- Institut für Landtechnik -

Development and Evaluation of a Prototype of an Electronic Cookbook

I n a u g u r a l - D i s s e r t a t i o n

zur

Erlangung des Grades

Doktor der Ernährungs- und Haushaltswissenschaft

(Dr.oec.troph.)

der Hohen Landwirtschaftlichen Fakultät

der

Rheinischen Friedrich-Wilhelms-Universität

zu Bonn

vorgelegt am

10.04.2007

von

Daniel Pozzi

aus

Wuppertal

(D98)

Referent: Prof. Dr. rer. nat. Rainer Stamminger

Koreferent: Prof. Dr. rer. pol. Michael-Burkhard Piorkowsky

Tag der mündlichen Prüfung: 4. Juli 2007

Erscheinungsjahr: 2007

Diese Dissertation ist auf dem Hochschulschriftenserver der ULB Bonn

http://hss.ulb.uni-bonn.de/diss_online elektronisch publiziert.

Deutsche Kurzfassung

Entwicklung und Bewertung eines Prototyps eines elektronischen Kochbuchs

Die vorliegende Arbeit ist eine explorative „User Centered Design" - Studie zur Nutzbarkeit eines elektronischen Kochbuchs bei der Nahrungszubereitung. Als erstes Ziel der Arbeit war zunächst zu klären, welche Funktionen zur Unterstützung des Haushalts bei der Nahrungszubereitung nutzenbringend erscheinen. Als zweites Ziel war zu testen, ob die Nutzung eines elektronischen Kochbuchs Einfluss auf das Kochverhalten hat.

Es zeigt sich, dass sich die Nahrungszubereitung im Haushalt in mindestens zwei Situationen unterteilen lässt. In alltäglichen Situationen werden Mahlzeiten in der Regel innerhalb von 30 Minuten ohne Rezept zubereitet, wobei es schwer fällt, auf eine ausgewogene Ernährung zu achten. Die seltenere Herstellung aufwändiger Mahlzeiten stellt dagegen hohe Anforderungen an den Koch. Zubereitungsdauern von zwei Stunden sowie die Nutzung unbekannter Rezepte sind die Regel.

Zur quantitativen Bewertung des Kochverhaltens wurde eine Methode entwickelt und in realitätsnahen Versuchen zusammen mit einem Prototyp eines elektronischen Kochbuchs angewandt. Mittels zweier Rezepte, die unter Beobachtung zubereitet wurden, wurde dieser Prototyp gegen ein konventionelles Kochbuch getestet.
Anhand der Versuche lässt sich kein Einfluß des Prototyps auf das Kochverhalten feststellen, was auch durch die subjektive Einschätzung der Probanden bestätigt wird. Insgesamt weisen die Daten jedoch starke Streuungen auf, die mögliche geringe Auswirkungen des elektronischen Kochbuchs überdecken können, denn zwischen den Probanden lassen sich starke Unterschiede im Kochverhalten und insbesondere in der Zubereitungsdauer beobachten. Diese Schwankungen lassen sich größtenteils durch die vom Rezept benötigten, aber individuell unterschiedlich ausgeprägten Fähigkeiten bei der Zubereitung erklären.

Dass die Nutzung eines elektronischen Kochbuchs das Kochverhalten nicht messbar beeinflusst, kann positiv gewertet werden. Denn obwohl die Verhältnismäßigkeit von technischem Aufwand zu Mehrnutzen nicht gegeben ist, bietet sich dadurch Potential für zukünftige Arbeiten, wenn der Prototyp als Basis für weitere Entwicklungen verstanden wird. Durch die in der Arbeit umrissene Rezeptstruktur kann ein elektronisches Kochbuch Informationen gezielt multimedial übermitteln und so potentielle Fehlerquellen in der Zubereitung reduzieren. Ebenso kann durch eine Vernetzung der Küchengeräte mit geeigneter Darstellung der Prozesse und fachkundigen Hinweisen ein Beitrag geleistet werden, Zutaten in optimaler Weise zu verarbeiten und somit eine hohe Qualität der Mahlzeiten zu gewähren.

Abstract

Development and Evaluation of a Prototype of an Electronic Cookbook

This work is an explorative study on the development and evaluation of a prototype of an electronic cookbook for food preparation. The methods correspond to a large extend to the User Centered Design approach, i.e. first guidelines for product development are derived from a consumer study which reassumes and extends findings from literature. Then, the prototype delivered by the project partner is tested to determine in how far the cooking behaviour is influenced by such a system.

On the basis of contemporary research it is deduced that food preparation divides into at least two situations: everyday cooking and cooking for special occasions. In common situations meals are normally prepared within 30 minutes without recipe and under several limitations, as the lack to respect a well-balanced nutrition. In contrast, elaborate meals for special occasions are prepared infrequently and make high demands on knowledge, time and preparation techniques. Durations of two hours of preparation time and the use of recipes are the rule. New recipes are tried out which require unknown ingredients and techniques.

The prototype used for the experiments offers functions for quick switching between recipes, easy conversion of ingredient amounts and easy creation of shopping lists to support both everyday and special occasion cooking. By means of two recipes prepared by test persons under observation and under realistic conditions the prototype was tested against a conventional cookbook. In doing so, a method to assess cooking behaviour quantitatively is implemented for the first time.

The results of the cooking experiments do not reveal an influence of the electronic cookbook, which is also underlined by the subjective rating of the participants. Solely the combination of first participation, the unused prototype and the more complex recipe leads to a slight overload of working capacity at times, which does not affect the general behaviour, though.
A characteristic of the quantitative data is the high variability, which would mask possible weaker influences of the electronic cookbook. Strong differences are observable between the participants, which mainly affects the total preparation time. To a high extend these difference can be explained by the individually differently pronounced skills which required to prepare the recipe.

It can be assessed as good that the prototype has no measurable influence on cooking behaviour, although the adequacy of resources can be put into question. However, if the used prototype is seen as a basis for future work, the efforts can be justified. Especially the briefly outlined advanced recipe structure in combination with an electronic cookbook could transfer purposeful information to reduce sources of errors. Furthermore, a connection to the appliances with a proper display of the processes and expert advice could aid to prepare ingredients optimally and thereby ensure a high meal quality.

Contents

”If people take the trouble to cook, you should take the trouble to eat.”
Robert Morley, Actor and Playwright. 1908-1992

1. Introduction

Cooking is a multi-faceted part of today's life. Contemporary eating patterns are distinguished by the number, order and format of the courses, the sequence of use and combination of food, preparation techniques, the time to prepare the meal and the time between meals as well as the social factors like the situation and the structure of the company (Oltersdorf *et al.*, 1999).

The beginnings of food preparation were of course more elementary. Traces from fireplaces in Africa imply a 1.5 million year old history of cooking, and it is sure that fire was used to prepare food 230,000 years ago. If our predecessors were able to communicate knowledge on specific procedures and the challenges to prepare food, the first recipes can be considered to be of equal age as food preparation itself (James, 1989; Berg & Rumm-Kreuter, 1996).
Fire has been the prevalent means to heat food through the ancient and the medieval times since now. The Romans spread the concept of the kitchen as a dedicated single room with a fire stove in Europe 2000 years ago. Since then, the concept was extended, but the poorest and the richest still cook (or let cook) with fire. The fire stove was improved by the gas cooker in 1812, by electric cookers in 1890 and then by the microwave in 1965 (Wood, 1996).

This chapter outlines how complex food preparation has become and which attempts are made to cope with this situation. First, the meaning of recipes and cooking are described in the context of contemporary households and and how habits have changed with global nutrition trends. Second, studies are presented that focus on food preparation work improvement as well as projects which develop solutions for cooking in the future.

1.1 Meaning and Use of Recipes and Cookbooks

1.1.1 The Purposes of Recipes

A recipe is a guideline to prepare the specified dish. It generally consists of three parts: enumeration of ingredients, instructions and characteristics for evaluation of the result. Rogov (2006) defines recipes as follows:

> "A written recipe is a kind of permanent reference and both chefs and cookbook writers will do well to keep in mind that the primary purpose of any recipe is to aid the writer or those who later read the recipe to prepare the dish being described."

Zacharias & Dürr (1992) demand that ingredients should be named in their usual denotation and accepted measures (teaspoons and the like are only permitted if the success is not endangered, but spices do not necessarily need to be given in precise amounts). The procedure should be written in keywords or full sentences, and a rational method of operation should be made possible. Lastly, characteristics for evaluation should contain the expectable yield, the look and consistency and if desired nutritional information.

Rogov (2006) emphasises that reading recipes should be enjoyable instead of scaring the reader with too much detail. He gives examples as to which kind of information is needed if the recipe is meant to be shared with a larger audience, such as precise amounts or produce that have not been named before, for instance when roasted breadcrumbs are suddenly referred to as croutons. For professionals though, ingredient amounts could be left out as well as the "compounds" (smaller integrated recipes like a bechamel sauce).
However, the author claims that more than 50% of cookbook buyers do not cook and that therefore the level of detail higly depends on the intended audience. His general advices for larger audiences are:

- list ingredients in order of use
- if used at the same time, list in order of amounts (higher first)
- easily measurable units for amounts
- do not assume advanced knowledge
- list compounds separately, but nearby
- number instruction steps
- refer to clear oven temperatures (and preheated ovens)
- give approximate cooking times
- test the recipe (for instance, in adopted recipe cooking times may vary)
- give credit to the original author

Gisslen (2003) underlines that the function of recipes is to control quality by specific instructions and quantity in terms of precise ingredient amount. Beyond that "some judgement by the cook is always required", because of three reasons: food products vary in size, ripeness and taste, kitchens do not have the same equipment and it is not possible to give exact instructions how to make a "thick" sauce or to cook at "medium" heat. He points out that learning to cook is not simply learning recipes, but learning the basic techniques which enable the cook to understand recipes.

1.1.2 Advanced Structures of Recipes

A technical approach to understand recipes (“cooking for engineers”) is introduced by Chu (2006). Besides rich use of images, the author creates a recipe structure that represents the material flow by linking ingredients to the steps and output of previous steps. Therefore the logical sequence of steps, as shown in figure 1-1, is represented.

Pecan Coffee Cake (serves 16)

Batter

1 cup (225 g) butter, softened	cream	beat	mix in 1 at a time	mix	fold in
1-1/2 cup (300 g) granulated sugar					
1 cup (230 g) sour cream					
2 large (100 g) eggs					
1 Tbs. (15 mL) vanilla extract					
2 cups (125 g) sifted all-purpose flour	whisk to combine				
1/4 tsp. (1.5 g) salt					
1 Tbs. (14 g) baking powder					
1/4 cup (25 g) chopped pecans	toast	process to crumbs			

Streusel

2 Tbs. (30 g) butter	melt	mix	mix
1 cup (110 g) chopped pecans	toast		
1 tsp. ground cinnamon			
1/2 cup (110 g) brown sugar			

Pecan Coffee Cake

Preheat oven to 350°F (175°C) and line 9x13-in. pan with parchment paper			
Batter	pour into 9x13-in. pan	top	bake 350°F (175°C) 35 min.
Streusel			

Figure 1-1: Recipe structure introduced by Chu (2006),
copied from http://www.cookingforengineers.com/recipe.php?id=168

The scientific background of domestic cooking is explained by Barham (2001) and This-Benckhard (2005). Their recipes are interrupted by background explanations of chemical and physical processes that decide upon success or failure of preparation techniques. Accordingly, This-Benckhard demands a clear structure for recipes that provide hints which are needed for the successful completion of the recipe.

Pennington (1996) calls for a standardised system (“International Interface Standard”) to describe food in databases. This system is meant to link ingredients, to regard translations and to make ethnic food distinguishable. For homemade recipes such information can be geographical area, cuisine as well as specific ingredients and instructions. Also Schulze (1998) discusses the advantages of a standardised structure to exchange food data.

Aspects of food safety in recipes are also subject of investigation, since many recipes contain instructions that affect food safety either positively or negatively. Griffith *et al.* (1994) review cookbooks and magazines for food safety information using a self developed checklist and find that only 20% of the analysed items contain hygiene information. Thus, the authors suggest to modify these to "advocate and reinforce the food hygiene message".
The Recipe Hazard Analysis System (RHAS) is an approach which is closely related to the HACCP concept for large-scale food production. It analyses recipes for hazardous ingredients and processes or missing information such as the lack of precise time and temperature information on storing conditions, be it keeping cooked meals warm or storing them in the fridge (Zottala & Wolf, 1981; Worsfold, 1995).

1.1.3 History and Use of Cookbooks

The first collection of recipes is a Babylonian clay tablet dating back to 1500 b.c., which contains recipes for some elegant meals. Written recipes were used for the first time around 600 b.c. in the Persian army, and the most famous early cookbook is "de re coquinaria" by Marcus Apicius written in the 1st century a.d.. Since then, most recipes and food have found their way into today's kitchen through trade routes, but a few were also spread by conquerors in wars (Dose, 1988; Rogov, 2006) .

The eldest written collection of recipes in Germany dates to 1350, and the first printed cookbook was "Küchenmeysterey", published in 1485 and used for about 200 years (Hajek, 1958; Dose, 1988). Until the 19th century, paper cookbooks in France and Germany were only used by upper classes. Accordingly they mostly contained sophisticated recipes for the gentry. Later the reduction of book prices and broader mass education opened access to cookbooks to the public. Since then, the number of publications has grown continuously and is estimated to up to 5000 different cookbooks in Germany for 1989 (Dose, 1988; Wood, 1996; Schlegel-Matthies, 1997b).

Today, cookbooks are only one possible source of recipes. McKie & Wood (1992) identify about 20 different possibilities to obtain recipes, of which the cookbook is the most frequently used. More than half of their sample owns between four and ten cookbooks. The authors furthermore report that 88% of the women and 75% of men share recipes with family, friends and neighbours and that 64% of women and 50% of men read recipes for pleasure. Interestingly, Hertzler & Bruce (2002) find that the sources of recipes are similar for both sexes, except for cookbooks, which are significantly used more often by female students.

The Sozioland (2004) study reveals that cookbooks are used merely for inspiration and not followed strictly and not used to learn to cook (however, about 30% state to cook exclusively from recipes). Two thirds of the participants take ideas first of all from cookbooks and magazines. Further sources of inspiration are identified: A half, mostly elder, is inspired during shopping, 44% from the internet, 25% from parents and grandparents and up to 25% from TV. Cooking from own ideas and adding ingredients intuitively is done by maximal 50% and increasing with age.

1.2 Diversification of Eating and Cooking Habits

Cooking and eating can be systemised by eating patterns, the meal format and the social organisation. In the developed world, these have diversified and consumption changed its purpose beyond serving basic human needs. It is linked more to symbolic meanings, values and lifestyles (Bruhn, 1998; Shaw & Clarke, 1998; Mäkela *et al.*, 1999; Oltersdorf *et al.*, 1999).

The diversification of cooking habits is partially caused by the increasing complexity of activities peripheral to the consumption of food. These activities of household production are referred to as "Food Management", and they are interweaved with each other. For instance, planning of acquisition requires knowledge of food quality, of the social environment, market prices and availability. The resulting decisions are furthermore determined by limiting factors like money, healthiness and conflicting preferences (Karg & Leidrich, 1989; Shepherd & Sparks, 1994; Berg & Rumm-Kreuter, 1996; Davies & Madran, 1997; Schlegel-Matthies, 1997a; Venkatesh, 1997; Harnack *et al.*, 1998; Bayer *et al.*, 1999; Oltersdorf *et al.*, 1999; Connors *et al.*, 2001; Hansen, 2002; Stead *et al.*, 2004).

1.2.1 Globalisation of Cuisine and Regional Foods

Consumption of food has become a complex task in a world with diverse lifestyles and open markets. Though traditional local dishes still play a role in nutrition, cuisine has become global and more and more foreign foods and dishes are adopted to the countries' cuisines. Especially the healthier Mediterranean diets are adopted in northern European countries, but rarely vice versa. This in nutritional sense welcome phenomenon is foiled by the trend to consume more convenience foods in both the northern and the southern regions (Tollin, 1990; Shaw & Clarke, 1998; Lang & Caraher, 2001; Rumm-Kreuter, 2001; Lyon *et al.*, 2003; Jones *et al.*, 2004; Millstone & Lang, 2004).

In addition, Siemering (1996) predicts that many culinarians will become “Virtual Globetrotter”, surfing the internet for new cooking inspirations. He also is concerned about food quality in future blended cuisines, which might on the one hand become a “mish-mash” of styles, but on the other hand hold ready undiscovered fruits and new recipes.

In their case study on local food and its routes to the market Jones *et al.* (2004) assess an increasing trend towards internationalisation of food supply, but predict a small but growing interest in local foods as well. Consistent results find Kuznesof *et al.* (1997) in their focus group discussion study. The authors point out that this development implies are higher importance of local recipes and regional foods, which are no longer poorer people‘s food. Instead, they often have become premium, hand-crafted products.

1.2.2 Cooking Efforts: Demand for Convenience and Eating Out.

Convenience food is foodstuff that is preprocessed (cut, washed, pre-cooked etc.) by the manufacturer “in which significant preparation time, culinary skills, or energy inputs have been transferred from the home kitchen to the food processor and distributor” (Traub and Odland, 1979; see Capps *et al.* 1985). As part of buyer’s time-saving strategies, convenience food plays an important role on today‘s mass markets, but also the lack of cooking skills leads to increased consumption of preprocessed food (Davies & Madran, 1997; Candel, 2001).
The findings of the interview study by Connors *et al.* (2001) confirm this. Interviewees have little interest in cooking when time is short, so convenience products are chosen instead - even if people are convinced that these conflict with healthy eating. The study also reveals that the type of cooking highly depends on the situation and the meal attendants.

Issues to healthy eating caused by the increasing consumption of convenience products are claimed by several authors. Lang & Caraher (2001) point out that if convenience food is easily accessible, the need to learn cooking reduces. Apathy and time are additional barriers to learn. Confidence in cooking has gender, age and class bias, tech skills rise while basic skills such as cooking decline. Candel (2001) finds that enjoyment of preparation and use of convenience are negatively related.

Brombach (1999) reports of a study conducted in 4 European major cities with 40 participants each. Her main findings are that the majority of women cooks daily, but under time pressure: within 30 minutes the dishes have to be served. During the weekend, the time used is about an hour longer, and additionally the behaviour changes in favour of increased home cooking.

Differences also derive from age and gender: women and elder people normally invest more time into food preparation (Küster, 1996; Kutsch, 1996; Berg & Rumm-Kreuter, 1996; Claupein *et al.*, 2001). Similarly, Lang & Caraher (2001) find that women cook 5.8 days per week on average while men cook only 2.5 days per week, but men to cook more often on special occasions.

A shift to eat out more frequently in Europe is shown by Glew (1990), Tollin (1990) and Aranceta (2001). This is however related to the household income (Candel, 2001). In the study of Hertzler & Bruce (2002), about half of the respondents said to eat out most weeks, although this is not related to cooking ability or recipe source.

Developments in Central Europe and the United Kingdom. In Germany, nutrition after the second world war is determined by extreme poverty in the early years and a phase of overcompensation in the 60s of the last century (Schlegel-Matthies, 1997b; Hirschfelder, 2001).
Later, a diversification of consumption styles can be observed, including the demand for time-saving convenience products and ethnic foods Bayer *et al.* (1999). The authors identify twelve socio-economic trends that cause the changes of nutrition, among which are: change of family and household structure, more working women, higher education, divergence of poor and wealthy classes, increasing range of foreign products and ethic trends.

The data from Sozioland (2004) underlines this development: up to 80% agree to the statement that "cooking is more than pure food preparation, and additional 10% see it neutrally. Furthermore, no difference between genders concerning this statement can be observed, but the elder interviewees tend to agree more. Accordingly, merely the younger participants state to favour convenience products. Globalisation has influenced the German cuisine as well: pasta is appreciated by 80% and rice dishes by 50% of the respondents.Asked which cuisines they like best, 33% favour Italian, about 15% Asian and only 15% the traditional German dishes.

French habits of cooking and eating diverge with global trends. Karg & Leidrich (1989) present differences between the traditionally oriented Burgueois sticking to several-course menus, in contrast to younger people following newer forms of eating; "Fast Food". The authors also see a trend to decrease time for domestic food preparation where foods are favoured which are less work- and time-consuming.

Developments in Scandinavia. Within Scandinavia, eating habits appear to be different: The Norwegian and Danish dinner meal does not always exist in Sweden and Finland, where hot

lunch is preferred. Also the latter countries far more often have two hot meals a day (Mäkela *et al.*, 1999).
According to Tollin (1990) food is the second largest household expenditure in Sweden with 17.3% of the private consumption, but with very pluralistic patterns. Food consumption has changed towards a concern for physical well-being and a more price-conscious consumption. The main meal is often taken outside home. The latest trend is an increased consumption of purely hedonistic products like beer, confectionery and carbonated soft-drinks.

Holm (1996) reviews a study of food and its relation to identity among Copenhagen residents. She identifies the ambition to have proper family meals, the common conflicts of cooking and weight loss, and also a trend to avoid industrially produced foods and favour natural foods instead.

Developments in the Mediterranean Region. The mediterranean countries‘ diets are often referred to for nutritional reference because of their healthiness, as the typical mediterranean diet consists for instance of more unsaturated fats, vegetables, fish and fewer meat (Alberti-Fidanza, 1990). However, the most rational combination of these foods lies in the past: For Italy in 1950 and for Spain in 1970. Currently, Portugal seems to be closest to the optimum, and France the farthest (ibid.). Accordingly, Turrini *et al.* (2001) identify a slight convenience trend in Italy and remain of traditional diversities between Italian regions.
In Spain, Aranceta (2001) finds “a shift towards a greater consumption of processed food rather than fresh food” and indicators for the trend to eat outside the home during weekdays and leisure time.

1.2.3 Studies on Food Management Habits

Caraher *et al.* (1999) analyse the 1993 Health and Lifestyle Survey in the UK for relations of cooking skills and food choice. Their dominant finding is that women play a major role in food preparation. Daily cooking is performed by 68% of the women, and only 18% of men in this study.

Nicolaas (1995) reviews a study which was conducted in Great Britain in 1993 with more than 2000 adults aged 16 and above. The author finds differences between the cooking habits of the genders: 80% of women state to cook every meal, but only 22% of men do. However, about 60% of the men cook once or twice a week or more frequently, and men who tend to cook often are mostly single. The data also reveals that the more often people cook, the more knowledge they

have and the more cookbooks are used. Moreover, the survey shows that confidence in cooking skill is directly related to meal preparation frequency: The higher the confidence, the more often meals are prepared at home.

In Germany cooking is a common activity. A reasonable number of persons consider it important and entertaining rather than just a chore: Given the statement "Cooking is relaxation for me...", only about 20% of the participants deny, the rest answers neutrally to positively. In addition, the total agreement seems to increase with age: 10% in the youngest group, about 66% of elder people agree. Twenty percent of women state to cook daily, among elder women even up to 30%. Nearly 50% prepare dishes almost daily, 20% once a week (with a high share of young people). In addition, the data indicates that more men than women prefer to cook extraordinary meals (Sozioland, 2004).

Cooking Skills and Transfer of Knowledge.

Family is the first source of knowledge in Nicolaas (1995), for both women (82%) and men (53%). Cookbooks are the second important source women (57%), and third for men (30%). Instead of using cookbook or other sources, men tend to gain knowledge from their spouse or partner. Only few persons learn to cook from friends. The willingness to learn is equally distributed among men and women (ca. 40 %). Crossed with cooking frequency, those who prepare meals seldom state to be most eager to improve their skills (69% for women, 49% for men). Furthermore, the willingness to learn decreases with age.
A similar picture is rendered in the Sozioland (2004) study. Here the majority (75%, multiple answers possible) were taught either by their mother or learned by themselves. Schools play a minor role (20-30%), and cookbooks have hardly any importance (10%) as teaching media.

In most cases women teach cooking skills. The secondary source is school and the third cookbooks. Learning to cook from cookbooks is strongly associated with education, therefore cookbooks play a more important role in upper social classes with higher education. However, learning from cookbooks becomes more usual in later stages of life (Lang & Caraher, 2001).

Cooking from basic ingredients is not necessarily related to skill, as most people lack ideas, knowledge and menu-planning skills. However, women say to exceed men by far when asked for confidence in examples of food and cooking techniques (Caraher *et al.*, 1999; Davies & Madran, 1997; McKie & Wood, 1992).

Harnack *et al.* (1998) find consistent results in the U.S., where men are more involved in food management activities if women work full-time, but Hertzler & Bruce (2002) do not find differences in cooking skills between the genders in their convenience sample at a large U.S. university.

