Museum Guide Design

A Human-Environment Interaction Design Approach

by

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Abstract

From recent projects started it seems assumed that we already know what mobile guides to build. This becomes apparent from the applied approaches in the field of mobile computing, focusing on the engineering of mobile guide applications driven by technological advances. In this study the aim is to direct the museum guide design process by providing a deep understanding of the user interacting with(in) its environment. The weak methodological foundation in current approaches is addressed by giving a detailed account of the steps taken in this research by using methods from grounded theory.

First of all a model of the visitor interacting with(in) its environment is constructed from interviews, observations and immersion into the visitor's visit to the museum. This theory consists of the contextual aspects that are of main importance in interacting with(in) the environment. The model provides a high level view on the relations among the themes that pop up from the lower level visitor experiences. In the second part of the study, the use of the model for mobile guide design is explored by showing how elements of the model can be translated into design sensitivities in a grounded way. The design sensitivities, as an intermediate step in between a theory and concrete design requirements, shows the key principles mobile guide design is subject to. By converting these design sensitivities into system specific recommendations/ requirements a mock-up design could be made.

The system independent design sensitivities show that novel services can be created directly from the model, not identified by other projects in the field before. The high level view in the human-environment interaction model can also be valuable for other fields of research since it shows in a general way how visitors interact with(in) an environment. Also, the systematic, alternative, approach taken to mobile guide design is of value for the design of systems in the field of computing science in general. Furthermore, this study serves as an source of inspiration for other researchers to come up with more alternative (grounded) approaches to design.

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Glossary

Mobile museum guide. Portable device supporting the visitor in performing its tasks during the visit.

Environment. The totality of circumstances that surround one, especially: physical, social and cultural conditions.

Interaction. A type of action that occurs when entities have an effect upon one another, not necessarily of physical nature.

Experience. To undergo something that happens, and from which one may alter or contribute to one's knowledge, opinions or skills.

Gallery. A space or series of spaces that exhibit works of art.

Exhibition. A single space showing related works of art for an audience.

Exhibit. A set of related works of art.

Object. A single work of art.

Chapter 1: Introduction

1.1 Problem Statement

Last decade museums have enjoyed the rising popular demand for knowledge and a supplier that is capable of presenting ideas in a comprehensible and enjoyable way. The museum changed its traditional role from purely educational to a combination of education and entertainment. It has become a place where visitors learn and experience an enjoying visit at the same time. Rather then presenting the visitor with static objects, museums have to think of new ways to engage the visitor in the exhibits, thereby meeting the visitors' demands. Innovation has thus become part of the strategic agenda of museums. Part of this innovative approach is the use of mobile guides that aim to provide the visitor with an added experience by interaction with the device. At least, this is what is believed by many researchers to be the main use of such a guide.

Not only did the museum become more popular with the public, also researchers showed an increased interest in museums as part of their research projects. Traditionally, researchers felt challenged by the complexity of the museum and its visitors, which involves social, physical and psychological factors, but recently new fields of research have emerged in the museum, among them is the field of mobile computing. The rise in research focusing on mobile guides is mainly caused by advances in technology. Powerful pocket computers and a wide diversity of wireless technologies are readily available, serving as an easy platform to experiment with, and develop applications for. Unfortunately, this has led to the rather wild development of mobile guide applications.

From a recent review of mobile guides (Kjeldskov and Graham, 2003) it appears that most of the research conducted focuses on engineering systems using applied approaches, and if evaluation takes place it is done in a laboratory setting. Understanding of the situation under research, consisting of users interacting with(in) the environment, isn't gained before starting off with the actual design. Potential users are involved in the development at a late stage, if at all. Furthermore, if they were involved, the natural setting was often lost by not conducting any research in the field at all.

1.2 Aim

In this thesis the problem of an underdeveloped understanding of visitors interacting with(in) their environment is addressed by the construction of a comprehensible model of how humans interact with(in) the museum environment. Subsequently, the use of this model for the design of a mobile guide is explored.

Before detailing the approach taken in this study, the issues in current approaches are first elaborated on. As already mentioned shortly, current research in the field of mobile guides show a clear bias towards building applications of mobile guides (Kjeldskov and Graham, 2003). The focus in these studies is on the exploration of mobile guide implementations, mainly to test its use as a guide in order to overcome technical difficulties and usability issues. In most cases, applications were build from scratch using experience and knowledge previously gained in the field of computing science. It thus seems assumed that it is already known what to build. Systems are being developed and evaluated on a trial and error basis, instead of on a strong foundation. This poses serious limitations on the validity of these studies as they are driven by technological advances and have a weak methodological basis. Furthermore, from the limited focus on real world

studies it can be concluded that taking into account visitors and their environment is considered of less importance in mobile guides.

Here it is reasoned for that without first gaining an accurate understanding of the user and its environment, one is not able to design a mobile guide that supports visitors in their interaction with(in) that environment. Gaining understanding in the field from a visitor point of view provides the information necessary to decide about what functionalities best support the user interacting with(in) its environment. Approaching mobile guide design from this perspective is a grounded method. Instead of trying to model the user around the system, the system is build around a model of the user, supporting the interaction with(in) the environment in a natural, human way. Therefore, the aim here is not to develop a system ourselves, but instead we aim to explore the possibilities of an alternative design approach that has the ability to inform the design of such systems. The focus is thus not on the human-computer interaction, but as defined here, on the human-environment interaction to guide the former process.

Following from the previous outline, the research question defined here is:

Can an increased understanding of users interacting with(in) their environment direct the museum guide design process?

The research question consists of two parts, which are dealt with separately in this study:

- Gaining understanding of the users interacting with(in) their environment
- An exploration of how this can be used to inform the design of a mobile guide

Both parts will be addressed in this study, but the focus is clearly on the former since this serves as a basis for the latter part: an alternative approach to design. The second part thus tests the practical applicability of the approach for mobile (museum) guide design.

This study has an explorative character. It aims to build a theory by doing (empirical) research in the field with visitors of the museum. The use of this theory is explored by applying it to the field of mobile guides. The outcomes serve as input to define hypotheses about the (general) applicability of the model for mobile guide design. This should be a valuable insight for future research.

It is expected that this study contributes to the field in several ways. First of all, the approach itself is unique for the field of information science; bridging the gap with other fields of research. Secondly, it is expected that the resulting model will be applicable to other situations than the museum environment, making it also a valuable insight for other fields of research. Thirdly, it is aimed for that this approach inspires researchers to come up with more alternative approaches to designing (mobile guide) applications that first of all gain understanding of the situation under research.

1.3 Research Approach

Following from the aim of this thesis, the approach taken here is to guide the design of mobile guides by gaining a thorough understanding of how visitors interact with(in) their environment. Understanding how visitors behave, what their experiences mean and what the role of the environment is in their visit will provide the input necessary for a system design that supports the user's museum experience in a particular environment. This approach doesn't only cover the interaction of the user with its environment, but also how technology, the museum and, even wider, how the social relations are involved in this interaction.

Since the focus in this study is on developing a theory instead of testing one, it is of main importance to describe the methodology in great detail. Central to this methodology is the grounded theory approach (e.g. Glaser and Strauss, 1967). Because grounded theories are drawn from data they are likely to offer insight, enhance understanding and provide a meaningful guide to action (Strauss and Corbin, 1998). The need for such a systematic approach followed from the lack of a methodological foundation in current approaches. Furthermore, it provides transparency to the way the data is gathered and subsequently analyzed, especially of importance in qualitative research.

Apart from the identified gap in understanding in mobile guide projects, the project itself was inspired by the work of Paay (e.g. Paay, 2003). As part of her Ph.D. project she modeled the physical environment of a public space. Soon it appeared that this model was too limiting to inform mobile guide design, therefore she started a study aiming at gaining understanding of the social interactions within the same public space. Here, the interactions with (physically), as well as within the environment (socially) are integrated into one study, resulting in a human-environment interaction model of the museum.

As mentioned before, the study can largely be divided into two parts: understanding of the human-environment interaction and the use thereof for museum guide design. The first part is approached by closely being involved in, and observing visitors during their visit in the museum. Visitors are interviewed by means of contextual inquiry: interviewing them in the field, reflecting on their behavior, getting to know what is behind the direct observations. Also, methods of ethnography are used by taking part in the visit, thereby being closely involved in the interactions of the group with each other and with the physical environment to further understand what is going one. These real-world, low level experiences are abstracted into a high level model that displays the essence/ core. In the second part of the study this model is translated into design sensitivities that aim to inform mobile guide design. Deliberately there is chosen not to translate directly into design requirements since this notion is too limiting: the richness of users' experience cannot be captured in mere requirements. Moreover, they have a focus on a specific implementation. Defining design sensitivities must be seen as a creative, grounded process. Bridging the gap between the model and final design requirements cannot be done in one step. Besides, this is out of the scope for this project.

1.4 Thesis Outline

The advances in agent technology, important for understanding how museum guide systems evolved, is described in chapter 2. It highlights the technical aspects of the museum guide systems, what kind of agent technologies there are and what devices and positioning techniques are being used within these systems. Also, included are descriptions of projects on mobile guide systems that were recently initiated. This is followed by a discussion of what the role of agents in mobile guide is and what shortcomings there are in current approaches of mobile guide design.

Chapter 3 starts off with an outline of important basic concepts. Concepts that are included in this chapter are both on a higher, more general human-computer interaction level, like user-centered design or on a more specific level, like context-awareness and indexicality. These concepts are central to the research topic in question and partly justifies for the approach taken in this study. Chapter 3 also addresses the importance of environmental aspects for the visitors of a museum. In addition, the visitor itself and its role in the museum is portrait.

In chapter 4 related work is presented. Two Ph.D. projects are included that were partly used as a source of inspiration for this thesis. Followed by a discussion it is made

clear how and why the approach on museum guide design taken in this study differs from current approaches.

Chapter 5 combines the knowledge gained from previous chapters and proposes a method to extract “design sensitivities” for mobile guides from a field experiment. The methodology is described in detail to show how the final theory is created with a strong methodological foundation, using grounded theory. Grounded theory, as a paradigm, is visible throughout this study.

The plain results of the analysis of the field study are presented in Chapter 6. This includes the intermediate steps taken that finally led to the human-environment interaction model. This approach makes transparent the steps taken and also shows what results there are on a lower level. Subsequently the results are discussed separately and in general in chapter 7. The themes are described in detail as well as how they make up for the final human-environment interaction model.

Design sensitivities that flowed directly from the model are defined and further elaborated on in chapter 8. In addition, their use is demonstrated by transforming them into a specific mock-up design. To conclude that chapter recommendations for mobile guide development are given.

In chapter 9 the main conclusions of this study are drawn and in chapter 10 suggestions are done for further research.

Chapter 2: Background

2.1 Introduction

In the start of this thesis project the focus was on the role of agents in developing mobile museum guide applications. More specifically, opportunities were looked for how to use agent technology in the interaction of the guide with its user. From this exploration, mainly by reading books and papers on the use of agent technology in mobile guides, it soon appeared that already a lot of projects were initiated that focused on the engineering of mobile guide applications with the use of agent technology, mainly as the reasoning technology behind the mobile guide. From this exploration and discussions with other researchers I came across interesting leads that finally led to the shift in this study from an engineering perspective to the understanding of the context (user and environment) to guide engineering initiatives. This shift better fitted my background as an information scientists as well.

Although the focus is thus not particularly on agents, mobile guide technologies and related projects, it is still valuable to include this background information in this thesis. Without providing a discussion on agents and technology for mobile museum guides, one doesn't have an image of what the power of intelligent agents are in combination with the technologies available today. In other words: it sets the scene for the approach taken in this study. Together with an overview of the projects that were recently initiated, it also demonstrates how it differs from current approaches.

2.2 Intelligent Agents

2.2.1 Agent basics

This section, together with the following section, will introduce the basics of (intelligent) agents, what types of agents there are, which type will specifically be of focus in museum guides and with what technology museum guides they can be embedded into the museum environment.

Agents are part of the artificial intelligence (AI) field of computing science and date back to the end of the 60's, when the first application was born, named Eliza. She was created in order to simulate a conversation with a psychotherapist. This agent simply analyzes the question being asked and, based on recognized keywords, replies with one or more corresponding answers. Since then great developments have been made (Serenko and Detlor, 2004). Agent applications have been developed that are able to operate independent, collaborate with other agents and resemble human intelligence. They are currently largely used in the industry (e.g. manufacturing/ air traffic control), medical institutions (e.g. patient monitoring) and many more applications (Jennings and Wooldridge, 1998).

But what exactly *is* an agent? Unfortunately there is no real consensus on what it exactly is (Franklin and Greasser, 1996). Also, no universally accepted definition of an agent can be provided. However, most of the definitions provided in the literature share aspects on what agents comprise. I will use the definition of Wooldridge and Jennings (1995), since it covers most of these aspects and is widely accepted in the literature:

> An agent is a computer system that is situated in some environment, and that is capable of autonomous action in this environment in order to meet its design objectives. Wooldridge and Jennings, 1995.

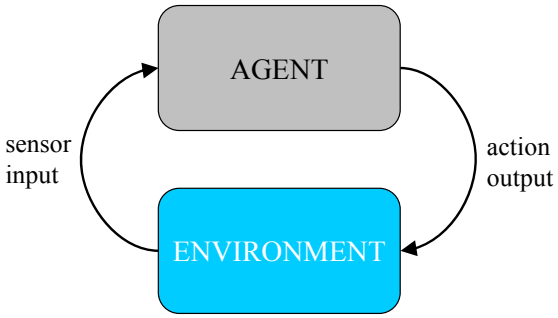

Figure 1. An agent in its environment (source: Wooldridge, 2002, p. 16)

Figure 1 displays a diagram in which the interaction between the agent and its environment is presented. The agent will normally have partial control over its environment; it can influence it by performing certain actions. This does not mean that these actions will always result in the desired effect. The agent therefore has to choose which actions to perform that will lead to the objectives it has been designed for.

Apart from agents having control over its own actions, *intelligent* agents are capable of *flexible* autonomous actions. According to Wooldridge and Jennings (1995) this means that intelligent agents should have the following properties:

Autonomy. Agents operate without the direct intervention of others, and have some control over there own actions.
Reactivity. Intelligent agents are capable to perceive their environment, and respond in a timely fashion to changes that occur in it.
Pro-activeness. Intelligent agents should have the ability to exhibit goal-directed behavior by taking the initiative where appropriate.
Social ability. Intelligent agents are capable of interacting with other agents and humans.

In addition to these properties Franklin and Greasser (1996) also suggest that adaptivity and continuity are properties of (intelligent) agents. They extracted these properties from their analysis of the definitions of agents used by several authors. Continuity refers to agents as a continuously running process and with adaptivity is meant that agents have the ability to change its behavior based on previous experiences, although the latter property is not considered obligatory.

When speaking of the term agents further on, I refer to intelligent agents.

2.2.2 Typology of agents

Besides the autonomous, single-agent systems there are also multi-agent systems. These systems consist of autonomous agents cooperating with each other to reach common design objectives, while simultaneously each agent aims for individual objectives. In order to do so, agents have to communicate with each other about their individual objectives; what part of the environment is being influenced by each agent to prevent interference. Only then a successful and effective collaboration can be achieved (Wooldridge, 2002, p. 105-6).

Apart from the distinction between multi- and single-agent systems there are several other ways in which agents can be classified. Serenko and Detlor (2004) distinguish two general types of agents: the service and user oriented agents. Nwana (1996) uses the primary attributes agents *should* have, to construct a more specific agent typology. She

derived these primary attributes mainly from an abstraction of the properties identified by Wooldridge and Jennings (1995). The three attributes are:

Autonomy. Agents can operate on their own without the need for guidance.
Cooperation. Agents can interact with other agents (multi-agent systems) or with humans via some communication language.
Learning. For agents to act intelligent they have to perceive and react to changes in their environment, and learn from it, expressed in improved behavior.

From these attributes Nwana (1996) derived four types of agents: collaborative agents, collaborative learning agents, interface agents and smart agents (figure 2).

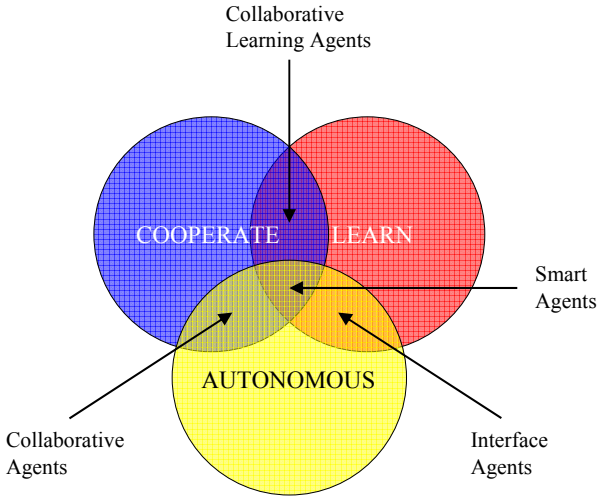

Figure 2. Agent typology (source: Nwana, 1996)

However, as Nwana (1996) emphasized herself, these distinctions are not definitive. *Typically*, with interface agents the emphasis is on learning and autonomy, but they could, in some sense, cooperate as well. Also, *ideally* smart agents should incorporate all three areas equally well. To complete the list of types of agents other ways of classification can be used: by role (information agents), either deliberative or reactive (reactive agents), either static or mobile (mobile agents) and a combination of types of agents (hybrid agents). This results in the following list of types of agents:

- Collaborative agents
- Interface agents
- Mobile agents
- Information agents
- Reactive agents
- Smart agents
- Hybrid agents

The type of agent suitable for applications of mobile guides has the characteristics of an interface agent, also known as the personal assistant, although used in a different form and setting than initially introduced, namely in dynamically changing tasks and environment. The interface agent as Maes (1994) introduced it is used as an agent that performs relatively simple and repetitive tasks for its user to reduce work and information overload. Other benefits are that the agent can adapt to the user's preferences and habits and can share this know-how with other agents in its environment, for the advantage of

serving their users. Many of these benefits rely on the learning component of the interface agent. It learns in four different ways: it observes and imitates the user's behavior, it adapts based on user feedback, it can be trained by the user on the basis of examples and it can request advice from other interface agents (Maes, 1994). Clearly, the interface agent closely collaborates with the user in the same (virtual) environment on a specific task. Furthermore, Chin (1991) argues that an intelligent interface that knows more than its user should be an intelligent agent in order to pro-actively assist the user. An example of an interface agent is the Calendar Agent (Kozierok and Maes, 1993) that assists users in scheduling meetings. It is able to learn preferences of its user, like meeting times and durations. Figure 3 provides an overview of the interface agent how Maes (1994) views it.

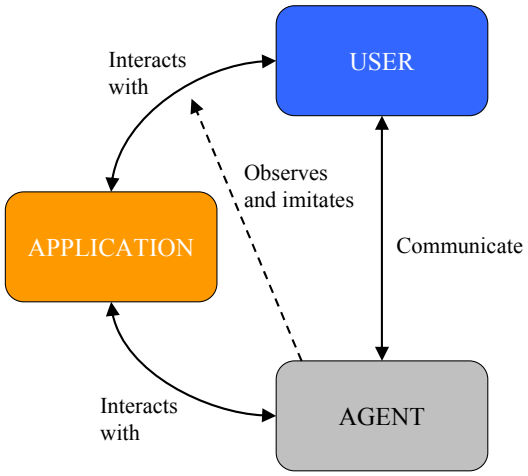

Figure 3. Interface agent (source: Maes, 1994)

One of the challenges of interface agents is to extend its range of applications to other areas (Nwana and Ndumu, 1997). In this thesis the concept of the interface agent of Maes (1994) will be adapted to the museum setting. As will be shown in further chapters the physical environment of a museum is an important aspect for the user as well as the agent. The agent will be able to use this contextual information to adapt the information it presents to the user, whereas the user orients itself by making use of aspects of the environment and other information that is explicitly present. Furthermore, it not only assists the user in its current tasks (e.g. navigating through the environment, interpreting exhibitions etc.), but also exhibits pro-active behavior (e.g. it presents objects of interest, shared interests between users, upcoming events, etc.). The interface agent might also show (implicit) learning, based on the exhibits and objects viewed by the user (duration, interrelations, etc.), but not to the extent of the interface agent of Maes (1994), which is more focused on one type of user, in a static environment with simple, more or less fixed, tasks. Overall, applying interface agents to the museum domain makes it more complex than Maes' (1994) interface agent (Nwana and Ndumu, 1997).

2.3 Mobile Guide Technologies

2.3.1 Mobile devices

Apart from getting familiar with agent technologies, one should also gain insight in the devices that are currently available to present the information on and communicate with the user. The devices discussed here are all mobile, since visitors of a museum must have the freedom to explore the museum by walking around and, in the case of a hands-on exhibition, touching objects. Besides the devices available to the mass, tailor-made devices for museums will also be included. After discussing the mobile devices they will be categorized according to their way of presenting information to and interacting with its user. This makes it possible to give recommendations for museum guide design that are not focused on a particular device, but a wider range of devices. By doing so near future devices will also be covered.

Traditionally, museum guide systems have been developed that rely on audio only, like headphones, tape machines and CD-players. These devices clearly have some limitations: they are rather immobile (freedom, size and weight), hard to keep up-to-date (to reflect changes in an exhibition), purely content based (static information about objects) and therefore lack interaction with the visitor. Nowadays computationally powerful, low cost devices are available that have a bunch of integrated features: (touch screen) color displays, wireless connection, multimedia support and support for different storage-media. Besides these widely available devices, also tailor-made museum guides are available, although on a limited scale. Table 1 summarizes the comparison of different museum guide systems on aspects of implementation, operation, user-friendliness and features.

Table 1. Comparison of museum guide systems (adapted from Chou et al., 2004)

	Traditional	*Tailored*	*Mobile Phone*	*PDA*
Setup time	Short	Short	Short	Short
Long term expense	Medium	Low	Low	Low
Maintainability	Hard	Medium	Medium	Easy
Mobility	Low	High	High	High
Ways to communicate information	Audio only	Audio only	Text, audio, (video and graphics)	Text, audio, video and graphics
Connectivity (wireless)	Low	Medium	High	High
Content integrity	Low	Medium	Medium	High
Ease to operaton	Medium	Easy	Hard	Medium
Available to deaf	No	No	Yes	Yes
Available to blind	Yes	Yes	Yes	Yes

The tailored devices, generally looking like (large) phones with (MP3) audio functionality, accessed through several buttons on the device, have numerous advantages over traditional museum guide systems, but also some important disadvantages compared to mobile phones and PDA's. They are easy to operate because of the limited ways to interact with the device. On the other hand, they are generally not available to deaf people and have limited ways to present information on and interact with the user. Mobile phones are hard to use due to its small screen and specific design as a telecommunication device. However, mobile phones increasingly begin to incorporate feature of PDA's, like color screens, alternative ways of interacting with the devices and multimedia features.

The devices mentioned in table 1 can be categorized according to the way they communicate information to the user. They are either purely audio or fully multimedia based. The latter category can be subdivided into devices with a small screen, typically using buttons to interact, and a mid-size screen typically using touch as a means to interact with the user. Figure 4 gives an overview of this categorization of museum guide systems.

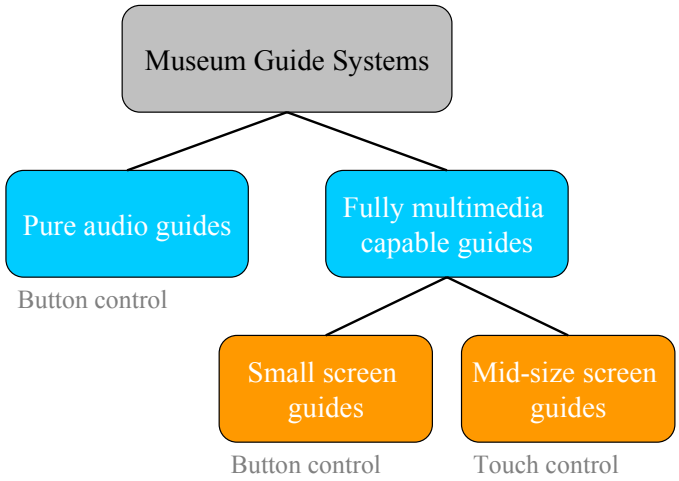

Figure 4. Typology of museum guide systems

2.3.2 Positioning techniques

Previously was mentioned that museum guide systems make use of the contextual information, present in the environment the user is in at that moment. One of the criteria for the agent to reason about the contextual information is that it has the ability to sense the user's current location. Several techniques are available for the museum guide to determine that location. Each of these positioning techniques have typical characteristics that have to fit the requirements of the museum guide application.

The identification of the user's position can be performed at various levels of granularity, depending on the requirements of the mobile guide (Ciavarella and Paternò, 2003): the exact location in the exhibition, the area the user is in, or even wider: the exhibition the user is in. Each of these levels correlate with certain technologies for position determination, as will be shown in the comparison below. The five technologies discussed are: GPS (Global Positioning System), WLAN (Wireless Local Area Network), Bluetooth, infrared and RFID (Radio Frequency Identification).

GPS. GPS is a system to determine one's position on the globe. A GPS receiver uses satellites around the globe to calculate its current position. Unfortunately the reception of the signals from these satellites is limited to the open air. Signals are too weak to enter indoor locations. Another issue is its accuracy; with current technology a precision of up to 2 meters can be obtained, although this is highly dependent on factors such as satellite availability, surrounding etc. Clearly this technology is designed for outdoor location determination.

WLAN. WLAN is normally used for connection of devices to a network within a range of about 100 meters of an access-point. To use this technique to locate the exact position of the user advanced methods have to be used. One of these methods is triangulation: using and combining data from multiple (usually three) access-points to calculate position coordinates (Bahl and Padmanabhan, 2000). Other issues are the

interference between access-points and the high power consumption of the WLAN receiver.

Bluetooth. This technology is especially developed for mobile devices, since it consumes very little power, can be integrated into a device and has a maximum range of about 10 (class 2) or 100 (class 1) meters. Again issues of interference have to be considered. The position can be determined fairly accurate due to methods that take the signal strength into consideration in calculating the user's position, although the direction the signal comes from is hard to determine. Triangulation can also be used in Bluetooth for more precise positioning, although this is not very common due to the fact that more transponders have to be used.

Infrared. Infrared is a point-to-point style technology. The mobile device has to be pointed in the direction of the transmitter to transmit data, usually within a 30-degree angle and a maximum distance of 1 to 2 meters. This poses serious limitations to the freedom of the user.

RFID. This recently introduced technology is still under development and applications are now being implemented, mostly commercial. RFID makes use of a receiver (scanner) and RFID-tags. There are two types of tags: active and passive. Active RFID-tags require power to operate, but have a bigger range (currently maximum of about 1 meter, compared to 10 centimeter for passive tags). The range not only depends on the tags, but also the scanner. A great advantage is its expense: a passive tag only cost about 20 cents. It is expected that scanners will soon be developed for mobile devices (especially PDA's) that are smaller and have a bigger range. Right now this issue limits the user's freedom.

Table 2 summarizes the suitability of each of these positioning techniques for museum guide systems.

Table 2. Comparison of several positioning techniques (partly adapted from Chou et al., 2004)

	GPS	*WLAN*	*Bluetooth*	*Infrared*	*RFID*
Range	Wide	Micro	Micro	Pico	Pico
Positioning accuracy	Low	Average	Average	High	High
Directional signaling	No	No	No	Yes	Yes
Power consumption	High	High	Low	Low	Low
Cost to make every object locate-able	Low	High	Medium	Low	Low
User freedom	High	High	High	Low	Average

From this table can be drawn that a high positioning accuracy is positively correlated with directional signal, but somewhat negatively correlated with the freedom of the user. Methods that are able to more accurately determine the position of the user have to be developed for Bluetooth since this technology seems to have the highest potential at this moment. RFID, due to its low costs, has a good potential in the future when issues with the size and range of the receiver/ tag has been solved. These conclusions have been drawn independent from the applications a particular positioning technique can be used for. It is likely that a certain application suits a particular positioning technique the best. If objects close together should be distinguished, RFID could be the best solution, where in the case of an art museum visitors might step back to get a better overview of a painting. The use of Bluetooth technology would be advisable in that case. This is referred to by Cheverst et al. (2002) as granularity of the location; the smaller the size of the object's "nimbus", the finer the location granularity required.

2.4 Mobile Guide Projects

2.4.1 Introduction

The major research projects on mobile guides that have been completed in the last decade, or are still ongoing are discussed in more detail in this section. It shows how mobile guides eventually evolved from digital guidebooks to location-aware systems. Initially, "mobile guides" functioned as repositories of information, borrowing features from existing sources of information, whereas the latest implementations offer intelligent behavior based on the user's current location, visit patterns and other information from the environment. As we will see, past and recent research in the field of mobile HCI has had a strong focus on the engineering of mobile guides using applied approaches or the evaluation thereof by doing lab experiments (Kjeldskov and Graham, 2003). These ways of doing research poses serious impediments on further research in the field of mobile HCI. Current work lacks basic (and field) research; opportunities exist for the development of (grounded) theoretical frameworks to promote description and understanding (Kjeldskov and Graham, 2003).

This overview also serves as an insight in what has, and what has not, already been explored in the field of mobile guides in terms of visitors, field or pre-implementation research done. This thus serves as a means for justification of the research approach taken in this study. Furthermore, the steps involved in a "traditional" mobile guide project become clear; from scoping the project through to requirements gathering (if any), to an implementation, and finally an evaluation thereof.

2.4.2 Cyberguide

The Cyberguide project was shaped by the Future Computing Environments (FCE) Group within the College of Computing and the Graphics, Visualization and Usability (GVU Centre) at Georgia Tech and was launched in 1995, being one of the first mobile guide projects. The project team focused on developing applications that arose from the activities that could best be supported by mobile technology instead of an evolutionary approach from the desktop paradigm of computing. In other words; the goal of this project was to explore (context-aware) mobile applications for future computing environments (Abowd et al., 1997).

