CMSC 20370/30370: Inclusive Technology: Design For Underserved and Marginalized Communities GP1

Project Proposal

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An overview of the user group you are focused on and the problem or issue you are tackling and why an interface or system is necessary to solve it. If technology is not currently being used in the scenarios you are examining, then explain why. Explain what your research questions are and what you aim to learn about the user group you have chosen and the problem space.

We are focusing on how people who are deaf and hard of hearing navigate life on the University of Chicago campus, particularly when they are on the go. While people who are deaf and hard of hearing have a multitude of mechanisms through which they navigate their environment, in some situations hearing impaired people experience less situational awareness as a result of limited audio input. This could pose safety issues or inconvenience. In our research, we will consider the task of navigating around outside on the UChicago campus and Hyde Park, for example when students and staff walk between buildings on the quad, or head to restaurants in downtown Hyde Park at night.

Current technology for people who are deaf and hard of hearing emphasizes tools to construct an environment compatible with hearing impairment but doesn't do as much to support users as they enter hostile environments. Our focus will be on the latter effort, which acknowledges that many environments, including spaces on the UChicago campus, are not accessible for hearing impaired people. This technology could include a wearable piece of technology or an interface connected to an existing device like a mobile phone.

Our device will also focus on providing some of the most important audio input which increases situational awareness when deaf and hard of hearing people navigate UChicago. In particular, we will focus on audio input that is necessary for the safety of the user. For example, our device might inform the user when their name is being called or they are surrounded by sirens or shouting.

In our research, we are interested in learning in what form and under what circumstances people who are deaf and hard of hearing at UChicago might benefit from technology which improves situational awareness. Specifically, we want to uncover:

- What do people who are deaf and hard of hearing find easy and difficult about navigating the UChicago campus?
- What strategies do people who are deaf and hard of hearing have for navigating the UChicago campus? What technologies aid in these efforts?
- What kinds of technological assistance could improve the safety of people who are deaf and hard of hearing at UChicago when they are navigating campus?

Discuss the methods you will use for collecting data about your users.

We will use semi-structured interviews to reach out to people who experience the problems associated with limited auditory input and discover how they are currently navigating UChicago and what opportunities exist for technology to improve their safety.

We will also use a short survey to reach a proxy user group to bolster our interview data. Specifically, we will send a survey out to students who limit their environmental audio input by wearing headphones around campus. We will use this survey to determine under what circumstances these users have faced safety issues when navigating the UChicago campus.

State why you chose these methods over other possible methods.

We do not anticipate having a very large sample size to gather from, so we want to get a large amount of data from each participant. Video interviews will yield the most amount of data per individual. We will use a semi-structured format so that our conversations cover all of the points we are interested in and have some consistency across interviews, but allow flexibility for us to probe into ideas and concerns brought up by our interviewees. Data collection from proxy users will allow us to gather more data and could help us cover a wide spectrum of hearing limitations such as distracted users listening to music. Since the value-add of these efforts hinges on larger n's in data collection, we will send out a short survey rather than engage in interviews with this population.

Describe the type of data you will collect (interview, observations, participant observation, surveys, etc)

We will collect long-form video interviews, a short survey, and video demo unit trials (including an interview portion) on willing participants.

Detail the number of participants you intend to have, the length of time you will spend with them and what kinds of questions you will ask or activities you will perform and why.

For the initial interviews, we will spend about 1 hour with interviewees. We hope to recruit at least 3-5 people for interviews. Since we expect recruitment for the interviews to be difficult, we

want to get as much data as possible from our interviewees without asking too much. We will ask questions about their experience on campus and their current strategies for coping with hearing impairment. We will also ask questions about design suggestions for technology to improve safety.

For the survey, we will ask about if and when headphone-distracted users feel unsafe on campus. We will ask for technology design suggestions here as well, since the development will likely benefit both the proxy and the target user group. We will keep the survey short in order that lots of people will be willing to participate and because this is not our target audience, but rather a supplement to the interview data. We expect to get data from 20-30 headphone users.

