

Design for Social Accessibility: Incorporating Social Factors in the  
Design of Accessible Technologies

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**Abstract**

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Design of Accessible Technologies

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Assistive technologies are intended to help people with disabilities accomplish everyday tasks. Yet, such technologies are traditionally designed mainly with functionality in mind, not with consideration for social situations of use. As a result, assistive technologies can be awkward-looking and socially awkward to use, leading to misperceptions about these technologies and their users. These misperceptions can impact users' sense of self-efficacy and self-confidence, leading assistive technology users to feel self-conscious when using devices in public or social settings, ultimately limiting access. Furthermore, most technology design approaches either assume accessibility is "someone else's job" or that functional accessibility is

the only focus, promoting an inclination to overlook accessibility in design overall and preventing designers from fully considering social aspects of accessibility.

In this dissertation, I present original empirical studies that investigate the social implications of assistive technology use. I conceptualize “socially accessible design,” and examine how to effectively incorporate social factors into user-centered design techniques. To address the negative and stigmatizing social perceptions associated with assistive technologies, I define *Social Accessibility* as a new property of accessible technologies extending our understanding of accessibility to include considerations of both functional usability and social situations of use. I present *Design for Social Accessibility* as a guiding perspective and a set of design tools and techniques emphasizing social factors in technology design. Through a series of design workshops, I demonstrate how designers can use Design for Social Accessibility by: focusing on functional usability and social situations of use; increasing awareness for how design can engender, rather than impede, access for people with visual impairments, particularly within social contexts; and working with users with and without visual impairments in assessing when design influences self-confidence and self-consciousness.

In this dissertation, I: (1) define social accessibility as a new property of technology artifacts that extends accessibility to include functional and social factors; (2) demonstrate that Design for Social Accessibility can help improve the design of technologies usable by people with visual impairments when applied to design methods by bringing awareness to designers about how design engenders or impedes access in functional and social factors of use; and (3) develop and verify a tool that can help designers assess the social accessibility of technology design. The contributions of this dissertation are conceptual—motivating the need for, and defining social accessibility and how it relates to functional accessibility; and empirical and

methodological—showing how social factors influence assistive technology use and access, and applying findings to increase awareness, change perspectives, and improve tools and techniques for the design of socially accessible technologies.

The thesis of this dissertation is:

*Design for Social Accessibility produces technology designs judged by people with and without visual impairments to be functionally and socially accessible, addressing feelings of self-consciousness and self-confidence in technology use.*

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# DEDICATION

To Tayllor, Brynn, and Miles

In memory of  
Sadako and Takeshi Sakata and Jean Satsuki Shinohara

## Chapter 1. INTRODUCTION

Personal technologies—laptops, tablets, smartphones, and wearables—are increasingly appropriated to reflect identity and stylistic preference, particularly when similar functionality reduces consumer choice to brand loyalty, technical inclination, or self-expression. For example, in Figure 1.1, the photographer remarks about the couple’s Apple and Lenovo laptop choices: “My guess: she’s a writer or an artist, or maybe works as an admin assistant for a theater group. He’s a consultant, or maybe works as admin manager for a government agency...” (Yourdon, 2009). Yet, most personal electronic devices are not usable by people with disabilities, who are instead limited to assistive technologies, devices designed to aid impairment, such as hearing aids for the deaf or electronic Braille devices for the blind. In contrast to mainstream personal technologies, assistive technologies are designed to provide access and accommodation, not to reflect identity and stylistic preference, although, as a type of personal technology, they can be perceived that way. We see this in the reaction of the photographer of the BrailleNote in Figure 1.1, who did not know what the device was as he described, “his screenless keyboard computer interface thingy... I really wanted to see what it felt like but I didn’t have the nerve to ask him” (Ganderson, 2008).



**Figure 1.1. Left, a couple sits side-by-side in the park on their laptops. She is using an Apple Macbook, he, a Lenovo. Right, the BrailleNote, a device with Braille input and output.**

Although the photographers' reactions to Figure 1.1 are an indication of how bystanders view different personal technologies, it says little about what a user might think. In an excerpt from her memoir, Laurie Rubin recounts a childhood experience that illustrates one user's perspective:

*"Laurie, are you able to hear me?" [Tasha, the teacher] asked, hesitating a little.*

*"Yep, I'm blind, not deaf," I said, intending to sound cheerful, though the laughter I expected from her and my peers didn't come.*

*"Oh, I know, Laurie, I just meant that you have your ear piece in."*

*My laptop, now plugged into an outlet in the very back corner of the classroom, had a synthesized voice telling me what was on the screen. In order to spare the others in my class the sound of its emotionless drone, I plugged a one-sided earphone into it, which allowed me to listen to the teacher and type notes at the same time.*

*"I'm glad you're able to hear me then," Tasha said with an awkward chuckle. "You just look like a robot all hooked up to your machine like that. I wanted to make sure you're with me."*

*I blushed, suddenly feeling like the kid with the pocket protector again. It was no wonder the others around me were so uncomfortable in my presence. I was an alien from outer space, a foreigner with some curious customs, and now, Tasha had voiced out loud that I was a robot, unrelatable, inhuman.*

*— Laurie Rubin (Rubin, 2012)*

In this scenario, Laurie's personal assistive technology is clearly linked to her identity, even though she did not choose to present herself as "a robot." The connection between technology and identity is undeniable; her technology contributed to a perception of her as unrelatable, leading Laurie to feel "inhuman" in a room full of her own peers. This scenario also highlights a key point: so many factors could contribute to the interaction described, the role of her assistive technology, its design, presentation, and use, had an inflated influence on how Laurie was perceived and identified. Laurie's story illustrates a common experience reported by people with disabilities when they use assistive technologies: that oftentimes, the differences in

assistive technologies from mainstream technologies contribute to socially awkward situations and incorrect perceptions, and lead people with disabilities to feel self-conscious, sometimes abandoning their technologies. Although current technology designs have improved, past studies have shown that between 24% to 56% of devices are abandoned or “disused” (devices not used, or used incorrectly), and up to 15% are never used at all (Hocking, 1999; Phillips & Zhao, 1993).

The growing presence of personal technologies in the social milieu means they are an increasing part of the social conversation about presentation, identity, personal expression, and style. Within this social milieu, assistive technologies can appear to be awkward-looking and socially awkward to use because most people without disabilities are not familiar with what assistive technologies do, and how and why they are used (Marcia J. Scherer, 1993a). In social situations when people with disabilities are out and about—at happy hour with friends, commuting on the bus, at work in the office or coffee shop—their assistive devices stand out when juxtaposed with popular “mainstream” devices, potentially marking users with disabilities as an “other” (Shinohara & Wobbrock, 2016). The implications for being marked as “other” can have negative effects on how a person feels, and can impact access—the very thing assistive technologies are there to provide.

I refer to “mainstream technologies” as those created for an assumed nondisabled audience. Assistive technologies are proprietary technologies created specifically for people with disabilities. Like the assumptions made about the devices in Figure 1.1, personal technologies have become one way to express and perceive identity. Meanwhile, the “special” label nondisabled people give assistive technologies means that such devices “mark” users as having a disabled identity, one with limited or no ability to use popular technologies (DePoy & Gilson,

2014). Aware of these pervasive attitudes, yet limited in options and in how they are identified, disabled users report feeling uncomfortable when using assistive technologies in social situations. Discomfort leads to limited use, even abandonment, resulting in decreased access (Hocking, 1999; Pape, Kim, & Weiner, 2002; P. Parette & Scherer, 2004; Phillips & Zhao, 1993).

This dissertation investigates how design impacts perceptions of accessible technologies and of the people who use them. I focus on the role of social perception in influencing use and access, and I offer strategies to increase awareness of, and consideration for, the role of social factors in accessible technology design. The notion that an assistive technology identifies a user as an “outsider” reflects the social value increasingly placed on digital, personal technologies. I argue that access can be impeded by non-functional forces, such as social situations, that create access barriers regardless of how functionally capable an artifact is.

A different perspective on accessibility is needed, one that extends the current function-centered view to include a social component grounded not only in utility but also in the ways users choose to identify and express themselves, whether through self-presentation or within social interactions. I extend the traditional conception of accessibility—typically focused exclusively on utility—to also include social factors like self-expression and the ways they affect how an artifact might be used. I call this design property *social accessibility*, comprising functional utility and social usability, which I designate as how an artifact operates functionally and in social situations, with a corresponding design perspective, *Design for Social Accessibility*, that can be used as a lens to facilitate socially accessible technology design. In this dissertation, I (1) define social accessibility as a new property of technology artifacts that extends accessibility to include functional and social factors; (2) demonstrate that *Design for Social Accessibility* can help improve the design of technologies usable by people with visual impairments when applied

to design methods by bringing awareness to designers about how design engenders or impedes access through functional *and* social factors of use; and (3) develop and verify a tool that can help designers assess the social accessibility of technology design. As a design perspective, *Design for Social Accessibility* has applications in assessing and informing design critique, method, and practice. In the course of this work, I demonstrate the following thesis:

*Design for Social Accessibility produces technology designs judged by people with and without visual impairments to be functionally and socially accessible, addressing feelings of self-consciousness and self-confidence in technology use.*

In the process of demonstrating the above thesis, I answer the following research questions:

- RQ1. What is social accessibility?
- RQ2-a. How does social accessibility inform design?
- RQ2-b. How can social accessibility be used in design? What is Design for Social Accessibility? What are its key ingredients?
- RQ3. How do designers engage with design methods infused with social accessibility? How can the social accessibility of a technology be evaluated?

## 1.1 UNDERSTANDING ASSISTIVE TECHNOLOGY USE IN SOCIAL SITUATIONS

### 1.1.1 *Assistive Functionality*

Assistive technologies range from non-digital devices like white canes for blind people to automatic video captioning for deaf people. Built off traditionally rehabilitative perspectives, assistive technologies tend to be created via a purview that places disability as an inherent problem in the body to be fixed or accommodated (that is, from the medical model of disability (L. J. Davis, 2010)). Rehabilitation engineering and related fields, such as occupational therapy

and physical therapy, drive innovative solutions in assistive technology development that address unique challenges faced by people with a variety of abilities. Solutions that ensure access to other technologies, services, and tasks for people with disabilities are essential to increasing access overall for people with disabilities. However, functional progress is often made without regard for personal or social preference, key factors in device abandonment (Hocking, 1999; Phillips & Zhao, 1993; Marcia J. Scherer, 1993a), and ultimately, inaccessibility. Thus, whereas mainstream technologies typically aim to improve or augment our daily experiences, the essential aim of assistive technology is to solve a problem of human functioning. A result of this perspective is that assistive technology is often focused on meeting functional impairments, overlooking social implications of technology use.

#### 1.1.2 *Social Implications of Using Assistive Technology*

People with disabilities participate in a social world as much as people without disabilities; amidst an increase in mobile technologies, our social lives are impacted more than ever by the technologies we use whether we are disabled or not. As actors in a social world, we are constantly gauging our self-identity with how we are presenting ourselves to others (Goffman, 1959). In any social interaction, an individual's presentation is one way to convey self-expression. For people with disabilities, the notion of self-presentation and perception by others—as social actors, but also as individuals with disabilities—plays an important role in social interactions with others. How we present ourselves to others is tied to how we want them to perceive us, within certain parameters: the social situation at hand, certain characteristics of ourselves that we cannot change, and certain attributes and behavioral characteristics that we may control.

Already usually “marked” for their disability, assistive technologies created in a function-focused approach can further impact perceptions of people with disabilities when devices are considered by observers to be “weird” or “clunky.” Bystanders may incorrectly reason why a person would use an assistive technology, and cast a misguided judgment on the user. People with disabilities, aware of social stigma around disabilities and presumptions associated with assistive technologies, might decide when and how to use their technologies based on these social expectations. If a user feels uncomfortable using their device in a given social situation they may alter their use of, or abandon altogether, their technology to avoid drawing unwanted attention, limiting or losing access (Hocking, 1999; Phillips & Zhao, 1993; Marcia J. Scherer, 1993a, 1993b). Therefore, although assistive technologies are created to provide access for people with disabilities to a variety of social interactions, daily tasks, or other information and services, the design of such technologies may impact the way such technologies are used. When this occurs, users are not benefiting from the technology.

Functional and social aspects of technology use influence access for people with disabilities. Specifically, social aspects of use may play a key role in access, highlighting that a more holistic approach to assistive technology design can benefit accessibility overall.

## 1.2 DESIGN FOR SOCIAL ACCESSIBILITY

The current technological landscape is rife with innovation for intelligent and automated computing capabilities, from virtual and augmented reality (Oculus Rift, HoloLens) to voice activated services (Siri, Cortana, Alexa), to self-driving cars (Über, Tesla, Google). These technical advances are clear opportunities for including accessibility in future innovations. Incorporating accessibility in the development of these next-generation technical solutions could alleviate many barriers to access for people with disabilities, create technologies usable by a

broader audience, and introduce accessible solutions into the fundamental technical makeup of future generations of technology development. Yet, assistive technologies continue to differ from mainstream technologies created for nondisabled users; technology design practices, including those focused on disability, do not seem to reliably produce accessible technologies aimed at inclusion along both functional and social dimensions.

Popular approaches to technology design include the design thinking paradigm (Brown, 2008) and the user-centered design methodology (Gould & Lewis, 1985). Foremost in recent technology design strategies is a focus on the user. At the same time, design perspectives for diverse users, like people with disabilities, either assume accessibility is “someone else’s job” or else is the only focus of design (Cook & Hussey, 2002; Cook, Polgar, & Livingston, 2010). Thus, despite a surge in design practices centered on people, there is an inclination to overlook users with disabilities in design overall, preventing designers from fully considering holistic aspects of accessibility. One way to address social aspects of assistive technology use is to incorporate accessibility in mainstream technology design as much as possible. Doing so enables people with disabilities to use technology that everyone else also uses, and eliminates some aspects of “otherness” a distinguishing factor of assistive technology design. How can we engage designers in truly empathetic design strategies that promotes awareness and a reshaping of the ways that we design future technologies?

The current paradigms affirm that inclusion is covered by “empathizing” or centering on the user, but I argue that inclusion should come before that. Instead, changing the way we think about design should start with the designer’s understanding of, and approach to, design. Thus, in this dissertation, I offer strategies to improve designers’ orientation to design overall toward an adoptable and inclusive design practice.

Specifically, I present a framework for Design for Social Accessibility, represented as a design space, that emphasizes the functional *and social* factors in design. I developed a set of method cards drawing on actual experiences people with disabilities reported in my prior work (Shinohara & Wobbrock, 2016), to prompt designers to consider how social contexts of use influence or are influenced by accessible technology design. And, I developed an evaluation tool to help designers assess the social accessibility of technology design.

The design space, method cards, and evaluation tool help frame Design for Social Accessibility as a design perspective that extends our understanding of accessibility and challenges our assumptions of what is accessible design and how it is accomplished.

As a design perspective, Design for Social Accessibility embraces the following tenets: (1) emphasizing that design work should include users with and without impairments; (2) incorporating social accessibility, focusing on both functional and social aspects of artifact design; and, (3) increasing designer awareness of these functional and social issues through reflection. Items (2) and (3) are facilitated through the framework, method cards and evaluation tool, all created to promote awareness and to prompt reflection on socially accessible design. Design for Social Accessibility can be used to shape and assess design outcomes on how functional and social factors influence self-confidence and self-consciousness by users with and without disabilities. For the purposes of scoping this research, my dissertation focuses on users with visual impairments.

Through the use of design workshops, I verify Design for Social Accessibility as one way to think about accessible design, and as a set of techniques that designers can use when creating socially accessible design solutions. I show that designers are able to work with disabled and nondisabled users simultaneously, that designers can use the Design for Social Accessibility

Framework to brainstorm and critique ideas, and that using the Design for Social Accessibility Method Cards helps increase awareness about social contexts of use. Finally, I validate the evaluation tool that designers, together with users, can employ to evaluate whether a technology is socially accessible.

### 1.3 CONTRIBUTIONS OF THIS DISSERTATION

In this dissertation, I define social accessibility and develop and validate Design for Social Accessibility as one way to address socially accessible design. In addition, I provide tools and techniques for designers to adopt this new orientation in their own design practice. Below, I outline the specific contributions of this work:

- A. I present empirical results showing how social factors affect accessibility at least as much as functional factors do;
- B. I describe conceptual work defining social accessibility and how it relates to functional accessibility;
- C. I contribute methodological work defining Design for Social Accessibility, a design orientation and a set of tools and techniques, that designers can use;
- D. I present empirical work validating Design for Social Accessibility and showing how designers relate to, and employ, a socially focused design perspective in their design work;
- E. I present empirical work validating a Design for Social Accessibility Evaluation Tool that allows designers to determine how socially accessible a given design is.

## 1.4 ORGANIZATION OF DISSERTATION

In this dissertation, I lay out the empirical and conceptual foundation for social accessibility and Design for Social Accessibility, and I demonstrate how Design for Social Accessibility can be useful for designers.

### 1.4.1 *Chapter 2 – Theoretical Foundations: The Design and the Social Stigma of Disability*

- My work is influenced by theories in Disability Studies and the social sciences around social identity and social interactions, and theories that define design thinking. This chapter discusses the theories of social behavior, including how we shape our self-identity, and then how we might choose to express that identity to others, through our presentation of self.
- In addition, I discuss Disability Studies, its models of disability, and how these perspectives influence my view on technology design.
- I cover a brief history of the disability rights movement, the motivation and trajectory of this civil rights movement through to the passing of the Americans with Disabilities Act in 1990, the ADA on technology development.
- I discuss design thinking, and how my understanding of design (and my use of design in this work) is influenced by design philosophies from Simon to Schön, including aspects of reflection-in-action and reflection-on-action, and the idea of “designerly ways of knowing” dictating a rigor and practice of design.

#### 1.4.2 *Chapter 3 – Related Work: The Design and Social Stigma of Assistive Technologies*

- I discuss the history of assistive technology and development, including how people with disabilities use assistive technologies.
- In addition, I discuss how occupational and physical therapy disciplines address matching person with technology.
- Human-Computer Interaction design strategies include several that focus on, or specifically may benefit, disability, including Universal Design, User-Sensitive Inclusive Design, Ability-Based Design, Design for User Empowerment, Participatory Design and Value Sensitive Design. I cover these in brief as they have influenced and informed directions of this work.

#### 1.4.3 *Chapter 4 – In the Shadow of Misperception: The Social Acceptance of Assistive Technology*

- This chapter describes initial research I conducted showing that people with disabilities felt others associated negative connotations with assistive technologies. Related to stigmas that might originate from social constructions of disability, these perceptions confirmed related work that found that negative meaning associated with (sometimes stigmatized) assistive technologies could lead to technology abandonment, and ultimately, loss of access.

1.4.4 *Chapter 5 – Defining Social Accessibility: Self-Conscious of Self-Confident? A Diary Study Conceptualizing the Social Accessibility of Assistive Technology*

- This chapter describes a diary study I conducted that investigated which design elements contribute to misperceptions, and how people without disabilities do perceive assistive devices.
- From the findings of this diary study, I derived the concept of social accessibility, a property of technology design that incorporates social and functional factors.

1.4.5 *Chapter 6 – Developing Design for Social Accessibility: How Designing for People with and without Disabilities Shapes Student Design Thinking*

- I describe formative work I conducted, while teaching undergraduate Informatics students, to develop the framework and tenets for Design for Social Accessibility.
- I describe the orientation of Design for Social Accessibility, a design perspective to facilitate a consideration for functional and social aspects in accessible technology designs. And, I derive three tenets for Design for Social Accessibility: (1) Working with users with and without disabilities; (2) Incorporating social as well as functional factors in design; (3) Incorporating a reflective process that builds on perspectives of disabled experiences. I developed a framework and set of method cards to help facilitate these perspectives.

1.4.6 *Chapter 7 – Design Workshops: Validating Design for Social Accessibility*

- I describe the workshops I conducted to validate Design for Social Accessibility, and report on the results of that work.

#### 1.4.7 *Chapter 8 – Evaluating Socially Accessible Design*

- I created and deployed an evaluation tool to assess the social accessibility of technologies. I recruited both assistive technology users and designers to evaluate a predetermined set of assistive technologies.
- Results showed that users and designers were able to assess technologies on design dimensions and social contexts of use. Recommendations are included for future work to evaluate in-person deployments of the tool.

#### 1.4.8 *Chapter 9 – Future Work and Conclusion*

- I end the dissertation with directions for future work and the contributions of this dissertation to the broader fields of Human-Computer Interaction, Accessibility, and Design.

### 1.5 SUMMARY

Ultimately, more can be done to improve the accessibility of new technologies, particularly through changing the way we address design in general. Not only has the landscape of technical innovation improved to make accessibility possible now more than ever, it embraces disabled users as part of the mainstream target user base (not as an afterthought), and it is the right thing to do. We can shape the future of accessible technology design now more than ever, but first we have to make the inclusion of diverse users as an essential part of the technology design process. In my dissertation, I define social accessibility to identify an as-yet ignored area of technology design, I uncover opportunities for incorporating social accessibility within design, and offer solutions to improve design practice by incorporating an emphasis in social accessibility, and developing tools that designers can use.

## Chapter 2. THEORETICAL FOUNDATIONS: THE DESIGN AND THE SOCIAL STIGMA OF DISABILITY

### 2.1 INTRODUCTION

In this chapter, I define the theoretical foundations that motivate social considerations in technology design for users with disabilities. Social Science literature, Disability Studies, and Design form the cornerstone of this dissertation; the intersection of these domains underscore the impact of assistive technology design in social situations. Unlike mainstream personal technologies, assistive technologies carry the baggage of an ableist tradition—a tendency to discriminate in favor of nondisabled people—sometimes borne out of social stigma. Yet, Disability Studies frames a critical approach to how such technologies are created, distributed, and used (Mankoff, Hayes, & Kasnitz, 2010). Ultimately, a Disability Studies framing motivates a change in how we engage design for the future.

As seen in the perception of Laurie looking “like a robot,” personal technologies have become one of a set of tools and behaviors that, intentionally or not, express and are used to perceive social identity (Carter & Grover, 2015). But, when nondisabled people designate assistive technologies as “special,” the devices “mark” users as having a disabled identity, with limited or no ability to use popular technologies (DePoy & Gilson, 2014). Aware of these pervasive attitudes, but limited in available choices, disabled users report feeling uncomfortable when using assistive technologies in social situations (Marcia J. Scherer, 1993a; Shinohara & Wobbrock, 2011). Discomfort, particularly in social situations, leads to limited use, even abandonment, resulting in decreased access (Hocking, 1999; Pape et al., 2002; P. Parette & Scherer, 2004; Phillips & Zhao, 1993).

In addition to specifying these theoretical foundations, I also examine the social forces we draw on to define our own identity, ultimately guiding our presentation of self to others. Then, I relate how personal technologies are harnessed as objects of self-expression. I situate disability, as a social construct and an identity, within the larger social phenomenon of disability in the United States, as it incorporates civil rights and equal access. I explore disability within the domain of design, beginning with identifying what design is (and is to me, in this dissertation), and how specific approaches to technology design may contribute to perpetuating stigmatization of people with disabilities. In doing so, I examine the current view of assistive technology within the critical tradition of Disability Studies and the reflective practice of Design. In applying socially constructed views on disability and on design, I conclude by arguing that mainstream technology design is either disability-specific or disability-excluding and that this dichotomy is problematic.

## 2.2 A ROLE FOR TECHNOLOGY IN SOCIAL IDENTITY AND SELF-EXPRESSION

Sociology and social psychology are disciplines focused on understanding issues of self-concept, identity, and social norms. These perspectives are uniquely poised to help disentangle what happens in social situations around assistive technology use. Understanding how self-concept and identity are co-constructed with social interactions sets the foundation necessary to study how identities and social interactions are influenced through technology use.

### 2.2.1 *Self-Concept and Identity*

Regardless of how technology is used and perceived as an artifact of self-expression, identity—the root of one’s expression of self—is constructed from social relationships and experiences. In turn, a person’s sense of self and identity motivates personal behavior and

individual choice in social presentation (Giddens, 1991, 1993). Understanding how sense of self and identity are constructed explains social protocol, attitudes, and behavior in social situations. In an essay about aspects of self and identity for people with disabilities, Christiansen argues that our sense of self is rooted in the meaning we derive from emotion, sensation, and thoughts. He states that identity is our shared sense of self, socially constructed (shaped by and shaping our relationships with others), and therefore, that identity is directly tied to both the way a person views them self, and the way others view a person (Christiansen, 1999). The human instinct to solicit inferential meaning from social interactions, the notion that “I wonder what she thinks I’m thinking...” contributes to the conceptual modeling of social situations (Tomasello, 2014). We take in what we see about others around us, including our reactions and their reactions, in a constantly running narrative of our position among other social players. Thus, identity is an understanding of our own life narrative, providing “coherence and meaning for everyday events,” (Christiansen, 1999) with the goal of attaining feelings of well-being, satisfaction, and happiness. Christiansen writes of identity “as the superordinate view of ourselves that includes both self-esteem and the self-concept, but also importantly reflects, and is influenced by, the larger social world in which we find ourselves” (Christiansen, 1999). The notion that people are social beings is at least two-fold. First, our self-conception is constructed through our own socialization; we get a sense of who are by learning who others are and how we think they perceive us. Second, to determine who they are (and our identity), we engage in social interactions with others, participating in communities that ultimately also reinforce identity.

We are who we are, then, because of who we are with; our social experiences drive how we self-identify and how we want others to identify us. Where self-identity may be derived of

the social situations one experiences, the collective conceptualization of the social narrative is an understanding of how the social world works. That is, the communities through which we identify ourselves shape our sense of “norms,” manifesting as what is typical or not within a social group. Driven also by moral, religious, legal, or political beliefs, this collective social sense contributes to our understanding of what is acceptable (Christiansen, 1999; Giddens, 1993; Mead, 1962). In turn, the understanding of what is acceptable in society drives how we frame our existence alongside everyone else, choosing to align ourselves within the acceptable, outside of it, or on the margins of it. We gauge our position within or outside of a community based on how we choose to identify, yet because our identities emerge from our social experiences, we also are aware of what is acceptable within the communities of which we are a part. People are driven by a conception of right and wrong, guided by individual moral compasses of expectations in society, and by a willingness to contribute to and participate in that expectation. In many cases, an individual may choose to rebel against the norm, convey expressions of individuality, or, in extreme circumstances, engage in immoral or illegal action (Potts & Scannell, 2013). But not all choose to exist outside the perceived accepted norm of a social collective. Indeed, oftentimes, it is not an individual’s desired identity that is recognized by others, but a social construction of identity judged against what is perceived as the norm.

Who we are is driven by how we situate ourselves socially, guiding our understanding of identity and sense of self. This symbiosis between self-identity and social norms is influenced strongly by experience and individual character, and guides how we present ourselves to the world (Christiansen, 1999; Goffman, 1959). Although we are socialized to understand norms, and co-construct our identities through engaging in our social communities, at the same time, these norms dictate acceptable behaviors, even identities, which can have material consequences.

These play out in how we interact with others, how others interact with us, what we wear, what we use, and what we do. The notion of a social norm creates a category by which difference is noticed and measured. How we present ourselves and how we might deviate from the norm includes all aspects of the self: not only our social behaviors and interactions, but what we wear, what we use, and how we incorporate such artifacts in our own self-expression. In addition, the prevalence of personal technologies in our daily lives means that such artifacts are afforded a role in how we express ourselves. How are these views reflected in the technical artifacts we use? In what ways do technical artifacts contribute to aspects of our identity that include ability and participation in the broader social world? I draw on these conceptions to emphasize that there are many ways to express our identity, and technology, what we use and how we might use it, has become one of them.

### 2.2.2 *Social Identity, Context and Personal Space*

We construct our identity based on social experiences and interactions with others (Tomasello, 2009), eventually employing the artifacts we use to convey identity to others. We choose how we want to present ourselves to others based on these experiences and interactions (Goffman, 1959). To understand our relationship to personal technology, and why it matters what we use and how we use it, it is worth understanding how we designate artifacts to reflect our identity: We gauge appropriate behavior and present ourselves, in our behavior, by our use of artifacts, and through our interactions, according to how our identity aligns with that social norm. In this section, I show how social norms of behavior manifest, particularly in how we are expected (at least in the United States) to regard one another in public. The behaviors observed and studied by Hall and Goffman are norms that drive social interactions, and, when layered over our understanding of how social identity is shaped, are key in understanding how social

actors determine what is acceptable behavior in social situations. These theories provide an understanding for how individuals regard each other in social situations, regardless of self-identity or use of artifacts or technologies.

Context frames social order and helps us define proper conduct; it has much to do with governing social behavior around perceived norms (Goffman, 1959, 1963b; Hall, 1963). Edward T. Hall defined four types of personal space based on physical distance between individuals: intimate, personal, social and public (Hall, 1963, 1966). Each type of personal space involves different approaches to social behavior and knowledge about how people are generally expected to behave within those spaces. Goffman offers an analysis of interactions within social spaces (or “events”). One such interaction he defines is civil inattention, a co-present, mutual understanding of accepted behavior: strangers in public spaces approach and regard each other with nonverbal cues communicating a shared social recognition of one another, though they do not directly interact (Goffman, 1963b). Civil inattention is a type of unfocused interaction, which occurs when more than one person occupies a social space (typically delineated by social event boundaries or timelines) and do not directly interact with one another. In contrast, focused encounters include direct interactions, where the attention is given to participating individuals in a social event (Goffman, 1963b). Encounters dictate social behavior, regardless of whether it is focused or unfocused. These frameworks on social space and different types of social interactions help categorize and understand social behavior and perception.

### 2.2.3 *Technology as a Prop in Our Presentation of Self*

In assistive technology appropriation, it is often assumed that a technology is necessary to provide access or accommodation to a person with a disability. Couched in this assumption is the notion that functional access is more important than any other presentation of the person’s

identity. Although functional access is important, as with any behavior executed in social situations, it can become part of one's identity when observed by others. In Goffman's book on the presentation of self, he examines how we identify social norms, the expected behaviors of those norms, and align our own identities accordingly (Goffman, 1959). Goffman then explains how we choose to identify ourselves to others through a theater metaphor. Society and its norms are the stage and show, we are actors, utilizing costumes, props, actions, to present a chosen identity on stage, i.e., to the world around us. This analogy holds weight in our understanding of identity because, as on-stage, we can choose how to present ourselves to others, and, as off-stage, this presentation may or may not align with our authentic, "true," self or identity. But, in either case, the idea that we choose how we present ourselves relies on our understanding of social norms and how we identify within or outside of them. According to Goffman's theater metaphor, artifacts we wear and use are props that also play a role in the presentation of self. Props include any artifacts we incorporate, such as clothing, but also tools or objects, including personal technologies, like assistive devices. What props we use and how we use them thus become part of the narrative of our identity. A person might choose to wear all the latest fashions to share their interest in a trendy lifestyle, or they might identify with the vegan lifestyle and avoid clothing, possessions and food created from or with animal products or by-products. A person might also choose a wardrobe and artifacts seemingly outside the mainstream of the "fashionable," to identify with counter-cultural values. Although aspects of identity are not always a matter of personal choice, e.g., we do not choose the socio-economic status of our upbringing, when people can and do exercise choice, they have more control over which objects are commandeered in the presentation of self. As indicated in the Hello Kitty quote (below; see also Figure 2.1), our sense of self, our identity, is communicated not only via actions and words, but also through the things we like and use (Goffman, 1959).

*Hello Kitty touches people's everyday lives with her presence. With products ranging from keychains and clocks to mugs and shower curtains, one can easily live a Hello Kitty lifestyle, especially when purchasing everything using a Hello Kitty credit card. This is a lifestyle whose proponents find comfort in using a Hello Kitty pen as much as in driving a Hello Kitty car. It is a lifestyle witnessed in the bedrooms, kitchens, bathrooms and offices that are adorned with Hello Kitty from wall to wall, floor to ceiling, expressing the personal identity of their inhabitants through the brand. (Yano, 2015)*

Indeed, the identity of Hello Kitty herself is intentionally blank (no expression) so as to allow fans to identify with her through her products (Yano, 2015).

Similar to the ways that Hello Kitty is appropriated to reflect one's identity, the explosion in personal technologies, together with social media use, pushes the boundaries of socially identifying technologies: The increased popularity of mainstream personal technologies like smartphones and wearables, introduces such technologies into society, a part of our cultural make-up. We appropriate technology as artifacts of self-expression now more than ever. There is a growing list of ways to connect, communicate and identify with others, but the choice is ours as to which device we use.



**Figure 2.1. Left, an image of Hello Kitty next to “Hello Kitty Everyday” found with the quote above were part of the exhibit “Hello! Exploring the Supercute world of Hello Kitty” created by the Japanese American National Museum, with Sanrio Inc., shown at Experience Music Project Museum in Seattle (Yano, 2015). Right, a glasses decorating kit, in the style of Hello Kitty exemplifies a manifestation of the “identity” of Hello Kitty and her products.**

In an analysis of Information Systems research on identity related to information technology (IT) use, Carter and Grover examine IT identity as a determinant and consequent of an individual's identity (Carter & Grover, 2015). The relationship between identity and technology has become intertwined, and IT identity is "the extent to which a person views use of an IT as integral to his or her sense of self" (Carter & Grover, 2015). Like in the Hello Kitty phenomenon, appropriating technology for identity manifests when people choose and use technologies that they feel match their identity and that match how they want to present themselves to the world (Goffman, 1959); in turn, technology becomes associated with certain social roles (Carter & Grover, 2015).



**Figure 2.2. Ads for the Apple iPod show silhouettes using the music player, elevating the iconography of the device, allowing consumers to identify with the generic shadow (Fitzgerald, 2006).**

We saw this phenomenon in some of the first commercials for Apple's iPod music player, featuring a dancing silhouette with white earbuds overlaid in emphasis (Figure 2.2). The silhouette appeared to be enjoying the music and having fun. Much like the deliberately nondescript features of Hello Kitty, consumers were meant to identify as the dancer, represented as a nonspecific shadow. The iconic white earbuds became social indicators of iPod users in a market of music devices that only shipped with black earbuds (Buxton, 2007), symbols of a specific identity: a smart, fashionable and affluent music fan (Buxton, 2007).

Many characteristics define what is acceptable, and these characteristics are subjective. The literature in sociology and social psychology around acceptance, norms and identity contextualize the role of technology beyond just functional use. An examination of how social paradigms influence choice in socially observable environments is one way of explaining how people are motivated to act the way they do, to approach others the way they do, and to carry themselves the way they do in public. However, these perspectives do not explicitly include how disability, and social perceptions of disability, factor into social identity and social norms. As I discuss in the following section, the concept of “norms” and what is “normal,” in fact, plays a direct role in our societal regard for disability, but this view is changing.

### 2.3 DISABILITY STUDIES

Disability Studies is the discipline concerned with the notion of disability as a social construct, including different meanings of disability and their consequences. Perspectives from Disability Studies strongly inform my approach to how we regard assistive technologies and those who use them. Shifting from the notion of disability as a medical problem to a view of disability as socially constructed incurs a fundamentally different approach to how technology is designed and developed for people with disabilities. Before unpacking how such a view influences technology creation, I describe, in this section, the origins of Disability Studies, and why its perspectives are important to today’s approach to technology design, in general.

The Disability Studies perspective is influencing changing views of disability. Disability is defined by the World Health Organization as “an impairment is a problem in body function or structure; an activity limitation is a difficulty encountered by an individual in executing a task or action; while a participation restriction is a problem experienced by an individual in involvement in life situations.” (“Health Topics: Disabilities,” 2016) This definition reflects

current and changing perspectives on disability. Historically, disability has referred to limitations, or problems, in the body, a concept largely based on how human bodies deviated from the “normal”—the average—non-impaired person (L. Davis, 2010). For example, the original World Health Organization defined disability as, “Any restriction or lack ... of ability to perform an activity in the manner or within the range considered normal for a human being” (Rose, 2016). Defining “abnormal” as disabled as a response to “normal” cemented the idea that to have a disability meant that you were not a part of the typical societal discourse and community (L. Davis, 2010; Goffman, 1963b). However, mapping disability as abnormal, and therefore not normal, is problematic in several ways. First, it arbitrarily assigns preferred status to the average case, with no real basis for doing so (L. J. Davis, 2010). Second, even the average case does not account for the majority of the population; as indicated by the “flaw of averages,” designing for the average case may not fit a single individual case (Rose, 2016). Finally, the arbitrary assignment of the norm unnecessarily delegitimizes the disabled experience (Goffman, 1963b; Linton, 1998; Shapiro, 1994). In contrast, people with disabilities can be contributing members of society, and their individual and collective experiences can benefit society at-large and have already done so. Diversity benefits society at-large and is better for creativity, a key component for innovation and technical enterprise (Hewlett, Marshall, & Sherbin, 2013; Saxena, 2014). Changing social assumptions is not easy; but, through the disability rights movement, there is progress. Through the emergence of Disability Studies, we can adopt new lenses with which to look forward.

### 2.3.1 *Disability Studies: A History of Stigma*

People with disabilities have been stigmatized—viewed or marked as a “deviant other” (Goffman, 1963b), flawed or devalued (Grand, Bernier, & Strohmer, 1982)—in society such that

treatment of people with disabilities throughout history is fraught with pain and misunderstanding (Charlton, 1998; L. J. Davis, 2010; Shapiro, 1994). In simple terms, people with disabilities have been shunned and mistreated. People with disabilities were granted protection of the law under the Americans with Disabilities Act of 1990, which recognized that disabled citizens deserve the same treatment and opportunities as nondisabled citizens (“Americans with Disabilities Act of 1990,” 1990). For example, employers cannot discriminate on the basis of disability, and they are required to ensure appropriate accommodations are available. Yet, disabled people are not hired as often as they are qualified for jobs, as biases persist that prevent fair consideration for disabled job candidates (Hunt & Hunt, 2004). Despite positive change in social and public policy (Charlton, 1998), people with impairments continue to be stigmatized and perceived as less capable (F. Antonak & Livneh, 2000; Grand et al., 1982; Hergenrather & Rhodes, 2007). Unfortunately, stigma can be felt today in persisting ableist attitudes, perceptions that “render people who are not disabled as supreme” (Bolt, 2014).

Not seeing people with disabilities for who they are or what they can do, many nondisabled people *pity* those with disabilities (F. Antonak & Livneh, 2000; Rousso, 2013; Shapiro, 1994). Pity includes feeling sympathy and sorrow for the misfortune of others, meaning that having pity is to regard disabilities as undesirable. Pity is a negative perspective characterizing common attitudes about disability that persist even in fields typically considered sympathetic (Shapiro, 1994). Zychlinski et al. evaluated an intervention to influence the attitudes social work students had about disability (Zychlinski, Ben-Ezra, & Raz, 2015). The intervention was unsuccessful in influencing negative-to-positive attitude change: attitudes did not change either positively or negatively (F. Antonak & Livneh, 2000; Grand et al., 1982; Zychlinski et al.,

2015). The point is clear: even those who ought to be most understanding are biased; it is not easy to change attitudes.

Bias is a natural part of the human condition. Unfortunately, as evidenced by the social work study on student attitudes, negative bias, even pity, toward disability persists and is hard to change (Zychlinski et al., 2015). Stigma is strongly associated with disability (Elliott, Ziegler, Altman, & Scott, 1982; Fine & Asch, 1988; Goffman, 1963b) as demonstrated in the way nondisabled people view those with disabilities. Social decorum, particularly in the United States, dictates that disability be regarded differently from the “norm” or “normal” bodies, typically defined as not impaired (L. Davis, 2010; Elliott et al., 1982; Goffman, 1963b), and people are unsure of how to approach a person with a disability. In turn, stigma is the foundation on which misperceptions are based, and as discussed next, is reinforced by our collective construction of disability, socially, and in the environment, services and artifacts created to aid disability. In asking how to encourage people not to look upon disability with pity, but with acceptance, scholars raised awareness of the social construction of disability and its implications (Bolt, 2014; Rousso, 2013). Material consequences arise out social implications of biased conceptions of disability, such as being overlooked for a job because employers are not sure how to accommodate a disability despite an applicant’s qualifications. Disability Studies advocates an effort to change such biases.

### 2.3.2 *On Stigma*

When a person is found to deviate from others, social interaction can be disrupted. It is then that people may be marked for their difference from social norms. Goffman defines this as stigma: when an “attribute that is deeply discrediting” is associated with an individual (Goffman, 1963b). He emphasizes that crediting or discrediting individuals occurs when negotiating social

relationships. Thus, stigma is a socially constructed phenomenon; social norms influence the way social interactions are negotiated. If assistive devices mark users as “other,” this may create social barriers to access even while such devices should help overcome them.

Being marked as “other” also means that people with disabilities lose legitimacy (are discredited) and incur stigma when social interactions determine that they may not meet the implicit expectations of others. Here is where the collective societal construction of disability matters: we may not know what biases we hold, but we are observant when others are different from ourselves. Elements of discrediting attributes can include: visibility, pervasiveness in everyday life, centrality of a “problematic” attribute, and an inability to remove stigma. When these characteristics come together, they bring attention to the bearer, interrupting social discourse. Fine and Asch argue that disability is a socially constructed phenomena (Fine & Asch, 1988). The environment and attitudes of others create “barriers of discrimination” and inaccessibility, and not necessarily physical impairment. In this way, there is a social responsibility to provide for accessibility in the creation of environments and artifacts.

### 2.3.3 *Models of Disability*

We learn from Disability Studies that the meaning we derive from disability is associated with stigma, and that our own understanding of disability is constructed, but not always with merit. Disability Studies also offers ways to address this change in perspective, specifically, the notion of different conceptual models of disability, which I incorporate in this dissertation. The models of disability define different approaches to how we engage with disability, specifically how our bias may perpetuate stigma and injustice in access. My view on bias in technology design, particularly ableism, is guided by my understanding of the medical and social models of disability. In this section, I describe the different models, drawing out examples of how these

manifest in lived experiences of disability and why that is important. I move forward with this work, incorporating the social model of disability in technology design.

Activism and critical scholarship led to the emergence of the discipline of Disability Studies, encouraging new ways to engage the concept of disability, to question what it is and how we interact with it. In turn, Disability Studies raises critical awareness by giving agency to the disabled experience in reframing the meaning of disability (Hockenberry, 1995; Rousso, 2013). For example, John Hockenberry wrote (Hockenberry, 1995):

*She said she knew people in wheelchairs who were much more shriveled up. I can only assume that the expression on my face was one of extreme annoyance and skepticism. Her reaction was to redouble her efforts to convince me that she had some degree of expertise in these matters. She started to click off her credentials. She had worked for the outpatient clinic at a local hospital. She had been responsible for wheel-chair access at some community women's health film festival, and she was once roommates with a woman who signed for the hearing impaired. I should accept her as a progressive, hip, knowledgeable person where disability was concerned, and acknowledge her theories on shriveled muscles.*

*... I did not realize that I was a part of [the approaching woman's] own confrontation with the experience of disability. I was a part of this woman's experience of disabled people. That experience was so powerful that she suspected I might be having it along with her. But I was not. "No, I am John! I am a person, not a wheelchair. You must deal with me as I think of myself." This was how I responded.*

Hockenberry illustrates how constructions of disability contribute to stereotypes (and subsequently, awkward interactions like his). The especially poignant line, "You must deal with me as I think of myself," emphatically affirms the reality of the disabled experience: the woman patronizingly expected him to meet her own conceptions of disability before asking him about his own (Hockenberry, 1995). It is in these provocative ways that Disability Studies emerged as a critical awareness of conceptions of disability (Linton, 1998; Rousso, 2013), giving agency to the disabled experience as one way to contribute to a reframing of disability (Hockenberry, 1995; Rousso, 2013).

To address the concept of disability as a “stigmatized other,” scholars in Disability Studies categorized models of disability. Each model represents how a different community defines disability, depending on the historical and cultural traditions that each is grounded in. For instance, the medical model, historically the most common conception, defines disability as a problem inherent in the body, delineating between “normal” and “abnormal” bodies, while the social model defines the concept of disability not necessarily as an impairment in the body, but as a construction of the environment that impedes access by a range of different body types. In the medical model, a person in a wheelchair is disabled because they do not have functioning legs and cannot walk or climb stairs. In the social model, a person in a wheelchair is disabled not because of their legs, but because buildings do not include ramps to facilitate mobility.

The social model of disability encourages a critical look at how concepts are defined, with real implications. To its current definition of disability, the World Health Organization adds, “Disability is thus not just a health problem. It is a complex phenomenon, reflecting the interaction between features of a person’s body and features of the society in which he or she lives. Overcoming the difficulties faced by people with disabilities requires interventions to remove environmental and social barriers,” (“Health Topics: Disabilities,” 2016) placing the burden of disability on the spaces, processes, and artifacts of the environment, and the responsibility of constructing non-disabling environments on those who create and build (Swain, French, & Cameron, 2003). These models of disability contribute critically to our understanding of disability by bringing awareness to ableist attitudes and creating opportunities to pivot perceptions of disability away from stigmatizing constructs.

The conceptualization of disability and its influence on access impact those with the experience of disability. Like in Hockenberry’s story about the woman who confronted him

about his disability, people tend to associate aspects of disability with specific environmental constructs and assistive artifacts, regardless of the user's preference. People with disabilities are unable to construct a true presentation of self that aligns with their personal identities if people without disabilities continue to promote socially constructed and inaccurate perceptions of disabilities. Unfortunately, despite gains in Disability Studies to change attitudes and perspectives, such as through defining the different models, the concept of disability is constructed with bias, with ableist tendencies masquerading as charitable and helpful.

One way to engage these concepts as nondisabled researchers and designers is to learn from Disability Studies, and to re-situate and re-evaluate how we conceptualize disability. Reframing the different models of disability is one way we may become mindful of the construction and politics around what is disability. Even good intentions inadvertently contribute to inaccurate perceptions. As in Linton's (1998) description of "special" education, when nondisabled observers put a positive spin on "special" devices, they mark assistive technologies as "other" and differentiate them as categorically separate from mainstream devices (Elliott et al., 1982; Goffman, 1963b; Linton, 1998). By association, the "special" view relegates assistive technology users as "special," marking them as "other," apart from the "normal" technology user. Despite altruistic intentions, codifying assistive devices as "special" perpetuates socially embedded negative bias about disability. Against embedded attitudes already in place, incorrect perceptions of technology can become associated with users, perpetuating negative stigma and motivating a need to reassess categories placed on technology design.

In the next section, I unpack different views on design, discuss different design approaches motivated specifically for those with disabilities, and examine these design views through the critical framing of Disability Studies.

## 2.4 DESIGN FRAMED BY DISABILITY STUDIES

In this section, I consider how design and the practice of design are uniquely positioned to change the way we think about assistive technology design. Framed not only as a disciplined approach to creating novel artifacts, design viewed through Disability Studies motivates not only an approach, but also a practice of technology design that infuses and benefits from a social model of disability. First, I describe the phenomenon of design thinking and practice that informs my perspective, and that contributes to my understanding of technology design specifically around disability. Then, I discuss the notion that the concept of disability is itself designed, particularly, if we examine the artifacts, services and environments created to “help” people with disabilities. When we understand the notion of design as a way of thinking about how to create new artifacts, processes and services; when we understand how disability as a concept is also socially constructed, then we can see how disability, as we have known it, is designed, as a social construct. This social construct not only dictates how we create artifacts for use for people with disabilities, it also defines our behavior around them. Despite how entrenched the connection is between perspectives that define disability as inherently problematic in the body, and tools and technologies that embody negative stereotypes and stigma, I highlight this view as an opportunity to change how we approach design for disability, to encourage a positive perspective that is grounded in the social model of disability, that is reflective of the experience of disability not just one’s conception of disability as constructed by society’s rendering.

As a different way of thinking about the world, design is noted for specifically addressing “the specific, intentional, and non-existing,” with an emphasis on creating new artifacts through disciplined and rigorous practice (Cross, 1999; Stolterman, 2008), built on philosophies and theories grounded in reflection and “designerly” skill (Schön, 1987; Stolterman, 2008).

Experienced designers address complexity with an expertise gained through practice grounded in a rigorous and disciplined approach referred to by Nelson and Stolterman as “designerly way of thinking and acting” (Nelson & Stolterman, 2012; Stolterman, 2008).

#### 2.4.1 *Design Practice and Ways of Knowing*

There exists a set of problems so complex they defy even a single solution (Rittel & Webber, 1973). It follows that finding a single, appropriate solution could be impossible. Dubbed “wicked problems,” these are governed by a set of principles and comprise hard social, political, technical and scientific issues (Rittel & Webber, 1973). Design is uniquely positioned to deal with these types of problems.

In his seminal work, “The Sciences of the Artificial,” Herb Simon described his position on how a set of practices aimed at creating novel artifacts required formulated processes seeded by rigorous thinking. He identified systematic processes to strategically, and rationally, address complex, wicked problems. Identifying the appropriate solution to a complex problem, he reasoned, required a formal process to ensure all possible options were addressed and evaluated. These rationalized processes would be exhaustive and result in complete solutions.

In contrast to, and perhaps even in response to, Simon’s treatise introducing specific, rational processes on creating novel artifacts, Schön identified a different practice of design also aimed at addressing wicked problems. Reflection, Schön argued, was a key approach and designerly skill that allowed designers to evaluate a set of parameters, or constraints, identify the possible solutions, and synthesize those into a proposed solution. Acknowledging that wicked problems, by definition, may not necessarily be definitively solved, Schön’s reflection targets iterative improvement. This practice, which he designated as “reflection-in-action” and “reflection-on-action,” describes the actions architecture students engaged in, in the process of

identifying a solution for their architectural designs. The students, alongside their instructor, played with the space of available solutions—partial and complete—continuously edging toward a full solution. Schön reasoned that rather than take a formal and necessarily rational approach from the beginning, the students toyed with an idea and stood back to reflect on it (reflection-on-action), or they made continual adjustments as they constructed new ideas (reflection-in-action). Furthermore, designers engaged a different kind of thinking, an intuition, more than rational thought at times. Building on the iterative process, Schön observed the architecture students were encouraged to externalize, understand, reflect and then repeat the exercise in an effort to cycle through thought processes until they reached a satisfying solution. Furthermore, Schön recognized that this practice manifested in two ways: first, in real-time, a designer thinks and adjusts while working; second, in a post-hoc sense, taking a step back, a designer might extoll the virtues or flaws of a whole system by examining how it manifests within the larger framework. Key characteristics of design practice, then, are built on reflection-in-action and reflection-on-action (Schön, 1987).

My understanding of design builds on both Simon’s notion of rationale in rigor together with Schön’s emphasis on reflection toward creating an ideal solution. In addition, I unpack Nelson and Stolterman’s (2012) and Cross’s (1982, 2011) understanding of these approaches to design as a specific “way of knowing” (Cross, 1982, 2011; Nelson & Stolterman, 2012). If we view design as a discipline distinct from science and from art, we also acknowledge that expertise in design involves a set of philosophies, skills, and strategies as distinct as the field. Design is its own discipline, involving a unique way of thinking.

The Design Thinking paradigm, popularized through IDEO and Stanford University’s Design School, emphasizes five stages in an intentional practice of reflection and iteration. The

five stages are: (1) empathize with users, (2) define the problem, (3) ideate and brainstorm possible solutions, (4) prototype, and (5) test<sup>1</sup>. These five stages affirm as principles of design practice to ground solutions in user needs, to focus on problem space and constraints, and to iterate and reflect on both successes and failures in order to find solutions. Within these practices, designers arm themselves with experience and a “designerly way of knowing” as they engage design practice (Cross, 1982; Nelson & Stolterman, 2012). Because there can be no single, correct solution to a wicked problem, there can only be a “way of knowing” toward attaining the best solution possible in the given contexts and constraints. A unique skillset comprising reflexivity, creativity and discipline within constraints, design practice engages the making of new things, but also has a tolerance for trying ideas and reflecting on whether or not they worked. Thus, a great deal of skill is involved in the practice of design, not just in producing a final product (Nelson & Stolterman, 2012).

In the field of Human-Computer Interaction (HCI), user interface and user experience (UI/UX) design are common threads of design endeavors that embody certain elements of the design thinking paradigm. Particularly, these endeavors implement similar processes in order to facilitate a specific way of thinking about problem spaces. Practitioners identify user requirements, brainstorm solutions, synthesize prototypes and test designs. Of particular emphasis in the practice of design, even in the HCI tradition, is how to think about identifying a solution to a problem, and adopting flexible and reflective attitudes to solving complex problems.

