Mini Project

Human Computer Interaction and Inclusive Design Implications for Ticket Kiosks: A Pilot Study of Task Analysis and Usability

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ISLT 9460: Doctoral Seminar: Human-Computer Interaction Research and Analysis

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April 12, 2023

Abstract

The current ticket kiosks used in a U.S.-based metro transportation system is out of date and confusing for infrequent travelers to that area. Research and design solutions have been developed to overcome the existing challenges after the initial user research phase. This study also involves the evaluation of a ticket kiosk's user interface using screeners to recruit 3-12 participants who have previously purchased tickets via an interface, and the use of scenarios and tasks to identify usability and design issues. Iterative testing and design will include two testing feedback sessions, as part of the pilot study. The use of websites for interactive prototypes are also used to track first-clicks and task completion. With a design thinking approach and use of a think aloud protocol, iterative designs and evaluation were conducted with a particular focus on inclusive design aspects.

Keywords: human computer interaction, accessibility, usability, inclusive design, user experience (UX), user centered design (UCD), user interface design, self-service technologies, ticket kiosk, ticket vending machines

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Introduction

The current ticket kiosks used in a U.S.-based metro transportation system are out of date and confusing for infrequent travelers to that area. Research and design solutions have been developed to overcome the existing challenges after the initial user research phase. This study also involves the evaluation of a ticket kiosk's user interface using screeners to recruit 3-12 participants who have previously purchased tickets via an interface, and the use of scenarios and tasks to identify usability and design issues. Iterative testing and design will include two testing feedback sessions, as part of the pilot study. The use of websites for interactive prototypes are also used to track first-clicks and task completion. With a think aloud testing protocol and design thinking approach, the problem and solutions of a ticket kiosk design are discussed with a particular focus on inclusive design aspects.

For this first phase of the pilot study (mini project), the following aspects will be addressed: Problem analysis and user research, which includes the tasks analysis of the current system, user research and system research based on the current system, and a literature review involving HCI concepts, theories, and methods. The goal of the first phase is to evaluate the current interface and design a new interface that supports the various users and improves performance for infrequent passengers who begin their trip at the Washington National Airport.

To accomplish this goal, the following research questions will be answered:

RQ 1) What are the expectations of purchasing tickets at a kiosk and are they met in the prototype?

RQ 2) What problems do people have with the current and proposed user interfaces?

The Problem Summary

The current ticket kiosks used in a U.S.-based metro transportation system are out of date and confusing for infrequent travelers to that area. Research and design solutions have been developed to overcome the existing challenges. The second phase (to be completed in May 2023) is to identify whether the new user interface is successful in helping people complete tasks of purchasing a farecard from a ticket kiosk, and if the participants completed the tasks in a similar or different way.

The Solution Summary

Evaluation of the ticket kiosk prototype including the use of screeners to recruit participants and the use of scenarios and tasks to identify usability issues. The scenario focuses on infrequent passengerrs who being their trip at the Washington National Airport, using the metro system. The tasks were designed to uncover:

- An understanding of the user experience among the current and prototype versions of a ticket kiosk, including user expectations
- If the user interface (UI) is successful in helping people complete tasks with ease, including any note of inclusive design aspects to consider
- If participants completed the tasks in a similar or different way and any problems encountered

Problem Analysis and User Research

The current method in use for the Washington, D.C. (DC) metro ticket kiosk requires new users to determine the fare based on the destination and correct metro line (red, orange, blue, yellow, silver, or green) to get to their destination. The issue is that the fare must be determined **before** using the machine. This causes anxiety as infrequent users of the metro need to figure out how to use the machine before the train arrives; and need to figure out how to use the kiosk with people waiting to use the machine after them. Publicly accessible videos of people using the metro are available online (Cortez, 2018; Crrobins, 2010; DikiDinDC, 2021). Many of the videos show user confusion (mental model) and design flaws (lack of call to action/notifications to users during the transaction process).

This task analysis and usability study will evaluate the current user interface (UI) and design a new UI that 1) supports various users and 2) improves performance for infrequent passengers who start their travel at the Washington National Airport, using the DC Metro system.

Problem Statement

In order to understand the current ticket kiosk system processes, system and user research was conducted. The DC Metro uses a SmarTrip (registered trademark) Card for farecards and passes (more on this system infrastructure later). The current kiosk transaction method requires users to determine a fare based on the destination and correct metro line (red, orange, blue, yellow, silver, or green) to get to their destination. This is problematic as a passenger unfamiliar with the area must determine the fare to the destination **before** using the kiosk. This causes anxiety for passengers as they have to figure out how to use the machine before the train arrives, while also having to figure out how to use the kiosk with people waiting to use the machine after them.

Hierarchical Task Analysis

To further understand the ticket purchase process, a hierarchical task analysis of the current system was created as seen in *Appendix A*. "Task analysis can be defined as the study of what a user is required to do in terms of actions and/or cognitive processes to achieve a task. A detailed task analysis can be conducted to understand the current system and the information flows within it. Understanding these information flows and user actions is important if appropriate system features and functions are to be developed. Failure to allocate sufficient resources to task analysis increases the potential for costly problems arising in later phases of development" (Shepherd, 1985, 1989). any associate inputs and outputs (Maguire, 2001, 598).

HCI Concepts, Methods, and Theories

Human computer interaction (HCI) uses a variety of concepts, methods, and theories to explain, design, and evaluate the experience and relationship between humans and computers (or products). Some that are applicable to this pilot study include the following:

Gulf of Execution and Gulf of Evaluation

According to Whitenton (2018), *Gulf of Execution* is about understanding the state of the system (asking questions such as: How do I use this system?), while *Gulf of Evaluation* is about taking action to

accomplish a specific goal (asking what's the current state of the system?). These are two challenges a user needs to overcome to interact with a product successfully. Relatedly, a mental model (a theory of how a system works) is often used by designers alongside both *Gulfs* when creating visual and functional similarities between current and proposed design solutions. The current ticket kiosk system lacks intuitive answers to the *Gulf* questions.

Slips and Mistakes

When designing around user errors, both slips and mistakes can happen during the user experience. Slips are when a user intends to perform an action but ends up doing another, while mistakes are made when a user has a goal unrelated to the current task (Laubheimer, 2015). In the ticket kiosk example, a slip could result if a user wanted to purchase a farecard with a credit card, but instead used a debit card; and a mistake would result if a user wanted to purchase an unlimited 3-day pass but instead they bought a regular fare card that did not let them ride the train for three days. Both of these examples can happen in the current kiosk interface.

Gestalt Principles

Gestalt Principles are about human perception, where "users must be able to understand what they see —and find what they want—at a glance" (IDF, n.d.a). Going deeper, these principles look at the space or region of a design, figure or ground, proximity, etc., where the relation to similar or close objects by affects the human perception of the overall product. The figures of the current kiosk in *Appendix B* show the visual design confusion where *Gestalt Principles* need to be applied.

Fitts's Law

Fitts's Law is summarized as "the movement time to a target depends on the size of the target and the distance to the target" (Budiu, 2022). In a UX context, this means that if you want to prevent human error, then properly arrange elements of the user journey within close distance to each other. The "User Experience of the Metro System" section of this study will show how Fitts's Law is not applied in the current kiosk design.

Universal Design

Universal design is an approach to ensure the complete user experience is captured at every stage in order to have a solution designed with all users in mind (GSA, n.d.). There are seven principles of universal design, including: equitable use, flexibility in use, simple and intuitive use, perceptive information, tolerance for error, low physical effort, and size and space for approach and use (GSA, n.d). Physical effort/height, readability, language options, and flexibility in use are lacking in the current kiosk.

Design Thinking

Design thinking is a non-liner and iterative process that aims to understand users (IDF, n.d.b). Typically, this process goes through the five phases—empathize, define, ideate, prototype, and test—a process used by many UX-focused organizations and UX designers.

