PROJECTE DE FI DE CARRERA

TÍTOL DEL PFC: Evaluation of interactive installations for public spaces. Recommendations and case study.

TITULACIÓ: Enginyeria de Telecomunicació (segon cicle)

AUTOR: Ignacio Carril Ahumada

DIRECTORS: Roc Messeguer (EPSC), Liam Bannon (IDC, UL)

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Abstract

This master's thesis describes the evaluation test plan of an interactive installation designed for a public space, and the discussion of the issues arose during its implementation.

Evaluation is a critical aspect of the iterative development process of any application or system. It allows creating better products, with less errors, and better achievement of the user's requirements.

It is even more important when the system is intended for a public space due to the problems associated with this kind of settings. The user and design requirements are more difficult to capture and to define, and at the same time the complexity of the evaluation is considerably increased.

The evaluation experience described and the suggested recommendations might be of interest for any future attempt to develop and evaluate technology for a public space, as it is the case of the Milk Market project (the Recipe Station)

Resumen

Esta memoria describe la el plan de evaluación de una instalación interactiva diseñada para un espacio público, y la discusión y análisis de las cuestiones surgidas durante su implementación.

La evaluación es un aspecto crítico del proceso de desarrollo iterativo de cualquier aplicación o sistema. Permite crear mejores productos, con menos errores y alcanzar de forma más satisfactoria los requisitos de los usuarios.

Ésta adquiere especial relevancia cuando el sistema a diseñar está destinado a un espacio público, debido a los problemas asociados con este tipo de espacios. Los requisitos de los usuarios y de diseño resultan más difíciles de identificar y de definir, y al mismo tiempo la complejidad de la evaluación aumenta considerablemente.

La experiencia de evaluación descrita y las recomendaciones sugeridas en este documento pueden resultar de interés para cualquier proyecto o desarrollo futuro que pretenda desarrollar y evaluar tecnologías para espacios públicos, tal como ha sido el caso del desarrollo de la *Recipe Station* del *Milk Market*.

“When you are solving a problem, don't worry. Now, after you have solved the problem, then that's the time to worry.”
- Richard Feynman -

To Liam for the trust and for giving me the opportunity of joining the IDC
To the IDC members for welcoming me as one more, for the great advices and the help.
To Marc, Colm and Paragh, for sharing this adventure, teaching me something new everyday,

To the Stabbers, for being more than a family. Without them nothing would have been the same.
To my friends, and all those who shared these months in Limerick. It has been one of the most wonderful experiences of my life.

And especially to my parents, for everything

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INTRODUCTION

Traditionally the design of any interactive system from the engineering perspective consists in the following four steps: identification of the needs of the user or client, the definition of a set of requirements, the proposal of alternatives to achieve them, their analysis and finally the development and evaluation of the most suitable one.

If the system is to be used in public spaces by anyone the engineer will soon realize that there are several factors that increase the complexity of the analysis of the problem. Generally the range of user profiles to be considered, each with their own characteristics, needs and limitations (age, gender, skills, impairments, knowledge, background, ergonomy, etc), increases the set of requirements, and complicates all the stages of the design and development process, specially the evaluation on-site.

Moreover, the place can determine several requirements of the system, not only from the point of view of the environmental conditions (humidity, light, temperature, etc) but also from the social perspective (visibility, ease of use, safety, etc). In these cases the importance of usability is exacerbated, especially since the system will probably be standing alone, and the users will have to cope with it without any help, training, or encouraging. For this reason it is important to stress the need of undertaking these projects from a user centred perspective. And this includes not only the interactive interface but also all the rest of the system, from the structure, to the aesthetics, etc.

It is easy to state that the engineer will need a broader background to face these challenges: the understanding of the user needs considering the place and the social interactions around it, the corresponding definition of requirements and specially the evaluation of the different stages of the development process.

This wide range of challenges suggests the need of a multidisciplinary approach were different specialists can work together to overcome these challenges covering the different fronts and perspectives, from the sociological perspective, to the design aspects, and the technological issues.

Human Computer Interaction and User Centred Design

This situation in particular leaded to the creation of the Human-Computer Interaction (HCI) discipline, from the merge of interest of different disciplines like applied psychology, ergonomics, computing science, sociology, etc. So the HCI discipline is focused in the study of interaction between people (users) and computers, to design systems that minimize the barrier between their cognitive model of what users want to accomplish and the computers understanding.

At the same time the HCI discipline can be considered as the most suitable discipline to offer a common framework for the different specialities involved, giving a wide range of tools, and methodologies for user-centred design and evaluation.

One of these tools is the User Centred Design philosophy, which is based in three principles stated by Gould and Lewis (1985):

1. An early focus on users and tasks

2. Empirical measurement of product usage

3. Iterative design

These principles can be seen as obvious, but the same Gould shows how they are not obvious for a large amount of system designers. (Gould 1985a, Gould 1985b). Stating this has been one of the major concerns of HCI practitioners, and usability specialists, who emphasize their economical (Karat, C., 1990) and development benefits.

By these principles UCD can be seen as a design philosophy with the objective of producing products with a high degree of usability, while HCI is the discipline that provides and improves (by research) the tools and methods to achieve it.

This is illustrated in this report by the case study of the Milk Market project: the design and development of an interactive artefact to be installed in the weekly farmer's market in Limerick, by the Interaction Design Centre of the University of Limerick. The UCD and HCI were the core theories of this project, as they are in all the projects undertook by the IDC.

Structure of the report

I will use this case to show how the usability evaluation methodologies can be applied in an actual case and to describe the difficulties that arise during their application in the different stages of the design and development process. Some of these difficulties are inherent to the design for public spaces (identification of user needs, definition of requirements, and specially the evaluation on-site), and some others are caused by the lack of experience of the practitioners.

This master’s thesis is structured in five chapters. The first one introduces the actors involved in the Milk Market project and describes it. The second chapter explains the most relevant methods and techniques that were considered for during the planning of the evaluation.

The third chapter focuses in the evaluation and the test plan that was put in practice. From that experience we inferred the recommendations summarized in the fourth chapter, and the final conclusions that form the last chapter.

CHAPTER 1. THE MILK MARKET PROJECT

1.1. The Interaction Design Centre

The Interaction Design Centre (http://www.idc.ul.ie/index.html) was created in 1996 as an interdisciplinary research group in the Department of Computer Science and Information Systems of the University of Limerick, focused on the design, use and evaluation of information and communications technologies.

The IDC is also closely involved in a number of undergraduate and postgraduate courses such as the M.A./M.Sc. in Interactive Media, M.A./M.Sc. in Music Technology, B.Sc. in Digital Media Design and BSc in Music, Media & Performance Technology in the University of Limerick.

Since then the IDC has been involved in several projects, but their description does not form part of the scope of this thesis. All the projects at the IDC are based in the Human-Computer Interaction perspective, using the User-Centred Design as core design philosophy. The IDC is committed with this view and promotes its application in the development process to design according to the needs of the users and achieve better products.

1.1.1. Antecedents: Shared Worlds and the Shannon Portal

The Milk Market project is part of the Shared Worlds research project, funded by Science Foundation Ireland and carried by the IDC between January of 2004 and December 2007. It is devoted to study "*the development and use of novel interactive technologies within public spaces - such as museum galleries, shopping malls, airport passenger areas, and libraries*" (http://www.shared-worlds.org/). It is exploring not only how people use technologies in public spaces, but also how they might begin to live with them in their everyday lives.

All the research is based on the HCI perspective, where technological developments are based on both a theoretical and practical understanding of human activities in the world (Bannon 2005). The initial research identified two public sites: The Shannon Airport and the Milk Market. Both places present

1.1.1.1. The Shannon Portal

During the summer of 2006, the Shannon Airport hosted the first intervention of the Shared Worlds project: the Shannon Portal (http://www.shannonportal.ie/). It consisted in a fibber glass dolmen of the size of a desk embedded with a 21"screen and a computer system. The users could use an electronic pen on the screen to interact with the interactive application running in the computer to upload their pictures and send them by email as electronic postcards.

Fig. 1.1 The Shannon Portal

The aim of the SW project with the Shannon Portal was to develop an ``*interactive installation to engage and entertain passengers, staff, meters and greeters who find themselves waiting or -more generally- spending time at the airport".* During the month and a half that was installed in the hall of the Shannon airport it became a major attraction, engaging numerous interactions with the passengers waiting for their flight.

1.2. The Milk Market project

The Milk Market was identified as an historical urban place suitable for the Shared Worlds project. It is one of the main social spots in Limerick, located very close to main streets of the city centre. During the weekdays is used as public car park, but it is better know for hosting the farmer's market every Saturday morning for the last 150 years. The stalls sell a wide variety of fresh products, from vegetables, chesses, fish, and ready made products like hot dogs, to bakery. It also hosts shops and cafes which are the heart and character of the Milk Market.

The objective in this case was to find out ways to introduce interactive technologies with the potential to foster new forms of activities within the place. The initial research was focused in studying the place from the urban design perspective to understand how the place was perceived by the people.

This perspective would help to identify the townscape elements that provided character to the place in order to propose design approaches for the installation that integrate it into the place, keeping in mind the trade-off between the need to stand off and being harmonious with the place. At the same time it would also allow to outline the design requirements to support the sustainable development and conservation as historic centre, as it was recommended by the Venice Charter for Conservation (1964).

In brief, the Milk Market project was proposed as an opportunity to study how to bring technology to a public space with its own personality and a strong sense of community. The challenge was, therefore, designing an interactive installation that merges and enhances the social interactions offering a service that allows to create new ways to use and live the place and the community of the market.

One idea emerged as the most interesting among all the ideas considered during the brainstorming sessions held by the members of the Shared Worlds project: To design an artefact ready to deliver recipes according to the ingredients suggested by the users.

1.2.1. The Recipe Station

The Recipe Station was conceived as an exploratory exercise to try, on one hand, ways to introduce technology in a traditional public space not used to technology. On the other hand to evaluate how this technological artefact could foster the social interactions in the market, and in the more ambitious point of view, if it offered new ways to use the market and its application as a promotional system.

1.2.2. Concept design

The Recipe Centre comprised several elements. The main one was the Recipe Station itself, and the space surrounding it under the marquee. The second element was the ingredient cards that were given to some stall owners so they could deliver them to their costumers after buying something.

The design concept was based in two principles.

- Avoid the use of keyboard and mouse to use the Recipe Centre
- Foster social interactions, engaging the users with the community of the market.

The following sections describe the operation of the system to understand it, and then the issues that emerged during its implementation are detailed and analyzed.

Finally it details the technical decisions and how they were implemented. In this case more attention is paid to the RFID system, as it is the core technology of the project.

1.2.3. Operation of the system

The Recipe Station was designed to deliver recipes according to the ingredients suggested by the users. This would be done by introducing ingredient cards, each card corresponding with an ingredient available in the Milk Market. The system should identify the ingredient associated with the cards and offer a list of recipes that use one or more of those ingredients. The user should be able to go through the list and check the details of any of the recipes. The system should offer the option of printing any recipe in a way that the user can pick the print out home.

In order to describe the operation of the system we use the storytelling technique, which is an useful communication method borrowed form sociology for problem solving (Mitroff and Kilman, 1975), to describe and conceptualize complex ideas (Snowden 2002) and to create a shared understanding and encourage teamwork (Shaw *et al*. 1998).

Then the same model is described using an analytical method, the task analysis. This is done in order to exemplify different methods used during the design process.

1.2.4. Storytelling

The operation of the system at the Milk Market can be described using the storytelling method as it is shown in the following paragraphs:

> ``*John is visiting the Milk Market this Saturday morning because he wants to buy cheese for the lunch. His girlfriend Mary has invited her parents for lunch and John wants to surprise them with something special. He wanders around looking at the stuff sold in the different stalls. As he doesn't know what to buy decides to buy some Cheddar, the only cheese he knows what to do with. When he is paying the stall owner gives him a colourful plastic card. In one side it has the picture of cheeses as they are sold at the market, and the word Cheese written down. In the backside there is the address of the stall owner and the logos of the University of Limerick and the IDC. John asks surprised*
>
> *“What's this?”'*
>
> *“It is for getting recipes in the recipe machine over there, it's free, just put it in and you'll see.”*
>
> *“Ok, lets see” John approaches to the blue marquee that stands out among the other stalls and sees an artefact in the middle of it. It has a pyramid top, transparent and what it seems to be a small screen. The screen shows a message saying ``insert ingredients'' and an animated arrow points up to a slot in the pyramid.*

John introduces the card into the slot in the pyramid and ``Cheese'' appears in the screen. John presses the button ``Search for Recipes'' and then a list of recipes using cheese appear in the screen. He scrolls down and picks one by touching its name on the screen. Then it shows the description of the recipe, and other options at the left side of the screen, ingredients and cooking; and ``print recipe'', ``back'' and ``Exit'' buttons at the right. He checks the ``ingredients'' and the ``cooking'', and then he decides to print the recipe. A few seconds later a piece of paper with the recipe falls on a box at the side of the artefact. John picks it up and walks away while checks in the recipe what ingredients he will have to buy to surprise his in-laws."

The storytelling method allows communicating the functioning of the system in a clear and understandable way to anyone. At the same time provides an insight of the user's perspective to the design team very important to understand their needs. It is arguable what amount of personal details is needed to illustrate the case. For example, including the details about John's in-laws might seem superfluous, but it helps to understand the motivation of the potential user and to humanize the figure of the user in front of the designers and any listener of the story.

1.2.5. Task analysis

Task analysis is a method used in several disciplines (from design to engineering) to describe hierarchically the tasks required to complete a particular job. Each of the tasks can be broken down into a set of subtasks, and so on. Each task comprises an objective to achieve, a starting point, an action (or set of actions), and a stopping point when the objective has been achieved.

One of the benefits of the task analysis, according to Dumas and Redish (1999), is that it focuses attention on user's tasks and goals, helping designers to work considering them. At the same time provides a rational basis for design decisions.

In the case of Recipe Station the task analysis would start supposing that the user gets an ingredient card when buys something at the Milk Market. It is desirable that gets the card corresponding to what has bought. The tasks would be described as following, and illustrated in the figure 1.2.

