

E-Commerce and Visually Impaired

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Abstract: This paper is influenced by all web users that have a visual impairment disability and will focus on the implications of users with visual disabilities whilst using the web, specifically when concerned with using e-commerce websites. A significant amount of research will be conducted on the current usability guidelines and the problems that users with visual disabilities face whilst using the web. Research will be conducted in order to gain an understanding of the target audience and how the website needs to function to satisfy and comply with visually impaired user requirements. In order to achieve these aims an audit of well known e-commerce websites will be performed to discover the barriers and potential flaws in current e-commerce websites and produce a solution that satisfies all web users. A narrative set of guidelines will be produced from the findings of the early analysis in order to assist developers in creating an accessible e-commerce user interface.

Keywords: accessible e-commerce, Electronic Data Interchange, Visually Impaired,

I. INTRODUCTION

In recent years the World Wide Web has evolved and has become host to the rapid growth of online business know as e-business or e-commerce. E-commerce as we know it is the purchasing and selling of products online through a secure payment method, such as electronic bank transfer. Traditionally business transactions were conducted by the use of Electronic Data Interchange (EDI) over value-added networks (VAN) whereby companies would transfer information of similar format in a computer-to-computer exchange using two translator machines. However, according to Zwass, Vladimir, "traditional e-commerce, conducted with the use of information technologies centreing on electronic data interchange (EDI) over proprietary value-added networks, is rapidly moving to the Internet." [1].

E-commerce became established in the mid 1990's and evolved until the year 2000 when a major downturn occurred. Between 2000 and 2003, many industry observers were writing obituaries for electronic commerce. However, in the year 2003, e-commerce re-established and e-businesses' began to see returning profit. At this time e-commerce grew rapidly, quicker than it had initially in the mid 1990's and this upturn was widely regarded as the 2nd wave of e-commerce [2]. Webloyalty, an e-commerce specialist business, have produced figures that state; "Online retail is growing six times faster than high street sales and is predicted to exceed £37 billion by 2014." [3]. This rapid increase suggests that shoppers are now spending their money online rather than in the high street. This may be largely down to the fact that e-commerce websites can now be accessed by the use of Smart phones through the use of e-commerce shopping apps and can also be used with a tablet PC, such as Apples iPad, to pay, locate and compare the best deals available. An e-commerce websites main goal is to make a good first impression on its target audience. The first impression given is the determining factor of whether or not the user will use the website or hit the browsers back button and go elsewhere to shop for their desired product. If an e-commerce website does not make a good first impression, potentially clients will be lost. "80 percent of highly satisfied users will come back to purchase goods again within 2 months and 90 percent of them will recommend to the others" [2]. E-commerce has revolutionised the way business is conducted and the way in which consumers purchase products and services.

II. E-COMMERCE CONSUMERS

The most imperative role of any e-commerce website is to satisfy the user requirements. An e-commerce website is obligated to provide detailed information on its products and services. The quality and quantity of information is of utmost importance in providing an efficient, quality of service to the consumer. One of the many advantages of e-commerce for the consumer is that it is open 24/7. A consumer is able to pre-order or purchase items from an e-commerce site at any given time of day, normal high-street time constraints do not apply, therefore the online shopping experience is convenient and essential. The Disability Discrimination Act (DDA) requires all high street businesses to provide disabled users with provisional access unless it is deemed impractical. The law states that it is unlawful to treat a disabled person less favourably than an able bodied person for any reason in relation to their disability. Service providers have to make reasonable adjustments in order to facilitate a disabled person. Therefore, physical adaptations to real world properties to aid accessibility should be replicated online. An online equivalent to access ramps and automatic doors to buildings would be necessary to meet the requirements of all users without discriminating against disabled users.

This study is intended on exploring the current legislations and existing guidelines for designing and developing a usable and accessible e-commerce interface. The primary objective of the study is to create a narrative set of guidelines to assist users in designing and developing an e-commerce interface, so not to abandon those whom have a disability, as approximately 10 percent of all web users have some kind of disability [2]. An investigative analysis of the current major e-businesses, namely Amazon and eBay will be conducted in order to discover various website usability issues. Several validation tools and techniques as provided by the W3C and other websites will be used in order to gain an insight into the usability issues. Using the guidelines studied and current usability issues (as discovered from the analysis) a prototype E-commerce website will be designed and developed to assist developers in creating their E-commerce websites. The guidelines and prototype website will therefore be a point of reference for those whom wish to design and develop an E-commerce store in the future. The end solution will be developed from the guidelines researched and E-commerce specific guidelines created and adhere to all accessibility standards as an example of a wholly accessible E-commerce website.

III. E-COMMERCE AUDIT

In this section an early analysis of a well know e-commerce website is tested for conformity to current accessibility legislation and standards; identifying the current issues with the major e-commerce website “amazon.co.uk” using various validation tools and techniques. The aim is to uncover the current usability issues and provide a report for a set of guidelines to be produced and put into practise. It is not always possible to test each and every page of an e-commerce website as many e-commerce websites are vast and include thousands of pages of products, services and information. Therefore, it is necessary that a few selected pages are targeted to represent the entire website. For the purpose of this paper the main functional pages of the e-commerce websites will be tested, including the home page, search related pages, product pages and checkout. A User Experience (UX) audit will be conducted on a non-Silverlight, non-flash e-commerce website, namely Amazon.co.uk. Amazon is a well-recognised, leading Business to Consumer (B2C) e-commerce store for commodity items such as books and CD’s. Gary Schneider stated that; “People would visit Amazon.com whenever they wanted to buy a book because it would be the most likely store (physical or online) to have a particular title. After becoming satisfied customers, people would return to Amazon.com to buy more books and would eventually stop looking elsewhere.” [2].

The UX audit will focus on the barriers faced by those whom have a visual impairment. Determining the target audience assists forming the report to reflect the issues specific to those who will be affected by the issues. User experience is an extremely important aspect of e-commerce. If users have a bad experience using the website, they are unlikely to purchase a product from the website.

A. Methodologies

In order to obtain information on the usability issues of the current major e-commerce websites, several testing and evaluation tools unique to accessibility will be used, providing a report on the accessibility issues discovered. There are many web accessibility tools provided by the W3C used to assist developers in providing an accessible website. The W3C created a narrative set of guidelines, namely the WCAG, in order to encourage web developers to consider user accessibility when developing their websites. Performing accessibility and evaluation checks of the technical parameters of a website can be used to identify possible barriers to users with visual impairments. Once that the errors have been identified, amendments can be performed to rectify the errors and vastly improve the performance of the website.

B. Testing Tools

The testing tools used in this research work determine the conformance of the e-commerce websites against accessibility checks and also determine the conformance to the current accessibility guidelines, namely the WCAG 2.0 (AA). A select few of the testing tools will also investigate and evaluate web accessibility by users with colour blindness.

C. Automated testing

Automated testing tools are an effective method of highlighting potential errors and usability issues. Predominantly the automated testing tools are performed by online validators such as W3C validation service and automatically detect issues such as missing alternative text attributes and undefined document language types. However manual intervention is required in order to correct the problems highlighted.

