Improving Accessibility to the Visually Impaired

Through Web and Interface Design

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The purpose of this study was to investigate the current state of visual accessibility to visually impaired users in the areas of web and device interface design. As the Internet grows in importance and more people are expected to utilize networked technology the need for a truly accessibly system becomes more important.

Web designers play a tremendous role in controlling ease of access to content through the structure, layout and navigation options utilized in their designs. These choices dramatically impact a user's ability to fully utilize the capabilities of the Internet.

As network technology grows beyond the web, consumers are also becoming increasingly reliant on personal devices such as mobile phones and personal media players. These represent a burgeoning market that has grown very quickly and has not undergone extensive research on accessibility.

The results of this study were able to build model for improving accessibility in both of these markets. Through analysis of best technological practices in web design and personal interviews with visually impaired users it became clear that accessibility varies widely across commercial offerings in both web services and personal devices. It was concluded that with some simple modifications these systems can be improved dramatically.

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Chapter 1 – Introduction

Accessibility on the Internet, the ability for an individual to access information online, is not universal. Users who are visually impaired have been limited to using screen reading software that reads the content on the page in a synthesized voice or magnifies content on the page for easier viewing. The cost of this software limits its availability to some and does not function well if a web page utilizes a complex layout. Others have to struggle through sites with poor color contrast and difficult visibility. With a lack of well known, standardized guidelines for designing an accessible web page, designers often put little effort into accessibility and the results are typically far from perfect. Though more attention is being drawn to this issue, the true needs of the visually impaired are rarely communicated to designers. The purpose of this study was to ask: How can web designers better facilitate the needs of the visually impaired?

A large component of this research was establishing the state of digital accessibility and what methods have been effective. By knowing what works and what needs have been ignored, a set of best practices has emerged. One of the largest problems thus far is the usability of screen reading and/or magnification software, often referred to as a "screen reader", with poorly designed interfaces. Screen readers are sensitive to web content and choices in page design can lead to unintelligible results for the user. With more sites being designed by amateurs or automated systems, such as blogs, variance in page design has grown. This leads to more sites being constructed with no real attention paid to accessibility. In many cases this results in sites that are visually complex as well as some that are not properly programmed for access. For example, sites dependent on visual cues, such as adjacent headings describing a page, may be confusing when read with a screen reader or magnified. Logical layout, placing those two headings in a list instead, is more user-friendly. The World Wide Web Consortium (W3C) has worked hard to promote standards for Hypertext Markup Language (HTML), cascading style sheets (CSS) and other markup languages to improve rendering and, more recently, new

guidelines to make sites more accessible. In addition, research has been made into other aspects of accessibility. As the Internet reaches beyond web sites on personal computers and becomes a crucial aspect of our personal and professional lives, this study analyzed the broad status of digital accessibility.

This portion of the project focused on experiences of users who retain some of their sight but may be color blind or have other impairments. By interviewing and relating directly with users of varying levels of computer expertise and visual impairment the study evaluated the current state of accessibility across a broad base of needs and technology use. As personal dependence on the Internet varies across users, a diverse sample group allowed for more accurate measurement of a wide range of accessibility needs.

Throughout this research attention was be paid to legal attempts at standardization and enforcement. The United States has passed laws to regulate other aspect of accessibility but have not made significant, explicit rulings affecting the Internet. As potential rulings may overrule past methods, this is where initial research began

The purpose of this study was to examine the community that would benefit from accessibility developments and evaluate how effective design can solve problem of this nature. This study was able to determine a foundation for better practices. Research was made into available software options as well as effective design methods. Finally, ramifications of law and government regulation have been evaluated for any current or potential effects.

