Damien M. Berahzer. Scroll Placement and Handedness. A Master's Paper for the M.S. in I.S. degree. April, 2005. 46 pages. Advisor: Diane Kelly

This study explored how individuals categorized on handedness (being left or right hand dominant) reacted to having the vertical scroll bar of a web browser relocated to the left side of the screen. The relocation of the vertical scroll bar served as an alternative to the relocation of the prominent left aligned main navigation menu for most websites. Fifteen participants were recruited for the study. Each participant interacted with two versions of a web site in a modified browser to complete a set of ten short tasks. Participants completed tasks by interacting with a traditional and non-traditional vertical browser alignment. Left and right-handed participants were determined to be strikingly different in operation. Vertical scroll relocation produced some interesting results and responses.

Headings:

Handedness, User Interface Design, Scroll Placement, User-Centered Development

SCROLL PLACEMENT AND HANDEDNESS

by
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A Master's paper submitted to the faculty
of the School of Information and Library Science
of the University of North Carolina at Chapel Hill
in partial fulfillment of the requirements
for the degree of Master of Science in
Information Science.

Chapel Hill, North Carolina

April 2005

Approved by

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Introduction

Right aligned, left aligned, top aligned or bottom aligned. What constitutes the correct and most efficient alignment for the main navigation of a website? Studies indicate that most users expect the main navigation to be "almost exclusively located at the upper left side of a web page" (Bernard, 2001). Likewise, "51% of the most popular Websites are located flush against the left margin of the browser" (Bailey, 2002). There is a clear bias towards having the website and main navigation of the site left aligned. However, this practice may be one based on convention (Nielsen, 1999) rather than on empirical evidence supporting the use of this alignment.

Contributors to this debate have explored measurements of efficiency for task completion versus varying menu alignments. Factors considered include menu alignment, distance between targets, width of targets, accuracy of task completion, time taken to complete tasks and eye movement. While these factors contribute considerably to determining what may constitute the correct alignment for the main navigation of a website, many of the respected contributors have neglected to consider other elements that may prove instrumental to this debate. Two such factors are (1) Scroll placement and (2) Handedness. Merriam-Webster Online Dictionary defines handedness as: *a tendency to use one hand rather than the other*.

This study introduced the relocation of the scroll bar as a viable alternative to the multiple alignments possible for the main navigation. It relocated the vertical scroll bar to the left of the screen, placing it closer to the prominent left aligned website navigation. In tandem, it explores this possibility in relation to handedness (i.e. Does handedness act as a variable that determines the perceived usability of different scroll bar alignments?). It is interesting to note that little research has been done on website usability and handedness. Much of the research in usability has restricted itself to right-handed participants. This may be an unfair practice that forces left-handers to conform to right-handed constraints. By neglecting to explore the difference between these two user groups we run the risk of developing biased applications that possess the potential to cause harm to its users.

The study thus examined the interaction of right-handed and left-handed users with two simulated versions of a website in a browser. One version (referred to as the traditional system) consists of a left aligned website menu and a right aligned vertical scroll bar. The other version (referred to as the non-traditional) consists of a left aligned website menu and a left aligned vertical scroll bar.

Literature Review

Menu and Scroll Placement

For a long time research has focused to a great extent on the type of menus that are most effective. In 1988 Callahan, Hopkins, Weiser and Shneiderman examined the productivity level experienced by users when interacting with linear and pie menus. They found that pie menus consisting of exactly 8 items yielded a 15-20% increase in productivity of users when compared to its linear counterpart (1988, p. 100).

However, fewer studies exist that have explored the placement of menu on a website. Nielsen (1999) called the prevalence of left justified menus the “yellow fever syndrome”. He proclaimed to “never be a fan” of this menu placement because it takes up 20% of the screen. Since then screen resolution has vastly improved and this figure may decrease from any where between 10 to 15 % depending on user preferences. While acknowledging that the use of a left aligned navigation may be more of a convention, he purports that there are few usability reasons for the practice. Alternatively, he suggests it should be located on the right side of the screen as opposed to the prevalent left aligned menu placement. His two reasons are:

(1) Fitt’s Law (Kabbash, Patrick, Mackenzie and Buxton, p. 474) which states that the time to acquire a target is a function of the distance to and size of the target. Since the menu and scroll bar are objects that need to be manipulated by the user in finding information, placing the menu to the right minimizes the distance between click and scroll points. However, he did not consider the

possibility of moving the scroll bar to the left even though this would have achieved his goal of minimizing click distance.

(2) Users always look at the content first. Therefore, it makes most sense to place content as close to the left border as possible to save the user time as he/she reads from left to right (obviously this is not including those cultures in which users read from right to left). After users are finished reading the content they can naturally shift their gaze to the right to decide where they want to go next.

Kalbach and Bosenick (2003) also challenge the "current leading Web design thought that the main navigation should be left justified." Their experiment contrasted the usability of two Web page layouts: one with a left aligned main navigation menu and the other with a right aligned main navigation menu. The results showed that there was no major difference in task completion for the different menu alignments. In other studies their results also pointed to user indifference to the location of the main menu for the sites tested.

William Hudson (2002) questions the validity of placing menu items to the right of the screen. To combat Nielsen and others, he suggests that the other element of Fitt's law, size, can combat the distance issue. If items are made larger then the time to acquire the target is reduced. Also, many users now utilize the scroll wheel, thumb wheel and arrow keys to achieve scrolling within a website. According to Hudson the jury is still out on right-sided menus.

In parallel with Hudson's views, the findings of Hofer and Zimmermann (2000) reported by Kalbach and Bosenick (2003) support the use of left aligned menus. These

findings indicate that the left aligned menu out performed all other menu alignments by a factor of two while the right aligned menu yielded the longest time for task completion.

Even less work is done that examines the relocation of the vertical scroll bar as a factor influencing the usability of a web site. Dr. Bailey (2002) reports that experiments illustrate users prefer to have the scroll bar closer to the information (menus, list boxes etc) it was manipulating. He gives the ultimate alternatives for designers seeking to achieve the right combination of information, scroll bar alignment. He states that designers have one of two options:

(1) Move the most frequently used information to be near the vertical scrollbar, or

(2) Move the scrollbar to be closer to the information.

His first alternative mirrors the heart of the menu placement debate; move the menu items to the place that affords the user the highest usability. His second alternative is the one most contributors to the debate failed to consider.

Handedness

Right and left-handed individuals represent an operationally differentiated group that may exhibit differences in efficiency for application layouts. Booth and Hancock (2004) noted that there were significant discrepancies between left and right handed users when trying to acquire menu targets placed at different location on the screen. This experiment looked at differences in efficiency for right and left-handed individuals when interacting with circular and rectangular pop-up menus using the stylus input device. They gave two potential ways to compensate for the discrepancy in performance based on handedness factors. They were to:

(1) Provide and adaptable display that would allow the user to choose which menu placement suits him/her best and

(2) To model the application in such a way that it automatically adapts the display based on the handedness exhibited by the user.

This was one of the few experiments that addressed issues of handedness in application design and suggested ways of accounting for this difference.

