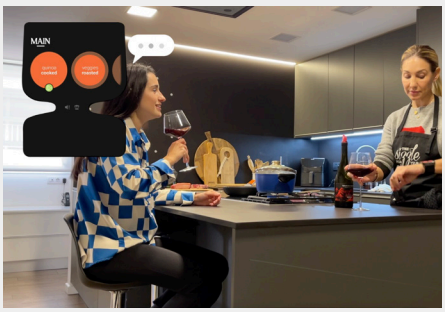


Figure 36
Frame captured from the video.

PART 3. CONCEPT SHOWCASE

Following the introduction to the concept, a video was displayed to show the use of Sous in a real context. The video helped clarify the different interactions that with the wearable while cooking, as well as visualising the information provided in a real scenario. As the video aimed to be as realistic as possible, the number of interventions shown was limited, since in a real case users would not want to be overloaded with information. However, in Part 2 participants had the chance to discover all the possible interventions.

PART 4. SEMI-STRUCTURED CONVERSATION

Once the concept was clearly explained, questions were asked to participants. The first part was a semi-structured conversation. Participants were asked initially to provide their general opinion about the concept and imagine themselves using it to trigger speculation. Next, they were asked to rate how their *Home Chef feeling* would be if using Sous, which was expanded by introducing further questions for each feeling — sense of control, creativity, culinary knowledge. This part concluded with a question that invited participants to speculate, in this case about potential features or characteristics they would like to see in Sous.

PART 5. QUESTIONNAIRE

The last step of the evaluation consisted of an online questionnaire that participants had to fill in individually as a follow-up activity. The survey translated the Design Guidelines into specific questions to evaluate them using Likert Scales to ease comparing participants' answers.

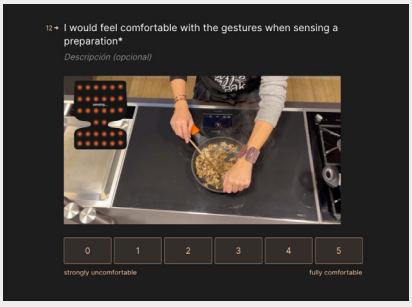


Figure 37
Question from the online survey.

RESULTS

This section comprises the results obtained from the user evaluation. The section is divided into two parts, the first focuses on the overall concept and achievement of the Design Goal, while the second analyses the answers from the survey conducted to evaluate the Design Guidelines.

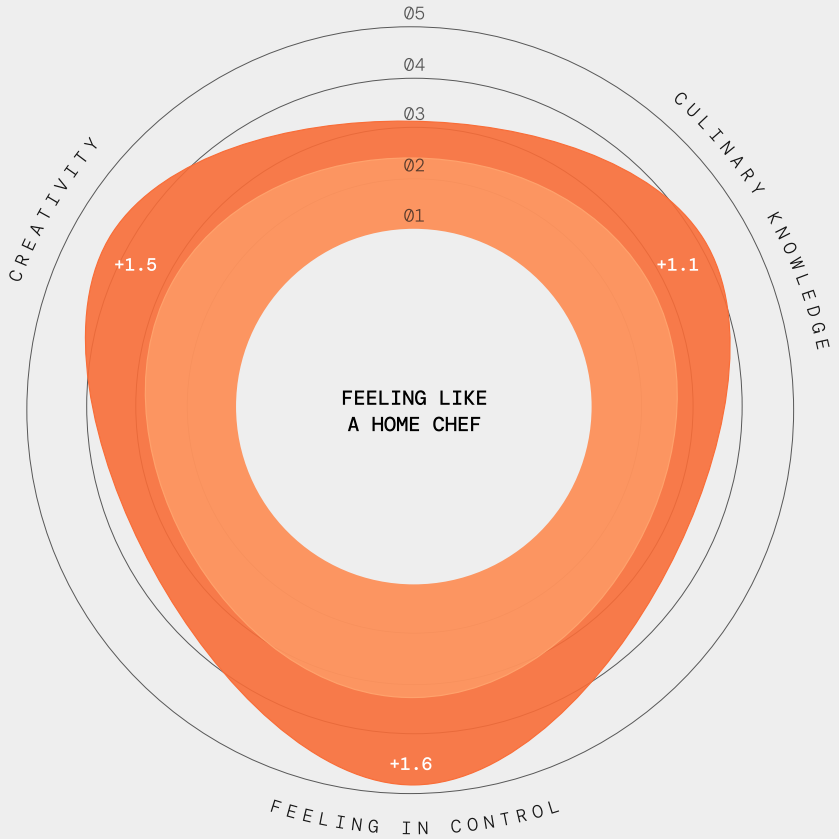


Figure 38
Graphic depicting participant's speculated increase of attributes when using Sous.

FEELING LIKE A HOME CHEF

According to participants' answers, it can be stated that the Design Goal "**Gaggenau's users should feel like Home Chefs when cooking special meals in their kitchens**" would be successfully achieved by introducing Sous in the target group's kitchens. Throughout the section, this idea will be dissected in more detail, although an overview of this can be seen in Figure 38. Participants were asked to rate and imagine their own feeling in control, creativity, and culinary knowledge if using Sous compared to the present. In accordance with the answers, the average perception of all three categories would increase when cooking with Sous, mainly the feeling in control *(+1.6)*, followed by creativity *(+1.5)*, and lastly, culinary knowledge *(+1.1)*. Nevertheless, it is important to highlight that this evaluation is based on personal perceptions and a speculative mindset. Hence, it hard to emphatically state that Sous would make their users feel like Home Chefs, but this feeling is likely to be enhanced by cooking with it.

EVALUATING THE DESIGN GOAL

OVERALL CONCEPT

Participants found the overall concept a positive addition to their kitchens as Sous would support them in obtaining better results, exploring new dishes, and consequently enjoy cooking more. The answers obtained during the evaluation pointed out that the concept is adapted to the context and its usability would be easy.
Regarding usability, or more in detail, the interpretation of the information provided by Sous, a popular opinion was that communicating in a visual way makes it easier to scan and react while also focusing on cooking.

> *"The fact that is really visual makes it easy to scan it, in a quick glimpse you have a deep sense of the preparation."*

Overall, the fact that Sous communicates the state of preparations by showing their doneness is the feature that was found the most important by all participants. Achieving the perfect doneness was considered by them as the most challenging thing in the kitchen.

> *"Doneness is essential, it totally influences the flavour and end-result."*

> *"The fact that it helps with the doneness is great because it's a really important thing when cooking but hard to master."*

All participants agreed with the idea that Sous does not threaten Home Chefs' leading role, but four of them highlighted that its role is to be an extra help or even part of a metaphorical *team*, which is aligned with the idea of HAC.

> *"My perspective when cooking with this would totally change, you could be cooking multiple things and feel really in control that all the preparations will come out good."*

> *"[having] this extra help to understand the food is what I really like"*

The main benefits associated with cooking with Sous that were broadly shared are: increase in optimisation by being able to cook multiple preparations at the same time, support on multitasking because the system can be trusted, increase in feelings of relaxing and enjoyment when cooking.

> *"Helps you be more effective while helping you experiment or explore when cooking"*

> *"The fact that you can be relaxed and enjoying the cooking process because you have this extra help to control is what I really like."*

FEELING IN CONTROL

Regarding control all participants agreed that it would increase when using Sous but differentiated two types. On one hand the main idea was that Sous increases the sense of control with the depiction of doneness. On the other, four participants stated precisely that it would help them feel more in control when exploring new combinations or techniques.

> *"The fact that you don't have to set alarms or timers yourself, having a visualisation that shows the doneness... this would increase my feeling of control"*

> *"I would feel safer when exploring new things, I would dare a bit more."*

Moreover, receiving suggestions throughout the cooking process has been perceived positively and as a non-intrusive intervention from the system to help perform better. However, one participant mentioned that it would be preferable to only receive suggestions at the begging or end to avoid confusion. Finally, it can be stated that the delegation of tasks was clear to participants as they perceived Sous as the responsible for achieving precision and detail while maintaining the Home Chef's leading capacity.

> *"I think who leads and decides is the Home Chef, but cooking is a teamwork, so having a device that helps on being more creative or to control everything would just make cooking better."*

CREATIVITY

The main idea in this category is that both the sensory dashboard and creative suggestions would be sources of inspiration that encourage exploring.

"Being able to cook dishes with real-time information is amazing, it makes it easier to create."

"Suggestions are great, at the end, you decide if you follow them or not, but they are a trigger to inspire you"

Nevertheless, two participants highlighted the importance of allowing personalisation in this aspect. On the one hand personalisation regarding one's preferences. On the other, regarding the level of detail especially on the screen with sensory information.

"It would be nice to have the option to choose the level of detail or complexity that is shown"

Regarding the sensory dashboard, participants perceived it not only as a source of inspiration but also as a new way to understand and expand their way of sensing preparations.

"I could get to know ingredients better and my capacity to sense preparations would get more broad"

"I really like the idea that the wearable helps you understand better the flavour, texture, possible combinations and that all this is super visual"

However, one participant mentioned that the fact that the information on the sensory dashboard is beyond common knowledge or a bit abstract, it would be difficult to know what steps to execute in case the texture or flavour was not the desired. Finally, a participant brought up the reflection doubting if following suggestions means being creative or not.

CULINARY KNOWLEDGE

Regarding knowledge three ideas were shared among all the participants. Firstly, the accessibility to information was considered a really positive aspect of the concept, which conveys in one single device all the information needed to execute the cooking process. Moreover, the fact that Sous is a wearable positioned on the wrist was seen as a way to increase the accessibility.

"By having the information on your wrist you have quick access to what you are cooking, then your knowledge also increases."

Secondly, the fact that one is aware of the current state of the preparations, the optimal doneness but also being suggested ways to enhance the result was perceived as a means to make more informed decisions.

"It helps you make decisions in a quick and easy way to cook better, as it indicates the current state of everything and the optimal procedure."

"It would provide me enough context to make informed decisions, now I base them on the photo of a recipe, but getting more detailed information would be helpful."

Lastly, participants highlighted the fact that using Sous often would contribute to a learning process both from the perspective of ingredients and technique.

"If I would use this almost on a daily basis I expect to get a lot of insight that tailors to my level of knowledge, that it helps me to get better. Maybe even to the point where I don't need it anymore."

EVALUATING THE DESIGN GUIDELINES

Figure 39
Visualization of participants answers from the Design Guidelines' survey

The overall evaluation of the questions associated with the Design Guidelines is quite positive (see Figure 39 for an overview). Especially the ones regarding the partnership created between Sous and the Home Chef, and the adaption to the context in terms of the space. However the opinion about adaption to the context from a functional way has had a less consistent answer, showing that there is room for improvement to make interacting with Sous less interfering with cooking. Intelligibility has been scored with high values, although the results also show this aspect can be improved which will be discussed in the next section. Augmenting the Home Chef's capacities has been perceived as achieved in terms of precision and detail and obtaining the best result, but it is not so clear if it would help users sense better the preparations. When contrasted with the first part of the evaluation it can be deduced that the sensing functionality contributes more to inspiration rather than to understanding the preparations. Trust is the aspect that has been scored with a lower or less homogeneous answer. According to the theory of autonomous agents, this is normal as trust with a smart device like Sous is known to increase throughout time. Finally, questions regarding human interactions reveal that these fit the context and user group, with the exception of using voice control which has less consistency of answers yet is still positive.

Although further iterations would be needed to guarantee a better completition of the Design Guidelines, the results point out a positive direction towards it.

FUTURE RECOMMENDATIONS

Based on the answers obtained from the participants during the different parts of the evaluation, together with a personal perspective about the concept of Sous explained in this project, the following list of future recommendations has been created. These future recommendations convey possible explorations and weak points that could be developed further in future iterations of the concept. Recommendations 1 and 2 refer to expanding the side of product design as Sous has been developed so far from conceptual perspective. The remaining recommendations are possible features that could improve the usability and overall experience when cooking with Sous.

1

VALIDATE THE INFORMATION FROM A UX/UI PERSPECTIVE

While the information shown on Sous' screen has been evaluated in terms of content, it would be necessary to carry out a proper user test that focuses on the UI to guarantee its understanding and accessibility.

2

REFINE THE SHAPE FROM AN ERGONOMIC'S PERSPECTIVE

The wearable's shape defined in the project is an initial direction, which has been validated briefly in terms of comfort while cooking. However, actions such as putting it on or just cooking with it should be included in a user test executed with a higher-fidelity prototype.

3

INCREASE AND EXPAND PERSONALIZATION OPTIONS

Although receiving suggestions based on one's preferences was positively received by participants, it was missed more options to personalize the experience. Currently only regulating creative suggestions was contemplated. However, including aspects such as skills level or specific areas of interests could increase the engagement with Sous.

4

BIGGER OVERVIEW OF THE COOKING PROCESS

Some participants mentioned that their feeling of control and trust would increase by having a better overview of the overall recipe, such as knowing in advance the next steps to be prepared. This was an idea considered initially, but it seemed rather corrective and not celebratory. However, to make the concept more holistic it is a feature to explore.

5

USE SOUS ALSO WHILE NOT WEARING IT

This idea was triggered by two participants who asked if using Sous from its charging dock could be possible. When thinking about it, it opens a wide range of opportunities. This could bring a new level of autonomy for example for routine meals, where only monitoring the doneness of the preparation is desired. In this way, the integration of the device in the kitchen would be better, as well as making the most out of Sous capacities.

6

ENHANCE THE EDUACTIONAL ASPECT

The concept presented includes the educational aspect as a secondary result from using Sous over time. However, it could be interesting to explore the introduction of this aspect with a more relevant role. In this way not only the experience would be better adapted to Home Chefs' skills level but also provide a more challenging experience, where users can keep learning and exploring new culinary opportunities.

PROJECT CONCLUSION

Sous can be seen as an initial step towards a celebratory shift in introducing technology in domestic kitchens. Sous is an example that autonomous agents can become collaborative partners. In the case of cooking, instead of threatening Home Chefs' involvement, autonomous agents can help stimulate users' creativity, feeling in control, and culinary expertise.
Although the initial goal was to recover the ritual character of domestic kitchens, the project has highlighted the need to keep the rational part too. Sous brings the ritual side as it allows Home Chefs to focus on the pleasures of cooking, such as exploring new recipes or sharing the moment with others while being relaxed. On the other hand, Home Chefs also want to surprise their guests by serving a delicious meal. To achieve it, including a rational side is essential, as it ensures precision and detail.

The final evaluation showed that the feelings associated with being a Home Chef could be fulfilled when cooking with Sous. Nevertheless, further testing with actual prototypes and context would be needed to assert feeling in control, being creative, and having culinary knowledge.
Integrating Sous into the Gaggenau ecosystem should be further developed to guarantee optimal functioning of the wearable and the appliances. The project's duration lead to leaving individual appliances out of the concept, but to provide a holistic experience, they should be considered. As explained in the metaphor used throughout the project, the kitchen should be seen as a *team*.

Regarding limitations of the project, the main one has been gathering participants both for the user research and evaluation. The difficulties in accessing the specific target group and the current COVID-19 situation have made it difficult to carry out the activities in context and with a broader group of participants.

PERSONAL REFLECTION

On a personal note, it has been the most challenging project I have had the chance to work on, but at the same time, the one I have enjoyed the most. Challenging because I explored new theoretical and translating this into a concept has involved some moments of uncertainty. Exciting because I have dived into the culinary world with a maximising glass, understanding better what it means to be a Chef or sense food in depth. Exciting also because I have learned many new things, especially in the fields of autonomous agents and embodied interactions. Designing on a conceptual level required me to change my mindset from an Industrial Design Engineer to an Interaction Designer, which has not always been the easiest. However, once I made this shift, I was more capable of reasoning and providing a meaningful story for every decision.

The robust research approach of this project has been enriching, as it has allowed me to look at things in more depth, sometimes having to reduce the scope of the project to avoid staying on superficiality. Sometimes this was an inner battle, as I would have loved to develop Sous more holistically. In this line, I am aware that there is much room for details' improvement regarding Sous' design, which would be a fantastic challenge to work on.
Regarding my skills, executing this project has allowed me to expand my knowledge about user research. The insightful feedback obtained from participants is the best reassurance of the need to contact real users and involve them in the design process.

Sometimes, my ambition has been a drawback that stopped me from moving forward with less fear or worries. However, the same ambition reminded me throughout the whole process that the most important thing was to enjoy, and I can proudly say that I have accomplished my goal.

I hope I have inspired you at least a bit with this project and passed on my passion for design and gastronomy.

Nuria N.

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APPENDIX

The appendix includes information to understand more in depth specific parts of the project.

Contents


A

APPENDIX A: Project Brief

DESIGN FOR our future

TU Delft

IDE Master Graduation

Project team, Procedural checks and personal Project brief

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

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

USE ADOBE ACROBAT READER TO OPEN, EDIT AND SAVE THIS DOCUMENT
Download again and reopen in case you tried other software, such as Preview (Mac) or a webbrowser.

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

family name	Nicolau i Torra
initials	N
given name	Nuria
student number	[redacted]
street & no.	[redacted]
zipcode & city	[redacted]
country	[redacted]
phone	[redacted]
email	[redacted]

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

IDE master(s): ( ) IPD ( ) DfI ( ) SPD

2nd non-IDE master:

individual programme: - - (give date of approval)

honours programme: ( ) Honours Programme Master

specialisation / annotation: ( ) Medisign ( ) Tech. in Sustainable Design ( ) Entrepeneurship

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

** chair	Gijs Huisman	dept. / section:	HCI / HICD
** mentor	Nazli Cila	dept. / section:	HCI / HICD
2nd mentor	Piotr Szpryngwald		
	organisation: Gaggenau		
	city: Munich	country:	Germany

comments (optional): The focus is on social interactions between users and smart appliances (HCI). The team's areas of expertise are complementary; relations with autonomous agents and embodied interaction.

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

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

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

TU Delft

Procedural Checks - IDE Master Graduation

APPROVAL PROJECT BRIEF

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

chair Gijs Huisman date 30 - 08 - 2021 signature

CHECK STUDY PROGRESS

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

Master electives no. of EC accumulated in total: 16 EC

Of which, taking the conditional requirements into account, can be part of the exam programme 16 EC

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

☐ YES all 1st year master courses passed

☐ NO missing 1st year master courses are:

name J. J. de Bruin date 31 - 08 - 2021 signature

J. J. de Bruin, SPA Digitally signed by J. J. de Bruin, SPA Date: 2021.08.31 13:17:42 +02'00'

FORMAL APPROVAL GRADUATION PROJECT

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

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

Content: ☐ APPROVED ○ NOT APPROVED

Procedure: ☐ APPROVED ○ NOT APPROVED

comments

name A. Huwae date 13 - 09 - 2021 signature

A. Huwae Digitally signed by A. Huwae Date: 2021.09.14 10:21:58 +02'00'

Initials & Name N Nicolau i Torra Student number 5194180

Title of Project Enriching the autonomous "ritual kitchen" with embodied interactions

Personal Project Brief - IDE Master Graduation

TU Delft

Enriching the autonomous "ritual kitchen" with embodied interactions

project title

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

start date 30 - 08 - 2021 28 - 01 - 2022 end date

INTRODUCTION **

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

Kitchens play an essential role in modern households and in our every day lives [1]. While its initial purpose was food preparation, the fact that food itself can be perceived as a social facilitator as cooking and eating encourage social relations [2, 3] influenced kitchens to become spaces to share time with others. This space can be understood from two perspectives, the rational kitchen — focused on efficiency — and the ritual kitchen — centered on social relations [4]. For the last decades, kitchens have been innovations hubs, especially regarding food storing and preparing processes (i.e. food processors, appliances controlled via apps or fridges that identify the food inside). This reveals that modern kitchens have reached high levels of functionality and spatial distribution. Nevertheless, its social character has been put on a side [1].

The concept of smart home appeared in the early 20th Century, with the promise of providing new levels of luxury, relaxation and indulgence [5]. The aim of smart environments is to adapt and respond to the needs of their residents, allowing them to gain control over the space[6]. In the context of the kitchen this means following an approach that conveys both the rational and ritual sides.
As mentioned above, gaining control is the main expectation users have when considering a smart environment. Nevertheless optimization, peace of mind, personalization and impressing others are also wishes from the users regarding smart homes. The end goal users have is being able to focus on pleasurable activities and delegating household chores to smart agents[7]. The introduction of autonomous systems equipped with intelligence can provide the flexible behavior users expect, since they learn from user's routines and and as a result provide personalized experience [8].
In addition to the aforementioned, conceiving the activities of cooking and eating as pleasurable [4, 7] creates a tension when only prioritizing efficiency and functionality for the smart behavior of the context. The automation of certain tasks is reshaping how we cook, done in some cases by a sequence of "clicks' on a digital interface (i.e. cooking with kitchen robots such as Thermomix). By constraining the user's gestural and manual activities, their thinking and communication processes are diminished [9], and as a result, they can feel less in control or a lack of freedom. Principles of embodied cognition will be introduced to balance this tension, understanding that there is no division between mind and body when interacting with the environment [10]. The introduction of embodied interactions will allow the users to communicate with the system through their bodily gestures, enhancing sense-making of the context and skilled actions [9, 11].

Gaggenau is one of the leading brands providing professional solutions for contemporary private high-end kitchens. According to the brand, the target consumer seeks a luxury experience. Under this premise two user groups are found. First — cultural connoisseurs — consider their kitchen the most important room, where they can expand their cooking skills using high-functionality tools. Secondly— mighty connectors — perceive their kitchens as social hubs, which should be inviting for their guests and not focus so much on cooking themselves. These two groups have significant differences regarding the needs for their kitchens and this poses a challenge since anything designed from a Gaggenau's perspective should fulfill both profiles. Gaggenau's current approach to the kitchen is pragmatic, focused high-end appliances that evoke luxury while being functional. The project aims to gain a wider perspective through an experiential approach that involves both the practical side and the social aspects of this context.

