

## **Accessible and Usable Web Design**

Joshua Kaufman

Project report submitted in part fulfillment of the requirements for the degree of Master of Science (Human-Computer Interaction with Ergonomics) in the Faculty of Life Sciences, University College London, 2004.

### **NOTE BY THE UNIVERSITY**

This project report is submitted as an examination paper. No responsibility can be held by London University for the accuracy or completeness of the material herein.

## Acknowledgements

I wish to thank:

- Dr. Jeremy Gow, for his insight and suggestions throughout the course of this project.
- The Usability Company, for proposing the project, allowing me to use their usability testing facility and for providing monetary incentive to my study participants.
- Arlene Kline, for her suggestions throughout the course of this project and assistance with The Usability Company's usability testing facility.
- The British Computer Association for the Blind, The Royal National Institute for the Blind, University College London Disability Services and British Blind Sport for their assistance in recruitment of partially sighted and blind participants.

## **Abstract**

The application of the accessibility and usability principles helps to ensure more accessible and usable Web sites. Accessibility and usability are typically addressed separately, but several recent studies have studied the convergence of these topics. This study aims to further explore the relationships between these two concepts through direct observation of both disabled and non-disabled users. A website was created which complied with both accessibility and usability guidelines. This website was then tested with both disabled and non-disabled users in order to identify accessibility and usability problems that are outside the scope the guidelines. The resulting data suggested several recommendations for creating more accessible and usable websites. Additionally, this study develops a framework for creating accessible and usable websites.

# Table of Contents

<b>1.</b>	<b>Introduction .....</b>	<b>1</b>
<b>2.</b>	<b>Literature Review.....</b>	<b>3</b>
2.1.	Assistive Technology.....	3
2.2.	Web Accessibility .....	3
2.3.	Accessibility Guidelines.....	3
2.4.	Web Usability .....	7
2.5.	Usability Heuristics.....	7
2.6.	Relationship Between Accessibility and Usability.....	9
<b>3.</b>	<b>Method .....</b>	<b>11</b>
3.1.	Rationale.....	11
3.2.	The Breez Computer website.....	11
3.3.	Website Testing.....	17
<b>4.</b>	<b>Results .....</b>	<b>21</b>
4.1.	Pre-test Questionnaire.....	22
4.2.	Think Aloud Observation .....	22
4.3.	Consistent Think Aloud Findings.....	29
4.4.	Post-test Questionnaire .....	30
4.5.	Usability and Accessibility Questionnaire .....	32
<b>5.</b>	<b>Discussion.....</b>	<b>34</b>
5.1.	De Facto Web Design Standards .....	34
5.2.	Use Considerations .....	35
5.3.	Usable Accessibility .....	37
5.4.	Usability Heuristics.....	38
<b>6.</b>	<b>Recommendations .....</b>	<b>39</b>
<b>7.</b>	<b>A Framework for Creating Accessible and Usable Web Designs.....</b>	<b>40</b>
<b>8.</b>	<b>Conclusions and Future Work.....</b>	<b>42</b>
<b>9.</b>	<b>Bibliography .....</b>	<b>43</b>
<b>10.</b>	<b>Appendix A: Website Testing Documents.....</b>	<b>45</b>
<b>11.</b>	<b>Appendix B: Results of Post-Test Questionnaire, Questions 3 – 7.....</b>	<b>54</b>

## List of Figures

Figure 1. Homepage of Breez Computer website. ....	13
Figure 2. Notebooks page of Breez Computer website.....	14
Figure 3. Item detail page of Breez Computer website.....	15
Figure 4. Payment page of Breez Computer website. ....	16
Figure 5. Breez Computer website site map.....	17
Figure 6. Responses to Pre-test Questionnaire, Question 5.....	21
Figure 7. Responses to Pre-test Questionnaire, Question 6.....	22
Figure 8. Responses to Post-test Questionnaire, Question 1.....	30
Figure 9. Responses to Post-test Questionnaire, Question 2.....	31
Figure 10. Responses to Usability Questionnaire.....	33
Figure 11. Responses to Accessibility Questionnaire. ....	33
Figure 12. Form with text (“Enter billing address”) in between form controls. ....	35
Figure 13. Product comparison table.....	36
Figure 14. Shipping rate table. ....	37
Figure 15. A framework for creating accessible and usable websites.....	41

## List of Tables

Table 1. Reported disability and assistive technology for each participant. ....	18
Table 2. Results of Post-Test Questionnaire, Questions 3 - 7. ....	56

# 1. Introduction

The use of the Web as a primary information channel is growing, and the number of users accessing the Web is steadily increasing. As the number of Web users grows, it is important that the information is both accessible and usable by all, including those with disabilities. The difficulties in providing such universal access can be addressed through the application of accessibility and usability guidelines such as the Web Content Accessibility Guidelines [25] and Jakob Nielsen's usability heuristics [17]. These guidelines have been generally successful in promoting accessibility and usability throughout the Web design and development community.

As they relate to Web design and development, accessibility and usability are usually treated as separate issues. For example, a website is said to be accessible if it can be used by everyone. However, an accessible website may still have usability problems. Similarly, a website can be considered usable, but still remain inaccessible to many users.

The convergence of accessibility and usability has been investigated before by Theofanos et al. [23] and Leporini et al. [13]. Theofanos observed and listened to blind users as they worked with websites using screen reader software. These observations led to a series of guidelines on how to create websites that are both accessible and usable. Leporini created a series of accessible usability criteria that are also based on the observation of blind users as they worked with websites using screen readers. This study will take a similar approach by directly observing both disabled (cognitively disabled, mobility impaired, vision impaired and blind) and non-disabled users and making recommendations based on these observations.

The aim of this research is to further explore the relationships between accessibility and usability. In particular, I would like to address the relevance of usability in the context of accessible websites and contribute to the recommendations put forth by previous research.

For this study, my research questions were:

Does the application of the Web Content Accessibility Guidelines and Nielsen's usability heuristics to the design and development of a website lead to a website that is accessible and usable?

If not, what else beyond the guidelines is required to create a website that is both accessible and usable?

My hypothesis is that the application of the guidelines will not produce an accessible and usable website. The purpose of this study is to determine what additional issues need to be considered in order to create accessible and usable websites. The first objective of this investigation is to put forth recommendations that are based on observation and qualitative analysis. A secondary objective is to form the basis of a framework for creating accessible and usable websites.

## **2. Literature Review**

Web usability has been an important topic since the Web has arrived, and there is a good deal of literature available on the subject. Web accessibility, on the other hand, is a relatively new topic, and significant research on the topic has only been carried out within the last 3 – 5 years. The following is a survey of the literature relevant to this study.

### **2.1. Assistive Technology**

Assistive technology is equipment or software that is used to increase, maintain, or improve functional capabilities of individuals with disabilities. As it relates to this study, assistive technology refers specifically to screen readers, which are programs used by the blind and visually impaired to read the contents of a screen aloud to the user. Screen readers read a page by linearizing its contents. That is, they transform the screen into a single stream of text and relay it to the user.

One of the most popular screen readers is JAWS for Windows, which was used by every visually impaired and blind user in this study. JAWS has several features which enable users to browse the Web more effectively. These include a list of all headers in the document, a list of all links in the document, keyboard shortcuts for navigating different type of Web page elements and forms mode for entering information into forms.

### **2.2. Web Accessibility**

Web accessibility moved to the forefront of Web design soon after the World Wide Web Consortium (W3C) founded the Web Accessibility Initiative (WAI) in 1997. The WAI pursues accessibility of the Web through five primary areas of work: technology guidelines, tools, education and outreach, and research and development. According to the WAI, “Web accessibility means access to the Web by everyone, regardless of disability” [2]. The description goes on to specify that Web accessibility includes websites, Web browsers, media players, Web authoring tools and evolving Web technologies.

### **2.3. Accessibility Guidelines**

The first major document produced by the World Wide Web Consortium was the Web Content Accessibility Guidelines 1.0 (WCAG) [25]. It consists of 14

guidelines that explain how to make websites accessible to people with disabilities. These guidelines are especially relevant to users of assistive technology, such as screen readers. Each guideline is followed by one or more checkpoints. Each checkpoint is given a priority between 1 and 3 depending on its relative importance. For a site to be considered accessible, priority 1 checkpoints *must* be addressed, priority 2 checkpoints *should* be addressed and priority 3 checkpoints *may* be addressed. Conformance Level “A” means that all priority 1 checkpoints are satisfied, Level “Double-A” means all priority 1 and 2 checkpoints are satisfied and Level “Triple-A” means that all priority 1, 2 and 3 checkpoints are satisfied. The following is a list of the guidelines and a summary of their checkpoints.

**1. Provide equivalent alternatives to auditory and visual content.**

This guideline refers to providing text equivalents for non-text content such as images, sounds and movies.

**2. Don’t rely on color alone.**

This guideline refers to two checkpoints. First, any information conveyed with color is also available without color. Second, the foreground and the background color should provide sufficient contrast so that visitors can view a site without straining their eyes.

**3. Use markup and style sheets and do so properly.**

This guideline refers to using W3C recommended markup languages and cascading style sheets for their intended purpose. That is, use markup for structure and cascading style sheets for presentation.

**4. Clarify natural language usage.**

This guideline refers to specifying the primary *natural* language and changes in primary *natural* language within pages.

**5. Create tables that transform gracefully.**

This guidelines places special emphasis on table elements and the importance of their correct markup, especially when used for the layout of pages, which should be avoided whenever possible.

**6. Ensure that pages featuring new technologies transform gracefully.**

This guideline refers to making sure content is still accessible for visitors with older technologies or those who choose to turn off newer features.

**7. Ensure user control of time-sensitive content changes.**

This guideline refers to ensuring that moving, blinking, auto-updating or auto-redirecting Web pages can be paused or stopped by the visitor.

**8. Ensure the direct accessibility of embedded user interfaces.**

This guideline refers to programmatic elements such as scripts and applets, which are programs embedded in Web pages. These programs should be directly accessible or compatible with assistive technologies.

**9. Design for device independence.**

This guideline refers to designing Web pages so that visitors using a variety of input/output devices can fully access the site.

**10. Use interim solutions.**

This guideline refers to using temporary solutions to create accessible content until assistive technologies address these issues.

**11. Use W3C technologies and guidelines.**

This guideline refers to using W3C technologies according to their specifications and to avoid using non-W3C and non-standard technologies.

**12. Provide context and orientation information.**

This guideline refers to grouping elements and providing context and orientation information about the relationship between the elements such as frames and labels.

**13. Provide clear navigation mechanisms.**

This guideline refers to providing clear and consistent navigation menus so that visitors can find what they are looking for on a site.

**14. Ensure that documents are clear and simple.**

This guideline refers to using consistent page layout, recognizable graphics and easy to understand language.

While the WCAG contain a great deal of useful information on how to make Web pages more accessible, the guidelines also have also been shown to have many shortcomings. For example, many Web designers have problems locating the information they required within the guidelines, such as how to implement the guidelines and information about general accessibility issues [3][22]. This can lead to misapplication of the guidelines and, therefore, inaccessible Web pages.

In addition to the basic navigation problems that exist within the WCAG, some studies have questioned the actual content of the guidelines. Several of these studies have addressed user groups which are not included in the guidelines. These groups include low-bandwidth users [14], mobility-impaired users, cognitively disabled users [9] and older adults [8].

