# Incorporating Social Factors in Accessible Design

**Kristen Shinohara[1], Jacob O. Wobbrock[2], Wanda Pratt[2]**

[1]B. Thomas Golisano College of Computing & Information Sciences
Rochester Institute of Technology
Rochester, NY, USA 14623
kristen.shinohara@rit.edu

[2]The Information School
DUB Group
University of Washington
Seattle, WA, USA 98195-2840
{wobbrock, wpratt}@uw.edu

## ABSTRACT

Personal technologies are rarely designed to be accessible to disabled people, partly due to the perceived challenge of including disability in design. Through design workshops, we addressed this challenge by infusing user-centered design activities with Design for Social Accessibility—a perspective emphasizing social aspects of accessibility—to investigate how professional designers can leverage social factors to include accessibility in design. We focused on how professional designers incorporated Design for Social Accessibility's three tenets: (1) to work with users *with* and *without* visual impairments; (2) to consider *social* and functional factors; (3) to employ tools—a framework and method cards—to raise awareness and prompt reflection on social aspects toward accessible design. We then interviewed designers about their workshop experiences. We found DSA to be an effective set of tools and strategies incorporating social/functional and non/disabled perspectives that helped designers create accessible design.

## CCS Concepts

• **Human-centered computing~Accessibility design and evaluation methods** • Human-centered computing~User centered design

## Author Keywords

Design workshops, accessibility, user-centered design.

## INTRODUCTION

People with disabilities rely on the accessibility of a technology to be able to use it. Yet, many mainstream personal technologies are not readily accessible to people with disabilities without additional accommodation. Accessibility research offers several approaches to promote inclusive design [19,23,28,35,36], and popular user interface and user experience (UI/UX) design approaches rely on "user-centered" strategies to include disabled users to achieve accessible design [27]. Although research demonstrates the value of designing accessible technologies for people with disabilities [23], the lack of accessible personal technologies on the market indicates that few working designers include disabled users in everyday practice. Despite efforts in the research domain to improve accessible design [24,35,36], influencing designers' actual practice remains challenging [13,32].

**Figure 1.** A professional designer (center) brainstorms with two users, one with a visual impairment (left) and one without (right).

Design for Social Accessibility (DSA) is one approach that targets how designers address accessible design by focusing on social and functional factors [28,31]. Prior research developing DSA found that engaging multiple disabled and nondisabled users and emphasizing social aspects of design helped student designers align with diverse needs [28,29,30,31]. In this study, we extended prior work and developed a framework and set of method cards to investigate how professional designers, rather than students, incorporate DSA to create accessible design. We asked: How effective is DSA in helping professional designers (1) include social factors to create accessible designs, and (2) work with multiple non/disabled users? We also sought to learn from professional designers' experiences, as opposed to students, and asked: what key considerations do designers make when tackling social factors in accessible design?

We conducted workshops infusing user-centered design (UCD) with DSA [28,29] to examine if incorporating social factors and multiple perspectives helped professional designers include accessibility in their design work (Figure 1). We scaffolded workshop activities with DSA's three tenets: (1) design for disability should include disabled and nondisabled users [29]; (2) design should address social *and*



*ASSETS '18,* October 22–24, 2018, Galway, Ireland
© 2018 Association for Computing Machinery.
ACM ISBN 978-1-4503-5650-3/18/10…$15.00
https://doi.org/10.1145/3234695.3236346

*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*

As shown above, visually impaired users educated sighted participants on experiences of disability. V3 also described how her technologies worked so that the sighted user and designer could understand designs she referenced:

*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*

Visually impaired users were disability and accessibility experts, supplying knowledge about accessible technologies. Next, we show how these contributions shaped discussions of social issues. It is unclear how scalable it is to leverage users' knowledge. It is possible to envision users eventually experiencing fatigue as the source of such information.

### Social Consideration Creates Space for Duality

Centering colocated discussions on social contexts of use helped participants align social preferences and identify a "duality" (as S5 called it, below) in the design itself—aspects where a design could be usable and appealing for both users. Workshop 5 participants narrowed the design form factor, choosing between a headband and watch:

*V5:…I don't know of anybody would really wanna always like have a headband on–*

*D5: yeah (laughs)*

*V5: or something like that, yeah.*

*D5: a watch or—what do you think?*

*S5: I think the watch would probably be good and then for a person who is—like has normal sight a watch would still be like, oh I can check the time, and blah blah blah blah blah, so you can still input like visual—like, uh, like for the able bodied people, right? …Um, and so like I think that provides a little more space for duality, so that not only allows him to find value from it, but also, um, a non-sight impaired person to find value from it, right? And so like, if he, if it's a watch that has a like a Bluetooth headset connected to it, then, um, I think like there's value for him there. And then there's also value for me in the actual watch as well, I guess. Does that make sense?*