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<sup>1</sup> <https://dschool.stanford.edu/>

## 2.4.2 *Designing Disability*

Scholars and practitioners have converged on the need for attention to the social implications of technologies designed for people with disabilities. While Disability Studies re-examined the meaning of “disability” (Linton, 1998), design practitioners from a variety of fields were honing discussions on “what is design?” and how to delineate what it means to architect, create, design and build in an increasingly digital world (Cross, 2011; Kimbell, 2011, 2012; Norman, 1988; Schon, 1992; Simon, 1969; Stolterman, 2008). Simon’s “courses of action aimed at changing existing situations into preferred ones” (Simon, 1969) contrasted with Schön’s (and later Cross and Kimbell’s) design as reflective practice, more than an epistemological grounding in the creation of new ideas (Kimbell, 2011, 2012; Schon, 1992). Design and practice are bound to the motivations and assumptions of the designer, whether intended or not (Winner, 1980). My goal in discussing design is to understand how design influences and is influenced by how we think about disability. As “Design Thinking” rose to mainstream popularity, it converged with Disability Studies in an awareness of what it means to have a disability, specifically how disability is a designed construct (DePoy & Gilson, 2014). The notion that disability is a “stigmatized other,” is designed (Bolt, 2014; L. J. Davis, 2010; DePoy & Gilson, 2014) through the services and artifacts created in the guise of “being helpful” to people with disabilities. DePoy and Gilson argue that disability-specific artifacts carry a “branding” of disability design. Hockenberry emphasized that nondisabled people are trying to help in what they think are best interests of the disabled (Hockenberry, 1995); DePoy and Gilson explicate the consequences in scathing terms:

*Hovering under the cultural radar of well-intentioned citizens and genuine helpers, be they laypersons or professionals, contemporary disability design is manipulative, employing diverse and surreptitious crafts and containment mechanisms that impose negative valuation, truncated rights, limited*

*opportunity, and even poverty, on those branded with this title. (DePoy & Gilson, 2014)*

Disability-as-designed infuses stereotypes and the consequences radiate significantly beyond the design of any one thing, perpetuating a cycle of stigmatizing disability. As Bolt critically referenced how posters represented disabled children for charity, “negative representation served only to elicit negative attitudes; it contributed to ableism in its laudatory enforcement of normalcy and to disablism in its pejorative representation of impairment” (Bolt, 2014). Via services, technologies, buildings, language and interactions, the concept of disability is constructed—designed—with the message that people with disabilities need help from the “able-bodied.”

Simi Linton’s discussion on the nuanced, yet significant variations for integrating disabled students in public schools compels us to understand how such designed perceptions of disability are affected by the structures (social and physical) we do build (Linton, 1998). She states, “because special education by structure and definition places disability as the major defining variable of learners, the field overemphasizes disability, milking it for explanatory value to justify organizing education into two separate systems. Meanwhile, general education underemphasizes and marginalizes this dimension of variation in students” (Linton, 1998).

In comparison, Pullin, charging that social appeal has a role in design for disability, notably brings attention to how design is embraced as a way to make a statement about disabled identities (Pullin, 2009). And, from a scholarly perspective, Mankoff et al. suggest assessing assistive technology research through the critical lens offered by Disability Studies (Mankoff et al., 2010). These views emphasize an awareness is needed to situate social constructions of disability in design.

Disability-as-designed is about the stigmatizing and ableist bias inherent in the construction of environment, services and artifacts. Further deconstructing this concept, the models of disability defined by scholars in Disability Studies demonstrate how different perceptions of what it means to be disabled shape environment, services, and artifacts. I infer that the latter contributes to the former—that is, the way we conceptualize disability influences our actions and creative outcomes.

### 2.4.3 *Using a Social Lens on Disability: Design as Disability-Excluding or Specific*

When examined through DePoy and Gilson’s argument that disability design brands negative stereotypes, through Hockenberry’s position that “help” is really not helpful if people are not open to “deal with me as I think of myself,” and through Linton’s analysis of the effects of special versus general education, we see the flaw in design perspectives that are disability-specific. A critical view on Hockenberry’s statement implores us to consider the person before the idea, a key concept on its own, but more significant when we emphasize social aspects in design. We cannot claim any awareness in social aspects of design if we fail to look past disability to the person and their preference for social presentation. A similar reprioritization of concepts comes out of the critical examination of assistive technology design and development (as done by Mankoff, et al. (2010), Pape, et al. (2002), and Parette and Scherer (2004), to name a few) and corroborates the significant role of the user. Indeed, prevailing attitudes cannot be changed merely by re-appropriating terms and language, although that can help (Bolt, 2014; Linton, 1998). Whatever the intention, altruistically separating “inclusive” approaches from main-line design practice does not compel “the rest of us” to consider those with disabilities as part of our target audience. As emphasized in Linton’s commentary on special versus mainstream education, separating the two marginalizes disabled technology users. More than this, however, designers

also lose the valuable insight of the disabled individual's social perspective as it relates to mainstream technology design. Instead, in practice, we relinquish responsibility to design for these populations to those who assume a disability-specific design approach. Together, these views emphasize that it matters how the responsibility of design is assumed. Who's job is it to design inclusively, not just with a disability-specific approach? Indeed, if we consider the potential consequences that result in design that is "manipulative, employing diverse and surreptitious crafts and containment mechanisms that impose negative valuation," (DePoy & Gilson, 2014) or that is abandoned (Pape et al., 2002; P. Parette & Scherer, 2004), we see that the attitudes of designers have as much to do with the social conception of assistive technology as does any user or bystander. Thus, designers, tasked with creating artifacts of the future, also have a responsibility to envision a positive social valuation of such artifacts, to impose not a negative valuation, but an inclusive one that does not divide disabled and nondisabled users, but that includes a broader spectrum of users.

The views of Hockenberry, DePoy and Gilson, Linton, and others can be used as a social lens on disability and can influence how we approach the construction of artifacts that are usable by people with disabilities. This lens takes a critical and socially constructed view and re-appropriates who decides what it means to be disabled, creating opportunities to question what makes a disabling situation and what it means to those with the experience of disability (particularly in social situations). Consider a thought experiment: is it possible to create an environment that is fully accessible to a person with a disability? I argue it is. Many visually impaired people live independently, having made necessary customizations to ensure that most if not all aspects of their home are accessible, like putting Braille labels on microwave buttons (Shinohara & Tenenberg, 2007). In contrast, our world is constructed on the assumption that the

typical person is not disabled, and consequently, workarounds are difficult and stigmatizing. Applying this to technologies, we see how most mainstream technologies are developed with the assumption that the typical user is not disabled and assistive technologies are designed with the view that impairment is so debilitating that functionality and utility are the only relevant aspects. Assistive technologies are often designed with the identity of disability evident in the presentation of the device. Considering disability as socially constructed creates an awareness of our predispositions as designers and technologists with the potential to change the way we look at technology design. In addition, design is uniquely situated to help us think differently about people and technology, specifically about disability.

Notwithstanding all the forces contributing to the creation and use of assistive technology, including niche and consumer markets, I highlight design as significantly affecting assistive technology use and perception. If we assess technology presentation and use by “reverse engineering” the *considerations* made in its construction, that is, if we take a critical view of the bias in assistive technology design, the function-centered priority of assistive technology design becomes quite evident. I corroborate this priority from a rehabilitation perspective, the tradition from which assistive technologies originated: impaired people need help, and we can engineer tools to help them (Cook & Hussey, 2002). To situate how people commonly think of disability, then: Assistive technologies are no less than disability-specific technologies. The prevailing views on assistive technology design are that such devices must aid people with impairments, prioritizing functional capability over appeal and usability (P. Parette & Scherer, 2004; Marcia J. Scherer, 1993a). In contrast, mainstream technologies are typically not considered for disabled use, as is evident in how few are made accessible from the start. Thus, existing design practices are disability-excluding, unless they are disability-specific. The

difference is how much attention is paid to utility versus implications of social use and appeal; there is a mismatch between the function-centered design of assistive technologies and the role they play in the social construction of users' lives. This mismatch provides motivation for the work of this dissertation on defining and promoting a concept of "social accessibility."

Positive and non-ableist perceptions of assistive technologies can impact perceptions of disability, and one way to undercut misperceptions is to view assistive technologies as artifacts for self-expression as much as for functional utility. If, as in the social model of disability, we consider the construction of the environment as instrumental in the experience of disability, then it is clear there is a role for design, not just of environments but of technologies. Designers can take deliberate actions and assume perspectives in their design practice to achieve accessible technology design. Thus, if design is political (Winner, 1980), then the concept of disability is itself designed.

## 2.5 SUMMARY

Although scholars have argued for a change in the way we construct our conception of disability, their message seems lost in translation with regard to technology designed for people with disabilities. If disability is a social construct, and contributes to a view of people with disabilities as a "stigmatized other," then language, services, artifacts, and the environment will be constructed with the view that disability is problematic, a view rooted in the medical model of disability. Technology designed with this purview of disability reflects that perspective: artifacts are designed in the image of disability as a problem of the body.

People with disabilities are fighting for equal access to services, information, daily activities. Reflecting on rising technical innovation through the social model of disability gives

power to change the technological environment, eventually ameliorating technological inequality. The critical views of Disability Studies offer a framing within which to approach the concept of disability as well as the artifacts that might affect the experience of disability. From the standpoint of the social model of disability, it is the responsibility of technology creators to consider how our conception of the wider world (of technology) contributes to a disabling world. These views inform my approach to disability and design, in particular, regarding assistive technology as a manifestation of our social construct of disability. Building on these views, the work in my dissertation investigates the experiences people with disabilities have with their assistive technologies, in an effort to characterize how assistive technology design influences use in social situations. An understanding of how design influences technology use may reveal the ways in which we ought to adjust our approach to design. Ultimately, if we can change our perspective on disability through design, perhaps we can not only change how others perceive disability, but also how we design technologies of the future, particularly how we prioritize accessible design.

## Chapter 3. RELATED WORK: THE DESIGN AND SOCIAL STIGMA OF ASSISTIVE TECHNOLOGIES

### 3.1 INTRODUCTION

In chapter 2, I laid the framework of social interactions and social behavior that contribute to how we form identity and choose to present ourselves to others. I incorporated perspectives from Disability Studies that shape the direction of my work, particularly the notion that disability is a social construct that can have many meanings, some of which can be designed. I included a discussion on the theoretical orientation of design thinking, based on the foundational work of Simon (1969) and Schön (1987), and considering the notion of “designerly way of knowing” that formulates a unique and specific approach and process to design. The way a designer regards their practice of design thinking shapes what strategies are used, how tools and techniques are applied to design, and can be influenced by social constructions of disability. However, as I show below, “the way a designer regards” a particular problem and creates its solution can have consequences when influenced by disability-specific tendencies.

In this chapter, I outline related work that builds on the foundation in chapter 2, and I examine design practices that focus on disability, or that are sensitive to diversity in design. I cover a brief history of assistive technology, particularly its role in occupational therapy as an aid to improve daily living for people with impairments. Indeed, typical User-Centered Design approaches tend to overlook accessibility requirements, except for legal reasons, but research has shown that specific design approaches that target users with disabilities do result in accessible designs for users. Yet, the related work on assistive technology use and abandonment indicates that devices designed to be disability-specific imbue socially constructed, and usually negative, meaning about disability to users, which may render otherwise functionally accessible

technologies inaccessible. Assistive technologies are often found to be considered stigmatizing and are associated with negative feelings, resulting in high abandonment rates, despite the increasing costs and customization accorded the devices themselves. Thus, I argue the ways in which we regard disability-specific design approaches and assistive technology use in rehabilitation, particularly in occupational therapy, weave a complicated and unique relationship between assistive technologies and the people who use them. I conclude that though strategies in design and assistive technology matching helped people with disabilities find appropriate devices for the tasks they wish to complete, such approaches still embed a medical model of disability, its ableist tendency to create devices and processes that render disabled technology users as second class to mainstream technology users.

### 3.2 DISABILITY SPECIFIC DESIGN APPROACHES

Given that my work focuses on the design of assistive technologies for people with disabilities, I discuss below the different approaches already in use, discern what makes them successful, and why they might not be adopted at a much higher rate than traditional user-centered design practices. Design approaches in Human-Computer Interaction that center on people differ slightly from traditional design practice typically focused on the materiality and construction of the designed artifact, i.e., not usually incorporating human stakeholders. The emphasis on people in Human-Computer Interaction design practices also implies that accessibility should be included by virtue of the user-centeredness of the process itself (Sharp, Rogers, & Preece, 2007). Yet, merely demarcating the first part of the design process as “user-centered” manifests in personal technologies that are still inaccessible to people with disabilities. Clearly, there is a gap in understanding how design ought to work and what actually happens.

### 3.2.1 *Approaches to Design for Disability*

In Human-Computer Interaction, design has been appropriated for disability among a number of approaches based on User-Centered Design, emphasizing iteration, feedback and user involvement (Gould & Lewis, 1985). Universal Design (Mace, Hardie, & Plaice, 1991) advocates solutions that are usable by as many people as possible (of as many abilities as possible); User-Sensitive Inclusive Design (A. Newell, Gregor, Morgan, Pullin, & Macaulay, 2011) encourages designers to engage users through techniques and tools that facilitate inclusiveness; Ability-Based Design (Gajos, Wobbrock, & Weld, 2008; Wobbrock, 2017; Wobbrock, Kane, Gajos, Harada, & Froehlich, 2011) emphasizes ability over disability, creating systems that work with users' abilities; Design for User Empowerment (Ladner, 2015) aims to increase participation by people with disabilities in the design process at every stage; Participatory Design (Schuler & Namioka, 1993) techniques treat users as equal partners in design processes and has been adapted for accessible design, and Value Sensitive Design (Friedman, Kahn, & Borning, 2006) weighs stakeholder values in a thorough process that evaluates conceptual and technical outcomes. These approaches share the view that disabled users contribute to the design process, and other than Participatory Design and Value-Sensitive Design, are generally disability-specific because they are focused on outcomes for users who have disabilities. In addition, these approaches are primarily concerned with functional aspects of technology design, with the result that social aspects may be ignored.

In this section, I cover each of these design approaches in detail, describing the main goals, the principles or steps in each process, and a nuanced characterization of each in its coverage of disability in design.

### 3.2.2 *Universal Design and User Interfaces for All*

Perhaps one of the most popular design strategies focusing on people with disabilities is Universal Design (Mace et al., 1991), which builds on the idea first propagated through architectural design. The main drive for Universal Design is to create a solution that can be used by the widest possible user base without additional adaptation or extra accommodation, it is defined as “the design of products and environments to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design” (Connell et al., 1997). Universal Design consists of seven principles, presented in Table 3.1. Emphasized across the seven principles is a theme of creating a design that is inclusive broadly and flexibly for a number of users, no matter their ability or background. Each principle is designed to allow designers to reflect on individual aspects that contribute to universal usability (Shneiderman, 2000). For example, in incorporating Universal Design in engineering curriculum, Bigelow observed that students asked user-specific questions, such as “What do we assume about abilities required for an effective user-environment interaction?” (Bigelow, 2015).

<b>Principle One: Equitable Use</b> - The design is useful and marketable to people with diverse abilities.
<b>Principle Two: Flexibility in Use</b> - The design accommodates a wide range of individual preferences and abilities.
<b>Principle Three: Simple and Intuitive Use</b> - Use of the design is easy to understand, regardless of the user's experience, knowledge, language skills, or current concentration level.
<b>Principle Four: Perceptible Information</b> - The design communicates necessary information effectively to the user, regardless of ambient conditions or the user's sensory abilities.
<b>Principle Five: Tolerance for Error</b> - The design minimizes hazards and the adverse consequences of accidental or unintended actions.
<b>Principle Six: Low Physical Effort</b> - The design can be used efficiently and comfortably and with a minimum of fatigue.
<b>Principle Seven: Size and Space for Approach and Use</b> - Appropriate size and space is provided for approach, reach, manipulation, and use regardless of user's body size, posture, or mobility.

**Table 3.1. The Principles of Universal Design (Connell et al., 1997)**

Oft cited examples of Universal Design include curb cuts, created for wheelchair access but benefiting anything with wheels including parents with strollers, and the Oxo Good Grips

products, which makes cooking utensils easier to handle. However, good, clear examples of Universal Design are harder to come by in “high technology,” and while there is no clear reason, some research indicates that it is because the one-size-fits-all approach is actually harder, or maybe even impossible, to achieve in specific cases (Harper, 2007; Stephanidis, Akoumianakis, Sfyarakis, & Paramythis, 1998). Thus, although Universal Design is often heralded as an untapped resource that could change the way technologies are created, eventually solving many accessibility problems, it could also be the case that Universal Design has some shortcomings that make it less applicable for complex user scenarios.

### 3.2.3 *User-Sensitive Inclusive Design*

User-Sensitive Inclusive Design, which builds on User-Centered Design and was a response to Universal Design, is specifically focused on un-alienating people with disabilities as a user group (A. F. Newell & Gregor, 2000). Using strategies that aim to increase familiarity with disability and accessibility, User-Sensitive Inclusive Design encourages designers to get to know users as people, rather than the disabilities they might experience. Noting that Universal Design may be limiting because of the “impossible” goal of meeting an intersection of needs, Newell et al. (2011) also highlight consequences of usability, “Providing access to people with certain types of disability can make the product significantly more difficult to use by people without disabilities, and often impossible to use by people with a different type of disability” (A. F. Newell & Gregor, 2000). In essence, designing an all-encompassing solution may benefit several user groups, yet still isolate others, such that there are no intersecting solutions that would be usable for all. Rather than roping in the broader and diverse abilities of the wider user population, as is the goal of Universal Design, User-Sensitive Inclusive Design emphasizes the notion of “inclusivity” to denote a specific focus on a targeted user group, with the express goals of

empathizing with users as people, not functional opportunities, and by identifying solutions to unique needs through a close examination of those needs (A. Newell et al., 2011). Thus, User-Sensitive Inclusive Design is exactly that, sensitive to unique user needs so as to be inclusive of a specific group of users, rather than attempt to find a single solution usable by all.

### 3.2.4 *Ability-Based Design*

In another response to both the traditional assistive technology and Universal Design approaches, and toward process-driven and design-oriented guidelines for “universal accessibility,” Stephanidis et al., mapped User-Centered Design processes to strategies for accessible system design (Stephanidis et al., 1998). These arguments served as a precursor to Ability-Based Design: that technical opportunities exist to develop interfaces toward universal accessibility (Wobbrock et al., 2011). Specifically, Stephanidis et al., argued that design processes could identify and address various use cases that address specific different abilities for users (Stephanidis et al., 1998). Building on the theme that the systems we design can, and should, take on the burden of adapting to the user’s needs rather than the other way around (Gajos, Wobbrock, & Weld, 2007; Gajos et al., 2008), Ability-Based Design promotes focusing on abilities rather than disabilities and harnessing system capability to customize accommodation when necessary. The principles of Ability-Based Design emphasize the responsibility of the system (via its designers and developers) to adapt and accommodate to those who would use it. The seven principles, shown in Table 3.2, strategically pivot on *ability* as central to design through emphasizing a stance and designer responsibility, and through highlighting the ways that system design can adapt to user needs.

A consequence of incorporating an ability-focused approach to design is that it gives users control over the use of the interface.

<p><b>Stance</b></p> <p><b>1. Ability</b> - Designers will focus on users' abilities, not dis-abilities, striving to leverage all that users can do in a given situation, context, or environment.</p> <p><b>2. Accountability</b> - Designers will respond to poor usability by changing systems, not users, leaving users as they are.</p> <p><b>3. Availability</b> - Designers will use affordable and available software, hardware, or other components that are acquirable through accessible means.</p>
<p><b>Interface</b></p> <p><b>4. Adaptation</b> - Interfaces might be adaptive or adaptable to provide the best possible match to users' abilities.</p> <p><b>5. Transparency</b> - Interfaces might give users awareness of adaptive behaviors and what governs them, and the means to inspect, override, discard, revert, store, retrieve, preview, alter, or test those behaviors</p>
<p><b>System</b></p> <p><b>6. Performance</b> - Systems might monitor, measure, model, display, predict, or otherwise utilize users' performance to provide the best possible match between systems and users' abilities.</p> <p><b>7. Context</b> - Systems might sense, measure, model, portray, or otherwise utilize users' situation, context, or environment to anticipate and accommodate effects on users' abilities.</p>

**Table 3.2. Principles of Ability-Based Design (Wobbrock, 2014, 2017; Wobbrock et al., 2011)**

Ability-Based Design essentially pivots the typical view of assistive technology design by emphasizing the focus on ability, rather than *dis*-ability. The simple but profound shift in design stance is an indicator of the strong bias to home in on impairments and limitations when designing assistive technology. It is too easy, perhaps a natural inclination whenever confronted with accommodating disability, to zoom in to the disability before the person, to isolate limitations, rather than focus on capabilities. However, by virtue of Ability-Based Design's core approach to pivot from disability to ability, the approach itself is at least somewhat disability-specific, and also does not incorporate themes of social situations of use.

3.2.5 *Design for User Empowerment*

Whereas the previous design approaches emphasize various ways to work with users with disabilities, incorporate their needs, or facilitate a specific way of interacting with them, Design for User Empowerment is built on the idea of self-determination (Ladner, 2015). When it comes to designing technologies for people with disabilities, it makes sense that people with

disabilities will be best equipped to address the problems that they themselves face in inaccessibility. Traditional design approaches often assume the designer leads the process in finding a solution, as well as that the designer has no disability and should work with or learn from the person with a disability. In contrast, in Design for User Empowerment, the goal is to empower users with disabilities to be the designers, developers and innovators themselves (Ladner, 2015). Such an approach requires a self-reflective look at the design and development system and to remove barriers that prevent people with disabilities from becoming designers and developers.

The main goal for Design for User Empowerment is to reflect on the infrastructure and support needed to encourage more people with disabilities to enter the design and technology development pipeline. The very nature of including more people with disabilities in these technical fields will ensure that design and development processes are infused with their take on all aspects of design, including both functional and social perspectives.

### 3.2.6 *Participatory Design*

Participatory Design, sometimes referred to as co-design, is not disability-specific, but it has been used to include people with disabilities within the design process (Azenkot et al., 2011). Unlike the other design approaches, participatory design regards users as experts in their own right, as well as key players in informing the design (Schuler & Namioka, 1993). Users might become familiar with the design process, i.e., participating in several rounds of providing user feedback on a certain feature. Thus, it is not unlike Design for User Empowerment, except that Participatory Design does not necessarily empower the user as the designer, who would be leading the design endeavor.

Participatory Design is useful because it holds users as key and equal players in terms of ideas and feedback. For accessibility, such interplay is key because only users with disabilities will have the experience of disability, and through Participatory Design, users have a mechanism to convey how these experiences impact technology design and use (Azenkot et al., 2011).

### 3.2.7 *Value Sensitive Design*

Like Participatory Design, Value Sensitive Design is not specifically geared for accessible design (Friedman et al., 2006). However, its principles and guiding strategies have been used in accessibility focused research and design projects (Deibel, 2011). The approach relies on uncovering stakeholder values through a series of investigations: conceptual, technical and empirical (Friedman et al., 2006). Through each strategy, designers and researchers are encouraged to mindfully and carefully consider design scenarios, and then to brainstorm value-driven outcomes for different design scenarios.

Value Sensitive Design is an appropriate approach for engaging the values of disabled user groups within a design process and it can involve people with disabilities as drivers of a design approach. However, because the method is not specifically focused on accessible design, it is left up to those adapting the approach to incorporate elements of accessibility.

### 3.2.8 *The Need for a Social Dimension in Design*

The approaches described above advocate improving design outcomes for people with disabilities and share a recognition for a particularly empathetic view on design overall. Not only do the approaches deliberately target and engage users to improve design, they provide tools and techniques that can intentionally be used to address accessibility-specific design problems. However, not all necessarily focus on accessibility, or the disabled experience beyond technology

use, and none explicitly focus on self-expression or implications of social interactions as key elements. These issues arise within certain approaches, like Design for User Empowerment where disabled designers will be attuned to their own experiences, or User-Sensitive Inclusive Design, which emphasizes developing social rapport as a way to empathize with disabled users, but these concerns are not equally weighted alongside functional concerns. The focus on disability separates design that is disability- and function-specific from design for everyone else. Explicitly including people with disabilities in design is a virtuous endeavor toward improving access. But, as discussed in chapter 2, myopically focusing on disability as separate from mainstream results in disability-specific design, thereby excluding those without disabilities and constructing a separated category of artifacts. A social perspective inspired by the social model of disability is one way to broaden how we address the design of artifacts for people with disabilities.

### 3.3 THE STIGMA OF ASSISTIVE TECHNOLOGY USE

The implications of the way that technology is designed affect use, to be sure, but the effects can be deleterious for users with disabilities when their assistive technologies are key to accomplishing tasks in everyday living. The influences of technology design and use, particularly when contributing to inaccessibility, motivate key aspects of my work: despite the emphasis on inclusion in the design approaches in the previous section, the lack of mainstream devices usable by people with disabilities indicates that personal technology design rarely targets users with disabilities. Why is that so? And, what can be done to address the gap in design approaches like those discussed in the previous section with actual technology production and use? Before diving into the question, I investigate the impact of assistive technology design that differs from

mainstream technology appeal; the issues are not non-trivial, and in fact are driven by human social tendencies to identify and be a part of the communities and environments we inhabit.

In this section, I examine the historic origins of assistive technologies and the tenuous relationship people with disabilities may have with their assistive devices. Although assistive technologies are created with the aim to help people with disabilities, such devices carry with them a burden of social stigma, “marking” users unlike other personal technologies. The implications how society regards assistive technologies, and by association, how people with disabilities feel about using them, ultimately seed the research and ideas in this dissertation.

### 3.3.1 *A Brief History of Assistive Technologies*

Assistive technologies are a unique category of personal technology, created to serve as an accommodation or proxy for impairment, such as in the way hearing aids do the “listening” and help people access sound. But, assistive technologies can be proxies on an abstract level as well: technologies do not have to “see” for people with visual impairments, rather the goal is to facilitate access to the information that others access via sight. Assistive technologies also fill gaps created when mainstream technologies are not accessible. For example, Job Access With Speech (JAWS) is a software program providing text-to-speech (i.e., screen reading) access and control to inaccessible personal computers for people with visual impairments.

Although assistive technologies are a very specific type of personal technology, they arose out of a different kind of motivation. Originally created with the aim of helping injured veterans of war (Charlton, 1998; Cook & Hussey, 2002), the goal of assistive technologies are to “increase, maintain or improve functional capabilities of individuals with disabilities” (Cook & Hussey, 2002). The first devices consisted of canes and crutches, prosthetics and other

apparatuses designed to accommodate missing or injured limbs (Cook & Hussey, 2002; Galvin & Scherer, 1996).

The altruistic nature of the rehabilitation perspective on assistive technology design and use is situated in the occupational and physical therapy fields (Marcia J. Scherer, 1993a). These domains are primarily focused on improving the quality of life for people with disabilities, and combine with engineering and medical or rehabilitation expertise (Christiansen, 1999; Marcia J. Scherer, 1993a). Much is invested in developing assistive technologies that accommodate impairment, and just as much is invested in appropriately matching users with devices that will benefit their life and daily living (M. J. Scherer & Craddock, 2002; Marcia J. Scherer, 1993a). Still, rates of abandonment are high, with prior work reporting between 24% and 56% of assistive technology users not using their devices, particularly when assistive technologies actually do not fit an individual's personal preferences or daily living habits (Hocking, 1999; Pape et al., 2002; P. Parette & Scherer, 2004). A closer look at the construction of assistive technologies, and the ways in which they are expected to fit within a user's life (compared with how they actually work out) indicate how meaning is associated with such devices. I discuss these perspectives in more detail next, highlighting the role of personal meaning in technology use and acceptance.

### 3.3.2 *The Influence of "Function or Feelings" in Assistive Technology Use*

Auspicious and altruistic beginnings for assistive technologies, as aids to help injured soldiers carry on in daily life as much as possible, evolved into customized technical or mechanical solutions, a key part of occupational and physical therapy practice (Trefler, 1987). The need to tailor solutions to individual needs means that assistive devices are typically functionally unique and complex, even when used by people with similar disabilities. However,

their origins in rehabilitation engineering and occupational therapy result in devices with high expectations for functional success.

Not only have engineering-based perspectives predominately been the guiding design approach in creating assistive technology solutions for disabled people, the discipline of occupational therapy is, at its core, a field concerned with helping people participate in everyday activities<sup>2</sup>. Occupational therapists include a variety of techniques and technologies to help them accomplish their job (Trefler, 1987). The increase in the number and availability of assistive technologies in the late 1980s and early 1990s motivated occupational therapists to actively push for better understanding of available devices and to find the right solutions for those who needed them (Gilkeson & Krouskop, 1987; Trefler, 1987). Preoccupied with the plethora of new technologies now widely available, and the sophistication of computer-based technologies, finding the right technical solution and appropriately matching it to a person in need constituted successful assistive technology use (Hocking, 1999; Trefler, 1987). Heralding success as functional independence meant associating failure with user incompetence or insufficient training; meanwhile, users' own perceptions and identities as disabled strongly influenced rates of abandonment, and rates of assistive technology abandonment were subsequently documented as high as 56% (Hocking, 1999).

Studies in occupational therapy and rehabilitation investigated why assistive technology users would abandon their devices, and determined that while technologies could be useful, and successful techniques in matching users with devices were key, users had assigned a host of meanings with their use of assistive technologies. People reported feeling “marked” by their assistive technologies because their devices look and feel “medicalized” (P. Parette & Scherer,

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<sup>2</sup> <http://www.aota.org/About-Occupational-Therapy.aspx>

2004; Marcia J. Scherer, 1993a). Reasons for abandoning devices comprised non-functional issues, and included acceptance of an acquired disability, concerns over physical appearance, social acceptability of assistive device use and incongruence with cultural traditions (Hocking, 1999; Pape et al., 2002). Despite the uniquely personal features of assistive technologies, such devices were regarded as only functional tools and thus could be considered stigmatizing (Bispo & Branco, 2008, 2009, 2011; Dawe, 2007; Jacobson, 2010; H. P. Parette, Wojcik, & Peterson-Karlan, 2005; P. Parette & Scherer, 2004; Marcia J. Scherer, 1993a). I highlight the notion that a person's own perception of identifying as disabled, or having to use a specific assistive device, influenced their use of the device so strongly that they stopped using it altogether. It is clear that people with disabilities could abandon assistive technologies for both functional and non-functional reasons (Hocking, 1999; Marcia J. Scherer, 1993a). People are less likely to use assistive technologies that draw unwanted attention due to noticeable differences in use, or because they stigmatize users (Hocking, 1999; Pape et al., 2002; P. Parette & Scherer, 2004; Marcia J. Scherer, 1993a).

Research in occupational therapy examined what therapists could do and offered strategies for improving how assistive technologies were developed, assessed, and paired with users (H. P. Parette, Huer, & Scherer, 2004; M. J. Scherer & Craddock, 2002; Marcia J. Scherer, 1993b, 1993a). Although strategies, like the Matching Person and Technology assessment tool were developed and ought to help find appropriate devices for people with disabilities (M. J. Scherer & Craddock, 2002), it has become clear that non-functional factors, or "feelings," have an outsized influence on technology abandonment (Hocking, 1999; Marcia J. Scherer, 1993a). Furthermore, it is worth noting that the field of occupational therapy is inherently biased to view its "clients" as less-able and less knowledgeable about disability and accommodation. Taken

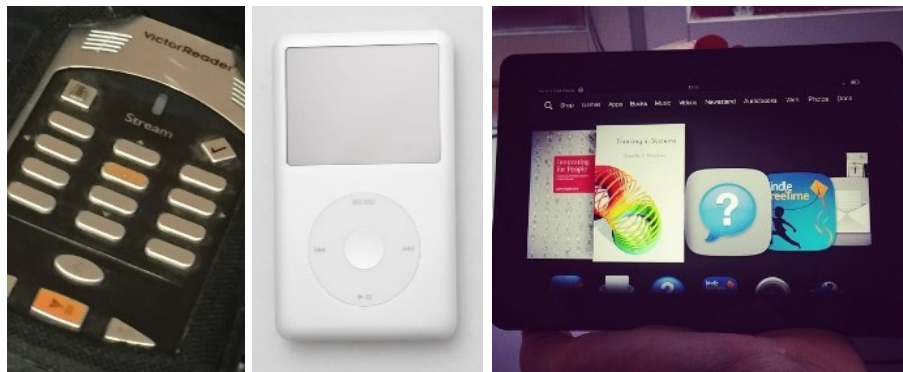
together, these views present an opportunity to incorporate the reflective approach of design, and the critical perspectives of Disability Studies.

### 3.3.3 *Assistive and Mainstream Technologies*

Assistive technologies have carried with them the label of being devices needed only by people with disabilities. This designation in the collective social consciousness alone relegates assistive technology use as difficult for people who have trouble identifying with their disability, or who do not wish to be identified as such. Unfortunately, rapid technology innovation in the last twenty years has reinforced the negative social designation of assistive technologies as stigmatizing. Few assistive technology options are available to users with disabilities and most mainstream technologies are not accessible off-the-shelf (Kane, Jayant, Wobbrock, & Ladner, 2009). Mainstream personal technologies are not accessible partly because people with disabilities are a small niche population of device users, and most technology companies are unwilling to invest resources on design and engineering for a small group with little return on investment (Marcia J. Scherer, 1993a). Not many assistive devices are available for the consumer market, or they are prohibitively expensive and hard to get or maintain (e.g., malfunctioning devices require special repair).

Adding to the stigma of current assistive technologies, then, is the rise and co-incidence of mainstream and assistive devices with similar capability, creating perceptions of what disabled people can and cannot do. Furthermore, the technological divide is not only technical or mechanical, but also legal, with insurance practices contributing to isolating accessible options in proprietary formats. For example, the Digital Accessible Information System (DAISY) makes copyrighted text available and accessible to those with “print disabilities,” those who have a limited ability, or none at all, to read print. With disability-specific devices supporting DAISY,

like the Victor Reader Stream (Figure 3.1), there persists the assumption that mainstream devices need not adopt strong accessible design (e.g., original versions of Amazon’s Kindle did not allow all books to be available in text-to-speech mode and did not natively use DAISY file formats (Friedlander, 2010a, 2010b)). Although the Victor Reader Stream is touted for its usability and its markedly sleeker form factor, it is considered bulky in comparison with products like the Apple iPod or Amazon’s Kindle Fire, which, in turn, fall short on accessibility (Mason, 2013).



**Figure 3.1. Left, a first generation Victor Reader Stream is an e-book device that plays DAISY format files. Its form is somewhat similar, and yet very different from mainstream counterparts, the Apple iPod (middle) and Amazon’s Kindle Fire (right). (Berkeley, 2009; Niemela, 2013)**

Functionally similar technologies that reside in socially different purviews impact use. For example, the BrailleNote (see Figure 1.1) is popular among blind users, supporting word processing, email, and internet connectivity. Operating like a laptop, a key difference is user interaction, via Braille or a screen and a QWERTY keyboard. Fundamentally, the devices are used for much the same reasons, like checking email, yet BrailleNote users report feeling uncomfortable when the device emphasizes their disability (Shinohara & Wobbrock, 2011). Nondisabled people do not know that BrailleNotes do things that laptops do, and because BrailleNotes closely resemble laptops (and are used in lieu of inaccessible laptops), others perceive the BrailleNote to have a unique purpose: to help people who cannot use laptops. By comparison, if white earbuds convey what device they are using, an iPod user gets functionality

and social capital, whereas a BrailleNote user sacrifices social capital for functionality (using proprietary instead of mainstream technology). It is also worth noting that these “fashionable” aspects of technology identity change with new technologies and trends; what is “cool” today may change tomorrow, but key is providing choices to users that cover the spectrum of what is in vogue, functionally and socially.

Not all technologies that are assistive or accessible are considered stigmatizing. Some popular devices do have accessible components. Apple’s built-in VoiceOver made sleek and appealing iPhones accessible, shifting the user demographic to include a number of blind people.

The inclination to view those with disabilities as necessarily needing help is an outdated view, couched in the medical model of disability, as is the assumption that disabled people need accommodation to be capable in—rather than have *access* to do—everyday tasks. Instead, if we adopt the notion that disability is a social construct, the design of which is perpetuated among the tools, services and technologies created with the goal of “helping” (DePoy & Gilson, 2014; Linton, 1998), then we can see the consequences are that technologies perpetuate a perception that people with disabilities need assistance. Thus, in my work, rather than tackling the issue of assistive technology design as one of “making it more mainstream” or “adding” a social dimension in the design process, I consider the underlying societal mechanisms that lead designers (and technology innovators in general) to *not* include disability as a core part of the target user group.

### 3.4 WEARABLES AND TECHNOLOGY ACCEPTANCE

The present day personal technology market is flooded with powerful, ubiquitous technologies available in a wide range of platforms and formats, affordable for use in everyday

personal life. In addition to providing functionality for everyday tasks, personal technologies can be selected on the basis of factors that reflect identity. Research applying the Technology Acceptance Model (Venkatesh, Morris, Gordon, & Davis, 2003) to wearable technologies suggests that perceived usefulness and ease of use are significant factors in whether or not an individual will choose to incorporate a wearable device in their daily life (Lee, 2009). Work investigating “smart clothing” similarly arrives at conclusions indicating a functional need, as well as aesthetic qualities that contribute to a user’s acceptance of wearable technologies (Ariyatun, Holland, Harrison, & Kazi, 2005).

Finally, in recent years, the low-cost availability of 3D printers has made do-it-yourself (DIY) accessibility a real possibility (Hurst & Kane, 2013). The “maker” and fashion communities have converged on design with an emphasis on individual expression (Lyden, 2015). We look forward to the future of these burgeoning communities, but highlight that few people today have regular access to 3D printers, that these tools and their software themselves must be accessible, and that adaptations may still incur a high cost to design and produce. Some knowledge of design may be required, and these printers are not designed for mass production, sometimes taking days to print a single item. 3D printers are well suited for individual DIY projects, but do not necessarily address design issues. Indeed, the concept of design for social consideration still deserves attention from the design and disability communities at large, and not only from proponents of DIY and maker culture.

### 3.5 SUMMARY

Although assistive technologies, by definition, are created to provide functional assistance, they tend to draw unwanted attention more often than not. Despite design strategies, particularly in the HCI tradition, that focus on people and accessibility, few technologies exist

that are accessible and considered socially appealing. Meanwhile, assistive technologies are often abandoned for personal and functional reasons alike (Hocking, 1999; Pape et al., 2002; P. Parette & Scherer, 2004; Marcia J. Scherer, 1993a). To address low acceptance rates of assistive devices, researchers in occupational therapy and rehabilitation suggested methods for matching users to technologies that would be useful for them (M. J. Scherer & Craddock, 2002). But such an approach adheres to the field-specific designation of occupational therapists as experts, disempowering users to choose what they prefer. Current trends in technical innovation provide comparison cases where mainstream technologies are functionally similar to assistive ones, yet uphold outdated perceptions that disability necessarily requires help or assistance.

Assistive technologies are often abandoned or considered ill-matched with users for a variety of reasons, resulting in reduced access or abandonment. These outcomes are problematic because they prevent sufficient participation in a social world. Increased public use of mainstream digital devices means that people are accustomed to seeing them in everyday situations, making the presence of assistive technologies stand out compared to mainstream counterparts. Indeed, assistive technologies are disability-specific, but perhaps do not need to be. Perhaps another possible strategy is to go further than matching people to devices, but to examine how technologists, in general, approach the tenuous coupling of human and technology: why not include people with disabilities in the general purview of design? More specifically, what is our role as technologists in technology creation, and how can we make change in positive and inclusive directions? The next few chapters of this dissertation outline the research I undertook to better understand and identify the forces that may negatively impact assistive technology use.

## Chapter 4. IN THE SHADOW OF MISPERCEPTION: THE SOCIAL ACCEPTANCE OF ASSISTIVE TECHNOLOGY<sup>3</sup>

### 4.1 INTRODUCTION

In this chapter, I describe research I conducted to understand the emergent relationship between people, assistive technologies and perceptions in social and public spaces. In chapters 2 and 3, I outlined theoretical foundations for socially constructed identities and described research indicating that people with disabilities abandon their technologies at fairly high rates. What about assistive technology use drives users to abandon their devices? The literature and related work indicate an underlying discrepancy between how assistive technologies are envisioned for use and how their use actually manifests in daily life. Rehabilitation and occupational therapy literature suggests discomfort with assistive technologies is not uncommon; Disability Studies and social sciences frame human social interactions as rooted in socially constructed perceptions of disability and identity. These lead to questions about what underlying social forces influence technology use for people with disabilities. In an effort to understand the phenomena around use, social perception, and abandonment, I conducted an interview study asking people with disabilities about how personal preference influences their use of assistive technologies in social situations.

The work described in this chapter provides empirical evidence demonstrating how assistive technology impacts social perceptions and access for people with disabilities, and vice versa. Specifically: disabled users are aware their devices notably differ from their nondisabled

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<sup>3</sup> Portions of this chapter were published as: Shinohara, K., & Wobbrock, J. O. (2011). In the shadow of misperception: Assistive technology use and social interactions. In Proc. CHI '11 (pp. 705–714). Vancouver, BC: ACM.

friends' devices, and might feel self-conscious about having different technologies, especially if the devices have the same capability as mainstream devices.

## 4.2 BACKGROUND AND MOTIVATION

As is apparent across the themes raised in chapters 2 and 3, assistive technology use does not happen in a social vacuum, and personal preferences in social contexts may dictate whether and how a device is used (Shinohara & Tenenberg, 2009). This implies an effect on technology use arising from social contexts. I conducted an interview study investigating the effects of assistive technology use in social and professional contexts from the perspective of people with disabilities, a perspective often lacking in assistive technology research. In this study, I asked twenty people with disabilities how they felt about using assistive technologies in social and professional contexts. I found that while assistive technology empowered and enabled participants to work, socialize, and orchestrate their lives, it still lives in the shadow of social misperceptions. These misperceptions may perpetuate social barriers to accessibility. Assistive technologies are used in social situations and not in isolated laboratories; therefore, design of such technologies must be assessed for impacts on social and professional interactions.

Assistive technologies often bridge functionally and socially-situated experiences. The movement led by Disability Studies rejected the notion of disability as a medical condition, and promoted the critical view of disability as socially constructed, emphasizing that impairment lies not in the person, but in the environment; access or in-access, thus, are situational and societal constructs. Rather than creating technologies and environments excluding people of varying abilities, this socially constructed view says the environment should be built to enable access. I take this one step further: technology should also be built not to disable, but to enable.

Many social factors pervade choices in using assistive technologies, not just usability and functionality: people with disabilities are more likely to abandon an assistive device if they do not accept their disability, if the device socially excludes them (makes them feel different from peers), or if the device significantly clashes with cultural values (Pape et al., 2002). Elements contributing to stigmatization were determined to be aesthetics, gender and age, social acceptability and deference of rehabilitation professionals (P. Parette & Scherer, 2004). Indeed, some assistive technology users employ modifications as a way to manage stigma, using customization to adjust devices to personal preference or preferred social identity (Jacobson, 2010).

Clearly, assistive technology is used in and around social interactions, and is subject to social expectations, but how? How much does perception shape meaning of assistive technologies in socially situated contexts? In what ways might assistive technologies mark users, perpetuating misperceptions about people with disabilities? These are some of the questions this empirical investigation addresses.

### 4.3 METHOD

I interviewed twenty participants in sessions ranging from 60 to 90 minutes. Interviews were held in university spaces or at participants' place of work or home. Participants were recruited through various local assistive technology center email lists and were compensated for their time. Eleven participants were blind; 3 lost their sight later in life, while 8 were blind from birth. Three participants had low vision, 1 due to macular degeneration. Four participants were deaf or hard of hearing, 1 lost hearing later in life, and 3 were deaf from birth. One participant was deaf-blind, 1 had cerebral palsy. Table 4.1 lists participants and technologies discussed or shared.

	<b>Disability</b>	<b>Age</b>	<b>Sex</b>	<b>Employment</b>	<b>Technology (previously used devices)</b>
1	Totally blind, born with vision in one eye	57	M	Retired fisherman, Sports Supervisor	JAWS, BrailleNote, HTC Touch Pro cell phone with MobileSpeak & MobileGeo, white cane, netbook, (Victor Reader), (Perkins Braille), BookSense, guide dog
2	Leber's Congenital Amaurosis (blind)	28	M	Assistive Technology Specialist	accessible cell phone, BrailleNote, KNFBReader, Victor Reader Stream
3	Congenitally blind, losing hearing	58	M	Retired	JAWS, hearing aids, Perkins Braille, (slate and stylus), (BrailleLite), Braille Display, (Duxbury), (books on record), (Optacon), white cane, cell phone - not accessible, talking watch
4	Lost sight 5 years prior, totally blind	30	F	Student	JAWS, talking watch, Nokia cell phone with MobileSpeak, white cane, Victor Reader
5	Born with low vision	44	F	Mental Health Counselor	ZoomText, Victor Reader, monocular, (books on CD), (books on cassette), (books on record), glasses for low vision, (CCTV), (large print typewriter)
6	Lost sight due to Retinitis Pigmentosa	71	F	Retired Librarian	VoiceNote, JAWS, Screen magnification, Screen contrast, CCTV, books on tape, Victor Reader Stream, Verizon LG cell phone - not voice accessible
7	Congenitally blind	58	F	Unemployed	JAWS, Braille, Victor Reader Stream, Slate and Stylus, (books on reel-to-reel books), (books on tape), Braille Display, (Braille N Speak), (portable typewriter)
8	Congenitally blind	58	F	Transition and Independent Living Specialist	(books on reel-to-reel tape), (books on tape), (books on record), BrailleNote, white cane, Nokia 6682 cell phone with Talks accessibility program, (Optacon), scanner with Kurzweil software, Duxbury
9	Low vision	49	F	Assistive Technology Instructor	white cane, speech program on computer, Nokia N86 with voice accessibility, BrailleNote, talking scale, (tape player for note taking), (Perkins Braille), (Slate and Stylus), (regular typewriter), (books on reel-to-reel tape), (CCTV)
10	Congenitally blind, losing hearing	56	F	Unemployed	Perkins Braille, hearing aids, Screen Reader, (optacon), Slate and Stylus, (portable typewriter)
11	Congenitally blind	61	F	Retired Social Worker	PacMate, iPhone, KNFBReader, scanner, Braille Display, talking microwave
12	Low vision, Macular Degeneration	72	F	Retired Professor	iPhone, iPad, magnifying glasses, glasses, monocular, JAWS
13	Deaf-blind, Usher's Syndrome	39	M	between jobs	Deaf-Blind Communicator, white cane, TTY, ZoomText
14	Deaf	38	F	Director, Human Services	iPod, videophones, phone captioning, pager with IP relay, TTY, Video Relay Service, (FM System), netbook, cell phone, flashing doorbell, flashing and vibrating bed alarm
15	Hard of hearing	59	M	Salesman	hearing aids, iPhone, headphones for home use, captioning, (ASL)
16	Hard of hearing, low vision (Usher's Syndrome)	52	M	Retired	hearing aids, white cane, Computer Aided Real Time captioning, guide dog, cell phone
17	Hard of hearing	56	F	Freelance Editor	cell phone with bluetooth, TTY, hearing aids,
18	Cerebral palsy	69	F	Advocate	Pathfinder Communication device
19	Congenitally blind	59	M	Singer	Victor Reader Stream, talking watch, BrailleLite, (Perkin's Braille)
20	Lost sight due to Retinitis Pigmentosa	48	M	Unemployed/Retired	CCTV, ZoomText, JAWS

**Table 4.1. Participants and Assistive Technologies**

Participants were asked about what assistive technologies they used, how these technologies were used, what they thought of their technologies, and what it was like to use assistive devices around others in social or work contexts. Wherever possible, participants were

encouraged to show their technologies. If participants had a disability since birth or childhood, they were asked to compare past and current devices. They were also asked if they thought there were misperceptions surrounding their technologies, and if they ever felt self-empowered or self-conscious when using their assistive devices.

#### 4.3.1 *Analysis*

All interviews were recorded and transcribed verbatim. Using a grounded theory approach (Glaser & Strauss, 1967; Strauss & Corbin, 1998), transcripts were coded using open and axial coding; similar categories and concepts were combined, then compared with concepts in subsequent interviews. Early interviews were initially open coded for specific concepts to pursue in later interviews. From the developed categories, dimensions and properties were drawn out.

### 4.4 RESULTS

I found that participants balanced complex relationships with their environment and with others while using their assistive technologies. They negotiated feeling self-conscious with the desire to be independent and the need to be productive, especially at work. Participants used a wide variety of proprietary and mainstream technologies, as shown in Table 4.1, over a range of social and personal activities, including: for education, traveling, entertainment, engaging with friends, at work, and safety. Devices discussed included electronic note takers, hearing aids, the Victor Reader Stream (digital book player), monoculars, magnifying glasses, and video relay services. Some participants also used mainstream devices, such as the Apple iPhone and iPad, netbooks, cell phones, laptops, and desktop computers. A range of devices and systems bridged proprietary and mainstream technologies, including Bluetooth-compatible hearing aids, and

JAWS (Job Access With Speech) software, as well as proprietary devices such as the Victor Reader Stream integrated with SD (Secure Digital memory) cards, and several blind participants used scanners with OCR (Optical Character Recognition) technology to access print.



**Figure 4.1. The Pathfinder Communication Device used by P18.**

#### 4.4.1 *Assistive Technology in a Social World*

Assistive devices played both central and peripheral roles in social interactions. For instance, the Pathfinder (Figure 4.1) and the Deaf-Blind Communicator were used as primary communication tools for P18 and P13, respectively. In comparison, the Victor Reader Stream and software like ZoomText and JAWS were peripheral in most social interactions. Technologies in central social roles were more conspicuous than others. While peripheral technologies were not usually central to interactions, many influenced how social interactions played out, particularly at work. If peripheral technologies were more visible and “weird” or “strange” looking, they tended to attract attention from others. Smaller devices and those that looked like mainstream counterparts attracted the least attention.

Participants were aware their devices attracted attention by the kinds of questions and comments they received. In some cases, participants were sensitive to the reactions of others around them, for instance, taking note when another person seemed uncomfortable, sent furtive

looks, or by their tone of voice. Despite this, participants did not significantly alter device use, although they reported feeling self-conscious about attention in a few situations: (1) if they had an “invisible disability,” one that may not be apparent without explicit disclosure; (2) when using traditional and socially recognizable devices, such as a white cane or hearing aids; and (3) when design attracted attention to differences from mainstream counterparts, for example, voice accessible phones that spoke aloud commands everyone could hear.

#### 4.4.2 *Just Like Everyone Else*

Participants valued technology enabling equal access because it allowed them to do things just like everyone else. Two caveats to this perspective were that participants felt they should retain disability-specific training (for example, blindness skills, or American Sign Language), and that not all technologies leveled the playing field of access. P18 explained that her device allowed others to “see I can communicate like any person,” resulting in improved social interactions. P7 felt empowered because she had access just like everyone else:

*... it's just neat that I can do things,... that other people can do. Like, I can have books to read that I want to read... when I first got my scanner I was really excited about it because then I could ... buy books that weren't available, and I could read those books,...I would say your technology is your lifeline...it opens up worlds of opportunity. -P7*

Still, participants reported assistive technologies lagged behind current technical standards, meaning they did not truly have access like everyone else. P2 discusses the appeal of mainstream technologies and how people feel about assistive technology always being a step behind:

*You know, if someone's using an iPhone, and I'm using an iPhone, that's normal, right? It's the same thing... like Universal Design, you build the accessibility directly into the products, then you're not using some clunky, blindness specific product. A term that gets thrown around sometimes is blind ghetto products. ... cell phones have, like, all these neat features and stuff, but,*

*...the BrailleNote's just catching up. When you know, it doesn't even have like, 802.11n, which is the new networking standard. You know, but it costs six grand. I mean, come on. -P2*

An important point must be made: participants recognized that no assistive technology would fully replace sight, hearing, or any kind of functioning. Rather, they most valued having access to the information and services everyone else had. Finally, as seen in these comments, many participants expressed the importance of being seen with assistive or mainstream devices in order to demonstrate how they were capable of doing just as much as anyone else.

#### 4.4.3 *Design and Aesthetics*

As mentioned previously, participants were aware of how their technologies differed from the mainstream status quo in quality of access and function, of how their technologies looked different than mainstream technologies. Device design and aesthetics were divided into appealing and unappealing characteristics, based on look and feel. It was noted that manufacturers of proprietary technology do not appear to make an effort to make their devices aesthetically appealing. P2 described his experience upon discovering the color of his BrailleNote earbuds:

*The original BrailleNote used to ship—I don't remember what color they were—but they were the ugliest earbuds you could possibly—like, bright orange or something. It came with these hideous earbuds. And, I had one of my friends—sighted friends—is like, 'man, you—those things are awful, dude. You should never use those.' And I had no idea. But, of course, they just thought, since it was a bunch of blind people they're shipping this stuff to, it didn't matter. -P2*

P10 explained she cared about the design of things she used because it could be a reflection on her:

*I like things attractive. Whatever adaptive equipment, I want it to look nice. You know, you got everybody with their iPods and their iPads and their Blackberries, you know, and they're whipped out, they're small... and they're nice looking. Cause—Apple would not be selling their "i" stuff if it wasn't good looking. And,*

*as a blind person, yeah, maybe I don't see it, but other people see it, and I want it to be, you know, just as glamorous as the next guy. –P10*

If a device looked similar to mainstream devices, or if few alternatives existed (for instance, electronic note takers are the only devices providing portable refreshable Braille), participants did not report feeling self-conscious. But, if devices looked unlike anything else (monoculars), or were altered versions of mainstream counterparts (extra thick glasses, large print typewriters), participants were more likely to report feeling self-conscious (Figure 4.2). This last category was compounded by the fact that many who used such devices also had “invisible disabilities” and could pass as having no disability (if they were not using assistive devices). Illustrating this point, P8, a transition specialist for young blind and low vision students, observed:

*So anything that might be cosmetic, is a real big... like the monoculars, or big thick glasses, or a hand held magnifier, you know. Some of those things are more of a cosmetic kind of thing. They're real visual... And even the large print books, because if you're carrying those around, they're probably, legal size paper, if not bigger. You know, so they really are huge compared to what other kids carry around. And so they don't like to carry those around. –P8*

Two of the three participants with low-vision reported they could pass as nondisabled if they were not using their devices. Speaking to this, P5 explained how she negotiated self-consciousness and utility:

*...a device is no use to you if you won't use it. So, I think there's some holes between shame and utilitarianism... Like, this is gonna be efficient for me, and I'm gonna do it. You know, and on the other end of it is, I'll just figure out any way to do this where I won't be noticed. And I've been on both ends of that and everywhere in between. –P5*

Internal battles between self-consciousness and utility were most prominent among the low-vision participants. Other participants also overcame feelings of self-consciousness through adopting utilitarian viewpoints, but to a lesser extent. Like P5, participants recognized their

devices as tools enabling them to do things such as write papers for school or contact work clients. Finally, while acknowledging different-looking devices attracted attention, some participants reported not feeling self-conscious.



