Usable, Accessible Web Pages for Low Vision: Criteria for Designers

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This paper identifies challenges for design of web pages for low vision. It examines key usability considerations (subject, occasion, audience, and purpose) for defining content for web pages and emphasizes seven basic principles of universal design. SOAP for web pages is a model that web page developers can use to define content criteria for websites. The model emphasizes an interdisciplinary approach to audience, needs, task, and requirements analysis. It discusses a user–centered approach (capture, specify, plan, realize, deliver) to usability testing. Additionally, this paper summarizes key findings from low vision research on type legibility. The paper concludes with design principles that can be derived from print–based studies (normal and subnormal vision) for developing accessible web pages.

USABLE, ACCESSIBLE WEB PAGES

Access technology (speech synthesizers, and Braille display technology) makes a myriad of documents, products, and services available to people with vision problems. So, *why can't everyone.everywhere read your web page?* If Jacob Nielsen (an expert on usability) were delivering this talk, he would probably reply, "Your web pages need work!" (http://inq.philly.com) (Philadelphia Newspapers, Inc., 2000, p. 1) Take the challenge; give yourself a LIFT and a WAMMI (http://www. webable.com)! Follow the W3C web page accessibility guidelines (http://www.w3.org) when coding your pages. Then, TIDY (http://www. webable.com) up your HTML code and get Bobby Approved! (http://www.cast.org). Last, display the web access symbol (http://www.boston. com/wgbh/pages/ncam/symbolwinner.html) signifying that an *effort* has been made to enhance access for universal audiences.

Challenges for design of web documents for low vision

Electronic displays of information pervade everyday life. The most obvious examples of such displays are, of course, personal computer monitors; however, electronic displays are found in countless other applications as well. Some common examples are airport information monitors, traffic warning and control boards, interactive self–service financial transaction terminals, appliance controls, and automobile dashboard gauges and controls. Ideally, the ubiquitous presence of electronic displays means that they must be usable by the widest audience possible. Designers of on–screen displays must strive to make those items usable by people with differing abilities as well as to a mainstream audience. When designing displays, a principal concern is for people with subnormal visual acuity or abnormal visual field. These readers are "reduced vision readers." A characteristic of the display that is merely an annoyance to a normal reader may cause the same display to be completely unusable by someone with reduced vision. Such visual impairments are a common problem. More than 100 million Americans wear corrective lenses (i.e., contact lenses or eyeglasses) and one out of every twenty Americans suffers from a reduced vision problem (Stoto, Behrens, & Rosemont, 1990). Moreover, it is possible that careful choices during the design process can enhance the effectiveness of the electronic document for many reduced vision readers. Additionally, text legibility is highly important to reduced vision readers because difficulty in reading often is the first, or most severe, result of their vision loss. Therefore, designers of electronic displays must make accessibility the first challenge in the design of on–screen text or a user interface.

"The most serious accessibility problems, given the current state of the web, relate to blind users and other users with visual disabilities because most web pages are highly visual" (Nielsen, 2000, p. 302). As a result, this visual delivery medium may encourage one to design around graphical objects that are not properly explained for non–graphical modes of communication (Sullivan, 1996-1997). Developers may need to make compromises in their web page designs to accomplish multimodal delivery for special needs audiences (Reece, 1992; Reece, 1993–1994; Reece & Scheiber, 1993). Seven basic principles of universal design may be helpful to designers in creating accessible web pages: (1) "equitable use," (2) "flexibility in use," (3) "simple and intuitive use," (4) "perceptible information," (5) "tolerance for error," (6) "low physical effort," and (7) "size and space for approach and use" (Connell, Jones, Mace, Mueller, Mullick, Ostroff, Sanford, Steinfeld, and Vanderheiden, 1995) http://www.design. ncsu. edu: 8120/cud/univ_design/princ_ overview.htm).

