Designing the Gender-Neutral User Experience

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Abstract

Ubiquitous computing and the World Wide Web were developed by predominantly male engineers. As such, a gender bias has been observed through the study of Gender Human-Computer Interaction (Gender HCI) in the area of user interface design, particularly on the Internet where a vast majority of websites are developed by men and as such are consistently scored higher by male users. The author proposed a hypothesis for creating a gender-neutral user experience that yields equal or better usability scores as more traditional, gender biased interfaces. An experiment was designed and conducted which tests this hypothesis by subjecting both male and female users to three interface types, two biased and one neutral, to see if a synthesis of male- and female-targeted design principles can be found.

Acknowledgements

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1 Introduction

1.1 Background

Gender Human-Computer Interaction (here forth referred to as Gender HCI) is a fairly new subset of traditional HCI that aims to explore how the different genders perceive and use computer interfaces differently. An important distinction to make is that we use the term "gender" to refer to someone's sexual identity, traditionally referred to as "masculine" and "feminine" and not their sex, though western society typically uses these terms interchangeably.

Although gender issues have come to the forefront in mainstream and political talks, gender biases still exist in our culture, and are deeply ingrained in many of our technologies and practices. This is not always attributed to some form of malice or sexism; it is a logical result of the sciences being dominated by male scientists and developers. Gender HCI is showing through experimentation that computing, specifically the user experience from using a computer interface, has a male bias. The literature shows that due to the fundamental differences in how males and females process information, as well as the differences in the gender roles in society, they have biases towards specific design elements that influence how they perceive a computing system.

User Experience (UX), within the context of this project, refers to how a person feels about using a product, system, or service (ISO 9241-210:2010). It is a subjective property unique to individuals, but has been abstracted and studied objectively through HCI research such that a computing environment can be optimized for its target audience so that they may have a positive user experience.

User Interface (UI) refers to the graphical elements in a computer program, system, or service as well as the interaction with that interface. The most notable examples of UI is the operating system, such as Windows or Mac OS, which is present on any home computing machine. Users come to learn about these interfaces and develop a mental model for them, as well as expectations about their behavior and use. This is why users traditionally refer to a system as "broken" if a system-wide error occurs, despite the error seldom being permanent.

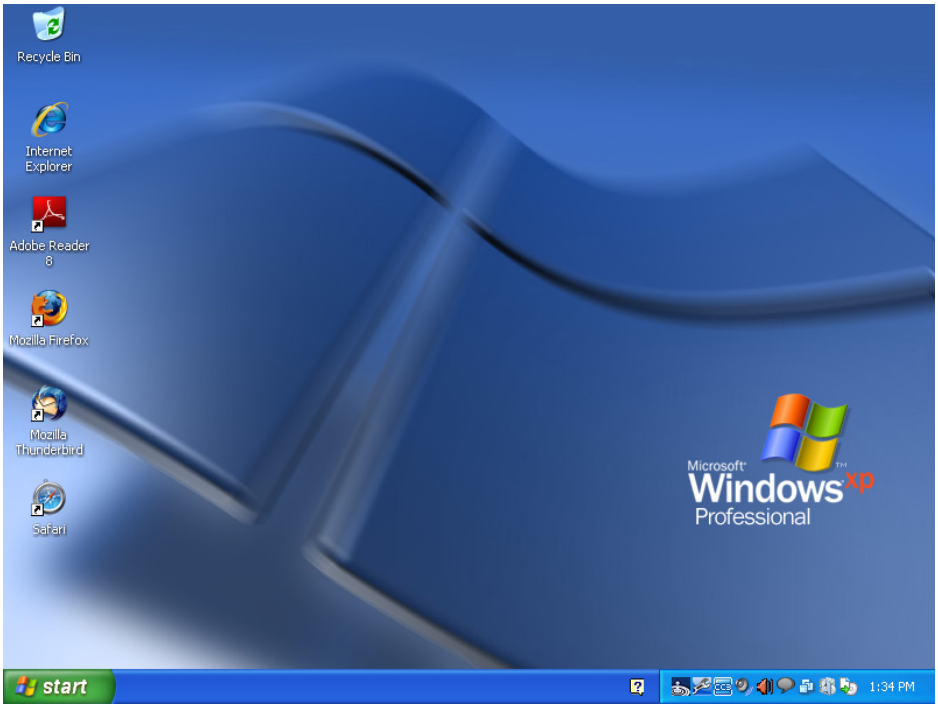


Figure 1 - User interface for Microsoft Windows XP, a popular operating system

Figure 2 - User interface for Apple Mac OS X, the main competitor to Windows, and know for beautiful interface design

Figure 3 - The Windows error screen known as the "Blue Screen of Death", it is widely known and reviled as it is not immediately helpful to non-technical users

What Gender HCI has found, and is demonstrated in the literature review section of this paper, is that the genders perceive user interfaces differently, and that male users will typically score a male-developed interface higher, as will females for female-developed interfaces. The research shows this can be attributed to a natural bias and tendency to design for what one personally likes, but such conjecture is beyond the scope of this project.

The most notable and easily studied example of this is in the web domain. Due to the widespread nature of the Internet, and how many devices are able to access websites, it is natural to consider this domain when researching Gender HCI, as it encompasses possibly the largest demographic of any computing system. Previous experiments show that there are distinct elements in website interface design that will be preferred by either males or females, and websites can be made to specifically target the genders using these principles.

1.2 Motivation

The literature shows that HCI researchers have been aware of the differences in how males and females perceive interfaces, though no long term solution has been presented as of yet. Since most interface developers are male, this fact is unlikely to change for quite some time.

Displeased with this, I set out to see if a sensible compromise could be made such that designers can employ specific design principles that are pleasing to all users and yield UX scores that are on par or better than the traditional interface scores.

During my research into interface design, I happened upon some universal principles that affect all human users equally. These are well known throughout history and include some more classical examples such as the golden ratio and the “rule of threes”, to the more recently observed such as the Biophilia Effect, an effect I describe in the design of the experiment and attempt to leverage in the gender-neutral design.

1.3 General Project Description

This project attempts to create a synthesis between male- and female-targeted interface designs. Common themes in gender biased interfaces are explored and documented, and a new gender neutral interface is suggested. Three interfaces, one targeted to males, one targeted to females, and one that aims to be gender neutral, are developed and a sample of users will be asked to use each interface for a fairly short time and then rate their experiences with them. This data will be used to compute a System Usability Scale, and the scales will be compared against each other to see if the gender neutral design does in fact yield as good, if not better, scores than the biased interfaces.

2 Literature Review

2.1 Ubiquitous Computing

The aptly coined term “ubiquitous computing” refers to how widespread the use of computing devices is in contemporary culture. It was first used by the late Mark Weiser (1952-1999), a developer of some of the most notable interface devices we use today such as the mouse and keyboard, and refers to computing becoming so saturated in culture that it seems to “disappear” as though it’s not really there, its integration so complete (Mühlhäuser, p.1). On ubiquitous computing devices, Weiser famously stated:

“*The most profound technologies are those that disappear. They weave themselves into the fabric of everyday life until they are indistinguishable from it.*” -Mark Weiser

This was his vision for computing which may not have entirely come to pass just yet but a cursory glance at today’s use of laptops, desktop machines, mobile devices such as phones as tablets, and a myriad other embedded devices suggests that computing is indeed becoming ubiquitous.

Perhaps the most fundamental shift in the prevalence computing was the World Wide Web, which sprung into prominence in the mid-1990s. As personal computers became more affordable, and Internet speeds increased in speed and technological sophistication, the “dot com” bubble saw a burst in Internet growth and suddenly the majority of accessible content was no longer on the local hard disk, but distributed among web servers around the world. This also gave rise to a whole new area of computer science we now know as “web development”, a discipline comprising of web page design and authoring, client/server programming, and rich media applications.

While there are an enormous amount of implications surrounding ubiquitous computing, from the issue of word processing and its effect on language and editing, to virtual reality and what the boundaries are between “real” and “virtually real”, the fundamental element of computing and all of HCI is interaction between the user and the computer. This project focuses on the users, specifically, and whether their genders are a factor in how they perceive computing systems.

Even within the realm of human-computer interaction, the amount of philosophical, societal, and cultural questions abound. We can further filter this area to ask specific questions such as:

- How does the visual representation of information on the screen affect our perception and processing of that information?
- How do color, layouts, and language affect our impression of an interface?
- How do the innate physiological and psychological differences in the genders come into play when using interfaces?

This project aims to address all of these with an emphasis on the third; how is a male's use and perception of an interface different from that of a female's for the same interface? Is there any difference at all? This is Gender HCI and there have been numerous informational studies that have been done in this area, some of which are outlined below.

Psychological and evolutionary studies have suggested and, in many cases, concretely shown a difference in how males and females see and process information. Notable examples are in color, word usage, and shapes which either due to genetic or psychological reasons, are perceived differently by the genders. These tenants are analyzed in different studies targeting the different subsets of Gender HCI in this section.

Perhaps most importantly for this project in particular is the establishment of past truths and principles that can be built upon and referenced during the project. For example, it is extremely helpful to know that researchers have already shown a link between gender and color, male and female design biases, and observations on language differences. With this knowledge as a foundation, the project can use it as a tool as hopefully new principles are discovered and new implications are found in the project's conclusion.