*D5: Um hm. So, we talked about making this just like everyone else, and so if—what else would the watch come with?*

*S5: probably tells the time (laughs)*

*D5: Well for you to be able to hear the things that you need to navigate the cruise. Like we said that has to—does that have to come with an earbud?*

*V5: No, because you could just connect to using Bluetooth, that's another way that you could make it more normal or whatever. –Workshop 5, Task 2*

As S5 commented, discussing social aspects of use "provides a little more space for duality" so that both visually impaired and sighted users "find value from it." We interpret "duality" as broadening form factor, capability and peripherals to accommodate more than visual impairment, but also the overall cruise experience. In this case, participants zeroed in on Bluetooth as a way to "make it more normal" because the technology is commonly used for personal audio, but it could also be used to make navigation directions accessible.

Similarly, D4 asked, "do we want to have a display?" prompting debate on social aspects of accessible navigation:

*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?*

*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. –Workshop 4, Task 2*

D4 identified a tradeoff between providing information through audio cues and the ability to hear ambient noises. Eventually, V4 validated the tradeoff for access:

*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… Cause the thing 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 2*

Above, participants' discussion led to access made on assumptions of the abilities of blind people, *i.e.*, V4 raised and debunked the myth that, "people think blind people have perfect hearing, and we don't." The mix of issues—social, functional, disabled, nondisabled—led them to recognize the need to access ambient sound and navigation information.

These examples show how questions about social and functional situations prompted discussions that yielded creative ideas to address the "duality" of accessible design. Thus, we observed that prioritizing social factors did not seem to take away from moving toward a viable solution. The focus on social aspects also did not inhibit discussions about functionality. Instead, participants shifted focus toward functional solutions that adhered to their social preferences (*i.e.*, wrist watch form factor and Bluetooth technology). Next, we show how the designers' ability to elicit and balance responses from both users contributed to productive and open-minded ideation.

### How Designers Balance User Voices

Working with two users influenced interpersonal dynamics and, consequently, the design process itself. Designers were surprised that working with two users enabled them to work quickly. D4 contrasted 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*

Designers noted the immediacy with which they exchanged ideas made the difference in addressing details. Below, D3 began with a question about options, and the discussion evolved to preferences for similar functionality (Figure 7).

**Figure 7.** D3 confers with both users during brainstorming.

*D3: So,… 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 [activate] 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 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… 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 above example demonstrates how quickly colocation aided ideation, often with a single prompt from the designer. Such prompts also guided users to reflect and progress ideas:

*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…*

*G: I don't know how feasible this would be, but considering the weight of a kiosk, but have you guys ever seen those desks that you could just like rise and if the kiosk itself were like on a rising or swivel-out thing, I think …probably figuring out where to grab, like maybe you could have some ridges or something. –Workshop 1, Task 1*

D1 clarified S1's thinking, rephrasing what S1 said as "tactile feedback." S1 reflected with, "I feel like that could get annoying…" Returning the idea as tactile feedback gave S1 a chance to debate different aspects of using that mode. The conversation led V1 to propose the screen as adjustable, not just requiring users to match its placement.

Colocation also provided an opportunity for designers to balance complex multiple perspectives at the intersection of accessible design in real-time. Visually impaired users were likely to comment on navigation issues as a key concern, and various voice and touch interactions were discussed. Sighted users were likely to admit they were not keen on voice commands, accessing information by touch and sight was sufficient. Ideas bounced back and forth quickly between users, providing insights into what worked (or did not work) for visually-impaired users versus what worked (or did not work) for sighted users. Designers managed both viewpoints by switching focus on *ideas* as they were discussed.

*S2: 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. (to V2) 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*

D2's line of questioning emerged as a response to S2's explanation that using a map was convenient. In his interview, D2 reflected why he sought both views: "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 prompted ideas from both and sought clarity about how maps are difficult (why voice input is useful for V2). Thus, for their part, designers solicited perspectives to inform a central idea.