The tools used to perform the audit are specified below:

- W3C Mark-up Validation Service (<http://validator.w3.org/>). The W3C validation service is an online testing tool that checks the validity of web documents in HTML, XHTML etc. The validation can automatically detect the character encoding and document type and documents the errors detected.

- Colour Blind Webpage Filter (<http://colorfilter.wickline.org/>). The Colour Blind Webpage filter is a simulation tool that reveals how a website looks to a user with colour blindness, including examples of the conditions; Protanopia, Deuteranopia, Tritanopia, Achromatopsia etc. simulating how the snapshot is viewed by a person with a colour blindness condition.
- Etre Web Accessibility Tool (<http://www.etre.com/tools/accessibilitycheck/>). The Etre Web Accessibility Tool evaluates the webpage against the WAI guidelines, relating to accessibility.
- A checker Web Accessibility Checker (<http://achecker.ca/checker/index.php>). The Achecker Web Accessibility checker checks single HTML pages against a range of accessibility standards, including the WCAG 1.0 & 2.0. The check can also be performed to conform to each of the priority levels, A, AA & AAA.

D. Audit Reporting Structure

First and foremost the authors will conduct a validation check on the HTML and CSS Mark-up language of the chosen website Amazon.co.uk. A validation check is simply a test to ensure that the Mark-up used conforms to the defined language type. The identified automated tool for checking compliancy and Mark-up errors is the W3C Mark-up Validation Service tool. The audit structure will be conducted by using each of the tools listed above to test each of the consecutive pages of the website. The homepage, search related pages, product/catalog pages and lastly the checkout pages will all be tested individually using the tools identified.

The tools will reveal the current usability issues and compliancy failures of the current major online retail businesses and provide detailed reports on the errors users with disabilities may face. This audit is focusing on the barriers faced by users with sight deficiencies such as colour blindness. The methodologies will enable the gathering of required improvements and barriers to overcome to produce a framework for an accessible e-commerce website. The main aim of the audit is to gather requirements to create a set of guidelines for developers to build improved, more accessible, usable websites. The audit will uncover the usability issues faced by users with impaired vision.

E. Audit of Amazon.co.uk

Users form their first impressions of a website homepage almost instantaneously, perceiving the colour scheme, credibility and usability of the website. Whether or not a user will purchase from the site is influenced by the credibility of the webpage i.e. whether or not it looks professional or amateur. To identify issues of Mark-up and CSS, the Amazon.co.uk homepage (www.amazon.co.uk) was entered into the address field of the W3C Mark-up Validation Service. Both the character encoding and document type was set to 'detect automatically' to see whether or not the document and coding types had been identified within the code.

Having configured the desired options the 'check' button was submitted and the service started.

The image shows the W3C Markup Validation Service interface. At the top, there is a blue header with the W3C logo and the text 'Markup Validation Service' and 'Check the markup (HTML, XHTML, ...) of Web documents'. Below the header, there are three tabs: 'Validate by URI', 'Validate by File Upload', and 'Validate by Direct Input'. The 'Validate by URI' tab is selected. Under this tab, there is a section 'Validate by URI' with the subtext 'Validate a document online'. Below this, there is a text input field for 'Address' containing the value 'www.amazon.co.uk'. Below the address field, there is a section 'More Options' with several settings: 'Character Encoding' set to '(detect automatically)', 'Document Type' set to '(detect automatically)', 'List Messages Sequentially' selected, 'Show Source', 'Show Outline', 'Clean up Markup with HTML-Tidy', 'Validate error pages', and 'Verbose Output' all unchecked. A 'Check' button is at the bottom right.

Figure 1 - W3C Validation of Amazon.co.uk

The check identified that Amazon.co.uk had 320 errors and 101 warnings.



Figure 2 - W3C Validation Error Report

Documented before the validation output report, the check identified the document type (DOCTYPE) was not stated within the document. Therefore, the validation report was forced to roll-back and validate the page against the default doctype; HTML 4.01 Transitional. The error is shown below in figure 3.

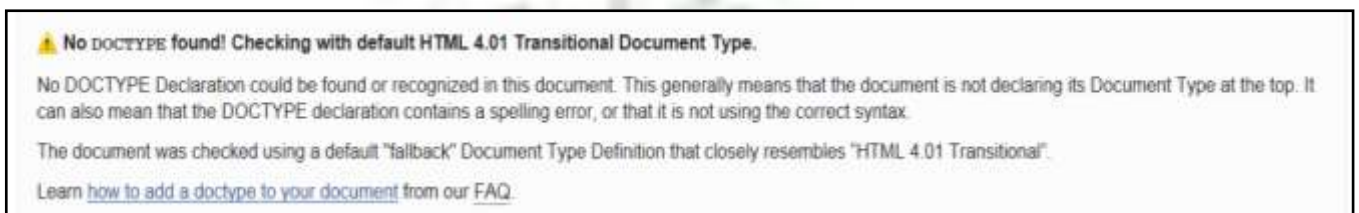


Figure 3 - DOCTYPE Validation Error

Many errors were identified in the findings of the validation report; this is due to the undeclared doctype which forces the validator to validate using a different doctype, which is more than likely to be the incorrect and generate false error messages. Before the Amazon.co.uk page can be declared as valid, a valid doctype is required. Having performed the general W3C validation service report, a more visual user-focused tool was used to identify the potential errors of the website homepage. A web accessibility check was performed using the Etre Web Accessibility Tool. The tool compares the submitted URL against the WAI accessibility guidelines and evaluates the findings.

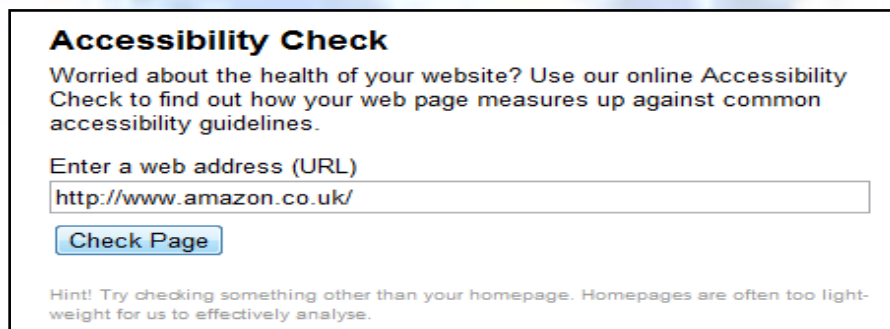


Figure 4 - Etre Web Accessibility Check

The URL was submitted and produced the results are shown in table I.

TABLE I. THE RESULTS PRODUCED




Priority 1 - "must fix"	 1 problem
Priority 2 - "should fix"	 35 problems
Priority 3 - "may fix"	 1 problem

Table I suggests that there is one critical error that needs to be fixed for the website to comply with the WAI guidelines. As it is a priority 1 requirement, the error must be fixed in order to provide the minimum, most basic level of accessibility. 35 other problems were identified and should be fixed providing the minimum accepted level of accessibility recommended by the European Union (EU). A 'may fix' error is suggested to be fixed to increase and maximise accessibility. The testing report indicated that one of the problems discovered was that nested tables were used i.e. tables placed within tables. Screen readers read website content in a linear fashion, however nested tables linearise poorly, therefore; the process by which a screen reader or speech browser interprets the content is compromised. Screen readers interpret html table's cell by cell (left to right, top to bottom) which is the correct sequence for reading tabular data; however nested tables do not work well with this process. One of the other errors listed within the report is the use of <iframe> elements with missing longdesc attributes. Often, a title attribute alone isn't enough to explain the iframe content; therefore it is recommended that a long description attribute is used to further explain the content and importance to blind users. The use of a long description attempts to convince blind users that accessing the content is worth their while. However, the longdesc attribute is poorly supported by the leading web browsers, therefore in order to provide the user with a description, a simple link to a page that describes the iframe content is required.

