Software personalization to meet the needs of older adults

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V.L. Hanson, A. Snow-Weaver, S. Trewin, Software personalization to meet the needs of older adults. Gerontechnology 2006; 5(3):160-169. Older adults experience predictable difficulties when using computers due to age related problems with vision, hearing, motor ability, and cognition. One way to make computers easier for older adults to use is to provide application customization features that can be set to meet individual needs. This paper discusses such customizations and reports on one effort underway to improve Web access for older adults. Usage patterns and lessons learned will be discussed.

Keywords: older adults, preferences, guidelines, Web design

Population statistics indicate that approximately one in every five people has a disability, many of which can impact ability to use a computer[1]. Considering that the incidence of such limitations increases with age, the importance of considering them in design becomes apparent. Meeting the needs of this growing population is critical – not just for 'recreational' surfing, but also to meet the needs of the aging workforce.

What is less apparent, however, is how to design for the 'typical' user and for users with a variety of individual needs.

We propose here flexibility as one approach to designing for a large number of users, specifically flexibility for older adults. Although often discussed as one monolithic group all having the same needs, older adults are actually a diverse group, differing on a number of dimensions[2], including the definition of 'older adult'. Age 65, for example, is often used to define 'older' adults, however, the American Association of Retired Persons[3] and SeniorNet[4] use 50 as the age for membership.

Some older adults are quite experienced computer users while others have never touched a computer. As the population ages, however, it is expected that the number of older computer users will dramatically increase, bringing to the forefront age-related issues that can negatively impact computer use[5]. These issues affect many aspects of computer use, including ability to see visually displayed information, hear audio information, use the mouse and keyboard, and comprehend complex material (*Table 1*).

Also relevant is the consideration that addressing these problems in isolation may not solve the problem. For example, accurate mouse usage requires

Table 1. Age-related difficulties and computer abilities impacted (adapted from Czaja & Moen[5]); and usage percentages of 'Web Adaptation Technology' software features as related to these difficulties; n = 886; n.a. = not available: keyboard navigation was implemented throughout the software without requiring special settings; as a result, statistics on usage are not available for this feature

Difficulties	Computer activities impacted	Software Features	% Usage
Changes in vision			
Acuity Contrast discriminations Color perception	Read text on computer screens Discriminate icons Locate information on complex displays or websites	Size Speak text Magnify page Text style Page colors Banner text Enlarge images Larger browser controls Larger pointer Letter spacing Line Spacing One column Hide backgrounds	41.2 35.9 35.1 34.9 30.5 26.4 24.2 22.0 15.8 14.0 13.0 5.6 5.5
Changes in hearing			
Hearing loss	Comprehend synthetic speech Detect auditory signals or alerting sounds Interact with multi-media programs	Speak text	35.9
Changes in motor skills			
Motor co-ordination Weakness, one or both sides of the body Tremors Rigidity / slow movement	Press keyboard keys accurately and quickly Use modifier keys Point at small targets Keep mouse steady while clicking Hold mouse button down while dragging	Dynamic keyboard Size Magnify page Larger browser controls StickyKeys MouseKeys Key Clicks One column Keyboard navigation	98.0 41.2 41.2 22.0 10.2 13.8 7.2 5.6 n.a.
Changes in cognitive abilities			
Memory declines Difficulty learning an unfamiliar domain Difficulty forming cognitive models of computer applications Attention problems	Learn new skills or applications Declines in recall of complex operating procedures or instructions Locate information on complex displays Comprehend instructions Integrate information Interference from previously learned skills	Magnify page Stop animations Hide images One column Hide backgrounds	41.2 15.4 9.1 5.6 5.5

not only good motor control but also visual acuity. People with poor vision will have difficulties clicking on small targets regardless of whether or not they possess good motor control[6].

Software that allows for personalization has the potential to significantly improve older adults' software usage. Our example application here is a Web browser. The Web has become an indis-

pensable source of information and communication both inside and outside the workplace. Older adults are expected to swell the ranks of Internet users shortly[7]. Guidelines for website design for older adults have been created and ideas for usability tested[8-11]. Few sites, however, apply these principles. The U.S. National Institute of Health website for senior health is one example of a site designed according to these principles[12]. Given that most websites are not designed according to these principles, we examine here various adaptations to help make non-conforming Web content and the browser itself more usable by older adults.

Adapting the Web to meet individual needs

The work described here is part of a larger project, begun in 2001 to address the Web usage needs of older adults[13]. The data we discuss are from a group of 886 users, ages 50 through 102, with most between 60 and 79 years old. All project participants were members of organizations that addressed technology use by older adults. The data reported here are a subset of data on a larger project that includes a number of organizations worldwide serving not only older adults, but also younger participants who have disabilities that impact ability to use computers (www.ibm.com/ibm/ibmgives/grant/helping/seniornet.shtml).