Designers admitted that the ability for users to get along was key in eliciting useful information. We observed a genial tone between participants, such as when users volunteered preferences, and conversed without designer interference. D2 expressed a concern that one user might dominate:

*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*

D5's take on how user interactions evolved in the workshop aligns with D2's perspective:

*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. –D5, Interview*

The ability for users to get along was key for designers to engage ideas. Those recruited for the study may have been characteristically genial and assertive; still, we observed that respectful interactions made for productive discussions. The presence of both users resulted in more than the sum of their perspectives as designers learned from users' interactions.

### How Designers Situated Experiences in Workshops

We interviewed designers to situate their professional roles in their workshop experience. We recruited designers who did not specialize in accessibility, though some encountered accessibility in their work (D2, D3, D4 reported addressing accessibility only for legal reasons). Designers reported little experience working with disabled users and that focusing on accessibility was seen as distracting from their priorities. Despite limited exposure to disability and accessibility, and some initial apprehension about working with multiple users in the given time, interviews revealed that designers felt comfortable with design tasks and showed how their thinking about accessible design evolved.

Designers initially did not feel confident in their ability to manage multiple users at once. For example, D5 reflected:

*…the design task was not uncomfortable. Yeah. Um, I think being exposed to both the physically disabled and non-physically disabled people working together has improved my perception of design with disabilities… it was comfortable, like being in the same room, definitely. But in terms of facilitating. I wasn't sure if I was comfortable or not. But that's probably just on me. –D5, Interview*

While design tasks were not daunting, constraints like time and multiple users at first seemed challenging to designers.

*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*

When asked if it was useful to work with two users, designers reflected on how working with visually impaired and sighted users helped ensure perspectives from both were 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*

We view these reflections as validating the design prompt and process, specifically working with both users, because it shows how designers engaged each concept.

## DISCUSSION

Our findings show that infusing user-centered design (UCD) with Design for Social Accessibility (DSA) helped designers engage reflective discussions with visually impaired and sighted users on socially accessible aspects of design. Such

discussions elicited more than the sum of individual perspectives, helping designers incorporate accessibility.

### Social Perspectives Benefit Design Process

Through the lens of the first DSA tenet—examining how designers worked with visually impaired and sighted users—we observed that colocation was effective in helping designers elicit discussions on sensitive social and functional access issues. These discussions expedited the process, allowing "a best candidate to emerge more rapidly," as D4 mentioned [23,29,36]. Through the lenses of the second and third DSA tenets—analyzing how designers included social factors and used the DSA framework and method cards—we found that leveraging these tools for social accessibility enabled designers to reflect on multiple perspectives (disabled, nondisabled, social, functional) while engaging the project domain spaces (personal technology use in shared social spaces, *i.e.*, the cruise ship) [6,22]. 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," *i.e.*, the intersection of ideas from *both* users was necessary to find solutions that worked for both users. Conversations at the intersection of non/disabled users and social/functional considerations provided "a little space for duality," as S5 called it. We interpret duality as a domain space emerging at the intersection of disabled *and* nondisabled users and social *and* functional needs. Thus, these strategies and tools eased accessible design by revealing new design opportunities arising from intersecting perspectives. We compare these findings with related work emphasizing empathy [24]: we agree that empathy is key to inclusive design, and effort should also be made to highlight intersecting perspectives (disabled and nondisabled) and design dimensions (social and functional) toward broadening the design domain space.

### Toward Socially Accessible Design

Designers in our study recognized disability as important in design, yet their everyday practice excluded disabled users. Thus, the skill and knowledge that "constitute the rigor and discipline" for these designers were quite without an accessibility or disability component [32]. Still, as observed in how D1 drew on her experiences using the framework, DSA helped the designers "prepare-for-action," *i.e.*, was not prescriptive, but leveraged designer autonomy and expertise *within* their current design processes [32]. In contrast to challenges faced by students in a design course [29], the professional designers in this study reported feeling comfortable with the design prompt and incorporating DSA, despite having little prior experience working with disabled users. Designers created paper mockups that were evaluated by users as meeting needs, while tackling complex issues (social/functional and non/disabled perspectives). Thus, we argue that infusing UCD with DSA aligned with the designers' expertise, bridging the gap from existing practice to new ways of thinking with tools for accessible design [32]. We outline implications for design practice that emerged:

- The barrier to working with visually impaired users is not so high. Our inquiry showed designers developed accessible solutions for both users even with limited prior experience. We infer that increasing knowledge, awareness and experience—even in small ways, *i.e.*, including visually impaired and sighted users—can improve accessible design.
- Designers' professional expertise enabled them to adapt to work with visually impaired and sighted users quickly: They invoked their preferred techniques while guiding users through complex design considerations.
- Designers do not have to be "accessibility specialists" to include disability in design. Designers ran into some technical unknowns (*e.g.*, some did not know the iPhone is accessible via VoiceOver), but this limitation did not prevent them from creating an accessible solution. Initial lack of technical accessibility knowledge is thus not necessarily a barrier to accessible design, provided an "expert user" with a disability is present.

