

Special Project:

Eye Movements during Creative Conceptualization in early Design phase

CAN EYE MOVEMENTS CREATE VIRTUAL OBJECTS?

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Abstract:

This paper is an extension of the series of papers that explore the way a designer uses mental imagery in solving a design problem.

The experiments addresses the following queries:

- Do eye movements reflect the mental image during early conceptualisation?
- Can eye movements create virtual objects?

Thus the project aims to identify the **potential and limitations of the eye movements as a source of shape information**.

The subjects for this study were practicing architects having sufficient experience in design field. Eye movements were recorded using iViewX eye tracking system while test subjects tackled the design task observing a plot image shown in perspective, as they verbalised their mental image.

The results achieved shows evidence that eye movements do reflect the mental image during conceptualisation, but the limitation were in the details of this images generated

Literature review

1. Mental Imagery as a design tool.

- Offers some clues to the designers internal mental world.

2. The potential of mental imaging in architectural design process.

- Studies the role and potential of 'Mental Imagery' in the architectural design process and the use of mental imagery as a feedback, in absence of other media.

3. Learning from the way designers model shapes in their mind.

- video taped records of earlier study were given to group of designers for decoding .

4. Castle in the air: A strategy to model shapes in a computer.

- study was based on a visualisation of a hypothetical system, where the designers develops a 3D shape using gestures and limited space.

5. What Do Eye Movements Reveal About Mental Imagery?

Evidence From Visual And Verbal Elicitations

By Roger Johansson, Jana Holsanova and Kenneth Holmqvist
Department of cognitive science, Lund University

Components of Eye Movements

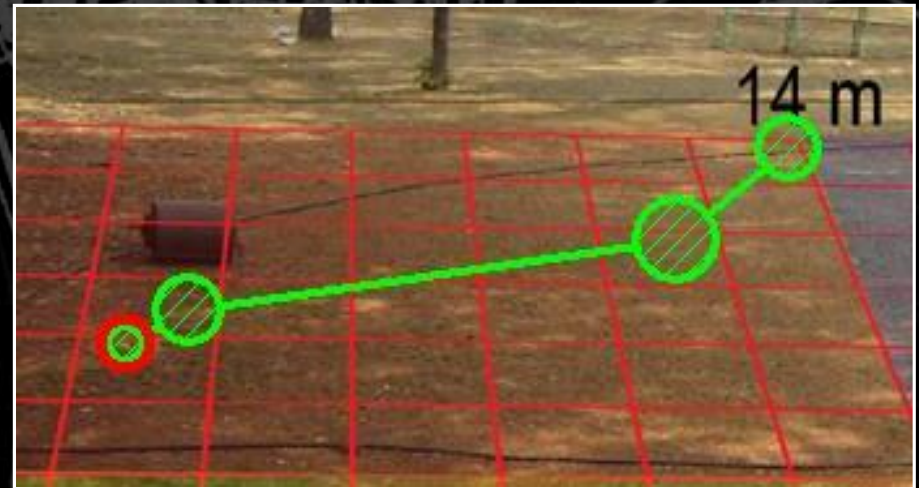
Saccades and Fixations

The eye is never still for very long. The eye moves around with small jerks, called **saccades**. We are generally not conscious of these small movements. If an image is projected on the retina so that it moves synchronously with the movement of the eye, the projected image starts to fade after a few seconds (Pritchard 1961). Small saccades, called **micro saccades**, keep the eyes constantly moving to reduce this effect.

When we are looking at the same spot for a longer period of time this can be considered a **fixation**. A fixation allows us to gather information about an object or area.

Visual Acuity

It is at the centre of the retina, the fovea, that visual acuity is at its best so, in order to perceive the sharpest possible image, the eyes rotate to move the area of interest to this part of the retina.



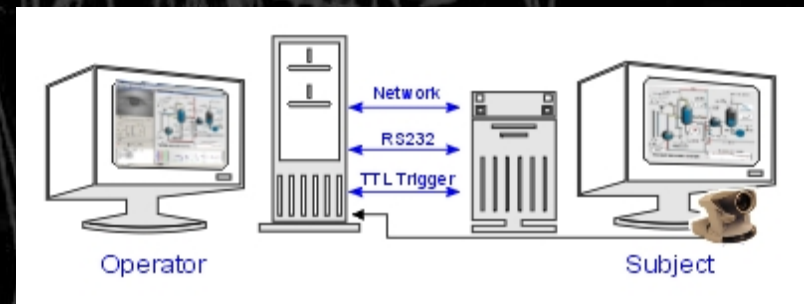
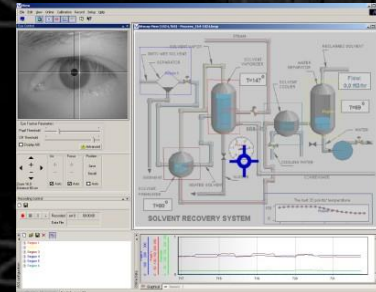
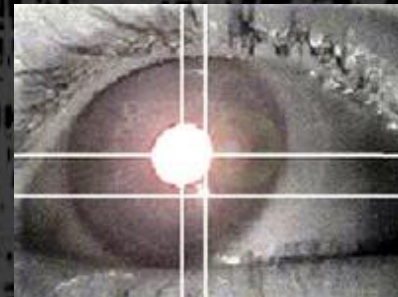
Literature review

Areas of Interest

When many fixations appear clustered close together this might suggest that there are some kind of stimuli in the proximity of these fixations that attracts attention. These clusters are called areas of interest.

Eye tracking hardware

The hardware used in this study is a corneal reflection system **iView X**. iView X RED computes gaze path and fixations contact-free. The system consists of an infrared lamp and a video camera connected to a PC. The light and the camera are positioned in front of the subject. The movement of the eye is calculated by the change of position of the pupil.



