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Chapter I

Web Accessibility and the Needs of Users with Disabilities

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Abstract

This chapter discusses Web accessibility, and focuses on the challenge of meeting the needs of a diverse audience with different types of disabilities, as well as outlining best practices.It presents the nature and need for Web accessibility, focusing on the UK legislation, and argues that e-accessibility goes beyond legal obligations offering life-enhancing opportunities and services, and promoting inclusion. The dynamics between the Web and its diverse audience are emphasized by giving an overview of the multiple facets of Web accessibility. It has been observed that accessibility is often discussed as affecting blind people only, and discussions frequently isolate a few aspects of it. The author hopes that, by demonstrating and offering ways of understanding Web accessibility and its multilayered nature, the ground will be laid for a more effective and inclusive approach towards Web accessibility as a process in Web design and development.

Introduction

Web accessibility is about being able to reach and use information and services regardless of the disability, and of the technology used. The primary focus is on people with disabilities with the secondary focus on people who use different browsers and technologies to access the Web.

Nowadays, not all people can afford broadband Internet connection, and not all people use Internet Explorer. There is a notable increase in the uptake of broadband Internet, but still, the market has not reached maturity levels: "At current rates of broadband adoption, there are on average a good eighteen months to two years of strong penetration increases across Western Europe before markets begin to mature" (Gower, 2005).

Although, the majority of Internet users seem to use Internet Explorer 6, Mozilla Firefox has become quite popular: "As of September 2005, estimates suggest that Firefox's usage share is around 7.6% of overall browser usage. Since its release, Firefox has slightly reduced Internet Explorer's dominant usage share" (Wikipedia, October, 2005). In addition, Firefox has become quite popular, especially among developers, for its advanced accessibility features, and it can be used as an aid for testing Web pages for accessibility, according to Lauke (2002). Also, the Opera browser comes with accessibility features such as page magnification, enhanced keyboard navigation, and style and colour customization by offering a set of style sheets that can be applied on a Web page (Opera.com, 2005). Web accessibility features are developed for different Web technologies recognizing the need to offer a good browsing experience to users with a range of abilities (Gunderson, 1997). This imposes the requirement for cross-browser as well as cross-platform compatibility. The latter will be presented.

Users can also access a Web site under constraining circumstances through a mobile phone or a public Internet terminal. A mouse may not be available, and the colours on the Web site may not be fully supported or properly displayed. The W3C WCAG 1.0 guidelines emphasize the variety of contexts in which people use the Web that need to be considered when designing and developing Web applications. More specifically, users:

- May not be able to see, hear, move, or may not be able to process some types of information easily or at all
- May have difficulty reading or comprehending text
- May not be able to use a keyboard or mouse
- May have a text-only screen, a small screen, or a slow Internet connection
- May not speak or understand fluently the language in which the document is written

- May be in a situation where their eyes, ears, or hands are busy or interfered with (e.g., driving to work, working in a loud environment)
- May have an early version of a browser, a different browser entirely, a voice browser, or a different operating system

It is important that a Web application can be accessed by people who use different technologies and under different circumstances, as previously discussed.

Moreover, the requirements of people with disabilities need to be considered when designing and building Web applications. Before considering their needs, it is important to look at the Disability Discrimination Act, the emphasis that is given on the rights of disabled people for accessing the Web, and the wider benefits for Web accessibility.

Legislation and the Need for Web Accessibility

Although the importance of Web accessibility is widely recognised-for example, in the U.S., Section 508 specifies that federal agencies must purchase electronic and information technology that is accessible (Thatcher, 2005)-the focus here is on the legislation in the UK. The Disability Discrimination Act (DDA) defines a disabled person as someone with "a physical or mental impairment which has a substantial and long term adverse effect on his ability to carry out normal day to day activities."

Part III of the Disability Discrimination Act gives disabled people important rights of access to everyday services, more specifically:

Duties under Part III are coming into force in three stages.

- Treating a disabled person less favourably because they are disabled has been unlawful since December 1996.
- Since October 1999, service providers have had to consider making reasonable adjustments to the way they deliver their services so that disabled people can use them.
- The final stage of the duties, which means service providers may have to consider making permanent physical adjustments to their premises, came into force in 2004.

