

# **Eye Tracking In Web Usability: What Users Really See**

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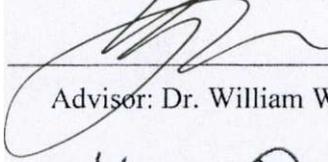
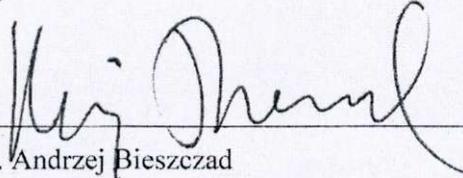
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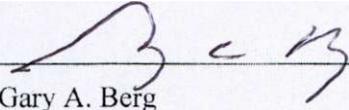
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## **Abstract**

Human Computer Interaction and usability have become increasingly important with the advent of the Internet and its pervasive use as means of communication, online commerce, and social networking. A user-friendly website now has the ability to boost sales and marketing campaigns as never before. As a result the need to present content on the World Wide Web in a manner that is attractive to end-users and potential customers has acquired immense commercial significance in addition to significant academic interest.

Website usability is the measure of how 'intuitively' a website presents its contents. Numerous tools and techniques have been developed to measure not just the usability of a website but to also correlate the information to actual end-results in terms of sales, calls to action, decline in customer support phone calls, and other such tangible measures.

Eye tracking is the process of recording the location of a gaze (the current location of focus) and the motion of the eye (from one location of focus to the next). The data collected by this process and the insight such information provides form one of the methods used to evaluate usability issues in Human Computer Interaction (HCI) within the commercial and academic environments.

In this study, three websites were developed. Each website was designed keeping in mind the best practices currently in vogue. Eye tracking and survey forms were then used to collect data on the user experiences of these websites. Eye tracking was used to determine the portions of these websites that get the most attention. Given that eye tracking measurement equipment is expensive, requires specialized skills, and can only be used for studies where the user is physically present, Attention Wizard [43], an eye tracking simulation tool was used to obtain eye tracking results using screen images of individual web pages.

Attention Wizard uses advanced artificial intelligence algorithms to simulate human visual processing and attention. In the process it creates an "attention heat map" of the web page to predict where a user is likely to look during the first few seconds of their visit.

In addition to Attention Wizard, Browsershots [45] was used to test the browser compatibility of the three websites. Browsershots creates screen images of how a web page is rendered by different browsers in different operating systems.

Results of the simulated eye tracking obtained using Attention Wizard are presented along with basic interpretations and analysis of what they suggest. Brief guidelines of best practices that can be drawn from the results and their interpretation are also provided. These guidelines confirm some of the existing best practices on web design.

Finally, results from the surveys are presented to back up the results of the simulated eye tracking with subjective feedback from real users.

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TABLE OF CONTENTS

**CHAPTER 1. INTRODUCTION.....11**

- 1.1 HISTORY OF EYE TRACKING IN HCI.....11
- 1.2 ANALYZING EYE MOVEMENTS.....12
  - 1.2.1 *Foveal and Peripheral Vision.....12*
  - 1.2.2 *Saccades and Fixation.....12*
  - 1.2.3 *Eye Tracking in Usability Studies.....12*
  - 1.2.4 *Eye Movement Research on Reading.....13*
  - 1.2.5 *Lower Level Linguistic Influences on Eye Movements.....13*
  - 1.2.6 *Higher Level Linguistic Influences on Eye Movements.....14*
- 1.3 MEASURES OF EYE SCANNING BEHAVIOR.....14
- 1.4 EYE TRACKING TECHNOLOGIES.....15
- 1.5 THE FARADAY MODEL.....15
- 1.6 THE MIND EYE HYPOTHESIS.....16
- 1.7 BENEFITS OF EYE TRACKING IN WEB DESIGN.....16
- 1.8 COMMERCIAL APPLICATIONS.....16
- 1.9 REMAINING CHAPTERS.....17
- 1.10 KEY TERMS.....17

**CHAPTER 2. EYE TRACKING IN WEBSITE USABILITY.....18**

- 2.1 PAGE LAYOUT.....18
  - 2.1.1 *Writing Style.....19*
  - 2.1.2 *Design for Efficiency.....19*
  - 2.1.3 *Support for Text-Only Browsers.....19*
  - 2.1.4 *Content Placement and Visual Indicators.....20*
  - 2.1.5 *Highlight the Most Important Element.....20*
  - 2.1.6 *Heat-Maps and Gaze Plots.....20*
  - 2.1.7 *The Price of Miscues.....21*
- 2.2 NAVIGATION.....22
  - 2.2.1 *Global Navigation.....22*
  - 2.2.2 *Local Navigation.....23*
  - 2.2.3 *Related Research.....23*
  - 2.2.4 *Consistent Category Names.....24*
  - 2.2.5 *Provide Navigational Options.....25*
  - 2.2.6 *Use Descriptive Tab Labels.....26*
- 2.3 FUNDAMENTAL WEBSITE DESIGN ELEMENTS.....27
  - 2.3.1 *Home Page.....27*
  - 2.3.2 *Shopping Carts.....27*
  - 2.3.3 *Web Forms.....28*
- 2.4 IMAGES.....30
  - 2.4.1 *Other Media.....32*
- 2.5 ADVERTISEMENTS.....32
  - 2.5.1 *Banner Blindness.....34*

**CHAPTER 3. DEVELOPED WEBSITES.....35**

- 3.1 TECHNOLOGIES USED.....35
  - 3.1.1 *HTML.....35*
  - 3.1.2 *CSS.....35*
  - 3.1.3 *JavaScript.....35*
  - 3.1.4 *AJAX.....35*

3.1.5	<i>PHP</i> .....	36
3.1.6	<i>MySQL</i> .....	36
3.1.7	<i>PHP + MySQL</i> .....	36
3.1.8	<i>WampServer</i> .....	36
3.1.9	<i>Browsershots</i> .....	36
3.1.10	<i>Attention Wizard: Eye Tracking without the Eyes</i> .....	36
3.2	WEB DEVELOPMENT.....	37
3.2.1	<i>Health Website</i> .....	37
3.2.2	<i>Kids and Parents Website</i> .....	41
3.2.3	<i>Desi Recipes Website</i> .....	44
CHAPTER 4. ANALYSIS OF DEVELOPED WEBSITES USING HEAT-MAPS & SURVEY FORMS.....		48
4.1	HEAT-MAPS.....	48
4.1.1	<i>Attention Heat-map</i> .....	48
4.1.2	<i>Heat-Maps of Health Website</i> .....	49
4.1.3	<i>Heat-Maps of Kids and Parents Website</i> .....	52
4.1.4	<i>Heat-Maps of Desi Recipes Website</i> .....	54
4.2	WEBSITE EVALUATION USING SURVEYS.....	57
CHAPTER 5. CONCLUSIONS.....		60
CHAPTER 6. FUTURE WORK.....		64

TABLE OF FIGURES

**Figure 1.** Commercially available eye trackers: head mounted, head restrained, and free head motion.....15

**Figure 2.** Eye movements were tracked to determine where users looked on a prototype page 19

**Figure 3.** Heat-map showing a standard step in the checkout process.....20

**Figure 4.** Gaze plot of one user's fixations on a website reveals an intense reading of the text with less attention to the photo, and a single look at the dog's face.....21

**Figure 5.** Navigation Inconsistency: link from the Swedish to the German and US pages but no link from the German to the Swedish page.....23

**Figure 6.** Clicking a name (top) on the page scrolls the page down to the speaker's bio (bottom).....23

**Figure 7.** Eye tracking study picture that shows most users concentrated on the top-left 24

**Figure 8.** Heat-map showing left-side navigation of an online banking system .. 24

**Figure 9.** Navigational options should be provided when design web page..... 25

**Figure 10.** These tab labels clearly describe the types of information.....26

**Figure 11.** These tab labels are not as descriptive and create confusion for users 26

**Figure 12.** Web page with links to both the main organization home page (clickable National Cancer Institute logo in the upper-left corner) as well as the sub-organization home page (Cancer Control Home link placed in the upper-right corner) .. 27

**Figure 13.** The row of navigation where the shopping cart appears on this site resembles utility navigation.....28

**Figure 14.** Gaze plot data from Matteo Penzo's study in [29] showing how people's eye move through a simple form.....29

**Figure 15.** Gaze fixation diagrams (between 30 to 40 seconds) show that eBay has longer gaze fixation duration than Yahoo's last name fields.....30

**Figure 16.** Mark optional fields clearly instead of using an asterisk.....30

**Figure 17.** Users searching for restaurants read the text in New York Magazine's restaurant page but did not look on the small and low-contrast images.....31

**Figure 18.** Minor tweaks in an image can increase the user's attention.....31

**Figure 19.** Women looked at the clothes and not the models.....32

**Figure 20.** Men looked at the models as much or more than the clothing ..... 32

**Figure 21.** Heat-maps show differences in visual attention attracted by the different banners 33

<b>Figure 22.</b>	Ads that blend into the look and feel of the page get more attention	34
<b>Figure 23.</b>	Layout of 'Health' website.....	37
<b>Figure 24.</b>	Browser Compatibility Test of 'Health' website on Windows.....	40
<b>Figure 25.</b>	Browser Compatibility Test of 'Health' website on Linux.....	40
<b>Figure 26.</b>	Browser Compatibility Test of 'Health' Website for Mac OSX.....	41
<b>Figure 27.</b>	Layout of 'Kids and Parents' Website.....	41
<b>Figure 28.</b>	Browser Compatibility Test of 'Kids and Parents' website for Windows	43
<b>Figure 29.</b>	Browser Compatibility Test of 'Kids and Parents' website for Linux	43
<b>Figure 30.</b>	Browser Compatibility Test of 'Kids and Parents' website for Mac OSX	44
<b>Figure 31.</b>	Layout of 'Desi Recipes' website.....	44
<b>Figure 32.</b>	Browser Compatibility Test of 'Desi Recipes' website for Windows	46
<b>Figure 33.</b>	Browser Compatibility Test of 'Desi Recipes' website for Linux ...	46
<b>Figure 34.</b>	Browser Compatibility Test of 'Desi Recipes' website for Mac OSX	47
<b>Figure 35.</b>	Heat-map of 'home' page.....	49
<b>Figure 36.</b>	Heat-map of 'BMI Calculator' page.....	49
<b>Figure 37.</b>	Heat-map of 'Food Calories Calculator' page.....	50
<b>Figure 38.</b>	Heat-map of 'Nutrition and Your Diet' page.....	50
<b>Figure 39.</b>	Heat-map of 'Food Guide' page.....	51
<b>Figure 40.</b>	Heat-map of 'Men's Health' page.....	51
<b>Figure 41.</b>	Heat-map of 'home' page.....	52
<b>Figure 42.</b>	Heat-map of 'Kids Health' page.....	52
<b>Figure 43.</b>	Heat-map of 'Talking with Kids' page.....	53
<b>Figure 44.</b>	Heat-map of 'Blogs: Post New Entry' page.....	53
<b>Figure 45.</b>	Heat-map of 'Blogs' page.....	54
<b>Figure 46.</b>	Heat-map of 'home' page.....	54
<b>Figure 47.</b>	Heat-map of 'Breakfast' page.....	55
<b>Figure 48.</b>	Heat-map of 'Appetizers' page.....	55
<b>Figure 49.</b>	Heat-map of 'User's Home' page.....	56
<b>Figure 50.</b>	Heat-map of 'Post a Recipe Form'.....	56

<b>Figure 51.</b>	Feedback results for 'Health' website.....	58
<b>Figure 52.</b>	Feedback results for 'Kids and Parents' website.....	58
<b>Figure 53.</b>	Feedback results for 'Desi Recipes' website.....	59

# **Chapter 1. Introduction**

Eye tracking is a technique used to monitor eye movements so that the researcher knows where a person is looking and the path taken by their eyes when moving from one location to another. In Human Computer Interaction (HCI), researchers use this technique to collect data on the amount of time spent on the various elements of an interface. It is also used to collect data on the paths or flows followed when viewing the various elements of an interface. The eye tracking data collected is then analyzed to gain insights that inform the design and usability improvements made to the interface. Eye tracking can also be applied to assist persons with disabilities navigate through an interface without mouse or keyboard input [1].

## **1.1 History of Eye Tracking in HCI**

The study of eye movements pre-dates the widespread use of computers by almost 100 years [2]. Initial eye tracking methods were invasive and used direct mechanical contact with the cornea. Dodge and Cline [3] developed a non-invasive eye tracking technique, using light reflected from the cornea. Their system could record only horizontal eye position onto a falling photographic plate and required the participant's head to be motionless. They and other researchers interested in eye movements made additional advances in eye tracking systems during the first half of the twentieth century by combining corneal reflection with various motion pictures techniques.

Eye movement research and eye tracking flourished in the 1970s with advances in both eye tracking technology and the psychological theory to link eye tracking data to cognitive processes. Much of the work focused on research in psychology and physiology to explore how the human eye operates and thereby gain a better understanding of the perceptual and cognitive processes. In addition, technical improvements were made to increase accuracy and reduce the impact of the tracking on those whose eyes were being tracked [2].

Recently, the use of eye tracking in human computer interaction has shown modest growth with its application in the usability of computer interfaces. With technological advances such as internet, email, and video conferencing, researchers have once again turned to eye tracking to gain insights into usability issues [2].

## 1.2 Analyzing Eye Movements

The tracking of eye movements is a powerful tool used to understand the process of visual search and scanning. Recording and analyzing eye movements allow researchers to better understand how individuals access and interact with visual information. Eye movement can be tracked across paper based materials, computer screens, or any plane defined in 3D space. In the last ten years numerous areas of application have opened up, including advertising and web page usability studies [4].