The 866 participants in this study were all from organizations in English-speaking countries (the United States, the United Kingdom, and Australia). Internet skills ranged from novices to experienced users. Most had limitations considered typical of normal aging, although some had more severe difficulties such as macular degeneration or partial paralysis. Some had used the software over a period of years, between mid-2002 and January 2006, while others were newer to the software. This report does not look at differences as a function of length of usage.

This work did not seek to build software that would be used by blind individuals, whose needs are well addressed in other software such as screen readers; nor did we seek to serve the needs of individuals with severe motor disabilities that prevented keyboard use. Our work addressed difficulties with using a mouse and keyboard, but still assumed that these would be the input devices of our users.

Reported here are the results from a project in which these older adults used adaptations integrated with Microsoft Internet Explorer®. As described elsewhere, the implementation of these adaptations in our 'Web Adaptation Technology' software occurred through a variety of means[14]. Critical, however, was the fact that the software employed a simple, accessible interface that allowed users to try out adaptations before selecting them (*Figure 1*). Figure 1A shows a Web page with no adaptations applied. Notice that an icon has been added to the toolbar. Selecting this icon displays a band at the bottom of the browser window allowing users to select various adaptations in any desired combination. This is important, particularly for users who may have multiple age-related issues. Some may, for example, need adaptations to accommodate loss of acuity, and also have a tremor that makes using the keyboard difficult. Once selected, these adaptations are applied to all Web pages loaded subsequently and are saved from session to session. Thus, the Web is personalized for individual use.

The role of accessibility standards

When websites conform to the W3C Web Content Accessibility Guidelines (WCAG15), the presentation of the content can be adapted. In particular, the following WCAG principles improve the adaptations that can be provided: (i) Providing text equivalents for visual con-

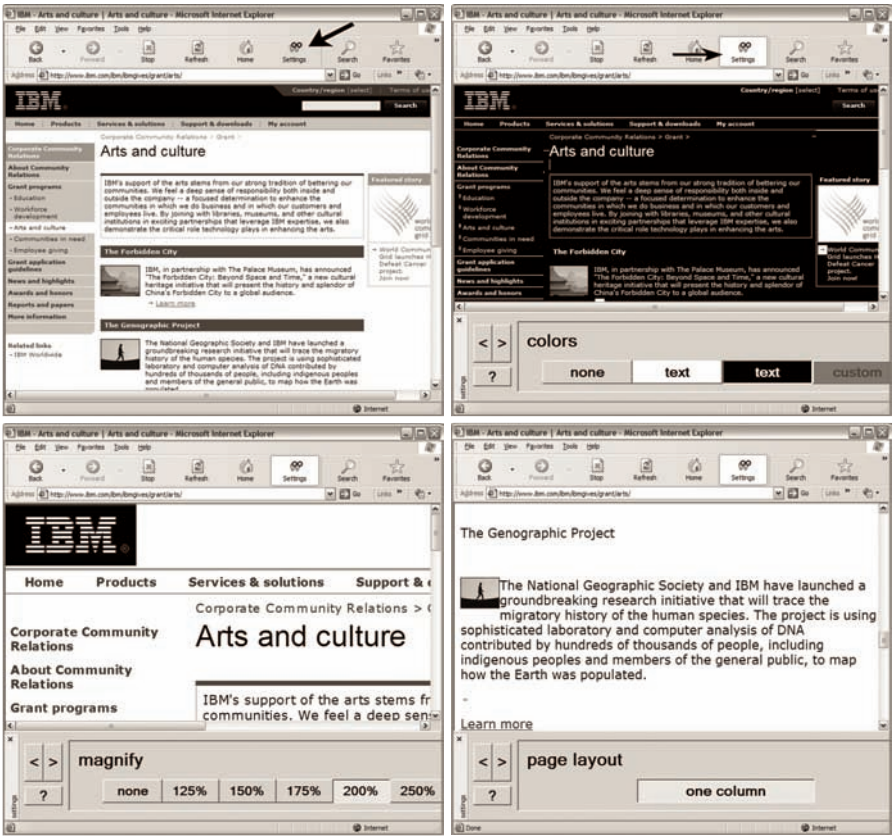

Figure 1. Screen shots of the 'Web Adaptation Technology' application; A (upper left): Web page with no adaptations applied; B (upper right): panel for colors, with the white on black option selected; C (lower left): panel for page magnification; D (lower right): page magnification from C when the 'one column' feature is selected; In C and D, line spacing and text style (boldest option, Arial Black) have been selected

tent – allows images to be hidden without loss of information; (ii) Using style sheets, not HTML elements, to control presentation – allows users to change fonts, font sizes, and colors and to suppress the display of background images; (iii) Ensuring that information is not conveyed using only color – allows users to change colors without losing information; (iv) Ensuring that layout tables make sense when linearized – allows the page to be presented as one simple column of information; and (v) Providing a method of skipping to the main content of the page – allows the alternative presentations, beginning with the main content.

