Lapses in end-to-end accessibility of modern web applications

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On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

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For many, web browsing is a mundane yet critical component of day-to-day life. Throughout their rise in popularity since the late 20th century, websites have increasingly been used for education, finances, entertainment and even supporting public infrastructure. More recently, complex sites have been labeled as “web applications”, aligning with an increased scope of features for end users. However, the ways in which users interact with these sites are often glossed over. For many, interaction is as simple as clicking with a mouse and typing with a keyboard, or — in an increasingly mobile-dominated age — swiping on a phone. For others, particularly users with disabilities, their interactions are much more complex and require additional consideration to adequately support.

Users with disabilities are a far from negligible population; an estimated 61 million, or 26% of American adults live with at least one disability (Centers for Disease Control and Prevention, 2020). The scope of these disabilities and their impact on interactions with web applications can vary, with common usage patterns including keyboard-only navigation, non-visual browsing through a screen reader or mouse-only navigation. Similarly, a majority of popular web applications today are largely inaccessible to users with disabilities; the accessibility non-profit organization WebAIM found in a 2022 survey that roughly 96.8% of the top 1,000,000 websites globally contained critical accessibility errors (WebAIM, 2022). Accessibility also extends beyond just users with disabilities. Simple adjustments such as enlarging text on a page or watching a video with captions are examples of web applications adapting to the needs of a particular user. In this sense, enhanced web accessibility is a common goal which can benefit an even larger audience.

Web applications are built using a common set of tools and languages, most commonly HTML, CSS and JavaScript. Notably, the internet is backwards compatible — standards which

guide development of these tools are iterative by nature, resulting in websites from the 1990s often still remaining functionally identical today. These standards are developed by independent organizations; notably, the World Wide Web Consortium (or W3C) is commonly viewed as the most authoritative group, publishing standards and recommendations across a wide range of web topics. These standards are consumed both by browser vendors, creating web browsers for users to use when accessing the web, as well as individual web engineers, creating user-facing web applications. By relying on shared web standards, web applications can be universal by nature and often behave functionally identically across different browsing contexts.

Within the W3C, the Web Accessibility Initiative (or WAI) publishes accessibility-focused resources, including official recommendations and educational content. Notably, the Web Content Accessibility Guidelines (or WCAG) provide recommendations for web application authors to effectively support users with disabilities, including varying degrees of success criteria (A, AA and AAA). Revisions of this document (with WCAG 2.1 being the latest) are commonly used as an objective benchmark of accessibility performance, particularly by legal entities which require accessibility compliance.

In this paper, I argue that limitations in accessibility of many web applications stem from a lack of a holistic view of web application development and the complex relationships between various actors, including (but not limited to) web engineers, standards developers, non-technical project stakeholders and educators. First, I will provide an overview of prior accessibility literature, including prior discourse on the state of web accessibility and an overview of notable case law. Next, my analysis will explore specific examples of social group relationships including ineffective web standards, lack of meaningful accessibility education for engineers and limited prioritization of accessibility work on engineering teams. Finally, I will end with

discussion of how to synthesize my findings into practical accessibility improvements for a particular social context.

LITERATURE REVIEW

Before delving into specific root causes in the larger system of web accessibility, it is worth refining the scope of "accessibility". Users with disabilities undoubtedly have highly unique and often non-overlapping workflows when interacting with the web; however, this paper will define "accessible" web applications as those which align with broader standards such as WCAG. In doing so, we can more narrowly focus analysis of web application development on intent towards supporting accessible user experiences. WCAG 2.1 explicitly notes this in its introduction, stating that "although these guidelines cover a wide range of issues, they are not able to address the needs of people with all types, degrees, and combinations of disability," (Kirkpatrick et al., 2018). Despite this limitation, standards published from established entities from the W3C provide authoritative guidance to use in more objectively guiding analysis of accessibility.

Prior web accessibility literature nearly unanimously supports the notion that the current state of accessibility in web applications insufficiently supports the needs of users with disabilities. However, perspectives on specific factors which most significantly contribute to this shortcoming vary widely. Some suggest that at a technical level, frameworks for implementing accessible applications such as WAI-ARIA are insufficient; an analysis from Stony Brook University notes that early standards defining HTML documents were not designed with accessibility in mind, and that "as the Web grows, the proverbial gap that ARIA was meant to fill only becomes larger," (Puzis et al., 2015, p. 1). Others have leaned into sociotechnical

exploration of the “digital divide”, suggesting that the inherently political nature of artifacts such as web standards necessitate broad and equitable representation of users throughout development (Adam & Kreps, 2009).