Under the Disability Discrimination Act framework and more precisely Part III of the Act, the Disability Rights Commission (DRC) recently launched a formal investigation into Web site accessibility in the UK, which demonstrates aspects of the DRC legal strategy for 2003-2006.

The DRC, with its legal strategy (2003), aims to create a society in which all disabled people can participate fully as equal citizens. It promotes the rights of disabled people by deploying its statutory rights to maximum effect. It has defined a legal strategy, covering the period of 2003-2006, aiming at exploring creative ways of promoting the rights of disabled people as a whole, rather than simply enforcing individual rights.

The DRC pays particular attention to accessibility issues and information access through the Web for various reasons:

- The Web is a relatively new social environment and a very powerful one. It presents a unique opportunity for intervention in favour of disability rights at an early stage.
- The Web is a digital environment and much more flexible compared to physical environments. Therefore, adjustments to accommodate disabled people can be made at relatively reasonable costs.
- The Web can benefit disabled people greatly by providing access to information and services remotely; for example, from the user's own environment, overcoming physical barriers.

Summarizing, from October 1, 2004, service providers have to make reasonable adjustments in the areas of employment, access to goods, facilities, and services so that disabled people are not discriminated against, but they receive equal treatment to nondisabled people. This applies to both physical and electronic environments, with the latter presenting an interesting and beneficial aspect to disabled users environment.

Web Accessibility Benefits beyond Law Obligation

There are 10 million people with disabilities in the UK, with an estimated annual spending power of £50 billion (DRC, 2005). By making a Web site accessible, there will be an increase in sales, achieving a fast return on investment for having made reasonable accessibility adjustments. On the other hand, the Web is universal;

therefore, a large number of people with disabilities could reach a Web site from different parts of the world. Bilotta and Todd (2003) mention that in the United States, 19.4% or 48.9 million people have a disability, with half of them (24.1 million) considered to be severely impaired. Also, the same authors state that: "Between 15% and 30% of the population have functional limitations that can affect their ability to use technology products (50 million in US, 750 million worldwide). It is estimated that people with disabilities control a discretionary income of over $175 billion annually in U.S. alone."

By improving accessibility on a Web site, usability levels also improve significantly. The DRC investigation (2004) found that users with disabilities took 50% longer to complete a task on an inaccessible site; therefore, accessibility increases productivity. An accessible site is also a site that uses W3C standards-compliant HTML code and cascading style sheets for controlling the layout. This way faster download times are achieved, and there is easier control over the site's presentation, thus maximizing efficiency and ease of use. Moreover, accessibility means cross-platform compatibility. A device-independent display of information can be reached by a much wider audience; therefore, increasing profits, especially for e-commerce sites.

In 2002, Pilling, Barrett, Floyd, and AbilityNet, a UK charity giving information and advice to disabled people, conducted a survey to gather information on the views of disabled people with experience of using a computer. A convenience sample was used, and 193 people responded, from which 136 were Internet users.

The survey results state amongst other findings:

- *"Internet usage enabled respondents to communicate with others, and to reach a variety of information resources in spite of difficulties. These groups included those who were unable to leave their homes, those who found writing or reading common forms of print inaccessible, or those with speech impairments.*
- *Disabled Internet users who needed assistive devices to use a computer and the Internet found fewer Web sites that were easy to use and navigate than did those not using assistive devices."*

Jim Murphy MP (EU, 2005), in his forward to the eAccessibility of public sector services report in the European Union, places the user needs at the centre of electronic services, stressing that this is not just beneficial for the individual, but for the wider society. He also supports that inclusion needs to be built-in to public service design from the beginning so that opportunities in education, employment, health, and social life are enhanced for every individual.

The UK online Annual Report 2002 of the cabinet office states that 54% of services were available electronically by the issue date of the report, while the government, through the Cabinet Office and the e-Envoy, aims to make all government services

available electronically by 2005 so that everybody can benefit from quick access to information and services.

In terms of benefiting the end users, the U.S. National Organization on Disability commissioned a survey in 2001 and found:

- Forty-eight percent of disabled people acknowledged that going online significantly increased their quality of life, compared with 27% of nondisabled people.
- Fifty-two percent with less severe disabilities and 34% with severe disabilities admitted that the Internet increased their ability to reach out and communicate with people who have similar interests and experiences, compared to 34% of the nondisabled online Americans.
- Fifty-two percent of the disabled interviewees said that the Internet helped them to be better informed about the world around them, compared to 39% of the nondisabled interviewees.