Given these implications, our study shows that DSA can be used to help designers to create accessible designs.

### Study Limitations

We refrain from making claims that DSA is better than other approaches for accessible design, as our study design was not comparative. Our investigation is limited as a contrived workshop, not a real-world setting. However, our goal was to investigate how including accessibility in the design process might manifest for designers. Our choice to employ a small number of in-depth workshops allowed for a rich dataset, in lieu of a large survey. Future work could involve a comparison of survey results with our findings here.

## CONCLUSION

Changing the culture and practice of design to include disabled users is one way to improve design [6,7,13,37]. We examined how infusing user-centered design techniques with Design for Social Accessibility helped designers incorporate accessibility. We showed that including visually-impaired *and* sighted users, and considering social and functional factors, helped designers envision a new domain space and creative solutions usable and appealing to disabled and nondisabled users. Accessible design is not an impossible challenge; instead, is within reach for professional designers, if given appropriate tools and resources. We offer Design for Social Accessibility as one such tool that designers can use to include disabled and nondisabled users and complex social and functional consideration toward accessible solutions.

## ACKNOWLEDGMENTS

This work was supported in part by the National Science Foundation under IIS-1217627, SES-1230435, IIS-0952786 and the University of Washington Harlan Hahn Award. We thank David Hendry for his early feedback on this work.