Most other studies have neglected to focus on handedness as a major variable or used only a sample of right handed participants. It seems researchers have stayed away from the issue of handedness for many reasons. Booth, Fisher and Po (2005) "ensured that all subjects were right-handed" (p. 294) to minimize any experimental bias due to handedness variables. Kalbach and Bosenick (2003) justify the use of right aligned web menus based on the prevalence of right handed users. For the most part there has been little work conducted that study relationships between usability and handedness. Studies have instead focused on dominant and non-dominant hand performance.

Kabbash, Mackenzie and Buxton (1993) explored the performance of users for preferred and non-preferred hands when interacting with input devices. They explored in more details the functions of clicking (equivalent to link selection) and dragging (equivalent to page scrolling using the scroll bar). For function such as scrolling the non-dominant hand performed just as well as its dominant counterpart.

Hinckley, Pausch, Profitt and Kassell (1998) discuss the use of a two handed user interface designed to augment a model for a three-dimensional neurosurgical visualization. This study attempted to surpass the boundaries of the current "WIMP" (Windows, Icons, Menu and Pointer) paradigm for graphical user interfaces. To get past

this model, new interfaces will need to “broaden the input capabilities of computers and improve the sensitivity of our interface designs to the rich set of human abilities and skills” (p. 261). They cite Card and Moran as having said that “technology must include a technical understanding of the user himself and of the nature of the human computer interaction” (p. 262).

Jakob Nielsen (2000) outlined the importance of having a “User-Centered Structure” in the development of e-commerce web sites. In one of his studies he reported that two models for the organization and display of information were compared and that the one that was designed according to the “most users’ mental model” (the way that most users thought about the domain or product lines) had a success rate of 80 percent. The other one that was structured according to the company’s internal mode of thinking only had a 9 percent success rate.

Preece, Rogers and Sharp (2002) stated that developers must “be more principled in deciding which choices to make by basing them on an understanding of the users” (p. 5). They argue that these considerations are essential for optimizing the user’s interaction with the systems. The importance of the user continues to be an emphatic consideration in the design an implementation of any systems project. In spite of this most research has neglected to focus on handedness as a way of understanding differentiated users. Without a true understanding of left-handed users, we cannot fully claim to have developed user-centered applications.

Apart from the principles of a user-centered approach there are other reasons why handedness is an important consideration. According to Coren (1992), “there are reasons to believe that the right-handed design of the world may actually constitute a danger for

the left-hander" (p. 249). Left-handers are pressured into manipulating work with their right hands or adopting awkward postures in order to manipulate right handed devices. What seems now as a simple adaptation by the minority (left-handers using right-handed mice) may have severe consequences in the future when human-computer interaction becomes more complex. A simple device such as a pair of scissors can illustrate this point. The first attempt at correcting scissors to include left-handers resulted in manufacturers adjusting the handle only. Subsequently, manufacturers were forced to move beyond the mere adjustment to include the more expensive step of adjusting blades so that left-handers could see the object they were cutting.

Differences between left and right-handers should be taken into account when applications are developed. Traditionally left-handers have been "ignored by designers, engineers and manufacturers" (McManus 2002). This practice is one that may lead dire consequences. McManus grasp the gravity of this practice, "in the words of Thomas Carlyle, 'Man is a tool-using animal…. Without tools he is nothing, with tools he is all,' then without left-handed tools a left-hander risks being nothing" (p. 280).

The research reported in this paper explored the trends in interaction for left-handed and right-handed users by conducting a usability study in which participants interacted with a traditional (left aligned website menu and a right aligned vertical scroll bar) and non-traditional (left aligned website menu and a left aligned vertical scroll bar) website and browser layout. Not much literature exists that explores the relationship between menu placement, handedness and scroll placement. This experiment examined any relationship among these three factors and provides a framework for furthering the discussion on menu placement.

The quantitative data were used to characterize traits between the user groups however, the qualitative data contributed more notably to the findings presented. The qualitative data were collected from a questionnaire where users were asked to reflect upon their interaction with a layout to which they were unaccustomed. The results of this study contribute some understanding of the missing elements to the menu placement debate, specifically, scroll placement and handedness. Scroll placement allows us to examine the alternatives that extend beyond the website by incorporating the browser itself as part of the problem. Conversely handedness allows us to gain a better understanding of the human-computer interaction. This understanding can be instrumental in the development of truly user-centered applications.

Method

The study presented users with an opportunity to interact with a non-traditional web browser, where the vertical scroll bar was located to the left of the screen. An examination of the interaction of left versus right-handed individuals to this type of browser layout adds to the understanding of how we may correctly address menu placement. By extension, this research may be helpful in the development of a technically unbiased system.

The structure of the study was as follows:

(1) The participants were divided into two groups: left-handers constituted one group while right-handers constituted the other group.

(2) Each participant interacted with both applications (the traditional left aligned menu, right aligned vertical scroll bar and the non-traditional left aligned menu, left aligned vertical scroll bar.

(3) Half the participants of each group were presented with the left aligned menu, left aligned vertical scroll bar first. The other half interacted with the left aligned menu, right aligned vertical scroll bar first.

(4) All participants were given the same set of ten tasks per site to perform.

(5) All tasks were presented to the participants in a random order by utilizing a random function developed in Flash ActionScript[1] 2.0.

[1] ActionScript 2.0 is a programming language developed by Macromedia Inc. for creating interactive and animated online applications.

(6) The results of each group were examined to determine if trends existed within a group. Then results were compared and contrasted between groups.

(7) Qualitative data were also obtained by asking the user to reflect upon, and examine their interaction with the different systems.

The time taken for users to complete the set of ten tasks was obtained by examining server logs. Each task presented to the user was linked to a specific image which was stored on a server. Likewise, each button was also linked to a specific image stored on the same server. Each image acted as a tag that identified which task was randomly presented to the user and which button was clicked by that user. The server recorded the time of each image request. The difference between the task image request (as the task was presented to the user by the system) and the correct button request (when the user clicked on the correct button) was recorded as the time used to successfully complete a given task.

The tasks were developed based on content derived from popular news websites such as CNN.com and WRAL.com. It was assumed that the categories used on such sites would be familiar and logical to web users. An attempt was made to make the tasks between applications similar. For example the traditional system possessed a task that required the user to select the “Politics” button while the non-traditional system had a task that required the user to select the “Government” button. To test that these tasks were reasonable, a small pilot study preceded the experiment. The pilot study consisted of four individuals, none of whom took part in the actual experiment.

Each set of ten tasks consisted of five tasks that required participants to view to an image. These images contained graphical and textual clues to aid the users in completing

the task. For example, the task that required the user to select the classifieds button had the words “Your one stop Classifieds Finder” located to the bottom of the classifieds tool shown in the picture. The remaining five tasks did not present the user with an image. It should be noted that even when an image was not visible to the user, the program requested the image that corresponded to that particular task from the server. This was necessary for tracking the time that each task was presented to the user.

Table 1 lists the tasks presented to the users and the buttons that corresponded to the correct selection for the traditional application. Table 2 lists the tasks presented to the users and the buttons that corresponded to the correct selection for the non- traditional application.

Table 1: Tasks presented to participants with the button that represented the right choice for completion of the task in the traditional application.

