Inclusive Digital Wallet – a field guide on enhancing the user interface design of an everyday object

by

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Abstract

The purpose of this study is to build upon past work on digital wallets to establish design requirements for an inclusive digital wallet(s). This research takes an inclusive design approach to define the design requirements, such that the design will be suitable for a wide range of people. The literature review shows a limited number of studies on how textile wallet design informs the design of digital wallets. This research contributes to this topic by combining the concepts of Inclusive Design with the AEIOU framework and Human-Artifact Model to reimagine the design of digital wallets. Rich qualitative information regarding habits and existing textile wallet preferences was gathered by conducting semi-structured interviews with potential users who had visual and dexterity challenges. Three different forms of digital wallet designs were also evaluated during the interviews. The results are presented to provide a new understanding of digital wallet design in the domain of Inclusive Design.

Keywords: *Wallet, user interface design, Inclusive Design*

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Dedication

In memory of my grandfather Chan Wai (1920-2013)

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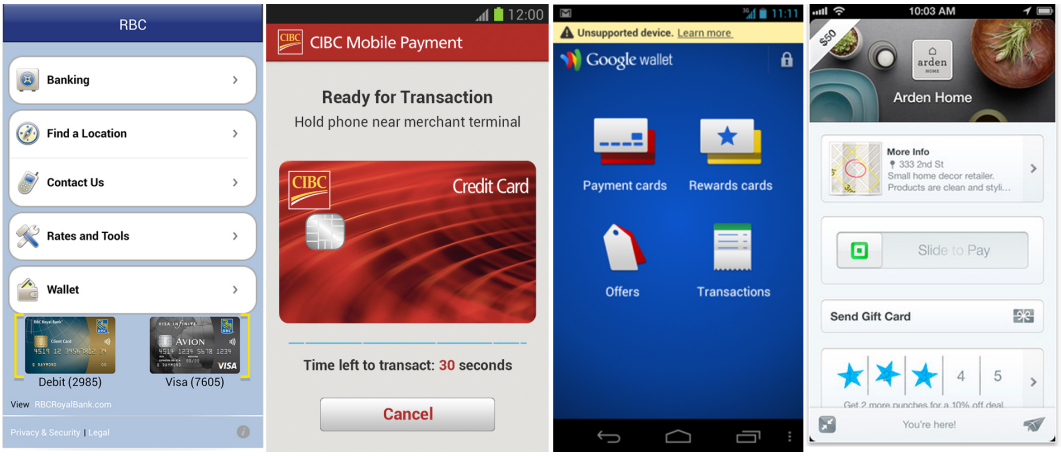
1 Introduction

A wallet is a small sized portable container, used to securely store small items such as cash, cards, and paper traces of everyday activities. In the design of digital payment systems, the term *wallet* is often being used to describe a software application or a device that provides similar functionality. In this research, the term *digital wallet* is used to describe an electronic device that provides services including but not limited to cards management, making a payment, or tracking payment activities (Figure 1).

Figure 1. Screenshot of commercial digital wallets



The picture shows screenshots of the RBC wallet, CIBC wallet, Google wallet and Square wallet. The first three wallets require one to tap the phone onto the sales terminal during a payment process. The last wallet requires the wallet holder to take a photo as means to verify one's identity.

A smartphone with Google Wallet is an example of a digital wallet. Google Wallet is a software module one can install on a smartphone. This software allows its owner to tap the phone at a sales terminal to make a payment. Also, one can add multiple payment cards to the Google Wallet similar to a textile wallet. More recently, digital wallets like Wocket Wallet and Coin are palm-size electronic objects designed to reduce the need to carry a textile wallet. Physical plastic payment card information can be transferred to the storage systems in these wallets so the wallet holder can carry less in their pockets.

Figure 2. Examples of digital wallet as a device

The picture on the left shows the front and back card of the Coin card. Picture on the right shows the front of Wocket.

Inclusive digital wallet is a concept that refers to a broad range of wallet design ideas, which address the needs of individuals from all walks of life. One can study this concept through Inclusive Design. Inclusive Design is a holistic design approach (Eikhaug et al., 2010) that attempts to include the widest range of consumers possible. Eikhaug et al. argues that inclusive design is a tool for innovation because it provides a way to explore needs which mainstream design has not yet addressed. They define mainstream design as products that are designed for people who are "young, able-bodied, right-handed, male, technology literate, have money and belong to the majority race and culture." This research builds upon past work on wallet design and applies an Inclusive Design approach to answer the question:

How can the examination of textile wallets, as handled by individuals with visual or dexterity challenges, influence the design thinking of a

digital wallet? The purpose of this study is to inform user interface and user experience designers about wallet usage patterns with a more diverse perspective. Therefore, designers can capitalize on this knowledge to create future digital wallet(s) that are more inclusive.

This study consists of three parts:

1. It applies Inclusive Design principles, AEIOU framework, and semi-structured interviewing methods in the data collection process. (Section: Methodology)

2. It applies an iterative design process with artifact analysis, Human-Artifact Model, and prototyping methods to examine possible design relationships between textile and digital wallets. (Section: Results)

3. It demonstrates four key themes that emerge from the iterative design process, which are access sharing, content organization, unintended handling, and multiple modes of replenishing the wallet. The research concludes with a discussion of the inclusive wallet. (Section: Discussion)

2 Literature Review

What have scholars studied so far about the design in digital and textile wallets? The literature review shows that only a few studies have explored a similar domain with respect to this research.

What's in Your Wallet? Implications for Global E-Wallet Design (Mainwaring et al., 2005) is one of the three studies that explore the topic of wallet design. Mainwaring et al.'s comparative ethnographic study looks at the use of a physical textile wallet among 28 professionals in London, Los Angeles, and Tokyo aged between 22 and 32. They found that digital wallet can assist in better access control and financial temptation management. Professionals with different cultural backgrounds have common needs such as segregating wallet contents by type, and utilize the wallet to collect items of everyday activities like tickets or business cards. Upon interviewing and shadowing the participants, they found that a physical textile wallet is

preferred for identity management and partitioning personal artifacts. Mainwaring et al. conclude their research by suggesting the design of a future distributed digital wallet can be in the form of a collection of smart cards. Although their research, which intended to survey wallet practices on a wide scale, uses the term “global e-wallet”, their findings did not address needs of people with varying forms of visual or dexterity challenges.

The second research by Arenas et al. (Arenas et al., 2011) is a textile wallet redesign study for people in stroke rehabilitation. They interviewed 17 residents at a supportive living facility in Chicago to develop five features that are important for people with varying forms of dexterity challenges. Though their research did not add to the discussion on the design of digital wallet with their findings, it shows that people with dexterity challenges can use straps, either attached to the wheelchair or on the body, to keep their content secure while travelling on a wheelchair. The need to operate a wallet with one hand is also another observation that can be applicable to the design of digital wallet.

Lastly, this major research project is inspired by Kestner et al.’s design of a Proverbial Wallet (Kestner et al., 2009). Unlike the previous two studies, Kestner et al’s work is a playful way to study the functions of a wallet. Through applying haptic actuators into a textile wallet, they created a wallet

that can respond to virtual monetary transactions with various animalistic qualities. For example, the wallet inflates like a peacock when the owner deposits money in his/her bank account, and closes tightly when the wallet holder reaches his/her spending limit. Kestner et al.'s study shows that there can be interesting ways to enhance a textile wallet such that it integrates virtual data to assist an individual (Kim et al., 2013).

Evolution of Wallet Design

Digital wallets manifest in the form of software applications such as Square Wallet[1], PayPal[2], Google Wallet[3] and M-Pesa Mobile Wallet are popular research subjects. These are software applications installed onto the mobile phone so one can make a purchase at a retail store by using the mobile phone at the checkout. The majority of studies on this form of digital wallet evaluate software functions and features, security implementation, emerging wireless data transmitting technologies, social adaptation models, and economic implications (Ghag & Hedge, 2012; Jack & Suri, 2011; Khan &

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[1] SquareWallet. (n.d.). Square Wallet – Pay with your name at your favorite Square merchants. Retrieved April 7, 2014, from https://squareup.com/wallet

[2] PayPal. (n.d.). Paypal Mobile Apps. Retrieved April 7, 2014, from https://www.paypal.com/webapps/mpp/mobile-apps

[3] Google Wallet. (n.d.). A smart, virtual wallet for in-store and online shopping. Retrieved April 7, 2014, from http://www.google.ca/wallet/

Craig-Lees, 2009; Amoroso & Magnier-Watanabe, 2012; Olsen et al., 2012; Jenkins, 2008). Little research has been done to examine these topics from the perspective of an individual with visual or dexterity challenges.

The rise of cryptocurrency, a decentralized digital currency that is driven by a peer-to-peer network without any association with any financial institutions, initiated a new wave of digital wallets. Software like Blockchain[4], MultiBit[5], KryptoKit[6] or Coinbase[7] allows its users to access their wallets with any portable device that has Internet connections. Wallets with cryptocurrency involve the management of long, encrypted text that might not be accessible and usable for people with visual challenges. Unfortunately, there is no literature that examines this type of digital wallet with a wide diversity of perspectives.

Lastly, emerging digital wallets like Coin[8] and Nymi[9] set out to explore new ways to connect technology and wallet. They introduced new methods of carrying cards by means of an interactive smartcard that can store

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[4] BlockChain. (n.d.). Bitcoin wallet – Be Your Own Bank. Retrieved March 23, 2014, from https://blockchain.info/wallet

[5] MultiBit. (n.d.). MultiBit. Retrieved March 23, 2014, from https://multibit.org

[6] KryptoKit. (February 24, 2014). KryptoKit. Retrieved March 23, 2014, from http://www.kryptokit.com

[7] Coinbase. (n.d.). Coinbase: Bitcoin Wallet. Retrieved March 23, 2014, from https://coinbase.com

[8] Coin. (October 3, 2013). Coin introduces Arduino-BLE Developer Kit. Retrieved March 23, 2014, from http://blog.onlycoin.com/posts/2013/10/3/coin-arduino-ble-dev-kit

[9] Bionym. (n.d.). Nymi | Develop. Retrieved April 7, 2014, from http://www.getnymi.com/develop/

information for multiple plastic payment cards into one small electronic device. The wallet holder can control the contents by interacting with the smartcard's low-energy display and controller button. The Nymi wristband can use the wallet holder's cardiac rhythm to authenticate identity, in an attempt to simplify the existing practice of presenting an identity card from a textile wallet.