This application focus led to thinking about possible uses for mobile guides and finally resulted in prototypes that delivered information regarding location and places of interest and supported the user by providing sophisticated map interactions, although position-awareness was not available at that time. Later prototypes headed towards applications with more context-aware functionality (intelligent handheld tour guides), where the position could be determined indoor by using infrared and outdoor by using GPS. The features that were implemented all focused around the user's location in the map for the use of orientation by the user.

2.4.3 HIPS

The second project portrayed is HIPS (Hyper-Interaction within Physical Space). The project is part of a European Programme that promotes human-centered methodologies for the design of tools supporting people in everyday working or leisure activities, funded by the European Commission. HIPS aims to develop a handheld electronic guide that allows to navigate both the physical space as well as the related informational space when visiting a museum or city (Broadbent and Marti, 1997). To reach this aim, HIPS main

research activities are developing new interaction paradigms for navigating physical spaces (Benelli and Bianchi, 2000).

The system provides the user with personalized and contextual information. This information is gathered from a diverse collection of sources: from explicit interaction by the user, implicit behavior of the user, the context and from the visitor's history. Together the application should provide the visitor with additional information (also from other visitors), audio guidance and context/ location dependent services, with the objective to enrich the user's experience of a physical space.

The project has a strong focus on developing the system with a user-centered design methodology. User-centered design, in their vision, is met by designing the system iteratively; redesigning the system multiple times based on tests of prototypes with users to make sure the system is designed to meet their needs. Scenarios are also used to make sure the resulting system fits the user's needs as much as possible.

2.4.4 GUIDE

GUIDE, introduced by the Distributed Multimedia Research Group (DMRG) at Lancaster University, focused on developing and evaluating an intelligent electronic tourist guide. The guide system has been built to overcome many of the limitations of the traditional information and navigation tools available to tourists (Cheverst et al., 2000).

Requirements for the mobile guide system have been gathered from interviews with the staff of the local tourist information centre and by observing the information needs of tourists at the tourist information centre. Requirements identified by these methods were: flexibility (adapt to the users preferences/ needs), context-sensitive information, support for dynamic information (presenting changes) and support for interactive services.

The final prototype received its information by communicating with WLAN access-points set up throughout the city. The data transferred contained geographic information for location determination, hypertext for content and information about (changing) events. Before being evaluated by visitors the guide was first opposed to an expert walkthrough. Part of the findings were implemented in the prototype and evaluated in the field by direct observation in which visitors were encouraged to talk-aloud and subsequent semi-structured interviews. From this validation of the usefulness of the guide it appeared that the features that were implemented (guidance, information, reservation and communication) worked reasonably well and the system in general was appreciated by the users of it.

2.4.5 PEACH

The scope of the PEACH (Personal Experience with Active Cultural Heritage) project is to significantly increase the quality of cultural heritage appreciation, in such a way as to transform passive objects into active ones that can be manipulated by the visitor, and thus aiding to bridge the gap between our past, which they represent, and our future, of which they are the seeds (Stock and Zancanaro, 2002). The two major partners involved in the project are ITC-irst (Italy) and DFKI (Germany).

The project has a two-fold approach. On the one hand, the project intends to link the physical space, where the cultural object is found, with the information space, where the meaning of the object is interpreted, while facilitating an augmented and personalized visit. On the other hand, it envisions a remote and interactive appreciation of cultural heritage by means of an accurate and virtual reconstruction of the object. Only the first approach is directly relevant for this thesis, since the aim is not to provide remote and/ or virtual representations of (parts of) the museum environment.

The focus in this project is clearly an enrichment of the museum visit by providing an extra dimension to the museum exhibitions. New ways of presenting/ interpreting objects are proposed that use visual representations combined with audio information.

2.4.6 CRUMPET

CRUMPET (Creation of User-friendly Mobile Services Personalized for Tourism) is a European IST project and has the goal of it in its name. CRUMPET has had two main objectives (Schmidt-Belz and Poslad, 2003). The first overall objective is to implement, validate and trial tourism-related value-added services for nomadic users (across mobile and fixed networks). The second is to evaluate the use of agent technology in terms of user-acceptability and best-practice, as a suitable approach for the fast creation of robust, scalable, seamlessly-accessible nomadic services.

Apart from these global objectives, the project has a strong focus on achieving several technological targets, including: the development of a service-oriented architecture to establish and deploy flexible tourism services and applications, integrating emerging technologies, use of contextual information, adaptability and using industry standards. Furthermore, several services and functionalities were defined that had to be supported by the guide. This outline sketches the breadth and infrastructural approach of the project.

As a last stage in the project, the CRUMPET approach and system have been validated at four European trial sites. This validation is based on a field test of the system and three questionnaires, one on the information needs of tourists, one on the usability of the system and one on the user-perceived qualities of the system. Outcomes of the analysis revealed that CRUMPET still, seeing the amount of services offered, lacked functionalities and offered functionalities not being used by its users, although in general location-based services were appreciated.

2.5 Conclusions

Agents have proven their use in the field of computing science and therefore gained widespread recognition (Wooldridge, 2002). Earlier, Jennings et al. (1998) already pointed out the importance of agent-based systems as a useful and powerful technology in providing solutions that meet real-world needs. In the relatively new domain of mobile and pervasive computing, agents play an important role. By combining the technology available for powerful, localized and context-aware computing with the reasoning power of intelligent agents, a fruitful combination is created, which offers new opportunities for human-computer interaction. These opportunities, held against the museum environment, have the potential to result in electronic museum guides that really contribute to a rich museum experience. Koch and Rahwan (2004) come to the same conclusion for an agent paradigm after mapping the requirements for intelligent mobile services, based on the fundamental requirements of future software systems, on multi-agent system solutions.

In the mobile guide projects mentioned we see a changing approach in the thinking about the development of applications for ubiquitous mobile computing. Figure 5 shows how this development can be displayed in an abstract form.

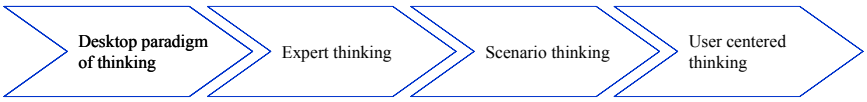

Figure 5. Changing approach to developing applications in ubiquitous mobile computing

The desktop paradigm of thinking represents the development based on applications from the desktop environment. This traditional way of thinking for example redevelops the desktop calendar or route planner for the use in a mobile environment. Expert thinking includes the development of applications based on experience and knowledge of the field; applications build from reasoning about possible uses (approach taken in Cyberguide and CRUMPET). Building applications from scenarios involves the thinking around the user's work environment or situation, although the scenarios are still being made and interpreted by the expert himself (e.g. visitor heritage appreciation in PEACH). The last way of developing applications for mobile use is from the perspective of the users of it; their input is used directly to guide the development of applications (as aimed for in HIPS).

From the approaches to build applications for ubiquitous mobile computing it can be concluded that the focus is on the *development* of what functionalities the guide should have, not on the *understanding* of the user interacting in its environment to inform this process. Although the "development" approach might be user-centered it doesn't mean that it fits the environment the user is interacting with. Directly mapping users' input on functionalities of mobile guides is hardly ever possible since the context of the user also has to be taken into account to develop applications that use the novel possibilities of ubiquitous mobile computing, rather than sticking to the re-arrangement of traditional desktop computing. Ubiquitous mobile computing should not be seen as a replacement of existing ways of visiting sites or providing information. Its novel possibilities should be explored, acting as a supplement, adding to the user's experience, rather then a substitute for existing implementations. Furthermore, developing from a functionality approach instead of a theory that emerged out of users' data is not a grounded approach. The technological approach taken in many projects rather limits the view; incorporating users in the study in a late stage is not sufficient to capture the user's experience of a space. By doing so not only the researcher/ developer has a biased view, also the user does since their view is limited to functionalities already implemented.

Kjeldskov and Graham (2003) addressed shortcomings in mobile guide research on a large scale. One of their conclusions characterizing mobile guide research is that, given the prevalent applied approach to engineering, it seems assumed that we already know what to build and how to overcome specific technical problems. What *is* useful and problematic is not being viewed from the perspective of the user. Their overview further showed that in evaluating mobile guides the focus is on functionality rather than contextual issues. Also, there is a limited focus on real-world studies and a lack of a methodological foundation. Concerning methods used there is a need for more basic research to develop theoretical frameworks and field research to explore use context and user needs, both for the purpose of description and understanding.

In this study, developing a mobile guide application is approached by first gaining understanding of the user in its environment. The second step is to explore the use of this model for mobile guide design. In contrast to traditional approaches, these two steps are not integrated; a translation is made from the resulting model how users interact in their environment to a set of system independent design sensitivities. Throughout this whole process no needs and wants are gathered, no applications are developed and no thinking in functionalities is done. Stepping away from the more traditional thinking of integrated steps in the development process, to a profound understanding and use of that to inform mobile guide design, opens up new ways of doing research in this field, thereby identifying new opportunities for design.

Chapter 3: Literature Review

3.1 Basic Concepts

3.1.1 Introduction

From a technological point of view mobile guides evolved from what is called ubiquitous computing, also known as pervasive computing. Pervasive computing strives to seamlessly integrate computing in the environment of humans. Embedding computing in the environment enables users to more naturally move around and interact with computers. This is strengthened by Weiser's (1991) vision on ubiquitous computing: computers should vanish into the background, fitting the human natural environment, instead of forcing humans to enter theirs. Weiser and Brown (1996) describe the ubiquitous computing era as the age of calm technology (many computers, one person), followed from the mainframe (one computer, many persons) and personal computer era (one computer, one person).

From the ubiquitous computing exposition above, it becomes clear that we are moving to an era where humans and the interaction with their environment is the focus of attention, with computers as the enabling technology. Unfortunately, there is not much known about the interaction of the users with their environment through computers. Combing the fields of human-computer interaction and agent technology with other fields of research focusing on the human-environment interaction (e.g. architecture and sociology), results in an alternative and highly potential approach in designing mobile guides. Satyanarayanan (2001) also addresses the need for the fusion of seemingly disjoint areas of research; there are challenging problems in pervasive computing to be researched that require to broaden the discourse on some topics.

Following from the need for comprehension of the user interacting with its environment, this chapter will depict concepts that raised from a human-computer interaction as well as an agent technology perspective.

3.1.2 User-Centered Design

User-Centered Design (UCD) is by most developers associated by taking the users' needs into account in the design process, in order to create usable computer interfaces. This view reflects only a part of what user-centered design is about. User-centered design is a philosophy in which users are placed at the center. It is about focusing on the users (dis-) abilities, needs and wants as they emerge in the interaction with "things". Referring to "things" instead of systems is done on purpose; it is a more general approach focused on the cognitive factors of the user and it can be applied to all kinds of designs. Its goal is to improve the usability and usefulness of the "things" users interact with.

The concept of UCD has received considerable attention last decades, especially in the field of HCI, but unfortunately is still not always fully considered in the design process. Too many designs take assumptions about what users really need or want. This also holds for developing museum guide systems; the technology-focused approach in agents, the reasoning technology behind museum guides, is regarded as one of the major impediments to the future development and adoption of intelligent agents by the end-user population (Nwana and Ndumu, 1999). They advocate for the development of applications where the user would really benefit from, based on their experience; not the wild development of possibly useful applications, guided by the increasing opportunities of available technologies.

Following from the idea of user-centered design and concurrently the need for a design approach that incorporates the user's experience, contextual design was born. Contextual design is a full design process from collecting data about users in the field, through interpretation and consolidation of that data, to the design of product concepts and a tested product structure (Holtzblatt, 2003). Making more usable products, products that people really want and could use, meant understanding what people were really tried to accomplish and designing new technology to support, extend, and transform that practice. The concept of contextual design, along with the concept of ethnography, is used in this research as the basis for methodological design, as described in-depth in chapter 5: Methodology. Since contextual design involves the complete process of designing a product, only a part of this total process is used in this study in an adapted form.

3.1.3 Context-awareness

Before discussing the concept of context-awareness the term context will be elaborated on, to capture what context is all about. Abowd and Dey (2000) define context as:

> Any information that can be used to characterize the situation of an entity, where an entity can be a person, place, physical or computational object. Abowd and Dey (2000).

In short it concerns the circumstances that surround a particular situation. The focus in the definition is on *any* information to characterize the situation of virtually *anything* (an "entity"). This stresses the enormous scope of "context". Mobile guides can't possibly obtain all of this information, although it is able to reason about its context with the information it captures. The input information (e.g. position, landmark, time, user's facts and preferences) can be combined with information already known by the system (e.g. social relations, visit pattern, other visitors' information, knowledge of the visitor about the environment/ objects, map of museum) to output information useful to the user in that particular situation. In context-aware computing the focus is specifically on *using* the input information of the context to provide smart services to the user in supporting its current tasks.

The terms location- or situation-awareness, used in several implementations of mobile guides, are too limited. These concepts only capture one aspect of the full scope of context-awareness. For the same reason the term context-awareness is sometimes used inappropriate, since some mobile guides only use raw coordinates to reason about the user's location. Instead, information about what is already known from the context (by the system and the user) and what is currently captured should be used to consider the context as much as possible. Context-awareness is thus more about how to use the information captured, rather than only focusing on gathering as much information from the context as possible.

Within context-aware computing Chen and Kotz (2000) distinguish between active and passive context-awareness:

Active context-awareness. This covers applications that automatically adapt to the discovered context, by changing its behavior.

Passive context-awareness. New or updated context is presented by the application to an interested user or the context is made persistent for the user to retrieve later.

This classification closely relates to the "push" or "pull" nature of an application. Either the mobile guide constantly updates its content (in the background) to the changing environment of the user or it gives the user the option to choose what is presented by the mobile guide, based on the changes it senses. An optimal mix between these two forms of context-aware computing has to be found: pushing all the information to the user creates a loss of control and might lead to excess content, whereas a completely pull approach leads to passive services where the user has to interact more intense with the mobile guide, loosening its power of being aware of its context (Kaasinen, 2003; Luyten and Coninx, 2004). Cheverst et al. (2002) show that a push approach to mobile guide design results in users forming an accurate mental model of the system behavior, although the correct creation of a mental model of the environment is not mentioned. Also, one of the goals of context-awareness is to reduce the explicit input from users, minimizing the human-computer interaction (Lieberman and Selker, 2000; Kjeldskov, 2002).

To give an idea of what context(-awareness) comprises of, Nivala and Sarjakoski (2003) provide a useful classification, consisting of the following components:

Computing. Context in the light of computing consists of the bandwidth available, nearby resources, networks etc.
User. Aspects of user context are the user its profile (e.g. visit composition, experience etc.), social situation, the system's purpose of use and cultural aspects.
Physical. Physical surroundings (e.g. noise levels etc.), location and orientation are part of the physical context.
Time. The most basic form of context is time.
History. Part of the historic context is mainly where visitors have been during their visit.

3.1.4 Indexicality

The term indexical originates from the field of semiotics. Semiotics is concerned with how we apprehend the world, make predictions, and develop meaning through signs. According to Peirce (1931-58, vol. 4) the model of a sign (e.g. the "stop" sign) consists of an object (to which the sign refers, e.g. the driver/ car), its representamen (how the sign manifests; its representation, e.g. red light) and its interpretant (what the sign communicates; its intended interpretation, e.g. red light means stopping). There are three types of representations (Peirce, 1931-58, vol. 2):

Symbolic: Representation based on conventions, e.g. traffic lights/ signs, Morse code.
Iconic: Representation based on similarity, e.g. scale model, a portrait.
Indexical: Representation based on a direct connection to what is to be interpreted (physical or causal), e.g. "natural" signals (ring-tone links to telephone), indexical words ('there' refers to something physical).

Kjeldskov (2002) relates these types of representations to the field of human computer interaction. The first two operate independent; they have no reference to spatial (space) and/ or temporal (time) location. Usually these are texts or graphics. Indexical representations on the other hand have a strong relation to spatial and/ or temporal location. Kjeldskov (2002) calls interfaces that are spatially as well as temporally indexical, "just-in-time" interfaces, presenting information based on the user's current location and time (e.g. on entering a cinema present the upcoming movies in that cinema).

As Kjeldskov (2002) points out, using the elements space and time, which are already present in the user's context, is not the only approach to simplify human-computer

interaction. Context consists of more than this, as must have become clear from previous section. Therefore in mobile guides any information can be indexed to the user's environment, making the information implicit and therefore unnecessary to be displayed. Paay and Kjeldskov (2004) for example applied the idea of indexicality to the build environment as part of gaining insight in the user's physical and social contexts. Her approach and methodology is described in more detail in the chapter 4: Related Work.

3.1.5 Conclusions

As the previous outline suggests, the concept of context-awareness as used in mobile guides up till now has to be widened beyond the infrastructural view of context. "Soft" contexts, like people and their knowledge, intelligence and creativity, and social contexts, like relations, behavior and others' knowledge also have to be taken into account when developing mobile guides (Rakotonirainy et al., 2000). Also, Barkhuus (2004) conclude that after an array of technological possibilities it is now time for a more humanistic and socially based approach to context-aware computing. The viewpoint of the end-users has been ignored in the empirical context-aware computing research, driven by technological advances (Chen and Kotz, 2000). Understanding the role of human activity within the environment is needed to inform design of information systems that can augment and enrich human experience of a space (Paay, 2004).

In this study it is aimed for to include "all" the contexts that surround the user in interaction with and within the museum environment. At first sight the difference between interaction with and within might seem subtle, but as pointed out in the introduction it is of main importance since it addresses the inclusion of the physical as well as the social contexts in this research. Interaction with the environment comprises of the use of informational elements (panels, labels, multimedia, signs, etc.), stimuli (parts/ properties of the objects presented, paths, points to enter/ gather/ rest) and physical interaction (hands-on). On the other hand, there are the interactions within the environment consisting of sharing activities between members of the visiting group, but also with staff/ physical guide (experience, knowledge).

3.2 Understanding Museums

3.2.1 Introduction

This chapter reflects on the museum as a complex environment where a visit is not being viewed as simply visually consuming objects, but as one where visitors use the museum space, prior knowledge, past experiences and social relations to interpret objects in an exhibition. Museums do not only display "the world" by materializing culture in objects, but also play a role in structuring the modern way of seeing and comprehending the world "as if it where an exhibit" (Macdonald and Fyfe, 1996, p. 7). In other words: museums not only reflect culture, they also help make it (Riegel, 1996).

Museums have changed considerably last decades. This is not only caused by enjoying the unprecedented popularity and growth of museums, caused by the rising popular demand, and a reliable and trusted supplier (Falk and Dierking, 2000, p. 2), but also due to a changing exhibition approach. What is displayed in the museum isn't any longer decided by the curator only, but increasingly guided by the interests of the (potential) visitors, making it a more objective approach. The trend is to move away from disempowering visitors; involvement in the museum environment as active producers of meaning, rather than leaving them as passive receivers (Ames, 1985; Hooper-Greenhill, 1990; Porter, 1996). Exhibitions have to be designed in such a way that visitors understand what is meant by the objects when they were created. The objects and their

texts have to provide multiple entries to support different ways of meaning-making; each visitor will learn from and interpret an object differently (Falk and Dierking, 1992, p. 136-39). Museums therefore regularly carry out visitor surveys to get to know and serve them better. Also, the museum doesn't only serve as a place to preserve the past, but also as a space to learn *and* to have fun (Falk and Dierking, 2000), both contributing to the museum experience. But learning doesn't happen by its own: families, groups and even strangers are involved in the social environment.

3.2.2 The environment

Already shortly mentioned, museums are not merely places of preservation, but encompass *spaces* wherefrom meaning is extracted by its visitors, making it also *places* of experience. The environment serves as a media to convey the message of the museum. Largely, one can say that the exhibitions, its objects and the messages that are explicitly and implicitly attached to it are one of the most important elements of the museum environment.

The exhibition is viewed as a typical medium for expressing the museum message (Maroević, 1995). The curators and exhibition designers form a specific ambience in which objects and the knowledge of them are displayed in such a way that not only defined messages (explicit information on labels, banners, etc), but also implicit messages are communicated. Visitors are stimulated to discover these implicit messages by the way objects are arranged and how context is added through images, animation, sound, etc. Other leads to communicate the intended message are also incorporated by linking it to past experiences, prior knowledge and social relations of the visitor, as will be discussed in the next section.

An exhibition can also be seen as an event where new relations are formed between the objects that represent different historical times (Maroević, 1995). The heritage objects in that exhibition are transformed from historical times to communication time; the time in which visitors interpret the message communicated to them through the object(s). The past is being integrated with the present. Visitors are not aware of this process, and they shouldn't be. The design of the exhibition should naturally communicate the intended message and leave room for the visitor to interpret this message in its own social environment. It's a process that is both cognitive and cultural (Kaplan, 1995). One should recognize that an exhibition is not simply a system of objects, a curator's vision and the way it is organized. Successful exhibitions should "move" the visitor: it should combine elements in unpredictable ways for individual visitors, who are then able to cross the invisible personal and cultural experience. In this sense the visitor has actively become part of the communication process.

From MacDonald and Alsford's (1991) article can be extracted that it is not really the objects themselves that have to be preserved, but the context and information that relates to the objects, without this information presenting it to the visitor would be worthless. This is reinforced by Hooper-Greenhill (1990) who argues that in thinking about collecting objects, curators should not solely concentrate on the object as a material thing, but rather on the social relations or articulatory practices through which the particular object emerged. With this information, objects in the exhibition can be arranged in such a way that it divides, controls and gives meaning to material things.

Figure 6 shows the relation between the role of the museum and the role of the visitor in an abstracted way. This overview is composed out of the previous outline in the literature. On a physical level (the environment) visitors perceive and interact with labels, exhibits, multimedia, etc. for the purpose of interpretation of the intended museum

message. On a conceptual level this is modeled as the museum providing the necessary context and history around its exhibits, ready to be interpreted by the visitor by using those links/ cues to activate related knowledge, previous experiences and the present situation.

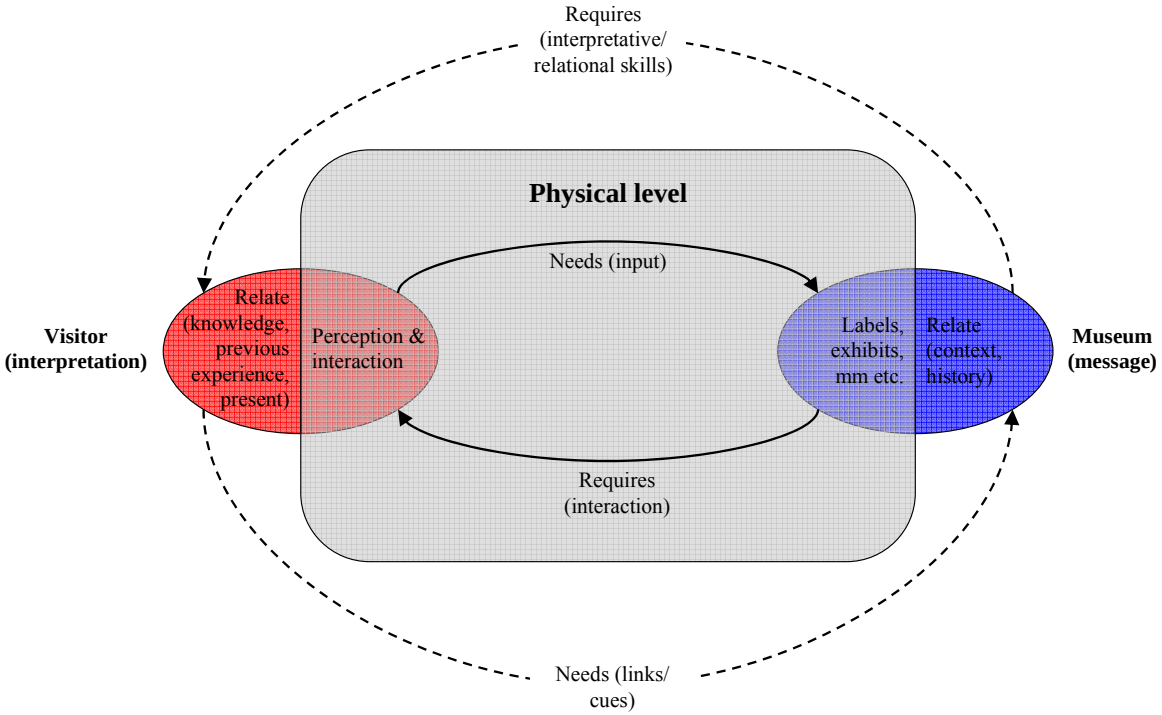

Figure 6. Relation between environment, exhibitions, objects and messages

Besides communicating the museum message to the visitors, the museum environment is being used for other purposes. Way-finding or navigating through the museum is one of them. Most first-time and occasional visitors behave disoriented when entering the museum. They first have to absorb and process the information that is visually present, before they decide where to go to. In trying to make sense of the overwhelming information, visitors often examine the museum map, but this only increased, rather than reduced visitors' confusion (Falk and Dierking, 1992, p. 59; Falk and Dierking, 2002, p. 117). In general, people seem to have difficulty reading maps (Lynch, 1960; Gould and White, 1974). Visitors form a model of the environment themselves and hardly refer to the map anymore. They constructed a mental map of the museum space during their visit, strongly guided by their curiosity (Falk and Dierking, 2002, p. 62, 144). These maps are highly accurate, even one week after their visit they are able to recall the complete museum plan (Falk and Dierking, 1992, p. 66). Elements of the environment can support visitors in creating a correct mental model, without having the feeling of being disoriented or lost. Clear paths, well marked and bounded districts, distinct transitions, recognizable landmarks, interiors with view of the surrounding external environment and spaces with interior grid patterns have the potential to contribute to an easy to navigate through environment (Lynch, 1960; Evans, 1980).

Another function of the environment is that it has to inform the visitor. It should be made clear what and especially where the visitor can find services the museum offers. Beforehand, visitors have a certain expectation of their visit, on entering the museum it should be clear that elements of these expectation are present within the museum. Basic

things like: where are the toilets, the restrooms, where can we get food, more information and where to leave behind possessions all contribute to a "safe" feeling and pleasant initial experience (Falk and Dierking, 1992; Falk and Dierking, 2002). Failing to do so increases the probability that visitors leave the museum with a negative experience. Proper signage can play an important role in fulfilling the coordination and visibility needs of the visitors, but cannot compensate for a disorienting environment (McManus, 1994).

Also, high levels of involvement in the environment, positive affect and increased learning are strongly correlated (Falk and Dierking, 2002, p. 63). Prior knowledge about what visitors can expect both cognitively (discussed in next section) and spatially showed the greatest amount of learning (Hein and Alexander, 1998). This is referred to by psychologists as an "advance organizer", and can be supported by the environment as described above.

3.2.3 The visitor

By now the importance of knowing the visitor should have become clear. Information on why, who, and who *not*, visits the museum, as well as visitors' behavior is critical for the success of exhibitions and museums as a whole. This section will further elaborate on these issues.

In the first place, what are actually the main reasons to visit a museum? Certainly people must have had particular motivations in mind when they decided to go to the museum. Moussouri (1996) identified six categories in which reasons for visiting a museum can be placed:

Education. The most important reason to visit a museum is because visitors wanted to learn 'something'. What they exactly wanted to learn is sometimes indicated more specific.

Entertainment. People go to museums to spend their free time to have fun and/ or to explore interesting, new 'things'. Visiting museums is a leisure-time experience (Falk and Dierking, 1992, p. 11).

Social event. By spending time together with family members or friends in a pleasant environment, museums contribute to the social experience of their visitors.

Life cycle. Visiting museums can be seen as part of an important experience at certain phases of one's life. The tradition of visiting museums is passed on by parents to their children.

Place. Reasons to visit museums as part of a cultural event, specific for a locale or region, are part of the 'place' category.

Practical. Practical factors include reasons such as time available, weather condition, distance and entrance fee.

In a follow-up study (Falk et al., 1998) almost all visitors cited the first two motivations, education and entertainment, as reasons for visiting the museum. Furthermore, in contrast to the popular belief that either visitors come to entertain or learn, evidence was found that visitors came both to learn *and* have fun. Visitors seek for a learning-oriented entertainment experience (Falk and Dierking, 2002, p. 73). But what exactly makes the visit an experience? It is not just about teaching or entertaining visitors that makes it an experience. Visitors have to actively get involved; it's about engaging visitors. The visitors should be stimulated to use their own personal context to form their personal view on the exhibits displayed.

Upon entering the museum visitors already formed expectations of their visit to the museum. These expectations consist of motivations, interests and prior museum experiences (Falk and Dierking, 2002, p. 76). Together, these are better known as the visitor's agenda. Motivation refers to the willingness of people to learn, be it intrinsic or extrinsic, were intrinsic motivation is more effective. Intrinsic motivation is closely related to the "free-choice" character of learning within a museum. No learning is forced from the outside; rather it is guided from one's own interests and stimulus from a supporting environment. It gives the visitor the feeling of control over the way of learning in the environment. Prior experiences with museums are formed from visits to other museums, which are likely to be initiated as part of the life cycle, as described above. If these "ideal" expectations occur in their "real" experience of the museum visit, then this significantly affects, in a positive way, the outcome of the visit as a whole (Falk et al., 1998).

Apart from having specific expectations about their visit, visitors neither enter the museum empty-headed. Visitors use their prior knowledge combined with the museum experience to gain understanding and get meaning out of the objects in the exhibition. Exhibitions can refine and extent prior knowledge, but might also reinforce preexisting ideas (Anderson et al., 2000). On the other hand, misconceptions in prior knowledge of visitors are very hard to cope with since knowledge structures are firmly held and thus very resistant to change. Exhibitions should therefore try to present the message hidden in the objects in many ways so that each visitor is able to interpret, and learn from, it in its own personal way. Furthermore, it is important that visitors remain in control of their own learning; they have the choice over what they will learn in the museum setting (Falk and Dierking, 2002, p. 84-7).