Button	Task
Home Page	Click on the link that will return you to the Home Page of the website.
Weather	You would like to know what the temperature will be tomorrow. Please Click on the link that will give you this information.
Business	Click on the button that will lead you to the information provided in the picture shown below.
Sports	This is your favorite past time. You love to get the latest and greatest on it. Examine the picture below to decide which link will yield the information you desire.
Politics	A major event is about to take place. You intend to keep up to date with the proceedings. It involves these two gentlemen. Select the ink that will take you to the information.
Technology	The threat of a new virus to cellular phones is making waves in the IT industry. Further information on this topic may be found by clicking on one of the links. Please do so now.

Law	The headlines read: “A federal judge dismissed a lawsuit claiming that American chemical companies committed crimes.” Click on the link in which the headlines may be found.
Health	The picture below illustrates information that may be found by clicking on this link. Please click on the link.
Entertainment	“We’re the knights of the round table.” ‘Spamalot’ stars David Hyde Pierce, Hank Azaria, Christopher Sieber, Steven Rogen and Tim Curry. Click on the link that will allow you to get more information on the even shown below.
About Us	The mission, the people, the history and information on the members of the website may be found by clicking on this link. Please do so now.

Table 2: Tasks presented to participants with the button that represented the correct choice for completion of the task in the non-traditional application.

Button	**Task**
Search	You are uncertain of which category the information you are seeking may be found. Select the button that will allow you to find where the information may be found on the site.
Weather	Click on the button that will yield the information shown in the picture below.
Photography	You once were a journalist and believe that the true power of telling a story lies in the magic of the pictures. Click on the button that will allow you to access these images.
Sports	March March March Madness! You love basketball and follow your team that’s heading to the national championship. Click on the button that will give you the latest information on your team.
Government	Legislators in your local town are debating the impacts of implementing a state lottery. You intend to keep yourself up to date with the proceedings. Click on the buttons that will give you information on this political debate.

Classifieds	You know exactly what you want. All that's left is for you to find it and buy it. You use the tool shown below. Click on the button that would have taken you to this tool.
Education	You are very passionate about this area. Click on the button that led you to the material shown below.
Fitness	You have heard about a novel machine that promises great results for getting and staying in shape. You want to find out more about it. Click on the button that will lead you to this device.
Work & Career	You have been contemplating making some changes in your life. You are looking into your options. Click on the button that yielded the information show below.
Contact Us	You need more information. Click on the button that would have yielded the page show below.

Friedman and Nissenbaum (1996) outline biases that may be associated with computer systems. For this experiment consideration is made to their interpretation of Preexisting and Technical bias. Preexisting Bias exist when computer systems embody "biases that exist independently, and usually prior to creation of the system" (p. 334). Nielsen's mention of convention of left handed menu may constitute such a bias. Convention may have established the bias of left aligned menus.

Technical Bias "arise from technical constraints or technical consideration" (p. 334). The current User Interface and system manipulation within a Windows Operating System Environment may constitute such a bias; by having application menus be left aligned by default and having mouse pointers that angle to the left. To combat some of these biases the application was designed to have no menus aligned for the browser (this refers to the menu items found on the various tool bars of the Internet Explorer, such as

Window – File, Edit, Back options etc.). The mouse pointer was also transformed into a cross hair located inside a circle. This type of design allows the cursor to be orientation neutral (Po, 298) reducing any bias toward a particular handedness group.

Participants

Fifteen participants were recruited from among members subscribed to the School of Information and Library Science at Chapel Hill Student mailing lists. An email was sent to members of these lists inviting them to participate in this study. Seven of the participants were left-handed (3 male participants and 4 female participants) and eight were right-handed (5 male participants and 3 female participants) so that 53% were male 47% were female. Since all participants indicated using a web browser more that 10 times per week, none of them had to be trained in the general principles of web usage. Two left-handed participants reported that English was not their first language. One left handed participant mentioned that he generally used a left-handed mouse whenever he got the opportunity but was just as comfortable using a right-handed mouse.

Apparatus

Participants were asked to interact with two Flash developed applications that were mock-ups of a website in a browser (Figure 1a and 1 b). These applications covered the entire screen of the monitor, so that the only thing the user saw was the mock website (i.e. there was no task bar and no wallpaper space displayed). This was done to minimize distraction from items not related to this study.

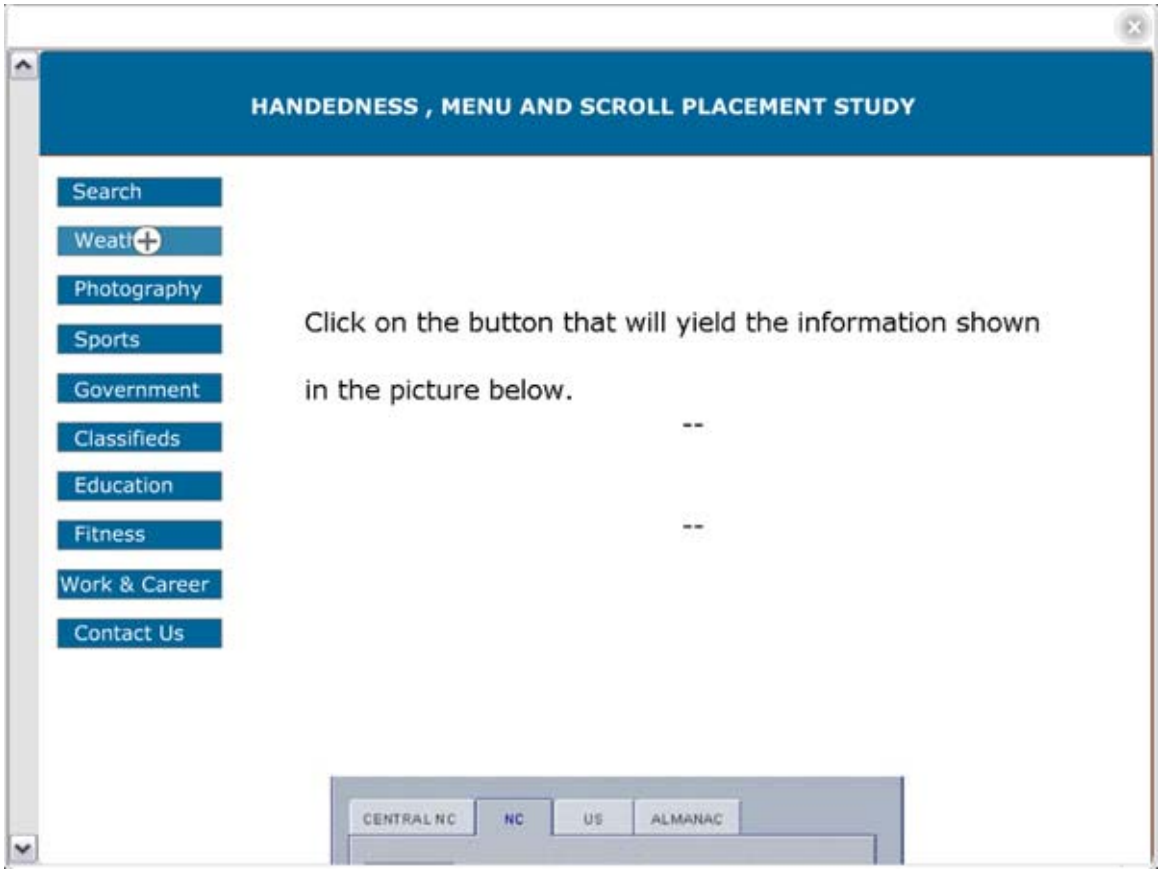

Figure 1a. Mock up of a website in a browser with a left aligned web menu and a left aligned vertical scroll bar.

