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Technology-Assisted Navigation in Public Spaces for Hard of Hearing People

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ABSTRACT

While it is incredibly difficult for a hearing person to understand exactly what it's like to be Deaf and hard of hearing, most individuals are aware that hearing difficulty comes with a unique set of challenges. This forces those who are Deaf and hard of hearing to experience the world in an entirely different way than the rest of the population, and not always how hearing people expect. Deaf and hard of hearing people cannot hear loudspeaker announcements, so utilizing public transportation often involves trying to communicate with hearing people which can be challenging. This is especially true when people are rushed. User-interface technology helps improve how people with different abilities navigate public spaces. However, through a comprehensive literature review, I concluded that the current mobile applications available do not effectively address these problems and others issues that Deaf travelers experience. This thesis focuses on tackling these issues in airports and by considering the experiences of those who cannot hear. Surveying and interviews were used to gain insight and knowledge from Deaf and hard of hearing individuals, which was used to guide the development of a design intervention. The design process included evaluating wireframe prototypes of smartphone application design through a series of user testing. This assisted in refining an application called the Hear Here app. The resulting design:

- Broadcasts information shown on airport monitors.

- Alerts and notifies travelers of changes in gates or flights that are announced by public announcements.

- Facilitates dialogue between Deaf and hearing travelers which eliminates feelings of frustration and isolation, especially during an emergency.

- Integrates airport maps to streamline wayfinding and navigation.

- Utilizes real-time translation of announcements to allow Deaf and hard of hearing people be aware of their surroundings and navigate public transportation with ease.

- Eases communication between the Deaf community and hearing individuals.

Technology-Assisted Navigation in Public Spaces for Hard of Hearing People

by
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ABSTRACT

CHAPTER 1
INTRODUCTION

Today, Deaf people and hearing people work and live integrated lives. However, people who are Deaf and hard of hearing still face considerable challenges in the society, particularly in public places. They experience and navigate the world much differently than those who can hear. For all people, missing a flight comes with both financial costs and frustration. When Deaf and hard of hearing people miss a flight due to abilities that are incompatible with an announcement system that is primarily audible, it results in added stress. For example, imagine being Deaf at the airport and missing the announcement that there was a gate change and then sitting at the gate for hours wondering why the plane hasn't boarded yet. Or, imagine missing the announcement that your flight was diverted because the announcement was not made accessible to you. These experiences are common. The National Association of the Deaf's website report that many Deaf and hard of hearing consumers have experienced these problems.

This thesis enhances understanding about the challenges that the Deaf community experiences with public announcements in United States airports and focuses on developing a design solution that addresses the problems.

Understanding the Deaf Community

Deaf culture is the set of social beliefs, behaviors, art, literary traditions, history, values, and shared institutions of communities that are influenced by deafness (Padden & Humphries, 2009). The culture includes the use of sign language as the main means of communication. Distinguished by the community as a cultural label, the word "deaf" is often written with a capital letter D and referred to as "big D Deaf" in speech and sign. When "deaf" is used as a label for an audiological condition, it is written with a lowercase letter d (Ladd, 2003, p.502). In this design thesis, Deaf is capitalized throughout because the work is focused on learning from and bettering the experiences of the community.

The Colorado Department of Human Services defines Deaf as "a group of people, with varying hearing acuity, whose primary mode of communication is a visual language (predominantly American Sign Language or ASL in the United States) and have a shared heritage and culture" (2010, p.15). This definition has been widely adopted within the culture and to some extent in other languages. The terms Deaf and deaf refer to distinct but partially overlapping groups of people (Cherasaro, 2018). For the purpose of this thesis, deaf people are defined by those with significant hearing loss and Deaf people are defined by those who identify with the community and culture, and use sign language as their primary means of communication.

Hamill & Stein (2011) suggest that identifying as Deaf and also a member of the Deaf community contributes to positive self-esteem in Deaf individuals. Blume (2009) suggests that this is because the community provides support, makes social interactions easier, and provides "refuge from the grinding frustrations of the hearing world." (2009, p.61). Blume further explains that Deaf individuals outside of this community may not have the same support in the hearing world, resulting in lower self-esteem. Hamil & Stein (2011) suggest that stereotypes, lack of knowledge, and negative attitudes about Deafness cause widespread discrimination against the Deaf community. According to Hamill & Stein, this can lead to a lower education and economic status for Deaf people.

CHAPTER 2

Literature Review & Discovery

The needs of Deaf people at airports have not been adequately addressed. This thesis asks: What problems do Deaf people encounter at airports? How can airports better accommodate and streamline stress-free travel for Deaf and hard of hearing people? This design research aims to address these questions in three ways. First, by analyzing related literature. Second, by learning from a survey that inquires about the travel experiences of the Deaf community. And third, by interviewing Deaf and hard of hearing participants in-person to obtain more information and details about their experiences. The results of this 3-part approach provide guidance for developing a design solution that can address the concerns of this thesis.

2.1   Related Literature

Several key questions guided the process of searching for literature and sources related to this thesis. The questions included the following:

- What does existing research or literature suggest about the travel experiences of the Deaf community?
- What assistance and facilities are available at airports for Deaf and hard of hearing people?
- Are Deaf people satisfied with the available assistance and facilities at airports?
- How do Deaf and hard of hearing people become aware of public announcement systems in public places?
- What is the easiest way for Deaf and hard of hearing people to communicate with a hearing person in public places?

The themes that emerged while seeking answers to these questions in the existing literature defined three, somewhat overlapping categories of information: 1) Deaf community, 2) Deaf Community and public transportation, and 3) Deaf community and air travel.

The search for answers in the related literature resulted in very few sources (only four articles). For this reason, information specialists at Syracuse University library were consulted to ensure a comprehensive search. The process of working with the specialists involved rethinking and refining the keywords. The database that was utilized during the expanded search were ERIC (Educational Resources Information Center) via Proquest.

Keywords	#	Date From 1980 t0 2019
Hearing impairment/Airport	1	2014
Hearing impairment/Airlines	0	
Hearing impairment/Air traveller	0	
Hearing impairment/Public transportation	0	
Deaf/Airport	1	1992
Deaf/Airlines	1	1992
Deaf/Air traveller	0	
Deaf/Public transportation	1	2009
Deafness/Airport	0	
Deafness/Airlines	0	
Deafness/Air traveller	0	
Deafness/Public transportation	1	2009
Hard of hearing/Airport	0	
Hard of hearing/Airlines	0	
Hard of hearing/Air traveller	0	
Hard of hearing/Public transportation	1	2009

Figure 1.1 . Related literature found by searching keywords in the ERIC (Educational Resources Information Center) database.

Figure 1.1 outlines the keywords that facilitated the search, including: hearing impairment, deaf, deafness, hard of hearing, public transportation, airport, air travelers, and airlines. The result was extraordinarily lacking with only six articles from 1992 to 2019. The following paragraphs describe what was learned from reviewing these sources and demonstrate that more research should focus on the Deaf and their travel needs and experiences.

The available sources were reviewed to understand the subject, to answer the thesis questions, and to identify methodologies that may be appropriate for developing a design intervention for assisting Deaf and hard of hearing people in navigating through public places. This analysis was used to guide the project moving forward. The sources are discussed in the following sections.

According to Ribas et al. (2016), current research about the accessibility of icons for Deaf and hard of hearing people does not provide useful guidelines for designers. The current sources lack suggestions and recommendations that designers can use for developmenting graphic icons that are specific to Deaf or hard of hearing people. This source suggests that developing icon designs should be a part of the process of this thesis.

Yeratziotiz & Zaphiris (2018) developed an innovative evaluation that aims to support Human-Computer Interaction experts and web developers in designing, evaluating websites and applications. According to their evaluation and information that they gained during their research, they suggest that more research is needed to make the web and applications more accessible to Deaf and hard of hearing people. Published in 2018, this recent source confirms that there is a gap; design research for this population is underdeveloped and in-need. This suggests that an app-based design intervention would address the gap and would contribute to knowledge.

Slyper, Kim & Sobek (2016) used interviews to learn about the safety- and alarm-related issues for Deaf people. Their study revealed what procedures the U.S. Department of Health, Safety, and Environment use to alert and notify all people (including the Deaf) during emergencies. They also clarified how emergency-related information is received. Their work suggests that communication tools can help Deaf and hard of hearing people in emergency situations. Their paper focuses on describing a particular tool that features a mobile application with a keyboard customized specifically for the Deaf community. The mobile application is meant to help Deaf and hard of hearing people converse with emergency personnel. The key features of this application are voice-to-text and text-to-voice. This source suggests that these features should be considered when developing a design intervention for this thesis.

Varzhel et al. (2017) interviewed Deaf and hard of hearing people to learn about the types of fire-detection devices that they commonly use. They found that specific features are typically featured in mobile-based fire detection devices that Deaf people use in emergency situations, and include: extra loud sirens, color-coded flashing fights, and vibration. This suggests that it would be appropriate to incorporate these features into a design intervention if it is a mobile-based device.

Several United States airline companies have mobile applications, and some provide features for assisting disabled people with navigating airport facilities and to help them experience more accessible travel. To obtain more information about these apps and how they specifically accommodate the Deaf, the top ten first-rate airlines identified by Maloney (2019) were contacted to learn more about the features of the apps. Of those contacted, all airline companies provide an app feature that informs the passengers of cancelled flights, but only four announce gate changes. Table 1.1 outlines what was learned from this process and suggests that Deaf and hard of hearing travelers are not adequately communicated with by the airlines.

U.S. Airline Company	Provides Gate Change Notifications	Provides Cancellation Notifications	Provides Public Announcement Notifications	Provides ASL Interpretation
Delta	✘	✔	✘	✔
Alaska	✔	✔	✘	✘
South West	✘	✔	✘	✔
United	✔	✔	✘	✔
Hawaiian	✔	✔	✘	✘
American	✘	✔	✘	✘
Jetblue	✘	✔	✘	✘
Allegiant	✘	✔	✘	✔
Spirit	✔	✔	✘	✔
Frontier	✘	✔	✘	✘

Table 1.1. Analysis of the features of U.S. Airlines mobile applications. The "X" indicates that the feature is not provided by the mobile application and does not adequately accommodate Deaf and hard of hearing travelers.

