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# Designing Around People

CWUAAT 2016

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# Preface

The Cambridge Workshops on Universal Access and Assistive Technology (CWUAAT) are a series of workshops, each of which is held at Cambridge University's Fitzwilliam College every two years. This volume: *Designing Around People* comes from the 8th in this series of highly successful events, held March 2016 at the University of Cambridge.

The greatly appreciated aspect of these workshops is that they are a single session running over three days in pleasant surroundings with many delegates from home and abroad staying on site. CWUAAT allows speakers longer presentation times and question sessions, carrying discussion on through the day into plenaries. The shared social, temporal and leisure spaces generate an enjoyable academic environment that is both creative and innovative. CWUAAT is one of the few gatherings where people interested in inclusive design, across different fields, including **designers, computer scientists, engineers, architects, ergonomists, ethnographers, policymakers and user communities, meet, discuss and collaborate.** CWUAAT has also become an international workshop, representing diverse cultures including France, India, Mauritius, China, Norway, Thailand, Slovakia, USA, Belgium, UK, Denmark and many more.

In the context of developing demographic changes leading to greater numbers of older people and people with disabilities, the general field of inclusive design research strives to relate the capabilities of the population to the design of products. Inclusive populations of older people contain a greater variation in sensory, cognitive and physical user capabilities. These variations may be co-occurring and rapidly changing, leading to a demanding design environment. Inclusive design research involves developing methods, technologies, tools and guidance for supporting product designers and architects to design for the widest possible population for a given range of capabilities, within a contemporary social and economic context.

Since the last CWUAAT a strong trend has emerged whereby theoretical understandings, methods and experience gained in usability and accessibility research has become more relevant to mainstream HCI, and in particular to Human Machine Interfaces (HMI), a field largely the preserve of Ergonomists and Human Factors researchers. In the Cambridge EDC lab alone more than four new projects are currently running in conjunction with industry; in Aerospace, automotive and mobile device research, that do exactly this. The key to this new emergence is the concept behind Situationally Induced Impairments (SIID) first identified by Sears et

al. (2003) and Newell et al. (1997); and since developed in multidisciplinary labs. These make a comparison between impairment and disability arising from health origins (HIID) and that occurring as a result of situational impairments, such as through cold, vibration, poor light or by the necessity for the user to carry out a pressing primary task, such as driving or piloting an aircraft.[1]

Recent research developments have addressed these issues in the context of automotive HMI design, military aircraft cockpit workload, governance and policy, daily living activities, the workplace, the built environment, computer gaming and mobile devices. Furthermore, increasingly, themes from an architectural background addressing public spaces and a predominance of papers dealing with dementia show that pressing current issues in society are finding their way through to research motivation. These are strongly represented in CWUAAT. This now demonstrates the multidisciplinary approach that is required for the diverse, sometimes conflicting demands of design for ageing and impairment, usability and accessibility and universal access. CWUAAT is established as a dissemination platform for such work.

The workshop has six main themes, distilled from the response to the call:

## I Reconciling Usability, Accessibility and Inclusive Design

It is important to make a distinction between commonly cited methods for user-centred design such as usability and accessibility, and inclusive design. In particular, usability approached deal with common nomothetic populations and hence can use small sample sizes. Inclusive design, however, explores the margins of mainstream populations and deliberately includes unusual multi-capability people, hence it cannot but sample widely. Accessibility has always been seen as catering for impaired users who by implication are seen as disabled in some way. It focusses on special adaptions for these people. Wentz and Lazar look at the impact of software updates and revisions on inclusion, highlighting this little recognised source of exclusion. Skjerve et al. uncover hidden exclusion resulting from insensitivity to social exclusion. Another interesting approach by Chrysikou sees mental illness as excluded by architecture that reflects a lack of openness in society.

## II Designing Inclusive Assistive and Rehabilitation Systems

CWUAAT has always received a continuous stream of excellent, challenging and novel papers in assistive technology. For example, a walking aid for developing countries that adapts its shape and configuration to its users' evolving conditions (Nickpour and O'Sullivan); or a way of cuing individual leg movements during rehabilitation using haptic cues (Georgiou et al.). Telehealth systems have been heavily invested in but Chamberlain et al. explore how effectively designs have limited inclusion, through poor understanding of cultural context. Finally a literature

[1] Newell AF et al. (1997) Human computer interfaces for people with disabilities. In Helander M, Landauer TK, Prabhu P (Eds.) Handbook of human computer interaction, pp.813-824

Sears A. Lin M, Jacko J, Xiao Y (2003) When computers fade… Pervasive computing and situationally induced impairments and disabilities. In: Proceedings of the HCI International 2003, pp. 1298-1302

review by Liu and Dong examine whether and how virtual reality could be therapeutic in pain management, with positive results.