### 1.2.1 Foveal and Peripheral Vision

Roughly speaking, human vision has two parts: a small central area with very high resolution, called **foveal vision**, and the vast majority of the visual field with lower resolution, called **peripheral vision**.

The human eye may seem a lot like a camera: it has a lens that can focus on items at a range of distances, an iris diaphragm in the form of the pupil to adjust for various levels of lighting, and a 'film' or sensor in the form of the retina to record the image. But the sensor eye doesn't provide the same resolution across an entire image as film does. Photos look equally sharp at the center as at the edges. Human vision, on the other hand, is only sharp in the center, and blurred at the edges. In peripheral vision for example, the eye sometimes interprets movement when there are none, and the eye is not very good at deciphering colors or details [5].

- People can only get detailed information about a small area at a time and, as a result, they need to move their eyes.
- Fovea provides detail about two degrees of visual angle.
- Peripheral vision provides information for deciding where to foveate next [6].

### 1.2.2 Saccades and Fixation

When the eye is resting or focused on a spot, it's called a **fixation**. The eye's rapid movement from one fixation to the next is called a **saccade**. Each saccade lasts between one-hundred and one-tenth of a second. The optical image on the retina blurs so much in this brief period that we are almost blind for the duration of a saccade [5]. Little or no visual processing can be achieved during a saccade and thus actual paths traveled during saccades are not useful for many research applications. Smaller eye movements that occur during fixations, such as tremors, drifts, and flicks often have little significance in higher-level analysis. [7].

### 1.2.3 Eye Tracking in Usability Studies

More and more usability companies have begun to offer eye tracking services such as heat-maps (will be discussed later). A usability practitioner [8] experienced in eye tracking stated that she looks for the following patterns in eye tracking data and suggested some possible interpretations:

- Long fixations (Interest or confusion)
- Back-track saccade (Possibly confusion)

- Not looking at elements of a page.
- Scanning behavior rather than reading behavior (What was the user looking for?)
- Back and forth between two objects (Trying to make a choice or comparison? Is it distracting?)
- First place the user looks. (Why did this draw their attention?)
- Last place the user looks. (Why did this lose their interest?)
- When making a choice, fixations back to one item, then final scan before making choice.
- Reading headings or subheadings but no more (Boring?)
- Interactions such as following an asterisk to a footnote, or a reference in the text to an image or other element

Patterns such as these are noted by the evaluator during a usability test and discussed with the user afterwards [8].

#### 1.2.4 Eye Movement Research on Reading

The research in [9] shows that "when people read sentences, their fixations are typically between 60 and 500 ms long (about 250 ms on average). Readers of English text move their eyes from left to right approximately 85% of the time and from right to left 15% of the time." Readers tend to fixate on content words, which are usually quite long, but skip function words, which are quite short. Fixations usually land between the beginning and center of a word (preferred viewing location) but there is some evidence suggesting that readers fixate on the informative portions of a word (the optimal viewing position). The number of characters that a reader can identify on any fixation is called the **visual span** and the number of characters that a reader processes at least partially during fixation is called **perceptual span**. For English readers the perceptual span is about four characters to the left and 15 characters to the right of fixation."

Readers make more fixations and fixate longer when they have any difficulty. They also make regressive saccades when they are not able to analyze the sentences properly [9].

#### 1.2.5 Lower Level Linguistic Influences on Eye Movements

"There has been a substantial amount of eye-movement research investigating lexical processing (word identification). The duration of a fixation on a word is affected by its basic lexical properties such as frequency and length. Lower frequency words are fixated for longer than higher frequency words and the longer a word is, the more likely a reader is to refixate it, producing increased gaze durations" [9].

Fixation times on lexically ambiguous words (for example bank) depend upon the word's meanings within the sentence context. When ambiguous words with two equally likely meanings are embedded in a sentential context, reading times are slower than for control words (with the same length and frequency in both cases). When an ambiguous word has a dominant meaning (biased words), readers fixate on it for no longer than they do on an unambiguous word in the sentential context that permits more a common meaning of the word. However, when a sentential context has less frequent meaning of a biased ambiguous word, fixation durations on the word increase as compared to control words [9].

### **1.2.6 Higher Level Linguistic Influences on Eye Movements**

Researchers [9] have typically compared eye movement records for syntactically ambiguous sentences with unambiguous sentences. These types of comparisons often show differences in eye movement patterns that have a syntactic misanalysis of the ambiguous portion of a sentence. When readers initially misanalyse a sentence syntactically, they are 'garden-pathed'. Usually, when readers are garden-pathed, the time spent on the disambiguating word is longer and readers often make regressions to re-read the sentences. But some evidence shows that readers do not always detect an initial misanalysis until a slightly disambiguating word has been read.

It can be hoped that future eye movement research will reveal insights into other such cognitive processes that result in eye movement patterns [9].

## **1.3 Measures of Eye Scanning Behavior**

Techniques enable the accurate recording of sequential movements of the eyes to provide an eye movement record that can be analyzed offline after testing. Such records may be useful for clinicians, vision researchers, and for those who are interested in exploring cognitive processing. A normal eye movement has a series of fixations and saccades. The eye shows small drift movements during fixations while saccades are fast ballistic movements of the eyes that re-locate the point of fixation. These are the result of an active neural command that programs the eye to rotate through a specified angle. The spatial and temporal features of this command can be measured [9].

Absolute spatial measures of eye movements, such as saccade length, are useful when relating the spatial aspects of the measurement to the material being viewed. Fixation duration, on the other hand, is the measure that relates to the temporal aspect of saccade programming [9].

Reading research shows that regressive saccades occur in order to re-read the text when readers have difficulty in linguistic processing. They provide information on how long the reader spent reprocessing the sentence, and when a linguistic factor affected the eye movement behavior [9].

## 1.4 Eye Tracking Technologies

Eye trackers send out an infrared light that is reflected from both the cornea and the retina. This reflection is captured and tracked by the equipment. Intrusive eye tracking systems require physical contact between the sensor apparatus and the user; non-intrusive eye tracking systems use camera based techniques and require no physical contact. Intrusive techniques can be significantly more accurate than non-intrusive techniques.

Camera based eye tracking systems come in several designs, capture the images, and may search different features of the eye in the images they capture. When commercial camera based trackers are attached to the head mount, they may be considered intrusive because of their proximity to the eye. Generally, commercial camera based trackers are remote. In a remote camera based system the allowed amount of head's motion varies with the vendor: from a few millimeters to approximately one cubic foot of working volume. A system that allows only a few millimeters of head motion typically requires a head restraint such as a chin rest. The following figure shows some camera based commercial systems [10].



**Figure 1.** Commercially available eye trackers: head mounted, head restrained, and free head motion

## 1.5 The Faraday Model

Faraday (2000) published the first model of visual attention on web pages based upon the knowledge of salient visual elements (SVE). According to Faraday's model, users scan web pages in two stages.

In first stage, the initial entry point on the web page is determined by SVE's of the web page using following hierarchy: motion, size, image, color, text style (e.g., bold, italic etc), and position. Thus, if motion is on a page, the item in motion will be the first entry point. If motion is absent, the largest element will be the first entry point, and so on. Given the absence of motion, size, image, color, or text style, position determines the first entry point.

In the second stage, the area around the entry point is defined and searched. Then this area is scanned in normal reading order until all items in the area have been fixated. If the target is not located within the area around the initial entry point, a new fixation point is selected from the hierarchy described in the first stage. The area around the new entry point is defined and scanned. This process is repeated until the target is found or the user stops the search [11].

## 1.6 The Mind Eye Hypothesis

According to the mind eye hypothesis, what people are looking at and what they are thinking tends to be the same. If taken to the extreme this may seem wrong. Looking and thinking are certainly not always intertwined. However, often enough, the mind eye hypothesis holds true for eye tracking to reveal what users pay attention to on web pages. One may conclude that fixations equal attention: People look at the design elements that they are concerned about, and the more they look at something, the more they think about it.

This doesn't mean that looking always indicates understanding. Many times users fixate on the item they need but do not select it. In these cases, they are not paying attention to the meaning of the words, image, or link even if they looked at them [5].

## 1.7 Benefits of Eye Tracking in Web Design

Knowing where on the screen visual attention is being directed has assumed greater significance now that websites are used to provide more and more information. Given that self-reporting tools such as questionnaires have the potential to produce biased or even wrong data; eye tracking can be an indispensable method for assessing the ease of use and effectiveness of a website. With the advances in technology, eye tracking has become a promising tool and eye tracking data is a necessary precondition for the analysis of visual attention patterns. One can now analyze how a user's eyes move across a web page in real time. Visualization techniques such as gaze plots and hot spots (obtained through heat-maps) illustrate how individuals or groups of people look at designs [12].

## 1.8 Commercial Applications

In recent years eye tracking technologies have elicited great interest in the world of commercial applications including web usability, advertising, medical research, computer usability etc. Numerous companies now offer eye tracking services and analysis.

The most prominent field of commercial eye tracking research is web usability. While traditional usability techniques are useful in providing information, eye tracking is the most effective technique to show which features are most eye-catching, which features cause confusion, and which features are ignored by the users. Specifically, eye tracking can be used to assess navigation usability, overall design, and many other site components.

Eye tracking is commonly used in a variety of different advertising media such as commercials, print advertisements, online advertisements, etc. Typically, the analyses focus on the visibility of a target product or logo in the magazine, newspaper, website, or television event [13].

Eye tracking is also using in the field of automotive design. Eye tracking cameras in automobiles can monitor the drowsiness or inattention of the driver [13]. Lexus claims to have equipped its LS 460 car with the first driver monitor system in 2006 to provide a warning if the driver takes their eyes off the road [14].

## **1.9 Remaining Chapters**

The rest of this thesis is organized as follows. The second chapter discusses eye tracking in web usability in detail. The third chapter presents the implementation details of three websites that utilize eye tracking concepts. It also presents the browser compatibility test results of each website. The fourth chapter presents an analysis of the developed websites by using heat-maps and survey forms. The fifth and sixth chapters provide the conclusions and suggest possible areas for future research.

## **1.10 Key Terms**

Eye tracking, web design, heat-maps and gaze plots.

# Chapter 2. Eye Tracking in Website Usability

Eye tracking is used in the evaluation of website design to determine what viewers look at on a web page. This evaluation tool is used to design more attractive web pages that gain users' visual attention. This chapter discusses how heat-maps and gaze plots generated by eye tracking can help us to design better page layouts, navigation, menus, images, and advertisements.

## 2.1 Page Layout

Unlike bank accounts, full is not better when it comes to web pages. Cluttered or complex web pages make it less likely people will find what they want. When designing a web page a designer should determine the following:

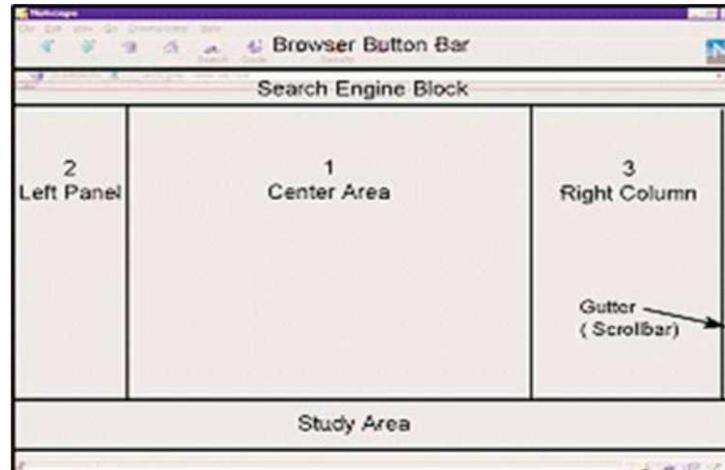
- What do visitors of their website want?
- What priority real estate sections (areas most eye catching to the users) are in the design.

Designers have almost no control over some factors that determine how users look at a page but using consistent web conventions that match a user's experience and expectations makes features familiar, visible, and attractive to them [5].

Some of the web design standards that users are familiar with are as follows:

- Noticeable menus with some graphics, usually at the top, on the left, or both
- A logo is usually present on the upper-left corner of all pages.
- A search field, when present, is at the upper right corner of a page.
- A shopping cart icon, for shopping websites, is present in the upper right corner of all pages.
- A login/out feature in the upper right corner of all pages [5].

The research in [15] shows that users typically look first at the center, then to the left, and finally to the right to find a link to click. The following figure 2 shows the design grid of an ideal web page. It was noticed that users did not go to the bottom and rarely looked at the 'Study Area' just above the browser's status line. It is interesting to note that users typically scrolled to the top to find information rather than looking at the bottom of the web page. Here peripheral vision played an important role: users rarely looked directly at the scrollbar because their gaze peaked considerably to the left of it. This shows that they don't look at the scrollbar even when using it. Peripheral vision obviously helped [15].



**Figure 2.** Eye movements were tracked to determine where users looked on a prototype page

### 2.1.1 Writing Style

People rarely read web pages word by word. They scan pages to find the information they want.

- The text should be scannable with bulleted lists, highlighted keywords, meaningful headings, and short sections of text.
- Start with the conclusion and then provide details.
- Make text concise and objective.
- Do not include unnecessary 'white space'.
- Do not expect users to read very large amount of text online, instead provide one large page for printing or a file to download [16].

### 2.1.2 Design for Efficiency

- It is important to minimize the download time as some web users may have slow internet connections.
- Graphics add interest but are slow to load and can impede navigation.
- Use the minimum number of colors to reduce the size of graphics.
- Use the alternative tag to describe graphics, as many users may not wait for graphics to load.
- Use small images, and interlaced images, repeat images where possible [16].

### 2.1.3 Support for Text-Only Browsers

Some users turn off graphics to increase speed while the visually impaired use text only browsers. To support text-only browsers, use a logical hierarchy of headings, avoid frames, and use alternative tags to describe the function of images [16].