Sequence and stages of experiment

Pilot Experiment

The subject chosen for pilot study were design students having architectural background and professional design experience.

Observations from the pilot experiments:

1. The design problem was too complex to be completed in the stipulated time period.
2. The eye movement recorder generated huge data and analysing it would consume a large of time and involved tedious manual computation.
3. The plot view needed to be zoomed into the design area, this eliminating unnecessary details that would distracts the subjects eye from the main plot area.
4. A scaled grid was needed on the plot with colour coded areas so that the subject would use them for proportional needs and also for clear communication.
5. It was observed that some time was needed by the subject for getting adjusted to this process of design.

Sequence and stages of experiment

Final Experiment

The final experiment was divided into two sessions. First was the practice session in which the design brief was to design a 'PCO booth with coffee stall'. Immediately following this session was the main session. The brief for this session was to design 'A Sports complex for IIT-Bombay'.

The typical sequence followed in both the session is as follows:

Stage 1:

Reading the Brief

- Asked to memorise the design briefs.
- Prompted missing details by the experimenter.
- Site plan print out shown to the subjects.

Stage 2:

Calibration of the eye tracking system.

Start of the presentation

The presentation shown on the screen was subdivided into slides.

Slide 1: Site plan

The first slide carried the site plan with all the architectural details. Here the subjects refreshed their information regarding the plan and all the doubts regarding the plan were cleared by the experimenter.

Sequence and stages of experiment

Slide 2: Over all site view

Second slide carried the photograph of the plot and the surrounding areas.

Slide 3: Plot view 1 with grid

This slide carried the zoomed image of the actual plot with the grids marked on it. At this stage the subjects were asked to start with the conceptualisation of the design.

Slide 4: Plot view 2 with grid

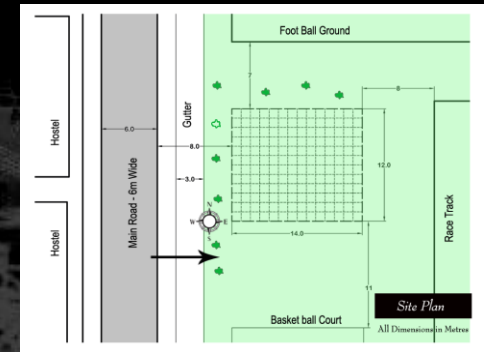
This slide was the same copy of the previous slide. This was done to separate the huge eye movement data generated.

Slide 5: Plot view 3 with grid

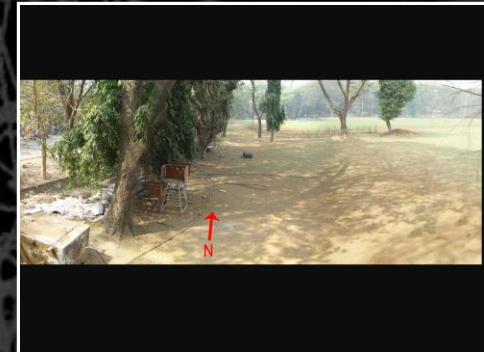
This slide was again the same copy of the previous slide. Final design articulation was done on this slide.

Stage 3:

Concentration on final mental image of the design.
Quick Sketching of the solution with each areas labeled and minor details included. These sketches would be used for final data analysis.



Site plan



Overall site view



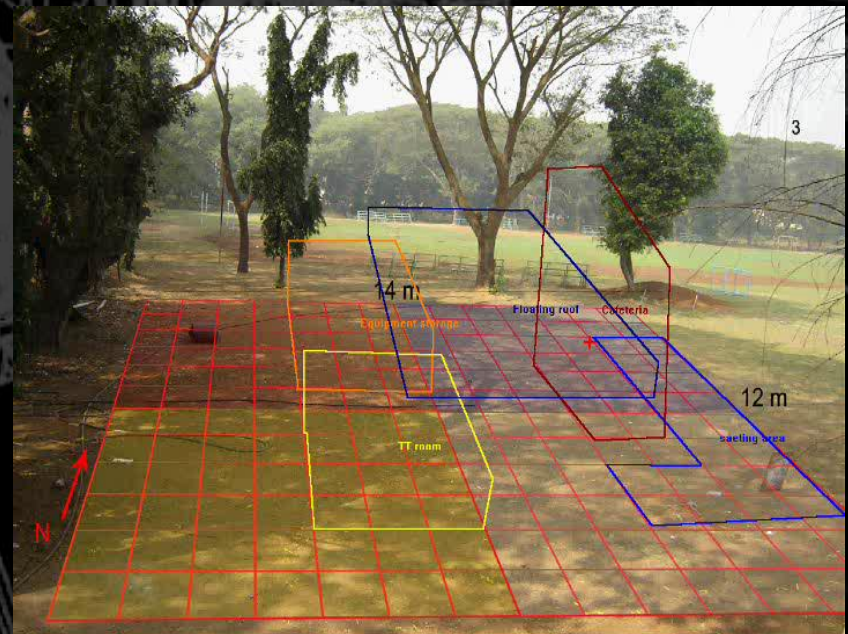
Plot View with grid

Analysis

After an overall study of the **eye movement data video** with the voice protocol for all the three four subjects, it was decided to study in detail the summarisation video of two subjects. Using the **Begaze** data analysis software different scan path patterns were generated to assist in further study.

