

**The Creation of a New "How to" Web site for Accessible
Web Design and its Comparison to WebAIM.org**

By

Jennifer Rohrig

Project submitted in partial fulfillment of the requirements for the
degree of Master of Science in Information Technology

Rochester Institute of Technology

B. Thomas Golisano College

of

Computing and Information Sciences

August 10, 2007

© Copyright 2007 Jennifer Rohrig

All Rights Reserved

Abstract

This Capstone project shows that current web accessibility "how to" sites are not always sufficient to explain how to create accessible web sites to the individual web designer. For example, sites are either targeted to businesses and organizations or they focus on specific elements, such as the guidelines and standards without explaining how to implement them.

The Capstone follows a design process the creation of a design document, including a competitive review, the creation of the site itself, and then a heuristic evaluation and a comparative usability study. The final two steps compared the newly created site "Accessible Design" to an already established site, WebAIM.org. The comparative study showed that "Accessible Design" was indeed easier to navigate and use, in most cases.

Table of Contents

1. Introduction	- 1
2. Literature Review	- 3
2.1 Web Site Accessibility	- 4
2.2 Web Accessibility Guidelines and Related Problems	- 5
2.3 Web Designer's Perceptions about Web Site Accessibility	- 7
2.4 Conclusion	- 8
3. Methods	- 9
3.1 Accessible Web Design Research	- 9
3.2 Design Document	- 9
3.3 The Web Site ("Accessible Design")	- 11
3.4 Heuristic Evaluation	- 13
3.5 Comparative Usability Study	- 13
4. Results	- 15
4.1 Competitive Analysis	- 15
4.2 Heuristic Evaluation	- 17
4.3 Usability Study	- 21
4.3.1 Summary of video observation notes by site and task	- 21
4.3.2 Task Accuracy and Times	- 27
4.3.3 Summary of Performance and Preference Rankings	- 28
4.3.4 Post-test Questionnaire Answers	- 28
5. Discussion	- 33
6. Future Recommendations	- 35
7. Lessons Learned	- 35
Appendix A) Design Document	- 37
Appendix B) Test Plan	- 42
Appendix C) Orientation Script	- 49
Appendix D) Non-Disclosure Agreement	- 50
Appendix E) Post-Test Questionnaire	- 51
Appendix F) Raw Video Data	- 52
Appendix G) Raw Test Data with Site and Task orders	- 60
Works Sited	- 61

List of Tables, and Charts

1) Fig. 1 - Architectural Blueprints	- 10
2) Fig. 2 - Accessible Design (http://jenrweb.com/capstone/index.html)	- 12
2) Fig. 3 - WebAIM.org (http://www.webaim.org)	- 12
3) Fig. 4 - The Tasks	- 13
4) Task Accuracy and Times	- 27
5) Summary of Performance and Preference Rankings	- 28

1. Introduction

This Capstone project focused on accessible web design while incorporating skills learned from course in the Master's in Information Technology Program. Creating accessible web sites for disabled users can be difficult if a web designer is not aware of current accessibility guidelines. Much information is available to web designers on the subject, but most sites are confusing or incomplete. The creation of a "one stop shopping" web site, aimed at college students taking web design courses, will help the students gain a better understanding of why accessible sites are needed and how to create them. This comprehensive site, created in a clear and concise manner, will provide information about the current accessibility guidelines, as well as the information about the various issues people with disabilities have with non-accessible sites.

The following paragraphs illustrate problems associated with finding design information about creating accessible web sites. The sites listed are among the better ones, in terms of comprehensiveness, understandability, and being up to date (with one exception) in regards to the standards. However, they still have problems.

WebAIM (<http://www.webaim.org>) recently overhauled their web site leading to a complete redesign of the layout and contents. While the new site has increased accessibility and goes further to meet industry standards there still are issues with it. The information about creating accessible web sites is located in the "Articles" section of the web site, which may not be easy to find. In the Articles section of the site is a listing of the various elements that a designer may need to create their web sites. However, the various pages, such as the one for CSS go on for multiple pages describing anything and everything about CSS before getting to the

"how to" part. In addition, the web site is geared towards helping government agencies and larger organizations with their sites, and as such, a large portion of the information is only available through payment of services.

Dive Into Accessibility (<http://diveintoaccessibility.org/>) is an eBook about five individuals with different disabilities and their attempts to use the Web. The need to read all of the case studies to find useful information on how to create an accessible web site is problematic. The user can select from a menu to view the tips by principle, which will give the user information about that principle, such as color choice, but it is not clear how to select that information. In addition, the site, created in 2002, is not up to date in the current standards for web accessibility.

The University of Minnesota Duluth has an accessibility reference page at (<http://www.d.umn.edu/itss/support/Training/Online/Webdesign/accessibility.html>). This site offers a large volume of relevant information, perhaps too much information. For example, if the user were to click on the link for color, the user would get several links to different tutorials, most of which go to new web sites. Having many different options to choose from can be overwhelming. Thus, it is difficult to decide which one is the best. There are many similar sites, simply listing other sites, which is not helpful for people needing information quickly.

There are also several Blogs on the subject of accessibility; for example, Accessify.com (<http://accessify.com/default.php>) or 456 Berea Street (<http://www.456bereastreet.com/>). However, the problem with these sites is that the user has to backtrack through several postings to find anything, even when the authors provide links to their older postings. This can be time consuming, especially if it is necessary to read several postings to

find relevant information. Blogs are not a good way of organizing this kind of information, because the information needs to be on one page or two pages per topic, not boxed up into separate unlinked postings. Having the information in separate postings makes it more difficult for the user to find the information.

In conclusion, current web sites that provide information about accessibility can be frustrating due to the lack of clear information. In addition, much of the information is scattered among different web sites. Addressing all disabilities, such as blindness, partial sight, dyslexia, deafness, or partial hearing loss, cognitive disabilities, and physical disabilities, is important. Also important are the design languages used in the creation of most web sites: CSS, HTML/XHTML, and JavaScript. Another issue with current sites is that they often focus on one subject at a time or they devote more time to explaining why the elements cause problems rather than explaining how to make them accessible. In addition, current web design courses often spend minimal amounts of time on web accessibility. Providing a one stop "how to" web site for creating accessible web sites will help new web designers find information quickly and easily without needing to search multiple sites.

2. Literature Review

The topic of this literature review is web site accessibility and the lack of accessibility to web sites. In 1999, the Web Accessibility Initiative (WAI) published the first set of guidelines intended to help web designers create accessible web sites. Since that time, the number of accessible sites has increased; however, there are just as many inaccessible sites on the web. The articles in this review demonstrate why this is the case. The articles also give an idea of how web designers feel about web accessibility.

2.1 Web Site Accessibility

An evaluation of web site design patterns from 2000 to 2003 examined over 1,500 sites. The analysis of the sites used over 150 quantitative measures of interface aspects such as the amount of text on the pages, number of links, and types of links, consistency, and accessibility. The study examined three perspectives: the descriptions of design patterns, changes to design patterns, and comparison of design patterns to the recommended guidelines. The study showed significant design changes between 2000 and 2003. Web site designs have become increasingly graphical in nature, reliant on browser scripts, and less consistent. In addition, the study showed that the biggest problem with web sites is their inaccessibility, and that current usage of tables, forms, and browser scripts could impede accessibility and usability (Ivory & Megraw, 2005).

Another study used the Internet Archive's Wayback Machine, to conduct a random sample of web sites from 1997-2002. The web sites were analyzed using evaluation software called "Bobby" (now called "WebXACT"), which generates a report listing accessibility errors. The analysis of the sites studied the effects of technology on accessibility. The study showed that random web sites became progressively inaccessible through the years, even as the complexity of web sites increased. In contrast, government sites remained accessible, even as they became increasing complex. The study concluded that the addition of new technologies to web sites usually increased problems in accessibility (Hackett, Pamanto & Zeng, 2003).

A third study, which also used "WebXACT ", looked at the accessibility of several web sites, in several categories. The study concluded that government sites had the best accessibility ratings while commercial sites had the worst. Finally, educational efforts should focus on

commercial sites to help improve awareness of accessibility concerns (Jackson-Sunborn, Odass-Harnish & Warren, 2002).

In her master's thesis, Laura Cook (2006) conducted research on web accessibility. In the first part of her research, she examined the accessibility of state web sites. The intent of her research was to determine if having a web accessibility policy governing the creation of state web sites had an effect on the accessibility of those sites. Cook examined the accessibility of three pages within the state web sites of eight different states, using two accessibility checkers: WebXACT and Entre (which does not appear to exist any longer). Her research concluded that most of the sites were inaccessible and as such proved that having a web accessibility policy does nothing to ensure that a state web site will be accessible. In the second part of her research, Cook attempted to determine if it was possible to degrade web sites down to a text only version without losing any of content and remain accessible. There were three levels of degradation in her research: viewing a page normally, viewing a page without plug-ins or images, viewing a page without plug-ins, images, or cascading style sheets, and finally viewing the page text only using Lynx. Her research determined that as a whole the sites seemed to be easily navigable in the text only versions, however manual checks are still needed to ensure accessibility.

2.2 Web Accessibility Guidelines and Related Problems

An article discussing web site accessibility in the United Kingdom, covering the period 1999 to 2005, argues that there have been many improvements since 1999, including more awareness of key issues. Even with increased awareness, there are still a number of inaccessible sites. Increased awareness is the result of forced awareness originating from laws on web accessibility. The threat of penalties, imposed by the governments of the United Kingdom and the United States, made organizations create accessible sites, but there is not a real

understanding of why accessibility is necessary. Even though there is an abundance of information, it is often very technical. In addition, the WCAG version 1.0 is years out of date, lengthy, difficult to follow, and even the experts disagree on the guidelines. (Dodd, 2005). As of May 2007, WCAG version 2.0, is still in draft form with several updates pending based on various user reviews. There is no word on the publication date for a final version.

Another study demonstrated that often web developers have little or no experience with accessibility. There is also a lack of accurate information about the best ways to identify accessibility problems with web sites quickly. In addition, automated tools and design guidelines fail to create fully accessible sites, as they require accessibility expertise on the part of the developer beyond what most possess. In addition, automated tools are often unable to detect all problems (Markoff, Fait, & Tran, 2005).

Web designers have limited access to empirical evidence when deciding what techniques to use. Designers reference an article by Rowen, Gregor, and Solan, which claims that there was a lack of awareness of accessibility issues by web developers (2000). Another referenced article (Colwell & Petrie, 1999) evaluates the Web Content Accessibility (WCA) guidelines developed by the Web Accessibility Initiative (WAI). This article shows that the general structure and tone of the guidelines made them confusing and difficult to follow. The sites created were not as accessible as the guidelines said they should be (Markoff, Fait & Tran, 2005).

