ABSTRACT

The paper considers some of the issues surrounding accessibility to Web systems and services by individuals with imperfect abilities. It is argued that, beyond the moral and legal reasons for accommodating the group, there are numerous advantages for business and commerce that can be achieved. The particular needs of disabled individuals with regard to Web content access are discussed. Then, certain common adaptive technologies that are aimed at accommodating this population are described. The intent is to provide insights into the special design requirements for Web content that these technologies demand. Two sets of standards are accessible Web content design, Subsection 1194.22 of Section 508, and W3C’s WCAG (Web Content Accessibility Guidelines), are briefly described. Finally, a business rationale for embracing adaptive technology is presented.

Keywords: assistive/adaptive technology; equality of access; Internet access; Section 508; universal design; WCAG; Web site design

Introduction

Debates concerning the problems and potential remedies surrounding the ever-growing digital divide are not uncommon. These discussions seem to most often focus on such factors as personal income (lower vs. higher) and geography (urban vs. suburban versus rural). There is, however, a significant and growing group of potential “digital have-nots” that is frequently overlooked. This group comprises individuals who have some form of physical or mental disability. While the need
for full enfranchisement of this group can be effectively argued on legal as well as ethical grounds, it can be shown to make sound business sense as well.

Consider this statistic: a startling 21.8% of Americans above the age of 16 have at least one disability that results in a “substantial limitation” of one or more “major life activities.” Examples of such disabilities are vision problems (3.5%), hearing problems (3.3%), difficulty using hands (3.0%), and learning disabilities such as dyslexia (1.4%; U.S. Department of Commerce, 2000, pp. 62-63). Each of these disabilities carries negative consequences regarding accessibility to Web-based resources.

The prevalence of disability increases with age. For example, 8.6% of Americans in the age group 16-24 have at least one disability. The percentage jumps to 52.1% when considering those of age 65 and above (U.S. Department of Commerce, 2000, p. 87). Much of this dramatic increase in rate is due to declining vision, hearing, and dexterity.

The youngest American baby boomers are now 40 years old. The average age of the population of the U.S. and of many other developed nations will increase substantially over the next few decades, as will the concomitant prevalence of physical disability. This demographic shift is due partly to the post World War II “population bubble,” but it is also due to the tremendous increase in life expectancy in modern times (an increase of 30 years since 1900 according to U.S. Administration on Aging statistics; Mosner & Spiezle, 2003). The U.S. Census Bureau projects that the segment of the American population comprising individuals of age 50 and above will grow by more than one quarter during the current decade alone (AARP, 2004).

Also growing dramatically is the average age of the workforce. Workers are delaying retirement for numerous reasons, while the rate at which younger workers enter the workforce is declining. In an increasingly Web-oriented information-based economy, worker productivity hinges on accessibility to Web-based systems. This issue demands more attention as the age of the workforce (read prevalence of physiological impairments among workers) increases.

This paper considers some of the issues surrounding accessibility to Web systems and services by individuals with imperfect abilities. It is argued that, beyond the moral and legal reasons for accommodating this group, there are numerous advantages for business and commerce that can be achieved.

Background and Nomenclature

As is the case with all technologies, the design and organization of Web content can greatly impact accessibility of that content by persons with certain physical or mental impediments. Consider, for example, those individuals who have even minor mobility or dexterity problems. This might include persons of advanced age, as well as those who suffer from arthritis, rheumatism, Parkinsonism, effects of stroke, or similar maladies. For this group an activity as simple as clicking a particular hot-zone on an image map can be difficult, depending on the size and the complexity of
the object. Even activities as common as using the scroll bar to move through the content of a Web page can be troublesome to individuals with motion impairments.

It should be noted that even conditions that are not considered disabling can negatively affect access to poorly designed Web content in certain circumstances. For example, about 8% of males worldwide are color deficient (often called color blindness). The vast majority of these individuals have problems discerning red or green. The prevalence and severity of this condition often increases with age. A commercial Web page that states that “products listed in red are currently out of stock” may convey little information to the color deficient electronic shopper.

