# How to improve the interaction with chip based travel cards with a new design that uses implicit interaction and electronic paper

Emma Landfors

Department of Computing Science Umeå University, Sweden dit06els@cs.umu.se

**Abstract.** This article investigates travel cards that are used today and some that has been used. It presents a new design, to do this the article reviews the technologies electronic paper and implicit interaction to determine if they can be used. The result of this article was a design that is simple to understand and provides the user with more information which gives the user a chance to engage in improved interaction.

# 1 Introduction

As the technology develops it becomes smaller and more hidden, not really allowing the users to experience it nor allowing them to be affected by the information it has to offer. This is certainly visible in how the chip based travel cards are used today. They show no information about the content of the card and therefore the card is often forgotten inside the user's wallet and that prohibits a true interaction between the travel cards and users. The travel ticketing system started with paper-only tickets that has developed to cards with a magnetic strip and has now developed to the chip based travel card. It is a plastic card containing a chip that has the information about the user's travels, but the card has no good way to give the information back to the user [7].

Along with the new type of travel cards (the chip based cards) other technologies for travel ticketing arise, for example mobile ticketing systems. Research shows that the surrounding environment in which the travel cards are used has a big impact on whether the cards is actually used or not. If the user, in last minute, finds out that the card is empty the user uses a mobile ticketing service instead [8]. With the previous types of travel cards (magnetic strip travel cards) though sometimes still used, the card gives the user a lot more information feedback, see figure 2. There are rarely any questions for the user to ask when they interact with the magnetic strip and since the artefact provides more information than the chip based travel card, it allows the user to engage in better interaction. If the user gets more information out of an artefact the user is bound to use it more instead of using other artefacts or other technologies for payment [9].

This article suggests a new design of the travel system today (cards and card readers) which cooperates different technologies that will encourage an attitude

change and encourage more frequent usage of the chip based cards. The cooperation is mainly between two technologies; the electronic paper and the chip based card. By adding implicit interaction to the design more information can be used. It will make the new design more beneficial and as a consequence more interesting for the user to use. The challenge and the problem in this article is: Is it possible to improve the interaction between humans and chip based travel cards with a new design that uses implicit interaction and electronic paper?

In the end it was evident that a new design could improve the modern type travel cards. A solution that provides a more dynamic information input for the user would offer a bigger interaction space than is offered today. The outcome of this work has provided a design suggestion that offers more information, at all time, for the user than is offered today. This improves the interaction and the knowledge regarding every day travel with public transportations.

The basic outline for this article is to first present some background knowledge in terms of shortly describing the technologies used, present some related work about the technologies, and then present a design suggestion. In the following section about travel cards a review will be presented visually that will show different types of travel cards available today and the type of information visible to the user. Section three is about the electronic paper and the basics of the technology, this to see what has been done and what is possible to do with the technology today. In section four the basics of implicit interaction will be presented, the article will also show some related work where implicit interaction has been used. The fifth section is about the method used in presenting the new design and how the previously presented work is used in the new design. Section six presents the design suggestion, what the new design will look like based on implicit interaction and electronic paper, but it will also present an evaluation of the new design. The article will end with a discussion and conclusion section. This section will also answer questions, if any emerged during the work with the article.

# 2 Travel cards

There are several types of travel cards available today and used for everyday travel. There are the ones that contains trips and those that are valid for a period of time, and there are different technologies the cards are manufactured by. Some are made out of paper with written information on the back and some has a magnetic strip containing the information, showing information on one side. There are also those made out of plastic with a chip containing the information showing no information about the content of the card. They all have one thing in common and that is to be of assistance when people travel.

#### 2.1 Examples of travel cards

In this section a presentation of the design of existing travel cards is made, not only the chip based card and cards with magnetic strip but also the design of the mobile paid tickets. By looking at the information visible on existing travel cards and by evaluating the importance of the information, it will become clear which type of information is crucial for the interaction and should be included in the new design. The evaluation is done by looking at different types of travel cards to see which type of information is most common.

The information on these cards and tickets shows:

- For how long the card/ticket is valid (time, number of zones, number of trips, etc.).
- Type of card/ticket (if the card uses zones, period of time, trips, etc.).
- Where it is valid (location, city, etc.).
- Information regarding the use of the card (ownership, validity, etc.).
- Some kind of verification number or issue number.

The most important type of information is the one concerning the card's validity: where and for how long it is valid. This type of information is visible on all types of travel cards and travel tickets, **except for the chip based card**.



Fig. 1. Images of the chip based travel cards fronts and backs.