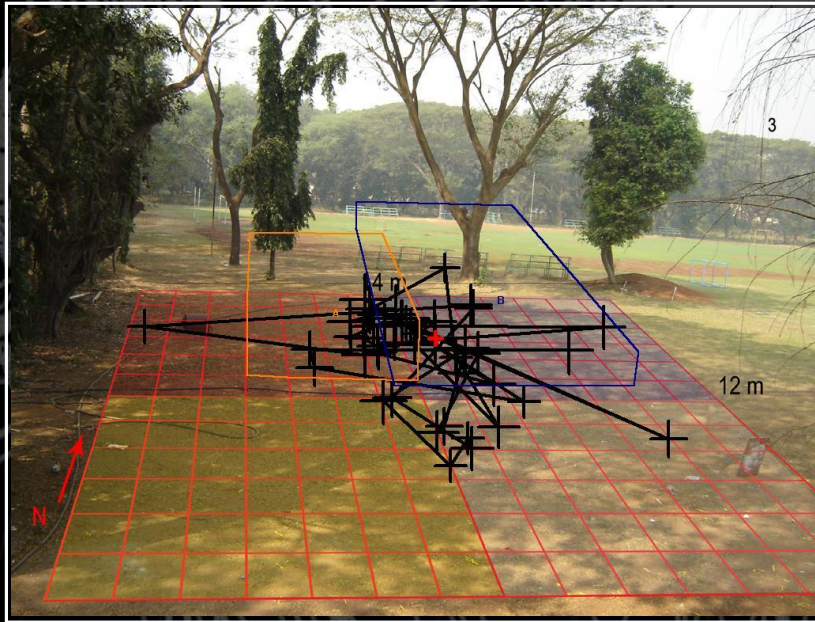
To draw conclusion from this data the analysis was done in three stages.

1. Comparison of eye movements and design style between the subjects.
2. Voice protocol study.
3. Percentage of fixation in the intended areas.

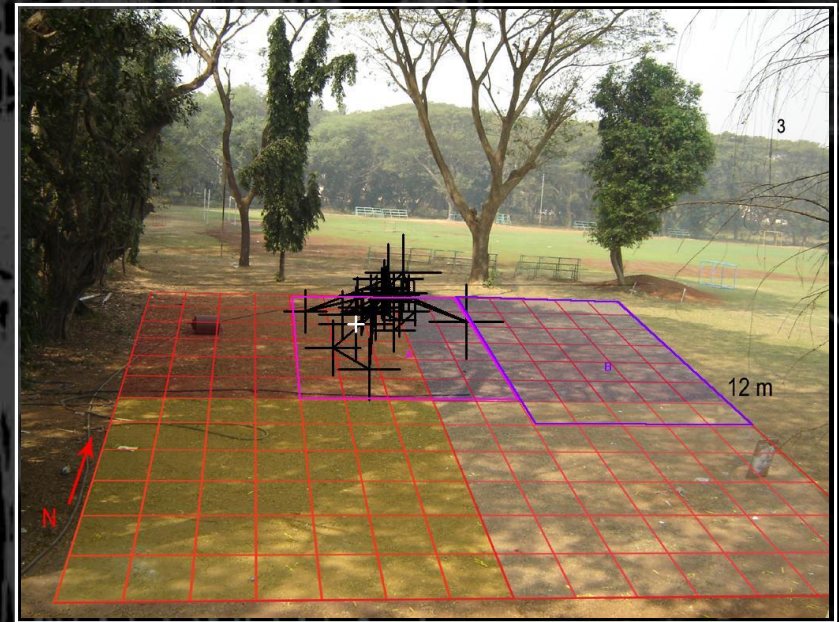


Analysis

1. Comparison of eye movements and design style between the subjects.



Scan path of MV when describing the equipment store (10sec)

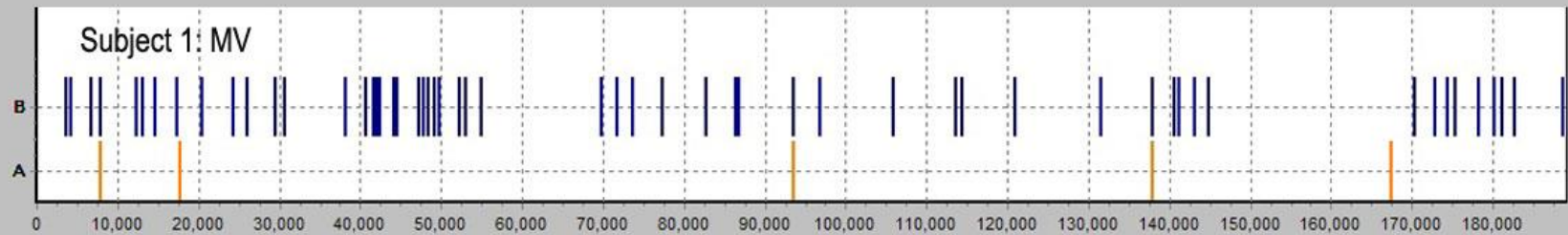


Scan path of SD when describing the Cafeteria (10sec)