Literature Review and User Research

Literature Review

The literature search included the use of the following terms: ticket kiosk, ticket vending machine, ticket machines, metro machines, metro vending machines, and self-service ticket machine. The topic can be applied to a variety of disciplines and therefore both databases and internet searches were utilized to

learn about prior studies. The ISO standards directory was also utilized for research on prior studies and design standards in practice. The International Organization for Standardization Organization (ISO), an independent, international organization with membership of over 160 national standard bodies that give credibility to standards development (ISO, n.d.) These ISO standards were helpful but not the focus of the pilot study. A list of the ISO standards, however, will apply to the second phase of research.

The literature for the first phase includes theories of user centered design (iteratively designing and testing with users) and user experience (UX) which seeks to understand the quality of the experience a user has with a specific system (Siebenhandl et. al, 2013; Subasi et., al, 2001). Self-service kiosks and machines pose a barrier for a number of populations, including older passengers (Siebenhandl et. al, 2013), people with low technological affinity (Siebenhandl et. al, 2013), navigational difficulties from lack of feedback or non-reversible actions (Connel et. al, 2004), and usage barriers from lack of universal design (Subasi et. al, 2001).

Muhammad et. al (2017) found that 80% of their study participants had difficulties in understanding ticket kiosk purchase procedures, with longer than average transaction times compared to purchases at a service counter. This study also used surveys, scenarios, tasks, and a retrospective think aloud technique to evaluate the success rate of the tasks. The Connel et. al (2004) study compared analytical usability evaluation methods by using cognitive walkthroughs of ticket vending machines and ultimately determined the importance of de-emphathizing the mainly quantitative approach typically used in usability evaluation which is typical for their field. Qualitative studies yield more effective design solutions.

Metro System and Infrastructure

Metro is a subway system on the east coast of the United States that connects the cities of Washington, DC, Virginia, and Maryland. The Metro system is operated by the Washington Metropolitan Area Transit Authority (WMATA), and it opened in 1976 with a current network of six lines, 97 stations, and 129 miles of route (Wikipedia, 2023).

Metro fares vary depending on the time of day and distance traveled. According to WMATA (2023a), the cost to ride during peak hours (weekdays 5:00am-9:30am; 3:00pm-7:00pm) ranges from $2.25 to $6.00 and off peak hours, night hours, and special fares for seniors and people with disabilities are less in comparison. There are also cheaper fares on the weekend, plus pass options, such as 3-day unlimited, 7-day unlimited, and monthly passes. Metro requires the use of a SmarTrip (trademark) farecard (a stored value card) since 2016, when they replaced the paper farecards (Wikipedia, 2023). SmarTrip can be purchased and used via an app on a smartphone or with the rechargeable plastic SmarTrip card (see Appenix B). Fare amounts are automatically deducted from the card at the exit gates of a metro station and value can be added to the card before or after a train ride.

Although tickets can be purchased online, on mobile devices, at rail stations, and retail outlets, this study exclusively focuses on the ticket machines located at the rail stations. These ticket kiosks (aka ticket vending machines), such as those located at the Washington National Airport, are likely the first point of access for new Metro travelers. Metro stations can be outdoors or underground, but each station usually has a few to several ticket kiosks available to passengers. All Metro stations have ticket kiosks, however there are a variety in use, with different heights, colors, markings or labels as seen in Figure 1. Additionally, the machines may operate in different ways. For example, some kiosks only add

value to a card already in possession and only takes cash payments, while other kiosks offer both farecards and passes and takes both cash and credit card payments (DikiDinDC, 2021). It is important to note that if a user is confused or needs assistance, there is no Metro personnel to help. Some stations even have signs posted that read: “Station Managers do not make change” (DikiDinDC, 2021, @3:56). This is another pain point for passengers, needing to have the right form of payment on hand for each Metro station. Finally, a publicly posted user compliant states the DC metro is “very frustrating for visitors especially—the fare structure is very different and much more complicated than other subway systems worldwide (Schoenfe as seen in Lee, 2006).

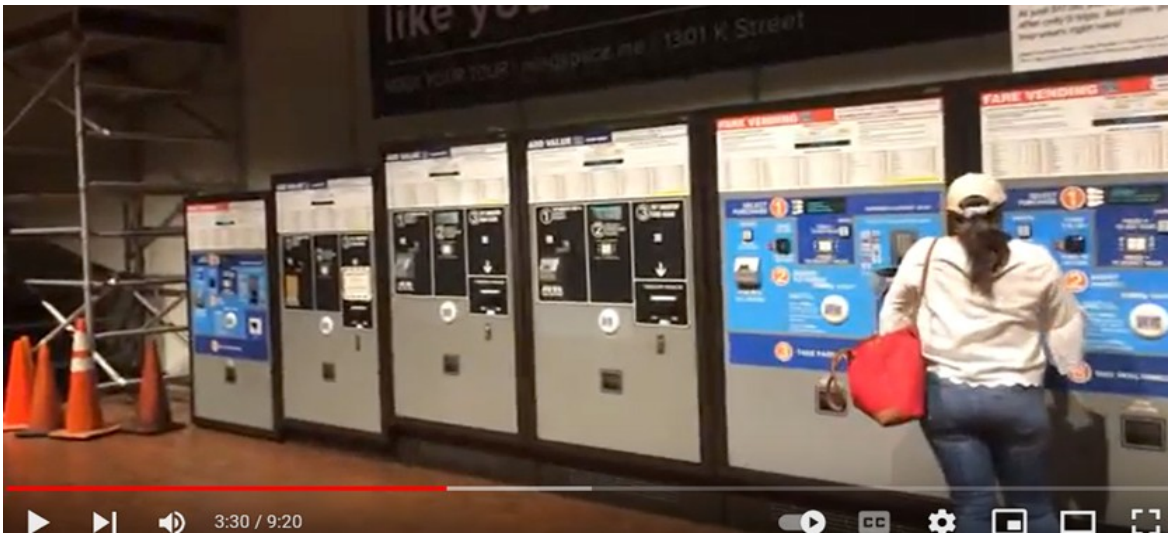

Figure 1: Screenshot of video showing lineup of ticket kiosks at DC metro. Source: Cortez (2018, @3:30)

As part of the initial research for redesign, this study will review just a portion of the existing kiosk varieties, including the following:

1. **Blue machines labeled “Passes/Farecards” as seen in Appendix B**
2. **Brown machines labeled “Farecards” as seen in Appendix B**
3. Blue machines labeled “Fare Vending” as seen in AppendixB
4. Brown machines labeled “Add Value” as seen in Appendix B

The four examples of kiosk machines describe above are just a sample. There are others, including variations of number 1 (Appendix B), where they appear to be the same machine with the exception of the label arrangement. Some versions are labeled “Farecards And Passes” while others are labeled “Passes/Farecards” or inverted as “Farecards/Passes.” These presumably mean the same thing, but it clearly shows a lack of consistency in design, where *slips* or *mistakes* could easily happen. Another example of a lack on consistency in design, is the sheer number of vending machine types. The above four alone are too many variations, and there are more than that in use as a quick search online shows for image search of “dc metro ticket vending machines.” *Gestalt and universal design principles* are clearly lacking in the current kiosk.

For the purposes of this study, the bolded numbers 1 and 2 (see Appendix B) will be the bases for design improvements. Additionally, it is important to note that although WMATA provides current train information to customers via websites and apps on mobile devices with modern technology standards, many of the ticket kiosks at the stations have not kept up with the same pace or standards.

