Optimization of Facility Layout Design via Feedback Loop Between Physical and Psychophysical Criteria Using Virtual Reality

Senior Design II (Spring 2021)  
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Project Objectives

- Develop initial layout design considering only known physical factors based on blueprints
- Develop VR models for facility layout design
- Collect data using eye-tracking software
- Analyze the data using analytics techniques such as AHP-based data normalization and P-value lowest performer comparison
- Optimize the layout based on identified psychophysical factors and trends
- Continue optimizing until an optimal response is reached and the model cannot be optimized further
- Present the best obtained model to the faculty

Project Process

- Iterative optimization process
- An iteration consists of three phases
  - Design
  - Testing
  - Data analysis
- Application setup and VR preparation includes
  - Importing packages into Unity
  - Human models implementation
  - Adding NPCs
  - Create a 6ft radius around objects
  - Adding user position tracking

Tools Used for Analysis

- iMotions software was used to track the user's eye movements within the model
  - Areas of Interest Analysis was used to track the users' time of first fixation for task locations
  - Gaze mapping and screen recordings were used to observe eye motions in the environment
- Scripts were written in Unity to obtain measurements of human behavior in the model
  - Code written to track how long a user stayed within a 6ft. radius of others in restaurant
  - Code written to track the total distance the user traveled in their simulation

Data Analysis

- Raw data
  - Creates normal distribution of participants
  - P-values
    - Identifies and compares worst performers
  - AHP Scoring
    - Gives overall score to each model based on normalized project measurements

Testing

- 24 total UNCC students participated in testing
- Users were properly trained before beginning
- Participants performed tasks that resembled a customer in a restaurant
- iMotions and automated scripts were used to collect psychophysical data from the participants in the restaurant model
- Completed 3 total iterations of the loop (Design, Testing, and Data Analysis)

Conclusions

- Virtual environment can enable virtually unlimited types of simulations; this can save a tremendous amount of capital especially for businesses
- Virtual environment can also help in testing a prototype before it is deployed in the field and thus avoid any costly mistakes that might have been overlooked
- The next several years will be crucial in adopting this technology; businesses that overlook it might not have a competitive edge in the future