Windman (2001) mentions another benefit in accessibility, as expressed by Brown: "by making Web sites more accessible for those with disabilities could also make them more accessible to those with different learning styles such as auditory, kinesthetic and visual. Consequently, opportunities for teaching as well as lifelong learning would be enhanced."

In this section, it has been shown that there are numerous benefits to Web accessibility ranging from greater profits for e-commerce sites to increasing effectiveness and productivity, as well as benefiting both the individual and the wider society. It should not come as a surprise that Web accessibility is beneficial to nondisabled users too, and greatly increases opportunities for e-inclusion making a real difference in people's lives, especially for those with disabilities.

For ensuring optimum accessibility for a Web site, the needs of users with disabilities need to be taken into account, and studied from the beginning as part of the requirements' definition phase in design and development. According to Henry et al. (Henry, Law, & Kitch, 2001), "Accessibility is most efficiently and effectively implemented when included from day one of a project. Considering accessibility early in the project will increase the design impact and decrease the resource impact." In order to include accessibility effectively, a variety of user needs have to be considered.

In the sections that follow, the different needs of people with various disabilities are outlined, and guidelines for meeting them are provided.

Colour Blind Users

One in 12 people have some sort of colour deficiency (Henderson, 2002). Colour blindness is an eye condition affecting the perception of colour. A person with colour blindness will not be able to distinguish certain colours or shades of them. There are mainly three types of colour blindness: protanomally, deuteranomally, and tritanomally, affecting the perception of red, green, and blue respectively. A person with colour blindness, unlike the misleading name of the condition, can see colours and does not perceive the world just in black and white (Eyecaresource.com, 2002).

People with colour deficiency require good colour contrast on Web sites, particularly for foreground and background colours for text. They also benefit when designers use a variety of ways, not just colour, for conveying information on the Web (WAI WCAG 1.0, 1999). For example, colour should not be used as the only way to communicate location on the navigation menu: additional changes in size or shape should also be used. This way, if users cannot see the difference in colour, they understand where they are because the menu link appears in bold and it is bigger than any other link in the main menu. Certain combinations of colours such as red, green, brown, grey, and purple should be avoided to style items that are next to each other (Hesperian, 2005). User control of style sheets is also very important. Style sheets are files that control the presentation of Web pages. This way, presentation is kept separately from content. If a Web site uses style sheets to control all its presentation aspects, then users will be able to override them from their browser and apply their own style sheet. This is in line with the generally supported view that allowing for customisation is the most efficient way to ensure accessibility for a wide audience (Skillsforaccess.org, 2005).

Blind Users

The graphical nature of the Web means that poor Web accessibility has an adverse effect on blind users. There is a range of assistive software that blind users use on the Web. Some of them are:

- **Screen readers:** Software programs that speak the content on the screen. They read text, buttons, and menus as well as images, provided that the images have appropriate text descriptions attached to them. Screen readers offer a variety of customization options for audio.

- **Speech recognition systems:** Provide voice control and data entry, and the user does not have to use any other input devices.
- **Refreshable braille displays:** Provide tactile output of information represented on the computer screen.
- **Speech synthesizers:** Translate text input into audio input.

Screen readers are the most popular assistive software that blind users use in order to access the Internet. Theofanos and Redish (2003), in a research study they conducted with blind users to understand their Web behaviour, found that blind users are as impatient as sighted users when trying to find information, and they "scan information with their ears" the way sighted users scan information with their eyes. This means that they do not listen to a Web page from beginning to end, but they navigate around, skipping text and listening to information that they think may be relevant to what they are looking for. Although screen readers are very useful and powerful tools, they impose great demands on the user. According to Theofanos and Redish (2003), screen-reader users must understand the browser, the screen reader, and the Web site they are visiting, which imposes a great mental load on them. This means that blind users need to split their cognitive energy between the browser, the screen reader, and the site. Under these circumstances, it is not easy to acquire a good mental model of the screen reader environment as well as the Web site navigation and content structure. Thus, it is not surprising at all that many users do not know all the functionalities of the assistive software they use.