With a growing number of digital wallet products available to the consumers, more research is needed to examine possible opportunities for these products to be usable by a wide range of people. This research presents some of the possible opportunities that one can leverage to make a product meet the needs of individuals with low-vision, blindness or dexterity challenges.

3 Methdology

This chapter begins with a general overview of the research process. Then it outlines all the methods used to provide a practical example of Inclusive Design research. The methods are: Inclusive Design principles, AEIOU framework, artifact analysis, semi-structured interview, prototyping, and Human-Artifact model.

Overview

This practice-based research combined an iterative design process which resulted in two testable prototypes, with eight user testing sessions to understand the real world demands and experiences of people with varying abilities. Based on the literature and my examination of other emerging technology, I created two digital wallets representing two possible solutions: a smartphone application and a dedicated smartcard device. A third model

with a biometric interface on a wristband was considered but then dropped as being overly specific and difficult to prototype.

The two prototypes were presented to people with visual or dexterity challenges. This initiated a discussion of challenges and solutions offered by the prototypes. Based on the feedback, the prototypes were refined and re-presented through a cycle of three iterations (See Iterative Prototype section for the details).

The research participants also took part in a series of semi-structured interviews to elicit their general behavior and activities regarding their existing textile wallet usage and experiences. Participants were allocated to one of the three iterations based on their availability (See Tables 1,2,3). People with varying visual or dexterity challenges were chosen with the intention to minimize the marginalization of individuals who might have been previously excluded from digital wallet studies (See Literature Review).

Table 1 : Participants included in 1st design iteration

Participant description	
#1: An individual who depends on audio feedback at the checkout.	Blind. Around age 40 who is working in a professional field.
#2: An individual who depends on large print at the checkout.	Low Vision. Around age 30 who is new to the country.
#3: An individual who travels using a walker and needs extra time at the checkout.	Dexterity challenge without attendant. Around age 40 and a mother of two teenagers.

Table 2 : Participants included in 2nd design iteration

Participant description	
#4: An individual who depends on audio feedback at the checkout.	Blind. Around age 20 who just recently graduated.
#5: An individual who travels using a wheelchair and needs extra time at the checkout.	Dexterity challenge with attendant. Around age 50, working in a professional field.
#6: An individual who travels using a wheelchair and needs extra time at the checkout.	Dexterity challenge with attendant. Around age 70, retired living by herself.

Table 3 : Participants included in 3rd design iteration

Participants description	
#7: An individual who requires a magnifying glass to read.	Low Vision. Around age 60, who is new to the country
#8: An individual who travels using a wheelchair and needs extra time at the checkout.	Dexterity challenge without attendant. Around age 30, workin in a professional field.

Inclusive Design Principles

Inclusive design is not a design for special needs. The subjects chosen in this research are not intended to be view as disabled people, but rather as inspirations for the designer, such that one can explore any missed opportunities in existing wallet design. The notion of disability in the context of inclusive design is that a design that fails to meet the individual's needs in a certain situation creates disability. As stated by Treviranus (Treviranus et al., 2010: page 16), "a possible more useful framing of the notion of disability in the digital realm is that disability is a mismatch between the needs of the individual and the experience of service delivered." This research addresses this notion of disability by using the AEIOU framework.

AEIOU Framework

The AEIOU framework (Martin et al., 2012) is a reminder that the researcher can observe the individual's needs from five different angles to come up with a more comprehensive assessment of the situation. The five angles are Activities, Environments, Interactions, Objects and Users. For example, the practice of storing and exchanging monetary items in a wallet is different between people with vision and those without, therefore, a designer could study the relations among these five angles to gain a better understanding of the needs of the individual (Schillmeier, 2007; page 604). In this research, the AEIOU framework is applied to the semi-structured interview process to guide the topics of discussion. This framework helps scrutinize needs of the individual from different angles in order to design a matching service for the digital wallet prototypes. Some of the questions are listed below and the data collection template is included in the appendix section.

Activities

- What kind of wallet do you use?
- Can you show me how you use it to make a payment at a store?

Environment

- How do you pay for your groceries?
- How do you withdraw cash from the bank?

Interactions

- Do you shop with a companion? If yes, what is the experience like?
- Have you had any bad experience using your wallet?

Object

- Where do you store your wallet?
- Can you tell me more about the challenges you've had with your wallet at the sales terminal?
- What does an ideal wallet look and feel like?

Users

- What is the interaction like between you and the cashier?
- What is the interaction like between you and the bank teller?
- What is the interaction like between you and the attendant?

Semi-structured Interview

For this practice-based research, a semi-structured interview method was used to find out an individual's needs and preferences for textile wallets and the digital wallet prototypes. A semi-structured interview method was chosen instead of a questionnaire or survey due to the importance of keeping the research questions open for the possibility of discovering any unforeseen findings. It enabled the interviewer to observe the actual handling of the textile wallet (Figure 3), digital wallet prototypes, and experience the emotional responses of the interviewees. The participants were assigned into one of the three design iterations, where the data gathered was used to refine the prototypes for successive rounds of interviews. This allowed one to refine and retest the wallet design continuously to ensure design decisions are acceptable to different individuals.

Figure 3. Braille labels

A participant showing the braille labels on one of her cards.

Artifact Analysis

Artifact analysis was initially a research method of anthropology to examine and record the material, aesthetic and interactive characteristics of an object (Martin et al., 2012). Artifact analysis has been applied outside of anthropology studies and into the field of interaction design (Djajadiningrat et al., 2000). In this research, artifact analysis was conducted during the interviews. One practice within artifact analysis was to employ the creation of photos and sketches during the meetings with participants. This method can be done quickly and the information captured can be rich in detail compared

to note taking, where the details (especially visual cues like scratches or subtle arrangement of items) can be lost during the transcription process. The observations gathered can inform one about the functions that the wallet can afford (Figures 4,5), which might influence the design of the digital wallet prototypes.

Figure 4. Wallet of a wheelchair user

Above: The user stores cards with different purposes within the same slot. There is also no cash in the wallet. The size of the wallet is too large to fit into pockets of clothing. Below: Photo of the same wallet being closed.

Figure 5. Wallet of a wheelchair user

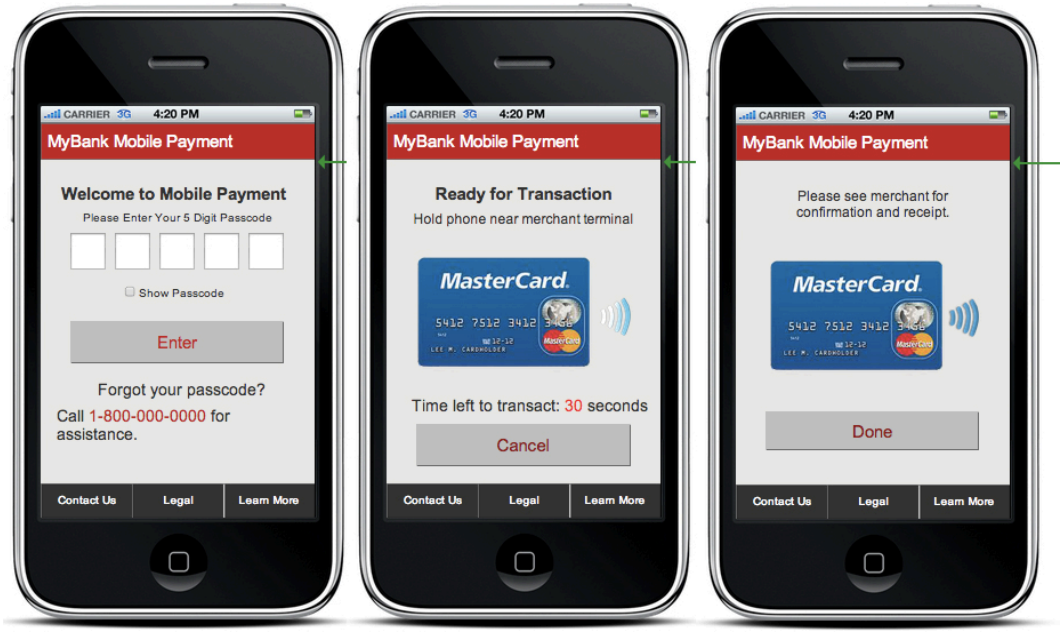
Iterative Prototyping

Prototyping is defined as “the tangible creation of artifacts at various levels of resolution, for development and testing of ideas within design teams and with clients and users.” (Martin et al., 2012) There are two digital wallet prototypes in this research[10] and they were tested three times in an iterative cycle.

The first prototype is a smartphone wallet, a digital wallet as a software application on a smartphone (Figure 6). A simple software application on an iPhone was created that models the functionalities of an existing smartphone wallet solution offered by a local bank. This prototype simulates a wallet with one bankcard inside where the wallet holder can review the information on a bankcard. One can also experience a digital wallet payment process by tapping the smartphone. The intention for modeling the initial prototype with an existing design is that the design contains an appropriate amount of functionality to illustrate the idea of a smartphone wallet. It also allows one to extend a design concept that has been researched and well tested.

[10] The detailed working of these designs can be found in Appendix A – Digital Wallet Interactions

Figure 6. Flow of interaction for the smartphone wallet prototype in the first iteration



Leftmost screen shows the launch of the wallet. Middle screen shows the payment card transmitting data. Right screen shows the payment is complete.