When discussing accessibility to the Internet, having information that is accessible is not the only hurdle. While accessibility describes the ability to access information, usability describes the relative ease in accessing this information. A site with greater usability not only provides access to information, but does so in a way that is easier for the user. As discussed in "Applying Web Usability Criteria," written by Barbara Leporini and Fabio Paternò, usability is just as important as accessibility. Programs designed to read the content to a user "interpret the code as it was written and arrange the page content in the form of a single column" (Leoporini 4). This method of navigating a page often becomes quite cumbersome. Pages designed with long lists of links, graphics, banner ads and other material ahead of the actual page content force users to listen to the same content when navigating through pages of a site. This content may also lose some of its meaning without visual context. "Features such as position, color, separating blank spaces, formatting features, and so forth" are often used to imply meaning, such as a bright red warning, to content that is lost when the user experiences the site aurally as opposed to visually (Leoporini 5). A disconnect exists between the aural experience and the visual experience. The considerations behind visual choices can still be conveyed in a way that will be communicated to non-sighted users. HTML gives structure and form to the content of a site through tags surrounding lengths of text. These tags define paragraphs, hyperlinks, allow placement of images and other structural considerations. HTML provides some of the means necessary for accommodation by allowing tags that contain content, such as descriptions of graphics, but that are not shown in a visual layout. This allows a designer to style a list, for example, with a bold font and bright colors to signify its importance on the page and supplement it with a 'hidden tag.' When the screen reader finds the list, the hidden tag will tell the user of any necessary emphasis. HTML also facilitates different levels of headings, numbered one through six. By structuring headings based on importance with their numerical value the significance of each header can be implied. Properly nested headings and

anchors, links to specific areas within a page, also facilitate easier navigation with a screen reader (Leoporini 4). Screen readers are able to scroll through headings and anchors, allowing users to hear the heading for each section. Like skimming through a book, this makes finding the intended content more convenient and efficient.

The need for these accommodations has been struggling to gain legal necessity, especially with the increasingly visual nature of web content. In their article "From Madness to Method: The Americans with Disabilities Act Meets the Internet," Ali Abrar and Kerry J. Dingle discuss the struggle in interpreting and applying the Americans with Disabilities Act (ADA) to online content and the extent to which users are being affected by later efforts at legal regulation. The ADA was designed to prevent discrimination against people who were disabled, requiring accommodations in varying situations. Title III of the ADA, which specifies necessary public accommodations for retail and other public businesses was passed in 1990, long before the Internet had reached prominence (Abrar 8). Clear outlines were made for physical accommodations, such as wheelchair ramps, but the necessity for electronic accommodation was unforeseeable. In 1995, for example, the Internet only had 16 million users worldwide (Abrar 9). With such a small number of people using the web regulation and equal access were not yet high priorities. In just ten years, however, that number jumped to over a billion users worldwide (Abrar 9). Suddenly, the digital realm became a viable source for the commerce and the exchange of information. This led to faster service speeds and sites with more rich visual media, such as graphics and video (Abrar 10). While rich media contributes greatly to the "social, intellectual, cultural and economic life of the community," it creates a "discontinuity of opportunity" between those who have access and those who do not (Abrar 12).

Originally, money was assumed to be the overall cause of this discontinuity (Abrar 13). With broadband speeds plummeting and overall access to the Internet increasing, the barrier of physical limitations has proved to be the ultimate challenge (Abrar 13). Data from the United States Census

show that 15 percent of Americans have a physical or sensory disability (Abrar 13). Furthermore, a study done in 2000 shows that 48 percent of disabled Internet users feel that web access has "significantly improved the quality of their lives," compared to only 27 percent for non-disabled users. Forty two percent stated they feel "connected to the world around them" and they have been able to "forge bonds with people who have similar interests or experiences" (Abrar 13). This data may appear misleading, however. The problem is that not all online media, especially services such as video sharing and e-commerce, is universally accessible to the visually impaired. The features of the Internet that garner the most notoriety are going unused by a demographic excited about the Internet.

Producing multimedia content becomes the focus of most designers and developers and accessibility fails to be a priority. Whereas, television accommodates the deaf with closed captioning, the Internet does not have a universal method to accommodate the blind (Abrar 13). The use of screen readers has made some inroads, but as discussed earlier, can only function properly with properly designed pages. With a departure from the earlier, text focused days of the Internet this process has become more separated from the design process (Abrar 13).

Direct legal requirement for improving accessibility is not an original component of the ADA. The Internet was not explicitly included, though other methods of telecommunications are heavily controlled (Abrar 15). Later attempts were made to bring regulation, including legislation in 1998 to make all government owned web sites accessible. This legislation was an amendment to the Rehabilitation Act of 1973, known as "Section 508" (Blansett 3). This lead to the creation of the Architectural Transportation Barriers Compliance Board, known as the "Access Board," to formulate and promote the standards required by government sites (Abrar 18). Many of their standards, including text alternatives for images and multimedia with "equivalent information or functionality and improved navigation in screen readers, have proven to be effective but failed to gain public prominence as their required use was limited to government sites (Abrar 18).

