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Evaluation of Interactive Tablets for Improving Customer Service in Restaurants

Master's Thesis at the
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Aachen, May 2012
Julian Meichsner

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Abstract

As tablets with touch input have become widely disseminated over the last few years, more and more industries make use of these devices. Upscale restaurants started to introduce tablets like the iPad as digital menus in order to replace traditional paper menus. By being able to include more media featuring the quality of available dishes and ideas behind them, and by designing the decision-making process more interactive, those digital menus aim at improving the customer experience. But while there exist many guidelines dealing with the design of paper menus in the hospitality industry, the development and especially benefits of digital menus have not been analyzed in-depth.

In this thesis, we analyze existing research about interactive devices for restaurant guests, and describe solutions already used in restaurants around the world. Two digital and two paper menus were developed in a user-centered design process, containing different types and amounts of content. The digital menus were implemented as iPad applications based on web technologies. A structure similar to paper menus, but using benefits of digital systems such as page hierarchies, video content and multitouch input, was chosen for the iPad menus as it showed a good usability even for unexperienced users.

The results of a conducted user study showed differences in the perceived quality of the restaurant and dishes, but no significant differences in price estimations for the items on the menus. The averaged time needed to choose one or several dishes was similar for the paper menus and the iPad menu without included videos. Using digital menus, long textual information was accepted, while it was perceived as disturbing in paper menus.

Based on the results of the user study and on interviews with professionals from the field, we provide guidelines for the design of interactive menus for upscale restaurants.

Überblick

Seit die Verbreitung von Tablet-Computer in den vergangenen Jahren stark angestiegen ist, werden diese in immer mehr Branchen eingesetzt. In gehobenen Restaurants wurde mit der Verwendung von Tablet-Computern wie dem iPad als digitale Speisekarte begonnen, um traditionelle Papierspeisekarten zu ersetzen. Durch die Möglichkeit, mit verschiedensten interaktiven Medien die Qualität der angebotenen Speisen und die Idee hinter diesen darzustellen, wird versucht das Restauranterlebnis zu verbessern. Aber während es eine Vielzahl an Richtlinien für die Gestaltung und den Aufbau von Papierspeisekarten gibt, sind die Entwicklung und insbesondere die Vorteile von digitalen Speisekarten weitestgehend unerforscht.

In dieser Arbeit analysieren wir vorhandene Forschungsarbeiten über interaktive Geräte für Restaurantgäste und beschreiben vorhandene Lösungen die bereits in Restaurants eingesetzt werden. Zwei digitale Speisekarten und zwei Papierspeisekarten mit verschiedenen Arten und verschiedener Menge an Inhalt wurden in einem benutzerzentriertem Designprozess entwickelt. Bei den digitalen Speisekarten handelt es sich um iPad-Anwendungen basierend auf Webtechnologien. Ein zu Papierspeisekarten ähnlicher Aufbau, jedoch mit Vorteilen von digitalen Systemen wie Seitenhierarchie, Videoinhalten und Multitoucheingabe, wurde für die iPad-Speisekarten gewählt, da dies auch für unerfahrene Benutzer intuitiv zu bedienen ist.

Die Ergebnisse einer durchgeführten Benutzerstudie zeigten Unterschiede in der wahrgenommenen Qualität des Restaurants und der Speisen, jedoch keine signifikanten Unterschiede in der preislichen Bewertung für Gerichte auf den Speisekarten. Die durchschnittliche Zeit, welche benötigt wurde um eine oder mehrere Speisen auszuwählen, war für alle Speisekarten ohne Videoinhalte ähnlich. Lange Beschreibungstexte wurden auf den digitalen Speisekarten akzeptiert, während diese auf Papierspeisekarten als störend empfunden wurden.

Basierend auf den Ergebnissen der Benutzerstudie und Interviews mit Personen, die in der Restaurantbranche tätig sind, stellen wir Richtlinien für die Erstellung von interaktiven Speisekarten für gehobene Restaurants vor.

Acknowledgements

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Last but not least I would like to thank my friends who motivated me throughout this thesis. A special thanks to Zuzi for always standing by my side. This work would not have been possible without them.

Conventions

Throughout this thesis we use the following conventions.

Text conventions

Definitions of technical terms or short excursus are set off in coloured boxes.

EXCURSUS:
Excursus are detailed discussions of a particular point in a book, usually in an appendix, or digressions in a written text.

Definition:
Excursus

Source code and implementation symbols are written in typewriter-style text or in code listings.

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myClass
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The whole thesis is written in American English. The questionnaires and content of the prototypes are written in German.

The plural ”we” will be used throughout this thesis instead of the singular ”I”, even when referring to work that was primarily or solely done by the author.

Cconventions for statistics

In boxplot diagrams, the whiskers extend to the maximal and minimal values in the dataset. An exception are values being more than 1.5 times of the interquartile range away from either end of the box; these are marked with a circle or asterisk (when being more than 3 times of the interquartile range away) and are not included in the whiskers length. The lower box boundary marks the 25% percentile; the upper boundary marks the 75% percentile. The line in the box indicates the median.

The standard deviation is abbreviated with *SD*.

Chapter 1

Introduction

"Let your mind start a journey thru a strange new world. Leave all thoughts of the world you knew before."

—Erich Fromm

Tablets

Since the introduction of Apple's iPad (see figure 1.1) and the Samsung Galaxy Tab in 2010, the tablet industry reports steady increases in sales. While 18 million devices were sold in 2010, this number has gone up to 73 million in 2011 [IDC, 2011, FPD, 2012]. Tablet computers existed a long time before that, but these new touch-based tablets were smaller, lighter, more affordable and were shipped with specially designed mobile operating systems. Thus, they are easier to use and better to transport than tablet computers based on traditional notebook hardware.

Tablets in restaurants

With the wide distribution of touch-based interactive tablets, many different industries started to make use of such devices [Kendall, 2010]. In the last few years restaurants worldwide introduced tablets and other interactive devices as a replacement or addition to traditional paper menus (see figure 1.2 for an example). By using touch input, digital menus allow a direct interaction with the content available on the menu. A large variety of content types and features can be added that would not be possible with paper menus, such as videos, interactive maps, three

Figure 1.1: The first Apple iPad released in 2010, which was also used in the context of this thesis.

dimensional representations of objects and many more. While some restaurants use digital menus to provide more information on their dishes and wines to enhance the user experience of their guests, some others try to save staff cost by offering the ability to place orders and pay cashless with the tablets, reducing the work and therefore the amount of waiters needed.

Mediating quality

By involving this new technology the restaurants can present information on their food in a way that would be impossible with paper based menus. Until now, the only possible means of communication between the chef of a restaurant and the guests were the items on the menu and the preparation of the meals. When using digital menus, the chef can mediate the quality of his cuisine, ingredients and receipts by placing additional information in a well designed manner accordingly. The idea and story behind a meal can be made visible while also interactively involving the guests.

Cost-benefit ratio

Nearly all restaurants that introduced digital menus so far achieved a high press visibility which helped to increase their sales. Therefore the investment in the hardware and

Figure 1.2: Interactive tablets as restaurant menus. Photo by *Mundo Global Tapas*.

software required pays off quickly. But as more and more restaurants do so, using tablets as menus will probably get more common in the future. Thus, the question whether it is profitable to introduce digital menus will depend on the benefits for the guests and the quality of the dishes that can be mediated with such applications.

Menu engineering

The design and structure of menus is a large research field in the hospitality industry, and many guidelines for developing menus for upscale restaurant already exist [Morrison, 1996, Bowen and Morris, 1995]. In the last few years, some research projects targeting technical details of interactive menu systems were conducted, like the construction of multi-touch tabletop systems or recommender systems. Such systems try to advice the guests which dishes and wines they could order based on several different factors. However, there was no research on how to harness digital menus to enhance the restaurant experience or the quality of the meals and restaurant the guests perceive. Another unexplored topic is the influence of digital menus on the atmosphere, as the atmosphere is the most important aspect of upscale restaurants beside of the quality of the meals and service [Kotler, 1973, Kivela, 1997].

Goal and contribution of this thesis

In this thesis we want to analyze the effect of digital menus on the guest's perception of the quality of a restaurant and how quality can be mediated with tablets and correspond-

ing software. Existing research on interactive devices in restaurants will be evaluated, as well as the experience of upscale restaurants that already introduced digital menus. Using a user-centered design approach, we created iPad and paper menus in order to conduct a user study about the influence of interactive menus and how quality of meals can be mediated with such technology. In the analysis of the results presented in this thesis, we will show that digital menus can increase the perceived quality of the restaurant as well as available dishes. Furthermore, the study revealed that longer textual information can be used in digital menus compared to paper menus without disturbing the users, as not all content has to be immediately visible. The time users took to decide on dishes to order was similar for both menu types. At the end of the thesis, we will provide guidelines for the structure, content and design of interactive tablet menus.

1.1 Thesis Structure

This thesis is structured as follows:

Chapter 2 In chapter 2—"Related Work" we present available research projects about different kinds of interactive devices in restaurants, e.g. tablets or interactive tabletops. In the second section some solutions currently used in restaurants are listed and described.

Chapter 3 In the third chapter (3—"Study Design") we provide information on the design and execution of the user study performed in the context of this thesis.

Chapter 4 The design of our menu prototypes is described in chapter 4—"Design and Implementation of the Prototypes". We explain the user-centered development of paper and software prototypes for digital and paper menus, and present the content included in these menus.

Chapter 5 In chapter 5—"Evaluation", the results of the conducted user study are presented. The statistical analysis of the data is shown and evaluated.

Chapter 6 Chapter 6—"Design Guidelines for Interactive Tablets in Restaurants" provides guidelines for the development and design of interactive tablets for use as restaurant menus. These guidelines are based on knowledge gained from the user study and several interviews with professionals from the restaurant industry.

Chapter 7 The last chapter (7—"Summary and Future Work") summarizes this thesis and points out some open research questions for future work on this topic.

At the beginning of each chapter we will provide a more detailed overview of the content after giving an introduction to the chapter.

Chapter 2

Related Work

"If you have an apple and I have an apple and we exchange apples then you and I will still each have one apple. But if you have an idea and I have an idea and we exchange these ideas, then each of us will have two ideas."

—George Bernard Shaw

While there are a few restaurants which introduced interactive devices for their customers before touch-based tablets started to become widely disseminated with the introduction of the iPad in 2010, the interest in such devices for a restaurant environment increased after that time. Reasons for that are sinking prices for interactive tablets and the development of adequate applications, the small form factor and weight, and the high performance of touch recognition respectively of the devices themselves. Together with the interest of restaurants in such devices, the research interest in this area has risen.

Chapter overview

In the first section of this chapter we present research projects dealing with interactive devices in the area of restaurant environments, targeted at enhancing the customer experience (section 2.1—"Research on Interactive Devices in Restaurants"). In the second main section some restaurants that have introduced interactive devices for their customers are listed, including information about the

technology and content available in those applications (section 2.2—"Interactive Devices Used in Restaurants").

2.1 Research on Interactive Devices in Restaurants

There has not been much research in the field of interactive devices for customers in restaurants, neither from a hospitality point of view nor in computer science. Most research projects in this area were carried out in the last couple of years as the availability of small tablet devices increased. Research before that was often either targeted at order systems or devices for the restaurant staff, like the work of Ansel and Dyer [1999], or at recommendation systems in restaurants, e.g. Sakaguchi et al. [2011]. In this section some research projects targeting the enhancement of customer experience are presented.

2.1.1 iMenu

iMenu is an interactive restaurant menu designed for children, developed in a research project at the University of Maryland by Brewer et al. [2010]. The initial idea was to create a device which allows restaurant guests to gain more control over the food ordering process, for example by being able to customize and order the dish using the device. Thus the customers feel more involved in a restaurant, which leads to a higher customer satisfaction.

Target group

The authors choose children as the target group because they are normally not as experienced as adults using digital interactive devices, therefore the user interface has to be very simple and intuitive. Also, the satisfaction of the children can influence the satisfaction and mood of the rest of the family. Being able to choose, customize, and order the dish without needing a waiter, the authors state that the menu is designed for chain restaurant instead of high-class restaurants.

Design and evaluation

A user-centered design approach was chosen for the menu. An intergenerational team including children was involved in the design process, which covered finding suitable devices, creating the features and interface of the software, building a prototype, and evaluating the menu. Some important features for the children were customization of the menu (as seen in figure 2.1), inclusion of pictures for every dish and for each ingredient on the customizing screen, and the possibility to play games on the device while waiting for the dish. The evaluation of iMenu was done with the same group of children that was involved in creating it. Overall the children were satisfied with the ability to have more control of customizing and ordering food. They named some areas of the application that needed slight improvements, such as finer adjustments of customized dishes.

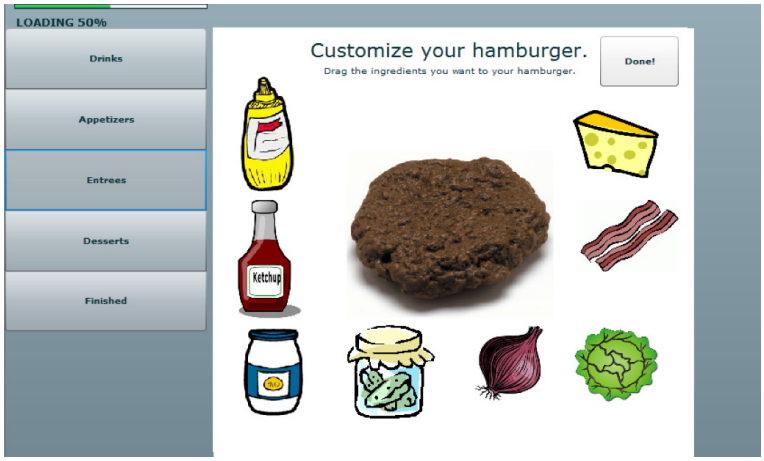

Figure 2.1: A screenshot of the user interface of *iMenu*. Children are able to customize their food using the touchscreen device. This figure is taken from [Brewer et al., 2010].

Contribution of *iMenu*

The authors of *iMenu* showed that digital menus can also be well-suited for children when designed appropriately. The most important aspect of digital menus for children is the customization functionality, as this target group is not as uncomplicated concerning food as older guests. By offering this functionality, children are more satisfied with the chosen meals. Furthermore, digital menus can be used to keep children busy by providing integrated games.

2.1.2 Automated Food Ordering System

Tan et al. [2010] created an automated food ordering system including an interactive user interface based on touch screens to order food, and wireless controlled robots to serve the prepared dishes. The goal of their project was to enable restaurants to serve large numbers of guests in areas of high population density in short time frames, for example restaurants in business districts at lunch hour. Additionally, it is designed to reduce staff costs, because ideally no waiter is needed for receiving orders or serving food.

System design

The system uses touch screens placed on each table. The guest can browse through the dishes offered by the restaurant, and add the desired ones to a kind of a shopping cart. Photos and short descriptions of each dish are presented to the guest, as well as general information about the restaurant itself in textual and visual form. After choosing the dish, the order is sent to a computer in the kitchen, where the kitchen staff can review all orders on a screen. When having questions or special wishes, the guest is able to start a video conference with an assistant in the kitchen using the system. After the dish is prepared, it is sent to the guest using robots. The system was not evaluated by the authors.

Contribution

As nearly every aspect of the food ordering and serving process was automated in this work, it is shown that digital systems in restaurants can be used to save time as well as staff costs. Thus, those automation systems are useful for lower class restaurants or chain restaurants.

2.1.3 moJo iCuisine

Chen et al. [2011] designed and implemented interactive tabletop systems for a western restaurant called *moJo iCuisine* in Taiwan. The aim of the project was to analyze the special needs of an interactive tabletop for restaurants, to design a tabletop system that fits seamlessly in the spatial design of the restaurant, and to observe the typical usage after the system was installed in the restaurant environment. They also looked into the integration of the interac-

tive tabletops and the services offered by the software into the common workflows in restaurants.

Requirement analysis

The first step of the research team was to perform a requirement analysis by interviewing restaurant owners. The main concerns of the owners were that the interaction between the staff and the customers should not be replaced by an interactive system, and that the customers could get distracted while having the dish. Therefore, the new system should concentrate on enhancing the experience of diners. After an observation of customers and standard procedures at a restaurant, six main steps in the dining process were identified: browsing the menu, ordering, waiting to be served, eating, filling out questionnaires by the restaurant, and paying. The interactive system was then designed to support each of those six steps. Some of the features include browsing a digitized menu, ordering a dish, playing games, changing the look of the tabletop, notify the waiter for the bill or other affairs, and filling out questionnaires provided by the restaurant.

Figure 2.2: One of the 22 interactive tabletops at moJo iCuisine in action. Figure from moJo iCuisine.

System design

The tabletops themselves were required to also serve as dining tables and were designed to fit well into the design of the restaurant. Each of the 22 tabletops installed in the restaurant consists of a capacitive sensor board integrated into the table for recognizing touch input by the customers, and a customized ball-shaped casing located above the table. Inside is a computer running all the software required, and a projector. By using a projector to project the user interface onto the table, it is possible to have the whole table covered with the images without frames, and to avoid items on the table obscuring parts of interface. The computer is connected to a local network for interaction with a central server, which provides the current menu and other data, and which handles orders and notifications for the waiters. All technical devices and wires are hidden inside the table, the globe above the table, and the walls. The structure of the tabletop is shown in figure 2.3, while a photo of a dining table in use is shown in figure 2.2.

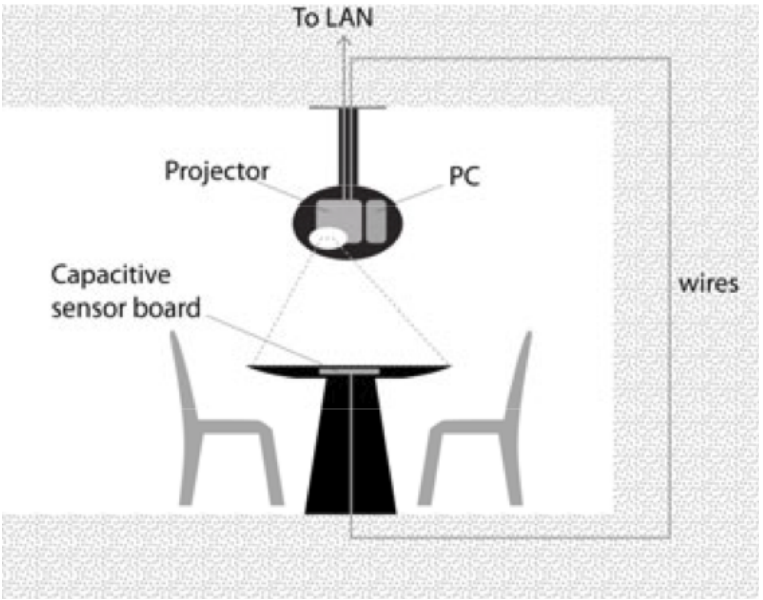

Figure 2.3: The setup of an interactive tabletop at moJo iCuisine, with the projector and the computer attached to the ceiling and the capacitive sensor board for touch input integrated into the table. This figure is taken from [Chen et al., 2011].

Evaluation

After the systems were installed for some time in moJo

iCuisine, the project was evaluated. Due to the high visibility of the restaurant in newspapers, magazines and blogs, the revenue increased significantly, and the costs were recovered after three months. A survey showed that most of the guests were visiting the restaurant because of the dining experience, and not because of the food. It also showed that the customers were able to operate the system without any further help, after being told that the interface is touch-sensitive. The users were pleased with the design, and stated that the systems were well integrated into the restaurant, and that they were not perceived as standalone devices, but part of moJo iCuisine itself.

Contribution of *moJo iCuisine*

The project evaluated a different approach for digital menus by not using tablet devices. The authors showed that interactive tabletops can be applied to restaurant settings in order to enhance the dining experience. By offering highly customizable interface designs and other features such as games, the system can support the interaction between guests visiting the restaurant together.

2.1.4 Good Choice Table

Good Choice Table[1] is a research project about group decision support systems (GDSS) in a restaurant setting by Igelmund et al. [2011]. Normally, GDSS are defined as technology based environments to support business groups working on the same project, e.g. in meetings [Dennis et al., 1988]. This support can either be for decision-making processes where all participants are located at the same place, or distributed via remote communication. The aim of this research project was to transfer the knowledge of face-to-face GDSS to non-business environments. An interactive tabletop prototype was developed and evaluated.

System design

The authors choose a restaurant setting for their prototype, because eating in a restaurant is an everyday situation where normally a group of guests has to decide which dishes and drinks each one of them orders. The GDSS should therefore support those groups by recommending

[1] http://www.goodchoicetable.com

Figure 2.4: The user interface of the Good Choice Table system on an interactive tabletop. Image courtesy of the Good Choice Table team.

matching wines, side orders or additional courses. Based on the fact that most western restaurants have dining tables, an interactive tabletop approach was used for the prototype. The table surface doubles as the user interface by using rear projection from a projector placed under the table. By using infrared illumination of the surface and detecting the infrared reflections with cameras, multi-touch input is supported. Thus, several users can interact with the system at the same time. The prototype tabletop is able to display the main user interface twice on the surface for supporting a maximum of two users seated face-to-face at the table, as seen in figure 2.4. For designing the user interface itself the following requirements were targeted and analyzed: easy to use menu and navigation, possibility to create, save and review favorites, possibility to order dishes, wine recommendation service, possibility to reject recommendations, and guiding through the order process [Igelmund et al., 2011].

Evaluation

An evaluation of the acceptance and usability of the system was performed after the implementation of the prototype. For the user study twelve students in the age of 20 to 24 years were invited, all studying at the University

of Applied Science Furtwangen and having a high affinity to information technology. All participants had to choose a dish and wine using a paper menu in one test, and using the GDSS in a second one. Afterwards they filled out questionnaires, which were divided into one part about usability, and one part about the acceptance and usefulness of the system. The usability questionnaire was created according to the system usability scale (see definition on this page). According to the authors, 100% of the participants stated that the system gives a lot of advantages, and 80% would appreciate using it in real restaurant settings. 82% also thought that a multitouch tabletop would be the best way to implement a GDSS in a restaurant. Most of the participants preferred the system over normal paper menus, mainly because the opportunity to add favorites helped them to decide on a dish. A test according to the system usability scale achieved a score of 80.36%. The authors admitted themselves that the chosen user group may have affected the outcome of the study, because of the high affinity to technology, the similar knowledge background, and a very narrow age range. It is considered to repeat the user study with a larger number of unpersuaded participants.

SYSTEM USABILITY SCALE:
The system usability scale (SUS) is a standard way to measure the usability of a system, e.g. a software system, using Likert scales. The original SUS developed by Brooke [1996] has ten different statements that can be rated by users between 1 (strongly agree) to 5 (strongly disagree). In order to create a system usability score, 0 to 4 points are given for each Likert scale. Those points are added up and then multiplied by 2.5. SUS scores range from 0 to 100 (higher is better) [Bangor et al., 2008].

Definition: *System Usability Scale*

The project showed that GDSS are well-suited for restaurant settings. By combining a digital menu with a recommender system, the satisfaction of guests concerning their choice and the restaurant can be increased. Especially guests unexperienced with wine selections can be supported by a recommendation of wines fitting to their chosen dishes. The acceptance of such systems in upscale restaurants has to be researched further.