Below is an example of an HTML iframe long description attribute:

```
<iframe longdesc="URL">
```

An absolute or relative URL can be used. An absolute URL directs to another webpage;

```
longdesc="http://www.tomoliverlund.co.uk/framedescription.txt"
```

As opposed to using a relative URL which links to a file;

```
longdesc="framedescription.txt"
```

Solely the title tag alone is not enough to inform a blind user of the content within the frame. Therefore the website does not conform to the WAI guidelines, specifically guideline;

H45: Using Longdesc.

One of the other errors was that of an absolute font size. When an absolute font size is user, users who have a visual impairment are unable to resize the font as the font is static (often an image or text as opposed to using HTML and CSS styling). In terms of e-commerce and visually impaired users, if users are unable to resize text, users are unlikely to read the details of products, which in turn makes it unlikely that the user will purchase a product. This would result in a potential loss of sale through a denial of service to users with disabilities.

Having highlighted numerous accessibility problems using the tools above, it was then decided that a more in depth, detailed approach should be used to discover the actual errors of the homepage, with reference to specific guidelines of the WCAG 2.0 and the specific lines of code where the error exists. The web accessibility checker by AChecker provides a more detailed reporting structure highlighting the conformance errors (to WCAG 2.0), specific errors within the code and identifies what needs to be amended to remove the accessibility barrier. The report format was structured to view the errors by their corresponding guideline. The guidelines to check against was selected as; WCAG 2.0 (Level AA) - A web developer **should** conform to this checkpoint, checkpoints 1 and 2.

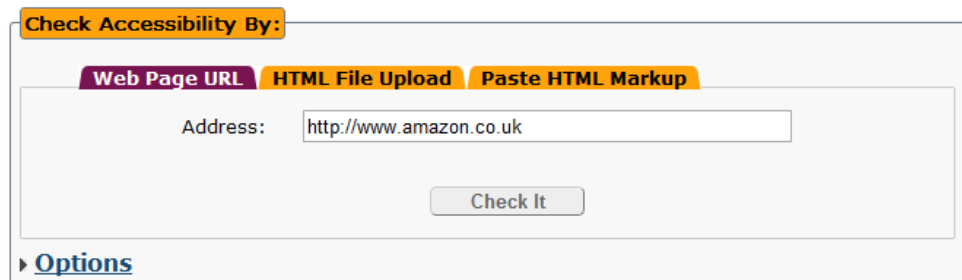
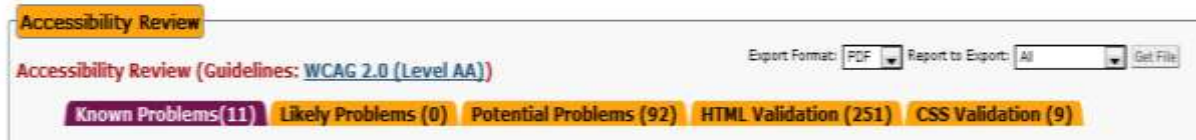


Figure 5: AChecker Accessibility Check

The check highlighted 11 known problems, 92 potential problems, 251 HTML validation problems and lastly 9 CSS validation problems.



The majority of errors reported were related to the insufficient contrast ratio of the foreground and background colour of the active link text. The repair note suggested that a sufficient contrast of 4.5:1 for standard text, or 3:1 for larger text was required in order to comply with guideline 1.4.

“1.4 Distinguishable: Make it easier for users to see and hear content including separating foreground from background. Success Criteria 1.4.3 Contrast (Minimum) (AA).

Check 303: The contrast between the colour of active link text and its background is not sufficient to meet WCAG2.0 Level AA.” (20).

Fixed size example: [colour contrast example](#)

Real size example (9.09 points): [colour contrast example](#)

The report signified that Amazon.co.uk failed to include an alternative text attribute for an image used as an anchor, i.e. the purpose of the image isn't stated. If the image is used as a link an alt attribute is required to describe the link destination. As discovered in the early analysis of the homepage using the W3C validation service tool, the document doctype is missing, conflicting with guideline 3.1 Readable: Make text content readable and understandable; Success Criteria 3.1.1 Language of Page (A). A HTML element is required to have a lang attribute as the attribute allows assistive technologies such as screen reader software to adapt and pronounce the syntax that matches the language of the content. Amazon.co.uk has failed to state a language type on the opening HTML element. To repair the missing doctype element, Amazon.co.uk should implement the following:

```
<html xmlns="http://www.w3.org/1999/xhtml" xml:lang="en-gb" lang="en-gb">
```

The colour blind webpage filter is a simulator that enables a user with full vision to reveal how an image may appear to a user with a colour blindness condition. The filter allows the user to select a colour filter and simulates how the website would be viewed by someone with a colour blindness condition. The tool simulates a variety of colour blindness conditions; Protanopia, Deuteranopia, Tritanopia, Monochromacy etc. The screenshot below is a screenshot of the original Amazon.co.uk homepage without a filter applied. This is how a user with full visual capabilities views the Amazon.co.uk website.



Figure 5 - Amazon.co.uk Website Screenshot

The first filter to be applied is the Protanopia filter (red/green colour blindness).

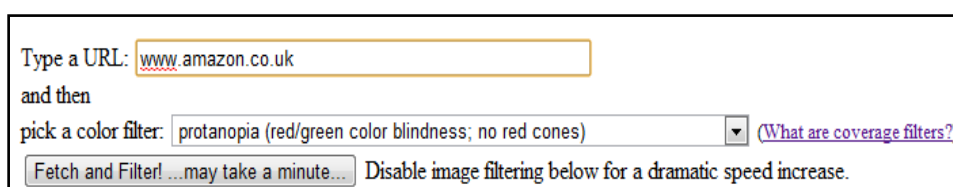


Figure 6 - Protanopia Filter Application

The Protanopia simulation produced the following results:



Figure 7 - Result of Protanopia Filter

As depicted in the screenshot above, the appearance of the website appears largely the same, albeit a little contrast reduced. However the links, menu and general use of colour is appropriate for users with Protanopia. Next, the filter was run using the Deuteranopia filter applied. The Deuteranopia simulation produced the following results:



Again, the results appeared largely the same as the results for Protanopia, similar to that of the original screenshot. The results can be explained by the conditions; Protanopia – no red cones and Deuteranopia – no green cones. As the website homepage doesn't feature these colours the webpage remains unaffected and is viewed similarly, if not the same as how a user without a colour blindness condition views the webpage. The next test was to test the webpage using the Tritanopia webpage filter. Users with Tritanopia colour blindness condition (blue/yellow colour blindness) have missing blue cones, therefore it is expected that the screenshot will appear different in colour. The Tritanopia filter produced the following screenshot:



Cases of Tritanopia are very rare, but users who have the condition are sensitive to the colour blue. There is a significant change in colour of the original 'orange' elements of the website as they now appear a shade of pink. The original light blue is now a darker, high contrast blue, which could potentially throw up errors when roll-overs are used on active menu links. Lastly, the Monochromacy filter was applied. The screenshot displayed the website in greyscale, only varying in contrast and brightness.



