



## USE OF EYE MOVEMENT TRACKING TECHNIQUE IN THE STUDY OF LAYOUT AND COMPOSITION DESIGN OF MEDIEVAL INDIAN MANUSCRIPTS

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### Abstract

A graphic design is the art of visual communication which combines text, images, and graphic elements to convey information to an audience. It is predominantly used in a 'Publication Design'. Visual hierarchy is the key element of any effective visual communication. It is an order, which directs the reader to absorb information in a particular way. 'Contrast', one of the principles of design is the key element preferably used to show visual hierarchy. This technique makes composition of a page effective and dynamic.

While observing Indian medieval manuscript designs, use of principles of design in planning of design is noticeable. A new technique called 'Eye Movement Tracking' is applied to study manuscripts. Equipment records observer's attention while looking at a visual design. This method to study layout design can give a new dimension in understanding medieval Indian Art and Design knowledge, and Indian Graphic Design Ideas applied in designing Manuscripts.

**Keywords:** Design History, Page Layout and Composition, Visual Hierarchy, Eye Movement Tracking, Indian Manuscripts

### 1. Introduction

Communicating ideas and information through art is known as Visual Communication. Every popular culture is lived and preserved and carried forward their cultural traits by various ways such as fine arts, literature, traditions, customs, etc. According to an English cultural theorist Raymond Williams (quoted in Jonathan Baldwin, 2006) defined the term 'culture' as the process of society's intellectual, spiritual, and aesthetic development. It is a particular way of life of the people, their period or the group and the works and practices of their intellectual and especially artistic activity e.g. poetry, novels, ballet, opera, and fine art.

The handwritten Indian manuscripts have touched upon various areas which represent Indian culture, medicine, dance, drama, science, etc. According to National Manuscript Mission founded by Government of India, a manuscript is a handwritten composition on a paper, a bark or on a cloth and that has significant scientific, historical or aesthetic value. The manuscripts are highly detailed by calligraphic text, and comprise images and other decorative elements, e.g. borders, motifs, etc.

In this research, the researcher wants to understand the design concept used in Indian manuscript design of medieval period. A 'design' is a process which includes conceptualization, visualization, problem solving ability, and functionality. It also involves aspects/features like, look and feels i.e. aesthetics. In the Indian context, the use of design concepts can be seen in a planning of manuscript which includes the application of design elements such as grid, margins, columns, alignment of text, folio number (navigation system), text in calligraphy form, illustrations, symbols, title page in the form of colophon area, flyleaf, etc. In case of paintings and illustrations, they are placed on page along with a text wrap; whereas motifs and symbols are also included in the manuscript design with specific purpose (semiotic). The 'elements of design' (e.g. line, shape, form, colour, texture, etc.) are also employed in the manuscripts.

According to the 'Modern Design Theory', a graphic design is "the art or profession of visual communication that combines images, words, and ideas to convey information to an audience." The graphic design theories are predominantly applied in a book design which is known as 'Publication Design'. The page layout is an arrangement and a style treatment of the elements (content) on a page. In other words, it means a composition of a text (typography) and visual arts (e.g. paintings, images, and various design elements). Finally, the use of the elements and application of the principles of design are responsible for making a design aesthetically perfect.

With the advent of technology, in 1450 Guttenberg perfected movable type and came up with printing machine. St. Paul Church in Goa set up first printing press in India and started printing religious text in the sixteenth century, however, the mass printing started in eighteenth century. It is in this context there is a need to study Indian design aspect of the manuscript design before printing revolution started across the country (India).

In this research paper the researcher is intended to study how the principles of design such as contrast and visual hierarchy have been used in Indian manuscript design and how the designers of medieval period have successfully achieved a visual hierarchy in composing pages with the help of eye movement tracking device. To examine contemporary readers and their visual perception for retrieving information from medieval manuscript page layout.

The present paper is organised as follows. In the next section, researcher will present critical review undertaken in systematic approach. In the third section, researcher has discussed research hypothesis. In the fourth section, data collection instrument, procedure, and hypothesis testing in detailed. In the fifth section, concluded research findings and outlined researcher's unique contribution of the present study. Researcher further identified her limitations and derived further research directions.