**Figure 4.2. From left: Victor Reader Stream, monocular, glasses.**

#### 4.4.4 Avoidance

Many participants reported they avoided using certain technologies as much as possible at one time or another. P8 describes what she perceived cane-use to mean and how she did not want “that” to be her:

*...when I was a teenager I wasn't gonna use a white cane because I was blind and I didn't want—The only example I had of a blind person using a cane, it sounded like they were shuffling their feet, and they had their head down, and they were... you know? ...so I wasn't gonna use the cane. –P8*

Similarly, P9 explained why she refused to use a cane at first: “because I felt it really caused me to stand out.” She wanted to avoid being marked as the blind person P8 envisioned. Many of the blind and low-vision participants echoed this sentiment. But where P8 and P9 eventually did start using their canes, it was something P12, who had macular degeneration, still had not adopted:

*The kind of thing that I have a problem with, and I do not use, is a white cane. I mean, that is—that is a hurdle that, boy, that's gonna be awhile before I get over that one.... Because, it just immediately, kind of marks you out as different, as*

*having vision problems. Most people who meet me, until I tell them, have no idea. And, I guess I kind of prefer that. –P12*

Although not as prevalent, some participants with hearing loss also experienced a reluctance to wearing hearing aids so often associated with the elderly. P15 describes why:

*...it's just the acceptance of it, which is much harder, compared to, say like, glasses, which you know,... it's universal, it's socially accepted... Again, the frame of reference being that the people you knew who wore hearing aids was your grandfather. And, so there's that part of it. ...I think it's some sort of social stigma. And I still experience that now. –P15*

While P15 felt glasses were more socially acceptable than hearing aids, P10, herself congenitally blind, had a hard time accepting hearing loss and hearing aids:

*The hardest thing for me was to accept—was having to use a hearing aid. And, it took me a really long time. I was really kind of surprised at myself, 'cause I am pretty matter of fact. But it was just coming to terms with the fact that I wasn't hearing as well as I used to... I was afraid it would look awful. –P10*

Although the white cane is not an electronic assistive technology, it is an assistive device, and connotations participants associated with it tells much about the social meaning they attributed to this device. They were aware of the social stigma of these devices, and it did not matter if the participants were totally blind, had low vision, were born deaf or became deaf later in life. This tells us some assistive devices do, in fact, have strong social meaning associated with them. It is hard to guess how such perceptions came to be a part of these devices, but it is clear participants did not want to be associated with these perceptions. As seen in P8's comment about using the white cane, they felt such perceptions did not represent who they were at all.

#### 4.4.5 Safety

In contrast to avoidance, some participants purposefully chose to call attention to their disability, usually for safety reasons, through the use of their devices. P9 describes how she began to use her cane:

*...once I kind of... got over my inhibitions, and all the concerns that I felt about what people would think of me in high school, I found that it was so much easier. I mean, a cane gives information to the world. It says to people, 'this person is blind'... You know, 'give her another couple seconds before you blast on your horn when she's crossing the street,' you know? Um, 'just go easy.' ... So, to me, the cane was one of the most empowering things, but it was also... one of the most difficult things for me to sort of admit that I needed. –P9*

Not all assistive technology used for safety reasons were appropriated to identify the person with a disability. For instance, P14 used a pager with an IP address service in case of an emergency where she might need to call for help. P1 avoided any technology with wearable straps, wary that such devices might invite attackers to “yank” them off his neck. P20 explains why safety was an important concern:

*I would say it's a more perceived feeling of being threatened, or being less safe. And a lot of that is because there's a realization, first of all, we don't know our surroundings. Other than from what we can hear. And we can't run. And, maybe you can fight, but... you don't know who you're fighting and what they may have in their hand. And if you fight, you gotta get up close, and then—even then, what happens if you win? You still—what are you gonna do, grab your cane, and click clack, click clack, click clack down the street? So... you start thinking of all the implications, like, okay, hmm, I just need to be more aware of—that I keep myself out of situations that may be unsafe. –P20*

These descriptions give credence to the safety concerns of people with disabilities, while also highlighting important concepts of device design, use, and safety. It is important for people with disabilities to be able to identify and communicate something about their disability, depending on the context, but only if they so choose. Recall that P9 used her cane to identify her as visually impaired so people would know she may not see them. At the same time, P1 did not want people to recognize his blindness-specific technologies; thus, he did not wear them visibly for others to see, and he was wary of designs implicating a device be worn. Finally, expensive proprietary technologies are hard to replace and require extra security.

#### 4.4.6 Help

Themes of help arose out of many of the social interactions participants described. Not all kinds of help involved assistive technology directly, but I include them because they were strongly tied to perspectives on identity, which in turn, was tied to assistive technology use. Participants negotiated when they asked for help, especially if they had an assistive device at hand. P4 was careful when asking for help so as not to burden friends or family, and also because she did not want them to think less of her. Here, P4 associates asking for help with her own abilities, and consequently, how she wants others to identify her. She is concerned with what is portrayed about her if she asks for help too much:

*I don't want people to—just view me as a disabled person. I want them to view me as Karen, so, it's like when I ask them questions, it's like, okay, I'm this disabled person asking questions. It's not Karen asking questions. And it's just sort of like—sometimes if I ask questions a lot, then it's like my—it's like I'm losing my... personality. –P4*

Participants reported that strangers offered unwanted help, grabbing, pushing or pulling blind participants, assuming they knew where the participant was headed. People over-articulated or spoke loudly, trying to compensate for deaf participants' hearing loss. P5 received emails in large font by people who knew she had low vision and assumed she had no accommodations (in fact, she used ZoomText ). This “discombobulated” her (her word), requiring her to adjust software settings. In unwanted help, the helper identified the participant as having a disability, was unaware of the participant's abilities or accommodations, made assumptions, and took it upon themselves to “help.”

Issues of help were significant because they occurred often and because participants felt that if others saw them getting help, they would consider them less able. Issues of help have implications for assistive technology design. As I have shown, participants did not want to be

identified as helpless, they wanted others to see how assistive devices made them independent and capable. It was important for participants to be able to use devices confidently, and it was just as important for others to see this as well.

#### 4.4.7 *Ignorance and Misperceptions*

When participants were offered unwanted help, it was often because others did not know what the participants could do. Many social interactions involved participants answering questions about their disability or devices; some questions overstepped social and privacy boundaries, such as, “how did you lose your sight?” or, “What’s that?” interrupting participants about an assistive device they were using. Most participants welcomed the chance to educate others about having a disability, although some felt such questions were too personal and an invasion of privacy.

People asked questions because they were unfamiliar with assistive technology. One problem with this general unfamiliarity was that people then made incorrect assumptions. P6 described how the reactions of others made her feel self-conscious about what they were actually thinking about her using a VoiceNote :

*When you’re in a group of sighted—especially sighted people, you know, and you bring out something like this. They’ll say, ‘Oh, what’s that? What’s that? Oh, isn’t that wonderful?’ And they’ll get sort of patronizing. They’ll say, ‘oh, isn’t that wonderful? You can have that?’ –P6*

P6 discusses how this patronizing perspective from others leads to misperceptions about what her device can do:

*I have a friend and we were talking about being disabled. She said, ‘well, you have your VoiceNote.’ It’s like people think you can be normal... because you have some technology...you’re still not visually normal. But... I don’t know, she had the misperception that, well, I could just live a normal life because I had a VoiceNote... Well, I can live better. But I don’t... see, I’m comparing it to a visual*

*life. And, I thought, I still don't live a visual life, even though I have assistive technology. But, I know the difference between sighted life and not sighted life.*

*–P6*

While others think her device is “wonderful” and will make her “normal,” P6 instead views her device as just another tool that improves her life. P6’s encounters were not unique among the participants. They felt empowered and grateful to have assistive technologies, but as P10 explains, most participants considered their devices just another tool:

*I don't think it represents me as a person. It's a device. The same way as a sighted person using a blackberry or whatever—it doesn't represent them. It's just a tool that they have, it's a toy they play with all the time... that makes life a little bit more convenient... and that's the way I look at whatever adaptive technology I use. It's the same thing as my sighted neighbor using their computer toys. –P10*

Participants rejected supercilious comments about their devices because they patronized what participants felt was their ability to do just as anyone else. The perspective that assistive devices were “wonderful” and could make people with disabilities “normal” was a charitable view on assistive technology use, and was not accurate or realistic. The two most commonly reported misperceptions by others about assistive technologies were that (1) assistive technologies functionally eliminated a person’s disability (made them “normal”), and (2) that without an assistive technology, a person was helpless and could do nothing. The first misperception was rooted in ignorance about what assistive technologies do; the second was an assumption that the presence of an assistive technology meant a continual need for assistance.

#### 4.4.8 *Employment*

Participants viewed assistive technologies as a means to an end in employment situations. As important as having access and the ability to work was the perception on the part of others that participants had the ability to get a job done. For example, P4’s employer, a small

firm, was unaware of the technologies that would allow P4 access at work. Although she received a large monitor and JAWS software, her employer knew little about what might help her access print material with her sight nearly gone. In the end, she was demoted and given fewer responsibilities. P20 purchased his own assistive technology for work, and negotiated office interactions in new ways as a result:

*...you have to put your earphones on, so you don't annoy everybody around... and I didn't necessarily like ...being cut off from people. I like to sit in a room and hear what's going on... you know, get a sense of what's going on in... my team around me. And so that was my way of keeping track without being, you know, nosy. And so when I... was working with JAWS and had the earphones in, then I kind of felt a little cut off, and so that... took some getting used to. -P20*

Similarly, P14, who was deaf, found small workarounds so her vibrating pager would not attract unwanted attention at the office: "I finally got a mouse pad just to put the pager on so it wouldn't vibrate all over the table and make a loud noise and have people look at me." As an example of how choices affected work, P1 was hired for one job only when he described how he could get the job done:

*In the individual interview, they asked me one question, 'How you gonna do the paperwork and stuff we have?' I says, 'I got a Dell laptop that has screen reading software and if you can send it to me I can do it.' The head of human resources says, 'Well, you got the job, congratulations.' I says, 'What about the rest of the interview?' He says, 'You don't need it. You impressed us at the group interview, so we only had one question for you.' -P1*

At one point, he opted to use the BrailleNote, but eventually abandoned it for his Dell. The BrailleNote's proprietary software was incompatible with his employer's software.

The most serious concerns were about losing jobs, not based on abilities, but on perceptions of disabilities by others. For these reasons, if they could, participants chose not to disclose their disabilities. P6 explains why she did not tell her employer she was losing her sight, and that technologies could alleviate the perceptions she feared:

*I must admit, I kept it from them so they didn't know. ...because I didn't want to lose my job. Because I know—this was back in the 80s, and I saw how the workplace was. The people with disabilities were often... let go for various reasons. So... I think if you look more mainstream, you look more able, then you're more likely ... to be employed. –P6*

The reported barriers to employment seemed to have little to do with participants' actual abilities. Incompatibility issues and negotiating new office norms added to the effort required to gain access at work. However, more serious misperceptions about ability and the unfamiliarity with assistive technologies significantly affected employment.

## 4.5 DISCUSSION

Participants in this study felt empowered when using their devices, but were also aware of misperceptions others might have about assistive technologies. These misperceptions may be inherent to social stereotypes about disabilities, but how are they influenced by assistive technologies? Some participants did not want to use white canes and hearing aids because the social stigma associated with these identified them as less capable. Although they did not associate the same stereotypes with current electronic assistive devices, they acknowledged aesthetic and design issues distinguished their devices from mainstream devices with similar functionality. How does this affect access? I discuss here the possibilities for electronic assistive technologies to run the risk of perpetuating social barriers, and what these perceptions what I believe this means for assistive technology design.

### 4.5.1 *Implications of Misperceptions*

I found two common misperceptions of assistive technologies: (1) that assistive technologies functionally eliminate a disability, and (2) the presence of assistive technologies mean that people with disabilities are helpless without assistive technologies. Although

participants were not concerned that electronic assistive technologies marked them in the way white canes and hearing aids might, I believe these misperceptions are problematic because they incorrectly draw assumptions about the abilities of the people who use them.

#### 4.5.1.1 Misperceptions About Ability

Several participants were concerned about appearing unable to use their technologies; they did not want to contribute to misperceptions that they were not capable. For example, some assistive technologies had steep learning curves or required special training. Although participants patiently learned to use their technologies, as seen in issues with help, they were concerned that making mistakes would make them appear less capable. Appearing incompetent might perpetuate the misperception that people with disabilities were unable to do things for themselves.

#### 4.5.1.2 Misperceptions About Mainstream Technologies

Misperceptions also support stereotypes that people with disabilities cannot use mainstream technologies due to disability. Recall P2 mentioned, “if someone’s using an iPhone, and I’m using an iPhone, that’s normal, right? It’s the same thing.” This implies a special, proprietary cell phone indicates the person using it is not normal. In turn, it implies that person’s disability precludes them from using mainstream phones like everyone else. But, if a person cannot use a device because the device is inaccessible, and not necessarily because of the person’s disability, this becomes an unfair and inaccurate misperception. P10 explains why device appeal is important for social perception:

*I’m a person. Not... you know? That’s why I like to see things a little more attractive, compact... where people might not notice them as much. So that they treat it ... like anybody else’s toys. –P10*

Misperceptions imply an ambiguous social construct. As we have seen, electronic assistive technologies are relatively unknown to many people. Despite the fact that participants felt enabled by the technologies they used, ambiguous social constructs gave way to supercilious and patronizing misunderstandings on the part of others of what assistive technologies do. I contrast this misperception with evidence that two blind and low-vision participants used the iPhone, an example of mainstream technologies usable by people with disabilities because of its accessibility features. Given this, misperceptions about assistive technologies may run the risk of marking people with disabilities by implying an inability to use comparable, mainstream technologies.

#### 4.5.2 *A Case for Mainstream Accessibility*

The misperceptions reported in this study appear to do little to assuage common stereotypes, and may perpetuate them instead: social misperceptions hinder true access. Ideally, there would be no misperceptions of disability, and stereotypes of people with disabilities would be that they are technically savvy and employable. Yet, this is not so. And while we may not be able change social misperceptions of disability, perhaps we can design technologies to alleviate such misperceptions by making mainstream technologies more accessible, or proprietary technologies more socially acceptable. Evidence from this study reveals an opportunity for new approaches to design that goes beyond functionality and usability to prioritize the social contexts in which assistive technologies are used, thereby avoiding the creation of designs that mark or stigmatize.

Functional differences between assistive technologies and their mainstream counterparts influenced misperceptions. For example, when participants described assistive devices using mainstream terminology, such as “iPod-like” or “iPod-esque,” it illuminated differences. Why is

a device iPod-like, but not an iPod? Whether functional or perceived, inequalities perpetuated the notion that assistive technologies are built only for people with disabilities because they cannot use mainstream devices. In addition, both functional and perceived differences do nothing to indicate what abilities people with disabilities have.



**Figure 4.3. P1's BookSense digital MP3 player.**

I do not believe this means all devices and services must be mainstream technologies. The Victor Reader Stream was a popular device among participants, partly because of the free downloadable book service offered by the National Library Service<sup>4</sup>. Still, P1 preferred to use the smaller BookSense (Figure 4.3), as he describes here: “Half the size of the Victor Stream ...But this is like, cool. See I like this 'cause I can put this in a coat pocket... on a bus if I'm going a long way somewhere.” The BookSense is a proprietary device and P1 still used the NLS for free books to load on his device. While both the BookSense and the Victor Reader have phone keypads, in almost all other ways, the BookSense is aesthetically more appealing. P1's preference for the BookSense demonstrates that the proprietary nature of a device does not mean it should not

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<sup>4</sup> National Library Service for the Blind and Physically Handicapped. <http://www.loc.gov/nls/>, 2010

have a better design. Therefore, the social acceptability of assistive device design should not be overlooked.

#### 4.6 SUMMARY

This study found that misperceptions rooted in differences between assistive and mainstream technologies led to socially constructed ambiguities around a person's ability. To that end, I identified two common misperceptions of assistive technologies. First, that assistive technologies eliminate a person's disability, making them functionally equivalent to a person with no disability. And second, that people with disabilities can do nothing without their devices. These indicate assistive technologies do not bridge social misperceptions of disability, and therefore may not meet their potential for enabling access. Design of assistive technology, whether proprietary or mainstream, should address not only function, usability, and cost, but also aesthetics and social acceptance. Furthermore, if people with disabilities use the same technology as everyone else, perceptions of what they can and cannot do may be re-aligned. After all, the technology now exists to provide them with this access, we should consider what this means for reducing stigma and changing perceptions. I close with a quote from P5, encapsulating social implications uncovered in this study:

*Well, it's difficult being a disabled person in this society, and people are...not kind. But you get this sense of—there's something wrong with me, people don't like me, I'm unappealing, I look pathetic, I look un-sexy, you know, whatever it is. And, people are staring at me, and they are. I'm not making this up. I'm not paranoid. I mean, they are! And, it's because they wonder what that is (points to device). They haven't seen that before. They want to know what's up with the person using it...I don't want to look helpless, I don't want to look pathetic, or something... so it took me a long time to...now I think I can just do it without really worrying about it at all, but what I had to do at first—this was many years of work—but what I had to do at first was cultivate this sort of 'f\*\*\* you' attitude, you know? –P5*

I believe more socially acceptable design might draw less unnecessary attention and change misperceptions about assistive devices. If “strange looking” devices mark a person as being dis-abled, perhaps socially acceptable, “cool” devices would indicate a person is capable of as much as everyone else. As Pullin emphasizes, addressing creative tensions between function and “fashion” in assistive technology may support “positive images of disability” (Pullin, 2009). There is an opportunity, then for design practices that address not only functionality and usability, but perception, misperception, stigma, affect, and aesthetics to maximize a device’s social acceptability.

In addition to form factor, usability and usefulness also contribute to assistive technology abandonment (Hocking, 1999; Pape et al., 2002; P. Parette & Scherer, 2004; Marcia J. Scherer, 1993a). Usability has an impact on how people feel about using their devices, and assistive devices are typically successful at providing users with functional capability promoting self-efficacy. But, to fail at using a technology in front of others could have greater negative consequences than not using the device at all (Hocking, 1999). While nondisabled users bemoan an unusable app (including blaming themselves for system errors despite usability issues (Norman, 1988)), disabled users worry their impairment is emphasized in the wake of a failed app (Branham & Kane, 2015). The bar is high to demonstrate self-efficacy via the use of technologies (whether assistive or mainstream) because people with disabilities are sensitive to the fact that others judge them on what they can do. Users report limited access and low feelings of self-efficacy when they feel less confident about their ability to use a device that should be tailored to their needs (Branham & Kane, 2015; Shinohara & Wobbrock, 2011); there is a fear that failure to demonstrate technical skill results in appearing less able and could be stigmatizing. In addition, fewer technologies for people with disabilities means that users have even fewer

choices if they cannot use a device. Awareness of similar but inaccessible mainstream devices make assistive technology users feel that their devices are less functionally relevant by comparison. Thus, much of the participants' feedback rested on assumptions about what others were thinking about their use of assistive technologies. And although participants could often tie feelings directly to a conversation or specific interaction, this study did not examine perspectives of nondisabled people who witnessed the use of assistive devices.

The findings from this interview study provide evidence that a technology's design and presentation has impact on the social interactions of users. But, what about technology design? What role, if any, does context have? What do bystanders think of these devices, and how are their perceptions shaped? Do people without disabilities actually form misperceptions about assistive technologies and disabled technology users? I address these questions in the next chapter: I conducted a diary study, investigating what socio-technical elements contribute to users' feeling self-conscious or self-confident about technology use. I also asked nondisabled participants about their perceptions of assistive technologies they see in public spaces.

## Chapter 5. DEFINING SOCIAL ACCESSIBILITY: SELF-CONSCIOUS OR SELF-CONFIDENT? A DIARY STUDY CONCEPTUALIZING THE SOCIAL ACCESSIBILITY OF ASSISTIVE TECHNOLOGY<sup>5</sup>

### 5.1 INTRODUCTION

The study described in the previous chapter found that participants were aware of the negative valuation associated with assistive technologies, sometimes to the point of affecting access. In this chapter, I describe a follow up study investigating elements of technology design that may contribute to negative perceptions. To understand the social dimensions of assistive technology use, specifically the perceptions and self-perceptions of assistive technology users, I conducted a diary study identifying and then bringing considerations of social accessibility to assistive technology design. Defining social accessibility as that which serves as a vehicle conveying both ability and social identity, I discuss how these themes contribute to the conception of a new perspective, Design for Social Accessibility. Building on prior work in understanding the misperceptions of assistive technology users (Shinohara & Wobbrock, 2011), I undertook an empirical study of people with and without disabilities to understand how perceptions of assistive technology use in public and social spaces arise.

The key findings of this work lie in contextualizing the social accessibility of assistive technology and in understanding how assistive technology is perceived in social situations. I provide evidence that: (1) technology breakdowns are both functional and social, and can

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<sup>5</sup> Portions of this chapter were published as: Shinohara, K., & Wobbrock, J. O. (2016). Self-Conscious or Self-Confident? A Diary Study Conceptualizing the Social Accessibility of Assistive Technology. *ACM Transactions on Accessible Computing*, 8(2), 1–31.

therefore negatively affect social interactions; (2) the opposite of a breakdown is manifested as self-efficacy and self-confidence, leading to positive social interactions; (3) feelings of self-consciousness and self-confidence are indicative of the role assistive technology plays in “socially recursive inference,” and is characterized by the social feedback loop from which individual social behavior is derived (Mead, 1962; Tomasello, 2014); (4) the functional and social design of technology can affect social participation; (5) and the existence of assistive technology is noticed and contributes to misperceptions of people with disabilities. In particular, if a technology malfunctions, attracts unwanted attention, or is incongruent to a user’s identity, users feel self-conscious. In contrast, when a technology works well and aligns with a user’s preferred identity, users feel confident. The misperceptions reported in this study corroborated findings from the interview study presented in chapter 4 (Shinohara & Wobbrock, 2011), demonstrating that form factor, along with the consequences of breakdowns and competence—feelings of self-efficacy, self-confidence, or self-consciousness—contribute to these misperceptions.

The contributions of this work include: (1) An empirical investigation of the social implications and impacts of using assistive technology in social and public spaces; (2) a first conceptualization of social accessibility and Design for Social Accessibility built upon the theme that self-consciousness and self-confidence in assistive technology use contribute to social breakdowns and self-efficacy, impacts use in social spaces, and perceptions of ability for people with disabilities. Design for Social Accessibility is discussed as a reflective stance with key questions to prompt a sensitivity to social accessibility in design.

## 5.2 BACKGROUND AND MOTIVATION

As highlighted in the previous study, the needs of people with disabilities are not limited to functional capability. As personal devices become increasingly mobile, observable, and commonplace in public and social spaces, the need for accessibility stretches into the social milieu. Personal technologies such as laptops, tablets, cell phones, and wearable technologies such as glasses and smart watches permeate modern society. Small mobile devices, including those worn on the body, bring with them heightened social exposure of who is using such technologies, how such technologies are used, and for what purpose. Heightened awareness influences social expectation around technology, resulting in devices becoming a function of self-expression and identity promulgation (Carter & Grover, 2015). With the increasing popularity of wearables, like smart watches and glasses, personal technology is fast becoming a vehicle for self-expression, especially for those with disabilities who may need to use technologies for functional purposes due to disability. Mainstream technologies are usually the least conspicuous, blending into popular culture, and are rarely accessible without modification, and may require noticeable add-ons or adaptations to allow users with disabilities to use them. As determined in the previous study, assistive devices specifically created to be accessible are often not as appealing as mainstream options, instead function-centered designs tend to communicate that the person using them has quite limited ability (Shinohara & Wobbrock, 2011).

What does it mean for an assistive technology to be “accepted” in social situations? There are many characteristics that might define what is acceptable and these ideas are subjective. Therefore, in addition to understanding the landscape of assistive technology adoption and use, and reflecting on the theoretical foundations in sociology around acceptance, norms and identity, I build on questions such as: what motivates people to act the way they do, to approach

others the way they do, and to carry themselves the way they do in public? Specifically, given the ways that social paradigms influence people's choices in observable technology use, what characteristics of assistive technology are considered acceptable, if any, and why? As demonstrated in chapters 2 and 3, the literature provides a robust explanation of technology abandonment, the influence of "cool" new devices (like wearables), and the interplay of identity and social interaction, but does not yet look at how identity, social interaction, and design characteristics contribute to assistive technology acceptance.

Who we are is driven by how we situate ourselves socially, guiding our understanding of identity and sense of self. This symbiosis between self-identity and social norms is influenced strongly by experience and individual character, and guides how we present ourselves to the world (Christiansen, 1999; Goffman, 1959). How are these views reflected in demonstrating ability, identity, and the self we present to others? The goal of this study is to understand how social participation influences how individuals perceive assistive technology.

### 5.2.1 *Meaningful Artifacts*

This study is motivated by the notion that current processing power and design skill ought to produce high functioning, high quality, socially accessible technologies. I consider that an assistive device is viewed as a personal artifact which holds personal meaning, contributes to self-identity, and thus carries strong social implications. Traditional assistive technology designs rarely incorporate consideration for personal, social, and self-presentational needs. When processing power was at a premium, sacrificing personal and social consideration may have been a fair use of resources, but today's handheld mobile devices alone surpass mainframe computing power from decades ago. Constructing identity through expression includes the use of daily artifacts and items of dress towards a polished appearance (Csikszentmihalyi & Rochberg-

Halton, 1981; Goffman, 1959). Personal digital technologies are adopted as expressions of identity, as fashion items and indicators of technical prowess. Increasingly, it matters what “tech” one uses. The proliferation of items like the iPhone and the personal laptop are not just because they are considered “cool,” but because such devices promote social stature, personal identity, encourage self-expression, demonstrate competence and, in many cases, facilitate inclusion.

Although the Technology Acceptance Model aptly suggests that perceived usefulness and ease of use are key factors determining technology adoption, the social acceptance of everyday wearable devices is still to be determined (Edwards, 2003), yet the increase in wearable technologies (i.e., Fitbit, Google Glass, Nike Fuel, etc.) blurs function and fashion. Clearly, some mix of form and function together make such technologies “cool.”

There is strong motivation for better socio-technical coupling between people with disabilities and the assistive technology they use so that users feel comfortable, supported, and aligned socially and culturally. How do socio-technical interactions influence what is acceptable in social situations? By gathering data on what people think of assistive technology use in social and professional situations and why, my aim is to further our understanding of how design may facilitate positive outcomes for assistive technology use in social, public and professional situations.

Despite efforts to better match assistive technologies to those who would use them, it has become apparent that the crux of the issue may be how well the designs of technology are suited to the person who would use them (Christiansen, 1999; Pape et al., 2002). Yet previous research does not address how design might facilitate social inclusion. Furthermore, rather than appealing to ability as a binary situation (disability vs. ability), approaching disability as a multi-faceted

range of abilities allows us to focus on and give value to characteristics of specific experiences of disability (Linton, 1998). I entertained a different view: what if we took a step back and looked at how technology was designed and for whom? Rather than concede to the limited choice available, how can we create more acceptable choices for those who would use it? Inspired by the social model of disability, I view current technology design as insufficiently meeting the needs of the person-technology relationship (not as the relationship being incorrectly formed). Instead of engaging in a one-size-fits-all view of disability, focusing my effort in this study on those with sensory disabilities allowed me to constrain the research to a class of technologies (highly mobile and bridging mainstream personal devices) that increasingly blurs the line between proprietary and popular. This limitation on disability (and subsequently, technology), provided opportunities to investigate perceptions of devices that often were not meant to be assistive but could be accessible. At the intersection of social identity and assistive technology use, it is useful to look at technologies not as immutable choices.

Is the “cool” factor of wearable technologies transferrable to technologies used by people with disabilities? How does the design of technology influence feelings of use? To learn about how this might be possible, I conducted the following diary study.

### 5.3 METHOD

I conducted a diary study with two groups of participants to investigate feelings and perceptions of assistive technology use in social, public and work situations. The first group comprised individuals with sensory disabilities: those who were blind, had low vision, were deaf or hard of hearing. The second group comprised those who had no disabilities. Participants were recruited through local mailing lists for community organizations, such as the Washington State Department of Services for the Blind and the Bellevue Hearing Loss Association. Additional

recruitment was completed by word of mouth through social media and individual contacts. Each group wrote diary entries about experiences with assistive technologies in social, public and work situations over the course of four weeks. Following the diary study, participants were interviewed about their experiences. Interviews were 30 minutes to an hour, depending on the number of diary entries collected, and were conducted over the phone or in person.

To limit the scope of devices, I restricted study participants with disabilities to those who were blind, vision-impaired, deaf or hard of hearing. Reasons for this limitation were two-fold: First, to limit the number of devices studied and exclude devices that lacked an analog for nondisabled people (e.g., there is not quite a wheelchair equivalent for nondisabled people); and second, with the introduction of mainstream accessibility features like Apple's VoiceOver, I sought an opportunity to understand how disabled technology users felt about devices that could be in the mainstream, but were not.

I collected 147 diary entries and conducted 22 interviews with 25 total participants. From Group 1 (sensory disabilities), I collected 97 diary entries from 14 participants (8 female), averaging 6.9 entries per person (Table 5.1). I conducted 12 interviews. Diary entries were parsed for completeness, relevance, and response to the study prompts. For example, entries that focused on usability, but excluded social and technical descriptions, were omitted because the goal of the diary study was to understand social and functional influences, not just how usable a technology was. Most interviews sufficiently addressed omissions, but there were a few that did not (particularly for participants who could not be interviewed due to scheduling or other constraints). A total of 69 entries from Group 1 were analyzed after parsing. From Group 2 (no disabilities), I collected 50 total diary entries from 11 participants (5 female), averaging 4.5 entries per person and conducted 10 interviews (Table 5.1). After vetting entries for relevance to the

diary prompts, three were omitted, and 47 entries from Group 2 were analyzed. Diary entries captured socio-technical interactions that contributed to feelings of self-consciousness or self-confidence.

Participant	Sex	(Self Described) Disability	Age	Occupation	Entries
G1P1	M	blind, onset at 25	28	student	10
G1P2	F	low vision, onset at 7	28	student	12
G1P4	M	deaf	50	software engineer	6
G1P5	M	blind	59	retired	6
G1P6	M	hard of hearing	58	unemployed	1
G1P7	M	born blind with some vision	60	retired teacher	8
G1P8	M	blind	26	student	5
G1P9	F	hard of hearing	23	student	5
G1P10	F	deaf	19	student	5
G1P11	F	hearing loss	65	database programmer	4
G1P12	F	deaf	21	student	6
G1P13	F	blind	22	research assistant	12
G1P14	F	total blindness	19	student	12
G1P16	F	blind, deaf	23	unemployed	5

**Table 5.1. Group 1, Participants with Sensory Disabilities.**

Participant	Sex	Age	Occupation	Entries
G2P1	M	32	multimedia specialist	5
G2P2	M	31	case manager	4
G2P3	F	29	engineer	1
G2P4	F	29	engineer	5
G2P5	F	29	engineer	3
G2P6	M	24	unemployed	5
G2P7	F	32	nanny	8
G2P8	M	26	tea shop supervisor	2
G2P9	M	32	web developer	5
G2P10	F	33	graduate student	7
G2P11	M	35	merchandising manager	5

**Table 5.2. Group 2, Participants without Disabilities**

### 5.3.1 *Diary Entries, Group 1: People with Sensory Disabilities*

I focused on sensory disabilities to limit the scope of technologies included and for the potential for ambiguity in social interaction, particularly for those with “invisible” disabilities. Group 1 participants were prompted to write diary entries when they felt self-conscious or self-confident using their technologies in public or social situations, or at work. Participants were

asked to write about events that occurred around others because I wanted to get a sense of the socio-technical interactions that impacted users' feelings. They were prompted for self-conscious or self-confident feelings to elicit moments and contexts that supported or challenged their sense of self. Capturing social circumstances personally affecting participants provided us with a sense of what they valued in social situations. Therefore, not only did the data show how participants felt, what technologies they were using, and who they were with, it also gave a sense of what parts of interactions were key to participants' comfort or discomfort.

### 5.3.2 *Diary Entries, Group 2: People without Disabilities*

Participants without disabilities (Group 2) were asked to write diary entries any time they saw, or thought they saw, a person with a disability using an assistive device or technology as a personal aid. Participants were asked to describe the general context (location, time of day, any people who were around), the technology observed (in their own words), and their feelings and reactions about the scenario witnessed. The prompt for Group 2's diary entries was intentionally ambiguous to allow participants to determine for themselves, guided by their own perceptions, what constituted a disability and an assistive device. Participants in this group were largely unfamiliar with common items used by people with disabilities, such as a BrailleNote, or cochlear implants (common items used by participants in Group 1). However, familiarity with assistive technology was unimportant, as participants' reactions to any situation involving a device would be legitimate provided they merely perceived the device to be assistive and the observed person to have a disability. Additionally, the prompt was not restricted to perceived sensory disabilities because of the limited interactions nondisabled individuals usually have with people with disabilities.

I note that participants without disabilities (Group 2) were generally young professionals in urban and technology-forward cities and characteristically were generally well educated and technically savvy with respect to the “latest and greatest” gadgets. This limited the sample to a relatively young cohort; I gauged participants’ observations and perceptions as perhaps more accepting of different or new technologies compared to others who might be older or in less technology-oriented settings. Although I was unable to verify whether Group 2 participants saw actual assistive technology in use, I could be fairly confident in their technical acumen to adequately judge a device being used as a personal assistive aid.

Finally, although the final counts of diary entries received represented the different groups’ perspectives proportionally (there were more participants with more entries in Group 1), I note that there may be many reasons for the seemingly low numbers overall. The study design was meant to be flexible, encouraging participants to include entries as often as they experienced these issues and my goal was to capture meaningful descriptions. I asked participants to write about every time they felt self-conscious or self-confident, but of course, it would be impossible to know if they were successful at capturing every situation. At the same time, some participants may have felt more comfortable than others in a given setting with a specific device, affecting diary counts, and that is a matter of personal preference.

### 5.3.3 *Interviews*

At the conclusion of the 4-week diary portion of the study, interviews were conducted with participants for follow up and clarification. Interviews allowed participants to verify thoughts, feelings and reactions, and to offer further insight as to why they may have felt a certain way. Questions for interviews were developed based on individual participant diary

entries, e.g., “In your first entry, you describe a man using an ‘old’ cane. Why did you think the cane was old?”

#### 5.3.4 *Analysis*

Both inductive and deductive qualitative analyses were conducted on the diary entries and interview transcripts. Interviews were incorporated as part of the diary data since the purpose of interviews was to clarify and expand on thoughts and ideas already expressed. An inductive analysis was conducted to allow themes and categories to emerge from the data itself. Applying practices from grounded theory, codes derived from the data were categorized thematically (Glaser & Strauss, 1967). In deductive analysis, I applied a sociological lens based on Hall’s theory of proxemics and Goffman’s categorization of social encounters to understand the kinds of interactions that occurred around technology use (Goffman, 1963a; Hall, 1966).

I conducted the initial inductive analysis. As interviews concluded, synopses were captured with contact summary sheets, as defined by Miles and Huberman (Miles & Huberman, 1994), to highlight concepts that arose in conversation. Common themes that persisted across diary entries, interview notes and transcripts were coded into a list of initial codes. Themes were identified by key words or phrases that repeatedly surfaced (for example, if a participant actively used “self-conscious”), or descriptions of concepts that relayed such ideas (for example, if a participant described feeling worried that others would think less of them due to technological failure). High level categories and themes were vetted through discussion with a second collaborator. As the data were compiled and coded, categories emerged and recurring themes were noted (See Table 5.3).

The wide range of different contexts, people and relationships, and locations meant I needed categories to describe the social structures within which each recorded experience took

place. I constructed categories based on Goffman's encounters and Hall's theory of proxemics in a deductive analysis to frame the different types of interactions. Goffman defined focused encounters as direct interactions where attention is given to participating individuals in a social event, and unfocused encounters as interactions where several individuals occupy a social space (delineated by social event boundaries or timelines) and do not directly interact with one another (Goffman, 1963a). Hall's theory of proxemics allowed me to characterize social interactions described in diary entries according to his social distance spectrum: intimate, personal, social, and public (Hall, 1963). I interpreted Hall's social distance as reflective of social expectations and employing proxemics was a powerful way to separate out context-dependent interactions by framing diary entries across seemingly different interactions but with similar contextual overtones and social cues. For example, with proxemics, I could compare a conversation on a bus between strangers with a conversation at an office party among coworkers. These situations differ contextually in location and public exposure, but proxemics comparison allowed me to classify the social spaces similarly as participants engaged in similar social decorum.

Applying Goffman's and Hall's categories allowed me to separate out focused and unfocused interactions, and to examine the markers around encounters that brought interactions to the fore (e.g., the difference between being just another passenger on the bus and conversing with a stranger about the iPhone's accessibility options). Meanwhile, inductive analysis allowed me to get a sense of the influence of technology, context and people on social interactions and personal feelings of use. Put together, I was able to see how different social situations contributed to different feelings of use, for example, when participants were more likely to feel self-conscious about technology use, if at all. In combining themes, I could identify the types of feelings participants had (self-conscious, self-confident, etc.), and determine what kind of situation may

have contributed to those feelings (a technical or social breakdown facilitated by the function or form factor of a particular device, for example). Detailed categorizing and labeling of data is shown in the online-only supplementary material on the ACM Digital Library.

<b>Group 1 Categories and Themes</b>	
<b>Reactions and perceptions</b>	
	others have of technology, of one's own technology
<b>Influence on social interaction</b>	
	technological requirements in use affect social interaction, context aids easy interaction
	form factor and functionality influence on social interaction contributes to social breakdown
<b>Influence on feeling and use</b>	
	functionality (affects feelings of use in public, about oneself such as feeling confident or not)
	social context (influences use and feelings of use, when approached out of curiosity regarding technology, when in certain locations)
<b>Expectations</b>	
	others have (of technology, of disabled, of disability - due to technology)
	of self (when technology does not work, when exceeding expectations of others)
<b>Group 2 Categories and Themes</b>	
<b>Help</b>	
	feelings (approving, good, self-conscious) about helping; preconceived ideas of whether people with disabilities want help
<b>Assumptions, expectations</b>	
	making assumptions about disabilities
<b>Feeling self-conscious</b>	
	(outside of helping) about offending, about not discriminating, of how to act around people with disabilities
<b>Perception, feelings</b>	
	form factor (as main contributing factor to perception of person, in feeling self-conscious or self-confident, and toward expectations of technology)
	functionality (as main contributing factor to perception of person, in feeling self-conscious or self-confident, and toward expectations of technology)
	person (action and attitude of person with disability as main contributing factor to perception of person)

**Table 5.3. High Level Categories and Themes from Initial Inductive Analysis**

## 5.4 RESULTS

### 5.4.1 *Group 1 Data (from Participants with Sensory Disabilities)*

Participants in Group 1 had disabilities ranging from blind to low vision and from deaf to some hearing loss. Technology use varied across users; blind and low vision participants used: BrailleNote and BrailleSense, PC computers with JAWS (Job Access With Speech) text-to-speech

software, Apple Macbooks with VoiceOver, smartphones including iPhones, smartphone technology including Sendero GPS, monocles and glasses, canes, seeing eye dogs and a variety of software apps, including VizWiz (Bigham et al., 2010) and OneBusAway (Azenkot et al., 2011; Ferris, Watkins, & Borning, 2010). Deaf and hard of hearing participants used: cochlear implants, hearing aids, cell phones with loop technology, captioning technology such as in-person transcribers, pocket talkers, and FM systems. Two hearing-impaired participants were fluent in ASL.

Utilizing Hall's theory of proxemics and Goffman's characterization of focused and unfocused encounters, I identified 9 intimate space interactions, 7 personal space interactions, 40 social space interactions, and 13 public space interactions (see online-only supplementary material on the ACM Digital Library for tabulated data). I found all intimate and personal space interactions were focused encounters, and almost all public space interactions were unfocused encounters. Social space interactions included both focused and unfocused encounters. Contextual themes emerged for both positive and negative feelings across all spaces: (1) situations where participants were able to accomplish a task, or could explain or show off their devices, were related with positive feelings; (2) conversely, interactions attracting unwanted attention or that involved breakdowns resulted in negative feelings. Further analysis revealed themes in breakdowns: (2a) functional breakdowns (and sometimes the mere presence) of assistive technologies elicited breakdowns in social interactions by attracting unwanted attention; and (2b) social breakdowns occurred when social interactions highlighted embarrassing features and inequalities of assistive technologies, even if assistive technologies worked functionally. Both scenarios (2a and 2b) highlighted disability through systematic functional and social breakdowns and drawing unwanted attention to participants.

#### 5.4.1.1 Group 1: Competence and Self-Efficacy

Successful use of assistive technology results in feeling competent and having a sense of self-efficacy. Not only did having access and the ability to accomplish tasks boost self-confidence, but having the chance to tell others about assistive technology and what one was capable of doing increased feelings of technical and social inclusion.

##### Access and Ability

The primary purpose for any assistive technology is to provide a desired function. Participants reported self-confidence when their technologies worked as expected and helped them accomplish a task. G1P4 lost his hearing at 13 years old and did not get a cochlear implant until he was 38. Although his implant helped him capture sounds, he admitted a lot of work was required on his part to understand everyday conversation. When his implant worked well, it provided him useful access to conversation without other aids. He described such a conversation with his mother during his son's birthday party, noting the conversation was well supported by his cochlear implant:

*Much more comfortable and enjoyable to have the conversation with the implant rather than having her write or someone else interpret. It is a lot more of an actual conversation when you are looking at the person's face rather than their writing or typing, or at another person who is interpreting—it is direct communication. –G1P4*

While G1P4 used other assistive technology when necessary, including written notes back and forth, or an ASL interpreter, he appreciated the ability to have an unmediated face to face conversation. In another example, G1P5, who was blind and did not read Braille relied on his technology to access restaurant menus. Unable to use the Braille menu at a restaurant, he pulled up the menu online using his iPod Touch:

*I thought it was awesome that I could have the menu to a restaurant accessible to me since I cannot read Braille, and I did not have to have my friend take their time to read the entire menu to me. –G1P5*

### Demonstrating Technical Savviness

In G1P5's example, more than just an aid, assistive technology is the primary personal or functional device with which many people with disabilities conduct day to day tasks around others. In situations like G1P4's cochlear implant example, an assistive technology may be a supporting device when directly interfacing with others; having the implant work well was crucial to a successful conversation. Successful operation allowed participants to feel technologically savvy and professionally polished. Participants wrote about using their technologies at work and the implications of being technically savvy. G1P8 led an online Skype presentation using his laptop with JAWS software. He further explained why he felt productive and confident:

*I was giving a presentation about accessibility, and the act of using my assistive technology fluently, professionally, and in a way in which I explained what I was doing grabbed everyone's attention enough to then get them to really listen to what I was teaching.*

*I was able to get something done, and contribute to improving the situation very quickly and effectively. In addition, because my audience was actively engaged, even enthused, about my topic, but only as a result of first fishing them in with the assistive technology usage. –G1P8*

G1P8 attributed his successful presentation to his technical savviness with his assistive technology and felt good that he met his presentation goals professionally.

### Ability to Participate Just Like Everyone Else

Assistive technology was most socially viable for participants who felt "just like everyone else" when they used it. G1P5 sold his Seahawks tickets and verified the cash with an app on his iPod Touch.

*I felt great being able to have the capability to check my own currency and be so independent and not having to depend on and or find a 3rd party person who which [sic] would of been a stranger also... because having the feeling of doing it myself and felt that realism of... I am just like a sighted person counting currency and making a transaction without having someone coming with me... the iTouch / iPhone devices with the free speech that Apple puts in all their devices is making my life so much more like a sighted person and makes me feel so much more able to be independent. –G1P5*

Not only did having the ability to verify the transaction help G1P5 be independent, the device's form factor contributed to his feeling "more like a sighted person." Function was key in G1P5's interaction, but just as he also took pride in using a mainstream device common for sighted users, form factor could also influence perceptions and interactions. G1P7 was approached by another coffee shop patron about his MacBook:

*I'd guess it's not uncommon to feel a little uneasy when entering any establishment with a guide dog because one never knows what to expect. This, however, was a familiar place to me where I knew some of the people. Actually, in this case, it was refreshing to not have the focus of the conversation on blindness or access technology. The conversation centered on the mainstream computer, nothing more, nothing less, and that's what's important. Stuff like this levels the playing field. –G1P7*

Describing why he felt this way, he wrote:

*I'm so used to being asked about my guide dog or, "What's that?" when I'm using my Braille PDA. It naturally is pleasant when conversations focus on mainstream technology that one can use right along with one's peers. –G1P7*

He reflected on the role of the MacBook's mix of function and form:

*Mainstream technology such as a MacBook with VoiceOver built in is, in my mind, a huge step forward. Many people use this same technology for work and entertainment. Anyone can anywhere at any time use the same technology without having to install 3rd party expensive screen reading software that may or may not work. In situations like this, there is a common interest that has nothing to do with blindness. People are truly able to connect with one another. –G1P7*

In this way, G1P7 highlighted the significance of even appearing to use the same technology as nondisabled people.

### Influencing Social Perception

Perceived social implications dictated expectations, even when participants were not co-present with others. At work, G1P9 was given a week to learn a new system, design a new database, and set up accounts. She was provided a private workspace enabling her to complete the task in a matter of hours, rather than days. G1P9 wanted to make a good impression and like her supervisor, had implicit expectations of how long it would take to complete her tasks. Appropriate accommodations helped her exceed expectations and her confidence grew.

*I felt very confident in my abilities with this experience. With the other frustrations I had been experiencing, this was one of the positive realizations I had. It made me realize that I can do well when given the accommodations I need and that it is fair for me to ask for them. I felt as though that [sic] I could be just as good an employee as a nondisabled one when given the accommodations I need to do well. –G1P9*

Although G1P9 was not present with others as she completed her task, her ability to meet the task goals on time had implications for her confidence and success.

### Supporting the Ability to Help Others

Not only was function and form important for increasing self-confidence and impressions of professionalism, having the ability to help boosted self-efficacy and self-confidence. It contributed positively to what others thought of the participant. When traveling in a car with a friend, G1P1 used his phone to help find the way. He wrote:

*I wouldn't have been able to do that without the accessibility features of the iPhone. But more than that, my friend was really impressed with me and my phone. I felt like he felt like I wasn't going to be able to help him get to where we needed to go. So I really felt like I was helpful. It was nice to feel that way. I don't always feel like I can help, and sometimes when I could help, people don't always let me help because of my disability. –G1P1*

G1P1 felt good that he could be helpful and realized the social implications of the incident: his friend witnessed his helpfulness by way of his technological expertise with a common mainstream device. I point out here that the significance of showing he could use a typically

mainstream device even with his disability was not lost on G1P1. As noted in prior work (Shinohara & Wobbrock, 2011), the implications for demonstrating ability through these socially nuanced contexts lends great meaning to the “mainstream” aspect of G1P1’s device. G1P1 recognized that not only was it common for others not to expect much from him, they also may not have “let [him] help because of [his] disability,” regardless of his technical ability.

### Educating and Sharing with Others

Participants were wary of being patronized about using assistive technology, but they appreciated opportunities to share how assistive technology worked, to show what technology allowed them to do, and to educate others about technology and disability. In many cases, assistive technology provided a vehicle for conversation about access and disability. G1P1 met with his college math instructor to discuss how assistive technology could help G1P1 understand the course material. Understanding that most people are not familiar with assistive technology and therefore make assumptions about disability, G1P1 was grateful for the opportunity to show his instructor what worked best for a blind person.

*It was really neat to be working with my teacher and teaching him about the programs that are out there and the one I use. It really helped him to understand what it might be like to not be able to see and only be able to listen to the material. He also had a better understanding for what challenges there was [sic] for formats that worked with the assistive technology and the ones that don't work well with it.*

–G1P1

In another similar interaction, G1P1 indulged inquirers about his technology. He recognized he had an opportunity to educate others and change perceptions about accessibility and disability by answering questions about his laptop.

*It felt pretty good to know that I can tell other people about this and educate them at the same time. To be honest, I also felt like I was “cool” I have a laptop that I can use and it talks. How “cool” is that. It seems like a lot of people out there that can see or have vision are really in the dark about the things that*

*visually impaired people can do and the things that are out there for visually impaired people. –G1P1*

#### 5.4.1.2 Group 1: Breakdowns

Participants reported feeling frustrated, embarrassed or awkward when experiencing breakdowns. In addition to malfunctioning technology, breakdowns included technology that worked, but interrupted social discourse by drawing unwanted attention to a person's disability. Such occurrences highlight the need for design considerations that go beyond achieving only functional-restorative goals.

#### Social Implications of Breakdowns

Whether alone or with others, the breakdowns experienced by participants were heightened by social implications of a given situation. In the above section, I discussed how adequate support allowed G1P9 to complete work tasks early and gave her confidence about her ability to get things done, something she felt was crucial toward setting a good impression. In contrast, participants were aware that inadequate support or malfunctioning technology had potentially adverse social and professional implications. For example, G1P13 experienced a breakdown when her JAWS program froze while preparing for a work meeting. The breakdown increased her anxiety because she wished to be professionally prepared. She was annoyed because while technological issues were not uncommon, there were significant implications when it came to assistive technology:

*I didn't want to try to explain to someone who I was supposed to meet professionally with for work why my technology wasn't working properly when they probably are not familiar with assistive technology and wouldn't really understand. I feel like although things like this are out of my control, they are still my fault, because I use technology differently from most people and that it is my responsibility to compensate. –G1P13*

When prompted about the influence of context and people on her annoyance, she wrote:

*I was about to have a meeting and wanted to look good. This meeting was professional, so my expectations for their performance were higher than just interacting with someone in public, as theirs were for me. –G1P13*

G1P13 shared in the typical anxieties and appropriate professional conduct, yet, her concerns were skewed because she understood that most people were not familiar with assistive technology. Indeed, she remarked in her interview that although she liked the advantages of having a portable Braille display, she switched from a BrailleNote to a laptop because “I would try to keep it low profile because I didn’t – I just got sick of answering people’s questions about it... It just kind of got annoying after awhile.” G1P13 did not express feeling self-conscious, but she was hyper aware of being perceived at least as competent as her peers. She carried an expectation for her assistive technology to function properly and invisibly (without obvious functional or social breakdown, as evidenced by her choice to switch from BrailleNote to laptop), so that it would not draw attention to her disability.

Other participants similarly discussed the implications of assistive technology breakdowns on social interactions. G1P1 wrote about social consequences, even if the technology worked as expected. While hanging out with friends, he felt it was “bothersome” to try to socialize and “use something that assists you, like I have been trying to use my iPhone.” He concedes “I can’t hear my phone talk to me or read me what’s on the screen. To me that means I would have to use it outside or leave.” Aware that his friends were using their phones as they socialized to play games, text with others, or browse the web, he became frustrated. He explained:

*I know that my friends around me can see and don’t have vision problems. So I know that they are freely using their phones to text and do things on their phones. I don’t want to be rude and just get up to use my phone. I would if it was an emergency. but I am trying to hang out with my friends and it gets hard to do that and be able to use my phone the same way that my friends are using their phones at the same time. Also I feel like I might be annoying to others that*

*are doing things if I use my phone around them. So today and like many other times I just choose not to use my phone. –G1P1*

His blindness dictated he could not use the phone as his friends did because he could not hear phone commands in the noisy setting, just as similarly, he felt that using the accessibility features on his phone might also be awkward around his friends, and he chose not to use it. So while G1P1 enjoyed time with friends and enjoyed the use of a mainstream iPhone, he still encountered usage breakdowns because of the social implications of using a talking phone in such a setting.