This literature review as a whole suggests that accessing public announcements is one of the most significant difficulties that Deaf people face when they are using public transportation (such as trains, subways, and flights). This is understandable, considering that important announcements like delays and gate changes are often made over a speaker. Deaf people cannot hear these and are left following other people's movements and challenged to figure out what information was announced. This causes Deaf people to be reliant on their fellow passengers and their willingness to help. It can be assumed that there are several instances when hearing people lack empathy for the Deaf people, are too rushed to help, or do not have time to stop and explain the announcement to the Deaf person. The challenges inherent in this type of situation can also be assumed. The Deaf might struggle to communicate with hearing people who use verbal and auditory abilities to start a conversation with another person. A Deaf person might need to tap on a stranger's shoulder or to wave their hand in front of their face to visually get their attention and to receive help. During conversations with hearing people, the Deaf and hard of hearing people sometimes need to look at people's faces to read their lips, write out their question on their phone or on paper, or a combination of both. This might be uncomfortable for people who can hear.

Summary of Related Literature

The previous section presents what we know about the experiences and challenges of Deaf and hard of hearing traveler. The lack of data and articles about this topic demonstrates a gap and suggests that there is a need for design researchers to address how the Deaf community experiences travel-related communication and announcements. The information that was collected by talking to the airline companies confirms that this gap is particularly apparent in airports. Yeratzioti & Zaphiris (2018) suggest that a design intervention in the form of a digital interface or application is an important starting point to explore a design intervention that addresses this.

Most airlines have mobile applications that provide a degree of support to ease travel for people with disabilities, including the Deaf community. However, the applications available provide limited functions and fail to accommodate all needs that Deaf and hard of hearing have during air travel, including: notification of gate changes and flight cancellations, access to information through public announcement (PA) systems, and options to fluidly communicate with hearing travelers. However, more information is necessary to move forward with guiding a design intervention. The following section explains how the discovery of knowledge was enhanced and supported moving forward with a design.

2.2 Enhancing Discovery

Transportation by air in the United States can be complex because it often involves wayfinding expansive terminal buildings, navigating large and seemingly chaotic crowds of people, and performing multiple changes between vehicles (flights, trains, etc). The literature review in the previous section demonstrates that our understanding about the experiences of these environments is very limited for Deaf and hard of hearing travelers. To guide a design intervention that addresses the problem, it was necessary to collect additional information from Deaf people. Table 2.1 shows that several approaches were used to investigate this further and to provide the information needed to move forward. The methods that asked participants to share their personal experiences were IRB approved

Collection Method	Type of Data	Purpose
Survey	Descriptive & Numerical	Gather information about their experiences in airports
Interview	Descriptive	Gather information about their experiences in public places & communication with hearing people.
User Testing	Descriptive & Numerical	Gather information about their opinion about the Hear Here app, after using it.

Table 2.1. Overview of methods for discovery and design development

Survey

Due to the lack of sufficient literature related to this topic, it was critical to supplement the information about Deaf and hard of hearing travelers through alternative means. Anonymous, online surveying was used as a starting point to enhance understanding. Asking the right questions and finding the correct number of eligible people was very challenging. The survey was designed to learn more about the challenges of the Deaf and hard of hearing community, challenges they have in their daily life to communicate with hearing people in public places and to collect stories about their travel experiences in airports. The survey was consulted by a leader in this field who is also Deaf professor at Syracuse University. They assisted in finding appropriate participants and agreed to mentor the process

The study quickly gained interest. 36 Deaf and hard of hearing participants over the course of two Months (18 years or older). The survey revealed that airports are particularly problematic for Deaf people who travel because missing a flight costs them money and time. The survey also revealed that:

100% of participants indicated that vibration is the best method for alert them to something important.
100% of participants indicated that their primary method of communicating with the general public is by typing on their smartphones.
100% of participants shared stressful experiences in airports. They described seeing hearing people react to announcements that they could not access and having to follow people to find out what was happening.

The findings from the survey suggest that an enhanced application for smartphones might be a useful tool for addressing the concerns of this thesis. Deaf people already use them to communicate with other travelers in public places, especially if they do not know American Sign Language. The survey also suggests that Deaf travelers find the vibration functions that are already built into their smartphones as useful notification methods. According to Alnfiai & Sampali (2017), an accessible app might remove the communication barriers and reduce anxiety and frustration. This source combined with the results of the survey support that a digital device or an app is an appropriate design intervention to develop to facilitate positive, stress-eliminating experiences for Deaf and hard of hearing travelers.

Interview

Meeting face-to-face with participants and having conversations with them about the challenges of travel provide designers with valuable information that can be used to start ideation. Interviewing Deaf and hard of hearing people was a difficult task, but also a fantastic experience while working on this project. Nine participants agreed to be individually interviewed in-person; three were Syracuse professors, three were university students, and three were those involved with a Syracuse-based group called Deaf Coffee CNY Social.

The interviews were very useful in providing detailed information necessary to guide a design intervention. The shared experiences were descriptive and rich, and illustrated that communication while traveling through airports is a problem that is commonly experienced by the Deaf community. For instance, when asked to share their experiences of feeling anxious when traveling, one Deaf participant shared:

If I am alone, I feel great anxiety because I can see that the gate agent or airline representative is providing information to the passengers, and I can't access this information. My anxiety is heightened when I see passengers moving to another gate in response to the announcement. Of course, if I'm traveling with a companion with typical hearing, the companion can keep me up to date.

Another Deaf participant who uses cochlear implants provided insight when asked how they deal or cope with the problem when it's happening. They shared:

> *I will ask for a Complaint Resolution Officer (CRO) required by the airline to handle complaints or difficult situations involving people with disabilities. The problem is that the CRO does not know sign language and does not bring with him or her an iPad or some other device to communicate with the deaf or hard of hearing person. The CRO is useless in this situation.*

Because "stress" emerged in the survey as an important aspect of experiencing communication in airports, the participants were also asked if they had ever changed their travel plans to avoid stressful airport situations. One Deaf participant (who is also a member of a local, online social platform for the Deaf community) shared:

> *Well, the problem is that a stressful situation at the airport is suddenly thrust on me. For example, I'll be dropped off only to discover that my flight was canceled or delayed. Or I'll be sitting at the gate waiting for my flight only to discover it was canceled or delayed. There's nothing I can do except to wait in anxiety.*

The information that the participants during the interviews suggest that Deaf and hard of hearing people generally have anxiety about air travel because their past experiences have resulted in overall doubt about the services that are provided by airlines and airports. They have a difficult time communicating with people (including airline employees) when they don't know American Sign language. Also, they shared that the people who provide the airport services for disabled people generally do not understand Deafness and the needs of the Deaf community. The ignorance of the employees makes Deaf and hard of hearing people feel isolated and isolated from society.

Participants of this research have experienced difficulty in airports when there are gate changes or when flights are delayed or canceled. It is clear that these difficulties are because public announcements are audio-based systems that they are unable to hear. What's more, the interviews reveal that navigating airports become more difficult for Deaf and hard of hearing travelers when their anxiety in increased. The participants suggested that a tool (such as a mobile application) that can help them easily, quickly, and comfortably communicate with hearing people who don't know American Sign Language would help improve their traveling experience, and is greatly desired.

Overview of the Problem

The literature review and process of discovery have defined the scope of issues that Deaf and hard of hearing travelers experience, and include:

● Difficulties communicating with hearing people and notifications when traveling.

● Difficulties wayfinding and navigating airports.

● Heightened stress and anxiety when traveling because of previous experiences in airports that were bad or caused psychological distress.

● Challenges with the people that work in airports and for airlines who are supposed to provide services to disabled travelers; they are ignorant about deafness and the needs of the Deaf community.

After gathering the information through articles and literature, and by rephrasing through conducting a survey and interviews, it was time to apply the knowledge to an iterative design process. Ideation began by asking how to apply what the literature suggests as useful and by figuring out possibilities for how to address the needs that were expressed by the participants through the
survey and during interviews.