In an article written for the *Library Journal,* Jim Blansett, Reference Librarian at the University of Alabama in Tuscaloosa, details the impacts and effectiveness of Section 508 on school library web sites. As most of these institutions fall under government regulation, their web sites are held to standards set by Section 508. Results, however, have been disappointing. According to Blansett "only 47 percent of [library and information service] schools and 60 percent of their libraries" are fully accessible as defined by Section 508 (Blansett 2). The rules are seen as an "unfunded mandate" by institutions and are often deemed expensive to implement. In many cases this is not true, as minor changes to sites can often dramatically improve access (Blansett 2). The problem is compounded as most institutions do not develop their own systems but instead purchase them from compliant providers (Blansett 3). When problems arise it slows the adoption progress as changes must also go through a content provider.

In 2000, Congress held hearings related to regulating privately owned web sites under Title III but a consensus could not be reached due to three main issues (Abrar 19). Concerns were raised over "wholesale application of the ADA" and potential First Amendment implications with "an officially approved manner of expression [coming] to displace the older ideal of free expression" (Abrar 20). Others argued that regulation would only affect the "general applicability ...and [regulation of] commercial activity, not speech" (Abrar 20). The second issue focused on the cost of implementing broad accessibility. With a constant churn of new technology both in web media and adaptive technology there was speculation that web developers would be caught in a constant process of expensive upgrades. No data was presented to support actual costs (Abrar 20). The last issue was the question if government regulation would stifle the growth of accessibility technology or promote further innovation (Abrar 21). Professionals from the accessibility industry claimed legislation "where prematurely applied can have the effect of slowing technology innovation," while others suggested the ADA "fosters future technological innovation and economic activity in the private Internet-based

service industry" (Abrar 21). A House of Representatives Report was compiled after the hearing but Congress is yet to make any action related to applying Title III to private web sites.

The Department of Justice (DOJ), responsible for promoting the ADA, seems to read Title III to apply to private sites but have not released formal documentation addressing the issue (Abrar 21). They have filed one *amicus curiae* brief, information offered to assist in trial proceedings by a non-participating party. It was concerning the requirement of "appropriate auxiliary aids and services where necessary to ensure effective communication with individuals with disabilities" for privately operated web services (Abrar 22). Due to the "informality of proclamations" by the DOJ their stance remains unclear. With the lack of a Title III Internet amendment proposed by the DOJ or Congress, the formulation of laws has been left to courts on a case basis (Abrar 22).

One of the most significant cases to date, at least in grandeur, is a class action suit filed against Target Corporation by the National Federation of the Blind (NFB). Full documentation on the case is provided online by the NFB at http://www.nfbtargetlawsuit.com. As described in the Final Case Settlement, part of the online documentation provided by the NFB, Target was charged six million dollars in damages due to the determined inaccessibility of their online store. The ruling of the case was interpreted under Title III of the ADA. The site will be monitored to ensure that "blind guests using screen-reader software may acquire the same information and engage in the same transactions as are available to sighted guests with substantially equivalent ease of use" (Final Settlement, §6). The results of this case have not yet set precedent for any other trials.

The question remains how to successfully formulate laws or regulations to enforce accessibility on the Internet. Needs have grown more defined by blind and visually impaired users. Some systems have been developed to meet these needs, such as screen readers, but web sites are often not designed with their function in mind. A clear cut legal precedent has not been established, but groups like the National Federation for the Blind are making progress by challenging major corporations.

The goal of this research was to find better solutions for web designers to foster Internet accessibility for the visually impaired. Research has already been made into how to communicate visual information to the non-sighted, the problem lies in propagating and encouraging usable methods to designers and developers. Government agencies have been unable to develop a legally required standard. Private efforts to build a standard have struggled to gain wide usage. This is due largely in part to a false perception of difficulty or expense and assumptions that it will compromise traditional visual design. This project focused on applying past attempts in new ways, looking for methods that can be formulated into a simple solution that do not restrict designers or inhibit non-sighted or visually impaired users. The project used descriptive research, historical research and personal interviews to gather data from visually impaired users.

Prior to beginning the personal interview phase, research was conducted on current software for visually impaired users. This focused mainly on the commercial products Zoom Text and JAWS, the most prevalent products on the market, as well as tools included in major commercial operating systems. Zoom Text and JAWS both offer free demo versions of software, allowing in-depth analysis of the software before discussing it with full time users.

