SIGACCESS NEWSLETTER

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Projection Mapping as a Method to Improve Board Game Accessibility

Kirsty Noble and Michael Crabb

We use technology to add a secondary information layer that provides board game content on top of the physical board game that is being played.

In the first article Kirsty Noble and Michael Crabb describe their work on improving board game overall accessibility. They present a preliminary study that uncovers some of the problems in current board game sessions. They end the article by providing a set of design guidelines for augmented physical board games.

Technology Use and Non-Use by Low-Income Blind People in India

Aditya Vashistha and Richard Anderson

Low-income blind people in India face a complex array of socioeconomic barriers, language constraints and infrastructural challenges that impede their use of assistive technologies.

In the second article Aditya Vashistha and Richard Anderson present their main findings after conducting two studies on how low-income blind people in India appropriate general-purpose technologies to overcome socioeconomic barriers. They finish by providing specific recommendations to the SIGACCESS community.

How Disability Discrimination Law can Enable New Assistive Technologies

Reuben Kirkham

This article is an overview of my varied work aimed at exploring how disability discrimination law can enable new assistive technologies

Finally, Reuben Kirkam writes a very interesting and personal view on the current implementation and limitations of disability discrimination law. Central to this discussion and analysis is the concept of reasonable adjustment and its impact on the rights of people with disabilities.

Hugo Nicolau
Newsletter editor

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Projection Mapping as a Method to Improve Board Game Accessibility

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Abstract
In this work, we explore the concept of using projected content on top of board game sessions in order to improve the overall accessibility of a board game session. In our work we use technology to add a secondary information layer that provides board game content on top of the physical board game that is being played. We present an initial study examining the types of problems that exist in board game sessions and provide guidance on how projection mapped systems can be used in order to increase accessibility in this area.

Introduction and Related Work
Board games can be one of the easiest ways for people to sit down and enjoy a shared gaming experience. They can be played with very little cost but give players the opportunity to build friendships and increase their social skills. However, learning and remembering all of the rules for specific board games can be difficult task, especially with more complicated games with multiple playing pieces and cards, all of which can have different rules attached to their usage.

The accessibility of board games is a relatively uncovered topic, with very few academic works focusing on this area. Instead, a large amount of attention is place on making computer versions of games fully accessible with a notable examples of this being UA-Chess (Grammenos, Savidis, & Stephanidis, 2005). In contrast, the popular "Meeple Like Us" website (Heron, 2016) provides a substantial number of accessibility tear downs of board games, and identified potential visual, cognitive, physical, communication, emotional and socioeconomic accessibility issues that may impact on an individual's ability to play a particular board game. It is clear that accessibility challenges exist on a number of levels when playing board games and that there is an opportunity for technology to enhance the overall experience of these gaming sessions.

Previous work has explored how fully digital board games can be created on table top devices in order to explore how gamers can work together in digital spaces (Whalen, 2003). Researchers have also built bespoke board games themselves to test how computers can augment the experience of playing a board game (Peitz, Björk, & Jäppinen, 2006). However, work examining electronic board games has encountered problems such as reduced player involvement and enjoyment (Wallace et al., 2012).

Experimental Design
The purpose of this initial work is to gather information from users on the difficulties that exist when learning to play a new board game. In these sessions participants were introduced to a board game and given the opportunity to play a game. Game sessions lasted 30 minutes. These

sessions were used to gain an insight into potential opportunities where projection mapping on top of an active board game session could be used to improve the overall accessibility of these games.

Session Participants

Participants in this initial work were selected based on their previous experience in playing board games and an overall interest in the research project. Ethical approval for this work was obtained from the Robert Gordon University Ethical Approval Board. Two session types were used in this work:

- *Session Type A* – The first board game session type consisted of a two player game that was played by the researcher and also by a second player. Participants in this session type had no previous experience in the selected board game that was being played. After rules were explained and a small number of practice rounds played, participants individually took the lead in playing the game.
- *Session Type B* – The second session type consisted of a four player game that was played by the researcher and three others. The participants in this session type also had no previous experience of playing the selected board game. Similar to above, rules were explained and then a small number of practice rounds played. Players were then free to play the game together.

These two session types were chosen to simulate common player numbers when participating in a board game session with different player numbers creating different social dynamics during sessions.

Board Game Selection

In this work we attempted to promote discussion between players. It was decided that the board game Forbidden Island (Leacock, 2010) should be used. Forbidden island is a popular cooperative board game where players must work together in order to collect 4 different treasures and then escape the island, all while the island itself is attempting to make the players lose. Players must work together to collect these treasures and will only succeed through teamwork. Forbidden Island is described as a Family Adventure/Card-Game and has received multiple awards since its introduction (Board Game Geek, 2010).

In Forbidden Island the object of the game is to collect 4 treasures from the board by collecting a set number of associated treasure cards. Players must accomplish this goal while also saving the island that is sinking beneath them at the same time. Players all play collectively as a team to accomplish this goal.

In order to play the game, first, a diamond shaped board is constructed out of 24 individual 'location' tiles. Player pawns are then placed on the board at specific locations (e.g. The pilot starts on the helipad). Game turns then take place with each player participating in three phases:

- Action Phase: players take it in turn to perform 4 actions with these relating to player movement, swapping cards with other players, collecting treasure, and saving sinking island location tiles.
- Treasure Deck Phase: players turn over 2 cards from a treasure deck and add these cards to their hand.

- Island Flooding Phase: players turn over a set number of cards from a 'flood' deck in order to determine what locations on the island will begin sinking. The number of cards that is turned over in this phase is determined by the game difficulty that is set and also the number of 'water rising' cards that have been drawn from the treasure deck

The game finished when players have successfully collected the four treasure items and escaped from the island, or when the treasure items are no longer accessible because of flooded tiles and players lose the game.

Analysis

All board game sessions were transcribed and then read through by the research team to look for initial themes. As themes emerged an analysis theme tree was created based on the interactions that occurred between players (shown in Figure 1). The items selected were chosen to promote qualitative code co-occurrence in further analysis. Transcripts were then imported into the Dedoose qualitative analysis package (Lieber & Weisner, 2013) and transcripts split into small narrative passages. Passages were then coded using the analysis theme tree. In total, 137 excerpts were coded independently by two researchers.