Computer technology makes it possible for people with vision problems to use information when web pages are written in **valid** hypertext mark–up language (HTML) (Royal National Institute for the Blind, 1995–2001). To accommodate low vision readers, it is essential that text alternatives be provided for every non–text element on a web page (Royal National Institute for the Blind, 1995–2001). It is user needs that vary depending on how a person's eye condition affects vision (Appendix D).

SOAP For Web Pages

To understand user needs, web developers will want to know who the audience is for their website (Flanders & Willis, 1998; Nielsen, 2000). Five filter questions are helpful in understanding what you know about the audience: (1) "Who is your audience?" (2) "How well does the site meet the needs of your audience?" (3) "Do web surfers get what they come for when they visit your site?" (4) "What do users think of your site once they get there?" (5) "How does your audience act once they get to your site?" (http://inq.philly.com).

The questions that the article poses may also parallel those in current research on audience analysis (Hager & Scheiber, 1992; Kilian, 1996–2001; Lay, Wahlstrom, Rude, Selfe, & Selzer, 2000; Lynch & Horton, 1999; Mathes & Stevenson, 1991; Reece, 1993–1994; To understand audience, it may also helpful to define subject, occasion, and purpose (Boley, 1980; Reece, 1993–1994). The SOAP model, given in Appendix A, provides top–level questions to consider for each content category. This paper identifies five types of web visitors: (1) Occasional and Casual Surfers, (2) Novice Surfers, (3) Expert and Master (Frequent) Surfers, (4) Special Needs Surfers, and (5) International Surfers. These visitors can be associated with four occasions for using web pages: (1) viewing, (2) listening, (3) reading, and (4) retrieving.

Occasional and Casual Surfers are visitors that may be influenced by web pages that get their attention (graphics, design, eye candy, audio). They tend to be skimmers and retrieve information using "hit and run" techniques (Kilian, 1996–2001). For this audience, home pages are key for conveying clear statements about the content of the website.

Novice Surfers will appreciate clear web page structure (queueing) for navigation. They like overviews, and attention devices (graphics and design), definitions of technical terms, acronyms, and pages that contain callouts of key technical material (Frequently Asked Questions) (Lynch & Horton, 1999).

Expert and Master (Frequent) Surfers prefer quick, accurate access to information and use detailed menus efficiently. They tend to be very familiar with the web. Generally, they have specific reading goals, use scrolling features, and are technical experts at web tasks such as downloading resources and using search engines efficiently (Lynch & Horton, 1999). In general, they are avid readers and favor printed materials for reading.

Special Needs Surfers tend to use a variety of assistive technologies based upon their needs (Burgstahler, 1999; http://www.humanware.com; http://www.sun.com). This paper identifies 15 categories for assistive technologies that can be associated with vision–related activities. Some of these technologies include: (1) **Color Setting Adjustments**, (2) **Computer Monitors** (screen size, (Fine & Peli, 1996)) (3) **Contrast Control** (computer monitor settings, Closed Circuit Television (CCTV) positive and negative settings, special filters (Lightstone, 1997)), (4) **Custom or Special Key Functions** (larger keys, extra spacing between keys, large print key top labels, StickyKeys, RepeatKeys, SlowKeys, MouseKeys, ToggleKeys, BounceKeys, keyboard guards, special switches, abbreviation, expansion (macros), (5) **Custom and Rehabilitative Technologies**, http://www.arch.gatech.edu/crt/crthome.htm, (6) **Flexible Browser Settings**, (7) **Input/Output Devices** (Input: special–purpose keyboard, trackball, mouth stick, head stick, splinted hand; Output: voice output), (8) **Special–purpose Keyboards** (Braille, left– or right–handed, mini, expanded, ergonomic), (9) **Keyboard Emulation** (scanning, Morse code input), (10) **Magnification and Clarification Devices** (prescriptive (glasses, contact lenses, computer glasses, readers), non–prescriptive (readers), hand–held (magnifiers), stand–alone (CCTV), or application driven), (11) **Multiple Modes of Access** (calculator, computer, television, telephone, cell phone, fax, automatic teller machine, TDD business lines, portable desk accessory, wireless technologies) (12) **Resolution** (number of pixels, rows, and columns on screens), (13) **Special Media** (anti–glare screens, disk guides), (14) **Software** (speech recognition, optical character, e–mail, word prediction, web browsers, word processing, spreadsheets, data bases, project management, time management, on–screen help), and (15) **Text Formatting** (ASCII text, familiar typeface (Figure 1), print at visual threshold, semi–bold emphasis, fonts in Roman posture, large print, easy–to–recognize numeric character set, contrast in foreground and background, HTML ALT parameter).