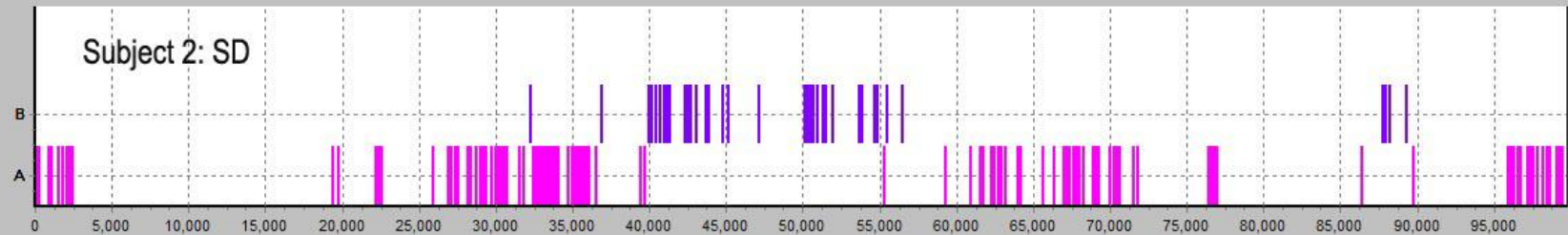
Analysis

1. Comparison of eye movements and design style between the subjects.

AQIs vs. Time



AQIs vs. Time

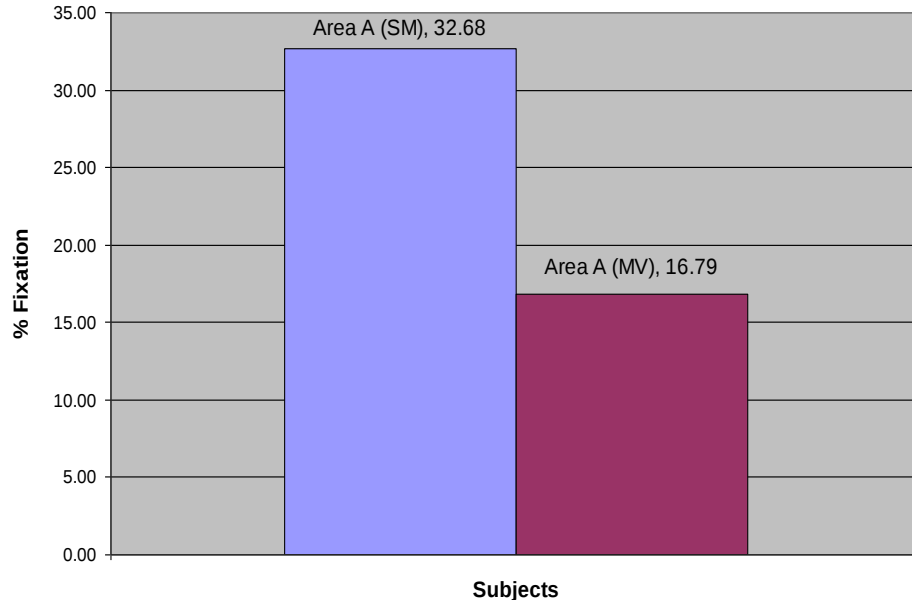


AOI v/s Time sequence chart

Analysis

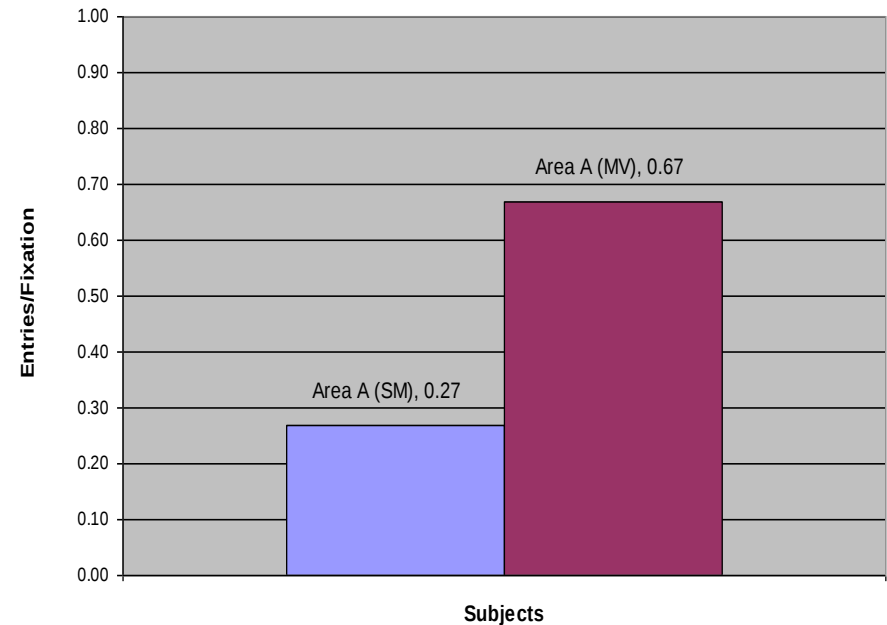
1. Comparison of eye movements and design style between the subjects.

