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Understanding Interaction Facilitated by Near Field Communication: A Case Study

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Therese Drivenes

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Therese Drivenes

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Summary

Many of us are used to interact with desktop computers through windows, icons, menus and pointers. But, computing is becoming increasingly more intertwined with the things in our everyday life. As new technologies emerge, new interaction techniques appear and affect how we interact with them. Near Field Communication (NFC) is a low-power wireless technology that contributes to bridging the gap between the physical and virtual world. NFC is a subset of RFID-technology, but more suited for use on mobile phones. Since NFC is a new technology with a new interaction paradigm, it is interesting to look at how people understand the interaction with them. This thesis seeks to investigate how users understand the interaction with NFC and its possible challenges. The thesis approaches the research question by looking at three topics: users' perception of the technology, feedback, and mental models.

These topics are explored through a qualitative case study, performed in collaboration with the research project MobileSage at the Norwegian Computing Center. MobileSage developed a help-on-demand application, and it is used as a means to investigate users interaction with NFC enabled smartphones and posters with NFC at Stortinget Station in Oslo. The interpretive paradigm serves as an underlying epistemology in our study, which means that we focus on the full complexity of human sense making as the situation emerges. Qualitative methods have been applied in the investigation of the area, specifically observations, interviews and a focus group.

The analysis shows that the NFC Forum symbol, which was used to present the NFC functionality on the posters, was not perceived in the way the NFC Forum had intended. The participants only perceived it at as a branding symbol that did not invite them to interact with it, and thus they did not see the link between the phone and the posters. The feedback the participants got during their interaction with NFC, both typical Graphical User Interface-feedback as well as Tangible User Interface-feedback, did not seem to be sufficient in supporting their interaction in the given context. The feedback needs to be clearer and appear faster. The participants in the study were not familiar with NFC. In order to figure out what to do, the participants used models from their earlier experiences with other technologies, such as photography, credit and debit cards and QR codes. The models they used did not always guide them in a good way, but as they become familiar with this interaction mode the mental models can change and become more suitable for their interaction with NFC. Affordances and metaphors can help first-time users in their understanding and learning, but only to a certain extent. For this reason, we believe it is necessary for users to undergo a short learning process for them to understand how to interact.

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Oslo, May 2013

Therese Drivenes

"Tag Cloud": The most frequently used words in the thesis (tagcrowd.com)

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1 Introduction

Mark Weiser introduced the field of Ubiquitous Computing and the idea of "invisible" computing (Weiser 1991). The desktop machines would largely disappear, but the computing would become intertwined with the things in our everyday life. By now, most of us are used to interact with traditional desktop computers or laptops with keyboards and pointers. But as new technologies emerge, new interaction techniques appear and become more central in the way we interact with technology in our everyday life. Interaction can take place everywhere, for instance in the grocery store or at the bus stop where a smartphone can be used to get context relevant information by holding it towards posters or other devices.

This thesis investigates how users understand and interact with the low-power wireless technology, Near Field Communication (NFC) on smartphones. Wireless technologies have been around for a long time, but they tend to use large amounts of power and often require specialized equipment to enable communication. However, low-power wireless technologies have grown in use the last decade, especially NFC that has been referred to as an up and coming technology for some years now (Torney 2012). Other similar technologies are Bluetooth and DASH7, but NFC is significant because of its short communication range. NFC is a subset of the RFID technology, but is more tailored for use on mobile phones because of the short range making it more secure and easier to control. An increasing number of devices in our surroundings are also being equipped with NFC technology, meaning the phone can be used as a means to exchange information in the environment. When two NFC-enabled devices are brought close together, they can exchange information without the users having to input any values themselves. This type of interaction gives rise to new communication methods between mobile devices and the surrounding world. In this thesis I investigate how users interact with NFC-enabled smartphones and posters with NFC.

1.1 Motivation

When I was working as a research assistant at the Norwegian Computing Center, I visited many different topics within the field of ICT. I have always been very interested in working with the users of systems and looking at how they interpret things, which often appear to differ from what one thought beforehand. One of the technologies I learned about was NFC, which was quite different compared to what I had worked with earlier. I have mostly been working with the design and evaluation of Graphical User Interfaces (GUIs), like websites and applications. When investigating the use of NFC it is not only the design of GUIs that are important for users' understanding, as the interaction often takes place in different contexts in the world. In desktop computing one mainly relates to the screen, but in NFC-interaction the surroundings and the NFC-enabled devices or tags also are important. I found it interesting to look at other ways of interacting with technology to gain knowledge about users understanding of it. Instead of focusing only on the technical side of NFC, I focused on the human element: people interacting with NFC.

Another reason why this topic triggered my interest is that if users actually know how to use NFC, it is a viable wireless low power technology. Instead of being a technology that in theory can be useful in several purposes, it may survive because of its ease of use. Thus, I wanted to learn more about this up and coming technology that is said to "make life easier and more convenient for consumers around the world by making it simpler to make transactions, exchange digital content, and connect electronic devices with a touch[1]". My focus is related to users understanding and interaction; how they know what to do and what guides their interaction.

1.2 Problem Area

One day I was sitting on the tram a woman did not manage to validate her ticket because she did not use the card correctly. She swiped her travel card fast from left to right, but did not get any feedback from the validation machine, and gives up in frustration. She should have held her card still against the machine until she got a response in the form of a sound and a message on the screen. The machine or symbol in itself did not say anything about what type of interaction was expected from the user, at least not for this user. She went to find herself a place to sit even if the ticket was not validated. If there were a ticket control, she would receive a fine for not

[1] http://www.nfc-forum.org/aboutnfc/, Jan 19th, 2013.

having a valid ticket, not to mention the added embarrassment of being caught in front of all the other passengers. The fact that a ticket was ready to be validated if she had used the machine correctly is an additional insult in this situation.

This was just an example illustrating how interactions that in theory are very simple, can cause difficulties an even lead to financial consequences for people who are not familiar with how one should interact with them. NFC has a far-reaching use area; it does not have one specific purpose, but many different ones and exists on a range of devices. What remains is to inform people about another wireless communication technology, which does not compete with Bluetooth and Wi-Fi, but complement them. One factor that may be problematic in this case is that there does not seem to be a clear and consistent language of how to communicate the use of NFC. The symbolic or iconography of NFC today consist of many different symbols, exposing users to a fragmented picture of the technology. We will look at how users understand how to interact with the technology and investigate what factors may affect their understanding.

NFC does not seem to have reached its peak level yet. There exist several NFC-enabled devices and services, but in this thesis we focus on the interaction between NFC-enabled smartphones and the environment, more specifically posters with NFC tags at Stortinget Station in Oslo. The posters were equipped with NFC tags that the user could touch with an NFC-enabled mobile phone and get different information on their phone. Figure 1 illustrates the different actors of the NFC-interaction in our case. The relationships between all the actors affect the understanding of NFC as well as the interaction with the technology.

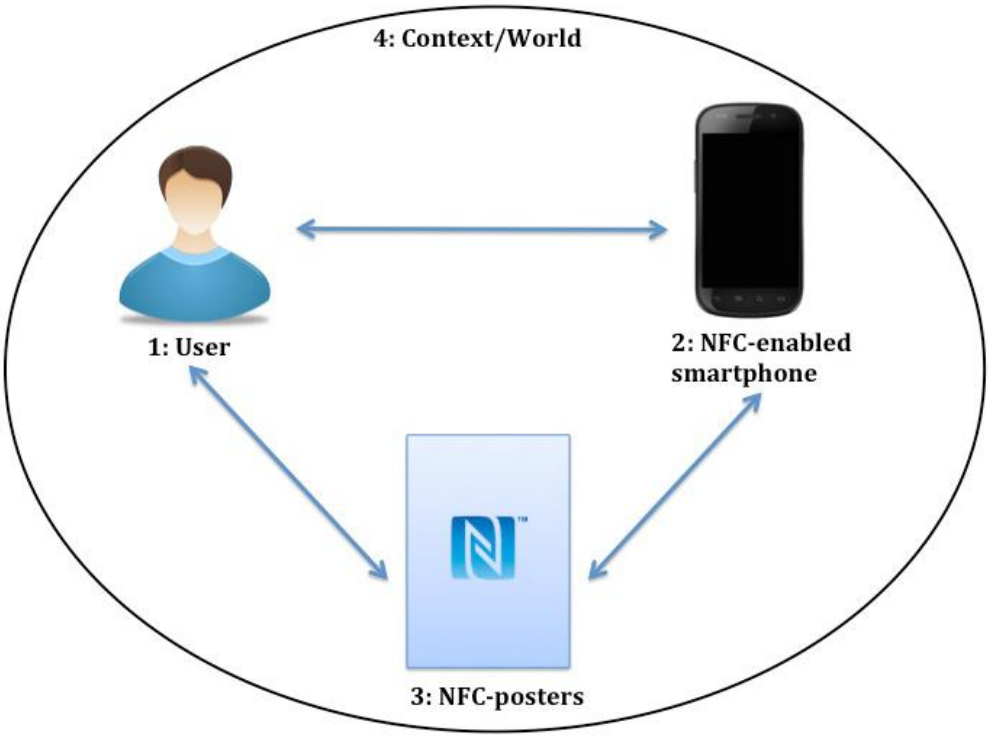


Figure 1: Illustration of the problem area (1: User, 2: NFC-phone, 3: NFC poster)

An increasing number of the mobile phones in the world are now smartphones, and we are becoming more and more reliant on them according to a survey performed by Google[2]. Many are used to interacting with smartphones and traditional desktop computers, but paradigms like Physical Mobile Interaction, introduce new ways of interacting, focusing on bridging the gap between the physical world and the virtual world. UPC barcodes, QR codes, Bluetooth and NFC are examples of technologies seeking to bridge this gap. However, there has not been a major focus on how people perceive, understand and interact with technologies like NFC. The story from earlier with the woman on the tram shows that people do not always understand what interaction is required. And these types of difficulties were also relevant in my study of the participant's interaction with an NFC-enabled smartphone and posters with NFC. The thesis will look at the different aspects of the interaction with NFC-technology, and investigate how the participants understand the use of NFC technology.

The case study is associated with a project called MobileSage[3] at the Norwegian Computing Center that aims to develop a personal agent or application on smartphones providing a help-on-demand service. My purpose is to use this

[2] Our Mobile Planet: http://services.google.com/fh/files/blogs/our_mobile_planet_norway_en.pdf
[3] http://mobilesage.no

application as a lens, looking at the participants' understanding of the interaction with NFC technology, meaning that the evaluation of the application design will not be the main topic, even if some aspects of it may be of relevance.

1.3 Research Question

This master thesis has been conducted in the field of design, use and interaction, and the main focus is on the interaction between users, NFC-enabled smartphones, and the NFC-enabled physical environment. I focus on understanding the interaction as well as investigating the possible challenges with the NFC-interaction. I investigate and go in depth of this area and make an attempt to generate research that can contribute to the field of NFC-interaction. To advance knowledge in this area I ask the following research question: *How do the participants understand the interaction with an NFC-enabled mobile phone and the environment?* The research question will be discussed by looking into three topics:

Part 1 - User's perception of the technology

The first part of the discussion will focus on how the participants perceive NFC. As I present the NFC-functionality on the posters by using the NFC Forum symbol, this will be one of the relevant factors in the discussion.

Part 2 - Feedback

In the second part of the discussion we will discuss the role of different types of feedback when participants are interacting with the phone and the posters.

Part 3 - Mental Models

Third we will discuss what mental models the participants may have when interacting with NFC, and investigate how they affect their interaction.

1.4 Chapter Guide

The layout of the rest of the thesis is as follows:

Chapter 2: Background. In this chapter I will introduce the theoretical framework of the thesis and terms used to analyze the gathered material. I position the present study by looking into literature concerning NFC interaction. A short overview of NFC's position in the market today is also given to provide knowledge about the current situation.

Chapter 3: Methodology. The chosen methodology is described, a qualitative case study, and reflections on my choice of methodology and methods for gathering and analyzing data. Ethics and validity issues will also be discussed.

Chapter 4: Case. This chapter presents the case study of the thesis and my particular focus during the case study

Chapter 5: Findings. The chapter is divided into four parts: observations at Stortinget Station, interviews with participants from Seniornett, interview with Assoc. Prof. Kjetil Nordby, and a focus group.

Chapter 6: Discussion. The discussion chapter discusses the overall research question, and is divided into three parts: user's perception of the technology, feedback, and mental models.

Chapter 7: Conclusion. The conclusion summarizes the most important findings and concluding remarks. Reflections around the process will be described, and future work within the given research field will be suggested.

2 Background

> We live in a complex world, filled with myriad objects, tools, toys, and people. Our lives are spent in diverse interaction with this environment. Yet, for the most part, our computing takes place sitting in front of, and staring at, a single glowing screen attached to an array of buttons and a mouse.
>
> Shaer & Hornecker (2010)

In the following chapter we will explore the theory and literature that has been helpful and relevant to position our work within the field. Some well-established theories and concepts from the field of *Interaction Design* and *Human-Computer Interaction* (HCI) will be introduced, as they will support the analysis of the gathered empirical data. To get an overview of the different methods that makes it possible for the virtual world and the physical world to communicate, some of these methods will be introduced. Finally, we will focus on the development within the field of NFC as well as relevant literature related to NFC based interaction.

2.1 Interaction Design & Human-Computer Interaction

Interaction Design and HCI are two closely related fields. The main difference between them is their scopes. Interaction design concerns a larger area compared to HCI by focusing on theory, research and the practice of designing user experiences for all types of technologies and products (Preece et al. 2007). HCI, on the other, has a narrower focus where one is concerned with the design, evaluation, and implementation of interactive computing systems for human use (Preece et al. 2007). Interaction Design works as an umbrella term for the many interdisciplinary fields. Sharp, Rogers and Preece (2007, p.9), defines interaction design as follows "designing interactive products to support the way people communicate and interact in their everyday and working life's."

This is a broad definition that doesn't necessarily mean interaction between humans and desktop computers, but possibly also human-to-human or human-to-environment. The users that have participated in the evaluations for this thesis engaged and interacted with smart posters in the environment.

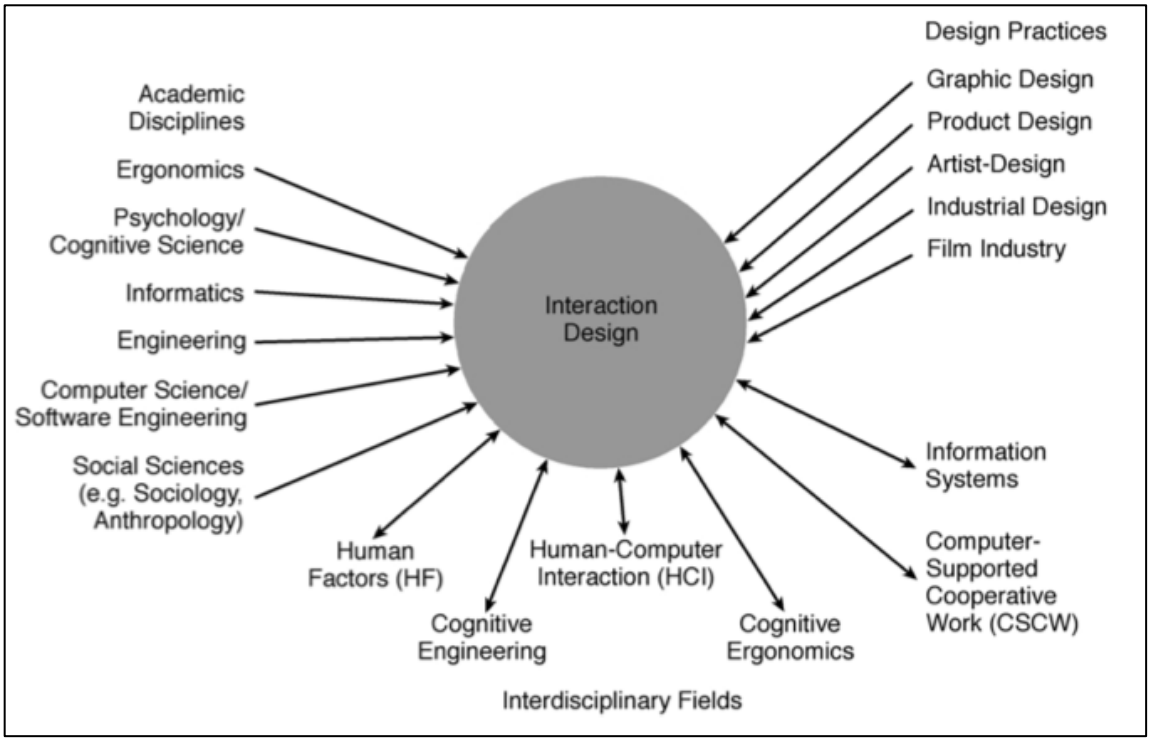


Figure 2: ID as an umbrella term (Preece et al. 2007)

Daniel Fällman (2003) investigates the use of mobile information technology in his doctoral dissertation, according to the relationship between the human user, artifact and the world, and how these relationships may be regarded as different from

mainstream HCI. As the name implies, the HCI field mostly deals with the interaction between a human user and a computer device, without taking any specific considerations to the physical and social contexts of the world. According to Fällman (2003), Human-Computer Interaction should be reinterpreted and more accurately approached as *Human-Computer-World interaction*. In our case, it is necessary to look at all these three aspects of the interaction, as it is situated in the real world, more specifically Stortinget Station, and involves human users and smartphones interacting with the physical surroundings. He separates the different relationships a user could have with the technology and the world, for instance when the user is not actively involved with the technology. If the user has the phone in the pocket or bag, the attention is on the world, while the phone is in more of a background relationship (Figure 3).

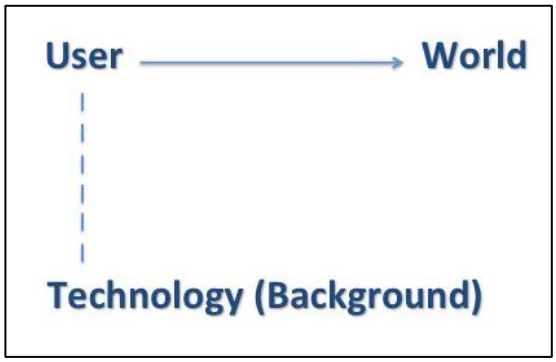


Figure 3: Technology in a background Relationship (Fällman, 2003)

When the user finds something of potential interest in the world and is about to use the device, in our case this could be a tag to touch, the three-way relationship changes slightly. The user takes the phone from the pocket or bag, making the relationship between the technology and the user in this situation stronger (Figure 4). However, the strongest relations between the user and the world, still remains.

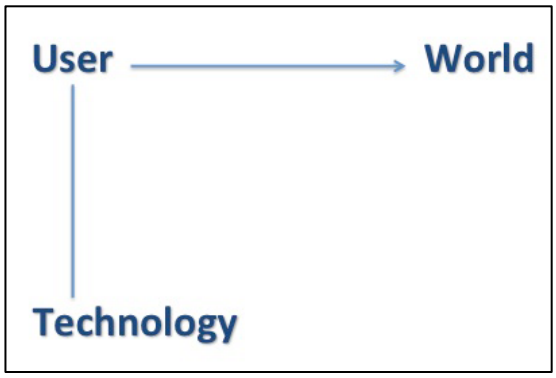


Figure 4: The relationship between the user and the technology strenghtens (Fällman, 2003)

The relationship again starts to shift when the user raises the phone to touch and read the tag. Now the user holds the phone more purposefully in the direction of the object of interest. Fällman (2003) uses an example with a digital camera. In this case the relationship with the world may get somewhat weaker as the user who is about to take a picture see the world through the camera and the attention is then separated between the world and the device. In our case, the phone does not allow the user to see the world through the phone, but the relationship between the technology and the world get stronger as the user is about to make use of the NFC enabled phone with the NFC enabled environment. The main focus here is to be aware of how we look at the relationships and aspects of interaction between the user, technology and the world.