The blue "Pass/Farecard" (or is equivalent; e.g. Appendix B number 1) kiosks accept both cash and credit cards and sells both farecards and passes. These machines also enable users to add value to a SmarTrip card (rechargeable card). The brown "Farecards" (Appendix B, number 2) kiosks only accept cash and can only add value to an existing farecard with change only dispensing in coins and with a max change return of $5.00 (Living, 2015). With both blue and brown machine options, the general steps to operating the machine include:

1. Knowing where you want to go and the cost for that ride. This can be looked up on a map nearby the ticket machine;select kiosks may have a chart of all the stations. (Appendix B, number 1 has the chart listed on the machine, but the height to read or font size may make it impractical for some passengers to use effectively).
2. Follow the instructions on the machine. These steps are different, depending on the kiosk used.

There are several caveats to traveling that passengers don't know based on the current vending machine design. According to Arciniega (2023), a SmarTrip card is required for each rider over the age of five. This also means that up to two children under the age of five may travel for free with a fare-paying passenger. Arciniega (2023) and Cooper (2020) note the placement of helpful information as critical, which this study does not find readily available on the current kiosk designs described above. Examples of helpful information of the Metro ticket system not available on the kiosks include:

- SmarTrip cards can be purchased online for $10 ($2 for the card and preloaded with $8 of credit)
- SmarTrip cards can hold up to $300 value
- If the SmarTrip card is registered (optional), your lost or stolen card will not lose value of the card
- Discounted fares for school children, passengers with disabilities, and the elderly.
- Option of a virtual SmarTrip card for your smartphone (using Apple Wallet or Google Pay)
- SmarTrip cards can also be used for fares on regional buses
- Downloaded apps can help with purchasing cards, checking train times and maps
- Pay-as-you-go passes (1-day pass, 3-day pass, 7-day pass, monthly, and employer pass)
- Metro fares on weekends are cheaper than weekdays, with a flat $2 fare on Saturdays and Sundays

  If users knew this bullet list of helpful information, their mental model and options would be more clear.

User Experience of Metro System

For user research, this study observed the user journey of several metro passengers via publicly posted online videos. One specific user journey of the DC metro is discussed in the following paragraphs, with screenshots from Crrobins (2010) as documented in her video posted on Youtube.

In the Crrobins' video, she is pointing to the Smithsonian stop in the fare chart, which is a necessary step before making a ticket purchase. However, if she were any shorter, or if the station was higher on the

fare chart list, she would not be able to read this cart (see Figure 1). This is an accessibility pain point which is also observed in DikiDinDC (2021, @3:03).

Figure 2: Screenshot farechart showing inaccessible height of station information. Source: Crrobins (2010)

Continuing with the Crrobins (2010) video demonstrates the remaining user experience of purchasing a ticket with the metro system. Pointing to the Smithsonian station with a zoomed in perspective, shows that station is on the blue or orange line, takes about 30 minutes in travel time, and has a fare of $4.15 (one way during rush hour) or $2.75 (no rush hour) as seen in Figure 2. After this, Crrobins (2010) walks away from the ticket kiosk, to elsewhere at the station to show the "we are here" map and where she points to the Smithsonian stop on the Metro map, identifying what stations to transfer to if a different line is needed for the journey. This information is not explained at the ticket kiosk, a pain point for the user experience, which can relate to a UX lens *Gestalt Principles* and of *Fitts's Law* where variables affecting the movement time/distance impacts human error (Budiu, 2022). This pain point shows a need to properly arrange elements of the user journey within close distance.

Figure 3: Closer look at the Smithsonian Station Details. Source: @Crrobins (2010)

After adding value and inserting her credit card for payment, the kiosk screen flashes "retouch card to complete" (Figure 3) though it is small font in context of the small screen size and among all the buttons and other features of the larger kiosk machine altogether. This is a pain point of call to action (CTAs) or notifications as missing or lack visibility, which can cause user anxiety or frustration. This pain point was also addressed in the literature review (Cornnel et. al, 2004). Similarly, at the start of her video, Crrobins (2010, @2:08) stops her ticket purchase journey to help the passenger at the machine next to her, who had put money in the machine but nothing happened and the passenger didn't know what to do next. This was also a pain point emphasized in the literature (Muhammad et. al, 2017), and also with the *Gulf*

of Execution and *Gulf of Evaluation*. There was no clear CTA or notification for the passenger to know what to do next. As a result, Crrobins pushed a button and the ticket released for the passenger, who took the ticket and ran off in a hurry. The fix was simple, the push of a button, yet it was unclear to the passenger.

This experience shows user confusion (mental model) and design flaws, including a lack of call to action/ notifications to the user on the process of the transaction flow and lack of universal design.

Figure 4: CTA/Notification to User not easily visible "Retouch card to complete"). Source: Crrobins (2010)

Iterative Design Solutions

Design Tenets

After watching Metro users perform purchasing tasks (via publicly accessible videos, see Cortez, 2018; Crobins, 2010; DikiDinDC, 2021), reviewing principles of universal design, reviewing the current metro kiosk designs, and reviewing relevant ISO standards, the following design tenets were created:

- Accessibility for equitable use: Built-in accessibility features impact everyone, in order to reach buttons/controls, for reading text sizes and heights, for language options, for payment options, and so forth.
- Intuitive instructions: A clear mental model of what to do next in the process
- Offering options: Giving users control for flexibility in use that is specific to their needs

Method and Theory Application

With these design tenets in mind, iterative creation and editing began for the wireframes, screeners, tasks, mockups, and prototypes.

Design Thinking

The design thinking approach was the foundation among these solutions of the pilot study. Although briefly mentioned earlier, the following five phases are detailed more in this section as applied to the pilot study (IDF, n.d.):

- **Phase 1: Empathize—Research Your Users' Needs**
  Pilot study: Problem Analysis and User Research section
- **Phase 2: Define—State Your Users' Needs and Problems**
  Pilot study: Problem Analysis and User Research section
- **Phase 3: Ideate—Challenge Assumptions and Create Ideas**
  Pilot study: Iterative Design Solutions section (e.g. Wireframes)
- **Phase 4: Prototype—Start to Create Solutions**
  Pilot study: Iterative Design Solutions section (e.g. Prototype)
- **Phase 5: Test—Try Your Solutions Out**
  Pilot study: Evaluation Methods section

Universal Design

Universal design was used as a way to keep all users in mind during the design process. Specifically, accessibility was a high priority, with a focus on people with disabilities such a mobility or reach difficulties concerning a person's height or wheelchair use, plus visual difficulties, from text size or font selection, distance or location of interaction touchpoints, and well as hearing or vision difficulties. There was also an intentional focus on language. For example, the keyboard for English, Spanish and Italian speakers uses the QWERTY layout, however French has an AZERTY layout, and German uses the QWERTZ layout. Thus, the language selected in a product, should have a keyboard that represents the corresponding layout for that language.

Fitts's Law and Gestalt Principles

Fitts's Law of proximity and Gestalt Principles were also applied, especially pertaining to layout, color contrast, color selection, icon consistently, and object location.

Wireframes

The previous hierarchical task analysis diagram (Appendix A) was improved upon with wireframes for the proposed kiosk. A wireframe typically focuses on the functionality and physical layout of the design, without color or graphics. The wireframes (Appendix C) are based on pain points discovered in user research and the literature review. Iterating on wireframe drafts led to the creation of a prototype based on the wireframes.

Scenario and Tasks

The wireframes and prototypes were created based on a specific scenario and tasks. "Scenarios give detailed realistic examples of how users may carry out their tasks in a specified context with the future system...Scenarios encourage designers to consider the characteristics of the intended users, their tasks and their environment, and enable usability issues to be explored at a very early stage in the design process (before a commitment to code has been made)" (Maguire, 2001, 600). A reminder of the scenario: Infrequent passengers traveling via the metro in Washington, D.C.