According to Kutsch (1996) exist remarkable differences in cooking knowledge: 80% of housewives rate their knowledge either "good" or "very good", whereas 40% of the men state to have insufficient cooking knowledge. Berg & Rumm-Kreuter (1996) cite the German Iglo study of 1995, in which 60% of the female participants state to have good or very good cooking skills, but 29% of the male deny to possess cooking abilities.

Cook Types

Among people who are involved in preparation of food, several different types and attitudes towards cooking can be identified. The works cited below have in common to identify at least three cooking attitudes:

- cooking seen as a duty without enjoyment
- cooking for pleasure
- people who do not cook or try to avoid it

Goldsmith *et al.* (1997) identify three attitudes towards cooking in their survey with 323 participants from a smaller US city, namely: "pro-snacking", "convenience-shopping" and "likes cooking". On the contrary, Wansink & Lee (2004) distinguish American cooks by the preferred food: either vegetable or fruit lover. According to their findings the vegetable lovers cook more frequently for guests, claim to cook nutritious meals and try new recipes more frequently. The authors furthermore relate these findings to the works of Franey (1993), who describes this group as adventurous cooks.

Stead *et al.* (2004) explore the different approaches to cooking using a focus group study in the UK and distinguish three types: Confident cooks, who have a wider repertoire of dishes and know various cooking techniques, but also demand advice and sources of inspiration. "Basic but fearful" cooks have basic skills and competence, but feel bored by their standard range of dishes and are anxious to try new ones. Finally, "hopeless cooks" report to have no skills and to use mostly pre-prepared foods. Although improvement of skills is appreciated, this group has no clue how to improve. The major barrier to improve cooking skills is the anxiety to fail and the lack of knowledge when specific terms are used.

In Sweden Tollin (1990) identifies three groups of consumers: “Price in Focus”, Quality-Seekers and up to 27% enthusiasts. Enthusiasts are characterised as people who do not mind to cook for several hours at the weekend, who collect recipes to a great extend, serve relatively more foreign dishes and high-priced foods and seem to have a high quality demand.

Attitudes towards cooking were also investigated in a survey by a German cooking magazine, cited in Berg & Rumm-Kreuter (1996). Six different characters are described: Occasional cooks (13%), who do not like cooking and thus prepare dishes rarely. They do not spend much on kitchen equipment but claim to able to prepare complex menus as well. Ambitious cooks (20%), who possess excellent skills, tend to experiment, buy sophisticated equipment and lay emphasis on on quality in everyday situations as well. The “Sourpuss” (12%) is a type which does not like to cook, but likes to eat. They have few to none cooking skills and are solely male. Quick cooks (13%) are hardly interested in cooking and mainly use ready-made meals and convenience products. Dutiful cooks (22%) have good to professional cooking knowledge and see cooking as a task, but with few passion. Healthy eating is important for them. This group consists mostly over married women over 40 years. Finally, critical cooks are aware of food quality and often try new and exotic recipes. They have good skills and know to prepare complex menus. Eating is a passion for them, and many gourmets are found among them.

1.2.4 Future Trends

Most authors predict a further diversification of lifestyles and eating behaviours. Bruhn (1998) identifies several major trends which influence future food consumption behaviour: Growth in convenience foods, increased emphasis on safety, development of nutrafoods and blending of ethnic specialities. This development derives from decreasing household sizes, income effects on food expenditure, the ageing society and ethnic mixing.

Bayer *et al.* (1999) raises twelve socio-economic theses with regard to consumption behaviour. She predicts more “conscient” behavioural patterns due to higher education and an increased demand of healthy food. Also, a decrease in consumption of warm meals in the household is predicted, accompanied by a higher use of microwave ovens and time-saving food. Furthermore, cooking will be celebrated in familiar circles and ethnic foods will gain importance.

Berg & Rumm-Kreuter (1996) summarise the three future studies “Mensch und Ernährung” (1986), “Popcorn-Report” (1992) and “Trends 2015” (1995). All have in common to predict a growing health awareness and corresponding consumption, return to traditional values, including

the trend back to more home-made meals. At the same time use of convenience food will remain an important part of food markets. Consumers are expected to become more critical and the eating culture of the future will ”have many faces”.

Lang & Caraher (2001) mainly see a growth of the convenience- and take-away food sector. They predict that technological abilities such as knowing to program a microwave oven will become more important than preparing food from basic ingredients and methods.

The “Future of the UK 2010” report predicts a paradigm change: Personalised consumer needs make mass market foods “a thing of the past”. Instead, food quality dominates the demand and organically produced foods become more important. Reasons for this change are seen in the social development towards self-actualisation, and especially a growing group of “inner directed” people. These persons are concerned about quality of life in terms of responsibility, spiritual growth and individual freedom (McNulty, 1990).

The scenario of life in 2020 by Scharioth *et al.* (2004) predicts a high market share of ecological food and the comeback of local foods. Furthermore the authors see a development towards simple cooking, without complex sauces and many ingredients. In contrary to that, the authors describe the rise of the “Slow Food” motion and a comprehensive “Homing” trend: Cooking becomes are ritual of sharing recipes, cooking together in dinner parties and cooking circles.

1.2.5 Summary

The area of food preparation has become complex due to the rivalry of regional, global and convenience offers, each having their advantages and disadvantages to the consumer’s well-being. In other words, the consumer has to decide between fully homemade and partially outsourced food preparation for a multitude of different situations in his life. Two major, but contrary habits can be observed:

- **Everyday cooking**: The demand for quick repletion from either easy meals, fast-food, eating out or convenience food.
- **Special Occasions**: Cooking as enjoyment and self-realisation, with a demand for fresh high-quality ingredients and sophisticated and time consuming techniques.

In the case of everyday cooking, efforts are naturally limited and cookbooks are merely used for inspiration, if at all. On the one hand, the decision to cook quickly with lower efforts often conflicts with healthy eating. On the other hand, the alternative requires much time and

knowledge and is therefore chosen more seldom. Thus it can be concluded that the higher the effort is, the more do people rely on cookbooks, recipes and the traditional way of cooking.

Lastly, the nearer past was determined by a shift to increased use of convenience products. This trend will remain in the near future, but be accompanied by a backward trend to healthier nutrition and more home made cooking.

1.3 Approaches to Improve Domestic Food Management

Several academic and commercial projects have been launched to improve food management activities in the household, ranging from simple remotely controllable appliances to futuristic ideas using technology that is not available on end consumer markets yet (see Bell & Kaye, 2002). In the following those scientific works are cited which cover aspects of food preparation, i.e. that are directly related to the processing of food for cooking thus the context of this work.

La Cantina. La cantina is a smart kitchen run by the Counter Intelligence group in the basement of MIT Media Lab, that hosts several projects: Mr. Java is a coffee machine recognising the user‘s mug and serving the personally preferred coffee along with the latest news of the user‘s interest. PC Dinners is a microwave oven that scans barcodes on prepackaged food, determines the optimal cooking time and plays music while heating the food. Robocrop augments a hydroponic garden and keep the user informed about the plants’ health status (Bell & Kaye, 2002).
The most important project in the context of this work is counterActive. CounterActive displays recipes down on the kitchen counter, on a special space that is equipped with a touch sensor, allowing to navigate through the recipe (see figure 1-1). Furthermore, the recipe is digitally enhanced by providing side information on ingredients or typical sounds of a French market for a Chicken Provencale recipe (Ju *et al.*, 2001; Bell & Kaye, 2002).

Augmented Reality Kitchen. Bonanni *et al.* (2005) have extended the above into the Augmented Reality kitchen. A technology called “Everywhere Display” is used to project information on any surface. The authors make use of flowchart-like recipes to “easily recognise the sequential order”. This sequence is graphically abstracted and projected on kitchen surfaces (see figure 1-2).

Figure 1-1: The counterActive project by Bell & Kaye (2001)

Cabinets are equipped with lighted handles, the sink is colourable in red or blue according to the water temperature, a fridge camera to see the content without having to open it, and a infrared thermometer (RangeFinder) mounted above the stove to directly measure cookware and food temperature and determine the durations of the state.

A pilot study was run to determine differences in preparation using the new technologies (five participants, plus eight in a control group without assistive technology). The task was to boil an egg. No significant speed improvements were observed using the assisting features, but neither any disadvantages. None of the times to find the recipe, the needed tools or the operation of range were significantly different from the control group‘s times.

Figure 1-2: Augmented Reality Kitchen‘s GUI . The photo was copied from Bonanni *et al.* (2005).

Cook’s Collage. The working hypothesis for Tran & Mynatt (2002) is that cooking is a “multitask” action in homes, sharing attention with other duties and causing the cook to “lose track” occasionally. The authors present a video system that keeps track of actions by capturing all actions and showing stills on monitors as memory aid. The images are however still manually shot by an observer (“Wizard of Oz”) and the authors acknowledge that a technical solution is not yet available.

Cooking performance is measured under occurring interruptions (scheduled by the observer), which are intended to cause memory slips and by introducing a second task to overload working memory: language learning or preparing another recipe.

After participation of 22 graduate students, the authors conclude that the second task significantly overloaded working memory, but the participants also developed strategies to keep track (e.g. by grouping ingredients according to their use). These strategies were only partially successful. In ex-post interviews many people uttered that they could trust Cook‘s Collage more than their memory (Tran *et al.*, 2000; Tran & Mynatt, 2002).

eyeCOOK. EyeCook is a digitally extended cookbook, that is capable of eye-gaze and speech recognition. Working hypothesis is that cooking involves “many conflicting demands for user attention” and that meal preparation can be stressful (Bradbury *et al.*, 2003; Shell *et al.*, 2003). In order to reduce workload and the need for user mediated input, eyeCOOK features automatic timers based on the context (cooking mode and current recipe step) and an adaptive display that changes and accepts voice commands if the cook stands in front of it.

Living Cookbook and “Kitchen of the future”. Living Cookbook, developed by Terrenghi *et al.* (2006) is a kitchen appliance that allows to record and reproduce cooking sessions by means of screens and cameras. One main goal is to encourage people to record their own personalised and therefore unique recipes, which renders cooking more as “edutainment” rather than as a process of work steps.
The authors carried out eight real cooking sessions to test usability of the system as well as the whole experience. Stress is reported even from research team members when cooking, but rather related to the culinary outcome than from using the system. Advantages are seen more in emotional support than in cooking support.
The “kitchen of the future” is a comparable approach by Siio *et al.* (2004). By use of several video cameras that are activated by foot switches, the cook can create web-ready recipes while cooking.

VERA. The Visual Enhanced Recipe Application (VERA) is a computer program which displays recipes suitable for people with aphasia, an acquired language disorder (Tee *et al.*, 2005). Their approach is to present a recipe mainly visually by means of a semantic model for cooking instructions. Based on this, the recipe is rendered using merely icons in a flow-chart like layout. Test were carried out with four participants with different degrees of impairment, each used once a text-based recipe and once the prototype (sample size per factor combination is one). As indicator of performance the authors use the number and severeness of observer interventions to complete the recipe (instead of risking the participant to fail his task). The results are slightly controversial:the authors attest a benefit for heavier impaired persons, but no clear gain for the

fewer impaired (one case even performed better with the text version). Furthermore the authors mention a possible learning effect during the second cooking session.

CHEF. CHEF is a case-based planner software for recipe creation. It is an implementation of a memory based planning system which is able to create plans (recipes) to achieve given goals based on the experience of previous plans and failures. CHEF further knows about objects and is therefore able to modify plans. In an example the system is told to select a stir-fry dish with beef and broccoli. As only a stir-fry dish with beef and beans is available in its memory, the system replaces the beans and changes the instruction as well as the cooking time for broccoli (Hammond, 1989, 1990).

Usability of a Cooking Timer. Crawford *et al.* (2001) evaluate the usability of a screen-based prototype of a cooker timer and food menu system by means of several techniques. These include a usability questionnaire, observation, interview, as well as Hierarchical Task Analysis (HTA) and Task Analysis for Error Identification (TAFEI). By these means the authors identify several details how the oven timer could be improved. For instance, they suggest to remove the initial language selection as source of error as well as a second temperature display to compare between actual and set temperature.

Other Improvements on Cookbooks and Recipes

Ludwig & Reitter (1999) create a taxonomy for verbs related to cooking procedures, which can be used to understand recipes. Similarly, the "Food Oracle" by Liu (2003) parses plaintext recipes and enriches them by linking information like ethnic and geographic context, naming substitutions for ingredients, and compiling a list of steps from cooking procedure keywords like "poach".

A computer system to plan diabetic diets in hospitals is presented by Schaeffler *et al.* (1994). For households Karg & Kreutzmeier (1996) develop an information system to optimise nutritional intake. The linked database regards nutrient requirements as well as nutrient contents of food and preparation times for the dishes.

SERPHA is a similar system for diet planning by Piekarski & Pfau (1993). It allows to plan meals for households and regards objective nutritional demands of all members as well as subjective demands such as taste, preferences, etc.

Chen *et al.* (2002) create "The Interactive Chef", a context-aware cookbook that answers questions concerning the quantity and ingredients for each recipe step. The authors claim that novices could "benefit immensely" from their intelligent assistance.

In his master thesis Gray (1999) describes a vision of a networked kitchen, run by sophisticated software that is connected to appliances, tag readers and knows about available ingredients, the user's tasks etc. One feature regarding cooking is the ability to process recipes in terms of scheduling steps, manage resource utilisation and to react to unexpected situations, all based on case-based planning by rules.

Ali *et al.* (2004) describe a scenario of smart kitchen appliances communicating with RFID enabled food packages. Furthermore, they make use of an XML-based recipe structure which contains elements such as *steps, ingredients, action* and attributes as *time, timeunit* (without further explanation).

1.4 Studies on Cooking and on the Duration of Preparation

Anderson *et al.* (2004) conducted a video study on food preparation with 99 participants in the western United States. Three small surveillance cameras were installed around the kitchen to record food preparation behaviour. The study focused on cooking hygiene aspects, i.e. to prepare a beef, chicken or fish entree. Therefore among others, cleaning durations of vegetables were recorded. For washing a tomato, the authors recorded a strong variation: an average of 5.6 seconds, with a standard deviation of 5.2 seconds and a range from 1 to 55 seconds.

The study food safety issues in Australian households by (Jay *et al.*, 1999) uses video observation, and questionnaires to determine food safety knowledge before beginning observation. A similar study was carried out by Hansen (2002). They positioned three cameras in people's kitchens and recorded and observed in an adjacent room. Foodstuff was bought, then the participant prepared the dishes as usual, handling interruptions as usual. In the following the tape was reviewed and encoded by two research assistants.

Food preparation times for meals prepared from a bioregenerative food supply was measured by Olabi *et al.* (1999) to explore how much of scarce labour time in space is required to be taken away from concurrent tasks. The authors carried out a time study by videotaping a professional chef preparing six dishes at different events without repetition. A videotape an-

alyst team classified his actions according to a scheme while reviewing the tape. Although the tasks were precisely defined, their beginning and end were hard to define in the review. The main conclusion is that ”active food preparation time” varies a lot with the recipe. In fact, they report that the active time is determining the total preparation time (70 - 80% of the duration).

The efforts of large-scale production of dishes in canteen kitchens have been explored by Gros (1977). To produce 80l of Bechamel sauce conventionally, only 25.9% percent of the time respectively 39.38 working minutes are needed for cooking, the rest is used for setup, gathering etc. For 200l of Bechamel, 25.6% of the time respectively 44.69 working minutes are needed.

Betz *et al.* (1991) compile a detailed collection of data on manual processing of different food in canteen kitchen. For slicing a tomato with a knife, the processing of a portion is stated to require 0.5 minutes, to cutting it into segments only 0.28 minutes. Cleaning by hand in a sink required 0.06 minutes per portion.

Zacharias & Dürr (1992) present comprehensive data on food and dish preparation times. Their findings are valid under the assumptions that used foodstuff is of best quality (Handelsklasse 1), working persons operate under normal ratio and working space and tasks are optimally arranged. If these criteria are not met, the authors recommend to use values raised by 5-10%. Table 1-1 lists selected results.

Table 1-1: Selected food preparation times by Zacharias & Dürr (1992)

Type of food	Quantity (kg/pcs)	Activity	Equipment	Milling	Variation (min)	Mean (min)
Carrots	1 / 18	peel	peeler		2.8 - 7.5	4.8
	1 / 18	cut	kitchen knife	1-3 cm	8.4 - 10.0	9.6
Tomatoes	1 / 15	clean, cut	kitchen knife	3-4 mm slices		4.3
Onions	1 / 8-20	peel	kitchen knife		3.2 - 4.2	3.7
	0.1 / 1	peel	kitchen knife		0.2 - 0.6	0.3
	0.1 / 1	cut	kitchen knife	dices	0.2 - 2.5	1.2

The KTBL data collection on catering and service by Gerhard *et al.* (1998) lists food preparation working times for canteen kitchen as well as private household kitchens. According to their research, the times for preparation and machine cleaning of carrots does not increase proportionally with serving size: for carrots, two servings require 3.5 minutes, four servings 5.3 minutes

Table 1-2: Selected dish preparation times by Gerhard *et al.* (1998)

Dish	Amount / serving (g or ml)	Make-ready (min)	Fixed duration (min)	Variable duration (min)
Minestrone	600	6.1	34.1	4.1
Carrots (raw)	85	1.2	0.6	0.4
Tomatoes (raw)	80	1.5	0.4	0.1
Carrots	250	0.0	5.8	2.4
Tomatoes	150	2.9	12.8	0.6
Bechamel	125	2.2	4.2	0.1

and eight servings 8.8 minutes. For tomatoes the slope is even less. In addition to the above, the times are splitted in fixed and variable amounts (depending on servings, see table 1-2).

Butijn *et al.* (1998) examine the ease of use of food products designed for microwave ovens. Two user panels are involved to test products in real cooking tasks twice per week over a period of five weeks. Data gathering is carried out by use of questionnaires and group interviews with the participants after performing their tasks. Corresponding to the works mentioned above, the authors report a high variability of quantified data as an outcome.

2. Goals of this work

Contemporary research reveals the various challenges the household faces in food preparation, and conventional cookbooks do not fully respond to these circumstances. Similar to other projects, this work follows the motivation to enhance the cooking experience with a dedicated computer system. Two steps of an UCD process are presented in this work, namely to extend research by specific questions to gain guidelines for product development and to test a prototype of an electronic cookbook for its usefulness.

The first goal is to find guidelines for product development. Knowledge on specific aspects of food preparation, like recipe or cookbook use during cooking is necessary for the development to meet user requirements and demands.
To determine in how far food preparation behaviour is influenced by global trends and challenges, selected issues of current research are reassumed in a consumer study and extended by detailed aspects on recipe and cookbook use, cooking challenges like time estimation, doneness estimation, specific techniques and appliance use. Based on the study specifications are worked out and presented here along with survey results.

The second goal is to assess the influence of the prototype on cooking performance. To decide upon the usefulness of the electronic cookbook the cooking behaviour of test persons performing realistic tasks needs to be measured. The goal is to probe the cooks‘s mental tasks during cooking and their practical execution during live cooking sessions. Adressed mental tasks are the rescaling of recipe servings, alignment with instruction sequence, challenges, problems, caveats of cooking, impressions and feelings during cooking and evaluation of the outcome. Executional measures are durations of recipe steps or single actions, appliance use, cookbook use and error rate.
Since food preparation behaviour of non-professional cooks has never been assessed quantitatively in terms other than total working time and projects that develop electronic cookbooks do not evaluate these to a satisfactory extend (see 1.3), a side-goal of this work is the development of an assessment method for home cooking. By means of this method it is compared if, and in how far an electronic cookbook prototype influences cooking behaviour.

3. Materials and Methods

The proceeding of this work is oriented to the UCD process (Bevan & Curson, 1999; Rauterberg, 2003; Dahm, 2006). Initiated by a problem definition phase, then followed by research and analysis, functional specification and building. Finally the prototype is tested against the requirements and improved if necessary. The cycle is repeated until a satisfactory usability has been achieved (see figure 3-1).
Usability is "the quality of use" and can be operationalised by characteristics as usefulness, effectiveness, readability and consistency, error prevention, flexibility, simplicity, learnability and likeability. (Vildjiounaite *et al.*, 2003; DIN124, 2003; Wickens *et al.*, 2004).

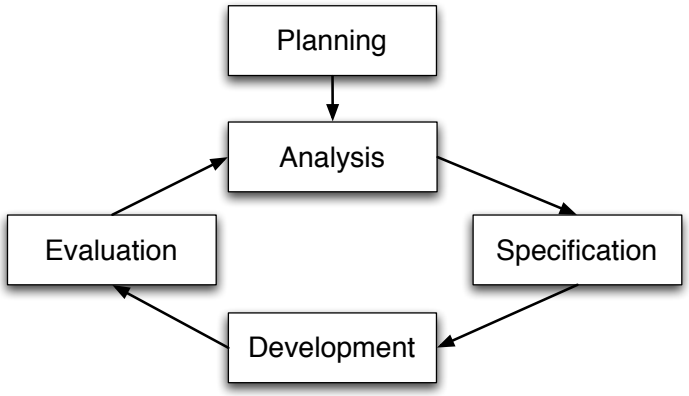

Figure 3-1: The user centered design process, adapted from Bevan & Curson (1999)

In this work a special emphasis is laid on the software testing to reach a high level of usability. In similar sequence to UCD, first the survey methods are described below, followed by the cooking observation proceeding.

3.1 Consumer Investigation on Food Management

In early stages of product development a questionnaire based survey is an appropriate method to gain insight into the relevant area (Hom, 1998). The questionnaire used in this work (see appendix A.1) was used to collect specific data on food management habits. It covers general aspects to compare them against other studies (Nicolaas, 1995; Sozioland, 2004), as well as specific details discussed with the Bonn group of the Deutscher Hausfrauenbund (Pozzi, 2005).

The internet was chosen as medium since it continuously gains importance, is cost-effective, requires relatively short field times and data can be gathered and evaluated automatically. A disadvantage is the low share of internet users across the population and the fact that internet users differ from the population concerning age, gender and education. This problem was minimised by making a deliberate choice, i.e. screening the sample for specific quota. Thereby was tried to cover relevant aspects of the population in the sample (Berekoven *et al.*, 1999; Batinic & Bosnjak, 2000; Bandilla *et al.*, 2001; Mayer, 2004).

Six European countries were chosen from different geographic locations, and from each 100 participants were required. The translations and the realisation were carried out by Ciao AG, Münich, an agency specialised in online consumer data collection. Random samples of customers were invited to participate in the survey until the targeted number of valid questionnaires was completed.

Pretests were carried out beforehand to ensure completeness and comprehensibility. Apart from few demographical questions, the questionnaire was fully standardised and consisted only of closed questions with given answers to choose from (Mayer, 2004).

3.1.1 Sample Screening

Criteria for participation in the survey were gender, a minimum age of 25 years, composition of the household, own responsibility for purchases and especially involvement in household works. The following additional quotas were set:

- **Relevant knowledge:** No person employed in the sectors marketing, market research, advertising, journalism, public relations, data computing or household appliance production / sales / services
- **Recent participation in a similar study:** Persons were not eligible if they participated in a study or group discussion on electrical household appliances
- **Gender:** 50% (or slightly more) females
- **Age:** Two groups were focused: 50% of people being 25-45 years old, and 50% being 46-65 years old. Other ages were screened out.
- **Occupation:** It was aimed at to have equal shares of housewives, part time and full time workers.
- **Job position:** Top managers, entrepreneurs of large companies and manual workers were screened out.

- **Cohabitation:** Comparable shares of persons living with their parents, solitarily, with their partner or their husband were to be attained.
- **Appliance purchase:** All participants needed to be responsible or co-responsible for choosing and purchasing household appliances.
- **Appliance use:** All participants needed to possess one of the following cooking devices: oven, hob or microwave.
- **Up-to-date knowledge:** Only those persons were eligible who bought an appliance less than 5 years ago, to avoid being confronted with already solved problems.
- **Food management:** Participants were chosen to be involved "often" in at least two of the following activities: setting up the shopping list, planning what to eat, foodstuff shopping, stockpiling, use of either hob, microwave or oven, cleaning up after the meals
- **Internet access and use:** To ensure to recruit a reasonable amount of people with computer experience, at least 50% needed to have internet access and gather or manage private information (email, stocks, schedules, cinema...)

3.1.2 Ex Post Control and Evaluation

After completion the raw survey data was returned as SPSS data files and converted to R format using SPSS2R. Then sample was cleaned from possible dishonest participants or those who answered questions randomly. Control questions (Q8,Q8b, see appendix A.1) were posted at the beginning and repeated at the end of the questionnaire. People who varied two or more scale levels were accordingly sorted out.

