DIGITALLY ENHANCED CONSUMER PACKAGED GOODS: A DATA-INSPIRED IDEATION APPROACH

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Thesis submitted to the University of Nottingham for the degree of Doctor of Philosophy.

May 2022

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To my family.
*My mom and my two sisters, and especially to **my dad**,*
who went ahead us to heaven.

Pensar es olvidar diferencias,
es generalizar, abstraer.
[Thinking is to forget irrelevant
details, to generalize, to
abstract].

Borges (1944)

ACKNOWLEDGMENTS

Firstly, I would like to express immense gratitude to my supervisors at the University of Nottingham: Joel E. Fischer and Martin Baumers, from the Mixed Reality Lab and the Centre for Additive Manufacturing, respectively. Thank you for your time, endless patience, invaluable insight, and unwavering support throughout what has not been an uneventful period. Not only did you offer sound academic guidance, but you were also always more than willing to share professional and personal advice. There were some difficult moments, but I took great comfort in knowing that you always had my best interests at heart. Please know that I am eternally grateful for everything, and that without your support, this thesis would not have been possible.

I would also like to extend a most sincere thanks to my supervisor from my industrial partner, Robert Treloar, from Unilever. First of all, I would like to thank you for trusting me to carry out this project; undoubtedly this PhD has definitely changed my life. I have always very much appreciated our conversations and the decades of accumulated knowledge of the field which you have graciously done your best to impart to me. I would also like to show my gratitude to professor Steve Benford from the Mixed Reality lab, for the support given to me during the first year of my doctoral programme, as well as the opportunities he offered throughout my PhD to collaborate on a variety of projects which enriched my experience.

I would be remiss not to thank The Horizon Centre for Doctoral Training, which provided the financial support to conduct this PhD research, and the Mixed Reality Lab, which hosted me throughout my entire graduate program, allowing me to fully immerse myself in the field of human-computer interaction and providing the countless resources and expert consultation necessary to make my work successful. I also must express my gratitude to the School of Computer Science for providing the facilities and support necessary for this project.

A special thanks to Andrea, Emma, Felicia, Monica, and Laura from Horizon, as well as all the administrative staff from the School of Computer Science; not only for their support with all the paperwork, but also for their kindness and encouragement along the way.

I would like to particularly thank my friend Max Spiegel for his exceptional support in proofreading, improving my ideas, and sharing his wisdom all this time throughout our informal conversations.

To my family who, with their regular and genuinely-concerned calls, attention, and love, helped me cope with this project, especially during the highest points of the pandemic, in which I found refuge at home.

I extend my general gratitude to all my many friends and colleagues in the School of Computer Science, especially the good people of Mixed Reality Lab and Horizon CDT. I list them here in no particular order (undoubtedly and unfortunately with the inevitable unintentional omission of some, to whom I apologise in advance): Ahmed, Carolina, Damla, Ed, Fraz, Gisela, Hanne, Johan, Juan, Keerthy, Marie, Martin P, Pepita, Rebecca, Serena, Susan, Symeon, Vanja, and Velvet; thank you all. I would also like to thank all the friends that I made in Nottingham in and outside of the University, including (just to mention a few) Amina, Adrian, Diego, Fatima, Francesca, Kate, Lizita, Michael, Pal, Yareli, Ulises, and Uzzy, among many, many others.

I would also like to express my sincere gratitude to the scores of participants who, throughout the studies of this project, selflessly gave their time and effort through their participation. Without you, this work would have clearly been impossible.

This research was supported by the Horizon Centre for Doctoral Training at the University of Nottingham (UKRI Grant No. EP/P510592/1) and by Unilever UK Ltd.

ABSTRACT

Consumer packaged goods (CPG) are disposable, relatively low-price, frequently-purchased products such as a bottle of milk or a bar of chocolate. CPGs have a pervasive presence in our everyday practices, and a number of instances have shown the potential of integrating their existing functionalities into the Internet of Things (IoT). Such innovations as, for example, a pill container which reminds one when to take their medication, or a disposable toothbrush which teaches children about oral hygiene, illustrate the capacity of digitally enhanced CPGs to have a positive impact in countless aspects of our lives. However, despite recent research in human-computer interaction (HCI) aimed specifically at enhancing interactions with CPGs, devising enhanced versions of these goods which meet people's needs and reflect their values remains quite elusive. Many challenges in the design of enhanced CPGs stem from their defining characteristics, including their disposability and frequent need to be replenished, as well as from the fact that they are rarely used in isolation, but rather in conjunction with one another as sets.

While it has been demonstrated that providing data about item usage during the design process represents a substantially powerful approach for creating effective products, this has not yet been applied in the creation of enhanced CPGs, as we currently lack even a rudimentary understanding of their use. This thesis represents the body of knowledge gathered through the completion of two fieldwork studies focused on how CPGs are used in the practice of cooking. Furthermore, it utilises an understanding of CPG interactions and, through two participatory design workshops, explores how such insights

can inspire the conceptualisation of enhanced CPGs.

The fieldwork study of this thesis focused on the interactions of CPGs in cooking, which was chosen due to it being one of the most prevalent everyday practices involving CPGs. We examined cooking in two situational contexts: the preparation of familiar meals (those which could be prepared from memory) and that of unfamiliar meals (those which people had never cooked before). The first analysis was concerned with only the preparation of the unfamiliar meals, while in the second analysis we conducted a comparative analysis between familiar and unfamiliar meals. We employed a mixed-methods approach for blending quantitative and qualitative analysis methods. Overall, these studies revealed different characteristics of CPG interactions, including aspects of information-gathering, frequency of task saturation, and the sets of CPGs and utensils which appear together often. One example of our findings was that meal preparation was generally similar regardless of familiarity, as revealed by the repeated use of a select few CPGs across many meals and the consistency of their number of interactions. We then discussed the implications these findings have for the design of digitally-enhanced CPGs with the overall goal of promoting enhancements which fit our routines and habits rather than require us to adapt our practices to the IoT.

Inspired by frameworks which have placed data at the centre of the design process, the participatory designs employed in this thesis, made use of the data gathered from the above mentioned fieldwork studies as a tool for participants to inspire the design of enhanced CPGs. We devised a structured workshop to study how participants drew upon the data, as well as how they perceive the influence this approach had on their ideation process. To facilitate their use of the data, we devised an array of design resources including data visualisations and design cards. We explored our approach in two studies: one which consisted of participants from the general public, and the other which consisted of professional designers. Analysing the role of data as expressed through participants' comments and designs, we found that data served as a basis for the creation of unique concepts imbued with a sense of empathy and a greater consideration for the experiences and interests of others. Furthermore, we found that participants considered possible negative ramifications of the use of data for design, including ethical and privacy issues which may stem from such data collection, as well as a potential bias towards focusing on aspects highlighted by the data.

This thesis makes a number of contributions in showing that a detailed understanding of CPG interactions in practice can lead to insights which inspire the design of technologically-enhanced CPGs. It also presents analysis methods to further study the use of CPGs in practice, as well as an approach which enables people with no relevant formal training to utilise data effectively. In addition, this work provides implications for designing enhanced versions of CPGs which fit their practical contexts of use. For an accurate view of this research and its contributions, its limitations must be acknowledged, such as the relatively small size of our data sample and our bias towards the use of technologies to provide product enhancements. Nevertheless, our work highlights the need for an understanding of the practical use of objects to better design technological innovations which fit well into their real-world interactions, and serves to emphasise the need to continue research on CPG innovations. This work represents merely the first steps towards CPGs which are designed using a solid foundation of an empirical working knowledge of the practices in which CPGs play a role.

DECLARATION

I hereby declare that except where specific reference is made to the work of others, the contents of this thesis titled "Digitally Enhanced Consumer Packaged Goods: A Data-Inspired Ideation Approach" is my own work from the time of my PhD at the University of Nottingham under the supervision of Dr. Joel E. Fischer and Dr. Martin Baumers, and that it has never been submitted for the award of any degree, diploma, or any similar type of recognition.

Jose Gustavo Berumen Salazar
May 2022

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ACRONYMS

ACM	Association for Computing Machinery
ANOVA	Analysis of Variance
CPG	Consumer Packaged Goods
DDD	Data-Driven Design
EC	Eigenvector Centrality
FMCG	Fast-Moving Consumer Goods
GDPR	General Data Protection Regulation
HCI	Human-Computer Interaction
IoT	Internet of Things
IQR	Interquartile Range
LCD	Liquid Crystal Display
M	Mean
RFID	Radio-Frequency Identification
SD	Standard Deviation

1. Finding Design Opportunities for Smartness in Consumer-Packaged Goods. (2019) *In Proceedings of the CHI 2019 Workshop: New Directions for the IoT: Automate, Share, Build, and Care.* [Workshop Paper]
2. Quantitative Ethnography of Cooking to Inform the Design of Smart FMCG Technologies. (2021) *In Proceedings of the International Conference in Quantitative Ethnography 2021 Doctoral Corsortium.* [Doctoral Consortium]
3. An Exploration Into Tracking the Use of Consumer Goods with RFID. (2021) *In Proceedings of the 11th International Conference on the Internet of Things.* [Poster]

Under Review

1. Interactions of Fast-Moving Consumer Goods in Cooking: Insights from a Quantitative Ethnographic Study.
2. Consumer Goods Interactions in Cooking: A Comparative Quantitative Ethnographic Study.
3. Data-Inspired Ideation: Data as a Resource for Designing Digitally Enhanced Consumer Goods.

1 INTRODUCTION

Consumer packaged goods (CPG) are disposable, relatively low-cost, frequently replenished products. CPGs cover a wide variety of categories including packaged foods, beverages, personal care products, toiletries, and over-the-counter drugs (Sable, 2018). CPGs are an essential part of our lives and are vital components in many of our activities throughout the day, from making a cup of coffee in the morning to brushing one's teeth using toothpaste before going to bed. A number of points are particularly illustrative of the prevalence of CPGs, such as the fact that everyday more than 2.5 billion people use products from just one of the top CPG manufacturers every day (Unilever, 2016), and that CPGs represent more than half of all consumer spending (Labor Statistics, 2020).

There is a growing industry interest in developing technologically enhanced versions of CPGs, incorporating them to the Internet of Things (IoT) to create products which better cater to people's needs and improve the consumer experience. This potential has not been lost on the CPG industry, which is expected to reach more than $17 trillion by 2025, as it is making one of its highest priorities the development of enhanced versions of their products, equipping them with beneficial functionalities (Končar et al., 2020). In this thesis, we define **enhanced CPGs** as CPGs incorporated with IoT and other technologies which confer additional functionalities making them capable of dynamically responding to interactions (a more detailed explanation is given in Chapter 2). Enhanced CPGs could not only have a positive impact on our lives, but also help reduce some of the negative aspects associated with CPGs in general;

for example, the value of additional functions could help CPGs transition from disposable packaging to reusable containers, thereby offsetting some of their environmental impacts.

However, despite recent research in human-computer interaction (HCI) aimed specifically at enhancing interactions with CPGs (Altarriba-Bertran et al., 2019; Petit, Velasco, and Spence, 2019), devising enhanced versions of these goods which actually meet people's needs remains quite challenging. There have been few implementations of enhanced CPGs and associated devices released onto the market. These CPGs have failed to become widely-adopted, and have thus far experienced only a fleeting interest from consumers. The Amazon Dash button—a CPG ordering device—for example, was discontinued in part because its main function of automatic reordering was found to be redundant given the availability of voice-controlled assistants (BBC, 2019). Industries and academia see the potential of utilising data about the interactions of CPGs in practical settings to inform the design of innovative products that respond to actual consumer needs and are more likely to be incorporated into people's practices (Lorenzini and Olsson, 2019a).

Objects such as CPGs have subtle yet complex systems of interactions associated with their use which only become known after careful observation. As an example, Hyland et al. (2018) studying the routine of shopping for ingredients were able to identify the hidden methodologies employed by shoppers and consider how such methodologies may pose challenges and opportunities for the design of proactive systems aimed at supporting the practice of grocery shopping. However, despite the increasing research into CPG interactions, most studies on the topic have focused on the 'point of purchase' and 'checkout' stages of interaction rather than focusing on their practical interactions (Mumani and Stone, 2018).

As important as it is to ground the design of enhanced CPGs with empirical insights, it is also vital to include in the design process users of products and professionals involved in product development to create designs which are more likely to respond to people's actual needs. There is great potential in utilising data about the interactions of CPGs in practical settings, not only to reveal hidden patterns of use, but also to inspire the design of innovative products (Lorenzini and Olsson, 2019a). The insights such data provides have the possibility to empower people from diverse backgrounds to become involved in the design process. Data visualisations coupled with design workshops have proven effective in closing the gap between those with and those without the skills to work with data effectively (D'Ignazio, 2017). However, such an approach has not yet been applied to the design of enhanced CPGs.

Through careful observations in the field, we believe that it is possible to understand how people perform practices which involve interactions with CPGs. This thesis is informed by a "practice perspective" which it attempts to obtain an understanding of CPG interactions in the practice of cooking (see Chapter 3 for a further elaboration on this approach). We believe that such an understanding is essential to identifying areas in which CPGs can provide valuable support to consumers by adding features which facilitate their use. In the next step of our research, we adopted a participatory design approach and passed the insights gathered from our fieldwork studies along to consumers and professionals with experience in product development in order to inspire the design of enhanced CPGs. Thus, the goals this thesis aims to accomplish are twofold: one is an understanding of CPG interactions in the practice of cooking, and another is an exploration into how data helps people inspire the design of enhanced CPG.

In doing so, we also develop methods for the analysis of CPG interactions in practice, as well as a method for the use of those insights as a resource for the design of enhanced CPGs (Chapter 5).

In the following sections of this chapter, we will present the specific problems this thesis aims to address, the objectives we aim to accomplish, and the research questions we aim to answer. The remainder of this chapter will position the work within of this thesis amongst the wider field of HCI and introduce the research space under examination.[1]

1 For the sake of full transparency, we must disclose the fact that this thesis has been supported by a grant from Unilever, one of the largest manufacturers of CPGs. Subsequently, this thesis was partially motivated by an interest on the part of Unilever to explore innovation in enhanced CPGs; however, the company had no input whatsoever on the results, nor did they direct our research in any way or determine the process by which it was conducted.
The research of this thesis was conducted as part of the Horizon Centre for Doctoral Training (CDT) programme. Horizon CDT collaborates with industry partners to conduct research relevant to both industry and university research interests. In this regard, the topic of this thesis was originally developed by Unilever, the industry partner of this project, and assigned to the author of this thesis at the start of the PhD. The author and the supervisors then took the project and independently further developed the topic. The research team of this thesis occasionally provided updates on its development, and had meetings with the industry partner to gain insight into the implications and relevance of their work in an industrial setting.
For further information about the programme, visit the Horizon CDT site: https://cdt.horizon.ac.uk/programme/

1.1 PROBLEM DEFINITION

CPGs are essential components in many of our daily activities and are interwoven into our everyday lives. They are vital for commonplace practices such as cooking, shopping, cleaning, and grooming. Due to their ubiquitous presence, innovations in CPGs have an immense potential to benefit people by providing additional functionalities tailored to fit their context of use and better support people's needs. The incorporation of IoT technologies to CPGs could help them to provide feedback about product consumption, teach consumers about proper product use, and provide an entertaining experience to promote changes in behaviour.

Despite the promise which enhanced CPGs hold for consumers, to this day there has been little research on their development, and those available in the market have experienced only a fleeting interest from consumers. Designing for enhanced CPGs may be even more challenging than doing so for more conventional and durable goods (e.g., a watch Lyons, 2015) due to their defining characteristics, including their disposability and frequent need to be replenished (Laan and Aurisicchio, 2017), as well as the fact that they are rarely used in isolation, but rather in conjunction with one another as complements (Berumen et al., 2019).

CPGs are very relevant, and the notion of enhancing them is very promising, but we still lack effective design strategies. A promising solution for overcoming the difficulties of creating enhanced CPGs which provide significant value would be to take a design approach which is firmly rooted in empirical insights about their usage. Such an approach inspired by design ethnography has proven effective for the creation of a variety of devices (Crabtree and Tolmie, 2016) including software, smart devices, and virtual environments (for a review, see Randall and Rouncefield, 2017). Moreover, recent approaches in product development have demonstrated the relevance of using data as well as the power of including consumers as part of the design process. Industry experts have proposed expanding the role of data, not only for improving technical systems, but also in guiding decisions about *what to design* (Bertoni, 2018) and increasing the level of consumer involvement. We thus believe that it is essential to capture the opinions of consumers and those involved in development as early as possible to create products which are more likely to cater to our needs. To our knowledge, no approach which incorporates data about CPG usage has yet been applied towards the creation of enhanced CPGs.

As we mentioned in the previous section and will expand on in the literature review (Chapter 2), there is a lack of empirical studies focused on understanding the practical use of CPGs in the household environment. We will also dive into recent approaches which have harnessed data as a resource for design in the early stages of product development. This thesis is also motivated by the growing development of enhanced CPGs in the industry, as they appear to provide one of the most promising avenues for product improvement and responding to consumers' ever-growing demands.

This thesis has two primary objectives: one is to provide an understanding of CPG interactions in practice, and the other is to explore the value of such an understanding to inspire the design of enhanced CPGs. To the first point, we will investigate how CPGs are actually used in the practice of cooking. In doing so, we will take a practice perspective (Kuutti and Bannon, 2014) in which we study CPGs as resources within the practices they are part of. To accomplish our second objective, we will make use of the participatory design (Kuhn and Muller, 1993) perspective to inform design workshops in order to present the insights gathered from the fieldwork to a wide range of participants in an easy and accessible manner, thereby facilitating the conceptualisation of enhanced CPGs. There is a sizable amount of work regarding the use of data as a resource for design; however, its application to the creation of enhanced CPGs remains lacking. Through empirical observation in the field, we strive to attain an understanding of the ways in which CPGs are used in practice, and through design workshops we seek to present those insights to consumers and designers. Ultimately, this thesis aims to show how the design of enhanced CPGs can benefit from being grounded in empirical insights.

1.2 RESEARCH QUESTIONS

There is a well-established principle in the field of HCI of gathering insights from first-hand ethnographic observations to understand *what is accomplished*, and only then envision *what might be accomplished* in order to inform the design of technologies which suit our practices (Crabtree, Rouncefield, and Tolmie, 2012). However, so far research into enhanced CPGs has focused primarily on isolated user-product interactions (Mumani and Stone, 2018) and has yet to generate a more in-depth understanding of their practical and contextual interactions. In a first attempt to understand how we can collect data about the interactions of CPGs, we will explore through the use of ethnographically-inspired methods how CPGs are used in the practice of cooking to answer our first research question:

RQ1 How do people interact with CPGs in the practice of cooking?

Even though cooking is a widely-studied setting within HCI, and ethnographic methods have been used to understand the social interactions of the practice, to our understanding, there are no specific methods for analysing individual interactions involving CPGs. For this thesis, we developed our own methods to analyse different aspects of CPG interactions. Informed by a quantitative ethnographic approach (Shaffer, 2017a), we developed a set of mixed methods to analyse the data which integrate insights from statistical analyses and qualitative insights from fieldwork. The basis of the analysis consisted of capturing the interactions with any object used in cooking, including CPGs and utensils. The methods allowed us to answer the following research question:

RQ2 How can we gain insight into the interactions of CPGs in practice?

Given that conceptualisation is argued to have the greatest influence on determining the level of product innovation (Han et al., 2020), it is essential to capture the opinions of different people involved in the use and design of CPGs as early as possible in the development process. However, while it has been argued that interactional data represent a useful resource for design (Mortier et al., 2014) which could in turn be employed to empower a wide range of stakeholders, this has not yet been applied to the creation of digitally enhanced CPGs. Through explorations into the use of data for designing enhanced CPGs, we aim to provide an answer to our third research question:

RQ3 How do people make use of data about interactions with CPGs to conceptualise digitally enhanced versions of these products?

To facilitate the presentation of data to a wider variety of participants, we devised a design workshop inspired by the participatory design perspective (Muller and Kuhn, 1993). We made use of data visualisations to present the data in an easy and accessible manner. The design workshop included a structured process, design cards and a design sheet to facilitate the sketching of CPGs and allow participants to focus on the interpretation and use of data. We reflect on the strengths of the approach as well as potential areas of opportunities for improvement in order to answer our fourth research question:

RQ4 How can we develop a method which allows for the creation of enhanced CPGs inspired by data?

1.3 RESEARCH AREAS

This thesis adopts an iterative approach combining research on fieldwork, and participatory design, and makes contributions to the following research areas:

- HCI – The derivation of insights for the design of technologically enhanced CPGs, which is an emerging topic of interest within the field of HCI and could contribute to promoting increasing research on this area.
- Mixed-Methods Research – A mixed-methods approach combining quantitative and qualitative methods was employed in the analysis of the fieldwork.
- Participatory Design – The approach stressed the involvement of consumers and professionals with experience in product development to design goods which meet consumer and industry needs.

1.4 CONTRIBUTIONS

The four main contributions of this thesis are stated in the list below:

1. Understanding of the Practical CPG Interactions – An understanding of how CPGs are used in the practice of cooking.

2. Mixed Methods to Analyse CPG Interactions – A set of specially-tailored quantitative and qualitative design methods for understanding the interactions of CPGs in the practice of cooking.

3. Data-Inspired Ideation Approach – An approach for participatory design which employs data about CPG interactions for the creation of technological enhancements.

4. Insights for the Design of Enhanced CPGs – Practical insights for the design of enhanced CPGs obtained from consumers and professionals with experience in product development.

The first and second contributions are developed in Chapter 4, the third contribution is developed in Chapter 5 and the fourth contribution is developed in Chapters 6 and 7.

1.5 STRUCTURE OF THE THESIS

This thesis is structured in three parts and consists of nine chapters in total. We provide a brief summary of the contribution of each chapter in the section below:

Part I provides relevant background literature over the course of two chapters. First, the 'literature review' (Chapter 2), which introduces relevant topics for this thesis including the latest developments in enhanced CPGs, domestic studies on cooking, and data-inspired approaches for design. The second chapter is the 'approach' (Chapter 3), and provides the relevant literature for the research methodologies which were employed in the empirical studies. It describes such methods

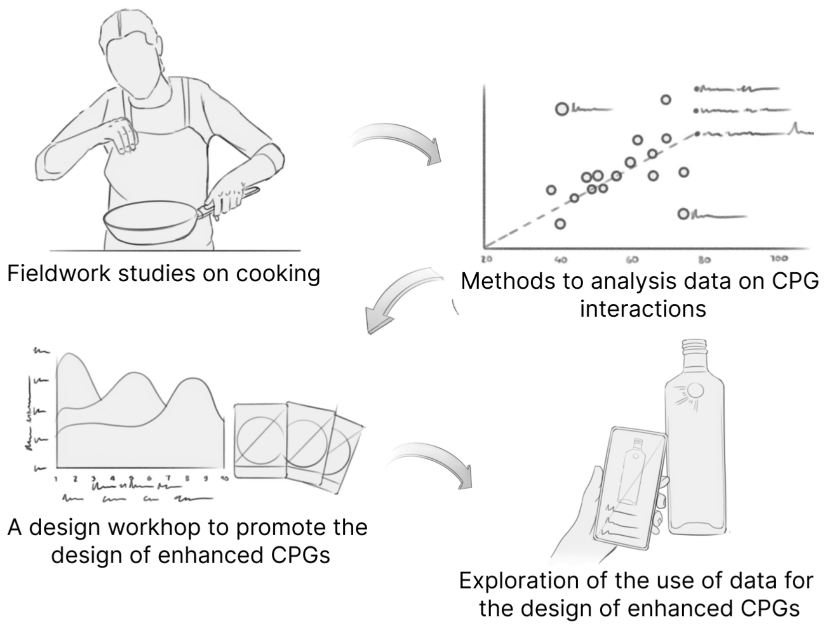


Figure 1: Steps comprising the research work of this thesis.

and approaches as the practice perspective, ethnographic fieldwork, participatory design, and thematic analysis.

Part II constitutes the empirical work of this thesis. It contains four chapters, each of which is concerned with a different study. Chapter 4 presents our fieldwork study on cooking which focuses on the interactions of CPGs in the preparation of familiar meals and on the interactions of CPGs in the preparation of unfamiliar meals compared to those in familiar meals. Chapter 5 details the development of the design resources used for the workshop studies. The chapter describes how data drawn from the ethnographic work was used to inspire the creation of the data visualisations in an iterative process as well as how the data visualisations, design cards, and design sheets were developed. Chapter 6 presents the design workshop study, which included only consumers with no prior experience in product development and aimed to promote the use of data for the design of enhanced CPGs. Chapter 7 presents the second design workshop study, which this time included professional designers and had a greater emphasis on exploring the value of data for design. Figure 1[2] represents the relationship among the empirical work of this thesis.

Part III discusses the empirical work in this thesis. Chapter 8 examines the findings of the earlier chapters on empirical work and their relationship to each other as well as to the broader literature in HCI. Chapter 9 culminates with a brief summary of the work accomplished, and by stating the key contributions made in terms of methodology, understanding of CPG interactions, and data-inspired approaches for design. Finally, we close with some considerations about the implications of our work for future research, and some possible directions the field may take moving forward.

2 An artist was commissioned to create these illustrations. The copyright to the illustrations is held by the author of this thesis.

Part I

BACKGROUND AND APPROACH

2

LITERATURE REVIEW

This chapter introduces the three essential themes of this thesis: consumer packaged goods (CPG), domestic cooking, and data-inspired design. It serves to introduce the basis of the research which informed and led to the development of our research questions previously outlined in Chapter 1. The following section on CPG provides a comprehensive definition of these products and surveys recent research into developing innovations for enhanced CPGs. In later sections, we summarise related work on domestic cooking and data-inspired approaches for design which inform our fieldwork study (Chapter 4) and participatory design studies (Chapters 6 & 7), respectively. A brief summary of the sections is presented below:

Consumer Packaged Goods

> This first section 2.1 provides a definition of CPG and outlines their essential characteristics, highlighting their relevance in our everyday lives. It serves as the foundation for our discussion of the ways in which industry and HCI researchers are creating innovations for those products. The section also introduces the concept of enhanced CPGs, along with some examples. Finally, it delivers an overview of how enhanced CPGs are collocated within the wider field of HCI, and their potential relevance in society.

Domestic Cooking

> The second section 2.2 gives a general overview of the literature on domestic cooking. It defines the

concept of home meal preparation and establishes its relevance in everyday life, then gives a summary of the different methods for investigation including surveys, language based-methods, and testing prototypes. It then introduces studies on situated cooking, with a focus on fieldwork and devising implications for the design of technologies. Finally, the section concludes by discussing the influence of situational contexts, particularly in the preparation of unfamiliar meals.

Data-Inspired Design

The third section 2.3 highlights the different ways in which data has been used for the design of technologies, describing how Internet of Things (IoT) technologies are changing the landscape to inform and improve the innovation process. The section delves into data-inspired approaches for design in the industry as well as in the field of HCI. It closes by providing perspectives on the wider consequences of treating data as a design resource, raising ethical considerations such as the protection of privacy, and discussing how researchers might find a compromise between the potential this approach offers and the challenges it introduces.

This literature review seeks to situate the contribution of this thesis within interdisciplinary fields and discourses centred around social practises relating to technologies and approaches for the design of technological artefacts. The contributions of this thesis are based not on theoretical or technological contributions, but rather on a practical perspective. We aim to provide an understanding of how CPGs are used in the household environment, as well as an account of the implications of this understanding for the design of enhanced CPGs from the perspective of consumers and designers.

This literature review has a strong emphasis on HCI and ubiquitous computing. Thus, in spite of our efforts to give a comprehensive account by relating our work to as many fields as possible, we found it necessary to disregard some aspects of CPG design such as its implication for economics and manufacturing. This thesis is concerned mainly with food-related CPGs—in particular those which are involved in meal preparation. The decision to focus on these CPGs came from a need to narrow our scope given the vast quantities of these products in existence such that we might obtain a detailed comprehension of their use and subsequently obtain more robust design implications.

2.1 CONSUMER PACKAGED GOODS

2.1.1 *Defining characteristics*

CPGs, also known as fast-moving consumer goods (FMCG), are non-durable goods which are consumed completely or partially upon each use. CPGs compose almost the entirety of products one normally buys in the supermarket. Some of the main characteristics of CPGs include a short lifespan, relatively low price, and ease of replacement. They are generally considered to be expendable and therefore lacking in intrinsic value as individual units. CPGs usually come in a protective package which also serves to differentiate the product from other brands and, due to their low profit margin, must be sold in high volumes to generate a sustainable revenue.

CPGs stand in contrast to durable goods such as furniture, technological devices, and automobiles, which do not experience significant wear upon each use thus lasting longer before requiring replacement. The distinction between CPGs and durable goods is not a binary one; rather their classification may better be regarded as a spectrum. One can find many examples of each which lack one or more of their 'defining' characteristics: premium expensive spirits could have prices which far exceed those of many durable goods, personalised bottles of soda containing people's names can make them seem unique and confer an apparent intrinsic value, and some ballpoint pens do not experience a noticeable depletion upon a single use. The categorization of an item as a CPG seems to be the result it bearing several qualities which are generally considered exemplary of such products rather than strict conformity to an itemised checklist.

CPGs are an essential component of our lives, and on average people spend a considerable amount of their income on these products. The expenses of CPGs and related products for a middle-income American household account for more than half of their consumer spending (Labor Statistics, 2020). In the UK, households spent more than £60 weekly on food and non-alcoholic drinks in 2018 (National Statistics, 2020). CPGs have a great impact on the economy; the global market share for these products was valued at more than $10 trillion in 2017 and is projected to increase to more than $17 trillion by 2025 (Sable, 2018). CPGs have a pervasive presence in our lives. To give a better sense of their ubiquity, in a single day, a European family of three had more than three hundred interactions with CPGs (Crabtree and Tolmie, 2016), and just one of the world's largest CPG companies had its products used by an estimated 2.5 billion people across the globe (Unilever, 2016).

Because CPGs are vital for countless activities, they obviously have an impact on many aspects of our lives. Table 1 provides a non-comprehensive list of some of the impacts those activities have had in culture, well-being, and social relationships:

Table 1: Benefits of practices associated with CPGs.

Practice	**Benefits**
Cooking	Nutritional and psycho-social (Farmer, Touchton-Leonard, and Ross, 2018)
Baking	A resource in therapy for mental health (Majlesi and Ekström, 2016)
Tea drinking	Social and cultural relevance and relaxation (Wang, 2011; Steptoe et al., 2007)
Personal care	Emotional benefits associated with personal care (Apaolaza-Ibantilde, Hartmann, Terlutter, et al., 2011)
Washing hands	Help preventing the transmission of diseases (Jensen et al., 2015)

Moreover, CPGs are associated with some of the greatest concerns of our current society, such as healthy eating and climate change, making both positive and negative contributions to those areas. For instance, CPGs include food products with wildly varying nutritional values, which could either contribute to maintaining a healthy weight or lead to obesity. There are efforts from the CPG sector to make changes and become a positive factor by helping individuals and the societies in which they live achieve their goals as a result of mounting pressure from consumers who are calling upon companies to be more socially responsible. The modern consumer expects CPGs to do more than meet common standards regarding their quality and pricing. Some of the demands of customers in the past years have included ergonomically-designed packaging, as well as healthier, environmentally-friendly, and ethically-sourced products planned as much around their digital presence as their physical one.

CPGs are a factor in people's lives and contribute to our success or failure to meet our daily goals (Comber et al., 2014). These objects as part of people's practices might have subtle, complex patterns of interactions which only become known after careful observation. Although there is a lack of studies on the use of CPGs in practical contexts, we can look at how other objects are utilised to get a sense of their complex interactions. As an example of the hidden life of objects, Crabtree and Rodden (2004) illuminate the complex practises and behaviours in the domestic environment through an analysis of the handling of paper mail in the home. Although apparently a simple activity, it has rich patterns of interactions which, among others, include efficiency in the collection of mail despite not being coordinated by the nomination of an official collector, authority to open mail for junior members by senior members, and dynamic placement of mail in various locations according to its perceived relevance.

Another interesting finding concerning everyday and mundane objects is that people continually reconfigure spaces and objects within them to meet particular demands (Taylor and Swan, 2005). They re-purpose many objects for a variety of reasons; they customise and modify things, changing their possible uses to better suit their needs. For instance, one might purchase an item originally intended to serve as a baby book, only to later re-purposed it for storing phone numbers and recipes. Overall, it has been found that products which are flexible enough to serve different purposes and are incorporated effortlessly into people's routines are considered to be well-integrated into people's lives (Bakker, Hoven, and Eggen, 2015).

2.1.2 *Enhanced CPGs*

Even though many common CPG brands and products have existed for centuries, the industry has been constantly innovating to satisfy ever-evolving customer needs (Thain and Bradley, 2014). To illustrate, beer is one of the oldest prepared beverages and is believed to date back thousands of years (Hornsey, 2003). What may well be the oldest known food quality law was applied to beer with the introduction of beer 'purity laws' as early as the year 1156 CE (Meussdoerffer, 2009). During the Industrial Revolution, many processes involved in beer production moved away from being artisanal in favour of newfound manufacturing methods (Cornell, 2003). More recently, in the early twentieth century, brown bottles were introduced to help shield their contents from UV rays, and the first beer can was introduced in the 1930s (Maxwell, 1993). To this day, innovations in beer are still occurring, such as bottles being incorporated with LCD screens and sensors which react to music being played (John, 2020).

It is important to note that, unlike durable goods, a CPG's packaging is often considered part of the product itself, as it serves a functional purpose (Oki and Sasaki, 2000; Underwood, 2003). As such, one of the most important areas of innovation for CPG industries is focused on equipping packaging with technology. Improvements to the packaging helps CPGs to better serve their primary purposes and enhance consumer experiences through added functionalities (Lydekaityte, 2019). Some recent innovations in CPGs are focused on the use of biomaterials in packaging, such as nanotechnologies which extend the shelf life of beverages (Farmer, 2013).

Research into enhanced CPGs has been focused primarily on applications of different active and intelligent packaging (Lydekaityte and Tambo, 2020). Active packaging uses biomaterials to directly interact with its contents and monitor quality, safety, and shelf life (Farmer, Touchton-Leonard, and Ross, 2018; Meroni, 2000). One example of active packaging is an antimicrobial material which reduces contamination in meat products, thereby extending shelf life and improving safety (Quintavalla and Vicini, 2002). Intelligent packaging contains a component which monitors the product and provides reliable information about its condition, packaging, and the surrounding environment (Vanderroost et al., 2014). An example of intelligent packaging is the inclusion of freshness indicators which monitor the quality of perishables by reacting to metabolites in the contents, then relaying that information to consumers (Poyatos-Racionero et al., 2018). The third type of packaging is interactive packaging, which is based on reciprocal interactions between people and the product creating a two-way communication channel allowing for more dynamic responses from technology-based systems (Wyser et al., 2016). Interactive features include providing entertainment, helping with the collection of feedback, and facilitating product management (Foroudi et al., 2018).

> For the purposes of this thesis, we define **enhanced CPGs** as CPGs incorporated with IoT technologies which confer them with additional functionalities capable of dynamically responding to their interactions. We envisioned integrating technologies into the CPG itself (e.g. in their own packaging) or incorporating them into surrounding devices (e.g. smart assistants). See Figure 2[1] for a visual representation of an enhanced CPG.

Enhanced CPGs find their place within the IoT, a paradigm envisioned as a network of interconnected machines and

1 An artist was commissioned to create these illustrations. The copyright to the illustrations is held by the author of this thesis.

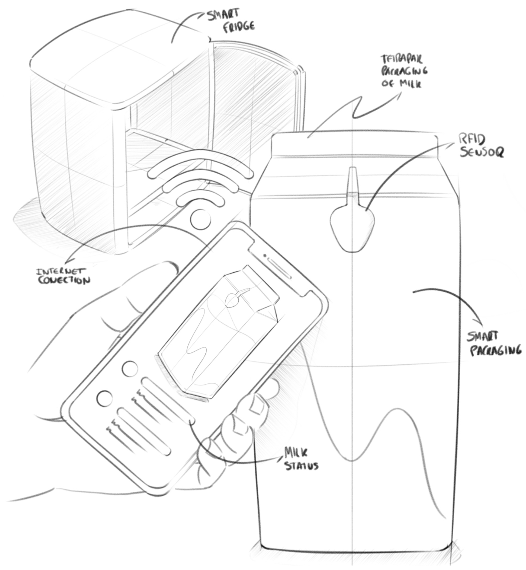


Figure 2: Representation of an enhanced CPG: A bottle of milk equipped with a sensor and connected to smart devices that provides dynamic notifications.

devices capable of digitally interacting with each other (Lee and Lee, 2015). At the core of the IoT is the collection of information by objects about their surroundings, and the use of said information to make sense of their interactions and respond accordingly (Bertin, Crespi, and Magedanz, 2013). The few existing implementations of enhanced CPGs have usually been focused only on a singular aspect. Some examples include: a) marketing; providing product information and functionalities to facilitate and encourage brand selection and decision-making at the point of purchase (Petit, Velasco, and Spence, 2019), b) product experience; incorporating entertainment such as music to make product interactions more enjoyable (Petit et al., 2015), and c) security; assisting in and facilitating the authentication of products and preventing counterfeiting (Vehmas et al., 2018).

The development of functionalities for CPGs has piqued the interest of many in the field of HCI, where the emergence of subfields such as human-packaging interaction (Mumani and

Stone, 2018) and human-food interaction (Altarriba-Bertran et al., 2019) has led to the creation of technologies which can enhance one's experience. Petit, Velasco, and Spence (2019) highlight the efforts to develop sensory-enabled packaging which delivers novel yet informative experiences—for example suggesting recipes through augmented reality. Altarriba-Bertran et al. (2019) have cited the opportunity to harmoniously integrate social food traditions, personal habits, and technological solutions to support a future for playful and sustainable food practices (Altarriba-Bertran and Wilde, 2018).

The design of technologies for CPGs is particularly challenging, even more so than for other more conventional design practices like those for durable goods (Cambre and Kulkarni, 2019). Some examples of enhanced CPGs have been plagued by unforeseen issues that only became apparent when finally deployed. TagItSmart, a platform to help the life-cycle management of CPGs (Vehmas et al., 2018), has not been able to achieve widespread acceptance as the industry has still chosen to rely upon time-tested solutions such as barcodes. A smart bottle, which offered entertainment such as music to complement the drinking experience (Stylus, 2012), was discontinued after a brief period on the market. One reason for its discontinuation and that of other similar enhanced CPGs may be that they failed to garner more than a passing interest, and the vast majority of consumers treated them as little more than mere novelties (Newgarden et al., 2004).

Some of the difficulties surrounding the developing enhanced CPGs stem from their defining characteristics, such as their low cost, disposability, and ubiquity in our everyday lives (Laan and Aurisicchio, 2017). To overcome the challenges of designing innovative CPGs, our study follows the approach of developing an understanding of their interactions in practical settings, not only to reveal hidden patterns of use, but also to identify specific cases for intervention (Lorenzini and Olsson, 2019b). Nevertheless, given the importance of CPGs and the emergence of technological enhancements to them, it has become necessary to overcome this challenge using a variety of approaches, and to design products which satisfy consumer needs and provide extra value.

CPGs, like any other object, lend themselves to a particular set of actions and interactions, which need to be observed from the dyadic, human-object level, all the way up to the practical and contextual level. However, while considerable efforts have been made towards understanding these isolated user-product interactions, there is a lack of more than a superficial grasp of how they occur within more practical, contextual settings. In a review of more than 100 studies on user-packaging interactions, of which approximately two-thirds were related to CPGs, it was found that the existing research was predominantly focused on the 'point of purchase' and 'checkout' stages (Mumani and Stone, 2018). Only four studies were found on 'handling,' and even those focused solely on the mechanical properties of interactions rather than on their practical use. The research on packaging has been dominated by engineering (Hanlon and Kelsey, 1998; Pecht, 1991) and ergonomic aspects of packaging (Stern, 1981). A deeper understanding of the contexts of CPG use has proven effective in developing guidelines for predicting their performance (Yiangkamolsing, Bohez, and Bueren, 2010) and in providing a framework for design (Lorenzini and Olsson, 2019b).

2.1.3 *Section summary*

This section introduced the concept of CPG, contrasted that concept with its counterpart, durable goods, and reflected on the essential characteristics of CPGs to allow the reader a clearer picture of what a CPG is. Additionally, the section has given an account of the relevance of CPGs as well as how, despite usually being considered irrelevant, their uses are interwoven in our everyday lives. This section also introduces the key concept of enhanced CPGs, describing the ways in which the IoT is being incorporated into these products to provide additional functionalities, and discusses some examples of those innovations. In so doing, we highlight two shortcomings of the literature: one being the lack of studies investigating how CPGs are used by consumers in the household environment, and the other being the lack of enhanced CPGs with designs based on empirical insights. The empirical work in this thesis aims to address both shortcomings by providing an understanding of CPGs' practical interactions (Chapter 4), and by investigating ways to conceptualise enhanced CPGs (Chapters 6 & 7). Finally, this section presents a clear definition of CPGs and enhanced CPGs—concepts which are going to be referenced throughout the remainder of this thesis.

2.2 DOMESTIC COOKING

2.2.1 *Methods for the study of cooking*

There is a vast body of literature on cooking including large academic compendiums (e.g., historical accounts, Symons, 2003) and diverse non-academic sources (e.g., cookbooks, Clancy, 2013). We provide a list of the methods we considered relevant for our aims. For each of the methods, we provide its description, purpose, and examples of findings.

This section makes no pretence to serve as an exhaustive review; rather, it aims to provide an account of some of the methods employed while researching cooking. We attempted to be as comprehensive as possible with our selection of methods, but we acknowledge that many are absent from this review. Some methods which had to be omitted for the sake of brevity include: sociological works (Goody and Goody, 1982), laboratory experiments (Rohrbach et al., 2012), and economic studies (Manibog, 1984).

Surveys. These are large national surveys which capture mostly quantitative information about how people engage in their everyday habits and routines. Some keep cooking itself as their primary object of interest, while others inquire about cooking as part of a larger evaluation of habits. These studies contribute to our knowledge about cooking habits, perceived cooking skills, and expenditure in food ingredients, as well as other associated practises such as eating and energy consumption.

In some time-use survey studies, people complete diaries and use their own words to describe how they spend their time in a day. Comparing cooking durations between households in France and the US during the 1985-2010 period, it has been found that the time spent has been in decline (Plessz and Étilé, 2019). Such declines in household cooking times have been found in other industrialised nations such as the UK, as is illustrated by data gathered in the 1960s (Sullivan and Gershuny, 2001). However, when distinguished by gender, it was found that males in the US increased their daily time spent cooking by 8.3 minutes, with as many as 55.5 minutes per day being the average for middle income families (Smith, Ng, and Popkin, 2013). Despite the decline in time spent cooking, a 2005 survey in the UK revealed that a majority of people do devote at least some time to cooking every day regardless of their gender, and that 60% of women and 33% of men engaged in the activity for at least 30 minutes each day.

Language-based methods. These are conversations with different levels of structure in which the researchers ask participants questions through such methods as personal interviews, focus groups, and diary and photo elicitation. The aim of these studies is to explore perceptions, concepts, concerns, barriers, and other important factors relating to cooking in great detail. These studies request people to express through discourse the meanings and motivations behind the practice of cooking.

Exploring the perceptions and other important factors relating to cooking, people expressed that, despite barriers to preparing meals at homes such as a lack of affordability, time, and enjoyment, people have a desire to make their meals at home using fresh ingredients (Wolfson et al., 2016). Using photographic food diaries to encourage conversation during interviews, it was found that practises, experiences, and perceptions varied widely over time. Many were influenced by social factors and personal desires, and still more aspired to increase their skills in preparing healthy meals from scratch (Mills et al., 2017). One's access to food and shopping habits affected cooking practises: shopping at full-service grocery stores and cooking at home were associated with a healthier diet, and shopping at convenience stores coincided with an increase in the purchase of unhealthy foods (Gustat et al., 2017).

Embodied interaction methods. Using observational methods, researchers attempt to get firsthand experience of people's practises through field observations and by immersing themselves as much as possible in the situation. Researchers aim to gain trust by building friendly relationships, and they also attempt to achieve a level of basic competence in the practice they aim to study; for instance, by learning to play video games to study gaming as a culture. They enhance their accounts using a variety of evidence such as field notes, artefacts, and video and audio recordings. In these methods, researchers attempt to position themselves in the midst of their object of study to uncover the meanings behind peoples' actions.

Decades of fieldwork provide a fine-grained ethnographic account. An immersive look at the everyday cooking practices of Greek islanders reveals the methods the locals employed, as well as their associated values and the nature of various social relationships formed around them (Sutton, 2014). Conducting a digital ethnographic study of how people cooperate, researchers identified eight different formations in which people arranged themselves such as face-to-face, L-shaped, and semi-circular (Paay, Kjeldskov, and Skov, 2015).

Testing prototypes. In these studies, researchers implement new technologies in different stages of development, from prototypical to fully-functional, to explore the impact of technological intervention on cooking. Usually, researchers attempt to support people and facilitate accomplishing tasks relating to cooking by providing guidance, for instance by helping to measure out a portion or by automatically reordering groceries.

A cabinet equipped with an RFID antenna and digital scales along with a set of packages equipped with sensors were used to construct a smart kitchen cabinet which was capable of identifying groceries stored inside of it. It recognized the location and weight of the items and updated a database with a list of groceries present (Amutha, Sethukkarasi, and Pitchiah, 2012). Another example was a software and hardware platform which dynamically generated a user interface to guide consumers through a recipe. The system automatically triggered novel assistance modules such as an adaptive hob control, a stirring detector which was integrated into the workspace, and a computer vision system which estimated the quantity of liquid contained within a vessel (Neumann et al., 2017). In another study, a kitchen was equipped with embedded displays, video cameras, microphones, sensors, switches, and networked remote kitchen counters. The system was capable of recording activities, playing videos of cooking, connecting people via video conferences, and providing interactive cooking navigation (Siio, Hamada, and Mima, 2007).

Cooking interventions. These are programs which aim to promote better habits and teach healthy cooking skills. Their goal is to help people increase their consumption of fresh ingredients and guide them in the production of healthier home-made meals. These programs are usually organised by a government agency in cooperation with specialists in the field, and are targeted at a specific demographic, such as a minority group or the elderly. After the program, researchers assess the effect on participants' cooking skills and eating habits.

One study investigated the effectiveness of different instructional modes for learning to cook a meal using a variety of behaviour change techniques. Researchers measured the extent to which the participants experienced enjoyment, perceived difficulty, confidence, and intentions to cook using basic ingredients influenced their cooking habits. They found a significant increase in enjoyment, confidence, and desire to cook using ingredients from scratch (Lavelle et al., 2016). Another example was a nutritional education programme called "Cooking with a Chef." The program aimed to improve skills and habits concerning the selection of foods. Participation consisted of a weekly series of six interactive cooking lessons with a chef and dietitian. The program was indeed found to be successful in improving the skills needed for sustainable, healthful menu changes at home (Condrasky, Graham, and Kamp, 2006). In another study, they assessed the outcomes of a community-based nutrition and cooking education program for older men held within a recreation facility. The majority of participants gained confidence, increased their frequency of cooking, developed skills for preparing healthy meals, and improved the variety in their diets (Keller et al., 2004).

2.2.2 *Studies on cooking*

Through the proposed use of observational methods, such as ethnographic research, one can develop 'implications for design'. Crabtree, Rouncefield, and Tolmie (2012), in their book 'Doing Design Ethnography', propose that, using the findings derived from fieldwork observations, one can identify and distil those aspects which are crucial to maintain from those which can be modified. Cataloguing the activities and places in which CPGs were used during the day, researchers cited potential opportunities and challenges in the development of IoT technologies (Crabtree and Tolmie, 2016). Insights from cooking observations were used to identify the requirements in developing sensors and an infrastructure to monitor the use of utensils, allowing for a way in which to measure culinary competence (Wagner et al., 2011).

Observations were also used to estimate the environmental impact (e.g., energy consumption) related to cooking. Such estimates can be employed to help people reflect on their environmental footprint and allow innovators to work in collaboration with researchers to make an effort towards reducing these undesirable effects (Clear et al., 2013). Researchers proposed a food consumption life-cycle as a framework for identifying how and in which situations digital interventions could be useful in promoting change concerning food-related behaviours. This framework was created based on videos of cooking and associated activities taken using wearable cameras (Nagarajan et al., 2020). Based on videos of eating in the UK and Malaysia, researchers proposed a similar framework for identifying the situations in which digital interventions would

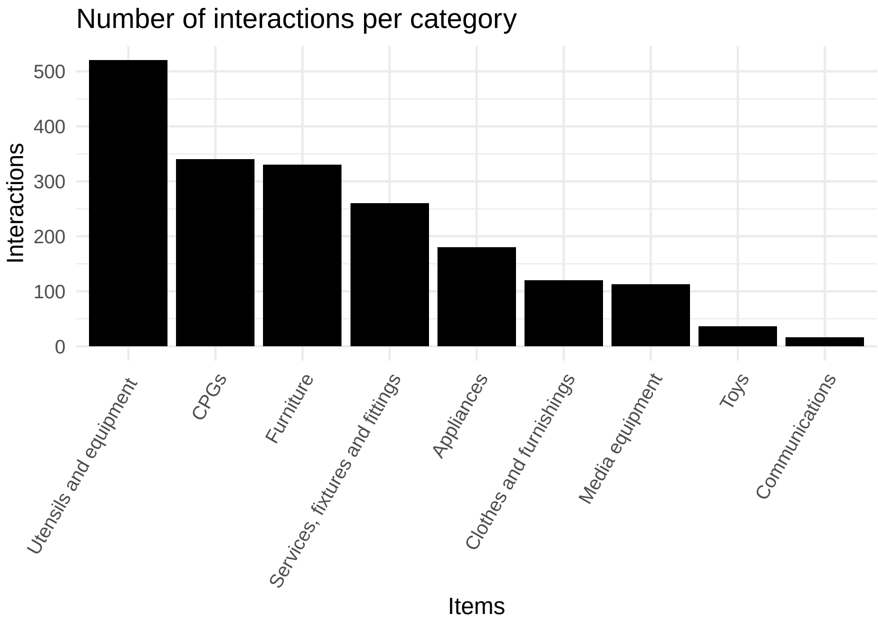


Figure 3: Number of interactions with items in a household in a 24-hour period.
Figure created using data from Crabtree and Tolmie (2016).

be most likely to promote positive behavioural changes, as well as for using current behaviours to design human-food interactions (Ng et al., 2015).

A number of studies exploring practices related to cooking provide valuable insights into CPG interactions, though they do not focus specifically on the use of CPGs themselves. Examining the interactions which people had with objects on a regular basis, Crabtree and Tolmie (2016) found that CPGs were second only to household utensils in terms of number, with more than 300 interactions on average per day (see Figure 3). Observing the various practices with food at home such as preserving, fermenting, and pickling, researchers detailed the motivations, and workarounds behind sustainability and associated practises (Kuznetsov, Santana, and Long, 2016). Other researchers, in studying the routine of shopping, were able to elucidate the methodologies employed by shoppers and illustrated how they may pose challenges for the design of proactive systems (Hyland et al., 2018). Through an online survey concerning 23 utensils, researchers measured their frequency of use and ascribed them a rank from 'high' to 'low'. They did not find a strong relationship between the use of utensils and social or economic demographics (Wang and Worsley, 2014).

While a large number of technologies for the smart home have been designed to aid people in different aspects of cooking—social components (Terrenghi, Hilliges, and Butz, 2007), counting calories (Chi et al., 2007), culinary skills (Sato, Watanabe, and Rekimoto, 2014)—few have specifically focused on CPGs. One of these implementations made predictions about the consumption of essential ingredients, which helped researchers identify various contingencies pivotal in shaping the cycle of consumption at home including routine changes, preferences, and sporadic events (Fuentes et al., 2019). An unpredictable produce box scheme, which delivered a randomised assortment of fruits and vegetables through a subscription service, was tested to identify the consequences of delegating shopping to automated systems and study the way people accommodate their cooking habits to make use of food which was purchased with no prearranged purpose (Verame et al., 2018).

2.2.2.1 *Situational contexts of cooking*

The extensive research on cooking has provided a wealth of information on the everyday practice, revealing its methodologies (Sutton, 2014) and associated values (Wolfson and Bleich, 2015). Among the different means of studying cooking, ethnographic research has proven an ideal method for revealing, by way of first-hand empirical accounts, the methodologies which people generally employ (Torkkeli, Mäkelä, and Niva, 2018). Through repeated observations of household cooking, De Léon (2003) illustrated that the complexity of the kitchen environment was owing in part to its blend of *fixed* elements (e.g. infrastructure) and *flexible* ones (e.g. duration), showing that people actively altered some of those elements to better serve their needs. A large number of technologies for the smart kitchen have been designed to aid people in different aspects of cooking, such as promoting healthy eating by providing nutritional facts (Chi et al., 2007), improving culinary skills by giving guidance (Sato, Watanabe, and Rekimoto, 2014), and fostering relationships through sharing recipes (Terrenghi, Hilliges, and Butz, 2007).

Studying common cooking habits, Hove et al. (2020) identified opposing situations and their impact on temporal, social, physical, and informational contexts, which in turn influence interactions with objects. The authors organised these opposing situational contexts into four types: namely, 'cooking familiar meals or unfamiliar meals', 'cooking for oneself or for guests', 'cooking on a weekday or during the weekend', and 'cooking alone or together'; and argued for further exploration of the impact requirements of these contexts in the development of technologies. If greater access to information is required for unfamiliar meals, the researchers proposed that technologies should then provide flexible feedback to address the uncertainties which stem from this type of cooking.