Extending from the research of the *Literature Review* section, interviews focused on two major aspects of accessibility. The first is Internet use, building an accurate model of how users interact with the web. This focused on gathering information about their personal habits and web sites that they commonly visit. The second was based around the general state of accessibility on personal computers and mobile devices such as cellular phones and media players. As the Internet grows and spreads, these devices now provide new connections to online content and digital media. These devices also represent a new era in interface design as the history of these devices is fairly brief. Without longstanding methodology, interface design best practices have not yet been developed.

Users were contacted for participation in this study through the Disability Resource Center at California Polytechnic State University, San Luis Obispo. After meeting with a staff specialist in access solutions, a solicitation was sent to students and contacts affiliated with the Center with encouragements to forward the request along to any other potential participants. This led to six responses from a range of students and community members. Once schedules were taken into consideration this led to four personal interviews.

Each interview was tailored to the subject with the intent of gaining their personal insights on accessibility, though a focus was made on the Internet, computers and personal electronics. They were free form, with few scripted questions. Topics discussed included cellular telephones, personal media players, computer platforms, accessibility software, large print and digital books and the associated costs of purchasing products targeted at improving accessibility. Though not all of these topics pertain to web and interface design, they allowed users to share their personal methods of content interaction and provide further examples of both positive and negative experiences with accessible products. The end goal was to build a broad picture of what can be considered an accessible interface, as different devices and media provide different characteristics. Brief notes were taken during the interview and compiled into more complete summaries immediately following.

After the interview process was complete, notes were compiled and recurring themes were analyzed. These formed the foundation of the *Results* section to follow. By applying these recurring themes with best practices for web design and weighing personal opinions from participants, the *Conclusions* section was completed. This resulted in a succinct summary of techniques and methods that can be applied by web or interface designers for improving the overall visual accessibility of a website or product.

Chapter 4 – Results

After interviewing several visually impaired computer users of varying age and with differing levels of computer expertise and visual impairment, several major results become clear. The first is that the current state of visual accessibility on computers in general is improving. Most of the subjects interviewed, none of whom were fully blind, were mostly satisfied with their current software solution. Most often the accessibility software of choice was Zoom Text, sold by AI Squared. Zoom Text offers two major licensing options - a single computer license to be installed on a single machine from compact disc, and a USB key option that allows a single user to use Zoom Text without full installation on any Windows computer. The users interviewed who relied on Zoom Text all used the single machine license. Zoom Text was complemented for it ease of use, customization and its simple menus. This allowed an extremely specific solution based on each individuals specific needs, most often increasing the size of screen content and increasing contrast, while making it easy to adjust options as use necessitated. Zoom Text also includes a screen reader. Designed to read mainly screen content, such as body text on a website, it is not powerful enough to provide full audio navigation. Zoom Text also offers an optional high contrast keyboard, with large white letters on black buttons as well as Zoom Text shortcut keys labeled across the top of the keyboard. The most common complaint about Zoom Text was the price - $400 for a single machine license and $80 for the optional keyboard. Updates to the software cost approximately $300. Overall, interview participants stated that Zoom Text provided an easier, more usable solution over software they had used in the past. For some this included older versions of Zoom Text, but also software included with major operating systems.

The users who relied on Zoom Text referenced a wide array of tasks that they were able to perform with their computer that would otherwise range from inconvenient to impossible. Most used their computers as an integral part of their education or professional career and did not consider Zoom Text itself a hindrance to their productivity. Tasks such as managing email and word processing were

most common. While native software interfaces, discussed later, occasionally introduce unavoidable issues, Zoom Text was still seen as a helpful productivity tool with these tasks.

Nearly all also used the computer for recreation and entertainment by shopping online, downloading music and managing personal media players or using social networking web sites. With the exception of the slight learning curve present in most software geared toward accessibility or any other function, they felt that using Zoom Text as part of their recreation did not induce any significant hindrance other than cost and actually opened them up to many pleasurable activities. Cost was a common theme among study participants as computers and software are already significant investments.

This leads to the second conclusion - major operating systems provide vastly different access options. Half of the users interviewed used Windows XP Professional with Service Pack 2 while the others used Apple's OS X Leopard and OS X Snow Leopard. No users had Windows Vista or any version of Linux installed on a machine that they owned. As of the interview process, Windows 7 had not yet been released to retail.