## 2. Literature Review

Researcher has conducted an exhaustive literature review of extant relevant literature through books, journals, and online sources. Researcher classified literature as:

- 2.1 Visual perception – Stages and Process
- 2.2 Contrast and Visual hierarchy in design
- 2.3 Eye Movement tracking Technology and its use in visual design

### 2.1 Visual perception – Stages and Process

In the study of visual perception or how human being looks at an object, it has been observed that human eye looks for an important thing while observing a visual design. Dabner (David Dabner, 2010, p. 38) thinks that ‘to develop good compositional skills, it is important to understand the role of visual perception (like way our eyes and brains make sense of what we see), and its role is communication. Our eyes are constantly supplying information to our brain, which processes and makes sense of that visual input. The relationship between visual elements strongly affects the way we perceive them’. There are various stages in visual perception, such as recognition, action and acknowledge. Goldstein holds a view that (Goldstein, 2002, p. 6) ‘Recognition is our ability to place an object in a category and action includes motor activities such as moving the head or eyes and locomoting through the environment.’ The knowledge is nothing but recognition of different script and images stored in the memory and then retrieve them.

It is the designer who shows path to the reader’s eye while scanning through design or looking at the visual. It is achieved by effective application of the principles namely contrast in the elements, which create visual hierarchies. Wong suggests (Wong, 1972) that the contrast means a difference. It is way beyond common understanding that is opposite. One may find contrast in size, shape, colour, texture, direction, position, space, and gravity e.g. small/big, black/white, dark/light, etc. This relation between the elements affects the way the human being notice it. This is known as ‘figure-ground’ relationship. According to Gestalt psychology, it is where the figure means element or object and the ground is background area or a space behind the object. Usually, one notices first a figure and then a background. This is a cognitive ability of human being which helps the reader to understand difference between elements based on contrast.

### 2.2 Contrast and Visual Hierarchy in Design

Design is a visual language built on fundamental principles and elements. Dabner points out (David Dabner, 2010, p. 49) ‘**Contrast** can create visual emphasis in the form of large type and imagery’. It creates momentum and rhythm’. To emphasis specific area in the design, the designers make use of the contrast. This creates visual order or visual hierarchy. A **visual hierarchy** means elements arranged in layout according to emphasis. It helps reader to see different level of information as per the degree of importance. There are many aspects which control a visual hierarchy, e.g. size, colour, value, density, white space, etc. To get the expected result, a thoughtful consideration on content of layout is necessary. For that, designer has to visualise the concept before finalising the design. Difference in type size and keeping it bold or normal is a popular option for applying styles for heading, sub-headings, body copy, captions, etc. The colour can also be employed by making type reverse or to add rule to attract attention. A designer has to first establish a ‘**focal point**’ of a design, once it is established he/she creates a hierarchy of elements to guide the viewer through a layout, from major to minor sections of the page. For example, the beginning with the headline as a focal point, perhaps the viewer will be led to a subhead, a pull quote, then to the body copy. This helps in creating sense of movement and rhythm in layout. Sherin understanding about white space in layout is (Sherin, 2013) white space in any layout decreases clutter and helps in emphasizing the contents providing visual pause.

The ‘**grid**’ can also be used to arrange elements on the page. According to many in the field grid is a division of space using horizontal and vertical lines known as rows and columns. The use of a grid system for page layout makes it easy to organize and balance all of design elements. Graphics, text, photos, navigation elements, anything that is going to be visible on a page can be organized using a grid. Sherin explains (Sherin, 2013) ‘Using simple grid makes the composition cohesive and give a designer the opportunity to place elements in the same or similar place on multiple pages. This visual repetition makes it easy for reader to know where to find content.’ Ambrose and Harris state that (Ambrose & Harris, 2011, p. 27) ‘Grid is a means of positioning and containing the elements of a design in order to facilitate and ease decision making. Grid shaves varying degrees of complexity and so can provide for a vast number of design and positioning possibilities’. Ambrose and Harris (Ambrose & Harris, 2011) consider modular grid based on columns and rows is the key design tool. Designers generally, develop a grid which is flexible to arrange text and images of different sizes. More comprehensive study by Hashimoto and Clayton (Hashimoto & Clayton, 2009) explain that, form of visual design decides the line direction of any visual.