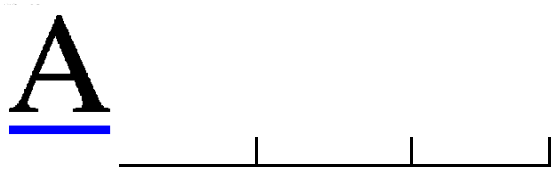

Figure 1. Fonts for Accessible Web Pages
Source: (Reece, 2001).

International Surfers may be near or distant in location and may appreciate language translation support for text and color on key web pages. They may have difficulty with jargon, technical terms, and slang words.

Dray (2001) recommends a five–step, user–centered state model for usability requirements for conducting a needs, task, and requirements analysis: (1) capture, (2) specify,

(3) plan, (4) realize, and (5) deliver. This process may be useful to web page designers in creating usable, accessible electronic documents. Usability testing techniques are now evolving; some findings from current practice are given in Appendix C.

LEGIBILITY AND PRINTED DOCUMENTS

The term legibility refers to the degree to which text can be comprehended or understood. Examples of general definitions include the "ease and speed of reading" (Tinker, 1965, p. 120), the "effectiveness of typography in communicating the text code" (Arditi & Cagenello, 1992, p. 324), and "typographic clarity" (Haley, 1999). However, there is no agreement on a detailed definition of the term. Those definitions may vary according to the specific application and may be based upon measurements such as perception at a distance or speed of reading (Arditi & Cagenello, 1992; Tinker, 1965).

Regardless of the specific definition, legibility can be difficult to measure because it may involve the interaction of several factors. Because of the complexity of that interaction, isolation of the individual variables for measurement may be difficult, and moreover, the collective effect of the variables may be very different from the effects considered individually (Rubinstein, 1988).

The earliest work on type legibility dates back more than 150 years, and over 300 studies, covering a wide variety of topics related to the legibility of type, have been reported since 1925 (Cornog, Rose, & Walkowicz, 1964; Rehe, 1974; Spencer, 1968; and Tinker, 1963). These studies involved several diverse fields, such as ophthalmology, education, journalism, graphic design, information design, and instructional design (Arditi & Knoblauch, 1994; Arditi, 1996; Felker, Pickering, Charrow, Holland, & Redish, 1981; Hartley, 1978; Hartley & Burnhill, 1977; Hartley, Burnhill, & Fraser, 1974; Hartley, Fraser, & Burnhill, 1974; Hartley & Jonassen, 1985; Hartley, Young, & Burnhill, 1974, 1975; Tinker, 1963; Tinker & Paterson, 1944; Tschichold, 1967; United States Government Printing Office, 1951; White, 1987; and Wrolstad, 1960). Most of this work has dealt with print media for normal readers. Moreover, Paterson and Tinker (1929, 1931, 1932, and 1940) generally are credited with conducting the most exhaustive experimental studies on typography for that media and audience.