1. The user approaches to the Recipe Station
2. Inserts the card.
3. May select and check a recipe (or as many as he want)
4. May print one or more.
5. May go back to the list of recipes

6. May exit to the beginning

Consider that the user may pick one or more cards among those available next to the Recipe Station, and that the user may leave at any moment

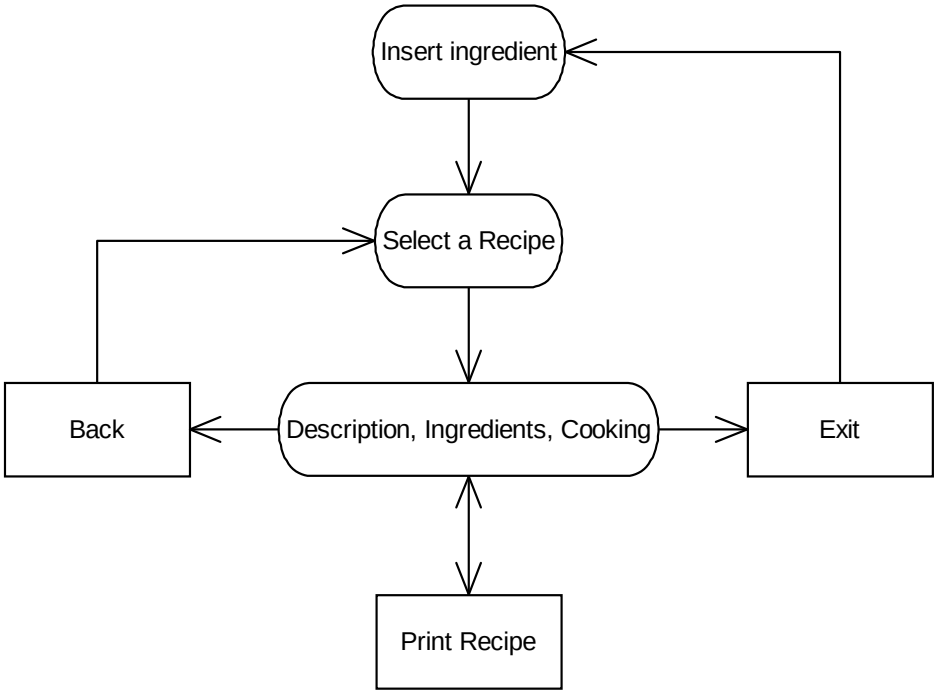

Fig. 1.2 Scheme of the application/interface workflow

The task analysis can be detailed in several levels, and illustrated with various diagrams. In this case this description exemplifies the simplicity of the model proposed and its functionality, and was used as guideline for the interface design and implementation.

1.2.6. Technical Description

The selection of technologies was done considering the previous experience with other projects, and the availability of resources at the IDC. For this reason the selection and the design concept were done in parallel by the members of the Shared Worlds project.

1.2.6.1. Hardware

The system architecture of the Recipe Centre was based in three different elements, the printer, the RFID system, and the touch screens, all connected to two computers, as it is described in the following figure.

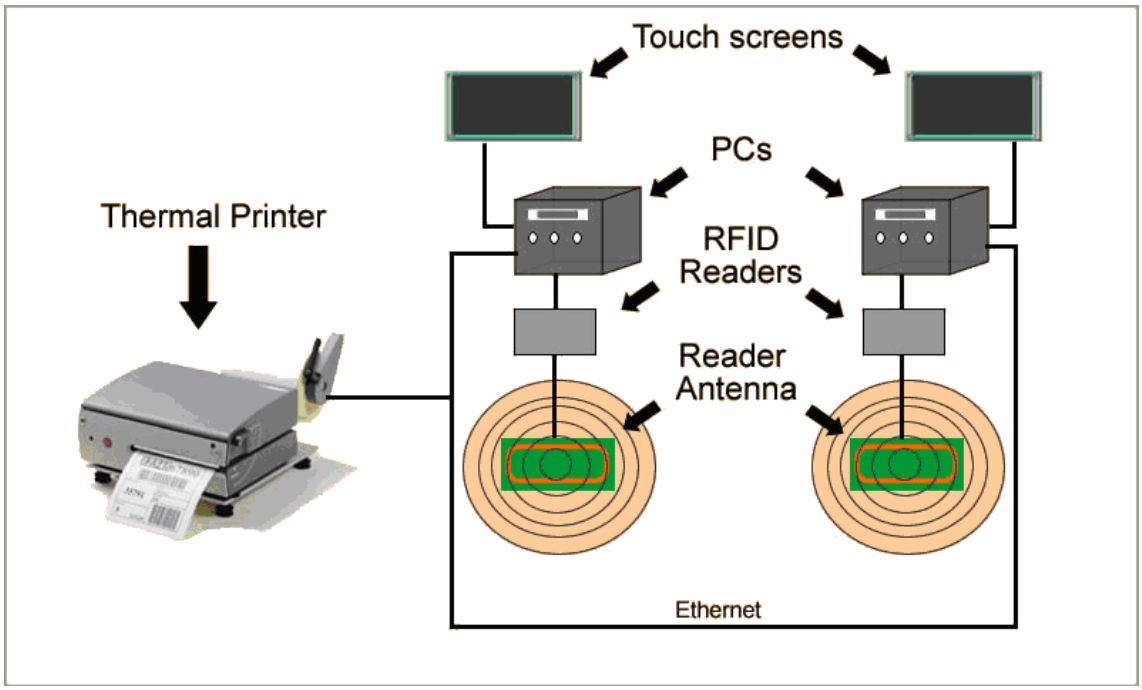

Fig. 1.3 Components of the system

Computers

Two PC's with Windows XP were the controllers of the system Both of them were *Barebone* models, characterized by the compact size of the computer boxes ("*shuttle box*"). The size of the "*shuttle*" boxes was a relevant requirement as they had to fit inside of the structure of the Recipe Station with the rest of the components.

Interface

A seven inches touch-screen TFT-LCD VGA monitor (named *Liliput* by the manufacturer), was connected to each PC. Each of them had to be calibrated individually.

Printer

An *Imaje Compact 4* thermal printer networked to the controller PCs via a 1000Base-T Ethernet hub allowed the data accessed from the database of recipes to be printed out in 100mm thermal paper. A printer driver application coordinated and transported the data from each controller PC to the thermal printer.

The weight and the layout of the printer determined the design of the structure to fit it. Moreover, as the thermal paper was feed by paper rolls, the printer had to be accessible to change the paper rolls when they were finished.

RFID system

In the case of the Recipe Station we were using a 13.56 MHz frequency RFID system from Texas Instruments, TAG- IT Reader System Series 6000 (formerly named as Series 320, both discontinued). We had available two readers and one antenna from the Texas Instruments system.

Fig. 1.4 RFID custom antenna

As the Recipe Station was conceived for two simultaneous users, and as the standard antenna used for the *TAG-IT 320* system did not suit the contours of the design. A specially designed antenna had to be manufactured to allow the RFID antenna to integrate seamlessly into the installations design. Two custom RFID antennas were manufactured according to the design suggested by Texas Instrument at *"HF Antenna Cookbook"*, using a printed circuit. The details about the building, the tuning, and the testing can be checked in the appendix.

The transponders, or tags, were embedded inside the ingredients cards, so the users would not perceive them.

Fig. 1.5 Different prototypes of the ingredients cards (left and centre) and the final version (right)

The development and testing process of the RFID antennas is detailed in Annex 1.

1.2.6.2. Software

Macromedia Flash was used to a create a GUI application that gathered the RFID data from the reader server applications and then using this data queried a MySQL database for relevant information relating to the data stored on the RFID tag. Then based on the users' interaction, the GUI could communicate the database information to the printer driver application for printout.

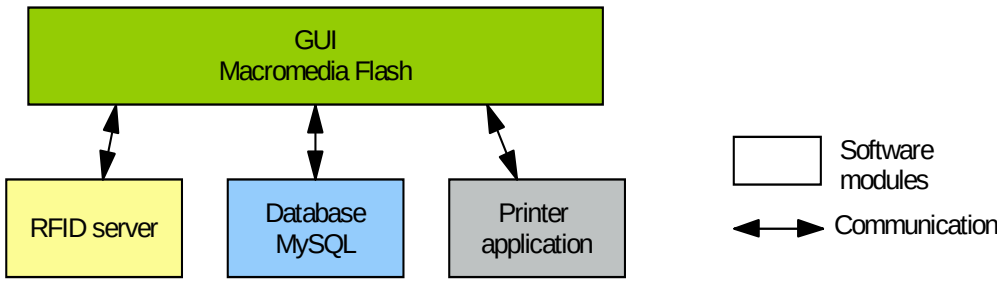

Fig. 1.6 Software architecture

1.2.6.3. Discussion

The selection of technologies considered the experience with previous projects. The RFID system had been used in a similar way (tags embedded in cards, and hiding the RFID reader to users) in the Hunt Museum during the SHAPE Project.

The rest of components and technologies were chosen according to availability at the IDC (the shuttles and the touch-screens were already there). The design of the structure was done after the selection of these technologies, and it was adapted to host them.

If the computers had been bigger, or the screens had been larger, the design of the structure would have been different.

1.2.6.4. Conclusion

When the function of the system is well defined and clearly depends more from the technical than from the aesthetic and functional details of the structure, it is important to adapt the design to the technical requirements, instead of all the way round.

Figure 1.7 shows how the different hardware elements were integrated in the bottom part of the structure of the Recipe Centre in order to keep the gravity centre as low as possible. It is easy to see that the hardware determined the

design of the structure, as if the computers had been bigger the proposed design would have to be modified.

Fig. 1.7 Detail of the hardware as it was installed in the structure of the Recipe Centre

CHAPTER 2. Evaluation methods and initial test plan

2.1. Evaluation methods proposed

There is a wide range of evaluation methods that can be applied to an interactive system to asses its usability. The investigator or practitioner has to choose the most suitable ones according to the characteristics of the system, the evaluation requirements, and the availability of resources, and the outcomes of the different methods. A lot of literature is devoted to describe and analyze these methods (Hartson et al. 2003, Jacko and Sears 2003, Jordan 2000, Rubin 1994, Dumas and Redish 1993). This report only describes some of the methods considered for the evaluation of the Recipe Station, in this chapter, and how they were applied, in the next chapter.

Usability methods are usually classified as analytical methods or empirical (they arrive to conclusions through observation, analysis, and inference).

The analytical methods require a theoretical model to arrive to conclusions through the use of calculation, deduction or judgement by specialists. These include design guidelines, heuristic evaluation, and cognitive walkthrough among others.

Basically all of them consist in a list of usability requirements which conformance has to be confirmed by the practitioner, or group of practitioners. Apparently they can offer a quantitative outcome, according with the requirements achievement percentage, but they still are subject to the judgement of the practitioner.

Meanwhile the empirical methods require a prototype of the system to arrive to conclusions through observation of its use, analysis, and inference.

2.1.1. Heuristic evaluation

The Heuristic evaluation methods involve the evaluation of the interface by an expert that judges its compliance with an accepted set of usability rules. These rules, or heuristics, can be seen as "`golden rules"' derived from extensive guidelines.

The Heuristic Evaluation was originally developed by Nielsen and Molich (1990) and refined by Nielsen (1994).

The expert may be a specialist about a particular aspect of design or a particular application area. But the expert may also be someone with specialist knowledge of the needs of the end users (for example handicapped users) or a HCI specialist with little or no involvement in the project. Nielsen indicates that a

"*double*" specialist, that is, a specialist who is also an expert in the particular technology employed by the product is more effective than one without such knowledge.

Nielsen (1992) again describes the heuristic evaluation process as the reviewer doing two or more passes through the interface, inspecting the flow of the interface, and examine each screen according to the usability principles (such as use the user's language, be consistent, provide feedback, provide exits, provide good error messages, prevent errors, etc).

The interface of the prototype should have reached a functional level so the experts can evaluate how the usability principles are applied. This makes this method not suitable for the early stages of the design process, when the interface is not developed yet and the usability principles have not been implemented, of for the late stages, when it is difficult to incorporate changes to the system. In this last case it can be seen as an interesting method to get suggestions for future versions.

The main advantages of this method are its reduced cost compared with usability testing, which needs more time and resources, and the fact that experts usually identify different problems than the users. As the experts would make observations according to their expertise they may help to improve the system from their perspective (for example a computing science expert would focus in the computing issues as memory load, system architecture, etc, while a graphic designer would focus in aesthetics).

The main weakness of this method comes from the fact that the end user does not take part and the context is ignored. This means that as there is no direct evidence from users that any of the issues identified by the experts are relevant for the users, the heuristic evaluation is not able to confirm by itself if the prototype satisfies the needs of the users.

2.1.2. Usability test

One of the most important stages of the usability testing is planning the test. This should allow to identify and establish the how, when, where, who and why of the test.

This test plan can be done in several ways, more or less informal. It is possible that in certain cases, when the objectives and the methods to apply appear to be very clear, the practitioner can consider that there is no need to document a formal test plan. Rubin (1994) defends the importance of a formal approach as the written document provides a focal point to the test, helps to identify the required resources, and can be used as a communication tool between the different members of the working team.

In order to achieve this he proposes a structured format for the outcome document that should detail the following points:

- Purpose

This section consists in a brief high level description of the reason to perform the test.

- Problem statement

This is the most important section of the plan, as it should list as precise and clearly as possible all the questions and objectives that need to be solved with the test. The objectives can be expressed as statements or questions grouped in the categories of the different aspects to study. These should be focused in particular problems and issues, avoiding vague and undefined expressions.

For example, instead of asking *"is the current system usable?"* document should contain a list of the particular concerns about each part of the system, as following.

Hardware

1- Is the 20-character display adequate to communicate all messages?

Software

1- Do the screens reflect the end user's conceptual model?

2- Is the response time a cause of user frustration or errors?

General

1- What obstacles prevent completion of setup tasks?

2- Is the new release harder to use than its predecessor?

- User profile

This should describe the end user that is going to be tested.

- Method of evaluation

This section should include a detailed description of how the evaluation test is going to be carried out. The more detailed it is the more helpful it will be to identify the equipment and the resources needed. At the same time it will allow refining certain aspects of the test design, as the number of users, identify possible problems or difficulties, or just use it as guideline for the test.

