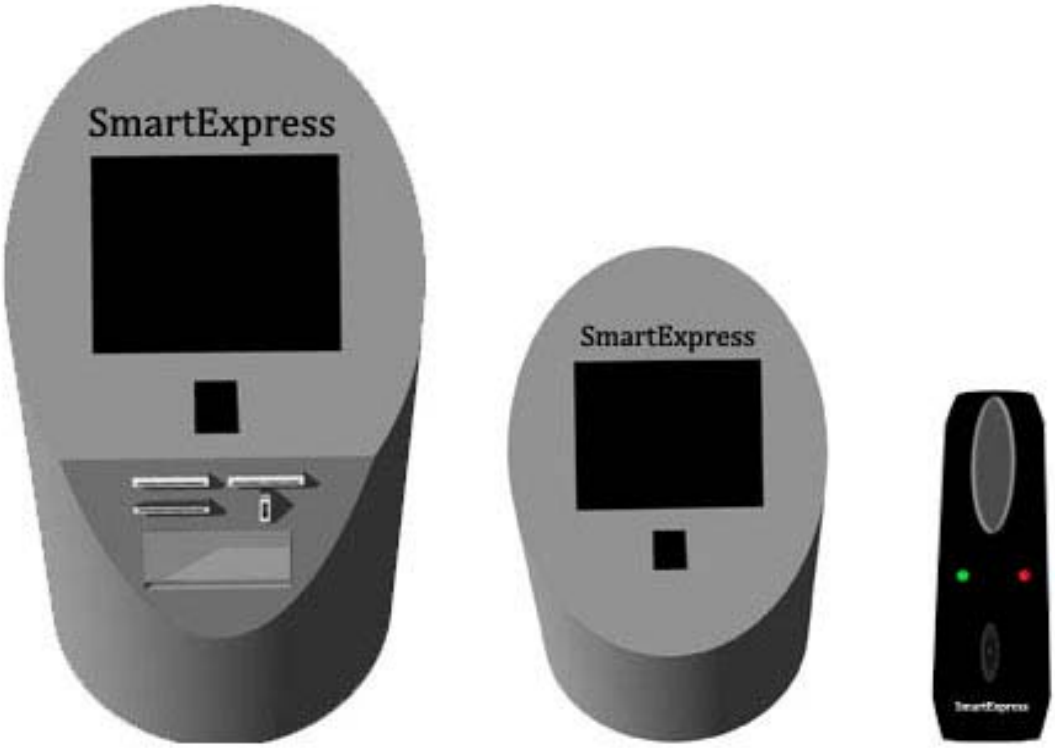
SmartExpress

A design solution on transportation payment



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Abstract

This is a research focusing on stimulating the comfort and safety when it comes to payment for travelling with the trains and the busses in the Swedish county Skane. The question at the issue is; can we create a system that doesn’t require the responsibility of carrying a particular tool? Can we give the passengers the possibility to control their accounts to register in a more independent way than today with Skanetrafiken? And can this be done by using fingerprint technology?

My goal is mainly to observe today’s monthly and discount-card system in Skane and around the world, discover the disadvantages and design a new system as solution. The new payment system is called SmartExpress. It involves fingerprint recognition and will hopefully fit in today’s technology and have useful possibilities that will come in handy for the next generations.

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1. Introduction

One of the most common things for the citizens around the world is travelling with trains and busses. Even some people that have cars or other vehicles prefer to take the train or the bus once in a while. Both passengers and the workers within this area need fast and straightforward action possibilities to be able to enjoy more of the comfort and safety regarding their trips by means their trips need to be easier, more comfortable and time saving without technical issues. The passengers also dislike when they're on the line at the agencies waiting for their turn to pay, when the paying machine looks complicated or functions badly and also that their cards can get demagnetized or lost. The whole idea with this work started long before starting my research. I was one day at the central station in Malmoe and walked by Skanetrafiken's ticket machines. I watched people buying their tickets and refilling their cards and asked the questions: How easy is it actually to travel with Skanetrafiken's system? What could be the best way to create an alternate system that can solve the problems with today's cards? And in which ways could it be unique and more useful? Watching a handicapped man getting on the bus with two bags in his hands, first putting them down and then reaching for his wallet and hardly taking his card out while the other woman behind him is waiting convinced me that there needs to be another way; another tool for this sort of payment that can make it more comfortable and time-saving for the man, the woman behind him, all the other passengers on the bus, and the bus driver as well. I continued with the questions: What payment opportunities could be given for people to travel with the trains and busses in the most comfortable and safest way? What would also make it easy and time saving for both the passengers and the workers within this area? ”

Later on I came up with the idea of using fingerprint technology for transportation payment and wanted to see if there are technical possibilities without any security problems to be able to build the needed system. I imagined a system where the passenger scanned her/his finger to verify the payment on the train and on the bus. I was aware that it had to be a very strong and quick system; it had to be secure and as qualified as possible but personally considered the concept as a useful research that maybe could be applied in daily life as well.

My research points at today's issues with transportation payment for trains and busses and comes with a new system called SmartExpress as an alternate.

1.1 Background

In all the countries around the world, transportation payment for busses and trains are done by using a tool; mostly a magstripe card. They all have a thing in common; the passengers need to use a tool to verify their payments with.

The reason for designing a system that involves fingerprint recognition is to make it possible for the passengers to not worry about carrying this particular tool to pay with, and to not worry about losing it or getting it damaged as well. If they for instance get robbed or lose their bags, their fingerprint will still take them home or wherever they need to go. Since today's cards have the disadvantage of getting demagnetized, they will feel more secure about never getting their tool destroyed.
At the same time payment with fingerprint will be easier and more time-saving than payment with cards; the passengers won't need to keep an eye on it and have it ready before getting on the bus or on the train like today; since their finger in this concept is the actual tool.

1.2 Purpose

The purpose with this project is to analyze today’s transportation payment systems for busses and trains around the world (especially in Skane) and create an alternate system that can increase comfort and security both for the passengers and the workers within this area. Through my observations and studies I will look into possibilities (both technical and logical), and try to implement them into the new concept to create a better system.

2. Skanetrafiken and around the world

"Mobile- ticketing with sms has been a success in many towns in Sweden. Skanetrafiken has been taking another road, they don't have the cash-stop at this time yet but they want to serve the whole area with mobile and instead of just short messaging, they want you to download a Java product on your phone and use it either for buying ticket function or save the time table on your phone. I think there will be a large increase of using mobile phone for ticketing in the future. Then of course you shouldn't forget the problem that the battery must be loaded, what is the cost, what kind of agreement do you have with our telecom partner, does it allow you to do this internet handling or such things… so that of course makes it a little bit more complicated. The way we do it is a bit more complicated than a short message so it will also keep down number of people that can be interested to use it." (Lundberg, Mats/ Skanetrafiken)

Smart Card: Skanetrafiken has recently changed their system by using smart card. The benefits with smart card are that it's not easy to break and it provides a faster entrance on the bus. At the same time you don't need to insert it into the machine so the speed of getting into the bus will accelerate. You hold the card close to the reader that detects all the data from it. You can refill the card via internet or your bank account on a monthly base and your new period will automatically load on your card.

Mobile-ticketing: Mobile-ticketing system in the Swedish county Skane is still being tested and is expected to politically be confirmed by august/2009 (Skanetrafiken, 2009). At first you send an SMS to the company and then get a link back where you can download the needed program to your phone(only once in the beginning). You afterwards run the program, choose your destination and ticket type and buy your ticket. On the bus you hold up your phone to a reader that recognizes the data stored in it. You are able to load prepayments onto your cell phone, either directly from your bank account or credit card.

Most of the transportation payment systems around the world are becoming contactless and developing in the mobile-ticketing (See picture 1) and smart card (See Picture 2) direction.

Picture 1, mobile ticketing (http://www.rfidjournal.com/article/view/2062/1/1)

Picture 2, smart card (http://www.fta.dot.gov/smartcard_1.jpg)

Mobile ticketing is being tested in the Finnish city Oulu (RFID Journal, 2005) where Buscom has its headquarters. The test involves Buscom employees using RFID-enabled Nokia 3220 phones that feature tags embed in the shell that connect to an application located in the handset. According to Buscom, using mobile phones in place of smart cards for public transport can bring many benefits to transportation companies and their passengers. "Big cities spend millions and millions of dollars on their sales and distribution networks, as well as on smart cards and paper tickets," says Buscom's managing director, Kauko Suhonen. "Using mobile phones could cut a lot of that expense." For bus customers, the technology would bring several benefits that smart card systems cannot deliver. They could use the phone's Internet connection to pay for a ticket and load it into the device, for example, and they could also use the phone's display screen to check ticket balance and usage, and other data.