In the demos, we will spend 30-45 minutes with a user. The user will spend some time interacting with the device before we will ask open-ended questions about their experience with the device and suggestions for future design iterations. We hope to do demos with some of our interviewees, and supplement the user population with some proxy users such that we have at least 5 people demo our prototype.

Discuss how you will record the data

We will record the interviews with in-laptop recording software or a physical camera. We will record survey data through a google form. We will record user tests with in-laptop recording software or a physical camera.

Describe how you will analyze the data

We will annotate the video interviews, develop a codebook from a sample interview, and develop the codebook as we go through all interviews. We will then group our codes such that each group will answer a different research question. Finally, we will group the codes such that each one addresses a different design idea.

For our survey we will use basic descriptive statistics to get a sense of how the distracted headphone-wearers at UChicago navigate campus. With our open-ended question, if we get enough responses we will code these questions and do a similar analysis to our other qualitative (interview) data.

Finally, with user feedback from demo designs we will transcribe the videos and generate a codebook from a sample user test and then develop it as needed alongside the remainder of our user tests. We will then group codes by themes in design successes, themes in design failures, themes in design suggestions, and themes in how the user actually used the device(s).

Describe the important characteristics of users you are studying (e.g. are you studying a particular age group, or demographic, and why?)

We are studying hearing impaired people at UChicago, considering a wide spectrum of people from deaf people to hard of hearing people. We will consider anyone who identifies as hard of hearing so as to create a product that is widely usable and positively impact as many people as we can. We are interested in this population because we feel that it is underserved. While hearing-impaired people find ways to successfully navigate the world, many spaces and activities at UChicago are not welcoming to people of differing abilities, particularly hearing-impaired people. By improving the capacity for hearing impaired people to navigate the UChicago campus, we will help make the campus a more welcoming place for hearing impaired people which might contribute to amplifying diversity among all roles (student, staff, contractors) at UChicago.

We are limiting our research to users at UChicago so that the spaces navigated (UChicago, Hyde Park) are left constant and our technology can focus on the specific safety issues that are experienced in this environment. Further, we can actually access and navigate these spaces ourselves in our design process and evaluation process, and we can access the user group with ease. We are not limiting our research to only students because while we want to keep the environment constant, we want our technology to be widely usable and we want to collect as much data as possible. We also believe that the situations we are considering--navigating campus especially outdoors and emergency situations--will often be universal to students, staff, and professors.

We also believe that our safety-focused technology might improve safety for a broader population of students on campus. For example, we are using distracted users who are wearing headphones as a proxy user group. Although our design is focused on deaf and hard of hearing individuals, if it is usable by distracted users, then accidents between distracted users and others (cars, pedestrians, bikes, etc) could be reduced.

Describe the tasks that users are performing and which your solution will support:

The task we are considering is navigation around UChicago campus and Hyde Park, maintaining situational awareness especially in emergency situations.

A description of the important characteristics of the tasks performed by users in the problem space you are examining.

Importantly, we are interested in situations when users are navigating campus amidst audio that is of extreme importance; for example, in an emergency situation. This involves ensuring that users have adequate information, whether visual or tactile, about their surroundings in order to

remain safe and aware of important (and/or dangerous) situations. The task space will be mostly outdoors in places where there is a lot of ambient noise. One of the main issues we will address with our technology is what audio input from within this ambient noise is necessary and/or desired by the user and what audio input is not. A major pitfall of many existing technologies is that they might overwhelm the user with notifications of surrounding noises.

The tasks performed will be everyday navigation, and we will ask users to demo our device on what they consider a normal daily walk, whether it be from class to dorm, from work to apartment, or from an RSO activity to a dinner on 53rd street. We hope to consider walks in many different parts of campus and at different times of day.

A description of the important characteristics of the task environment in which users are engaged in the task (e.g. lab, mobile, on the go etc).

Our environment is focused on the University of Chicago campus and Hyde Park. Thus the task environment is strictly on the go/ in movement however our final solution may involve introducing a new task environment such as using a smartphone app or wearable. The environment will include ambient sounds as well as more important sounds like sounds from other people talking to or near the user as well as cars and sirens.