Guidance for meeting the needs of blind users on the Web:

- Blind people require appropriate text descriptions for images, diagrams, image maps, image links, videos, and animation. The only exception is when images are used for decoration or to support the layout of the page. Text descriptions are important for assistive technologies such as screen readers and Braille displays.
- Intuitive keyboard navigation is essential for a blind person as they do not use the mouse. The reason is quite obvious: the mouse requires hand and eye coordination, and blind users do not know where to move it or when to click it as they cannot see what is on the screen.
- Standards compliant well-structured code is equally important so that the screen reader can use it to communicate the structure of a Web page to the user.
- Data tables need to be coded with care so that data cells are associated with their respective header cells. Screen readers read in a serial form in a top-to-bottom, left-to-right fashion and therefore, a data table will not make sense unless properly coded.

- All form controls need to have clear labels associated with them so that the screen reader can communicate to the user what each form control is about.
- Tabbing from link to link needs to be intuitive and easy to understand. Creating a logical tab order and meaningful link names, avoiding "More" and "Click here," makes navigation more effective.
- Ways of skipping over navigation menus are essential so that the user can jump to the main content straight away, if they wish so, without having to listen to navigation links, which is tiring and frustrating.
- Audio descriptions need to be provided for videos if the video contains visual information that is not communicated through audio output and therefore, may be missed by blind users (Smith, 2003).
- Clear and easy-to-understand navigation structures can greatly enhance the user's experience so that blind users can easily find their way around a Web site.

Partially Sighted Users

The technical definition for partially sighted is that one's best-corrected visual acuity is no better than 20 out of 70 in either eye. This is better than just perceiving light (BraillePlus.net, 2004). For using the Web, different customisation options and technologies can be employed by partially sighted users ranging from using specialist software such as screen magnifiers to customising the operating system and browser settings. Partially sighted people mainly use magnification software to magnify a Web page, change colours both foreground and background, and customize the appearance of the cursor so that it can be easily perceived. According to RNIB (2005), the principle behind magnification software is that the image on the standard computer screen can be artificially enlarged, meaning that only a part of the content can be seen at a time. The scale of magnification can be up to 16 times, whereas magnification up to 32 times can also be available. However, the magnification degree has an impact on the ease of navigation; information access with great magnification being hard to manage. Screen magnifiers can offer a variety of ways for magnification. They can magnify the whole screen and show only a part of the screen at a time, they can have only a specific part of the screen magnified or follow the mouse, offering mouse driven magnification and focus.

Partially sighted users also require screen-reading compatibility, as they often prefer to listen to a page while navigating it. For this reason, some magnification software has embedded screen-reading functionalities. The use of clear and high-quality images on Web pages, particularly for functional images such as image maps and graphical buttons, is important so that they remain clear enough when magnified. However,

the use of images as text needs to be avoided because text on images is not flexible, and users cannot customize it to suit their needs (RNIB, 2005). It would be a misconception to think that every partially sighted user uses magnification software. Some people prefer to customize their operating system and browser instead. So the coding of the page itself should allow for such settings to take place, that is, to allow for customizable colour schemes with style sheets and customizable text, as well as having a Web site layout that flows nicely on different screen resolutions. In terms of customising the operating system, there are, for example, several screen enhancement features integrated within Windows (RNIB, 2005):

- High-contrast colour schemes
- Large standard fonts
- Modifying the screen resolution
- Customisation options for the mouse pointer and the cursor

Also Mac OS X offers a variety of accessibility features too (Apple.com, 2005):

- Voice-over with speech and audio cues and talking alerts
- Zoom capabilities for enlarging the screen
- Magnification for QuickTime video
- Screen movement customisation when using the mouse
- Cursor scaling and customisation
- Contrast and colour adjustment controls

In addition, for accommodating the needs of partially sighted users, the following need to be taken into account:

- Using pop-up windows wisely and avoiding them in favour of other methods and techniques. The fact that a partially sighted user cannot have a full view of a Web page means that they may not notice a pop-up window that has opened on a different part of the screen than the one they are looking at (Jensen, 1998). Using audio alerts for pop-up windows/messages could also help.
- Making good use of CSS for styling the presentation of a Web page and specifying both background and foreground colours in CSS.
- Using standard styles for links; for example, underlined text so that the partially sighted user does not miss the link because of its appearance.

