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## **An Examination of Web Site Accessibility Issues**

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### **ABSTRACT**

*The Web is becoming more important for communication and for data access. Unfortunately, not all Web sites are accessible for all users. Web accessibility is concerned with overcoming the barriers that users with disabilities face when they try to access information on Web sites. Currently, for disabled users, the Web presents many barriers that make it difficult to use. These barriers can be addressed by organizational commitment and by improved development techniques. This paper examines how Web accessibility standards and legal mandates are affecting the design of corporate and governmental Web sites, and how the rate of adoption can be improved through increased awareness and education. In addition, it discusses the current need to create a methodology to assess the accessibility skills of information systems developers.*

### **INTRODUCTION**

The Web is an important tool for communication, searching, shopping, and data gathering. The Web is accessed from desktop PCs, notebook PCs with wireless connections, and, increasingly, from mobile phones (eMarketer, 2006). In fact, search giant Google is developing services for mobile phones (Hansell, 2006). The Web is important to the "information hungry" (Bohman, 2003), and it gives people with disabilities, especially those with vision impairment or motor disabilities, new opportunities not previously available, though they still face barriers (Bohman, 2003). For example, videos without captioning are not useful to the deaf. Screen readers, or text-to-speech synthesizer software that "read" the screen to the vision impaired, and other assistive technologies require that pages be coded correctly in order to reproduce the site accurately. Those with motor disabilities cannot navigate Web sites that require a mouse. These examples point to the need for accessible Web sites (Bohman, 2003).

There is currently no law in the United States that dictates Web site accessibility, and legal issues relating to Web accessibility are open to misinterpretation. However, standards are available to guide the development of accessible Web sites. The objectives of this paper are to 1. Examine how Web accessibility standards and legal mandates are affecting the design of corporate and governmental Web sites and 2. How the rate of adoption can be improved through increased awareness and education. This paper examines the importance of Web accessibility, legal issues and regulations, guidelines and standards, levels of adoption or compliance, how accessibility issues are covered in the classroom, and how developer competence in accessibility might be assessed, in an educational setting.

### **THE NEED FOR AN ACCESSIBLE WEB**

The growing importance of the Web for communication and data access points to the need for accessibility. Web accessibility is concerned with overcoming the barriers that users with disabilities face when they try to access information on Web sites (White, Goette, and Young, 2005). "An accessible information technology (IT) solution is one that is usable by all people, regardless of ability or disability" (Brunet, et al., 2005). Currently, for disabled users, the Web presents many barriers that make it hard to use. For example, although over half of university library Web sites are accessible by the disabled, less than 20 percent of Fortune 100 Web sites are (Loiacono and McCoy, 2004). Even with assistive technologies such as screen readers some Web sites are inaccessible (Schmetzke, 2001).

These examples of accessibility barriers suggest a need for increased developer awareness, changes in the way they are trained, and for organizations to provide resources to improve the accessibility of their Web sites.

Although many Web sites are inaccessible to assistive technologies, sites from federal agencies and libraries are required to be compliant with current accessibility standards. Assistive technologies include screen readers, closed captioning displays, and special keyboards and other input devices for those with limited hand use (Brunet, et al., 2005). Moreover, the processes used to add accessibility to a Web site result in other benefits, such as improved adaptability with mobile devices ("Online Overview of WAI"). Mobile phone accessibility will continue to be an issue because nearly 30% of mobile phone users worldwide have browsed the Internet with a wireless handset (eMarketer, 2006). Thus, accessibility awareness among developers can, as a byproduct, improve Web site access for a rapidly growing application of cellular technology.

### *Demographics*

Over 100 million adults are online in the US (Internet Activities, 2005). According to a Harris Poll, Internet users who are disabled spend about twice the amount of time online as those without disabilities (Jackson-Sanborn, et al., 2002), and approximately 54 million Americans have some form of physical or mental disability (Schmetzke, 2001). Worldwide, the number of people with visual impairment exceeds 160 million; over 20 percent of these are blind (Resnikoff, et al., 2004).