### Technological Breakdowns

Since participants would not use an assistive technology unless they needed aid, technological failure was particularly frustrating. It was also embarrassing because participants felt a need to participate in the social discourse around them without drawing unwanted attention, and without being the source of delay that technological breakdowns created. For example, G1P10's FM system (a device with a microphone that transmits sounds via radio waves to a receiver, generally worn behind the ear) stopped working during a panel of women professionals. Jumping up to fix it drew full attention to her from panelists and the audience. She wrote how she felt:

*Embarrassed! And nervous or anxious, when the FM system stopped working midway when the professional holding it was still speaking. I felt fine after the panel though, because the FM system was really crucial to understanding the panel, and my transcriber was slow to transcribe the panel's Q & A. –G1P10*

G1P10 weighed drawing attention to herself in this forum versus being unable to understand what the panel was saying:

*It was off-putting to be on the spot, but since I was sitting up front, I had to quickly run to the panel table to check the condition of the FM system (and take it back with me when I verified that it just wouldn't turn on) when they looked at me. I just think it's embarrassing when something stops working midway and*

*I don't want to interrupt the flow of the conversation just for my benefit... I did not want the attention to be focused on me; I wanted the attention to be focused on the female professionals on the panel. I was going to check on the FM system when the FM system was later passed to the professional who was the closest to me and had finished speaking, so that it wouldn't seem as dramatic, but then a new question popped up and they kept the discussion going so it was hard to interrupt. I think my inner frustration with my inability to hear their voices loudly built up... –G1P10*

In addition, the context of the location and the people around her added to her anxiety:

*I think that the location... played a partial role in how I felt, because I was representing myself and the University... with my behavior, and I wanted to be respectful of people, and I didn't want to be rude by suddenly asking them to check the FM system in the middle of their answers. –G1P10*

Although participants experienced breakdowns when technology failed, they also reported social breakdowns when technology worked. These occurrences indicate that functional correctness is not enough; a sensitivity for social implications, that is, acceptance in social situations, is also a must for successful assistive technology design. On the first day at a new class, G1P6 was called out by his professor because his new hearing aids made a whining sound. He described the situation:

*It was my first full day with hearing aids, ... I had taken the hearing aids out before class started because all the people coming in the door were making very loud noises with the door that hurt my ears with the devices in. (hearing aids pick up and amplify sounds that are sharp more so than talking.)*

*When the class was starting, I was putting in the hearing aids, and they make a whine when you do this and it bothered the instructor. He demanded to know who was making the noise. I went to put in the second hearing aid, and he got pissed with the whine. He stopped class and demanded to know who was making the noise. I told him and the class: "I just got new hearing aids today, first day with hearing aids. The sharp noises and everybody talking was overwhelming so I had to take them out. When class started I was putting them back in, and they apparently whine when I do this, for that I apologize, but I really want to thank you for embarrassing me in front of everyone." –G1P6*

G1P6 reported that this made him feel, “Like crap, I wanted to crawl out of the room.” He further contextualized his frustration with the history of his hearing aids:

*These were my first hearing aids, I intentionally got the ones that go inside your ear so no one would know that I had to use hearing aids. And on day one everyone was flatly told I had hearing aids. –G1P6*

G1P6 intended to fit in with the rest of the class by selecting smaller hearing aids, but while they functioned generally as he expected, they had a noisy side effect drawing unwanted attention, culminating in a dissatisfying social outcome.

Breakdowns were frustrating for all participants. Whether around close family or in public spaces, participants experienced a range of social situations where technologies failed to meet functional and social expectations and brought unwanted attention. For example, G1P4's cochlear implant fell off when his young son gave him a hug as they sat down for a movie in a theater. He described how he felt and why:

*Awkward, embarrassed, angry. Because it emphasizes how fragile and in-the-way the device is, as well as bringing my disability front-and-center and ruining the moment. –G1P4*

He was aware of the effect of the incident, “My son felt bad about knocking it off, which in turn made me more irritated with the situation.” A happy and cherished moment faded into embarrassment and awkwardness when the cochlear implant was knocked off, G1P4's son began to feel bad, and G1P4 himself resented the fragility of his technology. In another example, G1P9 was on a work call in shared office. Given the small space and presence of familiar coworkers, G1P9's experience differed from G1P4's interaction in a public movie theater. Still, similar issues were at stake as she wrote about using her phone with hearing aids while within earshot of her coworkers:

*It was awkward to know that I was being watched because it made it harder to continue with the conversation on the phone normally.*

*I felt as though I was a distraction for others because I had to use the phone in a non-conventional way (using the loop). I also simply felt like even with that technology to assist me, I was still at a disadvantage compared to my other co-*

*workers who could use the phone without being concerned about understanding the other person. –G1P9*

She qualified the significance of the form factor of the loop she used for the phone call:

*It attracted attention to me by its distinctiveness--using the loop, using the remote that it was connected to. It is not as attention-catching as the old FM systems used to be and was modeled to look more like an mp3 player, but it was still obvious to my co-workers what it was. –G1P9*

G1P9's experience was frustrating because she had a hard time understanding the person on the other end of the line, and was aware her coworkers could overhear her technical difficulties. Add to this the distinct loop technology she used with hearing aids and she was self-conscious about attention drawn to the phone call. Though we cannot be sure of what her coworkers actually thought, her perception of awkwardness around the situation compelled her to end the call early.

### Transitional Encounters

Unfocused encounters occurred when participants did not directly interface with others present. Transitional encounters began as unfocused and drew focus to a participant, noted as unfocused to focused in my analysis. Most of these interactions were initiated by strangers, and most resulted in negative feelings. For example, G1P12 already had several interactions with the staff at a restaurant by the time a waiter noticed her cochlear implants. She described the waiter's changed behavior:

*A waiter started talking to me very slowly and loudly when he recognized my implants. Prior to recognizing my implants, he talked to me as if I was a hearing person. –G1P12*

G1P12 felt, "Discriminated, signaled out, annoyed, frustrated," and explained:

*My implants automatically signal to other people that I have a hearing loss or that I am deaf. The busy restaurant made me feel like the waiters had no patience with my hearing loss, that the restaurant felt as if I was slowing them down. –G1P12*

Although her cochlear implants worked just fine, just noticing them caused a behavioral and attitudinal change in the waiter. G1P12 did not report feeling self-conscious before the waiter's behavior change, the transition of bringing attention to the previously unnoticed device facilitated a self-conscious experience for G1P12.

#### 5.4.2 *Group 2 Data (from People without Disabilities)*

Whereas many entries from Group 1 participants centered around circumstances of technology use, Group 2 participants (without disabilities) described seeing technologies used by people with disabilities. Group 2 participants comprised mostly professional men and women, reporting on a variety of assistive technologies they saw in public spaces, including: manual and electric wheelchairs, scooters, canes, walkers, hearing aids and other hearing technologies, prosthetics, and screen magnifiers.

Group 2 participants were unlikely to directly interact with people with disabilities on a regular basis. Most diary entries from Group 2 described interactions that took place across public or social spaces and could not be appropriately categorized according to Hall's personal spaces. An analysis revealed themes around "perception of disability": (1) participants formed perceptions around technology appearance and use, including (1a) judgments about technology users, and (1b) feelings of self-consciousness, (2) participants formed perceptions from context of use, and (3) sometimes participants had neutral perceptions and were less biased toward assistive technology and disability. Participant perceptions were guided by preconceived expectations of assistive technology and disability and by individual interpretation of accepted social decorum around people with disabilities.

#### 5.4.2.1 Group 2: Perceptions Rooted in Technology

Most frequently, Group 2 participants described feelings and reactions based on perceptions of technology appearance and use. Participants reacted to assistive technology in two ways: (1) When observing technology users, Group 2 participants applied judgment on the situation or person, and (2) when directly engaging with technology users, participants described feeling self-conscious. Many participants applied a judgment on challenges and abilities based on perceptions of the technology they saw. Appraisals ranged from pity and sympathy to approval, or to feeling glad or inspired that the person with a disability had help or assistance needed. For example, G2P6 felt “approving” when he saw family members help an older woman with a cane:

*The cane indicated that she had difficulty walking and needed assistance. The role of people (family members) assisting by bringing the car around had the most effect on the way I felt. –G2P6*

In his interview, G2P6 qualified, “If there was no one assisting her actively, that would be what would make me disapprove of the situation.” He explained why:

*I guess so like when you’re a little kid like your parents take care of you and when you grow up then you have to take care of whatever kids you have—your parents. When you’re at that age, like for me my expectation for people that age is for their children, if they have children, to assist them and I guess that could just be cultural. –G2P6*

G2P6 felt that his upbringing and cultural background dictated a responsibility to help an elderly family member in need and since this woman had a cane, she needed help. In contrast, form factor could also result in positive perceptions. On seeing a man in a wheelchair with “hand rims for users who race/exercise in their chairs,” G2P6 described the man as “very independent and athletic,” and he explained why:

*Well, he had like gloves on; he seemed like he was very active and very independent and didn’t need anyone to help him and just like any other day for*

*him. So if you have rails on your wheelchair that means like you want to go fast around, he also had gloves on; that means you want to get somewhere fast very often so you wouldn't get like blisters on your hands. –G2P6*

Perceptions also characterized whether or not a participant approached an assistive technology user. Group 2 participants felt self-conscious when they engaged in, or felt they were about to engage in, direct interaction with technology users because they were concerned about offending users. Participants wrestled to understand ambiguous social cues and debated appropriate decorum around people with disabilities. G2P4 encountered a man in a wheelchair at the theater, and wrote:

*I was confused, but also ashamed to ask if he was in line... because I generally don't talk to strangers, and am probably generally less comfortable around people in wheelchairs because I don't want to offend them by cutting in line, or getting in the way.*

*It was a busy theater, so he could have been in line, but I wasn't sure and his being in a wheelchair was more confusing to me than if he wasn't because I wasn't sure if he was sitting in that exact location by choice or if he was waiting for someone to move him. –G2P4*

G2P4 admits her apprehension was because she did not want to offend the man, and she debated approaching the man because she was unsure of the situation. Should she have known whether or not the man was waiting to be pushed? Would asking him if he was in line be offensive? G2P4 did not know how to read the social cues from the man in the wheelchair; in her case, this ambiguity made her feel less comfortable about how to act. Ultimately, she chose not to interact with the man.

Similarly, G2P5's experience of seeing a man with a cane entering a building and her decision not to help exemplified her inner debate of what might be offensive:

*I didn't offer to help open the door because I remember someone saying that disabled people like to do things on their own. He could've possibly taken offense to me offering to help him. –G2P5*

In her interview, G2P5 later added more context behind her decision:

*Well I heard that... People say that if they have disabilities then they don't necessarily want any help. They prefer to do it themselves, but at the same time I don't want to offend anyone too. So ... I'm torn a little in between those thoughts because sometimes I want to help, but then I don't want to offend them. I don't think that they can't do it on their own—that's not my intention of offering to help—but I always have to second-guess myself whether or not I actually want to offer... I mean, in that situation, I had to think about whether I would have offered someone else without a disability to hold the door open.*  
—G2P5

G2P4 and G2P5 articulate a common theme among Group 2 participants. Many were self-conscious about initiating interactions with people with disabilities because they did not want to offend. Participants were sensitive about whether or not to offer help, even if they would have offered it to a nondisabled person and they avoided direct interaction because they were unsure how to avoid appearing offensive.

#### 5.4.2.2 Group 2: Perceptions Rooted in Context

Some Group 2 entries described feelings strongly tied to context of use. While I acknowledge that simply seeing an assistive technology in use may generally have tipped off any reaction, I identified ten diary entries where context seemed to strongly influence the way participants felt. In one, G2P3 was surprised to see a woman with a white cane walking in a busy parking lot while talking on the phone.

*I felt a little surprised that she was able to walk so "normally" with her walking stick and talking on her cellphone at the same time. I guess I would have thought that if you cannot see, it would be even more difficult to multi-task while walking. Especially in a busy, crowded, and potentially dangerous area (cars around).*

*The fact that she was talking on a cellphone like any "normal" person would be while walking made her stand out as not being inhibited by her blindness.*  
—G2P3

While G2P3 noticed the blind person walking in the parking lot “normally,” she attributes her surprise to the context in which it occurred:

*The fact that she was in a busy area with cars definitely made me notice the girl and find it unusual that she was able to navigate without sight, and talk on the phone at the same time. If it were in a safer environment, it would not have been so surprising. –G2P3*

G2P3’s expectation of white canes was such that one would need to be able to hear without distraction what was going on in the surrounding environment. Add to that the reasonable safety concerns when in a parking lot, and G2P3’s expectations of how a blind person would act in such a situation were upended. Her expectation was that the blind person she saw was indeed blind; however, there is no way of knowing whether the person may instead have had low vision.

Similarly, G2P6 expressed sympathy and concern for a person he saw in a darkened city street at night, struggling with two canes. G2P6 explained in his interview:

*I guess the location itself... There’s always some random person that comes up to you, like asks you for money or “can I get a cigarette?” The surroundings... I don’t feel it’s very safe and then add in the fact that you can’t see anything and you can get mugged at any moment ... and you can’t do anything about it. That’s what made me feel sympathetic towards them. Because they’re pretty much helpless if like something happens to you. Then it gets compounded by the time [of night] that there are less people out and about.*

*If there was another person there helping them, maybe just have the walking stick in his left-hand and like another person holding his hand or grabbing his arm and guiding him. Like help him walk the street to traverse from point A to point B and that would be a lot better than being by himself at night... –G2P6*

Although G2P6 recognized the situation of having to navigate city streets with two canes could be precarious, his impression of the unsafe street added to his sympathy.

Some perceptions rooted in context were influenced by perceived attitudes about technology users. G2P7 described her feelings on seeing a man in a wheelchair while shopping, “I was disturbed and felt pity for him.” She explained:

*[He] was sitting, facing the wall near the front of the store. As if he was waiting for someone or had just been left there.*

*I was there waiting for five minutes. In that time, the gentleman [was] mostly looking at his hands, or glancing around. People stared as they passed by, but no one engaged him or came for him. –G2P7*

She wrote that location and context influenced how she felt, particularly that, “the gentleman being in the chair and facing the wall played a large part.” Similarly, G2P11 had a perception of a customer to his shop based on the attitude with which she carried herself. Wanting to accommodate customers with disabilities, G2P11 initially tried to be helpful. However, this customer’s attitude toward him and his employees made him question that she had a disability at all:

*She is there almost every night. She does not need the wheelchair. She walks around just fine; she even pushes herself around backwards. On top of that, she wants special treatment because she is in a wheelchair.*

*My employees get upset that she uses the wheelchair when she doesn't need it. This lady angers me. There are people that actually need it, and here's someone that is trying to acquire pity and special treatment. Yuck! –G2P11*

G2P11 felt angry about what he perceived as her exploitation of exceptional service for customers with disabilities. While there was no way to verify if this woman did have a disability, G2P11’s feelings about her were strongly guided not just because she had a wheelchair, but by how she used it and her attitude toward others.

#### 5.4.2.3 Group 2: Neutral Perceptions

Three entries described little judgment or self-consciousness based on technology or context, as if technology and disability had no bearing on how they felt. There may be no truly

neutral perspective, however, I identify these entries as neutral because participants did not explicitly indicate bias rooted in assistive technology or disability (particularly in contrast with other entries). For example, G2P1 felt annoyed as he waited for a slow pedestrian with a cane to cross the street:

*[The people] getting off the bus just assume they can walk where ever they wish and cars will yield to them. She is no exception. None of them use a cross walk or walk in groups or anything to help keep traffic moving through the area. So I was annoyed as usual. –G2P1*

When prompted about the role of the technology in influencing how he felt, he responded, “None really, while she is slow crossing the street, I didn't feel any different towards her than anyone else.” G2P1 felt equally annoyed toward the woman with the cane as he did with the other patrons, as they all walked slowly and blocked his path.

G2P2 offered a similar description of his experience riding a bus with newly installed accessible automated announcement systems. He liked the system because, “I can close my eyes to ‘nap’ and hear the announcement and know where we are.” Prompted about the role in technology in how he felt, he responded:

*This is an excellent upgrade in their system. Previously, bus drivers were required to announce the stops, if they did not do so, they would be penalized by their employer. This removes this responsibility and allows the driver to focus on driving. –G2P2*

G2P2 recognized the implementation of the announcement system as an accessible feature, but did not offer any other qualifications for it.

Still, neutral perceptions highlighted that even unbiased participants carried social sensitivities about interacting with assistive technology users. G2P10 submitted several entries describing interactions between her young children and assistive technology users. In one, her

family waited to be seated at a restaurant and her four year old daughter struck up a conversation with an elderly woman with a cane:

*The woman was very nice, but I felt a little worried that my daughter would draw too much attention to her cane and make her feel embarrassed. My daughter kept staring at her cane and even pointed to it a couple of times during the conversation, but the woman either didn't notice or didn't mind. –G2P10*

G2P10 explained her own reaction to the situation:

*Young children are very observant of anything that's unusual to them, and they often find accessible technology quite fascinating. This is fine, as long as the person using the technology doesn't feel self-conscious about it. –G2P10*

In another entry, G2P10 described how her nine year old son and young daughter made outbursts when they saw a man on a scooter. She noted she felt self-conscious of the man being uncomfortable at the attention of her children, adding:

*I don't want my children's innocent interest in and tendency to verbally point out the way that people are different to offend or embarrass anyone. My husband and I work hard to teach our kids manners, and they honestly don't mean to be rude (there's never any negative judgment in their exclamations, which mostly consist of them saying "Wow, that's cool!") but I don't want them to be interpreted as such. –G2P10*

G2P10's self-consciousness was related to her children's uninhibited reaction to assistive technology and affirmed norms embedded in our adult knowledge of appropriate social interactions. G2P10 sought to instill open mindedness in her children, but she was aware social expectations might have made technology users feel uncomfortable. Toward the end of the study, G2P10 offered insight to her experiences:

*I've realized, in the course of this project, that a lot of the weirdness that people might feel about accessible technology has to do with not wanting to make the person using the technology feel uncomfortable. –G2P10*

We find these viewpoints illuminating, indicative of judgment passed on the situation at large, but not on any one aspect of a disabled individual, their technology, or their ability.

The in situ descriptions of Group 2 participants provide an in-the-moment perspective of inner debates nondisabled participants engage in when encountering assistive technology in the social milieu. It is safe to assume that most observations reflected on a person with a disability using an assistive technology, but there is no way to be sure about the level of severity of the disability itself. (Maybe a person had low vision, but still used a white cane and was not completely blind?) Either way, participants made assumptions about levels of disability to help themselves explain technologies they saw and to draw inferences from the situations they witnessed.

## 5.5 DISCUSSION

The data shows there is a kind of “social negotiation” on either side of assistive technology use in which participants attempt to align their behavior when they encounter each other. I note that the findings are limited by the scope of technologies observed by the two different groups: Group 1 participants primarily wrote about experiences with software and hardware technologies popular among people with sensory disabilities while Group 2 participants wrote mostly about larger, visible technologies common for people with physical disabilities. I temper the discussion with the concession that both groups were unable to provide observations on the same set or type of technologies, though I recognize this as a tradeoff of the study design (it would be impossible to control how two groups “in the wild” might comment on the exact same observations). Given this caveat, both groups were concerned with social presentation: Group 1 participants with presenting an able self, and Group 2 participants with appearing understanding, non-judgmental, helpful, or sympathetic. I found that both groups presented complementary evidence of socially recursive inference (Tomasello, 2014): Group 1’s perceptions were influenced by what they thought people without disabilities thought, while

Group 2 perceptions and behavior were guided by what they thought people with disabilities thought. Following the discussion, I offer a definition for socially accessible technology: that which serves as a vehicle conveying both ability and social identity.

#### 5.5.1 *Interactions in the Public Sphere: Negotiating Social Norms*

Feelings of self-consciousness for both groups of participants were most prevalent when on the boundaries of social interactions. Implications for functional failure not only affected productivity, but also significantly impacted social and professional relationships for Group 1 (disabled) participants. Where functionality was not an issue, social breakdowns occurred when unwanted attention was drawn to a device. Transitional encounters (noted as "unfocused to focused" encounters) that brought attention to assistive technology use were examples of Group 1 participants being "outed" as deviating from expected norms. Although Group 1 participants did not mind being approached out of curiosity, they were sensitive to patronizing and sympathetic remarks and unwanted reactions from others, and they were typically concerned with presenting an able self, particularly when the social consensus was to be "one of the crowd," and especially when working. As a result, participants wanted to draw the right kind of attention to themselves: portraying identities of ability, professionalism, being technically savvy and socially adjusted.

In comparison, Group 2 (nondisabled) participants were sensitive to expected behavior when directly engaging assistive technology users and when proximal distance elicited potential interaction. Not knowing the most appropriate response to seeing a person use assistive technology in public, most Group 2 participants experienced apprehension over how to react: They were concerned that bumping into wheelchair users or offering help might be considered offensive. Participants in Group 2 worried that calling out a disability or need would be offensive,

while at the same time they harbored perceptions that an assistive technology indicated a need or limitation of ability. Direct interaction with people with disabilities was not required for Group 2 participants to feel self-conscious about potential interactions or to experience concern about offending people with disabilities.

#### 5.5.1.1 Expectations

When it came to negotiating interactions, both groups constantly tested expectations of appropriate social behavior around assistive technology. Group 1 participants were aware of what others might expect of them, as demonstrated when they showed off what they could do and enthusiastically shared how their technologies worked. At work, Group 1 participants held themselves to the same level of expectation as other nondisabled employees. Witnessing scenarios that challenged expectations compelled Group 2 participants to reflect on what they thought of assistive technology and disability. Such reflections implied (1) Group 2 participants had a vague sense of what disabilities might entail, and (2) their expectations were influenced by technology form factor and the attitude and ability of the user. For example, recall G2P3's expectations about blindness was challenged by seeing a person with a cane on the phone while walking in a busy parking lot. Though G2P3 at first assumed the presence of a cane (represented by its form in the shape and color of the canes that people with visual impairments use), further observation of the encounter allowed her to see how it was used, and to adjust her expectations.

#### 5.5.1.2 Social Encounters and Disability

As with expectations, Group 1 participants (with disabilities) were cognizant of how using assistive technology contributed to an ever changing social knowledge base of what it means to have a disability in today's society. While participants were quick to share what their technologies do and portray disabilities in a positive light, they were also apprehensive and self-

conscious about situations in which they had little control: where their disability was highlighted in a less appealing way. Aware that social perception of disability is not always positive, and is often incorrect, some Group 1 participants were sensitive to situations where outing their disability conflicted with the identities they wished to portray. This was evident in G1P12's experience with the restaurant waiter, whose reaction to her cochlear implants was not an accurate reflection of her ability or identity.

Group 2 participants (without disabilities) struggled to understand expectations around disabilities and to know how to react, behave, or even feel. Encountering assistive technology in use highlighted ambiguous social rules involving people with disabilities. G2P4 felt self-conscious about potentially bumping into people with wheelchairs because she perceived wheelchairs as less mobile than walking. Whether or not her comparison of walking versus wheelchairs was viable, she felt apprehensive when approaching potential interactions. She stated, "I consciously thought about not bumping into them because of their wheelchairs." Her perception and reaction to wheelchairs precedes any interaction she had with them, ultimately preventing interactions (as it did when she encountered the man in the wheelchair at the theater).

#### 5.5.1.3 Function and Self-Efficacy

Function fulfills a sense of purpose, boosts self-efficacy and control and promotes a positive sense of self. The main focus of assistive technology is to provide functional capability where there might be a physical, sensory or cognitive impairment (Cook & Hussey, 2002). This unique characteristic is what most separates assistive technologies from mainstream devices. Yet, the effectiveness of such technologies may also depend on characteristics that may vary depending on context, user, and type of technology. A proprietary assistive device and a

mainstream accessible technology may both contribute to low feelings of self-efficacy, or feelings of self-consciousness, if an individual is unable to participate in a social situation as desired. When a device successfully supports a user's identity, functionally and socially, the device "disappears" into the task-at-hand (Suchman, 2007; Winograd, 1996), supporting the flow of social discourse. Although the data is limited in scope, the findings offer a brief window into themes that influence how function, social context, self-efficacy and identity intersect in assistive technology use. Assistive technologies that supported a positive sense of self-efficacy in participants (G1P1 feeling good about using his iPhone to find directions and G1P8 feeling productive and confident in his use of JAWS and Skype in a successful business presentation, for example), arguably contributed to their sense of identity and ability.

#### 5.5.1.4 Form Factor and Self-Confidence

Group 1 participants (with disabilities) cared about how they might appear to others, as manifested in the desire to appear professional when fretting over functional breakdowns, or when experiencing social breakdowns. G1P13 related this experience when VoiceOver on her iPhone began relaying text messages to her while she was conducting a work interview: "Typically, I appreciate this information. However, I was trying to have a professional phone call." She explained why this particular scenario caused her stress: "The interviewee was getting an impression of the university and our research team from me, and I wanted to make this the best impression possible." Also compelling was G1P12's telling of the restaurant waiter's reaction to her cochlear implants. It was not until he saw her implants that he began to treat her differently, even though nothing about either the implants' functioning or her ability to interact with him had changed. Thus, despite her ability to interact with him and others without issue just moments before, his perception that the form of the device was a hearing aid of some sort

contributed to the waiter's overall (incorrect) perception that she could not hear or communicate at all. G1P12's frustration with the situation is indicative of her desire not to be identified as "disabled" by her device.

Group 2 participants (without disabilities) developed misperceptions about disabilities when encountering assistive technology in use. For example, engaging with the notion that a person in a wheelchair would only use it if they could not walk, participants in Group 2 justified wheelchair use with a significant physical need (and made adjustments when the form of the wheelchair dictated otherwise, such as in G2P6's description of the "athletic" wheelchair). Yet, disability runs a spectrum of needs, e.g., not all people who use white canes are completely blind. And the whole of a person's ability is not matched by the perceived use or needs of the technology that a person uses. The reactions of the participants lead me to understand that the mere presence of assistive technology may not communicate or promote the abilities of users.

Group 2 participants notably commented on positive and self-confident attitudes when technology users exceeded expectations of disability. In comparison, Group 1 participants expressed feelings of self-confidence when technology use demonstrated ability and polished professionalism. A personal technology, as much as any personal artifact, arguably has a potential for form factor (whether desired or not) to enhance an individual's sense of self (Csikszentmihalyi & Rochberg-Halton, 1981). Therefore, I believe that just as design may have the potential to positively influence self-efficacy, there is a potential for form factor to be designed to better communicate self-identity. If we, as technology users, consider that we are all actors in a social presentation (Goffman, 1959), then all artifacts at our disposal on a daily basis are props we select and use toward supporting, in some way or another, our roles among family,

friends, and strangers. Presenting a role in social and public situations is equally important for those with and without disabilities.

#### 5.5.1.5 Appearance and Attitude: Creating Perceptions of Ability

Human actions and thoughts are influenced by social relationships, experiences and an understanding of social norms (Mead, 1962). Insufficient function and incongruous form factors are reflected in our appearance and attitude, contributing to the perceptions that others develop of us. Technology becomes a part of the awareness of self that is presented to others, as manifested in the ardent “image debates” people have over PCs vs. Macs, or Android phones vs. iPhones. Through function and form then, technology has the potential to help people construct the image they wish others to see. The data highlights situations of use where function and form may have influenced functional and social breakdowns, respectively.

Participants on both sides of disability tried to avoid potentially uncomfortable situations. Both groups were hypersensitive to socially recursive inferences: Group 1 participants considered whether their actions might be thought of as “disabled,” much the same way that Group 2 participants did not want to offend. Regardless of the type or severity of disability, or of the accessibility provided by technology, participants without disabilities drew on expectations based on ambiguous social norms. They also drew on how they hoped to be perceived according to social norms (appearing “accepting” of people with disabilities), and how they believed they should behave when entering into a focused encounter with a person with a disability. Therefore, I cannot understate the forces of social expectation and influence on perception.

#### 5.5.1.6 Motivating Socially Accessible Design

Design has the potential to promote an identity congruous with one's self-narrative through function and form. When functional breakdowns contributed to uncomfortable situations, Group 1 participants were not only conscious of the technological failure, but of the implications of their ability to successfully use their devices, for example G1P13's concern that failing devices might reflect on her inability to get work done or her inability to conduct herself professionally. The literature on how people with disabilities might co-construct identity through technology use (Christiansen, 1999) further supports the notion that such functional breakdowns may influence identity as much as form factor in design (Csikszentmihalyi & Rochberg-Halton, 1981; Goffman, 1959). I identify this relationship between function, form factor and identity as socio-technical identity, constructed by the ways personal technologies define our sense of self within the communities of which we are a part. Defining this relationship strengthens the view that personal preference and meaning are key factors of assistive technology adoption and use (Hocking, 1999; Kintsch & DePaula, 2002; Phillips & Zhao, 1993; Marcia J. Scherer, 1993a), but I contrast the findings in this study with related work advocating for better matching between technology users and their assistive devices (M. J. Scherer & Craddock, 2002). While sensitivity is indeed required when selecting appropriate technologies for users with disabilities, a matching framework is appropriate only for existing technologies and assumes designs as somewhat immutable, a given. Placed within the context of prior work, the findings indicate that technology matching may miss an important aspect of technology use: its inception and design. I argue that, as designers, we ought to emphasize the way assistive technology design fits in with the social unfolding of users' daily lives. If technology as it is fails to meet user needs, then we may need to step back and re-think how we construct accessible artifacts in the first place. In addition, merely providing alternatives or adaptations may not

result in functional or social access, as seen in similar responses to both mainstream and assistive technology in many diary entries. Thus, this study guides us toward a new vision on accessible technology design: The implications for design to foster socio-technical access equality are more than post-hoc principles or frameworks, but rather a change in philosophical foundation, a development of a designer's stance positioning accessible design solidly under identity, function, and personal meaning. I argue that this vision must be clear, not just for creating assistive technology and not just for the accessibility-minded designer, but for any designer to understand how to make technologies accessible overall.

Two themes emerged from the data that conceptualize acceptable design of accessible artifacts. The first is that functional and social breakdowns, due to assistive technology use, result in negative feelings and awkward or embarrassing encounters. The second theme is that having the ability to accomplish goals through the successful use of assistive technology, or having the chance to "show off," result in positive feelings and a confident sense of self. Further, this competence is served both by function and by form, as shown in G1P1's desire to be viewed as another competent iPhone user, by G1P13's desire to appear professional to others through effective use of her technologies, and by G1P12's desire not to be treated as being unable to communicate merely because she uses cochlear implants, to name a few examples. Owing to the concerns expressed by both participants with and without disabilities, I posit that a useful conceptualization of socially accessible design is one in which design serves as a vehicle conveying both ability and social identity. Achieving socially accessible technology designs motivates the need for a unified holistic view on both functional and social aspects of design, not as mutually exclusive, but as complementary dimensions.

#### 5.5.1.7 Limitations and Generalizability

I accompanied diary entries with follow-up interviews to clarify and confirm participant ideas and thoughts. In addition, I situated the motivation for and results of this study within existing literature on the acceptance, adoption, and abandonment of assistive technology, and its influence on personal and social identity. The findings confirm similar research on why people with disabilities are likely to avoid or abandon assistive technology, and corroborates that the self-consciousness around what others might think about assistive technology is founded. I would be careful, however, to generalize Group 1 findings to the wider community of individuals with other kinds of disabilities (for example, physical or cognitive), as they may have a host of different types of social expectations around assistive technology use. And although Group 2 participants contribute a rich set of data across a range of different kinds of assistive devices, the sample is limited to mostly professional young adults. Additional investigations would have to be done with other populations of people with a variety of other disabilities and ages to generalize.

Finally, in attempting a more ecologically valid approach, I structured the study design to encourage Group 2 participants to record what they experienced “in the wild.” Unfortunately, most people are generally unfamiliar with assistive technology for people with sensory disabilities (including software adaptations or mobile accessories like hearing loops). Thus, Group 2 data is mostly limited to observations of devices that are more obvious in public spaces, such as for those with physical disabilities. A replication of this study to strengthen and verify these results should ask nondisabled participants to focus on participant observations of either mobility impairments or on sensory impairments, but perhaps not both.

## 5.6 CHANGING HOW WE THINK ABOUT ACCESSIBLE DESIGN

The data suggests that current assistive technology designs may influence perceptions of disability when functional or social breakdowns bring disability to the forefront, particularly when design influences self-consciousness or self-confidence. Reflecting on this phenomenon, I define *social accessibility* as new property of technology design extending accessibility to include functional and social factors.

Although designing functional accessibility is crucial (Connell et al., 1997; Danford, 2003; A. F. Newell & Gregor, 2000; A. Newell et al., 2011; Wobbrock et al., 2011), I argue that post-hoc or disability-specific mindsets may perpetuate misperceptions about disability (as shown in Group 2 participants) because participants were already anticipating social ambiguity when confronted with assistive technology use in public. Perhaps misperceptions of assistive technology and disability are so ingrained in society and people's thinking that such perceptions are almost unwittingly designed into our technologies (DePoy & Gilson, 2014). Rather than unintentionally isolating accessibility from overall designs by giving accessibility the burden of an added approach or post-hoc constraint, I propose a change in attitude toward designing for disability. The aim of changing attitudes would be to shift focus from already produced assistive technologies toward the inception of ideas before device creation. For example, before a given technology is made and pushed to market, how can designers prioritize accessibility, acceptance, competence, positive perception, and the social dimensions and impacts of design? How can assistive technology designs reinforce notions of ability, capability, inclusion, professionalism, self-efficacy, and self-confidence? These are personal and social considerations that go beyond mere functional concerns. Perhaps, assistive technology design should be sensitive to influences on identity by embodying socio-technical approaches. Assistive technology users in Group 1

were aware of perceptions others may have had of them, and those in Group 2 did, in fact, make judgments about people with disabilities based on perceptions of assistive technology. A socio-technical-centered stance supports self-expression and identity.

## 5.7 SUMMARY

The study participants' experiences largely centered around the notion of how technology may or may not be an extension of the identity we want others to see. Group 1 participants (with disabilities) demonstrated that as players in a social world, using assistive technology elicits not just functional challenges, but significant social challenges as well. Feelings and perceptions around assistive technology use often identified people by their disability, not by their ability, and certainly not by their non-assistive technology identity. Similarly, Group 2 (nondisabled) participants perceived that technology users needed help or were unable to do things because of the presence of assistive technology and by the attitudes and appearances exuded by the users themselves.

This work provided an empirical investigation of the social implications of using assistive technology in social and public spaces and provided evidence that: (1) technology breakdowns are both functional and social, and negatively affect social interactions; (2) the opposite of a breakdown manifests as self-efficacy and self-confidence, leading to positive social interactions; (3) feelings of self-consciousness and self-confidence when using assistive technologies are evidence of socially recursive inference, the feedback loop of, "I think I know what she is thinking;" (4) functional and social design considerations can affect social participation; and (5) corroborates prior work (Shinohara & Wobbrock, 2011) and found further evidence that assistive technology is noticed and does contribute to misperceptions of people with disabilities.

By reframing what it means to be disabled, the social model of disability shifts the focus of design away from the impairment of the individual toward the disabling aspects of the environment. Applying this critical and socially constructed lens on design for disability frames another way to think about how the design of personal technologies is disabling. Shifting the focus from the user-as-disabled to technology-design-as-disabling re-orient technical interventions from “fixing” impairments toward one of enabling access. I thus reframe my view of technology through a social lens recognizing technology’s role in social situations: The degree to which a technology is disabling in social situations is how socially usable that technology is. Socially usable aspects include how socially appealing a design is, how well a design facilitates access in social use, and promulgates rather than stifles self-expression.

We are increasingly in a world where personal technology is used to express individuality, yet people with disabilities have limited opportunities to do so. The themes presented in this diary study provide insight into the ways that current assistive technologies are perceived by both users and bystanders. In particular, I highlighted that such perceptions appear to contribute to feelings of self-consciousness or self-confidence in assistive device use.

The literature reflects a consideration that how an assistive device is used and perceived in social situations is instrumental in how effective the device is. Specifically, the experiences and rhetoric of scholars in Disability Studies and from design tell us that the ways assistive technologies make users feel and the stereotypes that persist (1) are important in the social and functional access they enable and impact, and (2) can be and are designed (DePoy & Gilson, 2014; Hockenberry, 1995; Mankoff et al., 2010; A. Newell et al., 2011; Pape et al., 2002; Pullin, 2009; Marcia J. Scherer, 1993a). In this sense, neither disability-excluding (usually of mainstream devices) nor disability-specific approaches to technology design are attuned to the social

implications of technology use by people with disabilities. Furthermore, attitudes from each only serve to persist the separation of those with disabilities from those without (Linton, 1998); the social separation mimicking the functional separation of these two groups of users. I highlight this opportunity to reconsider how we design for disability, and discuss next how I view social accessibility as one way of doing so, on the basis that, in technology design, social considerations are as important as functional considerations.

## 5.8 THE CASE FOR SOCIAL ACCESSIBILITY

The desired impact of this work is to make an empirical case for considering social accessibility in the design of assistive technology, and to introduce a notion of Design for Social Accessibility as a design stance countervailing the function-centered design tradition prevalent with assistive technology design.

If personal devices are viewed as forms of expression and identity (Carter & Grover, 2015), it is worth understanding how nondisabled people perceive assistive technologies. I found that assistive technology use influences assumptions nondisabled people make about what it means to have a disability. People without disabilities are unfamiliar with and do not know how to ask about assistive devices (Shinohara & Wobbrock, 2011, 2016). They may form misperceptions about assistive technologies, that the technology user needs help, leading to the perception that the user cannot do for themselves, or that users cannot use a mainstream device because their disability prevents them (Shinohara & Wobbrock, 2011). The belief that people with disabilities must use “special” devices is reinforced. But, these perceptions are often inaccurate and have negative implications, perpetuating stigmatizing stereotypes of assistive technologies, communicating that a user: (1) has a disability, (2) cannot use a similar mainstream device, and therefore (3) needs assistance (Shinohara & Wobbrock, 2011). Furthermore, the fears

that disabled users have of appearing less able are confirmed. Perceptions could be rooted in deep-seated social stigmas associated with disability, reinforced when little is known about assistive technologies.

In investigating how assistive technology use contributes to users feeling stigmatized, in the diary study (Shinohara & Wobbrock, 2016), I investigated user and observer perspectives of assistive technologies in public spaces, specifically implications of use for users' social identity: first that a user might not like the way the device looks or makes them look. Second, the opposite is also possible, and a user might like the way the device looks or makes them look. Third, an assistive technology is not usable or useful so the user feels incompetent when using the device. Fourth, an assistive technology is usable and useful so the user feels skilled and confident in using it. The first two consequences deal with technology presentation, use, and social appeal, while the latter two address how usability and utility impact self-efficacy, including presenting oneself as competent. I unpack how these perspectives contribute to stigmatizing views on assistive technology and those who use it.

If an assistive technology marks a person as “unable” in a social situation when they prefer to identify otherwise, such technology misrepresents the true identity of that person. The social implications are deleterious for users with disabilities, denying them this important channel to self-express even while users of mainstream technologies readily can. Yet, as I have thus far discussed, previous research has shown the prevailing views on disability, and subsequently assistive technology, tend to prioritize functional capability over social appeal and personal preference (P. Parette & Scherer, 2004; Marcia J. Scherer, 1993a). The result is a negative social association of assistive technology (Shinohara & Wobbrock, 2011, 2016), and a designed and often stigmatized view of disability (DePoy & Gilson, 2014; Linton, 1998). Assistive

technology users are viewed as faulty or impaired and can feel self-conscious or uncomfortable, as highlighted when a participant noted, “You know, if someone’s using an iPhone, and I’m using an iPhone, that’s normal, right? ... a term that gets thrown around sometimes is blind ghetto products ...cell phones have all these neat features and stuff, but ...the BrailleNote’s just catching up” (Shinohara & Wobbrock, 2011). As I discussed in chapter 3, disability-specific design approaches tend to be function-centered even if user-centered, perpetuating the “special” category of assistive technologies, removing the responsibility to make mainstream devices accessible, and disregarding the social role of technologies.

Juxtaposing assistive technologies next to mainstream counterparts implies inability attributed with assistive devices rather than non-assistive ones. Accurate perceptions of assistive technology by nondisabled people can positively impact perceptions of disability, and one way to undercut misperceptions might be to incorporate socially usable elements into the design of assistive technology. A person who is blind certainly knows how to make a phone call: dial the number of the party you wish to contact. But the mechanism for dialing could be accessible (a physical keypad) or not (a screen with icons only distinguishable visually), as is the case with popular smartphones. It is not, as might be assumed, that a blind person cannot use a smartphone to call someone. It is only that the smartphone is not accessible to them. Likewise, if a person is comfortable using a magnifier privately at home, but is hesitant to use it to read a menu at a restaurant, we might say the social situation affects use. In essence, the user may not feel comfortable with the identity conveyed by the magnifier in public. Thus, a social lens on these examples highlights how design and use can enable access in social situations. If people with disabilities were seen using the same devices as nondisabled people, then the technology itself would not be an indicator of difference or a source of social discomfort. It is not possible to

predict how this might change what is perceived about disability, but it would be clear that disabled and nondisabled people would be using the same technologies. I emphasized the role of personal technology in self-expression, including implications for how assistive devices are perceived, specifically: how presentation and use influences feelings of self-consciousness and incompetence, or efficacy and self-confidence (Shinohara & Wobbrock, 2016); or how seeing assistive technologies influences perceptions and can be stigmatizing (Shinohara & Wobbrock, 2011).

Notwithstanding the forces contributing to the creation and use of assistive technology, including niche consumer markets, non-functional aspects impact use, and attitudes about disability might affect how assistive technology is created. If technology designers think of disability in the medical model, they are likely to create artifacts reflecting that view and that contribute to a disabling environment. Although an understanding of disability rooted in the medical model may help focus on successful functional interventions, research has shown that users abandon a technology when they feel the technology incorrectly conveys characteristics about themselves, even if it works as it should (Hocking, 1999; Phillips & Zhao, 1993; Shinohara & Wobbrock, 2011). Abandonment and losing access are consequences of missed opportunities to create design enabling use in social situations, as well as achieving functional capability.

Although assistive technologies are inherently utilitarian, a design perspective too couched in ableism defines success as functional capability. Yet, one can imagine it is easy to meet this metric for success while also failing to meet socially desired outcomes. Functional capability should remain an important consideration: when technology is useful and usable, it influences self-efficacy, and how skilled we feel we are in doing something (Csikszentmihalyi, 1990). It makes sense that traditional design approaches for disabled users first try to address

functional use (Mace et al., 1991; A. Newell et al., 2011; Wobbrock et al., 2011), since most designers do not have disabilities and do not understand how those who are different interact with technologies. However, a device has utility only if users can successfully achieve their goals with it (Marcia J. Scherer, 1993a). Too often, mainstream technologies out-muscle assistive devices on similar functionality, such as the lag that results in adding post-hoc accommodation, i.e., when JAWS users experience a delay in updates that must propagate through each time their operating system is updated.

Thus, I frame social accessibility to challenge assumptions that accessibility is only about functional utility (Shinohara & Wobbrock, 2016), and to emphasize social consideration. If nondisabled users can choose among “sleek” mainstream technologies then people with disabilities ought to have similar choices. I see regard for choice based on social and functional factors extending the desiderata of good design for technologies usable by people with disabilities.

The results from the diary study (Shinohara & Wobbrock, 2016) and from prior work (Shinohara & Wobbrock, 2011) inform key themes and reflective questions about design that may be appropriately addressed by Design for Social Accessibility, that incorporate diversity in users as well as strong functionality. What design principles and design process can support the reliable achievement of positive social outcomes when using accessible technologies? How can design reflect ability through accessibility? What resources and techniques must be altered, included or excluded to support disability constraints? Key for any technology used by people with disabilities is the requirement for robust functionality (true for technology adoption by people without disabilities as well (Lee, 2009; Venkatesh et al., 2003)).

Reflection on design encourages sensitivity to disability in design when emphasizing socio-technical identity. Engaging designers to understand how existing philosophies and practices influence design work may uncover ways to incorporate functional and social disability-specific sensitivities into design practices (Cross, 2011). As a next step, I examine strategies for Design for Social Accessibility within the context of a design course investigating how student design perspectives were influenced by this nascent design concept.

## Chapter 6. DEVELOPING DESIGN FOR SOCIAL ACCESSIBILITY: HOW DESIGNING FOR PEOPLE WITH AND WITHOUT DISABILITIES SHAPES STUDENT DESIGN THINKING<sup>6</sup>

### 6.1 INTRODUCTION

In the chapters above, I argued that assistive technology can identify users as outsiders, reflecting how negative associations of disability are increasingly placed on digital devices. In chapter 4, I presented an interview study demonstrating that access can be impeded by non-functional forces, such as social situations, that create barriers regardless of how functionally capable a device is. In chapter 5, I presented a diary study demonstrating that a different perspective on accessibility is needed in design to encompass a social component, including the ways users choose to identify and express themselves. I extended the typical conception of accessibility—focused exclusively on functionality—to also include social consideration of technology use including social appeal, self-expression, and use in social situations. I defined this extension of accessibility as *social accessibility*, a design property combining social and functional aspects toward a holistic conception of accessibility.

The ideas and work presented thus far in this dissertation assert essentially that mainstream technologies ought to be accessible whenever possible, and barring that, assistive technologies ought to be artifacts for self-expression, as much as any mainstream technology. But to say so and do so require different things. What does it mean to make mainstream designs accessible and to value assistive technologies as artifacts for self-expression? Everything is

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<sup>6</sup> Portions of this chapter were published as: Shinohara, K., Bennett, C. L., & Wobbrock, J. O. (2016). How Designing for People With and Without Disabilities Shapes Student Design Thinking. In Proc. ASSETS '16. (pp. 229–237). Reno, Nevada, USA: ACM.

designed, whether consciously or not. Nondisabled designers and those not familiar with accessibility tend to design with the notion that functional utility is “enough” for disabled users (Ladner, 2015). As I have argued, such a perspective ignores social aspects of accessibility, creating non-functional barriers for even accessible technologies.

In this chapter, I build on the concept of social accessibility, toward developing design techniques and tools that incorporate social accessibility. I develop Design for Social Accessibility by way of a design thinking course study, defining a design perspective facilitating socially accessible design, where “design perspective” refers to the “characteristic theories and know-how-theories for making judgments that foreground a particular element of the design process, or constellation of elements” (Hendry & Friedman, 2008). As the social model of disability demonstrates, social issues can be addressed through a reconceptualization of what it means to be accessible. To that end, the goal of Design for Social Accessibility is to shift the way we think about design for disability, to influence technology designers to consider functional *and* social aspects of design.

I present a study I conducted through two offerings of a Design Thinking course to investigate how student designers shape their perspectives on accessible design. I sought to determine what elements of the design thinking process compel student designers to incorporate accessibility in their practice of design. Although it is well known and accepted that people gain awareness and empathy from exposure to people not like themselves (Ludi, 2007; Waller, Hanson, & Sloan, 2009), I offer a specific account of how novice student designers come to think about accessibility (and people with disabilities) toward a unifying perspective on accessible design. I show what elements among the constellation of strategies and influences students

applied and experienced can be useful for shifting perspectives in accessible design, toward an orientation and practice of design that forms the basis for Design for Social Accessibility.

Evidence across both course offerings demonstrate how students addressed tensions and challenges in designing for multiple disabled stakeholders, and how design approaches shaped student design thinking. I found that designing for both disabled and nondisabled users surfaced unique tensions between social and functional needs across both user groups (Shinohara, Bennett, & Wobbrock, 2016). Addressing functional versus social tensions challenged students to re-assess their view of disability and accessibility, and stretched their capacity as designers of accessible solutions. Students employed strategies, such as tackling disabled user requirements and then testing them for nondisabled usability, to bridge challenges of designing for the two users groups. Notably, students leveraged nondisabled users to incorporate social aspects of technology use, e.g., to gauge how a technology design might appeal to bystanders. Engaging tensions that emerged from designing for two user populations challenged students to balance requirements from both sides, encouraging them to shift from ableist perspectives of disability toward an inclusive approach to design overall (Shinohara et al., 2016).

Findings from this study form the basis for Design for Social Accessibility, built on key themes that design practice incorporating social accessibility includes: (1) working with multiple stakeholders with and without disabilities whenever possible, and (2) intentionally approaching design decisions with a balance of social and functional considerations. To support the second suggestion, I developed a framework to aid consideration along social and functional dimensions and a set of method cards (see Appendix II) to prompt awareness of socio-technical contexts of use. These findings and these tools inform Design for Social Accessibility promoting accessibility in design thinking in general (Shinohara & Wobbrock, 2016).

## 6.2 BACKGROUND AND MOTIVATION

As prior work in previous chapters has shown, an emphasis on understanding users in design thinking and user-centered design does not appear to translate into more accessible technologies. Instead, current mainstream personal technologies remain inaccessible; people who create mainstream technologies do not regularly incorporate accessible design except, perhaps, to satisfy legal requirements (Crutchfield, 2016). Design thinking has become a popular approach to the design process with creative methods, and user-centered design techniques emphasize the user's experience. Although research espouses the benefits of designing with people with disabilities (Ladner, 2015; A. Newell et al., 2011; Sharp et al., 2007; Wobbrock et al., 2011), the lack of accessible mainstream technologies indicates that few designers effectively do so. Promoting inclusion in the design process has not been enough to motivate a sweeping change in making technologies accessible. Accessibility is often approached as "someone else's job," and the responsibility of accessible design is relegated to a niche group of designers (Cook & Hussey, 2002; Cook et al., 2010). Although prior work demonstrated that designing directly with people with disabilities can improve accessible technology outcomes (Bigelow, 2012; Ludi, 2007; Waller et al., 2009), it is yet unclear how to encourage designers to adopt accessibility as a core goal of the technology design process.

My own view is influenced by the criticality of Disability Studies: designers ought to be aware of the agency they give (or do not give) users, and the user must be the one who decides. The challenge is how to make this approachable and usable at the design level, without watering down the experience and complicating the practice. Research focused on the process of design must adhere to designers' own expertise and approach to creating novel artifacts. Studying specific techniques or interventions requires drawing on designers' expertise in a "prepared-for-

action” approach that builds on the skill and knowledge, rather than a “guided-in-action” approach that may overstep designer judgment and rationale (Stolterman, 2008).

Thus, whatever the intention, altruistically separating “inclusive” approaches from mainstream design practice does not compel designers of mainstream products to consider those with disabilities as part of their target audience, much less consider social implications of use for disabled users. Instead, in practice they relinquish responsibility to those who assume a disability-specific approach. It matters how responsibility is assumed when potential consequences include design that leads users to feel self-conscious, and to abandon technology. Designers’ attitudes have as much to do with the social conception of assistive technology as does any bystander in public and it is to designers’ attitudes—about what constitutes inclusive design—that a change in design practice should appeal to.

When mainstream technologies are not made to be accessible and people with disabilities do not use them, the myth that they *do not* use mainstream technologies because they *cannot* is perpetuated. Inaccessible technologies are indicative of a shortcoming in current approaches to technology design. The literature, and my work to date, suggests an opportunity to pivot the way that we perceive technology access in the first place, to change the ways that technologies are designed by changing how designers incorporate accessibility in their design thinking. Indeed, technology students and designers alike may not identify their work as an opportunity to incorporate accessibility in the early stages of design. Thus, the focus of this study is to demonstrate that (1) not only is it possible to incorporate such thinking in the very early stages of design work, (2) it can also shift perspectives among student designers, giving them skills and experiences that enable them to create accessible technology designs, while shaping their

approach to design overall. The goal of this study, then, is to investigate how a change in design thinking and perspectives, toward inclusion, can be accomplished.

In gauging how to approach technology design, I reference the values of Schön's practice of reflection. Specifically, in personal technology design, the solution does not merely exist as an entity unto itself, technologies exist within users' larger personal, social, and functional ecosystems. That is, a smart watch does not merely tell time and post email notifications. It also lives on a person's wrist throughout the day, an ever-present accessory seen by others with a notification system that impacts daily activities, including social ones. Where Schön identified the reflective work that emerged from students' interactions with ideas and designs, I examine further the implications of a variety of stakeholders throughout the design process, and how the interactions among stakeholders and designers affect the ways that students construct their own "designerly ways of knowing."

Previous research in college technology design courses examined how engineering and computer science students addressed accessibility in requirements gathering, brainstorming, and prototyping solutions, highlighting the benefits of working with users (Bigelow, 2012; Ludi, 2007; Waller et al., 2009). Research in Universal Design in education promoted increased awareness of accessibility in teaching, confirming that prioritizing accessibility and including people with disabilities improved understanding about disabled technology users' needs (Burgstahler, 2015). Yet, strategies for inclusive design tend to remain disability-specific. To avoid this bias, I expanded the course project to challenge students to design for multiple users with and without disabilities in an effort to promote the view that disability is just one part of diversity among technology users. I purposefully structured the course to engage disability not as separate from design, but as part of a greater socio-technical community of users.

## 6.3 METHOD

I conducted a study through two university course offerings of design thinking, taught a year apart. The study goals were to investigate how student designers shape their perspectives on design, and to determine how elements of the design process compel students to incorporate accessibility in their thinking and design practice. The course was a junior-level introductory design thinking course that is required for all students in the major. Although the curricular goals of the two offerings of the course were the same, I made subtle changes to the second course offering after reflecting on the successes and challenges of the first course. In this section, I first describe the course offering overall, its curriculum goals and the general structure that I used. Then, I describe distinguishing details of the individual courses. I refer to the offerings as Course Offering A and Course Offering B and label participants as A or B, respectively.