2.1.1 From Graphical User Interfaces to Tangible User Interfaces

For many years it seemed that human computer interfaces only were limited to a desktop computer, a keyboard and a mouse to interact with windows, icons, menus and pointers (WIMP). But in the last decades Tangible User Interfaces (TUIs) have emerged to become a new interface type that connects the physical and the digital worlds (Shaer & Hornecker 2010). While traditional desktop computing or Graphical User Interfaces (GUIs) are like a window making it possible for us to reach in to the digital world, the design of TUIs requires that we design not only the digital but also the physical (Hornecker & Buur 2006).

According to Shaer and E. Hornecker (2010), TUIs provide tangible representations of digital information and controls. So, instead of using a keyboard or a mouse in order to interact with the information, a person can interact directly with the information through their hands. In this case one interacts with the world through and with a mobile phone to transfer information, meaning one cannot manipulate the world with the hands, but it still differs from the traditional desktop computing in that it is more connected with the interaction that takes place in the physical world. This is because one can interact with the physical world by using the mobile phone. In GUIs one largely relies on visual information, and to some degree audio, in TUIs it is not only visual or auditory information or feedback that is important when informing the users of what is happening, but also haptic feedback.

2.1.2 User Experience

The user experience is important for interaction design (Preece et al. 2007). Everything that is used by someone has a user experience: a toothbrush, a bottle, a microwave, a website etc. User experience develops from how the product behaves and how people use it. It concerns how people feel, if they are satisfied or frustrated. According to Preece et al., (2007, p.15) it is not possible to design a user experience, but it is possible to design *for* a user experience. In the case of this thesis, where people are going to interact with NFC-enabled smartphones and the physical environment, a good user experience is essential to make sure people actually will make use of the technology. There are many user experience goals in interaction design and in Table 1 are some examples from Preece et al., (2007). Most of them are related to positive user experiences, but negative user experience goals are also included below, as it may be relevant in some particular cases.

User Experience Goals				
rewarding	challenging	surprising	annoying	frustrating
satisfying	enjoyable	engaging	pleasurable	exciting
entertaining	helpful	motivating	fun	provocative

Table 1: Examples of user experience goals (Preece et al., 2007)

2.1.3 Design Principles

When interaction designers are designing for a good user experience or evaluating designs, many of them make use of design principles to guide their thinking. They aid the discussion of the design, and help the designer to think about the many aspects of the design (Preece et al. 2007). Design principles do not go into much detail, but helps the interaction designer to make sure important features of an interface are included. Donald Norman introduced a set of design principles in his book "The Design of Everyday Things" that was first published in 1988. These are also presented by Preece et.al. (2007), and have become well-established principles in the field of interaction design. The design principles are as follows: *Visibility, Consistency, Feedback, Mapping, Affordance,* and *Constraints* (Donald Norman 2002).

2.1.4 The Principles of Feedback & Affordance

We introduced Norman's design principles, but let's examine the feedback and affordance principles more closely. These principles are most relevant for the work done in the thesis.

Feedback

As already mentioned Norman (2002) and Preece et.al (2007) talks about the principles of feedback, visibility and affordance in interaction design. Ben Shneiderman (2004, p.74) also present his "Eight Golden Rules of Interface Design", were he defines the principle for feedback as follows.

> Offer informative feedback. For every operator action, there should be some system feedback. For frequent and minor actions, the response can be modest, while for infrequent and major actions, the response should be more substantial.

Jakob Nielsen, also includes feedback in his 10 usability heuristics (Nielsen 1990). The heuristic "Visibility of system status" describes feedback in the following way, "The system should always keep users informed about what is going on, through appropriate feedback within reasonable time" (Nielsen 1990, 25.02.2013).

The principles or heuristics mentioned above are general and quite open for interpretation, as they do not say anything specific about what type of feedback one should offer. This is of course dependent of the system type, the context and the user needs. For instance, a Tangible User Interface (TUI) might require other feedback types compared to a Graphical User Interface (GUI). In the traditional desktop metaphor, users manipulate digital information with a mouse and a keyboard, and get most of the feedback about what happens, visually on the screen, sometimes in combination with sound. In the study of Laehyun et.al. (2007), the researchers developed a TUI system where users could manipulate information on a large display through a physical device they call SmartPuck. In this case, they found it necessary to offer multi-modal feedback, such as visual, auditory, and haptic feedback. The visual feedback was given through LED lights, while auditory feedback was given through the speaker, and the haptic feedback was given through vibrations from the SmartPuck.

This shows that it is important to evaluate what type of feedback is necessary in different situations. In a context were there is noise from the surroundings, it might

be an advantage to focus on visual and haptic feedback, and for people who are visually impaired, auditory and haptic feedback is essential (Eika Sandnes 2011).

Affordance

When talking about the concept of affordances, it is natural to start with Gibson's theory of affordances (1977), as the term originally was proposed in his ecological approach to perception. Gibson's theory was developed to provide an account of animals' action and perception in their natural environments, and he asserted that animals directly pick up significant information, affordances, from the ambient optic array (J. Gibson 1977). So, he argues that animals pick up affordances as possibilities for action, which is determined by the objective surroundings and the animal's capabilities (J. Gibson 1977).

According to Norman (2002) affordances give strong clues about the possible uses, functionality and actions. If affordances are taken advantage of, he argues that there is no need for labels or instructions; the users know what to do just by looking. While Gibson theory of affordance argue that it is "Independent of the actor's experience, knowledge, culture, or ability to perceive", Norman's view argue that it can be dependent of these factors (McGrenere & Ho 2000, p.3). This means that Norman is of the opinion that people may perceive affordances differently dependent of their background knowledge and experiences as well as their culture. In an article from 2004, Norman tries to clarify the affordance concept, and note that the term *perceived affordances* would more accurately explain the concept. He explains it by stressing that the important factor for a designer is whether a user perceive that some action is possible or not. This means that the real affordances do not necessarily have to be the same as the perceived affordances (Norman 2004). Icons are often considered the most important factor of visible affordances, even if they do not always seem to serve their function (Raskin 2000), and we will return to this topic in Section 2.1.5.

The principle of visibility is related to the principle of affordance, and is according to Norman (2002) a good reminder of what can be done. Sometimes a system may have several functionalities, but it lacks the same number of visible controls, making it hard for the user to know how to use all the functionalities. An object might be visible in the sense that it is there, on for instance a poster or a device, but it might be too small to be noticed or the contrast might not be good enough to separate it from its background (Raskin 2000).

There have been discussions about the definition of affordance, but what they all have in common is that it deals with the action possibilities the things in the environment offer people (Kaptelinin & Nardi 2012). Affordance is of importance in our study because it says something about users immediate reactions to what they see and can be important when users are confronted with a new technology. The way the technology presents itself to novice users can be essential for their understanding of the technology.

2.1.5 Icons

Icons are often considered to be very central in relation to visible or perceived affordances. They are used in all sorts of settings to make it easier for us to identify buttons, tasks, things and other objects. Icons can make a user interface more visual appealing, as well as it can help clarify what users should do. However, icons often require explanation instead of them alone explaining the purpose (Raskin 2000). This can be illustrated by the need for a text box that appear when moving the marker above the icon, at least in traditional desktop interfaces. Raskin argue that it is essential that icons:

- Are visually distinct
- Do a good job of representing the appropriate concept
- Are presented at a reasonably large size, typically larger than text label would be. (2000, p.170)

Raskin (2000) is however of the opinion that icons violate the principle of visibility because their meaning and purpose are not visible, and thus he thinks text is more suitable for explaining the meaning of something. Cooper & Reimann (2003) argue that reading is slower and more difficult than recognizing images, but on the other side, images lack the precision and clarity of text. Images or pictographs may be ambiguous until one actually learns what they mean. Cooper & Reimann (2003) also discuss the way designers often think they have to create visual metaphors that convey immediate meaning for first-time users, and argue that one should not hope for such magical powers in a metaphor. It is easier to find images representing things, rather than actions or relationships (Cooper & Reimann 2003).

2.1.6 Mental Models

Software systems often consist of complex structures that enable their functionality, but when people use the product they do not necessarily know what happens in the background. For instance when someone use a movie projector, they most likely do not think about all the elements working together to project the picture, they merely think of it as a device that moves the picture, making it appear. According to Cooper (2003) users do not need to have knowledge about how a system's inner mechanisms actually works in order to use it. Instead they create a mental model enabling them to perform the right interactions even if it does not reflect the inner mechanisms of a system. However, the differences between the user's mental model and the system image can often be quite distinct.

There are three different aspects of mental models; *design model*, *the user's model*, and the *system image* (Norman 2002). The design model is the designer's conceptual model, the user's model is the mental model developed through interaction with the system, and the system image results from the structure that has been built. Designers expect the user model or their mental model to be similar with the design model. But as designers do not speak directly to the users and the mental models not are directly observable, the communication goes through the system image. If the system image does not manage to make the design model consistent and clear, the users will get the wrong mental model (Norman 2002). The designer's model (or represented model in Figure 5) should get as close as possible to user's mental model, in order to make users understand what to do (Cooper & Reimann 2003).

Figure 5: Mental Models (A.Cooper et al. 2007)

Mental models are according to Susan Carey (1986) created from prior experiences with similar devices and software, things they have heard others say, assumptions they have, and from their direct experience with a product or a device. People's mental models can vary, and more novice users may have a simpler mental model

compared to expert users. However, Melander, Landauer & Prabhu (1997) argue that broad classifications of users as experts or novices doesn't seem to be very helpful in relation to mental models, as one might be expert in one area and a novice in another. According to Cooper (2003), mental models do not have to be true or accurate, but they should enable users to do what they want to do effectively. Some people think of the computer screen as the computer itself, while the computer doing all the work, really is below their desk. This, however, is not essential for the user's basic understanding as it is the screen they relate to. In our study it is interesting to investigate what mental models participants have of the interaction. We can investigate whether the models guide them in a good way, making them more efficient or mislead them and make them less efficient.

Metaphors are closely related to mental models, and systems and interfaces often use metaphors to make the functions of a system more intuitive. "Metaphoric interfaces rely on intuitive connections that the user makes between the visual cues in an interface and its function" (Cooper & Reimann 2003, p.247). An example of a metaphor is the trash can symbol from user interfaces that is supposed to convey the purpose of the button. By using metaphors like this for interaction there is no need to have knowledge about the mechanics of the software. We grasp the meaning of the metaphors because we connect them with other things we have already learned. However, metaphors have some limitations according to Cooper & Reimann (2003). The associations have to be perceived in similar ways for both the designer and the user, and if the user's cultural background differ from the designer's background, it is easy for metaphors to fail.

Idioms, on the other hand, differ from metaphors. While metaphors tries to provoke some kind of associative connection with the user, idioms have to be learned for us to understand them (Cooper & Reimann 2003). Hyperlinks and drop-downs are examples of things we learn idiomatically rather than intuit metaphorically. Idioms are widely used in branding, where icons and symbols obtain meaning from its use. An example can be the McDonalds symbol that because of its use have common meaning among people (Cooper & Reimann 2003).

2.2 Bridging the Gap Between the Virtual & Physical world

There are many ways of linking the virtual world with the physical world, for instance by scanning a barcode, making a Bluetooth connection, or scanning an NFC tag. In the last decade, low power, wireless technologies has grown and opened many possible ways of connecting, and several objects are being equipped with sensors that increase the possibilities for communication. Low power simply means that one use a minimum amount of power to enable interaction. In the following section, we have included not only wireless low power technologies, but also technologies were one use a camera. This is because they also offer a way to bridge the gap between the virtual and the physical world, even if they cannot be considered wireless low power technologies. The ways people are used to interact with the physical world may affect the way they interact with new technologies, and here we will shortly present ways of interacting with the physical environment.

Figure 6: Ways of bridging the gap between the virtual and physical world

2.2.1 Universal Product Code

A barcode, or a Universal Product Code (UPC) is an optical machine-readable representation of data that this related to an object, for instance to keep information about products, people, animals or goods (Finkenzeller, 2010). The UPC helps people organize different things so one can keep track of their location at all times. Most people have probably gotten to know barcodes through consumer products as they

are to be found on almost every product you buy in the store. One of the disadvantages with barcodes is their low storage capacity and that they cannot be reprogrammed.

2.2.2 QR Code

Because of the UPC bar code's weaknesses, the Quick Response Code (QR Code) or two-dimensional barcode emerged. Compared to conventional bar codes, the QR Codes are capable of storing several hundreds times more information (Rouillard 2008). A QR code is a type of two-dimensional symbology developed by Denzo Wave and released in 1994. The purpose of the QR Codes was to be easily interpreted by scanner equipment.

> QR Code (2D-Code) contains information in both the vertical and horizontal directions, whereas a barcode contains data in one direction only. QR Codes hold a considerably greater volume of information than a bar code. (Rouillard 2008, p.51).

QR Codes can be read using a scanner application on a smartphone and other scanner devices (Rouillard 2008). They can link directly to text, emails, websites, phone numbers and more. The disadvantage with QR Codes in relation to smartphones is that you first have to download an application, open the application to scan it, and keep the phone still for it to be read properly.

2.2.3 Bluetooth

Bluetooth is a wireless communication technology, and can be found in mobile phones and many other devices. It is a low power technology and allows a range of devices to connect and communicate with each other. Even Bluetooth is called a short-range communication technology, but it has a much larger range compared to NFC. The range of a Bluetooth device is about 10 meters, but the communication can also be centered between the phone in your pocket and the headset on your head (Franklin & Layton 2011). The range of a Bluetooth connection might pose a risk of interference with other systems, and to avoid this interference it only sends out very weak signals. The connection between Bluetooth-enabled devices is created automatically as described below:

> When the devices come within range of each other, an electronic conversation takes place to determine whether they have data to share or whether one needs to control the other. The user doesn't have to

> press a button or give a command - the electronic conversation happens automatically. (Franklin & Layton 2011, 14.01.2013)

This differs from NFC, where you have to hold the phone close to the tag or the other enabled device to establish communication between them. This makes it more secure when it comes to possible interferences with other systems, as well as the user is more in control of the interaction.

2.2.4 DASH7

DASH7 is another wireless low power technology that has many similarities with NFC. Originally it was created for military use and is still used in this field (MacManus 2010). Both of them enable your phone to communicate with other devices, and it is said that DASH7 is "Ideal for large area sensor networking or supporting reliable communication with things on the move" (MacManus 2010, 14.01.2013). The main difference between DASH7 and NFC is the range of the communication. While NFC has a very short range, DASH7 has a much longer range, up to hundreds of meters.

Another low power, wireless technology is ZigBee, which is a direct competitor of DASH7.

2.3 Radio Frequency Identification (RFID) *&* Near Field Communication (NFC)

In the following section we will provide an overview of some of the previous research and the development within the field of NFC. The main focus will be on the interaction area of NFC, which concerns how users interact and understand the technology. There are many studies related to more technical issues concerning NFC, for instance security (Madlmayr et al. 2008; Haselsteiner & Breitfuß 2006; Verdult & Kooman 2011). If people are to use the services, it is also important to focus on how people interact with it and understand it. There have been conducted some studies investigating the understanding and interaction of NFC, but this focus area is still, to the best of our knowledge under-researched. With this, we aim to present relevant work and development that position the thesis in the field.

2.3.1 Market Outlook

In the past few years, the expectation and interest in NFC has grown, and it has become a promising technological development in the field of ICT (Murphy 2010). NFC technology is a short-range, high frequency, low bandwidth, and wireless communication technology based on radio frequency identification (RFID) (Finkenzeller 2010). NFC has received the most attention in the area of contactless payment and ticketing. Google have developed, Google Wallet[4], which is a mobile payment system where users can save all their cards and either use the cards online or in a physical store. This gives people the possibility to replace their traditional wallet with a virtual one. But, NFC is also relevant for many other purposes like information retrieval, information sharing, ticketing, or access control.

NFC allows users to connect devices and access content by holding the NFC-enabled devices near each other. A unique property of NFC interaction is the short operating distance between devices and tags, about three to five centimeters. To promote the use of NFC technology, the NFC Forum was formed in 2004. Their goal is to advance the use of NFC technology by developing specifications, ensuring interoperability among devices and services, and educating the market[5]. They state that:

> Near Field Communication (NFC) technology makes life easier and more convenient for consumers around the world by making it simpler to make transactions, exchange digital content, and connect electronic devices with a touch. [6]

A key driver for the market of NFC services is the availability of NFC technology on mobile phones and other mobile devices (Murphy 2010). Service providers need a large number of NFC enabled devices to make the investment in NFC services worthwhile. When talking about NFC adoption, one cannot avoid mentioning the elephant in the room, Apple. Apple's iPhone has been popular ever since the first version was released in January 2007, and Apple is now a powerful player in the mobile market[7]. When Apple launched the iPhone 5 in September 2012, many expected that it would include an NFC chip. Instead, Apple chose to focus on their own Passbook technology[8]. Yet, it is possible to have iPhones work with NFC. A possible solution is a NFC case that enables the technology simply by putting it

[4] http://www.google.com/wallet/

[5] http://www.nfc-forum.org/aboutnfc/business_driver/

[6] http://www.nfc-forum.org/aboutnfc/

[7] http://www.statista.com/topics/870/iphone/, Jan 1st, 2013

[8] http://news.cnet.com/8301-13579_3-57511682-37/no-nfc-for-you-iphone-5-heres-apples-explanation/, Jan 29th, 2013

around the phone. Even without NFC on iPhones, Frost & Sullivan (Murphy 2010) estimate that the number of NFC enabled phones will reach 863,000,000 units by 2015. This means that mobile phones with NFC will represent over 53 percent of the overall market; opening for great possibilities of the use of RFID and NFC technology.

The availability of NFC enabled devices is one of the conditions for the technology to be widely adapted in the society. Another important part concerning the adaption of NFC is the user's understanding of the interaction with the technology. Even if the technology has been around for some years, most users are still unfamiliar with NFC. It is therefore important to look at how people understand and interact with the technology in the best way.

2.3.2 NFC based Interaction

The first systems linking the virtual and physical world mostly relied on RFID tags and devices. Want et. al (1999) was one of the first to experiment with different scenarios linking everyday objects to digital information by using RFID tags, and this work forms the basis for much of the research involving tagging objects (Anokwa et al. 2007). One of the examples of how to use RFID tags involved augmenting books or business cards. These tags simply offered an electronic version of the book or card. Another example was to scan a book and purchase it from an online store (Want et al. 1999). Today these types of applications mostly rely on NFC, as it is more tailored for mobile phones.

Physical Mobile Interaction & Physical Browsing

Ailisto et al. (2009) use the term *Physical Browsing* when referring to the user paradigm that links physical objects to digital devices by different interaction techniques. Broll et al. (2009) use the term *Physical Mobile Interaction* to refer to the interaction between a mobile device and the physical environment. NFC is one of the central low-power technologies that enable these paradigms. Both Physical Browsing and Physical Mobile Interaction recognize the paradigms of *touching, pointing and scanning*, and both see mobile phones as the means for interaction between the user and the physical world (Ailisto et al. 2009).

Broll et al. (2009) focused on learnability and guidance of users interacting with NFC enabled phones and posters. Their goal was to increase the accessibility and usability of the NFC-based interaction by giving the users visual cues and guidance on the mobile phone and on the posters. To get users who are not familiar with the

technology started using NFC, Broll et al. (2009) indicated that a dedicated start-tag for interaction would be appropriate (Figure 7). They recommend an enlarged symbol with text explaining how to interact with the posters. They noted that users have not paid attention to similar explanations in earlier studies, but they argue that the distinctive color (red) of the text and border might catch the users attention (Broll et al. 2009). Some of the posters also offered multi-tag interaction, where the users could choose a movie, number of tickets etc. The interaction steps were illustrated by numbering each of the tags.