These numbers, and thus the importance of Web accessibility, will grow in the coming years due to two demographic trends. The use of online shopping may increase as the U.S. population ages and begins to experience health problems accompanied by declines in vision, hearing, and physical mobility (Loiacono, 2004). The population of individuals over the age of 50 is growing faster than the world population in general, and more than 82 percent of all blind people are over 50 years of age (Resnikoff, 2004). A second factor is the significant improvements in health care that have increased the survival rate of children with disabilities (Loiacono, 2004). The numbers of people with age-related disabilities such as vision loss will increase as more of the world's population survives into adulthood (West and Sommer, 2001). The number of children and teenagers disabled in the US is estimated to be 5.2 million; these children will grow up and will be a part of the adult economy (Schmetzke, 2001). These are international trends; at least 10% of the population is disabled in most countries, thus Web accessibility will only become more important worldwide as the average age in most countries increases ("Online Overview of WAI"). These demographic trends explain why it is important for organizations to be sensitive to all users of their Web site.

Despite the fact that there are a large number of individuals who require accessible Web sites, many companies still have not employed the necessary standards. Although the majority of blind people live in developing countries (West and Sommer, 2001), disability advocates point out that the disabled community is a virtually untapped market that should be addressed (Robitaille, 2003). Moreover, the Web is beginning to displace traditional sources for news, information, commerce, entertainment, education, workplace interaction, and government services ("Online Overview of WAI"). Unfortunately, the disabled community will remain an untapped market without support from the educational community to improve developer awareness.

As security improves and more people become comfortable with Web-based shopping, the number of online shoppers will increase. Over 75 percent of people with disabilities use the Web for product searches and half make purchases online (Loiacono and McCoy, 2004), and 50 percent of working adults with disabilities shop online (Loiacono, 2004). If online retailers provide an accessible means for disabled users to shop their sites, they could likely increase their sales as well. In addition, there is a significant level of interest in e-government services, especially in developed countries (Goings, Young, and Hendry, 2003). Finally, accessibility will increase in importance in developed countries as the visual requirements of a technological workplace also increase (West and Sommer, 2001).

Improved developer awareness is one channel for improving Web site accessibility. Other factors for organizations to consider when considering the accessibility of their Web sites include their public image, regulations, potential business success, and the public efforts of advocacy groups (Loiacono, 2004). A firm can enhance its public image through "demonstrations of concern for socially marginalized groups or causes" (Loiacono, 2004). Organizations may eventually be forced to address federal involvement, including regulations enforcing site accessibility as well as various court rulings (Loiacono, 2004). Advocacy groups, such as the American Foundation for the Blind (AFB),

the National Federation of the Blind (NFB), and the American Council of the Blind are lobbying Congress and businesses to increase Web accessibility. These groups assist individuals in court cases against organizations with inaccessible Web sites, hoping to set a precedent for others to follow.

## **REGULATION ENFORCEMENT**

Accessibility alone may not compel organizations to improve Web sites accessibility. Regulatory encouragement includes the Americans with Disabilities Act of 1990 (ADA), Section 508 Amendment of the Rehabilitation Act of 1973, and other court rulings.