LEGIBILITY AND ELECTRONIC DISPLAYS

It is often argued that electronic documents require design techniques that are different from those used for print–based documents (Hartley, 1987; Morrison, Ross, O'Dell, Schultz, and Higginbotham–Wheat, 1989; Sullivan, 1997; Tomasi & Mehlenbacher, 1999). The issue becomes even more controversial when dealing with multimode documents (i.e., documents that are from a single source and are intended for delivery in more than one mode, such as print, on–line, multimedia, etc.) (Reece, 1992; Reece & Scheiber, 1993, and Reece, 1993–1994).

The differing requirements for print–based and electronic documents result from several characteristics, such as: (1) space and usage, (2) resolution, (3) color, (4) contrast, brightness, and effect of ambient conditions, (5) viewing limitations, (6) display distortions, (7) aging of electronic displays, (8) appearance control, and (8) variable characteristics of media.

Despite these differences, the specific issues associated with electronic displays have received little attention in comparison to the work devoted to the design of legible printed documents. Hence, a common approach to designing electronic displays has been to simply extend existing print–based principles and apply them to electronic displays (Williams, 1994; Williams & Tollett, 1998). (See Figures 1–2 and Appendix B.) Legibility is one such design issue that has been addressed in this manner. Moreover, most of the work associated with electronic displays has been directed toward normal readers rather than reduced vision readers.

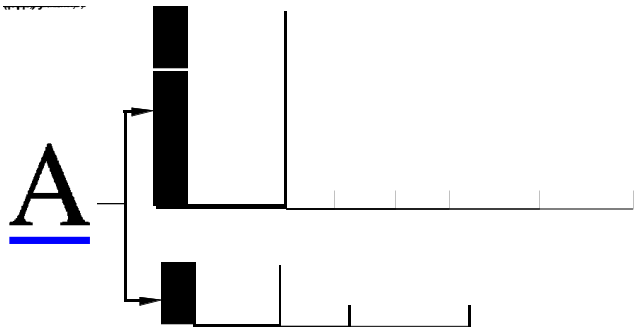

Figure 2. Text Attributes for Accessible Web Pages (*Sources:* Reece, 2001; Shaw, 1969; Spencer, 1968; and Text Matters, 1998.)

LEGIBILITY AND REDUCED VISION

The legibility problem becomes even more complicated when reduced vision readers are considered. The need to address accessibility issues is now focusing interest on that group (Arditi, 1994; Stueben & Vockell, 1993). Moreover, the importance of text legibility and typographical factors in the design of materials for reduced vision readers is recognized (Hartley, 1994).

Reduced vision readers suffer some degree of visual impairment that is not correctable by means such as contact lenses, eyeglasses, or surgery (The Lighthouse, 1995, 1998-2001). This impairment may result in a number of problems during reading, such as seeing double images, losing place or moving from one line to another when reading words on a line, skipping lines surrounding the intended reading position, seeing words as being spread apart, or seeing letters or symbols as moving about (Meares, 1980).

Reduced vision readers may use a variety of means to compensate for the difficulties that they experience in reading. In some instances, they may use the same material as normal readers with customizations that accommodate their needs. For example, they might modify the choice of fonts or background colors in an electronic display to suit their reading preferences (National Technology Access Program, 1998; DeBord–Schulze, 1997; Trace, 1997-2001; DO-IT!, 1997; Vanderheiden, Chisholm, & Ewers, 1997). In more severe cases, however, reduced vision readers may be limited to reading text that is very large, held very close, or highly magnified (Bergman, 1994–1997). Specialized equipment, such as magnifying readers for printed documents or screen reading software (DeBord–Schulze, 1997; University of Washington, 1997) for computer displays, may be required. Such software normally results in the display of a limited number of characters of text a line at a time and requires the use of large computer monitors (Fine & Peli, 1996). It is clear that text legibility is a particular concern for reduced vision readers. While some studies of this issue have been performed, they have been directed almost exclusively toward printed documents rather than electronic displays.

