Sensed

Navigate the world. Sight Unseen

Prepared for 2020 Capstone at the University of Washington
Human-Centered Design & Engineering Graduate Program

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Table of contents

Our core team	3
Project Overview	4
Project focus	8
Formative research	10
Methodology & methods	16
Project timeline	20
References	22

Our core team

We've bult a cross-functional team aligned on our approach.

Cyrus Majd

Product Designer

(Product Design, Prototyping)

Cyrus is a Cockpit UX Design Engineer at Boeing with 4+ years in systems design. He's currently working with a team of designers, engineers, and pilots to create the future of piloting interfaces. In his previous roles he's worked on various consumer electronics devices from ideation phase to testing and debugging. Cyrus will use his strengths as the Product Designer.

Caitlin Karpinski

UX Designer & Content Strategist

(Accessibility Designer, User Requirements, UX Writing)

Through her background in writing and marketing, Caitlin learned to understand customer needs and translate them into stories and strategic decisions. Recently, she has worked in various roles at Microsoft including as a Web Production Manager for internal readiness sites and an Assistant Platform Manager for external blogs. Caitlin is taking charge as the UX Designer & Content Strategist.

Molly Olsen

Product Manager

(Research, Deliverables & Productivity)

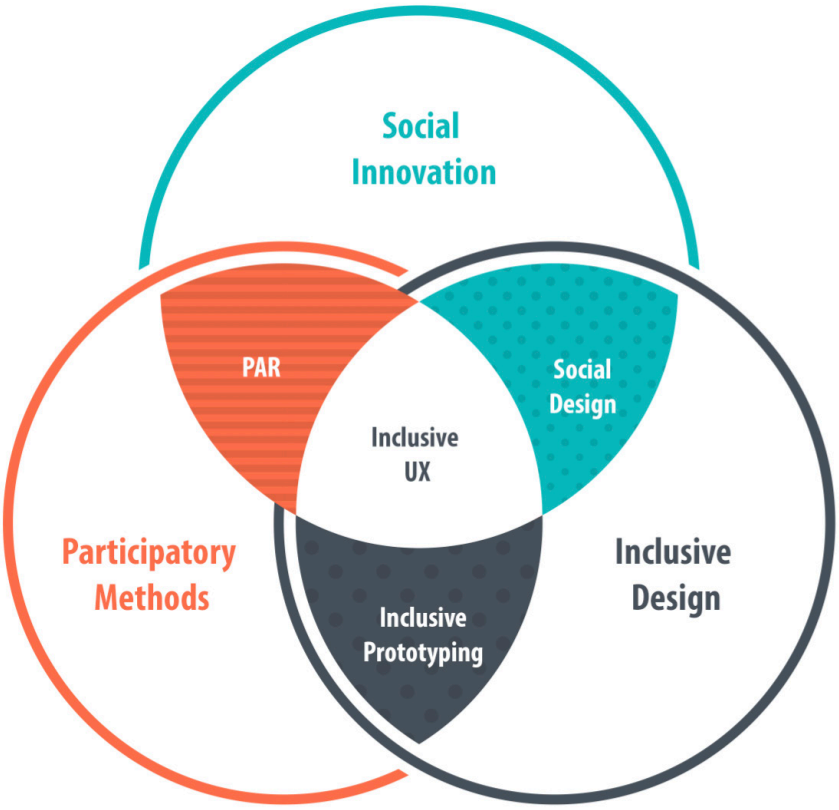
Molly teaches math at an alternative high school serving students who have not found success in the traditional classroom. Her purpose is to reach a wide demographic through exploratory and hands-on techniques that engage students. Her ability to empathize and create has translated to designing with and for users. Molly will take on the role of Product Manager

Mathias Burton

UX Research

(Research & Usability)

Mathias has over a decade of research and design experience, tackling complex social initiatives including open government, open access, and access to justice. He focuses on leveraging human-centered methods to enable social innovation and lead product teams. Mat will use his expertise to be the UX Research Lead.



Rethinking our process, refocusing our outputs, & reconsidering our role.

An inclusive user experience includes the intersection of three practices that center on people

About our project

Navigating an urban, or unfamiliar space, is a challenging task requiring us to utilize a variety of our senses to gather information regarding our surroundings. The information we perceive allows us to gain situational awareness and form decisions about how to get to our destination safely. Most of this information is gathered by our eyes, therefore this daily task is more challenging for more than 285 million people worldwide identified with having a vision disability [1].