Comparison of % fixation



Graph 1: % Fixation of each subjects

Comparison of Entries per fixation

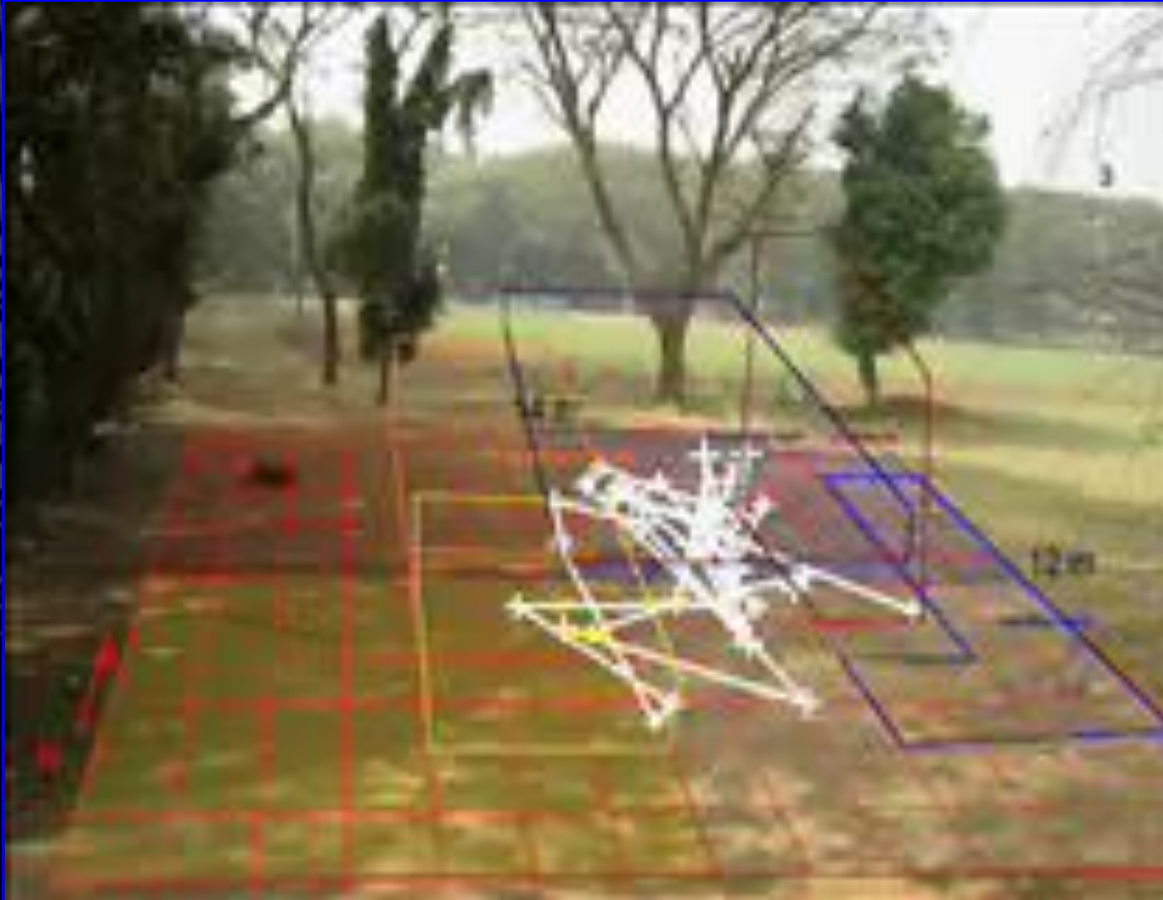


Graph 2: Entries per fixation for each subject

The subject when talking about a particular area or mentally imagining about a object often moved to inspect other parts of the picture, while they simultaneously continued to describe the previously perceived image