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Personal Project Brief - IDE Master Graduation

introduction (continued): space for images

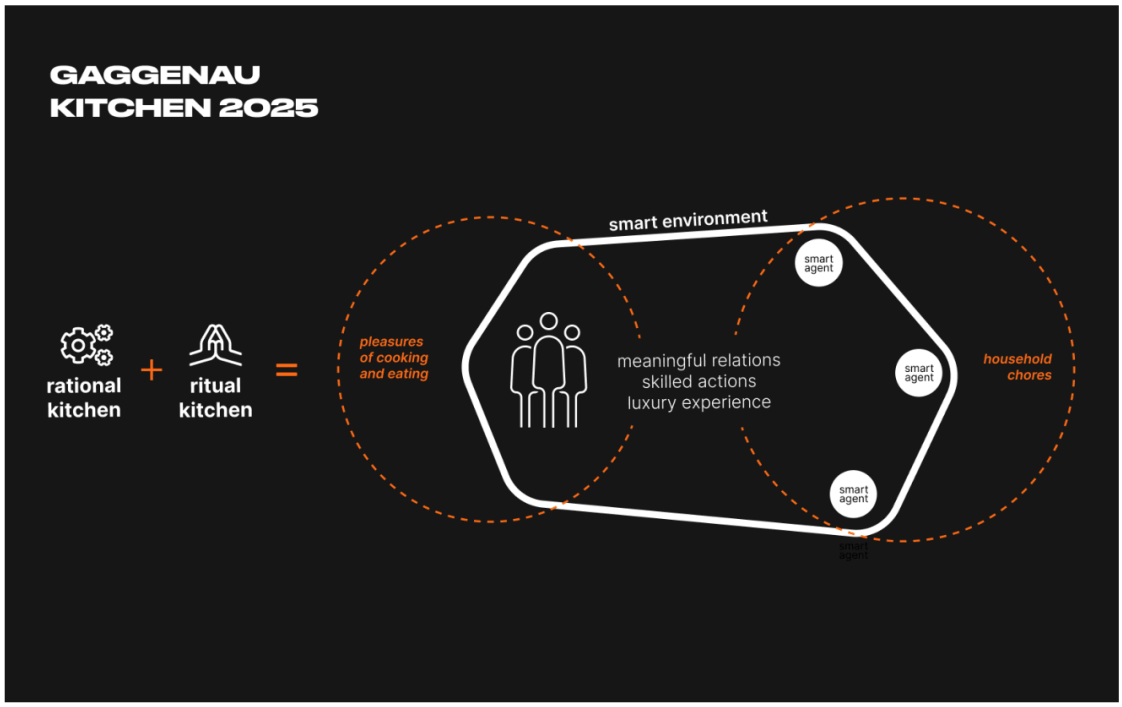


image / figure 1: Project overview

image / figure 2: Actors and relations in the smart connected kitchen

TU Delft

Personal Project Brief - IDE Master Graduation

PROBLEM DEFINITION **

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

The main challenge addressed in this project is the tension that arises with the introduction of autonomy since the users' social role and sense of achievement when cooking and spending time in the kitchen appears to be threatened by the smart agents that replace them in certain tasks [7]. While delegating chore tasks is something desired, in order to enhance the cooking experience and the enjoyment associated to this activity, it is important to identify the pleasurable tasks from these processes. Moreover, embodied interacting can help increase users' feeling of freedom and control by involving skilled actions and bodily gestures[9]. Gaggenau's target customers increase the challenge. The mighty connectors focus on the ritual kitchen, therefore cooking processes could be delegated to autonomous agents. The cultural connoisseurs aim to expand their cookings skills, hence embodied interactions that help them on the sense-making of the context and learning by doing gain relevance [9]. The result of this theoretical approaches has to convey the main expectation of the user, having personalised luxury experiences in their kitchens.
The relationships with the elements of the kitchen itself are crucial. Currently there is a fear that digital appliances will not make proper decisions or fail to complete the orders in the desired way [7]. This highlights the need of introducing not only automation but also intelligence to the context, which makes it able to understand the intention of the user and act according to it [12]. Plus, the relationships built between user and smart agent should be based on trust. To achieve this, two main aspects need to be fulfilled: flexibility and understanding [6]. Flexibility to identify the user's routine but also allow exceptions (i.e. cooking can be pleasurable some days but after a stressful day it can be an exhausting task [7]). Interactions and relations between users and smart agents imply mutual intelligibility [12]. To have agents that learn correctly, understanding users' intentions is necessary. On the other hand, trustful relationships can be enhanced if users are able to understand the learning process of smart agents.

ASSIGNMENT **

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

Designing a concept of a smart kitchen for the near future based on embodied interactions. The solution should make the experience in the kitchen enjoyable by allowing social relationships while enhancing the pleasures of cooking and eating.

Arriving to the aforementioned solution requires research activities to understand its different elements. The initial research will be grounded on a theoretical perspective about autonomy and embodied cognition. User research will follow to provide a clearer meaning of "enjoyable experience", done by asserting the target group's needs and wishes. This will also lead to studying the social relations that take place in the context, its actors and the nature of these relations. User research will help dissecting the concept of pleasure associated to cooking and eating, according to this, the tasks to delegate to smart agents can be determined (undesired to be completed by the users). To get a deeper understanding of the user, on one hand Gaggenau will provide with detailed insights. On the other hand, participants for the user research will be gathered using my own network and a snowball sampling technique [13]. All these activities will lead to defining which processes and elements will be part of the future connected kitchen. Finally, the assignment involves understanding the socio-ethical issues derived from a smart kitchen while involving data-driven technologies such as AI to provides personalized and flexible experiences.

The deliverable will be the concept of a smart kitchen; the presentation format will be decided after the findings of the project. Digital materials will allow communicating the concept in its totality and prototypes from detailed parts used during the ideation phase will give a glance of specific interactions.

Initials & Name N Nicolau i Torra Student number 5194180

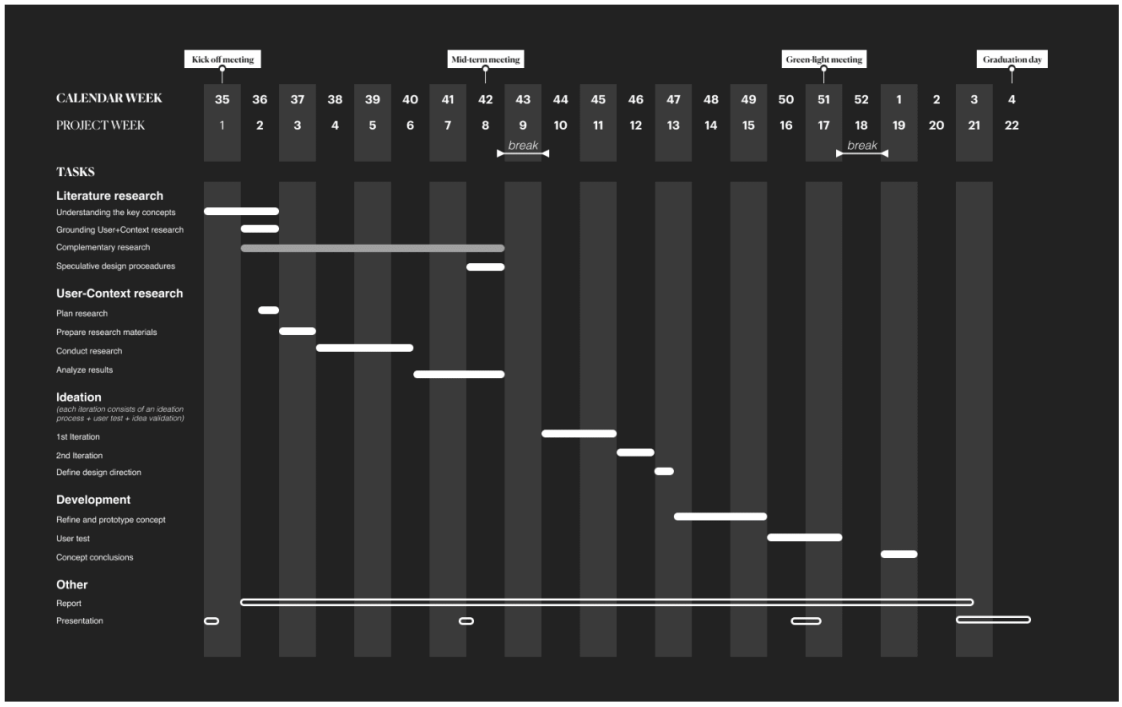
Title of Project Enriching the autonomous "ritual kitchen" with embodied interactions

Personal Project Brief - IDE Master Graduation

PLANNING AND APPROACH **

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

start date 30 - 8 - 2021 28 - 1 - 2022 end date



The project will be divided in the following phases: Literature review, User-context research, Ideation, Development.

The first two phases correspond to the research approach I want to follow. First, a theoretical perspective to analyse the concepts of autonomy, embodied interactions and the smart kitchen. Followed by fieldwork research based on generative techniques [14] to gain understanding of the current situation of the context as well as future opportunities. The research part will last about half of the project, which means that the conclusions and according design direction will be presented during the mid-term meeting.

The second and creative part of the project will consist on ideation and development. Methodologies from speculative [15] design will be used during these phases in order to trigger new ideas and develop a realistic concept for the near future. As opposed to conventional procedures that pose the focus only on the rational kitchen [4] and therefore making this space functional and efficient, involving speculative design will help to envision the context also from its social character and therefore help Gaggenau add new value to the future kitchen.
During the ideation phase, two iteration cycles will be carried out in order to validate the diverse ideas, from which a third and final iteration will take place on the development phase, ending with a user test.

Communication and visual thinking will be present since the early stages of the project, which means starting the report and defining the communication style.

Personal Project Brief - IDE Master Graduation

TU Delft

MOTIVATION AND PERSONAL AMBITIONS

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

In my opinion, the graduation project is the culmination of the last 6 years of studies (bachelor+master), the bridge between the academic and professional worlds. For this reason, I had no doubt I wanted to make the most of the freedom given by TU Delft regarding the topic selection, and I decided to pursue my passions: gastronomy and digital technologies. I have always been fascinated about these two worlds, and now I have the opportunity to see how they co-exist.

During the master and especially during the research project I carried out during the third semester, I have had the chance to expand my research skills, from a theoretical perspective but also by following fieldwork activities. This project gives me the chance to prove these learnings and convey with developing a concept, involving my creative skills.
Soft-skills will play a key role during the 100 days this project will last. On one hand, carrying out a clear project plan and sticking to it will help me be on track and be organized with the diverse tasks. On the other hand, I have had some experience during the courses with stake-holders management, but working with a company like Gaggenau will help me strengthen my competences in this area.

While I have been able to work in food design related projects in the past, it is the first time I will dive into the world of autonomous agents and connected environments. As an interaction designer this is my biggest ambition, understanding how users' will interact with smart ecosystems while making sure that the psychological needs of competence, relatedness and autonomy are maintained.

Speculative design methodologies have always triggered my curiosity, since they help to create a wide range of possible solutions for the future, enhancing creative thinking. This will be my first time using these type of methodologies but I am sure it will help me be more open-minded when approaching a design opportunity.

FINAL COMMENTS

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

Initials & Name N Nicolau i Torra Student number 5194180

Title of Project Enriching the autonomous "ritual kitchen" with embodied interactions

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APPENDIX B: Gaggenau's ecosystem

The different categories of appliances and processes that Gaggenau currently focuses on. In orange, the functions carried out using the app Home Connect.

OVEN

MICROWAVE

The epitome of culinary excellence, the object of desire for the private chef: the Gaggenau oven.

HC: Suggest specific settings: time, temperature, humidity.

VACUUM DRAWER

COOKTOPS

EXTRACTORS

Gaggenau cooktops and extractors do not just look the part; designed with performance, discretion and aesthetics in mind, they are inspired by the professional kitchen.

HC: Connect ventilation to hob, control it from there

COOKING

COFFEE MACHINES

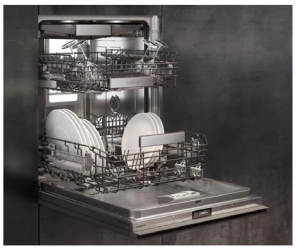
Not just a your coffe

HC: Switc

REFRIGERATOR

Extending freshness ingredien presentin best light

HC: Man consump activate



ARMING
RAWER

DISHWASHER

Clean with care and intelligence, before revealing it beautifully.

HC: Learn about the settings

TUMBLE DRYER

CLEANING

WASHING MACHINE

ny coffee,
ee.

h on and activate

STORAGE

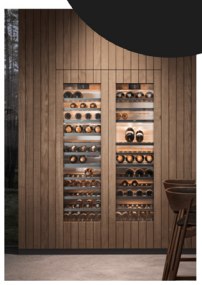
g the
s of your
ts and
g all in its
.

age
tion,
eco-mode

WINE CABINETS

Protect, present, prepare.

HC: Define temperature



HOME CONNECT

Therefore our appliances are going to be equipped with Home Connect, a platform allowing you to intuitively communicate with your appliance digitally, remotely and at will – while also offering a wide range of other advantages such as remote diagnostics and integration into selected home management systems

**For all BSH Group's brands*

APPENDIX C: User research setup

C.1 Consent form template

GAGGENAU

TU Delft

Consent form User Research

The following is a consent form for a research project focused on redesigning the role of the future kitchen.

Participating in this study involves taking some photos of your private kitchen and answering questions about your personal experience in it. This includes questions about moments such as cooking and eating, social relationships that occur in this context and digital devices that might be used during these situations.

You will receive instructions to guide you during the "Photo Safari" activity where you would photograph your kitchen from your own perspective, which can be done at your own path. At the end of the study, we will interview you for approximately 30 minutes.

1. I understand that my participation is voluntary and that I can withdraw and discontinue participation at any stage of this study without questions asked. I can do so by emailing Nuria Nicolau (n.nicolautorra@gmail.com).

2. I understand that as part of this study I will be asked to take photos of my private kitchen.

3. I understand that participating in this study involves taking part in an interview of approximately 30 minutes. The interview will be audio recorded for analysis purposes.

4. I understand that information I provide will be used for reports, publications, websites.5.

5. I agree that my information can be quoted in research outputs. I agree that the photos and notes that I provide as part of the research kit can be shown or quoted in research outputs as long as I remain non-identifiable.

6. I have read and understood the explanation provided to me. I have had all my questions answered to my satisfaction, and voluntarily agree to participate in this study.

7. I have been given a copy of this consent form.

Date

_____

Participant signature

Researcher signature

Researcher details:

Participant Name

Nuria Nicolau Torra (n.nicolautorra@gmail.com)

C.2 Photo Safari instructions

CAPTURING YOUR KITCHEN

INSTRUCTIONS

During this activity I want you to reflect about your experiences in your kitchen. And of course, I want to start by *thanking you* for being part of this research. Before you we move to the tasks, I want to make clear three things:

1. There is no right or wrong, so feel free to explore the exercices from your own perspective, all interpretations are welcomed.

2. Although this activity involves photos, I don't expect you to be a professional, so focus on capturing the idea and don't worry about the quality of the image. Below you can find examples of the type of images I am interested on:

Don't try to imitate stock photos that lack of meaning.

Don't modify the environment to take nice looking photos

Instead show the what is relevant from your perspective.

Instead photograph your experience being realistic

3. If photographing yourself or other household memeber would make the photo more explanatory and richer, please do it and we will make sure everyone is anonymized and unidentifiable.

CAPTURING YOUR KITCHEN

THE TASKS

PART 1: individual

As this is an individual activity, each member of the household participating has to take its own photos. Do not share your results until everyone has completed the tasks.
Take a photo for each of the following ideas:

- **The image that comes to your mind when you think about your kitchen**
- **Your favourite thing from your kitchen (object, area, moment...)**
- **What you dislike the most from your kitchen (object, area, moment...)**
- **If there is something else that makes your kitchen special, plese photograph it**

PART 2:

This can be done by any of the members of the household, or as a collaborative task.
Take photos of the following:

- **A general photo of the space (neutral)**
- **Capture a routine dinner in this space and/or the eating area**
- **Digital and electronic devices used in the kitchen for any purpose**

PART 3:

For the last part I will ask you to look on your photo library and search for images from special occasions at home. In particular moments related to cooking and eating that are not part of your routine such as special meals you cooked or meals with guests (the food, the setup, the people at your house). Collect a few images from these moments.

C.3 Interview structure

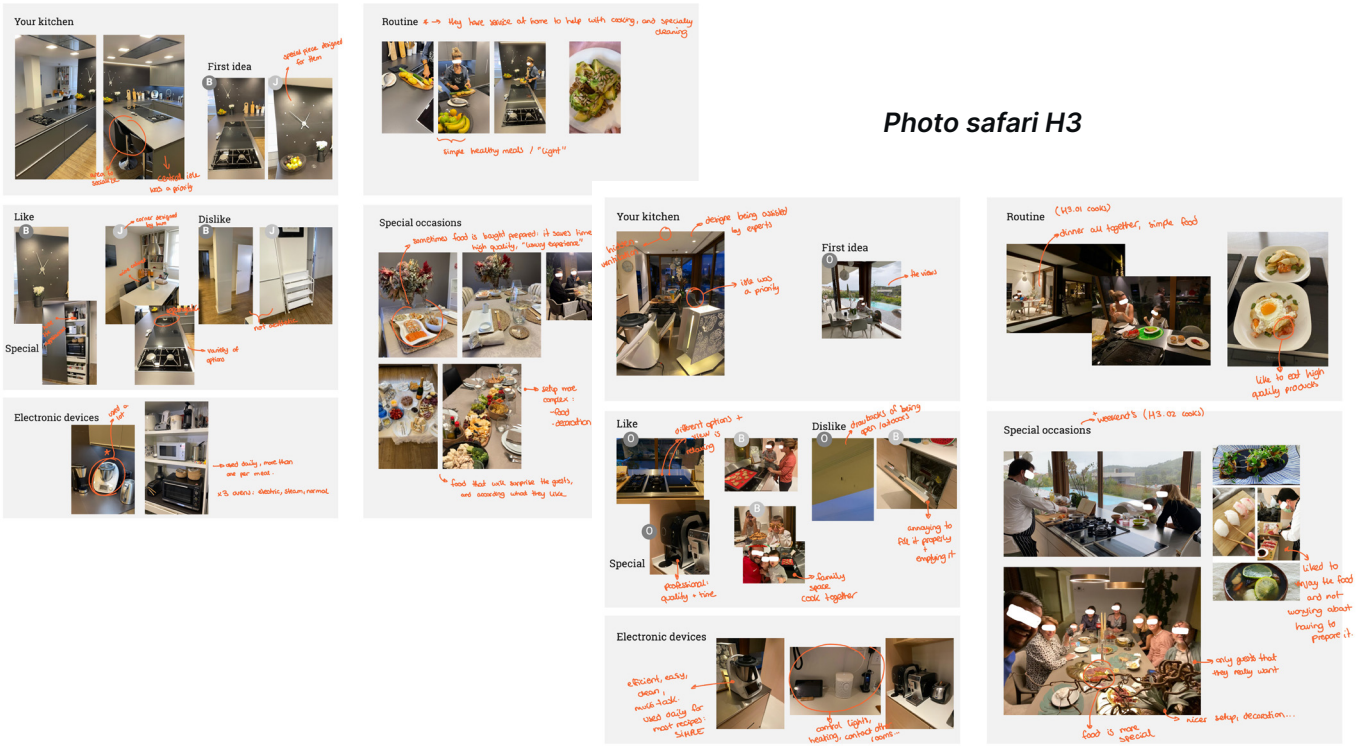
	Customary pleasantries	
ice-breaker	1- How long have you been living in this house? During this time have you done any renovations of your kitchen? 2- How would you describe your kitchen in one sentence?	*(If affirmative, ask what+why)* *Could you please elaborate a bit on this description?*
T1. pleasures/pains	*(Based on the photos)* 3- Ask why they like/dislike the chosen thing. 4- Describe the experience and feelings.	 *Imagine yourself doing/using the thing, and describe the process*
T2. routine use	5- How would you describe your role in the kitchen? 5.1- In case of cooking: pleasures 6- In a normal day, how is your kitchen used? 7- Could you please describe a routine meal at home? *(relevant things on the photos, discuss it)*	*Clarify: which tasks mainly performed* *Ask to elaborate* *Detail in types of conversations, food...*
T3. special occasions	8- Whenever you invite guests for a meal, how do you like them to feel? What is the thing you care most about? 9- What do you like the most about these occasions? And the least? *(relevant things on the photos, discuss it)*	*Why do you care so much about this?* *Ask to elaborate*
T4. digital devices	*(Based on the photos)* 9- Why do you use these digital devices? 10- Which are the main benefits from your perspective? 11- Is there something that you miss or would like to have in your kitchen?	 *Ask to elaborate*
closing	Now I would like you to think in the future, imagine your kitchen 5 years from now. If you had to say two things that you would love to have, what would it be? Think freely, with no restrictions.	
	Customary pleasantries	

APPENDIX D: User research thematic analysis

Step 1: Observe and **analyze the photos** sent by the participants to **capture relevant ideas**

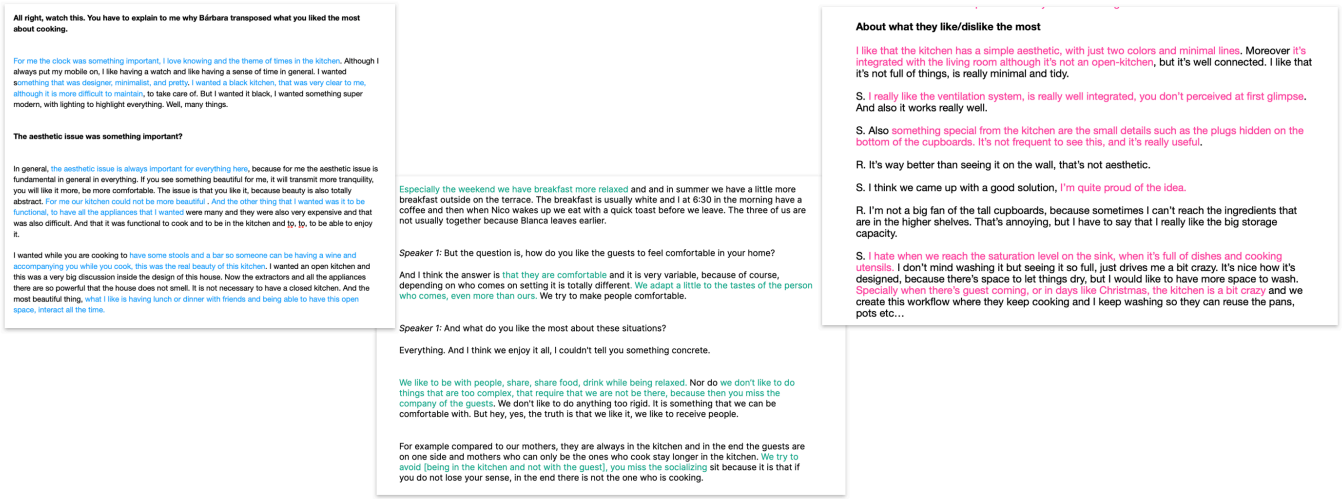
Photo safari H1

Photo safari H3



Examples of the analysis method from participants' Photo Safari

Step 2: Transcribe **the interviews** and highlight the relevant **quotes** from each



All right, watch this. You have to explain to me why Bárbara transposed what you liked the most about cooking.

For me the clock was something important, I love knowing and the theme of times in the kitchen. Although I always put my mobile on, I like having a watch and like having a sense of time in general. I wanted something that was designer, minimalist, and pretty, I wanted a black kitchen, that was very clear to me, although it is more difficult to maintain, to take care of. But I wanted it black, I wanted something super modern, with lighting to highlight everything. Well, many things.

The aesthetic issue was something important?

In general, the aesthetic issue is always important for everything here, because for me the aesthetic issue is fundamental in general in everything. If you see something beautiful for me, it will transmit more tranquility, you will like it more, be more comfortable. The issue is that you like it, because beauty is also totally abstract. For me our kitchen could not be more beautiful . And the other thing that I wanted was it to be functional, to have all the appliances that I wanted were many and they were also very expensive and that was also difficult. And that it was functional to cook and to be in the kitchen and to, to, to be able to enjoy it.

I wanted while you are cooking to have some stools and a bar so someone can be having a wine and accompanying you while you cook, this was the real beauty of this kitchen. I wanted an open kitchen and this was a very big discussion inside the design of this house. Now the extractors and all the appliances there are so powerful that the house does not smell. It is not necessary to have a closed kitchen. And the most beautiful thing, what I like is having lunch or dinner with friends and being able to have this open space, interact all the time.

Especially the weekend we have breakfast more relaxed and and in summer we have a little more breakfast outside on the terrace. The breakfast is usually white and I at 6:30 in the morning have a coffee and then when Nico wakes up we eat with a quick toast before we leave. The three of us are not usually together because Blanca leaves earlier.

Speaker 1: But the question is, how do you like the guests to feel comfortable in your home?

And I think the answer is that they are comfortable and it is very variable, because of course, depending on who comes on setting it is totally different. We adapt a little to the tastes of the person who comes, even more than ours. We try to make people comfortable.

Speaker 1: And what do you like the most about these situations?

Everything. And I think we enjoy it all, I couldn't tell you something concrete.

We like to be with people, share, share food, drink while being relaxed. Nor do we don't like to do things that are too complex, that require that we are not be there, because then you miss the company of the guests. We don't like to do anything too rigid. It is something that we can be comfortable with. But hey, yes, the truth is that we like it, we like to receive people.

For example compared to our mothers, they are always in the kitchen and in the end the guests are on one side and mothers who can only be the ones who cook stay longer in the kitchen. We try to avoid [being in the kitchen and not with the guest], you miss the socializing sit because it is that if you do not lose your sense, in the end there is not the one who is cooking.