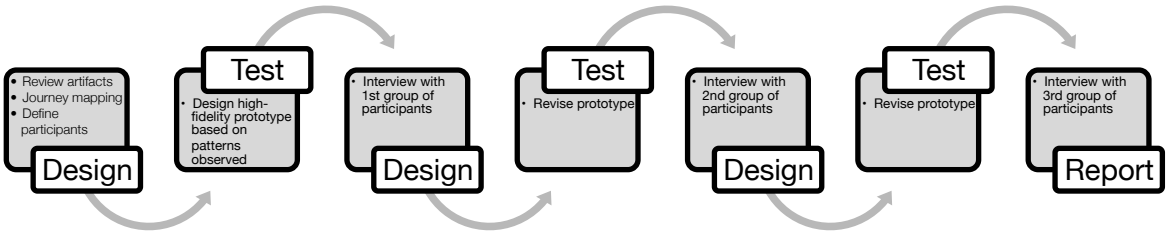
The second prototype is a smartcard wallet. Its functionalities are modeled after the Coin card as introduced in the literature review section. Due to limited time and expertise on hardware engineering, a prototype with the same dimensions as the Coin card was created to demonstrate the concept of a smartcard wallet (Figure 7). The prototype has one tactile button and a black and white screen. During the hands-on evaluation, the researcher simulates the experience of the digital wallet by describing the changes on the screen as the participants interact with the prototype.

Figure 7. Smartcard wallet

Left picture shows the participant pressing the button on the smartcard wallet. Right picture shows the front and back view of the paper prototype.

During an interview session, the smartphone wallet was introduced after the discussion of the textile wallets, then followed by a presentation of the smartcard wallet. Participants were encouraged to interact with the prototypes. Next in the interview process was to have the participant discuss his/her ideas about how a digital wallet could be designed to better match his/her needs and expectations. The user feedback was integrated into the Human-Artifact Model (Bødker, 2011) where they influenced design decisions for the next iteration of digital wallet prototypes (Figure 8).

Figure 8. Data collection and design process



Human-Artifact Model

The Human-Artifact model is a guide to help record research insights from two perspectives, the *artifact* being the digital wallet prototypes or a textile wallet, and the *human* which is the participant being interviewed.

Human-Artifact Model

	Artifact	Human
Why?	**Motivational aspects**	**Motivational orientation**
What?	**Instrumental aspects**	**Goal orientation**
How?	**Operational aspects** **- Handling aspects**	**Operational orientation** **- Learned handling**
	Adaptive aspects	**Adaptation**

> **Human-Artifact Model – The human half comprises the learned routines and action possibilities of the user, the artifact half comprises the assumptions and constraints of use embedded in the artifact. The three levels reflecting the activity hierarchy: Activity, action and operation, with the bottom level reflecting the separation of learned handling and of adaptation to physical conditions (classical affordances). The questions of Why? What? and How? help zoom in on each of these analytical levels. (Bødker, 2012, p. 101)**

This model was chosen for two reasons. First, the model can be applied to capture old practices in order to better analyze the history of how to modify a textile wallet to satisfy needs. Second, this model provides a systematic way to iterate the design of the prototypes (See Results).

In this research, the Human-Artifact model was used extensively. Within each design iteration, the model was used twice, once to generate insights for the smartphone wallet prototype and secondly to generate insights for the smartcard wallet prototype. This process was repeated for the second and third iterations. For example, the observations relating to how the smartphone prototype can solve accessibility barriers are viewed from two different angles (Operational aspects in the artifact column and Operational orientation in the human column). First, it records the design element(s)

within the prototype that supports the need. Second, it records the participant's capability and knowledge in using the prototype. The result is that one can better assess whether the prototype is making assumptions of its user, and helps to identify the design element that forms the exclusion. Consequently, this assessment influences a set of design changes for the prototypes, which are then tested with the next group of participants. The Human-Artifact model provides a technique for one to make design decisions based on using two different lenses to code the qualitative data.

4 Results

The results in this chapter are organized into three sections. Each section focuses on a different user group and one of three stages of design iteration. First, a section begins with the interview results on the use of textile wallets. Second, it records feedback on the smartphone prototype and its analysis by using the Human-Artifact Model. Lastly, the same structure is being used to report on the smartcard prototype, where it describes how the observations were used to transform the design.

First Design Iteration

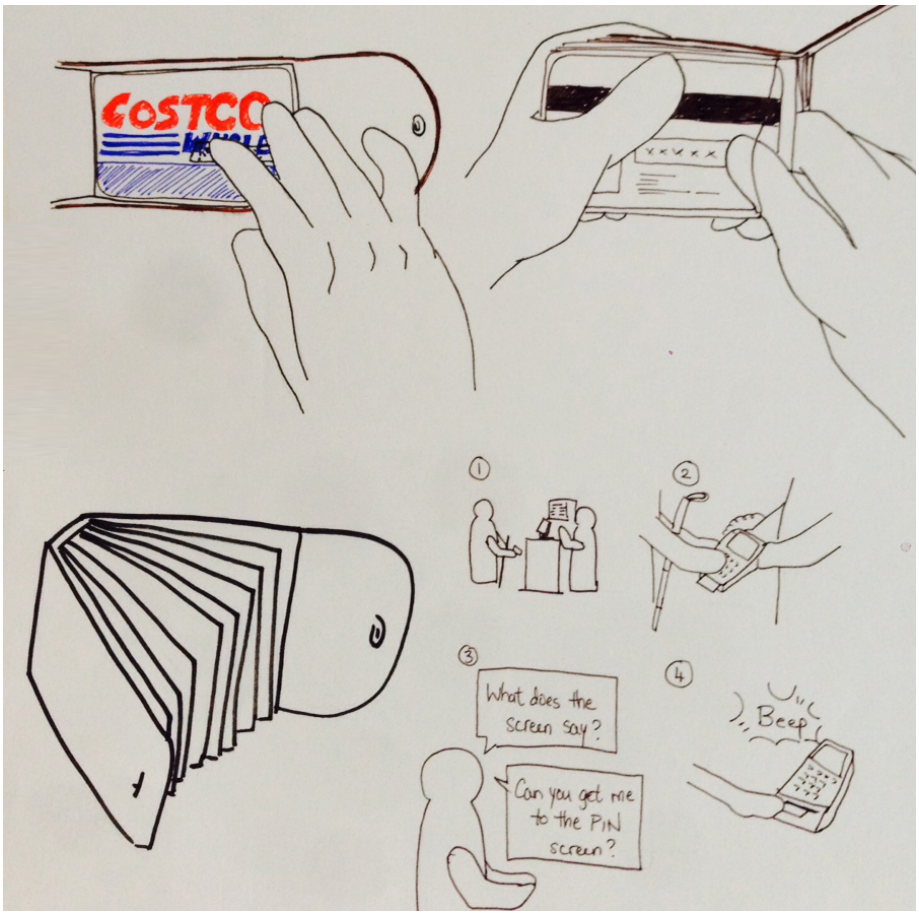
For each of the three participants, a discussion about the everyday usage of a textile wallet reveals a number of barriers encountered during its usage. The individual who is blind reported that payment cards do not have tactile

feedback for easy identification, therefore, he overcomes this barrier by choosing a wallet that is in the format of a photo album where he can feel the custom braille labels easily without taking any cards out (Figure 9).

Figure 9. Wallet in the format of a photo album

However, due to the design of wallet, it increases the thickness significantly and he uses another simple billfold wallet to hold cash, receipts and identity documents. The secondary wallet is lighter to carry and can fit into the front pocket of his shirt or the back pocket of his pants. This individual expressed major concern about paper receipts. He said that the receipts are a waste of space in his wallet because he cannot read the text. The only purpose to keep the receipts is when he needs to exchange an item after purchase and he usually asks his family for help (Figure 10).

Figure 10. Sketch of braille labels and wallet handling



The individual uses a wallet that resembles a photo album. Braille labels are added to each card inside the wallet. During the use of a sales terminal, he asks the casher to advance the screen for him.

For the individual who has low vision, his textile wallet does not have any features that could support his need for large format text. He uses a billfold leather wallet given by his mother as a gift over ten years ago. The wallet does not show much wear and tear on the surface but the threads between the inside compartments are loosening. The wallet also contains an insert to

store his transit card and student card. He said the design of the compartments is perfect for him. He can identify the different payment mediums by the design and color. During the discussion of the lifecycle of the wallet, he mentioned that when he travels to unfamiliar places he would plan ahead and remove contents from his wallet to avoid the risk of them getting stolen.

The individual with dexterity challenges reported that her trifold textile wallet is problematic during the payment process because its compartments are too tight to access easily and quickly with her injured wrist. She puts multiple cards within one slot because the wallet does not have enough slots. Lifting the heavy wallet out from her handbag with one hand is also a challenge because she needs the other hand to balance herself on the walker. She wishes that she could carry fewer cards by consolidating all the bankcards together. She said that the wallet is a gift from her daughter and the insert inside the wallet contains a family photo.

Smartphone Wallet Discussion

An observation on the use of the smartphone wallet prototype shows that all three participants had no previous experience in using digital wallets. Two out of three participants are familiar with the functionality and handling of a

smartphone. They have demonstrated the ability to use the smartphone wallet without difficulties. These two participants also made suggestions after testing the prototype. As explained by the individual with low vision, "*Right now I don't check the paper receipt. With an app I can check it by increasing the font size. I will have more confidence in shopping at the grocery store*." He also suggested that the phone provides a new way to interact with the cashier by not having to read the sales terminal as it is challenging to read text on existing sales terminals.

The individual who is blind finds the smartphone wallet useful because it has audio feedback of his credit card information, whereas currently he depends on braille labeling. He said he would like to use a smartphone wallet where it does not require him to enter the card information each time he receives a new credit card. His current braille labeling system requires extra effort and time, because it requires a sighted person to read out the new card information to him.

In contrast, the participant who is hesitant about the smartphone wallet said that it does not help her solve the problem with wallet weight. The prototype shows only one bankcard in the system so she said it only reduces one bankcard from her wallet. She would still have to carry her existing wallet for other bankcards, identity cards and cash in addition to the smartphone. She

currently owns a mobile flip-phone and she is more comfortable with her flip-phone because it fits inside her palm.