Figure 7: Dedicated start-tag

Ailisto et al. (2009), studied eight different use cases for interacting with NFC including information retrieval, ticketing, and value transactions. The researchers investigated the interaction design issues in the different application domains. The findings from the trials were related to tag size, tag location, multi-touch, and feedback. They found the tag size to be limiting, as it does not follow the form and size of the natural world. When used on posters, they found that the tags were difficult to see from a distance due to their small size. In the study, they also found that the freedom of placing the tags anywhere in the physical environment could lead to inconsistencies in the design and confuse the users. In some of the trials, multi-tag interaction was possible. They did not explain how they visualized the order of interaction, but mention that the phone could reflect the selection of choices. There were also some issues with the feedback in the applications as the "sensitivity" of the readers differed between applications. They therefore stressed the importance of consistent feedback in all types of applications. In some of their trials, they used the NFC Forum symbol (Figure 8) to visualize the presence of the NFC functionality.

Figure 8: NFC Forum Symbol

Vergara et al. (2010), proposed and investigated an NFC-based system with the purpose of helping care-dependent people. The system would make it easier for patients to get prescriptions and information about drugs at home, with the purpose of increasing their independence. To ask for prescriptions, one should touch the tag with the same title, then touch the tags of the drugs they need, and again touch the "Ask for Prescriptions" tag (Figure 9) to send it to the doctor (Vergara et al. 2010). The researchers claim "Care-dependent people interact with the system, and subsequently obtain services, without needing to know how to use neither a mobile phone nor a computer" (Vergara et al. 2010,p.28). To visualize the tags they do not use an NFC symbol of any sort, but illustrations of the actions with text. For instance, to "Ask for prescriptions" they use an illustration of a mobile phone with an arrow pointing to a doctor (Figure 9). This might be a good way to visualize the interaction, but as a multi-tag interaction is required, it does not necessarily mean that the interaction is intuitive enough for people with no mobile – or computer – experience, at least not without some guidance.

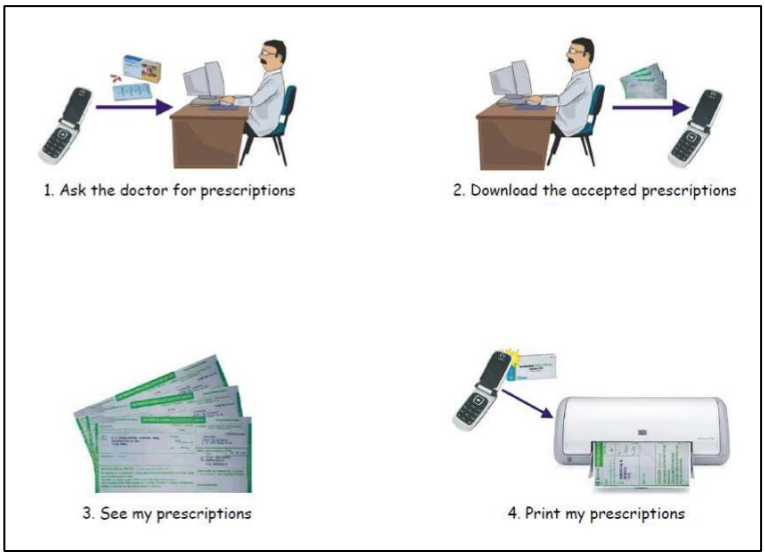


Figure 9: Tags Panel

Designing New Interactions

Kjetil Nordby and Andrew Morrison from Oslo School of Architecture & Design, approach NFC-based interaction from a different angle compared to the ones already mentioned. Instead of investigating the area through different users trials, they look at what the NFC technology offers designers in creating new innovative interactions (Nordby & Morrison 2010). The authors focus on how the technology can be interpreted as design affordances, and they present the following three design affordances; *Need related design affordances, instrumental design affordances* and *operational design affordances* (Nordby & Morrison 2010). They present a new

interaction paradigm called *Tap and Hold* (Figure 10), where Tap means moving a phone in and out of a field, and Hold means holding the phone over a tag. Physical manipulation of the radio fields is central in this paradigm. They argue that this has the potential to be associated with the GUIs "Drag and Drop" interaction, and offer new interaction possibilities that more specifically captures the tangible potential of NFC. However, NFC interaction is most often linked to the *Touch* paradigm (Broll et al., 2009; Möller, Kranz, Diewald, & Roalter, 2012).

Kranz and Möller state, *"*Touching is a proximity-based approach that allows to identify an object by bringing the phone close to it*"* (2012,p.2). Meaning one actually does not have to *touch* the tags or other devices in order to read or write. The distance is however, quite short (three to five cm) dependent of the sensitivity of the tags, and sometimes one almost has to touch the tag or the other device to read it or write something to it.

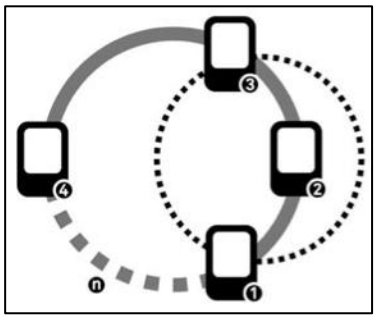


Figure 10: Tap and Hold Model

Single Tags vs. Multiple Tags

In many of the mentioned studies above, multi-tag interaction is involved. In multi-tag based applications, several tags are represented on the smart object where each of them has a different value, which is required by the multi-tag application. An example of multi-tag interaction is Broll et al.'s movie poster, where one can select movie, timeslot, cinema and number of people, by touching each of the tags with the phone (Broll et al. 2009). Single-tag applications run on the mobile phone and are triggered when users touch an NFC tag on an object with their mobile device. Single-tag interaction could be when one uses the mobile phone to get information from a NFC-poster, like we do in the present study. Communication between the two entities is then enabled and data can then be exchanged (Nundloll-Ramdhany 2007). Multi-tag interaction is a way of experimenting with the possibilities of NFC interaction, but it might also cause more interaction difficulties and design

challenges, as it is more complex compared to the single-tag interaction. It may create a need for a more obvious and consistent visualizing of the interaction steps.

Iconography and Design

In the different studies, everyone uses different symbols or illustrations to visualize the NFC functionality. Broll et al. (2009) used a symbol that, to us, was unknown, while Ailisto et al. (2009) use the NFC Forum symbol at least in some of the user trials. M. Vergara et al. (2010) do not use a symbol in the same way as the two other studies, but an illustration. None of the studies focus on the iconography in itself, and this could be important to create a consistent picture of the technology to users, and convey what interaction is required from the users in both single-tag interactions and multi-tag interactions.

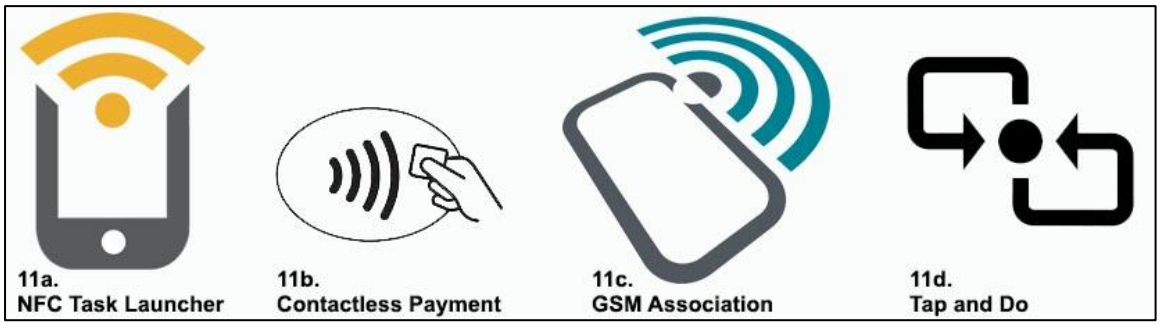


Figure 11: Examples of NFC icons today (From left: 11a NFC Task Launcher, 11b Contactless Payment, 11c GSM Association, 11d Tap and Do).

While the NFC Forum wishes to establish their symbol (Figure 8) as a standard for all NFC service providers, many providers create their own NFC symbols (Figure 11). This presents potential users with a fragmented iconography (Balaban 2012). Microsoft has introduced their own NFC symbol called, "Tap and Do" (Figure 11d) that is to be used on all Windows 8 devices. While the GSM Association, the large trade group representing most mobile operators worldwide, also has introduced its own NFC symbol, called "NFC Icon" (Figure 11c). Like the NFC Forum, they also would like the icon to become the universal symbol for NFC (Balaban 2012). The main critique of the NFC Forum symbol is that it does not say enough about how it is used. As Bob Whelan, co-founder of U.S.-based NFC Labels puts it, "The NFC Forum symbol doesn't have a 'verb' in it" (in Balaban 2012), meaning it lacks some sort of action, or something that triggers action. And it seems the NFC Forum plans to use the symbol as both a touch point symbol and a branding symbol:

> The NFC Forum N-Symbol lets consumers know that NFC services are available on mobile devices and other consumer electronics, as well as smart posters, signs, badges, labels, etc. It indicates where to touch to enable NFC services.
>
> The N-Symbol on a display screen, digital media, product packaging, or product or service promotional material indicates that the particular software, product, or service has NFC capabilities[9].

This might be problematic, as touch point symbols should offer some sort of action possibilities, compared to a branding symbol that do not need to take this into account. We will discuss this topic further in chapter 6. Next we will provide a short presentation of some of the technical details of NFC.

2.3.3 NFC: Technical Details

NFC or Near Field Communication is based on and extends RFID (Finkenzeller 2010). RFID is probably most known in association with consumer products, where it provides a unique ID to each of the objects. In order to retrieve the identifying information one has to touch the RFID device. NFC is developed considering the use of RFID on mobile devices and communication between them and other readers and tags (Finkenzeller 2010). NFC has a wide range of use areas, and some of them are:

- Ticketing
- Cashless Payment
- Getting information
- Share information (ex. business cards)
- Access Control
- Loyalty

Internal Structure

The internal structure of an NFC tag consists of an antenna, a chip and an inlay, and can carry a small amount of information. The antenna of an NFC tag is made of either aluminum or copper, and it is the antenna that converts the magnetic fields into electricity. The tag works at a frequency of 13,56 Mhz. The tiny chip inside a tag is the one responsible for storing the information and controlling how it is accessed[10].

[9] http://www.nfc-forum.org/resources/N-Mark/
[10] http://rapidnfc.com/what_is_nfc

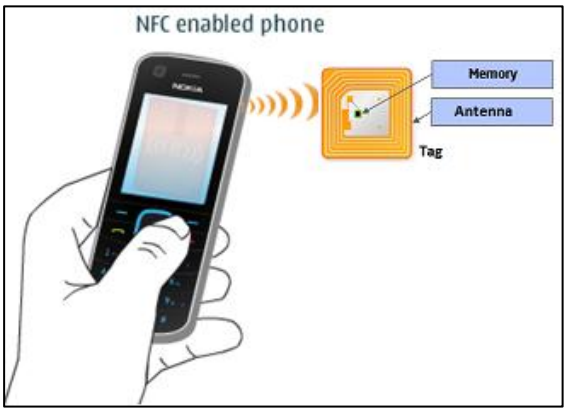


Figure 12: Internal structure of NFC tag[11]

Communication Modes

NFC based communication between two devices is possible when one device acts as a reader/writer and the other device acts as a tag. NFC devices support two communication modes, active and passive. NFC tags are passive, which means they do not have their own power supply, but they get power from other NFC-enabled devices. A tag can for instance be a small tag inside a poster. When an NFC-enabled device, for instance a smartphone, is held close to the tag, electricity flows through the circuitry of the chip and generates a magnetic field. The magnetic field creates electricity within the NFC tag and it is created a radio field. The smartphone is an active device because it has its own power supply. The radio field created by the tag then interacts with the field created by the phone. The NFC chip in the smartphone detects and decodes the radio field, and allows information to be transferred wirelessly, for example an URL to a website (Strickland 2012).

Operating Modes

In *read/write* mode (Figure 13) an NFC-enabled phone can either read information from a supported NFC tag or write information to it. A NFC-enabled phone can for instance get the number for a taxi from a tag or write an URL to a tag. In this study the phone operates in this modes when the participants hold the phone towards the NFC tags to get information.

[11]http://www.developer.nokia.com/Community/Wiki/Inside_NFC:_Usages_and_Working_Principles

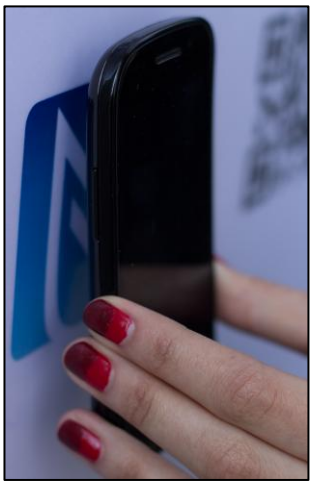


Figure 13: Read/write mode

In *peer-to-peer* mode (Figure 14) two NFC-enabled devices can exchange data. For instance, two NFC-enabled smartphones can exchange business cards by holding them close to each other. The two devices act as passive and active interchangeably, when a device sends information it is active and when it receives information it acts passive.

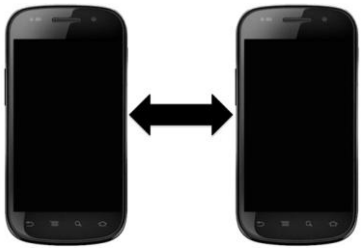


Figure 14: Peer-to-peer mode

In *card emulation* mode the NFC device behaves much like a traditional contactless smart card with external readers (travel card). This enables contactless mobile payment, ticketing, and other tasks without changing the infrastructure[12].

Figure 15: Card emulation mode[13]

[12] http://www.nfc-forum.org/resources/faqs#howwork

[13] Picture from: http://phandroid.com/wp-content/uploads/2013/02/visa-paywave-olympics.jpg

The difference between an NFC tag and an NFC-enabled device is that the tag is a passive device that stores data, which can be read by the NFC-enabled device. An NFC-enabled device can however operate in reader/writer mode and in peer-to-peer mode, and possibly also in card emulation mode[14].

2.4 Summary

In this chapter we have taken a look at the interaction design field, design principles, mental models, and other themes that may be central in the investigation of the given topic. Also, we have looked at some of the technologies that contribute to bridging the gap between the virtual and physical world, NFC in particular. Do people know how to interact with these things? This is what we are going to investigate, but how do we do that? We need a good research methodology and methods, and we will present and argue why we have chosen the specific research methodology and methods in our investigation. That is the topic of our next chapter.

[14] http://www.nfc-forum.org/resources/faqs#howwork

3 Methodology

In the following chapter we describe the methodology and methods that have been used to collect data for this thesis, as well as why these choices are suitable. The application of the methodology and methods in the research will also be further explained, as well as we will talk about the issues related to ethics and validity in the case study. We have performed a qualitative case study, and we used the following methods in our investigation of the topic:

- Observations
- Interviews
- Focus Group

The chapter starts by looking at different ways to approach a study and we explain why we have chosen the given research approach in our study.

3.1 Research Methodology

There are different ways of approaching a field in research, but the most distinctive directions are qualitative inquiries and quantitative inquiries. In a qualitative inquiry one seek to discover and describe what a certain group of people do in their everyday life and what their actions mean to them. A quantitative inquiry on the other hand focus more on measurable data and thus often require a larger group of users included in the investigation. While a qualitative researcher may ask "What are the kinds of things (material and symbolic) to which people in this setting orient as they conduct everyday life?" the quantitative researcher asks, "How many instances of a certain kind are there here?" (Erickson 2011, p.43)

Examples of qualitative research methods can be observation, interview, focus group, and audio/video. A small number of participants and in depth analysis often recognize qualitative research. Methods used in quantitative research can be surveys, questionnaires, statistics, and quantity often equals quality in these types of methods. Some of the quantitative methods, like surveys or laboratory experiments, have however been well accepted in social sciences (D. Myers 1997). And even if most researchers perform either a qualitative or quantitative study, it has become more common to combine methods from the different directions (D. Myers 1997).

In this study we have chosen to conduct a qualitative inquiry, not a quantitative. The reason for the choice of a qualitative research approach is that the study seeks to get a deeper understanding of people's thoughts, interactions, and unconscious reactions towards the technology. On the other side, it might have been possible to do a quantitative study. We could have tested a theory about how people interact with NFC and gather information through a survey. But as the technology is still not mainstream enough it could be difficult to gather enough information. Therefore we argue that an in-depth study on a few people was a better choice for our purpose.

So, the main importance in this study is to gain insight about how users think and interact with the NFC technology in the given context. With this in mind, it was natural to let the *interpretive* paradigm guide the research, unlike the *positivist* or *critical* paradigm. According to Kaplan & Maxwell (1994) "interpretive research does not predefine dependent and independent variables, but focuses on the full

complexity of human sense making as the situation emerges" (in D. Myers 1997, p.5).
The positivist paradigm generally assumes that the reality is objectively given, and can be described by measurable properties that are independent of the observer. The critical paradigm focus on conflicts and contradictions, believing that social reality is historically constituted and produced and reproduced by people (D. Myers 1997).

As it is not our goal to focus on measurable objective data or power relations, the positivist or critical paradigm is not the most suitable for our purpose. The interpretive paradigm aim to understand something through the meanings people assign to them, and as our intention is to look at how people understand and interact with NFC, we find the interpretive paradigm to support the purpose of our study in a good way. This paradigm will serve as an underlying epistemology in this research.

The overall methodology of a study can be defined as a general approach to the study of research topics (Silverman, 2005). There are different research methodologies one can choose among when performing a study, and to make the best choice for the given study, one has to look at what type of research is going to be performed. We have chosen to investigate the area through a *case study*, which can be defined as "An intensive analysis of an individual unit (person or community) stressing developmental factors in relation to environment." (Flyvbjerg 2011,p.301)

There are different types of case studies to choose among; *intrinsic, instrumental*, and *collective* (Stake 1995). When performing an intrinsic case study, we are not necessarily interested in the given case to learn about a general phenomenon or to say something about other cases, but to learn something about the particular case. The case in itself is interesting. With an instrumental case study the intention is to study a case and learn something on a more general level, compared to the intrinsic style (Stake 1995). While a collective case study seek to explore differences within and between cases (Baxter & Jack 2008). We have chosen to perform an instrumental case study because we investigate a case to understand the concept on a more general level. As in this case, the goal is to look at the interaction and, if possible, say something about their understanding of the NFC interaction in general (Stake 1995).

According to Robert K. Yin (1994) case studies are the preferred strategy when posing "how" or "why" questions, when the investigator has little control over the events, and when the focus is on a contemporary phenomenon within a real-life context (K. Yin, Robert, 1:1994). In this research, a "how" question is asked to investigate the given area. The participants will be observed in a real-life context, not in a lab.

We could for instance have chosen to let the *Action Research* methodology guide the way we performed the research. This is an iterative process between the researcher and the users, where the goal is to diagnose a problem, plan actions, implement actions, and evaluate the outcomes, which then may lead to a new diagnosis (D. Myers 1997). In our study we seek to gain knowledge about the participants' interaction and understanding of NFC, and as action research seem to focus more on improving current practices, rather than gaining knowledge, we found the case study to be more appropriate for this study.

Grounded Theory is another possible methodology that focus on the developing of theory that is grounded in data systematically gathered and analyzed (Strauss & Corbin 1994). The intention of this thesis is not to develop theories, but as mentioned to gain knowledge and investigate the use area of NFC, and therefore grounded theory is not a good choice for us.