Currently, Buscom reports, trial passengers load prepayments onto their mobile phones by visiting an NFC-equipped ticket office. Even in the planned commercial system, such a visit would be necessary for the first payment, and to install the required application onto the phone. Starting in March, however, when up to 30 phones will be equipped to use the new payment system, the trial will add the option for a participant to use a phone's Internet connection to buy travel credit. The payment will be made either by deducting from the passenger's bank account or by credit card. Buscom says its system already works, and that the trial's purpose is to determine how best to handle exceptions and real-life problems such as phones that are lost or have dead batteries (RFID Journal, 2005).

Another contactless transportation payment system for busses has been developed in Turkey (Contactless News, 2009).VeriFone Holdings has developed an EMV-certified integrated transportation payment system in conjunction with Bank Asya that is being used on buses in the city of Kahramanmaras.

The system was designed to enable municipalities to transition their bus systems from cash to bank cards and credit cards. VeriFone designed an integrated solution that accepts payment by EMV cards and utilizes contactless technology. Bank Asya will issue payment cards for the system and MasterCard PayPass contactless cards that will speed up passenger payment. MasterCard and Bank Asya recently launched AsyaCard DIT, a multi-application chip and PIN card that combines MasterCard EMV OneSmart features with an integrated municipal toll and transit application as well as contactless technology.

In addition to paying for bus fares, AsyaCard DIT owners can use their cards for tolls on motorways and bridges, including the two bridges over the Bosphorus Straight in Istanbul that connects Europe and Asia.

Also in the city of Bristol about 100 miles west of London is looking at adding a contactless card system similar to London's Oyster card in an attempt to speed up loading times of buses and trains. Some 20 or 30 passengers would be able to board a bus in seconds, simply tapping their cards against a sensor, rather than the five minutes it could take now if drivers have to deal with cash and hand out change.

The Bristol City Council has agreed to fund a study to examine the feasibility of introducing reloadable payment smart cards. Still, implementation of such a program is at least a year off (Contactless News, 2009).

When looking at Russia, we see that the use of plastic cards has become widespread over recent years and the deployment of equipment at point of sale is accelerating. This development of cards entails an increased risk of card piracy, trafficking and phishing, forcing banks and public-sector organizations to look for new protection solutions (Contactless News, 2009).

The keen interest generated by near field communication over recent years has concentrated on the possibility of transferring credit and debit cards to mobile phones in order to make contactless payments regarding contactless transportation payment systems in France as well.

However, the complexity of setting up standardized and secure NFC systems, as well as the need for the various players – operators, card issuers and associations – to agree on a suitable service model, has delayed the wide-scale launch of contactless payment systems in France (Contactless News, 2009).

Dublin's Railway Procurement Agency has chosen IBM to create and implement the infrastructure for a public transport ticketing system in the greater Dublin area. The payment system will enable commuters to use a single pre-paid contactless card similar to London's Oyster, for travel on all buses, trains, trams and coaches in the city (Contactless News, 2009).

This next generation automatic fare collection solution has the capacity to process up to two million transactions a day and can be extended to include other value-added services such as reloading the card via the Internet and retail payments.

In addition to working with the city of Dublin, IBM is also assisting the cities of London, Stockholm, Singapore and Brisbane, to meet traffic management and congestion challenges. IBM has established a team of professionals working on a range of technologies and solutions, including researching, testing and developing new Intelligent Transport system management capabilities (Contactless News, 2009).

As we can see contactless card and mobile-ticketing are today's most considered payment systems around the world and are still in the process of developing. And as we can see, there are security issues with copying magstripe cards and with the internet handling, also complexity of technical issues with these systems.

My goal now is to find the possibilities for SmartExpress to build its fingerprint system in the best way.

3. Travelling with fingerprint

3.1 Fingerprint Research

Archaeological findings show the interest in the individuality of the fingerprints although scientific researchers do not appear until the sixteenth century. Since then, a large number of studies have been performed. In 19th century, these identifying keys were used as trial proofs. During last decades, the intent of fingerprint recognition was very useful in forensic labours. Nowadays, fingerprint matching as a measure of safety in the verification programs is a hot topic (Nordberg, 2007)

Verifying with fingerprint is a safe method by adjusting the numbers of minutiae (Neureka, 2009). It can today be processed in two different ways, either by an optical sensor or by a capacitance sensor. An optical sensor reads a fingerprint as a photographic picture X Y matrix on a 2D picture. It has advantages such low price and is less-sensitive for physical damage and that's why it should be chosen when building the system for SmartExpress. You replace your finger on a sensor which measures the electric currents that show up between the valleys and heights of your fingerprint. It's possible to read 30-40 different minutiae from a usual fingerprint. FBI has in their investigations showed that two individuals can not have more than eight of these characteristic ones in common. America has based the identification with fingerprint to 12 matching minutiae but some states have less demand. One of the advantages with fingerprint is that it has kept itself stable compared to voice and face-scanning.

To match a print, a fingerprint technician scans in the print in question, and computer algorithms are utilized to mark all minutia points, cores, and deltas detected on the print (Wikipedia, 2008).

In the 2000s, electronic fingerprint readers have been introduced for security applications such as identification of computer users. However, early devices have been discovered to be vulnerable to quite simple methods of deception, such as fake fingerprints cast ingles. In 2006, fingerprint sensors gained popularity in the notebook PC market. Built-in sensors in

ThinkPads, VAIO laptops, and others also double as motion detectors for document scrolling, like the scroll wheel (Wikipedia, 2009).

Fingerprint SDK stands for Software Development Kit and is a software toolkit that allows the integration of biometric fingerprint recognition into various applications (Wikipedia, 2009). It provides a basic framework of functions to talk to a fingerprint scanner, capture an image, extract the unique minutiae data from the image, and compare two sets of extracted minutiae data. All of the more complex features and functionality are built upon this framework. On this page (Wikipedia, 2009), one of the important notes is that there are SDKs which are capable of 1 to N up to millions of prints. Some SDKs are capable of positive ID against large populations, as confirmed by sizable commercial deployment using 1 to N ID. Another important note written on this page (Wikipedia, 2009) is about providing a complete encrypted storage and indexing capabilities, using industry standard databases and platforms to store the extracted minutiae.

There is an international fingerprint competition called Fingerprint Verification Competition (FVC, 2006) whose organizers are:

1. Biometric System Laboratory (University of Bologna)

2. Pattern Recognition and Image Processing Laboratory (Michigan State University)

3. Biometric Test Center (San Jose State University)

4. Biometric Recognition Group – ATVS (Universidad Autonoma de Madrid)

FVC is the world's largest competition for fingerprint verification algorithms. Their goal is to discover recent advances in fingerprint verification and reach out to its development. FVC applies algorithms over four databases of fingerprint images from multiple sources and computes a set of biometrics parameters describing its accuracy and performance behavior. Each of four image database has diverse quality and characteristics depending of the source sensor type. The FVC 2006 databases were obtained from the following sources:

Database 1: Electric field sensor

Database 2: Optical sensor

Database 3: Thermal sweeping sensor

Database 4: Artificial images from SFinGe v 3.0 software

These events received great attention both from academic and industrial biometric communities. They established a common benchmark, allowing developers to unambiguously compare their algorithms, and provided an overview of the state-of-the-art in fingerprint recognition. The aim is to track recent advances in fingerprint verification, for both academia and industry, and to benchmark the state-of-the-art in fingerprint technology. The participants can be from academia, from the industry, or independent developers (FVC, 2006). I personally found those competitions very educating and also cooperative regarding building the needed fingerprint system for SmartExpress.

I called Per-Ragnar Johansson (Escalation specialist at Microsoft Sweden) to talk about different fingerprint devices and he sent me some links as examples. In one of those links I was convinced that the fingerprint sensor for SmartExpress is supposed to be optical (Biolink, 2007) since it provides the highest quality and accuracy of identification regardless of the skin color and operates effectively with problem fingers (dry or damaged skin, etc.). Another useful link that he informed me about was Biometric Solution's webpage (Biometric Solution, 2009) where different fingerprint devices were listed with images and their characteristics. Since the technique of these fingerprint devices are limited and intended to be used by limited amount of people, I was again convinced that a new system for the SmartExpress products needs to be built instead of applying the concept of an existing product but those links were absolutely educating regarding more knowledge about fingerprint technology and some existing products.