Task 1
Buying a Metro farecard at the Washington National Airport (DCA) to arrive at a specific destination (Gallery Place)

Task2
Buying a Metro farecard with a specific dollar value purchased

Design of Mockups and Prototypes

Design ideas progress through iterative development. “Mock-ups and simulation of the system are necessary to support this iterative design lifecycle. At the simplest, they may consist of a series of user interface screens and a partial database allowing potential users to interact with, visualize and comment on the future design.” (Maguire, 2001, p. 604). These are produced early and quickly and then tested for user feedback in order to identify large problems early to mitigate cost and time later on. Low fidelity prototypes (paper wireframes) were drafted and iterated on before higher fidelity prototypes (digital simulation) were put to the test with users to evaluate the functional needs of users and effectiveness of the system design.

The annotated mockup is in Appendix D, which has information to indicate screen design changes as the user advances through the transaction process. A mockup is typically built from the wireframes and reflects a realistic look by including color and graphics. Annotations were added to the mockup to indicate screen changes when the user interacts with the design. Both the wireframes and mockups show the information flow and task completion for two specific tasks related to infrequent travelers.

Note there is an interactive prototype available via Figma. Both the interactive prototype and the annotated mockup (Appendix D) show other options in the UI, such as adding value to an existing farecard or purchasing a pass, however, the wireframes and prototypes were solely designed for infrequent passengers per the parameters of the pilot study. It is possible future studies could involve wider design implications for the other purchase options.

An example of iterating between challenging assumptions (ideate) with language barriers and the solution for it (protoype) had me think, create, and test how to include various language options with the kiosk’s keyboard.

Evaluation Methods

Evaluation methods were iterative in nature, as was the design. Testing is critically important to overall success of any design and multiple methods of evaluation are used in order to increase the success rate.

First, there was a self-test of the prototype, where edits were made along with more ideation in order to challenge assumptions that were made in the initial design.

Second, screeners (surveys) and tasks were created in order to conduct user testing as a form of evaluation for the pilot study. The screeners and tasks directly relate to the pilot study’s research questions. An institutional review board (IRB) application was submitted and approved for this pilot study. User testing in this manner will be conducted with one survey and two separate phases of tasks analysis interviews (each phase with 3-5 participants each). “When running user tests, the emphasis may be on identifying system problems and feeding them quickly into the design process (formative

testing). A small number of test sessions may be sufficient for this purpose with the evaluator observing system users and making notes...The technique can be used to identify the most significant user-interface problems." (Maguire, 2001, p. 614). Both user testing sessions will be completed by June 2023. The combination of the quantitative and qualitative approach used in this evaluation will give a clearer direction on improvements needed for the design.

Third, the actual testing of the prototype with users. The first session of user testing commenced in April 2023. Initial survey results show participants want inclusive design options (such as language options and various payment options) yet the ticket kiosks they've used to date do not have these options. Initial tasks interviews found similar results, where the inclusive design features (such as options to go back to previous screen or audio as an a language option) were highly touted as very important and useful in the prototype tested. This data will be combined with the second session of data collection in May 2023.

Fourth, design changes were made based on the initial survey and first session of user testing interviews.

Fifth, another round of user testing and survey data in May 2023 will yield yet another round of iterative design changes based on the data collection and analysis.

Sixth, would be future testing. If this pilot were to gain traction for further development, a larger scale usability testing study should be conducted with a larger user population in the future. In this instance, UX designers would benefit by using a functionality matrix to analyze survey and interview data. This type of matrix can help highlight the criticality of various product features, which helps designers know the higher priorities to focus on with subsequent iterations. Further evaluation after that would include software prototypes with an actual kiosk for simulation testing.

Early analysis of usability studies can show 85% of major usability problems after testing with just 5-8 users (Nielsen & Landauer, 1993). As a result, this pilot study focuses on two sets of 3-5 user testing sessions (tasks) and a survey. The first set of users were tested in April 2023, and the second set of users will be tested in May 2023. Screeners and tasks for the user testing are in Appendix E.

Use of participatory evaluation, where "users employ a prototype as they work through task scenarios [where] they explain what they are doing by talking or "thinking-aloud"" (Maguire, 2001, p. 616) is also utilized in this pilot study. As this is only a pilot, other evaluation methods were not applied. However, controlled user testing, a real-world and observed task process would be a recommended step if the design was contracted for further development. Other advanced methods for evaluation could include the use of cognitive workload evaluation, in order to assess how much mental effort a user expends while using a prototype or functioning system (Maguire, 2001).

Conclusion

Several rounds of ideation, design, and testing (evaluation) were used as part of the iterative development process. Looking at inclusive design implications for a ticket kiosk can help relieve anxiety of infrequent travelers in an unfamiliar area, but because of the universality of the design, they will also benefit frequent users as initial results of user testing indicate. This pilot study focused on user research and inclusive design aspects to improve current designs in use and future research is needed, especially with more user testing sessions.

Although this pilot study specifically looked at the design and usability of ticket kiosks, the iterative design and inclusive design recommendations are broadly applicable for other uses. For example, the same accessible and inclusive design process can be beneficial to ticket kiosks at airports, used in a lobby for reserving concert tickets, paying parking fees, or tickets for entrance to museums, amusement parks, utility bill payments, hospital or medical payments, gym memberships, and more.

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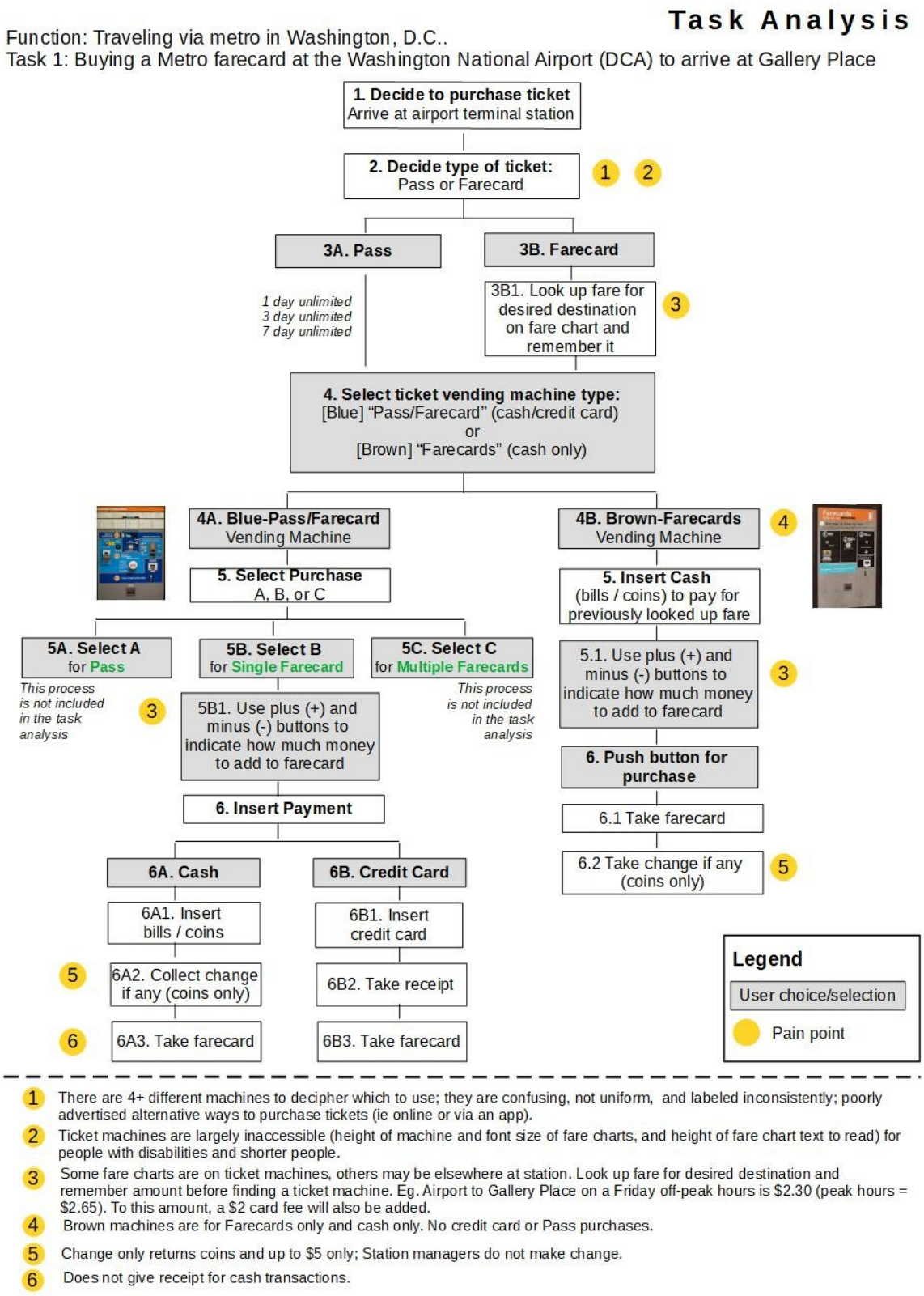
Note: Appendices included below, but also submitted as separate PDFs for better readability.