**Colour** is used in a design to attract attention of the reader, and to group elements, indicate meaning, and thereby enhance aesthetics quality of the layout. The scholars like Lindwell, Holden and Butler (William Lidwell, 2003) suggest that the “Colour should be used conservatively. More number of colours more the complex design.” They further suggest limiting the palette of colours to help eyes in order to process information at a glance’. Further they state that ‘Saturated colours are perceived as more exiting and dynamic and these pure hues attract attention more than desaturated colours’. According to David Dabner (David Dabner, 2010, p. 100) ‘Colour is a powerful tool, especially in information design; it is used to help the designer organize data into various structures. The psychologists have proved that the colour of an object captures the attention of the reader first and then it is followed by its shape and other details. Catalogues and books often have different colours coded sections to help navigation through pages. Such visual associations can help to delineate sections within a body of text and highlight a number of different levels of importance. The eye picks up this difference very quickly’.

Shrerin suggest (Sherin, 2013) using of **imagery** in design attracts viewer’s attention. It helps in expressing concept and strengthens ideas. She further adds by stating use of imagery in visual design enhances content and expresses mood and rhetoric of design. Images help in determine focal point of composition.

2.3 Eye Movement tracking Technology and its use in visual design

The eye movement tracking devices used in research based on principles of visual communication. Human eye looks for an important thing while going through a visual design and eye movement tracker captures the motion of eyes. According to Santella, (Santella, 2005) ‘Important locations are identified from eye movement recording’. Yu & Li (Yu & Li, 2015) suggests that it is a method to study processing of visual information. The eye movement tracking technology is nowadays commonly used in advertising, packaging design, web usability, etc. It is used to examine the focus of a reader/user. It provides sequence path (scan path) which is nothing but a movement of eye, i.e. gazing (where a reader a looking at), besides other factors such as (1) heat maps of every participant (2) an analysis of how much time is spent on looking at different areas, and, (3) analysis in the form of key performance indicator, binning report, dwell time average report, etc. It is a quantitative method of collecting information.

3. Research Process

- 3.1 Investigate visual design; its system and environment
- 3.2 To search for design ideas from the past and its association with the general concepts of modern design
- 3.3 Data collection using desktop Eye Tracker Equipment
- 3.4 Data Analysis

A desktop eye tracker device is used for testing participants. Nine participants, from various backgrounds took active part in this visual experiment. Quantitative data collected from the device and to analyse the data qualitative method was used.

Procedures

- Step 1 : Selection of a representative Manuscript Page
- Step 2 : Reader has been instructed to go through the visual design (Fig. 1)
- Step 3 : The Eye Movement Tracker device captured the reader’s movement of eyes sequentially
- Step 4 : Different areas of manuscript page are divided according content and function

Manuscript page selected which comprises of text, image, borders, and surrounded area of hole for binding purpose which is ornamented by motifs, navigation system, etc. It is an illustrated Prakrit Jain Manuscript of Kalpasutra, written in Nagari script created in Gujarat, India in early 16th century. Material used is paper and designed by unknown artists. This is currently available at Victoria and Albert Museum, London (Museum number: IS.46:1-1959)



Fig. 1 - Original Image (Credits: Victoria and Albert Museum, London)

The Eye Movement Tracker device captured the reader’s movement of eyes sequentially i.e. scan path (see Fig.2). The scan path provided the order in which the page has been viewed by the each reader and recorded the time spent on a gaze spot area. Smaller (size of) the gaze spot- time spent on viewing the area is less; whereas bigger (size of) the gaze spot - time spent on viewing the area is more.



