Managing Accessibility in Software Systems

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Abstract

The goal of accessibility in software systems is to produce software that is accessible to users independent of limitations that they may have. Although accessibility is frequently discussed as a “feel good” topic, along with usability and other nice to haves, the authors believe that accessibility should be understood to be a central component for software quality, due to the tangible and intangible risks associated with inaccessible software. In order to achieve the goals of inclusive software, accessibility must take on a broader role and move beyond testing against predetermined standards and instead be built into the Software Development Lifecycle as a crucial component of a software project. By doing so, we can expand the margins of our community of meaning to which a software speaks.

This paper seeks to explore the following topics:

• What is accessibility, and why it’s important?
• How do we expand our understanding of accessibility in the context of Diversity, Equity, and Inclusion?
• How should accessibility be managed in this expanded “community of meaning” for the quality of information technology?

Biography

Jack McDowell works with the State of Oregon’s Statewide QA Program. The Statewide QA Program provides Quality Assurance services for Oregon’s Major IT Projects, and Quality Assurance consultation to Oregon State Agencies. Before this, he was a web developer and the chief editor of a community newspaper in Arlington, Virginia. Originally from Buenos Aires, Argentina where he lived before attending college in the US. He holds a Master’s degree in political science from the University of Oregon and a certification in ITIL.

Ying Ki Kwong is the E-Government Program Manager with the State of Oregon. Prior he was the IT Investment Oversight Coordinator in the same office and was Project Office Manager of the Medicaid Management Information System Project in the Oregon Department of Human Services. In the private sector, Dr. Kwong was CEO of a Hong Kong-based internet B2B portal and a program manager in the Video & Networking Division of Tektronix. In these roles, he has managed software based systems/applications, products, and business process improvements. He received the doctorate from the School of Applied & Engineering Physics at Cornell University and was adjunct faculty in the School of Business Administration at Portland State University. He holds the PMP certification since 2003.

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1 Introduction

The goal of accessibility in software systems is to produce software that is accessible to users independent of limitations that they may have. Although accessibility is frequently discussed as a “feel good” topic, along with usability and other nice to haves, the authors believe that accessibility should be understood to be a central component for software quality, due to the tangible and intangible risks associated with inaccessible software.

Accessibility has traditionally been focused on physical disabilities, and therefore building in accessibility usually means complying with WCAG 2.0 AA, section 508, or similar standards. Equating accessibility with standards compliance creates two important issues.

First, while content may be technically accessible, standards rarely measure the ease of use and understanding of the content which they are evaluating. Standards, in order to be broadly applicable and non-prescriptive in their implementation, set guidelines which can be achieved through different means, for example, whether an alt tag is descriptive and representative is up to the content creator and the auditor.

Second, by thinking of accessibility in terms of diversity, equity, and inclusion, we can and should expand the scope of accessibility beyond physical disabilities to also include cultural, linguistic, educational and related socio-economic factors in our understanding of accessibility.

In order to achieve the goals of inclusive software, accessibility must take on a broader role and move beyond testing against predetermined standards and instead be built into the Software Development Lifecycle as a crucial component of a software project. By doing so, we can expand the margins of our community of meaning to which a software speaks.

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2 What is Accessibility in IT Systems?

In order to address why accessibility is important, and how a broader understanding of accessibility can improve software quality, we must first understand the typical definition of accessibility. Accessibility as is normally understood in IT systems means that software products, web pages, etc. can be used by people with a variety of disabilities independently, that is, without a chaperone or employee assistance (e.g. for accessible service please call this number).¹

2.1 The role of standards.

While accessibility itself is a broadly defined topic, it is typically understood through standards, mainly the Web Content Accessibility Guidelines (hereafter WCAG) and Section 508 of the Rehabilitation Act of 1973 (hereafter Section 508). WCAG is an international standard published by the Web Accessibility Initiative (WAI) of the World Wide Web Consortium (W3C). Section 508 is a U.S. federal standard that

¹ For additional information see https://digital.gov/resources/introduction-accessibility/
mainly applies to U.S. Federal agencies, but may also apply to entities receiving federal funding, such as states or contractors.

