Web Accessibility

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Abstract

The increasing provision of Web-based information resources has moved from a simple text interface to dynamic and interactive designs. While this move has provided people with a more creative and flexible experience, there are dangers that some people will be excluded because they cannot use standard methods of access. Research has shown that people with disabilities are most at risk of being excluded from access, and in particular people who are blind or visually impaired and who use assistive technologies such as screen readers. In a library environment, ensuring access for all is important because the method of delivery is predominantly Web-based and the development of e-book provision will provide increased opportunities to access library services remotely. This article reviews some key issues relating to Web accessibility, identifying methods of access, principles of accessibility and usability, and how Web accessibility can be assessed. Studies show that despite a growing awareness of Web accessibility issues, people are still experiencing barriers to access. Research initiatives identified in this article, and the development of the W3C WAI WCAG version 2.0, show that the research momentum is being maintained, and together with specific library-oriented research this can only be positive for the development of the profession's practice in this area.

Introduction

The accessibility of Web-based information can be improved in two principal ways: through the use of access technology and through adopting good practice in interface design. Both are of equal importance: provision of assistive equipment (adaptive, enabling, or access technology)

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will enable a visually impaired user to access on-screen information receiving output in a way that is appropriate to their needs. However, in addition to this, the information provided on screen must be presented in a way that can be interpreted by any kind of access technology. This is what is referred to as "accessible Web design," "design for all," or "universal design." The need for a universal approach has been driven by the increasing complexity of the design and delivery of Web-based information, moving from a predominantly text-based interface to a dynamic, multimedia interface offering visual, audio, and interactive ways to access and use the information provided.

"Design for all" in a library environment basically means that library information technology (IT) systems and interfaces must be designed in a way that enables them to be read and interacted with easily by all users of the library, whether they physically are visiting the library itself or accessing it remotely and regardless of any disability or access preference they may have. The Royal National Institute of the Blind (RNIB) describes "design for all" in relation to Web sites as "a single version of the Web site which is accessible to everyone" and that "well designed graphics and multimedia are a positive aid to using and understanding websites, and do not need to be sacrificed for accessibility" (RNIB, 2005). This is a general shift away from the provision of parallel "accessible" Web sites, such as the provision of a text-only version, to the provision of a single version that is fully accessible.

A number of factors have contributed to the case for Web accessibility. These have been outlined by the World Wide Web Consortium (W3C) as a "Business Case for Web Accessibility" (Henry, 2005) and include the following headings:

- Social factors
- Technical factors
- Financial factors
- Legal and policy factors

Considering the points above further, the social case for Web accessibility lies in the belief that everyone has a right to access, not just people who can afford the technology or who access it via standard equipment and browsers. As well as helping people with disabilities to gain access to electronic information, it is generally accepted that good design for accessibility is good design for everyone. This is becoming even more apparent since people are accessing the Web in so many different ways, such as via a mobile phone, PDA, or a Palmtop computer. However, there are particular groups who will benefit even more from accessible design, including

- people who are blind (either totally blind or with no useful sight) who need to use screen reading technology or refreshable Braille to access the Web;

- people with a visual impairment who need to use screen magnification or screen enlargements/adjustments;
- people with a learning difficulty such as dyslexia who need to adjust the screen or text or who use screen reading aids;
- people who have a hearing impairment and need to have any audio or sound captioned or described in text; and
- people who have a physical impairment that does not allow them to use a mouse, or who need to use assistive technologies such as joysticks, switches, or speech input to access the Web.

Of the above groups, the people who would most benefit from good Web design are generally people who are blind, partially sighted, or dyslexic, and in particular those who use screen reading technology (DRC, 2004).

From a technical point of view, Web accessibility is important to ensure interoperability between different applications and to enable users to access the Web using their preferred format. This could be via assistive technology to interact directly with the site or to download information into an alternative format.

Financial motives for ensuring Web accessibility will be varied, as organizations have different reasons for establishing a Web presence. It may be to disseminate information about the organization, promote the services it delivers, provide links to related information, or for buying and/or selling goods and services. Being seen as supporting accessibility is also important to business image.

Current and impending legislation (both in the UK and other countries) relating to the provision of services to disabled people has forced many organizations to reconsider their strategies and policies for service provision (see Cabinet Office, 2005; Oppenheim & Selby, 1999; Ormes, 2001). In the UK the Disability Discrimination Act (DDA) (1995) requires (under Part III of the act) providers of "goods, facilities and services," such as libraries, to provide an equal level of services to all of their customers. It also states that no extra charges can be imposed for service provision in relation to a person's disability, for example, charging a fee to produce materials in alternative formats (DRC, 2002). Part 4 of the DDA, the Special Educational Needs and Disability Act (2001), covers services already covered by Part 3 of the DDA but now affects all education and training providing by higher education, including its libraries. This requires UK universities to provide access to assistive technologies such as Braille readers and speech output and "that material placed on the Web is accessible" (Doyle & Robson, 2002, p. 52). The legislation also states that no extra charges can be imposed for service provision in relation to a person's disability, for example, the provision of works in large print or Braille. The Disability Discrimination Bill (Great Britain, 2004) contains

a new public sector duty to promote equality, such as the procurement of goods that meet accessibility standards.