Additionally, there are a few studies which investigate the usability aspects of the WCAG. For example, the WCAG promote physical accessibility, but do not emphasize the ease of use aspects of the Web.

Theofanos et al. [23] observed and listened to sixteen blind users as they worked with websites using screen reader software, assistive technology that reads the screen to the user. During this process, they learned much about how blind users work with websites and what this means for Web designers and developers. The result of this study was thirty-two guidelines aimed at helping designers and developers create websites that are more usable to screen reader users. These guidelines are grouped into lessons learned about:

- 1. Using a screen reader.**

These guidelines are focused on the differences in how screen reader users and sighted users browse the Web.

- 2. Navigating through websites.**

These guidelines were focused on how screen reader users find what they need on a website.

- 3. Filling out forms.**

These guidelines were focused on how screen reader users find and fill out forms.

Leporini et al. [13] expressed similar concern for the usability aspects of the Web Content Accessibility Guidelines. Rather than develop guidelines, which can be subject to interpretation, the authors proposed eighteen accessible usability criteria developed by analyzing potential issues within an accessible site, analyzing potential solutions and finally defining the proposed criteria. The criteria are grouped into three subsets of usability:

- 1. Effectiveness.**

These are criteria whose application is important for reaching the user's goal.

- 2. Efficiency.**

These are criteria that allow users to find the desired information more quickly.

### **3. Satisfaction.**

These are criteria that help to produce a website that is more pleasant and easier to navigate.

## **2.4. Web Usability**

Jakob Nielsen almost single-handedly created the field of Web usability. He came to the forefront of usability research through his seminal usability book, Usability Engineering [19]. Five years later he wrote Designing Web Usability [15], which set the standard for Web usability worldwide. According to Nielsen, “usability is a quality attribute that assesses how easy user interfaces are to use” [18]. He continues to list the five components of usability: learnability, efficiency, memorability, errors and satisfaction. Nielsen’s heuristic evaluation method, included in his book Usability Inspection Methods [20], has become a standard for creating usable websites and evaluating the usability of websites.

## **2.5. Usability Heuristics**

Jakob Nielsen originated heuristic evaluation in the early 1990s and has compiled the most comprehensive set of heuristics [17]. They were created by analyzing more than two hundred usability problems and statistically reducing the set to the ten most important guidelines. Following is a list of these guidelines along their description:

### **1. Visibility of system status.**

The system should always keep users informed about what is going on, through appropriate feedback within reasonable time.

### **2. Match between system and the real world.**

The system should speak the users' language, with words, phrases and concepts familiar to the user, rather than system-oriented terms. Follow real-world conventions, making information appear in a natural and logical order.

### **3. User control and freedom.**

Users often choose system functions by mistake and will need a clearly marked "emergency exit" to leave the unwanted state without having to go through an extended dialogue. Support undo and redo.

**4. Consistency and standards.**

Users should not have to wonder whether different words, situations, or actions mean the same thing. Follow platform conventions.

**5. Error prevention.**

Even better than good error messages is a careful design which prevents a problem from occurring in the first place.

**6. Recognition rather than recall.**

Make objects, actions, and options visible. The user should not have to remember information from one part of the dialogue to another.

Instructions for use of the system should be visible or easily retrievable whenever appropriate.

**7. Flexibility and efficiency of use.**

Accelerators – unseen by the novice user – may often speed up the interaction for the expert user such that the system can cater to both inexperienced and experienced users. Allow users to tailor frequent actions.

**8. Aesthetic and minimalist design.**

Dialogues should not contain information which is irrelevant or rarely needed. Every extra unit of information in a dialogue competes with the relevant units of information and diminishes their relative visibility.

**9. Help users recognize, diagnose, and recover from errors.**

Error messages should be expressed in plain language (no codes), precisely indicate the problem, and constructively suggest a solution.

**10. Help and documentation.**

Even though it is better if the system can be used without documentation, it may be necessary to provide help and documentation. Any such information should be easy to search, focused on the user's task, list concrete steps to be carried out, and not be too large.

These heuristics can be powerful usability tools, but their ability to predict the usability of a given system has been questioned in several papers [12][6][11][16]. Most of these studies point to two key issues with heuristic

evaluation. The first is that the evaluators are surrogate users and not typical users of a website and thus are unable to find problems that real users may encounter. The second is that heuristic evaluation is highly dependent on the skills and experience of the evaluator. Because of this second point, one evaluator may find many more problems or entirely different problems with an interface than other.

## **2.6. Relationship Between Accessibility and Usability**

In “Constructing Accessible Websites” [10], Henry introduces the topic of Web accessibility and the dynamic relationship between accessibility and usability. He describes the five previously mentioned elements of usability and how they improve the experience of using a website. Where usability aims to improve the user experience, accessibility aims to improve the user experience for more people in more situations.

Henry goes on to point out the problems with accessibility regulations: there is an emphasis on meeting technical aspects at the expense of the human interaction aspects. That is, if alternative text for an image isn’t meaningful in the context of a Web page, the page may pass an automated or manual check for accessibility but still not be usable [13][23][7].

The Disability Rights Commission recently made the most striking claim against accessibility regulations. In a formal investigation, they found that 45% of the problems encountered by disabled users when attempting to navigate websites cannot be attributed to explicit violations of the Web Content Accessibility Guidelines [4]. In other words, many of the problems that disabled users encountered were not directly related to the accessibility of the content; instead they were related to the usability of the content. The World Wide Web Consortium criticized these findings shortly afterwards [24] replying that in actuality, 95% of the problems could, in fact, be attributed to violations of the Web Content Accessibility Guidelines. Regardless of how many of the encountered problems can be attributed to the Web Content Accessibility Guidelines, this controversy makes it clear that *some* problems exist with the guidelines.

These problems along with the problems described in sections 2.4 and 2.6 introduce an interesting dynamic between accessibility, usability and the

guidelines designed to support them. The accessibility guidelines do not adequately address usability issues and the usability guidelines do not adequately address accessibility issues. Within this report, I will seek to determine what additional issues should be addressed outside of the guidelines in order to create websites that are accessible and usable.

### **3. Method**

In order to identify additional accessibility and usability issues, an experimental website was created to be tested with both disabled and non-disabled users. This website (for the fictional company “Breez Computer”) was built to comply with both the Web Content Accessibility Guidelines and Nielsen’s usability heuristics. When reading the accessibility and usability guidelines, it is clear that they are both open to interpretation. While it may not be possible to create a website that follows the guidelines exactly as the guidelines’ authors intended them to be followed, it is still possible to build a website that could be considered generally accessible and usable by a majority of users.

#### **3.1. Rationale**

By testing a website that complies with both accessibility and usability guidelines, I hoped to analyze an implementation of the guidelines in order to find accessibility and usability problems that are outside the scope of the Web Content Accessibility Guidelines and Nielsen’s usability heuristics. In turn, these findings would allow me to create hypothetical recommendations for improving the usability and accessibility of websites and form the basis of a framework for creating accessible and usable websites. In fact, this is the same method used by both Theofanos et al. [23] and Leporini et al. [13]. I should emphasize that it was not the point of this study to gather quantitative data and decisively conclude which problems are outside the scope of the Web Content Accessibility Guidelines and Nielsen’s usability heuristics. A much larger user pool will be required for this type of study in the future.

I tested the website with both disabled and non-disabled users because “accessible,” in its broadest definition, means usable by everyone. Just as important as the accessibility and usability of the site for blind users is the accessibility and usability of the site for sighted users.

#### **3.2. The Breez Computer Website**

Breez Computer is a mock computer and computer accessories retailer, similar to Gateway or Dell although on a much smaller scale. Before developing a website for Breez Computer, both the Web Content Accessibility Guidelines and

Nielsen's usability heuristics were analyzed so that they could be implemented properly. Then throughout the development process, the guidelines were applied to the development of the website. The following is a brief outline of the development process:

**1. Scenario.**

A scenario was created that identified the business goals of the project and the products offered by Breez Computer.

**2. Information architecture.**

This scenario was then translated into an information architecture, including the navigation, page layout and content organization.

**3. Visual Design.**

The visual design of the site was developed. As recommended by heuristic 8, the visual design was created to be aesthetic and minimal.

**4. Content creation.**

Content for each page was identified and created. This included written copy and product images. As suggested by heuristic 2 and accessibility guideline 14, pages were created to be as clear and understandable as possible.

**5. Development of website.**

Finally, the website was developed using XHTML<sup>1</sup> and CSS<sup>2</sup>. Nearly all of the accessibility guidelines were relevant to this stage of the process.

The final website consisted of 45 pages divided into logical content areas.

Several screenshots of the Breez Computer website are shown in Figure 1,

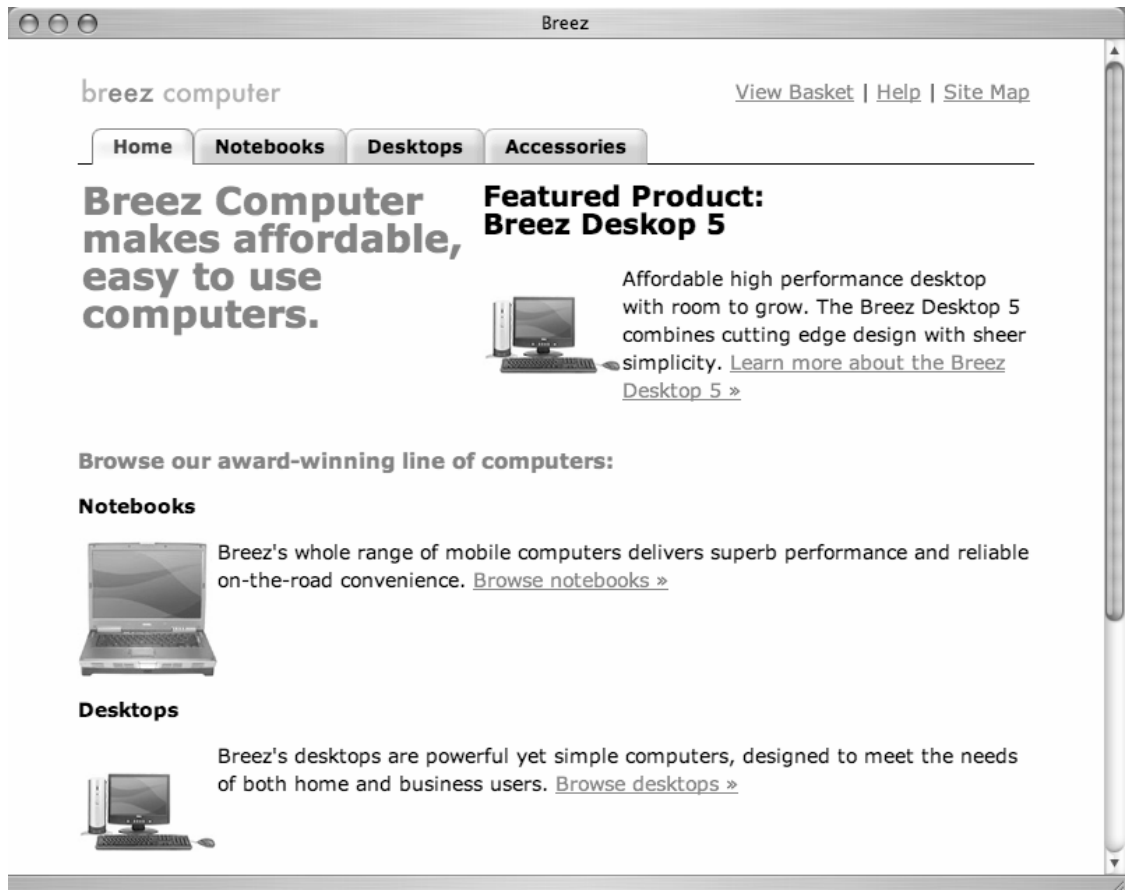
Figure 2, Figure 3 and Figure 4. Figure 5 shows a site map of the Breez

Computer website.