These standards are used in order to determine whether a system is accessible. For example, there is a specific section of WCAG 2.0 which addresses which attributes a non-text image should have in order to be considered “accessible”, such as including attributes which provide a text content equivalent so that screen readers can interpret the meaning of the page\(^2\). The WCAG standard includes guidelines that cover the gamut of web elements and situations such as video content, text contrast, headings, etc., the idea being that by following these guidelines, websites and applications will be accessible.

Although not always optimal, accessibility features to support physical disabilities can be retrofitted or integrated into an existing software system to accommodate end-user needs. In practice, developers use open source or commercial software components / scripts to enhance different parts of a code base. This is usually done by modifying templates or available services, in order to achieve compliance with applicable technical standards, e.g. WCAG 2.0 or HTML5. These approaches can be quite effective as aspects of assistive technologies (AT), because modern browsers have built-in support to interpret and render accessibility features, such as ARIA label (Accessible Rich Internet Applications labels for labeling a web element) and Alt text (alternative text for describing an image). Incorporating these AT elements in a template can go a long way toward improving accessibility but, of course, only to the extent anticipated and enabled by the underlying standards.

To assure the quality of accessibility in this context, current best practices may call for different types of “accessibility testing.” First, a software system can be subjected to testing using automated tools, in order to identify non-compliance with one or more technical standards. Second, users with actual accessibility needs may act as testers during User Acceptance Testing (UAT). As an example of this type of accessibility testing, the state of Oregon may involve the Commission for the Blind or an independent contractor to perform accessibility testing of a website or an application before launch.

For the authors, one lesson learned from accessibility testing of different websites / applications is: CAPTCHA (Completely Automated Public Turing test to tell Computers and Humans Apart) as a security measure that uses visual images based challenge-response is not accessible for visually impaired users. This means alternatives to CAPTCHA need to be considered during procurement, solution architecture, software design / development, and ongoing support & maintenance – potentially impacting all aspects of the system development life cycle (SDLC) of a website or an application.

### 2.2 Multilingual Software Development

Language accessibility, like other aspects of accessibility discussed above, is often an afterthought in the SDLC of a software system. The authors believe this is a poorly understood challenge in most organizations, and multi-lingual software must be planned from the start of a project and then throughout a software system’s life cycle. This is so even though modern operating systems for computers and mobile devices support internationalization and have native support for many languages beside English through Unicode and other standards.

In fact, there is substantial experience in the software industry when comes to multilingual software development. Historically, this has to do with “localization” of software for users in different parts of the world. However, as will be discussed below in Section 4.3, this need for “localization” is increasingly in one’s own geographic locale, at least for countries with increasingly diverse demographics. In developing multilingual software, the following considerations and best practices are noteworthy:

- **Project Management.**
  - Software features that support multiple languages should be planned early, both in terms of business requirements on target languages and associated budget. This is especially

\(^2\) Web Content Accessibility Guidelines (WCAG) 2.0 provide guidelines on text equivalent content for screen readers: https://www.w3.org/TR/2008/REC-WCAG20-20081211/#text-equiv-all
true for procured systems, because unstated requirements will not be part of executed contracts and, thus, will not be delivered by contractors.

- To assure timely delivery of software in different target languages, development efforts and translation workflow must be integrated. This is important in most projects / organizations for which development effort and translation effort are managed separately.

- **Solution Architecture & Tools.**
  - Multilingual software means navigation (including the selection of languages) and user interface are in multiple languages -- not just the contents. Elements that support navigation and user interface must be translated, stored, and presented to users under programmatic controls.
  - Multilingual contents mean text, graphics, audio, and video materials in multiple languages. Text and graphic elements require translation; while audio and video elements require, at a minimum, translation of captions or subtitles. These elements must be stored and presented to users under programmatic controls.
  - Development tools for multilingual development need to be used to reduce repetitive tasks, reduce human errors, and to assure overall quality. An example of this in Linux is the gettext package for multi-lingual messages support.

- **Team Sensibility**
  - Team members should understand that multilingual software development is not “busy work,” because users that require the multilingual support would be unable to use the software otherwise.
  - Optimized user experience (UX) requires language-specific tailoring of elements that support navigation, user interface, and contents. Extra time may be needed for necessary refactoring of these elements to achieve optimal UX.