- Implementing a good colour contrast, especially between text and its background, and avoiding text on background images.
- Structuring information into short pages: a short page is much easier to use when greatly magnified than a long page that is likely to become very long with magnification and thus difficult to use and navigate. When long pages cannot be avoided, then breaking them with extra navigation links could help so that information can be easily reached. Many people find it difficult to read scrolling text, and constantly moving gifs can be distracting.
- Rollovers and expandable JavaScript menus can be problematic if the user has to click on an area and the menu expands away from what they initially clicked.
- Grouping of controls and content in a visual and intuitive way.
- Using clear labelling and positioning of form controls so that it is clear which form control a label refers to.
- Consistent word spacing and consistent presentation and layout in general.
- Offering a range of colour schemes for customisation.

The category of partially sighted users covers a variety of visual impairments; therefore, there are a variety of needs that fall under it.

Velleman (2005) talks about visual efficiency as a combination of visual memory, perception, cognitive, and motivational factors. Because of the different mix of this visual efficiency for partially sighted users, there can be great differences between this user group and their visual possibilities. This presents the need for customization offering a range of settings when looking at addressing the needs of partially sighted users on the Web.

Mobility-Impaired Users

There are three levels of mobility impairment including slightly impaired mobility, intermediate impaired mobility, and severe impaired mobility (Deng, 2001). The first level can occur as a result of aging and overuse of upper limbs such as repetitive strain injuries. The second level may include weakness and skeletal impairments, amongst others. At the third level, users experience lack of muscular control that may be partial or may affect the whole body. People with upper limb disorders such as arthritis and repetitive strain injury use the keyboard to navigate the Web. They find it hard to use complex navigation mechanisms designed for mouse users such as frames, rollovers, and JavaScript mouse events. They also benefit from the

provision of keyboard shortcuts for frequently used controls. This applies for blind users too as they cannot use the mouse. Adequate seating and positioning is also important because this affects computer access, particularly for mobility-impaired users. The user, in order to access the computer and activate input devices, needs to sit in a way that is comfortable to them and close to the technology being used (University of Washington, 2005). Adjustable keyboards, monitors, and desks can significantly contribute to a pleasant and efficient computer use, as well as appropriate desk room for accommodating a wheelchair. Mobility impaired people may use a variety of assistive devices such as:

- Alternative keyboards
- Trackballs
- Head controlled pointing systems that translate head movements into mouse movements
- Switches
- On-screen keyboards
- Speech recognition software

Designers and developers can accommodate the main needs of mobility-impaired people by (Deng, 2001):

- Using a logical tab order (using the tab key from the keyboard to navigate from link to link) mapped to the layout of the controls and the layout of information on the screen
- Using keyboard mapping for speeding up keyboard interaction and enhancing alternative input methods
- Avoiding conflicts with the operation of assistive software such as screen readers, and exploiting the built-in accessibility features of operating systems
- Providing multiple methods for access via the tab key as well as the use of shortcut keys
- Defining hot keys for more functionality for example, allowing the user to go backwards from link to link
- Ensuring that access keys and hot keys for frequently used functionalities are reachable using one hand, for people using one hand only
- Avoiding repetitive key presses that would be uncomfortable for users with repetitive strain injuries
- Placing frequently used links and functions on the first navigation level without requiring the user to navigate a lot to reach them

Deaf Users

There is a growing concern for deaf people accessing the Web, as the use of audio and multimedia content on Web sites is becoming increasingly popular. The Web is moving from a text-based interface to a multimodal environment with the increasing use of multimedia; this environment, despite being more interesting and engaging, presents barriers to deaf people (Paciello, 2005). Deaf people cannot access audio output. When using audio to communicate the system state for example, other means such as text need to be used so that the same information can be accessed in an alternative format. People with hearing impairments require synchronized captioning for video clips and transcripts for audio clips. According to the US Department of Education (2000), captioning not only gives information access to people with a hearing loss, but also to those with literacy needs. Captions also benefit new readers and people who are learning English as a second language (Association of Science Technology Centers, 2004).

There are two types of captions:

1. **Closed captions:** They appear only when the user's technology, for example media player, supports them. Using closed captions on videos means that the user needs to be aware of their existence and knows how to turn them on and off. This is because closed captions are not embedded in the video, but are provided separately. If captions are preserved as text, users will be able to archive and index video content; this is lost with open captions (AccessIT, University of Washington, 2005). Also Clark (2004) supports that transcripts created from captions—using valid and semantic mark up—are a useful resource for searching and archiving information provided in a video.
2. **Open captions:** One distinct advantage of open captioning is that it is always on and always available and accessible (Clark, 2004). Also, open captioning has universal design benefits for people and does not only benefit those with hearing impairments. However, open captions, unlike closed captions, can loose their quality when the encoded video is compressed (AccessIT, University of Washington, 2005).