As the results above indicate, in terms of visibility for colour blind users, the website performance and overall user experience is excellent as the webpage renders legibly. Amazon.co.uk has chosen colours that contrast well and appears largely the same for most colour blind users.

F. Search pages

A search facility is a critical, necessary function of any e-commerce website. In order for a user to purchase a product, they need to be able to locate it. The search must have a simple user interface and search the entire website and the results must be legible to all users. "Site designers must create sophisticated, but simple search engines capable of delivering the goods on the user's first search query." (23).

Firstly, a manual search was conducted using the main search feature of the Amazon.co.uk website. For the purpose of this report the book; 'Steve Jobs biography' will be used as a search criterion.



The screenshot above displays the search results of the search keyword; 'Steve Jobs biography'. The results are listed in a structured manner, categorised by the relevance of the product to the search term. The results display a thumbnail image of the product and are upfront with the total cost of the item including shipping. Red and green text is used to highlight delivery times and pricing, which could potentially cause problems for users with Protanopia and Deuteranopia. The colour blind simulator was used to check for the potential issues. The screenshot below displays the results page with the Protanopia filter applied:



The results still appear to be legible; however the colours of the red/green text have changed to a less obvious colour. When tested using the Deuteranopia filter, the screenshot appeared almost identical to that above.

G. Product page

Upon initial use of the product page, it was noted that there were no roll-over states for the button; adding an item to the shopping basket. Using a roll-over state would help identify the placement of the user's cursor and confirm the actions of their doing. The product page is again, upfront with pricing and has a notification of whether or not the product is in or out of stock. Delivery estimates are also provided. An Accessible product page is a necessity. If users are unable to use the product page, items cannot be purchased. Using the Achecker Web Accessibility Checker to check for errors against the WCAG 2.0 (AA), numerous avoidable errors were reported, including missing alternative text and colour contrasting issues. Again, the issue of the undeclared doctype impeded the results. The audit report displayed 11 know problems, all of which could be rectified with little effort to ensure full accessibility by visually impaired users.



The product details, such as the dimensions and page statistics appear midway down the product page. Amazon.co.uk pushes suggestions of other products purchased by users who purchased the Steve Jobs biography and products that are frequently bought together.



The above suggestions are secondary to the details of the product, therefore should be placed after the details of the product have been covered. Having to scroll a considerable way down the product page for the product details is not ideal and could potentially put off users from purchasing a product if they cannot find the information they seek. Furthermore, the Product Description is placed towards the bottom of the product page and is easily lost in the clutter of the product page. The description along with the product details should have placement towards the top of the product page as they have more relevance to the product and are of more importance to the user than what other users have previously bought. The customer reviews elongate the height of the page, making it an arduous task to scroll to the bottom of the webpage. The customer reviews do not have a character limit and display the full review elongating the page unnecessarily. A line break, such as '...read more' should be implemented, allowing the users to click to read more if they wish to do so. A character limit should be introduced to constrain the length of the reviews. Absurdly long customer review spanning the full height of the webpage and more:

100 of 116 people found the following review helpful

4.0 out of 5 stars **Flawed man, Flawed autobiography**, 28 OCT 2011

By [hemmerlyguy](#) - [See all my reviews](#)

The common view: Steve Jobs: The Definitive Biography by Walter Isaacson, Kindle Edition

I was eagerly anticipating this biography. Steve Jobs is a man who has fascinated me for many years and I looked forward into gaining an insight into the man who has had such a big effect on the modern world. Another reason why this biography was so potentially interesting was that it was authored by a man who for a long time was intensely private, but was now facing his own mortality.

The book itself is written by famed biographer Walter Isaacson, who had previously written critically acclaimed biographies of Einstein and Benjamin Franklin. However interestingly this is the first time he had written one about a living person, especially one he knew well.

The biography itself starts off promisingly with a description of Steve Jobs' early life, his adoption, his immersion in the counter culture and the early days of Apple. I think what is most fascinating is the ability for someone like Jobs to just walk into a job with no qualifications or experience, which shows a lot about Silicon Valley in those days. As the story unfolds we see the other side of Jobs, the petulant individual who could antagonise as much as inspire. It becomes clear that one of Jobs' talents was his ability to understand the expectations and weaknesses of an individual. However he is often as not used that ability to destroy as much as achieve.

The story moves on to the breakup with Apple, his creation of NeXT and Pixar and his triumphant return to Apple. It is at that point that I feel the autobiography loses steam. The description of his success at Apple could have been written just as well by someone at Apple Inc. and while his successes should be celebrated, there is not enough critique of the mistakes made on the way. We also lose Jobs the individual as it concentrates on Apple and some of the individuals there. Maybe its because the author was talking to people still employed at Apple, but we get less of Jobs the petulant tyrant and more of Jobs the inspirational genius. The book ends with Jobs fight against cancer. This is again where we get a better insight of his true character.

If you are buying this book like me to get a insight into the true Steve Jobs, you may be disappointed. I feel it is not often the biographer perceives the veil. Stranger, probably he is the most open when he is discussing the music he had on his iPod. There is also a nagging feeling that Steve Jobs was using this book to extend his famed reality distortion field beyond the grave and I feel the author to often did not go deeply enough into some of the issues raised. For example Jobs stated a number of times that he felt the use of LSD was an important contributor to his success, but the author never questioned his feelings on drug taking and how it affects society. Also the contrast of a man who was proud of his counter culture values, but at the same time amassed billions, sometimes at the expense of close colleagues, and never was a believer in philanthropy was never adequately explored. In some ways you feel the author got too close to the subject and at times loses his objectivity. In that he is not alone, Steve Jobs had that affect on people.

However despite its flaws it is still a recommended read and if nothing else provides a fascinating insight into the early days of Silicon Valley. It is also the closest anyone will now get to the modern day aphorism that was Steve Jobs.

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H. Checkout page

For the purpose of this audit, the item 'Steve Jobs biography' was added to the basket and checkout process proceeded. Almost instantaneously, it was apparent that Amazon.co.uk requires users to register with the website before they are able to checkout with the product. Requiring users to register first as opposed to checking out as a 'Guest' puts off users from using the website, as they may wish to use the website as a one off and don't want marketing emails associated with the account.

An account was created to illustrate the checkout stages when purchasing a product from the Amazon.co.uk website. The progress bar indicated that there would be a total of 7 stages before checkout would be completed.

Once that the details had been entered, the create account button was submitted.