## III Measuring Product Demand and Peoples' Capabilities

Measuring product demand, as the flip side of understanding people's capabilities, has always been an essential part of inclusive design. Together they allow a sensitivity analysis of exclusion or difficulty. A classic example is Waller et al., who devise a novel method for assessing visual exclusion for icons using a method of walking backwards to beyond resolving distance. A more modern approach by Ning and Dong extends data collection into scanners and big data in order to tackle outliers in sampling. An exciting and effective design study shows how good design for Dementia really needs to understand requirements. The resulting "Day clock" product is uniquely configured and is an unusual victory over casual thoughtless design that does not take the users' needs into account. Similarly, Rogers, looks at care for Dementia in Scotland, through the eyes of each user's "perfect day", collecting a huge amount of valuable data using this simple design-led approach in conjunction with stakeholders.

## IV Designing Cognitive Interaction With Emerging Technologies

Cognitive science is now an integral part of design of human machine interfaces and interaction interfaces, primarily through considerations of working memory, mental models and visual search. At a basic level, users themselves are developing and theorising about the designs that are effective, utilising the latest technologies in HCI. Exciting new dimensions are being opened up by extending mainstream science into interaction design. New research work on cognitive control of prehension is being used in movement kinematics for the individual (Holt et al.). Emotional computing theory can assist therapy robots with non-verbal communication. Cognitive science developments tend to be at the cutting edge of research and Karam and Langdon, for example, are no different, as they explore the limitations of haptics that simply vibrate, and posit a new interaction realm of somato-sensory, cross-modal interactions.

## V Designing Inclusive Architecture: Buildings and Spaces

Arguably, one of CWUAAT's most successful development areas has been in buildings and public spaces and architectural design. This has been due to participation from KU Leuven, whose professional approach has seen some truly remarkable insights in both care and ageing through the architectural perspective. In this volume they critique users' responses to modern designs of small-scale housing for the elderly (Coomans et al.) arguing that follow-up studies may reveal failure to meet requirements. In a second study, Van Steenwinkel et al., a critical appraisal is made of dementia care facilities focussing on how older and outdated buildings present difficulties for support of dementia. Other contributors examine the important role of architecture for visually impaired navigation (Williams et al.), and how architecture and the design and usage of space is critical to stroke rehabilitation (Anåker et al.).

## VI User Profiling and Visualising Inclusion

Another growth area for inclusive design has been in the use of personae and associated methodology for developing and understanding of users' lived experience. Kunur et al. use ethnographic design as a lead-in method of developing usage cases for automotive HMI for cars of the future. They argue for an agile and inexpensive process that can be employed in a technology design area traditionally closed to human centred design, and demonstrate its concept. A complementary paper by Morris and Mueller shows how good quality user data can be collected and used as a key element in developing wireless technology that is responsive to inclusion. In particular, the extension of user profiles to disability and wider capability ranges can be an effective tool to engage technology stakeholders.

Another type of user profiling is possible when objective data about user capabilities and performance; such as eye-tracking, are used to drive adaptive interfaces to better match cognitive demand and reduce occurrences for cognitive overload (Chakraborty et al.). This adaptive approach to inclusion is increasingly popular, has featured in past CWUAAT volumes, and relies critically on accurate objective profiling to avoid clashes.

This book contains the reviewed papers from CWUAAT 2016 that were invited for oral presentation. The papers that have been included were selected by extensive peer review carried out by an international panel of currently active researchers. The chapters forming the book represent an edited sample of current national and international research in the fields of inclusive and architectural design, universal access, HMI, and assistive and rehabilitative technology.

We would like to thank all those authors and researchers who have contributed to CWUAAT 2016 and to the preparation of this book. We would also like to thank the external reviewers who took part in the review process. Many thanks are also due to the reviewing members of the Programme Committee who have renewed their intention to support the workshop series. We are grateful to the staff at Fitzwilliam College for their patience and help.