The terms assistive technology and adaptive technology are used to describe technologies that are intended to help provide independence to disabled individuals. The two terms are often used interchangeably, but in the case of adaptive technology (AT), the focus is on providing access to products and systems which were designed for use by people who are not disabled. The Web is an example of such a system. Adaptive and assistive technologies, when applied to computing and information systems, are sometimes referred to as “electronic curb cuts.” This term makes an analogy to the decades-old federally mandated removal of curbs at pedestrian crossing points to facilitate use by persons in wheelchairs.

In the case of the Web, the adaptive technological problems can be particularly vexing because of its stateless, two-tiered (i.e., client/server) architecture. That is, the adaptive technologies reside on the client side, but the Web content can be designed and served with no knowledge of how the AT is configured, or even that such is being used. Consequently, Web content that is designed without regard for such technologies can render the content useless for the end user.

An approach to Web content design that aimed at reducing or eliminating barriers to accessibility, and at facilitating the effectiveness of AT, is said to be an accessible Web design. Related to this is the notion of universal design where the intent is to meet the needs of the broadest range of clients, regardless of their individual abilities, disabilities, circumstances, or environments. In the words of Mates (2004, p. 2), “The webpage designer addressing universal design and accessibility is more concerned with information dissemination for all, rather than visual appeal for most. When designing the document, an attempt is made to make all the material displayed as accessible as possible, whether it is a menu item, graphic, or video clip. Creating accessible Web pages may not take additional money, just more time and consideration.”

Adaptive technology on the Web can be as simple as tweaking your browser settings to display the largest text size, or to specify default colors for text and background. Most current Microsoft products, including IE, provide a set of options aimed at broadening accessibility. In the case of IE the user is able to prevent a Web page from overriding his or her choice of text colors, font styles, or font sizes. There is also an option to force the use of a local (i.e., user-supplied) style sheet for rendering the presentation.
Users with poor vision or with learning disabilities, for example, will often configure their browsers to display oversized text in a non-serif style (e.g., Arial) with a high-contrast color scheme (e.g., black on white). Features which might be distracting, such as background images and italic type, may be removed, and all text may be displayed in bold style to further enhance contrast. The implication of this with respect to Web content design is that the presentation rendered on the client side may be very different from that which is conceived in the mind of the designer. Any meaning or information that is presented only through color, text style, or the like may be lost. The principles of universal design are aimed at avoiding this.

While the previous description of employing AT — modifying standard browser behavior through intrinsic features — is relevant to this discussion, more substantial accommodations are often made through third-party solutions. In this case hardware and/or software devices and mechanisms are initially designed with a specific accommodation in mind. Two common examples of this are large-print access systems and screen-reading systems. These two types of AT are now briefly described within the context of Web-based content so that some of the complexities and special requirements can be understood.

**Web Content and Large-Print Access Systems**

Large-print access systems usually comprise a screen magnification software component and may or may not include a special large monitor device suitable for handling the large display image. Large-print access systems are used to accommodate individuals with impaired vision, but with sufficient vision to discern shapes. The systems also are of aid to individuals with certain forms of learning disabilities. These systems are projected to become more commonplace as our population ages.

With large-print access systems, the complexity with respect to Web content accessibility stems from the fact that the systems can severely distort the visual presentation, and the nature of this distortion can vary substantially. In some cases the entire page is magnified so there is relatively little geometric distortion, but only a portion of the page may be visible at one time, depending on the size of the display device. In extreme cases only one or two words may be displayed on the screen at a time.

Other software products of this type will enlarge only the textual content but leave graphic content untouched. Note that words contained within images may therefore be unreadable. Still other products will only magnify the area of the screen that surrounds the mouse pointer, or will magnify an area of the screen and will move the magnified area down the page at a fixed rate. In this latter case, the user is forced to process the information from top to bottom, regardless of the design of the content.

