Designing for Collaborative Content Creation for People with Vision Impairments

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ABSTRACT

My work contributes to developing a comprehensive understanding of how people with vision impairments perform collaborative work with their sighted colleagues through the study of two diverse contexts – collaborative writing and collaborative making. Building on the insights gathered from my ethnographic field observations and interviews, I design, build and evaluate new systems to better support accessibility in groupwork. By critically reflecting on the ways in which accessibility is negotiated through interpersonal relations and organizational structures, my research informs the design of collaborative technology that can support interdependent, co-creative practices in ability-diverse teams.

INTRODUCTION

In recent days, diversity and inclusion initiatives have garnered much public and scholarly attention, with a strong call to action to create and sustain employment and education opportunities for people with disabilities. In reality, though, a huge disparity still remains in educational and career prospects for people with disabilities. As of 2017, only 37% of 20.5 million

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ACM CCS CONCEPTS
•Human-centered computing ~Accessibility
•Human-centered computing ~Collaborative and social computing

KEYWORDS

Accessibility; vision impairments; ability-diverse teams; collaborative writing; collaborative making

RESEARCH QUESTIONS

RQ1. How is accessibility negotiated and sustained in ability-diverse teams?

RQ2a. How might we design interactive technologies to support collaborative content production in ability-diverse teams, particularly teams comprised of blind and sighted individuals?

RQ2b. How might new interactive technologies impact collaborative work practices, shared norms and dynamics within ability-diverse teams?

American adults with disabilities have employment, compared to 77% of those without disabilities [1]. The lack of accessible tools for content production and collaboration is likely to further contribute to this disparity, given that collaborative tools are pervasively used in academic and professional settings nowadays [17, 20]. Since most workplaces are predominantly able-bodied, navigating inaccessible collaborative tools and team practices gets increasingly complicated for people with disabilities [7, 10].

In my PhD research, I study and design for *accessible collaborative content production*, with a specific focus on collaboration between people with and without vision impairments. To develop a holistic understanding of accessibility in collaborative content production, I investigate two diverse yet complementary contexts that are relatively unexplored in the large and growing literature on ability-diverse collaboration (e.g., [4, 7, 8, 16, 19, 21, 26]). First, I focus on *collaborative writing* in professional settings where writing activities of blind and sighted colleagues (e.g., editing a shared document, exchanging feedback on drafts) are distributed across time and space and performed remotely using digital writing tools (e.g., Microsoft Word, Google Docs). The second aspect of my work explores co-located collaboration in a creative making context, specifically *collaborative weaving* where blind weavers and sighted instructors work together in a community weaving studio to produce hand-woven products using physical materials and tools (e.g., loom, shuttle, yarns). In both contexts, my work first investigates the way people with vision impairments interact with the digital and material tools and their sighted collaborators to co-create an accessible space for producing shared content. Second, leveraging insights from these current practices, I design interactive non-visual technologies to support accessible collaboration and investigate how these technologies may initiate changes in ability-diverse team practices. By studying these two contexts that are diverse in terms of location, tools, scope, and organizational milieu, my work will uncover rich nuances of ability-diverse collaboration that can manifest in and have implications for other forms of collaborative work such as programming, brainstorming, drawing, crafting and so on.

RESEARCH APPROACH AND METHODS

I draw from literature in Computer-Supported Collaborative Work (CSCW), Human-Computer Interaction (HCI), assistive technology, and critical disability studies to inform my work. Over the years, a significant body of CSCW and HCI research has studied the ways people produce shared content, exchange feedback and interact with each other using collaborative tools [5, 17, 20, 23], and designed new systems to support these collaboration practices [18, 23, 24]. Yet, many questions remain around the accessibility of these systems for teams with diverse visual abilities. To address these questions, I take a multi-stage approach that includes qualitative methods (e.g., contextual interviews, ethnographic field observations) and system design and evaluation through controlled experiments as well as design-oriented methodologies (e.g., research through design [25]). Through qualitative and critical analyses of interview and observation data and quantitative examination of experimental user evaluation data, my work contributes to both theoretical and