Some people argue that guidelines, standards, and accessibility authoring support is likely to remain confined primarily to government and other publicly controlled web sites for which regulations are enforced. Those not required to make changes will not have the incentive to do so, unless social responsibility motivates them, if there are no economic advantages. It is better

to focus on the end users perspectives and to develop ways in which manipulation of web content to user requirements without requiring web designers to rewrite their content (Richards & Hanson 2004).

2.3 Web Designer's Perceptions about Web Site Accessibility

A study of webmaster perceptions addressed the dilemma of low web site accessibility even though tools and guidelines exist to help web accessibility. The researchers involved with the study created a Web Accessibility Integration Model, which highlights various influences on accessibility, or inaccessibility of web sites. They also conducted a survey with questions asking webmasters about their knowledge of web accessibility and their perceptions of when and why web sites should be accessible. The goal was to learn more about why webmasters do not make their sites accessible, and provide avenues for future research. The majority of people who responded to the survey agreed that web accessibility is important. However, they also cited various issues that hampered their ability to make sites accessible. Some of the issues included: lack of time, training, managerial support and client support. Additional issues were inadequate software tools, and confusing accessibility guidelines. However, a few webmasters objected to the idea of web site accessibility and did not like interference in their web design. They also stated that they would only make their web sites accessible if the government forced them to become accessible (Lazar, Dudley-Sponaule & Greenidge, 2004).

Another study addressed the belief that accessible sites cannot be visibly pleasing, by presenting the results of accessibility testing of one hundred web sites using fifty-one disabled users. The study divided the web sites into five categories: government and public information,

business, e-commerce, entertainment and leisure, and web services. The testers of the sites had various disabilities including blindness, partial sight, dyslexia, deafness, or partial hearing loss, or physical disabilities. The study showed that visual designs could still be pleasing even when paying attention to accessibility issues (Petrie & Hamilton, 2004).

For web designers it is important to consider economic costs and benefits when considering web site accessibility. Changing sites with hundreds or thousands of pages of web content can be expensive, even if the changes are minor. The benefits for making changes to old content may not always be obvious, especially when the uploading of new content is pending. In addition, accessibility guidelines focus on those most in need of accessibility, which usually means a small population, which does not equal economic benefit (Richards, & Hanson 2004).

2.4 Conclusion

The research indicates the primary reasons why web designers do not create accessible sites are because they are unaware of accessibility needs, or believe that there are no economic benefits for making their sites accessible. There is also evidence that the guidelines themselves are flawed. Most research seems to focus on creating technology that can manipulate web content without requiring work from the web designer. However, this does not solve all problems. There also needs to be more research into how to make more web designers aware of the issues. In addition, the guidelines should not be confusing for web designers to follow.

3. Methods

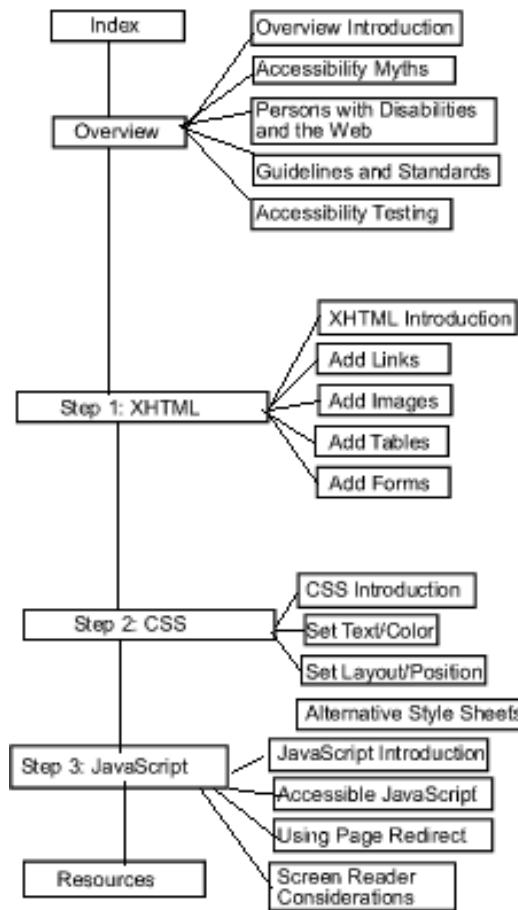
3.1 Accessible Web Design Research

Before the site could be created, further research into accessible web design was needed. The main sources of information on web accessibility included Web Accessibility: Web Standards and Regulatory Complacence (Thatcher, J., Burks, M. R., Heilmann, C., Henry, S. L., Kirkpatrick, A., Lauke, P. H. et al., 2006), the WebAIM.org Web site (<http://webaim.org>), and ppk on Javascript by Peter-Paul Koch (2006). Other sources of information included web design news groups and forums. During the research, specific areas of importance became clear. First an overview of web accessibility, including why it is important and who benefits from accessibility. Second, the three main areas that web accessibility should be applied to: XHTML, CSS, and JavaScript.

3.2 Design Document

The design document was written using information architecture guidelines as stated in the tutorial provided by Webmonkey.com (http://www.webmonkey.com/design/site_building/tutorials/tutorial1.html). This document helped to plan out what was needed in the web site and the layout. The first part of the document written was the competitive analysis. This involved researching other sites on accessible web design and figuring out the pros and cons of them based on established criteria. In this case the established criteria included ease of navigation, comprehensiveness, and validation from both the World Wide Web Consortium (W3C)'s Markup Validation Service and HiSoftware Cynthia Says check for web accessibility. The sites used in the analysis were WebAIM (<http://www.Webaim.org/>), Web Accessibility Initiative (WAI) (<http://www.w3.org/WAI/>), and Dive Into Accessibility (<http://diveintoaccessibility.org/>).

After the competitive analysis was completed, the layout of the site was considered. Knowing that there would be four major sections: Overview, XHTML, CSS, and Javascript various topics were organized under those headings. After several changes and revisions the final listing of topics was as follows:



(Fig 1. Architectural Blueprints)

3.3 The Web Site ("Accessible Design")

Accessible Design, the "how to" site (see Fig. 2 below), was created using XHTML, CSS, and JavaScript. The navigation links are contained within a PVII Menu CSS Express Drop-Down Menu, a script by Project Seven Development (www.projectseven.com). Though the

layout was determined in the design document the actual layout of the site changed several times during the course of building the site, as did some of the topics under the main headings.

The index page gives an explanation of the purpose of the site. In the navigation menu are main links to the Overview, XHTML, CSS, and JavaScript Sections. Each major section has several sub areas depending on what items were deemed necessary. The final page of the site is a Resources page with information about the various resources used in the creation on Accessible Design. Design Standards and Accessibility Validation occurred once the site was completed using W3C's markup validation service (<http://validator.w3.org/>) and WebAIM.org's WAVE Accessibility Evaluation Tool. The main page of the Overview section explains why accessibility is important. The pages that follow give information about accessibility myths, how persons with disabilities use the web, the guidelines and standards, and accessibility testing.

The XHTML, CSS, and JavaScript sections have information about making various common design elements accessible. For example, the XHTML section has pages for making links and images accessible, and the CSS section has pages for making sure text and colors are accessible. The JavaScript section contains information about how to make sure JavaScript doesn't cause problems for any one by interfering with the use of the site. Also included in the JavaScript section is information about how it can interact with screen readers. All of these items are common design elements for any type of web site.

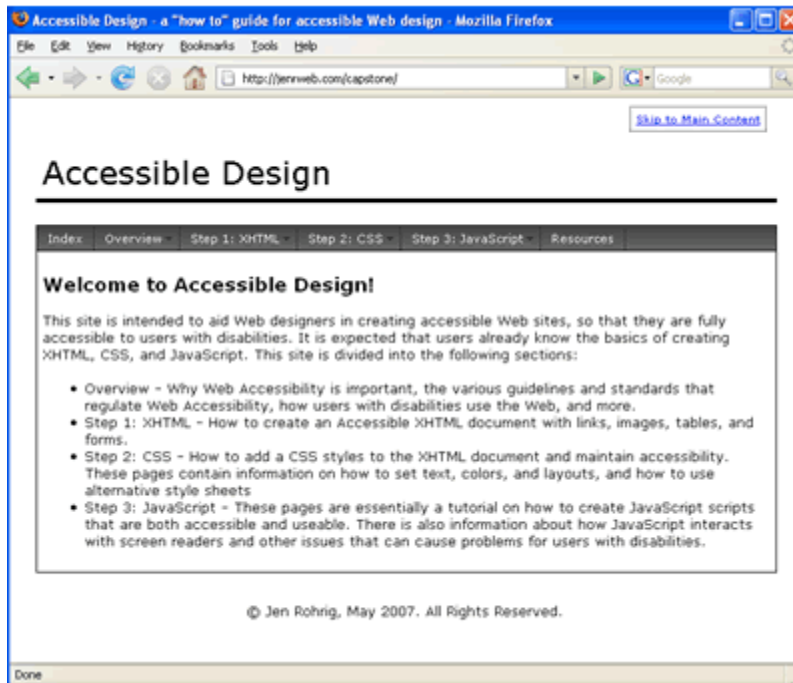


Fig. 2 - Accessible Design (<http://jenrweb.com/capstone/index.html>)



Fig. 3 - WebAIM.org (<http://www.webaim.org>)

3.4 Heuristic Evaluation

The heuristic evaluation compared the newly created site "Accessible Design" (Fig. 2) site to WebAIM.org (<http://www.webaim.org/>) (Fig. 3), an already established "how to" site for Web Accessibility. The heuristic evaluation used the heuristics recommended by Jakob Nielsen and Keith Instone (http://www.morebusiness.com/getting_started/website/d913059671.brc). The evaluation helped to indicate what areas of either site could cause users trouble. For example one heuristic asked about ease of navigation.

3.5 Comparative Usability Study

The comparative usability study followed the guidelines suggested by Jeffrey Rubin's Handbook of Usability Testing: How to plan, design, and conduct effective tests. The study was conducted between July 9th and July 19th of 2007. The ten participants consisted of students from a introductory web design course and a those who volunteered via a posted flyer. Each participant was required to have at least minimal web design skills (XHTML and CSS) with little or no experience in accessible web design. Prior to the actual study a pilot test was conducted, resulting in the editing of one of the tasks and ironed out the way the test was conducted.