About what they like/dislike the most

I like that the kitchen has a simple aesthetic, with just two colors and minimal lines. Moreover it's integrated with the living room although it's not an open-kitchen, but it's well connected. I like that it's not full of things, is really minimal and tidy.

S. I really like the ventilation system, is really well integrated, you don't perceived at first glimpse. And also it works really well.

S. Also something special from the kitchen are the small details such as the plugs hidden on the bottom of the cupboards. It's not frequent to see this, and it's really useful.

R. It's way better than seeing it on the wall, that's not aesthetic.

S. I think we came up with a good solution, I'm quite proud of the idea.

R. I'm not a big fan of the tall cupboards, because sometimes I can't reach the ingredients that are in the higher shelves. That's annoying, but I have to say that I really like the big storage capacity.

S. I hate when we reach the saturation level on the sink, when it's full of dishes and cooking utensils. I don't mind washing it but seeing it so full, just drives me a bit crazy. It's nice how it's designed, because there's space to let things dry, but I would like to have more space to wash. Specially when there's guest coming, or in days like Christmas, the kitchen is a bit crazy and we create this workflow where they keep cooking and I keep washing so they can reuse the pans, pots etc...

Screenshot from different parts of the interviews' transcripts with highlighted quotes.

Step 3: Cluster all the quotes according the topic mentioned.

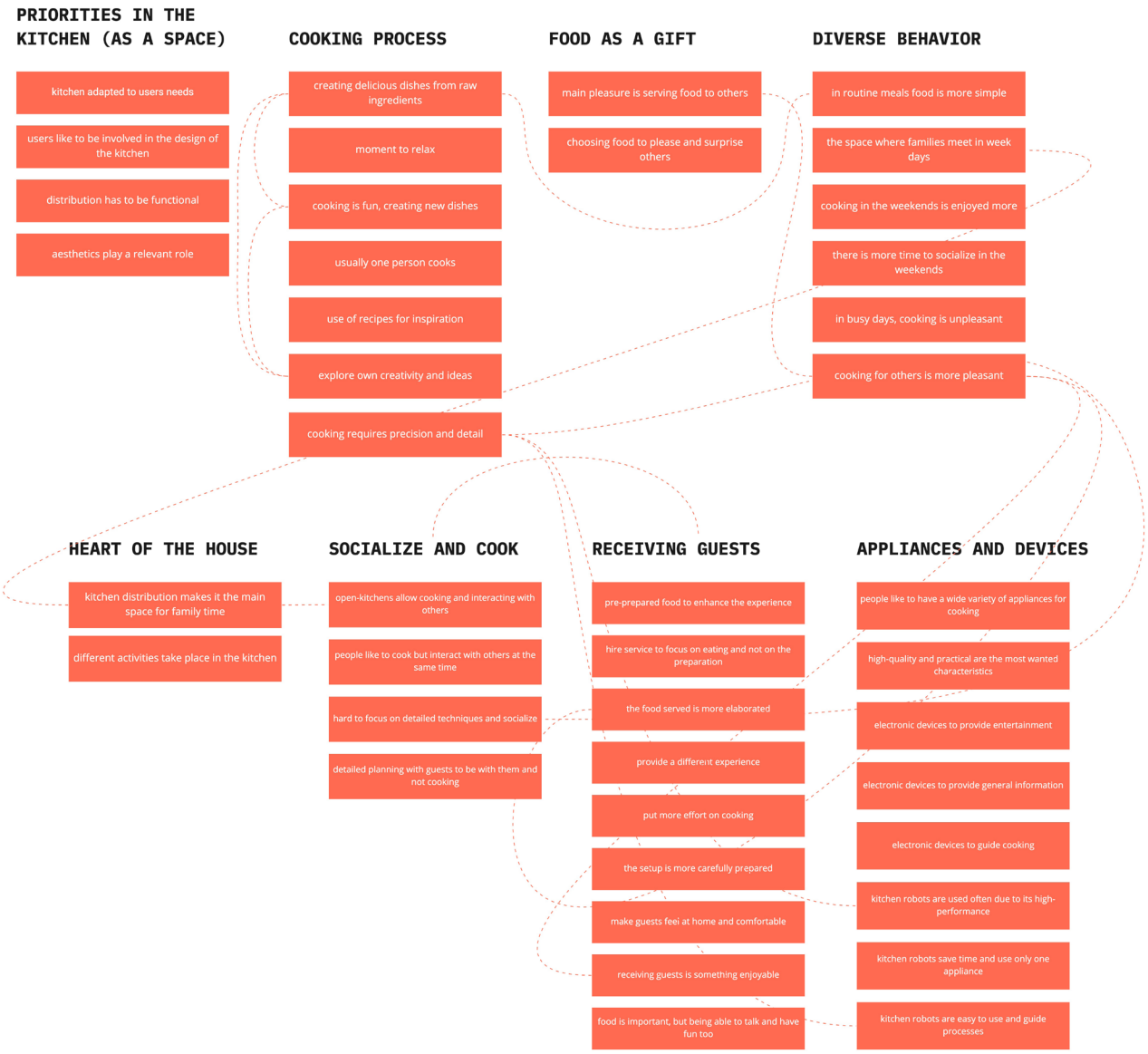
CLUSTER DATA

grouped qualitative data in clusters

Step 4: Create **affinity diagrams** to group the data

AFFINITY DIAGRAM

bigger clusters and their meanings



Step 5: Generate **themes**

REFINING THE THEMES

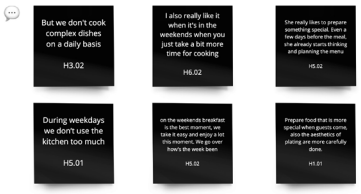
Connecting the ideas and clusters, identifying the relevant aspects

FUNCTIONAL AESTHETIC

Design the kitchen according one's preferences, making it functional and comfortable while having aesthetics as a priority.

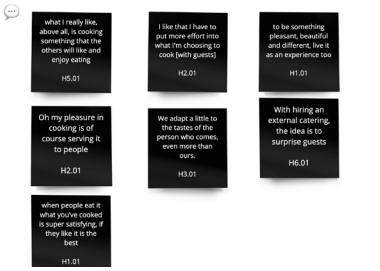
USE PATTERNS

Depending on the occasion, the kitchen is used in a different way. The routine asks for simple dishes, while on weekends families spend more time cooking and together, preparing more complex meals. In special occasions, such as birthdays or when receiving guests, the whole setup is more elaborated, and the food is carefully choosen.



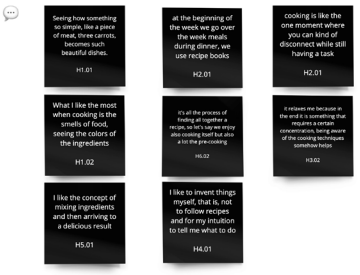
PLEASING OTHERS

The most enjoyed aspect of cooking is serving food to others. This is why when preparing meals for guests or the family, the dishes are more carefully prepared, putting extra effort. Also the overall experience is planned to surprise.



COOKING AS A PLEASURE

Usually it's one person the one that cooks and enjoys it the most. Participants mentioned specially the fact of creating new dishes and combining different ingredients to make delicious dishes the best part. Most of them use recipes to get inspiration, but add personal touches. Cooking is also perceived as a relaxing activity.



PRECISION AND DETAIL

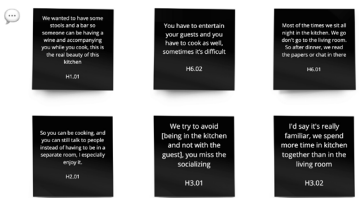
Cooking requires being precise and detailed, and kitchen appliances can help on achieving this. However, socializing while cooking makes this hard.

TECHNOLOGY

The user group likes to have a wide variety of appliances that facilitate the cooking process and guide it. These appliances have to be high-quality and provide perfect results, while being easy to use.
Some electronic devices are used for entertainment.

SOCIALIZING HUB

Kitchens are where families spend most of their time together. Moreover, the person who cooks likes to do it without being isolated, so having the chance to interact with others. The distribution of the kitchen plays an essential role on allowing this.



APPENDIX E: Understanding the cooking process

The cooking process and its different steps has been analyzed in order to understand the touchpoints between the user and the kitchen, as well as identifying possible opportunities of the smart kitchen to make the experience more celebratory.

	ideation	procurement	preparation
What is the goal of the phase?	Decide what to cook	Ensure the availability of the needed ingredients, tools and materials	Division of tasks and pr the raw ingredients
What actions take place in these phases?	discuss with others look for inspiration ideate a combination browse recipes check available ingredients	share the moment with others prepare kitchen to cook buy ingredients organize ingredients kitchen prepare appliances	use the hands use of cooking utensils use of appliances talk with others ask for help
What knowledge or information is needed in each step to achieve the best results	Final result Flavour combinations Possible techniques with the owned appliances Complexity of the concept	Necessary ingredients Where to obtain the ingredients Needed utensils, appliances	Technique skills Times Next step Conservation of preparations
How can autonomous agents maximize the performance?	*Trigger creative thinking: new ways of using appliances, food combinations*	*Suggest where to get specific ingredients* *Help with personalization when lacking something*	*Precision and detail* *Guide through process*

repare

cooking

Transform raw ingredients through different processes

Use of appliances

Technique skills

Expected result: visual

Expected result: flavour

Time

Next step

State of the ingredients (raw-cooked)

Precision and detail

Guide through process

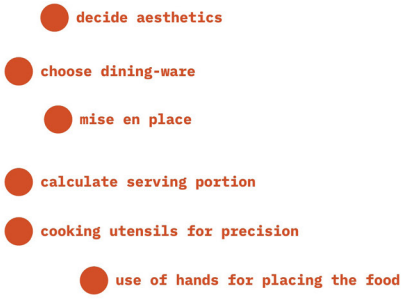
Trigger creativity

Encourage personalization

Visualize state of cooking process (ingredients)

plating

Arranging the ingredients before being served, in a balanced and aesthetic way



Tools to use

Technique skills

Aesthetic possibilities

Portion size

Ingredients balance

Trigger creativity

Guide through process

Precision and detail

serving

Present the dish to the dinir guests

Dish content

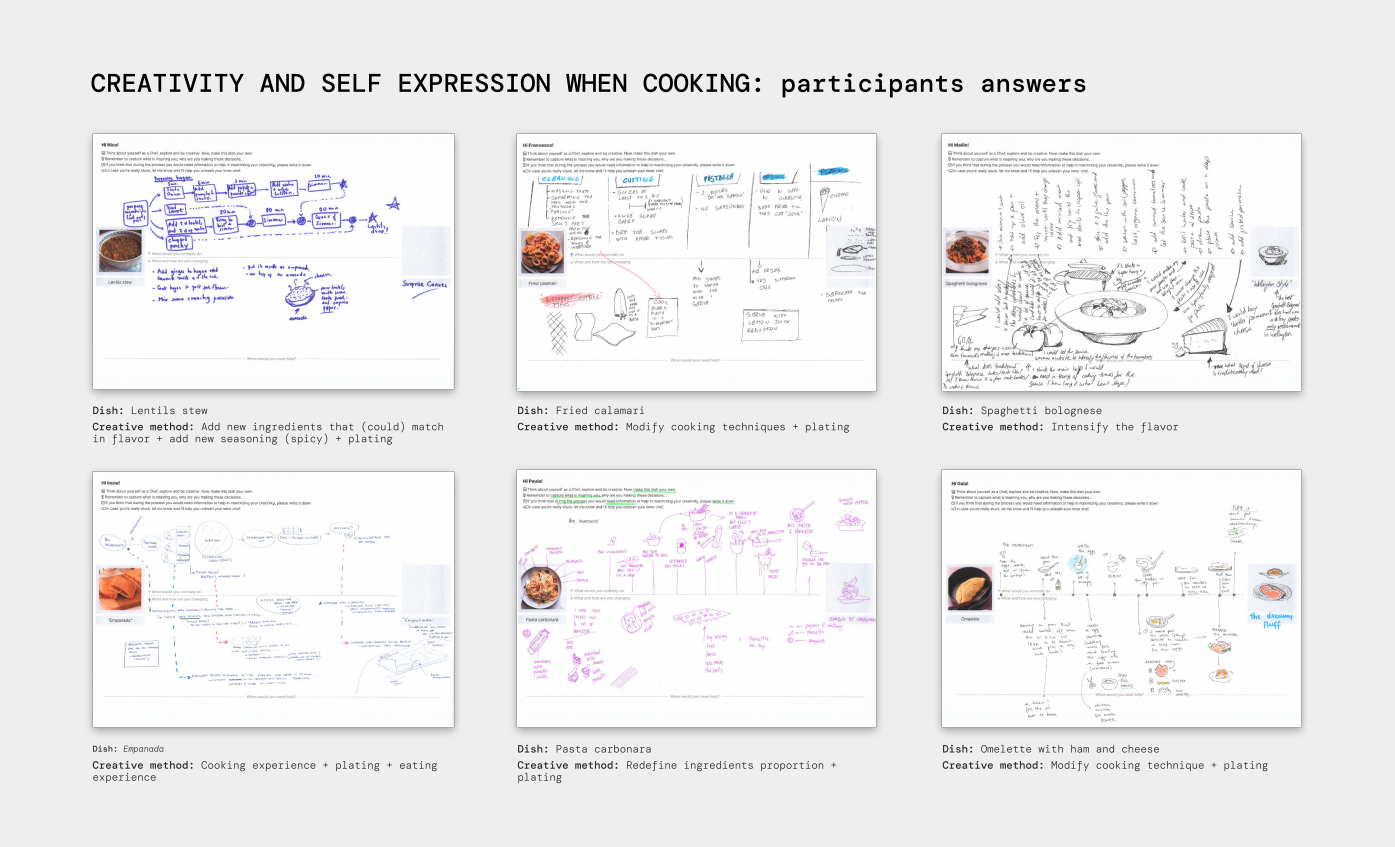
Wine pairing

Assist pairing decisions

APPENDIX F: Inspiration activities

F.1 Ideation workshop

A groupal ideation session has been carried out as a source of inspiration and to reduce personal bias and design fixation. The session has been focused on exploring **how different people approach the creative process in the kitchen** through adding a personal touch to their favourite dish. This activity was followed by a **reflection and open conversation** with the participants. The session lasted 1:30h and 6 participants took part of it.



Participants results for the creative activity (num 1).

Activity 1

For the first activity, participants were asked prior to the session to indicate their favourite dish. In this activity participants had to rethink this dish with their personal vision, being creative, for this, a template was provided.

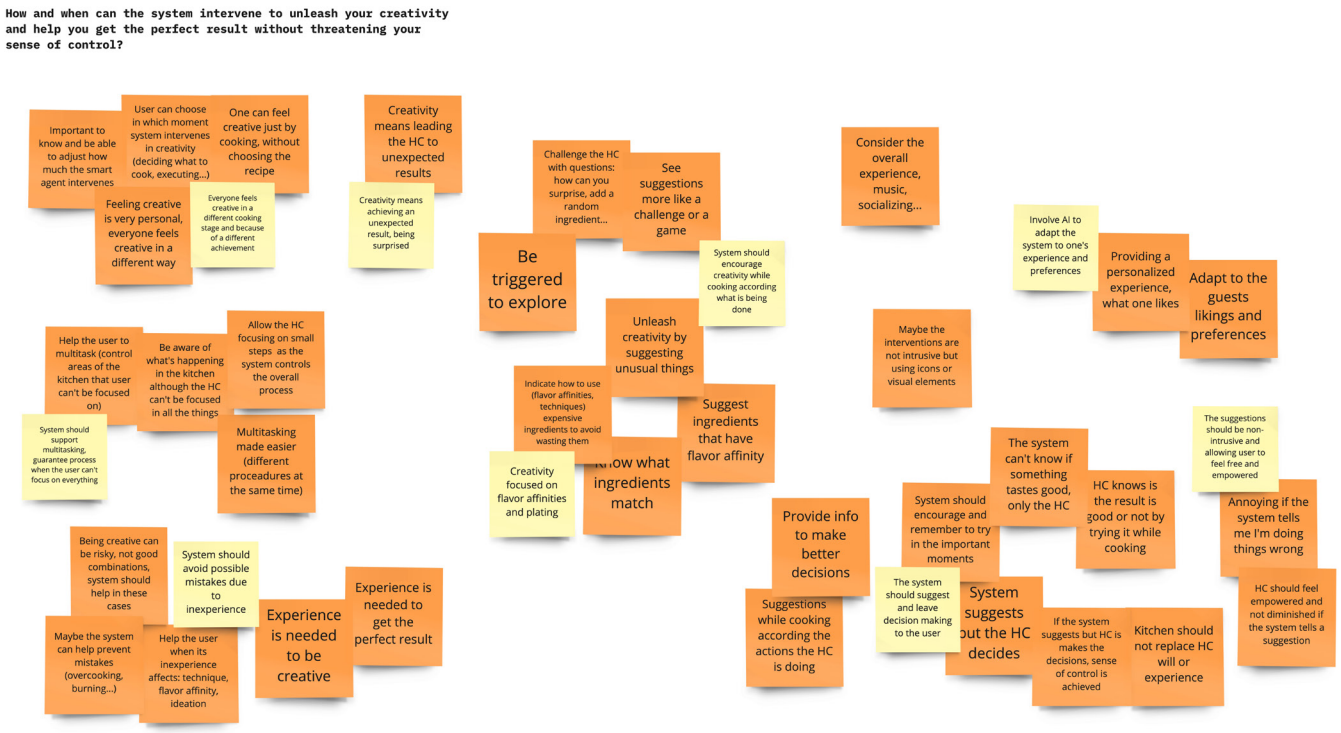
The template allowed participants to indicate the process followed to cook the meal (starting from preparation until plating), and was divided in two areas. The top part is reserved for the steps that are usually followed, while the area in the bottom is where they could express how they are changing the recipe. Participants were encouraged to indicate the rational behind their decisions as well as their inspiration sources. Finally, a space was also reserved to write down the moments in which participants felt they would need external help.

The results indicate how every participant followed a different creative approach, from re-making the dish by chosing alternative cooking methods, to adding new ingredients or reinventing the way to serve it.

Participants during the session.

Activity 2

The second part of the workshop has consisted in a discussion and reflection around the question: **how and when can the system intervene to unleaash your creativity and help you get the perfect the result withouth threatening your sense of control**?



Notes written by the participants during the reflection activity (digitalized version).

Conclusions

According both parts of the ideation session, the following conclusions have been drawn:

- Creativity means achieving an unexpected result, being surprised.
- Everyone feels creative in a different cooking stage and because of a different achievement.
- Participants understand creativity to be focused on flavor affinities and plating.
- The system should encourage creativity while cooking according what is being done (real-time).
- The system should suggest and leave decision making to the user.
- The suggestions should be non-intrusive and allowing users to feel free and empowered.
- Involve AI to adapt the system to one's experience and preferences.
- System should avoid possible mistakes due to inexperience.
- System should support multitasking, guarantee process when the user can not focus on everything

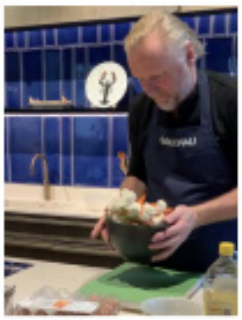
Another relevant observation is the fact that all participants had an explorative approach when asked to be creative with their favourite dish, being guided by their intuition to make decisions in the moment. However, a few situations in which the system could help them have been mentioned:

- Flavor affinities (knowing possible ingredients combinations)
- Timings (cooking times to get the best result)
- Temperature (to cook a specific ingredient)
- Indicate or even turn off appliance if an elaboration might get overcooked/burnt.
- Know how things should taste
- Help on providing ideas about what to cook
- Recipes for specific ingredients
- How to exectute a specific technique

F.2 Showcooking at Gaggenau

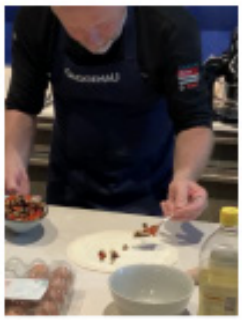
The following images were captured in the showcooking at Gaggenau's showroom in Amsterdam on the 13th of November 2021 executed by the Dutch chef Marcel Rijsman. The analysis of the session has consisted on capturing the moments in which the chef used its senses to follow the cooking process and make decisions.

Adding oil to the veggies
to feel the amount poured



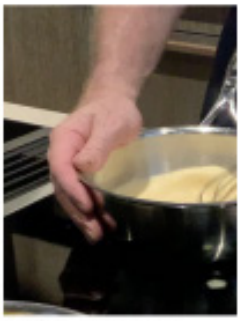
Mixing the veggies
to check mix

Knead the dough
to feel the thickness



Spreading toppings
to distribute homogeneous

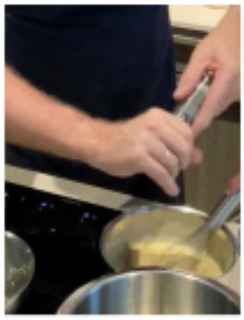
Confirm doneness
check the color of the base



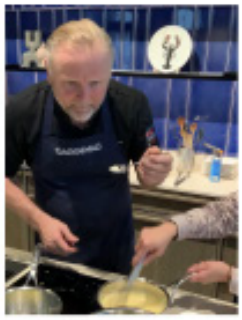
Check the temperature
to feel the temperature

Mix the ingredients
to feel the texture

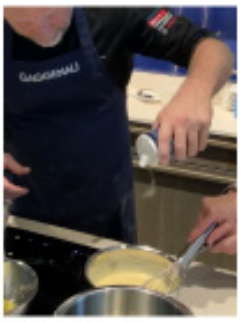
Adding melted butter
to feel the texture, amount



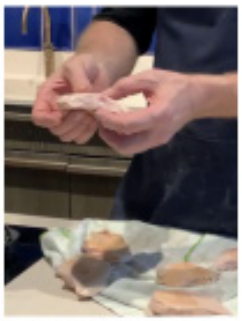
Seasoning the sauce
to feel the amount added



Trying the food
to analyze the flavor

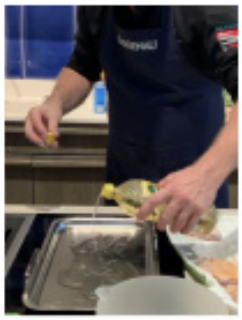


Seasoning the sauce
to feel the amount added



Show the technique's benefit
to feel the doneness and tenderness of the chicken

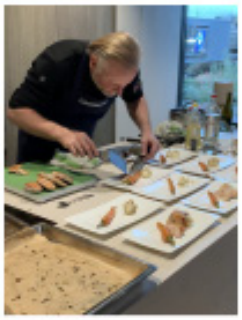
Checking the temperature
to see water evaporate



Pouring oil into the pan
to control quantity poured

Check chicken doneness
to see the color

Season the ingredients
to feel the amount of salt



Plating
to define the composition

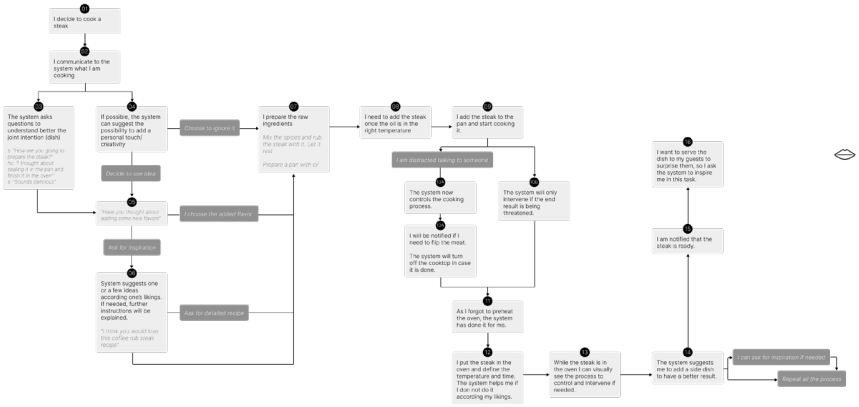
Plating
to be precise

Plating
to be precise

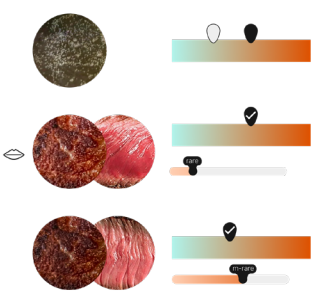
F.3 Recipes analysis

This section of the appendix includes different recipes analysed from different perspectives in order to understand how the system could be helpful on triggering the creativity throughout their execution as well as guaranteeing the best result. For each recipe three steps were carried out, the first one was done on the inspiration phase, while the following two are part of the first and second iterations executed during ideation.