In the United States Section 508 of the U.S. Rehabilitation Act requires federal government Web sites to be made accessible to people with disabilities. This law is based on W3C Priority 1 checkpoints. The act also prohibits federal agencies from buying, developing, maintaining, or using electronic and information technology that is inaccessible to people with disabilities.

Although there is currently no pan-European legislation relating to Web accessibility, the member states of the EU are required to adhere to the eEurope Action Plan (European Commission, 2002) designed to increase use of the Internet in all areas of European society. The Action Plan recommends the adoption of the Web Accessibility Initiative (WAI) guidelines and the development of a European Design for All curriculum, thereby strengthening assistive technology and design for all standardization. Recommendations are also made relating to the procurement of accessible public information and communication technologies, along the same lines as the Section 508 legislation in the United States, which requires the procurement of electronic and information technologies that are accessible to people with disabilities.

Since 2002 the European Commission has disseminated a Communication on e-Accessibility, which aims to move forward the recommendations of the Action Plan and to achieve "an 'Information Society for All', promoting an inclusive digital society that provides opportunities for all and minimises the risk of exclusion" (European Commission, 2005). The measures recommended by the commission include Design for All methods in the design of products and services, including the design and evaluation of Web sites and drawing on recommendations made by the W3C/WAI. At present e-Accessibility is implemented on a voluntary basis, but if sufficient progress has not been made by the planned review of progress, then legislative action may have to be considered.

The Digital Library

While there is no universally accepted definition of a digital library, it is useful to think of it as a series of interrelated services built on digital information content. The key user-related processes have been variously defined, perhaps most commonly as resource discovery, location, request, and delivery. In order for resources to be discovered and used they must be described (that is, metadata created) and organized. Services are then built on this organized content. In order for the effort expended to be worthwhile, these services must be used, and for that to take place there must be some kind of user interface. As Arms has put it, "a digital library is only as good as its interface" (2000, p. 160).

The interface of choice for nearly all digital library services is the World Wide Web. Although significant changes are taking place in Web technologies, the graphical user interface (GUI) has rapidly become dominant and looks likely to remain so. From an accessibility perspective this has at least allowed standard approaches to be developed to try to ensure that all users are able to access all services. The library Web site will provide information about opening times, services offered, and contact details. It may also offer access to the catalog, online journals, abstracts, and contents pages, as well as providing online access to borrower details and renewal and reservation services. The provision of full-text journal articles and the development of e-book provision will provide increased opportunities to access library services remotely. This will be further enhanced by the continued implementation of copyright legislation that allows alternative formats designed for people with visual or other impairments to be produced from digital files.

It is often difficult to differentiate meaningfully between the "library" and other information services in the electronic landscape. Indeed, there is considerable evidence that at least some groups of users tend to try to resolve their information needs first by use of general search engines and only move on to library services when that source fails (see, for example, some of the results of the Centre for Research in Library and Information Management [CERLIM] project EDNER, available at http://www.cerlim.ac.uk/edner/welcome.html). It is unlikely, however, that they would distinguish any one set of services as a "library." Increasingly, portals are being developed to provide an access point to a range of such services, and it is now perhaps more meaningful to speak of the digital library as encompassing a wide range of services accessed through a portal, which may be "internally" or "externally" provided and mediated.

Whatever the focus, ensuring access to as many people as possible makes good business sense as well as being ethically and legally sound. To quote Arms again, "digital libraries are of little value unless they are easy to use effectively" (2000, p. 143). This is particularly true for users with a visual impairment, who in the past have all too often been treated as a side issue in designing the user interface. If "design for all" principles are fully implemented across all library IT systems, including their Web sites, all users will be provided with an equitable level of access to information and services.

Assistive/Adaptive Technologies

Technology can provide the means for a blind or partially sighted person to overcome barriers such as the need to read print, use a computer, take notes and communicate both on paper and electronically. Video magnifiers and electronic readers, Optical Character Recognition software,

magnification software, speech output systems and electronic Braille devices all have a part to play in a solution for a particular individual.

These computer-related aids and equipment are commonly known as "assistive," "adaptive," "access," or "enabling" technology. Often people will use a combination of the above technologies to enable them to read electronic print. For example, they may use speech output predominantly, with Braille output to verify unusual spellings or language. Magnification may be used to explore a page, with speech output to read out more text-rich parts of the page.

Research and development into the provision of computer-related aids have been driven by a belief in universal access for all. Projects include TIDE ACCESS, which focused on the "design for all" concept (Stephanidis & Emiliani, 1998), and the SPEECH project (Zajicek & Powell, 1997), which built a conceptual model of the Web for visually impaired users through development of the BrookesTalk Web browser. BrookesTalk aimed to present the contents of Web pages for anyone using speech-only technology. Other examples include the development work undertaken by the Trace Center (O'Briant, 1999) in the United States and the continued work on standards and guidelines relating to all areas of the Web undertaken by the W3C Web Accessibility Initiative.

Despite the excellent work that continues in the development and provision of assistive technologies, the success of these technologies lies also in the design of Web sites. Unless accessibility is built into the design of a site, even the most up-to-date assistive technologies will still be unable to access it. It should also be noted that different types of assistive technologies present different problems to accessing a Web site. Observations in the Non-visual Access to the Digital Library project (NoVA) (Craven & Brophy, 2003, p. 118) revealed problems specific to assistive technologies, such as pixelated text when using magnification and screen readers not reading out every link on a page because of poor layout.