3.2 Ethical Aspects *&* Validity

In a study were voluntary participants take part, ethical considerations needs to be addressed. According to the ESRC Research Ethics Framework:

> Research staff and subjects must be informed fully about the purpose, methods and intended possible uses of the research, what their participation in the research entails and what risks, if any, are involved.
>
> (2005, p.1 in Crang & Cook 2007)

The study is collecting data about a certain user group, and has been reported and approved by the Norwegian Social Science Data Services (NSD)[15], and through the MobileSage project. The form from NSD is to be found in Appendix H. No information about race, ethnicity or religious views was gathered, but information like age, sex and smartphone experience. Consent forms and information about the

[15] http://www.nsd.uib.no

study was given to the users involved in the study, to make sure they knew what information was being gathered and what type of study they were participating in. The papers were sent to the participants beforehand so that they had some time to read though them, but they were also presented on the evaluation days, interviews and focus group. These forms are to be found in Appendix B and C. The gathered data should be saved according to legislations and destroyed or made unidentifiable after the study is ended to ensure the anonymity of the participants (Crang & Cook 2007). The destruction of the material will happen after the finishing of the study, and the all the information about informants are unidentifiable at this point.

When performing a study it is also important to remember that information is not simply discovered by a detached researcher, but constructed out of an intersubjective research process. This means that the context and the researchers may have an affect on the users behavior in the study. If an interview for instance is recorded or filmed, it is likely that the user's behavior or answers can be affected by this (Crang & Cook 2007). Audio recording can be less intrusive compared to video recording, because it allows observers to be more mobile as well as it let the interviewer pay more attention to the interviewee (Preece et al. 2007). Audio recording was used in our study to be as present as possible, and minimize the settings' influence on the participants involved.

In social science, triangulation is known as the mixing of data or methods so that diverse viewpoints cast light upon the topic being studied (Olsen 2004). The validity and credibility of findings often increase by providing several perspectives through triangulation of methods (Preece et al. 2007). This way a researcher can try to avoid the biases that may appear in studies using one single method in the investigation of a topic. In this study, different methods were used to complement each other and together give a broader picture of the NFC-based interaction. The observations are followed by interviews to obtain information about why the participants acted as they did. All the methods included in the study will be presented in the following section.

3.3 Research Methods

3.3.1 Observation

> Nothing is stranger than this business of humans observing other humans in order to write about them (Behar 1996 p.5).

Observation is a useful data gathering technique that in this case was used at Stortinget Station to look at how the participants interacted with the NFC-enabled phones and the posters in the environment. Observations in the field can be helpful in finding details that other methods may not be able to retrieve, as well as it provides a context for the tasks to be performed (Preece et al. 2007). Note taking can be an important method when observing users in action, as there are a lot of things happening and it may be difficult to remember every detail without taking some notes or record video. Taking notes can ensure that one gets the most out of the observations by providing more accurate and rich empirical data.

The degree of participation in observations differs, depending on the type of study. One could either have a passive observer role or one could be a participant observer. A passive observer will not take part in what is happening at all, while a participant observer tries to become a full member of the group studied (Preece et al. 2007). In our case, we tried to have a more passive role, but the circumstances made it difficult to exclude ourselves completely from what was happening, as it was necessary for us to come a bit close up to see what they were doing with the phone and with the posters. The participants were novices and if they got stuck at some point it was necessary for us to provide some hints or help. However, we tried to keep the involvement to a minimum.

It is not uncommon for people who are under the researcher's gaze, to feel unsure, threatened and self-conscious, as they are aware that everything they say or do might be written down and used as evidence in the given research (Crang & Cook 2007). Also, the users involved are not necessarily 100 percent honest, certain of what they think and consistent in what they say through all contexts (Crang & Cook 2007), therefore it is important to be aware of this and critical to what one observe as a researcher. When asking people questions they often say things or remember things differently than what they actually do. So, when trying to give a real picture of something, observation is necessary in order to provide an accurate account of what actually happened. Observation can uncover the possible differences between what the participants say they do and what they actually do (Preece et al. 2007).

3.3.2 Semi-structured Interviews

After the field studies or the observations of the participants, it was important to get more specific information about their experience of the interaction with NFC-

phones and posters at Stortinget Station. Our observations alone could not provide sufficient information about the participants' experience, and for this reason it was conducted semi-structured interviews with the participants after the observations (Appendix E and F). Semi-structured interviews, does not have a very strict structure (Crang & Cook 2007). The questions had been specified beforehand, but these worked more like guiding points that led the conversation forward. If the participants brought up other thoughts and themes it was okay, as the goal was to get as much information as possible about their thoughts and associations concerning NFC interaction. We focused on finding the right questions to ask (Crang & Cook, 2007) to avoid asking leading questions and not limit the participants' answers. For this reason, many of the questions were quite open.

We also performed an interview with Assoc. Prof. Kjetil Nordby from Oslo School of Architecture & Design (Appendix G). This was also performed in a semi-structured manner, and the main goal of this interview was to highlight challenges and possibilities with NFC, specifically in relation to interaction.

All the interviews were recorded to avoid too much distracting note taking and to make the conversation as natural as possible. Even if the whole conversation is recorded, this cannot capture all aspects of an interview. If the interviewee points to show something on the mobile phone or refers to something else that cannot be captured by the recorder, it is important to take good notes that explains what they are referring to, and thus make the data as valuable as possible (Crang & Cook 2007). To make sure all aspects were covered, taking some notes was necessary during the interviews, but only to capture factors like the ones mentioned above. Also, it was important to allocate some time right after the interviews to be able to summarize thoughts while they still were fresh.

3.3.3 Focus Group

To gather more information about users perception and understanding of NFC we held a *focus group*. A focus group is a valuable method in qualitative research as "it illustrates and explores the intersubjective dynamics of thought, speech, and understanding" (Crang & Cook 2007, p.91). The main topic of the focus group was the iconography of NFC. The iconography today is quite fragmented, with several different symbols representing NFC functionality. The purpose was to get the participants views on the existing iconography, to see if it conveys something

about the use of NFC to them. We also looked at some of the iconography in public transport to see if it could be possible to learn something from this field.

When performing a focus group it is important to think about the group dynamic. According to Crang & Cook (2007) most authors recommend avoiding already existing groups, as the there can be personal dynamics in the group that the researcher is not aware of. On the other, it might be of benefit to have a group of people that are familiar with each other, as someone may be more comfortable and they are used to the way the group interact. The participants that were recruited for this focus group were familiar with each other as they were classmates. They were used to having academic discussions with each other, and this could work as a benefit for the focus group. It was however important to be aware of everyone in the group, to ensure that the more talkative ones did not dominate the conversation (Preece et al. 2007).

3.4 Summary

We have presented and described the methodology of our study, a qualitative, instrumental case study within the interpretive paradigm. This means that we focus on the full complexity of human sense making in our study, we wish to gain knowledge about how users think and act in the given context. We have also argued why other methodologies are not suitable for our purpose, and we have looked at different considerations one has to think about concerning ethics and validity when performing a study. The methods applied in the study are also introduced and explained. Next, we will describe the specific case for the study and introduce our collaboration partners.

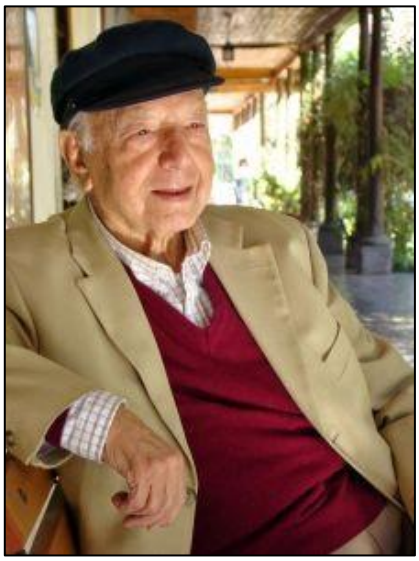
4 Case

In the following chapter the case for this master thesis is presented and described, as well as the collaboration partners throughout this period. The work has been focused within a research project named MobileSage at the Norwegian Computing Center. The use area of the MobileSage application and the program for the evaluations will also be described. This is a large international research project, and therefore it was necessary to narrow down the focus of this thesis. My focus within the project will be described further. The three following activities have been conducted in our investigation:

- Observations and interviews with the participants at Stortinget Station and Seniornett.
- Interview with Associate Professor Kjetil Nordby at Oslo School of Architecture.
- Focus group on iconography at the University of Oslo.

4.1 MobileSage – Situated Adaptive Guidance for the Mobile Elderly

The main case for this study was done in collaboration with a research project called MobileSage. This is a research project at the Norwegian Computing Center and is part of the AAL Joint Program and the funding comes from the research bodies in these countries. The project started in July 2011 and will be finished in January 2014. MobileSage is creating a help-on-demand tool for the self-serve society. In our everyday lives, we encounter devices, services, and appliances that we must operate. While this may be easy when we are young, people that are older may find it difficult to remember how to operate something (for example, an automatic ticketing machine). MobileSage's help-on-demand tool will help these people by giving them the exact help they need "just in time." The main target group of the MobileSage service developed in Norway is older adults with or without disabilities. To illustrate in what types of situations the application seek to provide help, we present the following scenario:



Karl from Germany is at the Nationalteateret train station in Oslo and wants to buy a train ticket. However, he does not understand how to use the ticket kiosk, which is placed there, and presses the assistance button on his smartphone. The smartphone tracks Karl's position by means of a combination of positioning techniques, such as AGPS/ GPS, WLAN triangulation, and GSM/GPRS triangulation. It further learns from a search in a GIS system that there is a ticket machine nearby, for which various documents with help in several modalities (text, audio, video, etc.) and several languages are available. As Karl suffers from dyslexia, which in turn is stored in Karl's profile together with his language preference, the smartphone decides to show him an instruction video in German about how to use the ticket kiosk, while the user interface of both the assistance agent and the media player adapt to Karl's needs. The agent also learns from previous interaction, such as number of pauses and repeats, by means of which the content presentation is altered. Karl is satisfied with the instructions given, is now able to buy the desired ticket and reaches the train with plenty of time[16].

[16] http://mobilesage.no/en/node/29/

4.2 Seniornett

The participants for the case study were recruited from the organization Seniornett Norway[17]. This is an organization working to include seniors (55+) in the information society. The goal is to let everyone have the possibility to be familiar with modern technology. Seniornett's headquarters is in Oslo, but there are 126 clubs spread over all counties, and they arrange courses suitable for seniors, for instance courses about smartphones, applications, searching the web.

4.3 The MobileSage Application

The overall objective for the MobileSage project is to create an application (Figure 18) on the smartphone that provides a help-on-demand service. This service is supposed to offer relevant, accessible, and usable content upon request, in the form of multimodal and personalized instruction and guidance. One of the main goals is to increase the independence of the elderly, by offering help for self-help to trigger their own problem solving skills in the everyday life.

To make sure the evaluations at Stortinget Station would be as realistic as possible, we made a lot of content for the application. Video, text, animation and sound were prepared to give the users content in different modalities and languages to choose among. Most of the content referred to public transport, especially linked to Stortinget Station for it to be relevant in the specific case. The application allows the users to touch tags by using NFC, search for content in a traditional way with text search, and search for locations and routes using a map. The intention was to let the users scan QR codes as well, but this functionality was not the focus in this evaluation. The result the participants get is based on the choices they make in the settings, for instance if they choose to get information in all modalities or only video or text.

However, the main focus of this thesis it not to look at the content of the application or the application in general, but to use it as a means to investigate the interaction with NFC. Our focus will be further specified in section 4.7.

[17] http://www.seniornett.no

4.4 Program for Evaluations at Stortinget Station

The evaluation at Stortinget Station consisted of the following four parts:

- Part 1: Preparations at Seniornett
- Part 2: Performing tasks at Stortinget Station
- Part 3: Interviews with participants at Seniornett

4.4.1 Part 1: Preparations at Seniornett

The first part of the evaluation was to inform the users about the project and the purpose of the evaluation. Here we asked about their experience with smartphones and how they characterized themselves as ICT users. A walkthrough of the basic functions of the MobileSage application followed this. Afterwards, the participant defined a profile with the desired font size, additional languages, and type of media.

4.4.2 Part 2: Observations of tasks at Stortinget station

Before the evaluations started posters had been put out by the entrance and down at the station. On each poster, there was a question followed by an NFC tag and a QR code leading to the same information. While, the initial plan was to let the participants choose between NFC and QR codes, the current version of the app made it difficult to scan the QR codes. As NFC was the main focus from the start this was no problem for the evaluation, but this is why the QR codes appear on the posters. Two NFC tags were attached to the back of the posters behind the NFC Forum symbol to enable the functionality (Figure 16). The participants performed the following five tasks by touching the NFC tags on the posters.

1. By Stortinget station: Find the way to the ticket machine. Find the MobileSage poster by the entrance, and hold the phone against the NFC-symbol. Follow the instructions.
2. By the machine. How to buy a ticket. Hold the phone against the NFC-symbol. Follow the instructions.
3. Buy ticket from the machine.
4. Validate ticket. Use the phone to get information “How to validate a ticket”. Follow the instructions.
5. Find your way to the right platform. Touch the NFC tag on the relevant poster like you did earlier, and follow the instructions.

Figure 16: Two NFC tags was attached to the back of the posters behind the NFC Forum symbol that was visible to the participants

4.4.3 Part 3: Interviews with Participants at Seniornett

After the participants had performed the tasks, interviews with each of them were held, concerning their experience of the application and the use of NFC. The complete interview guide can be found in Appendix E and F.

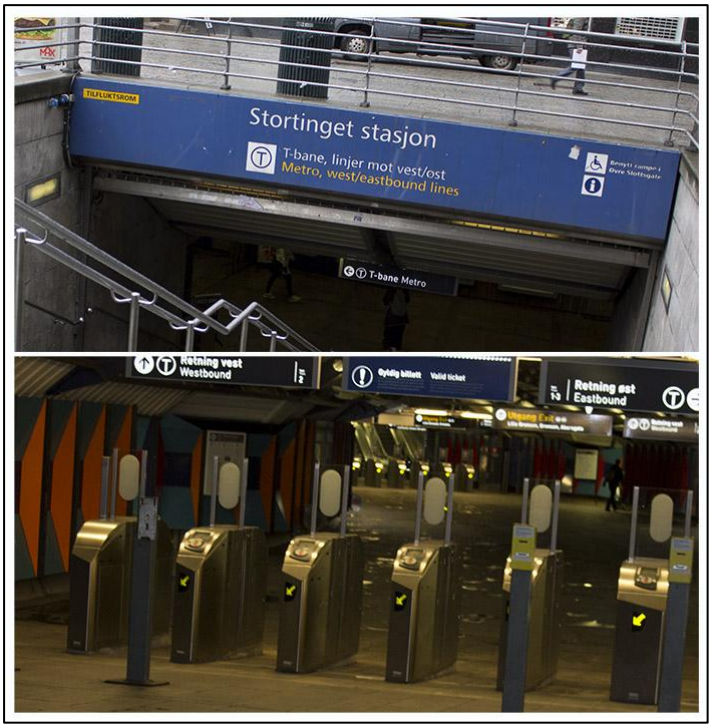


Figure 17: The context of the study: Stortinget Station (Top: Entrance to station, bottom: Ticketing area)

4.5 Interview with Assoc. Prof. Kjetil Nordby

We also conducted an interview with Associate Professor Kjetil Nordby from Oslo School of Architecture and Design (Appendix G). Nordby has extensive experience with the technology and has conducted much work in the area of RFID and NFC. The main goal with the interview was to get insight and perspectives on the development in the field of NFC, especially in relation to interaction. It is important to say that the interview was performed in an informal manner, and that the data from the interview may not be regarded as findings in the same manner as the data from the observations at Stortinget Station and interviews with the participants. But Nordby's responses from the interview can give important insight to the discussion of the given topic. He has much experience with RFID and NFC, and comes from a research field with an industrial design focus. In 2011 he delivered his doctoral dissertation *Between the Tag and the Screen* that partly focuses on opportunities and challenges of NFC as design material. Because of his focus as well as his long experience with the technology, he could bring valuable information and shed light on different perspectives in the area of NFC-interaction.

4.6 Focus Group on Iconography

The NFC Forum symbol has received a lot of criticism from actors in the industry, and to explore how users understand different symbols used today, we conducted a focus group were iconography were the main topic. We looked at NFC symbols as well as symbols used in public transport. In Table 2 we present the complete structure of the focus group.

Structure of Focus Group	How
1. Present project and informed consent. Sign consent forms.	Shortly present the master thesis, the MobileSage project, and aim of the focus group. Each sign two consent forms, one for them and one for the researcher
2. Do you know what NFC is or do you have any knowledge about it?	Participants answer in a non-structured way, but make sure everyone answers.
3. Show the NFC Forum symbol. Ask if they have seen it. What do they associate with it? Does it say anything about how to interact?	Discussion
4. Is it possible to design an NFC iconography that is intuitive and says something about how one should interact, even if one does not have any knowledge of NFC?	Discussion
5. Show a selection of NFC symbols	Discussion about the symbols
6. Show different symbols from public transport. Can NFC learn something from this field?	Discussion about the symbols

Table 2: Structure of focus group

4.7 Near Field Communication & Users

The MobileSage project is a large international project that embraces several different fields and challenges within the ICT-area. To narrow down the focus of the thesis, a specific area within the project has been chosen. The main focus here is NFC technology on smart phones to connect and interact with the physical world (NFC-posters) in a public transport setting. As NFC still is an unknown technology for the general user, it is important to look at how they understand the technology and how they interact with it. This way it is possible to take a look at how people behave when using the technology in a relevant context where they can be affected by the surroundings.

The main user group in the thesis is *novice users*. Novice users in this case, mean users who do not have extensive experience with smartphones or NFC technology.

The purpose of the MobileSage application is to reach out to inexperienced users, and offer them help when they need it in the way they want it. *Expert users* might not experience the same benefit of this type of concept as they have other needs compared to novice users (Galitz O. 2007). According to Galitz O. (2007, p.88) novice users need "restricted vocabulary, simple tasks, small number of possibilities and very informative feedback", while expert users, on the other hand, can have more possibilities and less informative feedback. However, the concept of the application is *not* the main focus, but the interaction with the NFC technology. It is also important to be aware that there are differences between every single user; even if some of them are novices in one area they might be experts in another area.

Participants for the evaluation at Stortinget Station were recruited from different Seniornett offices in the Oslo area. In Table 3 we present information about the participant's age, phone types and how they characterized themselves as ICT-users.

Participants	Information
Number:	8 (3 male, 5 female)
Age:	From 65 to 75 years
Type of phones:	4 smartphones, 4 other types (3 Samsung Galaxy, 1 iPhone 5, 1 Sony Ericsson (Older phone), and 3 Nokia (older phones).)
How they characterized themselves as ICT-users:	2 beginners, 3 with some experience, 3 with long experience.
Experience with smartphones:	4 (out of 8) had experience with smartphones. The other 4 had experience with older mobile phones.

Table 3: Information about the participants in the observations at Stortinget Station and interviews at Seniornett

5 Findings

This chapter presents the findings that have been generated through the use of the methods that have been applied; Observations at Stortinget Station, interviews with the participants from the observations, interview with Associate Professor Kjetil Nordby, and a focus group. These findings helped answer the research questions of the thesis, and here the findings from each method are presented chronologically as they were conducted in the study. We will start by presenting the findings from the observations performed at Stortinget Station in Oslo.

5.1 Observations at Stortinget Station

On the first day of the evaluations at Stortinget Station there were three participants, and on the second day of the evaluations there were five participants, altogether eight participants the two days. The purpose of these observations was to see how the participants interacted with NFC and the MobileSage application. In this section the focus will be how the participants interacted with NFC and how they understood the technology.

Before the evaluations, we discussed whether to have an enabled NFC button or not in the MobileSage application, because it is possible to hide this button or show the button in the menu. As the NFC functionality lies within the phones, and one does not need a button to activate it, we decided to exclude the button from the menu to avoid an extra step.