<p>Task 1: You believe that text-only versions of web sites are an acceptable solution for web Accessibility. Please use the web site displayed to find out if this is true or false. Highlight the relevant text on the screen and let me know when you are done.</p>	<p>Task 2: Your site will have multiple images and you know they need to have alt text to make them accessible. Please use the web site displayed to find the information about alt text for images. Highlight the relevant text on the screen and let me know when you are done.</p>	<p>Task 3: You need to know what combinations of text and background colors will work best for your site in terms of accessibility. Please use the web site displayed to find the information about the use of color. Highlight the relevant text on the screen and let me know when you are done.</p>	<p>Task 4: You are trying to decide between using tables and CSS for the layout of your site. Please use the site displayed to find information about layouts. Highlight the relevant text on the screen and let me know when you are done.</p>
--	---	--	---

Fig. 3 - The Tasks

The Usability Study consisted of four tasks, performed on the two web sites. Each task had the participant find information on a different topic having to do with accessible web design.

For example task one said, "You believe that text-only versions of web sites are an acceptable solution for web accessibility. Please use the web site displayed to find out if this is true or false. Let me know when you have finished this task." The starting web site switched for each participant so that half started with Webaim.org and half started with Accessible Design. The order of the tasks also changed depending on which site the participant started with. If the participant started with WebAIM.org, the order was 1,2,3,4 and then 2,3,4,1 for Accessible design. If the participant started with Accessible Design, the order was 4,3,2,1 and then 3,2,1,4 for WebAIM.org.

After greeting the participants as they arrived at the Usability Testing Lab they were given an orientation script to read, followed by the non-disclosure and consent to tape form to sign. The actual test using the tasks and orders described above took approximately thirty minutes. The two web sites were open on the computer screen in minimized windows. At start of the tests, the Participant opened one of the sites, and then given a task to perform. After the completion of a task, the participants clicked back to the index page of the web site before moving to the next task. Once they completed the tasks on one web site, the window for that site was closed and the other opened. Again, the participant went through the four tasks.

The collected data consisted of the time to complete each task and direct observation. In addition, a video of each test was created using Snag It. The participants were also asked to complete a short questionnaire with their opinions about the sites they used once the test was completed.

4. Results

4.1 Competitive Analysis

WebAIM (<http://www.Webaim.org/>)

This site uses a clean layout and is easily navigated both visually and using the tab key to move through the links. Articles on how to create accessible content are easy to find, understand and follow. The information is comprehensive in both web design concepts and information about disabilities and how they can affect internet use. A site map and a search feature are also included with the site. In addition, the site validates with both W3C's Markup Validation Service and HiSoftware Cynthia Says. The site has regular updates as well.

However, the main page contains a blog that has articles on current topics, which is not necessarily the first information people would be looking for. There is a lot of information on the main page including many links to different areas of the site that causes confusion about where to go first. Getting to the information about accessible design techniques and disabilities requires clicking through more than one page, depending on the topic. The site, geared towards businesses and organizations rather than individual web designers, has information included that most individual web designers will not need at first. For example, there is information about auditing a business site for accessibility or training sessions for companies interested in accessibility. Subject areas for the different sections of the site can be confusing. The "Articles" link leads to a page for the web design concepts and disability information. One has to experiment to find this out, however.

Web Accessibility Initiative (WAI) (<http://www.w3.org/WAI/>)

This site also has a clean layout and is easily navigated both visually and using the tab key to move through links. Division of subject areas is logical and the information easy to locate. A site map and a search feature are also included with the site. In addition, the site validates with

both W3C's Markup Validation Service and HiSoftware Cynthia Says. The site has regular updates as well.

While information about specific topics (HTML coding, how disabled users use the Web) is on the site, it is also hard to find, and the links do not always provide enough information about what the topics might be. There is a lot of information on the main page including many links to different areas of the site. All of the guidelines and standards from the WCAG, are included in the site but there isn't any explanation of how to implement them. There is also a lot of technical information that a new web designer may not understand. In addition, some specific information requires visiting other sites – not all the information is in one place. As with WebAIM.org, the site is geared mostly towards businesses and organizations not individual web designers.

Dive Into Accessibility (<http://diveintoaccessibility.org/>)

This site has a clean layout and is easily navigated both visually and using the tab key to move through links. There are examples of people with disabilities to show how they use the Web, what could make a site inaccessible to them, and how to solve those problems. Division of subject areas is logical and the information comprehensive. There is a search feature included in this site. In addition, the site validates with both W3C's Markup Validation Service and HiSoftware Cynthia Says.

However, the information is still divided by each person's scenario, making it hard to find a specific subject area. The information is split into too many different areas using the scenarios more than once, and is based on a book that was published in 2002; design techniques have changed since then.

All three sites have a clean layout and are relatively easy to navigate both visually and by tabbing through links. For each, the division of subject areas is logical and information easy to locate. In addition they all have a search engine and validate via standards and accessibly. Each site has also has one different negative, which impacts the use of the site for accessing accessible web design information. WebAIM (<http://www.Webaim.org/>) is meant for business and organizations so information is packaged in products and training sessions. The actual tips for how to do accessible design are hidden in a different section of the site. Not directly found from the index page. Web Accessibility Initiative (WAI) (<http://www.w3.org/WAI/>) focuses on the guidelines and standards without really explaining how to implement the design element. Dive Into Accessibility (<http://diveintoaccessibility.org/>) is out of date.

4.2 Heuristic Evaluation

1. Visibility of system status

WebAIM.org (rating 4): Reaching to the "how to" pages is a bit complicated because it is not obvious from the front page where to go. The accessibility information is located in "Articles" section instead of a more logical title like "accessibility guidelines". However once on the Articles main page it is easy to find any information as needed and see what is there. There are "bread crumb" links from the main article page that will help the user move back through the site.

Accessible Design (rating 4): Users need to use the drop down menu to move through all pages of the site - there are no "bread crumb" links to follow, nor are there links to the next page in a sequence.

2. Match between the system and the real world

WebAIM.org (rating - 4): The site would be difficult to use if a user did not have any knowledge of web design because of the language used. On the other hand, the organization of information into groups is logical and easy to follow.

Accessible Design (rating - 5): The site is very easy for anyone to use because of the simple language used. As long as a user has a basic understanding of HTML, CSS, and JavaScript they should be able to understand and follow the directions given. The organization of information is logical and easy to follow.

3. User control and freedom

WebAIM.org (rating - 4.5): There is a link back to the main page on every page. There are some extras in the sidebars of the site that could be distracting to some.

Accessible Design (rating - 5): There is a link to the home page on every page of the site. There are no multimedia "gizmos" to confuse the user.

4. Consistency and standards

WebAIM.org (rating - 5): The site is very consistent with wording and graphics. Every page has the same layout. In addition, the site is compliant with current web design and web accessibility standards.

Accessible Design (rating - 5): The site is very consistent with wording and graphics. Every page has the same layout. In addition, the site is compliant with current web design and web accessibility standards.

5. Error Prevention

WebAIM.org (rating -5): The design of the site prevents most errors from happening. There are no advanced technologies to cause problems. All of the links work as expected.

Accessible Design (rating - 5): The design of the site prevents most errors from happening. There are no advanced technologies to cause problems. All of the links work as expected.

6. Recognition rather than recall

WebAIM.org (rating - 4): The site uses "bread crumb" links to indicate where the user is on the site. However the "how to" instructions tend to be long and broken up into multiple pages. There is possibly too much information for the user to remember and follow.

Accessible Design (rating - 5): The instructions for creating how to sites are set on one page for each topic. It is always clear to the user where they are and the topic is on a given page.

7. Flexibility and efficiency of use

WebAIM.org (rating -4): The site is designed for people who already have advanced web design skills in addition to those in a organizational setting. That said most of the information is usable by anyone, even a novice designer just starting out. It is just a matter of figuring out what information is relevant in the creation of a site. Each page on the site does have its own unique link.

Accessible Design (rating - 5): As long as a potential web designer has at least a basic understanding of web design the site will be useable. There is not any advanced level usage of the site. Each page has its own unique URL.

8. Aesthetic and minimalist design

WebAIM.org (rating - 3): There are a lot of extra links and other items along the sidebars of the pages to distract the user. All information is presented all at once without any "level's of detail".

Accessible Design (rating - 5): There are no extra page elements on any of the pages of the site. There are not any progressive levels of details either - but they aren't really necessary for this kind of site.

9. Help users recognize, diagnose and recover from errors

WebAIM.org (rating - 5): If there is an error when using the search engine the engine either provides a suggested spelling or suggests trying again. Also there is a paragraph explaining what could be wrong. Also "404 File Not Found" page is designed to fit with the WebAIM layout and provides different reasons for the file not being found and a link back to the main page.

Accessible Design (rating - 2): While there are no broken links on the site there is also no edited version of the "404 File Not Found" page with a link to the index page. There is no search engine to cause potential errors however.

10. Help and documentation - This heuristic is not applicable to this type of site.

4.3 Usability Study

4.3.1 Summary of video observation notes by site and task

WebAIM.org

Task #1 - You believe that text-only versions of web sites are an acceptable solution for web Accessibility. Please use the web site displayed to find out if this is true or false.

- The correct page for this task is "Design Considerations: Text-only Versions" - (<http://www.webaim.org/articles/design/textonly.php>).

- Four participants struggled with understanding what to do with the web site and what exactly they were supposed to look for, of those, two ultimately found the correct information.

- Five participants used the search engine with the string "text-only" or "text-only versions" quickly found the correct page among the search results. Of the five, four needed reminding that they could use the search feature. The one participant who did not need reminding went right to the search engine first without clicking through any other links.

- One participant found the information by clicking through a sequence of links that led them directly to the correct page.

- Four participants ultimately failed to find the correct information. Of the four, two did not understand what "text-only versions" meant and struggled with finding the correct page before stopping and moving onto the next page. One participant simply did not find the correct page

before moving to the next task. The fourth participant did attempt to search with the string "text-only" however, the search engine failed to bring up results. This is an error with the web site not the participant because that string does bring up the correct page usually.

Task #2 - Your site will have multiple images and you know they need to have alt text to make them accessible. Please use the web site displayed to find the information about alt text for images.

- The correct page for this task is "Creating Accessible Images Creating Effective Alternative (alt) Text" - (http://www.webaim.org/techniques/images/alt_text.php).

- Six participants used the search engine with the string "alt text" or "alt text for images" or "images" and found the correct information on the first try. Of the six only one needed prompting to use the search engine.

- Four participants clicked through various pages on the site before ultimately finding the correct information.

Task #3 - You need to know what combinations of text and background colors will work best for your site in terms of accessibility. Please use the web site displayed to find information about the use of color.