Fig. 2. Images of the magnetic strip travel cards fronts and backs.



Fig. 3. Images of different types of mobile ticketing services

## 3 Electronic paper

The electronic paper has been around for a while and it is not until recently it started to be used in everyday things such as signs, portable reading device, etc.

The technology consists of e-ink which is million small beads that has a negative side and a positive side. These beads turn to the other side when they are exposed to electricity and consequently change colour from white to black, etc. The e-ink only needs electricity when it changes colour mainly because the e-paper does not need any back-lighting, which is why it is perfect to use e-paper for signs and other displays that does not need a lot of electricity. The electronic paper is made by printing electronic ink on a sheet of plastic, this in turn laminated on a layer of circuitry which makes a grid of pixels [3].

#### 3.1 Related work

Following is a brief summary of projects, concepts and/or products that has been developed recently using electronic paper.

**3.1.1 Microcup** This type of electronic paper looks like most electronic paper, what is different with this one is the way it is being manufactured. Instead of printing electronic ink on a plastic sheet, this paper is manufactured by filling a grid of small cups with electrophoretic fluid and sealed with a special type of film. Thanks to the small cups this electronic paper is flexible and has a smaller risk to break and start to leak, even for big sheets of electronic paper. There has been some first generation products developed and manufactured for example; a smart card, advertising posters used in stores, all using Microcup electronic paper [6].

**3.1.2** Electronic Newspaper The electronic newspaper is made with the electronic paper which is being used so that the newspaper appears to be printed in paper but is actually digital. It offers a combination between the lightness of the traditional newspaper and the dynamic news stream the Internet has to offer. A study of existing electronic newspapers found that it was difficult to design a newspaper that reminds the user of a newspaper in paper since the electronic paper reminds so much of a computer screen. Most readers expects a newspaper to act like a newspaper not a computer screen. To solve the task a study of traditional newspaper was done, from the study inspiration regarding the design and layout was drawn from the newspapers. The influence from traditional newspaper helps new users to be familiar to the new electronic newspaper [2].

# 4 Implicit interaction

Implicit interaction is a natural part of human life, we experience it every day when interacting with humans, the problem today is that technology has no

good way of sensing it. The implicit interaction is most common with the interaction between humans (gestures, body language, etc.) since humans both have a way to give implicit meaning to our actions but also the knowledge of interpret implicit actions. The word 'implicit' in implicit interaction indicates some kind of information that the system perceives from the user's action and what the system perceives is not the user's primarily action, it is the user's secondary action; an automated action that the system can use as input [9]. One example of an implicit interaction is when a driver hits the break to stop their car, then implicit information is signalled to other drivers around so they in turn can stop. The implicit information in this case is the red lights on the back of the car.

The interaction between humans and technology can either be explicit or implicit. If the technology has sensors or in any way can perceive the user, even if it is only a little, it can use implicit interaction. To be able to differentiate humans implicit interactions from explicit interactions the sensor system needs to know the environment it is in. The system has to be able to perceive what the user is doing, but also it needs to be able to interpret what the user has done [9]. By placing sensors on human held devices technology has a way of providing information to other devices by using implicit interaction.



Fig. 4. Image of a framework that describes different interactions.

The goal with the implicit interaction is to have technology integrated seamlessly into the human life, without annoying users in their environment. A way of doing this is to make technological solutions more sociable and act more as humans, if the technology tries to act as a human being and fails it is more efficient to just show information [11]. To find possible implicit interaction and to integrate technology a way of making the intended interaction obvious to the users has to be identified. The previous framework is a way to identify different ways of interaction, see figure 4. The figure describes the attention demand; the amount of attention demanded of the user by the computer system, it also describes who the indicator of the interaction is; if the system took the initiative the user's interactions are proactive and if the user took the initiative the interactions are reactive [11]. How well the implicit interaction is performed all comes down to how well the system can determine users intended action [9].

#### 4.1 Related work

By looking at related work regarding implicit interaction ideas and inspiration for the design can be found. The following is a summary of the most relevant work.

**4.1.1 Range** This is an electronic whiteboard targeted for public use. It uses proximity sensing functions to change between display and authoring mode, in order to improve conditions when writing. The basic functions of the whiteboard is that the system gives the user feedback of what it has perceived, that the system show the user what it is doing and an opportunity for the user to stop a system action. The work shows the importance of the users initiative to implicit interaction but it also shows that a design solution can be based on field studies rather than conventions, specifically regarding the design of implicit interaction [12].