**Web Content and Screen-Reading Systems**

When a disability is such that large-print technology is unsuitable — say in the case of blindness, severe dyslexia, or literacy problems — a screen-reading tech-
nology may be employed. The intent of these systems, also known as audio- or speech-output systems, is to allow the user to “listen” to whatever content is presented on the screen. Output is in the form of a simulated voice that is driven by screen-reading software. Screen-reading systems are practical for any computing application where text-based output is generated. When the output moves beyond a pure text presentation of words, the efficacy of the systems can suffer if the information is improperly structured.

In the case of Web applications, screen-reading software relies heavily on punctuation and on the source markup tags to determine how textual content should be presented aurally. For example, proper use of the <H1> and the <H2> tags on a page would be required for the software to accurately interpret content as a primary heading or as a secondary heading. Text size or presentation format would not be a factor in this decision. Similarly, appropriate use of the <UL> tag followed by a series of <LI> tags would be required for the software to present the content aurally as a bulleted list of items rather than as a sequence of paragraphs, each headed with a dot icon. As for graphic elements such as charts, icons, animations, background images, button images, and so forth, the screen-reader relies exclusively on the ALT (alternate text) attribute or on the LONGDESC (long description) attribute of the image element.

Designing Web content that will be accurately interpreted by this technology can be challenging. In practice, validation of Web-based applications usually extends to the point where it is determined that the content is **visually** correct. Speech-output technology requires that the content be **syntactically** correct (e.g., just because something appears as a bulleted list when viewed in a browser, doesn’t mean that it will be interpreted as such by a screen reader).

A mouse is a visually driven device, so mice are not used with screen-reading systems. All input is provided through the keyboard, and focus is given to individual hyperlinks and form objects with the Tab key. The visual cues that normally guide the sighted user as to the requirements of input or the interpretation of output are totally irrelevant in this environment. It is vital, therefore, that all of the visual guides within Web content be supplemented with commensurate textual information so that equivalent aural guides can be provided by the system.

Graphic elements that are meant to provide information content must be coded differently from those that are intended to provide only visual enhancement. The former group should include tagged alternate text that provides as much of the information content as is practical. The latter group should have a null alternate text description (ALT = “”) to prevent the screen reader from announcing the presence of an “unspecified graphic element” to the user. Chart and graph entities should include a full summary of the content as a linked, plain text description (LONGDESC attribute or “d-link”).

With highly interactive applications, such as those involving e-commerce, it is vital that the traditional visual cues be supplemented with equivalent textual information. The disabled individual will be
tabbing through and “hearing” the individual items on an interactive Web form rather than viewing the entire form and configuring or filling in the relevant form objects with the aid of a mouse. The overall demands of the application (e.g., which fields are required and which are optional) as well as the semantic of each individual item (e.g., What is the implication of selecting this checkbox?) must be clearly detailed for the screen-reader software.

**Designing for AT: Standards and Guidelines**

Depending on the situation, accessibility of Web content may be legally mandated. The determining factor is whether the site is within the scope of Section 508. Section 508 is a part of the Rehabilitation Act of 1973. This section requires that information systems utilized by U.S. Government agencies be accessible to people with disabilities. Both in-house developed and outsourced systems fall under the purview of Section 508. For the first 25 years of its existence the principles of Section 508 were largely unenforceable and ignored. That changed in 1998 with amendments to the act instituted by President Clinton. The 1998 amendments to Section 508 provided technical standards, which are unambiguous and enforceable. Many other nations have similar legislation in place.

The intent of Section 508 is surely noble. The motivation is to “eliminate barriers in information technology, present new opportunities to people with disabilities and encourage development of technologies focused on these goals” (Light-house International, 2004a). The expectation is that Federal employees, who are disabled, as well as disabled members of the public at large, are to have access to Federal information services at the same level as their non-disabled counterparts.