Users who had extensive experience with OS X found that the included software was often a powerful enough solution, providing a better set of customization options and more intuitive controls than the tools offered in Windows. Users in this study praised its powerful magnification and contrast adjustment tools, as well its screen reader and custom keyboard shortcuts. One user explained that after switching from Windows to OS X, he completely eliminated his need for JAWS, a much more costly counterpart to Zoom Text with enhanced screen reading capability and the ability to provide full audio navigation. His experience with the upgrades offered when switching from OS X Leopard to Snow Leopard only improved his experience, a major set of upgrades that went mostly unannounced during the release of Snow Leopard. Furthermore, the menus are simple enough that he is able to setup any Mac running OS X within a matter of minutes. The comparative cost savings were also quite attractive, as an upgrade license for OS X was available for under $100 and JAWS costs upwards of $1000.

As a counterpoint, users in this study who relied on Windows found that additional software was a necessity. Included tools provided few options for customization, were not intuitive to operate and were not as easy to access as tools available in recent versions of OS X. Multiple users were further dissatisfied with the amount of general software that was exclusive to Windows, tying them to an operating system that they found inaccessible without spending several hundred dollars on additional software. After programs such as Microsoft Office became available on Mac OS X, these problems will likely grow less common for most computer users. However, after the initial investment in Zoom Text and learning routines and habits working within Windows, few users in this study felt motivated to switch operating systems. Though this problem of general productivity software being tied down to a single operating system is no direct fault of Microsoft or Apple, it does present a genuine issue for those who need improved visual access..

Overall, this suggests that for general computer usage visual impairments are becoming less detrimental to the computer experience. Users interviewed for this study ranged in age from 19 to 85, some using the computer since childhood and others beginning as adults. The additional learning curve that older users experienced in years past has diminished to some degree when dealing with new software, though it is not entirely gone. While all are generally much happier using the computer now compared to a decade ago, interface design can still create unexpected problems for visually impaired users. Updates to commonly used tools such as word processors can still create localized problems. A prime example is Microsoft Office 2007 and its 'ribbon' menu interface that eliminated drop down menus and created a series of panels and buttons. While intended for improved aesthetics and efficiency, for users in this study who had learned to adapt to the previous menu style this created a new obstacle within software that they had been using for years.

This idea suggests that the most significant problem with web content and applications in regards to accessibility is interface design. As websites often behave like applications, interface design

affects websites. This imparts a large amount of responsibility on web designers. While software tools can help a user adjust the content to their needs, such as increasing text size, they cannot adjust menu systems, navigation placement or content layout. When using the Internet these problems become the most visible, as website designs change much more often than in commercially released software. The quality of website development is also subject to more variability than most software. With the advent of inexpensive web design tools almost anyone can produce a website, often with mixed results and little attention paid to accessibility.

For users in this study, one of the most frequent problems was with layout. When working with a web browser and screen magnification software, layout choices made by a sighted designer may become nearly unintelligible. Magnification on poorly designed sites may lead to forms that do not flow logically, buttons that become hidden by large amounts of scrolling or pages that load with blank space as the only visible content. For others who do not need the full experience offered by a screen magnifier, the only adjustment they make may be to the font size within the browser. For sites that do not accommodate fluid layout sizes, large text may 'break' the layout, causing text to overflow from its containers, wrap incorrectly around media elements or overlay on top of other text. Subjects noted that layout issues often increased a particular site's difficulty of use, forcing them to learn the various intricacies of a site before being able to access content. For most, the threshold of being willing to learn how to use a site before deciding to look for a better alternative was very low.

Other major issues with websites were focused around content structure. Specifically, navigation was a key concern. Users in this study explained that many websites commonly use multiple types of navigation, such as menu across the top of the page as well as a sidebar menu. Again, this often made sites more difficult to use. When magnified, only one menu may be visible or visual cues to a secondary menu, such as using a certain color, may be lost due to user adjustments to color contrast. One user who formally used JAWS pointed out that software can not always read popup or drop down menus, a common staple of web designers. Placing menu content behind illegible menus forces

searching and obscures content, instead of allowing quick and easy access. Furthermore, many sites also use inconsistent navigation schemes, a common downside to the influx of amateur web developers. Inconsistent navigation eliminates the familiarity a user builds within a website and forces them to constantly relearn and adapt to the interface being presented to them.