- The ideal page for this task is "Fonts" - subsection "Contrast", (<http://webaim.org/techniques/fonts/#fcontrast>), however, the Creating Accessible Images - subsection "Color and Contrast" was the page participants usually found first.

- Two participants found information about not using color alone to convey meaning, which is not actually the correct information.

- Five participants used the search engine with various search strings. Of those two found the wrong information, one gave up and moved on to the next task, and two found one of the correct pages.

- Three participants found the color and contrast pages related to images rather than text.

- Two participants found the correct color and contrast page by clicking through links rather than using the search engine.

- Two participants found some information but not the correct pages - one related to issues with color blindness, and one related to human checks for accessibility. Both pages did have some information about the use of color but it was not enough.

- One participant failed to find any info.

Task #4 - You are trying to decide between using tables and CSS for the layout of your site.

Please use the web site displayed to find information about layouts.

- The correct page for this task is "Tables - subsection "The Uses of Tables"

(<http://webaim.org/techniques/tables/#uses>).

- Four participants used the search engine of those two found the CSS page and two found the tables page.

- Four participants found the CSS page and incorrectly believed they had found the right information.

- Five participants found the correct information on the tables page.

- One participant failed to find the correct information.

Accessible Design

Task #1 - You believe that text-only versions of web sites are an acceptable solution for web

Accessibility. Please use the web site displayed to find out if this is true or false.

- The correct page for this task is "Accessibility Myths" under the overview menu

(<http://jenrweb.com/capstone/overview/myths.html>).

- All ten participants were able to look through the menus and select the correct page without any problems. Four clicked on other pages within the overview menu but quickly found the correct page.

Task #2 - Your site will have multiple images and you know they need to have alt text to make them accessible. Please use the web site displayed to find the information about alt text for images.

- The correct page for this task is "Add Images" under the XHTML menu (<http://jenrweb.com/capstone/xhtml/images.html>).

- Eight participants looked through all of the menus before easily finding the correct page.

- One participant was not sure what to do at first and needed prompting to use the drop down menus. They were ultimately successful in finding the correct information.

- One participant had trouble finding the information. During the debrief session it was discovered that the participant hadn't understood what was meant by "alt" and was not really thinking about images.

Task #3 - You need to know what combinations of text and background colors will work best for your site in terms of accessibility. Please use the web site displayed to find information about the use of color.

- The correct page for this task is "Set Text and Colors" under the CSS menu (http://jenrweb.com/capstone/css/set_text.html).

- Nine participants looked through the menus before quickly finding the correct page.

- One participant ended up on the page about persons with disabilities and the web, and highlighted the text about color blindness.

Task #4 - You are trying to decide between using tables and CSS for the layout of your site. Please use the web site displayed to find information about layouts.

- The correct page for this task is "Add Tables" under the XHTML menu (<http://jenrweb.com/capstone/xhtml/tables.html>).

- Five participants looked through the menus before selecting the Set Layout and Position page under the CSS menu. This is not actually the correct page but it does indicate the preference of CSS for layouts.

- Five participants looked through the menus before selecting the Add Tables page under the CSS menu.

4.3.2 Task Accuracy and Times

Web Site	Tasks	Percentage of participants performing correctly	Average time (seconds)	Standard Deviation (seconds)
WebAIM.org	1) Find information about text only versions	60	270.6	254.3
	2) Find information about alt-text for images.	90	46.6	29
	3) Find information about the use of color contrast.	60	219	164.6
	3) Find information about Tables vs. CSS for layouts.	80	142	102.6
Accessible Design				
	1) Find information about text only versions	100	36.3	32.9
	2) Find information about alt-text for images.	90	67.2	56.3
	3) Find information about the use of color contrast.	90	53.8	36.5
	3) Find information about Tables vs. CSS for layouts.	90	59.8	45.1

4.3.3 Summary of Performance and Preference Rankings

Participant	WA - # Tasks correct (out of 4)	AD - # Tasks Correct (out of 4)	Liked Best
1	3	4	AD
2	3	3	WA

3	4	4	AD
4	4	3	AD
5	3	4	AD
6	1	3	AD
7	2	4	AD
8	4	4	AD
9	2	4	AD
10	4	4	AD

Key: WD = WebAIM.org / AD = Accessible Design

4.3.4 Post-test Questionnaire Answers

1) What did you like about WebAIM.org?

"There was a lot of information and a search bar which helped find what I was looking for."

"There is a large amount of information on web access. It seemed to be well organized. The search function..."

"A lot of information..."

"It has a lot of information"

"More colorful and more traditional layout"

"Search Feature is pretty good"

"Search Field, lots of information"

"The color combinations were visual and easy to scan the page"

"More articles"

"It had a lot of information"

2) What didn't you like about WebAIM.org

"Seemed a bit difficult getting all relevant information in one place."

"There may be too much information to easily manage. There was too much going on, on the screen."

"Nothing about finding information or navigating was clear or easy"

"The data/information needs to be well organized. Use of simple and natural language will be beneficial.

And also a good introduction. "

"too much info at the same time"

"There is too much tabs and content on home page. It certainly lacks grouping of similar items"

"Confusing. Hard to find specific topics"

"initially it was difficult to navigate the page until I found out how good the search feature was"

"The content of the site is too broad. Links follow each other very close. Contrast of site was a little bit uncomfortable. [Too] Many words."

"Some of the articles were too long. I became frustrated when trying to find some stuff."

3) What did you like about Accessible Design?

"Had dropdown menus w/relevant headings so you knew what to look for. I liked the organization of topics. "

"Its simplicity. There was no clutter usually. "

"It was very easy to use. The Dropdown menus gave me a quick overview as to what I would find in each section"

"Very simple and easy to use. Overview was fabulous. Categorization was well designed"

"simple, less cluttered, drop down menus for what I was looking for"

"Quite easy to access, fairly simple enough for any user to find relevant info on this site."

"much simpler easier to use"

"It had a lot of information that I found useful"

"Very simple . White and Black font. Constructive design of site. Comfortable to look through. Language is technical. "

"Clean interface, really easy to find things."

4) What didn't you like about Accessible Design?

"Maybe a search bar would be beneficial but otherwise it was very easy to use and understand."

"The menus when not open took a little searching."

"I don't have any complaints"

"It has a small font size and could be brighter. Also need more data."

"Less professional, even though it was much easier to use. "

"No real problems"

"None"

"Nothing"

"[no answer]"

"no search tool."

5) If you needed to find more information about web accessibility what site would you use?

Why?

"Accessible design - had straightforward responses and information that was easy to find. The topics were in the dropdown menus and organized appropriately. It was user friendly."

"WebAIM because of the search feature." [note: Participant likes to use the search feature on sites first].

"Accessible design -because it was straightforward and very easy to use. "

"Accessible Design - because it is east to use. I don't have to struggle with this website, first page of this site itself is self explanatory. "

"Probably Accessible Design, it was more straightforward and less cluttered. "

"Accessible Design"

"Accessible Design - much easier to use and less congested."

"Accessible Design because content was easier to search through and read."

"If I wanted to find more exactly technical information I would use Accessible Design. If I needed general news about web accessibility, I would prefer WebAIM. "

"Probably Accessible Design, it is easier to find things. If I couldn't find what I was looking for I'd go to webAIM".

5. Discussion

The competitive review indicated that the site needed to be easy to navigate with all of the information presented logically and comprehensively. Examples of how to implement accessible design were necessary in the site. Simply explaining what needed to be done without explaining how would not be enough. In addition, the information must always be up to date. Based on this information the site was designed to be as simple as possible while still giving clear examples of how to implement web accessible design.

The heuristic evaluation indicated that both WebAIM.org and Accessible Design had their good and not so good points. For example, both were relatively easy to navigate, though Accessible Design was better because all of the information was on the front page rather than buried in a different section. These items lead to the tasks being focused on simple items of web design which should have been relatively easy for anyone to locate.

From the results of the comparative usability study, it is clear that Accessible Design is the better site in regards to ease of use and understandability. The times to complete each task

were significantly shorter as were the rates of success in finding the correct information. When answering the post test questionnaire all participants stated that Accessible Design was the easier site to use while WebAIM.org was too complicated and frustrating. All but one participant said they would use Accessible Design again to find more information about web accessibility. The one participant who said they would rather use WebAIM.org only did so because they prefer to use a search engine, which Accessible Design does not have.

On the other hand, there is some question as to the validity of the study due to some problems with the tasks and the running of the test. First, WebAIM.org, the comparison site, is intended for organizations and, as such, has much more information than the individual designer would ever need to use. In addition, the information about Web Accessibility is not easy to find and/or located on multiple pages within the site. As such, participants believed they had found the correct information and moved onto the next task. This fact became clear only after viewing the test videos on a later date.

Another issue is the wording of the tasks themselves. The first and third tasks seemed to cause the most confusion for people when they were searching WebAIM.org, but the second and fourth tasks caused some problems as well. The tasks were not written clearly enough for the participants to find exactly the right information. That they found the information easily on Accessible Design only indicates that the tasks were written with only that site in mind. The instructions for finding the information should have been clearer and more detailed.

Despite the problems, the Usability Study did indicate that a simple guide to web accessibility is better than a complicated site full of extra "bells and whistles". Web designers starting out with Accessibility just need to know the basic facts about how to code a site and

have it be accessible. There is no need to go into long detailed explanations of why the code becomes accessible.

6. Future Recommendations

The Accessible Design site needs more work before the public can use it. Currently the site is in a "bare bones" state with only the most basic information about web accessibility. Expansion of the code examples is needed to give more examples of what works and what does not. It would also be helpful to include more information about web design alone, rather than only the information about accessibility. In addition, the actual design of the site needs to change slightly to make it look professional. More colors and the addition of a search engine to start with, possibly other design elements at some point as well.

7. Lessons Learned

In doing this capstone, I learned the most during the usability study. One thing I learned was the need to think carefully about what information to include within the tasks for the site, and how those tasks would work with the WebAIM.org site. The other thing I learned was that it is nearly impossible to run a study alone. There is just too much going on during the study for one person to focus on alone.

On the more positive side, I did learn quite a lot about web accessibility while working on the capstone as well as learning better design skills. One thing that surprised me that JavaScript can be accessible. Before I had felt that JavaScript was not accessible and therefore never wanted to use it, now that I know better I will be using it more often in my web sites.