To be able to gain more knowledge about children's fingerprints I contacted Roger Andersson (Fingerprint specialist at Malmoe Police Station). He stated that children's fingerprints are no problem to read but because of their physical development; they get bigger with time and their shapes get modified. He said that this wouldn’t be a problem since the fingerprint system is being used as a payment tool that is valid for maximum a year, but they will need to update their monthly and discount membership after a few months from their registration.

3.2 Final concept of the fingerprint system for SmartExpress

After my research about the technique of fingerprint technology and observations of the user's needs, I have listed the required properties of the needed fingerprint system for SmartExpress. To be able to create a qualified and secure concept by using fingerprint technology, the builded fingerprint system will have the following characteristics:

1. Optical sensors with the programming package SDK (to make it strong against hot, cold, dusty or sweaty skin and physical damage and also provide a high user-capacity of saving millions of prints).

2. Verification in maximum one second (to fulfill its purpose and make it easier and time saving).

3. Presenting every user as a number in the database when reading and saving the fingerprint instead of saving any personal information (to avoid making the users feel uncomfortable with their fingerprint as identification and bring comfort, ease and security into their lives), also give them the option to anytime delete their fingerprints from the database by cancelling their membership (to make them feel comfortable to try the system without fear by knowing that they can change their minds and cancel it).

4. Letting the users have an alternate finger option in case they don't have the possibility to use their main one at the moment (to give them an alternate possibility to do their payments with).

5. Letting the users choose any finger they want out of all their fingers when stating the main and alternate finger (to not cause any confusions and let them express themselves in the way that they want, to let them use the finger that they are most comfortable with also giving them the possibility to be able to use both hands).

6. Giving the users the possibility to change their main and alternate finger (to make them feel secure about having the possibility to state a new choice just like changing passwords on the computers and other digital devices).

7. Letting the users have a receipt as proof to their membership if needed. It is for their security to make them feel secure that it's their own membership and also for users that have had an accident or other problems with their hands and can neither use their main or alternate finger.

8. Letting the users scan their fingers in any rotation (to scan the fingerprint faster without focusing on replacing the finger in a certain angle).

4. Research methods and theories

4.1 Qualitative research

As Cooper and Reimann also points out (Cooper&Reimann, 2003), a qualitative research helps us understand the existing products and how they are used. They help us understand the problems that the new product hopes to address. They also let us analyze technical, business, and environmental contexts of the product to be designed and other social aspects in domain question. Types of qualitative research are Stakeholder interviews, Subject matter expert (SME) interviews, User and customer interviews, User observation/ethnographic field studies, Literature review, and Product/prototype and competitive audits (Cooper&Reimann, 2003).

Stakeholder and Subject matter expert (SME) interviews

“Research for any product design, though it must end with understanding the user, should start by understanding the business and technical context in which the product will be built. Stakeholders are any key members of the organization commissioning the design work, and typically include the managers and key contributors from engineering, sales, product marketing, marketing communications, customer support, and usability.” (Cooper&Reimann, 2003)

“Some stakeholders may also be subject matter experts (SMEs): experts on the domain within which the product you are designing will operate.”(Cooper&Reimann, 2003)

To be able to see from a perspective of the company that owns the stations, I met Thomas Franzon who is a project leader at Jernhusen. He talked about today’s card system, compared it with SmartExpress and focused on its development. He described today's card as a

valuable document that can possibly be lost or damaged so a better system could be built instead today's ordinary system according to him. He also pointed out that people today need to queue up at only one certain place (Skanetrafiken agencies) to buy their card or refill monthly and that this is a problem which needs to be solved. An advantage with the card system is that it's possible to loan it out to others according to Franzon but he would still consider having something that isn't possible to get rid of instead. He said that SmartExpress would make it faster, easier and safer for the passengers; it would increase the security; but only if one could manage to build it. He also suggested that the companies in Sweden should cooperate and make it one payment system everywhere in Sweden. He claimed that cooperating would bring financial advantages.

"I think it's necessary to get many companies into the system. Otherwise you have to use this machine for one company, and another machine or ticket machine for another company so it's very important to connect the companies operating trains and busses together in one system and I know that there are thoughts about it but it's very hard to fix it. That's my opinion and what I heard of those who's operating the trains and busses. I am also a little curious, what about the costs for the machines; if it's a new technique in the beginning maybe it's expensive but if its spreading around the country, the cost will downsize, of course, of course...I think that SmartExpress is very nicely, very convenient, I would recommend it." Franzon, Thomas/Jernhusen

Another interview was with Oscar Grönvall; traffic manager from Tyrens. He discussed Skanetrafiken and SmartExpress, focused on the time-process to realize the system to make its advantages come true and considered it as a long processed research that can be used by the next generations.

"I think the advantages (with Skanetrafiken's cards) is that you can refill it by your computer at home, and you only have to recharge it outside on the valuators, so it's easier for most of the people today that work with computers...of course we can find a way to pay without a card, it's easy but I don't think it's that easy to find that system sure enough at this time.....of course it's easier (with SmartExpress), you always have the fingerprint with you so it's good to get rid of the card." Grönvall, Oscar/Tyrens

Mattias Wallergård, teacher from Lund University Design Center focused on the concept and the design of SmartExpress. He analyzed the concept and the design of SmartExpress, pointed at today's design issues about the ticket machines. He suggested some observations and shared his design knowledge.

"Well, it's quite hard to forget your hands at home, (laughing), I can see efficiency factor also, in the sense that you don't have actually take out your wallet and all those things so you save time there; time and effort. Eventually you have to take off your glove but it's still easier than taking out the wallet I would say...of course it has an easier interface...I guess it would be very hard to put the finger the wrong way...it would be easier than card, definitely..." Wallergård, Mattias/Lund University-Design Center

Interview with Mats Lundberg from Skanetrafiken (responsible for the ticket machines) gave me the possibility to look from a management perspective and see the ideas on how to improve the concept for SmartExpress. He talked about Skanetrafiken and looked into

important aspects of SmartExpress. He compared those two and discussed the possible technical problems with the wireless devices and pointed out the needed solutions. He said that fingerprint has better possibilities and is easier since it can't be interrupted like the cards but discussed the possible issues with the communication between the database and the units outside for wireless connection on the trains and busses. He said that Skanetrafiken has the problem with recognizing the updates in milliseconds and is still working on it. He also said that this problem would probably be solved with the faster communication of the next generations when the connection is more developed. The stationary system would work without any problem because of the existing office environment according to him; but the wireless communication needs a development.

“Anyone can use it (Skanetrafiken's cards), your family, if you want to borrow it to your friend; as long as one person, one card; that’s one benefit. You can refill the card via internet or your bank account on a monthly base and your new period will automatically be loaded on your card. Magstripes have been easy to copy for many years but together with the whole system we have kept it very low. There are attempts of copying cards, create cards yourself, etc but we caught them in daily base and got them on hot lists, so I think security has worked. The disadvantages are that of course magstripe card and magstripe is very easy to disturb someway...You don’t have to carry any cards (SmartExpress); you always have it with you; that’s the benefit.” Lundberg, Mats/Skanetrafiken

User and customer interviews

“Customers of a product are those people who make the decision to purchase it. For consumer products, customers are frequently users of the product; although for products aimed at children or teens, the customers are parents or other adult supervisiors of children.” (Cooper&Reimann, 2003)

To be able to see the first reaction on people, I did interviews with random people regarding Skanetrafiken and SmartExpress. When asking them about how they analyze today's card system with Skanetrafiken, mostly young people said that they are very annoyed when their cards get demagnetized. They dislike the fact that they always have to watch out so that they don't have their digital stuff close to their bags:

“Well my card gets demagnetized. I have many digital things in my bag so I always have to have my card far away from them and every time it happens I have to go to Skanetrafiken and change it. It's stressful.”

Some people complained that the ticket machines are out of function:

“The machines are often out of function. I get angry when I get on the train and explain the situation and say that I need to buy it on the train instead. Sometimes I get the feeling that they don't believe me and it's not even my fault.”

Some people were unpleased about the fact that they can't buy a monthly card anywhere else than at Skanetrafiken’s agencies and whenever they want to.