Beside navigation, the second major concern with content structure is due to cluttered and complex content layouts. Advertisements, videos, Flash content and other forms of non-static media are becoming common place. In addition, recent developments in web design allow designers more elaborate controls over page content than in the past, allowing sites to be more visually complex. This becomes a significant issue when relying on a screen reader to relay body text. Interrupting the logical flow of text with media can often disrupt the screen reader, damaging that users experience. One user noted after visiting a popular lifestyle website that Zoom Text was not able to decipher editorial content from ad content, essentially interrupting the article with a sales pitch. For users relying on visual tools, clutter becomes even more glaring. Large advertisements become even larger when the screen is magnified, possibly occupying the entire screen. These ads become massive distractions as the intended page content becomes obscured and hidden. Those that feature animation, blinking colors or flashing text were almost unanimously described as illegible when viewed in reverse contrast. Sites with a complicated flow of information, distributing content to multiple portions of the page without clear labeling, further increase difficulty of use when viewed with a magnifier as only certain aspects of the site can be viewed at once.

Finally, one of the most prevalent issues with web design is color contrast. As previously mentioned, one of Zoom Text's most popular features is to adjust screen and content contrast. Typically this is achieved through color inversion, replacing colors on screen with the opposite color or by limiting colors on screen to a certain color pallet. This allows users with difficulties distinguishing certain colors to adjust presentation to fit their needs. Users in this study often used color inversion as a method of improving readability and reducing eyestrain. Many expressed discomfort when trying to

read black text on a white background due to the overwhelming brightness of a mostly white screen, especially when reading text is straining. Others also critiqued sites that use white text over colored backgrounds or text and backgrounds of similar shades. Attempting to distinguish text from the background is more difficult in these situations, and the focus required often caused eye strain. Examples of these concerns surface in several popular websites and online services. Two common mentions in this study were Facebook and Yahoo Mail due to their recent interface revisions. Much like the interface change in Microsoft Office 2007, users critiqued the sudden and dramatic choices that Facebook and Yahoo made because they required users to relearn the respective site's interface. As both of these sites play a serious role in online communications users felt mandated to continue using these services. In addition, Facebook and the Yahoo homepage (in addition to Yahoo Mail) were criticized for their complicated navigation and the overwhelming amount of content laid out on a single page. Both sites feature extensive menus and text that is broken up by photographs, graphics and other media, making it hard to navigate with magnification or a screen reader. Users in this study conversely praised Google's online mail service, GMail. GMail is one of few web services to allow extensive customization to the interface. Users of the service are able to utilize custom themes that replace the default styling, allowing a high contrast or large type version to be used.

As the Internet is moving beyond personal computers and even beyond web sites, web accessibility is starting to affect a wider range of devices and services. One example is iTunes music software and the iTunes music store. Several users in this study had experience with iTunes with somewhat polarized opinions. Some found the music store easy to navigate with its consistent menus and breadcrumb system, a menu that provides links to each preceding layer of navigation relative to the content currently being viewed. Others criticized their cluttered homepage, made up largely of photos and graphics that are usually hard to interpret when used with contrast adjustment. Further criticisms extended to their small type and gray color scheme when shopping for individual pieces of media. One

user whose professional responsibilities require purchasing and providing music for presentations also commented on the ease of syncing media with the iPod portable music player. However, the iPod itself was somewhat scrutinized for its touch wheel interface, as opposed to physical buttons, and a preset interface made up of small text and graphics.

The use of physical buttons became a recurring theme in discussing other web connected devices over the course of this study. Where touchscreens have steadily infiltrated cellular telephones and personal media places, users interviewed denounced the use of touchscreens almost entirely. With most devices having interfaces with little room for customization, users relied on memory and routines when using devices. Tactile response from buttons were said to provide the most effective system for building muscle memory with a device. By becoming familiar with which buttons perform which functions, use of the device became less tied to visually interpreting the information on the screen and more tied to physical interaction. Such devices include the BlackBerry and Creative Zen personal media player. One participant in this study with extensive experience working with both Apple iPods and Creative Zens has developed a strong preference for the Zen, partially due to the large text used in its interface but also the physical keys used to control the device. Another participant explained that, though popular, he would never use a touch screen cellular phone as the interface provides no tactile feedback. Though small, the physical keyboard of his BlackBerry phone provides enough feedback that he can touch type and use the device comfortably despite having a small screen.