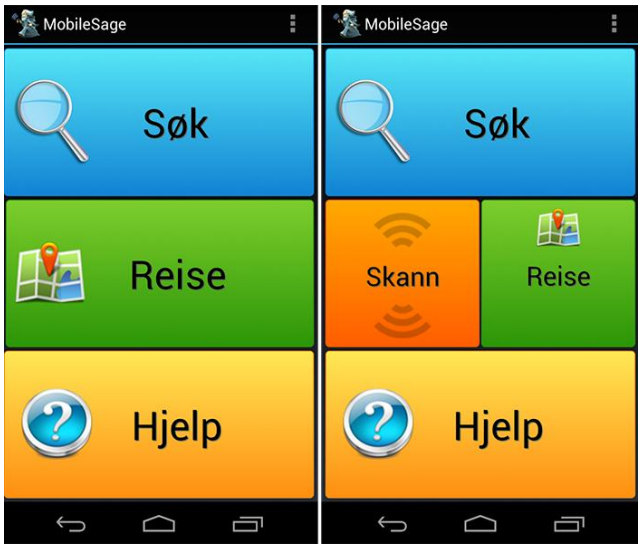


Figure 18: Main menu of the MobileSage application with no NFC button and with NFC button (Orange button).

5.1.1 Before Touching the Tag

Before the evaluations started five posters were set up at the entrance of Stortinget Station and down at the station (Figure 19). The posters had a question followed by an NFC tag and a QR code, and the participants were supposed to touch the NFC tags to get answers to the questions. Examples of questions are, “Where is the ticket machine?” or “How do I validate my ticket?” and they would get a video, text or information in another modality explaining this. At first, we gave no guidance to the participants about how they should use the smartphone with the posters, except from the short intro at Seniornett. This was because we wanted to see the

participants' immediate reaction to the posters and the symbols used, and if there were any chance for them to figure it out on their own. However, it seemed very difficult for all of the participants to understand *what* and *where* to touch, as they had never seen the NFC Forum symbol before. The symbol in itself did not seem to give them any clues about how they should interact with it, so the participants had to be told that they should hold the phone against the symbol, but nothing were said about *how* they should hold the phone. Most of them asked how they were supposed to hold it, but they were encouraged to try out themselves first. Three of the participants held the phone with the screen against the symbol at first, but when they did not get any feedback two of them turned the phone around with the backside of the phone against the symbol. One of them needed some hints and then managed to touch the tag. Another also held the phone too far away from the tag for it to be read, and asked what distance was necessary.

Figure 19: One of the posters we had down at the station with the question: "How do I validate a ticket?"

So, this shows he was uncertain about how far away or how close he should hold the phone to the tag, and mentions that the size of the symbol confuses him. Two of the other participants held the phone with the back against the symbol right away, but one of them kept too much distance for the tag to be read. One participant started by holding the phone with the back against a surface outside of the poster area were there was some old posters. With some guiding she managed to scan the NFC tag.

The last two participants held the phone in a more diagonal way with the tip of the phone against the symbol, and did not manage to read the tag before the phone was held in a more straight position. This was probably because the first poster at the one entrance of the station was placed a bit too low, and the NFC chips in the phones we used are located in the center of the phone, which made it difficult to read when holding only the tip of the phone towards the tag. They were also unsure as to whether they should hold it still or swipe the phone over the NFC Forum symbol, and for how long they should keep it there.

Also, one of the participants did not understand the meaning of the question asked on one of the posters; "How do I validate my ticket?" (Figure 19). This was because she did not know what the word "validate" meant. This could be because she was not familiar with the new expressions that came with the electronic tickets, as she probably was used to other expressions like stamping.

5.1.2 During & After Touching the Tag

Sometimes after the touching of NFC tags the loading wheel kept going on the screen even if the data was downloaded and ready. This made the participants believe that the reading did not succeed. In fact one could just tap the screen and then the loading message would go away. As this is not very logical, the users did not try this out. Some of the participants held the phone against the tag for a very long time, which probably was caused by the loading message on the screen. To read the tag one only has to hold it near the tag until the loading wheel starts to run, it is not necessary to hold it there till the loading of data is finished. But as the participants did not know this, they kept it there a very long time. This was a general problem that all of the participants experienced at one time, and a participant asked how long she had to keep the phone there.

Here we can see that the time issue was a problem for many of the users, because they did not understand when they should remove the phone or for how long they should keep it there for the reading to succeed. This probably means that they were not given enough information for them to be certain the reading was complete. Especially down at the station where there was a lot of ambient noise, and the participants sometimes did not hear the sound coming from the phone, confirming that the tag had been read. This did not happen every time, but when it happened the users seemed unsure, but understood that something had happened as it was activity on the mobile screen. However, some of them held the phone with the screen against

the tag, and when they did not hear the confirmation sound they got confused because of the lack of information as they did not see what was happening on the screen.

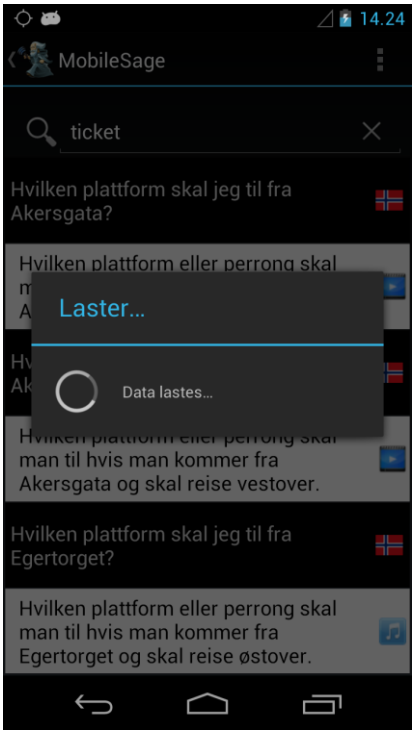


Figure 20: Loading when information already is downloaded

After the tag was read, the participants got a list of results based on the tag they had touched and the type of modalities they had chosen in the profile settings in the MobileSage application (Figure 21). The question they needed to get an answer to was listed, and next to it was an icon describing the type of modality, for instance video, text, sound. However, everyone experienced some difficulties at this point. They could not find the given alternative right away, they had to do a lot of scrolling, and in the end everyone needed some sort of assistance or hint in order to find the right one. In relation to the result list one of the participants said: "To me, it looks like it is the same question repeating itself."

The question that was on the posters was listed in the result, but as many of them had chosen to get information in many different modalities, the list consisted of the same questions repeating itself, but with different icons next to them to inform about the modality type. This could for instance be a video icon or a sound icon. If they had chosen many modality outputs in the profile settings menu, the list could be quite long with a lot of text. The icons describing the different modality types seemed to be ignored by everyone, or at least it did not look like they understood their intention.

There were also text headings in the result list that were supposed to differ between the different types of information, and they were not clickable. However, three participants tried to click the headings in the result list, because they thought they were clickable. This seemed to make the participants confused and unsure of what to choose and what could be chosen. It seemed that they expected a simpler response to the reading of the tag, and all participants got confused when the response they got was this list.

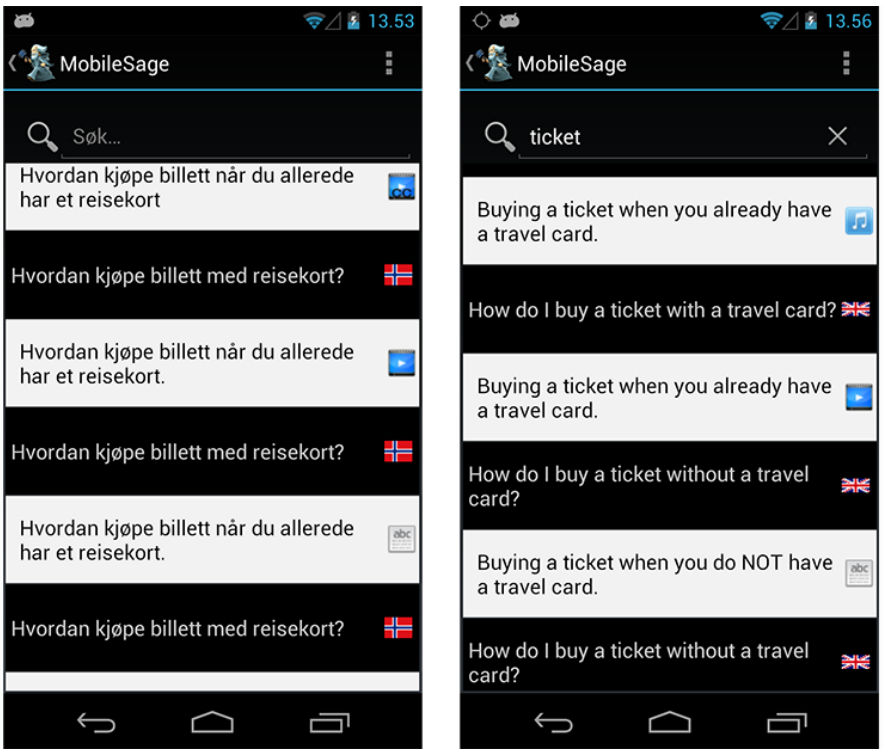


Figure 21: Examples of the result lists that met the participants after touching tag.

5.1.3 Technical Issues

There were some issues with having enough bandwidth during the evaluation. When there was Wi-Fi access or 3G coverage, videos played just fine. However, down at the subway station, there was only EDGE coverage. This resulted in videos not being downloaded and stopping shortly after they started. To minimize this, videos with small file sizes was used; the largest was around 750 KB, with the average being around 300 KB. But the problem was still present. The lack of bandwidth affected audio less, and text worked fine. This may also have been connected to the already mentioned problem with the loading screen. Because they did not get any response the first time they touched the tag, they sometimes tried one more time. Each time a tag is read, a query is sent. If the connectivity was bad, the second query may have got stuck "loading", leading to the loading screen that confused the participants.

Finally, there were problems with NFC tags placed on a metal surface. The metal caused interference that made it difficult to read the tag. Moving the poster to a non-metal surface solved the problem.

5.2 Interviews with Participants from Seniornett

After the participants had performed the tasks at Stortinget Station, each participant was interviewed about their experience. The interviews consisted of questions about their experience of NFC interaction and of the MobileSage application itself.

5.2.1 Knowledge of NFC

When asking if the participants had heard about NFC, three out of eight answered yes. However, two of them had just heard the name and did not know anything about it, and had never seen the NFC Forum symbol before. The third one had never seen the symbol before either, but had some knowledge about NFC, as he generally was quite interested in technology. Four of the participants used the travel card from Ruter, but they did not know that this uses the same technology as NFC. One of the participants said: “I have never known that it was possible to hold your phone in front of these and get so much information back.” This shows that he was unaware of the connection between the mobile phone and a symbol like this. He did not know that one could put the phone close to this NFC Forum symbol on the posters and get information on the mobile phone.

5.2.2 Before Touching the Tag

As mentioned earlier, the first barrier for the participants was to understand *what* to scan, as they had never seen the NFC symbol before and therefore had no relation to it. They also found it difficult to know *how* to scan the symbol. The NFC symbol itself was visible on the poster, but it did not seem to give the users any information about interaction. When asking if the symbol gave them information about action or any clues as to how they should use the mobile phone, everyone said no. The following comment can illustrate this problem: “If I see the symbol alone it doesn’t say me anything, it could as well be the symbol of a Narvesen Kiosk.”

This statement shows that the NFC Forum symbol does not convey any meaningful information to him, at least not about action or interaction. Instead he compares it to a symbol of a kiosk, meaning that his associations when looking at the symbol refers to branding rather than a touch point.

Another participant has the similar associations: “The design in itself reminds me of a sign.” The statement from this participant also reflects that the symbol does not convey information about interaction to her. She did not say what particular sign she was thinking of, but she could not say that it gave her much useful information. One of the participants also had trouble with finding the “right” distance from the NFC symbol, as he thought the symbol was too big in relative to the phone. When asking why, he said that he thought of it as aerial photography, thus he had to “capture” the whole picture by holding the phone far away from the symbol. He also mentioned that it would be better if the size of the symbols changed, for instance to a barcode size. The reason for us choosing the given size on the symbols was that they should be easy to spot, but here we see that, at least this user found it to be too large. This way of thinking, was also the reason why he changed from holding the phone with the screen against the tag to holding the back of the phone against the tag:

> It’s basically here I shoot pictures, and then I find it logical that this is the place that has to be visible, and then I should see the picture here (points to screen)

Here we see that he refers to photography when trying to find the best way to use the phone. He is not the only one referring to photography when explaining how he interacts, three of the other participants also talked about photography in some way when explaining their interaction: ”You have to have the camera so that you don’t take a picture of yourself, but of the symbol.” So, here we see that his explanation for holding the phone with the back against the symbol and not with the screen towards the symbol reflects the way he uses the phone when he takes pictures. Another comment from a participant also referred to photography: “It clicked as if it took a picture, and then something appeared.”

Here the participant talks about the confirmation sound when reading a tag. The sound used to confirm the reading of the tag is not in reality similar to the sound one get when taking a picture with the phone, but here we see that this is what the participant relates to when explaining what happened. The comment from one of the other participants did not relate to photography, she talks about other factors when explaining the way she used the phone:

> Eventually, I realized that I had to have the back of the phone against it, not the screen. The reason for this was that I noticed that it didn't work at first, and then I thought that it would be logical to use the back so I didn't damage the screen. So, that was what I was thinking, but otherwise it worked from both sides, however it seemed to work better when I held the back against it.

From this we see that the reason why she changed from holding the phone with the screen towards the symbol to holding the back against it was that she did not want to damage the screen on the phone. By experimenting she found the best way to use the phone.

5.2.3 During *&* After Touching the Tag

During and after touching the tag, most of the participants remembered that "something happened on the screen" or that the phone was "loading data". Six of the participants mentioned the beep or a click as some referred to it as a camera. However, the phone sometimes made a sound when nothing happened on the phone, and one of the participants found this very misleading. Because of the sound level at the station, the participants sometimes did not hear the beep, and then they relied on what was happening on the screen. In some cases, the participants felt a bit uncertain about how long they should keep the phone near the tag. In the interview one of the participants said:

> One could have gotten a message when it was okay to remove the phone, so that you don't have to hold it against the tag till it's finished. Otherwise, one might stand there, thinking. Is it finished now? Can I remove it?

In the observations we noticed this problem as many held the phone towards the tag for a very long time. This shows that the participants felt they did not get a sufficient amount of information about when it was okay to remove the phone from the tag, which lead to uncertainty. None of the participants could say for sure if they remembered the vibrations from the phone. They thought there were some vibrations from the phone when they touched the tag, but they could not say for certain if this was something that had affected how certain they were in the interaction. When asking what type of response they expected when touching the NFC tags, one of them said it should be more information in the form of sound and light, as well as the information should appear faster. Four of the participants said they wanted more information, while the observations also showed that there might be a need for *clearer* information to avoid uncertainty. One participant who scanned the tag with the question: "Where is the ticket machine?" said: "I would've thought

that the picture of where the ticket machine is, appeared on the screen." Again, we see the reference to photography when talking about their interaction.

5.2.4 NFC as a Method

Four out of eight participants said in the interviews that they thought NFC reminded them of QR codes. Six out of eight thought that NFC was a better method for collecting data, compared to regular text search. This was because they thought the letters on the keyboard was too small, so it did not actually have anything to do with the application in itself, but the use of the keyboard on smartphones. One of the participants said:

> …then you get the information right away, you don't have to write something, because it is not always easy to write with these phones, you often press the wrong letters…

So, here we see that this participant found NFC to be a simpler method for obtaining information, but the small letters on the phone may have affected this. Especially one participant found the small letters problematic, as she had absolutely no experience with smartphones, and therefore she felt more comfortable with touching the phone against the tag to collect information. It is however difficult to say if she had preferred typing if the phone had larger letters, but in general it seemed that the participants were positive to NFC as a method and found it to be an easy way to obtain information.

5.2.5 Response Time

The response time is both a more technical issue, as well as it affects the feedback of the application and thus how the participants experienced the interaction. Five out eight thought that the response time was too long. Because of the connection problems down at the station (Section 5.1.3), the response time could be quite long sometimes, and according to this issue one participant said:

> If it had taken so long, I'd be annoyed. I would not have waited so long for the video to show up. If I could have seen that it was working on it, I would have understood more. If the app for instance told me, that there was no connection, it would have been better

In the quote from the interview above, it is apparent that it is the lack of information or feedback about what is happening, that is causing his irritation. The phone did not give any meaningful information about why it took so long and often the screen just turned black. The other three who did not think the response time was any problem,

might have been too kind, as it exceeded 10 seconds at some points. Below, are some of the answers received when asking if they thought they had to wait a long time for the system to respond: “No, it was not a big deal that I had to wait.” Here the answer may also have been affected by the context of the interaction. If they actually had been in a hurry, trying to catch a subway, this issue probably would have had a greater impact on the ones using the application. However, in this situation, they were participating in a research project and were not on the go or in a hurry to get somewhere. Another participant mentions her age as a factor that might have been relevant: ”No, I don’t think the response time was too long, but that probably has something to do with my age, an 18 year old would have answered something else.”

She thinks younger people in general might have higher demands according to response time because they might be used to a higher tempo than people her age. However, this view may also have been affected by the way the evaluation was set up, in this context the waiting was not a big issue. But, if she had been waiting for the video to load to get help with the ticket machine, and the line of people kept growing behind her, the waiting might have been a more prominent issue. One of the other participants mentioned this factor: “I don’t think the response time was that long, but if I had been in a hurry I guess everything would have seemed like a long time.”

So, this also points to the given context of the actions performed. It could mean that he did not find the response time to be long in context of the research project, but if he had been in a hurry he would have had a different perception.

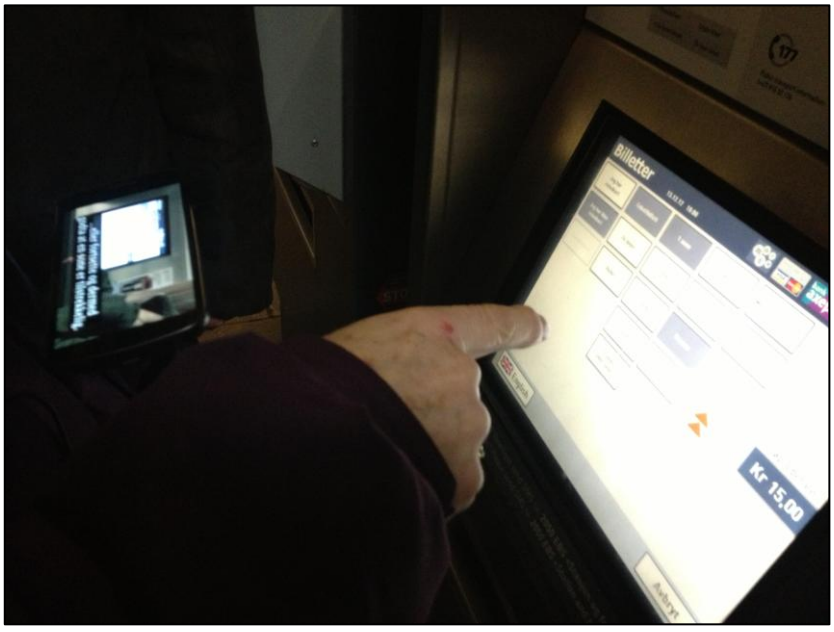


Figure 22: A participant from the study looks at a video showing her how to use the ticket machine.

5.2.6 The MobileSage Application

When asking what the participants thought about the MobileSage application in general, they were positive to the concept of getting help information when you need it. However, they did not think the system worked in an optimal way, yet. Regarding how the MobileSage application works with NFC, one issue was quite apparent under the evaluations. The list of results the participants got after scanning the NFC tags confused them and slowed them down. They did not understand the icons illustrating different modalities and had to scroll a lot in order to get the information they wanted. In the interview one of them said: "The same text appears three to four times, and then you say that one is text and the other is video etc. It's cumbersome."

This participant expresses his dissatisfaction with the result he got, and it is clear that he does not understand the visualization of the different modalities; it only seemed to confuse him and the other participants. He also comments on the interface in general: "Because of the combination of texts and menus and stuff like that, I get the feeling that there is a programmer who set it up". Here we see that more design related issues also was brought up. There is however a programmer behind every interface, but his statements about the list being made by a programmer seems to imply that he feels more work needs to be done in the design of the results.