Our non-visual navigation project, named Sensed, is aiming to help people with vision impairment overcome this challenge and gain more independence while safely navigating a city. Our formative research uncovered some of the typical processes and tools blind and visually impaired individuals (BVI) utilize to travel independently as well as unmet needs in the areas of situational awareness and obstacle detection.Through participatory research, design, and physical prototyping methodologies, we aim to better understand what other type of information our users need to improve their experience in these areas and what the best methods are to provide that information to them.

Our problem space

The opportunity with Nonvisual Nagiation

Some of our initial interviews uncovered findings that have allowed us to define our problem space. When navigating an urban environment, BVI individuals have unique needs in order to safely reach their destination without the assistance of a sighted person to guide them. An urban environment comes with its own unique opportunities and challenges. Technology including GPS, smartphones, and other devices are providing new ways for blind users to get directions and information about their environment so that they can travel more independently. Many also use traditional aids for non visual navigation including guide dogs and white canes. Some key pain points include the difficulty in discovering new obstacles in an environment, knowing when someone or something is approaching, and sensing anything beyond the reach of a cane [4].

Our Project Goals

Understand the experience of navigating an urban environment non-visually,

Explore specific scenarios, pain points and adaptations created by participants

Address the issues surrounding navigation without sight

Iterate on prototypes that aim to solve one or more of the pain points

Motivations

The aim of this project is to design a useful solution that would address challenges that blind and visually impaired (BVI) individuals have when navigating an urban environment. We are interested in social innovation, inclusive design approaches, participatory research, and rapid prototyping.

Target Users

We will focus on the blind community, primarily in Seattle. We'll prioritize working adults who frequently navigate the city and elderly citizens that have adapted or are adapting to sight loss. We will also leverage the expertise of people who have worked in this space and are familiar with interacting with individuals that experience vision impairment.

Benefits

The benefits of this project include discovering solutions that could improve the daily lives of those with vision impairment and increase their independence. We also seek to demonstrate how designers can leverage emerging approaches that emphasize inclusive innovation in-practice such as biographical prototyping and rapid iterative testing and evaluation.

Project focus

Our project is focused on utilizing research and prototyping methods to identify ways technology can help blind & visually-impaired individuals (BVI) navigate an outdoor space safely and independently. Throughout this project, we will work toward a solution that answers our primary design question

Existing Ecosystem

What methods and tools do BVI utilize while navigating?

Present Capacity

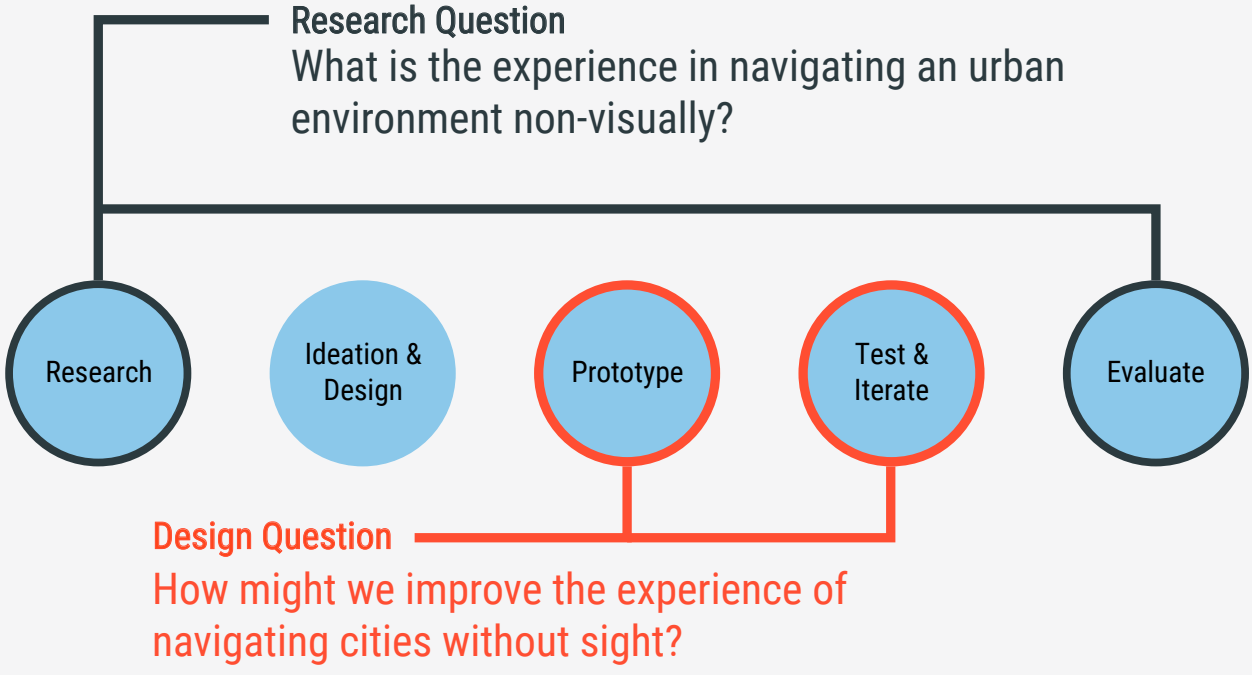
What type of situational awareness information do BVI gain from tools?

