Designing Web Systems for Adaptive Technology

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INTRODUCTION

For over a decade the term *digital divide* has been used to refer to discrepancies between various population segments in terms of access to information technologies. The digital divide is in opposition to the ideal of *equality of access* in which all citizens are afforded uniform access to information and information technology. Discussions on this topic seem to most often focus on such factors as race, income, education, geography, and the like. There is, however, a significant and growing group of "digital have-nots" that is frequently overlooked. This group comprises individuals who have some form of physical, sensory, and 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 from the most recent U.S. Census. 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, according to 2005 data, 12.1% of Americans in the age group 16-64 have at least one disability. The percentage jumps to 40.5% when considering those of age 65 and above (U.S. Department of Commerce, 2006, Table S1801). Much of this dramatic increase in occurrence is due to declining vision, hearing, and dexterity (Bergel, Chadwick-Dias, & Tullis, 2005; Fox, 2004; Loiacono, McCoy, & Chin, 2005; Steinmetz, 2006).

The youngest American baby boomers are now in their forties. The average age of the population of the U.S. and of most other developed nations will increase substantially over the next few decades, as will the concomitant prevalence of physical disability (Bergel et al., 2005). 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 segment of the American population comprising individuals of age 50 and above will grow from the current 38% to 47% by the end of the next decade (Moos, 2005).

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 (Mosner & Spiezle, 2003). 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 article 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

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 or disabilities. 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 scrollbar 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 sever-

ity of this condition often increases with age. A commercial Web page that states *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 which are intended to help provide independence to disabled individuals. The two terms are often used interchangeably in the literature, but in the case of adaptive technology (AT), the focus is on providing access to products and systems which were initially 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 (2006, ch. 2, sec. 2)

The Web page 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 above 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 or software devices and mechanisms are 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 of such systems can be understood. The intention here is to illustrate how the efficacy of such systems is affected by Web content design. A full discussion of third-party AT solutions is beyond the scope of this article.

WEB-BASED EXAMPLE: 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 cognitive or learning disabilities. These systems are expected to become more commonplace as our population ages.

With large-print access systems, the complication 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