'Web adaptation technology' will work even for many legacy websites that do not conform to WCAG. Such adaptations do not, however, eliminate the need for Web authors to conform to the WCAG principles.

Addressing changes in vision

Vision impairments are the most common difficulty for older adults using the Web. Age-related changes in acuity, contrast discriminations, and color perception are common[16,17]. Certain changes such as font enlargement, font style (sans serif), increased inter-letter spacing, and enhanced color contrast can increase legibility[10,18,19].

To address these specific issues, the software provided a number of features: (i) ***Speak text***: reads aloud text: individual words, paragraphs, links, or other selec-

ted text (The version of ViaVoice used depends on the user's country. Users in the USA have the US version with an American dialect, while users in the United Kingdom and Australia use the UK version with a British accent); (ii) ***Text size***: increases text size (text wraps); (iii) ***Magnify***: magnifies whole page, including images (no wrapping); (iv) ***Banner text***: displays selected text very large one line at a time at the top of the browser window; (v) ***Text style***: displays text in chosen sans serif font of increasing boldness (Arial, Verdana, Arial Black); (vi) ***Colors***: displays pages in selected color schemes (foreground, background, visited link, unvisited link, and hover links are automatically adjusted); also removes background images; (vii) ***Letter spacing***: increases the space between letters in words; (viii) ***Line spacing***: increases the spacing between lines; (ix) ***One column***: linearizes a page so that content is presented in a single column; (x) ***Enlarge images***: GIF and JPEG images are shown enlarged in a separate window when the mouse cursor is pointed at them; there is also the option to sharpen the enlarged JPEG images; (xi) ***Large browser controls***: displays file menus, scroll bars, status line, and tooltips enlarged; (xii) ***Large pointers***: uses enlarged mouse pointers; and (xiii) ***Hide backgrounds***: suppresses background images or patterns.

Table 1 lists the usage frequency of each adaptation, derived by examining user preferences at one snapshot in time. Reported is the percentage of users who had a particular option set. The percentages of use do not total to 100% as many users employ multiple adaptations.

Speak text

In earlier work, it was found that about 46% of users with disabilities use the speak text feature[20]. However, when looking only at older adults, it appears that fewer (35.9%) use the feature. This difference may simply reflect the fact that older adults more often have computers that do not support speech. Alternatively, this difference may indicate that the older users find that the other options provide all the help that they need in order to make Web pages readable. This may be particularly true if they have age-related changes in hearing that make synthetic speech difficult to understand[5].

Enlarging content

Text enlargement was used by 41.2% of these individuals (*Table 1*). Most choose to use only small amounts of text enlargement (corresponding to the 'larger' and 'largest' options in Internet Explorer's text size menu options). Similarly, for page magnification, which was set by 35.1% of the users, many selected only small amounts of magnification (corresponding to 125% magnification).

Figure 2 shows the percentage of participants using text enlargement, page magnification, and banner text. As can be seen, more use the banner text than either of the other means for displaying very large text. Furthermore, use of banner text tends to co-occur with the use of speak text, letter and line spacing, and somewhat larger text, bolder text, magnified text, larger pointers, and larger browser controls[20]. It seems that those who need only slight enlargement modify the text size, while those needing greater enlargement of the page content choose one of the other two options.

Navigational issues are huge for people with low vision who *do* use a great deal of text enlargement or page magnification. The small amount of material still viewable in a window once content is enlarged makes it difficult to get a sense of the page. To address this problem, the one column option was recently included in our application. This option re-

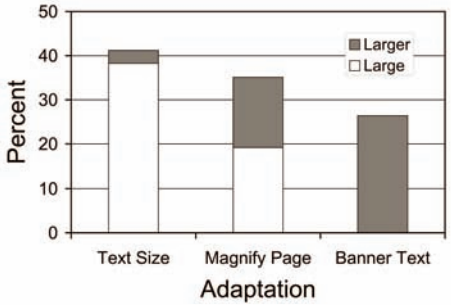

Figure 2. Usage frequency of content enlargement features, showing percentage of small amounts of enlargement for the text size and page magnification, vs. greater amounts of enlargement for these features and the banner text feature

formats multicolumn pages into a single column eliminating the need for horizontal scrolling (*Figure 1*D). In cases where the webpage authors provide skip navigation links as required by WCAG, the software brings the user directly to the main page content. To date, only about 5% of the users have this feature set. Since this is a new feature available to few users, its utility is unrepresented in the percentages reported here.