At this stage it is important to stress the need of ensuring experimental rigor and consistency during the tests. This means that the tests should be conducted in as identical as possible from test to test, ensuring that users work under the same conditions.

To achieve this Rubin recommends the use of scripts during the test sessions, checklists to ensure the accomplishment of objectives or tasks, and that all the test sessions are conducted by the same person. It is also recommended to make the testing environment as realistic as possible.

A secondary advantage of detailing this section, and the entire test plan, is that it will offer the chance to other members of the work team to review the method and suggest improvements.

- Task list

Description of the series of tasks that the user has to do during the usability test. This requires a previous task analysis by the design team as it is described in the section 1.2.5.

- Test monitor role

In order to ensure consistency it is desirable that all the tests are done under the same circumstances. For this reason it might be helpful to define the role of the test conductor, setting the level of neutrality, or the expected level of participation.

- Test environment/equipment

Listing the equipment required for the test might prevent problems during its execution, and at the same time ensures the consistency of the tests. It is important to note that the test might require a written consent from the users to allow the recording and the use of the collected data for the means of documentation, according to current legislation.

The rest of the plan can include the detail of the evaluation measures that are going to be obtained, and the way the results would be reflected in the test report.

This formal method to do the test plan might result tedious to the practitioners but it facilitates the documentation of the process and the communication of the results to the rest of the members of the design team. Moreover, this formal model can be simplified according to the needs of the evaluation team.

2.1.3. Prototyping

Prototyping consists in building a model of the system in order to test it. It can be classified as high-fidelity prototyping when it is very detailed, elaborated and functional, and low-fidelity when it just resembles certain characteristics of the intended model. Any method, technique or material is acceptable for building prototype models (Lucci and Orlandini, 1990).

It is important to consider that studies show that there are few differences between high and low-fidelity prototypes in terms of the number or types of problems identified in an usability test (Cantani and Biers 1998, Landay and Myers 1995).

2.1.4. Think aloud

This method consists in encouraging the users to communicate their thoughts, feelings, expectations and whatever they want to report during the usability

testing. In order to carry it out first the practitioner has to introduce the users to the method by a briefing about the instructions. These should consist in a description of how the test will proceed, and which are the objectives of the test. It is very important to state that the test is not evaluating their skills or experience with similar systems.

There are two different ways to apply the method. The concurrent thinking aloud consists in asking the users to speak as they use it. Meanwhile the retrospective thinking aloud consists in recording the test sessions and then watching the video with the user to comment it.

Bowers and Snyder (1990) indicate that there are no differences between both approaches in task performing or task difficulty rating. They also state that concurrent think aloud typically gets four times more statements verbalized but almost all are descriptions of what they were doing, reading or seeing. Then during the retrospective sessions the users “can give their full attention to the verbalizations and in doing so give richer information”.

The advantage of these methods resides in the fact that they identify relevant usability problems from the user perspective. But the practitioner has to be careful to avoid being too intrusive, and keep a balance between the friendly facilitator and the neutral observer.

2.2. Designed test plan

Evaluation was a major concern of the design team and for this reason the test plan was coordinated with the development process to set the milestones. It was conceived as an iterative process divided in three phases, each one corresponding to a different prototype.

The table 2-1 summarizes the test plan as it was initially conceived. The overall system would be evaluated during all the phases, but each phase would be focused in a particular set of issues. For this reason the evaluation methods would be selected according to the needs and requirements of each phase.

It was desirable to implement the findings and observations of each test as soon as possible, without waiting for the next phase, in order to evaluate them in the next test.

In order to ensure the consistency of the tests, they should be conducted by the same operators, using the same briefing, the same script and having the same objectives fro all the tests. The result of all the tests should be documented by the same means, with a file for each session reporting the user profile, the time of the test, the recording details (identification code, and means used) and a description of the different observations regarding the corresponding objectives and the general comments.

Every phase should produce a document summarizing the relevant observations, the outcomes of the evaluation, and the measures taken, whether they introduced changes in the system or not.

Table 2-1 Test plan summary

	Phase 1	Phase 2	Phase 3
Evaluation objectives	Interface: *Buttons* *Colours* *Menus* *Font size* *Use* Structure: *Ergonomics (height and angle)*	Interface: *Use* Structure: *Ergonomics (height and angle)* *Two screens* Print out delivery	Interface: *Use* Structure: *Ergonomics* *Aesthetics* Social interaction
Number of users	10	5	-
Methods	Heuristic evaluation Usability testing, Concurrent Think aloud Task list	Idem	Idem Semi-structured interviews Questionnaires
Resources	Prototype 1 Video	Prototype 2 Video	Prototype 3 Video Audio Photos

The complexity of the evaluation was expected to increase in each phase, adding evaluation objectives and methods to the previous ones. The following sections describe each phase and how they were planed to be implemented. Then in the next chapter describes the result of the evaluation.

2.2.1. First phase

The first phase was focused in evaluate the interface (ease of use, and the size, colours, location, and shape of the different buttons, controls and menus), the ergonomics of the prototype (height and angle of the screen) and the aesthetic suggestions for the next prototype. In this case it consisted in a high-fidelity prototype, shown in figure 2.1, with the interface program running in one of the

computers and connected to one touch screen set up on a temporal structure that allowed having the touch-screen at a similar height of the proposed design.

Fig. 2.1 First high fidelity prototype

Initially the test was planned for a cast of fifteen users that would test the system in groups or individually. This included the members of the IDC, which would be considered experts, although they would do the test in the same conditions of the rest of the users. It was desired that the users profile corresponded with the wide variety of end users that would be at the Milk Market. This means that the cast of users should cover a wide range of ages, and computer literacy levels for both genders.

2.2.1.1. Usability test

The method chosen for the evaluation consisted in a usability test were the user started to use the system after briefing with the description of the project, the objectives of the test and the introduction to the talk aloud method. At the same time they were informed that the test would be recorded by video, and that a small microphone would record their comments. The video would be focused in their use of the screen and the interface, in order to identify possible issues and future documentation.

2.2.1.2. Task list

The test would consider three different tasks, that would consist first in a free use of the system and telling their impressions about it, then as second task some of them would be asked to print a recipe if they had not done it before, and finally the third task would consist in printing a recipe, checking other ingredients and recipes, and then having to find the initial recipe. Not all the users would do all the tasks, as not all would do the test in groups. The decision of how to group the users and the tasks that they would have assigned would be taken during the progress of the tests according to availability and the evaluation needs of the team.

The groups of users would test the interface and the issues that would arise of the simultaneous use of both screens. This information should be considered for the design of the final structure and is particularly relevant as it could affect the use, perception and result of the system on-site.

2.2.1.3. Checklist

The objectives of the evaluation would be listed in a categorized checklist in order to be able to verify the observation of each of them a significant amount of times. The test operator would be responsible of setting the recording of the experiment, as well as verifying the objectives checklist, taking notes of the different observations and the relevant comments of the users during the test, as well as conducting the interview and discussion after the walkthrough.

2.2.1.4. Heuristic evaluation

The evaluation team should find a set of heuristics applicable to the evaluation of the interface, and the structure. The team members would be the experts applying the method and analyzing its result.

2.2.2. Second phase

The second phase of the evaluation test would be carried out with a second version of the prototype including the improvements suggested during the previous phase. Users would use a prototype with the same structure but with two functional screens, and with the printer located into the structure in order to simulate the final design. The objectives of this second phase would be focused in the social interaction around the installation, and the integration of all the functional parts of the system.

It would take place at the IDC, with five different users. Three of them would be selected among the participants of the first phase, in order to state and analysis the evolution of the prototype. The other two users would be using the system for the first time.

The evaluation methods would be the same from the previous phase, focusing in the design aspects of the structure, as well as the aesthetics. The resulting observations would be considered for the implementation of the third prototype.

Unfortunately this phase of the evaluation could not be accomplished due to unforeseen difficulties with the development, and the users' availability, as it is described in the next chapter.

2.2.3. Third phase

The third phase would correspond with the final and fully functional version of the structure and the system. This could include the evaluation of the space surrounding the installation, which includes all the elements covered by the marquee and the communication means used to offer visibility to the overall installation. It would be carried out at the Milk Market focused in the evaluation of the social interactions that may emerge around the Recipe Station.

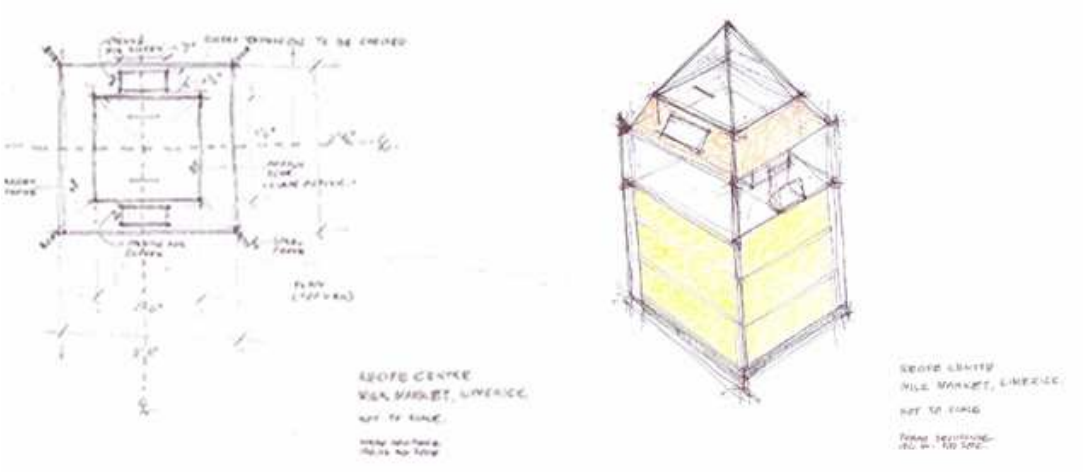

Fig. 2.2 Sketch of the final prototype

2.2.3.1. Data mining and evaluation methods

The expected social interactions would be evaluated by the first time on site. For this reason it was important to test in advance the positioning of the video cameras in the marquee hosting the Recipe Station. This should consider the location, the movement of the users and the evaluation objectives. This particular evaluation task should be done at the IDC installing the marquee and finding or creating the suitable means to ensure the proper recording of the social interactions and the interface use. This would require the use of two different video cameras in different angles.

The design team should also define the means to capture the evaluation data to complement the video recording. The semi structured interviews would be carried out by two members of the team and this would require discussing and agreeing a common model of interview, sharing objectives and methodologies, in order to ensure the consistency of the test.

2.2.3.2. Particular issues

This phase of the evaluation would have to sort several logistic issues. The design team would have to bring to the Milk Market not only the Recipe Station all the components of the system (cards, marquee, extra paper rolls, and

advertising elements) but also all the evaluation equipment and the required tools to set everything up. This includes from pens and notebooks, to the video cameras with extra supplies (tapes, batteries, etc), and tools for cutting plastic ties, duct tape, etc.

It was advisable to create a checklist with all the essential elements in order to avoid forgetting any of them before going to the market.

The design team should also find a mean to transport all the material to the Milk Market and the team members. Apparently the best option would consist in hiring a van big enough to carry all the material but not too big to go through the entrance arch of the Milk Market.

CHAPTER 3 TEST IMPLEMENTATION

The execution of the test plan encountered several difficulties that obliged to change the test plan. The details of each phase are explained, in the following sections and summarized in the table 3-1.

Table 3-1 Summary of the implemented evaluation

	Phase 1	Phase 2	Phase 3
Evaluation objectives	Interface: *Buttons* *Colours* *Menus* *Font size* *Use* Structure: *Ergonomics (height and angle)*		Interface: Idem Structure: Ergonomics Aesthetics Two screens Print out delivery Social interaction
Number of users	15	0	-
Methods	Experts evaluation *(5 users)* Usability testing *(10 users)* Concurrent Think aloud Task list Checklist		Think aloud Semi-structured interviews Questionnaires
Resources	Prototype 1 Video		Prototype 2 and 3 Video Audio Photos

3.1. First phase: Evaluation at the IDC

The first phase lasted for two weeks, and fifteen users tested the prototype at the IDC. Ten of the users were post-graduate students from the UL, and the five

others were members of the IDC, which were considered as experts due to their experience with similar projects and their knowledge about HCI.

The tests were done individually and in groups of up to three users. All the users received the same briefing, avoiding explaining how to use it in order to evaluate the intuitiveness of the design and the need of instructions. All the tests were recorded on video, focused in the screen to evaluate the use of the interface, and conducted by two members of the team.

The users were encouraged to think aloud their impressions and feelings during the entire test. Both of the practitioners participated giving hints, and suggesting topics to the users. After the test both shared their notes and observations and decided the modifications and the timing to implement and evaluate them.

Fig. 3.1 First prototype as it was evaluated (right) and detail of the interface (left)

3.1.1. Users profile

One of the first difficulties found during the first tests was the availability of a wide variety of users. As the tests were conducted at the IDC I could only cast the users among the university students. The first users were part of the post-graduate students from the UL They agreed to participate in the tests attending to the existing friendship and the offer of tea and biscuits after the test.

It can be argued that this reduces the representatives (the value of the representation) of the results of the test as the users did not correspond with all the profile of users considered during the design process. This turned into a major concern during the evaluation process of the first prototype as the system could not be tested by elderly users. In order to reduce this lack the users were asked during the test about the suitability of the system for old people, persons with sight problems or even big and rough hands (according with the farmers profile in this case).

The first users tested the system individually. In order to evaluate the intuitiveness of the interface the users would not be explained how to use the system.

It was observed that when the briefing included references to *"introduce a card in it"* (without specifying where or how) the users had less difficulties or showed less doubts at the time to start using the system. When the test was done by a group of users only the first user expressed doubts about how to use the system, and the rest of the group participated actively to solve them, stating the collaborative process associated to the discovery of the system.

3.1.2. Number of users

Most of the problems with the interface were identified and covered with the six first users, and the rest of the users identified very few new problems. This confirms the observations done by Virzi (1990, 1992), as five participants cover 80% of the problems, while ten participants cover 90% of problems.