Insights for Smartphone Wallet Design

One applies the Human-Artifact Model to analyze the observation during the use of smartphone wallet prototype, in order to come up with insights for the next design iteration. The table below summarizes the participants' motivations, goals and handling of the prototype. The first level of the model suggests that the designer can leverage accessible content as a motivational need. The second level of the model gives insight that the prototype can be made more attractive if it can help reduce the weight of an existing textile wallet. The third level reveals that the smartphone wallet can better integrate with the entire payment process, especially on the interactions after the payment has been authorized but the receipt is still in paper format. The number indicator [1] represents participant #1 (Please cross reference to Tables 1,2,3).

Table 4 : Smartphone Wallet Prototype #1

	Smartphone Wallet Prototype #1	Participants
Why?	*Why is it designed?* Smartphone can store and preauthorize one bankcard so one can tap and pay at the checkout.	*Why should the user use it?* Provides accessible information on contents inside the wallet [1] No need to use the sales terminal [2] No need to put strain on hand when retrieving a bankcard [3]
What?	*It helps the user do…* Make a fast payment by tapping the phone onto the terminal. Make a fast payment by preauthorizing the PIN code. Make a secure payment by not having to handover a bankcard to a stranger.	*What are the possible and critical goals?* Shop with confidence [2] Reducing weight of the textile wallet [3]
How?	*How does it help mediate the actions required? What are the physical affordances.* Text to speech capabilities. Existing smartphone users will not have to learn how to use the application. Requires the user to call the bank to activate and link the bankcard. Allows larger margin of error by tapping the phone, precision of inserting the card is not required.	*How does it meet human operations that are taught and learned?* Already know how to handle the buttons on a phone [1,2] Already know how to operate accessibility functions on phone. [1,2] Get the phone out to pay and open textile wallet to store the receipt. [3] Fear of dropping the phone [3]

Smartcard Wallet Discussion

The next prototype presented to the same group of participants was a paper version of a smartcard wallet. The prototype simulates a device that can store all debit cards, credit cards, gift cards, loyalty and membership cards where multiple accounts and information can be retrieved in one place[11]. All the participants are unfamiliar with the design and had to learn how to use the prototype. The participants show that they are able to grasp the concept, referring to it as “like a credit card”. The individual with dexterity challenges expresses that it is light to carry and does not require any effort to press the button on the card. She said the card could speed up the process of making a payment because she does not need to struggle with any wallet compartments. During the discussion she compared the smartcard wallet with her wallet and attempted to insert the prototype into one of the compartments.

The individual with low vision examined the prototype carefully and questioned the size of the screen. He said that it does not ease the payment process because the display on the device only shows the card information, where he would still need to interact with the low-contrast sales

[11] At the time of this writing, this product is still not available in Canada. See https://onlycoin.com/support/faq/

terminal to enter the PIN. He suggested that, "*I would increase the font size of this display as large as possible. It's much faster using this compared to the mobile app, less stuff (instructions) for me to read*", one would only be required to press a button to advance to the next card where in the smartphone app there are instructions to read in addition to the card information. The individual who is blind quickly pointed out that the smartcard wallet is not usable at all because it lacks audio feedback and it does not provide any tactile feedback like a traditional wallet. He expressed concern about accessing the specific contents, "*I need to access the CVC code for online shopping.*" He expressed that he will not be motivated to use this smartcard wallet.

Insights for Smartcard Wallet Design

Again, the prototype was evaluated systematically by applying the Human-Artifact Model (Table 5). One insight is that the smartcard wallet prototype is not usable under situations where sense of vision is not available. In addition, the individuals see the design as an analogy of a credit card that can be integrated into their existing wallets.

Table 5 : Smartcard Wallet Prototype #1

	Smartcard Prototype #1	Participants
Why?	*Why is it designed?* One card that stores all the user's payment cards so one can carry less. It adds security to the card where one can deactivate quickly if the card gets stolen.	*Why should the user use it?* No incentive for using it [1] No need to put strain on hand when retrieving a bankcard [3] Speed up payment process [3] Lighter wallet [2,3]
What?	*It helps the user do…* Comprehensive payment card management. Organize, track and secure payment cards.	*What are the possible and critical goals?* Know about the contents stored inside [1] Wish there was a number pad to enter PIN [2] To assist in reducing weight of the textile wallet [3]
How?	*How does it help mediate the actions required? Handling and affordances.* One tactile button for manipulating the system. One handed operation. Would still require the user to pass the card to a cashier and authorize using the sales terminal.	*How does it meet human operations that are taught and learned?* The look and feel, and size is like a credit card [1] Already know how to press a button to control a device. [1,2,3] Stores the card into her existing textile wallet [3]

Second Design Iteration

The findings from the first iteration point towards possible improvements for the smartphone wallet prototype such that it simulates a variety of contents

similar to a physical wallet. It provides storage for digital identity cards, reward cards and receipts (Figures 11,12,13). The smartcard wallet prototype was modified to imply an audio feedback feature. The thickness of the prototype has been increased to simulate the hardware support of the audio feature on the device (Figure 14).

Figure 11. Modified smartphone prototype – making a payment

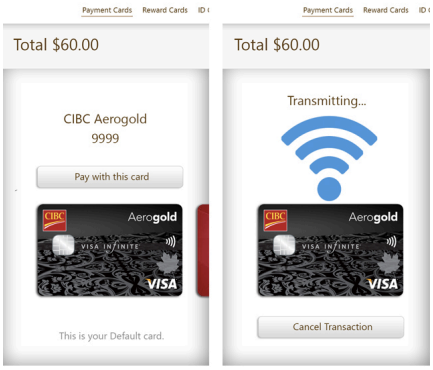


Figure 12. Modified smartphone prototype – password input methods

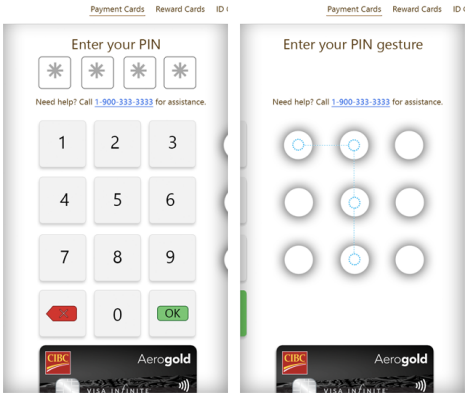


Figure 13. Modified smartphone prototype – different wallet compartments

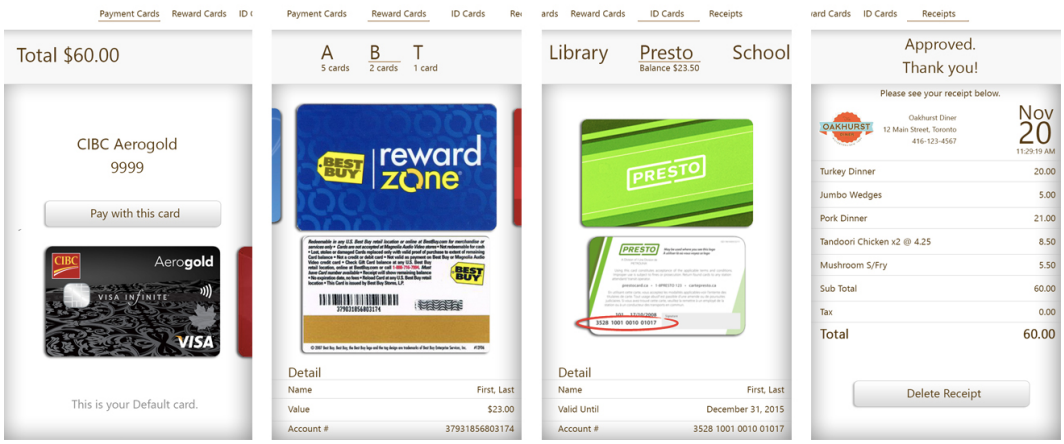
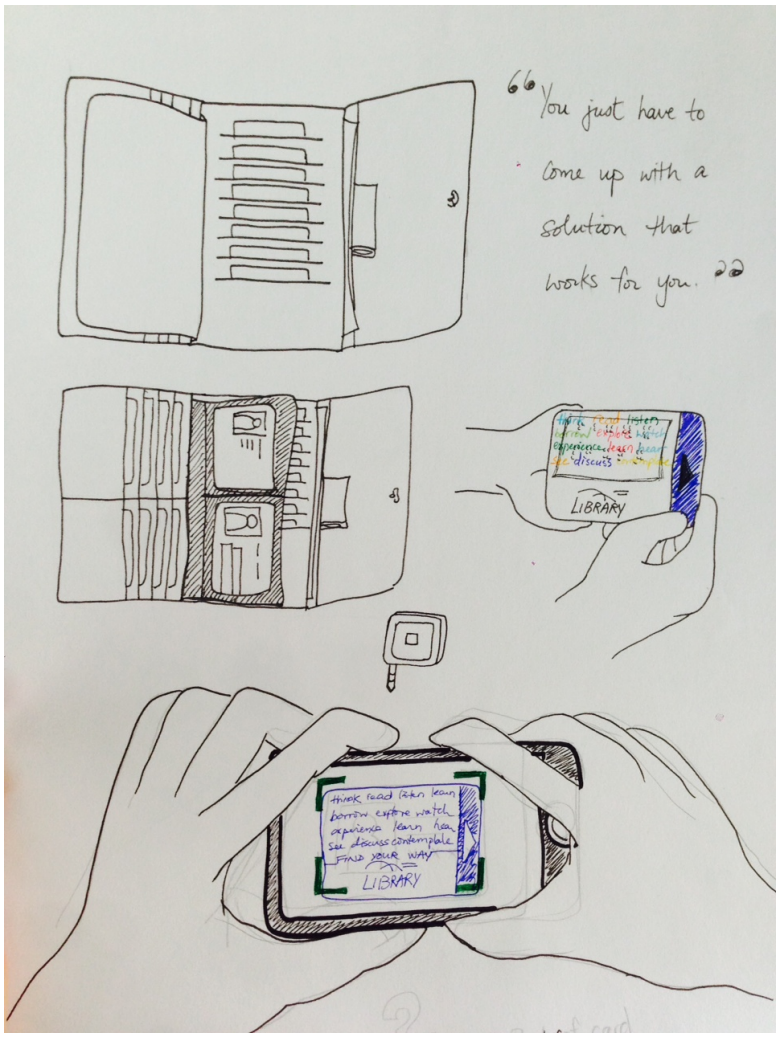


Figure 14. Modified smartcard prototype with speaker

Similar to the previous structure in the first design iteration section, the following sections summarize the existing textile wallet usage from three individuals, followed by a discussion of the digital wallet prototypes. The first

participant from this group has not had any vision since birth. She uses a trifold designer wallet that has a button to secure the items inside. She said that she has no difficulties in using her wallet, "*It's about finding a system that works for you.*" The insert inside her wallet looks like a book (Figure 15). She groups the content by frequency of use. Bankcards, library card and health card with braille labels are grouped on one side. The clear plastic insert contains a transit pass and school identity card. Reward cards and other personal affiliated items are grouped on the opposite side of the frequently used cards. The back of the wallet has a zipper compartment for coins but she said it is often not being used. She considers her wallet as a personal item that no one else should have access to.