How visitors learn in museums is described in-depth by Falk and Dierking (2002) in their book "Learning from Museums". They initially proposed a framework that tried to accommodate much of the diversity and complexity surrounding learning, called the Interactive Experience Model (Falk and Dierking, 1992). It covers all aspects of the museum visit from the perspective of the visitor. The model consists of the interaction between the following three contexts, of which each of them are continuously constructed by the visitor:

Personal context. Many of the aspects of the personal context have already passed by. It largely consists of the knowledge a visitor already possesses; its prior knowledge, and the visitor's interests, motivations and previous experiences; the visitor's agenda. The personal context is able to explain many of the differences in visitor behavior and learning that exist. First-time and occasional visitors differ from frequent visitors because of their expectations that are formed by direct and repeated museum experience (Falk and Dierking, 1992, p. 27). Expert and novice visitors differ in the amount and diversity of knowledge about the subjects of the exhibitions and the museum in general. Due to the ability to chunk contents in higher-order categories, because of the rich background knowledge, experts can readily see relationships and appreciate concepts. Unsavvy visitors on the other hand have to cope with seemingly unrelated objects (Hedge, 1995).

Social context. The social context strongly influences every visitor's perspective. The museum experience differs when one visits the museum as a member of the family, as a single adult, as part of a group or along with an expert. Part of the social context is also the interaction with the staff, volunteers and other visitors of the museum. All of these social interactions play a role in shaping the museum visit (Falk and Dierking, 1992, p. 41).

Physical context. The previous section already described the environment of the museum in detail. What visitors observe and how they behave within the museum is influenced by their physical context and strongly determines the museum experience. What pathway visitors take, how they allocate their time and what patterns of behavior emerge all depend on the physical context (Falk and Dierking, 1992, p. 55-8).

Figure 7 gives an overview of how the three contexts interact to form an "interactive experience".

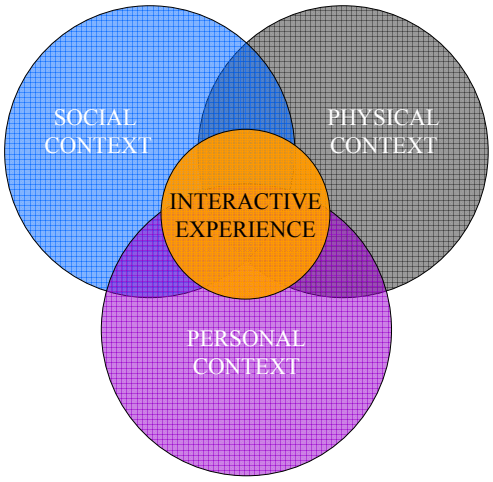

Figure 7. Interactive Experience Model (source: Falk and Dierking , 1992, p. 5)

Later, Falk and Dierking (2002) built upon and refined the Interactive Experience Model recasting it as the Contextual Model of Learning. The elements of this model remained the same, except for renaming the social context to sociocultural context. Adding "culture" to the social context is a matter of definition, since the term "social" implies having shared values and beliefs: culture. The most important difference is that a fourth dimension has been added: time. Over years Falk and Dierking (2002) realized that learning must be seen as an activity within a larger context, evolving over time. As individuals interact with the contexts surrounding them throughout their lives meaning is built up, layer upon layer. It is important to keep in mind that each of the contexts are still, as initially proposed, highly dependent on each other therefore not really separate. Learning as a concept consists of the interaction and integration of these contexts. Figure 8 captures the dynamic relation between the three contexts and its evolvement over time.

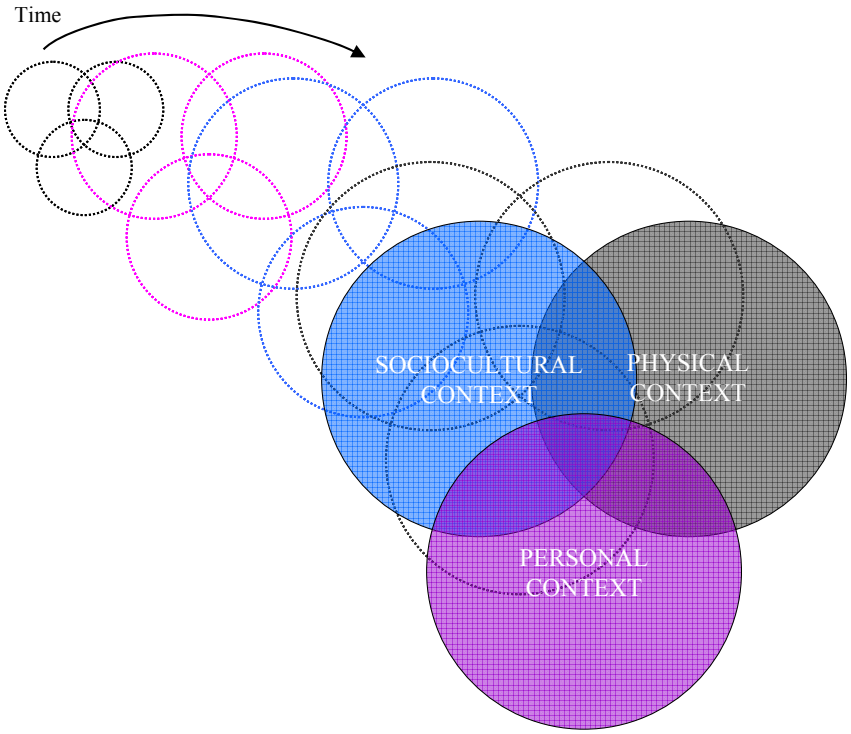

Figure 8. Contextual Model of Learning (source: Falk and Dierking, 2002, p. 12)

Coincidence or not, the three contexts of the Contextual Model of Learning in museums (Falk and Dierking, 2002) correspond with the dimensions that constitute the experience of place, as viewed by Tuan (1977). According to Tuan (1977) place is to be seen as a space that is created by people's experience. The four dimensions of the experience of place are: physical, personal, social and cultural. Relating this concept of experience of place to the Contextual Model of Learning in museums, one can conclude that museums as a place of experience is formed by the visitors of that space, stressing the importance of the notion of visitors within that environment.

After exploring aspects of the visit itself, it is now time to discuss who visits museums and what characteristics these groups of visitors have. Visitors visit the museum individually, as a couple or in groups. Within groups of visitors a distinction can be made between groups of adults or groups that contain children. Groups with children consist of families, children with teachers (school field trips) or children among each other. McManus (1994) surveyed what percentages of these groups are represented in museums, based on a representative sample of visitors to the Natural History Museum, London (McManus, 1987). Table 3 gives an overview of this representation of museum audience.

Table 3. Representation of museum audience (source: McManus, 1994)

	Visitor groups (%)		*Visitor individuals (%)*	
Groups with children	46.3	(n=297)	68.2	(n=1,072)
Singletons	31.5	(n=202)	12.9	(n= 202)
Couples	13.9	(n= 89)	11.9	(n= 178)
Adult groups	8.3	(n= 53)	7.6	(n= 120)

From this table it can be drawn that nearly 76% of all (individual) visitors are part of a group. It is no surprise that members of groups have some sort of a relation with each other and therefore show high levels of social interaction. Through this social interaction members gain understanding and interest by the communication and shared reinforcement

of prior knowledge, previous experiences and relation of the objects to other (social) experiences (Fyfe and Ross, 1996; Falk and Dierking, 2002). Besides this verbal social behavior, members also carefully observe one another, other visitors and staff to behave appropriately in the museum setting (Falk and Dierking, 2002, p. 94). In groups with children, adults focus more on the interaction with their children and learning aspects at their level, rather than on their own learning, as occurs in adult groups (McManus, 1987). Besides this learning focus, families visit museums to build and strengthen family ties as part of the pleasure agenda. Also, families don't seem to read object texts extensively, rather they are extremely likely to participate in interactive exhibitions (McManus, 1994). The free-choice and explorative nature of museums excellently suits school field trips. Children are eager to learn new things and interact with the objects in the museum. Again, opportunities for social interaction with peers are beneficial to learning in groups (Azmitia, 1996).

Fyfe and Ross (1996) argue that most experienced visitors have a background of consumption of heritage and show high levels of curiosity; they are in search of self-identity (knowing how humans lived, what they produced and how that fits in their current lives) and empowerment (gaining knowledge). Singletons tend to show similar behavior to members of a group, which is quite obvious since it actually *are* individuals that form a group, only then within a specific social setting. They observe others and some even visit the museum with the intention to meet others. Generally singletons come to learn by themselves, but it is argued for that sociocultural factors influence such a visit (Falk and Dierking, 2002, p. 106). Furthermore, they are characterized by brief visits to exhibitions and extensive reading of objects texts (McManus, 1994).

Looking at the individual level, what are typical characteristics of a museum visitor? Results from demographic museum visitors studies are relatively consist about what the visitor profile is like: white, middle class, relatively young, well educated and reasonably affluent (e.g. Merriman, 1989, p. 156; Pearce, 1991, p. 100; Falk and Dierking, 1992, p. 20). Furthermore, non-visitation is characterized by factors of ethnicity, elderly age and disability (Hooper-Greenhill, 1994). It is argued for that museums clearly don't fulfill their mission to serve all sections of society equally (Moore, 1999, p. 15).

3.2.4 Conclusions

This chapter showed how visitors behave and interact in the complex museum environment. From the great diversity of literature reviewed it becomes clear that visitors extensively use their environment for all kinds of tasks (interpretation, navigation, socialization, communication). But not all of these tasks always fully succeed because of the lack of knowledge on the side of the visitor or lack of cues from the environment. What exactly is missing in the environment or where the user fails to understand the objects can be important information to gain further understanding in how to assist the user in supporting his tasks. Unfortunately many researchers choose the museum as a research environment not because of its complexity and opportunities for exploring new ways of doing research, but because of the assumption that visitors need more contextual information, without gaining a deep understanding of what is really needed. This trend became clear from a critical projection on major mobile guide projects that were initiated last decade.

Why are museums so challenging to research in? Due to the many influencing factors museums have to cope with from the inside as well as outside, new ways of using information that is readily available in a smart way has to be explored. Having more information available about the context and behavior of the visitor within the environment

means that part of the reasoning about objects and movement of the visitor through the museum *might* be performed by an agent. One of the opportunities of these kinds of applications is mentioned by Fahy (1995); increased use of electronic media *may* make it easier to adopt a more multidisciplinary approach to collections interpretation to communicate the intended museum message to the visitor. The question remains whether this really improves visitors' understanding. Approaching the complexity in which the museum is involved from the other way around, the visitor instead of the technological perspective, seems far more grounded.

This chapter further served as a valuable insight in constructing a methodology that focuses on the research problem in question. Narrowing down the focus of the field research appropriately and using key informants/ visitors are, according to Millen (2000), key strategies to design rapid ethnographic methods. As chapter 5 will discuss in more detail, rapid ethnography is an important approach to methodology design, mainly due to the limited time available for this research.

Chapter 4: Related Work

4.1 Introduction

Works of other researchers related to the approach taken here are, as already hinted in the description of the mobile guide projects, rather limited. A reason for this is that only recently it is believed that gaining understanding of the situation and users under research is as important, if not more important, as the development process itself (e.g. Rakotonirainy et al., 2000, Chen and Kotz, 2000, Barkhuus, 2004). Another recent development is the inclusion of methods traditionally regarded as exclusively belonging to other fields of research, like site investigation for architecture and user research in sociology (e.g. Satyanarayanan, 2001).

The works discussed in relation to this study are both conducted for the degree of Ph.D.. The descriptions offered here are therefore part of a larger project, discussing the full project is out of scope for this study. The projects were chosen not only because they were initiated or completed recently, but also because they both offer a good view of what grounded steps are needed to a come to an understanding of the user and its environment, and to show how this results in a successful (implemented) project. Both projects are critically described to point out inconsistencies and uncertainties in the outcomes and methods used.

In the last section, limitations as well as how this project differs from the Ph.D. projects mentioned will be addressed. From this discussion the research approach taken in, and the design of, this study naturally arises. In particular the ongoing project of Paay (Paay and Kjedskov, 2005a; 2005b) has served as a great source of inspiration for this thesis, especially in developing an effective methodology to gather and analyze the data needed to successfully complete this project.

4.2 Situating "Place" in Interaction Design: Enhancing the User Experience in Interactive Environments

The author of this Ph.D. thesis is Luigina Ciolfi, working at the University of Limerick, Department of Computer Science and Information Systems. She has been working on the project until mid 2004.

In her work she introduces the geographical notion of place in interaction design to explore the role of physical space and place in influencing the interaction between users and ubiquitous technologies, and how this can be taken into account in the design of systems that change aspects of the physical environment (Ciolfi, 2004). Hereby she extends current approaches by the design of interactive environments through the conceptualization of spaces as places by using concepts from humanistic geography. In her view place can be seen as experienced space, where space is being referred to in relation with the geometric and physical aspects of the environment. She further highlights the different dimensions of experience of place. Taking into account these dimensions (personal, social, physical and cultural) provides the depth needed for a grounded design of interactive environments.

With "interactive environments" is referred to particular ubiquitous computing systems: those that are embedded within a physical environment, augmenting it with novel possibilities for interaction. This type of ubiquitous system is different from the mobile guides proposed here, since the former usually offers a hands-on experience with

the objects on display instead of an enhanced mediated experience throughout the museum in the latter case.

To capture the visitors' use of and relationships with the space required the researcher to closely understand the visitor's experiences of a place. Concurrently, rich qualitative methods where chosen that made it possible for the researcher to study visitors' activities within a space and to highlight in them the emergence of the four dimensions. The techniques used are:

Contextual Inquiry. This ethnographically based approach is used to study users in their context of interaction. Close involvement in the context of use of a system increases the understanding of the system.

Cultural Probes and inspirational materials. To capture the emotional aspects of one's attachment to a place, materials are to be gathered about which a creative discussion can be held. This method provides additional insight in the user' experience of a space by broadening the view obtained during observation.

Walkthroughs. A "physical" walkthrough captures the embodied experience of an actual environment and aims to show the user's connection and perception of an actual space.

L. Ciolfi argues that a combination of each of these methods can provide a rich picture of how visitors experience a particular environment, as they focus on all the different dimensions of place. It is made clear that it is not the goal, and perhaps not even possible, to translate the data directly to design requirements. Focusing on particular designs and/ or systems limits the analysis too much; experience is to complex, diverse and interesting to "flatten"; understanding experience of place can lead to design for possibilities, as a creative process.

The data collection in the field consisted of a combination of the methods mentioned above, where visitors as well as staff of the museum served as participants in the study. Subsequently, L. Ciolfi performed an analysis of the dimensions of the environment by interviewing staff and inspecting the environment herself, observing visitors interacting within the exhibitions, observing visitors during object-handling sessions and walkthroughs followed by informal sessions of docents to reveal the use of narratives in the museum.

The resulting design sensitivities, categorized in the dimensions of place, and key-concepts were used to guide the design of a new interactive exhibition, called "Re-Tracing the Past". This exhibition is completely built on the theories and insights acquired during the study. Finally, the visitors' experience with the newly designed exhibition was traced to validate the emergence of the dimensions of place in the data.

4.3 Gaining Understanding of, and Studying User Experience in Public Places

Jeni Paay's ongoing Ph.D. project (Paay, 2003; 2004, Paay and Kjeldskov, 2005a; 2005b) at the University of Melbourne, Department of Information Systems, has gaining understanding of, and studying user experience in public spaces as subject. She specifically has interests in a thorough understanding of the physical environment and the (social) interactions within it. Intermediate results include comprehensive frameworks for the understanding of visitors interacting in public spaces, in such a way that they can inform mobile guide design.

The project started off by the understanding and modeling of the built environment for the purpose of informing mobile guide design. From a field study and the architectural analysis of Federation Square, Melbourne, she presented a descriptive framework, MIRANDA (Multilayer Information Related to Architectural aNalysis Data Abstraction), which extracts the fundamental architectural and informational features of the built environment (Paay, 2003, Paay and Kjeldskov, 2005a). The approach taken in that part of the study is followed from the view that people have a strong ability to make sense out of the physical space they are moving in. Consequently, these environmental features can be taken into account by a mobile guide to simplify the human-computer interaction by making use of knowledge-in-the-world. Information that is indexed to the user's context doesn't have to be explicitly mentioned in the guide anymore.

Inspired by Lynch (1960) and Alexander et al. (1977) the field study was performed consisting of: an inspection of the site (expert audits, including notes and photographs), coding of the data (based on Lynch (1960) and Alexander et al. (1977)), analysis of the data, data synthesizing (developing MIRANDA) and the design of a mobile guide prototype. The coding of the data was made up of information (distance, visibility, location etc.), of signage present at the site and architectural elements (districts, landmarks, nodes etc. and patterns). The methods used for analysis of the data were sequentially: highlighting concepts and themes, and affinity diagramming to group and refine key concepts. In the synthesizing step the "vocabulary" (words that characterized the space), resulting from the affinity diagramming, was used to create a syntax of the language that emerged, and was named MIRANDA. MIRANDA thus makes available a vocabulary of a specific space that can then be used to understand the key physical characteristics of a built environment (Paay and Kjeldskov, 2005a). A graphical representation of the syntax of MIRANDA is included in appendix 1: MIRANDA representation. The syntax is as follows: *[+, -]<descriptor>.<attribute>*, where *[+, -]* signifies either a positive or negative form of the phrase and the thickness of the lines symbolize the strength of the relation between the pairs of words/ concepts.

The identified districts, followed from the Lynchian analysis, enriched with the key architectural characteristics, resulted in a conceptual image of the space. This consequently provided the input for three overall mobile guide design ideas: location determination by district, interactive photorealistic representation of the districts augmented by text/ symbols, and locations and navigation expressed through rich descriptions of the distinctive characteristics of the place.

From the analysis of the space by means of MIRANDA it soon appeared that only information and architectural elements of the space didn't suffice to capture the richness of the interaction within the environment. Social elements should also be included to comprehend the user's experience of that space. From this need the analytical model SOPHIA (SOcial PHysical Interaction Analysis) was developed.

J. Paay used McCullough's (McCullough, 2001) typologies of everyday situations as a starting "vocabulary" to analyze the social activities of a place. Concurrently this vocabulary was used as the basis for a study of the social interaction in a public place. The methods of field observation used to gather the required data are contextual interview and observational ethnographic techniques. After the field visits, the recordings were reviewed, transcribed and analyzed. The analysis of the transcript involved open coding to identify key words, events and underlying phenomena. Higher-level themes were extracted and grouped by using axial coding, as a sub-process of open coding, until a small set of high-level concepts was extracted. Using affinity diagramming the conceptual framework SOPHIA was created, which contained seven high-level themes, grouped into

three main concepts of social interaction in a physical setting of a public space. The complete framework is included in appendix 2: SOPHIA framework.
The framework served as a main guidance for the identification of design ideas for a paper prototype. Four of the seven design ideas that erupted from the data were: indexing content to history and context, indexing directions for way finding to familiar places, representing current activities within close proximity and supporting meeting up by communication about places, activities and time. Each of these design ideas are directly drawn from the themes and categories in SOPHIA. Currently the design ideas for the paper prototype have been implemented in a functional prototype and have been evaluated in a large-scale field study. More about the final prototype "Just-for-Us" and how the social aspect have been incorporated in that system can be read in the paper called "Just-for-Us: A Context-Aware Mobile Information System Facilitating Sociality" by Kjeldskov and Paay (2005).

4.4 Discussion

Looking at the Ph.D. project of L. Ciolfi, this project differs in a couple of ways. We already mentioned the difference in the type of ubiquitous system focused on: embedded within a physical environment (e.g. an interactive cabinet) versus a mobile guide throughout the visit. Of more importance is the discrepancy between the methods chosen and the actual methods conducted. The methods cultural probes and inspirational materials are included in the study by observing visitors during an object-handling session. Walkthroughs are used in the study to reveal the use of narratives in the museum by informal sessions with docents. But the most important methodological method mentioned, contextual inquiry, doesn't clearly erupt from either the data or the description of the way the data is collected in the field. Being closely involved in the visit is especially important in capturing the actual, unbiased, experience of the visitor through observation and contextual interviews. From her description of the data collection it appears that the visitors are only observed from a distance, not closely accompanied during their visit. The interpretation thereof is left to the researcher herself, whereas in ethnographic methods the researcher itself is actively involved in the visit and therefore gains a thorough understanding of it.

Compared to L.Ciolfi's project, J. Paay's Ph.D. project shows more resemblance with this study. Similar to this study, her study also has a focus on the understanding of users and their environment to finally inform mobile guide design. Dissimilar is the research site in question, which has quite different characteristics, and concurrently the mobile guide supporting these environmental characteristics is informed in a different way. First of all the site itself is distinctive; public, open air, places offer clear architectural surfaces and features that contribute to the legibility of the public place under research (Lynch (1960) and Alexander (Alexander et al. (1977)), the indoor museum environment *might* show similar affordances in its exhibitions/ objects to communicate the museum message. From further exploration and investigation in the field it should become clear to what extent the museum environment functions as a place that offers the same informational and physical cues as in public, "architectural driven". A separate study should reveal this applicability of outdoor to indoor situation, however for now it is out of scope for project. Furthermore, the basic function of the site is leisure time spending (eating, drinking, going out) in the case of J. Paay's study versus mainly entertainment and educational in the case of the museum. In the former case the role of the visitor is to socialize in various ways with others, whether in the latter visitors simultaneously socialize with members of their group and gain understanding of the exhibits displayed. Another aspect where

museum environments clearly differ from open public places is the goal with which they are designed. Where open public spaces focus on the recognizability of particular areas (districts and landmarks) for way-finding, museum environments add to this the complexity of a visitor to which the message of the museum has to be communicated, present in the exhibits displayed. Arrangement of objects and reconstructing its original setting are only two examples of how the environment plays an important role in communicating the messages hidden in the exhibitions for the purpose of an accurate understanding by the visitor.

Moving away from the physical roles of the environment we end up on the "soft" side of the environment; the interactions within the environment. Again, there are differences between the public and the museum place. Both visitors of the public and museum place have socializing on their agenda, although in a very different form. In the case of public places visitors want to socialize for example with friends for reasons of leisure time spending. In the museum environment visitors want to socialize with members of the visiting group for reasons of understanding, thereby gaining knowledge from others or relating it to past experiences.

In our case studying the users' interaction with the environment means more than the social interaction *within* that environment, also the interaction *with* the physical environment is of great importance. For example how visitors interpret and try to manipulate exhibits, how the personal background plays part in the understanding/ recognition, how relations between exhibits are laid by visitors; it encompasses more than the social interaction within the environment. Hence, in this study the social as well as the physical interaction is combined in one study, whereas J. Paay clearly made a separation between studying the physical and social aspects of the environment due to specific architectural elements present in the site.

Another difference is the starting point for the study, where J. Paay uses existing theories (architectural; Lynch (1960) and Alexander (Alexander et al. (1977)), social; McCullough, 2001) as a basis/ inspiration for further research, in this study it is aimed to build a theory from "scratch" using grounded theory, although it has to be mentioned that J. Paay's work served as a source of inspiration. Also, as discussed in next chapter, I would rather like to speak of an informed grounded theory, because of the literature study done prior to the actual research in the field.

Due to the extensive description of J. Paay's Ph.D. project's methodology much of it can be transferred to this study. Methods used and part of the analysis have served as a valuable insight to build a solid and sound methodology for this study. The frameworks that resulted out of the data can, because of the differences mentioned above, not be mapped directly to this study, but will still be useful in the way the data can be represented, abstracted and analyzed.

Chapter 5: Methodology

5.1 Background to research design

Before describing the research approach taken, first some background information is provided to introduce the underlying basics of the research design.

5.1.1 Qualitative versus quantitative research

There has always been an ongoing debate of a qualitative versus a quantitative research approach. Some researchers prefer quantitative research for its objectivity while others prefer qualitative research for its close involvement in the situation under research. Traditionally, quantitative research has been associated with the words scientific and statistics, whereas qualitative research has largely been linked with subjectivity, non-scientific and interpretivism (Westmarland, 2001). Luckily, many researchers nowadays believe that the quantitative-qualitative argument is essentially unproductive (Miles and Huberman, 1994, p. 41). Rather, the choice for one or the other approach depends on the nature of the research problem in question (Strauss and Corbin, 1998, p. 11). Approaching the choice of research techniques from this perspective, as one should, results in a methodology that aims for finding answers to the research problem by providing the right data, whether this is achieved by techniques from qualitative or quantitative methods. Also, it is advocated for by several researchers that linking quantitative and qualitative methods can result in advantages from both approaches by using techniques that complement each other or even address the interplay between the two (Miles and Huberman, 1994, p. 41; Strauss and Corbin, 1998, p. 34).

The methods chosen in this research chiefly rely on a qualitative approach to research. In understanding how users interact with and use elements of their environment statistical procedures or other means of quantification don't suffice. Methods that capture the richness of people's experiences, behavior and interactions are needed. The researcher has to be closely involved in the data gathering process, since that contributes to the understanding of how the environment is used and perceived by its visitors. Therefore, it is essential to perform the study in the field. In contrast to lab settings, gathering data in the field ensures that the original context is preserved and rich, diverse data is collected. Besides the field study, critical and creative thinking has to be applied to the data in order to get meaning out of it. From this analysis a conceptual framework (or theory) can be derived. This need for explorative thinking is hard to incorporate in quantitative methods, where one is usually more bound to factual (numeric) data. Besides, looking at the overall goals of quantitative vs. qualitative research approach, it can be concluded that the former aims at testing a model, whereas the latter, in correspondence with the aim of this study, seeks to construct such a model.

The qualitative methods chosen in this study for data collection as well as analysis thereof have largely been derived from contextual design, ethnography and grounded theory. Grounded theory as a paradigm throughout the study and contextual design and ethnography as guiding approaches to collect data in the field. One of the drawbacks researchers mention about doing qualitative research are its subjective inductions and deductions. By applying a grounded theory approach in this study it is aimed for to reduce these factors by offering step by step analysis that can easily be traced back to the data the conclusions where drawn from.

5.1.2 Contextual design

Contextual design basically is about learning the user, its (work) situation and its interactions with(in) the environment to inform system design. It has a strong focus on improving the work and the role of solid system design in supporting that. It is a user-centered approach in which the user's context (work situation) plays an major role. This understanding fully guides the design process; it aims to design systems that fit the user's situation.

In their book 'Contextual Design: Defining Customer-Centered Systems', Beyer and Holzblatt (1997) describe in detail the steps to be taken to design systems that focus on users in their work-environment. These steps include techniques for gathering, analyzing and transforming data to guide the complete system design cycle. Contextual design consists of seven elements:

Contextual Inquiry. The first step covers the understanding of the user: their needs, their wants and their approach to the work. The technique to uncover this data is interviewing and observing the user in their environment while they work. The focus is on learning by discovery rather than looking for answers on hypotheses.

Work modeling. Besides understanding the user it is important to understand its work (environment). By interpreting the data gathered, work models can be constructed that each provide a different perspective on the situation the user operates in. There are four distinct models, made explicit in the form of diagrams: flow models, sequence models, cultural models and physical models.

Consolidation. Systems are to be made for a whole user population, so the individual data has to be analyzed for common patterns and structures without losing individual variation. The goal is to bring individual data together and produce a single picture of the population by looking across multiple users. This is achieved through an affinity diagram, a hierarchical diagram showing the scope of the domain, and consolidated work models, showing the underlying pattern and structure.

Work redesign. The consolidated data is being used to drive conversations about how work could be improved and what technology could be put in place to support this new work practice.

User Environment Design. The UED shows each part of the system, how it supports the user's work, exactly what function is available in that part, and how it connects with other parts of the system from a user's point of view. It is a floor plan that captures the structure of the system that fits the user's work.

Test mock-up with users. Iteratively paper prototyping and confronting the user with it to test the resulting designs.

Putting it into practice. Concerns the practical issues of implementation. Fitting the resulting design to the organization determines part of its success.

Relating contextual design to this study, one can conclude that especially the techniques for data gathering and analysis are interesting. Contextual inquiry as a method has the power to gather needs, wants and implications users face in their current environment. Carefully and extensively observing and interviewing users results in a potentially rich data set. Additional notes taken during this process provides multiple viewpoints for further analysis. Contextual design incorporates a focused analysis that has the ability to bring the data to a higher level while preserving variations. The modeling and design approaches that flow from the data analysis are directed towards identifying improvements in the work sphere and how the system should support this and therefore

not (directly) applicable to this study. Especially the overall approach of contextual design, which started off with the idea of contextual inquiry, seem valuable for this study since it aims to understand its users and surrounding (task, environment) by means of discovery to guide the design process.

5.1.3 Ethnography

The importance of using ethnography in research had already long been recognized by anthropologists and other social researchers before this view was adopted by researchers of other areas. The need for ethnography to direct design follows from the recognition by researchers that interactive technologies increasingly rely upon an appreciation of the social circumstances in which systems are deployed and used (Hemmings and Crabtree, 2002). Ethnography is concerned with the qualitative description of humans' social lives. Its focus is not on the production of research data or providing a toolbox of techniques, but rather the way in which such data is gathered and transformed into a written or visual form. Methods and techniques have been developed to enable the development of a descriptive and holistic view of activities as they occur in their everyday setting from the point of view of users (Blomberg et al., 2003). Blomberg et al. (2003) further define a few basic principles of ethnography:

Natural setting. To gain understanding of a world you have to encounter it a first-hand. Studying users in their everyday lives is motivated by the view that they have limited ability to describe what, how and why they do it without access to social and physical aspects of the setting in question. Also, some aspects of users' experiences can only be understood through observation.

Holistic. Activities users employ have to be understood within a larger context. Studying an activity in isolation, without reference to other activities that occur in time and space, leads to a limited and misleading understanding of that situation.