An analysis of existing systems that address the problem or how users currently address the problem if none exist. Detail the strengths and weaknesses of existing systems.

ALD's, Cochlear implants, Hearing aids

These systems enhance hearing and awareness in all everyday activities. These devices are easy to use in that once in place, the user does not have to adjust them much (except for turning hearing aids on and off if desired). These devices are a clean solution to the issue of lack of audio input in that they simply increase the capacity of the person to hear. They have a simple conceptual model and in the case of hearing aids actually give the user new hearing capacities in that the user can turn the hearing aids up or down depending on the situation.

That said, these devices can be very expensive and thus are not easily accessible. Further, not all deaf and hard of hearing individuals want to use this strategy because, for example, they might be used to not hearing or strongly compelled to remain in the Deaf community without any hearing abilities.While hearing aids and cochlear implants can improve sound recognition, they generally do not help the wearer localize sound as well.

Communication Access Real-time Translation (CART) that translates speech to text

This is good for singular conversations or taking phone calls, allows for more freedom for deaf and hard of hearing individuals (don't have to rely on other translators or to only have conversations with people who can sign, etc). However, it can be very difficult with several audio inputs, which means this technology doesn't work in the ambient outdoor on-the-go spaces that we are looking to address

Google Glass (Word Lens)

This system displays speech said into text and translates, which is good for singular conversations or taking phone calls and allows for more freedom for deaf and hard of hearing individuals (don't have to rely on other translators or to only have conversations with people who can sign, etc). However, it requires Google Glass (which is discontinued and expensive), and may not work with multiple audio inputs coming from the surroundings, which means this technology doesn't work in the ambient outdoor on-the-go spaces that we are looking to address

Devices that use lights or vibrations as an alert to replace audio (i.e. visual alarms)

These devices are good for emergencies or important audio input. Vibrational devices deal with the issue that sometimes tech relies on flashing lights or other visuals that might not work if the user is asleep or simply facing the wrong direction in a room. These devices are widely used and thus comfortable/familiar to deaf and hard of hearing individuals. However, lights can pose issues when the user is not in a productive position to receive this information, for example when the user is asleep or outside. Lights and vibrations can lead to sensory overload if too many sounds are relayed to the user.

Captioned telephones and TV's

These allow users who can read to communicate via phone and watch TV in regular life, they are easy to use and understand, and addresses speech to text without issues of multiple audio sources. Nonetheless, this doesn't address navigating campus, and is only accessible to users who can read and/or have strong vision. These devices also require users to be fully attentive to the TV or phone call since they might miss something if they look away for a moment

Sonocent software

This software allows users to take notes in class when notes are delivered via audio, and effectively sorts different kinds of noise (ambient class noise vs lecturer). However, it is a complicated system to use, and has many features which can be overwhelming and are not easily discoverable

A description of relevant literature on the problem (if any) and any other social or technical considerations that affect the problem space and or the users you are studying (e.g. if you are studying kids, you need to take into account their parent's behaviors too).

Importantly, literature on designing campus spaces for deaf and hard of hearing users often relies on what are called the DeafSpace Design Guidelines. These guidelines include the following: Sensory Reach, Mobility and Proximity, Light and Color, Space and Proximity, and Acoustics. Sensory reach describes the area of one's surroundings that may not be immediately apparent to many hearing people through an acute sensitivity of visual and tactile cues such as the movement of shadows, vibrations, or even the reading of subtle shifts in the expression/position of others around them. Mobility and Proximity guidelines indicate that occupants of the space should be able to move such that they can maintain a wide visual range such that they can stay alert for hazards while also communicating with others. Light and Color guidelines indicate that light should not obstruct visuals (e.g. via glare), rather the space should support robust visual communication. Space and Proximity refers to the capacity for a deaf or hard of hearing individual to view the full body of the person with which they are communicating. Finally, Acoustics guidelines indicate that spaces should not increase issues with distracting or overwhelming noise experienced by deaf or hard of hearing individuals who wear hearing aids or have cochlear implants, for example by preventing echos or reverberating sounds.