*Pat Langdon, and*
*The CWUAAT Editorial Committee*
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*March 2016*

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# Part I

# Reconciling Usability, Accessibility and Inclusive Design

# Exploring the Impact of Inaccessible Redesign and Updates

**B. Wentz and J. Lazar**

**Abstract:** For many blind users, updated software versions or revised websites, apps, and operating systems can create a situation where an interface that may have been accessible is no longer accessible, more difficult to use, or confusing. Websites, apps, and cloud-based software are modified on a frequent basis, and many organizations do not have a formal process in place to ensure that those changes comply with accessibility requirements. A web-based survey was conducted to collect feedback from users who are blind to learn more about the impact that website, software, and mobile app updates can have on accessibility and use. The results of the survey illustrate the negative impact that inaccessible updates and revisions can have on users with disabilities.

## 1 Introduction

Websites, software, apps, and operating systems are updated so frequently that many individuals rarely pay close attention to the occurrence. A user is more likely to notice, however, when an update or newer version creates a situation in which the software or technology is no longer usable, more difficult to use, or confusing. For many of the estimated 285 million individuals worldwide who are blind or have low vision (WHO 2014), it is likely that a website, app, or software update will create significant usability challenges and frustration. Publicity frequently surrounds the creation or modification of technology that results in it becoming more inclusive, and inclusive design with a focus on the user is often touted as a positive or responsible corporate decision. A more common situation is that a website, software application, or operating system that was accessible is updated and the newer version poses accessibility barriers. The sudden dearth of accessibility and usability means that the lives, education, workplace experience, and social inclusion of many individuals are negatively affected. This exploratory study begins to investigate the impact that web, software and

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technology changes and updates can have on blind users, based on the responses to a survey of 150 blind users.

## 2 Related Literature

People with disabilities often use different types of assistive technology to access computers, mobile devices, applications, and web-based information. For instance, blind users may use a screen reader, which will take what appears on the computer screen, and provide computer-synthesized speech output. Deaf or hard of hearing users may use captioning on video or transcripts instead of audio. People with motor impairments that have limited use of their hands may use a keyboard but not a pointing device (such as a mouse), or they might use an adaptive keyboard, or instead of a keyboard use speech recognition or head tracking to control their device. A set of international technical standards for making websites accessible for people with disabilities, called the Web Content Accessibility Guidelines (WCAG), has been in existence since 1999 (W3C 2012). These technical standards cover perceptual and motor impairments as well as some cognitive impairments, and are considered to be the international standard for making websites accessible. There is also a set of rules, known as WCAG2ICT, for applying the WCAG principles to all types of technologies, including operating systems and software applications. When a website, other software or OS is designed using accessibility guidelines, it meets the needs of a broad range of users. Accessible websites typically meet the needs of people with perceptual impairments (low vision or blind, deaf or hard of hearing), motor impairments (limited or no use of hands for pointing or typing), and some cognitive impairments.

A growing number of organizations are placing importance on products, applications, and web content that are designed for and usable by the widest range of users. This field of focus is often referred to as inclusive design. The basis for adhering to accessibility requirements for inclusive design is frequently derived from international standards such as WCAG, and methodologies for incorporating users directly into the development and design processes. For user experience guidelines, inclusive design research frequently points to ISO (International Organization for Standardization) standards, such as 9241 which provides guidance on usability (UsabilityNet 2006). Other ISO standards related to usability focus on things such as software development, quality standards, and ergonomics. The UXPA (User Experience Professionals Association) also maintains the Usability Body of Knowledge for the usability profession (UXPA 2010). Organizations often highlight the creation of a new product or service that adheres to inclusive design. The British Standards Institute (BSI 2005) described inclusive design as “a comprehensive framework to help all private enterprises, public sector and not-for-profit organizations ensure that disabled people’s needs are considered throughout the lifecycle of a product or service.” These concepts have been widely promoted through the efforts of organizations such as the EDC (Engineering Design Centre) at the University of Cambridge through their

"Inclusive Design Toolkit" project (EDC 2015). A closely related concept is that of universal design or universal usability (Shneiderman 2000).