Despite it having long been argued that studies should focus on the preparation of unfamiliar meals (De Léon, 2003), to the best of our knowledge, such research is scarce. Through testing a prototypical cooking assistant, Vildjiounaite et al. (2011) found a trade-off between providing efficient assistance and avoiding intrusive interruptions in both the context of cooking familiar as well as that of unfamiliar meals. Participants only welcomed audio reminders when they were preparing unfamiliar meals, but preferred to disable them when preparing familiar ones. There have also been technologies developed to provide support in the preparation of unfamiliar meals only. 'CounterActive' is a smart kitchen infrastructure and cookbook which provides interactive guidance when following a recipe (Ju et al., 2001), and 'Recipe 1M' is a neural network image-recipe retrieval system which inputs images and outputs related recipes (Salvador et al., 2017).

2.2.3 *Section summary*

This section provides a general overview of cooking, from constructing a definition to describing the variety of methods used to study the practice. It then positions cooking within HCI and ubiquitous computing. In doing so, we reflected on studies in HCI in which researchers attempt first to obtain a holistic understanding of the use of objects within an actual social setting, and then to think critically about the design of technologies which properly fit within their context of use. The subsequent sections are devoted to the summary of other studies on contextual interactions, with a particular emphasis on fieldwork given how instrumental this literature was in positioning our field studies within the wider body of related research. We then looked at how an understanding from empirical observations is utilised to derive implications for the design of technologies and reflect on the advantages of this approach, which we later implemented in our own fashion. Overall, the section contextualised our fieldwork within the broader field of HCI and, more specifically, amongst research into the practice of cooking.

2.3 DATA INSPIRED DESIGN

2.3.1 *Approaches to data-driven design*

Whether designers employ data derived from personal experiences or from more systematic and formal studies, "design is and always has been informed by data" (King, Churchill, and Tan, 2017, p. xii). In user-centred design disciplines, practitioners frequently obtain an understanding of people and their interactions with objects through a variety of methods—usability testing, fieldwork, and focus groups, among others—to guide the design of experiences and technologies (Zimmerman, Forlizzi, and Evenson, 2007). In a clear-cut example, ethnographic approaches have been employed to generate implications for design which inform a range of technical systems from the workplace to virtual environments (Randall and Rouncefield, 2017).

User-centred design methods have been enriched through the automated collection of digital information (Dahlstedt, 2019). User analytics are employed, for instance, to establish effective and rewarding experiences provided by digital services (Gomez-Uribe and Hunt, 2016). The availability of ubiquitous computing technologies increases the opportunity to collect data about our interactions with everyday objects, as well as about the practices and contexts associated with them (Mortier et al., 2014).

There is a long history in engineering and industry of employing data-driven approaches for design, encompassing multiple methods which use data collected from technical systems to support optimisation and prevention of failures (Ferguson et al., 1998). Data have increasingly been employed to promote innovation in identifying, deriving, and improving design requirements (Zhang et al., 2017). Industry experts have proposed expanding the role of data not only for improving technical systems, but also in guiding decisions about *what to develop* (Bertoni, 2018). Recent approaches boast the value of artificial intelligence techniques, for instance, to spark creativity by revealing patterns hidden in massive volumes of seemingly heterogeneous data (Cantamessa et al., 2020).

The integration of data into approaches for design also facilitates the inclusion of a greater and more diverse cross-section of people, with consumers being especially sought after due to their invaluable knowledge about the practical use of products. Russo-Spena and Mele (2012) identified what they termed 'five Co-s' in innovation, which they consider to be part of the 'co-creation' process: 'co-evaluation', 'co-design', 'co-testing', 'co-launching' and 'co-ideation'. It is precisely co-ideation, referring to the involvement of consumers in the generation of ideas for the development of innovative products, which has the highest level of influence in product innovation. Companies are increasingly more open to crowdsourced innovation and actively promoting the involvement of consumers (Grover and Kohli, 2012). Industries have shown a strong desire to encourage consumers to involve themselves in co-design by creating platforms through which they can submit their ideas for review and potential further development (see Table 2 for an example of those platforms). To give a sense of the value of consumer insights, in recent years more than 35% of new products from Procter & Gamble have had elements which originated from their consumer base (Han et al., 2019).

There has also been an increasing interest in HCI concerning the value of data collected from IoT devices to serve as a resource in ideation (Frens, 2017). In their joint work, Bogers et al. (2018) developed a design approach which employed interactional data as creative material. In one of their studies, they used a 'connected baby bottle' which recorded its own in-

Table 2: Industry platforms to promote innovation.

Brand	Platform	Main Phase	Participants
P&G	Connect+Develop	Co-Design	Professionals
			Partners
			Expert
			Intermediaries
			Managers
			Consumers
MulinoBianco	Nel mulino che vorrei	Co-ideation	Consumers
		Co-evaluation	Fans
			Managers
Starbucks	Mystarbucksidea	Co-ideation	Consumers
		Co-evaluation	Fans
			Managers

Modified table taken from Russo-Spena and Mele (2012)

teractions in order to create design probes capable of providing meaningful information about feeding practises (Bogers et al., 2016). In a later study, they invited healthcare professionals to collaborate with parents using their individual priorities as a basis for building well-informed interpretations and deciding which data types were most valuable (Kollenburg et al., 2018). Their findings illustrate one way in which people from significantly diverse backgrounds can put much of the data collected from connected devices to good use.

Researchers have also expounded upon the intricacies of interpreting vast quantities of data and subsequently provided insights to facilitate the process of finding meaningful interpretations. Kun, Mulder, and Kortuem (2018b) first examined how designers made use of data in their design practises and, after the researchers established that designers needed to acquire skills for making sense of data, they developed a method to improve data literacy, emphasising the need to present data in an accessible way (Kun, Mulder, and Kortuem, 2018a). Gorkovenko et al. (2020) employed a data-driven approach for product development, exploring how designers could use live data from connected devices. Through a series of workshops, they found that designers eagerly and creatively made use of the data—a finding which challenges the view that data may lead to a reduction in human agency.

2.3.2 *Considerations on the use of data*

It is clear that industries and designers understand the value of quantitative data collected from connected devices for their creative and innovative purposes (Darzentas et al., 2021), and recently there has been a call for the integration of more qualitative data for a more complete picture (Gabriel et al., 2016). However, questions remain as to how designers would ultimately draw conclusions from the data (Fei et al., 2018) and, specifically, how they would respond to the additional responsibilities which come with the use of said data. While there are some guidelines for good design practises (McNabola, 2013), there are as of yet no regulations for the wider collection and use of data for design purposes.

The outcomes of such uses of data can have far-reaching implications beyond those intended for design, which has the potential to create an imbalance in favour of industries (Correll, 2019). Despite efforts to keep data as objective as possible, even raw data are not neutral due to the underlying decisions made regarding their collection, selection, analysis, and presentation, as these factors influence the conclusions which are drawn (Gitelman, 2013). These decisions are made by designers and corporations whose interests are reflected in the curated data. As stated by Haraway (1988), there is "no such thing as an objective view from nowhere, knowledge is situated". The collection of data from smart devices could lead industries to extend undesirable activities to the home environment such as surveillance capitalism and presumption (Ritzer and Jurgenson, 2010). The former, surveillance capitalism, refers to selling data for profit (Zuboff, 2015), while the latter, presumption, refers to harnessing people's labour to increase profit (Ritzer and Jurgenson, 2010). There should be an attempt to strike a balance between the benefits of using data in design and the potential issues such collection of data might pose.

While there are mandatory regulations to protect consumer privacy in academic and legal contexts, it is as of yet unclear how they could be applied in industrial situations. Researchers in academia have to follow guidelines such as the General Data Protection Regulation (GDPR) (Parliament-EU, 2009) and Association for Computing Machinery (ACM) Code of Ethics (Anderson, 1992). Implementing such regulations is time-consuming and requires a great deal of involvement, which could prevent them from being scaled up to fit the fast-paced environment of industry (Bourgeois, Kortuem, and Kawsar, 2018). As an example, one essential component of ethical academic research is the acquisition of informed consent, which must be done before any data are gathered. In addition, policies should be transparent and expressed in clear language, and people should have the opportunity to opt out of the study at any time (Parliament-EU, 2009). There have been significant obstacles in applying the same regulations to industry, and even when such endeavours are successful, companies will often find a way to circumvent these standards. For example, even after websites were required to obtain consent to collect data from their users, the impact has been marginal as people quite often fail to read the terms and conditions before accepting them (Sanchez-Rola et al., 2019).

As a response to these newer practices of data collection for design, there has been a surge in studies on "critical data science" (Dalton, Taylor, and Thatcher, 2016), a field which aims to explore the unintended implications for consumers, industries, and designers. In these studies, researchers explore the unique cultural and ethical challenges posed by the automated collection of data. Further, issues of causality (Illari and Russo, 2014), quality (Floridi and Illari, 2014), security (Taddeo and Floridi, 2017), and uncertainty (Leonelli, 2015) continue to provoke debate among researchers and practitioners. Some have proposed taking a more serious approach towards the development of agendas which can respond to such issues (Boyd and Crawford, 2012). One example of these studies is the work by Dörk et al. (2013) on the analysis of data visualisations to make the designers' values explicit, in which researchers also argue for the promote the self-critique of one's own work. They endorse a higher prioritisation of data-intensive and positivist approaches over the long-held post-positivist approaches (Kitchin, 2015). Given the increase of data being used for design purposes, it is necessary to reflect together with practitioners, aiming to find good practises for gathering such data.

One potential avenue for a solution is the involvement of consumers and designers by contributing their views on data collection, as it has been demonstrated that participatory design can be used for issues which do not yet exist (Mattelmäki and Visser, 2011). While participatory design is commonly used in the ideation process, it could also be employed in the earlier stage of data collection, thus stakeholders could discuss the advantages and disadvantages of data collection while working together towards finding compromises.

2.3.3 *Section summary*

This section has provided a general overview of how data has been used in industrial and academic settings to inform the design of technological devices. It first gives an introduction to how HCI researchers create implications for design based on insights from empirical observations, but points out that so far the approach is limited to being viable only for people with prior knowledge in the field. It then provides an account of how data has always been a tool for design, whether collected from informal observations or through more methodical means. From this, the section then moves to reflect on how the data collected from IoT devices are changing the landscape of design practices. Here, the section provides examples from HCI illustrating collaborative ways in which consumers and/or designers could make use of the data to fit their needs. Finally, we critically examine such uses of data, particularly with respect to their possible far-reaching consequences for ethics, privacy, and regulation. It then concludes with a reflection on how data can be used in a balanced and fair way by consumers, designers, and industry alike. Overall, the section serves as a foundation to position our workshop studies (Chapters 6 & 7) within the wider field of data-driven approaches for design.

2.4 CHAPTER SUMMARY

This literature review began by constructing a clear definition of CPGs and demonstrating their relevance to our everyday practices, then using this to develop the concept of enhanced CPGs 2.1. In addition, we have given an account of the challenges for designing enhanced CPGs and the need to ground the design of such enhancements in an understanding of their practical interactions. We have striven to draw attention to the gap in the literature regarding the lack of studies exploring CPG interactions in practice. The empirical work in this thesis, then, will aim to address said gap by focusing our fieldwork study on CPG interactions in the practice of cooking (Chapter 4). Our comprehensive review of prior studies on domestic cooking 2.2 served as the foundation to inform the design of our fieldwork, and also introduced a brief description of the variety of methods employed to study cooking in the household environment in order to then delve deeper into fieldwork studies and the relevance of their insights to inform the design of technologies. We highlighted that, despite the vast literature on domestic cooking and the fact that CPGs are an essential component of this practice, to this day there remains a lack of focus on understanding CPGs interactions in context. The final subsection on data-inspired design 2.3 shows the potential of employing data about product usage to inform the design of innovations. We draw attention to the shortcomings of this approach not being applied in the design of enhanced CPGs, an issue which we aim to address in our workshop studies (Chapters 6 & 7). Lastly, this final subsection 2.3 reflects on the far-reaching consequences of the use of data beyond design, including considerations relating to privacy and ethics. We stress the importance of including people's perspectives to find responsible ways to use data in design. This is precisely what we attempted in our last study in which, together with professional designers, we reflected on how data can be used responsibly, contributing to the ongoing conversation on the use of data for design.

3 APPROACH

This chapter discusses the approach which informed the conceptual design, procedures for data collection, and analytical methods used within this thesis. In the first section, we address the methodology for fieldwork studies on cooking (Chapter 4), while the second section addresses the methodology for the design workshop studies (Chapters 6 & 7) and the development of the design workshops (Chapter 5).

The first section 3.1 presents the 'practice perspective', which both fieldwork studies drew upon to inform the theoretical lens through which they aimed to understand how people interact with CPGs in the practice of cooking. The methods of data collection, which were informed by the ethnographic approach, are also introduced in this section 3.1.2 including field notes and video recording. This section also describes, in 3.1.3, mixed methods research techniques informed by a quantitative ethnographic approach, which were used to analyse the data collected.

The second section 3.2 addresses the approach for the design workshop studies. In this section, 'participatory design' is briefly introduced stating clearly the relevance of including users in the design process. This approach informed our methodology to study how people might contribute to the design of enhanced versions of CPGs. A structured workshop process and design tools were used as part of our methods of data collection. The process and tools were influenced by prior design workshop studies which are discussed in 3.2.2. The data analysis in 3.2.3 presents thematic and polytextual thematic analysis, which were employed to uncover patterns in the textual and visual data as captured in the workshops. Table 3 presents a summary of the analytical approach, data collection, and analysis methods employed for the empirical studies of this thesis.

Table 3: Methodologies employed for the studies of this thesis.

Studies	Fieldwork on cooking (Chapter 4)	Design workshop (Chapters 6 & 7)
Approach	Practice perspective	Participatory design
Data collection	Ethnography	Design workshop
Analysis methods	Mixed methods & Quantitative ethnography	Thematic & Polytextual thematic analysis

It is necessary to reiterate that this thesis followed a pragmatic approach seeking to provide the best answer to the research questions (Chapter 1). Each decision in the planning, data collection, and analysis has been made carefully and was grounded in the literature as well as in our understanding of the object of our study.

3.1 UNDERSTANDING CPG INTERACTIONS IN PRACTICE

3.1.1 *Methodological approach*

The development of enhanced versions of CPGs and the necessary infrastructure of technological systems would demand functionalities which both respond to the use of CPGs and address the complex relationships between people and these products (Candy and Costello, 2008). Thus, knowledge about the practical use of CPGs becomes an urgent necessity for broadening the set of elements considered in the design process and creating better products which are more likely to actually be used by consumers (Balka and Wagner, 2006).

A 'practice' is a specific way of conducting a routine; in other words, a routine performed by an individual in a particular way. Examples of practices include everyday activities, such as ways of cooking, working, taking care of oneself (Reckwitz, 2002). Wulf et al. (2011), elaborating on the work of Reckwitz, provided one of the most well-rounded definitions of practice:

> A practice is understood to be a mainly routinized pattern of human action which is not only encompassed by mental and physical forms of activity but that is also greatly imprinted by objects, especially by tools, media, and their usage. A practice is grounded in background knowledge that is both not entirely explicit and containing emotional as well as motivational elements. Practices, therefore, represent collective patterns of interaction that are reproduced in specific contexts.
>
> —Wulf et al. (2011, p. 506)

A drive towards centering attention on practice has occurred only recently in the field of HCI as the ubiquity of computers and related technologies has made it a necessity to consider how technology fits into our everyday lives (Kuutti and Bannon, 2014). A turn to practise in HCI has emphasised the consideration of a practice as the smallest unit of analysis, as well as of influence. The practice perspective is a complement to the interaction perspective, which is employed in HCI for the development of technologies, and which focuses on individual interactions between people and objects. The practice perspective, on the other hand, focuses on all the components of the practice and the way that people accomplish their routines (Kuutti and Bannon, 2014).

The incorporation of technology has the potential to improve and transform, but also to disrupt existing practices. As such, the design of technology should be seen as an influence on practices (Rohde et al., 2009). According to Orlikowski (2000), the transformation of practices by technology can be affected in three ways: 1) *Inertia*: in which people retain their existing way of doing things 2) *Application*: in which people slightly augment their existing ways of doing things, and 3) *Change*: in which people substantially alter their existing way of doing things.

Taking a practice perspective, one can focus on both the intended and unintended consequences of technology, as its use in the real world often differs from that which was intended in its design. CPGs still have plenty of room for improvement, and this becomes particularly apparent when such real-world uses are given the attention they deserve. CPGs are inextricably linked with our daily activities, hence the effectiveness of such products should be evaluated by analysing their interactions both in isolation and during their associated practices, as well as the by analysing other items CPGs are used in combination with.

As described in the Introduction (Chapter 2) the research by Crabtree and Tolmie (2016) is an example of ethnographic work which has focused on the study of items in the household environment. This study described quantitatively different aspects of their practical interactions including frequency, categories, and places of use.

As one of the most prevalent components in many of our practices, CPGs inevitably have an impact on our lives. However, as previously mentioned there is a lack of understanding concerning their contextual uses in general. Such knowledge would be essential in identifying opportunities for design. Through careful observations in the field, we aim to understand how CPGs are used to perform the practice of cooking. Overall, the practice perspective informed our choices, and the analytical lens through which we have attempted to increase our knowledge of this topic. Cooking was selected because it is one practice which regularly requires the use of CPGs. By sales, food-related products compose the largest category of CPGs, and because cooking occurs within a confined space, this made it quite suitable for observational study.

3.1.2 *Data collection*

Ethnography, originally developed for the field of anthropology, is an approach which is focused on the study of such things as people's beliefs, social interactions, and behaviours. It involves direct participation and observation over a period of time, as well as an analytical approach for data analysis (Berry, 2011b). As stated by Crabtree, Rouncefield, and Tolmie (2012, p. 2) "Ethnography is a tool that we can use to unpack members' mastery of practical sociology in empirical detail". The following definition of ethnography captures the essential characteristics of an ethnographic approach:

> Ethnography can be defined as the study of people in naturally occurring settings or 'fields' by means of methods which capture their social meanings and ordinary activities, involving the researcher participating directly in the setting (if not always the activities) in order to collect data in a systematic manner, but without meaning being imposed on them externally.

—Miller and Brewer (2003, p. 100)

Ethnography was popularised by the work of Malinowski (2013) through the intensive anthropological research studying the native inhabitants of Guinea with a focus on the immersion in communities and cultures. This work laid the foundation for ethnography as a method which requires the fieldworker to understand the phenomena under investigation from the point of view of the people being studied. However, this is different from the style of ethnographic approach taken in this study in which the practice of cooking is examined and how it occurs in the household environment. Ethnographic methods for studying such urban settings were popularised by the Chicago School of Sociology (Thomas, 1983). Researchers from that institution brought the lens of an ethnographic approach to examine through face-to-face interactions various aspects of life in urban environments, such as the conditions of working class youth, practices of illness and care, and dance halls (Deegan, 2001).

The fieldworker, as an observer, attempts to immerse themselves in the practice to discover what is hidden in everyday life. In addition, they often attempt to obtain a vulgar competency; that is, a basic level of skill pertaining to practice under study. The ethnographic process involves the collection of data through a variety of methods including field notes, journals, audio and video recording, as well the collection of cultural artefacts (Naidoo, 2012). The collected data is then interpreted using an 'analytical mentality' (Button, 2000).

In the ethnographic approach, there is no set of rigid steps to follow; rather, the researcher has to formulate their approach to uncover what is often *'seen but unnoticed'* (Garfinkel, 1964) in everyday life. Data in general has no objectively correct interpretation, as the same piece of information can be seen as justifying vastly different if not outright diametrically opposing conclusions. But the value of the ethnographic account lies in providing an explanation of the data, albeit only a partial one. As stated by Rosen (1991, p. 2) "While an ethnographic report may—and depending upon the writer frequently does—claim interpretive authority, each report is limited insofar as it derives from what is a partial perspective".

An ethnographic approach informed the methods of data collection in the fieldwork studies of this thesis, as there was an emphasis on discovering the intricacies of domestic cooking and the usage of CPGs. Fieldwork observations were conducted to gather evidence through video recordings and field notes on how members of the general public interact with CPGs during the practice of cooking.

3.1.3 *Analysis*

3.1.3.1 *Quantitative ethnography*

Quantitative ethnography, introduced by David Shaffer, is a methodology which blends 'thin' descriptions—surface level observations derived from numerical methods—with 'thick' descriptions—interpretations which add contextual knowledge (Shaffer, 2017a).

Quantitative ethnography seeks to bridge the gap between quantitative and qualitative methods. The context from ethnographic findings guides and provides a comprehensive interpretation of the statistical analysis, while the statistical analysis summarises and helps strengthen the relevance of ethnographic findings. The incorporation of quantitative methods allows one to manage and initially make sense of data, as well as identify significant statistical patterns such as distributions, outliers, and correlations which emerge from data aggregates. This may not be identifiable from a purely qualitative analysis, which focuses on giving meaning to specific segments of the observed interactions. The resulting summary then grants the opportunity to focus on specific details and incorporate knowledge from the observed practice to give it a qualitative and detailed description (Geertz, 2020).

It is a challenge to combine quantitative and qualitative methods because the aims, capabilities, and strengths are fundamentally different for each. On one hand, quantitative analysis is most effective in supporting broad generalisation from large data samples. On the other, qualitative analysis is most effective in relatively small samples and for developing deep and meaningful insights (Neyland, 2013). Whereas quantitative findings are superficial yet generally applicable, qualitative discoveries are thorough yet narrowly focused, hence the need to merge them and combine their strengths. Quantitative ethnography offers a guide for fusing these two methods using both the general knowledge from quantitative methods and the deep insights of qualitative methods (Shaffer, 2017a).

Currently, a large majority of research performed through quantitative ethnography is focused on studies concerning education and learning (Barbara and Szilvia, 2021); however, researchers are expanding their methods and applying them in a wider variety of studies. Most quantitative ethnographic methods are focused on analysis of conversation using emic and etic interpretations. They also have an emphasis on epistemic network analysis—a technique for modelling and comparing the structure of connections between elements in individually-coded data (Shaffer, Collier, and Ruis, 2016). However, despite the progress in the development of methods for quantitative ethnography, they have not yet been applied to analyse specific item interactions like those of CPGs.

Given the limitations of quantitative ethnography methods to analyse the fieldwork data of this thesis, we employed mixed-methods inspired by quantitative ethnography for their analysis. The analytical methods of this thesis aim to use statistical evaluation to guide our exploration of the complete set of item interactions in cooking, and then incorporate ethnographic findings to elucidate different features of CPG interactions. Although the methods are exploratory, they comply with the premise of data analysis as stated by Glesne (2016, p. 193) "Data analysis is the process of organising data in light of your increasingly sophisticated judgments, that is, of the meaning-finding interpretations that you are learning to make about the shape of your study"

3.1.3.2 *Mixed methods*

Table 4: Six steps of data analysis in mixed methods research.

	Step	Procedure
1	Preparation	Converting raw data into a form useful for analysis.
2	Exploration	Identifying broad trends and understandings of the database.
3	Analysis	Addressing research questions or hypotheses using the appropriate tests.
4	Representation	Creating a summary in form of collection of statements, tables, or figures.
5	Interpretation	Advancing the meaning of the results in view of the research problems, hypotheses, and literature.
6	Validation	Checking on the quality of the data, the results, and interpretation of the results.

Steps proposed by Creswell and Clark, 2017

The iterative technique created for mixed-methods research by Creswell and Clark (2017) in their influential book, 'Mixed Methods Research', guided our exploratory analysis. In it, the authors argue against the tradition of analysing quantitative data using quantitative methods, while analysing qualitative data using qualitative methods. They proposed that the data and outcomes are represented, interpreted, and validated by researchers employing mixed methods and consider six steps for the analysis of both qualitative and quantitative data (see Table 4).

A primary feature of mixed methods analysis is **integration**, which is defined as "the point in the research procedures where qualitative research interfaces with quantitative research" (Creswell and Clark, 2017, p. 316). There are four considerations which should taken into account when planning integration: 1) *Intent of integration*, reasons to integrate both data types; 2) *Procedures for integration*, reflections about the methods used to integrate data; 3) *Representation of integration*, considerations about how the findings are presented; and 4) *Interpretation of integration*, inferences from the combined findings and representations which answer the research question. Onwuegbuzie and Teddlie (2003) proposed seven ways for data integration, which are described below:

1. Data reduction: Summarising data through statistical analysis and/or writing summaries.

2. Data display: Consolidating data through tables, charts and rubrics.

3. Data transformation: Converting qualitative data into quantitative data, and vice-versa.

4. Data correlation: Correlating the quantitative data with quantified qualitative data.

5. Data consolidation: Combining both data types to create new or consolidated variables or data sets.

6. Data comparison: Contrasting data from different sources

7. Data integration: Incorporating all data into a coherent whole set.

Another characteristic of the mixed methods research which is leveraged for the fieldwork studies is its ability to focus on general as well as specific aspects of the data; a concept often known simply as 'zooming in' and 'zooming out' (Nicolini, 2009). This ability would prove essential in the analyses within this thesis in that it allowed a focus equally both on the general patterns of CPG usage, as well as on specific details of their interactions. In the development of our research methods, the seven integration procedures mentioned above, as well as zooming in and out, were followed as seen fit. In this thesis, mixed-methods analysis integrating quantitative and qualitative findings were employed to analyse the data on CPG interactions captured during the fieldwork study on cooking (Chapter 4). The methods helped shed light into the general use of CPGs and select specific characteristics of their use for further analysis.

3.2 INSPIRING THE DESIGN OF ENHANCED CPGS USING DATA

3.2.1 *Methodological approach*

The methodology of our design workshop study (Chapter 5) is inspired by participatory design, an approach which aims to incorporate the expertise of users into the design process as early as possible such that the resulting technologies reflect their knowledge, interests, and needs. Participatory design is based on the argument that those who will ultimately be using the products should be involved in interaction design, with their input being given the same importance as that from professional designers (Kuhn and Muller, 1993). The following definition captures the essence of participatory design:

> A process of investigating, understanding, reflecting upon, establishing, developing, and supporting mutual learning between multiple participants in collective 'reflection-inaction'. The participants typically undertake the two principal roles of users and designers where the designers strive to learn the realities of the users' situation while the users strive to articulate their desired aims and learn appropriate technological means to obtain them.
>
> —Robertson and Simonsen (2012, p. 2)

There are two fundamental aspects of participatory design (Brandt, Binder, and Sanders, 2012). One is design by doing, which is the prioritisation of hands-on design. Participatory design aims to enable users to have a voice in the design process, without the need for them to have professional training to express their needs. For this purpose, researchers provide low-fidelity tools which anyone can make use of. Another is mutual reciprocal learning, in which they foster a process of learning from both users and designers alike in order to take mutual advantage of one another's skills and knowledge (Floyd et al., 1989).

Participatory design is founded upon the principle of consensus design due to its democratic and egalitarian roots, and finds its origins in the Scandinavian tradition of user involvement. It then went on to flourish in the 1980s when it was related to the workplace democratic movement (Nygaard and Bergo, 1975). This movement was driven by a response to the transformation of the workplace resulting from the introduction of computers. Participatory design in this stage sought to provide people with tools to improve their workplace and expand on their talents (Hartson and Pyla, 2018). Scandinavian countries during that time were influenced by social and contextual factors which lent themselves to approaches which attempted to capture the opinions of those who had conventionally been ignored.

Early iterations of participatory design adopted a view in which workers were empowered to "codetermine the development of the information system and of their workplace" (Clement and Besselaar, 1993). People expected to have a greater say in many elements of their lives, and they were willing to take part in collective action around common interests and ideals. In response to these events, researchers strived to give greater priority to the experience of all kinds of users (Robertson and Simonsen, 2012). That is why researchers started to develop tools and procedures to facilitate the inclusion of people regardless of their prior experience in product development.

The design workshop studies in this thesis (Chapters 6 & 7) have been informed by the essential characteristics of participatory design to foster user involvement. Particularly, the design workshops aim to provide a structured process and design tools to empower consumers and professional designers to make use of data. These two groups represent those most likely to benefit from making effective use of data about CPG interactions.

3.2.2 *Data collection*

One of the most prominent early initiatives which inspired the development of design workshops is UTOPIA, a project developed by Bødker et al. (1987). One of the project's key goals was to circumvent the limits of including workers in the early stages of design by supplying insights for actual product development. The project used mock-ups in order to facilitate workers in expressing their feedback on their workplace and work practises, including direct participation throughout the design process. Technical and social requirements, as well as opportunities and challenges, were equally taken into account. As stated by Bannon, UTOPIA attempted to move the design approach *from human factors to human actors* (Bannon, Bødker, et al., 1991).

Another well-known initiative which advanced the use of participatory design in HCI was the work by (Muller, 1991) on PICTIVE, or "Plastic Interface for Collaborative Technology Initiatives through Video Exploration." In PICTIVE, informed by the mockup methods of UTOPIA, the researcher took a design-by-doing approach, using low technologies such as paper and pencil to support rapid prototyping and provide equal opportunities for those with and without experience in design. The workshops were video-recorded to document and communicate the design process among the participants and thus support collaboration. The goals of the project included empowering users in the design of systems which would impact their work, improving their quality by involving design professionals, and improving the design process by consulting with representatives from major companies. Participants in PICTIVE usually reported enjoying the process and satisfaction in expressing their ideas.

In addition to the above mentioned seminal work in participatory design, more contemporary work has also informed the design workshops as well as the design tools of this thesis. The design workshops take particular inspiration from prior work with design tools (Mora, Gianni, and Divitini, 2017), visualisations (Nilsson et al., 2019), and design cards (Wetzel, Rodden, and Benford, 2017). Tiles, a card-based ideation toolkit, helped to generate ideas for augmented products. The design tools allowed people without prior experience in design to use those cards as a resource for their innovations (Mora, Gianni, and Divitini, 2017). Furthermore, storyboards (Nilsson et al., 2019) as well as videos (Nilsson et al., 2020) of utopian and dystopian scenarios involving autonomous systems motivated participants to think more carefully about the consequences of technologies. A mixed-reality deck of ideation cards enabled the design of games in a playful and collaborative manner (Wetzel, Rodden, and Benford, 2017), and allowed for the exploration of important aspects of game development, along with promoting reflections on the design concepts.

In our design workshops data visualisations, design cards, and a design sheet along with a structure design process were used to facilitate the sketching of enhanced CPGs (Chapter 5). The data was collected by recording videos of the online sessions and capturing photographs of the sketches and any other material produced by the participants (Chapters 6 & 7).

3.2.3 *Analysis*

3.2.3.1 *Thematic analysis*

To analyse the content of participants' comments and conversation during the design workshops, thematic analysis was employed to uncover the influence of data in design as well as patterns in the design concepts. The term 'thematic analysis' has been used to refer to a variety of different techniques for data analysis in social sciences aimed at finding themes in qualitative data (Willig and Rogers, 2017). Since the publication of the seminal paper "Using Thematic Analysis in Psychology" (Braun and Clarke, 2006), the method has gained immense popularity and has been recognised as a well-respected approach (Willig and Rogers, 2017). In this thesis, we use the reflexive approach of thematic analysis approach by Braun and Clarke (2006), which they defined as follows:

> Thematic analysis is a method for identifying, analysing and reporting patterns (themes) within data. It minimally organizes and describes your data set in (rich) detail.
>
> —Braun and Clarke (2006, p. 80)

The distinctive characteristic of reflexive thematic analysis is the active role of the researcher in the knowledge production process (Braun and Clarke, 2020). Thematic analysis aims to go beyond a simple summary by identifying and interpreting essential features of the data guided by the research questions. The end goal for thematic analysis is to produce a rigorous report ensuring a high-quality interpretation by virtue of a two-stage review process in which themes and codes are compared both with each other and against the entire dataset (Braun and Clarke, 2006).

Codes are the smallest units of analysis, capturing interesting properties of the data which are potentially relevant to the research questions and serving as the building blocks for **themes**. Themes, in turn, are larger patterns of meaning organised around a core concept which provide a framework

Table 5: Phases of Thematic Analysis.

	Steps	Description
1	Familiarising with the data	Transcribing data, reading, re-reading the data, and noting down initial ideas.
2	Generating initial codes	Coding interesting features of the data in a systematic fashion across the entire data set, collating relevant information to each code.
3	Searching for themes	Collating codes into potential themes, gathering all data relevant to each potential theme.
4	Reviewing themes	Checking if the themes work in relation to the coded extracts and the data set, generating a thematic 'map'.
5	Defining themes	Refine the specifics of each theme, and the overall story the analysis tells, generating clear definitions and names for each theme.
6	Producing the report	Final analysis of selected extracts, relating the analysis back to research questions and literature, producing a report of the analysis.

Phases proposed by Braun and Clarke (2006)

for summarising the analytic observations of the researcher. "A theme captures something important about the data in relation to the research question, and represents some level of patterned response or meaning within the data set" (Braun and Clarke, 2006, p. 82).

The approach of thematic analysis by Braun and Clarke followed in this thesis involves a six-phase analytic process (see Table 5). The term 'phase' highlights that, for many approaches in this qualitative analysis, it is not strictly linear, but rather an iterative and recursive process which is employed.

3.2.3.2 *Polytextual Thematic Analysis*

To analyse the sketches, this thesis employed polytextual thematic analysis. According to Gleesson (2012, p. 319), polytextual thematic analysis "...involves viewing the pictures repeatedly while reading and considering the various cultural images and texts that enable their interpretation. In the process we are looking for key themes, and key words that will capture recurring visual images." This approach for analysing visual material is informed by methods which incorporate visual ethnography, visual sociology, and visual anthropology, and was inspired by the work of Pink (2013) as well as by Rose (2001), in their work conducting visual ethnography. There are eleven basic steps for the performance of polytextual thematic analysis:

1. Examine the images multiple times over and in as many different ways as possible, noting any prospective themes which seem to arise.
2. Feel the effects which the images evoke, and describe those feelings as thoroughly as possible in notes.
3. Gather together all the material relevant to a theme in which a proto-theme appears to repeat.
4. Write a brief description and/or definition of the prototheme(s).
5. Review again all the images to evaluate whether the proto-themes appear in others as well.
6. Synthesise all the relevant material for a proto-theme.
7. Repeat the process to identify proto-themes in other images until no more distinctive proto-themes appear.

8. Analyse the description of the themes in relation to each other to identify the extent to which they are distinct.

9. Review the themes to see whether there are any clusters which suggest a higher-order grouping theme.

10. Write a definition for the higher-order theme and consider the relation of all other themes to it.

11. Select the themes which best address the research questions.

Polytextual thematic analysis is considered to be *polytextual* because it assumes all information, textual and visual, is interrelated and can be understood by referencing them to other types of information (Curt, 1994). The analysis is also considered to be *thematic* because, as with thematic analysis, it attempts to capture commonalities and patterns which emerge from the data.

3.3 CHAPTER SUMMARY

This section has introduced the methodology which informed the planning of the study, the data collection, and the analysis of our empirical work. The specificities for the studies will be addressed in their respective chapters on empirical work; however, this section provided a brief review and relevant examples of the foundational research which informed our studies.

The practice perspective taken for the fieldwork studies allowed us to focus on several aspects of CPG interaction beyond the dyadic human-object level, and provide insights for the development of technologies which better fit into people's everyday lives and suit their needs. An ethnographic approach informed the methods of data collection for our fieldwork, and we emphasised the fact that there is no singular way to conduct an analysis, but rather that it depends on the researcher, setting, and specific research questions. As a result of both this flexibility and our interest to provide a detailed understanding of CPG interactions, this thesis made use of quantitative ethnography and mixed-methods research to develop its analysis techniques. These blended quantitative and qualitative approaches sought to obtain the best from both methods, integrating generalisations from statistical findings and detailed accounts from contextual understanding.

Participatory design in turn, due to its essential characteristics of incorporating the expertise of users in the design of technologies, came as an opportune approach for our workshop, as this thesis attempts to explore how insights about CPG interactions can inspire the design of enhanced CPGs. The structure of the design workshops and the design tools were grounded in the work from participatory design, including vanguard projects such as PICTIVE, along with more recent ones such as Tiles, in which they made use of low-fidelity tools and a simple design process to facilitate ideation. Finally, for the examination of participants' statements and sketches, thematic analysis and polytextual thematic analysis were employed to identify the characteristics of the design concepts and the influence of data on ideation.

Part II

EMPIRICAL WORK

4

CPGS IN THE PREPARATION OF MEALS: AN EXPLORATORY STUDY

This chapter presents a fieldwork study focused on the preparation of familiar meals, which the participant knew how to prepare by heart; and of unfamiliar meals, which the participant had never cooked before and therefore had to rely on a recipe. This study aims to understand the specific CPG interactions in these different meal types of meals detailing their interactions in familiar meals, and then doing the same for unfamiliar meals and making a comparison between them. The choice of this as our research topic arose from a desire to comprehend how different situational contexts of cooking might provide insights into general and specific properties of CPG interaction, particularly as it pertains to the influence of the meal type.

For the purpose of highlighting exactly how an understanding of different cooking situations can inform the design of enhanced CPGs, we conducted a comparative fieldwork study on the preparation of familiar meals and unfamiliar meals, identifying the characteristics which appeared most relevant between these contrasting contexts. In our process of developing a method for the formation of such practical insights, twenty households were each visited twice. On each occasion, participants were then observed as they cooked either the familiar or unfamiliar meal which they had previously chosen. The sessions were captured on video, and a detailed record of the interactions between individuals, CPGs, and other items was made. We employed a mixed-methods approach to analyse the data focussing on CPG frequential, sequential, and correlational features.

The findings of this chapter are divided in two sections. In the first section, the main findings concerning the familiar meals are presented. The second section presents the relevant findings concerning the unfamiliar meals and performs the comparison. Despite the involvement of the same participants, the findings from both sections presented in this chapter are remarkably distinct. In the first study, we put a greater emphasis on quantitative methods while using qualitative methods merely to provide an explanation for the quantitative findings. In the second set of findings, however, we put a greater emphasis on the integration of quantitative and qualitative findings to elucidate the similarities and differences in CPG usage between these two meal types.

As an exploratory investigation into how CPGs are used in practice, the methods and knowledge presented in this study can be valuable in creating enhanced CPGs by promoting a product development process in which decisions are firmly grounded in empirical insights.

4.1 introduction

There is a well-established principle in the field of HCI of gathering insights from first-hand ethnographic observations to understand *what is accomplished*, and only then envision *what might be accomplished* in order to inform the design of technologies which suit people's practices (Crabtree, Rouncefield, and Tolmie, 2012). However, so far research into enhanced CPGs has focused primarily on isolated user-product interactions (Mumani and Stone, 2018) and has yet to generate a more in-depth understanding of their practical and contextual interactions. Perhaps as a consequence of this, innovations in CPGs have been plagued by unforeseen issues which only emerged once the items were deployed in real-life situations. The Amazon Dash button, for example, was discontinued in part because its main function of automatic reordering was found to be redundant given the availability of smart assistants (BBC, 2019). In retrospect, this could have been better anticipated had the designers of this product drawn upon research into how people actually organise their shopping as a social activity (Hyland et al., 2018).

To develop enhanced CPGs, it is necessary to obtain an understanding of their specific practices (Kuutti and Bannon, 2014) and different contexts (Dourish, 2004). A deeper understanding of such context has proven useful in designing innovative CPG packaging (Ward, Buckle, and Clarkson, 2010) and developing guidelines for assessing the items' performance (Yiangkamolsing, Bohez, and Bueren, 2010). Nevertheless, despite significant progress in the field of the user-packaging interaction for CPGs (a review of which can be found here: Mumani and Stone, 2018), there is a lack of understanding concerning how CPGs are utilised by consumers beyond simply investigating their pragmatic and primary functions (Petrelli, 2017). There is information about the production of CPGs in factories, as well as their management and sale in the retail sector (Sonneveld, 2000), but little is known about how consumers utilise these products inside households. Building an understanding of the use of CPGs in practice, this study seeks to apply that information for the promotion of designs firmly grounded in empirical insights (Shahmohammadi et al., 2020), developing novel digital dimensions for interaction and user experience (Lydekaityte, 2019), and making products which can be smoothly integrated into their practical contexts (Balka and Wagner, 2006).

To investigate the interactions of CPGs and other items involved in cooking, this study adopts a *practice perspective*, which, as discussed in Chapter 3, treats a practice as the smallest unit of analysis and intervention (Kuutti and Bannon, 2014). Cooking is an exemplary case of a practice necessitating CPGs playing distinct roles in a variety of situations, and thus serves to bring into the forefront the issue of how contextual differences influence design (Nardi, Vatrapu, and Clemmensen, 2011). This practice is also of great interest for most people, as it consumes a considerable amount of time, and many express a desire to improve their cooking skills (Wolfson and Bleich, 2015). Previous research has shown that opposing situations of cooking influence the interactions with objects (Hove et al., 2020) and the requirements of supporting technologies (Vildjiounaite et al., 2011). Studies on the practice of cooking, in addition, have been used extensively to inform promising innovations for the household environment (Paay, Kjeldskov, and Skov, 2015; Rodden et al., 2013). As an example, Fuentes et al. (2019) developed a grocery-tracking system to support shopping by building upon an understanding of the social practice of making grocery lists. However, to the best of our knowledge, there is an absence of studies having a clear focus on the use of CPGs in cooking.

A mixed-methods approach, (Creswell and Clark, 2017) inspired by quantitative ethnography (Shaffer, 2017a) and which integrates both quantitative and qualitative methods, is employed to analyse and give meaning to the vast amounts of data gathered about CPG interactions. The approach was applied in analysing different features of the CPGs' usages including in both familiar and unfamiliar meals including frequency of involvement in meals, time of use within a session, and combinatorial use with other items. Each of the findings can help guide the development of their enhanced versions by providing insights from a unique standpoint.

Overall, this study seeks to provide contributions in both our understanding of CPG practical interactions, as well as in new methods for achieving a better one.

For the sake of clarity, the qualitative data in the ethnographic study originates from the contextual interpretations of the ethnographic data, and not from an analysis of the conversations with participants. Our qualitative data was derived from the observations captured during fieldwork through taking field notes, and by repeated observation of the video recordings.

The data sample consisted of more than 16, 000 individual interactions for 251 distinct items. As the basis of our exploratory analysis, we focused on multiple features of the interactions, including their frequencies, durations, and the point in the session at which they occurred.

4.2 STUDY DESIGN

To conduct a first-hand investigation of how CPGs are used in two situational contexts of cooking, we organised a field study in which we examined the preparation of both unfamiliar as well as familiar meals. This was inspired by precedents which also used fieldwork to investigate cooking (De Léon, 2003; Torkkeli, Mäkelä, and Niva, 2018; Paay, Kjeldskov, and Skov, 2015) and CPG interactions in the household environment (Crabtree and Tolmie, 2016).

4.2.1 *Field study*

Participants were asked to cook in their own homes on two separate occasions, preparing a meal of their choice each time as either the familiar or unfamiliar meal. Participants were allowed to cook with someone else, in which case the one who contacted the researcher was designated the 'primary participant', and any others were labelled 'assistants'. There were no restrictions placed on what time of day the sessions were to take place, nor on their duration. The study was approved by the University's Ethics Committee, and recruitment was conducted through social media, referrals, and the researchers' social networks.

One researcher took on the role of the fieldworker and was tasked with visiting the households, as well as with collecting the data through note-taking and video recordings. To record the sessions, three cameras were positioned and oriented towards the areas most commonly used for cooking. Participants helped position the cameras and gave verbal reassurance that the cameras were not disturbing them. Sessions began when participants started retrieving ingredients and ended when they finished preparing the meal. At the end of each session, participants were interviewed about the experience. We had obtained informed consent from all participants, and they each received the prearranged compensation of a £30 gift card. All the households were located in the greater Nottingham area.

Informed consent was obtained from all the participants in the study. First, the researcher surveyed demographic information, household characteristics, and cooking practices of only the primary participant. Next, with the help of the participant, the researcher recorded a video taking stock of all the CPGs available in the kitchen, then positioned three video cameras and oriented them towards the participant's usual cooking

Figure 4: Example of a recording of a cooking session from one of the three cameras.

area (see Figure 4). Participants gave verbal reassurance that the equipment was not disturbing them. The recording started when participants began to retrieve ingredients and ended when they finished cooking or served the meal. The researcher was present during the session, taking notes and engaging in conversation with the participants, so long as this was not considered a distraction for them. Lastly, a semi-structured interview was conducted to discuss the participants' cooking experience, after which they each received a £20 gift card as compensation.

4.2.2 *Data sample*

Twenty participants prepared meals in the study across forty cooking sessions. The following demographic data corresponds to these twenty primary participants as shown in Table 6. The age range of the primary participants was 19- 72 years of age, with the mean being 35 (SD = 11.6) (Table 9), and to-

Table 6: Basic information about participants.

P	**Gender**	**Age**	Inhabitants	HI	Skills
01	M	25	Professionals	2	Intermediate
02	NB	28	Students	4	Intermediate
03	M	19	Students	6	Intermediate
04	F	50	Family	4	Intermediate
05	M	30	Couple	2	Intermediate
06	F	32	Professionals	4	Advanced
07	M	32	Family	3	Intermediate
08	F	33	Couple	2	Basic
09	F	29	Couple	2	Intermediate
10	M	29	Couple	2	Advanced
11	F	29	Couple	2	Intermediate
12	M	46	Family	5	Intermediate
13	F	29	Couple	2	Intermediate
14	F	35	Family	4	Intermediate
15	F	72	Couple	2	Intermediate
16	F	40	Family	3	Intermediate
17	F	32	Professionals	6	Intermediate
18	F	26	Professionals	3	Intermediate
19	F	37	Family	3	Intermediate
20	M	46	Family	3	Intermediate

Notes: P = Participant; HI = Household inhabitants; M = Male; F = Female; NB = Non binary

gether represented fourteen nationalities. Twelve participants self-identified as female, five as male, and one as non-binary. Fifteen considered their cooking skills to be intermediate, two basic, and one advanced. Seven of the households were inhabited by couples, while five were occupied by couples along with their children, and the other six were shared accommodations – four of which were inhabited by professionals, and two by students. Two participants and their sessions (p07 and p20) were removed from the unfamiliar meal sample after their unfamiliar meal was deemed ineligible for inclusion in the study due to their having prepared a considerable portion of it in advance. Five additional assistant participants provided support, either in the preparation of both meals (p05, p09, and p18), or just in the preparation of either the unfamiliar (p13) or familiar meal (p14).

The sessions for both familiar and unfamiliar meals took place around the same time of day for most participants (n = 18). The mean duration for the unfamiliar meal sessions was 66 minutes (SD = 29), and the mean for familiar meal sessions was 58 minutes (SD = 23). There were no significant differences in duration between the two meal types $t(17) = -2.5$, $p = .02$. Regarding the sources of the recipes which participants followed in the unfamiliar meals, eleven participants used a digital device, and nine used an analogue source. The digital devices included phone (n = 6), laptop (n = 4), and tablet (n = 1), while the analogue sources included recipe book (n = 6), notebook (n = 2), and recipe sheet (n = 1).

4.2.3 *Classification of data*

4.2.3.1 *Items*

The items were classified using a nested hierarchy consisting of three levels. From largest to smallest, they were: *type*, *category*, and *item*.

Type. Objects involved in the meal-preparation process were assigned to one of three general types: CPGs, utensils, or environment items. The CPG type consisted of all the items which met the aforementioned criteria for CPGs, The utensil type consisted mainly of tools and devices which were easily portable, and objects belonging to the environment type

Table 7: List of familiar and unfamiliar meals.

P	Familiar meal	Unfamiliar meal
01	Chicken coconut curry	Mac and cheese
02	Chickpeas curry	Butternut squash curry
03	Spaghetti bolognese	Stir fry chicken and rice
04	Green vegetable soup	Tomato and chorizo rigatoni
05	Spaghetti bolognese	Mexican chicken stew
06	Vegetables noodles	Chicken gyros
07	Oven roasted chicken	Pomegranate rice and salad
08	Scrambled eggs and toast	Ricotta pancakes
09	Chicken fajitas	Beef, bean, and beer chili
10	Scrambled eggs	Mushroom risotto
11	Spaghetti bolognese	Crispy five-spice chicken
12	Beef mince tacos	Spanish tortilla
13	Risotto with prawns	Keralan chicken curry
14	Vegetable-based stew	Cream of spinach soup
15	Rice with chickpeas	Spinach and chickpea soup
16	Oven roasted chicken	White beans with artichokes
17	Shepherd's pie	Szechuan cabbage and chilli beef
18	Pasta napoletana	Spinach malfatti ricotta
19	Shepherd's pie	Prawn and black beans curry
20	Creamy chicken pasta	Spicy beef with coriander relish

Notes: P = Participant

consisted of building structures and appliances.

Category. Objects of the same type with similar characteristics and usage were grouped together into categories. The development of categories for CPGs were informed by previous classifications of ingredients and groceries (Carlsson-Kanyama, Ekström, and Shanahan, 2003). For instance, the category *spices* consisted of solid substances commonly packaged in a bottle and added to food for flavour enhancement.

Item. The objects were assigned a label under the name by which they are commonly known, each of which was termed an item. For example, bottles of both fine and rock salt were labelled simply as 'salt.' Other characteristics, such as physical properties of the products and their uses, were employed to differentiate items which, albeit similar, are handled differently and cannot easily be considered as replacements for one another. For example, a bottle of garlic granules and a bulb of garlic received distinct labels: dried garlic and garlic, respectively. If more than one item with the same label was used within the same session, each received a second label to uniquely identify it.

The items required a total of 197 distinct labels. Out of those items, 115 of them were CPGs, 71 were utensils, and 13 were environment items. The CPGs were subdivided into 15 categories: baked goods, beverages, cleaning products, condiments, dairy products and eggs, dried goods, disposables and food storage, fruits, legumes, meats, oils and fats, rice and pasta, spices, stationery, and vegetables. See Figure 5 for a visual representation of the hierarchy.

A note about the combination of CPGs: when a given CPG was mixed with another CPG or group of CPGs, this combination was labelled as 'food' for reasons of practical data handling. In this study, 'food' is defined as the combination of two or more CPGs such that the resulting amalgamation can no longer be meaningfully said to exist as a group of distinct CPGs, but rather as a combination of ingredients.

4.2.3.2 *Interactions*

The basis of the analysis of this study consisted of manually capturing all items and their interactions with participants in the process of preparing the meal. An 'interaction' was consid-

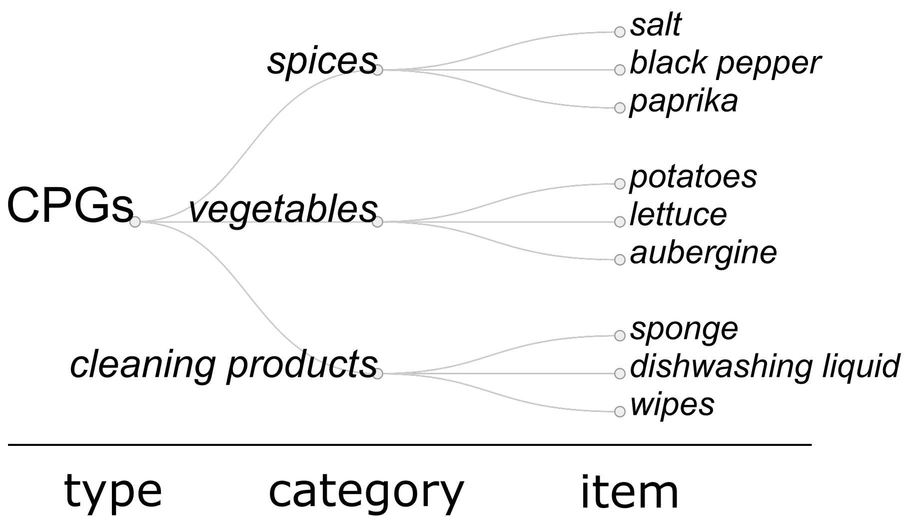


Figure 5: Hierarchical classification of selected CPGs.

ered any instance in which an item was used, either through direct physical contact (e.g. grabbing a pinch of salt from a bag by hand) or through the use of another item (e.g. retrieving a portion of salt by using a spoon). In the previous examples, the former would be counted as a singular interaction with salt, while the latter would be counted as two: one for the salt and another for the spoon. Each item interaction was given a unique identification tag and included its start and end times. The durations of the interactions were recorded in two-second intervals; thus, interactions with durations below this two-second threshold were still recorded as lasting two seconds. The end time of an interaction was considered to be the point at which the participant ceased contact with the item.

4.2.4 *Analysis methods*

The development of the analysis methods incorporated insights from fieldwork records, exploratory data analysis, knowledge of cooking, and references to the literature. The importance of the findings from these methods, rather than serving to make generalisations, may well provide an understanding of how CPGs are utilised when preparing a meal. Specific findings might be limited to the data sample, the meals prepared, and the context in which the study took place. However, findings about how CPGs and other items are utilised within cooking likely reflect the more general features of the practice. There are only a finite number of usages which one can get from a CPG. This study can help to uncover those patterns and construct a meaningful interpretation, and it ultimately aims to uncover *'the animal in the foliage'* (Garfinkel, Lynch, and Livingston, 1981). The analysis methods focused on different features of CPG interactions. We devised specific analysis methods for the analysis of familiar meals and for unfamiliar meals. The set of methods for each of these meals are presented below:

4.2.4.1 *Familiar meals*

1. Involvement: Estimating the number of CPGs utilised per session and ascertaining what fraction of the total available stock it represented. An item was considered to be involved in a session if it had at least one interaction in that session.

2. Interactions: Counting the number of interactions participants had with CPGs and other items as well as the interactions between these items while cooking.

3. Phases: Identifying the distinct periods within the cooking sessions in which interactions took place. Each session was divided into ten periods of equal length, and interactions were assigned to their corresponding phases according to their start times.

4. Conditionality: obtaining the conditional probabilities of one item being involved in a session given that another was involved. The probability of item A being used in a session given that item B was used in that same session is known as the "conditional probability of A given B," and is denoted by $P(A \mid B)$.