Descriptive. Ethnography provides a descriptive understanding of users' (everyday) activities from different perspectives. Purely descriptive understandings are hard to accomplish, since it is always more or less shaped by the perspective of the researcher and the aim of the study, to name a few factors that are involved. However this doesn't diminish the value for design by describing the realities users are engaged in.

Users' point of view. Ethnographers are concerned with the understanding and description of users' behavior in terms relevant and meaningful to the studied participants.

From these four characteristics one can extract the key assumption of ethnography: entering into a close interaction with and providing a detailed description of users in their lives, ethnographers can better understand the beliefs, motivations, and behaviors of their participants than any other approach (Hammersly, 1992).

Methods and techniques in ethnography relevant for this study are: observation and interviewing. Traditionally in situ observation is associated with spending long periods in a given field site. Due to shifts in research focus (e.g. away from studying entire societies) and study locations (e.g. less isolated settings) shorter fieldworks are performed that still lead to valuable insights that other methods cannot obtain (Blomberg et al., 2003). Observation makes it possible to gather tacit knowledge and overcome the gap between what users say and what they actually do. Interviews give understanding of the user's perspective. Interviews can be conducted before (to inform the observation), during (to gain understanding in situ) or after (reflect on and validate observation) an ethnographic study. Observations alone are not enough to address the research objectives (Blomberg et

al., 2003). A combination of techniques allows the ethnographer to view things from a variety of perspectives, increasing the validity of the methodology.

From the need to use more time efficient ethnographic methods, the field of rapid ethnography emerged. It consist of a collection of field methods intended to provide reasonable understanding of users and their activities given limited time in the field (Millen, 2000). Millen (2000) used the following three field research strategies/ ideas to introduce a rapid way of doing ethnographic research, compared to traditional ethnography:

Focus and key informants. A wide-angle lens approach to fieldwork might result in benefits of data breath to identify patterns of behavior otherwise not noted and data reuse by other researchers, which might provide new insights. However, a lot of data neither proves to be useful nor interesting, wasting invested time and energy. A strong focus on the research question before entering the field results in a data collection strategy that yields useful and actionable data. Finding interesting patterns and exceptional behavior is one of the goals of ethnographic research. The sampling strategy should therefore aid the researcher in efficiently identifying these patterns and behavior. Finding interesting and valuable participants results in a potentially greater interaction and relationship, and, consequently, in an increased depth of insight into their behavior. As time-sampling strategy information about users visiting the site can be used to optimally choose the right times for the study.

Interactive observation. Multiple views of the activities performed by the user can be turned into a richer description and understanding of the situation. Discrepancies and gaps in understanding can be noted and resolved. Other approaches to a more interactive research include activity walkthroughs, contextual inquiry and 'participant observation', participating in the activity of interest for the user.

Computerized and collaborative data analysis. Text and multimedia analysis tools are available these days that aid the researcher in the usually time intensive data analysis. Understanding field data in teams of researchers is another way of saving time. Analytical processes used by the team are: cognitive mapping, pictorial story telling and scenario analysis.

Part of the strategies to reduce field- and analysis-time mentioned above can be used in this research. The amount of time for gathering as well as analyzing the data is rather limited in this study, especially compared to the time traditional ethnographers take for these parts of their study (typically 12 months or more to attain total immersion). Attention should be paid to select participants that have the potential to really provide valuable data, serving as key informants. Further, the aim is not to try and "cover it all"; focus on what is relevant to solve the research problem in question. Especially during the research one should gain increased insight in what areas to explore in depth and the ones that are of less importance.

5.1.4 Grounded theory

Grounded theory is more a way of doing research than a mere data analysis method. It covers the full process from entering the field to the building of a theory. During the collection of the data the researcher should reflect upon the actions of the participant: "what is he/she trying to accomplish?", "why is he/she doing this?" and "what's going on?". Basically the researcher already does some analysis in the field, looking at the data

from different levels of abstraction for purpose of understanding. In other words; the researcher aims to conceptualize "what's going on" (Glaser and Strauss, 1967).

Grounded theories, because they are drawn from data, are likely to offer insight, enhance understanding and provide a meaningful guide to action (Strauss and Corbin, 1998, p. 12). Generally, this systematic approach is considered to be an extensive iterative process. With iterative is meant that the data is continuously being reviewed at different levels of abstraction by comparing, changing and (re)structuring concepts to understand what the key concepts are that make up the theory. This explains why grounded theory was initially named "constant comparative method" (Glaser and Strauss, 1967).

Since the theory emerges from empirical data it is possible to trace back the results to the data, making it a less subjective approach, one of the drawbacks often mentioned of doing qualitative research. Inevitably, the identification, formulation and interpretation of the concepts remain dependent on the capabilities and skills of the researcher. Also, because of the wide applicability nearly every researcher fits the grounded theory approach differently into the research design, advocating for the need to develop a meta grounded theory model.

The grounded theory method consists of the following key analytical elements:

Coding. This is the process of categorizing the qualitative data, including the details and implications of these categories. The first step of coding is open coding in which the data is considered in-depth; concepts are identified and an initial classification is made. Open coding is followed by axial coding to systematically develop and relate categories for theory building, and/ or by selective coding; integrate and refine theory by organizing categories around a central concept.

Memoing. Memoing concerns recording notes that contain the products of analysis or directions of the researcher as they evolve throughout the study. Memoing is considered of great importance since it serves as a record for (analytical) thoughts of the researcher for the purpose of justification and not missing out essential information.

Diagramming. A diagram integrates the details of the data, visualizes the relationships between the concepts identified and focuses, like the other steps, on the emerging theory.

In this study we will not make use of the full iterative process as proposed by Strauss and Corbin (1998), although parts of the analytical steps can be used to make sense out of the gathered data. Going over the data over and over again would simply take too much time (in gathering as well as analyzing the data), although this undeniably might lead to a more optimal theory. Also, it is suggested to enter the field "empty headed" to have a blank view on "what is going on". This would mean even more iterations to get to the point where it is all about; the core concepts. Personally, I would like to speak of *informed* grounded theory; it would be naïve to think that one enters the field without any pre-knowledge. A researcher always has knowledge of the field and a certain motivation to start doing the research at all. Furthermore, the underlying thought of the whole process has been valuable to this research since it has a strong focus on building understanding from a qualitative data perspective instead of building from ones own experience and/ or technological possibilities.

5.2 Research design

5.2.1 Research design approach

Before reviewing the data collection and analysis techniques, first of all the general approach is discussed. Much of the work of Paay (Paay, 2003; 2004, Paay and Kjeldskov, 2005a; 2005b) is being used as a source of inspiration for giving shape to the methodology of this research. She described the research situation, methods and results in great detail, which made parts of her research highly transferable. The general approach is also guided by the grounded theory paradigm and a combination of the contextual design and ethnography approaches. Methods from grounded theory will mainly be used for data analysis purposes whereas methods of contextual design and ethnography will be used for the collection of the data. As mentioned earlier, the overall ideas of grounded theory will be visible throughout the study.

Whereas Paay approached her Ph.D. project by conducting separate studies for the understanding of the physical environment and the social interactions within that environment, I have tried to combine those into one study. This particular approach has been chosen, because there was a wide variety of literature available that provided a deep understanding of the museum space itself (see chapter 3 for details of this literature study). Furthermore, it was reasoned for (see chapter 4: Related Work) that researching the specific architectural features, present in the research site, was out of scope for this study and hypothesized dissimilar from the indoor situation in museums. Also the limited time available played a role in this choice.

Already shortly mentioned, the methodology of this research is based on methods from contextual design and ethnography. Both approaches take notion of the user, its environment and interactions, although from a different perspective and scope. Contextual design is a system development approach, existing of a series of techniques that make sure that the designed system fits into people's lives, whereas ethnography has its roots in social and cultural anthropology and therefore consists of a broader view of activities as they occur in everyday settings from the user point of view. The need for a methodology that takes these views into consideration resulted from the elucidation in previous chapters.

Users have to cope with socially and physically complex structures in the museum environment. Museum guides can be designed in a smart way by taking advantage of the user's knowledge-in-the-world to assist them during their visit, increasing the museum experience. The challenge is to find appropriate methods to capture the visitors' interaction with the physical as well as the social environment in the museum space.

For the collection of the data in the field we make use of the following methods, including a description of what the methods aim to collect, without going into much detail on how it was conducted in the field (described in the next section):

Ethnographic observation by participating and immersion in the visit generates a profound perception of the visitors' interactions. Elements that are used (or lack) in understanding the exhibits/ objects present and in moving around the environment are identified. Furthermore, the importance of socializing is addressed as being part of the environment. Insight is provided into how visitors socially organize themselves; to make visible what is otherwise considered being implicitly present. It provides an interpretative and descriptive view on what is going on in interacting with(in) the environment. Ethnographic observation is combined with:

Contextual inquiry to reflect on the observed behaviors. Discovering motivations for the behavior of visitors by interviewing them relies less on the subjective interpretation of the researcher and also provides a more in-depth understanding of the situation and contexts involved. This is achieved by creating a natural dialogue, a "partnership" with the participants to gather more than merely opinions as would be the case in "normal" (structured or unstructured) interviews. It is based on discovery instead of looking for particular information/ results. Focus is another important aspect of contextual inquiry. Based on findings in the field one shifts or changes focus during or after (for further contextual inquiries) interacting with the participant. As the study evolves important aspects should emerge that the researcher wants to further explore. By doing so understanding is gained by filling in the missing pieces that make up the complete picture.

To analyze the data gathered in the field we will use the following analysis techniques from grounded theory:

Open coding to categorize the identified codes, without taking any prior assumptions about what the resulting theory might be. Codes are named parts of the transcript, sometimes referred to as concepts since it represents what a particular piece of data comprises. This is the first step in the abstraction of the raw data. It provides insight in what the raw data is about using categories and codes as strong representations thereof. Open coding is followed by:

Axial coding to identify the themes that occur in the data by organizing the concepts. In other words: the goal is to look for relationships among the codes. Again, this is a process that further abstracts the data. The researcher should let go of the raw data and have a clear view on what the core concepts are to identify the main themes that emerged from the data. It should represent what the most important findings are, what the data really is about, not directly related, but still traceable, to the raw data. Themes therefore symbolize prominent aspects of participants' accounts.

The last step of the data analysis is to relate the themes to each other, completing the theory and forming the final interaction model. This is done by making use of *affinity diagramming* as a grouping technique. The idea of affinity diagramming is to group and discuss pre-existing concepts. Related concepts are placed together by people participating in the session. This will lead to a discussion about the, usually initial, grouping of concepts. In this process concepts are continuously rearranged, groups are being split and new groups are formed. When a satisfying grouping is reached the groups can be named to further categorize the groups, making up the final model.

The complete design of this study as well as important choices made during this phase are outlined in more detail further in this chapter.

5.2.2 Data collection

5.2.2.1 Introduction

The collection of the data was carried out in the field at the Melbourne Museum, Carlton, Victoria, Australia. The museum provided the opportunity to freely perform the research in the field. To help guide the project the Market Research & Evaluation department of Museum Victoria provided their knowledge and experience on doing visitor research in the field. This proved of great use since finding key informants appeared more difficult

than initial thought. They also assisted in successfully setting out the project. For a detailed description and characteristics of the site, we refer to the next subsection.

The total time available for the collection of the data was with two weeks rather limited, especially when looking at the duration of traditional ethnographic studies. The fieldwork was performed from the 2nd until the 17th of April 2005 during the regional school holidays and included recordings during the week on different times of the day and of varying length. In total twenty participants cooperated with an average age of 37. On average every participant took part in the study for forty minutes. The first two respondents were part of a pilot that was held to determine whether the participant selection strategy and method of questioning worked out well, and to test the recording equipment.

The main researcher carried out the full study, meaning: the observation of the participants, taking notes in the field, interviewing them and keeping track of the recording thereof. Looking at this resource and time constraint we decided to apply the strategies from Millen (2000), mentioned earlier, to perform a rapid way of doing ethnography. A strong focus on the research question before entering the field results in a data collection strategy that yields useful and actionable data. Strengthening and, where needed, shifting focus based on intermediate findings, results in time savings and high quality data (Millen, 2000).

5.2.2.2 Melbourne Museum

Because of the importance of the museum environment in this study, a short overview of the museum itself, its space and the organization behind Melbourne Museum is given. This will provide the necessary context to understand in what sort of museum (space) the research is held and what their specific goals and characteristics are.

Melbourne Museum is part of Museum Victoria, Australia's largest public museum organization. It is the State Museum for Victoria, responsible for the care of the state's collections, conducting research, and providing access to the public. In total the collections consists of approximately 16 million individual items. The organization operates three campuses, all situated in Melbourne, Victoria; Melbourne Museum, Scienceworks and Melbourne Planetarium, and the Immigration Museum. Museum Victoria aims to take visitors on a journey of discovery to a new world of knowledge and perspective. Their vision is as follows:

> Museum Victoria will reach out to an increasingly diverse audience through its collections and associated knowledge, using innovative programs that engage and fascinate. We will contribute to our community's understanding of the world, and ensure that our inheritance is augmented and passed on to future generations.
> Museum Victoria, Strategic Plan: Exploring Victoria, Discovering the World.

Melbourne Museum opened its new building for visitors in October 2000. Compared to the old building, located in the Melbourne city centre, the new museum is a great piece of modern architecture, constructed using concrete, aluminum and glass as its main components. Seeing this remarkable building is already an experience by its own. Basically, the museum is composed of concrete boxes, containing distinctly different exhibition spaces, connected by streets of glass. This makes the museum transparent, bright and spacious.

The museum has six levels, of which three are open to the public. Appendix 3 contains an illustration of the eight galleries and other areas of the museum. Each of the

galleries complement to Australia's rich heritage, but can be classified as being part of Australia's cultural, scientific or natural wealth. The diversity offered makes sure everybody, from the young to the elderly, can find exhibits of their interest. Apart from the static exhibits, the museum also offers visitors interactivity through electronic displays and panels, hands-on experiences and an information centre, named InfoZone.

Looking at the visitor profile of Melbourne Museum one can conclude that most visitors are first timers, visiting as a family or as a group of adults, are aged 40 years on average and visit the museum for nearly three hours. A more detailed overview of the visitor composition is given in the table below.

Table 4. Visitor composition Melbourne Museum (source: Melbourne Museum, July – Dec 2004, rounded)

	Visitor groups (%)
Groups with children	54
Singletons	-
Adult groups	47

	Visitor age (%)
Under 25	17
26-39	37
40-59	34
60+	13

Already shortly mentioned, the museum, and in specific the Market Research & Evaluation department, was of great help in this project. They not only helped setting up the project, but also made available the necessary equipment to record and analyze the interviews, and made it possible for me to reward the participants with free entry to the museum. Their enthusiasm for the project has the potential for a fruitful collaboration in the near future.

5.2.2.3 Sampling strategy

Before entering the field, we defined a specific sampling strategy for whom to optimally include in the study. Carefully selecting participants not only increases the quality of the data, but as pointed out by Millen (2000), also makes it possible to reduce the amount of time invested in fieldwork, because key-informants are more likely to provide in-depth information due to an increased interaction between the researcher and the participant.

Sampling is concerned with the way participants are chosen from a larger collection or population. There are largely two approaches to sampling; probability sampling and non-probability sampling (Neuman, 2003). Probability sampling is associated with quantitative research; its goal is to get a representative sample in order to produce accurate generalizations. Qualitative researchers focus less on a representative sample, instead they seek to find cases that will clarify and deepen understanding. The non-probability sampling techniques that most resemble the strategy chosen in this study are convenience combined with purposive sampling.

Initially, the participants in this research were chosen based on their availability and willingness to cooperate in the study. After interviewing and observing a couple of respondents this strategy was changed to more carefully select participants, in such a way that they were likely to be informative for the research and keep on adding value during the research. This meant that younger adults (typically younger than 25, either individual, as a couple or as part of a group) were excluded from taking part in the study. Also, potential participants that showed a minimum level of interest in the research when asked to cooperate were not included as a preventive measure. The decision to exclude these groups was based on the two pilots that were held as well as experience with conducting research with other participants.

Because of the expected level of depth of the interviews there is chosen to include adults only. It is not that children are not interesting to research, the contrary is true; they

have much to offer (e.g. different interface designs, personalization issues, communication, levels of interaction), but this would even further broaden the research. Doing research from a children's perspective is above all considered to be a separate field of research (Kusunoki, 2002). Within adults it is interesting to see how elderly interact dissimilar from mature adults within the museum environment, due to their differing visitor agenda and background knowledge. Also visiting the museum as being part of a group compared to visiting individually might cause different visiting patterns that are valuable to note. To capture these varieties it is aimed for to include both elderly and mature adults in different group constitutions (singletons and as part of a group (couples, families and among each other).

Ideally, the sample of this study should reflect the average visitors of Melbourne Museum or even of museum visitors in general. Although trying to be as representative as possible should not be a primary goal in qualitative research, one can see from table 5 that the sample in this study is quite representative for the population.

Table 5. Sample representativeness (source: Melbourne Museum, July – Dec 2004, rounded[#] & McManus, 1994[†]). *Number includes couples

	Sample (n=20) (%)	*Melbourne Museum (%)[#]*	*Museums general (%)[†]*
Groups with children	60	54	68.2
Singletons	5	-	12.9
Couples	25	-	11.9
Adult groups	10	47*	7.6

There was no stipulated number of participants; this depended on the amount of participants willing to cooperate and the number of participants needed until a certain point of saturation was reached. This "point of saturation" is referred to as data saturation; no new themes emerge from the data anymore.

It is important to note that in this study, just as in other ethnographic studies, "continuous sampling" exists. Based on the experiences during the fieldwork the focus may be sharpened and/ or shifted (Goldbart and Hustler, 2005). Exploring the visitor's behavior is not looking for an answer to a specific question; the data is being shaped during the fieldwork and therefore one zooms into interesting findings.

Reviewing the sampling process, we can conclude that there was an estimated non-response of 50 percent. The reasons for not participating in the study were mostly time related; visitors were limited by the time scheduled for the visit. Others wanted to keep an eye on the children (increased non-response due to school holidays) or were simply not interested.

5.2.2.4 Participant selection process & ethics

To overcome possible ethical issues, we decided to trouble the participants as less as possible during their visit, and inform them beforehand as good as possible about the research. Rewards were given upon commitment to participate in the study, to promote active participation in the research. This included free entrance for the visiting group to the main museum as well as to the special touring exhibition (Dinosaurs from China). The participants were informed of the free entrance after they committed to participate in the study to prevent it being the incentive to participate.

Selection of the participants was done on-site, no people were approached beforehand, and except for bearing in mind the sampling strategy (to address variety) no other criteria for selection were set. Potential participants were approached upon entry of the museum whether they wanted to participate in a study of the museum, in cooperation

with the University of Melbourne and Utrecht University. They were given a paper with a brief overview of the project, which included a short introduction, the goals of the research, how their confidentiality was protected and what they were asked to do during the research (included in appendix 5: Project description). On agreement to participate in the project they were asked to sign the attached consent form.

In order not to interrupt the natural way of visiting too much, we decided to let the participant explore the exhibitions freely. It is desirable that the researcher really participates in the visit, not only interrupting the visit by posing questions related to the research, but also discussing the exhibits displayed. Again, this is done to make sure that a deepened understanding is gained of visitors interacting with(in) their environment in a natural way.

Before starting off with the fieldwork a human ethics application has been submitted, and approval has been granted from the Melbourne Research and Innovation Office, University of Melbourne. All research involving humans carried out at the University of Melbourne require ethics approval, in total this process takes about one month. This is part of a policy set out on national level by the Australian government and aims to protect the welfare and rights of participants in research. The government published a document in which the principles of ethical conduct are described, every institution carrying out research involving humans should stick to those principles.

5.2.2.5 Methods & procedures

From the research approach it became clear that the following methods for gathering data were used: ethnographic observation and contextual inquiry. The methods themselves as well as how they were carried out in this study is described in more detail below.

For the modeling of the interaction with the museum environment methods of contextual design and ethnography are used. These methods include *ethnographic observation* together with *contextual inquiry*. Both of these methods are conducted in the field with visitors as participants, and selected based on the sampling strategy described earlier.

Ethnographic observation arose from the field of ethnography; studying people in their environment for understanding how they interpret their worlds (Goldbart and Hustler, 2005). The researcher acts as a participant observer, immersing into the visit of others to closely understand how visitors behave within that environment. During this participation the visitor's behavior was observed and notes were taken of events and/ or actions that were of interest for the study. To further deepen the understanding of the actions of visitors they are regularly asked to reflect on their behavior by posing them question by the means of *contextual inquiry*. Knowledge about the interaction with the environment is gathered from the visitor's point of view, and concurrently interpretation is less dependent on the researcher himself. This way of doing observation corresponds with what Millen (2000) called interactive observation. Benefits of this interactivity during observation are richer descriptions and understanding of the situation. Furthermore, discrepancies and gaps in understanding can be noted to be resolved later on in the session with the current participant or to be explored with other participants.

In order to have a global idea of the kind of questions to raise, a discussion guide was created with the help of the museum, based on their expertise with extracting visitors' experiences in the field. This set of questions was constructed towards capturing the visitors experience in interacting with(in) the environment. It also asks for way finding and orientation within the environment. Especially in the start of the research this was of great help, guiding the interviewing process.

The participants were told that the total commitment of them will be about 20 minutes. However, it was expected that the actual time the researcher will take part in the visit will be longer due to natural and non-intrusive nature of the research. This should be long enough to capture a complete and diverse view of the visitor's interaction and behavior within the museum environment, without annoying the visitor. It is of great importance that the participant feels at ease at all times, since this will not only improve the quality of the data gathered, but also an increased dialog between the visitor and participant. In this study this was achieved by letting the participant (and the group he/ she was in) explore the museum themselves for the first couple of minutes. Apart from the questions focused on understanding their behavior and experiences, also a natural dialog is started, discussing exhibits, related experiences etc. This positively influences the creation of a partnership between the researcher and the participant. Just like in a natural dialog this promotes participant to start a dialog themselves.

Apart from these main methods of gathering data also a 5-minute questionnaire is handed over to the participants after the study. The goal of this questionnaire is capture information about the participants that took part in the research, how often and why they visit Melbourne museum. This data will mainly be used for statistic purposes. This questionnaire asks the visitor about his personal details (gender and age), residence/ origin, museum visits in general (frequency) and 'this' museum visit in specific (visiting as individual/couple/adult group/adult group with children, last visit and visited exhibition before, expertise on topics exhibition, reasons to visit). The questionnaire is included in appendix 4: Questionnaire.

5.2.2.6 Materials

The materials used in this study are limited. Using equipment that gathers enormous amounts of data, for example tracking the exact position of the visitor and video taping throughout the visit also mean that this data has to be analyzed accordingly. Looking at the limited time available for this project, we have explicitly chosen not to take this approach. Another reason not to capture extremely rich data is because, in our opinion, it doesn't add up to the already fairly rich data being gathered in the field. Closely experiencing the visit from a visitor point of view should provide the data needed in this study. This conclusion can be backed up with the results Paay (2004) obtained in her study, also without using extremely rich methods of data gathering. Creating additional viewpoints by using video taped material might provide further findings, but also brings along issues of validity because of the subjective interpretations involved in analyzing such data.

For the ethnographic observation and contextual inquiry with the museum visitors an audio-only device with microphone was used to record the conversations. The device used is a Sony DAT recorder, chosen for its capability to record digital audio. The recorder was put in the back pocket and a clip-on microphone was used to have the ability to walk around freely. Doing so made it possible to focus on taking notes, posing questions and converse with the participant. Also, it is perceived less obtrusive for the participant. Disadvantage of using a clip-on microphone is the short range: it is important that the researcher stays close to the participant to record what he/ she is saying. The quality of the audio also appeared to depend on the angle of the participant compared to the microphone. Positioning face-to-face in a conversation is not always possible, but delivers the best recording quality. Apart from recording the dialogues, a notebook as well as the museum visitor guide were used to take notes on for later analysis.

5.2.3 Data analysis

5.2.3.1 Introduction

This section will detail the way the data is analyzed, mainly using methods from grounded theory. The various steps, from transcribing the raw data, that is the interview and observational data, till the resulting theory/ model, are discussed separately.

As mentioned before, in total 20 participants cooperated in the study with an average duration of 40 minutes. This resulted in a total of 755 minutes (roughly 12,5 hours) of recordings. Along with this data about one A4 of notes consisting of observations and initial analysis were made in the field for every participant.

Due to the limited availability of human resources during the fieldwork (only one researcher), notes made during the research have been elaborated shortly after each session to make sure a complete and detailed image of the visitor interaction with its environment is captured. Especially for studies that rely on grounded theory it is of main importance that all data is retained, whether it are short notes, thoughts etc, after all "all is data" (Glaser, 2001).

5.2.3.2 Data transcription

Before actually analyzing the data gathered in the field it first of all has to be transcribed properly. In total transcribing the interviews took about two weeks due to difficulties in understanding the respondents, caused by background noise, distance to the microphone and specific Australian dialects as addressed before. Another week was needed to filter, group, analyze and add the notes.

The process of transcribing the interview and observational data consisted of the following steps:

Review complete visit. After each session the visit was reviewed completely to note findings that could not be made during the session. Also initial notes/ ideas on how to analyze the data as well as references and remarks to other data were recorded. This step makes sure that all relevant data gained during the visit is inscribed.

Transcribe spoken interactions. The next step is to transcribe the spoken interactions, between the researcher, the participant and other visitors that belonged to the group of the participant. Gestures and actions of visitors as well as some contextual information, where important for the research and/ or understanding of the transcript, were added to this part of the transcription.

Transcribe interactions with(in) environment. This part of the transcription comprises the interactions of the participant with and within its environment, extracted from the observations of the participant. These situated interactions include remarkable (social) behavior of the participant. This means that the situated interactions are only listed if it did add up to the spoken data and was of value for the study.

From the previous outline the following columns for the transcription evolved:

- Transcript (spoken interaction, including gestures and actions of visitors)
- Interactions (observational data, containing notable (social) behavior)
- Notes (on analysis, initial thoughts, relation to other data etc.)

During the analysis phase one column was added to this overview. The column added for the codes, representing concepts and properties present in the raw data, has been derived from the open coding of the transcript. One of the transcripts, including interactions, notes and codes can be viewed in Appendix 6: Sample transcript.

5.2.3.3 Data analysis approach

The overall goal of the data analysis is to make sense of the data gathered, that is to make explicit what is going on in the data. Concepts that emerge from the raw data, of importance for the interaction with(in) the environment, have to be extracted accordingly. These concepts, providing an abstracted view on the raw data, can be grouped and compared to discover mutual relations, thereby taking a step back from the lower level data. Doing so provides the insight necessary to tell what the data is really about, to gain understanding of what is going on, seeing the bigger picture emerge. These themes are the building blocks for the formation of a grounded theory, a model of the visitor's interaction with(in) its environment in the museum. They feature important characteristics of participants' accounts.

The previous paragraph summarized the general data analysis approach: from the low level experiences in the field and the identification of higher level themes to the final interaction theory. This process has been heavily influenced by methods from grounded theory. Therefore, the image sketched here is somewhat overly simplistic. Grounded theory cannot be seen as an isolated set of methods, it is an approach that covers the full methodology, from the gathering of the data onwards. In the field the researcher already does some pre-analysis that shapes what the researcher wants to further explore. This is an iterative process that continues its way during the analysis phase. Initial concepts are defined, and further refined until a satisfying set of concepts is reached that cover the essence of certain pieces of data. Looking at the data with a different perspective over and over again builds an understanding of what is behind the data. These emerging themes should logically refer to relations between (groups) of concepts.

The step of making theory out of the themes was guided by the affinity diagramming method. J. Paay, with her experience in using the method (Paay, 2003), assisted in this process by discussing the themes. Usually this process is performed in a focus group, but people needed for such a session couldn't be arranged in such a short period of time. She was not involved in the project at an earlier stage, so this helped start the discussion about grouping the themes together, having to justify certain groupings. Also, sharing expertise in successfully identifying themes was of help to the project.

5.2.3.4 Qualitative data analysis

After the transcription of the data, *open coding* was used to consider the data in-depth to code the transcribed interviews. A "code" is a label assigned to a certain piece of information. Open coding is adapted from the grounded analysis method of Strauss and Corbin (1998) and involves identification of the main concepts in the transcript by closely looking at the data and comparing it with previous data reviewed to identify as many properties and dimensions as possible (Corbin and Holt, 2005). In this process new codes are created and others refined (guided by the constant comparison notion in grounded theory).

Coding is basically the process of labeling certain parts of the transcript, concepts that represent what a certain passage of the transcript is about. Each line of the transcript is considered and may contain more than one code, indicating that part has multiple meanings in the research. *Open* coding refers to the rather unstructured way of coding the document. Coding is not done around a certain core concept, as is the case in selective

coding. Whatever relevant to the study is coded directly from the data, no predefined list is used.

To add meaning to the concepts they were classified into categories and subcategories during and after the coding of the complete transcript. This context provides an initial grouping of the codes, used for further analysis of relations between the codes. The categories can have a descriptive character, but can also be of a more analytical kind, having a more interpretive character. The output of the open coding is a classified list of concepts, showing on a rather low level what the data is about.

For the process of coding the transcripts we made use of the program Nvivo 2.0, developed by QSR International. This qualitative data analysis tool makes it possible to easily create and manage codes for the analysis of any kind of textual data. Nvivo partly quantifies the qualitative data by providing the number of characters and the amount of passages per code as well as the amount of cases that contained a particular code. The build-in analysis function is mainly focused on pattern recognition on raw data level, making it less suitable for this study, but still valuable for its general coding functionality. Other useful features include the separation of the document into cases and assigning attributes to each of these cases for further analysis. The main functions used in this study are related to the coder, which has the ability to select and label parts of the transcript. Codes can easily be reviewed, without having to rename every instance of that code. Also the instances belonging to a particular code can easily be accessed through the coder. Categories and subcategories are presented as a tree with branches, which in turn contain the codes. Figure 9 shows a screenshot of Nvivo.