### 2.1.4 Content Placement and Visual Indicators

Eliminating or at least demoting the less important items on a page helps users see more important options more quickly. Sparseness is not the most important factor in page layout. The placement of content and usable visual design is more important than page density in web design [5].

### 2.1.5 Highlight the Most Important Element

All designers know that their web page is competing with other web pages for people's attention. But there is also competition occurring on each page. Menus, images, links, and promotions are competing with one another for people's attention and not all of them can win.

Every web page asks users to look at or select one item over another; therefore it is important for designers to know which elements have the strongest attraction for users. Designers should make most important element more visible to get user's attention [5].

### 2.1.6 Heat-Maps and Gaze Plots

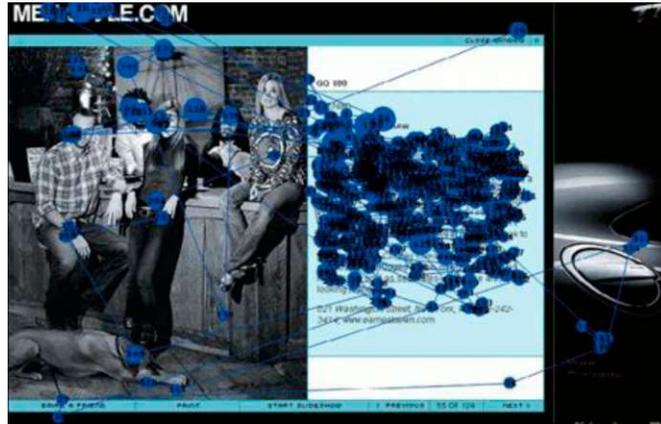
Heat-maps are the best-known visualization technique for eye tracking studies. In a heat-map, a screenshot is color-coded according to the amount of visual attention attracted by each part. The red areas indicate the most attention, the yellow areas indicate fewer fixations, and the blue areas indicate the least-viewed areas. If an area is gray, it didn't attract any fixations. Heat-maps show how many seconds users looked at different screen elements, not how many times they looked at them [5].

The following heat-map in figure 3 shows a standard step in the check out process, which separates new customers from returning customers. It can be easily seen that people allocated most of their attention to the First Time Customer area because first time shoppers tested this site [5].



Figure 3. Heat-map showing a standard step in the checkout process

A **gaze plot** represents fixations during a single user's visit to a page. An example gaze plot is shown in figure 4 as a series of blue dots, each indicating one fixation. The size of each dot represents the duration of that fixation; the bigger dots indicate longer durations. The dots are numbered, showing the sequence of the fixations. The thin lines, connecting the fixations, indicate the saccades as the eye moved from one location to the next. Humans are blind during saccades, so the user didn't see the elements under the thin lines; only those under the dots [5].



**Figure 4.** Gaze plot of one user's fixations on a website reveals an intense reading of the text with less attention to the photo, and a single look at the dog's face

### 2.1.7 The Price of Miscues

Elements that mislead site visitors are called miscues. Even if people get past them and complete their tasks successfully, the miscues are a problem. Users should spend their time, thought, and fixations on the right command for their task, not on design elements that are not what they need. Web pages may include entertaining elements such as a phrase, article, or image that make users interested or happy, but distracting users with these items at the wrong time can be unproductive [5].

Miscues have the most profound effect on task time and user satisfaction. Even if users don't realize that they are spending more time than they should have to on a task, they don't like wasting time and feeling unproductive. These feelings are typically reflected in their ratings of a site. A successful website is one in which the most important features are easy for people to see and use. To create a successful website, a designer should not use too many commands, banners, images, and other items that can result in visual noise [5].

## 2.2 Navigation

The web is the archetypal **information space**. It is a combination of contents and presentations that allow people to plan monitor and control their activities [17]. Websites have different districts with nodes and paths that link the sections together. However, even on a well designed site it can be difficult to find all the information you need. It is impossible to design a site that fulfills the information needs of all the users of the site on a single screen [18].

People use navigation on a website to move from one page to another page to gather all the information that is required. This is a key activity that people undertake [18]. According to Brinck, Gergle, and Wood [19 ] the design of navigation mechanisms is the second main pillar of information architecture. Rosenfeld and Morville [20] identify three key features of a good navigation design for websites: labeling, navigation support, and searching mechanisms.

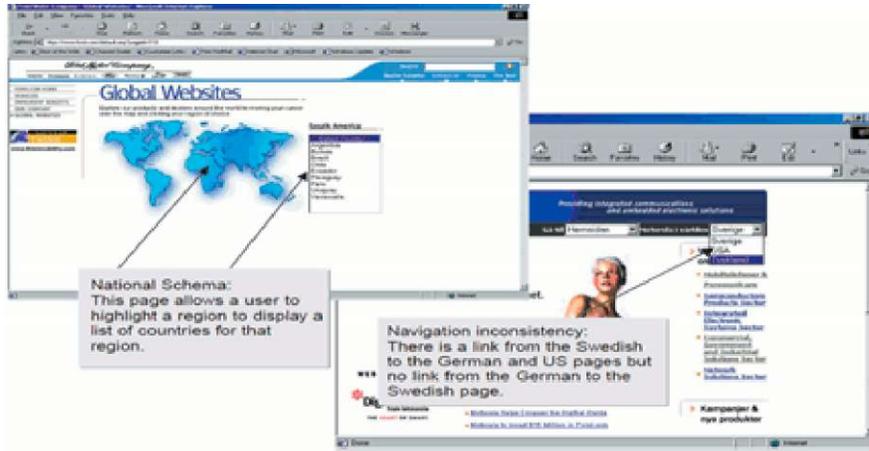
Global and local navigation bars help visitors pick their way through the site structure. Site maps and good feedback representing a user's location on a website is also helpful. When a number of activities or pages have to be visited in a sequence, a site 'wizard' is helpful, guiding people and explaining the purpose of each activity. For example buying tickets or booking flights [18].

In well designed sites, users do not get trapped in dead-end pages. A website's navigation scheme and features should allow users to find and access information effectively and efficiently. Menus and links are an important part of the web and hypertext media. Designing links to look like links, and menus to look like menus, is relatively easy today on the web. But organizing and naming them is one of the most difficult and time-consuming challenges for web designers [5].

### 2.2.1 Global Navigation

Global, top-level, persistent, or primary navigation is navigation that is displayed on every web page, usually at the top or left of the screen. This type of navigation provides access to the main content sections or services. It helps to orient the user to their surroundings. The text chosen for navigation links (label) can help to describe the content or services the website provides. For example, if the global navigation items are Headlines, Breaking News, and Articles, it can be deduced that the website represents a newspaper or news-agency. If the current section is highlighted, the global navigation may describe the type of content the current web page contains [21].

The following figure shows a world map website. This website supports global navigation using a different website for each country. The second web page illustrates inconsistent global navigation where a user cannot switch the country selection easily. In terms of global usability, not all country websites navigate consistently to other country websites [22].



**Figure 5.** Navigation Inconsistency: link from the Swedish to the German and US pages but no link from the German to the Swedish page

### 2.2.2 Local Navigation

Local navigation (see figure 6), guides a user to a specific section on a long page. These could be handy on a schedule page if a user wanted to jump to a particular session [23].



**Figure 6.** Clicking a name (top) on the page scrolls the page down to the speaker's bio (bottom)

### 2.2.3 Related Research

For the positioning of screen elements, eye tracking can show where users expect certain elements. In a study to compare different types of navigation menus (see figure 7), users were shown a website and were asked, which site it was. Most users concentrated on the left top side of each site no matter where the main navigation was actually positioned. [24].



**Figure 7.** Eye tracking study picture that shows most users concentrated on the top-left

In a study of an online banking system [24], users were shown the entry page of the system and asked what they could do there. The following figure shows a hot spot visualization of a left-side navigation of this situation. Eye tracking data clearly shows that the links underneath the text 'UNSERE ANGEBOTE ONLINE' get much less attention than the links above it. The reason is that the text does not look like the other menu items, but looks like a heading. Because users are not too interested in this 'heading', they ignore the text underneath the 'heading' as well.



**Figure 8.** Heat-map showing left-side navigation of an online banking system

#### 2.2.4 Consistent Category Names

Nielsen [25] shows that the success rate for product search is 80% when menu labels conformed to expectations. This drops to 9% with unfamiliar menu labels. From this finding and others Nielsen developed the following 'Jacob's Law of Web User experience':

"Users spend most of their time on other sites. Thus, anything that is a convention and used on the majority of other sites will be burned into the users' brains and you can only deviate from it on pain of major usability problems".

Conventions play an important role in web design guidelines. For example, the IBM designs guidelines [26 ] suggest that persistent navigation links should be placed on the left or top of the page 'because these are the areas users expect to find them'.

Website menus are organized in various ways: by types of products, user tasks, user backgrounds, etc. Many menus also combine different categories. It may be unrealistic to expect all menu categories and choices to be parallel, but designers should still try to make menu choices expected and analogous as far as possible. The designer should use consistent wording when naming categories in menus, on pages, and in tables. For example, a designer should not combine a single-noun link label, such as Clothing, with a verb-noun label, such as Buy Bedding, in the same list. Instead, they should make it clear in the list heading that these are products for sale and then use uniform link wording, such as Bedding and Clothing [5].

### 2.2.5 Provide Navigational Options

Many web pages contain links that open new browser windows. When these browser windows open, the Back button is disabled. If the new window opens full-screen, users may not realize that they have been redirected to another window, and may become frustrated because they cannot click Back to return to the previous page.

If such links are used on a website, the newly-opened window should contain some action control to close the window so that the user can return to the original browser window. Designers should not create web pages that disable the browser's Back button. Disabling the Back button will create confusion and frustration for users [27].

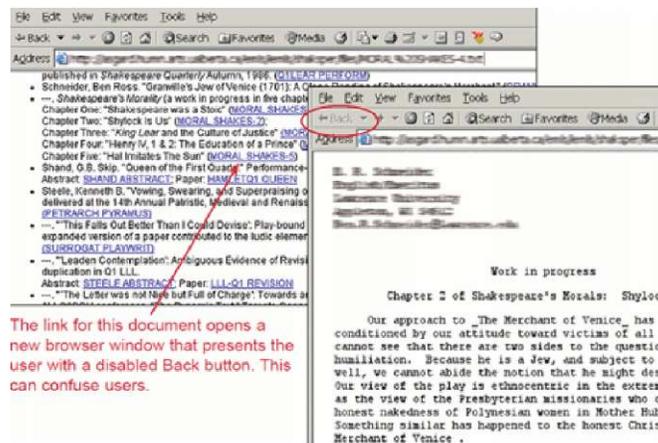


Figure 9. Navigational options should be provided when design web page

### 2.2.6 Use Descriptive Tab Labels

Users like tabs when they have labels that are descriptive enough to allow error-free selections. Designers should not use tabs if tab labels cannot be made clear because of the lack of space. Navigation tabs should be located at the top of the page, and look like clickable version of real-world tabs. Users can be confused about the use of tabs when they do not look like real-world tabs. Users click appropriately in tabs that look like real-world tabs [27].



**Figure 10.** These tab labels clearly describe the types of information



**Figure 11.** These tab labels are not as descriptive and create confusion for users

Navigation is the visual and accessible representation of the information architecture of a web site. Creating good navigation, one that is pervasive and yet unobtrusive, presents the most difficult challenges for web designers. But mastering the challenges is essential because the words used in links, buttons, and menus determine how successful people are in doing or finding what they came for in the first place. It also influences their overall impressions of a site along with their perceptions of what the site contains. Designers should make navigation terms as descriptive and straightforward as possible, unusual and difficult names will confuse users [5].

## 2.3 Fundamental Website Design Elements

This section discusses how people generally look at various elements on pages because of different site designs.

### 2.3.1 Home Page

The home page is different from all other web site pages. A well-constructed homepage will project a good first impression on the visitors. It is important to ensure that the homepage has all the features expected of a homepage and looks like a homepage to users. A homepage should clearly communicate the site's purpose, and show all major options available on the web site. Designers should provide easy access to the homepage from every page in the site [28].

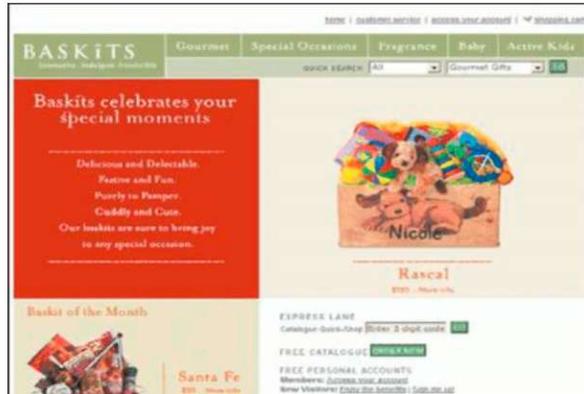
Many sites place the organization's logo on the top of every page and link it to the home page. While many users expect that a logo will be clickable, many other users will not realize that it is a link to the homepage. Designers should include a link labeled 'Home' near the top of the page to help those users [28].



**Figure 12.** Web page with links to both the main organization home page (clickable National Cancer Institute logo in the upper-left corner) as well as the sub-organization home page (Cancer Control Home link placed in the upper-right corner)

### 2.3.2 Shopping Carts

The shopping cart is an essential component of an e-commerce site. It enables the conversion of a need or desire into a sale. The web site for Baskits, which sells gift baskets, features a few rows of top horizontal navigation, with the shopping cart at the right in the uppermost row (figure 13). But in this design, the uppermost navigation does not look like a banner. Instead, it resembles traditional utility navigation [5].