4.2.4.2 *Unfamiliar meals*

1. Information gathering: To better understand the cooking process, we describe noticeable activities people accomplished with CPGs including gathering information from packaging, re-purposing the use of items, and replacing ingredients. We decided to focus on information gathering because this activity occurred more frequently while preparing unfamiliar meals, and because it is associated with obstacles to meal preparation (Garcia et al., 2017). This process was informed by research concerning the identification of problematic (Buchanan, 1992) and creative situations (Hyland et al., 2018) as a resource for guiding design. We detailed each instance in which a label on packaging was read including its duration, the items involved, and events which led to its occurrence.

2. Tasks in intervals of high activity: To explore periods in which people appeared to be more active than others, we decided to more closely examine the portions of sessions with the largest number of interactions. To facilitate this analysis, each session was divided into one-minute intervals. We then decided to analyse the rate of interactions per minute, as well as to identify the activities that they were involved in along with recording their start and end times. We visually identified a total of 20 activities such as chopping, seasoning and mixing

based on commonly-known classifications (Wagner et al., 2011). We were inspired by the concept of affordances (Gibson, 1996) and the application of computer vision automating the detection of activities (Nagarajan et al., 2020).

3. Connectivity among items: To investigate how items were utilised in conjunction during the preparation of meals, we conducted a network analysis (Hansen and Smith, 2014). Following previous work which represented practices as a network of interconnected elements (Higginson et al., 2015; Lawo et al., 2020), we constructed an undirected network for each of the cooking sessions representing the interactions of both CPGs and utensils. In the networks, the sizes of nodes represent the number of interactions, and the thickness of the edges and inverse of the proximities between nodes correlate with the number of interactions between them (Kuijer, Jong, and Eijk, 2013). As an example, an onion that was sliced using a knife and chopping board would be represented by a graph with an edge connecting the onion and knife nodes, another connecting the onion and chopping board nodes, and one more connecting the knife and chopping board nodes.

4.3 FINDINGS: FAMILIAR MEALS

The main findings of each analysis method as applied to the three levels of the nested hierarchy (type, category, and item), are described. The analyses focused primarily on CPGs, but also integrated utensils and environment items to draw comparisons. The findings are divided into two sections. First, a quantitative section provides a summary of the statistical analyses. Second, a qualitative section provides an interpretation of the results informed by the insights derived from the contextual understanding of the fieldwork.

4.3.1 *Involvement*

Results showed that participants utilised a relatively small fraction of the CPGs at their disposal when cooking a meal. Participants utilised a median of 18 CPGs to prepare a meal (*IQR* = 16–21) from a median of 203 available CPGs (*IQR* = 160–229). The CPGs involved ranged from a minimum of 6 (P07) to a maximum of 36 (P17). The available CPGs ranged from 38 (P03) to 429 (P17). The CPGs involved represented a median of 9% (*IQR* = 8–12) of the available CPGs. The number of CPGs involved per session correlated positively with the number of CPGs available $r(18) = .64$, $p = .01$.

Apart from a small set of CPGs, most CPGs were involved in relatively few sessions. CPGs were involved in a median of 2 sessions (*IQR* = 1–3), which represented 10% of all sessions. Only 20 CPGs (18% of 115) were involved in 25% or more of the sessions. Among those items, the ten CPGs with the largest involvement were salt, oil, sponge, black pepper, onion, dishwashing liquid, bouillon, cheese, garlic, and kitchen roll (see Figure 6).

The CPGs that were most commonly involved were not necessarily the most available CPGs. The category of CPGs with the greatest involvement was vegetables (30%), while the most commonly found category of CPGs available was spices (15%). Categories of CPGs with a short life span had a greater involvement as a percent compared to their availability; this was found in the categories vegetables (22% availability to 32% involvement), meats (4% availability to 7% involvement), and

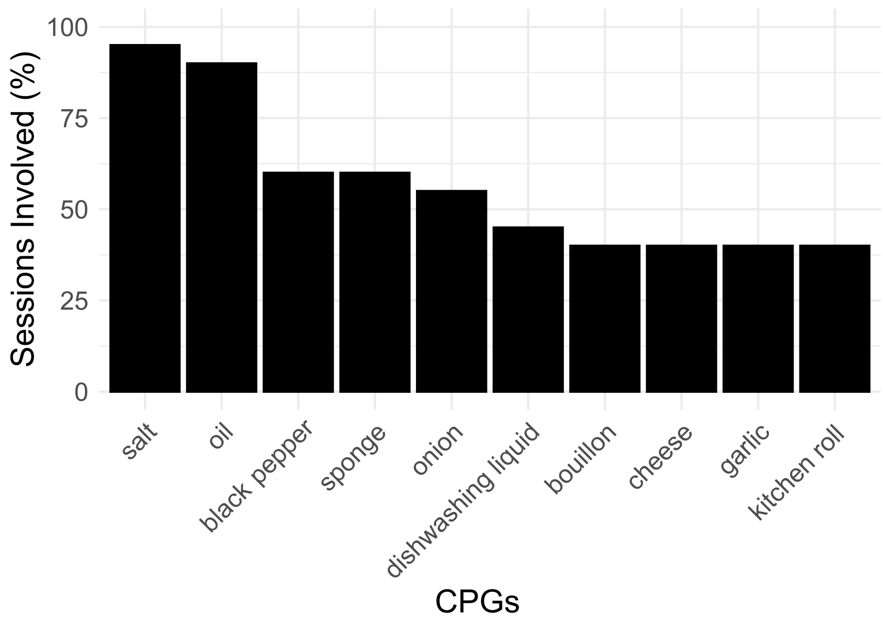


Figure 6: CPGs with the highest involvement across sessions.

dairy products and eggs (6% availability to 9% involvement). The proportion of categories of CPGs available in the kitchens did not correlate with the proportion of categories of CPGs utilised in preparing a meal $r(18) = .55$, $p = .05$.

The findings indicate that, when preparing a meal, the number of CPGs that are utilised is usually a small fraction of the total CPGs available. A given CPG may be chosen for inclusion in a recipe for a variety of reasons, among them being that it is an essential component of a meal, the cook being experienced in how to utilise it, and it being positioned in such a way that it is frequently seen. When choosing ingredients for a recipe, people may be aware of the need to make use of certain ingredients as soon as possible because of their short lifespans.

CPGs that fall into the vegetables, meats, and dairy products and eggs categories had greater rates of involvement compared to their availability. Those CPGs with a short life span must be constantly replenished, as opposed to other CPGs that have longer life spans and are thus more prone to accruing a wider variety of these items over time, such as those pertaining to the *spices* category. The findings also suggest that variety is a key component of the role of CPGs in cooking, as only a small subset are shared across many sessions while the majority have a much more narrow application and are only used in certain recipes. In brief, given a group of basic, versatile, and commonly-utilised ingredients such as salt, oil, and black pepper, people seem to employ a distinct and unique set of additional CPGs for each meal.

4.3.2 *Interactions*

The results showed that CPG interactions accounted for a small portion of all the interactions. There were 1303 interactions with CPGs across all the cooking sessions, which represented 18% of all the interactions, and is a decline from the 32% percent of CPGs involved in the cooking sessions. There were 3976 interactions with utensils (55%) and 888 interactions with environment items (12%).

A few subsets of CPGs accounted for most of the interactions. Only 17 out of the 115 total CPGs (15%) accounted for 50% of all CPG interactions. The 10 CPGs with the greatest number of interactions were the items cheese, salt, oil, onions, sponge, courgette, kitchen roll, minced meat, eggs and mushrooms (see Figure 7). Three categories of CPGs accounted for more than half of all the CPG interactions, those categories being vegetables (32%), spices (14%), and cleaning products (12%).

Each CPG had only a few interactions per session. The individual CPGs had a median of 3 interactions per session (IQR = 1.7–5) across all sessions in which they were utilised.

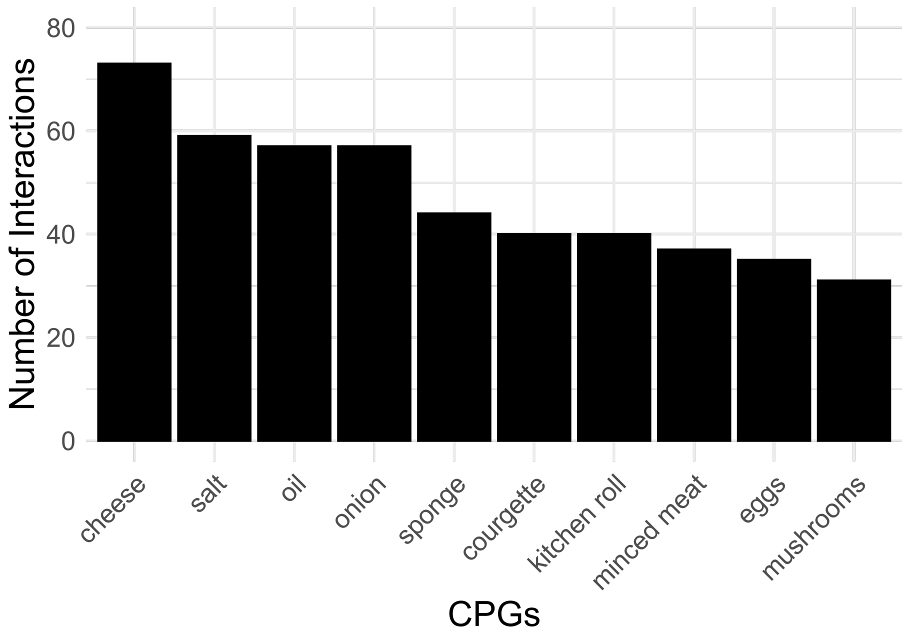


Figure 7: CPGs with the largest number of interactions.

The CPGs with the greatest number of interactions were also the CPGs that were commonly involved in most sessions $r(111) = .83$, $p = .01$. The categories vegetables and meats had the largest median number of interactions (*median* = 5) across the sessions in which they were involved. A one-way, between-group ANOVA showed that there was a significant difference between the number of interactions of vegetables and meats and those of other categories such as condiments, spices, and cleaning products at the $p = .01$ level (F (13, 3.27) = 48.56).

The findings suggest that CPGs are interacted with a small number of times. This is reflected in the fact that, among other findings, their average number of interactions represented only one fifth of the total number of interactions per session. This suggests that CPGs had a restrictive use before they were transformed into food and their interactions were no longer counted individually. The nature of interactions that people have with CPGs may be constrained by virtue of the properties of the products themselves. One could imagine that, for a bottle of salt, most interactions it was involved in were for the purpose of retrieval, seasoning, or storing. Additionally, utensils and environment items are essential for the use of CPGs. Participants had thrice the number of interactions with utensils that they did with CPGs. Most CPGs seem to require the use of at least one utensil. For example, to chop onions, people need a chopping board and a knife. CPGs that required manipulation before they were incorporated into food had more interactions than other CPGs; vegetables and meats had more interactions than condiments and spices. The CPGs with the largest number of interactions are also those which have interactions independent of the packaging, such as vegetables compared to spices.

4.3.3 *Phases*

There are differences by type of item in the distribution of interactions along the temporal phases of the cooking sessions. CPGs (*median* = 38.6; *IQR* = 16–66) and environment items interactions (*median* = 46.7; *IQR* = 20–73) occurred most commonly during the first phases of the sessions, while utensil interactions occurred most commonly in the middle phases of the session (*median* = 51.5; *IQR* = 28–73).

The results also showed that participants had most of their interactions in the first temporal phases. Half of the interactions occurred in the first four phases (51%), and the first phase had the largest number of CPGs retrieved (17%). The most common categories of the interactions in the first four phases were vegetables (44%), spices (12%), and meats (11%). The results showed that participants retrieved most of the items at the beginning. Half of the items were retrieved in the first three phases (55%), and the first interval was the

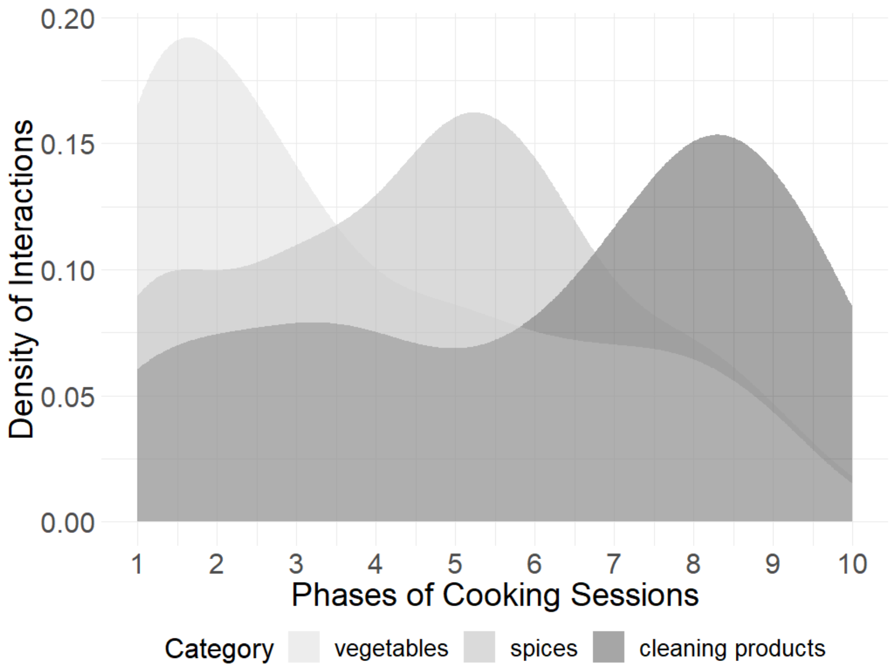


Figure 8: Distribution of interactions for selected categories across phases.

phase with the largest number of CPGs interacted for the first time (36%).

The distribution showed that there are differences in the number interactions across phases according to the category of CPG (see Figure 8). *Vegetables* were most commonly interacted with at the beginning, with a peak of interactions just before the second phase, spices was distributed along the sessions with the peak of interactions around the fifth phase, and cleaning products had most of its interactions at the end with a peak of interaction around the eight phase.

The findings suggest that, in cooking, people had their first interactions with most of the CPGs involved at the beginning, and then interacted with those items throughout the rest of the session. People kept retrieving CPGs, but at a diminished rate, and usually stopped retrieving CPGs entirely by the last quarter of the session. It could be that more CPGs were retrieved after the meal was served. For instance, people may have retrieved items from the condiments category such as balsamic vinegar and hot sauce when they sat down to eat. However, the methods in this study did not allow us to capture such items as they only recorded the interactions until the moment people served their meals. The findings also suggest that different categories of items become involved at different phases in the cooking sessions. For instance, items from the vegetables category were used at the beginning of the sessions and required somewhat longer preparation times, as they often first had to be peeled and chopped to be fit for their eventual use in the recipe. This is in contrast to the categories of items that were more commonly interacted with at the end of the session such as cleaning products, which are commonly used to clean the mess produced by the previous categories of items.

4.3.4 *Conditionality*

The concurrent analysis of CPGs showed that CPGs are utilised in recurring pairs with other CPGs, utensils, and environment items. The most frequent pairs of CPGs were composed of the CPGs with the largest involvement across sessions, the most frequent pair was {salt, oil} with an involvement frequency of 95% of the sessions. Other frequent pairs include {salt, black pepper} (55%), {oil, onions} (55%), and {sponge, dishwashing liquid} (45%).

The three highest conditional probabilities associated with pairs of CPGs were $P(\text{salt} \mid \text{oil}) = 0.95$, $P(\text{onions} \mid \text{black pepper}) = 0.75$, and $P(\text{dishwashing liquid} \mid \text{sponge}) = 0.75$ (Figure 9). The conditional of salt and oil probabilities were nearly one regardless of the ingredient constituting the conditioning event. In other words, given that any ingredient besides salt or oil was used, the probability that salt and oil were also used was almost 1. Averaging across all conditioning items, the conditional probabilities associated with salt and oil given the use of any CPG are P(salt | [CPG]) = 0.97 and P(oil | [CPG]) = 0.96.

The pairing of individual CPGs revealed items that are similar to each other and that are used in combination. Taking the item onions as an example, for pairs in which onions are an element, the conditional probability of there being other CPGs from the category vegetables is higher than that of finding items from other categories. For instance, P(ginger | onions) = 0.64, P(tomatoes | onions) = 0.45, and P(mushrooms | onions) = 0.36. When pairing utensils and CPGs, the utensils complementing the CPG in each pair are those one customarily associates with activities involving that CPG. In the pairing of onions with utensils, for example, the most prevalent items were those associated with preparation, disposal, and storage: P(knife | onions) = 1, P(chopping board | onions) = 1, P(trash bin | onions) = 1, and P(fridge | onions) = 1.

Items which are strongly associated with specific activities are commonly found to be paired. Pairs of items containing salt and black pepper are likely to be associated with basic seasoning of ingredients, pairs containing the item *oil* are likely to be associated with heating and flavouring, and pairs containing the item sponge or dishwashing liquid are strongly associated with washing dishes. Pairs containing a CPG are often complemented with utensils that are necessary for its use. For instance, the most common utensils associated with onions were chopping board, knife, and trash bin, which are linked to chopping onions and the disposal of its waste. Additionally, CPGs which have similar features and properties repeatedly appeared in pairs. For instance, other CPGs frequently appearing in the pairs containing onions include garlic

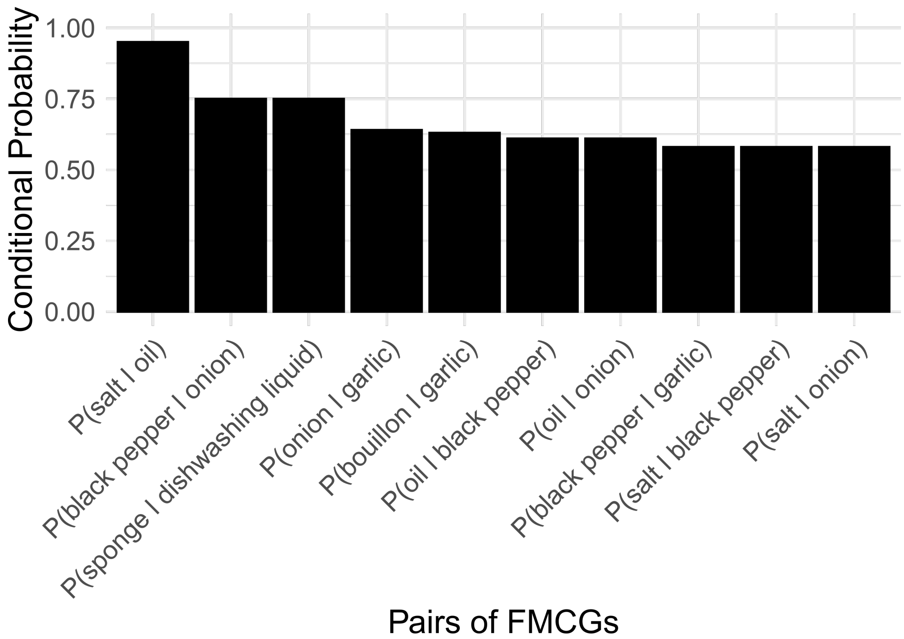


Figure 9: Pairs of CPGs with the highest conditional probabilities.

and tomatoes. These three CPGs have a similar use; they also belong to the category vegetables, and are usually chopped before being added and incorporated into food. Knowledge about the usage of items in pairs could be useful for expanding and specialising their application and opening new avenues to novel understandings of CPGs in groups.

4.4 FINDINGS: UNFAMILIAR MEALS

In this section, we present a summary of the overall trends revealed through our statistical analyses, and in the following subsections, we delve into further detail about the specific aspects of CPG interactions.

At the surface level, there were few differences concerning CPGs interactions between the two distinct meal types. There was a lack of statistically significant differences in the number of CPGs used per session and their average number of interactions. The number of CPGs involved in unfamiliar meals (M = 22.2, SD = 6.6) were not significantly higher to those in familiar meals (M = 18.4, SD = 7), $t(17) = -2.1$, $p = .05$. The number of CPG interactions per session were also not significantly higher for unfamiliar (M = 79.1, SD = 37.1) compared with familiar meals (M = 65.2, SD = 30.6) $t(17) = -1.8$, $p = .09$.

There were, however, significant differences in the utensil involvement between meal types. Unfamiliar meals utilised a larger number of utensils per session (M = 38.7.1, SD = 13.9) than familiar meals (M = 29.6, SD = 13.2) $t(17) = -2.9$, $p <$ .01. The number of utensil interactions per session were also different between unfamiliar meals (M = 275.9, SD = 125.8) and familiar meals (M = 200.1, SD = 98.7) $t(17) = 2.8$, $p < .05$. Overall, cooking unfamiliar meals involved significantly more utensils, which may reflect the use of more specified utensils and preparation methods.

We also found that many participants shared CPGs across both of their meals; that is, they used the same ingredients regardless of the meal. A mean of 7.9 CPGs (SD = 3.1) were used in both meal types for each participant, representing 35% of the average total goods used in unfamiliar meals. Some of the CPGs most commonly shared between meal types included basic ingredients such as salt, oil, and black pepper.

4.4.1 *Information gathering*

Although quantitative analysis highlighted no substantial differences in CPGs usage between meal types, the more qualitative analysis revealed that one of the most noteworthy uses of CPGs was associated with gathering information by reading the labels on packaging.

Figure 10: Instances of information gathering displaying four different purposes of reading labels.

There were 22 instances of information gathering in unfamiliar meals compared to only 4 in familiar meals. Generally, participants read the label of a given consumer good only once per session, except for one unfamiliar meal in which P11 read the label on a pack of noodles on three separate occasions. The CPGs for which people read the labels varied widely in unfamiliar meals and included items that belonged to the categories of carbs, dairy, condiments and spices. This was markedly different from the familiar meals, for which the CPGs belonged only to the category of carbs. In unfamiliar meals, all the labels read by participants were for CPGs which participants did not use in their familiar meals, and had limited to no prior experience with.

Analysing what happened before and after each instance of reading labels, we found that this activity had distinct purposes (see Figure 10). Some instances were just momentary occurrences in which people quickly got information and carried on with cooking, such as when P04 checked the expiration date on a chorizo package and, after finding that the product was fresh, immediately resumed preparation. However, others represented a challenge which broke the rhythm of cooking, such as when P08 read the label of a bag of flour to see how to measure out a serving size and resorted to asking for help to get the desired amount. We found through observation and interviews that people read the labels for four different purposes: *to verify product information*, *to check cooking instructions*, *to satisfy their curiosity*, and *to measure out a portion*. There were instances of each of these purposes during the preparation of unfamiliar meals, with the purpose of measuring a portion (n = 8) being the most common, while in familiar meals people read the labels only to verify information (n = 3).

The reading of labels also varied greatly in duration. The durations had a mean of about thirty seconds for both unfamiliar meals (M = 32) as well as familiar meals (M = 34), and they ranged from a minimum of four seconds to a maximum of one minute and twenty-two seconds. When classifying the instances involving information-gathering by purpose, reading to satisfy curiosity had the shortest average duration (M = 21), and reading to measure out a portion had the longest (M = 40). One reason for these larger durations when measuring out portions was that reading, in these cases, was usually followed by continuous interaction with the CPGs until the participants obtained the desired amount of the product, whereas reading to satisfy curiosity usually just consisted of skimming the package to find some information such as nutritional facts, then immediately setting it aside.

Regarding the time in the cooking session at which the label-reading took place, most of these interactions occurred at the beginning (n = 16); though a few also occurred during the middle (n = 6) and end of some of the sessions (n = 2). We also found that 90% of label reading in unfamiliar meals occurred just after reading the step in the recipe which called for the use of said ingredient. One of many examples was when P06 learned about the use of pita bread near the end of the session, as the penultimate step of the recipe for chicken gyros required one to warm the pitas. The participant then read the packaging to check the heating instructions before putting them into the toaster.

4.4.2 *Tasks in intervals of high activity*

We found that there were more interactions per interval for the combined class of CPGs and utensils in unfamiliar meals (M = 7, SD = 4.5) than in familiar meals (M = 6.4, SD = 4) $t(3.1)$ = 2234.8, $p < .05$.

To further analyse these intervals with the largest number of interactions, we selected those that were in the upper 75$^{\text{th}}$ percentile for both meal types. In this percentile, there were also more interactions per minute for CPGs and utensils in the unfamiliar meals (M = 11.1, SD = 2.1) than the familiar meals (M = 10.4, SD = 2.4) $t(2.8)$ = 514.4, $p < .01$. We additionally found that there were a larger number of shorter interactions—those lasting less than 10 seconds—in unfamiliar meals (M = 1.1, SD = 2.6) than in familiar meals (M = 0.9, SD = 2.4) $t(2.4)$ = 3624.2, $p < .05$.

To document what people accomplished in these intervals of high activity, we selected 60 such intervals from each type of meal and detailed the activities therein. We found that such intervals contained more activities per minute in unfamiliar meals (M = 5.9, SD = 1.9) than in familiar meals (M = 3.8, SD = 1) $t(7.6)$ = 101.7, $p < .01$. The most common activities in unfamiliar meals were stirring (20%), retrieving (19%), and reading recipes (13%); while in the familiar meals they were stirring (24%), retrieving (17%), and adding (11%). We also found that during such intervals, *task repetition*—an instance in which an activity was stopped then resumed within the same minute—was more prevalent in unfamiliar meals (M = 1.4, SD = 0.9) than in familiar meals (M = 0.6, SD = 0.6) $t(5.7) = 111.5$, $p < .01$. The most commonly repeated activities in unfamiliar meals were stirring (n = 23), retrieving (n = 12), and reading recipes (n = 12); while in familiar meals they were stirring (n = 16), retrieving (n = 6), and chopping (n = 4).

To provide a more detailed account of those intervals of high activity, we selected ten such intervals for each meal type to explore their characteristics. We found that in the unfamiliar meals, there were more occurrences of *task simultaneity*—an instance in which multiple activities occurred in parallel, starting new activities before completing others. This suggests, as one would expect, that people may have been less in-control and were more blindly following the instructions in the recipe as they read them. For familiar meals, on the other hand, the process seemed to be more sequential as participants generally completed a task before moving on. They did not repeat activities as often as in unfamiliar meals, and arguably appeared to be more in-control and efficient (see Figure 11).

Although we did not explore these findings in depth during the interviews, after the preparation of unfamiliar meals, people more commonly expressed a desire for technology which could provide support during moments of feeling overwhelmed. Switching between different activities appeared to have been an issue for participants when cooking unfamiliar meals, as they also expressed a feeling of not being totally in-control, specifically through comments on the difficulties posed by constantly needing to check the recipe and being un-

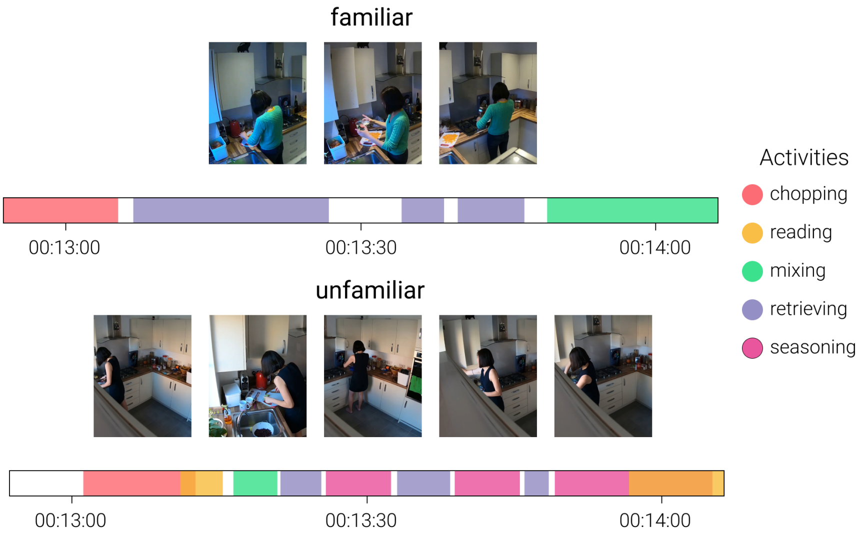


Figure 11: A section of both meal types by P19 showing the higher frequency of switching between tasks in unfamiliar meals.

able to anticipate the next step. Unfamiliar meals often seemed to represent uncertainty, as participants did not know which activities were required, and some were simply following the instructions of the recipe one step at a time, as P08 expressed below.

P08. *"So, I missed a couple of steps, and I was like, 'oh.' I didn't know how it was going to turn out. (...) And you also have to constantly consult the recipe."*

4.4.3 *Connectivity among items*

To form an understanding of the interconnections in meal preparation, we provide a statistical and visual analysis of some features, both general and specific, of the networks for familiar and unfamiliar meals.

For the combined class of both CPGs and utensils, there were a significantly larger number of nodes in the network for the unfamiliar meals (M = 40.3, SD = 7.6) than in those for the familiar meals (M = 35.7, SD = 12.1) $t(-2.5) = 17$, $p < .05$. However, there were no differences in the average degree—the number of edges per node, between unfamiliar (M = 6.2, SD = 1.4) and familiar meals (M = 5.9, SD = 1.6) $t(-0.84) = 17$, $p = .41$. This suggests that CPGs are likely to have a similar number of interactions regardless of the meal type.

To obtain a sense of the extent to which the nodes tended to cluster together, we analysed modularity—a measurement of the density of the network—and found that there were no significant differences in this metric between unfamiliar meals (M = 0.6, SD = 0.06) and familiar meals (M = 0.6, SD = 0.09) $t(1.84) = 17$, $p = .08$, suggesting that items are likely in a network to physically cluster together with a similar strength regardless of meal type, which might represent that items are used together with other items in a similar way regardless of the meal, for example the items onion, chopping board, and knife might be use together in any meal.

Network visualisations help to understand the roles that the items and their use in combination play in the preparation of a meal. As an illustrative example, the networks for the familiar and unfamiliar meals prepared by P11 are presented in Figure 12.

The visualisation gives a sense of the way items were used during cooking. In both meals, CPGs generally form clusters with other CPGs and utensils which are closely associated with their use. For instance, we can see 'spaghetti-cooking spoon-pan' in the familiar meal and 'chicken-chopping board-knife' in the unfamiliar meal. We also observe that some items had a greater influence because of their node size and central position in the network, such as spaghetti and chicken in the familiar and unfamiliar meal, respectively. The graphs also allowed us to see items which were separated from the

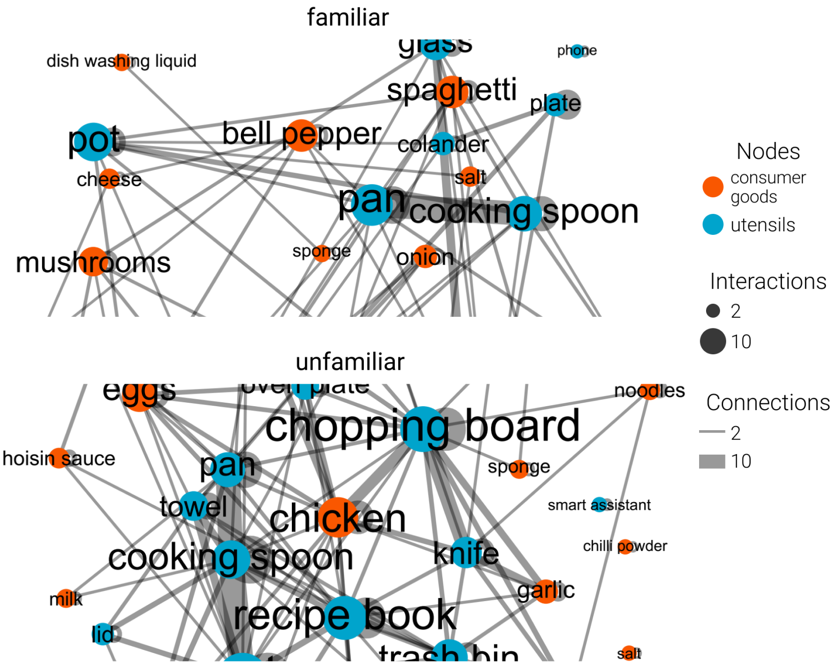


Figure 12: Segment of networks that show the nodes with the greatest centralities for CPGs and utensils in both meal types by P11.

network; as we observed in both meals, digital devices such as phones and smart assistants did not share a connection with any other item, thus appearing as isolated nodes.

In an attempt to identify the most relevant CPGs for each meal, we analysed the eigenvector centrality (EC)—a measure of the importance of each node in the network. We found that the CPGs with the highest EC values represented the ingredients that were most essential for the preparation of a meal, such as *cheese* ($EC = 0.27$) in mac and cheese (P01 unfamiliar meal), and corresponded to the nodes with the greatest size. The CPGs with the highest EC had a mean of 5.9 neighbours ($SD = 3.1$) in unfamiliar meals and 5.6 ($SD = 2.5$) in familiar meals, representing almost a fifth of the items used in any meal: 18% in unfamiliar meals and 19% in familiar meals.

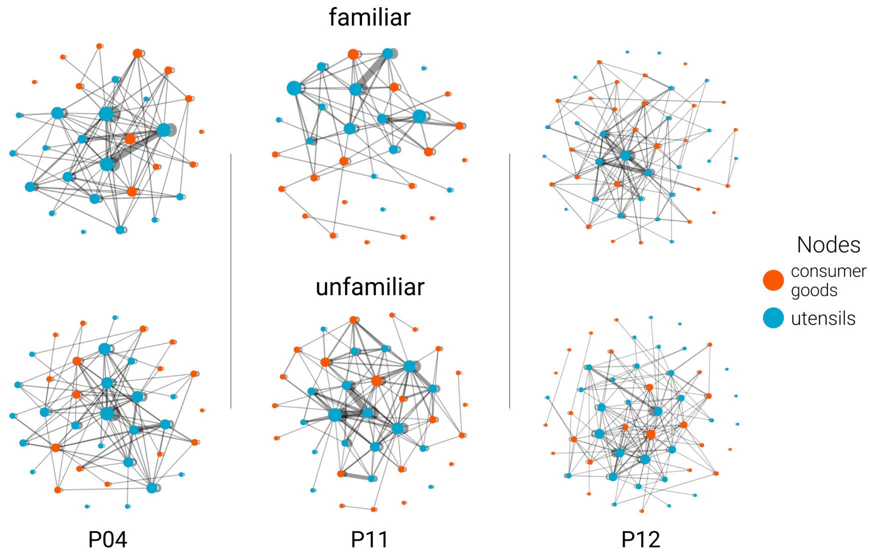


Figure 13: Networks of both meal types for three participants showing the similarities in shape between the networks of each participant.

The overall forms of the graphs had more similarities between the familiar and unfamiliar sessions for each participant than between any sessions from different participants. In Figure 13, we can see that the networks for P04 have a relatively loose shape, with the connected nodes comparatively spread out in a single, large component and surrounded by few unconnected nodes. This stands in contrast to the networks for P12, in which the central components have a higher concentration of nodes and seem to exert a greater draw on other nodes. We investigated whether there were differences in average degree and modularity, then compared them across different participants without regard for meal type. We found that there were significant differences in the average degrees of CPGs (M = 3.2, SD = 1.1) $t(12.2) = 17$, $p <$ .01, as well as in modularity (M = 0.58, SD = 0.06) $t(38.5) = 17$, $p <$ .01. This could be an indication that the personal habits of each participant played a larger role in determining the general structure of the graph than the type of meal being prepared.

4.5 CHAPTER SUMMARY

The rapidly-changing landscape of the CPG industry is now more than ever incorporating technologies to enhance its products. Ever-increasing customer demands and the need for products which fit into our practices require finding innovative designs based on empirical insights. To overcome this challenge, an in-depth understanding of our interactions with CPGs is essential. Our findings demonstrated that CPGs have complex patterns of use which are only revealed by means of a thorough analysis. This study serves as the foundation for the next our next chapter concerning the development of design resources and a design workshop (Chapter 5) and the exploration of empirical insights as a source of inspiration (Chapter 6 & 7).

This research contributed to obtaining an understanding of the complex patterns of interactions by employing fieldwork and an analytical approach to identify the instances which might prove informative for design. It represents the first detailed exploration into how CPGs are utilised within people's households during the practice of cooking. Our findings show that meal preparation is largely similar regardless of familiarity, as revealed by the shared use of certain CPGs and approximately equal number of interactions with them across all sessions. However, the preparation of unfamiliar meals had some notable differences on the finer scales, and we highlighted three such aspects which could be used as cases for design; specifically, the circumstances surrounding information-gathering from reading the label on packaging, task saturation due to the increased frequency of switching between actions, and the influence of specific ingredients in the aggregate connection networks.

This work provides two specific contributions. First, it presents analysis methods to study the use of CPGs in practice, which can be applied to a broader set of contexts. For example, by examining CPGs used in cleaning, our methods can help uncover characteristics of CPG usage in this practice. Second, it consolidates the insights acquired using our various methods of analysis; the combination of both quantitative and qualitative methods allows researchers to give a clearer meaning to the results, thus enhancing our understanding of the findings. It is to be expected that the proposed approach would face many challenges in the long process of translating insights from fieldwork into the deployment of a product in a practical context. To illustrate, the finding that CPGs are usually used in tandem suggests there is value in designing for them in sets rather than in isolation, yet this would require companies to create innovations compatible with those of their competitors; a degree of cooperation not usually found.

The set of analysis methods and findings for both familiar meals and unfamiliar meals have helped us to answer our first two research questions. Their results provided insights into such aspects as those concerning the involvement of CPGs across meals and the characteristics of information-gathering, thereby helping to answer our first research question: *How do people interact with CPGs in the practice of cooking?*. The methods of analysis focusing on specific item interactions, which allowed us to examine aspects of CPG usage ranging from the identification of general patterns to more in-depth features, have helped us to answer our second research question: *How can we obtain an understanding of the interactions of CPGs in practice?*.

The implications that these findings have for the design of digitally-enhanced CPGs and how they might contribute to design o such products which fit people's routines and habits (rather than requiring them to adapt their practices to technologies) will later be included in the discussion section (Chapter 8). The insights gathered in this study were used in the design workshop studies (Chapters 6 & 7) to explore how data can be used as a resource for design, thereby helping us to answer our research questions (Chapter 1).

4.5.1 *Accomplishments*

Overall, this chapter advances our knowledge regarding the use of CPGs in the practice of cooking. As previously stated in Chapter 3, despite CPGs' relevance in our everyday lives, no studies to date have not focused on understanding the practical interactions of their. We have provided an understanding of different aspects of CPG usage; including, their frequency of involvement across meals, number of interactions per session, phases of activity, characteristics of information-gathering, and their combinatorial nature of their use. Methodologically, through ethnographic observations and a mixed-methods approach for data analysis, we have laid the foundations for attaining a better understanding of the interactions of CPGs not only in the practice of cooking, but in many practices of which they are essential components. The empirical insights of this study will later be explored in the discussion (Chapter 8) with an eye towards implications for the design of enhanced CPGs.

4.5.2 *Outlook*

In this chapter, we obtain insights about how CPGs are used in cooking in two situational contexts: the preparation of familiar meals, and that of unfamiliar meals. The focus on unfamiliar meals allowed us to identify similarities and differences in CPG use in that specific context, which in turn might lead to design implications for the preparation of meals with which people generally lack experience. The findings gathered in our two fieldwork studies on cooking were later used in our design workshops to explore alongside with consumers and professional designers how such knowledge might lead to innovation. We decided to present these findings to members of the general public to explore their potential value for design, expanding upon the implications for design which is drawn from data. We believe, given the highly subjective nature of data interpretation, that a greater number of people making use of such data could lead to more diversity in enhanced CPG designs. To present our findings, we made use of visualisations, a structured workshop process, and design tools; all of which we describe in detail in later sections.

5 THE CREATION OF THE DESIGN WORKSHOPS.

This chapter presents the development of the design resources used for the workshop studies (Chapters 6 & 7). The data collected from the participants in these design workshops is presented in the above-mentioned chapters. This chapter focuses on how the various components and design resources of the workshop were devised, including the data visualisations, design cards, and design sheet. The chapter describes in detail how data drawn from the ethnographic study on cooking (Chapter 5) was used to inform the creation of the data visualisations through the use of an iterative process.

Informed by narrative visualisation (Segel and Heer, 2010) and visualisation representations (Carpendale, 2008), various data representations were created. Each representation employed in the workshop was made with the objective of improving the way the data was presented in response to participants' feedback. In addition, data from different features of CPG usage was explored in each iteration in accordance with the empirical findings, thereby showing which were most frequently utilised. The style employed for each iteration and its justifications are described in the sections below, and are summarised in Table 8.

5.0.1 *Basic information*

Simple numerical data, typically just numbers or short summaries of the, were presented alongside a simple graphic that represented the data. The visualisations presented raw data

Table 8: Visualisation types utilised in each workshop.

Iteration	Data visualisation
Pilot	Basic information
First	Simple charts
Second	Animated items
Third	Contextual visualisation
Designers	Situational visualisations

almost much as it would be described in a report. To illustrate, for the data *interactions* and CPG *salt*, an icon of a moving hand was placed in the middle, and below it was information about the average number of interactions per session. These representations were intended as the first test in order to explore whether participants could derive insights from the data. The data contained information related to such aspects as *activities*, *durations*, *interactions*, *involvement*, *phases*, *places*, *sequences*, and *varieties*.

5.0.1.1 *Data and visualisations*

The data used on the first test for the item, salt, contained information on each of the eight aspects listed above. We selected the CPGs most commonly involved in the sessions as we interpreted their frequency of involvement to be indicative of their relevance in cooking, and hence to their potential for creating a smart version of these products. For example, one piece of data on salt included the average number of interactions (M = 3.1, SD = 3.3) and their range (min = 1 and max = 15), as well as the total number of interactions it was involved in across familiar meals (n = 115) (see Figure 14).

Figure 14: Example of a *basic information* visualisation for the item *salt* and data *interactions*. The visualisation displays an icon in the centre representing interaction, along with a description of the findings.

5.0.1.2 *Findings and improvements*

Different components related to the design cards were reflected in the design—including the use of technologies such as holograms, sensors, and smart glasses—as well as features such as sustainability and support (see Figure 15). We found that participants were able to follow the instructions and create their own design concepts. Nevertheless, we found that, while participants made effective use of the design cards, the data visualisations were not used to the same extent in the creations of their concepts. The design did not reflect the use of data as much as the use of design cards. We reasoned that this, in part, was due to the raw nature of the data visualisations, which provided almost no context for the information. In response to this, in the next iteration of the workshop we decided to incorporate more context to be conveyed alongside with the data.

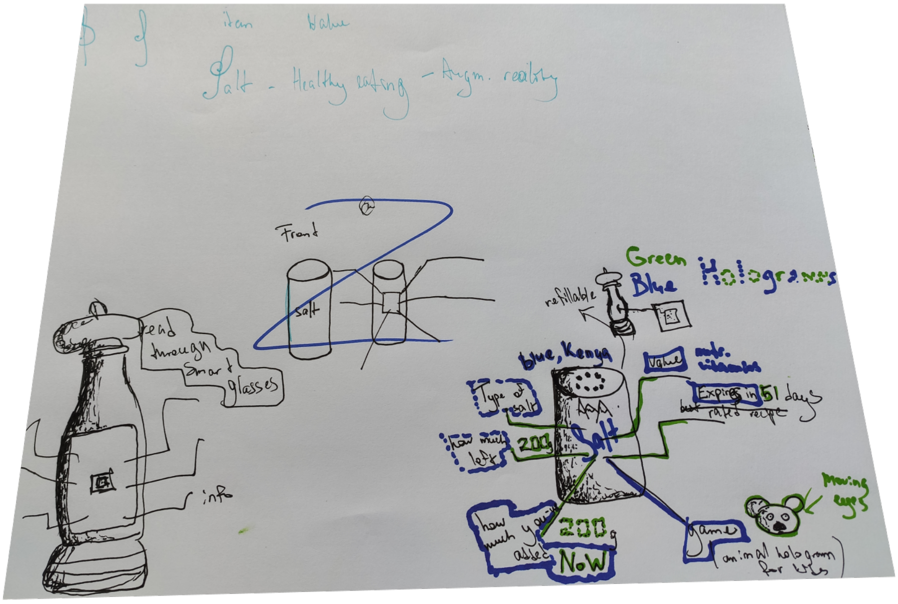


Figure 15: Design of an enhanced bottle of *salt* created using basic information visualisations.

5.0.2 *Simple charts*

Simple visualisations of items were created based mostly on quantitative data with little-to-no contextual information. To give an example, for the data *activities* and CPG *oil*, representative images of the most common activities associated with the item (*heating* and *flavouring*) were selected, with the sizes of the images indicating their frequencies. These representations were intended to allow participants to make a neutral and non-directed interpretation of data. The data represented included *activities*, *collaboration*, *places*, and *varieties*.

5.0.2.1 *Data and visualisations*

The data used in the simple charts, as it was the first iteration of the format, used the data collected in the ethnographic study on *activities*, *places*, *versions* and *networks* for the items *cheese*, *dishwashing*, *eggs*, *oil*, *onion* and *salt*. We selected six of

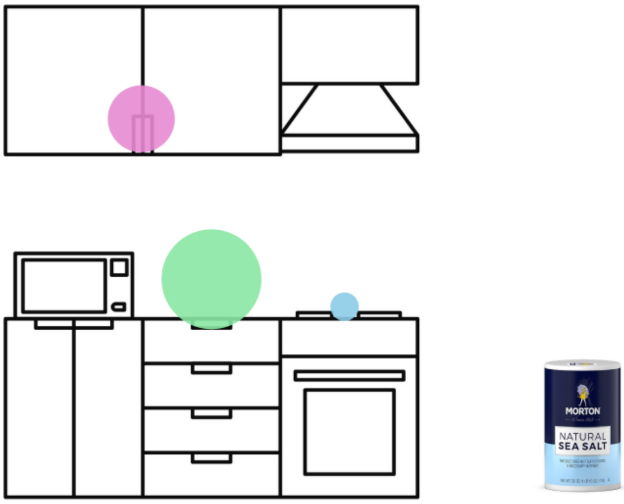


Figure 16: Example of *simple charts* visualisation for the item *salt* and data *places*. The visualisation displays the layout of a kitchen and the frequency of interactions in different sections.

the ten CPGs people had the most interactions with. While making these selections, we made an effort to create a diverse group of CPGs with unique characteristics of use which could lead to novel design concepts. The data for the item *salt* on the activities *places* consisted of the percentages of time during which they were interacted with in various locations within the kitchen: counter (57%), stove (32%), and cupboard (12%). The data was represented by circles, with the size of each being proportional to the percentage (see Figure 21).

5.0.2.2 *Findings and improvements*

We identified that, in these designs, data played a greater role in their conceptualisation, partly due to the revisions made to the design sheet and improvement in the instructions. In addition, participants were reminded about the need to use data as one of the components in their designs. As an example of one design that was informed by this visualisation was a design for an enhanced dishwashing liquid included the creation

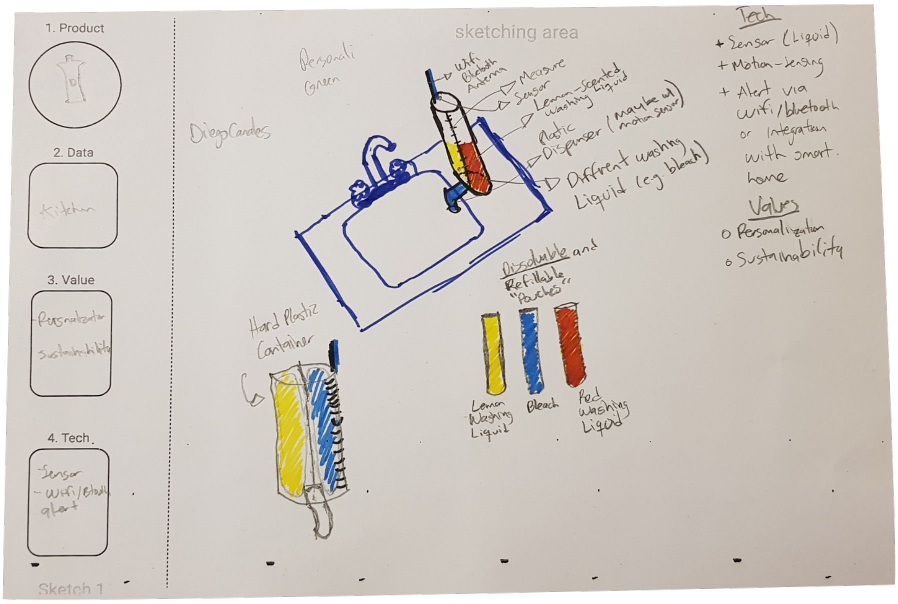


Figure 17: Example of simple charts visualisations for the item *salt*. The right-side board shows the visualisation for the data on *activities*.

of dissolvable and refillable pouches, as well as a smart container, which dispenses the right amount of dishwashing liquid for each utensil depending on factors such as its size and purpose. In order to accomplish this, the device is incorporated with sensors which detect the utensils and determine the minimum amount of liquid necessary (see Figure 17). We found that participants in this case made more use of the data than in the previous workshop; however, their understanding of the data remained rudimentary, and its influence on design remained superficial or, at best, inferior when compared to the influence of the design cards. This was captured in participants' comments, such as that made by **P01**: *"Regarding the visualisation, maybe not to leave me that much [to think about it]. I don't know like how to interpret the data."* Therefore, in the next iteration of the workshop, we decided that it may do better to convey the information as more of a story rather than just presenting seemingly disjointed findings.

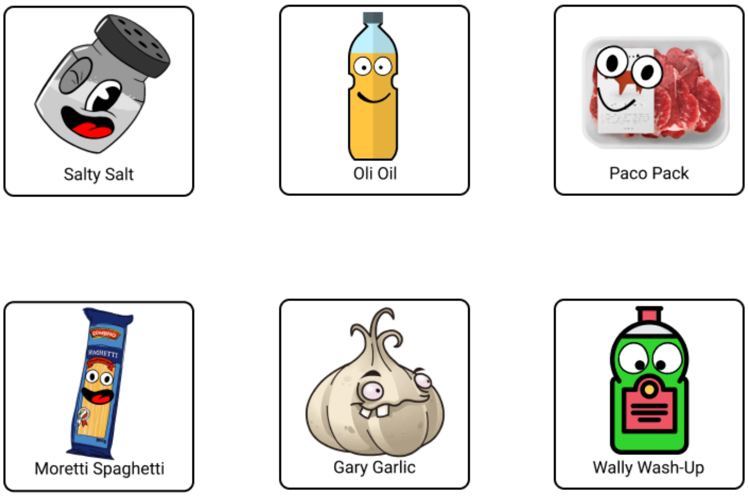


Figure 18: Animated items for the CPGs *dishwashing*, *garlic*, *mince beef*, *oil*, *salt*, and *spaghetti* used in the visualisations.

5.0.3 *Animated items*

Inspired by the Japanese concept of *tsukumogami*, roughly translated as "tool spirit," we created cartoon characters of CPGs. The characters were presented in a user-experience persona template, and were complemented by a comic which told a short story based on its data. For example, the comic for *oil* told the story of how it was used in the preparation of chicken curry. These representations were designed to provide more context for the data and encourage people to think about the practical interactions of CPGs. The data represented included *activities*, *collaboration*, *consumption*, *duration*, *interactions*, *involvement*, *places*, *specific situations*, and *varieties*.

5.0.3.1 *Data and visualisations*

The data was arranged in a persona-style board to allow participants to find all the data in a single place and make it easier to

Figure 19: Board containing all the data for the item *salt* for the animated items.

navigate (see Figure 18). The data displayed included information on *activities*, *places*, *versions* and *networks*, as well as basic data such as *duration*, *meals* and *interactions* for the items *dishwashing*, *garlic*, *mince beef*, *oil*, *salt* and *spaghetti*. Aiming to make the data visualisations more appealing, we created a character and comic for each of the CPGs in which the anthropomorphized products describe their use in the preparation of a meal making use of the data in their story. All the characters are shown in Figure 19. For some of them, such as *salty salt* for *salt* and *oli oil* for *oil*, we attempted to give them humorous names to impart the design process with a more relaxed feeling. The comic for *salt*, which is exemplary of the comics in general, we made use of the data *collaboration*, *meals*, *sequence* and *versions* to describe how salt was used in the preparation of *scrambled eggs* and an *avocado spread*; explaining how different CPGs were used in combinations, as well as the order in which they were employed. The comic also described the type of *salt* used and how it was handled. See Figure 20 for an extract of the comic.

Figure 20: Example of one of the comics for *animated items* the item *salt* displaying data on *collaboration, meals, sequence* and *versions*.

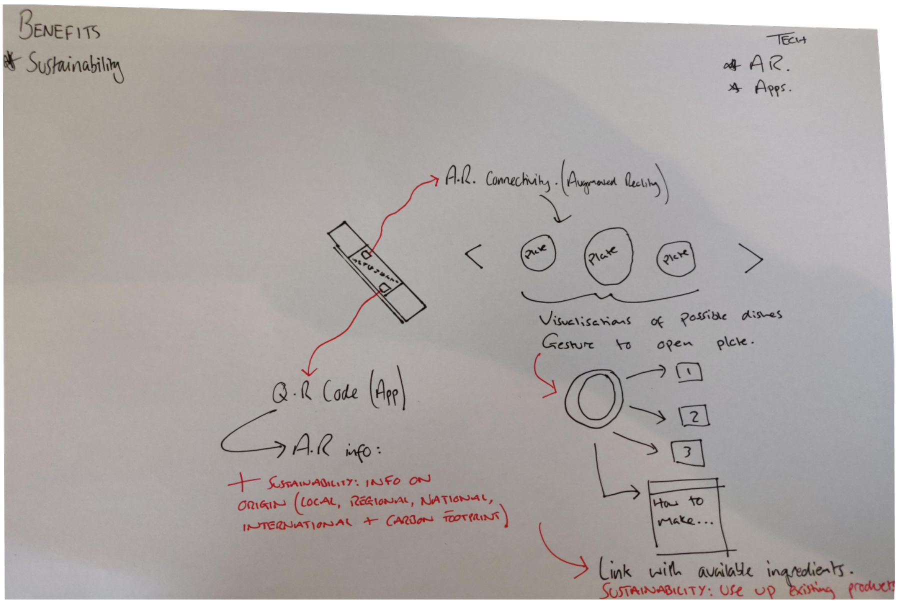


Figure 21: Example of the comic for the item *salt* describing the use of the item in the preparation of a meal.