Additionally, modern United States case law suggests that web accessibility is increasingly becoming an enforceable legal requirement for entities creating web content. A recent case *Robles v. Domino's Pizza, LLC* (2019) illustrates this notion effectively: a blind user, unable to order a pizza through Domino’s online platform, argued that the business was in violation of the Americans with Disabilities Act (or ADA). In a landmark decision, a District Court ruled that the ADA was applicable, citing its clear requirement of “full and equal enjoyment of the goods, services, facilities, privileges, advantages, or accommodations”. Notably, the court ordered Domino’s to comply with WCAG 2.0, reinforcing the standard’s position as an enforceable set of requirements. A 2022 release from the Department of Justice explicitly reinforces this notion of legal enforcement, providing in-depth guidance on web accessibility and stating “[the Department of Justice] is committed to using its enforcement authority to ensure website accessibility for people with disabilities,” (*Guidance on Web Accessibility and the ADA*, 2022).

To aid in exploring relationships between various groups of actors associated with web application accessibility, I utilize Pinch and Bijker’s Social Construction of Technology (or SCOT) framework. SCOT introduces the notion of “relevant social groups”, representing actors which interface with a shared technology throughout a larger social ecosystem. Notably, social groups can be defined based on actors with a consistent perspective towards an artifact — as Pinch and Bijker describe, “all members of a certain social group share the same set of meanings, attached to a specific artefact,” (Pinch & Bijker, 1984, p. 414). For the purposes of this analysis,

a particular web application being developed can be considered the artifact at hand. Actors within relevant social groups do not necessarily need to be directly involved in development of a particular web application; for example, web standards authors remain detached from low-level development but no doubt influence the implementation of virtually all web content. In this sense, we can more effectively trace direct and implicit forces affecting end-to-end web accessibility.

METHODS

Web standards such as the W3C's WCAG are undoubtedly essential artifacts to consider in the broader chain of end-to-end web accessibility. As a result, policy analysis of WCAG revisions (especially its most recent revision from 2018, WCAG 2.1) and similar web accessibility standards was a central method throughout my research. Specifically, I'm interested in analyzing the iteration of standards since their inception and how their scope and implementation have changed alongside development of the larger web ecosystem.

More broadly, my research also relies on discourse analysis of perspectives throughout the accessibility space. I explored interpretations from both technical and non-technical accessibility advocates, contributors to standards organizations such as the W3C and non-engineer stakeholders of product development teams. Aggregating these perspectives will allow for a more cohesive portrayal of both strengths and pain points across the space, ultimately supporting analysis of relevant social groups inhibiting web accessibility.

ANALYSIS

For many web engineers, standards such as the W3C's WCAG do not effectively support day-to-day development of accessible web applications. Though often very detailed, web accessibility standards are often presented as formal, highly technical documents which are largely unapproachable to individual engineers. Furthermore, these recommendations often disregard the practical context of web applications, opting for higher-level descriptions; as described by an analysis from the University of Patras, "[standards] are often stated at such an abstract level that tends to make unclear how to operationalize them," (Katsanos et al., 2012, p. 80). While these context-independent guidelines allow standards to remain largely objective, particularly in instances of legal enforcement of web accessibility, they are ultimately ineffective in aiding web engineers largely responsible for accessible implementation.

Similarly, web accessibility standards have become increasingly technology-agnostic; while this in many ways future-proofs them and shifts their focus onto users themselves, it further discourages engineers from utilizing them in practical accessibility work. As described by former W3C Accessibility Guidelines Working Group member Joe Clark, "WCAG 2 was written and rewritten and rewritten to apply to everything. Along the way, it lost the ability to apply to the real things real developers work on every day," (Clark, 2006). Critics of this perspective may argue that decoupling of standards from low-level implementation bindings allow for platform growth independent of the lifecycle of accessibility standards. However, others counter that standards like WCAG are specifically written as *web* accessibility standards; while broader digital accessibility is an important topic, advocates like Clark suggest that keeping these standards scoped to the concerns of web applications will aid in incentivizing engineers to rely on standards themselves as effective day-to-day tools.

Within the context of SCOT, the benefits of these objective accessibility standards for two of the largest relevant social groups, web engineers and users with disabilities, remain largely contentious. To build web experiences which meaningfully address the wide range of accessibility-based needs, web engineers need resources at-hand which provide practical benefits during development. While the information contained within technical standards can be useful in some contexts, it arguably is not the most effective means of enabling engineers to serve their target users, including those with disabilities. Furthermore, this ineffectiveness highlights a gap in the social relationship between web engineers and standards developers; if standards aren't adequately supporting accessible application development, they ultimately fail to serve their most relevant audience.