Another issue identified as influencing the success of assistive technologies is user training. JAWS, for example, is a powerful screen reader that provides the user with many options in terms of Web site navigation. It is an extremely complex (and expensive) piece of technology that requires initial training in its use if its potential is to be realized and may also require further training whenever a new version is released. Observations made during the NoVA project confirmed that success in using some of the more advanced features provided by screen reading technology was often dependent on awareness, training, and experience (Craven & Brophy, 2003, p. 118).

In a public access setting, such as a library, it is also essential that staff are fully trained in the use of assistive technologies provided on the open access computers. Staff must feel confident in providing assistance as

well as be aware of the particular difficulties faced by visually impaired people.

Design of Accessible Web Interfaces

In the literature Web accessibility generally refers to the application of technical solutions to the design of a Web site in order to render it more accessible to users, in particular users of assistive technologies. Technical solutions refer to the correct application of properly validated coding such as Hypertext Mark-up Language (HTML) or Extensible Hypertext Mark-up Language (XHTML), which define the structure of the content, together with the use of cascading style sheets (CSS), which define the way the content is displayed. A wide range of articles, books, and reports can be found on the subject of Web accessibility (see for example Brophy & Craven, 2000; Nielsen, 2000; Paciello, 2000; Thatcher et al., 2002; Waters, 1997), but probably the most influential work relating to the design of accessible Web interfaces has been that of the World Wide Web Consortium (W3C) Web Accessibility Initiative (WAI). WAI provides a comprehensive set of guidelines and checkpoints to help ensure Web sites embrace the concept of "design for all." These are available in a number of categories covering guidelines for the accessibility of Authoring Tools (ATAG), User Agents (UAAG), and probably the most well-known, the Web Content Accessibility Guidelines, or WCAG.

The WCAG Checkpoints (W3C, 1999) are divided into a number of priority and conformance levels to help people to assess the accessibility of their Web sites:

- Priority 1: A Web content developer must satisfy this checkpoint, otherwise, one or more groups will find it impossible to access information in the document. Satisfying this checkpoint is a basic requirement for some groups to be able to use Web documents.
- Priority 2: A Web content developer should satisfy this checkpoint, otherwise, one or more groups will find it difficult to access information in the document. Satisfying this checkpoint will remove significant barriers to accessing Web documents.
- Priority 3: A Web content developer may address this checkpoint, otherwise, one or more groups will find it somewhat difficult to access information in the document. Satisfying this checkpoint will improve access to Web documents.

Priority levels are further defined by a level of conformance (W3C, 1999):

- "A": all Priority 1 checkpoints are satisfied
- "A-A": all Priority 1 and 2 checkpoints are satisfied
- "A-A-A": all Priority 1, 2, and 3 checkpoints are satisfied

The WAI also suggests the following ten "Quick Tips" (W3C, 2001), which should cover the main issues needed to ensure a Web page is accessible:

- Images and animations—use the "ALT" attribute to describe the function of each visual
- Image maps—use client-side image maps 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 organisation—use headings, lists and consistent structure. Use CSS for layout and style where possible
- Graphs and charts—summarise or use the "longdesc" attribute
- Scripts, applets and plug-ins—provide alternative content in case active features are inaccessible or unsupported
- Frames—use <noframes> and meaningful titles
- Tables—make line-by-line reading sensible. Summarise
- Check your work, validate—use tools, checklists and guidelines at: http://www.w3.org/WAI/Resources

A fully comprehensive list of the checkpoints provided in the WCAG version 1.0, which the WAI recommend, are used in conjunction with the two other guidelines produced by the W3C/WAI. These are guidelines on the accessibility of authoring tools (Authoring Tools Accessibility Guidelines, ATAG) and guidelines on the accessibility of user agents, such as Web browsers (User Agent Accessibility Guidelines, UAAG).

Most organizations concentrate on the WCAG; many have also produced their own accessibility guidelines based on the WCAG recommendations, but they are often written in less technical terms or focus on issues specific to the organization. For example, Urban (2002) considers the successful implementation of accessibility into different enterprises, such as large organizations, educational institutions, or government entities. In the UK the Cabinet Office e-Government Unit's Guidelines for government Web sites (http://www.cabinetoffice.gov.uk/e-government/resources/handbook/introduction.asp) state that all UK government Web sites should, as a minimum, adhere to both Priority 1 and 2 levels of the WCAG (version 1.0), in other words be A-A compliant.

Currently WCAG version 1.0 is still the working document that should be referred to. However, WCAG version 2.0 is still in production, and the last Working Draft was issued in April 2006. A final call for review was also issued, with comments requested by June 2006. Following an extensive review process, a final working draft is promised in "early 2007." Until WCAG 2.0 becomes a W3C Recommendation, WCAG 1.0 will continue to be the working document to use.