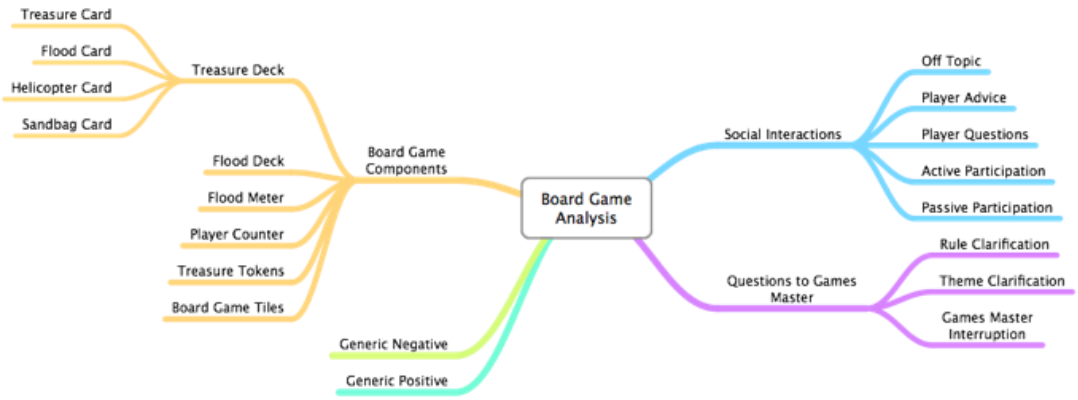

Figure 1 - Qualitative Analysis Tree

Results and Discussion

The purpose of analysis was to uncover themes that were present based on conversations between participants during the board game sessions. Several themes emerged during analysis several

Board Game Theme Understanding

Did you understand the concept of the board game? Did you grasp how the game was setup? Or how the game ended?

A key issue that emerged during the experimental sessions focused on players developing an understanding of the board game itself. Some participants struggled to grasp the concept of how the board game is set up with individual pieces rather than a large board to place the board game components upon. While this is a problem that is unique to board games such as Forbidden Island, it demonstrates an underlying issue in players' perception of the overall theme of a board game that they are playing.

Researcher - "This is what makes up the island, not a big board."
Player 1 – "Not a big board?"

Researcher – "So first of all you make it like a grid… like this."
Player 1 – "So they are all different parts of the island?"

Using projections of a semi realistic themed 'board' for players to place tiles onto will aid in the increase the understanding of the board game concept and may also increases the overall immersive theme of playing the game. This will also have the added benefit of creating set locations for different board game objects, which has the potential to be exploited in terms of the cognitive recall that is needed for understanding board game phases.

Player Identification

Were you able to determine where each player was on the board with the use of the game components, coloured peg pawns?

A second theme that emerged in analysis was based on player understanding of their own player's pieces on the board. Again, this is to be expected with a cooperative game such as Forbidden Island as one of the key concepts of the game is for players to work together as a collective and for less emphasis to be placed on a player's individual peg pawn. Throughout gameplay, participants raised several questions regarding their own pieces with comments such as "*who is yellow?"* and "*what colour are you?"* being commonplace.

In a similar theme to the above, creating a coloured 'home' space for players that says who they are, which colour they are, and highlights their current position. This again could aid in the cognitive recall that is needed in playing board games and also provides players with a small space where they can store their cards, creating a separation between cards that are in play and cards that have yet to be drawn.

Player Participation

Were you able to cooperate successfully as a team? Was everyone cooperating equally or was there a player who controlled the decision makings for the team?

One of the main obstacles in a co-operative game play is to keep everyone involved without causing tension or passive aggression to reach that end goal. Players reviewed the game as to some extent, tense with players making solely poor decisions, which effected badly on the gameplay.

"No I didn't move."
"Yeah but you could of. We need to work together remember?"

The idea of player cooperation is key in games where players have to work together and it can be commonplace for one player to take control and run the entire gaming session. This will be an extremely difficult area to be improved by the addition of projected content. This is therefore an area that deserves further investigation in future studies to understand how projected content can be used to influence the social dynamic of playing cooperative board games.

Rule Clarification

Did everyone in the team understand the rules of the game? Did everyone follow the rules? Was this the first time you played this game before?

The crucial challenge throughout the play session was for participants to learn and follow the rules of the game. Players asked the games-master questions about specific aspects of the game play for clarification for what was and was not allowed at certain points of time during the game

"It's still my turn"
"How?"
"Because I still have to take three cards"

"You can't move like that"
"Yes, she can, she is the explorer"

There are a large number of opportunities that arise in using projected content in order to aid in player understanding of board game rules. It may be possible to use projections to highlight which player is performing an action, which actions are allowed to be performed at specific times, and also various options that exist for players to aid them in deciding what actions to take.

Conclusions and Future Work

Based on the above, we are now examining how projection mapping onto active board game session could improve the overall accessibility in playing these games. The suggestions made are designed to improve the cognitive and social challenges that exist in participating in this type of cooperative board game. Once completed we aim to examine more detailed accessibility challenges such as the recolouring of board game content in order to aid players with CVD, methods to include 'virtual' players through the use of a secondary layer of projected content, and also how projection mapped board games can be crossed over with accessible digital products through systems such as Tabletop Simulator (Berserk Games, 2015).

We propose the following guidelines which will be used to create our prototype system in the next stage of this work:

1. **Projections should expand the game space in order to enforce the overall theme of the game being played.** Projection of a board for players to work around and to aid in enforcing the overall theme of the game
2. **Projections should create visible locations for items such as card decks and player cards.** Projection of 'home sections' for players to store their cards to give players an indication to what player was moving at a given time, and also to reinforce the special abilities of each character
3. **Projections should provide additional instructions for players on the current state of the board.** This should include highlighting of helpful information such as the current player that is performing an action, the potential actions that can be performed, and instructions on the different phases of a player turn that have to be completed.

Figure 2 - Early Prototype Mock Up of Projection Mapping on top of Board Game

We are now working on creating a prototype system that can be used to project additional content onto a board game surface, a very early prototype of this is shown in Figure 2. This is being carried out in order to further test the strengths and limitations of board game projection mapping and how this can be used to create more inclusive board gaming experiences.

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TECHNOLOGY USE AND NON-USE BY LOW-INCOME BLIND PEOPLE IN INDIA

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Abstract

Low-income blind people in India face a complex array of socioeconomic barriers, language constraints and infrastructural challenges that impede their use of assistive technologies that are primarily designed for blind communities in the developed world. The environment of constraint and disability has led low-income blind people to appropriate general-purpose technologies as assistive technologies, and use them to orchestrate new coproduction, consumption and sharing practices to address their educational needs. Low-income blind people also use mainstream social media platforms not only to access instrumental information and entertainment, but also to demonstrate their technology acumen to the society, and build meaningful connections with both blind and sighted communities.