**Figure 13.** The row of navigation where the shopping cart appears on this site resembles utility navigation

On this site, 36% of people found the shopping cart within five or fewer fixations, another 36% found it in 10 or fewer fixations. 18% of people found it in 20 or fewer fixations, and only 9% needed more than 20 fixations to find it. Because the Baskits' page is not too cluttered, users can find the menu easily [5].

### 2.3.3 Web Forms

The order in which interface elements are presented is important for any web page, including those with forms or applications. It should be easy for users to quickly look at, register, and deal with all parts of a form [5].

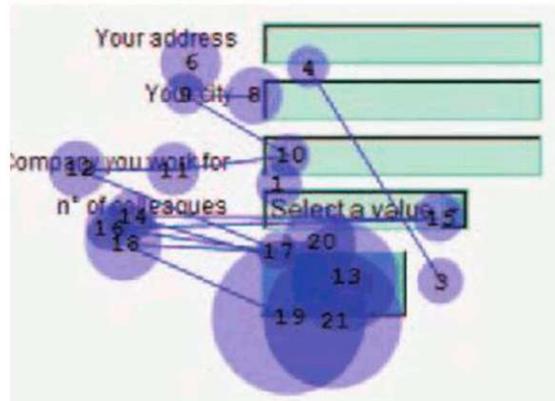
In addition to the contents and organization of a form, numerous visual and interaction design considerations play an important role in how people complete forms. To keep people focused on completing a form, a designer should consider which web site elements help them to complete form and which elements distract them from completing it [29].

According to Matteo Penzo's study [30],

**Left-aligned Labels:** These are easily associated labels with the proper input fields. Users took more time because of excessive distances between labels inputs.

**Right-aligned Labels:** These reduced overall number of fixations by nearly half. Forms completion times were cut nearly half.

**Top-aligned Labels:** These permitted users to capture both labels and inputs with a single eye movement. It was noticed that form completion times were fastest.

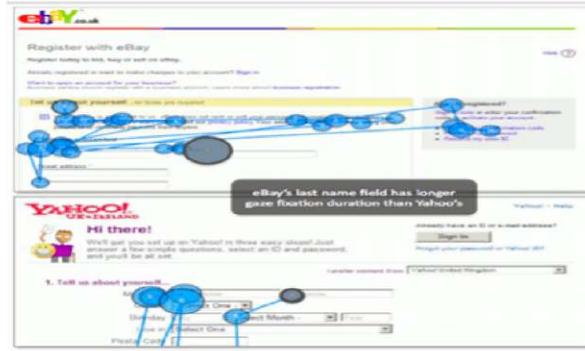


**Figure 14.** Gaze plot data from Matteo Penzo's study in [29] showing how people's eye move through a simple form

The following insights, obtained from various eye tracking research [31], inform the best practices that can be used to build usable forms for most situations.

- Users complete web forms from top to bottom. Therefore, forms with a simple vertical layout are always better than multi-column layout.
- Left-aligned labels have a tidier, clear layout and they enable users to quickly scan each label.
- Users expect to see names (first and last name), dates (year, month and day), and time (hour and minute) written on a single line. When putting more than one field on a line, they should be designed carefully.
- When more than one field is placed on a line, designers should make sure that they are designed to look like a single piece of information by, for example, sharing a single label or putting them closer to each other.
- According to eye tracking studies, colored or shaded grouping headers should be used only when they are important.

The following figure shows that eBay has more eye fixations and longer viewing durations than Yahoo on the last name field. This might be due to two reasons: the gap between both fields is smaller on Yahoo's page and, more importantly, both fields share the same label (same for birthday's day, month and year in Yahoo). Psychologically, participants treated both fields as a single question and did not feel that they were entering two pieces of information [31].



**Figure 15.** Gaze fixation diagrams (between 30 to 40 seconds) show that eBay has longer gaze fixation duration than Yahoo's last name fields

Research in [31] also shows that not all participants know what an asterisk '\*' means. Therefore, it is better to place the word 'optional' inside the text boxes in grayed fonts, as shown in figure 16. In this case, it is not possible for users to miss it and there is no extra eye movement needed to read it.

The figure shows a form with five input fields. The labels are: "First line of address", "Second line of address", "Town / City", "County", and "Post Code". The labels for "Second line of address" and "County" are in a lighter gray font and include the word "Optional" in a smaller font size, indicating that these fields are optional.

**Figure 16.** Mark optional fields clearly instead of using an asterisk

## 2.4 Images

Images are a powerful part of web design. Good images explain a concept, convey information, and enhance people's overall experience on a site. Bad images waste space, are ignored by users, and create more confusion [5].

Pictures express ideas and thoughts effectively. They have the potential to leave a lasting impression on the viewers mind. As is the case with the print and audio-visual media, the World Wide Web is also equipped to make extensive use of static and dynamic pictures for effective communication.

Images are an integral part of web site design. While the appropriate use of images enhances the look of a web site and invites traffic, the inappropriate use of images has the potential to ruin the web site. Pictures help in forming a lasting impact on the human brain. It influences the buying habit of the customers. It demonstrates the products and services effectively and helps to create a memorable impression on the users [32].

People don't waste time trying to figure out what the subject of a low contrast image is. They simply ignore it (see figure 17) [5].



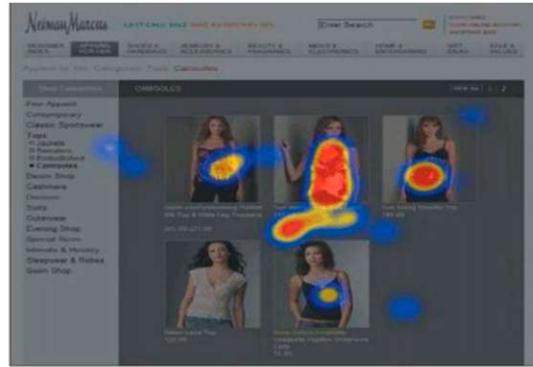
**Figure 17.** Users searching for restaurants read the text in New York Magazine's restaurant page but did not look on the small and low-contrast images

The Sunsilk heat-maps [33] show several key principles that are important (see figure 18). In one image, the model stares straight at the reader. In the other image the model looks at the product. The following heat-maps in figure 18 demonstrate how effective even minor tweaks can be in the overall ROI (Return on Investment) of marketing materials.



**Figure 18.** Minor tweaks in an image can increase the user's attention

The research in [5] shows that images of women and men get looked at in about one-third of cases. But people spend 21% more time looking at images of women (1.15 seconds) than of men (.95 seconds). And they give women 4.51 fixations on average, compared to 3.95 for men (see figure 19 and figure 20).



**Figure 19.** Women looked at the clothes and not the models



**Figure 20.** Men looked at the models as much or more than the clothing

One can safely conclude that images have a significant role to play in the design of a web site.

### 2.4.1 Other Media

The ability of a web site to present information using other media such as movies, animation, and audio distinguish it from information presented using the traditional print medium. Studies on online electronic materials have shown that this integration of other media keeps a users attention and, when used effectively, can enhance usability. However, designers should be careful when using these elements because their improper use distracts users. Additionally, heavy utilization of media elements consumes website server's hard disk space and lengthens the downloading time [34].

## 2.5 Advertisements

Eye tracking usability research helps us determine when and how much people look at advertisements on the web and what attributes of advertisements attract their attention. Eye tracking tells us that people look at advertisements when they want to find specific information or when they are just shopping around. The look of an ad is important, but so is its placement on the page [5].

Here are some of the major lessons learned about ads from eye tracking research:

- Ads in the top and left portions of a home page receive the most eye fixations. Ads in the right column are treated by users as an afterthought. Ads at the bottom of the page are typically only seen by a small percentage of people.
- Close proximity to popular editorial content helps ads get noticed. When an ad is separated from editorial matter either by white space or a rule, the ad receives fewer fixations than when there is no such barrier.
- Of all types of ads tested, text ads are viewed most intently. On average, text ads are viewed for about seven seconds, and the best display ads are only looked at for one to two seconds.
- When it comes to ads, size matters. Bigger ads have a better chance of being seen. Small ads on the right side of home pages are viewed about a third of the time. Small ads on the rest of the page rarely attract attention [35].

Valassis [36] had two different banner creatives in mind for its client, targeted at a web page for buying and renting movies. One design was 'Red' and the other 'Blue'. The purpose of the study was to identify the following:

- Best banner creative
- Best placement on page
- Specific elements of the banner that attracted most attention

Two offline web pages with the different banners were shown to all respondents in random order to smooth out learning effects. The following instruction was displayed for respondents, "Please use this website to buy or rent a DVD you like". As soon as people completed the task, the test session was finished.

The results showed the 'Red' design attracted more attention than the 'Blue' design, improving the overall result of the campaign [36].



**Figure 21.** Heat-maps show differences in visual attention attracted by the different banners

In the top area, the Red design attracted 22% more attention (103 fixations compared to 86 fixations). The study also found that the 'Top' banner area performed 2.3 times better visually than the 'Bottom' area [36].

In another study [37] it was found that ads that blended into surrounding editorial content on a new homepage attracted people's eyes more often than ads that featured contrasting colors or designs. If an ad was approximately the same background color as the rest of the page, it received more eye fixations.



**Figure 22.** Ads that blend into the look and feel of the page get more attention

### 2.5.1 Banner Blindness

The notion of 'banner blindness' introduced by Benway and Lane [38], indicates that users tend to ignore banner-like big, flashy, and colorful information on web pages. Although there is some controversy around this phenomenon, recent studies also confirm that banner blindness exists [39].

Banner blindness can be reduced by using following methods:

- **Ad Rotation:** This shows multiple advertisements in a single location on a web page and is a common method used by webmasters to ensure that visitors don't immediately overlook the specific advertisements they run. In the case of contextual advertisements, rotating them can be used with different color schemes and formats. This might be useful.
- **Incorporate Tagline and Unique Names:** A tagline is a brief phrase that explains and defines the benefit of a product or service to the consumers in a memorable manner. Make the messages a variation or spin on the tagline or name of the site being advertised on.
- **Use Images of Faces:** An attractive face can be included in an advertisement in order to make it stand out from the rest of the site. Most content-heavy websites feature lots of text and the use of faces in advertisements may reduce the banner blindness [40].

## Chapter 3. Developed Websites

As part of this thesis, three websites were developed. Templates for these websites are designed carefully and eye tracking data was obtained by creating heat-maps using Attention Wizard [43]. HTML, CSS, and JavaScript were used to design the front-end of the websites. PHP and MySQL were used at the back-end to make the websites dynamic. AJAX was also used in one website to increase the download speed.

### 3.1 Technologies Used

The following technologies were used when developing the web sites for this thesis.

#### 3.1.1 HTML

HTML is a language for describing web pages. It stands for Hyper Text Markup Language. HTML uses markup tags to describe web pages [41].

#### 3.1.2 CSS

CSS stands for Cascading Style Sheets. Styles define how to display HTML elements. External Style Sheets can save a lot of work. Styles are normally saved in an external CSS files. External style sheets enable us to change the appearance and layout of all the pages in a website by editing one single file [41].

#### 3.1.3 JavaScript

JavaScript was designed to add interactivity to HTML pages. It is a scripting language (A scripting language is a lightweight programming language) usually embedded directly into HTML pages. JavaScript is an interpreted language (scripts execute without preliminary compilation). Anyone can use it without purchasing a license [41].

#### 3.1.4 AJAX

Asynchronous JavaScript and XML (AJAX) is a technique for creating fast and dynamic web pages. It allows web pages to be updated asynchronously by exchanging small amounts of data with the server behind the scenes. This means that it is possible to update parts of a web page without reloading the entire page [41].

### **3.1.5 PHP**

PHP stands for PHP: Hypertext Preprocessor. It is a server-side scripting language, like ASP. PHP scripts are executed on the server and support many databases (MySQL, Informix, Oracle, Sybase, Solid, PostgreSQL, Generic ODBC, etc.). PHP is open source software. PHP is a free to download, runs on different platforms (Windows, Linux, UNIX, etc.), and is compatible with almost all web servers (Apache, IIS, etc.)[41].

### **3.1.6 MySQL**

MySQL is a database server and ideal for both small and large applications. MySQL supports standard SQL, compiles on a number of platforms, and is free to download and use [41].

### **3.1.7 PHP + MySQL**

PHP combined with MySQL are cross-platform (One can develop in Windows and serve on a UNIX platform) [41].

### **3.1.8 WampServer**

WampServer is a Windows web development environment. It enables creating web applications with Apache, PHP, and MySQL. It also comes with PHPMyAdmin to easily manage databases. WampServer installs automatically (installer) and its usage is very intuitive. One can tune a server without even touching the setting files. Once WampServer is installed, it is possible to add as many Apache, MySQL, and PHP releases as desired [42].

### **3.1.9 Browsershots**

Cross-browser compatibility is one of the most complex issues one encounters in web development. Some online services and tools are available for browser tests. Browsershots [45] was the tool used for the purposes of this study. This tool creates screenshots of web pages in different operating systems and browsers. It is a free open structure online web application, which provides the developers a convenient way to test their website's browser compatibility in one place. When a web address is submitted, it is added to the job queue. A number of distributed computers open the website in their browser, take screenshots, and upload them for review.

### **3.1.10 Attention Wizard: Eye Tracking without the Eyes**

AttentionWizard [43] uses advanced artificial intelligence algorithms to simulate human visual processing and attention. It is a combination of 'bottom-up' visual system building blocks and 'top-down' higher cognitive processes such as object recognition. Bottom-up features considered include color differences, contrast, density, brightness and intensity, edges and intersections, length and width, curves, and line orientations. Top-down algorithms recognize larger letters and text, skin texture, and human faces.

By using AttentionWizard, it is possible to accurately simulate how a web page will be viewed during the first few seconds of eye movement, and where attention will be focused. The results are available instantly and do not require expensive eye-tracking studies, or page-tagging and time-consuming data gathering to create mouse-tracking heat-maps.