WCAG 2.0 covers issues relating to Web accessibility, and, where they

have an impact on accessibility, usability issues will be addressed. Four principles of Web accessibility are proposed in the current draft document (W3C, 2005):

- Content must be perceivable to each user
- User interface components in the content must be operable by each user
- Content and controls must be understandable to each user
- Content must be robust enough to work with current and future technologies

The W3C and WAI provide an important framework for ensuring accessible Web design, development, and assessment. This has been the focus of an EU Web Accessibility Benchmarking (WAB) cluster of three EU-funded projects working in liaison with the W3C/WAI to develop a harmonized European methodology for evaluation and benchmarking of Web sites: the Unified Web Accessibility Methodology, or UWEM (see http://www.wabcluster.org/). The Cluster Projects are looking at three specific areas:

- The European Internet Accessibility Observatory (EIAO)—preparation of a platform for a possible observatory (measurement machine with modular tests, site inventory for jurisdictions, results management and aggregation)
- SupportEAM—investigation of a possible Web accessibility quality mark (proposal of a certification mechanism and authority, national help desks, training material etc.)
- BenToWeb—production of test suites for evaluation tools and evaluation modules for checkpoints difficult to automatize. Research into integration of testing modules in CMS and issues related to dynamic multiversion Web pages

By coordinating aspects of the work described above, the three projects will work together to develop an EU-harmonized assessment methodology for Web accessibility, based on W3C/WAI and to be synchronized with the move from WCAG 1.0 to WCAG 2.0. The UWEM will be developed iteratively involving evaluations with potential users of the methodology (for example, Web site developers and accessibility experts) and users of Web sites (including people with a range of disabilities) to cross-validate the checklist.

As well as involving users in the development of the UWEM, the methodology itself will include a section on User Testing Protocols. This emphasizes to anyone considering or preparing to undertake Web accessibility assessment that, whether using the WCAG guidelines or other approaches to assess the accessibility and usability of Web sites and Web-based services, it is important to involve users and take into consideration their requirements for an accessible Web.

Although widely used, the WCAG have often been criticized for being difficult to implement and even difficult to understand (although it is hoped that WCAG 2.0 will address this issue). In a formal investigation of Web accessibility in the UK, the Disability Rights Commission (DRC) tested 1,000 Web sites using a software tool, then compared results of detailed evaluations by 50 users with a variety of impairments (DRC, 2004). The study evaluated user attempts to perform set tasks with an assessment criteria of ease of use and success of outcome. Users also participated in focus groups and interviews to explore accessibility and usability issues further. A controlled study of six Web sites was also undertaken by a group of blind users and nondisabled users to assess the difference between the effects of inaccessible design and of the impairment. Focus group discussions concentrated on how people use the Web, what they find useful, the variety of problems they encounter in accessing Web sites, and the problems associated with the assistive technology they use. The study identified 585 accessibility and usability problems. The most reported problems relating to the WCAG checkpoints were as follows (DRC, 2004):

- Checkpoint 1.1: Provide a text equivalent for every non-text element
- Checkpoint 2.2: Ensure foreground and background colour combinations provide sufficient colour contrast, etc.
- Checkpoint 6.3: Ensure pages are usable when scripts, etc. are turned off, and if this is not possible provide an alternative
- Checkpoint 7.3: Until user agents allow users to freeze moving content, avoid movement in pages
- Checkpoint 10.1: Until user agents allow users to turn off spawned windows, do not cause pop ups without informing the user.
- Checkpoint 12.3: Divide large blocks of information into more manageable groups where natural and appropriate
- Checkpoint 13.1: Clearly identify the target of each link
- Checkpoint 14.1: Use the clearest and simplest language appropriate for a site's content

As a result of these findings the DRC recommended the WCAG should "provide better coverage of information architecture and navigation design issues in relation to accessibility," addressing in particular elements relating to the problems identified above (DRC, 2004, pp. 47–48).

With this in mind, some individuals and organizations have decided to take a more holistic approach to Web accessibility rather than relying on existing guidelines and recommendations. One example described by Kelly, Phipps, and Swift (2004) outlines broad issues for consideration such as "the purpose of the Web site, interoperability, cultural and resource issues" as well as usability and accessibility issues. The focus is to take a more pragmatic approach to accessibility rather than trying to achieve the "holy grail" of W3C AAA compliance. Kelly, Phipps, and Howell (2005) recog-

nize that this approach has limitations when compared with the W3C WAI guidelines but argue that "a checklist approach can, in fact, be counterproductive as it encourages developers to prioritise the objective areas which testing tools can easily report on."

Web Usability

Web usability generally refers to the experience the user has when reading and interacting with a Web site, whether using assistive technology or a standard computer set up. Conflicts can exist between accessibility and usability because, in practice, the former tends to be technology led and the latter user led. In the Web environment, studies into usability have identified content organization and navigation paths as the most important factors to aid the information seeking of visually impaired people. Other factors could include link effectiveness and differentiation and destination prediction (Goble, Harper, & Stevens, 2000). The Towel project (Goble et al., 2000) took a novel approach by identifying a number of issues relating to travel and mobility that a visually impaired person will need to address in order to achieve their travel task. For example, they need to have advance knowledge of any obstacles on the route (in other words, a preview of what is ahead). The project mapped this "real life" experience of travel into the virtual environment to help demonstrate how Web developers should be thinking about the design of the interface to enhance the visually impaired user's experience. Craven (2003) explored the concept of mapping the visually impaired user experience onto established models for information-seeking behavior to take usability issues a step further by focusing on a user-led rather than system-led approach to Web design, thus helping to improve the information-seeking experience of visually impaired people in Web-based environments.