---

<sup>1</sup> A reformulation of HTML, Extended HyperText Markup Language (XHTML) is a new language for building Web pages that has been proposed as a World Wide Web Consortium Recommendation.

<sup>2</sup> Cascading Style Sheets (CSS) describe how a Web page should be displayed or printed.







**Figure 1. Homepage of Breez Computer website.**

Notebooks | Breez

breez computer [View Basket](#) | [Help](#) | [Site Map](#)

[Home](#) | [Notebooks](#) | [Desktops](#) | [Accessories](#)

<b>Notebook 5</b>	<b>Notebook 10</b>	<b>Notebook 15</b>	<b>Notebook 20</b>
			
£1399	£1499	£1499	£1599
<b>Processor</b> Intel Centrino 715	<b>Processor</b> Intel Pentium M 715	<b>Processor</b> Intel Pentium M 518	<b>Processor</b> Intel Centrino 780
<b>Operating System</b> Windows XP	<b>Operating System</b> Windows XP	<b>Operating System</b> Windows XP	<b>Operating System</b> Windows XP
<b>Memory</b> 512 MB RAM	<b>Memory</b> 256 MB RAM	<b>Memory</b> 256 MB RAM	<b>Memory</b> 512 MB RAM
<b>Hard Drive</b> 40 GB	<b>Hard Drive</b> 40 GB	<b>Hard Drive</b> 30 GB	<b>Hard Drive</b> 40 GB
<b>Optical Drive</b> CD-RW/DVD Combo	<b>Optical Drive</b> CD-RW/DVD Combo	<b>Optical Drive</b> CD-RW/DVD Combo	<b>Optical Drive</b> CD-ROM
<b>Screen Size</b> 14.1"	<b>Screen Size</b> 15"	<b>Screen Size</b> 17.1"	<b>Screen Size</b> 15.4"
<b>Select Notebook</b> 5	<b>Select Notebook</b> 10	<b>Select Notebook</b> 15	<b>Select Notebook</b> 20

[Contact Us](#) | [Terms of Use](#) | [Privacy Policy](#)

**Figure 2. Notebooks page of Breez Computer website.**



**Figure 3. Item detail page of Breez Computer website.**

Checkout | Breez

breez computer [View Basket](#) | [Help](#) | [Site Map](#)

[Home](#) [Notebooks](#) [Desktops](#) [Accessories](#)

Sign In → Shipping → **Payment** → Place Order

**Select payment type**

Select Payment Type ▾

**Enter payment details**

Credit Card Number

Expiration Date

Name on card

**Enter billing address**

Address Line 1:

Address Line 2:

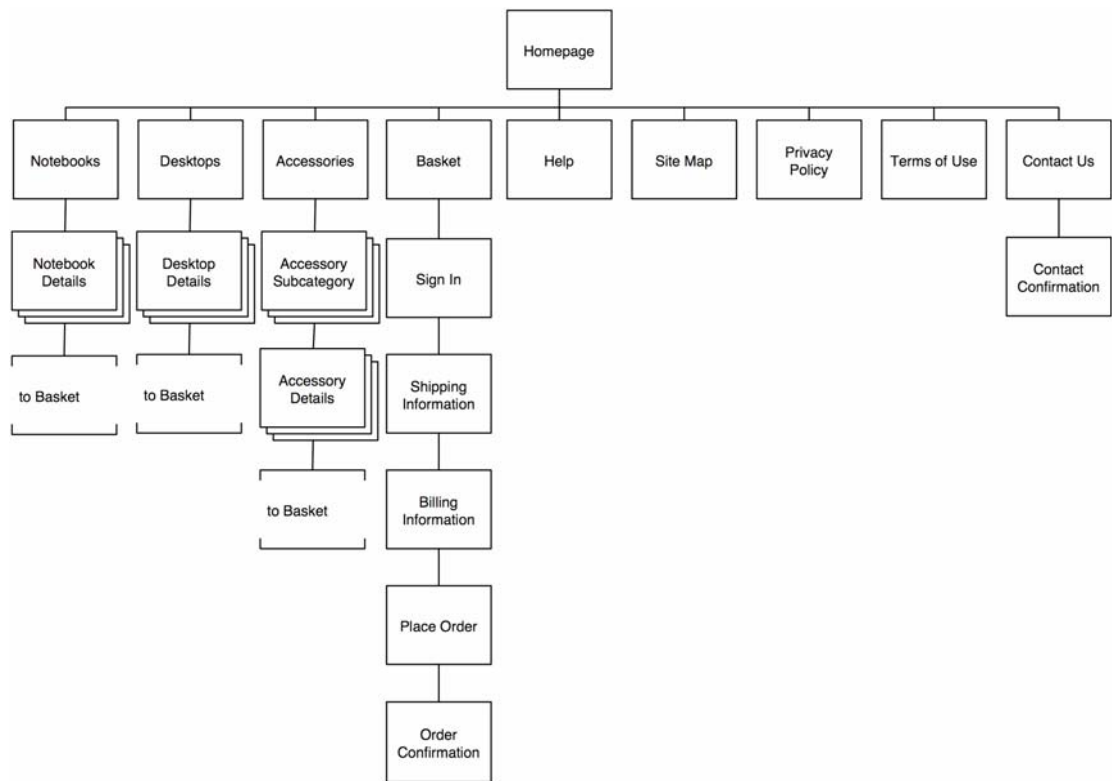
City:

County:

Postal Code:

Phone Number:

**Figure 4. Payment page of Breez Computer website.**



**Figure 5. Breez Computer website site map.**

Creating a website according to a business scenario led to an unforeseen limitation in the study. The accessibility guidelines are very detailed and contain guidelines for the use of nearly every aspect of XHTML. As with any business website, not every aspect of XHTML was required in its construction. Because of this, the website was not able to test every checkpoint of the accessibility guidelines. As discussed in section 3.1, future studies will be required to test all checkpoints.

### **3.3. Website Testing**

The website was tested with eleven users, who had the profiles outlined in Table 1. As previously stated, several studies have identified that the Web Content Accessibility Guidelines do not adequately address the needs of low-bandwidth users [14], mobility-impaired users, cognitively disabled users [9] and older adults [8]. As a result of these studies, I have attempted to include as many users from these groups as possible in my study. A major focus of this study was the use of screen readers by blind users. While I tried to include as many blind users as possible, recruiting such users was relatively difficult. I

User	Reported Disability	Assistive Technology Used
1N – 4N	No disabilities reported	None
5D	Dyslexia	None
6C	Carpel Tunnel Syndrome	None
7I	Visual impairment	Contrast adjustment
8I	Visual impairment	JAWS for Windows
9B	Total blindness	JAWS for Windows
10B	Total blindness	JAWS for Windows
11B	Total blindness	JAWS for Windows

**Table 1. Reported disability and assistive technology for each participant. Letter after participant number indicates reported disability, if any.**

consequently was not able to include as many visually impaired and blind users as I would have liked to include.

Testing was conducted by myself at The Usability Company’s usability testing facility or either the home or work location of those users who were unable to transport themselves to the testing facility. Each testing session was conducted in the same fashion. The following is a list of the testing procedure along with any applicable notes for each step. See Appendix A for copies of all website testing documents.

**1. The user was provided an Informed Consent Form to be signed.**

This form, provided by The Usability Company, contained information on how the session would progress, about the audio and video recording and their rights as a participant in this study.

**2. The user was provided a pre-test questionnaire to be completed.**

The pre-test questionnaire, provided by The Usability Company, contained questions about the user’s profile and familiarity with the Breez Computer website.

**3. The user was given oral instructions for the testing session.**

These instructions stated that they were not being tested and should think aloud as they work. The think out loud protocol is discussed in [5].

**4. The user was given a list of seven tasks to be completed during the session through using the Breez Computer website.**

These tasks were representative of the types of tasks typical users would attempt to accomplish on such a website. The following tasks were given:

1. What does IEEE mean?
2. What is the total shipping cost for an order containing 3 items?
3. How can one opt-out of Breez Computer's marketing email?
4. Find and add the notebook with the largest screen to your basket.
5. Find and add the MP3 player with the largest capacity to your basket.
6. Find and add a printer with memory card slots to your basket.
7. After completing task no. 6, proceed to checkout and place an order using the following information: (See Appendix A for complete task information.)

- 5. For testing sessions that took place at The Usability Company, audio and video recording began at this point. For testing sessions that took place outside of The Usability Company, tests were recorded by written record.**

Both audio and video were recorded using a separate computer, a digital video camera, a microphone, an audio-visual mixer and audio-visual capture software.

- 6. The user was instructed to begin the tasks.**

Sighted users were asked to read tasks before beginning them. The tasks were read aloud to the visually impaired and blind users.

- 7. Written notes were taken while the user attempted to complete the tasks and think aloud.**

Where additional clarity was required on the part of the evaluator, additional questions were asked.

- 8. The user was given a post-test questionnaire to be completed.**

The post-test questionnaire, provided by The Usability Company, contained general questions about the usability of the Breez Computer website, what the user liked and disliked about the website and what changes they would suggest. This questionnaire was given to allow the

user to provide any additional information they that might not have been evident through observation.