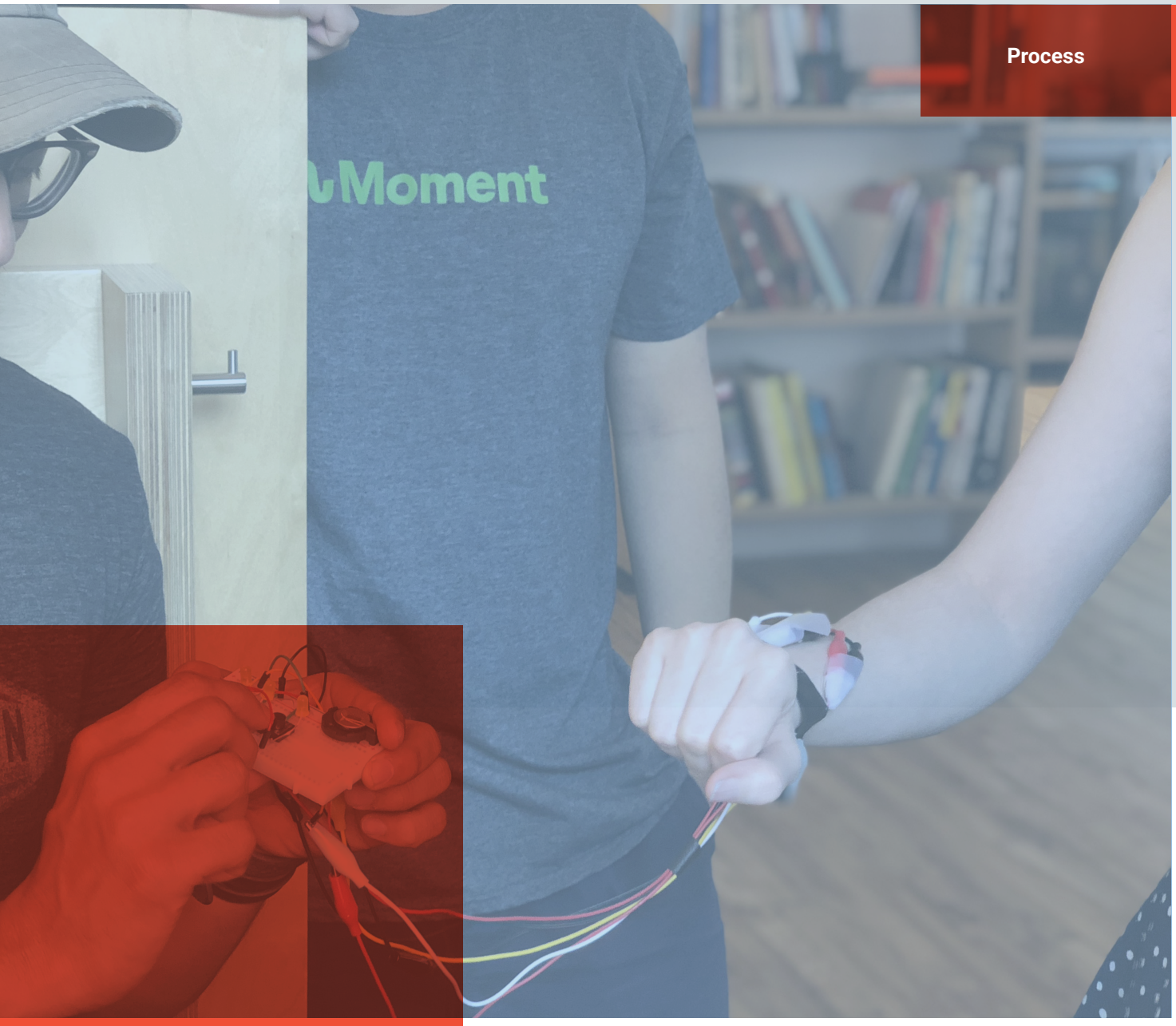
Ideal Capacity

What information helps BVI navigate safely and independently?