All figures and tables presenting data were produced by R 2.x (R Development Core Team, 2005) and the corresponding functions for cross-tabulation, running under Mac OS X 10.4.

3.2 Laboratory Cooking Observations

User panel research in a laboratory is the method of choice to test unknown products. Though time and resource intensive and of low statistical power, it allows a complete assessment of the product or the relevant features. Observational studies are advisable for user interface interaction studies, especially if real tasks have to be performed and in cases where "smart" technology" is used (Butijn *et al.*, 1998; Vildjiounaite *et al.*, 2003; Wickens *et al.*, 2004).

One of the drawbacks of laboratory environments is fixation. Unlike in natural situations some extraneous factors are blocked out intentionally, and for certain products exactly these problems may only appear in realistic environments and can thus not be examined (Wickens *et al.*, 2004). To minimise this problem a certain degree of freedom for the user was allowed: Listening to music, phone call interruptions as well as calling people if necessary were permitted to feel comfortable. In addition to that, the participants were encouraged to prepare the recipe "as they would do at home", i.e. by using the spices they prefer. The recipes were chosen to be of medium difficulty for most users and to require more actions and thereby more time. An experiment length of 90 minutes was estimated.

Foregoing observations in real households - as originally planned - revealed that presence of an observer changes the situation and influenced the test person. Moreover, not all kitchen provided enough space to install the data gathering equipment in place and the prototype in its stand (see below).

3.2.1 Experimental design

The two factors of the experiment were dichotomous each: Recipes (Lasagna, Cannelloni) and the cookbook (conventional, electronic). To avoid overly influence of the unknown environment, which would lower the external validity, each participant cooked twice and received support in finding things. The second participation is considered as a third factor in test evaluation, since the first two factors (recipe and cookbook) were both exchanged at the second participation This cross-over design reduces possible effects which could be carried over (Sarris & Reiß, 2005). A similar design is used for instance by Tee *et al.* (2005), and other studies described in 1.4.

Using a sample size of 10 participants and having 4 factor combinations (see table 3-1) plus repetition, the complete analysis consisted of 80 experiments to carry out.

3.2.2 Panel

A convenience sample was used to reach the required number of test persons. Test persons were acquired from a Uni Bonn database of persons who participated in other tests before (not cooking-related), by word-of-mouth and by announcements made in local supermarkets. Every participant received a book voucher as allowance.

Table 3-1: Groups and factors for cooking observations

Group	Run	Recipe	Cookbook	Code
I	1	Lasagna	conventional	L1
	2	Cannelloni	electronic	C2EC
II	1	Lasagna	electronic	L1EC
	2	Cannelloni	conventional	C2
III	1	Cannelloni	conventional	L1
	2	Lasagna	electronic	L2EC
IV	1	Cannelloni	electronic	C1EC
	2	Lasagna	conventional	L2

The sample was open to criteria like age, cooking experience, cooking attitudes and equipment at home. The only restriction was to have a majority of females in each group and and comparable age structure. People with obvious handicaps could not be regarded (see table 4-22).

To prevent symptoms of fatigue and to minimise possible carry over effects (see Sarris & Reiß, 2005), the time span between the first and the second participation was limited to at least one day pause and to maximal two to three weeks. Those participants reattending after a longer period were offered to be introduced again. The time of day to begin a test was set no earlier than 10:00 in the morning respectively 18:00 in the evening.

3.2.3 Proceeding

At the first attendance the test person was introduced to the environment and shown the cameras and microphones. The appliances were briefly explained and locations of all available equipment were shown (see figure 3-4). Moreover, the participants were told to be allowed to ask for locations and appliance functions at any time during the session. The purpose of the experiment was told as well.

After having been introduced the participant received written instructions, which were also presented and explained in free speech by the observer (see Sarris & Reiß, 2005). Then the test person was left alone to start preparation. The following tasks had to be accomplished:

1. Find the recipe in the given cookbook.
2. Recalculate the ingredients for the given number of servings.

3. Gather ingredients and put those missing on the shopping list.

4. Begin preparation.

5. Take notes (only with electronic cookbook).

3.2.4 The Used Prototype and Its Specific Features

The "vertical prototype" electronic cookbook was designed and programmed by the Electrolux Group (see figure 3-1). A vertical prototype implements the exact functionality, but only for a small section of the product to save resources (Hom, 1998; Dahm, 2006). The system used in the experiments provided functions for recipe browsing, a method to bookmark several recipes and a dedicated view to proceed with these recipes. A feature to recalculate recipes linearly was implemented in the prototype as well as one to create shopping lists.

The function to rescale recipes implemented a linear rescaling, since no standard is available to recalculate recipes, although it is not always correct. Large variations are introduced for instance by different cuts of meat, whether food is raw or cooked and different dilutions. Moreover, cooking times only remain unchanged if pot sizes do so, too. In some cases temperature needs to be increased when preparing larger masses which require more energy to heat (Blades, 2002; Gisslen, 2003).

The shopping list function offered a way to transfer items from the recipe's ingredient list to the shopping list by marking them and then clicking the appropriate button (see figure 3-2). Accordingly, a further instruction to the participants was to gather the foodstuff given in the ingredient list before beginning to cook. The list had to be compared against the items in the cupboards and in the fridge, then the missing item, which had been hidden by the operator before, had to be marked.

3.2.5 Methods of Data Gathering

During the observed cooking sessions videotaping was used to record the experiments, which is recommend for such proceeding and can be reviewed later (Barnes, 1980; Gomoll & Nicol, 1990). This method is also used in other cooking studies, e.g. Olabi *et al.* (1999) and Terrenghi *et al.* (2006).

Figure 3-1: The electronic cookbook prototype in its stand, with plexiglass cover.

In combination with video observation the “thinking aloud” technique (Hom, 1998) was chosen, i.e. the user was asked to express loudly his thoughts and emotions. This is necessary because of the insights that were requested to obtain concerning handling with recipes and the UCD process.

Two questionnaires were handed out to be filled out after the experiment. One was used to raise demographic and personal information, the second was handed out to enhance video observation with experiences the participant made and which were possibly not expressed or observed.

Evaluation of Usability. The usability evaluation was carried out as a part of the cooking experiments. All actions performed on the user interface were tracked by a small video camera mounted under the cupboard close to the stand. Thereby the operator was able to follow directly the interaction.

Afterwards the participants were asked to fill out a questionnaire and could attend an interview with observer at will. The questionnaire contained evaluation schemes on common questions (for both cookbook types) as well as for specific questions on usability of the prototype. The specific part used Likert scales to rate properties like readability or impression of the screen layout (Bandilla *et al.*, 2001).

Figure 3-2: An early layout of the recipe view, showing an example recipe which was copied and translated from Gräfe und Unzer 2003). The version user for testing was in German language.

3.2.6 Equipment

The section of the test kitchen to be used by the participants offered a common range of appliances (a common fume hood, Electrolux EHS 6651P hob and Avantgarde B9971-4 oven) and a broad variety of usual kitchen equipment.

Four cameras were mounted in the kitchen, showing the stove, the oven, the cookbook and an overview on the whole room (see figure 3-4). The two cameras mounted directly in the participant‘s reach were Monacor TVCCD-32ACOL mini-cameras with CMOS sensor (32x32x30mm

size), to be as unintrusive as possible. The two other cameras (Monacor TVCCD255COL with VZLCS-914M or VZLCS-5016M) mounted under the ceiling had CCD-sensors. All gave a colour picture (see figure 3-3). A microphone was placed in the kitchen near the hob to record sounds, appliance beeps or speech. Two loudspeakers on top of the shelves were used to communicate to the participant.

The observer sat in a different room, in front of a 70cm TV screen connected to a four way switch (Monacor TVSP-46COL quad processor) to change between the four single camera views and a 2x2 view. The video signal was also fed into to a standard PC for digital recording (using a Monacor USB-20V GrabBeeX video grabber). A microphone in the observation room allowed to speak to the participant.

Figure 3-3: Camera views for video observation

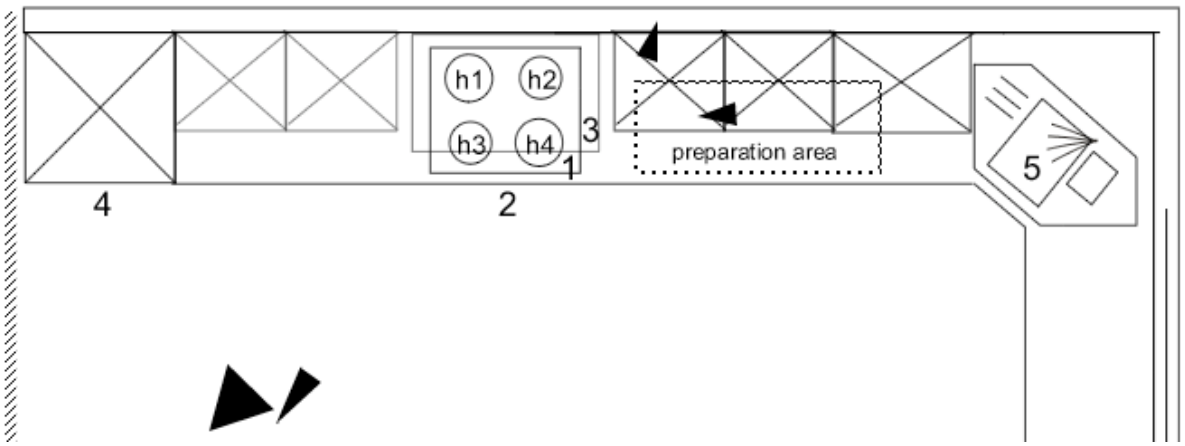

Figure 3-4: Test kitchen layout: Hob (1), oven (2), fume cupboard (3), fridge (4), sink (5). The black triangles represent position and direction of the cameras. The use of the preparation area was not mandatory, but recommended.

The Cookbooks and the Recipes

Two recipes were chosen from the German cookbook "Küchen-Klassiker" (Gräfe und Unzer, 2003): Meat Lasagna and Cannelloni (see appendix A.2). The decision was taken because the recipes needed to be comparable and met the following requirements:

- same dish category (both pasta dishes with sauce)
- reasonably high number of actions needed to observe possible differences
- hob and oven use needed
- in the source the recipes cover a whole page and show a picture
- the recipes must be known in most European countries
- medium level of difficulty

Provided Foods

The foods were provided depending on the recipe that was selected by the test operator. Beforehand was ensured that all required ingredients were in place, except when one ingredient was willingly hidden for the shopping list task (see above).
As far as possible the food was bought from the same brand and from the same supplier. A basic equipment of needed spices was provided, along with some extra spices which could be used at will. To ensure least distraction, same number of necessary actions for the cook and for safety reasons all ingredients were provided in closed containers. Fresh ingredients like dairy products or minced meat were discarded if not fully used.

3.2.7 Observation Logging to Measure Cooking Performance

The original intention to measure the quality of the resulting meal was abandoned because of the limitations of the project. Either several professional tasters would have been needed, which were not available (see DIN 10961:1996-08, DIN 10969:2001-05) or a very subjective rating would have been obtained from the participant‘s guests. Instead, it was tried to measure the cook‘s satisfaction in the post-test questionnaire.

Assessment of product interaction is often performed by Human Factor (HF) methods. If deficiencies in a system exist, either the task performance or the user's well-being can be diminished and thus can be measured. HF techniques include data collection, task analysis, human error identification, charting techniques, mental workload assessment, interface analysis and several other Stanton *et al.* (2005); Gawron *et al.* (2006).

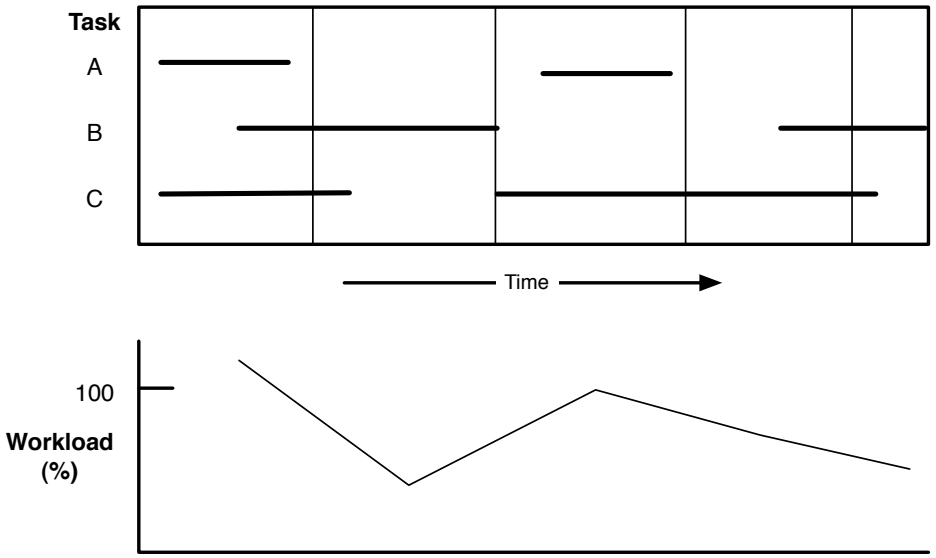

Figure 3-5: Task analysis by timelines, adapted from Wickens *et al.* (2004)

The graphical analysis of working processes is described in Aft (2000); Annett & Stanton (2000); Stanton *et al.* (2005). Though having several limitations, for simple purposes timelines can be used to represent the sequence of incidents and different tasks (Johnson, 1998; Wickens *et al.*, 2004).

Studies of the course of food preparation using timelines were carried out by Andersson *et al.* (1985) in their study on streamlining canteen food production. The authors use diagrams showing the sequence of preparation steps and the task sharing between several appliance operators. A simpler implementation of course analysis is used by Busse *et al.* (1994).

The task performance can be used to evaluate the usability of the researched item (Hom, 1998). In this work the cookbook was expected to influence cooking performance primarily in terms of total needed time and number and duration of reading attempts. Furthermore, it was tried to classify further action such as gathering, stirring, manual preparation, appliance operation and so forth. On this account the actions listed in table 3-2 were chosen to be recorded.

The distinction whether a movement was a new action was subjectively made by the observer: It was considered for instance as the same action, when participants read in the cookbook, left and attempted to gather an ingredient, but suddenly moved back and had another look at the instructions without actually taking it. Stirring in two different pots was considered as different actions, accordingly manually prepare (e.g. cutting) different ingredients. Handling two pieces of the same ingredients directly after each other was considered as one action, though.

Table 3-2: Classification of observable actions

Action	Characteristics
dead time	thinking, without moving or reading waiting phone calls
reading	head turns to cookbook and remains has recording priority over simultaneous actions
gathering	gathering and searching cleaning; waste disposal waste disposal
manual preparation	examples: cutting, washing, blending all actions with food except gathering and stirring new food is a new action
stirring	present at hob and dealing one of the pots
appliance operation	changing power levels; use of hob timer, on/off dealing with oven touch controls dealing with fume cupboard controls

Logging was done by means of the self developed software ObsLogger, which stored the data into a MySQL database. The observator entered a letter corresponding to an action right after recognising it. and thereby tracked length of the actions and numbers. Later statistics and graphical output - a timeline - of the actions (see figure 3-6 on page 37) were produced by "R" (R Development Core Team, 2005).

Error Classification and Measurement

In addition to the above, errors and insights from "thinking aloud" were logged as well. Error recorded during cooking sessions do not fully apply to the classification given in theory (see 3.2.7). Following problems arise:

- Errors are not always observable immediately. Lapses like forgetting a recipe step might as well have been postponed by the participant.
- Slips are not necessarily always noticed by the participant. If so, some might be corrected immediately, making it hard to decide if a slip occurred.
- Errors like choosing the wrong pot size might not be expressed.
- Violations could not be observed because the participants were free to modify the recipe according to their gusto.

Error measurement is one means to measure for user task performance. Originally developed for safety critical environments as aviation or nuclear plants, it has been applied to medicine and public products as well (Barber & Stanton, 1996; Gawron *et al.*, 2006).

Gawron *et al.* (2006) developed a classification of errors for medicine. However, such a classification is not available for the field of household work let alone food preparation. Furthermore Dekker (2003) warns that error classification can deepen investigative biases.

An incident is considered an error if the target was not reached and the cause is not coincidence. Human Error is categorised by the grade of information processing as follows (Reason, 1994; Wickens *et al.*, 2004)

- **Mistakes** are failures in evaluation or derivation of ways to achieve a goal, i.e. wrong conclusions
  - **Knowledge-based mistakes:** wrong perception
  - **Rule-based Mistakes:** choice of a wrong if-then rule
  - **Violation:** willing deviations from the plan

- **Errors** are failures in storing or realising of a sequence of action, regardless whether the plan was adequate:
  - **Slips:** actions that were not realised according to plans.
  - **Lapses:** hidden failures causes by memory lack (e.g. to forget a recipe step)

3.2.8 Calculations

Group statistics were calculated using the arithmetic mean (function `"mean"`) and the empirical standard deviation (function `"sd"`).

Statistical Tests Instead of the full test outputs returned by R, only the p-values are documented in this work, rounded to three decimal places. The p-value is the probability of obtaining a result at least as extreme as the observed data, under the assumption that the data point was only the result of chance (Clauß & und Lothar Partzsch, 1999; Dalgaard, 2002; Zöfel, 2002).

The statistical test applied on the cross tables was the X^2 - Test, to test observed table cell counts for independence from expected counts (function `"chisq.test"`). The test to compare the distributions of the duration of looks into the cookbook was the Mann-Whitney test (function `"wilcox.test"` in R, see Dalgaard (2002)).

To compare the groups for factor influence (cookbook, recipe, repetition) a three-way analysis of variance was applied to the data using the `"lm"` linear model and `"anova"` functions in R (Venables & Ripley, 2001; Dalgaard, 2002; Faraway, 2002). If the assumption of homogenous variances is not met, Zöfel (2002) recommends to use a 0.01 level of significance to get a factual 0.05 level.

Working Speed Comparisons. To compare the participants performances in the two experiments, it is necessary to transform the values first. A linear transformation (equation 3.1) turns the normal variable $X \sim N(\sigma, \mu)$ into a standardised normal variable $Z \sim N(1, 0)$:

$$Z = \frac{x - \mu}{\sigma} \tag{3.1}$$

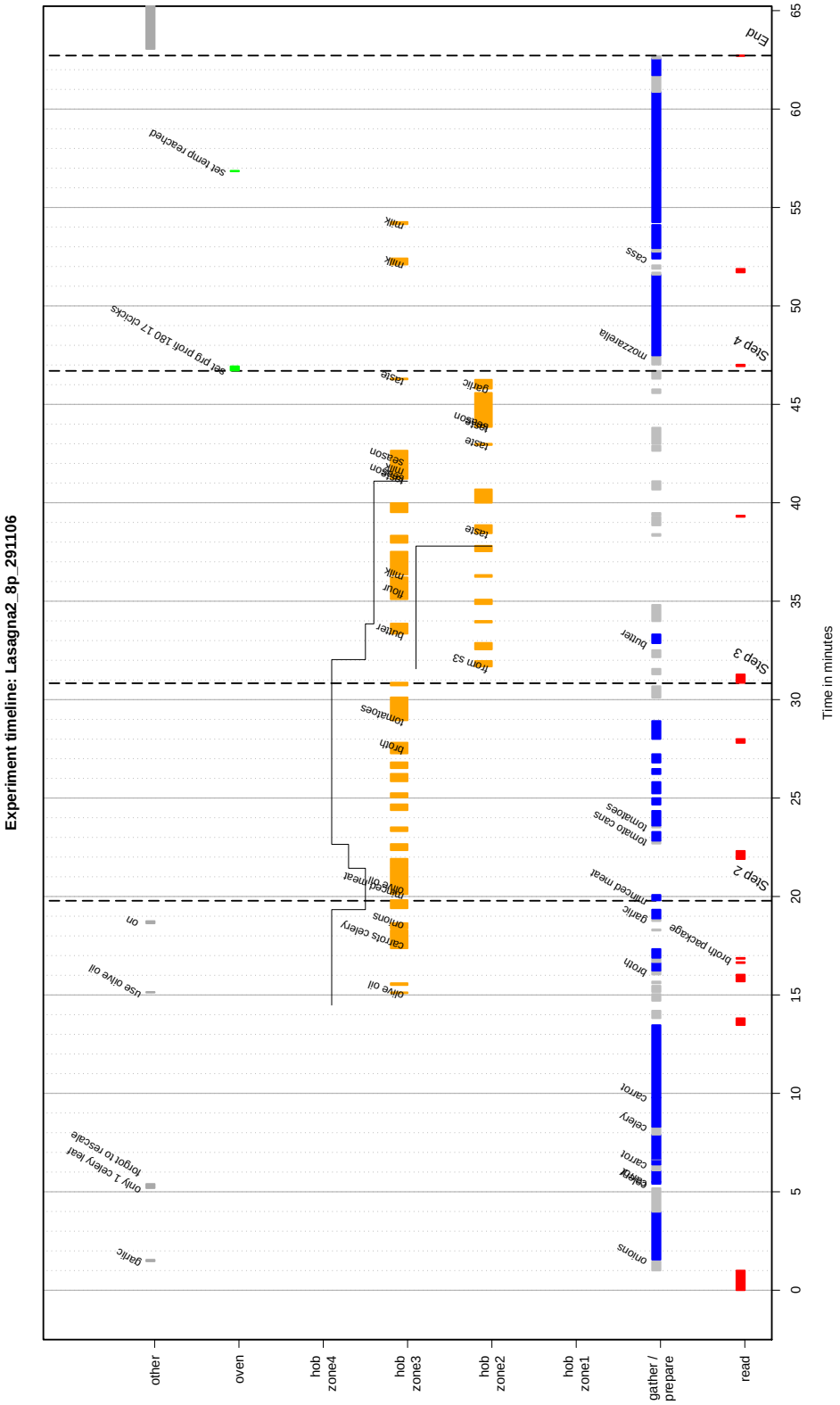

Figure 3-6: Timeline of an experiment. The bottom row shows reading actions (read). Above all manual actions like gathering and manual preparation are displayed. The ”hob” rows represent the events on each of the hob zones, with the black line indicating the power level. The top line shows dead time and insights. The x-axis is scaled in minutes.

4. Results

In the following the finding of this work are shown. The first part summarizes the consumer survey. The second part shows exemplary insights from usability testing. Lastly, the data derived from the cooking sessions is presented in detail.

4.1 Consumer Investigation on Food Management

The data sample consisted of 605 participants after removal of 18 unreliable datasets. The following tables show percentages instead of absolute values. Only selected cross-tabulations are documented which contribute to deeper understanding.

4.1.1 Panel Characteristics

The panel consists of equal shares of men and women, and of merely younger people. Nearly one half of the participants is between 25 and 34 years old, about 20% between 35 and 44 years, and 16% between 20 and 24 years. The elder groups between 45 and 65 years are relatively underrepresented. More than half of the participants is single (52.5%) and roughly 40% married. Within the singles, the group between 25 and 34 years of age is the largest fraction (about a third of the whole sample).

Table 4-1: Age and gender distribution in the sample (values in percent)

Gender / age	20-24	25-34	35-44	45-55	56-65	Total
Male	6.3	23.5	9.8	6.4	2.5	48.5
Female	9.9	25.6	11.4	4.0	0.7	51.6
Total	16.2	49.1	21.2	10.4	3.2	100

The professions which generate the household main income are dominated by employees (53%), followed by skilled workers and officals, which both have a share of about 18%. Finally, about ten percent self-employed persons, such as doctors, lawyers and freelancers.

Cooking Skill. The average cooking skill is ”good”; few people did not know how to cook, and about a third stated that their skill is rated ”very good”. Only few participants stated that

their cooking skills are not appreciated by their friends and family (see table 4-2). Among the very good, the majority is female, and the stated skills significantly differ from the male ($p = 0.049$). Elder people are rated better ($p < 0.001$). Furthermore, it seems that cooking frequency is related to skill: the better the skill the more often is cooked, and vice versa.

Table 4-2: Statements on own cooking skill by age (in percent, columnwise)

Skill / age class	20-24	25-34	35-44	45-55	56-65	Total
Very good	28.4	32.0	27.5	33.3	46.9	31.1
Good	54.9	51.9	53.1	57.1	40.6	52.9
Average	12.3	14.1	17.1	6.7	6.2	13.4
Adequate	3.1	2.0	2.4	2.9	0.0	2.3
Poor	1.2	0.0	0.0	0.0	6.2	0.4

4.1.2 Cooking Habits

Cooking seems to be one of the frequent domestic tasks. About 70% state to cook at least once per day. However, everyday cooking can be distinguished from cooking for special occasions very clearly: Special cooking is done rarely (about 10% do it once per week, the rest even less frequently, see table 4-3).