Also, when deciding what to choose, open or closed captions or even a combination of both (Clark, 2004), the Web application, the task as well as the context of use, needs to be carefully considered. Paciello (2005) offers some guidance on implementing captions:

- The user needs to be informed that captioning has been implemented (especially when using closed captioning) through a set of instructions on the homepage. This also could be added in the accessibility statement of a Web site.
- A textual captioning indicator is more accessible for deaf blind users than an image or icon. If this is provided, then appropriate alternative text needs to be used.
- Simple language needs to be used, along with short sentences.

Also Smith (2003), mentioning Section 508 and W3C WCAG 1.0 guidelines for multimedia and audio, emphasizes that captioning needs to be:

- *Synchronized* with the audio being played
- *Equivalent* in value and meaning to the spoken words or sounds
- *Accessible* in terms of being readily available to those who need it

Because there is a range of different captioning styles that are often divergent, there is a need to explore best practices and to choose a consistent style to follow that applies to the audio content being captioned and the task that it supports (Clark, 2004). However, captioning is not always enough to make content accessible to deaf people as, for many people who are deaf, their first language is Sign Language and not English. According to Byrne (2004), the most effective way to make content accessible to Sign Language users is to provide a Sign Language version of all content. This option can be very costly, and current research focuses on the development of signing avatars (virtual humans) so that it is easier and more cost effective to provide Web content in sign language. Providing captioning and using Sign Language alternatives are the most effective methods to make audio content accessible for hearing impaired users. An integral part of producing accessible content for audio is not only to follow existing guidelines and best practices, but also to constantly review and to test captioning or Sign language content with hearing impaired users (Skillsforaccess.org, 2005).

Cognitively Impaired Users

People with cognitive impairments or learning disabilities are the largest disability group. These impairments affect memory, perception, problem solving, and conceptualisation. Attention deficit disorder and dyslexia are some examples. Although

the user needs are quite diverse within this group, cognitively impaired people can greatly benefit if a few provisions are made on Web sites such as:

- Clear and simple layout and language,
- Consistent navigational schemes with the key navigation on the same location for every page,
- Use of images and illustrations to supplement text content,
- Grouping of information in small and logical chunks, and
- Lack of distracting visual and audio elements.

It may seem that there is a conflict between the needs of cognitively impaired and blind users as blind users do not need images and illustrations, whereas cognitively impaired users benefit from them. However, the use of images is compatible with the requirements of both user groups as long as adequate alternative text is provided for the images.

Dyslexia is a common form of cognitive impairment, and a brief overview of it and the challenges it presents is given.

The British Dyslexia Association gives a comprehensive definition of dyslexia:

Dyslexia is best described as a combination of abilities and difficulties that affect the learning process in one or more of reading, spelling and writing. Accompanying weaknesses may be identified in areas of speed of processing, short term memory, sequencing and organisation, auditory and/or visual perception, spoken language and motor skills.

Rainger (2003) describes the difficulties that dyslexic users may face at two levels.

At the first level, problems with visual processing that lead to slow visual object recognition and low visual concentration levels as well as over-sensitivity to light, meaning that dyslexic users can be affected by both the look of a graphical user interface (GUI) and the visual readability of the content.

At the second level, dyslexic users experience problems with short term and working memory, structure, and sequencing. This has obvious implications on the structure of information affecting the accessibility of information architecture.

As a result, the more complex and cluttered a site is, the more difficult it is going to be for a dyslexic user to find their way around, navigate deep in the site, and find their way back. This imposes the requirement not only for laying out content clearly using "white space," reducing information density, and grouping navigation mechanisms, but also for simplifying site structures.