**9. The user was given an oral usability questionnaire.**

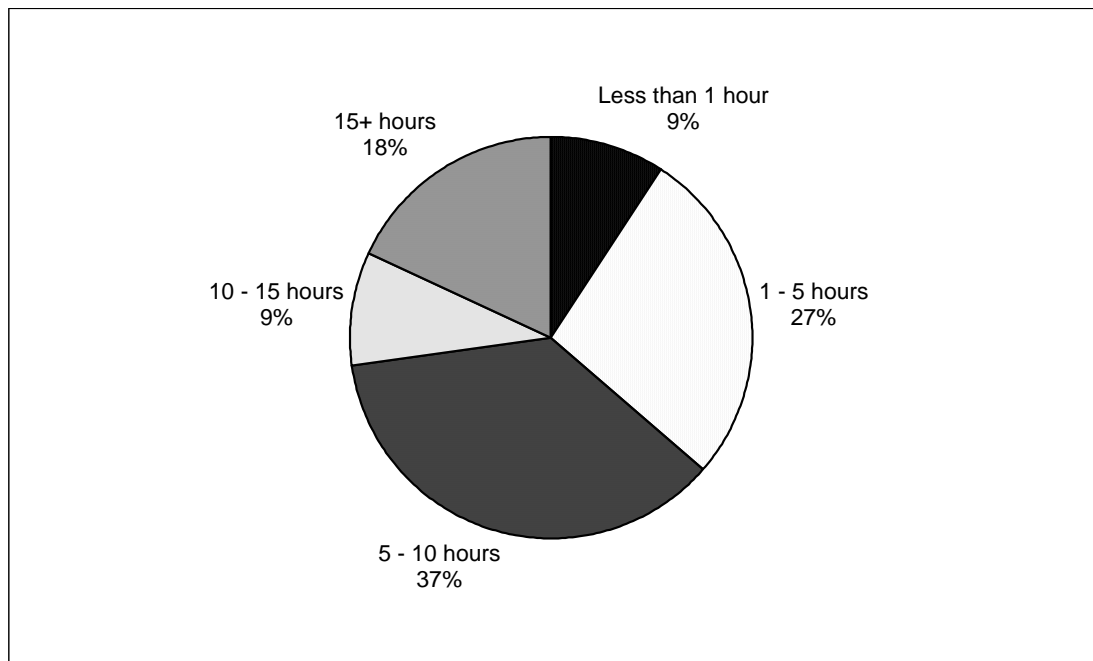
The usability questionnaire was focused on the Nielsen's usability heuristics. This questionnaire was given in order to determine if the website met these heuristics. Because I expected certain questions would require clarification this questionnaire was given orally.

**10. If applicable, the user was given an oral accessibility questionnaire.**

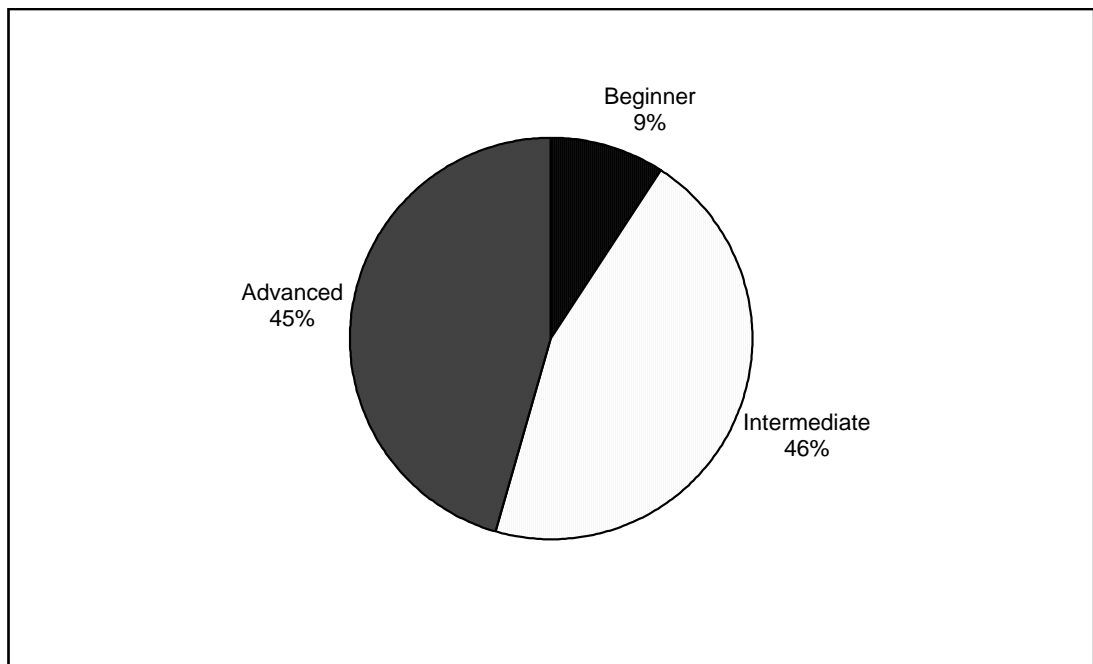
The accessibility questionnaire was focused on the Web Content Accessibility Guidelines. Since these guidelines focus on users with visual disabilities, the accessibility questionnaire was only appropriate for users who reported a visual impairment or total blindness. This questionnaire was given orally in each case.

## 4. Results

Most results of the website testing were as expected, but some findings led to unexpected and interesting results. The think aloud observation revealed the most interesting results. The accessibility and usability questionnaires confirmed that the Breez Computer website was generally accessible and usable. Finally, the post-test questionnaire did not reveal anything not found in the think aloud observation, but reinforced other findings.



**Figure 6. Responses to Pre-test Questionnaire, Question 5: How often approximately do you use the Internet in an average week?**



**Figure 7. Responses to Pre-test Questionnaire, Question 6: How would you rate your proficiency level with the Internet?**

#### **4.1. Pre-test Questionnaire**

User profile information was gathered in the Pre-test Questionnaire. Age of users ranged from 18 to over 55. 27% of users were male and 73% were female. Occupations included several students, a dancer, an office manager, a receptionist, a bicycle technician, a Web developer and a psychotherapist. All users reported a familiarity with the Internet. All but one user reported that they had used the Internet for three or more years. Internet use and Internet proficiency level is summarized in Figure 6 and Figure 7.

#### **4.2. Think Aloud Observation**

Results from the think aloud observation are summarized in sections 4.2.1 – 4.2.11, structured by task number.

##### **4.2.1. User 1N (Non-disabled, No Assistive Technology)**

- **Task 1.** At first impression, user 1N said the site was simple and easy to figure out. 1N noted that there were very limited menus and preferred to use a search box to find such information.
- **Task 2.** 1N said they did not relate the label “Help” to shipping rate; 1N typically would only use help when they had problems.

- **Task 3** revealed similar concerns. 1N did not relate unsubscribing from a newsletter to the label “Privacy Policy.”
- **Tasks 4 – 6.** On the product pages, 1N said there was not enough information about the products and made several suggestions for information that could be included on these pages.
- **Task 7.** While in the checkout process 1N noted that the use of breadcrumbs<sup>3</sup> was good. 1N would have liked to see examples on how to input information, such as credit card numbers and dates. 1N also said that it would be nice if they could say the billing address is the same as the shipping address.

#### 4.2.2. User 2N (Non-disabled, No Assistive Technology)

- **Task 1.** User 2N wanted to use a search to find the definition of IEEE. After trying to find the definition for several minutes, 2N eventually gave up.
- **Task 2.** 2N first looked for shipping costs on the product detail page. Next, 2N tried to determine the cost of three items by adding three items to their shopping basket. After finding the shipping rate table on the help page, 2N noted that they would have to go back to the product page to find the cost of the item before calculating shipping cost (even though the price of each item was unrelated to its shipping cost).
- **Task 3.** 2N said they would first attempt to unsubscribe by going through the buying process. Then if that was unsuccessful, they would use the contact form.
- **Tasks 4 – 6.** 2N was confused about the product buttons because they did not realize they were buttons. 2N was also confused about the terms that had a dotted underline. (Terms that had a dotted underline were defined using the acronym element.)
- **Task 7.** Like 1N, 2N also did not want to have to type the billing address in again.

---

<sup>3</sup> Breadcrumbs are a trail of links showing either how you got there or where you are in the hierarchy of the website.

#### **4.2.3. User 3N (Non-disabled, No Assistive Technology)**

- **Task 1.** User 3N found the definition of IEEE on the help page soon after beginning, but 3N noted they were not sure if a glossary was there.
- **Task 2.** 3N again proceeded straight to the help page and quickly found the shipping rate table, but was confused if they could use it properly.
- **Task 3.** After looking in the help section again, 3N guessed they should send an email.
- **Tasks 4 – 6.** 3N was able to find products relatively quickly, but was confused about the product buttons.
- **Task 7.** During checkout, 3N was annoyed that they could not automatically select the shipping address for the billing address.

#### **4.2.4. User 4N (Non-disabled, No Assistive Technology)**

- **Task 1.** User 4N found the definition of IEEE on the help page soon after trying a few other pages.
- **Task 2.** 4N quickly found the shipping rate table, but they thought it was interactive, which it was not.
- **Task 3.** After trying to find unsubscribe information on several pages, 4N eventually gave up on task 3.
- **Tasks 4 – 6** generally proceeded without any incident, but 4N was slightly confused by the product buttons.
- **Task 7.** 4N also expected to be able to specify that their billing address was the same as their shipping address.

#### **4.2.5. User 5D (Dyslexic, No Assistive Technology)**

- **Task 1.** User 5D first mentioned that they would use a different site to find the definition of IEEE. 5D navigated to the help page, but did not notice the defined term, which was on the page. Soon afterwards, 5D gave up saying that they are not sure how they would find it.
- **Task 2 – 3** proceeded without incident.
- **Task 4.** 5D associated the product number with the size of the product's screen, which was incorrect.
- **Task 5 – 6** proceeded without incident.

- **Task 7.** 5D entered “England” in the county. Follow up questions found that 5D misread the input label as country instead of county. After the test, 5D said that their dyslexia did not affect the use of the Breez Computer website.

#### **4.2.6. User 6C (Carpel Tunnel, No Assistive Technology)**

- **Task 1.** User 6C first looked for a search feature to find the definition of IEEE. When they realized there was no search feature, 6C looked elsewhere and soon found it on the help page.
- **Task 2.** 6C scrolled past the shipping rate table several times, but eventually found it.
- **Task 3.** 6C first assumed they had to register. 6C continued searching and eventually found the opt-out information in the privacy policy.
- **Tasks 4 – 7** were completed without incident. 6C noted that the forms were very clear and simple.

#### **4.2.7. User 7I (Vision Impaired, Contrast Adjustment)**

- **Task 1.** User 7I wanted to look on a different site before searching the Breez Computer website for the definition of IEEE. After I explained that they must use the Breez Computer website, 7I proceeded to the help section. 7I was looking directly at the acronym IEEE, but did not notice it. They noted they would have liked to use a search feature to find the term.
- **Task 2** proceeded without incident.
- **Task 3.** 7I did not find the information explain how to unsubscribe, but instead used the contact form to request to be unsubscribed.
- **Task 4.** 7I tried both the desktops and accessories before arriving at the notebooks page.
- **Task 5** proceeded without incident.
- **Task 6.** They commented that it was easy to find the right product when product information is under each picture.
- **Task 7.** When signing in, 7I noted they could not read the password upon entering it, which made it difficult to know if they typed the correct word. While entering shipping and billing information, 7I did not enter

information in the correct text inputs. Finally, 7I noted that they should be able to specify that the billing address is the same as the shipping address.

#### **4.2.8. User 8I (Vision Impaired, Screen reader)**

- **Task 1.** User 8I commented that they did not use the sophisticated parts of JAWS, such as keyboard shortcuts, just the basics. The first thing they did was listen to the entire homepage, then noted that they would not go to this site to find the definition of IEEE. After browsing around the site for several minutes, they eventually found IEEE on the product page, where it is mentioned but not defined. At this point, 8I said they would go to Google to define the term.
- **Task 2.** 8I took almost two full minutes to understand the shipping rate table, and said they would prefer to go through the checkout to find the total shipping cost.
- **Task 3.** They proceeded directly to the privacy policy, but skipped past the information about opting out of emails. During this task, they noted that the site map was quite good. While back in the privacy policy, they used the text search feature to find “e-mail.”
- **Task 4.** 8I found the notebooks page and found the screen size information in the comparison table. After selecting the notebook, they initially passed over the “Add to Basket” button, but then went back and selected it.
- **Tasks 5 – 6** proceeded without incident.
- **Task 7.** I noticed that JAWS did not read “Enter Shipping Address,” a header in the middle of the form. It was later pointed out that this was because JAWS was in forms mode, which skips over text in between form inputs.
- 8I used the link browser feature of JAWS several times during the test to find links to certain information. When asked why they used this feature, 8I responded that once they realized the links are clear and unique, they knew they could use it.