Introduction

To date, many of the world's biggest advances in assistive technologies have primarily benefitted visually impaired people living in developed countries, like North America and Europe, that contains only 10% of the world's visually impaired population. However, 90% of the world's 285 million visually impaired people live in low-income settings [31]. India, with more than 63 million visually impaired people, is home to the world's largest number of blind people, many of whom are living in rural areas under severe financial constraints. Prior research has found that the prevalence of blindness is much higher among rural people than urban dwellers [17], and in poor clusters than in affluent clusters [8]. Assistive technologies well-suited for blind people living in developed countries are often inappropriate, expensive and unusable for low-income blind people living in resource-constrained environments in developing regions due to various socioeconomic factors and infrastructural constraints, including cost, language, literacy, and the availability of computing devices and bandwidth. For example, 58% of India's population earns less than USD 3 a day [36], 26% of the adult Indian population are illiterate [37], and around 72% are illiterate with respect to English [4]. Though India alone has more than 1 billion mobile phone subscriptions [35], only 15% of the mobile subscribers use a smartphone [15], and 28% of the population have access to the Internet [33]. The statistics for low-income blind people in India paints an even grimmer picture. To design new information and communication technologies and re-appropriate the existing ones, it is important to gain a deeper understanding of the motivations, technologies, challenges, and coping mechanisms that comes into play when low-income blind people produce, consume, curate , and share digital content.

Prior works in the accessibility domain have examined technology use by blind people in developed countries, and designed new interfaces, devices and mediums for them [1,2,6,7,14,16,18,26,30,32]. Information and Communication Technologies for Development (ICTD) researchers have also studied screen reader usage by blind people in developing regions [13,21], examined challenges faced by them in exploring employment opportunities [20], documented experience of blind people who use mobile devices [19], and explored the role of

mobile devices in providing them access to social, economic, and architectural spaces and interplay between gender and disability [22]. However, the participants in these works were primarily from middle or upper class urban backgrounds and thus, were not representative of blind people in rural and peri-urban India.

Despite the majority of blind people living in low-income settings in developing regions, the research examining their technology use and non-use, constraints and opportunities, and costs and benefits is severely limited. One of the primary reasons for the scarcity of such work is the hardship experienced by researchers in discovering, contacting and gaining the trust of blind communities in remote rural areas and low-income settings. In prior work, we designed, built and deployed *Sangeet Swara* — a voice-based social media platform accessible using basic phones and without Internet connectivity — that received broad and impassioned usage by low-income blind people in remote rural and peri-urban areas in India [28]. The accidental success of our platform offered us opportunities to cultivate a trusting relationship with these blind people and examine their educational ecosystem. The objective of this study (henceforth education study) was to examine mediums and technologies used by them to access educational content, challenges encountered by them, and their coping mechanisms, and to apply that knowledge towards designing new or improved tools/processes/policy for supporting the educational ecosystem [27]. The access to *Sangeet Swara* users and a prior relationship with a non-governmental organization specializing in computer training for low-income blind people enabled us to also examine their social media landscape. The objective of this study (henceforth social media study) was to examine the use and non-use of existing mainstream social media platforms, including Facebook, WhatsApp and Twitter, by low-income blind people in India, analyze content generated by them, identify benefits received and challenges encountered by them, and contrast their usage of existing social media platforms with *Sangeet Swara* [29].

In this article, we offer high-level insights gained from the two studies and request readers to study our prior work [27,29] to access more information. We highlight how low-income blind people in India, despite living under severe financial constraints and with lack of accessible technologies, innovate novel mechanisms to address their educational, information and entertainment needs. Though they are often undervalued by the society, they use technologies to demonstrate their technology acumen to others, uplift their social standing, and build meaningful connections with both blind and sighted people.

Methodology

The findings presented in this article are based on ten semi-structured interviews with blind students of various educational levels, six interviews with blind teachers, analysis of online content available on websites of six nationwide government entities, non-profit organizations and non-governmental organizations (NGOs) generating educational content for blind communities, eighteen interviews with blind social media users and non-users, two interviews with computer instructors for blind people, another two interviews with facilitators of a computer training program for blind people, telephonic survey of fifty-three blind *Sangeet Swara* users, thirteen interviews with blind *Sangeet Swara* users, and analysis of their call logs and interactions. Each interview and telephonic survey was translated and transcribed in English, and was analyzed using open coding.

	Age (years)	Male	Rural or peri-urban areas	Completely blind	Owned smartphone	Median daily family income	Student	Teacher	Unemployed	Others
Education study participants	27.2	94%	100%	94%	19%	USD 2.74 (students) USD 13.70 (teachers)	10	6	0	0
Facebook, WhatsApp and Twitter users and non- users	24.2	89%	67%	62%	11%	USD 5.45	14	0	3	1
Sangeet Swara users	24.6	93%	67%	NA	NA	USD 3.52	24	7	6	16

Table 1: Demographic information of participants in our prior research works.

Demographic Information

The participants were from eleven states in India. 93% of the participants were male and 7% were female. 73% of them were from rural and peri-urban areas while the remaining were from low-income societies in urban areas. The majority of them were from families of farmers, daily wage labourers, small-shop owners, carpenters, and household help. The average family size of the participants was seven. Almost 80% of them were financially dependent on their family members, and lived under severe poverty with less than USD 2 per day. All of them were native Hindi speakers, only one participant spoke fluent English, and many spoke a local dialect of Hindi. Of the eighteen social media users and non-users, nine participants used only Facebook, four used all the three platforms (Facebook, WhatsApp and Twitter), one used only WhatsApp, another used both Facebook and WhatsApp, and three did not use any social media platforms. Table 1 shows high-level demographic information of low-income blind people who participated in our studies that examined their educational and social media landscape. We encourage the readers to study our prior work [27,29] for more detailed information on the methodology, demographics, and analysis.

Findings

We now present a high-level synthesis of our findings from two prior research works to demonstrate how low-income blind people in India design new coproduction, consumption and sharing practices for accessing instrumental and entertaining information, uplift their social status, and transform their relationship with both the blind and sighted communities. We also highlight the challenges encountered by them in using accessible technologies and how they appropriate general-purpose devices and technologies to support their needs.

Challenges in Accessing Content

We found that low-income blind people in India experience acute shortage of accessible educational content, including Braille books, professionally authored audio books, and online content in local languages. Though participants reported several limitations of Braille books, such as rare availability after high school, high cost, heavy, and limited physical storage to store them, all but two participants found Braille to be their preferred content format in comparison to audio

content and textual digital content. They found Braille easier to understand and remember content, and associated its use with independence. Unlike audio books, Braille books were considered easier to go back and review, and of consistent quality. A participant reported:

"Personally, I am a supporter of Braille. Braille is the real thing. There are two things: first, eating food yourself. Second, someone else feeds you. Braille is like eating food from your own hands and audio books are as if someone else is feeding you."

