Tending a Wild Garden: Library Web Design for Persons with Disabilities

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Nearly one-fifth of Americans have some form of disability, and accessibility guidelines and standards that apply to libraries are complicated, unclear, and difficult to achieve. Understanding how persons with disabilities access Web-based content is critical to accessible design. Recent research supports the use of a database-driven model for library Web development. Existing technologies offer a variety of tools to meet disabled patrons' needs, and resources exist to assist library professionals in obtaining and evaluating product accessibility information from vendors. Librarians in charge of technology can best serve these patrons by proactively updating and adapting services as assistive technologies improve.

In March 2007, eighty-two countries signed the United Nations' Convention on the Rights of Persons with Disabilities, including Canada, the European Community, and the United States. The convention's purpose was "to promote, protect and ensure the full and equal enjoyment of all human rights and fundamental freedoms by all persons with disabilities, and to promote respect for their inherent dignity."[1] Among the many proscriptions for assuring respect and equal treatment of people with disabilities (PWD) under the law, signatories agreed to take appropriate measures:

  (g) To promote access for persons with disabilities to new information and communications technologies and systems, including the Internet; and
  (h) To promote the design, development, production and distribution of accessible information and communications technologies and systems at an early stage, so that these technologies and systems become accessible at minimum cost.

In addition, the convention seeks to guarantee equal access to information by doing the following:

  (c) Urging private entities that provide services to the general public, including through the Internet, to provide information and services in accessible and usable formats for persons with disabilities; and
  (d) Encouraging the mass media, including providers of information through the Internet, to make their services accessible to persons with disabilities.[2]

Because the Internet and its design standards are evolving at a dizzying rate, it is difficult to create websites that are both cutting-edge and standards-compliant.

This paper evaluates the challenge of Web design as it relates to individuals with disabilities, exploring current standards, and offering recommendations for accessible development. Examining the provision of IT for this demographic is vital because according to the U.S. Census Bureau, the U.S. public includes about 51.2 million noninstitutionalized people living with disabilities, 32.5 million of which are severely disabled. This means that nearly one-fifth of the U.S. public faces some physical, mental, sensory, or other functional impairment (18 percent in 2002).[3] Because a library's mandate is to make its resources accessible to everyone, it is important to attend to the special challenges faced by patrons with disabilities and to offer appropriate services with those special needs in mind.

Current U.S. regulations, standards, and guidelines

In 1990 Congress enacted the Americans with Disabilities Act (ADA), the first comprehensive legislation mandating equal treatment under the law for PWD. The ADA prohibits discrimination against PWD in employment, public services, public accommodations, and in telecommunications. Title II of the ADA mandates that all state governments, local governments, and public agencies provide access for PWD to all of their activities, services, and programs. Since school, public, and academic libraries are under the purview of Title II, they must "furnish auxiliary aids and services when necessary to ensure effective communication."[4] Though predating widespread use of the Internet, the law's intent points toward the adoption and adaptation of appropriate technologies to allow persons with a variety of disabilities to access electronic resources in a way that is most effective for them.

Changes to Section 508 of the 1973 Rehabilitation Act enacted in 1998 and 2000 introduced the first standards for "accessible information technology recognized by the federal government."[5] Many state and local governments have since passed laws applying the standards of Section 508 to government agencies and related services. According to the Access Board, the independent federal agency charged with assuring compliance with a variety of laws regarding services to PWD, information and communication technology (ICT) includes

> any equipment or interconnected system or subsystem of equipment, that is used in the creation, conversion, or duplication of data or information. The term electronic

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and information technology includes, but is not limited to, telecommunications products (such as telephones), information kiosks and transaction machines, World Wide Web sites, multimedia, and office equipment such as copiers and fax machines.[6]

The Access Board further specifies guidelines for "Web-based intranet and internet information and applications," which are directly relevant to the provision of such services in libraries.[7] What follows is a detailed examination of these standards with examples to assist in understanding and implementation.

(a) A text equivalent for every non-text element shall be provided. Assistive technology cannot yet describe what pictures and other images look like; they require meaningful text-based information associated with each picture. If an image directs the user to do something, the associated text must explain the purpose and meaning of the image. This way, someone who cannot see the screen can understand and navigate the page successfully. This is generally accomplished by using the "alt" and "longdesc" attributes for images: . However, these aids also can clutter a page when not used properly. The current versions of the most popular screen-reader software do not limit the amount of "alt" text they can read. However, Freedom Scientific's JAWS 6.x divides the "alt" attribute into distinct chunks of 125 characters each (excluding spaces) and reads them separately as if they were separate graphics.[8] This can be confusing to the end user. Longer content can be put into a separate text file and the file linked to using the "longdesc" attribute. When a page contains audio or video files, a text alternative needs to be provided. For audio files such as interviews, lectures, and podcasts, a link to a transcript of the audio file must be immediately available. For video clips such as those on YouTube, captions must accompany the clip.