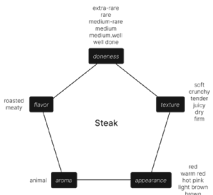
STEAK: add new ingredient



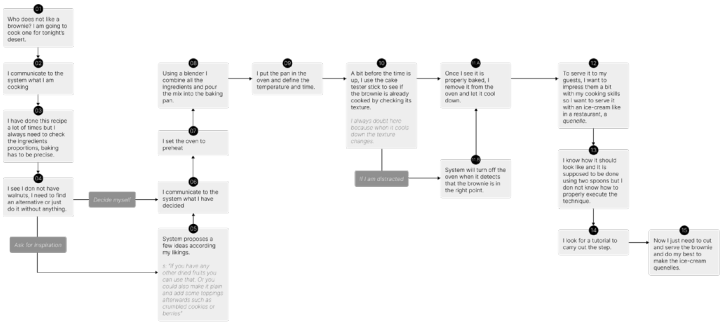
Sensory info throughout the process



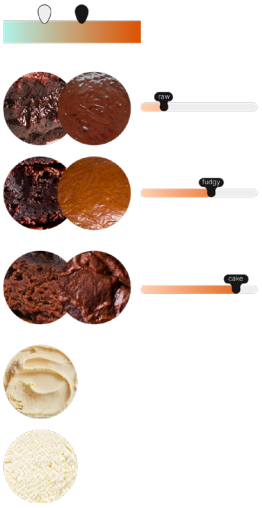
Translating the sensory info



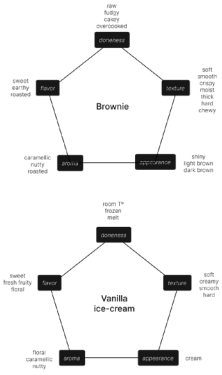
BROWNIE: play with food composition



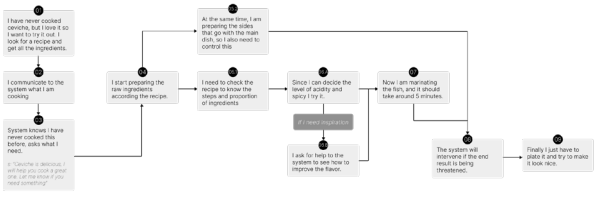
Sensory info throughout the process



Translating the sensory info

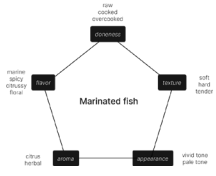


CEVICHE: cooking a new recipe

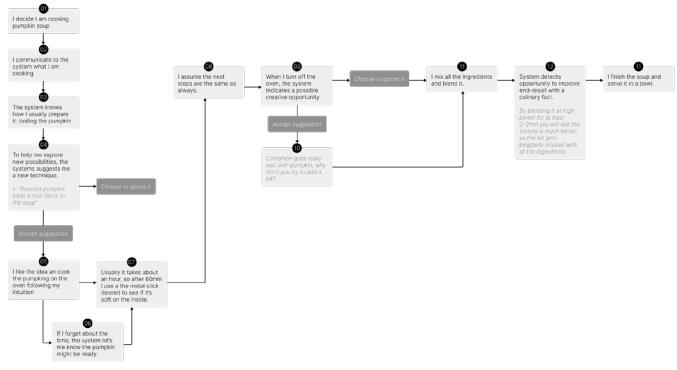


Sensory info throughout the process

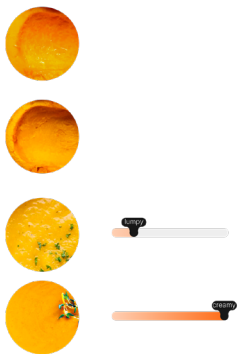
Translating the sensory info



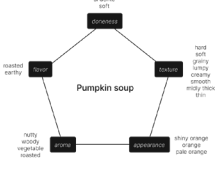
PUMPKIN SOUP: new cooking technique + explore new flavor combination



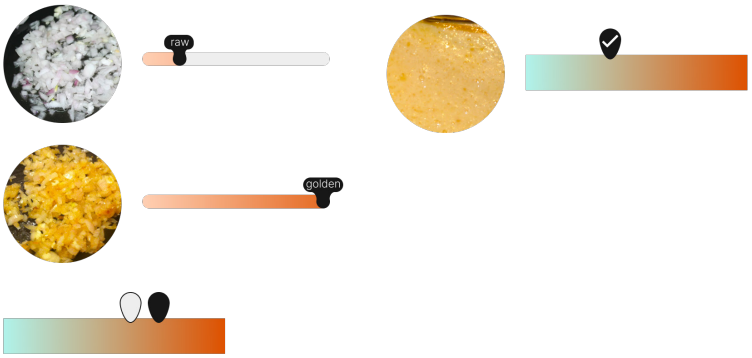
Sensory info throughout the process

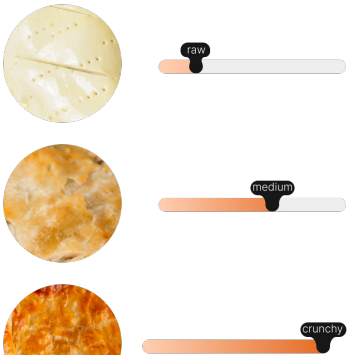


Translating the sensory info

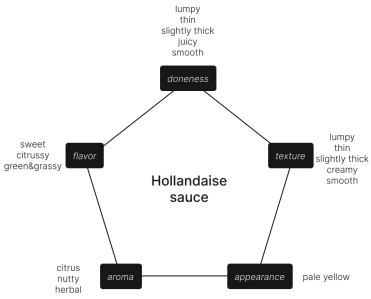


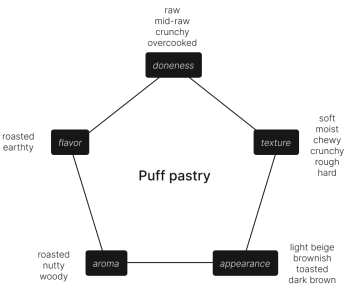
Sensory info throughout the process

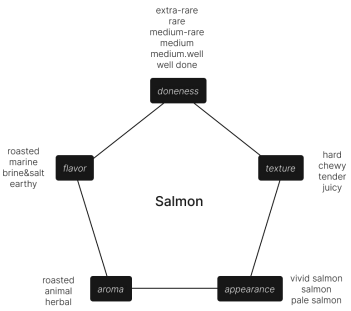




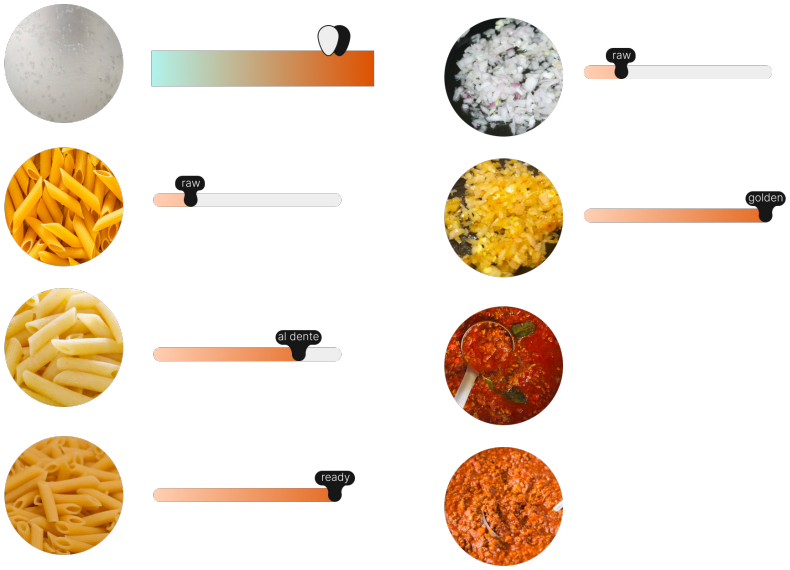
Translating the sensory info



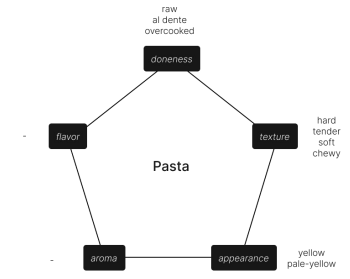


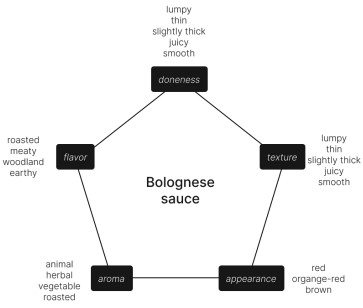


Sensory info throughout the process

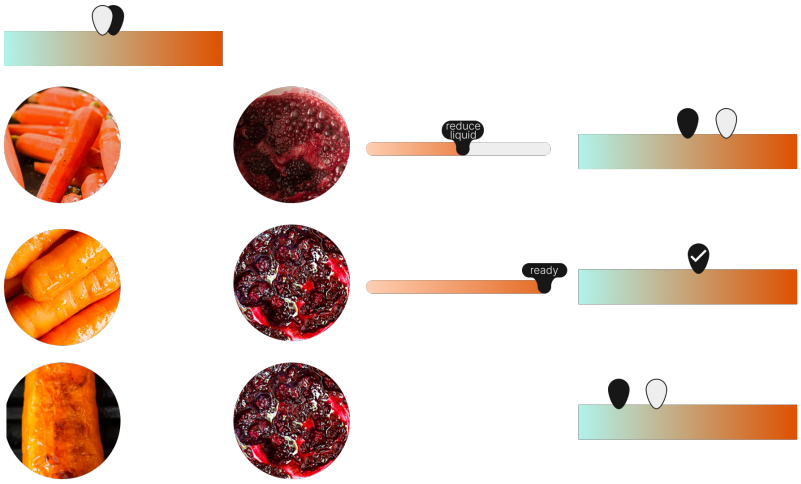


Translating the sensory info

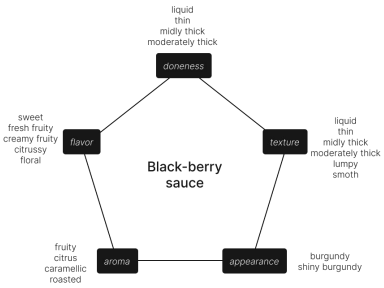


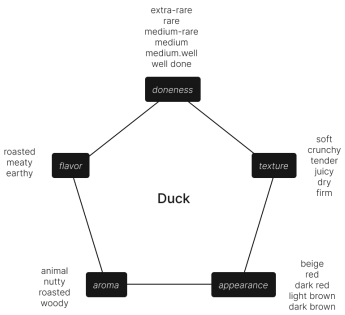


Sensory info throughout the process



Translating the sensory info





Appendix G: Iteration cycles

G.1 First Iteration

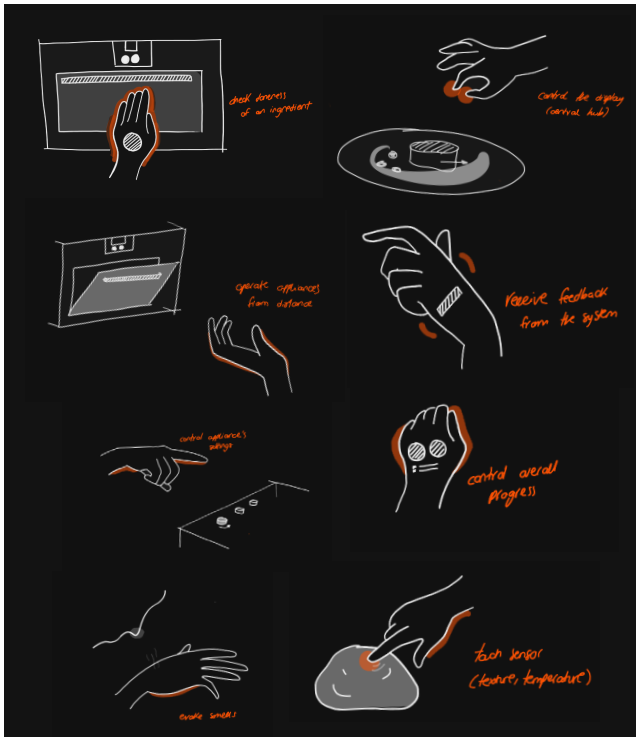
This is the first iteration carried out during the ideation phase. which started with the idea of using a wearable to be more aware of the cooking process and a central hub to provide information about it.

GOALS

Validate the main concept by focusing on the communication aspects, validate the information shown and if the system is capable of triggering creativity and helping the user be in control and stay informed.

METHOD

The iteration started with an ideation session to define the potential functionalities of the wearable and central hub.
This was followed by evaluating the initial concept with different participants. 5 participants were explained the idea using storytelling, while 2 others took part in a user test where the use of the concept in cont ext was evaluated.
For the test a quick prototype was made, with different prompts used to emulate the information of the system throughout the process (A. Parts of the meal B. Ingredient's doneness C. Action icons D. Inspiration). Moreover, the facilitator of the test enacted the system in regards of the voice control feature.



Sketches done during the ideation for the iteration

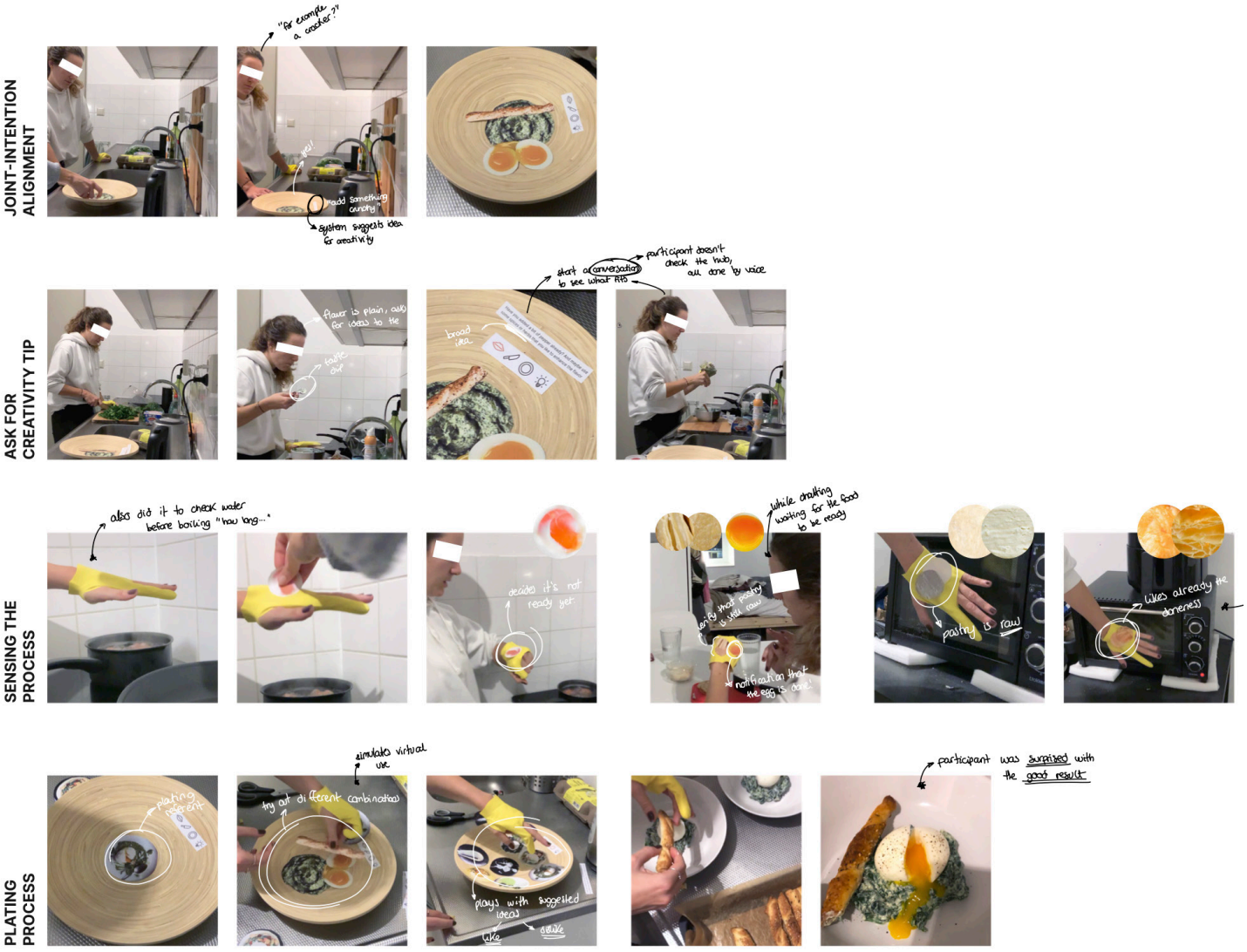
Quick prototype used to simulate the wearable.

Ressources used to carry out the *Wizard of Oz* during hte test.

CONCLUSIONS

According the different conversations with potential users and the test carried out, these are the aspects to consider for future iterations.

- People liked the idea of a wearable that helps you cook better and control everything that is going on in your kitchen.
- Being able to visualize the joint-intention after aligning it with the system is nice. However people want to have a more detailed overview (i.e. different elements of the recipe).
- Providing insight on how to structure the cooking process in case multiple dishes or preparations are needed has been found relevant (i.e. indicating optimal time to start each preparation).
- Showing the recipe is not needed, but in some cases providing chef tips could be helpful (i.e. " meat can be in room temperature for 1h before cooking it, use thick salt when boiling pasta...).
- Sensory information has been well received as a guide to make decisions, but it has to be understandable
- The fact that the wearable notifies you in a non-intrusive way is nice. Perhaps notifying with a bit of time so it is not a rushed action.
- When interacting with the central-hub, possibility to adjust from full voice-only important-none (like a Google Maps assistant).



Images (and notes) captured from the recording of the user test.

6.2 Second Iteration

The second iteration aims to improve the initial concept based on the insights obtained from the first iteration.

GOALS

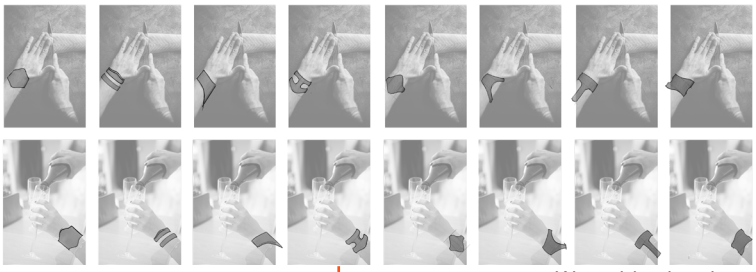
Validate the main concept by focusing on the communication aspects, validate the information shown and if the system is capable of triggering creativity and helping the user be in control and stay informed.

METHOD

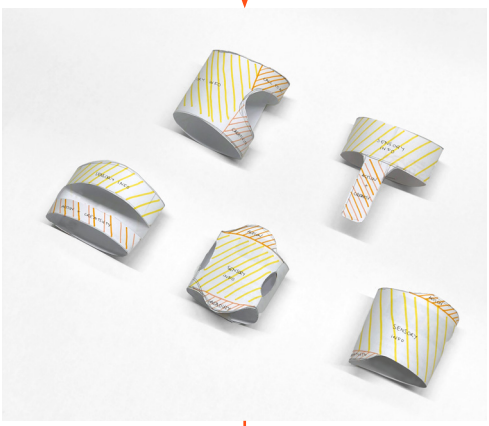
This iteration has been carried out by doing different activities, so instead of making one prototype and test it, the aim has been validating smaller parts of the concept individually.

- *(1) Shape* Regarding the shape, a moodboard has been done to obtain some inspiration. Then, sketches, paper and cardboard prototypes have been done to visualize the idea in 3D. Finally, the cardboard prototypes have been tried during cooking sessions to validate their usability.
- *(2) Information shown* An exercise to refine the information displayed by the wearable has been executed. This has lead to moving from literal sensory information, to creating the pentagram of sensory data that helps understanding the state of an elaboration.
- *(3) Interface* Finally, the first wireframes for the interface of the wearable have been designed. Those have been shown to 4 participants to evaluate their understanding and feeling in control

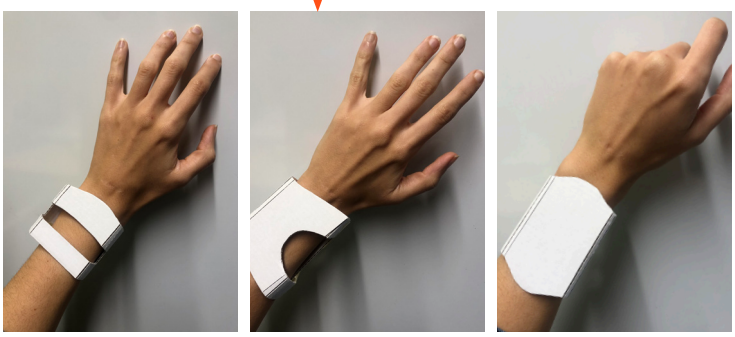
Moodboard to define the shape of the wearable based on jewelry.



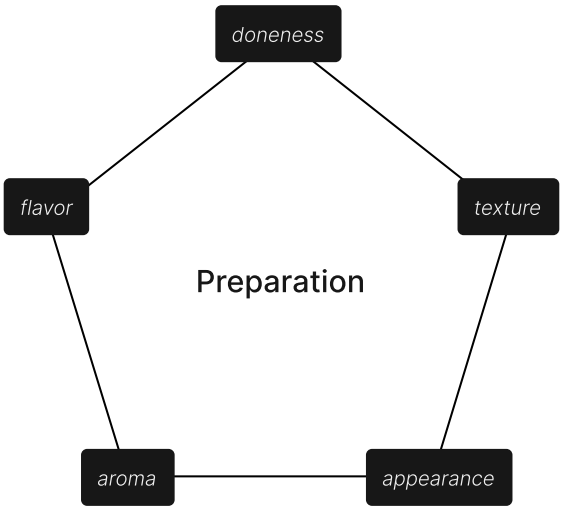
Wearable sketches.



Paper prototypes to define info areas



Carboard prototypes used to test the wearable's comfort on the wrist.