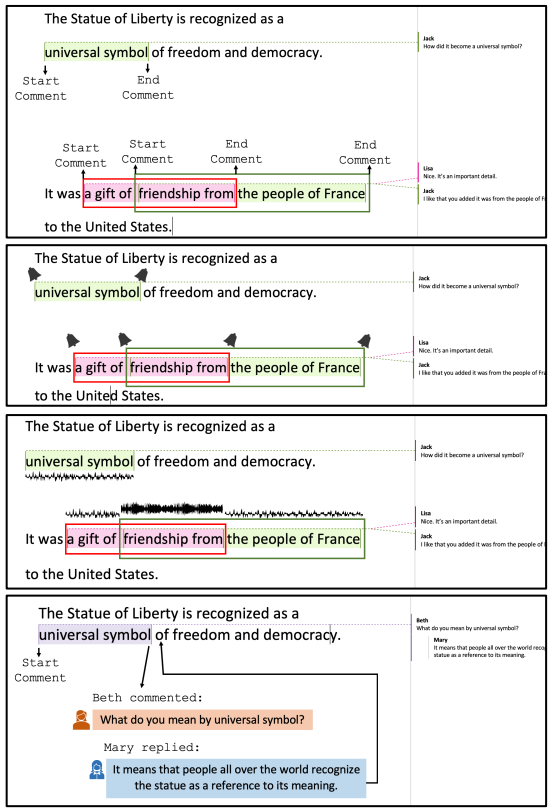

Figure 1: Auditory representations of comments are shown for a passage with three comments (second and third comments are overlapping with each other). From the top: 1) default technique: screen reader spoken announcements (i.e., 'start comment' and 'end comment') indicate the starting and ending of a comment, 2) earcons: two short-lived tones (denoted by bell icons slanted left and right) represent the starting and ending of a comment, 3) tone overlay: a continuous background tone plays alongside text containing comment(s), with the pitch increasing for overlapping comments (denoted by low and high frequency waveforms respectively) 4) voice coding: different text-to-speech voices (highlighted in orange and blue) read comments and replies from different co-authors.

practical underpinnings implicated in accessible collaboration in ability-diverse teams. Inspired by Kafer's political/relational model of disability [16] and work from other critical disability scholars [4, 12, 13, 22], I view disability as enacted through particular socio-material configurations and interactions rather than located solely on the individual or in society. Considering access as a "way to move" in the world [12], I focus on designing technologies as a first step towards ensuring accessibility in collaborative content production.

RESEARCH OVERVIEW

The following studies address my broader research questions (**RQ1** and **RQ2**) in both collaborative writing and collaborative weaving contexts.

Understanding Accessibility in Collaborative Content Production

My work starts with addressing **RQ1** where I investigate how people with vision impairments produce collaborative content by interacting with the tools in their workspace and their sighted collaborators and what factors play a role in creating and negotiating accessibility in their work. Through contextual interviews in the collaborative writing context, I found that screen reader users must navigate an ecosystem of mostly inaccessible digital writing tools to consume multiple layers of complex collaboration information (e.g., comments, track changes, real-time edits) along with the document content, primarily through spoken announcements [10]. For example, in a shared document, screen reader users hear spoken notifications of comments and edits (e.g., 'start comment', 'end comment') interlaced with text content (see Figure 1, topmost). As a result, the reading flow gets interrupted by a continuous and copious amount of collaboration notifications, making it cognitively overloading for users to comprehend the text content and understand who edited or commented what, where, and when, especially if there are multiple edits or comments within a small portion of the text (e.g., a sentence). To avoid these complexities, our participants devise alternative strategies for collaborative writing that circumvent the traditional collaboration features, such as leaving comments inline within the document text, switching to additional communication mediums (e.g., phone, instant messaging) and so on. Implementing these workarounds, however, often demands a consensus among all parties involved in the collaborative work, which subsequently adds to social, relational and professional repercussions for people with vision impairments in a predominantly sighted workplace. Ultimately, we see that creating accessibility in collaborative work is a complex, interdependent [4] process that is shaped by interpersonal relations, power dynamics, and organizational ableism.