Though screen reader software has been an integral part of the lives of blind communities in the developed world, we found that several low-income blind people used them only sparingly. In fact, 57% of the participants in the education study never used a screen reader software, and roughly 20% did not even know its purpose. Screen reader software were less popular for two reasons. First, the majority of participants lacked access to computing devices, such as computer, tablets, and smartphones. Roughly 81% of the participants in education study and 89% participants in the social media study were using basic phones or feature phones incapable of supporting screen reader software. 57% of the participants of the education study never used a computer and the remaining used it sparingly. The cost of devices and the Internet was prohibitively expensive for them. Though many participants were aware of the importance of computing devices and the Internet in accessing information and entertaining content, they saved money for supporting their daily living requirements. A participant reported:

"I rarely shave and get a haircut because I am unemployed. My financial situation is terrible and I have no family support. If there is no income, there will be no phone, no Internet, and no Facebook..."

Participants also found it challenging to use computer in public spaces like Internet café. The accessibility features were often deactivated on the computers in the interest of sighted customers. Several café owners had also disabled USB port for security purposes, because of which blind customers could not run NVDA from a portable flash drive. A participant stated:

"Going to a café is a laborious task. The computers there do not have screen reader software. I have requested the owner to install them, but he is not interested because few blind people go to his café."

Second, those participants who had intermittent access to a computing device and the Internet found it challenging to find content in Hindi. Most of the content available online was in English, a language many of them feared because of limited language proficiency. The interview with instructors revealed that most participants studied in a Hindi-medium school and had limited exposure to English. According to them, 90% of the students who came to their computer training program in the last two years were unable even to write their name in English. Participants found it difficult to understand the American accent of screen reader software and coped with it by reducing the playback speed. Several of them felt disadvantaged and had lower self-esteem because of lack of English language skills. One of them stated:

"I have to keep the speed of the talking software very slow and this hampers my productivity. Though our intellect is comparable to sighted people, we are unable to compete with them because of the lack of English skills. I feel disadvantaged."

Though some screen reader software supports Indian languages, many participants did not know about them. Others sparingly used them because of the lack of access to textual content in local language, and the poor quality of the output of inexpensive local language speech synthesizers.

Though we assumed the cost of screen reader software like JAWS to be the significant bottleneck for adoption, we found that all screen reader software users in our sample were either using a pirated copy of JAWs or a free screen reader software like NVDA. The low availability of Braille content and constraints with screen reader software forced many participants to rely on audio format, both in offline and online settings, to access educational content.

The findings of our social media study also attributed the cost of devices and the Internet, and challenges with screen reader software to be the prime reason for non-use of social media platforms. The study also revealed that several inaccessible features, such as lack of caption on photos shared on Facebook, Twitter and WhatsApp, lack of commands for Facebook chatting, difficulty in searching for friends and sending friend requests, and inability to send and listen to WhatsApp voice messages due to overlapping of the voice output from screen reader software, among others, affected the adoption of mainstream social media platforms.

Coproduction and Peer Sharing of Educational Content

Though several community champions, and governmental and non-governmental organizations, such as National Institute for the Visually Handicapped, All India Confederation of the Blind, and the National Association for the Blind, among others, produce high quality audio books, a great deal of educational content remains unavailable to low-income blind people in rural and peri-urban areas because of time-consuming services, lack of coordination among several producers, and absence of centralized repository of available books. The environment of constraint and disability has created a thriving ecosystem comprising of user generated content and peer sharing, that is orchestrated by low-income blind people living in rural and peri-urban areas. We discovered that low-income blind people produce their own educational content in audio format either individually or collaboratively. The ecosystem also involves diverse stakeholders, including blind teachers, social connections of the blind (friends and family), social workers, and sighted university students, who are producing and/or sharing educational content to either receive instrumental information, social incentives, and financial incentives.

For producing content, blind participants purchased books for sighted audience and asked their social connections to record it for them. Several of them were also approached by their sighted peers and social workers who offered to record chapters for them. In the event when recording by their social connections was not feasible in a timely fashion, they collaboratively hired a reader for the group by paying anywhere between USD 0.50-2 per hour. Often, the group coordinated among themselves to record the reading sessions using a mobile phone, tape recorder or a laptop. Participants reported that the user generated content, thus obtained, is so abundant that it is not uncommon to see two people in the same class room accessing an audio chapter recorded by two different people. Some blind teachers and students also maintain offline repositories to store, categorize and index the educational content for further distribution.

For accessing content, participants reported that the easiest and fastest way to access any educational content is to ask their friends and teachers for it. They relied heavily on peer sharing to access user-generated as well as professionally produced audio content. They used a wide variety of mechanisms, including sharing CDs, exchanging memory cards, and intermediated sharing [24], to send and receive educational content. Though prior research has documented peer-to-peer media sharing in low-income contexts by sighted people [12,25], to our surprise, several blind participants used Bluetooth to transfer audio book chapters to others. The drive to access and share educational content motivated them to overcome significant barriers in user

interface design. They initiated Bluetooth sharing by memorizing the complex steps of button presses and user interface navigation.

Though it is not uncommon to see disabled stakeholders appropriate general-purpose devices to serve as assistive devices because of their high cost or low usability [3,9,10], the ecosystem we unearthed is unique because of its focus on educational content, involvement of marginalized low-income blind people living in rural and peri-urban areas on less than USD 2 per day, the reliance on low-cost offline technologies such as tape recorders, basic mobile phones, CD players, and the disproportionate amount of user-generated content and peer-sharing than institutionalized and systematic production and indexing of accessible educational content. The ecosystem discovered here is a rare example of a bottom-up, community-driven, organic and self-sustaining intervention in educational domain and reinforces the notion that that outside help may not always be needed for marginalized populations to apply new technologies to gain instrumental benefits. Though looking from a contemporary lens of technology adoption and use, it appears that the blind community is lagging behind since the existing assistive technology (such as screen reader software and Braille printer), devices (smartphones, tablets and computer), and the Internet is unaffordable and inappropriate for many of them. However, a closer look at the educational ecosystem reveals that these blind users are leaders and early adopters in producing multimedia content and designing new sharing practices to quench their thirst for educational material that is not available in other forms.

Bridging the Gap between the Sighted and Blind

Beyond the obvious use of social media platforms, such as widening the social circle, accessing and sharing news, songs and other informational content, sending photos and chatting, among others, our social media study revealed several unique affordances that social media platforms accorded to low-income blind people.