The application ran on a Dell Dimension 8200 series computer with a 2.8 GHz Pentium(R) 4 processor and a 19" Dell P991 Trinitron monitor with maximum resolution of 1280 X 1024 pixels. For this study the resolution was set to a resolution of 1024 X 768. The application itself was developed using specifications of 800 X 600. However, the built in fscommand[2] function of Flash was utilized to allow the application to fit exactly to whatever screen resolution was used on a given monitor. This meant that all the components of the application were displayed at a size 1.28 times that which it was

[2] The fscommand function was used to configure the stand alone Flash Player on the computer to fill the entire screen only showing the contents of what was developed in Flash. There were no windows holding the application.

created. The size increase meant that the targets (buttons on the website, and the scroll up and scroll down arrows of the vertical scroll bar) were easier to acquire. Images requested by the application were hosted on a server running Apache 2.0. This server did not host any other content for the duration of the study.

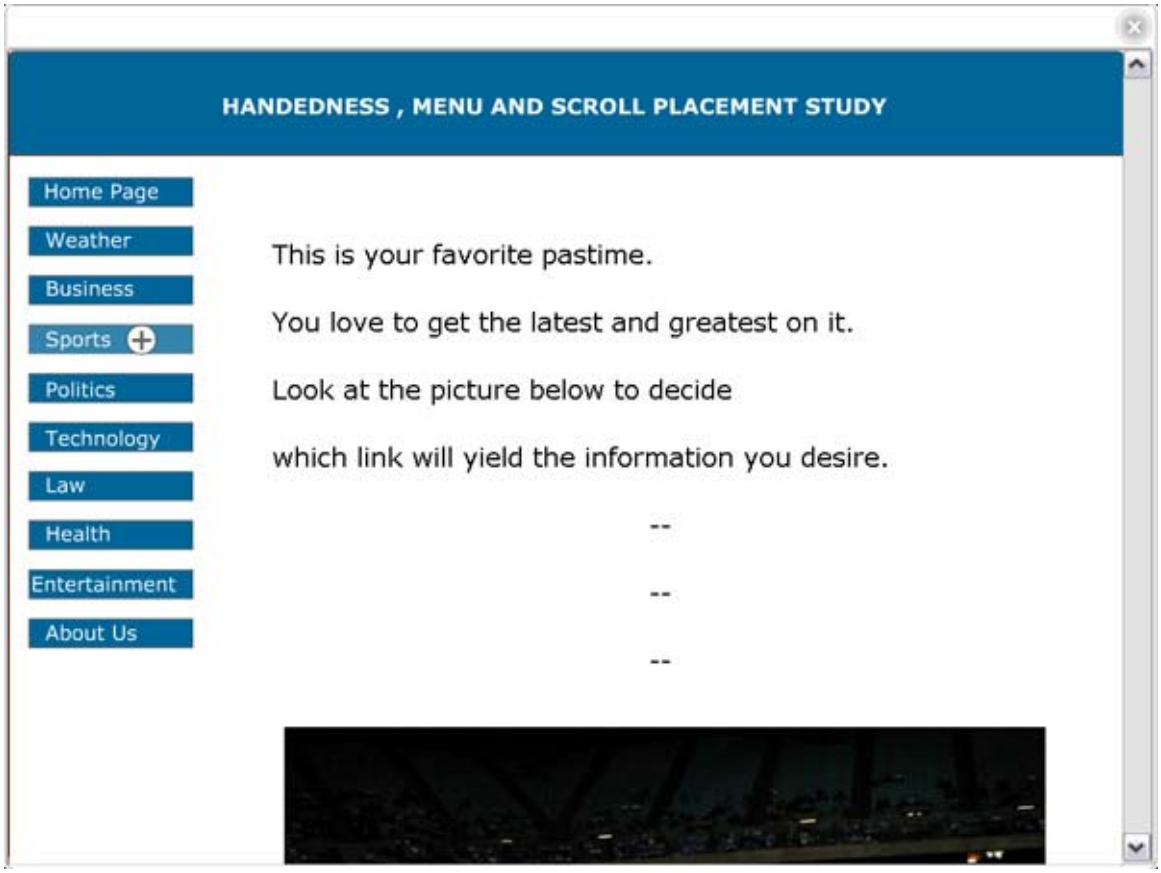

Figure 1b. Mock up of a website in a browser with a left aligned web menu and a right aligned vertical scroll bar.

The application was built with certain differences and limitations.

(1) The traditional pointer was replaced with a circle that had a cross hair running through it. This orientation for a mouse pointer reduced the indication of a

preference to being right or left-handed as is shown by the tilted pointer that points to the left in typical right-handed mice.

(2) The application was developed to resemble a website in a browser; however the browser portion of the application did not posses “Standard Buttons”, “Links” and “Address” bar of most IE browsers. These options are normally left aligned and may constitute a form of preexisting Technical Bias. Addressing this issue is beyond this study. Also for purposes of this study the only option other than scrolling that could be performed on the browser portion was to close it out.

(3) The scroll wheel ability found on most mice was not programmed into the application. Users were not told of this limitation but were observed to see if they tried to use this functionality as well as other ways for navigating through the website.

For tasks that required participants to examine an image, most of the image positioned below the initial viewable portion of the screen. This ensured that participants had to scroll for some of the tasks, preventing them from simply keeping the cursor positioned over the menu and not interacting fully with the application.

Procedure

The study was approved by the UNC Behavioral IRB, Study # LIBS 2005-033.
Participants were informed verbally of the contents of the study at the beginning of the scheduled participation time. They were told that they were being asked to interact with two versions of an application that simulated a website in a browser. These two applications varied from each other in several ways. No mention was made of the exact

differences between the applications and no participants asked about these differences before they began the study. However, participants were told that they were free to ask questions at anytime if they needed clarification on anything during the course of the study.

At the beginning of the study participants were asked a fill out an entry questionnaire (See Appendix A) in order to categorize them. Specifically, they were asked which hand represented their more dominant hand to determine their handedness. They were also asked to indicate their gender and whether English was their native language. Upon completion of the entry questionnaire participants were allowed to begin interacting with one version of the application when ready. Half the participants of each group was presented with the traditional system (left aligned menu and right aligned vertical scroll bar) and the other half with the nontraditional (left aligned menu and left aligned vertical scroll bar).