Figure 15. Trifold wallet for participant #4



The sketch shows the three sides of the trifold wallet that is neatly organized with one card per slot. The sketch also records how the participant holds the phone to try to capture an image of the card.

The individual with dexterity challenges who has an attendant with her said that it is extremely difficult to manipulate her wallets. She travels by a wheelchair and her wallets are inside her handbag that is strapped between her hip and an armrest. She uses one wallet that can be described as a

pouch that contains identity cards, a banknote and some coins. She also carries a trifold designer wallet that she has received as a gift. It contains payment cards and other personal items such as business cards, notes and tickets. She is comfortable with using two wallets, however, observation shows that it requires a great amount of strength to retrieve the trifold wallet from her handbag, and it takes time to position the wallet properly on her lap with the right orientation.

One major feature she depends on is the secure fastener of her pouch wallet, which is attached to her handbag. She explains that it is an essential feature because she cannot reach the wallet if it falls out from her lap. This way is also safer because it is harder to steal. She shares wallet access with her attendants. Attendants provide assistance to wheelchair users in situations where physical help is needed, such as operating a sales terminal that is mounted outside the reach of a wheelchair user. An attendant can be requested to accompany one's shopping trip depending on the attendant's availability. The participant said that she has to provide instructions each time she shops with a new attendant. Some attendants have misplaced her cards in different wallet compartments during a shopping trip, which causes distress and inefficiency for the next attendant.

The third individual also travels with a wheelchair and has limited movement on her arms and wrists. She has a different speech pattern and requires extra time to express her needs verbally. Her wallet is a square shaped billfold wallet and it is neatly organized. She said that contents are being filed regularly so she could carry less. She has been using the wallet for a long time and she shares the same concern as the previous participant.

Smartphone Wallet Discussion

A discussion with the three participants on the smartphone wallet prototype is summarized in Table 6. The design is acceptable to the individual who is blind. She owns an iPhone and she could operate the prototype without assistance. However, she is concerned about the ease of content navigation based on audio feedback. The prototype provides a user interface that organizes the wallet content into four categories; payment cards, reward cards, ID cards, and a section for electronic receipts. Selecting a category will reveal another menu, for example, selecting ID cards activates a menu for Library, Transit, and School related items. The design is intended to be customizable by the wallet holder where she can add new categories to organize the contents.

Additionally it was challenging for her to understand what is contained inside the smartphone wallet. She said she prefers a menu system that lists all the cards available, where she can quickly anticipate the next action during a transaction. "*With an app you wouldn't have to worry so much on the accessibility features. Maybe try to make it easy to know what options are there so I can hear what is coming.*" Furthermore, she suggested that the PIN input in the prototype is not usable by the blind. The smartphone user should be comfortable with the device's default numeric input method, that the suggested design might create confusion. The suggested gesture PIN input method is unfamiliar to her.

The two individuals with dexterity challenges do not own any smartphones. They share the same concern about the price of obtaining a digital wallet on a smartphone. They also question its ease of use for people who are not computer literate. They are interested to learn how to transfer existing wallet contents into the digital version. Upon testing the prototype, both reported that grip is a major concern for a smartphone wallet. With respect to the wallet's functionality, both appreciate the option of using the smartphone as a PIN input device such that they do not have to depend on others to operate inaccessible sales terminals. Having a smartphone wallet keeps everything within an arm's reach. One participant made a remark on her

concern for security, "*I worry that if it's in your cellphone, like money stuff needs to be more secure. So I would like to see a separate thing (object or device).*" Furthermore, the individual with a different speech pattern suggested that the timeout limit should be adjustable because people like her might need more time to communicate with the cashier in order to get help during the payment process.

Insights for Smartphone Wallet Design

In comparison to the previous design iteration, this group of individuals is more sensitive to the activities involved in owning and operating a smartphone wallet prototype. The Human-Artifact Model leads to an insight that personalization of content manipulation on a smartphone wallet is not limited to graphical or textual design, it could also involve the flow of the audio feedback and the timing of events happening in the digital system.

Table 6 : Smartphone Wallet Prototype #2

	Smartphone Wallet Prototype #2	Participants
Why?	*Why is it designed?* Store and preauthorize multiple bankcards, reward cards, membership cards and digital receipts. One can tap and pay at the checkout.	*Why should the user use it?* Easier to use than existing sales terminal [4] An option to be independent [5,6] Not attracted to this option as battery life, technicality and price are concerns [6]
What?	It helps the user do… Consolidate plastic payment cards into one central place and keeps it neatly organized. Information about each card has been digitalized. Make a secure payment by not having to hand over a bankcard to a stranger.	What are the possible and critical goals? Can find out detail about content without the use of braille [4] Cannot picture what's contained in the wallet [4] Carry one wallet instead of two [5] Makes PIN input reachable [5,6]
How?	How does it help mediate the actions required? Handling and affordances. Text to speech capabilities. Existing smartphone users will not have to learn how to use the application. Requires the user to call the bank to activate and link bankcard. Allows larger margin of error by tapping the phone instead of inserting cards into sales terminal.	How does it meet human operations that are taught and learned? Accessibility feature and key input is familiar to a smartphone user [4] Not comfortable with the slippery material on the smartphone [5,6] Not familiar with how to operate a smartphone [6] Timeout feature is stressful [6]

Smartcard Wallet Discussion

For the second smartcard prototype, all participants express that the smartcard wallet is an attractive concept over the smartphone wallet. The individual who is blind sees this as an opportunity to bring awareness to designers about accessible payment cards. The smartcard wallet is light and can reduce the need to carry her collection of cards. Storing sensitive information on a smartphone is not an ideal solution for her; she prefers the smartcard wallet more. However, she is reserved about adding identity related items onto the device and in favor of using her existing trifold wallet. She suggests that the prototype might not be usable in situations when one needs to traverse a large number of cards. She said that the prototype has only one button and questions how she can interrupt the traversing of cards in case she wants to backtrack to the previous item. The design of the audio feature is also a concern, she suggests adding a headphone option as one might not be able to hear in a noisy setting even if the card is held close to the ear.

The second participant likes the smartcard wallet concept because it is light to carry, and minimum effort is needed to select an item from the wallet. She is interested to learn more about the security features in place to prevent theft. When asked about how she would store this device, she said she

intended to place the smartcard in her trifold wallet along with her cash and receipts. The third participant said the smartcard wallet is small and easier to stow than the smartphone. She would be interested to see a more attractive design that is catered to the taste of a 70 year old. The current color and design is too masculine. Her handling of the smartcard prototype shows that low-grip flat surface and the button size are not ideal for trembling hands. The prototype fell off her hand onto her lap several times, so she attempted to use the button as a grip.

Insights for Smartcard Wallet Design

This group of individuals brings more awareness to the physical design aspects of the smartcard wallet. The Human-Artifact Model informed a need to redesign the control button.

Table 7: Smartcard Wallet Prototype #2

	Smartcard Wallet Prototype #2	Participants
Why?	Why is it designed? One card that stores all the user's payment cards so one can carry less. It adds security to the card where one can deactivate quickly if the card gets stolen.	Why should the user use it? Store all payment cards [4] Light to carry [5] Easy to hide [6]
What?	It helps the user do… Comprehensive payment card management Organize, track and secure payment cards	What are the possible and critical goals? Know about the contents stored inside [4] Wish there was better security features in case of theft [5] To assist in reducing weight of the textile wallet [3]
How?	How does it help mediate the actions required? Handling and affordances. One tactile button for manipulating the system One handed operation Would still require the user to pass the card to a cashier and authorize using the sales terminal	How does it meet human operations that are taught and learned? Audio feature is not intuitive to use. [4] Traversing the cards using one button is cumbersome. [4] Already know how to press a button to control a device. [4,5,6] Trembling hands cause accidental activation. [6]

Third Design Iteration

The last two interviews involve one individual with low vision and an individual with dexterity challenges without attendant. The individual with low vision does not use any payment cards and only carries her bankcard when she needs to update her bankbook. She also carries two wallets with her. One billfold wallet contains cash, health card, photos, medical records and personal notes. Another is a smaller billfold with her transit pass, pre-paid card and some cash. She said she has been a victim of theft before and, since then, she carries one wallet in her handbag and one inside her clothing. She also mentioned that she uses different wallets in different environments; for example, for ad hoc shopping she would use the smaller wallet to avoid prying eyes because she is unfamiliar with the surroundings. For banking, she would use the larger wallet because she can carry more cash inside. Her major concern about wallet usage is when she has to interact in a low light environment and she has difficulty using banknotes. She has to make an effort to ensure her banknotes are separated into different compartments before a shopping trip.

The last individual travels with a wheelchair and she has a guide dog to accompany her. Interestingly, she also carries two wallets (Figure 16).