In general the participants thought that the application would be very helpful in a new place, either on vacation or in another city, but when they knew the area, they felt it was not as appropriate. However, this did not apply to all of the functionality in the application. The majority liked the video content about how to use the ticket machine, as they did not have much experience with the machines (Figure 22). The content that was made for the application is however not of main importance; we focus on the findings concerning the users' interaction.

5.2.7 Summary of Findings from Observations *&* Interviews

In the following we will summarize the main findings from the observations at Stortinget Station and the interviews to clarify the different problems and the participants' solution strategies in the three stages of the interaction: before touching the tag, during the touching of the tag, and after the touching.

Before Touching the Tag

The observations at Stortinget Station and the interviews with the participants showed that they first of all had problems understanding *what* to touch. This mostly revolves around the communication between the users and the visualization of the NFC functionality in the world. They had never seen the NFC Forum symbol before and it became obvious that the posters and the NFC Forum symbol did not seem to convey any meaningful information to them as to why they should approach it and what they should do. So, this means that the possibilities offered by the posters with the NFC Forum symbol was invisible to them, and thus also the link between the phone and NFC Forum symbol or the posters in general. The solution to this problem in this case, was to give the participants some information about what they should do; by telling them they had to hold phone towards the NFC Forum symbol for them to be able to move forward with the tasks.

During the Touching of the Tag

Next, the observations and interviews also showed that the participants did not understand *how* to touch the symbol on the posters in order to read the tag. They got information about what they should touch with their phone, but not about how they should approach it. This also relates to the NFC Forum symbol, as this symbol was what the participants related to and it did not seem to convey any meaningful information to them about how to approach it. Because of this, the participants had different solution strategies (Figure 23), and they experienced difficulties with the following factors when deciding how the should interact with the posters:

- **Distance.** Some of the participants had trouble finding the correct distance between the phone and the NFC Forum symbol for the tag to be read. Especially one participant held the phone quite far from the symbol and because of this he was unable to read the tag. This he explained by referring to aerial photography, he wanted to "capture" the whole picture (NFC Forum symbol).
- **Direction.** Three of the participants held the phone with the screen towards the symbol at first, while two of them held it with the back of the phone towards the symbol. However, the three participants who used the screen side of the phone eventually changed to using the backside of the phone because they saw that something happened on the screen and because they did not want to damage the screen. When explaining their interaction the often referred to photography in some way.

- **Where to touch.** Two of the participants held the phone in a more diagonal way with the tip of the phone towards the symbol. Because the NFC chip is placed in the center of the phone, they did not manage to read the tag before they held in in a more straight up position. This relates to people not knowing exactly which part of the phone should touch the symbol. At first, one participant did not touch the symbol on the poster at all, but a different area outside the poster.
- **Time.** Most of the participants held the phone towards the tag longer than necessary, because they did not get enough information for them to decide when it was okay to remove the phone.
- **Movement.** The participants asked how they should use the phone, but we decided it was best for them to try it out themselves first to see how they figured it out. Most of them held it still, but we could see that two of them first tried swiping the phone from one side to the other, before they changed to holding it still.

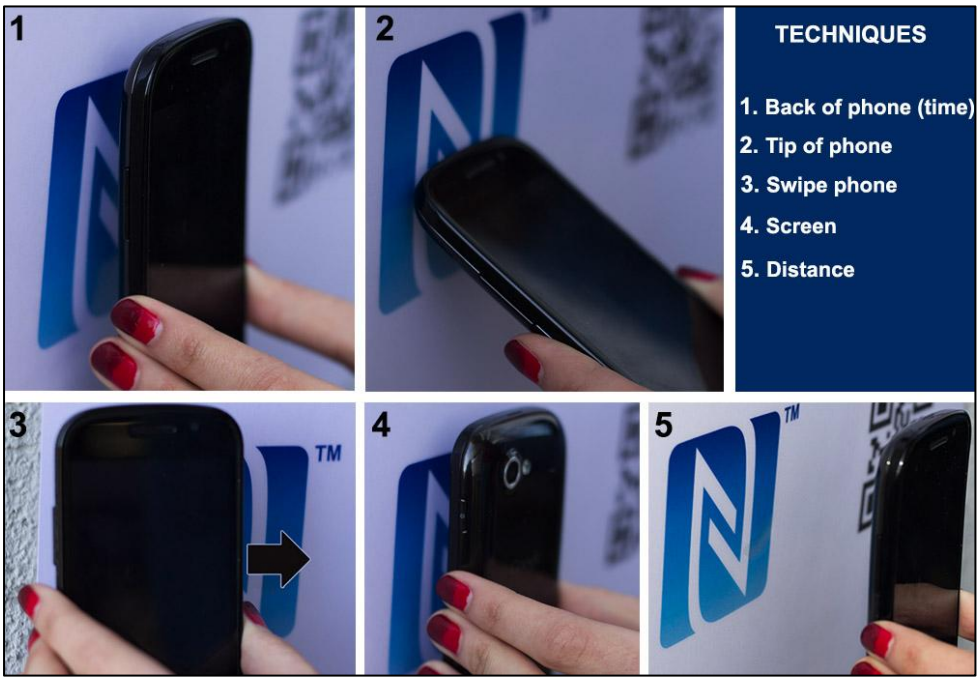


Figure 23: Illustration of different solution strategies among participants (1. Back of phone, 2. Tip of phone, 3. Swipe phone, 4. Screen, 5. Distance)

After Touching the Tag

There was also uncertainty among the participants after the reading of the tag. Because of the loading screen they were unsure as to whether the tag had been read or not, and sometimes they did not hear the confirmation sound, probably because of the noise at the station, but there could also be other reasons. The result from the reading turned out to be different from what the participants had expected. They had

expected it to be simpler and that they would get directly to the relevant information. Instead they had to search through a long list of text, and had problems finding what they were looking for because of the way information was presented.

5.3 Interview with Assoc. Prof. Kjetil Nordby

The interview with Associate Professor Kjetil Nordby from Oslo School of Architecture and Design, included topics of how users interact with NFC technology, iconography and the development within the field of NFC in general.

5.3.1 Before Touching the Tag

Something that was recurring in the evaluations was that the participants did not know how or where to put the phone to read the tags. The reason for this was maybe because they had never seen the NFC Forum symbol, and that it did not give them any information about what to do. So, can it be possible to make novice users understand what they should do and how they should interact by giving more information and providing an intuitive iconography? According to Nordby, this is difficult to achieve:

> Even if the interaction in itself is simple, the concept of what is happening is very complex for the users. Today, the NFC system does not only consist of the chips inside the mobile phones, but also of software on your mobile phone. And it is not given that all users know their phones so well. The phones we tested (in our work at the school of Architecture) all had different interfaces, the providers had implemented it in different ways.

So, even if the interaction itself is simple Nordby thinks the concept might be complex for the user, and all the different interfaces offered by providers do not make it easier. He also notes that the fact that everyone does not have the technology on their phones is a problem, because one cannot simply say "Put the phone her", but, "*If* you have it, put the phone here." Nordby says that people do not know whether they have NFC on their phones or not, and if everyone had NFC enabled phones it would be easier to assume that everyone had read a tag once before. When discussing iconography, Nordby is of the opinion that it should be enough in itself to guide users, but currently it is not. Regarding the NFC Forum symbol, he says:

> I don't think it will convey any meaning to the users. Often it is not shown with phones either, so it may look more like Wi-Fi symbols, it will not provide any immediate association with the user.

What Nordby means by this is that the symbols could have included a phone to clarify how it is used. Another possibility Nordby mentions is to provide very clear instruction, for instance a video showing exactly how one should interact, but again he returns to the problem concerning lack of support, asking: "How can we then distinguish between the different user groups?"

However, he suggests one approach concerning the telecoms who know which phones have a NFC chip, the Telecom operators could send "NFC training" by SMS or links, to all the owners of NFC-enabled phones. Until the NFC technology becomes ubiquitous, Nordby thinks it will require training: "It is easy to perform the movement or gesture as long as one knows why, but people do not know why they do it or what they get back."

When discussing if there are ways to make it more intuitive for users to know how to interact with NFC, the principle of affordance is brought up, or communication as he preferred to call it. He thinks the affordance concept is inadequate in regards to cultural factors:

> Today, you cannot clearly see where you should hold the phone (…). The same applies to the field that should be read, if you hold the phone against the symbol, how do you know exactly where to hold it or if you should swipe it from left to right or just hold it still?

In our study we experienced this problem, and there were many variations in the way the participants chose to use the phone. Each person's background may have affected they way they chose to approach it.

5.3.2 During *&* after Touching the Tag

When talking about what happens after one has touched the tag, he points to the transfer time as an important part. This concerns how fast the tag is read, and is dependent of how much data is transferred. He also thinks it is important that users get some sort of feedback if they cut the contact before the reading of the tag is finished. If not, it might be difficult for the user to know whether it worked or not. To solve this he argue that it is important to give some sort of information that tells users that a file is being transferred, for instance an animation of the progress. He stresses that one of the most important factors about feedback, is to assure users that they have done things right, to avoid uncertainty.

5.3.3 Users

Nordby points out that it is important to think about who we are designing for, and also suggest that an animated iconography explaining how to read a tag could be displayed on the physical device. The main user group in this study is novices; they do not have much smartphone experience and do not know the NFC technology very well. Nordby was however, somewhat skeptical to our choice of users, because their lack of experience.

Nordby thinks it would be more interesting to see what the users think after they have gotten a small introduction. As mentioned earlier, we noticed that it was necessary to give the participants some information before they started, as they did not have much experience with smartphones or NFC. So, this could maybe correspond to the small introduction Nordby refers to.

5.3.4 NFC vs. QR Codes

In the interviews we noticed that some of the users thought QR codes were the same as NFC or in the same category. Nordby thinks the main differences between the two is that it is possible to transfer or share more data with NFC, they are easier to read, you do not have to start an application as the NFC technology lies within the phone itself: “When you scan a QR code, you actually have to look at the screen and hold it still to activate it.”

So, he is of the opinion that the scanning of a QR code requires more effort compared to touching a NFC tag. In the MobileSage application it was possible to either add a “Scan/Touch”-button or to not have a button like this at all. The purpose was to have a button where it was possible to scan QR codes or read NFC tags, but as the QR codes was excluded from the evaluations, NFC was the only option. And as NFC lies within the phone, meaning you do not have to open an application to make it work, we decided to leave it out. When asking Nordby how users then would know about the existence of the NFC functionality, he answers: “But why on earth should they know about that? The whole point with NFC is that it’s supposed to be on”.

One of the reasons for why we considered including this button in the first place, was that it could make the participants aware of the existence of the functionality. Without the button, there would not be anything in the application indicating the existence of NFC functionality. However, it is not necessary with a button, it would as mentioned just create extra steps, making the NFC method less smooth and in reality

it does not have any function. Nordby does not see the need for a button like this. This is because NFC is quite similar as Bluetooth; it is either on or off, one does not have to press a button in an application to activate it.

5.3.5 Summary of Interview with Kjetil Nordby

Nordby argues that it is problematic that not everyone has the NFC-technology on their phones, and thinks that good iconography will not be sufficient to make users understand what they should do. He does not believe that the NFC Forum symbol will convey any meaning to users, and that it is difficult to know how one should use the phone (swipe, hold still), thus he suggests that different types of NFC-training might be necessary. Nordby also points to feedback as an important factor to avoid uncertainty, both in regards to how fast the tag is read and what feedback is given if the user for instance cut the contact before the reading of the tag is finished. Also, he finds the NFC interaction to be easier compared to the interaction with QR codes, as it is not necessary to open an application and they are easier to read.

5.4 Focus Group: NFC Iconography

To take a closer look at some of difficulties concerning NFC based interaction, a focus group with five participants were conducted. The main topic for the focus group was "NFC Iconography". In Table 4 you can see more information about the participants.

Participants	Information
Number:	5 (1 female, 4 males)
Age:	From 25 to 36
Type of phones:	Everyone had smartphones. (3 Android and 2 iPhones)
ICT – experience:	Everyone had a long ICT-experience
Background:	All of them are students at the University of Oslo

Table 4: Information about participants in Focus Group

To begin with, it was important to get an overview of the participants' knowledge of NFC. As they all were design and informatics students, it did not come as a surprise that everyone had heard about it, but that was it. They knew what the letters stood for, but did not have much knowledge about NFC beyond that. Three of the participants actually had NFC enabled phones, but they were not aware of it before this focus group. Thus it was not a factor that affected their choice of mobile phone.

5.4.1 The NFC Forum Symbol

Next, a picture of the NFC Forum symbol (Figure 24) was shown to the participants, and none of them had seen it before. One participant said *"*Instant Coffee*"* was his first association when he saw it. When we asked if it gave any information about what one could do with it, one participant responded in the following way: "I think about a real estate business when I see it actually." Similar with the participants from the evaluations, he also thought of it as more of a sign or a branding symbol, while another participant said:

> It seems like it tries to be more cool and smooth, I can see that there is a N and a F, and if I use a little imagination I guess I can see a C letter as well, but I don't understand much of it.

It looked like the symbol did not convey very much meaningful to them, instead they talked about it as more of a branding symbol. One of them actually said that he could see an N, F and maybe a C, no one else has interpreted it this way. However, some of them noted that it is not known for people yet, and therefore it did not convey anything meaningful to them.

Everyone agreed that to the general user, it does not give any information about communication. One participant pointed to a QR code and argued that most people seemed to know what they are, and another participant in the focus group responded:

> Let's say they had marketed it well, and everyone who used NFC had this symbol (NFC Forum Symbol), then people probably would have more knowledge about it, so the fact that it is not so widespread today might be an important issue.

The participants again returned to the fact that NFC is not well known for people yet, and that this might be an important factor when it comes to understanding what it is supposed to be used for. Six years ago most people probably did not know what QR codes were either. However, they also thought it could be possible to design an iconography that that is more intuitive, even for people who do not have any knowledge of NFC. One referred to the Wi-Fi symbols on a computer as more intuitive, but is uncertain whether this also is a result of the widespread use or if the symbols themselves are more intuitive.

5.4.2 NFC Iconography Today

Later in the focus group, a number of different NFC symbols were presented to the participants (Figure 24). The given symbols were examples of a selection of NFC symbols that are used today or going to be used to inform people about NFC functionality. As discussed in section 2.3.2. there are several competing symbols for NFC. Referring to Microsoft's "Tap and Do" symbol (Figure 24), one the participants said: "The understanding I have when looking at it, is that I am going nowhere."

And the others seemed to agree with this interpretation. Even if it was said with a somewhat ironic tone, it was obvious that the Tap and Do-symbol did not give them any fruitful information. When we talked about the symbol for contactless payment (Figure 24), everyone agreed that they found this a bit more understandable based on the action to be performed. This they explained by its focus on an interaction, illustrating two things that are brought together. Nokia has a simple symbol showing the letters NFC (Figure 24), and the participants thought it was difficult to get any information from this unless you already know what NFC is. The Cityzi symbol (Figure 24) was however one of the symbols they felt they did not get any information from, it was to abstract and difficult to understand they say. The symbol from GSMA Association (Figure 24) was a bit more understandable to them compared to Microsoft symbol, because it was exemplified with a mobile phone. And everyone agreed that many of the symbols reminded them of Wi-Fi-symbols.

Figure 24: NFC Iconography, in center is the NFC Forum Symbol

5.4.3 Iconography in Public Transport

Next, the focus group was shown a selection of symbols used from public transport (Figure 25). These were included as they are to support the users in their interacting in that field, and thus can give some useful information about users thoughts about these.

First, Ruter's touch point symbol (Figure 25) was showed to the participants. Ruter is the company responsible for public transport in Oslo and Akershus. The participants thought that the symbol itself was not very good, but because of its widespread use, people know it. One of them pointed out that he remembered the confusion in the beginning of its launch: "People only know how to use it now because they have learned it; people did not know what to do when it first arrived." One participant said he had seen other people use it, but he did not find it descriptive. While another said he thought "Swipe past the symbol" when he saw it, not hold it still. The group was also shown a symbol from public transport in Bergen (Figure 25), a hand holding a card, they all thought this was clearer compared to Ruter's symbol: "To me, it says, hold your card here, not swipe."

Figure 25: Ruter's touch point and Skyss' touch point

So, this shows that they thought this symbol conveyed more meaningful information about the interaction required. A participant questioned the use area the NFC Forum symbol: “On the box of the device or as a touch point, or both?” He thought it would work well as branding on packages, but not in the context of use. For a touch point symbol the group thought that it could be emphasized that it concerns two separate things and that something moves between them.

5.4.4 Summary of Focus Group

The participants in the focus group perceived the NFC Forum symbol as a branding symbol, rather than a touch point symbol. However, they point to marketing and widespread use as an important factor for it to be recognized by users. They found the contactless payment symbol and the GSMA symbol to be more understandable as the required interaction was more obvious when looking at them. However, all of the participants thought many of the NFC-symbols looked more like Wi-Fi-symbols. When showing the Ruter’s touch point symbol they thought it looked liked it required a swipe-movement, while the touch point symbol from public transport in Bergen conveyed the required interaction in a better way. Again, they point to marketing and learning as a relevant factor for people to be familiar with the use of these types of symbols.

6 Discussion

Several methods have been applied to increase the reliability of this study. All the methods support one another and intend to enable the answering of the research questions in the best possible way. The methods have lead to interesting information about the interaction and understanding of NFC technology, and in this chapter the research question will be discussed in relation to theory from Chapter 2. The research question to be discussed is the following: *How do the participants understand the interaction with an NFC-enabled mobile phone and the environment?*

In the evaluations at Stortinget Station we wanted to look at how participants understood NFC interaction, how the participants interacted and investigate what guided them in their interaction with the NFC posters. We divide the research question into three parts to better structure the discussion: user's perception of the technology, feedback, and mental models.

6.1 User's Perception of the Technology

The participants first had some difficulties understanding what to touch or what to do in general when they were introduced with the posters that should help them get the information. Even if they had gotten a short introduction at the premises of Seniornett, it looked as if they were unsure of what to do. They did not seem to perceive the action possibilities the posters at the station offered them, and thus they might not have understood the link between the smartphones and the posters. According to Fällman (2003) the use of mobile information technology cannot easily be defined as human-computer interaction, because it also has an interest in the physical and social contexts of the world.

Because of the aspects of the world Fällman argues that human-computer interaction should be reinterpreted and approached as *human-computer-world interaction* (Fällman 2003). An example could be the interaction we have observed in our study, where the participants use a smartphone to get information from the posters at Stortinget Station. In the beginning of the interaction they held the phone passively in their hand, searching for something of interest in the world, in this case, an NFC tag to touch. At this stage the relationship between the user and the world is the strongest as their attention is focused on finding what to touch (Figure 26). But when the participants start to make use of the posters with the NFC Forum symbol, the relationship between the user and the technology strengthens as they move the phone more purposefully towards the symbol (Fällman 2003). It was however quite difficult for some of the participants to understand what to touch, and one of the participants tried to touch something outside the poster area. For them to be sure of what to do, it was necessary to give the participants some information about what they should hold the phone towards so that they would be able to move on with the tasks.

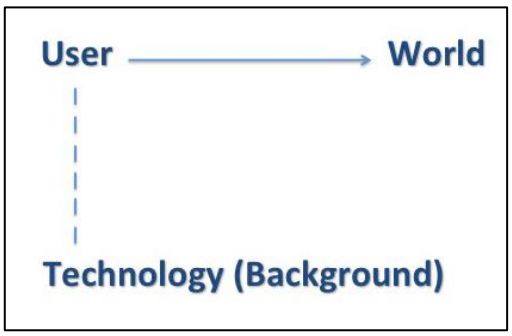


Figure 26: Technology in a background relationship.