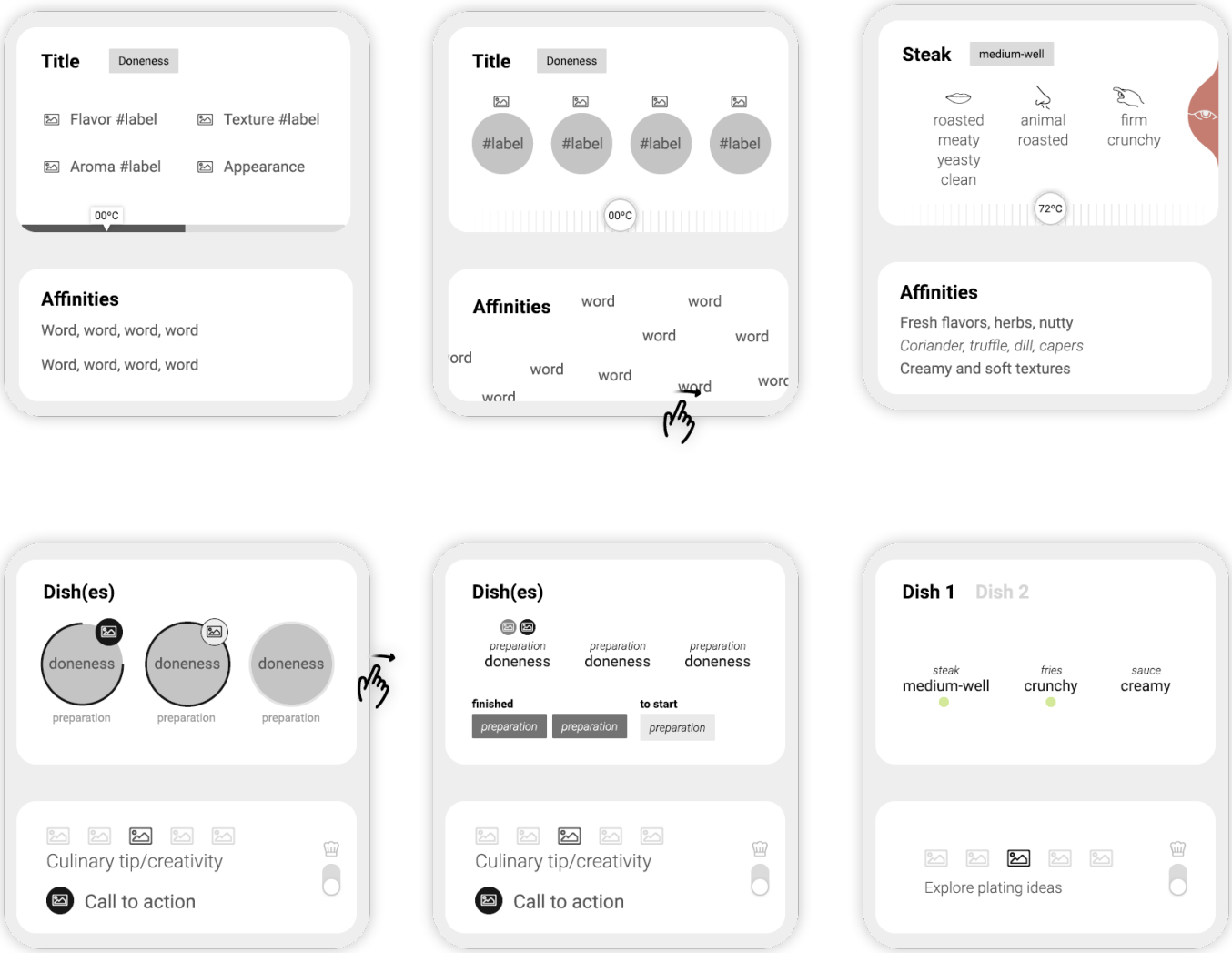


Pentagram of a preparation's sensory information.

Conclusions

The evaluation of the different parts of the iteration lead to the following conclusions.

- Each sensory variable has a different evolution and impact on decision-making, visually treat them accordingly.
- People specially liked the idea of using sensory information in a new way, it helped them think differently. Someone mentioned “it makes you feel more like a wine expert, or just like you know better what you are doing”.
- Regarding the affinities, some people prefer having broader suggestions that allows them to explore. Whereas other potential users mentioned that having suggestions according to their likings and also to what they have available at home would be preferred.
- When asked about feeling in control when looking at the dashboard people missed having access to information such as timers or the current appliances settings.
- While having freedom to make decisions and being a system based on suggestions, people missed having more guidance regarding the optimal result. Some ideas that participants mentioned where:
  -being able to see my preferred doneness
  -see how renowned chefs do it
  -see the best doneness for a specific product
- Having the wearable in the wrist is comfortable and doesn’t interrupt the cooking process. Moreover it guarantees that the information will always be easy to access for the user.



Wireframes designed on the second iteration to test the information displayed with participants.

G.3 Third Iteration

This is the third and final iteration carried out in the project, which conveys all the conclusions from the previous ones and aims to refine the concept.

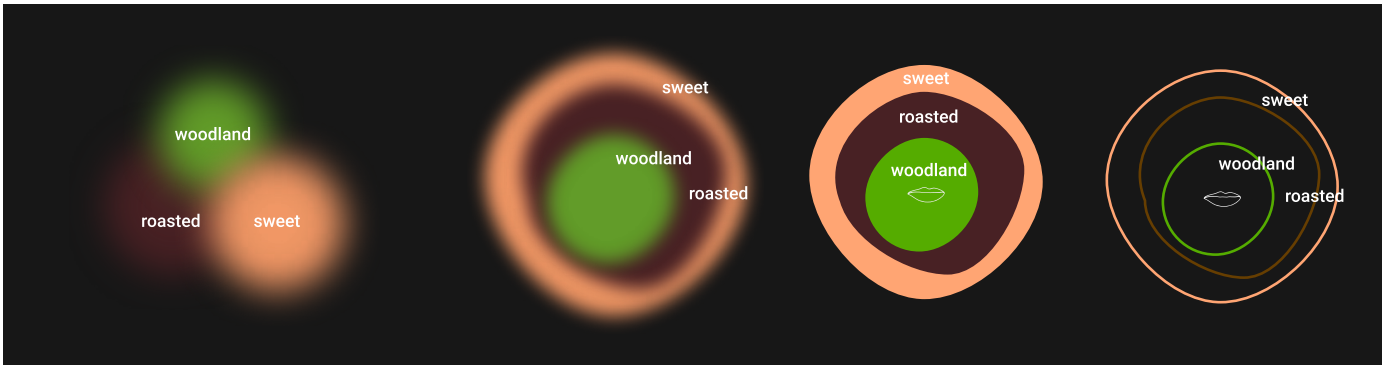
GOALS

Refining the shape, the visual information and the interactions with the wearable.

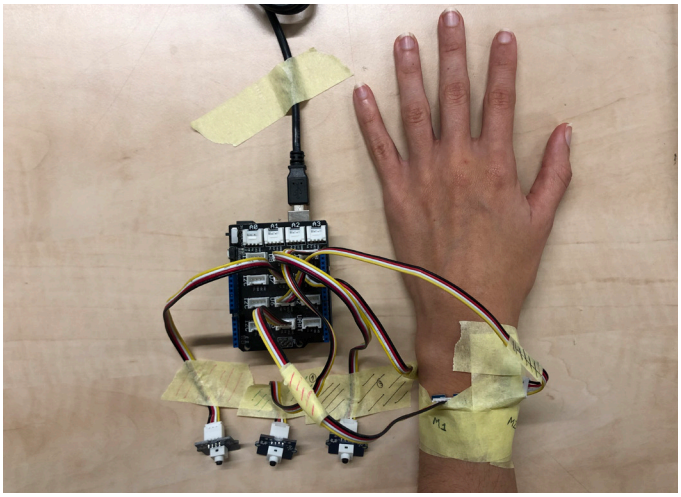
METHOD

Again, to proceed with this iteration the concept has been divided in different parts in order to refine the overall idea.

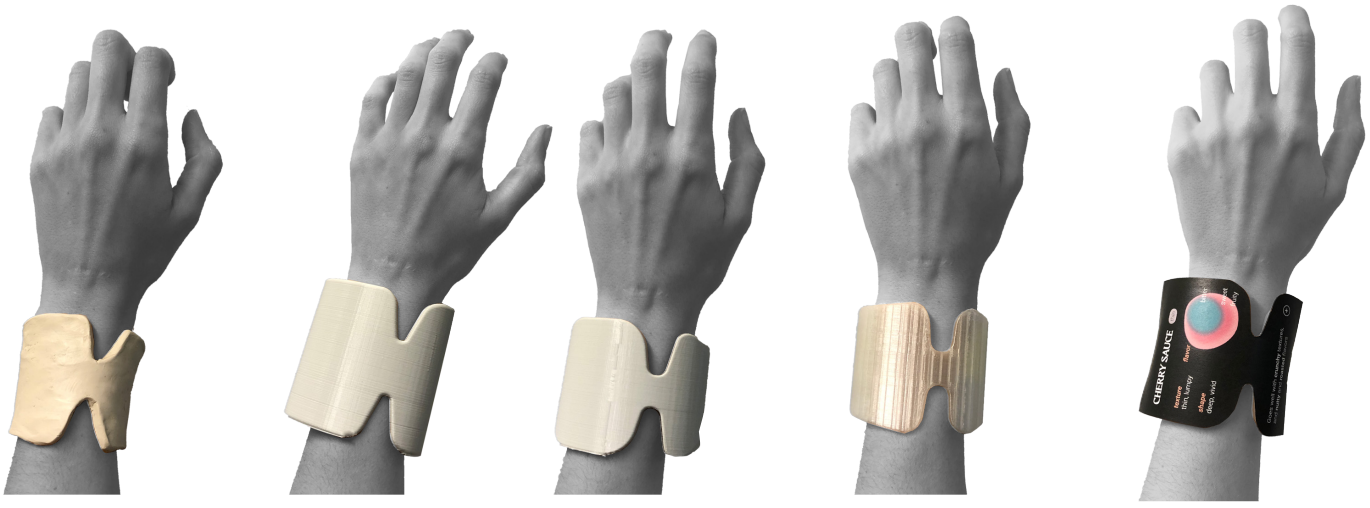
- *(1) Shape* Since the comfort and accessibility of the wearable in the wrist was already validated, in this iteration models (clay, 3D printing) have been done to define the final shape. The goals were to have the information sections dividided by the shape, make it aesthetic and comfortable.
- *(2) Information shown* The sensory information has been refined in terms of categories and visualization. Moreover, in the dashboard elements for guiding the user have been introduced.
- *(3) Autonomy levels, settings* Targeting the different modes of the system and how to adjust them have also been considered.
- *(4) Feedback* In this iteration the haptic feedback has been tested. By creating a quick prototype with vibration motors that 3 participants testes while working to analyze the non-intrusive character of this type of interaction.



Different visualizations for the sensory information, the final selection was based on feedback received from potential users.



Prototype made to test the haptic feedback of the wearable.

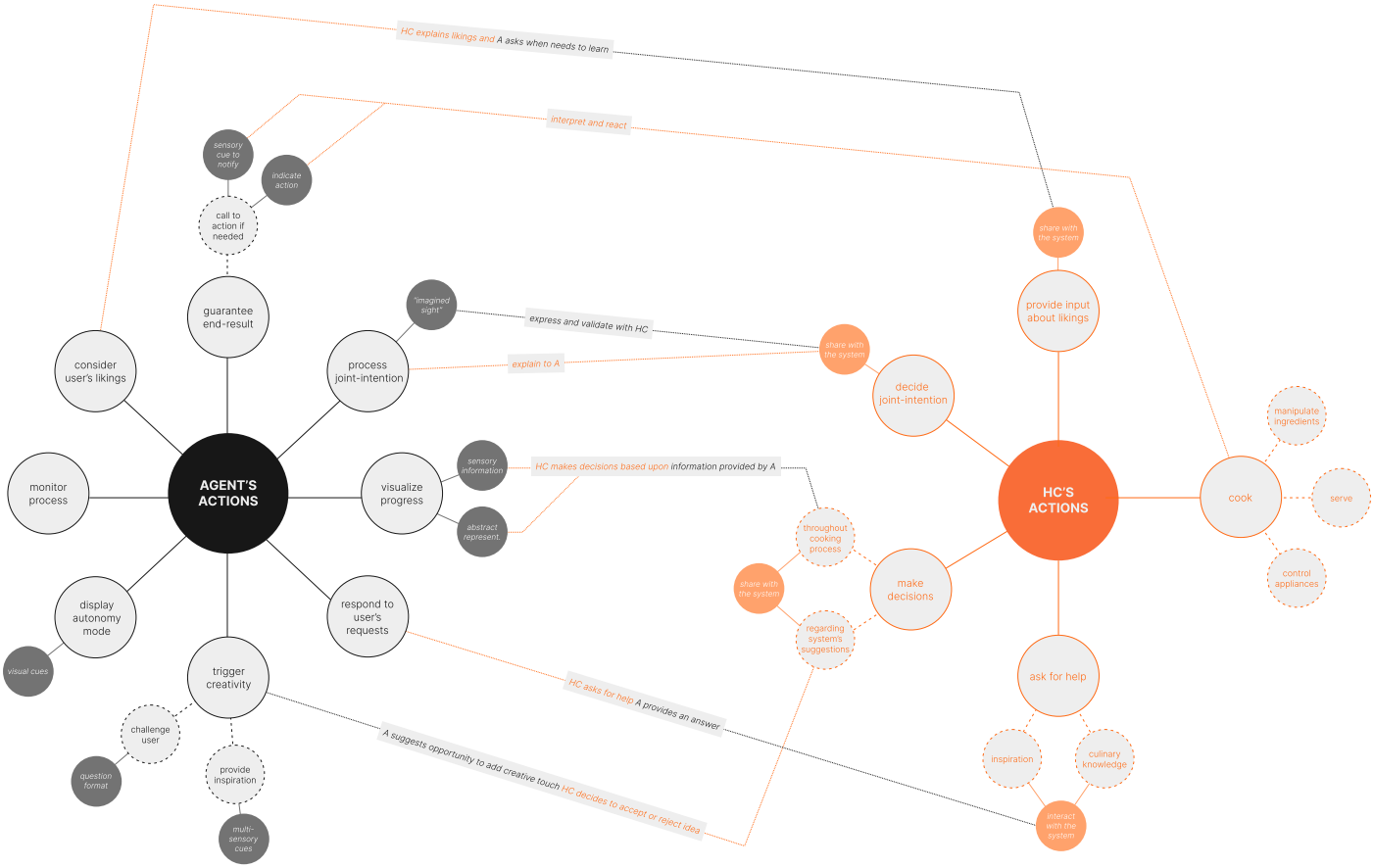


Evolution of the shape by using different prototyping techniques.

Appendix H: Why a wearable

The following analysis were done in order to evaluate the advantages of having a wearable. On one hand, by considering it the central hub of the system. Secondly, validating the idea of having the sensory sensors embedded on it instead of on the individual appliances.

INFORMATION ARCHITECTURE



Network of actions and possible touchpoints between entities.

FUNCTIONALITIES MATRIX

	oven	microwave	cooktop	ventilation	coffee m.	vacuum d.	warming d.	fridge	wine c.	central hub
INTERPRET JOINT-END										
Understand joint-end	-	-	-	--	-	--	--	-	-	++
Align expectations	-	-	-	--	-	--	--	-	-	++
PROVIDE INSIGHT										
Display sensory information	++	++	++	--	++	+	+	++	++	++
Display overall progress	-	--	-	--	--	--	--	-	--	++
Trigger creativity	+	-	+	--	+	+	-	+	+	++
Call to action	+	+	+	--	+	+	+	+	+	++
SUPPORT MULTI-TASKING										
Regulate settings + on/off	++	++	++	++	++	++	++	++	++	++
Provide feedback of state	+	+	+	+	+	+	+	+	+	++
PERSONALIZATION										
Create a personal "palate"	-	-	-	--	-	-	-	-	-	+
Consider personal likings	+	+	+	--	+	+	+	+	+	++

Central Hub evaluation matrix.

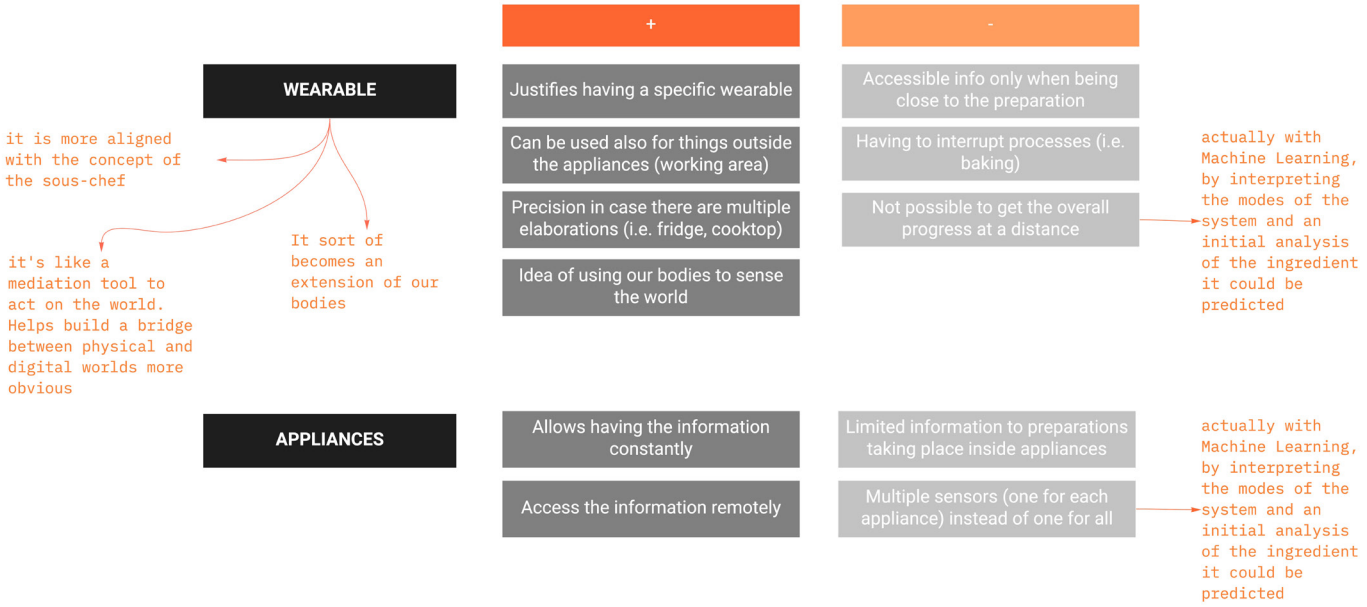
This matrix compares the possibility of accomplishing each sub-function for each appliance of Gaggenau's ecosystem with a central hub (the wearable).

++ Perfect execution of task
+ Possibility to execute task
- Not optimal to execute task
-- Impossible to execute task

SENSOR'S POSITION

Comparing the advantages (+) and disadvantages (-) of embedding the sensors in either the wearable or the individual appliances has been done to lead to a logic decision. Based on the results of this analysis, the decision is to incorporate the sensors that provide higher sensory information in the wearable, whereas the ones that indicate the overall state of the preparation should be in the appliances to allow the remote control and constant access.

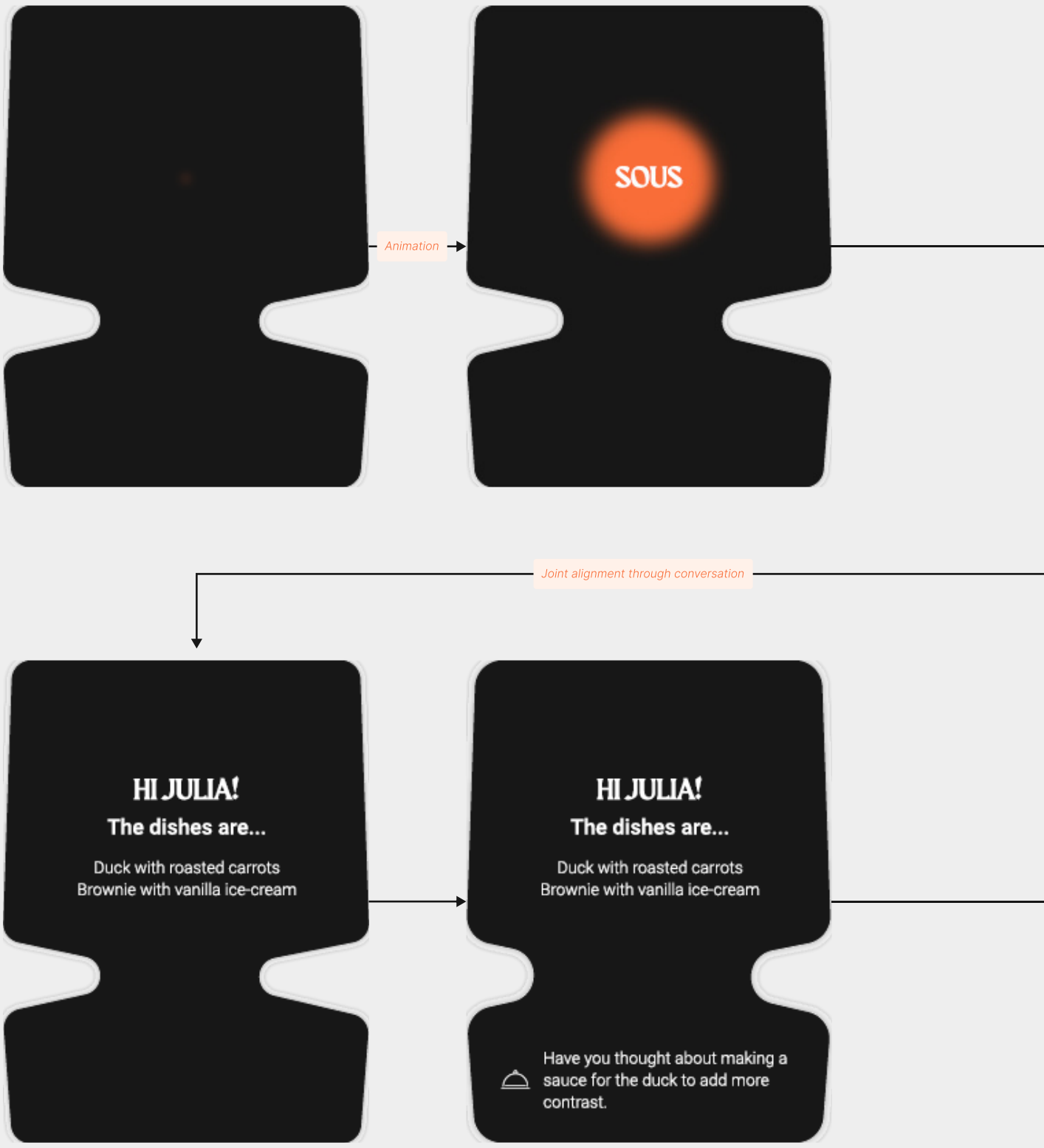
(It has to be around 25cm above the food)

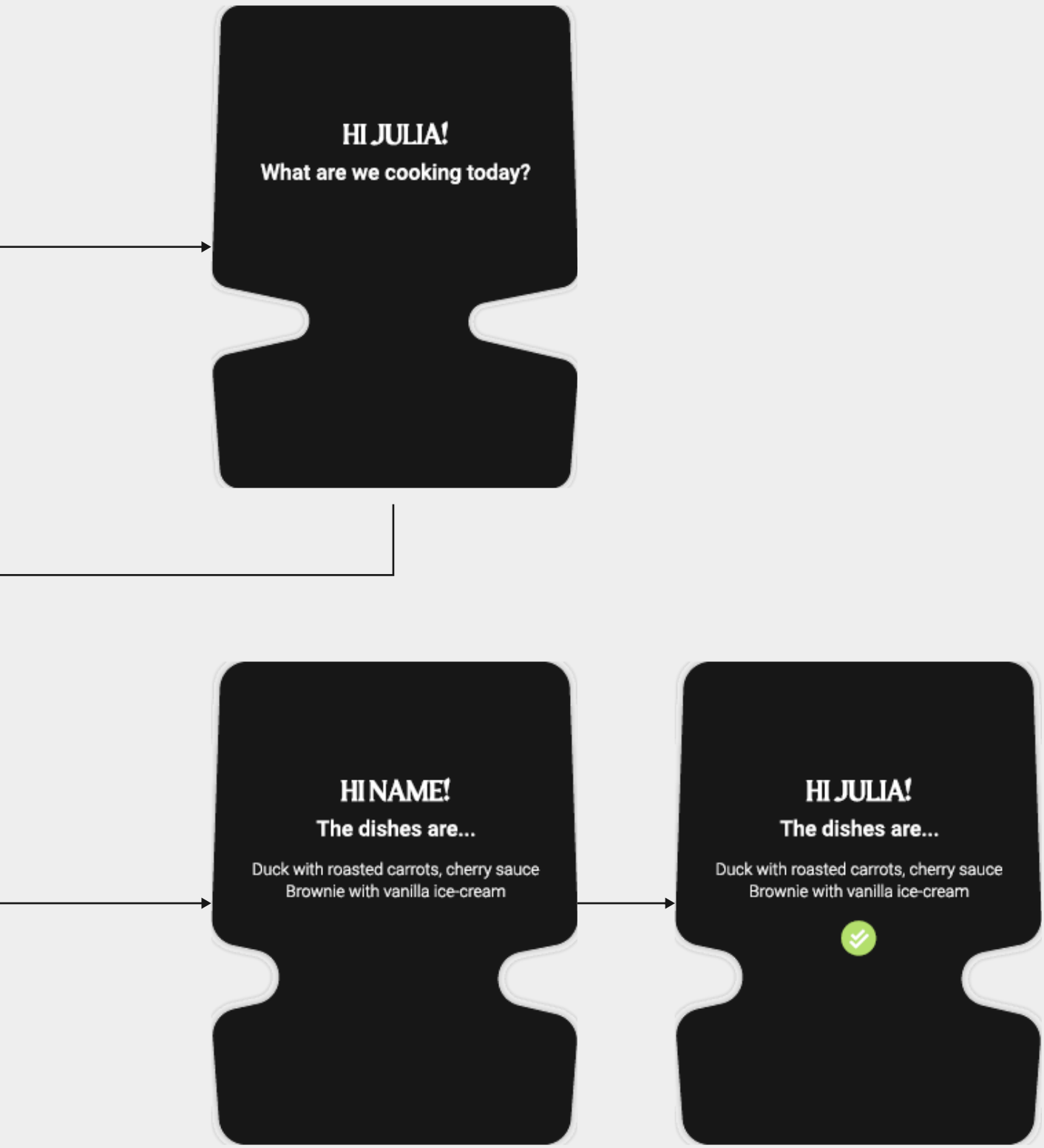


Plus and cons of introducing the sensors in the wearable or appliances.