2.2 Gender Human-Computer Interaction Studies

2.2.1 The Gloria Moss et al. Studies

In researching Gender HCI, a group of papers by Gloria Moss, a research fellow at Glamorgan University in Wales, and her co-researchers surface that show significant groundwork laid in this area. Their work, which roughly covers the span of 1999 through 2006, progressively reveal enlightening, if not immensely interesting, differences in how males and females perceive and

rate websites. These studies also show a strong indication that the sexes will rate designs higher if they were designed by someone that is their own sex; this was first observed in the field of graphic design by analyzing business cards (Moss and Coleman), where men were more likely to use standard shaped cards on white backgrounds while females were often more adventurous with their designs, opting for unconventional shapes and using more color, suggesting a "willingness among women to put aesthetics above practical considerations and form above function" (Moss and Gunn, 2005). This same research extended to the web domain, where it was found that males will nearly always rate male-designed websites higher than female-designed ones, with the opposite being true for females.

What the Moss et al. studies observe, specifically the paper "Websites and services branding: implications of Universities' websites for internal and external communication", is that there is a prevalence of male IT professionals, and that these male developers tend to design for a male aesthetic.

It is important to note the "mirroring principle", whereby the "efficacy of tools or messages can be maximized by ensuring that they contain features that mirror the preferences of the target market" (Moss, Gunn, and Heller 2005). This suggests that there are cases where creating a gender biased interface is wise and preferable to a neutral one, the case study in the paper being cosmetics retailer websites which feature predominantly female aesthetics which are likely to be rated higher by female users. It follows that not all websites should be neutral, but this project is specifically measuring the relative rating of neutral websites compared to biased ones, regardless of context. This may, however, suggest a benefit in designing for a wide audience through the use of neutral design principles.

It is interesting to note that studies on demographics have not considered that a website can have a "gender", as Gloria Moss and colleagues have shown. A more mathematical approach, where a study attempted to find demographics by known age, gender, and webpage surfing habits, argued that such a complex mathematical model using Bayesian frameworks had to be used "since webpages don't have explicit demographic attributes, we cannot simply label a webpage as male, female, or teenage directly" (Jian Hu et al.). This is an intriguing oversight in the engineering approach, and suggests that a possible, separate study could be attempted which combines the subjective analysis and Gender Bias Coefficient approach of Moss, discussed below, with the mathematical modeling of Hu.

The main takeaway from these studies is that there is a clear bias in different design elements that can give a website its own "gender". But is this really a problem that needs to be addressed? It is, according to Batya Friedman of Colby College and The Mina Institute, who states that not only does bias exist in computing, but that "as with other criteria for good computer systems, such as reliability, accuracy, and efficiency, freedom from bias should be held out as an ideal" (Friedman and Nissenbaum)

2.2.1.1 Gender Bias Coefficient

To differentiate between male and female design tendencies, Moss and Gunn created the "Gender Bias Coefficient", which assigns a value to website interfaces indicating how strongly they reflect a male bias. A figure greater than 0.5 indicates a male bias, exactly 0.5 being neutral, and less than 0.5 indicating less male targeted aspects and more female bias. It follows then that this project can make use of the Gender Bias Coefficient for the experiment, and the neutral interface should be designed to be as close to 0.5 as possible, though since this is a system built on relativity, an exact coefficient cannot be assigned. A tolerance must be set not unlike specifying the confidence level in statistics, where perhaps values in the range of 0.4-0.6 shall be considered "neutral enough". The characteristics observed in "Some men like it black, some women like it pink" (2006) are used to generate this coefficient.

In order to derive the coefficient, 11 statistically significant characteristics are observed and rated on the 0.1 to 1.0 scale. In the paper, "Successes and Failures of the Mirroring Principle: The Case of Angling and Beauty Websites", websites were analyzed based on their design aesthetic and assigned gender bias coefficients. A detailed explanation of the characteristics follows:

> "...One of these characteristics concerned navigation issues, with women's websites statistically more likely than the men's to contain links to fewer sites. A further characteristic concerned language, with women's websites showing a statistically greater tendency than the males to employ abbreviations (significant at the $p < 0.005$ level), self-denigration (significant at the $p < 0.0001$ level), non-expert (significant at the $p < 0.0001$ level) and informal language (significant at the $p < 0.005$ level). A final set of characteristics concerned visual elements, with the female websites significantly more likely than the male ones, statistically, to use rounded rather than straight shapes (at the $p < 0.05$ level), to avoid a horizontal layout (at the $p < 0.0001$ level), to use more colours

> for typography (at the $p < 0.0001$ level), informal typography (at the $p < 0.05$ level), and more of certain specific colours - white, yellow, pink and mauve - for typography ($p < 0.0001$). There are also statistically significant tendencies for the male-produced websites to use crests, and for each gender to depict images of people of their own gender (at the $p < 0.01$ level). These differences are sufficiently numerous and significant to be suggestive of a masculine/feminine design production aesthetic continuum." (Moss et al. 2007)

To calculate the Gender Bias Coefficient for female bias, the number of female factors from the above list are divided by the sum of female and male factors. To calculate the male bias, the same calculation is carried out but with the number of male factors in the numerator. Some, but not all of these factors will be intentionally used in the experiment, which is detailed in the design phase, section 5.

2.2.2 Color

One of the main areas where males and females have shown a significant statistical difference is color. Many studies in biology and psychology have been done to explore this issue, taking special note of males' higher chance of being color blind and cultural effects on gender, such as the blue color scheme used in male toddler environments and pink for females.

For adult computer users, the specific colors used (blue versus pink) does not seem to be as significant as the usage of color in general. The previously cited Moss and Coleman study showed that men prefer more "flat" grayscale colors, which seems to correlate with an image of professionalism and authority, while females use more colors overall, specifically white, pink, yellow, and mauve.

Another interesting study measured the effect of the color red on web-based tests of general knowledge. This illustrated a relation between the color red and cognitive abilities. The study found that overall performance for men dropped with the increasing use of red, while females seemed unaffected (Gnambs et al.). This suggests that some design aspects affect the genders independently of one another. It begs the question of whether there exists a color palette that does not degrade cognitive abilities for either gender. This will be explored through a nature scheme as detailed in section 4. There are myriad other implications of color use, as colors have significant meanings across cultures, for example the color green signifies money and capitalism

in western societies (among other meanings), but is chiefly associated with life and living things in Japan.

2.2.3 Language, Feminism, and Self-Efficacy

Males and females differentiate themselves in the manners in which they express themselves and communicate with one another. This is evident in the seminal linguistics studies by Deborah Tannen, in which she shows that genders are very different in how they use language, with males using more formal and "professional" speech, larger words, and seldom reveal personal information, while women are more "conversational", use informal speech and are more willing to provide insight on themselves and others. This also draws parallels to certain stereotypes in the genders, with males being seen as more competitive and aggressive (Tannen).

Once again we can look to the Moss et al. research to show how this is relevant to interaction design, as they showed that out of five language elements, namely:

1. Extent of the use of abbreviations. This term was understood as including all abbreviated grammatical forms and was construed as a barometer of informality.
2. Amount of self-denigration. This term is understood as including the use of language or visuals that detract from the self-importance of the writer and was construed as a barometer of competitiveness. It is assumed that high levels of self-denigration will point to low levels of overt competitiveness and low levels of self-denigration to high levels of overt competitiveness.
3. Amount of expert language used. Expert language is defined as language which is exclusive to a particular body of expertise, and formal rather than informal in character. It is assumed that high levels of expertise point to high levels of overt competitiveness, and low levels to low levels of overt competitiveness.
4. Inclusion of references to own achievements. It is assumed that high and low levels will work as for expert language above.
5. Register of the language. Whether the language sounds formal, informal, or a combination of both. Typically this can be categorized as "professional", language one uses in a social setting where etiquette, tact, and

The study revealed "statistically significant differences on four of the five language elements, with females showing a statistically greater tendency than the males to employ abbreviations, self-denigration, non-expert and informal language" (Moss et al.).

These findings suggest that feminist issues that exist in the real world are prevalent in the web domain and are just as important to consider as visual design elements. A survey of this issue was conducted by Shaowen Bardzell, who analyzed feminism in HCI areas from game design to interface design, and concludes that one can distinguish two general ways that feminism contributes to interaction design (Bardzell, 2010):

- Critique-based contributions rely on the use of feminist approaches to analyze designs and design processes in order to expose their unintended consequences. Such contributions indirectly benefit interaction design by raising our sensibilities surrounding issues of concern.
- Generative contributions involve the use of feminist approaches explicitly in decision-making and design process to generate new design insights and influence the design process tangibly. Such contributions leverage feminism to understand design contexts (e.g., “the home” or the “workplace”), to help identify needs and requirements, discover opportunities for design, offer leads toward solutions to design problems, and suggest evaluation criteria for working prototypes, etc.

This project will use Generative feminist contributions as a gender neutral interface is developed with feminist concepts and contexts in mind throughout the design process. That is to say, as the female-biased design is being developed, its structure and content will be consciously driven by an understanding and acknowledgment of female design biases as were gleaned through the literature review.

3 Problem Statement

The aim of this project is to produce an interface design and set of design principles that are pleasing to all users regardless of gender. Research has paved the way for such experimentation though no definitive solutions have been derived to address the issue of gender biased interfaces.

Current interface trends are predominantly biased towards male users, as the male gender has been considered the "default" gender in computing for decades. Interfaces that are rated high by women users do exist, but are in the minority and more often than not, professional interfaces will have a significant male bias as seen in the Moss and Gunn study on university interfaces.

As such, a synthesis of male and female design preferences is suggested and tested against biased interfaces to see if such a compromise is viable and recommendable for contemporary UI designers. The interface will be evaluated by human subjects, where they will rate the interface alongside two biased interfaces. A System Usability Scale will be administered, and statistical analysis will show how the neutral interface fares against the biased ones.

4 A Hypothesized Gender-Neutral User Experience Design

Here we acknowledge and analyze the biased design principles that have led to an acceptance of bias existing in the computing world. We build on the biased characteristics pointed out in the Moss et al. research and discuss a way to derive a set of universal, unbiased principles with which to design new systems.