- **ADA** Although the ADA requires organizations to make physical accommodations for the disabled (Loiacono, 2004), the Web was virtually non-existent in 1990 (Robitaille, 2003). The ADA has been applied to the Web through lawsuits (Loiacono, 2004). Title III forbids “discrimination in public places and places where commerce is affected,” but the ADA does not explicitly include the Internet (Robitaille, 2003). However, the ADA does imply coverage of all domains, including the Internet, because according to the Department of Justice the ADA “cover[s] entities that use the Internet for communications regarding their programs, goods, or services [and they] must be prepared to offer these communications through accessible means” (Kaplan, 2000). The courts, however, have yet to agree upon whether the ADA applies to the Internet (Donston, 2003).
- **Section 508** A 1998 amendment to the Rehabilitation Act of 1973, Section 508 requires electronic and information technologies used by federal agencies be accessible to users with disabilities, provided the changes do not cause “undue burden” on the agency (Loiacono, 2004). It encourages the private sector to make similar accommodations (Robitaille, 2003). “Undue burden” is a matter of interpretation. Federal sites were given a deadline of June 2001 for compliance. However, agencies are still trying to interpret and update their sites (Donston, 2003; Yu, 2002). The Department of Education requires all states, colleges, universities, and libraries receiving federal funds from the Technology Related Assistance for Individuals with Disabilities Act of 1988 to comply with Section 508 (Zavoina, 2001).
- **Court Cases** AOL was sued by the National Federation of the Blind (NFB) because the service violated the ADA by not working with screen readers. The Department of Justice “ruled that Web sites are public accommodations and must therefore offer access to the disabled” (Heim, 2000). The NFB dropped its suit to allow AOL time to make software changes (Chong, 2003). Access Now, Inc. and Robert Gumson, a blind Web user, filed a lawsuit contending that Southwest Airlines violated the ADA because its Web site was inaccessible to visually impaired users (Donston, 2003). On appeal the court upheld the ruling that the ADA indeed did not apply to the Internet (McCullagh, 2004). A court case in Georgia pitted an individual with blindness against the Metropolitan Atlanta Rapid Transit Authority (MARTA). MARTA’s Web site showed transit schedules that were inaccessible to users who were visually impaired. The ruling stated that MARTA is a government agency, and its Web site must be accessible to all individuals with disabilities (White, Goette, & Young, 2005).

Court cases address the Internet as a public accommodation. The ADA lists places that are “public accommodations,” but it doesn’t mention the Web. The courts interpret the ADA case by case, but no single case has set precedence in the matter because the Internet was not a consideration when the ADA was passed in 1990.

Conversely, while the courts work through deciding how the ADA applies to the Internet, the concept of Web accessibility as “the right thing to do” remains. The motivations for creating an accessible Web site (the “why” do it question) will then fall into three categories:

- **Mandate** – certain entities must conform due to federal mandate.
- **Commercial Motivation** – users who need accessibility accommodations are potential customers.
- **Corporate good** – organizations should improve the accessibility of their Web sites because of a desire to be inclusive and open to the needs of many.

Interestingly, these factors are similar to the reasons Fortune 500 firms cite for creating minority and women-owned business enterprise programs to attract small suppliers (Young, 2005). The following section describes “how” organizations can develop or modify Web sites to improve accessibility.

## ACCESSIBILITY GUIDELINES

Accessibility guidelines provide standards for coding or creating Web pages that can be properly traversed by assistive technologies such as screen readers. Those assistive technologies must successfully translate the graphical user interface, which is the primary human-computer interface in existence (Brunet, et al., 2005), into a different form such as usable/readable text or a voice translation.

Two primary guidelines for Web accessibility in the U.S. are the World Wide Web Consortium (W3C) Web Accessibility Initiative's "Web Content Accessibility Guidelines" and the Access Board's Section 508 Standards. The difference between the two guidelines is that the Web Content Accessibility Guidelines apply to any site internationally while the Section 508 Standards apply only to those sites affected by Section 508.

### *Web Content Accessibility Guidelines*

The Web Accessibility Initiative (WAI) has developed guidelines for creating Web accessible content. The WAI began in 1996 by the W3C, "an international, vendor-neutral consortium that promotes evolution and interoperability of the Web." The WAI is supported by government bodies across the world as well as large firms ("Online Overview of WAI"). The WAI Web Content Accessibility Guidelines 1.0 (WCAG) explain how developers can create accessible Web sites.

WCAG rates a site's accessibility by assigning a priority level (Loiacono, 2004):

- *Priority 1* is the basic level and is a point at which some, but not all, disabled groups can use Web content.
- *Priority 2* expands beyond Priority 1 levels to "remove significant barriers."
- *Priority 3*, the highest level of accessibility under the WCAG, seeks to "improve access."

For most Web sites, Priority 1 is considered "a basic requirement [and] Priority 2 and 3, respectively 'should' and 'may' be satisfied" (Williams and Rattray, 2003). Sites are also given three conformance levels: level "A" is reached when a site meets all Priority 1 standards; "Double-A" is reached when Priority 1 and 2 are met; and "Triple-A" is earned when all three Priority levels have been satisfied (WCAG, 1999).