The process of discovery as a whole suggests that the problems that Deaf travelers experience in airports might be improved through a well-designed mobile device or application that features three attributes (Figure 2.1). The attributes include features that: 1) properly alert when there are public announcements, 2) facilitate communicating with hearing people, and 3) provide interactive airport maps. Awareness of public announcement systems will reduce their anxiety and give deaf and hard of hearing people confidence that they will not miss their flight. If communication with hearing people is easier, it can eliminate the need, to each different airline and whether an interpreter is available. Having access to internal airport maps will make Deaf travelers feel more independent in finding their way, especially when they are rushed and don't have time to ask others. This will reduce the anxiety of communicating as well.
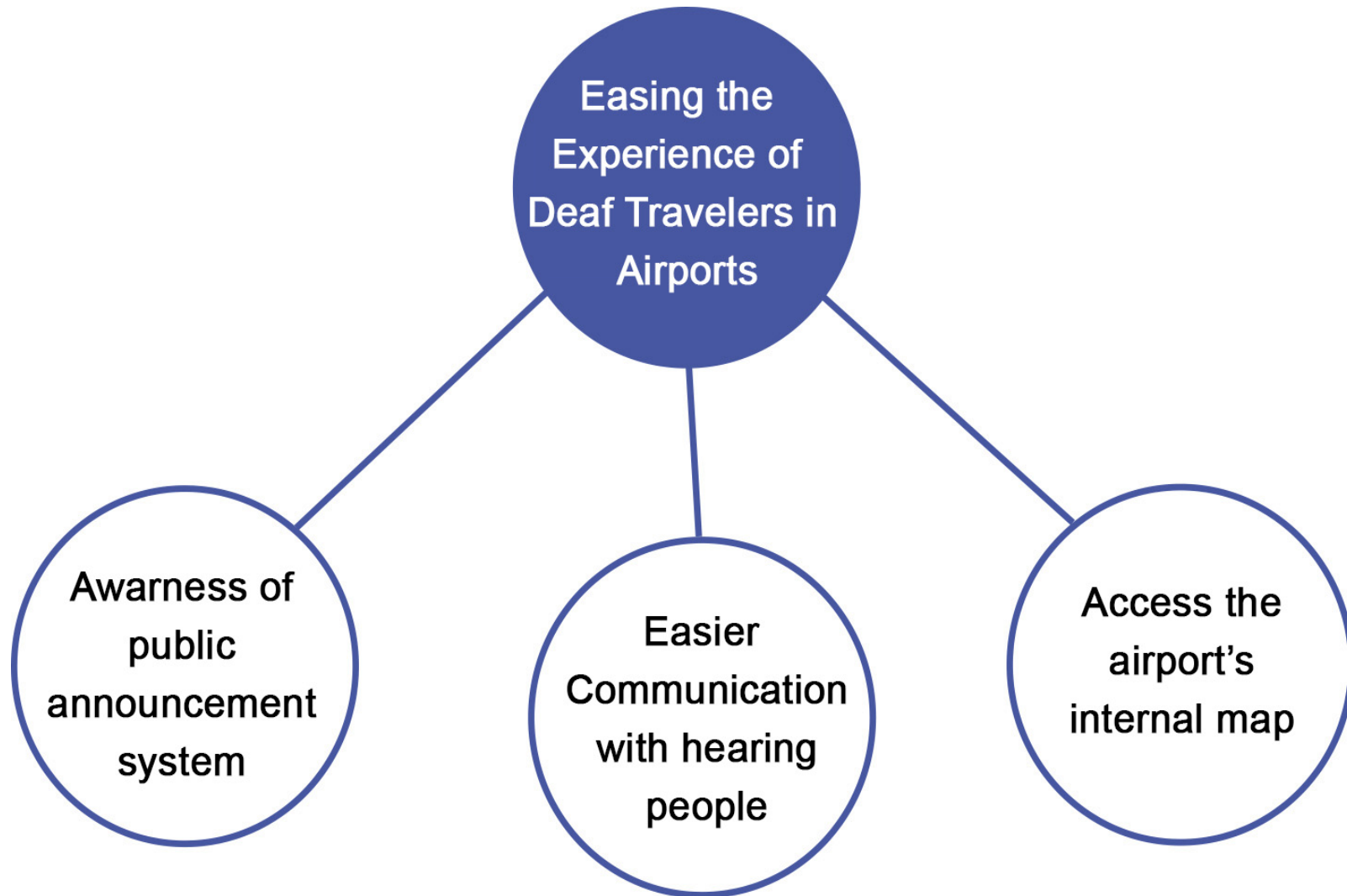
Figure 1.2. Overview of the three attributes that might ease the experiences of Deaf and hard of hearing travelers in airports

Based on all information collected through conducting a literature review, survey, and interviews, developing a mobile application that incorporates these attributes is a good initial approach to designing a design intervention that meets the needs of Deaf and hard of hearing travelers. The summary of what should be considered in the design of the mobile application includes:

● Developing an application that can broadcasts the information shown on the airports monitors.

● Developing a smartphone-based alert and notification system that broadcasts changes in the gates or flights announced by public announcements.

● Creating a practical and straightforward tool that facilitates dialogue between Deaf and hearing travelers to eliminate feelings of frustration and isolation, especially during an emergency.

● Integrating airport maps with applications to streamline wayfinding and navigation.

CHAPTER 3

Prototyping & Testing

Wire-frames

The knowledge gained through conducting the survey and interviews guided the development of initial wireframe prototypes of app technology that could be evaluated through user testing. The initial prototypes focused on developing ways to help Deaf and hard of hearing people navigate public spaces. The prototypes allowed participants to provide simple feedback about the design through a process of interacting with the wireframe, and to share how they could be developed or customized to be better. For instance, buttons were placed in the app with the labels "My Plane," " Communicate," "Map," and a fourth button without indication of the function. Participants could give suggestions for what the fourth button might be, or could comment on those already labeled.

Prototypes

I created several rounds of sketches and paper prototypes of smartphone applications to facilitate the process of conducting usability testing with nine Deaf and hard of hearing participants and four designers (figure 3.1). Iterating after each round when participants provided feedback, the sketches and prototypes were modified. This process was implemented before forming an interactive prototype using the digital design platforms called Sketch and Figma. The initial prototyping phase resulted in five interface designs.
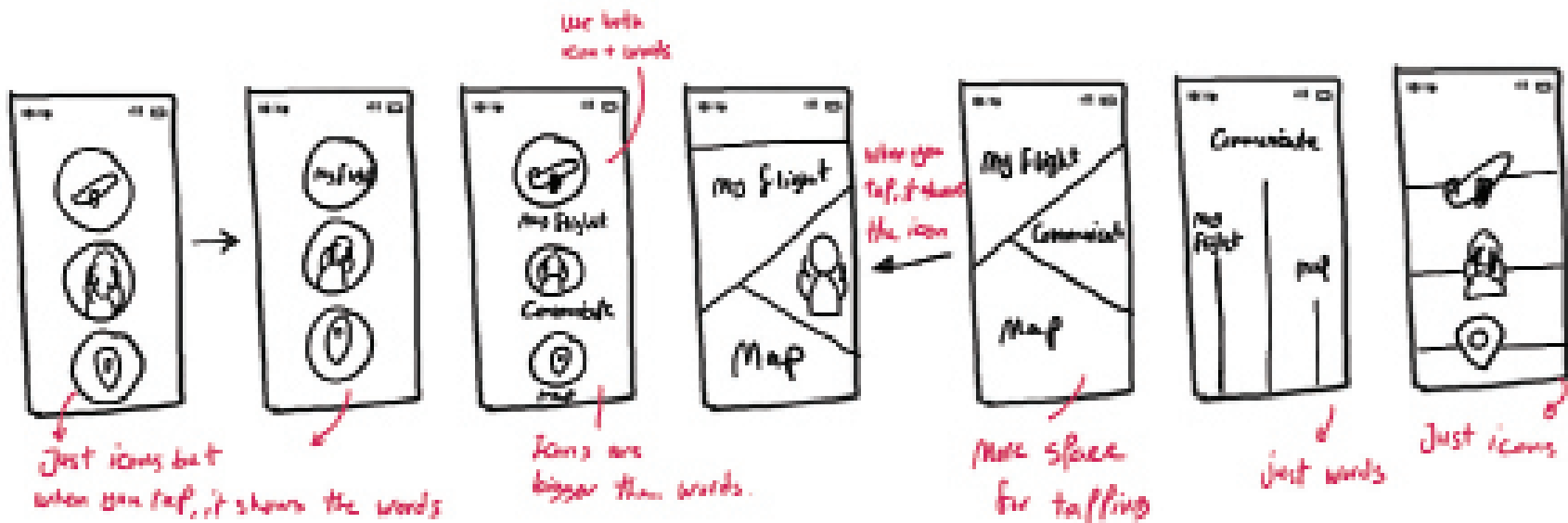
Figure 3.1 . wireframes, designated by an ipad pro

The participants shared their opinions about the wireframe prototypes and agreed that a developed design should include the four following attributes. The following describes the outcome of the user testing for each of the four features:

- "Home" page, featuring:
  - Information related to flights that are announced by public announcement systems and shown on airport monitors.

  - Tools to interact with hearing people.

  - Tools to find navigation routes in airports.

- "My Flight" page, featuring:
  - Ability to enter their flight information manually to receive notifications about any
  - changes related to their flights.

  - Settings for how to receive notifications, such as the option to change the type of vibration.

- "Communicate" with others, including:
    - The ability to view another person's face when using the typing function through a rotated keyboard.

    - The ability for hearing people to communicate verbally with Deaf and hard of hearing people, and in the other hand Deaf and hard of hearing users communicate through typing.

- Access to "Maps", featuring:
    - Access to the airport's internal maps to help travelers find gates, terminals, and other destinations.

    - Access fast routes to destinations in airports without having to ask questions from others.

Home Page User-testing

Participant feedback (n=13) from conducting the first phase of user testing (figure 3.2) for the Home Page revealed:

- 4/9 of participants (44%) said that the icon design for the "Communicate" button could be more clear. They suggested that it be simplified to visually represent the word communicate in American Sign Language.

- 6/13 of participants (46%) said rectangular shapes of the buttons make them think that there were more buttons than there were. Therefore, they tried to scroll down and became confused.

- 13/13 of participants (100%) liked the label "Communicate" for the second section.
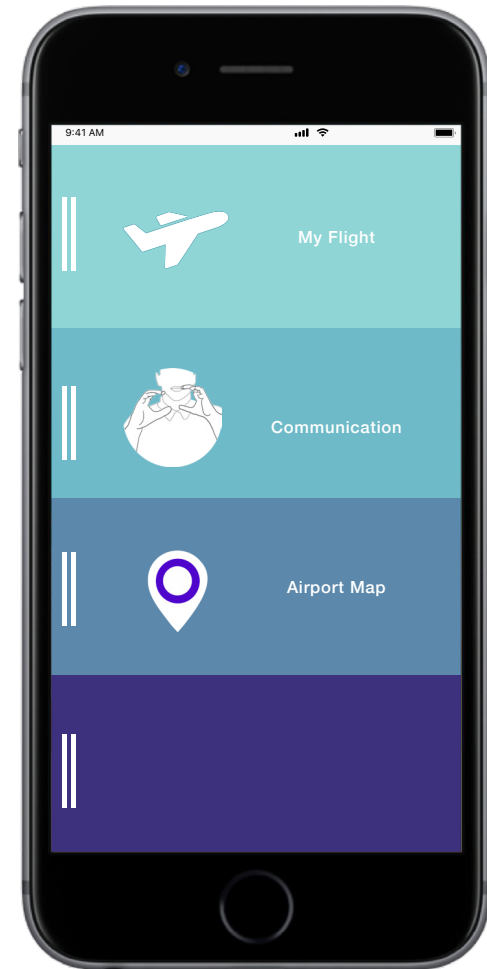
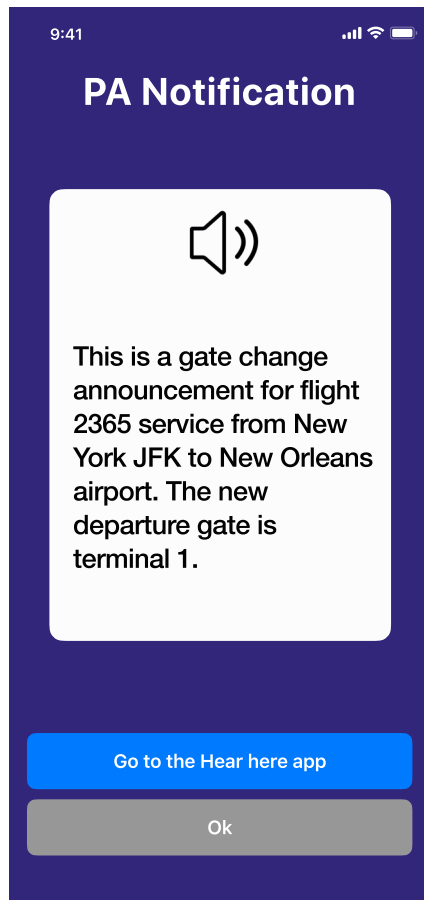*Figure 3.2 .* Home page sketch, Phase #1