### 3 Why is Accessibility Important?

Broadly speaking, we can summarize the importance of accessibility as three points:

- Uncertain regulatory climate - is accessibility the law?
- Better Software Broader user base - does accessibility produce better software?
- Change in societal norm and corporate responsibility - does accessibility produce more inclusive software?

#### 3.1 Uncertain Regulatory Climate

The uncertain regulatory climate, particularly in the United States, has received much attention recently with the lawsuit against Domino's Pizza and subsequent lawsuits against other corporations which have met diverse outcomes. As such, it is not possible to claim with certainty that accessibility is the law, but rather that accessibility may be the law, and the penalties for not following through may be steep.

Accessibility in software products may be required due to laws and regulations and may cause significant risks to IT managers. Certain sectors have specific regulations that govern accessibility requirements, such as Section 508 that covers Federal Agencies or State laws that may require adherence to a standard such as WCAG 2.0 AA. However, the regulatory landscape is rapidly evolving, and recent US case law has applied the scope of the Americans with Disabilities Act to private companies (Domino's pizza v. Guillermo Robles no. 18-1539). As a result, software accessibility may be required for any public software product.
3.2 Better Software and Information Technology

Software that is accessible by virtue of following existing standards is likely to be more consistent and function as intended across more platforms. For example, using our example of alternative text tags (alt tags), images that are correctly tagged produce additional value beyond accessibility, such as improving Search Engine Optimization whereby search engines are able to better categorize an image, providing a fallback for all users before an image loads, and providing tooltip information. Likewise, heading structures which follow a hierarchical structure provide better structure and ease of reading for all users.

3.3 Diversity, Equity and Inclusion

Any level of improved accessibility has the benefit of improving usability and increasing the user base. For example, software which can be accessed by screen readers has the added benefit that visually impaired users will be able to use the product. In this area, there is a wide gamut of accessibility targets to meet, which are usually governed by the standards mentioned previously.

While we have so far focused on disabilities, a broader understanding of accessibility should include the goal of increasing diversity and inclusion. In international marketing, this broader understanding of accessibility is not a novel concept, and localization is commonly used.

4 Managing Accessibility

We can think of Accessibility as three distinct types: exclusionary accessibility, inclusionary accessibility based on standards, and inclusionary accessibility based on diversity, equity and inclusion.

<table>
<thead>
<tr>
<th>Impact</th>
<th>Type of Mitigation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-Physical Disabilities</td>
<td>No</td>
</tr>
<tr>
<td>Diversity, Equity, Inclusion</td>
<td>No</td>
</tr>
</tbody>
</table>

4.1 Separate but Equal

A common way of improving accessibility is to create multiple pathways to reach diverse customers. This can take multiple forms, such as:

- Text only pages
- Phone support or email requests for assistance
- Degraded service
Text only pages provide an alternative to multimedia rich experiences by copying relevant text to provide an alternative without images, colors, fonts or other elements that may cause accessibility issues for physically disabled individuals. Oregon.gov, the web portal for the State of Oregon implemented accessibility by providing such text only links but phased out this approach in order to improve accessibility.

The World Wide Web Consortium's Web Content Accessibility Guidelines 1.0 state that text-only pages should only be used as a last resort:

11.4 If, after best efforts, you cannot create an accessible page, provide a link to an alternative page that uses W3C® technologies, is accessible, has equivalent information (or functionality), and is updated as often as the inaccessible (original) page.

The Section 508 Standards make a similar statement:

(k) A text-only page, with equivalent information or functionality, shall be provided to make a web site comply with the provisions of this part, when compliance cannot be accomplished in any other way. The content of the text-only page shall be updated whenever the primary page changes.

While this may provide a similar end result, it may not provide a similar experience.

4.2 Standards-Driven Approach

The current understanding of accessibility centers on providing physically disabled people with a use experience as similar to that of non-disabled people. For example, in order to be accessible to vision-impaired visitors, a web page typically has certain attributes (such as alt tags, aria labels, headings) which enable screen readers and other assistive devices to interpret and read a page aloud. This understanding of providing a common platform has evolved from the previous understanding of accessibility that allowed a “separate but equal” way of accomplishing accessibility, such as creating text only pages. The unified approach is already an improvement, as when implemented correctly, it does not artificially degrade the user experience for disabled individuals.