In the paper "Exploring Sound Awareness in the Home for People who are Deaf or Hard of Hearing" the researchers identified a few major design areas for sound awareness. Actionability, Trust and confidence, Privacy, Information overload, Contextualized feedback, and System installation. Actionability describes the desire for the system to produce signals that are useful to the user, if the user receives feedback from the system that the user does not find actionable the system becomes overbearing and distracting. Trust and Confidence describes the need for the system feedback to be accurate, this is ultra imperative to maintaining a sense of safety while using the system. It may be better to give many accurate non-actionable signals rather than a singular inaccurate actionable signal. Privacy was a large concern especially in the domicile environment, but will likely be less of a concern in the work/commuting space. Information overload and contextualized feedback refer to the users understanding of the signals. And finally, system installation refers to the ease of setup and how quick a user can go from not using the system to using it.

An important social consideration for this work acknowledges that UChicago wasn't designed with the deaf in mind (i.e. using DeafSpace guidelines) and thus can pose as a barrier for those who are deaf and hard of hearing. This implies that it might be upsetting to users who we interview to talk about challenges on campus. We also will likely discover that the deaf and hard of hearing population at UChicago might experience many accessibility issues that we as the researchers could not have anticipated. That being said, UChicago does provide certain

accommodations for deaf and hard of hearing students through the office of Student Disability Services.

Finally, research into 3D sound localization shows insight into (a) how the issue of audio inputs to improve situational awareness might be resolved but also (b) how difficult this task really is. Although many current designs naturally rely on this technique (i.e. Jain et al, HAUNT), sound localization is still only somewhat accurate and often struggles with multiple audio inputs, especially when these audio inputs are of the same pitch/tone/volume. Furthermore, this technology must be wrapped up in an otherwise well-designed device in order to be usable.

A list of the initial evaluation criteria for your eventual design to determine if is a success or failure drawing from usability principles we have learned in class as well as what data you will collect to see whether your design meets these criteria

Data on criteria (numeric bullets) will be collected through questions/responses (alphabet bullets) listed below. Questions with "yes" or "no" answers can be coded as numeric and basic descriptive statistics can be used to analyze these areas (for example, in evaluation criteria 1 below). Other data will be transcribed and analyzed qualitatively, with answers grouped by evaluation criteria. If they are not immediately answered by the user, the questions below will explicitly be asked in the user demo interview.

1. **Usefulness**: The level to which the target demo found the system to be useful to their life.
    a. Did the user say they would use this system in their life?
    b. Did the user think that the system might be useful for other people?
    c. Did the user think that the system was redundant with existing devices or strategies?
2. **Solution:** The level to which the target user's safety was improved by the device.
3. **Intuitiveness:** The level to which the target demo found the design intuitive/easy to use.
    a. Was the device usable without instruction?
    b. Was the device used successfully?
    c. Did the user feel frustrated when using the device?
4. **User Experience:** The level to which the target demo user was excited about the possibility of such a system, and willingness to continue using it.
    a. Did the user express enthusiasm when using the device?
    b. Did the user say they would actually use this device in their life?
    c. Did the user state they had a positive or negative experience when using the device?
    d. Did the user see the potential for the design (e.g. present slight modifications) or think it is off track (e.g. present an alternative design solution)?

We will also ask for and record all pros and cons that the target demo found when using the system, and use this data to analyze the degree to which we are meeting the evaluation criteria as listed above.

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Appendix: Interview & Survey Guide

Semi-Structured Interview Questions

1. How are you doing today?
2. What is your occupation?
3. What does a regular day look like for you? What kinds of activities do you engage in?
4. Can you tell us a little bit about your level of hearing?
5. What are some challenges that you experience when navigating campus, Hyde Park?
    a. [if not covered] Do you ever feel unsafe when walking around campus or Hyde Park? If so, can you explain when and why?
6. Are there devices that you currently use to cope with your level of hearing?
7. What do you like about them?
8. What do you dislike about them?
9. [if not covered] Are there devices that you use to improve safety when walking around campus, Hyde Park?
10. If you could invent any device(s) to help navigate, what would it be? Regardless of if it is technologically feasible currently.