3.1.3. Task lists, and checklists

The three different tasks lists were used mostly as script for the test, and were formally applied only in four occasions, showing that they were not particularly useful for retrieving new information. This was attributed to the simplicity of the system that consisted basically in four steps. At the same time this allowed us to confirm the ease of use and the good learnability of use of the system by the users.

Another document used during the tests was the checklist with the evaluation objectives. This document was redesigned twice in order to facilitate the work of the test operator. First the objective statements were reduced to a schematic expression and organized in according to order suggested by the users. This can be considered as a spontaneous heuristic modelling of the prototype that helped to understand how the system was perceived. But during the following tests it could be observed how the vision of the system by the users was heavily biased by their background. The students with a technical background focused in the technical and implementation aspects of the system, while the students with a background in marketing and business were mainly concerned about the visibility and promoting aspects of the system.

As result it seems that the checklist could be organized the criteria of both, the users and the operator, although it is important to keep in mind the importance of the consistency of the different tests before changing any of the working documents. If they are changed in every test it is possible that the evaluation loses experimental rigor as the tests are not conducted in the same conditions. For this reason the changes of the working documents were cosmetic and did not affect the content of them.

3.1.4. Experts evaluation

The tests with expert users were undertaken in a more informal way, without recording the video and only reporting their observations in the checklist (only in two cases) and taking notes (all the cases).

At the time of documenting the tests it was shown that the amount of data available was considerable, and it was increased with the analysis and processing of the video information. For this reason the video was only processed to document certain aspects of the evaluation, especially in order to show the evolution of the interface.

3.1.5. Result of the evaluation

The outcome of the 10 tests carried during the first stage of the evaluation resulted in a document that summarized all the observations mentioned by the users, grouping them according to the objectives list, and including the number of times that observation had been commented by a different user. It also included the summary of the suggestions for the design of the structure made by the users.

This document was used in the team meeting to state the changes done during the first evaluation cycle and as working document for the design of the structure of the Recipe Centre. Regarding this it was observed that the users could not perceive the pyramidal design as related with food that the dark colours of the structure of the prototype were not inviting, although the overall design of the prototype was perceived as surprising and hi-tech. The initial impressions of the design were overcome by the use experience that in general was considered a pleasant experience.

3.1.5.1. Test results

The tests helped to identify twenty three different problems in the interface that derived in the corresponding modifications. Five design considerations were included in the final design, and two major concerns of the design team (shape of the Recipe Station was not related with food, and the design was not appreciated), while a serious concern was demystified (the screen was small but was enough).

The tests were open ended, and users were encouraged to share any kind of observation. Moreover, after the test all the users were invited to tea and biscuits, offering an opportunity for a more relaxed conversation. This showed to be a great opportunity to get a better insight of the impressions and concerns of the users.

The task list showed to be too complex and unnecessary to conduct the test, because the workflow of the interface had very little options. But it was very useful as a walkthrough to analyse the interface.

3.2. Second phase

This phase of the evaluation could not be done due to the difficulties found during the building of the second prototype. The second touch screen was broken by accident, and the new structure of the prototype could not be built on time. When these problems were solved the users were unable to attend the tests due to schedule problems.

For this reason the second prototype was tested in the market, with a whole new structure and a top part finished in aluminium.

3.3. Third phase: Evaluation at the market

The rest of the evaluation took place at the Milk Market, with real users. The Recipe Station was installed in five different weeks from the 13th of January to the 20th of February (note that the Milk Market is a weekly event taking place every Saturday morning from eight o'clock in the morning to two o'clock in the afternoon, approximately).

3.3.1. Different prototypes

This phase was intended to evaluate the third, and supposedly, final prototype. The fact that the second phase of the evaluation could not be undertaken the aesthetics of the second prototype were not tested before going to the market.

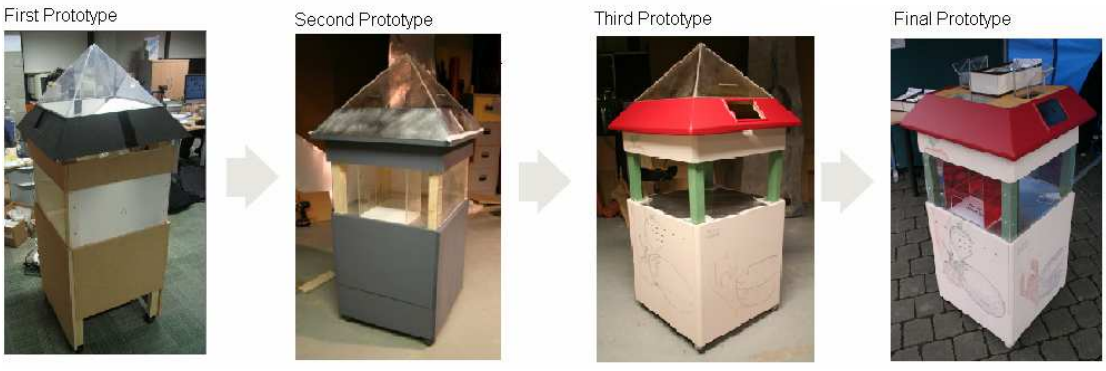

FIG. 3.2 Evolution of the different prototypes

The result was that this second prototype, made of wood and covered with aluminium and grey paint, received a very cold welcome by the users, who

disliked the design "*grey, cold, and unfriendly*". But after its use most of the users appreciated the system as a "*great idea*".

Most of the users had to be encouraged to use it.

These observations led to the building of the third prototype, which received better appreciations and was more attractive for users. Finally the prototype had to be adapted to substitute the transparent pyramid at the top as it got broken during the way back to the university on the second day at the market. This final version of the prototype included several minor changes suggested by the users and the observations and according to the interviews it improved the overall perception of the system by the users.

3.3.2. Evaluation

3.3.2.1. Difficulty in casting representative users

The testing team was concerned by the fact that the profile of the users testing the prototype in the laboratory was not representative enough to guarantee the validity of the testing. This concern was present since the beginning of the tests, and was included during the tests and the evaluation of results by asking the users about their perception of the system from the perspective other persons different to themselves (elderly, handicapped, or just tall, short, etc). It can be argued that this was a flaw of the evaluation, and that these topics should be evaluated by real users that feature them.

But the evaluation on site showed that there were no particular differences between the observations made by the testing users in the laboratory and the final users in the market.

3.3.2.2. Data mining in public spaces

The main issue of the evaluation in the market consisted in the difficulty of gathering information from the users. Visitors to the market were reluctant to participate in interviews; no matter it was a questionnaire, or a semi-structured interview.

The video recording was affected by the environmental noise, and the light changes. And the use of a professional sound recording system was not enough to acquire a useful sound record of the user interaction with the system.

Fig. 3.3 Testing the video cameras location

The practitioner is the most reliable source of feedback, but it was found that during the interaction with the users it was easy to bias the interviews. To avoid this, the interviews were carried out by two members of the design team, one taking a more active part and sharing their observations afterwards. This showed to be an effective method when the system had only one touch screen (two first days at the market), as users were using the Recipe Station one by one.

It was extremely difficult to supervise together the use and the interviews when both of the screens were working. The amount of simultaneous users and the emerging social interactions to observe increased considerably, especially in the fourth and fifth day.

3.3.2.3. Evaluation methods for public spaces

The evaluation methods available today are designed to be applied in a controlled environment like a laboratory or the working place of the final users. None of them consider the difficulties associated with the evaluation in a public space and for this reason their application results to be more complex than usual.

The experts' evaluation offers very little information since there are no specific guidelines, or heuristics for these cases.

The usability testing seems to offer the best results, but during its planning it is vital to test and evaluate the own methods of data gathering, like video and audio recording, interviews, etc. The difficulties to retrieve the desired information from the users are very difficult to foresee.

Moreover the practitioner has to realize that his presence during the evaluation is intrusive, and that the social constraints are more present than in a private space. These constraints might prevent several users to give clear and honest feedback, since the social space requires an unconscious exercise of telling the others what they want to hear in order to be in good terms together. At the

same time it is not surprising to find users that feel reluctant to participate in a artificial situation as the evaluation of an artefact in a public space.

The overcome of these difficulties depends entirely on the skills of the practitioner, and provably the increase of experience in this field would improve the results.

3.3.3. Technical aspects

The technical development of the Recipe Station included several challenges that were addressed during the iterative evaluation process. However, there were certain problems that would require more work from the design team.

- **Screen**: The screen was perceived as big enough, although it would have been appreciated if it was bigger. Moreover in the sunny days the bright light created a lot of reflection that complicated their use.

- **Communicating instructions of use:** The design team experimented with different solutions to communicate details of the system like were to pick up the recipe, or were to introduce the cards with the intervention of anyone.

  The solutions with light and/or sound signals had to be discarded due to the environmental factors (in day time no one would notice any light, and the surrounding noise would mask any noise). The animations with diagrams of the station were the most successful solution, although the observation of other users was the most effective.

3.3.4. Aesthetics

The design of the first prototype was perceived as surprising and strange. None of the users considered it related with food, and most of them argued that they would need to be introduced to the system, as they would have never guessed what it was about by seeing it, although some of them recognized that having such an unusual shape would make them feel curious

The comments about the first prototype focused in relating it with technology (several comments similar to this one; *“looks like a spaceship”*) and it was perceived as *“cold”,* and *“not inviting”.*

The second prototype was perceived as *“home made”, “unfinished”,* and *“fun for kids”*, especially due to the crayon drawings. At the same time one user considered this detail by saying that “*doesn’t look professional”.*

3.3.5. Use

The interviews showed that most of the users were highly satisfied with the system after the use. In their opinion it was a great idea and most of them would use it in the market.

These were just some of the reactions of the users:

"Cool",
"Great idea!",
"I am vegetarian, I really need this",
"it had to be done before"

"You are taking this around the supermarkets, and the cities, don't you?"
"I loved to see the cards inside, that was the way to see it related with food"

"Magic, it's magic." (Tom)
"Who is organizing all this?" "What's the purpose?" (man, 70 years old)

Fig. 3.3 Examples of reactions of the users after using the system

Although most of the comments were positive there were also complains. As for example the case of a middle age man that after using it for thirty seconds left after grumbling *"I have plenty of recipes at home".*

Apart from the comments from the users the most interesting insights came from the observation during the use of the Recipe Station and the

3.3.5.1. Particular observations

Some of the most interesting comments were related with the applications suggested by users. We identified a group of users that used the Recipe

Station more than one day. In these cases two different motivations were observed:

- **Getting a recipe after buying certain ingredients:** Users were interested in cooking something in particular, for example leeks pie. So after buying the leeks they wanted to get a recipe.

- **Buying ingredients after getting a recipe:** Users were coming to the Recipe Station to get a recipe for the day, and then they would buy the corresponding ingredients.

The first observation corroborated the use expected in the design concept, proving that the Recipe Station could complement the current use of the Milk Market.
Meanwhile the second observation is much more interesting as it means that the Recipe Station created a new way to use the Milk Market, and confirms the marketing opportunity represented by custom interactive artefacts.

Other interesting comments from users were related with the possible applications of the system:

- **Handheld device for kitchens:**
  One of the users was a chef in a Greek restaurant and suggested us to adapt the system to a handheld device to be able to access to recipes without needing heavy and uneasy books. This could be adapted for a domestic use and commercialized.

- **Paying service for supermarkets:**
  Several users suggested that the service could charge a small amount of money for the print outs (between 20 and 50 cents).

These can be seen as ideas for possible future developments, and at the same time shows how the Recipe station was perceived as a useful idea.

3.3.6. Social interactions

The social interactions fostered by the installation could only be evaluated in the last phase of the evaluation, when it was installed in the market. In addition to this the simultaneous use of both touch screens could not be tested until the third day at the market, because one of them got broken during the building process.

Different roles or levels of engaging were identified during the observations on-site:

- **On-lookers:** People passing by, paying more or less attention to the installation. They may notice the installation and take a look but not even stopping to figure out what it is.

- **Explorers**: People that would explore the space and the system, checking the cards, discovering the operation of the system by their own or by observing other users. They may leave at any stage or become users. It was usual to find cases of collaborative exploration with estrangers.

- **Users**: People using the Recipe Station

- **Teachers**: It was common to find users introducing others to the operation of the system. The collaboration could be observed in different levels, from letting others to observe what they were doing (for example using the touch screen), to actively explain them the operation of the system.

All these roles were assumed by persons of all condition, gender, and age, with strangers or with acquaintances.

These different levels of engagement were expressed in terms of discovery, enjoyment and collaboration. The use of the Recipe Station turned out as a playful activity that fostered the collaboration between strangers, and the social interactions.

Most of the interactions took place around four activities: Sorting through cards, using the touch screen, picking up the printed out recipes, and figuring out what the system consisted of.

3.3.6.1. Examples of the engagement process

Many of the interactions with the installation involved individuals first observing the scene around the installation and then becoming increasingly engaged with the installation (figure 3.3 shows a particular example of this). This process of engagement was in keeping with how market users become engaged with stalls in the market by first observing the scene and then coming into interaction by the qualities of the scene. In the case of the Recipe Station the social and playful aspects which had direct correlation with the content of the market.

Fig. 3.5 Example of user increasing her level of engagement

Teaching and learning occurred in collaborative and coordinated efforts between members of groups, many previous users of the station tutored new users. Many of the collaborations in learning were between the young children and adults, with mostly the children providing the tutelage, as figure 3.5 shows.

Fig. 3.6 Example of diferent roles during the engagement process. The girl in brown is teaching how to use it to a stranger, while the woman is exploring.

Children were especially active exploring and discovering the Recipe Station. Apart from their tutelage to teach the use of the system to adults, they also explored intensively the structure and the playful details of the Recipe Centre.

Fig. 3.7 Children enjoying using and exploring the Recipe Station

The fact that the recipes in the stations database were recipes contributed by market users (see figure 3.7) attached social and affective meanings to the content the installation provided. This allowed experienced users of the space to share and express their personal knowledge of food in the market thus augmenting the existing social exchanges surrounding food. The content of the recipes sparked conversion and discussions regarding the cooking and the market produce which was part of the recipe ingredients.