The screenshot shows the Amazon.co.uk checkout page. At the top, the Amazon logo and navigation links (WELCOME, ADDRESS, ITEMS, WRAP, DISPATCH, PAY, CONFIRM) are visible. Below the navigation, there is a section titled "Want an alternative to home delivery?" with a link to "Search for a Pick-up Location near you". The main form is titled "Enter a new delivery address." and includes fields for Full Name, Address Line 1, Address Line 2, Town/City, County, Postcode, Country, and Phone Number. A "Continue" button is at the bottom. To the right, there is a section titled "Search for a Pick-up Location near you" with options to search by address, postcode, or landmark, and a "Search" button.

To test the validation of the form fields, the postcode was entered into the phone number field and the postcode field left blank. Upon continuing the following validation message was displayed:

The screenshot shows the Amazon.co.uk checkout page with a "Verify Address - Amazon.com Checkout" message. A yellow banner contains an "Important Message" stating: "There is a problem with your address submission. Please fill in all required address fields." Below this, the address form is shown with the following fields: Full Name (Visual E-Commerce), Address Line 1 (Liverpool John Moores University), Address Line 2 (James Parsons Building, Byron Street), Town/City (LIVERPOOL), County (Merseyside), Postcode (empty), Country (United Kingdom), and Phone Number (L3 5UZ). A red error message "Please enter a valid postal code." is displayed below the Postcode field. Buttons for "Dispatch to this address" and "Return to address book" are visible.

The postcode validation worked well; however, the phone number field appeared not to have a validation integer string as it accepted the postcode in the phone number field. Amazon.co.uk need to be careful in remaining consistent with validation and error messages. The next step required a confirmation of delivery address, after having already clicked dispatch to this address. The checkout steps have the user repeating information they have already submitted which is frustrating and increases the time spent at checkout.

The screenshot shows the Amazon.co.uk checkout page with a "Verify your delivery address" message. The message states: "Visual E-Commerce, there's a problem with the address provided - we've marked our suggestions in red below. Please choose which version of the address you want to use, or click edit next to the address you want to change." Below this, there are two address options: "Original address" (Visual E-Commerce, L1MU, Byron Street, Liverpool, Merseyside, L3 5UZ, United Kingdom) and "Suggested Address" (Visual E-Commerce, Liverpool John Moores University, James Parsons Building, Byron Street, LIVERPOOL, Merseyside, L3 3AF, United Kingdom). The "Suggested Address" fields are highlighted in red. Buttons for "Dispatch to selected address" and "Return to address book" are visible. Below this, there is a section titled "Or enter a new delivery address" with the same form fields as the previous screenshot.

Having reconfirmed the dispatch address the next stage requires a credit/debit card to be entered to purchase the product.

The screenshot shows the Amazon.co.uk checkout page. At the top, there's a navigation bar with 'amazon.co.uk' and a progress indicator: WELCOME ADDRESS ITEMS WRAP DISPATCH PAY CONFIRM. Below this, a heading asks 'How would you like to pay?'. A promotional banner offers a £10.00 discount on a £15.00 purchase with a credit card, plus 2% Loyalty Points. Below the banner, there are two main sections: 'Your credit cards' and 'Other payment options'. The 'Your credit cards' section shows two cards: a Solo/Maestro card and a Visa/Delta/Electron card. The 'Other payment options' section includes 'Credit or Debit Cards' and 'GIFT Cards & Promotional Codes'. A 'Continue' button is visible at the bottom right of the payment options section.

Having entered a payment method, continue was submitted to reach the final checkout stage; Review and Place Order.

The screenshot shows the Amazon.co.uk checkout page at the 'Review Your Order' stage. The navigation bar is the same as in the previous screenshot. Below the navigation bar, there's a heading 'Review Your Order' and a sub-heading 'By placing your order, you agree to Amazon.co.uk's Privacy Notice and Conditions of Use & Sale'. The page is divided into several sections: 'Delivery Address' (Tom Lund, 7 Langdale Avenue, Pensby, Winal CH615XP, United Kingdom, Phone: 01516481463), 'Payment Information' (visa ending in 6316), 'Gift Cards & Promotional Codes' (Apply), and 'Order Summary' (Items: £11.00, Postage & Packing: £3.00, Total before VAT: £14.00, VAT: £0.00, Order Total: £14.00). Below these sections, there's a 'Guaranteed delivery date: April 7, 2012' and a 'Choose your Prime delivery speed' section with options for 'FREE First Class (up to 2 business days)', 'FREE One-Day Delivery: get it on Saturday, April 7', and '£4.49/item Express Delivery: get it guaranteed by 1pm on Saturday, April 7'. A product preview for 'Steve Jobs: The Exclusive Biography' is shown. At the bottom, there's a 'Need help?' section with links to 'help pages' and 'contact us', and a 'Conditions of Use | Privacy Notice | 1996-2012, Amazon.com, Inc. and its affiliates' footer.

The previous checkout stages were arduous and took a considerable amount of time to complete. Amazon has separated the checkout process into several stages to make the process easy to complete, however there are too many stages. A total of 7 stages of entering information were required before the product order could be placed. Amazon.co.uk could do with reviewing, simplifying and streamlining their checkout process in order to achieve a more usable user-interactive checkout.

IV. E-COMMERCE GUIDELINES

In this chapter the author will propose a set of e-commerce specific guidelines derived from the results of the early analysis of the major e-commerce websites in order to combat the usability issues faced by users with a visual impairment. The guidelines will then further be used to develop a working prototype that adheres to and completes the visual accessibility framework. The following framework guidelines aim not to replace, but to comply to and be applicable to all e-commerce websites.

A. General

1) Guideline 1.1

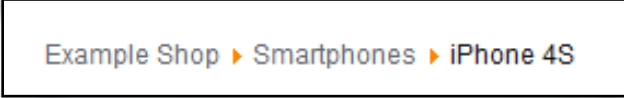
Make use of headings, sub headings and use breadcrumb navigation to inform users of their position on the website.

Text headings and sub headings that are analysed by search engines are headings such as H1, H2, and subheading H3. Paragraphs are also analysed for readability, including the alignment, font used and numeric value of the words.

<h1> is the HTML element for the first heading of a web document. <h2> is used as a subheading often defining a summary of the paragraph content. Displayed below is HTML source code illustrating the use of headings and heading hierarchy.

```
<h1>Main Title</h1>
<h2>Sub Title</h2>
<h3>Sub-Sub Title</h3>
<p>Paragraph</p>
```

There are also heading elements that range up to <h6> used to highlight the least important heading, however, headings h1 to h4 are the most commonly used. Most users scan text rather than read website content, therefore it is a good idea to provide users with a heading hierarchy and use sub headings where possible to outline to the user what the content is about. Web Credible recommend that developers should be roughly aiming for one sub-heading every two to four paragraphs. Most importantly, the sub-headings should group on-page content into logical groups, to allow site visitors to easily access the information that they're after (31). The term 'breadcrumb', is a term adopted from the fairy tale Hansel and Gretel whereby Hansel left a trail of breadcrumbs as an indication of how to get back home. In terms of a virtual breadcrumb trail a trail can be created to help users navigate within websites and provide users with the information as to where the user is within the site, allowing the user to 'jump' to any previous page in the trail without having to use the browser navigation tools (32). Breadcrumbs, when used, allow users to efficiently navigate the website. Path breadcrumbs, as shown in the figure below display the navigation structure and paths taken to reach the current destination.