(b) Equivalent alternatives for any multimedia presentation shall be synchronized with the presentation. This means that captions for video must be real-time and synchronized with the actions in the video, not contained solely in a separate transcript.

(c) Web pages shall be designed so that all information conveyed with color is also available without color, for example from context or markup. While color can be used, it cannot be the sole source or indicator of information. Imagine an educational website offering a story problem presented in black and green print, and the answer to the problem could be deciphered using only the green letters. This would be inaccessible to students who have certain forms of color-blindness as well as those who use screen-reader software.

(d) Documents shall be organized so they are readable without requiring an associated style sheet. The introduction of cascading style sheets (CSS) can improve accessibility because they allow the separation of presentation from content. However, not all browsers fully support CSS, so webpages need to be designed so any browser can read them accurately. The content needs to be organized so that it can be read and understood with CSS formatting turned off.

(e) Redundant text links shall be provided for each active region of a server-side image map, and

(f) Client-side image maps shall be provided instead of server-side image maps except where the regions cannot be defined with an available geometric shape. An image map can be thought of as a geometrically defined and arranged group of links to other content on a site. A clickable map of the fifty U.S. states is an example of a functioning image map. A server-side image map would appear to a screen reader only as a set of coordinates, whereas client-side maps can include information about where the link leads through "alt" text. The best practice is to only use client-side image maps and make sure the "alt" text is descriptive and meaningful.

(g) Row and column headers shall be identified for data tables, and

(h) Markup shall be used to associate data cells and header cells for data tables that have two or more logical levels of row or column headers. Correct table coding is critical. Each table should use the "table summary" attribute to provide a meaningful description of its content and arrangement: <table summary="Concise explanation belongs here.">. Headers should be coded using the table header ("th") tag, and its "scope" attribute should specify whether the header applies to a row or a column: <th scope="col"> or <th scope="row">. If the table's content is complex, it may be necessary to provide an alternative presentation of the information. It is best to rely on CSS for page layout, taking into consideration the directions in subparagraph (d) above.

(i) Frames shall be titled with text that facilitates frame identification and navigation. Frames are a deprecated feature of HTML, and their use should be avoided in favor of CSS layout.

(j) Pages shall be designed to avoid causing the screen to flicker with a frequency greater than 2 Hz and lower than 55 Hz. Lights with flicker rates in this range can trigger epileptic seizures. Blinking or flashing elements on

a webpage should be avoided until browsers provide the user with the ability to control flickering.

(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 any other way. The content of the text-only page shall be updated whenever the primary page changes. Complex content that is entirely visual in nature may require a separate text-only page, such as a page showing the English alphabet in American Sign Language. This requirement also serves as a stopgap measure for existing sites that require reworking for accessibility. Some consider this to be the Web's version of separate-but-equal services, and should be avoided.[9] Offering a text-only alternative site can increase the sense of exclusion that PWD already feel. Also, such versions of a website tend not to be equivalent to the parent site, leaving out promotions or advertisements. Finally, a text-only version increases the workload of Web development staff, making them more costly than creating a single, fully accessible site in the first place.

(l) When pages utilize scripting languages to display content, or to create interface elements, the information provided by the script shall be identified with functional text that can be read by assistive technology. Scripting languages such as JavaScript allow for more interactive content on a page while reducing the number of times the computer screen needs to be refreshed. If functional text is not available, the screen reader attempts to read the script's code, which outputs as a meaningless jumble of characters. Using redundant text links avoids this result.

(m) When a Web page requires that an applet, plug-in, or other application be present on the client system to interpret page content, the page must provide a link to a plug-in or applet that complies with [Subpart B: technical standards] §1194.22(a) through (i). Web developers need to ascertain whether a given plug-in or applet is accessible before requiring their webpage's visitors to use it. When using applications such as QuickTime or RealAudio, it is important to provide an accessible link on the same page that will allow users to install the necessary plug-in.

(n) When electronic forms are designed to be completed on-line, the form shall allow people using assistive technology to access information, field elements, and functionality required for completion and submission of the form, including all directions and cues. If scripts used in the completion of the form are inaccessible, an alternative method of completing the form must be made immediately available. Each element of a form needs to be labeled properly using the <label> tag.