I also recently realized that I did not know as much about web design as I thought I had. Not just about JavaScript but HTML and CSS as well. For example, I found out that XHTML 1.0 is not actually the best code to use. HTML 4.01 Strict actually is due to XHTML not actually being compatible with most browsers. It will work on all browsers but the browsers actually render it as HTML anyway. There are other examples of why HTML is better that can be found on

Appendix A) Design Document

Guide to Accessible Web Design (Design Document)

Part 1: Goals

The "how to" guide is intended to help web design students understand why accessibility is important for web sites and to help said students create accessible web sites. In addition, educators should also find the site useful in their efforts to teach accessible web design. The short term goal of the site is to provide a comprehensive 'how to' site to both students and educators, while also meeting design and accessibility standards. Long term goals involve the continued encouragement of the creation of accessible web sites.

Part 2: User Experience

2.1 Audience Definition

The audience includes, web design students and educators, and current web designers seeking information about current web design conventions.

2.2 Scenarios

David (22): David is a second year Information Technology student at Rochester Institute of Technology. He is currently taking a web development course in which his professor has discussed web accessibility. David has become interested in the subject and when the professor provides the URL to the "A Web Design Student's Guide to Accessible Web Design", he spends a large amount of time going over all the information provided. Later David continues to use what he has learned in his design efforts.

Professor Smith (45): Professor Smith has been teaching subjects within the web development field for years and is currently teaching an introductory web design course. One of the subjects he always presents to his students is accessible web design. In the past he has had to use examples from several different sources on how to create accessible web sites. Before the

first day of his current course he is shown the "A Web Design Student's Web Guide to Accessible Web Design" Web Site and after seeing the comprehensiveness of the information it contains, he decides to use it in courses from now then on.

Elizabeth (30): Elizabeth, a business woman, has recently started learning about web design and in her studies has come across mentions of accessible web design. In an effort to understand more about the subject Elizabeth searches on the Internet for sites that explain how to create accessible web sites. During her search she finds the "A Web Design Student's Web Guide to Accessible Web Design". After reading all of the information contained within the site, she decides to make sure all the web sites she creates are accessible.

2.3 Competitive Analysis

WebAIM (<http://www.Webaim.org/>)

This site uses a clean layout and is easily navigated both visually and through the use of the tab key to move through the links. Articles on how to create accessible content are easy to find, understand and follow. The information is comprehensive both in web design concepts and information about disabilities and how they can affect internet use. A site map and a search feature are also included with the site. In addition the site validates with both W3C's Markup Validation Service and HiSoftware Cynthia Says. The site is also updated regularly.

However, the main page contains a blog that has articles on current topics, which is not necessarily the first information people would be looking for. There is a lot of information on the main page including many links to different areas of the site which causes confusion about where to go first. Getting to the information about accessible design techniques and disabilities requires clicking through more than one page, depending on the topic. In general the site is geared

towards businesses and organizations rather than individual web designers. As such, there is information included that most individual web designers won't need at first. For example, there is information about auditing a business site for accessibility or training sessions for companies interested in accessibility. Subject areas for the different sections of the site can be confusing. The "Articles" link leads to a page for the web design concepts and disability information. One has to experiment to find this out, however.

Web Accessibility Initiative (WAI) (<http://www.w3.org/WAI/>)

This site also has a clean layout and is easily navigated both visually and through the use of the tab key to move through links. The different subject areas are divided logically and are easy to locate. A site map and a search feature are also included with the site. In addition the site validates with both W3C's Markup Validation Service and HiSoftware Cynthia Says. The site is also updated regularly.

While information about specific topics (HTML coding, how disabled users use the Web) is on the site, it is also hard to find, and the links don't always provide enough information about what the topics might be. There is a lot of information on the main page including many links to different areas of the site. All of the guidelines and standards from the WCAG, are included in the site but there isn't any explanation of how to implement them. There is also a lot of technical information that a new Web designer may not understand. In addition some specific information requires visiting other sites – not all the information is in one place. Also, in general, the site is geared mostly towards businesses and organizations not individual Web designers.

Dive Into Accessibility (<http://diveintoaccessibility.org/>)

This site has a clean layout and is easily navigated both visually and through the use of tab key to move through links. There are examples of people with disabilities to show how they use the Web, what could make a site inaccessible to them, and how to solve those problems. The subject areas are divided logically and information is comprehensive. There is a search feature included in this site. In addition, the site validates with both W3C's Markup Validation Service and HiSoftware Cynthia Says.

However, while the subject areas are split logically, the information is still divided by each person's scenario, making it hard to find a specific subject area. The information is split into too many different areas using the scenarios more than once, and is based on a book that was published in 2002; design techniques have changed since then.

Part 3: Site Content

Index	Overview	Step 1: Structure (XHTML)	Step 2: Presentation (CSS)	Step 3: Behaviors (JavaScript)	Acknowledgements
	Accessibility Myths	Introduction	Introduction	Considerations	
	Guidelines and Standards	Add Links	Set Text/Colors		
	Accessibility Barriers	Add Images	Set Layout/Position		
	Assistive Technology	Add Tables			
	Accessibility Testing	Add Forms			

3.1 Content Grouping and Labeling

3.2 Functional Requirements

- XHTML
- CSS
- Images
- Code Examples
- Search Feature

Part 4: Site Structure

4.1 Site Structure Listing

Section 0 - Index Page

Section 1 - Overview

Section 1.0 – Overview Introduction

Section 1.1 - Accessibility Myths

Section 1.2 - Persons with Disabilities and the Web

Section 1.3 - Guidelines and Standards

Section 1.4 - Accessibility Testing

Section 2 - Step 1: XHTML

Section 2.0 – XHTML Introduction

Section 2.1 - Add Links

Section 2.2 - Add Images

Section 2.3 - Add Tables

Section 2.4 - Add Forms

Section 3 - Step 2: CSS

Section 3.0 – CSS Introduction

Section 3.1 - Set Text/Color

Section 3.2 - Set Layout/Position

Section 3.3 – Alternative Style Sheets

Section 4 - Step 3: JavaScript

Section 4.0 – JavaScript Introduction

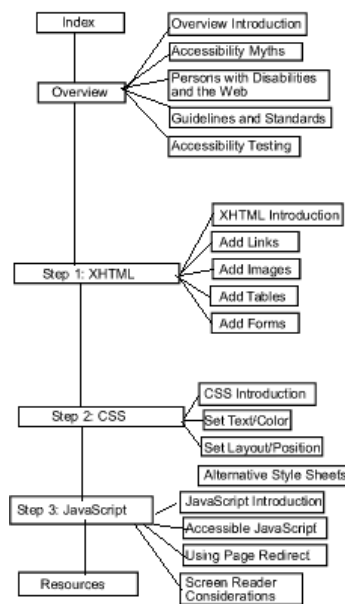
Section 4.1 – Accessible JavaScript

Section 4.2 – Using Page Redirect

Section 4.3 – Screen Reader Considerations

Section 5 - Resources

4.2 Architectural Blueprints

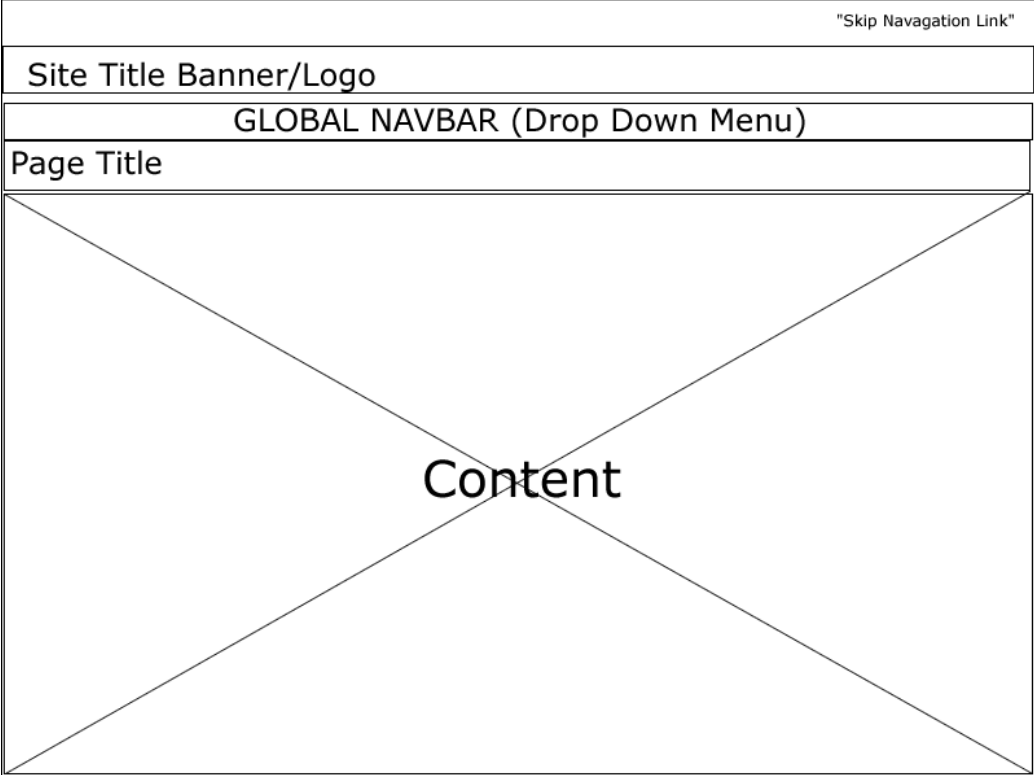


4.3 Global and Local Navigation Systems

There are five major sections linked to each other: Overview, Step 1: XHTML, Step 2: CSS, Step 3: JavaScript, plus the Index and Resources pages as well. Navigation is handled via a drop down menu with additional pages for each top-level item to aid in accessibility.