Example Shop > Smartphones > iPhone 4S

Figure 8 - E-commerce Breadcrumb Trail Example

Each of the steps separated by the orange indication arrows are clickable links and return the user to the previous step when clicked. Thus, usability is enhanced. However, a further investigation as performed by Rogers and Chaparro indicated that; of the participants that were exposed to a site with a breadcrumb trail (n=30), 40% used the breadcrumb five or more times to navigate on the site (Range = 5 - 31, n=14). However, this accounted for only 6% of the navigation overall. The Back button, the main Navigation bar, and embedded links were used the majority of the time (33).

2) Guideline 1.2

A text equivalent for every non-text element should be provided (e.g. via 'alt', 'longdesc', or in element content) (34).

It is essential for a developer to include alternative text attributes on non-text elements such as images as visually impaired users have difficulty viewing images and other media rich content, therefore an alternative description is required. This includes: images, graphical representations of text (including symbols), image map regions, animations (e.g., animated GIFs), applets and programmatic objects, ASCII art, frames, scripts, images used as list bullets, spacers, graphical buttons, sounds (played with or without user interaction), stand-alone audio files, audio tracks of video, and video (35). The source code below makes use of an 'alt' attribute, defining an alternative description of the image for the visually impaired.

```

```

If an alternative text attribute is not suffice to explain the image, a 'longdesc' attribute can be used to convey the purpose and relevance of the image to the user.

```

```

In 'ipad.html':

An image of an iPad displaying the e-commerce example shop used in order to display the functionality of the website when viewing the website using mobile devices.

If the above 'longdesc' feature is unable to be interpreted, a title attribute can be used in order to convey the relevance of the image to the content.

```

<a href="ipad.html" title="Description of iPad compatibility"></a>
```

3) Guideline 1.3

Use Mark-up and CSS where possible allowing text-size & other accessibility functions to operate correctly.

The use of mark-up allows developers to consistently provide information to the viewer dynamically as using mark-up improperly hinders accessibility (36). The use of HTML 'lang' attribute within the header of the HTML page defines the language used. Defining the language attribute assists screen reader speech synthesisers in rendering the content in a more direct and meaningful manner, based upon the language chosen and the cultural practices of the chosen language. E.g. defining the HTML language as 'en' defines the language as English which is culturally read in a linear manner from left to right and 'en-gb' contains a regional sub tag and defines the language as British English, taking into account the distinction between countries that predominantly use the English language.

HTML language tag, specifying the language code and sub tag for the content in an element:

```
<meta name="language" content="en-GB">
```

XML language defined for content within XHTML documents:

```
<html xmlns="http://www.w3.org/1999/xhtml" xml:lang="en-gb" lang="en-gb">
```

As aforementioned in Chapter 2, the use of correctly written mark-up is essential for web-based screen reader software. As an example of the latter, typically blind or severely vision impaired users will use synthesised text-to-speech (TTS) software in order to access websites and interpret website content. However, improper hierarchical use of headings such as H1, H2 and H3 sub-headings can confuse screen reader software, often resulting in a parse error; 'there are no headings on this webpage'. If a developer uses an image of a title rather than CSS styling the title, the font increase and decrease functions will not work as the title is static, therefore incomprehensible by users with low vision.

"Screen readers can only read textual elements of web pages, so graphics and scripts cannot be interpreted" (37). If alternative text attributes for graphical images are provided, screen readers will pick up and explain the relevance of the graphic to the user, however, if missing; the user could miss out on useful or significant information. It is essential that developers control the website modules using CSS styling as apposed using images to convey the information. If graphical images and/or animations are used, provide relevant alternative text attributes in order to explain the importance of the image. The alternative text should also describe the appearance of the visual content of the image, to convey the illustration. Users with sight impairments often view small portions of the website content at one given time and may also use screen reader software to convey the content of the webpage, therefore the content is required to contain sufficient headings, tab index, tables, structured navigation etc. in order to serve its purpose and portray the content to the user. The entire paragraph above is concerned with checkpoint 3.1 of the Web Content Accessibility Guidelines 1.0 (WCAG): "When an appropriate mark-up language exists, use mark-up rather than images to convey information. [Priority 2]." (38).

Not only does correctly formed CSS enhance the usability for users with visual and other sensory impairments; correctly standardised CSS assists website Search Engine Optimisation (SEO), reflecting relevant content through the use of relevant key words and terms. Search engines such as Google, read website content and ranks the website content within the results based on the relevance of the search term. Therefore, if correctly used mark-up and alternative text attributes are provided, it is viewed as a 'vote in your favour' and ranked higher up in the search results of Google as more content is relevant to the search term.

4) Guideline 1.4

Website logo should be placed to the left and linked to the website homepage. Linking the website logo to the website home page assists users in navigating home. The aim is to provide as many routes possible to the website pages through the use of strategically placed links, enhancing the usability of the website. The logo area needs to be prominent and attract the attention of the user when the user enters the website. The upper-left corner is usually the best placement for languages that read from left to right (39). A tag line of less than 100 characters may also be placed below the logo to summarise the website content. However, a tag line may not be required if the company logo is self-explanatory.

5) Guideline 1.5

Ensure there is sufficient contrast between the background and foreground ensuring visibility is consistent for all users. To accommodate colour deficient users, such as users with Monochromacy a sufficient high colour contrast option must be used. Text and background colours must be legible and of a sufficient colour contrast. Select colour combinations that contrast well together and increase lightness between colours. Make use of colour hexadecimal and/or RGB numbers over names of colours in the CSS style sheet. In accordance with the WCAG 2.0 guidelines a 1.4.3 Contrast (Minimum) should be used: The visual presentation of text and images of text has a contrast ratio of at least 4.5:1, except for the following: (Level AA) Large Text: Large-scale text and images of large-scale text have a contrast ratio of at least 3:1;

Incidental: Text or images of text that are part of an inactive user interface component, that are pure decoration, that are not visible to anyone, or that are part of a picture that contains significant other visual content, have no contrast requirement.

Logotypes: Text that is part of a logo or brand name has no minimum contrast requirement. (19).

6) Guideline 1.6

Provide the option of resizing text; increase and decrease text-size. An option to resize text is an essential aspect of web design to enable users with disabilities to operate the web. Most commonly, web browsers have the ability to change the text size of web pages however, if static text is used the text is unable to be resized. Developers cannot solely rely on the user's web browser to alter the text size. An accessibility option to resize text shows the user that the website is user friendly and is accessible by users with a visual impairment.

Guideline 1.4.4 of the WCAG 2.0 states:

1.4.4 Resize text: Except for captions and images of text, text can be resized without assistive technology up to 200 percent without loss of content or functionality. (Level AA) (19). A user with a visual impairment may be required to increase the text size to be able to read the content as they may struggle to read small text. Therefore, the option of increasing the text size enables the user to read the content more easily, thus removing the barrier of illegible content. The text size is required to be increased up to twice the original text size i.e. 200%. Keyboard Accessibility: Enhance website functionality and navigation available from the use of a keyboard.

For many users with disabilities such as visual impairments, the use of a keyboard to navigate a website is required. Aim to ensure that all website functionality can be performed by the use of the keyboard only, without including timing requirements for specific keystrokes.