(o) A method shall be provided that permits users to skip repetitive navigation links. Persons using screen reader software typically navigate through pages using the Tab key, listening as the text is read aloud. Websites commonly place their logo at the top of each page and make this graphic a link to the site's homepage. Many sites also use a line of graphic images just beneath this logo on every page to serve as a navigation bar. To avoid having to listen through this same list of links on every page just to get to the page's content, a "skip to content" link as the first option at the top of each page provides a simple solution to this problem.

(p) When a timed response is required, the user shall be alerted and given sufficient time to indicate more time is required. Some sites log a user off if they have not typed or otherwise interacted with the page after a certain time period. Users must be notified in advance that this is going to happen and given sufficient time to respond and request more time as needed.

Standards-setting groups and their work

One organization that seeks to move Internet technology beyond basic Section 508 compliance is the Web Accessibility Initiative (WAI) of the World Wide Web Consortium (W3C). The mission of the WAI is to develop

- guidelines that are widely regarded as the international standard for Web accessibility;
- support materials to help understand and implement Web accessibility; and
- resources through international collaboration.[10]

The W3C published its first Web Content Accessibility Guidelines (WCAG 1.0) in May of 1999 for making online content accessible to PWD. By following these guidelines, developers create Web content that is readily available to every user regardless of the way it's accessed. The WAI provides ten quick tips for improving accessibility in website design:

- *Images and animations*. Use the "alt" attribute to describe the function of each visual.
- *Image maps*. Use the client-side map and text for hotspots.
- *Multimedia*. Provide captioning and transcripts of audio, and descriptions of video.

- *Hypertext links*. Use text that makes sense when read out of context. For example, avoid "click here."
- *Page organization*. Use headings, lists, and consistent structure. Use CSS for layout and style where possible.
- *Graphs and charts*. Summarize or use the "longdesc" attribute.
- *Scripts, applets, and plug-ins*. Provide alternative content in case active features are inaccessible or unsupported.
- *Frames*. Use the "noframes" element and meaningful titles.
- *Tables*. Make line-by-line reading sensible. Summarize.
- *Check your work*. Validate. Use tools, checklist, and guidelines at http://www.w3.org/TR/WCAG.[11]

Many libraries and other organizations have sought to follow WCAG 1.0 since it was published. Recently, the W3C updated their standards to WCAG 2.0, and the WAI website offers an overview of these guidelines along with a "customizable quick reference" designed to facilitate successful compliance. The principles behind 2.0 can be summarized by the acronym P.O.U.R.

Perceivable
- Provide text alternatives for non-text content.
- Provide captions and alternatives for multimedia.
- Make information adaptable and available to assistive technologies.
- Use sufficient contrast to make things easy to see and hear.

Operable
- Make all functionality keyboard accessible.
- Give users enough time to read and use content.
- Do not use content known to cause seizures.
- Help users navigate and find content.

Understandable
- Make text readable and understandable.
- Make content appear and operate in predictable ways.
- Help users avoid and correct mistakes.

Robust
- Maximize compatibility with current and future technologies.[12]

These guidelines offer assistance in creating accessible Web-based materials. Given their breadth, however, they raise concerns of overly wide interpretation and the strong possibility of falling short of Section 508 standards. Reading the details in WCAG 2.0 does not give any additional assistance to library Web developers on how to create a Section 508–compliant website. Clark points out that the three WCAG 2.0 documents are long (72–165 pages), confusing, and sometimes internally contradictory.[13] The goal of a library webmaster is to provide an interface (website, OPAC, database, and so on) that is both cutting-edge and accessible, and to encourage its use by patrons of all ability levels. While they have outlined a helpful rationale, the W3C's overlong guidelines do little to help library Web developers to achieve this goal.

Recommendations

Libraries today typically offer three types of Web-based resources: (1) access to the Internet, (2) access to subscription databases, and (3) a library's own webpage, all of which need to be accessible to PWD. Libraries trying to comply with Section 508 are required to "furnish auxiliary aids and services when necessary to ensure effective communication."[14] There are a number of options available to libraries on tight budgets. The first set involves the features built into each computer's operating system and software. For some users with visual impairments, enlarging the font size of text and images on the screen will make electronic content more accessible. Both Macintosh and Windows system software have universal-access capabilities built in, including the ability to read aloud text that is on the screen using synthesized speech. The Mac read-aloud tool is called Voice Over; the Windows read-aloud tool is called Narrator. Both systems allow for screen magnification. Exploring and learning the capabilities of these systems to enhance accessibility is a free and easy first step for any library's technology offerings, regardless of funding restrictions.