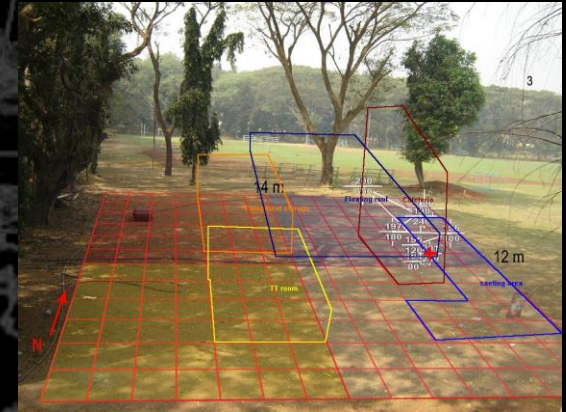
Analysis

2. Voice protocol study.

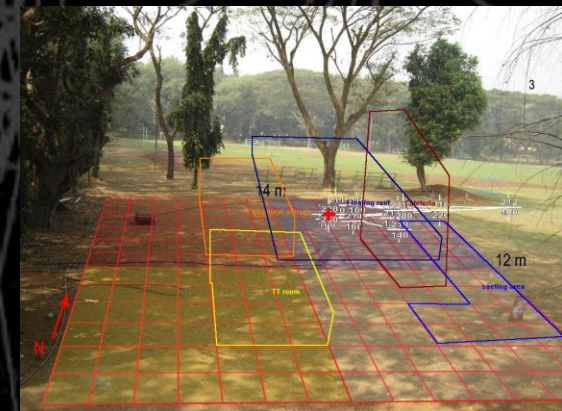


RT 7:18

... Whole long strip of Display area .. Which has a covering with a floated slab



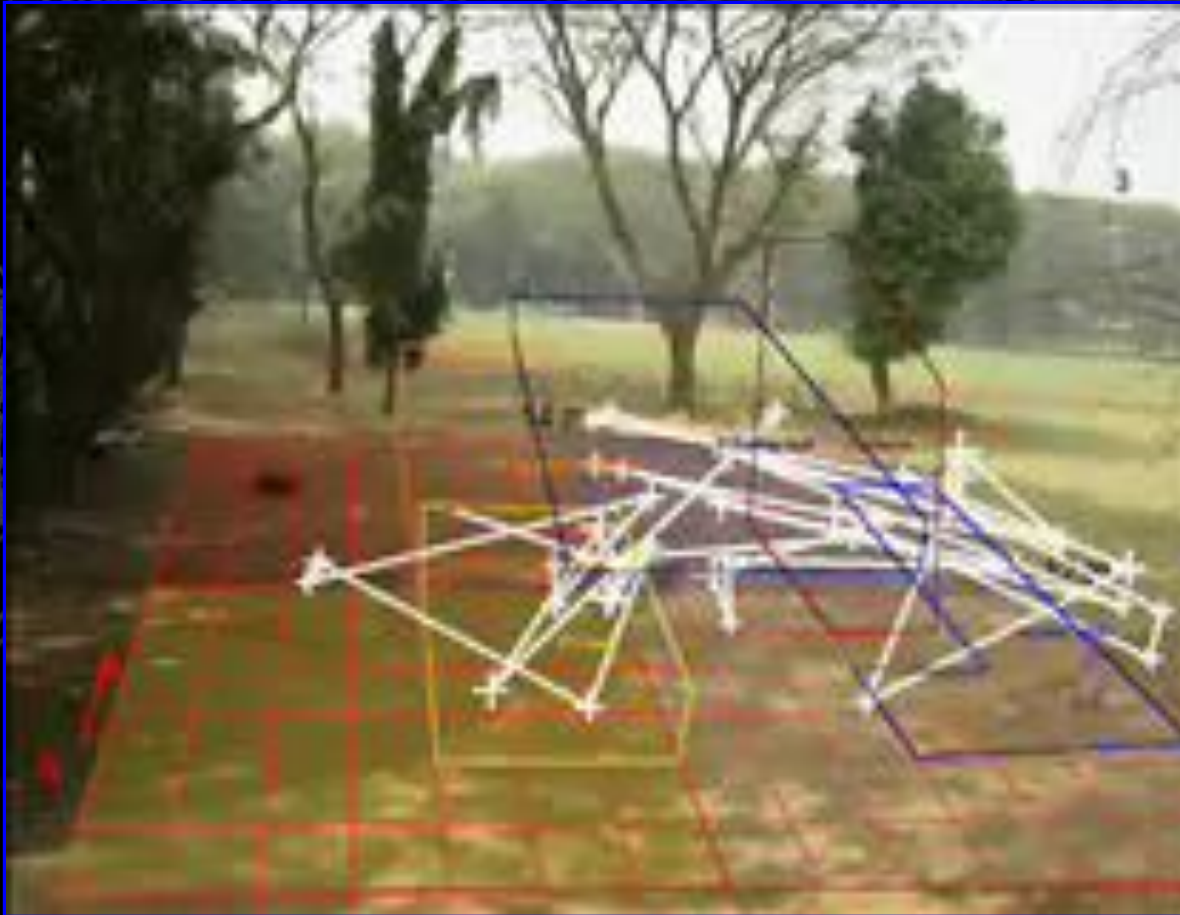
Whole long strip of Display area



Which has a covering with a floated slab

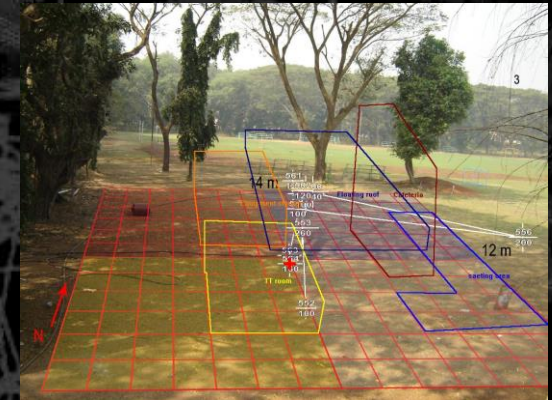
Analysis

2. Voice protocol study.

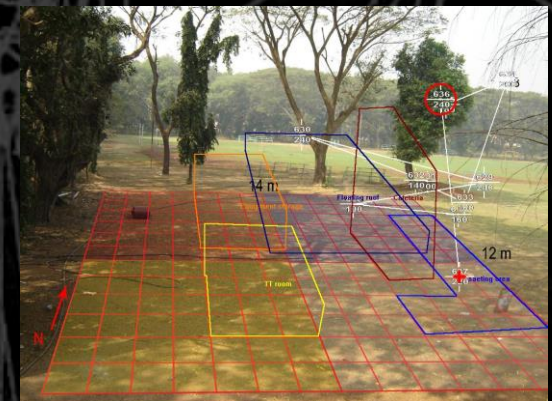


RT 5:50

... the height is about 3 mtrs .. When u move into the display area the step goes about... 5mtrs..... The whole concrete block which is really tall