### 6.3.1 *Design Thinking Course Overview*

In this section, I describe the curricular outline common between the two course offerings. I conducted the design thinking course study with student designers as they learned user-centered design, focusing my investigation on how students engaged users with disabilities, and on student reactions and reflections throughout the design process. I prioritized inclusive design by having student designers work with both disabled and nondisabled users to facilitate awareness from different perspectives. I prompted students to reflect on their experiences, specifically how they viewed and interacted with disability and design.

The curriculum of design thinking—a course utilizing Norman’s and Buxton’s popular texts (Buxton, 2007; Norman, 1988)—focused on core elements of the user-centered design process: needs assessment, ideation, low- and high-fidelity prototyping (see Figure 6.1), and user-

testing. Students conducted interviews, created personas and scenarios, generated conceptual models, sketched and ideated, created paper-based and interactive prototypes, applied usability heuristics, and tested their designs with users. I set an expectation that accessible design was part of design overall and a requirement to design for both users with and without disabilities. The rationale for tasking students to design for both user groups was that rather than designing a “specialized” technology specifically for people with disabilities, students were to design an accessible technology usable and appealing to anyone. Students worked in groups and each group was paired with a dedicated person with a disability with whom students worked throughout the term. Students were largely left on their own to find nondisabled users, although I facilitated in-class paired feedback sessions, heuristic evaluations, and usability testing to assess nondisabled user interactions. Each week, students were introduced to a new concept and participated in activities to gain experience working with different techniques around that concept. Students applied this new knowledge in a term-long project to develop a usable prototype by the end of the course.



**Figure 6.1. A student from Course A walks an expert user through a paper prototype.**

To aid students in the task of designing for users with disabilities, I included readings from various existing approaches to design for diverse populations: User-Sensitive Inclusive

Design (A. Newell et al., 2011), Ability-Based Design (Wobbrock et al., 2011), Universal Design (Mace et al., 1991), Participatory Design (Schuler & Namioka, 1993), Design for Social Accessibility (Shinohara et al., 2016; Shinohara & Wobbrock, 2016), and Value Sensitive Design (Friedman et al., 2006). The level of detail of instruction on the different approaches differed by course offering (which I discuss in detail below).

At the beginning of each course offering, a blind guest speaker familiarized students with appropriate etiquette for interacting with people with disabilities through a question and answer forum. In the course, we referred to participants with disabilities as expert users to emphasize their expertise in the use of accessible technologies. Students met with their groups' dedicated expert users roughly every other week (a total of four times). Each session with expert users lasted approximately one hour, during which time student groups shared design artifacts for feedback. Expert users evaluated the final designs during a fifth session. Next, I discuss detailed differences of the individual course offerings, and I characterize students and participants with disabilities.

### 6.3.2 *Unique Components of Course Offering A*

In Course Offering A (referred to hereafter as "Course A" and denoted by "A" in student, group, and expert user references), I examined how students' design thinking was shaped when incorporating accessibility throughout the course. Course A students learned about the following design approaches for diverse user groups: Ability-Based Design, User-Sensitive Inclusive Design, Universal Design, Participatory Design, Value Sensitive Design, and Design for Social Accessibility. In-class lectures briefly covered each design approach, and student groups were assigned readings from different approaches to guide their work. Students were not given other instruction on design approaches and were encouraged to incorporate what they could from

each design approach. I considered it compulsory to introduce students to disability-aware design approaches due to course expectations to create accessible designs, however, the lack of in-depth instruction on each approach precluded students' ability to gain expertise.

Student project groups were divided between two randomly assigned design prompts. Project groups in Table 6.1 worked with blind or low-vision expert users and were tasked to design real-time augmented reality (walking) navigation application; project groups in Table 6.2 worked with deaf or hard of hearing expert users and were tasked to design an application providing real-time captioning of nearby speakers.

Group	Student Designers	Expert User
AG1	A12 (M), A22 (M), A41 (M), A31 (F)	AE1 (M), Blind
AG2	A1 (F), A26 (M), A28 (F), A36 (M)	AE2 (M), Blind
AG3	A19 (M), A21 (M), A33 (M), A35 (F)	AE3 (F), Low-vision
AG4	A6 (F), A8 (M), A23 (M), A34 (M)	AE4 (F), Low-vision
AG5	A2 (F), A9 (M), A15 (F)	AE5 (F), Blind
AG6	A11 (M), A13 (M), A25 (F), A42 (M)	AE6 (F), Blind

**Table 6.1. Design Course A groups—focused on real-time augmented reality navigation—student designers, and expert users.**

Group	Student Designers	Expert User
AG7	A14 (M), A30 (M), A38 (M), A39 (M)	AE7 (F), Deaf
AG8	A3 (M), A5 (F), A20 (M), A32 (M)	AE8 (F), Hard of Hearing
AG9	A10 (F), A16 (F), A29 (M), A37 (M)	AE9 (M), Deaf
AG10	A4 (M), A7 (M), A27 (M)	AE10 (F), Hard of Hearing
AG11	A17 (M), A18 (M), A24 (F), A40 (M)	AE11 (M), Deaf

**Table 6.2 Design Course A groups—focused on real-time live captioning—student designers, and expert users.**

**Participants.** Forty-two undergraduate students (12 female) participated in the study. No students had any known disabilities, few students had design experience, and only a handful of students had interacted with people with disabilities prior to the course. Only six of the 42 students had substantial interactions with people with disabilities before the course, such as having a close friend who is blind. Fifteen students reported limited interactions, from meeting

blind massage therapists to grandparents with hearing loss. Of those, four had working interactions, such as briefly tutoring a deaf student.

Students worked with 11 (seven female) expert users who were either blind or low-vision or deaf or hard of hearing. Expert users were recruited through local disability groups and assistive technology listservs, such as the Department of Services for the Blind, National Federation of the Blind, Hearing Loss Association, and the university disability club.

### 6.3.3 *Unique Components of Course Offering B*

Course offering B (referred to hereafter as “Course B” and denoted by “B” in student, group, and expert user references) focused investigations on specific elements of students’ design experiences. Groups in Course A worked with a single dedicated expert user, but in Course B, groups worked with a dedicated expert user throughout the course and conducted additional “round robin” feedback sessions with two different expert users during the second and third sessions. In contrast to Course A, to facilitate expert user rotation, and to allow for refined analysis around a particular design experience, all student groups were tasked with the same design prompt, focused on blind or low-vision users.

To investigate influences on students’ approach to accessible design work, I made intentional changes in the way I incorporated design approaches for users with disabilities. To understand how accessibility focused design approaches might influence design thinking with respect to disability, in Course B I limited the design approaches covered Ability-Based Design, Universal Design, User-Sensitive Inclusive Design, and Design for Social Accessibility. I conducted in-class workshops twice throughout the term, facilitating in-depth engagement with individual design approaches. In each workshop, which I led, students working with the same design approach engaged in discussion to understand their design approach in the context of

their project, strategizing ways to incorporate their design approach at various points in the process.

All student groups in Course B were given the same prompt: to design an indoor wayfinding application. Students were told to presume indoor building information would be crowd-sourced with appropriate data points for helping navigate inside buildings. Thus, students were tasked with designing an appropriate interface and interactions to assist blind, low-vision, and sighted users with finding their way inside buildings (See Figure 6.2).

**Participants.** Thirty-six students worked in 10 arbitrarily assigned groups of three or four. Sixteen students reported some limited experiences with people with disabilities, such as distant relatives or high school classmates. Of those sixteen, eight students had substantial interactions with people with disabilities before the course, such as leading youth camps, or volunteering with an organization. Twenty students reported little or no past experiences. A greater percentage of students in Course B reported some level of prior experience with people with disabilities compared to Course A. Although some of this could be chance, I acknowledge a possibility that students communicated between years and the course reputation for accessibility might have attracted students who self-selected into enrolling in the second offering. However, a majority of the students across both courses had little or no prior experience with people with disabilities. Students met with their dedicated expert user four times throughout the term. In the second and third meetings, students spent 15 minutes with a new expert user and 30 minutes with their dedicated expert user. These “round robin” sessions allowed students to receive feedback from multiple stakeholders with a range of visual impairments. Student groups and their assigned expert users are shown in Table 6.3.



**Figure 6.2. An expert user tests the high-fidelity prototype's navigation in the hallway.**

<b>Grp.</b>	<b>Student Designers</b>	<b>Dedicated Expert User</b>	<b>Round Robin 1</b>	<b>Round Robin 2</b>
BG1	B1 (F), B11 (M), B21 (M), BS31 (F)	BE6 (F), Low-Vision	BE4	BE9
BG2	B2 (F), B12 (M), B22 (F), B32 (M)	BE4 (M), Blind	BE6	BE3
BG3	B3 (M), B13 (F), B23 (F), B33 (M)	BE10 (M), Blind	BE9	-
BG4	B4 (F), B14 (M), B24 (M), B34 (M)	BE9 (F), Low-Vision	BE10	BE4
BG5	B5 (M), B15 (F), B25 (M), B35 (F)	BE2 (F), Blind	BE8	BE1
BG6	B6 (M), B13 (M), B26 (M), B36 (M)	BE1 (M), Blind	BE7	BE2
BG7	B7 (M), B17 (M), B27 (M)	BE5 (M), Blind	BE3	-
BG8	B8 (M), B18 (F), B28 (M)	BE3 (F), Blind	BE5	BE6
BG9	B9 (M), B19 (M), B29 (F)	BE8 (F), Low-Vision	BE2	BE7
BG10	B10 (F), B20 (M), B30 (F)	BE7 (F), Low-Vision	BE1	BE8

**Table 6.3. Course B student groups, expert users.**

#### 6.3.4 *Data and Analysis*

Data sets from both courses comprise student assignments including weekly reflective journals, interview protocols and summaries, observations, brainstorm, sketches, design rationales, user testing results and heuristic evaluations, final design specifications, design

process books, and expert user evaluations of student designs. Expert users evaluated student work mid-term and at the end of the course.

I analyzed data from Course A both deductively and inductively following systematic qualitative data analysis methods (Miles & Huberman, 1994; Strauss & Corbin, 1998). Table 3 summarizes the codes. I selected 14 deductive codes based on related work to accentuate known issues about assistive technology use (Marcia J. Scherer, 1993a; Shinohara & Wobbrock, 2011, 2016). I identified an additional six inductive codes based on the data. Two coders openly and separately coded two groups' data to generate an inductive code list. We discussed and refined code definitions: similar concepts that arose were discussed and combined where relevant, and connections were drawn across categories. Then, the two coders independently coded 10% of the 338 student journal entries. A Cohen's Kappa calculated on the coders' results yielded  $\kappa = 0.79$ , indicating strong agreement between the coders. The Kappa was determined by tabulating where coders marked specific codes, i.e., text marked with the same codes indicated agreement. The result is thus the ratio of the total number of codes assigned by the codes that were in agreement. A single researcher coded the remaining data. Both researchers discussed and confirmed the final categories and themes. Analysis focused on how students considered disability as they developed an understanding of design.

Data from Course B were analyzed deductively based on findings from Course A, following the 20 high-level codes derived from the initial course (see Table 6.4). Additional analysis was conducted on student experiences with design approaches, and strategies utilized to address the prompt to design for multiple stakeholders with and without disabilities. I conducted the initial analysis pass on data from Course B based on the coding manual from Course A and to identify codes and themes that emerged from differences in Course B around

design approaches and multiple stakeholders, followed by additional discussion and analysis with co-authors.

<b>Deductive Codes</b>
Ability and equal access: just like everyone else
Aesthetics and form factor, user appearance
Avoidance
Safety and help
Attitude
Ignorance
Contextual influence
Employment
Technology type: mainstream or proprietary
Breakdowns: functional and social
Social expectations, transitional encounters
User confidence, showing technical savviness, educating/sharing
User self-consciousness
Mis/perceptions: social, technical, contextual, neutral
<b>Inductive codes from Course A</b> (Shinohara et al., 2016)
Perceptions, expectations: learning and design
Attitude, reflection, learning: disability, accessibility, design thinking
Tensions, challenges: design for disability, cost, complexity
Techniques and tools
Design decisions: accessibility, usability, prioritizing, assumptions
Working with users with disabilities, in groups: prior experiences
<b>Codes from Course B analysis</b>
Design Approaches: helping multiple stakeholders
Ability-Based Design: intersecting abilities, adaptation
Universal Design: for multiple stakeholders, focusing on tasks and situations
User-Sensitive Inclusive Design: for multiple stakeholders, mainstream appeal
Design for Social Accessibility: mainstream perspectives, aesthetics, social use
Multiple Stakeholders: strategies and design decisions, helpful – gives perspective, helpful – understanding diversity in disability, challenges and complications, strategies – design approach

**Table 6.4. Deductive codes from prior work (Shinohara & Wobbrock, 2011, 2016)**

## 6.4 FINDINGS

All groups from both course offerings successfully created high-fidelity prototypes that they could test with expert users at the end of the 10-week term. Expert users judged whether or not the final designs met their expectations. Experiences and reflections reported by students from both course offerings confirmed that inclusion of users with disabilities can influence designers toward accessible solutions. Findings from Course A indicated that challenges and tensions surfaced when students designed solutions to satisfy both disabled and nondisabled

users, and that the experience of working with expert users influenced students' attitudes positively about accessibility overall. Students from Course A reported changing perspectives about (1) designing for disability, particularly that it was not as hard as they initially thought; and (2) that they had a role and responsibility in creating accessible designs.

Findings from Course B corroborated those from Course A, and indicated that working with multiple expert users helped students gain a deeper understanding of diversity within seemingly similar disabilities. Students in Course B came to recognize that individual differences and preferences, even within similar disabilities, influence and are influenced by design decisions, a realization that broadened student awareness of disabled experiences.

Findings from Course B built upon findings from Course A, contextualizing specific elements of design approaches that guided student design thinking when students addressed challenges across multiple stakeholders. Together, the data from both courses contribute to a rich understanding of our approach to design and accessibility can impact student design perspectives.

Cumulatively, the findings from both course offerings inform my understanding about how we might incur change in design practice by working with multiple stakeholders with and without disabilities whenever possible. In addition, strong influences by non-functional (i.e., social) factors emerged either as design considerations to address specific user needs, or as an intentional approach to design overall. Whether students were directly addressing an expert user's non-functional needs or were preparing interview questions of a social nature to build rapport, students' design thinking took note of social factors.

#### 6.4.1 *Multiple Stakeholders With and Without Disabilities*

In Course A, I found that working with both disabled and nondisabled users surfaced different tensions and challenges that encouraged student designers to consider accessibility as a key component of all design, not just a specialty, guideline fulfillment, or after-thought. In Course B, I found that working with multiple stakeholders also surfaced tensions and challenges, this time by addressing differences between expert users of similar disabilities. When students tackled challenging scenarios, they did so by incorporating diverse perspectives.

##### 6.4.1.1 Functional and Non-Functional Factors

Balancing the different user requirements for users with and without disabilities was not a nontrivial challenge for students. Not only did students have to manage differences across user needs, but students had to design a solution for the intersection of those needs. However, I found that students reframed challenges as constraints, and in turn, created opportunities for design ideas. Emerging tensions from designing for both disabled and nondisabled users were different from challenges typically faced when designing for only one group or the other. These tensions influenced student perceptions of the difficulty or feasibility of accessible design (Shinohara et al., 2016).

Students struggled to bridge functional and non-functional needs of users with and without disabilities. Students were overwhelmed by what they needed to learn about how disabled people used technologies. Ableist attitudes at first narrowed their perspective: students considered the disability before the person, sometimes myopically focused on functional issues, despite the emphasis in user-centered design on holistic user experience. To address disabled user needs, students began by asking, “what functionality will address impairments?” rather than

other concerns, like how might a design operate in the social ecosystem of technology use. A2 considered “intuitive aesthetics” unnecessary for blind users:

*Though our product will still have to be usable for able-bodied people, it will be interesting to design something that has to have a very intuitive layout rather than intuitive aesthetics. For a blind person, it doesn't necessarily have to look pretty, but the way things are laid out has to provide smooth navigation. I think that might be one of the biggest challenges we'll face; how to organize the features we want to include. –A2, Journal 2*

There exist functional differences between disabled and nondisabled users, but the language A2 used reflected an intentional view that disabled users may not care about “aesthetics” as much as nondisabled users. The benefit of working directly with expert users was that students learned about the non-functional needs they otherwise might have been overlooked:

*Learning about how AE7's iPhone was her go-to device was really valuable, because we were then able to identify that we should be designing for an iPhone. We knew it needed to be cheap and simple, because AE7's a busy woman, and she's a college student with a light budget. These kinds of facts about our expert user that we learned through the interview helped create more physical and practical constraints on our design. –A14, Journal 8*

The non-functional needs enumerated by expert users contrasted with the function-only view students initially held. Students benefited from working with expert users who gave feedback highlighting non-functional needs, and from designing for nondisabled users because it challenged students to strategize ways to address tensions exposed by non-functional needs. Specifically, students did not try to “imagine what it would be like” to be a user with a disability as a strategy (which tends to be an ableist exercise); they learned directly from expert users when non-functional characteristics were a priority. I highlight that these non-functional needs characterized technology use in a social environment. Understanding that dimensions like safety

and social appeal were important to expert users and nondisabled users alike made students aware of what they had (or did not have) in common with expert users:

*...we examined the social implications of always having a phone out and reading off a phone while talking with someone. Since so many people find that to be rude, we began to explore ways of allowing our users to read the text while staying engaged in the conversation. AE9 was a great help with this by pointing out how important eye contact and facial expressions are to him.*

*–A16, Journal 4*

Another social concern unique to expert users was the aspect of disability itself. Managing an image-as-disabled was a disabled experience that students may not have anticipated. Specifically, some social issues were unique to the experience of disability:

*Perhaps the most important discovery was that two particular factors were most important to our target user: accuracy and unobtrusiveness... She also said that she wanted the application not to call unnecessary attention to her hearing loss; she did not want it [to] be stigmatizing. –A7, Journal 3*

A7's expert user prioritized functional accuracy and unobtrusiveness. Although these two issues are not always opposing, for a person with a disability, they can be.

#### 6.4.1.2 Tensions and Opportunities

Students applied different strategies to challenges that arose between functional and social issues. The findings indicate that having a requirement to also design for nondisabled users gave students another tool with which to strategize. A24's group learned the severity of the social issue of drawing "unnecessary attention" because AE11 was less likely to use technology that was not discreet.

*We were also able to learn what is important to them when it comes to assistive hearing technology; for example, AE11 made it very clear that inconspicuousness is important to them in a product—if something isn't discreet or just about invisible, they are much less likely to use it. –A24, Journal 3*

For AE11, functional success alone did not necessarily translate into access. Students took this feedback to heart. AE11's group reflected:

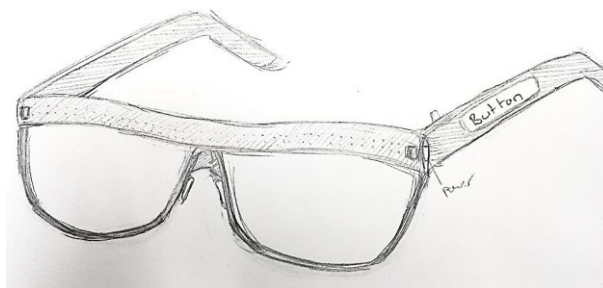
*Glasses were chosen because, as a group, we figured that holding a device up while talking, or listening to someone would be distracting for all parties involved. We wanted to reduce this social awkwardness as much as possible.*  
–AE11's group design rationale (see Figure 6.3)

With a clearer awareness of what they, as nondisabled users, had in common with expert users, students sometimes referred to a nondisabled understanding of social issues to find solutions. B25 indicated how his group balanced challenges:

*When designing for people without disabilities, I felt like I was designing something for myself or for a friend. I had more of an immediate idea of what direction to take. When designing for the blind, I felt like I needed direction from our expert user, who would come up with very good ideas that I most likely would have never thought of.* –B25, Journal 10

Indeed, students focused on what users have in common or started from their expert user's requirements and found ways it might also appeal to nondisabled users. A23's group circled between the requirements of both user groups:

*We need to constantly be looking back at the problems that we set out to solve with our design. Is this helping people navigate even with visual impairment? Will this let people explore what is around them? By continually referring to these questions and considering if we are still answering a definitive yes then I have confidence our design will stay on track.* –A23, Journal 4



**Figure 6.3.** A sketch of AE11's group's glasses design, described as: "designed to have a profile of modern 'hip' glasses."

#### 6.4.1.3 Strategies for Designing for Multiple Stakeholders

It is known that people with even the same or similar disability, just like any other nondisabled individuals, might have very different experiences of disability. Although low-vision and blind people have very different kinds of impairment, students did not make the distinction as it related to their design work until they switched expert users and were faced with different requirements. Requiring students in Course B to elicit feedback from multiple visually impaired expert users allowed students to examine their design work across complex user constraints. Despite the challenges of such constraints, student groups balanced the different sources of feedback to arrive at a complete design. I next discuss how adding multiple stakeholders with disabilities in Course B increased obstacles students faced when encountering expert users with different experiences, and students' strategies for addressing them.

I found that interacting directly with expert users gave students insight and awareness into how accessible design can impact technology use for people with disabilities. In working with multiple stakeholders, a diversity of views was evident:

*It has been interesting to work with different expert users. I think that the more that we work with, the more obvious it is becoming which aspects of the app our user has liked boil down to person preference rather than actual functionality or usability of the application. –B31, Journal 6*

Working with multiple expert users required students to address diverse perspectives within even a “single” disability, like low-vision. At the outset, these complex factors could be considered difficult, a complicated task for novice student designers. However, I found that students, often guided by their design approaches, welcomed multiple points of view, and were able to find ways to incorporate the different feedback they received. Students were capable of including a wide range of users, welcomed the diverse perspectives, and found value among different experiences:

*We found out that one expert user found something completely not helpful to the indoor navigation process, but found out another expert user would find it extremely helpful. This helps us realize that some of our ideas may not be actually be worthless and may only appeal to a portion of our users. But having each idea critiqued and evaluated really helped us identify if they were viable for actual usage. –B5, Journal 5*

Students learned about the diversity within an impairment when they met with blind and low-vision expert users, recognizing the challenge of incorporating several viewpoints in one design:

*Having as many potential users as possible critiquing the experience definitely adds to our overall design, and lets us learn about the different types of accessibility needs we need to address. –B25, Journal 5*

Yet, students were open to new perspectives on design presented by multiple expert users:

*It has been both easy and difficult to incorporate the different perspectives of users who have varying levels of ability. I had not realized how much I depend on my own perspective when designing. –B27, Journal 10*

Students saw the value of receiving multiple perspectives, and gained a greater awareness about differences in disability, particularly when they interacted with expert users with disabilities unlike their dedicated expert user. Students were not expecting a range of experience across a single category of “visually impaired.”

## 6.4.2 Perspectives in Design Thinking

### 6.4.2.1 Attitudes About Disability and Accessibility

Learning about disabled experiences compelled students to re-assess their understanding of accessible design. Including nondisabled users prioritized non-functional needs. For example, working with expert user AE2 emphasized the disparate state of technologies:

*We have also paid more attention to refining our choices regarding the placement, sizing, and labeling of inputs and information, all areas in which*

*small changes can modify the effectiveness and physical usability of the application. These changes reflect, for me, a broader change in my understanding of design and accessibility. AE2's encouragement to investigate the existing marketplace showed me just how separate the industrial fields of design and design for those with disabilities have become. Seeing him use his devices firsthand has demonstrated why that practice is flawed, ignorant, and impractical. The structure of this course has also been encouraging for me in thinking about the inclusion of users in the design process. –A26, Journal 9*

Indeed, the challenges put before students stretched their experience with design and disability; addressing both target user populations were daunting, particularly if student designers had little or no experience with design or disability. But these perceptions of accessibility changed as they continued to work with expert users. Initially, students had altruistic reactions to the design project. However, despite feel-good attitudes and a desire to “be helpful” to people with disabilities, altruism stemmed from a sympathy toward disability. Sympathetic attitudes are not necessarily a bad thing—sympathy exposes misperceptions and assumptions—but sympathy can manifest as ableist and create barriers to understanding and creating accessible design.

Many students expressed discomfort and self-consciousness prior to meeting expert users, despite the guest lecture about appropriate etiquette. Some students found the guest speaker helpful, but for others it did not allay fears of being offensive because they lacked experience of one-on-one interactions.

*I am very nervous... I don't know what to say, or how to act around a disabled person. Even though guidelines were handed out in class, I am worried I will forget the polite behavior I studied, and simply make a fool out of myself.  
B21, Journal 0*

Students were self-conscious about their ignorance of disability:

*I felt sad and was worried that I could unintentionally hurt [people with disabilities] through my ignorance. The worst fear was sparked by blind people and there were a couple of reasons. First of all, I consider myself a visual thinker, so the loss of vision seems one of the most terrifying complications to me.*

*Therefore, I am worried that I can unintentionally hurt a blind person—I feel so sorry for blind people, but they want to be treated like everyone else.*  
—A1, Journal 2

B34 had a similar reaction, guided by social stigma and perceptions about disability.

*Another aspect that leads to my fear is the concept of not being able to behave normally. I am scared that I will be both awkward and uncomfortable. I, myself, have fears of being inflicted with disabilities and as a result the sight of seeing those with the disabilities may lead me to not act or speak normally.*  
—B34, Journal 0

Students were self-conscious about being offensive because they did not know what was acceptable or unacceptable behavior around people with disabilities—the knowledge void was filled only by their unconscious ableist perspectives. The view that B34 had, of “fears of being inflicted with disabilities and as a result the sight of seeing those with the disabilities,” emphasized how students focused on the disability, unaware of the ableist tendency in this thinking, though students were not expected to know or think otherwise. Such sentiments were common among students as the weeks went on, and here the data from both course offerings confirms findings from prior work (Ludi, 2007; Waller et al., 2009): Interacting with expert users opened students’ minds to a diverse view on accessibility. More time with expert users was beneficial. As students adjusted to using appropriate disability etiquette (i.e., asking if a person needs help instead of assuming their impairment means they need help) and overcame communication barriers, the unknowns that made design for disability seem impossible became more passé. Furthermore, as shown above, working with multiple expert users also broadened student conceptions about variations even within a “single” disability.

*It was also interesting to discuss our ideas with a new expert user, because it allowed us to gain another perspective. With User-Sensitive Inclusive Design, it is important to be inclusive of our entire audience. BE10 and BE9 have different backgrounds and have different needs. It is important to remember that their lifestyles will differ, even though they are both visually impaired.* —B13, Journal

Students were more informed about the disabled experience and could make educated design decisions to address issues their expert users described. Rather than trying to imagine what it is to not have sight, students learned from someone who had skill and experience navigating the world without sight. I contrast the sentiment in the following statement that defers to the expert user's navigation skill with comments from A1 and B34 above that implied that being blind rendered one helpless.

*Our expert user is, though blind, perfectly capable of navigating himself if he is aware of what is around him. To that end we focused a lot of brainstorming time on building an app that doesn't tell him where to go, but instead tells him where he is and what is around him, then lets him do the navigating himself because he can do that just fine and sometimes he really prefers to do that rather than take step by step directions. –B12, Journal 4*

Multiple sessions helped students learn about their expert user as a person, not a disability, and helped students to learn from their mistakes; one awkward meeting would make the next more productive as students learned better ways to ask questions. Students found that incorporating accessibility did not detrimentally affect the rest of their design:

*Working with accessibility as one of your central focuses when designing a product does seem to improve the quality and usability of the final design overall. What I was surprised about is that I don't feel this is just because an accessibility focus forces the design to be "easier to use," but because the focus of people with accessibility issues is to be able to behave just like everyone else. Thus, working with people with hearing loss, sight loss, movement problems, etc., helps you focus with laser-precision on the most important and basic human needs. –A40, Journal 8*

As A40 mentioned, students learned that accessibility did not have to be an excessive burden on design, but could be another way to improve design overall. Key to this understanding was for students to be able to acknowledge: (1) the multiple issues at play for the various users, and (2) that the students, as designers themselves, could meet the challenges emerging from the tensions between the different issues.

#### 6.4.2.2 Design Approaches and Complex User Requirements

Working with multiple stakeholders provided students with diverse views on their designs. Students employed a variety of strategies to manage conflicting viewpoints, including referring to their assigned design approaches for guidance. In this section, I discuss how Course B students leveraged their assigned design approaches to address conflicting issues among multiple stakeholders. Students were assigned to work with Ability-Based Design (Wobbrock et al., 2011), Universal Design (Mace et al., 1991), User-Sensitive Inclusive Design (A. Newell et al., 2011) and Design for Social Accessibility (Shinohara & Wobbrock, 2016) design approaches. I organized workshops encouraging students to reflect often on how they relied on guidance from their design approaches. What emerged from these student experiences was a pattern of referring to design approaches specifically to solve problems that arose from expert user needs, especially to address conflicts between multiple stakeholders. Design approaches launched students in distinct directions, but design approaches also had a hand in directing how students approached complex problems. Understanding design in light of the design approaches influenced the ways that students approached accessible design.

Each design approach provided a different perspective that students benefited from in their design processes. Student reflections about design approaches highlighted how student thinking emerged around nuanced concepts. For example, student groups working with Ability-Based Design notably had positive experiences with the approach, and were likely to point to the intersection of abilities as their main strategies for addressing complex user scenarios. I discuss the different perspectives that emerged through each design approach in detail below.

##### Ability-Based Design

Students who worked with Ability-Based Design intentionally focused on abilities rather than disabilities. As we noted, without knowing what it is like to be disabled, students were at a

loss as to how to design for people with disabilities. The guidance by Ability-Based Design to focus on users' abilities was a defining strategy for students using this design approach.

In the beginning, students embraced the core principles of Ability-Based Design to focus first on what users can do, and not users' limitations or impairments. For example, B32 reflected on how his group intended to proceed with their project based on his group's understanding of Ability-Based Design, with attention to how things are done, not necessarily on comparing it with how nondisabled users might complete a task.

*Our interview questions will be based more about the current things they are doing with applications on their phones, and by closely examining these actions we will be able to build a stronger conceptual model of our final application, in the hopes of not even having to mention that there are hearing or vision impaired. –B32, Journal 2*

B22 reflected on how focusing on ability guided specific design decisions along the way.

*The design approach my group has taken is Ability-Based Design, and this approach has greatly helped us in our design process. We have been perceiving problem-solving differently, by thinking about what our users can do, and how this application can be the most efficient for them. –B22, Journal 6*

As projects continued, students' ability to follow through with their design approaches was tested. Tasked with designing for users with and without disabilities, and grappling with feedback from multiple expert users, students using Ability-Based Design relied on useful principles in their design approach to help them through challenges. As B10 explained:

*Taking perspectives from both nondisabled expert users and disabled expert users into consideration definitely increases the difficulties of the design. The requirements of these stakeholders might even conflict. We discussed this situation... and finalized the design based on the guidelines of the Ability-Based Design approach. –B10, Journal 10*

B20 articulated how his group referred to adaptation when they could no longer find solutions to meet intersecting expert user requirements:

*I was unclear on how to apply our approach because not all users have the same abilities. So I did not know what abilities we should focus our design on. However, after working with the expert users I realized that they have similar abilities with one another. So we just focused on those similar abilities and based our design off of those abilities. We made sure that when we created our design that the user would not have to adapt to the system. We designed our project so that the system has to adapt to the user. –B20, Journal 6*

B20 continued on to elaborate how Ability-Based Design helped his group:

*The idea of focusing on an ability instead of disability makes it so that no person is discriminated against. I think the seven principles of Ability-Based Design are solid and are good guidelines for designers to follow. Also having the system adapt to the user, takes a lot of the burden away from the user and makes the application a lot easier to use if implemented correctly.  
–B20, Journal 10*

The guiding principle of Ability-Based Design to focus on what users can do shaped how B20 thought about design in a fundamental way: by creating a system that adapted to user needs, rather than placing the onus on the user to find the right accommodation. The assumption of the burden of access is shouldered by the student designer, via the perspective of their design approach, but Ability-Based Design's principles were flexible enough to accommodate divergent requirements.

### Universal Design

Students who worked with Universal Design had the benefit of a design approach that necessitated thinking about broader user groups from the beginning. While students using Ability-Based Design aligned their design approach with the task to design for users with and without disabilities, students working with Universal Design embraced differing requirements because it dictated that design should address specific needs by responding to individual issues.

*Getting conflicting feedback has been very beneficial because it has reminded us to keep Universal Design in mind as we are talking to the expert users. We can ask them questions about what they think will be most beneficial for all users and then give ideas about changing settings so that the application will work for each individual's needs.... we are able to meet the needs of a broader audience,*

*which is the main goal of Universal Design. The process is undoubtedly allowing us to improve our design. –B4, Journal 6*

I note that the view expressed by B4 is in contrast to typical design attitudes which, by the nature of defaulting to target users without disabilities, assumes that users with disabilities are left alone to get access or find accommodation. Students working with Universal Design addressed conflicting feedback in different ways from students working with Ability-Based Design. By definition, Universal Design required a single unmodified design to be useful to a wide audience. Customization or adaptation renders a core design not universally usable and so is not the goal of Universal Design. Students had to find, within a single solution, the set of features that would be usable to the widest possible user group. One notable contrast to Ability-Based Design was instead of allowing adaptation and customization, Universal Design expected a single concept to cater to a variety of user scenarios.

*One facet of Universal Design is an attempt to not have to design extra features for any specific group. This leads our group to a problem. Any program that relies solely on sound would be difficult to use by a person with sight. It also would be unuseable by a deaf person. This means that our product must have multiple avenues of use, which is a bit contradictory to Universal Design.  
–B14, Journal 2*

Whereas Ability-Based Design, through its seven principles, could give students structured guidance about how to address specific nuances, such as what to do when conflicts arose between users, Universal Design was much less clear. This design goal is challenging without the fallback of customization or adaptation.

*The main focus of the design approach is to design something that may be used by the widest possible audience, without adding alternate implementations or features except when absolutely necessary. –B4, Journal 6*

Thus, while at the outset, Universal Design's appeal to a wide audience was welcoming for students, in practice it was difficult to implement. The principles of Universal Design set

about a framework of constraints, but did not provide bootstraps to help students if they discovered no plausible set of features was possible for non-intersecting use cases.

### User-Sensitive Inclusive Design

User-Sensitive Inclusive Design led students to begin their design thinking through a social perspective. User-Sensitive Inclusive Design advocates developing rapport with users toward a working relationship grounded in mutual respect; designers interact with users both as traditional experts in functional needs, but also as people in a social sense. Embracing empathy is a core value emphasized in User-Sensitive Inclusive Design: the more designers can understand the user's experience, the more likely they are to refer to such a perspective throughout the design process and beyond.

For students who were unaccustomed to working in design, much less with people with disabilities, the guidance from User-Sensitive Inclusive Design to approach users in "everyday" ways reflected strongly in how they pursued their design work. Specifically, while students working with Ability-Based Design closely examined expert users' abilities to inform features useful across different users, students working with User-Sensitive Inclusive Design consciously focused on users as social actors who use technologies. This perspective shifted student mindset around a relationship with users as a key strategy.

*To take this population into account, the User-Sensitive Inclusive Design approach's main goal is to foster a relationship between the designer and the user with disability. –B33, Journal 2*

A value of User-Sensitive Inclusive Design is to consider all users equally, as social actors. Students interpreted this perspective to begin with social interactions before individual technical and functional needs:

*I feel we are able to apply our design approach during these feedback sessions by talking with BE10 like we would with any other user about how our design*

*should be changed. We don't view him as a "special" type of user that we need added features for. Rather, we include him as a user who is just as important as any sighted user and are fully able to use our design approach of User-Sensitive Inclusive Design by taking his perspectives as valuable opinions that are completely considered in our design moving forward. –B23, Journal 6*

Although it may seem that treating expert users as “just as important as any sighted user” should go without saying, I highlight that students were nervous about interacting with people with disabilities. The separation between students and disability in students’ daily lives was a barrier to interacting with people with disabilities; students, like most nondisabled people, were socialized to see the disability, not the person. B23 outlined how her group specifically asked questions about their expert user’s experience, while not asking about accessibility from the start. Instead, her group chose to allow their user to dictate the course of the conversation about his accessible technology use:

*We also demonstrated concepts of User-Sensitive Inclusive Design by not asking BE10 any specific questions about his blindness. Although being visually impaired clearly affected his answers to almost all of our questions, we could have had the same interview questions for someone fully sighted. This demonstrates ideas in User-Sensitive Inclusive Design by choosing to include users with disabilities rather than treat them as a special case with questions that clearly set them apart as a different type of user rather than keeping in mind the idea that BE10 is just another potential user that we should cater our design to. –B23, Journal 3*

### Design for Social Accessibility

Like User-Sensitive Inclusive Design, Design for Social Accessibility emphasizes a social perspective on design, rather than based on any specific orientation to ability or disability. And like Universal Design, Design for Social Accessibility offers few specific strategies to help students incorporate social consideration in their design practice. Instead, Design for Social Accessibility provided a high level view on accessible design featuring social consideration as its core principle, while leaving students to work out details using traditional user-centered design

techniques. Students initially emphasized superficial aspects of social appeal before uncovering how functionality and social behavior influenced design and use.

*Our design approach might detract the functionality aspect from our design because we might focus too much on the aesthetics of it, trying to make it suitable for the non-visually impaired as much as the visually impaired that we might not make it as useful and functional for the visually impaired. We might be inclined to choose a design that looks more visually appealing rather than one that is more functional for a visually impaired user. –B1, Journal 2*

A corollary to the focus on aesthetic appeal was that accessible design does not have to be proprietary. Students aligned social consideration and appeal by unifying preferences across disabled and nondisabled target users: the best way to ensure a design does not inappropriately call attention to a user is to create a design that is suitable for use by mainstream standards.

*This design approach... will offer many implications of what my design has to be. Personally, I don't think creating proprietary hardware is feasible for this kind of design approach. Having a gadget that is only for way-finding, separate from every other device people use would almost certainly stand out in public. –B21, Journal 2*

In turn, students relied on their own understanding of mainstream design.

*We decided that [using Design for Social Accessibility] would mean that we ought to limit the way in which our device looks and the way in which it communicates with the user to things that are already common in mainstream technology. This would ensure that the user would not be sticking out for using some foreign, alien-like device. –B31, Journal 10*

Although the strategy of aligning accessible design with mainstream design led students to construct a more egalitarian view of design in general, students encountered challenges when users prioritized function over aesthetics. B25 was caught off guard when his expert user had no problem with how a particular technology might look:

*BE2 was actually very indifferent to the subject. When asked if she would sacrifice some functionality for gains in terms of how beautiful the device looked. She said she would much rather it function well and consistently well, and she expressed that she cares little how she looks to others. She stated she*

*enjoyed talking to people, and even if her technology was viewed as odd, it would serve as a conversation starter in any case. –B25, Journal 3*

I note in B25's quote above that when asked about the "beauty" of her device vs. functionality, BE2 unequivocally prioritized function. Her response makes sense since the purpose for using devices is dictated by utility in the first place. Students misinterpreted "social" to only mean aesthetic dimensions, not social implications of use. Yet, we note BE2's response gets to the social life of assistive technology use when she refers to her devices as a "conversation starter."

Although groups using Design for Social Accessibility initially assumed social issues of use were mainly cosmetic, the role of functional implications in social contexts became evident. As the term continued and students worked on specific design decisions, they began to realize implications of use in social situations. Students reflected on instances of technology use that aligned with expectations for social behavior and interactions, not just aesthetic appeal.

*We realized that one of the main functionalities that really made [expert user ] feel uncomfortable in public was that her phone made too many loud sounds at once and that seemed to catch the attention of people around her. Our understanding of our design approach evolved from just focusing on the aesthetics of our app or the common functionality of it, to also focusing on expectations in a given social interaction. –B1, Journal 6*

Students' awareness of social implications of technology use heightened their critiques of designs more focused on function.

*Having overheard a bit from over groups testing their projects during the last lab, our solution, which includes a mute mode, silent option and the ability to customize sounds to make the application seem more normal, drastically contrasts with the solutions which are constantly spewing directions and navigational information. –B31, Journal 6*

In the end, student groups reconciled social situations of use as not just aesthetically relevant, but also connected to functional expectations of use and interactions in social contexts.

*We focused on developing self-efficacy and confidence through our minimalist, easy-to-navigate layout as well as through our tutorial/helps and tips feature that takes a user step by step through using our application with an option to opt out at any time. –B29, Journal 10*

Aspects of design approaches that had an impact on how students perceived design, along with working with multiple expert users, guided student impressions about disability and accessibility.

## 6.5 DISCUSSION

Despite emphasis on the user in user-centered design, current mainstream personal technology design is predominately inaccessible, disregarding disabled users as part of that user-base. I investigated how designing for disabled and nondisabled users in the user-centered design process influenced student perspectives. I found that student attitudes and perspectives on accessibility corroborated related work indicating that separating disability and mainstream design approaches reinforces the notion that accessibility is “someone else’s job” (Burgstahler, 2015; Ludi, 2007; Waller et al., 2009).

The findings from this study add to the existing body of research in Universal Design in education (Burgstahler, 2015) an empirical study of students tasked with inclusively designing for people with disabilities in a classroom setting. These findings expand on strategies bolstering awareness of the importance of accessibility. I found evidence of ableist attitudes implicit in students’ initial approaches to accessibility, confirming and extending work by Ludi and Waller, that interacting with people with disabilities can help students develop a better understanding of disability and design (Ludi, 2007; Waller et al., 2009).

Through different design approaches and techniques, students were able to adjust how they thought about design. Students initially did not consider accessibility a core part of overall

design, and students were aware that understanding users was a basic step in the user-centered design cycle. Yet, students did not necessarily turn this awareness of empathy into action: despite having a grasp on the importance of empathy in design, students did not know how to empathize with disabled users in their own design work. Various design approaches, such as User-Sensitive Inclusive Design, made explicit what students could do to “foster a relationship” as B33 mentioned, ultimately cultivating empathetic perspectives in student designers.

#### 6.5.1 *Confluence of Constraints: Multiple Expert Users and Design Approaches*

Students reported changing the way they thought about accessibility, and most confessed they expected design for users with disabilities to be more difficult than for nondisabled users. But at the conclusion of Course A, 21 out of 36 students admitted that designing for disability was not as hard as they thought it would be. Ten reported no change, and only two felt it was harder. In Course B, 18 out of 36 indicated they felt designing for disability was not as difficult as they thought it would be, 14 reported no change, and four indicated they thought it was more difficult. I highlight that interactions with expert users helped students gain an appreciation for accessibility by humanizing the relevant issues.

The assumptions about design and disability that student designers initially had led to an understanding that most first-time designers do not typically come to technology design with an appreciation of the needs of disabled users. It was not that students felt they should not design for disabled users, but they believed nondisabled users were the presumptive de facto target audience. Simply put, in their role as designers, students did not think it was their job to design for disability. Social psychology suggests that student designers’ expectations around disability are almost certainly shaped by previous experience (Christiansen, 1999; Mead, 1962). Students’

prior experiences left them unprepared to know how to interact with people with disabilities, and some students exhibited ableist views.

Students situated their perceptions toward disabled users as a stigmatized “other” (Elliott et al., 1982; Fine & Asch, 1988; Goffman, 1963b). B34’s statement that, “I, myself, have fears of being inflicted with disabilities,” reveals a conflation of disability as a disease, stigmatizing people with disabilities as a marked “other,” (Goffman, 1963b). Pitying and stigmatizing disability led students to feel self-conscious about offending expert users. Opening up the concept of the “user” to include disabled and nondisabled people gives more stakeholders an equal chance to influence design. With this requirement, students were prevented from separating “normal” from accessible.

Working with multiple disabled users took students’ empathy one step further: they came to appreciate an experience different from their own, and as designers found ways for people with different experiences with disability to use the same technology. This appreciation re-centers the notion that incorporating accessibility necessarily means focusing exclusively on disabled users, positioning designers as “helping” disabled users, and instead shapes a perspective where designs encompass a range of unique abilities in a unified experience.

Addressing the challenges of working with multiple expert users helped the task of designing for disabled and nondisabled users by diversifying the perspectives that defined how users with visual impairments might use personal technologies. Although a range of perspectives could provide challenging conflicts, students relied on principles from their design approaches to guide them in how to handle complex issues. This confluence of challenges and directed guidance forged a nuanced approach in how students addressed accessible design. On the surface, it is a key part of a design approach to support more than one user; after all, the goal is

to create solutions that will be helpful to a targeted user group. However, it became apparent that specific elements of design approaches opened up avenues of design consideration that were helpful in addressing issues related to diverse abilities. Notably, Ability-Based Design guided students to consider the intersection of abilities (and adaptations where needed), and User-Sensitive Inclusive Design and Design for Social Accessibility prompted students to pay close attention to social rapport and social situations of use, respectively, making possible the idea that mainstream design ought to be the basis for accessible design. The strategy of rooting the problem space within a mainstream construct is a significant and unexpected (though desired) move for student designers.

Including people with disabilities involves more than just face time (Ludi, 2007; Shinohara et al., 2016; Waller et al., 2009), it involves enmeshing multiple stakeholders of both disabled and nondisabled viewpoints throughout the design process. Designers need to consider disabled users as part of the whole user base, not as a separate group or set of requirements. Student designers regarded accessibility as part of their larger aims when they: (1) gave agency to the disabled user as a person (not a disability) with an equal stake in design outcomes like any nondisabled user, and when (2) they saw themselves as having agency and skill as designers to create technology that fulfilled needs for both groups. Furthermore, perspectives and differences in design approaches guided students in addressing the challenges they faced, both in overall perspective and in specific techniques.

### 6.5.2 *Toward Design for Social Accessibility in Mainstream Technology Design*

The students' experiences led to a better understanding about how we might bring about change in design practice. Students relied more on their design approaches than expected, particularly considering the limitations in learning about specific aspects of each approach (i.e.,

workshops were helpful, but not in-depth). I relate students' flexibility with design approaches to their novice understanding of design overall: with no prior experience with design or disability, students would come trust their design approaches, evidence showed that student design thinking was influenced by their design approaches. Together with the challenge of designing for multiple stakeholders with and without disabilities, design approaches were uniquely poised to provide students with appropriate high-level and detailed guidance in a given situation. Design approaches called on students to consider specific aspects of ability (Ability-Based Design and Universal Design), or they compelled students to broaden their awareness of disability within larger socio-technical relationships (User-Sensitive Inclusive Design and Design for Social Accessibility). I harness these findings into guidelines to effectively cultivate a mindset that is open to broader notions of accessible design. I refine Design for Social Accessibility and include a framework and techniques informed by the results of this study.

My goal in refining Design for Social Accessibility is to motivate accessible design in the larger ecosystem of personal technologies. The emphasis on social situations of use, while a defining characteristic of Design for Social Accessibility, is just one piece of the larger context of the impact of accessible design. Thus, I present a set of grounding tenets for Design for Social Accessibility aimed at changing the way we think about design in general, in order to benefit design for all.

- First, design ought to fundamentally come to incorporate users with and without disabilities throughout the design process. Finding a solution that bridged these two seemingly disparate user groups was driving force in compelling students to seriously evaluate how their ideas addressed different accessibility requirements and fit within the mainstream technology milieu. Because students also worked with people with

disabilities, centering designs within a mainstream context in no way limited the accessibility of the final design. These aims are similar to Design for User Empowerment (Ladner, 2015), which emphasizes increasing designers and developers with disabilities; I highlight that the design purview overall should encompass users with disabilities as part of key target users.

- Second, design ought to address functional and social factors simultaneously because of the power of each dimension to affect accessibility outcomes and because of the impact to users with disabilities. Although User-Sensitive Inclusive Design and Design for Social Accessibility were helpful in guiding students through high-level concepts pertaining to social situations of use, students assumed that social consideration would be limited to aesthetic appeal. Social behavior, or interactions with others, did not initially register as part of social consideration. Thus, I constructed a framework (see Figure 6.4) to help direct consideration along social and functional dimensions, emphasizing the roles each plays in accessible design.
- Third, designers ought to work with tools such as method cards (see Figure 6.5) to spur their consideration of social factors in accessible design. I created a set of method cards to prompt designers for contexts of use that may be relevant for disabled users. The goal of such method cards are to aid nondisabled designers in systematically thinking through circumstances they would not be familiar with, to help them ask the right questions of the right people, or to help them make in-depth consideration along more than just functional parameters.

### 6.5.3 *Design for Social Accessibility Framework*

Ideally all technical projects should have a designer with a disability on board (Ladner, 2015), but such an approach could be impractical if few designers have disabilities. The next best case is to encourage nondisabled designers to incorporate disability in design overall, including working with disabled users when possible, and to understand why social aspects of accessibility are as vital as functional aspects. To this end, I conceptualized a Design for Social Accessibility Framework illustrating how social accessibility comprises functional and social aspects (see Figure 6.4). As a design perspective, Design for Social Accessibility elevates social considerations alongside functional ones toward a holistic notion of accessibility: social accessibility. The Design for Social Accessibility Framework spatially situates functionally and socially usable aspects of design by showing how each complements the other, and demonstrating how each might operate alone. The framework is not pitting concepts against each other so much as facilitating their combination, akin to informing design will and intention, “initiating and directing change based on human agency” (Nelson & Stolterman, 2012). The framework ought to inform design judgment toward an ultimate particular (Nelson & Stolterman, 2012): Technologies considered to be useful and that positively facilitate use in social situations are considered socially accessible (top-right quadrant); the opposite, technologies that are difficult to use and negatively impact social interaction, are inaccessible.

Key characteristics of socially and functionally usable design are utility and expressiveness; though they are not opposed to one another and are not mutually exclusive. Aspects of design that are socially and functionally usable are closely intertwined and related, sometimes in complex ways. Next, I demonstrate how the Design for Social Accessibility Framework can be applied as a lens in design critique. I follow Carter and Grover’s analysis that

identity is tied to the individual (Carter & Grover, 2015), and acknowledge that it matters who decides what has utility and social appeal and this judgment ought to reside with the user. Thus, the examples are based on experiences reported in prior work.

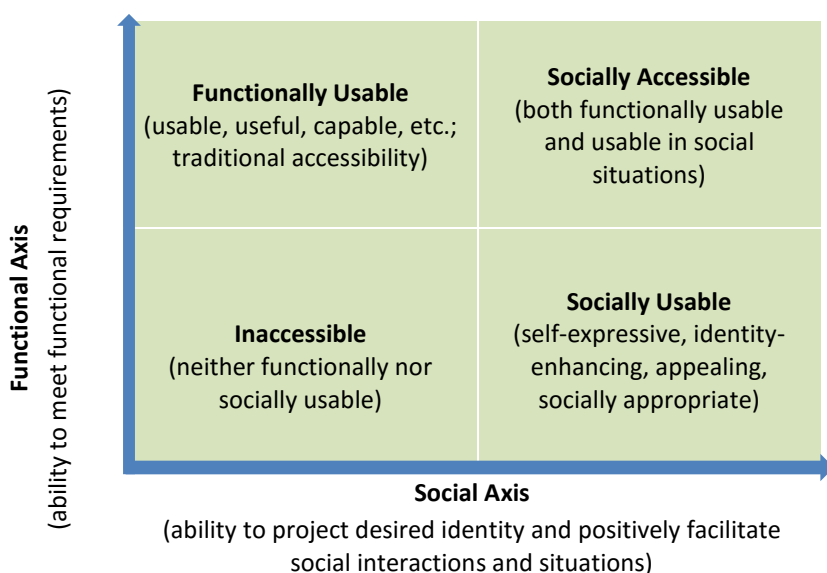
**Socially Usable.** The popular Kindle Fire utilizes Android's text to speech engine, Talkback, to make the device accessible for visually impaired users. Despite this attempt to provide access, the "devil is in the details" as one Talkback reviewer put it, and not all functional components accessibly meet user needs. The inclusion of accessibility in this popular device make it socially usable, but its limited capability place it low on functional utility.

**Functionally Usable.** Monoculars are magnifying devices used by people with low vision to see items like street signs or restaurant menus. As described in prior work, monocular users report being approached, sometimes patronizingly (Shinohara & Wobbrock, 2011). The usefulness for people with low vision makes monoculars functionally usable, but unfamiliar presentation makes them less socially usable.

**Socially Accessible.** Pullin identified eye-glasses as the quintessential assistive technology that is also a fashion accessory (Pullin, 2009). Those who use eye-glasses tend to do so because their uncorrected vision is poor. Eye-glasses are certainly an assistive technology, but they have become fashionable such that we do not associate the use of eye-glasses with a disability. In fact, some people wear eye-glasses as fashion accessories even without corrective lenses.

**Inaccessible.** Technologies assessed as inaccessible are neither functionally or socially accessible. Cochlear implants are hearing devices attached to the user's head behind the ear. Cochlear implants provide access to sounds, but many debate their true usefulness, as they reportedly have limited ability to reproduce sound accurately (Power, 2005; Tucker, 1998).