Delivery Stream

What is the best method to provide such information to BVI?





Project Deliverables

User Requirements List (4x)

- After Preliminary Research
- After CoDesign+Usability Session 1
- After CoDesign+Usability Session 2
- After CoDesign+Usability Session 3 (Final Set)

Design Specification Documents (3x)

- After CoDesign+Usability Session 1
- After CoDesign+Usability Session 2
- After CoDesign+Usability Session 3 (Final Set)

Prototype (3x)

- Lo-Fi
- Mid-Fi
- Hi-Fi (Final Prototype)

Initial research conducted in the Winter and early Spring quarters will help us understand the current landscape and opportunities. We will use these insights to generate an initial set of User Requirements. This document will help our team ideate and create multiple Lo-Fi prototypes that can act as a kit to use in the first round of Co-Design+Usability sessions.

Learnings from this session will then be used to further define the User Requirements and System Design Specification Documents, defining the Mid-Fi prototype(s) that our team will use during the second round of Co-Design+Usability session.

Following the second session, we will update our User Requirements and System Design Specification Document to generate our Hi-Fi prototype and perform the third and final Co-Design+Usability session. We will then capture our learnings in the final set of User Requirements, Design Specification Document, and Future Consideration Document.

Formative Research

The Blind Community & Nonvisual Navigation

In the U.S. alone, over 7 million people aged 16 and older have a vision disability [1]. When navigating an urban environment, people with vision impairments have unique needs. In order to navigate independently and safely, blind users must be trained in the use of tools that help them understand where they are and avoid obstacles [2]. Our project focuses in the area of nonvisual navigation (NVN), that is, traveling through an environment without the use of sight [3]. The VEMI Lab out of the University of Maine has spent the past couple decades exploring this area. There are two areas of focus within NVN: internal and external navigation. Internal navigation brings a contained environment, but is limited in the stored or public information about it[4]. Current research emphasizes the use of beacons that interact with devices on participants while the BVI may or may not have assistive devices with them (i.e can or guide dog) [5].

Our group decided that external navigation was a more appealing problem space, allowing us to focus more on the interaction between BVI and technology, rather than technical complexities that internal navigation required. External navigation benefits far more from GPS, though granularity is still a persistent problem [6]. From our interview with Alan, a BVI from the Washington Talking Book Library, BVI tend to travel less frequently than sighted individuals. One key variable in the external navigation experience is the knowledge of a destination. While a sighted person will utilize the visual environment to confirm that they have arrived at a destination such as a bus stop, a BVI must leverage physical landmarks, tactile signage, or sheer faith in the technology output from a GPS.

Nonvisual Navigation Market & Contextual Factors

When current assistive measures fail, and they frequently do, many BVI use a tool called Aira, which allows users to speak to a sighted person on the phone while sharing the scene through the phone's camera. The sighted person can help describe the user's context and make sure they get in the right lyft or uber, or are standing at the right bus stop [7]. Lastly, BVI must handle a higher cognitive load when traveling externally (ref VEMI), so the medium by which we communicate with users (voice, haptic, etc), must consider the competing load BVI faces [3]. This is also why adaptations of effective tools like the white cane can be problematic. BVI are trained to handle the cognitive load of these tools through orientation and mobility training (OTM). OTM takes place over multiple hours and increases in complexity as BVI develops skills a visual traveler takes for granted [8].

The environment one is traveling in also makes a significant impact on the experience of a BVI. Navigating through a city comes with some unique factors; cities have multiple destinations, multiple modes of transportation, changing environment quality and accessibility (construction or varietal sidewalk availability, and variance in augmentation (audible crossings, textured pavement stops, obstructions)[9]. While some transportation networks have accessible features to support BVI , there's no absolute standard for how to place or signal signage, and not all BVI are competent with braille [10].

Key Scenarios

A BVI is walking to a park and a bicycle is approaching that's not paying attention.

A BVI is walking to the grocery store on a familiar path but encounters construction along the way.

A BVI is heading to a job interview from their home at a building they haven't been to before in a large dowtown area.

A BVI is heading to a new bus stop and isn't certain when they arrived ot if it's the right one.

A BVI gets off on the wrong stop and is trying to get back to the right location.

Key Findings

Blind users interact with the environment in unique ways such as touching a pole to evaluate if they are at a bus stop. They can leverage their cane, hand, or body to do this.