Additionally, it has long been suggested that studies consider the type of eye disorder that causes the reduced vision problem (Prince, 1957; Shaw, 1969). This need arises because of the differing effects of various disorders. Two such examples are macular disease, which may cause difficulty in near reading tasks (Corn & Koenig, 1996), and retinitis pigmentosa, which may cause loss of color perception and difficulty in focusing (DeBord–Schulze, 1997; Thomas, 1997; The Lighthouse, 1998-2001).

Most early work on legibility for reduced vision readers deals with improving printed materials for children (Shaw, 1969). Only a few studies (Prince, 1957; Prince, 1958; Prince, 1959; Prince, 1960; Prince, 1966) addressed print for reduced vision in an adult population.

Prince (1957, 1958, 1959, 1960, 1967) provides some of the earliest recommendations regarding typographical factors in the preparation of materials for reduced vision readers. In the earliest work, he finds that reduced vision readers recognize lowercase letters in the form of familiar words (called “word pictures”) much more easily than letters in other contexts due to the readers filling in information from the context to produce an appropriate interpretation (Prince, 1957). Additionally, he notes that material with additional interletter spacing is read more easily than densely packed text by such readers. Later, he determined that readers with subnormal vision also prefer text with increased interword spacing and leading (i.e., interline spacing) (Prince, 1959).

Next, Prince (1960) examined the preferences of reduced vision readers for backgrounds of various density gray for printed material. He found preferences but was not able to establish conclusive relationships between those preferences and the participants’ ocular conditions. It is notable that all of the nearsighted (myopic) participants preferred low contrast backgrounds.

Finally, in a hypothetical discussion, Prince (1967) suggests that experienced reduced vision readers may prefer serif typefaces to sans serif typefaces. Moreover, he argues that these preferences may differ between adult and children reduced vision readers. This phenomenon would be expected because adults who have been active readers will have much more experience than children.

The work by Shaw (1969) is a key study of legibility and reduced vision readers (adults and children). This research was the first to examine print for reduced vision readers by direct observation. It examined the effect of typographical changes on the ease with which reduced vision readers could read continuous text on paper. Variations of typeface (serif and sans serif), type weight (bold and medium), and type spacing (interletter, interword, and interline) were examined. Familiar words from standardized lists used in schools were arranged in semantically anomalous random sentences to avoid the effect of clues of context.

Shaw found that type size is one of the most important factors for adult reduced vision readers, with those participants exhibiting preferences for sizes larger than 10–12 points (Appendix D). The relative size and weighting of the typeface were secondary contributing factors to legibility when considered collectively. The study also showed that other differences in typeface seem to have little effect of legibility, although there was some preference for sans serif faces. This preference, however, may have been related to the reading experiences of the participants. Additionally, spacing variations do not seem to affect legibility. Moreover, the typographical changes appeared to help adults more than children. Finally, the use of word and phrase units also was of importance.
Additionally, Shaw found relationships between the pathological conditions that caused the reduced vision and the preferences (Appendix D). Participants with glaucoma preferred bolder type and were most affected by typographical changes, especially size and weight. Participants with cataracts were helped more by increases in weight than increases in size, while this characteristic

was reversed for participants with myopia. Finally, participants with age–related macular degeneration (AMD) were helped by increases in size and a change to a sans serif typeface. Moreover, there were no cases in which typographical changes were helpful to one group and detrimental to the others. It must also be noted that Shaw's work did not include a control group; hence, her preferences from a group of reduced vision readers cannot be compared to those of normal readers.

Several studies on the psychophysics of reading have been conducted using both normal and reduced vision readers. These studies have addressed such topics as font and reading rates (Legge, Peli, Rubin, Schleske, 1985), font and contrast sensitivity function on reading (Legge, Rubin, Luebker, 1987), influence of fonts in normal and reduced vision reading acuity (Mansfield, Legge, & Bane, 1996-2001), recognition of characters within the visual span at a glance as related to reading speed deficits (Legge, Ahn, Klitz, & Luebker, 1997), and reading speed related to page navigation problems associated with using magnifiers (Beckmann & Legge, 1996; den Brinker & Beek, 1996; den Brinker & Beek, 1994; den Brinker & Bruggeman, 1996; DeBord–Schulze, 1997; Fine, Kirschen, & Peli, 1996).