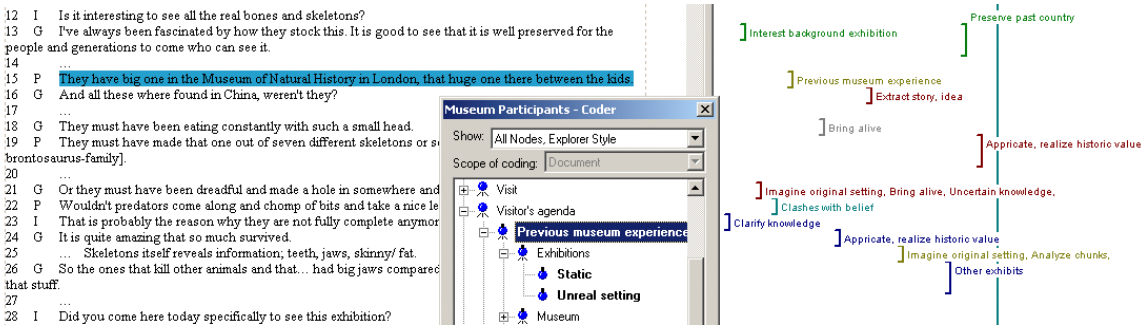

Figure 9. Screenshot of Nvivo's coder

Open coding is followed by *axial coding*, a qualitative data analysis method that also has its origin in grounded theory. The focus of axial coding is on looking at the data from an abstracted view, using the results that flowed from the open coding step. *Axial* refers to the process of relating codes (again notion of constant comparison), thereby looking at the data from a high-level perspective. Extracting links between codes gains insight in what is really going on in the data. This insight is not only gained during this step of the analysis, but also in the field and especially during the step of transcribing and coding the interview data. Over time the gaps in understanding, necessary to complete the bigger picture, are filled in.

The process of coding data along the axis consists of constantly comparing codes, grouping them, using knowledge previously acquired, the (sub)categories made earlier and notes taken on initial analysis (in the field and as memos throughout the study). Important is to focus on the core relations, the links that are relevant to the study, since usually more data is coded in the previous step (*open* coding) than needed to make up for the essence in the data. To discern between major and minor concepts one could make use of the quantification of the codes as offered by Nvivo, but in this study we didn't heavily

rely on this selection. The reason for that is if you decide to do so, hard selection criteria have to be set about what and what not to include, not taking into account important observations made in the field and understanding gained throughout the study (recorded as notes/ memos) as indicators for the importance of a certain concept. Furthermore concepts that were explored and observed later don't occur as often in concepts that were noted earlier in the study, not necessarily making them less important.

Linking codes and thereby creating a bigger picture of what is going on resulted in a set of themes that emerged from the data. Themes thus represent the most important aspects in participants' accounts, what the data essentially is about. These high level representations of the data serve as the starting point for the final theory.

The creation of a theory from the themes is a far from straightforward process, it involves building a consist and comprehensive framework around the themes. The resulting theory should provide the context to understand what the relations between and meaning of the themes is. Combined it gives shape to the human-environment interaction model, scoped to a museum environment. To effectively build the framework around the themes we made use of *affinity diagramming* (Miles, 1994).

Affinity diagramming is a simple method for organizing concepts into logical groups. The process of sorting the concepts is usually done in a (focus) group, but due to time and resource limitations, this could not be arrange within the set time. Instead, the affinity diagramming was held with J. Paay, a Ph.D. student from Melbourne University, which has experience with organizing focus group sessions. Her input was used to reflect on the grouping I came up with, putting the model up for discussion. Because she wasn't aware of the details of the research project I had to justify the decisions made in creating the (initial) grouping of the themes. This considerable increased the quality (having to justify, reviewing, feedback) and accuracy (fine tuning, reviewing, naming) of the final model.

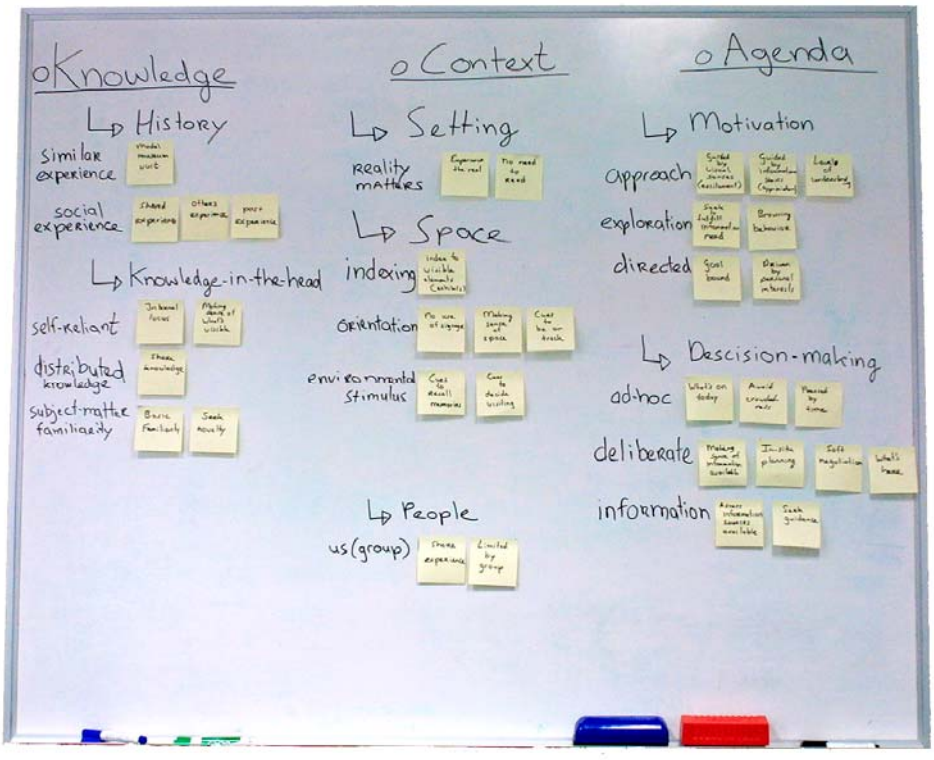

Figure 10. Affinity diagramming using sticky notes and a whiteboard

The first step is to write the concepts/ themes on sticky notes. Subsequently the sticky notes are sorted into groups on a whiteboard to easily (re)name groups. This is a time consuming and iterative process. Concepts are moved to other groups, new groups are formed, others are split until a satisfying grouping arises that fit the themes. The next step is to give each of the groups names that capture what the group constitutes of. The last step is to further abstract and contextualize the grouping by creating a hierarchy of groups, until a level that represents the core concepts of human-environment interaction. This process was repeated twice, and thus two sessions of two hours each were organized, the first one to discuss the initial model and grouping strategy, the second discussion was held to discuss a more final model. In total creating the model from the themes took about ten hours, divided over three days of brainstorming and thinking over the project. Figure 10 on the previous page shows the result of affinity diagramming using sticky notes on a whiteboard. The resulting model can be viewed more clearly in coming chapters in the tabular format.

5.2.4 Methodology overview

Figure 11 summarizes the techniques used for the collection of the data, the way analysis is carried out and the (intermediate) results that sprouted from the use of these methods. The last two steps form the second part of the research. Here, the resulting human-environment interaction model is translated into design sensitivities that are used to come up with a mobile museum guide prototype.

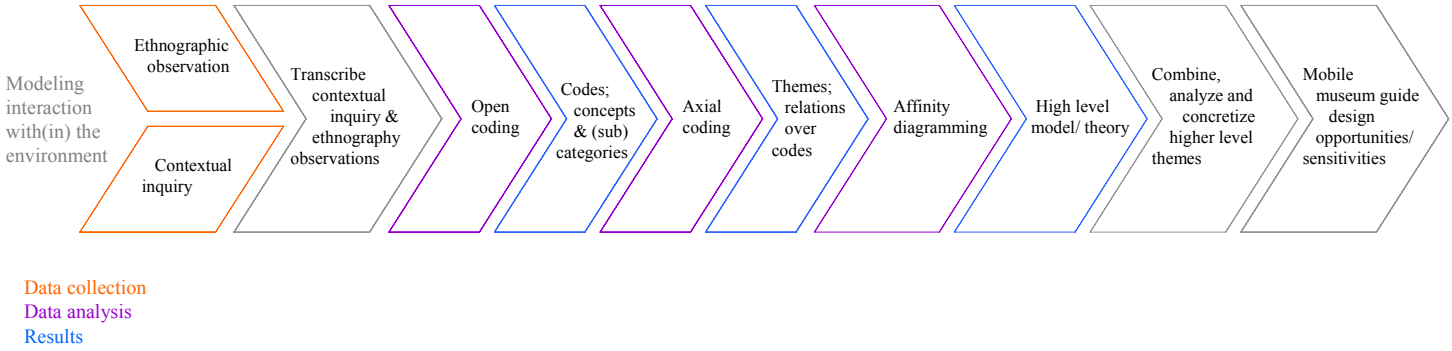

Figure 11. Overview of methods used and (intermediate) results

Chapter 6: Results

6.1 Codes & categories

Table 6 present the codes and (sub)categories resulting from the open coding of the transcript, including some main statistics from Nvivo. The (sub)categories are greyed out slightly to be able to discern between them and the codes. In total 144 codes were identified, not taking in to account the (sub)categories (195 tree nodes in total). An example of passages belonging to particular codes can be seen in detail in appendix 6: Sample transcript.

Table 6. Overview of the categorization of the codes

Codes & (sub)categories	*Tree address*	*Characters coded*	*Passages coded*	*# participants*	*% participants*
Orientation	1	0	0	0	0
Orientation/Disoriented	1 1	0	0	0	0
Orientation/Disoriented/Disorientation causes	1 1 1	0	0	0	0
Orientation/Disoriented/Disorientation causes/Position unknown	1 1 1 1	326	8	6	33
Orientation/Disoriented/Disorientation causes/Goal not visible	1 1 1 2	496	9	6	33
Orientation/Disoriented/Disorientation causes/No directions	1 1 1 3	480	11	6	33
Orientation/Disoriented/Disorientation causes/Intended path not clear	1 1 1 4	931	11	6	33
Orientation/Disoriented/Orientation aid	1 1 2	364	9	7	39
Orientation/Disoriented/First-time visitor excuse	1 1 3	289	2	2	11
Orientation/Oriented	1 2	0	0	0	0
Orientation/Oriented/Index to environment	1 2 1	550	10	6	33
Orientation/Oriented/Mental model	1 2 2	0	0	0	0
Orientation/Oriented/Mental model/Built during visit	1 2 2 1	445	5	4	22
Orientation/Oriented/Mental model/Complete, confident previous visit	1 2 2 2	989	7	3	17
Averages ((sub)categories not included)		*541*	*8*	*5*	*28*
Interpretation	2	0	0	0	0
Interpretation/Relate to	2 1	0	0	0	0
Interpretation/Relate to/Personal experiences	2 1 1	3522	25	11	61
Interpretation/Relate to/Knowledge possessed	2 1 2	0	0	0	0

Interpretation/Relate to/Knowledge possessed/Adequate - reason	2 1 2 1	2087	12	7	39
Interpretation/Relate to/Knowledge possessed/Exact	2 1 2 2	531	5	5	28
Interpretation/Relate to/Knowledge possessed/Seek confirmation knowledge	2 1 2 3	531	9	4	22
Interpretation/Relate to/Knowledge possessed/Inadequate - imagine	2 1 2 4	870	8	3	17
Interpretation/Relate to/Present situation	2 1 3	1938	9	5	28
Interpretation/Relate to/Other exhibits	2 1 4	2140	19	10	56
Interpretation/Gain knowledge	2 2	0	0	0	0
Interpretation/Gain knowledge/Unaware	2 2 1	0	0	0	0
Interpretation/Gain knowledge/Unaware/From experience	2 2 1 1	666	10	6	33
Interpretation/Gain knowledge/Aware	2 2 2	0	0	0	0
Interpretation/Gain knowledge/Aware/Group members	2 2 2 1	1008	13	7	39
Interpretation/Gain knowledge/Aware/Physical guide	2 2 2 2	1187	16	7	39
Interpretation/Gain knowledge/Aware/Labels & panels	2 2 2 3	1517	14	7	39
Interpretation/Gain knowledge/Aware/Labels & panels/Basic, clear information for public	2 2 2 3 1	1477	12	3	17
Interpretation/Gain knowledge/Aware/Labels & panels/Detailed information professional	2 2 2 3 2	873	6	3	17
Interpretation/Transfer	2 3	0	0	0	0
Interpretation/Transfer/Translate simple terms	2 3 1	920	8	5	28
Interpretation/Transfer/Express knowledge	2 3 2	2483	17	7	39
Interpretation/Transfer/Bring under attention	2 3 3	1859	29	14	78
Interpretation/Transfer/Correct knowledge	2 3 4	236	7	2	11
Interpretation/Transfer/Clarify knowledge	2 3 5	1097	16	5	28
Interpretation/Transfer/Transfer aid	2 3 6	618	8	5	28
Interpretation/Depth	2 4	0	0	0	0
Interpretation/Depth/Direct observation	2 4 1	0	0	0	0
Interpretation/Depth/Direct observation/Minimum interpretation	2 4 1 1	1719	15	6	33
Interpretation/Depth/Direct observation/Clear by itself, self-explaining	2 4 1 2	593	4	3	17
Interpretation/Depth/Conceptual	2 4 2	0	0	0	0
Interpretation/Depth/Conceptual/Bring alive	2 4 2 1	1022	11	6	33
Interpretation/Depth/Conceptual/Analyze chunks	2 4 2 2	532	6	5	28
Interpretation/Depth/Conceptual/Context	2 4 2 3	1497	13	6	33
Interpretation/Depth/Conceptual/Extract story, idea	2 4 2 4	965	8	6	33
Interpretation/Depth/Conceptual/Identify sections, areas	2 4 2 5	341	2	2	11

Averages ((sub)categories not included)		*1240*	*12*	*6*	*32*
Artifacts	3	0	0	0	0
Artifacts/Exhibits	3 1	0	0	0	0
Artifacts/Exhibits/Attended to	3 1 1	0	0	0	0
Artifacts/Exhibits/Attended to/Recognition	3 1 1 1	428	10	5	28
Artifacts/Exhibits/Attended to/Match interests	3 1 1 2	912	11	6	33
Artifacts/Exhibits/Attended to/Proportions	3 1 1 3	925	17	12	67
Artifacts/Exhibits/Attended to/On the way	3 1 1 4	332	6	6	33
Artifacts/Exhibits/Attended to/Causes increased interest in subject	3 1 1 5	328	4	3	17
Artifacts/Exhibits/Attended to/Attended by other visitors	3 1 1 6	175	3	3	17
Artifacts/Exhibits/Attended to/Visit by exhibit name, description	3 1 1 7	341	5	4	22
Artifacts/Exhibits/Labels	3 1 2	0	0	0	0
Artifacts/Exhibits/Labels/Readability	3 1 2 2	0	0	0	0
Artifacts/Exhibits/Labels/Readability/Large font	3 1 2 2 1	66	1	1	6
Artifacts/Exhibits/Labels/Readability/Adequacy	3 1 2 2 2	421	2	2	11
Artifacts/Exhibits/Labels/Readability/Lighting	3 1 2 2 3	152	2	2	11
Artifacts/Exhibits/Labels/Readability/Position	3 1 2 2 4	224	3	2	11
Artifacts/Exhibits/Labels/Mapping problems	3 1 2 3	537	7	3	17
Artifacts/Exhibits/Raise questions, discussion	3 1 3	0	0	0	0
Artifacts/Exhibits/Raise questions, discussion/Utter discontent	3 1 3 1	2475	7	2	11
Artifacts/Exhibits/Raise questions, discussion/Not knowledgeable	3 1 3 2	965	17	10	56
Artifacts/Exhibits/Raise questions, discussion/Lack self-explaining	3 1 3 3	950	8	4	22
Artifacts/Exhibits/Raise questions, discussion/Uncertain knowledge	3 1 3 4	783	17	8	44
Artifacts/Exhibits/Raise questions, discussion/Clashes with belief	3 1 3 5	665	10	7	39
Artifacts/Exhibits/Observed	3 1 4	0	0	0	0
Artifacts/Exhibits/Observed/In detail	3 1 4 1	0	0	0	0
Artifacts/Exhibits/Observed/In detail/Different angles	3 1 4 1 1	312	5	5	28
Artifacts/Exhibits/Observed/In detail/Close-up	3 1 4 1 2	1105	15	7	39
Artifacts/Exhibits/Observed/Overview	3 1 4 2	0	0	0	0
Artifacts/Exhibits/Observed/Overview/Back up	3 1 4 2 1	123	2	2	11
Artifacts/Exhibits/Observed/Overview/Unobstructed	3 1 4 2 2	192	1	1	6
Artifacts/Exhibits/Skipped	3 1 5	0	0	0	0

Artifacts/Exhibits/Skipped/Knowledgeable; not novel	3 1 5 1	609	6	5	28
Artifacts/Exhibitions	3 2	0	0	0	0
Artifacts/Exhibitions/Interest background exhibition	3 2 1	1008	12	10	56
Artifacts/Exhibitions/Uncrowded	3 2 2	199	3	3	17
Artifacts/Exhibitions/Size	3 2 3	311	6	5	28
Artifacts/Exhibitions/Visit by exhibition name, description	3 2 4	714	8	6	33
Artifacts/Museum	3 3	0	0	0	0
Artifacts/Museum/Preserve past country	3 3 1	1121	8	3	17
Artifacts/Museum/Offers the exclusive, inaccessible	3 3 2	981	8	7	39
Artifacts/Museum/Stylish	3 3 3	84	3	2	11
Artifacts/Museum/Spacious	3 3 4	172	5	5	28
Artifacts/Museum/Light	3 3 5	63	2	2	11
Averages ((sub)categories not included)		*570*	*7*	*5*	*26*
Visit	4	0	0	0	0
Visit/Focus	4 1	0	0	0	0
Visit/Focus/Children	4 1 1	1890	25	13	72
Visit/Focus/Children/Intimacy	4 1 1 1	117	2	2	11
Visit/Focus/Children/Attention-span	4 1 1 2	393	3	3	17
Visit/Focus/Children/Seek excitement	4 1 1 3	565	8	7	39
Visit/Focus/Children/Seek excitement/Involvement	4 1 1 3 1	1291	16	10	56
Visit/Focus/Children/Seek excitement/Involvement/Motivating	4 1 1 3 1 1	224	2	2	11
Visit/Focus/Children/Seek excitement/Involvement/Attention throughout visit	4 1 1 3 1 2	658	6	4	22
Visit/Focus/Children/Seek excitement/Large exhibits	4 1 1 3 2	175	2	2	11
Visit/Focus/Children/Lack conceptual understanding	4 1 1 4	2034	20	11	61
Visit/Focus/Adults	4 1 2	0	0	0	0
Visit/Focus/Adults/Reading, static information	4 1 2 1	853	12	8	44
Visit/Focus/Adults/Appreciate, realize historic value	4 1 2 2	2245	30	10	56
Visit/Focus/Adults/Imagine original setting	4 1 2 3	481	6	5	28
Visit/Pace	4 2	0	0	0	0
Visit/Pace/Set by children	4 2 1	330	7	6	33
Visit/Pace/Set by parent	4 2 2	78	3	2	11
Visit/Concerns	4 3	0	0	0	0

Visit/Concerns/Time left	4 3 1	69	2	1	6
Visit/Concerns/Break, rest	4 3 2	816	10	4	22
Visit/Concerns/Children	4 3 3	928	9	5	28
Visit/Limitations	4 4	0	0	0	0
Visit/Limitations/Group members	4 4 1	279	4	3	17
Visit/Limitations/Group members/Interests	4 4 1 1	544	7	6	33
Visit/Limitations/Group members/Reading behavior	4 4 1 2	990	11	8	44
Visit/Limitations/Time available	4 4 2	626	9	5	28
Visit/Limitations/Crowdedness	4 4 3	370	5	2	11
Visit/Guided tour	4 5	0	0	0	0
Visit/Guided tour/Freedom	4 5 1	606	4	3	17
Visit/Guided tour/Pace	4 5 2	249	2	2	11
Visit/Guided tour/Non-native language	4 5 3	406	6	6	33
Visit/Guided tour/Individual needs	4 5 4	161	2	2	11
Visit/Guided tour/Additional information, opinion	4 5 5	1603	11	6	33
Visit/Guided tour/Suit static exhibits	4 5 6	336	2	1	6
Visit/Guided tour/Cope with involvement	4 5 7	322	2	1	6
Visit/Guided tour/Guidance, selection	4 5 8	766	8	5	28
Visit/Guided tour/Audible prefer above reading	4 5 9	752	8	3	17
Averages ((sub)categories not included)		*682*	*8*	*5*	*27*
Visitor's agenda	5	0	0	0	0
Visitor's agenda/Previous museum experience	5 1	889	7	5	28
Visitor's agenda/Previous museum experience/Exhibitions	5 1 1	0	0	0	0
Visitor's agenda/Previous museum experience/Exhibitions/Static	5 1 1 1	224	4	4	22
Visitor's agenda/Previous museum experience/Exhibitions/Unreal setting	5 1 1 2	52	1	1	6
Visitor's agenda/Previous museum experience/Museum	5 1 2	0	0	0	0
Visitor's agenda/Previous museum experience/Museum/Old	5 1 2 1	253	4	4	22
Visitor's agenda/Previous museum experience/Museum/Not spacious	5 1 2 2	36	2	2	11
Visitor's agenda/Previous museum experience/Museum/Entrance-fee	5 1 2 3	454	2	1	6
Visitor's agenda/Previous museum experience/Sets model museum behavior	5 1 3	1087	10	6	33
Visitor's agenda/Expectations	5 2	0	0	0	0
Visitor's agenda/Expectations/Adult directed	5 2 1	0	0	0	0

Visitor's agenda/Expectations/Adult directed/Encounter expected later	5 2 1 1	231	3	2	11
Visitor's agenda/Expectations/Adult directed/History, typical country	5 2 1 2	1329	11	4	22
Visitor's agenda/Expectations/Adult directed/Somebody to refer to	5 2 1 3	305	4	3	17
Visitor's agenda/Expectations/Adult directed/Authenticity	5 2 1 4	316	3	1	6
Visitor's agenda/Expectations/Adult directed/Specific topic; detailed information	5 2 1 5	119	2	1	6
Visitor's agenda/Expectations/Adult directed/Basic knowledge; basic expectations	5 2 1 6	851	9	7	39
Visitor's agenda/Expectations/Adult directed/No learning; knowledgeable	5 2 1 7	656	6	5	28
Visitor's agenda/Expectations/Children directed	5 2 2	0	0	0	0
Visitor's agenda/Expectations/Children directed/Real looks	5 2 2 1	153	2	2	11
Visitor's agenda/Motivation	5 3	0	0	0	0
Visitor's agenda/Motivation/Browse-extensive	5 3 1	285	3	2	11
Visitor's agenda/Motivation/Browse-impression	5 3 2	2312	17	6	33
Visitor's agenda/Motivation/Browse-experience	5 3 3	912	8	3	17
Visitor's agenda/Motivation/Goal bound-experience-browse	5 3 4	1296	18	6	33
Visitor's agenda/Motivation/Goal bound-extensive-browse	5 3 5	558	4	3	17
Visitor's agenda/Motivation/Goal bound-impression-browse	5 3 6	476	6	3	17
Averages ((sub)categories not included)		*609*	*5*	*3*	*16*
Experience	6	0	0	0	0
Experience/During-visit experience	6 1	0	0	0	0
Experience/During-visit experience/Reflect previous museum experiences	6 1 1	2106	14	8	44
Experience/During-visit experience/Unexpected elements; discern main	6 1 2	650	7	6	33
Experience/During-visit experience/Reality	6 1 3	0	0	0	0
Experience/During-visit experience/Reality/Real setting	6 1 3 1	1258	13	6	33
Experience/During-visit experience/Reality/Provide when appropriate	6 1 3 2	590	3	2	11
Experience/During-visit experience/Reality/Added dimension	6 1 3 3	1511	16	8	44
Experience/During-visit experience/Reality/Substitute for reading	6 1 3 4	1027	7	6	33
Experience/During-visit experience/Reality/Atmosphere	6 1 3 5	859	8	5	28
Experience/During-visit experience/Sets visit expectations	6 1 4	975	8	5	28
Experience/During-visit experience/Recall, revive previous experiences	6 1 5	3256	17	7	39
Experience/Pre-visit experience	6 2	0	0	0	0
Experience/Pre-visit experience/Excitement	6 2 1	145	1	1	6
Experience/Pre-visit experience/Transport	6 2 2	557	3	3	17

Experience/After-visit experience	6 3	0	0	0	0
Experience/After-visit experience/Endured experience	6 3 1	604	7	5	28
Experience/After-visit experience/Visit memory	6 3 2	504	6	5	28
Averages ((sub)categories not included)		*1080*	*8*	*5*	*29*
Preparation	7	0	0	0	0
Preparation/Basic knowledge	7 1	0	0	0	0
Preparation/Basic knowledge/Sources basic knowledge	7 1 1	199	8	4	22
Preparation/Basic knowledge/Create awareness	7 1 2	848	6	3	17
Preparation/Basic knowledge/Prerequisite experience & knowledge	7 1 3	880	7	5	28
Preparation/Planning	7 2	0	0	0	0
Preparation/Planning/Pre	7 2 1	0	0	0	0
Preparation/Planning/Pre/Specific goal	7 2 1 1	652	9	7	39
Preparation/Planning/Pre/What's here	7 2 1 2	1368	12	7	39
Preparation/Planning/Pre/Recommendation	7 2 1 3	421	4	3	17
Preparation/Planning/Pre/Deliberate visits	7 2 1 4	915	5	4	22
Preparation/Planning/In-situ	7 2 2	0	0	0	0
Preparation/Planning/In-situ/Sources in-situ planning	7 2 2 1	153	4	4	22
Preparation/Planning/In-situ/Unplanned	7 2 2 2	92	1	1	6
Preparation/Planning/In-situ/Ad-hoc	7 2 2 3	541	9	7	39
Preparation/Planning/In-situ/Planned	7 2 2 4	222	5	3	17
Preparation/Planning/In-situ/Recommendation	7 2 2 5	393	5	4	22
Preparation/Planning/What's on today	7 2 3	719	10	8	44
Averages ((sub)categories not included)		*569*	*7*	*5*	*26*
Averages (overall)		*756*	*8*	*5*	*26*

6.2 Themes

Table 7 presents the themes and the codes from which the themes were inferred using axial coding, as described in detail in the methodology chapter. The 144 codes (or 195 nodes in the categorization tree) were reduced in this process to 35 key themes. The numbers behind the codes correspond with their position in the categorization tree (the tree address), as can be seen in previous table.