Image enlargement that can be combined with sharpening is the final type of adaptation for enlarging webpage content. Although we can't determine from the preferences settings alone how often individual images are selected for enlargement, the settings do indicate that this option was set by nearly one quarter of these older Web users.

Adjustments to font and page presentation

Other visual adaptations provided for various changes to the font and page presentation. These other transformations are used less often than enlargements, but still appear to be broadly applicable (*Table 1*). Text style and color changes were very popular, each used by more than 30% of the older adults. There is no clear preference for any one of the text fonts. Black text on a white background was the most popular color scheme.

Letter and line spacing are used by some people, although not as frequently as the other features discussed here, despite the fact that increasing spacing is known to improve legibility[10,18]. Our interviews with older adults were unanimous among those who tried these options that the spacing features, particularly the line spacing, made it much easier to read the text. The lack of more widespread adoption of these spacing features may indicate that most users did not try it.

Backgrounds are images or patterns that webpage authors sometimes use like wallpaper on their pages. Hiding backgrounds improves legibility of text and was explicitly set by only about 5% of our users. However, the colors option removed backgrounds for the 30% of users who set this option.

Enlarging controls

The software allowed not only for adaptations to page content, but also for adaptations to the browser itself. Users were able to enlarge parts of the browser (for instance, file menus and scroll bars) as well as enlarging the mouse pointers. The usage of these features was not common (*Table 1*). The magnification of the mouse pointers was implemented using the Windows® large pointer option. Most who tried the large pointer option indicated that they could not see the difference, although many expressed the desire to use this feature if there was more enlargement of the pointer. Based on this feedback, we currently are implementing very large pointers that are better suited for the needs of low vision users[21].

Most users liked the larger browser controls but did not understand the termin-

ology (browser 'controls') and simply did not try the option.

Changes in motor abilities

Keyboard and mouse accessibility can be a problem area for older computer users[13]. Age-related changes in motor co-ordination can cause difficulty with fine positioning movements, higher error rates when typing or selecting targets, and lower movement velocities[22]. After a stroke, some users may need to type and point using only one hand.

A number of features were potentially useful. For example, magnification not only makes text easier to see, but also makes targets easier to click. The one column feature reduces mouse usage by eliminating horizontal scrolling.

Standard keyboard accessibility options provide solutions to many seniors' typing and pointing difficulties, however, many users in the study were largely unaware of these features. The software offered an easy way to select some of these options: (i) One hand: activates the StickyKeys feature of Windows®; (ii) Key clicks: activates the audible key clicks feature; and (iii) Use keyboard: activates the MouseKeys feature.

The One Hand option, used by 10.2% of the older adults allows users to enter multi-key commands without having to hold down modifier keys (for instance, Control-P to print). Key clicks, used by 7.2% of the users, provides an audible click whenever a key is pressed. The 'Use Keyboard' option, used by 13.8% of the older adults allows users to point and click using the keys of the standard numeric keypad. Many users like to make large positioning movements with the standard mouse, then use key presses for fine positioning and clicking. Interestingly, these are much higher rates of use than would normally be found for these features.

The software also provided some automatic keyboard adaptation. Older users experiencing motor control difficulties may be slower to release a key, producing unintended repeated characters. This 'key repeat rate' can be adjusted but the operating system setting is difficult to discover and configure. The software adjusts it automatically using a dynamic agent based on a task-independent, language-independent model of keyboard use. It chooses an appropriate key repeat delay[23,24], and sets this in a non-disruptive way[25]. As a safety measure, automatic adaptation is stopped if the users set their own keyboard accessibility options. 2% of our users have explicitly chosen their own keyboard settings, while the agent remains active for 98%.

Changes in cognitive abilities

Changes in cognitive abilities can also impact the ability of older adults to use computer applications (*Table 1*)[26-28]. In our early interviews with users from SeniorNet, we received a number of complaints about complexity of Web pages[13]. For example, these older adults reported difficulties finding important information in pages that had visual clutter, irrelevant information, multi-column page layouts, background images, and distracting animations.

The software options below address cognitive issues: (i) Stop animations: freezes animated gifs on their last frame; and (ii) Hide images: suppresses the display of images on Web pages; ALT text, if provided, is displayed.