The WCAG consists of fourteen guidelines that include a description and checkpoints for developers of accessible content. It specifies that whenever information is conveyed through color, sound, or an image, alternative descriptions should be provided within the HTML. Using alternative text allows assistive technologies to interpret the code and relay it to the user (Jackson-Sanborn et al., 2002). Tables must be coded properly to be interpreted correctly by screen readers. According to the WCAG, tables used purely for layout purposes and not to convey tabular information should be avoided (style sheets should be used in these situations). Row and column headers should be included for all data tables to meet Priority 1 standards (WCAG, 1999). Although proposed in 1999, Priority 1 errors are commonly found in library sites (Schmetzke, 2001), U.S. federal government Web sites (Jackson-Sanborn et al., 2002), sites in the U.K. (Williams and Rattray, 2003), electronic journal search pages (Coonin, 2002), and retail sites (Loiacono and McCoy, 2004).

Design requirements vary by type of disability. The types of accommodations required for accessibility include descriptions/captioning of graphics or video, well marked tables and frames, and input alternatives such as speech. Accessibility guidelines focus on increasing usability for people with visual impairments, however developers must also consider users who are deaf, have physical limitations, or have cognitive disabilities. Technically, accessibility is provided by separating data presentation information (e.g., HTML tags) from the semantic information that describes the content of the data or image being presented (Brunet, et al., 2005).

The U.S. Access Board establishes guidelines in all areas of accessibility. The organization created standards for compliance with Section 508 of the Rehabilitation Act. Most Fortune 100 companies (94% based on Section 508 criteria) do not provide fully accessible home pages (Loiacono, 2004). All federal sites, and organizations doing business with the government, must comply with these standards if compliance does not cause "undue burden." A site that satisfies WCAG Priority 1 must meet the following additional standards to be Section 508 compliant ("Electronic and Information Technology Accessibility Standards", 2000):

- Any information provided by scripts used to display content or create interface elements must be identified with text that is readable by assistive technologies (screen readers).
- A link must be provided to an accessible compliant applet or plug-in when such technologies are required to interpret page content.
- All information, field elements, and functionality required for the online completion of an electronic form must be work with assistive technologies.
- Users must be allowed to skip repetitive navigation links.
- Users must be alerted, given sufficient time, and be able to request more time when a timed response is required.

### *Implementation of Accessibility Standards*

Although only minor adjustments may be necessary to make Web pages more accessible, few organizations make accessibility a priority. For example, in a recent examination of state government Web sites, over 30% showed Priority 1 errors and nearly 98% had Priority 2 errors (White, Goette, and Young, 2005). Organizations may “lack awareness of the issue, time constraints, and the general stress of having to keep up with new technologies and modifications to Web sites” (Loiacono, 2004). It may be in an organization’s best interests to be proactive in the areas of Web accessibility (Loiacono, 2004). A significant barrier to implementation is that most companies are not currently required to follow guidelines of the ADA and Section 508 (Yu, 2002). In addition, accessibility features are often added as a technology matures rather than be designed in from the beginning (Brunet, et al., 2005).

Unfortunately, organizations are not motivated to make their Web sites accessible to the disabled because they often do not anticipate significant returns on the investment, arguing that the market isn’t big enough. Organizations believe that making their site accessible will be costly and that they will have to replace attractive graphics with a plain site that has large fonts (Heim, 2000), which leads to unnecessary hostility between Web designers and people with disabilities (Bohman, 2003).

In a study of commercial and government sites, Jackson-Sanborn et al. (2002) found that many businesses do not feel that making accommodations is justifiable and the disabled population is not large enough. Thus, some large corporations have not completed the adaptations to make their Web sites accessible. “Companies that overlook this market may be doing so at long term risk to their legal position, public image, and ultimately, their business success” (Loiacono, 2004). Loiacono (2004) found few corporate home pages are accessible; less than 20% of Fortune 100 home pages were fully accessible to people with disabilities, only 6% of sites were approved under Section 508 guidelines, and none were approved under the WCAG guidelines.