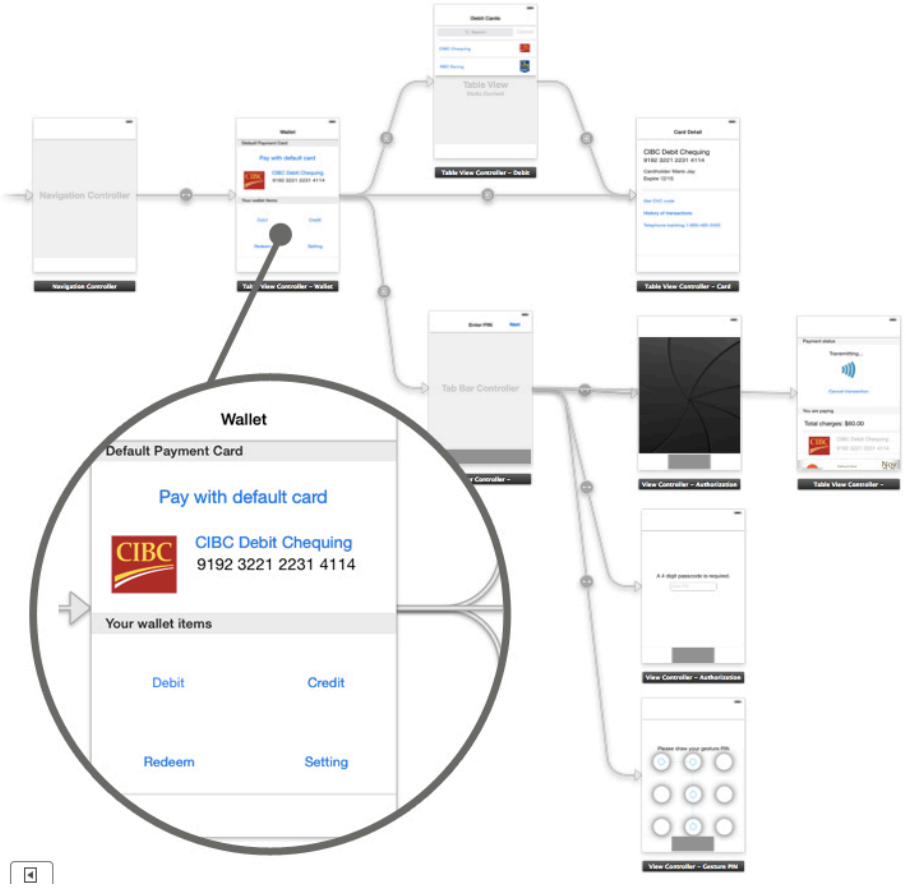
Figure 16. Two wallets system

She does not use cash and prefers payment cards. Her reason is that banknotes are slippery and not sanitary. Her experience with her wallet is similar to the other participants who travel in a wheelchair. The wallet she carries frequently has a wristband that she can attach onto her wrist or wheelchair for security purposes. She mentioned that guide dogs can be trained to assist in the process of paying. For example, the guide dog can retrieve a wallet from a backpack and place it on her lap. Observation shows that the guide dog can distract his owner when a stranger tries to interact with the owner.

Insight on personalization features from the second design iteration has been incorporated into the third prototype by adding a Setting menu item into the

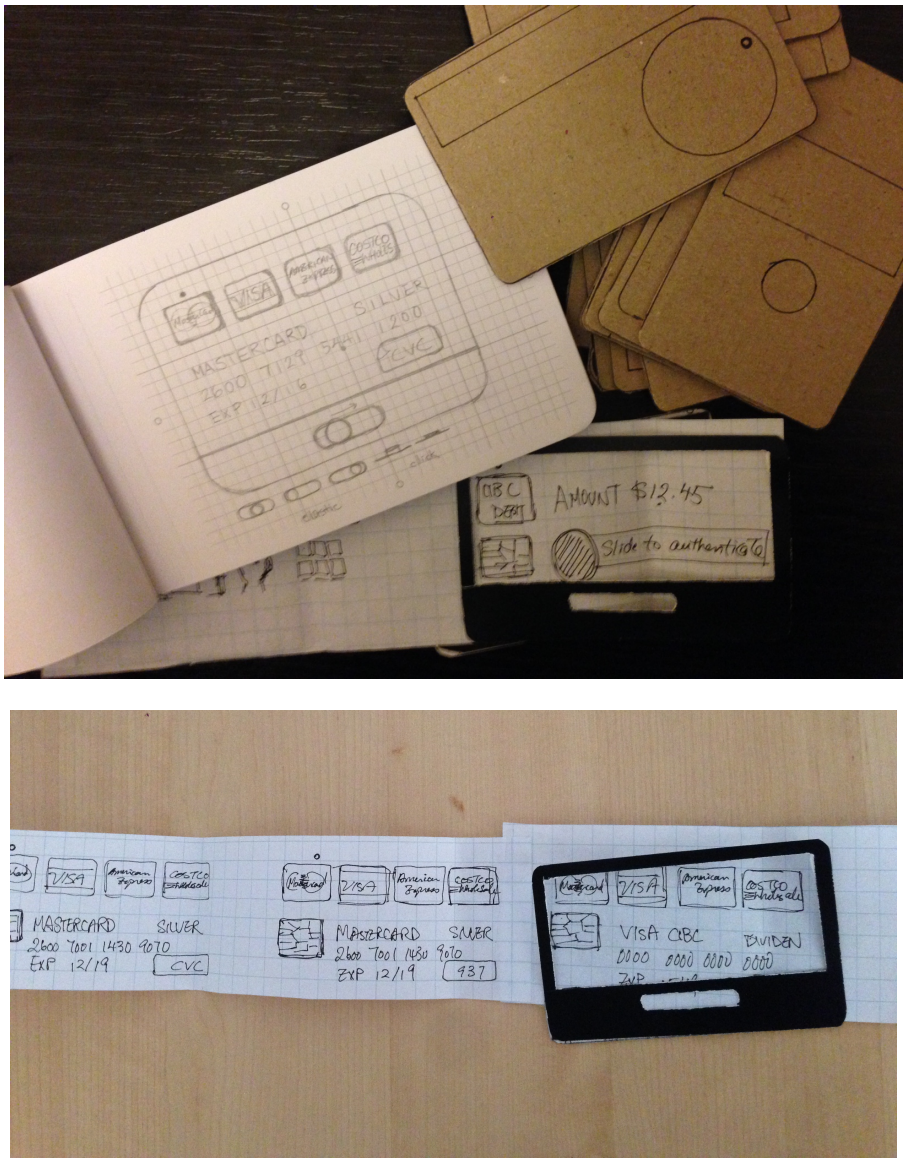
menu design to address categorization and timeout preferences. Design changes to the third iteration of the smartcard prototype were described to the participants. The changes include larger display, headphone plug and a slider button at the center for traversing the contents quickly.

Figure 17. Modified smartphone prototype – settings



The above diagram shows the planning of the user interface using Xcode. The designer anticipated issues early on in the design stage simply by thinking how different people will interact with the system using visual and audio modes, as well as considering the timing of interactions under different situations. The result is a high-fidelity prototype that is capable of delivering the design concept to people with different abilities.

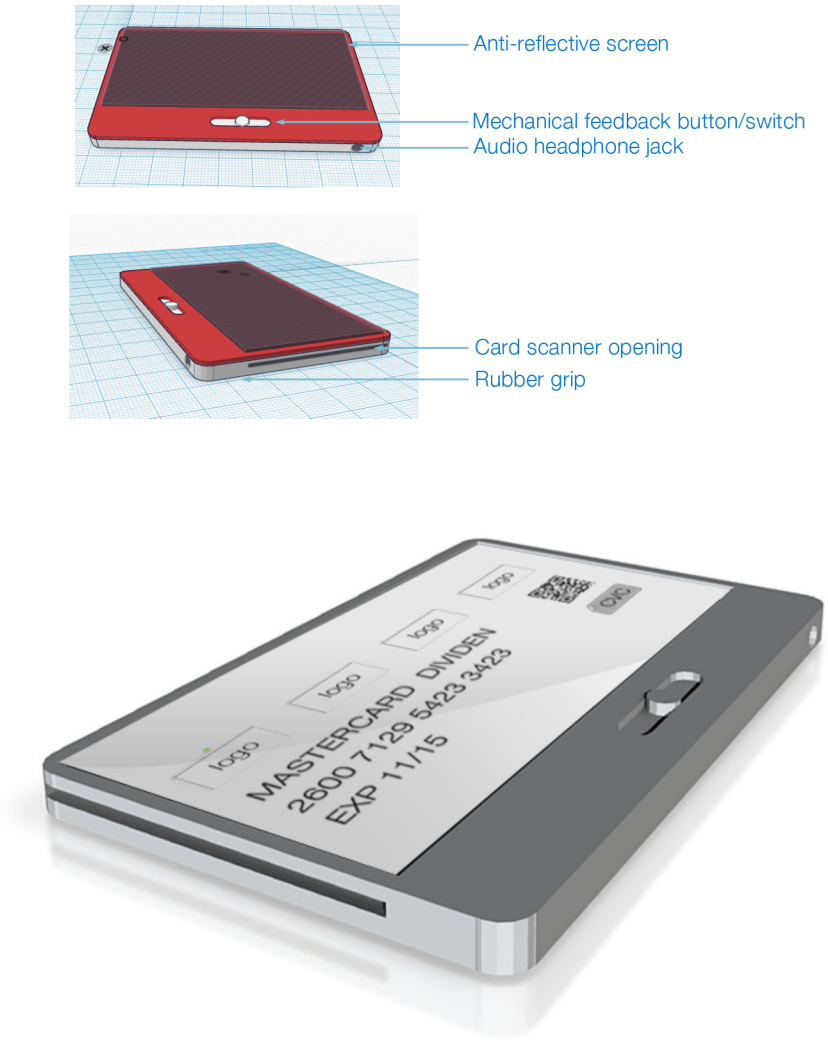
Figure 18. Modified smartcard prototype – redesign process



Above: Using cardboards to test the different screen and button placements.