#### 4.2.9. User 9B (Blind, Screen Reader)

- **Task 1.** User 9B immediately used the headings browser to get their orientation of the page.
- **Task 2.** Like 8I, 9B took several minutes to understand shipping rate table and even said that the table was awful. 9B expected a table listing quantities and cost per number of items, but said that the current table would be more understandable if it was not inside a table and written with a screen reader in mind.
- **Task 3.** 9B said there should be a box somewhere for unsubscribing while again using the heading browser.
- **Task 4.** While browsing the notebook comparison table, 9B used shortcuts to read the table headers.
- **Tasks 5 – 6** were completed without incident.
- **Task 7.** 9B said the checkout forms were not bad, but they also said that sometimes you have to guess which input to use. While entering information into a form, 9B forgot to change to forms mode. They noted this can cause you to jump all over the place because the shortcuts in forms mode are different. Again, JAWS did not read “Enter Billing Address” because it was in forms mode.
- As with 8I, JAWS did not read the “skip navigation” links. Like 8I, 9B also used the link browser many times during the test, but 9B also used the heading browser a few times.

#### 4.2.10. User 10B (Blind, Screen Reader)

- **Task 1.** User 10B immediately looked for a search feature in order to find the definition of IEEE and said they would have preferred to use a search feature.
- **Task 2.** 10B said they liked that “Help” is a heading because they can jump right to it with JAWS. While listening to the table summary<sup>4</sup>, they said they were not sure if the summary was useful if the table is already described above. Again, it took several minutes for 10B to understand

---

<sup>4</sup> When creating a table in XHTML, designers and developers can use the `summary` attribute of the table element to describe the table.

the shipping rate table. They also mentioned that it would have made more sense if it was not in a table and just explained.

- **Task 3.** While they were browsing the text, they commented that they were a searcher not a browser. They do not like to read the whole page if it is unnecessary.
- **Task 4.** 10B tried to use the headings browser to navigate the page, but once they realized the page did not contain any headings, they thought it was a shame. While browsing the product table, 10B commented that it might be better if the table was turned on its side, for example, with the products on the left side of the table instead of the top. They mentioned this because of the way they navigated the table, which was usually a left to right movement. Once 10B found the notebook with the largest screen, they said they had to go back to the beginning to find its name.
- **Tasks 5 – 6** revealed similar problems with product tables. Afterwards, 10B commented that they liked that it lets you know what's in your basket.
- **Task 6.** 10B asked if the graphic and text could be linked together instead of separately.
- **Task 7.** 10B said they would have liked to have drop downs for the expiration date. Finally, they made a comment similar to previous users in that they should be able to specify that the billing address is the same as the shipping address.

#### **4.2.11. User 11B (Blind, Screen Reader)**

- **Task 1.** After arriving at the help page, user 11B used the search command in JAWS to find the term IEEE.
- **Tasks 2 – 3.** 11B again used the search command to find the respective content. They were successful during task 2 when they searched for “shipping” on the help page, but after using the search command to search for “e-mail” on several pages, 11B eventually gave up.
- **Task 4.** Like 10B, 11B navigated the product tables from left to right. After attempting to understand the table for several minutes, they eventually gave up saying that they could not make sense of the table.

- **Tasks 5 – 6.** They used the same process to navigate both the products tables and gave up in both cases. After these tasks, 11B, like 10B, noted they would prefer if the products were listed on the left side instead of the top.
- **Task 7.** 11B noticed that JAWS skipped over the heading on the billing form and they said the form was confusing because of that. They would prefer if the input label said “Billing Address Line 1” instead of “Address Line 1” so that the instructive heading would not be necessary.
- As a general note, 11B was the only blind user who listened to most pages in their entirety before selecting a link.

### **4.3. Consistent Think Aloud Findings**

Results from the think aloud observation were quite varied, but there were several consistent findings. The first of these, appearing in 5 out of 11 users, was a preference for a search input to use when searching for specific information, such as products or definitions of terms. Another consistent finding during the think aloud, appearing in 6 out of 11 users, was a preference or expectation that they that should not have to type in the billing address because they are usually allowed to specify that the billing address is the same as the shipping address. The third consistent finding, appearing in 5 out of 11 users, was a misunderstanding of shipping rate table. Sighted users did not find the table intuitive while the table was not understandable when linearized for screen reader users.

Among blind and visually impaired users only, there were five consistent findings. The first, appearing in 3 out of 5 users, was the statement that they had to turn off forms mode<sup>5</sup> so that JAWS reads the text in between form inputs. The second consistent finding, appearing in 2 out of 5 users, was a preference for the product comparison table to be turned on its side, with the products on the left side of the table rather than the top. The third consistent finding, appearing in 2 out of 5 users, was a preference for “skip navigation” links. Finally, the fourth consistent finding, appearing in 4 out of 5 users, was a misunderstanding of the shipping rate table.

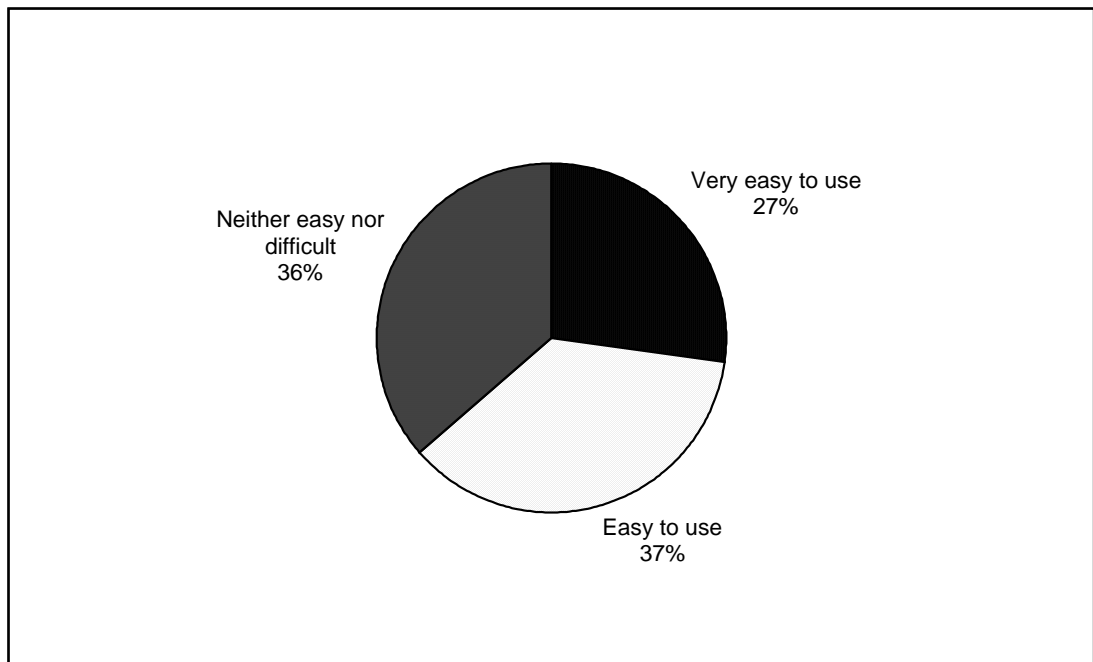
---

<sup>5</sup> Forms mode is a feature of the JAWS for Windows screen reader which allows the user to enter text into the form field using the keyboard.

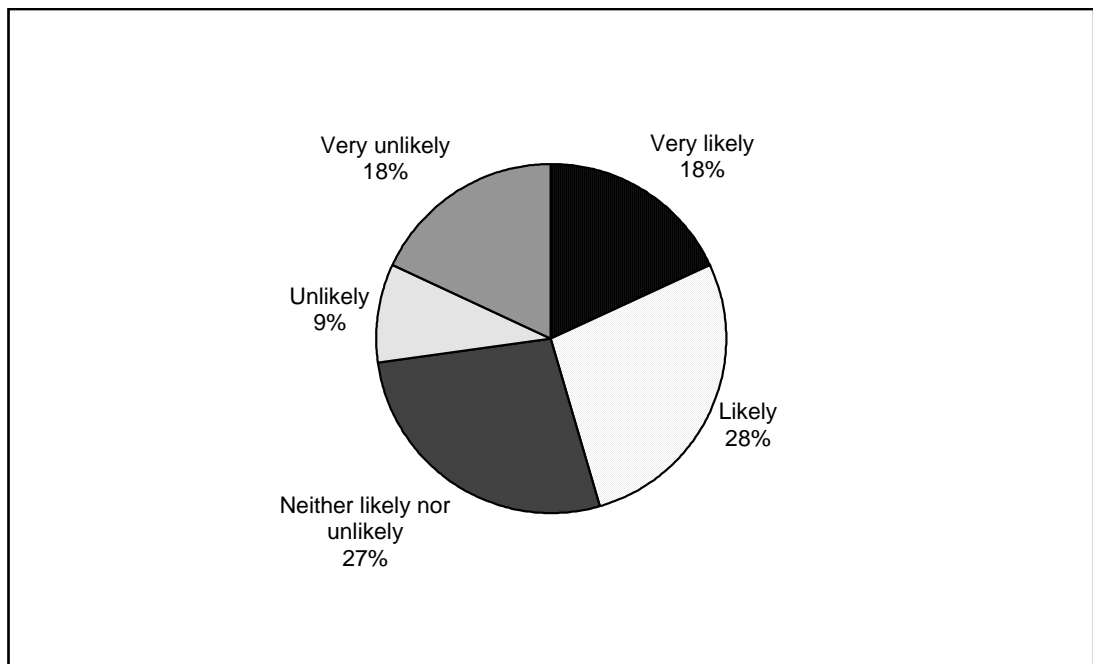
There were several outlier findings worth noting. 2 of the 6 sighted users made the statement that the buttons on the category pages and product pages did not look like buttons. 3 out of 11 users made the statement that they thought “Select,” which appeared in the product comparison table, meant, “Add to Basket.” (Add to Basket actually appeared on the product detail page.) Finally, 2 of 11 users made that statement that the Breez Computer website was too minimal.

#### 4.4. Post-test Questionnaire

The post-test questionnaire captured general feedback on the website. General ease of use and likeliness of using the Breez Computer website to purchase a computer are summarized in Figure 8 and Figure 9, respectively.



**Figure 8. Responses to Post-test Questionnaire, Question 1: On the following scale please indicate how easy to use or difficult to use your felt the Breez Computer website was.**



**Figure 9. Responses to Post-test Questionnaire, Question 2: On the following scale please indicate how likely you would be to use the Breez Computer website to purchase a computer or computer accessories in the future.**

Responses to the remaining post-test questionnaire were generally quite varied. General consistencies that emerged for each question, if any, are summarized in the following sections. Full results for questions 3 – 7 are available in Appendix B.