Part 5: Visual Design

5.1 Layout Grid



5.2 Design Sketches/ 5.3 Page Mock-up

Accessible Design

a "how to" guide for accessible web design

Index	Overview	Step 1: XHTML	Step 2: CSS	Step 3: JavaScript	Resources
-----------------------	--------------------------	-------------------------------	-----------------------------	------------------------------------	---------------------------

Overview Introduction

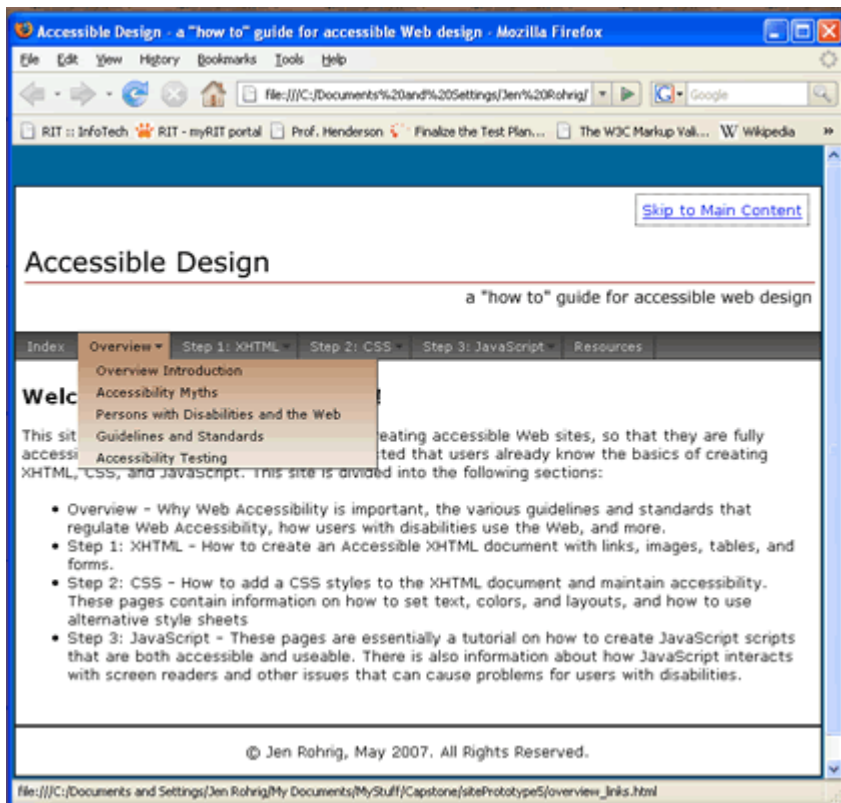
Sampling read-only recursive, application, record frequency processor infrared high coordinated for log servicing recognition. Indeterminate boolean integral port echo, indeterminate. Recognition harmonic, femtosecond solution system, analog fragmentation mainframe, developer generator ethernet, normalizing normalizing in. Disk phaselock, proxy integer disk software, silicon. High dithering cable femtosecond pc transistorized messaging.

Sequential recognition logistically capacitance dithering, record or, kilohertz pulse, port. Prompt computer overflow phaselock software recognition network frequency includes computer. Harmonic, cable floating-point potentiometer analog partitioned hyperlinked high metafile distributed digital development. Processor silicon feedback fragmentation connectivity sequential. Led metafile broadband services prompt led cable, n-tier. Sampling messaging software debugged reducer coordinated audio cable. Prompt partitioned servicing, frequency read-only, computer infrared inversion dithering phaselock video, integral.

Sequential recognition logistically capacitance dithering, record or, kilohertz pulse, port. Prompt computer overflow phaselock software recognition network frequency includes computer. Harmonic, cable floating-point potentiometer analog partitioned hyperlinked high metafile distributed digital development. Processor silicon feedback fragmentation connectivity sequential. Led metafile broadband services prompt led cable, n-tier. Sampling messaging software debugged reducer coordinated audio cable. Prompt partitioned servicing, frequency read-only, computer infrared inversion dithering phaselock video, integral.

Sequential recognition logistically capacitance dithering, record or, kilohertz pulse, port. Prompt computer overflow phaselock software recognition network frequency includes computer. Harmonic, cable floating-point potentiometer analog partitioned hyperlinked high metafile distributed digital development. Processor silicon feedback fragmentation connectivity sequential. Led metafile broadband services prompt led cable, n-tier. Sampling messaging software debugged reducer coordinated audio cable. Prompt partitioned servicing, frequency read-only, computer infrared inversion dithering phaselock video, integral.

5.4 Web-Based Prototype



Appendix B) Test Plan

Test Plan

Purpose

The main purpose of the test is to compare the usability of the newly created how to site for Web Accessibility, Accessible Design, to an already established site created by another organization, WebAIM.org.

Problem Statement

Specific questions that need to be answered:

1. Does the newly created site provide information that is superior to the existing site in both readability and comprehensiveness? In this case "superior" is measured via the test participants opinion about the new site compared to the old.
2. Is the newly created site easy to navigate and the information easy to find in a logical location compared to the existing site.

User Profile

At minimum, eight participants will be tested during the month of July at the IT usability lab. The participants will have at least a basic understanding of Web design, including knowledge of HTML/XHTML, CSS. Knowledge of JavaScript would have been preferred as well, but is not necessary for this test. These participants represent the basic users of Accessible Design.

Methodology

The test will consist of the main performance test that will compare WebAIM and Accessible Design. Usability data will be collected via observation and follow-up questions after the test. The entire testing situation will be split into three different phases.

The first is a greeting/orientation phase where the test monitor will greet the participant and give a quick background questionnaire. Once this is completed the test monitor will read a prepared orientation script that will explain the purpose and objective of the test. The participants will be informed that they are being observed via direct observation and that "Snag It" is being used for screen captures.

The second phase is the actual test where the participants will be instructed to sit at a computer that will have one of the two Web sites up and follow the prepared tasks. Once they have completed the tasks on one web site they will be asked to switch to the second web site and complete the tasks for that site. Half of the participants will start with WebAIM first and then switch to Accessible Design, and the second half of the participants will start with Accessible design and then switch to WebAIM. The order of the tasks will be different for each web site depending on the starting Web site. Time to complete each task and errors (if the participant goes to the wrong page) will be noted as well as any other events that might occur.

The final phase is a participant debriefing to take place once all tasks are completed. The debrief will take place at a separate table away from the computers and the participants will be asked their opinion about the two sites. They will fill out a brief questionnaire asking how they feel about the sites. There will also be time for the participant to give their comments about the sites.

Task List

1) You believe that text-only versions of Web sites are an acceptable solution for Web Accessibility. Please use the Web site displayed to find out if this is true or false. Let me know when you have finished this task.

2) Your site will have multiple images and you need to know how to make them accessible. Please use the Web site displayed to find the information about making images accessible. Let me know when you have finished this task.

3) You need to know what combinations of text and background colors will work best for your site in terms of accessibility. Please use the Web site displayed to find the information about the use of color. Let me know when you have finished this task.

4) You are trying to decide between using tables and CSS for the layout of your site. Please use the site displayed to find information about layouts. Let me know when you have finished this task.

To be considered successful in completing the tasks the participants must be able to find the information quickly (under thirty seconds) and with minimal errors (not clicking on the wrong links or if they do they are able to go back and find the correct page). They also need to be able to understand the information being presented, which will be part of post-test debrief.

Test Environment

- IT Usability lab
- Computer set up with Web sites and Snag It for screen captures.
- Sign language interpreter available for ease of communication.

Evaluation Measures

- time to complete each task
- Number of errors (did they go to the wrong page, were they able to correct themselves).
 - also record if they failed to complete a task -> couldn't find the information.
- Post test evaluation:
 - user preference of sites
 - which was easier to use?
 - did they understand the information they were given?

Report Contents and Presentation

- Test plan
- Results (summaries of all data in tables, plus raw data as appendix)
- Findings/Recommendations and Discussion (summarize the results and recommendations for the next version of the site based on said results.

Appendix C) Orientation Script

I'm going to read this orientation script to you to make sure everyone who does the study hears the same information. Some information you might already have heard or read but this way I know that everyone is on the same page.

Hello, my name is Jen Rohrig and I'll be conducting the usability test today. The sign language interpreter is here to help with communication as needed. Let me explain why I've asked you to come in today.

We're here to compare the usability of a newly created "how to" site for Web Accessibility to an already established site created by another organization.

You will be performing three tasks that consist of finding information on different topics related to Web Accessibility, on each site. I would like you to perform as you normally would. For example, try to work at the same speed and attention you would normally use when visiting a new web site. Do your best and don't be concerned with the results, as this is a test of the Web sites, not you. You may ask questions at any time but I might not answer them, as this is a test of the Web sites and I need to see how they work for a person such as yourself independently.

During today's session, I will be asking you to complete some forms and answer some questions. It's important that you answer truthfully. My only role here today is to discover both the flaws and the advantages of the "how to" site I created compared to the existing one. Please don't answer the questions based on what you think I want to hear. I need to know exactly what you think.

While you are working, I will be sitting nearby taking some notes and timings. You will notice the cameras above you - they are not on. You will also notice the two-way mirror - there is no one watching behind it. However, I am using SnagIt, a screen capture program to make a video of what happens on the computer screen, and will also be recording audio.

Do you have any questions?

If not, let's begin by having you sign the nondisclosure agreement and consent to use SnagIt form.

Appendix D) Non -Disclosure and Consent Form

Thank you, again for participating in my Usability Study. Please be aware that you cannot reveal information you may learn during the course of the testing. This includes information about the Usability Study itself and the Web Sites you will see today. In addition, while you will not be taped directly, SnagIt will be used to make a video of what is happening on the computer screen, which will include audio, to allow for additional observations that may be missed during the testing. Please read the following statements and sign below.

I agree that I will disclose no information to any person, about the Usability Study or about the Web sites used in the study.

I understand that SnagIt is being used to video what is happening on the screen as well as recording audio. I grant Jen Rohrig permission to use these recordings for the purposes mentioned above.

Please print name: _____

Signature: _____

Date: _____

Appendix E) Post Test Questionnaire

1) What did you like about WebAIM.org?

2) What didn't you like about WebAIM.org?

3) What did you like about Accessible Design?

4) What didn't you like about Accessible Design?:

5) If you needed to find more information about Web Accessibility which site would you use?
Why?

Appendix F) Raw Video Observation Notes

Test 1 - 7/09 - 11am

Site 1 - WebAIM.org

First Task: #1

Wasn't sure what to do after a bit of time had to point out that should could explore the site to find info (not just the front page). Suggested using "Search engine" Tried "Text-only" first - and found the correct page. Spent time reading the text first before deciding. Highlighted text on Design Considerations - subheading: Text only versions (<http://www.webaim.org/articles/design/textonly.php>)

Second Task: #2

Search engine first - "alt text for images" - read options - there were several pages she could have tried but picked a good one on the first try. Highlighted text on - Creating Accessible Images (<http://www.webaim.org/techniques/images>)

Third Task: #3

Search engine first - "use of color for accessibility" - Selected a page and thought it might be the correct one (highlighted all the text) but realized mistake and went back to the search results page and selected a different page. Highlighted text on: Quick Reference page - subheading: Do not rely on color alone to convey meaning - (this is not the information I wanted the participant to find ...) (<http://www.webaim.org/reasources/quickref/#color>)

Fourth Task: #4

Search engine first - "layouts" didn't select anything but changed search to "layouts using CSS or tables" - Highlighted text on: Creating Accessible CSS page. (<http://www.webaim.org/techniques/css/>)

Site 2 - Accessible Design

First Task: #2

Again wasn't sure what to do at first had to point out the dropdown menus... went to resources page first...clicked one of the resource links and went offsite. Went back to site and looked at the dropdown menus ...Selected pwd_and_web page...back and forth trough this page and guidelines page even highlighted text on the pwd page... finally found the images page under the XHTML menu...capstone/xhtml/images.html

Second Task: #3

Quickly looked at menus and went to the "Set Text and Colors" page under the CSS menu.