The perceptions and experiences of Web use by blind and visually impaired users have been explored in a number of surveys and studies (Berry, 1999; Brophy & Craven, 1999; Coyne & Nielsen, 2001; Craven & Brophy, 2003; Craven & Snaprud, 2005; Kelly, Phipps, & Howell, 2005; Lewis, 2004; Nielsen, 2002; Pilling, Barrett, & Floyd, 2004). Sadly, it seems that although progress has been made toward a more accessible Web, many of the problems cited in 1999 are still in evidence six years later.

Blind and visually impaired users experiences with Web use were summarized by Berry (1999) in a literature review on issues of visual impairment. The paper describes a study undertaken with a group of blind and partially sighted students and staff to ascertain their experiences in accessing and using the Web. Those with total sight loss or those with partial sight who were inexperienced Web users were identified as experiencing severe problems due to poor Web design. They were more likely to become frustrated and switch off the computer. Feedback from a sample of visually impaired users who explored a selection of Web sites for the Resources

for Visually Impaired Users of the Electronic Library (REVIEL) project (Brophy & Craven, 1999), undertaken by CERLIM, identified problems using Web sites using screen reading technologies. These included repetitive text, inappropriate ALT tags and link descriptions, and problems filling out forms. It is interesting that the problems highlighted in this study, undertaken in 1998, are still being cited by users as accessibility problems in 2005 (see Craven & Snaprud, 2005).

A study conducted by the Nielsen Norman group also found that blind and visually impaired people experienced usability problems navigating the Web, estimating that "the Web is about three times easier to use for sighted users than it is for users who are blind or who have low vision" (Coyne & Nielsen, 2001, p. 5). The findings of the Nielsen Norman group concurred with results from usability tests undertaken for the NoVA project (Craven & Brophy, 2003), which also identified users of screen reading assistive technologies to be the most severely affected by badly designed Web pages. The NoVA project also provided an insight to the types of problems faced by all users. The focus of the project was on the information-seeking behavior of blind and visually impaired people, but the control group of sighted users also highlighted usability problems, thus reinforcing the importance of involving all types of users in any design and development project.

The study showed that although the design of accessible Web sites is improving, all types of user can be faced with navigational problems. Some problems experienced are due to accessibility and usability conflicts, such as inappropriate or unhelpful use of alternative text or poor use of language. Other problems are due to a lack of understanding of the different ways users interact with and navigate Web-based resources. In many cases Web designers have clearly placed more emphasis on promotion of a particular product or service than on usability or accessibility and appear to be unaware of, or to be ignoring, the results of accessibility and usability research.

A survey of blind and visually impaired people using electronic information services in public libraries (Lewis, 2004) found that adherence to accessibility guidelines will not necessarily ensure services are usable for blind and visually impaired people. As a simple example, the WCAG mandate an "ALT" (alternative) text for all images and other nontextual elements, but while the presence or absence of text can be checked automatically, what cannot be checked in this way is the meaning of the text supplied. And, as Kelly, Phipps, & Howell, (2005) have pointed out, "technical accessibility does not equate to intellectual accessibility . . . an ALT tag merely names, not explains an image." A need for feedback from real users is essential alongside automated testing of Web sites to ensure guidelines are valid and relevant. Lack of familiarity with electronic equipment and a lack of support and training in its use was also identified as a barrier to accessibility.

These issues were explored further in a study of disabled people and the Internet (Pilling, Barrett, & Floyd, 2004). Of the 196 respondents, 20 percent were either registered blind, had a severe visual disability and other disability, or other visual impairment. The study revealed the users would like Web sites to have the following:

- Guides on the home page informing people about the site's contents
- Less cluttered pages
- Fewer graphics and advertising
- Links to be clearer and fewer
- Print size and colours to be easily changeable
- Greater standardisation
- Search to be more clearly marked and more precise
- Better accessibility for voice recognition system users (Pilling, Barrett, & Floyd, 2004, pp. 34–36)

People using assistive technologies described the problems they experienced accessing the Internet. For example, screen magnification "looks a bit fuzzy when it's blown up" (Pilling, Barrett, & Floyd, 2004, p. 30). Problems with screen readers were described, as well as not being able to afford the more up-to-date technologies such as JAWS (Pilling, Barrett, & Floyd, 2004, p. 32). Lack of support and training in the use of assistive technologies were identified as additional barriers to access.

Barriers can also arise because many disabled people cannot afford, or are not motivated, to upgrade their assistive software to the latest version. This issue has often been neglected, with designers making unwarranted assumptions as to what will be available to the user. Thus, a considerable amount of effort expended on checking whether current versions of popular products "work" (in accessibility terms) has ignored the issue that real users may be accessing current Web pages with old software. Pilling's report of 2004 reveals that little has changed since the Craven and Brophy study (2003), and a more recent study (Craven & Snaprud, 2005) shows that, again, the same problems are being experienced by disabled users.

The European Internet Accessibility Observatory Project (EIAO) conducted user requirements and usability studies to inform the technical development of its Web accessibility assessment and data-gathering tool (Craven & Snaprud, 2005). A survey on user requirements for an accessible Web site involved end users and included a range of disabilities, although blind and visually impaired users were predominant in responding. Analysis of the survey data showed that keyboard access (shortcut keys, tab navigation, and/or keyboard navigation) was the most frequently cited accessibility problem experienced by the respondents. This is a particular problem for someone who needs to use keystrokes to navigate a page that has been designed to be navigated using a mouse. For example, they may be forced to listen to the whole page being read rather than be-

ing able to tab logically to a relevant link, or through the main headings on the page. Problems either with lack of ALT text or poor use of ALT text were also cited. An example of inappropriate ALT text described by one of the participants was a customer services telephone number displayed as a graphic with the ALT text as "Customer Services telephone number." This clearly demonstrates that a lack of awareness of the purpose of ALT text still exists.