One of the most common sub-groups of BVI are from the eldery community; people losing sight due to aging. Losing sight as an adult may produce disinterest in learning braille or emotional challenges such as the loss of independence.

Cognitive load can be a serious impediment in supporting blind travelers. In not having sight to take shortcuts in situational awareness, BVI pay attention to a lot of sensory input that is otherwise ignored.

Services for the blind come from departments, often provided by the state including giving orientation and mobility training (OTM). Blindness and Low-vision are considered legal disabilities and are supported by acts including the Americans with Disabilities Act of 1990.

Tactile Signage (Braille) is very helpful in resituating blind travel, however detectability of the signage is it's own challenge.

Tactile signs are sparse and people pick off pieces, forcing cities to move from acrylic to zinc to prevent such vandalism.

As technology gets better, blind people are more dependent on it. This increaases the responsibility and granularity of information that BVI expect.

Market Exploration

We will focus on the blind community, primarily in Seattle. We'll pursue working adults navigating the city and elderly citizens that have adapted or are adapting to sight loss. According to the National Federation of the Blind, there are "no generally accepted definitions for visually impaired, low vision, or vision loss. [1]." In the state of Washington, there are 161,900 blind individuals.

The Washington Department of services for the blind help around 1,000 individuals every quarter to cope with vision loss. The Washington Talking book library services approximately 9,000 individuals in the Seattle and surrounding area. We will select our qualitative sample from these organizations. Given the limited access to participants, we'll leverage all blind participants we're able to connect with.

Competitor Research

aira

Aira can be used as a smartphone application or a wearable set of smart sunglasses to find out information about immediate surroundings. Through the device, the user contacts a live remote agent to view their surroundings through an attached camera. The agent often answers questions or describes the visible area to the user. Users pay for a monthly subscription of minutes to use Aira. This service is commonly used by those in the blind and low vision community of Seattle [source > interviews].

be my eyes

Be My Eyes is a smartphone application that works similarly to Aira, but the app is free. Users can contact volunteers who utilize the user's cellphone camera to tell them about their surroundings. Some users have expressed that it can take longer to get assistance through the Be My Eyes app than through Aira. Additionally, Be My Eyes volunteers typically can only help with simple tasks, while Aira agents tend to have more expertise in assisting blind people effectively

wayfindr

WayFindr is an application that provides indoor navigation support in public spaces to the blind and low-vision community. It started by assisting users through voice command in navigating the London Underground based on their GPS location and desired destination. It gives specific information about how many steps to expect on a staircase, when and where they should scan their metro card, and so on.

BlindSquare

BlindSquare is a smartphone application that tells users about their surroundings such as an upcoming intersection or current address. The data also pairs with FourSquare and OpenStreetMap to inform users about nearby points of interest such as popular restaurants and stores, or service locations such as post offices and libraries. Users can create an account to save favorite places and to receive curated offerings based on their interests. In reading app

Market Analysis

Category	Features	Aira	Be My Eyes	WayFindr	BlindSquare
Type	Wearable	✔	✘	✘	✘
	Smartphone App	✔	✔	✔	✔
Purpose	Indoor navigation	✔	✔	✔	✘
	Outdoor navigation	✔	✔	✔	✔
	A to B Directions	✘	✘	✔	✔
	Automatic feedback on surroundings	✘	✘	✘	✔
	Curated feedback on surroundings	✔	✔	✘	✘
Data Source	Live P2P Support	✔	✔	✘	✘
	P2P crowdsourced	✘	✘	✘	✘
	Object Sensors	✘	✘	✘	✘
	GPS	✘	✘	✔	✔
	Camera	✔	✔	✘	✘
Processing	Data / Wifi Usage	✔	✔	✔	✔
	Available Offline	✘	✘	✔	✘
Feedback	Audible	✔	✔	✔	✔
	Haptic	✘	✘	✘	✘

Based on our formative research, we outlined the user journey for a blind individual travelling through an urban environment independently. It includes 7 phases: Planning, Receiving Directions, Situational Awareness, Obstacle Detection, Mode Change, Last Mile and Arrival/Reflection.

Our research also uncovered unmet needs related to the Situational Awareness and Obstacle Detection phases. Situational Awareness refers to a person's knowledge of the environment surrounding them, especially as it relates to the task at hand. This can be general information about a space or specific information about an object the person is approaching. Obstacle detection is deeply connected to Situational Awareness because when an obstacle is encountered, it is more likely to be disorientating for a blind traveller, and in addition to knowing how to get back on the right path, they may need help regaining situational awareness.