While Section 508 applies to all information technology systems developed or procured by government agencies, Subsection 1194.22 has arguably been the biggest burden for agencies. This subsection has to do with Web-based, both Internet and intranet, applications and systems. The difficulty surrounding Subsection 1194.22 is understandable in considering that the accommodations legislated by Section 508 must be available to the general public. The agencies responsible for Section 508 compliance have no control over the hardware or software choices or configurations utilized by the public clients of the Web systems that they host.

Subsection 1194.22 includes sixteen specific guidelines (labeled a through p) that must be met for full compliance. Subsection 1194.22(a), for example, reads as follows: “A text equivalent for every non-text element [of the web content] shall be provided (e.g., via ‘alt,’ ‘longdesc,’ or in element content).” As another example, Subsection 1194.22(c) reads: “Web pages shall be designed so that all information conveyed with color is also available without color, for example from context or markup.” The full list of guidelines is available at http://www.section508.gov/index.cfm?FuseAction=Content&ID=12#Web.

Often confused with Section 508 is WCAG (Web Content Accessibility
Guidelines). This set of guidelines, aimed at reducing barriers to accessibility, was introduced in 1999 by the World Wide Web Consortium (W3C) as a part of its Web Accessibility Initiative. This W3C initiative commenced in 1997 and its intended purpose is best described by Tim Berners-Lee in the inaugural press release as follows: “The W3C is committed to removing accessibility barriers for all people with disabilities, including the deaf, blind, physically challenged, and cognitive or visually impaired. We plan to work aggressively with government, industry, and community leaders to establish and attain web accessibility goals” (World Wide Web Consortium, 1997). Unlike Section 508, WCAG is not a legal mandate.

WCAG comprises fourteen basic guidelines aimed at ensuring accessibility. An example is Guideline 1, which states, “Provide equivalent alternatives to auditory and visual content.” Each of the fourteen general principles is accompanied by a set (one to 10) of numbered checkpoints describing how the guideline would be applied in specific application scenario examples. Each checkpoint is assigned a priority from one to three. To denote impact on resulting accessibility, priorities one, two, and three are ascribed the respective tags must satisfy, should satisfy, and may address. In terms of WCAG conformance, Web content can conform at one of three levels as shown in Table 1. The full WCAG specification can be found at http://www.w3.org/TR/WAI-WEBCONTENT/.

The motivations behind the two standards (WCAG and Subsection 1194.22) are similar, that is, to eliminate barriers to accessibility to Web content. Their orientations differ slightly, however, because Section 508 focuses exclusively on disabilities, while WCAG also recognizes environmental and equipment factors such as noisy and poorly-lit surroundings, and hands-free applications. For this and other reasons, full compliance with one standard does not necessarily indicate full compliance with the other.

**Embracing AT:**
**The Business Rationale**

Whether legally mandated or not, at least partial compliance with Section 508, with WCAG, or with both is a responsible business practice. The case for accessible Web design is easy to make on ethical grounds alone. It is difficult to argue that Web content made available to some should not be made available to all, regardless of ability, disability, or situation. Each step toward further compliance represents an increase in potential reach of an organization’s Web-based messages and services. An organization’s employees also

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**Table 1. WCAG conformance requirements**

<table>
<thead>
<tr>
<th>Conformance Level</th>
<th>Requirements</th>
</tr>
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<tbody>
<tr>
<td>Level AAA</td>
<td>Web content satisfies all checkpoints of Priority 3 and above.</td>
</tr>
<tr>
<td>Level AA</td>
<td>Web content satisfies all checkpoints of Priority 2 and above.</td>
</tr>
<tr>
<td>Level A</td>
<td>Web content satisfies all checkpoints of Priority 1.</td>
</tr>
</tbody>
</table>
stand to realize advantages of increased accessibility to Internet and intranet-based content in the workplace. This becomes especially pertinent as the workforce ages.

As a side benefit, accessible design practices are known to simplify the structure of Web pages and Web sites much as adhering to accepted software development practices and standards leads to improved software design and performance. The end result of each of these efforts is fewer errors and simplified maintenance, leading to reduced cost.