Table 4-3: Cooking frequency per week (in percent)

Cooking Frequency per week	never	rarely	1-2	2x or more	ca. 5x	more than 5x
Everyday situations	0.0	3.0	10.1	14.5	42.3	30.1
Special occasions	0.0	49.1	41.8	7.6	1.0	0.5
Eating out	6.4	55.9	28.1	8.3	1.3	0.0

Further findings were:

- People who tend to cook often in everyday situations also cook for special occasions more frequently.
- Age comparison of cooking frequencies revealed a possible tendency of younger people to cook more frequently.
- Retired persons and the youngest in this study probably do more Special Cooking than the middle aged.

- Singles cook less and prefer to eat out more than the others.
- Male persons seem to cook more often for special occasions.

The number of persons a meal is prepared for depends much on the situation. About half of the participants state to cook for two persons including the cook on everyday situations, this changes significantly on special occasions. Most often meals are prepared for five or more persons, few for only two person (16%) and almost never for just one person (see table 4-4).

Table 4-4: Average servings per meal (in percent)

Situation / servings	varies	1	2	3 - 4	5 or more
Everyday situations	0.0	18.2	48.6	27.9	5.3
Special occasions	3.1	3.0	16.0	31.1	46.8

Use of Appliances and Support Like Timers

As expected, the hob is the most popular cooking device and more than 50% of the sample use it always. The oven is used often or more frequently by more than half of the participants, but the Microwave is less popular. The microwave is rather used for quick cooking only - and very diversely throughout the countries. The use of dedicated or special appliances like bread baking machines, rice cookers or the like is very limited: One third of the sample never uses such items, another third only rarely (see table 4-5).

Table 4-5: Appliance use (in percent)

Appliance use / frequency	never	rarely	sometimes	often	always
Hob	2.6	0.8	2.3	30.6	63.6
Oven	0.8	4.6	24.3	56.0	14.2
Microwave	11.9	13.9	28.8	35.5	9.9
Special appliances	32.4	30.2	21.8	12.4	3.1

About a third of the sample does not have or use helpers like timers, while another third rates them as very useful. The oven timer (automatic stop) is, among the rest, the most accepted. However, microwave programs are available to more persons than the other types and they are considered more helpful (84.1% possess microwaves, only about 70% possess egg watches, oven timer or oven programs).

Further observations:

- People who use appliances more often have better knowledge about their features and rate usefulness higher.
- The usefulness of assisting facilities such as an egg watch or appliance programmes is rated higher by persons cooking more frequently.

Meal Preparation Time

Ninety percent of the respondents state to cook no more than an hour in everyday situation, and a third of the participants state to spend only 30 minutes or less for everyday meal preparation. For special occasions the image is contrary: 54% prepare special meals within two hours, and another 30% even invest more than two hours of time.

Comparing the frequency of everyday cooking to the average meal preparation time, it becomes clear that people cooking seldomly also tend to cook in short time. However, this does not apply to the behaviour on special occasions (see table 4-6).

Table 4-6: Cooking frequency and duration. Values are given in percent of rows and columns

Frequency / duration	Don't know	< 30 min	30 - 60 min	1 - 2 h	2+ h
Everyday situations					
Rarely	0.0	0.7	2.0	0.3	0.0
Once a week	0.0	5.3	4.5	0.3	0.0
More than once a week	0.0	5.6	7.9	0.8	0.2
(Almost) every day	0.0	13.1	27.1	2.1	0.0
More than once a day	0.0	7.9	19.3	2.5	0.3
Total	0.0	32.6	60.8	6.1	0.5
Special occasions					
Never	0.0	0.0	0.0	0.0	0.0
Rarely	0.8	0.2	7.4	28.1	12.6
Once a week	0.5	0.2	4.6	21.3	15.2
More than once a week	0.2	0.3	0.5	4.1	2.5
(Almost) every day	0.2	0.2	0.2	0.3	0.2
More than once a day	0.0	0.0	0.2	0.3	0.0
Total	1.7	0.8	12.9	54.2	30.4

Statements on Cooking Attitudes

Asked about their attitude towards cooking, many of the participants utter a relative high interest in cooking. For instance, many people seem to be interested in improving their skills. Contrary is that many people dislike having the role of the cook in their household (see table 4-7).

Table 4-7: Cooking attitudes (in percent; without indecisive answers, which were less than 1%)

Statements / agreement	not at all	hardly	fairly strong	very strong
I like to learn and improve.	3.3	10.5	28.4	57.8
A good meal pays off the time.	1.7	10.9	30.0	57.5
I like to cook.	2.7	13.6	36.0	47.8
I can express my creativity.	9.0	22.3	36.9	31.8
I put much efforts in cooking.	8.3	27.3	35.4	29.0
I like to be the cook.	17.2	25.7	34.1	23.0

4.1.3 Differences between Everyday and Special Occasion Cooking

The most important differences between everyday and special occasion cooking are the efforts put into creating a nice ambience and making the meals look good. Also, people chose more challenging recipes that require ingredients of higher quality. About the half of the sample prefers fresh, unprocessed ingredients for special occasions instead of preprocessed or convenience food (see table 4-8), while In everyday situations cooking fast and easy from available ingredients is popular (see table 4-10).

Table 4-8: Selected differences between everyday cooking and special occasions (in percent)

Statement / difference	I take no notice.	No	Yes
Create an extraordinary atmosphere	4.6	17.2	78.2
Make the meals look very good	6.4	21.2	72.4
Choose more ambitious recipes	6.3	32.9	60.8
Use more high quality ingredients	5.0	40.2	54.9
Use more fresh unprocessed ingredients	6.3	46.1	47.6
We cook together	10.9	53.1	36.0
Tools I normally wouldn't use	8.4	65.1	26.4

Recipe use is very common for special occasion cooking, as the chosen dishes are often unknown or require unusual ingredients or methods. Only a minority, roughly 20% of the whole sample,

states to cook from recipes often or always in everyday situations, but more than 46% rely on them rarely or even never. In the contrary, nearly 60% use recipes always or often on special occasions, which means that those meals are seldom prepared off by heart or improvisational (see table 4-9).

Table 4-9: Cooking guided by recipe in different situations (in percent)

Recipe guided cooking	never	rarely	sometimes	often	always
Everyday situations	12.4	34.0	33.7	14.4	5.5
Special occasions	2.6	8.6	30.1	43.6	15.0

Table 4-10: Cooking efforts in different situations (in percent)

Recipe choice behaviour / frequency	never	rarely	sometimes	often
I try something new.				
Everyday	1.8	23.6	55.4	19.2
Special occasion	1.7	10.4	41.0	46.9
I remind other people's suggestions.				
Everyday	4.1	24.1	55.9	15.9
Special occasion	4.5	21.5	50.7	23.3
I cook from available ingredients.				
Everyday	2.3	8.6	30.6	58.5
Special occasion	7.6	38.8	30.9	22.6
I choose something quick and easy.				
Everyday	0.3	4.5	33.6	61.7
Special occasion	16.4	42.3	31.2	10.1

4.1.4 The Use of Recipes and Cookbooks

Primary source of recipes and inspiration are cookbooks, closely followed by cooking websites and selfmade private collections. Since the survey was web based, cooking websites as source of inspiration might be overrepresented, though. Inspiration is not taken from media such as computers without internet, video or dvd nor cooking courses (see table 4-11).

Table 4-11: Source of recipes and inspiration

Sources / frequency	never	rarely	sometimes	often
Cookbook	4.1	15.9	42.8	37.2
Websites	16.2	19.0	36.7	28.1
Handwritten collection	19.0	18.2	36.0	26.8
Magazines	12.9	29.1	36.0	22.0
Computer	34.9	21.5	28.6	15.0
Video, DVD and TV	49.6	20.7	24.1	5.6
Cooking course or group	86.0	10.2	2.1	1.7

Alignment to Recipe Instructions

Recipes are merely followed in such a way that the non-appliance part is accepted, while the most frequent deviation from instruction is the adaption to used eqipment. About a third of all participants often change the temperature or cooking time. Secondly, ingredient type and amounts are changed. Exchanging the preparation techniques or the sequence of steps is of course rarely possible, therefore the frequencies of about 40% in the ”sometimes” category should be regarded as relatively high (see table 4-12).

Table 4-12: Recipe adaption (in percent)

Variation / frequency	never	rarely	sometimes	often	always
I adapt times.	7.3	18.5	36.5	26.9	10.7
I change temperatures.	9.4	23.5	32.6	23.8	10.7
I use different amounts.	7.1	18.0	43.3	28.3	3.3
I use different ingredients.	7.1	18.8	47.4	25.3	1.3
I use different preparation methods.	7.8	29.8	42.0	18.8	1.7
I change work step sequence.	12.2	32.9	36.9	16.7	1.3

Difficulties in Recipe Choice

Among the addressed difficulties are a few which seem to be really difficult for the participants. Two thirds made the experience that the most difficult task is to meet the peoples’ taste when choosing a recipe. Moreover, about a half states that regarding diets and cooking balanced meals in short time is difficult. Finding a recipe that is not too expensive is rather difficult for roughly

40% of the sample. The participants seem to know which recipes can be cooked with their equipment and do not see any problems in reusing leftovers (see table 4-13).

- In most cases a clear difference between the genders cannot be observed, but among those who see at least little difficulties, women are the majority.
- With increasing skill the difficulty of the addressed problems seems to decrease.
- The difficulty of regarding diets seems not to be affected though.

Table 4-13: Recipe choice difficulties (in percent)

Find a recipe that ... / difficulty	n.a.	not at all	not really	to some extend	yes
...meets everyone's taste	0.5	10.9	23.0	39.3	26.3
...regards diets	2.0	19.2	26.0	36.7	16.2
...is a balanced meal in short time	1.8	15.9	31.1	35.4	15.9
...uses leftovers	4.8	30.1	33.2	19.7	12.2
...meets my skills	1.2	23.8	33.6	34.7	6.8
...matches other courses	1.7	16.5	36.7	33.7	11.4
...is not too expensive	1.0	19.7	36.4	32.1	10.9
...is possible with my equipment	0.8	23.6	38.3	28.3	8.9

How Cookbooks are Seen

Above all, cookbooks are rated very positively. In situations when people are stuck with a problem, cookbooks are used and regarded as helpful. However, the majority of the sample is of the opinion that cookbooks are lacking background information only 13.6% think that critical points are explained well (see table 4-14).

Only two of the given statements were rated differently by the genders, namely that informations given in cookbooks are sometimes lacking or false and that navigation can be difficult. In both cases men outnumber women in the group having the most difficulties. Comparing these statements against the persons' skills, it turns out that the attitude towards cookbooks depends much on the skill: The better it is, the better are cookbooks rated.

Table 4-14: Statements on cookbooks (in percent)

Statement / agreement	n.a.	not at all	not really	yes, a bit	yes
Positive statements					
Helps me when I am stuck	2.6	13.9	19.0	35.7	28.8
Easy to vary the recipes	3.3	9.4	27.1	36.2	24.0
Enough hints to critical points	6.4	6.8	33.2	40.0	13.6
Enough basic instructions	6.8	15.9	33.2	31.6	12.6
Negative statements					
Background information missing	3.3	6.1	24.8	41.7	24.1
Too many complex recipes	2.8	14.5	28.8	37.9	16.0
Change the sorting	6.6	15.5	23.8	38.3	15.7
Informations lack or false	7.6	17.5	33.9	31.2	9.8
Navigation is difficult	2.5	22.1	41.0	28.8	5.6

4.1.5 Issues of Practical Cooking

Roughly estimated half of the participants feel that the issues adressed in table 4-15 are at least ”to some extend” difficult. Dealing with unknown ingredients is the most difficult task, along with the recalculation of ingredient amounts. Being present in the kitchen and judging whether the food is done is seen less difficult than other points.

Table 4-15: Common difficulties of cooking (in percent)

General difficulties	n.a.	no	not really	to some extend	yes
To deal with unknown ingredients	1.0	9.9	29.9	42.0	17.2
Recalculation of ingredients	0.2	21.2	26.1	36.5	16.0
Preparing several things at once	0.5	18.8	29.4	35.2	16.0
Judging doneness	0.8	20.8	31.4	33.4	13.6
Being present	0.2	23.6	35.5	29.8	10.9

Estimating durations is moderately difficult. Only ten percent consider it difficult, but up to the half regards it “to some extend” difficult. Among the adressed difficulties estimating the time that is needed to preheat the oven plays the least role. In the average, only about 20% of the sample sees this as a problem “to some extend” or more (see table 4-16).
The chosen example of fileting a fish is by far the most difficult (it corresponds more to Special Cooking than the other examples). Cooking rice or pasta, everyday tasks in many countries, are accordingly seen as easy tasks (see table 4-17).

Table 4-16: Time estimation difficulties (in percent)

Estimation task / difficulty	n.a.	no	not really	to some extent	yes
When to begin to finish in time	0.3	22.3	32.2	34.5	10.6
How long to cook an ingredient	0.2	18.5	36.0	34.7	10.6
Single work step duration	0.3	18.5	30.9	40.5	9.8
When to preheat the oven	0.3	36.2	35.7	18.2	9.6

Acute difficulties caused by mistakes, forgotten actions or lack of knowledge play a role insofar as roughly a quarter of the participants state to face these events at least sometimes. However, only between 2-4% have such problems often and 20–30% say to never face such problems (see table 4-18).

Table 4-17: Difficulty of specific preparation techniques (in percent)

Task / difficulty	n.a.	done easily	moderately difficult	very difficult
Fileting a fish	10.4	30.9	30.1	28.6
Making a sauce	2.5	64.8	25.3	7.4
Baking a cake	5.5	62.1	26.6	5.8
Roast meat tender	3.1	65.0	28.3	3.6
Cleaning vegetables	3.8	80.8	12.1	3.3
Cooking pasta al dente	3.3	85.1	10.2	1.3
Cooking rice	2.0	87.3	9.4	1.3

Table 4-18: Acute difficulties while cooking (in percent)

Acute problem / occurrence	never	rarely	sometimes	often
Taken wrong amount	21.3	49.6	25.6	3.5
Don‘t know next step	25.1	50.1	21.5	3.3
Don‘t know how to do a work step	24.1	49.8	23.5	2.6
Forget to control doneness	35.9	43.8	16.9	3.5
Too much power	43.8	40.2	13.7	2.3
Forget to switch on	26.3	49.4	20.7	3.6

4.1.6 Difficulties of Food Management

The presented food management actvities are evaluated contrarily (see table 4-19). Obviously abstract tasks like planning the aquisitions and controlling the budget are rather disliked - only a third of the sample “rather enjoys” them, whereas activities closely related to shopping (and shopping itself) are enjoyed much more.

Table 4-19: Rating of food management activities (in percent)

Activity / perception		difficult	easy
Planning the acquisitions	boring	25.2	18.1
	enjoyable	8.9	47.9
Controlling the budget	boring	30.2	28.5
	enjoyable	10.2	31.1
Writing the shopping list	boring	6.4	21.8
	enjoyable	4.6	67.2
Balancing the meals	boring	18.6	8.6
	enjoyable	29.9	42.9
Checking the market for offers	boring	13.4	12.3
	enjoyable	13.1	61.2
Going shopping	boring	9.3	15.9
	enjoyable	4.2	70.6
Buying and preparing seasonal offers	boring	21.6	9.3
	enjoyable	22.6	46.6

Stockpiling issues

Decay of fresh food is an event that is experienced often (about two thirds observed this sometimes or often). Also, passed use-by dates are a frequent experience. Probably people do now about the right storing conditions or forget to check, because passed use-by dates are an important issue as well. Stock amount related issues are secondary. Difficulties concerning the amount of food are less common. As a general statement it can be said that there are both people who are in good control of their stock and such which have noticeable difficulties (see table 4-20).

Table 4-20: Storing issues (in percent)

Issue / occurrence	never	rarely	sometimes	often
Decay of fresh food	19.8	20.7	26.1	38.7
Passed use-by dates	31.5	27.5	20.4	27.4
Too few in stock	19.4	25.9	27.8	17.5
Not to know how much in stock	29.4	25.8	25.7	16.4

Addressing Diets

Healty eating is the most frequently regarded diet, next to weight reduction. For nutrition in case of illness and ethical diets there seems to be a more distinct behaviour, as these diets tend more to be either addressed or not. Ethically motivated diets play a minor role compared to other diets, though still about a third of the partcipants knows well to address these. Among the persons who know to address diets best, women outnumber men for every type of diet (see table 4-21).

Table 4-21: Ability to address diets (in percent)

Diet / regard	Not necessary	I take no notice	a little	well
Weight reduction	7.6	25.3	43.3	23.8
Healthy eating	7.4	22.1	41.0	29.4
Illness nutrition	15.9	20.3	22.6	41.2
Ethically motivated	27.8	25.3	17.4	29.6

4.1.7 Summary and Indications for Development

Common trends as identified by other authors (see above) can be confirmed: Either people do everyday cooking up to one hour per meal with easier recipes and from available and maybe preprocessed ingredients. Or, occasionally, they cook special meals with much more effort and often unknown ingredients of higher quality. Special emphasis is laid on the ambience and look of the food.

Cookbooks are primarily used for inspiration. They are less used for everyday cooking, instead referred to when recipes, procedures or ingredients are unknown or other difficulties are faced. Recipes are used in a similar way: they are adapted to the available equipment and ingredients are varied according to the user's need: instructions are altered, especially the appliance-related

instructions. During preparation itself the most important issue is the estimation of time, be it cooking time of an ingredient or the whole duration of preparation. The following points should be seen as indications for prototype development, not as mandatory features:

- an appearance that resembles more to magazines than common cookbooks
- means to browse and navigate quickly and more effectively than in conventional cookbooks
- a possibility to regard diets, respectively the choice of recipes corresponding to a diet
- a food database and a way to provide information on unknown ingredients
- recalculation of amounts when the number of servings is changed
- display of more than one recipe at a time or a way to quickly change the recipe
- a option to attach notes to a recipe

4.2 Results of the Cooking Experiments

Though only 80 complete experiments were needed, over 100 test had to be carried out. Several participants were not able to reattend the study because of lack of time, and a few experiments were regards as invalid if the participants stated to have suffered from overly strong nervousness and also showed anxious behaviour.

4.2.1 Data of Cooking Performance Measurement

First of all, the performance data exhibits strong variances. Each measured characteristic shows to be influenced to a high extend from human behaviour. Indeed, a broad variety of techniques, working speed and cooking knowledge could be noticed. Similar tasks were approached by the test persons in very contrary ways. Table 4-22 gives an overview on the mean data per factor combination. Afterwards each measurement is examined in detail.

Measured covariates were gender, age, years of cooking experience, whether the recipe was known and how nervous the participant felt. The response of knowing similar recipes to manual preparation time is significant (p=0.030), and those test persons being familiar with the recipe prepared manual steps in shorter time. However, the effect gets lost in the total duration of the cooking session. The remaining covariates did not effect the measured data.

Table 4-22: Experimental data overview. All values are factor combination means ± standard deviation

All data	L1	L1EC	L2	L2EC	C1	C1EC	C2	C2EC
Participants (n)	10	10	10	10	10	10	10	10
Female ratio	90%	80%	70%	70%	70%	70%	80%	90%
Age (y.)	28 ± 6.7	28.5 ± 7.9	33.9 ± 15.4	27.4 ± 6.8	27.4 ± 6.8	33.9 ± 15.4	28.5 ± 7.9	28 ± 6.7
Experience (y.)	10.9 ± 5.9	9 ± 6.4	15.6 ± 16.2	9.6 ± 6.3	9.6 ± 6.3	15.6 ± 16.2	9 ± 6.4	10.9 ± 5.9
Recipe known	1.6 ± 0.8	1.8 ± 0.8	1.5 ± 0.7	1.8 ± 1	2.4 ± 0.7	1.9 ± 1	2.4 ± 0.8	2.4 ± 0.5
Observed actions (n)								
Total	174.3 ± 32.3	162.7 ± 25.1	157.8 ± 25.7	159 ± 34.3	136.6 ± 21.8	158.8 ± 22.3	134.2 ± 26.9	134.6 ± 21.7
Cookbook views	34.9 ± 5.3	39 ± 7.6	24 ± 9	32.3 ± 10.9	29.8 ± 8.4	33.3 ± 8	24.8 ± 7.7	26.8 ± 5.1
Hob commands	17.1 ± 6.3	22.5 ± 5.7	16.5 ± 4.1	14.4 ± 5.1	17.6 ± 3.5	19 ± 6.9	19.9 ± 6.7	15 ± 3.8
Fume hood	0.9 ± 0.6	0.9 ± 0.7	0.7 ± 0.5	1.2 ± 1.8	0.5 ± 0.5	0.8 ± 0.9	0.7 ± 0.8	0.8 ± 1
Oven clicks	25.3 ± 19.6	20 ± 7.4	32.8 ± 20.7	18.5 ± 12.4	20.4 ± 11.6	22.7 ± 13.4	20.9 ± 6.6	25.6 ± 14
Recipe variations	6.4 ± 4	2.3 ± 2.3	3.7 ± 1.4	4.2 ± 4.7	2.3 ± 1.8	1.2 ± 1.2	1.1 ± 0.9	3.8 ± 2.1
Times (in minutes)								
Total	72.2 ± 12.2	77.3 ± 11.7	69.1 ± 14	75.9 ± 16.1	73.4 ± 15.9	77.8 ± 11.8	75.4 ± 11	73.6 ± 7.6
Reading	9.4 ± 2.4	12.6 ± 3.1	7.2 ± 3	9.9 ± 3.5	8.6 ± 2.8	10.5 ± 2.8	6.8 ± 2.5	9.2 ± 2.8
Gathering	9.6 ± 2.3	8.9 ± 2.7	9.9 ± 1.6	10.3 ± 1.8	9.5 ± 3.7	9.3 ± 1.2	8.2 ± 2.2	8.9 ± 2.1
Attended Cooking	19 ± 3.4	18.3 ± 4.3	19.5 ± 5.8	20.3 ± 7	16.7 ± 4.7	19.1 ± 4.9	19.6 ± 4.1	17 ± 2.7
Manual Preparation	30.5 ± 7.8	30.1 ± 5.1	28.9 ± 7	32.7 ± 8.8	34.1 ± 9.2	34.8 ± 7.4	36.2 ± 5.5	35.2 ± 5.2
Baking	39 ± 4.8	38 ± 4.3	40.5 ± 8.1	39.6 ± 5.3	34.4 ± 6.7	30 ± 5.2	33.6 ± 3.7	37.1 ± 10
Time shares (in %)								
Reading time	13.7 ± 2.6	18 ± 3.8	10.9 ± 3.3	13.5 ± 4.5	12.6 ± 3.8	14.2 ± 3.4	9.4 ± 2.5	13 ± 3.4
Gathering time	14.1 ± 2.2	13.1 ± 4.1	15.8 ± 3.6	14.5 ± 3.1	13.7 ± 3.8	12.7 ± 2.1	11.6 ± 2.3	12.7 ± 2.7
Attended Cooking	27.9 ± 3.6	25.9 ± 4.6	29.3 ± 4.5	27.4 ± 5.8	24.2 ± 4	26.1 ± 5.3	27.9 ± 5.4	24.4 ± 3.6
Manual Preparation	44.3 ± 5.5	42.9 ± 4.7	44.2 ± 6.1	44.5 ± 6.3	49.4 ± 6.2	46.9 ± 5.7	51.3 ± 4.6	50 ± 4.2

Observed Actions

The number of observed action depends on the recipe, of course. For Lasagna, on average about 160 actions were observed, with an exception of 174 actions in group I due to an extreme outlier. For Cannelloni about 135 actions are needed, with the exception of 159 actions in average in group IV (see figure 4-1).
A three-way ANOVA accordingly returns only the recipe as highly significant ($p<0.001$) factor. Thus, the conclusion can be drawn that the Lasagna recipe needs more single actions though both recipes consist of four steps each.