As we saw through our competitive analysis, several products already provide assistance for the first two phases. For example there are specialized GPS applications and add-ons to common smartphone maps that are accessible for blind individuals to help in the planning and give step by step directions. We aim to prototype solutions that can enhance rather than detract from these technologies.

Nonvisual Navigation Journey

Situational Awareness

a person's knowledge of the environment surrounding them, especially as it relates to the task at hand. This can be general information about a space or specific information about an object the person is approaching.

Obstacle Detection / Landmark

An object that a blind traveler encounters with their body, cane, or guide dog. A key facet of detection is timing; when the obstacle is detected or a landmark is reached. Obstacle detection can disorient, cycling a traveler back to situational awareness.

Planning
- Find accessible crossings
- Mark points of interest
- Compare modes of travel

Receiving Directions
- Get notified of each leg of the route
- Start, pause, repeat, skip, etc.
- Add own notes about a leg

Situational Awareness
- Get general description of an area
- Request more information
- Recognize an object

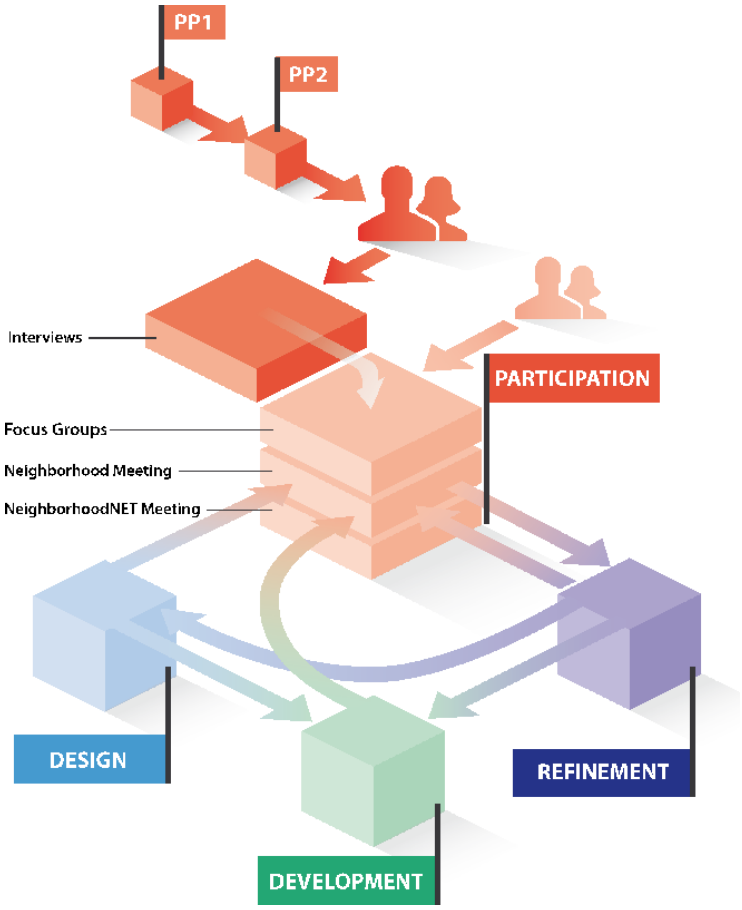
Obstacle Detection
- Be notified of obstacles
- Mark obstacle for future reference
- Details of obstacles dimensions / speed

Mode Change
- Find alternative routes
- Know accessiblility of alternatives
- Compare routes in real-time

Last Mile
- Know location of entrances
- Know when stop is approaching
- General description of space

Arrive / Reflect
- Add notes about location
- Meet with a nearby person
- Save route for future trips

Methodology & Methods



Methodology

Participatory Design

No members of our team are blind or visually impaired and thus are not part of the population for whom we intend to build a solution. To effectively integrate our users into our process, we intend to frame our methods around the Participatory Design methodology. This approach encourages active user and stakeholder engagement through each of the research, design, and prototyping phases [Martin]. Each of our methods have been carefully selected to promote inclusion from our users by recognizing their expertise at the forefront.

Rationale

Involving our users throughout the entire process allows us to offset our own biases in designing for a population different from ourselves [Microsoft]. This framework is also particularly appropriate in giving a disabled group of people a substantiated voice for which they are the primary stakeholders with the intention of countering traditional hierarchies [Bennett].