Libraries and their information resources must be accessible under an extension of Section 508. In Schmetzke’s (2001) study of university libraries and library schools, the Web sites of twenty-four highly ranked library schools and their university libraries were evaluated under Section 508 guidelines. The average percentage of approved pages per Web site was 59% for libraries and 23% for library schools tested. However, compliance percentages for both categories ranged from 0 to 100%. The low rate of compliance from library schools suggests a lack of awareness among staff and faculty (Schmetzke, 2001).

The accessibility of federal agencies, which spend \$30 billion on information technology products and services each year, is regulated by Section 508. West (2003) examined the Web sites of federal agencies, as well as states and city governments using Bobby (a popular site compliance tool) for WCAG and Section 508 compliance, finding that federal sites were generally more compliant than state and city government sites.

Although compliance is higher for government entities than for commercial Web sites, the percentage of government sites is still low. Section 508 lacks the same level of enforcement as buildings, which are regulated and enforced to be accessible. Nonprofit organizations could encourage accessibility by publicizing and commending agencies that are doing exemplary jobs of making their Web sites accessible (West, 2003). A few countries outside of the United States have set Web accessibility guidelines into law. For example, Britain’s Disabled Discrimination Act included Web accessibility guidelines in 1999 and went into affect in 2004 (Lacy, 2004).

Determining which standards to use and what changes to make is the first challenge in developing an accessible Web site. The standard will be the WAI's WCAG guidelines for many organizations. However, the site must also comply with Section 508 if the organization is a library, university, government-related, or has federal contracts.

Typically, complete redesigns are unnecessary to update a Web site for accessibility and any changes are made within the HTML. Sites designed with templates or cascading-style-sheets are significantly easier to update. Even when a full redesign is called for, most sites can remain visually similar to previous versions. The costs for these changes may be minimal and organizations complaining about the expense of making a Web site accessible may misunderstand the exact number of changes necessary (Jackson-Sanborn et al., 2002). For example, a common problem with Web accessibility is often the failure to provide alternate text for all images (Loiacono, 2004). Alternate text is needed for screen reader technology. While not as easy to fix, absolute instead of relative sizing of text was found on 99% of the home pages examined. Site visitors, especially those that are visually impaired, often must change the text size and thus these sizes should not be an absolute fixed size, but should be adjustable. Other accessibility problems were: not explicitly associating form controls and their labels, requiring the use of a mouse for event handlers, lack of public text identifiers, and multiple links to the same page using different link phrases (Loiacono, 2004).

Jackson-Sanborn et al. (2002) evaluated six categories of sites, finding that most (66.1%) failed accessibility testing for WCAG Priority 1. Government sites had the highest (60%) pass rate, followed by colleges (43%), clothing sites (40%), international sites (29%) job sites (19%), and overall most popular sites last (15%). Most of the errors found would have no visible effect on the site's design if corrected, and other errors that would impact the design could be coded differently thus keeping the same site appearance (Jackson-Sanborn, et al., 2002). Other than government sites, most sites do not meet the lowest levels of accessibility standards (WCAG Priority 1 and 2). More than three-fourths (77%) of Fortune 100 companies failed to add alternate text to all images and nearly all (96%) use absolute instead of relative positioning. Unfortunately, even most (60%) of the leading disability Web sites in the United Kingdom fail to meet the standards ("Disability 50 Report", 2004).

### *Testing Tools*

Tools can evaluate a site's accessibility against Section 508 and the W3C's WCAG standards (Donston, 2003). A popular accessibility tool is WebXact (<http://webxact.watchfire.com/>). The free online validator can test a Web site against both WCAG and Section 508 standards and provide prioritized suggestions based on the WCAG. Critical issues can be identified during the design process before a site is released to the public (Bobby Online, 2005). The WAVE tool lets users enter a URL to be tested on the Web site, uploading the page to be tested, or via the browser toolbar. When tested, the page is displayed in the user's browser along with icons that mark areas in question for the developer (WAVE, 2005).