Why did the participants not seem to understand what they should touch? To get the answers to the questions on the posters they were supposed to touch the NFC Forum symbol with the smartphones. But it seemed the symbol did not convey meaningful information to them, at least not about interaction. As mentioned in section 5.2.2 the participants did not think the NFC Forum symbol gave them any information about what to do. They associated it with a branding symbol like the logo of a Narvesen kiosk and others. In addition to the symbol there was a question on the posters, but this did not seem to make it any easier for them. NFC Forum has specified the symbol to be used as both a branding symbol *and* a touch point symbol. However, it only seemed to be perceived as the former by the participants from the evaluations at Stortinget Station and the focus group. Participants from the focus group associated it with a coffee brand, a real estate business, and did not find it to be suitable to use it to interact with NFC. So, why does the NFC Forum symbol not seem to work as a touch point symbol? Kjetil Nordby was quite clear in his opinion about the NFC Forum symbol and other NFC symbols as touch points for NFC-interaction. He did not think it would convey any meaning to the users.

So, he suggested it might be easier for users if phones were shown in the presentation of the technology, maybe to help users understand that phones are the enablers of the functionality. Nor does Bob Whelan, co-founder of U.S.-based NFC Labels seem to have faith in the NFC Forum symbol as a touch point symbol, and argues that the NFC Forum symbol does not have a 'verb' in it (in Balaban 2012), that it does not say anything about what the user should do. The NFC Forum symbol does not succeed to inform the participants of what to do and how, and this could be related to what Norman (2002) refers to as affordance.

According to Norman (2002) affordances should provide strong clues about the possible uses, functionality and actions of something, for instance physical products or graphical elements. Looking at Gibson's definition of affordance from Chapter 2, he argues that it is independent of users background, knowledge and culture, and he considers the surroundings as an objective factor (J. Gibson 1977). So, he thinks affordances are perceived similar by everyone, and not affected by their earlier experiences. In relation to our study we find it difficult to adopt Gibson's view on affordances, as our observations tell us that the participant's backgrounds and earlier experiences may have affected the way they perceived the presentation of NFC technology. Norman (2004) argue that users' background, knowledge and culture affect their view on affordances, and thus we find Normans definition of *perceived affordances* to be more suitable in relation to our study. He argues that

affordances are perceived differently dependent on users' knowledge, experience and culture (Norman 2004). In our case the affordance is related to a graphic symbol on posters in the physical surroundings that are supposed to enable communication with phones, but the participants did not see this connection. They did not perceive the symbol to have any useful affordances about interaction despite NFC Forums intention to use it as a touch point symbol. This shows that the intended affordances not always are coherent with the perceived affordances of the users (Norman 2004). One of the reasons for this could be that the participants, as mentioned, perceived it as a branding symbol, and that they do not think of branding symbols as something they are supposed to interact with.

The participants view on the NFC Forum symbol may be related to idioms, which often are used in branding and marketing (Cooper & Reimann 2003). Unlike metaphors, they do not try to provoke some kind of association about its use, but one has to learn them in order to understand what they mean (Cooper & Reimann 2003). An example could be the Coca Cola symbol that does not say much about its meaning, but people have a shared understanding of what it means because of its use, and that they have learned it. Most people know they can get something cold to drink when they see the symbol outside a store.

User's problems understanding the NFC Forum symbol as a touch point may be the reason why providers of NFC services have started to make their own symbols to present possible NFC interaction. The participants from the focus group indicated that the symbols that more directly presented the interaction, were the ones that gave them most information about what to do, for example the symbol from public transport in Bergen (Figure 25). Nordby argue that it might have been better if everyone had NFC on their phones, because it then would be easier to assume people had used it before. In that case he thinks that good iconography could have been sufficient to inform users, but not today.

According to Raskin (2000) it is important that icons represent the appropriate concept in a good way, but the feedback from the participants in both the focus group and interviews show that the NFC Forum symbol did not succeed in doing this. Unless people already know the purpose of the symbol, it seems to be difficult for users to interpret how it should be used. Raskin (2000) also argue that symbols lack clarity and that symbols alone is unable to convey the meaning of it.

The participants did not know that the phone could work as a controller to enable the functionality in the tags, and this could be related to the principle of mapping, which should convey the relationship to controls and their effect (Norman 2002). The reason for this could be that the participants were not used to this type of relationship between a mobile and a symbol in the real world, and as Cooper & Reimann (2003) states; it is easier to find images representing things, rather than actions or relationships. People are in general more used to interact with symbols in GUIs, and this new way of interacting with symbols in the physical world might be difficult to understand before it is learned.

NFC technology has many different use areas; downloading information to the phone, validating tickets, making payments, exchanging information between two enabled devices etc. By presenting users with a fragmented presentation of NFC functionality, it might be more difficult for users to create a consistent picture of NFC, as Balaban (2012) indicate. One could then think that it would be better to use one single symbol to present all types of NFC functionality to make it easier for users to recognize it and eventually get familiar with how it is used. However, we already see that this can be difficult because of the strong market interests. Large organizations like Google, Microsoft and the GSM Association have made their own symbols (Balaban 2012). On the other side, the use of a single symbol for all use areas could fail to convey the purpose of each use area. If, for instance the NFC Forum symbol is used for all areas it may succeed in creating a consistent picture of the technology, but the meaning and purpose of each area might not come through. So, another approach could be to create symbols that are associated with the given actions it performs, for instance one for payment, one for downloading information etc. However, it is important not to overestimate the power of icons and their metaphors, as they can be perceived differently dependent of users' backgrounds. Cooper and Reimann disagree with the way many designers think they have to invent visual metaphors for icons that adequately convey meaning to first-time users (Cooper & Reimann 2003, p.383). This does not necessarily mean that it is not possible to create icons that are more understandable than others, the participants in the focus group found some of the NFC symbols more understandable than the NFC Forum symbol. But it might be risky to rely only on the icon in itself to convey the meaning and purpose to users, as the meanings of icons often are ambiguous until it is learned.

So, metaphors in interaction design may not always be sufficient in conveying the purpose of something. A good example of a well-established metaphor is the Floppy disk (Figure 27), which means "Save". Devices with these types of disks have not

been manufactured for some time, so the Floppy disk symbol then means “Save” for a whole generation that has never seen one before. Thus, this means that the symbol does not have the same metaphoric meaning for those who have not seen one before, instead they have *learned* its meaning (Cooper & Reimann 2003). In relation to the NFC Forum symbol used on the posters at Stortinget Station we see that even if the symbol does not seem to be a good touch point symbol, it would be naive to only rely on the symbol itself to convey its purpose to novice users. Metaphors and affordance can offer a small boost in learnability to first-time users, but their meaning is ambiguous, and as mentioned it will remain ambiguous until it is learned. The participants from the focus group also said that they did not find the Flexus touch point symbol very meaningful in the beginning, but as they watched how others did it and it became widespread they learned how to use it.

Figure 27: Floppy Disk Icon

6.2 Feedback

After the participants had figured out how to use the phone, there were some factors that can be related to time and feedback that made them unsure of what happened and what they should do. There have been formulated several principles and guidelines concerning feedback in design, and they all emphasize the importance of informing users about what is going on through appropriate feedback within reasonable time (Nielsen 1990; Shneiderman & Plaisant 2004; Norman 2002; Preece et al. 2007). In this case, many of the participants held the phone against the tag for a very long time, because of the loading screen that was still there even when the tag was read. Some of them also thought the reading of the tag were unsuccessful because of this. One of the participants ended up asking for how long she had to keep the phone there. She was unsure about this because she did not get any feedback that indicated that she could remove the phone. She expected some sort of feedback in terms of a message on the screen, as the loading screen did not give her any useful information. In this situation, a more understandable animation of the progress on the screen probably would maybe have been helpful so that the participants could have been aware of what was happening. However, the NFC tags just had a reference to an URL. The reading of the tag was probably already done even if the loading screen still was visible, what takes time is getting the information from the server. So, the loading screen is actually representing the fetching of the information from

the server, not the reading of the tag itself. In this situation the participants may have had a mental model that the information was retrieved directly from the tag. Regardless of this, the participants should get sufficient information for them to understand what is happening. This concerns typical visual feedback that we often see in GUIs, but it is still important as the participants also related to the mobile phone. In this stage of the interaction, the attention shifts from the world to the technology. The relationship between the participant and the world gets weaker and the relationship between the participant and the mobile phone stronger because they now focus more on the phone (Fällman 2003).

Perhaps visual feedback is not enough to support the participants' interaction? Haptic feedback was also given in the form of vibrations from the phone when the tag was read, and this type of feedback is often used in TUIs. But it did not seem to be of major importance for the participants' understanding. This could however be difficult to say for sure as the participants might register this type of feedback without being conscious of it. The participants could not remember the haptic feedback, and thus it is difficult to say something about its effect. When the tag was read, a sound came from the phone. In some cases the participants did not hear the sound, and this could have been due to the ambient noise from the station. We could see that they were unsure when it happened, especially the ones who first held the phone with the screen towards the tag, as they could not see what happened on the screen. When they did not hear the sound nor see the screen, it was only the vibrations from the phone that indicated that something had happened. In one situation the sound was present even if the tag was not read, and the participant who experienced this found it to be very confusing.

This could not easily have been uncovered in a lab or other more controlled environments, and thus we find that testing in the real world was necessary. The connection problems down at the station also became more apparent in this context compared to what it would have been in a lab where this would be easier to control.

From this we can see that the context of the study made it necessary to provide several types of feedback compared to what may be necessary in traditional desktop computing. Even if there was feedback from the screen as well as vibrations, and sound, it did not always seem like this was enough for the participants to feel confident. Or more correctly, the feedback from the screen should be clearer and more understandable, as well as the sound feedback should be more consistent. Use

of lights from the phone could also have been relevant, but this was not included in this investigation.

6.3 Mental Models

We return to the story from Section 1.2, where a woman struggled to find the right way to use her electronic travel card with the validation point at the tram. She is not the only one who has experienced difficulties, and especially during the introduction of Ruter's electronic ticketing system in Oslo, called Flexus[18], many users had problems figuring out how they should use the new travel cards. Like the woman from the example, many tried swiping the travel card instead of holding it still towards the symbol on the validation point. The travel cards look a lot like credit or debit cards, and the most common metaphor for usage at the time was to swipe your card. This could have been transferred over to the Flexus system, and it shows that users maybe did not have the relevant mental models when interacting with the new electronic system.

According to Norman (2002, p.17) "Mental models are the models people have of themselves, others, the environment, and the things with which they interact". Or more specifically, mental models are what people have in their heads that guides their use of things (Norman 2002). Users' way of interacting with the electronic travel cards and the validation points may have been affected by the mental models they created in their heads to figure out what to do. Also, users were not yet familiar with the electronic cards and the fact that one could store tickets on them. Instead many users thought of them as paper tickets that one tossed after they were finished. At one point, an article state that Ruter was having a shortage of travel cards because users threw them away after one use (Skulstad 2011). This shows that the users' interaction with the electronic system may have been affected by earlier experiences with credit or debit cards and paper tickets, and Susan Carey (1986) argue that mental models are created from prior experiences with similar devices and software.

Also, users perception of the touch point symbol (Figure 28) that was introduced could have affected how users chose to approach it. One of the participants from the focus group said his associations when looking at the Ruter touch point symbol in itself was to swipe past the symbol, instead of holding it still as is required. The rest of the participants in the focus group also thought it looked like the symbol referred

[18] It is no longer called Flexus, but renamed to 'Travelcard'.

to some kind of movement being necessary, because of the arrows pointing upwards or in general because of their mental model of the symbol.

Figure 28: Ruter's Touch Point Symbol

Even if it is concerns two different situations there is some similarities with the introduction of Ruter's electronic system and the introduction of NFC. When the participants from the evaluations at Stortinget Station knew that they were supposed to touch the NFC Forum symbol with their phone, they were also unsure of how they should use the phone. As mentioned in section 5.2.7 there were variations in use relating to: distance from phone to tag, direction of phone, where to touch, time, and movement. Nordby also point to the problem of knowing how one should use the phone, if one should hold it still or swipe it. He is questioning how users should know exactly what to do.

As the participants in general did not have much knowledge about the technology and the NFC Forum symbol did not convey anything meaningful to them, they tried out different solution strategies. Even if the technology was new to them, it should not be necessary to know how the technology actually works in order to use it (Cooper & Reimann 2003). The participants should not need to know that the communication between two NFC-enabled devices happens through electromagnetic fields to use it. When explaining their interaction the participants often referred to other technologies or activities they knew from earlier experiences. One of the participants who held the phone very far from the NFC Forum symbol asked what distance was necessary, and explained his way of thinking by referring to photography, specifically aerial photography. He thought the symbol was too large relative to the phone, and that he held the phone like this to "capture" the whole image. Many of the other participants also referred to photography, but it seemed like their models referred more to their earlier experiences from using a mobile phone camera, as you can see from the following user quotes in Table 5:

Quotes from participants:	Context:
1. "It's basically here I shoot pictures, and then I find it logical that this is the place that has to be visible, and then I should see the picture here (points to screen)"	Referring to photography when explaining why he held the back of the phone towards the tag (Direction).
2. "You have to have the camera so that you don't take a picture of yourself, but of the symbol"	Referring to photography when explaining why he held the back of the phone towards the tag (Direction).
3. "It clicked as if it took a picture, and then something appeared"	Referring to photography when explaining the feedback sound from mobile phone.
4. "I would've thought that the picture of where the ticket machine is, appeared on the screen."	Referring to photography when explaining what she expected would happen after touching the tag.

Table 5: Quotes from participants referring to photography in some way

In quote 1 and 2 we see that the participants seem to use their mental model of how they use a mobile camera to explain why they chose to hold the mobile phone in the given direction. In quote 3 and 4 they refer to photography when explaining the feedback sound from the phone and what they expected to happen after touching the tag. They are not necessarily only referring to photography with a mobile phone, possibly photography in general, but as they were using a mobile phone in the evaluations it is likely that this was the type of photography they referred to.

A couple of the participants in the evaluation at Stortinget Station also tried to swipe the phone (movement) instead of holding it still. Because of this the tag could not be read, but as they continued experimenting they noticed that it worked better when holding it still. The reason why they swiped it in the first place may also be related to their experiences using credit and debit cards, even if the phone does not look like these types of cards. This is however difficult to say for sure as the participants' mental models are not directly observable, and even the participants' themselves may not be aware of the mental models they use to guide their interaction (Norman 2002). As we said in section 5.1.1 there were also QR codes on the posters as they initially were supposed to be included in the case. This may also have affected the way they interacted, as most of them had some knowledge about QR codes and some of them pointed out in the interview that they found it to be quite similar to the NFC-interaction.

As we see, it seemed like the participants did not have relevant mental models of how to interact with NFC, because they did not have any experience or knowledge of how it was to be used. One of the participants said: “I have never known that it was possible to hold your phone in front of these and get so much information back.” Instead they used models of what they had learned from earlier experiences like:

- Swiping a debit-credit card
- Taking pictures
- Scanning QR codes

As Cooper (2003) argues, mental models do not have to be true or accurate, but they should enable users to do what they want to do effectively. So, even if the participants used models from their earlier experiences, they could be sufficient as long as they guide them in a good way. In this case they did not always support the participants effectively in their interaction, for instance when they swiped the phone or held it too far away. Mental models are however not immutable, they can be changed (Cooper & Reimann 2003). NFC is a relatively new technology, at least to the general user, but as people get familiar with it and learn it their mental models may adjust and become more relevant for their interaction with NFC.

Even if reading of tags is a new interaction mode, it seemed as the participants found it to be easier once they were more familiar with the concept. This shows that people are likely to accept this technique once they have undergone a learning curve.

7 Conclusion

The main objective of this thesis has been to gain knowledge about how users understand the interaction with NFC-technology in the given case. By asking the research question: "*How do the participants understand the interaction with an NFC-enabled mobile phone and the environment?"* and investigating it trough the three topics: User's perception of the technology, Feedback, and Mental Models, this thesis has analyzed the participants' understanding and interaction with NFC. The area has been investigated through observations, interviews and focus group. Even if NFC has been around for nearly a decade it has not achieved very widespread use, and the communication of the technology to users has not been a major focus. For this reason, it has been interesting to look at what the participant's found difficult, and what factors are necessary to make the understanding of NFC interaction easier.

The way the participants interacted is a result of many factors: mental models, the context, feedback, and the way they perceived the NFC Forum symbol as a branding symbol rather than an invitation to interact. I will summarize the main concluding remarks in the following sections.

7.1 User's Perception of the Technology

In the study we used the NFC Forum symbol on the posters to represent the NFC functionality and where the participants should hold the phone. Even if the participants got a short introduction, they were still unsure about what to do and why. The NFC Forum symbol did not seem to convey any meaningful information to them, and they *did not perceive it as an invitation to interact*. It becomes clear that they *perceived it as a branding symbol*, rather than a touch point symbol, while NFC Forum intend to use it for both purposes. So, the intended affordances were not coherent with the perceived affordances of the participants. Thus, the participants *did not see the link between the smartphones and the posters*, because they did not perceive branding symbols as something one could interact with in that way. None of the participants were familiar with NFC and the NFC Forum symbol beforehand. *Affordances and metaphors could offer some help* in regards to learnability for first-time users, but only to a certain extent. The NFC Forum symbol could be improved for it to convey more about its use, but as people perceive affordances in different ways, it might not be sufficient. For this reason, *learning* is also an important factor because symbols often remain ambiguous until they are learned.

7.2 Feedback

The feedback that was supposed to support the participants in their interaction consisted of feedback from the screen, vibrations and sound. When touching the tag, many participants held the phone towards the tag for a very long time. This was due to the *lack of feedback from the screen* as well as the loading screen that confused them and made them think the reading had failed. The participants expected feedback in the terms of a message assuring them if the tag was read and when the phone could be removed. It was not only the feedback from the GUI that confused them, but also the *inconsistent sound-feedback*. The sound from the phone that was supposed to indicate the reading of the tag, often appeared even when nothing had happened and the tag had not been read. Sometimes the participants *did not hear the sound* from the phone because of the noise from the station, which especially made them insure of what happened when they held the phone with the screen towards the tag. This would have been difficult to discover in a more controlled lab setting, showing that the testing in the real world was necessary. It also shows that the *context* of the study required other types of feedback compared to what may be necessary in traditional desktop computing. The provided feedback did not seem to be sufficient in this context and we see the need for:

- More consistent feedback
- Clearer feedback from the screen within a reasonable time

7.3 Mental Models

When the participants interacted with the posters there were many variations in how they chose to approach it relating to: distance from phone to tag, direction of phone, where to touch, time, and movement. When they explained their interaction the participants often *referred to other technologies they knew from earlier experiences*. One explained the distance he kept from the NFC Forum symbol by referring to aerial photography. Many of the other participants referred to *photography* in general, when explaining the direction they held the phone and what they expected to happen when they touched the tag. Two of the participants also tried swiping the phone from one side to another, and this may have been affected by their experience with *debit and credit cards*. The QR codes on the posters could also have had an impact on the way they interacted. Many of the participants had some knowledge about the use of QR codes and found the interaction to be very similar with NFC. So, the information we got from observations and interviews indicated that the participants referred to earlier experiences with the following technologies in their interaction:

- Photography,
- Debit/credit cards, and
- QR codes

However, it seemed like the most recurring mental model or metaphor among the participants were photography. This shows how people try to understand new technologies through the old. The mental models helped the participants to a certain extent, but not all of them guided them in a good way. Mental models are however not immutable, and as people get more familiar with the use of NFC and learn it, the models can be adjusted and thus become more relevant and helpful for the interaction with NFC.

The way the participants perceived NFC, the feedback, the context, and the models they had of earlier experiences with technology affected how they interacted with and understood NFC. The participants were not familiar with the interaction mode introduced by the paradigm of physical mobile interaction, and it might be necessary for users to undergo a short learning process for them to understand how to interact. This new way of interacting with technology will also affect how we design for users. As we move from interaction with desktop computers to interaction with the

physical world, designers have to think differently about how they design to make it easier for users to learn how to use it.