Table 7. Overview of the resulting themes

Themes	*Corresponding codes*
Assess information sources available	Orientation o Position unknown [1 1 1 1] o Goal not visible [1 1 1 2] Interpretation o Group members [2 2 2 1] Artifacts o Raise questions, discussion [3 1 3] o Not knowledgeable [3 1 3 2]
No need to read	Interpretation o From experience [2 2 1 1] o Direct observation [2 4 1] Visit o Audible prefer above reading [4 5 9] Experience o Substitute for reading [6 1 3 4]
Share knowledge	Interpretation o Group members [2 2 2 1] o Physical guide [2 2 2 2] o Express knowledge [2 3 2] o Correct knowledge [2 3 4] o Clarify knowledge [2 3 5] Preparation o Basic knowledge [7 1] Artifacts o Raise questions, discussion [3 1 3] o Not knowledgeable [3 1 3 2] o Uncertain knowledge [3 1 3 4] Visitor's agenda o Somebody to refer to [5 2 1 3]
Seek to fulfill information need	Interpretation o Seek confirmation knowledge [2 1 2 3] Artifacts o Not knowledgeable [3 1 3 2] o Uncertain knowledge [3 1 3 4] o Preserve past country [3 3 1] o Offers exclusive, inaccessible [3 3 2] Visit o Individual needs [4 5 4] o Additional information, opinion [4 5 5] Visitor's agenda o Encounter expected later [5 2 1 1]

Share experience	Interpretation o Bring under attention [2 3 3] Experience o Endured experience [6 3 1] o Visit memory [6 3 2]
Reflect on model museum visit	Visitor's agenda o Sets model museum behavior [5 1 3] Experience o Reflect previous museum experience [6 1 1]
Crowdedness	Artifacts o Unobstructed [3 1 4 2 2] o Uncrowded [3 2 2] o Spacious [3 3 4] Visit o Crowdedness [4 4 3]
Driven by (personal) interests	Artifacts o Match interests [3 1 1 2] o On the way [3 1 1 4] o Visit by exhibit name, description [3 1 1 7] o Recognition [3 1 1 1] o Visit by exhibition name, description [3 2 4] o Causes increased interest in subject [3 1 1 5] Visit o Interests [4 4 1 1] Interpretation o Personal experiences [2 1 1] o Knowledge possessed [2 1 2]
Browsing behavior	Artifacts o On the way [3 1 1 4] o Match interests [3 1 1 2] o Recognition [3 1 1 1] Visitor's agenda o Motivation [5 3] Visit o Freedom [4 5 1]
In-situ planning	Preparation o Planned [7 2 2 4] o Unplanned [7 2 2 2] o Ad-hoc [7 2 2 3] o In-situ [7 2 2]
Seek novelty	Artifacts o Not knowledgeable [3 1 3 2] o Knowledgeable; not novel [3 1 5 1] Visitor's agenda o No learning; knowledgeable [5 2 1 7] Experience o Unexpected elements; discern main [6 1 2]
Limited by group	Visit o Attention-span [4 1 1 2] o Reading behavior [4 4 1 2] o Interests [4 4 1 1] o Pace [4 5 2]

Making sense of visible (exhibits)	Interpretation o Adequate – reason [2 1 2 1] o Inadequate – imagine [2 1 2 4] o Other exhibits [2 1 4] o Conceptual [2 4 2] Artifacts o Close-up [3 1 4 1 2] o Back up [3 1 4 2 1] Visit o Imagine original setting [4 1 2 3]
Index to visible elements (exhibits)	Orientation o Index to environment [1 2 1] Interpretation o Bring under attention [2 3 3]
Making sense of information available	Orientation o Disorientation causes [1 1 1] o First-time visitor excuse [1 1 3] Interpretation o Translate simple terms [2 3 1] Visit o Imagine original setting [4 1 2 3] Preparation o What's here [7 2 1 2]
Goal bound	Visitor's agenda o Motivation [5 3] Preparation o Specific goal [7 2 2 1]
Pressed by time	Visit o Pace [4 2] o Time left [4 3 1] o Time available [4 4 2]
Cues to decide visiting	Orientation o Orientation aid [1 1 2] Artifacts o Visit by exhibit name, description [3 1 1 7] o Visit by exhibition name, description [3 2 4] o Knowledgeable, not novel [3 1 5 1] Preparation o Recommendation [7 2 1 3 & 7 2 2 5] o Sources in-situ planning [7 2 2 1]
Cues to recall memories	Interpretation o Personal experiences [2 1 1] Visitor's agenda o Previous museum experience [5 1] Experience o Reflect previous museum experience [6 1 1] o Recall, revive previous experiences [6 1 5]
Soft-negotiation	Preparation o Recommendation [7 2 1 3 & 7 2 2 5] o What's here [7 2 1 2] o Unplanned [7 2 2 2] o Ad-hoc [7 2 2 3] o Planned [7 2 2 4] Visit o Set by children [4 2 1] o Set by parent [4 2 2]

No use of signage	Orientation o Disorientation causes [1 1 1] o Orientation aid [1 1 2] o Mental model [1 2 2]
Guided by visual senses (excitement)	Visit o Involvement [4 1 1 3 1] o Cope with involvement [4 5 7] Visitor's agenda o Browse-experience [5 3 3] o Goal bound-experience-browse [5 3 4] Experience o Reality [6 1 3] Interpretation o Direct observation [2 4 1]
Guided by informational senses (appreciation)	Artifacts o Causes increased interest in subject [3 1 1 5] o Interest background exhibition [3 2 1] o Preserve past country [3 3 1] o Offers the exclusive, inaccessible [3 3 2] Visit o Reading, static information [4 1 2 1] o Appreciate, realize historic value [4 1 2 2] Visitor's agenda o Authenticity [5 2 1 4] Interpretation o Labels & panels [2 2 2 3] o Conceptual [2 4 2]
Level of understanding	Interpretation o Other exhibits [2 1 4] o Basic, clear information for public [2 2 2 3 1] o Detailed information professional [2 2 2 3 2] o Translate simple terms [2 3 1] o Direct observation [2 4 1] o Conceptual [2 4 2] Visitor's agenda o Specific topic; detailed information [5 2 1 5] o Basic knowledge; basic understanding [5 2 1 6] o Motivation [5 3] Visit o Lack conceptual understanding [4 1 1 4]
Experience real	Interpretation o From experience [2 2 1 1] Artifacts o Different angles [3 1 4 1 1] o Close-up [3 1 4 1 2] o Back up [3 1 4 2 1] o Proportions [3 1 1 3] Experience o Real setting [6 1 3 1] o Added dimension [6 1 3 3] o Atmosphere [6 1 3 5] Visitor's agenda o Authenticity [5 2 1 4]

Cues to be on track	Orientation o Index to environment [1 2 1] o Built during visit [1 2 2 1] Artifacts o Visit by exhibition name, description [2 3 4]
Seek guidance	Orientation o Orientation aid [1 1 2] o Disorientation causes [1 1 1] Interpretation o Physical guide [2 2 2 2] Visit o Set by children [4 2 1] o Set by parents [4 2 2] o Guidance, selection [4 5 8] Visitor's agenda o Somebody to refer to [5 2 1 3] Preparation o Recommendation [7 2 1 3 & 7 2 2 5]
Internal locus	Orientation o Complete, confident previous visit [1 2 2 2] Interpretation o Personal experiences [2 1 1] o Adequate – reason [2 1 2 1] o Inadequate – imagine [2 1 2 4] o Seek confirmation knowledge [2 1 2 3] Artifacts o Clashes with belief [3 1 3 5] o Knowledgeable; not novel [3 1 5 1] Visitor's agenda o No learning; knowledgeable [5 2 1 7]
Basic familiarity	Interpretation o Knowledge possessed [2 1 2] o Personal experiences [2 1 1] o Preparation o Basic knowledge [7 1] o Create awareness [7 1 2] o Prerequisite experience & knowledge [7 1 3]
What's on today	Preparation o What's on today [7 2 3]
What's here	Preparation o What's here [7 2 1 2] Visitor's agenda o History, typical country [5 2 1 2] o Encounter expected later [5 2 1 1] o Authenticity [5 2 1 4]
Past experience	Interpretation o Personal experiences [2 1 1] Experience o Recall, revive previous experiences [6 1 5] Visitor's agenda o Previous museum experience [5 1]

Shared experience	Interpretation o Personal experiences [2 1 1] Experience o Recall, revive previous experiences [6 1 5] Visitor's agenda o Previous museum experience [5 1]
Making sense of space	Orientation o Mental model [1 2 2] o Intended path not clear [1 1 1 4] o Position unknown [1 1 1 1] Artifacts o Interest background exhibition [3 2 1]
Others' experience	Visit o Additional information, opinion [4 5 5] Preparation o Recommendation [7 2 1 3 & 7 2 2 5] o What's here [7 2 1 2] Artifacts o Attended by other visitors [3 1 1 6]

Chapter 7: Towards a Framework for Mobile Guide Design

7.1 Introduction

This chapter will discuss the outcomes of this study on different levels. First of all the themes will be further described on. This provides an account of how the themes came about. Where possible, themes are grounded by findings from research done previously, but as mentioned in the introduction we aimed to build a theory for the purpose of understanding, making it hard to fully justify the results. This was one of the reasons why we applied grounded theory; it describes and visualizes the steps from raw data until a final model in a transparent way. Kjeldskov and Graham (2003) identified the need for field research aimed at understanding the use of mobile guides from a user perspective. This gap in mobile guide research also means that, except from basic museum (visitor) research, not a lot of research has been conducted that covers the field of research in this study.

The codes themselves are not being discussed separately since they were drawn directly from the data, as can be seen in appendix 6: Sample transcript. They don't need any further explanation, because its justification becomes clear from the raw data itself in combination with the (sub)categories that provide the necessary context.

The discussion of the themes is followed by the discussion of the resulting theory. The elements that make up the model as well as how to interpret it are explained. Furthermore, the model is related to the work of J. Paay. At last, the applicability of the model for mobile guide design will be shown by drawing up design sensitivities from elements in the human-environment interaction model and designing a mock-up screenshot, heading towards a possible implementation of a mobile museum guide system.

Limitation of this study, as well as issues of validity and reliability are also discussed in detail in this chapter.

7.2 Interpreting the themes

This section will discuss the way the themes are to be interpreted in the context of human-environment interaction. This includes a description of what the themes comprise. The codes of which the themes are composed (highlighted in italics) as well as the participants' accounts are used in this explanation/ justification.

Isolated themes are discussed separately, whereas related themes are discussed together:

Assess information sources available (1) & seek to fulfill information need (2). In interacting with exhibits present (e.g. interpretation, observation etc.) and for purposes of orientation (e.g. way-finding, mental model, signage etc.), visitors follow the strategy of assessing the available information sources. Information sources that are easily accessed or most likely to contain the information needed are chosen first of all, cascading down to sources less accessible/ likely to contain the information. Visitors rather ask their way around when their *goal is not* directly *visible* then looking it up themselves, the same goes when their current *position* is *unknown*. Visitors also *raise questions* and promote *discussion* when together with other *group*

members when they are *not knowledgeable* or *uncertain* about their *knowledge*, thereby hoping to easily get the information they want (cascading; from own knowledge to group, to reference materials, to labels/ panels to asking museum staff). In their search they *expect* to *encounter* specific needs/ information *later*, raising specific expectations beforehand about the museum including the museum's role as *preserver* of the *past* of the *country* and as an institute that *offers* insight in the *exclusive*, otherwise *inaccessible* to the public. Visitors have specific *individual needs* (e.g. *additional information and opinions*) that often remain unanswered during their visit.

No need to read (3). Visitors don't often read labels, panels or other information, because experiencing the exhibit on its own also seem to provide the information wanted. For visitors, *direct observation*, without going into detail by either reasoning about the exhibit/ object or gathering further information, is sometimes satisfying enough, thereby acting as a *substitute for reading*. Implicitly, visitors learn *from experience*, this is especially the case with children. As we will see later on, cues from the exhibits are used for purposes of recalling experiences and knowledge, decision to visit and orientation. Furthermore, visitors *prefer to hear information* instead of having to *read* themselves. It is expected that these observations are more explicitly present in museums that have objects that resemble reality instead of more static objects (e.g. art museums) that usually require more interpretation and specific knowledge from the visitor.

Share knowledge (4) & share experience (5). Visitors are eager to *express* their *knowledge* of a certain object, or knowledge that is related to that object. This knowledge is shared between *members* of the *group*, but also between a *physical guide* and visitors. Visitors also *correct* false *knowledge* of others and further *clarify* points made by others as well as points made by themselves. Visitors *raise questions* or start a *discussion* either when they are *not knowledgeable* or are *uncertain* about their *knowledge* on the subject, expecting to find answers from others by sharing their knowledge. When they cannot fulfill their information need, *somebody* should be present *to refer to*. It is assumed by visitors that others have a *basic knowledge* of the subjects in the museum. Museum experience is shared between visitors to *bring* interesting exhibits/ objects *under attention*. This *experience endures* further outside the museum walls and *memories* of the *visit* are taken home. Sharing knowledge and experience is an important part of the social interaction within the environment, mainly for purposes of understanding. Evidence from several studies (e.g. McManus, 1987) show the importance of communicating visitors' museum experience and earning from exhibits to others.

Reflect on model museum visit (6). Based on experiences from previous museum visits, visitors build a *model museum visit behavior*; how one should behave in museums according to them, mainly extracted from observation of others. During their visit they continuously *reflect* on this set of *previous museum experiences*. Subsequently this set is updated/ adjusted to form a new model of what a museum visit looks like. Anything that contradicts with this model (e.g. touching objects, being quiet, heritage site, not having labels etc.) is considered "different" and therefore open to discussion.

Crowdedness (7). Visitors don't expect that there will be no crowd at all, but in general they want to avoid *crowded* situations at all times. Reasons for this behavior are that they are looking for a *spacious* looking environment that gives them an *unobstructed* view on the objects on display.

Browsing behavior (8), goal bound (9) & driven by personal interests (10). From the observations it appeared that most, if not all, visitors show an unpredictable visit

behavior/ path. This behavior is characterized by visiting exhibits/ objects *on the way*, by *recognition* (relation to a previous experience) and that *match* their *interests*. This matching is done by mapping interests, mainly consisting of *personal experiences* and *knowledge possessed*, on the *exhibition/ exhibit name and description*. Interest in a particular exhibit causes a noticeable *increase* in the *interest* for the *subject*, exhibition or *related exhibits*. Apart from "browsing" through the museum, visitors also have a *specific goal* in mind when entering the museum. This can be a special exhibition that they wanted to see, more specific an exhibit, or more general visiting for members of the group. For both *browsing* and *goal bound* behavior we identified three sub-types of behavior: *extensive* (visiting nearly all exhibits and extensive reading), *impression* (view main exhibits of exhibitions) and *experience* (visit most attractive and interactive exhibits). From Nvivo data it appears that most people that visit with a certain goal in mind come to experience and visitors that browse around want to see the main exhibits of the museum, this corresponds with findings from the field. Visitors want to move around *freely*, not being bound to a physical guide or by the group as detailed later on.

In-situ planning (11). In-situ planning refers to planning (scheduling what to visit) that is done in the museum. In-situ planning comes from three forms of planning: *planned* (the visit is planned on entry of the museum), *unplanned* (no planning is done, just walking off in a particular direction) and *ad-hoc* (short-term planning, planning based on what one encounters). Since most participants were first-time visitors it makes sense that an ad-hoc strategy was chosen by most of them (see also Nvivo data) since they didn't know what to expect and what was going on.

Seek novelty (12). Whether it is part of an overall goal to learn, be entertained or socialize, visitors seek novelty. Visitors are surprised by *unexpected elements* that *discern from* the *main* subject in the exhibition (e.g. presentation on the construction of the exhibition, interactive elements, atmosphere etc.). Exhibits are visited, because visitors are *not knowledgeable* of the subject on display. The contrary, being *knowledgeable*, i.e. the subject *not* being completely *novel* to the visitor, has been found as well. Visitor *don't* even *expect to learn* when knowledgeable of the topic presented.

Making sense of visible (exhibits) (13), making sense of space (14) & no use of signage (15). In making sense of exhibits and objects the visitor thinks further than the mere direct observation thereof, the exhibit is approached on a *conceptual* level. Objects are decomposed into concepts that are of interest for the visitor and makes it able to interpret them by the process of either *adequately reasoning* about them (from profound knowledge) or *inadequately imagining* (guessing with basic knowledge) what its function could be. The object is looked at in detail (*close-up*) and from a distance (*back up*) to get a good overview (pieces falling together). This detailed observation and analysis results in a deepened understanding of the exhibit/ object, thereby being able to *imagine its original properties, setting and context*. For orientation, instead of interpretation purposes visitors make sense of the museum space. From the moment they enter the museum a *mental model* is constructed of the space surrounding them. In the beginning this is observed as visitors absorbing their environment for a while before continuing. During the visit visitors soon build a model of the space surrounding them, but this doesn't necessarily correspond with the real structure; *intended paths* are *not* always *clear*. Initially visitors relied on the map of the museum, thereby *not knowing* their current *position* and not using signs. After exploring the space for a while visitors get acquainted to the environment and don't refer to the map as often anymore, advocating for the construction of a mental model.

Initially, not using signs and not knowing where they are/ where to go *caused disorientation* and concurrently *orientation aid* (map of museum of no use, instead consult physical guide/ museum staff) was needed.

Others' experience (16), shared experience (17) & past experience (18). Experiences from others about their visit impacts what visitors want and come to see. What visitors come to see is influenced upfront by *recommendations* from others. Also, within the museum they counsel others to get to know *what's here*. *Additional information* and *opinions*, in the form of how others' experienced exhibits, is welcomed by visitors. They don't only directly ask advice, but also observe behavior of others to act upon as an implicit recommendation; *attending* exhibits visited *by other visitors*. Apart from having experience from others, visitors also have past experience themselves. This is not bound to *experience* from *previous museum* visits, but also includes *personal experiences* (e.g. from holidays, work, family etc.). These experiences are used for interpreting exhibits, but often exhibits make people *recall and revive previous*, mostly personal, *experiences*. Similar to (personal) past experiences, visitors have shared experiences, consisting of identical past experiences that were experienced by multiple people.

What's on today (19) & what's here (20). In general visitors don't have any idea *what's on today* in the museum. These are events organized by the museum; special exhibitions and shows that commence on specific times. When visitors are made aware of these occasions (and are close in proximity) nearly all are interested. Most visitors are neither informed of *what's* in the *museum*, although they have an general idea of what the museum should offer, shaped by model museum visit: *typical history* of the *country* displayed as *authentic* exhibits. If they don't come across elements that correspond with their model of the museum they *expect* to *encounter* it *later* on in their visit.

Level of understanding (21) & basic familiarity (22). The level of understanding is not only related to the *motivation* of the visitor, but also to the capabilities and background knowledge of the visitor. Some visitors only *directly observe* objects, not willing or able to further discuss, relate or think about the object, while others approach the object on a *conceptual* level, i.e. decomposing into understandable pieces and relating them to *other exhibits*. Therefore, museums provide *basic, clear information for the public* and more *detailed information for the professional*. This is consistent with how visitors with different levels of knowledge approach the exhibits; *specific topical knowledge* requires *detailed information*, while *basic knowledge* results in *basic expectations*. Due to variations in capabilities some visitors *lack conceptual understanding* (mostly children), therefore a *translation into simple terms* should be provided to support these variations. It is assumed not only by the museum, but also by the visitors that there is a basic familiarity of the objects on display. This is a *prerequisite to experience* and further gain *knowledge* on the subject. People not *possessing* this primitive type of *knowledge* or didn't gain this from *personal experiences*, usually children, are prepared before visiting the museum by others to be at least familiar with the concepts on display. *Basic knowledge* is provided to *create* this *awareness*.

Internal locus (23) & making sense of information available (24). With internal locus is meant that visitors strongly rely on, explain from and refer to their own sources (e.g. knowledge, experience etc.) rather than using external sources (e.g. others, static information etc.). As mentioned before, when advancing an exhibit visitors start *reasoning* with *adequate knowledge* or *imagine* with *inadequate* knowledge before reading any information. This process is followed by *seeking* for a *confirmation* of

their *knowledge* about the exhibit. When information provided by others or from labels/ panels *clashes with beliefs* it is not considered to be true, although it often concerns plain facts. This *confidence* is also found in orientation; the mental *model* formed from a *previous visit* is rather complete, visitors even refuse to accept a museum map.

Seek guidance (25). People seek *aid* in *orientation* when they feel *disoriented* when finding their way around (e.g. when position is unknown, goal is not visible, no directions are provided, the intended path is not clear etc.). This guidance is often provided by a *physical guide*, a member of the museum staff, somebody whom they can *refer to*. During the visit it notably becomes clear that a member (pace *set by children or parents*) of the group takes the lead and guides the visit. The need for *guidance* also becomes apparent from visitors who are looking for *recommendations* on what they should see in the museum; a *selection* of the key exhibits of the museum.

Cues to decide visiting (26), cues to be on track (27) & cues to recall memories (28). A cue is either a consciously or unconsciously perceived signal, coming from the environment, that prompts an action or particular behavior. In the light of the museum, cues are extracted from the environment for different purposes. The first one is to decide whether or not to visit an *exhibition* or *exhibit* by its *name and/ or description*. Especially in the start, visitors have to map exhibit names on their interests and on the subjects they *don't* already have a profound *knowledge* of. The museum map thus serves as one of the *sources* for *planning in-situ*. Another valuable source is *recommendations* from others. The second use of cues in the museum is for orientation. *During* the *visit* a mental model is *built* of the museum space that people use in reference to certain areas they have been before (e.g. next to, opposite of etc.), thereby *indexing* to the *environment*. Objects, *exhibition names* and *descriptions* are used as references to head in the intended direction. The last use of cues is in *recalling and reviving previous experiences.* Objects/ exhibits serve as stimulators for activating these *personal* or *previous museum experiences*.

Index to visible elements (exhibits) (29). Contrary to cues to be on track, indexing refers to using indicators from the environment for the use as a reference, instead of a stimulus coming from the environment. *Indexing* is mainly used as a reference to known and visible elements in the *environment* for the purpose of navigation/ orientation, but is also used to refer to *bring* exhibits *under attention* by referring to (properties of) them. Using indexing makes sure visitors between each other and visitors and (agent) systems refer to/ talk about the same concepts/ elements of the environment since indexes are context dependent and thus observable.

Experience real (30). In the theme "No need to read (3)" the importance of experiencing exhibits has already partly been addressed. Visitors gain knowledge *from experience* unconsciously; the object is analyzed by looking *close-up*, from *different angles*, by *backing up* to get an overview and its *proportions* become clear by viewing it in reality. Reality *adds* an important *dimension* to visiting museums, it is one of the reason to actually go and visit museums. Reading about it, seeing it in animations, movies or books is different: it lacks the feeling of reality. Elements that add up to the feeling of reality, identified in this study, are related to the *authenticity* of the objects, the *setting* in which the object is put to create the original context and to create an *atmosphere* corresponding with the message the exhibition wants to communicate (e.g. with the use of sounds, lights, motion etc).

Soft negotiation (31). Soft negotiation is the label assigned to negotiation on the basis of trusting the persons involved and avoiding conflicts by making concessions to easily

reach an agreement. Soft negotiation is part of the planning process of a visiting group, whether that is *unplanned*, *ad-hoc* or *planned*. In this process a member of the group starts the discussion what to see, using *what's here* and negotiating what other members of the group want to see. This takes the form of gathering *recommendations* from visitors by requesting advice on what to see. In families, making up for 60 percent of all visitors, this process is usually guided by the *parents*, but focused on the *children*.

Guided by visual senses (excitement) (32) & guided by informational senses (appreciation) (33). These themes are both related to the level of understanding, but have a focus on how the visit in general is approached and determines how people behave within and interact with the museum environment. On the one side there are visitors who are mainly in the museum for reasons of entertainment (e.g. groups with young children), and on the other side there are visitors who come to gain knowledge (e.g. adult groups). Elements in the museum that take care of *involvement* in the exhibits serve as motivators for *attention throughout* the visit. The overall motivation of visually guided visitors is characterized by *browsing* through exhibitions with a focus on *experiencing reality*, but not going much further than *directly observing* exhibits (i.e. no reasoning about, isolated view, high pace, surface thinking). Visitors motivated to go a step further in interpreting the objects present have the following distinguishing characteristics: *read static information* (on *labels* and *panels*) in more detail, expect the museum to *preserve* the *past of the country*, *offer the exclusive* otherwise *inaccessible* to the public, assume objects are *authentic* and thus *realize and appreciate the value of history*. Exhibits are broken down into *concepts* of interest of the visitor, and where necessary further deepened. Approaching exhibits and exhibitions from this viewpoint opens up opportunities like showing *interest in the background of the exhibition* and looking for *relations between objects*, since interest aroused by a particular part of the exhibition might result in an *increased interest* in the *subject in general*.

Limited by group (34) & pressed by time (35). In interacting with(in) the environment visitors encounter limitations. Two of these limitations that came up strong are group and time limitations. Individual differences in *attention-span, reading behavior, interests* and *pace* cause the group to split apart during the visit. Visitors are annoyed by having to wait or hasten by the different visit style of other members. Groups with children especially have to take the limited *attention-span* of the children into account. Furthermore, visitors are limited by the *time available* for the visit (fit in schedule for the day) and concerned by the *time left* (wanting to visit "everything" within a set time). Bollo and Pozollo (2005) come to the same conclusion about these time-related limitation: "the visitor's time is a scarce resource: the overall time devoted to the visit is very often underestimated or not sufficient for an ideal and complete vision of the works on display".

The previous outline showed what the themes are composed of and what their meaning is. Correctly naming each of these themes is of great importance since it are the building blocks of a grounded theory. For issues of validity not only the naming is of importance, but also providing a justification of what it is composed of. Naming concepts in such a way that it fully represents what its content is, is part of content validity. It should be clear what the themes are composed of by looking at its name. If it doesn't cover its full content it is to limited, loosing detail and possibly findings from the data in the abstraction process to a final theory. On the other hand, if its naming is to broad, a misleading image of the data is created, representing findings that don't appear from the

data. Therefore transparency of what it is composed of is of major importance for the accountability thereof.

Apart from whether a theme covers its content, transparency is also important in accounting for a valid construct. This is closely related to content validity since, in the case of the themes, it also largely is a labeling issue. In construct validity one is concerned with whether constructs measure what the are aimed to measure. The process from abstraction of the codes to themes involves generalizing lower level data. Showing how the themes came about in this process is thus critically in providing valid, traceable results. The structured way of analyzing the data to produce grounded results is strongly present in grounded theory (Corbin & Holt, 2005), the approach taken in this study. Thinking through the themes, discussing them with experts (museum staff) and using the methods described are measures to increased construct validity. We made sure no themes overlapped in such a way that they cross-purposed each other. In addition themes were defined in a neutral way; that is to avoid positive/ negative notions as much as possible. Other ways of increasing construct validity is by using cross-validation. Cross-validating subjective observations with objective measure increases the validity. Because in this study the focus in on fully understanding the visitor in its environment by immersion in the visit, we explicitly chose not to use any quantitative measures, although they were gathered (Nvivo statistics & questionnaire). They simply don't provide the depth, context and richness of qualitative data gathering methods.

7.3 Constructing the Human-Environment Interaction Model

In this section we will discuss how the human-environment interaction model was created and how one should interpret it. A comparison with the work of J. Paay is also given.

In order to add value the model has to adds up to the already defined themes. Just like the codes have no meaning in the context of human-environment interaction by its own, themes don't either. By relating codes to each other, understanding of what is going on in the data was reached. At first sight the codes didn't seem interrelated, but as the research progressed the essential connections became obvious. The same applies to the themes; on their own it are important identifiers of the raw data, but to form a theory that provides understanding on a conceptual level on should go a step further. This step consists of linking and categorizing the themes to be able to build the context around the themes that make up for final theory. By doing so the meaning of the themes become clear in the light of a human-environment interaction perspective. Continuously abstracting categories of themes will finally result in the core concepts of human-environment interaction.

For grouping and relating themes affinity diagramming was used. This resulted in an named set of groups that served as a starting point for further categorization to build up the model. The content of the model is discussed around the three core concepts:

Knowledge. *Similar experience* together with *social experience* was further grouped as *history*, being part of the core concept *knowledge*. *History* contains themes that are related to experience build up from former experiences, either *similar* (from own/ others' visits) or *social* (from personal experiences not related to museum visits) *experiences*. The other category directly falling under *knowledge* is *knowledge-in-the-head*, referring to the knowledge one possesses on entry of the museum. Although *knowledge-in-the-head* also contains for example historical facts used in the interaction with the environment, it indicates that it is not directly related to the history of visiting the environment or related experiences. *Self-reliant* means visitors strongly use own knowledge to interpret and explain what is going on in the

environment, while *distributed knowledge* refers to using knowledge from and provide knowledge to others for this purpose. *Subject-matter familiarity* concerns to what extent knowledge is already possessed about the subject, determining the approach visitors take in interacting with the environment.

Context. *Context* are all the circumstances in which the interaction with the environment takes place. The major categories in *context* are: *setting, space* and *people*. *Setting*, as interpreted in the light of environmental interaction, is the way in which the physical elements of the environment are presented. The themes in this category are grouped as *reality matters*. Visitors value the added dimension above static presentations of objects, for experience focused people this is even the main reason to visit the museum. S*pace*, the (elements of the) physical environment, has the following leafs: *indexing, orientation* and *environmental stimulus*. *Indexing* and *environmental stimulus* are opposites of each other; where in *indexing* one adverts to an element of the environment, in *environmental stimulus* the impulse comes from the environment in the form of cues. *Orientation* covers the themes that have to do with visitors understanding of their position in the environment. The *people* category is limited to *us* (the *group* themselves), visitors don't appear to have socialization with other visitors than their group high on their agenda.

Agenda. The last group is *agenda*. In the context of museum the word is rather ambiguous. A*genda* is not only related to the word schedule, but also to the concept of visitor's agenda. Visitor's agenda has already been mentioned in detail, it contains the motivations, prior museum experiences and interests of a visitor (Falk and Dierking, 2002). In our model, prior museum experience has already been grouped under *knowledge - history*, since the focus in our model is on the interaction of humans in the museum environment instead of focusing on the properties of the visitors only. Motivations and interests are grouped in one; *motivation*. *Motivation* here is not limited to the willingness of people to undertake something, but also includes motivators (like interests, personal drive and curiosity) and related behavior. It thus has a broadened view on *motivation* in relation to interacting with(in) the environment. Under the category comes: *approach* (with what intention are elements of the environment approached), *exploration* (wandering around, aimed or by discovery) and *directedness* (guided by motivators). The other leaf of *agenda* is *decision-making* and has to do with sources needed for *decision-making* and on what basis and for what purpose decisions are made. For this process *information* is gathered from physical guides, museum staff, members of the visiting group, maps, labels and panels. This process also includes evaluating the sources available. Based on this *information* decisions are made on *ad-hoc* (immediate, short term, decisions based on stimuli coming from interacting with the environment)or more *deliberate* basis (upfront decisions, planning and discussing options available).

Table 8 on the next page shows the final theory that resulted from the affinity diagramming with the themes that were identified in the previous outline.

Table 8. Human-environment interaction model for museums

Knowledge	history	similar experience	*Reflect on model museum visit* *Others' experience*
		social experience	*Past experience* *Shared experience*
	knowledge-in-the-head	self-reliant	*Internal locus* *Making sense of visible (exhibits)*
		distributed knowledge	*Share knowledge*
		subject-matter familiarity	*Basic familiarity* *Seek novelty*
Context	setting	reality matters	*No need to read* *Experience real*
	space	indexing	*Index to visible elements (exhibits)*
		orientation	*Making sense of space* *Cues to be on track* *No use of signage*
		environmental stimulus	*Cues to decide visiting* *Cues to recall memories*
	people	us (group)	*Share experience* *Limited by group*
Agenda	motivation	approach	*Guided by informational senses (appreciation)* *Guided by visual senses (excitement)* *Level of understanding*
		exploration	*Seek to fulfill information need* *Browsing behavior*
		directedness	*Goal bound* *Directed by (personal) interests*
	decision-making	ad-hoc	*Crowdedness* *What's on today* *Pressed by time*
		deliberate	*In-situ planning* *What's here* *Soft-negotiation* *Making sense of information available*
		information	*Seek guidance* *Assess information sources available*

The theories created serves as a valuable tool for understanding how humans (and in specific visitors of the museum) interact with(in) their environment. The concepts provide a comprehensible framework around the themes. This doesn't only make the (relations between the) themes more clear, but also shows what other central factors and properties are involved. It makes explicit what would otherwise be left to interpretation of the reader. Because of its generality the model can be applied to various fields of research, to name a few: psychology; insight in human thinking and behavior, architecture; for designing places, computing science; for designing systems in general.