Survey Questions for proxy users

1. Do you use headphones when you walk around campus or Hyde Park?
2. At what level do you play your music?
    a. (1) can hear most things
    b. (2) can maintain a conversation but can't hear ambient noise
    c. (3) can hear most medium to loud sounds like raised voices and close by noises
    d. (4) can only hear loud noises like shouts or sirens
    e. (5) can't hear anything
3. Have you ever felt like your safety was endangered while wearing headphones?
    a. yes/no
4. If so, describe an example.
5. Are there situations where you don't wear headphones for safety reasons?
    a. yes/no
6. If so, describe an example.
7. Is there any kind of audio input you wish you could get information about while wearing headphones? (for example, sirens or your name being called)
    a. yes/no
8. If so, describe an example.

9. If you could invent any device(s) to help navigate while using your headphones, what would it be? Regardless of if it is technologically feasible currently.

Demo Test Questions / Prompts

1. How would you expect to use this device in your day-to-day?
2. What do you think about the device?
3. How useful do you think it is?
4. How easy or intuitive is it to use?
5. Could you see yourself benefitting from this device?
6. Are there changes you would make to the device?
7. *gives instructions* Does this change your answer to any of the previous questions?
8. Which devices do you like or dislike?

THE UNIVERSITY OF CHICAGO

Version: 1.0

Consent Form for Research Participation

Study Number:
Study Title: Developing Technology for Individuals who are Deaf and Hard of Hearing at UChicago.
Researcher(s): Ni'Gere Epps, Benjamin Prevor, Mercedes Wentwirth-Nice, supervised by Marshini Chetty

This is a consent form for research participation. It contains important information about this study and what to expect if you decide to participate. Your participation is voluntary.

Purpose: We are conducting research with the intent of developing technology to support people who are deaf and hard of hearing at the University of Chicago. Our goal is to learn how people who are deaf and hard of hearing navigate the University of Chicago and Hyde Park and what strategies they have for navigating spaces at the University of Chicago and in Hyde Park. We believe that by using this research to develop relevant and useful technology, we can improve the safety and comfort of people who are deaf and hard of hearing and promote diversity and inclusion at the University of Chicago.

Procedures and Time Required: "You will be asked to participate in one 45-minute interviews in-person or over video call. With your permission, the interviews will be video-recorded. You may withdraw from the interview at any time."

Risks and Benefits: As applicable. If no direct risks, indicate, "Your participation in this study does not involve any risks to you beyond those of everyday life. Taking part in this research may not benefit you personally, but we may learn new things that could help others."

Confidentiality: Video and audio recordings of videos will under no circumstances be shared beyond the three primary project researchers. Data from interview transcriptions may be included directly in reports and shared for future research, but any use of identifiers including names, addresses, or other personal information will be redacted in the transcription process. If you decide to withdraw from this study early, we will ask permission to use data collected up to the point of withdrawal in analysis.

Contacts & Questions:
If you have questions or concerns about the study, you can contact the researchers at mercedeswn@uchicago.edu or (267) 818-0420.

If you have any questions about your rights as a participant in this research, feel you have been harmed, or wish to discuss other study-related concerns with someone who is not part of the research team, you can contact the University of Chicago Social & Behavioral Sciences Institutional Review Board (IRB): phone (773) 702-2915, email sbs-irb@uchicago.edu.

Consent:
Participation is voluntary. Refusal to participate or withdrawing from the research will involve no penalty or loss of benefits to which you might otherwise be entitled. You will be provided a copy of this form. By signing below, you agree to participate in the research.

_____

Participant's Signature

_____ _____

Participant's Name (printed) **Date**

Optional Elements:

Yes	No	
_____	_____	The researchers may retain your contact information in order to contact you in the future to see whether you are interested in participating in other research studies.