B. Navigation

1) Guideline 2.1

Design consistent navigation that is simple, intuitive and obvious and remain in the same locations on each page (40). Design pages to use consistent navigation methods. This is particularly important for people with low vision using screen magnifiers. Since they cannot see the entire screen at once, the more they can predict where elements are, the easier it is for them to get an overall feel for a page. Organization should be as consistent as possible so people don't have to spend time relearning navigation on each page, which might prevent them from finding the page's actual content. (41) According to (40) navigation controls must be located in the same location on every page. The navigation title attributes must also be self-descriptive matching the headings of the destination pages. Child menus should only be used if necessary and the links should be direct to the relevant placement of the pages.

2) Guidelines 2.2

Navigation must make use of roll-over and highlighting functions providing feedback to the user of their position on the navigation. Orientation cues are excellent for providing the user with feedback as to where they have placed their cursor and also the highlighted navigation will indicate what page the user is on. Wayfinding orientation will inform the user of their current position within the website. For instructional purposes the figure below portrays an example of a horizontal navigation menu with the current page 'active' as yellow (#ffc000) and the cursor 'rollover' as blue (#397bd9).

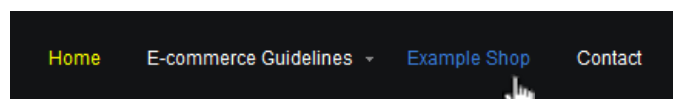


Figure 9 - Navigation Highlighting Functions **CSS Navigation Active:**

```
/* Navigation - Active */
#rt-menu ul.menu li.active a, #rt-
menu ul.menu li.active a:hover, .menutop li.root.active > .item, .menutop li.root.active > .item:hover, .menu-type-
splitmenu .menutop li.active .item {color:#ffc000;}
```

CSS Navigation Rollover:

```
/* Navigation - Hovers */
#rt-menu ul.menu li a:hover, .menutop li.root > .item:hover, .menutop li.active.root.f-mainparent-
itemfocus > .item, .menutop li.root.f-mainparent-itemfocus > .item, .menu-type-splitmenu .menutop li:hover > .item {
color:#397bd9;}
```

C. Search Functions

1) Guideline 3.1

A search function should be visible and remain on every page in the same position. According to (40) the search function is the most important feature of an e-commerce website. The search function must be easy to find and search the entire site. Therefore, it is recommended that the search function be placed in a position users expect to find it, like the upper-right or upper-left corner of a page. For users with low vision or no vision, this is particularly important (42). The search feature must be in the same position on each and every page and be of adequate width with enough space for at least 30 characters (39).

2) Guideline 3.2

Advanced search and filter options should be considered to refine the search results. An advanced search feature is a necessary feature of any e-commerce website. The advanced search allows users to refine the results that they seek, enhancing the usability of the website. It is recommended that the user is able to perform a search of specific categories to assist in discovering the search results. To ensure that the search is kept as simple as possible offer users the option to do an advanced search only when the search results are presented. An AJAX search module used within this thesis displays the search results in real-time and includes advanced usability including script enhancements for intuitive navigation.

3) Guideline 3.3

The search function must allow users to search by product name, SKU code, category, manufacturer and product price. The search feature must have the ability to search the entire website. The search function should also allow users to search by product name, SKU code, category, manufacturer and product price in order to help users refine their search category and results.

D. Product Catalog

1) Guideline 4.1

Product layout must be consistent and in a grid format e.g. three products per row. Products must be categorised and in a layout that is clear, concise and correctly formatted. The product layout should remain uncluttered and make use of whitespace. Dependant on the amount of space, it is recommended that you use three products per row with sufficient padding between product images to help individualise products.

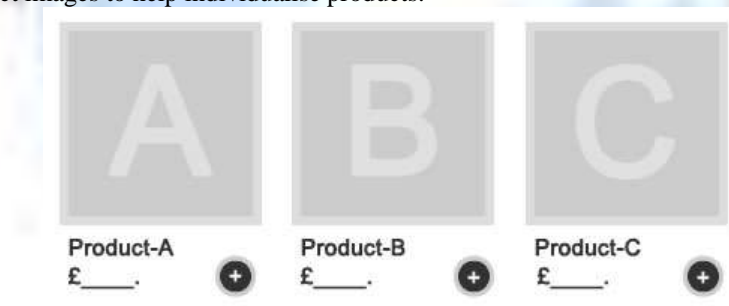


Figure 10 - Product Layout Example

2) Guidelines 4.2

Present accurate, consistent and detailed descriptions and images of products (43). Product descriptions should remain accurate, descriptive and provide the user with sufficient information about the product. The product page should present the details of a single product only to avoid confusion between other products; however related products may be displayed as a secondary focus towards the bottom of the product page. The product image should be recognisable, accurate and of high quality with as few visual distractions within the image. "Recognising a familiar item visually is easier for some people than recalling its name." (44). Provide users with clickable thumbnail images providing several views of the product from all angles, including different variations of the product such as product colours. However, the importance of displaying multiple images depends entirely on the product. If a detailed image is not required, then it is not necessary to provide the user with one. According to (44) users sometimes wanted to see other views of items (especially clothing and furniture). Seeing the side or back of an item was important to their purchasing decision.

To accommodate users who have difficulty seeing, or who turn off images on their browsers, it remains important to provide meaningful ALT text. ALT text is what appears when the user has turned off images, and it's also what screen readers, or voice browsers, speak (44).

3) **Guideline 4.3**

Provide users with the total product price (and currency); be upfront with pricing on both the category and product pages. One of the main factors of success of an E-commerce website is that of honesty. An honest retailer will gain the trust of the user i.e. the person's willingness to invest time, money, and personal data in an e-commerce site in return for goods and services that meet certain expectations (45). Therefore, it is good practise to be upfront with regards to product pricing. If possible, provide the user with a price breakdown of price before tax, price after tax and total price including shipping. If products are discounted, display the RRP and discounted price. The figure below is a snapshot of Amazon's upfront approach to product and delivery pricing:



Figure 11 - Upfront Pricing on Amazon Product Page

The Nielsen Norman Group Conducted a test on 20 e-commerce sites and reported that users appreciated seeing information about additional costs right on the product page, rather than waiting until the checkout process. Some, but not all users recognized that the total cost would depend on where the item was shipped (44). Indicate the product pricing in the relevant currency such as (£)GBP for United Kingdom and (\$)USS for the United States.

4) **Guideline 4.4**

Provide sufficient product availability information. Products should remain on the product page even if out of stock. Availability information is important to users. If a product is out of stock and isn't indicated on the website, allowing a user to purchase the product it would take a longer amount of time to be delivered, sacrificing the buyers trust. If possible keep the user informed of stock levels. Items that are unavailable for immediate purpose should be appropriately labelled 'out of stock' and not be removed from the product catalog. If the product were to be removed, the user would potentially go elsewhere to shop for the product. However, if the product remains competitive and is worth the wait for increased stock users are likely to bookmark the product page and check back at a later date. If a shipment of stock is expected on a particular date, label the product with the delivery of stock estimate date, keeping users informed of your stock levels builds their trust in the company. The length of time that the user is willing to wait can depend on several factors, including how much the user wants the item and whether the user can obtain a suitable alternative more quickly. If a product is not available right away, the user may opt to:

- Wait for the site to ship the item
- Shop elsewhere
- Give up on that item, perhaps choosing something else
- Buy nothing (44)

5) **Guideline 4.5**

Users should be able to add items to their shopping cart without having to register first. Registration must always be optional. Requiring registration before or during a purchase drives away business. If a user fails or refuses to register, and registration is required, the failure results in a sales catastrophe for the site, which is not what either the prospective buyer or seller intended. People who give up on a website may not be back again (46). Allow users to add items to their cart without having to register first. Provide the option to register with the website, but do not force registration. "Of the nine sites that required registration, four sites experienced complete purchase failures with one or more users because of problems during login and registration. Allowing customers to register optionally after a purchase is much better, because then it doesn't interrupt or prevent the sale, and it is less offensive to customers because they have a choice" (46).