**4.1.2** Towards Implicit Interaction This is a project that has been developed to investigate how recognition of movement can be made with a set of simple sensors, in the sense of wearable computing. The project device consists of a working glove with attached sensors to recognize the users current activity, focused on the activities hammering and screw driving. The project was considered a success with an 89.47 percent recognition of activities given the sensors' limited capabilities. Problems arose when the glove needed to tell when it was idle, i.e. when it tried to distinguish explicit actions from implicit actions [5].

## 5 Method

To come up with a new design on the travel card inspiration has been drawn from previous chapters about implicit interaction and electronic paper, but also from the investigation of current solutions. The idea is to form a design suggestion that is informative for the user as well as to the guards that works with the cards every day. The focal point of the new design will be a design used in one city's public transportations and for users that use travel cards regularly.

The design suggestion is a concept, it will show what the design will look like and the technology solution behind the design suggestion will not be addressed in the article.

# 6 Design suggestion

The goal of the new design is a design that will lure the user to really use the travel card instead of hiding it in their valet, and at the same time be easy to understand for both frequent and seldom users. This is done by making the chip based card more dynamic and fun for the user.

By taking inspiration from the implicit interaction the new design will use a new factor for users, a factor that will show the user when they last used their card, which will make them take out their card and use it more. This is done by providing dynamic and visual information about the user's travel habits implicitly, for example: if the user uses the card at night the card will become dark with light writing and the other way around during the day. This will give the user dynamic and interesting information about their travel habits, where the implicit interaction is what time the user travelled.

The information that is focused on in making the new design suggestion was collected from an extraction of information from available cards, see list in section 2.1). The type of information that is shown on all cards or tickets with most information is where and when (i.e. how long) it is valid, which feels instinctively to be the most important type of information a user could get. To give the users even more interesting information an indicator is positioned on the card along with the written information, this indicator shows the user how much of their travel capabilities are left. The indicator also provides further understanding of possible travels, for example; for children, for those who has trouble reading or has low vision. But it will also be useful for everyone who uses the card, it will give the user a quick information overlook if needed.

When the technology of the electronic paper is developed further the travel card could change colour when it is used during different times of the day, instead of only changing from black to white. If the user for instance mostly uses their card between the hours 13-16 it will become one colour, and if the user mostly use it between the hours 19-23 it will become another colour, etc.

If the system require the user to remove the card from the wallet to register a trip, the updating of the card's visible information will become an implicit interaction and if the card gives the users more information it is more likely that the user remove it from their wallet. The card then gives them a beneficial knowledge and will be more frequently used [9]. By changing the hardware of the system behind the chip based card, the system could require the user to use their card. This could be done by having a slot running along one of the edges of the card.



Fig. 5. Images of what the new design will look like in day-time.



Fig. 6. Images of what the new design will look like during the night.

Since the electronic paper needs electric power to update the presented information [3] the user needs to come close to the chip reader or slide the card in a reader to directly expose the card to electricity. With some type of electronic paper there is a risk for the paper to become faded after a while of not exposing the card to electricity. This could be a type of implicit interaction or function which will encourage the user to update and use their card since the card loses information after a while.

The most challenging part of the implicit interaction is to make the intended interaction obvious, especially when the user needs to update their card. To help determine what kind of action to take and what type of interaction should be used previous framework of interactions is used, see figure 4. The goal is to use interaction that is known to the user and to keep the level of interaction in the

lower right quadrant of the framework. By using that quadrant the interaction between the user (i.e. the card) and the system will be the most implicit, and the user only has to focus on the known action with the card. The known action is in this case the action to present the travel card to a reader or slide the travel card in a reader in order to register a trip.

## 6.1 Design evaluation

Following is an evaluation of the new design using W3C guidelines [1] for web applications, it will be performed to determine the usability of the new design. In this article no deeper explanation than the title of the guidelines will be made, the guidelines will be mentioned in regards of the new design and existing travel cards.

These guidelines point out the most relevant and important aspects in the design of the card, and since the guidelines consists of a lot of checkpoints only the most relevant checkpoints will be used to evaluate the new design. W3C guidelines were chosen since they were the only guidelines with reasonable amount of checkpoints appropriate for this purpose.

**6.1.1 Don't rely on colour alone** The first version of the travel card's new design consist mainly of black and white colours, i.e. contrast colours, since the electronic paper is not yet available in other colours. On the other hand the available travel cards has a lot of colours but tries to compensate the colours by using a distinct colour for the font.