Appendix A: Hierarchical Task Analysis Diagram



Appendix B: Current Metro System Ticket Kiosk and Process

Figure 5: SmarTrip farecard. Source: WMATA (2023c)

NUMBER 1-Vending Machine 1 : Passes/Farecards. Source: WMATA

Number 2--Vending Machine 2: Farecards. Source: Secure ID News

Number 3--Vending Machine 3: Fare Vending. Source: McNichols

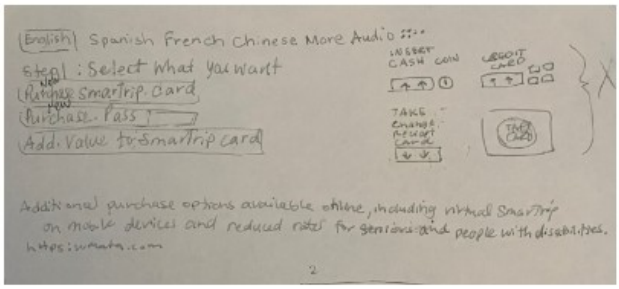
Number 4--Vending Machine 4: Add Value. Source: WMATA

Appendix C: Wireframes

Wireframes

Function: Traveling via metro in Washington, D.C..
Task 1: Buying a Metro farecard at the Washington National Airport (DCA) to arrive at Gallery Place
Task2: Buying a Metro farecard with a specific dollar value purchased

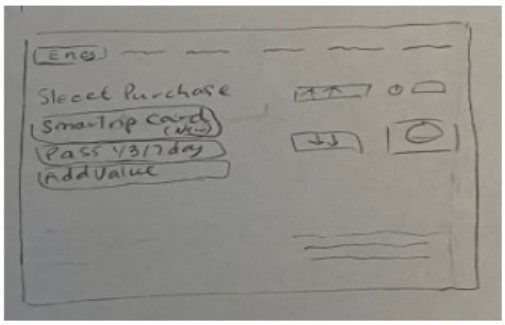
Homescreen (left) and Payment / Call to Action (right)



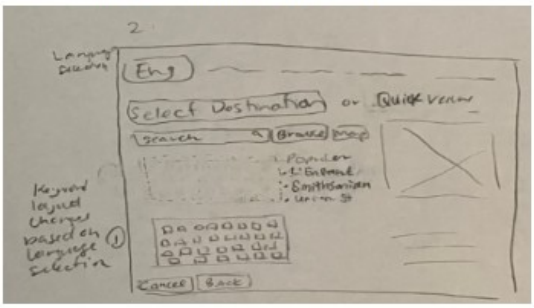
* The right side of the system is the payment method and CTA instructions (via blinking notifications to user.).

The right side never changes text, therefore the remaining wireframes may use X as placeholder for this side of the system that the user interacts with.

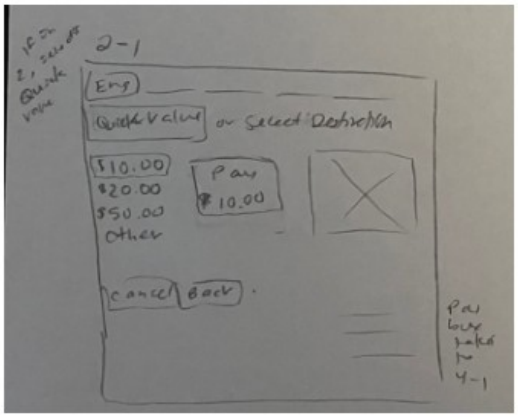
1. Homescreen



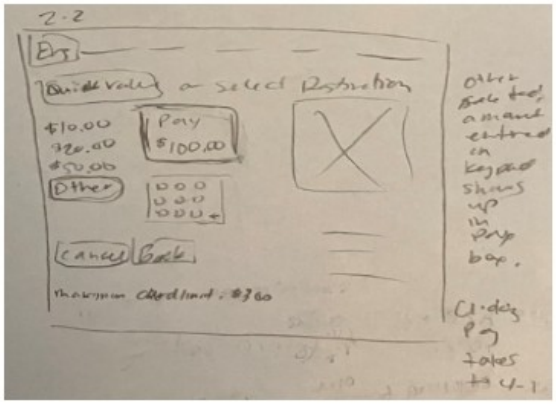
2. Selection Destination (TASK 1)



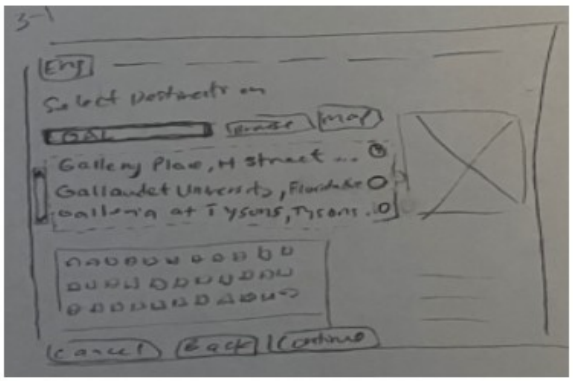
2-1. Quick Value, if $10 (TASK 2)



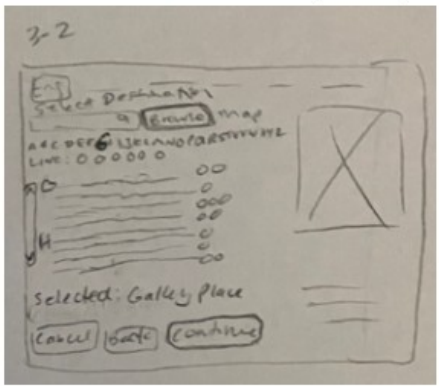
2-2. Quick Value, if $100 (TASK 2)



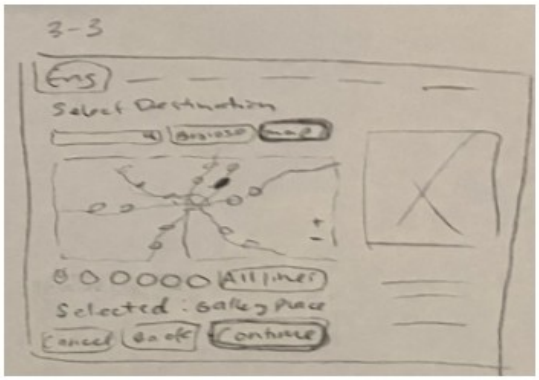
3-1. Selection via Search (TASK 1)