“They don't open early. When I sometimes go to work in the morning I have to buy a ticket because they are closed and my monthly card has expired and I can't even buy a discount card and I want that possibility. ”

“I think that they are slow. To refill my discount card I sometimes stand on the line for so long. Sometimes it gets too long that I miss the train”

When talking about SmartExpress, most of the people looked curious and interested. They discussed the security aspects of the fingerprint system by asking questions about what I thought of doing to increase the security with the system, what I've done to make it used in the most useful way. Some were unsure if their fingerprint could be stolen and wanted to be convinced that it isn't easy to do that. They would like it if such a system existed but weren’t sure that the required possibilities exists. Since those interviews occurred during the beginning of my research, there wasn’t user-testing or presentation of a full concept, they weren’t totally convinced that it is what it sounds like, so the conversations ended with curiosity. The idea of a fingerprint system as a payment tool sounded good to them but they would rather understand and see more of it before they could make a full comment on it.

Later on, after making some illustrations of the devices and their interfaces, I did more interviews. The concept was developed and the images of the designed system helped people get a clearer vision about SmartExpress. Most of them talked mostly about the process of building the fingerprint system. When telling them about how the system will work, they were convinced that it isn't easy to abuse since there is a possibility to chose any finger as a password, and an alternate finger and a receipt (see register monthly/register discount) but had doubts about the devices' power. They wanted to know more about the sensitivity of the devices and pointed out that they still need to be functioning very well when for example the weather is cold or when the fingers are dusty and so on. Most of them said that they would feel more comfortable and it would be more time saving with a fingerprint instead of a card because it is easier to keep an eye on and use but that was only as long as the fingerprint system and the machines were good enough. Some people even asked about how the connection on the bus and on the train will be and if it will be fast enough so that the verification could occur fast.

Young people appreciated the system more and some older people were more unsure of how to use the SmartMachines (see SmartMachine) when showing them the steps on the interface. But the opportunity to register at the agencies and some other stores gave most of them a good feeling about getting the job done by the receptionists and some even said that they would in the beginning register at the agencies and after a while use the SmartMachines when they are more familiar with the system. Most of the parents would consider using SmartExpress instead of today's card system with Skanetrafiken.

“If it's possible to build such a system, I would consider it.”

“I really like that I won't need to carry something. I think it's good and gives a free feeling.”

“If it doesn't have the problems, they system I mean, I want SmartExpress”

“If it is secure, if the system doesn't break easily and works fast I think it's the best. I would feel secure that my child has it.”

User Observation and/ethnographic field studies

“Basically you can talk to users about how they think they behave, or you can observe it firsthand. The latter route provides superior results.”(Cooper&Reimann, 2003)

The very first and one of the most important research methods used was observing people in the related areas. Studying the passenger’s actions while interacting with the ticket machines, watching them do their payments on the trains and busses made me realize some difficulties that they had. My observations and ethnographic field studies helped me understand and analyze their frustrations with today's card system, its domain-related issues and vocabulary. For example watching people queuing up at Skanetrafiken’s agencies made me realize that there has got to be more possibilities to buy or refill the cards. Watching a child using a card on the bus; the difficulties he had after inserting it on the wrong direction and all the technical problems that this action caused made me think of the possibilities of an easier tool to pay with.

Litterature Review

“The design team should collect the literature, use it as a basis for developing questions to ask stakeholders and SMEs , and later use it to supply additional domain knowledge and vocabulary, and to check against user data.” (Cooper&Reimann, 2003)

In order to keep my knowledge fresh about the certain topics that need to be brought up when doing an interview with a certain stakeholder or a SME, I printed out some papers where related info from the research links were listed as topics. Those papers also included a sort of presentation of my work and the questions for those interviews.

Product and Competitive Audits

“Also in parallel to stakeholder and SME interviews, it is often quite helpful for the design team to examine any existing version or prototype of the product, as well as its chief competitors” (Cooper&Reimann, 2003)

I printed some pictures of SmartExpress devices and their interfaces to show the stakeholders and SMEs while presenting my work. Just like using illustrations in a paper work; showing those during stakeholder and SME interviews helped them get a better vision and analyze the concept of SmartExpress.

4.2 Persona and scenario

A scenario is an "informal narrative description" (Carroll, 2000). It describes human activities or tasks in a story that allows exploration and discussion of contexts, needs, and requirements. (Preece, Rogers & Sharp, 2002)

Just as physicists create models of the atom based on raw, observed data and intuitive synthesis of the patterns in their data, so must designers create models of users based on raw, observed behaviors and intuitive synthesis of the patterns in the data. Only after we formalize such patterns can we hope to systematically construct patterns of interactions that smoothly match the behaviors, mental models, and goals of users. Personas provide this formalization. (Cooper & Reimann, 2003)

When discussing with my advisor Mikael Svedemar at one of our meetings, his idea of a tourist using SmartExpress got me inspired. Later on, the interview with an Irish friend convinced me to use his perspective in the scenario. His exciting expressions when telling him about registering monthly with the SmartMachines made me want to write about two friends talking about the system where one of them is familiar with it and the other one is not. The interview with my friend ended by him wishing SmartExpress to be realized and the following scenario reminds of our conversation.

Peter, a 28 year-old student arrives from Dublin/Ireland to Kastrup/Copenhagen Airport. He is on his summer vacation, on his way to Malmoe/Sweden to spend the holiday with his childhood-friend Anders. Anders' father is Irish and his mother is Swedish. He lived in Ireland until his parents got divorced and then moved to Sweden with his mother when he was 12. He never lost contact with Peter though, they chat almost everyday and visit each other from time to time.

While waiting for the train outside on the track, Peter notices the unique-looking machines, gets up and walks through them with curiosity. He realizes what he sees is a transportation payment machine for trains and busses called SmartMachine that belongs to the company SmartExpress used in the county Skane of Sweden. He decides to test it until his train comes because there is still 15 minutes left. After first selecting the language English, he tries to register a monthly membership. He comes to the page where he is supposed to state the destination by picking the two cities to display the zone and he easily selects Malmoe at first but doesn't know what his second choice should be since he doesn't know much about the cities of Sweden. He decides to give his friend Anders a call:

Peter: Hi dude! What's up? I am now waiting for the train to Malmoe but that's actually not why I called you for.

Anders: Hi Peter! I'm so happy to hear that you have arrived! What happened?

Peter: Man, there is this interesting transportation payment machine with touch-screen function and I want to register monthly. What do you say? Do you think it's a good one?

Anders: Yeah that's clever to do actually. We now pay our trips with our fingerprints, you won't need to carry anything to pay for your trip when you are here; we're going to travel a lot and enjoy it!

Peter: That sounds cool buddy! But I need your help now. What city should I choose as a second one? I have no clues about the other cities and zones.

Anders: We are going to travel a lot and I will show you the most of the cities in beautiful Skane! Just click on the Skane-Smart button for the whole Skane. It's cheap, and will come in handy after all. And by the way, don't forget to make your period choice with the calendar below.

Peter: Okay, I chose SkaneSmart. Dude, I already stated the days and scanned my finger but why does it want an alternate finger?

Anders: Well for instance… what if you have an accident and are not able to use your main one at the moment? Sorry for saying this by the way, I hope it never happens but you know incase… And also imagine that there is a problem and they suspect that you have copied it somehow. Then they will ask you to scan your alternate one to make sure that it is your own membership, otherwise they'll get you on their hot list. You know what I mean?

Peter: Yeah, that sounds good, I really dig this buddy! Okay, I did my payment and now got two things here. What is SmartCode?

Anders: SmartCode is the username and password for you to take advantage of their online possibilities. By using this code, you can download timetables to your mobile, get updated information about the traffic, the zones and so on… and you can also refill online with it. The other one is a receipt as proof to your payment; also for your own security. But you don't need to worry about using it unless you are trying to copy someone else's fingerprint or you had an accident with your hand or something.

Peter: (With an ironic laugh) Haha! Good God! Funny… anyway, what about the "Fingerprint Options" button?

Anders: You can change the choice of what finger you want to use; just like changing your password on your computer. You first scan your existing password and then chose the new one and verify once again. The same you can do with the alternate finger as well.

Peter: Cool. I hope this system comes to Ireland sometime in the future. It's awesome. Hey! The train is here, I'm getting on now.

Anders: Okay, they will come and ask you to scan your finger on the black wireless device called "SmartChecker", just so you know! I will be at the station to meet you so see you soon!

Peter: Allright buddy! See you!