Below: Sketches of each screen were made on a long strip of paper, to simulate the advancement to the subsequent screens by sliding the paper left and right within the device window.

Figure 19. Modified smartcard prototype – 3D printing



Top: Two screenshots of the 3D model made using TinkerCAD.

Bottom: A rendering of a digital wallet concept. It has a slot for reading cards, a tactile slider button to advance the contents in the wallet and a screen to show the content inside the wallet. A headphone outlet is available for audio feedback.

Smartphone Wallet Discussion

A discussion with the two participants on the smartphone wallet prototype is summarized in Table 8. The individual with low-vision owns a mobile flip-phone. She indicated that she would like to upgrade to a smartphone because the buttons on her phone are not responsive after extensive use. After experiencing the smartphone wallet prototype, she pointed out that it is not useful to her needs. She does not like the idea of carrying a bankcard with her regularly even when it is digitally secured with a password. However, she said she is willing to use the smartphone wallet for reward or pre-paid cards if the balance amounts are readily available. She was not aware of the convenience of brightness settings on a smartphone until she accidentally activated the menu settings, which might benefit her needs.

The last participant said a smartphone wallet would be helpful to her since she only uses bankcards and pre-paid cards. She avoids using cash because of hygiene concerns. She currently owns a smartphone and it is possible for her to eliminate one of her wallets with a smartphone wallet. During the interview she did not interact with the smartphone wallet because she requires the phone to be mounted on her wheelchair in order to use it easily. However, upon demonstrating the application she pointed out a privacy concern for PIN input. Since the smartphone is mounted to the

wheelchair, it is not easy for her to cover the screen to increase privacy. She dislikes the idea of a fingerprint authentication system and questions its reliability for situations like wearing gloves or fingers with lotion. It is also not ideal for her to pass the phone to the terminal for payment authentication because it requires effort to release the device from the mount.

Table 8 : Smartphone Wallet Prototype #3

	Smartphone Wallet Prototype #3	Participants
Why?	Why is it designed? Store and preauthorize multiple bankcards, reward cards, membership cards and digital receipts. One can tap and pay at the checkout.	Why should the user use it? Not attracted to this option for bankcard [7] Attracted to this option for points cards [7] Can replace one of the two wallets [8]
What?	It helps the user do… Consolidate plastic payment cards into one central place and keeps it neatly organized. Information about each card has been digitalized. Make a secure payment by not having to hand over a bankcard to a stranger.	What are the possible and critical goals? Makes points card easier to use [7] Makes PIN input reachable [8]
How?	How does it help mediate the actions required? Handling and affordances. Text to speech capabilities. Existing smartphone users will not have to learn how to use the application. Requires the user to call the bank to activate and link bankcard. Allows larger margin of error by tapping the phone instead of inserting cards into sales terminal.	How does it meet human operations that are taught and learned? New concepts to be learn on a mobile phone [7] Accessibility feature and key input is familiar to a smartphone user [8]

Smartcard Wallet Discussion

The individual with low-vision was not familiar with a low-fidelity prototype and initially had trouble understanding the design concept. The prototype screen shows the bank name and the type of credit card shown (See Appendix A). This text description is not comprehensible by her since she is not familiar with the different types of credit cards. Upon explaining more about features that might be relevant to her needs, she questioned how to refill a pre-paid card if it is stored inside the smartcard wallet. Transferring a pre-paid card is another concern because currently she can pass the card to her sister to use. Nevertheless, she thinks the smartcard wallet is better than the smartphone wallet because she can easily allow others to use her card for long-term use without sacrificing the ability to make phone calls.

For the individual with dexterity challenges, she is interested in the smartcard wallet because it is a separate personal item. Also it is light to carry without the need to mount it to a wheelchair. However, she said she is more familiar with her smartphone so the smartphone wallet is appealing as well. Observation shows that the button on the smartcard wallet is not at an ideal location for her to press. She had to press the button using the knuckle on her thumb, which can add strain to her wrist. The design changes to the

third smartcard prototype were explained to her verbally. It seems to be a viable solution to solve the button problem that she was having.

Table 9 : Smartcard Wallet Prototype #3

	Smartcard Wallet Prototype #3	Participants
Why?	Why is it designed? One card that stores all the user's payment cards so one can carry less. It adds security to the card where one can deactivate quickly if the card gets stolen.	Why should the user use it? Instant information on the content inside [7] Stores all payment cards [8] No mounting to wheelchair [8]
What?	It helps the user do… Comprehensive payment card management Organize, track and secure payment cards	What are the possible and critical goals? Transfer cards with others [7] Less to carry [8]
How?	How does it help mediate the actions required? Handling and affordances. One tactile button for manipulating the system One-handed operation Would still require the user to pass the card to a cashier and authorize using the sales terminal	How does it meet human operations that are taught and learned? Already know how to press a button to control a device. [7,8] Trouble understanding abbreviation of text [7] Language barrier [7] Thumb pressing puts strain on hand [8]

This chapter provided detailed records of eight interviews and its impact to the digital wallet prototypes. The information is intended to demonstrate a practical example of the amount of analysis and the complexity involved in designing for a diverse set of individuals. The next chapter is a discussion of the research results.

5 Discussion

The objective of this research has been to obtain new knowledge about digital wallet design to meet the diverse needs of users. Approaching this goal with an Inclusive Design perspective is not easy; it requires one to exploit patterns observed within a diverse set of individuals. This research utilizes the AEIOU framework and semi-structured interviews during the data collection process, in order to uncover mismatches between the expectations of the wallet holder and the activities involved. Similarly, the function of the Human-Artifact Model is to increase awareness of tensions between the purpose of the prototype and the expectations of its user. As a result, improvements were made to the prototypes to better meet the expectations of the users. The following sections will discuss the themes that emerged through the examination of textile wallets, and how the methodology in this research assisted the design thinking of the digital wallet.

Access Sharing

The research result shows that individuals with dexterity challenges might require attendants to assist in a payment process. Through applying the AEIOU framework, one is able to discover the access barriers between the attendant, the wallet holder, and the wallet. The wallet holder needs to give the attendant full wallet access or partial access to the wallet content, in cases where he/she is unable to carry out an activity that requires the use of a wallet. The interviews also show that contents can be misplaced and sharing a PIN with the attendant is not an ideal solution. This leads to the conclusion that access sharing and content organization is a need for the wallet holder but existing textile wallets cannot offer this service. The AEIOU framework provided a technique to scrutinize the research subject in relation to different environments, people, and things, parallel to the objective in Inclusive Design.

The need for access sharing is not limited to people with dexterity challenges. Individuals with visual challenges might have the same demand. The first blind participant in this research expressed that his family members often need to assist him in managing receipts and relaying payment card information. Furthermore, the second low-vision participant expressed that she currently is able to share a pre-paid card with her sister and worries that

a digital wallet solution will prevent this use case. Future digital wallet improvements might include services that can grant temporary access for attendants and other trusted individuals on site, without giving them the full access to all of the contents inside.

Content Organization

As illustrated by participants with attendants, sharing access to the wallet can result in a re-organization of the contents inside. The prototyping exercise and the application of the Human-Artifact model helped answer the need of content organization in case someone else accidently rearranged the contents in a wallet. The second version of the smartphone wallet design consisted of payment cards categorization, which can help its owner to neatly structure the wallet contents after each use. One requires a high-fidelity prototype with text-to-speech capability in order to test this design with individuals who are blind. Navigating the proposed structure in audio format proved to be an average solution because it is time consuming. Future digital wallet can explore customizable wallet partitioning that is efficient in audio format.

Unforeseen Handling

Semi-structured interviews, artifact analysis and Inclusive Design principles can reveal surprising findings. The combination of these methods contributed to the discovery of three unforeseen design opportunities, namely, the effect of trembling hands during the use of a smartcard wallet, the unexpressed need of using the textile wallet as a key holder through photographs, and the use of textile wallet by a guide dog. These observations are a result of maintaining an open mind when studying a diverse group of participants, as well as the open communication expressed in a semi-structured interview. Future designers might be able to capitalize on these observations to build better digital wallet(s) by enhancing error handling or security mechanisms for the above use cases.

Multiple Modes to Replenish Wallet

Unlike textile wallets, digital wallets have a direct connection with the contents stored inside. For example, the smartphone wallet has a touchscreen that allows one to add or remove a card. The card information is stored on the device or virtually over the Internet. Similarly, the smartcard wallet has one button that allows the user to manipulate the virtual content

stored inside. Unfortunately, this research did not address to the participants that one can add items to the smartcard wallet.

In one of the discussions on textile wallet, the participant without sight said that it is troublesome for him to add new cards to his wallet because of the braille labeling. A background research on existing smartphone wallet functionality shows that common ways to add items to the wallet include, 1) taking a photo of the front and back of a physical card, 2) enter the card information manually, or 3) slide the card onto a proprietary card-reading device that is connected to the smartphone's headphone outlet. For an individual without sight the first two methods would still require assistance from someone in order to identify the information and the orientation of the physical card. The third solution interrupts the text-to-speech functionality, which is unusable for blind individuals. Future digital wallet designers could examine the use of adaptive user interfaces where it allows the loading/reloading of items for individuals with different sensory needs.

Adaptive user interfaces are often used to address inclusive design challenges. Vanderheiden et al.'s research (Vanderheiden et al, 2013) shows that customizable visual or audio interfaces based on users' profiles allow a wide range of individuals to use and interconnect with electronic devices. In this research, the prototypes helped one to identify issues that

can be solved by adaptive user interfaces. For example, the smartcard wallet can adjust to the user's low vision profile to increase its font size. Similarly, PIN input on a smartphone wallet can be made to have a longer timeout period so people with restricted dexterity can enter the PIN independently with ease. There is no evidence that existing consumer digital wallets have support for the above use cases, therefore, adaptive user interfaces could be considered in future digital wallet development.