Previous research has highlighted that blind users are more likely to avoid content if they know in advance that it will cause them accessibility problems (Bigham et al. 2007), and when there are barriers to completing their tasks due to accessibility challenges, there is a resulting loss of time (Lazar et al. 2007). Inclusive, accessible design has been an answer to these challenges, but the nature of technology is that there is often a constant stream of changes and updates. The need for revisions and new versions are not necessarily the problem. A significant problem does exist, however, when those new versions, updates, and revisions create a decrease in or lack of accessibility. Some organizations have shown an awareness of this problem by simply maintaining multiple versions of devices, software, and websites for a period of time. It has also been well-documented that this approach to the inaccessible update problem is neither equitable or inclusive (Wentz et al. 2011, Wentz and Lazar 2011). Asking users to simply use an older version, because the newer version is inaccessible, can also create the appearance that users with disabilities are not able to be at the cutting edge of technology, whereas nothing could be further from the truth. Furthermore, when users with disabilities choose not to update versions because of perceived accessibility barriers, it can lead to increased security threats (Vaniea et al. 2014).

While users can choose not to update to newer versions if they are not accessible and are aware of the barriers in advance, this scenario is becoming less prevalent due to the evolving nature of software. As more software moves from being updated every 2-3 years, with users choosing the updates, to instead being provided through the cloud, software updates become much more frequent, and users become less aware of them, since they are transparent to the user. The likelihood of having an update that causes accessibility barriers, also increases (Lazar et al. 2015). Cloud computing specifically increases the likelihood of the problem, since the user no longer is in control of version updating, and no longer "downloads an update."

# 3 Research Methodology

In early 2015, a web-based survey was created to collect feedback from users who are blind to learn more about the impact that website, software, and mobile app updates can have on accessibility and use. Survey data were collected during June and July 2015 from 150 respondents who were self-reported as blind and 18 years of age or older through recruitment emails sent out to organizations such as the American Council of the Blind and the National Federation of the Blind. The survey took an average of 15 minutes for respondents to complete and asked questions regarding devices used to access software and the Web as well as experiences and preferences related to software and website revisions and updates.

The survey began with an introduction to the survey and informed consent information for the respondents. Questions were adaptive, in that if a respondent did not indicate the usage of a mobile phone, no questions regarding mobile phone usage would be asked. Some survey questions required a specific answer (yes or no), a selection from a list, or a Likert-scale rating of 1 through 5. Those questions and responses will be described in section 4.1 and 4.2 below. They primarily investigated usage patterns and the existence of problems related to new versions and/or updates. Other survey questions were optional and open-ended, allowing for qualitative user feedback and responses. Those results will be described in section 4.3 below.

# 4 Results

## 4.1 Usage Patterns

The first question on the survey asked respondents to select the devices that they regularly use for software and the Web: "On a weekly basis (including both work and personal use), I use the following devices to access software and the Web (you may select more than one)." The results showed that most respondents use desktop computers (71%), laptops (68%), and mobile phones (76%) to access software and the Web. Tablet usage was reported by 18% of the respondents. This question was followed by a question asking "What is your primary desktop or laptop operating system." The majority of respondents (87%) reported that as being Microsoft Windows. For those using tablets, some version of the iPad was reported to be the dominant product (86%). For mobile phones, various iPhone models were the primary choice (84%).

## 4.2 Existence of Problems

The responses regarding the existence of accessibility problems after updates or newer versions was evidenced by the following survey data. When respondents were asked "Have you ever experienced a desktop or laptop operating system update that caused an accessibility problem after you installed a newer version?" 60% responded with a yes. For a question "Have you ever experienced, when you updated your desktop or laptop software to a newer version, it suddenly became inaccessible?" 55% of respondents reported this experience. For questions related to mobile devices and apps, 54% of respondents reported that a mobile device system update caused an accessibility problem, and 61% reported that they experienced an accessibility problem after updating a mobile app. A question specifically related to website revisions and updates asked "Have you ever experienced a website becoming inaccessible, when the site is completely re-designed or updated?" This resulted in an 80% response of "yes."

## 4.3 Tangible Impact

The survey next tried ascertain more of the impact of these problems. Respondents were asked “Has a new version or update with a website, software, or technology ever prevented you from completing a task at work?” and this resulted in a 58% response of “yes.” The majority of respondents (78%) also reported that a new version or update of a website, software or technology prevented them from using it for recreational or personal use. There was also an impact on education or training, with 51% responding that an update or new version prevented them from completing education or training.

Table 1 summarizes the responses to the question “If a new version or update of a website, software, or technology is optional, how likely are you to adopt the update or new version (on a scale of 1-5, with 1 being extremely unlikely)?”