Deaf Blind Users

According to Sense (2005), a UK charity for deaf blind people and for those with associated disabilities, there are 40 deaf blind people per 100,000 in the population. In addition, there are overall 23,000 deaf blind people living in the UK. Someone is called deaf blind when neither their sight nor hearing can compensate for the impairment of the other sense: in other words, they cannot function as a deaf person or a blind person (Sense, 2005). Some people may have nearly complete loss of both senses, where others may have some remaining hearing or vision. People who experience total loss of both senses use refreshable Braille displays to access the Internet. The Braille display transforms all the textual content of the Web page into Braille tactile output. That is, any images or multimedia that do not have appropriate textual descriptions cannot be accessed.

There are different grades of deaf blindness (Deafblind UK, 2004). A deaf blind person may have little remaining sight and thus prefer to read text in large print, customize the text size on a Web site, or use magnification software. For those with no remaining vision, accessing information in a tactile form by reading Braille or Moon with their fingertips is essential. However, those who have a little hearing left may access information using audio; for example, by listening to audiotapes and using a screen reader for accessing the Web. According to Deafblind UK (2005), "deaf blind people remain second class citizens due to the widespread lack of knowledge and the misconceptions surrounding their disability." The design and development of technologies considering the needs of disabled people can greatly enhance the way deaf blind people interact with their environment.

Elderly Users

By 2020, half the adults in the UK will be aged 50+. By 2050, those aged 65-84 will number 1.3 billion globally (Coleman, 2005). According to Nielsen (2002), by 2010, American seniors (aged 65 and over) will spend about $25 billion per year on e-commerce purchases, based on current trends. Also, elderly users go online mainly to find health information, to plan personal travel, and for e-mail. Nielsen (2002) conducted a study with 20 elderly users on 20 U.S. sites, and with 4 elderly users on 4 Japanese sites, and concluded that current Web sites were twice as hard to use for seniors as they were for younger users. The same author supports that "seniors are affected more by usability problems than younger users. Among the obvious physical attributes often affected by the human aging process are eyesight, precision of movement, and memory." The main ageing-related functional impairments can be grouped into two general categories (Zaphiris & Kurniawan, 2005):

1. Vision-related impairments (decline in static acuity, dynamic acuity, contrast sensitivity, colour sensitivity, sensitivity to glare, decrease in visual field, and decrease in processing visual information), and
2. Psychomotor, attention (declines in selective and divided attention), memory and learning, intelligence, and expertise impairments.

At first glance, it may seem that age-related impairments may not pose significant difficulties in using the Web if we look at them individually. However, taken together, as they frequently occur, they may have a cumulative effect that makes Web interaction more difficult for older people (Zaphiris & Kurniawan, 2005).

General guidance for meeting the needs of elderly users on the Web includes (Nielsen, 2002; U.S. Department of Health and Human Services, 2001):

- Support for larger font sizes than those younger users prefer.
- Sites mainly aimed at target seniors should use at least 12-point type as the default.
- Large text for hypertext links and large enough clickable areas and controls.
- Adequate spacing between links and controls to avoid accidental activation.
- Avoidance of the requirement for precise mouse movements that is often caused by hierarchical and pull down menus.
- Using simple and explicit navigation mechanisms that are easy to learn and use, as well as using clear labels for navigation.
- Left justifying and double spacing text.
- Writing in simple language as well as using positive statements and active voice.
- Providing a text version for multimedia files such as captioning, video, and audio.
- Providing a site map that easily communicates the site structure.
- Using good colour contrast with plain backgrounds, particularly for text.
- Including a site guide that demonstrates to the user how to use the site, as well as offering a telephone number to talk to a person if the user needs to.
- Using error messages that are easy to notice as well as providing clear guidance of what the error is and how to recover from it.

Accessibility Testing Methods

It is fundamental to study the needs of users with disabilities and age-related impairments at the requirements stage of the project lifecycle; however, more techniques have to be employed at different stages to ensure that a Web site is truly accessible and useful.