An additional, and often unexpected, benefit of accessibility guideline compliance is that the design principles greatly facilitate accessibility of Web content by devices and technologies that are unrelated to disability. Examples of these technologies are PDAs, handheld computers, Web-enabled phones, automobile-based PCs, audio browsers, and the like. It turns out that the special requirements of these client-side devices are the same as those of most adaptive technologies; specifically, the requirement that the content be independent from display issues. Still another benefit is that the efficacy of the modified Web content is increased in less than perfect work environments, such as conditions of poor lighting, or when using older monochrome or LCD screens.

When the physical cuts in the curbs of roadways were federally mandated decades ago to allow wheelchair access, the general population realized unanticipated benefits. These physical curb cuts also facilitated the use of bicycles, roller blades, baby strollers, shopping carts, and skateboards. Similarly, the “electronic curb cuts” can simplify the use of numerous Web-enabled technologies by the population at large.

Where B2C e-commerce is concerned, the disabled population — one of the largest minorities that exists — represents a potential market niche that is largely untapped or under-tapped (Swain, 2004). Despite the heterogeneity with respect to demographic and disability factors, this market segment exhibits numerous features that should be of interest to e-tailers.

Of all adults who use the Internet, disabled adults spend twice as much time online, an additional ten hours per week, than the non-disabled. This former group is also substantially more likely (48% vs. 27%) to recognize the Internet as factor that “significantly improves the quality of their lives.” The difference becomes more pronounced (56% vs. 6%) when considering individuals 65 and older (Taylor, 2000). Slicing this market segment across other demographic factors reveals additional enticements. Granted, in almost all cases, home Internet access, as well as general PC usage is lower among disabled individuals compared to the non-disabled. However, the discrepancy diminishes as both income and education rise (U.S. Department of Commerce, 2000). In other words, it is the wealthiest and the most educated of the disabled population who are in the best position to engage in Web-based commerce.

Considering the age factor, which correlates with the incidence of physical impairment and with reliance on technology accommodation, the numbers present a clear message. The U.S. market segment comprising those of age 50 and above will increase by more than 27%
during the present decade. This age group currently accounts for more than 40% of all US consumer spending and controls 70% of the total U.S. net worth (AARP, 2004). Of all online buyers, 68% are over 40 years old (Lighthouse International, 2004b).

The segment of the population that relies on special accommodation appears, therefore, willing and ready to embrace the B2C e-commerce paradigm. They may be willing and ready, but are they able? The answer to this question may depend on the degree to which accessibility features are included in commercial Web sites and Web services.

**Conclusion**

Overall, there seem to be numerous business advantages related to accessibility conformance of Web systems. There are potential productivity gains from the aging workforce that can be realized through accommodations in Internet and intranet work environments. There are potential performance and maintenance benefits with regard to server-side systems, as well as simplified integration of newer client-side technologies. From the B2C perspective there is the potential for expanded audience reach and for increased share of an under-exploited market niche.

There is an obvious need for training and awareness of these issues by Web developers and programmers. Web content should be designed from the start with accessibility features in mind. Unfortunately, this author has found that current Web development training materials are sorely lacking on this dimension. Overall, they pay little if any attention to issues such as Section 508 or WCAG conformance. We can only hope that this situation changes in the not-too-distant future.

**References**


Stu (Wes) Westin is a professor of information systems at the University of Rhode Island. He holds an MS degree in marketing and a PhD in information systems from the University of Massachusetts at Amherst. His current research interests are in the areas of software development, and the use and adoption of information technologies. Dr. Westin has published articles in a variety of academic journals including *MIS Quarterly*, *Journal of Database Management*, *Information & Management*, *Behaviour & Information Technology*, *Telematics and Informatics*, *Information Resources Management Journal*, *Journal of End User Computing*, *Communication Research Reports*, *Journal of Marketing Research*, and *Public Choice*. In addition, he has developed numerous custom software systems for research and educational applications. He has lectured in the U.S. and in Europe on topics of information systems and information technology.