As mentioned previously, one advantage of a standards-based approach is that it is easy to test a product against a standard. Numerous tools exist, such as WebAIM or SiteImprove that produce automatic reports in order to highlight areas to be improved. Further, there are specific accreditations such as the Department of Homeland Security’s Trusted Tester Program that allows individuals to become certified in order to conduct accessibility scans to determine compliance with section 508. Through these tools and programs, products can be improved in order to meet existing standards.

4.2.1 Diversity, Equity and Inclusion Shortcomings of a Standards-Based Approach

While a standards-based approach can enable compliance with a standard, there are a number of shortcomings. First, a standard cannot account for specific nuances in meaning, the comprehension level of users, their language and culture or their access to technology and tools. It is true that broad standards requirements can be included, such as ensuring that a website degrades gracefully under low bandwidth situations, but the results can vary greatly in how such a standard is implemented.

A second issue is related to economic equity. Up until now, we have mentioned in passing the use of screen readers to enable accessibility for the visually impaired. While screen readers are a viable tool from a technological perspective, their cost can often times be prohibitive. While Open Source screen

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3 For Oregon’s historical accessibility page, see: https://web.archive.org/web/20060105054832/http://www.oregon.gov/accessibility.shtml
4 https://www.washington.edu/accesscomputing/are-text-only-web-pages-accessible-alternative
5 Standards approach to testing, ease of verification, e.g. trusted tester.
6 For additional information regarding the Trusted Tester Program, see: https://www.dhs.gov/trusted-tester
readers such as NV Access\textsuperscript{7} have recently begun to fill the gap, it is important to be mindful that just because a technology is available does not make it broadly accessible\textsuperscript{8}.

### 4.3 Accessibility and the Digital Divide: Diversity, Equity and Inclusion Considerations

Using a diversity, equity and inclusion lens can help us adopt a broader understanding of accessibility, which in turn can help us reach a broader audience in an equitable way. When thinking of accessibility through these lenses, it is important to start with what the authors have previously discussed as a “Community of Meaning”. A “Community of Meaning” is a construct that embodies the linguistic, socio-economic and cultural space where an individual exists.

#### 4.3.1 Language & Culture

**Multilingual Sites.** With international travel, migration, and globalization, websites -- together with underlying software and information technology -- often need to offer services to users in different languages from different countries or cultures. For examples, agencies of the state of Oregon where the authors work often provide information in multiple languages. Besides English, these languages may include Spanish, Russian, Chinese, Vietnamese, and others.

**Plain Language.** While “Language” itself is an important consideration, it is also noteworthy to highlight that education level and literacy also play a role. A common issue seen in Government and large organizations is to have subject matter experts write content, resulting in content that is difficult for the layperson to understand\textsuperscript{9}. Mitigations for these types of issues can be put in place in multiple levels, such as conducting user acceptance tests with target audience users that are unfamiliar with jargon or using automated tools to analyze reading levels\textsuperscript{10}.

**Communication Challenges in Multilingual & Multi-Cultural Communications.** In this context, the challenges faced are similar to those in international business; except the diversity of languages and cultures may not be distant and is increasingly in one’s city, county, state / province, or country. Among professionals that work in international marketing, the typical challenges are [Keegan 2008]:

- A message may not get through to the target audience;
- A message may reach the target audience but may not be understood or may be misunderstood;
- The effectiveness of a message is impaired by noise due to competing messages from other sources that result in confusion, distraction, and miscommunication;
- A message may reach the target audience and understood but may not compel the recipient to take the action desired by the message sender.

Proponents of "one world, one voice" view (with variations such as “one team, one voice”) may argue that the world is converging and there is substantial similarity among what appeals to different groups – even if they speak different languages, come from different cultures, or have different socioeconomic backgrounds. At least in international marketing, this view is to be contrasted with proponents of “localization” that believe messages are fundamentally ineffective if they are not adapted or tailored in a culturally meaningful or sensitive way. An important ramification of this view is that literal translation, without appropriate adaptation or tailoring based on cultural and socioeconomic considerations, would be

\textsuperscript{7} \url{https://www.nvaccess.org/}
\textsuperscript{8} The State of Colorado recently amended its Accessibility Law to remove the mention of specific standards and instead focus on the concept of accessibility.
\textsuperscript{9} State of Oregon: Department of Administrative Services - Plain language
\textsuperscript{10} Hemingway Editor (hemingwayapp.com)
“lost in translation.” This then results in ineffective communications of all types, ranging from loss of
fidelity of meaning to total loss of meaning and even unintended misinformation.