While understanding of collaborators' actions and resulting content in the remote collaborative writing context mostly manifests through auditory cues provided by digital tools (i.e., screen readers), in the co-located context of weaving, we see that awareness of work process and coordination happens through visually impaired weavers' embodied interaction with the tangible materials as well as with their sighted instructors. Specifically, through my ethnographic field

Figure 2: Top: Lisa (weaver) feels tension on the threads to check whether the loom needs to be advanced. Middle: Laura (instructor) provides hand-over-hand support to a weaver while passing the shuttle. Bottom: Amy (weaver) works on a 'summer winter' pattern with two multi-shaded blue yarns.

observations and contextual interviews at a communal weaving studio [9], I found that blind weavers attend to the interactive properties of materials (e.g., tension, texture, collision) (see Figure 2) to develop a comprehensive understanding of the system state and the progress of their work. In addition, they engage in coordinated embodied interaction (e.g., hand-over-hand support) with their sighted instructors to learn the basics of weaving and perform tedious tasks (e.g., fixing mistakes through unweaving). Interestingly, contrary to the way visually impaired writers must navigate power dynamics and ableist team practices in professional collaborative writing context [10], we see a shift in power differentials in the communal weaving studio. Here, blind weavers and sighted instructors work together in a way that ensures weavers' agency in deciding what kind of assistance they need, rather than making them passive recipients of support. This again underscores the critical role interpersonal relations, organizational structures and community ethos play in defining the extent to which accessibility is enacted in ability-diverse teams.

Designing Non-visual Technologies for Collaborative Content Production

From our contextual interviews and field observations, we see that to develop an understanding of the work process and the product, people with vision impairments must sift through and make sense of complex multi-layer information they receive from screen reader speech output (in the digital writing context [10]) or embodied cues from physical materials (in the weaving context [9]). Drawing upon these insights, I designed non-visual technologies to better support people with vision impairments in perceiving the process and progress of their work, collaborators' actions and the resulting content (**RQ2a**). Specifically, in the collaborative writing context, I developed a prototype that uses non-speech audio [14] (e.g., earcons, tone overlay) and multiple text-to-speech voices (see Figure 1) to present comments and suggested edits in a document. Through mixed-method analyses on a controlled evaluation study with screen reader users, I found that replacing spoken announcement with non-speech audio potentially reduces cognitive overload in distinguishing between collaboration information and text content. In addition, non-speech audio helps users better understand who edited or commented what in a document while reducing disruption in their reading flow and improving work efficiency [11].

Next, in the weaving context, my colleagues and I explored whether similar audio cues could enhance blind weavers' embodied understanding of the weaving process and the state of the woven product (e.g., inconsistencies in the pattern). We iteratively designed and evaluated an audio-enhanced loom that provides auditory feedback through musical notes and ambient sounds (e.g., birds' chirping or footsteps) while a weaver performs different steps of the weaving cycle.

Studying the Impact of Non-visual Technologies on Ability-Diverse Collaboration

In the next phase of my work, I will investigate whether and how integrating non-visual interactive technologies influence collaborative content production practices between blind and sighted collaborators (**RQ2b**). To this end, my colleagues and I are developing an extension for a widely