7.4 Future Work

In this thesis I have looked into different aspects concerning understanding of interaction with NFC technology, but there are still areas that would be interesting to investigate further in a more extensive study.

I have mainly looked at NFC technology in relation to smartphones and posters with NFC, but it would also have been relevant to look at the many other use areas of the technology, like payment or ticketing. It has however been conducted quite a few studies on contactless payment as this is one of the most known use areas. And even if I have not tested ticketing directly, I have investigated the use of NFC in a context that also is relevant in this area. NFC can be used for so many purposes, and it would be very interesting to investigate how users understand the interaction in each of the use areas and different contexts. A collective case study could be performed in order to find similarities and differences in each of the cases.

With more time and resources it could have been useful to conduct another iteration with observations and interviews, but with different symbols adjusted according to the participants' responses and approved feedback. The application could also offer an animation or an illustration of the required interaction, to provide first-time users with a simple instruction. Then it could have been possible to see if this has an affect on users interaction and understanding.

In a few years it would have been interesting to revisit the topic and see if NFC has become more understood, and if a standardized symbol has come out. Manufacturers and others in the technology industry have predicted that it is just a matter of time before NFC fully enters the market, but it still seems that there is some work left for this to happen. NFC has so many interesting use areas that could make everyday activities easier, but it is not enough that manufacturers believe in NFC, one also has to find a way to get users interested.

When I think back to the story from section 1.2 about the woman who could not validate her ticket, I know that I from time to time still see people doing it wrong. Now the electronic travel card is about the only choice users have, as paper tickets

have been phased out. Many people depend on public transport to get around, and thus they have to use the travel card. NFC, on the other is not necessarily a technology that will replace important functions in people's everyday life. For this reason, the way NFC is introduced to potential users is of major importance to make sure it is easy to learn and use.

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Appendix A: Information Sheet 1

Informasjonsskriv om masteroppgave - "Understanding interaction facilitated by Near Field Communication: A Case Study"

Student: Therese Drivenes
Studiested: Universitetet i Oslo, Institutt for Informatikk
Masterretning: Informatics: Design, Use, Interaction (http://bit.ly/gSCdE0)
Veileder v/UiO: Jo Herstad
Veileder v/Norsk Regnesentral (NR): Ivar Solheim
Samarbeidsprosjekt: Mobilesage på NR (http://mobilesage.eu)
Leveringsdato: 13. Mai, 2013

Bakgrunn

Dette er et forskningsstudie som undersøker hvordan personer interagerer med NFC-teknologi i de fysiske omgivelsene i en kollektivtrafikk-setting. NFC, eller Near Field Communication er en teknologi som blir mer og mer vanlig på smarttelefoner. Ved hjelp av denne teknologien kan mobiletelefoner kommunisere med de fysiske omgivelsene, f.eks. en billettautomat, ved å holde den nær en annen NFC-brikke plassert på billettautomaten.

Hensikten med studiet

Hensikten med studiet er å få et bilde av eventuelle utfordringer personer opplever ved bruk av NFC-teknologi i den gitte konteksten. Studiet søker svar på om teknologier som NFC er forståelig og intuitiv for brukerne, og om bruk av andre typer teknologier kan være med på å påvirke hvordan en oppfatter denne teknologien. Hovedfokuset er på designprinsippene *feedback* og *visibility,* og det skal gjennomføres brukerutprøvinger med brukere på Stortinget stasjon før jul. Her får deltagerne noen oppgaver de skal gjennomføre ved hjelpe av blant annet NFC. Fokuset er ikke billettkjøp, men å la bruker innhente nyttig informasjon ved bruk av en smarttelefon med NFC.

Studiet gjennomføres i sammenheng med min masteroppgave ved Universitetet i Oslo på Institutt for Informatikk. Jeg skriver masteroppgaven min innenfor et forskningsprosjekt ved Norsk Regnesentral, som heter Mobilesage. Dette er et omfattende internasjonalt prosjekt som tar for seg mange problemstillinger, men mitt fokus innenfor prosjektet er altså NFC-teknologi. Hvis du ønsker å lese mer om prosjektet Mobilesage, finner du en lenke til prosjektsiden lenger oppe på siden.

Appendix B: Information Sheet 2

Bli med og prøv ut morgendagens mobilteknologi!
Her er en mulighet til å være med på å påvirke morgendagens mobilteknologi! Vi vil gjerne ha deg med i et forskningsprosjekt som har som mål å tilby eldre nye måter å bruke mobiltelefonen på. Prosjektet heter MobileSage og skal hjelpe eldre og andre å løse oppgaver og utfordringer i hverdagen, både hjemme, ute og på reise.

Det engelske ordet MobileSage betyr, direkte oversatt, «Mobil vismann» og dette sier også mye om hva prosjektet dreier seg om. Ved hjelp av MobileSage vil nyere mobiltelefoner, mer spesifikt såkalte smarttelefoner, tilby hjelp og informasjon som er tilpasset den enkelte brukers preferanser og også mulige funksjonsnedsettelser. Har du synsnedsettelser, så vil MobileSage tilpasse hjelpeinformasjonen til dette.

I prosjektet ser vi spesielt på hvordan MobileSage kan være til hjelp når du er på reise. Vi skal nå prøve ut systemet på ett område: hjelp til å finne fram og til å betale billetter på en T-banestasjon. Ved hjelp av MobileSage vil du kunne bruke smarttelefonen til å orientere deg på stasjonen, finne fram til billettautomaten, få hjelp til hvordan du bruker automaten samt til å finne fram til riktig plattform.
Mer konkret, her er hva vi ønsker du skal være med på:

- Først skal du møte i Seniornetts lokaler i Oslo hvor du vil få all nødvendig opplæringen og informasjon på forhånd.
- Vi har med en smarttelefon som du skal bruke.
- Etter opplæringen vil vi gå til Stortinget stasjon (ca 200 m) der utprøvingen vil skje.
- Utprøvingen skjer inne på Stortinget stasjon. Du vil få nøye beskjed om hva du skal gjøre.
- Du vil kunne spørre om hjelp underveis siden det vil være forskere i nærheten.
- Etter at du er ferdig, vil vi stille deg noen spørsmål.
- Det hele vil vare ca 1 ½ time.

Det er ikke noe krav at du bruker mobiltelefonen ofte eller på en avansert måte, eller at du er spesielt interessert i teknologi. Du behøver ikke ha erfaring med smarttelefoner.

All informasjon gitt av deg i løpet av utprøvingen vil være konfidensiell. Ingen utenfor prosjektet vil ha tilgang til informasjon gitt av deg, og denne informasjonen vil kun bli brukt som grunnlag for forskning i prosjektet.
Prosjektet er internasjonalt og er finansiert dels av EU-kommisjonen og dels av Norges Forskningsråd. Det er deltakere fra Norge, Romania, Spania og Storbritannia. Norske deltakere er Seniornett, Ruter AS og Norsk Regnesentral.
Alle deltakere vil få et gavekort verdt kr 500.
Du må gjerne ta kontakt med undertegnede eller Seniornett hvis det er noe du lurer på.

Med vennlig hilsen,

Ivar Solheim, sjefsforsker
Norsk Regnesentral
Tlf 99408821, e-post: solheim@nr.no

Appendix C: Consent Form

Forespørsel om deltakelse i masterprosjekt: "Understanding interaction facilitated by Near Field Communication: A Case Study"

Bakgrunn

Dette er en forespørsel til deg om å delta i en forskningsstudie som undersøker hvordan personer interagerer med NFC-teknologi i de fysiske omgivelsene. NFC, eller Near Field Communication er en teknologi som blir mer og mer vanlig på smarttelefoner. Ved hjelp av denne teknologien kan mobiletelefoner kommunisere med de fysiske omgivelsene, f.eks. en billettautomat, ved å holde mobilen nær en annen NFC-brikke plassert på billettautomaten.

Hensikten med studiet er å få et bilde av hvilke utfordringer personer opplever med bruk av NFC-teknologi i den gitte konteksten og hvordan en kan løse eventuelle utfordringer. Studiet søker svar på om teknologier som NFC er forståelig og intuitiv for brukerne, og om bruk av andre typer teknologier kan være med på å påvirke hvordan en oppfatter denne teknologien. Studiet gjennomføres i sammenheng med min masteroppgave ved Universitetet i Oslo på Institutt for Informatikk.

Formålet med studien er å få et bilde av hvordan personer bruker og forstår NFC-teknologi, og dermed hente inn informasjon om hvordan en kan gjøre interaksjonen med denne teknologien enklere og mer brukervennlig.

Behandling av data

For å unngå for mye distraherende notatskriving vil samtalen bli tatt opp. Denne informasjonen skal kun brukes til oppgavens formål og vil bli lagret på et sikkert sted, utilgjengelig for uvedkommende. Sier du ja til å delta har du krav på å få innsyn i hvilke opplysninger som er lagret om deg. Du kan også trekke deg fra studien når som helst og be om at all innsamlet data om deg slettes. All informasjon vil uansett bli slettet etter endt studie, det vil si senest juni 2013.

Frivillig deltakelse

Det er frivillig å delta i studien. Dersom du velger å ikke delta, trenger du ikke å oppgi noen grunn. Om du skulle bestemme deg for ikke å delta, får dette ingen konsekvenser. Om du nå sier ja til å delta, kan du også senere trekke tilbake ditt samtykke. Dersom du senere ønsker å trekke deg, kan du kontakte [Therese Drivenes, Mobil: 97799836].

Samtykke for deltakelse i studien

Jeg er villig til å delta i studien

(Signert av prosjektdeltaker, dato)

Bekreftelse på at informasjon er gitt deltakeren i studien

Jeg bekrefter å ha gitt informasjon om studien

(Signert, rolle i studien, dato)

Appendix D: Program for Evaluations

Task/action	MobileSage interaction	Content	Modality (text, audio, video)	Duration
Preparations/instructions				
Welcome and information to participants. - Check that the participant is informed about the project and the purpose of the test - General Information presented about the test. - Participant sign a consent form.				
Instruction about how to use MobileSage (MS) and its functions: - "Hands on" instruction about how to use the MobileSage application. - Show basic functions: scan, travel, search. Show how NFC and QR works. - Show how to edit and change profile settings	Instruction, walk through with MS instructor	MS app (all functions)	all	
Define personal profile settings. 1.1 Language 1.2 Fonts 1.3 Preferred mode				
Present task sheet (see below, the task sheet provides the same information, in a				
Test tasks				
Task 1: Open MS app and learn how to navigate to Stortinget Station from the present location (appr. 250 meters, two streets)	Push Travel, find map, navigate to the station. Walk to the station.	MS app, travel function		
Task 2: Find way in Stortinget Station 2.1 Scan a NFC tag at the entrance and read/hear/see the instruction. 2.2 Find way and walk to the ticket machine	Use NFC tag at the entrance (a poster with MS and NFC logos). Hold phone close to the tag. See/hear the instruction (depending on type of modality)	Guidance in three different modalities: (audio, video, text)	All (can choose, according to profile settings)	
Task 3 How to buy ticket. Read and hear information about how to use ticket machine. 3.1 Put the phone close to the NFC tag on the ticket machine 3.2 See/hear/read the instruction video that pops up about how to use the machine.	Use NFC tag by the ticket machines (poster with MS and NFC logos)	Guidance in three different modalities: (audio, video, text	All (can choose, according to profile settings)	
Task 4: Validate ticket. 4.1 Find information about validation – how to validate the ticket. You can use Search function or you can scan the NFC tag beside the validation machine.	Use Search or scan. Do as the content info advises, step by step	Guidance in three different modalities: (audio,	All (can choose, according to profile	

4.1 Read/hear/see the information about how to put the phone close to the NFC tag on the ticket machine		video, text	settings)	
Task 5: Find the way to correct platform 4.1 Find information about how to find platform – how to validate the ticket. You can use Search function or you can scan the NFC tag beside the validation machine. 4.1 Read/hear/see the information about how to put the phone close to the NFC tag on the ticket machine	Use Search or scan. Hold phone close to other NFC tag, placed on the inside of the gates	The map of Stortinget Station appears, showing where you are and how to get to the correct platform	All (can choose, according to profile settings)	
Task 6: Navigate back to Stortinget Station, the entrance	Push Travel, find map, navigate to the station.	Map of Station. Walk to the entrance	All (can choose, according to profile settings)	
TOTAL:				**XX min**

Appendix E: Interview Guide 1

Questions	Answers
Participant Number: Age:	
Spørsmål aller først, etter formaliteter og samtykke er underskrevet	
1 Kva slags mobiltelefon bruker du?	
2. Har du erfaring med smarttelefon? Evt hvor lenge	
3. Hvordan vil du karakterisere seg selv som IKT-bruker: A: nybegynner, B: noe erfaring, C: lang erfaring.	
Spørsmål etter utprøving	
Innstillinger	
1 Greide du å lage din egen profil?	
3 Var det enkelt, middels eller vanskelig å lage profil?	
3 Var font størrelsen passelig for deg?	
4. Hvilke output-typer valgte du? Hvorfor?	
Reise	
5, Var Reise-funksjonen enkel, middels eller vanskelig å bruke?	
6. Hvis vanskelig - Hva syntes du var vanskelig med denne funksjonen?	
7. Syntes du denne funksjonen var nyttig? Ja, Nei,. Vet ikke	
Søk	
6. Var Søk-funksjonen, enkel, middels eller vanskelig å bruke?	
7. Hvis vanskelig - Hva syntes du var vanskelig med denne funksjonen?	
8. Syntes du denne funksjonen var nyttig? Ja, Nei,. Vet ikke	
(HER kommer Thereses spørsmål)	

Generelt	
9. Opplevde du at du måtte vente lenge før systemet ga deg respons?	
10. Var MobileSage-systemet forståelig og logisk lagt opp? Utdyp gjerne.	
11. Synes du et system der du får "hjelp når du trenger det" vil være nyttig for deg?	
12. Har du noen forslag til hvordan MobileSage-systemet kan gjøres bedre?	

Appendix F: Interview Guide 2

Intervjuguide

Intervjuguiden skal benyttes i sammenheng med intervjuene som skal gjennomføres i etterkant av observasjonene på Stortinget stasjon.

1. Har du hørt om NFC før?

2. Har du brukt eller bruker du Ruter sitt elektroniske reisekort?

3. Hva synes du om denne metoden for å betjene NFC? Hvordan var det å finne riktig måte å holde mobilen på? F.eks. vannrett, loddrett, med skjermen eller baksiden mot tag etc.

4. Hva skjedde etter du fikk kontakt med NFC-leserne? Hva slags tilbakemelding fikk du?
    a. Var det noen informasjon du mener burde ha vært med i tilbakemeldingen? I så fall, hvilken informasjon?
    b. Var det noen informasjon som føltes overflødig? I så fall, hvilken?

5. Hvilke tanker gjør du deg rundt det å bruke mobiltelefonen på denne måten?

6. Er det noen andre interaksjonsformer eller teknologier du synes ligner eller minner om NFC?

7. Hva synes du om NFC som en betjeningsmetode?
    a. Hvordan synes du NFC fungerte sammenlignet med tekstsøket?

8. Har du hørt om QR-koder? I så fall, hva synes du om bruken av disse? (Vise et bilde av en QR-kode).

9. Følte du at informasjonen du fikk hadde noen nytteverdi for deg?
    a. Hvilken type ting kunne du tenke deg å få informasjon/hjelp til?

Appendix G: Interview Guide 3

Intervjuguide
Kjetil Nordby (AHO)

Bakgrunn

Fortell litt om prosjektet

NFC og interaksjon

1. Tror du at NFC på samme måte som QR-koder ikke kan få en mening for folk uten at de vet om hva det er på forhånd? Med dette mener jeg om det ikke er mulig å designe og visualisere hvordan man skal interagere med NFC uavhengig av hvor mye erfaring personer har med teknologien?

2. Hvordan tror du man kan gjøre det mer intuitivt for brukere å vite hvordan en skal interagere med NFC?

3. Ulike perspektiver på affordance? Hva tenker du affordance er?

4. *Feedback i grafiske grensesnitt sammenlignet med TUIs*: Synes du det burde utvikles egne retninglinjer for feedback i forhold til fysisk interaksjon? Viktig å ha feedback som passer i mange kontekster? (Bråk, på farten.etc.) forslag til litteratur?

5. Mange av dem jeg har hatt med på brukerutprøvinger, benyttet ulike metaforer når de snakket om NFC og det er tydelig i deres interaksjon at metaforene påvirket hvordan de interagerte med teknolgien. Tror du en bør ta slike metaforer i betraktning når en designer interaksjoner?

6. Hva mener du er hovedforskjellen mellom NFC og QR-koder, rent interaksjonsmessig? (Mange som tenkte at dette var det samme)

7. Tror du at NFC tar over på mange områder selvom NFC ikke ble inkludert på iPhone 5? Tror du bruk av NFC-tilbehør blir aktuelt? (for telefoner som ikke har NFC)

Appendix H: NSD Form

Norsk samfunnsvitenskapelig datatjeneste AS
NORWEGIAN SOCIAL SCIENCE DATA SERVICES

Harald Hårfagres gate 29
N-5007 Bergen
Norway
Tel: +47-55 58 21 17
Fax: +47-55 58 96 50
nsd@nsd.uib.no
www.nsd.uib.no
Org.nr. 985 321 884

Jo Herstad
Institutt for informatikk
Universitetet i Oslo
Postboks 1080 Blindern
0316 OSLO

Vår dato: 21.11.2012 Vår ref:32146 / 3 / MAS Deres dato: Deres ref:

TILBAKEMELDING PÅ MELDING OM BEHANDLING AV PERSONOPPLYSNINGER

Vi viser til melding om behandling av personopplysninger, mottatt 15.11.2012. Meldingen gjelder prosjektet:

32146	*The Usability of Interaction between a Smartphone and the Environment facilitated by Near Field Communication (NFC)*
Behandlingsansvarlig	*Universitetet i Oslo, ved institusjonens øverste leder*
Daglig ansvarlig	*Jo Herstad*
Student	*Therese Drivenes*

Personvernombudet har vurdert prosjektet og finner at behandlingen av personopplysninger er meldepliktig i henhold til personopplysningsloven § 31. Behandlingen tilfredsstiller kravene i personopplysningsloven.

Personvernombudets vurdering forutsetter at prosjektet gjennomføres i tråd med opplysningene gitt i meldeskjemaet, korrespondanse med ombudet, eventuelle kommentarer samt personopplysningsloven og helseregisterloven med forskrifter. Behandlingen av personopplysninger kan settes i gang.

Det gjøres oppmerksom på at det skal gis ny melding dersom behandlingen endres i forhold til de opplysninger som ligger til grunn for personvernombudets vurdering. Endringsmeldinger gis via et eget skjema, http://www.nsd.uib.no/personvern/forsk_stud/skjema.html. Det skal også gis melding etter tre år dersom prosjektet fortsatt pågår. Meldinger skal skje skriftlig til ombudet.

Personvernombudet har lagt ut opplysninger om prosjektet i en offentlig database, http://pvo.nsd.no/prosjekt.

Personvernombudet vil ved prosjektets avslutning, 31.05.2013, rette en henvendelse angående status for behandlingen av personopplysninger.

Vennlig hilsen

for
Vigdis Namtvedt Kvalheim

Mads Solberg

Mads Solberg tlf: 55 58 89 28
Vedlegg: Prosjektvurdering
Kopi: Therese Drivenes, Ullevålsveien 10, 0171 OSLO

Avdelingskontorer / District Offices:
OSLO: NSD. Universitetet i Oslo, Postboks 1055 Blindern, 0316 Oslo. Tel: +47-22 85 52 11. nsd@uio.no
TRONDHEIM: NSD. Norges teknisk-naturvitenskapelige universitet, 7491 Trondheim. Tel: +47-73 59 19 07. kyrre.svarva@svt.ntnu.no