Physical keys are not always enough to make a mobile device truly accessible, however. Mobile phones were oft criticized in this study as few offer the right balance of options to the user. Every user in the study who used a mobile phone noted the difficulty they underwent in finding a usable device. Where devices did exist that offered screen reading, interface options, and large, high contrast screens these devices were considered too expensive for the amount of use they expected. However, typical offerings from providers were often limited and left users with only a few choices. The result was that

many users felt left in a void to choose from devices that were not useful enough and devices that were too complicated for partially sighted users. While devices do exist with screen reading capability and more accessible visual interfaces they are often much more expensive and harder to use. The common result in this study was a compromise, leaning towards a less functional device in exchange for lower cost.

The biggest conclusion that can be drawn from this study is that accessibility cannot be an afterthought. Designers have an enormous responsibility thrust open them as the Internet represents one of the biggest technological revolutions in modern history. The results from the interviews in this study demonstrate that too often access for all users is not taken into account. Though software tools like Zoom Text have improved functionality for well designed software, poorly designed interfaces can not be compensated for. Following are several specific responses to problems developed during the research and interview portions.

Web page layouts can take accessibility into consideration with several specific design considerations. To avoid the appearance of a blank page upon loading, content should be kept near the upper left corner of the browser. When magnified this may be the only area that is visible. Users are accustomed to seeing graphics, background images or text to signify a page has loaded. Without any visual cues it is less clear when a page has loaded, what content is on that page or where to begin looking at that page.

Second, color contrast is an important consideration. Those who have a need for reverse contrast or color specific adjustments may not have the software available to them to adjust the contrast on the page. Designers can aid these situations by designing sites with legible contrast in mind, as well as with use of simple controls to allow the user to choose different contrast settings. Scripting languages available to web designers have advanced to the point that adding in a simple button to substitute cascading style sheets has become a simple process.

Third, designers need to accommodate increasing text size. Some browsers have improved their zoom functions, allowing entire pages to be neatly magnified. However, this magnifies all page content as well as the text. Many users still rely on their browser's ability to manually adjust only the size of the text. Layouts designed around rigid page sizes do not often accommodate this. As the text gets larger

the containing elements do not, and eventually the text overflows and breaks the layout. By using a cascading style sheet with fluid sizes, the structure of a site can change size as the text does. Type is measured in units called ems, equivalent to approximately 16 pixels. By setting up text and container sizes using em's instead of the absolute size pixels, the size of containers become based on the size of the text and grow accordingly.

Attention needs to be paid to navigation structure and design. Cascading style sheets allow complicated drop down menus, allowing large amounts of information to be neatly hidden behind a row of buttons or text, appearing in layers as the buttons above are hovered over with the mouse. However, screen reading software is not always capable of recognizing text content within a drop down menu. The result is that as more buttons appear, the software is not able to read the content to the user. Designers can avoid this issue by building less complicated menus that are not heavily dependent on drop down structures except where absolutely necessary.

Navigation should be consistent across all pages of a web site. Users develop habits and patterns around navigation. When faced with inconsistent navigation schemes, such as different menu structures on different pages, users are constantly forced to adapt. This prevents users from growing comfortable within a site and distracts from content. Furthermore, navigation should be localized in a single area as opposed to spread throughout the page. Common notions for navigation, such as a left sidebar menu, are useful when visitors arrive on a site for the first time. This reduces the need to learn how to use a page and increase the ease with which users navigate within a site.

Web sites are not the only interfaces that are subject to revisions. Phones, media players and other portable devices are becoming commonplace and can almost be considered a necessity as they are able to provide communication, data storage and media playback. These interfaces represent an overlooked portion of accessibility. Touchscreens and entirely graphical interfaces do not offer appropriate feedback for a user who is visually impaired. Interfaces with rigid options and little

opportunity to customize are an additional problem. Participants in this study praised devices with physical buttons, large text and the ability to change the layout and interface as they saw fit. Allowing the user options for text size, color and background can severely affect a user's experience with that device.

Overall, users who are visually impaired must be taken into consideration early in the design process. Accommodations are not overwhelmingly difficult and typically only require a small amount of planning as a project begins. While the largest problems web designers lie in content layout and navigation, methods for correction are not difficult to implement. The fluidity of web design compared to that of hardware interfaces on personal differences suggests that web accessibility may improve at a faster rate as information spreads. Currently commercial software is doing its part in aiding users in using their personal computers more easily though still with extreme cost. As time goes on these solutions may become cheaper, but have not been subject to the same competition as other software markets.

As users grow more aware of options available to them and as designers become more aware of methods to embrace the state of accessibility will continue to improve, though it is still far from perfect.

Endnotes

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