E.

F. Shopping Cart and Checkout

1) **Guideline 5.1**

Simplify and streamline the whole ordering process, obtain only required information. It is important to simplify the ordering process of purchasing a product to allow users to checkout with their desired shopping basket as smoothly and

as quickly as possible. By simplifying the process, obtaining only required information; users are less likely to abandon their shopping cart if they are faced with an abundance of required text fields irrelevant to the purchasing of the product. Obtaining only required information saves time and simplifies the whole ordering process. Avoid confusing the user; aim to ensure that the text fields are self-explanatory and easy to complete, making use of a tab index for quick keyboard navigation.

2) Guideline 5.2

Show users the checkout stages using a progress bar and highlight where they are upon checkout. Provide users with a linear procedure to completing the checkout process. A progress bar identifies at what stage the user is at upon checkout. An indication of the steps to complete is often enough to encourage shoppers to checkout and purchase the items in their shopping cart. Keeping the user informed of their progress at all times puts the user at ease. Illustrations of the checkout processes are often used as an indication of progress, having the steps to complete 'greyed out' as a secondary step to the current step to be taken. However, the Nielsen Norman Group discovered that upon checkout; "the only problem with these graphics was that users sometimes tried to click the graphic to skip to a later step, typically shipping, because they had questions about that step of the process" (46). To address this problem, provide the user with tool tips and guidance on how to checkout, providing obvious action buttons to continue to the next checkout step.

3) Guideline 5.3

Highlight required form fields. When designing and developing form fields it is wise to use a CSS Focus state to help specify which form field the user has clicked on, highlighting the field ready for user input. The CSS example below portrays the use of a border colour to signify the form field selected.

```
textarea:focus {  
border: 2px solid #ffc000;  
}
```

The highlighted field focus above is highlighted in a bold yellow colour to signify the field selected. It is also important to highlight incorrect or missing required form fields that the user may have missed. Required fields are often marked by an asterisk (*). This is often standard procedure on many websites upon checkout and registration, however if a required field is missed such as a credit card expiry date then the required fields become highlighted upon validation. A red border colour is often used to highlight a missing required field as the colour red is associated with an error or wrong doing.

4) Guideline 5.4

The shopping basket is to be placed in the upper most top right hand position of the E-commerce website and indicate if it contains products.

The shopping cart must explicitly display the active content within the cart enabling the user to retrieve and checkout their chosen products at a later stage. When a user adds an item to their shopping cart, provide a link to checkout and alternatively provide the user with a link to 'continue shopping'. This allows the user to remain on their current page and continue to add products to their basket as they may wish to purchase more than one item. According to P. Markellou the best location to place the shopping cart is at the right top area as users will look there first to find the link. A visual indication whether the cart contains product must be shown in the shopping cart. (47)

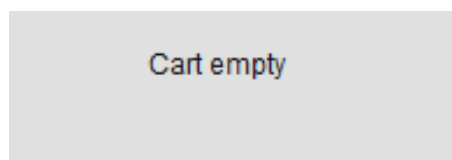


Figure 12 - Shopping Cart Empty

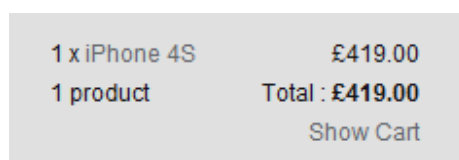


Figure 13 - Active Product in Shopping Cart

Typically when an item is added to the cart, the e-commerce site will create and store an HTML 'cookie' either on the client's browser or server side; if the client has selected an option to prevent cookies from being stored on their machine. A HTML cookie is a piece of state data that is stored to allow the user to return to the origin of the original state. For example, if a user was to add an item to a basket and then leave the website all together, a HTML cookie will be stored that remembers the item added and current website state and will be displayed in the basket once that the user returns to the website and is returned to the original state. Ensure that the shopping cart remains in the same placement on each page of the website. Users with visual impairments often memorise and/or visualise website framework to allow them to operate the website with ease; however, if placements of important website aspects, such as an e-commerce shopping cart were moved from page to page, this would confuse and frustrate the user and could be viewed as an unfair dismissal of service.

5) Guideline 5.5

Highlight delivery costs on order summary before the purchase is made. Be upfront with pricing. If a product demands a fee for delivery, include the fee in the early stages of the checkout process. The number one cause of abandoned shopping carts is the shipping pricing is too costly and is only revealed upon the final checkout stages.

6) Guideline 5.6

Display help and tool tips for form fields. If text fields are unobvious, provide the user with tool tips in order to explain the details required. The tool tips are often displayed if a user places the mouse cursor over the title of the required field as a directional tip to how to perform the procedure or complete the required form field. Tool tips may also appear as validation is put into place, such as a missing required form field. A tool tip will be displayed explaining the reasons for the submission error.

V. CONCLUSIONS

The research and development of this paper has covered all aspects of the usability issues faced by users with visual impairments and has provided a solution and recommendations for accessible user interface design. This paper has provided an example of measures to improve accessibility for the visually impaired. The guidelines determine recommendations for accessible e-commerce websites. The audit has helped to uncover the unique requirements of those who have a visual impairment and has provided developers with a framework to assist them in producing usable website designs. The Framework helps developers to develop websites in accordance to the guidelines and aim not to abandon users with visual impairments. The testing methods used within this thesis have proven to be successful, although the testing tools are concerned with disabilities in general, a select few tools were visual specific, such as the colour blind tool.

The tools used therefore have identified errors not solely concerned with visual disabilities, but by which users with other disabilities may face. As a result of this, the prototype website, when tested, still contains several errors. However, these errors are not specific to the visually impaired and do not hinder access by a user with a visual impairment. The paper has provided developers with new standards to follow in developing e-commerce websites that are accessible by all users with a visual impairment. The framework has proven to eliminate the errors outlined in the initial audit and make e-commerce websites more usable, catering to the requirements of the visually impaired. In essence, the accessibility adjustments to real world properties have been replicated in the functional prototype, facilitating the visually impaired without discrimination. The framework produced is a solution to the problems previously faced.

Given the range of disabilities and time constraints applied to this paper, this research work has focused upon one disability impairment in terms of users with visual impairments. In order to provide developers with additional scope for successfully developing accessible e-commerce websites, continued work would be to include further research and analysis of the implications that users with other disabilities may face when using the web, including users with physical disabilities, cognitive and other sensory impairments.

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