My Flight

Communicate

Map
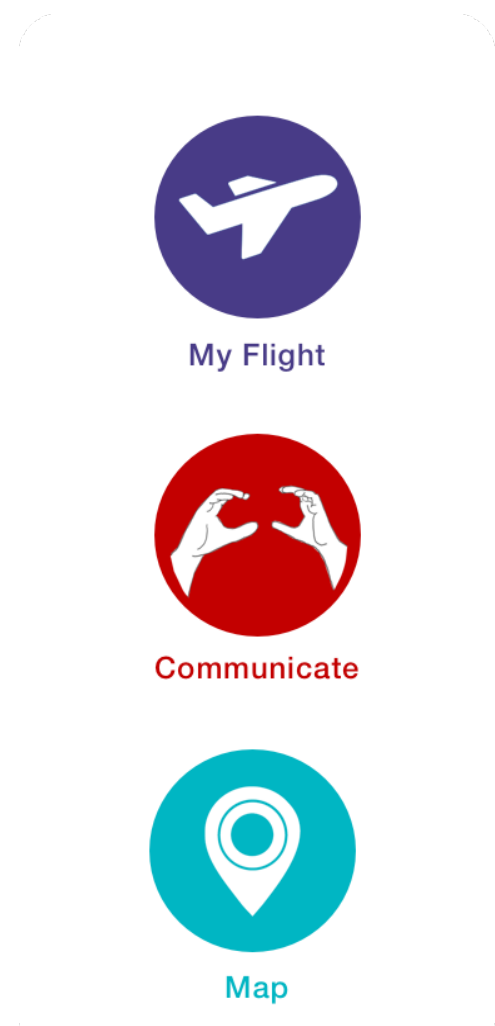
Figure 3.3 . Home page sketch, Phase #2

The Home Page was modified based on the feedback and developed for a second phase of user testing. The changes included modifying the shapes of the buttons and also developing an improved icon for "Communicate." The second phase was evaluated through user testing with Deaf and hard of hearing participants (n=9) and hearing participants (n=4). articipants' feedback revealed:

- 9/9 of Deaf and hard of hearing participants (100%) said the communicate icon design is obvious and works well now.

- 13/13 of all participants (100%) were satisfied with the shape of the buttons.

- 4/9 of participants (44%) said that the icon design for the "Communicate" button could be more clear. They suggested that it be simplified to visually represent the word communicate in American Sign Language.

- 6/13 of participants (46%) said rectangular shapes of the buttons make them think that there were more buttons than there were. Therefore, they tried to scroll down and became confused.

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My Flight Page User-testing

Participant feedback (n=13) from conducting the first phase of user testing (figure 3.4) for the My Flight Page revealed:

- 5/13 of participants (38%) said the page showing flight information was a little messy and they asked for it to be redesigned.

- 6/13 of participants (46%) wanted to see how the public announcement alert would appear in the page and asked for a button to be added to give them an opportunity to control it. They wanted an on/off control for the alarm and notifications concerning broadcasts about flight information.

- 8/13 of participants (61%) said they like to access to Communicate and Map section by bottom navigation bar when they are in My Flight page.
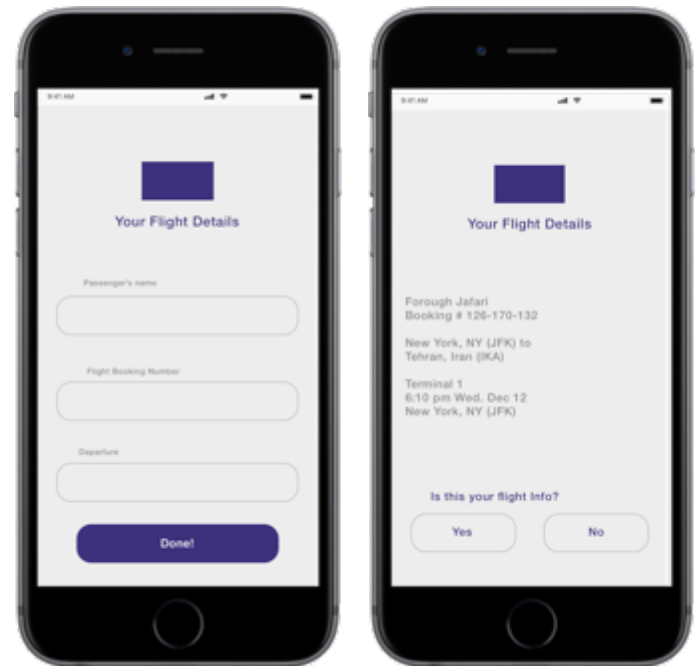
Figure 3.4 . My flight page sketch, Phase #1

Figure 3.5 . My flight page sketch,
Phase #2

The My Flight section was modified based on the feedback and developed for a second phase of user testing. The changes included adding the bottom navigation bar to make all three options available for them in each page, providing settings for how to receive notifications and changing the design and color to make it better visually.

The second phase was evaluated through user testing with Deaf and hard of hearing participants (n=9) and hearing participants (n=4).articipants' feedback revealed:

● 13/13 of participants (100%) were satisfied with how pages looked.

● 13/13 of participants (100%) like the notification alert for public announcements and the large font because it is easier to read, especially if they have anxiety.

● 13/13 of participants (100%) said they wanted a bottom navigation bar to help make their journey in the app more intuitive.
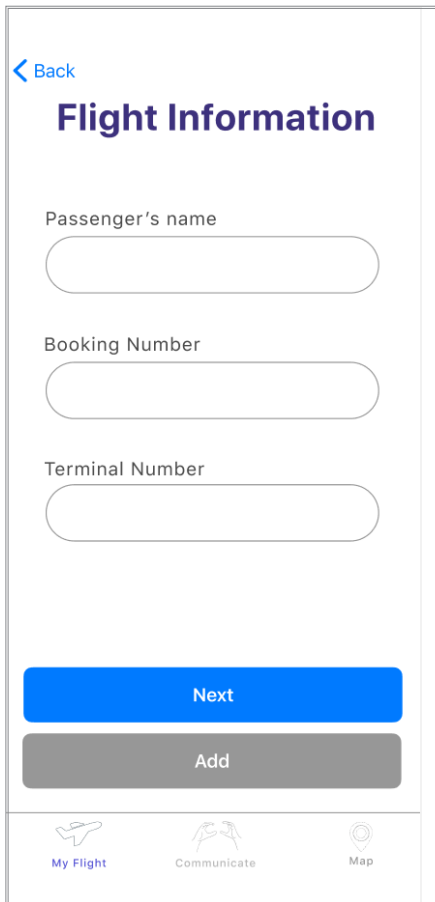
Figure 3.5 . My flight page sketch, Phase #2

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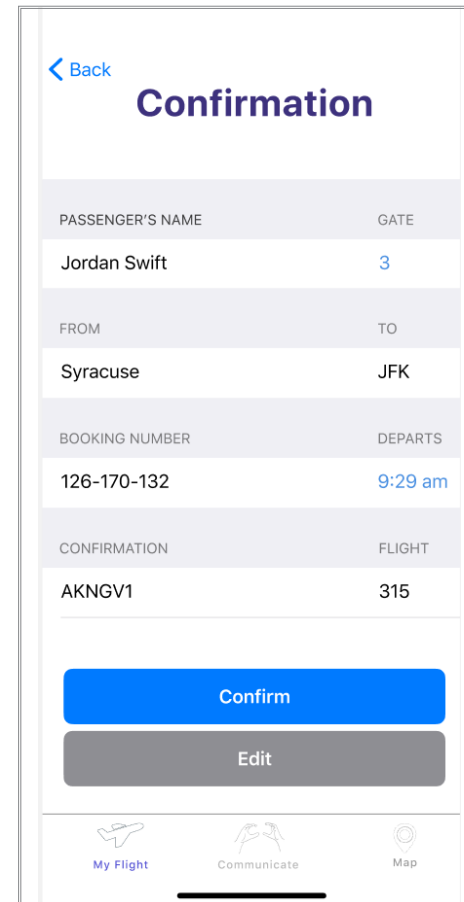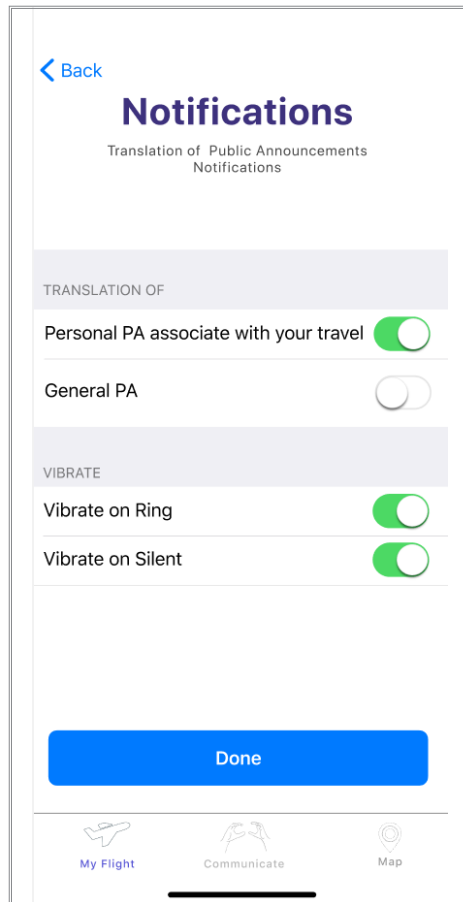
Communicate Page User-testing

Participant feedback (n=13) from conducting the first phase of user testing
(figure 3.6) for the Communicate Page revealed:

- 10/13 of participants (77%) said that finding their questions in the
  rectangle was not comfortable because it takes time and it might make the
  hearing person uncomfortable as well.