User testing

After building the prototype of the SmartMachine device (see Building the prototype of SmartMachine), I did user testing on people in different ages by paying attention to important theories to test the interaction with the machine itself and its interface:

"User testing is an applied form of experimentation used by developers to test whether the product they develop is usable by the intended user population to achieve their tasks." (Dumas and Redish, 1999)

"In user testing the time it takes typical users to complete clearly defined, typical tasks is measured and the number and type of errors they make are recorded." (Preece, Rogers and Sharp, 2002)

"Many proffesionals recommend that 5-12 testers is enough." (Dumas and Redish, 1999)

User testing for the prototype of SmartMachine had five participants. One of testers had academic background and knowledge about interaction design. Four of them were college students and one was an old working man. The reason that I mostly tested this prototype on younger people was to be able to focus more on the next generations regarding the concept for SmartExpress. Choosing an old person was to still be able understand the difficulties that old people can face since the possibility of being familiar with the technologies like touchscreens and fingerprint system is less with older people. The participants were being tested one by one alone. Before doing the test, they were informed about the whole concept of SmartExpress, but mainly about using SmartMachines. After going through the steps one by one, and getting enough knowledge, they made their comments.

Results of the comments and the observations on the interaction and functionality of SmartMachine:

The comments on the interface of the prototype and the concept of using it were positive. All the five users were quickly going through the steps on the touchscreen and easily became friends with it. As they went through the steps, they kept asking more and more about the concept of SmartExpress and reacted in a positive way when hearing more and more as well. The listed points below are the results of the comments and observations:

- The drop-down menus and the buttons need to be bigger.
- The user wants to know as much as possible from the beginning; a map that shows all the zones between the stated distance between the two cities is necessary (see Register Monthly).
- The user wants to know as much as possible about all the choices he needs to make; a help button is required where he can get all the info he needs.
- The user is afraid of using his fingerprint as an identification tool and needs the possibility to quit his membership; a delete membership button is required for not being afraid of testing the system by knowing that he anytime can delete his

fingerprint whenever he wants. This option lets the user understand that his/her fingerprint doesn't have any other value than just a number in the database.

- The user likes that she's not limited when she wants to register; there is no certain shop to go to and she can do it on her own with SmartMachine.
- The user finds the interface simple and it's easy for him to go through the steps.
- The user finds SmartCode very smart. (see SmartCode)
- The user loves the possibility of starting her discount with 100kr.
- Four of the users are very positive about SmartExpress and SmartMachines, and they find it much better than today's card system.
- One user would maybe register his fingerprint after making sure that the fingerprint system fulfills its purpose and doesn't cause him any problems.
- The user finds the structure of SmartMachine very logical.
- The user wants more colors on the machines.
- The user finds the system more time-saving and easier than how it is with Skanetrafiken.

5. Designing the system for SmartExpress

Picture 3, an illustration of the interaction with SmartMachine (redesigned from: http://www.drives.co.uk/news/images/Moeller%20fingerprint%20reader.jpg)

Since the intended group for SmartExpress is all kinds of people that travel with busses and trains, it needs a simple pedagogical usability structure and not cause any confusion.

There are three different devices designed for SmartExpress:

1. SmartMachine (stationary)

2. SmartBus (wireless)

3. SmartChecker (wireless)

5.1 SmartMachine

SmartMachines (See picture 4) are stationary and have light-gray color. Their measurements are 120cm high and around 60cm wide. This is intentionally made for people with wheel-chairs and for shorter people to be able to use it easier. They are shaped as a cylinder and have touch-screen functionality.

“Some people actually pee in there (ticket machines) just because they think it’s fun and the people coming behind have to put their hands in their pee. People do really disgusting stuff with public terminals and that's quite important to know actually so I don't know how that would affect your interface but maybe it could be some simple design feature... they would

try with karate kicks, they would do whatever to see what happens to the machine and treat it badly, that's what people do, unfortunately. It seems maybe extreme but it could be interesting to have it at least in the back head." Wallergård, Mattias – Lund University/Design Center

The SmartMachines are intended to be in and outside of the central stations and the other cooperative companies (see Other Companies). The reason of not having them at many bus stops or other public places outside is to avoid the problem of abuse. My observations and interviews showed that some people intend to damage Skanetrafiken's ticket machines just to have fun and that sad fact was necessary to keep in mind since there is a need of making it more difficult for these certain people to do that.

Below the touchscreen, there is a fingerprint scan area. On the front there are four slots. The top slot on the left reads the chip of the card for age verification (ID card). The slot below that one reads the magstripe of the card for education verification (student card). Bank-cards can be used on both depending on what is going to be read (chip or magstripe). The two slots on the right are for payment with notes and coins.

Under the slots, there is a ticket-container where the user in the end of their registration picks the ticket, the receipt and the SmartCode (See SmartCode).

In order for handicaps and individuals with disabilities; the situation was considered early in the design process for the disabled users. SmartMachines are designed by a size intended for both disabled and non-disabled people in order to not reduce many differences. For example a wheel-chair user will be able to use the SmartMachine easily thanks to its size.

Since SmartMachines offer touch-screen, blind users can't get possible navigation from them besides getting help so they are offered to be registered at the SmartExpress agencies and at the other cooperative stores where the receptionists do the job. On the other hand, they will also be able to pay with discount at SmartExpress agencies or other cooperative stores, and use it anytime within 24 hours. They will also have right to do their ticket payment on the train with the same price.

Picture 4, SmartMachine

Analyzing the interface and the interaction with SmartMachines

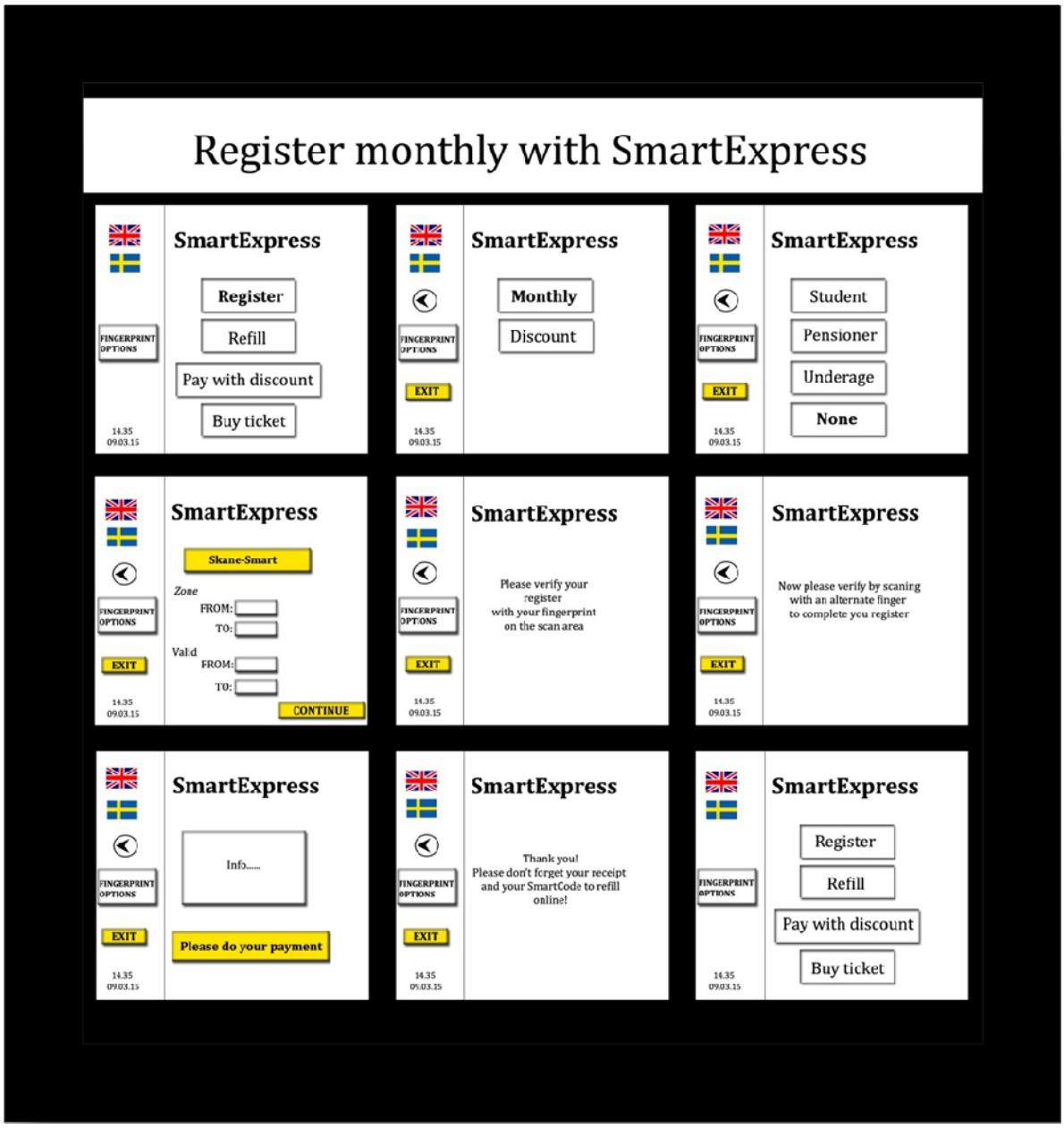
On the interface of the SmartMachine, the important information is high-lighted and the text of the buttons gets bold when you hover over it. (See picture 5) Formats for dates of the Flash-made interface are adopted and the display is organized by ensuring that the grouping of information is well-motivated. At every step, it's clear that they are expected to do next. The colors of the interface are chosen by paying attention that it's as light as possible and the structure is designed by the intention of keeping it simple and clear.