In each system participants were presented with a set of ten tasks. The order in which the tasks were given was completely random. The system first presented the user with a task to accomplish. A participant successfully completed a task by selecting the button on the left aligned menu that corresponded to the scenario given in that task. A new task (webpage) appeared after the user successfully completed the task. If participants incorrectly completed a task they were given a message by the application that informed them of the error. The message stated, “There seems to be an error in your selection. Please try again” (See Figure 2). Participants repeated the task until they completed it successfully. This ensured that participants took time to correctly interact with the site and the instructions given. Note that in Figure 2 the picture is not seen. The

errors message pushed it down by two lines. In this scenario participants were forced to scroll to see the image again if they needed to view it to remind them of the content. This element also helped to ensure that participants took time to interact with the application. During their interaction notes were taken that reflected the behavior of participants. For example some participants were seen trying to use the scroll wheel and others attempted to use arrow keys to navigate through the site.

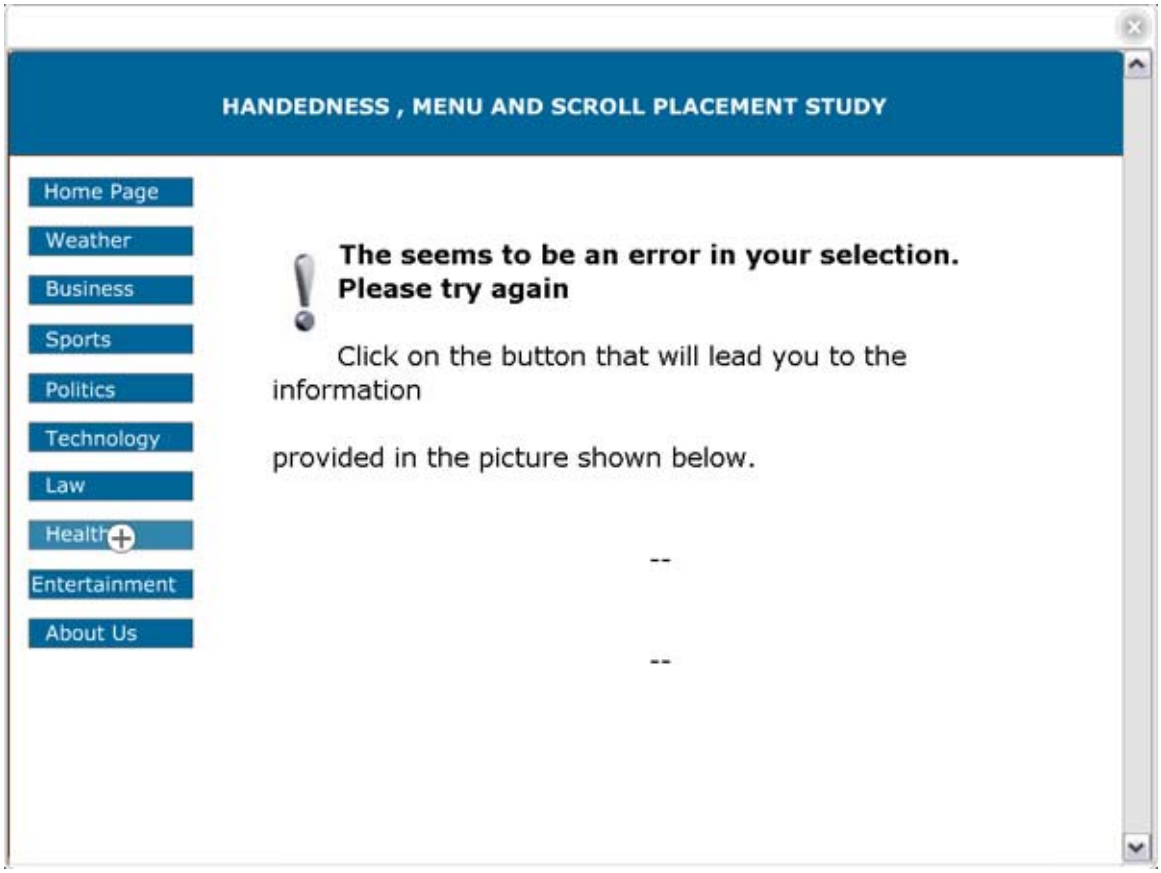

Figure 2. Error message given to participants when they clicked on the incorrect button. Incorrect in this study refers to the button the system expected the user to click on.

For both applications the main site navigation consisting of ten buttons was always left aligned. However, the contents (buttons) of the main navigation were

different for each application (See Figure 3). The difference in menu contents helped to negate the possibility of participants memorizing the button options in one application and then decreasing their time for completing tasks for the other application that followed. The buttons comprised of white Verdana text on a dark blue background which changed to a lighter shade of blue when participants positioned the cross hair pointer over the buttons. This helped participants to be certain of which button they were going to select for the given task.

Figure 3: Navigational Menus for both applications.

Not all tasks were constructed to be simple and straight forward. Participants were required to use judgment in selecting a button to successfully complete tasks. This factor helped to ensure the experiment closely resembled online browsing. When browsing,

individuals utilize cognitive resources making decisions as to where they may find the information they seek.

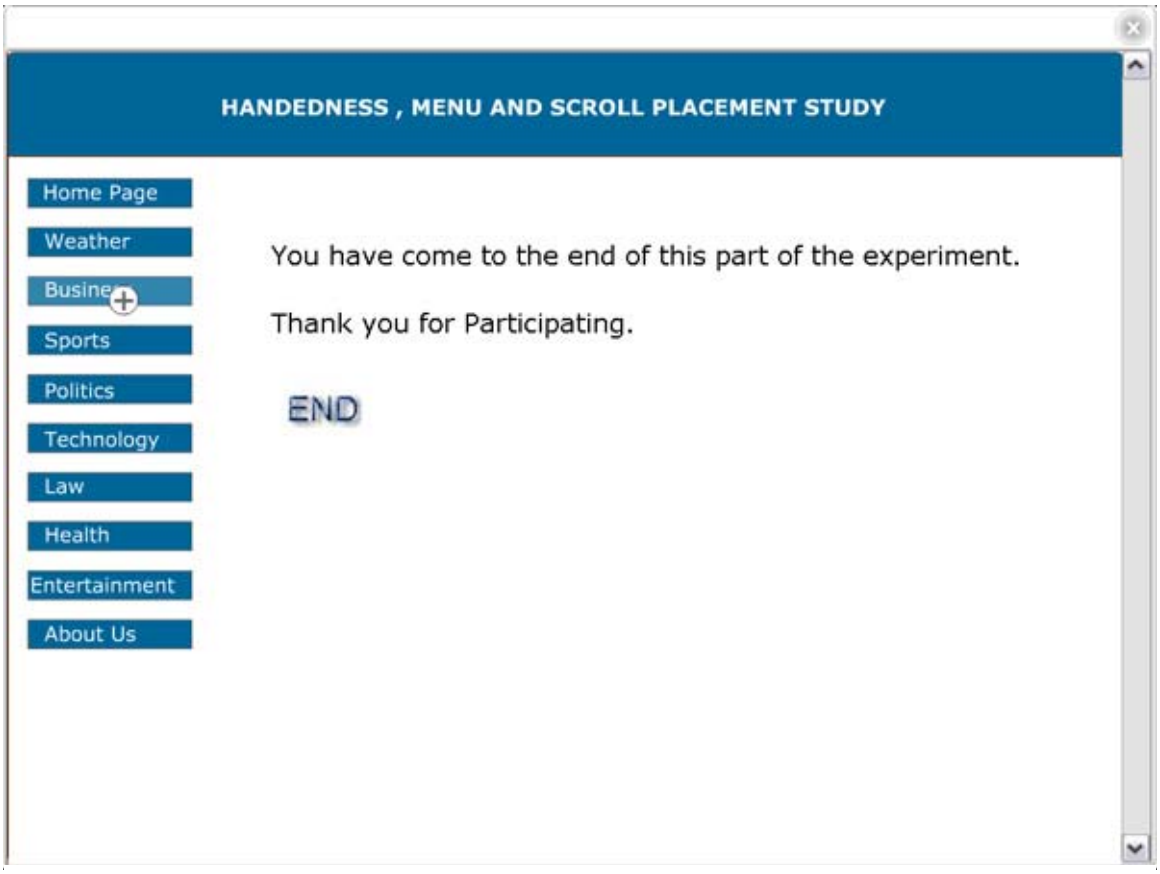

Figure 4: Successful Completion of tasks message.