**4.4.1. Question 3: Please give examples of where you thought the Breez Computer website was difficult to use.**

Among all users, appearing in 4 out of 11 responses, was the response that it was difficult to find certain information. Among blind and visually impaired users, appearing in 2 out of 5 responses, was the response that the product tables were confusing.

**4.4.2. Question 4: What features do you think would make the Breez Computer website more useful?**

Among all users, appearing in 2 out of 11 responses, was the response that it should prompt to use the shipping address for the billing address. Among blind

and visually impaired users, appearing in 2 out of 5 responses, was the response that all pages should have skip navigation links<sup>6</sup>.

#### **4.4.3. Question 5: What did you like MOST about the Breez**

##### **Computer website?**

Among all users, appearing in 3 out of 11 responses, was the response that it was easy to compare products. Appearing in 2 out of 11 responses, was the response that it had a minimal design. Among blind and visually impaired users, appearing in 2 out of 5 responses, was the response that pages were simple and obvious.

#### **4.4.4. Question 6: What did you like LEAST about the Breez**

##### **Computer website?**

No consistent responses appeared among all users. However, among blind and visually impaired users, appearing in 2 out of 5 responses, was the response that the product comparison table was confusing.

#### **4.4.5. Question 7: What would you change about the Breez**

##### **Computer website?**

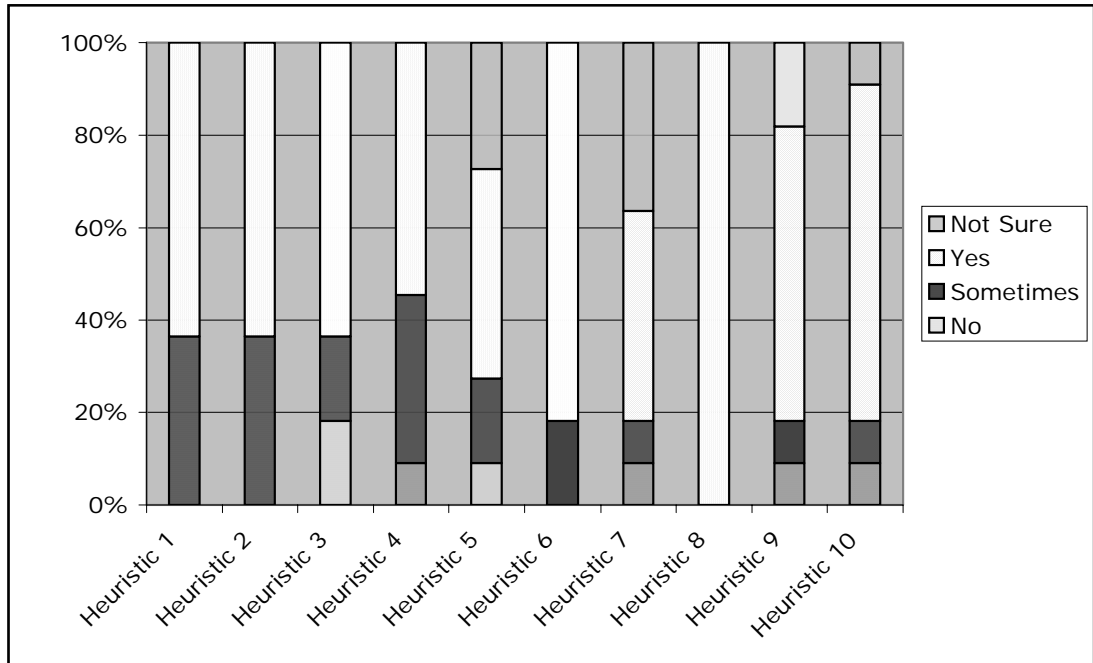
No consistent responses appeared among all users. Among blind and visually impaired users, appearing in 2 out of 5 responses, was the response that the product comparison table layout should be changed.

#### **4.5. Usability and Accessibility Questionnaire**

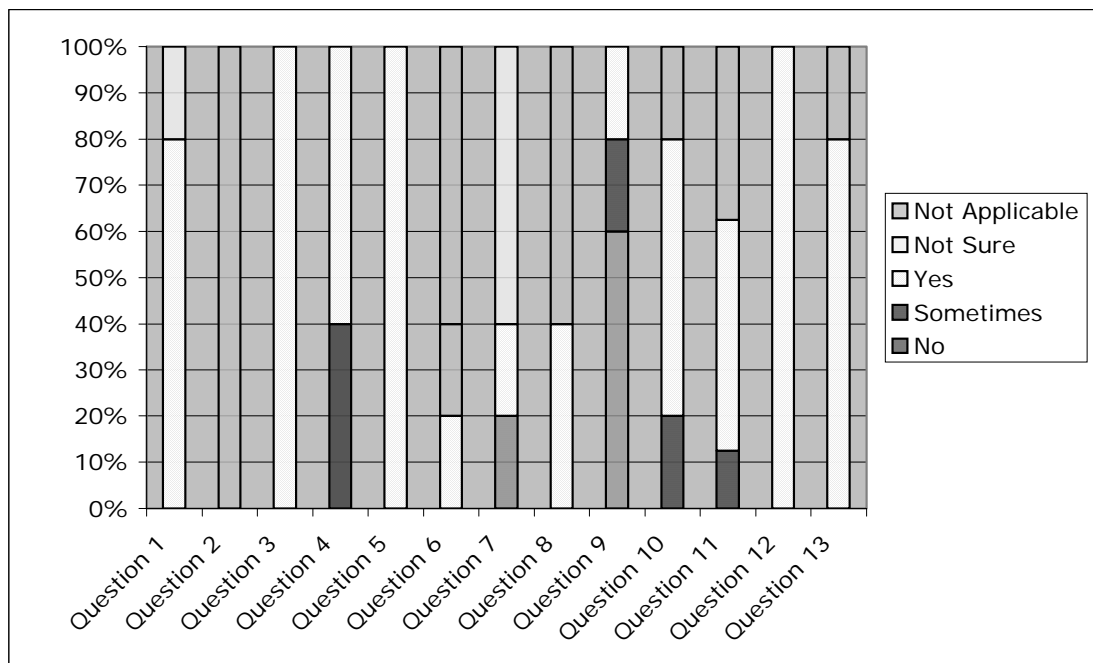
Responses to the usability questionnaire and accessibility questionnaire are summarized in Figure 10 and Figure 11, respectively.

---

<sup>6</sup> Skip navigation links, sometimes times hidden from sighted users, allow screen reader users to skip over repetitive navigation items.



**Figure 10. Responses to Usability Questionnaire. See Appendix A for questionnaire.**



**Figure 11. Responses to Accessibility Questionnaire. See Appendix A for questionnaire.**

## 5. Discussion

The results of the usability and accessibility questionnaire, which tested the website's compliance with guidelines, both point to a generally usable and accessible website. However, during the think aloud and from the responses received in the post-test questionnaire, it is apparent that there were still several major issues with the Breez Computer website in terms of its usability and accessibility. The responses gathered during this study can be grouped into two main sections: de facto Web design standards and use considerations. In addition to discussing the findings from this study, I will also be discussing general content usability and usability heuristics as they apply to Web accessibility.

### 5.1. De Facto Web Design Standards

Of the consistent think aloud findings, there were several findings that could be considered part of de facto Web design standards. Regarding standards, Nielsen [21] suggests, "If 80% or more of the big sites do things in a single way, then this is the de-facto standard and you *have* to comply." Adkisson [1] examined 75 leading e-commerce websites in order to identify the different types of de facto standards on the Web. This study revealed that 93% of websites provided a global search function, which allows users to search all pages within a single website. The study contained nothing about how a global search function contributes to the overall usability or accessibility of a website. However, Nielsen's article goes on to say that "no website is seen in isolation: users come to your site expecting things to work the same way they are already used to." This was the case with the Breez Computer website. Nearly half of the users expected a search feature because they are used to seeing such a feature on similar websites they have visited in the past.

Another consistent think aloud finding that could be considered a de facto Web design standard is a feature that allows users to specify their billing address is the same as the shipping address. In fact, 6 out of 11 users preferred or expected to specify this during their checkout process.

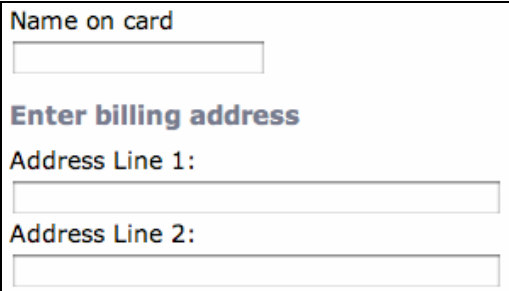
Nielsen does not specifically mention de facto standards in his usability heuristics [17]. However, heuristic 4, which covers consistency and standards, can be interpreted as referring to de facto standards.

## 5.2. Use Considerations

There were several usability issues with the Breez Computer website than are directly related to the use of screen reader software, or in the case of this study, the JAWS for Windows screen reader. This was the premise of previous research by Theofanos et al. [23] where they observed blind users work with websites using screen reader software. This study found similar issues related to the use of screen reader software, specifically forms mode, navigating tables and reading content.

Forms mode is a feature of the JAWS screen reader which allows the user to enter text into the form field using the keyboard. When in forms mode, a form control can be manipulated using the up, down, left and right arrow keys, the focus can be moved to the next control using TAB and moved to the previous control using SHIFT+TAB. When using a form, this works well except in cases where the form contains text in between form controls as in Figure 12. In these cases, JAWS skipped over this text because forms mode only skips between form controls. In this study, all screen reader users noticed this and became frustrated that they had to turn off forms mode to hear the text before the form.

Navigating the product comparison table, shown in Figure 13, was another usability issue for a couple screen reader users, although the table conformed to both accessibility and usability guidelines. When navigating the table these users would read the table first from left to right and then top to



The image shows a screenshot of a web form. At the top, there is a label "Name on card" followed by a text input field. Below this is a bold blue heading "Enter billing address". Underneath the heading are two more text input fields, each preceded by the label "Address Line 1:" and "Address Line 2:" respectively. The text "Enter billing address" is positioned between the "Name on card" field and the "Address Line 1:" field, which is the issue described in the text.

**Figure 12. Form with text (“Enter billing address”) in between form controls.**

bottom instead of first from top to bottom and then left to right. In other words, they would hear “Memory 512 MB RAM, Memory 256 MB RAM, Memory 256 MB RAM, Memory 512 MB RAM” without knowing which computer each specification referred to. They would have to move back to the top of the table in order to find this information. This frustrated these users considerably. The suggestion made by both blind users who encountered this issue was to turn the product comparison table on its side, so that the screen reader would read the name of the product then each product’s specifications.