Libraries with more substantial technology budgets have a wide variety of hardware and software options to choose from to meet the needs of PWD. For patrons with visual impairments, several software packages are available to read aloud the content of a website or other electronic document using synthesized speech. JAWS by Freedom Scientific and WindowEyes by GW Micro are two of the best-known software packages, and both include the ability to output to a refreshable Braille display (which both companies also sell). Kurzweil 3000 is an education-oriented software package that not only reads on-screen text aloud but has a wealth of additional tools to assist students with learning difficulties such as attention deficit disorder or dyslexia. It is designed to integrate with any education package as well as to assist students whose primary language is not English. Persons with low vision needing screen magnification beyond the features Windows offers may look to Magic by Freedom Scientific or ZoomText by Ai Squared. Some of these

software companies offer free trial versions, have online demonstrations, or both. Because prices for this software and related equipment can be high, it is prudent to first check with patrons with visual impairments and professionals in the field prior to making your purchase.

Humbert and Stores, members of Indiana University's Web Accessibility Team, offer accessibility evaluations of websites and other services at the university. When asked to compare Windows and Macintosh systems as to their usefulness in assisting PWD with Web-based media, Humbert rated the Windows operating system superior, explaining that it has the proper "handles" coded into its software for screen readers and assistive technologies to grab onto. Assistive technology software is more stable in Windows Vista because its predecessor, Windows XP, "used hacked together drivers to display the information."[15] Humbert discourages the use of Vista and JAWS on an older machine because Vista is a memory hog and can crash JAWS along with the rest of the system. The Web browsers Internet Explorer and Firefox allow the user to enlarge text and images on a webpage, though Firefox is more effective. Text can be enlarged only if the webpage being viewed is designed using resizable fonts. Stores, who is profoundly visually impaired, uses JAWS screen-reader software to work and to surf the Web. She notes that both browsers work equally well with screen-reader software.[16]

An important Web-based resource that libraries provide is subscription databases. However, as one study has shown, "most librarians lack the time, resources and/or skills to evaluate the degree to which their library subscription databases are accessible to their disability communities."[17] The question is do the vendors themselves make an effort to produce an accessible product? A 2007 survey of twelve major database companies found that while most "have integrated accessibility standards/ guidelines into their search interfaces and/or plan to improve accessibility in future releases," only five actually conducted usability studies with people who use assistive technology. A number of studies have found that "while most databases are functionally accessible, companies need to do more to meet the needs of the disability community and assure librarians of the accessibility of their products."[18]

Subscription databases can be inaccessible to PWD in the display of search results and accompanying information. The three most common forms of results delivery are HTML full text, HTML full text with graphics, and PDF files. PDF files are notoriously inaccessible to persons using screen readers. While Adobe has made significant strides in rendering PDFs accessible, many databases contain numerous PDF documents created in versions of Adobe Acrobat prior to version 5.0 (released in 2001), which are not properly tagged for screen readers. Even newer PDF documents are only as accessible

as their tagging allows. Journal articles received from publishers may or may not be properly tagged, so database companies cannot guarantee that their content is fully accessible. One vendor that is avoiding this trap is JSTOR. Using optical character recognition (OCR) software, JSTOR delivers image-based PDFs with embedded text to make their content available to screen readers.[19] Librarians must insist that database packages be accessible and compatible with the forms of assistive technology most frequently used by their patrons, both in-house and online.

One tool used to evaluate database (or other product) accessibility is the Voluntary Product Accessibility Template (VPAT). Created in partnership between the Information Technology Industry (ITI) Council and the U.S. General Services Administration (GSA) in 2001, it provides "a simple, Internet-based tool to assist Federal contracting and procurement officials in fulfilling the new market research requirements contained in the Section 508 implementing regulations."[20] VPAT is a voluntary disclosure form arranged in a series of tables listing the criteria of relevant subsections of Section 508 discussed previously. Blank cells are provided to allow company representatives to describe how their product's supporting features meet the criteria and to provide additional detailed information. Library personnel can request that vendors complete this form to document which subsections of Section 508 their products meet, and how. To be most useful, the form needs to be completed by company representatives with both a clear understanding of Section 508 and its technical details and thorough knowledge of their product. Knowledgeable library staff are encouraged to verify the quality and accuracy of the information provided before purchasing.