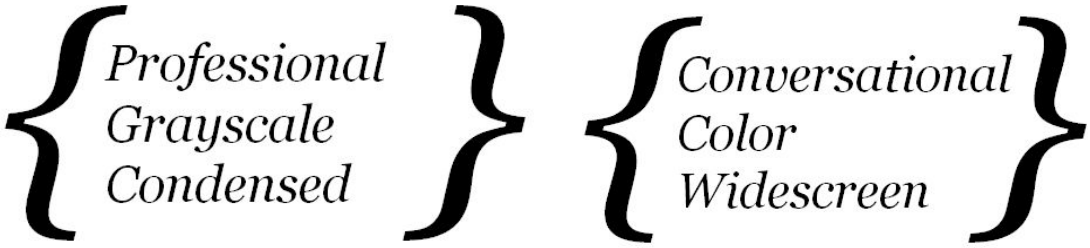
4.1 Synthesis of Gender-Biased Design Principles

To recapture the biased traits noted in the Moss research, male and female design biases tend to fall into categories such as:

- Language - males typically use more professional, assertive speech. Women tend to be more conversational and less formal.
- Color - males tend to use less variation in color and lean toward grayscale, or only dark, cool colors. Females use much more color, including brighter ones such as white, yellow, pink, and mauve.
- Layout and data structure - males have a tendency to design with rigid, less rounded edges and organize data in condensed rows. Women design with more organic, amorphous shapes, and display data in wide, spread out areas.

For this project I focus on these three areas, for simplicity and for brevity. It is possible that other bias principles may come into play, but these three categories seem to account for much of the differences in how males and females rate interfaces. I start by grouping these unique traits by gender, and treating them like sets:

Male Set: Female set:



I then sought to find a union of these two sets, to form a universal set of design principles that should appeal to both genders, and indeed any user. This universal set should also contain the established design principles from art history, architecture, and any other field where a standard has been found that humans in general find pleasing. This would thus include well known design principles such as the golden ratio, color theory, and the "rule of threes". In researching such principles I discovered the Biophilia Effect, and wanted to see if this could be leveraged in the neutral design to make it appealing to both genders.

4.1.1 The Biophilia Effect

The Biophilia Effect is the name for something that has been described by artists and philosophers for many years, namely that humans enjoy being around nature and subjected to nature scenery. Nature has been revered by many cultures and religions for millennia, so it is no surprise to find that this has been researched and has shown to have a real effect and yield benefits for humans within certain contexts.

Perhaps one of the earliest uses of this effect is in architecture, where artisans and builders have built structures that take advantage of being near trees and vistas, or even contemporary structures with landscaping and gardens included in the plans.

Figure 4 - An example of internal structures making use of nature scenery, invoking the Biophilia Effect

The effect is said to improve concentration and focus, and foster a calm temperament as well as reduce stress. This was tested with school children, where a class of seven- to twelve-year-olds that had windows overlooking nature scenery had higher gains in test scores than other relocated students that did not have the same scenery (Wells, 2000). A similar effect has been seen in college students whose dorm windows offered nature views.

Beyond actually seeing the outdoors and real vegetation, the effect seems to still work even with posters and other imagery (Kaplan, 1995). This means that the effect can potentially work in a user interface that uses nature imagery. I intend to use this in the neutral design by setting the background image to be something nature themed.

4.2 Requirements for Success

In user interface design, relative satisfaction of each user is subjective and therefore difficult to quantify. However, HCI practices allow us to abstract such subjective data and compare it statistically with that of other users. Trends can usually be found, as were found in the research done by Moss and Gunn. We can define "success" here as a clear increase in SUS in the neutral interface over that of the targeted interfaces.

The expected result is that the male users will, by majority, rate the male-biased interface higher than the female-biased interface, and vice versa. Since the goal of the project is to find an interface that works for all users, it follows that an acceptable result is an average SUS for the neutral interface being at least the average of the SUS for the two biased interfaces for each user; that is, males prefer it over the female-biased interface, and females prefer it over the male-biased interface. An ideal definition of success would entail the neutral interface scoring higher than the two biased interfaces for all users, indicating a unanimously and clear improvement over traditional, gender biased interfaces.

4.2.1 System Usability Scale

In order to measure success of the experiment, some form of metrics would be desired that can be analyzed and modeled statistically. Luckily the field of HCI has developed reliable means of gathering data from such experiments. In deciding how to measure success, the exact nature of the experiment was not yet decided and so it was difficult to decide on a system to use. Some possibilities that came up were tracking user activity by logging mouse clicks and timing actions as well as a simple questionnaire.

As I developed the flow for the experiment and decided on a web interface as the vehicle for the study, the decision to use the System Usability Scale (SUS) came naturally and lent itself very well to this scenario. The SUS is a simple, ten-item scale giving a global view of subjective assessments of usability (Brooke, 1996). By collecting responses to ten weighted questions, and then converting these values into a score out of 100, one can measure the relative usability of a system, where a score of 68 has unofficially been deemed a good, average score.

The original series of questions appears like so:

1. I think that I would like to use this system frequently
2. I found the system unnecessarily complex
3. I thought the system was easy to use
4. I think that I would need the support of a technical person to be able to use this system
5. I found the various functions in this system were well integrated
6. I thought there was too much inconsistency in this system
7. I would imagine that most people would learn to use this system very quickly
8. I found the system very cumbersome to use
9. I felt very confident using the system
10. I needed to learn a lot of things before I could get going with this system

I felt that the wording in these questions felt a little unapproachable and a little too formal. I wanted the study to be accessible and enjoyable for a wide range of participants, and so I made some slight changes to the questions, in addition to make them specific to websites:

1. I think that I would like to use this site frequently
2. I found the site unnecessarily complex
3. I thought the site was easy to use
4. I think that I would need help from a technical person to be able to use this system
5. I found the parts of the site fit well together
6. I thought the site wasn't consistent
7. I think most people would learn to use the site very quickly
8. I found the site cumbersome to use
9. I felt very confident using the site
10. I needed to learn a lot of things before I could get going with this site

In addition to the ten SUS questions, I ask two preceding questions, for demographic and analysis purposes:

1. Gender: male or female
2. Which category below includes your age?
    a. 17 or younger
    b. 18-20
    c. 21-29
    d. 30-39
    e. 40-49
    f. 50-59
    g. 60 or older

The final SUS score is calculated by the following method:

- For odd items: subtract one from the user response.
- For even-numbered items: subtract the user responses from 5
- This scales all values from 0 to 4 (with four being the most positive response).
- Add up the converted responses for each user and multiply that total by 2.5. This converts the range of possible values from 0 to 100 instead of from 0 to 40.

For this experiment, success is measured in the SUS scores and the hypothesis is accepted under these conditions:

For males: the average SUS score for the neutral website must be greater than the average of the scores for the two biased sites.
Avg_m neutral > Avg_m biased
And similarly for the female users:
Avg_f neutral > Avg_f biased

5 Designing the Experiment

5.1 Deployment

Initially, the planned method for deployment of the experiment was to develop a mobile application. This was my initial plan due to being in the graduate special topics course on Mobile HCI. However, this immediately proved to be a daunting task once we looked at the hurdles that would need to be overcome, not to mention the limited sample size that would result. Some questions asked were:

- How difficult and how time consuming would it be to develop a mobile application?
- Which platform would it be for? Options include: iOS, Android, Symbian, Windows Phone
- How would the app get certified and ready for download?
- How difficult would the install process be? Would users even be willing to go through this process?

After contemplating these issues, the second and most natural method came to light, which is to do a website-based experiment. Websites offer numerous advantages that make them well suited to this kind of study, where we are looking for as large a sample size as possible, within as short a time frame as possible, and as accessible as possible.

Web deployment became the clear choice especially once other development factors were considered. Web development is easily iterable; making changes and seeing their results has a very short turnaround time, making last minute edits or changes as a result of bugs and errors easy to implement. Furthermore, the internet is clearly a ubiquitous technology. Asking users to visit a website and participate in an experiment is as easy as directing their web browsers to a link and navigating the study website as they would any other. It takes advantage of the mental model users will already have for internet usage, and will allow the users to look past such issues as installation, further education on use of the system, and enables them to focus on the core pieces of the experiment.,

5.2 Use Cases

In order to rule out as many variables and conditions beyond the scope of the experiment, the tasks for this experiment were designed to be as simple as possible. I wanted there to be no doubt that the users were being influenced by the interface itself the most. To this end, I designed a simple book-buying task flow that would be exactly the same across the three sites. Regardless of how difficult/easy these tasks would be, the fact that they are exactly alike for all three sites would serve as a baseline from which I could measure the relative usability for the users.

Other tasks were considered for the experiment. The initial brainstorm involved anything that could be seen as "neutral" and something that both males and females would want to do. Other possibilities included a food ordering website, and another being a media purchasing website with books, movies, and compact discs. After discussing these possibilities briefly with third parties, it seemed that the media website seemed the best option. As development started, I further refined it to be solely a book buying website, simulating a private company's web presence where they have a limited selection of some popular titles.

Once the form of the website was decided, the task flow was planned as thus:

1. **Read front page**
2. **Go to book inventory page, add books to cart**
3. **Go to checkout page, review cart and hit Check Out**

After this set of tasks, the user is brought to the SUS survey page.