The participants used social media platforms an instrument to receive valuable information about scholarships and health schemes, employment opportunities, and educational material. Though participants had access to mobile phones, they could not communicate with their friends regularly because of harsh financial constraints that made even phone calls unaffordable. A participant stated:

"I only call my friends when I have a question related to a career opportunity or to wish them on festivals. Every time I call, I have to speak for 4-5 minutes and that is expensive."

They used social media platforms as an affordable alternative to bridge the communication gap and thus, strengthen their offline social network of blind friends, colleagues and teachers. Social media platforms not only empowered these users to have longer and frequent conversations through online chatting, they also provided them avenues to discuss topics relating to national and regional interest, and access entertaining content.

Several participants reported that they were treated in a condescending manner by the society, including their friends, colleagues and even family members. A participant expressed:

"People think that even if we study, we will not get a job. When we go to mobile shops for recharging the Internet, they think that we are joking. They have a perception that even if I use Facebook who is going to be friends with me?"

Many of them used social media platforms, especially to have conversations with sighted friends and strangers with the intent to change their perception about the blind. On average, 25% of

their connections were people they never met before, and 69% of their social media friends were sighted people. Participants expressed a deep desire to prove others that they are equally confident and knowledgeable. The desire motivated them to demonstrate their technology acumen to their critiques, using social media platforms. A participant explained:

"When I say to people that I use a computer, then no one believes me. They think I am blind and when they cannot operate a computer properly how I will be able to. But when I send a request on Facebook, they know it is me who has sent that request. People in my locality now know that I use the computer."

Since *Sangeet Swara* could be accessed by anyone who could call a toll-free number, it provided several benefits to those who could not use mainstream social media platforms because of several socioeconomic barriers, infrastructural challenges and language constraints. Though the usage of *Sangeet Swara* was similar to the mainstream social media platforms (such as increasing social connections, strengthen existing connections, access entertaining information, and receiving instrumental benefits, among others), the adoption of *Sangeet Swara* was much higher among low-income blind population across several states in India. Many participants shared that the platform connected them with blind participants in other states and far-off locations for the first time. In fact, *Sangeet Swara* was the first social media platform for 90% of its blind users. Many low-income users believed that the platform was designed exclusively to connect blind people all across India, and provide them opportunities to learn skills, and share information, news, and entertainment.

To summarize, though participants faced very great challenges in accessing mainstream social media platforms, they used them to uplift their social standing among sighted people, make meaningful connections with the blind, access instrumental information, and build self-confidence. *Sangeet Swara* proved to be an accessible platform that capitalized on the strengths of voice and enabled people to create, access and share content in Hindi language.

Recommendations for SIGACCESS Community

Smartphone and Internet penetration is rapidly increasing in developing regions. In India alone, annual smartphone subscription and Internet user growth rate is 55% and 33%, respectively [15]. In fact, 65% of India's Internet traffic comes from mobile devices [15]. The average selling price of smartphones has declined by 16% over past two years [5] resulting in availability of affordable Android phones for less than USD 30. Moreover, the cost of accessing the Internet has steeply declined [11]. Based on the advances in availability and cost, it is inevitable that more low-income, low-literate blind people will have access to smartphones and the Internet in a near future. Recognizing the growing adoption in developing regions, several existing social network service providers have built specialized applications for resource-constrained environments. For instance, Facebook, YouTube and SMS GupShup launched Facebook Lite, YouTube Go, and GupShup messenger, respectively. However, the accessibility challenges are still unaddressed even in the specialized applications. We exhort the research community to capitalize on the rapidly changing infrastructure and ecosystem to design affordable and usable assistive technologies for low-income blind people in India. There are several interesting opportunities such as generating online resources in local languages, building tools to convert educational content in English to other languages, building smartphone-based educational applications that are grounded in local context, designing new accessible interfaces on modern as well as legacy computing devices, building new crowdsourcing systems to provide additional earning

opportunities to low-income blind people, and designing local language digital assistive technologies, among others. Prior studies have also established that in comparison to sighted people, low-income blind people have disproportionate access to educational opportunities, health benefits [23,38], and job prospects [20] that impede their potential of overcoming poverty. There is a need to design and build new technologies that let low-income blind people produce, consume and share information in diverse domains, including health, education, agriculture, civic engagement, finance, and journalism, among others. The technological solutions have the potential to dramatically impact the lives of 256 million visually impaired people living in low-income settings.

Our studies also revealed a disconcerting reality — low technology adoption and use by low-income blind women living in rural and peri-urban India because of several social and cultural factors. Over 90% of all the blind participants in our prior work were male. Even on *Sangeet Swara*, a social media platform that could be accessed simply by placing phone calls on a toll-free line, only 7% of all participants were estimated to be women. The lack of technology use and adoption is much widespread. According to a recent GSMA report [34], almost 1.7 billion women in low- and middle-income countries do not even own mobile phones, and women in South Asia are 38% less likely to own a phone than men. The lack of access to technology limits their access to several health schemes, scholarships, policies, and employment opportunities. During the course of our studies, some women participants expressed that the access to information is the single best thing that has transformed their lives. There is an urgent need to address this pervasive lack of technology adoption by blind women in low-income settings. This could be accomplished by incorporating policies, incentives, and social and behavior change communication tools to support technology adoption, creating awareness about the opportunities available to them through print and media campaigns, and designing usable technologies that are cognizant of their economic, social and infrastructural constraints.

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How Disability Discrimination Law can enable New Assistive Technologies

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Abstract

Disability Discrimination Law is a relatively recent innovation whose principles have now been accepted by the vast majority of the world's nations. Chief amongst these is the elastic yet mercurial concept of reasonable adjustments, which can have some surprising yet potent implications for this rights of people with disabilities. This article is an overview of my varied work aimed at exploring how disability discrimination law can enable new assistive technologies, including systems of general utility (e.g. Google Glass) which as a side effect, can also assist in helping ameliorate disability related disadvantages. At the same time, I also discuss some of the existing limitations with respect to disability discrimination law and its implementation.