Cochlear implants are controversial among those in the Deaf community who feel the technology perpetuates a medical model of deafness, that it encourages a normalized view on hearing, and threatens Deaf culture (P. Parette & Scherer, 2004; Power, 2005). As reported in prior work, the implants' likelihood of falling off easily can make them the center of awkward social situations (Shinohara & Wobbrock, 2011). The embattled existence of the implants within the Deaf community (e.g., around issues about Deaf identity) and inconsistency in function renders them as having low utility and low social appeal. In relation to the literature reporting users feeling self-conscious about cochlear implants in certain social situations, they have a likelihood of being assessed as inaccessible in the framework.



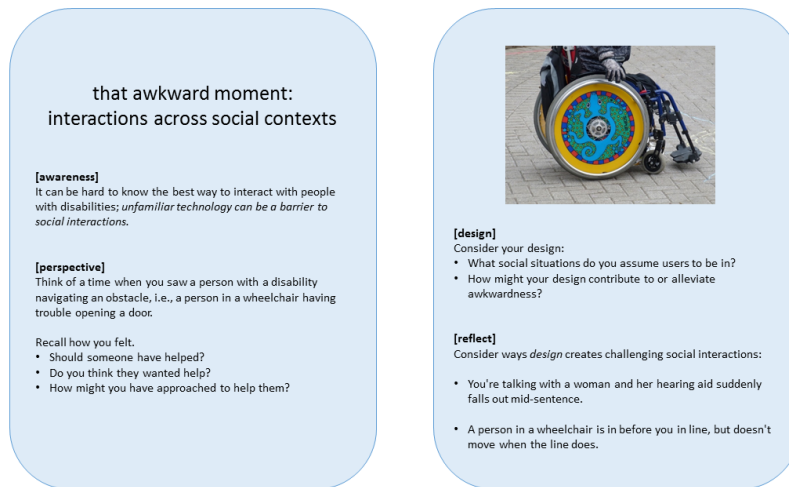
**Figure 6.4. The Design for Social Accessibility Framework illustrates the relationship between functionally (y-axis) and socially (x-axis) usable aspects in socially accessible design. Designs considered functionally and socially usable are socially accessible (top-right).**

My suggestions for the Design for Social Accessibility Framework are subject to individual assessment. For example, a cochlear implant user might define themselves by proudly wearing one and not experience awkwardness. The main aim of the framework is for designers to explicitly consider if a cochlear implant was worn in such a fragile state that it could fall off,

what might then be the consequences for use in social situations and how can design address such issues? Thus, although other aspects of technology design, like cost, contribute to and affect access, my goal is to emphasize that social factors and functional factors influence access. The complementary axes in the Design for Social Accessibility Framework are useful for re-aligning critiques of existing designs and informing future designs by facilitating consideration of how each component contributes to the social accessibility of a design.

#### 6.5.4 *Design for Social Accessibility Method Cards*

In addition to the framework described above, I developed a set of five method cards as a tool for designers to reflect on the complex issues contributing to social accessibility (see Figure 6.5). As a portable mechanism useful for provoking ideas and promoting methods quickly, method cards are familiar in the HCI designer's toolkit. Modeled after the IDEO Method Cards ("Method Cards for IDEO: 51-card deck to inspire design," 2016) and the Value-Sensitive Design Envisioning Cards (Friedman & Hendry, 2012), Design for Social Accessibility Method Cards adopt an approach much like the Value Sensitive Design Envisioning cards. The goal of the cards is to increase awareness and to provide ways to mediate conversation around sensitive topics that might be difficult for designers to ask of disabled users. For example, one card addresses "that awkward moment" and offers questions for designers to consider, "what would you do if you saw a wheelchair user who needed help?" and design prompts they can apply in their design work, "How might your design contribute to or alleviate awkwardness?" The goal is to provide a tool designers can reference that raises awareness of social issues in use and provides perspective about the disabled experience. The cards are not stand-ins for talking to people with disabilities, but rather are guides to help designers productively engage users with disabilities around issues related to social accessibility.



**Figure 6.5. An example Design for Social Accessibility Method Card: “audience: perceptions of “special” technologies,” aims to broaden awareness for issues in assistive technology use in social situations. (see Appendix II for a larger version of the full set).**

## 6.6 SUMMARY

I justify Design for Social Accessibility as a way to facilitate social accessibility in design critique, and to inform design method and technique. I organize key concepts of functional utility and social use into a framework demonstrating how Design for Social Accessibility incorporates social accessibility in design, and I introduce Design for Social Accessibility Method Cards as a way to increase awareness and to mediate reflection and conversation around sensitive topics that might be difficult for designers to ask of disabled users. The result is the first working conceptualization of Social Accessibility and what it means to prioritize it in design.

As technologists, we should take a closer look at the artifacts we design and build for others, and we must consider how paradigms of technology design and use influence situations of use for all kinds of people. Reframing how we view design, toward incorporating a socially accessible view, ought to encourage designers to create technologies that are not only functionally capable, but also socially usable for people with disabilities. We also have the opportunity to see disability as an expression of the diversity of human life (Ladner, 2015).

“Disability as diversity” reframes the issue as one akin to other quests for diversity. I argue, we ought to care about the impressions people have of assistive technology and disability because when allowed appropriate access, disabled people can contribute to social life every bit as much as nondisabled people.

This study is limited by students’ novice design experience. I captured students’ perspectives, but it is yet unknown how professional designers would handle similar challenges, and we cannot be sure how learning design in the first place might have impacted perspectives.

## Chapter 7. DESIGN WORKSHOPS: VALIDATING DESIGN FOR SOCIAL ACCESSIBILITY

### 7.1 INTRODUCTION

In the previous chapters of this dissertation, I theoretically grounded the motivation for social consideration in the design and use of assistive technologies. In chapters 2 and 3, I presented related work, and prior work I conducted, showing that people who use assistive technologies are aware of social stigma associated with such devices. In chapters 4 and 5, I described research I conducted to investigate elements of technology design and use that contributed to misperceptions around assistive technologies and those who use them.

Chapter 6 described empirical and design-based investigations conducted to understand how design thinking is shaped for student designers, toward developing a design perspective and set of strategies that facilitate social accessibility in technology design.

In this chapter, I describe an empirical study investigating how professional designers used *Design for Social Accessibility*. Including a pilot, I conducted five three-hour design workshops with professional designers working with users with and without visual impairments in user-centered design activities, such as brainstorming and low-fidelity prototyping (see Figure 7.1). My aims for this investigation were to determine if Design for Social Accessibility—incorporated within elements of the design process, including tools, techniques and user involvement—could shape designer perspectives on accessibility.

Influenced by the social model of disability, I considered how artifact design contributes to our collective perceptions about disabled technology users. In framing technology design based on a perspective rooted in the social model of disability, I shift the design consideration

not on assistive technologies, but on consideration of accessibility in social contexts. Assistive devices are those created specifically for people with disabilities, but if we take into consideration the social implications of proprietary assistive technology use, and reframe our understanding of design to be inclusive, then we must also shift: from “assistive” to “accessible.” Assistive technologies have their place in the technology spectrum, but in this dissertation, I argue for a change in our ultimate design goals: whenever possible, we should create *accessible* technologies that people with and without disabilities can use. With this distinction in mind, I pursued a study to investigate how Design for Social Accessibility helps designers to create socially accessible designs.



**Figure 7.1. A designer (center) brainstorms with two users, one with a visual impairment (left) and one without (right).**

## 7.2 BACKGROUND AND MOTIVATION

Inclusive design intentionally focuses on creating systems and technologies to be usable by people with disabilities. As I discussed in chapter 3, sometimes these approaches create designs that are disability-specific, in that the designs are primarily used to create solutions for

people with disabilities but not for nondisabled users. In contrast, designs in the Universal Design tradition are created with a diverse set of users in mind and are intended to be usable by people with or without disabilities. Although there are important and nuanced differences between the various ways accessibility is included in design, I distinguish them from mainstream approaches that tend not to consider people with disabilities as primary target users.

Experienced designers tackle complexity with a well-honed perspective gained through design practice grounded in rigorous and disciplined approaches referred to by Nelson and Stolterman as “designerly ways of thinking and acting” (Nelson & Stolterman, 2012; Stolterman, 2008). Research focused on the process of design must, therefore, acknowledge and refer to designers’ own expertise and approach to creating novel artifacts. In studying techniques to improve design practice, I aim to respect designers’ expertise in a “prepared-for-action” approach that builds on the skill and knowledge, rather than a “guided-in-action” approach that may overstep designer judgment and rationale (Stolterman, 2008). Therefore, I seek to understand the ways in which designers, established in their own designerly ways of knowing, are able to effectively incorporate Design for Social Accessibility with sufficient design judgment and argumentation (Cross, 2011; Nelson & Stolterman, 2012; Stolterman, 2008).

Recent technical advances in intelligent and autonomous computing, (e.g., Siri, Cortana, Alexa, HoloLens, Oculus Rift, self-driving cars) have the potential to facilitate alternative access to information (e.g., via voice command (Kuang, 2016)) and to the surrounding environment (virtual or augmented reality (Haynes, 2015)). In addition, autonomous vehicles could increase transportation opportunities for many who are unable to drive (Reznik, n.d.; Urmson, 2015). The technical landscape is shifting with increased opportunity to seamlessly include accessibility into mainstream technology design, yet few professional designers avail themselves of these

advances to produce technologies that are usable by people with disabilities (Larson, 2016). An exception would be the Apple iPhone, with its built-in accessibility features, such as Apple's VoiceOver screen-reading system.

Inclusive design approaches, such as those discussed in chapter 3, emphasize that a focus on accessibility can be combined with innovative intelligent and autonomous technical capabilities, though this opportunity has yet to be fully realized. Instead, design practices often remain focused on primary use cases that target nondisabled users, rather than broaden design perspectives to include disability, much less to include social aspects of disability. Given the dearth of design perspectives that inclusively address accessibility and social factors in design, I defined the three tenets of Design for Social Accessibility to focus specifically on broadening inclusion for people with and without disabilities, to explicitly consider social, as well as functional factors, and to engage in reflection so as to encourage not just a shift in doing design, but in design thinking. In this chapter, I describe a workshop-based study I conducted to verify the feasibility of Design for Social Accessibility. Through the workshops, I determined how designers are able to incorporate aspects of Design for Social Accessibility in typical user-centered design tasks.

### 7.3 METHOD

I conducted five, three-hour design workshops and observed how designers addressed social accessibility while working with users with and without visual impairments in a user-centered design process. Following each workshop, I interviewed designers about their experience, including their typical design work, to gain an understanding of whether and how they approached accessibility, whether they considered social factors, and what their perspective was on working with users with visual impairments and users with disabilities overall. I asked

designers questions such as, “What was it like to work with both users? And, how did it compare with your typical design work?” In the following sections, I detail the specific aspects of the workshops.

### 7.3.1 *Participants*

One designer led each workshop, working with a user with a visual impairment and a user without, for a total of 15 study participants. The breakdown of participants is shown in Table 7.1. Each designer had at least three years of professional UI/UX or industrial design experience, and users with visual impairments ranged from low-vision to completely blind. Although designers were recruited for expertise in interaction design, user experience design, or user-centered design specifically, they did not specialize in accessible design. Designers D2, D4 and D5 had prior experience with accessibility, or with tasks to design for people with disabilities. However, for D2 and D4, these tasks were not the main focus of their design work. D5 was working on a project for people with physical disabilities at the time of the workshop, although she did not work with people with disabilities. I specifically recruited designers who did not identify as “accessibility experts” to understand how general design practitioners approach accessibility.

The visually impaired and non-visually impaired users did not have experience with design. Users were introduced as having the “user expertise” to contribute throughout the workshop. Visually impaired users were recruited through local disability community groups and assistive technology listservs. Visually impaired users had vision-impairments that ranged from blind to low-vision. V5 was also in a wheelchair. Non-visually impaired users were recruited via social media and email listservs.

<b>Workshop</b>	<b>Designer Title-Yrs Experience</b>	<b>Visually Impaired User</b>	<b>Sighted User</b>
1	D1 (F, 25 yrs) Product Designer-6 yrs	V1 (F, 20 yrs) low vision	S1 (F, 24 yrs)
2	D2 (M, 31 yrs) Senior Designer-5 yrs	V2 (F, 54 yrs) low vision	S2 (F, 29 yrs)
3	D3 (F, 54 yrs) Designer-5 yrs	V3 (F, 34 yrs) light/dark vision	S3 (F, 37 yrs)
4	D4 (M, 44 yrs) IT Consultant-5 yrs	V4 (F, 63 yrs), blind	S4 (F, 34 yrs)
5	D5 (F, 25 yrs) Technical Designer-3 yrs	V5 (M, 32 yrs), Stargardt's, no central vision	S5 (F, 18 yrs)

**Table 7.1. Workshop designers and users.**

### 7.3.2 *The Workshops*

Workshops were three hours long and included four main tasks user-centered design: brainstorming (divergent thinking), synthesis (convergent thinking), prototyping (making), testing (evaluating). Each task was allotted approximately 20 to 30 minutes of design time, and the breakdown is shown in Table 7.2. Time limits were imposed because the main goal was to determine whether designers were able to progress toward accessible design at each stage, not necessarily to have a refined solution. I provided materials used in the workshops, although a few designers brought their own pencils and sketch pads. Designers were provided a variety of basic office supplies to work with, including index cards, Post-It notes, Scotch tape, glue sticks, markers, highlighters, pens, and paper clips. Designers also had access to a white board and large conference table.

I conducted the first workshop as a pilot; the changes I made as a result were to eliminate a heuristic evaluation, and to split the second task into synthesis and prototyping phases (of fifteen minutes each) to give more time for them to generate a single design idea and mock up. Because the data from the pilot was still otherwise valid, as pertains to the process and techniques employed, the data for the first workshop was analyzed alongside the rest.

Preceding and immediately following each workshop, designers completed an attitudes toward persons with disabilities survey interspersed with a survey about attitudes toward user-centered design (Frick, Boling, Kim, Oswald, & Zazelenchuk, 2001; Yuker, 1988).

<b>Workshop Activity</b>	<b>Description</b>
Pre-study survey	Attitudes toward UCD Attitudes toward PWD
Target users	People with and without visual impairments
Task 1: Ideation	Design for Social Accessibility Method Cards Design for Social Accessibility Framework
Task 1 Reflection	Designers and Users are prompted to reflect on Task 1; Designers are separated from users to complete the reflection.
Task 2a: Synthesis Task 2b: Prototyping	Synthesis with both users, prompts for self-consciousness/self-confidence as well as efficacy and usefulness Prototype one brainstormed idea using paper prototyping materials
Task 2 Reflection	Designers and Users are prompted to reflect on Task 2; Designers are separated from users to complete the reflection.
Task 3: Evaluation	Testing prompts for self-consciousness/self-confidence, efficacy, usefulness Design for Social Accessibility Framework to evaluate for social accessibility
Task 3 Reflection	Designers and Users are prompted to reflect on Task 3; Designers are separated from users to complete the reflection.
Post-study survey	Attitudes toward UCD Attitudes toward PWD
Post-study questionnaires and interviews	Users will respond to a quick questionnaire about their experience Designers will be interviewed about their experience

**Table 7.2. Each design workshop consisted of a series of user-centered design tasks. Designers infused aspects of Design for Social Accessibility with each task.**

All designers were given the same prompt, to create an on-body device for cruise ship passengers to track ship information or on-board activities (see Appendix I for the full design prompt). This prompt was designed to facilitate consideration for solutions of particular salience with regard to social accessibility. Thus, elements considered in creating the design prompt included targeting users who were both visually impaired and not visually impaired, contexts of use that were social and public, situations of use that were personal, and that involved social interactions with others, inquiry or information seeking tasks.

Designers were instructed that the designed solution should be usable both for users with and without a visual impairment, and that they could leverage the expertise of the two users in

the workshop. Thus, the workshops were structured to allow designers to take the lead, engaging users as they felt necessary. Designers were encouraged to use techniques that they typically used at each design phase, eventually developing a paper prototype representing the final design. Designers engaged users throughout the workshop and elicited feedback as befit their own style.

At the end of each task, designers and users responded to brief reflection prompts. When completing reflection prompts, designers and users were separated to provide privacy. In the ideation task, designers brainstormed solutions to the prompt. The synthesis and prototyping task was broken into two phases because the activities were closely related; designers and users reflected once for both phases. In the synthesis phase designers first narrowed the brainstorm ideas into a final idea that could be roughly paper prototyped. Then, in the prototyping phase, designers prototyped a crude, low-fidelity paper manifestation of their design idea (see Figure 7.2). In the evaluation task, designers and users conducted brief user testing to assess whether the prototypes met requirements. User testing was not overly formal, but served as a reflective opportunity for designers and users to assess how the rough prototype met their design goals. After completing all three tasks, users completed a questionnaire to evaluate how well the solution addressed their needs and to assess their experiences working with the designers.

### 7.3.3 *Data and Analysis*

Data consisted of workshop videos and photos, transcripts, design artifacts, designer and user reflections, user questionnaires, and designer interview transcripts. I first conducted open and inductive coding on the interview transcripts guided by a grounded theory approach workshops (Glaser & Strauss, 1967; Miles & Huberman, 1994; Strauss & Corbin, 1998). I used axial coding to elicit themes that emerged from the interviews. Then, I conducted open and inductive coding on the workshop transcripts, reflections and user questionnaires. My analysis

focused on the success of each workshop to create designs evaluated positively (about which designers and users were both felt proud), and on elements of the design process that indicated how well designers were able to incorporate concepts of social accessibility, and techniques and tools for Design for Social Accessibility. My observation notes and memos were analyzed and compared with emergent themes (Miles & Huberman, 1994). With the codes from the workshop, I went back and re-coded the interview transcripts, looking for elements that may have occurred in both. Continuing with deductive coding, I then conducted a comparison across themes from prior work because the goal of the workshops is to determine if Design for Social Accessibility, as developed, could be used by professional designers. Themes were compared across prior work to develop social accessibility (the interview and diary studies, in chapters 4 and 5) and the concepts that contributed to the development of Design for Social Accessibility (based on findings from the design thinking courses with student designers, in chapter 6). I conducted axial coding across interviews and workshops, with a focus on themes that emerged across the designers' experiences. For example, designer impressions of their workshop experiences were corroborated with observations that emerged from the data. In addition, I analyzed designers' comfort and approach to accessible design in the workshop and in their daily work (as communicated in the interviews), and on designers' interactions with users throughout the workshop. A focus was given to these latter concepts as a result of initial coding and observations, indicating emergent themes around workshop dynamics and idea and user balancing that occurred. A list of initial codes, across both the workshops and the designer interviews, is shown in Table 7.3.

<b>Incorporating Social Accessibility</b>	
Defining social accessibility	Awareness and understanding
Everybody/everyone can use it	Perspective on design and disability
Increases diversity of ideas	Inclusion: disabled and nondisabled
The design	
<b>Design for Social Accessibility Tools and Techniques</b>	
Framework	Good for brainstorm
Method cards	Technique
Awareness	Multiple users strategy
Aligning ideas	
<b>Disability knowledge sharing</b>	
Challenging	Hard to know about visual capabilities
<b>Workshop dynamics</b>	
Design lead	Switch user focus
Team management	
<b>Ideas</b>	
Pivot ideas	Social consideration
Access consideration	
<b>Inclusive Design</b>	
Challenges	
<b>Working with people</b>	
Design practice	Impact of multiple users
Benefits	Working with disabled users

**Table 7.3. High level codes for workshop and designer interview data.**



**Figure 7.2. D2 assembles a paper prototype.**

## 7.4 FINDINGS

Designers and users evaluated their prototypes as successful, though rough, in terms of meeting their overall design goals. Designers were able to incorporate elements of Design for Social Accessibility within the design cycle per the workshop exercises as indicated in questions they asked of users and considerations they expressed throughout the process. However, challenges and surprises emerged from a detailed analysis of the data. Not all designers used all tools effectively, and completed designs were very rough and difficult to systematically and rigorously evaluate. In addition, in conducting the study as a design inquiry on the effectiveness of the tools and techniques, an analysis of the findings provides specific insight into how the framework, method cards, and other aspects of design techniques influenced different interactions. Specifically, the ways in which social accessibility, the framework, (see Figure 6.4) and the method cards (see Figure 6.5) guided designers to conceptualize designs congruent with the social model of disability. In this section, I describe in further detail workshop dynamics, the role and expertise of designers and users, and operationalization of social accessibility in design.

### 7.4.1 *Workshop Dynamics*

Designers reflected that they became more aware about access issues as the workshops progressed. Despite having familiarity with accessibility guidelines for legal reasons, in their jobs, designers did not typically incorporate accessibility or disability into their daily work unless they were required to do so. In this section, I summarize designers' prior work experiences with accessibility and disability and include an account of their workshop participation and reflections on their experience.

#### 7.4.1.1 Designers' Prior Work Experiences

Designers indicated they did not have much experience working with people with disabilities in their jobs. In my interviews with designers, they characterized a range of experiences and perceptions about disability and accessibility. D1 did not work on accessibility projects, but was aware of a time when her company was notified via lawsuit to make their product accessible to color blind users. Neither D2 nor D3 were aware of legal accessibility requirements, including Web Content Accessibility Guidelines (WCAG) and Section 508. Neither worked with users, with or without disabilities, on their design projects. D4 had pushed for a project involving visually impaired users, including briefly interviewing at least one user, but in the end had to abandon creating an accessible design for visually impaired users due to company directives. D5 had been working on a project designing airplane lavatories for wheelchair users, but did not meet directly with any users in her design process.

Interviews revealed a number of barriers to inclusion that designers faced in their daily jobs. Despite agreeing that accessibility was important, it was rare for designers to work with people in their design work, and they did not work with people with disabilities at all.

Designers referred to themselves as the ideal—nondisabled—user. D3 interpreted her requirements to be that the “user would be—anybody,” D3 explained what that meant for her in the context of the workshop:

*I don't think it was necessary to have the second one [the non-visually impaired user] because I would be the second one. I mean because I could totally vouch for, you know, what it's like to not even have any... because I don't have any hearing impairments or vision or whatever. –D3, Interview*

Project managers created business goals, which directed design work, and defined accessibility as an “edge case;” designers were not compelled by external forces to include accessibility in the design process and often constraints of the job prevented them from doing

so. Designers were not the decision makers and did not dictate what they designed or for whom they designed. D4 had to concede his goals for inclusive design to business leadership:

*The other consultants were MBAs, so you had people come from business school, who—again, first and foremost, thinking kind of like money first, and I came from a different background—and I think we kind of defaulted to—more the business side of things, whereas you take certain shortcuts and ... [accessibility’s] kind of a shortcut that you may not think about or apply time to because it’s taking away from the execution of just getting something to the client. –D4, Interview*

As D4’s comment indicated, designers were aware that in the cutthroat technology industry, projects happen on expedited timelines and everything is optimized. The perception was that only large companies have resources to support “extra” design and development, as D4 explained:

*Very big companies, like Google, like Amazon, like Microsoft—because they’ve got a ton of research—Apple—they have billions of dollars. You know, if they throw ten million at this, it’s nothing to them. It’s nothing. But you know, like a smaller company who has even like a hundred million in annual revenue—I would imagine, oftentimes, they’re not going to—because they’re focusing on a target market and delivering to that target market. And sometimes—many times that target market doesn’t consider the needs of those who have a disability of some sort. –D4, Interview*

Similarly, even though D1 and D5 had been tasked with disability-specific projects at some point, they did not incorporate accessible aspects of these disability-specific projects into their “mainstream” design work. D5 noted that even in her disability-specific project involving wheelchair access on airplanes, she was limited by the company’s resources:

*Even though we might want to make [the project] so that it is accessible physically and make it so that there’s still some dignity for all people involved, it might not actually be carried out because the company’s gonna follow the law, at minimum. And, it might cost more money or something—it impacts what can happen to the overall space. –D5, Interview*

She goes on to discuss the cost and resource analysis that dictates what she designs:

*If [users with disabilities] do need help, then if you [as the designer] don't provide them the space for that, then you're not supporting their functional needs... But, the thing is, how often does that happen? And so those are the things that you're weighing against. It doesn't happen as often, and so how much comfort level do you have to give all the people involved? Yeah.*

*—D5, Interview*

D5's project involved meeting legal standards and little more, despite her acknowledgement that it could make the use case difficult for a person with a disability. Further, she did not work with users in her design work. Although the aims of D5's work included an accessible accommodation, it did not change parameters instrumental to her process.

D5's experience highlighted an outcome of external constraints driving priorities. Her goals included a focus on the primary use case, driven by client expectations. Similarly, D4's experience with clients and business leaders enforced a focus on primary users, which assumed users without disabilities, before pursuing accessibility. The separating of users by ability contributed to the perspective that excluding people with disabilities from the core design process was typical or expected. When I asked the designers about working with disabled users during the design process, it became apparent that it did not occur to designers that they could incorporate accessibility in their core design process.

*Tech companies, in general, that are for profit—you make a business case for any kind of drastic design decision, especially for accessibility. At the startup I worked at, which was less than 200 people, it would be considered an edge case, making a design accessible. Because it's like less than 10% of our user base, and with the very limited resources of a startup, we need to focus on the majority of the user base, which sometimes will not include accessibility. Which is probably why we didn't think about the visual impairment stuff until way further down the line. Because when you're first just trying to survive as a startup, the product is mostly just trying to make it work and then accessibility is like the cherry on top. —D1, Interview*

The paradigm of delineating population segments and defining primary users as nondisabled characterized designers' thinking and practice of design, not to mention limiting

their reach to nondisabled users only. D1's comment was echoed by the other designers, and contextualized "designerly" approaches to dealing with the complexity of legal accessibility requirements without support. Design choices were predicated on this separation of disabled versus nondisabled users (in the designers' experiences). The distinction had consequences for how designers considered the different user groups. The nature of how they perceived their role in addressing needs for disabled users emerged via the language used to talk about how their work was affected:

*So I guess, the natural approach is basically when you're trying to design for situations like that, you basically design for the audience and then try to extrapolate for someone who is disabled. So the general approach, if you look at most applications, is basically build assistive technologies on top of what they're already building. -D2, Interview*

Thus, the "natural" approach was to optimize for a nondisabled user, and then to "extrapolate" for other use cases. In other words, designers considered it "natural" to create for a base case of nondisabled users, regarding accessibility as an add-on after-the-fact. This description demonstrated D2's designerly way of approaching such problems. Here, his use of language to denote the natural, ordinary, common or usual approach excludes accessibility as a viable "natural" part of the process. Normalizing "natural" to mean optimizing for nondisabled (in D1's words, "majority of the user base") meant that designers developed a practice of design separating accessible needs as outside the predefined "norm" of nondisabled users.

Furthermore, past exposure to accessibility and disability was scant enough to reinforce perceptions on the complexity of inclusive design, rather than to motivate it. D1 once saw a blind software engineer give a talk to developers to motivate inclusion, but the takeaway message was overwhelming and confusing:

*And then how do you design that? Because if I had a search page, if I had a ton of things on that, and then somebody, we, as designers had never thought of*

*beforehand of designing it that way. But then it comes to what is the priority, in our design process. Usually it's that you're meeting certain requirements. Which probably doesn't include accessibility on that list. –D1, Interview*

D1's comment highlights consequences of working within a paradigm separating out disability, confirmed by the designers' practice of not working with users with disabilities (or with users at all). While the blind software engineer motivated the need for accessibility, D1 did not feel equipped to address it. As noted, only D4 had worked directly with people with disabilities on a design project when he began interviewing people with visual impairments for a startup. His story further emphasizes D1's reaction to the blind software engineer, when he tried to move forward with accessible design work, he ran into technical accessibility issues that overwhelmed the project focus:

*I guess there's an asymmetry, like we, as designers, had a concept of: alright, here's what someone who's visually impaired would need. And so we'll do x, y, and z. And then we talked to someone like, no, no, no, you're totally missing the—you're not understanding from an authentic standpoint. I mean, you can have assumptions, but you have to verify the assumption—so again, that was helpful for us, and that's what we decided at that point that we need to push off. That we needed to do more significant research, or even with additional funding, hire a usability researcher to actually perform this type of testing.  
–D4, Interview*

Like D1's experience of feeling overwhelmed by the unknown challenges in accessibility, D4's experiences were no less fraught, even though he started out with good intentions. Accessibility constitutes an element of added complexity as D4 described, and the designers initially treated it as a foreign concept requiring specialized skill or additional know-how.

The paradigm of focusing on disabled users due to resource and company constraints perhaps contributed to shaping a practice of design that waylaid accessibility. In any case, it is this practice that characterized the designers' and their approaches to the workshop.

My interviews indicated that designers felt ill-equipped to handle accessibility issues—or were not allowed to—and that focusing on accessibility would distract from their priorities. In contrast, in the workshops, designers demonstrated skilled, designerly approaches grounded in experience working on complex problems. The nature of this skill allowed the designers to approach the workshop accessibility requirements with rigor and discipline that marked their work, notwithstanding their perceptions of their ability to address such problems or to manage multiple stakeholders.

#### 7.4.1.2 Designers' Workshop Participation

Despite limited prior experience working with users with or without disabilities, or with accessible design, in the workshops, designers demonstrated an ability to work with visually impaired and sighted users, through a careful balancing of both users and ideas. Although they reported not feeling very confident about leading a group, designers stuck to the generation of ideas and creation of the design itself and in doing so, effectively guided users through the different design tasks. Designers did not view themselves as team leaders, but they had skill and confidence as *designers* to push on *ideas*, while avoiding interpersonal conflict. This emergent dynamic was pervasive across all workshops, and involved nuanced and skilled attention to ideas, constraints, and the design process itself.

In working with users with and without visual impairments, designers were confronted with complex use cases and ideas that typically did not arise when design tasks did not include working with users. D2 elaborated on his impressions of working with a user with a visual impairment, contrasting it with design work that occurs in isolation. The ideas that emerged, he argued, are different than one can conceive of without a user's input.

*I mean, having her input, if I'm designing stuff, was just significant rather than me—because, ... taking even [my company], even the previous companies I worked with right, because a lot of the times, we basically just design in isolation, we basically come up with like—oh, let's come up with wireframes and then let's come up with the design and then show it and then see how they react to it. But then actually talking to [visually impaired users], understanding what are the challenges they face, how they go about it, doing a play-act, play-acting them through, uh... different scenarios, it's pretty helpful because then you start seeing things that you don't even realize. –D2, Interview*

Thus, there were many benefits to including people with visual impairments in the workshops, but this is not unknown, as prior work has shown that working with people with disabilities positively impacts the accessibility of the designed outcome (Bigelow, 2012; Ludi, 2007; A. Newell et al., 2011). What I focus on in these workshops is the emergent phenomenon of having two users, representing different user perspectives, working with the designer at the same time. In this section, I present findings that detail some of the interactions that came about from interactions between the designer and two users in each workshop.

### Focus Switching

One way that designers demonstrated their skill in managing multiple viewpoints was their subtle, yet effective ability to pivot or switch focus on the idea being discussed, to bring attention to specific areas of consideration through discussion between users. In the following example, D2 follows S2's idea justifying a wristband by acknowledging the idea, and then turning to consult V2:

*S2: You use it for the time that you're on the cruise and then return and it's something like that.*

*D2: Well, that's a great idea. (turning to V2) Would that be something you would be comfortable—like carrying a wrist band or—*

*V2: Sure, um, and I know they're really light weight, aren't they?*

*–Workshop 2, Task 2*

Even as the conversation became more involved, D2 continued to explore how comfortable S2 felt about the idea of using the design in a public setting, skillfully switching focus between users:

*D2: Okay, so one quick question: would you be comfortable wearing this in a public setting? If someone would actually designed this up for you? What would you prefer it looks like? You said a wrist band would work out. But is there anything specific that you'd be looking out from a design standpoint so that you're more comfortable wearing in a public setting?*

*S2: I would think—one, color options. Because you know, [if] my boyfriend and I are both gonna go on this cruise, we don't want to have the same exact one because we want to be able to tell ours apart. But then, also, I won't wear hot pink. I don't want it to be hot pink—like a lower profile, maybe not necessarily giant, gaudy, bulky, it may be functional, but if it doesn't have an outward appeal, I might feel a little more awkward wearing it. Because it's not a necessity for me to get around.*

*D2: Right. (turning to V2) What about you?*

*V2: I mean, my personal preference would be not to call attention to it. So, look like a piece of casual jewelry or not be a bright color. Problem is, everybody's tastes are different and there's gonna be people that like that neon yellow color. The nice thing about if it's kind of a neutral color, its gonna blend in with whatever you're wearing. There's lots of different kinds of vision loss and for that reason some people are gonna see blues better, some are gonna see reds better, so if there was a possibility of an assortment... [but] that's more expensive, probably, to do that.*

*–Workshop 2, Task 2*

D2 prompted both users, collecting their ideas and input, moving from one to the next while they described their preferences. We can also see, in this conversation, that both users contribute their views about acceptable visual appeal of the design.

### Designers' Sensibilities

Designers' skill and sensibilities emerged in the ways they handled discussions, such as encouraging users to reflect on their own thinking. In the following example, D1 asks the users

for their impressions about a concept they are discussing. She then paraphrases S1's response as "something like tactile feedback," reflecting back the ideas that S1 started with:

*D1: Or people who are in wheelchairs, or if you can't really see the screen, how will you interact with that? So, like what's a good workaround for it.*

*S1: Well, I'm thinking- because even I think it's hard, too, knowing where to scan. I mean, sometimes you're even at the grocery store and you're like scanning and scanning and scanning – something's not happening, but maybe if there's like a sensor or a buzzer that like – like your watch buzzed when you were nearby one, so that it just like alerts you to the fact that you're close by.*

*D1: Okay, so something like tactile feedback.*

*S1: Although, I feel like that could get annoying if you're walking around. So, obviously, you could turn it off or on, or something. So if you needed to find one, you'd turn it on so that you could just have your wrist out, but...*

*–Workshop 1, Task 1*

When D1 reflected back on S1's thinking, rephrasing what S1 had said, S1 responded by moving forward with the idea "although, I feel like that could get annoying..." given the new encapsulation of "tactile feedback." Observations showed that designers were skilled at eliciting different viewpoints, as demonstrated in the following snippet and reflection:

*S2: Yeah. Well, for me specifically, but I don't have an impairment where I can... I can actually look at a map, look at it for a few seconds, put it away. Okay, I think I took a wrong turn, pull it back out. That's not an issue for me as much as it may be for others, or, you know, with the voice commands, I don't use that as much. But it's a technology I have.*

*D2: Um hm. And you said you would prefer something that's actually more voice based, that tells you, you need to walk 50 steps down and then 50 feet and then take a left, and then that's like the first room on the right, instead?*

*V2: Um, yeah, in general I find maps hard to use just because of the size. And, in addition, I have to pull these out so I'm always carrying this extra stuff. I can't just kind of be carefree.*

*D2: Uh okay, so you say something that's voice driven would actually help you?*

*V2: Sure. Um, I mean if it was something where if I had enough vision without these—I lug my purse with me everywhere cause it has my stylus, it has my*

*phone, it has my 3 inch thick glasses. Um, if I didn't have to do that and I could—if I was given a phone, on a cruise ship, and I knew that the big round green button in the upper left was voice information, and I could just tap on that and then say, where is the bathroom? Where is the closest bathroom? And the voice guided me, that would be really, really helpful.*

–Workshop 2, Task 2

Interactions between users benefited from the designer's skill to be able to weigh conflicting ideas. In reflecting on interactions, such as the one above, D2 described his objectives:

*It was a question of balancing. I guess what I was really trying to figure out was, would she, S2, use something that V2 would actually use?*

–D2, Interview

As is clear both in his actions and in his comments, D2 attempted to find common ground between the two users. Both users were honest in their appraisal of a design with a small map or other navigational features and D2 leveraged this in his questions to grasp the preferences of each.

In the following snippet, D4 prompted users for their opinion about the current design and what should be included in the device's display. As they talked, the users converged on a problem, which D4 then articulated:

*D4: So, again, thinking about, like kind of like a wrist watch, I think we wouldn't have – do we want to have a display? I was thinking like buttons. We could use for the thing...*

*S4: Yeah, I'm thinking buttons, too, because if you have the audio cues, you don't need-*

*V4: Or maybe if you have a microphone on it, so that you can ask questions, have like a little switch so you make sure that it's off when it should be off.*

*S4: Actually, if it's in your wrist, do you really need an earpiece, can't you just like do the Dick Tracy phone thing?*

*V4: Yeah.*

*D4: Well, I guess—you know, that's a good question, let's talk about that for a minute here. So, one of the things we had originally talked about was that .. you*

*would get information ... served to you based on your location, so if you walked by the lounge, it would say, hey you're at the lounge, this is what's going on right now. You can go in or not. So we would be taking away that kind of ambient information, but you know, that's a tradeoff.*

At this point in the discussion, D4 identified a tradeoff between providing information to users of their design through audio cues, and the ability to hear ambient noises, though he was not quite aware of the implications for access. Eventually, V4 took the “tradeoff” to task, validating it as a tradeoff for access. D4’s prompt of “you know, what’s a tradeoff” re-directed the conversation around ambient information, to which S4 responded:

*S4: What if the earpiece was optional?*

*D4: Yeah I think—I think that—yes. So, optional earpiece. Because then maybe that would be potentially more helpful to a visually impaired user.*

*S4: And also more useful to—some people will want an earpiece just because they're like, well this is so much easier, it's like one of those Bluetooth headphones. And other people'd be like, that would look terrible with my earrings, I would rather be able to just hold my wrist up to my ear.*

*V4: And people think that blind people have perfect hearing, and we don't. You know, some of us have hearing losses and this and that. It depends on the cause of blindness, and a lot of times earbuds will block your hearing, that's why some people have gotten really excited about the bone conductor headphones. They're kind of expensive, I've heard they're like \$300.*

*D4: Yeah, I'm familiar with that technology, too. It seems really promising.*

*V4: Cause the thing is, is you don't want all your hearing blocked, cause you're using your hearing to navigate.*

*D4: Right, oh! That's a great consideration. So if you have an earpiece all the time, you know there's other ambient sound that would be helpful for you just to navigate around, and if you have an earpiece, you're obfuscating, you know, your ability to kind of take in the ambient sound. Oh, that's good.*

–Workshop 4, Task 2A

### Efficient Ideation

As I have shown in the previous examples, designers’ facilitation of the two users allowed ideas to bounce back and forth quickly, providing valuable insights along the way into what

worked (or did not work) for visually impaired users versus what worked (or did not work) for sighted users. Coupled with designers' ability to deftly manage user ideas, the back and forth between the two users was effective, time efficient, and beneficial to developing a viable solution. The snippet below characterizes the type of interaction that was common among all workshop participants. D3 began with a question about options, prompting V3 to volunteer accessibility considerations. When S3 offered up a suggestion, with the MacBook mouse pad as an example, V3 responded with her preferences interacting with similar functionality on the Apple Watch.

*D3: So, we want to—either you could hit the button, and then it wakes up, or you could voice activate it, so you could do both ways.*

*V3: I think you should also have it activated by just tapping the screen in case we have people with orthopedic challenges?*

*S3: What if the whole screen taps? Because the way—like, the—like the mouse on the MacBooks, the whole mouse pad is a clicker.*

*V3: Right. Yeah, that's—I was just thinking—cause one of the things I didn't like about the Apple Watch is that you had to press and hold the little rotating dial to get Siri to listen to you.*

*S3: Yeah.*

*V3: and it would have been neat if I could have just press and held on the—on the touch screen.*

*—Workshop 3, Task 2*

The example above demonstrated how quickly information and ideas transpired between designers and users, often, like in this case, with a single prompt from the designer. Without comparison with a designer-only example it is hard to determine the impact of these interactions. But designers also noticed how efficient discussions were among users throughout the workshops. D4 described how harnessing different viewpoints, specifically alongside the perspective of a visually impaired user, sped up the process:

*To actually have people in the room, or have someone in the room definitely changes the dynamic and gets you there faster. Gets you there more effectively because—they can—they'll bring up points that you won't have thought, you can't have thought about because you haven't been in their shoes to that degree.*  
—D4, Interview

D4 further contrasted this with his experiences working with one user at a time:

*I think what would happen is one person or the other—individually, you would come up with a design. So you might come up with multiple designs, which is cool because then you have multiple candidates. But here, we had—I think almost a best candidate emerge more rapidly, which I think was helpful.*  
—D4, Interview

At the beginning of this section, I noted that it is known that working with users with disabilities is likely to help designers to create accessible solutions. D5 reflected on the importance of also working with nondisabled users, to ensure that perspectives from both target user groups is included:

*If you want to design something that's inclusive, you have to have both parties involved, right? So that was good. Um, so that's why I'm surprised about—what I'm surprised about myself is like, I should be thinking about the nondisabled as well as the disabled rather than just focus on the disabled.* —D5, Interview

Similarly, D4 noted if he had worked with only a single non-visually impaired user, he might have missed key insights about alternative design options.

*If it was just us two (non-visually impaired user and designer), we might have gotten to a completely different place than we would have than—than user testing on people who are visually impaired.* —D4, Interview

Thus, the experience of working with both users with and without visual impairments raised an awareness of how multiple perspectives contributed to design ideas. Designers, like in D4's comment above, noticed the impact of multiple viewpoints to help ideas along.

#### 7.4.2 *Roles and Expertise of Users*

Not only did users play a key role in workshop progress, it was the co-location of two users, representing two different user perspectives that elicited ideas. As noted in the previous sections, users discussed ideas in rapid fashion, and, aided by designer prompts, moved ideas along quickly. Key themes arose from the intersection of user perspectives, discussions about disability and accessibility, and consideration for social contexts of use. Users exhibited easy-going attitudes and a willingness to work with each other. Even while users did not agree on every issue, they remained courteous, open-minded, and willing to dissect disagreements to move design decisions toward consensus as much as possible. In addition, sighted users acknowledged accessibility issues and were just as open-minded as designers in asking pointed questions about disability if they were curious about the visually impaired user's disability and how it might impact their design options and choices.

##### 7.4.2.1 *User Interactions and Dynamics*

It was expected that designers would take on leadership of the workshop sessions, guiding users through the various stages, and the productive and creative dynamic that users engaged in was unexpectedly strong. Users were earnest in their opinions and honest about their preferences. Users were also up-front about admitting what would not work for them, but might work for the other user. Often users volunteered information even if they were not asked about it explicitly. Led by designers to consider the various aspects of the design prompt, users were forthcoming in ideas and played ideas off each other so that brainstorming and reflective interactions were productive, quick and creative. Oftentimes users would continue conversing about ideas without interference from the designer:

*V2: It's a whole lot better to know that the Mexican restaurant you're going to fits your menu options and fits your price range before putting all the effort into going there, and then finding out, oh, I can't eat here, I'm lactose intolerant or something like that.*

*S2: And, another beneficial functionality, for restaurants or something like that—because obviously cruise ships have everything connected—is there a wait list, or is there a wait time?*

*V2: Oh, that's a good idea.*

*S2: ...because I personally wouldn't think of walking five minutes over there, realizing it's a half hour wait and either deciding, oh it sounds good I'll wait, or no, I'm gonna go back to this other place I passed. But for some people, you've made the ordeal of getting all the way over there, you know, can you place yourself on a list, or can you check before you leave. And, again, it may change in the time that you get there, but knowing what to anticipate.*

*—Workshop 2, Task 3*

In the above exchange V2 and S2 weigh different options whether an information system should convey menu or wait time details for restaurants. The evolution of the idea began as a navigation tool to guide users to restaurants on the cruise ship, eventually surfacing issues of time and information availability.

D5 described his take on how user interactions evolved in the workshop:

*They were bouncing ideas off each other, and that was really cool to see. And, they presented what would be good for them and what wouldn't be good for them, but they also recognized how other people not in their situation would utilize the design. So that was really cool to see. —D5, Interview*

As D5 noted, the ability for users to get along was key in eliciting useful information. D2 specifically expressed a concern for users that might dominate the conversation and noted that users did not overtake conversations and were open to others' views:

*The good thing was, both of them were really responsive. The challenge is if one of them is really gregarious and one is super quiet. Then you're just getting feedback from one person. That—thankfully that didn't happen. But I've seen that happen in the past and you have just one very dominant respondent in the group who just takes over the whole challenge. —D2, Interview*

It could be a characteristic of the individuals recruited for the study, but overall interactions between participants in the workshops were friendly and respectful, even though different perspectives prevailed (such as the ways that sighted versus visually impaired users might use a design).

#### 7.4.2.2 Disability Knowledge Sharing

Both users played integral roles through the design processes in the workshops. Visually impaired users were the disability and accessibility experts, contributing information and answering questions about how they used technologies so that designers could get a sense of accessibility requirements. In addition, visually impaired users would share experiences they had with technologies in the past to illustrate their preferences. Designers and sighted users both consulted visually impaired users about their disability, about the technologies they used, and about their preferences regarding the design at hand. For example, when the conversation turned to touch screens, V2 volunteered information about how those technologies might work for her:

*I have to be really close to something to see it. Or use my 3 inch thick glasses. So when it's up here... I... I can't get close enough to it, or I can read the bottom line, but I can't get close enough to read the top line.*  
—V2, Workshop 2, Task 1

Similarly, V3 described the ways that her accessible technologies worked so that the sighted user and designer could get an understanding the design dimensions she was referring to in their discussion.

*With VoiceOver on it that doesn't matter. I can hit anything on the screen and it doesn't change anything because I'm not activating it until I tell it to. Um, so you wanna make sure that the visually impaired users are—have a separate set of interactive things. Or you could make it more based on voice activation. I think that voice activation allows for a lot of usability.*  
—V3, Workshop 3, Task 1

To characterize V5's visual impairment in order to know what to design for, D5 asked about his vision capability:

*D5: So what is your vision capability?*

*V5: Okay, it's—the disease is called Stargardt's, which is the juvenile form of macular degeneration. So I have scarring over the macula, which is in the center of the eyes, so that—okay, it makes it so my depth perception is not as good and I can't see certain colors, and my visual acuity is about 20/400, I think, yeah.*

*D5: What does that mean?*

*V5: Um... instead of 20/20 it's 20/400 so for every 20—for a normal person for what they can see at 400 feet, I can see at 20 feet.*

*—Workshop 5, Task 1*

Based on his description, D5 chose defer to V5's visual acuity as a baseline constraint for the design, stating: "So, ... vision—like vision constraints, we're gonna use your constraints for visual impaired [users]." Designers continued to defer to visually impaired users as the design ideas changed and a solution emerged. Visually impaired users were consulted for functional design considerations as well as social ones. In this snippet, D2 clarifies the level of detail V2 would require to use a tool to navigate:

*D2: And would you – you said you would prefer something that's actually more voice based, that actually tells you—saying, okay your room is—you need to walk 50 steps down and then 50 feet and then take a left, and then that's like the first room on the right, instead?*

*V2: Um, yeah, in general I find maps hard to use just because of the size. And, in addition, I have to pull these out so I'm always carrying this extra stuff. I can't just kind of be carefree.*

*—Workshop 2, Task 2*

Similarly, D3 tried to get a sense of what kind of navigation V3 required, not knowing how much indoor assistance she might need. V3 clarified how it works if she uses a navigation aid to find a venue, such as the ship's casino.

*D3: So what would happen if you said, I want to go to the casino. It would get you in the casino, but it wouldn't get you to a table, correct?*

*V3: No, it would not, and that's okay. As long as it gets you to the door.*

*D3: Okay. Okay, that's what—that's what I was envisioning is that it would actually get you in the door.*

*A3: After that point, you can use sighted assistance, so if I'm gonna go to the buffet, I'm obviously not just going to walk through the buffet, um, without making sure that I have—I have navigational help to a table. Yeah, and I would not expect my watch to do that.*

*—Workshop 3, Task 2*

Meanwhile, sighted users not only brought an added perspective, they also consulted visually impaired users about issues of access or how a disability might impact design choices around an idea. For example, S5 inquired about how V5's visual acuity might limit his ability to view a small display:

*S5: So understanding how well your visual impairment is, like if there was something on a small display, would you be able to read it?*

*V5: No, but it would have to read it like my iPad or my iPhone does, so like if it has a touch screen, then you can put your finger on it, and then have it read what's under your finger.*

*—Workshop 5, Task 2*

Sharing disability knowledge was a frequent contribution by the visually impaired users, however it is unclear how sustainable this might be, as it is possible to envision users eventually experiencing fatigue having to be the source of such information.

### 7.4.3 *Operationalization of Social Accessibility in Design*

Ultimately, designers were able to incorporate aspects of Design for Social Accessibility throughout the workshop, from referencing the framework (see Figure 6.4) to utilizing method cards (see Figure 6.5), to consulting and engaging users on topics relevant to both functional and

social aspects of the design. In this section, I breakdown several dimensions of operationalizing social accessibility within the design process that emerged from the workshops. First, I outline how designers and users defined social accessibility for themselves. Then, I demonstrate how these definitions manifested throughout designer-user interactions. In the second half of the section, I describe the ways that designers incorporated the framework and used method cards. I end with a description of how social aspects of design were intertwined with functional consideration.

#### 7.4.3.1 How Designers and Users Define and Use Social Accessibility

An important aspect in determining the effectiveness of Design for Social Accessibility was to gauge how designers and users defined for themselves what social accessibility meant, and how they applied this meaning throughout the design process. Designers and users utilized the framework to help them visualize the design space of the social and functional factors of social accessibility. Designers referred to the method cards in shaping their understanding of the concept (particularly D2 and D4). However, all designers did need a moment to assess what they thought social accessibility was, before they could move on to considering how to include it in their design work.

The evidence indicated that designers sufficiently understood social accessibility and that they were able to incorporate the concept in their design work in the workshop. Furthermore, designers were able to incorporate social accessibility through the use of the framework and method cards within design inquiries and rationale, and within specific techniques, in how they prompted users and assessed user input.

### For Everyone / Everyone will have it

Designers and users alike agreed that to be socially accessible, a design should be usable and appealing to everyone. One way this idea manifested was in striving to find a solution that everyone would have and could use, in their own way. During the evaluation phase, D2 reflected on whether or not he felt their design met social requirements. In doing so, he noted that a “commonly accepted theme” that arose from discussion was that it was preferable if everyone had the same thing, rather than creating specific designs for different users:

*And also, it would be nice, I mean, what I got across both was people would generally prefer it if everyone is wearing it. So that it's actually more of a commonly accepted theme. Rather than just a specific section of the group.*  
–D2, Workshop 2, Task 3

Perspectives on design ideas that appealed to everyone were also prevalent in the ways questions were posed to assess whether visually impaired users felt something was acceptable in social situations:

*V5: Everybody can seem like they fit in and—even if you have to use it for something slightly different.*

*D5: Yeah, you'll still feel comfortable because someone else has it, they're not going to question what you're wearing. Yeah.*

*S5: Just like everyone else.*

–Workshop 5, Task 1

Furthermore, in the same workshop, V5 also identified the designing for “everyone else” not only does not single out individuals, it ought to make the designer’s work easier to be inclusive up front rather than address one target user at a time.

*D5: There's always gonna be like fallbacks in each design, but we'll always try to create one that's—um, as best as we can with whatever we're limited to. Um, ideally, you'd want to have something just like everyone else, right?*

*V5: Um hm.*

*S5: Yeah. It wouldn't marginalize you, or anything?*

*All: Yeah.*

*V5: If you have something like everybody else, then it makes it easier. It wouldn't marginalize me, but then it would also make it easier for you as a designer, too, wouldn't it?*

*–Workshop 5, Task 1*

It is worth noting a distinction between creating a design for everyone, as workshop participants decided to do, and Universal Design: workshop users identified different features specific to only visually impaired or non-visually impaired users, and did not necessarily stick to a one-size-fits-all approach. But certain characteristics, and the overall artifact, it was decided, should be the same for everyone.