Fig. 3.8 Recipes sent in by market users

CHAPTER 4. RECOMMENDATIONS

The objective for any installation of this kind usually is to improve the process of engagement. This means to increase the amount of people that goes from being on-lookers to active users by exploring the system. How to achieve this is one of the main questions to be addressed by all the disciplines involved with this kind of projects, and far beyond the scope of this report.

This chapter focuses in the recommendations suggested for the design and development process of similar projects intended for public spaces. Obviously this includes the evaluation issues as an integral element.

4.1. Design and development process

The experience of the Milk Market project confirms the suitability of the HCI perspective and the UCD philosophy to develop interactive installations for public spaces. The benefits of this perspective has been discussed in the previous chapters

4.1.1. Communication problems in multidisciplinary teams

Ideally the HCI approaches problems and challenges from a multidisciplinary perspective. This is by having different discipline specialists combining their knowledge to address a problem. But it is possible that one of these discipline specialists, for some reason, takes the leadership imposing their perspective over the others. Apart from the reason behind, this can derive to an analysis that ignores and avoids the benefits of the multidisciplinar approach.

In our case this is exemplified by the previous deep and extensive analysis of place, which academically resulted in a very interesting work, but that from the practical point of view, failed to identify certain factors crucial for the implementation and development of the concept design.

This can be attributed to the difficulties in communication that arise in multidisciplinar teams, and the lack of a common view, as it is discused in the following section.

4.1.2. Multidisciplinarity and the need of a common HCI background

Multidisciplinarity involves new challenges in the communication and the coordination between the members of the design team (or teams). The fact that they may have their own knowledge, operating procedures, methods, view of design process and means to communicate about the design, can lead to problems of communication, misunderstandings, and conflicts of interests within

the team, specially since they may also have different responsibilities according to their knowledge background.

It is easy to state the need of collaboration between the members of the team to overcome the mentioned difficulties caused by the multisciplinarity.

Kleismann (Kleismann et al. 2007) addresses this issue in industrial design teams and recommends the creation of a shared understanding of the design process and the design content. The shared understanding is defined as:

> "*the similarity in the individual perceptions of actors about either how the design content is conceptualized (content) or how the transactive memory system works (process)"*.

Considering that the communication about the design content is seen as the most difficult kind of communication when trying to reach shared understanding (Olson 1992), it is important to understand the factors that influence its achievement.

From the point of view of the team members (actors) identifies the following as the main factors:

- The ability of an actor to make a transformation of knowledge
- The similarity in language used between the actors

The transformation of knowledge refers to the need of adapting and transforming their inner knowledge in order to express it in a way that is clearly understood by the other actors/team members that lack of that particular knowledge. The similarity in language can be seen as how similar is their knowledge so they can express ideas an concepts using common terms and perspectives.

There are other factors like the experience of the actors, and their empathy about the interest of a task but we consider them dependent of the two main ones, as the experience is one way to learn a common language and how to transform knowledge while the understanding of the interest of a task can also depend of the experience and is facilitated by the use of a similar language.

Once both factors are identified it is important to see how to act to minimize their impact.

From our experience with the Milk Market project we propose to use the HCI discipline as common knowledge that would offer the required communication tools as common concepts and terms, as well as an overall perspective of the design process, stating the relation and importance of its different stages.

This is possible due to the multidisciplinar nature of HCI, as it comes from the interjection of several disciplines concerned with the design, evaluation and

implementation of computing systems for human use and with the study of major phenomena surrounding them. (Hewett et al. 1996).

If a design team receives formation in HCI their members will find much more easier to transform the knowledge about their discipline in terms of a knowledge in common for all of them. At the same time they will share the same perspective about the design process and the importance of evaluation as an integral part of it. This would facilitate the understanding of the design process as an iterative cycle centred in the user and the evaluation, knowing the priority tasks in each stage and their dependencies.

4.1.2.1. External mediation

When members of the working team collide with different views about the project the mediation of an external agent might help to clarify the terms. It can be argued that this should be the task of the manager, but in our opinion it might be more helpful if the mediator has no relation of power with the members of the team, but an insight of the project and experience in the field.

4.1.3. Technical aspects

Most of the technical problems addressed after the installation in the market were related with design flaws of the structure of the Recipe Station. Users could not see were the recipes were delivered without turning around the station, and during the sunny days the screens were difficult to see due to reflection.

The expert evaluation pointed out these problems but the design team was committed with the design concept and did not include any modification to address them in an earlier stage.

This states the need of having a common perspective of the development process and the priorities in every stage.

4.2. Public spaces

As stated before, the public space emerges as a very important factor when designing any kind of installation for it. It constraints and affects all the stages and dimensions of the design process.

Ethnographic and observational studies can provide an insight of the reality and the deep aspects of a social environment, their passive nature makes them suitable just to gather descriptive information. This information does not guarantee a deep understanding of it, as most of the operational insights of the place require to the researcher a considerable amount of empathy to understand the practical implications of any change in the operational cycle of the place.

Including the public space as scenario for the early evaluation and prototyping of all the design concept helps to get the feedback that can confirm which aspects are doable and which are not (or just not recommendable).

4.2.1. Evaluation

The following list summarizes the main recommendations to take in consideration for the evaluation in public spaces.

- **Use complementary evaluation methods:**

  There is not a perfect method that identifies the 100% of the usability problems. Moreover most of the usability evaluation methods are subject to evaluator's influence when analysing the data gathered from the tests.

  > *"When four research evaluators with extensive knowledge in HCI evaluated the same four usability test sessions, almost half of the problems were detected by only a single evaluator, while just 20% of the problems were detected by all evaluators. […] Moreover, the evaluators disagreed substantially in their judgment of what constituted the ten most severe problems." (Jacobsen and Bonnie 1998)*

  For this reason it is important not to rely only in one method and to share the evaluation tasks among more than one evaluator. It is also a good practise to contrast and comment the observations and the methods with external HCI practitioners.

- **Plan and test your data mining methods**

  Recording a usability test in a public space is much more challenging than in a controlled environment like a laboratory. The environment will affect the data recording, and the possible sources of interferences are countless (from people passing by to kids playing with the installation, ambient music, changing light, etc). The best way to identify these factors is planning and testing the intended methods and tools before starting the evaluation.

- **Prototype all the elements of the system, and evaluate them in the final setting as soon as possible**

  The best way to get an insight of the public space is testing a prototype. Testing the design concept in early stages of the development process with mock-up prototypes allows identifying possible flaws that could determine the viability of the system.

  As Rohn and Braun (1993) state 80% of the maintenance is due to unforeseen or unmet user requirements, and as Pressman (1992) notes

80% of software life cycle costs occur during the maintenance phase. This shows the importance of identifying, as soon as possible, the factors that might compromise the implementation of the system.

These factors are more numerous in public spaces, and very difficult to predict and recreate in laboratory. For this reason it is important to prioritize prototyping all the elements of the system and their evaluation in the public space.

In the case of the Recipe Station this was not done, and one of the most interesting elements of the concept design (the participation of the stall owners delivering the cards) showed to be unfeasible when the system was deployed. The design team managed to overcome this difficulty by creating a delivery system that needed four evaluation cycles to be satisfactory. Detecting this issue in an earlier stage would have produced a better delivery system and changes in the design concept impossible to address in the late stages of the development process.

- **Identify the stakeholders of the project/system and get them involved during the design process**

  As the previous example illustrates the involvement of the stakeholders in the development process might help to identify possible flaws of the design concept. In that case the stakeholders that were not involved in the design process were the stall owners. They were asked to participate by giving recipes, and informed about our plan, but they did not evaluate it.

CHAPTER 5. CONCLUSIONS

5.1. The importance of HCI

The HCI discipline has proven to offer a set of tools and requirements very useful for the addressing the challenges associated to the design and development of the interactive Recipe Centre, and in particular those related with the public space were it was installed.

First it offers a theoretical framework to study the different factors that affect the project, from users to place including their interrelation. This helps to capture not only the user requirements but the design requirements like aesthetics that will influence all the other stages.

Second, it provides the UCD philosophy that helps to organize and plan the development process focused in the needs of the users, and how to evaluate their fulfillment.

Third, it can be used as a common background in multidisciplinary teams, facilitating communication between the team members from different disciplines. By this they can achieve a common view of the project and an understanding of the priorities and the goals of each stage of the development process.

This means that the risk of internal problems within the team members due to misunderstandings and unshared objectives could be reduced, as they may be able to express their particular knowledge or view in the common terms of HCI.

The best way to achieve this might be by forming/educating the team members, which could be expensive and hard to do, specially in business world.

5.2. The importance of evaluation and usability testing

The iterative process of implementation and evaluation allows to create better products, and involving the users putting them at the centre of the development process allows to create more satisfying products. Definitely the user-centred design model offers much more benefits than downsides, and it is worth implementing it in any development process.

It is a design philosophy that places the priorities in satisfying the user, and therefore, the client. It can be applied not only to the development of artefacts or software applications, but to any product. And this includes from the concept ideas to the creation of documentation.

5.2.1. Evaluation is neither easy nor complicated

Evaluation might seem a straight forward task, but it requires planning and analysis. It is important to define clearly the objectives of the evaluation, but at the same time the evaluator has to be flexible enough to perceive unforeseen issues that may emerge during the evaluation.

Evaluation has to become an integral element of the development process and for this reason it has to be tested and improved iteratively. It is better to start the evaluation with a sketched plan and a mock-up prototype than designing an extremely detailed plan and postpone the evaluation.

5.2.2. Need to cope with ambiguity

The evaluation helps to identify clear usability problems that can be addressed with more or less technical difficulties. But the practitioner has to be ready to work with certain level of ambiguity associated with the qualitative data gathered and the open ended nature of the observations. Engineers might find this ambiguity confusing at the beginning as they are more familiar with quantitative data. This requires an adaptation period of time that can be shortened by working in multidisciplinary teams with experience in evaluation.

5.3. Environmental evaluation

During the development of the Recipe Centre the design team avoided the use of paints containing lead, and polluting dissolvent. In the case of chloroform, used to glue the pieces of the pyramid made of Perspex, it was handled according to the Irish regulations.

The design team made all the efforts to reuse technologies that were already available at the IDC. After building the structure all the spare materials were classified between those that could be kept for a future use in the IDC, and those that had to be disposed. In the last case the materials were classified and disposed in the corresponding recycling container.

5.4. Future lines of development

The evaluation of the Recipe Station at the Milk Market brought up several conclusions. The system was perceived as a “great idea” and users found several applications, some of them surprising and interesting as the section 3.3.5 illustrates.

Once the suitability of the design concept has been proved the next stage in the development of the Recipe Station should take the following directions:

- **Redesign as a stand alone system**

In order to deploy the Recipe Centre as a stand-alone installation it should be redesigned to be as

- **Evaluation of alternative designs**

Another option is to drive an exploratory research evaluating alternative designs in order to identify design factors for interactive artefacts for public spaces. This would help to take design decisions about which is the best strategy; standing out or integrating the design in the environment, or how to keep a trade of between both.

This research would require the development and evaluation of three different prototypes, at least. These can be low fidelity prototypes to evaluate de design concept, facilitating the research and reducing the research cost.

5.4.1. Study of the business opportunity

The experience at the Milk Market showed that there is a business opportunity in designing custom interactive installations for public spaces. Weiser's (1991) ubiquitous computing model, where computers would be present everywhere waving into the fabric of everyday things, is complemented with the information appliances (Norman, D., 1998), tools designed to perform a specific activity, such as music, photography or writing.

The model proposed with the Milk Market project consists in designing an interactive installation to perform a specific activity customized to merge with the place engaging it nurturing new ways to use it. The artefact turns into a service that might be available only in that place, augmenting and enriching it.
This is particularly interesting for historical and traditional public spaces where technology is not present and difficult to introduce without altering the nature and the balance of the place. Our design proposal ensures the integration and the respect of the place, understanding the needs of the users and improving their experience of the place.

There are two business opportunities identified directly related with the Recipe Station:

- Adapting the Recipe Station to similar places
  This would consist in finding new places and enterprises interested in hosting an evolved version of the Recipe Station. These might be supermarkets, malls, farmer's markets, etc.

- Designing customized solutions under demand
  The experience gained during this and the precedent projects allows the IDC to be able to face the challenge of designing any custom installation for public spaces.

Moreover, there is a third business opportunity in commercializing the know-how acquired at the IDC. This could be done at two different levels:

- Consultancy for building and evaluating interactive installations for public spaces.

- Formation in HCI for business and enterprises based in multidisciplinary teams. As the sections 4.1.1 and 4.1.2 state the HCI knowledge can improve the outcomes of multidisciplinary teams, and what is more important, reduce the difficulties associated to them. It is possible that proving the proposed hypothesis would require further research, but the evidences presented in this report strongly suggests its viability.

5.5. Personal conclusions

It is not easy to summarize the personal conclusions learned from this project, especially considering the challenge or learning and working with a completely new discipline in a foreign university. The development and evaluation of the Recipe Station meant a great challenge and a great opportunity to work and study in a foreign university, and the University of Limerick in particular. Forming part of the IDC was a pleasure and a challenge too, as a big effort had to be done to keep in with the high standards set by their members

Synthesizing all this experience in only 50 pages forced to focus in just certain aspects, leaving apart many others. This showed to be a difficult task as the amount of lessons learned during the different stages of the development process are countless, and very useful for the future challenges.

This experience also allowed me to discover a new discipline as the HCI, that proposes a more humanistic perspective in enginering projects. I find this particularly interesting and in my opinion opens the door to a lot of applications in the future. Moreover I consider this experience allowed us to identify great opportunities around HCI and for the design of custom interactive installations for public spaces in particular.

The success of the Recipe Centre is hard to quantify but the perception after the analysis of all the data gathered is very positive. The users provided very enthusiastic feedback after using it, proving that it was a great ideal. We could confirm that it was perceived as a novelty, as a technological artifact very easy to use, and useful. It fostered social interactions at all the levels, from the on-lookers (commenting and wondering about it without taking part), the visitors that were curious and stopped there trying to discover what it was, to the active users that enjoyed the its use. And the range of users goes from kids to grandmothers, families, couples, people alone, visitors, stall owners, etc. And this includes a wide variety of nationalities too (Irish, Polish, Spanish, French, Germans, Greeks, Finish, British, Italians, etc).