Only 15.4% of the older adults used Stop animations (*Table 1*), despite the fact that a large number of older adults we interviewed found animations distracting. The low usage may be due to the fact that this feature does not work consistently. The software is able to stop the animation programmatically

for animated GIFs, however, it cannot stop all animations. For example, in order for Flash animations to be paused, this capability must be provided in the Flash animation itself. In talking with users, it was clear that there is confusion about the 'Stop Animations' feature. Understandably, users don't know how an animation is implemented and would be confused if the feature does not work for all animations.

Hide images was used by 9.1% of our older users. While many reported this feature very helpful in reducing distractions and visual clutter, it is not known if these users missed critical information by turning off the images. Web designers often embed critical information in images, particularly images used as buttons, and may not always provide ALT text that would allow a user to know the content of the image if it is not displayed. Ensuring that websites conform to WCAG, which requires text equivalents for all images, eliminates the problem of missing information.

Several features added to make text larger or more legible also had the effect of reducing complexity. By changing presentation from a multi-column to single column display, page layout was less confusing. Hiding backgrounds reduced information on the screen. And, interestingly, feedback about the magnify option indicated that it was used by some to reduce visual clutter on Web pages. When content is magnified, less content can appear in a browser window. For some people, simply providing less information in the window was very helpful.

Lessons learned

'Web Adaptation Technology' offers many adaptations, some of which provide different alternatives to address a particular need. For example, text that is too small to read can be transformed by making it larger, magnifying the page, using banner text, or using speech. Older adults using the software made varied choices about which adaptations they wanted, even when tackling the same underlying problem. Each approach has advantages and disadvantages. For example, magnifying the page also makes images and targets such as check boxes bigger and easier to select, but makes it more difficult to navigate the page as a whole. Providing multiple similar adaptations makes it easier to choose a solution that not only tackles the underlying problem, but does it in a way that plays to the individual's strengths. This level of flexibility is crucial when supporting older adults, who may have multiple age-related changes. Although Web authors are often concerned that page presentation be as designed[29], providing flexibility will allow more users to effectively access the sites.

Even though a feature may have a low usage frequency, it may be essential for those who are using it. For example, a one finger typist may find it nearly impossible to type essential characters like the '@' sign of an email address without using the StickyKeys feature.

Accessibility standards are important for Web content developers to follow, but even pages fully authored in accord with standards are not sufficient to meet the diversity of user needs. It is also necessary for the browser application to provide the flexibility to adapt to user needs[29]. Some forms of flexibility directly affect look and feel, while others require a broader awareness of the different ways in which people access and control applications. Designers should not assume that users will have a physical keyboard and a mouse, or be able to use them quickly and accurately. For example, some websites present the user with moving targets that may be impossible to hit when using MouseKeys. If designers are aware of the different ways that people do pointing, they may avoid designs with inaccessible features.

Perhaps it is not surprising that the features requested to meet the needs of older adults[13] have been found to meet the needs of user populations who have limited vision, motor ability, or limited English or reading proficiency. Although initially designed for older adults, the 'Web Adaptation Technology' software has been adopted by many other users who for reasons other than aging need the same types of adaptations designed for older adults[20]. To better address needs of these user communities, we are currently working on our accessibility-Works Firefox® browser implementation that will incorporate additional features[21].

Conclusions

In summary, we found that older adults often utilized the different presentation and input adaptations provided by our software. The experience of the project has shown that older adults find it useful to choose a personal set of adaptations when using the Web and will do so if given a simple, obvious interface that demonstrates the adaptations. The great variety of settings used by older adults strongly suggests that it would not be useful to bundle together a set of adaptations and present these as a single 'older adult profile'.

The software used automatic adaptation to adjust the key repeat delay to suit each individual user. In general, when a user's needs can be reliably inferred from their actions, and the adaptation being controlled does not require any special behavior from the user, this automatic approach may be appropriate[25]. This helps to reduce the complexity of the user interaction with the software as a whole.

The adaptation options users select in this Web application would be useful in other applications too. Clearly, it is appropriate for users to define a single preference profile that can be used by many different applications[30]. Applications could use such a profile to automatically make adaptations for the current user. Alternatively, where a particular adaptation is available through the operating system (for instance, a high contrast color scheme), applications could and should inherit the setting from the operating system, which in turn uses the individual's profile.

Regardless of the mechanism used to achieve the personalization, older adults will benefit from the kinds of flexibility of presentation and control offered in the software. To claim universal usability, applications used by older adults should therefore be capable of accommodating these kinds of transformations and control techniques.

Acknowledgements

We would like to thank Susan Crayne for her help in extracting user preferences from the database.

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