Introduction

The UN Convention on the Rights of Persons with Disabilities has led to disability discrimination law being implemented in the vast majority of the world's nations. Central to this convention and therefore disability discrimination law is the concept of reasonable adjustment. This recognises the fact that people with disabilities require steps to be taken in order help ameliorate the disadvantages which would otherwise arise from their impairments. By contrast, most prior legislation was paternalistic [3], focussing upon provisions such as quotas and welfare, rather than allowing disabled people to be included and valued as people.[1]

It can now be reasonably expected that the concept of reasonable adjustment will take increased prominence in legal systems around the world. There are some observations that should be made on how this duty has generally been implemented. First, reasonable does not mean 'reasonable', at least in the sense of the legal 'man on the street' test. Rather, the concept of reasonableness must be weighed against the purpose and intent of the duty to make reasonable adjustments, namely the goal to fully include and empower people with disabilities to lead equal lives. Second, the cost of an individual reasonable adjustment is seldom a permitted reason for an organisation to refuse to make it, likewise with the potential inconvenience that a given adjustment would imply. As such, organisations have sometimes been required to provide reasonable adjustments – such as sign-language interpreters – which are more expensive than the employee's salary. Third, the reasonable adjustment duty can be narrow: organisations are not generally expected to change the nature of the service that they provide to accommodate the needs of people with disabilities, whilst employers can make reasonable adjustments in a way that the person with a disability might not accept. Fourth, in many jurisdictions, the reasonable adjustment duty can properly be said to be 'objective': the question is whether or not there are reasonable steps by

[1] Prior to the UN CRPD being mooted, the main dissenters from this approach were the United States of America (with the Americians with Disabilities Act (1990)) and the United Kingdom (with the introduction of the Disability Discrimination Act (1995).

which an organisation could have eliminated that person's disadvantage, as opposed why an organisation took the steps that it did.

These ideas are not necessarily intuitive, even to most lawyers and judges. This means that there can be a rather inconsistent body of caselaw, which does not always reflect the general intent and purpose of the legislation. Disability discrimination law, also suffers from the challenge of mercuriality: to put it another way, the law can depend upon the proclivities of individual judges, rather than a purposeful consideration of what the law is designed to address. Nevertheless, understanding how this area of law operates is fundamental to the development and deployment of assistive technology, at least if we want technologies that people with disabilities will be properly supported in fully enjoying the benefits of. In what follows, I explain some pertinent implications of the law for assistive technology, whilst also exploring some of the challenges and difficulties that arise in using this area of law.

Innovations in Reasonable Adjustments

My research has involved developing an understanding of how the reasonable adjustment duty applies to assistive technology. There are three important ways that in which disability discrimination law should enhance practice around the design and deployment of assistive technology: the concept of permissibility, the requirement to support assistive technology in the wild and the opportunity to develop new assistive technologies bespoke to the needs of individuals.

Permissibility

Whether or not Google Glass (and similar systems) are automatically allowed in most public spaces is probably the most important example of permissibility. Permissibility simply means that a technology is allowed to be used in a given space in a particular manner.

As I argued for in [5], the fact that Google Glass (and its successors) could be an assistive technology and does not in and of itself violate other laws (in most circumstances and countries) means that allowing its use in public spaces is a reasonable adjustments. From a metaphorical perspective, this scenario is little different than with respect to guide dogs: whilst some organisations may have an objection to dogs, be it for religious or practical reasons, there is no legal basis for depriving someone of the assistive tool which assists them.

It would therefore be a reasonable adjustment for someone with a disability to use Google Glass in public, provided that the system in question was genuinely assisting someone with a disability. However, some applications would need to be discrete to properly assist someone with a disability, where the intention might be to hide the effects of an impairment. It is not difficult to envisage systems which are at the least, designed to have the effect of assisting people with cognitive impairments in social settings.[2] Nor is it difficult to expect that someone would use a range of augmented reality assisted prompting to remind them of the need to take steps to address a medical condition, including one which might be potentially embarrassing to the person involved.

[2] For the interested reader, this scenario (and the potentially difficult ethical issues that it raises) is discussed at length in IEEE Pervasive Computing in a separate article (see [7])

In certain cases then, it would be cause actual harm to an end user to have to explain why they would need to use the augmented reality system in question. The primary objections towards such systems are general weak, namely unsubstantiated fears around privacy and copyright, with the implication that a potential assistive technology is really being used nefariously. It is very difficult to see how these fears – especially given the criminal law ought to provide adequate protection in the latter case – can be used as a basis for requiring someone to justify their use of an assistive technology. As such, there is an inevitable side effect that people without disabilities can effectively rely upon the protections available to those with disabilities, thereby establishing the permissibility of these more challenge assistive technologies generally, even though they might not always be being used as a reasonable adjustment.

However, this is not to say that the fact that these systems are legally reasonable under existing legislation will mean that there will not be future, more specific restrictions on augmented reality systems. As such, it is important to consider carefully how future systems might be designed to maintain the current legal status of permissibility. It would be far more provident for the HCI and technology communities to devise their own regulations for such systems, rather than risking them simply being imposed by the political establishment in response to some form of complaint or crisis.

Supporting Wearable Assistive Technology

An early, perhaps archetypical, form of wearable assistive technology is the Hearing Aid, which typically uses a microprocessor to 'remap' sound to enable someone with a hearing impairment to maximise the use of their remaining hearing. Importantly, Hearing Aids are already supported in a wide range of locations via the medium of installed induction loops, including shops, museums and cinemas. These systems have been installed for the purposes of making a reasonable adjustment for people with hearing impairments.

For the purposes of discrimination law, it is worth highlighting some features of induction loops which makes their installation legally reasonable (and thus, obligatory) in most public venues:

- **(Low) Cost.** The cost of an induction loop system is relatively small, requiring around £300-500 for a simple installation, as well as a small amount of ongoing costs in maintaining the system. In most cases, this would be a very small proportion of an organisations turnover.
- **(Significant) Benefit.** The benefit of an induction loop is that it enables a relatively large potential pool of people to be able to access a range of services, i.e. anyone who uses a hearing aid and has difficulty in processing conversations against background noise. This has the result of enabling this group to be able to access these services in a face to face manner on an equal basis to people without hearing impairments.
- **Standardisation.** There is a standard implementation for an induction loop system. As such, there is no need for an organisation to support a range of potential and incompatible systems, which might interfere with one another. Instead, it can be sure that its installation will support all hearing aid users for many years to come.
- **(Limited) Disruption or Inconvenience.** The installation of an induction loop system involves no disruption once installed, and possibly a minor amount of inconvenience when installing the system. Relative to the benefits of installing the system to people with disabilities, the minor and brief inconvenience of installing the system carries insufficient weight to come close to preventing its installation being a legal requirement under the anticipatory duty.