It is interesting to note that although turning the table on its side with the product headings on the left side of the table may make the page more usable to certain screen reader users, this is in direct conflict with Nielsen’s recommendation [21] to use de facto standards when designing a website. A review of three major online computer retailers, Dell, Gateway and HP, showed that each retailer used a product comparison table with the product headings on

breez computer <a href="#">View Basket</a>   <a href="#">Help</a>   <a href="#">Site Map</a>							
Home		Notebooks		Desktops		Accessories	
Notebook 5		Notebook 10		Notebook 15		Notebook 20	
£1399		£1499		£1499		£1599	
<b>Processor</b> Intel Centrino 715		<b>Processor</b> Intel Pentium M 715		<b>Processor</b> Intel Pentium M 518		<b>Processor</b> Intel Centrino 780	
<b>Operating System</b> Windows XP		<b>Operating System</b> Windows XP		<b>Operating System</b> Windows XP		<b>Operating System</b> Windows XP	
<b>Memory</b> 512 MB RAM		<b>Memory</b> 256 MB RAM		<b>Memory</b> 256 MB RAM		<b>Memory</b> 512 MB RAM	
<b>Hard Drive</b> 40 GB		<b>Hard Drive</b> 40 GB		<b>Hard Drive</b> 30 GB		<b>Hard Drive</b> 40 GB	
<b>Optical Drive</b> CD-RW/DVD Combo		<b>Optical Drive</b> CD-RW/DVD Combo		<b>Optical Drive</b> CD-RW/DVD Combo		<b>Optical Drive</b> CD-ROM	
<b>Screen Size</b> 14.1"		<b>Screen Size</b> 15"		<b>Screen Size</b> 17.1"		<b>Screen Size</b> 15.4"	
<b>Select Notebook</b> 5		<b>Select Notebook</b> 10		<b>Select Notebook</b> 15		<b>Select Notebook</b> 20	

Figure 13. Product comparison table.

the top.

The final usability issue for screen reader users was the shipping rate table, shown in Figure 14. All screen reader users had problems understanding this table because of the way JAWS read its contents. For example, the first line read (where words in CAPS are phonetic translations of symbols in the table) “Paren Number of Items EX Cost per Item Paren PLUS Flat Shipping Charge EQUALS Shipping Cost.” The second line read “Paren EX one POUND Paren PLUS eight POUND EQUALS.” It’s understandable why this listening to this would cause confusion.

### 5.3. Usable Accessibility

In addition to the work in this study, Leporini et al. [13] has proposed 18 criteria designed to improve accessible website usability for users who access the Web with a screen reader. These criteria were created with three navigational problems in mind:

#### 1. Lack of context

Screen reader users may lose the overall context of the page by reading only small portions of texts.

#### 2. Information overloading

Sections of a page such as lists of links, advertisements, and menus may overload the screen reader user because they have to read everything almost every time.

#### 3. Excessive sequencing in reading the information

Using a screen reader can constrain the users to follow the page content sequentially.

The results of this study do not support the problems outlined by Leporini et al., but we both share the opinion that the Web Content Accessibility Guidelines do not consider usability enough in the context of accessibility.

<b>(Number of Items x Cost per Item) + Flat Shipping Charge = Shipping Cost</b>			
(	x £1 )	+ £8	=

Figure 14. Shipping rate table.

#### **5.4. Usability Heuristics**

In addition to the usability heuristics' questionable ability to predict the usability of a system, another problem with the heuristics is that they say nothing about the accessibility of the website. This is interesting since by nature, a website must be accessible before it can ever be considered usable. While it may be true that Nielsen's heuristics were not created to be inclusive of accessibility issues, the absence of accessibility considerations within the heuristics is an important point since accessibility is such a vital aspect of the Web's utility.

## 6. Recommendations

The first objective of this study was to put forth recommendations that are based on observation and qualitative analysis. In order to create websites that are both accessible and usable, I can make several recommendations based on this work.

1. Consider de facto Web standards. In particular, consider including standards such as:
  - 1.1. A search feature.
  - 1.2. The ability to specify that a billing address is the same as the shipping address.
2. Consider screen reader users. In particular, consider how screen readers handle:
  - 2.1. Forms. Screen readers in forms mode may not read descriptive text in between form inputs. Use the `fieldset` and `legend` XHTML elements to make forms more understandable.
  - 2.2. Table navigation. Tables oriented with headers on the top side of the table may not be understandable. Orient tables to be read from left to right with headers on the left side of the table.
  - 2.3. Reading symbolic characters. Certain characters may not be understandable when read by screen reader. Test all content with a screen reader to ensure that it's understandable.

Previous work by Nielsen [17] and Theofanos [23] supports recommendation 1 and recommendation 2.1, respectively.

Although de facto web standards are important to consider, they might be in conflict with best practices for screen reader users. For example, the de facto standard for product comparison tables might be to orient the products from left to right, but as discussed in section 5.2, two of the blind users had difficulty with this type of table orientation.

## 7. A Framework for Creating Accessible and Usable Web Designs

A secondary objective of this study was to create a framework for creating websites that are both accessible and usable. This objective was met by combining the results of this study with previous research to create a new framework.

The two main groupings within this framework are physical accessibility, the quality that allows the user to get to the information, and functional accessibility, the quality that allows the user to make use of the information for the intended purpose. The main contributor to physical accessibility is the Web Content Accessibility Guidelines. The four main contributors to functional accessibility are:

1. **The accessible usability criteria by Leporini et al. [13].**

The Web Content Accessibility Guidelines, while quite good at promoting physical accessibility, lack basic usability considerations. The accessible usability criteria address many of these usability issues in the context of the Web Content Accessibility Guidelines.

2. **Use considerations recommendations as discussed in section 6 and by Theofanos et al. [23].**

To better meet the needs of users, it is necessary to understand them and how they work with their tools. These guidelines were developed through direct observation of users and address many “real world” usability issues.

3. **De facto standards as discussed in section 6 and by Nielsen [21] and Adkisson [1].**

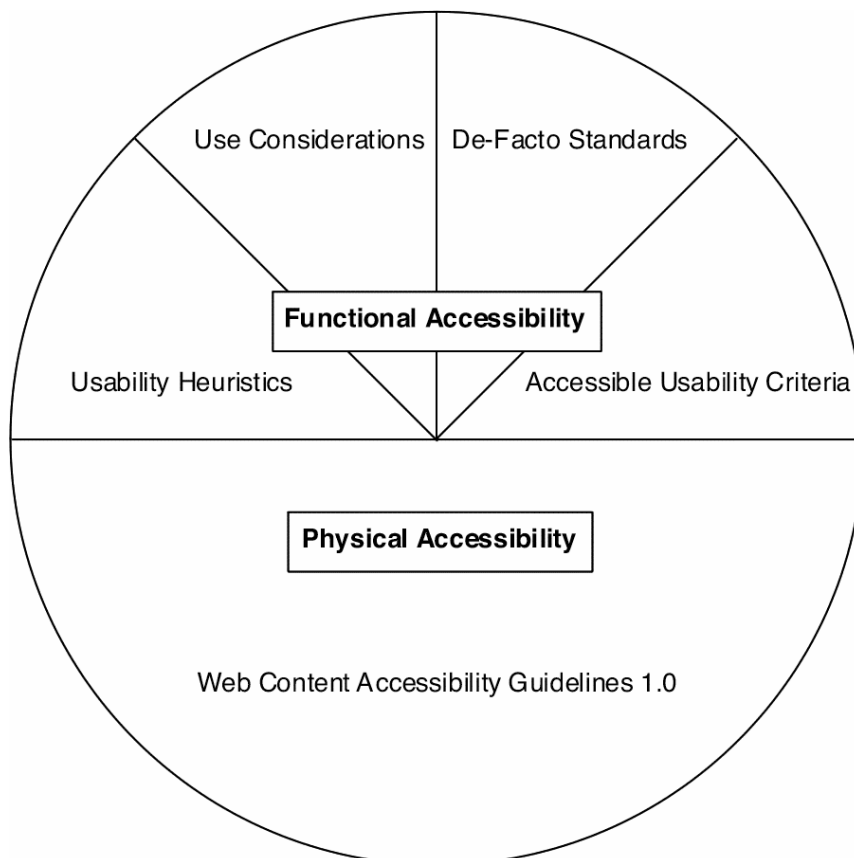
As documented by Nielsen and Adkisson, users expect what they are used to experiencing. Including de facto standards that are familiar to users will improve the usability of a website through their inclusion alone.

4. **Usability heuristics by Nielsen [17].**

Nielsen's usability heuristics, although flawed in that different evaluators can interpret them differently, have been documented to improve the usability of a website for both disabled and non-disabled users.

Diagrammatically, this framework can be depicted as in Figure 15. Previous to this framework, accessibility and usability have generally been regarded as separate topics within the Web development community. This framework presents a holistic view of accessibility and usability, clarifying their individual different aspects.

The intention is that Web designers and developers will adopt this framework as an aid to creating websites that are both accessible and usable. This framework can be used throughout the development process in different combinations. For example, when planning a website, de facto standards can be considered. Designers can then take into account use considerations and usability heuristics. Finally, during development, the Web Content Accessibility Guidelines 1.0 and accessible usability criteria can be consulted.



**Figure 15. A framework for creating accessible and usable websites.**

## **8. Conclusions and Future Work**

Although Figure 10 and Figure 11 show that the Breez Computer website was generally accessible and usable, think aloud and post-test questionnaire results indicate there were several significant usability and accessibility issues with the website as discussed in section 5. The use considerations are consistent with previous findings by Theofanos et al. [23].

This study was also interested in determining what else beyond the accessibility and usability guidelines are required for creating a website that is accessible and usable. The data from this study indicates that de facto Web design standards are an important aspect of a usable website. The work by Leporini et al. [13] should also be acknowledged for creating accessible usability criteria which are designed to improve the usability of accessible Web sites.

This study provides a basis for much future work in the area of accessible and usable web design. Due to logistical constraints, the website and user pool used in this study was relatively small. Future work would benefit from testing with a larger scale website and a larger pool of users. Also, since only a limited set of XHTML was used in this study, future studies should investigate more aspects of XHTML in different combinations. Finally, future work can use the framework presented in this study as a basis for investigation, allowing researchers to focus on specific aspects of the relationship between accessibility and usability.