5.3 The Male Biased Interface

In designing the male interface, I had the benefit of drawing from my own biases as a male, and also the fact that many websites from the dawn of the internet have been designed and developed by men. Therefore one only needs to think about what a typical website may look like, perhaps a slightly old fashioned one that may be run by a middle aged man to run his business. In this case, a book buying business. I drew from the traits observed in the Moss et al. research, as well as the set I defined in section 4, to come up with a general idea of what the male biased site would look like. My initial plan for the male site would have these characteristics:

- Very few colors, perhaps only one outer color with a white content area

- No rounded corners, all straight edges and 90 degree corners
- More formal, professional sounding language, including the title
- Narrow, condensed and orderly content organization, for vertical eye scanning

Using these guidelines, I developed the following mockup, which would be used to drive the implementation, as detailed in section 6:

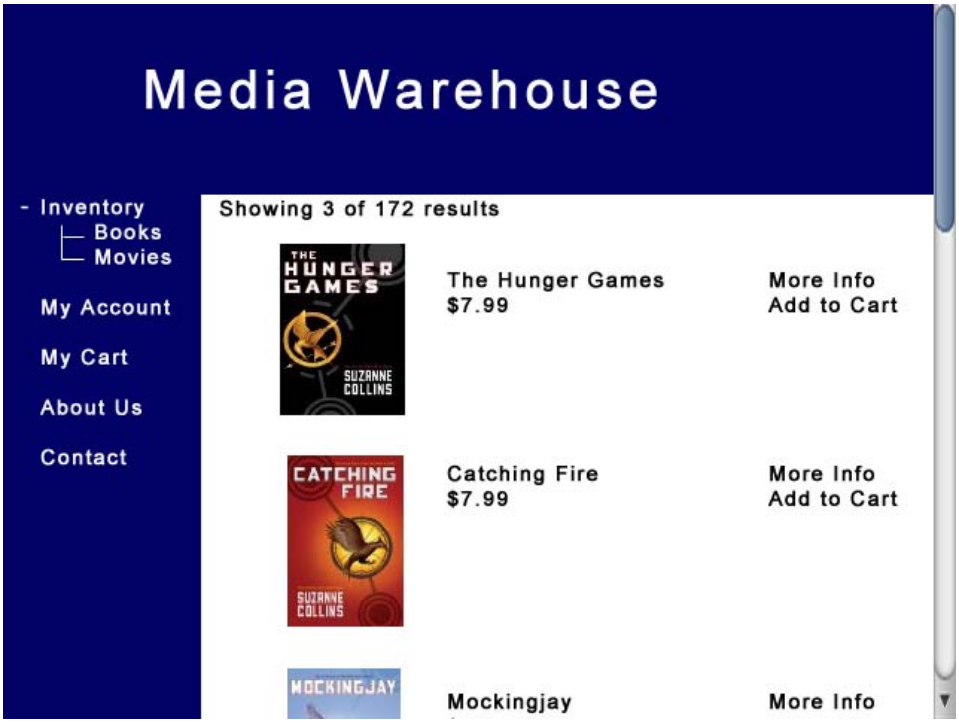


Figure 5 - Mockup for initial design of the male biased website

5.4 The Female Biased Interface

The female interface would prove to be the most difficult to design. As a male developer, I inherently have my own biases, and lack the psychology to design for a female user such that she would rate it highly. The Moss research suggests that females will rate a site highly if it was developed by a female, without them being aware of this fact. Trying to account for this as best as I can, I consulted some female art students to find out what they would want to see in an interface, what appeals to them, and what advice they could depart such that my task in designing for the female audience would be easier and, hopefully, successful.

Again consulting my set from section 4, I created this list of characteristics I wanted to feature in the female biased design:

- Vibrant, multiple colors. Use colors as observed in the Moss papers, namely yellow, mauve, and white
- Rounded corners, make the layout feel organic and amorphous
- Conversational language. Use of first person singular pronouns, to give the feel that this website represents a person, not just a business. Also use emoticons and other casual internet-specific language elements.
- Wider content area than the male biased website, for horizontal eye scanning.

Using these guidelines, I developed the following mockup, which would be used to drive the implementation, as detailed in section 6:

Figure 6 - Mockup for initial design of the female biased website

5.5 The Gender Neutral Interface

The neutral interface was the most enjoyable to design since I did not have to stick to the rigid confines of the male design set, while also being free of the drawbacks present in designing the female interface. I knew that the Biophilia Effect would be used, so I immediately thought to use a nature themed background. After searching through Google's image search for open-source images, I found what I believed to be a great background featuring close-up photography of vibrant, green grass. This would provide the nature imagery I would need to produce the

effect, as well as provide a nice color scheme that would be an intermediary between the male and female sites. The use of the subtle, low opacity title text was simply an aesthetic choice. My thought process here was that it would force the user to acknowledge the nature background by reading it, at least subconsciously. The navigation links would also be laid over the background. The content area would have some transparency as well, so the nature imagery is present anywhere the user looks in the interface. My hope is that this would create a calming effect as described in the Biophilia Effect research. I used these guidelines when creating the design mockup:

- Nature imagery in background and present throughout interface
- Rounded corners, but less so than the female interface
- Minimal language use, and in a casual but non-conversational tone when in use
- A mix of widely placed content but in a vertical scrolling area
-

Using these guidelines, I developed the following mockup, which would be used to drive the implementation, as detailed in section 6:

Figure 7 - Mockup for initial design of the gender neutral website

5.6 Experiment Procedure

Once the individual elements of the experiment were designed, it was challenging to find an optimal procedure and flow such that users would enjoy taking part in the study and not feel like it was taking too much time.

My initial design entailed using all three websites, with the SUS survey taking place in between each website. The flow of the experiment would look like this:

[Intro page] -> **[Website 1]** -> **[SUS 1]** -> **[Website 2]** -> **[SUS 2]** -> **[Website 3]** -> **[SUS 3]**

I discussed this with my adviser and we agreed that having to take three ten-question surveys is a bit much. In addition to this, I feared that a bias would arise within the experiment if the user were to see all three websites back-to-back. Since the tasks are equal in difficulty and function, by the second website the user would have already developed a sense for how to navigate and quickly use the site, and may finish the tasks too quickly such that there was not enough opportunity for the design to influence the user, which is the intent of the entire experiment.

My second approach, and the one that was used for the final experiment, entailed having the users start at a common front page but, upon agreeing to the consent form and starting the experiment, would be randomly navigated to only one of the three websites, after which they would fill out the SUS for the website they used. At first I had reservations about this since it relies on probability to ensure that users get spread evenly across the three websites, and if the sample size was too small, there was a possibility of too many users being directed to one website and not enough to others. In addition, I was prepared to have many more male users take part than female, given the WPI student body demographics, and was wary of how the distribution of female users would work, when there's a 1 in 3 chance of being directed to each site. Fortunately, and as is noted in section 8, there was a large enough sample that this became a non-issue.

The final experiment flow:

[Intro page] -> **[Website 1 OR Website 2 OR Website 3]** -> **[SUS]**

6 Implementing the Experiment

The challenges involved in choosing web deployment included actually getting up to speed on the technology required to create the experiment website, as well as establishing a development pipeline to facilitate development. These issues are explored in the following sections.

6.1 HTML5, CSS3, and JavaScript

The current trends in web development revolve around the use of the latest HTML standard: HTML5. This new standard builds on older versions, such as HTML4 and XHTML, but deprecates a lot of the old tags found in those standards in favor of new semantic tags that are more straightforward and facilitate creating clean, readable web pages without the need to "hack" them together with the <table> and tags as was often the case in earlier years. HTML5, accompanied with Cascading Style Sheets (CSS) enables the development of extensible, flexible, and easily iterable website design and development. This is made possible through new features such as the <section> and <nav> tags, which signify a "section" and a "navigation bar" respectively. The CSS features allow flexible and modular styling for HTML elements, which results in very readable and minimal code in the HTML document. Furthermore, HTML5 has a more strict standard which must be adhered to in order to be validated by the World Wide Web Consortium. Validated HTML5 markup is considered to be a "best practice" and as such one should strive for markup that adheres to the standard, which was a goal in developing this experiment.

In addition to the structural and presentational features afforded by HTML5 and CSS3, dynamic elements are made possible via JavaScript, a scripting language loosely based on the Java programming language that is becoming a standard feature for many mainstream web browsers such as Google Chrome and Mozilla Firefox.

JavaScript enables the developer to embed scripting code in a webpage that can dynamically alter page elements as well as respond to user input. JavaScript would be necessary to create some of the features planned for the experiment, namely:

1. Redirecting the user to a random site out of the three possible sites after they visit the main page

2. The shopping cart functionality for "purchasing" the books. Namely, it would need to support a persistent shopping cart, not unlike those found on large e-commerce sites such as Amazon and Buy.com. No actual "checkout" functionality would be needed, as the shopping cart task is just there as a prototype to simulate adding items to a cart, but still some kind of dynamic programmable elements would be needed since HMTL5 and CSS3 only dictate what content appears on a page and how that content appears to the user; it does not provide methods for manipulating or changing that content.

Some of the website-specific HTML and CSS features are listed in the following sections:

6.1.1 Neutral Website

Specific development relevant to the neutral site involved creatign a nature background that would scale well when the browser window was resized. This would that this pivotal design piece would not become obscured or skewed to the point where it was unrecognizable to the user. Subtle text glow effects were used for the hyperlinks, which would allow the links to stand out aghainst the background image when the user hovers over them with their mouse cursor.

Without delving into the specifics of this CSS, suffice it to say that it specifies that any hyperlink, which uses the anchor tag, <a>, while the user is hovering over it with their mouse, change the text color to white, and give it a linear color transformation such that the color change is gradual, giving it a "fade" effect. This ended up looking very good over the nature background and was used for the final design.

6.1.2 Male Biased Website

The male biased website ended up being the easiest to develop. Since the design was extremely minimal, and based largely on the bland, practical web designs of the early 2000s. No special coding or markup was required to make this website beyond simple HTML and CSS. This actually kept in spirit with the design, as it was meant to be extremely minimalist and simple in comparison with the Neutral and Female Biased websites.