In print–based studies involving color contrast, Lightstone (1997) found that spectral filters were helpful to some patients during reading tasks. Additionally, Eperjesi, Fowler, and Kempster (1995) discover that color contrast may assist subnormal readers in object recognition rather than enhance reading and that dark letters on white background may be preferred. Eperjesi, Fowler, and Kempster (1995) discover that color contrast may assist subnormal readers in object recognition rather than enhance reading and that dark letters on white background may be preferred.

Some studies that included reduced vision readers involved electronic displays. Much of this work centered around the effect of color upon legibility. Legge and Rubin (1986) explore the relationship of color to legibility of text on a television monitor in a distance reading task. Neutral–density and Wratten color filters were placed over the monitor as participants read material. The results indicate that for this task, wavelength alone does not play a significant role. Moreover, when wavelength is a factor, these researchers suggest that the legibility tends to be optimal for green or gray.

CONCLUSIONS

Few studies, however, have examined other typographical issues associated with text legibility on electronic displays for an audience with reduced vision. In one notable study, Fine and Peli (1995) examine the effects of spatial filtering on reading rate, the effects of character size, and the effects of luminance using a monitor and a low vision magnifier. They conclude that some reduced vision readers may benefit more from increased luminance from the use of larger characters.

No studies, however, provide guidance for selecting typefaces to produce legible electronic displays for reduced vision readers. Any available recommendations result from extending either print–based studies or studies using normal readers to this situation. Additionally, no studies have examined any associations that may exist between the source of the reduced vision and legibility of text on electronic displays.

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APPENDIX A

Table 1. SOAP for Web Pages: Content Criteria for Accessible Web Page Design for Everyone.Everywhere

Category and Content Criteria
Subject
What topics (critical product information, business operations, general information, training and education, career planning, job network, internet search) should be included to ensure that material is cohesive?
What material will the communication cover?
What are critical information needs for the multidimensional audiences?
How can the material be sequenced for maximum usability?
Occasion
When will the audience most often use the web pages (viewing, listening, reading, retrieving)?
How fast will the audience need to access the information?
Where will the audience access the communication?
Will there be a need to customize the material for multidimensional audiences?
What tasks will the audience perform as they use the web materials?
Audience
Who is the primary audience (business websites, non–profit sites, informational sites, opinion sites, and ego sites)?
How many audience levels will there be for the web materials (Occasional and Casual Surfers, Novice Surfers, Expert and Master (frequent) Surfers, Special Needs Surfers, and International Surfers)?
What are the multidimensional audience levels?
What level of experience does each level have?
What job categories can be assigned to the audience?
What type of subject knowledge does each audience level have?
What role or level of decision–making authority can be assigned to the audience?
Purpose
What is the goal or aim (to earn money, to provide information and/or opinions, to stroke egos, to create a professional image) of the site?
What will be the scope for the web materials?
What purpose for reading, listening, viewing, and retrieving can be assigned to the audience?

Sources: Adapted from textual material in Flanders & Willis, 1999; Hager & Scheiber, 1992; Kilian, 1996–2001; Lay et al., 2000; Lynch & Horton, 1999; Reece, 1993–1994.

Note: More details are available on the SOAP model upon request.