- 11/13 of participants (84%) said there is not enough space between the
  purple rectangle and keyboard. They said that more space would make it
  easier to read the conversation and follow it.

- 10/13 of participants (77%) do not like the idea of giving their phone to a
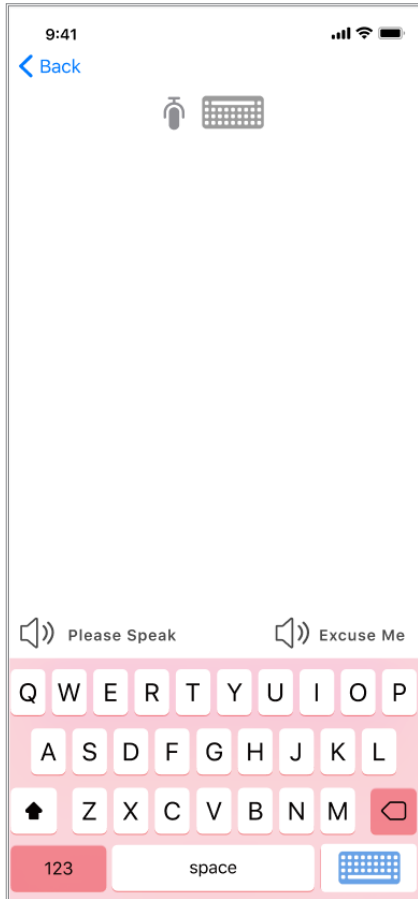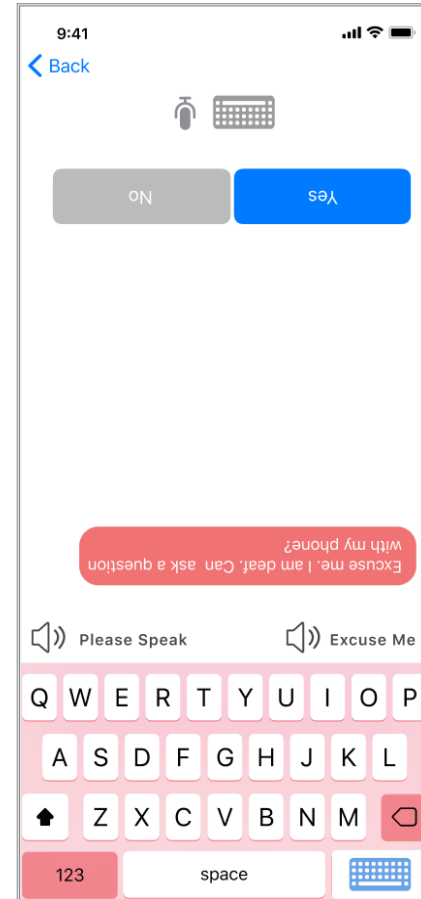 stranger for communicating through type.
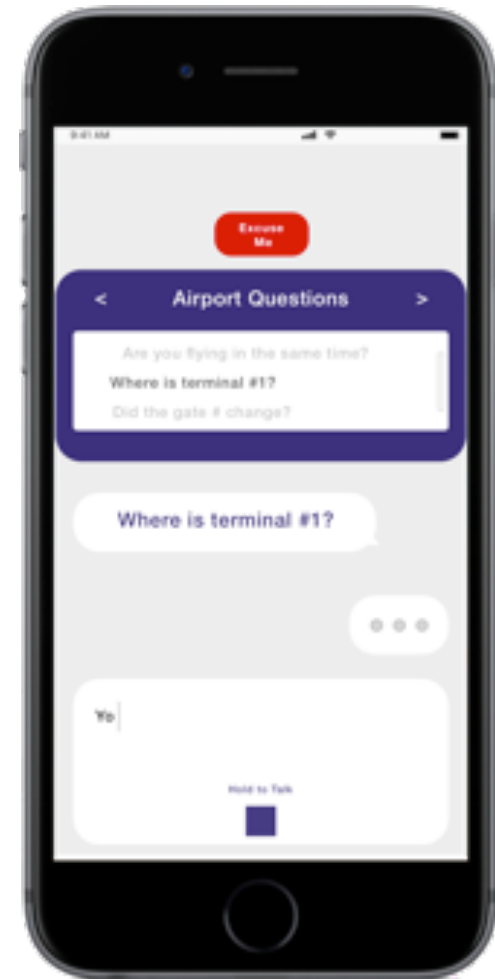
Figure 3.6 . Communicate page sketch,
Phase #1

Hearing person view

By tapping on the "Excuse Me" button, the deaf/hard of hearing user can start his/her conversation with a hearing person faster and easier and more understandable for hearing people.
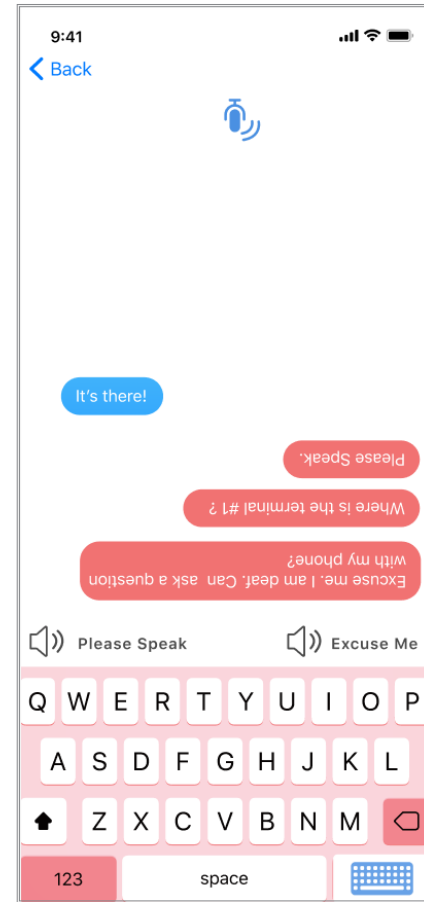
Deaf/ Hard of hearing person view

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Hearing person view

Creates an opportunity to initiate
a conversation with a stranger by
providing the button initiates a verbal
greeting.

Deaf/ Hard of hearing person view

The Communicate Page was modified based on the feedback and developed for a second phase of user testing. The changes included the ability to get the attention of a hearing person by tapping on a button which plays a voice to begin an audible conversation. The idea was that the verbal feature would make communicating feel more natural for a hearing person, and the keyboard would quickly allow the conversation to accommodate the Deaf person's needs. The second phase was evaluated through user testing with Deaf and hard of hearing participants (n=9) and hearing participants (n=4).articipants' feedback revealed:

- 13/13 of participants (100%) said that the "Excuse me" button made them feel com fortable starting a conversation with a stranger.

- 13/13 of participants (100%) said the upside down screen feature was helpful and allowed them to communicate faster and more easily with hearing people. They liked that they could read the message while still being able to see the hearing per son's face.

Map Page User-testing

Participant feedback (n=13) from conducting the first phase of user testing (figure 3.8) for the Map Page revealed:

- 13/13 of participants (100%) said they like the idea of having access to the airport's internal map, and they think this section will reduce their anxiety while they navigate airports.
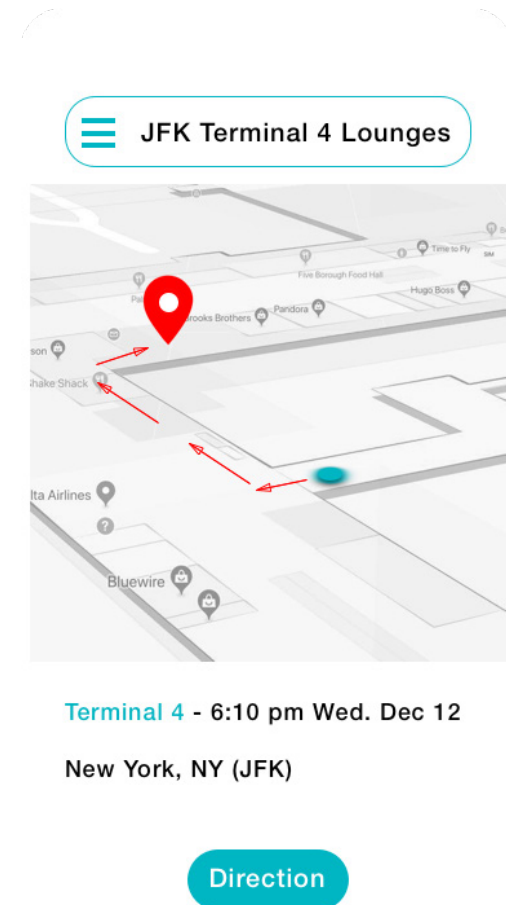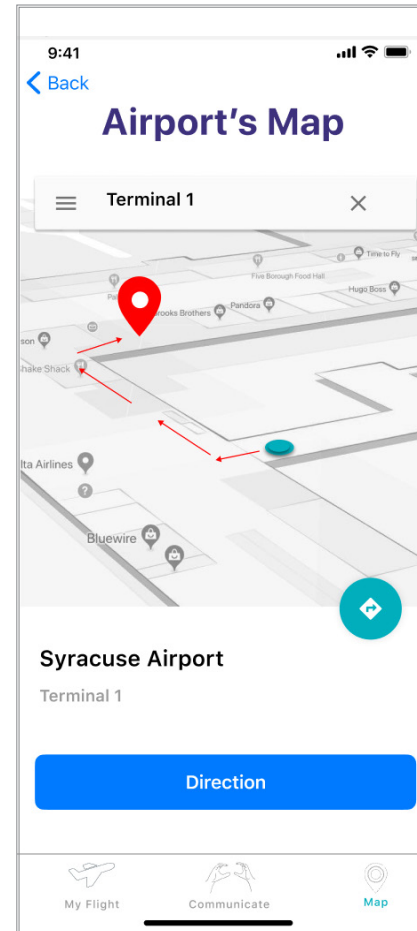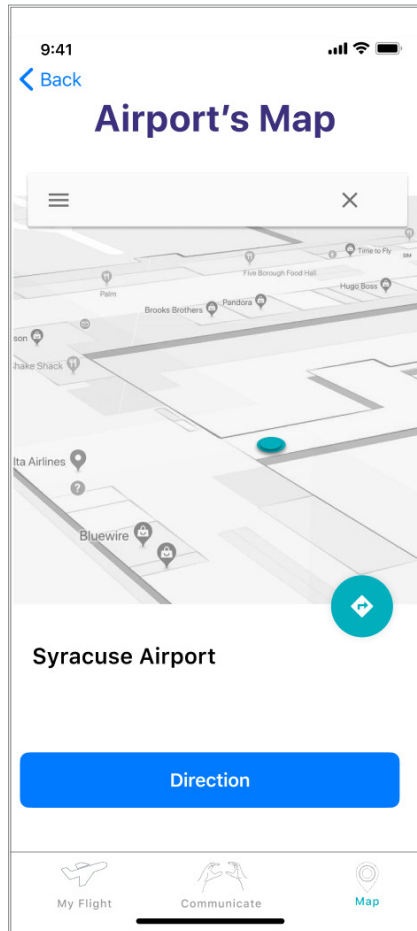