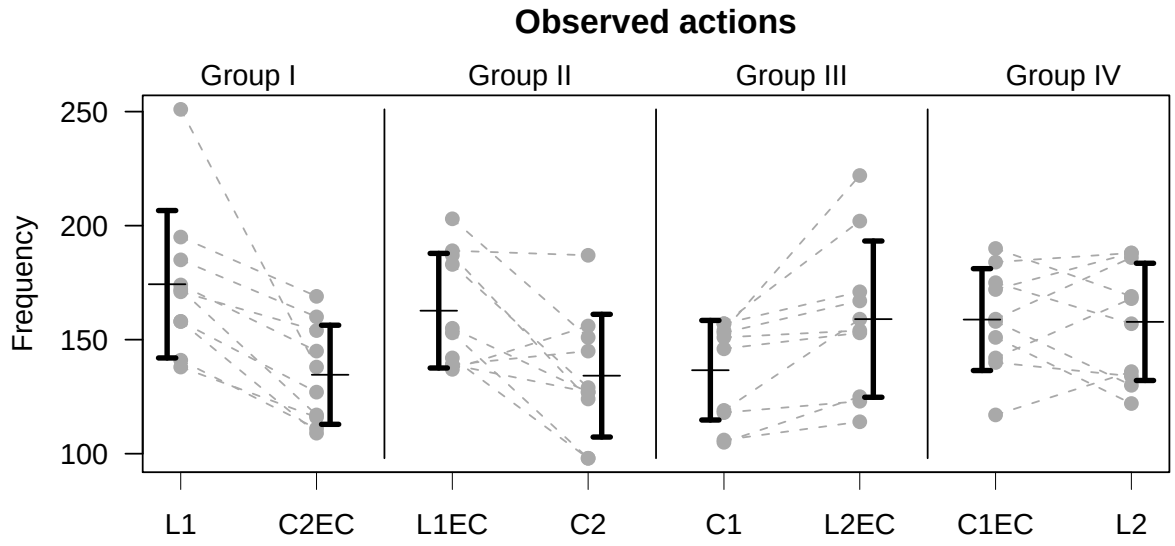

Figure 4-1: Observed actions to prepare the whole meal. The black vertical bars indicate the mean and the standard deviation. The grey points represent test persons, connected with a dotted line to their second participation.

Total Duration of Attended Preparation

The duration to prepare either Lasagna or Cannelloni without baking is nearly equal with about 75 minutes (ANOVA shows no differences). However, vast differences within the groups can be observed. Quick participants were able to prepare each of the dishes within about 50 minutes, while slower persons required the double time (see figure 4-2).

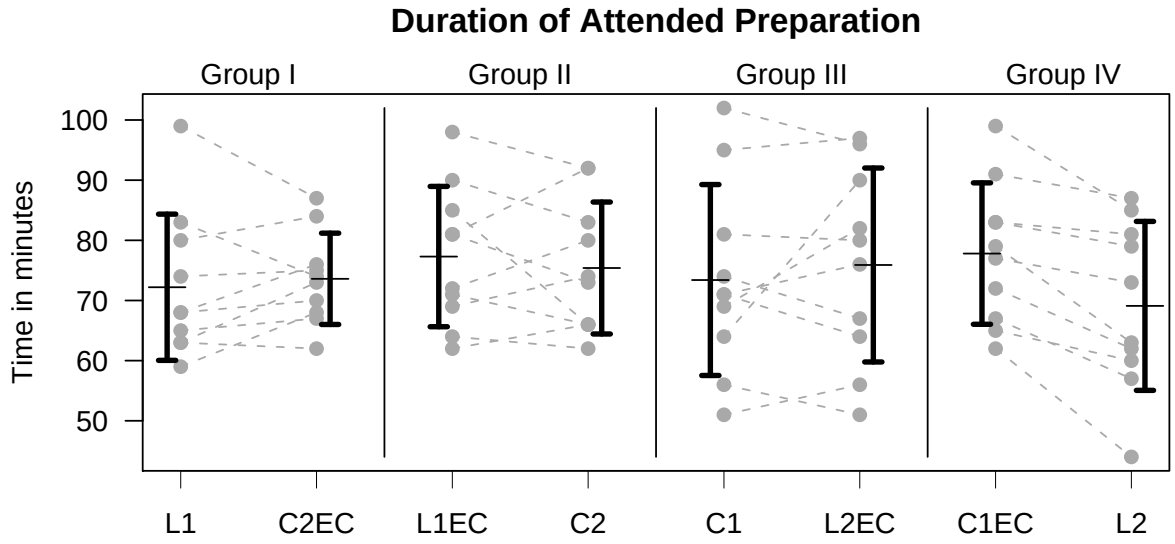

Figure 4-2: Total duration of meal preparation

Furthermore, it can be determined visually that the spread of the times within the group remains in the second run as high as in the first run, and that group III has a quite large variance compared to others. The analysis of variance returns no significant factors.
After normalising the data to the factor combination means and plotting both participations against each other, a correlation is visible (see figure 4-3). In many cases the participants' speed in relation to their group is steady. If a participant cooked quickly at the first participation, he also cooked quickly at the second time.

A simple linear regression delivers a correlation coefficient of $R^2 = 0.645$. In other words, almost two thirds of the deviation from the group mean is declared by the personal working speed. The slope is 0.80 (i.e. the second participation is slightly faster), which is a possible indication for a learning effect, though is not indicated by ANOVA.

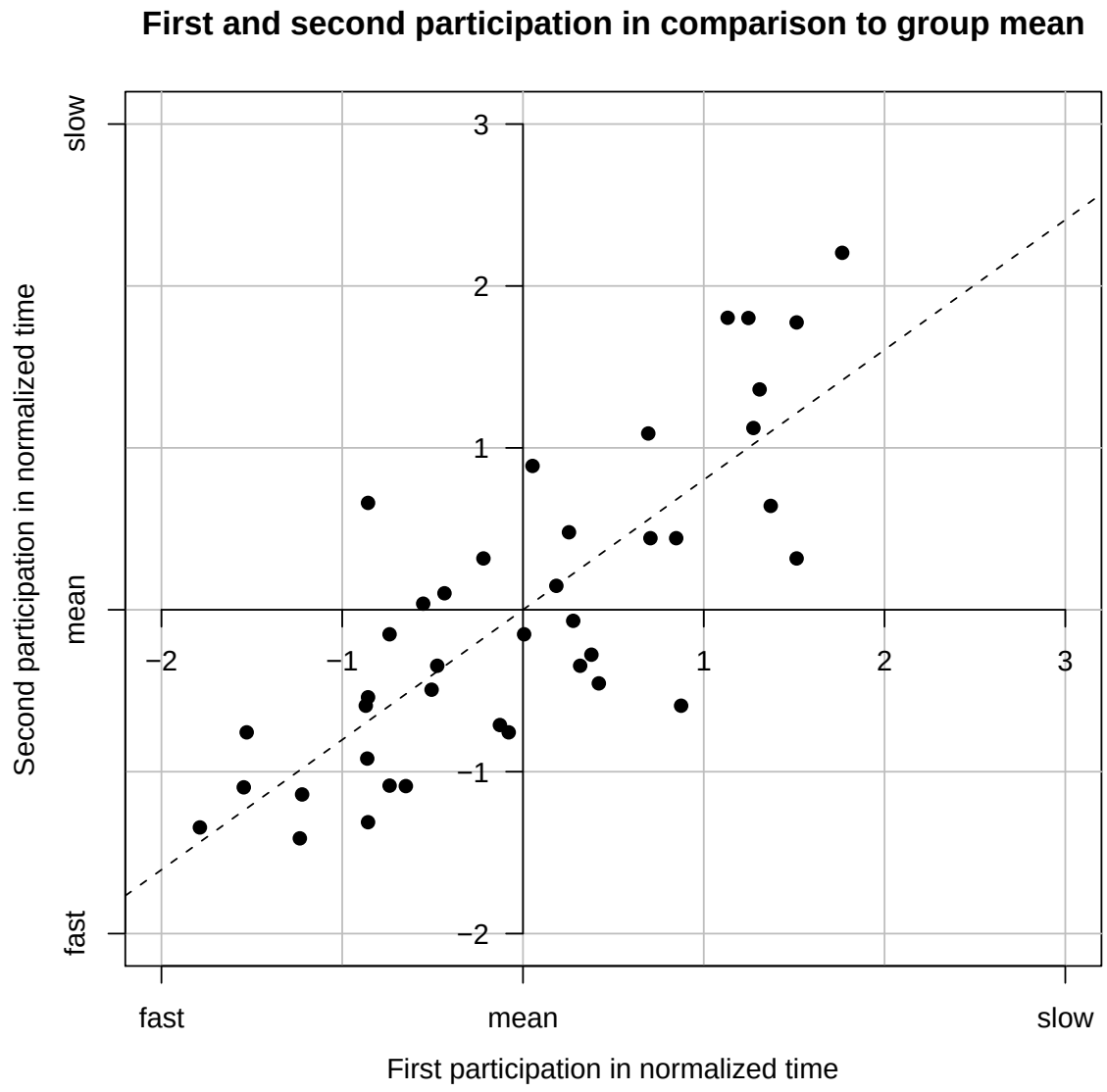

Figure 4-3: Relation between the durations of first and second participation. The axes are scaled in standard deviations, i.e. roughly estimated distances of 10 minutes (depending on the group).

Frequency of Reading Actions

The time to search the recipe in both cookbook types was nearly equal (mostly found within 10-20 seconds), the number of actions differs strongly. The factor combination averages range from 24.0 to 39.0. Individuals have made at least 10, and maximally over 50 reading attempts.

All three factors have an influence of the read count. The recipe ($p=0.033$) has a significant influence under the assumption of equal variances. However, run ($p<0.001$) and cookbook ($p=0.014$) have a significant influence even without this assumption. The influence of the cookbook can of course be explained with the extra task to use the shopping list feature. The reason why test persons look into the cookbook more often at the first participation remains undisclosed. It can only be guessed that nervousness and the intention to avoid mistakes was increased.

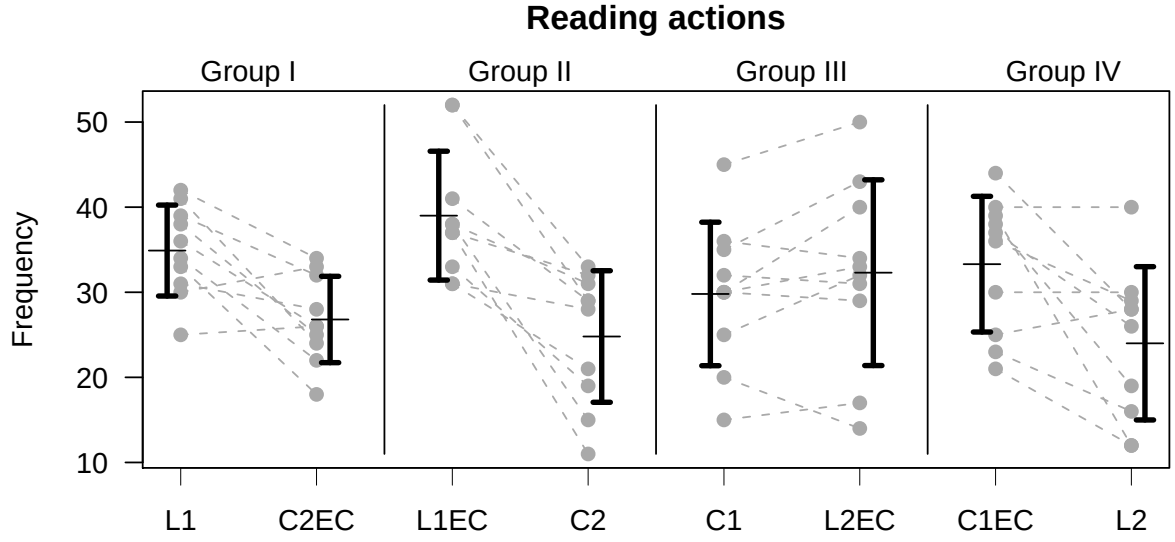

Figure 4-4: Cookbook views

Total Reading Duration

As a value directly related to the number of reading attempts, the total reading time correlates to the number of reading actions. The averages stand in the same relation to each other, and all averages are located between 7 and 10 minutes, except for group II, where the highest difference and upper and lower limits are located. Average reading duration was 12.6 minutes using the electronic cookbook to prepare Lasagna and 6.8 minutes on average with the conventional

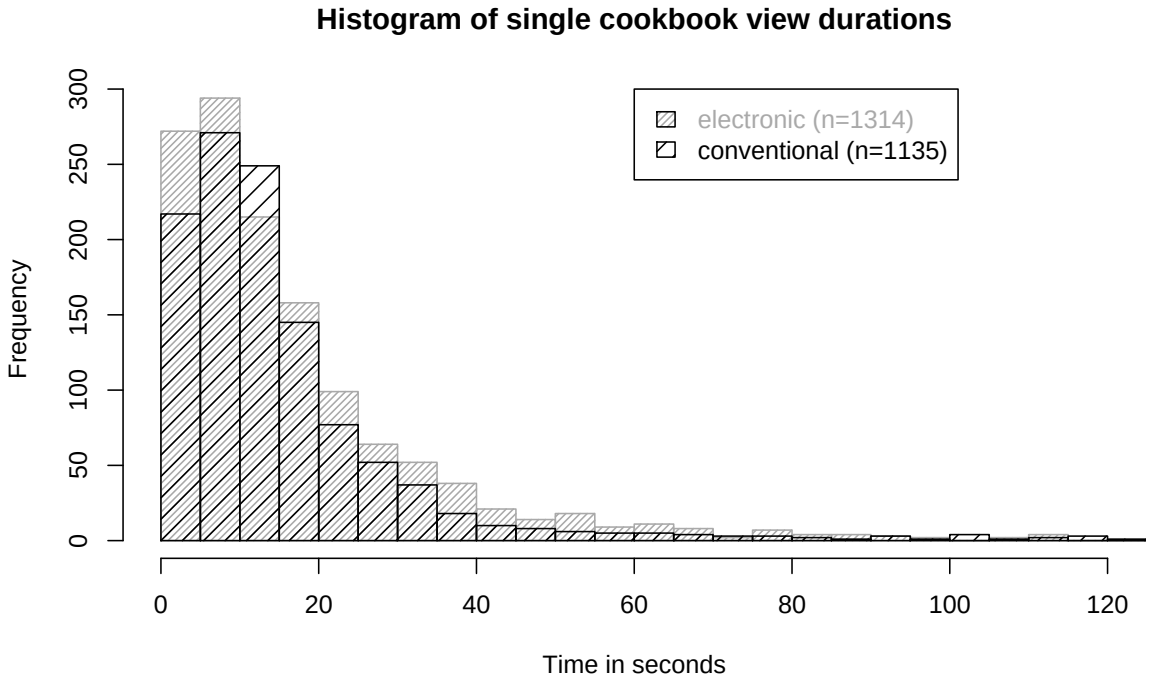

Figure 4-5: Histogram of durations of single reading action

cookbook to prepare Cannelloni.

The individual summed up reading duration varies from nearly 200 to more than 1000 seconds. The length of single reading attempts is displayed in the histogram in figure 4-5. The values follow an extremely right skewed distribution with a mean of 18.2 and a median of 12. 75% of the observed attempts were shorter or equal 21 seconds.
A two-sided Mann-Whitney test returns that the distributions are statistically different at the 5% significance level (p=0.014). Hence it can be concluded by visual interpretation the the spread of reading durations is wider using the electronic cookbook. Both more short actions (equal or less 5 seconds) and longer actions (above 20 seconds) were observed.

The analysis of variance indicates highly significant influence of the cookbook type ($p<0.001$) and the run (p=0.003). While the electronic cookbook and the corresponding extra task obviously increase reading duration, it remains undisclosed why participants need less reading time during the second participation.

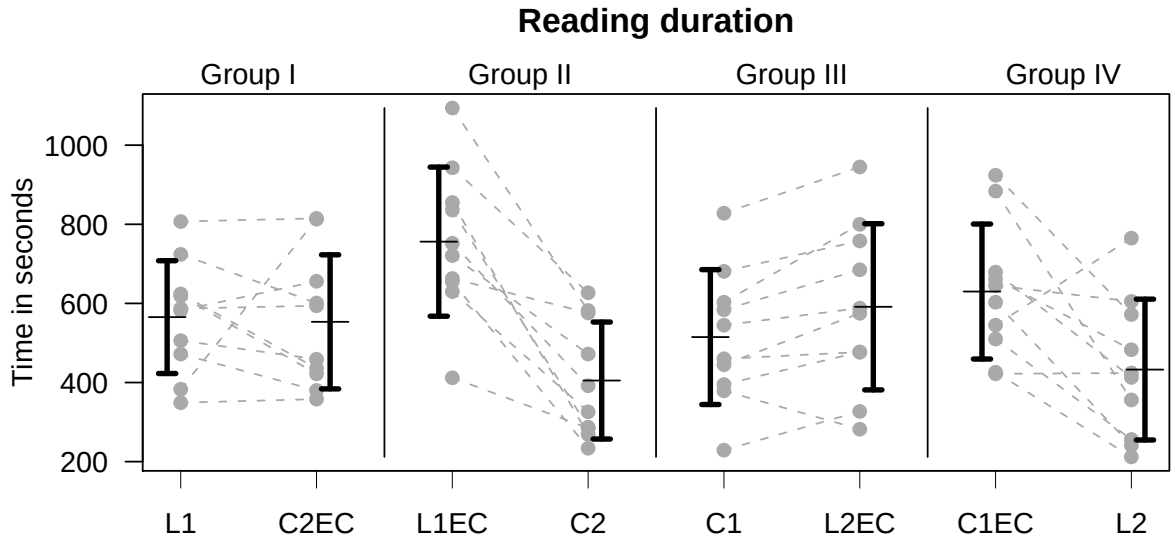

Figure 4-6: Total reading duration

Gathering and Setup Duration

The time needed to gather ingredient and equipment varies less between the groups than other measured data, as those tasks were partially guided by the observer in order to minimise the effect of the unknown kitchen.

The group averages are located around 10 minutes, with relatively few participants needing less than 6 or more than 12 minutes (1st quartile is 468.5 seconds, 3rd quartile is 660.0 seconds of all participants). Accordingly, the ANOVA returns no significant factors. See figure 4-7.

Duration of Hob Attendance

The time spent stirring is quite diverse in relation to other measures. The group means are mostly located around 20 minutes, but the standard deviations differ strongly, especially group III shows very inconsistent behaviour. The data ranges from about 10 to 34 minutes. Expectedly, an ANOVA does not indicate any significant influence of the factors (see figure 4-8).

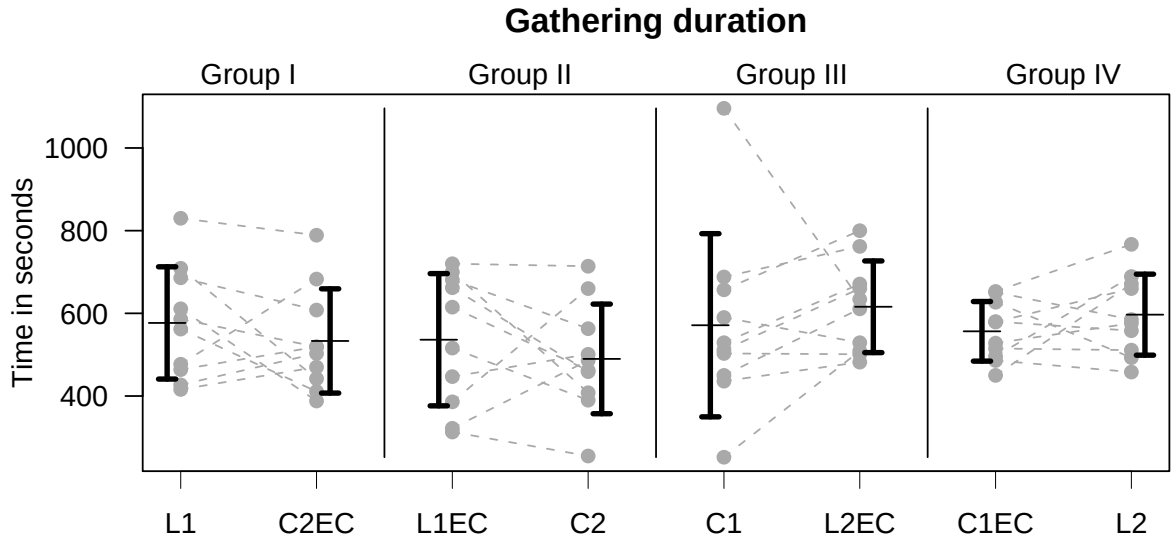

Figure 4-7: Cumulated duration of gathering activities

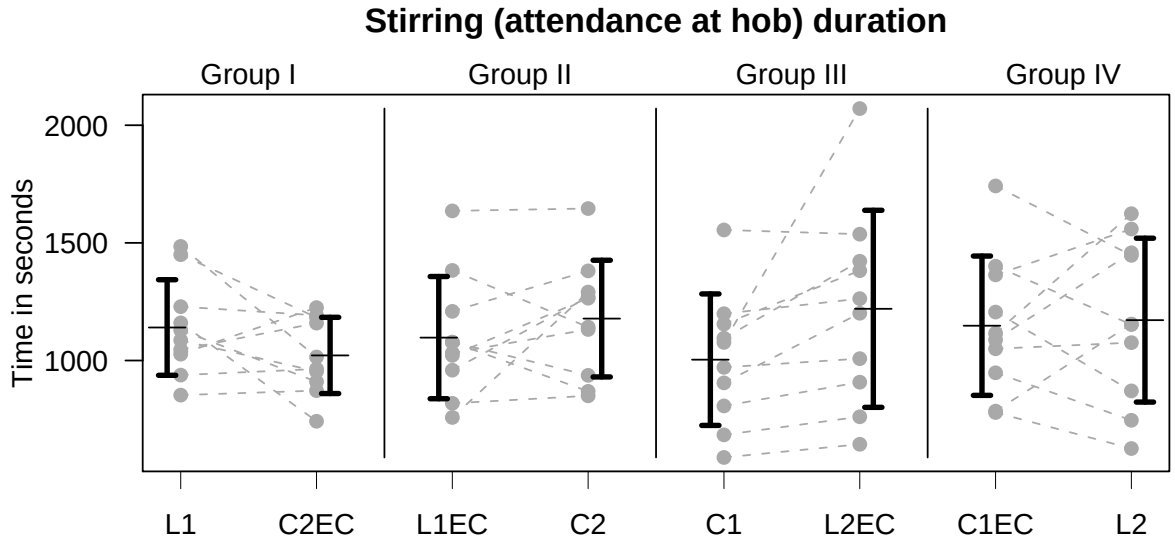

Figure 4-8: Hob attendance

Duration of Manual Preparation

The time spent preparing food manually is most variable data in this work. While some took more than 50 minutes for Cannelloni, others needed roughly 25. The manual steps for Lasagna could be done in 18 as well as in 47 minutes (see figure 4-9). However, it was visible that the degree of milling for instance depended very much, and therefore experienced cooks were not necessarily the fastest, because they invested more effort to prepare the foodstuff.
The group averages for Cannelloni are located mostly around 35 minutes, and for Lasagna at 30 minutes. Accordingly, the three-way ANOVA returns a highly significant influence of recipe with p=0.006, but the variances seem to depend more on the group than on the recipe. Again, group III shows a higher spread of times than the other groups. No factor influences can be detected with an analysis of variance.

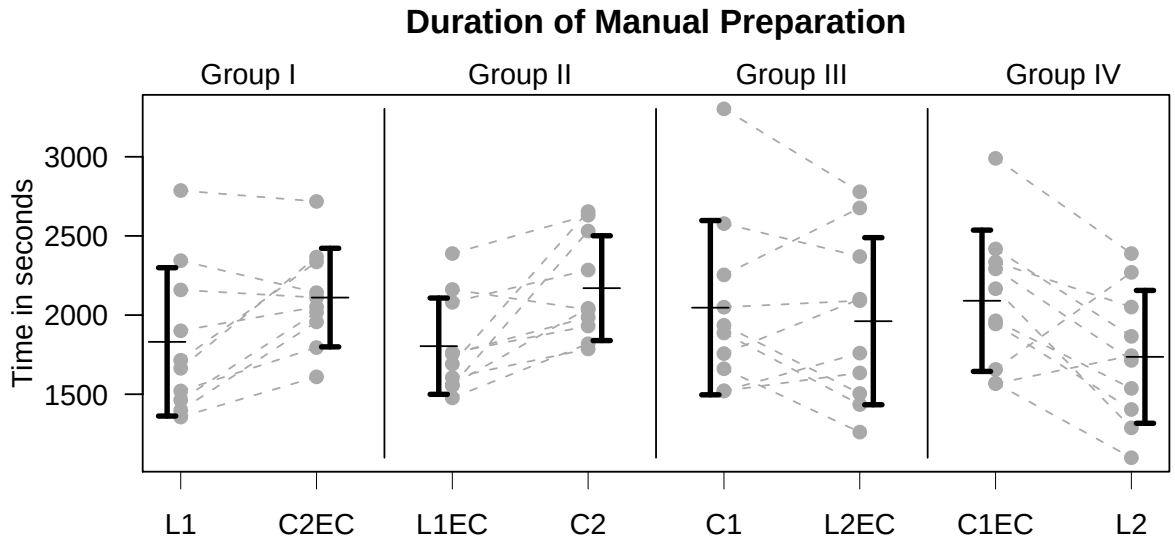

Figure 4-9: Durations of the manual preparation steps

Duration of Single Recipe Instruction Steps

The time required to perform the steps given in the instructions has been recorded as far as possible, i.e. it has been determined subjectively by the operator using the timeline log files, which proved to be occasionally difficult. Only on few occasions the test persons reported to have finished a step and, furthermore, steps sometimes overlapped and thereby step ends were not clearly definable.