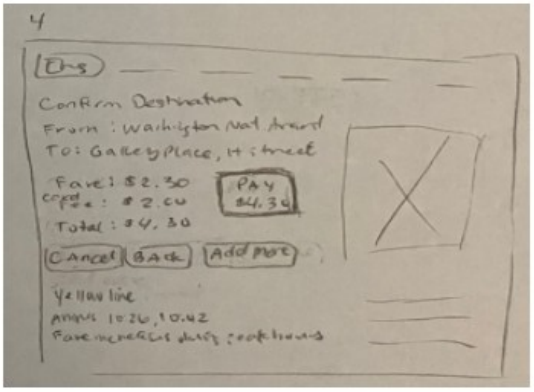
3-2. Selection via Browse (TASK 1)



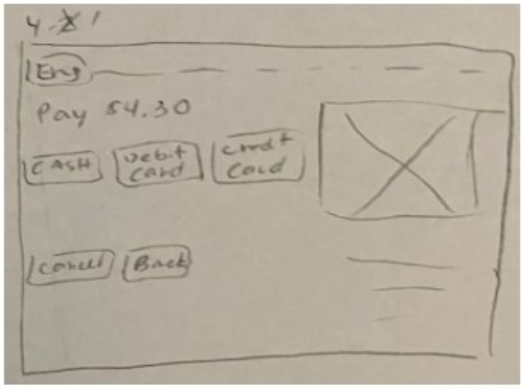
3-3. Selection via Map (TASK 1)



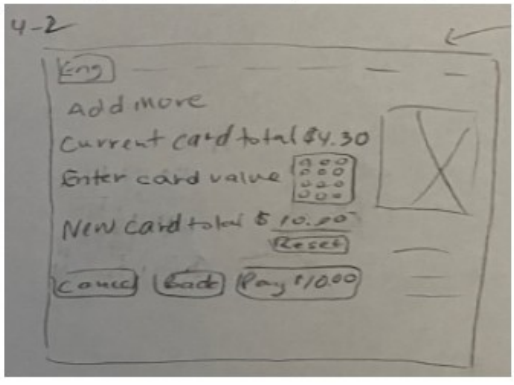
4. Confirm Destination / Amount (TASK 1)



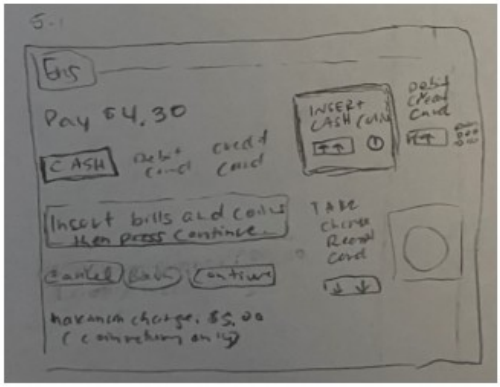
4-1. Payment Method Selection (TASK 1)



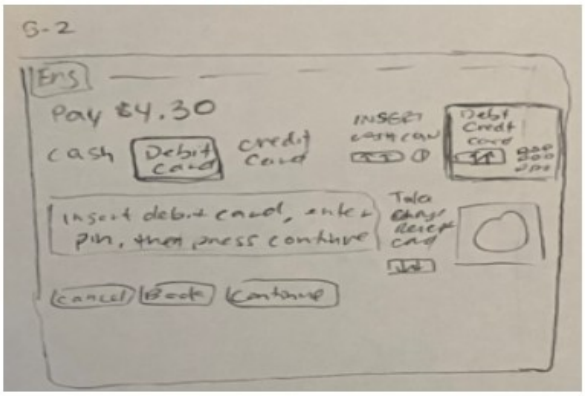
4-2. Payment Add More (TASK 1 &2)



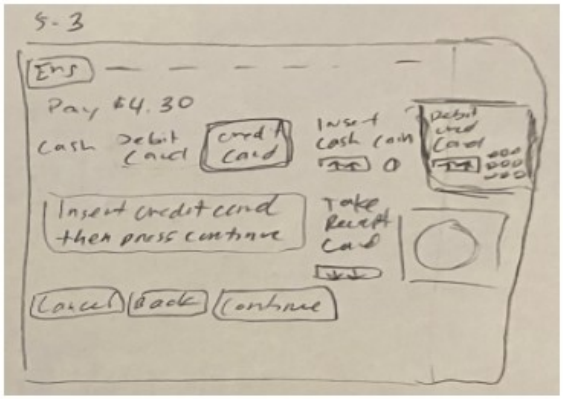
5-1. Pay Cash (TASK 1 & 2)



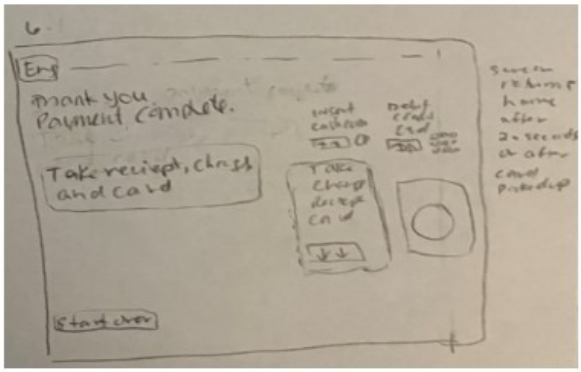
5-2. Pay Debit (TASK 1 & 2)



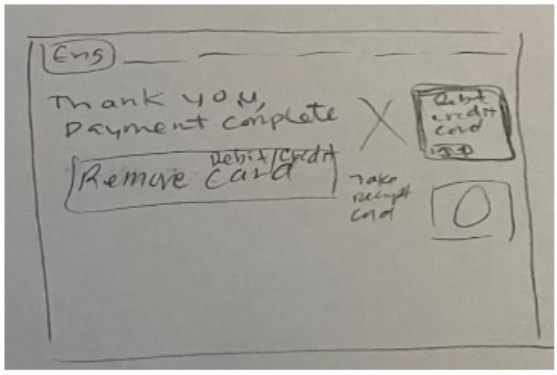
5-3. Pay Credit (TASK 1 & 2)



6-1. Payment Complete Cash (TASK 1 & 2)



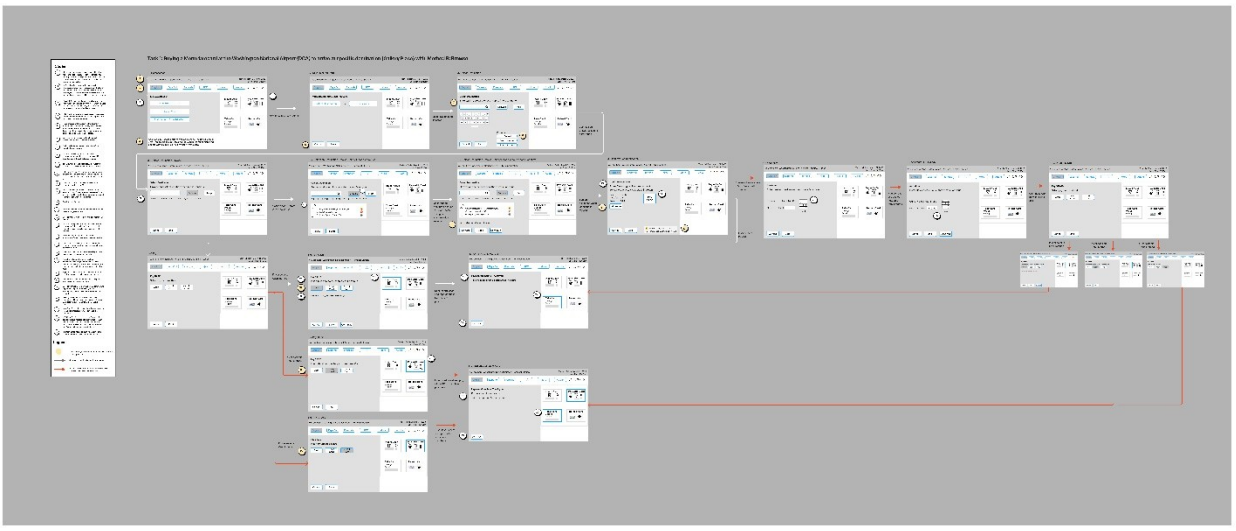
6-2. Payment Complete Debit/ Credit (TASK 1 & 2)