5.0.3.2 *Findings and improvements*

We found that participants were able to make more contextual use of the data, as their designs reflected the ways in which CPGs are actually used. As an example, the design for an enhanced spaghetti that provides information about sustainability through the use of an app and augmented reality visualisations suggesting how to cook different dishes combining available CPGs. Although we identified that participants made use of the data and took into consideration the practical usage of CPGs, some participants expressed that the comics were juvenile or immature, and not very appropriate for educating adults, especially given their inevitable previous knowledge about the use of CPGs. This was captured in ideas expressed by participants, such as the statement made by **P01**: *"I don't like these cartoons . . . I feel that the cartoons are used so you are not intimidating people. But I got the message that you are almost patronising me because they are so cartoony and simple, as if you're trying to be my friends, and it's not necessary.*

5.0.4 *Contextual visualisations*

Four styles of data representation were selected: annotated graphs, network visualisations, thumbnails, and videos. Each of which was accompanied by a brief description providing context. Turning again to the example involving *oil* and the data on *activities* for *heating*, a short clip of a person adding oil to a hot pan was presented, along with the description of the cook and the meal prepared. These representations were designed to provide contextual information in a more balanced and neutral manner. These representations included data on *activities, collaboration, consumption, interactions, specific situations,* and *varieties*.

5.0.4.1 *Data and visualisations*

The data used on these visualisations was aimed at presenting adults with the contextualised information in a more adequate way. Our hopes were that such additional information would help people to make sense of the data, but without the 'silliness' of the comics. We made use of visualisations including narrated videos, annotated graphs, and network visualisations. In this version of the workshop, we also set the data in a persona-style board to make it more accessible (see Figure 22). The data used in these visualisations included that on *involvement, activities, collaboration* and *version* for the items *oil, mince beef, salt,* and *spaghetti*. We attempted to provide more realistic visualisations as we increasingly believe in people's ability to create insights from data. As an example, for the data *activities*, we described how people measure out portions, and we give a brief description of the meal being prepared while a short video plays showing a participant accomplishing that activity (see Figure 23).

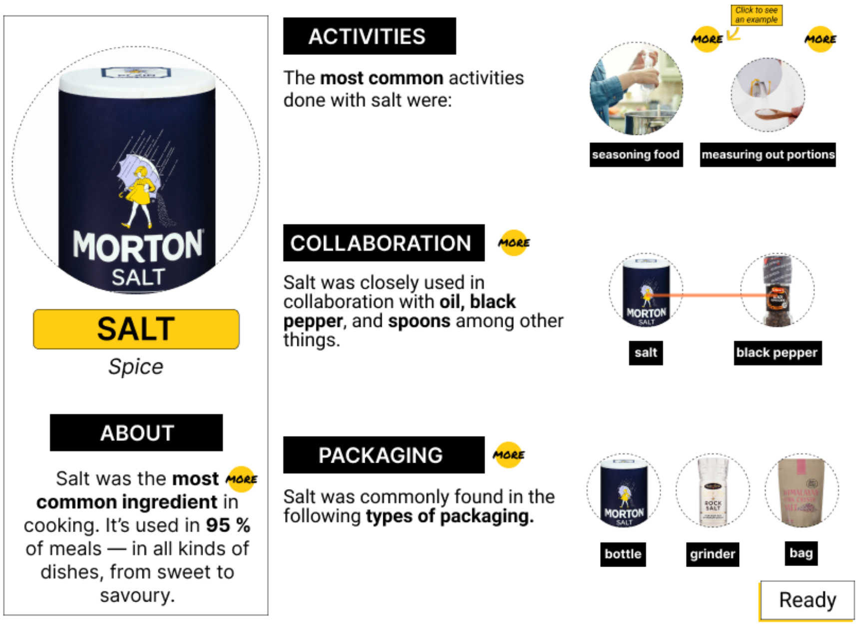


Figure 22: Board containing all the data for the item *salt* for the contextual visualisations.

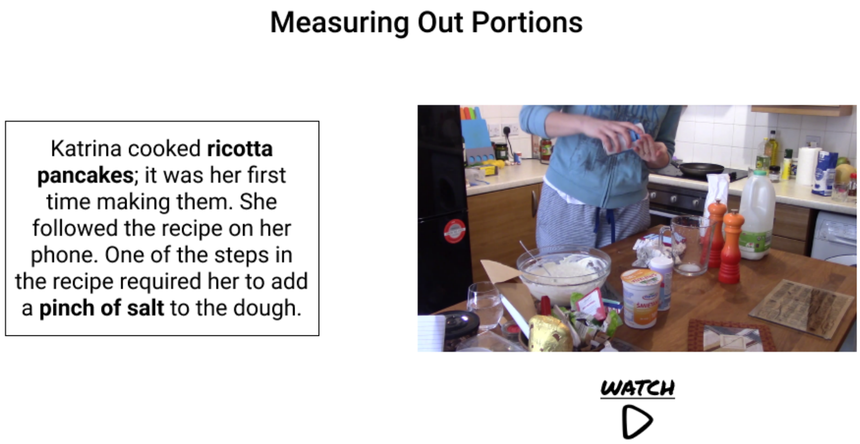


Figure 23: Example of *contextual visualisations* for the item *salt* and data *activities*. The visualisation contains a short description of meal preparation as well as a video involving such activity.

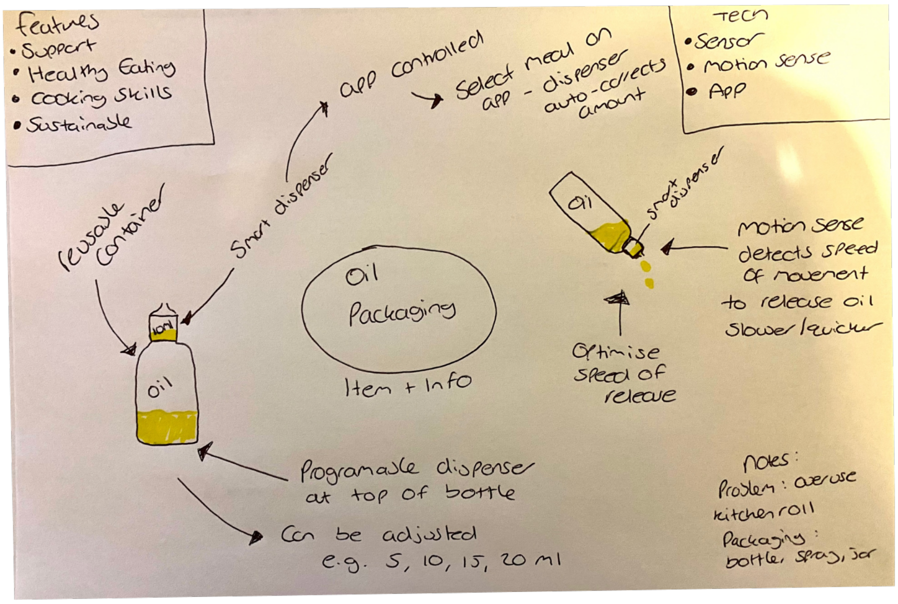


Figure 24: Design of an enhanced bottle of *oil* created using data from contextual visualisations.

5.0.4.2 *Findings and improvements*

Similarly to the previous version of the workshop, we identified that the designs from the participants reflected the ways in which CPGs are utilised in the practice of cooking. One of those designs was an enhanced version of *oil* which made use of the characteristics of the packaging, as well as a smart cap which dispenses the right amount of oil depending on the dish (see Figure 24). We found that participants were able to make more contextual use of the data as their designs reflected the ways in which CPGs are used. As an example, a participant ideated the design for an enhanced spaghetti packaging which provides information about sustainability through the use of an app and augmented reality suggesting how to cook different dishes.] Overall, participants expressed satisfaction with these data visualisations **P20:** *"No, I mean it's good that there is little information, otherwise I will get overwhelmed by all the pieces of information [...] I cannot think of anything to add right now"*

5.0.5 *Situational visualisations*

In this type of visualisation we presented data for three features of meal preparation: *aggregates*, *items usage* and *specific situations*[1]. We used the visualisation styles employed in the previous version of the workshop: *annotated graphs*, *network visualisations*, *thumbnails*, and *videos*. The data visualisations were also accompanied by a brief description providing context. For example, the data on *specific situations* representing differences in the switching of activities in the familiar versus the unfamiliar meals was represented by a graph representing *activities* and their duration within a segment of time, and snapshots of the sequence of activities and pictures of the CPGs involved in those segments. These representations were designed to provide contextual information concerning three different types of data.

5.0.5.1 *Data and visualisations*

Given that the previous visualisations were well-received by the participants and led to the creation of unique designs, they were reused in this version of the workshop. The contribution made in this workshop was the performance of a comparison between data on familiar and unfamiliar meals. In this version of the workshop, we allowed people to select the kind of data they wanted to explore. The data used in these visualisations included that on *involvement*, *activities*, *collaboration*, *task switching*, along with *versions* for the items (*oil*, *mince beef*, *salt*, and *spaghetti*). We encouraged participants to take into consideration the different situations of CPG usage when designing their concepts. As an example, for the data on *task switching*, we presented the sequence of activities that participants performed which occurred within the duration of a one-minute segment

1 These data types are described in more detail in Chapter 7

Figure 25: Example of *situational visualisations* for the data *switching activities* showing the differences between familiar and unfamiliar meals.

for both familiar and unfamiliar meals showing the duration for each (Figure 25).

5.0.5.2 *Findings and improvements*

The designs of the participants took into consideration the situational contexts of use of CPGs, mainly providing support for the preparation of unfamiliar meals or supporting the use of those items which are rarely-used. As an example, the Meal Maker app identifies which ingredients are present and which meals can be prepared from them, then guides people step-by-step (see Figure 26). As in the previous workshop, participants expressed satisfaction with the visualisations and they helped to make effective use of the data **P10**: *"Um.... This is not a bad way to do it, because designers don't understand data as such. Sometimes it goes over their heads because obviously it's very analytical, and obviously there are a lot of different types of presenting data in various ways."*

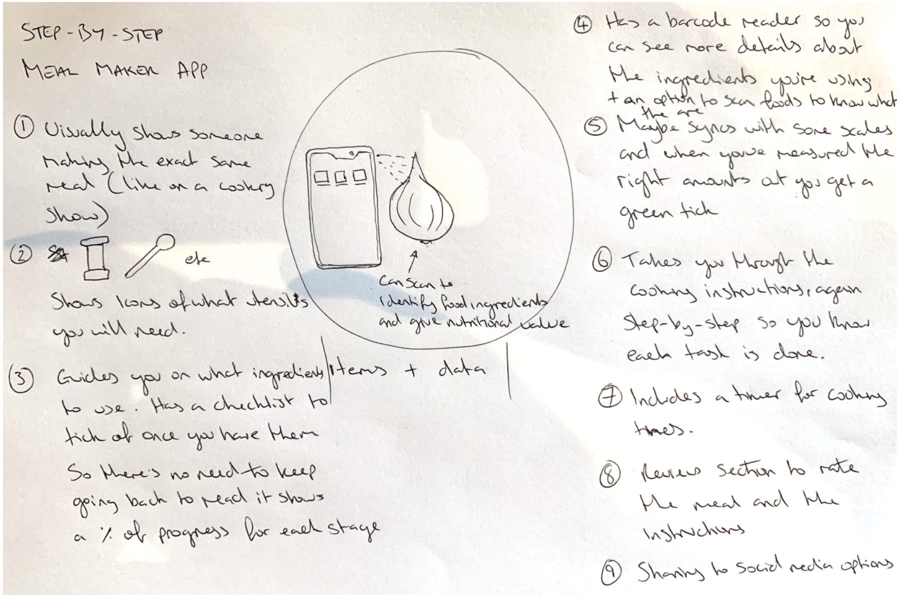


Figure 26: Design of an app that provides support for the preparation of unfamiliar meals using data from situational visualisations.

5.1 DESIGN CARDS

The design cards were inspired by similar cards which had been previously used in other ideation studies Mora, Gianni, and Divitini, 2017; Wetzel, Rodden, and Benford, 2017, and by a prior series of participatory workshops conducted by the first author of this study in collaboration with a large CPG company. In these workshops, participants expressed satisfaction and felt at ease using the cards to ideate product enhancements.

The full set was composed of ten *features* cards, ten *technologies* cards, and eight *items* cards. Each was rectangular and colour-coded, and had been printed with an image and title; the *features* and *technologies* cards bore a description as well. Each *features* card represented a beneficial functionality or attribute which participants could incorporate (Figure 28). Examples included *amusement*, *cooking skills*, and *efficiency*. The *technologies* cards had a device, software system, or some other technology which participants could choose from in order to incorporate the selected features. Examples of these technologies included *3D printing*, *augmented reality*, and *motion sense*. The *items* cards contained CPGs which participants could choose to make designs for. Examples included *oil*, *salt*, and *spaghetti*.

We employed an iterative process to design the cards, making improvements in each version aiming to facilitate the use and understanding of the cards. All versions of the cards are displayed in Figure 25. Below, we describe the changes for each version, as well as the reasoning behind the modifications. For the sake of clarity, the cards were not informed by the ethnographic findings obtained in Chapter 4

First version. The design cards used in the pilot workshop were labelled with a *feature* or *technology* at the top. The cards also contained a representative image, a description, and an example of such a *feature* or *technology*. From this first iteration of the workshop, we found that people did not experience any apparent difficulties using the cards, allowing them to be well-integrated in the design concepts. This was captured in comments such as that expressed by **P02**" *The cards were very useful to do quick designs* .

Second version. In spite of the success of the cards, we made modifications to facilitate an understanding of their contents because a fair number of participants asked for clarification for some of the cards in the first iteration of the workshop. The measures taken to this end included changing the single coloured stripe for two in the second version of the cards —one stripe at top and another at the bottom—as well as modifying the description and examples of the *feature* or *technology* displayed in the card. As expressed by **P10**, *"I think I think the* *cards were good and helpful".*

Third version. For the third version of the design cards, we removed the top stripe, as well as the feature and technology examples according to each card. We increased the font of the title as well as the description. We also increased the size of the image as well as changing the images on some of the cards for a more clearly representative one. We noticed that people asked fewer questions for these cards, and, as with previous workshops, participants easily used their design concepts, and their designs were influenced by these cards. The ease of using the design cards was expressed by several participants through comments such as that by **P19** *I like ideation cards. In general, I think they are great*.

Fourth version. In the final version of the design cards, which were employed in the third version of the workshop, we again used a design very similar to the previous workshops. The modifications were in making the size of the font to the title smaller, increasing the change of the image and simplifying the description card. For some of the cards, we changed the images by attempting to replace them with a more easily-identifiable image. Once again, as in the previous workshops, we found that people used the cards effectively. Participants generally expressed that they enjoyed using the cards and that they were helpful in coming up with creative ideas **P22:** *"I love the ideation cards. I love [...] the way they work and get you thinking out of your own box"*.

5.2 DESIGN SHEET

In order to be clear, we would like to mention that we did not specifically ask participants for their feedback on the design sheet, but rather for their feedback on the workshop process in general. This was done for two reasons: time limitations with participants, and our goals to explore in greater detail the influence of data for design. The modifications made on the design sheet were based on the understanding which we gathered from carefully observing how the sheet was helping them to create their design concepts.

In the first version of the workshop, we did not have a design sheet; we only asked the participants during the pilot to use a regular sheet of paper. The use of a simple sheet helped participants to create their designs. However, due to the fact that we incorporated the design cards, we reasoned that a structure design sheet helps to incorporate all the elements necessary to create a design concept and thus would decrease the burden on participants.

In the first iteration of the workshop, we created a design sheet inspired by the successful use of design cards in related and contemporary design workshops in which they helped participants to make use of design resources and structure their ideation process (Bilstrup, Kaspersen, and Petersen, 2020; Mora, Gianni, and Divitini, 2017). Our aim in using the design sheet was to facilitate the incorporation of all the necessary elements to create a design concept. On the left of the sheet, we included four blank sections to be filled with the design cards: one space was reserved for *item(s)*, one for *data*, and the two others for *features*, *technologies*. Overall, we identified that participants made good use of the design sheet, and that they had no difficulties filling out the sections and creating their designs. Participants generally expressed satisfaction with the design sheet, stating how their utility in facilitating the creation of design concepts.

In the second iteration of the design sheet, we placed the *data* and *item* section at the sector of the sheet in order to

emphasise the importance of data in the creation of design concepts. This design sheet was utilised for the second and third iteration of the workshop. The design sheet itself was a horizontally-oriented sheet with a sketching area and four blank sections: one space was reserved for *data*, and the others for the *features*, *technologies*, and *items* cards (Figure 28). Each section had to be filled in with at least one piece of data or design card, but participants were free to choose more if they so desired. The design sheet served as a template, facilitating the collection and organisation of elements necessary to create a sketch. We found that participants were able to use these sheets with relative ease and faced few difficulties with its use. When participants were asked about their experience with the design sheet, they did not express any complaints about the sheet, nor any suggestions to improve it.
For the third version of the design sheet, we used a simplified version containing only the central circle for the data and items. This was because we had decided not to use the design cards in the workshop with designers due to the fact that we aimed to focus more on the influence of data, and we believed that because of their experience they did not have such resources. We identified that, despite the changes in the design sheet, participants were capable of producing their designs and incorporating the data into the design process.

5.3 CHAPTER SUMMARY

This study provides a thorough explanation of how the design cards, design sheet, and data visualisations used in the workshops were created. These resources were enhanced through an iterative process, with adjustments being made at each stage to make it easier for them to be used in the development of enhanced CPGs.

The chapter is mainly focused on describing the process of how we transitioned from data obtained from the quantitative ethnographic studies to the creation of data visualisations. For each data visualisation style, we describe the data used, as well as the manner and imagery used to present it. We described how people used the data and summarised their ideas on how such visualisations might be improved. We also explained how we implemented the participants' suggestions and insights about the effectiveness of the visualisations to make changes in the next iterations of the data visualisations. Similarly, we described the process in which we made improvements to the design cards and design sheets.

The chapter shows that participants can make appropriate use of the design resources. Participants prefer resources which have sufficient clarity and simplicity such that they can take and implement it in their designs. Generally, participants had fewer suggestions and negative comments about the data visualisation with each iteration, which we took as an indication that the suggested changes had proven effective. Overall, participants expressed satisfaction with the use of the data visualisations as well as the design cards and design sheet as these resources helped them to create their own versions of enhanced CPGs.

5.3.1 *Accomplishments*

This chapter has explained how the design resources were developed, along with the initial insights and opinions of participants who made use of them. Here, we accomplished the creation of the design resources which are used in the data-inspired ideation approach (Chapters 6 & 7). These resources allowed us to empower consumers and professional designers alike with respect to the development of enhanced

CPGs. This work as a whole has given an exploration into how our design resources can be used for the ideation of enhanced products.

5.3.2 *Outlook*

This study developed data visualisation inspired by findings obtained from our ethnographic studies on cooking (Chapter 4), thereby setting the scene for the use of data as a resource for design. In the next Chapters (6 & 7), we will focus precisely on how consumers and professional designers can make use of such data-informed resources for the creation of enhanced CPGs. We believe that the presentation of our findings through visualisations could help participants to understand and implement insights which positively inform the design of their own enhanced CPGs.

6 DESIGNING ENHANCED CPGS. AN EXPLORATION WITH CONSUMERS

This chapter discusses the results of a study on how consumers use data about CPG interactions in cooking as a resource to conceptualise potential technological enhancements. We devised a 'data-inspired ideation approach' using data visualisations, design cards, a design sheet, and a structured workshop process to facilitate ideation. The fieldwork study (Chapter 4) explored how people interacted with CPGs in their everyday lives while preparing both familiar and unfamiliar meals, as well as providing insights about broad and specific features of CPG interactions. Our mixed-methods analysis revealed surface-level similarities between these two kinds of meal preparation such as the number of CPGs used per meal, along with differences surrounding more detailed aspects such as the higher frequency of gathering information from packaging in unfamiliar meals. In the previous Chapter 5, we made use of the insights gathered about CPG interactions in cooking to develop data visualisations as well as other design resources to facilitate the use of data to inform the design of enhanced CPGs.

The study in this chapter builds upon the understanding gathered about CPG interactions in cooking to explore how individuals with no previous experience in product development can make use of those insights to design enhanced CPGs. Inspired by a participatory approach, this study arose from an interest in including a more diverse group of people in creating designs from data, beyond those which the researchers of these studies could have devised. This in turn could help to expand on the ideas about the value and influence of data for design, as well as promote the creation of enhanced CPGs which meet people's actual needs and requirements.

6.1 INTRODUCTION

The design of enhanced CPGs may be even more challenging than for more conventional and durable goods (e.g., a watch Lyons, 2015) due to the CPG defining characteristics, including their disposability and frequent need to be re-purchased (Laan and Aurisicchio, 2017), as well as the fact that they are rarely used in isolation, but rather in conjunction with one another as complements (Berumen et al., 2019). Qualities such as these normally do not lend themselves to the equipment of modern digital technologies. Emboldened by the capabilities of IoT technologies, contemporary approaches to product development emphasise the value both of involving consumers through participatory design in the early stages (Bogers et al., 2018), and of utilising data about our practical interactions with everyday objects (Gorkovenko et al., 2020). Given that conceptualisation is the stage argued to have the greatest influence in determining the level of product innovation (Han et al., 2020), it is essential to capture the opinions of consumers as early as possible to create products which are most likely to properly cater to their needs. However, while it has been demonstrated that providing data about item usage during the design process represents a substantially powerful approach (Mortier et al., 2014), to our understanding this has not yet been applied in the creation of enhanced CPGs.

As one of the most prevalent everyday practices involving CPGs, our work draws upon data on the interactions consumers have with CPGs in cooking collected in our fieldwork study (Chapter 4). The study presented here seeks to explore how consumers make use of these specific data as a resource with which to design digitally enhanced CPGs. Inspired by previous frameworks which have placed data at the centre of the design process (Bogers et al., 2018; Gorkovenko et al., 2020; Kun, Mulder, and Kortuem, 2018b), we present a 'data-inspired ideation approach' as a tool for participants to explore data on how CPG are used in practice, and to inspire the creation of sketches. We devised a structured workshop to study how participants actually draw upon the data as well as how they reflect on the influence this approach had on their ideation process. To facilitate the participants' use of the data, we devised an array of design resources including *data visualisations*, as well as *design cards* and a *design sheet*. Our findings are thus informed by a thematic analysis concerning both the sketches and comments made during the creation and explanation of the participant's concepts.

The main contribution of this study is an exploration of how consumers make use of data as they formulate designs of enhanced CPGs. In this regard, we found that participants effectively drew on the data in three distinct ways: 1) to develop a varied and pragmatic understanding of CPGs, 2) to consider the experience of others by promoting inclusivity, and 3) to bring to light latent information not intrinsically associated with the data provided. We discuss how the concepts reflected common design topics, including digitisation of information and adaptation rather than innovation. This work demonstrates the merits of our approach, which can be adapted by researchers and designers who are interested in digitally enhancing CPGs.

6.2 STUDY DESIGN

Informed by design research through practice for its commitment to learning from the lived experience (Koskinen et al., 2011), we devised a data-inspired ideation approach which puts data visualisations at the centre of the process. Within the context of this study, we use the word **'data'** to refer to our quantitative and qualitative findings on the use of CPGs in cooking collected from fieldwork observations. To facilitate an understanding and use of the data, we then devised design resources based on our data, including data visualisations, design cards and a design sheet.

The following sections describe the field study from which we obtained the data, the design resources created on the basis of that data, the workshop structure, and study sessions.

6.2.1 *Data on CPG interactions*

In order to collect data about the interactions of CPGs in cooking, we conducted a fieldwork study, which we briefly describe below for completeness of this chapter and to provide context for the creation of the data visualisations (the study is described in full in Chapter 4). Our goal in this work is not to give a comprehensive account of how CPGs are interacted with in cooking, but to present some of these data as resources to explore the ways in which consumers can draw inspiration to ideate digitally enhanced CPGs.

We visited twenty households in the greater Nottingham area to observe people as they cooked a meal of their choice and which they knew how to prepare by heart. We recorded the sessions on video and collected field notes focusing on the interactions with CPGs. The participants had a mean age of 35 years (*SD* = 12), and most of them mentioned that they cooked regularly, described their skills as average, and expressed that they generally enjoyed the activity. The dishes chosen were all relatively common within the United Kingdom, with some even being cooked in multiple sessions by multiple participants, such as: *oven-roasted chicken*, *scrambled eggs*, *shepherd's pie*, *and spaghetti bolognese*.

The basis of the analysis consisted of capturing every interaction for each item used during the sessions, including CPGs and utensils. An 'interaction' was considered any instance in which a participant had contact with an item. Each item interaction was given a unique identification tag which included its start and end times. We employed a mixed-methods approach (Creswell and Clark, 2017) to analyse and give a meaningful interpretation to this vast quantity of data, blending summaries from statistical methods with contextual knowledge from observations made in the field and during revisions of the video recordings.

We focused on different features of the interactions including their frequencies, durations, and the point in the session at which they occurred, among others. Gradually informed by the understanding gathered from exploratory statistical analysis and a contextual understanding of the interactions, we focused our analysis on six different features of item usage which we deemed to have the greatest potential for design: 1) *activities*, which tasks were accomplished; 2) *combinations*, groups of items commonly used together; 3) *consumption*, the fraction of an item consumed; 4) *interactions*, the number of times people interacted with items; 5) *situations*, problems or remarkable instances of use; and 6) *varieties*, a description of the items' classifications and uses.

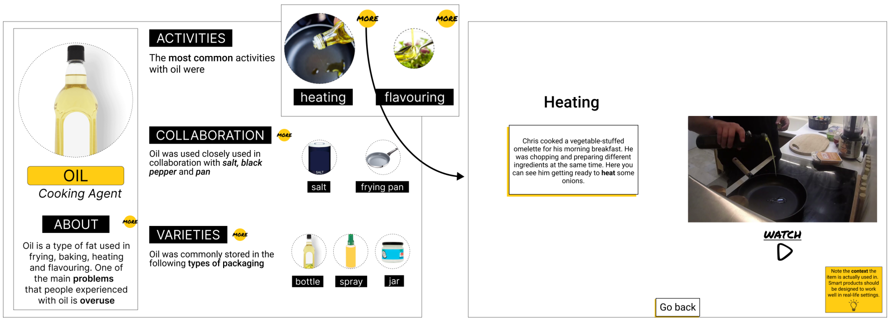


Figure 27: An example of data visualisation for the item *oil*. The left-side board contains all the data for the item *oil*. The right-side board shows the visualisation for the data on *activities*.

6.2.2 *Design resources*

The design resources were devised to help lay people without expertise in product development create sketches of digitally enhanced CPGs.

6.2.2.1 *Data visualisations*

To present our data in an accessible and understandable manner, we made use of different representations informed by narrative visualisations (Segel and Heer, 2010) and visualisation representations (Carpendale, 2008).

The data on the eight most frequently used CPGs, as found in the fieldwork, was presented in a *persona* style board. The board contained four sections: *about*, *activities*, *combination*, and *varieties*; each of which contained information derived from our findings concerning the six features of item usage mentioned above. Each section contained a button that displayed more information and a visualisation about the topic featured on the label when clicked. Four visualisations were selected, including annotated graphs, network visualisations, thumbnails, and videos; each accompanied by a brief description for context.

For example, as shown in Figure 27 for the CPG *oil* and data *activities*, a short video of a person adding oil to a hot pan was shown, illustrating one of the most common activities it was involved in, along with giving contextual information about the person cooking and the meal being prepared (see Appendix E for a complete example of visualisations for a CPG).

6.2.2.2 *Design cards*

The design cards were informed by similar cards used in other ideation studies (Mora, Gianni, and Divitini, 2017; Wetzel, Rodden, and Benford, 2017), and by a previous series of participatory workshops conducted by the first author of this study in collaboration with a large CPG company. In these workshops, participants expressed satisfaction and felt at ease using the design cards to ideate product enhancements.

The design cards were composed of ten *features* cards, ten *technologies* cards, and eight *items* cards. Each card was rectangular and colour-coded, and had been printed with an image and title; *features* and *technologies* cards bore a description as well. Each *features* card represents a beneficial functionality or attribute which participants might want to incorporate (Figure 28). Examples included *amusement, cooking skills,* and *efficiency*. The *technologies* cards had a device, software system, or some other technology participants could choose from in order to incorporate the selected features. Examples of these technologies included *3D printing, augmented reality,* and *motion sense*. The *items* cards contained CPGs which participants could choose to make designs for. Examples included *oil, salt,* and *spaghetti*.

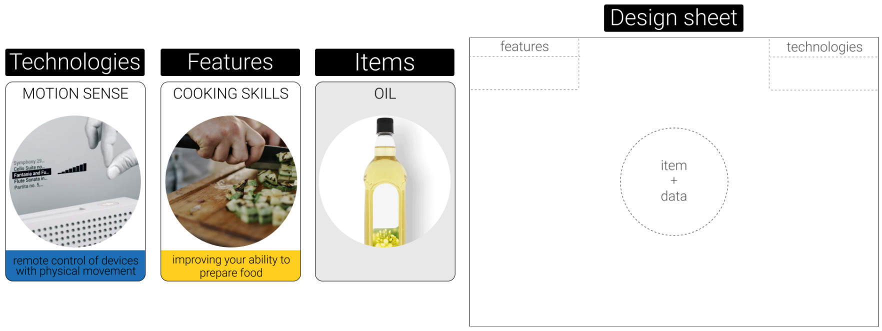


Figure 28: Examples of the design cards: *features*, *technologies*, and *items* cards, as well as the *design sheet*.

6.2.2.3 *Design sheet*

This was a horizontally-oriented sheet with a sketching area and four blank sections: one space was reserved for *data*, and the others for the *features*, *technologies*, and *items* cards (Figure 28). Each section had to be filled with at least one piece of data or design card, but participants were free to choose more if they so desired. The design sheet served as a template, facilitating the collection and organisation of elements necessary to create a sketch.

6.2.3 *Workshop structure*

A functional prototype of an interactive website was created in the vector graphics editor Figma to guide participants throughout the workshop (see Appendix E for a full sequence of the frames shown to a participant during the workshop). To ensure adequate progress, one researcher took on the role of facilitator in all sessions, guiding participants and making sure everything was clear. The workshop consisted of eight sequential steps as described below.

1. *Relevant themes:* Participants were briefly introduced to, then encouraged to discuss, each of the topics of CPGs,

cooking, and smart products.

2. *Sketching introduction:* An explanation of sketching was given, along with some techniques for making their own. Some examples of sketches from outside the workshop were also examined. Participants were advised not to be constrained by any perceived technological limitations.

3. *Design cards and sheet:* The design cards and design sheet were presented to participants, after which they were allotted time to explore them. They were then asked to make a hand-drawn copy of the design sheet.

4. *Design process:* The steps for creating a sketch were provided to participants both verbally and in writing. The steps included how to use the data as a resource for inspiration, employ design cards as components for the creation of enhanced CPGs, and integrate these resources within the design sheet to create their sketches.

5. *Data exploration:* Participants selected a CPG and explored its data visualisations. They were encouraged to take note of anything they deemed potentially useful for later use in their designs.

6. *Sketching:* Participants created their sketches at their own pace. They were encouraged to draw upon everything they had learned about their chosen CPG.

7. *Presentation:* Participants gave a presentation on their designs and responded to any questions posed by the

facilitator.

8. *Reflection:* Participants reflected critically on, then discussed, the influence of the data on their designs, as well as the value of the workshop process and design cards.

We acknowledge that our design approach influenced the way in which participants framed their design process. Inasmuch as *any* approach, even one without apparent structure and guidance, results in participants forming a frame of view by virtue of their habitual methods of problem-solving (Paton and Dorst, 2011). Given the inevitability of influencing the way in which participants approach a design task, we decided to aim at facilitating the use of the data while keeping distractions posed by other aspects of the sketching task as minimal as possible.

6.2.4 *Workshop study*

In preparation for the workshop, participants were asked to have sheets of paper ready, along with pens, markers, or any other materials suitable for making sketches. The study was conducted online due to health and safety measures in response to the COVID-19 pandemic. Participants joined the online sessions by video conference at a time prearranged at their convenience. Sessions were individual; most having only one participant, but occasionally having two. Prior to sketching, they received a document containing the design resources for the selected CPGs, which they explored at their own pace. They were asked to sketch two designs, though sketching a single design was acceptable when there was a time constraint. The sessions had an average duration of about 1 hour and 30 minutes. The study was approved by the University's Ethics Committee, and informed consent was obtained from all participants. At the end of the session, participants provided feedback for improving the workshop, and they received a £15 gift card as compensation.

6.2.5 *Data sample*

Thirty participants took part in our study, sixteen of whom self-identified as female, thirteen as male, and one as non-binary. The participants had ages ranging from 18 to 55 years old, with the majority of the participants in their 20s. They were employed in a wide variety of occupations including lecturer, factory worker, engineer, dentist, IT professional, and student (Table 9). Most participants were British, although the sample also included individuals from countries in Europe and North America. Recruitment was conducted through an advertisement which was shared on mailing lists and social media, as well as through personal referrals. We sought out participants who were consistent users of CPGs, cooked regularly, had experience with smart products, and had not been involved in CPG development. We aimed to get a sample which at least partially represented general consumers with no prior experience in product development. We then determined the number of participants using an assessment of data saturation (Hagaman and Wutich, 2016). After this, we checked whether new ideas had arisen after each participant, and recruitment was stopped when that was no longer the case. We also noted that our relatively small data did not prevent the generalisation of major discoveries, as has been previously been argued (Twidale, Randall, and Bentley, 1994; Nilsson et al., 2019).

6.2.6 *Data collection and analysis methods*

In every session, we collected field notes, made audio and video recordings, and took photographs of the sketches and other materials produced by participants. The audio recordings of each session were transcribed anonymously and in full. We took an exploratory approach to effectively gauge the value of our data visualisations for sketching enhanced CPGs. This relied on the first-hand nature of the way in which the effects of the data were directly communicated to researchers as found in similar studies (Gorkovenko et al., 2020; Kun, Mulder, and Kortuem, 2018a). Thematic analysis was performed on the transcriptions (Braun and Clarke, 2006), while polytextual analysis was applied to the sketches (Gleesson, 2012). The findings are thus composed of an interweaving of thematic elements obtained from both methods. The transcriptions and sketches were initially encoded independently by the author of this thesis, and a segment of selected codes was later chosen in collaboration with other researchers to identify any inconsistencies. The codes were then further examined to identify the main themes. The analysis focused on identifying emergent themes, which we then gradually refined through an iterative process.

6.3 FINDINGS

We give an overview of the most prevalent commonalities in a number of the characteristics exhibited by the design concepts, and we reflect on the underlying use of both the design cards and workshop structure. This serves as a basis for the following section, in which we unpack participants' comments and the content of their designs to analyse the influence of the data.

Table 9: Sample of consumers in design workshop.

P	Gender	Occupation	Age
01	F	Marketing communicator	18-25
02	F	Lecturer	36-45
03	M	Architect	26-35
04	F	Homemaker	26-35
05	F	Data analyst	26-35
06	M	Marketing manager	26-35
07	F	Legal assistant	18-25
08	M	Mechanical engineer	26-35
09	F	Impact officer	46-55
10	NB	Graduate student	26-35
11	M	Bartender	26-35
12	M	Graduate student	26-35
13	F	Psychologist	36-45
14	M	Environmental engineer	26-35
15	F	Food scientist	26-35
16	M	Industrial engineer	26-35
17	M	Consultant	26-35
18	M	Security analyst	46-55
19	F	Clinical researcher	26-35
20	F	Graduate student	26-35
21	F	Administrative assistant	26-35
22	M	Graduate student	26-35
23	M	Social researcher	26-35
24	F	Project manager	36-45
25	F	Lecturer	26-35
26	F	Graduate student	26-35
27	M	Musician	18-25
28	F	Waitress	18-25
29	M	Software developer	36-45
30	F	Factory worker	18-25

Notes: Participant; F = Female; M = Male; NB = Non binary

6.3.1 *The creation of design concepts*

The sketches amounted to a total of 58 designs, each representing a different concept. The most common CPGs that participants chose to sketch for were *oil* (14), *spaghetti* (10), and *minced meat* (9). The designs employed a mean of 2 pieces of *data*, 2.6 *features* cards, and 2.2 *technologies* cards. The most commonly-used pieces of *data* were those on *activities* (37), *specific situations* (24), and *combinations* (17). The most commonly-incorporated *features* cards were *cooking skills* (21), *healthy eating* (18), and *sustainability*; and for *technologies*, they were *sensors* (44), *apps* (24), and *smart assistants* (20).

It was quite apparent that the resources did indeed prove helpful, and the vast majority of participants expressed satisfaction with the design cards and sheet as well as with the workshop structure in general. Many compensated for their lack of design experience with their ability to use the cards and design sheet, often suggesting their 'outsider' perspective acted as an advantage. As expressed by P06, *"they helped me frame my idea, and I am not very good at imagining things"*. The cards were sufficiently versatile to include every idea participants suggested, and therefore did not measurably limit their creativity. As noted by P12, *"the cards are broad enough so different things can be included"*.

The workshop process led to the creation of unique designs with no two being the same. Even when participants imagined similar structures, they almost always envisioned different functionalities and/or benefits. For example, of the 14 design concepts for *oil*, 4 of them featured a smart dispenser for more efficient portions, yet they still serve different purposes. The design by P26, for example, integrated the features *cooking skills* and *efficiency*, along with the technologies *smart assistant* and *motion sense*, to improve one's techniques in their use of oil.

By contrast, the design by P23 integrated the features *cooking skills* and *healthy eating*, along with the technologies *apps* and *sensors*, to focus on an an enhancement which was solely aimed at accurately dispensing the desired amount efficiently.

Despite the uniqueness of each concept, we identified three of the most common benefits which participants intended their enhanced CPGs to deliver:

Transmission of knowledge. These designs for CPGs aimed to provide a practical understanding and, subsequently, direct and pragmatic assistance during meal preparation. The facts and guidance which these interactive products seek to deliver are traditionally acquired through direct experience, learning from others, or formal education. Participants expressed that gaining such information would likely improve their skills and be a complement to more conventional ways of learning. Examples of these functionalities include explanations of how to properly use a product, suggestions on how to improve the flavour of a dish, and tips for avoiding common mistakes.

Digitisation of existing functions. These designs often included digitised versions of functions already provided by conventional packaging. Digital components were integrated into the packaging through sensors that connected CPGs to nearby smart devices. These functionalities aimed to solve commonly experienced problems or to improve the successful properties of conventional CPGs. Enhancing CPGs was seen in these cases as a way to improve the products without necessarily making radical changes. Examples of such digitised functionalities included automated portion dispensation, accessing product information through augmented reality, and the determination of a product's freshness.

Incorporation of values. These designs attempted to incorporate technologies which promote desirable intrinsic values such as sustainability, ethical sourcing, and healthy eating. Participants looked for ways to transform CPGs into more socially-responsible products. They often stated that technology could help consumers to promote business practices which they support, and furthermore could help CPGs overcome some of the most common challenges they face. Strides to promote these values were made by, for example, creating zero-waste refillable subscription services, promoting consumption from local producers, and tracing supply chain networks to ascertain the origins of a product.

6.3.2 *Data visualisations in the ideation process*

We found that participants imagined a specific situation of CPG usage which then served as the basis for their sketches. We describe three main themes regarding how data visualisations were drawn upon in the ideation process.

1. *Variety of interpretations:* A data visualisation was interpreted in multiple ways and ascribed various meanings based on perspectives, and such differences influenced the distinct designs of the concepts.
2. *Considering the practices of others:* Reflections of insights from practices which participants deemed as different to their own were employed to create more inclusive functionalities.
3. *Influence of latent information:* Strongly-implied ideas, although not actually present within the data visualisation, influence the design process as a consequence of participants' personal experiences.

6.3.2.1 *Variety of interpretations*

Participants frequently took on multiple, unrelated, independent perspectives on the basis of the same data visualisation. These angles of interpretation often had distinctive consequences for design. While generally perceived as opening venues for considering different dimensions of CPGs usage, the resources were also interpreted by some as imposing constraints and leading to designing for certain kinds of situations over others. An example of the latter sentiment was expressed by P13, whose perception was that a piece of data (i.e. about the packaging of oil influencing the way it is handled) could delimit which aspects taken into account and, consequently, reduce the number of innovations which might be conceived.

P13. *"It's almost like you, when you're showing that video, it's almost like a leading question. And you're saying to people almost subconsciously, 'there is a problem here we're going to solve'."*

An opposing opinion was found to be expressed by P16, who stated that this same piece of data expanded their considerations and made them more well-informed.

P16. *"Yeah, it will help with that, making the design better at getting different perspectives of looking at the food, maybe from the quality side, from the cost—really the economic side [...] the environment side."*

Contrasting interpretations of data visualisations led to rich designs reflecting the individuality of the perspectives contributed by each participant. The information about salt being the most commonly-utilised ingredient was interpreted by P03 as illustrating the need to provide ways to ease the purchase of common ingredients. This is in stark contrast to P22, who saw this as representing a missed opportunity to

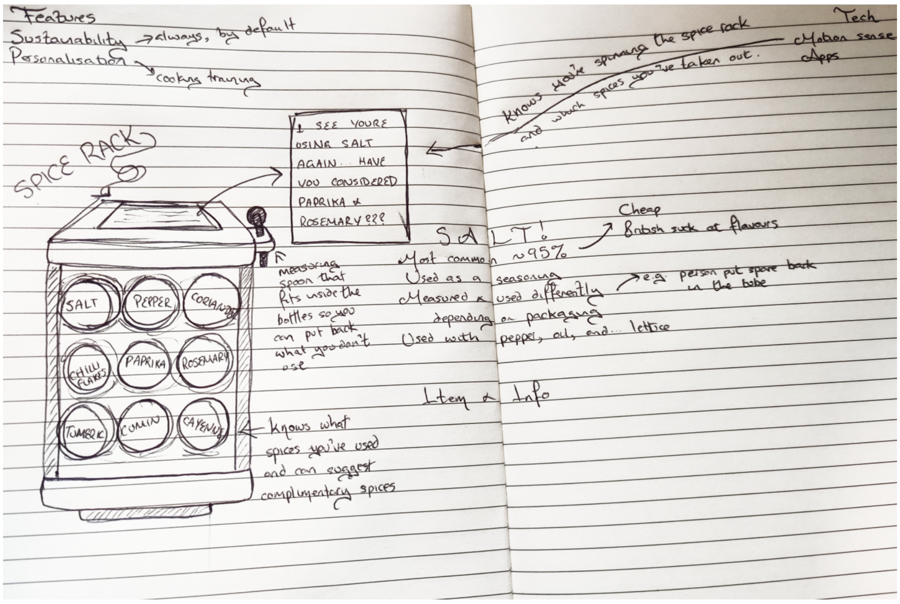


Figure 29: Design by P22 of a "smart spice rack".

use alternative seasonings. The 'ease-of-purchase' interpretation led to designing containers which would be part of a subscription-based service for buying bulk salt, milk, eggs, and other frequently-consumed ingredients, while the 'missed opportunity' interpretation inspired the design of a smart spice rack which would recommend a blend of spices depending on the food being prepared, as shown in Figure 29.

P22. *"I'm just thinking you could do more. Yeah, I mean I know that there were like hundreds of products that were used and salt is the default, which is why it kind of made sense for it to be the gateway drug for the other spices."*

In essence, people created unique and subjective interpretations which were influenced by their own experiences, knowledge, and backgrounds. The interpretations which participants ascribed to the data were highly-dependent on the lens through which they chose to view that data, as well as the elements on which they decide to focus their attention.

6.3.2.2 *Considering the practices of others*

People had a variety of reactions when learning about the cooking practices of others, particularly when those methods differed significantly from their own. Some accepted them as simply different, others questioned their own, and a handful even deemed these other practices as inefficient. Nonetheless, participants were still willing to draw inspiration from practices they disagreed with for their designs. P23 objected to the action of returning the remaining half of a minced meat package to the fridge and, as a result, designed a tag for the detection and prevention of product expiration (see Figure 30).

P23. *"Yeah, so the people's behaviour of only using half a pack. I thought if they struggle with waste [...] and not knowing after you've used it, 'cause, like, another reason that I wouldn't only use half a pack is because I wouldn't know how long really it would last for."*

Participants realised the limitations of their personal knowledge and recognized that, when attempting to derive inspiration from the data, they could not avoid basing it primarily on their own experiences. The data ignited their curiosity for thinking about the experiences of others, and they expressed having taken into account those from drastically different cultures and/or backgrounds. The sources detailing others' practices may have helped participants make their sketches inclusive by considering multiple perspectives as to why something might be valuable. They expressed that otherwise their innovations might have been aimed at only one person: namely, themselves.

P14 provided an analogy to illustrate how they interpreted the data, as well as how people process disinformation in general.

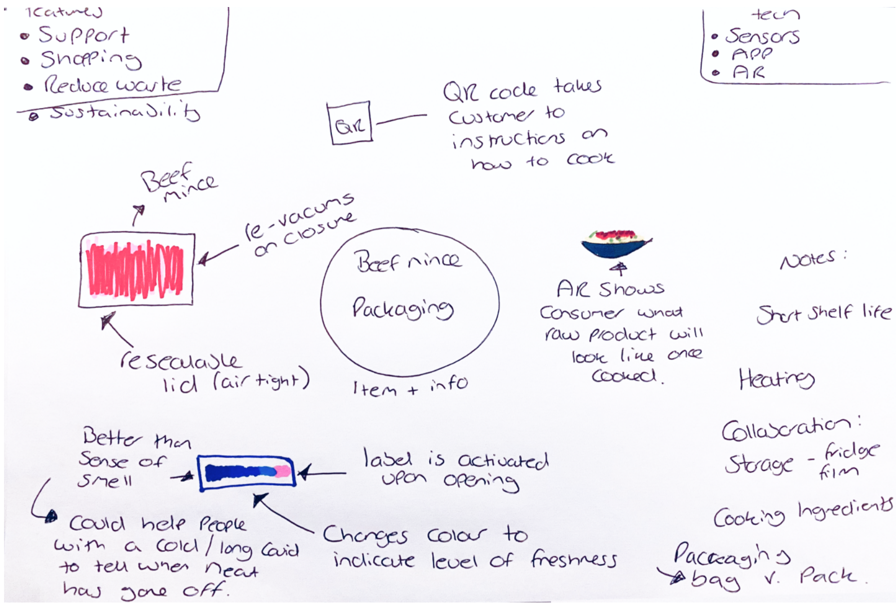


Figure 30: Design by P23 of a "resealable minced beef pack".

P14. *"[...] without data, it's very easy to fall into your own... t-to be stuck in your own perceptions of the world, right? [...] you extrapolate this to like the way the news works. If you only read The Sun newspaper, you only ever think that immigrants are the big problem of the world, right? But if you read many different newspapers, maybe you get—have an informed decision."*

In summary, when reasoning about the data, people were forced to consider the circumstances of others and, in doing so, they acquired resources which may have been what led them to create design concepts with a more inclusive range of applications than would have been the case if they had only considered their own experiences. Expanding the set of intended users for a design may have allowed participants to reevaluate their own biases and take a more conscientious approach.

6.3.2.3 *Influence of latent information*

In forming their interpretations, participants related the data to a wide range of ideas which, although perhaps being rather strongly implied, were not actually present within the data visualisations. Participants drew on their own personal knowledge and interests, as well as introduced assumptions which led them to contest, critique, and challenge the provided data. Some participants found the data that was absent to be more telling than that which was actually shown:

P09. *"It woke up my interest to know more about history... It would have been interesting, a little bit more history detail. That's why I didn't learn anything. But you know, I think maybe it came from China, didn't it? Or originally? Or things like that? [...] Maybe it would be nice to know..."*

In this instance for P09, despite a sentiment that the information given was already widely-known, it brought to their attention a number of related concepts in which they were interested. Consequently, their disappointment with the lack of information provided on the package about the history of spaghetti motivated them to create a package equipped with a sensor which would activate an app providing information about the origins of pasta.

Other participants seemed to have made assumptions about the assumed demographics from which the information came and hypothesised on the future adoption of their designs. For example, data about spaghetti bolognese being one of the most-consumed dishes in the United Kingdom was cited by P15 to justify their position that some British citizens would experience problems with the dish because they have poor cooking skills. In spite of any potential enhancements, the participant believed it unlikely that people would be

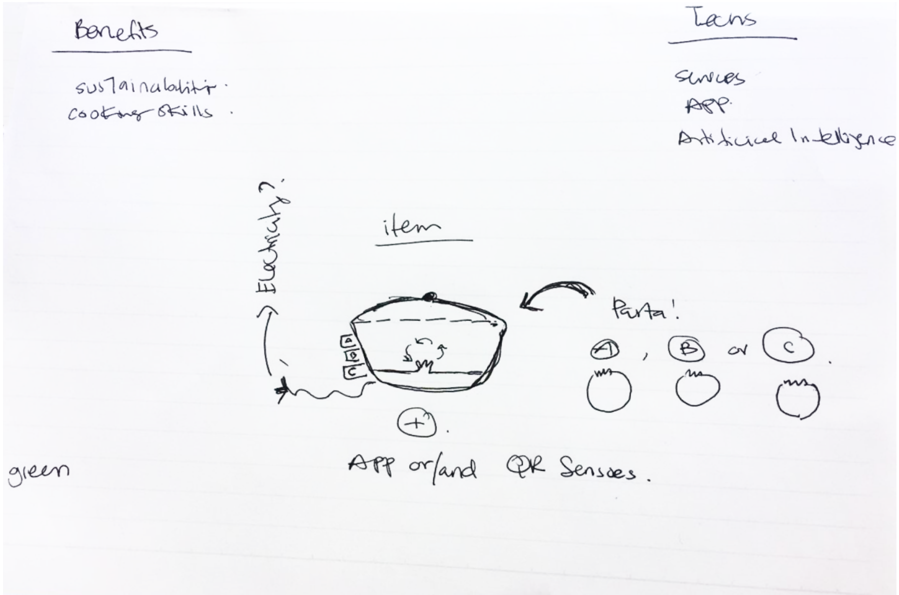


Figure 31: Design by P15 of a “smart pasta pot cooker”.

able to improve their cooking skills in general. Nevertheless, P15 designed enhancements aimed at helping in this area, proposing a connected pot which stored and dispensed oil, salt, and black pepper to help cook spaghetti as shown in Figure 31.

P15. *“At some point, it says that it is the most common dish prepared in the UK. So it’s something that a lot of people might experience problems with, yeah? [...] But, how do you make it accessible and easy?”*

Overall, participants did not limit their ideation to being influenced exclusively by the information presented or the direct logical implications thereof. They voiced assumptions, invented different contexts, and envisioned some possible ramifications of adopting such technology. Participants’ reflections were not solely about what was explicitly provided, but rather everything which they could associate with the data.

6.4 CHAPTER SUMMARY

This study provides an understanding of how consumers made use of data about CPG interactions to ideate digitally enhanced versions of CPGs, as well as how custom-made data visualisations, design tools, and a structured workshop facilitate the design process for people without design experience.

The findings clearly suggest that data about the practical uses of CPGs can be successfully utilised by members of the general public to create a wide variety of designs. Generally, participants appreciated the design resources and considered them to be helpful. Many participants compensated for their lack of design experience with the use of the design tools, which served as a scaffolding for creating their innovations. The design process resulted in the creation of unique designs, which exhibited common themes relating to the topics of information in design, value-sensitive design, and adaptation rather than innovation.

Regarding the use of data for inspiration, they were incorporated into design concepts in markedly distinct ways. While similarities among the design concepts appeared, they still displayed different functionalities and purposes. The use of data was clearly evident in the resulting designs in three ways. First, there was variety in participants' interpretations of the data which seemingly stemmed from their own personal experiences, knowledge, and backgrounds, resulting in great diversity among the innovations proposed. Second, there was a stronger focus on the experiences of others, which led to the creation of more inclusive designs. Third, there was often an association of indirectly-related concepts with the information actually provided, resulting in designs based on ideas which were only associated with the data tangentially.

6.4.1 *Accomplishments*

This chapter has explored how consumers made use of data about CPG interactions to ideate digital enhancements. In order to conduct this study, a data-inspired ideation approach was devised around the use of data visualisations, design tools, and a structured workshop process. Participants generally expressed satisfaction with workshop and design tools, thus demonstrating the value of the data-inspired approach and its potential for use in other studies with similar aims. Moreover, in terms of design concepts, the study has allowed us to gather a wide diversity of design concepts which could later be used for the development of enhanced CPGs. This work has given an exploratory but powerful glimpse into how the general public actually make use of data, thereby revealing characteristics of their thought processes relating to design.

6.4.2 *Outlook*

This study expands on the implications for design which can be devised from our findings on practical CPG interactions during cooking by engaging consumers in the design process. They were able to create unique designs and interpretations of data which expanded the considerations made by the researchers. This work clearly illustrates the value of data for design. However, it leaves unanswered questions related to more nuanced and detailed concepts about the wider implications of such uses of data. This study shows the need to further explore our data alongside people with experience in product development in order to harness their expertise and explore not only how data can be used for ideation, but also the advantages and disadvantages of using data from the perspective of designers. Consequently, the study in the next Chapter 7 aims to once again explore the value of data for design, but this time with the input of professional designers. Additionally, it explores topics such as privacy in data collection, as well as ethical considerations about how such data is used.