Contribution of *Good Coice Table*

2.2 Interactive Devices Used in Restaurants

In the last couple of years, many high-class restaurants world-wide started to introduce interactive handheld devices for their customers. While the target of some of these systems is solely to reduce staff cost by transferring the ordering process to digital devices, some aim at offering more information about dishes or wines for the restaurant guests in a well designed way, thus enhancing customer experience. In this section we present some solutions that are currently used in restaurants around the globe. We visited one of these restaurants using tablets as menus and had telephone interviews with some other restaurants in order to get a better understanding of their systems. The section will be concluded by a short summary.

2.2.1 Next Level

Next Level is a modern fine-dining restaurant of the Kameha Grand[2] hotel in Bonn, Germany. In summer 2011, they introduced an iPad-based digital menu for their guests. The Next Level was the first restaurant in Germany which introduced digital menus. We visited the restaurant to have a look at the menu and conducted an interview with the Director of Guest Relations of the Kameha Grand.

Look and feel of the devices

Currently the restaurant uses five iPads, which are brought to younger guests, regular customers who are known for using the iPad, or on request of every other guest. The iPads themselves are bound in white leather cases similar to high quality paper menus, in order to fit the design of the devices to the restaurant environment. Hence, the digital menus feel more integrated into the location, which alone can lead to a higher usage acceptance. A photo of an iPad used by the Next Level is shown in figure 2.5. The user interface is also designed to fit the atmosphere of the Next Level.

[2] http://www.kamehagrand.com/

Figure 2.5: The digital menu used by the restaurant *Next Level* at the Kameha Grand in Bonn. Image courtesy of Kameha Grand.

Features of the digital menu

The start screen of the application shows a menu with entries for the different courses, i.e. appetizer, main courses, dessert etc., drinks, as well as other information about the restaurant. The dishes are divided into several categories like dishes with meat, fish, and so on. Beside of the name of the dishes, there are small descriptions and photos included for a minority of the offered dishes. A photo of one of these information pages for a main course is shown in figure 2.5 Using a feature similar to a digital shopping cart, the user is able to create a list of all dishes and drinks he wants to have, which he can show the waiter. Thus, the user does not need to remember all items he wants to order. In order to offer an individual and professional service by the staff, it is not possible to place the order via the iPad. An additional feature is the inclusion of wine recommendations for most of the dishes, which are given by the chief sommelier. They link to the pages of the corresponding wine, where additional information about the taste and origin can be seen. It is also possible to access a live video stream from the kitchen via the start screen, where the restaurant guests can watch the food being prepared from three different cameras. The cameras only show the food and dishes and not the kitchen staff itself.

Usage and acceptance

A large amount of guests visit the Next Level because they want to try out the digital menus. The guests are overall interested in this new relatively new medium, and are pleased with the user interface and the features offered by

application. About 50 guests use the iPad each day, 90% of them also use the video feature. Most users are able to operate the digital menu without further help of the staff. The waiters do not have much additional work with the iPads. The iPads are put into charging stations after returning from the customers, and the maintenance of the hardware and software is performed by the IT department. All members of the kitchen staff agreed on the installation of cameras in the kitchen.

Development

The iPad menu was developed in a cooperation between the German Telekom, which is also located in Bonn, the Kameha Grand, and an IT company for the programming of the web-based application. The management and service team of the hotel, the development team itself as well as colleagues were regarded as possible restaurant guests, thus no external users were involved in the development process. Through a higher number of guests and the presentation of an innovation on the German restaurant market at the time of introduction, the investment in the required hardware and software payed off.

2.2.2 Mundo Global Tapas

Mundo Global Tapas[3] is a Spanish tapas restaurant in the North Sydney Rydges Hotel (North Sydney, Australia), where all paper menus were replaced by iPad menus in June 2010 [News Digital Media, 2010]. As to their own press release, it was the first restaurant in Australia to implement the whole ordering system based on the Apple iPad [Rydges Hotels, 2010]. The custom-made iPad application shows all dishes and drinks in a list similar to paper based menus: they are sorted by courses and types (dessert, salads, sides etc.), and a short description is written next to the name of a dish. Instead of displaying a long list of items through which the user has to scroll, chunks of items are separated on different pages, similar to standard menus. By swiping to the left or the right it is possible to change the page. Additionally to the small textual information, a photo can be displayed by tapping on a button next to the

[3] http://www.mundo.com.au/

dish. When opening the photo for a wine a short description of the origin and taste of the selected wine is displayed under it.

Features

An important feature for the restaurant is the ability for guests to order food via the iPad. For that a second button is located next to the menu items, which adds an item to an order list. When pressing it a small confirmation is displayed and the customer can browse for other items. Before placing an order it is possible to review and change the list. After confirming the order it is sent over a wireless network to a server in the kitchen, which prints it out including additional information like the table of the customer. From that moment on it is not possible to change an order. The billing process is also done automatically based on all orders from one table that reach the main server. Still, the paying process is done manually by a waiter that takes a printout from the server to the table.

Future work

The restaurant and the development team of the application intend to add more features to it, for example pairing dishes and automatic wine suggestions. Because the development was not done exclusively for the Mundo Global Tapas it is likely that the same application will be used by other restaurants in the future.

2.2.3 Chicago Cut Steakhouse

The Chicago Cut Steakhouse[4] in Chicago (Illinois, USA) introduced digital wine cards based on iPads in January 2011 [FOCUS Online, 2011]. Currently there are 40 iPads available in the restaurant, which can be used to browse through the about 750 different wines that are offered. A search function is included to find the desired wine, and several different search criteria can be used, e.g. price, origin, or name. The taste and the origin of each wine are described in a few sentences, and the origin is shown on a map using Google Maps. By the addition of photos showing the labels, the guests can read all information written on the bottles. A photo of the digital wine card showing an

[4] http://www.chicagocutsteakhouse.com/

overview of available wines is presented in figure 2.6.

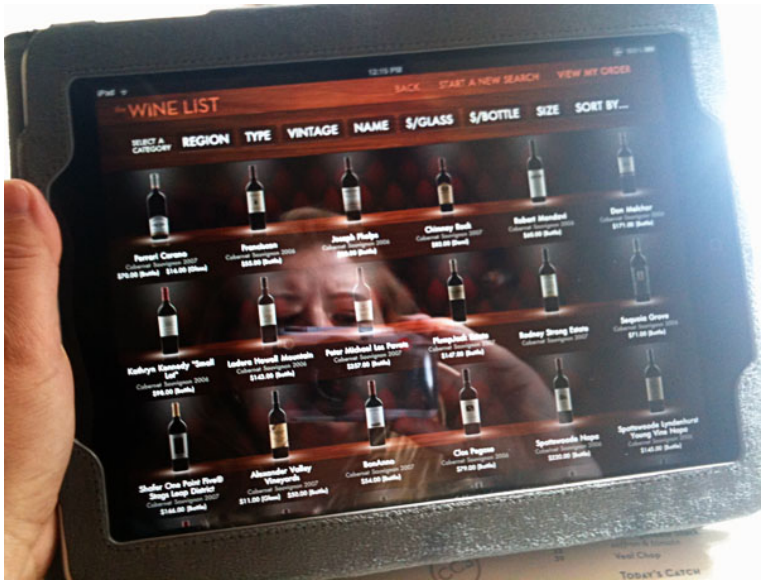

Figure 2.6: An overview of available wines on the iPad based wine card at the Chicago Cut Steakhouse. Image courtesy of Rachelle Bowden (*www.rachelleb.com*).

Sales and Evaluation

Because the wine sales per customer have risen by about 20% after the introduction of the digital wine cards, the investment in the devices has paid off quickly. Part of this success may be based on the high visibility in local and international press shortly after the launch, which has happened to most of the restaurants using digital menus. A downside for the Chicago Cut is the maintenance of the hardware. The iPads have to be charged regularly, otherwise the guests would be frustrated because of devices that shut down during use because of low battery. Due to the high price of the hardware, the restaurant installed special localization software in order to find stolen devices.

2.2.4 AIDAsol

AIDA Cruises[5] is a German-based cruising company with a fleet of eight cruise vessels (and four more being built at

[5] http://www.aida.com

the moment). In 2010 a series of iPad apps was published, including apps for customers as well as apps for travel agencies. AIDA gave about 1000 iPads to the biggest travel agencies that cooperate with them for marketing reasons. Pre-installed on those iPads were apps to show AIDA's offers and information on the fleet. An iPad app for customers which is available via the Apple AppStore can be used to take virtual tours through the different vessels. In March 2011 the cruise vessel *AIDAsol* was finished and opened, being able to host a maximum of about 2.600 passengers. In two of the restaurants on board, the Rossini and the Buffalo Steak House, digital menus using the iPad were introduced [AIDA Cruises, 2011].

Figure 2.7: An overview of available dishes on the digital menu at the Buffalo Steak House on the *AIDAsol*. Image courtesy of *www.cruisertricks.de*.

Features of the digital menu

The iPad menu offers the ability to place orders digitally by using a kind of shopping cart for the dishes and drinks. On the start screen the user may choose between dishes, wines, beers and other beverages. A short manual on how to operate the application is also shown on this screen. After selecting a category, a list of the offered dishes or drinks as seen in figure 2.7 is shown, with each entry including the name, a short description, the price and a small photo. Tapping on any of the items leads to a fullscreen photo of it (see figure 2.8). A transparent overlay with a more detailed

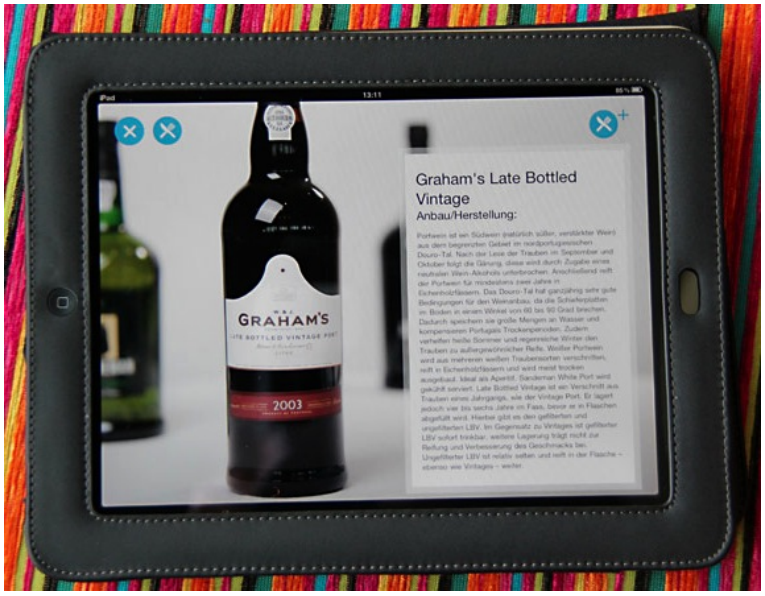

Figure 2.8: A detailed view of an item on the digital menu on the *AIDAsol*. Image courtesy of *www.cruisertricks.de*.

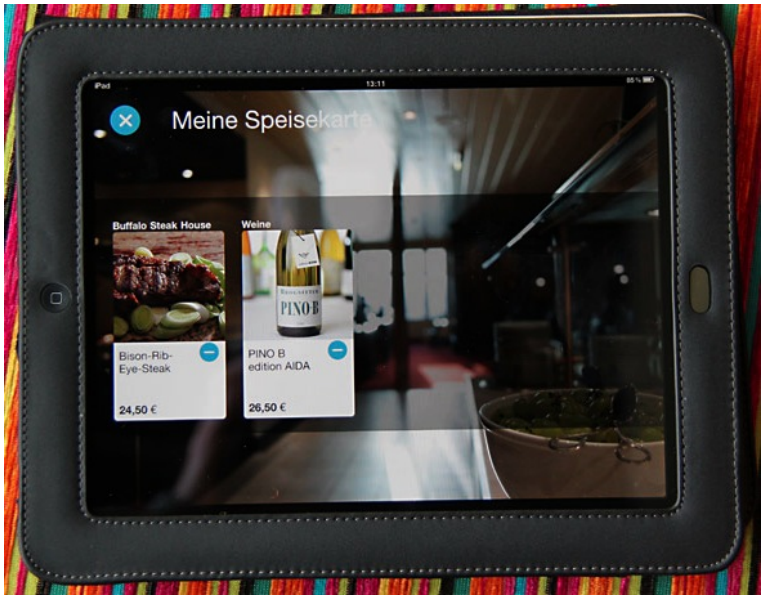

Figure 2.9: The order list with a dish and a wine added to it on the digital menu on the *AIDAsol*. Image courtesy of *www.cruisertricks.de*.

description is shown on about a quarter to half of the screen size. The user can either swipe through the fullscreen pages of the dishes, or tap a button to return to the overview list. With a second button he is able to add an item to his order list, which gets confirmed by a small overlay. A third button directs the user directly to his order list, as shown in figure 2.9, where he can browse through the added items, edit the list, go back to the dishes, or place the order.

Future plans

AIDA is planning to bring the iPad menu to a new ship called *AIDAmar*, which will probably be opened in summer 2012. Currently there are no plans on upgrading the restaurants of the existing fleet to support digital menus.

2.2.5 Do at The View

Do at The View[6] is a modern "musically inspired" restaurant and bar in Atlanta (USA) which offers a media enriched dining experience. It was opened in May 2011 and specializes on pizza and tapas. For a unique ambience a DJ was hired to create seamless music tracks that are played in the dining room. Three of the walls surrounding the dining area serve as a canvas for image and video projections that are adjusted according to the ambient music. Light effects on a 20 feet high waterfall and colored lights aimed at the tables support this spatial design. An iPad is placed on every dining table, iPod touches are placed at the bar and additionally some iPads are also attached to the wall in the bathrooms [PadGadget, 2011]. Paper based menus are completely replaced by the digital ones, no traditional menus are available for backup or as an alternative. A part of the dining room, including the video projections and the iPads on special stands on each table, can be seen in figure 2.10.

Design and features

The menu application running on the iPads at the dining tables was created exclusively by an iOS developer hired by the restaurant. Four buttons are always visible on top of the screen: access to the list of drinks, dishes, viewing an order list, and calling a waiter. When selecting drinks or dishes,

[6] http://www.doattheview.com/

Figure 2.10: The ambient design of the dining room at *Do at The View*, with an iPad placed on every dining table. Photo from the *do [dough]* press kit.

an overview over different categories (e.g. appetizers and pizza for dishes, beer and wines for drinks) is shown, together with a sample photo for each category. After selecting a category all available items are listed in two columns, as can be seen in figure 2.11. Each item is presented by a title, a short description, a small photo and the price. Via a button next to an item, a guest can view its options and add it to his order list. After finishing the selection, he can access his order list, edit it and send it directly to a computer in the restaurant kitchen. The food is then prepared, and the ordered items are automatically added to the bill for the specific table. Because of this digital ordering, just one waiter has to be on duty when the restaurant is open. He is responsible for serving the dishes and the payment process, and can be called to a table by tapping a button in the iPad application. Additionally to serving as a digital menu, a chat function is built into the software. Guests can chat with each in a general chat room for the whole restaurant, or can enter private chat rooms with individual guests.

iPod touches as bar menu

The iPod touches placed at the bar run a similar version of the iPad software, with the difference of just showing drinks and snacks available at the bar. It is not possible or

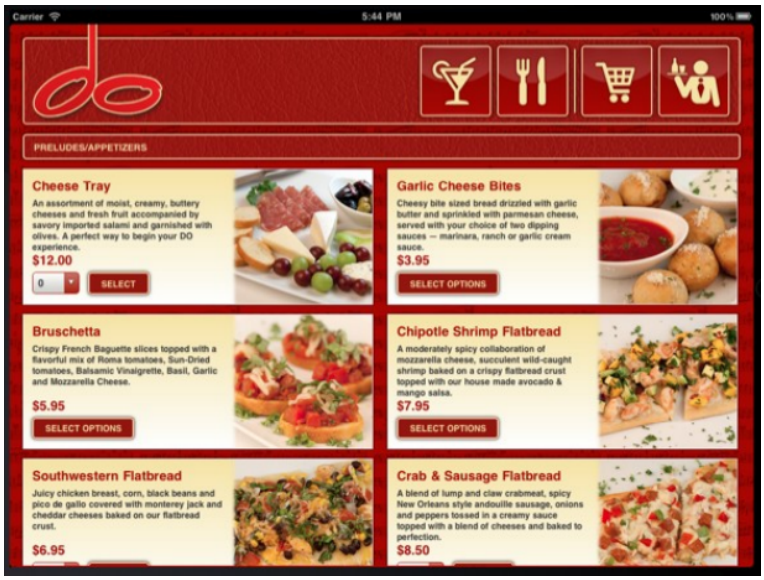

Figure 2.11: The digital menu with an overview over available dishes at *Do at The View*. Image from the *do [dough]* press kit.

necessary to place orders using the iPod touches, because a barkeeper is serving the customers at the bar in person. Because these smaller devices can be carried away more easily, they are given out by the barkeeper and have to be handed over again after ordering.

2.2.6 Bone's

At Bone's[7] , an upscale steakhouse in Atlanta (USA), digital wine cards were introduced late 2010 [New York Times, 2010]. Despite the restaurant being styled in a more traditional way, without much modern interior or technical gadgets, all paper based wine menus have been replaced by 30 iPads. The menus containing available dishes are still handed out as paper versions, and a sommelier is available for further advice.

The application called *iCellar*, which was exclusively de- Features

[7] http://www.bonesrestaurant.com/

signed for Bone's, allows the customers to browse through all 1.350 different wine labels available at the restaurant. It is possible to search for a specific wine by name, vineyard, type, region, price and other data important for a wine selection. Each wine is presented by a picture of the bottle with the label visible. A description of the taste and the origin extends a list of characteristics for the chosen wine. Additionally, the ratings of a well-known wine writer and tester are shown for each wine, and can be used for sorting the whole wine list. As to the owners of the restaurant, the addition of this rating (reaching from 0 to 100 points) often leads the customers to choose a better and more expensive wine. Furthermore, the restaurant guests are more satisfied with their wine selection, as they are encouraged by good reviews and ratings provided by the digital menu. The acceptance of orders is still done by the sommelier or waiters.

Evaluation and development of sales

One of the two owners of the restaurant was skeptical that interactive wine cards could distract the customers or depersonalize the dining experience, but after a testing period these concerns did not prove true. For keeping a high service quality the sommeliers were not replaced by the iPads. They are still available for advice and serving the wine, and some customers rely more on the knowledge of the sommeliers than on their own choice after browsing the wine card. In the first two weeks after introduction of the new wine cards the sales of wine has risen by a significant amount. Per diner the wine purchases were about 11% higher than with traditional wine lists. After being interviewed by the restaurant staff, some customers said that the devices helped growing their interest in wine, because browsing through all available wines and getting that much of information was not possible before. Also the choice of a wine is done with more confidence, with less guests wanting the additional advice of the sommeliers. While the sales of wine have risen, the sales of beer and cocktails have fallen, because many guests usually ordering those drinks switched over to ordering from the wine list.

2.2.7 Observations

Information content of digital menus vs. paper menus

In this chapter we presented six restaurants that introduced

digital menus in the last few years in order to show different approaches in use. All systems try to include more information on the digital menus than on traditional paper menus, even though some of them would be possible to transfer to paper menus. Examples are photos, characteristics of wines, and longer textual descriptions. As those types of information are normally nor used on paper menus of upscale restaurants, we will try to find some reasons for this in our user study that will be described in the following chapter 3—"Study Design".

Content of menus in upscale restaurants

Another interesting, but foreseeable observation is that the amount of innovative features decreases in the upper class restaurants. For example, while restaurants such as those on the *AIDA* fleet and the *Do at The View* offer ordering systems included in the digital menus, more traditional restaurants like *Bone's* and *Chicago Cut* reduce their digital menus on presenting information about available wines. Modern fine-dining restaurants such as the *Next Level* also offer live streams and other content beside of available dishes and drinks. These content types are normally not available in restaurants with higher price ranges.

Lessons learned

We used our observations of the aforementioned digital menus to find out open research questions about the topic, as explained in the next chapter. Furthermore, we conducted interviews with professionals from the field about some of the features present in the presented menus, e.g. videos and ordering systems. Features and design approaches of those menus were also integrated in the user-centered design process for our prototypes, which will be illustrated in chapter 4—"Design and Implementation of the Prototypes".

Chapter 3

Study Design

"A fact is a simple statement that everyone believes. It is innocent, unless found guilty. A hypothesis is a novel suggestion that no one wants to believe. It is guilty, until found effective."

—Edward Teller

A major part of our research project was the design and execution of a user study to analyze digital interactive menus on tablet devices for upscale restaurants. The emphasis lay on a comparison to paper menus. Four menu prototypes were developed using a user-centered design approach and afterwards evaluated in this study.

Chapter overview

In this chapter the different parts of our user study and other methods used to gather information about restaurant environments will be explained. Furthermore we will outline how we chose participants, how we executed the user study and what hypotheses we wanted to prove or reject by performing it.

3.1 Interviews

Experts

A crucial way of learning about a specific area of application and the environment a system will be running in is to

perform interviews with experts of that field. For that reason we tried to include experts from the gastronomy and hospitality industry, such as restaurant owners, chefs and employees, and designers familiar with the production of menus for high-class restaurants.

Results

The findings influenced the way we designed our digital and paper based menus, and are therefore explained in the section 4.1—"Preliminary Findings" of chapter 4—"Design and Implementation of the Prototypes".

3.2 Preliminary Questionnaire

We used a preliminary questionnaire in a small high-class restaurant to find out what the guests think about digital menus without having used one before, and what kind of information they expect from a menu of any kind. The study was performed at the restaurant and wine bar *Justus K* in Aachen. It consisted of two different parts: one larger part of questions, taking approximately five minutes to answer, that the participants answered after ordering but before being served. The second part was conducted after finishing all ordered meals. The whole questionnaire was moderated.

Questions in the first part of the questionnaire

In the first part of the questionnaire, we asked what dishes the restaurant guests ordered, and what they expected from the meal in regards of the taste and the optical presentation. Several questions were targeting the menu and the information content of menus in general. At *Justus K*, a large wall-mounted blackboard, visible from all tables, is used as a menu, as seen in figure 3.1. The participants should state if they like the look of the menu, if it contains all information they needed for choosing a dish, and what kind of information they miss. In regards of digital menus we asked what kind of menu they would prefer (wall-mounted, paper based, digital) and whether they could imagine using a digital menu in restaurants. We listed additional information types that could be included in menus in general (wine recommendation, idea behind a recipe, preparation of the food, specialities of the ingredients, eligibility for vegetar-

ians or persons suffering from allergies), and the participants had to state whether they find this kind of information important or disturbing on a Likert scale. Additionally, they had to rank different media that can be used to display different information: textual information, pictures and videos.

Figure 3.1: The wall-mounted menu at the restaurant and wine bar *Justus K*.

Questions in the second part of the questionnaire

The second part of the questionnaire concluded the first few questions of the previous part: the restaurant guests should state whether their expectations were fulfilled or not. Furthermore we collected information about the participants themselves, i.e. the gender, age and how often they visited the restaurant *Justus K*. The whole questionnaire can be seen in appendix A—"Preliminary Moderated Questionnaire".

Results

In total twelve guests, mainly in the age range of 30 to 50, were surveyed, all of them visiting *Justus K* several times per year and already familiar with the restaurant. The preliminary questionnaire was not statistically evaluated because of the low amount of participants. The results were analyzed qualitatively and gave us important input for the design of our prototypes. Those findings are listed in section 4.1—"Preliminary Findings". The questions dealing with the expectation of the dishes in the first and second

part of the questionnaire could not be evaluated because of the knowledge the participants had about the dishes served in the restaurant and their quality.