After successfully completing the set of ten tasks the participants were given a message (See Figure 4) stating, “You have come to the end of this part of the experiment. Thank you for participating.” to inform them that they had come to the end of that part of the study. Upon successful completion of the set of ten tasks participants were asked to fill out a post system questionnaire (See Appendix B). This was done for each application for a total of two post system questionnaires per participant. Participants were then asked

to complete an exit questionnaire (See Appendix C). This questionnaire focused on comparing the two applications. They were asked to indicate if they preferred one application to the other and to state why.

The times taken for participants to complete tasks were obtained by examining the Web server logs for the machine on which the images were hosted. Times to complete tasks were determined by calculating the time between a task being presented to the user and the correct button being clicked. Each task requested an image that identified the task when loaded and each button requested an image that identified that button when clicked. Figure 5 shows an example of the serve logs.

```
------.ils.unc.edu - - [28/Mar/2005:10:53:53 -0500] "GET /thesis/image06.jpg
        HTTP/1.1" 200 13220 "http://152.2.81.140/thesis/image06.jpg"
        "Shockwave Flash"
------.ils.unc.edu - - [28/Mar/2005:10:54:17 -0500] "GET /thesis/button06.jpg
        HTTP/1.1" 200 13822 "http://152.2.81.140/thesis/button06.jpg"
        "Shockwave Flash"
------.ils.unc.edu - - [28/Mar/2005:10:54:17 -0500] "GET /thesis/image00.jpg
        HTTP/1.1" 200 13220 "http://152.2.81.140/thesis/image00.jpg"
        "Shockwave Flash"
------.ils.unc.edu - - [28/Mar/2005:10:54:23 -0500] "GET /thesis/button00.jpg
        HTTP/1.1" 200 13821 "http://152.2.81.140/thesis/button00.jpg"
        "Shockwave Flash"
------.ils.unc.edu - - [28/Mar/2005:10:54:23 -0500] "GET /thesis/image03.jpg
        HTTP/1.1" 200 63718 "http://152.2.81.140/thesis/image03.jpg"
        "Shockwave Flash"
------.ils.unc.edu - - [28/Mar/2005:10:54:38 -0500] "GET /thesis/button03.jpg
        HTTP/1.1" 200 13820 "http://152.2.81.140/thesis/button03.jpg"
        "Shockwave Flash"
-------.ils.unc.edu - - [28/Mar/2005:10:54:38 -0500] "GET /thesis/image04.jpg
        HTTP/1.1" 200 50628 "http://152.2.81.140/thesis/image04.jpg"
        "Shockwave Flash"
-------.ils.unc.edu - - [28/Mar/2005:10:55:06 -0500] "GET /thesis/button04.jpg
        HTTP/1.1" 200 13809 "http://152.2.81.140/thesis/button04.jpg"
        "Shockwave Flash"
```

Figure 5. Server logs indicating tasks (requests for imagexx.jpg) and button click (requests for buttonxx.jpg).The name of the requesting machine has been replaced by ------- for security and privacy reasons.

In the server logs shown above task seven (identified by the request for image06.jpg) was presented to the user at 10:53:53 a.m. Button six (identified by the request for button06.jpg) was clicked at 10:54:17 a.m. Images and buttons JPEGs were related to the task by a factor of minus one. The time taken to complete task seven corresponded to the time between the request for image06.jpg and button06.jpg (in this case 24 seconds).

Results and Discussion

Tables 3 and 4 show the total times in seconds for right-handed and left-handed participants to complete the set of ten tasks for the right aligned (traditional system) and left aligned (non-traditional system) vertical scroll bar. The shaded cells indicate those participants that interacted with the traditional system first. Right-handed participants 1, 2, 3 and 8; and, left-handed participants 2, 4, 5 and 6 interacted with this version of the application first.

Table 3: Time in seconds for right-handed and left handed participants to complete set of ten tasks when using the RIGHT aligned vertical scroll bar.

	Participant Times for Right and Left Handed Participants when interacting with the Right Aligned Scroll Bar									
	1	2	3	4	5	6	7	8	**Average**	STD. DEV.
Right Handed Times	102	103	145	91	160	100	98	88	**110.9**	26.5
Left Handed Times	67	89	123	99	104	195	105		**111.7**	40.5

Table 4: Time in seconds for right-handed and left handed participants to complete set of ten tasks when using the LEFT aligned vertical scroll bar.

	Participant Times for Right and Left Handed Participants when interacting with the Left Aligned Scroll Bar									
	1	2	3	4	5	6	7	8	**Average**	STD. DEV.
Right Handed Times	59	100	100	162	258	83	178	88	**128.5**	66.0
Left Handed Times	84	107	182	75	98	195	146		**126.7**	48.0

The figures illustrated in the tables above do not indicate any major difference in efficiency of task completion between left and right handed users when using either a right aligned or left aligned vertical scroll bar. However, there were differences among participants that may have contributed to this occurrence. English was not the native language for two of the left handed participants. These participants required further explanation on some of the tasks. For example, one participant never encountered the word classifieds before; this corresponded to a task that was associated with button six of the application with the left aligned vertical scroll bar. Clarification of terms increased the time for these participants to complete tasks. These participants also expressed being highly nervous during the study due to their language constraints.

While there may be other factors that accounted for differences in time taken to complete task among users those mentioned above are considered to be comparably different and unique to only these two participants. Removing these participants' times results in a noted difference between efficiency of task for right-handed and left-handed individuals. Table 5 and Table 6 show the modified averages for right-handed and left-handed users when interacting with the right and left aligned vertical scroll bar applications. The times for the participants mentioned before were not included in this average and is denoted by having the times scratched off in the tables.

The averages show a considerable difference between right-handed and left-handed individuals. Left handed individuals performed better on both applications suggesting that there is a difference in the way both groups operate on a functional level when interacting with websites.

Table 5: Modified Average Times in seconds for right-handed and left handed participants to complete set of ten tasks when using the LEFT aligned vertical scroll bar.

	Modified Participant Times for Right and Left Handed Participants when interacting with the Right Aligned Scroll Bar									
	1	2	3	4	5	6	7	8	**Average**	STD. DEV.
Right Handed Times	102	103	145	91	160	100	98	88	**110.9**	26.5
Left Handed Times	67	89	~~123~~	99	104	~~195~~	105		**92.8**	15.8

Table 6: Modified Average Times in seconds for right-handed and left handed participants to complete set of ten tasks when using the LEFT aligned vertical scroll bar.