The numbers of actions are minimized and as clear as possible to understand. One of the problems that can occur while interacting with the system is the language problem. Since English often serves such a purpose, there is a command of English except for Swedish as an international language besides Swedish. (Del Galdo, 1996) Language choices are on the top-left buttons displayed as English and Swedish flags.

There is a choice displayed for you to change your main and alternate finger anytime with the "fingerprint options" button on the left (see picture 5). You first scan the main and the alternate finger to verify existing password, and then state your new choice.

During your interaction with the SmartMachines you can edit your choices by clicking on the back button below the Swedish flag displayed on the left (see Picture 5) to go to the previous page or you can use the yellow exit button the left if you want to cancel your register.

Register monthly: Registering monthly will be possible except for going to the agency; with the SmartMachines.



Picture 5, Steps for registering monthly with SmartMachines

Now let's take a look at how registering a monthly membership with the SmartMachines works. Let's follow the steps by starting from left.

There are four main choices on the first page of the touchscreen on the SmartMachines: Register Refill, Pay with discount and Buy ticket. As we can see, registering monthly is cheaper if you are a student, a child, or a pensioner. If you are a child (underage) or a pensioner, you will be asked to insert your ID in the chip slot (see picture 4) to verify your age. If you are a student, you will drag your student card on the magstripe slot (under the chip slot on the left). The next step is to pick the zone by selecting two cities by means from a city to another. After picking your zone you will also need to click on the calendar below for distance to indicate time of the period for your membership. When you are done with those two choices, you can continue to the next page and verify your register with your fingerprint on the scan area below the touchscreen (see picture 4). You can pick whatever finger you wish out of all your fingers and will afterwards be asked to choose an alternate

one for your own security if needed. After scanning your main and alternate finger, information about your register will be displayed which means it’s time for you to do your payment. After your payment (either with cash or bank card) you will get two receipts; one that includes info about your register (which you may need to keep as proof and show if necessary) and the other one called SmartCode (see SmartCode).

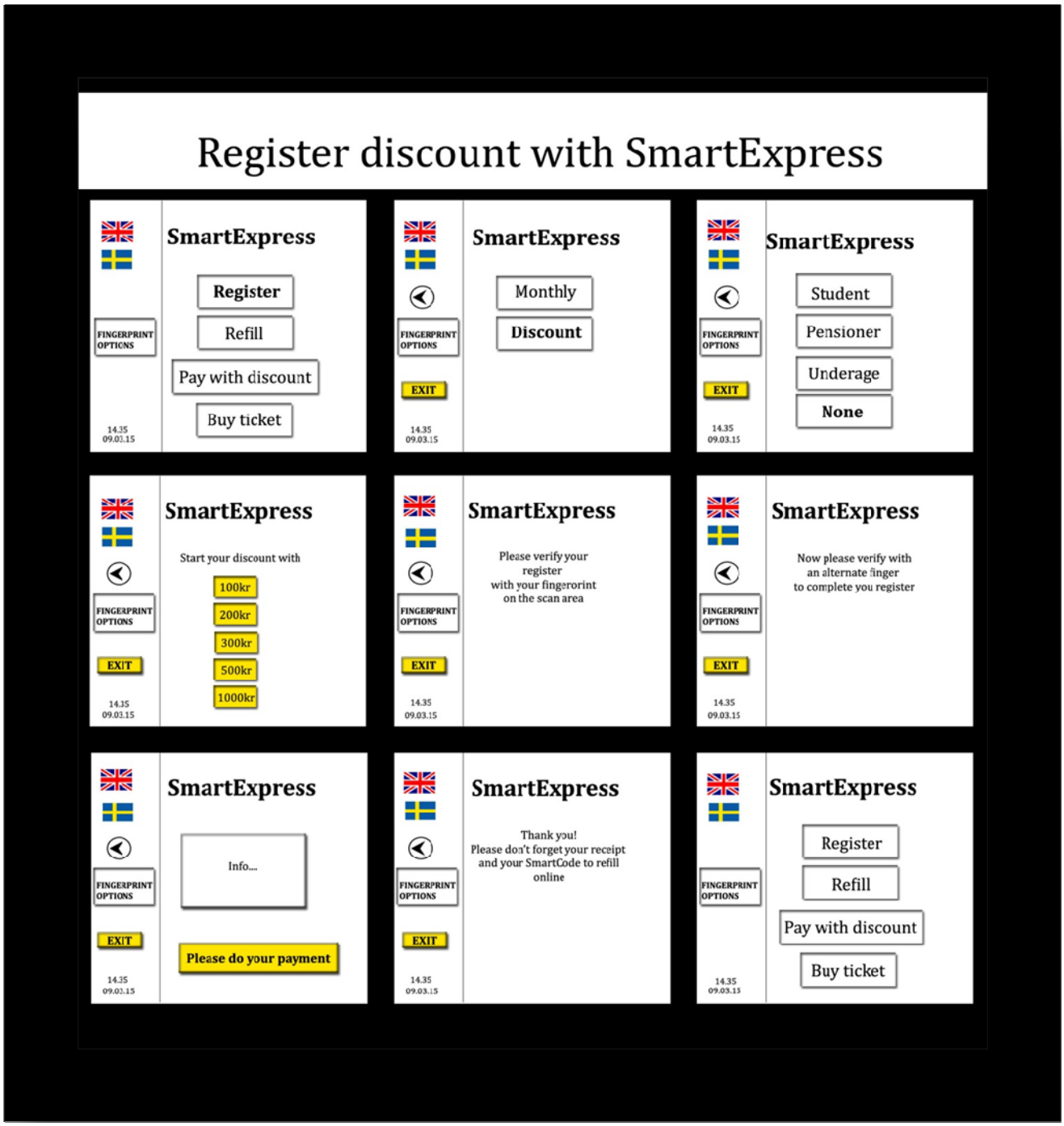
Registering monthly will also be available at the SmartExpress agencies (see SmartExpress Agencies) and some other cooperative companies (see Other Companies).

Register discount: Registering discount with SmartExpress will be possible by the user him/herself by using the SmartMachines. Just like when you register monthly, you will have the advantage of paying less with discount if you are a student, pensioner or underage. Otherwise you will chose none and pay the standard price for discount.

One of the differences between Skanetrafiken and SmartExpress is that you will be able to start your discount with at least 100kr. Today, it is 200kr with Skanetrafiken. That is also the same when you refill your discount (see Refill Discount). The purpose is to give the users more financial possibilities to register.

After choosing the amount you will be asked to scan your finger and afterwards your alternate one to verify your register. Then the information about your registration will be displayed and below that info, you will be asked to do your payment (see Picture 6). The last step is to pick your receipt and SmartCode (see SmartCode).

You will also be able to register your discount membership by help from the receptionists at the SmartExpress agencies (see SmartExpress Agencies) and at some other companies cooperating with SmartExpress (see Other Companies).



Picture 6, Registering discount steps with SmartMachines

Refill monthly: Refilling monthly is very similar to registering monthly except that you won't need to state any info about yourself like you do when you register; for example if you are a student, that information will already be saved in the database since you already are registered. You will first be asked to scan your main finger, then pick your destination and period and afterwards do your payment.

You will also be able to refill monthly by help from the receptionists at the SmartExpress agencies (see SmartExpress Agencies), at SmartExpress.com (see SmartExpress.com) and at some other companies cooperating with SmartExpress (see Other Companies).