Fig. 2 – Scan path of one of the observer

Once, a survey is done, an image thus obtained has been divided in seven different areas of interest. (see Fig.3)

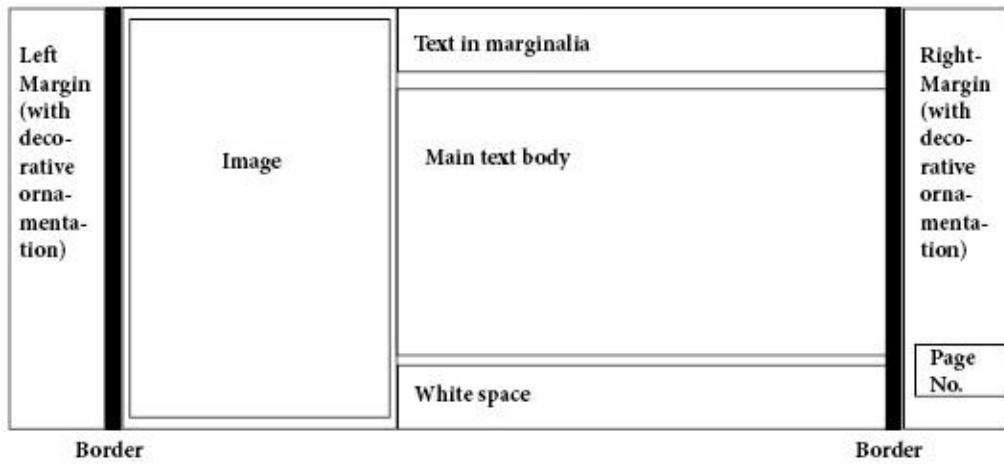


Fig. 3 - Area of Interest

### 4. Research Findings and Discussions

#### Analysis of How Participants viewed the Layout

The key performance results (Fig. 4) shows that fixation count for the image and the Main Text Body area is ten and for white area it is eight. The more count in fixations in particular area indicates that the particular area was more noticeable than the rest.

Color code	Area of Interest	Entry Time	Dwell Time	Hit Ratio	Revisits	Revisitors	Average Fixation	First Fixation	Fixation Count
	Left and right margin with ornamentation	3529 ms	382 ms (2%)	4/9 (44%)	2	3/4	101 ms	74 ms	2
	Image	3622 ms	3272 ms (22%)	8/9 (89%)	4	6/8	252 ms	209 ms	10
	Text in marginalia	4457 ms	358 ms (1%)	3/9 (33%)	3	2/3	53 ms	70 ms	2
	Main Body Text	755 ms	2802 ms (20%)	7/9 (78%)	5	6/7	211 ms	171 ms	10
	White Space	1707 ms	2125 ms (10%)	8/9 (89%)	5	7/8	193 ms	157 ms	8
	Page No.	10163 ms	263 ms (1%)	3/9 (33%)	1	1/3	117 ms	91 ms	1
	Vertical Borders	3988 ms	43 ms (0%)	1/9 (11%)	1	1/1	21 ms	33 ms	0

Fig 4 - Key Performance Indicator – All Participants

Fig 5 – Area of Interest Chart for all participants

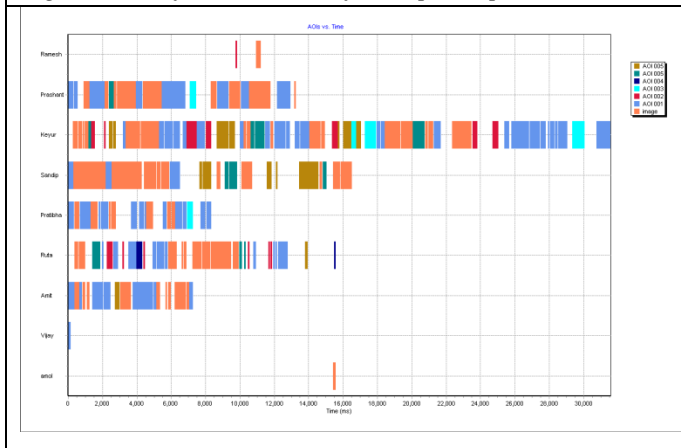
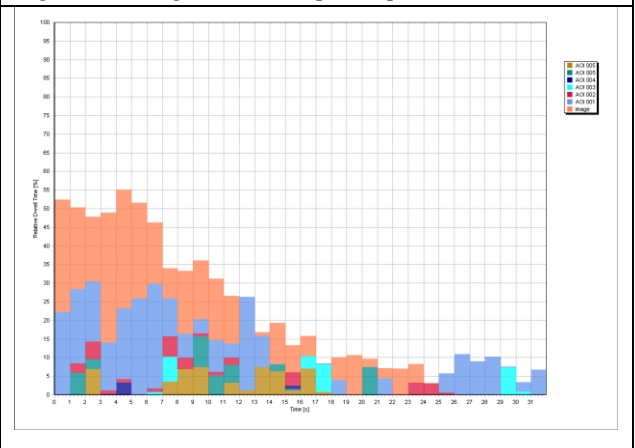