But we also realize that there were issues to be improved, that certain decisions at early stages of the design process constrained the system (size of the screens, stall owners not delivering cards). In design there is not a right or wrong proposal, just better and worst ones. As this would require further prototyping and evaluation it could not be addressed with the resources available. Moreover considering that any evaluation in a public space requires more time than the equivalent in the laboratory, especially when evaluating social interactions, the need for resources increases.

Summing up, as Aboulafia and Bannon (2004) state:

> ``*Emotions are not subordinated to activity. Emotions, such as happiness, appear to be its result and the 'mechanism' of its movement. In order to be happy, one must have some kind of goal; then striving toward it, one will experience happiness without directly focusing on it."*

In the case of the Recipe Centre it has been proved that it offered an alternative way to buy at the Milk Market. The visitors could explore the use of new ingredients that were unknown for them, and moreover, they had another objective at the time of going to the market: trying something new. Suggest an unexpected and enjoyable experience in such a conservative environment results surprising. Achieve this is a success.

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ANNEX - 1 RFID

This annex consists in a brief introduction to the RFID technology and the description of the implementation and testing of the custom RFID antennas required for the Recipe Station. These antennas had to be built and tested in one week after the evaluation of the first prototype, to substitute the former antenna from Texas Instruments, as its contour did not satisfy the design requirements.

Description of the technology

The Radio Frequency Identification technology is used to identify objects that have been tagged with RFID tags. These tags, also known as transponders, consist in a small antenna and a microchip that react sending certain information coded in the microchip when the antenna receives a signal at certain frequency.

The most common RFID systems respond to the “reader talks first” model combined with passive tags. This means that the tags have no batteries, they are only feed by the energy of the signal sent by the reader, and they will not transmit any signal unless they first receive one from the reader. The RFID systems with active tags are more expensive, as the tags have to have batteries, adding complexity to the system (batteries have to be checked and replace if necessary) and increasing the cost.

	Frequency range	Transmission ranges
Low-frequency	30 KHz to 500 KHz	< 2 meters
Medium-Frequency	3.155 MHz to 27.283 MHz	5 meters to 20 meters
High-frequency	850 MHz to 950 MHz 2.4 GHz to 2.5 GHz	> 30 meters

Table A1-1 Classification of RFID systems

The passive RFID systems operate as follows: the reader sends the reading signal to the antenna which transmits it as an electromagnetic signal at certain radio frequency. The antenna of the RFID tags, is designed to be coupled with the frequency of the signal in order to get the maximum amount of energy from it that is possible. That energy feeds the microchip which then can send back a signal with the code that has coded in its memory. The reader’s antenna receives this second signal and allows the reader to identify the code sent by the tag. By this means the reader can read information from the tags. And by the same means, using a particular set of instructions, the reader can write information in the memory of the tags programming them.

Problem statement

In the case of the Recipe Station we were using a 13.56 MHz frequency RFID system from Texas Instruments, *TAG- IT Reader System Series 6000* (formerly named as Series 320, both discontinued). We had available two readers and one antenna from the Texas Instruments system, and there was no way to acquire an extra antenna from the manufacturer. For this reason I proposed to design a custom antenna for the second reader, in order to be able to adapt the artefact for two simultaneous users using two screens and two readers.

The design requirements for the antenna were:

- It had to work with the Texas Instrument Tag-it RFID system.
- It had to fit inside the structure.
- It had to avoid interferences with the other antenna and the operation of the system.

This last point had to be thoroughly tested, not only to avoid interferences but also not to read cards before they were introduced into the structure, and not reading the cards from the opposite user.

Research

Due to the lack of time the research prioritised the finding of already made design. The design of the antenna was chosen between those available at the Texas Instrument HF Antenna Cookbook[1] document. It consists in a 150mm x 100mm antenna on a printed circuit, and it matches the requirements of the the Tag- it Reader System Series 6000 (formerly published as Series 320).

Across the parallel pads are a 10K Ohm, 1W resistor to reduce the Q to 27 and 305 pF (180 pF + 100 pF + 6 to 30 pF variable, 100V) capacitance for the resonant frequency adjustment. In series we need to solder 32 pF (22 pF + 6 to 30 pF variable, 100V) capacitance to match the antenna to 50 Ohms. It was designed to use a SMA connector but it could be substituted by soldering a coaxial cable directly to the pads to reduce cost, or just for testing.

[1] http://www.ti.com/rfid/docs/manuals/appNotes/HFAntennaCookbook.pdf

Fig. A1.1 Layout of the custom RFID antenna

Building

The antenna was build using the facilities of the Electronics Engineering Centre of the UL and the IDC laboratory. Once we had the printed circuit ready we realized that the parallel pads were not large enough to host all the components, as the original layout was done for micro components that were not available for us. We solved this problem by creating extra lines to connect them with the variable capacitor. This would at the same time facilitate the task of tuning as it could be reached more easily without touching the other components.

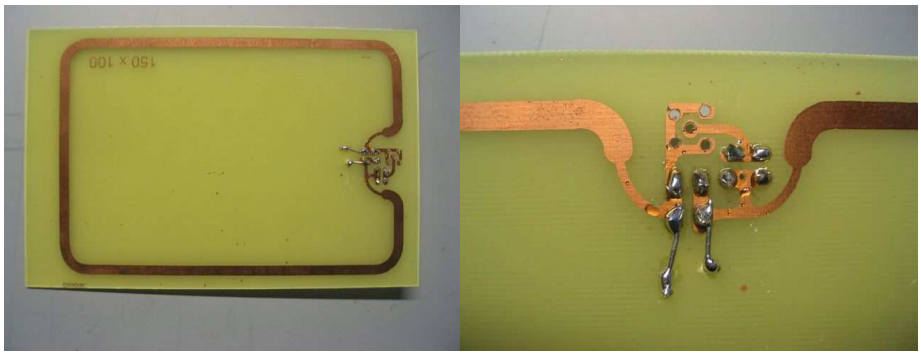


Fig. A1.2 Custom RFID antenna (right) and detail of the extra lines done to solder the components

Testing

A qualitative study was carried out to discover how the performance of the antenna was affected by the presence of different materials around. In particular we were interested in verify if the fact of using wood and aluminum in the building of the body of the recipe centre would affect the RFID system, and then making the corresponding modifications to the design of the body of the recipe centre.

We considered the distance at which the cards were read by the system, in different circumstances. In the first case we placed the antenna over a cardboard box which simulated empty space as the signal attenuation associated to cardboard is minimal. Then we placed it over wood, 2cm, and 4mm thick. Finally we placed it over an aluminum sheet of 4mm thick, first leaving no space between the antenna and the aluminum and after leaving two centimeters of free space. We also measured the distance at which the cards were read when these materials were placed between the reader and the cards. In all the cases we checked if the orientation of the card respect the reader, parallel or perpendicular affected to the reading.

The results of these experiments can be seen in the next table. The values in blank correspond with those cases were the RFID tags were unable to be read by the antenna.

	Silver side		**Cooper side**	
	Parallel	Perpendicular	Parallel	Perpendicular
Free space	18 cm	6 cm	18 cm	6 cm
Wood 5mm attached	18 cm	6 cm	18 cm	6 cm
Wood 5mm (separated)	18 cm	6 cm	18 cm	6 cm
Wood 2 cm attached	18 cm	6 cm	16 cm	4 cm
Wood 2 cm (separated)	18 cm	6 cm	14 cm	2 cm
Aluminum 5mm attached	3 cm	-	-	-
Aluminum 5mm (separated 2cm)	4 cm	2 cm	-	-

Table A1-2 Meassurements of the RFID antenna test

Note that the aluminium severely interfered with the RFID signals, as expected, while wood did not produce relevant effects.

Findings

As it is shown in the table A1-2 the presence of wood didn't affect the performance of the antenna, while the aluminum clearly did. The relative position of the cards respect the reader's antenna determines the distance at which they can be read,

Apart from these basic observations we could also state that the cards were read from a slightly larger distance (an average of two centimeters more) when they were facing the antenna with the *silver* side.

Conclusions

The results of the tests show by one side that the designed antenna worked as expected, and that it could be use in side the structure of the Recipe Station as long as some considerations with the materials and the design were made. This helped to discard the use of aluminium in the building of the structure, as it was considered during a certaing stage of the design process.

The suggested materials for the Recipe Station were compatible with the RFID system and the new antennas. The final design of the station should consider the cards are read from a further distance when they are not in perpendicular with the reader's antenna, and it should never be attached to any metal surface without leaving a certain distance.

The different performance result depending on the side of the RFID tags had no relevant implications in the system. Further research would be required to identify more clearly the reach of these observations.

These findings keep in with those expected from the theoretical approach.

ANNEX 2 - HCI and UCD

Definitions

Donald Norman is acknowledged as having coined the term User Centred Design. In the book ``The Psychology of Everyday Things'' (Norman, 1986) he emphasizes the importance of design in our everyday lives, and the consequences of errors caused by bad designs. Uses the term ``*user centered design*'' to describe design based on the needs of the user, considering issues like aesthetics as secondary.

And in the book co-edited and participated with Stephen Draper (it consisted in a collection of articles related with the area) *"User Centered System Design",* he prescribes the following recommendations:

- *Create a science of user-centered design.*
- *Take interface design seriously as an independent and important problem.*
- *Separate the design of the interface from the design of the system.*
- *Do user-centered system design: Start with the needs of the user.*

UCD is based in three principles stated by Gould and Lewis in 1985:

1. An early focus on users and tasks
2. Empirical measurement of product usage
3. Iterative design

These principles can be seen as obvious, but the same Gould shows how they are not obvious for a large amount of system designers. (Gould 1985a, Gould 1985b). Stating this has been one of the major concerns of HCI practitioners, and usability specialists, who emphasize their economical and development benefits.

By these principles UCD can be seen as a design philosophy with the objective of producing products with a high degree of usability, while HCI is the discipline that provides and improves (by research) the tools and methods to achieve it.

Usability definitions

This suggests that usability is the core issue for both, HCI and UCD, although there is no agreement about its definition. Some authors propose a wider definition, like Nielsen (1990) *"usability is the measure of the quality of the user experience when interacting with something"*, Dumas and Redish (1994) "*people who use the product can do so quickly and easily to accomplish their own tasks"* or the Usability Professionals Association "*Usability is an approach to product development that incorporates direct user feedback throughout the*

development cycle in order to reduce costs and create products and tools that meet user needs."

The standard ISO9241-11 defines usability as "a measure of the effectiveness, efficiency and satisfaction with which specified users can achieve specified goals in a particular environment".

> ``*It is important to realize that usability is not a single, one-dimensional property of a user interface. Usability has multiple components and is traditionally associated with these five usability attributes: learnability, efficiency, memorability, errors, satisfaction."* (Nielsen, J., 1993

It is easy to state that all these definitions rely on the list of four usability factors outlined by Booth (1989):

- Usefulness (degree to which a product enables to achieve user's goals)
- Effectiveness (ease of use)
- Learnability
- Attitude (user's perceptions, feelings and opinions)

These definitions may suggest again that usability is the final objective in UCD. But current research in HCI is extending its objectives. Jordan (2000) states this by his proposition of a hierarchy of consumer needs were once usability is achieved, pleasure is the next step. He explains by stating that ``when people become used to products with an appropriate functionality, then they want products that were easy to use.

After this, people want something more: Products that are more than merely tools, that offer something extra, that bring not only functional benefits but also emotional ones." This can be achieved by means of a pleasurable experience.

This view confirms that usability is only one step in the design and development of pleasurable products, interfaces, or applications. At the same time I consider that complements Booth's view by stating that his four factors of usability can be seen as a list of goals to achieve usability, set in order of importance/need. The last factor, attitude, is clearly concerned with user experience, and it is desirable that designers want it to be as satisfying and pleasurable as possible.

But this approach raises a very important question: How to evaluate and specially, to measure, pleasurability?

Unfortunately there is no clear and definitive answer to this.

The Oxford English Dictionary [http://dictionary.oed.com/] defines pleasure as:

> *"The condition or sensation induced by the experience or anticipation of what is felt to be good or desirable; a feeling of happy satisfaction or enjoyment; delight, gratification. Opposed to pain."*

This definition offers to hints to approach the challenge of achieving/applying pleasurability in the developments. First it states that is an element with multiple facets, so it is necessarily complex and admits approaches from different angles. Secondly, being ``opposed to pain'' suggests that it can be achieved by avoiding the sources/causes of pain to users.

A lot of interest has risen in the HCI discipline around this point, deriving in what is known as Affective Design, or Emotional Design. This approach considers emotions as an integral part of the user, which inevitably influence his experience. It proposes to address the sources of frustration during the design phase to eliminate them.

Origin of HCI and UCD

Neither HCI nor UCD emerged suddenly. During the first half of the 20th century the fields of industrial engineering and psychology both got involved in engineering design issues. Frederick Taylor was promoting the idea of ``the gradual substitution of science for rule of thumb throughout the mechanic arts'' (Taylor 1911) setting the bases for systems engineering.

Meanwhile psychology started to be applied to overcome practical problems in other fields like personnel selection (Scott), training, efficiency at the workplace (Münsterberg), and military design. In particular, the military developments promoted the studies about the user-interface problems, especially with aviation equipment during the Second World War. This concern with the cognitive limitations and the perceptual-motor skills derived in the foundation of the ergonomics discipline as part of the Human factors (Chapanis 1949).

Nowadays ergonomics is considered the applied science involved with the physical characteristics of people and their response to the environment
Ergonomics is nowadays the engineering discipline

Areas of knowledge that involved human behaviour and attributes (i.e., decision making process, organization design, human perception relative to design) became known as human factors. Meanwhile ergonomics is more related with the areas of knowledge involved with demographics and physiology to measure the physical characteristics of people and their responses to their environments, with particular reference to health and performance.

There is a lot of overlap in these disciplines; and most of the times are named indistinctively. However, Human Factors generally refers to hardware design while HCI generally refers to software design. At the same time Human Factors can be found referred as Ergonomics in Europe, while HCI used to be known as Computer-Human Interaction in USA. This states the multiplicity of terms for similar concepts which complicates any initial study of these subjects.