This could and should apply to a range of systems that support wearable technology. For instance, one way of conducting indoor localisation (and thus navigation) in the abstract might be computer vision. However, this approach would involve systems which may well be unworkable, especially in a comfortable form factor. However, it is technically feasible to markup a building with an indoor localisation and/or marker system to assist with this issue. Separately it would also be perfectly feasible, to use indoor Wi-Fi to provide real-time remote assistance to the user of an augmented assistive technology via telepresence: this could be very helpful for people with cognitive or social impairments. Presuming that standards can be agreed and a benefit for a relatively wide group of disabled people can be shown, then there is little reason why these solutions should not be embedded in the built environment on the basis of disability discrimination law. This has some significant implications for the design of assistive technology: a legal solution might well be better than a technical solution and enable a range of assistive technologies which otherwise would be technically infeasible. However, taking advantage of the law requires a thoughtful approach and the gathering of evidence in respect of specific types of assistive technologies: it also requires an emphasis upon the underpinning standards. That said, at least in the latter respect, the HCI community has had some great success in formally establishing many of these standards, especially with respect to websites and other internet platforms [10]. As such, it is now time to move those standards into the ubiquitous and wearable space.

Bespoke Assistive Technology

There are some other questions that we can ask which are more challenging. One example is this: is it reasonable for an employer to build an assistive technology for an employee who becomes disabled? If so, does this apply in challenging environments? Perhaps surprisingly, the answer is often yes, depending upon the feasibility and cost of the technology itself. There are three key concerns that arise (presuming the technology has the effect of enabling the person with a disability to continue in their role):

- The cost of the technology.
- The safety and reliability of the technology.
- The level of disruption that the technology would impose.

Whilst highly cost effective, a DIY approach would not necessarily achieve the latter two requirements, because the technology will not have been developed or designed by a trained engineer. As such, what I will term a 'bespoke' approach towards assistive technologies is where a qualified engineer developed and implemented the solution in line with existing engineering standards. This has certain advantages, namely a strong degree of quality assurance and professionalism in the construction process.

As part of my work with the BBC, this proposed approach was explored thoroughly with respect to live television production environments (see [6]) using a qualitative mixed methods approach. This was a particularly challenging setting because it places strong human performance demands on individual operators, including in respect of safety and production quality, meaning that assistive technologies must be reliable and not interfere with existing practices. The other challenge was that there were no 'off-the-shelf' accessible systems: existing interfaces were designed prior to accessibility being a substantial or recognised consideration.

The only real solution is therefore to build custom assistive technologies in response to individual disabilities, for instance remapping an existing interface, or even developing entirely new pieces of equipment.[3] The core question was whether or not this was legally reasonable. One important point to note is that most of the expense is incurred when building an assistive technology, whilst a far smaller proportion occurs as part of the iterative process of determining whether or not the assistive technology ought to be built. In UK law, at the least, a proposed adjustment can be reasonable even if there is very little prospect that it might succeed in retaining a person in employment. Turning to the case law, redeployment of an employee who was off sick for an extended period of time (Leeds Teaching Hospital NHS Trust v Foster UKEAT/0552/10/JOJ) or the provision of private psychological treatment (Croft Vets & Ors v Butcher UKEAT/0430/12/LA) were both found to be reasonable adjustments in these cases, despite the expectation that they were unlikely to succeed in returning the employee in question to work. Both would incur substantial expense, most likely over and above what would be required to explore a bespoke assistive technology, and with a lower prospect of success.

Once a bespoke assistive technology design has been identified, then the prospect of success is high. This means that a system which would have a considerable expense attached to it would be legally reasonable in most cases, much as a sign language interpreter, whilst expensive, is mandatory in a wide range of circumstances. With wearable augmented reality systems becoming commercially available, combined with the considerable reduction in the cost of physical computing (and fabrication), an engineer developed system is well within the realms of being realisable within the confines of disability discrimination law.

In a way, this approach challenges the assumption that cheaper and DIY is the best route to consider. Sometimes more complex or expensive systems are required and expected, especially in the domain of employment (or education), where this approach is supported by discrimination law. In the context of the employment sphere, this suggests that future efforts might be best focussed upon making available assistive technology components which can be customised or tailored by experienced engineers, rather than the more ambitious goal of trying to give the end user full control.

Challenges in Reasonable Adjustments

It would be wrong to pretend that there are not challenges in respect of how the reasonable adjustment duty has been implemented. These are important to note and understand, so that assistive technology can take into account how the law works.

Technological Illiteracy

Unfortunately, many judges are technologically and mathematically illiterate.[4] This is a pertinent issue, because the Tribunal judges who will be deciding on a day to day basis whether an assistive technology is permissible may not be able to understand the assistive technology in question. If they cannot do so, then this risks a technology which is in the abstract reasonable being ruled (wrongly) to be otherwise by a Tribunal, with serious consequences for the person in question.

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[3] One example which we explored was CanAssist's pole-cam powerchair, which was a camera boom attached to an electric wheelchair, with additional controls to enable to someone who has no use of their legs to perform documentary film making. So building a new system in response to an individual request can potentially be realistic, even in a challenging setting such as this one.

[4] See [11] for a particularly vivid discussion of these issues.

It is therefore necessary to provide with an assistive technology an intuitive understanding of how it operates, so that a person with a disability can easily overcome the objections that might be raised in respect of utilising it. As most of these objections will rotate around perceived risks or inconveniences, it is important that assistive technology design expressly consider these potential complaints, including ones which might seem to be unlikely or plainly wrong to people from a technical background. Ideally, such explanations should be built into systems as and when they are deployed, to help salve objections and to increase the likelihood that the disabled person in question will be fully included.

HCI's Rejection of the Duty to Make Reasonable Adjustments

Some of my research has involved exploring the experiences of postgraduate researchers with disabilities. Academia is an example of an environment where reasonable adjustments are difficult to determine and to make. The investigation at [9] documented the experiences and barriers faced by many people with disabilities in academic research environments, the main challenges and issues being as follows:

- **Accessing the academic community.** The majority of our participants found that they were disconnected with the academic community within and beyond their institution. This was primarily due to disability related barriers created by the University's failure to make reasonable adjustments (e.g. hosting a department in an inaccessible location, or refusing to pay the additional costs of conference attendance)
- **Getting research done.** The underlying problem for most of our participants was the failure of the disability services to understand what a PhD involved. As such, essential equipment and assistive technology was provided late (or on occasions never), and even when provided, was often outwith the appropriate support and training. This had the effect of significantly slowing research progress and making it difficult to publish papers in the external academic community.
- **Limited institutional choice.** Many of our participants found that their disability was the deciding factor in determining which institutions to attend. This meant that they often eschewed institutions which were more 'esteemed', in order to attend an institution which was perceived to be more accessible. This same point applied to the choices of courses which they undertook, in order to minimise the risk of reasonable adjustments not being made.
- **Adversarial engagements.** The general failures in making reasonable adjustments by the institutions also had an effect on student-faculty interactions. This meant that, despite some notable exceptions, the disability of the student was not fully accommodated in the working relationship between student and supervisor, and on occasions, even turned it into a hostile one. The net effect was to significantly reduce the opportunities of research students with disabilities, especially with respect to developing an academic career.