3.3 Comparison of Digital Interactive Menus and Paper Menus

The main part of our user study was a comparison of digital tablet based menus and paper menus for high-class restaurants. When starting to to design the study, we faced some difficulties regarding the creation of comparable prototypes.

Design possibilities of digital menus

As it is the case with most designs or user interfaces, there does not exist a best solution for a digital menu and a paper menu. While there are design guidelines and best practices for traditional paper menus, e.g. how it has to be structured and what kind of information should be included, those guidelines do not exist for digital menus. Compared to a paper menu, menus based on tablets have more "degrees of freedom" concerning the design. A traditional paper menu normally consists of one or several paper sheets, bound or folded to leaflets or put into folders. Thus, a guest always sees all information included in the menu, unless he skips pages. In a digital menu the content can be spread across several screens, or any other interactive implementation to display or browse through the information can be used. Therefore, even while the user should be able to access all content, he does not necessarily need to see it all. There are many ways to design software interfaces for menus, from long lists containing all dishes through which the user can scroll, over displaying single pages that can be flipped like a book, to interactive methods that are not possible with paper menus.

Design approach for the user study

In order to be able to compare digital and paper menus in a user study, one could compare the best possible digital menu with the best possible paper menu. Because it is impossible to define a best possible way to design such menus, and because comparing two arbitrary menus would not deliver meaningful results, we decided to create

similar digital and paper menus for the user study.

Section overview

In this section, we will explain which hypotheses we defined, what kind of menu prototypes we designed, how we created a questionnaire and executed the user study in order to verify our hypotheses. Furthermore information about how and where we chose the participants will be given at the end of the section.

3.3.1 Hypotheses

Before starting to design the menu prototypes and a procedure for the user study, we defined three main hypotheses that we wanted to prove in the user study:

Hypothesis 1 The perceived quality of the dishes in a restaurant is higher when using interactive digital menus instead of non-interactive paper menus.

Hypothesis 2 The time a user needs to choose a dish from an intuitive digital menu is not significantly longer than choosing from paper menus with the same amount of information.

Hypothesis 3 The length of textual information in interactive digital menus can be higher than in paper menus without disturbing the user.

Explanation of the hypotheses

By providing information about the food of a restaurant in a high-quality and polished interactive way, we believe that a guest perceives the quality of the dishes to be higher and more valuable, thus we formulated hypothesis 1. It is the fundamental hypotheses for the user study, and thus for the design of the menu prototypes. We assumed the statement of hypothesis 2, but if hypothesis 1 would be validated, even a small increase in time a guest needs to choose his dish would be acceptable. Because the user of a digital menu does not need to see all information contained in the menu, as stated in the introduction to this chapter, we expect hypothesis 3.

Effect of videos on hypothesis 2

Because videos and other media that pauses the user's interaction with the application, e.g. animations, prolong the time needed by the user to choose a dish by their length, hypothesis 2 is unlikely to be proved when using such content. Therefore we define a similar hypothesis 2b:

Hypothesis 2b The time a user needs to choose a dish from an intuitive digital menu without videos is not significantly longer than choosing from paper menus with the same amount of information.

3.3.2 Prototypes

We designed four different menu prototypes for the user study in order to examine our aforementioned hypotheses:

Digital menu An interactive menu running on a tablet device, including advantages of digital menu over a paper menu, such as possibilities to navigate through all items and usage of video content.

Digital menu without videos An exact copy of the digital menu, with exclusion of videos.

Extended paper menu A paper menu with all information contained in the digital menu with the exception of media that is not possible on paper, e.g. videos. Design and structure are similar to the digital menu.

Simple paper menu A traditional paper menu of upscale restaurants without graphical elements or photos, and with few textual information on the dishes.

Explanation of the different menus

In order to get meaningful results for a comparison between digital and paper menus, we cannot compare two menus with a huge difference of information content. Therefore the extended paper menu contains the same textual and graphical information as the digital menu as far as possible. The digital menu still has all advantages of a software application. For an analysis of the influence of

videos on the perceived quality of the offered dishes, a digital menu without videos was added to the user study. Furthermore, the menu without videos is needed to test hypothesis 2b.

Simple paper menu

The simple paper menu reflects menus often found in high-class restaurants, with short descriptions of the available dishes and no photos or other graphical elements. It was added to the user study to analyze the effect of additional textual information and photos on paper menus, as it is the case with the extended paper menu.

Exclusion of prices on all four menus

For uninfluenced results on the perceived quality of the dishes, no prices were shown on each of the four menus. Also, the exclusion of the prices allowed us to let those be guessed by the participants, as it will be explained in the following section.

3.3.3 Questionnaire

An important way to evaluate the created prototypes was the usage of a questionnaire that the participants had to fill out. It was designed to give insights of the perceived quality of the dishes on the menus, and to deliver appropriate data for proving or disproving our hypotheses. Four questionnaires, each for one of the menu types, were created. The majority of the questions and tasks were identical, but some differences existed due to the difference of the prototypes themselves.

Estimated prices

In the first part of the questionnaire, the participants were asked how they would guess the prices of all items on the menu in Euros. No price ranges were predefined, allowing the participants to freely state any price. These values were later used to evaluate how the participants perceived the quality of the presented dishes, as it is a cultural fact that price of food rises with an increase of quality. Using this kind of answers also allows a more accurate and broader analysis of the perceived quality than using Likert scales where the participants would have to rate the quality.

Definition:
Likert scale

LIKERT SCALE:
A Likert scale, named after the inventor Rensis Likert, is an approach to scale responses in questionnaires. It consists of several Likert items, where the participants have to rate a statement on a given scale, typical using the five levels "Strongly agree", "Agree", "Neither agree or disagree", "Disagree" and "Strongly disagree". The Likert scale itself is the sum of all responses. It can be evaluated by comparing the medians, or by using non-parametric tests. [Trochim and Donnelly, 2001]

Questions and Likert scales about the menu

In the second part of the survey some statements were presented that the participants had to rate on five-level Likert items, ranging from "Strongly agree" to "Strongly disagree". The following statements were included in all four questionnaires:

The menu provided all information for making a decision. Judging the impact of the difference in the amount of information provided in the four different menus.

I assume that the offered dishes are valuable. analysis of the perceived quality of the dishes.

The menu had a clear structure. analysis of the usability and how well the participants got along with the menus.

The menu is suited for a high-class restaurant. Insight on how the participants perceived the quality of the menu itself and the fictive restaurant.

I missed the following information: wine recommendation; eligibility for vegetarians. analysis of what information the participants would like to have on menus.

Additionally the questionnaires for some of the menu types contained the following statements:

I had difficulties operating the menu. Evaluation of the usability of the software menu prototypes. Digital menu with and without videos only.

I find the photos distracting. analysis on the acceptance of photos for describing a meal, as usage of photos is not very common in upscale restaurant settings. Both digital menus and extended paper menu.

The videos helped to make a decision. Evaluation of how far videos help in the decision-making progress. Digital menu with videos only.

The texts were too long. Statement to verify hypothesis 3. Both digital menus and extended paper menu.

Questions on restaurant visits

The third part of the survey contained questions about restaurant visits of the participants. They were asked if they visited restaurants using digital menus before, and if yes, what kind of devices were used and what impressions they had of those menus. Also the participants had to specify how often they visit restaurants, given the scale "several times a week", "approximately one time per week", "several times per month" and "less frequent".

Personal information

In the final part of the questionnaire we asked about personal information of the participants: gender, age and occupation, in order to approximately classify the participants concerning their income. It is expected that participants with a low income would spend less in a restaurant, therefore their rating in the first part of our survey would possibly be lower. Additionally, we asked whether the participants use smartphones with touch input, tablet devices or none of that regularly. Someone without experience with touch input would probably have difficulties in using a tablet based digital menu.

Actual questionnaires

All four questionnaires used in the user study are enclosed in appendix B—"User Study Questionnaires".

3.3.4 Execution of the User Study

Between-group design

The whole user study follows a between-group (also called between-subjects) design. In contrast to a within-subjects (repeated measures) design, each participant used and evaluated only one of the four menus, resulting in four

groups needed for the study. Especially the estimation of prices in the questionnaire would have been strongly influenced when testing several menu types with one participant, thus the results would not be meaningful. The participants were allocated in one of the four groups randomly in order to prevent an affection of the time of the day, the exact location or others.

Execution with silent observation

At the beginning we introduced ourselves to each participant, explaining that the user study deals with menus in general. The menu was handed out, and we kindly asked to browse through the menu and select one or several courses that the participants would like to order. They were silently observed, giving us insights into their browsing behavior, problems that might occur and what kind of information they payed attention to. The time needed to select the courses was measured for testing hypothesis 2. In order to not stress the participants, or influence the time or decision, the time measurement was not communicated to them, and not made visible. Because an exact measurement is not possible and was not needed, the time was rounded up or down to five second intervals.

Completing the questionnaire

After choosing one or several courses, the participants were asked to fill out the questionnaire. They were able to browse through the menu again for estimating and stating the prices or answering the other questions and tasks. We helped the participants in cases of unclear points.

Additional questions

Some of the participants asked for the real prices, the restaurant where the content was retrieved from, and details on our research project. Those questions were answered after the questionnaire was fully filled out in order not to influence any results.

3.3.5 Location and Participants

Location for the user study

As we did not want to have a large amount of students or computer scientists as participants in our user study, we did not perform it in a lab anywhere at the university. One can imagine that this kind of participants would have influenced the outcome of the study due to high technolog-

ical affinity or low experience with high-class restaurants. Using a real restaurant environment would also have influenced the results because of the atmosphere and the furnishing. Furthermore, most guests choose a restaurant by purpose, and know in which price class the dishes will be. Getting participants into a restaurant that they do now know in order to perform a user study would have been difficult. Therefore we chose the market place in front of the city hall of Aachen as the location (see figure 3.2 for a photo). During the warmer months of the year a lot of cafés and bars around the place put tables and chairs for their guests outside. We asked the owners or those responsible for the cafés for permission to perform the user study with their guests seated outside. The benefit in comparison to asking pedestrians was that the café guests stayed at the same place for a longer period of time, allowing them to take more time to evaluate the menu and fill out the questionnaire.

Figure 3.2: The market place in front of the city hall of Aachen. Photo by Carolus Ludovicus.

Participants

For each of the four different test conditions (digital menu with and without video, extended paper menu and simple paper menu) we targeted an amount of ten participants, so a total of 40 people were needed. We performed the user study at the end of March and the beginning of April 2012

before the lecture period at university started. Therefore less students were around the city compared to the time during the semester, allowing us to lower the amount of students for the study. In order to get a group of participants that would also be expected in a high-class restaurant, we tried to involve a broad age class, and not only a younger age group that often has more experience with tablet devices.

Chapter 4

Design and Implementation of the Prototypes

"A picture is worth a thousand words. An interface is worth a thousand pictures."

—Ben Shneiderman

In this chapter we will discuss the design and implementation process of the software menus and the paper menus used for our user study.

Iterative user-centered design

An iterative design approach according to Nielsen [1993] was performed during the process where a product or software is created in multiple versions in repeated steps. The three main steps in the method we applied are the designing process itself, the implementation and analysis. All steps are user-centered, so potential users of the software are included in the whole process. In the design step, rough interface sketches and considerations on the functionality and users are created in the first few iterations, while the quality and resolution is increasing over time. Afterwards, the designs are implemented in form of paper prototypes, mockups, or polished software applications. Then these prototypes are tested and analyzed in collaboration with potential users, e.g. in user studies. The whole process is re-

peated until a satisfying product is created. Because of the three main parts it consists of, the process is called the *DIA cycle*. Figure 4.1 depicts the concept of the user-centered design approach.

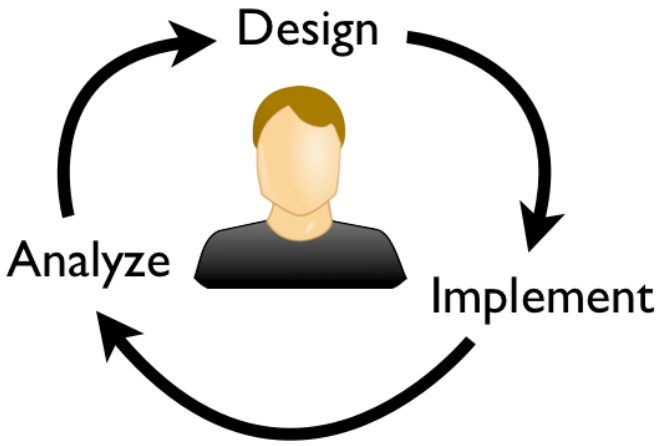

Figure 4.1: The concept of the DIA cycle, an iterative user-centered design approach.

Chapter Overview

In this chapter several steps in the DIA cycles performed during the prototyping phase are explained. The subsequent section 4.1—"Preliminary Findings" outlines some findings from our preliminary questionnaire and interviews that are important for the design of the prototypes. In the section 4.2—"Paper Prototypes" several paper prototypes are illustrated, including insights into changes and decisions that were made. Afterwards we show what content was included in the menus and how we created it (section 4.3—"Content"). In section 4.4—"Software Prototype" the design and implementation of the software prototypes is shown, followed by the design of the paper menus for the user study (4.5—"Paper-Based Menu Cards").

4.1 Preliminary Findings

Personal interaction

We used initial interviews with three different restaurant owners and chefs to explore what kind of features of digital

menus are desired or mandatory in high-class restaurants. The main concern was that the software could minimize the interaction between the guests and the restaurant staff. This interaction is crucial for the quality and satisfaction of the guests, as it is a very personal way to customize the restaurant experience for every customer. A skilled employee has experience about dishes fitting together and knowledge about which wine is suitable for a specific dish. Furthermore, he knows the regular customers and can adapt himself individually to every guest. Therefore we did not want to include order functionality in our digital menu in order to maximize the contact between staff and guests.

Information content

Also most of the twelve participants of the preliminary questionnaire said that a traditional menu, with just the name of the dish written on it, would offer all information they needed for deciding on an item, the idea of including more information was very welcomed. Additional information about the preparation of a meal, ideas behind the receipt, specialities of the ingredients and wine recommendations got the most positive feedback.

Design

In our preliminary questionnaire at *Justus K*, most of the participants stated that they did not want to use digital menus in restaurants. Reasons for that were that an interactive tablet would be ”too technical and uncomfortable”, ”not suitable for a cozy environment” or that it would ”distract from the social aspects of visiting a restaurant in a group”. One participant said that she was ”spending the whole day in front of a computer”, and thus did not want to have one in front of her in the evening. It is important to note that none of these participants has used a digital menu card before. Therefore we can draw as conclusions from this questionnaire and interviews that a digital menu card must not look and feel like a regular computer software, but more like a traditional menu. A calm and simple interface is required to not distract from social interactions between guests.

Usability

Usability is an important aspect of a digital menu. In a standard restaurant environment one can not assume that every customer has knowledge about devices with touch input or software at all. On the other hand, communication between people visiting a restaurant together is a relevant part of the

whole restaurant experience, so the time needed to choose a dish should not be too long. Therefore reading a list of instructions on how to use the menu would be violating this goal. Thus our target was to create a simple and intuitive, but informative and polished digital menu.

4.2 Paper Prototypes

Storyboard

The first step to design our interactive as well as the paper based menus was the sketching of a storyboard. A storyboard consists of several hand-drawn images depicting a short story of how a system is used, and what can be done with a system. Being part of the user requirements analysis, such a storyboard can be used to show the relationship between users and the system [Maguire and Bevan, 2002], and some benefits that a user should get by using our system instead of another one (which in our case would be a traditional paper menu). Our storyboard illustrating one aspect of the differences between digital and paper menus is shown in figure 4.2. It shows a restaurant guest using a paper menu, and one using a digital menu. The user of the paper menu perceives the prices as too high for the served dish. When using the digital menu, the guest reads about specialities and the quality of the ingredients, and thus is satisfied when he is being served. By showing the storyboard to potential users, we could evaluate if the interaction methods and the usage context we had in mind are useful, and they could easily see what our system is supposed to do.

User interface sketches

We created several different sketches of the user interface as a second step in the DIA cycle based on literature about designing menus, like Wachholz and Weiss [1999] and Sommer [2011], existing digital and paper based menus, and general design rules. We present three of the created user interface sketches.

Interface orientation

In order to decide if the interface orientation should be 'portrait' or 'landscape' (vertical or horizontal), we asked several potential users about their preferences. Some of them were given tablets to hold, to see in which orientation they

Figure 4.2: A storyboard depicting the difference in perceived quality between paper menus (top) and digital menus (bottom).

would like the tablet to hold while browsing a menu. Out of six users all preferred a portrait orientation, because they felt more comfortable to hold for a longer period of time that way and it is more similar to holding a sheet of paper.

First UI design approach

One of the first approaches was based on the look and feel of standard iPad applications, as seen in figure 4.3 (see section 4.4.1—"Device and Platform" for more information about our choice of the device and platform). Several tabs on the bottom of the screen lead to the different courses and parts of the menu: appetizer, main dishes, desserts, wines and other beverages. The main part of the screen shows a list of available items including the name, a short description and the price. A tap on one item would enlarge the area for it, showing additional information as well as photos and videos. A second tap on the item would minimize it again.

Second UI design approach

Another user interface design is shown in figure 4.4. The different dishes offered by the restaurant are shown in a

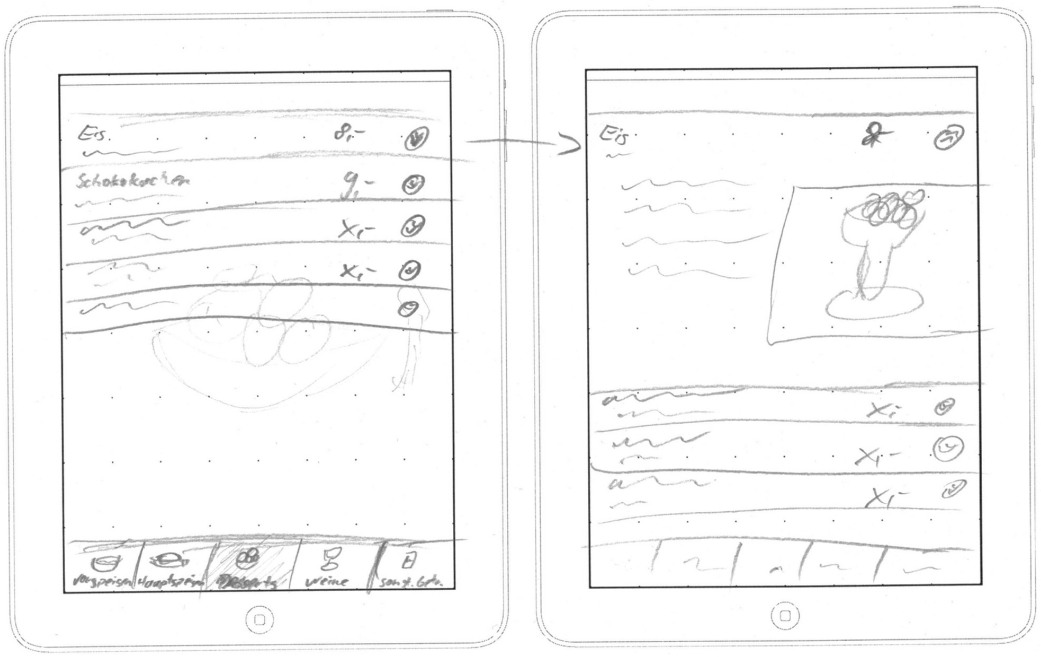

Figure 4.3: One of the first hand-drawn user interface design approaches.

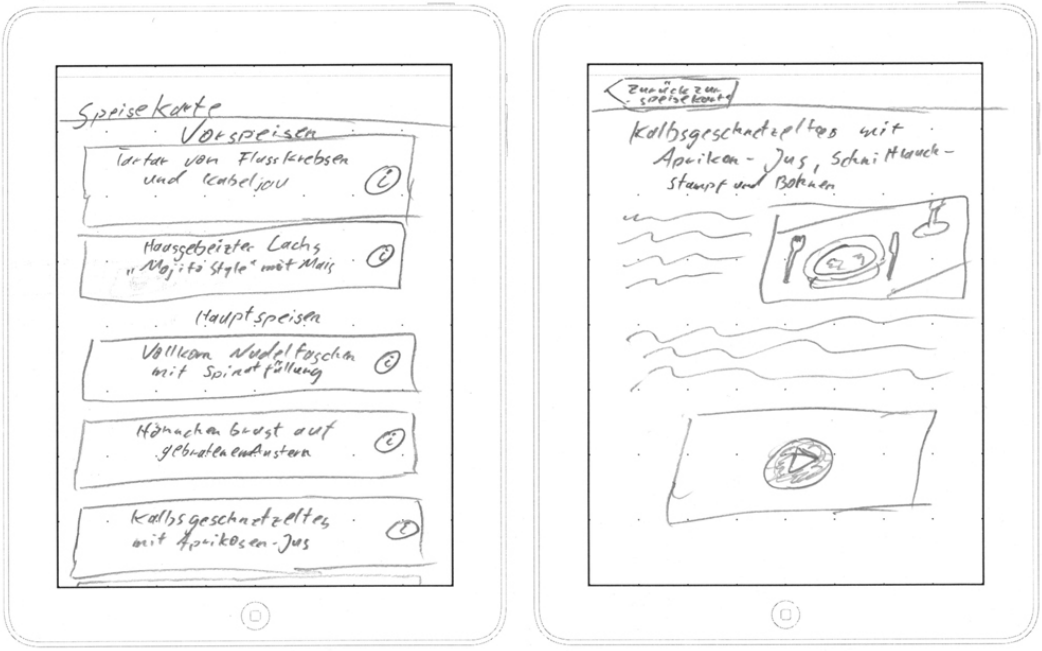

Figure 4.4: The second sketched approach to the user interface design of the digital menu.

scrollable list. Each item consists of a box with the name of the dish, and an *info* icon on the right. Headers for the courses are shown between the dishes. By tapping one of the boxes, an information view opens. The whole screen is then used to show a description for the dish, and information about the idea behind the dish, the origin of the ingredients and the preparation. Photos and videos can also be included. A large labeled button on the upper left of the screen, shaped like a back button, can be tapped to get back to the whole menu.