Figure 3.8 . Map page sketch, Phase #1

Figure 3.9 . Map page sketch, Phase #2

App Simulation

After executing all the application pages, I completed the logo and the name of the app with the help of my outside committee member, Professor Masiclat, director and new Media management in the Newhouse at Syracuse University. The application was named "Hear Here." Then I used the design platforms called Figma and Protopie to make Hear Here interactive and to simulate an operable version of the mobile application. Figures 3.10 through 3.14 show how users can interact with the Hear Here app:

Figure 3.10 . Simulated Hear Here application developed, the Home Page, using the design platforms called Figma and Protopie.

Figure 3.11 . Simulated Hear Here application developed, the My Flight page, using the design platforms called Figma and Protopie.

Figure 3.12 . Simulated Hear Here application developed, the Communicate page, using the design platforms called Figma and Protopie.
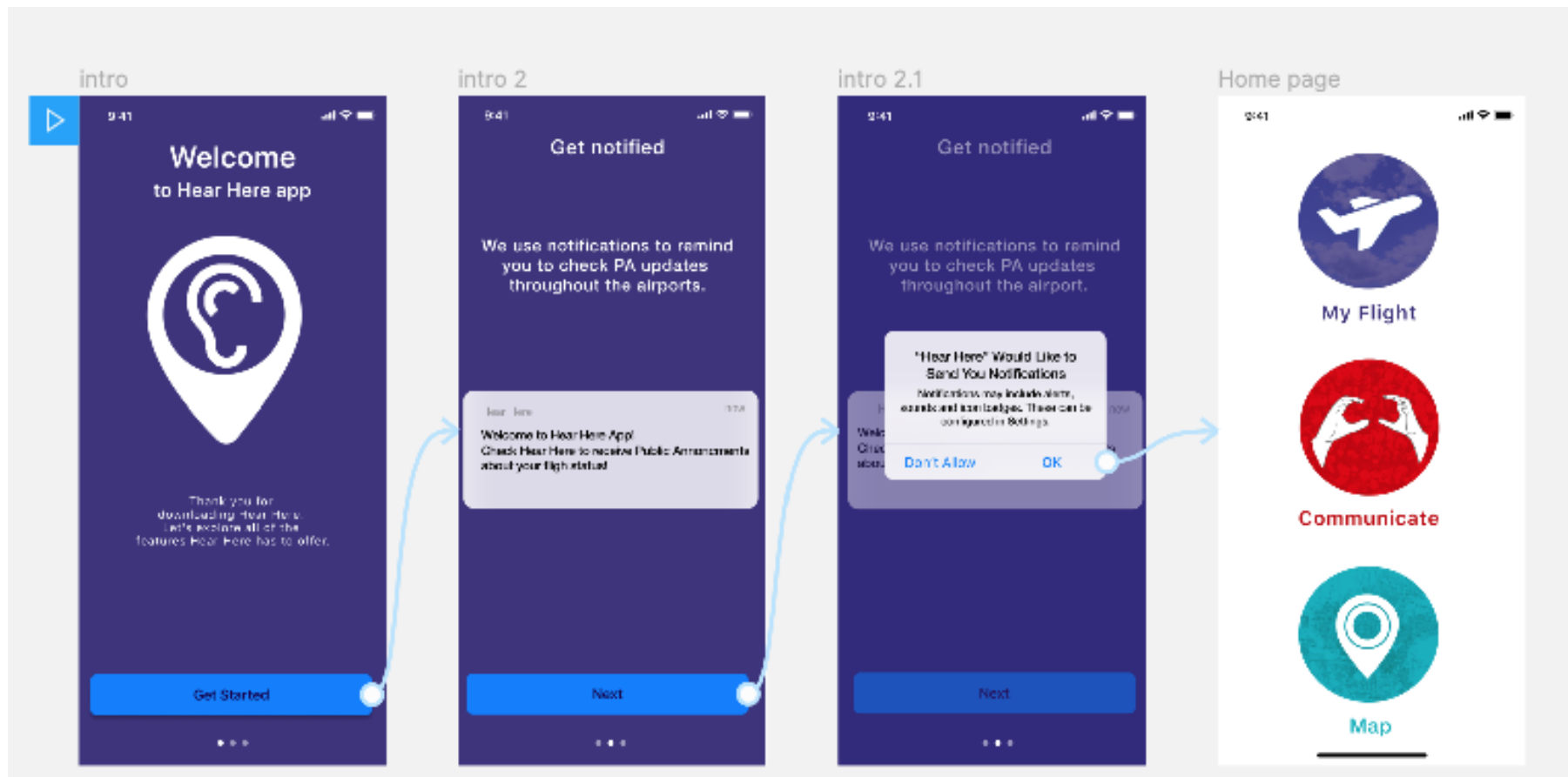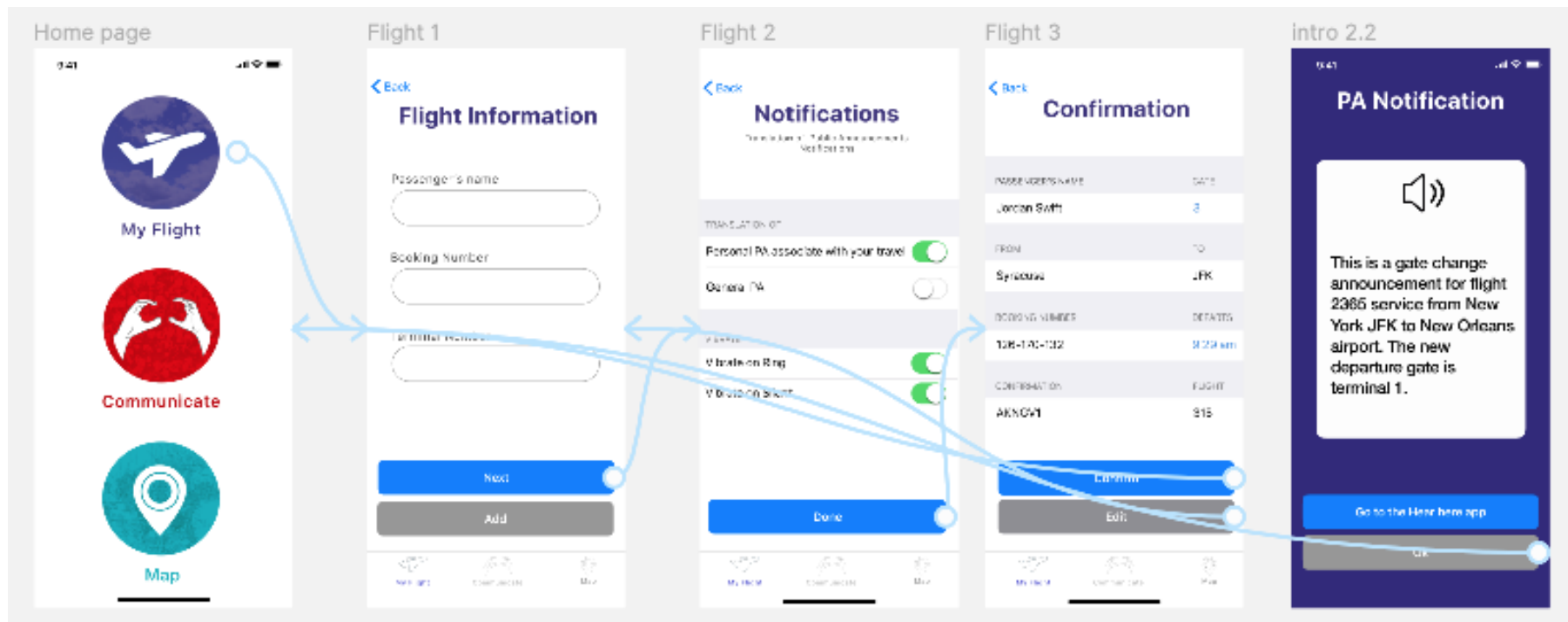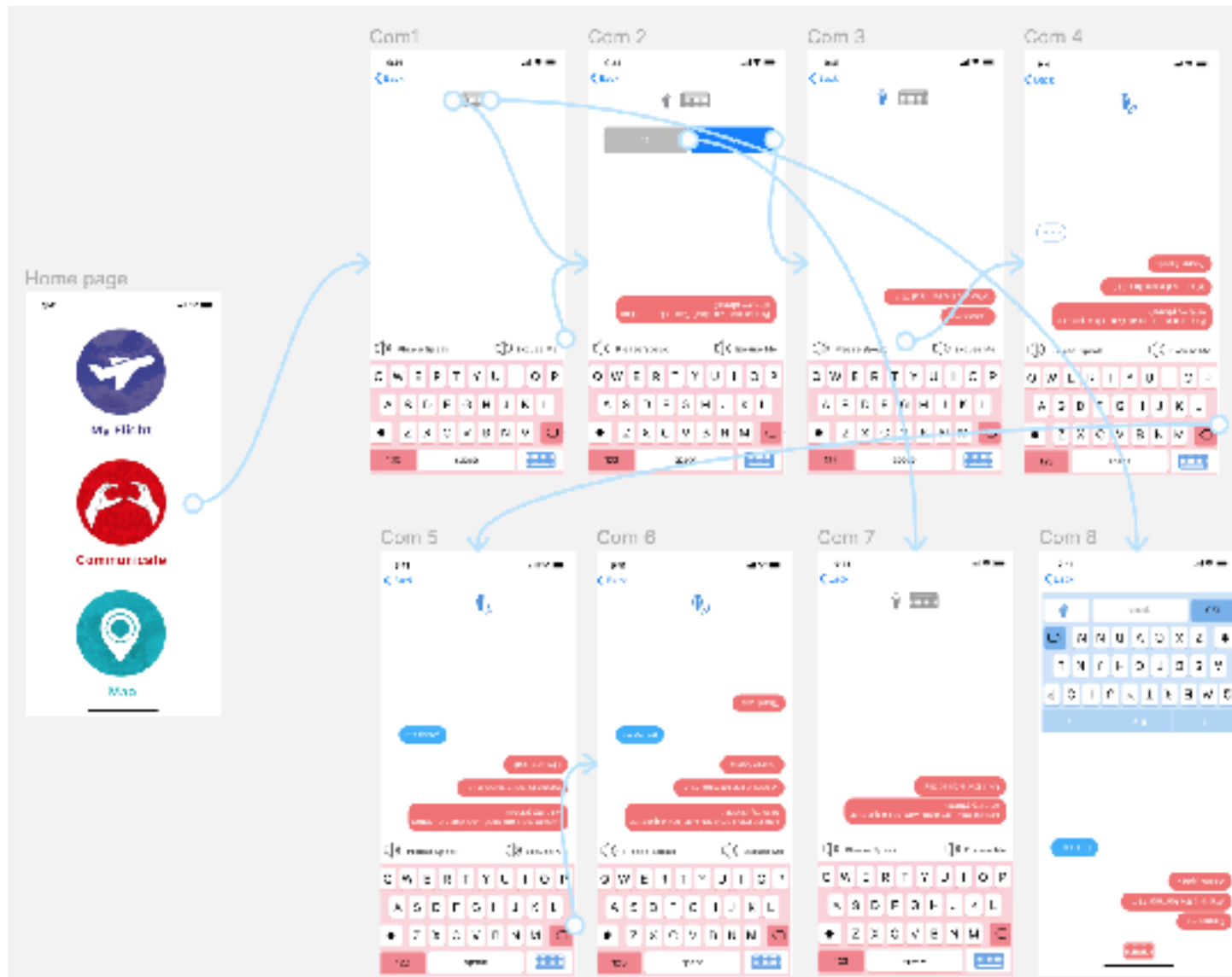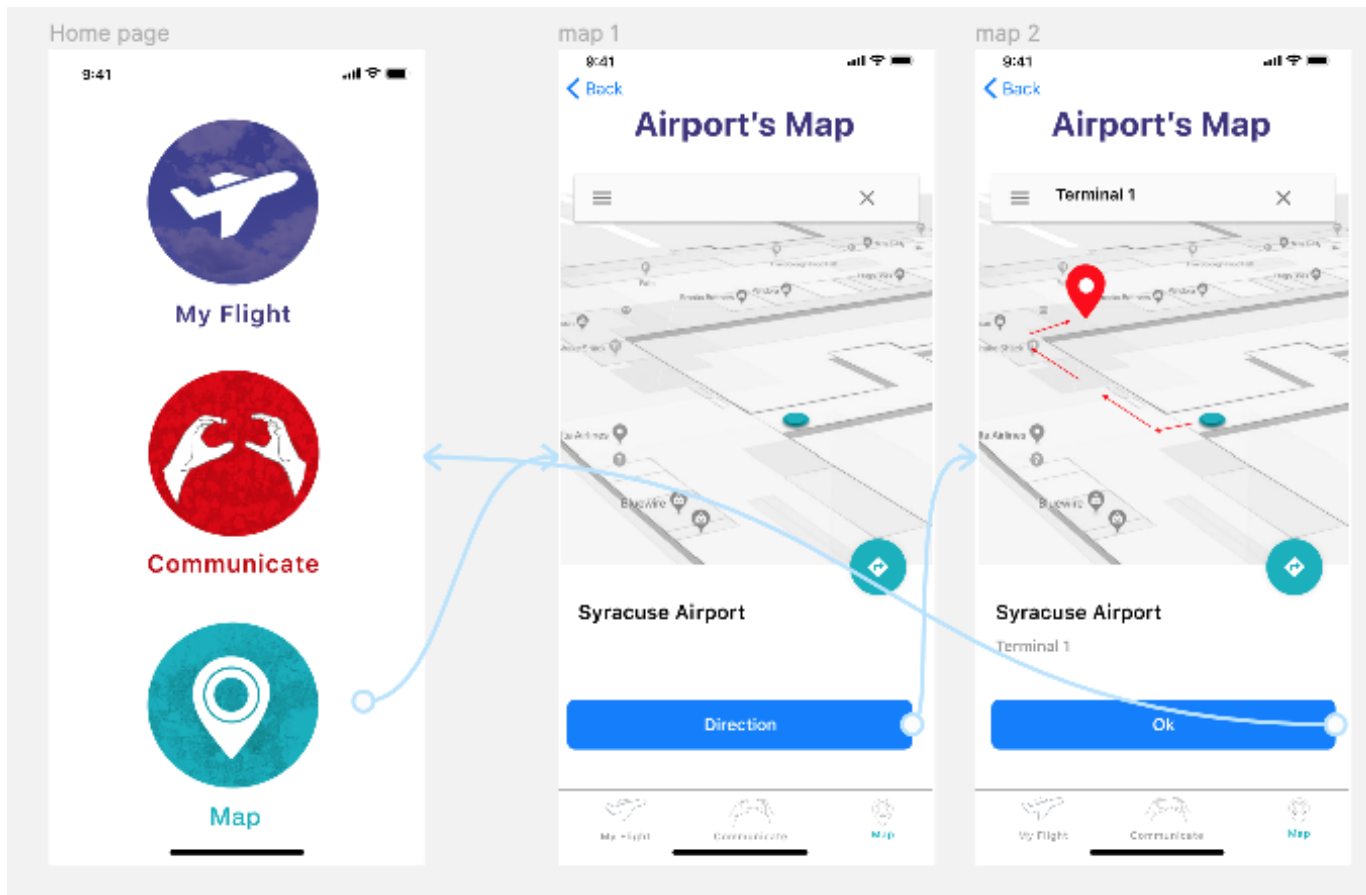
Figure 3.13 . Simulated Hear Here application developed, the Map Page, using the design platforms called Figma and Protopie.
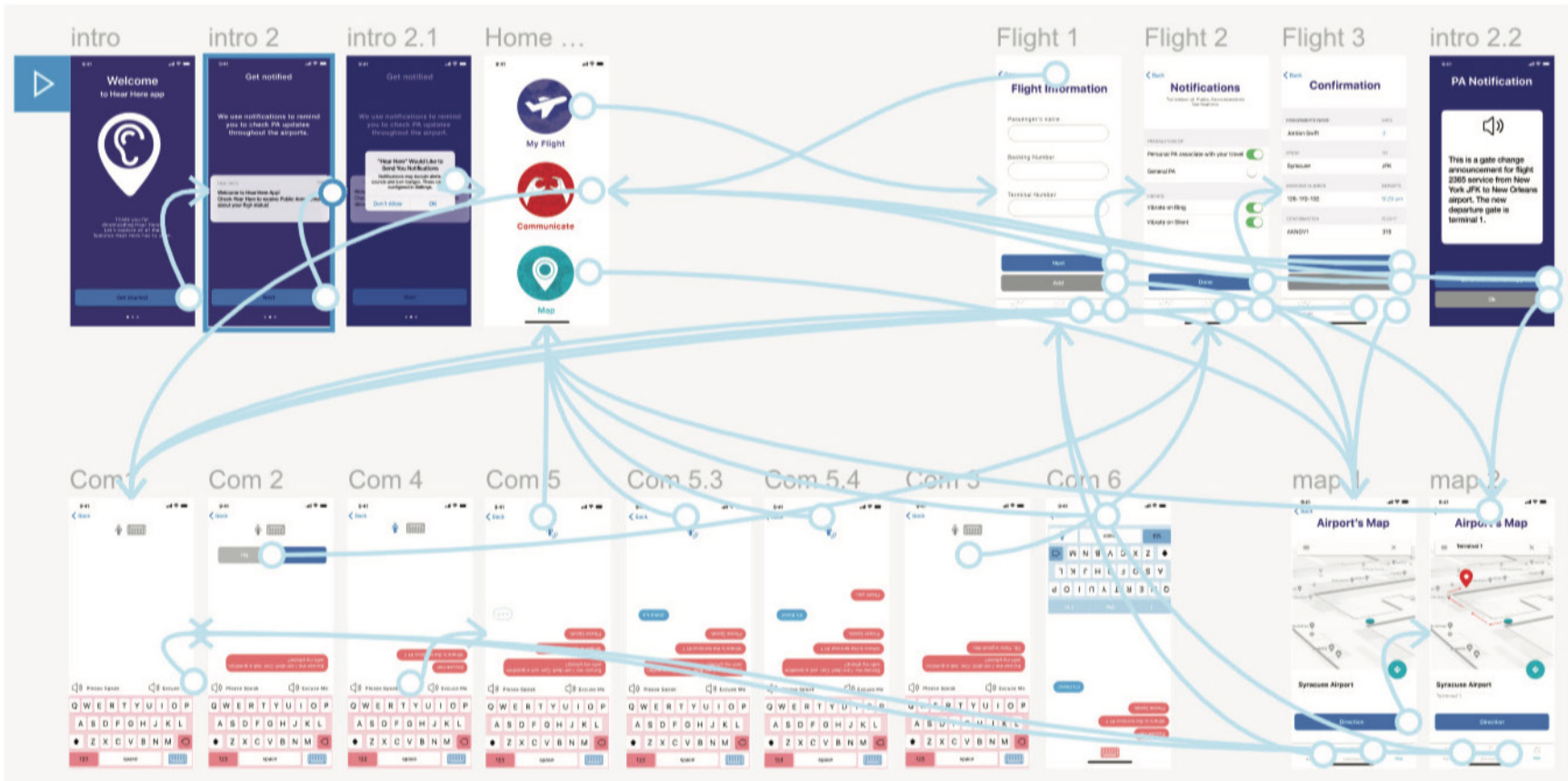
Figure 3.14 . Simulated Hear Here application developed using the design platforms called Figma and Protopie