Refill discount: ***"****Refilling... I find incredibly annoying for example that you can't refill with paying just 100kr, I think the bottom is at least 200, right? I find it incredibly annoying because sometimes you only have 100kr and they don't accept it so you have to go some other place and maybe you don't have money on your card. You don't have cash so what do you do? You have to walk home. That happened to me once actually so that is incredibly annoying actually." Wallergård, Mattias/Lund University-Design Center*

Refilling discount is also most likely similar to registering discount, but is done by less steps. The first step is to scan your main finger and your current balance will be displayed, then you will state your choice of how much money you would like to refill it with (minimum 100kr) and finally do your payment.

You will also be able to refill discount by help from the receptionists at the SmartExpress agencies (see SmartExpress Agencies), at SmartExpress.com (see SmartExpress.com), and at some other companies cooperating with SmartExpress (see Other Companies).

Pay with discount: Paying for a trip with discount by using SmartMachines is done by first scanning the main finger. You afterwards state your destination and the type of your payment (Adult/Child/Duo-Family) and finally do your payment.

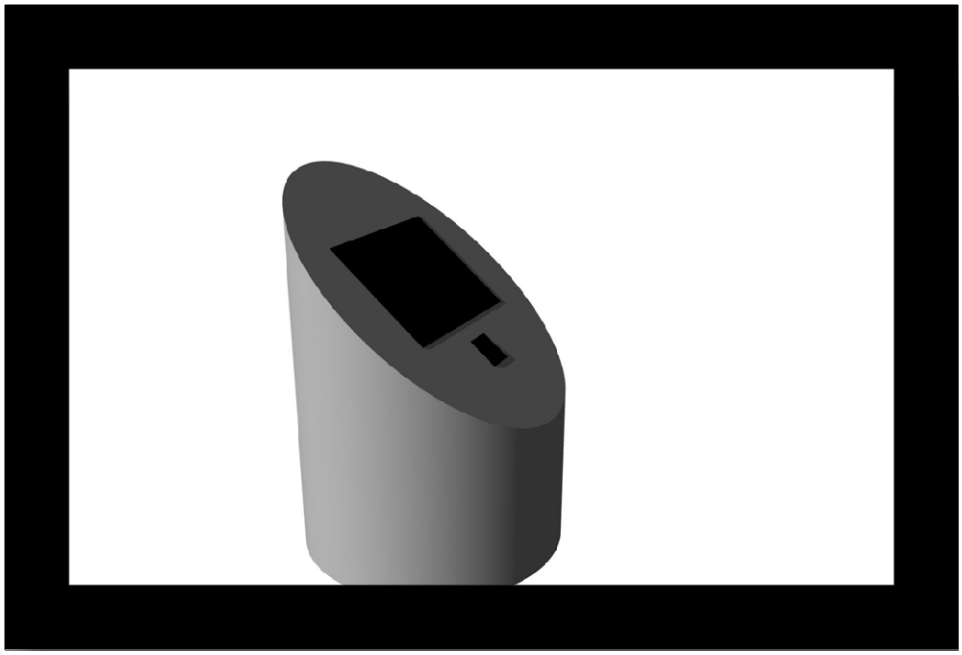
You can also pay for your trip with discount at the SmartExpress agencies (see SmartExpress Agencies), at some other companies cooperating with SmartExpress (see Other Companies), and on the busses by help from the bus drivers.

Buy ticket: Buying a ticket will be possible with the SmartMachines, at SmartExpress agencies, at other cooperating stores and on the busses. It doesn't include any fingerprint; you complete your steps on the touch-screen by first choosing destination and then the type of your ticket. You do your payment and get your ticket. If you get on the train before buying a ticket, you will have to pay extra for it; just like today with Skanetrafiken.

5.2 SmartBus

“I've been working with a lot with people with cognitive disabilities in public transport situations and talking with themselves, of course but also with occupational therapists; one of the biggest problems is the card readers on the bus. For example how the hell do you rotate the damn thing? And how do you know that your purchase has not been registered? There is a little red lamp that will blink, what the hell does that mean? (Ironic laugh) I don't know! And also, how much money has been taken from your card? How much remains? You know it seems of course that you just see if I have like 102kr and 50ore or something like that, it says one, zero, two, five, zero (10250); there is no dot...it's real bad feedback from the system, very very unclear.”Wallergård, Mattias/Lund University-Design Center

SmartBus (See picture 7) looks similar to the SmartMachine. It has the color light-gray and is around 60cm high and 30cm wide. It's in the shape of cylinder just like SmartMachine and has a display screen with information. The fingerprint scan area is replaced below the display screen.
SmartBus is wireless and communicates with the units outside to get updated information into the database. So every time you register, refill, buy a ticket, do another payment or change your password before you get on the bus, the SmartBus device reads the information into the database through wireless connection from the units outside.



Picture 7, SmartBus

Analyzing the interface and the interaction with SmartBus

After getting on the bus when first scanning the finger, the SmartBus device responds with a sound, logo and text on the screen. If payment is verified, you hear the verifying sound and see the text on the screen appearing as “Payment verified” and your updated info with a green logo (see Picture 8) shows up. If your payment isn't verified, you hear the warning sound and see the red logo with the text on the screen displayed as “Not valid” (see Picture 9). On the left side of the interface, formats of dates are adopted. Besides paying on the bus, you will also be able to refill your membership by scanning your finger on the SmartBus device while the bus driver does the job with the computer system connected to it. After refilling (either discount or monthly), you will get information about how much money (discount) or time (monthly) you have left.

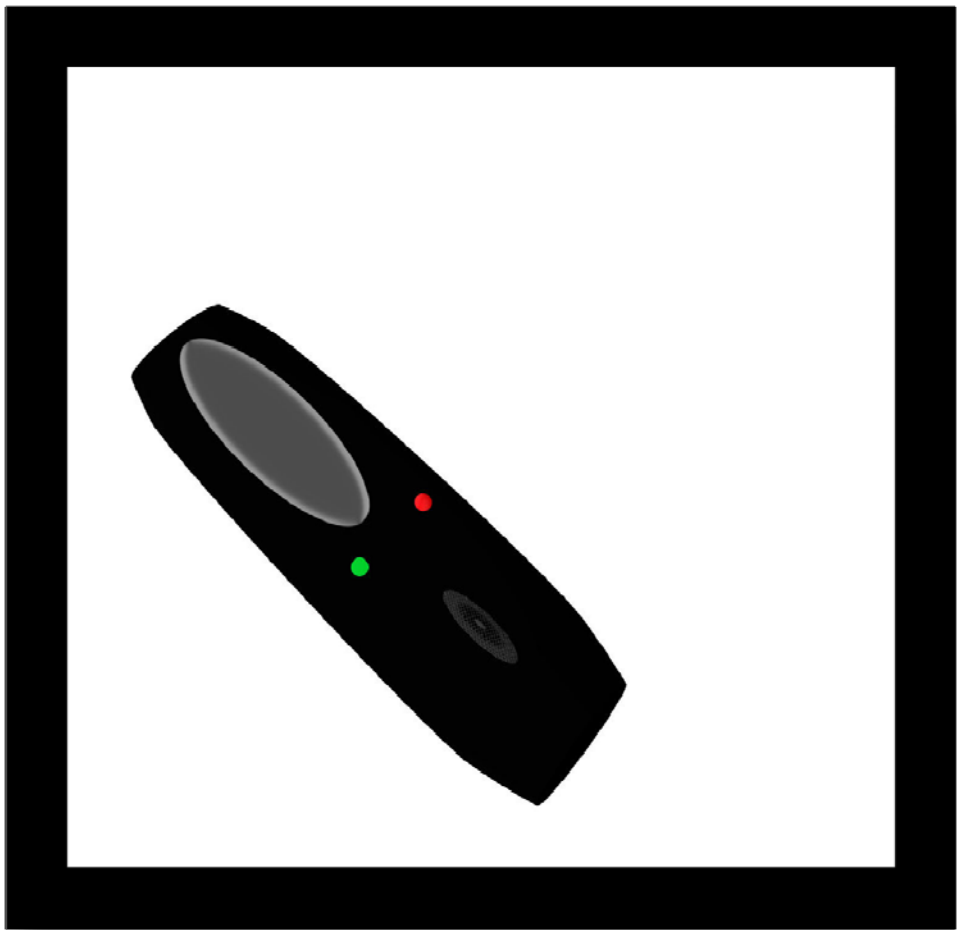
Picture 8, Illustration of a valid payment on the interface of SmartBus devices

Picture 9, Illustration of a non-valid payment on the interface of SmartBus devices

5.3 SmartChecker

SmartChecker (See picture 10) is also wireless and reads the fingerprints from the database by communicating with the units outside. It's in black color and the measurements are around 25cm high and 10cm wide. It is used by the checkers on the train to check your payment and also by you to verify your payment by scanning your finger on the scan area. Below the scan area there is one green and one red light. If your payment is verified; the green light is activated, if not; the red one lights up and the checker will in that case ask to scan your alternate finger. If you have had an accident and can’t use your main and alternate finger anymore, you will be asked to show your receipt that you got when you registered.