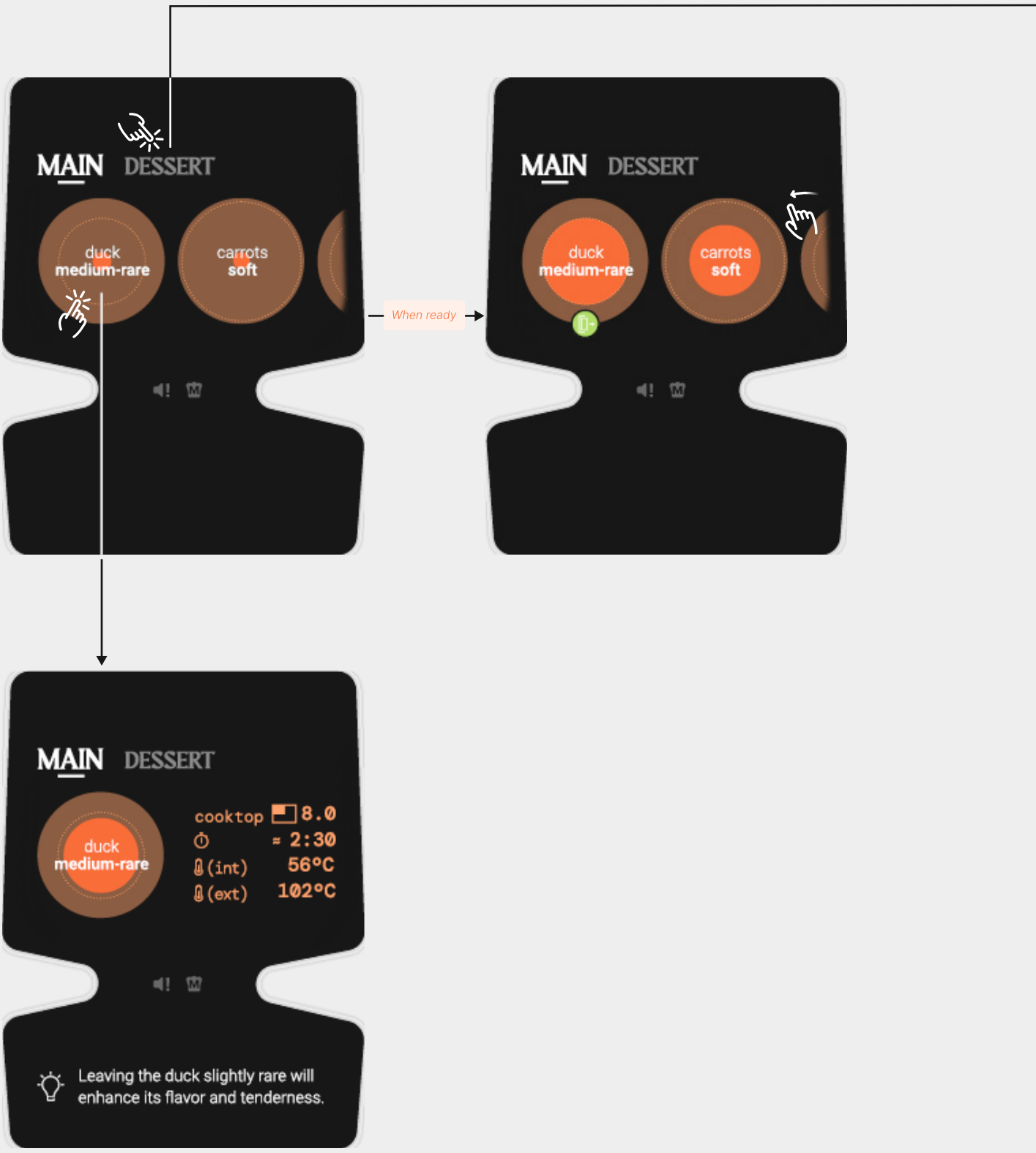
Appendix I: UI Design flows

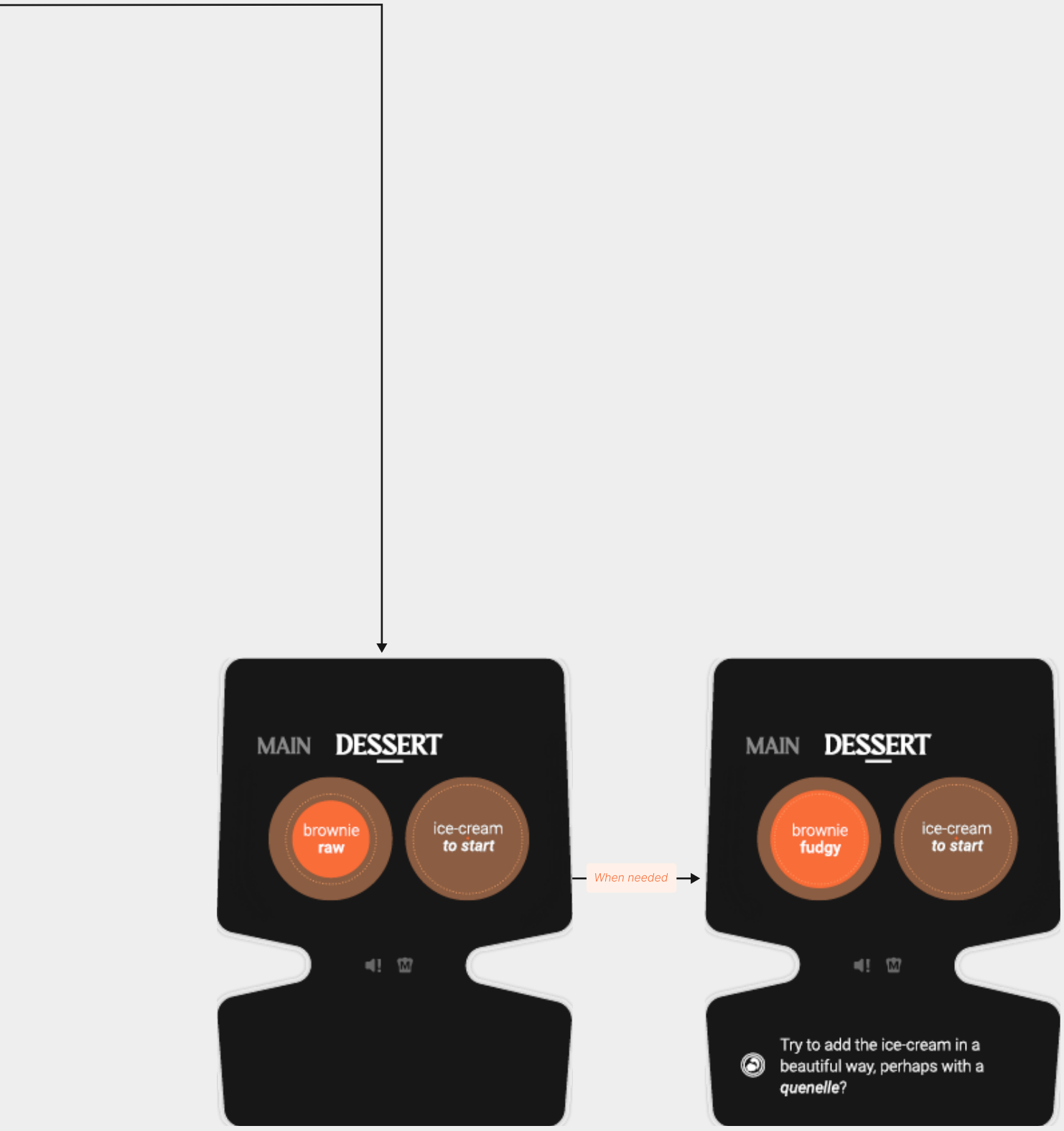
I.1 JOINT-INTENTION



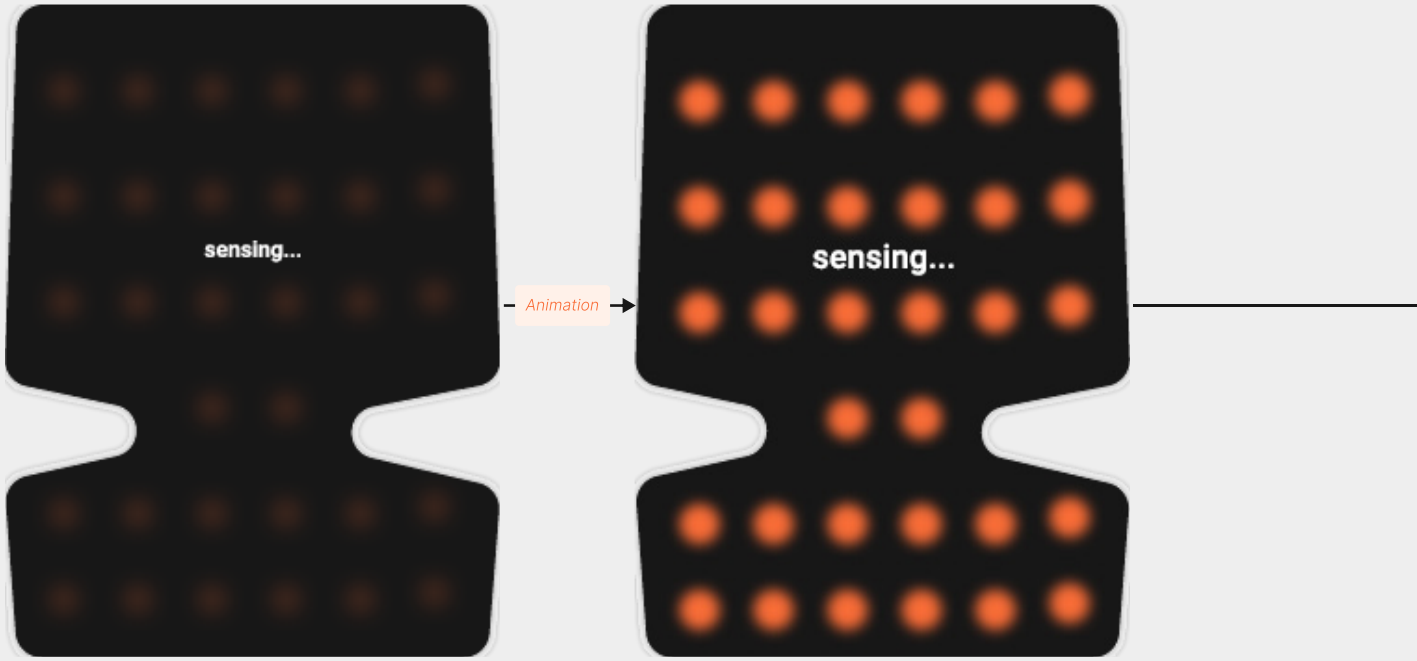

HI JULIA!
What are we cooking today?
HI NAME!
The dishes are...
Duck with roasted carrots, cherry sauce
Brownie with vanilla ice-cream
HI JULIA!
The dishes are...
Duck with roasted carrots, cherry sauce
Brownie with vanilla ice-cream

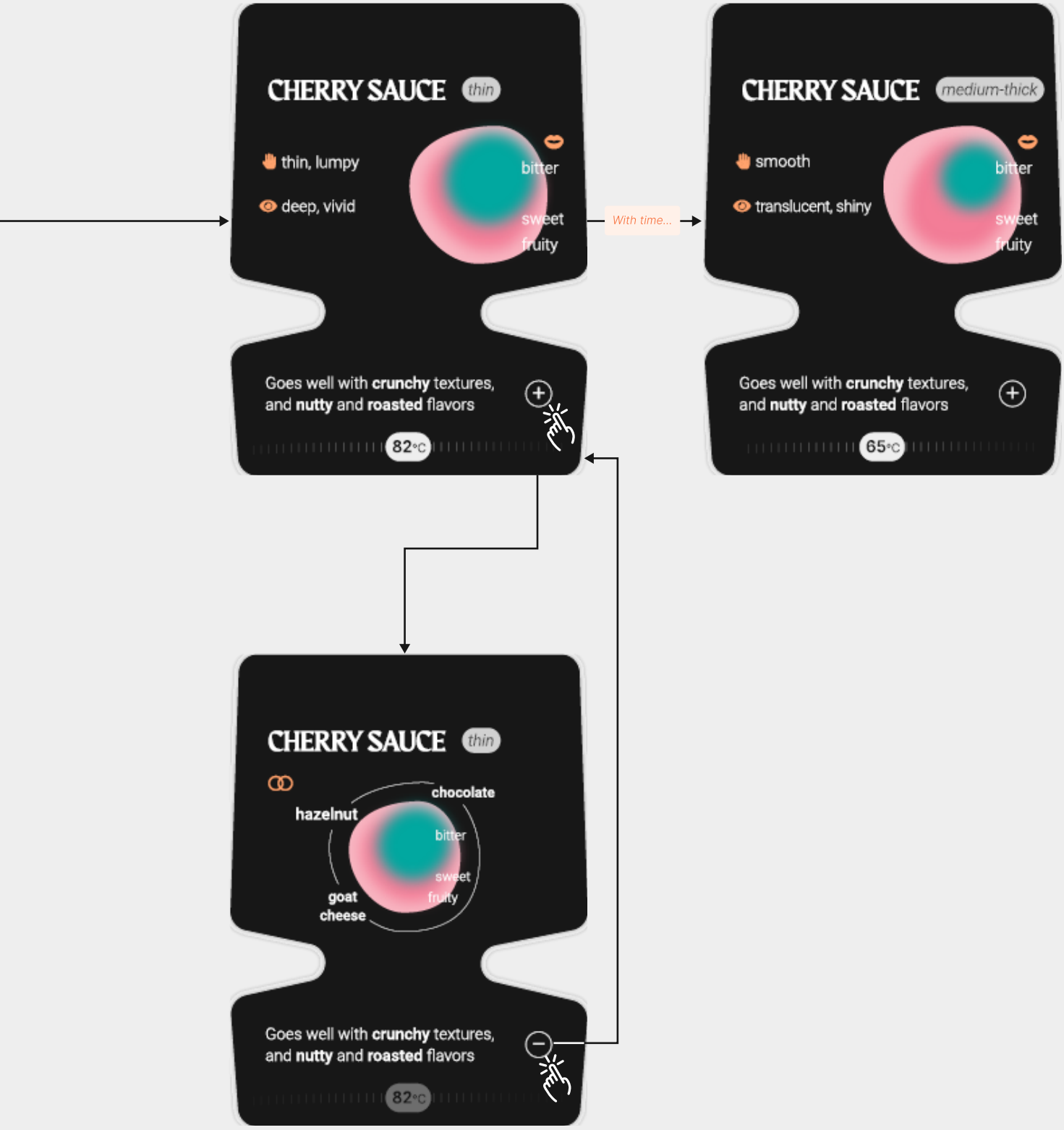
I.2 DASHBOARD




MAIN DESSERT
brownie raw
ice-cream to start
When needed
MAIN DESSERT
brownie fudgy
ice-cream to start
Try to add the ice-cream in a beautiful way, perhaps with a quenelle?

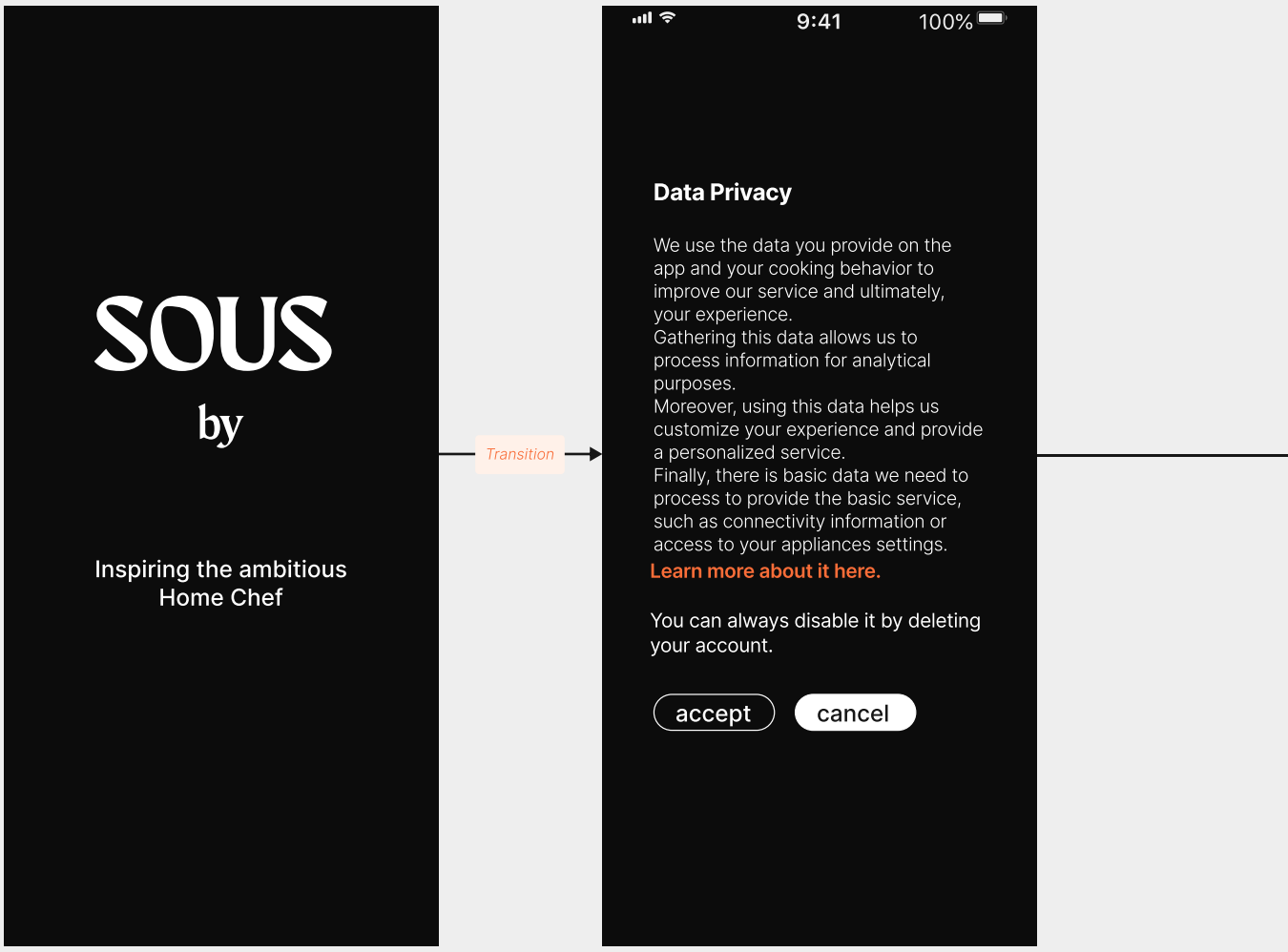
I.3 SENSING

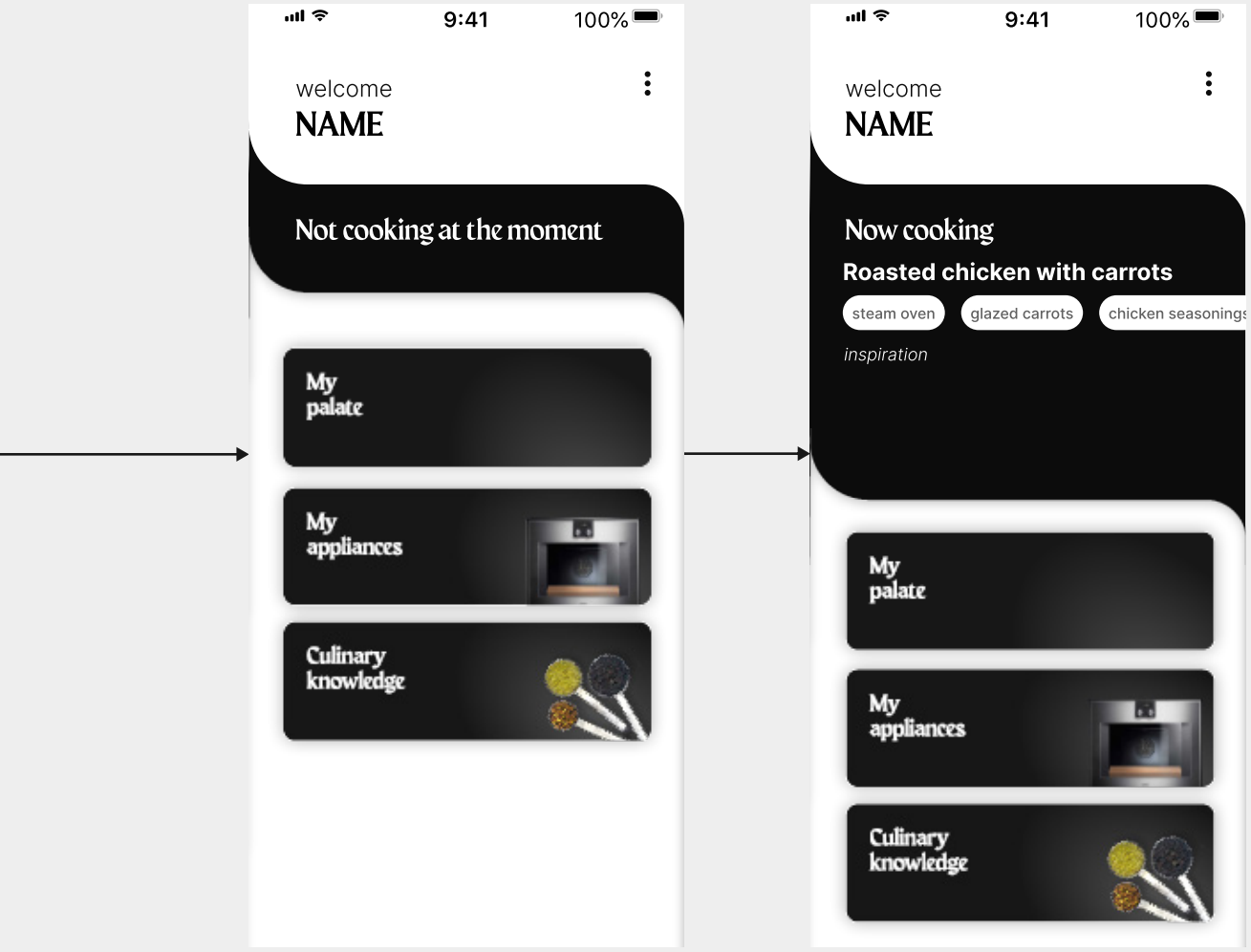



CHERRY SAUCE
thin
thin, lumpy
deep, vivid
bitter
sweet
fruity
Goes well with crunchy textures, and nutty and roasted flavors
82°C
With time...
CHERRY SAUCE
medium-thick
smooth
translucent, shiny
bitter
sweet
fruity
Goes well with crunchy textures, and nutty and roasted flavors
65°C
CHERRY SAUCE
thin
chocolate
hazelnut
bitter
sweet
fruity
goat cheese
Goes well with crunchy textures, and nutty and roasted flavors
82°C