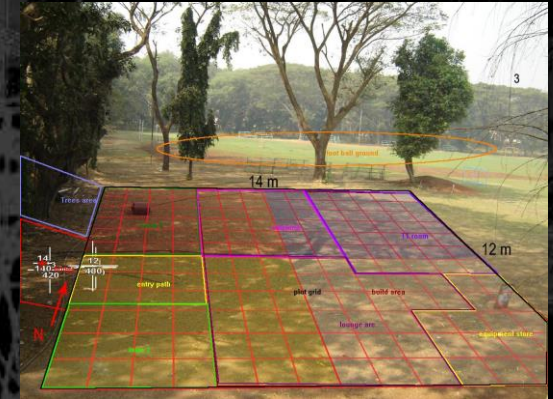
... the height is about 3 mtrs



... the concrete block which is really tall

Analysis

2. Voice protocol study.



... entry will be via the bridge



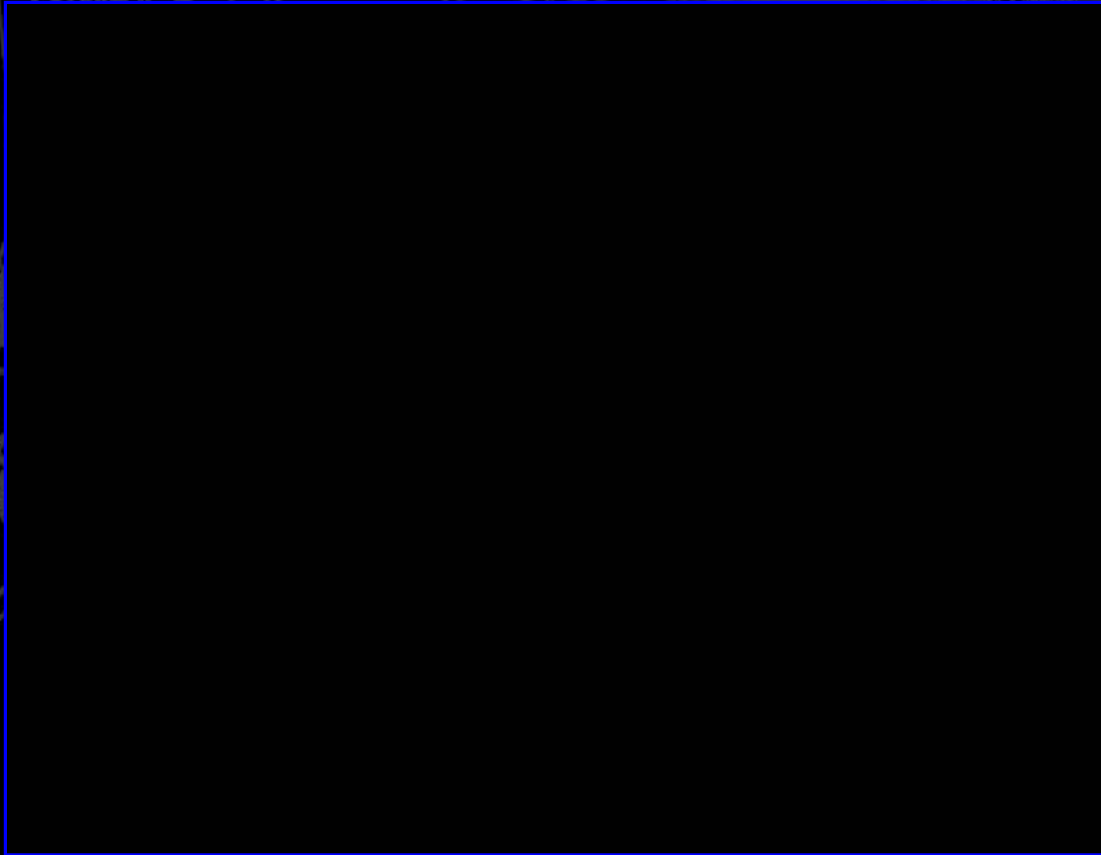
.... Open seating for students

RT 8:55

... entry will be via the bridge which will be good landscape feature Open seating for students Entry for sports complex will be in centre of lawn area...

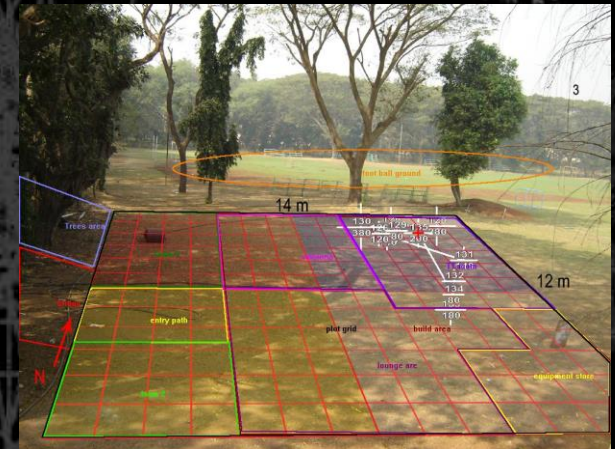
Analysis

2. Voice protocol study.

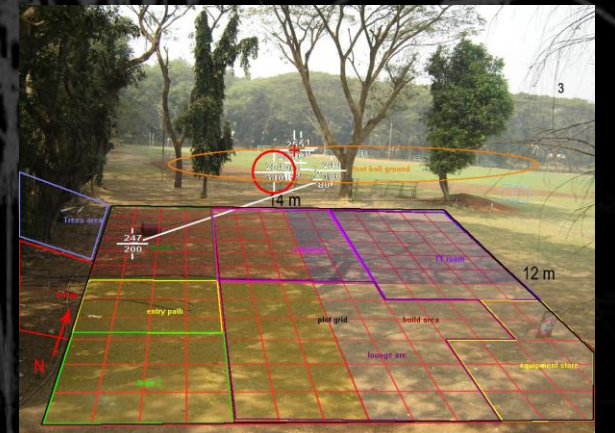


RT 9:25 and 9:58

... right corner ther will be ... Table tennis room Cafeteria will have a good view of the front landscape and backside.... i.e the open area.... Open play ground