Success Criteria

Our methodology encourages constant user input, and our methods will be considered successful if we gain insight about the users needs and suggestions for our product. On a similar note, we will define our product to be successful if there is constant alignment between the product features and the users requirements. This will be assessed in various ways depending on the method.

Method	Rationale	Artifact)s)
Interviews with Users and SMEs To explore the initial problem space, interviews will be conducted with Subject Matter Experts and our blind or low-vision users. Individuals are considered SMEs if they have worked directly with the user population for a substantial amount of time. Interviews will be held 1:1 in a space accommodating the interviewee. The interview will be guided by the predeveloped Research Questions, and follow-up questions will be based on responses. Our intention is to qualitatively scope the problem space for a solution. We intend to complete these interviews during the Capstone Planning phase in order to inform future design sessions.	Because no members of our team are part of the user population, we intend to build an initial list of findings from these interviews without inserting our own biases. The responses to these interviews will allow us to scope our problem space and will also inform the content of our Experience-Based Survey	**The interviewer will take informal notes that will be summarized in a post-reflection paragraph. The findings will be analyzed to scope the problem space, potentially redefine design requirements, and guide the survey questions.**
Experience-Based Surveys As opposed to the theory-based questions developed in a traditional survey, the questions developed in Experience-Based Surveys are generated from the experiences of interviewed users [Tonetto]. The qualitative interviews conducted in the previous phase will guide the survey questions that would be electronically sent to a larger population of people in the blind and low-vision community. We intend to have both quantitative and qualitative questions to gain various forms of insight. We will leverage various blind and low-vision organizations in the Seattle area to send our survey to as many people within our user population as possible. The accessibility of the survey via screen readers is also a high priority.	While the findings from the initial interviews may be true for those individuals, this survey would allow us to gauge how common those experiences are for a larger group of people [Tonetto].	**Raw quantitative data from the survey results will be synthesized to reveal trends in terms of frequency. Our team will analyze qualitative data through affinity diagrams to gather other key insights about our problem space.**
Shadowing Shadowing sessions will occur during the pre-capstone phase and in the first week of Spring quarter before Co-Design Session 1. This technique involves following a single participant on a typical commute to a location they may frequent. Many of our participants are members of the Washington Talking Book Library, and we would likely document their commute to that location asking them to speak aloud where appropriate. We will conclude with a debrief discussion of the commute in relation to the participant's life. We hope to conduct at least one shadowing session given the short timeframe but would like to schedule as many as we are able before the first co-design session.	This is a valuable method in observing user behavior in case they're unaware of their tendencies or are not able to articulate it in an interview setting [IDEO].	**The shadower will video-record the session and ask real-time questions throughout. They will take notes during the debrief, and a summary of the session will be made in a post-reflection paragraph. The findings will be analyzed to scope the problem space, potentially redefine design requirements, and inform the co-design sessions.**
Autoethnographic Usability Testing We, as researchers, anticipate simulating the logistics of our sessions and the usability of our prototypes as if we are blind or low-vision users. This may uncover some glaring design flaws in our activities or the prototypes before presenting them to our user group. A total of three autoethnographic usability tests will occur before each Co-Design Session:	In an ideal world, we would be able to adequately compensate users to test our prototypes as often as possible. Due to financial and scheduling constraints, this is likely infeasible. Autoethnographic studies attempt to put researchers in the problem space of the users where they analyze the effectiveness of their solutions [Ellis].	**The notes taken in the usability tests will be analyzed in real time to implement small iterations on the session activities and the prototypes. Findings that would require more time-consuming iterations will be documented as well. Pictures will also be taken to show how our prototype has evolved over time.**

Co Design & Prototyping sessions

We anticipate the bulk of our research to result from the co-design sessions where we work actively with the users to find solutions within the problem space. Based on Cynthia Bennett's Biographical Prototyping model, we hope to have 3 participants and 4 researchers in each session to ensure the thoughts of each participant are expressed [Bennet2]. We anticipate having 3 co-design sessions with two weeks between each to allow for time in developing prototypes.

Rationale

These sessions are designed to be primarily open-ended while "priming" the user with potential features the solution could have. Their engagement in the process and generation of potential solutions would predict the most valid and useful product in the problems space [Martin]. We anticipate being able to feasibly compensate users for 3 Co-Design sessions while maximizing feedback in the allotted time frame of the capstone project.