## **IMPROVING ACCESSIBILITY AWARENESS**

Organizations can be educated about accessibility in two ways (Jackson-Sanborn et al., 2002). One way is to encourage universities and vocational schools to include accessibility as part of the fundamentals of Web design. Trade journal and magazine articles would educate professionals outside of education fields. A second approach is for designers to use assistive tools evaluate their sites, thus motivating designers to make their sites more accessible.

Professional training, in the form of books, workshops, courses, and online materials, through presentations, workshops, and tutoring is essential for applying accessibility standards (Bohman, 2003). In these ways a developer can be taught Web site compliance, but it takes practice to use the methodologies, so ongoing education is needed through consultants, classes, and discussion groups (Bohman, 2003).

For colleges and universities, accessibility should become part of the standard computer science or information systems curriculum. Students normally take a foundation course in Web design and HTML. The coding and methodologies of Web accessibility should be included in this entry-level course. For instance, as a student learns how to add an image to a Web page, he/she can also be taught the importance of alternate text. Upper-level Web programming courses could include accessibility in the curriculum, focusing on usability along with appearance by demonstrating the appropriate use of HTML tables and form elements.

Some universities offer degrees in Human-Computer Interaction, which emphasize how computer interfaces are designed and implemented and the way users interact with them. Usability in these curricula could also include accessibility. Graduates are considered to be specialists in the area of interface design and evaluation. However, there are far more IS/IT graduates (not to mention people with no training whatsoever) who develop Web and other software interfaces without this usability expertise. Thus, it is important to add basic usability and accessibility content elements to the traditional IS/IT courses when interfaces are discussed.

Education is important for increasing the adoption of Web accessibility standards, and it avoids legal mandates. Computer science and information systems students could graduate with the knowledge needed to apply accessibility standards if exposed to accessibility standards in both introductory courses and upper-level Web programming and design courses. Once they enter the workplace, these students, along with other coworkers who have received accessibility training, could influence organizations to develop accessible information systems. As with security, accessibility should become designed in rather than simply an afterthought.

### *Teaching Web Accessibility*

Some textbooks include a chapter, or at least mention, web accessibility issues, but others do not. Therefore, it is worth the time and effort to prepare a basic lecture on why accessibility is important. By thoroughly discussing accessibility in the classroom, an instructor can make students aware of how the ADA applies to Web page design. Accessibility should be discussed in all information system classes that deal with user interfaces or information systems design issues. Many students are not aware of accessibility and making more individuals aware of Web page accessibility is, therefore, appropriate for instructional faculty. However, awareness alone does not usually lead to accessible Web pages.

In order to create accessible Web pages, students must be required to create accessible pages for a class. By using the W3C accessibility guidelines in class, students can learn to design accessible Web pages from the beginning. A screen reader cannot read graphic images on a Web page without alternative text (alt) attributes for the images (Brunet, et al., 2005). Thus, in a classroom setting, if a student is always taught that an "alt" tag is required for an image (i.e., points are lost on an assignment if there is no alt tag), then the student will always put an alt tag for an image because that is how the student learned to design a Web page. In like manner, other accessibility guidelines can be easily incorporated into existing assignments.

One requirement that should be enforced is the validation of pages for accessibility. By going to <http://webxact.watchfire.com/>, a student can validate his/her page for accessibility. The service is free, and the report shows which guidelines are validated and how improvements may be made. Webxact™ is not the only validator available. Another is <http://www.cynthiaasays.com/>. Using multiple tools provides a better overall result (i.e., a more accessible Web site) because different tools are better at finding certain problems.

If validation is required, then students will quickly learn what type of code causes problems. Conversely, if validation is not required, then students do not believe that validation for accessibility is really important. Students will begin to recognize the importance of creating pages that are accessible if instructors require Web pages to meet Priority 2 Guidelines for accessibility.