This visual attention predicting tool in [43] was used to create eye tracking data, specifically heat-maps.

## 3.2 Web Development

Three websites were developed and the effectiveness of the websites was determined by creating heat-maps and survey forms. The heat-maps and survey forms are discussed in next chapter. The following is an elaboration of how these web sites were designed to achieve the best eye tracking results.

### 3.2.1 Health Website

<http://farrukhjabeen.info/health/>

This website shows a simple, user friendly layout (figure 23) and provides valuable information about health, including some health calculators. The purpose of the website has been made obvious so that users can recognize it without effort. It uses a simple and consistent drop-down and vertical list navigation throughout the website.



Figure 23. Layout of 'Health' website

A drop-down list allows the user to choose one value from the list. When a drop-down list is inactive, it displays a single value. When user activates it by clicking, it displays (drops-down) a list of values, from which the user may select one. Drop-down lists allows the user to access any page of the website easily. A drop-down list enables us to include a large number of links without taking up space or adding clutter.

The menu bar in this web site has five drop-down lists: 'Home', 'Diet', 'HealthHubs', 'Fitness' and 'Mental Health' available on each web page. When a user positions the pointer over a menu item, the browser displays a list of drop-down items. For example, 'Diet' is highlighted when the pointer is hovered over it and displays its list of three items: 'Nutrition and Your Diet', 'Food Guides', and 'Tips for Dine Out'. The user can click any item to go to the desired page. The 'Nutrition and Your Diet' page gives information about Carbohydrates, Protein, Fat, Saturated Fat, Trans Fat, Cholesterol, and Fiber and Sodium along with the foods in which they are present. This page also provides an outline of daily nutritional recommendations. The 'Food Guides' page recommends serving sizes for a variety of foods. The 'Tips for Dine Out' page provides tips for a healthy dine out experience.

The second menu item 'Healthhubs' consists of four items: 'Men's Health', 'Women's Health', 'Children's Health' and 'Senior's Health'. The third menu item 'Fitness' has three items: 'Exercise', 'Yoga', and 'Food and Fitness'. The last menu item 'Mental health' consists of three items: 'Symptoms and Diagnosis', 'Treatment' and 'Daily Life'.

The vertical menu list on the left side of the page, a common navigation element, has been used to display the Health Calculators. Three types of Health Calculators are available, 'BMI', 'Ideal Weight', and 'Food calories'. In 'BMI Calculator', users can check the BMI (Body Mass Index) by entering height and weight. 'Ideal Weight Calculator' gives the ideal weight of users using gender, frame size, and height information. In the 'Food Calories Calculator', users can enter any food name to display nutrition data for 100 grams of the food. They can also select the Food Group to enter a food name to get the desired results. The SR22 [44] database from U.S. Department of Agriculture (USDA) is used.

An appropriate color scheme was used to ensure the colors were not dull or harsh. A dark background was not used to minimize the effort required to read. The font-size was adjusted to ensure ease of use and access. Improper font sizes, too big or too small, make reading the content more difficult.

Relevant and appropriately sized images were used to minimize download time while maintaining visual appeal. In addition, the images were optimized to speed up page loading time. Browsershots was used to test the browser compatibility of the 'Health' website on the various operating systems.

### **Browser Compatibility Test of Health Website**

According to figure 24, 25, 26 the site's design was compatible with the following browsers on Windows, Linux and Mac OSX:

Whitlows	Linux	Mac OSX
SeaMonkey2.0 Windows XP	Epiphany 2.22 Ubuntu 8.04 LTS	Safari 5.0 Mac OSX 10.5
Opera 8.54 Windows XP	Firefox 3.0.3 Ubuntu 8.04 LTS	Camino 2.0.3 Mac OS X 10.5
Minefield 3.7 Windows XP	Galeon 2.0.4 Ubuntu 8.04 LTS	
Netscape 8.1.3 Windows XP	Kazehakase 0.5.2 Ubuntu 8.04 LTS	
K-Melon 1.5.0 Windows XP	Firefox 2.0.0.19 Ubuntu 8.04 LTS	
Safari 4.0.3 Windows XP	SeaMonkey 2.0.6 Ubuntu S. 10	
Firefox 3.5.6 Windows XP	SeaMonkey 1.1.12 Ubuntu 8.04 LTS	
Firefox 3.6 Windows XP	Firefox 3.5.9 Ubuntu 8.04 LTS	
Navigator 9.0.0.6 Windows XP	Firefox 4.0 Ubuntu 8.04 LTS	
Opera 7.11 Windows XP	Opera 9.80 Ubuntu 8.04 LTS	
MISE 7.0 Windows XP	Firefox 3.6.3 Ubuntu 9.10	
Opera 9.63 Windows XP	Keape 3.6.3 Ubuntu 9.10	
MSIE 8.0 Windows XP	Konqueror 4.4 Ubuntu 9.10	
SeaMonkey 1.1.14 Windows XP	Opera 10.0 Ubuntu 9.10	
Firefox 3.0.6 Windows XP	Flock 2.6.1 Ubuntu 9.10	
Avant 11.7 Windows XP	Konqueror 3.5 Debian Testing	
Flock 2.5 Windows XP	Konqueror 4.2 Debian Testing	
K-Melon 1.1.4 Windows XP	Navigator 9.0.0.6 Debian Testing	
Opera 9.80 Windows XP	Opera 9.63 Debian Testing	
Flock 2.6.1 Windows XP	Keape 1.1.13 Debian Testing	
Opera 7.03 Windows 2000	Shiretoko 3.5 Debian Testing	
Safari 5.0.1 Windows 7	Iceweasel 2.0.0.19 Debian 4.0	
MSIE 8.0 Windows 7	Iceweasel 3.0.4 Debian Testing	
Opera 9.62 Windows 2000	Minefield 3.7 Debian Testing	
Opera 7.54 Windows 2000		
Opera 10.00 Windows 2000		
Opera 9.64 Windows XP		
Opera 9.61 Windows XP		
Opera 9.60 Windows XP		
Opera 9.52 Windows XP		
Safari 3.0 Windows XP		
Opera 9.50 Windows XP		

Table 1: Browser Compatibility Test of Health website for Windows, Linux and Mac OSX

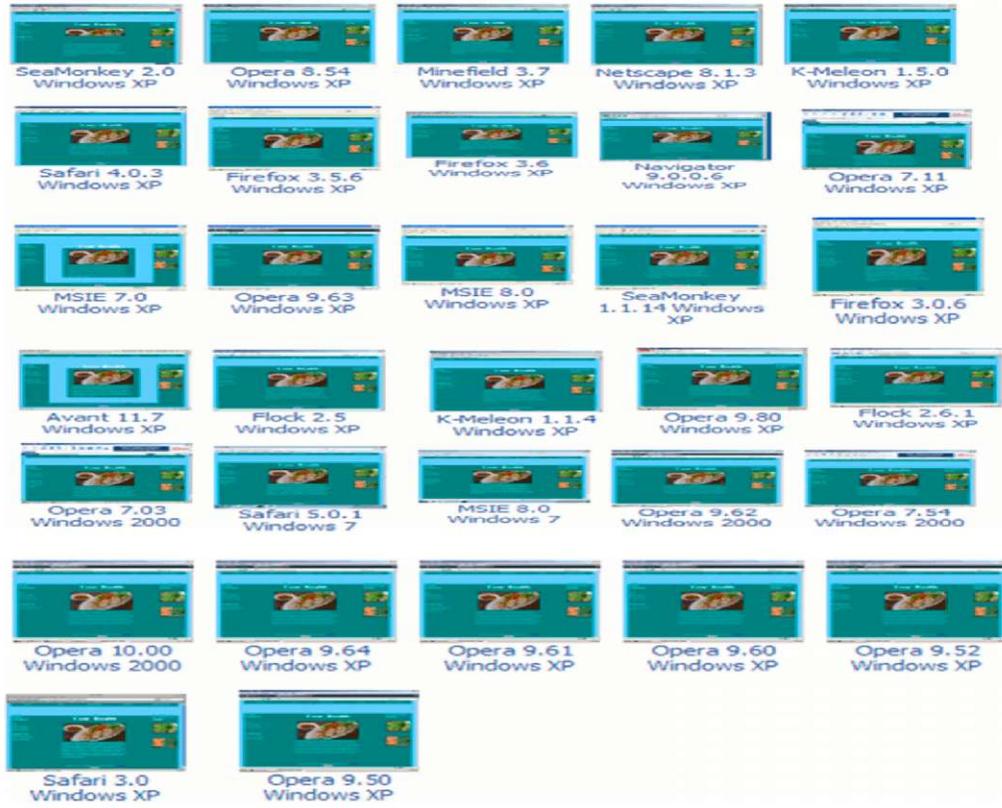
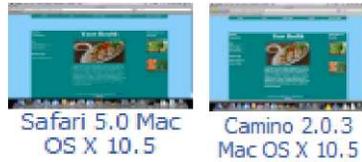


Figure 24. Browser Compatibility Test of 'Health' website on Windows



Figure 25. Browser Compatibility Test of 'Health' website on Linux



**Figure 26.** Browser Compatibility Test of 'Health' Website for Mac OS X

### 3.2.2 Kids and Parents Website

<http://farrukhjabeen.info/kidsparents/>

This website uses a clean layout (figure 27) to provide parents information about children. Horizontal and vertical menus are used for navigation. When a user visits a new website their primary focus point is typically the horizontal navigation bar. In this website the horizontal navigation bar consists of six elements: 'Home', 'Kids Health' 'Taking with Kids', 'Growing Body and Mind', 'Staying Safe' and 'Blogs'.

Blogs allow visitors to add their own content to the site. This is a great tool for parents to share ideas and discuss different issues related to their children.

The vertical menu was placed at the left side of the page. Three age groups (0 to 6, 7 to 11, and 12 to 18) were created to cluster the issues appropriately. The vertical and horizontal menus are available on every web page, allowing users access to any page, including the home page, from all pages on the web site.

The backgrounds were designed to create a positive impression on users. A light background image was used to facilitate ease of use in reading the contents of the website. Attention was also paid to pick the color scheme, images, and font- sizes most likely to attract users.

AJAX was used in this website. AJAX is a technique used to create fast and dynamic web pages. Web pages that do not use AJAX need to reload the entire page each time any content on the page changes. When AJAX is used, the entire page need not be uploaded; only the part of the web page that changed can be updated to save time and speed up page response.



**Figure 27.** Layout of 'Kids and Parents' Website

Browsershots was used to test the browser compatibility of the 'Kids and Parents' website on the various operating systems. Some browsers could not upload the video embedded on home page because the plug-in was not downloaded.

**Browser Compatibility Test of Kids and Parents Website**

According to figure 28, 29, 30 the site's design was compatible with the following browsers on Windows, Linux and Mac OSX:

Windows	Linux	Mac OSX
Opera 7.03 Windows 2000	Epiphany 2,22 Ubuntu 8,04LTS	Firefox3,6,8Mac OSX 10,5
Opera 7.54 Windows 2000	Kazehakase 0,5,2 UbuntuS, 04LTS	Safari 5.0 Mac OSX 10,5
SafariS. 0 Windows XP	Galeon2.0.4 Ubuntu 8.04L TS	Camino2.0.3Mac OSX 10.5
Opera 9,64 Windows XP	Shiretoko 3,5 Debian Testing	
Opera 9.61 Windows XP	Iceweasel 2.0.0.19 Debian 4.0	
Opera 9.60 Windows XP	Firefox 3.0.3 Ubuntu 8.04LTS	
Opera 9.51 Windows XP	Chrome 5,0,375,125 Ubuntu 8,04LTS	
Opera 9.52 Windows XP	Firefox 3.5.9 Ubuntu 8.04LTS	
Opera 8.53 Windows XP	Firefox 3,6,3 Ubuntu 8,04LTS	
Chrome 5.0.375.125 WindowsXP	Firefox 4.0 Ubuntu 8.04LTS	
Opera 8.0 Windows XP	SeaMonkey 2.0.6 Ubuntu9.10	
Opera 9.50 WindowsXP	Firefox2.0.0,19 UbuntuS,04LTS	
Opera 7.11 WindowsXP	Opera 9.80 Gentoo 2008.0	
MSIE 8.0 WindowsXP	Iceweasel 3.0.4 Debian Testing	
Firefox 3.0.6 Windows XP	Navigator 9.0.0.6 Debian Testing	
SeaMonkey 1.1 14 Windows XP	Minefield 3.7 Debian Testing	
Shiretoko3,5 Windows XP	Iceap3.6.3Ubuntu9.10	
Opera 9.63 WindowsXP	Konqueror4.4 Ubuntu 9.10	
Flock2.5.6 WindowsXP	Opera 10.0 UnuntuS. 10	
SeaMonkey 2.0 Windows XP	Flock2,6,1 Ubuntu 9,10	
Minefield 3.7 Windows XP		
Firefox 3.6 Windows XP		
K-Meleon 1.5.0 Windows XP		
Opera 9.80 WindowsXP		
Opera 8.54 WindowsXP		
Netscape 8.1.3 Windows XP		
Navigator9.0.0 5 Windows XP		
K-Meleon 1.1.4 Windows XP		
MSIE 6.0 WindowsXP		
Firefox 3,5,6 Windows XP		
Safari 5,0,1 Windows 7		
MSIE 5.01 Windows 2000		

Table 2: Browser Compatibility Test of Kids and Parents website for Windows, Linux and Mac OSX