Respondents also cited problems relating to the organization of the page, leading to an inability to navigate the site. They described how some Web sites and Web pages had been organized in a way that was not logical to navigate using tab keys or that had been designed with too many layers, which made it difficult for them to find the information they were looking for. Single pages that were overly long were also mentioned as a problem for some users because they had to keep scrolling down the page and possibly up again, making it a time-consuming process. For someone using screen reading technology, poor use of titles for Web pages prevents them from quickly establishing which page they are looking at (the screen reader can read out the title first). An example of poor use of titles is each page of a site simply giving the name of the company, thus not helping visitors to quickly establish which part of the site they are in.

Problems using FLASH, JAVA Script, and PDF were also cited by users, particularly those using screen reading technologies. Access to these proprietary formats have recently generated a great deal of discussion among Web developers and designers and accessibility experts. Whereas work has been undertaken to help make these formats more accessible for people using assistive technologies (Gavin, 2005; Nielsen, 2002), the EIAO study showed that end users still perceive them as inaccessible. One argument is that although these formats are much more accessible, many people are either not aware of this or are not prepared to try and use them because of a bad experience in the past. Another argument is that although these formats are "technically" accessible, they are not necessarily usable yet and may also require the use of the most up-to-date versions (both the format itself and the assistive technology) to render them accessible.

Assessment of Web Accessibility

Assessment of accessibility can be undertaken using a variety of methods. Automatic accessibility evaluation tools are a popular way of assessing the accessibility of Web sites because they can be performed quickly and are often free of charge. Cynthia Says (http://www.cynthiasays.com/) and WAVE (http://www.wave.webaim.org/wave/index.jsp) are examples of free online checking services (a comprehensive list of tools is available at http://www.w3.org/WAI/ER/existingtools.html). But this is only part of the process: the results from automated testing can often be misinterpreted and will not provide the whole picture in terms of accessibility. A

mixture of methods is therefore recommended, such as those suggested by the W3C (n.d.) in the Evaluating Websites for Accessibility section. These could include

- semi-automatic and automatic testing using validation tools (to check that valid mark-up has been used) and accessibility checking tools (to check that accessible mark-up has been used);
- manual evaluation using relevant criteria for assessment such as the Web Content Accessibility Guidelines checkpoints and priority levels; and
- user testing of specific features of a Web site; this should include people with a mixture of disabilities, different technical abilities, and users of assistive technologies.

A study of the accessibility of 134 UK higher education library Web sites, conducted for the Resources for Visually Impaired Users of the Digital Library project (Brophy & Craven, 1999), identified a number of examples of good practice, with 49 of the 134 home pages evaluated being eligible for the Bobby Approved Icon. However, the study acknowledged that using an automated checker such as Bobby (now WebXact: http://www.watchfire.com) has its limitations, citing examples of accessibility problems identified manually that were not identified by Bobby.

Since this study was undertaken awareness of the limitations of automated checking has increased considerably; however, it should be noted that the accessibility problems identified by the study were similar to more recent studies, which have used a mixture of automated, expert, and user testing (see City University, 2004). Problems cited in 1999 included missing or inappropriate alternative text, problems with tables and frames, and poor use of colors. A study of UK public library Web sites was conducted by UKOLN (Ormes & Peacock, 1999), and, similar to the analysis of higher education Web pages (Brophy & Craven, 1999), this study revealed accessibility in public libraries at that time to be patchy, concluding that "UK public library Web sites are in the early stages of development and this is reflected in the general low level of fully accessible sites" (Ormes & Peacock, 1999, p. 18).

A further study of the accessibility of 162 UK university home pages was carried out in 2002, again using the Bobby accessibility checking tool (and acknowledging its limitations) (Kelly, 2002). The results from Bobby were also compared with compliance with the Web Accessibility Initiative priority levels, and whereas it revealed a trend toward more accessible Web pages, only a small number of home pages appeared to comply with WAI AA guidelines by having no Priority 1 or 2 errors. The study recommended further exploration of the reason for such low numbers.

A study of the accessibility of museum, library, and archive Websites (City University, 2004) tested a sample of 300 such sites in England and 25 international sites, using both automated tools and user testing, for

compliance with WCAG 1.0 checkpoints. Findings revealed that 42 percent of English and 20 percent of international pages only met the basic WCAG level (A), and only 3 percent met AA (when tested with an automated tool). Blind people in the user testing panel found it impossible to complete 33 percent of the tasks they undertook. In general, 22 percent of the problems experienced by the user panel were not identified by automated testing of WCAG 1.0 checkpoints. The most common problems identified were poorly named hypertext links and lack of provision to skip through the navigational links (SKIP NAV) directly to the content. A lack of descriptions for images (ALT text), poor color schemes, and lack of accessibility options were also mentioned. The user panel liked good use of colors to highlight visited hypertext links and when proper links were labelled individually.