Once students are graduating with the knowledge that accessibility is important, and they have the skills to create accessible Web pages, then the Internet will (slowly) begin to be a better place for individuals requiring accessible Web pages. Unfortunately, improving accessibility awareness among the current cohort of students does not directly address the lack of awareness of in-place developers and does not compensate for the huge inventory of existing Web sites that were not developed with accessibility in mind. In addition, accessibility will only improve as organizations dedicate system development resources to address the problem.

## **ASSESSING ACCESSIBILITY PROFICIENCY**

Organizations must not only adopt (or in the case of accessibility develop) appropriate technology but employees must be willing and able to use that technology well. In order to provide well-trained employees, educational systems must ensure that technology takes center stage (Devi, 2002). In many instances, especially in primary educational units, technology is used as a learning tool to explore other subjects. The focus is not on teaching



technology, but rather learning *with* technology (Devi, 2002). Unfortunately, user competence with information technology is critical given its direct relationship with workplace productivity (Magnet, 1994). In regards to teaching accessibility, instructors must create a new generation of developers who are aware of, educated in, and willing to incorporate accessibility into the Web sites they build.

The measurement of user (or developer) competence, however, is difficult. In a very thorough review of the literature concerning user competence, Marcolin, Compeau, Munro, and Huff (2000) discuss the lack of a consistent definition for the concept of user competence in the current literature. They report that not only are different terms, such as user proficiency or user literacy, used to describe the concept, but in many cases, the measurements of these concepts differ greatly. Measurement techniques used in the literature include paper and pencil measures, self reports of ability, and typologies (see Marcolin, et al., 2000 for this review). These different approaches yield different results, even when measuring a single concept. Marcolin et al. suggest that the type of competence must be defined specifically and the type of measurement used must be factored into the conclusions that are drawn from the research. Again, in regards to measuring accessibility competency, the industry will need to begin developing a set of standards to measure developer competence in creating accessible Web sites. The standards exist already for measuring the accessibility level of a Web site (i.e., the end product); what remains is the creation of standards to measure the accessibility skills of the developers (i.e., the producers of the end product).

An example of the defined competence approach was utilized by Carnes, Awang, and Robles (2004) when developing an assessment project for an office and business information systems program. Business leaders, faculty, graduates, and administrators helped identify those skills and professional competencies that were necessary to succeed in the work force. The assessment instruments were designed to evaluate those competencies in a business success context. The results of this project were then used to assess the program and to provide feedback for continued program improvement. Carnes, et al. conclude that the use of a content validation program assessment can enable educators to assess and modify programs to meet the needs of students, potential employers, and any academic standards. The existing accessibility standards define outputs; the industry needs a set of "accessibility competencies" against which it can measure the skills of developers in creating accessible Web sites.

## CONCLUSION

This paper has examined the "what," "why," "how," and "where" questions concerning accessibility. The focus of accessibility is on designing products that are usable by the "widest range of people, operating in the widest range of situations, as is commercially practical" (Brunet, et al., 2005). Surveys reveal a growing need for Web accessibility and concerns about the visual requirements for functioning in the marketplace of developed world economies. Studies show that the current level of Web accessibility is at best mixed for both commercial and government Web sites. Sites may require a rewrite to become accessible, but prior studies show that the costs of adapting Web sites are not as intensive as many companies would think. Web accessibility also calls for sites to be more thoroughly tested and evaluated; this practice can be done with various on-line tools.

Education is critical to increasing accessibility standards adoption by Web developers. Web developers must consider accessibility from the very beginning of site design. For example, use case diagrams (an object-oriented technique) are created early in the development cycle, in part, as a way of identifying key users of the system. Developers should be sensitive to all potential users, including those with accessibility issues, as they begin user interface design.

This paper has proposed avenues for improving accessibility awareness among computer science and information systems students. In addition, this paper suggests the importance of developing and assessing developer competence in accessibility. We can measure site accessibility, but we cannot currently measure developer competencies in building accessible sites. Measuring developer competence is, therefore, an issue for future research.

In summary, improvements to accessibility will come as developers are trained (to understand the standards, develop sites that conform to guidelines, and use assistive tools to test for conformance), and as organizations become aware of the importance of accessibility and commit resources to address the accessibility of their Web sites.

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