### Prompting Social Considerations

Another way that designers' understanding of social accessibility was evident was in the way they consulted users. Designers asked questions about social situations, and asked users about their preferences for social contexts, their comfort level in different scenarios, and in using different kinds of designs. For example, as they dived into their design ideas, D2 raised the question about interacting with some of their proposed features in social settings:

*Okay. Say you're using a voice interface, now one of the concerns people might have is disturbing someone else, since you're actually hearing it. Is that something that would bother you? I mean, let's say you're using voice interface, or would you prefer that you have a way to switch between voice and text? If that option was there? –D2, Workshop 2, Task 1*

Similarly, D2 pitched their idea of an earbud with a wristband as a leading idea because everyone could wear the wristband, but earbuds could still be available as an option:

*D4: I think that combination of wrist band and then earbud for- because perhaps not everyone needs to use the earbud, but the earbud would be an option for any user to use. It could be helpful for both visually or non-visually impaired—so as far as a wearable technology, we think the wristband is a good solution?*

V4: *It's very inobtrusive.*

S4: *Yeah, and if people are worried about tan lines just swap to the other wrist.*

–Workshop 4, Task 2A

Users as well as designers led prompts about social consideration, such as V3 here:

V3: *And I think the social aspect would be people just choosing how do I want to interact with this. You know, if I get to—if I'm in a place where I want to be, um, I need that auditory feedback to tell me what I'm doing, then, I might be expecting that I'm not really going to be paying attention to people while I'm walking. Um, whereas maybe the haptic would allow for more interaction with people.*

D3: *Um, I'm not—I didn't follow that.*

V3: *Um, so, if you have something in your ear, that you're listening to, you're almost signifying socially that you're not willing to listen to people.*

D3: *True, true, true. Yes.*

–Workshop 3, Task 3

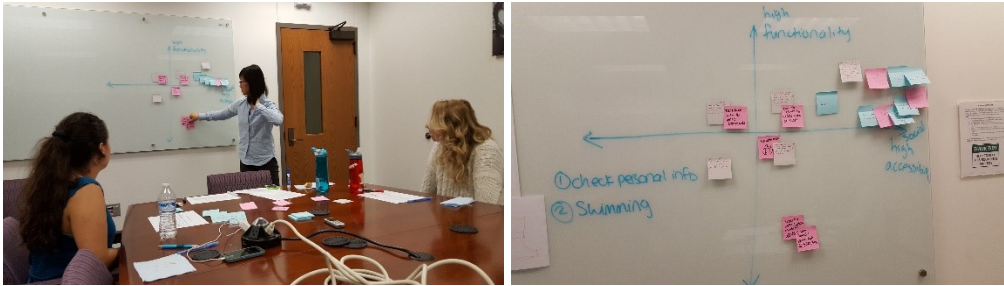
#### 7.4.3.2 Design for Social Accessibility in Action, Emerging Techniques

##### Framework

Designers referred to the framework before and during workshops to help their own understanding of how to apply social accessibility, to prompt users, to guide discussion and design decisions. For example, D1 below referred to the framework after the brainstorming task, and during the synthesis task, in leading the users to assess how their design might fit the requirements of what might be considered socially accessible:

*So we want to focus on the high social accessibility and then the high functionality and looks like all our concepts in this quadrant are around a kiosk and like some kind of—like a chip or device you wear on your body and then you can then go to a kiosk located around the ship and then see more information. So why don't we go prototype that, since that's what we're going to be doing next, so I believe we have. –D1, Workshop 1, Task 2*

D1 utilized the whiteboard to draw a large version of the framework on which they could place Post-It notes with ideas on it (see Figure 7.3). The group used the framework this way to help them identify which idea, or set of ideas, to pursue toward their final design.



**Figure 7.3. Designer 1 employs the whiteboard to categorize ideas according to the Design for Social Accessibility Framework.**

Referring to the framework was also helpful in allowing users to relate the design choices to appropriate social considerations. In the following, D4 prompted users about considering social accessibility while referring to the framework. S4 responded with a specific consideration for one kind of possible social response.

*D4: Is there anything else we can do to iterate through this design to uh, to make it more socially accessible? I mean, so I guess, on one axis, is it functional? So we—*

*S4: I guess there could be men who are big babies who are like 'I don't like the flower.'*

*—Workshop 4, Task 2B*

### Method Cards

The method cards prompted awareness about specific examples and contexts, drawing out elements of socially accessible technology use. Method cards were used less directly to help gain an understanding of the concept of social accessibility. Instead, examples from the cards illustrated what it might look like for a social situation to influence or be influenced by design. Method cards prompted designers to consider contexts and ask questions they might not have thought of otherwise. In the following example, D1 read off the description of the “Non-use”

card, then prompted users to consider what aspects of their brainstorm might be affected by scenarios raised in the card:

*D1: Okay. So, in regards to our brainstorm, we can think about – do we see any weaknesses in our pool of ideas right now, in terms of, social situations and why someone would choose, maybe, not to use one of our ideas. I feel like it is a bit similar to this—um, yeah, do you guys have any thoughts on this?*

*S1: I think it's—I just come back to the thing that V1's already talking about with like, holding it up really close to your face might make—you know, some people feel awkward or uncomfortable.*

*V1: Um, this is probably not a good answer, I'm not sure. But it is a thought. Um, mealtimes, I know that a lot of people really value just like trying to switch off, and actually have a conversation. Maybe?*

*–Workshop 1, Task 1*

As we can see, the prompt elicited considerations for implications of users in different social situations. In this case, they considered what kind of social situation could move someone to not use a technology. These discussions led the group to incorporate, in their design, the capability to allow a manual shut off. Similarly, D5 read through the “Audience” card and the group discussed some aspects of audience that might influence their design choices:

*D5: (laughs) Um, audience? So, it's like semi-socially acceptable, semi workable, or—ah, works, but it's, like, not as socially accessible.*

*S5: It just—you don't want it to attract unnecessary attention to you, if you're using it. So,...*

*V5: Yeah.*

*D5: We can use that.*

*S5: Yeah, so, like you want something that is low-key.*

*V5: That's sounds good. Yes, yes.*

*S5: Right, you don't want to use it and have a lot of people pay attention to you.*

*–Workshop 5, Task 1*

In addition, users would employ the cards as well:

*S5: If we're thinking about this—that awkward moment—it is like an awkward thing to have everyone constantly have this thing like talking to them. There's a lot of overlap, right? And so—*

*V5: —and so – that's—*

*D5: —so it would need to have some type of—*

*V5: —need like Bluetooth or —*

*S5: —ear – earbud thing?*

*–Workshop 5, Task 1*

In this scenario, S5 entertained what constitutes an awkward moment, and reflected on elements of their design so far. She determined that the voice feedback could create awkward moments in certain social situations. This idea led the team to consider making earbuds an option, as a possible way to address potentially awkward situations.

#### Prompting for both social and functional aspects

Designers were adept at engaging both users in discussion and consideration around functional and social aspects. As mentioned previously, despite being nervous at leading a small group of users, designers were well-versed in design technique and process and gently questioned ideas or raised new ones. An emergent technique included designers' ability to draw out consideration among users, not just by asking their opinions, but also engaging them in actively discussing, ideating, and then reflecting as they progressed. For example, at the start of

a discussion about whether their design was headed in the right direction with respect to social accessibility, D4 prefaced with a review of their aims in achieving socially accessible design:

*I do want to integrate one of these cards, too, so you know, we talked about cruise ships, we've talked—you know, the cruise ship experience.... And I think this one, um, so this is—this is one of the cards here, uhhh. Okay, so I think, you know, you know, on a cruise ship, I mean, I think one more thing we'll think about before we pivot into the synthesize use—is that again, not all experiences and accommodations provide equal access, so you know, if—if users use special accommodations to do the same things as everyone else around them, um, so I again how can we—I guess, what are the considerations in our brainstorming to make sure that we're making this—we're considering usability in our design—in our design framework here. You know, and also—referring to the functional and social access, again is it both functionally usable but then socially accessible.*

*—D4, Workshop 4, Task 1*

Following this prompt, the users begin to consider the different scenarios and possibilities that came to mind, including branding and design, until the group finally settled on a few key dimensions:

*V4: And just simple and sleek and then it's—it's all so it's not as noticeable to have that little simple, sleek, smooth, you know, with the little—just a couple little buttons on it. Then it doesn't become as obtrusive to the whole world.*

*S4: Well, but also if you, like, minimize it too much, it really starts to become, oh, well that's for handicap people like if the more you utilitarian it gets, the more it stops looking like a fashion accessory.*

*D4: Right, so ... I think this is—that's speaks in the socially acceptable—*

*—Workshop 4, Task 2*

#### 7.4.4 *Designers' Workshop Experiences: Increased Awareness*

A positive outcome, and overarching theme of this body of work, is the increased awareness about accessibility and disability that emerged from the workshops. Designers learned about different aspects of accessibility, about disability, and about their own capacity to facilitate an inclusive design process. When asked if their perceptions about disability had

changed, designers reported that their experiences in the workshop influenced how they thought about certain aspects of design. D2 described his perception in terms of typical design work:

*[My perceptions are] definitely improved because it actually just shows me how much more I—you'd be—socially and contextually aware. ... say tomorrow I'm going to back design something. If I'm designing it for someone I need to be contextually aware of what are the use cases they'll use it. What are the scenarios. You're just not talking interaction flows, you're not talking about just going from one input to another. You're not talking about what happens when they click this button. But then, where could they be using this? Could they be using this in a day like this with bright sunshine, where there's like high contrast? Can they see it outside? Can they even see what's there on that? So, those are things you need to be aware of, so, definitely. –D2, Interview*

D4 related his perception to the success of the design process overall:

*I think [my perceptions] actually improved further, like having more exposure to like, the framework and the cards and I think the actual design process here—and to see what we could create in a short period of time. Yeah I think it certainly was eye opening. Again, I hadn't had this—when I first saw that time sheet, I was like, oh crap, there's just ... what the hell are we gonna come up with? It's going to be complete garbage. And I think we came up with something that had some potential. –D4, Interview*

Indicating that feeling that their design outcome was a success validated D4's experience and the perceptions he had about the overall process. D1 admitted an awareness about what's "cool" in design, even for disabled users:

*Yeah because I had not previously considered how much of an impact the social situation can have on somebody not wanting to use a thing. Especially if it's for an—like a disability—I guess people already don't really want to use things if they're uncool, like trying to think of an example of something that's—even if you're not disabled and it's not cool, you don't want to use it... If you're really dependent on it, then it's probably even worse because it's like, I have to use this thing, but it's embarrassing. –D1, Interview*

Having two users representing two different user groups structured conversations that demonstrated the kinds of issues at the intersection of accessible design. For example, visually impaired participants were more likely to comment on navigation issues as a key concern, and various voice and touch interactions were discussed as a result. At the same time, sighted

participants admitted they were not keen on using voice commands if they had ready access to screen or touch technologies; accessing information by touch and sight was sufficient. As demonstrated in this section, designers skillfully navigated different preferences by validating ideas, reflecting on what users said, and prompting clarification.

Designers described the input by visually impaired users as helpful, and admitted that visually impaired users raised awareness of things designers would not have otherwise thought about. When asked about her perspectives about disability and design after the workshop, D3 explained:

*I—almost want to say “improved” because I’ve never actually worked with somebody who’s visually impaired before... now that I can put a—personalized face to it—going through that step, I can see what she would be, you know, the stumbling blocks that she would have on that. –D3, Interview*

In contrast with designers’ work experiences, emergent themes that arose from the workshop experiences indicated that designers felt optimistic about how they might harness their existing expertise in engaging users toward accessible design. The design workshops offered a reflective way to elicit insights from designers, while validating that the technique of working with visually impaired and non-impaired users simultaneously resonated with designers’ existing practice. In deliberating on the workshop experience, designers admitted that working toward accessible design was not as daunting as they thought it would be, and that working with users with and without visual impairments simultaneously was valuable. By engaging in the workshop, the technique of working with the two users helped the designers prepare for action, i.e., it was not prescriptive, and instead leveraged designer autonomy and expertise within their current design processes.

Given the time constraints for each design task, and the confluence of interacting with multiple users and using novel tools, I assert that the findings indicate Design for Social

Accessibility as a feasible perspective and set of techniques for professional designers. Designers were able to incorporate the Design for Social Accessibility Framework and Method Cards, to develop low-fidelity prototypes that could be evaluated, and to lead multiple users through design tasks.

## 7.5 DISCUSSION

The goal of the design workshops was to determine if professional designers could incorporate Design for Social Accessibility within user-centered design tasks to create an artifact to meet a specific prompt. The workshops incorporated the three tenets of Design for Social Accessibility: (1) designers worked with users with and without visual impairments; (2) designers incorporated functional and social aspects in design – particularly utilizing the framework to help them do so; (3) and, designers reflected on their experiences along the way, responding to reflection prompts, and utilizing the method cards to prompt them to consider other kinds of social contexts of use. Findings showed that designers were able to incorporate Design for Social Accessibility, and that users were satisfied that the designs met their needs. Designers were able to elicit useful feedback from both visually impaired and non-visually impaired users, and designers were able to use the framework and method cards to help them in their design tasks. In addition, synergistic themes emerged from the collocation of designers and users in the same space discussing accessibility, design and social contexts. Specifically, dynamics that emerged between designers and users was unexpectedly beneficial to the overall process and contributed to the experiences for those involved. Users contributed their own perspectives and were open minded to others, and designers were able to build on these perspectives efficiently and effectively.

### 7.5.1 *Emergent Workshop Dynamics*

Both designers and users played integral parts in facilitating productive idea generation, knowledge sharing, and awareness about disability and accessibility. The Design for Social Accessibility Framework and Method Cards motivated appropriate ideation by providing contexts to reflect on, and by prompting designers and users about social situations of use. These prompts often led designers to other lines of questioning about different experiences users had. Indeed, the exercise of balancing two users, and their ideas, and pivoting the focus to engage contrasting perspectives, contributed to a positive workshop experience that resulted in productive idea generation.

Designers noted that the immediacy with which they could exchange ideas made the difference in efficiency and addressing revisions. Designers felt they benefited from feedback and insights from both users. D4 elaborated why synchronous interaction with two users was beneficial:

*So we have kind of a polarity of two types of users, visually impaired and non-visually impaired. I thought that was really insightful. I think if I had a session with each individually and kind of went through a design process and usually design is a team, go in the brainstorm and all the phases, but having both voices, even just the two voices, I thought we got a lot more out of that. There was a lot more insight to be gleaned by having both voices here. –D4, Interview*

As D5 reflected, “If you want to design something that’s inclusive, you have to have both parties involved, right? ... I should be thinking about the nondisabled as well as the disabled,” indicating that working with both users was viewed by designers as beneficial in their design process. The perception among designers that having both users was helpful, and not superfluous, is key because the goal is to find strategies that will support their ‘designerly’ way of thinking (Nelson & Stolterman, 2012).

### 7.5.2 Incorporating Social Accessibility

One of the key insights to emerge from the workshop was the distinction between knowledge about accessibility, how it actually impacts users, and the implications for social considerations in design. As D2 noted in his interview:

*Constraints for social use, not really. In a sense its more—if you look at accessibility, you're still—a significant misunderstanding is you're still looking at more like the screen level, you're not talking about how it's actually being used socially. That's not actually taken into consideration. –D2, Interview*

Although designers, particularly D2 and D3, were familiar with accessibility guidelines and often cited Section 508 as a legal requirement in their work, there was a mismatch between what designers felt beholden to do in a legal sense compared with what might actually be accessible. In addition, designers knew little about existing technical capabilities that were accessible to visually impaired users. As shown above, visually impaired users took on the role of educating fellow workshop participants not only about their visual impairment, but also about the accessible technologies they used. Visually impaired users informed designers and sighted users about VoiceOver with the iPhone and iPad, other phone technologies, height constraints (such as for V5's wheelchair), and accessibility features in common devices and technologies, such as tactile refreshable Braille and Apple Watches and ATMs.

Although designers could incorporate socially accessible design thinking within their design process, there were aspects about disability and accessibility that designers could have benefited from before the workshops. Design for Social Accessibility, as defined for the purposes of the workshops, did not require a certain level of design expertise to incorporate functional accessibility; however, observations indicated that designers could have benefited from some minimal knowledge. Some initial information might help designers to become familiar with what is available, or provide enough information so that designers know what questions to ask with

respect to functional accessibility, as well as social accessibility. In addition, it is not reasonable to expect visually impaired users to be the ones to educate designers about existing technologies, accessible designs or the experience of disability. Some amount of information ought to be made available to designers to expedite the process and to alleviate the burden on visually impaired users in some cases.

Despite beginning at a slight disadvantage by being unaware of some aspect of technical accessibility (such as not knowing about Apple’s VoiceOver technology), designers were able to climb the learning curve and effectively incorporate social factors throughout the design process. Aside from some specific knowledge about accessible technologies, the task of creating a solution that would be functionally accessible was comfortably addressed by working with both users in the design process. That is, designers had the necessary skill to investigate specific accessibility issues—at least as much as was possible in the short time during the workshop.

#### 7.5.2.1 Framework and Method Cards Align with Design Thinking

A key distinguishing element of social accessibility is that it is not just social or functional factors in consideration, but a combination of both. The framework (Figure 6.4) and method cards (Figure 6.5) were helpful in bringing attention to specific intersections of technology use in social contexts. At the same time, some improvements could be made to make them more effective. One unanticipated outcome was that D3 did not take much time to peruse the method cards before attempting to use them. Her approach of scanning the (mostly decorative) images as a way of using the cards was revealing in the ways that cards could be misconstrued, incorrectly applied, or altogether overlooked due to time constraints. In contrast, the other designers either took a moment to read the cards to themselves, or read them aloud to the group. In such cases, designers identified a prompt for discussion with the group. The most critical

feedback on the cards, however, centered around the lengthy descriptions for each scenario. When used successfully, designers could incorporate the cards at an appropriate time in their process (usually during brainstorming or synthesizing) to augment the group's design progress.

Similarly, all designers were able to incorporate the framework. The most common use was to determine how to operationalize the novel concept of social accessibility. Understandably, designers and users alike were not familiar with the concept, and they all took some time to understand what it meant, and how they could apply it. The framework was essential to helping workshop participants envision what a socially accessible artifact might be. To this end, designers' suggested improvements for the framework included example designs for each of the quadrants. Such examples were left out of the version of the framework given in the workshops because of the nuanced and subjective nature of what might be socially accessible. That is, the framework ought to help include and address areas of functional capability and social appeal, while at the same time, allow designers to include a variety of perspectives. Essentially, there is no wrong answer as to what is socially appealing or usable, although there may be a general consensus for a particular design. Feedback from designers, and observations of how participants attempted to define social accessibility, indicated that providing examples could help expedite understanding and promote efficient use of the framework as a tool.

#### 7.5.2.2 Designerly Ways of Including Social Accessibility

A key observation from the workshops was that designers exhibited a set of skills and perspectives that were unique to their profession. Designers were adept at confronting a complex problem, at incorporating multiple possible constraints (in the form of the framework), at considering a wide variety of perspectives (as prompted by the method cards), and at managing a diversity of ideas. These observations, in the course of a single design workshop, were

indicative of their skills as designers, and evidence of their ability to employ a designerly way of thinking toward the challenges present in the workshops (Cross, 1982; Nelson & Stolterman, 2012). When contrasted with some of the challenges faced by students in the design thinking course study (chapter 6), it was evident that the professional designers brought along a unique perspective and skillset, i.e., students were less skilled at managing multiple ideas and perspectives. Furthermore, designers' ability to address these challenges and come up with a solution (with observable ease) is a testimony to their profession and skill. It also demonstrated the feasibility of Design for Social Accessibility as a design perspective that could be adopted by designers to a productive end.

In addition to demonstrating that incorporating social accessibility within the design process is congruent with design thinking and designers' practices, emergent and unexpected benefits, such as the back and forth between two users and the efficiency with which ideas transpired, added to the value of Design for Social Accessibility as part of the design process. Not only were designers able to include elements of social accessibility within their design thinking, making progress toward creating a socially accessible design artifact, but the interactions and social considerations that surfaced had more impact than initially expected.

Finally, it is worth noting that upon finishing the workshops, designers indicated they were more attuned to accessibility issues than they had been previously. Indeed, comparisons of pre- and post-surveys of the Attitudes Towards Disabled Persons Scale, Form A (ATDP-A) indicated that participation in the workshops improved designers' attitudes toward people with disabilities. The average of the initial scores across all five designers was 127. The average of the post-survey scores was 139.6, with an average increase in the scores of 13 points. All post-survey scores were higher than the pre-survey scores. Higher scores indicate "respondents perceive

disabled persons as similar to nondisabled persons,” while lower scores “indicate the respondent perceives disabled persons as different from nondisabled persons.” Thus, we can interpret the increase in scores from the pre-survey to the post-survey to indicate that designers more positively perceived disabled people *after* the workshops. It is difficult to say how persistent these attitude changes might be, and that could be a topic for future work. However, it is telling that interactions within the workshop influenced designers to think more positively about disability than before the workshops. Furthermore, while the survey could only indicate attitude toward disability, interview data showed designers also developed a deeper appreciation for social situations of technology design. Where attitude changes can most likely be attributed to interfacing with the visually impaired users or even to being instructed to create accessible designs, awareness of social implications in design were specifically prompted by the framework and method cards used as part of Design for Social Accessibility.

## 7.6 SUMMARY

A positive dynamic arose out of the intersection of multiple diverse voices in the room that were facilitated by prompting (in the Design for Social Accessibility Framework and Method Cards). Although the contrived workshop setting has its limitations, but these constraints did not prevent groups from coming up with designs about which they were excited.

Designers’ daily work included barriers to addressing accessible design, in turn shaping the essential nature of their design practice (Cross, 1982, 2011; Nelson & Stolterman, 2012). It was not in their opinion that accessibility necessarily had to be a part of the core design process. Despite this characterization of accessibility as an afterthought to the core design process, emergent experiences in the workshops indicated that the designers were skilled enough to take on the challenges posed. Designers were able to understand and apply concepts of accessibility

throughout the design process, using the framework, the method cards, and appropriately prompting users to elicit responses about design use in social contexts.



**Figure 7.4. V5 tests the prototype (on his wrist) developed in the design workshop.**

The workshops revealed that designers could incorporate Design for Social Accessibility and that the method cards and framework aligned with designers' skill and experiences, their rationality resonance (Stolterman, 2008).

Interviews indicated designers lacked an accessibility component to their design practice, but emergent qualities of the workshops demonstrated that designers were skilled and equipped to create solutions and prototype ideas even when tasked to bring visually impaired and nondisabled users into the fold. Findings suggest that designers were willing to, and had the necessary expertise to, work with users with and without visual impairments even though they were not accustomed to such work in practice. The designers' attention to user needs, design rationale, and judgment while working in an unfamiliar problem space was an indication of using the Design for Social Accessibility techniques with the two users. That is, incorporating

the three tenets of Design for Social Accessibility made sense to designers such that it resonated with their design rationale and way of doing design (Stolterman, 2008). Designers were able to incorporate working with both users within their own expertise because it aligned with their skill and technique.

The following are specific implications for design practice that emerged from the design workshops:

- The barrier to working with people with visual impairments is not so high. The workshops demonstrated that even with limited prior experience, designers were able to elicit requirements of their visually impaired users and could develop accessible design solutions for both users. I infer that increasing knowledge, awareness and experience—in even the smallest ways—together with minimal intervention, such as including two users at once as was done in this study, could contribute to increased accessibility in design.
- The level of expertise and skill of the designers allowed them to quickly adapt their approach to include designing for users with visual impairments. In the brief time that designers worked with users in the workshop, designers were able to address the design prompt with rigor as evidenced by the processes each designer underwent and the mock-ups they produced.
- Related to the first point, designers do not have to be “accessibility specialists” to include disability in their work. Designers occasionally ran into technical unknowns (for example, some did not know the iPhone is accessible via VoiceOver), but this limitation did not keep them from creating a solution geared to be accessible for both users. Initial

lack of detailed technical knowledge about accessibility is therefore not necessarily a barrier to creating accessible design.

Changing the culture of design to include users with disabilities within the core process is one way to improve design (Cross, 1982; Gould & Lewis, 1985). The findings from these workshops demonstrate that specific techniques of inclusion can be a form of design support that helps guide designers as they navigate the complexities of designing for accessibility.

In summary, the added complexity of working with users with and without visual impairments was not outside the wheelhouse of designers' skill and expertise. Thus, designers accepted that social accessibility was an important part of technology design.

Findings from the workshops offer insights that working with users with and without visual impairments simultaneously in the design process builds on designers' expertise productively and efficiently, and could be one way to augment the design process to incorporate social accessibility. Designers were able to incorporate Design for Social Accessibility within their own processes, worked with users with and without visual impairments, and created designs constructed with a consideration for social situations of use. Unfortunately, one side-effect of the time constraints of the workshops was that it was not feasible to evaluate the resulting prototypes for social accessibility by a neutral third party evaluator. Designers and users assessed their designs as socially accessible after brief evaluations and reflections in the workshops. Still, the question remains as to how a design could be assessed along social and functional factors. In the next chapter, I offer one way that technologies could be evaluated for social accessibility.

## Chapter 8. EVALUATING SOCIALLY ACCESSIBLE DESIGN

### 8.1 INTRODUCTION

The design workshops described in chapter 7 demonstrated that designers can incorporate Design for Social Accessibility within user-centered design techniques. A limitation of the workshops, however, was that solutions could not effectively be evaluated for social accessibility, partly due to the quick-and-dirty techniques employed to create the prototypes and to the roughness of the prototypes themselves. To assess Design for Social Accessibility, we need a means to evaluate solutions for social accessibility. Due to time constraints, the designs produced in the workshops could not fully be assessed alongside social contexts. Therefore, to address the issue of evaluation, I developed a Design for Social Accessibility Evaluation Rubric, a tool to aid designers in determining the social accessibility of a given technology design.

The goal of the rubric is to assess what feelings are evoked when certain design elements and social contexts converge. These feelings of self-consciousness or self-confidence reflect how socially accessible a technology is perceived to be by a user. As discussed in chapters 3 and 4, feelings of self-consciousness and self-confidence emerge when specific design elements intersect with social situations of use and user preferences. Thus, the rubric relies on evaluator experiences about situations that may make them feel self-conscious, comfortable, or self-confident when confronted with a combination of social situations and design elements. To be clear, a valid assessment of experiences, design, and social context relies on user input, as well as designer expertise. For this evaluation investigation, a total of 24 users and 31 designers completed 40 evaluations using the online version of the rubric. An example of the online version of the rubric can be found in Appendix V.

## 8.2 BACKGROUND AND MOTIVATION

To create technologies that incorporate the property of social accessibility means that there must be a way to evaluate that the property of social accessibility is present. An evaluation rubric ought to assess across the following factors that comprise social accessibility and that are emphasized in Design for Social Accessibility: (1) inputs and assessment from users, not just designers; (2) social contexts of use; (3) specific design elements; and (4) feelings of self-consciousness and self-confidence. Evaluating each of these components in isolation is not sufficient because, as shown in the initial chapters of this dissertation, it is the intersection of these phenomena that contributes to how socially accessible a technology is. For example, if a person has gained expertise in using an older model cell phone, they may exhibit confidence in using their phone, despite popular opinion that might judge the phone to be “outdated.” Evaluating designs for social accessibility, then, must involve multiple stakeholder perspectives and a consideration for complex phenomena.

Usability heuristics and user testing are common methods used to evaluate technical systems. Focusing on how well a user may be able to leverage design elements in a given system, these approaches are centered on functional usability (Nielsen, 1994; Nielsen & Molich, 1990). Similarly, accessibility guidelines, such as WCAG (Web Content Accessibility Guidelines), focus on aspects of accessibility that tend to be limited to functional access (Casare, Silva, Martins, & Moraes, 2016; Reid & Snow-Weaver, 2008). In contrast, this investigation focuses on social aspects of use—not just usability—that may impact access. Thus, not only must this evaluation tool go beyond heuristics, it should emphasize the role of the user’s perspective. This evaluation tool differs from existing evaluation techniques in that the focus is on social as well as functional breakdowns, and the involvement of the user as a key evaluator.

The goal of developing this tool is to take a first step toward providing a means for designers to evaluate designs for social accessibility. The tool focuses on measuring technology design elements within specific contexts. In addition, inputs are incorporated across both users and designers. The value assessed for each measurement is in terms of confidence level: evaluators assess whether a given technology and context makes them feel self-confident or self-conscious (or anything in between).

Ideally, an evaluation would be conducted in person. Due to resource and time constraints, and because a baseline assessment tool was the focus of this investigation, this rubric was evaluated as an online tool. One benefit of distributing the tool online was that, if successful, it could increase the scale of future evaluations. Traditionally, research and design work recruiting people with disabilities can be limited by resource or population constraints. There are not as many people with disabilities, and they can be hard to contact or to bring in to a specific location for user testing. Therefore, a usable online tool would help broaden the reach for designers.

### 8.3 METHOD

The elements comprising the rubric were drawn from findings from the diary study (Shinohara & Wobbrock, 2016), and involved a process of intentional design decisions, which I document in this section. The goal of creating a rubric was to encapsulate contexts and design elements that, when put together, may contribute to specific user and bystander reactions. The rubric was created with both designers and users in mind, defining socio-technical phenomena for evaluators to assess, score, and reflect upon.

### 8.3.1 *Creating the Rubric*

I referred to previous work to identify salient social contexts that could be relatable as well as evoke the appropriate responses accorded common social decorum (Shinohara & Wobbrock, 2011, 2016). I drew on past participant data to determine design parameters that, when intersected with social contexts, might create an environment that elicits feelings of self-conscious or self-confidence (Shinohara & Wobbrock, 2016). In this section, I document the design considerations I made in defining the various aspects of the evaluation rubric, beginning with the role of the evaluators and their expected roles in using the tool.

#### 8.3.1.1 Evaluators

As mentioned above, the purpose of the evaluation tool is to help designers assess social accessibility of technology design. However, per the tenet in Design for Social Accessibility that users with disabilities ought to be included in the design process, so should evaluators also include target users with disabilities. With this in mind, I created the tool such that an evaluation is rendered complete only when both a designer and a user with a disability have completed it. To this end, prompts address both designers and users. Although the scenarios and design elements that are evaluated are essentially the same, I created two versions, thereby creating space for a designer and a user to evaluate each component, enforcing the notion that an evaluation is only complete when both parties have completed an evaluation.

Once social contexts and design elements (detailed in the sections below) were selected and incorporated into the tool, prompts were drawn from the first-person perspective (to reflect the users' point-of-view) and from the third-person perspective (to reflect the designers' perspective and way of thinking). It is important to emphasize both perspectives because only users can reflect on what it is really like to use specific technologies in each scenario, based on

their lived experiences. Thus, designers should not be required to put themselves “in someone else’s shoes,” but it allows designers to impart their professional knowledge in design and to reflect on specific elements and social contexts. By incorporating both viewpoints, the rubric can ensure that the user’s experience is incorporated and valued as part of the evaluation, meanwhile, the designer’s professional assessment can also be included.

### 8.3.1.2 Social Contexts

Contexts of use as important factors emerged from findings in my prior work (see chapters 4 and 5). For example, this quote from a participant in the diary study led to the restaurant description:

*I still have to be hunched over to see the menu through it because using the still frame option would not be using my time well and quickly before they come to ask for what I want. People stared of course, who were sitting close to us. –G1P2*

I drew on these findings in creating a list of contexts that might be familiar to most technology users, i.e., working in a coffee shop. In addition, I selected contexts that might also draw out emphasized social expectations. In the scenario that G1P2 described, there are socialized human behaviors in which restaurant patrons partake in and accept as part of the activity of eating in a public setting. As participants in a social world, we tend to rely on these schemas to know what to expect or how to behave (Novick & Bassok, 2005), and as exemplified by G1P2’s comment, we learn to identify deviations from these expectations. Thus, drawing on some of these common settings would ensure that evaluators would be familiar with the social expectations of a given activity, while also identifying what elements of it could lead to a social breakdown.

In accordance with the proximal observations reported in chapter 5, I further categorized social contexts based on Hall’s proxemics: public, social, personal and intimate (Hall, 1963, 1966).

In defining social contexts for each category, I could be sure to address different types of expected social interactions within each.

### 8.3.1.3 Technology Design Elements

Once a set of contexts were roughly defined, I generated a list of design elements that commonly arose from discussions in prior work (see chapters 4 and 5). These elements typically included the form factor and shape of a device, the sounds it made, including button or key pushes, as well as system message notifications and other sounds, the visual language both of the technology's appearance as well as how it would be handled and its colors and visual design. Design elements fell within major categories that would also be familiar to evaluators, as they assessed a combination of design elements and a social contexts. In addition, because I was designing the rubric to be used for any personal technology (including hardware and software), high level categories had to be flexible.

Design elements for assessment were determined to be: input, output, other functional operations, visual and physical appearance and overall fit. Specific parameters for each high-level category were not necessarily originally defined, as these could change depending on device, i.e., an e-book might have text-to-speech but few other sounds, whereas a Braille display might also have mechanical sounds associated with each Braille refresh or key-press. Thus, evaluators would know what high-level category was being assessed, and they would identify what elements specific to the technology they were evaluating, e.g., noisy output might be attributed specifically to a technology's clicks.

### 8.3.2 *Piloting and Iterating*

Once I had defined the individual components for assessment, I synthesized them into a single rubric, which I then tested with student designers as well as graduate and faculty

researchers. I initially created a full rubric, covering all proximal categories identified by Hall (public, social, personal and intimate contexts) (Hall, 1963, 1966). It became clear that evaluating across all categories might be too time intensive, and so a subset of categories of social and personal contexts were included in an initial test. The rationale for including social and personal contexts were that “social” contexts were the most frequently recorded interactions in the diary study, and because personal interactions would involve direct interaction (“public” was not guaranteed to include direct social interaction), and a sensitivity to closer interactions as well.

Initial pilot tests revealed that evaluators experienced difficulty relating to the social contexts and the particular design elements they were being asked to assess. Subsequent versions therefore included asking evaluators to describe the design of the technology they were assessing (for example, identifying what kind of sounds it makes), and refining the wording for each scenario to allow it to be both specific enough to draw out the appropriate reaction (feeling some level of comfort, whether self-conscious or self-confident), and general enough to apply to a wide range of personal technologies.

### 8.3.3 *Evaluating the Rubric*

An online version of the rubric was launched and disseminated to users with visual impairments and designers to test its effectiveness in evaluating technologies for social accessibility. The online mechanism was selected due to resource constraints and also to ensure wide recruitment of users with visual impairments. Designers and users evaluated a predetermined set of technologies through the online rubric. Users were asked to evaluate devices they already had experience using, while designers were given system specifications and asked to watch a three to four minute video to become familiar with the technology they were

evaluating (see Table 8.1 for the list of technologies and video URLs). In this section, I outline the components comprising the online rubric, the participants, and its execution.

As mentioned, designers were shown videos about the technologies they were to evaluate to familiarize themselves with what the technology did, how it might be used, and who might use it. Videos were found on YouTube and were selected for tutorial-like information. Parameters for selecting a video included: holding or carrying the technology so that viewers could get a sense of its weight and handling, information on technology function and features, and information on how the technology was used. Videos were also constrained to a three to four minute segment in order to keep them manageable in the timeframe that designers were expected to complete the evaluation. Technical specifications were included with the video, and pulled from manufacturer documentation. Specifications varied based on company and technology, but included similar information across technologies, such as dimensions, weight, technical information like memory or hardware components, and peripherals or functionality specific to the technology. For example, specifications describing hand-held magnifiers included magnifying capacity.

#### 8.3.3.1 Selecting Devices for Evaluation

To ensure the rubric would be used to assess assistive or accessible aspects of design, selected technologies were limited to assistive technologies. Future iterations should include both assistive and mainstream accessible technologies. The first iteration was scoped to focus on assistive technologies to maximize feedback from enough users based on their actual experiences. A list of common assistive technologies was generated based on devices reported in chapters 4 and 5 and an assistive technology professional was consulted to refine the list to items that were common, popular or unpopular, etc. Ultimately, four categories of devices were

selected: DAISY players, Braille displays, note takers, and hand-held video magnifiers (see Table 8.1).

Items were grouped by category to facilitate recruitment. To increase recruitment success rate, users were recruited based on a list of technologies representing that category and they could complete an evaluation of a technology with which they had experience. Designers were assigned a single technology, one for each category, since they would have no prior knowledge or experience using any technology.

#### 8.3.3.2 Study Participants

Designers were recruited for their knowledge of UI/UX design using social media, and were required to have some design experience, although they were not required to be professional designers. Designers could qualify for the study if they had completed some courses in design. Users were recruited through an online website popular with blind and low-vision consumers, as well as some local listservs. Users were recruited based on the technologies they had experience using.

Because the online rubric was not a study in examining the participants' perspectives of technology use, participants were eligible to complete the rubric multiple times, as long as they met the requirements for the original recruitment (for example, as long as a user had used a second device, they could complete a rubric for two devices). Participants were not allowed to complete rubrics for the same device more than once.

Participants were offered compensation for each rubric completed as well as an added incentive to enter a drawing for a gift card. A total of 24 users and 31 designers completed 40 evaluations.

<b>Technology Categories</b>	<b>Evaluators and Specific Technologies</b>
DAISY Players	<p><b>Users</b></p> <p>A - HIMS Blaze EZ/ET, Humanware Victor Reader Stream (any generation), HIMS BookSense (any model), HandyTech Actilino</p> <p>B - NLS digital talking book player, PlexTalk ptx, Humanware Victor Reader Stratus</p> <hr/> <p><b>Designers</b></p> <p>A - Victor Reader Stream -  <a href="https://www.youtube.com/embed/nCQWhwqRACs?start=10&amp;end=207">https://www.youtube.com/embed/nCQWhwqRACs?start=10&amp;end=207</a></p> <p>B - National Library Service Digital Talking Book Player  <a href="https://www.youtube.com/embed/h0oUNSOcABQ?start=87&amp;end=215">https://www.youtube.com/embed/h0oUNSOcABQ?start=87&amp;end=215</a></p>
Braille Displays	<p><b>Users</b></p> <p>A - Brailiant 40, Vario Ultra, Handy Tech (Easy Braille and Easy Braille Bluetooth, Active Star, Active Braille)</p> <p>B - Focus 40 Blue, Brailiant 80, PowerBraille, HIMS Braille Edge</p> <hr/> <p><b>Designers</b></p> <p>A - Brailino - <a href="https://www.youtube.com/embed/pO4c-6f9Ud8?start=17&amp;end=220">https://www.youtube.com/embed/pO4c-6f9Ud8?start=17&amp;end=220</a></p> <p>B - Focus 40 -  <a href="https://www.youtube.com/embed/SIoovK0Bvd0?start=32&amp;end=147">https://www.youtube.com/embed/SIoovK0Bvd0?start=32&amp;end=147</a></p>
Note-takers	<p><b>Users</b></p> <p>A - BrailleNote (any model except MPower), BrailleSense</p> <p>B - PacMate (any model, any generation), BrailleNote MPower</p> <hr/> <p><b>Designers</b></p> <p>A - BrailleNote Touch -  <a href="https://www.youtube.com/embed/OtKzDhqGRBA?start=69&amp;end=278">https://www.youtube.com/embed/OtKzDhqGRBA?start=69&amp;end=278</a></p> <p>B - PacMate - <a href="https://www.youtube.com/embed/cqJUq93FHkQ?end=114">https://www.youtube.com/embed/cqJUq93FHkQ?end=114</a></p>
Hand-held Video Magnifiers	<p><b>Users</b></p> <p>A - Optelec Compact 5 and Compact Touch, i-LoView, Freedom Scientific Ruby XL HD, Enhanced Vision Amigo HD 7, Pebble and Pebble Mini</p> <p>B - QuickLook 2GO and Focus, Explore 3, Mobilux Digital Inspection, HIMS SenseView</p> <hr/> <p><b>Designers</b></p> <p>A - Optelec HD - <a href="https://www.youtube.com/embed/ZGIg5c3cORI?end=83">https://www.youtube.com/embed/ZGIg5c3cORI?end=83</a></p> <p>B - SenseView Duo -  <a href="https://www.youtube.com/embed/xvzrQeGHKdI?end=141">https://www.youtube.com/embed/xvzrQeGHKdI?end=141</a></p>

**Table 8.1. List of Devices for Evaluation**

### 8.3.3.3 Online Logistics

The goal of the online investigation was to determine the effectiveness of using the rubric to evaluate technologies for their social accessibility. Thus, a smaller pool of participants was sufficient, and recruitment was capped at no more than 5 participants per device category, for 10 total evaluations per overall category, and 40 rubrics completed per evaluator group (total 80

overall). An online script was used to route and track evaluators. Once rubrics were filled by the quota, the script stopped routing participants. If rubrics were begun but not completed, the script was updated to ensure the full number of participants could fill out a rubric for each technology category.

## 8.4 FINDINGS

The response rate for both users and designers was high and quotas for all rubric categories were met quickly, that is, enough users and designers filled out rubrics to close the online evaluation. Unfortunately, some of the users either were not aware of specific rubrics for designated technologies, or they persisted in filling out rubrics for the technologies they used, regardless of what they were assigned to assess. Thus, many of the users filled out rubrics for a technology other than the one they were assigned to evaluate (for example, many users who were assigned the hand-held magnifier category completed rubrics evaluating note takers instead). Although the online script counted and tracked rubric assignments, it could not account for users filling out rubrics for different devices. In addition, although rubrics were assigned for specific devices and titled as such, all the rubrics were essentially the same. A key component of the overall rubric design was keeping all the rubrics the same, regardless of the technology that was evaluated, because the goal was to assess the effectiveness of the evaluation tool across different technologies. Thus, although the maximum allowable users completed all rubrics, there is less data on users evaluating hand-held magnifiers and a large number of evaluations of note takers. Due to cost constraints (users were paid even if they completed a rubric on the wrong device because it was not clear if they misunderstood or if they persisted despite instructions), I was unable to continue recruiting for rubrics that lacked the numbers originally anticipated. (Table 8.2 below shows the number of completed rubrics for a given technology in parentheses).

Despite the recruitment hiccups, however, enough data was collected across most of the technologies to get a sense of the success and effectiveness of the tool.

#### 8.4.1 *Rubric Results*

Overall, results showed that participants were able to use the rubric to assess technologies for social accessibility. Across technologies, participants tended to evaluate categories of devices similarly. Table 8.2 shows composite scores for each participant type (designer or user), technology and design elements. Each score reflects the sum of the averages (to give a raw composite, not an average) across the social contexts at which design elements were assessed. It is not necessary to determine the average of the overall design element and social context because the goal is to find a score to compare across evaluators, devices and social contexts. For example, users determined if the design elements that comprise the input mechanism and handling of a technology made them feel self-conscious, comfortable, or self-confident in a set of given scenarios. Their responses across those scenarios were averaged, to obtain a score for a given design element and scenario across the users. The sum of those scores gave a raw composite, shown in Table 8.2, to represent the overall score assessed by users for each technology and design category. It is not necessary to calculate descriptive or inferential statistics for each score because the goal of the study was not to determine how socially accessible a given set of technologies may be. Instead, the goal is to create a tool that designers and technology users can employ to assess a design's social accessibility. Therefore, the desired result from this investigation was to elicit appropriate responses from designers and users that indicated they reflected on how the combination of design elements and social scenarios made them feel.

	<b>Designer</b>		<b>User</b>	
<b>DAISY Reader</b>	National Library Service Reader (6)	Victor Reader Stream (5)	National Library Service Reader, Plectalk (3)	Victor Reader Stream (6)
overall	9.0	13.8	8.2	11.8
input	11.3	14.0	11.3	9.0
output	12.0	15.4	12.8	13.9
visual appeal	10.3	15.2	15.3	14.4
out and about	12.6	15.8	12.2	11.9
<b>Braille Display</b>	Focus 40 (5)	Brailino (5)	Focus (3)	Brailiant (3)
overall	14.2	12.8	14.7	12.3
input	14.1	15.0	12.5	13.5
output	13.0	15.3	13.7	16.0
visual appeal	13.6	12.0	12.0	15.5
out and about	14.6	16.2	13.0	15.0
<b>Magnifier</b>	SenseView (5)	Optelec (5)	QuickLook (1)	Ruby (1)
overall	11.4	13.4	9.0	13.0
input	11.4	14.8	17.0	5.0
output	13.3	17.1	16.0	7.0
visual appeal	15.0	15.8	13.0	10.0
out and about	13.9	15.5	15.0	14.0
<b>Notetaker</b>	PacMate (5)	BrailleNote (5)	MPower or Pacmate (6)	BrailleNote (15)
overall	11.6	12.8	12.7	15.3
input	15.0	12.8	11.9	15.3
output	14.4	11.0	13.2	16.1
visual appeal	15.6	13.6	13.3	15.6
out and about	15.9	12.4	13.7	16.1

**Table 8.2. Technologies evaluated by designers and users (number of responses), higher scores indicate more socially accessible evaluation.**

Composite scores were calculated across users for a given technology and design elements to allow an analysis on the results at-a-glance: broadly, did evaluators respond to design and social contexts similarly? A desired outcome is for scores in the right column for each evaluator to be higher than those on the left; however, it does not have to be so. For example, users' scores for the BrailleNote are all higher than scores for the MPower or Pacmate. Although this is the ideal scenario and would indicate that overall, users felt more confident interacting with that technology's design feature within a given context, it is not required to be so because different people will have different preferences, and there is flexibility constructed within the rubric to allow for this. Clearly, not all scores in the right columns for each technology and

participant group are higher than those on the left. For example, many of the responses for QuickLook are higher than for Ruby. However, these scores reflect just one person's preference (one person completed a rubric for each technology).

In addition to rating how they felt, participants were asked why they responded the way they did. These open-ended responses allowed participants to fill in other situations or uses that were not considered, as well as to offer some indication as to the effectiveness of the tool itself. For example, in the following two comments from the rubric response sections, both a designer and a user responded similarly to the prompt about why they might feel self-conscious when using a DAISY reader to lead a meeting:

*Need voice input, will make people know that [they] have reading obstacles.  
–Designer, Victor Reader Stream*

Meanwhile, a user indicated a similar theme:

*In cases where I need to input information for a meeting, the Victor is inadequate because it lacks the ability to input text. The only thing it does well is memo recording. –User, Victor Reader Stream*

Comparatively, the designer in the quote below responded to the National Library Service reader, the “less cool” version of the Victor Reader Stream. The designer detailed specifically which design elements may contribute to conveying information that could contribute to feeling self-conscious:

*Because input is done using the built-in mic, the user must actively speak as they record. Depending on the nature of their recording, they may not want to use it. Additionally, depending on the tape or audio book they are inputting, they have to feel for which one in particular they want, which may make them feel self-conscious as they are inserting it into the device.  
–Designer, National Library Service E-Reader*

The comments assessed for the DAISY readers help verify how evaluators scored these technologies (for example, scores for DAISY readers generally were higher for the Victor Reader

Stream than for the National Library Service Player). Given statements such as these, we can be more confident in the veracity of the ratings (than without the statements) that evaluators understood the meaning of the prompt and that they meant how they scored it (low scores meant more self-conscious). The following comments not only reflect similar thinking about the BrailleNote device for both a designer and a user, they also were reported for the same output design element. Where the designer described the voice as like a “robot”:

*Robot speech-to-text as they type is confusing. Maybe easier if it reads after a sentence or something. –Designer, BrailleNote*

The user indicated how the voice had been a problem for them:

*Sometimes I've randomly enabled the speech mode, which is slightly embarrassing. –User, BrailleNote*

It is worth noting that the reasons for indicating that they would feel self-conscious are the output mechanism, the text-to-speech engine. However, the aspect of it is less clearly stated by the user, who just says that having the speech enabled “randomly” can be embarrassing. It is unclear if it is because it could be disruptive in a quiet environment, or if it could be due to the “robot” like sound of the voice. At the same time, the situation of “randomly” having the text-to-speech enacted inadvertently, causing the user to feel self-conscious, could be subtle enough that a designer could miss it. As demonstrated in this last example, whereas user quotes tended to be situation specific (and associated with an actual experience), designer comments were likely to include descriptive language. Yet, we can see that both designer and user touch on similar aspects, and their assessments complement, rather than contradict, each other.

Indeed, the consistency of the messages that come across in these open ended responses indicate that evaluators did assess elements appropriately.

*In the scenario with ordering from a menu, I think the user would feel self-conscious using the technology because they would have to listen to the output either via the device's built-in speaker, or plug in headphones to first listen to the menu in order to get the information. This is a process that actively shows the user's disability to the waiting staff, server, and other restaurant-goers.*

*–Designer*

As seen in this quote above, the designer exhibits a fair amount of effort to understand how a user may feel in the given scenario. Key to this assessment is the designer's awareness of how context plus design elements manifest, shown in the statement, "this is a process that actively shows the user's disability to the waiting staff."

## 8.5 DISCUSSION

The evaluation rubric showed promising results. Particularly across users, designers and technologies, the investigation showed that an intersection of design elements and social situations *can* be assessed. Heuristic evaluations, whether for general usability or focused specifically on accessibility, tend to isolate specific functional parameters for assessment (Casare et al., 2016; Nielsen, 1994; Reid & Snow-Weaver, 2008), whereas the Design for Social Accessibility Evaluation Rubric requires evaluators to consider the complex interplay of design elements and social contexts. Furthermore, evaluators were asked to respond with a subjective assessment: would they feel self-conscious or self-confident, given the intersection of technology use and social situations? Given these complex issues, the co-incidence of responses that tended to be similar within technology categories was promising, and the assessments were further corroborated by participants' comments. Not only did comments align, but also the reasons given.

However, it was not always the case that evaluators agreed. Although it was neither the goal of this investigation, a requirement of the rubric, that evaluators agree on all aspects of

technology design and social contexts, a form of agreement consistent and reliable across a set of assessments is necessary to ensure confidence that the tool would successfully determine a technology to be “socially accessible.” At this point in time, with the current set of results, I would refrain from making such a claim. At the same time, the findings are promising and motivate certain improvements appropriate for a larger deployment of the tool, to assess how it might perform during in-person use. Improvements for future assessments should include refining wording that describes the scenarios and creating tutorial videos rather than using pre-existing videos to ensure consistency across devices. Further, more work can be done to investigate better ways to evaluate specific design elements, such as visual appeal.

What do the results indicate about evaluating social accessibility? It can be done, but it might be difficult; two aspects bear further investigation: (1) how to tighten up the tool to ensure that evaluations are more consistent, if possible, across certain scenarios and certain technologies, (2) how useful the tool is in practice. If a completed rubric is given to a designer, how can they use it in their actual design work? Turning the results around to a useful end in design practice gives the tool full utility and fulfills an evaluative component for Design for Social Accessibility.

## 8.6 SUMMARY

The rubric was successful in that evaluators were able to say whether they would feel self-conscious or self-confident when using technologies in given social scenarios. These results, while consistent with written responses and scores across designers, users, and technologies, should be investigated further. In addition, the online launch limited the ability to assess whether a designer would find the rubric useful. Thus, future work should include verifying how well evaluators felt the tool reflected their feelings, should investigate in-person versions of the tool,

and assess how designers would interpret and use results for improving designs. However, this investigation does verify the evaluation rubric to be a viable initial instantiation of a tool to verify socially accessible design of technologies. Although there is room for improvement, this study of the viability of the current rubric demonstrates the first attempt at assessing a technology's social accessibility. Through incorporating evaluative components of (1) visually impaired and designer perspectives, (2) specific design elements, (3) social contexts, and (4) eliciting feelings of self-consciousness and self-confidence, this tool builds on the concept of social accessibility and contributes to Design for Social Accessibility.

## Chapter 9. FUTURE WORK AND CONCLUSION

### 9.1 SUMMARY OF FINDINGS

In the caption associated with the image in Figure 9.1, the photographer stated (Dombrowski, 2010):

*When I set eyes on the Braille tablet I'd heard so much about, it was the clunkiest, ugliest-looking piece of hardware I'd seen in a long time. Until I realized it was never meant to be seen.*



**Figure 9.1. A BrailleNote device.**

The irony of the image is that it was seen, by a photographer, who then formed a perception about it, describing it as “the ugliest-looking piece of hardware.” Much like the images in the opening pages of this dissertation, technologies carry with them social meaning in the contexts in which they are used. The work presented in this dissertation unpacks the implications of the meaning of accessible technologies, conceptualizing a property of design as a way to encapsulate the socio-technical phenomenon, and developing a design perspective, Design for Social Accessibility, to facilitate a social component in accessible technology design. Ultimately, this dissertation shows that there is meaning associated with accessible technologies created for people with disabilities, but that by shifting design thinking to incorporate aspects of

social accessibility, particularly through Design for Social Accessibility, we can change how we approach design for people with disabilities, to be more inclusive in the mainstream, and we can encourage an emphasis on the social implications of accessible design.

#### 9.1.1 *Assistive Technology Use in Social Situations: Defining Social Accessibility*

The presence of personal and mobile devices has become a part of our collective social consensus of what is used in social and public spaces. The existing landscape of technologies define what we consider acceptable to use in social contexts. More mobile technologies means that more people are using technologies when out and about in public and social spaces. No longer are personal computers relegated only to the home; people are using personal technologies while on-the-go, in the presence of others, even as a way of interacting with others. The same is true for people with disabilities who use assistive technologies when they are in public and social settings. My work leading to this dissertation indicated that social factors influence how people with disabilities use their assistive technologies, oftentimes driven by misperceptions about assistive technologies and the people who use them. Many personal technologies are discretionary, or are one of several options for consumers, while, in contrast, assistive technologies might provide necessary access and options might only consist of proprietary choices. Yet, research has shown that users could be dissuaded from using a technology if they felt strongly that it was undesirable to use in a given context, even abandoning technologies that are incongruent with user preferences or that make a user feel stigmatized (Hocking, 1999; Pape et al., 2002; P. Parette & Scherer, 2004). My early research examined assistive technology use in social and public spaces, and identified that the design of such technologies may “mark” users in social spaces, particularly if devices are “weird” looking or awkward to use; bystanders may associate incorrect or negative assumptions about what people

with disabilities can or cannot do, based on perceptions of assistive technologies (Shinohara & Wobbrock, 2011).

I next examined, through a diary study, what design elements contribute to users feeling self-conscious or self-confident when using their assistive technologies in social situations (Shinohara & Wobbrock, 2016). In addition, I investigated what people without disabilities thought about assistive technologies they saw used in public spaces. Did bystanders really form incorrect perceptions about assistive technologies? Findings from the diary study highlighted a mix of social context, user preference and attitude, and technology design that influenced the ways people with disabilities felt about using their devices in social spaces, and that influenced the ways that bystanders gauged perceptions of assistive technology use. I also noted that social breakdowns could impede access. Much like functional breakdowns, social breakdowns occur when social situations inhibit use, such as compelling a user not to use their assistive technology when in a given situation. Unlike functional breakdowns, however, social breakdowns occurred regardless of the actual functionality of a technology. Through these findings, I defined *social accessibility* as a design property incorporating social and functional factors in technology designs.