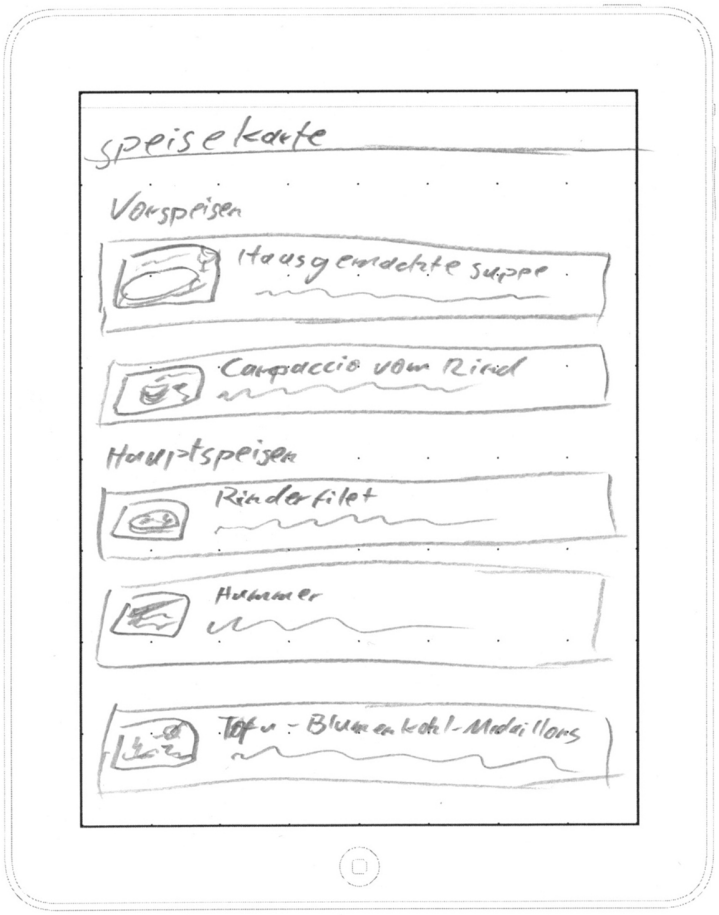

Figure 4.5: A third user interface design. The detail page is identical to the one from the second approach, see figure 4.4.

Third UI design approach

The third interface design approach (see figure 4.5) is similar to the second one. According to Wachholz and Weiss

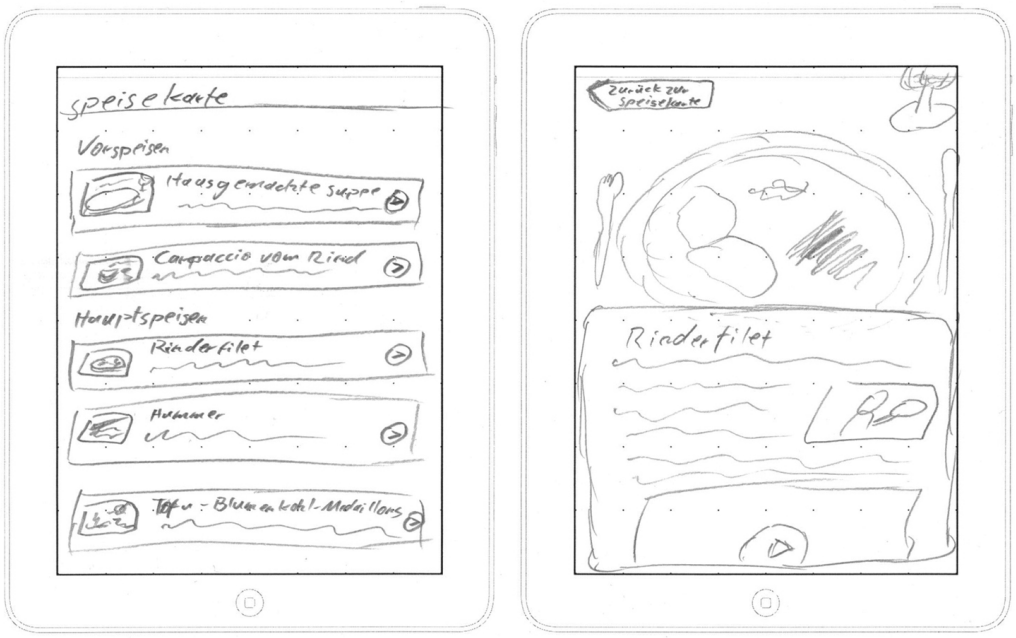

Figure 4.6: The final user interface sketch after several user tests and discussions with a designer.

[1999], photos of the dishes are a good way to help the guest to remember a specific dish better, so we included a small preview photo in the menu overview, on the left side of the name. We also added a short description right under each dish name. The text and headers are left-aligned for better readability. The detail view for more information on a dish is identical to the second approach.

Evaluation of the design approaches and changes after user interviews

We evaluated the different designs by showing them to potential users, chefs and owners of restaurants, and a designer with experience in menu design. While our first approach was intuitive to those familiar with iPad applications, it was not very graphical or visual appealing. It did not offer enough space to present the dishes adequately. Most users liked the design of the third approach better than the one from the second, mainly because one could see a photo of the dish before going to the detail view. Some users had difficulties to see that they could tap on one item, so we added an arrow icon on the right side of a box, which helped to perceive the box as a large button. Together with the experienced designer we made some changes to

the design of the information view: a fullscreen photo was added in the background, with the main part of the dish showing in the upper half of the screen. The area containing more photos and textual information was placed in the lower part of the screen, with some amount of transparency added so that the background photo would be visible, but the text fully readable. After creating a sketch with these changes (see figure 4.6), we again asked several potential users, getting positive feedback about the interaction design and graphical design. We decided to take this user interface sketch as a guideline for the software prototype, which will be described in section 4.4—"Software Prototype".

4.3 Content

Before creating a software prototype, we wanted to get some content like photos and information about the dishes that we could present in the menu. As our initial idea was to evaluate interactive tablets for upscale restaurants, we asked several of those restaurants in the area if they could provide us with information about their food and give us access to their kitchen for taking photos and videos. The owner and chef of the restaurant and wine bar *Justus K*, Justus Kleineidam, gave us a positive answer.

Dishes used for our menu

We were able to visit the kitchen on one evening to get most of the content we needed. The menu of the restaurant changes very frequently, so we had no second chance to get videos or photos for the dishes that were served on that day. Listed on the menu were two starters, three main courses and two desserts:

- Carpaccio vom Rinderfilet (carpaccio of beef tenderloin)
- Möhren-Ingwersuppe (carrot ginger soup)
- Jakobsmuscheln (scallops)
- Rehrücken in Portwein-Jus (saddle of venison in port wine gravy)

- Ziegenkäse in Blätterteigtasche (filled puff pastry with goat cheese)
- Hummer und Bries (lobster and ris)
- Warmes Schokoküchlein (warm chocolate cake)
- Käseplatte (cheese plate)

4.3.1 Descriptions

For the digital menu and the extended paper menu some longer textual descriptions were needed. It should contain information about the ingredients, the preparation and the idea behind a dish in an appetizing way. Beside the evening we spent at *Justus K* for the photos and videos, we met with him on another day and talked about the dishes that are included in the menu. For a better idea how the ingredients are chosen we accompanied him on the way through several supermarkets and dealers where he hand-picks most of them (see figure 4.7). Afterwards, we created texts for the menu with his help. Because the texts should also each fit on one page in the paper menu in a well readable size, and the guests of a restaurant should finish reading it in a reasonable amount of time, we chose a text of medium length, most between five and eight sentences long. The full texts can be read in the extended paper menu in appendix C—"Extended Paper Menu".

4.3.2 Photos

An important type of content for the menu are photos. As stated before in section 4.2, they are useful for the guests to better remember a specific dish, and to quickly get an idea of a dish. For communicating a high quality and delicious taste of food, the quality of the photos has to be high. Using low quality photos can have a deterrent effect on the guests, and thus have a worse effect than using no photos in a menu [Wachholz and Weiss, 1999].

Photos taken at an upscale restaurant

We took some hundred photos at *Justus K* in order to have

Figure 4.7: Justus Kleineidam, owner and chef of the restaurant and wine bar *Justus K*, selecting ingredients for the dinner.

a broad choice for creating a selection for the prototypes. Between two and three photos for each dish on the menu were then selected and processed with Adobe Photoshop CS5. The background image of the detail page in the digital menu and the analogues page in the extended paper menu show the final dish after being prepared and decorated. Other photos shown on that page depict the preparation of that dish. The smaller photo in the overview used in the digital menu is a cropped version of the background image. A photo taken at *Justus K* is shown in figure 4.8, while the photos used in the digital menu as well as the extended paper menu are shown in appendix C—"Extended Paper Menu".

4.3.3 Videos

For the digital menu we included videos for five of the items listed on it: scallops, saddle of venison in port wine gravy, filled puff pastry with goat cheese, lobster and rid, and the warm chocolate cake. Unfortunately we were unable to create video material for the other three dishes in our prototype menu.

Figure 4.8: One of the photos taken at *Justus K* for the digital menu and extended paper menu, showing the preparation of a dish.

Videos recorded in a real world restaurant setting

The video material was taken at *Justus K*. Afterwards we cut the five final videos with Adobe Premiere Pro CS5 and exported them in the native resolution of the iPad (1024 by 768 pixels). They show the preparation of the ingredients, the cooking of the food and decoration of the plates in short sequences. The shortest video is 14 seconds long, while the longest has a duration of 29 seconds. Using this length of an average of about 22 seconds, the videos do not hold the guest too long from browsing through the menu, but help to get a good impression of how the dishes are prepared. A screenshot of one of the videos is shown in figure 4.9.

4.4 Software Prototype

In parallel to the creation of the content for the menu, we started to develop a software prototype for the user study according to the design sketches and ideas that were shown and explained earlier. In this section some information about the platform (4.4.1—"Device and Platform") and frameworks used for the prototype (4.4.2—"Software Frameworks and Libraries") will be given, as

Figure 4.9: A screenshot of a video for the digital menu, showing the preparation of a chocolate cake.

well as a description about the implementation itself (4.4.3—"Implementation").

Web technologies

We decided to use some web development techniques and frameworks for the prototype although the digital menu is supposed to run natively on a tablet device. Building upon web frameworks as well as on mobile development frameworks allows us to quickly build prototypes that are very similar to native mobile applications concerning look and feel. A comparison of native and web applications will be given later in this chapter.

4.4.1 Device and Platform

The menu software was developed for and running on an iPad. As mentioned in the introduction to this thesis, the iPad devices are widely used and amongst the most popular tablets. A large amount of restaurants already using interactive devices for their customers utilize iPads for their needs, as seen in section 2.2—"Interactive Devices Used in Restaurants". Compared to most other tablets it is relatively light, and neither too large for handheld use nor too small for good readability. Having a 9.7" display it is possible to display a reasonable amount of information. Also,

there are many useful frameworks and tools available for iPad development. Therefore it is well-suited for our user study.

iOS

The operating system running on the iPad, as well as on iPod touches, iPhones and the newer Apple TV, is Apple iOS[1]. Being based on Mac OS X, the operating system running on Macs, it is also a UNIX operating system. iOS is completely touch oriented as a touch screen is the main input for iOS devices, so applications running on iOS normally offer interface elements large enough to be operated by a finger. For text input an on-screen keyboard can be activated, and hardware keyboards can be connected via Bluetooth. Since mobile devices have limited space and resources, just one application is running in the foreground at a given time. Until version 3.2 multitasking was only allowed for pre-installed applications from Apple, which was supposed to maximize performance and battery life. With iOS 4 some limited functionality for multi-tasking was introduced, e.g. performing specific operations in applications running in the background and switching between applications without loss of their state.

Objective-C, Cocoa touch and Xcode

Being built similar to Mac OS X, applications for iOS devices are programmed using the Objective-C programming language. Cocoa touch is provided as an API for iOS, which offers an abstraction layer for the operating system. It is based on Cocoa, the main API for Mac OS X, and was modified for the special needs of touch input and mobile devices. Cocoa touch includes functionality for recognizing touches and gestures, access to hardware features of the devices, the aforementioned multi-task support and provides important frameworks for native applications. Xcode, the Integrated Development Environment (IDE) from Apple, can be used for developing iOS applications. Beside the support and tools for writing code it has a built-in graphical interface builder, which allows to visually create and modify views of iOS apps and connecting interface widgets to methods in the code.

Software versions used

An iPad of the first generation (released in 2010) was used for the project running on the latest iOS version 5.1. Xcode

[1] Apple iOS was called iPhone OS until June 2010

4 served as the development environment in various subversions released during the development process.

4.4.2 Software Frameworks and Libraries

In this section the software frameworks used for programming the digital menu prototype will be presented and described. The most important features used for our software prototypes get explained, while the implementation of our software using those features will be covered in section 4.4.3—"Implementation".

PhoneGap

PhoneGap[2] is an open-source multi-platform mobile development framework [Christ, 2011], which is maintained and owned by Adobe Systems since October 2011[3]. It allows the creation of mobile applications with HTML5 and JavaScript with access to native APIs and the ability to install the applications natively on supported mobile operating systems. Currently all major mobile operating systems are supported, including iOS, Android, Windows Phone 7, BlackBerry and others. The code of PhoneGap was contributed to the Apache Software Foundation (ASF) and will be developed further under the project name *Apache Cordova*[4] , formerly also known as *Apache Callback*.

Platform dependent part of PhoneGap for iOS apps

A PhoneGap application consists of a platform dependent and a platform independent part. The platform dependent part for all supported platforms is provided via a file download. When developing for iOS devices, the platform dependent part can also be added as an Xcode project template. Included in the template code is the base frame needed for every iOS app, like an app delegate file with all necessary methods, mandatory main property list files and a main view controller. Also included is an API providing

[2] http://phonegap.com/

[3] Adobe Systems Inc. bought Nitobi Software, a company that developed and created PhoneGap, in 2009.

[4] http://incubator.apache.org/cordova/

access to a large amount of native device services and to the hardware, e.g. notifications, local storage, compass and accelerometer among others. After compiling and starting the template, a web view controller is loaded in full screen mode showing the part of the application programmed in the platform independent part. While most work for an application is done in that part, some device dependent settings have to be set for each platform. For iOS apps the main property list file has to be set up with the desired values and the launch images have to be loaded. Supported device orientations have to be set for each platform independently as well. While it is possible to add native code to the project, i.e. Objective-C code for iOS platforms, it is not recommended due to the loss of the highly flexible multi-platform support of the created application.

Platform independent part of PhoneGap

The platform independent part of an PhoneGap project is the main part for building an interactive application. The programming is done with web technologies similar to building interactive websites: HTML is used to create the structure and part of the functionality of the pages of the app, with HTML5 being fully supported. For specifying the design CSS tags can be added inline or as external CSS files. The main functionality is programmed in JavaScript and using the PhoneGap JavaScript libraries to gain access to the aforementioned native APIs. Using mobile web frameworks such as *jQuery mobile*, which will be described in section 4.4.2, one could easily emulate the look and most of the feel of native mobile applications.

Storage API

For our software prototype we used the *Storage* API of PhoneGap which provides access to native storage options [Nitobi Software, 2012]. It allows to create or open a local *SQLite* database (see definition box) and to perform actions on it using standard SQLite queries. Due to the compatibility of PhoneGap's storage implementation with the W3C Web SQL Database specification as well as W3C Web Storage API specification, the native device implementation can be used, if supported, to provide a higher performance [Nitobi Software, 2012]. The PhoneGap implementation switches to the built-in support automatically if available. Thus the high flexibility of multi-platform support can be retained while also offering better performance on compatible devices.

SQLITE:
SQLite is an embeddable serverless relational database management system based on a small C library [Newman, 2004]. By combining the database engine and interface into one single library it can achieve a high performance on database operations. As being designed for embedded systems it does not implement all of the SQL standard methods and features, like an object rights management. It is able to store all data into a single file, thus write operations can only be performed sequentially. Today it is mostly used in embedded systems, mobile devices or for local storage of web browsers, and is claimed to be the most widely deployed SQL database [SQLite Consortium, 2006].

Definition: *SQLite*

Use of PhoneGap for App Store apps

After Apple performed changes to the iPhone SDK developer license agreement in April 2010, the use of the PhoneGap framework for app development and submission to the Apple App Store is allowed [Nitobi Software, 2010]. Before that, applications using PhoneGap or other multiplatform development frameworks or compilers would be rejected from the App Store.

PhoneGap apps vs. native apps

A benefit of using PhoneGap instead of developing a native Cocoa Touch iOS app is the flexibility and speed during prototyping. One is normally working with a small amount of files under PhoneGap, and being based on HTML the structure of the application can be changed very quickly, as well as the look of all pages by replacing or changing the external CSS file. Especially when having more experience and knowledge about web development than iOS programming using PhoneGap as development framework the prototyping process can be a lot faster. The loss of the native look and feel of a mobile application can be compensated by other web frameworks available. Sometimes, as in our application, the look of a standard iOS app is not needed. The downside is that even with web development frameworks such as jQuery mobile the feel and behavior of the apps is slightly different, and does not match perfectly the native behavior.

Used PhoneGap version

For our final software prototype version 1.5.0 of PhoneGap was used, released on March 6th 2012, being the last ver-

sion before the name change to Apache Cordova, which happened with version 1.6.0 in April 2012.

jQuery and jQuery Mobile

jQuery

jQuery[5] is a JavaScript class library for general web development purposes published under a GNU General Public License (GPL). The main functionality lies in traversing, manipulating and selecting nodes of the Document Object Model (DOM) of HTML files, event handling, Ajax[6] operations and animations [Bibeault and Katz, 2008]. Today, jQuery is a quasi standard for modern websites using JavaScript.

jQuery DOM operations

The jQuery DOM operations allow to traverse the DOM structure of a document and manipulate this structure or individual nodes. For selecting a specific node or several nodes at once a jQuery selector in the form of `$("<selector>")` can be used, where `<selector>` can be either a CSS ID or the name of an HTML tag or a more complex selector statement. For example, the selector `$("body")` would select the `body` element of an HTML document, `$("a")` would select all anchor nodes, and `$('a[href|="test.html"]')` would select all anchor nodes linking to `test.html`. After selecting one or more nodes, these can be modified, deleted or moved. Also, child nodes can be added at a arbitrary position in the DOM. While it is possible to insert one child node at a time without using jQuery, the framework offers the possibility to add child nodes at selected nodes using a jQuery selector and to insert several child nodes in one command. The command `append()` adds an arbitrary amount of nodes and content at the end of the selected node. When inserting content with the *append* command, no syntax check is performed, thus faulty HTML code in such a command may result in a corrupt DOM tree.

jQuery Mobile

jQuery Mobile[7] is a touch-optimized JavaScript- and HTML5-based web framework targeted at development of

[5] http://jquery.com/
[6] Asynchronous JavaScript and XML
[7] http://jquerymobile.com/

mobile web pages [Reid, 2011]. By using provided themes, animations and page structures, one can build mobile web pages with the look and feel of native mobile applications. It is built on jQuery and jQuery UI (a JavaScript library which provides advanced animations and effects), but does not include the functionality of the jQuery library. Thus it does not replace but complement jQuery.

jQuery Mobile page structure

In a typical mobile website using jQuery Mobile, all pages are defined in a single HTML document. The single pages are divided and specified using a jQuery Mobile specific `data-role="page"` attribute for an arbitrary element. Normally this is a general `div` element because it does not define any properties or settings by itself. Inside a page some other data roles can be defined for several different parts, like header or footer that are used by most jQuery Mobile templates. When creating multi-page applications or websites more than one page can be defined with the `data-role` attribute. Additionally an ID has to be given to each defined page by defining an `id` attribute inside the same element as the `data-role` attribute. By creating a hyperlink to one of those IDs, e.g. `<a href="#test">Go to the test page</a>` when a page with `id="test"` was defined, the user can go to that page defined in the same HTML document by clicking or touching this hyperlink. A benefit of such a single document method is a consistency in JavaScript methods and variables, for those do not lose their state as it would be the case when loading a separate HTML document. Another advantage is a drastical increase in performance, especially on mobile devices. The whole document does only need to be loaded once, so their are no lags when loading different documents. While loading a simple HTML file does not need many resources, loading all included JavaScript libraries or other external files, as it is done automatically, does so.

Page transitions and animations in jQuery Mobile

jQuery Mobile offers some built-in settings for creating animations, e.g. animating page transitions. All animations are CSS-based and most of them require the browser or device to support 3D transformations. When switching the page which is displayed, one is able to specify a page transition animation directly in the hyperlink or command responsible for the page change. Some of the nine (plus the no animation transition `none`) predefined page transi-

tions (plus the none animation transition) mimic different available transitions of native mobile applications, e.g. the `slide` transition imitating the change of views in iOS applications or the `flow` transition being similar to switching applications on iPads using multitouch gestures. Thus it is possible to give web-based applications the look of native applications. The page transitions can be specified by using the `data-transition` attribute in the element linking to the other page. When a Back button provided by jQuery Mobile is pressed the transition will automatically be animated in a reversed direction. By adding the attribute `data-direction="reverse"` next to the transition attribute the reversed animation is also performed.

Multitouch support and events in jQuery Mobile

Some advanced features of jQuery Mobile include an event library for handling touch or other device events, like orientation changes or scrolling, and for handling page events, e.g. page initialization or page change events. By using a `bind` method one can bind an event to elements in the document, and optionally perform actions when this event is triggered. For reacting to touch input five touch events can be observed: a normal tap, a tap that is held for one second or more, swipe gestures with configurable properties, e.g. duration or length of movement, and pre-defined swipe gestures in left and right direction.

Versions used

We used version 1.7.1 of jQuery (released November 21st, 2011) and version 1.0.1 of jQuery mobile (released January 26th, 2012) for our software prototype.

iScroll

iScroll[8] is a JavaScript library developed by Matteo Spinelli including functionality to offer scrolling inside HTML elements with a fixed width and/or height. Most mobile web browsers, like Safari on iOS devices or browsers for the Android operating system, either do not provide a way to do so or have suboptimal and non performant implementations [Oehlman and Blanc, 2011]. With iScroll one can define specific HTML elements that get scrolling support by

[8] http://cubiq.org/iscroll

initializing an iScroll object and passing the ID of that element. Besides of adding simple scrolling functionality, iScroll is also able to add bouncing and rubber band effects to the selected areas of the page like it would occur on native iOS applications. When dragging the content over the end, the content would move less than the finger, and bounce back to the edge when releasing the finger from the touchscreen. Other native behavior of iOS apps is supported as well, e.g. inertia scrolling, fading small scrollbars, or direction lock when dragging in one direction. In the latest versions pinch and zoom gestures were added to iScroll with the same functionality as iOS scroll views. All animations of iScroll are implemented as CSS animations. With more and more features added to the library, the download package now also contains a *Lite Edition* with a reduced method set but smaller file size, thus reducing the memory load of mobile devices.

iScroll version used

iScroll version 4.1.7, released on July 3rd in 2011, was used for our software prototype. Only the features contained in the iScroll Lite Edition script were required in our application.

4.4.3 Implementation

The software prototypes are web-based applications developed with PhoneGap for iOS, so that they can run as native apps on an iPad. A multi-page layout based on jQuery Mobile is used, therefore the whole application structure is defined in a single HTML file.

Content storage

In order to avoid the definition of several similar pages for the detail views of the eight dishes on the menu, the structure is created dynamically when loading the application. The information texts for the different items, as well as the category and links to photos, are loaded into a SQLite database via the PhoneGap storage API after starting the application. SQLite databases are persistent even when the application is terminated by the operating system, thus the database file does not need to be filled again at the next start of the application, except if entries that are loaded into the database have changed. While the entries are coded into a

```
1 tx.executeSql('SELECT * FROM MENUCARD', [], function
      (tx, result) {
2   for (var i = 0; i < result.rows.length; i++) {
3     $("." + result.rows.item(i).category).append
          (...);
4     $('body').append("<div data-role='page' id='" +
          result.rows.item(i).shortname + "'> ... </
          div>");
5   }
6 }
```

Listing 4.1: Dynamic creation of the page structure

separate JavaScript file in the application package for our prototypes, it could easily be changed to load the content from an external server in a real restaurant environment.