**6.1.2** Create tables that transform gracefully The existing travel cards has no information on the card that can be transformed, all their information is static and shown on a separate screen when registering a trip. On the new design the front side of the card consist of a figure that is positioned in the center by itself and the text beneath is also positioned in the center with space around. Transformation (i.e. when the users travel opportunities change) should not be a problem. The only possible concern could be when the user buys a lot of trips which makes the validity field many tokens.

**6.1.3** Ensure user control of time-sensitive content changes This is not a problem with the new design nor the available solutions, there is rarely any fast blinking in the solutions that could cause seizures. The new design is however blinking, at least once when registering a trip, is not sufficient to harm the user.

**6.1.4** Ensure direct accessibility of embedded user interfaces Direct accessibility is non-existing on existing travel cards, however on the new design the front side of the card provide the user with information regarding the content. The information input available on the new design is kept to a minimum to maximum the accessibility.

**6.1.5 Design for device-independence** The new design could integrate a whole county's travel cards so that one card could be used for many solutions. Depending on the hardware solution possibilities the card could furthermore consist of a RFID based solution providing an alternative solution for systems that does not install the slot solution, and therefore might not use the electronic paper solution of the new design. With existing solutions you need a new card for a new solution, and these solutions are different in every city.

**6.1.6** Use interim solutions Since the new design needs a RFID reader (or something similar) to get information from the user's card, older solution would also be able to function. The new solution needs to extract implementation from the older solution so that both technologies can function at the same time.

**6.1.7 Provide context and orientation information** The new design provide context information since the implicit interaction gives the user information about when the user made its most recent journey, dark or light design depending on which time of the hour its used. By using the same colour or same contrast level on the written information as well as on the indicator, the user should understand the relation between the text and the indicator. The card also gives the user information about where the card is valid, i.e. orientation information.

**6.1.8 Provide clear navigation mechanisms** The indicator on the new design functions as a navigation mechanism, it help the user to get a richer and bigger understanding about their travels and travel possibilities. What could be interpret as a navigation mechanisms in existing solutions, is the red or green light and/or the beeping sound when users registers a trip.

**6.1.9** Ensure that documents are clear and simple Since the existing travel cards shows no information about the user's travels the existing travel cards does not have a problem with keeping the design and layout of the information clear and simple. The document, i.e. the card, is kept too simple and too clear. However the systems (external screens, etc.) found on buses or trains is kept semi-clear due to its colour coding when register a trip, i.e. green lighting when the registration is passed and red when there is a registration that is not valid, but is too badly light in general to be able to see any other information it has to offer. The new design has kept the information variables to an minimum to minimize possible information overload and input confusion.

# 7 Discussion and conclusion

A new design could help improve the interaction and it is possible but somehow forgotten. Attempts have been made to improve the use of travel cards both for the user and for the people working with the travel cards, such as guards. While the focus has been on improving the simplicity for the guards the usability for the user has been a bit overlooked, the user has to come in contact with either the guards or other public means to receive information from their travel card. Even though there are some solutions that consists of a website which provides the user with information about their card, this information can sometimes be inadequate and not available when needed. Not only would a new design help users to understand their travel opportunities better, it could also help them to interact and appreciate technology better. It might even prohibit users from spending unnecessary money.

Despite the fact that a mobile ticketing service solution probably would work just as well as a chip based card solution it would be ashame if the chip based travel cards were to be extinct just because there is new technology that could do the job instead. Why not use existing solutions and update the technology which could further improve the overall solution. By doing this more users can appreciate the solution as a coherent group instead of dividing them. The groups consisting of old users that are used to paper travel card and users that are used to mobile ticketing. The electronic newspaper [2] is also one example of an artefact that has to deal with two user groups, in terms of reading. People experienced with technological news streams and people who are only used to the paper version of news streams. This was a help when inspiration to the new design was needed, it gave an idea to take inspiration from previously used solutions.

For future work an evaluation of the whole system combined with user interviews and polls should be performed before the solution is further developed. The new design would mean a new kind of use of technologies not commonly used, for instance the electronic paper. A prototype has to be made to really evaluate the functions behind the overall system, even though an analytic evaluation of the design has already been made. After reading the study about mobile ticketing services [8] it became clear that the lack of user's travel information is connected to the fact that the use of mobile ticketing services gets more and more common. This proves that existing solutions has made typing a text with your mobile phone (mobile ticketing services) more convenient than being unsure of the status on your travel card. This is one of the reasons of why this article was written.

These travel cards are supposed to help people get around and travel, some might be intimidated by the technology and the fuzzy information output they give today. This is an unnecessary contradiction in our age with expanding technology resources.

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