6 Conclusion and Future Work

Although much research has been done on digital wallets as explained in this paper, most are related to security, privacy and functionality. The preliminary findings in this research suggest that Inclusive Design illuminates new opportunities in design because needs from non-mainstream users are being discovered. Individuals with visual and dexterity challenges have desires for better access sharing and content organization. They are susceptible to experience unforeseen handling of a wallet. Furthermore, they reminded one that multiple modes of interactions are easy to obtain for a textile wallet, either by adding braille or verbally asking another person to relay the information. However, it could be difficult when interacting with the virtual contents in a digital wallet. Digital wallet designers, whether they are designing smartphone wallet, smartcard wallet or other forms of digital wallet, can leverage these three themes to create more innovative solutions.

While this preliminary research relied on paper prototypes and mockups, more functional prototypes would be able to better simulate real world usage. This will enable deeper synthesis of real life situations, particularly for individuals who are blind. The paper prototypes did not allow for consistent audio feedback as the interviewer needed to audio transcribe the user interface and describe the situation at the same time. Also, this research combines a number of methods with the intention to bring together different perspectives. For the purpose of Inclusive Design, AEIOU framework works well to bring out the diverse viewpoints in this research. In contrast, the Human-Artifact model places too much emphasis on the human's ability/disability in handling an artifact, where one can easily overlook the details of the environment pertaining the activities. Nonetheless, the Inclusive Design approach acted as a reminder to reframe the notion of disability when working with the Human-Artifact model.

This research did not report the digital wallet design from other perspectives (such as cashiers, merchants, product designers, financial and telecomm service providers), which might provide different rationales on accessibility challenges and solutions to existing digital wallets. Future studies could examine the topics of textile and digital wallet from the perspectives mentioned above. In addition, other use cases of digital wallet are interesting

topics to explore to possibly address the need for financial inclusion. Previous researches on the use (or the avoidance) of wallets in developing countries (Chipchase, 2009, p.17-18; Morawczynski & Pickens, 2009) can be a source of inspiration for future inclusive digital wallet designers. In conclusion, this work is only a part of a continuous journey in applying the notion of Inclusive Design to the design of an everyday object.

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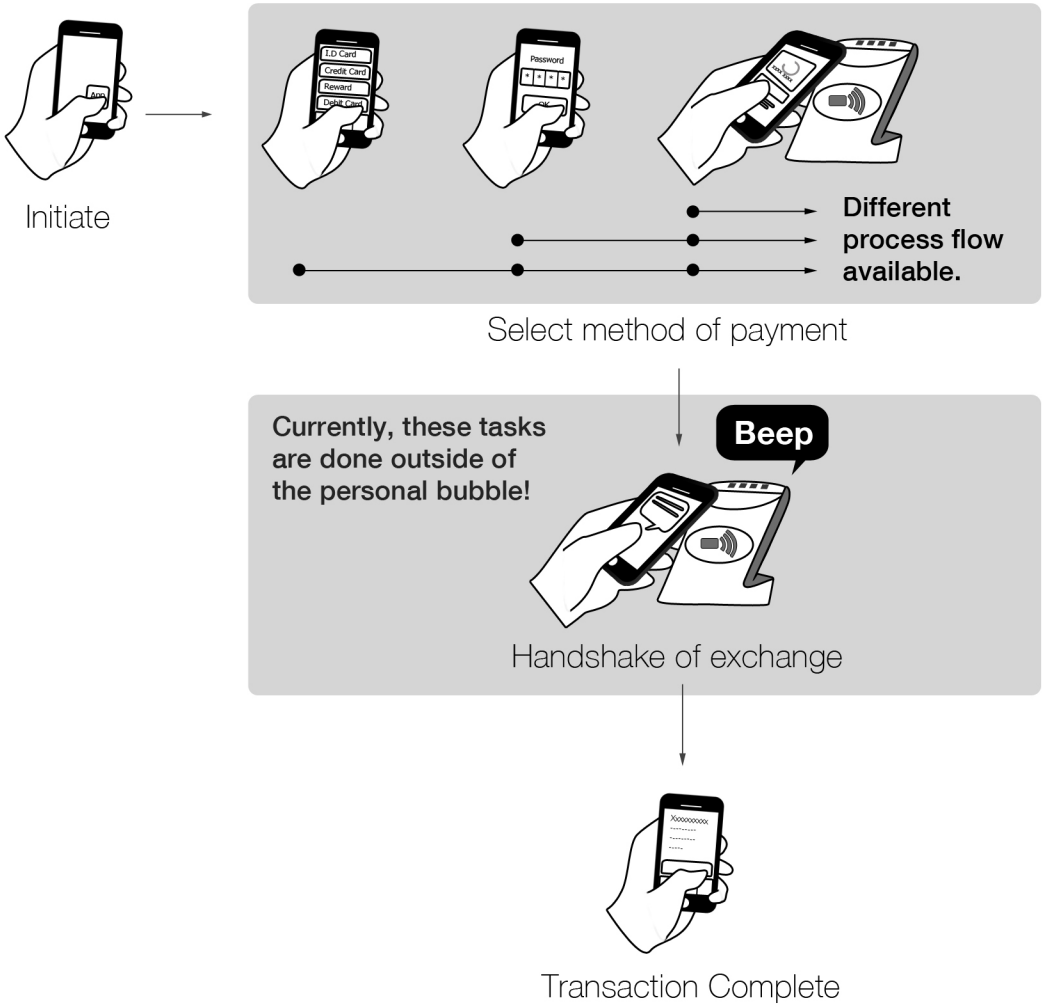
Appendix A - Digital Wallet Interactions

Mobile app journey



A mobile wallet journey usually begins with a registration process with an online wallet service. Users are required to create an account online and step through pages of consent forms, security agreements and card setup. There is also paperwork involved with the telecomm providers to

link the wallet account with the mobile device. Some wallet solutions like Square Wallet, require the user to take a photo using the smartphone as part of the setup process so the photo can be used as a form of authentication at the checkout. The diagram above shows the typical tap-and-pay mobile phone payment process. First, the user presses onto the phone to initiate the wallet app. There are different process flows available. Whether the app asks the user to select a card first or enter the pin first, the next step is to tap the phone to the point-of-sales terminal to start the handshake of exchange. Once the merchant's system acknowledges the payment, it beeps and the user gets a transaction complete message on their phone. The user can choose to close the wallet app at the end of the transaction and repeat the same process again for the next shopping trip.

Interactive smartcard journey

Transaction Complete

This diagram shows the Coin card payment process (https://onlycoin.com/). According to the product demo, a user has to download an application onto the mobile phone and create an account to link with the smartcard wirelessly with Bluetooth signal. Coin provides a card swiping device where the user can connect it to the phone's headphone jack to transfer existing payment cards onto the digital

account. The user initiates the wallet by pressing a button to navigate to the card that he/she will use to pay for the goods. There is only one button to navigate back and forth between the cards loaded into the system. The user then hands over the card to the merchant to swipe it at the terminal. When the transaction gets approved, the merchant hands the card back to the owner along with the paper receipt, alternatively, the merchant can also send an electronic receipt that will be available on the user's mobile device. The usage journey ends with the user putting the Coin card back into his/her pocket for later use.

Wearable wristband wallet journey

This research was originally planned to have a third prototype. However, the results were inconclusive. The results for the wearable wristband approach are not reusable by future researchers because there were too many unknown variables for the design scenario. The prototype, which is based on a product called Nymi (http://www.getnymi.com/), could not clearly illustrate the user experience that the designer was aiming to test. For example, the idea of the wristband is to have the individual press a button to authenticate a payment. However, some individuals had difficulty in conceptualizing where the money was being stored and how the data got transmitted once the button was pressed. The scenario walk through turned out to be too much of a fictional idea that the participants could not comprehend in order to finish the exercise.

At the point of this writing, the product is still under development, so many of the details are still just a speculation. The user journey begins with a user logging onto the Nymi website to purchase the wristband.

Once the user obtains the product, he/she is required to create an account and calibrate the wristband with the wearer's cardiac rhythm to authenticate the identity. The user makes a purchase by passing by the checkout stand and initiating the wireless authorization by placing a finger on the topside sensor of the device. When the wrist is in contact with the bottom sensor (on wearing hand), the vibration and LED signal will tell whether the transaction is authenticated (or rejected). The paper receipt of the transaction will be returned to the wearer (or if possible sent to the wearer's associated email account).

Appendix B – AEIOU framework and interview questions

The following table was used to collect data for semi-structured interviews.

	Participant 1	Participant 2
Activities		
Paying for transit		
Paying for grocery		
Banking		
Lending money		
Borrowing money		
Environment		
At a busy public place		
At a private place		
At a public place during the day		
At a public place during the evening		
Interactions		
Filing		
Searching		
Organizing		
Social interactions		
Objects		
Cash		
Pre-paid cards		
Credit/Debit cards		
Other contents in the wallet		
Users		
Relationship with the wallet		
Preferences		
Needs		
Value of wallet		
Biases		

Appendix C – Human-Artifact Model

The following table shows one of the Human-Artifact models created. It looks at the textile wallet and human interaction.

	Artifact	Human
Why? Why is it designed, what drives the design of a wallet? What activity is it supposed to mediate?	Motivational aspects Fashion statement Financial control Palm-sized portable container	Motivational orientation Centralize portable financial and identity storage system
What? What the artifact may help the user do What are the possible and critical goals of actions for the user	Instrumental aspects Slots can hold banknote, coins, cheques, receipts, identity documents, cards Zippers, magnets, Velcro, elastic as security measure Material and design to represent personal taste	Goal orientation Access to own money, personal identification and transaction records anywhere and anytime Connect to the society by being able to pay for needs, gain access to institutions and services.
How? How is it being handled? What are the	Operational aspects Supports hand and finger actions: slide, push, pull, pick, grasp, place	Operational orientation Learned routine to organize, categorize and sort items

learned operations, habits		
	Portable Fits inside garment easily	Conscious to have it close to the body for convenience, access and sense of security Used as a tool to impose sentimental value based on culture

Appendix D – REB Approval