**Table 1** Responses for adopting an optional update or new version, indicating some hesitancy to adopt new versions or updates

| Rating | Respondent Results |
|---|---|
| 1 | 8% |
| 2 | 14% |
| 3 | 34% |
| 4 | 29% |
| 5 | 15% |

When asked “Have you ever purchased a technology device, software, or paid web service because you knew it was more accessible than the alternatives?” 83% responded with “yes.” What a statement regarding the costs/benefits of creating accessible products! When asked “How likely are you to install security updates (on a scale of 1-5, with 1 being extremely unlikely)?” the majority of users still favored installing the security updates (with 71% of respondents selecting a 4 or 5). In a follow-up question, 58% of respondents reported no accessibility problems with security updates. When asked “How likely are you to install a screen reader update (on a scale of 1-5, with 5 being extremely likely)?” the overwhelming majority of respondents favored installing the screen reader update. The results of the screen reader update question are contained in Table 2. The majority of respondents (52%) reported no problems with screen reader updates in a subsequent question.

**Table 2** Responses for screen reader update or new version, indicating few concerns with screen reader updates

| Rating | Respondent Results |
|---|---|
| 1 | 7% |
| 2 | 4% |
| 3 | 12% |
| 4 | 18% |
| 5 | 60% |

## 4.4 User Experiences

Qualitative, open-ended questions were created to describe and provide examples of the problems experienced by users. For example, when the survey asked respondents about problems with a desktop or laptop operating system updates, responses included that they are "not accessible to a blind person, the screen reader failed to read the page, VoiceOver would [afterward] run sluggishly, OS functions were difficult to find afterward, or I had to downgrade to the previous OS." These were a sampling of the responses from the 60% of users that reported this type of accessibility problem. The question about accessibility barriers after updating desktop or laptop software to a newer version, resulted in comments such as: "I could not get into programs, buttons were not labelled, I could no longer receive email, or I couldn't navigate with the usual keystrokes." Again, this was the experience of the majority (55%) of respondents. The question related to problems when updating mobile device software to a newer version, resulted in comments such as: "my iPhone quit talking when I upgraded it, an iOS update caused the phone app to not allow the deletion of voice mails, I could no longer use certain apps efficiently, gestures that worked previously did not work after the update, or [I experienced] VoiceOver glitches."

When respondents described the problems they experienced when updating mobile apps to newer versions, they noted things such as "Facebook and Twitter would not work, certain parts of apps wouldn't work, buttons were no longer accessible, the screen reader would now lose focus on the app, many apps were no longer usable, new button labels did not make sense, and [there were] problems with apps such as Amazon, FourSquare, Pandora, Sirius XM, Dropbox, and Hulu+. Several iOS apps that used to be accessible, no longer are, including

the Weather Channel (which, over the course of several updates, went from fully accessible to unusable), NFL Sunday Ticket from Directv, and Delivery.com." These comments illustrate the experience of the 61% of respondents who reported these problems.

For the question related to problems when a website is updated, there were comments such as "JAWS (screen reader) hot keys no longer worked, the website was no longer accessible with Google Chrome, there was a new CAPTCHA without audio options, dropdown menus were not accessible, new buttons were not labelled, and links and labels do not make sense." Other respondents commented that this "frequently happens with banking or finance, newspaper, sports, hotel, and shopping websites (where the shopping cart no longer works)." Other respondents noted that this "happens also with hotel and airline websites, Blackboard became less accessible with the new version, and with Amazon I frequently have to use a mobile or older version." An overwhelming 80% of respondents reported this type of experience on websites.

In an attempt to report the reactions and feelings that users experience with these occurrences, the survey asked users to "describe your initial reaction when you learn about a required new version or update with a website, software, or technology that you use." It is not a surprise that the common responses included terms such as "frustration, annoyed, apprehension, stressed, and hassle."

# 5 Discussion

From a compliance monitoring point of view, software, OS, and design updates pose a major challenge. The major approaches utilized for compliance monitoring related to technology accessibility often involve either expenditures as a trigger for compliance checks or the updating of content as a trigger for compliance checks. When money is spent on new technology, there are lots of procedures in place for ensuring that the money is spent properly, and among the most successful approaches for accessibility compliance has been to use procurement contracts in government, universities, and companies. For instance, the practice of utilizing procurement contracts can require that a technology be accessible, can provide an indemnification clause so that the vendor is financially responsible for accessibility barriers, and can specify the terms under which a technology will be tested for accessibility (Lazar et al. 2015). So, the financial controls can help improve accessibility. When content is updated on a public web site, there is often an office at the government, university, or company, that approves the release of information to the public (known as an office of communications, marketing, or public information). Even with large-scale content on a website, with hundreds of content contributors, those contributors can be required to sign a contract noting that they can lose their account on the content management system for posting inaccessible content (Lazar and Olalere 2011).