## REFERENCES


1. Jane Bringolf. 2008. Universal design: is it accessible? *Multi: The Journal of Plurality and Diversity in Design* 1, 2.
2. Julian Brinkley, Brianna Posadas, Julia Woodward, and Juan E. Gilbert. 2017. Opinions and Preferences of Blind and Low Vision Consumers Regarding Self-Driving Vehicles: Results of Focus Group Discussions. In *Proc. ASSETS '17*, 290–299.
3. Tim Brown. 2008. Design Thinking. *Harvard business review* 86, 6: 84–92.
4. Sheryl Burgstahler. 2015. *Universal design in higher education: from principles to practice*. Cambridge, Massachusetts : Harvard Education Press, Cambridge, Massachusetts.
5. Betty Rose Connell, Mike Jones, Ron Mace, Jim Mueller, Abir Mullick, Elaine Ostroff, Jon Sanford, Ed Steinfeld, Molly Story, and Gregg Vanderheiden. 1997. The Principles of Universal Design. Retrieved from https://www.ncsu.edu/ncsu/design/cud/about_ud/udprinciplestext.htm
6. Nigel Cross. 1982. Designerly ways of knowing. *Special Issue Design Education* 3, 4: 221–227. https://doi.org/10.1016/0142-694X(82)90040-0
7. Nigel Cross. 2011. *Design thinking : understanding how designers think and work*. Berg, Oxford; New York.
8. Lennard Davis. 2010. Constructing Normalcy. In *The Disability Studies Reader* (Third Edition). Taylor & Francis, 3–19.
9. Jason Dearen. 2018. Driverless cars give hope to blind - are automakers onboard? *Sacramento Bee*. Retrieved April 17, 2018 from http://www.sacbee.com/news/article208779379.html
10. Elizabeth DePoy and Stephen Gilson. 2014. *Branding and designing disability: reconceptualising disability studies*. Abingdon, Oxon : Routledge.
11. Barney G. Glaser and Anselm L. Strauss. 1967. *The Discovery of Grounded Theory*. Aldine Publishing Co, Chicago, IL.
12. Erving Goffman. 1963. *Stigma*. Englewood Cliffs, N.J., Prentice-Hall, Englewood Cliffs, N.J.
13. Elizabeth Goodman, Erik Stolterman, and Ron Wakkary. 2011. Understanding interaction design practices. In *Proc CHI '11*, 1061–1070.
14. John D. Gould and Clayton Lewis. 1985. Designing for usability: Key principles and what designers think. *CACM* 28, 3: 300–311.
15. Joan M. Greenbaum and Morten Kyng. 1991. *Design at work: cooperative design of computer systems*. Erlbaum Assoc., Hillsdale, N.J.
16. Maya Haynes. 2015. Use Your Head! Microsoft's HoloLens. *Aidis Trust Blog*. Retrieved from http://blog.aidis.org/use-your-head-microsofts-hololens
17. Cliff Kuang. 2016. Microsoft's Radical Bet on a New Type of Design Thinking. *The Big Idea*. Retrieved September 11, 2016 from https://www.fastcodesign.com/3054927/the-big-idea/microsofts-inspiring-bet-on-a-radical-new-type-of-design-thinking
18. L. Tonin, T. Carlson, R. Leeb, and J. del R. Millán. 2011. Brain-controlled telepresence robot by motor-disabled people. In *2011 Annual International Conference of the IEEE Engineering in Medicine and Biology Society*, 4227–4230. https://doi.org/10.1109/IEMBS.2011.6091049
19. Richard E. Ladner. 2015. Design for user empowerment. *interactions* 22, 2: 24–29.
20. Selena Larson. 2016. How Pokemon Go is creating a barrier for gamers with disabilities. *The Daily Dot Debug*. Retrieved September 11, 2016 from http://www.dailydot.com/debug/pokemon-go-disabilities-problematic/
21. Matthew B. Miles and A. M. Huberman. 1994. *Qualitative data analysis: an expanded sourcebook*. Sage Publications, Thousand Oaks.
22. Harold G Nelson and Erik Stolterman. 2012. *The design way: intentional change in an unpredictable world*. MIT Press, Cambridge, Massachusetts.
23. Alan Newell, P Gregor, M Morgan, Graham Pullin, and C Macaulay. 2011. User-Sensitive Inclusive Design. *Universal Access in the Information Society* 10, 3: 235–243.
24. Alan Newell, P Gregor, M Morgan, Graham Pullin, and C Macaulay. 2011. User-Sensitive Inclusive Design. *Universal Access in the Information Society* 10, 3: 235–243.
25. John Potts and John Scannell. 2013. *The unacceptable*. Palgrave Macmillan, Houndmills, Basingstoke, Hampshire.
26. Roland Reznik. Disability Advocates See Opportunity in Self Driving Cars. *Smart Chair*. Retrieved September 11, 2016 from http://kdsmartchair.com/blogs/news/110637830-disability-advocates-see-opportunity-in-self-driving-cars
27. Helen Sharp, Yvonne Rogers, and Jenny Preece. 2007. *Interaction design: beyond human-computer interaction*. Wiley, NJ.
28. Kristen Shinohara, Cynthia L. Bennett, Wanda Pratt, and Jacob O. Wobbrock. 2018. Tenets for Social Accessibility: Towards Humanizing Disabled People in Design. *ACM Transactions on Accessible Computing (TACCESS)* 11, 1: 1–31.
29. Kristen Shinohara, Cynthia L. Bennett, and Jacob O. Wobbrock. 2016. How Designing for People With and Without Disabilities Shapes Student Design Thinking. In *Proc. ASSETS '16.*, 229–237.
30. Kristen Shinohara and Jacob O. Wobbrock. 2011. In the shadow of misperception: Assistive technology use and social interactions. In *Proc. CHI '11*, 705–714.
31. Kristen Shinohara and Jacob O. Wobbrock. 2016. Self-Conscious or Self-Confident? A Diary Study

Conceptualizing the Social Accessibility of Assistive Technology. *ACM Transactions on Accessible Computing (TACCESS)* 8, 2: 1–31.
32. Erik Stolterman. 2008. The Nature of Design Practice and Implications for Interaction Design Research. *International Journal of Design* 2, 1: 55–65.
33. Katherine M. Tsui, Munjal Desai, Holly A. Yanco, and Chris Uhlik. 2011. Exploring use cases for telepresence robots. In *Proceedings of the 6th international conference on Human-robot interaction*, 11–18.
34. Chris Urmson. 2015. Green lights for our self-driving vehicle prototypes. *Google Blog*. Retrieved September 11, 2016 from https://googleblog.blogspot.com/2015/05/self-driving-vehicle-prototypes-on-road.html
35. Jacob O. Wobbrock, Krzysztof Z. Gajos, Shaun K. Kane, and Gregg C. Vanderheiden. 2018. Ability-based design. *Communnications of the ACM* 61, 6: 62–71.
36. Jacob O. Wobbrock, Shaun K. Kane, Krzysztof Z. Gajos, Susumu Harada, and Jon Froehlich. 2011. Ability-based design: Concept, principles, and examples. *ACM Transactions on Accessible Computing (TACCESS)* 3, 3: 1–27.
37. Xiao Zhang and Ron Wakkary. 2014. Understanding the role of designers' personal experiences in interaction design practice. In *Proc. DIS '14*, 895–904.