7

DESIGNING ENHANCED CPGS. AN EXPLORATION WITH DESIGNERS

This final empirical study discussed in this thesis presents a design workshop involving professional designers with experience in product development. It seeks to explore the wider implications of the use of data in design, and represents a continuation of the previous study (Chapter 6), which explored the extent to which consumers could make use of data in order to design enhanced CPGs. The results of the previous design workshop demonstrate that data is a valuable resource for generating innovation from consumers.

Inspired by participatory design, we believe that, as consumers are to be the main users of enhanced CPGs, professional designers would likely use data in developing novel versions of CPGs, and thus their inclusion in this thesis was necessary. In this chapter, we turn our attention towards exploring the data alongside those most likely affected by incorporating such information into design practices; namely, people with professional experience in product design. This study seeks to further investigate the use of data for designing enhanced CPG while consulting with designers to think critically on the advantages and disadvantages of such an approach.

This study employed a modified version of the workshop structure, data-visualisations, and design tools used in the previous Chapter 6. These modifications included the presentation of data from both fieldwork studies instead of only that from our research concerning familiar meals, and the incorporation of questions which address the potential value of data beyond its capacity for inspiring design. Given this study's many similarities with that of the previous Chapter 6, as both used a similar version of the data-inspired ideation approach, we have chosen to refer to the previous chapter and highlight the main differences in instances where the potential for confusion arises. Finally, this study concludes our exploration into the value of data for design and the ideation of enhanced CPGs.

7.1 INTRODUCTION

As previously mentioned, given that conceptualisation is the stage argued to have the greatest influence in determining innovation (Han et al., 2020), it is essential to capture the opinions of professionals regarding—those who will be affected by the inclusion of data in the design processes—to gather their opinions and use those insights to accommodate data into their approach. Despite the increasing use of data to support innovation, many questions remain as to how designers might integrate data into their practices (Fei et al., 2018). The interpretation and responsible use of data is rife with intricacies which designers must directly confront. Exploring the unintended implications of gathering data in design becomes a necessity (Dalton, Taylor, and Thatcher, 2016). In this regard, participatory design becomes a useful tool, as it allows for the exploration of technologies which do not yet exist (Mattelmäki and Visser, 2011), it is the case for data about CPG interactions and enhanced CPGs.

This work draws upon the data-inspired ideation approach developed in the previous workshop study (Chapter 6) to explore how professionals with experience in product development make use of data on CPGs interactions to enhanced CPGs and how they reflect on the implications of the data in their design practices. Inspired by previous frameworks which have placed data at the centre of the process (Bogers et al., 2018; Gorkovenko et al., 2020; Kun, Mulder, and Kortuem, 2018b), we present a modified version of the 'data-inspired ideation approach' as a tool for designers to explore the ramifications of employing data for inspiring their sketches of enhanced CPGs, and to promote their considerations of the data. In this workshop we made use of data visualisations, the design sheet, and the structured workshop process to facilitate designers in making their own interpretations of the data with as little outside influence as possible. The findings of this study were revealed, as in the previous study, through thematic analysis concerning the sketches and comments made during the creation and explanation of the designers' concepts.

The contribution of this study is in progressing the discussion regarding the implications of data for design from the perspective of professional designers. In this regard, we found that data helped designers to highlight aspects of the cooking practice, consider issues associated with the incorporation of data in design, and ponder the challenge of incorporating technologies into CPGs. The study also further proved the validity of the data-inspired ideation approach as a valuable resource to inspire design, not only for consumers but also for professional designers. This work also examines the design concepts inspired by data which designers stated, including suggestions on making recipes easier to follow, digitising information provided on packaging, and the creation of entertaining augmented experiences. This work demonstrates the value of our approach to not only serve as a source for the creation of design concepts but also to help critically reflect on the implications of data-informed approaches for design.

7.2 STUDY DESIGN

As in the previous design workshop (Chapter 6), informed by design research through practice (Koskinen et al., 2011), we devised a data-inspired ideation approach which set data visualisations at the centre of the ideation and reflection process. In this study, we define **data** as 'quantitative and qualitative findings about the use of CPGs collected from fieldwork in the practice of cooking'. To facilitate an understanding and use of the data, we employed data visualisations as well as a design sheet. Specifically, we made adaptations to our previous participatory design workshop seeking to increase focus on participants[1] reflections about the value of data.

The following sections describe the field study from which we obtained the data, the design resources created based on that data, the workshop structure, and the study sessions. The study was conducted online due to health and safety measures during the COVID-19 pandemic.

7.2.1 *Data on CPG interactions*

The dataset used in this study was collected in the fieldwork studies previously described in Chapter 4. The data sample included visits to twenty households in the greater Nottingham area, each on two separate occasions, to observe people cooking a familiar and unfamiliar meal of their choice. The main difference with the data presented in the previous workshop is that this present study includes additional data about unfamiliar meal preparations.

1 To avoid any confusion, all participants in this study were designers, and the word 'participant' implies 'designer' in this chapter.

As in the previous design workshop, the basis of the analysis consisted of capturing people's interactions with any item used during the cooking sessions, including CPGs and utensils. In this study, we present data from three different features of CPG interactions as described below.

1. *Aggregates:* findings about the general use of CPGs across all the sessions. The insights included discoveries about the most frequently used CPGs, and the phase of use of CPGs in the cooking session.

2. *Items usage:* features of CPGs usage particularly characteristics of packaging, as well as how people accomplish specific activities with CPGs such as measuring out portions.

3. *Specific situations:* characteristics of the preparation of unfamiliar meals, including switching tasks and gathering information from CPG packaging.

7.2.2 *Design resources*

In this design workshop the design resources included only data visualisations and a design sheet. The decision to not utilise the design cards in this study stemmed from two reasons: One is our belief that designers might not need as much support as consumers due to their experience, and the other is our position that the use of fewer design tools would allow for greater opportunity and time to discuss in further detail the value of data.

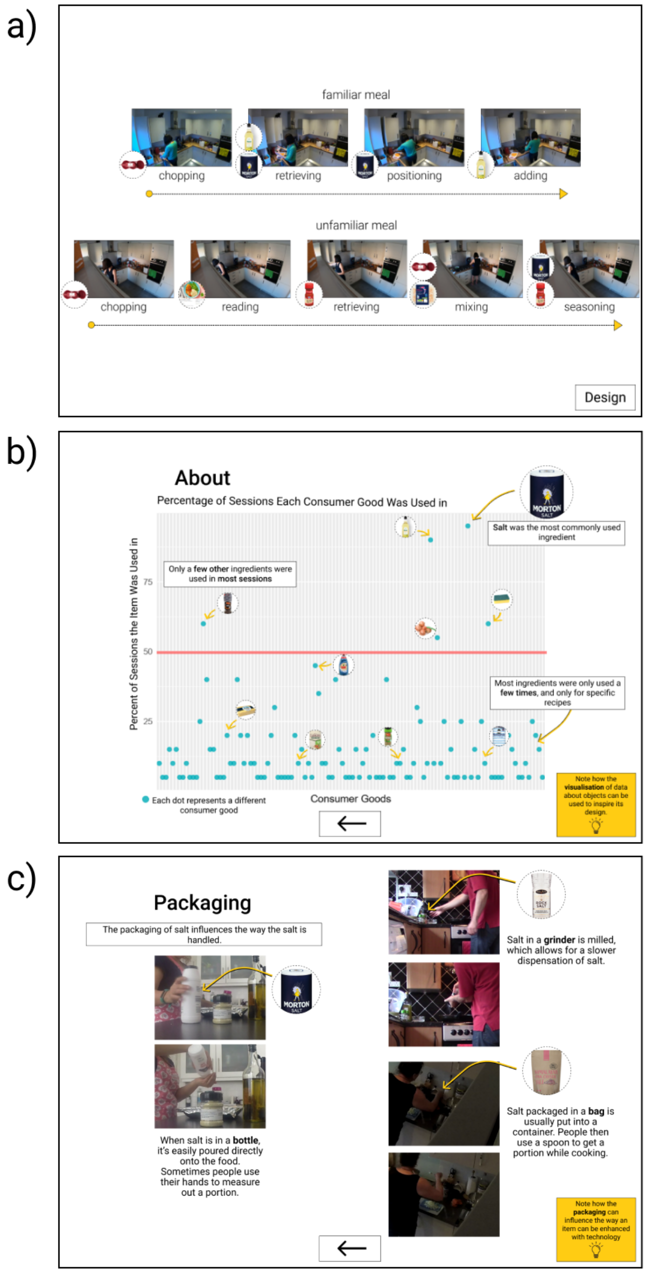


Figure 32: Three types of data based visualisation in this workshop: a) specific situations, b) aggregates, and c) items usage.

7.2.2.1 *Data visualisations*

To present our data in an accessible and understandable manner, we once again as in the previous workshop (Chapter 6) made use of different representations informed by narrative visualisations (Segel and Heer, 2010) and visualisation representations (Carpendale, 2008). The three types of data on CPGs found in the fieldwork were presented in a board (see Figure 32). For example, the data aggregates were shown on a bar graph representing the most common CPGs. In addition, the facilitator of the workshop provided an explanation of the data and answered any questions from the designers. In these visualisations, we strive for simplicity and decided to forego a higher level of detail in order to allow designers to make their own, unadulterated interpretations of the findings.

7.2.2.2 *Design sheet*

The design sheet used was also a modified version of that employed in the previous study. The modification included the removal of both sections for the design cards. Thus, the version employed for this study was a horizontally-oriented sheet with a sketching area and two blank sections: one reserved for *data* cards, and the other for *items* cards, respectively. Each section had to be filled with at least one piece of data or item, but participants were free to choose more if they so desired. The design sheet served as a template, facilitating the collection and organisation of elements necessary to create enhanced CPGs.

7.2.3 *Workshop structure*

We utilised the functional prototype of the interactive website again using the vector graphics editor Figma as in the previous study. We modified the prototype to cater to the characteristics of this study, including a greater space for questions and conversation. To ensure adequate progress, one researcher took on the role of facilitator in all sessions, guiding participants and ensuring that the instructions and process were clear. The workshop consisted of eight sequential stages as described below.

1. *Conversation:* A conversation about the designers' experience in their profession, product development and use of data for design. The conversation helped researchers to understand and learn about the background of the designers.

2. *Relevant themes:* A brief introduction to and a conversation for each of the following themes: CPGs, cooking, and smart products.

3. *Sketching introduction:* An explanation of sketching and how to produce sketches was given. Participants were advised not to let themselves be constrained by any perceived technological limitations or by a sense of a need to justify the utility of their ideas.

4. *Data exploration:* Participants were introduced to the data visualisations for each of the three data types: aggregates, item usage, and specific situations. The researcher provided an explanation, and participants were encouraged to ask questions and take notes of anything they found useful.

5. *Data considerations:* For each data type, participants were asked about the perceived value and potential issues

inherent in using data for design.

6. *Sketching:* Participants selected one of the three data types to use as a resource for design and created their sketches at their own pace. They were encouraged to draw upon everything they had learned about CPGs both through their personal experiences and the data provided in the workshop.

7. *Presentation:* Participants shared a photo of their design concept with the facilitator and gave a presentation on their designs. They focused on explaining each of their components and responded to any questions posed by the facilitator.

8. *Reflection:* Participants reflected on the influence (or lack thereof) of the data in their designs, as well as on the value of the design resources and workshop structure. At the end of the session, they provided feedback for improving data representation and the workshop.

7.2.4 *Workshop study*

Recruitment was conducted through mailing lists, social media, and referral, as well through the use of a recruitment agency. The study was approved by the University's Ethics Committee, and informed consent was obtained from all parties involved. Participants were asked to prepare paper, along with pens, markers, or any other materials for creating their sketches. They joined the online sessions by video conference using Microsoft Teams at a time prearranged at their convenience. Sessions were individual, having only one participant in each. The participants were asked to sketch only one design of an enhanced CPGs and express any ideas they might have had about the data visualisations presented to them. The sessions had an average duration of about 1 hour and 30 minutes. After the session, participants received a £50 gift card as compensation.

7.2.5 *Data sample*

Twenty participants took part in our study, half of whom self-identified as female, and half as male. The participants had a mean of 5.8 years (SD = 4.5) years of experience in product development, ranging from 1 year to 20. They had a wide range of occupations including UX researcher, product development manager, graphic designer, data scientist, and marketing manager (See Table 10 for a complete list of participants). The participants also worked in a variety of sectors, including product design, computer, hospitality, and manufacturing. They had been actively involved as designers in the development of CPGs for at least one year, and had experience using data as part of their design process. Most participants were based in the United Kingdom, although the sample included individuals from countries in Asia, Europe and North America. The criteria for participation included being currently employed by a company in the industry and having at least one year of experience in any stage of the product development process in any stage from idea generation to introduction of product in the market. We aimed to use a sample which was at least partially representative of the diverse backgrounds and specialties of professionals who are involved in the process of product development. We determined the number of participants in this study using an assessment of data saturation; that is, we completed our data sample when we determined that no new information was being obtained from the introduction of additional participants

(Hagaman and Wutich, 2016).

Table 10: Sample of designers in design workshop.

P	G	Position	Industry	Ed	YE
01	M	Operations engineer	Packaging manufacturing	BSc	7
02	F	Clinical researcher	Pharmaceutical	MSc	1
03	F	UX researcher	Computer software	MSc	8
04	F	Design engineer	Biomedical	MSc	4
05	F	Data scientist	Financial services	MSc	5
06	M	Product marketing	Computer software	MSc	6
07	F	UX researcher	Computer software	MSc	3
08	M	Graphic designer	Product development	MSc	20
09	F	UX researcher	Computer software	MSc	16
10	M	UX designer	Retail Sales & Marketing	BSc	5
11	M	Creative director	Branding & Design	MSc	5
12	M	Technical manager	Cosmetics Manufacturing	MSc	5
13	F	Business coordinator	Design	BSc	5
14	F	UX writer	Telecom services	BSc	2
15	M	Graphic designer	Design	BSc	5
16	F	Product developer	Kitchen manufacturing	BSc	5
17	M	Managing director	Computer software	BSc	2
18	M	Engagement manager	Computer software	BSc	5
19	F	Brand marketing	Hospitality	BSc	2
20	M	Behavioural researcher	Consultancy (Digital)	MSc	5

Notes: P = Participant; G = Gender; Ed = Education; YE = Years of Experience; UX = User Experience; M = Male; F = Female; BSc = Bachelor of Science; MSc = Master of Science

7.2.6 *Data collection and analysis methods*

In every session, we collected data through field notes, audio and video recordings, and photographs of the sketches along with any other materials produced by the participants. The audio recordings of each session were transcribed anonymously and in full. The analysis methods were exactly the same as the methods employed in the previous study (Chapter 6), the methodological approach of which is described in Chapter 3. Thematic analysis was performed on the transcriptions (Braun and Clarke, 2006), while polytextual analysis was applied to the sketches (Gleesson, 2012). The findings are thus composed of an interweaving of thematic elements obtained from both methods. The data was initially encoded independently by one of the authors, and a segment of selected codes was later chosen in collaboration with other researchers to identify any inconsistencies. The codes were then further examined to identify the main themes. The analysis focused on identifying emerging themes, which we then gradually refined through an iterative process. The analysis was centred on finding an answer for each of our two research questions—one to understand how data visualisation about CPGs interactions were utilised by designers in creating digital enhancements, and the other on the hopes and reservations designers have concerning the proposal of using data for design.

7.3 findings

7.3.1 *The creation of design concepts*

The large majority of the participants expressed satisfaction with the data visualisation as well as with the workshop structure in general, usually by stating their utility in helping them draft their ideas. By and large, participants had little difficulty making use of the data to inspire their designs and enjoyed the process.

The sketches amounted to a total of 20 designs, each representing a different concept. The most common CPGs which designers chose to sketch enhanced versions of were *salt* (7),

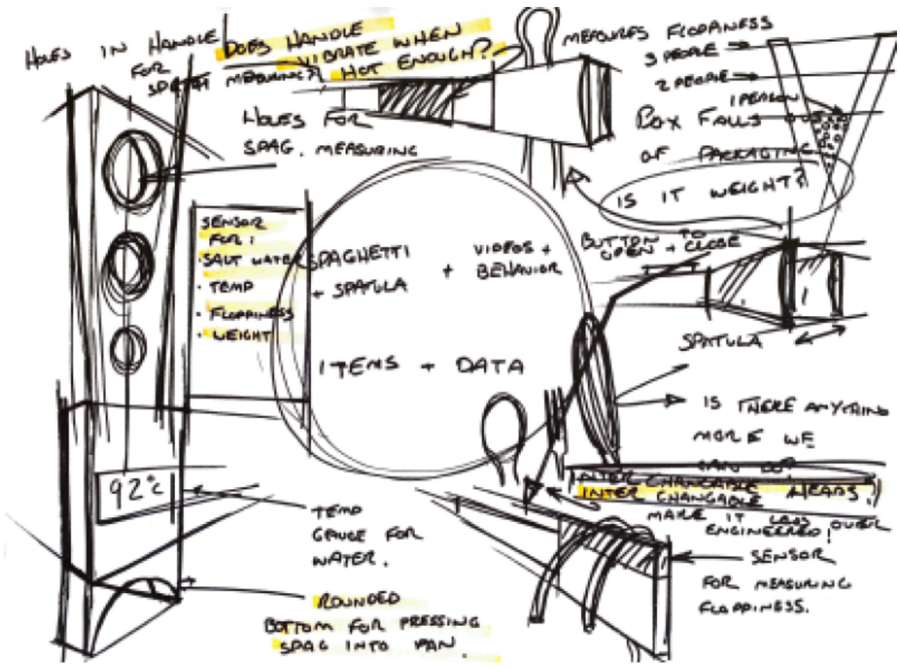


Figure 33: Design by D11 of a system of 'connected packaging'.

oil (3), and *spaghetti* (3). Additionally, some designers also devised innovations not for CPGs individually, but rather for groups (4). The data most often selected was that on situations (10), followed by that on items (6) and aggregates (4). Similar to the previous study, the workshop process resulted in the creation of completely unique designs from each participant. Even when participants devised similar enhancements, they envisioned them as having different functionalities and/or benefits. The design concepts were assembled into three distinct groupings according to their most common functionalities:

Support with unfamiliar CPGs. These designs focused on assisting consumers in the preparation of unfamiliar meals from individual tasks to providing tips about the entire cooking process. One example was a system of 'connected packaging' by D11 (see Figure 33), which linked CPG wrappers and containers with smart devices to provide personally-tailored instructions for the product's use. The designers also took notice of any possible indication that consumers were having

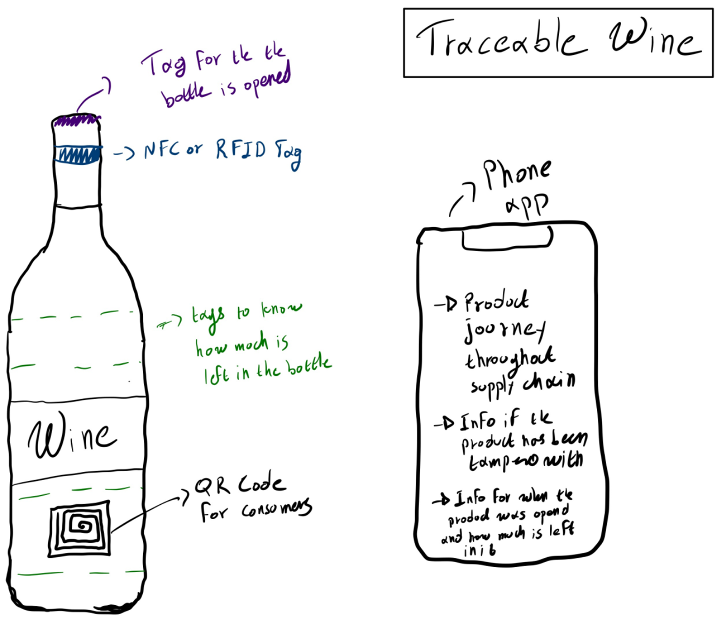


Figure 34: Design by D20 of a 'smart bottle of wine'.

difficulty with a particular situation. One trend which attracted attention was the fact that consumers switched tasks more often when preparing unfamiliar meals, which was taken by many to be an indication that those participants were having difficulties. They stated that such task switching needed to be reduced in order to prepare unfamiliar meals more efficiently and that, in effect, enhanced products could encourage one to increase their culinary repertoire.

Information about products. This group of designs was focused on aspects such as tracking product consumption, managing purchases, and measuring out portions. Designs entailed providing facts from other sources to elaborate on the information on the packaging. One such design was a 'connected bottle of wine' by D20. The bottle was equipped with sensors to allow for tracking across each stage of the supply chain. This would allow for a 'journey of the product' to be made available to consumers, as well as work towards preventing counterfeiting. Designers took inspiration from

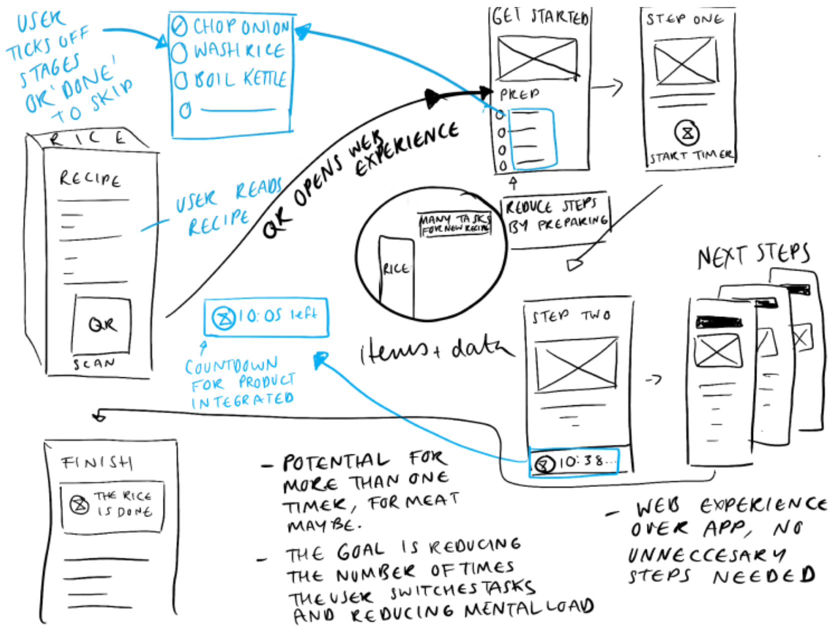


Figure 35: Design by D03 of 'interactive labels'.

observations they made about the often-overlooked characteristics of CPGs. The designs made use of general knowledge about the life-cycle of CPGs rather than just reflecting on how they are generally used.

Augmented experiences. These interventions borrowed from successful features already present in many package designs as a resource to create an experience for the consumer. One example is the concept of 'interactive labels' by D03 (see Figure 35), which provides accessible, memorable, and fun facts about CPGs. The designers drew from other popular features of packaging, like the inclusion of recipes on cereal boxes which can easily be torn off and referenced well beyond the lifespan of the original product. Recipes could be scanned and delivered through digital devices, and the content would be updated periodically. Designers were inspired by data, but all in all were more guided by sheer imagination than anything else.

Regarding on the reflections of designers on the value of data for design, we outline below the main themes regarding their consideration on data visualisations in the ideation process.

1. *Highlighting aspects of the cooking practice*: Data visualisations helped designers to focus on different aspects of cooking which they otherwise would have not considered. Designers reflected on hidden patterns and habits associated with the use of CPGs.
2. *Considering issues associated with the use of data*: Designers brought forward concerns about the ability of data to offer useful insights and to accurately reflect real cooking experiences in addition to raising questions about the responsible use of data.
3. *Pondering the challenges of innovation*: Designers gave consideration to issues associated with integrating technologies into CPGs without disrupting people's practices, as well as questioned the need to create enhanced versions of CPGs.

7.3.2 *Reflections about the implications of data in design*

7.3.2.1 *Highlighting aspects of the cooking practice*

Designers expressed that the insights which they had derived from the data helped them to better understand different aspects of cooking as a practice, including its practicalities and associated interactions involving CPGs.

Variety in practice and elucidating hidden patterns. Designers stated their convictions that this improved understanding could lead to improved product designs when put at the forefront of their conceptualisation process. They mentioned that data brought to light often-overlooked habits which could prove useful in providing feedback on consumers' habits. D14 echoed these sentiments, saying, *"People might not realise they're using too much salt, and then there is an angle there [...] You could integrate all sorts of food tracking apps to see how much salt you're using."*

It was expressed that the data led to the ability to take a greater variety of perspectives concerning the more procedural aspects of cooking. The data was gathered from a wide variety of participants, each with their own habits and practices. This diversity provided an opportunity to understand consumers whose procedures differ vastly from their own, allowing designers to keep the multitude of different approaches to cooking more in the forefront of their minds throughout the conceptualisation process.

D13. *"I think that data is quite valuable because it's something that you don't really think about, so anything that's done subconsciously...[sic] the data is more valuable because it breaks it down."*

Ways of interacting with CPGs. Designers reflected on CPG interactions, giving particular attention to the affordances of the products involved. They focused on the common uses of the products, along with how several of their physical properties influenced those uses. This helped them recognize the importance of identifying good design elements in already-existing products, then translating those elements into their new designs to keep those products familiar and useful. The value of preserving successful design elements is implicit in the comments made by D03 after reflecting on the design of Heinz ketchup bottles.

D03. *"One product that I really like is those ketchup bottles. I like the opening on the bottom so you don't have to turn it upside down again. [...] So, I think knowing how people interact with the objects* *can really help in design."*

Designers were also able to gain a clearer perspective on the use of these products in conjunction, such as their spatial and temporal relationships. These considerations contrasted with the approach more commonly taken by designers, many of whom expressed that they usually considered only the use of the product itself, and noted that enhanced products would need to be built in a manner which acknowledges the combinatorial nature of their existing analogues. This was expressed by D11, who said, *"I'd be looking at the behaviour between using those products. You know, how far away their spices are and what they're doing [...] I think that's potentially where I'd be if I was designing a product."*

Designers identified issues to be addressed—issues that were revealed by the data. Many expressed a strong need for interventions which improve health. As expressed by D03, *"From a health perspective, if you're trying to re-brand the company as a very health-conscious company, and, let's say, the goal might be reducing sodium intake [...] This packaging can get people to use less salt."* Moreover, designers expressed that much of the information helped them make predictions about future cooking issues.

D17. *"So I think those trends—the data trends—I think are the important ones, and the interactions between the data. I think predicting what a consumer is going to do next with their product is extremely valuable"*

7.3.3 *Considering issues associated with the use of data*

Designers also raised questions about the ability of data to provide insights for design, and the extent to which those insights accurately reflected real-world cooking experiences.

Reservations about findings. Designers cast doubts on the value of the findings. They expressed the difficulties in applying such insights in a way that would benefit a significant variety of people with a host of distinct cooking styles. In particular, concerns were expressed about the relatively small data sample, as well as the applicability of generalisations made from those insights. As expressed by D04, *"I would want to know how diverse the database was, as well how reflective it is of the wider population. I would expect that even in different parts of the UK, the kind of frequently-used CPGs might be a bit different."* They also questioned the extent to which the findings might be applicable to other cultures, highlighting habits and ingredients distinct from those found in the data.

D14. *"Some people may prepare different cuisines, and they may cook differently. For Asian cuisine, they tend to use all ingredients at the beginning."*

Designers also brought into question the factual nature and logical soundness of the findings. They hypothesised that an understanding of cooking (or any other aspect of people's lives) coming solely from data on item interactions would provide only a partial picture of reality, and that it is necessary to consult with consumers to interpret such data meaningfully and correctly. Some designers also pointed out that the level of detail in the data was insufficient, causing many of the insights drawn to be somewhat general and lacking in specificity.

D02. *"Again, I think it's too broad in the way that it could actually be used. I think probably that's a bit more dependent on what the person is actually cooking at that time, and so I don't know how reflective that'd be."*

Data protection and corporate responsibilities. Designers also expressed the importance of giving consideration to the kind and amount of data which would need to be collected. Questions were centred around which measures would be least likely to compromise privacy, and what would make enhanced versions of products valuable enough to properly offset the potential risks this collection of data would pose. As expressed by D08, *"I think it's the trade-off between privacy and convenience, where you trade for convenience against divulging private information."* In this regard, designers considered the potential risk of 'hacking', mentioning that incorporating technologies into CPGs could open the doors for criminals to gain access to private information. Thus, people's safety can be compromised by, for instance, mapping their routines and the times they are at home. As noted by D12 below:

D12. *"You have to make sure [the information] doesn't have location data, because if you have frequency and time of usage and location, it can actually put people in really unsafe situations; for example, if there's a data breach."*

Despite their differences, one conclusion that designers agreed on was that obtaining consent in a proper and well-informed manner would be essential before gathering such data. On top of that, companies must be careful not to violate any privacy laws. Designers stressed the necessity for clarity and transparency concerning the nature of the data collected, and that the collection process must be communicated in a comprehensible manner such that people can also make informed decisions and have the opportunity to opt out if they so desire. This sentiment was echoed by D20, saying, *"As long as you have consent from participants and you're not violating any privacy rules, it should be allowed."*

Designers also recognized the conflicts between company and consumer interests, as they are oftentimes in conflict with one another. For example, consumers frequently want to reduce consumption, whereas companies almost always try to increase sales. Designers attempted to find a compromise between what benefits companies and what benefits consumers. They also considered the possible unintended ramifications of data collection. D09 exemplified this sentiment when pointing out that, if people were going through difficult personal situations and companies were able to capture data reflecting that, those companies would then arguably have additional responsibilities towards their customers.

D09. *"What do you do if you start seeing somebody eat twenty ice cream pints in two weeks? Like maybe they're going through some shit. Do you do anything with that?"*

7.3.4 *Pondering the challenges of innovation*

Designers reflected on issues surrounding the incorporation of technologies into CPGs, and the way in which those technologies are adopted.

Fitting technologies into practice. Designers expressed that technologies should be able to fit comfortably into common practises, and consumers should have the opportunity to personalise any additional functionalities. As noted by D09, *"[Technologies] should not be a burden or be annoying [...] People would just say 'screw this, I'm turning it off'."* Many designers also felt that, despite being essential for cooking, CPGs are generally mundane and inexpensive products which rarely hold such an important place in our lives that they warrant any concerted attempt at improvement.

Considerations were also made about the adoption of technologies. Designers thought about the extent to which the enhanced CPGs could be effectively and conveniently used by the general public, as newer innovations often take time and effort to be assimilated. They stated that, given modern technological sophistication, the use of such CPGs would pose additional learning requirements for people who are less comfortable with smart devices. It could be, for instance, that sophisticated and specialised CPGs would require extensive training.

This was pointed out by D04, stating, *"[people] might not use them, and they might have a bad view on those products in the longer term."*

Designers considered the issues of over-engineering elaborate technological innovations, noting cases in which the simpler available CPGs would be equally or even more efficient and effective. They expressed that, despite the difficulties associated with the use of CPGs identified through the data, such challenges usually do not represent a problem worthy of consideration. And even when they do, the potential solution was argued to be so technically sophisticated as to discourage its implementation. This sentiment was expressed by D12 when attempting to design packaging which would prolong freshness, saying, *"we are again over-engineering a solution for an issue that might not be there."*

Advantage of analogous experiences. Designers wondered whether such innovations might not even be beneficial for CPGs after accounting for the disruptions they might cause, unless they could provide sufficiently better functionality. They examined the possibility of there being no need for such technological interventions, stating that consumers were already very resourceful and capable of solving most problems they encountered. Designers also reflected on their cooking experiences, finding that part of what makes the practise enjoyable is the lack of modern technologies. For some, it was enjoyable because it gave them an excuse to disconnect from screens, which they felt served as a sort of meditation. They expressed an appreciation for the analogue characteristics of the cooking practice, and were wary of the complexities which the additional technologies would introduce. As stated below:

D08. *"You gotta be quite careful about how you embed technology into this environment, because one of the reasons that I enjoy cooking is probably for the same reason that I like playing my acoustic guitar; it is that it does not have anything to do with technology."*

Designers also considered that findings which were perceived as issues may in fact be problems people enjoy solving and hence potentially desirable features. They expressed that people might enjoy the serendipity of discovery through cooking rather than always being told what to do. Such challenges represent an opportunity to experiment with different possible solutions and become fully-immersed in the experience. Designers expressed that these cases could be an opportunity for unique experiences, such as changing recipes in ways they otherwise would not have thought of.

D17. *"They might want to just be experimental and have that autonomy and, you know, they might like reading the labels and might not want other people to interpret their way of cooking for them."*

Designers also meditated on the challenges of innovation from the perspective of manufacturing, pointing to the difficulties of making changes in a highly-orchestrated production line. They pondered the question of whether all of this was worth it, and mentioned that it would be a great challenge to adapt to new technologies, in part due to the dynamic nature of innovation, which stands in clear contrast to the more static nature of traditional supply chain and manufacturing processes. This was expressed by D03 when stating that, *"One decision based on current data affects a whole season's worth of products, but if suddenly there's a market trend, or like a need for a different material or different packaging style, it could affect their supply chain."*

7.4 CHAPTER SUMMARY

This chapter brings to an end Part II—the empirical work of this thesis. The two fieldwork studies on cooking as well as those based on the design workshop, in their attempt to provide an answer to the research questions, have resulted in a method for the analysis of practical CPG interactions within a real-world context, an understanding of the usage of CPGs in cooking, and insights about the value of data for design. The fieldwork study in Chapter 4 in familiar meals provided general, surface-level insights about the use of CPGs and relied largely on statistical findings. Additionally, it contributed to the development of the analysis methods employed throughout our work. The findings about how interactions are distributed across the cooking phases, for instance, suggest that different categories of CPGs are used at different times during the cooking session. Those findings motivated the fieldwork study in unfamiliar meals in Chapter 4, which was an attempt to understand both how meal familiarity affects the use of CPGs, as well as how to develop analysis methods which 'zoom in' on CPG interactions. This second study revealed the similarities and unique characteristics of the use of CPGs in the preparation of unfamiliar meals. The finding, for example, about the higher frequency of information-gathering in unfamiliar meals demonstrates the potential of our methods to elucidate such characteristics, which in turn can lead to implications for design. The findings of the fieldwork inspired the design workshops due to the need to explore the value of such insights from the perspective of a more diverse group. In Chapter 6 inspired by participatory design, we developed a data-inspired approach which put data at the centre of the process. Consumers were able to make effective use of the data and create designs which exhibited greater consideration for the experiences of others and respect for their interests. This study inspired the final empirical work covered within this Chapter 7, in which we sought to explore the broader implications of the use of data in design from the perspective of professional designers. The findings of this study highlight critical considerations about the use of data, such as protection of people's privacy and the responsibilities of corporations.

This chapter showed how to engage in a constructive dialogue about the advantages and disadvantages of the use of data, making use of the expertise of professional designers. To explore such dialogues, modifications were made to the design workshop employed with consumers (Chapter 6). These changes included more freedom for participants to make and interpret the data, as well as a greater emphasis on considering the implications of inspiring the conceptualisation of enhanced CPGs with data. The modifications to the workshop proved fruitful, as designers were able to make their interpretations of the data and also engage in substantial dialogue about the far-reaching implications of the use of data.

7.4.1 *Accomplishments*

The final empirical work within this thesis has tested a data-inspired approach, demonstrating its potential not only with consumers, but also with people who have significant experience in design. This serves as evidence for the validity of our design approach. This study also extends on the findings of the previous workshop (Chapter 6) in fostering a conversation aimed at critically reflecting on the consequences that the use of data can have in designing enhanced CPGs. In doing so, designers ponder the benefits of data as consumers did, but they also give consideration to the potential challenges of innovation. For example designers questioned the need to create CPGs incorporated with IoT technologies and praised the benefits of analogous experiences. Furthermore, they also expressed reservations about the data collection itself, particularly due to the challenges of complying with data protection regulations.

7.4.2 *Outlook*

This chapter presents the conclusion of the empirical work of this thesis. Together, the four studies within this thesis have provided a partial answer to the research questions posed. However, it is still necessary to critically reflect on the meaning of the findings beyond descriptive explanations. In Part III, the discussion (Chapter 8) provides a detailed description showing how the findings answer the research questions. We do also provide an interpretation of the findings in relation to the literature and give an account of their value beyond the scope of this thesis.

Part III

SYNOPSIS

8

DISCUSSION

The discussion summarises and presents the findings of the empirical studies of this thesis to evaluate how they were instrumental in answering our research questions (Chapter 1) in light of the wider literature in HCI. This was accomplished by providing: 1) an understanding of how CPGs are used in the practice of cooking, 2) the development of a mixed-methods approach for the analysis of practical CPG interactions, 3) an exploration of the value of data for design from the perspectives of both consumers and designers, and 4) an approach for the use of data in the design of enhanced CPGs. In doing so, the discussion addresses two shortcomings of the literature: one being the lack of studies investigating how CPGs are used by consumers in the household, and the other the lack of enhanced CPGs whose designs are based on empirical insights about CPG interactions. Through a detailed treatment of these topics, the discussion of the findings takes care to highlight both the accomplishments of the studies and their shortcomings, and will also allow us a glimpse into some of the avenues by which this work can be advanced and expanded upon in the future. In doing so, in this chapter will demonstrate a contribution to the following four areas:

1. *Understanding of CPG interactions*—the findings concerning the use of CPGs in familiar and unfamiliar meals, as well the findings' relationship to both the literature on cooking and that on CPGs.
2. *Analysis methods*—the mixed-methods techniques employed for our analysis of CPG interactions in practice

and their relevance in different situational contexts of cooking.

3. *Data-inspired design*—the use of data for the creation of enhanced CPGs from the perspective of consumers and designers.

4. *Tool development*—a structured workshop process and design tools, including data based-visualisations, design cards, and a design sheet for the exploration and incorporation of data into the design of enhanced CPGs.

Each of the contributions provide an answer to the research questions of this thesis:

RQ1 How do people interact with CPGs in the practice of cooking?

RQ2 How can we obtain an understanding of the practical interactions of CPGs?

RQ3 What design implications could be drawn from an understanding of their practical interactions?

RQ4 How can we develop a method which promotes the creation of enhanced CPGs inspired by data?

The fieldwork study on cooking (Chapter 4) helped to create an understanding of CPG interactions in practice and the methods required for attaining it. Chapter 5 presented the development of the data visualisation, design cards, and design sheet used in the design workshops. The design workshop studies (Chapters 6 & 7) provided an exploration of the value of data for design.

8.1 UNDERSTANDING OF CPG INTERACTIONS

To answer the first research question (RQ1), our research revealed that CPGs exhibit complex patterns of interactions influenced by their context of use, the nature of which is revealed only after rigorous observations in the field and a carefully-chosen approach for analysis. This observation and detailed analysis of CPG interactions revealed patterns of use, most of which seem to be somewhat intuitive despite having remained until now undocumented. In turn, we draw on the domestic computing literature in HCI to position the contributions of our approach and we also devise design strategies which illustrate the potential our findings have to create *implications for design*.

8.1.1 *Interpretation of empirical findings*

The Literature review in Chapter 2 presented fieldwork studies on cooking within the field of HCI, studies that have revealed some noteworthy aspects of the practice. Some of these aspects included the description of how people arranged themselves in different *F-formations* while cooking together (Paay, Kjeldskov, and Skov, 2015), the utilisation of connected utensils to estimate people's cooking competence (Wagner et al., 2011), and the construction of a grocery-tracking system, built upon an understanding of the social practice of grocery list construction, to help shopping for ingredients (Fuentes et al., 2019). These are just a few elements of the literature which serve to illustrate the complexity of cooking, but they also demonstrate the power of fieldwork to shed light on hidden aspects of the practice. While cooking is a common topic of study in HCI (Ng et al., 2015; Torkkeli, Mäkelä, and Niva, 2018; De Léon, 2003), none has taken the use of CPGs as its specific subject of interest, thus making insights about their use in cooking so far merely circumstantial. Our work contributes towards filling the gap in targeted studies on the individual interactions of CPGs in cooking.

Our fieldwork study on familiar meals (Chapter 4) focused on frequential, sequential, and correlational features of CPG interactions with an emphasis on quantitative summaries. In the second analysis of our fieldwork (Chapter 4), our focus was turned towards the context of unfamiliar meals while using the interactions in familiar meals as a point of comparison. The second study revealed the characteristics of gathering information from packaging labels, the order of switching activities which occurred between tasks, and patterns regarding the use of items in combination. The work in this thesis aims to fill a gap in our knowledge of CPG interactions in a way which has the potential to lead to innovations for design.

As stated by Taylor and Swan (2005), objects have subtle, complex patterns of interactions which only become known after careful observation in the field. In this work, we have revealed a number of such patterns as they pertain to CPG interactions. In the example of mail handling, the operations one performed were dependent on the mail and those handling it. One illustrative discovery is that the type of a CPG seemed to serve as a predictor of how its interactions were distributed over the temporal phases of the sessions (Chapter 4). While vegetables were used in the first phases, spices were used midway through, and cleaning products towards the end of a cooking session. For the combined class of CPGs and utensils, we found that there were more interactions per interval in unfamiliar meals than in familiar meals. This was reflected by the higher prevalence of task repetition as well as by more instances of task simultaneity showing that, despite their apparently ordinary characteristics, CPGs have complex patterns of interactions which need to be closely examined. In a future study, it may be helpful to restrict the focus to specific CPGs, for example by detailing the interaction of a CPG such as salt across its shelf life. It may well be, for instance, that identifying the average consumption of salt could inform the development of functionalities aimed at moderating its use.

The results of this study reflect those of Crabtree and Tolmie (2016), who also found that CPGs were among the items with the most interactions, numbering just short of those involving utensils. In their study, they found that the category of 'utensils and equipment' accounted for the highest number of interactions in a single day. This is similar to our 'utensils' category, which our study also showed to have the highest number of interactions. Our findings confirm that the use of CPGs is interwoven with the use of utensils and that people interact with items together to accomplish activities. Overall results echoed the ideas expressed by other researchers about the importance of taking into account CPGs and all the items associated with their use to understand their practical interactions and design for their innovations:

> Our study raises the issue of designing for domestic activities by designing methodical assemblages of things—multiple things, occupying multiple categories. This means that it is not sufficient to design for FMCGs, for example, but the other things that are methodically implicated in their use need to be taken into account as well, such as utensils and furniture. Designing for methodically produced assemblages of things is a key design challenge, shifting the focus from individual things, and novel assemblages of sensors, to embedding computation in a myriad of mundane things situated within the home.

—Crabtree and Tolmie (2016, p. 1747)

8.1.2 *Considerations about the findings*

Considerations should be given to the inter-contextual stability of our insights; that is, the extent to which these findings could be generalised for different contexts of cooking, to larger segments of the population, and to different cultures and cuisines (Ottenbacher and Harrington, 2009). Cooking is a widespread and diverse practice occurring daily in most households which, aside from the type of meal being prepared, is influenced by several other factors including culture, socioeconomic status, and seasonality (Wolfson and Bleich, 2015). Questions might arise about the size of our sample and, consequently, the veracity of our findings. Nonetheless, that does not imply that our sample is not representative, inasmuch as the sample size does not necessarily limit or prevent identification of the ways people accomplish their work (Twidale, Randall, and Bentley, 1994) given that the methods they employ are relatively ubiquitous (Garfinkel, Lynch, and Livingston, 1981). For instance, even when the spices might vary, their use to flavour food seems to be common across cultures. As such, our approach helped to reveal more general patterns of CPG interactions which are likely to be found across the diversity of cooking.

Evidently, despite our effort to document as much as possible about CPG interactions, we obviously could not cover every possible aspect of their use in cooking. For instance, we did not focus on the estimation of CPG lifespan, perceived problems from the participants' perspectives, or places in which the items were used. Although those interactions might be relevant, we did not have enough data to perform a proper analysis of them. In further studies, different cooking situations (e.g. 'cooking alone' vs 'cooking for someone else'), as well as additional aspects of CPG usage, should be addressed.

8.1.3 *Implications for design*

Of particular interest to this study is the use of ethnographic findings in the derivation of implications for design (Stolterman, 1992). As stated by Crabtree, Rouncefield, and Tolmie (2012, p. 195) "You might reflect upon the significance that ethnographic findings have for design to elaborate what is important about the work of a setting, particularly what aspects of it cannot be dispensed with and are critical to maintaining and factor into the design." Conventionally, ethnographic research provides ideas for thinking about social life, which can be translated into constraints and opportunities for design (Dourish, 2006). Once the fieldwork has been analysed, researchers have to process their findings and convey their insights to individuals involved in the design and development of technology. The challenge is to make those insights accessible and relevant for all parties involved and, rather than being dismissed with a 'so what?', to instead use them to provide explanatory accounts of social interactions and novel design recommendations (Plowman, Rogers, and Ramage, 1995). Such insights may come in the form of directions, suggestions, and implications, among others (Baskerville and Myers, 2015). Examples of how some of the findings of this study can be translated into implications for design are provided in the form of guidelines, ideas, and suggestions, as described below.

8.1.3.1 ***Conveying information provided on the packaging***

One implication of the discovery that information-gathering is a pervasive activity in cooking unfamiliar meals is that consumers would likely benefit from having more ways to access information. The *digitalisation* of the packaging is ideal, not only for providing information but also for designing functionalities which respond to the different purposes of reading labels. Current solutions aimed at digitising the content of conventional packaging are achieving this through the integration of sensors and visual markers, as well as by connecting with mobile devices and cloud services. The platform 'TagItSmart!' attempts to bring ubiquitous computing technologies to mass-market goods in order to deliver specific information to customers (Vehmas et al., 2018; Gligoric et al., 2019) as demonstrated in a recent implementation for identifying counterfeit wine bottles (Popović et al., 2021). Several properties of the packaging and its affordances could also be used to create interactive experiences (Lydekaityte and Tambo, 2020). An implementation that harnesses the ways in which packaging is handled to provide assistance with properly using its contents is 'Concerto Timer', by Häagen-Dazs. This augmented reality app displays a violinist above the ice cream container once it is opened and plays music for the time recommended to let the ice cream soften (Kuriakose, 2013).

Incorporating knowledge about the purpose behind information-gathering—whether to measure a portion size, verify product information, check cooking instructions, or simply satisfy curiosity—makes it easier to design appropriate interventions. The known stages in cooking, for instance, could be used to predict which kind of information people would be most likely to look for at a given moment (Torkkeli, Mäkelä, and Niva, 2018). We believe that a smart assistant which guides people through a recipe (Nouri et al., 2020) could share the information on the current step in the recipe to other devices in the kitchen in order to prioritise the most useful content when skimming the packages. For instance, when reading a label before measuring out an ingredient, the serving size could be highlighted. Consumers should also have agency in how they would like the content to be provided, how interactive they would like those applications to be, and in which contexts they would want those functionalities to be active. As Vildjiounaite et al. (2011) found, the level of support people desire varies depending on the type of meal. People may want to employ these functionalities only for CPGs they rarely use, while for familiar meals they might not be so welcome to such distractions from the cooking process.

8.1.3.2 *Properly supporting cooking at moments of high activity*

We suggest that the cooking support provided by enhanced CPGs should reflect the flow of interactions and the goals people are seeking to accomplish (Shneiderman, 2009). In light of the increased frequency of intervals of high activity while preparing the unfamiliar meals and the associated sense of participants feeling overwhelmed, functionalities provided by CPGs could have a major impact in helping with task saturation. Providing support for challenging tasks has been at the core of many technologies developed for the smart kitchen, such as measuring out portions (Celik et al., 2018), keeping track of consumption (Amutha, Sethukkarasi, and Pitchiah, 2012), and reducing food waste (Rouillard, 2012). CPGs which are to be used in an unfamiliar recipe could remind people to retrieve them all at once before proceeding to the next step rather than separately and only when needed, and it could tell people when they can finally put an ingredient away thereby reducing clutter and making it easier to find what they need and to clean up afterwards. This might lead to a reduction in the time people spend searching for and managing ingredients, and thus in feelings of frustration.

Another design implication derived from our findings is that we might harness the patterns people display in their preparation of familiar meals to benefit the preparation of unfamiliar meals. When faced with multiple ways to accomplish the same task, technologically enhanced CPGs could recommend following similar sequences of actions as those to which the consumer is accustomed, allowing them to exploit the routinist nature of our everyday practices (Garfinkel, Lynch, and Livingston, 1981). The order of steps in a recipe could then be made flexible and arranged in such a way as to minimally deviate from one's regular habits. Someone accustomed to grinding their spices beforehand and using them to season the dish later could be instructed to follow this same procedure in a recipe which would, by default, instruct one to only introduce spices later. To provide this support, an initial identification of such patterns of activities would be essential, and previous studies have shown that such detection of individual habits and tendencies is technologically feasible (Nagarajan et al., 2020; Karungaru, 2019).

Creativity should inevitably remain an essential component in cooking and thus must not be restricted by technology. We believe that people may not want to obey the recipe to a tee, as we found that people usually deviate from the exact instructions by following the steps in a different order or by replacing ingredients. Furthermore, deviations from the recipe resulting in a serendipitous moment could bring about novel modifications to the recipe which better satisfy people's tastes (Spence et al., 2017). Someone retrieving ingredients, for instance, may find another seasoning which they suddenly decide would work well if incorporated. Additionally, the type of support one might want to receive is heavily dependent on the circumstances in which the meal is being prepared. As we found, one of the differences between the preparation of familiar and unfamiliar meals is that people seemed to be more efficient in the preparation of the former and followed a more optimised process (Chapter 4). Thus, on a busy day while preparing a familiar meal, one may want to make the process as streamlined as possible; however, during the weekends, while trying something new one may find the time and motivation to attempt a more complex dish (Wolfson and Bleich, 2015).

8.1.3.3 *Considering the combined use of items*

That the use of CPGs is intrinsically linked to that of other items could lead to an effort to design enhanced CPGs for collections rather than for isolated items, for instance by taking into account the sets of which a given CPG is a part and integrating these recurring sets into their designs. An enhanced packaging design to record the use of salt could benefit from carefully taking into consideration which items it most commonly pairs with. To illustrate, cupboards could sense when salt is retrieved and stored, and frying pans could sense when salt is added to food. Alternatively, people may be interested in avoiding items which frequently appear in sets in order to decrease their intake or explore alternative ingredients. People trying to decrease their consumption of salt may benefit from receiving a suggestion about using a wider variety of spices. For instance, individuals who usually season eggs with salt may receive suggestions about using black pepper and dried garlic instead.

Similarly to Crabtree and Tolmie (2016), we found that devices with computational power, such as mobile devices, are less strongly connected to CPGs and utensils required in the preparation of a meal could be an opportunity for design which may stem from better integrating these devices into the cooking process to take advantage of their capabilities. Mobile devices were used, for instance, to follow the steps of the recipe, but they did not seem to play any other role in cooking, and people stopped interacting with CPGs and other utensils while using these devices. Enhancements to CPGs could aim to connect them with mobile devices to harness the computational power that they offer. This could then allow smartphones to identify when a monotonous task is being performed, estimate its duration, and provide entertainment accordingly; if the next step in the recipe involves monotonously shredding cheese, and the individual cooking is known to like watching historical documentaries, a smart assistant might then suggest a list of short videos on history.

8.2 METHODS FOR UNDERSTANDING CPG INTERACTIONS

This section aims to provide an answer to our second research question (RQ2) by means of discussing the set of mixed methods for the analysis of interactions involving CPGs in the practice of cooking which this thesis provides. The empirical study was conducted through field observations and aimed to provide a detailed understanding of CPG interactions in two situational contexts of household cooking—namely, in the preparation of familiar and in that of unfamiliar meals. As mentioned in the Approach (Chapter 3), despite recent development in the field of quantitative ethnography, there is a lack of methods by which to investigate the characteristics of CPG usage. Consequently, we were in need of developing our own methods of analysis for this thesis.

The Literature review (Chapter 2) demonstrated there already exists a vast amount of work on the subject of cooking which has utilised a variety of methods such as surveys, cultural probes, and embodied methods of interaction. Among these methods, fieldwork was identified as being most suited to uncover *'the animal in the foliage'* (Garfinkel, Lynch, and Livingston, 1981); that is, the hidden complexities associated with the use of CPGs. We described the potential of video recordings for understanding interactions in everyday life and identifying situations around which to design digital interventions (Ng et al., 2015). As described in the Approach (Chapter 3), the relevance of ethnographic research to the goals of our research was evident and, as such, its methods proved ideal for revealing the techniques generally employed while cooking due to its basis in first-hand empirical accounts (Torkkeli, Mäkelä, and Niva, 2018). Ethnographic studies have illustrated the complexity involved in cooking due to the blend of fixed and flexible elements (De Léon, 2003), and have shown the value of studying opposing situations in meal preparation to obtain a better grasp on how CPGs and utensils are used in these processes (Hove et al., 2020).

Despite the vast literature on cooking, there is a lack of studies focused specifically on CPG interactions. In the Approach (Chapter 3), we reflected on the 'turn to practice' in HCI and how this approach allows researchers to first obtain a comprehensive understanding of the use of objects within an actual social setting, and second to think critically about the design of technologies. We saw ethnographic research as a method ideal for the study and collection of data on CPG interactions in practice. The development of our analysis methods was inspired by work on mixed-methods research (Creswell and Clark, 2017) and informed by quantitative ethnography (Shaffer, 2017a).