But software, web design, and OS updates pose a challenge to compliance because they do not go through approval channels for finance or communication.

Often, a new version arrives without users receiving any prior notification. While an internal company system may have gone through security checks on a test server before an update, if the software/OS/website is provided externally (e.g. an application provided through the cloud), often, users will just receive a new version or a slightly modified version without any warning (Lazar et al. 2015). The large web-based email providers, such as Yahoo and Google, are using this approach of multiple rounds of minute changes to the interface, with no obvious notification to users (Goel 2015). And that new version--that new modification--may have accessibility barriers. There are not yet any published best practices of how to manage compliance monitoring for versioning updates. However, two recent legal settlements in the US (one between the tax preparation provider H&R Block and the National Federation of the Blind, and one between the grocery delivery service Peapod and the US Department of Justice) have strict requirements for accessibility testing any new versions of the web site and mobile app before they are released to the public (Lazar et al. 2015).

Commercial entities should also be aware of the purchasing decisions that users with disabilities make, as was evident in the survey results. It is also noteworthy that financial and banking apps and websites were frequently mentioned by users that experienced these problems. The 80% of respondents (noted in section 4.2) that reported problems with an inaccessible new version or update to a website underscore the impact that this deterioration of inclusive design has on blind users. If an organization became aware that 80% of its customer base or employees would be impacted by an update or new version, would they take notice? One recent example is that of the Uber iOS app. In September 2015 the iOS app that was accessible for iPhone screen reader users suddenly became inaccessible because of an update, resulting in a problem that could prevent a customer base that might be likely to engage this service to be unable to request a ride. This highlights the everyday reality of versions, updates, and accessibility. As previously noted, some organizations, educational institutions and government agencies have adopted processes for ensuring that new products and content are accessible, often by leveraging a content management system to better monitor changes to the content. According to the ongoing reports of the accessibility status of web content, however (Loiacono et al. 2009, Lopez et al. 2010, Lazar et al. 2012, Lazar et al. 2013), there is a question of how well those processes are implemented.

Clearly there is a serious flaw in the longterm implementation of inclusive design. Accessible or usable for a moment in time does not mean accessible and usable forever. What is needed is some type of maintenance process as well, similar to what is endeavored for quality or change management. Future research on inclusive design should include a focus on maintaining sustainable accessibility and usability. Product roadmaps or revisions should include a plan for maintaining or improving the level of accessibility rather than merely serve as an opportunity to update or innovate at a speed that is faster than the competition. Based on the experiences of blind users, it is obvious that social inclusion and inclusive design demand results far different than the present reality.

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# An Intersectional Perspective on Web Accessibility

**R. Skjerve, G. A. Giannoumis and S. Naseem**

**Abstract:** Socially marginalised groups experience hostility in daily life, and hostility online adds to psychological pressure. For example, hate speech, typically defined as attacks on an individual or socially marginalised group, may impact access to web content for socially marginalised groups. In addition, rendered invisibility, for example being unable to choose your gender in a web form, may act as a psychological and practical barrier to accessing web content for groups, such as genderqueer, intersex and transgender persons. Research has yet to investigate the intersectionality of web accessibility. Preliminary results from semi-structured interviews with a select group of persons that experience multiple forms of discrimination suggest that marginalized individuals expect to experience oppressive content and consider oppressive content as a part of interacting with the web. In this paper, we examine a variety of oppressive mechanisms, including ableism, racism, and transphobia, and how in combination they relate to accessing and using web content. We argue that by ensuring the accessibility of web content substantively, future researchers and practitioners can promote a more universally accessible web. By taking into consideration experiences of hostility, web developers can better support access to information and communication on the web for everyone.

## 1 Introduction

Research on web accessibility has typically focused on the promoting and ensuring the usability of web content for persons with disabilities as a means for achieving social inclusion. Web accessibility relates to the legal principle of equal opportunity, which, according to legal scholars, obligates service providers to take positive steps to prevent discrimination by designing web content for use by persons with disabilities. Contiguously, architects, technology developers, and disability rights advocates began to argue that information and communication technology (ICT) should be designed for the broadest possible population, i.e., for the universal design of ICT.

While research in a variety of disciplines such as cognitive and clinical psychology, anthropology and sociology have empirically examined gender

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