Generating the page structure

After starting the application, an event listener on the event `eventready` is created. This event is triggered when the page and all included libraries are fully loaded and operational. After being triggered, a function called `onDeviceReady` is called, in which the database is opened and filled with content respectively updated if content has changed. Then the page content itself is created using a JavaScript function and jQuery operators as seen in listing 4.1. An SQL query is performed (line 1), selecting all entries in the `Menucard` table. On the overview page an entry for every dish is added under the correct category (appetizer, main course and dessert) as seen in line 3. Afterwards a jQuery Mobile page is created for each entry (line 4) with an unique ID for every dish. The HTML code appended in both operations is not shown in the listing for better readability.

Scrolling

In order to imitate the scrolling behavior of native iOS apps, iScroll is initialized for the overview page and the information area of the detail pages. While on the overview page it would not be necessary to use iScroll because it does not consist of a fixed sized `div` element, there would not be any bounce or rubber band effect when scrolling without iScroll. On the detail pages the information on the dish is put in a `div` element of fixed size and absolute position, therefore scrolling would not be possible without problems when not using iScroll. As problems may occur when initializing iScroll directly on startup, it is put into a timeout

```
1 setTimeout(function () {
2     myScroll = new iScroll('menu');
3 }, 0);
```

Listing 4.2: Initializing iScroll

```
1 $("#" + result.rows.item(i).kurzname).bind("
      swiperight", function(){
2     $.mobile.changePage('#menu', { transition: '
          reverse slide'});
3 });
```

Listing 4.3: Activating a swipe gesture

with time zero. This procedure is recommended by the author of the library and can be seen in listing 4.2.

Animations and gestures

For the transitions between the different pages the predefined slide animation of jQuery Mobile was used. This animation is identical to the animated page changes in native iOS applications. When navigating from a detail page to the overview page, the animation is reversed. A swipe gesture was activated for the detail pages: when performing a swipe in the right direction, the overview page is opened. The code can be seen in listing 4.3.

Difference between the two software prototypes

Two software prototypes were created and used for the user study. One of them includes the aforementioned videos, inserted at the bottom of the information area on the detail pages of the dishes. They are included in the source code with the HTML5 `video` tag, and offer all controls of the iPad video player after they are started by a single tap on it. It is possible to view them in a full screen manner, but they are also large enough to be viewed easily embedded on the page. For the second prototype the videos are removed in order to evaluate the effect of videos in the user study.

Screenshots

Figure 4.10 shows a screenshot of the overview page of the prototype. The dishes are separated by titles for the three courses. Every entry consists of a small photo on the left side, the name and a short description. The detail page for the main course "Hummer und Bries" (lobster and rid) is shown in figure 4.11. The background photo is added through the CSS property `background-image`. The infor-

mation area is a `div` element with a fixed size and absolute position. Using the RGBA color space supported by newer CSS versions, an RGB color space with an additional alpha channel, a transparency was added to the white background. On the upper left side of the page the back button can be seen. The name and a short description of the dish are shown on the top of the information area, followed by photos and a more detailed description. At the bottom of the screen an embedded video is visible.

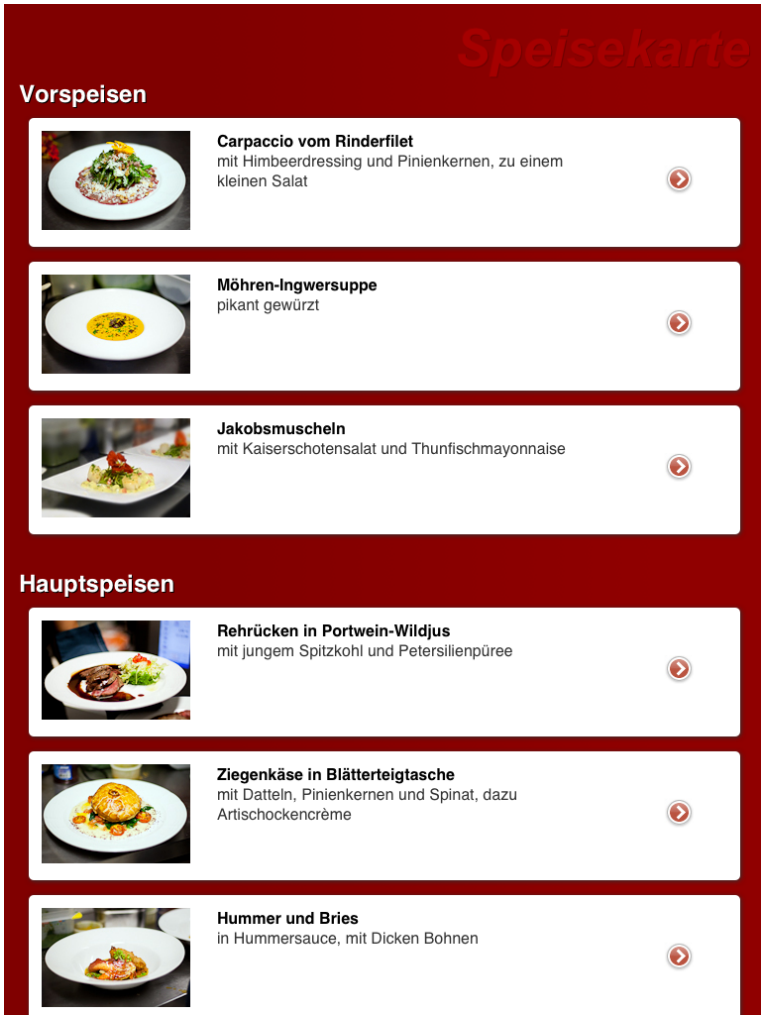

Figure 4.10: A screenshot of the overview page of the digital menu running on an iPad.

Figure 4.11: The detail page of the main course "Hummer und Bries" (lobster and ris) in the digital menu.

4.4.4 Performance Improvements

Google PageSpeed

After finishing the programming of the digital menu, the web-based part of the application was tested with the Google PageSpeed[9] extension for the Google Chrome web browser. This tool allows to evaluate the performance of a web page and shows detailed information on the speed of different parts or functions used in the website. Further-

[9]https://developers.google.com/speed/pagespeed/

more, it gives an overview on the loading times of images and included libraries.

Performance tweaks

Running some tests showed that the main performance problems were the dynamic creation of the page structure and the loading time for included JavaScript files. Some of the functions responsible for extending the DOM tree were tweaked to maximize the speed. All included and used JavaScript and CSS files were compressed for a faster loading time. The background images of the detail pages were saved as compressed JPEG files, keeping the quality high enough to not see typical JPEG artifacts. All in all the loading time of the application and the transition speed between different pages improved noticeable on a first generation iPad. All major points shown in PageSpeed were corrected, except remarks concerning changes on the web server, as the web server is simulated by PhoneGap when running as a native application on the iPad.

4.5 Paper-Based Menu Cards

As explained before in chapter 3—"Study Design", two different paper menus were created for the user study. One is a simple paper menu without photos, long textual descriptions and graphical elements as often used in restaurants. The other one is an extended paper menu designed similar to the digital menu.

Extended paper menu

The extended paper menu uses the same structure and design as the detail pages of the software menu. The three course categories are separated by additional pages with appetizer, main course and dessert written with white color on red background, the same colors used on the overview page of the digital menu. An overview page is omitted as it is unusual for a small paper based menu and would not offer any benefits. The pages were printed in color in DIN A5 size and bound as a brochure, as seen in figure 4.12. This size is very similar to the size of the 9.7" screen of an iPad. The menu consists of twelve pages: eight pages for the dishes itself, three pages as separating pages, and a title page. All twelve pages are shown in appendix C—

"Extended Paper Menu".

Figure 4.12: The finished extended paper menu used for the user study.

Simple paper menu

The simple paper menu contains only the names and short description of the eight dishes, separated by titles for the three course categories. No photos or other additional information were added in order to have a menu for the user study that resembles paper based menus often found in restaurants. The page was printed in DIN A4 size, a size normally used for menus, and put into a black folder. A photo can be seen in figure 4.13, while the menu itself is shown in appendix D—"Simple Paper Menu".

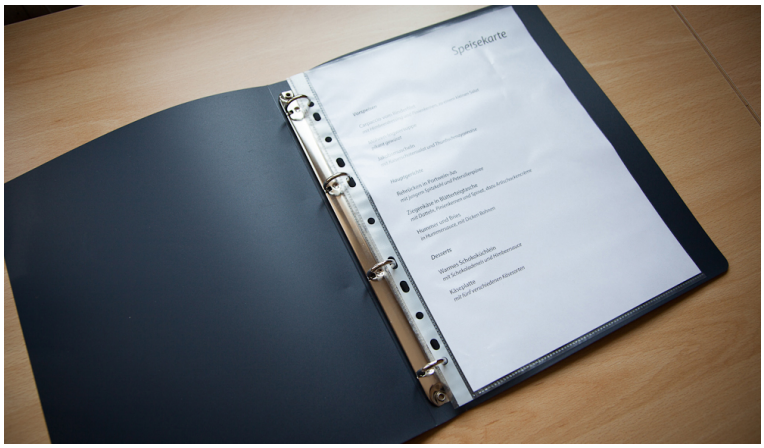

Figure 4.13: The simple paper menu for the user study.

Chapter 5

Evaluation

"No amount of experimentation can ever prove me right; a single experiment can prove me wrong."

—Albert Einstein

The aim of this thesis was to evaluate the effect of using digital menus instead of paper menus on the quality the guests perceive of the dishes and the restaurant, the time they spend browsing through the menu, and other effects. For retrieving meaningful data, we ran our user study that was explained in chapter 3—"Study Design" with 40 participants.

Chapter overview

In the first section of this chapter we will provide information on the demographics of the participants who took part in our user study. Afterwards the data gained in the study will be statistically analyzed, illustrated and interpreted. At the end of the chapter, some qualitative findings we made by observing and talking to the participants that are not acquired statistically are presented.

Statistics software

The data was analyzed with IBM SPSS Statistics[1] version 19, a professional statistics software. All boxplots are also generated using this software. The information content of these boxplots is explained in the *Conventions* section at the beginning of this theses.

[1] http://www-01.ibm.com/software/de/analytics/spss/products/statistics/

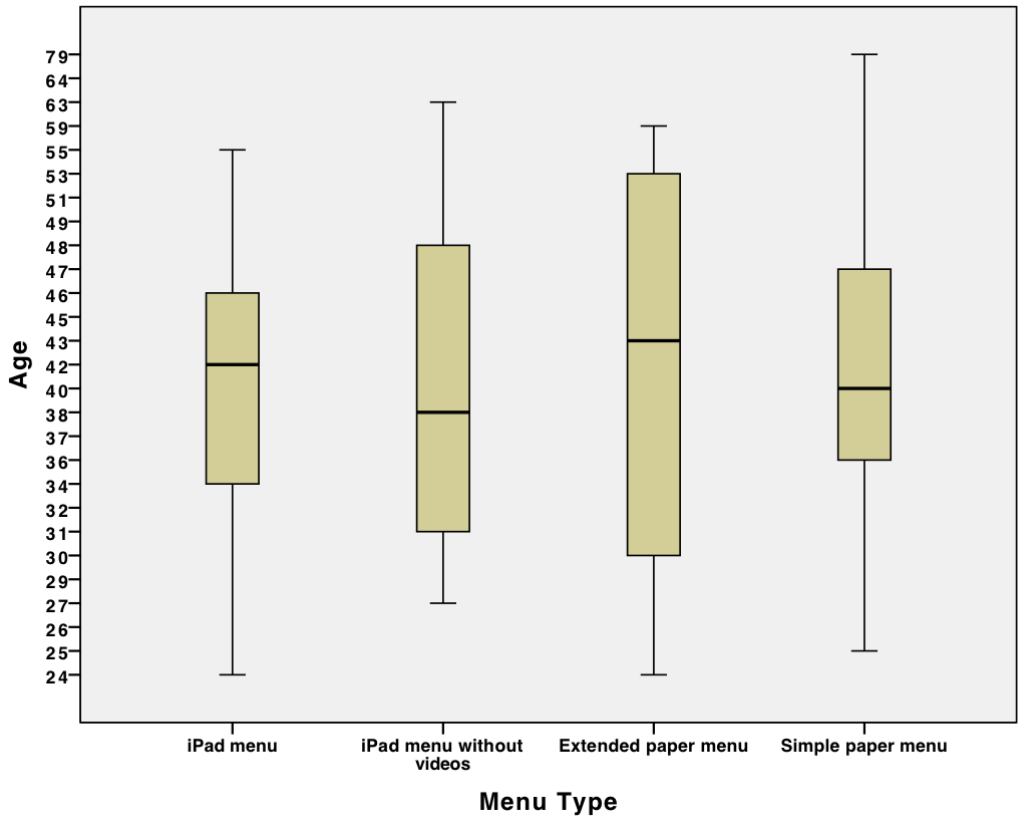

Figure 5.1: Boxplots of the age distribution in the four test groups.

5.1 Participants

Number of participants and outlier tests

In total 40 participants were involved in the user study, ten for each menu type. One of the participants tested on the full iPad menu seemed to have answered the question about the prices of the dishes with values far lower than the rest in his group. Thus, a Grubbs' test for outliers was performed. This statistical test developed by Grubbs [1969] is used to detect outliers in data sets that are assumed to be normally distributed. For four of the eight dishes, the test indicated this participant as an outlier, and the values for the four other dishes were also far off. We decided to remove the whole data set of that one participant, resulting in 39 data sets to be further statistically analyzed.

Demographics

The age of the 39 participants on average was 41.36 years

(*SD* = 12.47). There was no significant difference of the age between the four groups, as seen in figure 5.1. In total 22 of the participants were male, 17 female (4 in the iPad menu group, 3 in the group with iPad menus without videos, 6 in the group with extended paper menus and 4 in the simple paper menu group). Five participants were students, the rest had different kind of occupations, with a larger amount of higher class jobs like lawyers, physicians, or engineers. Nearly all participants had experience with the use of touch input, mainly from smartphones. About a quarter were working with iPads or other tablets regularly. On average the participants stated that they visit restaurants between one time a week and several times a month.

Equal characteristics of the user groups

The different attributes, like experience with touch input devices, the amount of restaurant visits and kind of occupation, were equally distributed between all four groups. Thus, no manipulation of the study results based on differences in the user groups are expected.

5.2 Price Comparison

For a statistical comparison of the values the participants of the user study answered as prices for the eight items on the four menus, we used MANOVA and ANOVA tests, as explained in the following definition boxes. All means and standard deviations of those values and the total means for each dependent variable (the dishes on the menu) are shown in table 5.1.

Definition: *ANOVA*

ANOVA:
ANOVA stands for *analysis of variance* and is a group of statistical methods which test the difference of means of more than two groups [Field, 2009]. The one-way ANOVA is used to test if statistically significant differences between the means of three or more independent groups exist.

Dependent variable	iPad	iPad w/o videos	Ext. paper	Simple paper	Total
Carpaccio	10.20 ± 3.09	10.00 ± 2.16	10.02 ± 2.22	8.81 ± 2.26	9.75 ± 2.41
Carrot ginger soup	7.17 ± 1.87	6.84 ± 1.66	6.32 ± 1.48	5.17 ± 1.15	6.35 ± 1.68
Scallops	12.31 ± 2.62	12.2 ± 2.30	10.76 ± 2.41	9.96 ± 3.30	11.28 ± 2.77
Saddle of venison	26.07 ± 3.86	25.72 ± 3.32	23.29 ± 4.80	21.24 ± 4.33	24.03 ± 4.42
Filled puff pastry	20.14 ± 3.26	19.23 ± 2.70	18.35 ± 4.20	15.02 ± 4.91	18.14 ± 4.21
Lobster and ris	26.69 ± 5.10	25.97 ± 3.77	23.61 ± 4.71	21.18 ± 5.14	24.30 ± 5.01
Warm chocolate cake	7.43 ± 1.83	7.10 ± 1.18	6.59 ± 1.79	5.50 ± 1.15	6.64 ± 1.65
Cheese plate	7.99 ± 3.17	7.74 ± 2.02	7.78 ± 2.05	6.85 ± 2.45	7.58 ± 2.39

Table 5.1: Means and *SD* of the estimated prices of the eight dishes for the four test conditions. All values are measured in Euros.

Definition: *MANOVA*

MANOVA:
MANOVA (an abbreviation for *multivariate analysis of variance*) is a generalized form of ANOVA that is used for situations where more than one dependent variable needs to be analyzed [Field, 2009].

5.2.1 Statistical Tests

One-way MANOVA test

Using Wilks' lambda statistic for the one-way MANOVA test, there was no statistically significant effect of the menu type on the estimation of the prices for the eight dishes ($\Lambda = 0.56, F_{24,82} = 0.76, p = 0.77 > .05$).

Single ANOVA tests

However, an ANOVA test for evaluating the different between-subjects effects of data for the price estimations was performed afterwards. It showed significant effects of the menu type on the estimated prize for *carrot ginger soup* ($F_{3,35} = 3.08, p = 0.040 < .05$), *saddle of venison in port wine gravy* ($F_{3,35} = 2.93, p = 0.047 < .05$), *filled puff pastry with goat cheese* ($F_{3,35} = 3.23, p = 0.035 < .05$) and *warm chocolate cake* ($F_{3,35} = 2.95, p = 0.046 < .05$). The *p*-value for *lobster and ris* was minimally higher then the significance threshold ($F_{3,35} = 2.73, p = 0.058 > .05$). There was no significant effect of menu type for the prices of *carpaccio of beef tenderloin* ($F_{3,35} = 0.67, p = 0.576 > .05$), *scallops* ($F_{3,35} = 1.76, p = 0.173 > .05$) and *cheeseboard* ($F_{3,35} = 0.42, p = 0.741 > .05$).

Tukey's HSD test

For the four dependent variables where a statistically sig-

nificant effect of the menu type was reported by the one-way ANOVA test, a Tukey's HSD (honestly significant difference) post-hoc test, also known as the Tukey's range test, was executed. Such a test is used to show between which test conditions a significant difference exists.

Post-hoc test: Carrot ginger soup

Tukey's HSD test showed significant differences between the estimated prices for the carrot ginger soup when using the iPad menu and the simple paper menu ($P = 0.040 < .05$). The other pair-wise post-hoc tests for the carrot ginger soup showed statistically insignificant differences.

Post-hoc test: Venison saddle in port wine gravy

For the venison saddle Tukey's HSD test showed no statistically significant differences. Due to other underlying calculations, this may be the case even though the previous one-way ANOVA test showed significant effects. However, the differences between the iPad menu and simple paper menu ($P = 0.070 > .05$) and the iPad menu without videos and the simple paper menu ($P = 0.090 > .05$) were only slightly above the significance threshold, but still there is no statistically significant difference.

Post-hoc test: Filled puff pastry with goat cheese

Tukey's HSD test showed a significant difference for the estimated price of the filled puff pastry between the iPad menu and the simple paper menu ($P = 0.033 < .05$). The other combinations of test conditions did not have statistically significant differences.

Post-hoc test: Warm chocolate cake

Testing the results for the chocolate cake with Tukey's HSD test also revealed significant differences between the estimated prices for the iPad menu and the simple paper menu ($P = 0.045 < .05$), but not between the other menu types.

5.2.2 Interpretation of the Results

Higher effects on main courses

In general, the four different test conditions showed more effects on the estimated prices of those dishes that are normally higher priced in restaurants, like the main courses. This may be due to the fact that the difference in regards of the prices between normal and high-class restaurants is larger for the main courses than desserts or appetizers. Another explanation may be that the names such as *cheese plate*

or *carpaccio of beef tenderloin* of some of the dishes sound less interesting or more like standard higher class food, instead of being something special that is worth more. Such dishes as carpaccio are also normally available in a broader range of restaurants, while some of the main courses are typical to higher class restaurants.

Effects of the results on hypothesis 1

Because of the outcome of the MANOVA test, which showed no statistically significant effect of the menu type on the price estimation of the dishes in the user study, our primary hypothesis 1 (see section 3.3.1—"Hypotheses") cannot be proved with the tests carried out. Because of the results of the one-way ANOVA regarding significant differences in the price estimations of three dishes between the iPad menu and the simple paper menu one can say that the menu type has some kind of influence on the perceived quality of the participants. By providing more information on the items on the menu, and presenting it in a high-quality digital way, participants estimated some prices higher than without those features.

Patterns in the analyzed data

By taking a look at the means in numerical form (see table 5.1) one can see that the means of the dependent variables of the test conditions iPad are higher than those of the other three conditions in all cases. In all but one dependent variables the means of the iPad menu without videos is close to the means of the iPad and surpasses the means of the paper menus. Also, the means of the estimated prices of the dishes are higher for the extended paper menu than those of the simple paper menu. As visible when analyzing the boxplots for the results of the price estimations for *saddle of venison* shown in figure 5.2 (the boxplots for all dishes and menu types are enclosed in appendix E—"Price Comparison: Boxplots") and the standard deviation in table 5.1, the price data is widely distributed. With regard to some significant differences of estimated prices dependent on the menu type that were shown by the one-way ANOVA tests, and the high standard deviation, we could only hypothesize that the amount of ten participants for each test condition was too small and a larger user group would reveal more statistically significant effects.

Power analysis

In order to check the power of our test results, we performed a post hoc power analysis for the conducted

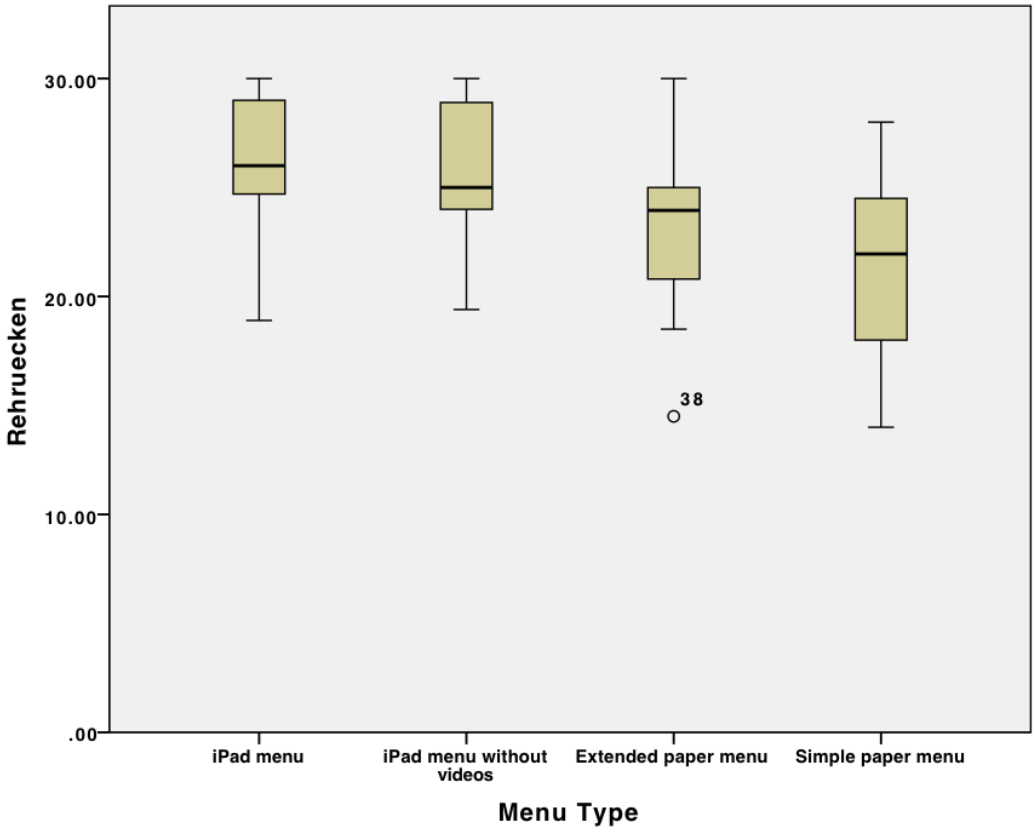

Figure 5.2: Boxplots showing the results for the dependent variable *saddle of venison in port wine gravy* and the different menu types in Euros.