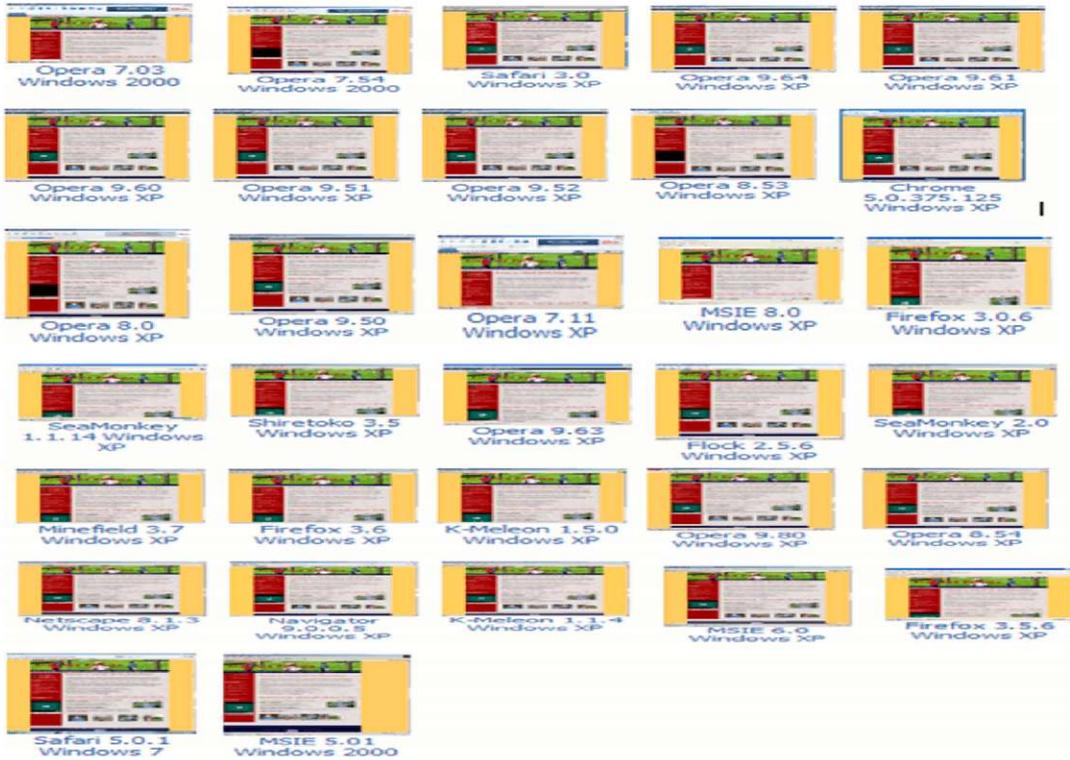


Figure 28. Browser Compatibility Test of 'Kids and Parents' website for Windows



Figure 29. Browser Compatibility Test of 'Kids and Parents' website for Linux



**Figure 30.** Browser Compatibility Test of 'Kids and Parents' website for Mac OS X

### 3.2.3 Desi Recipes Website

<http://farrukhjabeen.info/recipes/>

'Desi Recipes' was the third website created. This site uses a three-column layout (see figure 31). Horizontal and vertical menus were used for navigation. Both menus were designed for a clean, bold, and obvious look. Links were also designed for easier differentiation from normal text.

The horizontal menu was made up of four elements: 'Appetizers', 'Breakfast', 'Main Course', and 'Desserts'. The vertical menu consists of special and popular recipes and users can access them in just one click. Users can also search for a recipe by entering the name of the recipe in a search box. They can sign up for a free membership that provides them with more options such as the ability to post their own recipes and photographs. Membership also provides them with multiple blogging options.

Individual pages are created dynamically using information stored in a database. The advantage of using dynamically created web pages is that one does not need to maintain individual content pages. Instead, a server side PHP script is used along with a template to dynamically display the appropriate content.



**Figure 31.** Layout of 'Desi Recipes' website

A light background was used to enhance readability. The prime design directive used was to ensure an attractive color scheme along with inviting images. Browsershots was used to test the browser compatibility of the 'Desi Recipes' website on the various operating systems.

### Browser Compatibility Test of Desi Recipes Website

According to figure 32, 33, 34 the site's design was compatible with the following browsers on Windows, Linux and Mac OSX:

Windows	Linux	Mac OSX
Firefox3,5,6 Windows XP	Firefox 3,0,5 Ubuntu 8,04LTS	Safari3 2.3Mac OSX 10,5
Shiretoko3.5 Windows XP	Firefox2.0.0.19Ubuntu8.04LTS	Camino2.0.3Mac OSX 10.5
MSIE 8.0 WindowsXP	Galeon2.0.4Ubuntu8.04LTS	
Firefox3.0.6 WindowsXP	Shiretoko 3.5 Debian Testing	
Opera 8.54 WindowsXP	Kazehakase 0.5.2 Ubuntu8 04LTS	
Netscape 8.13 Windows XP	Iceweasel 3.0.4 Debian Testing	
Opera 9.63 WindowsXP	Iceweasel 2.0.0.19 Debian 4.0	
Firefox 3,6 Windows XP	Konqueror 3,5 Debian Testing	
SeaMonkey 1,1,14 Windows XP	Iceape1. 1,13 Debian Testing	
Opaa9.61 Windows XP	Epiphany 2,22 Ubuntu 8,04LTS	
SeaMonkey2.0 Windows XP	SeaMonkey 1,1,12 Ubuntu 8,04LTS	
Safari4,0 WindowsXP	Opera 9,63 Debian Testing	
K-Meleonl ,5,0 Windows XP	Konqueror 4,2 Debian Testing	
Avantl 1,7 WindowsXP	SeaMonkey 2,0,6 Debian Testing	
MSIE 7.0 WindowsXP	Opera 10.60 Debian Testing	
Minefield 3.7 Windows XP	Navigator 9.0.0.6 Debian Testing	
Flock2.5 WindowsXP	Minefield 3,7Debian Testing	
ChromeS.0.375.125 Windows XP	Firefox4.0DebianTesting	
Navigator9.0.0.5 Windows XP	Chrome 5.0.375.125 Debian Testing	
K- Meleon 1,1,4 Windows XP	Opera 9,80 Ubuntu 9,10	
Opera 9,80 WindowsXP	Chrome 6,0,472.63 Ubuntu8,04LTS	
Flock2.6.1 WindowsXP	Firefox3,6,3Ubuntu8,04LTS	
Opera 10.0 Windows 2000	Firefox 3,5,9 Ubuntu 8,04LTS	
Opera 9,62 Windows 2000	Iceape 3,6,3 Ubuntu9,10	
Opera 7,54 Windows 2000	Konqueror4,4 Ubuntu9,10	
MSIE5.01 Windows 2000	Opera 10.0Ubuntu9.10	
Minefield 3.2 Windows 2000		
Safari 3.0 WindowsXP		
Opera 9,51 WindowsXP		
Opera 9.50 WindowsXP		
Opera 9,52 WindowsXP		
Opera 9,60 WindowsXP		
Opera 9,64 Windows XP		

Table 3: Browser Compatibility Test of Desi Recipes website for Windows, Linux and Mac OSX

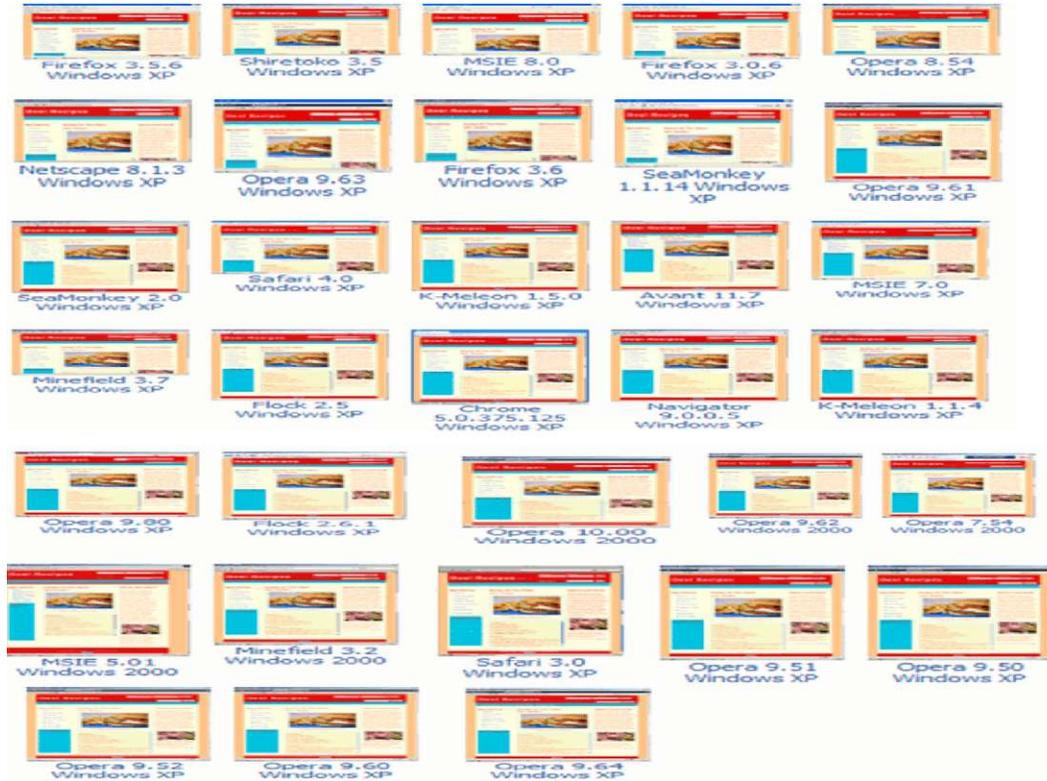


Figure 32. Browser Compatibility Test of 'Desi Recipes' website for Windows



Figure 33. Browser Compatibility Test of 'Desi Recipes' website for Linux



**Figure 34.** Browser Compatibility Test of 'Desi Recipes' website for Mac OSX

This chapter described the salient design decisions and features for the development of three websites and tested the browser compatibility for each website. The next chapter presents an analysis of the developed websites using heat-maps and survey forms.

# Chapter 4. Analysis of Developed Websites Using Heat-Maps & Survey Forms

## 4.1 Heat-Maps

Designers use eye-tracking to generate visual attention heat-maps that provide insights into where and for how long a user's eyes fixate on each part of the web page. In other words, heat-maps are visual representations of user's mouse or eye movements when they view a page. While such information can be invaluable, eye-tracking used to require specialized equipment and expertise, which may not be affordable in many instances. In recent times, several companies have begun to offer low-cost, equivalent services.

AttentionWizard [43] offers a free 'Lite' heat-maps service that was used to create heat-maps for the three websites developed for this research. This chapter discusses the insights gained by using Attention Wizard, which provided information on which parts of web pages probably grab the user's attention.

### 4.1.1 Attention Heat-map

An attention heat-map is a combination of two elements: predicted attention (hot spots) and eye gazing path.

The **hot spots** that can be found on a generated heat-map show areas of attention concentration. The greater the intensity of the hot spot, the more likely a user is to focus on that area of page.

The **eye gazing** path is represented by the numbered path. The eye gazing path depicts the path that user's eyes take when they first get to the page. Eye-gazing simulates the sequence of extremely rapid and involuntary eye movements ('saccades') that happen as the eye scans a page. Depending on the image submitted (full page or above-the-fold) the eye gazing path can differ significantly.

The eye gazing path is overlaid on an attention heat-map represented by different colors that predict areas where the eyes are likely to focus. Hotter areas indicate a more intense focus, while cooler areas show a lower level of awareness and importance.

### 4.1.2 Heat-Maps of Health Website

<http://farrukhjabeen.info/health/>

The attention heat-map of the home page of this website shows four hot spots: two on the center image, one on the photograph in the right column, and one at the bottom of the page. This heat-map shows that images attract the most attention, followed by the drop down and vertical menus.

The eye gaze path starts from the center image and ends at the drop down menu.



Figure 35. Heat-map of 'home' page

The attention heat-map of the 'BMI Calculator' page shows four hot spots: two on the footer, one between the text and footer, and one on the drop down menu. The focus areas of this page are the drop down menu and footer. The BMI calculator information and entry fields have low importance.

The eye gaze path starts from footer and ends near the entry fields of the BMI Calculator.

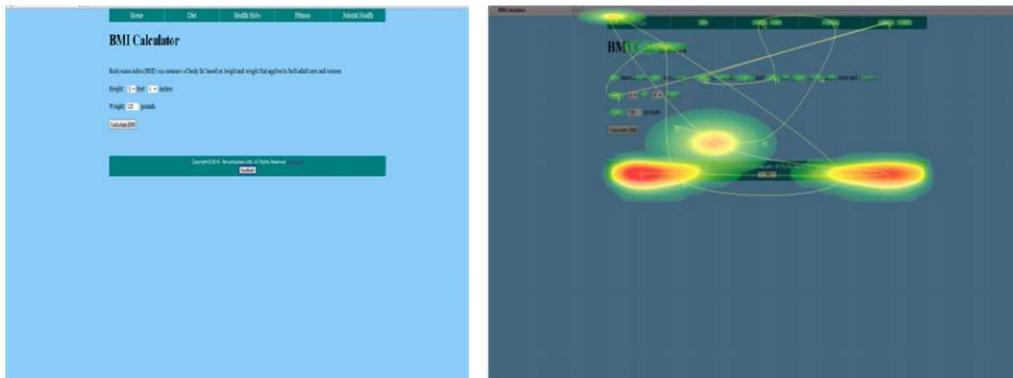


Figure 36. Heat-map of 'BMI Calculator' page

The attention heat-map of the 'Food Calories' page shows three hot spots: two on the image and one on entry field. This heat-map shows that images attract the most attention, followed by the drop down and vertical menus. Information and data about the food calories calculator is relatively unimportant.

The eye gaze path starts from the photograph and ends at the same place.