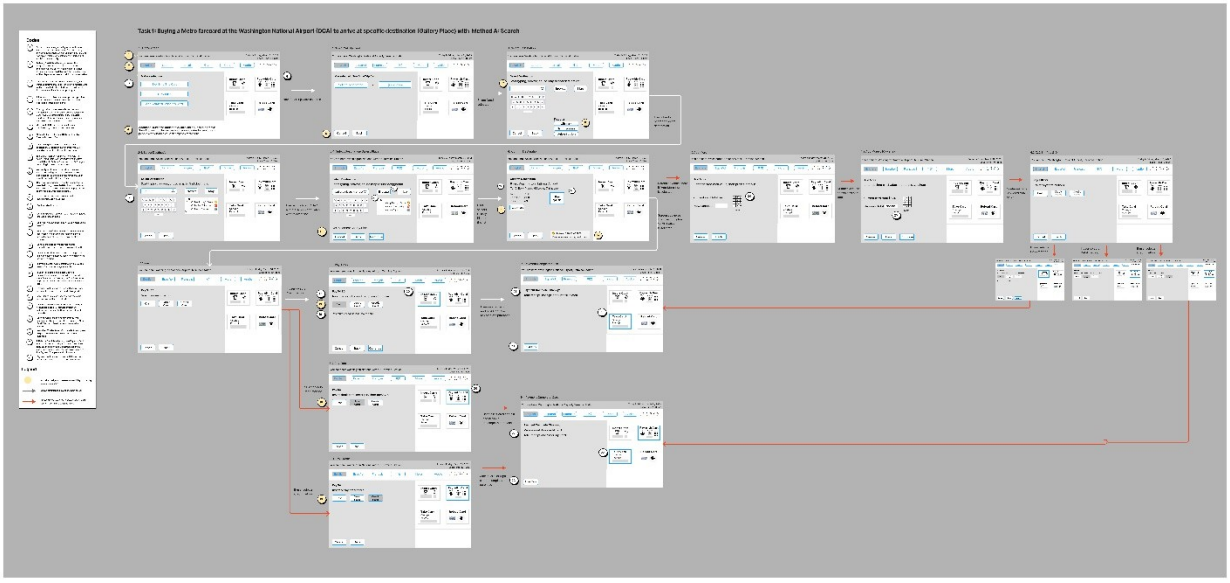


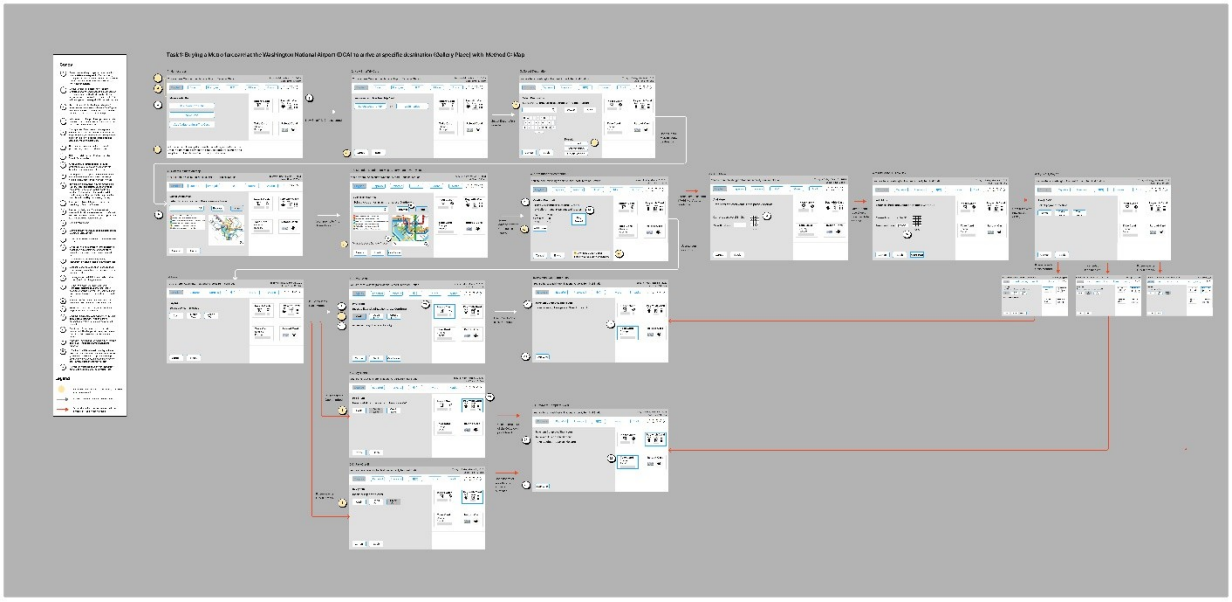
Appendix D: Annotated Prototype / Mockups

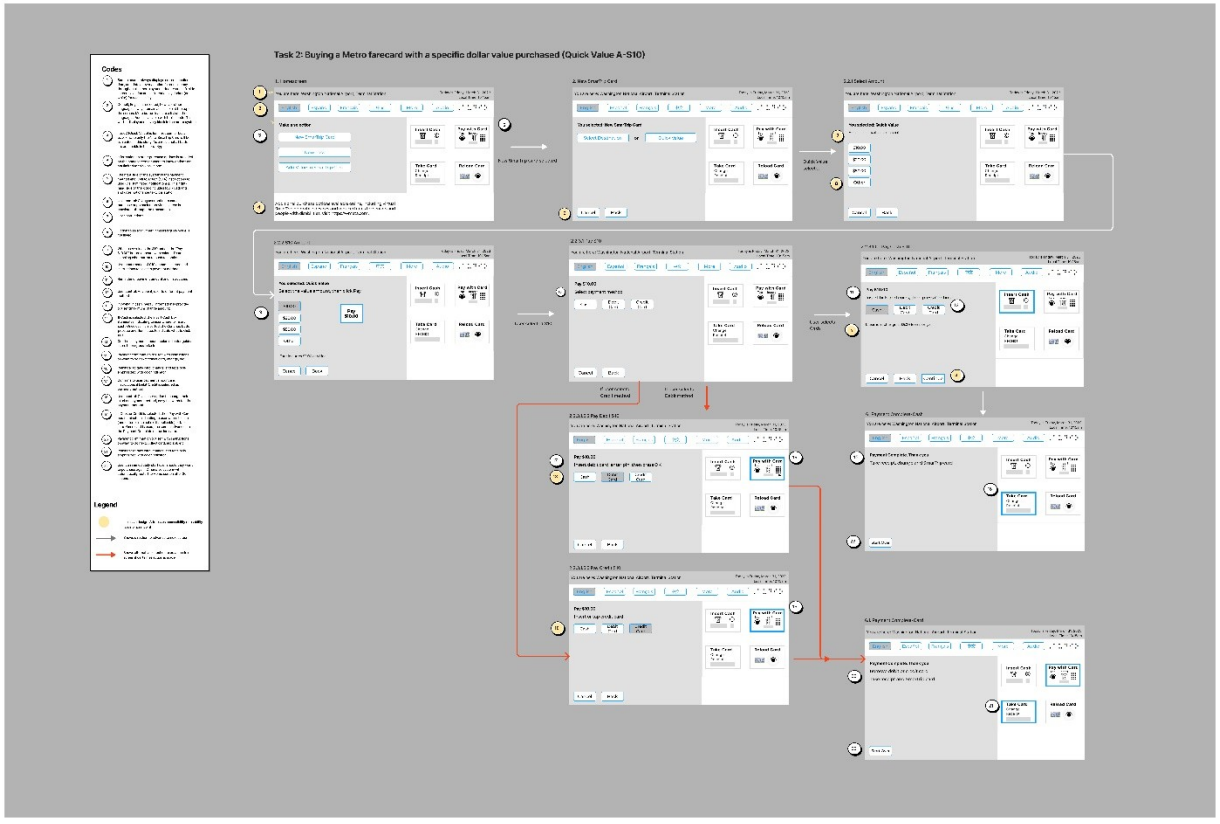
Interactive Prototype: [Online at Figma]