Fig. 6 - Binning Chart – All participants



<p>Time spent and order in which different areas looked upon by every observer AOI chart of all participants (Fig. 5) shows that out of nine observers the seven revisited image area more than 3 times. The four observers first looked at body copy area but they spent less time and later on their focus was shifted to the image and there they have spent more time on image. It is further noticed that the most of the observer's eye movement shows toggle between body copy and text area and this was followed by their shift in focus towards borders - left and right side and finally towards page navigation area, i.e. page number. The most common order in which the participants scanned the page was in this manner; a text first, followed by an image; once again a text then an image, and at the terminal stage on borders and page no. i.e. page navigation system.</p>	<p>Binning Chart of all participants (Fig. 6) shows that when participants started observing page, in the first seven milliseconds time shows the order of observed areas are; image, body copy, left border and motif, sub text on marginalia, right border and motif, and then page number. The observers again revisited the image, body copy, left border, sub text, page number, and finally concentrated on body copy area. The result is: Out of eight Readers, the seven revisited to white area that shows very well organization of positive and negative space. The negative space (white space) created a contrast.</p>
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#### *Dwell Time Average in Milliseconds*

The image is divided in to multiples grid of eight columns and eight rows (64 modules) and got analysis of average time spent by all users on each module. The dwell time average in milliseconds shows that, the areas attracted most to the readers are image (1882.6 ms), body copy (785.6 ms) and then page no. (543 ms).

## 5. Conclusion

The study led to the conclusions that, the proportion of the image and the colours used in the manuscript layout selected are heavy in relation to other areas e.g. body text, borders with ornamentation, etc. hereby creates contrast. Using this design principle, the emphasis has been created on an image which provides focal point to the reader. This automatically creates visual hierarchy. This shows designers were sensitive to colour, form and proportion.

Designer used limited number of colour palette to attract attention of prospective readers. The density of black colour used in the main body text and the text in marginalia is different. The Main Body Text is darker and its type is bigger in size than the text appears in marginalia. That's why reader looks at Main Body Text first rather than text in marginalia. Hence, creating visual hierarchy guides the reader what to see first at the outset. It creates momentum and rhythm in the layout. For punctuation mark i.e. vertical stroke (single *danda*) red colour has been used which helps reader in knowing that it is end of sentence. The dwell time result of image area i.e. time spent on looking at image, hit ratio, revisits shows that thoughtful use of colour in an image which was noticed prior to its shape and other details.

The image and the Main Body Text area has more fixation duration and their counts means they are more engaging and observer tried to understand more about the areas.

The overall page composition of the manuscript shows harmony among all elements of page design used, such as colours, image, text, motifs, borders, and page navigation system, etc. and provides visual movement and an order for a reader while going through the information on the page.

These findings shows that medieval Indian manuscript design artist were sensitive to colour, form and proportion.

### 5.1 Unique Contribution

Present study attempted to provide a framework to study Indian medieval manuscripts. Moreover this study contributes to literature by investigating Indian medieval manuscripts using new technology i.e. Eye Movement Tracker.

### 5.2 Limitations of study and further research directions

Like every study this research also has limitations. First, this study does not include study of overall composition methods and fundamentals of visual design. Second, according to National Mission for Manuscript (<http://www.namami.org/postservey.htm>) there is huge number of handwritten manuscripts available in entire India. Study of all manuscripts is difficult so representative manuscript selected for research.

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