Figure 37. Heat-map of 'Food Calories Calculator' page

The attention heat-map of the 'Nutrition and Your Diet' page shows three hot spots, all on images. The drop down menu and text did not get the attention, probably because the images can be used to navigate to the desired information section in the page.

The eye gaze path starts from an image and ends on text.

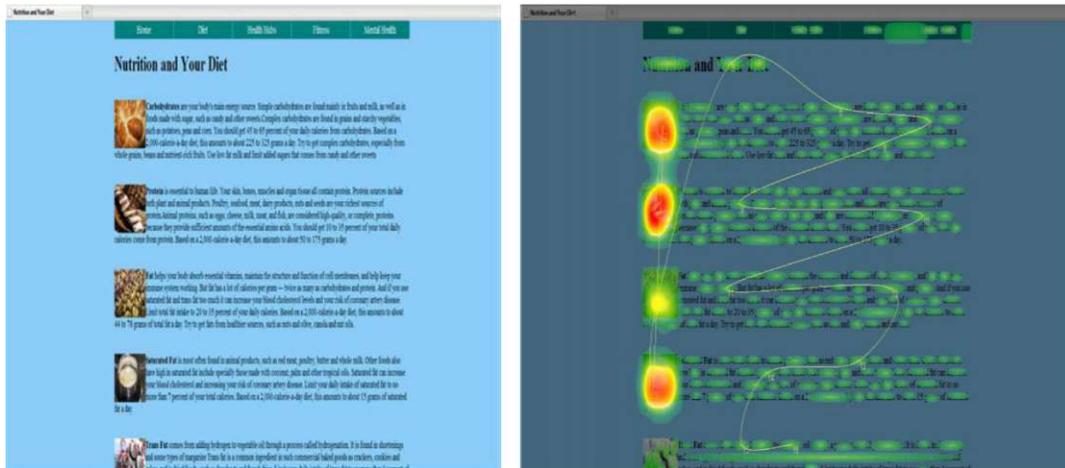


Figure 38. Heat-map of 'Nutrition and Your Diet' page

The attention heat-map of the 'Food Guide' page shows four hot spots: two on images, one on the footer, and one between the side heading and text. This heat-map shows that the photographs and headings gained most of the attention at the cost of the menus because the images can be used to navigate to the desired information section in the page.

The eye gaze path starts from photograph and ends on the text.

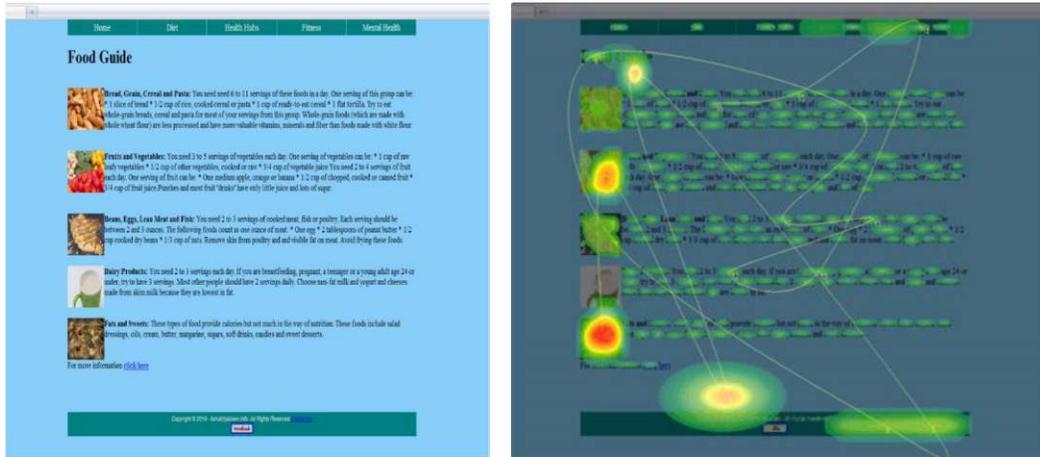


Figure 39. Heat-map of 'Food Guide' page

The attention heat-map of the 'Men's Health' page shows four hot spots: one on the image, two on the footer, and one on the drop down menu. This heat-map shows that the photographs supersede text has when it comes to garnering attention.

The eye gaze path starts from the photograph and ends on the text.

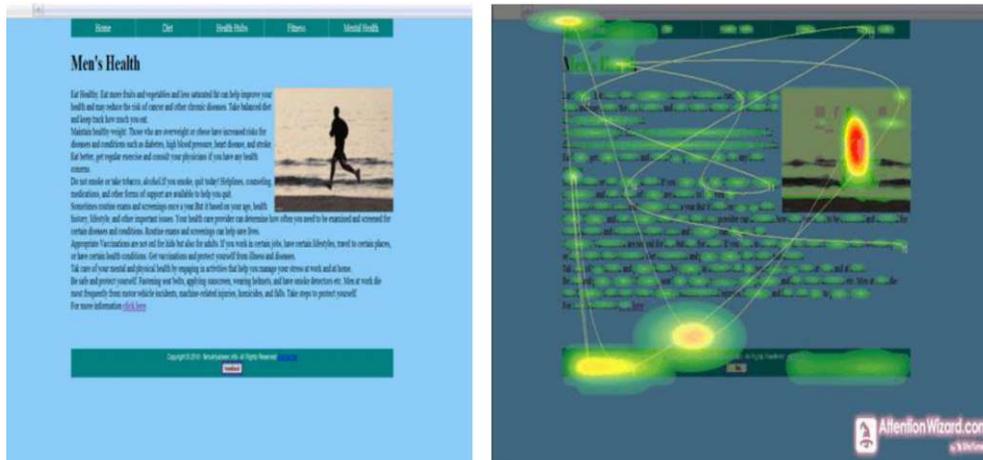


Figure 40. Heat-map of 'Men's Health' page

### 4.1.3 Heat-Maps of Kids and Parents Website

<http://farrukhjabeen.info/kidsparents/>

The attention heat-map of the home page of this website shows five hot spots: two on images, one on the right corner of the horizontal menu, one on the upper-left corner that includes some parts of the horizontal and vertical menus, and one on the YouTube video. Some small hot spots are also seen on the text.

The images, video, and menus attract the most attention. Interestingly enough, the text on this page gets attention, probably because of the bulleted lists.

The eye gaze path starts from the right corner of the horizontal menu and ends on text.



Figure 41. Heat-map of 'home' page

The attention heat-map of the 'Kids Health' page shows three hot spots: one on the photograph at the upper-right side of the page, one on the photograph at the lower-right corner of the image gallery, and one on upper-left corner between the horizontal and vertical menus. A small hot spot is also seen on the text.

The eye gaze path starts from the photograph at the lower-right corner and ends at the 'Parenting Tips for New Families' (left bar).



Figure 42. Heat-map of 'Kids Health' page

The attention heat-map of the 'Talking with Kids' page shows six hot spots: two on the image in the header, one on the left corner of the horizontal menu, one on the upper right corner (between the menus), and two on the image gallery. A small hot spot is also seen on the text. In this instance, the photograph placed at the right corner did not get the attention as in the other page.

The eye gaze path starts from the image gallery and ends on the video.



Figure 43. Heat-map of 'Talking with Kids' page

The attention heat-map of the 'Blogs: Post New Entry' page shows four hot spots: one on the upper-left corner (between the menus), one on the right corner of the horizontal menu, one on the YouTube video, and one on an entry field. In this case the entry fields, horizontal and vertical menus, and the video got the most attention.

The eye gaze path starts from right corner of the horizontal menu and ends near the video.

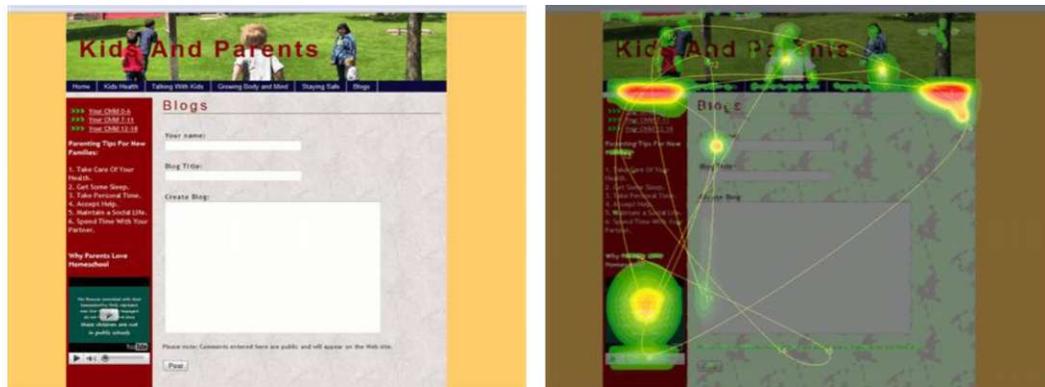


Figure 44. Heat-map of 'Blogs: Post New Entry' page

The attention heat-map of the 'Blogs' page shows four hot spots: one on the header image, one on the left corner of the horizontal menu, one on the right corner of the horizontal menu, and one is on text. In this instance the text receives a lot of the attention, followed by the horizontal menu and header image. The video fails to capture attention.

The eye gaze path starts from the right corner of the horizontal menu and ends on the text.



Figure 45. Heat-map of 'Blogs' page

#### 4.1.4 Heat-Maps of Desi Recipes Website

<http://farrukhjabeen.info/recipes/>

The attention heat-map of the home page of this website shows five hot spots: four on the 'Spices and Herbs' image and one on the 'Recipe Search' box. This shows that images and search are meaningful to the user.

The eye gaze path starts from the recipe search box and ends on the central photograph.



Figure 46. Heat-map of 'home' page

The attention heat-map of the 'Breakfast' page shows seven hot spots: four on images, one near the 'Spices and Herbs' heading, one on the 'Recipe Search' box, and one on the vertical menu. The images, sidebar, and search box assume the greatest importance for the user.

The eye gaze path starts from the 'Paratha' photograph and ends on 'Cooking Tips'.



Figure 47. Heat-map of 'Breakfast' page

The attention heat-map of the 'Appetizers' page shows seven hot spots: four on images, one near the 'Spices and Herbs' heading, one on the vertical menu, and one on the 'Recipe Search' box. Interestingly enough, only two of the four images attract attention. The other attention-catching areas are the same as on the previous page.

The eye gaze path starts from the 'Fried Prawn' photograph and ends on the description of 'Panipuri'.



Figure 48. Heat-map of 'Appetizers' page

The attention heat-map of a logged-in user's home page shows three hot spots: one on the main image, one near the 'Spices and Herbs' heading, and one on the vertical menu. As in some of the other pages, the search box got overlooked while the photograph, vertical menu, and sidebar continued to attract attention.

The starting and ending points of eye gaze path are on chicken photograph.

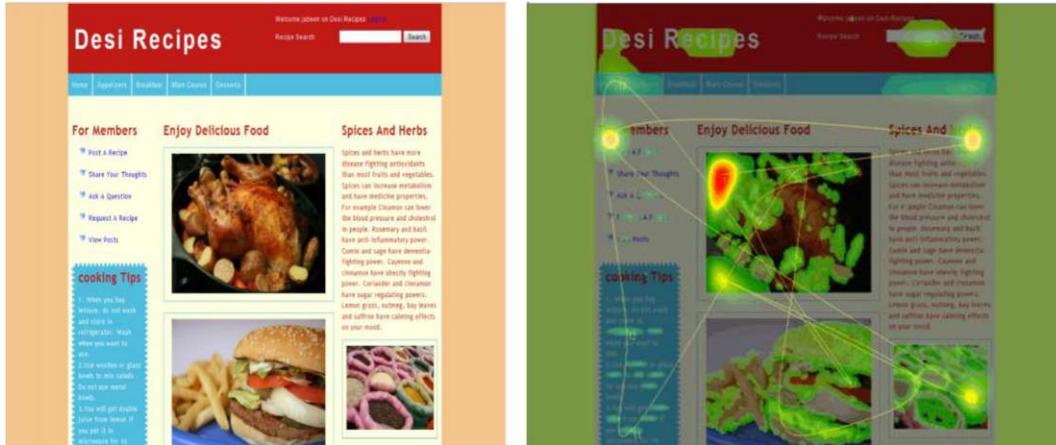


Figure 49. Heat-map of 'User's Home' page

The attention heat-map of the 'Post a Recipe' form shows three hot spots: two on the entry fields and one on the side heading. Even though this form has many entry fields, only those entry filed in the middle (Recipe type, Recipe description, and Upload recipe photo) attracted attention at the expense of all others.

The eye gaze path starts from the side heading and ends on the entry field.

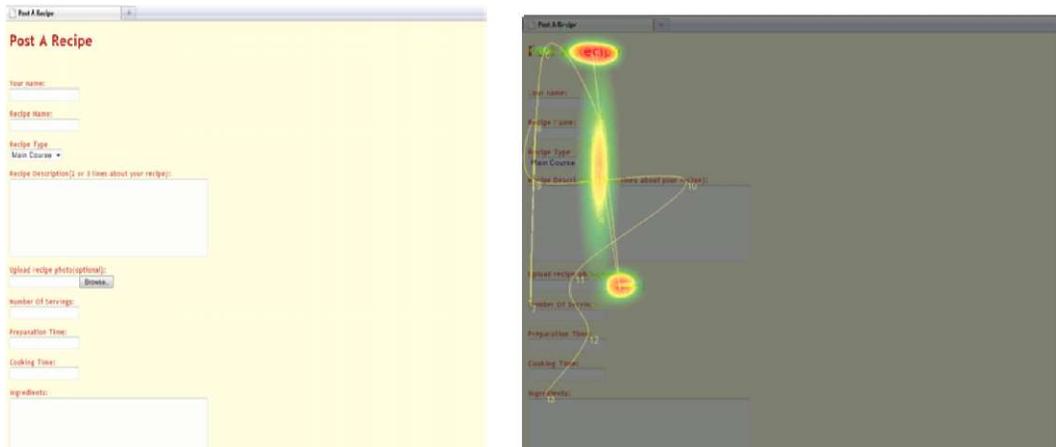


Figure 50. Heat-map of 'Post a Recipe Form'

The results of the preceding heat-maps show the parts of web pages that attracted attention, along with their eye gaze paths. These results provide a picture of how a web page is viewed during the first few seconds of eye movement, and where attention is focused. For the most part, images and graphics grab attention before any accompanying text. One could conclude that photos and images are important and effective tools not only for creating an attractive design but also for communicating ideas.