right corner ther will be ... Table tennis room

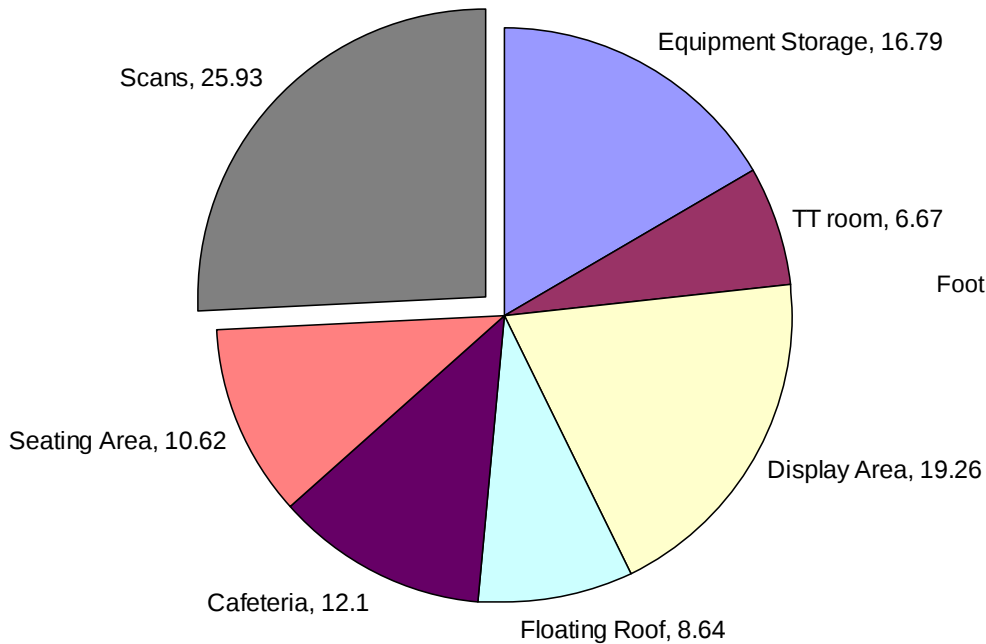


Cafeteria will have a good view

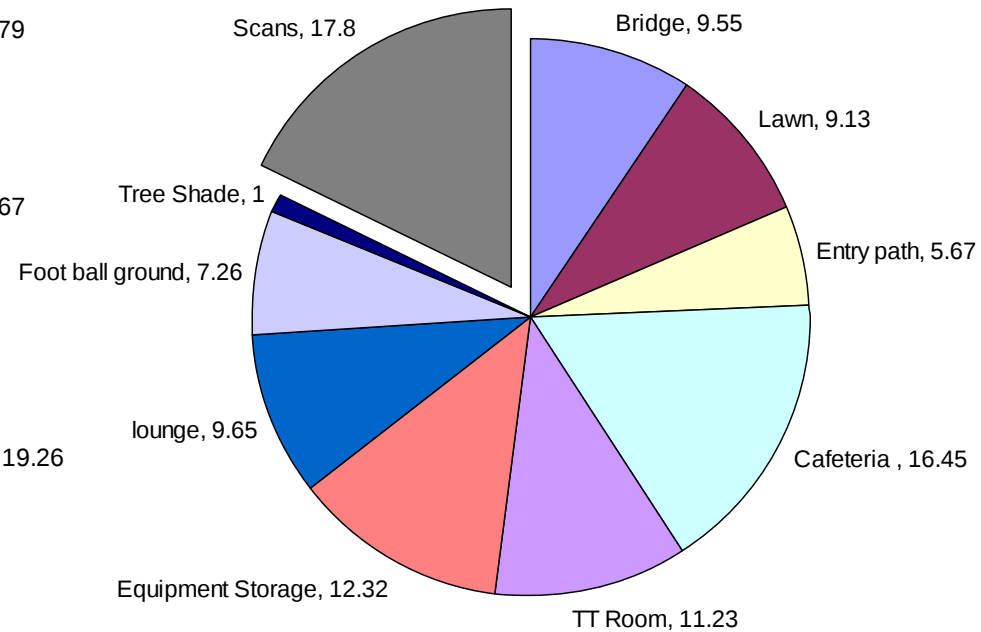
Analysis

3. Percentage of fixation in the intended areas.

% Fixation for MV

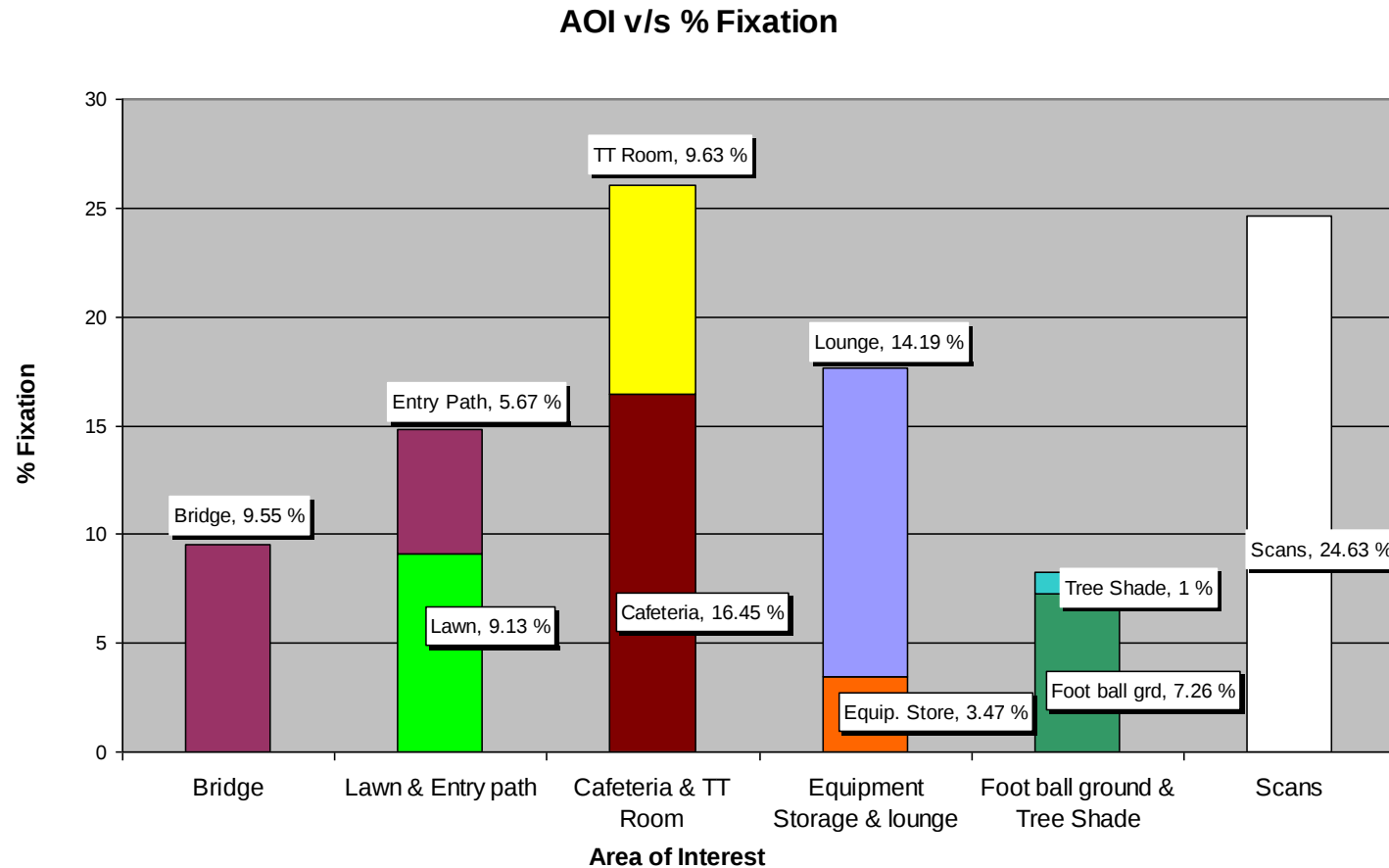


% Fixation for SD



Analysis

3. Percentage of fixation in the intended areas.



Inferences

Eye movements do follow the mental image in a person mind, but the effect is not so strong as to create a virtual shape on screen. This is due to the saccadic movement of the eye.

When following a direction the eye movements happen in that particular direction.

Also when a person is perceiving an image in his mind the eye move on other areas where the mental attention directs them for the purpose of scanning