MANOVA test with the tool G*Power 3[2] [Cohen, 1988, Faul et al., 2007]. The results for an effect size of $f^2(V) = 0.2$ showed a power of $\pi = 0.74$. Using the policy of a required test power of $\pi = 0.8$, our results are not meaningful enough. A calculation of the required sample size in order to achieve the statistical power needed showed 64 participants. Therefore we need to repeat the measures with additional participants.

5.3 Speed

As explained earlier in section 3.3.4—"Execution of the Method used

[2]http://www.psycho.uni-duesseldorf.de/abteilungen/aap/gpower3/

Menu type	Mean	Standard deviation
iPad menu	81.88	9.61
iPad menu without videos	69.00	11.97
Extended paper menu	73.13	4.56
Simple paper menu	61.67	9.68

Table 5.2: Means and *SD* of the measured time the participants needed to choose dishes to order (in seconds).

User Study", we measured the time the participants needed to choose one or several dishes from the menu that they would have liked to order. The participants were not aware of us taking time measurements, thus it did not influence the results. Because only one dependent variable (time) has to be analyzed in coherence with the four test conditions of the independent variable (menu type), a one-way ANOVA test can be used as statistical method, with Tukey's HSD as post-hoc test. The means and *SD* for the measured times is presented in table 5.2.

Results

The one-way ANOVA test showed that there is a significant effect of the menu type on the time a participant needed to choose courses out of the menu ($F_{3,21} = 6.59, p = 0.001 < .05$). Thus, the post-hoc test could be performed to show the pairwise differences of the means. It revealed statistically significant differences between the iPad menu and iPad menu without videos ($P = 0.038 < .05$) and the iPad menu to the simple paper menu ($P = 0.001 < .05$). The iPad menu without videos showed no significant differences to the extended paper menu ($P = 0.800 > .05$) and the simple paper menu ($P = 0.357 > .05$). Also, the test of iPad menu and extended paper menu and the two paper menus themselves showed no significant differences of the means ($P = 0.0279 > .05$ respectively $P = 0.086 > .05$).

Interpretation

Looking at the boxplots for the measured times for the four menu types (figure 5.3), one can also see the tendencies visible from the ANOVA results: the time taken to choose dishes to order is higher when using the iPad menu with videos than using the iPad menu without videos or the simple paper menu. The insignificant difference between iPad menu and extended paper menu showed in the statistical test may be due to a wider distribution of measure-

ments for the iPad menu compared to the measurements of the extended paper menu, or because the participants did have to browse through all pages in the extended paper menu, but could skip detail pages of uninteresting dishes in the iPad menu. The important result is that there is no significant effect of the menu type on the time when changing between the iPad menu without videos and the two paper menus. One can imagine that watching videos prolongs the time needed to make a decision by approximately the length of the watched videos, as discussed earlier in 3.3.1—"Hypotheses". As visible by the means in table 5.2, one can see that the mean time for deciding on one or more dishes is about ten seconds higher than for the two other menus with detailed information, and twenty seconds higher than using a simple paper menu. This difference can be explained by the behavior of the participants concerning videos, as not all participants watched videos, and those who watched a video did not start a second one, as further discussed in section 5.5—"Qualitative Observations and Findings". Thus, the difference between the iPad menu with videos and the other menus is due to the videos watched by some participants, and the slightly larger difference to the simple paper menu is simply because of the length and content of the menu itself.

Effects on hypothesis 2

As the post hoc tests showed no significant difference between the iPad menu and the paper menus, we cannot prove hypothesis 2. However, we predicted such an outcome and defined an alternative hypothesis 2b.

Effects on hypothesis 2b

For being able to judge on hypothesis 2b, we ran an ANOVA test again with the removal of the iPad menu as test condition, as we already predicted an influence of the videos on the time taken to decide on dishes. The repeated ANOVA test showed that there is no significant effect of the menu type on the time ($F_{2,24} = 3.18, p = 0.059 > .05$). Thus, we can prove hypothesis 2b.

Transfer of results to real world settings

We are aware that the measured times are not likely to be transferable to real restaurant settings, because guests would probably take longer times when they really have to spend money on their order and eat it. Nevertheless, we believe that the relation between the different menu types is reproducible in real world settings.

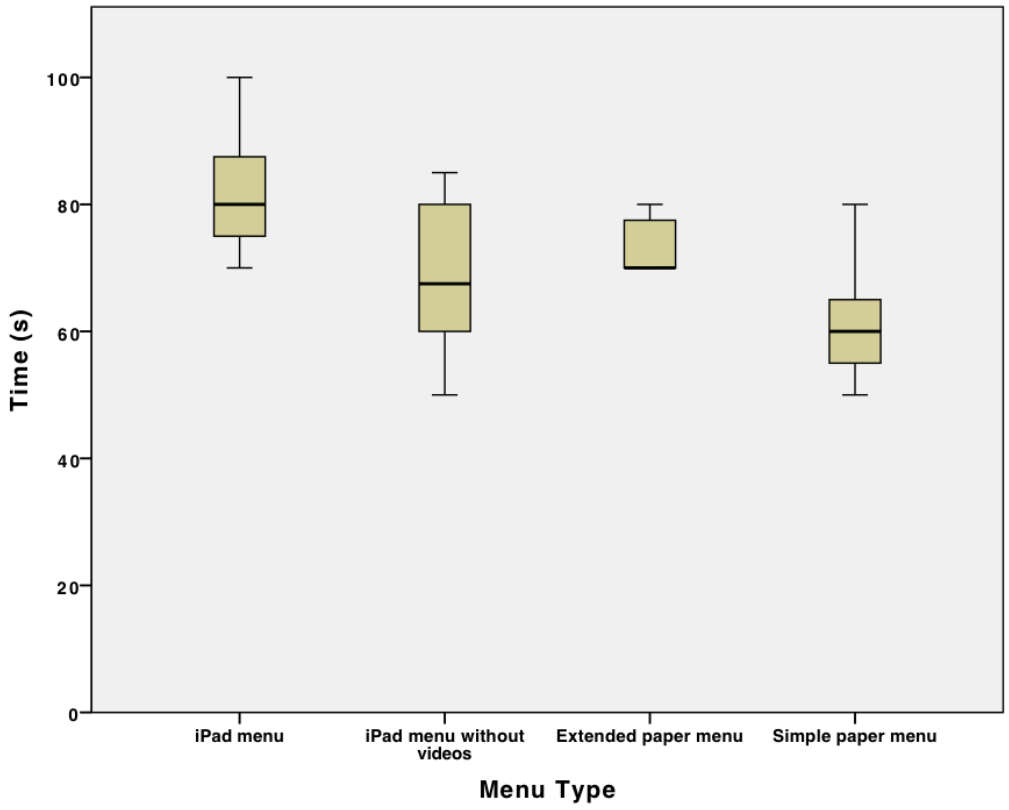

Figure 5.3: Boxplots showing the measured times the participants needed to choose one or more dishes for the four test conditions.

5.4 Questionnaire

A main part of the questionnaire consisted of statements that had to be rated on Likert scales. We used Kruskal-Wallis one-way ANOVA tests (see definition on page 79) to reveal significant differences between the means of the different Likert scales, and Mann-Whitney U tests (also called Wilcoxon rank-sum tests) as post-hoc tests. The possible range of all Likert item values in this section is between 1 and 5, reflecting a five-level Likert scale from ”Strongly agree” (1) to ”Strongly disagree” (5). The three intermediate values were not labeled on the questionnaire. In this section, we analyze the results of these Likert scales and provide interpretations.

Menu type	I assume that the offered dishes are valuable	The menu is suited for a high-class restaurant
iPad menu	1.00 ± 0.00	1.11 ± 0.33
iPad menu without videos	1.00 ± 0.00	1.10 ± 0.32
Extended paper menu	1.30 ± 0.48	1.90 ± 0.74
Simple paper menu	1.80 ± 0.42	2.00 ± 0.67

Table 5.3: Means and *SD* of the answers on the Likert scales concerning the perceived quality of the restaurant and dishes.

KRUSKAL-WALLIS ONE-WAY ANOVA:
The Kruskal-Wallis one-way analysis of variance, or Kruskal-Wallis H test, is a non-parametric method to compare the means of three or more independent groups that does not assume normal distribution, and is suitable for ordinal data. Thus, it is often used to statistically analyze Likert scales when having three or more test conditions. The Mann-Whitney U test can be used as non-parametric post-hoc test to analyze if the means of two independent variables are significantly different. [Field, 2009]

Definition: *Kruskal-Wallis one-way ANOVA*

5.4.1 Perceived Quality

In a broader sense we had two statements in the questionnaire to analyze the effect of the menu type on the quality the participants perceived of the dishes and the restaurant using the menu. Table 5.3 shows the means and standard deviations of the results.

I assume that the offered dishes are valuable

The first one was "*I assume that the offered dishes are valuable*". The Kruskal-Wallis test showed a significant effect of the menu type on the answers ($H_3 = 20.12, p < 0.005$). Using a Mann-Whitney post-hoc test revealed significant differences of the answers between the simple paper menu and the three other menu types, and insignificant differences between the two iPad menus and the extended paper menu. By looking at the means (see table 5.3), all four results show a tendency to "Strongly agree". But the outcome of the statistical tests show that by providing more

information on a menu the quality of the dishes the guests percieve is significant higher nonetheless.

The menu is suited for a high-class restaurant

The analysis of the second statement on quality of the menu and restaurant, *"The menu is suited for a high-class restaurant"*, also showed a significant effect of menu type ($H_3 = 16.29, p = 0.001 < .05$). By applying post-hoc tests, we discovered significant differences between the answers for the iPad menus and the paper menus. Thus, we can state that using digital menus instead of paper menus also has an significant effect on the perceived quality of the users concerning the menu and restaurant. The perceived quality is higher using the digital menus because of a lower mean for the results to this statement. Another reason may be that our paper prototypes were not as good as the iPad menus regarding the haptic and look, e.g. we did not use thick leather folders often found in high-quality restaurants.

Effects on hypothesis 1

Based on the results of these two Likert scales, one could say that there is a significant effect of the menu type on the perceived quality of the dishes and the restaurant, hence we could state hypotheses 1 as approved. However, because of the negative outcome of the MANOVA test on the estimated prices of the dishes discussed earlier, we do not want to fully accept hypothesis 1, and perform further studies.

5.4.2 Length of Texts

One of the statements was targeting the text length of the menu: *"The texts were too long"*. Because the simple paper menu did only consist of the names and the description in a couple of words, we did not ask the participants using that menu this question. The means and standard deviations of the results are shown in table 5.4.

Results

The menu type has a statistically significant effect on the text length that the participants found acceptable for the three menus ($H_2 = 8.63, p = 0.013 < .05$). Post-hoc tests show that the significant difference lies between the extended paper menu and the two digital menus. The difference between the iPad menus are insignificant. The mean of the results for the extended paper menu is 1.5 respectively

Menu type	The texts were too long
iPad menu	4.11 ± 0.93
iPad menu without videos	4.40 ± 0.84
Extended paper menu	2.90 ± 1.20

Table 5.4: Means and *SD* of the results of the Likert scale concerning the text length.

about 1.2 steps lower than those of the iPad menu and the iPad menu without videos.

Interpretation

Based on the results we can confirm hypothesis 3. Because both digital menus and the extended paper menu had the same design and texts, and the difference of the answers on the given statement are significant different, it seems that longer texts are acceptable on digital menus, but to lesser extent on paper menus. This may be due to the fact that the users have to see all the text when browsing through the paper menus, and are more likely to be tempted to read parts of the texts. When using our digital menus, the users have to open only the detail pages on the dishes that sound more interesting or better, thus they do not see unnecessary information. Therefore, digital menus have the benefit of allowing more textual information for those interested in one dish, without disturbing other users.

5.4.3 Information Content

Three of the statements that had to be rated on a Likert scale were targeted at opinions on the information content of the menus. The means and standard deviations for "*The menu provided all information needed for making a decision*" and "*I find the photos distracting*" are shown in table 5.5.

The menu provided all information needed for making a decision

The resulted means for the first statement showed a significant effect of the menu type on the answers ($F_3 = 11.65, p = 0.009 < .05$), but the multiple Mann-Whitney post-hoc tests showed no statistically significant differences of the mean. Because of the more precise results of the Mann-Whitney tests, we cannot prove the effect of the menu type on the an-

Menu type	The menu provided all information needed for making a decision	I find the photos disturbing
iPad menu	1.11 ± 0.33	5.00 ± 0.00
iPad menu without videos	1.00 ± 0.00	5.00 ± 0.00
Extended paper menu	1.70 ± 0.68	4.70 ± 0.48
Simple paper menu	1.50 ± 0.53	—

Table 5.5: Means and *SD* of the results for two Likert scales targeting at the information content.

swers for this statement. The means for all four menu types are between 1 and two, showing the participants strongly agreed on the statement.

I find the photos distracting

Running a Kruskal-Wallis test on the answers of the statement "*I find the photos distracting*" showed no significant effects of the menu type ($F_2 = 6.14, p = 0.089 > .05$). The means are all equal or near to 5, meaning the participants strongly disagreed on the statement. Thus we can deduce from this result that a larger amount of photos, including background photos, is acceptable for paper menus as well as digital menus. There were no photos on the simple paper menu, therefore no data is shown for this menu type.

The videos helped to make a decision

The statement *The videos helped to make a decision* was only visible in the questionnaire for the iPad menu, because the other three menus did not include any videos. The mean of the answers is 4.00 (*SD* = 0.87), meaning the participants mainly disagreed with this statement. Because the other tests mostly showed no significant differences between the iPad menu with and without videos, inclusions of videos does not seem to support the users in any way.

5.4.4 Usability

In order to analyze how well the participants could operate our digital and paper menus, two of the Likert scales had statements helping us to analyze the usability. The means and standard deviations of the results of those two Likert scales are shown in table 5.6.

Menu type	The menu had a clear structure	I had difficulties operating the menu
iPad menu	1.33 ± 0.50	4.22 ± 0.67
iPad menu without videos	1.20 ± 0.42	4.50 ± 0.53
Extended paper menu	2.00 ± 0.94	—
Simple paper menu	1.70 ± 0.68	—

Table 5.6: Means and *SD* of the results for two Likert scales targeting at the information content.

The menu had a clear structure

By analyzing the means, one can say that in general the participants agreed on the statement *The menu had a clear structure*. The Kruskal-Wallis test revealed no significant effect of the menu type on the answer to the Likert scale of this statement ($F_3 = 7.23, p = 0.065 > .05$). The results show that the participants found the menus to be clearly structured, and thus easy to navigate and browse through the pages in digital and paper form, and found the items on the position they expected them to be.

I had difficulties operating the menu

The statement "*I had difficulties operating the menu*" was generally answered with a strong tendency to "strongly disagree". A Kruskal-Wallis test showed no significant difference between the two menu types tested with this question ($F_1 = 0.85, p = 0.356 > .05$). Therefore we can state that the participants did not have problems operating our digital menus.

5.5 Qualitative Observations and Findings

Preliminary usage of digital menus

As explained before in chapter 3—"Study Design", one part of the questions asked about preliminary usage of digital menus in restaurants. Five participants used digital menus before. One of those used smartphone based beverage lists in a bar, the other four visited restaurants utilizing tablets as menus. Two participants found the use of digital menus in the restaurant strange and had problems to operate the software, especially because one of the application crashed several times and was not running smoothly. The other two

participants liked to use the digital menus, as the presentation of the dishes and the wine lists were highly polished and informative.

Additional desired information

One of the statements in the questionnaire was *"I missed the following information"* with the suggestions *wine recommendation* and *eligibility for vegetarians* for all menu types, and additionally *photos of the dishes* for the simple paper menu. The participants using the simple paper menu mainly stated that they do not miss photos on the menu (mean of 3.8). As one of the earlier statements regarding photos resulted in the finding that photos do not disturb the users, and the menus with photos got better results on a couple of questions, we can see that photos are not missed when not present, but help improving the presented quality of the dishes. Most participants answered that wine recommendations are welcomed on the menu. Only few participants missed a declaration of eligibility for vegetarians on the menu. Either those few were vegetarians themselves, or simply it was clear to most other participants which dishes contained meat and which not.

Video watching behavior

An interesting observation is the behavior of the participants regarding the videos. As we did not register the exact amount of participants that started a video, we can only estimate from observing them that about half of the ten participants using the full iPad menu did so. None of the participants who watched a video in full or partial length did start a second video. We cannot state the reason for this fact without further studies, but we can hypothesize that the videos were either not interesting or informative enough, or too long and thus delayed the decision-making process. Some of the participants only detected the availability of videos at the end of the study, giving us an indication that the videos were not prominent enough. This may be due to the position of the videos at the bottom of the detail pages, or due to the black and unobtrusive representation of the video player before starting videos. A solution would be to automatically start playing a video and display it at the top of the screen or in a larger player. One could also replace the background image by the video above the information area on the page. But because the videos did not support the users in their decision-making process, as seen in the previous section 5.4.3—"Information Content", it is

open to further research whether to include videos on digital menus or not.

Chapter 6

Design Guidelines for Interactive Tablets in Restaurants

"The Guide is definitive. Reality is often inaccurate."

—Douglas Adams

During the work on this thesis we gained knowledge about the technical side of digital menus, but more importantly about the the different groups that have to deal with menus in general. On the one side, this are the guests visiting restaurants, and the users of the menus in the proper sense. On the other side are restaurant owners, chefs and other employees. This group has to deal with the administration and maintenance of such devices, with the creation of the content and keeping it up-to-date. Also, the atmosphere of the restaurant plays a great role in the decision on menu types. We talked to many people from all mentioned groups about menus in general, digital versus paper menus and other related topics during our work, and got more insight from our user study.

Chapter overview

In this chapter we try to create some guidelines for interactive tablets in restaurants. Starting from a short discussion about digital and paper menus in general we go over ad-

vices on the devices themselves, the technical design of the software and the design of the user interface, and finally we discuss some content types and features that can be included in digital menus.

6.1 Digital Menus in General

Paper or digital menu

An interesting decision is whether to introduce digital menus at all. Using tablets as menus has some benefits over traditional paper or board menus. As we found out in the user study, the perceived quality of the restaurant and food may be higher, and it is possible to add more information to to the menu without overcharging or disturbing the guests. Digital menus allow to include more kinds of content and render the decision-making process more interactive. Features like digital ordering (see section 6.5.5—"Digital Ordering" later this chapter) also become possible.

Costs

A downside of digital menus are the higher initial costs due to the current high prices of tablets and software. On the other hand, when changing the items on the menu no additional costs arise, assuming an interface for the menus that can be controlled by the staff exists. Paper menus have to be printed out regularly when changes occur. When adding own photos or other interactive content, this may be more expensive for digital menus than for paper menus. When considering digital menus one should also consider servicing costs, and maybe an insurance in case a guest or employee accidentally damages one of the devices.

Atmosphere

One of the most important effects on the impression that a guest gets of a restaurant is the atmosphere. Many participants of our preliminary questionnaire told us that they think a digital menu may destroy it. The reason might be that they did not have not used digital menus before, and thus may thought of off-the-shelf devices that do not fit into the spatial design. A solution could be to use high-quality cases fitting to the interior of the restaurant, and thus blending into the atmosphere very well. An example for such a case is shown in figure 6.1, and a cover designed explicitly for a restaurant was shown in figure 2.5 earlier in chap-

ter 2.2.1—"Next Level". Also the brightness of the screens should be adjusted to fit the ambient light.

Figure 6.1: An hand-made iPad case made out of genuine leather. Photo by *www.almwild.de*.

Surprising the guests

One of the chefs we talked to said that he does not want to have any additional information beside of the name of the dish visible on his menu. He likes to surprise the guests, and some of the guests visit him regularly because of this approach. A digital menu would not make sense in such restaurants, as it would not be useful to hold more information, and the costs may be too high to just show names of the menus in a digital way.

Additional paper menus

Some restaurants which introduced digital menus have paper menus available as a backup, in case some guests do not want to choose from tablet menus or some devices are out of order and replacement is needed. While those paper menus should not contain all information of the digital ones, it is good to have some available.

6.2 Devices

Size and weight

When deciding on tablet devices, the most important spec-

ifications are the size and weight. Devices equivalent to the paper sizes DIN A4 or A5 have a screen size similar to paper menus and are therefore well-suited. Smaller screens would normally force the content to get too small for a convenient reading distance, while devices with larger screens tend to be too heavy for handheld use. One should assure that the weight of the devices is acceptable for holding it for a couple of minutes with one hand without getting uncomfortable.

Hardware specification

Depending on the features of the menu, the hardware specifications should be good enough to display everything smoothly and without delay in order to offer a good user experience. Lags in the user interface may quickly annoy the guests and are thus bad for the perception of the restaurant itself (compare to the user interface deadlines of Card et al. [1983]).

Amount

One should always have enough devices available for the restaurant guests. In contrast to paper menus, digital ones need to be charged, thus are not ready to use all the time. The impression the guests have of the restaurant may get bad if not enough devices are operational for every guest at one table, and if the devices shut down because of low battery charges.

6.3 Software Design

Content distribution

The software should be designed to allow fast changes to the menu content by mostly untrained employees. The staff should be able to administrate the content without having to delegate this work to the software company that developed the menu. Distributing the software via the application stores offered by some vendors may not be suitable for a single restaurant. But plugging all devices into a computer in order to update the information of the menu may also be cumbersome, especially far larger restaurants using many devices. The best solution is to provide the content on a local server to which the devices connect wirelessly. Whether to directly get the content from the server when loading a page or storing everything on the device and just

retrieve updates over the network depends on the restaurant environment and the content itself. If a high connection speed on a wireless network can be assured throughout the restaurant, and no large files need to be loaded, this may be the easier solution. But for better response times of the software, especially when videos are involved, local storage of those large files is crucial.

Web applications vs. native applications

Many tablet menus currently in use are web-based applications, e.g. the menu used in the *Next Level* (see section 2.2.1—"Next Level"). Programming our prototype for the user study with web technologies showed that it easily allows to create suitable applications. Because the look of native apps is normally not needed, as a design suiting to the restaurant should be used, web frameworks today offer everything needed to create software for tablets. It takes some time to enhance the performance and multitouch behavior of such applications, but the benefit is that the task of developing or updating the software can be done by web designers and web programmers, which is often more cost-effective than assigning it to a software company with mobile development experience. Also, assuming a good wireless connection, a web page could directly be loaded remotely without needing to synchronize devices. The main benefit of native mobile apps, e.g. developed with Objective-C and Cocoa Touch for iOS devices, is the better performance, especially for animated content and reaction to user input. Thus, the feel of the application is better without needing to put more effort into it. The identical look of native mobile applications is often not required, as custom interface widgets and designs are used for such tasks.