The UK Cabinet Office conducted extensive research into the accessibility of Web sites across the twenty-five member states of the European Union and the European Commission to test whether they are meeting the requirements for improving e-Accessibility (Cabinet Office, 2005). The study used a combination of manual and automated testing techniques to assess the accessibility of 436 online public Web sites. The findings revealed that "online public services have a long way to go before they are fully accessible and inclusive" (Cabinet Office, 2005, p. 2) and that the best way to improve the situation is through coordinated efforts among "public policy makers in the EU, Web managers and developers in public sector organisations and Web designers in the software industry" (Cabinet Office, 2005, p. 2).

The report also identified similar studies of the accessibility of public sector Web sites since 1999 and included references to studies from France, Ireland, the UK, and the United States (Cabinet Office, 2005, p. 79). However, according to the report, the "most useful study is the one carried out by the Disability Rights Commission in the UK" (Cabinet Office, 2005, p. 10). The study (DRC, 2004) conducted accessibility assessments of 1,000 Web sites, initially using a software accessibility checking tool and then comparing these with results of detailed evaluation from fifty users with a variety of disabilities. The study found that 81 percent of the Web sites surveyed failed to comply with the most basic of the WAI WCAG levels. Web sites were found to have been designed in a way that make it very difficult for people with particular impairments—especially those with a visual impairment—to make use of the services provided on the site. The report suggests that this is due to a "lack of interest and knowledge on the part of website developers" and from "perceived commercial obstacles to accessibility on the part of website commissioners" (DRC, 2004, p. 9).

The study reported that the group of people who are most likely to be disadvantaged by Web sites that have been designed without taking their needs into consideration are people who are blind and who use a screen

reader to access the Web. The study also found that using guidelines and automated testing tools were not enough to assess the accessibility of Web sites and that involving users—and in particular disabled people—in the design and testing process will help improve accessibility and usability. Involving people with different access requirements (such as disabled people or people using alternative devices such as a mobile phone) will provide a much richer insight into the accessibility of a Webpage.

Methods developed by the usability community for user testing can be utilized, ranging from expert approaches such as heuristic evaluation and cognitive walk-through (King et al., 2004), to basic interaction with the users themselves—perhaps simply asking them to comment on their experiences using a site or specific features of a site or service. More formal user testing can be achieved through structured or semistructured task-based exercises with a variety of users using observational and interview techniques (see, for example, Craven & Brophy, 2003), followed by query techniques such as focus groups or questionnaires.

Accessibility Awareness

To ensure Web sites are designed with accessibility in mind, it is essential that not only is awareness of accessibility among Web developers increased but that clear guidelines are also provided to enable this awareness to be put into practice. Current evidence shows that there is still some way to go in order to achieve this.

The ENABLED project (ENABLED, 2004) conducted a questionnaire among project partners to establish an overview of the awareness, knowledge, and training needs of Web developers in relation to Web accessibility issues for visually impaired people. Of the 269 responses received, 36 percent indicated that they tried to make their Web sites or applications accessible. The main reason given for not doing this was a lack of knowledge, in particular relating to accessibility features in Web site development tools. This lack of knowledge could be because only 13 percent of respondents said they had received any training in accessibility or usability and could also account for so many Web sites not being as accessible as they could or should be.

The Disability Rights Commission study (DRC, 2004) undertook an assessment of technical and commercial considerations that are discouraging the adoption of inclusive design. Responses revealed that 95 percent of Web site commissioners surveyed regarded the Web as an important resource and potential means of communication with customers. Levels of awareness of accessibility and inclusive design appeared to be quite good among large organizations, but less so among small- and medium-sized organizations. The main barriers to achieving accessibility were cited as the following:

- Perceived cost of accessibility in terms of money, time and staff resources
- Low level of knowledge about the issues and how to address them
- A perceived lack of simple guidelines, expertise and skills
- Obstacles presented by the increased demand for graphics and other technical constraints
- Conflict between accessibility and other considerations e.g. creativity
- General lack of awareness about the issues and their potential importance (DRC, 2004, p. 37)

Responses from the Web site development agencies suggested that 80 percent attempted to develop accessible sites at least some of the time. However, the Web site development agencies reported that customers were often uninterested or lacked knowledge about accessibility, although when presented with the business case they could be persuaded of the importance of accessibility for increasing usage.

Levels of accessibility expertise among Web site developers were low, although 70 percent claimed to conduct user testing. Methods for this were automated tools, use of the WAI Guidelines, and use of the RNIB Guidelines. The main problems in developing accessible Web sites were similar to those cited by the Web site commissioners, particularly:

- cost in time and resources;
- lack of knowledge;
- lack of authoritative guidance; and
- conflict with aesthetic and other design considerations. (DRC, 2004, p. 38)

Similar reasons for noncompliance with Web accessibility recommendations were cited in a study of 175 Webmasters in the United States (Lazar, Dudley-Sponaugle, & Greenridge, 2004).

In 2005 the SupportEAM project conducted an online survey on stakeholders' needs for a European e-Accessibility certification scheme (http://www.support-eam.org/). The survey covered commercial and noncommercial stakeholders and produced some interesting results relating to levels of Web accessibility awareness. For example, 80 percent of the 450 respondents said that they took accessibility into account when commissioning their Web sites, but of these, only 35 percent said they checked them for accessibility. Seventy-five percent of the respondents also stated that they would like to have some kind of methodology and criteria to achieve e-Accessibility certification of their Web sites. The conclusion drawn from this was that although people are aware of accessibility issues, they do not necessarily fully understand them or know how to implement them.