6.1.3 Female Biased Website

The female biased design required some special markup, as I wanted the menu to be dynamic and have a very nice aesthetic that stood out against the other two websites. I had an idea for the header navigation area that mimicked the appearance of notebook paper, with scribbled text

for the hyperlinks. Luckily, I happened upon a tutorial that actually uses this exact design, which can be found here:

http://webdesignerwall.com/tutorials/advanced-css-menu

With this tutorial I was able to create an attractive navigation section which used CSS markup not seen in the Neutral or Male Biased designs. The menu works by offsetting the images usd for the three links, so that when the user mouses over them, they move one half of their height to display the "hover" version, which in this case shows an image with a scribbled circle or underline. The paper image used for the background, and any other custom images, were created in Adobe Photoshop CS5, usually with the aid of freeware tutorials.

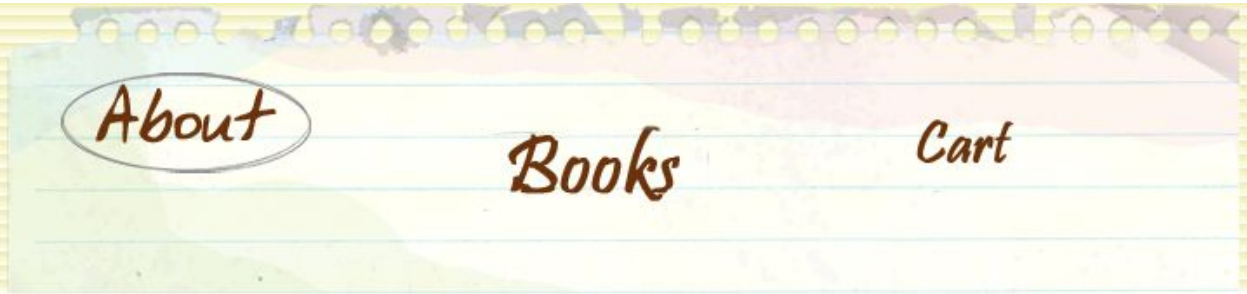


Figure 8 - The female biased website menu, with mouseover effect

Interestingly enough the background effect seen on this website was an accident. It was meant to display a radial white-to-yellow gradient but, for reasons unknown, renders as horizontal lines going down the page. This actually turned out to be a desirable effect as it looks like paneling one might see on the side of a house, giving the website the feeling of "home", a comfortable place, and fit well within the style.

6.2 Data Collection

The initial plan for collecting the SUS data was to use a PHP-driven custom coded survey system. This would allow complete flexibility and control over the data gathering portion of the project. The plan was to code the survey, embed it in webpages that users would be directed to after each website, and upon completion their results would be stored in text files. These text files could then be parsed using a small program written in Java or Python. However, as time became sparse and deadlines arose, it was clear that the survey system was going to add too much to the total time required for the development of the experiment. It was decided after

setting a hard deadline to abandon this approach and adopt a pre-made solution in SurveyMonkey. This service is a tried and proven solution for survey and metrics gathering, and became a clear and favorite option for getting the SUS data needed. SurveyMonkey provides services in several tiers, starting with a free (Basic) one and progressing to more costly plans. The plan that was one tier higher than Basic provided benefits that made it worth the cost, and so it was decided that I would purchase an upgraded account for these benefits, which included:

- Ability to gather unlimited results, as opposed to the upper limit imposed by the Basic plan
- The ability to export data to Microsoft Excel format

These two features alone made the subscription price worth it for this project, and the Excel feature became invaluable for analyzing the results of the SUS surveys, as it could be imported directly into Excel and, with the aid of formulas, analyzed accordingly.

6.3 JavaScript Elements

6.3.1 Random Page Direction

In order to direct users to a random website out of the three, a very simple JavaScript snippet was used that would create the HTML markup for a button. The hyperlink for the button would be randomly, with a 1 in 3 chance, be directed to one of the three websites.

According to the number of users per survey in the SurveyMonkey dashboard, the script did serve its purpose very well as each website was allocated roughly one third of the users. This is also due in part to the large sample size.

6.3.2 Shopping Cart

In order to facilitate making these websites look like a book buying service, a “dummy” checkout system needed to be in place that would allow users to add book objects to a persistent shopping cart implemented in JavaScript, and then show these items on a shopping cart page.

Rather than write the code for this from scratch, two open source and free JavaScript shopping cart systems were considered. The first system, nopcart, seemed to provide the right features but had harder to understand documentation. Implementing this cart system would have entailed too much research and development time, which was not available at this point in the project.

A second system, called simplecart, was ideal and fit in to the website development very well. The authors of this system have a great website with clear documentation and guides on how to integrate the cart into a website and also how to configure it. For the needs of this project, it fit very well and was instantly usable. Aside from a few visual formatting issues, the cart served its purpose very well and enabled users in the experiment to add items to a shopping cart as they would on any major shopping site such as Amazon.

6.4 Final Designs and Deviations from Planning Phase

Here are the final designs for the websites and the ways in which they deviate from the mockups in section 5.

6.4.1 Neutral Design

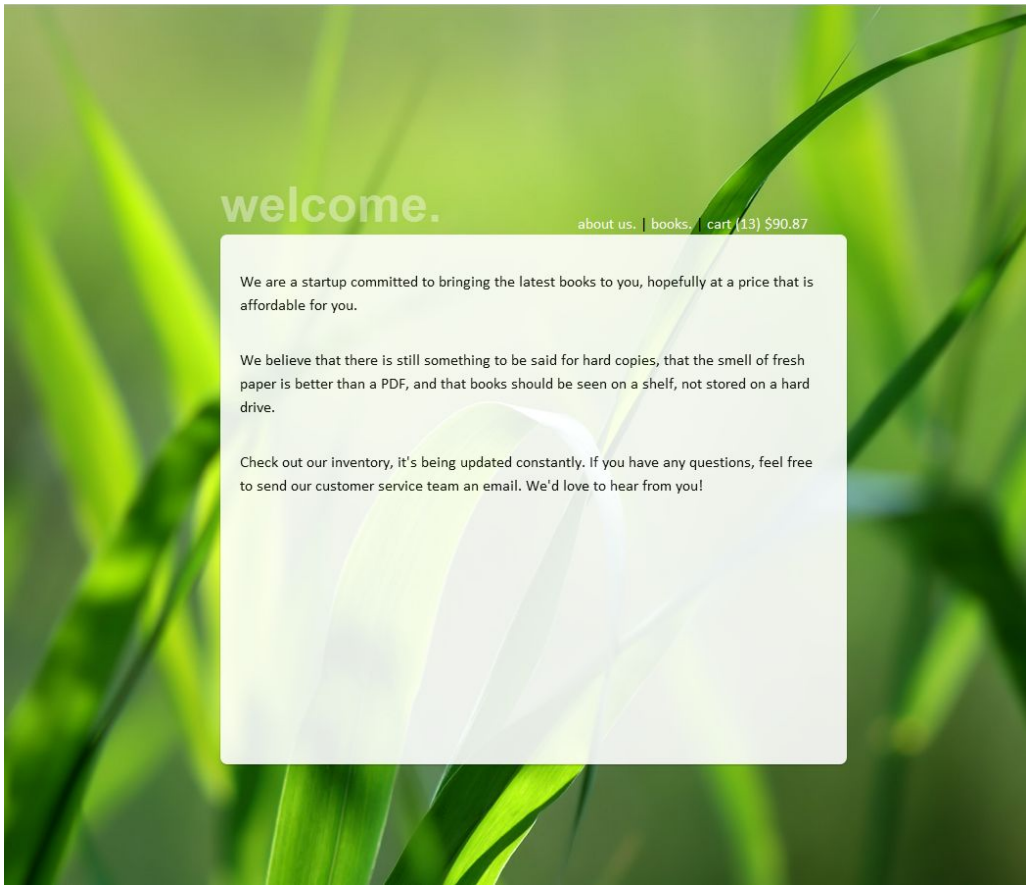


Figure 9 - Neutral Design front page

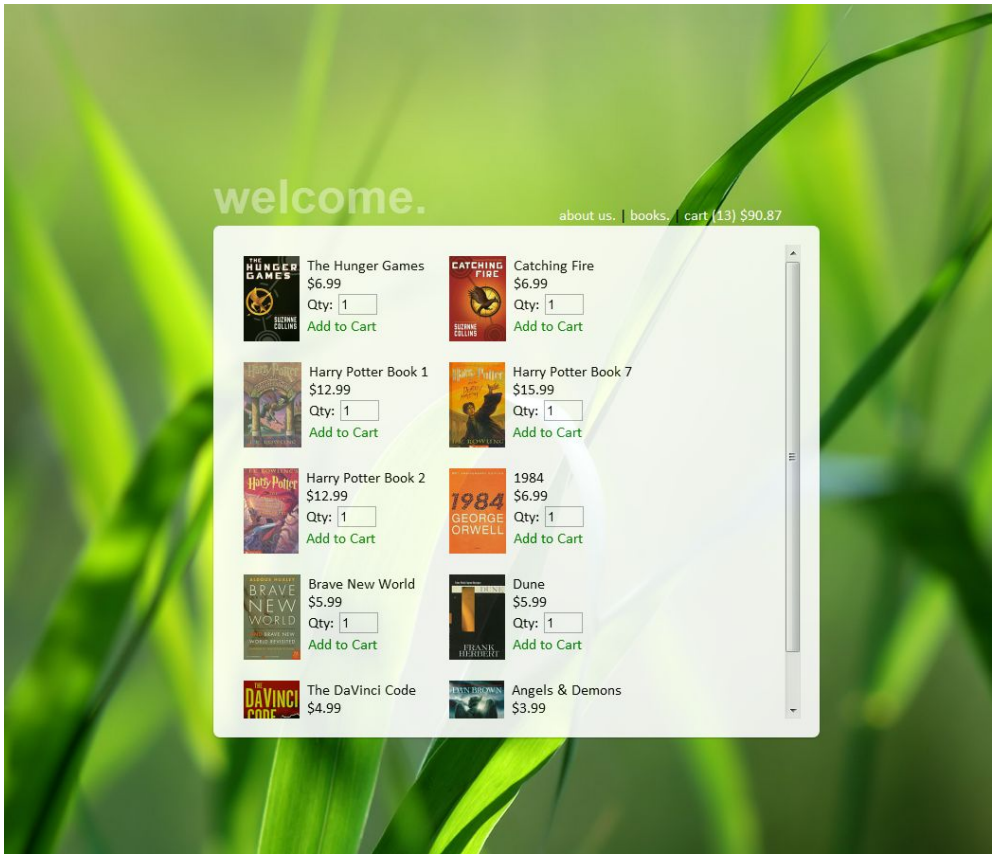


Figure 10 - Neutral Design book inventory

Notes:

- The neutral design adhered very closely to the mockups from section 5
- The language usage is meant to sound as though this is a “tech startup” style company, perhaps staffed by engineers and designers in their 20’s or 30’s, and could be either male or female
- The book inventory layout has two columns, and goes off the content page slightly

6.4.2 Male Biased Design

The male biased website went through some evolutions in the development phase. A decision was made to add a simple clipart, not necessarily for good design sense, but to show that male developers are not typically inclined to use high resolution images and may prefer function over form, as per the Moss et al. research.

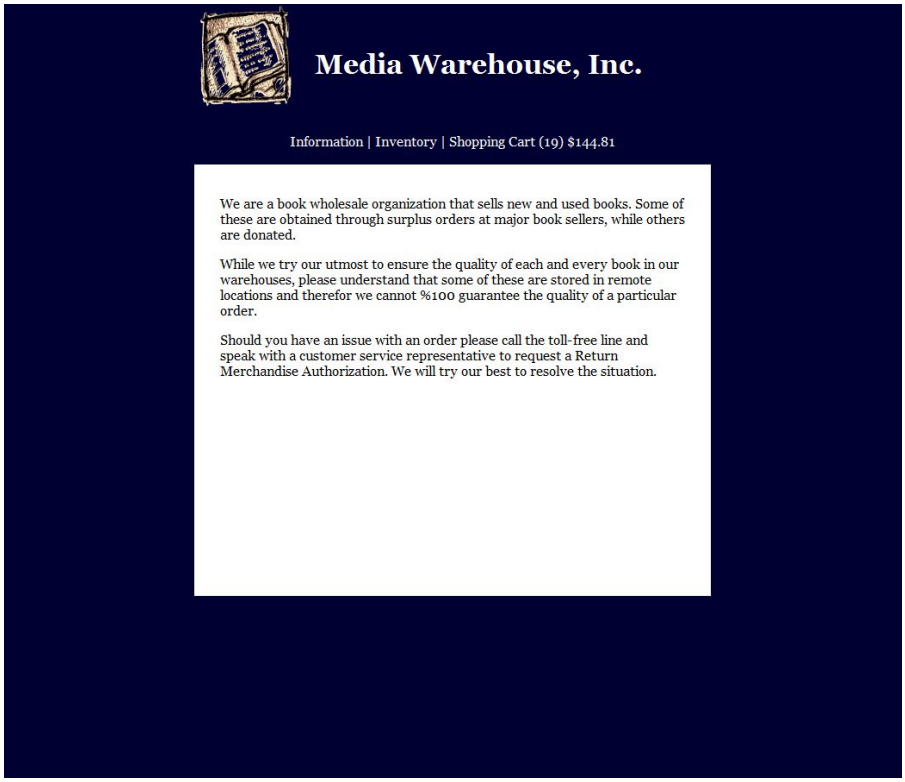


Figure 11 - Male Biased design front page

Figure 12 - Male Biased design book inventory

Notes:

- The navigation links read “Information” and “Inventory” in lieu of “About us” and “Books”, to make the website seem a little more standoffish and professional
- Some book images are replaced with question mark placeholder images; this was intentional, and is supposed to suggest that male developers may not care as much about graphical elements
- The language on the front page is very formal, and uses “We” in place of “I”, making the website seem a little more intimidating, as though it represents a company instead of a group of people
- The book inventory is single column, and extends vertically down the page

6.4.3 Female Biased Design

The female design was the most challenging to develop and went through the most changes during implementation. This was in part due to the feedback I received during the planning phase, as well as natural changes that arise while the mockup is translated into something functional and usable.

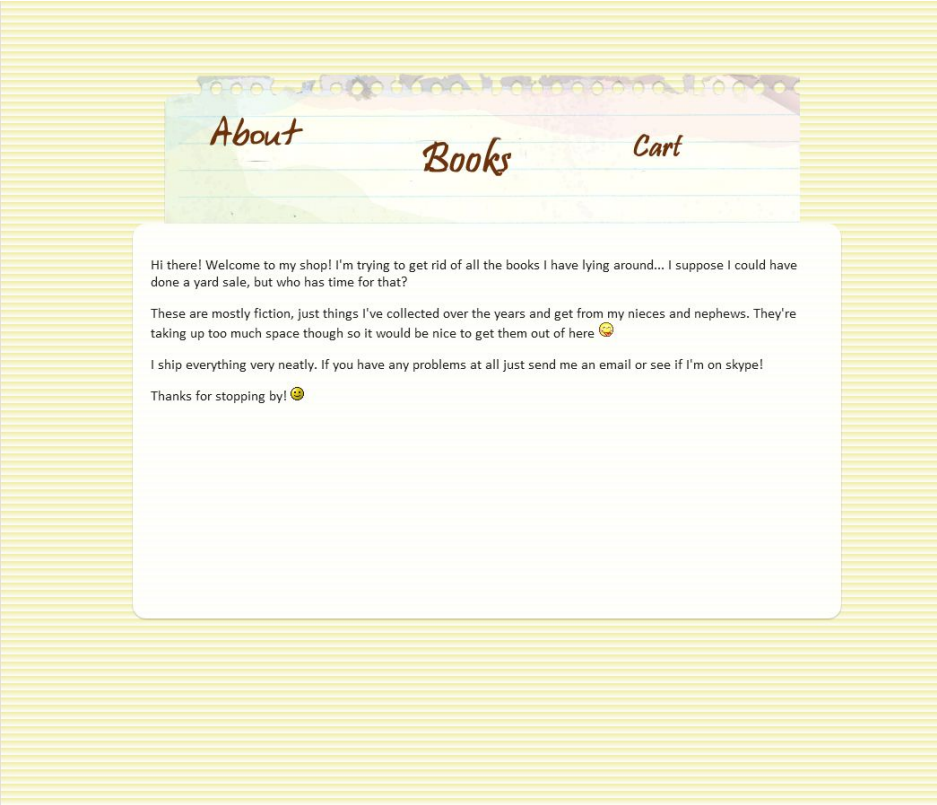


Figure 13 - Female Biased design front page

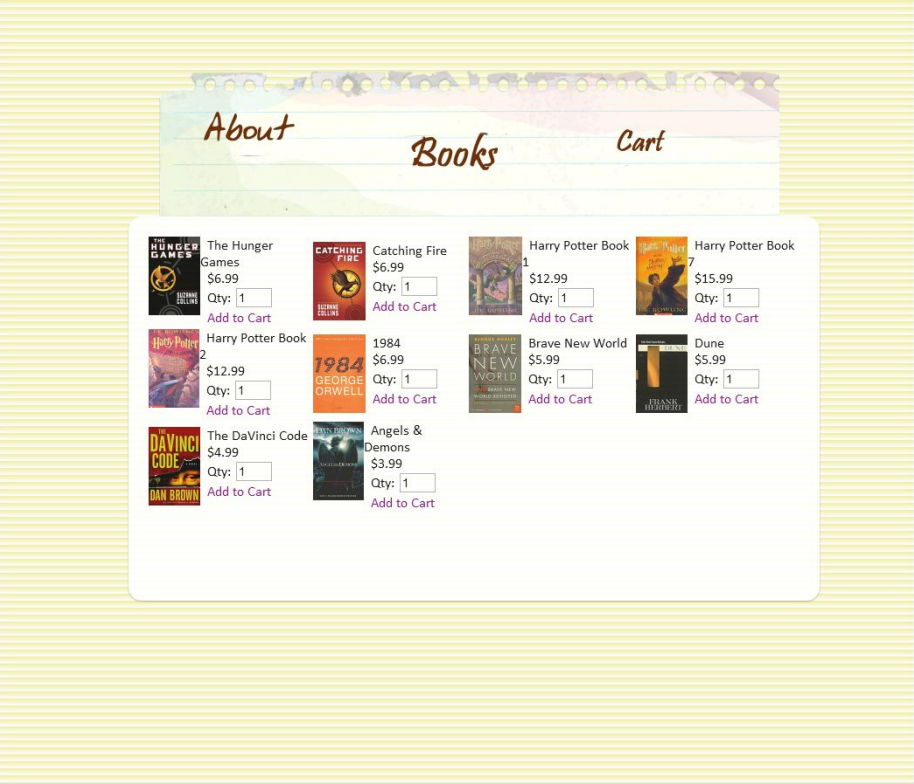


Figure 14 - Female Biased Design book inventory

Notes:

- Note the more fluid layout of the navigation menu items, as well as the informal font choice
- Emoticon usage on the front page, as well as a lot of of singular pronouns
- Has the widest content area, with the books filling four columns
- Color palette changed several times, but ended up being predominantly yellow, pink, blue, green, and white

7 Conducting the Experiment

7.1 Deployment and Recruiting Test Subjects

Deployment consisted of several phases. The first and most obvious choice was to send out a link to the WPI student body, asking them to voluntarily take part in the study. The email request looked like this:

> Hi everyone, please participate in this quick (less than 5 minutes) experiment on user interfaces. The focus of the experiment is how the different genders rate interfaces differently. If you would like to know more about the nature of the experiment, feel free to email me after you complete the survey.
>
> Also, please forward the link to anyone you think may be willing to participate. I'd like to get data from as wide a range of ages, backgrounds, and computer literacy as possible.
>
> Link: http://mqp.herokuapp.com
>
> Please note that this was not tested for mobile devices, just desktop browsers... you can use any one you like, though I've only confirmed it works in Firefox and Chrome.
>
> Thank you!
>
> -derrick.
>
> Project info:
> Students: Derrick Barth, CS
> Adviser: Jeff LeBlanc

The response to this email was fantastic, with many students opting to participate in the study the same day the email was sent out. By the end of the first day, each of the three websites had around thirty participants; this number grew to over a hundred each within several days.