Development models for UCD

The Waterfall model was the traditional development model used by the industrial sector until the end of the first half of the 20th century. Some versions or interpretations of the model use five stages instead, but in all the cases ideally each stage has to be completed and absolutely correct, as well as extensively documented, before advancing to the next stage. Apparently this should be enough to avoid errors that would be more difficult and expensive to correct in the later stages of the process.

The Waterfall model consists in sequential system design process divided in seven stages:

1. System concept
2. Identify and analyze requirements
3. Design,
4. Implementation,
5. Integration
6. Installation
7. Maintenance.

This model is still widely used in software development and is based in extensive work of documentation in every stage and the thoroughly verification of every phase before moving on to the next one. It can be seen as a structured approach that tries to avoid errors.

According to Rohn and Braun (1993) 80%of the maintenance is due to unforeseen or unmet user requirements, and at the same percentage corresponds with most of lifecycle cost (Kitsuse 1991). Moreover the detailed documentation should facilitate the knowledge transference between members of the working team, and help to identify possible problems. These properties imply a considerable effort for documenting requiring a considerable amount of resources.

The main drawback is that the system performance cannot be tested almost until the end of the process making it is very difficult to modify or correct the errors and requirements that could not be avoided in the early stages. This situation is made worse by the lack of involvement of users during the process, as their feedback is only considered in the last stages.

For this reason there are several modifications or variations of this model that try to solve this problem. For example the Iterative Waterfall (also known as Evolution model) applies iterations of the waterfall model until it is considered necessary. It does not reduce the documenting efforts or the time between evaluations, it just applies the same model once and once again.

The Spiral model was proposed by Barry Boehm (1986) to combine aspects of the rapid prototype, the waterfall model and risks analysis. It is intended for

large projects, as the iterations were originally envisioned to be from 6 months to 2 years long.

The users are involved in the requirements definition stage to define the as much in detail as possible, and then a first prototype is implemented and evaluated. The evaluation considers the strengths, the weakness and the risks analysis. The corresponding conclusions are considered for refining the requirements of the next prototype and involve again the users. These iterations are done as many times as it is needed until a final system is obtained, which would reach the last stage, maintenance.

The Spiral model combines the involvement of users in the process, the prototyping and the evaluation including risks evaluation, involves users during the requirements definition stage, at the end of the prototyping stage, which is iterated until the user or client is satisfied.

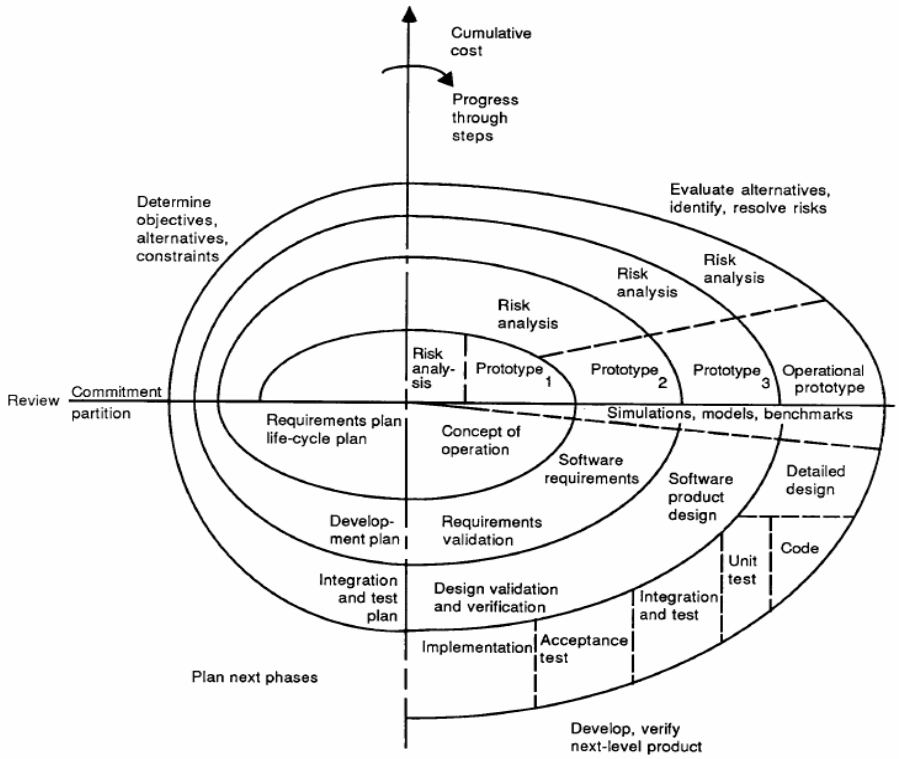


Fig. A2.3 Spiral model

The spiral model is intended for projects that last two or more years, and was designed to be integrated in the business cycle.

For shorter projects there are other alternative models available. For example Rapid Prototyping is an iterative model based in the development of small-scale prototypes since the early stages of the process. The prototypes are evaluated with the user and the conclusions are used to refine the requirements for the next prototype.

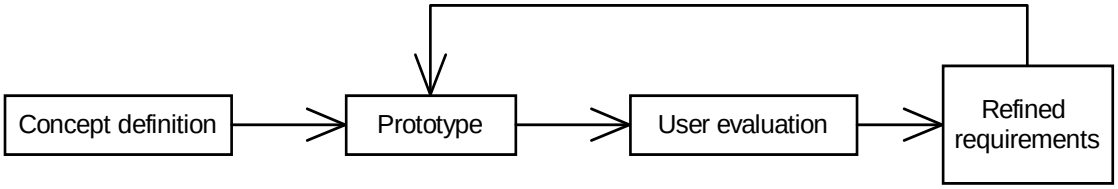


Fig. A2.4 Rapid Prototyping model

This is iterated as many times as it is needed. This model recommends the use of low-fidelity prototypes to reduce the time devoted to each cycle. For this reason is known as Rapid Prototyping.

Shackel (1991) proposed an alternative model based in 5 stages for any kind of project. Feasibility phase investigates the potential success of the proposed system. Then the research phase focuses in the requirements analysis in order to be ready to start the prototyping phase. Then the development phase continues the iterative usability testing with an evaluation plan, and team meetings are held to verify the progress of the project. Finally the operation phase focuses in the installation of the system.

Lindgaard (1994) proposes to integrate the prototyping into all phases and relevant points of the development process.

Rubin (1994) proposes a similar model, with more detailed phases but relying on the same principles.

These are just some examples of development models that can be find in the related literature. There are other numerous models, like the Star lifecycle (centred in evaluation for software development, but lacking of order, which may result in difficulties for large projects), or the standard ISO 13407 *("Human-centred design processes for interactive systems"*, a formal framework to introduce usability in the software and interactive systems). The design team has to decide whatt model is more suitable for the requirements of the project.

ANNEX 3 - DOCUMENTATION

This chapter includes some examples of the documentation developed and used during the different stages of the implementation and testing of the Recipe Station. The task list was designed as part of the test plan, as well as the test objectives. The test reports correspond with those undertaken at the IDC with the first prototype. The examples include one of the first tests and one of the last ones, to exemplify the evolution and the kind of observations done. Finally it shows the questionnaires that were used at the Milk Market during the evaluation.

A. Task list
B. Test objectives
C. Test reports
    a. Examples
    b. Summary
D. Questionaires

Task list

The following task list was defined as a set of three tasks covering all the usual combination of steps. The simplicity of the system did not allow to create more complex tasks. Each step included the corresponding test objectives for that step, and the hint that could be suggested to the user. This was done in order to ensure the consistency of the tests.

Task List

TASK 1: Go through the list of recipes and select one.
Steps: 1, 2, 3, 4, 5.

TASK 2: Go through the list and select at least two, and print one.
Steps: 1, 2, 3, 4, 5, 6.

TASK 3: Go back and Clear the list, then do either Task 1 or 2 again.
Steps: 1, 2, 3, 4, 5, 6, 7

Steps, objectives and hints

1- Insert Ingredients Starting to use it:
Can the user start to use the prototype alone?

Hint: Try to put the ingredients and click '*search'* when you are ready

Can the user guess how to introduce them?

Hint 2: Use the slot.

2- Select a Recipe
- Does the list correspond with what the user expected?
- Is it clear?
- Does the user what to do now?
  - **Hint:** Select one recipe.
- Does the user see how to get back to this list?
  - **Hint:** In step 3 press '*Back*'.

3- Recipe Description
- Check the description, the ingredients and the cooking.
- Does the user see how to get back to the recipe list?
  - **Hint:** In step 3 press "Back".
- Does the user see how to get back to the recipe list?
- Does the user see how to go to the Recipe ingredients?
- Does the user see how to go to the Recipe Cooking?

4- Recipe Ingredients
- Does the user see how to go to the Recipe Description?
- Does the user see how to go to the Recipe Cooking?
- Does the user see how to go to the Recipes list?
- Does the user see how to go to the Ingredients introduction?

5- Recipe Cooking
- Does the user see how to go to the Recipe Description?
- Does the user see how to go to the Recipe Ingredients?
- Does the user see how to go to the Recipes list?
- Does the user see how to go to the Ingredients introduction?

6- Printing
- Does the user see how to print?
- Does the user see how to get the printed recipe?
- Does the user see when the printed recipe is ready?
- Does the user see what to do after?

7- Back or Exit
- Does the user see how to go to the Recipes list?
- Does the user see how to go to the Ingredients introduction?

Examples of test reports

Only three of the ten test reports are included in this section, to exemplify the documentation of the tests, and their evolution. Note that they consisted in transcription of the notes taken during the test, which were complemented with the analysis of the video recorded in each case.

Test 1: Claudia

Milk Market Prototype testing

Name: Claudia

Background: Spanish Business admin Post-grad student

Date and time: 5:20 21st November

Recording code: #video 001#

Context:

She uses the first prototype at the IDC for X minutes after a short briefing. We gave her four different cards (beef, leeks, pasta, fish).

Observations during interaction:

She introduces Pasta and checks the recipes, then goes back and adds beef. She finds surprising that she was getting a recipe with salmon (which has no beef).

(Trouble with the arrows when there are no more recipes to show in the list, when the user reaches the bottom or the top of the list, the arrows are still there.)

User observations after interaction:

She finds the titles of the ingredients small and difficult to read.

The recipes shouldn't be contained in a frame, or should have more space at the sides.

She found difficult to introduce the cards, and suggested a design using balls instead of cards. *(Parag explains to her that the sellers will give cards of the ingredients which will also have their address. She finds that a good idea)*

She considers that the buttons are ok, but the arrows that should be bigger.

The printer is marvellous. The size of the printed letters is ok.

She wouldn't add more colour, maybe only to the buttons.

Her first impression was that she didn't know what it was, and she didn't see it related with food any way.

The height of the screen is alright.

She liked the idea of having two persons using it at the same time.

Test 5: Iosebas

Milk Market Prototype testing

Name: Iosebas

Background: Spanish Sociology student

Date and time: 22nd 12:30

Recording code: #video 005#

Context:

Tests it alone for six minutes, and has a very low level of English.

Observations during interaction:

Scared of pressing the tabs for Cooking and Ingredients.

"Couldn't it be done without the cards?"

Doubts when starting again

"I don't know what I've done but I lost it". (He presses exit without intention when scrolling down at the recipe description, twice)

The arrows in the middle of the recipe list are annoying (too close to 'exit' and 'back')

User observations after interaction:

Menu issues

Buttons	Suggests more space between them, prefers the big buttons of the beginning,
Scroll bars	Too close to buttons.
Instructions	Would need them if he were alone.
Feeling	It's easy to reach the recipes, but they lack of detail.
Text size	Maybe small for older people, fine for him.
Functionality	

Design

Height	Ok
Shape	It is a little bit scary, it is not aggressive, it is just too big for doing just that with the cards. Original, and guessed that it was the food pyramid when asked for the relation with food.
Colour	Demands more colour at the structure for having visual impact.

Test 10: Fernando

Milk Market Prototype testing

Name: Fernando

Background: Spanish Media Master student, computing science

Date and time: 22nd 15:30

Recording code: #video006#

Context:

Alone, and cannot print due to the paper shortage.

Observations during interaction:

Task 1: Starts easily with little indication and gets to the recipes with none.

"*'Search' what? 'Clear' what?"* Suggests 'Search recipes'.

(Tries to scroll down faster, by trying unsuccessfully to grab the scroll bar, and by holding down the arrows. He doesn't complain)

"The arrows in the recipe selection are better in another position, not the middle."

Points that he would have to print them as it is very difficult to see them at the screen (crowded. See the Cooking for Italian Meatballs)

The recipes suggested should have all the ingredients, not only one. We would prefer it to say: "We only have one recipe with all the ingredients but with salmon we have two more".

How does more people affect the recipe (quantities of the ingredients)

Complained about the pictures of the recipes "they are all the same"

Used it for 19 minutes.

User observations after interaction:

Suggests different soft colours for the different tabs

Put the scroll arrows in side the list of recipes.

Menu issues

Buttons	They are not self descriptive enough. 'Search recipes' instead of 'Search' Likes the big buttons at the beginning
Scroll bars	Move them to make more room for bigger buttons (He tries to scroll by holding down the up button)
Instructions	
Feeling	Lack of pictures for each recipe, lack of soft colours in tabs.
Text size	Too small in Recipe Ingredients
Functionality	

Design

Height	Too low
Shape	Not related with food, seems a house.
Colour	Needs more colour, maybe pictures of food, and informative labels "free recipes here".

Summary of the tests

This section is extracted from the document that summarized the observations from the ten usability tests done at the IDC with the first prototype.

Summary of the observations made from the interviews to testers
(prototype 0.1 of the Milk Market prove, The Recipe Center).