## 4.2 Website Evaluation Using Surveys

Website evaluation is the process of monitoring the performance and effectiveness of websites. It provides an opportunity to identify best practice and facilitates the improvement of current working practices. The key aim of website evaluation is to generate comparable data from which a best practice can be established. Without evaluation, it is not possible to determine the effectiveness of a website and the potential of website cannot be realized [48].

A user survey or questionnaire is one tool used in website evaluation. This study employed a survey to determine the perceived quality of the websites that were developed. The survey was conducted by using a feedback form attached to each website. The feedback form consisted of the following 25 questions. Users scored items on a scale of 1 to 5 where 1= bad and 5=good. The following list shows the questions that were asked.

1. Is the site's design visually appealing?
2. Are the colors used logically related and no harsh colors used.
3. Are the color choices visually accessible? (For example high enough in contrast to assist the colorblind and visually impaired in reading the site appropriately).
4. Is the design audience appropriate? The standard text size is readable, for visitors who do not know how to adjust their browsers.
5. The fonts are easily readable and look OK on various screen resolutions.
6. Is text broken small, readable chunks and highlighted using headings, sub-headings.?
7. Are there any credits to source for content that was not written by the site owner himself?
8. Is the website cross-browser compatible?
9. Are alt tags in place on all significant images?
10. Responsive on Click feedback. Is a response given immediately after a click is made on a hyperlink?
11. Do clickable items stylistically indicate that they are clickable?
12. Readability (somewhat addressed already), type face, font size.
13. How intuitive is it to navigate? Are signs obvious or obscured? Buttons/Links like text that are not clickable and vice versa, links/buttons that cannot be identified as such.
14. Clear statement of PURPOSE of the site?
15. Call to action on every page, no dead ends.
16. Data entry fields and buttons are labeled clearly.
17. No flashing or blinking text is used?

18. Is the contrast between text and its background color sufficient to make reading easy on the eyes?
19. Within articles, are there links to more detailed explanations of subjects, or definitions of jargon terms?
20. Does the site load quickly even for dialup users?
21. Are all links (internal and external) valid and active?
22. Are scripts free from errors?
23. Is the website free from server side errors?
24. Is every individual page only accessible via a single URL or are several URLs available (and worse, used) to access the same page? Duplicate Content Issue, Canonical URLs.
25. Do you think that appropriate images, photos are used in this website?

All CS and IT students (Graduate and Undergraduate) were invited to evaluate the websites. The following figures plot the responses that were elicited.

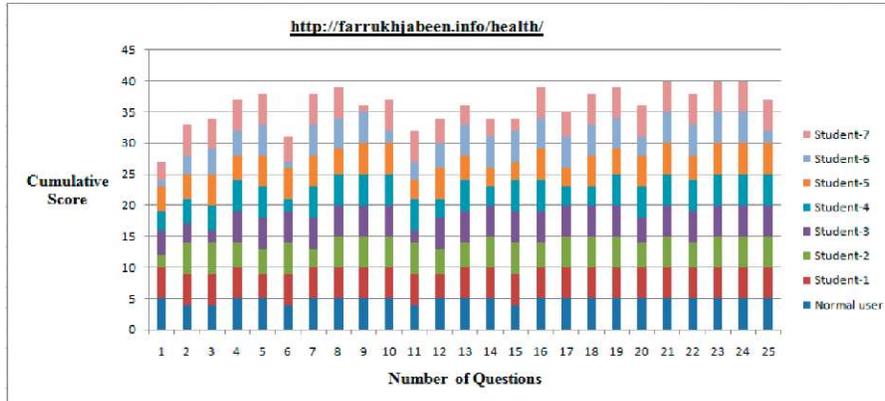


Figure 51. Feedback results for 'Health' website

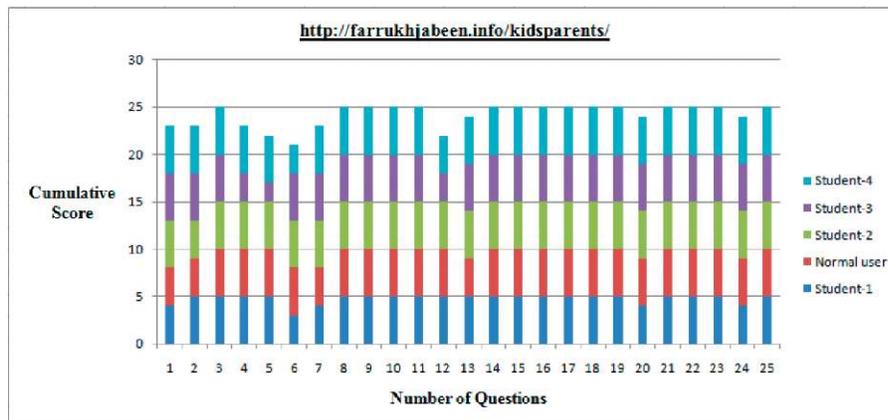
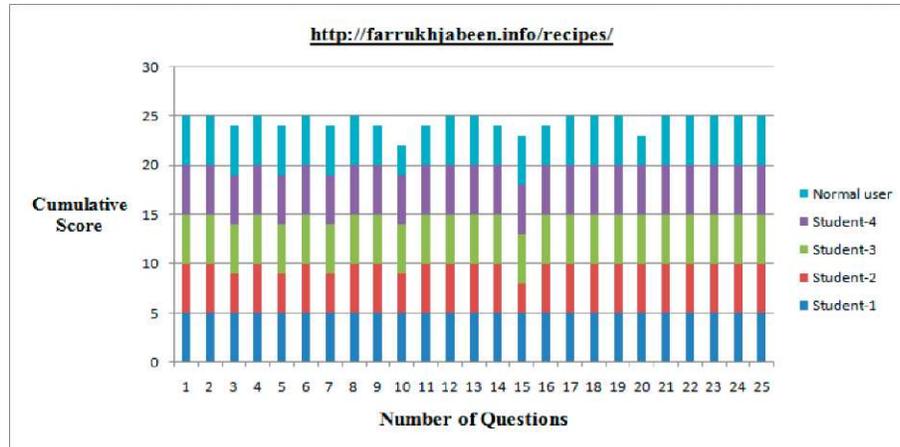


Figure 52. Feedback results for 'Kids and Parents' website



**Figure 53.** Feedback results for 'Desi Recipes' website

The results show that the Desi Recipe website got the highest score as compared to the other two websites.

## Chapter 5. Conclusions

Eye movements are fundamental to any interaction with a visual system, and their study can contribute to a better understanding of the function of visual systems and attention mechanisms. Eye-movement research can provide insights into the more complex aspects of human behavior and response in various situations such as during the selection of a product on an e-commerce website, playing tennis, or flying a jet plane. In such cases, eye-tracking technology can shed light on the different sources of information the subject is using, how frequently they are sampled, and how they affect decisions.

Good visual design is important in a wide range of activities. Given that fixations indicate what parts of the visual world have significance for the user, eye movement information can be used to modify visual displays. Regions that are fixated upon can be highlighted and made more accessible while those that are not fixated upon can be muted or even modified. Eye movements of a subject can provide researchers with a rich, dynamic data source which are also of great value to designers and engineers, as they allow for detailed measurements of how a user is interacting with a device [50].

One can conclude that eye tracking provides insights into user behaviors at a level and detail that is not possible with other, traditional usability studies. The insights it provides can help inform the design of better, more effective, and easier-to-use websites. Eye tracking is an essential and powerful tool that usability professionals can use to understand user behavior on the web. It is used in the evaluation of website design to determine what viewers look at on a web page, to design more attractive web pages that gain users' visual attention with better page layouts, navigation, menus, images, and advertisements. At the same time, eye tracking is certainly not the only usability evaluation method available. Eye tracking teaches us that we can make the world a little bit better if we design technology according to the human being's behavior [5].

As a part of this study we found the following do's and don'ts to create effective and eye-catching web pages.

### **Do's**

- Pages should be small because longer pages that require a lot of scrolling are unmanageable for online reading and degrade overall usability.
- Every page on the site should have a specific purpose, with a consistent look and feel.
- Pages should be structured consistently and should include a link to home page.
- Every page should have a descriptive and unique title.
- Text should be concise and objective.
- Information should be presented using bulleted lists, highlighted keywords, meaningful headings, and short sections.

- The informative text should start with the conclusion and then provide details.
- Implicit text should be used for links.
- All links should be visible.
- Feedback forms should be used for continual improvement.
- Navigation should be intuitive and proper.
- Menus should be noticeable, and be placed at the top, on the left, or both.
- Tab labels should be descriptive.
- Appropriate color scheme should be used.
- Effective images should be used.
- Alternative text should be used for images.
- Small images and interlaced images should be used and repeated where possible.
- Search (if necessary) should be accessible at the upper right corner of a page.
- Shopping cart icon (for shopping websites) should be placed in the upper right corner of all pages.
- A login/out feature should be placed in the upper right corner of all pages.
- Easy forms should be created for users so they can quickly look at, register, and deal with all parts of a form.
- More important elements should be highlighted to get user's attention.
- Website should be compatible with all the major browsers.

### **Don'ts**

- 'Under construction' pages should not appear after a user clicks on a link.
- Avoid the inclusion of irrelevant information and graphics.
- Very large amount of text online should not be used, instead provide one large page for printing or a file to download.
- Avoid the overuse of capital, bold, and italic text.
- Text should not be centered on pages because this could be hard to read.
- Blinking and flashing text should not be used.
- Bold text should not be overused.
- Meaningless and jargon words should not be used.
- Too many animations should not be used.
- There should not be links to irrelevant pages.
- Repeat links should not be overused.
- Ambivalent navigation should not be used.
- Dark backgrounds should not be used
- Large images with text should not be used.
- Small font and too many fonts should not be used.
- Too many colors should not be used.
- Avoid too many commands, banners, images, and other items that result in visual noise.

This project developed three websites and analyzed the eye tracking data by creating heat-maps. The heat-maps were created using AttentionWizard [43]. The results obtained using AttentionWizard largely correlate (75%+) with actual eye tracking and mouse tracking tools.

The attention heat-maps generated by Attention Wizard also tend to produce more focused hot spots because they simulate where the focus is likely to be the greatest. The attention heat-map's results show how a web page is likely to be viewed during the first few seconds of eye movement, and where attention will be focused.

Attention heat-maps assist the usability effort in various ways, based upon the website and its purposes. For example, if the purpose of a website is to communicate information, get users to register, or get users to purchase a product, using insights gleaned from heat-map results one can optimize the website and improve the site's conversion rates (the percentage of visitors who take or complete the desired action).

Attention heat-maps also help determine the optimum placement of the call to action (desired user response such as "buy", "donate", "register" etc) button and text. In addition, they can be used to evaluate whether the call to action is attracting the desired attention.

An attention heat-map is not a substitute for actual landing page testing. It cannot evaluate the effectiveness of sales copy, the strength of a brand or value proposition, the pricing of a product or service, the professionalism of the landing page design, or the web visitor's psychological reactions to the color scheme.

This study found that images and graphics draw attention before accompanying text. This means that photographs and images are excellent resources not only for creating an attractive design but also for communication. Appropriate images and graphics at strategic locations play an important role in the success of a website. This finding is in agreement with the generally accepted notion that the use of professional and attractive graphical elements on a website increases the proportion of user generated activity such as sales, newsletter subscription, and the amount of time spent on a particular site. The use of professional and attractive graphical elements is also known to convert more readers into buyers, and more visitors into subscribers.

Recent studies have confirmed that most people considering the purchase of a digital product visit the page listing the item four times before making their actual purchase. In this case, the graphical elements of website are a vital factor in helping them make a decision. A great visual experience convinces the buyers to buy the products. Given that visitors scan through a web page; they don't read it from start to end, we have to choose the images and graphics wisely in order to grab user's attention and draw them to most important parts of web page [46].

Images and graphics also play a crucial role in the success of banner ads. Banner ads are small advertisements that act as hyperlinks on a website and draw targeted traffic to build brand awareness or even sell products. Images and other graphical elements in the banner should be relevant to the product and services. Using banner advertisements is an effective method of publicizing a product or service. The more people that know about a business, the more customers it will draw in and more income will be generated [47].

This study also conducted surveys to evaluate the websites that were developed. While eye-tracking provides actual data on user behavior, a survey provides qualitative information on the user's perceptions. This ability to provide an insight into the reality as seen from a customer's perspective makes surveys an essential marketing and evaluation tool. A survey provides the most relevant information that is both helpful and meaningful [48].

## **Chapter 6. Future Work**

Future research needs to focus on the use of eye movements as a usability evaluation technique in the ecommerce websites. Electronic commerce or ecommerce involves transactions using the internet. While ecommerce has been around since the mid-90s, it has gained traction in recent years. Amazon, eBay, Yahoo, and Dell are some of the more successful businesses in this area [49].

As more consumers switch to shopping on the web, we need to examine and understand the factors that influence the way people react to user interfaces of ecommerce sites. For example, the factors that influence the user's visual attention on the user interface, and improving the usability of ecommerce sites by placing important information to attract user's first glance [51].

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