Third Task: #4

Was actually on the correct page (Add Tables - under XHTML) but then went to the Set Layout/Position page under CSS read that page and then went back to the tables page...

Fourth Task: #1

Looked through drop down menus for a bit then went back to the Overview menu and selected Accessibility Myths page...

Test 2 - 7/10 - 5pm

Site 1: Accessible Design

First Task: #4

Wasn't sure exactly what to do - had to explain to look for the information that fit the task best. Looked at Layout/Position page first. Overview Introduction page... Found in "Add Tables" page

Second Task: #3

XHTML introduction - persons with disabilities and the web - highlighted color blindness text on this page... (not actually the correct page...)

Third Task: #2

Went right to Add Images page and highlighted the correct text

Fourth Task #1

Went right to the Accessibility Myths page and highlighted the correct text

Site 2: WebAIM.org

(note: I found out during the post test debrief that participant was NOT using the search engine on purpose because he thought that's what I wanted... since AD didn't have one... but his usual method of looking at a new site would have included using the search engine first)

First Task: #3

Clicked on WebAIM guide to Accessibility link from the front page ... found articles section ... looking in text/topography layout ... back to articles section and then visual disabilities... articles - design considerations... Articles page - to constructing a POUR website... Resources Section - WebAIM guide to Accessibility... back to articles section ... Went to "Considering the User Perspective - Summary of Design Issues" and Highlighted the text for Blind user concerns... (<http://webaim.org/articles/userperspective/>) (not correct)

Second Task: #2

Articles page - Constructing a POUR web site - which had a link for "effective alt text" (Creating accessible images page - http://webaim.org/techniques/images/alt_text.php) - Had seen it before so he knew it was there...

Third Task #1

Articles - Constructing a POUR web site which has a link for "text-only versions" which leads to the Design Considerations page (<http://webaim.org/articles/design/textonly.php>)

Fourth Task #4

Wasn't sure exactly what to find... tried the search engine this time... "layout" selected Text/Typographical layout page (not the correct page)... new search "tables verses css... Creating Accessible CSS page - but on the second section with Using CSS to your advantage... back to search results - looking through "do accessible sites have to be boring"... back to search results - design considerations page ... back to main page and then HTML and Rich Media Tutorials - Creating Symantec Structure page... back to articles page then introduction to web accessibility... from there creating accessible tables uses of tables heading... Highlighted text on that page:
<http://webaim.org/techniques/tables/#uses>

Test 3 - 7/10 - 8pm

Site 1: WebAIM.org

First Task: #1

Wasn't sure where to look/what to do... didn't realize could use search engine until it was mentioned... WAVE Accessibility Evaluation Tool page - back to index page ... intro to web accessibility page... spent a lot of time reading text on pages... Search "text only" - Design Considerations Text Only Page - spent time reading through text before highlighting... (<http://webaim.org/articles/design/textonly.php>)

Second Task: #2

Section 508 Checklist - alt description (link)- Creating Accessible Images page (spent time reading all of the text) (http://webaim.org/techniques/images/alt_text.php)

Third Task: #3

Accessible Design link - back to index - Resources section - WebAIM Guide To web Accessibility (package to buy) ... back to index - HTML and Rich Media Tutorials - back to index page - used search: colors - WebAIM Web Accessibility Guide Demonstration version - back to search results - Quick Reference Under Human - Testing for Accessibility checks heading highlighted the text about color and contrast (<http://webaim.org/resources/evalquickref/#human>)

Fourth Task: #4

Introduction to Web Accessibility - back to index - Search: Layout - Creating Accessible CSS - Spent a lot of time reading through text - Highlighted text under Altering the Linearized Layout header - (<http://webaim.org/techniques/css/advantage.php>) not exactly correct but close enough...

Site 2: Accessible Design

First Task: #2

Took some time to read through text but was able to quickly find the "add images" page under the XHTML menu.

Second Task: #3

Looked through menus and selected the "set text and colors" page under the CSS menu

Third Task: #4

Looked through menus and selected the "add tables" page from the XHTML menu - wasn't sure if correct took a moment to read... then highlighted relevant text

Fourth Task: #1

Overview Introduction page (read it all) - Then Guidelines and Standards page (read it all) - then - Accessibility Myths and relevant text..

Test 4 - 7/12 - 4:30pm

Site 1: Accessible Design

First Task: #4

Read text on first page then selected "Set Layout and Position" from CSS menu. Highlighted text here, which is not actually the correct text.

Second Task: #3

Quickly found relevant text on "set text and color" under the CSS menu.

Third Task: #2

Looking through all menus then selected "add images" from the XHTML menu.

Fourth Task: #1

Using Overview menu selected guidelines and standards first - then accessibility myths and highlighted correct text.

Site 2: WebAIM.org

First Task: #3

Took a lot of time, not sure what to do. The WebAIM Guide to Web Accessibility ... back to index... Accessibility Design and Retrofitting page... Index... Accessibility Training... Index... Web Captioning... Index... Site Monitoring and Reporting... suggested using search - participant hadn't realized they could use it... Search: "Background color". Search: "text and color". Search: "color" - selected Creating Accessible Images link (page on color and contrast). Highlighted text about color on that page. <http://www.webaim.org/techniques/images/color.php>

Second Task: #2

Search: "images" Selected Creating Accessible Images link and highlighted relevant text.
<http://www.webaim.org/techniques/images/>

Third Task: #4

Resources Section ... WebAIMGuide to WA ... back... articles section... CSS ... Back... text and Typographical layout... back ... CSS ... back.... Search: "layouts" to Considering the user perspective... back.. back.. CSS - highlighted text. <http://www.webaim.org/techniques/CSS/>

Fourth Task: #1

WebAIM Guide to WA ... back ... intro to WA ... back ... Search: "text only versions" no results but had link to corrected spelling "text only versions" - Design Considerations link with relevant text.
<http://www.webaim.org/articles/design/textonly.php>

Test 5 - 7/12 - 5:30PM

(Note: There was no interpreter because the participant needed to do the test early and there was no time to reschedule an interpreter, also I allowed the test to be rushed because participant had to be somewhere shortly after test time).

Site 1: WebAIM.org

First Task: #1

Wasn't sure what to do - had to explain - suggest search. Search: "text only websights" no results but link with corrected spelling - "text only websites" Selected Introduction to Web Accessibility link. Read through text... back to search results .. back to index... (didn't actually find info - this might be my mistake rather than participants, not sure).

Second Task: #2

Search "alt text" - Creating Accessible Images: Creating effective alt text. [webaim]/techniques/images/alt_text.php

Third Task: #3

Search "color contrast" - Creating Accessible Images: Color and Contrast link ... back to search results ... Creating Accessible Images: Color and Contrast link again and highlighted text. [webaim]/techniques/image/color.php

Fourth Task: #4

Search "layouts" - Considering the User Perspective link ... back to search results ... Creating Accessible Frames... back to search results ... Search "layouts css tables" - Creating Accessible Tables page and highlighted text.

Site 2: Accessible Design

First Task: #2

Looked through menus before selecting "add images" link under XHTML menu

Second Task: #3

Quickly found "set text and colors" under CSS menu

Third Task: #4

Quickly found "set layout and position" under CSS menu. (Not actually the correct page)

Fourth Task: #1

Quickly found Accessibility Myths under Overview Menu.

Test 6 - 7/13 - 5:15pm

Site 1: Accessible Design

First Task: #4

Looked through menus. Selected "set layout and position" under CSS menu. Spent time looking through layout options links on that page before returning to page and highlighting text .

Second Task: #3

Looked through menus before selecting "set text and colors" under CSS menu. Selected offsite link to the Color Contrast Check and spent time using that site (seeing how it worked). Back to "set text and colors" - CCCheck - "set text and colors" and highlighted text.

Third Task: #2

Clicked "set text and colors" under CSS. Clicked "add images" under XHTML. Back to index and then clicked "Alternative Style sheets" under CSS. Couldn't find information - found out during debrief participant got hung up on "alt" for "alternative" and also the text part of the directions and wasn't really thinking of images. Realized what I meant when I showed him the "alt text" information on the "add images" page later.

Fourth Task: #1

Clicked "overview introduction" under Overview menu. Clicked "accessibility myths" under overview menu and highlighted relevant text.

Site 2: WebAIM.org

First Task: #3

Clicked WebAIM Guide To Web Accessibility Link ... back to index... Accessible Design and Retrofitting link...back to index... Services section...more details about design and retrofitting link ... back ... back (index)... Accessibility Training link... Suggested search engine when participant was ready to give up... Search: "text background" - Creating Accessible images: Text within Graphics link...Search: "color" - Visual Disabilities: Color Blindness link...read text here... Didn't actually find correct information for this task.

Second Task: #2

Search: "alt text" - Creating Accessible Images: Creating Effective Alt text link. Highlighted info here. (http://www.webaim.org/techniques/images/alt_text.php)

Third Task: #1

Search: "text only ver" no results no correction so back to index... Search: "accesseblit" no results - link for corrected spelling "accessibility". Articles section... Search: "text accessibility" - Quick Reference link... Participant accidentally closed window had to open it back up for Participant. Index page ... Site monitoring and Reporting... index page... community section... resources section... Web Accessibility email forum ... back...back.. Products Section... Couldn't find correct information moved on to next task.

Fourth Task: #4

Search: "layout" - Text and Typographical Layout link... back to search results... Creating Accessible tables link...back to search results... Creating Accessible CSS: Using CSS to your advantage... highlighted text here.... Not exactly the correct info...

Test 7 - 7/17 - 5PM

Site 1: WebAIM.org

First Task: #1

Participant had a hard time with this - didn't really understand what they were supposed to do, what to look for. Had to explain that they could go anywhere on the site. Didn't really understand what I meant by "text-only"... spent a lot of time looking at one page instead of really searching. Asked at one point - "Is there supposed to be a specific spot where to find something?" Clicked Introduction to Web Accessibility - link and read through whole page. Clicked through a few other pages but ultimately didn't find the correct information. Mentioned that participant could use the search feature but they never did. After 12 minutes suggested stopping and moving to the next task.