In order to effectively enable development of accessible web applications, developers must also be sufficiently exposed to the accessibility space and educated on common implementation patterns. The current state of accessibility education (or lack thereof) in "coding bootcamps" and higher-level education further reinforces accessibility as an afterthought in development. A survey of top-selling web development learning textbooks found that accessibility has little to no mention in comparison to more conventional topics; within resources which do reference accessibility, content is primarily limited to surface-level concepts such as alternate text on images rather than a more holistic understanding of the needs of users with disabilities (Rosmaita, 2006, p. 3-4). Some may argue that explicit education of these topics is unnecessary — with the rise of automated auditing tools, engineers can receive specific and actionable feedback to fix lapses in accessibility. However, others rebut that accessibility must be a fundamental consideration in application design; as Abuaddous et al. suggest, "there is a real need to move away from a problem-based approach towards a design principle approach for web

accessibility. [...] emphasizing the importance of accessibility guidelines should start early in web development education," (Abuaddous et al., 2016, p. 179). Such objective, "problem-based" approaches to accessibility effectively reduce the problem to a checklist and ignore the broader goal at hand. In this sense, priorities shift towards satisfying more immediate social groups (web accessibility auditors) rather than those which applications are ultimately designed to serve: *all* users, including those with disabilities. Within the scope of SCOT, this relationship between web engineers and educators becomes arguably one of the most important when considering lapses in the end-to-end chain of accessible application development. Within a team context, engineers are often the most vocal members to encourage focus towards accessibility. However, a lack of meaningful emphasis towards accessibility in foundational education may minimize these occurrences. In this sense, educators can have significant downstream effects on social groups, both explicit (engineers) and implicit (users ultimately utilizing built applications).

Beyond adequate education, resource allocation towards web accessibility within engineering teams is another area lacking in prioritization. Designing accessible experiences for users extends beyond just engineers — in many cases, receiving buy-in from non-technical stakeholders such as product managers is essential to ensuring time can be allotted towards accessibility efforts. In many cases, these stakeholders are too distant from the problem space; a survey of designers, information officers and accessibility advocates found 64% of those interviewed agreed that "management is unaware of the importance of web accessibility," (Loiacono et al., 2009, p. 130). For those that are aware, cost of implementation is one of the most frequent concerns mentioned (*Building for Digital Accessibility at Scale*, 2022). Furthermore, accessibility is often an intangible benefit; despite providing meaningful benefits to even users without disabilities, a lack of objective performance indicators makes efforts difficult

to rationalize for some (Peters & Bradbard, 2010, p. 218). This reduced focus on accessibility arguably diminishes the value of accessibility implementation as a marketable skill — in turn, the limited amount of accessibility education resources previously mentioned may further dwindle (Abuaddous et al., 2016, p. 172).

Though prioritizing accessibility has previously been seen to some as a good-will action towards users with disabilities, recent case law has demonstrated that inaccessible applications can have legal (and thus financial) ramifications on businesses. *Robles v. Domino's Pizza, LLC* (2019) has solidified this position, providing substantial legal precedent to support accessibility as a tangible business advantage. Further legislation such as the proposed "Websites and Software Applications Accessibility Act" reinforces the relevance of Title III of the ADA for digital-only businesses, citing a goal of "[addressing] and [remedying] the systemic nationwide problem of inaccessible websites and applications," (Websites and Software Applications Accessibility Act, 2022). In the wake of these developments, incentives across various relevant social groups may shift. Non-technical stakeholders such as product managers, given a potential legal threat, may increasingly prioritize accessibility work across teams. In turn, engineers may support these endeavors earlier in the design process, resulting in fewer ad-hoc fixes and more holistic implementation. As a result, the most immediate social group, users interacting with web applications, will ultimately receive better experiences.

CONCLUSION

Narrowing systemic causes of poor web accessibility requires analysis of multiple social groups, not just engineers responsible for implementation. Furthermore, these causes are intertwined by nature, requiring a larger push than simply addressing individual problems — for

example, lack of industry prioritization reinforcing sparse accessibility education content. Given this analysis, there still is no one-size-fits-all solution to prescribe; despite this, education of the broader topic space is a valuable first step to increasing awareness and effectively promoting positive systemic change.

For engineers, this research can provide a useful glimpse into shortcomings of existing accessibility infrastructure and potentially spark accessibility advocacy; standards published by the W3C go through several steps of approval, including "Working Draft" stages which encourage feedback from the open web community. For non-technical stakeholders, these findings can provide rationale for prioritizing accessibility work, both through tangible factors such as legal and financial implications as well as more subjective consideration for equitably supporting the needs of all possible users.

Despite its far-from-ideal current standing, the future of web accessibility is looking bright. WCAG 2.2 is set to be published in 2023, including additional success criteria in more practical areas of web applications such as user authentication (Adams et al., 2023). Furthermore, previously mentioned legislation such as the Websites and Software Applications Accessibility Act will increasingly solidify accessibility as a legal right and promote the topic to a wider range of audiences. Though systemic change is undoubtedly necessary, more local improvements can be made as well — through understanding of relationships between relevant social groups, individual web applications can take steps towards meaningfully improving their accessibility.

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