APPENDIX B

Table 2. Principles for Accessible Web Pages

Audio
Provide audio and text transcripts for video.
Color
Maximize contrast between foreground and background elements.
Avoid busy backgrounds that may interfere with reading.
Avoid loud textures, patterns, or images.
Use portable colors for backgrounds.
Contrast dark colors from the extremes on the color wheel with very light mid–scale colors.
Avoid contrasting light colors from extreme locations on the color wheel against dark mid–scale colors.
Avoid use of achromatic colors (white, grey, black) that are similar in brightness.
Avoid contrasting low chromatic colors with those that are similar in brightness.
Avoid contrasting hues from adjacent parts of the color wheel, especially if the colors do not contrast sharply.
Filtering (Lists)
Use ALT string to identify filter images such as bullets in lists.
Filtering (Frames)
Provide meaningful NOFRAMES content plus appropriate links to other pages on the site.
Omit frames whenever possible.
Avoid IFRAME until the technology becomes portable.
Use browser–compatible specifications when creating frame borders.
Images
Use the alternative text attribute (ALT text) of the image tag to provide a textual description of the image for people accessing the page in a non–graphical method (e.g., text only, speech, or Braille).
Use ALT text labels for image maps.
Use links for lengthy text descriptions of graphics.
Use ALT parameter to describe invisible graphics or

language preferences.
Use descriptions of links when using a client–side image map.
List links as text when confined to use of server–side image maps.
Use empty string annotations for decorative graphics.
Use a nonscript alternative when using scripts.
Provide alternative text when using applets.
Provide semantic titles to horizontal rules.

Input Forms

Avoid using image map "submit" buttons.
Use text labels for all controls.
Group and label related controls.
Group and label menu controls.
Consider using alternate page links with additional contact information.

Interletter Spacing

Avoid close interletter spacing for people with central visual field defects.
Use a wider spacing (e.g., monospaced fonts) than is provided in proportional fonts.

Interword Spacing

Use a wider spacing (e.g., monospaced fonts) than is provided in proportional fonts.

Leading

Use leading that is 25–30% of the point size.
Add spacing between paragraphs.
Apply more space between paragraphs than between lines.

Links

Provide text versions of the links associated with image maps.
Write link names so that they are self–explanatory.
Avoid presenting links directly next to each other.
Provide text–based links for graphics of text as links to facilitate browser changes for font size accommodations.
Verify that the links that readers need on a page are visible without scrolling.

Margins and Length of Line

Allow extra–wide binding margin for web materials intended for print.
Permit 50–65 characters per line.
Avoid leading reader's eye off screen prematurely.
Use generous space between columns.

Paragraph Style

Indent first line of paragraph.
Use hanging–indent style for paragraphs.

PDF Files

Provide HTML or plain text versions.
Make charts or graphs in the PDF file accessible.
Provide URL for "Access Adobe" at the Adobe website.

Shockwave, Scrolling Text, JavaScript, Plugins, etc.

Provide plain text HTML alternatives for material presented in formats other than plain HTML.
Ensure that meaningful content is available for Flash movies to users who cannot access Flash.
Use plain links to enable users to access subsequent pages of your site.
Ensure that JavaScript pages function correctly without scripts or provide parallel pages that do not use JavaScript.
Offer Flash and non–Flash versions of pages to ensure that users have control over how information is presented.
Avoid moving, blinking, and auto–refreshing text.

Tables

Label table rows and columns.
Summarize or repeat complex tabular information in alternative, non–tabular format.
Check that the tabular information is coherent when columns are removed.
Summarize or repeat complex tabular information in alternative, non–tabular format.
Check that the tabular information is coherent when columns are removed.

User Interaction

Use auditory rather than visual browswers.
Avoid requiring users to click on small or moving targets to proceed to another page.
Check that the TAB order uses a coherent sequence for the content.
Use TABINDEX attribute for cases where the tab sequence needs revising for coherence.

Video

Provide audio and text transcripts for video.

Web Page Downloads

Allow a maximum of 20 seconds for download of web pages using a medium speed internet connection.

Sources: Adapted from textual material in Alschuler, 1998; Arditi, 1994; Flanders & Willis, 1999; Kilian, 1999–2001; Fontaine, 1995; Lynch & Horton, 1999; Lay et al., 2000; Nielsen, 2000; The Lighthouse, 1995; Text Matters, 2001; Reece, 1993–1994; Reece, 2001; Royal National Institute for the Blind, 1995–2001; Sullivan & Manning (1996-1998); Usable Web., 1999–2001.