We believe that the applicability of our methods is not limited merely to the study of CPGs in the context of household cooking. Rather, they can be employed to evaluate a myriad of practices in various settings and contexts in which CPGs normally play a role, such as grooming, cleaning, and doing laundry. The strength of our approach stems from the combination of both quantitative and qualitative methods such that each informs the other. While our statistical analyses provided findings that only emerged from data aggregates such as frequencies, means, and group differences, our more conventional qualitative ethnographic methods provided detailed and contextual descriptions of the practice. In our fieldwork studies, quantitative methods provided a summary of findings, such as the frequency of CPG involvement and duration of activities as we identified, for instance, the set of the most commonly-used CPGs including salt, oil, and black pepper (Chapter 4). Qualitative methods, on the other hand, have focused on thick descriptions (Torkkeli, Mäkelä, and Niva, 2018) and insightful situations. For instance, qualitative methods allowed us to delve deeper and detail the instances of label reading and identify the different purposes for which people gather information from CPG packaging (Chapter 4). Incorporation of quantitative methods in ethnographic analysis provides a measure of the importance of findings, thereby helping to mitigate messiness in the data (Neyland, 2013).

Our approach provided descriptions and interpretations of CPG interactions as demonstrated in both the familiar and unfamiliar meals. To illustrate, in the familiar meals we described how different categories of items become involved at different phases in the cooking sessions, hence revealing characteristics of their use. For example, vegetables were used at the beginning of most of the sessions because they need to be prepared before integrating them into meals (Chapter 4). As ethnographic work usually focuses on thick descriptions (Torkkeli, Mäkelä, and Niva, 2018) and insightful situations (Paay, Kjeldskov, and Skov, 2015), it has not given detailed information about CPG interactions or those of any other items involved in cooking. Similarly, while quantitative methods provide insights about an entire dataset, they do not provide information about the practical context of use beyond the numerical data (Wagner et al., 2011; Wang and Worsley, 2014). The incorporation of quantitative methods into ethnography can help to reduce bias (Neyland, 2013) in ethnographic interpretations. Moreover, such incorporation can strengthen the relevance of findings by providing an 'evidence base' which is firmly rooted in empirical observation (Rousseau, 2006). Thus, our approach equips designers and researchers with a firm basis upon which they can construct novel design solutions (Gorkovenko et al., 2020).

Our analysis methods proved to be flexible enough to investigate cooking on a finer scale. In unfamiliar meals, the methods focused more on statistical analysis and generalisations, and the qualitative methods were integrated at a later stage to interpret the earlier quantitative findings. Using this approach, we found, for instance, the frequency of CPG involvement in meals. This suggests that variety is a key component of the role of CPGs in cooking, as only a small subset are shared across many sessions, whereas the majority of recipes are composed of a wider and more unique set of ingredients. In unfamiliar meals, however, the methods were focused on more specific aspects of interactions, the relevance of which was identified through the use of statistical techniques. However, in this case, the integration of quantitative with qualitative methods was accomplished in a more iterative process. Through quantitative analysis, we identified the increased frequency of reading labels in unfamiliar meals, and detailed observations revealed that the motivations for doing so included verifying product information, checking cooking instructions, measuring out portions, and satisfying curiosity (Chapter 4). Summarily, the careful application of our methods has shown their capacity to help us comprehend distinct aspects of CPG interactions in a number of different scenarios.

The methods of this study are very time-consuming and labour-intensive; the process of manually noting and cataloguing the interactions by meticulously observing the video recording took an entire week just for each session. This can be made more efficient once the methods are automated, which seems plausible in the near future given the large-scale introduction of RFID to CPG packaging (Economy Trade and Industry, 2017). Another way to improve our analysis methods would be to select a subset of the analysis methods and focus on making such analysis more efficient. For example, for functionalities which track CPG consumption, collecting data about the time at which a CPG had an interaction might not be necessary, thus recording only whether or not said CPG was used. Finally, data collected from CPG interaction should be given back to the consumers in an accessible manner so people could use those insights for their benefit, as for example people do with available connected devices such as fitness smartwatches. Such data should be provided in an easy and accessible manner and make use of effective visualisations so that people can make their own interpretations of data, bringing their own prior knowledge of their practices.

Although quantitative ethnography allowed us to obtain insights about numerous aspects of CPG interactions, it should be considered that other methods might also provide similar insights to those that we obtained. A researcher interested in investigating the use of CPG in practice might consider a multitude of methods. One example is the use of machine learning algorithms for computer vision. A very relevant such endeavour is EPIC Kitchens, which have made use of a large dataset of first-person video recordings of people cooking while verbally narrating their activities (Damen et al., 2022). The videos have been released, challenging experts in the field to develop algorithms that are able to identify the primary spatial zones of interaction and the activities accomplished in these areas (Nagarajan et al., 2020). Such an approach could be used to replace our current one of manually annotating activities. Another way that insights about the use of CPGs could have been obtained is through the use of language-based methods such as those mentioned in Chapter 2. Through interviews and surveys, it could be possible to obtain similar insights about the frequency of usage of CPGs and utensils. Through the data gathered by an online survey (Wang and Worsley, 2014), they were able to identify the frequencies of the most-used kitchen utensils. Similar surveys could have revealed the frequency of use of CPGs. In-depth, interviews could reveal insights into how people use CPGs and the difficulties they experience, as well as the things they enjoy about cooking (Wolfson and Bleich, 2015). Given that other methods could provide insights about the use of CPGs, one has to carefully consider which insights they are looking to obtain and subsequently select the most appropriate methods in terms of effort and results.

8.3 EXPLORING THE VALUE OF DATA FOR DESIGN

To provide an answer to our third research question (RQ3), the design workshop studies within this thesis (Chapters 6 & 7) sought to understand how data inspired the design of enhanced CPGs, and the influence of such data in participants' ideation processes. We aimed to have diversity among our participants[1] so that they might provide us with a variety of unique perspectives. Our study shows that the participants made effective use of the data visualisations to help sketch their enhanced versions. From the participants' statements and their design concepts, we found the data helped bring to mind many of the complexities associated with practical item use. Here, we discuss the design concepts and reasonings behind them in an attempt to elucidate in some detail the effect that the data had in the ideation process. Moreover, we explored some of the potential challenges of such an approach as well

1 Within this section, the term *participants* refers to both consumers and designers together unless specified otherwise.

as some potential solutions, and we also addressed various doubts about the value of devising technological enhancements for CPGs in general.

The Literature review (Chapter 2) established that data has long been traditionally used as part of the design process (King, Churchill, and Tan, 2017) and also documented the increasing use of data collected from connected devices as a resource in the early stages of innovation in both academic (Gorkovenko et al., 2020) and industrial settings (Ferguson et al., 1998). The incorporation of data in turn facilitates the inclusion of a greater variety of people interested in design, including consumers and professional designers, and highlights potential issues with using such data responsibly. We acknowledge that there are still no regulations or guidelines for the use of data in design, and that these issues still provoke debate in the field. Thus, the literature review firmly established the need for effective policies and safety measures surrounding the collection and use of data in design. To investigate the influence of data on the design of enhanced CPGs, we resorted to designing workshops inspired by participatory design, the merits of which we will discuss in the following section.

8.3.1 *Reflections on the value of data*

When reasoning about the value of data in ideation, we found that even a single data point usually had multiple meanings ascribed to it, each supporting different perspectives. The finding that salt was the most commonly-used ingredient was cited as inspiration for a design which facilitated its purchase (P03), as well as one which promoted the use of alternative spices (P22). We found that our participants, when forming insights for design, were more prone to giving markedly creative interpretations rather than incorporating only the facts presented. While it might be expected that people would articulate different perspectives and experiences, what is interesting is how this demonstrates another way in which data could spawn innovation. We feel that one clear reason for the highly subjective nature of the interpretations was the personal knowledge and biases brought by each individual—preconceptions which are crucial in determining how one ascribes meaning (Tolmie et al., 2016).

The interpretation of data also helped to magnify the consideration given to those with different backgrounds and cultures. Through data, participants seemed to envision different personas for whom they devised their innovations. While some imagined a hypothetical 'average' person, others drew from the characteristics of more diverse groups. This may promote designs which cater to individual interests. Such was the case for P23, who designed a resealable pack of minced meat which they thought could be useful for promoting environmentally-friendly alternatives. What we find to be beneficial from a design standpoint is the affordance of data to help participants see things from the perspectives of others. As noted by P14, without access to such a wealth of information, the participants' concepts might have been designed solely for themselves. Data can have the potential to broaden horizons and make us think more inclusively (Abascal and Nicolle, 2005). Such uses of data can lead to a multifaceted understanding and, consequently, expressing more empathy towards those whose conditions differ drastically from our own (Han et al., 2020).

Participants also challenged, complemented, or looked beyond the data to connect ideas which were, at most, only tangentially related. P15 proposed poor cooking skills to be the reason that spaghetti bolognese was prepared so frequently. In other instances, participants reacted to perceived gaps in the data by either ignoring the given information with their assumptions. There were a number of instances in which the data helped participants to conjure up old ideas which they had once considered but never found the chance to properly explore, such as when data about spaghetti served as an aide-mémoire for P09 and their interest in the spaghetti's history. On other occasions sometimes people just wanted a different story that the one can infer you mean their interpretation of the data—one that they may have felt more comfortable with. This especially happened when they disagreed with the data presented. Given the many ways in which people deviate from the data provided, design methods should harness the potential this presents by encouraging individuals to lean into their diversity of visions and ideas rather than stifle them (Stolterman, 1992).

Designers not only thought about the often *seen-but-unnoticed* aspects of CPG interactions (Garfinkel, 1964), but they also brought to the table different viewpoints about CPGs. Some interpretations were clearly associated with the data, such as the suggestion that the most commonly-used CPGs should be the CPGs that should be improved first due to their apparent importance, but there were others that bore little clear association at all, such as when that same data concerning the most frequently-used CPGs was taken as an symptom that people had too limited a repertoire of meals they were capable of preparing. These findings echoed the statement made by Meyer and Dykes (2018) that the interpretation of data is a constructive process in which people bring their own knowledge and experience, and is therefore a continuation of the data analysis. This attests to the diversity of designs which can be created given that, even when presented with the same piece of data, participants can interpret it in distinct ways and thus see it as inspiration for unique design implications.

Similar to data design cards and other design tools (Darzentas et al., 2021), data visualisations make designers aware of novel ideas, thereby helping people to look beyond the most immediate thoughts which come to mind and giving them the capacity to use their insights from data. Designers used the data to further investigate their pre-existing conceptions about the use of CPGs as we found the insights taken from the data were used to expand the set of aspects about CPGs and cooking which were factored into the design. Moreover, we demonstrated that data served to provoke questions which designers then attempted to answer using conclusions drawn from that very same data and their own personal knowledge, expanding upon the work on data-driven approaches for design (Gorkovenko et al., 2020). Overall, data had a transformative power regarding how participants conceptualised the design of enhanced CPGs as we found they considered interactions beyond the dyadic user-object level (Mumani and Stone, 2018) and took a more comprehensive perspective on practical CPG interactions.

8.3.2 *Implications for design*

In this section, we seek to summarise the results of our study for researchers and designers interested in facilitating data-inspired ideation.

8.3.2.1 ***Empowering consumers' innovations through data***

We found that participants readily drew upon the data visualisations and expressed satisfaction with their utility in helping to create their design concepts. As stated by P24, *"I was able to kind of use what I learned from the data to put them into the design itself"*. While we have an intuitive knowledge of how CPGs are used, we might not remember specific interactions with them due to their being commonly regarded as unimportant and a mere 'background feature' of our everyday lives (Oyarzún et al., 2017). Approaches to design which put data at the centre of the process have shown great potential (Bogers et al., 2016; Kollenburg et al., 2018; Gorkovenko et al., 2020; Kun, Mulder, and Kortuem, 2018a; Kun, Mulder, and Kortuem, 2018b) to create innovations grounded firmly in empirical insights. To our minds, the effects of including only general consumers in these data-driven approaches still remain woefully understudied. We contribute to these approaches by showing the value they can have for members of the general public, and demonstrate that consumers are highly capable of using such data for ideation when presented in an accessible manner.

8.3.2.2 *Harnessing data collected through the IoT*

The use of data in this study also represents a chance to harness the capacities of the IoT. CPGs are increasingly being incorporated with technologies which allow for the collection of information about their practical use (Vehmas et al., 2018). As we have already seen with other smart devices, there is great potential in digital information to make positive changes in our lives (Wang et al., 2015). Our insights also can help shape IoT technologies for CPGs. Showing the value of data for design can influence not only the creation of enhanced CPGs, but also the types of data which they might collect (Dalsgaard and Dindler, 2014). However, designers should be aware that data are not neutral, and that their selection and representation may cause consumers to gravitate towards unintentionally designing for a particular set of design characteristics (Meyer and Dykes, 2018). Although not a focus of this study, data in combination with design cards can also be used to spark conversations about issues of great concern including ethics, privacy, and security, which could further promote the development of more conscientious technologies (Urquhart and Craigon, 2021).

8.3.2.3 *Caveats concerning smart product design*

We are aware that not all innovations for CPGs have to be digital, and that the incorporation of IoT technologies can have negative effects (Farhan et al., 2018). To the first point, we acknowledge that each situation must be evaluated on a case-by-case basis, and that there are some instances in which the addition of any technology may not be desirable (Baumer and Silberman, 2011). We observed within the designs of participants that not all were heavily-reliant on technology. To the second issue, we would argue that most if not all of the possible problems which come with IoT technologies can equally find their solution within those same technologies. For instance, while some IoT technologies are difficult to re-utilise and recycle, enhanced CPGs could lead to functionalities which promote sustainability, such as preventing product waste in the household environment as well as in supply chains (Farhan et al., 2018). Moreover, enhanced CPGs would likely promote the use of more durable containers which lend themselves to increased reusability. On the whole, we believe that our findings still clearly indicate the importance of exploring how data can empower consumers in their efforts to shape product design. We recognized that in the field of CPGs, the interests of industry and consumers often diverge (Laran, 2016). As per what we feel to be in the best interests of our research goals, we have made the conscious decision here to effectively shelve industry interests in favour of respecting those of the consumer where the two may be in conflict.

8.3.3 *Challenges of using data in design*

Designers questioned the validity of the data to accurately represent reality on two different grounds. One consideration was expressed through doubts about whether or not data might only provide a partial and incomplete understanding of reality because of their inability to capture the environmental and social contexts behind the practices (Gabriel et al., 2016). There was a call for the inclusion of more contextual qualitative data in addition to the quantitative data. Such integration of data is an approach which is gaining popularity in industry and academic settings (Tao et al., 2018). Another consideration was regarding the relatively small sample size given the pervasive presence of cooking in almost every household. It has been pointed out that in data-inspired design, more data is not always better, and that what truly counts is a detailed understanding (Boyd and Crawford, 2012) in addition to a systematic approach to their collection and analysis (Kranzberg et al., 1985). The objectives of using the data must be clear in order for efficient planning and the proper allocation of resources.

We created a venue for discourse about the far-reaching consequences of data's use in design, and focused on analysing the potential ramifications beyond just those of the immediate technological developments. Consideration was also given to issues associated with the protection of privacy and the responsibilities of companies. Designers expressed their reservations about the collection of these kinds of data and grounded their arguments in the prominent scandals which many tech companies have faced concerning data management. Designers expressed that just because data are accessible does not make their use ethical, ideas that has been expressed by Richterich (2012, p. 9) "While certain data may be technically accessible, it remains questionable if and how researchers can ensure, for instance, that individuals privacy is not violated..." Issues were also raised about the protection of confidentiality, including those related to privacy as well as regulations for the collection of data from connected devices (Parliament-EU, 2009). Such considerations are even more important when we recognise that data collected on cooking could provide insights into other practices to which cooking is related. It has been shown that practices are interconnected and can be seen as networks, meaning that information about one practice can lead to insights about others (Lawo et al., 2020). Subsequently, collecting data on cooking allows for gaining insights into other practices as well, and thus measures to collect data *responsibly* must also be put in place to prevent any unethical use (Berry, 2011a).

The goal is to improve the cooking experience; not to develop technologies. This echoes back to views that call for a critical assessment of the design of any technology and question whether the development of such technology is appropriate (Baumer and Silberman, 2011). From a practice perspective, designers considered how technologies would fit into cooking and not just the development of digital artifacts (Kuutti and Bannon, 2014). References were made to calm computing (Weiser, 1994) as the designs aimed to fit technologies into peoples' habits so as to keep them unintrusive, only to be activated when they are needed. There was a call to preserve the non-digital characteristics of cooking in spite of the addition of technologies. Traditional ways of cooking could be seen as a resource for design rather than as something to be replaced. In a similar vein, some participants remarked on how cooking habits might be used to design playful interactions, thus making meal preparation a more enjoyable experience (Altarriba-Bertran et al., 2019).

Designers endorsed the implementation of stricter regulations to ensure data security and help create a proper balance between privacy and gathering information which benefits both consumers and companies (Han et al., 2019). Designers expressed that obtaining informed consent is an essential prerequisite for fostering responsible relationships between consumers and companies. However, it may be unreasonable for industries to obtain such consent for digital trace data in the same way as is done for academic studies. To act ethically, researchers must respect the importance of accountability (Dourish and Bell, 2011). Consumers are not generally aware of the many possible nefarious or unethical uses to which whatever information they consented to providing might be put. This exemplifies the need for participatory design both in the use of data as well as in the preceding collection process in order to listen to the concerns and opinions of those whom the data would be most likely collected from and address them accordingly. We can understand how to better accomplish this by working together in collaboration with consumers (Bogers et al., 2016).

8.4 METHODS FOR THE INTEGRATION OF DATA IN DESIGN

This section provides an answer to the fourth and last research question (RQ4) of this thesis. Here, we reflect upon the methodological contributions of the design workshops. We examine how participants made use of the design resources developed in Chapter 5—including data visualisations, design cards, and the design sheet—and evaluate how these might both enable and limit the conceptualisation of enhanced CPGs. This examination builds upon the existing literature on participatory design (Chapter 3) and data-driven approaches for design, as well as on prior research into enhanced CPGs (Chapter 2) as a source to identify the contributions of our design workshops within HCI and CPG innovation. The objective of the design workshops was to facilitate participants' understanding and subsequent use of data to inspire the design of enhanced CPGs. The design workshops were motivated by the need to present the findings from the fieldwork studies to a diverse group of participants—consumers and designers alike—in an accessible and structured manner.

The relevance of participatory design has been shown as an approach which promotes the incorporation of users as early as possible in the process (Kuhn and Muller, 1993). Our approach was influenced by prior work on participatory design such as UTOPIA (Bødker et al., 1987), specifically by its use of low-fidelity tools to support rapid prototyping and ideation. In addition, we borrowed from more contemporary design tools, such as the deck of mixed-reality ideation cards used in the work of Wetzel, Rodden, and Benford (2017) to facilitate the rapid conceptualisation of games. The following section demonstrates the growing relevance of data-driven approaches for design in industry and academia, and highlights how our work helps to fill the gap in the literature regarding the application of those approaches in the design of enhanced CPGs.

8.4.1 *Using design resources in innovation*

We propose that the findings obtained from our fieldwork studies be made publicly available so they can be further explored and that our understanding of CPG interactions might be strengthened. A great deal of work was put into translating the findings into effective visualisations informed by research on information visualisation (Carpendale, 2008; Huang et al., 2014) which could prove useful and meaningful for participants of the design workshops. The data visualisations were presented to the participants such that they were useful both for enabling participants to see the value in understanding how CPGs are currently utilised, as well as seeing their potential for enhancement (Sanders, Brandt, and Binder, 2010).

Even when participants were told not to be constrained by any perceived lack of utility in their designs or technological limitations, their concepts often exhibited incremental rather than radical innovation (Si and Chen, 2020). Our approach might have influenced participants to form ideas which they felt represented 'common sense' and practicality. Their concepts frequently employed technologies having a similar level of sophistication to those currently available on the market. It is possible that people attempted to imbue a sense of familiarity in their designs with the hope that the resulting products would be more appealing to others. Similarly, the most common benefits incorporated were those most closely-associated with cooking; namely, cooking skills, healthy eating, and sustainability. While a desire to improve cooking skills and eat healthy is something most of us share, sustainability is a value which is only recently being more tenaciously pursued due to the evolving environmental challenges threatening us. Designers should be aware that consumers might well unwittingly tend to create products with which they have some degree of familiarity, and if one desires participants to be more adventurous in their ideas, a more directive approach may be required (Drakeman and Oraiopoulos, 2020).

Our specially-purposed design cards served as a tool to make use of data as demonstrated in the wide variety of sketches of enhanced CPGs which consumers created (Chapter 6). We found that the cards were generally put to better use when presented alongside the data visualisations. While neither the cards nor data alone might be enough to foster creativity per se (Roy and Warren, 2019), our work has shown that they indeed hold such a potential when combined—especially for individuals with limited experience in design. We believe that cards can help people plan more clearly which attributes they want their products to have, leaving them free to think about other aspects of design (Wetzel, Rodden, and Benford, 2017). The utility of our design cards mirrored those by Mora, Gianni, and Divitini (2017), including their capacity for facilitating creative combinations of ideas, establishing a basis for understanding, and providing a structured framework. The cards helped participants easily navigate through the design process and simplified the integration of insights from the data by breaking down the sketching process into more manageable tasks. One concern which has been raised is the possibility that design cards might limit creativity by unintentionally directing people towards some designs and away from others (Roy and Warren, 2019). However, we found that this was not the case; participants expressed that the cards were flexible enough to accommodate any ideas they had, and this was reflected in the variety and uniqueness of their design concepts.

The design concepts created by participants were successfully focused on the practical use of CPGs. This was evident in the themes displayed by the designs including those which aimed to improve cooking skills (*transmission of knowledge*), facilitate product usage (*digitalisation of existing functions*), and integrate desirable values such as sustainability, ethical sourcing, and healthy eating (*incorporation of values*), among others. Data visualisations helped to foster an effective understanding of the information presented, allowing participants to use their newfound knowledge to make informed design decisions, for example by identifying potential problems. The benefits of keeping the circumstances of use at the forefront of participants' minds have long been obvious from a practice perspective (c.f. Kuutti and Bannon, 2014) as opposed to those perspectives in which the product is viewed more abstractly. To better make use of the data, designers may do well to employ frameworks such as the 'Contextual Wheel of Practice' in order to promote a more accurate understanding of the hands-on aspects of product usage and increasing collaboration with users (Entwistle et al., 2015).

8.4.2 *Innovation and design resources*

Our study also contributes to participatory design approaches in which people are generally encouraged to draw upon their experiences to identify problems and create solutions (Muller and Kuhn, 1993). Designers can improve their approaches by making use of data, whether from fieldwork observations or connected devices (Gorkovenko et al., 2020). Consumers, despite being experts of their own experiences, are a relatively untapped resource when it comes to first-hand knowledge about the practical use of CPGs, and companies are increasingly taking advantage of this by including them in the design process. One's capacity to use their own experience to inform design has until now been feasible only for experts with the training to introspect in such a way that proves fruitful (Neustaedter and Sengers, 2012). The presentation of data in a structured design approach like ours could facilitate the development of products which both better serve our needs and reflect a greater variety of interests (Luther et al., 2015). As expressed by P14, one cannot help but *"...be stuck in your own perceptions of the world"*. Involving more individuals and data in the design process could therefore lead to products aimed at serving a wider range of people and needs (Shea, Aish, and Gourtovaia, 2005).

Overall, data helped designers to think more about the practice than about the technologies, allowing them to consider how CPGs already accomplish their purposes and appreciate the impressive capability of low technologies to fit their needs (Taylor and Swan, 2005). Designers questioned the premise of needing to incorporate IoT technologies into CPGs. An appreciation for the respite provided by the lack of such technologies in the cooking experience was clearly at the root of this argument. Considerations about the perceived challenges as part of the enjoyment of cooking were also put forth (Gaver, Beaver, and Benford, 2003). In the opinion of designers who utilised constraints as a tool for creativity, embracing challenges in cooking instead of attempting to eliminate them through technology should be considered instrumental in improving these experiences (Spence et al., 2017).

One concern which could arise about the use of a structured process is its potential to hinder innovation. The design cards could, for instance, constrain the ideas incorporated by participants into their enhanced CPGs by limiting them to being solely based on whatever was included in the cards. As stated earlier, any design approach or lack thereof might influence how participants framed their design process (Paton and Dorst, 2011). Here, through the analysis of the resulting creations and ideas expressed during the workshop, we showed how our approach led to unique design concepts and interpretations. Despite sharing some a number of common themes, the resulting designs did have unique characteristics which clearly distinguished them from one another. Likewise, the design workshop elicited rich conversation about the far-reaching implications of data in design, as was evident in the diversity of topics which were brought into consideration. A comparative study seems necessary to better identify precisely which aspects of the designs were driven by the data and our approach. Nonetheless, for an exploratory study, our design approach represents a promising step towards the creation of enhanced CPGs based on data.

8.5 Chapter summary

The discussion assembled the main themes associated with the interpretation of our discoveries concerning CPG interactions in cooking. This section reflects on how insights about CPG interactions at different levels of detail revealed some intricacies of their use in cooking (Chapter 4). The findings demonstrate the complexities in the use of CPGs, and that these uses are intrinsic to their role in the preparation of meals. We found clear distinctions in the use of CPGs depending on meal type, such as the higher rate of interactions and increased instances of task simultaneity in unfamiliar meals. This illustrates the need to design technologies tailored to specific cooking situations.

The discussion on the fieldwork studies centred also on implications for design derived from the study on cooking (Chapter 4); turning findings into constraints and opportunities for designing enhanced CPGs which respond to people's actual needs. The implications for design attempt to address particular problems or situations for the purpose of making cooking easier and more enjoyable. One of those implications, for example, was inspired by the finding that, depending on their type, CPGs have more interactions at certain phases of the cooking process than others, which could lead to the development of functionalities that work harmoniously with those patterns of interactions. This thesis proposes that enhanced CPGs should be developed by working closely with regular users of the products, as well as with those directly involved in product development as we have attempted to do in this thesis (Chapters 6 & 7).

In this thesis, we have proposed the use of a mixed-methods approach for understanding CPG interactions. These methods consisted of examining individual interactions involving items and integrating quantitative and qualitative results to provide an understanding of different aspects of their use in varying levels of detail. The approach was applied in two distinct situations of cooking, showing the potential its methods hold for studies of other practices. We reflected on the limitations of the methods and their disadvantages, including the fact that they are very time-consuming and their requirement of having access to private spaces. We also provided some solutions for those shortcomings (e.g. automation of methods) and remarked on their relevance to grant us insights into the use of CPGs in the household environment.

We presented a data-inspired ideation approach to enable consumers to utilise data for devising digitally enhanced versions of CPGs (Chapter 5). Our findings from participatory workshops suggest that data about the practical uses of CPGs can be successfully utilised by consumers and designers alike. The data was incorporated into the design concepts in markedly different ways, clearly reflecting the diversity in participants' interpretations. Considerations about the perceived challenges potentially being an enjoyable part of cooking were also put forward (Gaver, Beaver, and Benford, 2003). Similar to the use of constraints as a tool for creativity in design, certain challenges one faces in cooking could be considered valuable components of the process which may lead to preparing dishes in unique ways (Spence et al., 2017). The data helped designers to think more about the practice and less about the technologies, leading them to consider the way in which CPGs and cooking may already be sufficiently well-designed and appreciating the versatility of non-digital technologies to fit their needs (Taylor and Swan, 2005).

Generally, participants expressed satisfaction with the design tools and workshop organisation, and they welcomed a structured process for streamlining the conceptualisation of enhanced CPGs. Furthermore, the approach was tested on two separate occasions with groups of participants who differed greatly in their design experience, helping to prove its potential to serve people of diverse backgrounds. Still, questions remain about the usefulness of the designs conceived in the workshop, which should be explored in future work through the testing of prototypes based upon some of the designs produced. This study represents a step towards devising an approach for the design of CPGs which takes into careful consideration their practical and contextual use, as well as towards demonstrating the value of the design tools in helping to make effective use of data.

9

CONCLUSIONS

This chapter provides the conclusion of this thesis and represents the culmination of our work. We first summarise the thesis as a whole, reflecting on its contributions to the field of HCI, and an presenting overview of the possible future directions which research into the design of enhanced CPGs might take.

9.1 SUMMARY

This thesis advocates for the design of enhanced CPGs which are grounded in empirical insights. It was motivated by the desire for CPGs which better serve our needs and fit into the practices of which they are a part. The relatively small number of enhanced CPGs available have experienced little success on the market, as most, if not all, have not properly been informed with an understanding of the practical interactions of CPGs in general. Thus, this work attempts to fill two gaps in the literature: one concerning an understanding of CPG interactions in the practice of cooking, and the other related to explorations into the value of data for inspiring the design of enhanced CPGs. In doing so, we also facilitated the development of two new methodological approaches. The first is a method by which to study and analyse the interactions of CPGs in practice, and the second is a data-inspired ideation approach (including a design workshop and design tools) for the conceptualisation of enhanced CPGs.

Our empirical work shows the complex nature of the use of CPGs, which is only revealed through careful observations. Using an empirical approach and through observations in the field, we obtained data which we analysed using our own aforementioned mixed-methods research techniques. These methods provide ways of blending quantitative and qualitative findings allowed us to obtain insights into both generalities and specifics of CPG interactions. The findings revealed aspects of their usage, such as the fact that salt, black pepper, and oil are the most commonly-used CPGs. This served as an indication of the relevance of CPGs given their high frequency of use and subsequently provided a strong argument as to why more focus should be given to their design. The findings also revealed some of the subtler aspects of CPGs in unfamiliar meals, such as the finding that people more frequently gathered information when preparing them. This discovery sparked discussion on the possibility of digitising the information normally provided by the packaging.

Moreover, the thesis shows the potential of using data to foster unique CPG designs aimed at better fitting into people's practices. The discoveries from the fieldwork were used as an opportunity to inform the design of enhanced CPGs. The data was presented in visualisations, and a structured workshop process were devised, along with design cards, to help participants conceptualise enhanced CPGs. First, we explored our design approach with people who lacked experience in professional product design to evaluate how they might make use of the data. We found that consumers were able to do so effectively and sketched unique designs imbued with qualities indicative of them having greater consideration for others. We then reasoned that the next step should be to evaluate how professionals with experience in design make use of such data. We found that designers and consumers alike conceptualised novel products capable of supporting the process of cooking unfamiliar meals through the digitisation of functionalities and the addition of features. Designers also reflected critically on the far-reaching implications of gathering data for design purposes, considering the challenges of incorporating IoT technologies into CPGs as well as issues relating to the responsible collection and use of data. The studies conducted and used for this thesis promote data-informed approaches for design in academia and industry, stressing the value of intervening at the early stages of the conceptualisation process.

9.2 MAIN CONTRIBUTIONS AND KEY CONCLUSIONS

This thesis makes four main contributions, each of them related to the research questions outlined in Chapter 1.

1. A detailed explanation of CPG interactions in the preparation of familiar and unfamiliar meals providing insight into various aspects of CPG usage as well as similarities and differences between these two types of meals.
2. The development of a mixed-methods approach for the study of CPG interactions in practice including methods for the collection, coding, and analysis of data.
3. An exploration which sheds new light on the potential of the use of data for designing enhanced CPGs, as well as a critical reflection on its implications for design.
4. The development of a data-inspired ideation approach, including a structured workshop process and design tools, which facilitate the use of data on CPG interactions to inspire designs and sketches of smart versions of these products.

9.2.1 *Knowledge about the practical use of CPGs in cooking*

To gain an understanding of the interactions of CPGs in the practice of cooking, we conducted fieldwork to collect evidence by way of first-hand observations in two distinct situational contexts: the preparation of familiar and unfamiliar meals. The cooking sessions were captured by video, and the individual interactions with CPGs were identified through direct observation of the footage. An array of analysis methods were developed due to the lack of precedents within the field for ascribing meaning to data on CPG interactions. The methods allowed for an integration of quantitative and qualitative findings to provide a detailed understanding of CPG interactions.

The fieldwork studies identified various aspects regarding CPG usage in the practice of cooking. These findings were examined to discuss their meaning within the wider context of literature on HCI. Our work revealed frequential, sequential, and correlational features. In the first fieldwork study on the preparation of familiar meals, we showed that the same small group of CPGs were frequently used across many different meals, that they were required at different stages of the cooking process depending on their type, and that they were consistently used in sets across multiple sessions. In the second fieldwork study, which centred on unfamiliar meals, the findings revealed some characteristics of the process of gathering information from packaging labels, the switching which occurred between tasks, and similarity of patterns regarding the use of items in combination between familiar and unfamiliar meals. We confirmed that CPGs have intricate patterns of use, and, following the principles of the practice perspective, believe that those patterns should be considered when designing innovations. We also took the opportunity to derive implications for design, proposing the creation of enhanced CPGs which fit harmoniously into the ways in which

CPGs are used and have a wide variety of added functions, for instance by promoting sustainability and more engaging cooking experiences. It is precisely the implications for design which close our fieldwork studies by finally providing an answer as to how an understanding of CPG usage could ultimately inform the design of enhanced versions of these products. Crucially, the implications suggest there is particular value in digitising information about CPGs conveyed through packaging, harnessing people's habits to simplify the preparation of unfamiliar meals, and creating functionalities which take into account the combined use of CPGs.

Over the course of our two empirical works, many intricacies of CPG interactions were revealed. The findings allowed us a glimpse into the ways in which CPGs are most commonly used. We believe that those insights about CPG usage can help to identify potential points for technological intervention. Other studies have researched the complexities associated with the practice of cooking (Paay, Kjeldskov, and Skov, 2015). Our work has shown, for instance, that CPGs are used in conjunction with one another during cooking. We firmly believe that, to make the most of data on CPG interactions, the best course of action is to give those findings back to both designers and consumers. This is precisely what we did in our third and fourth empirical studies. Beyond the research conducted for this thesis, its contributions can be extended through the development of prototypes of enhanced CPGs and an evaluation of their effectiveness in the field.

9.2.2 *Methodology for understanding interactions with CPGs*

The studies presented within this thesis made use of fieldwork to capture data on the interactions of CPGs in the practice of cooking. As pointed out in section (Chapter 3), despite the vast amount of literature on cooking and the wide variety of methods to study the practice of cooking, there are no specific methods for analysing the interactions of individual objects throughout the process. Thus, we were compelled to develop our own methods of analysis, which were informed by the recent development of quantitative ethnography. This is because quantitative ethnography provides a way to incorporate quantitative methods into ethnography, but these methods have not yet reached the maturity required to evaluate either cooking or CPGs. In the development of our own methods, we put a greater emphasis on the integration of quantitative with qualitative data, as well as on managing the sheer volume of data collected.

The methods allowed us to obtain a detailed understanding of CPG interactions in cooking and broadened the set of elements considered in the design of their enhanced versions. We highlighted the potential of ethnographic research as an ideal method for capturing our data. In ethnography, there is no set of rigid steps to follow. Rather, the researcher has to formulate their own procedure to identify what is often *'seen but unnoticed'* (Garfinkel, 1964). Given the lack of existing methods to analyse individual interactions of a large number of items within a practice, we were required to develop our own mixed-methods analysis inspired by quantitative ethnography. Our methods ultimately lead to unique findings and a deeper understanding of CPG interactions, exhibiting an integration of thick and thin descriptions. The analysis focused on the frequential, sequential, correlational, combinatorial, and handling features. Our methods proved to be flexible enough such that they were successfully employed in the two distinct situations of cooking covered in our work.

In future studies, our methods could benefit from attempting their application to a wider range of cultures and cooking styles in order to gauge the inter-contextual stability of our findings; that is, the degree to which they hold true in a wider data sample. These methods would be strengthened through their automation given their very time-consuming nature, as we were forced to manually identify each item interaction. The incorporation of IoT technologies into CPGs could serve not only to provide functionalities but also to automatically recognise item interactions. Our methods raised questions about the protection of privacy. In our fieldwork study (Chapter 4) participants granted us access to their households only after being provided with the details of our work and how their data was to be used such that they could then give informed consent. Looking ahead, it must always be remembered that any automated method which aims to collect data about items such as CPGs must take measures to ensure that participants are aware of what that collection of data entails.

The depth of the findings included in this thesis validates the use of our technique in further research aimed at understanding practical interactions involving CPGs. The methods could be applied not only to cooking, but to all practices in which CPGs are used. The rapid incorporation of IoT technologies into CPGs makes it necessary to have methods, like those developed here, which can make sense of the collected data. Interpreted data could then be useful in understanding our everyday practices as well as in promoting novel innovations and designs.

9.2.3 *Designing enhanced CPGs informed by data*

The design workshop studies covered in this thesis aimed to understand how data about CPG interactions can inspire the design of enhanced CPGs. We devised a 'data-inspired ideation approach', using data visualisations and design cards to facilitate the conceptualisation of enhanced CPGs and encourage participants to reflect on the value of data for design. We also expanded upon the potential implications for design of data beyond those which we devised in the discussion section (Chapter 8). We employed our approach in two distinct studies. In the first study (Chapter 6), we included only consumers with little to no prior experience in design due to our interest in evaluating what the average user of CPGs could do with data on their interactions. In the second study (Chapter 7), we chose participants who were professional designers with experience in product development to explore the consequences of their having such additional expertise and how that influenced the way in which they made use of the data.

Analysing the role of data as expressed through participants' comments and designs, we found that the information served as a basis for the creation of unique concepts which exhibited greater consideration for the experiences of others and attention to their interests. Moreover, we identified that designers put forth considerations about the implications of using data in regards to the protection of privacy and the challenges of incorporating IoT technologies into CPGs. The approach also contributed to the production of unique designs, with no two being the same. They exemplified common themes of digitising existing functions, incorporation of values, providing information about products, and the creation of augmented experiences. Our findings show the importance of providing data to consumers and designers alike for broadening and informing their contributions to the development of smart products. Moreover, the design workshop studies demonstrated the capacity of the design tools and a structured workshop process to empower consumers and designers alike to make effective use of the data visualisations.

Despite the fact that data has long been used as part of the design process (King, Churchill, and Tan, 2017), this study is the first to treat data as part of the design process specifically for the creation of enhanced CPGs. Our workshop studies contributed to the use of data as a powerful means by which to stimulate design at the early stages of the process. Given the advent of IoT technologies which can be embedded into CPGs, harnessing data collected through the IoT is a foregone conclusion, not only for the purposes of understanding our interactions with CPGs but also as a resource for design. As noted by designers in the second workshop study (Chapter 7), such uses of data come with many caveats; their responsible collection and subsequent use poses a threat to the privacy of consumers and increases the number of regulations which industries would need to follow to avoid acting irresponsibly. Designers backed the idea of adopting new regulations to mitigate these issues, for example by proposing measures to secure personal information and achieve a healthy balance between what is advantageous for consumers and what is desirable for businesses.

9.2.4 *Data-inspired workshop approach for the design of enhanced CPGs*

This thesis adopted a participatory design approach (Chapter 3) to orchestrate the workshops which encouraged participants to make effective use of data. Our data-inspired approach included specially-made data visualisations, design cards, and a design sheet, as well as a structured workshop process. As previously stated, the first design workshop study (Chapter 6) included only consumers without previous experience in design, while the second design workshop study (Chapter 7) included only professional designers with experience in product development. Participants in both studies were encouraged to interpret the data and to use their newfound knowledge of CPG interactions in practice to inform the design of their enhancements.

While the components of our design workshop—namely the design cards, design sheet, and structured workshop process—have been widely used in design research, we showed how they were integrated with data visualisations. With such integration, we aimed to facilitate the use of data by making the other aspects of the ideation process as easy as possible so participants could interpret the data to inspire their design concepts. The use of the design tools was more important for consumers than for designers. When working with designers, we put a greater emphasis on gathering their opinions on the data collection process and its implications for the protection of privacy. Analysing participants' comments, we found that they were satisfied with the design resources, as most stated they were pleased with the concepts they led to.

Regarding the role of data in the design process, they have been extensively used in product manufacturing. However, the use of data for design purposes in industrial settings is a more recent development. Similar to the use of the design tools, we found that participants effectively employed the data visualisations, and consumers and designers alike were able to understand, interpret, and apply their resulting insights to the creation of enhanced CPGs. People interpreted the data in many different ways. We identified that a single data point led to vastly different interpretations stemming from participants' knowledge, personal experiences, and connections to outside information. The characteristics of the data were reflected in designs which focused on the practical interactions of the product rather than on only individual interactions, as well as in the designs for sets of items instead of only for individual objects. The data visualisations also led some to ponder the challenges associated with the use of data, for example in the discussions about data protection and corporate responsibilities, sparking conversation among participants of the workshop to find potential solutions.

The design workshops of this thesis contribute to design perspectives in HCI which aim to incorporate data into their practices. This thesis demonstrates that, through a structured workshop process with effective visualisations, data can be a powerful resource and provide innovation for participants with different levels of design experience. Moreover, we demonstrated that the approach could be flexible enough to accommodate different design objectives, from merely sketching enhanced CPGs to fostering a discussion about the implications of data for design. This is an exploratory study, and the approach would benefit from further testing in different conditions, for example including different data resources and more collaboratively-designed activities.

9.3 CRITICAL REFLECTION

In this work, we have strived to elucidate and deliver an understanding of CPG interactions in the cooking practice as well as to explore the value of such an understanding for the conceptualisation of digital enhancements. However, as with any empirical work, ours has a number of limitations which must be considered when interpreting our findings and their potential implications. The main limitations of our work are the following:

1. The relatively small data sample in fieldwork studies
2. The exploratory nature of the methodological approach

3. The lack of testing of our approach in the design of products

Each of the limitations will now be discussed in detail below.

9.3.0.1 *Relatively small data sample*

The sample in this study, although diverse, is relatively small considering that cooking occurs in almost every household on a regular basis, that the meals people prepare and their cooking methods vary significantly, and that there exist a wide array of distinct cooking situations. However, that does not imply that the sample is not sufficient to provide useful insights about the practice of cooking (Twidale, Randall, and Bentley, 1994) given that the methods employed in meal preparation are relatively ubiquitous. As stated by Shaffer (2017b, p. 150) "...meaning is *local*, but not *too local*." Some specific findings of this study, such as the fact that minced meat was one of the most commonly-used CPGs, may apply only to this sample and reflect the cultures and demographics of the participants. Still, more general patterns of the item interactions are likely to be present in larger and more diverse populations, whereas the components which form the basis and determine the identity of a meal will vary greatly from dish to dish.

Considerations about the inter-contextual stability of insights should be taken into account, as well as different cultures and cuisines (Ottenbacher and Harrington, 2009). Cooking is a practice which, aside from the type of meal being prepared, is influenced by several other factors including culture, socioeconomic status, and seasonality (Wolfson and Bleich, 2015). Further studies should address different contexts and factors which might play a role in cooking. As an example of one such factor, it may be expected that the differences in cuisine between various regions inevitably lead to the use of unique ingredients and cooking techniques.

9.3.0.2 *Undeveloped methodological approach*

This study provides a mixed-methods approach and methods for understanding interactions involving CPGs from a practice perspective. These methods are not limited to the study of cooking and our sample. Rather, they can be employed to evaluate cooking practices in multiple settings and cultures, and even to better understand interactions involving CPGs in other practices such as cleaning, grooming, and doing laundry. The approach allowed for the incorporation of knowledge from both quantitative and qualitative methods. Statistical analyses provided findings which only emerged from data aggregates such as dispersion, correlation, and outliers. Qualitative methods provide meaning and contextual knowledge to observations in the field, such as the understanding that a surge of interactions involving cleaning products during the beginning phases of the session was the result of a spill and the need to clean it. The approach provided detailed descriptions and interpretations of CPG interactions, which had been lacking or barely-mentioned in previous studies. While ethnographic work usually focuses on thick descriptions (Torkkeli, Mäkelä, and Niva, 2018) and insightful situations (Paay, Kjeldskov, and Skov, 2015), it has not given detailed information about CPG interactions and those of other items involved in cooking. Similarly, while quantitative methods provide a summary of the general findings, they do not provide information about practical contexts of use beyond merely the numerical data (Wagner et al., 2011; Wang and Worsley, 2014). The incorporation of quantitative methods to ethnography can allow for obtaining a measure of the relevance of the findings and help to reduce bias (Neyland, 2013) in ethnographic interpretations. Moreover, it can strengthen the relevance of findings by providing an "evidence base" which is firmly-rooted in empirical observation and which one can then proceed to use as a guide in making their design decisions (Rousseau, 2006).

9.3.0.3 *Lack of testing of our approach to the design of products*

It should be considered that, although the focus of this study was on deriving implications for designing products embedded with technology, there are situations in which the most appropriate solution is not to design any technological intervention at all (Baumer and Silberman, 2011). The practice perspective argues that the introduction of new technologies is only one of many alternatives which can be deployed to bring change within a practice (Kuutti and Bannon, 2014). There is also a need to reflect on the ways in which people already accomplish their goals. They continually reconfigure and personalise spaces and the technologies within them to meet particular demands (Taylor and Swan, 2005; Wakkary and Maestri, 2008) as was found in this very study. For example, a participant reused bottles of ketchup to contain and dispense oil which, at least subjectively, made them feel they had better control of the product. In regards to not having applied our findings to the actual creation of enhanced CPGs, though not one of the objectives of this thesis, we have provided what we believe are valuable insights for the future development of enhanced CPGs.

9.4 FUTURE WORK

This chapter has consolidated and summarised the contributions contained within this thesis, as well as the limitations of our work. We believe that further research is needed to properly evaluate the veracity of the claim that a better understanding of interactions involving CPGs can prove fruitful for the development of enhanced CPGs. The necessity of such research is clearly related to the limitations of this thesis, and conducting it would also undoubtedly aid in the design of effective enhanced CPGs. The following are areas on which future research should focus and strive to make progress in:

First is a broader understanding of CPG interactions in practice necessitating a larger data sample and more practices and products. An understanding of CPGs in a more diverse and larger sample should lead to refined insights about both their general and specific characteristics. Identifying the patterns that remain despite the variations between meals can point to specific areas of innovation. As we have mentioned. our findings may very well prove relevant, as they would point towards features more worthy of our time and resources. It would be intriguing to see how such interactions differ or remain the same in other practices such as cleaning, grooming, and eating. In the case that there are clear similarities among different practices, this would quite likely lead to the design of general CPG functionalities. On the other hand, if these interactions are completely different, this would likely lead to functionalities which are tailored for specific purposes.

The second is to refine and automate our methodological approach, as well as confront and hopefully resolve at least some of the issues regarding the use of data in design. The methods of this study are very time-consuming and labour-intensive, though the automation of our methods seems plausible in the near future given the large-scale incorporation of RFID into CPG packaging. For example, one might cite the declaration made by Japan's Ministry of Economy Trade and Industry, which promised the introduction of 100 billion electronic tags for products in convenience stores all across Japanese cities (Economy Trade and Industry, 2017). A simplified version of our methods honed to study more targeted aspects of CPG interactions could help lead to such automation and render some of the more tedious aspects of the process unnecessary. There is also still a need to test the workshop with a larger group of people using different kinds of data. Something that could help would be the inclusion of a control group in the design workshops to better identify the influence of data in design.

Third is the development of enhanced CPGs based on our methodology, and the subsequent testing of those products in the field. Many valid arguments can be made about the capacity of our approach to achieve its design goals. For example, more than sixty design concepts were created during the workshop, and we devised six implications for design based on the results of the fieldwork. However, there is nothing which could replace actually testing technologies in the field to evaluate these concepts' effectiveness. The development of prototypes for a select group of those designs which are deemed most promising is but one of many possible next steps to take. Such testing does not necessitate the implementation of a fully-developed product; low-fidelity prototypes should be enough to gather valuable information about the potential of these designs.

9.5 CONCLUDING REMARKS

In conclusion, this thesis has provided insights into the practical interactions of CPGs in the practice of cooking, and has explored a number of implications of using those insights to inform the design of enhanced CPGs. In doing so, we have also developed analytical methods for the investigation of CPG interactions in practice, as well as a design workshop and design tools to facilitate the conceptualisation of such innovations. The empirical work of this thesis aimed to address a void in the literature regarding a practical understanding of CPG usage in practice as well as methods for the design of enhanced versions informed by empirical insights. We believe that our work contributes to highlighting the relevance of enhanced CPGs as a research area and could help to promote the further investigation of associated topics within the field of HCI. Our research calls attention to the often ignored aspects of CPG interactions, revealing hidden patterns of their use. Furthermore and to the same end, this work also underscores the relevance of grounding such design firmly upon empirical insights, revealing that this approach leads to the creation of unique concepts which again take into account a wider range of elements about CPG usage. In brief, this thesis contributes to the existing literature on fieldwork studies in cooking by emphasising on the role of CPG interactions in practice, providing a methodological approach for the analysis and use of data about CPG interactions, and, as promised, deriving insights for the design of enhanced CPGs.

Part IV

APPENDIX

A

ADDITIONAL DOCUMENTS ON FIELDWORK STUDIES

This appendix includes additional on the fieldwork study on cooking (Chapter 4):

- Appendix A.1 provides the information sheet and consent form given to participants prior to the study.
- Appendix A.2 provides the the study guidance documents.
- Appendix A.3 provides the demographics survey and cooking experience interview.

A.1 CONSENT FORM & INFORMATION SHEET

A.1.1 *Consent form*

CONSENT FORM

University of Nottingham
UK | CHINA | MALAYSIA

Date: 08/02/2019

Project: Enhancing practices through smart fast moving consumer goods

School of Computer Science Ethics Reference

Funded by: Horizon Centre for Doctoral Training at the University of Nottingham (UKRI Grant No. EP/P510592/1) and by Unilever UK Ltd

Please tick the appropriate boxes	**Yes**	**No**
1. Taking part in the study		
a) I (the participant) have read and understood the project information sheet dated 08/02/2019, or it has been read to me. I have been able to ask questions about the study and my questions have been answered satisfactorily.	☐	☐
b) I consent voluntarily to be a participant in this study and understand that I can refuse to answer questions and I can withdraw from the study at any time, without having to give a reason.	☐	☐
c) I understand that taking part in the study requires me to cook a meal of my choice and allowing the researcher of this study to take video, and audio, and notes while I cook. The study also requires me to allow the researcher to take a video of my groceries in my kitchen before I start cooking. If the researcher considers being relevant, the researcher will take photos of my kitchen. I also understand that taking part in the study requires me to answer questions related to my cooking experience, the researcher could ask such questions while I am cooking or at the end of the cooking session.	☐	☐
2. Use of my data in the study		
a) I understand that data which can identify me will not be shared beyond the research team of this study.	☐	☐
b) I agree that anonymized and processed copies of my data (i.e. data that do not contain any personally identifiable information) may be used for the following purposes:		
– Presentation and discussion of the project and its results in research activities (e.g., in supervision sessions, project meetings, conferences).	☐	☐
– Publications and reports describing the project and its results.	☐	☐
– Dissemination of the project and its results, including publication of data on web pages and databases.	☐	☐
– To be shared to other researchers (e.g. journal reviewer) at a reasonable request	☐	☐
– To be re-used for other studies (e.g. as a comparison in future work)	☐	☐
c) I give permission for my words to be quoted for the purposes described above, only after my identity has been protected by using a pseudonym.	☐	☐
d) I give permission for my visual image contained in photos or video gathered during the research to be used for the purposes described above. Only after my	☐	☐

[School of Computer Science model consent form, last updated 2018-05-22] 1

Figure 36: Consent form: Fieldwork studies on cooking (p. 1).

identity has been protected by blurring my face or not showing my face at all.

Please tick the appropriate boxes **Yes** **No**

3. Reuse of my data

a) I give permission for the data (only after anonymization) that I provide to be reused for the sole purposes of future research, publications, presentations and learning. ☐ ☐

b) I understand and agree that this may involve depositing my data (only after anonymization) in a data repository, which may be accessed by other researchers (e.g. journal reviewer) at a reasonable request. ☐ ☐

4. Security of my data

a) I understand that safeguards will be put in place to protect my identity and my data during the duration of the study, and after if my data is stored for future use. The safeguards include storing my raw data in a password-protected computer and to which only the research team of this study will have access. Only anonymous and processed copies of my data be stored in a secure digital repository provided by the University of Nottingham and may be available to other researchers (e.g. journal reviewer) at a reasonable request. ☐ ☐

b) I confirm that a written copy of these safeguards has been given to me in the University's privacy notice, and that they have been described to me and are acceptable to me. ☐ ☐

c) I understand that no computer system is completely secure and that there is a risk that a third party could obtain a copy of my anonymised data. ☐ ☐

5. Copyright

a) I give permission for data gathered during this project to be used, copied, excerpted, annotated, displayed, and distributed for the purposes to which I have consented. ☐ ☐

6. Signatures (sign as appropriate)

Name of participant (IN CAPITALS) Signature Date

If applicable:

For participants unable to sign their name, mark the box instead of signing

I have witnessed the accurate reading of the consent form with the participant and the individual has had the opportunity to ask questions. I confirm that the individual has given consent freely.

Name of witness (IN CAPITALS) Signature Date

[School of Computer Science model consent form, last updated 2018-05-22] 2

Figure 37: Consent form: Fieldwork studies on cooking (p. 2).

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

JOSE GUSTAVO BERUMEN SALAZAR

Name of researcher (IN CAPITALS)	Signature	Date

7. Researcher's contact details

Name: Jose Gustavo Berumen Salazar

Phone: [**REDACTED FOR THIS THESIS**]

Email: gustavo.berumen@nottingham.ac.uk

Provide the participant with a copy of the completed form either by email or hard copy as they prefer.

[School of Computer Science model consent form, last updated 2018-05-22] 3

Figure 38: Consent form: Fieldwork studies on cooking (p. 3).

A.1.2 *Information sheet*

PROJECT INFORMATION

University of Nottingham
UK | CHINA | MALAYSIA

Date: 08/02/2019

Project: Enhancing practices through smart fast moving consumer goods

School of Computer Science Ethics Reference:

Funded by: Horizon Centre for Doctoral Training at the University of Nottingham (UKRI Grant No. EP/P510592/1) and by Unilever UK Ltd.

Purpose of the research.

The aim of this study is to understand how people use and interact with consumer packaged goods (CPG) (e.g. packaged food) and utensils to cook. We, the research team of this study (Ph.D. student and academic supervisors), aim to use such understanding to later develop design interventions to create smart versions of CPGs. Those smart version of CPGs would support and/or improve people's practice of cooking by providing extra functionalities that could help to promote healthy cooking, reduce food waste or support the cooking process, among others.