The EIAO project also undertook a survey of stakeholders to establish the need for the proposed European Internet Accessibility Observatory (see Craven & Snaprud, 2005). Distribution took place to an initial sample

of fifty organizations identified as potential stakeholders. These included Web developers, Web designers, and Web service providers. As well as establishing the need for the Observatory, the findings also showed that stakeholders surveyed had an understanding of the importance of accessibility issues and of methods available to help guide them toward creating better Web sites. However, it cannot be assumed that all stakeholders will have this level of awareness, as some respondents commented that people they have to liaise with (for example, managers, policy makers, externally appointed Web designers) are often less aware of these issues.

Despite the fact that the majority of stakeholders surveyed showed awareness of accessibility issues and were in support of "design for all" principles, not all were actively involved in creating accessible Web sites. This was often dependent on the nature of their organization and work (that is, customer driven, resource driven, outsourcing, etc.). Stakeholders who were involved in addressing accessibility (through design, liaison, advice, etc.) cited a number of tools used to help them design accessible content, the most popular methods being the use of guidelines and standards. Respondents who said they regularly checked their sites for accessibility cited a combination of tools (automated, manual, external audits) rather than any one particular tool.

Respondents were very positive about having extra information such as suggestions on how to repair faults as well as a ranked list of improvements needed to make their site more accessible. They also mentioned the need to raise awareness about accessibility so that all those involved know why it is important, not just what needs to be done.

A common theme can be seen throughout the surveys described above. That is, whereas awareness of accessibility issues and the importance of accessible Web design undoubtedly exists, there is still a lack of understanding relating to the specific reasons for applying accessibility features to a Web site, as well as a lack of knowledge of how to implement them systematically and effectively. Could this be the reason that so many Web sites still do not meet accessibility requirements?

In the Cabinet Office study of the e-Accessibility of public sector services in the European Union, no less than twenty-one recommendations are made for policy development. The recommendations are aimed at public policy makers at EU level and in the Member States, Web managers and developers of all public sector organizations, and finally Web designers in the software industry. This final group is addressed in recommendation 19, where it is suggested that there is a need to "train all web designers in both the requirements for, and the techniques to achieve, fully accessible websites" (Cabinet Office, 2005, p. 62). This short but vital recommendation to the "software industry" should be broadened further to include any organization or institution that provides training courses in Web design. For example, departments of library, information, and com-

munication studies integrate accessibility awareness and solutions into any modules related to Web design or the provision of Web-based content.

A great deal of emphasis has been placed on the importance of Web accessibility and the need to adhere to standards and guidelines. The W3C WCAG in particular have been adopted by many public and private institutions as an indication of what level of accessibility their Web sites should reach. How the new version of WCAG (WCAG 2.0) will translate onto the many guidelines and policies developed by institutions and companies remains to be seen, and as Carey argues, the challenge for Web designers and developers "will not be the actual standard so much as finding tools to measure compliance" (Carey, 2002, p. 24). Continued work on a more holistic approach to accessibility, such as the recommendations for e-learning accessibility made by Kelly, Phipps, and Howell, will further complicate methods for assessing and measuring compliance; the holistic approach sees a need to "provide accessible learning experiences, and not necessarily an accessible e-learning experience" (Kelly, Phipps, & Howell, 2005), which are not necessarily bound by compliance to a set of checklists.

Although awareness of Web accessibility issues is increasing, results of various studies identified in this article have shown that a lack of knowledge still exists in how to implement Web accessibility and that there is a need for more effective guidance. This conclusion is confirmed by the continued widespread failure of Web sites to be fully accessible. After the DRC study (2004) was undertaken, the Disability Rights Commission in the UK commissioned the British Standards Institute (BSI) to produce new guidance to help increase knowledge and ability of Web developers and commissioners to implement Web accessibility effectively. Although the BSI is producing the guidelines, they will not be published as a full British Standard as this can take years to be approved. Instead, the guidance has been produced as a Publicly Available Specification (PAS), published as "PAS 78: Guide to good practice in commissioning accessible Websites" (BSI, 2006) It came into effect on March 8, 2006, and can be updated on a regular basis—generally after a period of around two years. It is therefore more in keeping with the rapid development of Web technologies.

Conclusions

Library researchers have been prominent in exploring ways of improving Web accessibility for the last decade. They have brought to the field an overriding concern for a user-centered approach, which has led to a series of user-focused studies showing precisely where common approaches to Web design have been failing those with disabilities. Projects such as REVIEL and NoVA, which were devised and undertaken at CERLIM, enabled the areas needing attention to be pinpointed and showed how targeted effort,

often quite modest in extent, could transform accessibility. A combination of improvements to access technology and adoption of "design for all" principles, coupled with staff and user training and awareness raising, has been shown to have significant, positive results. Over this period of time, libraries throughout the UK and elsewhere have been encouraged to mainstream accessibility, and, partly as a result of new legislation, to maintain the issue high among their priorities.

More recent research initiatives, exemplified by the European WAB cluster and by the development of the W3C WAI WCAG version 2.0, show that the research momentum is being maintained. That a library-oriented research center like CERLIM is heavily involved in this work through projects like EIAO can only be positive for the development of the profession's practice in this area.

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