When comparing our model with the one J. Paay developed for an architectural site focused on social interaction, the parallels are immediately notable. Similarities are mainly present on a high level, for example two out of three core concepts (knowledge and context) are identical. This correspondences clearly make sense since we are talking about people (knowledge) interacting in an environment (context), whether that is an

outdoor architectural site or a indoor museum space. Also, differences on a higher level can be explained. “Motivation” in J. Paay’s work is of major importance, characterized by the freely-visit nature compared to the more scheduled approach in museums, visible through the key concept “Agenda”. Other elements of the model that are environment/ situation specific include: knowledge-in-the-world; architectural affordances, knowledge-in-the-head; museum interpretation, reality matters; added dimension/ experience and setting matters; architectural features. The similarities between the models show that there is an opportunity to construct a general human-environment interaction model. This generalization is proof for a strong external validity, having the potential to use this model for other situations, though in an adapted form. This also increases the reliability of how the analysis was carried out since outcomes of this study (and of other studies) appear to correspond with specific field characteristics.

7.4 General discussion

Now the results have been discussed on a detailed level we can reflect on the study as a whole. The first point to be addressed is the context to which the results can be applied. As mentioned in the methodology chapter, the results have been gathered in one particular museum only, the question that comes up here is whether the data is representative for museums in general. Although the aim in qualitative research is not to generalize to a larger population, it appeared that the sample of this study is rather representative for museums in general (see methodology chapter). Of more importance is the generalizability of the results to other areas. Although this study focused on the interaction of visitors with(in) the museum environment it is expected that the content offered by museums doesn’t impact the results on a high level. On a lower level the impact of the content on the results in, for example, an arts museum are noticeable since the exhibits presented require specific knowledge to be interpreted correctly. On a higher level this comes down to the same concept of using or sharing this knowledge in the environment for interpretation purposes. A factor that also has an influence on the intermediate results is the way the museum has been set up; the level of interactivity, transparency of the structure of the museum/ exhibitions, type of objects, position/ arrangement of objects etc. Changing these factors results in a changed visitor experience of that environment and alters the intermediate results. For example, experiencing reality in a hands-on museum is related to being involved in the exhibits, whereas in an arts museum it is related to observing the work from different viewpoints and perspectives. Again, in the model it comes back under the same heading, advocating for the applicability of the model to other museums than the type of museum focused on in this study. This conclusion, together with the similarities in J. Paay’s model, makes the study highly transferable to other areas; supporting a strong external validity.

The grounded theory approach taken in this research, because of its structured way of gathering and transparent way of analyzing data, differs from the traditional way of conducting research with the help of this framework, and should therefore be discussed accordingly. Because this study is part of relatively short project of eight months, the amount of time spend in the field was limited to two weeks. Also, the project had been set out in detail before entering the field to make efficient use of the time, creating a strong focus on what kind of data to gather from whom and by what methods. This informed approach clashes partly with the traditional belief that on should have a (completely) blank view on entry of the site, creating the theory from “nil”. In that viewpoint the approach taken here is rather naïve; in our opinion one always has knowledge of the field and a specific idea on how to realize the aims in the project. Still, the grounded theory

proved valuable in accounting for the results, thereby increasing the internal validity. Furthermore, the literature was used as a source of inspiration and therefore served as a motivation to start the research at first.

Ideally, the study should have been conducted with at least two researchers, one researcher observing the situation, while the other performs the contextual inquiry. Doing both methods at once is perceived quite intensive since notes on analysis and observations have to be taken and meanwhile one has to pay attention to actions or specific behavior of the participant one want to further explore. The transcripts were coded using a data analysis tool (Nvivo) to maintain a high consistency in the transcripts, resulting in an increased intra-rater reliability. For this purpose also each transcript was looked at a second time (code-recode) when the final coding tree was composed. As mentioned before, using multiple ways of collecting data, known as triangulation, increased the construct validity. Subjective observations are combined with objective data from the contextual inquiry method.

Another limitation of doing research with one researcher is that it is hard to proof the transcripts were coded in a unbiased and objective way. The way raw data is coded should ideally correspond with the way another researcher should code it. As a result, the inter-rater reliability, the agreement among coders in the analysis of the data, can't be determined. As the term inter-*rater* suggests it is closely related to quantitative research, therefore inter-coder agreement is a better term in the context of qualitative research. The consequence of coding the data with one researcher is that one could seriously doubt the theoretical conclusions drawn from analysis of the data. At least, that would be the conclusion seen from a purely quantitative viewpoint, comparing clear numeric data. In qualitative research it is the researcher in the field that was closely involved with the participants under study and thus best knows how to interpret the intended meanings of their responses and behavior through close involvement (one of the principles of ethnography). In that sense the researcher should provide an accurate and valid interpretation of the accounts since processes that address accuracy in the form of hard correspondences don't necessarily improve the quality of the data analysis. The measures taken in this study to address the inter-coder reliability, partly making use of the suggestions from Carey and Oxtoby (1996), are: taking notes/ memos of interactions and initial analysis thoughts and including them in the transcript, using clear and descriptive codes with (sub) categories as context (instead of the usual bare numeric or cryptic codes (e.g. CAUSEMK) where a code book is essential), using a transparent and structured way of analyzing the data (grounded theory), consistent coding using a data analysis tool (QSR's Nvivo) and using the code-recode principle to gradually come up with a coding scheme that fully fits (and is tested on) the data set.

Chapter 8: Applying the Human-Environment Interaction Model

8.1 Introduction

It is now time to discuss how to explore the use of the model for mobile guide design. Traditionally, user needs and wants are translated into system specific requirements. The concepts of user needs, wants and system requirements are all on the same conceptual level, namely on application level. In this study we have taken the approach to first gain understanding of the field one wants to apply the mobile guide to. This resulted in a comprehensible model of humans interacting with and within the museum environment, seen completely separate from its final, hypothesized use as a mobile guide. The aim is not to go into implementation specific issues, rather our opinion is that system independent matters should be further explored, presenting it in a form where designers can hold on to. Thinking in requirements at this point is already too specific, focusing too much on features that should be present in the final implementation. Ciolfi (2004) came to the same conclusion that transforming into requirements is too limiting, thereby flattening the results that indirectly contain the rich experiences. Here, the term design sensitivities is used; what are the key principles mobile guide design is subject to, directly translated from the human-environment interaction model. Deliberately, there is a notion of freedom in this definition, making it able for developers to come up with implementation specific features, focused on the application in development.

In the next section a mock-up design is provided to demonstrate on a concrete level how these sensitivities could show up in a mobile guide implementation.

8.2 Design sensitivities

The direct translation from the main elements of the model (categories and themes) to the design sensitivities follows the grounded theory approach set out in this thesis. The design sensitivities can thus be traced back to, and justified by the model. The design sensitivities serve as a means for designers to base their functionalities on. It is a system independent way of approaching design; it gives shape to the framework a designer should think of when coming up with functionalities of the final application.

Important to note is that the list of recommendations that come out of the descriptions of the design sensitivities is not definite. As mentioned before, this is partly a creative process aimed at defining recommendations and more specific features for mobile guide that fit the design sensitivities as much as possible. Its end-use should be further explored in the field to test the practical use and usability of the implementation.

In defining the design sensitivities the same analysis method was used as in defining the themes, extracted from the codes, namely axial coding. The categories and themes that make up for the model are related to each other in the context of key principles for the design of mobile museum guides. This resulted in the following set of design sensitivities, where categories and themes are highlighted in italics.

8.2.1 Relate visit agenda to history and fit to deliberate decision-making process

Evidence from the data shows that visitors *plan* their visit *in-situ* based on *others, past and shared experience* with the museum. Visitors also *make sense of information* that is

available to them by reflecting gallery names (*what's here*) on their *interests*. In this process of *soft-negotiation, interests* from members of the group, for whom the visit is mainly organized, are taken into account to select the galleries to be visited. Most visitors have a specific *goal* for their visit in mind before entering the museum, either because that was a stimulus (advertisements etc.) to come to the museum or from recommendations *by others*. This specific *goal* is part of their agenda for the day, whether this is visited at first or later on in their visit. Furthermore, intentional planning (*deliberate, in-situ planning*) occurs initially (on entrance of the main museum) and after visiting each exhibition. Visitors experience problems in selecting exhibitions, asking for recommendations *(others experience)* and *seeking guidance* to gather more *information* to base their selections on.

First of all, the concept of using recommendations for the visit agenda in a mobile guide will be outlined in more detail. Visitors *seek guidance* in selecting the galleries to be visited, thereby mapping the information that is available on their *interests* (*making sense of information available*) and making use of *past experience* (from previous, personal, visits to the museum), *shared experience* (from previous visits to the museum with other members of the current visiting group) and *others experience* (from previous visits to the museum by other members of the current visiting group). The concepts *past, shared and others experience* are closely related and make up for the recommendation mechanism. The *past experience* of an individual is another individual's "*other experience*" or recommendation, and visa versa. If both individuals posses the same experience, then one speaks of *shared experience*. In other words; to make a useful recommendation to the visitor it has to be able to perceive how *others experienced* certain exhibitions and provide feedback on its *past experiences* with an exhibition. Based on the input from each visiting group a ranking of recommended galleries/ exhibitions can be provided. The composition of the visiting group can be used as a starting point for an initial ranking; from the coding of the raw data it appeared that one can largely distinguish between adult groups and groups with children. Luckily not every visiting group has the same interests; ranking on topical rather than on typical basis would require more specific knowledge of the interests of the visiting group. Part of this knowledge can be extracted from the exhibitions/ exhibits that were attended to by the group, thereby modeling visit patterns. More in-depth research in visit patterns is needed to construct accurate models of groups visiting the museum, this is outside the scope of the project.

Apart from presenting a ranked list of galleries, the visitor should also be able to view the galleries one level deeper; the exhibitions in each of the galleries. This need resulted from the fact that visitors would like to have their *goal* visible and to be able to reflect their *interests* on *what's here* (*making sense of the information available*) since not always enough information was present to make a selection (*seek guidance*). Providing more detailed information than a short introduction to the gallery is not necessary at this point, because visitors already have a *basic familiarity* with the *subjects* on display and more information might affect their natural anxiety/ need for *novelty*.

- Provide visitors with recommendations from others by presenting them a ranked list of galleries based on the feedback others gave on specific exhibitions.
- Offer a short description of what the gallery is about, including what exhibitions there are to be explored for purposes of planning the visit.

8.2.2 Support flexible visit agenda

Visitors never plan their visit fully upfront, *in-situ planning*, as indicated before, takes place initially and after having visited a particular exhibition. The initial planning serves as a way to get to know "*what's here*". After setting out to a particular gallery/ exhibition visitors show a strong *browsing behavior*. Based on what they are confronted with on the way (*cues to decide visiting*), that could be an exhibit or exhibition, they decide either to skip or visit it based on their *novelty* and *personal interests*. Other factors that play an important role are the *time available* and *crowdedness*. Visitors are limited by time, because they have other obligations that day or they don't want to spend too much time in the museum. Often visitors realize that there is too much to see all in one day and focus on what *interests* them most, while others want to see it all. Again, visitors are *guided by their interests* and show hard to predict *browsing behavior*. Instead of trying to predict the behavior another approach could be taken; to support the behavior.

Browsing behavior means visitors haven't planned their visit completely upfront (*in-situ planning*) and decide what to visit by mapping *cues from the environment* on their *personal interests* and *information need*. Important to note is that this assessment is performed continuously by the visitor and on the way. To better support the visitor in his decision to visit exhibitions that are on the way one should be able to not only order the list of galleries (and exhibitions) by recommendation, but also by proximity. Exhibitions that have already been visited should be grayed-out to show the visitor that that area has already been explored, building on the mental model of the visitor for the museum space (*making sense of space*). To this overview indexes for *crowdedness* and estimate *time* to visit could be added. By doing so the visitor would be able to select exhibitions that are on the toll, less crowded and that fit within the personal time-schedule.

As mentioned before the approach taken here is to support the *browsing behavior* of the visitor. Trying to predict its behavior means modeling the visit for purpose of guiding them throughout their visit. This is exactly what visitors perceive as limiting; being dependent on something/ somebody (*limited by group*); pace, interests, reading behavior.

- Support visitors' browsing behavior by introducing an indicator for the proximity to a certain gallery/ exhibition.
- Ad-hoc planning behavior should be supported by indicators for crowdedness and time needed to visit a particular gallery/ exhibition.

8.2.3 Index to visible elements for the purpose of way finding

On entrance of the main museum visitors absorb what is present in the environment *(making sense of space)* to construct a mental model of the space. Non first-time visitors have an accurate model of what's in the museum and don't need a map. In navigating through the space visitors *don't make use of any signage* at all. Instead, visitors try to *make sense of the information available* (visitors guide/ map) by mapping what is displayed on there to the environment surrounding them *(making sense of space)*. In navigating with a certain *goal* in mind visitors use *cues* from the environment as *indicators to be on track*. These cues include posters of exhibitions and other area's (café, entrance), and exhibits/ objects by itself. Especially in commencing their visit, visitors *seek guidance* on how to find their way to a certain exhibition by relying on the interpretive skills of other members of the group or by asking the museum staff, thereby *assessing the information sources available*. This has a couple of reasons. First of all, after having visited the first (often *goaled*) exhibition, visitors change to a more *browsing*

behavior, as mentioned before. Also, and because of the *browsing behavior*, visitors *make sense of their environment*, more than in the case of navigating to a certain exhibition, where they try hard to *make sense of the information available* to them (visitor's guide/ map) rather then spending time absorbing the elements of the environment. In *browsing* around visitor's *index to visible elements (exhibits)* not only to *share* their current *experience*, but also as an orientation help.

To support visitors in finding their way around, the guide should present the visitor with instructions that *index to visible elements* in the environment. This prevents misunderstandings caused by not knowing the current viewing direction or exact location of the visitor when using more traditional ways of directing people the right way. Another advantage is that visitors are likely to build up their mental model faster and more accurately, because they are "forced" to percept and analyze the elements that are present in the environment they are moving through.

- In giving directions for the purpose of way finding, index to elements that are directly observable in the environment.

8.2.4 Events that happen close in distance/ time

Visitors are interested in, and should therefore be notified of, events (*what's on today*) that happen close in future, and in distance, compared to the location they are at the moment. Although the "*what's on*" signs are put up, nobody reads the signs, similar to not reading *signage* for the use of finding one's way around. When confronted with the event, either by the museum staff or by coming across it while *browsing* around, people are *interested* and willing to interrupt their current visit to schedule that particular event in their visit agenda.

Visitors can be notified by the system that an event is happening or is about to happen close in future when they come near the location the event is being held. Showing events that are not indexed to the time and location is regarded useless. Visitors either forget about them, are not aware of the location of the event (*seek guidance*), of the event at all (*what's on today*) or are not located near the location the event is about the take place.

- Create awareness of services offered by mapping them on the context (time, location) the visitor is in at the moment.

8.2.5 Assist in building a correct mental model

A correct mental model is crucial for adequately navigating through the space. One suggestion for assistance in building a correct mental model of the environment is graying out the exhibitions already visited. This helps the visitor form a model of what has already been visited. In *making sense of the space* visitors complete their mental model of that environment bit by bit, thereby visitors don't (have to) use *signage*. Sense-making thus has a priority above using explicit information.

A layered, context-aware approach, to presenting information to the visitors also helps understanding its environment. Displaying gallery information (and names of exhibitions it contains) on entry introduces the visitor to the main areas of the museum space. Making visitors aware of where they are and adapting the information to this context-aware behavior provides the visitor with a sense of location and what its current surrounding is. Concretely, this means that within galleries visitors should be faced with information about the exhibitions that can be visited. Within the exhibitions the option to learn more about key objects should be given when approached by the visitor.

- Actively support the construction of an accurate mental model by providing indicators for areas already visited, that can be visited, the current location and the way the museum is build up (layered construct).

8.2.6 Annotation by visitors

Visitors are eager to express and thereby *share* their knowledge in the group they are visiting with. In addition visitors *recall memories* by seeing the objects and exhibits on display, referring to *past experiences* and *shared experiences*. For others this information/ vision is a way to understand what the object is about; the object is interpreted, and subsequently understanding of it is gained by using others' knowledge and experience. In most cases the vision of others is open to discussion, viewing the object from different perspectives. These "opinions" are interesting for others to hear as a context, providing a story around the object, as an alternative view, to complete missing knowledge and as a way to give feedback to the museum on what is missing.

- To express, and share knowledge and experience, visitors should have the ability to give feedback on the way they experienced a certain exhibit.
- Others should be provided with this feedback for interpretation and understanding purposes, and as a means to increase the overall museum experience.

8.2.7 Interact through the mobile guide

Multiple examples of how visitors use their environment have come by; on their way certain *cues* from the environment serve as indicators *to be on track* (advertisements, exhibits) and as stimulators *to recall memories* and *decide visiting*, visitors *make sense of the surrounding space* for *orientation* purposes, *sense is made out of what is visible* by relating exhibits to *knowledge-in-the-head* etc. Visitors have come to *experience the real*, not a virtual or informational representation of that. These findings show the importance of stimulating and preserving the interaction the visitor has with their environment. As its name implies, guides should support the user in performing its task, not trying to substitute for what is already there.

Related to the interaction through the guide is the way information is communicated to the visitor. Presenting the information in a textual way on the mobile guide, analogue to the way information is presented on labels and panels, limits the visitor in a sense that the environment cannot be observed at the same time. This advocates for the use of audio in communicating information to the visitor. From the lower level data (experiences) it also appeared that visitors prefer spoken information above having to read, because it distracts from actually observing the exhibits.

- In designing applications the interaction with the environment should be encouraged/ enriched, while the interaction with the device should be kept to a minimum.

8.2.8 Pull, not push information

There are a couple of reasons why the final application shouldn't push information to the visitors, but let the visitors in control themselves. In looking for *information* for *decision-making* visitors themselves *assess information sources available* and *seek guidance* when needed. This means that they will choose the most likely and easy accessible source themselves. Pushing information to the visitor will disturb this process and is likely to result in providing information the visitor doesn't need (at that moment). Also, from other elements in the model and behavior of the visitor it becomes clear that they are rather *self-reliant* and thus often don't want or need information. In interaction with the museum environment visitors also have the choice to read or request additional information, a mobile guide should incorporate this free choice too. Approaching exhibits from an explorative and creative point of view, using knowledge possessed and previous experiences, thereby reasoning and guessing about what is on display is part of the overall museum experience of a visitor. This *internal locus* also becomes clear from visitors strongly *making sense of what is visible* using their own resources.

- Applications should be pro-active, but not intrusive; it should not affect the user's control while offering context-aware services.

8.3 Mock-up museum guide design

To show more concretely what an implementation, using the previous design sensitivities, could look like two mock-up screen shots were designed. As mentioned before this is just one of the ways of using the design sensitivities for a specific device. Using audio only museum guides results in a completely different design, but more importantly can still fully make use of the design sensitivities. This proves the power of the design sensitivities compared to the rather limited use of requirements, which traditionally focuses on a specific device and/ or application.

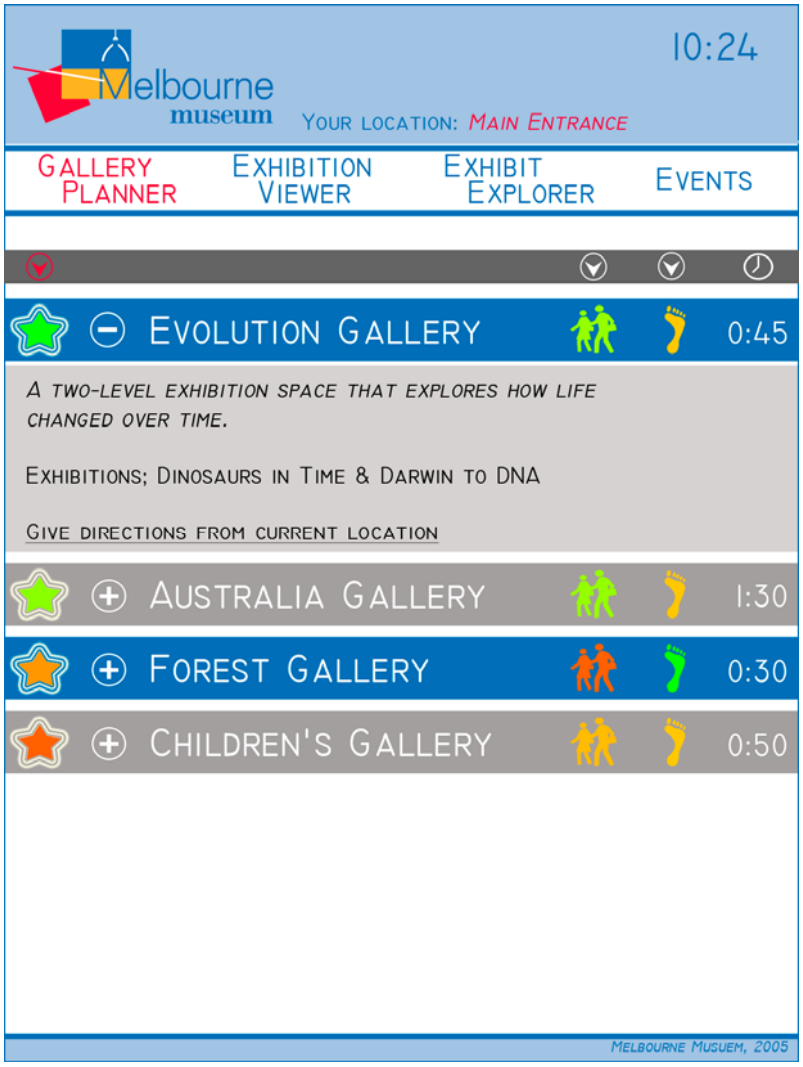

Figure 12. Museum guide mock-up design; Gallery Planner

Figure 12 shows the "Gallery Planner". In top of the screen the main menu is displayed. The menu options are: the Gallery Planner (shows what galleries there are including information for visitors to plan their visit), Exhibition Viewer (on entry of a gallery a list of the exhibitions present can be viewed, including a description thereof to decide upon visiting the exhibition), Exhibit Explorer (shows what exhibits are close to the current position of the visitor, and provides information in a visual and audible way) and Events (schedule of special events that happen close in time and distance). The current location of the visitor is also displayed for purposes of creating a correct mental model of the environment.

The Gallery Planner has a couple of functionalities that should help the user decide where to go to. This includes a (ranked) recommendation feature (symbolized as stars, colored from green until red), based on explicit user feedback about certain exhibitions and/ or implicit user data, like what other visitors have also visited that liked similar exhibitions, composition of the visiting group etc. To avoid crowded situations a indicator for how crowded a gallery is, is included (represented by colored people symbol, analogue to traffic-light), as well as indicators for the proximity (symbolized by footsteps) of the galleries and the approximate time that has to be scheduled to visit that part of the museum. Directions, using cues from the environment as indexes, are given to describe the way to a particular gallery. Visitors are free to visit exhibits on their way or enter other galleries, the museum guide adapts to this changing environment by providing the correct, contextualized, information.

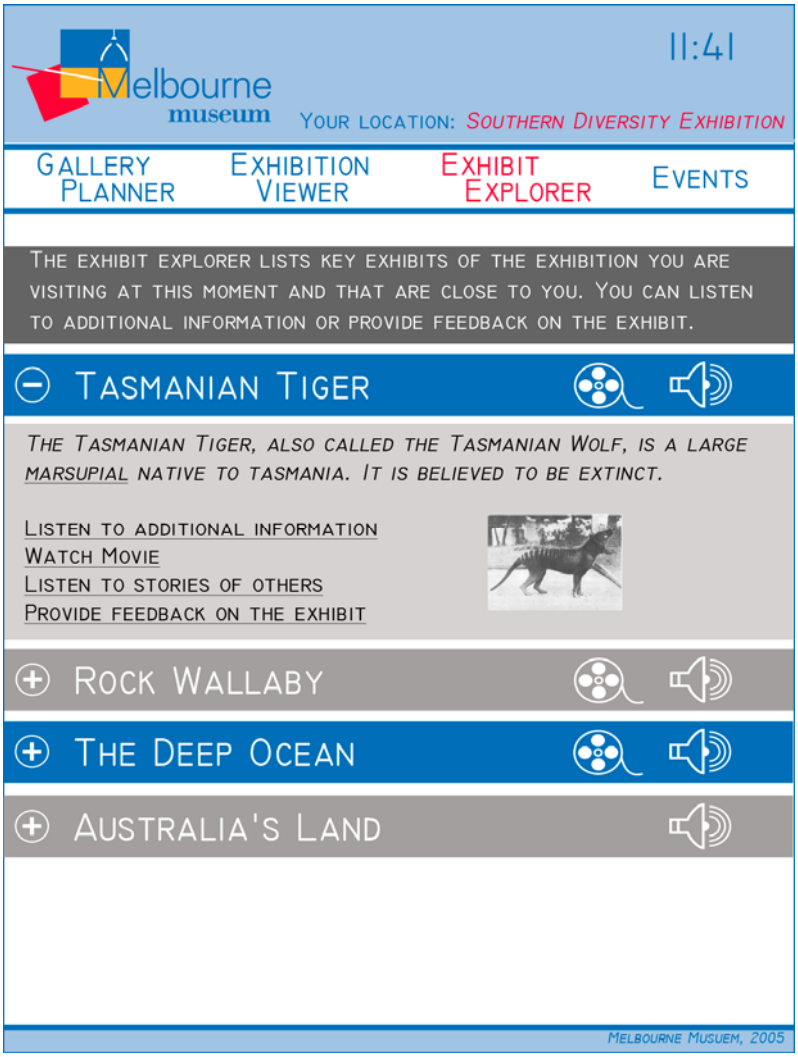

Figure 13. Museum guide mock-up design; Exhibit Explorer

The second screen mock-up design is concerned with the Exhibit Explorer. It shows what key exhibits there are, the ones to understand what the exhibition is about, close to the visitor. In addition to a short description of the exhibit, the visitor is able to request more material, such as a video, image gallery and audio. The icons next to the exhibit name represent what additional information can be requested. Also input from other visitors can be listened to and given by the current visitor by recording comments/ remarks/ opinions etc. on the device.

More explicitly the relation between the design sensitivities and the design are:

Relate visit agenda to history and fit to deliberate decision-making process. On entry of the main museum visitors have to plan where to initially go to. From the data it appeared that recommendations of others, and mapping "what's here" on group interests and knowledge already possessed are used for planning their visit. Recommendations are modeled in the system as colored stars that represent the fit between the galleries and the characteristics of the visiting group, e.g. based on group composition, what visitors have already visited, what other visitors have also visited, and from explicit feedback from other visitors about the exhibitions. The basic familiarity of visitors with the subjects on display in combination with the short description, gallery name and exhibitions within the gallery to make a decision where to go to.

Support flexible visit agenda. The system supports the browsing behavior by providing various levels of information, represented as the hierarchical menu; galleries, exhibitions and exhibits. The system will adapt its content depending on the location of the visitor. Despite automatically switching between the three abstraction layers the visitor itself is in full control of the system by manually switching to another mode. To better support planning activities on the way, visiting galleries that are less crowded, that are close in proximity and fit within the time schedule, corresponding indicators are added to the user interface.

Index to visible elements for the purpose of way finding. Although not fully visible in the mock-up designs, directions for finding the way to a specific galleries is given in such a way that it indexes to elements in the environment. This prevents steering the visitor in the wrong direction, as is often the case in providing explicit directions in the form of coordinates, and makes visitors aware of the elements in the environment, thereby building a strong mental model of the museum space.

Events that happen close in distance/ time. Visitors are made aware of "what's on today" by sensing the users location and comparing this with the events scheduled for that day. Notifying the user of upcoming events makes sure visitors don't miss out on positive museum experiences.

Assist in building a correct mental model. It is generally known that visitors don't use signage for the purpose of finding their way. Gradually they form an image of the museum space during their visit. Helping them correctly forming this model results in visitors being able to navigate through the museum with less frustration, more confidence and a higher accuracy. The layered approach in presenting information, displaying the current position, referring to elements of the environment and graying out galleries and exhibitions already visited should contribute to correctly building a mental model of the environment.

Annotation by visitors. Sharing knowledge and experience among visitors is supported by providing the option to record comments/ opinions/ remarks. This provides the additional viewpoints to interpret and understand the exhibits from different perspectives, adding up to the visitors experience.

Interact through, not with the mobile guide. From the system design approach above it has become clear that only interact with the mobile guide to gain only the necessary information for decisions, planning and navigating. In all cases it refers to elements of the environment.

Pull, not push information. The layered approach makes sure that only for purposes of understanding the current context is switched between the different levels, the freedom of the user is maintained in all situations.

8.4 Recommendations for mobile guide development

From the previous sections it has become clear that insight in how humans interact with(in) their environment could successfully be used to come up with a potentially useful mobile guide design. Defining design sensitivities served as an intermediate step to effectively translate from the model to final design requirements/ applications. The additional insight created in this step resulted in services that have not been commonly identified in recent studies focusing on the development of a mobile guide (see chapter 3 for details).

The systematic approach taken in this study, to finally come up with a concrete design, can be structured, and recommendations in the form of steps in the development of mobile guides in general, can be given. This overview is derived purely from the knowledge gained during this study, and therefore its practical use has not yet been proven. The recommendations are:

Head towards Contextual Design approach. It is not enough to focus on developing a mobile guide from the perspective of the user only (User-Centered Design). This view isolates the user from its environment and other contexts that surround the user, like social relations, and cognitive knowledge and capabilities. The user should be studied in the environment the mobile guide is used in (field experiments and evaluation). Only then it is made sure that insight is gained in the factors surrounding the user, and concurrently will be taken into account from the start in the full development process. This contextual view is especially important in mobile guide design where the application has to know about the user and its environment to provide context sensitive services. The seamless integration of computers in the environment (ubiquitous computing) will be of increased importance coming decades, stressing the need for an understanding of the factors involved, but also the technology to support this integration should be further examined. As addressed, it is expected that the field of agent technology is of major importance in this integration since it has the ability to connect the otherwise loose worlds together, opening up the world for smarter technology.