Observations related with each step

1- Insert Ingredients

Observation	#times/total
They are not self descriptive enough.	3/10

‘Search recipes’ instead of ‘Search’	
If two cards are inserted at the same time only reads one	3/10
“The screen should show ‘insert another ingredient’”	1/10
Titles of the ingredients small and difficult to read	1/10

2- Select a Recipe

Should show recipes containing only those ingredients not just one of them	3/10
Options for search: main course, desserts, special needs	2/10

3- Recipe Description

When a card is introduced in this step nothing happens	3/10

4- Recipe Ingredients

Small text	4/10

5- Recipe Cooking

Wider	3/10

6- Printing

Size ok	4/10
would have to print them as it is very difficult to see them at the screen	2/10

7- Exit

Small text Should keep the ingredients	2/10

8- Back

Observations classified by Issue

Instructions:	Would need them if he were alone.	9/10
	“There could be instructions labelled beside the screen.”	2/10
	Option of help menu at any time	1/10

Buttons:

	They are not self descriptive enough. ‘Search recipes’ instead of ‘Search’	3/10
Size	Likes the big buttons at the beginning	2/10
	More colour	1/10
	Lack of space	1/10
Problems	Presses clear without intention so he needs the card back	2/10
	Too sensitive, he printed twice without intention.	1/10
	“The arrows in the recipe selection are better in another position, not the middle.” Annoying.	2/10
	Presses the arrow buttons even when there is only one recipe in the list	4/10
	Presses exit without intention when scrolling down at the recipe description	3/10
	Put the scroll arrows in side the list of recipes.	1/10

Scroll bars	Move them to make more room for bigger buttons	2/10
	More space between them, prefers the big buttons of the beginning,	2/10
	Scroll by holding down	3/10
	Arrows bigger	1/10
	Too big	1/10
	Too small	2/10

Tabs	Soft colours	2/10
	Grey scale	2/10
	Change of texture	1/10

Screen

Size	Bigger	6/10
Angle	Lower	2/10
Height	Alright	3/10
	More comfortable if higher	2/10

Design

Shape	No clue if related with food.	5/10
	Seems a house.	2/10
	Guessed that it was the food pyramid when asked for the relation with food.	3/10
Colour	Needs more colour, maybe pictures of food,	1/10

	and informative labels “free recipes here”.	
	More colour at the structure for having visual impact	2/10
	Colour inside	1/10
Comments	It is a little bit scary, it is not agresive, it is just too big for doing just that with the cards.	1/10
	Interesting,	2/10
	strange	1/10
	ugly, and grey	1/10
	Needs a logo	1/10
	“It’s a cool idea”	2/10
	“Couldn’t it be done without the cards?”	1/10

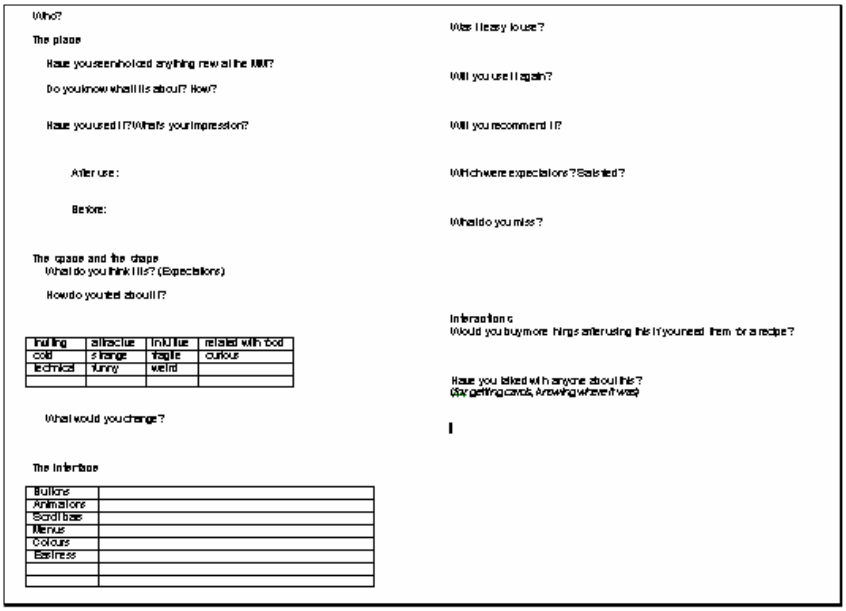
Recipes

Classified by country, cost, special needs, main course, …		2/10
Complain “Pictures are all the same”		3/10
How does more people affect the recipe		1/10
Lack of detail (tools, cost, calories …)		2/10
Text	Too small in Recipe Ingredients	4/10
	Shouldn’t be contained in a frame, or should have more space at the sides.	2/10
	Size ok	3/10
	Maybe small for older people	1/10

Questionaires

These questionaires were used as a guideline for the semistructured interviews at the Milk Market. During the first day the interviews were documented by notes in a notebook, which showed to be a much unstructured tool.

They were done vertically to be printed as a leaflet and give the impression of an interview with few points. The wide blank spaces were used to take notes about the points stated in the questionnaire, and they were not mandatory but just a suggested guideline for the interviewer.



Who?

The place

Have you seen/noticed anything new at the MMI?

Do you know what it is about? How?

Have you used it? What's your impression?

After use:

Before:

The space and the shape
What do you think it is? (Expectations)

How do you feel about it?

inviting	attractive	intuitive	related with food
cold	strange	fragile	curious
technical	funny	weird	

What would you change?

The interface

Buttons	
Animations	
Sound bites	
Menus	
Colours	
Easiness	

Was it easy to use?

Will you use it again?

Will you recommend it?

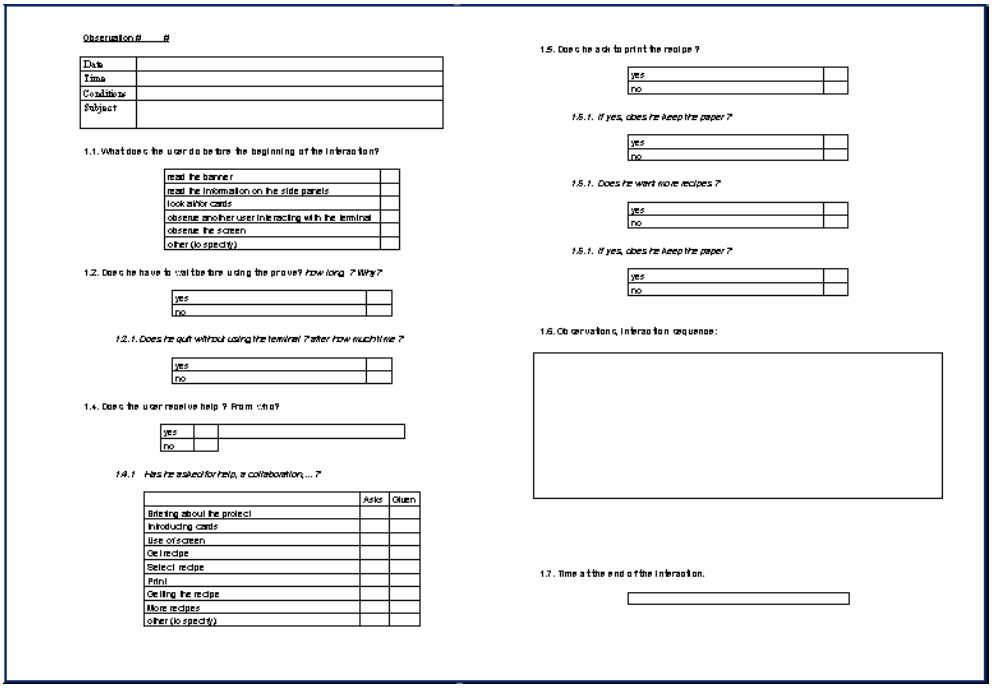
Which were expectations? Satisfied?

What do you miss?

Interaction:
Would you buy more things after using this if you need them for a recipe?

Have you talked with anyone about this?
(Like getting cards, Answering what we it was)

Fig. A3.5 Second day interview guideline



Observation # #

Date	
Time	
Conditions	
Subject	

1.1. What does the user do before the beginning of the interaction?

read the banner	
read the information on the side panels	
look at/for cards	
observe another user interacting with the terminal	
observe the screen	
other (to specify)	

1.2. Does he have to wait before using the prove? *how long ? Why?*

yes	
no	

1.2.1. Does he quit without using the terminal ? after how much time ?

yes	
no	

1.4. Does the user receive help ? From who?

yes		
no		

1.4.1 Has he asked for help, a collaboration, ... ?

	Asks	Given
Briefing about the project		
Introducing cards		
Use of screen		
Get recipe		
Select recipe		
Print		
Getting the recipe		
More recipes		
other (to specify)		

1.5. Does he ask to print the recipe ?

yes	
no	

1.5.1. If yes, does he keep the paper ?

yes	
no	

1.5.1. Does he want more recipes ?

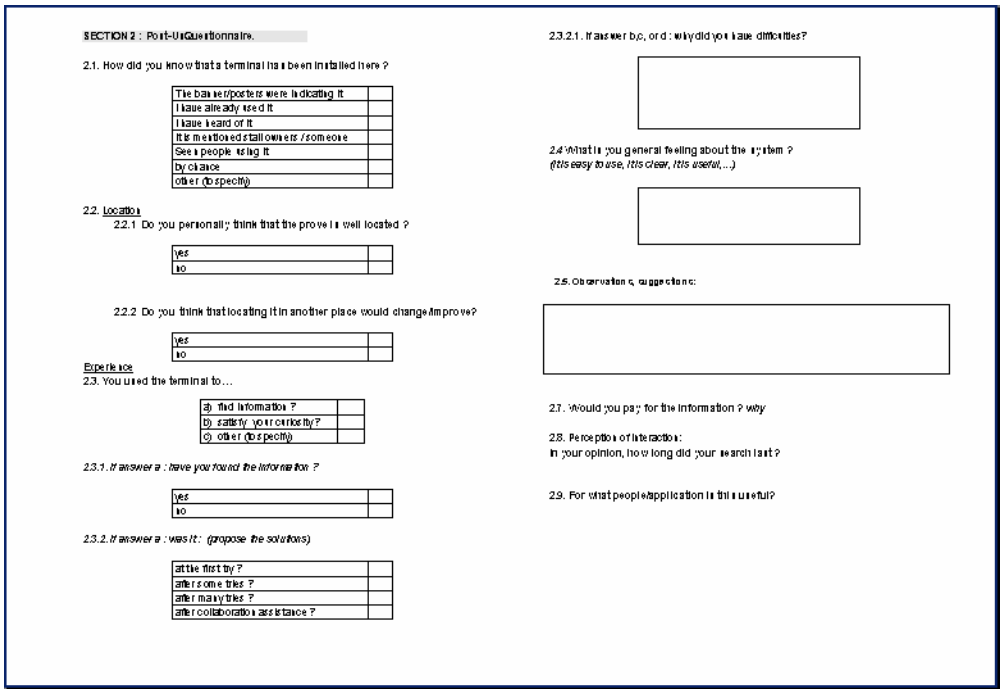
yes	
no	

1.5.1. If yes, does he keep the paper ?

yes	
no	

1.6. Observations, interaction sequence:

1.7. Time at the end of the interaction.



SECTION 2 : Post-UnQuestionnaire.

2.1. How did you know that a terminal has been installed here ?

The banner/posters were indicating it	
I have already used it	
I have heard of it	
It is mentioned at tall owners / someone	
See a people using it	
By chance	
other (to specify)	

2.2. Location

2.2.1 Do you personally think that the prove is well located ?

yes	
no	

2.2.2 Do you think that locating it in another place would change/improve?

yes	
no	

Experience

2.3. You used the terminal to…

a) find information ?	
b) satisfy your curiosity?	
c) other (to specify)	

2.3.1. If answer a : have you found the information ?

yes	
no	

2.3.2. If answer a : was it : (propose the solutions)

at the first try ?	
after some tries ?	
after many tries ?	
after collaboration assistance ?	

2.3.2.1. If answer b,c, or d : why did you have difficulties?

2.4 What is you general feeling about the system ?
(it is easy to use, it is clear, it is useful,…)

2.5. Observations, suggestions:

2.7. Would you pay for the information ? why

2.8. Perception of interaction:
In your opinion, how long did your search last ?

2.9. For what people/application is this useful?

Fig. A3.6 Third day

Issues

Creating the interview script was one of the more complex and open ended tasks of all the evaluation. This might be surprising, but the fact is that the words had to be chosen carefully to avoid driving the answer of the user by the terms of the question.

For example, questions like “would you recommend it?” could be expected to give a positive answer in most of the cases, due to the need to sympathise with the strangers in a public space.

There is not any particular method to approach this issue, and probably the sociology discipline is the most appropiate one to address this challenge.

ANNEX 4 – BUDGET

This is an estimated budget for the Milk Market project considering that all the material and tools required for the project had to be acquired. It also includes an estimation of the work hours required for each stage of the development.The current cost of the material bought for the project is much less as most of the tools were allready available at the IDC.

Development of the Recipe Station					
	Description	Nominal cost	Amount	Cost	Total
Building material					
	500 total		1	500	500
	Wood, Perspex, glue, nails, tools, paint, aluminium				0
Working hours			100	8	800
					0
System					0
	RFID cards		400	1,5	600
	RFID readers				0
	RFID antennas				0
	Screen	260	2	260	520
	Screen holder	20	1	20	20
	Printer	1500	1	1500	1500
	Network cables	3	3	3	9
	Hub*	100	2	100	200
	Shuttles*	2000	2	2000	4000
	Extras (mouse, etc)				0
Working hours			40	8	320
Programming					
Software	Flash				0
	C++				0
	DB				0
	Web page				0
					0
Hardware	PC		2	800	1600
Working hours			100	8	800
Testing					
	Videocamera *		2	800	1600
	Tapes		10	5	50
	Microphone*		1	2000	2000
	Editing software				0
	PC*		1	1000	1000
	Sound recorder*		1	2000	2000
	Tripod*		1	180	180
Working hours			50	8	400

Space					
	Marquee		1	945	945
	Table		1	100	100
	Lights		2	60	120
	Cable extension		1	30	30
	Covers		2	24	48
	weights		4	2	8
	grass		1	80	80
	banner		1	180	180
	side panels		2	40	80
	Paint		6	15	90
Working hours			160	8	1280
Operational costs					
	Van Hiring		5	60	300
	Milk Market hiring		4	130	520
				TOTAL	21880

If we discount the cost of the material already available at IDC (marked with an asterisc), the cost of the development of the Recipe Station reduces to 9.200 €. Part of this material was acquired for the Shared Worlds project, so for a more detailed and acurated budget it should included considering its amortization. This study is beyond the scope of this report.