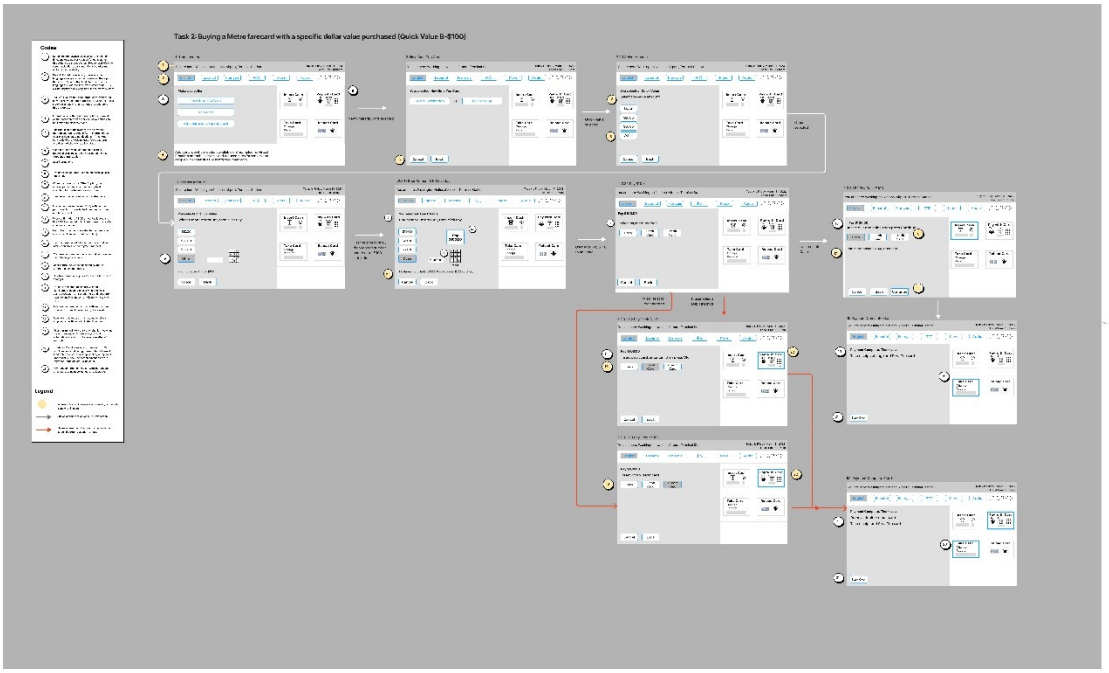
Annotated Mockup are submitted separately and included below:








Task 2: Buying a Metro farecard with a specific dollar value purchased (Quick Value A-$10)
Codes
Legend


Task 2: Buying a Metro farecard with a specific dollar value purchased (Quick Value $=$100)

Appendix E: Screeners and Tasks for Usability Survey and Interview

Study Description:

Evaluation of a ticket kiosk using screeners to recruit 3-12 participants who have previously purchased tickets via an interface, and the use of tasks to identify usability and design issues. Iterative testing and design will include two testing feedback sessions, each session with 3-6 participants. Sessions are to be done in-person or via Zoom, but not recorded, however notes will be taken. Use of websites for prototypes may be used to track first-clicks and task completion.

Research questions: 1) What are the expectations of purchasing tickets at kiosk and are they met in the prototype? and 2) What problems do people have with the user interface?

Screeners

Target Audience: Over the age of 18; Previously used kiosks to purchase tickets

Screener:

1. What age range best describes you?
   [ ] 18-29
   [ ] 30-49
   [ ] 50-69
   [ ]70+
2. Which of the following best describes you when purchasing tickets (train, movie, plane, concert, etc)?
   [ ] I purchase tickets online more than I purchase in-person (at store, kiosk)
   [ ] I purchase tickets in-person more than I purchase online
   [ ] I purchase tickets in-person and online equally as much
   [ ] I don't do the ticket purchasing for my household
3. When purchasing tickets, which is the most important to you?
   [ ] The price of the ticket
   [ ] How easy it is to purchase the ticket
   [ ] How long it takes to purchase the ticket
4. What train or subway systems have you used?
5. When you have purchased tickets from kiosks or machines, were you able to reach both the selection buttons and payment buttons?
   [ ] Yes, easily reached
   [ ] Yes, but difficult to access or reach
   [ ] Sometimes, it depends, I can reach the buttons sometimes,
   [ ] No, not able to reach the buttons
6. When you have purchased tickets from kiosks or machines, which (if any) of the following did you find or experience?
   [ ] Ability to pay in more than one method or way (cash, credit card, debit card, virtual wallet, etc)

[ ] Ability to select the language for your transaction (ie English, Spanish, Audio)
[ ] Ability to change the text size or zoom in/out for reading ability
[ ] Ability to go back to previous page/screen to change something
[ ] Other: (please describe)

7. Which of the following (if any) would be helpful to your ticket purchase experience at a kiosk or machine?
   [ ] Ability to easily read and reach screen and payment sections of the system
   [ ] Ability to pay in more than one method or way (cash, credit card, debit card, virtual wallet, etc)
   [ ] Ability to select the language for your transaction (ie English, Spanish, Audio)
   [ ] Ability to change the text size or zoom in/out for reading ability
   [ ] Ability to go back to previous page/screen to change something
   [ ] Other: (please describe)
8. When you have purchased tickets from kiosks or machines, how would you describe the selection and payment process navigation?
   [ ] The system was **very easy** to navigate
   [ ] The system was **somewhat easy** to navigate
   [ ] The system was **somewhat difficult** to navigate
   [ ] The system was **very difficult** to navigate
   [ ] I don't know or don't remember

Tasks (using think aloud)

- Objective: Identify a user's first step

  Task/Scenario

  You have a busy schedule and work or personal travel takes you to Washington, DC. At the airport, you find the metro terminal, where you need to take the metro to your destination. There are no cashiers but you find a ticket kiosk that shows this screen. What do you do next?

- Objective: How does the user navigate to the payment page for the selection destination of Gallery Place?

  Task/Scenario

  You have to take the metro to Gallery Place. How would you go about doing that?

- Objective: Understand ease or difficulty of purchasing a ticket (through completion to the payment confirmation page).

  Task/Scenario

Reflecting on that purchase, describe your experience.

- Objective: Understand ease or difficulty of a different ticket purchase

  Task/Scenario

  How would you start over?

  You decide to get another ticket. This time, you know you want to go to Gallery Place, but you may also make other stops. How would you make a purchase for that?

- Objective: Get any other user feedback

  Question:

  5. How would you describe the selection and payment process navigation?
     [ ] The system was **very easy** to navigate
     [ ] The system was **somewhat easy** to navigate
     [ ] The system was **somewhat difficult** to navigate
     [ ] The system was **very difficult** to navigate

  6. How does this prototype compare to other ticket kiosks you've used?
  7. What do you like about it?
  8. What would you change/improve?
  9. How long did it seem it took you to complete a ticket purchase?