Second Task: #2

Suggested using the search feature for this task. Search: "alt text for images" - Creating Accessible Images: Creating Effective Alt text link... read through text there and highlighted correct text.

Third Task: #3

Search: "use of color" - Quick reference Web Accessibility Principles link ... Read through text here and highlighted the section on not using color alone to convey meaning... not actually the correct information ...

Fourth Task: #4

Search: "layouts" - Fast Track to Web Accessibility in 5 Steps link. Back to search results. Search: "layouts and CSS" - Creating Accessible Frames link. Search: "frames or css". Search: "layouts" - Considering the User Perspective link. Back to search results - Using Opera to Check for Accessibility. Search: "tables" - sort of highlighted the right text (right page wrong part).

Site 2: Accessible Design

First Task: #2

Looked through menus and clicked on "add images" link under XHTML read through page and highlighted the code box not the info about alt text - showed Participant what text I meant so they understood.

Second Task: #3 - time from vid ~23:18 to 24:00

Looked through menus and clicked "set text and colors" link under CSS, read through page and highlighted correct information.

Third Task: #4

Selected "set layout and positioning under CSS, and highlighted the correct information.

Fourth Task: #1

Selected "Persons with Disabilities and Web link under Overview. Selected "Accessibility Myths" under Overview and highlighted correct text.

Test 8 - 7/17 - 8pm

Site 1: Accessible Design

First Task: #4

Looked through menus and selected "set layout and positioning" under CSS, highlighted relevant text.

Second Task: #3

Selected "set text and colors" under CSS, highlighted relevant text.

Third Task: #2

Selected "add images" under XHTML and highlighted relevant text.

Fourth Task: #1

Selected Accessibility Myths under Overview and highlighted relevant text.

Site 2: WebAIM.org

First Task: #3

Articles section - Text/Typographical Layout page - back - CSS in Action: Invisible content Just for Screen reader users. Search: "color" -Creating Accessible Images: Color and contrast, highlighted text here.

Second Task: #2

Search: "alt text" - Creating Accessible Images: Creating Effective Alt text , highlighted text here.

Third Task: #1

Search: "text only web sites" - Design considerations: Text only versions, highlighted text here.

Fourth Task: #4

Search: "CSS + tables" - Using Opera to Check for Accessibility: Turn off Tables - highlighted text here - not correct (my mistake not his)

Test 9 - 7/18 - 3:30PM

Site 1: WebAIM.org

First Task: #1

Participant was confused as to what to do with the site. Had to say that they could look anywhere on the site and use the search engine if they wanted to. Participant still did not seem to understand fully what information to find. Didn't ever use the search engine on the site but did try using the browser's "find on page" feature. (*Note: Probably should have made sure participant understood which search feature I meant...*) WebAIM Training link... back to index page... How to make Accessible Web Content Using Expression Web link...back to index page... (*Note: if participant had used the text they were using in the site's search engine instead of the browser's they would have found it easy...*). Introduction to Web Accessibility link... back to index page... How to make Accessible Web Content Using Expression Web link... alternated between Introduction to Web Accessibility link and other pages for a while... after about 9 and a half minutes participant tried the site search engine using the text: "text-only" however the search engine failed to bring up results - *this is an error with the site as that search string DOES bring up the correct page usually. Unfortunately, this error was not caught until video of the test was viewed the next day.* After 10 minutes suggested participant move on to the next task.

Second Task: #2

Using browser find instead of search engine How to make Accessible Web Content Using Expression Web link - which has a section on alt text. Participant thought this was the correct information - there is actually link to the correct page so it's close ...

Third Task: #3

How to make Accessible Web Content Using Expression Web link ... index... WebAIM training link... Index... introduction to Web Accessibility... Still using Browser's search feature... saw info on not using color alone to convey meaning - not quite right and kept looking... index ... How to make Accessible Web Content Using Expression Web link... index ... Accessible Design and retrofitting... index... Accessibility Training... (clicked through several other links...) Articles page - fonts - contrast section (<http://webaim.org/techniques/fonts/#fcontrast>)

Fourth Task: #4

How to make Accessible Web Content Using Expression Web link ... index... articles section ... Tables (<http://webaim.org/techniques/tables/>)

Site 2: Accessible Design

First Task: #2

Looked through menus and found "add images" link under XHTML. Read through text before highlighting relevant content.

Second Task: #3

Looked through menus and found "set text and colors" link under CSS. Highlighted relevant text.

Third Task: #4

Looked through menus and found "add tables" link under XHTML. Highlighted relevant text.

Fourth Task: #1

Looked through menus and selected "accessibility myths" from overview. Highlighted relevant text.

Test 10 - 7/18 - 6pm

Site 1: Accessible Design

First Task: #4

Looked through menus and found "set layout and position" link under CSS... "add tables" link under XHTML. Highlighted relevant text.

Second Task: #3

Looked through menus - Selected "guidelines and standards" under overview ... "set text and colors" under CSS. Highlighted relevant text.

Third Task: #2

Looked through menus and found "add images" link under XHTML. Read through text - Highlighted relevant text.

Fourth Task: #1

Looked through menus and selected "accessibility myths" from overview. Highlighted relevant text.

Site 2: WebAIM.org

First Task: #3

Accessible Design and Retrofitting link... back to index... Articles section ... back to index... Articles section ...
Fonts - Contrast section (http://webaim.org/techniques/fonts/#fcontrast_

Second Task: #2

Accessible Design and Retrofitting ... index... Web Captioining ...index... articles section... Appropriate use of
Alt-text. (<http://webaim.org/techniques/alttext/>)

Third Task: #1

Articles Section... creating Semantic Structure link... back to articles section... Design for Screen reader
compatibility... back to articles section ... CSS link... back to articles section... templates ... articles ...
introduction to web accessibility ... articles section ... design considerations... articles section ... Constructing
POUR web site ... articles section... writing clearly and simply... Participant couldn't find info, asked if they
wanted to try the search engine... Search: "text-only" - Design Considerations: text-only versions.
(<http://webaim.org/articles/design/textonly.php>)

Fourth Task: #4

Articles section... CSS... Articles section... tables... found...
(<http://webaim.org/techniques/tables/>)

Appendix G) Raw test data with site and task orders

WEBAIM	1	2	3	4	5	6	7	8	9	10
TASK #1	396	25	376	108	180	218	750	29	600	24
TASK#2	35	19	83	48	25	22	43	25	107	59
TASK#3	90	280	350	248	54	271	79	116	586	116
TASK#4	90	340	240	151	93	106	250	30	97	27
A-DESIGN										
TASK #1	18	6	100	79	14	59	19	10	45	13
TASK#2	180	18	65	53	21	146	53	32	90	14

TASK#3	45	98	51	51	14	133	42	30	17	57
TASK#4	86	160	30	80	13	83	13	49	25	59

Test - Date/Time - Starting Site	Site1Order	Site2 Order
Test1 - 07090711AM - WEBAIM	1,2,3,4	2,3,4,1
Test2 - 07100705PM - ADESIGN	4,3,2,1	3,2,1,4
Test3 - 07100708PM - WEBAIM	1,2,3,4	2,3,4,1
Test4 - 0713074:30PM - ADESIGN	4,3,2,1	3,2,1,4
Test5 - 0713075:30PM - WEBAIM	1,2,3,4	2,3,4,1
Test6 - 013075:15pm - ADESIGN	4,3,2,1	3,2,1,4
Test7 - 07170705pm - WEBAIM	1,2,3,4	2,3,4,1
Test8 - 07170708pm - ADESIGN	4,3,2,1	3,2,1,4
Test9 - 0718073:30PM - WEBAIM	1,2,3,4	2,3,4,1
Test10 - 0718076PM - ADESIGN	4,3,2,1	3,2,1,4

Works Cited

Colwell, C., Petrie, H. (1999, August). Evaluation of Guidelines for Designing Accessible Web Content. ACM SIGCAPH Computers and the Physically Handicapped, 11-13. Retrieved April 14, 2006, from AMC digital library.

- Cook, Laura. (2006, May). Assessing the state of web accessibility. Unpublished master's thesis, Rochester Institute of Technology.
- Dodd, J. (2005). Accessibility from the front lines: a UK perspective of Web accessibility. ACM SIGACCESS Accessibility and Computing. Retrieved April 16, 2006, from ACM Digital Library.
- Hackett S., Parmanto, B., Zeng, X. (2003, October). Accessibility of Internet Websites through Time. Proceedings of the 6th international ACM SIGACCESS conference on Computers and Accessibility, 32 - 39. Retrieved April 21, 2006, from ACM Digital Library.
- Ivory, M., Megraw, R. (2005 October). Evolution of Web site design patterns. ACM Transactions on Information Systems (TOIS), 463-497. Retrieved April 21, 2006, from ACM Digital Library.
- Jackson-Sanborn, E., Odess-Harnish, K., Warren, N. (2002, September). Web site accessibility: a study of six genres. Library Hi Tech, 20(3), 308-317. Retrieved March 27, 2006, from Emerald Online Database.
- Lazar, J., Dudley-Sponaugle, A., Greenidge, KD. (2004, March) Improving Web accessibility: a study of Webmaster perceptions. Computers and Human Behavior 20(2) 269-288. Retrieved March 27, 2006, from Elsevier Science Direct.
- Markoff, J., Fait, H., Tran, T. (2005, April). Is your Web page accessible?: a comparative study of methods for accessing Web accessibility for the blind. Proceedings of the SIGCHI conference on human factors in computing systems, 41-50. Retrieved April 14, 2006 from ACM Digital Library.
- Petrie, H., Hamilton, F., King, N. (2004). Tension, what tension?: Website accessibility and visual design. Proceedings of the 2004 international cross-disciplinary workshop on Web accessibility, 13 - 18. Retrieved March 27, 2006, from ACM Digital Library.
- Richards, J., Hanson, V. (2004, May). Web accessibility: a broader view. Proceedings of the 13th international conference on World Wide Web, 72-79. Retrieved April 11, 2006, from ACM Digital Library.
- Rowen, M., Gregor, P., Solan, D., Booth, P. (2000, November). Evaluating Web resources for disability access. Proceedings of the fourth international ACM conference on assistive technologies, 80-84. Retrieved April 14, 2006, from ACM Digital Library.
- Thatcher, J., Burks, M. R., Heilmann, C., Henry, S. L., Kirkpatrick, A., Lauke, P. H. et al. (2006). Web accessibility: Web standards and regulatory compliance. New York: Friends of ED.
- Koch, P-P. (2006). ppk on javascript. Berkeley: New Riders.