The duration of the single steps in the instruction text is directly related to the length of the single actions and thereby depends on the individual. For the Canneloni recipe (figure 4-10), the group averages per step are statistically independent from factor combination. The difference between quick and slow cooks is hundred percent of the quick cooks' times, i.e. quick cooks can perform the step in at least half of the time of an slow cook.

Step 1 for instance, which includes cutting and frying of vegetables, can roughly be estimated as being finished within 15 minutes, but there are people who need triple that time. The distribution of the values is relatively wide. The boxplot for the first steps gives 23.5 minutes as first quartile, respectively 32 minutes for the third quartile. In other words, the performance of the "central half" of the participants varies by 10 minutes. Similar statements can be made about the remaining steps. The Cannelloni recipe (figure 4-10) has similar ranges, excepted for the last step, which is just to cover the casserole with bechamel sauce and cheese.

Along with the pine nut roasting, the Bechamel sauce preparation was a source of strong variation. Those participants who did not know how to prepare the sauce often asked the observer for help when they could not find further information in the recipe text. Accordingly the duration to prepare the sauce increased much when they then waited for agglutinated butter and flour to melt. Then often hob power was increased again, which of course did not help. Savvy users who knew the proper technique required just a few minutes to accomplish the task.

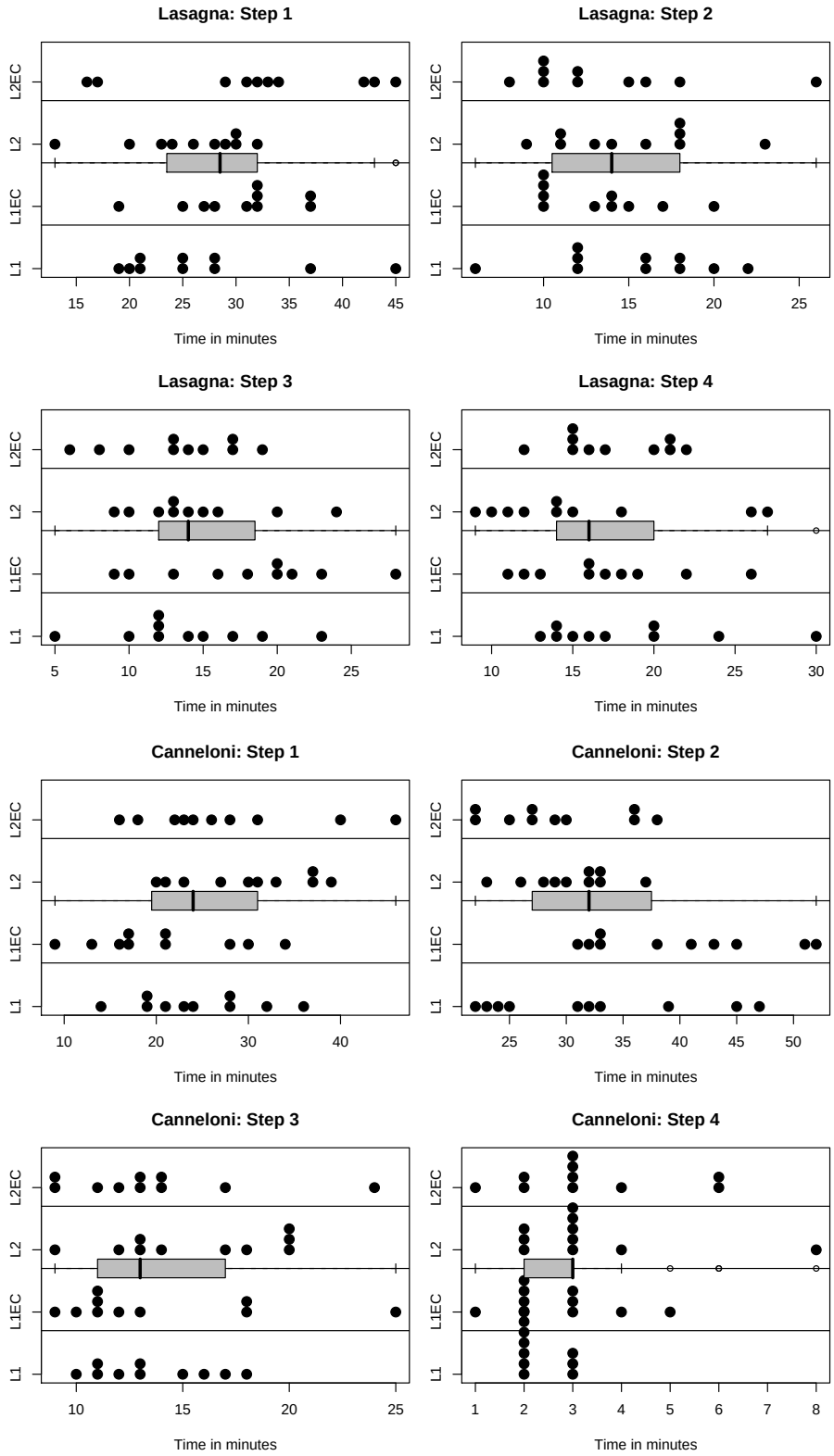

Figure 4-10: Duration of single recipe steps for Lasagna (above) and Cannelloni (below). Each point represents a participant. The boxplot in the middle indicates the distribution of all durations of the step. Notice that the data was determined manually and is therefore discrete (only full minutes).

4.2.2 Appliance Use During the Experiments

Hob use

Commands issued to the hob (referred to as “clicks”) include level switches as well as switches of additional heating elements and power-on commands. For the Lasagna recipe the ragout and the bechamel had to be prepared. The Cannelloni required three “hot” tasks: the spinach, the pine nuts and the bechamel sauce.
However, the average for both dishes is about 18 clicks, and the standard deviation is as least 5 commands per group. Statistical analysis determines run (p=0.035) as significant factor (more commands during the first participation), and the interaction between run and cookbook as most significant (p=0.006). This is also visible in figure 4-11. In the groups II and IV, who began with the electronic cookbook, several participants issued more than 20 commands, which is contrary in the other groups.
As many participants were not used to the hob and the touch-interface, the increased number of commands may be explained with their unexperiencedness and try-and-error use to get familiar with the device.

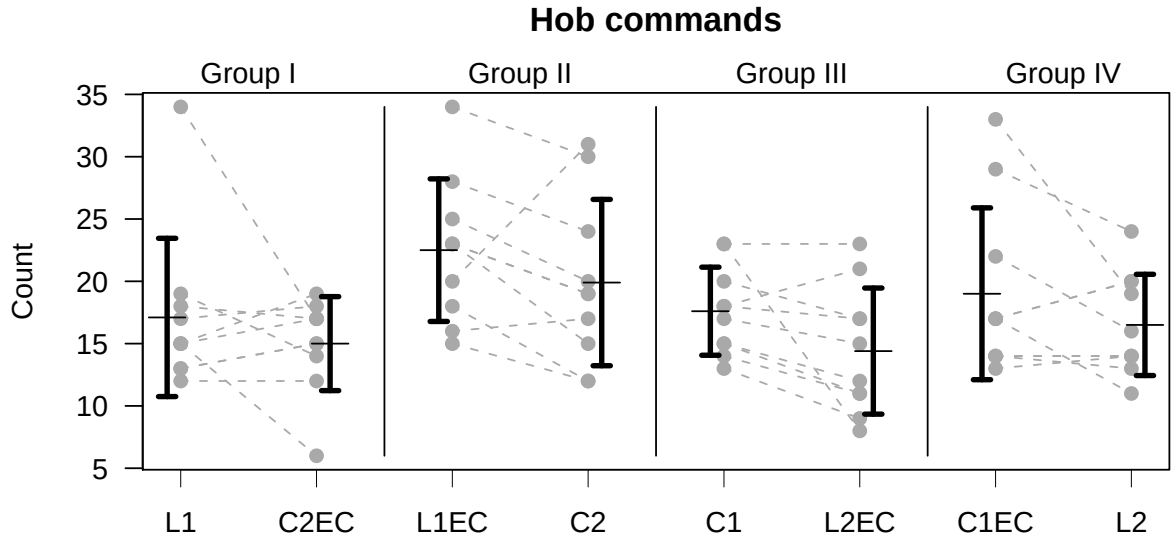

Figure 4-11: Hob commands

Oven use

The Cannelloni recipe stated to bake the dish in the oven at 180°C for 30 minutes, with a preheating phase at 180°C. The Lasagna was recommended to bake for 40 minutes at 160°C, but

with a preheating phase at 180°C. Actually, the oven was used differently than given in the recipe instructions. Figure 4-12 shows the real set temperatures (the temperature during longest period if the temperature was changed during baking) and the time from inserting the casserole until removal (sometimes the oven was powered off some minutes before). The decision to remove the casserole was up to the test persons and their feeling of appropriate browning and doneness of the dish.

The real baking time differs up to ten minutes from the given time, depending on the temperature. Though most participants chose the given temperature for the Cannelloni, the required time to bake the dish was longer in many cases. Similarly the Lasagna often stayed longer or shorter in the oven than required by the recipe.
Though the prepared dishes were not weighed before baking, it was obvious that their weight and the filling level of the casseroles varied with each experiment. It further seemed that the amount of liquid, either from the cooked vegetables or from amount of bechamel sauce, in the casserole before varied much.

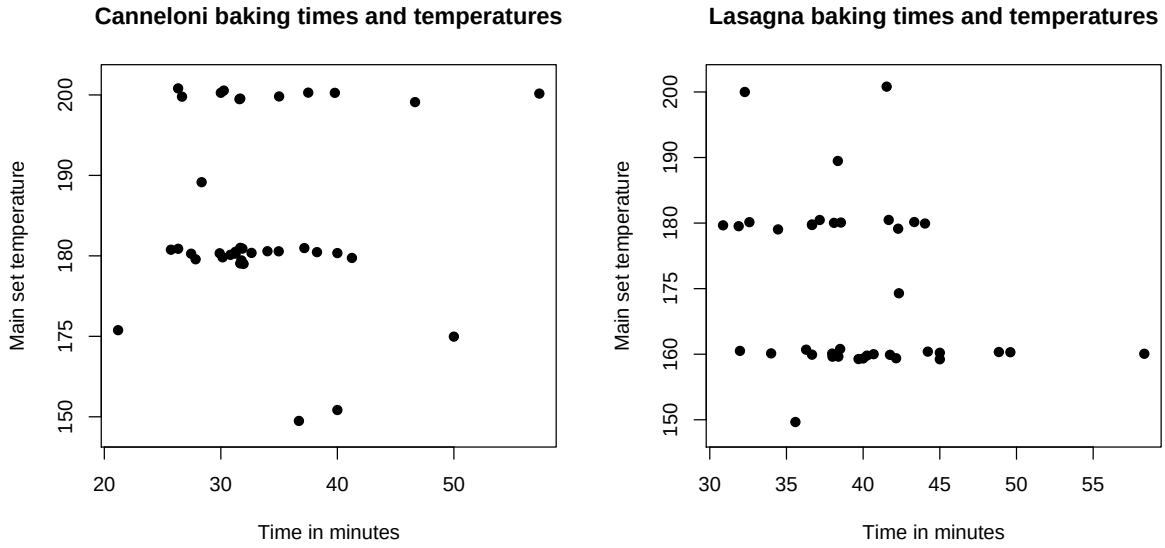

Figure 4-12: Real baking times. A small amount of jitter has been added to the points in y-direction to improve readability.

4.2.3 Influence of Individual Behaviour

The individual interaction with the cookbook and recipes is very diverse. The following data gives an impression on the mental processes of the test persons as far as they are quantifiable.

Missing Information

Table 4-23 lists the occurrences of information requests during the cooking sessions. Whenever a participant stated not to know how to proceed an instruction or asked for information not given in the recipe text (”Should I use the smaller or the larger casserole?”), this was noted as an information request. Since the importance of the request for the recipe to succeed was not classified, the data has qualitative character.

Table 4-23: Requests for further information per participant (absolute values)

Requests p.p. / Factors	C1	C1EC	C2	C2EC	L1	L1EC	L2	L2EC	Total
0	5	2	3	2	2	6	3	3	26 (32.5%)
1	3	5	6	3	4	3	6	4	34 (42.5%)
2	1	2	1	2	1	1	1	2	11 (13.8%)
3	0	0	0	3	0	0	0	0	3 (3.8%)
4	1	0	0	0	3	0	0	0	4 (5.0%)
5	0	1	0	0	0	0	0	1	2 (2.5%)
Total	9	14	8	16	18	5	8	11	-/-

About a third of the participants did not utter lack of information, but about half of the test persons requested information once or twice. A three-way ANOVA returns no significant influence of the factors. The frequently requested respectively missing information in 80 experiments were:

- which size of pots or casserole to choose (17x)
- information on an unknown ingredient (12x)
- how to proceed a certain unknown technique (9x)
- missing amounts, how much to use (9x)
- information on timing and step sequence (5x)

Substitution of Ingredients

Similar to the information request, the substitutions were not classified. Thus, the simple addition of a spice has the same weight as the substitution of a vegetable by a different kind. Therefore the

data has to be taken with caution. Table 4-24 shows how often test persons replaced ingredients by others or added new ones.

In only about one of five cases the recipe was prepared with the same ingredients as stated in the recipe, the rest of the prepared meals was modified. The most frequent change is one modification (22.5 %) and the highest count of modifications is 9. However, in less than 10% of the test more than five ingredients were replaced or added.

Table 4-24: Substitution of ingredients per participant (absolute values)

Substitutions p.p.	C1	C1EC	C2	C2EC	L1	L1EC	L2	L2EC	Total
0	3	3	3	1	0	2	0	3	15 (18.8%)
1	2	4	6	1	1	2	1	1	18 (22.5%)
2	3	1	1	2	1	4	2	1	15 (18.8%)
3	0	2	0	4	0	1	4	2	13 (16.3%)
4	2	0	0	0	2	0	1	0	5 (6.3%)
5	0	0	0	1	2	1	2	2	8 (10.0%)
6	0	0	0	0	1	0	0	0	1 (1.3%)
7	0	0	0	1	0	0	0	1	2 (2.5%)
8	0	0	0	0	1	0	0	0	1 (1.3%)
9	0	0	0	0	2	0	0	0	2 (2.5%)
Total	16	12	8	29	53	18	31	26	-/-

The ANOVA returns a highly significant influence of the recipe ($p < 0.001$) and also shows significant interactions between the cookbook and recipe and the cookbook and the participation. This result was expected, since the Lasagna was by far better known as the Cannelloni. Many participants stated accordingly that they would not modify an unknown recipe and that they felt more familiar with the testing environment in the second run. However, especially in the Lasagna recipe ingredients were replaced less frequently when the electronic cookbook was used.

Alignment with Ingredient Amounts

The following overview renders a picture in how far amateur cooks are aligned with ingredient amounts in recipe, i.e. how often they knowingly varied the given amount and also reported that loudly to the observer. (see table 4-25). The following remarks should also be taken into account:

- It was neither possible to record to which share a container like a cream cup was used, nor to record the exact weight to which participant measured when they used the scale.

- In addition, the scale was used by a few test persons who would not have used it in their kitchen. These persons stated to have used the scale either because of the surveillance or because of the too precise numbers in the electronic cookbook.
- Compared to the substitutions of ingredients the variations are relative few, because once an ingredient was replaced by another or added it was not applicable to record the deviation from the original amount.

Nearly 40% of the rest persons did not report to change the given measure, while about 38% varied amounts once, another 19% varied twice. Several occurrence can be linked to the use of two full cans of tomato instead of one and a half, which would have been the precise calculation for two more serving in the lasagne recipe. Similarly, when preparing the Cannelloni, most participants took the whole creme fraiche instead of leaving a small rest in the cup. This behaviour was reported as ”common” practice by the majority of participants. An ANOVA returns no significant differences.

Table 4-25: Deviation from ingredient amounts (absolute values)

Deviations p.p.	C1	C1EC	C2	C2EC	L1	L1EC	L2	L2EC	Total
0	7	5	4	1	4	4	2	4	31 (38.8%)
1	0	3	6	5	3	5	5	3	30 (37.5%)
2	2	2	0	3	2	1	3	2	15 (18.8%)
3	1	0	0	0	0	0	0	1	2 (2.5%)
4	0	0	0	1	0	0	0	0	1 (1.3%)
5	0	0	0	0	1	0	0	0	1 (1.3%)
Total	7	7	6	15	12	7	11	10	-/-

Individual Deviations from Recipe Instructions

Altering the instructions can be, for instance, reordering the recipe step sequence, e.g. to prepare the bechamel sauce first, or frying minced meat apart from the vegetables (in the Lasagna recipe). In about sixty percent of the cases the instructions were followed very closely. Only a few experienced cooks developed an own strategy to prepare the meals because of experiences they made earlier (see table 4-26), but were not necessarily faster.

Although it could be expected that the more popular Lasagna recipe would have been prepared in other ways more likely than the Cannelloni, an ANOVA returns no significance (neither recipe nor other factors).

Table 4-26: Deviation from recipe instructions (absolute values)

Deviations p.p.	C1	C1EC	C2	C2EC	L1	L1EC	L2	L2EC	Total
0	6	5	3	6	7	7	7	6	47 (58.8%)
1	4	5	7	4	2	2	3	3	30 (37.5%)
2	0	0	0	0	1	1	0	1	3 (3.8%)
Total	4	5	7	4	4	4	3	5	-/-

Memory Slips and Lapses During Preparation

Occurrences of forgetting information given in the recipe (see 3.2.7) could be observed in about 40% of the tests. The maximum count was two occurrences in all experiments and in only about six percent of the cases.
Most frequent issues were forgetting to rescale ingredients, forgetting to control for doneness (e.g. pine nut roasting) or simply to forget to add an ingredient or spice. Slips appeared significantly ($p=0.021$) more often during the first participation than in the second. Occurrences were for instance:

- forgetting to rescale according to the test instructions (9x)
- forgetting to add an ingredient (7x)
- skipping a recipe step or a part of it (2x)
- forgetting to taste the dish (2x)

Table 4-27: Memory slips during Preparation (absolute values)

Memory slips p.p.	C1	C1EC	C2	C2EC	L1	L1EC	L2	L2EC	Total
0	4	5	8	6	6	2	7	8	46 (57.5%)
1	6	3	2	4	3	8	2	1	29 (36.3%)
2	0	2	0	0	1	0	1	1	5 (6.3%)
Total	6	7	2	4	5	8	4	2	-/-

Cooking Errors

Error free preparation was completed by 57.5% of the participants, and nearly 29% made one error. Less than 13% committed two errors, and only one participant four errors. The frequencies per factor combination is documented in table 4-28. Examples were:

- burning the pine nuts in the Cannelloni recipe (15x)
- choosing a too small pot (2x)
- reading / understanding instructions falsely (1x)

An ANOVA resolves that the recipe is a significant factor (p = 0.032) and that the interaction between recipe and cookbook is a highly significant (p = 0.006) influence. That means that the Lasagna recipe is prone to errors and that the electronic cookbook in combination even raises the probability of errors.

Table 4-28: Errors during cooking (absolute values)

Errors p.p.	C1	C1EC	C2	C2EC	L1	L1EC	L2	L2EC	Total
0	7	7	4	8	7	3	5	5	46 (57.5%)
1	2	3	5	2	2	2	5	2	23 (28.8%)
2	1	0	1	0	1	4	0	3	10 (12.5%)
3	0	0	0	0	0	1	0	0	1 (1.3%)
Total errors	4	3	7	2	4	13	5	8	-/-

4.2.4 Experiment Summary

The measured data is subject to a very strong variation that is most probably caused by human influence. For most measured items the differences within the groups are much higher than possible differences between the factor combinations.

A crucial influence of the electronic cookbook prototype was not detectable under the chosen conditions. The whole duration of preparation was not affected by using the prototype. This conforms to a high extend with the impressions expressed by the test persons and the subjective point of view of the observer. The prototype was appreciated by the majority of test persons and refused by a smaller group, but all agreed after their participation that cooking with both cookbook types makes no difference.

However, taking into account the items in table 4-29, it can be concluded that the prototype had minor negative effects on actions that could be related to relaxation. Especially the combination of prototype and Lasagna at the first participation (an unknown environment) stands out to raise error rate and to reduce ingredient replacement.

Table 4-29: Summarised influences of the prototype. * = significant, ** = highly significant, ... = interaction

Measurement	RE	CB	Run	Remark
Reading actions	*	*	**	Shopping list extra task increases reading actions, and test persons look into the cookbook more often at first participation
Reading duration		**	**	Electronic cookbook and shopping list extra task increase reading time; less reading time during the second participation
Errors	*	...		Lasagna is prone to errors, the electronic cookbook in combination raises the error probability
Ingredient substitution	**	...	...	Influence of the recipe and interactions between cookbook:recipe / cookbook:run. Most participants would not modify an unknown recipe. Lesser with prototype and Lasagna
Hob commands		...	*	groups who began with the electronic cookbook and issued more commands

4.3 Examples of User Interface Review for Usability

By observing the interaction with the electronic cookbook user interface several issues could be identified to improve usability. The review of the first draft of the recipe view is shown in figure 4-1. Some exemplary points shall be explained here, though far more improvements were applied to the system:

1. The button to scroll the instruction text proved to be to small to be hit easily with the digitizer pen and furthermore was not self explanatory to all users. Future versions will use a wide scrollbar instead.

2. The recipe caption and general information blocks space that is needed during cooking to read the instructions without scrolling more than necessary. Since the general information is not needed during preparation, future versions will have a different layout.

3. The buttons used to recalculate amounts for the desired number of servings were not always recognised as such. Furthermore they did not allow continuos rescaling. They were replaced by a field showing the actual number of servings and two buttons to increase or decrease the servings.

4. The checkboxes left of the ingredients were much to small to be activated with one click of the digitizer. To solve this issue, the whole row holding the ingredient amount and name was turned into an active area. Furthermore, the roundings from rescaling the recipe proved to be too precise and confused most users (not shown in the figure).

5. As the instructions are the only important area during preparation, the text was enlarged, enhanced with pictures and the step separation was emphasised visually.

Figure 4-1: Examples of the UI revision. Here the recipe view is shown. See page 69 for explanation.

Moreover, it was found that the feature to add notes to recipes almost completely failed due to software and hardware issues. It was implemented as a small box on the screen where the user could take handwritten notes. The handling of the digitizer and the delay of the cookbook software made it nearly impossible, to write legible letters.

The appreciation of the electronic cookbook was overall very positive. In the interview after the experiment most participants uttered that they felt very familiar with the handling, though

smaller impairments like the precision and reactiveness of the digitizer and software bugs like far too precise rounding of the rescaled ingredient amounts exist.
Although the used hardware was in focus of the usability tests, several issues could be observed. First of all, the electronic cookbook was never removed from the stand. Im comparison to that, the conventional cookbook was carried around by a few number of persons, but mainly remained in one place. Even when the participants checked the fridge for needed ingredients, they left the cookbook in its place.

The use of a digitizer pen on the 12” touch screen was in many cases problematic; both with and without plexiglass cover user interface elements could not be activated directly with one click. A frequent observations was the lack of precision of the digitizer pen when test persons tried to click specific small UI elements (as described above; see Wickens *et al.* 2004).

Moreover, some participants occasionally forgot where they had put the pen. So instead of interacting with the device they had to search for it first. Three participants intuitively tried to interact with the UI using their finger instead of the touchscreen. Similar findings are for instance made by Tee *et al.* (2005), who prefer a touch-screen to digitizer pen.

5. Discussion

This work explores the demands of contemporary cooks and attempts to evaluate the usefulness of a prototype of an electronic cookbook to support the cook in his daily tasks. Have the goals been reached?