Like databases, a library's website needs to be accessible to patrons with a variety of needs. According to Muncaster, accessible sites are 35 percent easier for everyone to use and are more likely to be found by Internet search engines.[21] Fully accessible websites are simpler to maintain and are on average 50 percent smaller than inaccessible ones, which means they download faster, making them easier to use.[22] In creating a basic site, current best practice has been to render the content in HTML or XHTML and design the layout using CSS. This way, if it is discovered the site's pages are not fully accessible, a simple change to the CSS updates all pages, saving the site manager time and effort. Finally, creating an accessible site from the beginning is substantially easier than retrofitting an old one.

A complete rebuild of a library website is an opportunity to improve accessibility. Reynolds' article on creating a user-centered website for the Johnson County (Kans.) Library offers an example of how libraries can apply basic information architecture design principles on a budget. Johnson County focused on simple, low-budget

usability studies involving patrons in the selection of site navigation categories, designing the layout, and testing the resulting user interface. By involving average users in this process, this library was able to achieve substantial improvements in the site's usability. Prior to the redesign, usability testing determined that 42 percent of users were not successful in finding information on the library's old site. After the redesign, "only 4% of patrons were unsuccessful in finding core-task information on the first attempt."[23] Even so, a quick test of the site with the online accessibility evaluation tool CynthiaSays indicates that it still does not fully meet the requirements of Section 508. Had the library's staff included PWD in their process, the demonstrated degree of improvement might have allowed them to meet and possibly exceed this standard.

An understanding of how a person with disabilities experiences the online environment can help point the way toward improved accessibility. A recent study in the United Kingdom tracked the eye movements of able-bodied computer users in an effort to answer these questions. Researchers asked eighteen people with normal or corrected vision to search for answers on two versions of a BBC website—the standard graphical page and the text-only version. Subjects' eyes tended to dart around the standard page "as they attempt to locate what appears visually to be the next most likely location"[24] for the answer. But in searching the text-only page, subjects went line-by-line, making smaller jumps across each page. Researchers determined that the webpage and its layout serve as a form of external memory, providing visual cues to the structure of its content and how to navigate it. If the Internet is an information superhighway, then the layout of a standard webpage serves as the borders and directional signs for browsing.

The visual cues and navigation aids inherent in current webpages' layouts provide no auditory equivalent for presentation to people with visual impairments. Information seeking on the Web is a complex process requiring "the ability to switch and coordinate among multiple information-seeking strategies" such as browsing, scanning, query-based searching, and so on.[25] If Web browsers could translate formatting and presentation into audio tailored to the needs of the visually impaired, the use of the Internet would be a far more satisfying experience for those users. However, such Web programming would require years of additional research and development. In the meantime, Web librarians must strive to build sites that are clean, hierarchical, and usable by all persons by following to the standards and guidelines currently available.

One way to enhance the accessibility of sites is to follow a database-driven Web development model. In addition to using XHTML and CSS, Dunlap recommends that content be stored in a relational database such as MySQL and that a coding language such as PHP be used to create pages dynamically. This approach has two advantages. First, it allows for the creation of "a flexible website design style that lives in a single, easily modified file that controls the presentation of every Web page of the site."[26] Second, it requires far less time for site maintenance, freeing staff to devote time to assuring accessibility while accommodating changes in Web technology. Such a model can be used by database vendors to ensure that their services can seamlessly integrate with the library's online content.

Use of mobile phones and similar devices to browse the Web is at an all-time high, and content providers are eager to make their sites mobile-friendly. Many of these end users experience similar barriers to accessing this content as PWD do. For example, persons with some motor disabilities as well as mobile phones with only a numeric keypad cannot access sites with links requiring the use of a mouse. Sites that follow either the W3C's Mobile Web Best Practices (MWBP) or WCAG are well on their way to meeting both standards.[27] By properly associating labels with their controls, Internet content can be made fully accessible to both end users. Understanding the similarities between MWPB and WCAG can lead to website design that is truly perceivable, operable, understandable, and robust.

■ Summary

Librarians with responsibility for Web design and technology management operate in an evolving environment. Legal requirements make clear the expectation to serve the wide variety of needs of patrons with disabilities. Yet the guidelines and standards available to assist in this venture range from complex to vague and insufficient. Assistive technologies continue to improve with many traditional vendors confident that their products are accessible. In actual use, however, substantial challenges and shortcomings remain. The challenge for technology librarians is to be proactive in keeping abreast of technological advances, to experiment and learn from their efforts, and to continually update and adapt to provide Web or hypermedia information and services to patrons of all kinds.

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