## 9. Bibliography

- [1] Adkisson, H. Identifying De-Facto Standards for E-Commerce websites. (2002) University of Washington Graduate School.
- [2] Brewer, J., EOWG Participants. Online Overview of the Web Accessibility Initiative. (2003) <http://www.w3.org/Talks/WAI-Intro/slide3-0.html> (Accessed 1 July 2004)
- [3] Colwell, C. and Petrie, H. Evaluations of Guidelines for Designing Accessible Web Content. (1999) Position paper for IFIP TC 13 Interact '99 Workshop: Making Designers Aware of Existing Guidelines for Accessibility.
- [4] Disability Rights Commission. The Web: Access and Inclusion for Disabled People. (2004)
- [5] Ericsson, K. and Simon, H. Verbal Reports as Data. (1980) *Psychological Review*, Vol. 87, No. 3.
- [6] Gray, W. Discount or Disservice? Discount Usability Analysis – Evaluation at a bargain price or simply damaged merchandise? (1995) *Proceedings of CHI Companion '95*.
- [7] Hanson, V. The User Experience: Designs and Adaptations. (2004) *Proceedings of World Wide Web 2004*.
- [8] Hanson, V. and Richards, J. Web Accessibility: A Broader View. (2004) *Proceedings of World Wide Web 2004*.
- [9] Hull, L. Accessibility: It's Not Just for Disabilities Any More. (2004) *Interactions*. Vol. 11. No. 2.
- [10] Henry, S. et al. Constructing Accessible websites. (2002) Birmingham: Glasshaus.
- [11] Hvannberg, E. and Law, L. Complementarily and Convergence of Heuristic Evaluation and Usability Test: A Case Study of UNIVERSAL Brokerage Platform. (2002) *Proceedings of NordiCHI '02*.
- [12] Kantner, L. and Rosenbaum, S. Usability Studies of WWW Sites: Heuristic Evaluation vs. Laboratory Testing. (1997) *Proceedings of SIGDOC '97*.
- [13] Leporini, B. and Paternó, F. Increasing Usability When Interacting Through Screen Readers. (2003) *Universal Access in the Information Society*. Vol. 3. No. 1.
- [14] Mankoff, J., Anind, D., Moore, M., and Batra, U. Web Accessibility for Low Bandwidth Input. (2002) *Proceedings of the Fifth International ACM SIGCAPH Conference on Assistive Technologies*.
- [15] Nielsen, Jakob. *Designing Web Usability*. (2000) Indianapolis: New Riders Publishing.
- [16] Nielsen, J., Phillips, V. Estimating the Relative Usability of Two Interfaces: Heuristic, Formal, and Empirical Methods Compared. (1993) *Proceedings of the SIGCHI conference on human factors in computing systems*.
- [17] Nielsen, Jakob. *Heuristics for User Interface Design*. (1994) [http://www.useit.com/papers/heuristic/heuristic\\_list.html](http://www.useit.com/papers/heuristic/heuristic_list.html) (Accessed 3 July 2004)
- [18] Nielsen, Jakob. Usability 101. (2003) <http://useit.com/alertbox/20030825.html> (Accessed 1 July 2004)

- [19] Nielsen, Jakob. Usability Engineering. (1994) San Francisco: Morgan Kaufman.
- [20] Nielsen, Jakob. Usability Inspection Methods. (1994) New York: John Wiley & Sons.
- [21] Nielsen, Jakob. When Bad Design Elements Become the Standard. (1999) <http://www.useit.com/alertbox/991114.html> (Accessed 9 August 2004)
- [22] Sloan, D., Gregor, P., Rowan, M. and Booth, P. Accessible Accessibility. (2000) Conference on Universal Usability.
- [23] Theofanos, M. and Redish, J. Bridging the Gap Between Accessibility and Usability. (2003) Interactions. Vol. 10. No. 6.
- [24] W3C. W3C Web Accessibility Initiative Statement on Recent Report. (2004) <http://www.w3.org/2004/04/wai-drc-statement.html> (Accessed 3 July 2004)
- [25] W3C. Web Content Accessibility Guidelines 1.0. (1999) <http://www.w3.org/TR/WAI-WEBCONTENT/> (Accessed 30 June 2004)

## **10. Appendix A: Website Testing Documents**

## Informed Consent Form

You have been recruited as a research participant for our evaluation of the Breez Computer website. This evaluation is being conducted by Joshua Kaufman. I will be glad to answer any questions you have about the evaluation.

You will be asked to perform various tasks with the site that are typical of the kind of tasks real users would be attempting to accomplish using the site.

We are evaluating the sites with the intention of analysing their usability.

We are not in any way evaluating you.

We expect the session to last about one hour to one and a half hours, and you will be videotaped during the session.

During this session, the PC you will be performing the tasks on will be videotaped, your face will be videotaped, and your comments will be recorded. This videotape will be used only for purposes of evaluating the site and will not be distributed nor viewed by anyone not associated with this evaluation process.

Your name will not be associated with any data that is collected during this evaluation session.

There are no known risks associated with this evaluation. You will be asked to complete a background questionnaire and a feedback questionnaire, containing questions relevant to the site and its' evaluation.

As an incentive for participating in this evaluation you will receive an appropriate incentive.

I give consent to be audiotaped/videotaped during this study and for the use of these tapes for the purposes of evaluation.

**Please tick:** Yes [ ] No [ ]

Your rights as a participant are as follows:

1. You have the right to withdraw from the session at any time for any reason.
2. At the conclusion of the session, you may see your data, if you so desire. If you decide to withdraw your data, please inform one of the evaluators immediately.
3. You are requested not to discuss this session with the other people who may be participating in the evaluation.
4. Remember you cannot fail any part of this test and there are no right or wrong answers. The session is to identify usability problems with the sites. Your signature below indicates that you have read this consent form in its entirety and that you voluntarily agree to participate.

I have read the foregoing and fully understand the contents thereof.

Name \_\_\_\_\_

Signature \_\_\_\_\_

## Pre-test Questionnaire

Thank you for agreeing to participate in this usability test. Please answer the following questions about your experience with the Breez Computer website.

Privacy information: Please note that this questionnaire is completely confidential and anonymous. The information gathered herein will only be used for the purposes of this study.

1. Please indicate your age range:

18-24	25-34	35-44	45-54	55+
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

2. Please indicate your gender:

Male	Female
<input type="checkbox"/>	<input type="checkbox"/>

Your occupation: \_\_\_\_\_

3. How long have you been using the Internet?

Less than 3 months	3-6 months	6 months - 1 year	1-3 years	3+ years
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

4. How often approximately do you use the Internet in an average week?

Less than 1 hour	1-5 hours	5-10 hours	10-15 hours	15+ hours
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

5. How would you rate your proficiency level with the Internet?

None	Beginner	Intermediate	Advanced	Expert
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

6. How often have you used the Breez Computer website?

Never	Once	1-5 times	5-10 times	10+ times
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

7. Please give a brief (1-3 sentences) description of what you think the Breez Computer website is:

## Participant Instructions

Thank you for agreeing to participate in this usability study. Please keep in mind that you are not being evaluated. The purpose of this study is to identify issues with the usability of the site under evaluation. Therefore, there are no wrong answers and any comments you have should be made freely.

You will be given a list of tasks, provided on a Task Sheet, to perform using the site. Work through them as efficiently as you can but do not rush. Before beginning each task, please read the instructions out loud. Please continue to think out loud as you work. Describe your thoughts about the site, why you are performing certain actions, how you make your decisions, why something is bothering you and so forth.

If you feel you are stuck and would like to ask us a question, please do. We will, however, ask you to try to find your way around the problem before specifically answering you, as this is how we discover the most interesting aspects of the site.

You will have a series of tasks to complete. These tasks should take approximately 30 minutes to one hour to complete in total. You will be instructed when to begin.

Do you have any questions at this time?

## Task Sheet

1. What does IEEE mean?
2. What is the total shipping cost for an order containing 3 items?
3. How can one opt-out of Breez Computer's marketing email?
4. Find and add the notebook with the largest screen to your basket.
5. Find and add the MP3 player with the largest capacity to your basket.
6. Find and add a printer with memory card slots to your basket.
7. After completing task no. 6, proceed to checkout and place an order using the following information:

### User Information

Email: user@hotmail.com

Password: blueberry

### Shipping Address

Adam Smith

155a Hale Lane

Edgware

HA8 9QW

### Payment

Visa

4735 4659 3678 8539 7395

Expire Date: 11/06

Billing address is the same as the shipping address.

---

## Post-test Questionnaire

Thank you for completing the usability test. Please answer the following questions about your experience with the Breez Computer website.

Privacy information: Please note that this questionnaire is completely confidential and anonymous. The information gathered herein will only be used for the purposes of this study.

1. On the following scale please indicate how easy to use or difficult to use you felt the Breez Computer website was:

very easy to use	easy to use	neither easy nor difficult	difficult to use	very difficult to use
[ ]	[ ]	[ ]	[ ]	[ ]

2. On the following scale please indicate how likely you would be to use the Breez Computer website to purchase a computer or computer accessories in the future:

very likely	likely	neither likely nor unlikely	unlikely	very unlikely
[ ]	[ ]	[ ]	[ ]	[ ]

3. Please give examples of where you thought the Breez Computer website was difficult to use:

4. What features do you think would make the Breez Computer website more useful?

5. What did you like MOST about the Breez Computer website?

6. What did you like LEAST about the Breez Computer website?

7. What would you change about The Breez Computer website?

## Usability Questionnaire

1. Did the website give you appropriate feedback?
2. Did the website speak your language? Was it understandable?

3. Did the website provide you with adequate control and freedom?
4. Was the website similar to other websites you have used?
5. Did the website prevent errors?
6. Were objects, links and buttons on the website visible?
7. Did the website provide you with different ways to navigate?
8. Did the website have an aesthetic and minimalist design?
9. Did the website help you recover from errors?
10. Did the website provide adequate help?

## Accessibility Questionnaire

1. What do you think about the number of links on the page?
2. What, in your opinion, is the optimal number of links on a page?
3. How appropriate is the link text?
4. Does the link text make sense when read out of context?
5. Is it clear where each link will take you?
6. Do the colour combinations enhance clarity?
7. Would you want to/how would you change the colour combination of the text/background to enhance clarity?
8. Can you read the page in 'Inverse'?
9. Are there any features that are difficult to use with your assistive technology?
10. Are the ALT tags appropriate?
11. Is the content understandable?
12. How accessible/easy to use are the forms?
13. Does the assistive technology read the page properly?

## 11. Appendix B: Results of Post-Test Questionnaire, Questions 3 – 7

<b>Question 3: Please give examples of where you thought the Breez Computer website was difficult to use</b>	
1N	Difficult to find what I want
2N	Basket link, billing information, glossary in help
3N	I did not know how to go back to menu in help, having to double click to add something to the basket
4N	Having to type the address twice, the checkout task flow
5D	Nothing
6C	Not everything was obvious
7I	Finding certain information
8I	Nothing stands out
9B	Accessories page list items should be headings
10B	Product tables were confusing
11B	It skipped over heading in forms mode, the product tables were confusing
<b>Question 4: What features do you think would make the Breez Computer website more useful?</b>	
1N	Simple information, text-based information
2N	More color, improve shipping table, better tagline
3N	Help section needs back to top links, change “select” to “add to basket”
4N	It should store address and credit card information
5D	More bullet points
6C	More color
7I	Remember billing address
8I	Skip navigation links
9B	More headings
10B	Drop down product lists
11B	Skip links on every page
<b>Question 5: What did you like MOST about the Breez Computer website?</b>	
1N	Large font size, layout, structure

2N	Pictures, easy comparison, glossary
3N	Simple and minimal
4N	Minimal design
5D	Checkout process
6C	Its clarity, it's easy to compare items
7I	Clear pictures, easy to compare items
8I	Simple structure
9B	Glossary
10B	Uncluttered pages, properly tagged graphics
11B	Was obvious and explanatory
<b>Question 6: What did you like LEAST about the Breez Computer website?</b>	
1N	Not enough information, not trustworthy
2N	No payment confirmation, dry design
3N	Nothing
4N	Having to enter address twice
5D	Nothing
6C	Nothing
7I	Nothing
8I	Nothing stands out
9B	Shipping rate table
10B	Product tables
11B	Product tables
<b>Question 7: What would you change about The Breez Computer website?</b>	
1N	More information
2N	More color
3N	Back to top link in help
4N	Remember address and credit card information
5D	Nothing
6C	Nothing
7I	Remember address information
8I	Nothing
9B	Remove access keys

10B	Product tables need changed
11B	Change the layout of the product table

**Table 2. Results of Post-Test Questionnaire, Questions 3 - 7.**