As the concept of social accessibility emerged from the diary study, I considered what it would take to motivate an approach to design incorporating social accessibility. I conducted a design course study to examine the design practices of student designers and to investigate ways to integrate social accessibility in the design thinking process (Shinohara et al., 2016). Through a study of student work in the design thinking course, I determined that social accessibility can be incorporated into technology design through a new perspective called *Design for Social Accessibility*. As a design orientation, the main aim of Design for Social Accessibility is to

facilitate an inclusive design perspective and approach that emphasizes the consideration for social factors in accessible technology design.

The design course study brought to light the unique rigor and skill that designers bring to their practice, emphasized by the reflections of students as they developed a design thinking mindset and perspective. Thus, I incorporated elements of social accessibility in a design perspective that aligns with designers' skillful sensibilities, that relies on their "designerly way of knowing," by prompting awareness of different contexts of use (Nelson & Stolterman, 2012). Fostering a design orientation aimed at increasing awareness and reflection in a way that respects designers' own way of thinking serves two purposes: first, it defers to designers' expertise on design decisions, ultimately refraining from dictating what designers should do, while instead providing designers with information to bring perspective to the process. Second, it limits the need for added time and resources, keeping the burden of accessible design low, demonstrating that barriers to accessible design are not insurmountable, and motivating designers to include accessibility whenever possible. I incorporated these lessons learned from the design course investigation in the next iteration of Design for Social Accessibility.

#### 9.1.2 *Design for Social Accessibility: Addressing Social Accessibility*

Based on outcomes characterizing student experiences, successes and challenges in the design course study, I defined a set of three tenets that could be incorporated with existing practices to address social accessibility in technology design with Design for Social Accessibility. Drawn from my prior work investigating the influence of social interactions on assistive technology use (Shinohara & Wobbrock, 2011, 2016), and on my observations of how student designers' shaped their design thinking (Shinohara et al., 2016), the three tenets are focused on increasing awareness and creating contextually-aware and low-barrier avenues for designers to

include social factors in design. The first tenet is that the design process ought to include people with and without disabilities as the core target audience. All too often, designers are required to focus on a “primary” case of users in an attempt to make the design process efficient. However, such strategies in design inevitably leave out people with disabilities as core users, reducing accessibility to additional, post-hoc accommodation, if it is included at all. In addition, as a corollary, when people with disabilities are incorporated into design practice, people without disabilities are often excluded, resulting in designs that are not typically usable by people without disabilities. The result is that most mainstream personal technologies are not designed to be inclusive, even though they could be; and inclusive designs are proprietary, widening the gap between technologies for people with and people without disabilities.

Second, design should incorporate social situations of use as well as functional utility. Findings from my prior work indicated that technologies designed with only functional utility in mind may lack social appeal, or worse, be considered not socially acceptable. Ultimately, function-centered technology designs are perceived as less desirable in social situations, and leading to limited use or abandonment and inaccessibility. Technology use no longer happens in a sterile environment devoid of social influence or personal social preference. Designers ought to become aware of, and account for, the ways their designs exist within social contexts. To support a consideration for both social and functional situations of use, I constructed the Design for Social Accessibility Framework (Figure 6.4) that positions both domains within a 2D design space. Positing social accessibility as maximizing the complementary relationship of the two domains provides designers with a way to envision how elements of their design can address both social and functional factors.

Third, designers should consider different perspectives and reflect on how designs for users with disabilities might influence, or be influenced by, social situations. This last tenet engages “designerly ways of knowing,” drawing on designer expertise and skill in “reflection-on-action” or “reflection-in-action” (Cross, 1982; Nelson & Stolterman, 2012; Schön, 1987). But, reflecting on socially accessible design is most productive when contexts and constraints create intersecting or conflicting scenarios of technology use, those functional and social forces that led to social breakdowns observed in the diary study (Shinohara & Wobbrock, 2016). Therefore, I created method cards (Figure 6.5) to prompt designers to consider how social scenarios might intersect with design. The goal of the method cards is not to constrain designers to a method or design configuration, but to bring awareness to situations to which nondisabled designers might not be privy to. In addition, the cards provide questions that designers can draw on to ask sensitive questions about situations they might not be aware of and might not otherwise ask about. Thus, by broadening the possible contexts beyond a designer’s own experiences, the method cards can increase the tools at a designer’s disposal in addressing social factors in accessible design. When designing with disabled users, designers can reference the method cards to ask hard questions, or to inquire about situations of use about which they may not otherwise know to ask.

### 9.1.3 *Workshops: Using Design for Social Accessibility*

I investigated Design for Social Accessibility as a design perspective that designers can use in the user-centered design process by conducting a series of workshops where professional designers drew on the Design for Social Accessibility perspective, worked with users with and without visual impairments, and used the framework and method cards to create designs they evaluated as socially accessible.

To investigate the feasibility and effectiveness of Design for Social Accessibility, I conducted five design workshops with five professional designers. Incorporating all three tenets of Design for Social Accessibility, I facilitated workshops where designers incorporated social accessibility within user-centered design techniques, completing ideation, synthesis, prototyping and evaluation tasks. Designers were able to work with users, include aspects of social accessibility, and create low-fidelity prototypes that they assessed as having met requirements of the design prompt.

Outcomes of the workshop showed that designers and users were able to understand and incorporate the concept of social accessibility, such that they were able to incorporate themes of it into their design work. That is, the notion of social accessibility was accessible enough to workshop participants that they could work with the ideas presented within it. The tools and techniques offered for Design for Social Accessibility were helpful in facilitating understanding. For example, the framework visualization helped workshop participants (both designers and users) to understand how to maximize social and functional factors in design.

#### 9.1.3.1 Design for Social Accessibility Framework and Method Cards

During the workshops, I observed how designers used the Design for Social Accessibility Framework. Designers relied on the framework for two different parts in the process. First, they drew on the framework to help define what social accessibility meant to them. Because social accessibility was an idea not previously encountered, designers made sure they understood the concept so they could operationalize it in the design process. Second, designers relied on the framework to facilitate design sessions with users. Designers would refer users to the framework to show how ideas might fit along the continuum of functional and social factors indicated in the design space. Users also referred to the framework to shape their own understanding of

social accessibility, although less so than designers. As both a vehicle for definitively conveying what social accessibility is, and a way to operationalize that meaning into design ideas, the framework was successful in helping designers and users incorporate social and functional factors.

The framework could be improved to make it easier for designers to understand social accessibility. For example, D4 suggested plotting exemplars within the framework to demonstrate how existing and known designs might fit within the two dimensional space. Such exemplars were intentionally not plotted so as not to influence designers and users—ideal use of the framework would draw on an individual’s own conception of what is appealing and acceptable to them. However, the suggestions made by D4 and the experiences observed by some of the designers indicated that the framework could be improved to help designers grasp the concept of social accessibility more quickly and thus, more effectively.

The method cards prompted designers to consider and reflect on specific contexts of use and brought awareness to social factors comprising the social dimension in the framework. The method cards were successful in drawing out considerations for situations with which designers were not familiar with because the method cards referenced experiences with assistive technologies, as reported by participants with disabilities in the interview and diary studies (chapters 4 and 5) . In addition, when used appropriately in the design workshops, the method cards allowed designers to consider not just the scenarios suggested in the cards, but to also consider similar situations that users in the workshops might have had. Thus, the method cards were successful in increasing awareness about how design provides access in different contexts by referencing situations that designers would not have known to ask about without prompting.

Not all designers were successful in using the cards. Notably, D3 did not read the cards and presumed the images on the cards to represent different design options. Thus, improvements in the cards would include refining the wording to be simpler and more clear, to guide proper and effective use of the cards. In addition, the scenarios on the cards were drawn from experiences reported in prior work and they were not presumed to cover all possible social contexts that are representative of the experiences of disabled technology users. Therefore, future research may involve generating contexts that bring awareness to specific issues that users with disabilities do encounter. Finally, D5 suggested a card that summarizes disability-specific information that could be helpful in design scenarios, such as typical limitations experienced by visually impaired users, wheelchair users, motor-impaired users, or deaf or hard of hearing users. An information card could be cross-referenced with other cards, especially if designers have access to a limited pool of users, as they did in the workshops.

#### 9.1.3.2 Designers' Design Thinking

UI/UX and industrial designers were recruited to participate in the workshops, and all the designers described design work on products and services for use by people, yet their typical practice did not involve working with users, whether with disabilities or not. Designers agreed that accessibility was important, and that working with users would be beneficial, but they experienced barriers to incorporating accessibility into their daily design work. For example, the primary user was implicitly defined by business leadership to designers, as users without disabilities. In contrast, design workshops were explicitly designed to include users with and without visual impairments. Though it might seem that because designers' experiences did not include accessibility or working with disabled users they may have been ill-equipped to work with users, I observed that designers were able to encapsulate a diversity of user perspectives

within the workshops. These findings support the notion that elements of Design for Social Accessibility (such as working with people with disabilities and drawing on users' experiences and preferences) can be sufficiently integrated with a designers' own knowledge and skill. Despite not including accessibility in their typical design practice, the designers' expertise equipped them to rationalize and apply judgment toward a viable solution.

### 9.1.3.3 Supporting Designers to be Prepared for Action

Despite the abruptness with which designers were thrust into a situation working with visually impaired users, I observed designers working with confidence and professionalism, which speaks to their skill as designers and their comfort with the problem space and given constraints. The additional complexity of including a visually impaired and non-impaired user was within the realm of work that the designers were trained to address as demonstrated by their handling of the workshop prompt, the rigor and discipline they showed in the process and the dynamics of their group interactions (as led by designers) overall. I observed that the designers navigated the challenges of a shortened timeline successfully, working with two users at the same time, and working with a visually impaired user. Despite not having experience working with people with disabilities in the design process, designers skillfully facilitated brainstorming, asked appropriate but diverse questions, and rationalized decisions. Of course, I cannot be sure what designers were actually thinking at the time, but I note that designers were quick to jump into the design problem, worked through issues with poise, and developed prototypes that could be tested by both users.

Prototypes were not complete by any means, and designer self-evaluations during the workshops revealed areas they thought needed improvement, such as refining specific interface details, e.g., the size of a button or the exact commands for voice interaction. I attribute these

criticisms to the limitations of the workshops and to designers' skills in reflection and judgment, it was in their nature as designers to be critical of their own work. At the same time, designers were able to come up with a design that could be prototyped, that addressed the given prompt, and that was positively assessed by users.

The success the designers demonstrated in incorporating working with two users, using the framework and the method cards and in completing a low-fidelity prototype, demonstrated that Design for Social Accessibility is complementary to the designer's own skills and practice. I caution that the data can only show how useful Design for Social Accessibility was in the context of the brief workshop setting, but next steps of this work should involve taking these concepts into the field to observe how designers incorporate such thinking in their everyday work. At the same time, the positive findings indicated that there are opportunities to broaden the ways that designers are thinking about technology design. Designers exhibited a change in attitude toward disability (as indicated by the attitude surveys), and admitted they felt differently about the importance of accessibility as well. Thus, follow up work ought to include longitudinal analysis to determine if incorporating Design for Social Accessibility could incur a shift in the ways that designers consider disability and accessibility in the long term.

#### 9.1.4 *Evaluating Socially Accessible Design*

I created and evaluated an assessment tool to help designers evaluate technologies for social accessibility. If a designer incorporates Design for Social Accessibility within their own design practices, a method is necessary for the designer to assess if the resulting design is considered to be socially accessible. Thus, the goal of the assessment tool, an evaluation rubric, is to elicit designer and user judgments of social contexts and design elements: does an aspect of the technology design, when used in a specific social context, result in feelings of self-

consciousness or self-confidence? The launch of the online version of this evaluation rubric successfully drew responses from designers and users, who responded about how they felt about design elements in specific social contexts (for example, using a Braille display to lead a meeting in a work setting). Technologies were assessed per different dimensions; for example, first on sounds, then on how outputs looked and worked, etc. Scores given each dimension of design were corroborated by comments indicating why evaluators responded the way they did.

Whereas the evaluation rubric elicited responses about the social accessibility of different technologies, it is yet unclear how well the results of the evaluation inform further iterations of designs. In addition, although it was expected, responses were not always consistent across technologies and contexts, i.e., some evaluators were less bothered by text-to-speech in social situations than are others. If the tool produces useful information on how to improve design, then consistency across all users is not necessary (and most likely not achievable because the evaluation is asking for subjective responses).

#### 9.1.5 *Demonstrating the Thesis Statement*

In the beginning of this dissertation, I asserted a thesis arguing for a design perspective based on social accessibility that incorporates social and functional factors and that produces designs that are considered socially accessible. In the chapters hence, I demonstrated this claim. In chapters 4 and 5, I presented empirical evidence from my interview study showing that social contexts influence, and are influenced by, how assistive technologies are used. From my diary study, I investigated how design elements in social contexts contribute to feelings of self-consciousness and self-confidence. The findings from the interview and diary studies thus informed my definition of social accessibility, as a property of technology design that incorporates both social and functional factors.

In chapter 6, I presented investigations I conducted while teaching design thinking to determine techniques and develop tools to facilitate social accessibility in technology design practices, particularly within the user-centered design methodology. In working with informatics students in their design thinking course, I defined the three tenets of Design for Social Accessibility: (1) design with and for disabled and nondisabled users; (2) incorporate social and functional factors; (3) reflect on the diverse perspectives that arise in the design process. I developed the Design for Social Accessibility Framework (Figure 6.4) to help visualize social and functional factors within a design space for designers to operationalize. And, I developed the Design for Social Accessibility Method Cards (Figure 6.5) to prompt designers to consider and reflect on different perspectives, grounded in social contexts.

In chapter 7, I verified that professional designers can incorporate Design for Social Accessibility in their design work. Through a series of design workshops, I observed designers work with users with and without disabilities, using the framework and method cards that I developed. Users evaluated design outcomes from the workshops as functionally and socially accessible, meeting the needs they described to the designers. In addition, designers, through their own expertise, were able to integrate Design for Social Accessibility techniques into their design skillset.

In chapter 8, I developed and deployed an evaluation rubric to verify that social accessibility can be evaluated. Results from the deployment showed promising assessments across users, designers and technologies, demonstrating that the tool was successful in eliciting assessments relevant to social accessibility. More work would have to be done to translate evaluation results back into the design cycle, and to refine specific elements of the rubric itself.

However, the initial findings indicate an appropriate trajectory for how social accessibility can be evaluated.

Taken together, the culminating work in this dissertation clearly demonstrates that:

*Design for Social Accessibility produces technology designs judged by people with and without visual impairments to be functionally and socially accessible, addressing feelings of self-consciousness and self-confidence in technology use.*

## 9.2 REFLECTION AND DISCUSSION

I have shown that social accessibility is an identifiable design property of personal technologies, one that arises from the intersection of technology use and social context. In demonstrating that designers can incorporate design for social accessibility within user-centered design, I showed how awareness in design practice and exposure to people with lived experiences of disability *could* shift perspectives on disability and accessibility. In this section, I reflect on the outcomes of this research and discuss what it means within the broader context of technology design and accessibility.

The workshops showed that including elements of Design for Social Accessibility, such as working with disabled users and prompting for diverse user experiences with accessibility inherently made some parts of the process accessible. For example, brainstorming included accessible topics and was done accessibly, where verbal descriptions accompanied white board drawing so as to include all members in the process. Still, designers in this study were not briefed on ways they could make the process more accessible, but future instantiations of the process could do so. Inaccessibility in the design process must be addressed because one thing that stymied student design work (in the design course study) was that disabled users found themselves providing feedback on accessibility, rather than usability. This is problematic because, as indicated in the literature and prior work, a preoccupation with functional

accessibility over social situations of use results in technologies that users may be less comfortable with using in social and public contexts (Hocking, 1999; Pape et al., 2002; P. Parette & Scherer, 2004; Phillips & Zhao, 1993; Shinohara & Wobbrock, 2011). When too much of the process is inaccessible, it hinders feedback on usability and user testing, ultimately limiting reflection on social aspects and other contexts of use.

The evaluation rubric, though effective in eliciting responses that related to evaluating technologies along social accessibility, warrants a deeper investigation into effective ways to assess social accessibility. One key component of evaluation rests squarely on involving people with disabilities and soliciting their input as a cornerstone to determining success. If users cannot evaluate a technology as socially accessible, the evaluation should fail. Designers without disabilities do not have the experience to be able to assess what it might feel like to use a technology in a given social situation. At this point in time, the evaluation rubric isolates the “social accessibility” of a given technology to specific metrics, however, I would caution against using this as a metric for determining social accessibility, as I believe it is more nuanced than the tool can cover at this point.

The work presented in this dissertation is an initial attempt to define social accessibility and to apply it to design practice to create accessible technology designs. The outcomes of this work are positive, but I believe address complex human behaviors intertwined with technology use, and therefore will require continued improvement and scrutiny from diverse perspectives. It was difficult to account for the complex mix of socio-technical interactions, and even then, the ideas presented in this dissertation represent just one way of doing so. Indeed, incorporating social accessibility must emphasize human involvement and include a regard for diverse perspectives. Yet, social accessibility and diverse perspectives are not easily codified into a simple

recipe for design. People are messy, and human behavior is difficult—if not impossible—to predict, especially when it comes to socially relevant behaviors around technology use. Thus, one of the most challenging aspects of this work, that I think will continue to be difficult to achieve, will be to push back against developing a specific formula, and avoiding codifying social accessibility and over simplifying the value of users’ perspectives. Instead, I believe we can learn a lot from designers’ and users’ experiences, and that the essence of social accessibility should be to harness those perspectives in technology design. I believe one of the most valuable lessons that emerged from this work is the notion that accessible mainstream technology design *is* socially accessible design.

## 9.3 FUTURE WORK

### 9.3.1 *Limitations*

Although the workshops demonstrated that socially accessible design is achievable through Design for Social Accessibility, there were limitations to tools and methods that could not be addressed within the contrived workshop environment. For example, challenges that emerged from the design thinking course included issues where high-fidelity prototyping was inaccessible for users, obstructing user testing. These issues were out of scope of the workshops and so were not addressed. However, high-fidelity prototyping is often a key component of the design process, and the inaccessibility of both prototyping tools and their outputs would inhibit a successful design process. Design for Social Accessibility, as a design perspective, relies on the design process to be accessible to elicit appropriate feedback from users. In the workshops, designers did not create high-fidelity prototypes and so in that aspect, these issues were avoided. Low-fidelity prototyping, used without much issue in the design workshops, could be improved to be more accessible.

### 9.3.2 *Future Deployments and Research with Design for Social Accessibility*

The findings from this work indicate that social accessibility as a design property can be incorporated into the user-centered design process to create socially accessible technology designs. In particular, data from the workshops demonstrated that Design for Social Accessibility, as a guiding perspective and a set of techniques, was effective in (1) influencing designers to think about, and then elicit reflections on social factors in design, and (2) in using the framework and method cards to prompt awareness of how social situations influence or are influenced by technology use. However, workshops were limited in time and resources, and are a considerably contrived design scenario. Future work, therefore, should involve a longitudinal deployment of Design for Social Accessibility, where investigations focus on how designers apply concepts of social accessibility to address real-world design problems over time.

Additional improvements can also be made to the framework and method cards. An evaluation of how each might be used would also be areas for future work. What subtle changes or new inclusions in the framework might change the way that designers are guided to think about social factors in technology design? The scenarios included in the method cards were drawn from prior work, but the areas for possible consideration are limitless. What new method cards can be developed to increase awareness of different contexts of technology use that disabled users experience? Future work could also be conducted to determine a core set of scenarios that best represents common situations that people with disabilities might face, particularly with regard to specific design dimensions. For example, what are common issues that people might encounter when a device's output is loud enough for bystanders to hear?

### 9.3.3 *Refining the Evaluation Rubric*

Although the evaluation rubric was successful in eliciting assessments from users and designers along social and functional factors of technology design, more can be done to investigate evaluations for proximal delineations that were not addressed in the current version (public and intimate). Furthermore, like the method cards, the scenarios used in the evaluation rubric were drawn from prior work, as reported in chapters 3 and 4. Although results indicated that users and designers were able to relate to the scenarios offered (because they appropriately responded as feeling self-conscious or self-confident), future work could involve an investigation that explicitly looks at common scenarios that may better elicit the kinds of responses that the evaluation is seeking.

An evaluation would have to be done to determine how well the tool provides useful insights for a designer to be able to move forward. In addition, future work should examine best practices for deploying the rubric. Ideally, evaluation will involve a composite of responses from both a designer and a user. Also, although this study demonstrated that video prototypes were sufficient to allow designers to evaluate technologies, both designer and user evaluators should evaluate technologies in person as much as possible to ensure an accurate assessment.

### 9.3.4 *Shifting Perspectives*

Finally, a longitudinal study to determine how Design for Social Accessibility might change perspectives and attitudes over the long term should be conducted. This work is motivated by the current landscape of inaccessible technologies and the design practices that commonly assert inclusion is covered under the assumption that designers have empathy for users (Ludi, 2007; A. F. Newell & Gregor, 2000; Putnam, Dahman, Rose, Cheng, & Bradford, 2015; Waller et al., 2009). Unfortunately, the state of accessible technology design is underwhelming

when compared with the innovative opportunities currently facing the technical landscape. Can Design for Social Accessibility compel designers to pivot their current understanding of design toward social considerations in accessible design? A longitudinal exploration of the perspective promulgated by Design for Social Accessibility—that social factors in accessibility can be addressed in design in general—could answer these questions.

#### 9.4 CONTRIBUTIONS OF THIS DISSERTATION

My main goals for this dissertation are to define social accessibility as a property of design and to carve out a new design perspective, *Design for Social Accessibility*, to help achieve socially accessible design; to infuse Design for Social Accessibility in current design tasks that are usable by designers; to assess and verify that designers can apply Design for Social Accessibility in their work, and to verify that social accessibility can be evaluated along social and functional dimensions. A contribution of this dissertation is that it establishes a new perspective of what we consider accessible design, one that incorporates social and functional factors. Influenced by theories in Disability Studies and social sciences that the concept of disability can be socially constructed, even designed, and can influence our identities and how we present our social selves, this dissertation examines how we can move design thinking to incorporate social factors in accessible design through Design for Social Accessibility (Goffman, 1959; Linton, 1998). Outcomes of the design workshops designers can adopt perspectives in accessible design that are grounded in social and functional considerations. The contributions of this work are:

- (1) Empirical results showing that social aspects of use affect accessibility as much as functional ones, both of which should be considered in accessibility overall;

- (2) Conceptual work that defines *social accessibility* as a property of design and how it relates to and interacts with functional notions of accessibility, and *Design for Social Accessibility* as a new design perspective promoting socially accessible design;
- (3) Methodological work that defines and outlines *Design for Social Accessibility* as a perspective, a framework, and a set of method cards that can be used by designers;
- (4) Empirical work assessing the viability of *Design for Social Accessibility* as an applicable design perspective and evaluating the outcomes of methods infusing *Design for Social Accessibility*;
- (5) Methodological work that defines and verifies a Design for Social Accessibility Evaluation Rubric to assess the social accessibility of a given technology;
- (6) Empirical work assessing the viability of the Design for Social Accessibility Evaluation Rubric demonstrating that it elicits appropriate evaluations from users and designers along dimensions of social accessibility.

In addition to the research contributions listed, the Design for Social Accessibility Method Cards and Framework comprise a pragmatic contribution. As a set of tools, the method cards and framework can be used by designers to facilitate working with disabled users, and to augment their existing design practice.

## 9.5 CONCLUSION

In this dissertation, I show that social factors play a significant role in perceptions of assistive technologies, particularly in social and public situations; and that social accessibility, as a design property, is identifiable and can be addressed through design practice. Furthermore, I show that as a design property, technologies can be evaluated for how socially accessible they are. Although the assessment of whether a technology is socially accessible is ultimately a

combination of social and functional factors, it is also a subjective quality that must take into consideration the specific circumstances of personal preference and use.

Despite the functional capability of assistive technologies, misperceptions indicate that assistive technologies can “mark” users as outsiders, emphasizing that technology design has social value that increasingly influences how people feel when they use such devices. In this dissertation, I have shown how access is impeded by non-functional forces, such as feeling self-conscious or self-confident in social situations of use, that create access barriers regardless of how functionally capable an artifact is. I defined *social accessibility* as a property of design emphasizing both social and functional factors, and verified that *Design for Social Accessibility* is a viable design perspective informing design methods, influencing a change in view on design and disability for designers. Further, I have shown that technologies can be evaluated for social accessibility, the intersection of social contexts and specific design dimensions.

My work in this dissertation demonstrates that we have a responsibility as technology designers to shift our perspective on design overall, to see disability as diversity. As technology designers, we can, and we should, broaden our conception of design to improve access to participation in a social world for people with disabilities.

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## APPENDIX I. DESIGN PROMPT

### PROMPT

Leverage the capability of personal technologies, such as:

- Wearables (i.e., smartwatches, wearable fitness devices, smart glasses, headphones, smart clothing, smart jewelry, etc)
- Virtual/augmented reality (VR)
- Personal and on-body cameras
- and/or 3D printed objects,

to create an on-body artifact that augments the cruise ship experience for travelers where users are both visually impaired and not visually impaired and where elements of the experience covers:

- navigating all levels of the ship
- managing safety and emergency information and instructions
- supporting phone-free participation and engagement

and may also include but is not limited to:

- tracking passengers' onboard spending for meal plans or food/drink orders or dietary restrictions
- maintaining schedules for both on-ship and port activities
- facilitating communication with ship stewards, attendants and operators

## APPENDIX II. METHOD CARDS

### non-use

#### [awareness]

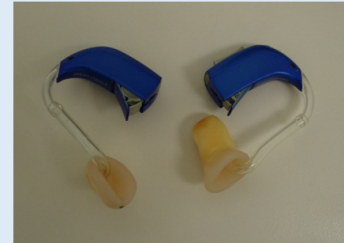
People may feel uncomfortable using personal technology around others, and may choose not to use a technology in some social situations.

#### Examples:

- Worrying that other people will notice hearing aids
- Feeling rude when a talking watch announces every hour

#### [perspective]

What are some social situations where using technology is unappealing or inappropriate? What about assistive technology, like hearing aids?



#### [design + reflect]

Consider how design is inappropriate or unappealing when used around others: Ask users when they choose not to use a device.

- When do they feel un/comfortable using technology?
- How does place or social situation (a party? at work?) contribute to how they feel?

\*Ask the above questions again, but about your design: when might users choose not to use your design?

### that awkward moment: interactions across social contexts

#### [awareness]

It can be hard to know the best way to interact with people with disabilities; *unfamiliar technology can be a barrier to social interactions.*

#### [perspective]

Think of a time when you saw a person with a disability navigating an obstacle, i.e., a person in a wheelchair having trouble opening a door.

#### Recall how you felt.

- Should someone have helped?
- Do you think they wanted help?
- How might you have approached to help them?



#### [design]

Consider your design:

- What social situations do you assume users to be in?
- How might your design contribute to or alleviate awkwardness?

#### [reflect]

Consider ways *design* creates challenging social interactions:

- You're talking with a woman and her hearing aid suddenly falls out mid-sentence.
- A person in a wheelchair is in before you in line, but doesn't move when the line does.

## audience: perceptions of “special” technologies

### [awareness]

*“Special” technologies used by people with disabilities may attract unwanted attention.*

For example, monocles (see back) allow people with low-vision to magnify text, like street signs.

### [perspective]

How are different technologies *perceived* in public places?

How might non-disabled people react to seeing a monocle used in an airport? What about the design of the monocle leads to such perceptions?



### [design + reflect]

1. Imagine using or seeing an assistive device, like a monocle or wheelchair in public.
2. Ask users what it's like to use assistive or mainstream devices in public. What are social interactions like?
3. Compare differences and similarities between your imagined scenario and users' descriptions.

What did you learn from the user? Did anything surprise you?

Did you make assumptions about technology use in social interactions? How can you ask about assumptions in the future?

## my professional life

### [awareness]

*People with disabilities use accommodations in their work that lead to different perceptions of ability or professionalism.*

Some devices include :

- Assistive computers and devices
- Assistive software
- Physical add-ons to existing equipment
- Extra time or space

### [perspective]

Ask users about accommodations they have seen or used in the workplace.

Ask users how the following professional values are important to them:

- Productivity
- Competence
- Teamwork



### [design]

Ask users how your design aligns with or doesn't align with their professional style.

### [reflect]

How do the values on the front of this card play into perceptions of coworkers in the following scenarios:

- In a meeting with respected colleagues, a coworker's phone loudly announces text messages.
- A coworker uses an assistive device to take notes and the bright orange headphones distracts others into asking about the technology.

## just like everyone else

### [awareness]

*Alternative accommodation does not always mean access is the same for people with disabilities.*

For example, sometimes there is only one accessible entrance to a large building and it is in the back.

### [perspective]

Consider how alternative accommodations might be used:

- Finding directions to a friend's house using Google Maps
- Using software to solve geometry or algebra problems
- Browsing an "accessible" version of a webpage versus "the original"



<http://adifferentkindofvision.blogspot.com/2015/03/braille-kit-for-ge-electric-range.html>

### [design]

Consider ways alternative uses of your design result in differences in access.

- Ask users to do the same task using your device in different ways (e.g., voice vs touch input). Are they able to accomplish the task? Are outcomes different?
- How can your design include different ways of doing the same things?

### [reflect]

Ask users to describe experiences when accommodation did not provide equal access, or if they used special accommodations to do the same thing as everyone else.

## APPENDIX III. ATTITUDES TOWARDS DISABLED PERSONS

### SCALES (ATDP-A)

Mark each statement in the left margin according to how much you agree or disagree with it. Please mark every one. Write +1, +2, +3: or -1, -2, -3: depending on how you feel in each case.

+3: I AGREE VERY MUCH

-1: I DISAGREE A LITTLE

+2: I AGREE PRETTY MUCH

-2: I DISAGREE PRETTY MUCH

+1: I AGREE A LITTLE

-3: I DISAGREE VERY MUCH

- \_\_\_\_\_ 1. Disabled people are often unfriendly.
- \_\_\_\_\_ 2. Disabled people should not have to compete for jobs with physically normal people.
- \_\_\_\_\_ 3. Disabled people are more emotional than other people.
- \_\_\_\_\_ 4. Most disabled persons are more self-conscious than other people.
- \_\_\_\_\_ 5. We should expect just as much from disabled as from nondisabled persons.
- \_\_\_\_\_ 6. Disabled workers cannot be as successful as other workers.
- \_\_\_\_\_ 7. Disabled people usually do not make much of a contribution to society.
- \_\_\_\_\_ 8. Most nondisabled people would not want to marry anyone who is physically disabled.
- \_\_\_\_\_ 9. Disabled people show as much enthusiasm as other people.
- \_\_\_\_\_ 10. Disabled persons are usually more sensitive than other people.
- \_\_\_\_\_ 11. Severely disabled persons are usually untidy.
- \_\_\_\_\_ 12. Most disabled people feel that they are as good as other people.
- \_\_\_\_\_ 13. The driving test given to a disabled person should be more severe than the one given to the nondisabled.
- \_\_\_\_\_ 14. Disabled people are usually sociable.
- \_\_\_\_\_ 15. Disabled persons usually are not as conscientious as physically normal persons.
- \_\_\_\_\_ 16. Severe disabled persons probably worry more about their health than those who have minor disabilities.
- \_\_\_\_\_ 17. Most disabled persons are not dissatisfied with themselves.
- \_\_\_\_\_ 18. There are more misfits among disabled persons than among nondisabled persons.
- \_\_\_\_\_ 19. Most disabled persons do not get discouraged easily.
- \_\_\_\_\_ 20. Most disabled persons resent physically normal people.
- \_\_\_\_\_ 21. Disabled children should compete with physically normal children.

- \_\_\_\_\_ 22. Most disabled persons can take care of themselves.
- \_\_\_\_\_ 23. It would be best if disabled persons would live and work with nondisabled persons.
- \_\_\_\_\_ 24. Most severely disabled people are just as ambitious as physically normal persons.
- \_\_\_\_\_ 25. Disabled people are just as self-confident as other people.
- \_\_\_\_\_ 26. Most disabled persons want more affection and praise than other people.
- \_\_\_\_\_ 27. Physically disabled persons are often less intelligent than nondisabled ones.
- \_\_\_\_\_ 28. Most disabled persons are different from nondisabled people.
- \_\_\_\_\_ 29. Disabled persons don't want any more sympathy than other people.
- \_\_\_\_\_ 30. The way disabled people act is irritating.

## SCORING THE ATDP

“The ATDP can be scored by hand or by computer. With either method, the first step is to change the sign of some of the items as listed below. Next, the sum of the changed items scores is obtained. The sign of this sum is then reversed, from negative to positive or positive to negative. The total scores can range from -60 to +60 on the twenty-item scale, Form O; and from -90 to +90 on the thirty-item scales, Forms A and B. To eliminate negative values, a constant of 60 is added to the score for Form O, and a constant of 90 is added on Forms A and B. The resulting theoretical range of scores is from 0 to 120 (Form O), or from 0 to 180 (Forms A and B). High scores relative to a specific group reflect positive, accepting attitudes; relatively low scores reflect negative, rejecting attitudes. (Yuker, 1988)

To summarize, scoring the ATDP involves four steps:

1) change the signs of the following items:

Form O: 2, 5, 6, 11, 12

Form A: 5, 9, 12, 14, 17, 19, 22, 23, 24, 25, 29

Form B: 1, 3, 4, 6, 7, 10, 12, 13, 22, 26, 28

2) Sum the scores, subtracting those with negative signs.

3) Change the sign of the sum.

4) Add 60 to the sum obtained for Form O, add 90 to the sum for Forms A and B.”

## APPENDIX IV. SOFTWARE DEVELOPERS' ATTITUDES TOWARD USER CENTERED DESIGN

\*I received the full version of this instrument from the original authors on March 16, 2016 (Frick et al., 2001). I include here a modified version that I incorporated with the ATDP (above). Designers were given a single survey that included an amalgam of the Software Developers' Attitudes survey and the Attitudes Towards Disabled Persons survey.

To the best of your knowledge or understanding, mark each statement in the left margin according to how much you agree or disagree with it. Please mark every one. Write +1, +2, +3: or -1, -2, -3: depending on how you feel in each case.

+3: I AGREE VERY MUCH

-3: I DISAGREE VERY MUCH

+2: I AGREE PRETTY MUCH

-2: I DISAGREE PRETTY MUCH

+1: I AGREE A LITTLE

-1: I DISAGREE A LITTLE

- \_\_\_ 1. Once I became involved with user-centered design activities, I changed my mind about what user-centered design is.
- \_\_\_ 2. After the first user test sessions I observed, I found that I had an altered view of my users.
- \_\_\_ 3. User test sessions usually do not give me new insights about my program.
- \_\_\_ 4. Participating in user test sessions was a positive experience.
- \_\_\_ 5. The user-centered design activities that I have participated in didn't generally add time to the product development cycle.
- \_\_\_ 6. It is important to conduct user test sessions many times throughout product development.
- \_\_\_ 7. In my opinion, user-centered design activities are worth the effort.
- \_\_\_ 8. Usability specialists are always pointing to "mistakes" of a program.
- \_\_\_ 9. The expense incurred by user-centered activities is offset by savings elsewhere in the development process or life-cycle of the product.
- \_\_\_ 10. I usually have confidence in the results of user test sessions.
- \_\_\_ 11. Usability specialists are usually interested in improving the overall quality of my program.
- \_\_\_ 12. In general, I would not recommend that other development teams spend effort on user-centered design activities.
- \_\_\_ 13. Overall, I don't enjoy participating in user testing sessions.
- \_\_\_ 14. Users in the test lab behave just the way I expected them to before I started attending user test sessions.

- \_\_\_15. Participating in user-centered design activities had little effect on my understanding of this discipline.
- \_\_\_16. User-centered design is more expensive than traditional product development.
- \_\_\_17. I usually learn a lot about my product as a result of user test sessions.
- \_\_\_18. My team's user-centered design activities tend to lengthen development time for our product.
- \_\_\_19. One user test session should be efficient for the development of most products.
- \_\_\_20. Even though user test sessions take extra work, it is worthwhile.
- \_\_\_21. Software developers should not rely on the results of user test sessions.
- \_\_\_22. In my development work, I find that the extra time it takes for user-centered design does not enhance my products.

## APPENDIX. V. EVALUATION RUBRIC

### TECHNOLOGY USERS

Below is the online version of the evaluation rubric for technology users.

Thank you for participating. In this survey, you will be asked about your experiences using your hand-held video magnifier. Throughout the survey, "Technology" refers to any hardware or software combination of your device.

Please answer the following questions based on your personal experiences with your technology.

**Question 1.** What is the brand and model of the technology you are evaluating? For example, "Humanware BrailleNote Apex, first generation"

**Question 2.** What do you mainly use this technology for?

**Question 3. About how long have you used this technology?**

**Question 4.** Drawing on your own experiences, imagine using this technology in situations like the following.

On a scale of 1 to 5, with 1 being self-conscious and 5 being confident, rate how you feel in general when you use this technology...

Rows

- To lead a meeting with coworkers.
- When it crashes or malfunctions while you lead a meeting with coworkers.
- To read the menu and make your order while with friends in a busy restaurant.
- To work in a coffee shop when suddenly an alarm or notification goes off.

1 (Self-conscious)

2

3 (Comfortable)

4

5 (Confident)

Using this technology's input does not affect my experience in this situation.

### **Input**

**Question 5.** Identify the sounds this technology makes when you input information into it. Select all that apply.

- Loud
- Soft
- Clangy
- Clicky
- Other:

**Question 6.** Gestures are motions required to use this technology, whether in front of a camera, typing on hard keys, or swiping on a track pad or touch screen.

What gestures do you typically use to input into this technology? Select all that apply.

- Large, sweeping gestures (for example, using mostly full arm)
- Medium gestures, moving hand from the wrist
- Small gestures, fine movement (for example, mostly using fingers, probably not moving the wrist a lot)
- Other:

**Question 7.** How do you hold or position this technology when inputting information into it? Select all that apply.

- Hand held- one hand
- Hand held - two hands
- Hold upright with hand(s)
- Hold flat or horizontal with hand(s)
- Lay flat on lap or table top
- Position with belt or lanyard against body
- Other:

**Question 8.** Alternate modes of input include voice, or external keyboards or other devices, etc. What alternate modes of input, if any, do you use with this technology? Select all that apply.

- External keyboard
- Voice Input
- Other:

**Question 9.** What kind of physical exertion is required to operate this technology? Select all that apply.

- Specific grasp or hold
- Lift
- Push (buttons, keys, or touch screen requires effort to push)
- None
- Other:

**Question 10.** Focusing on how you input into this technology, and drawing on your own experiences, imagine using the input interface in situations like the following.

On a scale of 1 to 5, with 1 being self-conscious and 5 being confident, rate how you feel using this technology's input interface...

Rows

- To lead a meeting with coworkers.
- When it crashes or malfunctions while you lead a meeting with coworkers.
- To read the menu and make your order while with friends in a busy restaurant.
- To work in a coffee shop when an alarm/notification goes off.

- 1 (Self-conscious)
- 2
- 3 (Comfortable)
- 4
- 5 (Confident)
- Using this technology's input does not affect my experience in this situation.

**Question 11.** In the previous scenarios, what about this technology, if anything, makes you feel self-conscious when you input information into it?

**Question 12.** In the previous scenarios, what about this technology, if anything, makes you feel confident when you input information into it?

### Output

**Question 13.** How does this technology output information to you?

Select all that apply.

- Lights
- Visual display - like a screen
- Visual display - text
- Visual display - images
- Silent mode or earbuds
- Sound - adjustable volume
- Sound - non-adjustable volume
- Sound - text-to-speech
- Sound - tones or beeps, no speech
- Tactile output - vibration
- Tactile output - Braille
- Tactile output - buttons, dials, or other hardware Other:

**Question 14.** What system notifications does this technology employ? Select all that apply.

- Loud beeps
- Flashing lights
- Vibrations
- Speech error messages
- Text error messages (on-screen)
- Other:

**Question 15.** Focusing on how this technology outputs information, and drawing on your own experiences, imagine interacting with the output interface in situations like the following.

On a scale of 1 to 5, with 1 being self-conscious and 5 being confident, rate how you feel interacting with this technology's output...

Rows

- To lead a meeting with coworkers.
  - When it crashes or malfunctions while you lead a meeting with coworkers.
  - To read the menu and make your order while with friends in a busy restaurant.
  - To work in a coffee shop when suddenly an alarm/notification goes off.
- 1 (Self-conscious)
  - 2
  - 3 (Comfortable)
  - 4
  - 5 (Confident)
  - Interacting with this technology's output does not affect my experience in this situation.

**Question 16.** In the previous scenarios, what about this technology, if anything, makes you feel self-conscious when you interact with its output?

**Question 17.** In the previous scenarios, what about this technology, if anything, makes you feel confident when you interact with its output?

### **Physical and Visual Appeal**

**Question 18.** In general, what is the visual design of this technology like?

Select all that apply.

- Black or mostly black
- Neutral colors
- Colorful
- Noticeable visual patterns
- Subtle visual patterns
- No visual patterns
- Smooth exterior texture
- Rough exterior texture
- Other:

**Question 19.** What is the size of this technology?

Select all that apply.

- Small - easily hand held, fits in jacket pocket
- Small - hand held, too large for jacket pocket
- Medium - hand held, fits on lap
- Medium - not quite hand held, requires lap or table top
- Large - longest side is 12 inches or more
- Large - it is barely portable, I only move it when I have to
- Other:

**Question 20.** What is the shape of this technology?

Select all that apply.

- Flat
- Square
- Rectangular
- Round
- Long
- Short
- Symmetrical
- Un-balanced (one side is heavier, wider, etc)
- Other:

**Question 21.** Focusing on the size and shape of this technology, and drawing on your own experiences, imagine using this technology in situations like the following.

On a scale of 1 to 5, with 1 being self-conscious and 5 being confident, rate how this technology's size and shape makes you feel when you use it...

Rows

- To lead a meeting with coworkers.
  - When it crashes or malfunctions while you lead a meeting with coworkers.
  - To read the menu and make your order while with friends in a busy restaurant.
  - To work in a coffee shop when suddenly an alarm/notification goes off.
- 1 (Self-conscious)
  - 2
  - 3 (Comfortable)
  - 4
  - 5 (Confident)
  - This technology's size and shape does not affect my experience in this situation.

**Question 22.** In the previous scenarios, what, if anything, about this technology's physical and visual appeal makes you feel self-conscious?

**Question 23.** In the previous scenarios, what, if anything, about this technology's physical and visual appeal makes you feel confident?

**Fit.**

**Question 24.** When out and about, how do you take this technology with you?

Select all that apply.

- Usually in my hands
- Usually in my pocket
- In a shoulder bag or purse
- In a backpack
- On my body, with a belt or strap
- I wear it on my head or shoulders
- I wear it on my wrist or arms
- Other:

**Question 25.** What user interface elements do you prefer to use on this technology?

Select all that apply.

- Buttons or controls - on side
- Buttons or controls - on the back
- Buttons or controls - on front
- Knobs or dials
- Headphone jack
- External speaker Touch Screen
- Other:

**Question 26.** What peripherals or connections do you use with this technology?

Select all that apply.

- Bluetooth
- Wi-fi
- Ethernet connection
- USB
- VGA, HDMI or other display
- Infrared
- None
- Other:

**Question 27.** Focusing on how this technology fits your personal preferences, and drawing on your own experiences, imagine using this technology in situations like the following.

On a scale of 1 to 5, with 1 being self-conscious and 5 being confident, rate how you feel this technology fits your preference...

Rows

- To lead a meeting with coworkers.
- When it crashes or malfunctions while you lead a meeting with coworkers.

- To read the menu and make your order while with friends in a busy restaurant.
- To work in a coffee shop when suddenly an alarm/notification goes off.

- 1 (Self-conscious)
- 2
- 3 (Comfortable)
- 4
- 5 (Confident)
- This technology's fit does not affect my experience in this situation.

**Question 28.** In the previous scenarios, what, if anything, about how this technology fits (or doesn't fit) your personal preferences when out and about makes you feel self-conscious?

**Question 29.** In the previous scenarios, what, if anything, about how this technology fits (or doesn't fit) your personal preferences when out and about makes you feel confident?

**Question 30.** Please enter your email address below so we may contact you with further details for compensation.

**Question 31.** What year were you born?

**Question 32.** What is your occupation?

## DESIGNERS

Below is the online version of the evaluation rubric for designers.

Thank you for participating. In this survey, you are evaluating a hand-held video magnifier.

This video magnifier is the SenseView Duo and it allows a user to magnify images or text. It has the following specifications:

Magnification of 2x to 13.4x (with distance camera)

Screen: 4.3" wide type LCD

Image capture and storage of up to 20 images

Color modes: full color, black/white, yellow/blue, yellow/black, blue/white

4 brightness levels

Battery: lithium polymer (rechargeable)

Battery duration: 4 hours continuous use

Dimensions: 17.8 cm x 8.7 cm x 2.8 cm (7" x 3" x 1.1")

Weight 261 g (0.57 lb)

Please familiarize yourself with the video magnifier's form and function with this quick video (watch with sound):

[video here]

Throughout this survey, "Technology" refers to any hardware or software combination of the Reader. Please answer the following questions based on your understanding of the technology's design and use.

(to access this video in a different tab or window, click here:

<https://www.youtube.com/embed/xvzrQeGHKdI?end=141>)

**Question 1.** In your own words, describe what this technology is used for.

**Question 2.** Drawing on your design experience and impression of this technology, imagine a person using this technology in situations like the following.

On a scale of 1 to 5, with 1 being self-conscious and 5 being confident, rate how a user might feel in general when using this technology...

Rows

- To lead a meeting with coworkers.
- When it crashes or malfunctions while leading a meeting with coworkers.
- To read the menu and make an order while with friends in a busy restaurant.
- To work in a coffee shop when suddenly an alarm or notification goes off.

- 1 (Self-conscious)
- 2
- 3 (Comfortable)
- 4
- 5 (Confident)
- Using this technology's input likely does not affect how the user feels in this situation.

**Question 3.** Identify the sounds this technology makes when the user inputs information into it.

Select all that apply.

- Loud
- Soft
- Clangy
- Clicky
- Other:

**Question 4.** Gestures are motions required to use this technology, whether in front of a camera, typing on hard keys, or swiping on a track pad or touch screen. What gestures are typically used to input into this technology? Select all that apply.

- Large, sweeping gestures (for example, using mostly full arm)
- Medium gestures, moving hand from the wrist
- Small gestures, fine movement (for example, mostly using fingers, probably not moving the wrist a lot)
- Other:

**Question 5.** How does a user hold or position this technology when inputting information into it? Select all that apply.


- Hand held- one hand
- Hand held - two hands
- Hold upright with hand(s)
- Hold flat or horizontal with hand(s)
- Lay flat on lap or table top
- Position with belt or lanyard against body
- Other:

**Question 6.** Alternate modes of input include voice, or external keyboards or other devices, etc. What alternate modes of input, if any, are used with this technology? Select all that apply.

- External keyboard
- Voice Input
- Other:

**Question 7.** What kind of physical exertion is required to operate this technology? Select all that apply.

- Specific grasp or hold

- Lift
- Push (buttons, keys, or touch screen requires effort to push)
- None
-   Other:

**Question 8.** Drawing on your understanding of the input functionality of this technology, and on your design experience, imagine a person using the input interface in situations like the following.

On a scale of 1 to 5, with 1 being self-conscious and 5 being confident, rate how a person might feel using this technology's input interface...

Rows


- To lead a meeting with coworkers.
  - When it crashes or malfunctions while leading a meeting with coworkers.
  - To read the menu and make an order while with friends in a busy restaurant.
  - To work in a coffee shop when an alarm/notification goes off.
- 1 (Self-conscious)
  - 2
  - 3 (Comfortable)
  - 4
  - 5 (Confident)
  - Using this technology's input likely does not affect how the user feels in this situation.

**Question 9.** In the previous scenarios, what about this technology, if anything, might make a user feel self-conscious when they input information into it?

**Question 10.** In the previous scenarios, what about this technology, if anything, might make a user feel confident when they input information into it?

## Output

**Question 11.** How does this technology output information? Select all that apply.

- Lights
- Visual display - like a screen
- Visual display - text
- Visual display - images
- Silent mode or earbuds
- Sound - adjustable volume
- Sound - non-adjustable volume
- Sound - text-to-speech
- Sound - tones or beeps, no speech
- Tactile output - vibration
- Tactile output - Braille
- Tactile output - buttons, dials, or other hardware
-   Other:

**Question 12.** What system notifications does this technology employ?  
Select all that apply.

- Loud beeps
- Flashing lights
- Vibrations
- Speech messages
- Text messages (on-screen)
- Other:

**Question 13.** Focusing on how this technology outputs information, and drawing on your design experience, imagine a person interacting with the technology output in situations like the following.

On a scale of 1 to 5, with 1 being self-conscious and 5 being confident, rate how a person might feel interacting with this technology's output...

Rows

- To lead a meeting with coworkers.
  - When it crashes or malfunctions while leading a meeting with coworkers.
  - To read the menu and make an order while with friends in a busy restaurant.
  - To work in a coffee shop when suddenly an alarm/notification goes off.
- 1 (Self-conscious)
  - 2
  - 3 (Comfortable)
  - 4
  - 5 (Confident)
  - Interacting with this technology's output likely does not affect how the user feels in this situation.

**Question 14.** In the previous scenarios, what about this technology, if anything, might make a user feel self-conscious when they interact with its output?

**Question 15.** In the previous scenarios, what about this technology, if anything, might make a user feel confident when they interact with its output?

### **Physical and Visual Appeal**

**Question 16.** In general, what is the visual design of this technology like? Select all that apply.

- Black or mostly black
- Neutral colors
- Colorful
- Noticeable visual patterns
- Subtle visual patterns
- No visual patterns
- Smooth exterior texture
- Rough exterior texture
- Other:

**Question 17.** What is the size of this technology? Select all that apply.

- Small - easily hand held, fits in jacket pocket
- Small - hand held, too large for jacket pocket
- Medium - hand held, fits on lap
- Medium - not quite hand held, requires lap or table top
- Large - longest side is 12 inches or more
- Large - it is barely portable, I only move it when I have to
- Other:

**Question 18.** What is the shape of this technology? Select all that apply.

- Flat
- Square
- Rectangular
- Round
- Long
- Short
- Symmetrical
- Un-balanced (one side is heavier, wider, etc)
- Other:

**Question 19.** Focusing on the size and shape of this technology, and drawing on your design experience, imagine a person using this technology in situations like the following.

On a scale of 1 to 5, with 1 being self-conscious and 5 being confident, rate how this technology's size and shape might make a person feel when they use it...

Rows

- To lead a meeting with coworkers.
  - When it crashes or malfunctions while leading a meeting with coworkers.
  - To read the menu and make an order while with friends in a busy restaurant.
  - To work in a coffee shop when suddenly an alarm/notification goes off.
- 1 (Self-conscious)
  - 2
  - 3 (Comfortable)
  - 4
  - 5 (Confident)
  -

This technology's size and shape likely does not affect how the user feels in this situation.

**Question 20.** In the previous scenarios, what, if anything, about this technology's physical and visual appeal might make a user feel self-conscious?

**Question 21.** In the previous scenarios, what, if anything, about this technology's physical and visual appeal might make a user feel confident?

**Fit.**

**Question 22.** When out and about, how does a user take this technology with them? Select all that apply.

- Carry it their hands
- In their pocket
- In a shoulder bag or purse
- In a backpack
- On the body, with a belt or strap
- On their head or shoulders
- Wear it on their wrist or arms
- Other:

**Question 23.** What user interface elements are on this technology? Select all that apply.

- Buttons or controls - on side
- Buttons or controls - on the back
- Buttons or controls - on front
- Knobs or dials
- Headphone jack
- External speaker
- Touch Screen
- Other:

**Question 24.** To your knowledge, what peripherals or connections are available with this technology? Select all that apply.

- Bluetooth
- Wi-fi
- Ethernet connection
- USB
- VGA, HDMI or other display
- Infrared
- None
- Other:

**Question 25.** Focusing on how this technology fits your understanding of typical user preferences, and drawing on your design experience, imagine a person using this technology in situations like the following.

On a scale of 1 to 5, with 1 being self-conscious and 5 being confident, rate how a user might feel this technology fits personal preference...

## Rows

- To lead a meeting with coworkers.
  - When it crashes or malfunctions while leading a meeting with coworkers.
  - To read the menu and make an order while with friends in a busy restaurant.
  - To work in a coffee shop when suddenly an alarm/notification goes off.
- 1 (Self-conscious)
  - 2
  - 3 (Comfortable)
  - 4
  - 5 (Confident)
  - This technology's fit likely does not affect how a user feels in this situation.

**Question 26.** In the previous scenarios, what, if anything, about how this technology fits user preference might make a user feel self-conscious?

**Question 27.** In the previous scenarios, what, if anything, about how this technology fits user preference might make a user feel confident?

**Question 28.** Please enter your email address below so we may contact you with further details for compensation.

**Question 29.** What year were you born?

**Question 30.** What is your occupation