	Modified Participant Times for Right and Left Handed Participants when interacting with the Left Aligned Scroll Bar									
	1	2	3	4	5	6	7	8	**Average**	STD. DEV.
Right Handed Times	59	100	100	162	258	83	178	88	**128.5**	66.0
Left Handed Times	84	107	~~182~~	75	98	~~195~~	146		**102**	27.5

The tables also indicate that participants generally took more time to complete the set of tasks in the application with the left aligned vertical scroll bar (See Table 7). These results do not support the theory of Fitt's Law. Having the scroll bar located to the left closer to the main navigation did not increase the efficiency (i.e. reduce the time taken) of task completion by users. However, further analysis of the experiment shows that the results do not necessarily contradict Fitt's law.

Table 7: Comparison of average times for right-handed and left-handed participants to complete the set of tasks for the right and left aligned vertical scroll bars.

	Right-Handed Participants	**Left-Handed Participants**
Right Aligned Vertical Scroll Bar	110.9	92.8
Left Aligned Vertical Scroll Bar	128.5	102

This occurrence may be accounted for in the differences between tasks for the different applications. Participants were given unique task in each application and the main navigations of the applications were notably different, only having two overlapping categories (the Weather and Sport buttons). The rest of the tasks dealt with unique categories which meant that each set of ten tasks could differ in overall difficulty for each participant. It should be noted that 80% of the participants rated both sets of tasks as having the same level of difficulty.

One other reason that accounted for this difference was that some of the participants took extra time to notice the scroll bar located on the left side of the screen. Some participants were seen dragging the pointer to the far right border of the screen where they expected to find to scroll bar. When asked about this they indicated having thought it may have popped out from this side of the screen in the same manner the task

bar would pop when the auto hide[3] is feature turned on. Some participants tried right clicking on the piece of the image they saw hoping to reveal the rest of it some how. Others just stared at the screen trying to decipher the meaning held in the small visible piece of the picture.

Six participants (3 right-handed and 3 left handed, constituting 40.0% of the participants) took a while to notice the scroll bar when it was placed on the left side of the screen. Of these, two of the right-handers and two left-handers interacted with the left aligned vertical scroll bar first. These participants simply did not expect to find the vertical scroll bar on the left side of the screen. One participant's word sums it best, "It was confusing at the beginning because I was looking for the scroll bar on the wrong side [right side where it generally is] of the screen. Actually I was not looking for it, I assumed that it was just going to be at the right, but it wasn't".

This was interesting behavior, especially as participants completed the entry questionnaire which asked participants to indicate where they would expect to find the vertical scroll bar. This question could have potentially acted as an indicator that the study may be looking at scroll placement options. These participants stuck to what they were familiar with and only explored other options when they were certain that the system would not give them what they expected.

Table 8 illustrates the difficulty level participants assigned to the set of tasks for each application along with the difficulty rating they assigned for using the system in general. Participants were asked to rate the tasks and ease of using the systems as: 1) Not Difficult, 2) Somewhat Difficult and 3) Very Difficult. In general most participants rated

[3] The auto hide feature is a MS Windows task bar feature that allows the user to have the Taskbar visible all the time, or keep it hidden until it is needed.

the tasks in the application where the vertical scroll bar was located on the right as being not difficult. Most participants also rated the use of this system as being not difficult as well. Most interesting of these results was that 61.5% of the participants who rated tasks in both systems as having the same level of difficulty rated use of the system in which the vertical scroll bar was located on the left to be more difficult to use. In contrast only one of these participants (participant 003R) rated the right aligned vertical scroll system to be more difficult to use.

Table 8: Difficulty rating participants assigned to tasks and system utilization by right and left-handed users (Participant are assigned a numeric ID followed by and R or L where R represents right-handers and L represents Left-handers)

	Task Difficulty		**System Difficulty**	
	Right Side	Left Side	Right Side	Left Side
001R	not	not	not	**somewhat**
002R	not	not	not	**somewhat**
003R	not	not	**somewhat**	not
004R	not	somewhat	not	somewhat
005R	not	somewhat	not	not
006R	not	not	not	**somewhat**
007R	not	not	not	**somewhat**
008R	not	not	not	not
001L	not	not	not	**somewhat**
002L	not	not	not	not
003L	somewhat	somewhat	not	**somewhat**
004L	not	not	not	not
005L	not	not	not	not
006L	not	not	not	**somewhat**
007L	somewhat	somewhat	not	**somewhat**

73.3% of the participants (6 right-handers and 5 left-handers) preferred to have the scroll bar located on the right side of the screen, 13.3% (1 right-hander-12.5% and 1 left-hander-14.3%) preferred to have it on the left and 13.3% (1 right-hander-12.5% and 1

left-hander-14.3%) had no preference. All of the participants who took a while to locate the vertical scroll bar when it was located on the left side of the screen preferred having it on the right. Most participants preferred the right aligned vertical scroll bar because it was what they were accustomed to. The reasons given for preferring the scroll bar located on the right or left side of the screen are summarized in Table 7.

Table 7. Participants reasons for preferring one vertical scroll bar alignment over the other.

Preferred vertical scroll on right side	**Preferred vertical scroll on left side**
I preferred it only mildly. It wasn't that I hated the scroll on the left, it jus that I'm not used looking for it there. So the scroll on the right seemed easier and therefore preferable.	Because the navigation buttons were on the left side, having the scroll bar on the same side minimized how far I had to move the mouse.
Just because it keeps the navigation bar and scroll bar separate, preventing me from hitting a link when meaning to scroll and vice versa.	Navigation Tools are close to each other and thus are easier to find and quicker to use.
I think with time I could become more proficient with the scroll on the left, but I was already used to it being on the right.	
Firstly that is where I am used to finding it. Secondly because I am right-handed and the mouse is to the right hand of the keyboard.	
It's mostly because of habit.	
It felt more natural. It's what I was used to.	
Having the scroll bar on the right felt more "connected" to the area it was manipulating.	
Didn't prefer left side system because I'm not	

used to it. I did not expect to see it on the left.	
Just used to bar being on the right, also may be because mouse is on the right.	
I am used to the right hand scrolling feature.	
Accustomed to the right-hand scroll bar placement. Felt like I'm "reaching across" to use the left-hand scroll bar. It felt unnatural and awkward.	

80% (7 right-handers and 5 left-handers) of the participants stated that they would prefer to have a choice is deciding where the scroll bar was located. Most of these participants felt that having a choice would better accommodate the preferences of different users and that having the ability to control configuration was desirable even if they were not going to use the feature. While most participants preferred the right aligned vertical scroll bar they still preferred having the choice to decide where it should go.

For the remaining 20% of the participants having the ability to choose where the vertical scroll bar was aligned did not matter. These participants felt that they could adapt easily to whichever side it was on or that the default setting of having the scroll bar placed on the right satisfied their preference, thus making a choice unnecessary.