To make this point more concrete, let us look at a specific example. During the state of Oregon’s early
response to the COVID-19 emergency in the spring of 2020, the state’s COVID-19 website offered
downloadable lawn signs with public service messages to encourage people to stay home and minimize
contact with others (in order to minimize the chance of COVID-19 transmission). As part of a major
communications campaign, the state translated these lawn signs into different languages. However, for
recent residents of Oregon that come from countries such as China, the idea of front lawn and the
purpose of lawn signs required some explanation, because the idea of a “lawn sign” would be quite
unfamiliar. In fact, some staff received the feedback that people that live in apartments or houses without
front lawn do not find downloadable lawn signs to be something that they can use.

4.3.2 Economic & Geographical Considerations

Additional considerations are related to Economic & Geographical considerations, such as: Under-
developed nations vs. first world countries, poverty and unaffordability, lack of funding and investment,
rural areas vs. urban. The digital divide can take a number of forms, such as compute power, types of
software used, and bandwidth.

Bandwidth: For example, limited bandwidth may make navigating through complex websites challenging
due to load times, incomplete page loads, etc.

Compute Resources: Compute resources is an interesting concept because a device with low
computing power and resources will not be able to run certain software products as well as a higher-
powered device, or not at all. Issues that may occur related to compute resources are slow loading pages
or applications crashing, and a general difficulty using applications or sites. A recent example would be
Windows 11, which set certain requirements so high that many otherwise modern devices are unable to
install it.

Required Software: For example, open-source software may be free, but may not produce the same
results. Certain software may require licenses due to proprietary technology, for example to edit a
Microsoft Video or PDF.

Browser Support: Users using operating systems which are End-Of-Life may also be unable to update
their browsers, for example Windows XP can only be updated to version 49, and Internet Explorer 8. As
such, computers with outdated operating systems or browsers may be unable to render websites.

4.3.3 Opportunities and Challenges

Managing accessibility in a diverse, equitable and inclusive way requires tradeoffs. From our discussion,
it should be apparent that stating that software should be accessible is a monumental task. Although the
authors believe that an expansive view of software quality is a central component of software quality, with
limited resources decisions must be made to prioritize accessibility improvements.

As we mentioned earlier, certain prioritizations may be dictated through laws and regulation, such as the
Americans with Disabilities Act or similar legislation. While laws and regulations provide a starting point,
expanding accessibility to cultural, linguistic and socioeconomic spaces requires additional considerations
in order to make investments where it counts.

The authors believe that these decisions themselves are context dependent and can be decided through
discourse in communities of meaning (McDowell 2020). In other words, a group of people has to go
through some sort of consensus development which matches the expectations of the community with the
best use of limited scarce resources are in order to maximize societal value. These types of decisions will
require balancing the limiting factors of effort and cost (of implementation and testing) with what is
reasonable accommodation.
In practice, this means that there isn’t a one size fits all to an expansive view of accessibility and highlights the issues of promulgating international standards as a one size fits all solution. For example, a community with diverse languages, may choose to prioritize multi-lingual accessibility, whereas a community that serves areas with low bandwidth penetration may seek to optimize content so that it requires low data. In both of these situations the risks associated are similar, that is, services are inaccessible to certain segments of the population, and yet different mitigation strategies may be appropriate.

**Conclusion**

While accessibility standards provide a good starting point for improving accessibility, they are limited in scope to disabilities and a universal understanding of accessibility. This paper has highlighted some of the shortcomings of this approach and provided alternatives to consider when implementing an expansive and inclusive view of accessibility. While there are many areas that merit additional consideration, such as linguistic, cultural and economic factors, there is no one size fits all accessibility. By working within specific communities of meaning, groups can tailor their understanding of accessibility in order to reach a consensus of where best to implement an expanded understanding of accessibility.
References