Note: This chart excludes the principles given in Figures 1–2. More detailed principles and evaluation instruments are available upon request.

APPENDIX C

Table 3. Usability Testing Techniques for Accessible Web Pages

Usability Testing Techniques for Accessible Web Pages
Requirements Analysis (Voice of the Customer)
Is the participant using the browser default values?
Does the participant have physical limitations such as vision impairment, color blindness, and so on?
What fonts reside on the participant's system?
Navigation
Are the web pages written in **valid** HTML?
Have the web pages been tested for accessibility?
Have the web pages been tested for usability?
Are the web pages understandable when tested using disengaged settings (mouse and graphics setting on the browser)?
What navigation problem result when using disengaged settings?
What navigation problems result when using a text–only browser?
Content
Are the transcripts accurate?
Contrast
Is there sufficient contrast for an easy–to–read document after converting the background image or color to a grayscale image using a graphics editor?
Color Scheme
How effectively can the web page color scheme be overridden by the user's browser settings?
Text Size
What are the results of pilot tests with users from the target population in text sizes: 10, 12, 14, 18, and 24 pt.?
Do browser settings allow web visitors to make adjustments in text size for the pages that they view?
Are relative font sizes being used in the HTML code?
Complex Images
Is there a placeholder letter "d" next to complex images for cueing readers to detailed descriptions of images?
Does the placeholder letter, "d," link to a page containing a detailed description of the image?
Correctness
Did the spell–checker find any errors?
Direct Observation
Have users of all abilities tested the web pages and provided feedback?
What new observations did you make about the usability of the web pages from the various groups of users?

Sources: Adapted from textual material in Flanders & Willis, 1998; Fontaine, 1995; Fuccella & Pizzolato (1999); Hamilton, 1997; Nielsen, 2000; Reece, 2001; and Royal National Institute for the Blind, 1995–2001.

APPENDIX D

Table 4. Key Findings of Legibility Studies for Low Vision Readers (adults and children) by Need and Visual Function in a Direct Observation, Normal Reading Context

Need (Presenting, Primary Etiology for Eye Problem)	Eye Segment (Anterior (front) or Posterior (back))	Usual Prognosis	Visual Function (Resolution or Visual Field)	Key Findings of Legibility Studies for Low Vision Readers (adults and children) by Need and Visual Function in a Direct Observation, Normal Reading Context*
Cataract	Anterior	Congenital (plus others—capsular, cortical, morgagnian, diabetic, infantile, lamellar, nuclear, senile, traumatic, and 25 polar)	Resolution	2, 6
Myopia	Anterior	Progressive	Visual Field	2
Macular Degeneration	Posterior	Unknown	Resolution	1, 2
Glaucoma	Posterior	Anatomical Predisposition, Congenital, Acute, Incidious	Visual Field	2, 3

Key to "onset" definition (King, 1999; Reece, 2001; Thomas, 1997): (a) congenital (present at birth), (b) acquired (adventitious condition due to accidental trauma, surgery, or illness), (c) progressive (neurological, neuromuscular conditions and other diseases), (d) temporary conditions (trauma condition due to surgery, accident, infections, occupational hazards, etc.), (e) genetic (inherited) conditions, (f) anatomical predisposition (anatomy susceptible to developing the condition), and (g) acute (painful), (h) insidious (chronic forms), and (i) unknown.

Key to Prior Print–based Research on Text Legibility for Adult Readers by Vision Need (Shaw, 1969): (1) Typeface, (2) Type size, (3) Type weight, (4) Spacing (interletter, interword, leading), (5) Typeface and weight; (6) Type size and weight.

*Note: Participants were binocular (aids worn) and used materials that resembled a normal reading task.

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