Nature of participation.

Your participation is voluntary and in order to participate you (the participant) should read and sign a consent form. Once you have understood the nature of your participation and we have answered all of your questions, if any, you will be able to participate.

Participant engagement.

Your participation involves cooking a **meal of your choice** and allowing one of the researchers (Ph.D student) of this study to be present during the cooking session to make observations. The study will take place inside your kitchen, and the duration of the study will comprise from the time you start to cook until you serve the dish. Other activities associated with cooking such as shopping and eating will not be considered for this study. We will collect video and audio recordings and notes while you cook. In addition, the researcher will take a video recording of all the CPGs that you have in your kitchen. During and at the end of the cooking session, the researcher may ask you to talk briefly about your cooking experience and/or answer questions regarding your cooking experience. If the researcher considers being relevant, the researcher will take photos of your kitchen. The researcher will collect the audiovisual information with the use of a video camera that we will place inside of your kitchen with your previous authorization.

Benefits and risks of the research.

Your participation in our research will help us to understand how CPGs and utensils are used in cooking, and such understanding will help us to identify design opportunities that could help us to create smarter versions of CPGs. Smart CPGs could have the potential to support and/or improve the practice of cooking by providing extra functionalities that could help to promote healthy cooking, reduce food waste or support in the cooking

[School of Computer Science sample information sheet, last updated 2018-07-13] 1

Figure 39: Information sheet: Fieldwork studies on cooking (p. 1).

process, among others. There are no risks associated with participation beyond those typically associated with cooking on your everyday life.

Use of your data.

Only the research team (Ph.D. student and academic supervisors) will be authorized access to the originally raw collected data. All personal information will be anonymized and no one outside of the research team will access to any personal information. Only anonymized data and processed data (i.e. transcripts of interviews and analyzed data of the cooking sessions that do not contain any personally identifiable information) will be used to support research publications, academic presentations and the Ph.D. researcher's thesis. Only the anonymized and processed data will be stored on a secure digital repository provided by the University of Nottingham and it could be made available to other researchers only after approval from the research team at a reasonably request. We will used pseudonyms in any resulting publication and your faces will be blurred so you cannot be identified.

Personal data collected will be held in a secure and safe manner in accordance with the Data Protection Act 2018. However, no computer system is perfectly secure and it is always possible that a third party might gain unauthorised access to the collected data.

Future use of your data.

Your anonymised data may be archived and reused in future for purposes that are in the public interest, or for historical, scientific or statistical purposes.

Procedure for withdrawal from the research.

You may withdraw from the study at any time and do not have to give reasons for why you no longer want to take part. If you wish to withdraw, please contact the researcher who gathered the data. If you receive no response from the researcher, please contact the School of Computer Science's Ethics Committee.

This research is being conducted by research staff from the Mixed Reality Lab at the University of Nottingham. This research project is supported by Horizon Centre for Doctoral Training at the University of Nottingham (UKRI Grant No. EP/P510592/1) and by Unilever UK Ltd. It has been reviewed and approved by the University of Nottingham, School of Computer Science Research Ethics Committee.

If you have questions please talk to a member of the research team, or after the event contact: Jose Gustavo Berumen Salazar, C10a, School of Computer Science, The University of Nottingham, Jubilee Campus, Nottingham NG8 1BB; email: gustavo.berumen@nottingham.ac.uk

Contact details of the ethics committee.

If you wish to file a complaint or exercise your rights you can contact the Ethics Committee at the following address: cs-ethicsadmin@cs.nott.ac.uk

[School of Computer Science sample information sheet, last updated 2018-07-13] 2

Figure 40: Information sheet: Fieldwork studies on cooking (p. 2).

A.2 STUDY GUIDANCE DOCUMENTS

A.2.1 *Invitation study*

Invitation to participate in the research project –

Enhancing practices through smart fast moving consumer goods

Hello,

We are conducting a study to **understand how people cook.** We want to know how people use groceries and utensils to cook. The insights we obtain from the study will help us to develop digital design interventions that could support and improve the cooking experience.

> **Your participation** involves cooking a meal of your choice and allowing one of the researchers of this study to be present during the cooking session to make observations of how you cook.
>
> The study will take place inside your kitchen, and the duration of the study will comprise from the time you start to cook until you serve the dish. Once you finished cooking, the researcher may ask you some questions in regards to your cooking experience.
>
> We have to collect video and audio recordings, notes and photos that help us to understand how you cook. We will collect such evidence only with your authorization.
>
> We will provide an inconvenience allowance of 20£ (in Amazon gift cards) for your participation.

If you are **interested** in taking part, please contact me at the email address and/or phone found below, and I will provide more information. Your participation is voluntary and you are free to withdraw at any point of the study.

Thank you,

Gustavo Berumen
gustavo.berumen@nottingham.ac.uk

Figure 41: Invitation to fieldwork study given to potential participants.

A.2.2 *Description: Meals*

Familiar meal description[1]

Cooking a Regular meal

What we mean by **cooking**

> ***Cooking is the process and skill of preparing a meal by combining, mixing, and heating (among other methods) ingredients.***

We expect cooking to require some skill, and that the meal is not only the result of re-heating or simply assembling already prepared food.

We do not consider cooking the following examples:

- × Frozen pizza
- × Ready to eat meals
- × Sandwiches

What we mean by a **regular meal**

A regular meal is a dish that you know how to cook. It could be something you cook regularly or that you have cooked a couple of times but you know how to cook it without the need to follow a recipe.

What meal(s) are you planning on cooking?

Please let us know

Figure 42: Description of familiar meals shared with participants of fieldwork studies.

1 At the time of the study, we referred to familiar meals as regular meals.

Unfamiliar meal description[2]

Cooking a New meal

What we mean by **cooking**

> ***Cooking is the process and skill of preparing a meal by combining, mixing, and heating (among other methods) ingredients.***

We expect cooking to require some skill, and that the meal is not only the result of re-heating or simply assembling already prepared food.

We do not consider cooking the following examples:

- × Frozen pizza
- × Ready to eat meals
- × Sandwiches

What we mean by a **new meal**

A new meal is a dish that you have never cooked before. Feel free to use any recipe.

What meal(s) are you planning on cooking?

Please let us know

Figure 43: Description of unfamiliar meals shared with participants of fieldwork studies.

2 At the time of the study, we referred to unfamiliar meals as new meals.

A.2.3 *Protocol study*

Protocol study

Steps

1. Call for participants
2. Wait for expression of interest
3. Give a detailed explanation of the study
    Assign participant to cook a regular or new meal
4. Ask participant what meal(s) they have in mind?
    Let them know whether or not the meal(s) qualify for the study
    [If necessary, repeat step 4]
5. Set appointment
6. Send a reminder to the participant a day before the appointment
7. Arrive on time to appointment
8. Build rapport with the participant
9. Ask the participant to sign the consent form
    Explain the study
    Answer participant's questions
10. Ask the participant to grant permission to go to their kitchen
    Talk briefly with the participant about their kitchen
11. Install the camera and find a suitable place to observe
12. Ask the participant to start cooking

Remember to tell about the “talk aloud” protocol

13. Observe and make notes
    Write notes and questions
    Talk with the participant if necessary
14. Wait until the participant finish cooking
15. Talk with the participant about the cooking experience
16. Finish study
    Give Amazon vouchers
17. Offer to help washing dishes and cleaning
18. Leave house

Figure 44: Steps followed in the fieldwork study from recruitment to leaving a participant’s house.

A.3 SURVEY & INTERVIEW

A.3.1 *Demographics survey*

Demographics

I prefer not to say. If you prefer not to answer any of the following questions.

1. Age: What is your age?

____

2. Gender: What is your gender?

____

3. Country of origin: Where are you from?

____

4. Time in UK: How long have you lived in the UK

____

5. Education: What is the highest level of education you have completed?

____

6. Occupation: Are you currently…?

____

7. Household: Type of house? (shared? flat, house, studio)

____

8. Occupants: How many people live in the house?

____

9. Time in current house: How long have you lived in this house?

____

10. Kitchen: How many kitchens does your house have?

____

11. Shared: What do you share in the kitchen?

Utensils ________
Food ________
Essentials (salt, oil, pepper) ________
Cleaning products ________

12. Cooking frequency: How often do you cook? (times per day/week)

____

13. Cooking meals: How many meals do you cook per session?

____

14. Cooking duration: How long does it take you to cook?

____

15. Cooking skills: How do you describe your cooking skills?

____
____

Figure 45: Survey of fieldwork studies.

A.3.2 *Cooking experience interview*

Cooking experience

I prefer not to say. If you prefer not to answer any of the following questions.

1. How would you describe this cooking experience?

Explain any difference with everyday cooking?

2. Did you experience any trouble or difficulty while cooking?

3. Did you experience any opportunity/creative situation while cooking?

4. How do you think technology can help in cooking?

5. Comments, questions, feedback

Figure 46: Interview of fieldwork studies.

B

ADDITIONAL INFORMATION ABOUT ANALYSIS METHODS

This appendix includes information about all the analysis methods explored to analyse the data that inspired the selected analysis methods used on the fieldwork study on cooking (see Chapter 4). The complete set of methods are listed below and are described in greater detail in their corresponding section.

- Appendix B.1 Counting of interactions.
- Appendix B.2 Duration of interactions.
- Appendix B.3 Listing the items involved in each session.
- Appendix B.4 Interactions across stages of cooking.
- Appendix B.5 Item interaction sequence.
- Appendix B.6 Places of interactions.
- Appendix B.7 Varieties of items.
- Appendix B.8 Activities involved in interactions.
- Appendix B.9 Classification of situations.
- Appendix B.10 Network of items' interactions.
- Appendix B.11 Participants' observations.
- Appendix B.12 Estimation of consumption.

B.1 COUNTING OF INTERACTIONS

This method is about counting all the interactions participants have with the items across the cooking sessions.

B.1.1 *Relevance*

This method allows us to identify which items and groups of items are most frequently used, as well as to estimate the average number of interactions of items and groups of items for the complete set of the sessions, identify the sessions with the highest and lowest number of interactions, and generally compare the number of interactions both within and between cooking sessions.

B.1.2 *Method*

Every time a participant touched an item, we counted this as an "interaction." This designation was given whether the participant touched an item with the purpose of using the item or the participant touched an item circumstantially. We counted each interaction regardless of the duration of the event. If, at any point, a participant stopped touching an item, then touched it again, this was counted as two separate interactions.

B.1.3 *Example*

An example of how interactions are counted would be as follows: For a participant retrieving a *can of tomatoes* from a *cupboard* and setting it on the *counter*, letting go of the can to grab the *can opener* which is already laying on the *counter*, then grabbing again and opening the *can of tomatoes* we would count two interactions for the *can of tomatoes*, one interaction for the *can opener*, and one for the *cupboard*. Note that we do not count any interactions with the *counter* as we consider it a place where interactions occur rather than an item.

B.1.4 *Motivation*

The purpose of this method is to answer questions such as:

- Which cooking sessions have more interactions than others?
- Which items have the largest number of interactions?
- How many times do people interact with a given item on average?

This method is inspired by studies aimed to understand the use of CPGs using observational studies (Crabtree and Tolmie, 2016) and the recognition of the use of kitchen utensils using sensing technologies (Wagner et al., 2011) and video sunglasses (Karungaru, 2019).

B.2 DURATION OF INTERACTIONS

This method is about identifying the length of duration in seconds of each of the interactions with items.

B.2.1 *Relevance*

This method allows us to determine the amount of time that people interact with items and groups of items, which can be used to identify aspects like the longest and shortest duration of interactions and general comparisons among subgroups of items and cooking sessions. The method informs about the relevance of interactions with items from a temporal perspective.

B.2.2 *Method*

We obtained the durations of interactions by subtracting the start time from the end time of each of the items' interactions. These time marks corresponded to the time participants started an interaction with an item and the time they finished that particular interaction. For a subgroup of items that have a continuous and autonomous operation like a stove, we counted the whole time that the item was active. Meanwhile, we counted other shorter interactions during the period of the aforementioned items' continuous use.

B.2.3 *Example*

Here we provide an illustrative example of how we determine the duration of interactions. While for a knife the duration of interactions would correspond to the amount of time a participant holds the item in their hand, counting the start of the duration to the time the participant grabs the knife and the end of the interaction when the participant stops touching the knife.

For a kettle the duration of the interactions would correspond to the amount of time the kettle was actively heating the water, the duration of additional interactions like for instance repositioning the kettle would also be accounted for.

B.2.4 *Motivation*

The purpose of this method is to answer questions such as:

- What is the average duration of interactions of a specific item like a bottle of salt?
- What are the items with which people have the longest interactions?
- Are there differences in the duration of items' interactions across cooking sessions?

This method is inspired by studies aimed to recognise the use of kitchen utensils using sensing technologies (Wagner et al., 2011), and computer vision (Nagarajan et al., 2020).

B.3 LISTING THE ITEMS INVOLVED IN EACH SESSION

This method is about listing the items that were employed in each cooking session.

B.3.1 *Relevance*

This method allows for the identification of which items most frequently appeared to be involved in the cooking sessions through their presence or absence with no regard for their number of interactions. Furthermore, this information allows for making comparisons between such things as the food ingredients actually employed in cooking a dish compared to the ingredients suggested in its recipe.

B.3.2 *Method*

We assigned a value of one for items that had at least one interaction during a cooking session, and zero for items that did not have any interactions during that session. In the hopes of achieving a greater depth of understanding, we conducted this analysis method in two distinct ways:

Grouping: Here, we treat a variety of similar forms of an item as one singular item. Different forms of an item are counted as if they were the same item. This method allows us to understand which items were used in preparing each recipe.

Distinct: Here, we counted all the forms of an item distinctly. Different forms of an item result in the counting of as many items as there were forms of the item. This method allows us to understand how many different varieties of an item are used in preparing each recipe.

B.3.3 *Example*

As an example of the grouping method, different forms of knives in a session such as small, large, fillet, and meat cleaver would all be counted as simply a "knife." An example of the distinct method, the three versions of the knife previously mentioned would be counted individually; resulting in a count of four knives "small", "large", "fillet" and "cleaver."

B.3.4 *Motivation*

The purpose of this method is to answer questions such as:

- Which items are more frequently employed across all the cooking sessions?
- What is the average number of items employed in a cooking session?
- Do people use different items when they cook a new meal compared to a familiar meal?

This method was inspired by the need to try to further identify the relevance of items not only by their number of interactions, but also their use across various cooking sessions. Food diaries studies (Pendergast et al., 2017), food ingredients recognition methods (Bolaños, Ferrà, and Radeva, 2017), and frameworks to list ingredients in a recipe informed this method (Yokoi et al., 2015).

B.4 INTERACTIONS ACROSS STAGES OF COOKING

This method is about identifying in which of the stages of the cooking sessions the interactions with the items take place.

B.4.1 *Relevance*

This method allows us to identify whether or not items have more interactions at a particular stage than others, as well as to determine whether certain stages contained a significantly higher number of interactions than others, among other comparisons evaluating other factors such as cooking sessions and participants.

B.4.2 *Method*

The stages were determined by two methods: one by dividing each session into n intervals of equal time (with the size of those intervals varying in proportion to the total length of the session), and the other by identifying three commonly known stages of cooking: preparation, heating and serving. To assign each item to one of the stages we took into consideration only the start time of the interaction.

B.4.3 *Example*

As an example, for a cooking session that had a total length of thirty-six minutes, we would divide it into three stages of twelve minutes. Then, for an interaction of an item in that cooking session with a start time at the five minute mark, we would assign that item interaction to the first stage.

B.4.4 *Motivation*

The purpose of this method is to answer questions such as:

- At which stage(s) is a given item detected to have more interactions?
- Are there items that have more interactions in one stage than others?
- Are differences in the stages the items detected to have interactions among people?

This method was inspired during the exploratory data analysis as we perceived that there were items that one would think should have had significantly more interactions in particular sections of the cooking session. We also informed our method by using stages of cooking as referenced in other studies (Torkkeli, Mäkelä, and Niva, 2018).

B.5 ITEM INTERACTION SEQUENCE

This method aims to establish the sequences of interactions people interacted with items.

B.5.1 *Relevance*

This method gives us a perspective on the order of items interactions based on their interactions and provides insights into the flow of the cooking sessions. Furthermore, for each item we can identify which items are interacted before, concurrent with, and after any item of interest.

B.5.2 *Method*

For each item, first we referenced the start and end time of each of their interactions. Then, we considered three possibilities for placement in their sequence:

"Before" for items with interactions that have an end time prior to the start time of the item of interest's interaction.

"Concurrent" for items with interactions for which the start and/or end times occur during the duration of the item of interest's interaction.

"After" for items with interactions that have a start time following the end time of the item of interest's interaction.

For "before" and "after" placement in the sequence, we limited the items to consider those that fall within a defined interval of time (e.g. 10 seconds) both prior to the start of or following the end of the item of interest's interaction. This is necessary to avoid considering all items in the session and to attempt to capture the flow of item usage in a meaningful way.

B.5.3 *Example*

To provide an example, the sequence of interactions of leaving a *glass* on the *counter*, then grabbing a pot from the other side of the *counter*, then filling the pot with water from the tap, then placing the pot back on the *counter*, and finally grabbing a phone to scroll down the recipe page would be registered as *glass* > *pot* > *tap* > *water* > *phone*. Taking the pot as the item of interest, the glass would be listed as a "before" interaction, tap and water would be listed as "concurrent" interactions, and phone would be listed as an "after" interaction.

B.5.4 *Motivation*

The purpose of this method is to answer questions such as:

- Which items are more commonly interacted with concurrently with other items?
- Are there items for which their interactions preceded the interactions of other items?
- Which items have interactions around the time of the interactions of other items?

This method was inspired by the need to get a sense of the workflow during cooking, as we think that the sequence of interactions could provide a richer understanding of how interactions with items occur. Studies about sequential event prediction, of how the use of an event could predict others, although not strictly a cooking study, informed this method (Singer and Lemmerich, 2016).

B.6 PLACES OF INTERACTIONS

This method is about describing the defined areas within the kitchen where the item interactions take place.

B.6.1 *Relevance*

This method allows us to identify the areas in the kitchen where items potentially have more interactions. In addition, we can make comparisons among items and groups of items to determine whether or not their interactions take place in different areas.

B.6.2 *Method*

We divided the kitchen into eight areas that cover all the places where the interactions with the items occurred: counter, cupboard, drawer, floor, fridge, sink, stove, and table. For this analysis we took into consideration only a subset of 22 CPGs and utensils with the largest number of interactions. We visually identified and noted the areas by re-watching a subset (10%) of the total interactions of the selected items. We selected the subset of the interactions for each of the cooking by first counting the number of interactions and then we calculated the number of interactions to select. We then divided the interactions into as many groups of the interactions to take and randomly select an interaction for every group. We limited our observations because of time limitations to watch again all the interactions and because we believed that we could get a fair estimation with a subset of the interactions.

B.6.3 *Example*

As an example, in a cooking session in which the participants have twenty interactions with the trash bin, we divide the interactions in two groups of ten. Then we randomly select one interaction within each of those groups; interactions number six and fourteen for example. Finally, we watch those interactions and record the area where the interactions with the trash bin take place; floor and sink for example.

B.6.4 *Motivation*

The purpose of this method is to answer questions such as:

- What are the areas of the kitchen where people have the most interactions with items?
- Which areas do people have interactions with a specific item?
- Are there differences in the areas in which people have interactions with a specific item depending on the type of meal?

The purpose of this method is to identify the places where the interaction with items takes places as this could inform the design of interactions. This method was inspired by the study of the places of interactions with items "interactional zones" (Crabtree and Tolmie, 2016) and "spatial zones of interaction" (Nagarajan et al., 2020).

B.7 VARIETIES OF ITEMS

This method is about describing the different versions for the items involved in cooking.

B.7.1 *Relevance*

This method allows us to identify the specific variety of items that were classified together under the same item name. Through this method, we can reveal differences between items that otherwise would be classified as a single uniform item.

B.7.2 *Method*

We selected a subset of CPGs and utensils with the largest number of interactions (n = 22) and isolated a percentage of videos containing their interactions in the same manner as we do select the subset of videos in "Places of Interactions" methods. We then made classifications about the variety of the items based on the relevant characteristics for each item based on distinct aspects for each item such as shape, form, size, color, and packaging.

B.7.3 *Example*

As an example, after watching a subset of videos for the item "cheese," we would identify the different varieties according to commonly known varieties of cheese that one can find in the supermarket such as parmesan, mozzarella, cheddar, mascarpone and ricotta, among others.

B.7.4 *Motivation*

The purpose of this method is to answer questions such as:

- How many varieties of a specific item people have interactions with?
- What are the items that have the most number of varieties of items?
- Are there differences between CPGs and utensils about their average number of varieties per item?

This method was designed in order to get a sense of the varieties of the forms, shapes, presentations, etc. the items used in cooking can be found in. We observed that items classified under the same name come in different varieties and decided to account for that. A quick search of an item like salt in an online supermarket website confirms the different varieties of an item (Tesco, 2019).

B.8 ACTIVITIES INVOLVED IN INTERACTIONS

This method is about describing the activities (mechanical skills) that people perform using the items.

B.8.1 *Relevance*

This method allows us to identify the activities associated with items, which although we can infer from the previous data, cannot be verified. We can identify what people accomplish with the items, how many different activities people accomplish with the items, and whether there are differences among groups of items.

B.8.2 *Method*

We selected a subset of CPGs and utensils with the largest number of interactions (n = 22) and isolated a percentage of videos containing their interactions in the same manner as we do select the subset of videos in "Places of Interactions" methods. We then made classifications about the activity that people accomplished using the item. We obtained the classification of activities using the classification of other studies in combination with our observations.

B.8.3 *Example*

As an example, for the item bottle of salt after watching a subset of videos, we would identify the different activities according to our established but still flexible list of activities which could have included reposition, retrieve, store, and sprinkle.

B.8.4 *Motivation*

The purpose of this method is to answer questions such as:

- What are the most common activities that people accomplish with items?
- How many activities do people accomplish with items on average?
- Are there differences between the activities people accomplish in the different types of meals?

The method was inspired by observations of the videos at identifying the items employed to accomplish different activities. We were inspired by the concept of affordances in HCI (Norman, 2013) and the detection of activities in cooking using computer vision (Nagarajan et al., 2020) and sensing systems (Wagner et al., 2011).

B.9 CLASSIFICATION OF SITUATIONS

This method is about the classification of a subset of specific situations during cooking that we deem most relevant to those interested in designing interventions for items interacted with during the cooking process.

B.9.1 *Relevance*

This method allows us to better understand the cooking process focusing in greater detail on specific situations that otherwise cannot be fully captured using our more quantitative methods.

B.9.2 *Method*

We identified each of these situations using one of the following methods: observing the videos and looking for interesting situations, reading over the field notes for situations that we found noteworthy, listening to the participants' comments during the cooking process and their interviews after the session, and analyzing the numerical data using R. We further divided the situations into two categories:

- Problematic: Situations that pose an apparent difficulty to the participant that they have to find a way to overcome or otherwise would affect the cooking.
- Remarkable: Situations involving novel or creative approaches that made them stand out from the conventional expectations of how steps are performed in cooking.

B.9.3 *Example*

An example of a problematic situation would be having to remove an excess of an ingredient as participants have to find a way to fix the meal. An example of a remarkable situation would be using an empty package as a temporary rubbish bin as this helps people to dispose of trash in a more efficient manner.

B.9.4 *Motivation*

The purpose of this method is to answer questions such as:

- What were the situations that led people to make mistakes?
- How problematic situations are represented in data?
- What are the unorthodox ways in which people interact with items?

This method was inspired during the observation of interesting situations in the cooking process during the observational study, video observations, and data analysis. We also inform the development of the analysis method by the body of literature concerning the identification of problems as an inspiration for guiding ideas for design (Buchanan, 1992) creativity in cooking and everyday life (McCabe and Waal Malefyt, 2015) and the development technology that supports people in cooking (Yonezawa et al., 2019).

B.10 NETWORK OF ITEMS' INTERACTIONS

This method allows us to have a visual representation though visual network of the interactions that the items had among themselves.

B.10.1 *Relevance*

The visualization gives a sense of the way items were interacted with during a given cooking session. We can make inferences about the connections of the items through network analysis and infer the use and relevance of items by looking at the visualizations. For instance, a cluster of items could suggest that those items are used in combination, while nodes with a prominent size suggest the relevance of those items in the cooking process.

B.10.2 *Method*

Each item was represented with a node, and edges connecting nodes represented their interactions. The size of the nodes represents the number of interactions that the node was involved in, and the proximity between any two connected nodes correlates with the number of interactions between them.

B.10.3 *Example*

To provide an example, for an onion that was sliced and then fried in a pan, we would note the following interactions: onion-chopping board, knife-onion, knife-chopping board, onion pan, onion oil, oil pan, and palette onion. In this situation, the onion would be the node with the bigger size because it has the largest number of interactions, and oil and chopping board would the items with the smaller nodes.

B.10.4 *Motivation*

The purpose of this method is to answer questions such as:

- Which items are central for recipes?
- Are there differences in the network representations of recipes among participants?
- Which items have many interactions in combination?

This method was inspired by our observations that some items commonly appear to be used in combination with other items. It was inspired by epistemic network analysis (Shaffer, 2017a), and social network analysis (Hansen and Smith, 2014), particularly applied to practices such as laundry (Higginson et al., 2015) and food practices (Lawo et al., 2020).

B.11 PARTICIPANTS' OBSERVATIONS

This method is about integrating the ideas expressed from the participants during the cooking session and the subsequent interview at the end of each cooking session.

B.11.1 *Relevance*

This method allows us to gather the ideas about aspects of the sessions that people consider relevant, as well as their suggestions and perspectives regarding the cooking process and the use of items.

B.11.2 *Method*

We conducted a semi-structured interview at the end of each cooking session and encouraged people to mention any situation that they considered relevant while they were cooking. We then transcribed the conversations and analyzed the data using thematically inspired analysis, focusing our analysis on the people's perception of CPGs.

B.11.3 *Example*

A common example of how people envision smart versions of CPGs is that they do not see how much room for improving CPGs through technology "Technology, I would embrace it. . . . I just can't think of anything until somebody shows me." Participant (20) who used a smart assistant and smart watch for cooking.

B.11.4 *Motivation*

The purpose of this method is to answer questions such as:

- How do people propose that the items can be improved?
- What do people think about the items?
- What ideas do people have about smart versions of CPGs?

This method was inspired by the need to include people's views and opinions to our mixed method research. We believe that people are experts in the use of CPGs, and their ideas are as valuable as the information we can obtain from other means. We used participatory design as we strive to incorporate the opinion of the participants to understand the cooking process (Muller and Kuhn, 1993).

B.12 ESTIMATION OF CONSUMPTION

This method is about obtaining an estimation of the extent to which CPGs are consumed during the cooking process.

B.12.1 *Relevance*

This method allows us to estimate whether the CPGs could have been used in more sessions besides the session in which we made observations.

B.12.2 *Method*

The estimates were made by the researcher through a visual inspection of the videos and their knowledge of the cooking session. This applies exclusively to CPGs and no other items, as CPGs are the only items that are depleted upon each use. This does not apply to other items such as knives that do not experience noteworthy depletion with each use, and aspects like the degradation of the blade's sharpness are not significant for the purposes of our study.

B.12.3 *Example*

An example of making such an estimation can be explained with a bag of frozen greens: If half of the contents of the bag are consumed, but still a portion of the product remains in the bag, we would estimate that half the frozen greens were consumed but the package of greens was not finished.

B.12.4 *Motivation*

The purpose of this method is to answer questions such as:

- What percentage of CPGs are completely consumed during a cooking session?
- How much of a particularly item is consumed during cooking?
- Which items are more likely to be consumed over multiple sessions?

This method was inspired by the need to have an estimation of the life expectancy of CPGs given their nature of having relatively short lifespans in terms of their utility (Carlsson-Kanyama, Ekström, and Shanahan, 2003).

C

DATA SET AND ANALYSIS SCRIPT OF FIELDWORK STUDIES

This appendix includes an example of a dataset of the cooking study (Chapter 4) and a fragment of the R script for data analysis. The appendix also contains the link to the repository of both the data sets and the analysis scripts.

- Appendix C.1 provides an example of a dataset of the cooking study.
- Appendix C.2 provides a fragment of a script of the R project used to analyse the datasets.

C.1 FIELDWORK DATA SET

order	items	items_uniq	type	start	end	duration	comments
1	bread	0	c	00:00:48	00:00:54	00:00:06	
2	case	glasses	u	00:00:56	00:01:06	00:00:10	
3	bellPepper	0	c	00:01:14	00:01:16	00:00:02	
4	eggs	0	c	00:01:16	00:01:18	00:00:02	
5	cheese	parmesan	c	00:01:16	00:01:18	00:00:02	
6	glassWine	1	u	00:01:28	00:01:32	00:00:04	
7	cider	0	c	00:01:28	00:01:32	00:00:04	
8	documents	0	u	00:01:36	00:01:38	00:00:02	
9	bellPepper	0	c	00:01:40	00:01:44	00:00:04	
10	chopB	blue	u	00:01:48	00:01:58	00:00:10	
11	chopB	gray	u	00:01:48	00:01:58	00:00:10	
12	mushrooms	0	c	00:02:00	00:02:08	00:00:08	
13	cpB	b_st_1	e	00:02:08	00:02:12	00:00:04	
14	pot	0	u	00:02:14	00:02:20	00:00:06	
15	towel	1	u	00:02:16	00:02:18	00:00:02	
16	cpB	a_st_1	e	00:02:20	00:02:36	00:00:16	
17	spaghetti	0	c	00:02:32	00:02:52	00:00:20	
18	stove	0	e	00:02:54	00:54:44	00:51:50	stove on
19	pot	0	u	00:03:00	00:03:30	00:00:30	
20	faucet	0	e	00:03:04	00:03:32	00:00:28	
21	water	0	c	00:03:04	00:03:32	00:00:28	
22	spaghetti	0	c	00:03:36	00:05:02	00:01:26	reading label
23	pot	0	u	00:05:02	00:05:08	00:00:06	
24	oil	olive	c	00:05:04	00:05:10	00:00:06	
25	salt	0	c	00:05:10	00:05:12	00:00:02	
26	spaghetti	0	c	00:05:14	00:05:18	00:00:04	
27	phone	0	u	00:05:16	00:05:18	00:00:02	
28	glassWine	1	u	00:05:22	00:05:26	00:00:04	
29	cider	0	c	00:05:22	00:05:26	00:00:04	
30	mushrooms	0	c	00:05:28	00:05:54	00:00:26	
31	towel	1	u	00:05:58	00:06:00	00:00:02	
32	mushrooms	0	c	00:06:00	00:07:48	00:01:48	
33	faucet	0	e	00:06:16	00:07:44	00:01:28	
34	water	0	c	00:06:16	00:07:44	00:01:28	
35	bowl	blue	u	00:06:20	00:07:48	00:01:28	
36	faucet	0	e	00:06:34	00:07:44	00:01:10	
37	water	0	c	00:06:34	00:07:44	00:01:10	
38	trashB	0	u	00:07:32	00:07:34	00:00:02	plastic bag
39	trashB	0	u	00:07:52	00:07:54	00:00:02	
40	faucet	0	e	00:07:54	00:07:56	00:00:02	
41	water	0	c	00:07:54	00:07:56	00:00:02	
42	towel	1	u	00:07:56	00:08:08	00:00:12	
43	spaghetti	0	c	00:08:10	00:08:16	00:00:06	
44	mushrooms	0	c	00:08:16	00:08:42	00:00:26	

Figure 47: Example of a fragment of raw data collected on item interactions.

Information about the data set

The dataset contains the following information for each of the items' interactions:

- order: The position of the interaction of the item.
- items: The name of the item.
- item_uniq: Specific name of the item, which was particularly relevant if more than one of the same item was used. An example includes items (oil) and "items_uniq" (olive). This is because it is likely more than one oil was used in that recipe.
- type: One of the following three types: CPGs (c), utensils (u) or environment (e).
- start: The time when participants began an interaction with an item.
- end: The time when participants ended an interaction with an item.
- duration: The length of an item interaction (end time – start time).
- comments: Those include situations worthy of special note and review.

Directory of the online repository containing the annotated data:

Please find the data set in the following repository: https://rdmc.nottingham.ac.uk/handle/internal/9513

C.2 SCRIPT FOR DATA ANALYSIS

```

#create concatenated df of reg and new
reg.list.concat <- do.call("rbind", reg.list)
new.list.concat <- do.call("rbind", new.list)

#create concatenated df of both reg and new
reg.list.concat$session <- "reg" #add session column to df
new.list.concat$session <- "new"
# merge data frames
reg.new.concat <- rbind(reg.list.concat,  new.list.concat)


# ================ 1. counting of items interactions for each participants  ================
# get frequency of use for each item and for all participants

freqs.analysis <- function(session){
  # change the name more function like name
  # select data
  if (session == "reg"){
    session.list <- reg.list
    len.session.list <- 1
  }
  else if (session == "new"){
    session.list <- new.list
    len.session.list <- 1
  }
  else if (session == "both"){
    session.list <- list(reg.list, new.list)
    len.session.list <- 2
  }
  else{
    stop(sQuote(session), "session should equal to either \"reg\" (regular) or \"new\" (new) or \"both\" (
  }

  # get numbber of cooking sessions (take into acount whether  list is simple or concatenated )
  cooking.sessions <- len.session.list * participants

  # data frame columns
  cols.names <-  c("items", 1:cooking.sessions)
  len.cols.names <- length(cols.names)

  # create freqs data frame to store calculations
  freqs.df <- data.frame()
  for (col in cols.names){freqs.df[[col]] <- as.numeric()}
  freqs.df[nrow(freqs.df)+len.items.names,] <- NA #add empty NAs
  freqs.df[,1] <- items.names

  # iterate over session types (reg and/or new)
  for (s in 1:len.session.list){

    # assign the session type to the session list object
    if (len.session.list == 2)
    {
      this.session.list <- session.list[[s]]
    }
    else if (len.session.list == 1){
```

Figure 48: Example of the R code used for data analysis.

Directory of the Github repository containing the scripts:

https://github.com/GustavoBerumen/CookingProject

D

ADDITIONAL DOCUMENTS ON DESIGN WORKSHOP STUDIES

This appendix includes additional information on the design workshop studies (Chapters 6 & 7):

- Appendix D.1 provides the information sheet and consent form given to participants prior to the study.
- Appendix D.2 provides the the study guidance documents.

D.1 consent form & information sheeet

D.1.1 *Consent form*

CONSENT FORM

University of Nottingham
UK | CHINA | MALAYSIA

Date: 18/03/2021

Project: Designing Smart Consumer Goods Workshops

School of Computer Science Ethics Reference: CS-2019-R61

Funded by: Horizon Centre for Doctoral Training at the University of Nottingham (UKRI Grant No. EP/P510592/1) and by Unilever UK Ltd

Please tick the appropriate boxes	**Yes**	**No**
1. Taking part in the study		
a) I have read and understood the project information sheet dated 18/03/2021, or it has been read to me. I have been able to ask questions about the study, and my questions have been answered satisfactorily to my satisfaction.	□	□
b) I consent voluntarily to be a participant in this study and understand that I can refuse to answer any questions. I also understand that I can withdraw from the study at any time, without having to give a reason.	□	□
c) I understand that taking part in the study requires that I take part in an online workshop, and allow the researcher of this study to collect the following data: ● Audio recording of my conversations in the workshop. ● Pictures of the any sketches that I will produce during the workshop. ● Video recordings of my participation in the workshop **(Optional).**	□	□
2. Use of my data in the study		
a) I understand that any data which could be used to identify me will not be shared be outside of the researcher team of this study.	□	□
b) I agree that anonymized and processed copies of my data (i.e. data that do not contain any personally identifiable information) may be used for the following purposes:		
– Presentation and discussion of the project and its results in research (e.g. presentations)	□	□
– Publications and reports describing the project and its results.	□	□
– Dissemination of the project and its results, including publication of data.	□	□
– To be shared to other researchers (e.g. a journal reviewer) at a reasonable request	□	□
– To be re-used for other studies (e.g. as a comparison in future work)	□	□
c) I give permission for my words to be quoted for the purposes described listed above, but only provided that my identity has been protected by using a pseudonym.	□	□
d) I give permission for my visual images, which include photos of my sketches and notes to be used for the purposes described listed above. This only after my identity has been protected by removing any personal information or data.	□	□

[School of Computer Science model consent form, last updated 2018-05-22] 1

Figure 49: Consent form: Workshop studies on cooking (p. 1).

Please tick the appropriate boxes **Yes** **No**

3. Reuse of my data

a) I give permission for the anonymized data that I provide to be reused for the sole purposes of future research, publications, presentations and learning. ☐ ☐

b) I understand and agree that this may involve depositing my data (only after anonymization in a data repository), which may then be accessed by other researchers at a reasonable request. ☐ ☐

4. Security of my data

a) I understand that safeguards will be put in place to protect my identity and my data both during my participation of the study as well as after, when the data is stored for future use usages. ☐ ☐
The safeguards include:

- Storing my raw data in a password-protected computer and in a secure digital repository provided by the University of Nottingham. Only the research team of this study will have access to the raw data.

b) I confirm that a written copy of these safeguards has been given to me in the University's privacy notice, and that they have been described to me and are acceptable to me. ☐ ☐

c) I understand that no computer system is completely secure and that there is a risk that a third party could obtain a copy of my anonymised data. ☐ ☐

5. Copyright

a) I give permission for data gathered during this project to be used, copied, excerpted, annotated, displayed and distributed for the purposes to which I have consented. ☐ ☐

b) I give permission for my data to be used to create the patent of a product invention. The rights of the patent of the product invention will belong to the University of Nottingham and Unilever UK LTD. ☐ ☐

6. Signatures (sign as appropriate)

______________________ ____________________ ________

Name of participant (IN CAPITALS) Signature Date

If applicable:

For participants unable to sign their name, mark the box instead of signing

Figure 50: Consent form: Workshop studies on cooking (p. 2).

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

JOSE GUSTAVO BERUMEN		
Name of researcher (IN CAPITALS)	Signature	Date

7. Researcher's contact details

Name: Jose Gustavo Berumen Salazar

Phone: 07510 8618 47

Email: gustavo.berumen@nottingham.ac.uk

Provide the participant with a copy of the completed form either by email or hard copy as they prefer.

[School of Computer Science model consent form, last updated 2018-05-22] 3

Figure 51: Consent form: Workshop studies on cooking (p. 3).

D.1.2 *Information sheet*

PROJECT INFORMATION

University of Nottingham
UK | CHINA | MALAYSIA

Date: 18/03/2021

Project: Designing Smart Consumer Goods Workshops

School of Computer Science Ethics Reference: CS-2019-R61

Funded by: Horizon Centre for Doctoral Training at the University of Nottingham (UKRI Grant No. EP/P510592/1) and by Unilever UK LTD.

Purpose of the research.

This study aims to create a collaborative environment during a workshop to create sketches of smart food-related consumer goods.

We seek to have a conversation about your experience in product development, as well as your use of data for design. We are interested in any stages of the product development process from idea generation to introduction in the market. We will not ask for any specific information about your work, but instead, we will discuss your work practices in general terms. For example, we may ask what kind of products you have helped develop, but we will not ask the name of the company you work.

We will also facilitate a discussion of your views about consumer goods, cooking, and smart products. We will provide you information about these topics in an organized manner so you can easily express your ideas. We will present *design tools* that we devised for this workshop, which you can use to design smart products. These tools include *design cards* and *data visualisations,* and you will be able to access them in Miro, an online collaborative digital whiteboard. You will be required two low-fidelity sketches of smart products. We consider a sketch as any kind of written material to represent your ideas such as a list of concepts, drawings, and diagrams.

We aim to use the results of this study to evaluate the value of data product development. The results will also be used as the basis of a chapter for a thesis, and potentially could be part of an academic publication.

Nature of participation.

Your participation is voluntary and in order to participate you (the participant) should read and sign the "Consent form" document provided to you. Once you have understood the nature of your participation and we have answered any questions, you will be able to take part in this study.

Participant engagement.

Your participation involves taking part in one workshop that has a duration of 1 hour and 30 minutes approximately. You will be asked to engage in the aforementioned conversations and then create sketches of smart versions of products. We will record and audio recording of the conversation and ask you to take and

1

Figure 52: Information sheet: Workshop studies on cooking (p. 1).

share pictures of your sketches. We have prepared a series of activities that will help you to express your ideas in a respectful environment.

The workshop will take place online through a video call using Microsoft Teams. We will ask you to find a quiet room at your home or office or any other safe space where you can use a laptop, tablet, desktop or phone with connection to the Internet.

Only after your authorization, we will start an audio recording of your participation during the workshop. Optionally, we would also record a video recording of the video call including your use of Miro. You will be asked whether you would like to give permission to record the video. We will ask you to take photographs of your sketches and share those photographs with us. We will advise you about turning off the location of your phone before you take the pictures. Otherwise, you may unwillingly share your location (e.g. address) with us.

Benefits and risks of the research.

Your participation will help us to understand how data can be used as a resource for designing smart products. In addition, your participation will help us to understand people's perception of consumer goods, cooking and smart products. The understanding from this study will help us to understand the relevance of data for design and to identify design opportunities that could help us to create smart products.

There are no risks associated with participation beyond those typically associated with having an online conversation, accessing the internet, and using office materials such as paper and markers.

Use of your data.

Only the research team (PhD student and academic supervisors) will be authorized access to the originally raw collected data. Only the research team will have access to non-anonymised data, such as the audio recordings of the workshop. Only anonymized data and processed data (i.e. transcripts of the conversations and analysed data of the workshop sessions that do not contain any personally identifiable information) will be used as the basis for a chapter of a thesis. Part of your data could potentially be used for an academic publication.

All the data will be stored on a secure digital repository provided by the University of Nottingham. Anonymized and processed data could be made available to other researchers only after approval from the research team if they deem the request to be reasonable in that it maintains the anonymity of the participants. We will use pseudonyms in any resulting publication, and your faces will be blurred so you cannot be identified. Additionally, any private information that can be used to identify you will be omitted.

It is possible that the data we collect from your participation could be used to develop a product or invention that may then be patented. In this case, the rights of the patent will belong to the University of Nottingham and Unilever UK LTD. The product or invention will be the result of further research in which part of your data may be in combination with data from other participants involved in the study. You can approve or deny the use of your data for this purpose in the Consent Form document.

2

Figure 53: Information sheet: Workshop studies on cooking (p. 2).

Personal data collected will be held in a secure and safe manner in accordance with the Data Protection Act 2018. However, no computer system is perfectly secure and it is always possible that a third party might gain unauthorised access to the collected data.

Future use of your data.

Your anonymised data may be archived and reused in future for purposes that are in the public interest, or for historical, scientific or statistical purposes.

Procedure for withdrawal from the research.

You may withdraw from the workshop hence the study at any time and do not have to give reasons for why you no longer want to take part.

To withdraw during the study, you will only need to inform one of the researchers of your decision during the workshop. If you decide to withdraw after your participation in the study, you can express that decision by communicating with the researchers using the email and phone contacts provided in the consent form. In both cases, you will not need to provide any reason for your decision. If you receive no response from the researcher, please contact the School of Computer Science's Ethics Committee.

You will have complete authorization to decide whether the researchers can keep your data; your personal information and any materials produced during the workshop. However, in the case of the mixed data that will be produced, if there is more than one participant during the workshop, complete removal might not always be possible. This is because your information will be integrated with that of the rest of the participants such that complete withdrawal would result in the loss of all the data. Still, in these kinds of circumstances, we will delete as much of your data as possible and offer to paraphrase your contributions to make them more general and unidentifiable.

This research is being conducted by research staff from the Mixed Reality Lab at the University of Nottingham. This research project is supported by Horizon Centre for Doctoral Training at the University of Nottingham (UKRI Grant No. EP/P510592/1) and by Unilever UK Ltd. It has been reviewed and approved by the University of Nottingham, School of Computer Science Research Ethics Committee.

If you have questions please talk to a member of the research team, or after the event contact: Jose Gustavo Berumen Salazar, C10a, School of Computer Science, The University of Nottingham, Jubilee Campus, Nottingham NG8 1BB; email: gustavo.berumen@nottingham.ac.uk

Contact details of the ethics committee.

If you wish to file a complaint or exercise your rights, you can contact the Ethics Committee at the following address: cs-ethicsadmin@cs.nott.ac.uk

3

Figure 54: Information sheet: Workshop studies on cooking (p. 3).

D.2 STUDY INVITATION

D.2.0.1 *Consumers workshop*

Invitation Designing Enhanced CPGs – Consumers

Study Overview

We are interested in finding out how data can be used for designing new products that can help people with cooking.

We are looking for participants to take part in an **online workshop** where together we will create sketches of smart products.

Requirements

You should
- Be 18 years old (or older)
- Own a computer or laptop
- Own a smart phone
- Have connection to internet
- Have sheets of paper and pens

Tasks

- Join an online workshop at the time of your convenience
- Express your ideas about cooking, consumer goods and smart products.
- Write down your thoughts during the workshop
- Make sketches of smart products (e.g. drawings). **No technical drawing skills required**
- Be available for approximately 1 hour and 30 minutes

Benefits

- £15 Amazon voucher ☺
- Have the chance to understand more about your own cooking process.
- Help researchers to understand the value of data for designing smart products.
-

Interested

Are you interested? Find out more here https://gustavoberumen.github.io/deswor/ (example website).

Contact Details
If you have any questions, comments or concerns, please feel free to reach out!
Gustavo – gustavo.berumen@nottingham.ac.uk

Figure 55: Invitation to workshop study (consumers) given to potential participants.

D.2.0.2 *Designers workshop*

Invitation Designing Enhanced CPGs – Designers

Study Overview

We are interested in finding out how data can be used for designing new products that can help people with cooking.

We are looking for professionals participants to take part in an **online workshop** where together we will create sketches of smart products.

Requirements

You should

- Have at least one year of experience in any stage of product development from ideation generation to introduction in the market. Software developers, graphic designers, UX researchers, among others are welcome.
- Be 18 years old (or older)
- Own a computer or laptop
- Own a smart phone
- Have connection to internet
- Have sheets of paper and pens

Tasks

- Describe your experience in product develop and in the use of data for design
- Join an online workshop at the time of your convenience
- Express your design practices and the use of data for design
- Express your ideas about cooking, consumer goods and smart products.
- Write down your thoughts during the workshop
- Make sketches of smart products (e.g. drawings). **No technical drawing skills required**
- Be available for approximately 1 hour and 30 minutes
- Allow to record an audio of the conversation (and optionally video of your participation) during the workshop

Benefits

- £40 Amazon voucher ☺
- Have the chance to understand more about your own cooking process.
- Help researchers to understand the value of data for designing smart products.

Interested

Are you interested? Find out more here https://gustavoberumen.github.io/deswor/

Contact Details

If you have any questions, comments or concerns, please feel free to reach out!
Gustavo – gustavo.berumen@nottingham.ac.uk

Figure 56: Invitation to workshop study (designers) given to potential participants.

E

ADDITIONAL INFORMATION WORKSHOP STUDIES

The appendix provides images of the design resources as well as the workshop used to conduct the design workshop studies (Chapters 6 & 7). This appendix includes an example of a transcript of the conversation captured during the workshop studies as well as one of the design sketches created by participants and a repository link for the complete set of these elements.

- Appendix E.1 provides images of the design resources and design workshop.
- Appendix E.2 provides examples of the data visualisations.
- Appendix E.3 provides an example of a transcript of a conversation and the link of the repositories of these datasets.
- Appendix E.4 provides a complete example of the sequence of frames for a design workshop.

E.1 DESIGN TOOLS

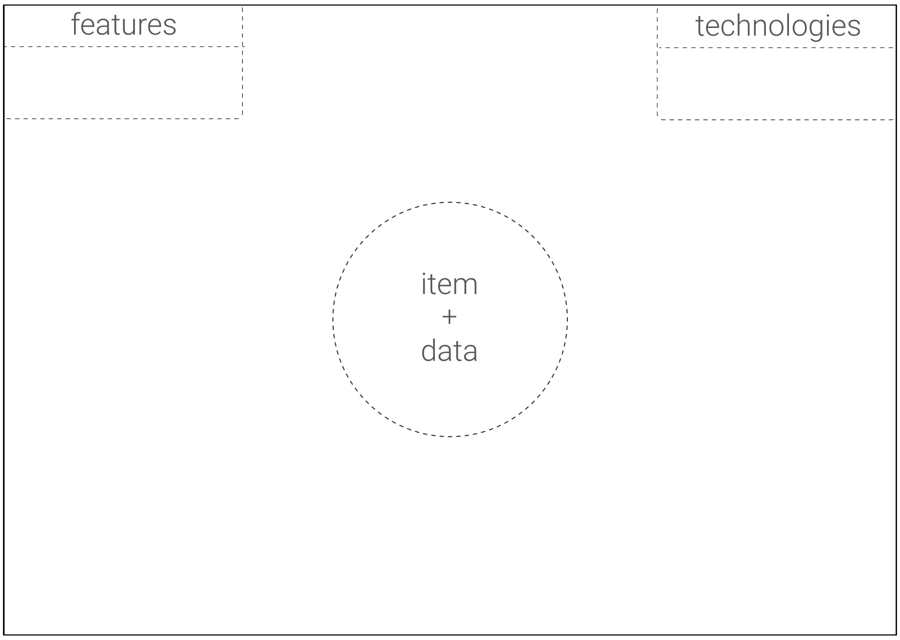


Figure 57: Design sheet.

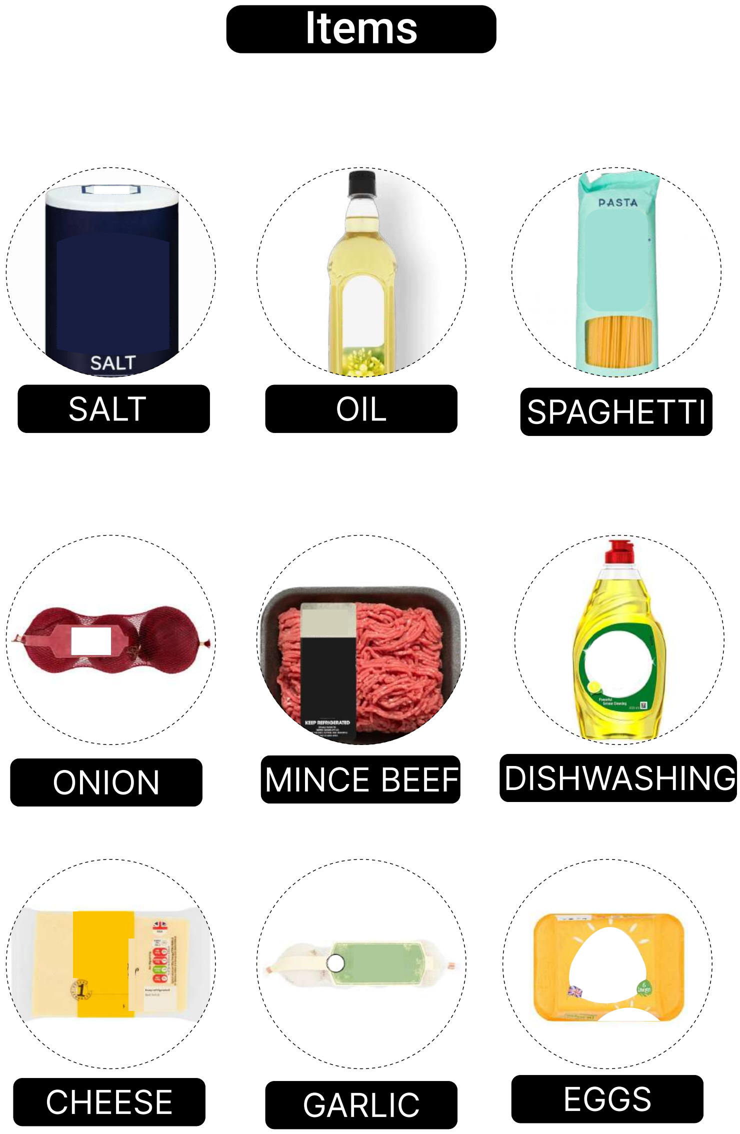


Figure 58: Design cards: Items.

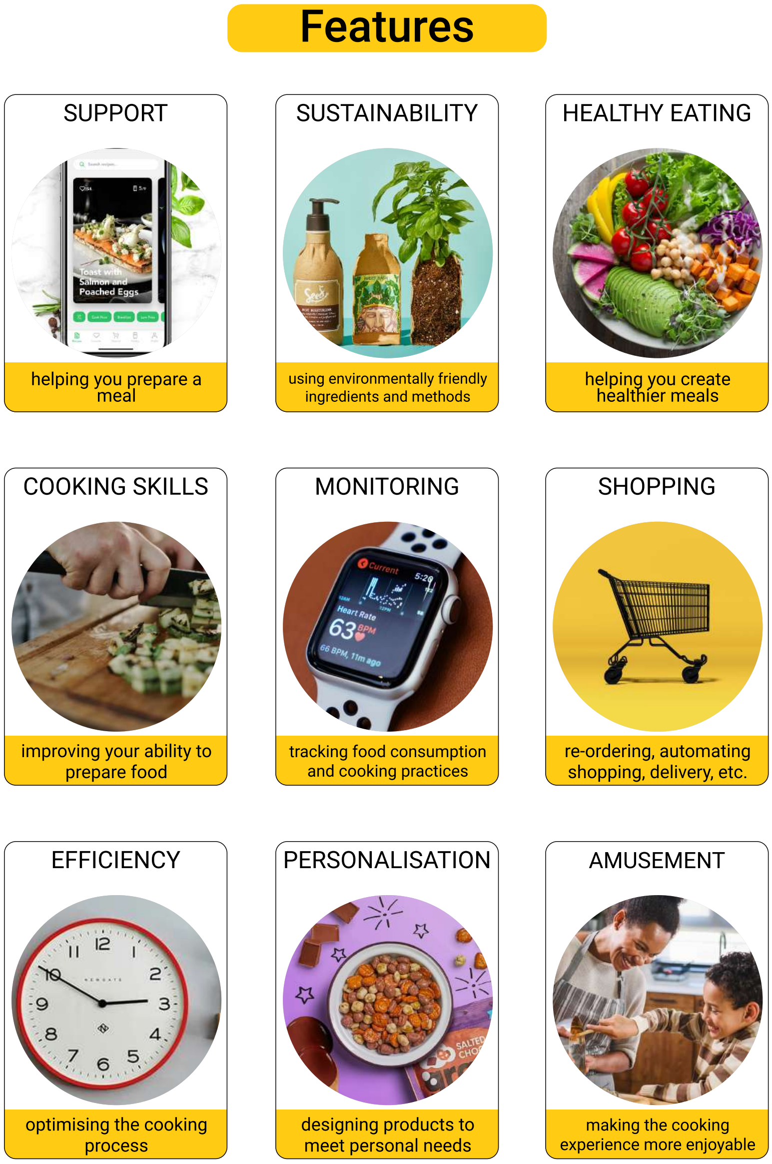


Figure 59: Design cards: Features.