Another source for the sample was acquaintances outside the WPI community, including art students at the Massachusetts College of Art and Design in Boston, Massachusetts. These students made up for a small, but valuable portion of the sample as their non-technical

backgrounds enabled them to see the study in a different way than the WPI students. This was evident in the feedback they gave me regarding the website designs.

Yet another valuable source of data was Integrated Computer Solutions, a company specialized in user interface development. This group comprised of people who had already graduated from college are working practitioners in the HCI field. As such, their views on the websites may be different from that of the WPI and MassArt undergraduates.

Finally, a link to the website hosting the experiment was posted on the social networking site, Facebook, which also saw an influx of users.

An extremely interesting result of the experiment is the unsolicited email feedback that was received by the participants. This feedback ranged from critiques on the design of the sites, the functionality, and even the shopping cart system. This may be due to the fact that the nature and purpose of the experiment was never explicitly stated, in order to keep the users impartial and unbiased. This seemed to result in users mistaking the experiment for one focused on design or the tasks, when in actuality it was simply to see how males and females rated the websites relative to each other.

8 Analysis of Results

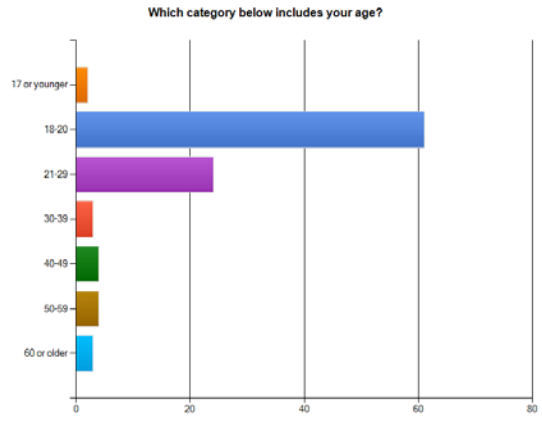
All numerical data was obtained from the Excel spreadsheets that were exported from the SurveyMonkey surveys. This data was easily analyzable in Excel using formulas and charts.

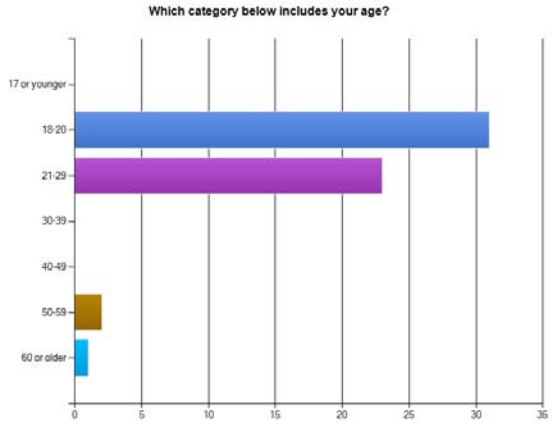
Numbers at a glance:

Total number of users across all websites: 444 (297 male + 147 female, for a ~2:1 ratio)

Neutral website: Males - 76, 63.9% Females - 43, 36.1%

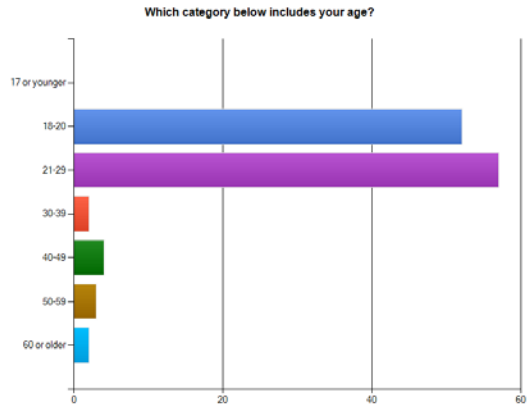
Age ranges:

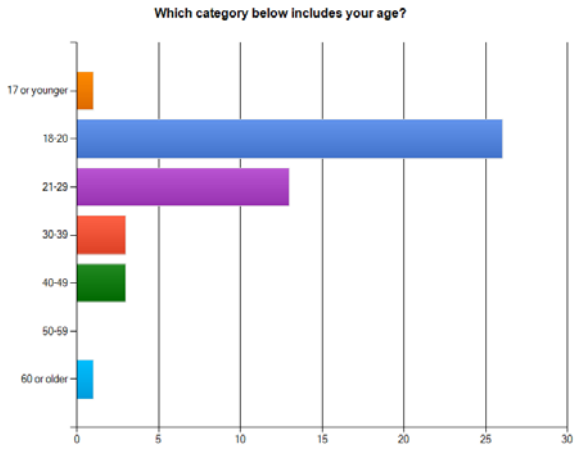




Male website: Males - 118, 71.9% Females - 47, 28.1%

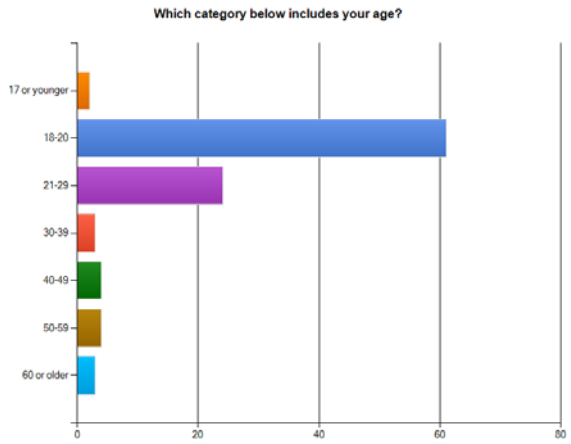
Age ranges:

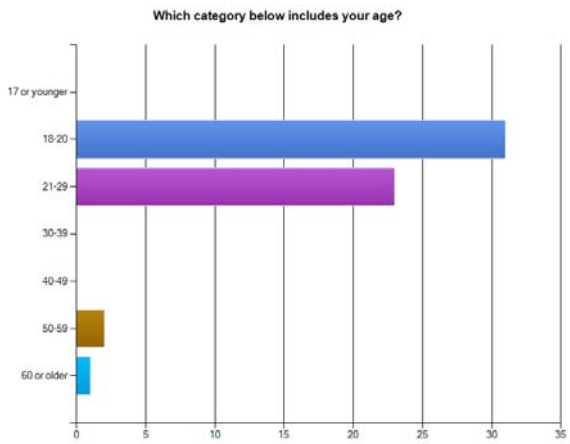




Female website: Males - 100, 63,9% Females - 57, 36.1%

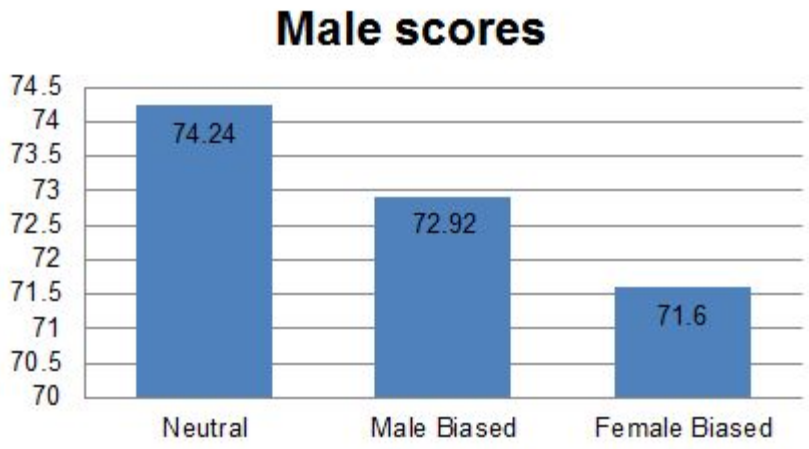
Age ranges:





8.1 Average Scores and Analysis by Gender

8.1.1 Male Scores



Neutral:

Sample Mean: 74.24

Standard Deviation: 17.12

Low: 35 High: 100 Range: 65

95% Confidence Interval: (74.19, 74.29)*

*we can be 95% confident that based on this sample, the population mean would fall within this interval

Male Biased:

Sample Mean: 72.92

Standard Deviation: 13.99

Low: 37.5 High: 95 Range: 57.5

95% Confidence Interval: (72.89, 72.95)*

*we can be 95% confident that based on this sample, the population mean would fall within this interval

Female Biased:

Sample Mean: 71.6

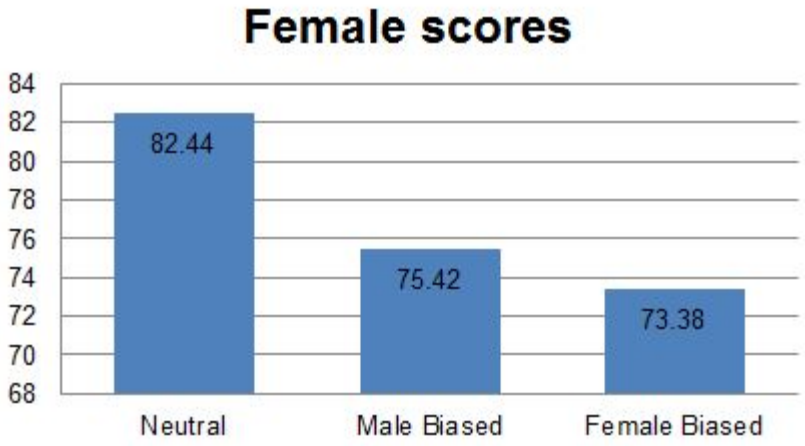
Standard Deviation: 13.99

Low: 32.5 High: 95 Range: 62.5

95% Confidence Interval: (71.56, 71.63)*

*we can be 95% confident that based on this sample, the population mean would fall within this interval

8.1.2 Female Scores



Neutral:

Sample Mean: 82.44

Standard Deviation: 11.34

Low: 50 High: 100 Range: 50

95% Confidence Interval: (82.39, 82.48)*

*we can be 95% confident that based on this sample, the population mean would fall within this interval.

Male Biased:

Sample Mean: 75.43

Standard Deviation: 15.26

Low: 25 High: 97.5 Range: 72.5

95% Confidence Interval: (75.36, 75.48)*

*we can be 95% confident that based on this sample, the population mean would fall within this interval

Female Biased:

Sample Mean: 73.38

Standard Deviation: 15.14

Low: 32.5 High: 95 Range: 62.5

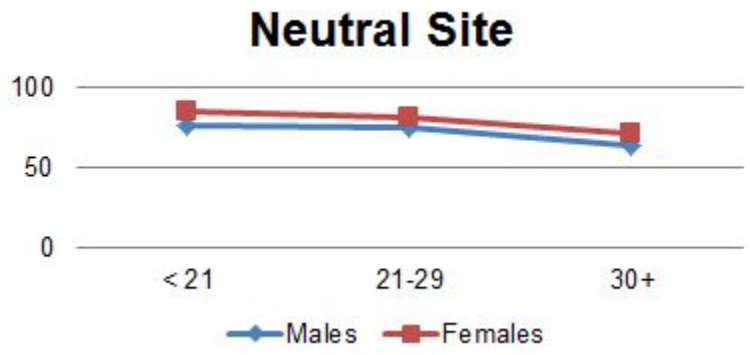
95% Confidence Interval: (73.33, 73.42)*

*we can be 95% confident that based on this sample, the population mean would fall within this interval

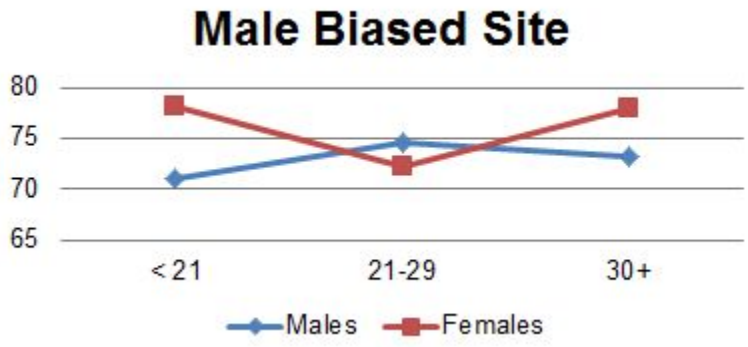
8.2 Average Scores by Age Range

Although the purpose of the study was to measure the values across the genders regardless of age, these charts are included to illustrate the interesting patterns between the different age groups.

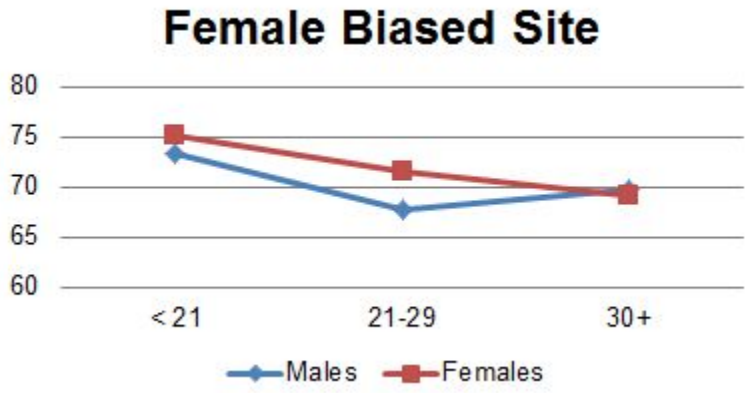
8.2.1 Neutral Design



8.2.2 Male Biased Design



8.2.3 Female Biased Design



9 Conclusion

From the charts and statistical data, it can be concluded that the Gender Neutral site was the highest rated out of all three. This actually confirms my hypothesis from the beginning of the project, but more importantly shows how much more this site was preferred over the two biased sites.

There are many things worth noting while observing the data:

- Both genders rated the female biased website the lowest. This could be due to a shift in values and gender roles in modern society, the nature of the sampled users, or because as a male designer I developed a website that female users would not rate as highly as if it were designed by a female. The Moss research supports that the genders will rate websites higher if they were developed by a same-gender developer.
- The female users tended to rate all websites higher than the male users
- Due to the tightness of the 95% confidence intervals, we can see that the sample means obtained here may not be far off from the population values
- Looking at the age groups yields some astounding observations, particularly in the Neutral website. Notice the similarity between the males' and females' scores within the different age groups. Both lines have a similar slope. This suggests that though age may be a factor in how much a user would like this website, a male and female user will rate the website roughly the same. This is the exact result we would want to see from a Gender Neutral design, and suggests that the design principles used for this website are sound principles that could be applied to any website to help make it more appealing to all users regardless of gender.
- Also note in the age groups for the male and female biased websites that the younger and older ranges didn't tend to follow their biases, however the middle range of 20-29 users did follow their biases. This suggests, like the chart for the neutral site, that age is a factor and that perhaps younger users (the "digital natives") are not as affected by traditional gender biases due to cultural and technological revolutions.

10 References

Bardzell, Shaowen. “Feminist HCI : Taking Stock and Outlining an Agenda for Design.” *Computing* (2010) : 1301-1310.

Friedman, B. and Nissenbaum, H. 1996. Bias in computer systems. *ACM Trans. Inf. Syst.*14, 3 (July 1996), 330-347.

Brooke, J. (1996). "SUS: a "quick and dirty" usability scale". In P. W. Jordan, B. Thomas, B. A. Weerdmeester, & A. L. McClelland. *Usability Evaluation in Industry*. London: Taylor and Francis.

Gnambs, Timo, Markus Appel, and Bernad Batinic. "Color Red in Web-based Knowledge Testing." *Computers in Human Behavior* 26.6 (2010): 1625-631. Print.

"ISO 9241-210:2010". International Organization for Standardization. Retrieved 26 April 2012.

Jian Hu, Hua-Jun Zeng, Hua Li, Cheng Niu, and Zheng Chen. 2007. Demographic prediction based on user's browsing behavior. In *Proceedings of the 16th international conference on World Wide Web* (WWW '07). ACM, New York, NY, USA, 151-160.

Kaplan, S. "The Restorative Benefits of Nature: Toward an Integrative Framework." *Journal of Environmental Psychology* 15.3 (1995): 169-82. Print.

Lidwell, William, Kritina Holden, Jill Butler, and Kimberly Elam. *Universal Principles of Design*. Beverly, MA: Rockport, 2010. Print.

Liu, Hugo. *Of Men, Women, and Computers: Data-Driven Gender Modeling for Improved User Interfaces*. UNT Digital Library. http://digital.library.unt.edu/ark:/67531/metadc30993/. Accessed March 6, 2012.

Moss, G.A. and Coleman, A. (2001), Choices and preferences: experiments on gender differences, *Journal of Brand Management*, 9, 2, 89 - 98.

Moss, G.A. and Gunn, R.W. (2005). Websites and services branding: implications of Universities' websites for internal and external communication, prepared for 4th International Critical Management Studies Conference.

Moss, G.A., Gunn, R.W. and Heller, J.A.G. Some men like it black, some women like it pink: consumer implications of differences in male and female website design, *Journal of Consumer Behaviour*, in press.

Moss, G.A., Gunn, R.W. and Kubacki, K.. "Successes and Failures of the Mirroring Principle: The Case of Angling and Beauty Websites." *International Journal of Consumer Studies* 31.3 (2007): 248-57. Print.

Mühlhäuser, Max, and Iryna Gurevych. *Handbook of Research on Ubiquitous Computing Technology for Real Time Enterprises*. Hershey, PA: Information Science Reference, 2008. Print.

Satchell, Christine. “Women are people too: The problem of designing for gender.” *CHI 2010 Critical Dialogue Workshop position paper*. 2010.

Sieverding, Monika, and Sabine C. Koch. "(Self-)Evaluation of Computer Competence: How Gender Matters." *Computers & Education* 52.3 (2009): 696-701. Print.

Tannen, Deborah. *You Just Don't Understand: Women and Men in Conversation*. New York, NY: Morrow, 1990. Print.

Wells, N. M. "At Home with Nature: Effects of "Greenness" on Children's Cognitive Functioning." *Environment and Behavior* 32.6 (2000): 775-95. Print.