The most widely used methods include:

- **Guidelines and best practices:** This often includes W3C accessibility guidelines, Web standards best practices, as well as guidelines and findings from research papers and Web blogs.
- **Audits:** Expert reviews using assistive software and performing a series of manual checks in the code as well as using automated tools on representative pages. In the case of dynamic Web sites managed with the use of a content management system, both the page templates and the extent to which the system produces accessible code and content need to be assessed (W3C WAI, 2005).
- **Testing using automated evaluation tools:** The W3C WAI (2005) recommends testing Web pages with at least two different automated tools, and comparing their results to ensure that they are valid. Automated tools perform a series of checks in the code of a Web site against W3C and Section 508 guidelines.
- **Browser extensions such as Firefox Web Developer Extension and other plug-in evaluation tools such as AIS Toolbar for Internet Explorer:** These tools are used to identify components of a Web page; to facilitate the use of other online accessibility applications such as the W3C Mark up Validation service, as well as linking to free automated testing tools. Another useful feature includes the use of simulations that help the user understand how users with certain disabilities experience aspects of the Web. These tools also provide links to references and additional resources for Web accessibility.
- **User testing:** This method involves a range of users with disabilities: setting tasks for them and observing how they use the Web site. The problems they encounter are analyzed and recommendations for addressing them are provided.

Each of these methods has its strengths and weaknesses; however, when carefully combined they can be very effective. For example, automated tools can process many Web pages quickly, and the evaluator can get an overview of some of the main issues that can be identified this way. Manual checks are very useful to assess many Web accessibility aspects (such as the presence of good alternative text for images) and making recommendations for addressing them; however, they are time

consuming and they assume a very good knowledge on the behalf of the evaluator. Browser extension and plug-ins are very convenient tools, but they cannot replace the use of assistive software, and they are not aimed to be used as such.

User testing is essential. It combines elements of usability and accessibility testing, and can identify problems that cannot be found using any other method. However, user testing requires a good sample of users, good knowledge of user testing methodologies, and avoidance of the risk to base recommendations on the preferences of one user. A combination of methods and techniques used in a systematic way is required for producing accessible Web sites.

Henry and Grossnickle (2004) talk about incorporating accessibility into user-centered design following a process of creating widely accessible products. Vanderheiden's and Tobias' (2000) approach has the same basis and is described with the term "universal design":

Universal design is the process of creating products (devices, environments, systems, and processes) which are usable by people with the widest possible range of abilities, operating within the widest possible range of situations (environments, conditions, and circumstances), as is commercially practical.

The European Union, in 2005, conducted an accessibility evaluation study that initially tested the accessibility of 436 government Web sites across the EU using automated tools. This was then followed by manual testing across a sample of them. The study revealed that only 3% of the 436 online public service Web sites assessed achieved basic accessibility compliance with W3C WAI WCAG 1.0.

It is becoming evident that a more systematic and thorough approach to Web accessibility is required for the development of accessible Web sites, an approach that spans from the requirements to the implementation stage of a Web project.

Conclusion

Examining the needs of users with disabilities helps to develop more useful and usable systems for everybody. Therefore, good design for people with disabilities results in good design for all (Vanderheiden, 2002).

All too often focus is placed on one user group that is mostly disadvantaged by poor Web accessibility. Moreover, very frequently there is a focus on accessibility in a prescriptive way, describing solutions without addressing and understanding the user needs that lie behind:

Many designers and developers are introduced to accessibility because of regulations and the need to comply with the law. In such cases, the motivation for accessibility is often limited to meeting standards and guidelines. Many times this puts the focus on the technical aspects of accessibility and the human interaction aspect is lost. (Henry, 2002)

Focusing on specific users and giving prescriptive solutions are very important in order to promote accessibility and stimulate interest, but they can also distract from the broader and deeper user needs for accessibility.

But accessibility is not limited to disability.

Vanderheiden and Henry (2003) give an interesting dimension to disability by seeing it as an intersection of the user's own abilities and their environment's characteristics for accommodating these abilities:

People experience disabilities ... not just because of their abilities or functional limitations, ... but rather as a result of the intersection—of a person's abilities and—the requirements of their environment.

Designers, developers, information architects, and usability specialists shape the Web on a daily basis. The requirements of this dynamic e-environment towards its users undergo constant change both at a technical and conceptual level, and this imposes great demand on every professional to update their knowledge by researching user needs in various contexts of use. The extent to which people will experience disabilities when using a Web site will depend on their abilities but above all, it will depend on how well the Web application has been designed to meet their needs.

Understanding user needs is important so that we can provide and maintain accessibility while knowing how to balance trade-offs between different user groups when designing Web sites and implementing accessibility. However, understanding the user needs and requirements is only the beginning. Web sites are built by people, and they need to be aware of the user needs, the latest accessibility standards, and best practices. Above all, accessibility needs to be treated as a process in Web design and development, and not a product itself.

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