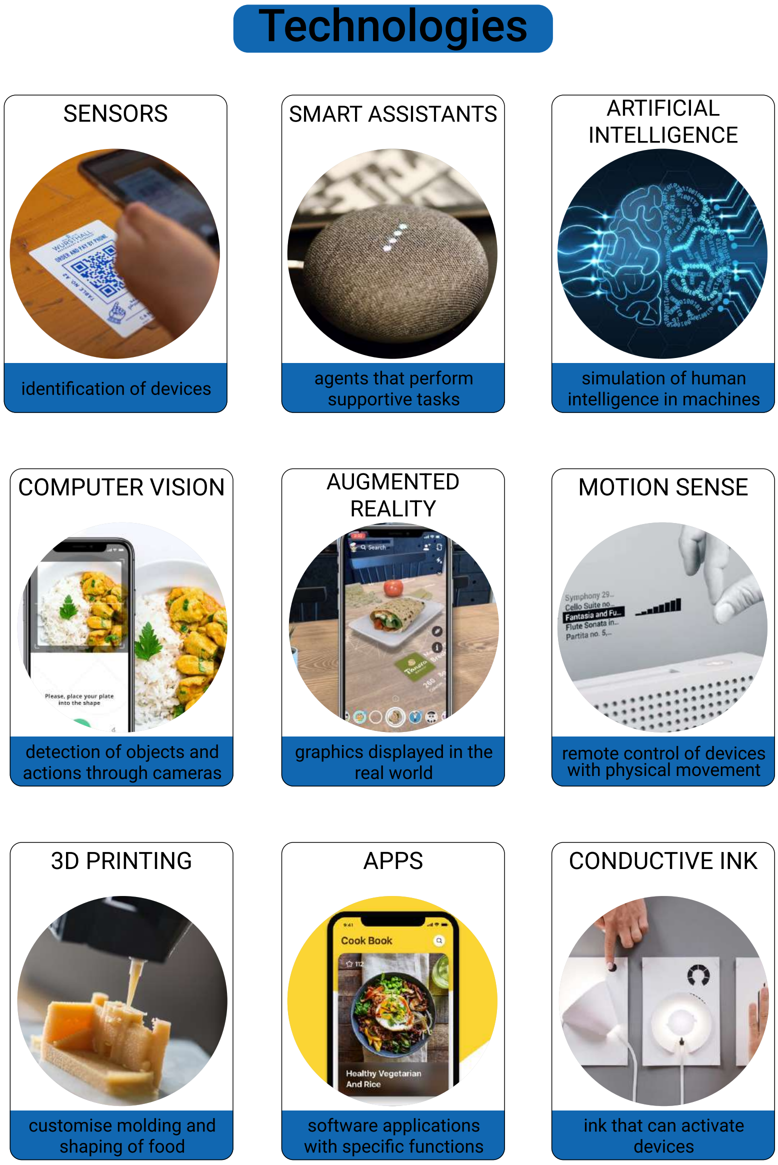


Figure 60: Design cards: Technologies.

E.2 DATA VISUALISATIONS

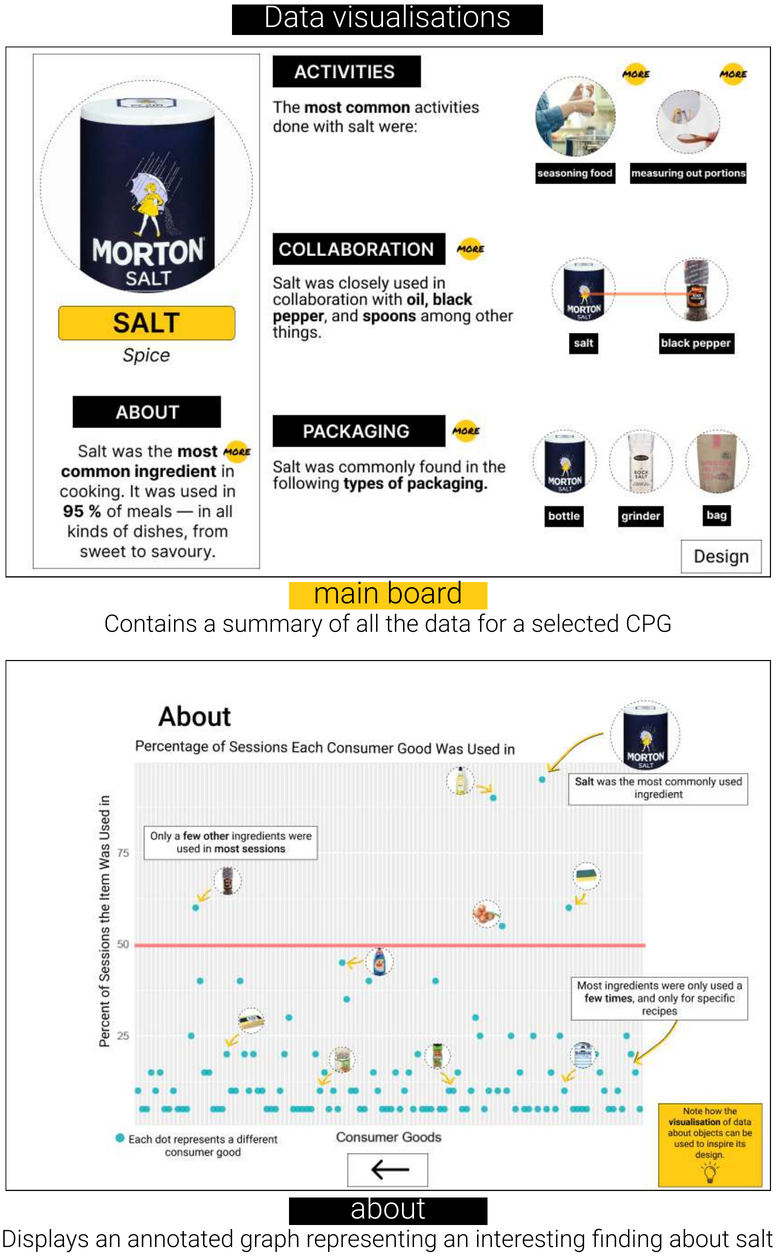
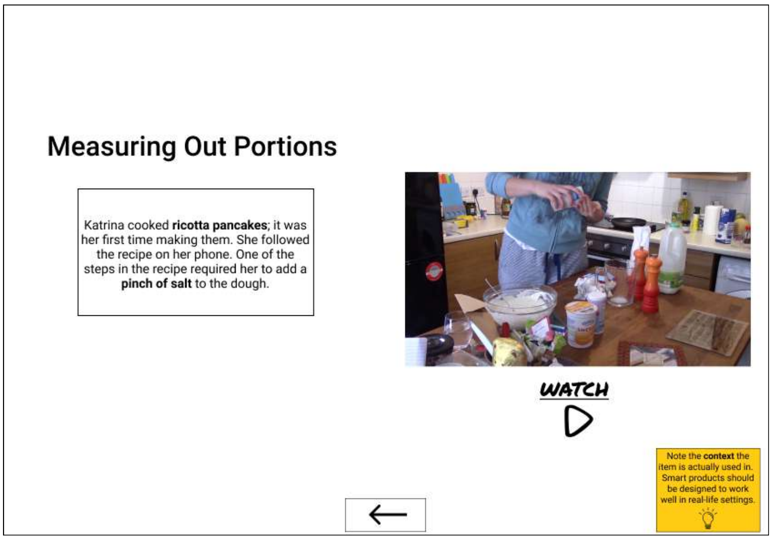
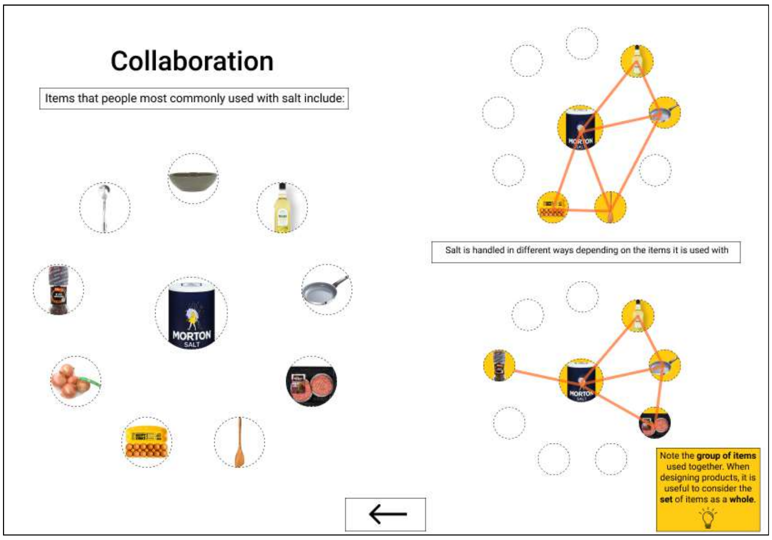


Figure 61: Data visualisation for selected CPG: main board (top) and 'about' visualisation (bottom).



activities

Gives a brief summary and shows a short video of one of the main activities for salt



collaboration

Shows sets of CPGs and utensils commonly used in combination with salt

Figure 62: Data visualisation for selected CPG: 'activities' (top) and 'collaboration' visualisation (bottom).

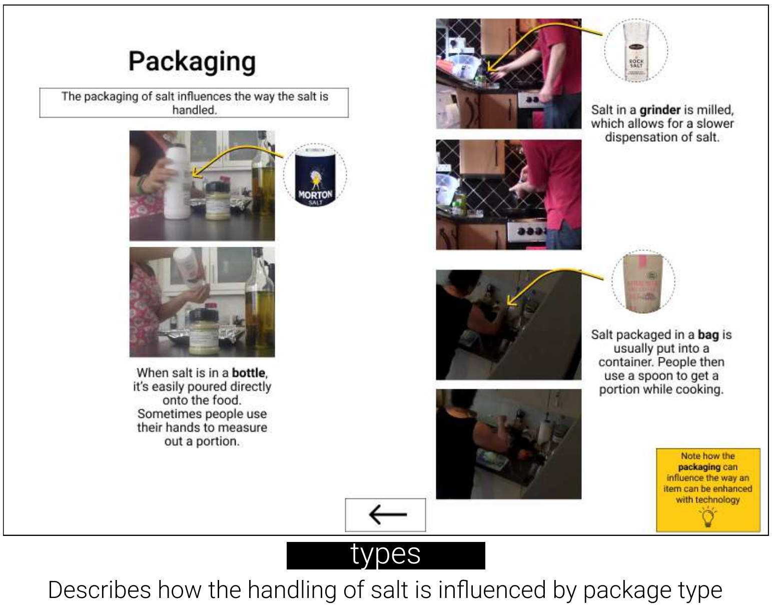


Figure 63: Data visualisation for selected CPG: 'types' visualisation.

E.3 DATA SETS DESIGN WORKSHOPS

00:25:12 Another example is like how people handle like a bar of soap. We stay the participant person, so into her hand, then use that hand to put this all into the vote and then return the extra salt to the bottle by hand, yeah?
00:25:28 And yet again, the same two questions regarding the value of this data for design and any issues you could foresee this incorrect.
00:25:41 Well, we we use the salt grinder. I personally don't add salt to any meals if it's cooked with it I don't mind.
00:25:50 If it you know if it's part of the cooking process like carrots in a in a pan without any salt taste quite boring down there, but I wouldn't really add salt to it once it's on my plate.
00:26:01 But I would.
00:26:04 You know, in our household we do the salt grinder and the put it straight out of the thing you buy from the shop straight into your hand. And doing that. We've never really bought salt in a bag that I'm aware of.
00:26:17 No don't, I don't.
00:26:21 I don't think I've ever considered what.
00:26:24 Salt comes in if I'm honest. Like you know that sugar comes in a bag. Yeah, you know. Paper bag.
00:26:32 But I don't actually know what's all comes in coz I just see on the table in either a salt dispenser with you know ten holes in or a grinder.
00:26:46 Suppose it, yet it's interesting to get you thinking of how you purchase salt from a shop.
00:26:56 Also consult is those kind of Congress and last for long, so it's not like rely.
00:27:03 A pack of cards on the left.
00:27:06 Today, yeah.
00:27:08 We have for months.
00:27:13 But I suppose there is something you can you can package anything to make it feel also luxurious. But like rock, Soul somehow seems more.
00:27:28 Desirable than just traditional table salt, so they've branded it in a way that makes you think like you're having a new experience.
00:27:41 There could be something there in the packaging that.
00:27:49 Perfect and so the last time lost out later we have. It's about comparison when people cook.
00:27:58 A million meals or something they know how to cook my heart compare when they cook an unfamiliar meal, something new and they had to pull out recipe.
00:28:07 So when we found that when people cook.
00:28:11 And you mean they tend to read the labels of ingredients more often? Yeah, finding cooking instructions to mention a portion or useful curiosity to know, like the calories, ingredients.
00:28:25 And also people tend to have a less sequential process of cooking.
00:28:30 So they tend to repeat more CAS. They tend to go back and forth between recipe instructions and they have to do.
00:28:40 And they seem to be less in control by the recipe steps.
00:28:46 Yet again, these two questions regarding the value of this data for design an issues you could foresee any issues.
00:28:56 I am well. I'd be the woman went with the times I've gotta make a meal for the kids and I'm always double checking what I've read already even if I know that something something goes in the oven at 200 degrees for 20 minutes I'll still go back and read it two or three times. So maybe there's a.
00:29:18 Maybe you could have some kind of technology that is a step by step process and it gives you, you know it audibly tells you.
00:29:28 The recipe and what stage you are putting it together maybe?
00:29:35 Perfect Blend, definitely doing this. Some people are visual learners. Some people are audio learners and if if I hear something, it's more likely to sink in then when I read it.
00:29:50 Pink.
00:29:52 Yeah, so maybe there could be something there that you can combine like this now. Consumer goods with some sort of technology probably already exists. You know a lot with Alexa and stuff like that. People have got them in the kitchens and things. Now we have and I wouldn't be at all surprised if Alexis got recipes on there and it takes you step by step process on how to make it.

8

Figure 64: Fragment of a transcript of a conversation recorded during the design workshops.

Due to the confidential nature of the conversations, the raw transcripts cannot be made publicly available in a repository.

E.4 WORKSHOP STRUCTURE

In this section, we present the complete set of frames for the third and and final version of the workshop structured employed in the workshop study involving consumers (Chapter 6). We present the sequence of frames that a participant would have seen if they have selected the CPG oil and they have explored all its data. The following frame in the sequence is indicated by the blue arrows.

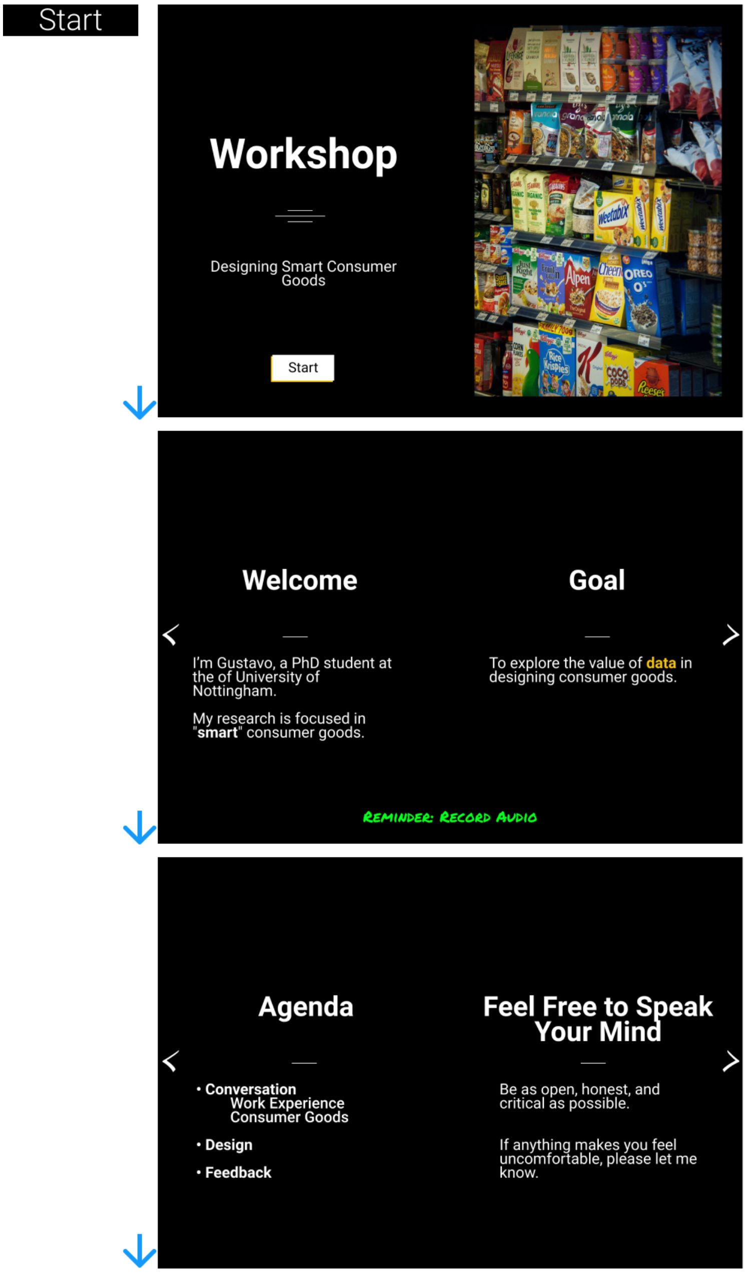


Figure 65: Workshop structure sequence: Frames 1-3.

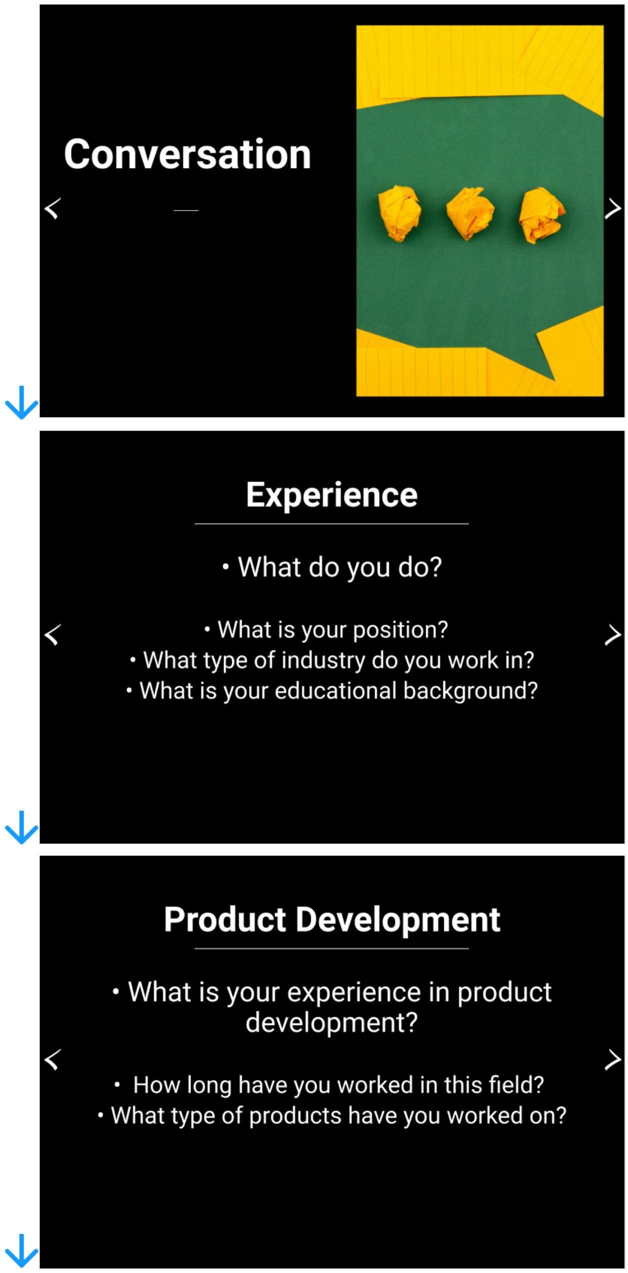


Figure 66: Workshop structure sequence: Frames 4-6.

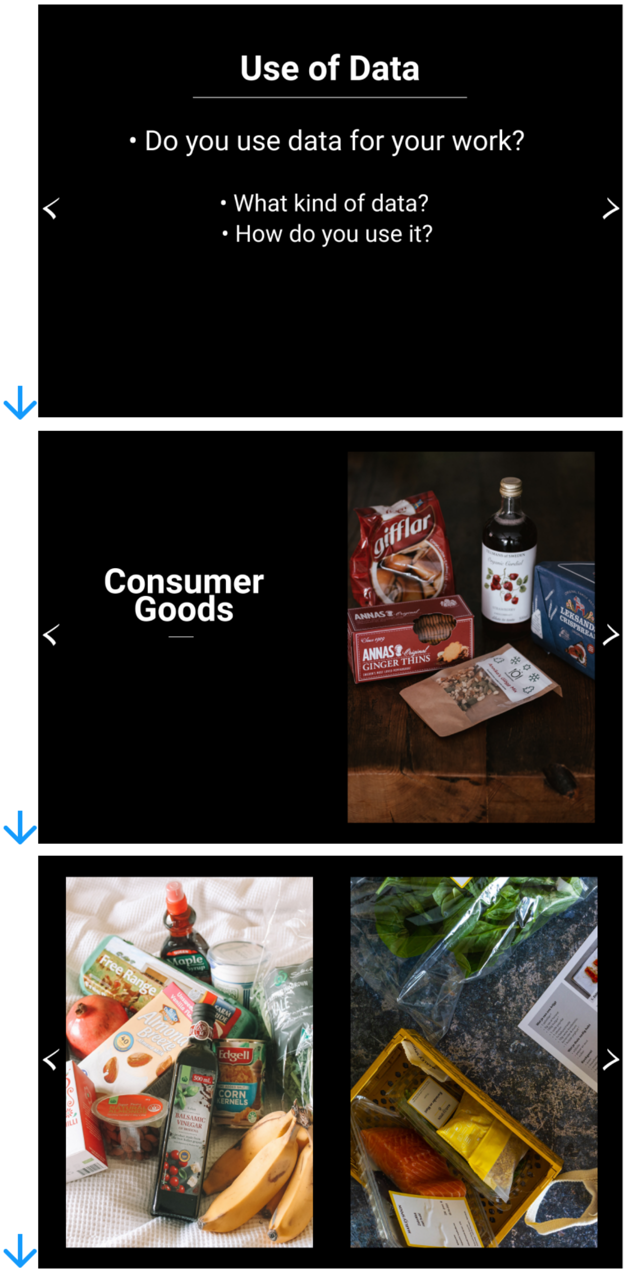


Figure 67: Workshop structure sequence: Frames 7-9.

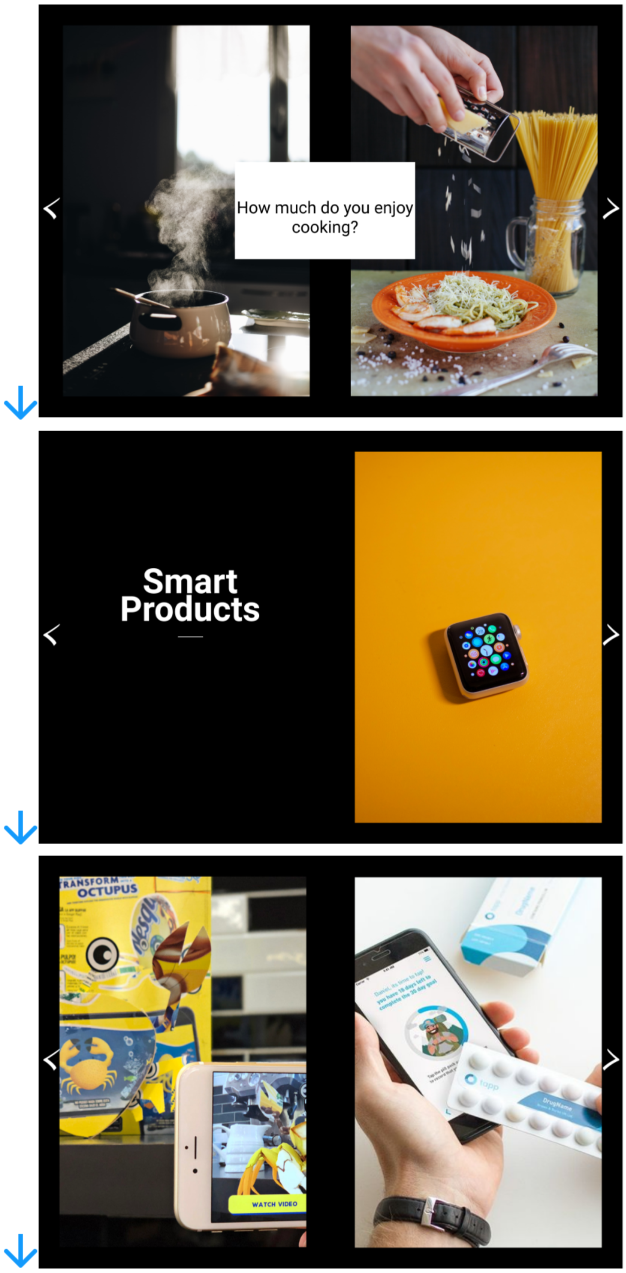


Figure 68: Workshop structure sequence: Frames 10-12.

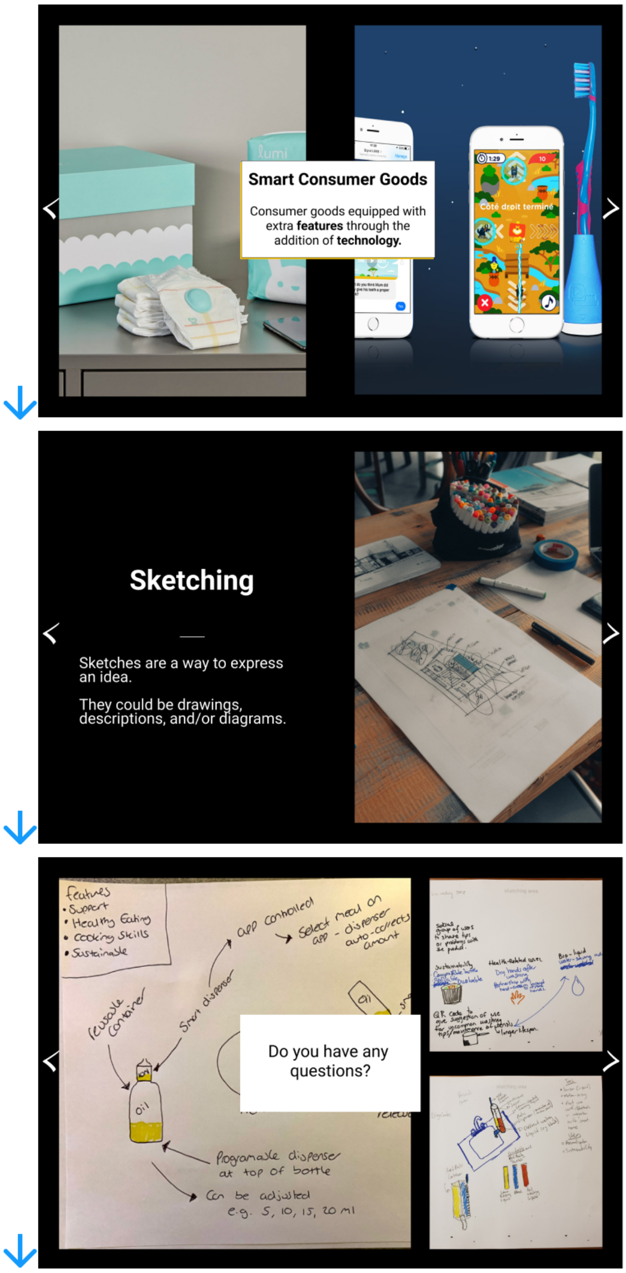


Figure 69: Workshop structure sequence: Frames 13-15.

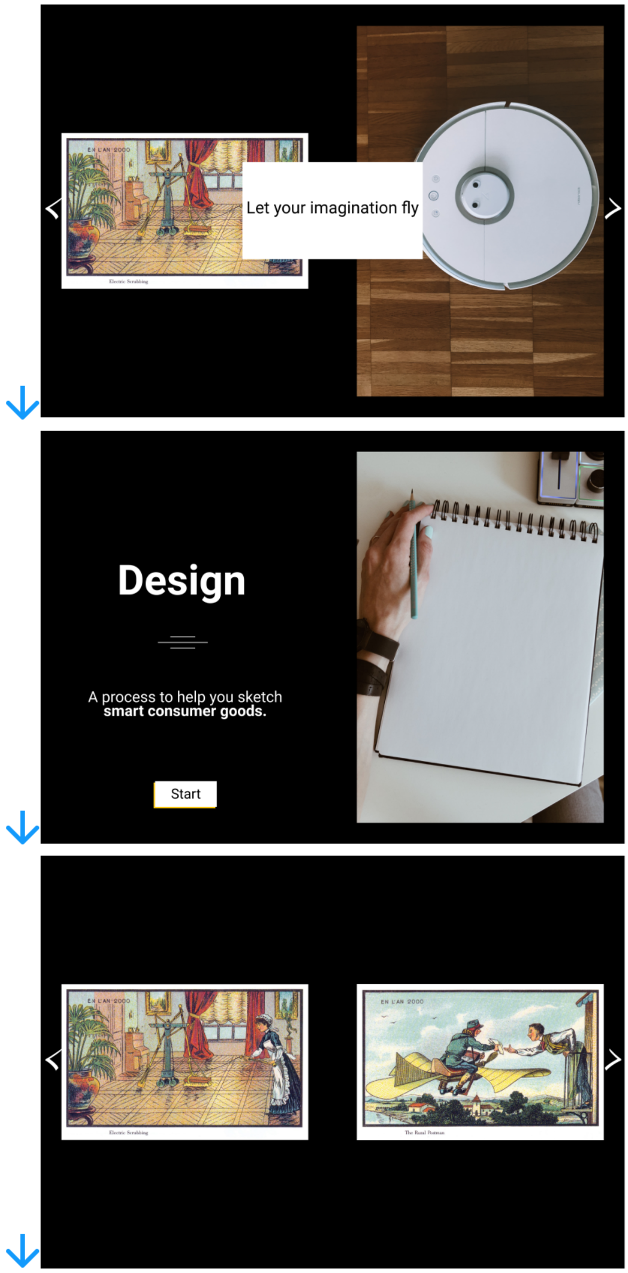


Figure 70: Workshop structure sequence: Frames 16-18.

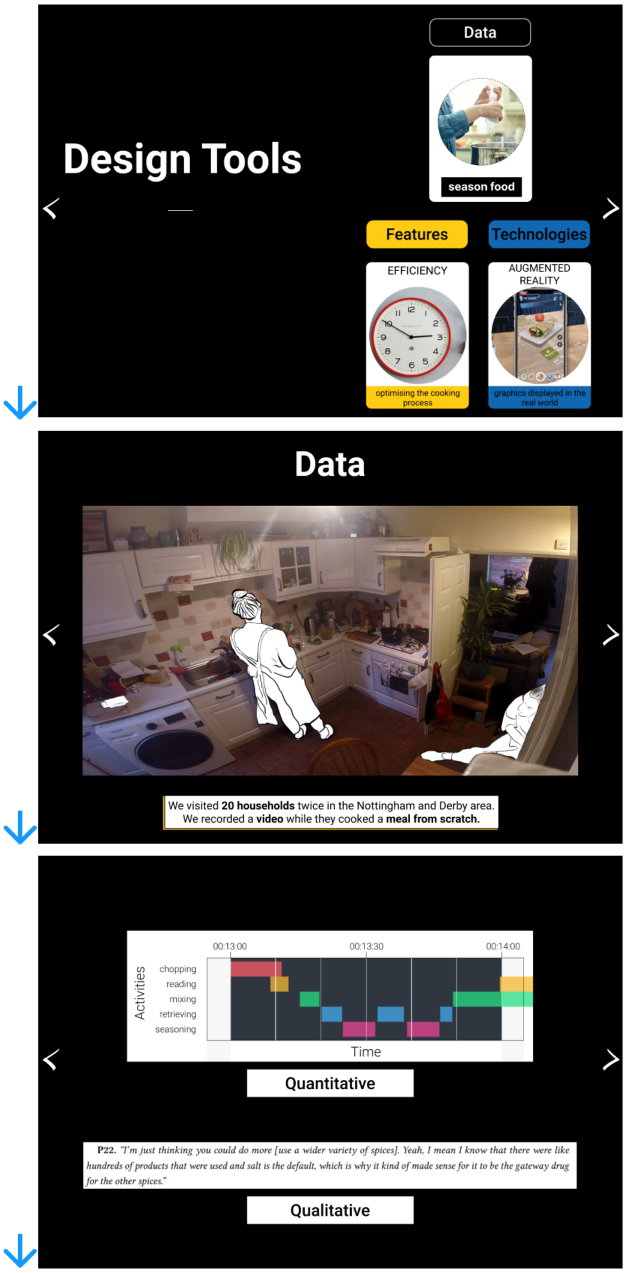


Figure 71: Workshop structure sequence: Frames 19-21.

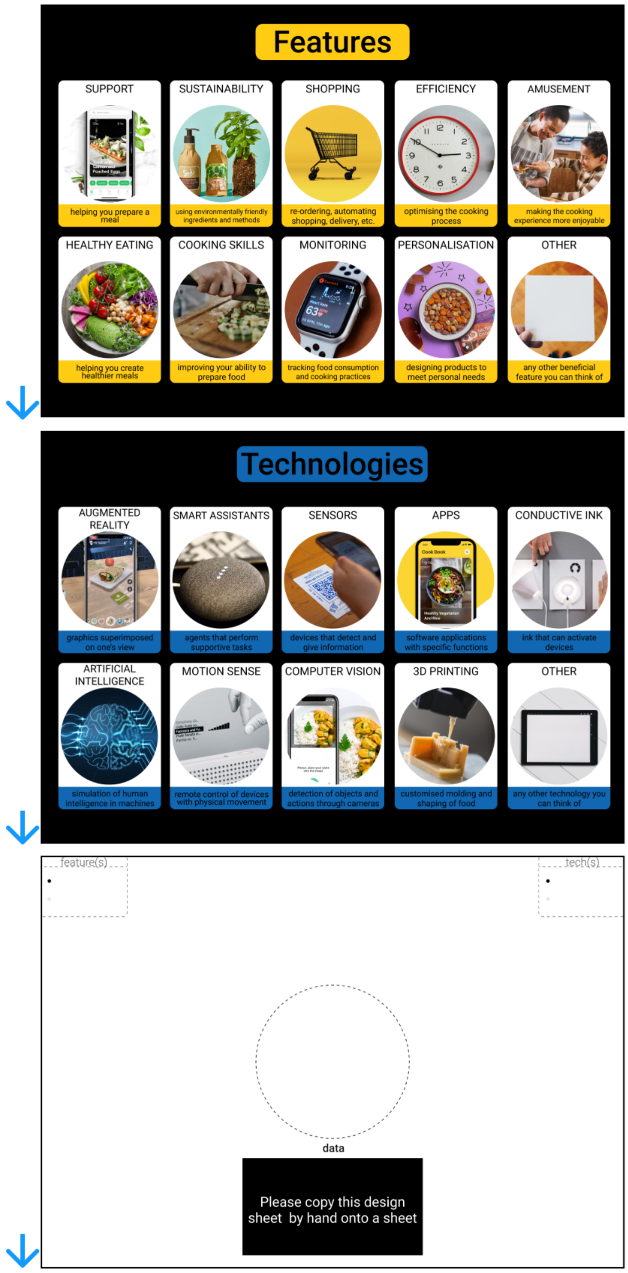


Figure 72: Workshop structure sequence: Frames 22-24.

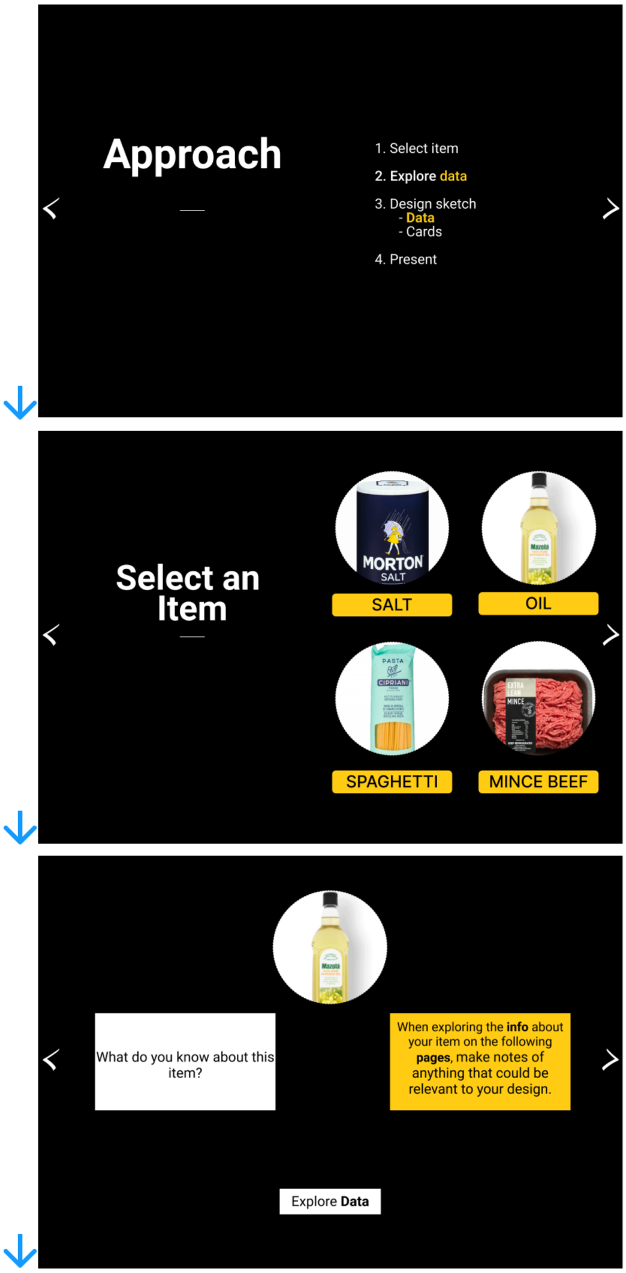


Figure 73: Workshop structure sequence: Frames 25-27.

Figure 74: Workshop structure sequence: Frames 28-30.

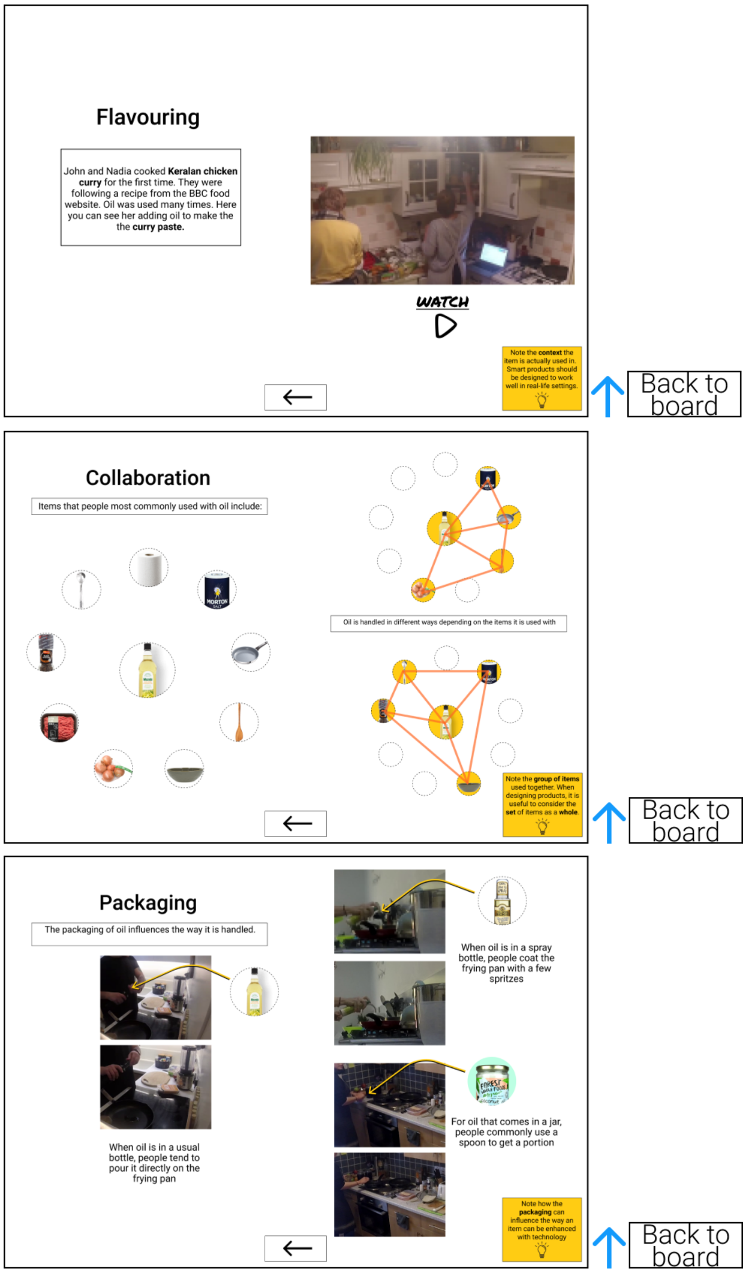
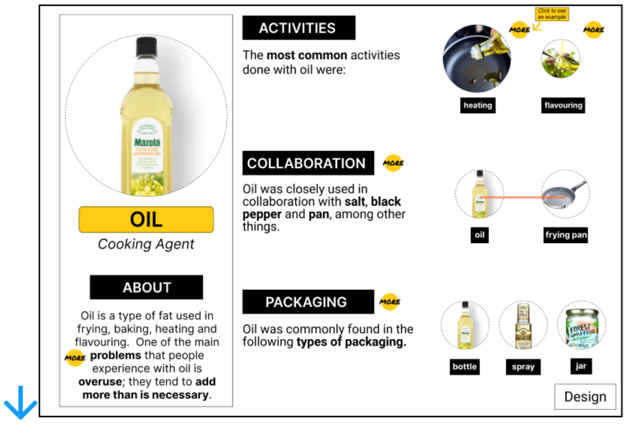
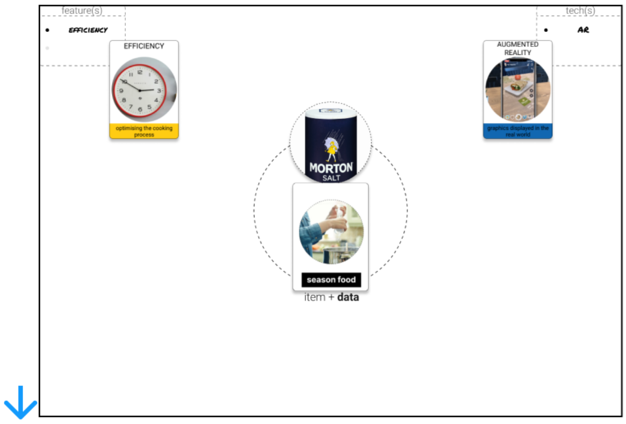


Figure 75: Workshop structure sequence: Frames 31-33.





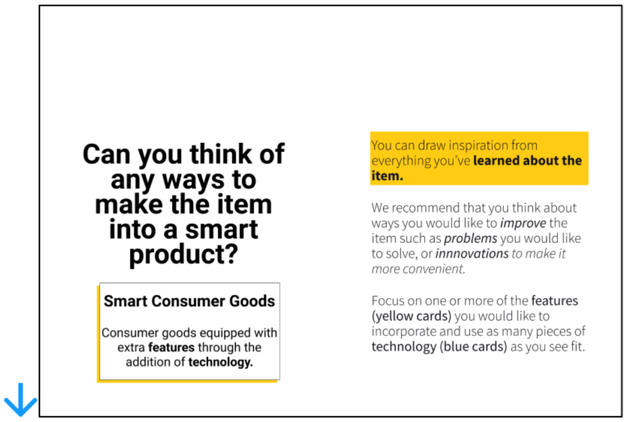


Figure 76: Workshop structure sequence: Frames 34-36.

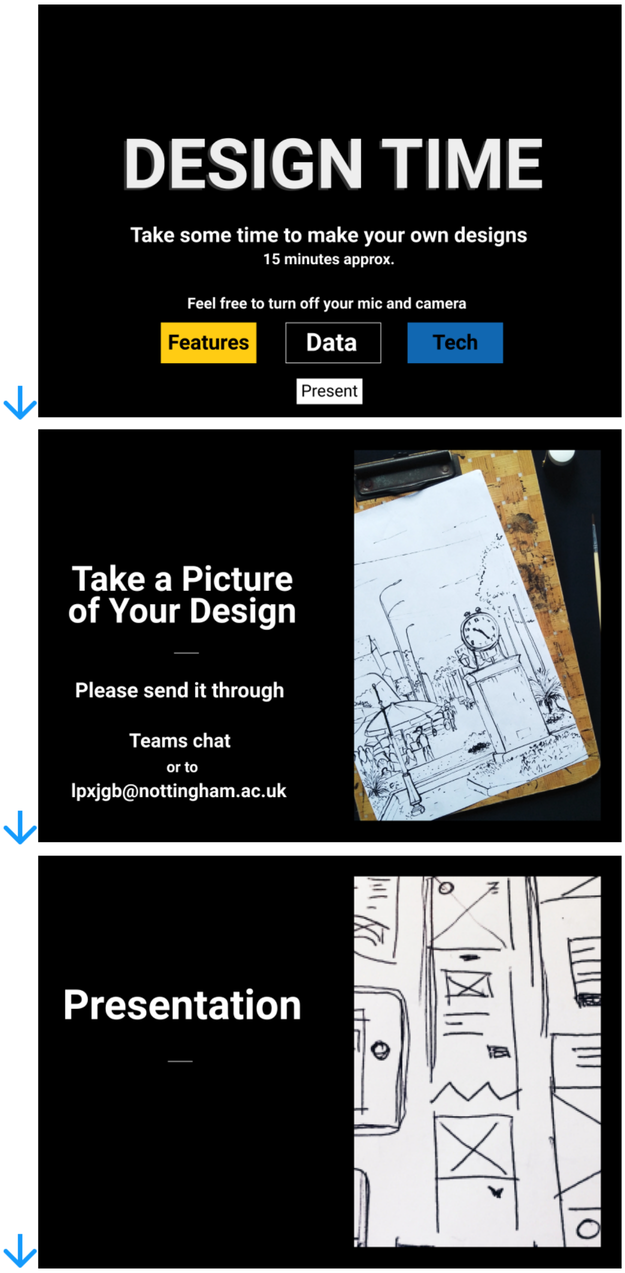


Figure 77: Workshop structure sequence: Frames 37-39.

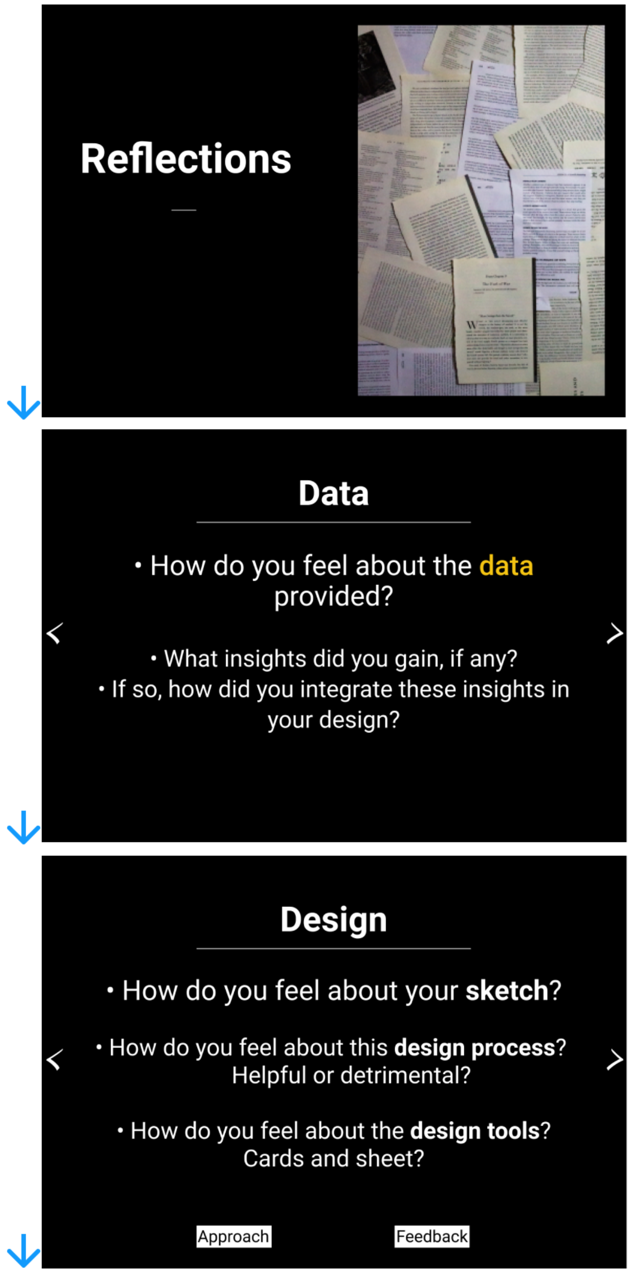


Figure 78: Workshop structure sequence: Frames 40-42.

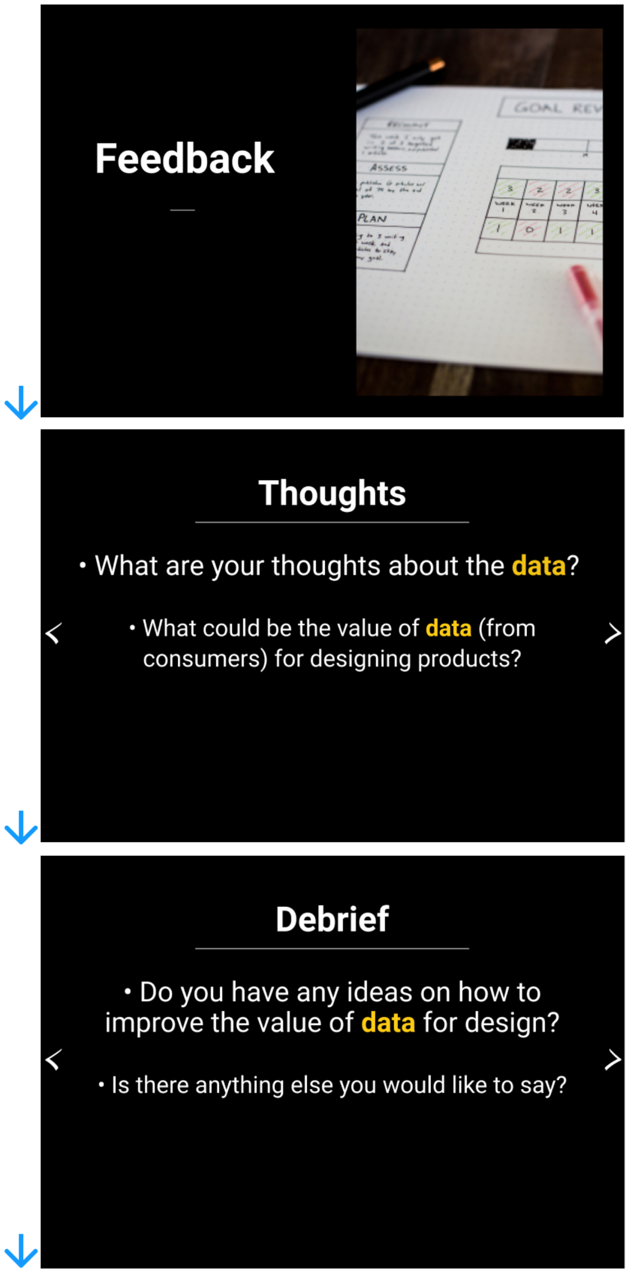


Figure 79: Workshop structure sequence: Frames 43-45.

Figure 80: Workshop structure sequence: Frames 46.

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This document was typeset using the typographical look-and-feel `classicthesis` developed by André Miede. The style was inspired by Robert Bringhurst's seminal book on typography "*The Elements of Typographic Style*". `classicthesis` is available for both LaTeX and LyX:

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Final Version as of August 22, 2022 (`classicthesis` version 4.2).

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