Developing Early Design Simulation Tools For Persons with Vision Impairments

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A Prototypical Spatial Representation Tool For Central and Peripheral Field of Vision

Application in Early Architectural Design Stage

Vidya Gowda
Current architectural design procedures fail to address spatial perception issues for senior adults with visual impairments. Thus, the study qualitatively analyzes a prototypical age-related low vision spatial representation tool that can inform decision making during the early design phase.

The two vision impairments that would be studied as a prototype are also considered as the most prevalent vision impairments affecting the senior adults:

1. **Age-related Macular Degeneration (Loss of Central Field of Vision)**
2. **Glaucoma (Loss of Peripheral field of Vision)**
Existing & Proposed Design Process

1. **Conceptual Design**
   - Produce major design changes
   - NO Client approves Design
     - YES Design Development / Standards and Codes
     - NO Meets minimum requirements
       - YES Construction / Documentation / Build generic mock up
       - NO Meets User accessibility Criteria
         - YES Occupancy / Evaluation
         - NO Meets User accessibility Criteria
           - YES Maintain
           - NO Repair
             - Make minor modification
               - NO Produce major design changes

2. **Maintain**
   - Existing & Proposed Design Process
Process of using early stage Graphic user interface for the Design Process

DIVA for Rhino: Visualization

Matlab masking prototype

Fisheye view

Create Script
Reimagine space: What cannot be seen due to vision loss

1. Select region
2. Apply filter
3. Apply original pixels
4. Reimagine

Loss of **Central Field of Vision (LC FOV)**

Loss of **Peripheral Field of Vision (LP FOV)**
Design Domain

- Rhino
- Grasshopper/Galapagos
- Radiance
- DIVA

GUI
- age-related low vision spatial representation tool

Matlab
- Multiple Bac Simulation
- Convert multiple frames into animation walkthrough

Dynamic central/peripheral vision loss

Contrast/Blur algorithm

*. 3ds
*. rad
*. jpg
*. hdr
*. jpg
video

Designer
Designing Features for the GUI

- User Defined Image Selection
- Slider bar tools control types and severity of vision impairment

Progression of Age-Related Macular Degeneration
(Restricted Central vision)

- Normal
- Early Stage
- Intermediate
- Advanced

Amsler grid

Progression of Glaucoma
(Restricted Peripheral vision)

- Normal
- Intermediate
- Advanced

- Slider bar to control the luminous contrast and the blur condition

- Dynamic space changes (i.e. movement, and diurnal and seasonal changes in space) further impact spatial perception for the senior adults with low vision
A Prototypical Spatial Representation Tool For Visual Comfort Evaluation in Transitional Spaces

Application in Early Architectural Design Stage

Dalia Hafiz
Daylighting glare

- Daylight plays a major role in the space making.
- Daylight is dynamic, it constantly changes creating glare and uniform light points in different time and days of the year.
- Most glare analysis tools are not applicable during the early stages of the design process.
Visual Comfort in The Design Process

1. Interview and discussion
   - Architect
   - Client

2. Information Gathering
   - Architect
   - Client ideas
   - Main philosophy

3. Schematic design & Feasibility
   - Main design concepts outlines
   - Building functions and spaces relationships and circulation.
   - Basic model study
   - Code analysis
   - Envelope shape and massing study
   - Visual Comfort Study

4. Design Development
   - Final design decisions
   - Materials specifications
   - Transformation of sketches & Diagrams to architecture drawings
   - Openings are defined
   - Furniture Layout

5. Bidding and negotiation
   - Contractors bids
   - Interviews
   - Contractor selection

6. Construction and occupation
   - Final Construction documents
   - Review invoices and schedule
   - Review design Vs construction
   - Developed permit documents
   - Refined details drawings
   - Contractor bid
   - Final construction documents
   - Building construction
   - Building occupancy

Visual Comfort Study

Date: 1/15/2014
Virginia Polytechnic Institute and State University
Prototype Application

The prototype aims to address:
- Factors influencing visual comfort.
- Better understanding of the visual conditions in the space.
- Better imagination of the space in terms of possible glare areas and times and ways to avoid them.

In order to achieve these goals a case study was examined from a visual comfort and daylight conditions perspective.

Prototype Main Goal

- Suggest possible changes and solution for better daylighting conditions
- Examine the qualitative dimension of the lighting conditions
- Evaluate visual comfort
- Considers time and space dynamics in daylit spaces
Visual adaptation

Vision can adapt to a wide range of lighting conditions. However, it takes time to adapt to the lighting changes in a space without causing discomfort to the visual system.

Thus, design of transitional spaces is essential as one experiences wider range of changes in lighting conditions while travelling from one point in space to the other.
Daylighting analysis tools

Main reason for not including daylighting analysis!

Profession

- Architect
- Engineer
- Student
- Researcher
- Other:

Type of Projects you work on

- Residential
- Educational
- Offices
- Museums
- Hospitals
- Other

Do you consider daylighting aspects during design?

No

Yes

Do you consider computer simulation software for daylighting analysis?

No

Yes

Go to Stage2

Why?

- Tools need daylighting experts
- Tools are hard to learn
- Daylight analysis is not required

Preferred Daylighting simulations outputs

- Yes
- No

When does daylighting analysis take place in the design process?

- Sketching stage
- Schematic design stage

What is the software used the most for the schematic design?

- CAD
- Rhino

Which buildings do you believe need daylighting study the most?

- Residential
- Offices

- Sketching stage
- Schematic design stage
A Case Study

Visual Comfort Evaluation in Transitional Spaces for Persons with Age-related Vision Impairments

Application in Cowgill Hall lobby - School of Architecture and Design - VT

Vidya Gowda Dalia Hafiz
Visual adaptation

Senior adults with vision impairments experience longer visual adaptation time under changing lighting conditions while using transitional spaces and this is one of the leading cause of visual discomfort.

The application of the two prototypes were studied for a case study of a transitional space.

- The prototypes help in reimagining spaces with changes in lighting condition and the vision impairments in seniors adults.
- The investigators study the usefulness of the prototypes during design decision making on the impact of visual adaptation.
Case Study

Cowgill Hall lobby

- The lobby serves as the school’s main exhibition space.
- The lobby is naturally and artificially lit.
- Discomfort conditions occur while entering and exiting the building.
- This case study was examined for its function and daylighting conditions.
Case Study

• Simulation points were placed every 3ft (based on pedestrian speed).

• Points were placed at 5.6 ft (eye level).

• Points were placed along the entrance/exit lobby path.
Case Study
Simulation approximating space transition for a person with age-related vision impairments
Thank you!

Questions
Case Study

Quantitative outputs

Simulations glare indexes outputs

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