First gain understanding as a strong foundation. At first sight it seems needless to say, but from the overview of projects recently started it appears that often projects begin with thinking in terms of system requirements for the development of applications. Subsequently, these implementations are tested on a trial and error basis. This weak foundation doesn't only push applications to the user, making them hard to use (if used at all), but moreover don't explore the novel possibilities of mobile guides. In this study it was advocated that a grounded approach results in potentially far more used, usable and innovative applications through its thoroughness in analyzing the situation at hand.

Make use of the additional design sensitivities. To get a better grip on the conversion from data and results from the field to final design requirements an intermediate layer was introduced in this study. By introducing this additional layer the developer has to explicitly think of general guidelines the overall design is subject to. This creates awareness of what is of major importance in the final design and serves as a framework to develop the mobile guide on. It also clarifies where and what role technology (in specific: agent technology, infrastructure, architecture etc.) plays in the final design.

Chapter 9: Conclusions

Looking back at the research approach taken in this study, the results that were achieved and the discussion that followed one can conclude that this study has contributed in several ways.

First of all, the way this study approached designing a mobile guide system is valuable to the field of information science in general. Methods for developing mobile guides that still rely on trial and error principle aren't scientifically sound. Designing from a user-centred perspective is already a step in the right direction, but as showed in this study gaining understanding of the environment the user is interacting with(in) is at least as important. Looking at only the user results in an isolated view where the context, especially important for mobile guide design, is lost. The human-environment interaction model was created directly from the experiences of visitors in the field in a transparent way using grounded theory. The model thus has a strong methodological foundation as apposed to the generally weak methodological bases in current approaches. This study has the potential to serve as a starting point for a new wave of alternative ways to approach (mobile guide) design.

Secondly, the resulting theory has its significance in other fields of research as well. The model shouldn't be seen as informing the field of mobile guide design only. It provides insight in how users interact with an environment and with entities within that environment. Especially looking at the higher level elements of the model, one can conclude that they are independent of a specific system or environment. It resembles behaviouristic approaches, traditionally considered to belong to studies in the field of anthropology. The model, for example, also has its use in the field of architecture, fitting the physical environment to the way people interact with it.

The research question of this study was defined as:

> *Can an increased understanding of users interacting with(in) their environment direct the museum guide design process?*

This research question was decomposed into a two phase approach:

- Gaining understanding of the users interacting with(in) their environment
- An exploration of how this can be used to inform the design of a mobile guide

It became apparent that the main focus in this study was on providing an increased understanding of users and their interaction with(in) the museum environment for the use of guide design. The main contribution of this study thus lies in the field of mobile computing. The human-environment interaction model was developed as a means to gain insight in how visitors of the museum interact with(in) their environment. Subsequently, its use for museum guide design was explored by taking elements from the model to define design sensitivities in a grounded way.

The resulting theory offered a high level view on the experiences of visitors, thereby creating the additional insight needed to understand what main aspects there were in interacting with(in) the environment. On a low level these aspects wouldn't have come out. By relating the themes that emerged from the users' experiences, one reflects on this data to show what it is really about. By providing a detailed account of the steps taken in this study not only a strong theory was created, but this high transparency also makes

visible on various levels of abstraction how visitors behave in the museum space. In addition, this makes the results of the study as well as the methodology highly transferable to other situations, studies and fields of research.

The model thus provides an enhanced insight in users interacting with(in) their environment, but is it also able to inform museum guide design? It was argued that directly formulating design requirements from the model flattens the richness of it too much, moreover "requirements" take notion of designing for a specific system, which was explicitly not the purpose of this study. Therefore, an intermediate step was taken to first construct a set of design sensitivities that directly flow from the model. From the design sensitivities it appeared that key principles and new services for guide design could be identified (in the form of overall recommendations) that were not found in results from studies looking for requirements for guide design from a user-centered design perspective. From that point of view introducing an additional step in between results from user studies and requirements for design is valuable since one is forced to abstract results in a universal format, to be used in design. From the design sensitivities it was also easier to justify choices made for the mock-up design since they are far more related to final requirements than the elements of the model do. Design sensitivities thus fill in the gap between results from user studies and design requirements.

In designing the mock-up, to demonstrate the "final" use of the design sensitivities, applications showed up that were new to studies focusing on the engineering of mobile guides. Besides, for example, simply providing users with maps, additional information and studying visit patterns, traditionally thought to enhance the users' experience, didn't come out as important in gaining understanding of the objects on display or in navigation through the museum space. This again proves the usefulness of the human-environment interaction model, this time specifically as guide for the design process. Also, the correspondences between the model constructed here and the one made by J. Paay (e.g. Paay, 2003; 2004) justifies for the approach taken in this, and her study.

From the previous outline a couple of hypotheses can be formulated that result from the explorative character of this study. It is expected that the model not only gains insight for the use in the field of mobile computing, but also for other fields of research:

Hypothesis 1. *The human-environment interaction model itself and the approach in general can be used in fields of research other than mobile computing as well.*

The design sensitivities add up to directly transforming to system specific requirements from the results of user studies:

Hypothesis 2. *The design sensitivities provide a system independent view on final design and can successfully be transformed into specific design requirements.*

Because the mock-up design requirements were directly taken from the design sensitivities it is expected to fit the users' experience (with)in the museum:

Hypothesis 3. *The services and applications that came out of the transformation from the design sensitivities to a mock-up museum guide design prove to be really used, and perceived useful by visitors of the museum.*

Chapter 10: Further Research

Following from the outcomes of this study and the hypotheses put, research opportunities come up that complement to the research performed in this study.

Most importantly, the use of the model should be tested in the field with a working implementation, only then its real use can be proven. In this study we purposely didn't further detail issues that may arise surrounding the implementation since this was out of the scope at this point. It is important to note that, despite the great technological advances of the last decade, still one cannot simply speak of "just" implementing and testing the outcomes of this study. It especially is a challenge to successfully integrate the technologies necessary into a working prototype, let alone the agent technology needed to perform (basic) reasoning. The model developed here gains the insight necessary for computer scientists to develop mobile guide platforms that are supported by the theory created here.

As already mentioned, the model build here has similarities with the model of J. Paay (e.g. Paay, 2003; 2004). Further research should make clear whether it is possible to combine the models into one overall human-environment interaction model, to be used for mobile guide design in general or in other fields of research. Differences in the research situation (museums versus public places) and site characteristics (indoor vs outdoor, architectural features) should be further explore to explain the differences and similarities between the models.

Another opportunity is the exploration of the model for other purposes then initially aimed for in this study, since it gains understanding of the users in interaction with the environment in general, seen from a higher level.

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Appendices

Appendix 1: MIRANDA representation

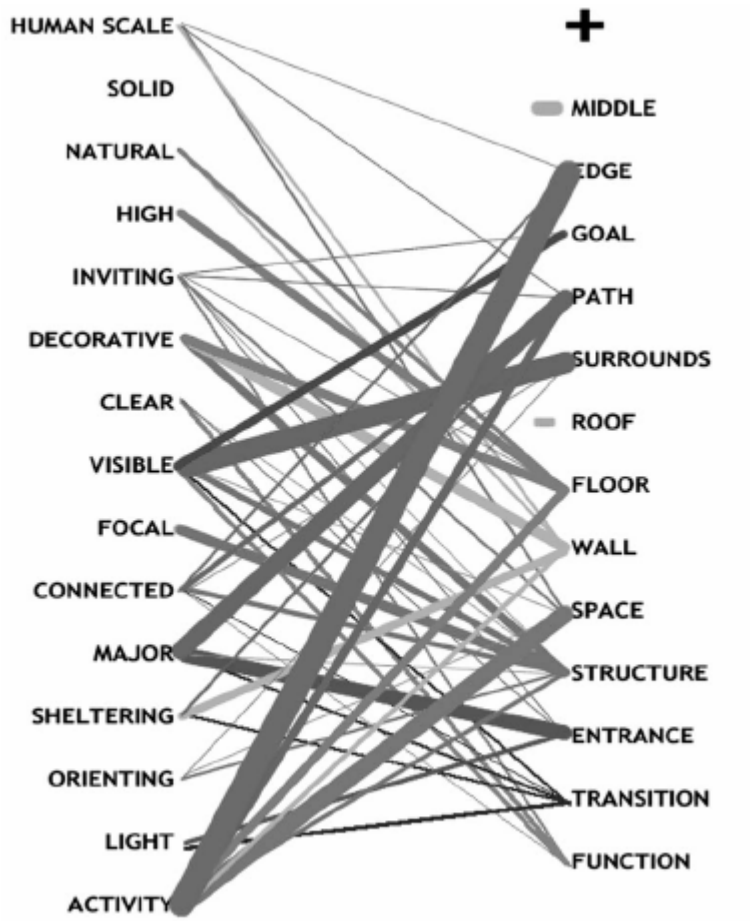

Figure 14. Abstraction of MIRANDA: positive description of architectural characteristics

Appendix 2: **SOPHIA framework**

Table 9. SOPHIA conceptual framework (source: Paay and Kjeldskov, 2005b).

Knowledge	knowledge-in-the-world	physical affordances	places to enter places for gathering landmarks as focal points
		social affordances	cues for what to do cues for where to go
	history	physical familiarity	familiar paths familiar places
		social experience	past experience shared experience experience of others (recommendation)
Context	people	us and them (group and others)	interaction by maintaining groups interaction by proximity interaction by watching the discomfort of waiting (waiting alone)
	situation	setting matters	setting - others (social setting - environment (physical) setting - convenience personal preferences
	surrounds	indexing	index to shared knowledge index to visible elements (landmarks) indexing to events and objects
Motivation	reflection	sizing up the situation	getting an overview pausing before committing
		information	different levels of information media screens as decoration what's new uncertainty
		making sense	making sense of a place making sense of what's happening
	extension	movement	transition through spaces spaces and places are dynamic wayfinding (people don't use signs)
		exploring	pervasive negotiation exploration for the sake of it wandering and browsing

Appendix 3: **Map of Melbourne Museum**

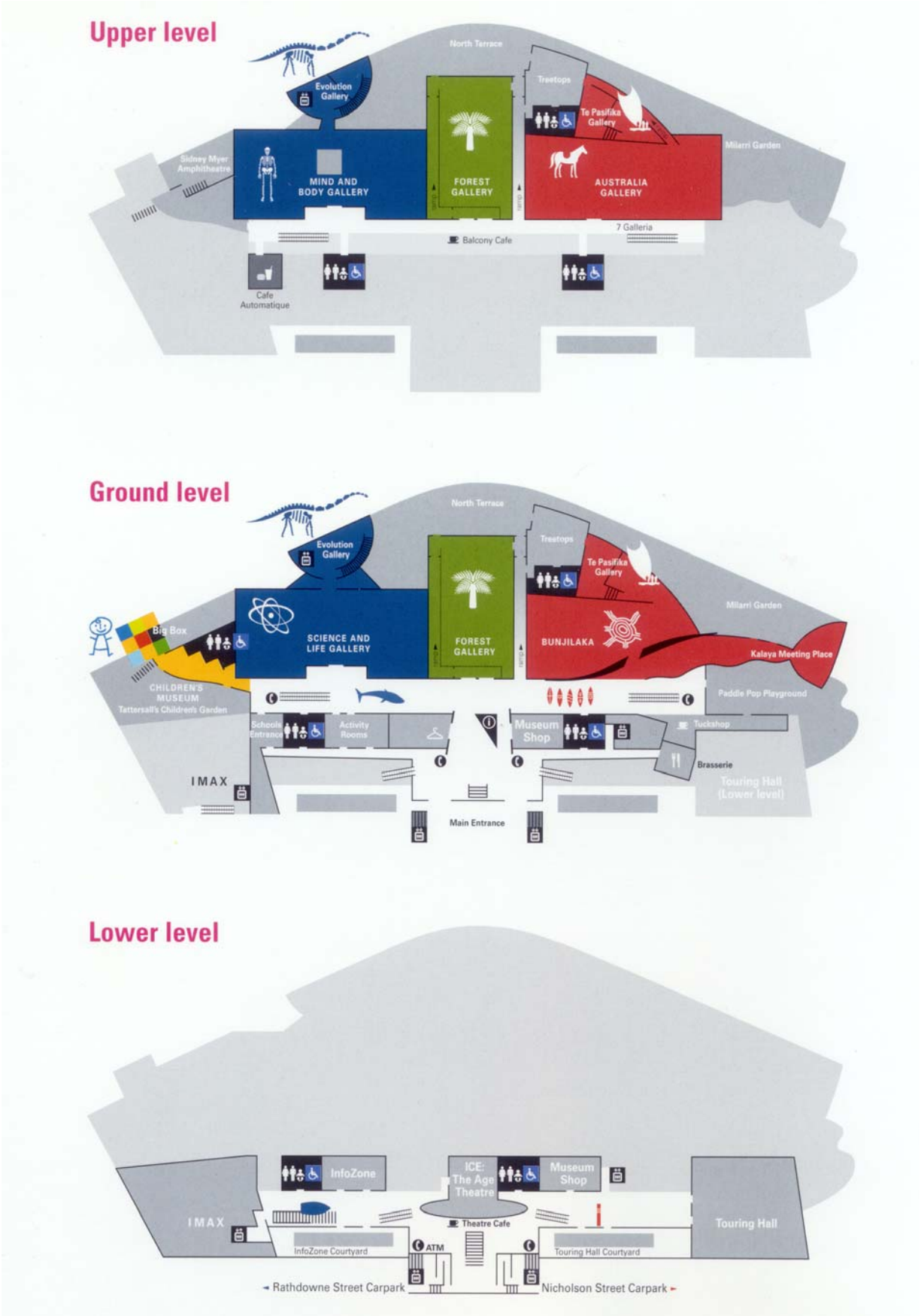

Figure 15. Map of Melbourne Museum

Appendix 4: Questionnaire

What is your gender?	□ Male □ Female
What age range do you fall in?	□ 18 - 34 □ 35 - 54 □ 55+
Where do you usually live?	□ Metropolitan Melbourne □ Regional Victoria □ Interstate □ International, please specify:
I visited today:	□ As an individual □ As a couple □ As part of a group of adults □ As part of a group with children
How often a year do you visit museums[1]? [1]Museums being buildings with multiple exhibitions, e.g. art galleries are not considered to be museums	□ Less than once □ Once □ 2 - 4 times □ More than 4 times
Please rank the following reasons to visit this museum according to their importance: (1 = Most important, 6 = Least important)	… Social event … Entertainment … Part of the 'life-cycle' (visit important as part of one's life) … Educational … Location/ place … Practical (e.g. entrance fee, time available, holiday)

When was the last time you visited this museum?	☐ Within the last 12 months ☐ Within the last 2 years ☐ Within the last 3 years ☐ Within the last 4 - 5 years ☐ Never before, this is my first visit

Have you visited this exhibition before?	☐ No ☐ Yes

What was your level of knowledge beforehand on the topics covered in this exhibition?	☐ Low ☐ Average ☐ High

Appendix 5: Project description

Project: "Museum Guide Design: A Human-Environment Interaction Design Approach"

As a visitor of the Melbourne Museum we would like you to participate in our research project. As an adult you were randomly selected from visitors, visiting the museum as an individual, a couple or as part of a group. The aim of this project is to investigate how visitors' interaction with the museum environment can inform the design of an electronic museum guide.

Should you agree to participate, you would be asked to contribute in the following way. During and after your visit you will be interviewed by me; this means that I will ask you questions about your behavior and experiences. With your permission, this is tape-recorded so that we can assure that we make an accurate record of our conversation. We estimate that the total time commitment required of you would not exceed 20 minutes.

This project does not involve any risks. The only anticipated inconvenience for you is the extra time taken by the interview during your visit of the museum. The information you provide will be treated as confidential and used for research purposes connected with this research project only. Confidentiality of the information provided will be protected subject to any legal limitations. Access to the information will be restricted to the investigators only.

As required by the University, data will be held in locked cabinets in the Department of Information Systems, and destroyed using confidential waste disposal techniques after five years following last publication from the research. You will not be identifiable in the research report written up for this research project.

Once the thesis arising from this research has been completed, a brief summary of the findings will be available to you on application to the Department of Information Systems or by contacting one of us personally. It is also possible that the results will be presented at academic conferences or be published in academic journals.
Please be advised that your participation in this study is completely voluntary. Should you wish to withdraw at any stage, or to withdraw any unprocessed data you have supplied, you are free to do so without prejudice.

If you have any questions about this research project please contact Liz Sonenberg on ph: 8344 1513.

Should you have any concerns about the conduct of the project, you are welcome to contact the Executive Officer, Human Research Ethics, The University of Melbourne, on ph: 8344 2073, or fax: 9347 6739.

Appendix 6: **Sample transcript**

Table 10. Transcript of participant 9

Date	08/04/2005
Duration	45 minutes
Visit path	Museum entry » General Hall (Aboriginal Shields) » In Honour of Lin Onus » General Hall (Whale) » Dinosaurs from China
Participant	Female, aged 55+, intrastate, visiting as a couple (participant herself (P) and her husband (H))

Psg	I/P/.	Transcript	Interactions	Notes	Codes
1		…			
2	P	We came particularly to see the dinosaurs. Particularly, but we like to walk around.		Specific goal, generally walk around.	Goal bound-impression-browse
3		…			
4	I	You saw the advertisement of the dinosaurs?			
5	P	Yes and my daughter came here and she told me it was very good and she told me I should go and see.		Visiting specific exhibit because recommended by relative.	Recommendation
6		… [entering in honour of Lin Onus]			
7	H	Is that for trapping?		Relate exhibits to common concepts; valid mapping?	Uncertain knowledge
8	P	Yes that is a fish trap, yes aboriginal fish trap.			Clarify knowledge
9	I	You already know a lot about aboriginals?			
10	P	I don't know a lot, but we have been to a lot of aboriginal exhibitions and stuff in the Northern Territory and Queensland.		Knowledge gained from previous museum visit on	Reflect on previous museum experience

				particular topic.	
11	H	Queensland and Rock Hampton…			
12		…	After reading label at entrance of exhibition decide not to enter main aboriginal exhibition; already knowledgeable.		Visit by exhibition name, description, Knowledgeable; not novel
13	H	Even in Bali the fauna is still preserved by the aboriginals.			Express knowledge
14		…			
15	I	Can you relate this to the aboriginals, these paintings?			
16	P	This type of painting, yes…			
17	H	…the artistic painting, those figures…			
18	P	…this is typical ordinary, this type of painting. But, it has all changed now, it has become more modern and using different colours. Like that, the aboriginals probably used those earth colours. Not lilies and…		Expect to see the authentic, original cultures/ exhibits.	Authenticity
19	I	No bright…			
20	P	Because their ground… their ground…the soil…the earth…			Clarify knowledge
21	H	They used to get their natural colours from the earth. From the different … [not understandable] in the earth. And those…that sort of colour never fades. In the Northern Territory in Catherine Gorge you go in trip on a ship on a boat. And there is one part, which ran after the Murray… [not understandable]. There is all water that comes down and exposes the painting, which has been there for years and every year it gets flooded, but it come down still the same. That's quite unique that.		Exhibits understood/ explained/ points made reinforced by reflecting on similar experiences.	Clarify knowledge, Recall, revive previous experiences
22	P	And that is all done with earth… ground and earth.			Clarify knowledge

23	H	And there is in Jerrony in the Northern Territory, there is a rock painting, which is about forty feet off the ground on a cliff hang. And that painting is there, but it always has been… [not understandable] always been vivid.		Exhibits activate grand long-lasting experiences.	Recall, revive previous experiences
24		…			
25	P	This is modern… this is a change.			Authenticity
26		…			
27	H	This one, they haven't dated it. It is canvas, it is a… [not understandable] from canvas. That's canvas, this isn't…it looks like it, but it is so old.	Looking detail at exhibit, eager to touch.		Lack self-explaining
28	I	Usually it deteriorates?			
29	H	It is high deteriorated, because of its age. That's why it would have been interesting to know what date it is was done.			Clarify knowledge
30		… [backing-up from painting]			Back up
31	P	I see, it is a skeleton.			
32	H	It has got a skeleton, yes [in the painting].			
33	P	That's why it is called grandmother grandmother… I think it is meant to be… the cloth used to grandmothers.		Exhibit not self-explainable; lacks information (age, origin, meaning title), results in questioning.	Lack self-explaining, Adequate - reason
34	H	Yeah, yeah… probably.			Group members
35	P	I think it, next to be though…			
36	H	I don't know if the…			
37		…			
38	H	Usually they have a little writing up above the painting, but here they only given… no dates.			Sets model museum visit
39	H	Anyway, which way to the dinosaurs?		Not using the map, knowing where to	Goal not visible, No directions

				go/ where they are.	
40		… [attracted by the blue whale]	Distracted from goaled exhibition set by size of exhibit.		On the way, Proportions
41	I	What do you think of the information that is given?			
42	P	This bit of information is good.			
43	I	You don't want more information?			
44	P	Oh no…			
45	H	We got a little more in Albony, in Albony there is a lot more.			
46	P	But that was all about whales only, so that is different. But this amount of information is enough. The aboriginal one, I don't think it is quite enough, the information on the art. But this is…enough! If you have got too much to cover… it's enough! And it is a nice large writing too, for all the older and retired.		Expects to see more/ in depth information in case the museum/ exhibition has exhibit as speciality. Label should be readable and adequate.	Specific topic; detailed information, Adequacy, Large font
47		… [walking around blue whale exhibit]	Approaching exhibit from different sides to see knowledge about exhibit being confirmed in reality.		Different angles
48	I	What is you first impression of the museum?			
49	P	We didn't like the new building, we are very old fashioned, we like that one [Royal Exhibition Building] better. Only because we are old fashioned. For lighting this is better.			Old, Light

50		… [walking up to the introduction to dinosaur from China exhibition]			
51	H	That it is still so well preserved after one-hundred-fifty million years.		Realize historic value/ fragility.	Appreciate, realize historic value
52	P	I wonder what such a thing would weight…			Not knowledgeable, proportions
53	H	Are they petrified?			Uncertain knowledge
54	I	The bones?			
55	P	It must have been after one-hundred-fifty million years.			Inadequate - imagine
56	I	No, they are real bones.			
57	P	Yeah, yeah, but they are fossilized.			
58	I	Yes, they have become solid.		Exhibit leads to discussion/ fantasizing about its original setting/ history/ properties.	
59		…			
60	H	This is [illustration, map of where the dinosaurs lived] their… was roadmap before the great continents existed. They are all together, see America and…			Express knowledge
61	I	It is really of that age.			Appreciate, realize historic value
62		…			
63	H	What is the height, nine meters is it? The height of the head? Nine meters?			Clashes with belief
64	I	Yes, nine meters.			Clarify knowledge

65	P	It is enormous.		Reality surprises, even though factual information known.	Proportions
66		…		Time-line of dinosaur evolution adds-up to understanding.	Context
67	I	What did you expect to see in this exhibition?			
68	P	What do I expect? Well a lot of skeletons [laughing]! And very interesting model natives.		Expectations very basic; skeletons and models.	Basic knowledge; basic expectations
69	H	This is the introduction?		Identifies function of exhibition areas.	Identifies sections, areas
70	I	Yes, the other should be more interesting.		Not impressed by the introduction to exhibition.	
71	P	Yes, that [pointing to the entrance] is the real exhibition.			
72		… [entering dinosaurs from China exhibition]			
73	I	Before you went into the museum, did you look up any information?			
74	H	No, no.			What's here, what's on today
75	P	Just my daughter said it is very good, you better go and see it. So, we used to find it, well it is here.			Recommendation
76	H	We read about it in books and so forth…		Assumes (average) knowledge about subject is adequate enough.	Basic knowledge; basic expectations
77	P	We read a lot.			Reading, static information
78		…			

79	I	What do you think of the information that is given?			
80	P	The information given in this area is very good, it is interesting, it is valid, it is large and it is adequate. So it is enough!			
81	H	Even to pronouncing their names!	Surprising elements of information adds-up to experience.		Unexpected elements; discern main
82	P	Yes.			
83	H	That is what I am saying, here [pointing at illustration on label].			
84		…			
85	H	Is that sound of this one or this one [juvenile/ adult dinosaurs, same family]?			Atmosphere
86	I	They are both the same. This is an adult and that is a juvenile.			
87	H	I see.	Relation between exhibits not always noted/ obvious.		
88	I	Do you like the sounds?			
89	H	Yes, it reminds me of the movie “Jurassic Park”.	Exhibits and atmosphere link to past memories.		Recall, revive previous experiences
90		…			
91	P	This is what ages they were in [looking at the illustration on label].			Bring under attention
92	H	The evolution, is it?			Uncertain knowledge
93	P	Yes.			
94	P	From the area from China.			
95	H	Centre China is it. Is that centre China?			Uncertain knowledge
96	I	Yes, it looks like the centre of China.		Without evidence	

				hard to imagine what it depicts.	
97		…			
98	H	And weapons of defence [dinosaurs tail], didn't it?		Parts of exhibits are detailed/ highlighted.	Uncertain knowledge, Inadequate – imagine, Analyze chunks
99		…			
100	H	That is the same one as before, in front [introduction in from of exhibition] I think?			Other exhibits
101	P	They look torn apart. They are very complete, aren't they?	Detailed look reveals true history/ structure/ fine-grained view.		Close-up
102		…			
103	P	It is interesting to know that the different types of soils in the different countries preserve their bones better. Because they said the aboriginal soil on the flat plains in China caused to preserve these items so well. Whereas in other areas skeletons disappeared.		Visitor eager to transfer knowledge.	Express knowledge
		…	Visitors attend to exhibits that are frequently visited by other visitors as well.		Attended by other visitors
104	H	These are the fossils are they?			Uncertain knowledge
105	P	Yes, they are the fossils of the fish that lived.			Clarify knowledge
106	H	I said they didn't clean out the soil?			Uncertain

					knowledge
107	P	What they do: clean the soil of the fossilized and find the details of the scales.		Importance of background information; what it is, where and how did they get it.	Clarify knowledge
108		…			
109	P	This is fun. This is the oldest… over 210 million years old. That [pointing at wrong exhibit belonging to the label] is the oldest one in the exhibition.			Mapping problems, Bring under attention, Appreciate, realize historic value
110	I	Number two.			
111	P	Yes, number two.	Linking exhibit with label hard when not aligned with each other.		Mapping problems
112		…			
113	P	I am wondering how they were so complete when they were found [laughing].			Appreciate, realize historic value
114	H	But off course they can't help it.			Appreciate, realize historic value
115	P	Well that's right. You couldn't find a complete animal [dinosaur].			Appreciate, realize historic value
116		…			
117	H	This is the quiz for children. Very good.			

118	P	This is very good for children. Excellent.			
119	I	What do you think is so attracting about it for the children?			
120	P	They can find the answer. Is it a dinosaur? It gives them more interest to find something. You can see how interesting it is.		Interactive exhibits awake interest of children; tool to learn.	Attention throughout visit
121		…			
122	P	Dinosaur means "terrible lizard". Now that is something new I learned. I didn't know that dinosaur meant "terrible lizard".		Pleasant, but not expecting to learn something new.	Labels & panels, No learning; knowledgeable
123	H	The meaning of the word dinosaur?			
124	P	Yes.			
125		…			
126	P	We learn something new every day.			No learning; knowledgeable
127		…			
128	I	What do you think of the way the exhibition is structured?			
129	P	I think it is very well structured. I am really quite taking lizards. I think it is very well structured, very interesting and not overly crowded! You can move around. And nicely lit too. The areas are nicely lit also, for older people to read and that. Very good and interesting.		Crowdedness, structure and atmosphere contribute to pleasant learning experience.	Uncrowded, Atmosphere, Lightning
130		… [looking at illustration of dinosaur]			
131	I	Is it important for you to see how they really lived?			
132	P	Do you see that sculpture [pointing at the illustration on the label]? That is interesting, but I could imagine it from this, itself, quite clearly. The kids would be interested to see that too.		Illustrations aren't necessary to imagine reality for adults.	

133	P	And what is very interesting is how they get their names.			Unexpected elements; discern main
134		…			
135	I	Would it be different if visiting with you grandchildren?			
136	P	Very exciting. I would love to, because they would be excited. In this way also we can concentrate on… what we want to concentrate on.		Visit with children is exciting, but has its limitations (pace, attention).	Interests, Seek excitement
137	H	Because with the children…			
138	P	Look at this one, look at that one…			Interests, Attention-span
139		…			
140	H	Here you can see how they get them out from the earth, is it?			Uncertain knowledge
141	P	How they get the bones…			
142	P	We have got the tapes from "Walking with Dinosaurs", you know the videotapes. They show you what they look like. But actually seeing, this is better. This makes it real.		Virtual can't compete with the real experience.	Added dimension
143		…			
144	H	There is two. We have seen these ones [plant species in fossil] growing actually in the caves wands. They actually built this. That is the only place in the world they know of.			Recall, revive previous experiences
145	I	Do you think that it is appropriate to have these kinds of exhibits [fossils of plants] apart from the dinosaurs?		Exhibits included that fit the setting/ story.	
146	H	Yes, from that timeframe.			Context
147	P	Because it shows you the relationship between that and that [dinosaur bones vs. plant fossils]. Because these are… [not understandable].			Other exhibits, Context

148	P	See that is with this kind… [not understandable] extinction, because they are still growing.		Adding exhibits complete timeframe.	
149		…			
150	H	And these are all from China?			Extract story, idea
151	P	They mainly are, yes.			
152	P	We have got one of these outside our garden.			Personal experiences
153	H	They do show them in relation to the plant-eating dinosaurs?		Exhibit's relation to exhibition/ other exhibits doesn't always naturally emerge.	Other exhibits
154	I	Yes, look at the big one behind you.			
155	P	Imagine how long it will take for the food to go from his mouth to his tummy. He will still be hungry while he is eating [laughing]!		Information can be extracted from the exhibits themselves.	Inadequate - imagine, Bring alive, Analyze chunks
156		…			
157	P	It is very fascinating to see that… the climatic changes and how it affects everything, doesn't it?		Higher level information from exhibition/ exhibits.	Present situation
158		…			