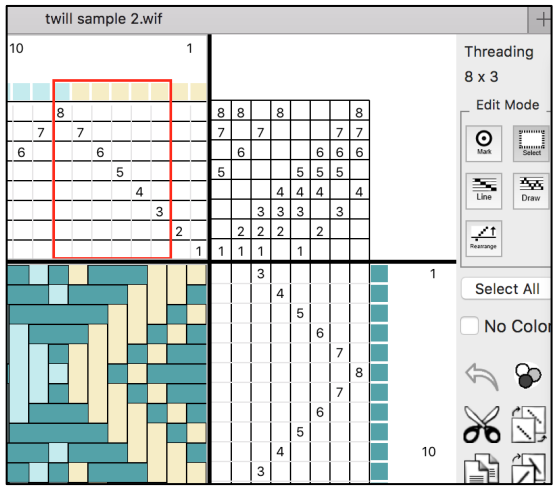

Figure 3: Screenshot of designing the draft for a 'twill' pattern on the WeaveIt software.
Source:http://www.weaveit.com/MacProduct.aspx

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adopted and open-source screen reader (NVDA) that will integrate a combination of non-speech audio, spatial sound and braille feedback to present collaboration information (e.g., comments, track changes, real-time edits) in a shared document. Additionally, to support naturalistic writing scenarios, the extension will allow customizable and interactive control so that users can opt to access, ignore, or respond to collaboration information, and easily navigate back and forth between collaboration content and document content as required. I plan to conduct a long-term field deployment study, where I will explore (1) how visually impaired writers make use of the new non-visual interactions in their regular work and (2) how these interactions impact their work practices, coordination and communication strategies and dynamics within ability-diverse groups.

To understand the role of interactive non-visual technologies in the weaving context, I will zoom in on the very first step of the weaving process – designing draft patterns (Figure 3). This step is particularly important, because weavers determine the look and feel of the end product by designing and visualizing draft patterns and in doing so, embed meaning into the product [10]. In the weaving studio, blind weavers verbally ideate with the instructors about color, texture and visual pattern of a project. Still, the hands-on process of preparing the draft pattern must be carried out by sighted instructors, since it requires expert weaving knowledge and the use of inaccessible graphics-heavy software (e.g., WeaveIt [3]). Taking a research through design approach [25], I aim to build an accessible collaborative designing tool that will incorporate multimodal control and feedback such as non-speech audio, sonification and refreshable tactile graphic display (e.g., Graphiti [2]) so that blind weavers can perceive how the draft patterns may look on the cloth in real-time. By evaluating this tool with the weavers and instructors at the community weaving studio, I will explore (1) how blind weavers can learn and more directly participate in the process of designing draft patterns using non-visual interactions and (2) how the integration of technology into the manual process of weaving might influence the embodied interplay between weavers and their material workspaces and enhance (or disrupt) the co-creative, interdependent [4] practices between blind weavers and sighted instructors.

CURRENT AND EXPECTED CONTRIBUTIONS

My work makes two primary contributions. First, through the investigation of collaborative writing and collaborative weaving practices, I contribute to a comprehensive understanding of how blind and sighted individuals collaborate in diverse contexts and coordinate their work through remote and co-located collaboration. Specifically, my work uncovers the complex ways accessibility is co-created by disabled content creators and their able-bodied collaborators and shaped by interpersonal relations, organizational constraints and inherent power dynamics within ability-diverse teams. Second, the multimodal, accessible interactions I am developing will potentially encourage us to rethink the design of collaborative productivity tools and digital-material creative making systems. In particular, these interactions could inform how technological augmentations can support collaboration awareness in the absence of a shared visual space and how these interventions shape work practices in ability-diverse teams.

GOALS FOR CSCW DC

I am about to start my 4th year as a PhD student in the Technology and Social Behavior program at Northwestern University. The CSCW 2020 DC occurs at a perfect time when I will start designing user studies for the final phases of my collaborative writing and collaborative weaving projects. Initially my plans for these studies involved in-person technology testing sessions and participatory design-based approaches. Due to the COVID-19 situation, however, I am revising my study plans and methodologies so that I can conduct them remotely. From the DC, I wish to get help in thinking through the set of methods I can use to holistically capture how technological enhancements could play a supporting role in collaborative content production practices in ability-diverse teams. In turn, I hope to contribute to the CSCW DC by sharing my experience in community-based research and designing accessible interactions.

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