Only two participants used the vertical scroll bar as the only means of navigation through the sites. The remaining 86% of the participants attempted to use the scroll wheel, arrows keys, page up and page down keys. These participants attempted to use these shortcuts first, before utilizing the scroll up and scroll down buttons on the vertical scroll bar. All of these participants noted the non-functionality of the scroll wheel and

stated that they would have preferred to use this mechanism for scrolling through pages rather than resorting to using the scroll up and scroll down buttons on the vertical scroll bar.

Conclusion

This study broadens the scope of the issue of menu placement on websites. It introduced the possibility of relocating the vertical scroll bar closer to the prevalent left aligned menus found on most sites today. It ventured into exploring this possibility along side focusing on handedness as a contributing factor to the debate and in so doing explored missing considerations. Studies have used Fitt's Law as a major element for conducting research with regards to menu placement. Yet not many have considered handedness or the possibility of relocating the vertical scroll bar of web browsers as being important.

The study investigated whether there were differences in performance and preference between left-handed and right-handed users when interacting with two versions of a website in a browser. Left-handers do seem to perform better on tasks in general than their right-handed counterparts regardless of alignment of the vertical scroll bar. This suggests that there are differences between these two groups that should be explored when addressing issues associated with Web graphical user interface design. Without exploring these differences we cannot claim to truly develop user-centered applications.

All but one of the left-handed individuals in this study generally utilize a right-handed mouse. Most commented on how they simply trained themselves to use a right-handed mouse because it was so prevalent. This subtle forced use of a widespread device may constitute a form of subjecting an unfair bias on a minority. Exploring differences

between operationally differentiated users can prevent the undue and unnecessary evil of subjecting individuals to unfair constraints.

The outcome of exploring these differences may not change any product or practice to any major extent but may help to prevent biases from being built into novel and widespread technology products. Technology has advanced far enough to make consideration for these differences with minor burdens being placed on developers and technology pioneers. This study explored this possibility by introducing the relocation of the scroll bar to the opposite side of the screen from which it is generally found in web browsers. There is no clear correlation to scroll placement and handedness; however, preexisting experience with a right aligned vertical scroll bar was affected the results obtained in this study. Participants' predetermined notions of where the scroll would be located did not affect their desire to be able to control or alter the system. While the majority of participants preferred to have the scroll bar aligned to the right, most of participants favored having a choice in deciding where the scroll bar would be located.

This choice, the ability to control the configuration of an application, can reduce the occurrence of forcing individuals to conform to a standard that does not suit them best. While individuals tend to adapt quickly to technology as in the case of left-handers training themselves to use right-handed mice, technology can aid users in developing practices and procedures that maximize their potential and productivity. Interesting practices and contribution to technology may have existed had left-handers always been afforded the use of a left-handed mouse.

The results of time taken to perform a set of task obtained by examining the server logs do not support Fitt's Law. There was no clear evidence that moving the scroll

bar closer to the menu items reduced the time taken by users to acquire a target (buttons on the menu). However, given the novelty of the experiment and the unfamiliarity of users to the relocation of the vertical scroll bar, these results cannot be used as a means of soundly contradicting Fitt's law. Participants' preoccupation with expecting to find a vertical scroll bar located on the right side of the screen increased the amount of time it took them to complete the tasks given. Fitt's law may prove to be true under different circumstances. Participants generally commented on how much easier the tasks became once they discovered the vertical scroll bar on the left of the screen and then appeared to easily adapt to this new configuration.

Participants also quickly adapted to not having some of the functionality they expected to find when viewing a website in a browser. This shows only that users can make do with the minimum. The fact that so many participants expected and tried to use the missing functionality points to the decreasing significance of having a "correct menu placement" debate. Participants utilize other means for navigating through websites. They no longer need to acquire a specific target to get at the information they seek. Distance between scroll bar buttons and menu items becomes less important. Even the participants who used only the vertical scroll bar to navigate up and down in the sites tried using the scroll space between the up and down scroll buttons to achieve scrolling. This region requires less accuracy to acquire and may reduce the time needed to obtain the information sought.

One interesting idea that came from one participant in the study suggested grouping the up and down activity of the vertical scroll bar with the back and forward activities of the back and forward buttons found in the "Standards Button" bar of web

browsers. This participant felt that the location of these in relation to each other unnecessarily increased the time taken for users to navigate through a site. Requiring the user to traverse the horizontal distance between the scroll-down and back buttons of a web browser is highly inefficient, and, in this case of this user, very annoying. This presents an interesting idea that interface designers may explore. It may make sense to group web browser navigation elements.

While the results of this experiment yielded some interesting observations mention should be made of the study limitations. The sample size was relatively small and consisted mainly of participants engaged in Information and Library Science programs. These individuals constitute a specialized group that may be more sensitive to issues of usability and navigation than the general community of web users. There was also no randomization process for selecting these participants from the community of users from which they were drawn. As such the sample was not representative of the general body of web users. However, the system that a particular user interacted with first was determined by using a process of random assignment.

Future Work

The difference in performance between left and right-handers is an area of study that may be further explored to construct theories of development that incorporate guidelines for producing biased free systems. It may open the doors for new possibilities in graphical user interface arrangement that may help individuals to maximize the productivity and potential. This uncharted territory may lead to the development of new practices that may further the advancement of technology development.

More research should be done to examine the effects of having the vertical scroll bar relocated to the left of the screen. In this type of study participants should be aware the relocation of the scroll bar and should have prior experience interacting with such a configuration. The results of such an experiment may prove to change the entire nature of the menu placement debate. It may result in the death of the debate as the placement of the menu no longer holds center stage in this issue. Users may define their own location of the vertical scroll bar and may adjust it at will to accommodate changes in web menu alignment.

Appendix A Entry Questionnaire

Please select one. **Participant # 00__**

(1) Which hand represents your more dominant hand?

(a) Left Hand (b) Right Hand

(2) How often would you say you use the Internet?

(a) 0 – 5 times per week

(b) 6 – 10 times per week

(c) more than 10 times per week

(3) When using a web browser where do you expect to find the main navigation menu?

(a) Left Side of the screen

(b) Right Side of the screen

(c) Top of the screen

(d) Bottom of the screen

(4) When using a web browser where do you expect to find the vertical scroll bar?

(a) Left Side

(b) Right Side

(5) What is your gender?

(a) Male

(b) Female

(6) Is English your native language?

Yes No

Appendix B

Post System Questionnaire

Please select one or write your views **Participant # 00__**

(1) On which side of the system was the scroll bar?

(a) Left Side (b) Right Side

(2) How difficult were the tasks on the sites?

(a) not at all difficult

(b) somewhat difficult

(c) very difficult

(3) How difficult was it for you to use the system?

(a) not at all difficult

(b) somewhat difficult

(c) very difficult

(3) Please share in your own words the experience of using the system.

_____

_____

_____

_____

_____

_____

Appendix C

Exit Questionnaire

Participant # 00__

(1) Did you prefer one system's interface to the other?

(a) Yes (b) No

(2) If yes, which one? _____

(3) Please indicate why you did or did not prefer one interface to the other.

_____

_____

_____

_____

_____

_____

(3) Would you prefer to have a choice in deciding where the scroll bar is located?

(a) Yes (b) No (c) Does not matter

(4) Why or Why not?

_____

_____

_____

_____

_____

_____

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