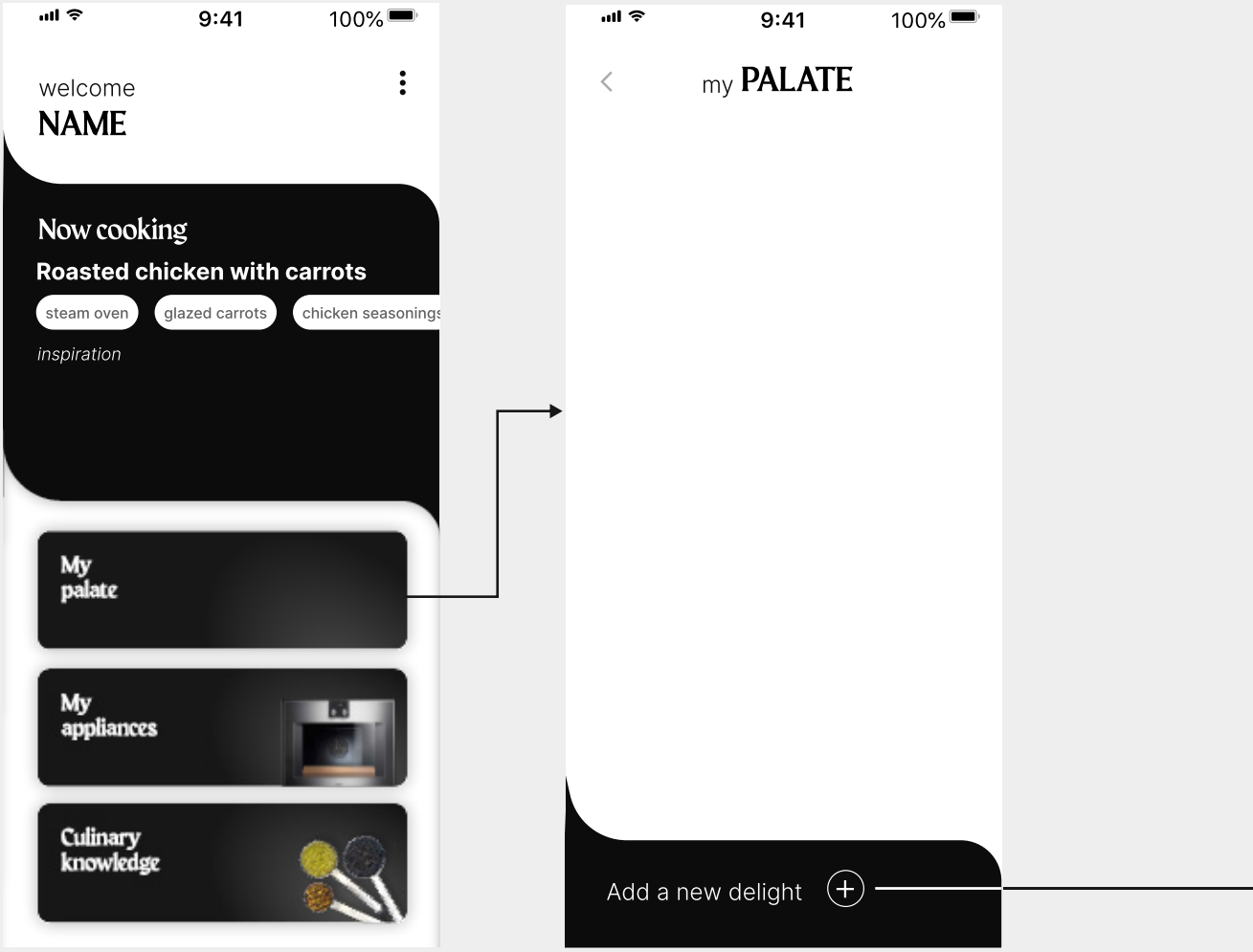
I.4 App

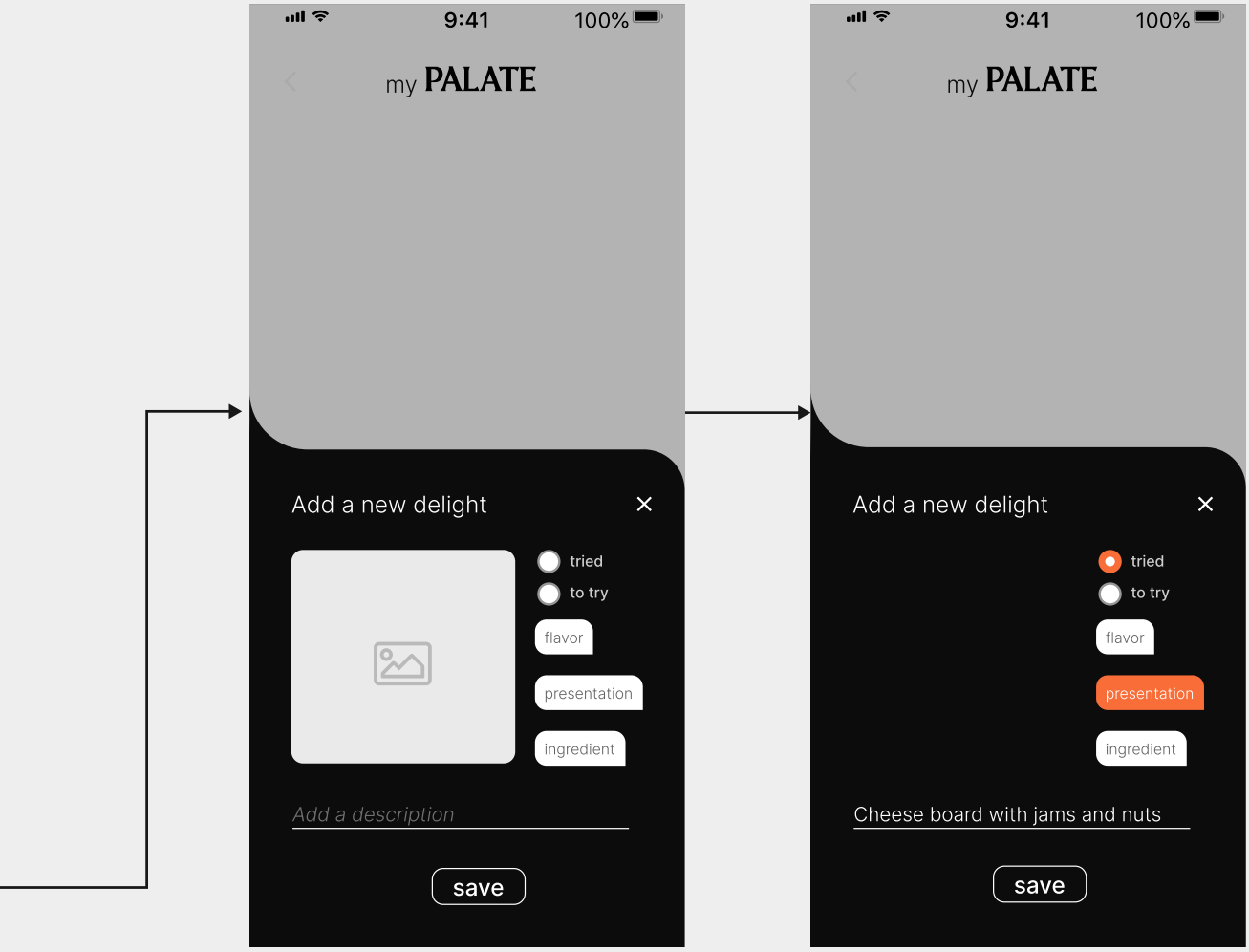
HOME SCREEN



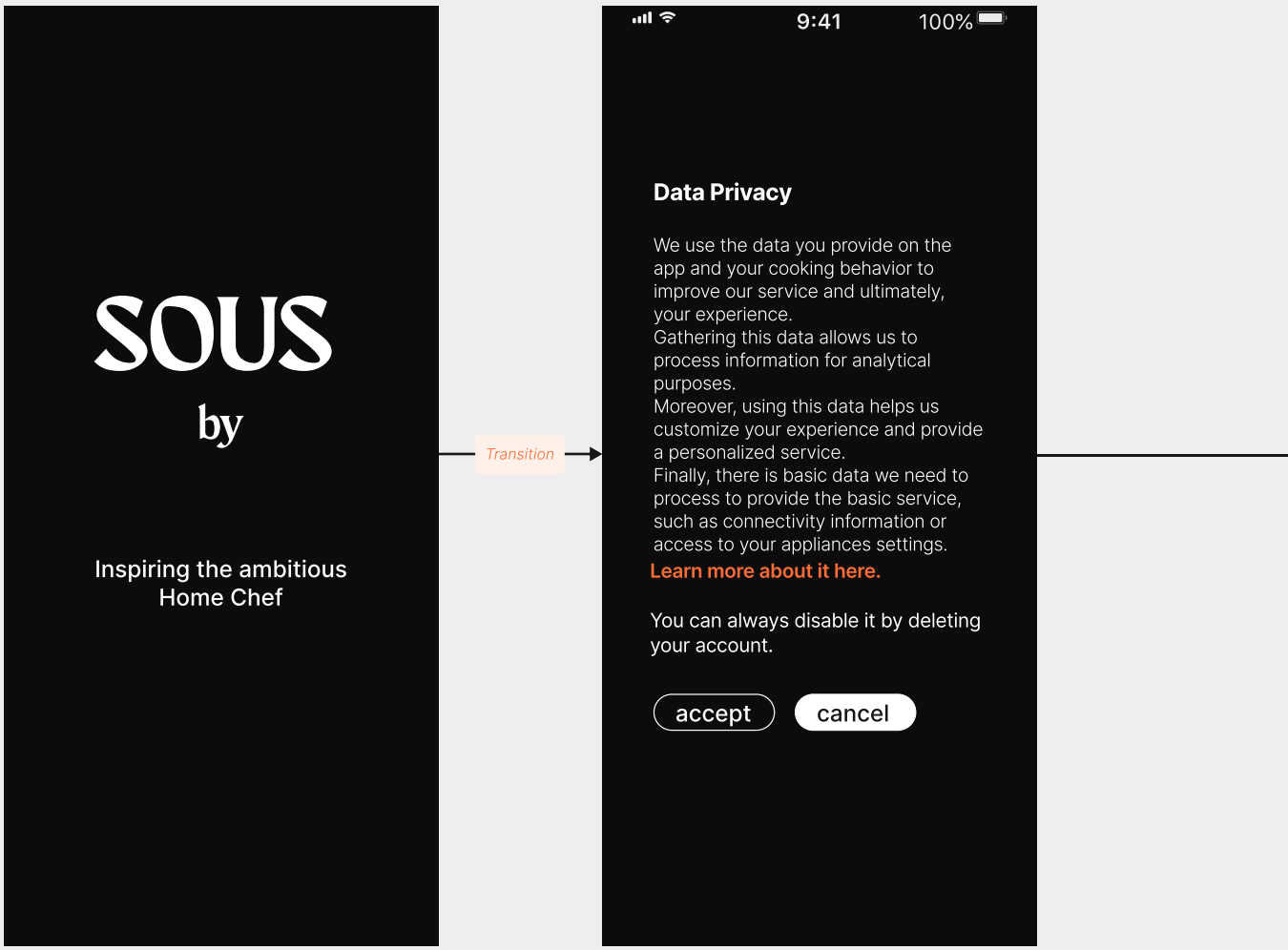

9:41
100%
welcome
NAME
Not cooking at the moment
My palate
My appliances
Culinary knowledge
9:41
100%
welcome
NAME
Now cooking
Roasted chicken with carrots
steam oven
glazed carrots
chicken seasonings
inspiration
My palate
My appliances
Culinary knowledge

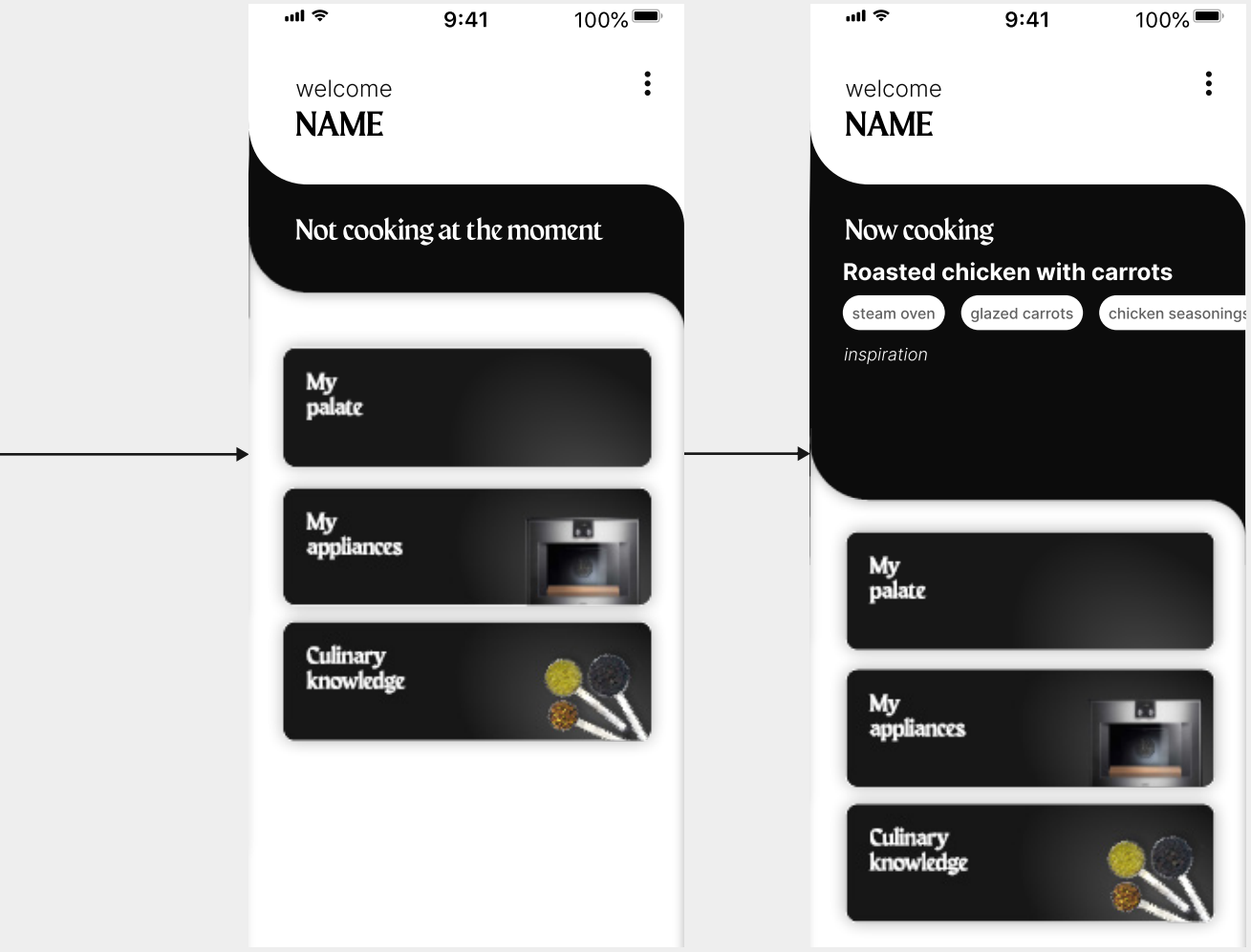
MY PALATE


9:41
100%
welcome
NAME
Now cooking
Roasted chicken with carrots
steam oven
glazed carrots
chicken seasonings
inspiration
My palate
My appliances
Culinary knowledge
9:41
100%
my PALATE
Add a new delight

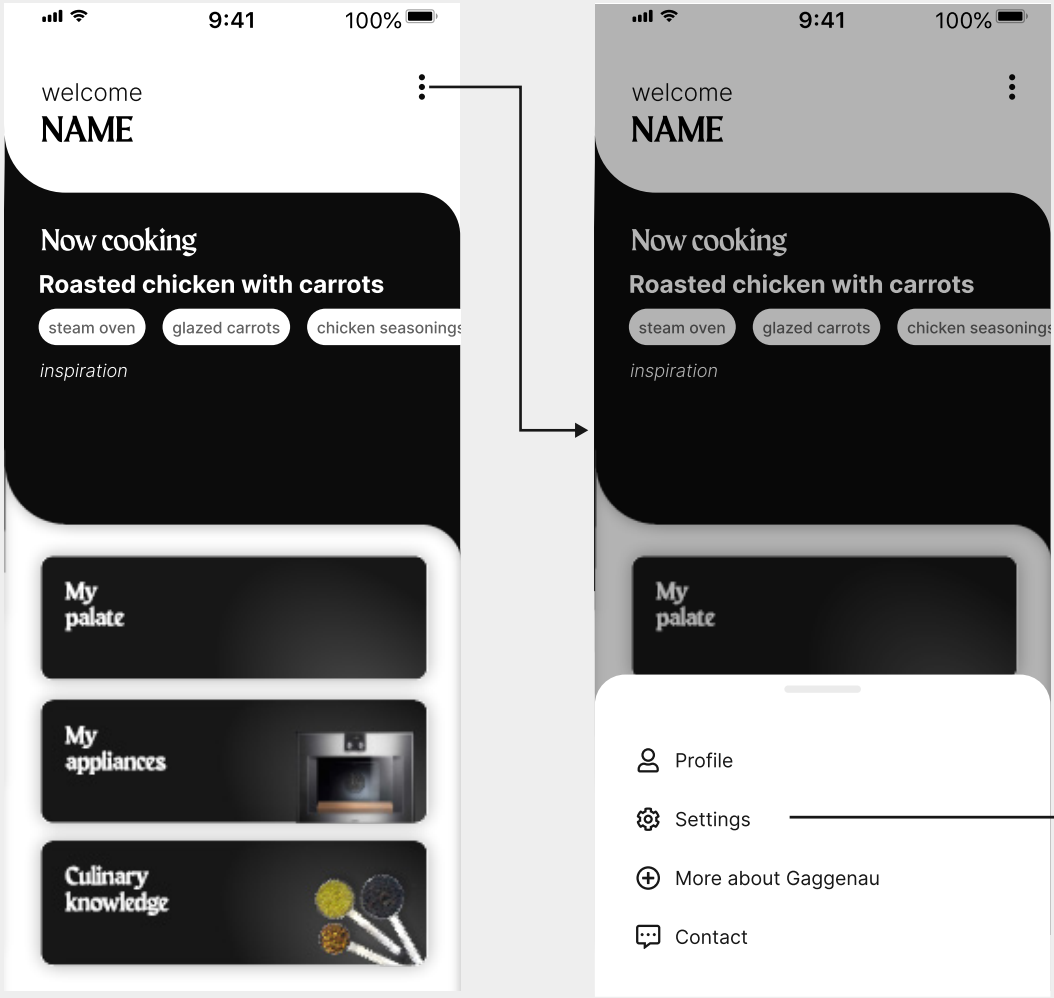

9:41
100%
my PALATE
Add a new delight
tried
to try
flavor
presentation
ingredient
Add a description
save
9:41
100%
my PALATE
Add a new delight
tried
to try
flavor
presentation
ingredient
Cheese board with jams and nuts
save

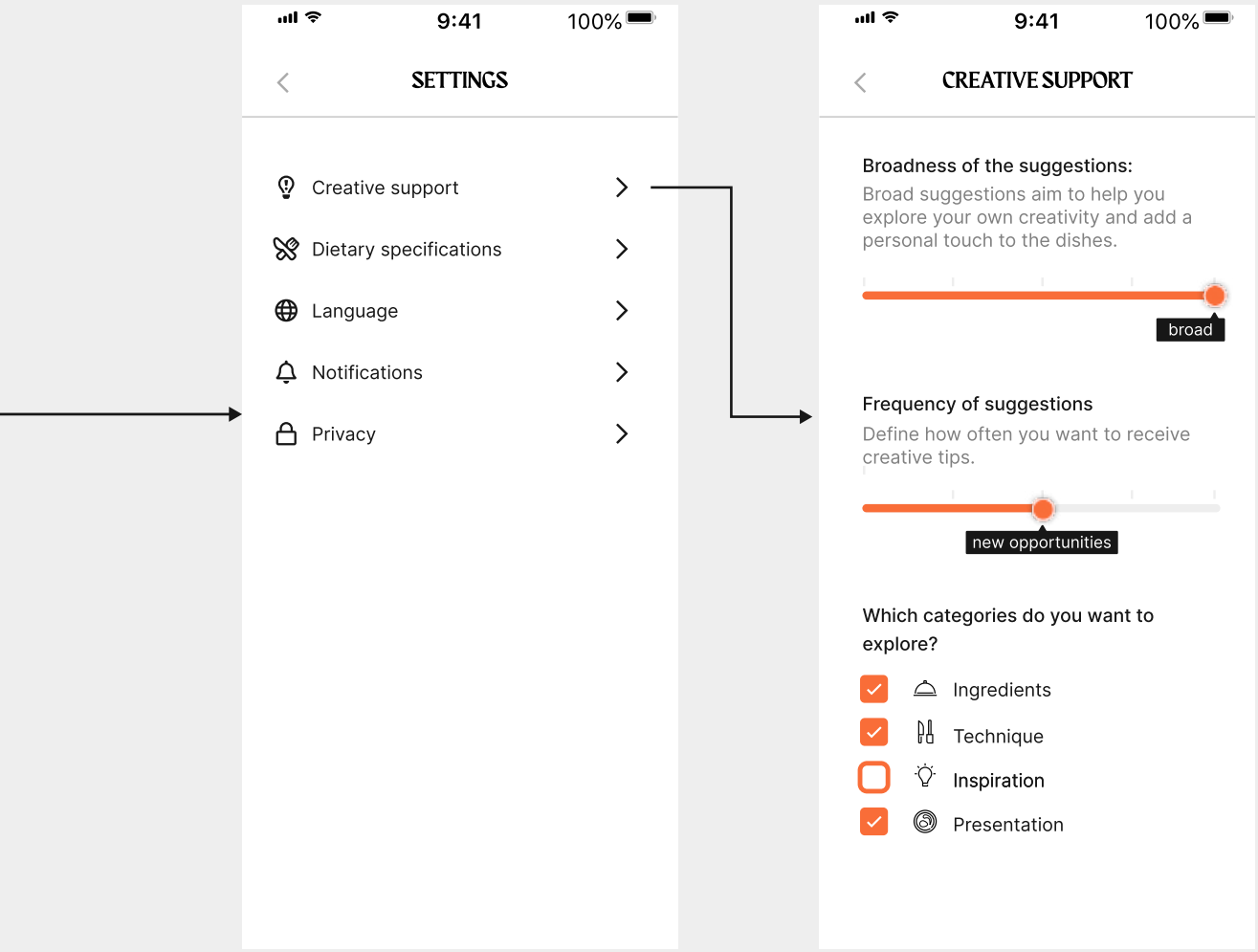
CULINARY KNOWLEDGE




9:41
100%
welcome
NAME
Not cooking at the moment
My palate
My appliances
Culinary knowledge
9:41
100%
welcome
NAME
Now cooking
Roasted chicken with carrots
steam oven
glazed carrots
chicken seasonings
inspiration
My palate
My appliances
Culinary knowledge

SETTINGS


9:41
100%
welcome
NAME
Now cooking
Roasted chicken with carrots
steam oven
glazed carrots
chicken seasonings
inspiration
My palate
My appliances
Culinary knowledge
9:41
100%
welcome
NAME
Now cooking
Roasted chicken with carrots
steam oven
glazed carrots
chicken seasonings
inspiration
My palate
Profile
Settings
More about Gaggenau
Contact

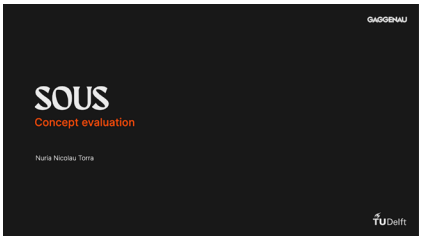

9:41
100%
SETTINGS
Creative support
Dietary specifications
Language
Notifications
Privacy
9:41
100%
CREATIVE SUPPORT
Broadness of the suggestions:
Broad suggestions aim to help you explore your own creativity and add a personal touch to the dishes.
broad
Frequency of suggestions
Define how often you want to receive creative tips.
new opportunities
Which categories do you want to explore?
Ingredients
Technique
Inspiration
Presentation

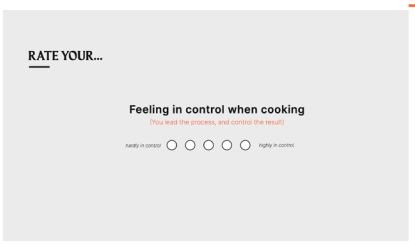
Appendix J: Concept Evaluation

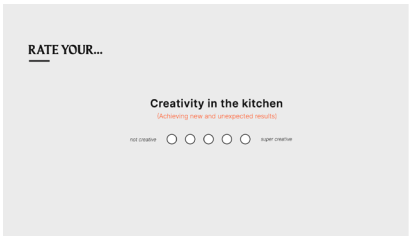
J.1 METHOD

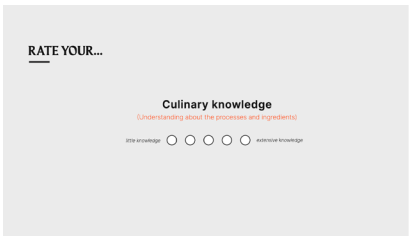
PART 1. INTRODUCTION

The first part of the evaluation was carried out using slides to introduce the project and explain the structure of the test.