Artifacts

Brainstorming processes often involve hand-written artifacts including sticky notes for the purpose of organizing ideas and finding relationships, but these techniques clearly do not accommodate to blind or low-vision users. After extensive research, we have not been able to find specific design activities that are developed for those who are blind or have low vision. We will make use of real-time collaboration technology such as Google Suite or Miroboard, and test their effectiveness in co-functioning with screen readers prior to the user sessions. Activities will be designed for both users and researchers to record their ideas on an individual, collaborative, and iterative space. This documentation will inform the design requirements for a prototype to be made before the next design session. We hope these innovative processes would not only inform our project in a rich way but would also provide techniques to future designers and researchers working with the blind and low-vision community.

Designers as Facilitators

Our approach to the human-centered design process advocates for the user, the expert, to take the reigns in creating solutions for their community. We are simply facilitators in prioritizing the user's voice and in developing the technology itself.

At the beginning of each session, the users will first iterate upon the design question and design requirements.The user will then walk through a typical navigational scenario to uncover potential questions, concerns, and solutions.

Session 1
Researchers will create Prototype Kit 1, which will include potential features of the product in the form of arduino outputs: audio notifiers, vibrating motors, pressure indicators, and other creative products that may provide haptic and audio feedback to the user. Their opinions will be recorded, and the first prototype will be

Session 2
the first medium-fidelity prototype, will be presented to the users along with scenarios for them to walk through. As a stretch goal, more than one prototype may be provided or Wizard-of-Oz'd to allow for comparison. Users will be encouraged to add or remove features to convey that the development of the prototype is still open-ended. . Their opinions and suggestions will be recorded to inform the specifications of Prototype 3.

Session 3
The second prototype presented to users, Prototype 3, will be medium to high fidelity. We anticipate the session to run similarly to Co-Design Session 2, but more evaluation of the prototype may take place. As a stretch goal, small iterations may be made on Prototype 3, but there may not be time to make those changes before creating the final deliverable (see Project Schedule in the next section).

Project timeline & breakdown

Method	Pre	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11
Interviews												
Experience-Based Survey												
Shadowing												
Co-Design Sessions												
Autoethno Usability Testing												
Prototypes		PK1			P2			P3				
Artifacts				PR1			PR2			Vid	FP	PB

Artifacts: (PR1) Progress Report 1, (PR2) Progress Report 2, (Vid) Video, (FP) Final Prototype, (PB) Process Book

Prototypes: (PK1) Prototype Kit 1, (P2) Med-Fi Prototypes, (P3) Final Prototype

Week 0 (Pre-Week)

Co-Design Plan + Order Parts

We'll finalize recruiting and prepare our prototyping kits for for the first session in week 2 of this plan.

Finish Interviews & Surveys

Week 1

Co-Design Plan + Shadowing

We'll confirm our participants can attend and shadow orientation training as well as blind travelers on their way to work.

Prototype Kit

Week 2

Co-Design Session 1

We'll conduct our first workshop with our prototype kit. We'll consolidate our findings afterwards with a team debrief.

In-person Session

Week 3

Prototype + Progress Report 1

Our first session findings will inform where to focus iteration for our prototypes. We anticipate focusing into 2-3 medium-fidelity prototypes for the following session.

Progress Report

Week 4

Prototype + Autoethnographic Usability

We'll finish our next phase of prototpying, with 2 to 3 options we can bring to the following session, shifitng to a mix of generative and evaluative activities.

Prototype 2

Week 5

Co-Design & Usability Session 2

We'll conduct our second workshop with our prototypes. We'll consolidate our findings from a debrief as well as select our final prototype direction.

In-person Session

Week 6

Prototype + Progress Report 2

Our second session findings will determine which prototype we'll progress to a final solution. We'll commit as a group to a direction to finalize, mapping out the final weeks of our project more explicitly.

Progress Report

Week 7

Prototype + Autoethnographic Usability

For our last iteration, we'll determin success metrics and define evaluative measure that we'll work with participants to better determine the value of our project.

Prototype 3

Week 8

Co-Design & Usability Session 3

Our final session wlll be a series of usability tests and debriefs with our participants, identifying the delta they would have to adopting an actuaal solution in the daily life.

In-person Session

Week 9

Video + Poster + Deliverable

We'll complete the artifacts for capstone to capture the research & design insights we gathered throughout the experience.

Project Video

Week 10

Process Book + Deliverable

We'll clean up and share out our "deliverable" which we anticipate being a refined verion of our 3rd prototype.

Final Prototype

Week 11

Process Book

We'll design the documents and artifacts in richer detail into our process book, enabling replication for future teams.

Process Book

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1 (abstract) - https://www.who.int/blindness/publications/globaldata/en/

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Thank you.