This work also led a set of proposed recommendations to address the implicit and discriminatory barriers in the existing academic processes within the HCI and Accessibility communities [8]. The response to this has been rather unfortunate, with a general denial that the research community has a responsibility to make reasonable adjustments (instead addressing these issues, these were seen to be the institutions problem), one anonymous reviewer even invited the authors (including myself) to "rant in the dark". However, the law takes a different view: just because the original source of the discrimination might be the institution that the person in question is based at, this does not mean that procedures and practices which disadvantage people with disabilities should

be allowed by the academic community, or that such practices are legal. Accordingly, we need to consider radically revising our processes – including those which we have become comfortable with – so that we can minimise the discriminatory effects of them. This means radically revising the peer review process[5] and the means by which academics are appointed to positions within the community, including substantive ones (i.e. PhD positions, fellowships and academic posts).[6]

The broader intellectual difficulty on the part of the HCI community which this refusal demonstrates is concerning. It demonstrates a disinclination or inability to understand disability discrimination law, or to accept the rather insistent demands which can emerge under that area of law. If the academic community displays an inability to understand these principles, then this is a serious barrier towards taking advantage of this area of law, especially in terms of having an impact upon how assistive technology is deployed and developed going forwards. This is a significant barrier for the HCI community and one which I hope to see addressed in the coming years.

Lawyer's Misunderstandings of Disability Discrimination

Compounding the above concerns is the fact that many or perhaps most judges have a poor understanding of discrimination law. This arises from the flexibility of disability discrimination law – at least in terms of how some of the underlying concepts are phrased in legislation - and the fact that it requires radically rethinking prior approaches towards legal decision making. Unfortunately, as the undergraduate employment law textbook points out, this also impacts directly on the case law [1][7]:

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[5] As we explained in some detail within the alt.chi paper, a process where the first interaction with the review process is when a work is completed is bound to be unlawfully discriminatory. This is because there is a need for reasonable adjustments to be agreed and affirmed before someone starts research: in the absence of an understanding of what a PhD involves by a University Disability Service, then this information must come from the academic community. Similarly, a review process which is 'single shot' (the typical conference reviewing model) rather than 'iterative' simply favours those who happen to be in the 'right' research group and already connected to the academic community, because those authors will have ready access to advice and assistance to give their papers a reasonable prospect of being able to get through the peer review process the first time around. And, if someone is less able to access the academic community, the current model of invitation (e.g. onto program and organising committees) rather than application is obviously going to unnecessarily disadvantage those who are less able to travel to conferences for a disability related reason.

[6] Unfortunately, most activity in the academic HCI community which asserts has the intention of enhance the opportunities for people with disabilities has been narrowly focussed. Accessibility has been conflated with disability inclusion, with the biggest interaction being on how authors ought to make PDF's accessible (rather than simply the conference moving away for an inaccessible template). Short of the ACM DL becoming generally accessible, this will have no real effect on whether or not someone is able to develop an academic career, because the visually impaired person will still not able to access the vast majority of the literature that they need (and either they will be supported in accessing that material, or they won't be, with the inevitable consequences for them if they are not). The implication is that all these efforts are now doing is distracting from addressing the fundamental problems and the root causes of under-inclusion within the academic community, rather than addressing the systematic problems in a holistic manner. Whilst that might be convenient for people who wish to maintain the comforts of the status quo, at best the current approach fails to actually grapple with the real issues and at worst, seeks to distract from them.

[7] There is a systematic culture within the UK legal system, which was documented rather directly by a barrister who subsequently became disabled. He stated that in his *"pupillage [he] learnt to view disabled people with derision and laughter. I copied the attitude of some more senior barristers towards them. In particular, there were one or two who relied for their work upon personal injury claims brought by physically and mentally disabled people. Doubtless their standard of work, of itself, was very good - but the attitude towards disabled people was demeaning. The tone taken by them was, at the best, to laugh at them and, at the worst, to belittle their chances of having the court do anything about*

> What remains is often more difficult to handle because it is not blatant. The issue is not that it is hard to prove, or that people keep it hidden. It is that some of the most intractable discrimination is perpetrated by accident, by 'good' people who simply cannot or will not accept this truth: just because (1) something has always been a certain way, and (2) nobody has bad intentions in keeping it that way, does not mean that nobody is getting unequally or unfairly hurt by it. ... Judges are no worse than other people, but neither are they any better. As a result a great many judicial decisions simply reflect the inability (or unwillingness) of judges to look past practices with which they have been comfortable for a lifetime, to see the relative disadvantage those practices and assumptions produce. In other words, some cases are just wrong, at least when measured against what equality law seeks to accomplish and actually expresses through statutory language.

This background shows the importance of understanding what happens and why in the legal setting. It is not enough to read judgements and jurisprudence to understand how the law applies to people with disabilities. This is particularly true with respect to the development of new assistive technologies, where we would hope to address how the law might apply to a novel system in several years' time, rather than how it current stands within pre-existing case law. At the same time, this existing judicial prejudice must be carefully accounted for in the design and exploration of assistive technologies, so that the negative impact of this can be minimised going forwards.

Conclusion

The concept of reasonable adjustment should be central to our consideration of assistive technology. This is because it serves as an effective boundary of what is possible: just as there is no point creating an assistive technology that someone is not allowed to use, it is also unfair not to make an assistive technology available based upon legal misunderstandings and misconceptions. An engagement with the law is therefore strategic, not only does it help ensure that the assistive technologies are always appropriate, but it also allows us to push forward boundaries, including by enhancing or supporting the implementation of the law itself. I hope that this will be a topic which becomes an increasingly important part of assistive technology research going forwards and thereby helping to ensure this academic community has a continued impact upon the lives of people with disabilities.

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their lot.[4]" Unfortunately this means that it cannot always be assumed that a Tribunal will be inclined to respect the rights of persons with disabilities. See also the Kapila Lecture by Mr Justice Brooke, as he then was [2] (this focusses on racism, but amply illustrates the underlying mechanisms of judicial discrimination against all protected groups), and also the very recent decision in Galo vs Bombardier Aerospace UK [2016] NICA 25, which underscores the existing problems with reasonable adjustments (in that case it was observed that the Industrial Tribunal of Northern Ireland failed to even issue the appropriate guidance – the Equal Treatment Bench Book – to its judges).

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