For the requirements to an electronic cookbook prototype based on literature review and a consumer survey, the answer can be affirmed. A detailed picture of contemporary food management and its challenges has been rendered and selected issues have been identified and regarded in development. However, only those features could be evaluated which are used in practical cooking. No conclusions can be drawn on long-term use.

For the cooking performance assessment, the answer is not that clear. Being an explorative study, it is a valuable discovery that human behaviour has such strong influences on food preparation. For instance, it is most important to know that in these scenarios two thirds of the participants were missing at least one information in the chosen recipes, or that over 80% varied one or more ingredient. Another important discovery is the very different working speed between persons and its steadiness for the same person (see below).

However, this spread was not expected at the time the study was planned, not detected during the pretests, let alone reported in literature. As open question remains if influences of the electronic cookbook prototype would have been detected with methods that were adapted to the variations in the data.

5.1 Methodological Issues

As the diversification of lifestyles lead to a multitude of nutritional behaviours, it may be asked how many people are confronted with the full range of food management tasks, and how many will follow a life of convenient outsourcing. Accordingly, the requirements for an electronic cookbook may rather correspond to an outdated picture of food management in the future or to behaviours which are dominant today but not in the future.

To conduct a web-based study on cooking habits could be seen as an attempt to link to contrary lifestyles. Although it has been tried to minimise biasing effects by proper screening methods, it remains uncertain whether the panel is indeed a good indicator for today‘s cooking and its challenges. It could as well be a group of people interested in technology and cooking (therefore participating in the survey), but more savvy in technology than in cooking techniques.
The sample size of each 100 people from six European countries should be considered as sufficient to make statements on common behaviour, rather than exploring differences between the countries. The raised data shows good consistence with data from other studies like Nicolaas (1995) and Sozioland (2004).

Specifying features for an electronic cookbook for the future deriving from research of the present may also be put into question. Why has a rather traditional approach been chosen?
Above all, the programming of a working prototype including a well-designed user interface required the intensive work of nearly a year to get to state in which the interface could be reliably tested without being inferior to conventional cookbooks. The scope of this work simply could not cover farther development.

Assessment of Cooking Performance

The performance measurement depended highly on the logging method. The logging system in combination with the reaction time of the observer had a delay of maximally 3 seconds. This delay is without influence though, since all recorded actions underlie this delays and are therefore only shifted. Furthermore, the beginnings and ends of actions performed by the test persons were not always clearly observable. While other studies used at least two observers (see Jay *et al.*, 1999; Olabi *et al.*, 1999, etc.) to encode the observation, this was not available in this work. Hence, the data is more subjective than in other studies, but at least always the same observer encoded the sessions.

Concerning the internal validity of the experiments, the question may be raised whether one use of the prototype is enough to draw conclusions. For instance Tee *et al.* (2005) ask if two uses are enough to evaluate their prototype.
Since the learning phase to used to this prototype was short, and the sample size of this study was after all much larger than in comparable studies, it may be concluded that one use of the prototype is sufficient for the usability testing purpose. Long-term studies with frequent uses of such a system in different situations are in any case advisable.

The sample that took part in the observational studies is biased towards younger people and naturally those people interested in food preparation. This might manifest itself in too positive ratings of the electronic cookbook, but most probably the measured data is not biased. The deviation within groups and especially the normally distributed values speaks against this assumption and indicates to have covered a broad range of cases.

The decision to add the extra task to put the missing item on the shopping list when the prototype was used had stronger effects than expected. The comparison between both cookbook types is problematic for the number of reading actions and reading duration. Therefore, the significantly increased values cannot be explained definitely.

5.2 Results

A major influence of the electronic cookbook prototype could not be found. Does this prove there is no difference using it? A closer look at the data summary reveals that the combination of prototype use, first participation and the slightly more intricate Lasagna recipe potentially confused the test persons. In this case the recipe was varied less and most errors and lapses were committed. This could however be interpreted as an aspect of overloaded workload, i.e. they were not able to fully cope with the artificial environment, the complex recipe and the unknown computer cookbook. Being familiar with the system and the test kitchen in a repeated measurement this effect is likely to decrease.
Then again, the number and types of occurences of slip, errors and the like support the working theses of projects of Bell & Kaye (2002) or Bonanni *et al.* (2005), who claim the need to support the cook in keeping track with his tasks.

A remarkable characteristic of the data is the strong variation of preparation times. Regardless of the factor combinations, within the groups a span of 100% was observable, e.g. the Lasagna was prepared within 50 as well as within over 100 minutes. What is the cause?
The share of manual preparation time of total duration is one explanation. Those participants who needed more time to finish the manually executed parts tended to attend longer than others. Furthermore, from the observers perspective, it was visible that the slowest cooks seldom did tasks in parallel. In extreme cases, they waited for a simmering pot until they began the next task. Maybe this behaviour can be associated to the “cook types” as presented in 1.2.3, but further analysis did not lead to results.

Having said that, could the methods themselves be the cause for the deviations? The unknown environment can be excluded, as the gathering times were steady and relatively low with about 10 minutes on average. If nervousness under observation was the reason, this would have affected the error rate, the number of reading actions or the like. No relation could be found, and besides that, many participants stated that their initial nervousness disappeared within minutes as soon as the sessions began. A means to analyse ”parallelism” of step processing would certainly allow a further explanation of behaviours.

One side aspect is the fact that most statements on preparation time in recipes now have to be taken with caution if the findings of this work are transferable. It was shown that in everyday situations recipes are chosen according to their expected duration of preparation, i.e. quick and easy dishes. It is questionable whether the expected durations meet the experienced duration and this will certainly lead to unsatisfactory situations when time is short and needed for other domestic works.

Recommendations for Future Studies

The findings of this works are related to the test kitchen they were prepared in and the given number of servings. In a different test kitchen, and especially in home kitchens, people’s natural cooking environments, some of the results could vary.
Serving sizes were not regarded, too. Other serving sizes of the Lasagna, for instance, might have delivered other results because of scaling effects or due to the fact that people are rather used to cook dishes dimensioned to their household, which is seldom six or eight persons.
Lastly, other recipes might as well have produced other results. The chosen recipes, both Pasta dishes, required much manual work and contained the bechamel sauce, which is difficult to prepare for novices. An interesting question is whether the individual performance remains steady when unsimilar dish types are prepared.

5.3 Future Applications for an Electronic Cookbook

A potentially useful extension of this electronic cookbook approach is a standardised advanced recipe structure. With regard to the sources of errors during preparation, the kind of information that the participants requested and the recipe characteristics demanded in research (see 1.1) the following structure is proposed: A well-formed document structure similar to internet pages that provides a ”head” for common information on the recipe and a ”body” for the instructions (see figure 5-1).

- The head should hold information like the title, description, copyrights etc.
- The body should contain steps and compound recipes, which themselves hold steps.
- Steps need to be distinguishable, not provided as plain text.
- To represent the material flow (see Chu, 2006) the steps should be linked by their produces in the step that requires the produce. Accordingly, ingredients should be linked to the step they are required for.
- Explaining media of any type, especially animations or video clip should be linkable to step in order give crucial information on preparation techniques or just a picture of an ingredient.

Using such a structure, evaluation criteria for certain steps can be given explicitly as well as food safety information for each step. Furthermore the steps could be made distinguishable and categorised in a similar way as the action classes during observation in this work.

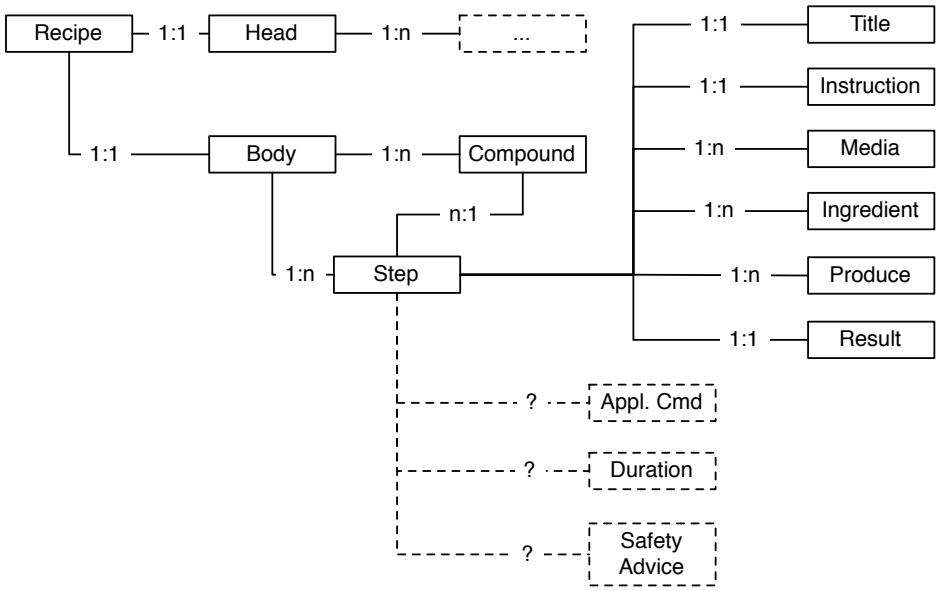

Figure 5-1: Draft proposal for an advanced recipe structure

Several studies proved that cooking is not learned from cookbooks (e.g. see Nicolaas, 1995), but mostly from mothers by demonstration. An advanced recipe with explaining media could provide this experience for many people who would like to improve their skills (see above), but do not have the possibility to learn cooking the usual way. Interested people with impairments could also benefit from the information included in the structure, with simple transformations it could be used in project such as described in Tee *et al.* (2005).

The creation of a recipe in the described form takes more time than writing simple plain text recipes. The structure has to be followed to make the recipe machine-readable and the media has to be produced.
However, this effort has to be done once and then the recipe can be easily reused, shared, modified to improve it and then be reshared. Furthermore, semi-structured recipes are available on many recipe websites today (except for Chu's recipes) and much effort to produce media is made by companies hiring professional food photographers or cooking tv shows. Hence, the prerequisites are fulfilled, only a proper structured has to be agreed on and published as a standard.

Uses of Technology

In combination with an advanced recipe structure, the use of cooking appliances can be enhanced if these are connected to the electronic cookbook. Many appliances today have small interfaces which provide few information. While this is not request by experienced cooks, beginners and those persons who recently acquired the appliance are in danger of burning meals (like the pine nuts in this study). The cookbook could act as a supplementary appliance interface that displays and explains information.

Theoretically cooking could be automated by means of such a system. Although Gisslen (2003) explains why the judgement of the cook is always required and Wickens *et al.* (2004) discusses general drawbacks of automation, the idea shall be discussed here briefly.
An electronic cookbook could help in cooking process monitoring and doneness estimation. Models to estimate cooking times are available, for instance by Sonesson *et al.* (2003). Temperature control of the cooking devices is still not trivial (Viljoen *et al.*, 2001), and it is often not possible to measure temperature in situ, i.e. inside the foodstuff, which is the relevant measure. The RangeFinder (see Bonanni *et al.* 2005 and section 1.3) is one proposed solution for this issue, a second is used by Nott & Hall (1999), who install magnet resonance imaging for such purposes.
Besides monitoring by sensors, cooking could also be supported by means of RFID chips. Ali *et al.* (2004) and Nair & Ullah (2003) both describe scenarios how a cook could benefit from object identification.

After all, none of the above mentioned technologies are ready for mass-scale implementation today and some could be regarded as technical excess in proportion to their benefit. Besides that, it may be asked if a system for domestic cooking should be developed that far. Instead, the skills and knowledge of its user should be trained by means of technology to avoid dependencies.

Further approaches have been made to enhance food management by providing further information. For instance Ransley *et al.* (2003) uses supermarket receipts to calculate energy and fat content of purchased food. The shopping list of this cookbook could forecast these data by means of a linked food database. Of course could recipes then be enhanced with nutritional data as well, which is already available in several products today.

6. Conclusion

This work has accompanied the development of a prototype of an electronic cookbook and tested it under conditions close to real life. The target to find specifications for such a cookbook has been reached, and the prototype performed equally in comparison to a conventional cookbook.

Although in an early stage of development and rather traditional than feature-laden, interacting with a computer in the kitchen has no disadvantages affecting the primary task “food preparation”. The current version has neither advantages though, but the basis has been laid for a broad range of extending possibilites that could prove to be of real value in the future.

The important finding in this work is the variety of cooking behaviours. Unexpected in the beginning, the influence of human behaviour on cooking proves to be dominant on the process. The use of recipes that require a hob, an oven and various preparation techniques has disclosed where the real challenges lie in food preparation. To process a recipe is a personal interpretation; the result in terms of invested effort and outcome can only be as good as the recipe and the knowledge required to prepare it. Knowledge is required to perform the techniques, to deal with the appliances and track processes of heat treatment as well as to organize the proceeding to mimize causes for errors and invested time.

Here arise new possibilities for an electronic cookbook. In combination with an electronic cookbook the presented recipe structure has potential to partially compensate lacking skill and other impairments and to support consumers in learning and mastering cooking tasks.

Bibliography

Aft, Lawrence S. 2000. *Work Measurement and Methods Improvement*. New York: Wiley.

Alberti-Fidanza, Adalberta. 1990. *Nutritional Adaption to New Life-Styles*. Bibliotheca Nutritio et Dieta, no. 45. Karger. Chap. Mediterranean Meal Patterns, pages 59–71.

Ali, Junaid Ahsen, Yoon, Won-Sik, Kim, Jai-Hoon, & Cho, We-Duke. 2004. U-Kitchen: Application Scenario. *In: Proceedings of the Second IEEE Workshop on Software Technologies for Future Embedded and Ubiquitous Systems*.

Anderson, Janet B., Shuster, Thomas A., Hansen, Kelee E., Levy, Alan S., & Volk, Athony. 2004. A Camera's View of Consumer Food-Handling Behaviors. *Journal of the American Dietetic Association*, **104**(2), 186–191.

Andersson, Yngve, Engström, Thomas, & Thorsell, Ulla. 1985. *unknown*. unknown. Chap. Production Planning in the Food Service, pages 209–238.

Annett, John, & Stanton, Neville. 2000. *Task Analysis*. Taylor & Francis.

Aranceta, Javier. 2001. Dietary guidelines for the Spanish population. *Public Health Nutrition*, **4**, 1399–1402.

Bandilla, W., Bosnjak, M., & Altdorfer, P. 2001. Effekte des Erhebungsverfahrens? Ein Vergleich zwischen einer webbasierten und einer schriftlichen Befragung zum ISSP-Modul Umwelt. *ZUMA-Nachrichten*, **25**(49), 7–28.

Barber, C., & Stanton, N.A. 1996. Human error identification techniques applied to public technology: predictions compared with observed use. *Applied Ergonomics*, **27**(2).

Barham, Peter. 2001. *Die letzten Geheimnisse der Kochkunst (original title: The Science of Cooking)*. Springer.

Barnes, Ralph M. 1980. *Motion and Time Study: Design and Measurement of Work*. New York: Wiley.

Batinic, B., & Bosnjak, M. 2000. *Internet für Psychologen*. Vol. 2. Göttingen: B. Batinic. Chap. Fragebogenuntersuchungen im Internet., pages 287–318.

Bayer, Otto, Kutsch, Thomas, & Ohly, Peter H. 1999. *Ernährung und Gesellschaft*. VS Verlag.

Bell, Genevieve, & Kaye, Joseph. 2001. *Designing Technology for Domestic Spaces: A Kitchen Manifesto*.

Bell, Genevieve, & Kaye, Joseph. 2002. *Designing technology for domestic spaces: A Kitchen Manifesto*.

Berekoven, L., Eckert, W., & Ellenrieder, P. 1999. *Marktforschung: methodische Grundlagen und praktische Anwendung*. Vol. 4. Wiesbaden: Gabler.

Berg, Ilona, & Rumm-Kreuter, Doris. 1996. *Haushalte an der Schwelle zum nächsten Jahrtausend*. Frankfurt/Main: Campus Verlag. Chap. Die Nahrungszubereitung im privaten Haushalt, pages 314–341.

Betz, U., Blosser-Reisen, L., Karg, G., & Lehmann, M. 1991. *Datensammlung für die Kalkulation der Kosten und des Arbeitszeitbedarfs im Haushalt*. Tech. rept. Kuratorium für Technik und Bauwesen in der Landwirtschaft eV, Münster.

Bevan, Nigel, & Curson, Ian. 1999. Planning and Implementing User-Centered Design. *In: CHI'99 Adjunct Proceedings*. Pittsburgh: ACM.

Blades, Mabel. 2002. Recipe calculations. *Nutrition and Food Science*, **32**(1), 13–16.

Bonanni, Leonardo, Lee, Chia-Hsun, & Selker, Ted. 2005. CounterIntelligence: Augmented Reality Kitchen. *In: Proceedings of the 2005 Conference on Human Factors in Computing Systems, CHI 2005*.

Bradbury, Jeremy S., Shell, Jeffrey S., & Knowles, Craig B. 2003. Hands on Cooking: Towards an Attentive Kitchen. *In: CHI 2003: New Horizons*.

Brombach, Christine. 1999. *Mahlzeit - (H)Ort der Familie?* EEE4C study.

Bruhn, Christine M. 1998. *Food Storage Stability*. Boca Raton: I.A. Taub and R.P. Singh. Chap. Consumer attitudes and perceptions, pages 507–517.

Busse, Brigitte, Hloch, Hans, Lichtenberg, Wolhart, Schmidt-Weller, Renate, & Schwartau-Schuldt, Silke. 1994. *Haushaltsführung aktuell*. Brigitte Busse.

Butijn, C.A.A., van Wechem, E.M., & Terpstra, P.M.J. 1998. Is user panel research the best way of assessing ease of use? *Journal of Consumer Studies and Home Economics*, **22**(2), 97–102.

Candel, M.J.J.M. 2001. Consumer‘s convenience orientation towards meal preparation: conceptualisation and measurement. *Appetite*, **36**, 15–28.

Capps, Oral, Tedford, John R., & Havlicek, Joseph. 1985. Household Demand for Convenience and Nonconvenience Foods. *American Journal of Agricultural Economics*, **67**(4), 862–869.

Caraher, Martin, Dixon, Paul, Lang, Tim, & Carr-Hill, Roy. 1999. The state of cooking in England: the relationship of cooking skills to food choice. *British food journal*, **101**(8), 590–609.

Chen, Leonard, Cheng, Sandra, Birnbaum, Larry, & Hammond, Kristian J. 2002. The Interactive Chef: A Task-Sensitive Assistant. *In: Proceedings of the 7th international conference on Intelligent user interfaces*. ACM.

Chu, Michael. 2006. *Cooking for Engineers*.

Claupein, Erika, Oltersdorf, Ulrich, & Walker, Georg. 2001. Zeit fürs Essen. *Pages 202–213 of:* Ehling, M., & Merz, J. (eds), *Zeitbudget in Deutschland - Erfahrungsberichte der Wissenschaft*, vol. 17. Statistisches Bundesamt.

Clauß, Günter, & und Lothar Partzsch, Fall-Rüdiger Finze. 1999. *Statistik für Soziologen, Pädagogen, Psychologen und Mediziner*. Vol. 3. Harri Deutsch.

Connors, M., Bisogni, C.A., Sobal, J., & Devine, C.M. 2001. Managing values in personal food systems. *Appetite*, **36**, 189–200.

Crawford, Joanne O., Taylor, Chris, & Po, Nicolas Li Wan. 2001. A Case Study of On-Screen Prototypes and Usability Evaluation of Electronic Timers and Food Menu Systems. *International Journal of Human-Computer Interaction*, **13**(2), 187–201.

Dahm, Markus. 2006. *Grundlagen der Mensch-Computer-Interaktion*. Pearson Prentince Hall.

Dalgaard. 2002. *Introductory statistics with R*. Springer.

Davies, Gary, & Madran, Canan. 1997. Time, food shopping and food preparation: some attitudinal linkage. *British food journal*, **99**(3), 80–88.

Dekker, Sidney W. A. 2003. Illusions of Explanation:A Critical Essay on Error Classification. *International Journal of Aviation Psychology*, **13**(2), 95–106.

DIN124. 2003. *DIN technical report 124 - Produects in Design for ALl.* Tech. rept. Deutsches Institut für Normung.

Dose, Hanna. 1988. *Der Beruf der Jungfrau*. Graphium. Chap. Die Geschichte des Kochbuchs - Das Kochbuch als geschichtliche Quelle.

Faraway, Julian. 2002. *Practical Regression and Anova using R*.

Franey, P. 1993. *A Chef's Tale: A Memoir of Food, France and America*. New York: Alfred A. Knopf.

Gawron, Valerie J., Drury, Colin G., Fairbanks, Rollin J., & Berger, Roseanne C. 2006. Medical Error and Human Factors Engineering: Where Are We Now? *American Journal of Medical Quality*, **21**(1), 57–67.

Gerhard, S., Gomm, U., Grßmann-Schnatz, I., Heegewaldt, K., Karg, G., Lütticken, I., Pfau, C., Pfluger, M., & Zängler, T. 1998. *Datensammlung Verpflegung und Service*. Tech. rept. Kuratorium für Technik und Bauwesen in der Landwirtschaft eV, Münster.

Gisslen, Wayne. 2003. *Essentials of Professional Cooking*. John Wiley and Sons.

Glew, George. 1990. *Nutritional Adaption to New Life-Styles*. Karger. Chap. European Trends in Conviviality and Eating Out.

Goldsmith, Ronald E., Freiden, Jon, & Henderson, Kenneth V. 1997. The impact of social values on food-related attitudes. *British food journal*, **99**(9), 352–257.

Gomoll, Kathleen, & Nicol, Anne. 1990. *Discussion of guidelines for user observation - From User Observation: Guidelines for Apple Developer*.

Gräfe und Unzer. 2003. *Küchen-Klassiker - die besten Rezepte von GU*. Gräfe und Unzer Verlag.

Gray, Matthew K. 1999 (June). *Infrastructure for an Intelligent Kitchen*. M.Phil. thesis, Massachusetts Institute of Technology.

Griffith, C.J., Mathias, K.A., & Price, P.E. 1994. The Mass Media and Food Hygiene Education. *British food journal*, **96**(9), 16–21.

Gros, Werner. 1977. *Praxis der Gemeinschaftsverpflegung*. Dreieich: Rhenania Fachverlag.

Hajek, Hans (ed). 1958. *Daz buch von guter spise: aus der Würzburg-Münchener Handschrift.* Berlin: Erich Schmidt Verlag.

Hammond, K. J. 1989. *Case-Based Planning: Viewing Planning as a Memory Task*. New York: Academic Press.

Hammond, Kristian J. 1990. Case-Based Planning: A Framework for Planning from Experience. *Cognitive Science*, **14**(3), 385–443.

Hansen, Kelee. 2002. Focus on Research Methods: Direct Observation Research. *In: 2nd National Conference for Food Safety Educators: "Thinking Globally–Working Locally: A Conference on Food Safety Education"*. The Food Safety and Inspection Service (FSIS), Orlando.

Harnack, Lisa, Story, Mary, Martinson, Brian, Neumark-Sztainer, Dianne, & Stang, Jamie. 1998. Guess who's cooking? The role of men in meal planning, shopping, and preparation in US families. *Journal of the American Dietetic Association*, **98**(9), 995–1000.

Hertzler, Ann A., & Bruce, F.A. 2002. Cooking, recipe use and food habits of college students and nutrition educators. *International Journal of Consumer Studies*, **26**(4), 240–245.

Hirschfelder, Gunther. 2001. *Europäische Esskultur - Eine Geschichte der Ernährung von der Steinzeit bis heute*. Campus Verlag.

Holm, Lotte. 1996. *Essen und Kulturelle Identität*. H.J. Teuteberg and G. Neumann and A. Wierlacher. Chap. Food and Identity Among Families in Copenhagen: A review of an interview Study, pages 357–371.

Hom, James. 1998. *The Usability Methods Toolbox Handbook*.

James, Steven R. 1989. Hominid use of fire in the lower and middle Pleistocene. A review of the evidence. *Current Anthropology*, **30**, 1–26.

Jay, Stephen, Comar, Derio, & Govenlock, Lachlan D. 1999. A Video Study of Australian Domestic Food-Handling Practises. *Journal of Food Protection*, **62**(11), 1285–1296.

Johnson, Chris. 1998. Representing the Impact of Time on Human Error and Systems Failure. *Interacting with Computers*, **11**(1), 53–86.

Jones, Peter, Comfort, Daphne, & Hiller, David. 2004. A case study of local food and its routes to market in the UK. *British food journal*, **106**(4), 328–335.