Software testing

An important task of the software development phase should be running stability and performance tests, as it should normally be the case in every software development process. When performance issues effect the user interface, e.g. animations are not running smoothly or the interface does not react on user input immediately, the restaurant experience is badly effected. Even worse, if software crashes occur, the reputation of the restaurant may be damaged due to unsatisfied customers. Because performance issues may be caused by memory leaks, it is necessary to detect them with appropriate tools and to run long-term tests.

6.4 User Interface Design

User-centered design

When designing the user interface and interaction methods of the digital menu, choosing a user-centered design approach is crucial. If the menu is going to be used in a specific restaurant, guests of this restaurant should be asked to evaluate the design. One should also think about the exact user groups, for normally guests from all different age groups will be using the menu, having different levels of experience with touch input devices and software in general.

Matching the spatial design

The whole design should be adjusted to fit to the spatial design of the restaurant and to corporate design guides, if available. Using a ready-to-buy software could destroy the atmosphere, because the digital menus will not fit well into the overall concept of the restaurant. Therefore the guests might perceive them as unfamiliar and distracting computers. Also, the interface should be as calm as possible, without too many animations, popups or other unforeseeable elements.

Page hierarchy

In order to make use of some benefits we found out in chapter 5—"Evaluation", the user should not be forced to see the whole content for all available items on the menu. By providing a page hierarchy with overview pages and detail pages, information on items the guest is not interested in can be hidden, allowing the addition of more content to every dish without overcharging him. It should be clear how to navigate between the different pages without providing many on-screen manuals.

Fitting into the environment

We are unable to give any further advice on the general design of the user interface besides the known rules about user interfaces in general, because a lot of different possibilities are available. There are many types of restaurants, and every one has a unique atmosphere it tries to mediate. A digital menu should always fit into the whole environment and infrastructure without being too obtrusive or distracting.

6.5 Content and Features

It is possible to include different kinds of features and content types in digital menus. We want to discuss those of them that were included in our prototypes, which we analyzed in the user study or that we talked about with professionals from the restaurant industry.

6.5.1 Photos

Quality of the photos

Photos on the menus are a good way to provide information about the dish and to help the guests to remember specific dishes (compare to Wachholz and Weiss [1999]). Furthermore, the users can analyze them easier and faster than long textual information. But in order to mediate a high quality of the items, the photos have also to be of high quality. For restaurants retaining the items on the menu for a longer period of time, the investment into a professional food photographer might pay off. But as many upscale restaurants change their menu more regularly, e.g. weekly, the costs for a photographer would be too high. Before adding low quality photos, or only photos for a small amount of available dishes, it is better to leave them out completely.

Photos of the preparation process

A nice addition are photos of the development and preparation of the meal. Because such photos can be more general, some of them can be included for several types of dishes and do not have to be updated as often. Certain images, as for example bloody and raw meat or boiling of living lobsters should be excluded as they may not be suitable for all guests.

6.5.2 Videos

Videos of the preparation of the food are far more sophisticated and thus cost-intensive than photographs. As we found out in our user study, they did not help the guests in their decision-making process, and did not seem to have

any influence on the perceived quality. Therefore it is not important to include videos on digital menus. If they are to be included, they have to be of high-quality and should be suitable for all kind of guests, like mentioned before for the case of photos.

6.5.3 Wine Recommendations and Lists

Available wine lists

Many participants of our user study stated that they would like to get wine recommendations on a menu. As we have seen in some solutions, tablets are well suited for displaying a large amount of information about wines, e.g. the origin, taste and matching to different meals, as for example the iPad menu of *AIDA* (see section 2.2.4—"AIDAsol"). Some applications are even specially designed for only offering a wine list and no menu of available dishes, like the iPad wine list of *Bone's* (see section 2.2.6—"Bone's") or the software used at *South Gate* as shown in figure 6.2.

Figure 6.2: The digital wine list of the restaurant *South Gate* in New York. Photo by *www.154southgate.com*.

Supplement to sommeliers

On the other hand, the employees of upscale restaurants told us that the sommelier or waiter should retain the task

of recommending matching wines. But adding wine recommendations on the menu and providing further information can be a good supplement to the staff, for it does not mean that those employees have to be replaced. Some guests may further rely on the knowledge of the sommeliers, but especially users without experience with wines may like to browse through interactive wine lists. As seen in the case of *Bone's*, where the sales of wine increased after the introduction of the wine cards, it can lead to an increase in the general interest in wines and should therefore be included.

6.5.4 Order List

Feature description

A feature implemented in many digital menus currently used by restaurants is the order list, or "shopping cart". The user is able to select different items from the menu that will be marked as selected, and visible on a separate page (an example may be seen in figure 2.9 of section 2.2.4—"AIDAsol"). Therefore he is able to open that page when the waiter arrives for taking orders, and does not need to remember everything. Note that ordering via the tablet is discussed separately in the next section (6.5.5—"Digital Ordering").

Unburdening the brain

We did not include this feature in our prototypes as we considered a menu with eight items to be to small to really need it. But some of the participants stated that they missed such feature in the menu. As humans can only remember a restricted amount of information in their short-term memory (see Card et al. [1983]), the guest is relieved by being able to create a kind of memo on the menu. Especially for longer menus this feature is a useful extension, but it can be appealing to some users even in the case of shorter menus. While some guests will probably not use it, an order list may be convenient when the time between the decision and placing the order is long.

6.5.5 Digital Ordering

Feature description

When introducing digital menus with order lists, as mentioned before, in a restaurant, the next logical step would be to allow ordering via the tablet. The order would then be sent wirelessly to the kitchen, where the staff can prepare the specific dishes. The addition of electronic cashless payment methods is also easy to implement for such a system.

Advantages and disadvantages of ordering systems

The benefit of this feature would be saving staff costs, as a smaller amount of waiters is needed. Their main tasks would be reduced to serving the meals and providing support in the case of problems or additional questions. On the other hand, an upscale restaurant often separates itself from standard quality restaurants by the communication between the employees and the guests. All guests and owners of high-class restaurants we spoke to did not want to use such features, as it would be counterproductive for the personal restaurant experience. A waiter can adjust himself to specific guests and normally has more knowledge of the dishes or wines than even a digital menu could provide. Therefore the decision about this feature has to be based on the type of restaurant. For higher class restaurant it should not be used in order to enhance the personal communication between the staff and guests. For other restaurants, where low prices of the dishes or fast processing of customers are more important than building up a special restaurant experience, this feature might be helpful.

Chapter 7

Summary and Future Work

"The best thing about the future is that it comes one day at a time."

—Abraham Lincoln

Chapter overview

In this last chapter we will summarize the work done for the purposes of this thesis, and provide an outlook on future research in the field of interactive tablets as menus in restaurants.

7.1 Summary and Contributions

Analysis of related work

In this thesis we evaluated digital interactive menus for upscale restaurants. Research already done on this topic was analyzed, and we found out that most of it did not include studies about the effect of digital menus on the restaurant guests. The majority of available work focuses on technologies that can be implemented in digital menus, for example ordering systems or recommender systems.

Digital menus in restaurants

We presented six different cases where digital menus, mainly based on tablets, are currently used in real restaurant settings. The technology and features of those menus

were listed, and we provided background information on the development of those menus, the effects on sales and impressions of guests wherever possible.

Study design

For analyzing the effect of different menu types on the customer experience we designed a user study, in which we compared two digital menus and two paper menus with different amount of information and features contained. The main hypothesis, stating that the quality of available dishes the guests percieve is higher when using well-designed interactive digital menus rather than non-interactive paper menus, was explained. We created a questionnaire and designed tasks that would help us to examine all three hypotheses about the influence of digital menus. The main part was a price estimation of the participants on all items on our menus, as in our culture higher prices are related to higher quality.

Prototypes

Four prototypes for the user study were developed in a user-centered design approach. Two of them were digital menus based on iPads, the other two were paper menus with different amount of information. We outlined the design process of those prototypes including results of preliminary questionnaires and interviews with restaurant guests as well as professionals from the restaurant industry. Furthermore, we provided insight about the implementation of the software prototypes. We chose web technologies for the applications, as it allowed us to quickly create prototypes running natively on the devices.

Results

We conducted the between-groups user study with 40 participants. We found out that there was no statistically significant effect of the menu type on the price estimated for the dishes in general, but some items on the digital menu were rated with higher prices than the same items on paper menus. Together with the result that the participants percieved the dishes presented on both digital menus as being more valuable than when presented on paper menus, we can say that digital menus mediate a higher quality of the dishes than paper menus, even when the amount of information is identical. Additionally, the task of choosing several dishes on the iPad menus could be accomplished as fast as on the paper menus when not including videos in the time measured. We also found out that a digital

menu with a menu hierarchy can contain more textual information than paper menus without disturbing the users. We assumed that this might be caused by a page hierarchy on the digital menus: while the users have to browse through all pages with detailed information when using paper menus, they only get to see the detail pages of dishes which they find interesting by looking at the short description and small photos on an overview page.

Design guidelines

In the previous chapter we presented some advice for deciding between paper and digital menus, and provided guidelines on the design of interactive menus. Based on knowledge gained from the user study and several interviews, we discussed different types of content that can be used for digital menus, and features made possible by using tablets.

7.2 Future Work

Based on the outcome of our user study, the interviews with restaurant owners, chefs and guests, and ideas we had during the work on this thesis, we will describe possible future work in this section.

7.2.1 Perceived Quality

Repetition of the user study

The statistical test performed to examine the effects of digital menus on the perceived quality, analyzed by price estimations, did not show significant differences between our four menus. As we discussed in chapter 5—"Evaluation", we hypothesize that a larger user group would have showed more significant results. Therefore we want to repeat the user study with more participants for each menu type in order to have more detailed results on the influence of digital menus on the perceived quality of the dishes and the restaurant.

Real world restaurant setting

Furthermore, a similar user study could be executed in a real restaurant with the restaurant guests. In our study we

showed differences of using various types of menus with different amount of information content, with the menus being the only information about the restaurant. By conducting a user study in a restaurant, the participants would also include their perception of the atmosphere and surrounding. Their decision on one or several dishes would also have more impact than it had in our study, as they would really order and pay the dish.

Different restaurant classes

At the beginning of our work we had the idea of testing digital menus in different classes of restaurants. One would be a smaller snack bar, another one a mid-class restaurant, and the third one an upscale restaurant as we used in this thesis. As we had to decide on one class for time reasons, another study could be performed using all this three classes to analyze differences of the effects of digital menus.

7.2.2 Videos and Live Streams

Further research on inclusion of videos

Participants of our user study stated that the videos included in the digital menus did not help with their decision which dish to order. There was no visible significant effect of the inclusion of videos on the participants besides of longer time needed to choose a dish. While it may be that videos do not mediate a higher quality of the food, the results may also be effected by the user group being too small, as only a small amount of participants watched one of the videos. Therefore another user study with a stronger focus on videos may be performed.

Live video streams

One of the restaurants using digital menus we visited included live video streams in the application which allowed the guests to watch the preparation of their food (see 2.2.1—"Next Level"). Such a feature could mediate a higher quality and better cost-benefit ratio, as the work brought up for a meal and the freshness of the ingredients can be visible. Some restaurants are using large windows between the seating area and the kitchen, or open kitchens, to use a similar effect. The downside is that the tablet has to be running during the preparation process, and could disturb the personal communication between the guests. This could be further analyzed in user studies.

7.2.3 Ordering Systems

A larger amount of restaurants that introduced digital menus included ordering systems with the software, allowing guests to place orders and pay directly using those devices. Most of these restaurants make use of this possibility to save staff costs. While employees of upscale restaurants we visited told us that such functionality would destroy the personal interaction between the waiter and guests, and thus lower the service and quality, the effects of digital ordering systems for restaurant guests has not been scientifically researched.

7.2.4 Different Design Approaches

More interactive design approaches

The designs of the digital menus created for our user study were based mainly on the structure of traditional paper menus. While this helped to offer a clear structure and thus good usability, some more interactive design approaches can be developed. An idea would be to illustrate the different dishes on a kind of virtual buffet, and show detailed information when touching an item. Another idea is to offer multiple questions the user answers or search criteria to get only a selection of dishes suitable for him, e.g. whether the food should be vegetarian or not, in which price range the dishes should be placed and so on. Some of those ideas could be tested and evaluated.

7.2.5 Recommender Systems

Effects of recommender systems on perceived quality

Current research done on recommender systems for use in restaurants are focused on technical details and how restaurant guests can be supported in their decision-making process (compare to [Adomavicius and Tuzhilin, 2005, Igelmund et al., 2011]). The influence of such recommender system on the perceived quality has yet to be analyzed. Also the difference of satisfaction between choosing from digital menus without further support and choosing recommended dishes could be evaluated.

Appendix A

Preliminary Moderated Questionnaire

The questionnaire was moderated, so additional information and explanations were given to those polled.

Umfrage Restaurant Justus K

Fragen zur Speisewahl

Was haben Sie bestellt?

Was erwarten Sie insgesamt vom bestellten Essen?

1	2	3	4	5
○	○	○	○	○

Was erwarten Sie vom bestellten Essen geschmacklich?

1	2	3	4	5
○	○	○	○	○

Was erwarten Sie von der Anrichtung des bestellten Essens?

1	2	3	4	5
○	○	○	○	○

Fragen zur Speisekarte

Gefällt Ihnen die Aufmachung der Speisekarte?

	1	2	3	4	5	
Stimme sehr zu	○	○	○	○	○	Stimme gar nicht zu

Bietet die Speisekarte Ihnen alle Informationen die Sie zur Auswahl des Gerichts benötigen?

	1	2	3	4	5	
Stimme sehr zu	○	○	○	○	○	Stimme gar nicht zu

Welche zusätzlichen Informationen auf der Speisekarte würden Sie sich wünschen?

Bitte sortieren Sie die folgenden Arten von Speisekarten nach Ihrer Präferenz.

	1	2	3	4
Wandtafel	○	○	○	○
Papierkarte	○	○	○	○
Digitale persönliche Karte	○	○	○	○
Digitale zentrale Systeme	○	○	○	○

Können Sie sich generell vorstellen eine digitale Speisekarte zu verwenden?

	1	2	3	4	5	
Stimme sehr zu	○	○	○	○	○	Stimme gar nicht zu

Begründung

Bewerten Sie die Wichtigkeit folgender Zusatzinformationen auf der Speisekarte?

	sehr wichtig	wichtig	unwichtig	störend	sehr störend
Weinempfehlungen	○	○	○	○	○
Rezeptentstehung	○	○	○	○	○
Zubereitung	○	○	○	○	○
Besonderheiten der Zutaten (z.B. Herkunft, Auswahl)	○	○	○	○	○
Eignung für spezielle Ernährung (z.B. vegetarisch, Allergien)	○	○	○	○	○

Welche weiteren Informationen fänden Sie interessant?

Bitte sortieren Sie die folgenden Medien nach Ihrer Präferenz um Informationen über die Speisen zu vermitteln.

	1	2	3	4
Text	○	○	○	○
Bild/Foto	○	○	○	○
Video	○	○	○	○
Live-Video	○	○	○	○

Fragen zur Person

Sind Sie...

- (•) männlich
- ( ) weiblich

Wie alt sind Sie?

- (•) < 18
- ( ) 18-25
- ( ) 26-35
- ( ) 36-45
- ( ) 46-55
- ( ) 56-65
- ( ) >65

Wie oft besuchen Sie das Restaurant Justus K zum Essen?

- (•) Erster Besuch
- ( ) Selten
- ( ) Mehrfach im Jahr
- ( ) Mehrfach im Monat

Fragen zur Speisewahl (nachher)

Wie fanden Sie das bestellte Essen insgesamt?

1	2	3	4	5
○	○	○	○	○

Wie fanden Sie das bestellte Essen geschmacklich?

1	2	3	4	5
○	○	○	○	○

Wie fanden Sie die Anrichtung des bestellten Essens?

1	2	3	4	5
○	○	○	○	○

Submit

Appendix B

User Study Questionnaires

This are the questionnaires used in the performed user study ordered as follows: full digital menu, digital menu excluding videos, extended paper menu, simple paper menu. The input field for the time (”Zeit”) was added after the study, and was not filled out by the participants.

Benutzerumfrage iPad Speisekarte

* Required

Preise der Gerichte

Was glauben Sie, was die einzelnen Gerichte kosten?

Carpaccio vom Rinderfilet *

Möhren-Ingwersuppe *

Jakobsmuscheln *

Rehrücken in Portwein-Wildjus *

Ziegenkäse in Blätterteigtasche *

Hummer und Bries *

Warmes Schokoküchlein *

Käseplatte *

Fragen zur Speisekarte

Die Karte hat alle Informationen bereitgestellt, die ich zur Auswahl brauchte. *

	1	2	3	4	5	
Stimme absolut zu	○	○	○	○	○	Stimme überhaupt nicht zu

Ich denke, dass die angebotenen Speisen hochwertig sind. *

	1	2	3	4	5	
Stimme absolut zu	○	○	○	○	○	Stimme überhaupt nicht zu

Ich hatte Probleme, die Speisekarte zu bedienen. *

	1	2	3	4	5	
Stimme absolut zu	○	○	○	○	○	Stimme überhaupt nicht zu

Die Karte war übersichtlich aufgebaut. *

	1	2	3	4	5	
Stimme absolut zu.	○	○	○	○	○	Stimme überhaupt nicht zu.

Die Karte passt zu einem sehr hochwertigen Restaurant. *

	1	2	3	4	5	
Stimme absolut zu	○	○	○	○	○	Stimme überhaupt nicht zu

Die Fotos auf der Karte waren sehr störend. *

	1	2	3	4	5	
Stimme absolut zu	○	○	○	○	○	Stimme überhaupt nicht zu

Die Videos zu den Speisen haben mir bei der Auswahl sehr geholfen. *

	1	2	3	4	5	
Stimme absolut zu	○	○	○	○	○	Stimme überhaupt nicht zu

Die Texte zu den Speisen waren zu lang. *

	1	2	3	4	5	
Stimme absolut zu.	○	○	○	○	○	Stimme überhaupt nicht zu.

Die folgenden Informationen haben mir gefehlt. *

	Stimme absolut zu.	2	3	4	Stimme überhaupt nicht zu.
Weinempfehlung	○	○	○	○	○
Eignung für spezielle Ernährung (Vegetarier, Allergiker, ...)	○	○	○	○	○

Restaurantbesuche

Wie oft gehen Sie in Restaurants essen? *

- ○ mehrmals die Woche
- ○ in etwa einmal die Woche
- ○ mehrmals pro Monat
- ○ seltener

Waren Sie bereits in einem Restaurant, welches digitale Geräte als Speisekarte benutzt? *

- ○ ja
- ○ nein

Wenn ja, welche Geräte wurden verwendet?

Wenn ja, beschreiben Sie in wenigen Worten Ihre Eindrücke der digitalen Speisekarte.

Angaben zur Person

Sind Sie... *

- ○ weiblich
- ○ männlich

Welchen Beruf üben Sie aus?

Wie alt sind Sie? *

Welche dieser Geräte verwenden Sie selbst regelmäßig? *

- [ ] Smartphones mit Touch-Eingabe (z.B. iPhone)
- [ ] iPad
- [ ] andere Tablet-Computer mit Touch-Eingabe

Zeit *

Submit

Benutzerumfrage iPad Speisekarte

* Required

Preise der Gerichte

Was glauben Sie, was die einzelnen Gerichte kosten?

Carpaccio vom Rinderfilet *

Möhren-Ingwersuppe *

Jakobsmuscheln *

Rehrücken in Portwein-Wildjus *

Ziegenkäse in Blätterteigtasche *

Hummer und Bries *

Warmes Schokoküchlein *

Käseplatte *

Fragen zur Speisekarte

Die Karte hat alle Informationen bereitgestellt, die ich zur Auswahl brauchte. *

	1	2	3	4	5	
Stimme absolut zu	○	○	○	○	○	Stimme überhaupt nicht zu

Ich denke, dass die angebotenen Speisen hochwertig sind. *

	1	2	3	4	5	
Stimme absolut zu	○	○	○	○	○	Stimme überhaupt nicht zu

Ich hatte Probleme, die Speisekarte zu bedienen. *

	1	2	3	4	5	
Stimme absolut zu	○	○	○	○	○	Stimme überhaupt nicht zu

Die Karte war übersichtlich aufgebaut. *

	1	2	3	4	5	
Stimme absolut zu.	○	○	○	○	○	Stimme überhaupt nicht zu.

Die Karte passt zu einem sehr hochwertigen Restaurant. *

	1	2	3	4	5	
Stimme absolut zu	○	○	○	○	○	Stimme überhaupt nicht zu

Die Fotos auf der Karte waren sehr störend. *

	1	2	3	4	5	
Stimme absolut zu	○	○	○	○	○	Stimme überhaupt nicht zu

Die Texte zu den Speisen waren zu lang. *

	1	2	3	4	5	
Stimme absolut zu.	○	○	○	○	○	Stimme überhaupt nicht zu.

Die folgenden Informationen haben mir gefehlt. *

	Stimme absolut zu.	2	3	4	Stimme überhaupt nicht zu.
Weinempfehlung	○	○	○	○	○
Eignung für spezielle Ernährung (Vegetarier, Allergiker, ...)	○	○	○	○	○
Videos zu den einzelnen Speisen (Zubereitung)	○	○	○	○	○

Restaurantbesuche

Wie oft gehen Sie in Restaurants essen? *

- ○ mehrmals die Woche
- ○ in etwa einmal die Woche
- ○ mehrmals pro Monat
- ○ seltener

Waren Sie bereits in einem Restaurant, welches digitale Geräte als Speisekarte benutzt? *

- ○ ja
- ○ nein

Wenn ja, welche Geräte wurden verwendet?

Wenn ja, beschreiben Sie in wenigen Worten Ihre Eindrücke der digitalen Speisekarte.

Angaben zur Person

Sind Sie... *

- ○ weiblich
- ○ männlich

Welchen Beruf üben Sie aus?

Wie alt sind Sie? *

Welche dieser Geräte verwenden Sie selbst regelmäßig?

- [ ] Smartphones mit Touch-Eingabe (z.B. iPhone)
- [ ] iPad
- [ ] andere Tablet-Computer mit Touch-Eingabe

Zeit? *

Submit

Benutzerumfrage Speisekarte

* Required

Preise der Gerichte

Was glauben Sie, was die einzelnen Gerichte kosten?

Carpaccio vom Rinderfilet *

Möhren-Ingwersuppe *

Jakobsmuscheln *

Rehrücken in Portwein-Wildjus *

Ziegenkäse in Blätterteigtasche *

Hummer und Bries *

Warmes Schokoküchlein *

Käseplatte *

Fragen zur Speisekarte

Die Karte hat alle Informationen bereitgestellt, die ich zur Auswahl brauchte. *

	1	2	3	4	5	
Stimme absolut zu	○	○	○	○	○	Stimme überhaupt nicht zu

Ich denke, dass die angebotenen Speisen hochwertig sind. *

	1	2	3	4	5	
Stimme absolut zu	○	○	○	○	○	Stimme überhaupt nicht zu

Die Karte war übersichtlich aufgebaut. *

	1	2	3	4	5	
Stimme absolut zu.	○	○	○	○	○	Stimme überhaupt nicht zu.

Die Karte passt zu einem sehr hochwertigen Restaurant. *

	1	2	3	4	5	
Stimme absolut zu	○	○	○	○	○	Stimme überhaupt nicht zu

Die Fotos auf der Karte waren sehr störend. *

	1	2	3	4	5	
Stimme absolut zu	○	○	○	○	○	Stimme überhaupt nicht zu

Die Texte zu den Speisen waren zu lang. *

	1	2	3	4	5	
Stimme absolut zu.	○	○	○	○	○	Stimme überhaupt nicht zu.