CHAPTER 4

Discussion

This thesis aimed to expand understanding about that challenges that Deaf and hard of hearing travelers experience in airports, and to develop a design intervention that improves their experiences. This section outlines the challenges and constraints of this design research, discusses the implications, and provides recommendations for continuing and enhancing this

Challenges and Constraints

From the beginning to the end, the design development of the Hear Here app faced various challenges and constraints. It was a challenge to find Deaf and hard of hearing people to participate in the survey and the interviews. The Deaf and hard of hearing have a distinct culture and language that sometimes felt very guarded by the participants. That said, finding a way to "enter" their community as a design researcher was difficult. Because of that, one of the limitations of this project was finding a sufficient number of Deaf and hard of hearing participants to fully inform the research and effectively guide the design process. To advance this design work and prepare it for market, it is necessary to conduct user testing with more participants, and perhaps beyond those in the United States and specific to English-based communication.

Another challenge was completing a working prototype. Testing a fully operable version of Hear Here in airports with actual Deaf travelers would provide more accurate feedback. This is surely a necessary step to refine the app and to prepare it for market.

Another challenge is that not all people have access to smartphones. Though the 36 participants who responded to the survey reported having and using smartphones, it should not be assumed that the majority of Deaf and hard of hearing people in the United States do. This is important to address since the design intervention of this thesis resulted in a tool that relies on smartphone technology. Without the proper device, some Deaf and hard of hearing people would not be able to access the tool. To ensure that all people have access to the Hear Here app, airports might consider providing Deaf and hard of hearing people with short-term use of devices that can operate the application and companion their travel experience from departure (point a) to arrival (point b).

Implications

One major implication of this design research is legally-related. Airports may have an obligation to provide tools such as the Hear Here app. The Americans with Disabilities Act (ADA) is a law that requires public facilities to be accessible to all. This includes making airports and terminals accessible. It does not say explicitly what the airports must do. But, the Hear Here app arguably provides sufficient communication access. ADA (2011) explains how Title II and Title III support that the Hear Here app should be available to Deaf and hard of hearing people by law.

Title II prevents discrimination and the denial of access to services, activities, and State and local entities, regardless if they receive federal funding. Title II is clarification and strengthens Section 504 of the Rehabilitation Act. If an airport is a public utility run by a state or county, Title II applies. Title III provides clarification to the Rehabilitation Act of 1973 regarding equal access to goods and services through e-commerce, access to information via the web, and for private businesses that do not receive federal funding and are not providing State or local services to the public. Technology has changed since the creation of the initial equality acts; the intent of the acts remains the same, to provide equal access for all Americans. The Department of Justice delivers enforcement over the private sector the same as the government sector. So if the airport is a privately owned business, Title lll applies.

In any case, all airports in the United States must comply with ADA. According to the ADA laws, adequate communication access for people with disabilities is required in public places, and the Hear Here app would help the airport fulfill its legal obligation.

It is also important to note that the Hear Here app benefits exceed those specific to airline travel. Though this work ultimately focused on enhancing the experiences of Deaf travelers in airports, the tool has several implications for navigating other public environments such as bus stations, subways, hospitals, even schools.

Conclusion

This project is one of the most challenging but exciting projects I've ever developed, and there is still so much that can be done to continue this meaningful work. Learning American Sign Language (ASL) allowed me to enter another world and to connect with my participants. The ASL of the Deaf community shared intimate aspects of their social and cultural life and helped me immensely at all stages. The experience of this work has provided first-hand insight that the Deaf community and the challenges they experience traveling have not been given the necessary attention by researchers and designers. Even though, fewer than one in 20 Americans are currently Deaf or hard of hearing (Mitchell, 2005). In round numbers, nearly 10,000,000 people are hard of
hearing, and close to 1,000,000 are functionally deaf (Mitchell, 2005).

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As a design researcher, this thesis has made it clear that the problems and issues that the Deaf community experience when traveling are simply not fully recognized. Part of the problem might stem from discomfort that Deaf and hard of hearing people people may have in expressing or communicating their experiences and concerns to the degree that they should. This may be especially true regarding problems associated with transportation. In 2006, airlines received about 14,000 disability-related complaints. Approximately 200 of these complaints were filed by Deaf, hard of hearing, or deaf-blind individuals. The U.S. Department of Transportation (DOT) received only 430 disability-related complaints in 2006 and only 480 disability-related complaints in 2007, and does not report the number of complaints filed by people who are Deaf, hard of hearing, or deaf-blind. Filing complaints and comprehensive reporting is critical if changes are going to be made to improve the travel experience for Deaf and hard of hearing people. For instance, if complaints are received, DOT can investigate complaints received and can enforce the laws that apply to airlines. When DOT does not hear from consumers, they are not aware of the issues and the problems continue.

This thesis aimed to improve the experiences of Deaf and hard of hearing travelers. The design intervention that resulted from this work was a smartphone application that enhances access to communication and navigation in airports. However, this is only a fraction of design interventions that might possibly respond to the problems. This thesis is a call for more design researchers and professionals to take an interest in this topic and to expand work in this area. More than anything, this thesis demonstrates how continued work on this topic requires participation of and insight from the Deaf community (especially for helping researchers who can hear to better understand the challenges and needs).

In conclusion, the Hear Here app contributes to a growing set of consumer technologies that consider accessibility an asset, rather than an inconvenience. In a way, this reflects a shift (however slight) towards social and cultural growth and heightened empathy towards all abilities. No longer perceived as eternal victims of circumstance whose only desire is to communicate with the hearing world, tomorrow promises an ethos where Deaf individuals are embraced as average Americans seeking ways to make life more simple, pleasurable, and fun. where Deaf individuals are embraced as average Americans seeking ways to make life more simple, pleasurable, and fun.

Appendices

Questionnaire

15-minute, online anonymous questionnaire

1.   Are you 18 years or older? (YES or NO)

2.   What is your gender? (Multiple choice with an additional 'Other' and 'Prefer not to say' options)

3.   Do you use a handheld device that uses data and WiFi (i.e. smart phones, smart watch)? (YES or NO)

4.   What term best describes you? (Multiple choice with options provided as follows: deaf, very hard of hearing, somewhat hard of hearing, and 'Other' option)

5.   What is your main method of communicating with members in your community (i.e. family, friends, neighbors)? (Short/Long response answer)

6.   What is your main method of communicating with the general public receptively? (Short/Long response answer)

7.   What is your main method of communicating with the general public expressively? (Short/Long response answer)

8.   What method do you use to navigate around your town or city? (Short/Long response answer)

9.   What kind of public transportation do you use? (Check all that apply)

10.   Have you ever been in a bus/train station and seen people react to an announce
         ment that you did not hear? (YES or NO)

a.   If yes, how did you react? (Short/Long response answer)

11.   What method do you use to communicate with someone in an airport or bus/train
         station if you want to ask them what an announcement said? (Short/Long response
         answer)

12.   How often do they understand your question? (Multiple choice with options
          provided as follows: never, occasionally, sometimes, often, always, and 'Other' option)

13.   How often do you understand the answer they give you? (Multiple choice with
          options provided as follows: never, occasionally, sometimes, often, always, and 'Other'
          option)

14.   When you ask a question to a random person, do you think they act normal or do
         they show they are not interested in answering you? (Short/Long response answer)

15.   If people are often not interested in answering your question, why do you think they
         don't want to? (Short/Long response answer)

Interview Protocols

Assessment questions given to participants during the one-on-one interview. Participants
will be given context to the motive creating such an application for hard-of-hearing people.
Context: Developing this application allows those hard of hearing to easily navigate through-
out public spaces, specifically public transportation environments. Within these spaces,
there are public address system (also known as, PA system) available to those in attendance.

This device would constantly update with information vital to making trips stress-free; however, it fails to address those hard of hearing.

Design

1.   Upon navigating the application, one could identify that there is a speech-to-text mechanism among other tabs available to provide additionally information in the public transportation space. What impressions do you have about the application? Could you easily identify the outline to the app and its predicted functionality?

2.   What ways would you improve the user experience in the website? In other words, what other designs would allow hard of hearing people to easily navigate the website to ensure they constantly are being updated about public transportation information?

Features

3.   Apart from design of the app, features are a vital component to the overall user experience. Besides the speech-to-text mechanism, what other services do you think should be added to the app to further guide those hard of hearing in these public spaces?

4.   Given that the application would be used mostly in airports, what types of questions would mostly be asked in this environment?

Beyond the proposed application

5.   How does this compare to devices that you've seen or used? If you can identify another application with similar capabilities, could you provide how this app satisfies the needs of a hard of hearing individual.

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