Below the lights, there is a speaker to verify with sound depending on whether your payment is valid or not. If your membership is valid, you hear the verifying sound and if not, you hear the warning sound.



Picture 10, SmartChecker

SmartCode: In the end of your register you will get your SmartCode which consists of a username and password that you login with to refill your account on SmartExpress' website “smartexpress.com” either through your mobile or your computer.

SmartExpress receipt: SmartExpress receipt is for the users to feel comfortable of having a proof except for their fingerprints. They get this receipt in the end of their registration together with their SmartCode (see SmartCode). It has information about their registration (time, type, money).

smartexpress.com: smartexpress.com is the website where you get all the information regarding travelling with trains and busses with SmartExpress. One of its biggest advantages is that you can refill your SmartExpress account (see SmartExpress Account) by logging in with your SmartCode and verifying with your bank number at smartexpress.com. You will besides be able to download all the time tables to your phone or computer, and also get updated about the traffic even without SmartCode (see SmartCode).

SmartExpress agencies: At the SmartExpress agencies, you will be able to register and refill your account, pay with your discount account and buy ticket by help from the receptionists. You can get information about the traffic and anything else regarding SmartExpress with their help.

Other Companies: Cooperating with other companies is to make it easier for you to register, refill and do your payments. For instance, today you can buy your ticket at some of the Pressbyran stores which can be time saving for you. You will have the possibility to register and refill your SmartExpress account even if you aren't close to the stations or the SmartExpress agencies. You will have the advantage of shopping and do your SmartExpress payments at the same place; both by yourself with the Smart Machines and by the receptionists with their computer system. The receptionists will do the job for you by using the program installed with a fingerprint scanner connected to their computer systems. The idea of cooperating with other stores is also intended to make it easier for you if you are far from the central station because today with Skanetrafiken you have to pay for the bus to get to the station if you want to buy your card.

SmartExpress account: Your SmartExpress account is where all your information is stored. If you have a monthly membership, then the valid period of your info will be on your receipt. The possibilities for you to be able to know how much of your discount you exactly have left on your account are:

1. Logging in to smartexpress.com with your SmartCode,
2. Through the SmartMachines,
3. Asking the receptionists of SmartExpress or the other stores cooperating with SmartExpress,
4. Asking the bus drivers.

5. Building the prototype of SmartMachine

Picture 11, Building the prototype of SmartMachine

Building the prototype of SmartMachine started from doing some measurements to build the wood structure (see Picture 11).Since the wood structure needed to be built into line with the touchscreen, the prototype turned out to be a bit bigger than its actual size. The touchscreen is built into the construction with the touch area facing upwards. There is a keyboard built inside the device to be able to fake the actions such as payment with cards, age verification and finger-scanning. These functions are actually working by the buttons of the keyboard where built materials press them when the user for example does the card payment, or fingerprint scanning.

7. Argument of Solution

“It's important how to in a pedagogical way let the user know; give them the right mental model of what data is actually stored because a I think lot of people don't understand the technology behind it that; okay, it's not going to scan all my life, it's not going to make aDNA sample and send it to some database, so they're not going to send me to some strange prison because I am blabla, so it could be a matter of how to present the technology in a pedagogical manner.” Wallergård, Mattias/Lund University-Design Center

To be able to avoid all the confusions with the technical and functional aspects of using SmartExpress, there will be a possibility to get information about how the system of SmartExpress and its devices are used. This would be possible at SmartExpress agencies and by the receptionists at the other cooperative companies. This information will also be available by a help button on the SmartMachines and on SmartExpress' website for people to understand the technology and make sure that it doesn't affect their personal lives. For instance many people will not know what it actually means to let the company save the fingerprint and they won't at first know that they only will be presented in its database by numbers. They will also need to gain knowledge of why the intended options with alternate finger and other fingerprint options exist and that is why they will be able to either read about it themselves or learn it by talking to responsible ones.

“I think when the product is made, I think it’ll be a very good product but I think it’s a long way to produce this product and have it sure that it’s all working. I think it’s perhaps very expensive product for the moment but in the future I think it will be a very good product. The new system that Skanetrafiken have, they started about 1990 or 1995 something like that, and now it’s on the move so it’s more than ten years before operating and still a lot of troubles with it and this is even more new so I think 40-50 years perhaps so it’s a long way there I think.” Grönvall, Oscar /Tyrens

SmartExpress has big advantages that today’s payment systems don’t have and could be the next generation concept if there are enough technical and financial possibilities but needs process to be realized. When interviewing the passengers, some were unsure about how the fingerprint system is going to be implemented and how it will function and also how it is going to be used. Even if they liked the idea, they wanted to test the machines and make sure that it can work fast and not cause problems. They wanted to make sure that it fulfills its purpose; that it really stimulates comfort and security and also works with a fast connection. They wanted the system only if it was strong enough against technical problems and they were convinced that it is good for people’s security to use fingerprint for transportation payment. They thought that it was a right choice for their security to not be registered by real name and that they will be presented as numbers in the database. They discussed mostly about the registration-refilling steps of the Smart Machines and appreciated that they’d be able to register their memberships on the machines by themselves. They were also supportive about the fact that there is only one machine instead of separating the ticket and the discount machine and they can even create their membership (register) by themselves with it. They were also happy about hearing that Smart Machines will be available at some other cooperative companies instead of only at the stations, but also at the agencies by receptionists for those who aren’t able or familiar with the system as well.

“I think it’s very good that you always have your thumb with you, it can’t be interrupted like the cards…but what could be a problem is to get down the information to the card reader in a bus or in a train device because of very bad communication. It also depends how much data you need to store even if it’s just a fingerprint and a serial number and a valid time. It’s a number of data and for example in Skanetrafiken we have a hundred thousand of period passes. All those cards need to be loaded perhaps into the bus device itself to have this rapid usage and to keep that database updated in all units; that might be the tricky part. With the new system we’re introducing where you can reload via internet; the data must be sent to the bus with a sort of list so when the card comes, it will be recognized and we are talking milliseconds…but with the new sort of 3G or next generation of mobile-phoning maybe that won’t be a problem…when online is faster, then this is okay because I don’t think you can send down that much data and keep it updated in all devices all the time so it is quite depending on the communication with database and the units outside. Depending on where the data is stored, if the data is to be stored in the units, it will be extremely complicated. If the communication is fast enough between the reader and a server somewhere where you have the information, then it’s quite easy to grow.” Lundberg, Mats/Skanetrafiken

As Mats Lundberg says, there has to be units outside with updated database just like today and all the fingerprints need to be stored into the devices for rapid usage. The wireless communication needs to be fast enough between the reader and a server with information.

“Magstripes have been easy to copy for many years but together with the whole system we have kept it very low. There are attempts of copying cards, create cards yourself, etc but we caught them in daily base and got them on hot lists, so I think security has worked. The disadvantages are that of course magstripe card and magstripe is very easy to disturb someway. “Mats Lundberg/Skanetrafiken

The system of SmartExpress needs to have the ability to detect attempts of fake or stolen fingerprints and make it impossible for the ones to abuse it. That is why there is a choice of selecting two different fingers (one main and one alternate) and an option to change them anytime wanted just like today’s change-password options with digital devices. Also, there needs to be a receipt for the users to keep as proof if they can't use their main and alternate fingers at the moment.

8. Summary

This study showed that people are in a big need of a change when it comes to payment with cards and other payment tools for busses and trains around the world. The observations and interviews with both users and experts within this area showed that SmartExpress would increase safety, security, and make it easier for the passengers to travel with. The interviews showed that most of people like the fact that they can loan their cards to others today, but would rather have the possibility to be able to have something that they never would get rid of; to use in a safer and easier way. The fingerprint technology with SmartExpress would be more time saving than other payment tools around the world since the actual tool here is the finger itself. If all the technology mentioned in this work could be applied in the devices, then SmartExpress could be the travelling artifact for the next generation and fingerprint technology could be considered as a payment tool for transportation payment.

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