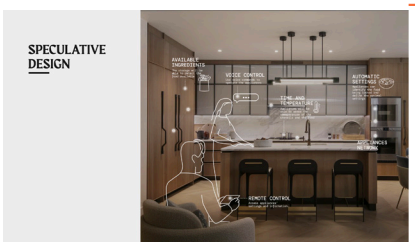


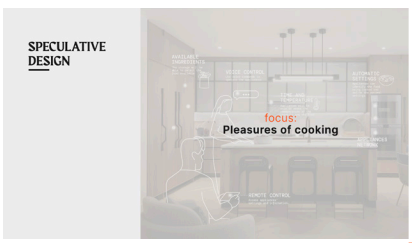






Initial questions to compare with the Home Chef feeling after presenting the concept.



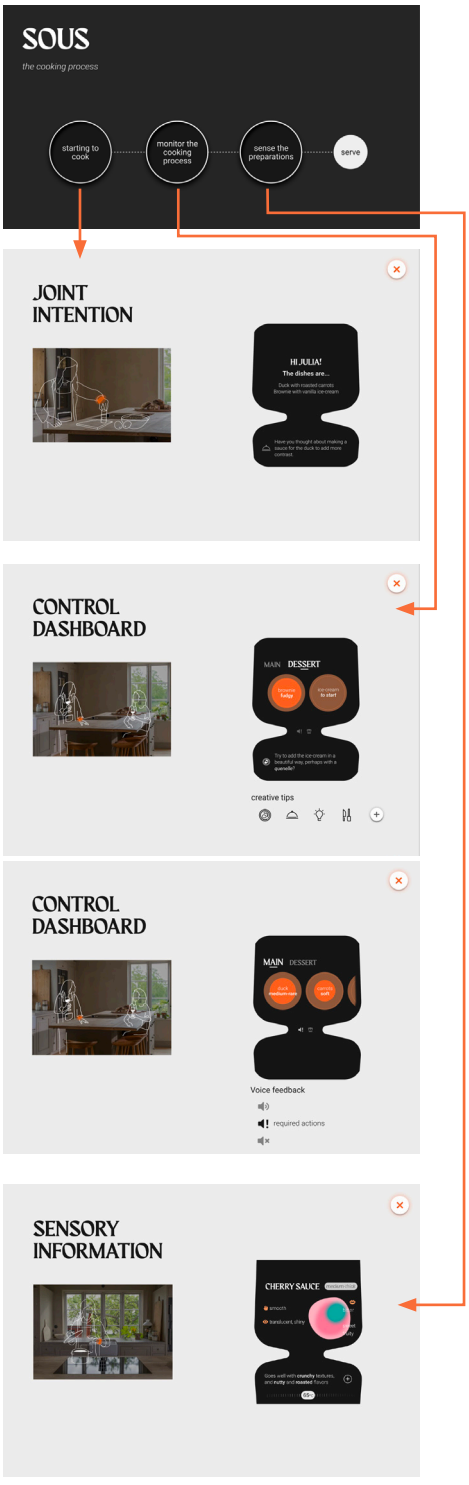


Introducing the speculated future

Screenshots of the slides used during the evaluation.

PART 2. PROTOTYPE

Using Figma a prototype from Sous' was made in order to explain the functioning of the concept in more detail. This allowed to navigate through the different screens and show participants how the data would be displayed.



Screenshots of the prototype created on Figma.

PART 3. VIDEO

To help participants understand the concept better, during the evaluation they were shown a video that illustrates the use of Sous in the real context. The video contained real scenes with an overlay of the wearable's screen.

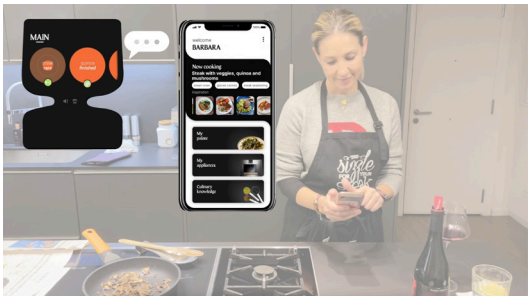
Conversation during joint-intention alignment

Scanning a preparation to sense it

Checking detail of appliance's status

Checking sensory details of a preparation

Monitoring doneness of ingredients



Using the app for plating inspiration

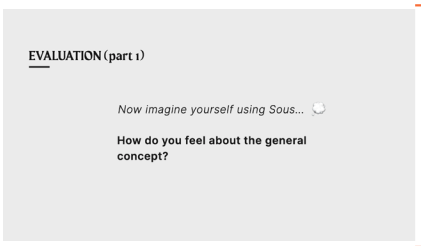
Socializing and still controlling the process

Making own decisions based on the info

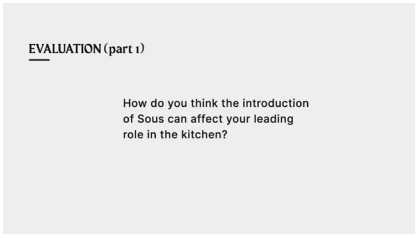
Screenshots from the showcase video.

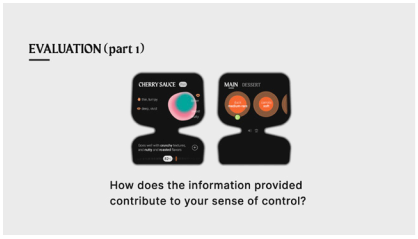
PART 4. EVALUATION (open-questions)

The first part of the questions to evaluate the concept consisted on open-ended questions to establish a conversation with the participants regarding creativity, feeling in control and culinary knowledge to validate the Design Goal. Slides have been used to facilitate this.

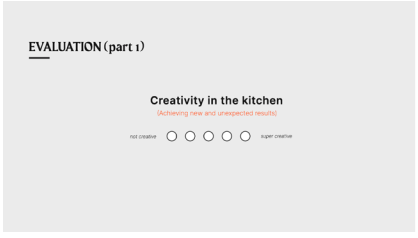


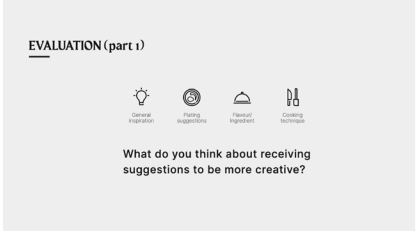
Conversation starter to trigger speculative mindset



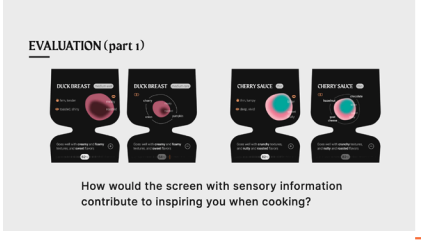


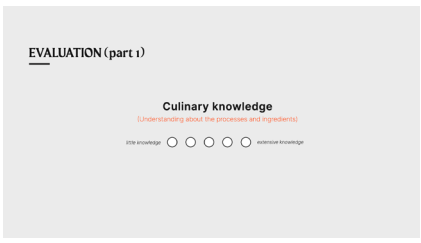
Questions about the topic feeling in control

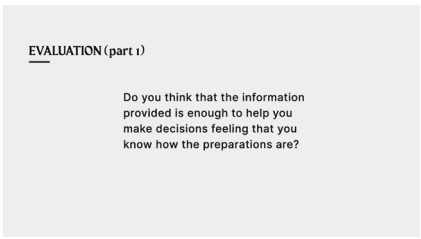


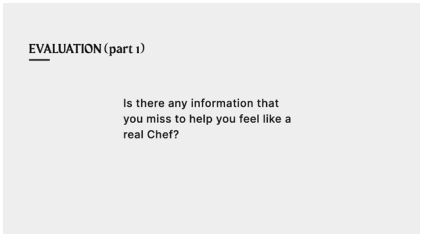


Questions about the topic creativity

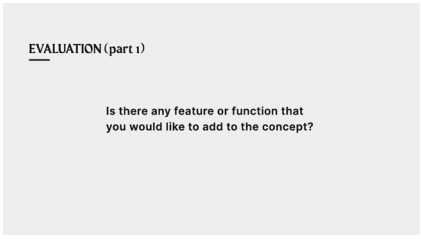








Questions about the topic culinary knowledge

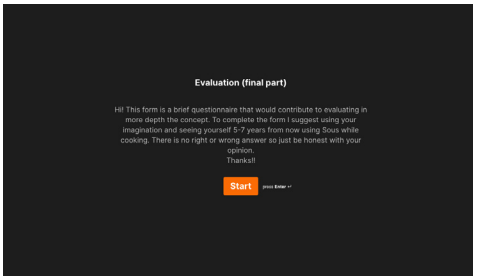


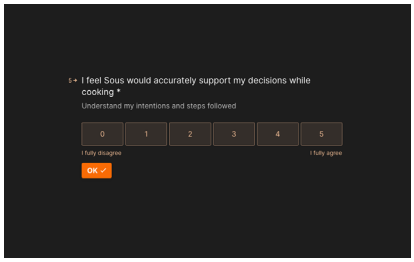
Closure, and participant's opportunity to speculate about the design and concept

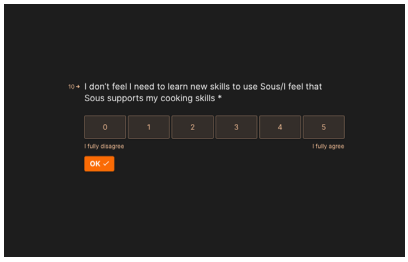
Screenshots of the slides used during the evaluation.

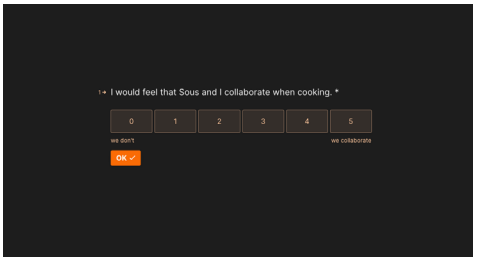
PART 5. EVALUATION (questionaire)

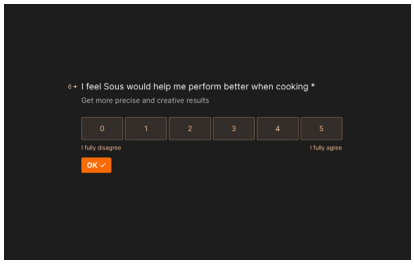
Lastly, a brief online survey was sent to participants in order to evaluate the Design Guidelines define on the project. This part was more rational and therefore a numeric questionaire was feasible for it. Images were attached next to the questions that required some extra information.

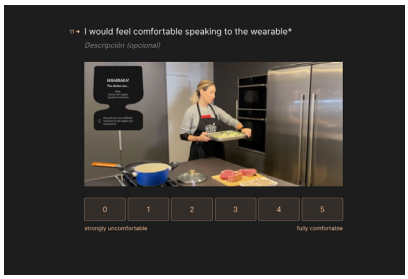


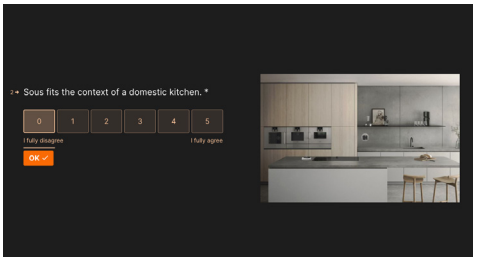


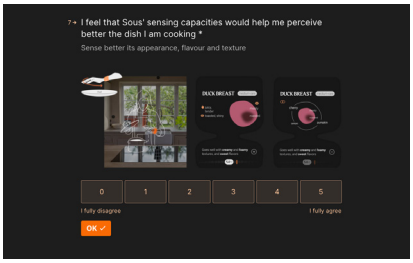


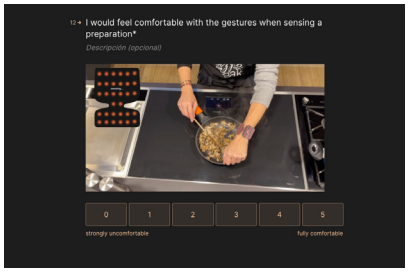


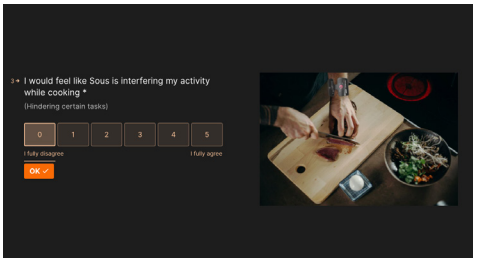


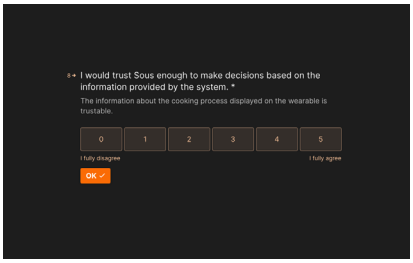


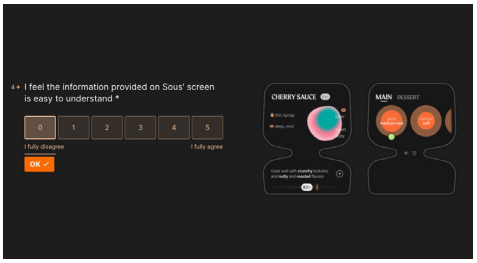


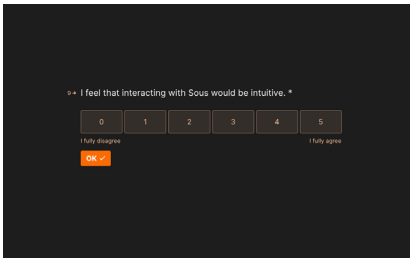










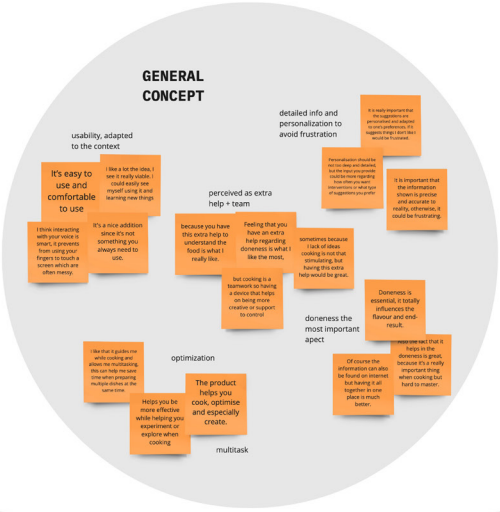


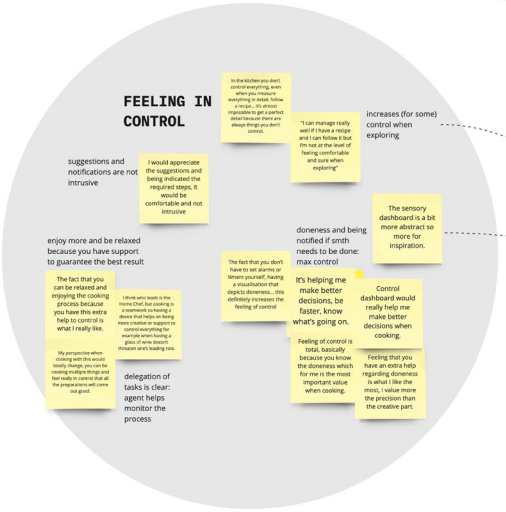
Screenshots of the online questionaire.

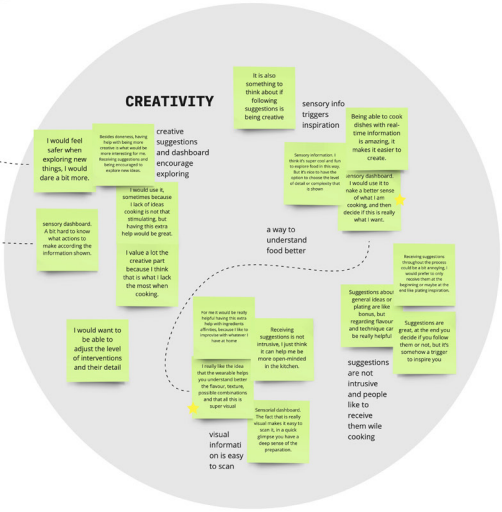
J.2 RESULTS

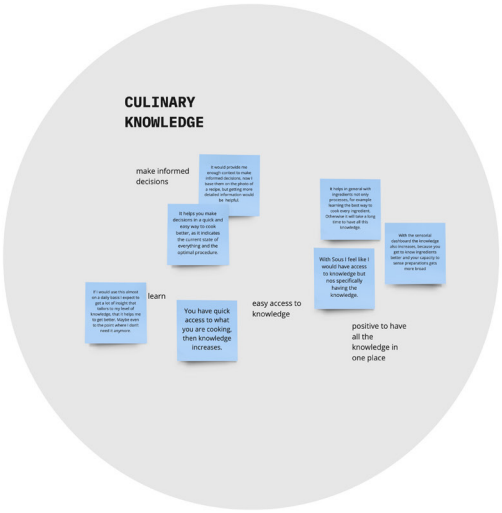
CLUSTER DATA

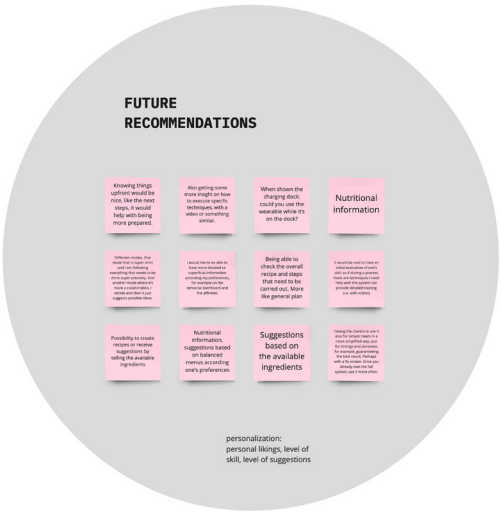
grouped quotes in each category, and clustered in main ideas







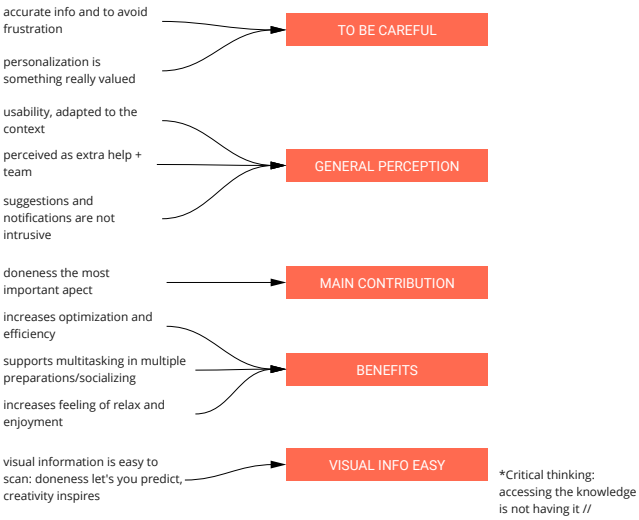




MAIN IDEAS

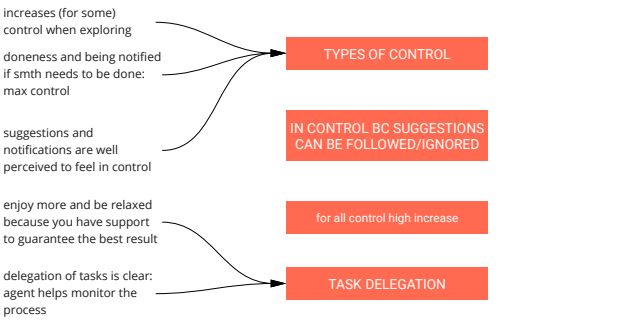
compilation of main conclusions

GENERAL CONCEPT

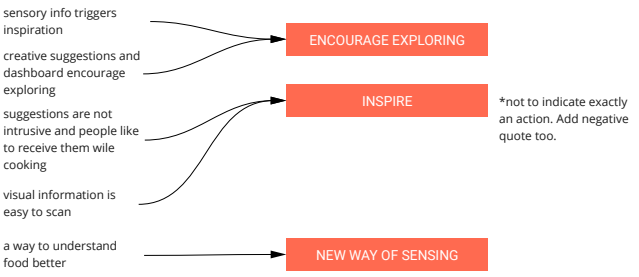


*Critical thinking: accessing the knowledge is not having it // following suggestions might not mean being creative

CONTROL



CREATIVITY



*not to indicate exactly an action. Add negative quote too.

KNOWLEDGE