Ju, Wendy, Hurwitz, Rebecca, Judd, Tilke, & Lee, Bonny. 2001. CounterActive: An Interactive Cookbook for the Kitchen Counter. *Pages 269–270 of: Extended Abstracts of CHI 2001*.

Karg, G., & Kreutzmeier, S. 1996. An information system for determining an optimal nutrition intake. *In:* Edwards, J. S. (ed), *Culinary Arts and Sciences - Global and National Perspectives*. Southhampton: Computational Mechanics Publications.

Karg, G., & Leidrich, H. 1989. Nahrung und Ernährung in Frankreich. *Hauswirtschaft und Wissenschaft*, **4**, 149–157.

Küster, Christine. 1996. *Haushalte an der Schwelle zum nächsten Jahrtausend*. Campus Verlag. Chap. Wieviel Zeit nimmt sich der Haushalt für die Ernährung?, pages 84–105.

Kutsch, Thomas. 1996. *Haushalte an der Schwelle zum nächsten Jahrtausend*. Frankfurt/Main: Campus Verlag. Chap. Haushalt und Ernährung, pages 254–279.

Kuznesof, Sharron, Tregear, Angela, & Moxey, Andrew. 1997. Regional foods: a consumer perspective. *British food journal*, **99**(6), 199–206.

Lang, Tim, & Caraher, Martin. 2001. Is there a culinary skill transition? Data and debate from the UK about changes in cooking culture. *Journal of the HEIA*, **8**(2), 2–14.

Liu, Hugo. 2003. *The Food Oracle: A Knowledge-Rich and Dynamic Recipe System*. draft.

Ludwig, Rainer, & Reitter, David. 1999. *Das Verbfeld Kochen im semantischen Modell - Eine Taxonomie und zwei Lexika in LOOM 3.0*.

Lyon, P., Colquhoun, A., & Janhonen-Abruquah, H. 2003. Consumer confidence and UK food retailing: why does local food matter? *Journal of Food, Agriculture and Environment*, **1**(1), 12–21.

Mäkela, J., Kjaernes, U., Ekström, M. Pipping, Fürst, E. L'Orange, j. Gronow, & Holm, L. 1999. Nordic Meals: Methodological Notes on a Comparative Survey. *Appetite*, **32**, 73–79.

Mayer, H.O. 2004. *Interview und schriftliche Befragung: Entwicklung, Durchführung und Auswertung.* Vol. 2. München: Oldenbourg Wissenschaftsverlag.

McKie, Linda J., & Wood, Roy C. 1992. People's Sources of Recipes: Some IMplications for an Understanding of Food-related Bahviour. *British food journal*, **94**(2), 12–17.

McNulty, Christine A. Ralph. 1990. *Nutritional Adaption to New Life-Styles*. Basel: Karger. Chap. Social Change and Food: New Consumer Typologies, pages 52–58.

Millstone, Eric, & Lang, Tim. 2004. *The Atlas of Food*. Earthscan.

Nair, Rahul, & Ullah, Osman. 2003. *Tracking Cooking Tasks Using RFID - CS 7470 Final Project Report*. Tech. rept. Georgia Tech College of Computing.

Nicolaas, Gerry. 1995. *Cooking: Attitudes and Behaviour*. Tech. rept. Office of Populations Censuses and Surveys.

Nott, Kevin P., & Hall, Laurance D. 1999. Advances in temperature valiation of foods. *Food Science & Technology*, **10**, 366–374.

Olabi, Ammar, Hunter, Jean, Jackson, Peter, Segal, Michele, Spies, Rupert, Wang, Carolyn, Lau, Christina, Ong, Christopher, Alexander, Conor, Raskob, Evan, Plichta, Jennifer, Zeira, Ohad, Rivera, Randy, Wang, Susan, Pottle, Bill, Leung, Calvin, Vicens, Carrie, Tao, Christine, Beers, Craig, Fung, Grace, Levine, Jacob, Yoo, Jeshin, Jackson, Joanna, Saikkonen, Kelly, Zimmerman, Matthew, Cunningham, Megan, Crum, Michele, Ishman, Naquan, Voo, Norman, Cadena, Raul, Relinger, Robert, & Wada, Soari. 1999. Work measurement for estimating food preparation time of a bioregenerative diet. *Habitation*, **9**, 17–30.

Oltersdorf, U., Schlettwein-Gsell, D., & Winkler, G. 1999. Assessing Eating Patterns - an Emerging Research Topic in Nutritional Sciences: Introduction to the Symposium. *Appetite*, 1–7.

Pennington, Jean A. T. 1996. Issues of food description. *Food Chemistry*, **57**(1), 145–148.

Piekarski, Johannes, & Pfau, Cornelie. 1993. *Soziale Forschung zum Ernährungsverhalten in den alten und neuen Bundesländern - Stand, Entwicklung, Perspektiven*. Bundesforschungsanstalt für Ernährung. Chap. Menüoptimierung mit dem Programmsystem "SERPHA", pages 185–194.

Pozzi, Daniel. 2005. *Expertengespräch mit dem Deutschen Hausfrauenbund*. personal communication.

R Development Core Team. 2005. *R: A language and environment for statistical computing*. R Foundation for Statistical Computing, Vienna, Austria.

Ransley, J.K., Donelly, J.K., Botham, H., Khara, T.N., Greenwood, D.C., & Cade, J.E. 2003. Use of supermarket receipts to estimate enery and fat content of food purchased by lean and overweight families. *Appetite*, **4**, 141–148.

Rauterberg, Michael. 2003. User Centered Design: What, Why, and When. *Pages 175–178 of:* Graefe, E. (ed), *tekom Jahrestagung 2003*.

Reason, James. 1994. *Menschliches Versagen*. Spektrum Akademischer Verlag.

Rogov, Daniel. 2006. *Rogov's Ramblings - The Art of Writing Workable Recipes*.

Rumm-Kreuter, Doris. 2001. Comparison of the Eating and Cooking Habits of Northern Europe and the Mediterranean Countries in the Past, Present and Future. *International journal for vitamin and nutrition research*, **71**(3), 141–148.

Sarris, Viktor, & Reiß, Siegbert. 2005. *Kurzer Leitfaden der Experimentalpsychologie*. Pearson.

Schaeffler, V., Lehmann, M., & Karg, G. 1994. Wissensbasierte Computerunterstützung bei der Planung von Diabetikerdiäten im Krankenhaus. *In: Ernährungs-Umschau*, vol. 41.

Scharioth, Joachim, Huber, Margit, Schulz, Katinka, & Pallas, Martina. 2004. *Horizons 2020 - Ein Szenario als Denkanstoß für die Zukunft*. Tech. rept. TNS Infratest Wirtschaftsforschung.

Schlegel-Matthies, Kirsten. 1997a. Alltägliche Aufgaben und Probleme im Haushalt - Identifikation und Entwicklung von Qualifikationen als wichtiger Bildungsauftrag für Herausforderungen der Zukunft. *Pages 157–168 of:* Richarz, Irmintraud (ed), *Der Haushalt, Neubewertung in der Postmoderne*.

Schlegel-Matthies, Kirsten. 1997b. Regionale Speisen in deutschen Kochbüchern des 19. und 20. Jahrhunderts. *In:* Teuteberg, Hans Jürgen (ed), *Kulturthema Essen: Essen und kulturelle Identität*. 2. Berlin: Akademie Verlag.

Schulze, Andrea. 1998. Vergleich der Ernährungssituation in Deutschland und Großbritannien. *In: Studien zur Haushaltsökonomie*, vol. 19. Europäischer Verlag der Wissenschaften.

Shaw, Deirdre S., & Clarke, Ian. 1998. Culture, consumption and choice: towards a conceptual relationship. *Journal of Consumer Studies and Home Economics*, **22**(September), 163–168.

Shell, Jeffrey S., Bradbury, Jeremy S., Knowles, Craig B., Dickie, Connor, & Vertegaal, Roel. 2003. eyeCOOK: A Gaze and Speech Enabled Attentive Cookbook. *In:* Verlag, Springer (ed), *Extended Abstracts of UbiComp 2003*.

Shepherd, R., & Sparks, P. 1994. *Measurement of Food Preferences*. London: Blackie Academic and Professional. Chap. Modelling food choice, pages 203–223.

Siemering, Art. 1996. Growing Momentum towards a Global Cuisine. *In: Food on the Move: Proceedings of the Oxford Symposium on Food and Cookery*. Prospect Books.

Siio, Itiro, Mima, Nyuri, Frank, Ian, Ono, Tetsuo, & Weintraub, Hillel. 2004. Making Recipes in the Kitchen of the Future. *In: CHI 2004 Conference Proceedings and Extended Abstracts*.

Sonesson, Ulf, Janestad, Hans, & Raaholt, Birgitta. 2003. *Energy for Preparation and Storing of Food - Models for calculation of energy use for cooking and cold storage in households*. Tech. rept. Institutet för livsmiddel och bioteknik.

Sozioland. 2004. *Tabellenband Kochen 2004*.

Stanton, Neville A., Salmon, Paul M., Walker, Guy H., Baber, Chris, & Jenkins, Daniel P. 2005. *Human Factors Methods - A Practical Guide for Engineering and Design*. Ashgate.

Stead, Martine, Caraher, Martin, Wrieden, Wendy, Longbottom, Patricia, Valentine, Karen, & Anderson, Annie. 2004. Confident, fearful and hopeless cooks - Findings from the development of a food-skills initiative. *British food journal*, **106**(4), 274–287.

Tee, Kimberly, Moffat, Karyn, Findlater, Leah, MacGregor, Eve, McGrenere, Joanna, Purves, Barbara, & Fels, Sidney S. 2005. A Visual Recipe Book for Persons with Language Impairments. *In: CHI 2005 Conference Proceedings and Extended Abstracts*. ACM.

Terrenghi, L., Hilliges, O., & Butz, A. 2006. Kitchen Stories: Sharing Recipes with the Living Cookbook. *In: Special edition of ACM/Springer Journal of Personal and Ubiquitous Computing*. Springer.

This-Benckhard, Hervé. 2005. *Kulinarische Geheimnisse (Révélations gastrononiques)*. Vol. 5. Piper Verlag.

Tollin, Karin. 1990. *Nutritional Adaption to New Life-Styles*. Bibliotheca Nutritio et Dieta, no. 45. J.C. Somogyi and E.H. Koskinen. Chap. Trends in the Choice of Food and Indicators of Differences in Consumption Styles, pages 17–51.

Tran, Quan T., & Mynatt, Elizabeth D. 2002. *What Was I Cooking? Towards Déjà Vu Displays of Everyday Memory*.

Tran, Quan T., Calcaterra, Gina, & Mynatt, Elizabeth D. 2000. *Cook's Collage: Déjà vu Display for a Home Kitchen*. ???

Turrini, A., Saba, A., Perrone, D., Cialfa, E., & D'Amicis, A. 2001. Food Consumption patterns in Italy: the INN-CA Study 1994-1996. *European Journal of Clinical Nutrition*, **55**, 571–588.

Venables, W.N., & Ripley, B.D. 2001. *Modern Applied Statistics with S-Plus*. 3 edn. New York: Springer.

Venkatesh, Alladi. 1997. Advances in Consumer Research: New Technologies for the Home-Development of a Theoretical Model of Household Adoption and Use. *Advances in Consumer Research*, **24**, 522–558.

Vildjiounaite, Elena, Malm, Esko-Juhani, Kaartinen, Jouni, & Alahuhta, Petteri. 2003. Networking of smart things in a smart home. *In: The Fifth Annual Conference on Ubiquitous Computing (UBICOMP 2003)*.

Viljoen, D. L., Muller, M., Swardt, J. B. De, Sadle, A., & Vosloo, M. C. 2001. Computerized electronic temperature control system for thermal efficiency during baking in food research. *International Journal of Consumer Studies*, **25**(1), 30–42.

Wansink, Brian, & Lee, Kyoungmi. 2004. Cooking Habits Provide a Key to 5 A Day Success. *Journal of the American Dietetic Association*, 1648–1650.

Wickens, Christopher D., Lee, John D., Liu, Yili, & Becker, Sallie E. Gordon. 2004. *An Introduction to Human Factors Engineering*. Pearson Prentince Hall.

Wood, Richard. 1996. *History of food and cooking*. Wayland.

Worsfold, Denise. 1995. Recipe for food safety. *Nutrition and Food Science*, 22–25.

Zacharias, Rosemarie, & Dürr, Horst. 1992. *Lebensmittelverarbeitung im Haushalt*. 5 edn. Stuttgart: Ulmer.

Zöfel, Peter. 2002. *Statistik verstehen - ein Begleitbuch zur computergestützten Anwendung*. Addison Wesley.

Zottala, Edmund, & Wolf, Isabel D. 1981. Recipe hazard analysis - RHAS - A Systematic Approach to Analyzing Potential Hazards in a Recipe for Food Preparation/Preservation. *Journal of Food Protection*, **44**(7), 560–564.

List of Figures

List of Tables

List of Abbreviations

ANOVA ..... Analysis of variance
GUI ..... graphical user interface
HACCP ..... Hazard Analysis and Critical Control Points
KTBL ..... Kuratorium für Technik und Bauwesen der Landwirtschaft
MIT ..... Massachusetts Institute of Technology
RFID ..... radio frequency identification
UCD ..... User Centered Design
UI ..... user interface

Units:

a.d. ..... anno domini
b.c. ..... before christi
sec ..... seconds
min ..... minutes
n ..... number
pct ..... percent
p.p. ..... per participant
sdev. ..... standard deviation (only in appendix)
tbsp. ..... tablespoon
tsp. ..... teaspoon

Group codes and custom abbreviations:

C1, C1EC, C2, C2EC, L1, L1EC, L2, L2EC ..... factor combinations, see table 3-1 on page 27
cb ..... cookbook

A. Appendix

A.1 The Questionnaire

Q1: How often do you (personally) cook in the course of a week?

Everyday cooking; Special occasion cooking; I go out to eat or have a meal delivered
(More than once a day; (Almost) every day, More than twice a week, Once or twice a week, Rarely, Never)

Q2: Which appliances are used for cooking in your household?

Hob; Oven; Microwave; Special appliances (such as steamer, rice cooker, bread making machine)
(Always, Often, Sometimes, Rarely, Never)

Q3: Who in your household makes the decisions about buying domestic appliance?

I decide alone; There is a joint decision; I am not involved in the decisions and leave it to others

Q4: When did you buy the most recent major kitchen appliance for cooking or baking?

Within the last 12 months; Within the last 5 years; More than 5 years ago

Q5: For how many people (including yourself) do you usually cook?

Everyday cooking; Cooking for special occasions
(1, 2, 3 - 4, 5 or more, Dont know)

Q6: How much time do you generally spend on preparing one meal?

Everyday cooking; Cooking for special occasions
(Less than 30 min, 30 min to 1 hour, 1 to 2 hours, More than 2 hours, Dont know)

Q7: How would friends or family rate your cooking?

Very good; Good; Average; Adequate; Poor

Q8: How strongly do you agree with these statements about cooking in general?

I enjoy having the role of cook in the household; I can express my creativity through it; I put a lot of effort into cooking; I enjoy cooking; A good meal is worth the effort; I would like to learn something new and improve my cooking
(Very strongly, Fairly strongly, Not very strongly, Not at all, Dont know)

Q9/Q10: Which of the following activities do you do? If applicable, please say whether you find them agreeable or not.

> Preparing a meal plan for the next few days; Controlling my budget, how much I can spend; Writing out the shopping list and planning the shopping; Looking for prices and offers; Going shopping; Finding out about seasonal offers and their storage; Assembling the things required before cooking; Ensuring the right balance of the ingredients for healthy eating or diet
> *(Enjoyable, Boring, Not something I do / Easy, Difficult)*

Q11: Do the following make any difference for you between special occasion cooking and everyday cooking?

> I use high-quality ingredients; I use appliances that I wouldnt normally use; I choose fresh, unprocessed ingredients; I choose ambitious recipes; We cook together, its not just me on my own; I try to create a special atmosphere; I take a lot of trouble to garnish the food or to make it look appetising
> *(Yes, No (makes no difference), I take no notice)*

Q12: How often is your cooking guided by the recipe, i.e. not from memory and not improvising?

> Everyday cooking; Cooking for special occasions
> *(Always, Often, Sometimes, Rarely, Never)*

Q13: How do you decide which dish to prepare in everyday cooking?

> I try something new; I remember suggestions made by friends; I choose a recipe that I can cook with the food available; I choose something quick and/or easy
> *(Often, Sometimes, Rarely, Never)*

Q14: How do you decide which dish to prepare on special occasions?

> I try something new; I remember suggestions made by friends; I choose a recipe that I can cook with the food available; I choose something quick and/or easy
> *(Often, Sometimes, Rarely, Never)*

Q15: From where do you draw inspiration or how do you look for a recipe?

> I go on a cookery course or am a member of a cookery group; I look for recipes in a cookery book; I look for recipes in magazines; I root around in my collection of handwritten or cut-out recipes; I draw inspiration from cookery courses on video or DVD or cookery programmes on television; I use my computer for recipe management; I visit a web site that has recipes available
> *(Often, Sometimes, Rarely, Never)*

Q16: Are any of the following difficult in choosing a recipe?

Finding a recipe that is within my capabilities; Finding a recipe that I can cook with my equipment; Choosing a recipe that is not too expensive; Choosing courses that go together; Complying with everyones taste and knowing what people like or dont like; Taking account of special needs, such as diets; Using leftover food in other meals; Preparing a balanced meal in a short time
(Yes, Yes - to some extent, Not really, Not at all, Don't know)

Q17: Is this a difficulty for you when cooking, in particular when cooking for special occasions?

Converting the quantity of ingredients for the right number of portions; Preparing several things at the same time; Handling new, unfamiliar ingredients; Being in the kitchen to give attention to the meals cooking; Judging whether a dish is done
(Yes, Yes - to some extent, Not really, Not at all, Don't know)

Q18: Do you agree with the following statements about cookery books?

It is difficult to find my way around the text; Sometimes I would like to re-sort the recipes; Much of the information is wrong or missing; Too many too complicated recipes are suggested; It is easy to vary the recipes; There are enough basic instructions for beginners; There is a lack of interesting background information; There are good tips and critical points are particularly emphasised; I use cookery books to help me if I dont know what to do next
(Yes, Yes - to some extent, Not really, Not at all, Don't know)

Q19: Do you have these difficulties with storage?

Not knowing whether or how much of a food is available; Too little of a given food; Spoilage of fresh food; Expired use-by dates
(Often, Sometimes, Rarely, Never)

Q20: Do you find it difficult to gauge the time?

...when to start cooking to be ready at the right time; ...how long individual steps will take; ...how long a given food needs cooking; ...how long the oven has to be preheated
(Yes, Yes - some extent, Not really, No, Don't know)

Q21: Do you find the following tasks a challenge for you?

Baking a cake; Cooking meat until tender; Filleting a whole fish; Cleaning vegetables; Cooking noodles/spaghetti al dente; Cooking rice; Preparing a sauce of your own
(Very difficult, Moderately difficult, I can do it easily, Dont know / not necessary)

Q22: How closely do you stick to the recipe when you are preparing a meal?

I use different preparation methods; I swap ingredients for others; I change the sequence of steps (as far as possible); I use different quantities from those indicated; I adjust the stated temperatures to my appliances; I adjust the stated cooking times to my appliances
(Always, Often, Sometimes, Rarely, Never)

Q23: How often do you find yourself in difficulty when cooking for the following reasons?

I forget to switch appliances on; I dont know how an instruction is to be carried out; I have taken the wrong quantity of an ingredient and dont know how I can correct it; I dont know which step comes next; I choose too high a setting or forget to turn it down, so that things burn or do not cook; I forget a recurring operation (e.g. stirring, moistening); I forget to check whether something is done
(Often, Sometimes, Rarely, Never)

Q24: How useful do you find the following cooking aids?

Egg timer; Timer on the oven (automatic cut-off); Programmes on your oven; Programmes on your microwave
(Very useful, Not very useful, Not at all useful, Not something I have)

Q25: How well do you take account of diets if necessary when cooking in your household (including guests)?

Weight reduction (Overweight); Health conscious (low-cholesterol, sports diets, bio-products, etc); Eating when ill (allergies, diabetes, no gluten, lactose, purine, high blood pressure); Ethical reasons (religious rules, vegetarianism, etc)
(Well, A little, I take no notice, Not necessary)

A.2 Recipes

The following recipes are translations from German (see Gräfe und Unzer, 2003). The original texts were used in the experiments.

A.2.1 Meat Lasagna

serves 6 persons

Ingredients

1 onion, 1 big carrot, 1 stalk celery, 50g smoked ham, 6 tbsp butter, 350g mixed minced meat, 200ml meat broth, 1 small can peeled tomatoes (400g), salt, pepper, 650ml milk, 3 tbsp flour, 250g mozarella cheese, 300g lasagna (uncooked), 70g freshly grated Parmiggiano cheese.

Instructions

1. Peel onion and carrot, wash celery. Dice all with ham. Melt 2 tbsp. butter and roast ham therein. Add onion and vegetables, steam until translucent.

2. Add the minced meat into the pan and fry at high temperature. Add the broth to loosen the crust. Cut the tomatoes into small pieces and add to into pan with juice. Season the ragout with salt and pepper, add 1/4l milk. Let the ragout simmer at low heat for about 2 hours. Stir from time to time and add liquid if necessary.

3. Melt the remaing butter for the bechamel sauce, and sweat the flour while stirring. Bit by bit add the remaining milk, whisking with an eggwhisker. Let simmer for 3-5 minutes and season with salt and pepper. If too viscous, add some more milk.

4. Preheat the oven at 180°C. Slice the Mozzarella. Pour out the bechamel in a baking casserole. Stratify lasagna, bechamel, Mozzarella and ragout in layers while sprinkling some parmesan cheese. Cover with lasagna and bechamel and remaining parmesan. Let bake in the hot oven (middle, hot air 160°C) for about 40 minutes, until the pasta is soft.

A.2.2 Canneloni with Spinach

General Information

serves 4 persons

Ingredients

250g Canneloni rolls, salt, 600g spinach, 150g smoked ham, 1 onion, 3 tbsp butter
100g creme fraiche, pepper, 50g pine nuts, 2 tbsp flour, 1/2l milk, fresh grated nutmeg, 100g fresh grated parmesan cheese, butter (for the casserole)

Instructions

1. For the noodle rolls bring plenty salted water to boil. Cook the rolls according to package until flexible to bend, quench with cold water and let drip off (step was skipped in experiments).

2. Remove the limp leaves and thick stems from spinach and wash it thoroughly. Remove rind and gristle from ham and cut to dices. Peel onion and dice, too. Steam onion dices in 1 tbsp butter until glassy, then add ham. Add the spinach and let it collapse. Stir while add creme fraiche and season to taste with salt and pepper.

3. Saut pine nuts in a pan without fat, then add to spinach. Butter a baking casserole. Fills canneloni rolls with spinach mass and place side by side in form.

4. Preheat the oven to 200°C. Melt the remaining butter, add flour while stirring. Let sweat until golden. Keep stirring with an eggwisker and add milk. Let simmer at medium heat for 3-5 minutes. Season with peper, salt and nutmeg.

5. Pour the sauce over noodle rolls, cover with cheese. Bake the canneloni in oven (middle, hot air 180°C) for about 30 minutes until light brown.

Acknowledgements

First of all I have to thank Prof. Dr. Rainer Stamminger, who encouraged me to write this thesis after completion of my diploma thesis under his mentoring. He attended it and approved the technical efforts that were necessary to build and the testing environment.

I also have to thank the team of the Section of Appliance Technology at University of Bonn, especially Anke Kruschwitz, Marina Niestrath and Simone Thomas who volunteered often as ”test person” during the pretests.

Special thank goes to the Electrolux Group, who funded this work. The development of the prototype was conducted and carried out by the Primary Development Cooking, the Core Innovation Technology and Industrial Design departments. Without their efforts this work had not been possible.

The technical installations were made possible by Dr. Gereon Broil, Dieter Kruft and Wilfried Berchtold from the Institute of Agricultural Technology, Bonn.

Thanks to my sister Carolina for proofreading my English and my mother Sigrun for her support.

I have to thank Prof. Dr. Michael-Burkhard Piorkowsky who agreed again to become the second examiner after my diploma thesis.

The recipes used in this work are reproduced by kind permission of the Gräfe und Unzer Verlag.

Last but not least I have to thank my participants who proved that research is not necessarily a bland work and provided so much useful feedback for improvement of the prototype. I appreciate their contribution very much.