Die folgenden Informationen haben mir gefehlt. *

	Stimme absolut zu.	2	3	4	Stimme überhaupt nicht zu.
Weinempfehlung	○	○	○	○	○
Eignung für spezielle Ernährung (Vegetarier, Allergiker, ...)	○	○	○	○	○

Restaurantbesuche

Wie oft gehen Sie in Restaurants essen? *

- ○ mehrmals die Woche
- ○ in etwa einmal die Woche
- ○ mehrmals pro Monat

- ◯ seltener

Waren Sie bereits in einem Restaurant, welches digitale Geräte als Speisekarte benutzt? *

- ◯ ja
- ◯ nein

Wenn ja, welche Geräte wurden verwendet?

Wenn ja, beschreiben Sie in wenigen Worten Ihre Eindrücke der digitalen Speisekarte.

Angaben zur Person

Sind Sie... *

- ◯ weiblich
- ◯ männlich

Welchen Beruf üben Sie aus?

Wie alt sind Sie? *

Welche dieser Geräte verwenden Sie selbst regelmäßig?

- ☐ Smartphones mit Touch-Eingabe (z.B. iPhone)
- ☐ iPad
- ☐ andere Tablet-Computer mit Touch-Eingabe

Zeit? *

Submit

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Benutzerumfrage Speisekarte

* Required

Preise der Gerichte

Was glauben Sie, was die einzelnen Gerichte kosten?

Carpaccio vom Rinderfilet *

Möhren-Ingwersuppe *

Jakobsmuscheln *

Rehrücken in Portwein-Wildjus *

Ziegenkäse in Blätterteigtasche *

Hummer und Bries *

Warmes Schokoküchlein *

Käseplatte *

Fragen zur Speisekarte

Die Karte hat alle Informationen bereitgestellt, die ich zur Auswahl brauchte. *

	1	2	3	4	5	
Stimme absolut zu	○	○	○	○	○	Stimme überhaupt nicht zu

Ich denke, dass die angebotenen Speisen hochwertig sind. *

	1	2	3	4	5	
Stimme absolut zu	○	○	○	○	○	Stimme überhaupt nicht zu

Die Karte war übersichtlich aufgebaut. *

	1	2	3	4	5	
Stimme absolut zu.	○	○	○	○	○	Stimme überhaupt nicht zu.

Die Karte passt zu einem sehr hochwertigen Restaurant. *

	1	2	3	4	5	
Stimme absolut zu	○	○	○	○	○	Stimme überhaupt nicht zu

Die folgenden Informationen haben mir gefehlt. *

	Stimme absolut zu.	2	3	4	Stimme überhaupt nicht zu.
Weinempfehlung	○	○	○	○	○
Eignung für spezielle Ernährung (Vegetarier, Allergiker, ...)	○	○	○	○	○
Genauere Informationen zu den Zutaten	○	○	○	○	○
Fotos zu den Speisen	○	○	○	○	○

Restaurantbesuche

Wie oft gehen Sie in Restaurants essen? *

- ○ mehrmals die Woche
- ○ in etwa einmal die Woche
- ○ mehrmals pro Monat
- ○ seltener

Waren Sie bereits in einem Restaurant, welches digitale Geräte als Speisekarte benutzt? *

- ○ ja
- ○ nein

Wenn ja, welche Geräte wurden verwendet?

Wenn ja, beschreiben Sie in wenigen Worten Ihre Eindrücke der digitalen Speisekarte.

Angaben zur Person

Sind Sie... *
- ◯ weiblich
- ◯ männlich

Welchen Beruf üben Sie aus?

Wie alt sind Sie? *

Welche dieser Geräte verwenden Sie selbst regelmäßig?
- ☐ Smartphones mit Touch-Eingabe (z.B. iPhone)
- ☐ iPad
- ☐ andere Tablet-Computer mit Touch-Eingabe

Zeit? *

Submit

Appendix C

Extended Paper Menu

Shown are the pages of the extended paper menu used in the user study. Each page was printed in the size of DIN A5, and then put together as a leaflet (see figure 4.12 for a photo). The content is exactly the same as in the digital menu prototype.

Speisekarte

Vorspeisen

Carpaccio vom Rinderfilet
mit Himbeerdressing und Pinienkernen, zu einem kleinen Salat

Unser hauchdünn geschnittenes Carpaccio vom Rinderfilet wird nur aus frischem Fleisch von Rinderzuchten aus der Region hergestellt. So bleibt es besonders zart und saftig. Begleitet wird diese Delikatesse von dem Kontrast der nussigen gerösteten Pinienkerne und einem fruchtigen Himbeerdressing. Dieses wird jeden Tag aus ganzen Himbeeren frisch hergestellt und serviert. Zusammen mit einem kleinen Salat und grob gehobeltem Parmesan entsteht so ein vielfältiges Geschmackserlebnis.

Möhren-Ingwersuppe
pikant gewürzt

Frische Möhren, welche von Ökobauern aus der Region angebaut werden, und aromatischer Ingwer werden für diese Suppe fein püriert. Abgeschmeckt wird sie mit bestem Curry. Dieses Rezept zeigt durch den pikanten Geschmack asiatische Einflüsse, zu denen unser Küchenchef auf diversen Asiareisen inspiriert wurde. Dazu wird unser selbst gebackenes Hausbrot serviert.

Jakobsmuscheln
mit Kaiserschotensalat und Thunfischmayonnaise

Nicht nur als Erkennungssymbol der Pilger zum Grab des heiligen Jakobs ist die Jakobsmuschel bekannt, sondern auch als eine wohlschmeckende Delikatesse. Aus Porten-Bessin, einer der größten Fischereihäfen in der Normandie in Frankreich, wird die große Pilgermuschel importiert, die wir in unserem Restaurant servieren. Natürlich haben alle verwendeten Muscheln das wichtige Rote Gütesiegel, das Label Rouge, erhalten, wodurch die beste Qualität garantiert wird. Die Muscheln werden kurz vorm Servieren auf gusseisernen Pfannen scharf angebraten. So bleiben sie im Inneren weich und saftig, und erhalten eine leicht knusprige Außenschicht. Der nussige und leicht süßliche Geschmack wird von der selbst hergestellten Thunfischmayonnaise noch unterstützt. Ein Kaiserschotensalat rundet diese beliebte Vorspeise ab.

Hauptgerichte

Rehrücken in Portwein-Jus
mit jungem Spitzkohl und Petersilienpüree

Das Fleisch für unseren Rehrücken wird von Hand ausgewählt. Erst kurz vor der Zubereitung trennen wir das beste Filet von den Knochen, um es extra saftig zu halten. In großen Stücken wird das Fleisch in gusseisernen Pfannen angebraten, und dann noch heiß in dünne Scheiben geschnitten. So wird garantiert, dass der Kern zart und weich bleibt, und so sein ganzes Aroma entfaltet. Durch süßen Portwein wird aus der Wildjus eine sommerliche Geschmacksunterstützung, welche perfekt von einem leichten Spitzkohlsalat mit Petersilienpüree begleitet wird.

Ziegenkäse in Blätterteigtasche
mit Datteln, Pinienkernen und Spinat, dazu Artischockencrème

Nicht nur für Vegetarier ist unsere Blätterteigtasche mit Ziegenkäse eine Empfehlung wert. Bester Pélardon aus 100% Ziegenmilch wird in große Kugeln gerollt, und zwischen zwei hauchdünnen Blätterteigscheiben gelegt. Anschließend wird die gefüllte Blätterteigtasche goldbraun gebacken.Serviert wird sie auf einem Blattspinat mit Tomaten, gerösteten Pinienkernen und Datteln. Geschmacklich wird der Pélardon von einer zartbitteren Artischockencrème. Unsere Liebe fürs Detail zeigt sich auch an den Kirschtomaten: jede einzelne wird von Hand geschnitten, mit Olivenöl betreufelt, gewürzt und anschließend kurz gebacken.

Hummer und Bries
in Hummersauce, mit Dicken Bohnen

Für besten Geschmack und besonders zartes Fleisch wird bei uns keine Tiefkühlware, sondern nur frischer Hummer verwendet. Auch das Kalbsbries wird von ausgesuchten Betrieben aus der Region geliefert. Um den Geschmack des Hummers perfekt zu begleiten, geben wir uns mit der Hummsersauce viel Mühe: Stundenlang werden die Hummerschalen mit Gemüse ausgekocht, und kurz mit Cognac flambiert. Danach wird die Sauce mit Weißwein und Kokosmilch vefeinert und gewürzt. Am Ende wird sie fein gesiebt, und in rein flüssiger Form wieder mehrere Stunden gekocht. So entsteht ein intensives, aber sehr vielseitiges Geschmacksbild. Dazu werden Große Bohnen serviert.

Desserts

Warmes Schokoküchlein
mit Schokoladeneis und Himbeersauce

Das Besondere an unseren Schokoküchlein: der Kern ist beim Servieren noch flüssig, um ein noch intensiveres Schokoladenaroma zu entfalten. Durch ihre Beliebtheit sind sie mittlerweile dauerhaft auf unserer Speisekarte zu finden. Der Teig und die Himbeersauce hierfür werden jeden Tag frisch zubereitet, um eine gleichbleibend hohe Qualität zu erhalten. Nur beste Schokolade von Läderach findet ihren Weg in die Schokoküchlein. Für die Himbeersauce werden frische ganze Himbeeren ausgekocht und von Hand gesiebt. Eine Kugel Schokoladeneis von Mövenpick ergänzt das warme Schokoküchlein perfekt.

Käseplatte
mit fünf verschiedenen Käsesorten

Die Käseplatte ist durchgängig auf unserer Karte zu finden. Zu recht, denn unsere Auswahl an fünf verschiedenen Käsesorten passt als Abschluss zu jedem Menü. Serviert werden die französischen Käsedelikatessen Roucoulons, Tete de Moine, Comtè und St. Andrè, und ein Le Tonneau aus der Schweiz.

Appendix D

Simple Paper Menu

This is the simplified version of the paper menu used in the user study. It was printed in the size of DIN A4, and put in a folder used in restaurants (see figure 4.13 for a photo).

Speisekarte

Vorspeisen

Carpaccio vom Rinderfilet
mit Himbeerdressing und Pinienkernen, zu einem kleinen Salat

Möhren-Ingwersuppe
pikant gewürzt

Jakobsmuscheln
mit Kaiserschotensalat und Thunfischmayonnaise

Hauptgerichte

Rehrücken in Portwein-Jus
mit jungem Spitzkohl und Petersilienpüree

Ziegenkäse in Blätterteigtasche
mit Datteln, Pinienkernen und Spinat, dazu Artischockencrème

Hummer und Bries
in Hummersauce, mit Dicken Bohnen

Desserts

Warmes Schokoküchlein
mit Schokoladeneis und Himbeersauce

Käseplatte
mit fünf verschiedenen Käsesorten

Appendix E

Price Comparison: Boxplots

These are the boxplots comparing the price estimations performed in the user study. Each figure represents the comparison of one dish that had to be rated, and thus contains one boxplot for each test condition (menu type). The values for the prices on the y-axes are specified in Euros.

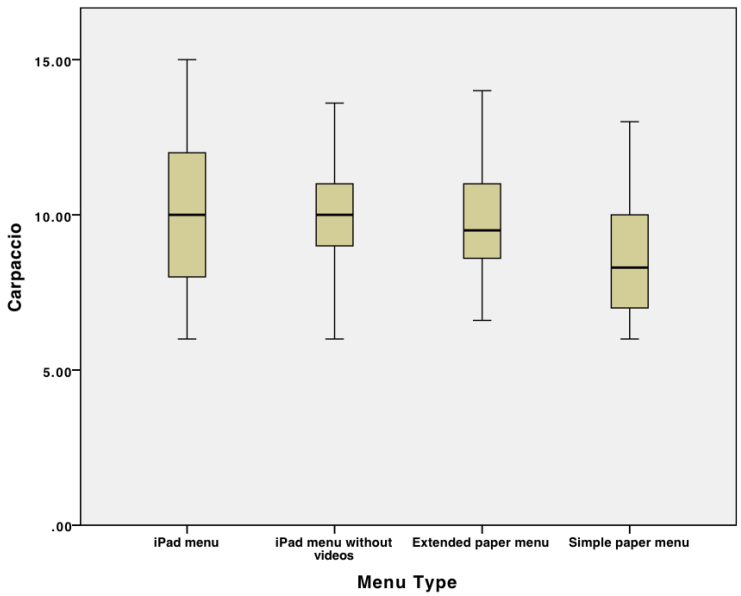

Figure E.1: Boxplots for the price comparison of *carpaccio of beef tenderloin*.

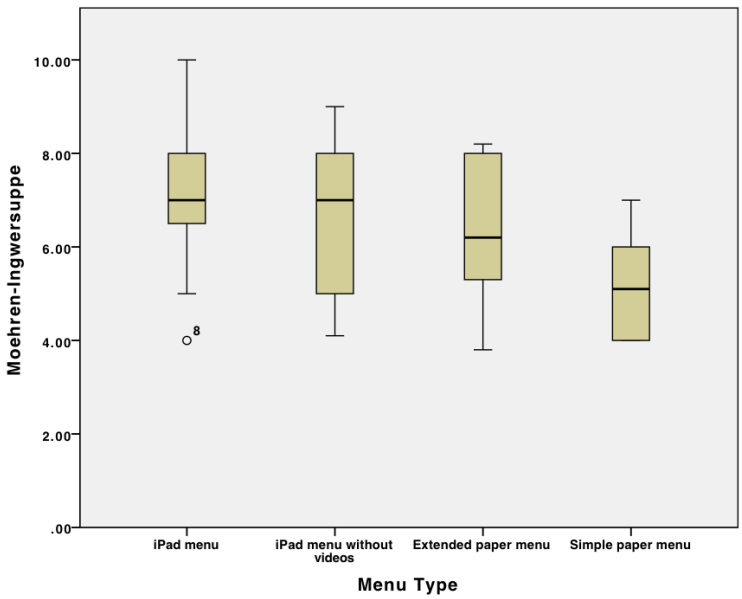

Figure E.2: Boxplots for the price comparison of *carrot ginger soup*.

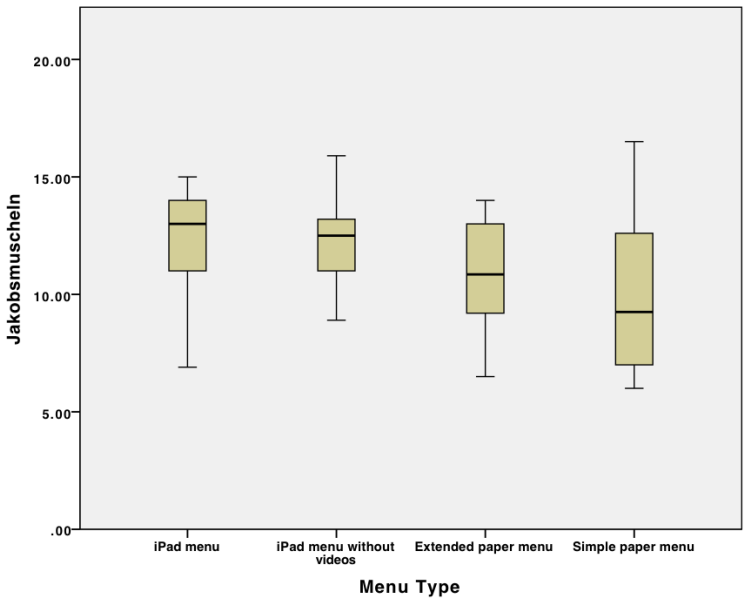

Figure E.3: Boxplots for the price comparison of *scallops*.

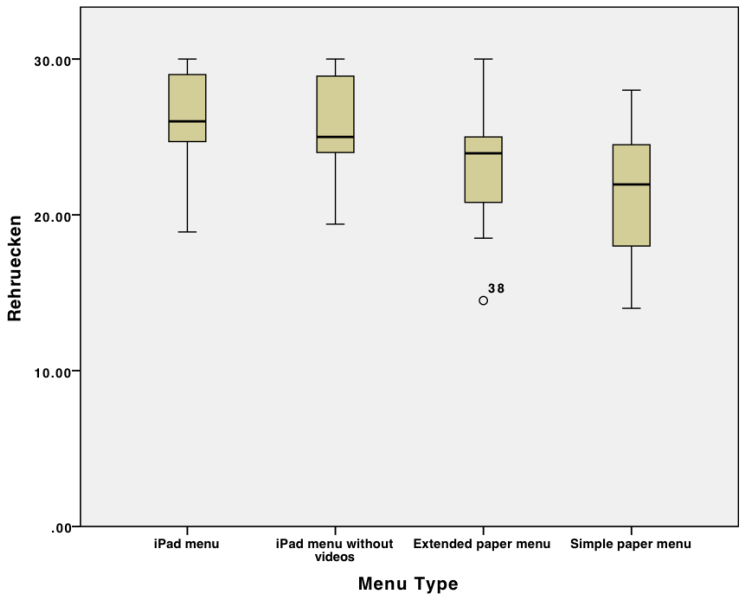

Figure E.4: Boxplots for the price comparison of *saddle of venison in port wine gravy*.

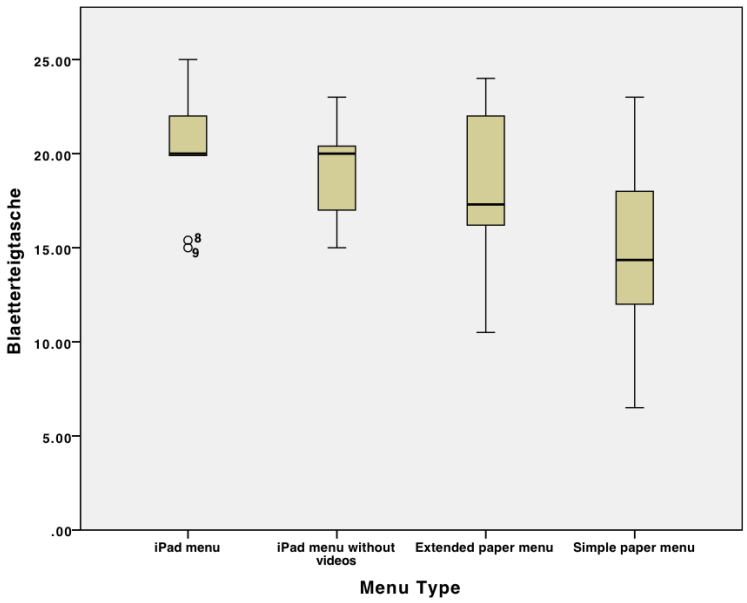

Figure E.5: Boxplots for the price comparison of *filled puff pastry with goat cheese*.

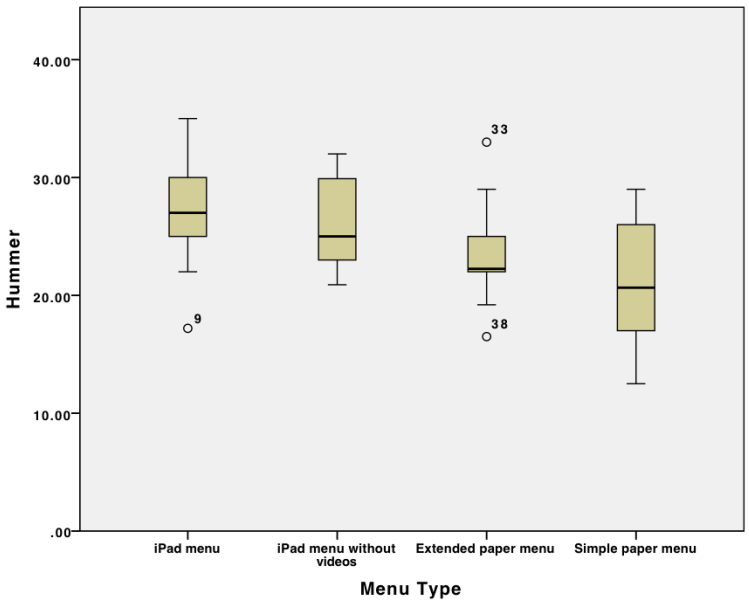

Figure E.6: Boxplot for the price comparison of *lobster and ris*.

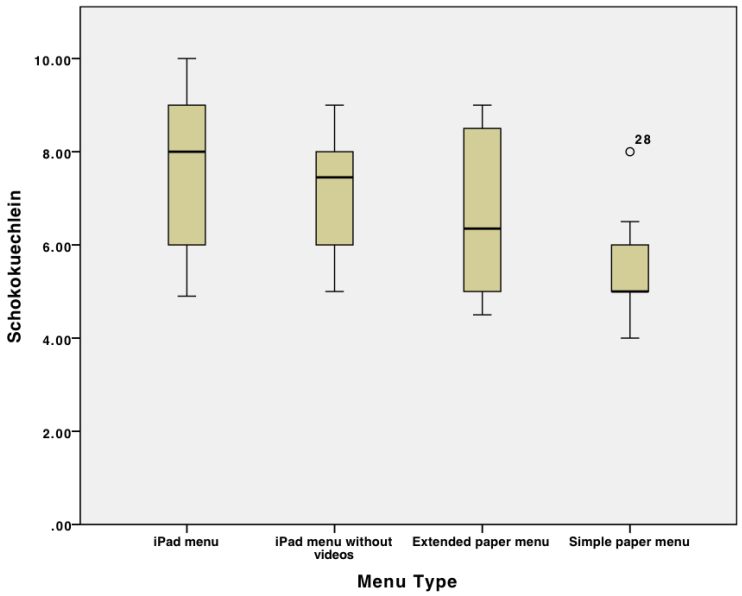

Figure E.7: Boxplot for the price comparison of *warm chocolate cake*.

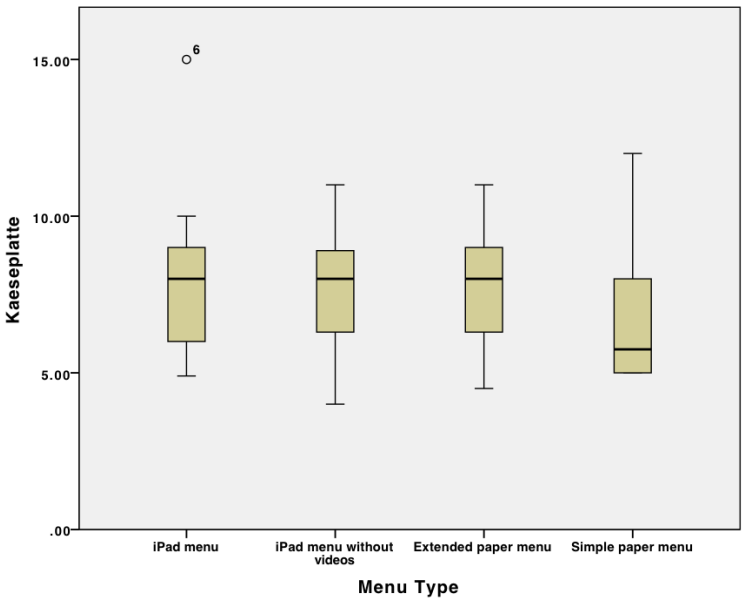

Figure E.8: Boxplot for the price comparison of *cheese plate*.

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