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04/13/2020
LAEP 6900

MODELING FOR SPATIAL MEMORY

Designing Controlled Virtual Environments for Psychological Testing

ABSTRACT

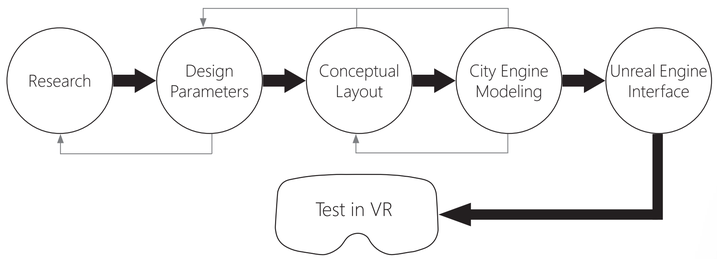
The purpose of this research is to help establish a framework of knowledge around people's "spatial gist" (spatial understanding) capacities that can inform the creation and implementation of spatial memory aptitude tests. This research overlaps the fields of psychology, computer science, and urban design. The aim of this project is to create a 9-block, 3D-modeled cityscape that can be used as a tool in future research projects. This iteration of the design will be based on psychological principles of wayfinding which include the use of districts, edges, paths, nodes, and landmarks as prescribed by Kevin Lynch in the book Image of the City. The model will be created using software applications like City Engine (ESRI), Rhinoceros 3D, and Unreal Engine. Then, the cityscape model will be imported into a virtual reality platform where people can wear VR headsets and interact with the environment at a human scale. This model will be offered as a prototype that can be used by future researchers for human subject testing of wayfinding capabilities.

BACKGROUND

Objective: Design an environment with controlled parameters that can be used as a model for psychological testing of spatial memory. The goal of this project is to create an interactive 3D model of 9 blocks in an urban environment that could be adjusted parametrically based upon different theories and principles of urban design to help researchers test spatial awareness. Human subject research is not a part of this project but is intended to be implemented by future researchers using the model.

METHODS

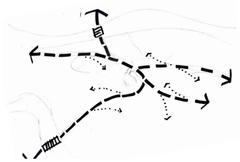
After a study of the Lynchian theories of wayfinding to inform design decisions, the model was created by defining the design parameters, creating conceptual layouts, and computer modeling in two software platforms: City Engine and Unreal Engine. The workflow of the project had a linear framework, but the actual process of design and modeling took a more recursive path (as shown in the diagram below). Many revisions were necessary to produce a refined product. After several iterations, the final model was created in City Engine, then imported into the gaming platform Unreal Engine for interactivity with Virtual Reality.

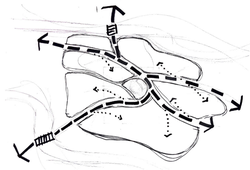


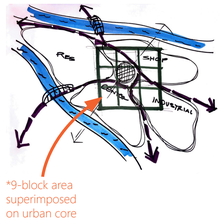
Design Parameters: Application of Lynchian Theories

District Identification	Residential District	Business District	City Center District
ID 1: (Path/Nodes)	ROAD	ROAD	ROAD
	1 Lane	2-lane w/ parallel parking	2 Lane
	No extra Lanes	Bus Lanes	Bus Lanes
	Street Trees in Median	Street Trees in Median	Street Trees, Lights, and Bus Stops
	Road Width = 10	Road Width = 30m	Road Width = 26m
	Sidewalk Width = 3	Sidewalk Width = 3m	Sidewalk Width = 5m (Trees Included)
	Crosswalk Paint	Crosswalk Paint	Crosswalk Pavers with Paint
ID 2: (Edges)	BUILDING	BUILDING	BUILDING
	Non-continuous (Green Space)	Continuous Façade	Continuous Façade with Plaza (Mixed Use)
	Height: 2-6 Stories	Height: 1-3 Stories	Height: 7+ Stories
ID 3: (Landmarks)	LANDMARK	LANDMARK	LANDMARK
	Gated Community Rock Signage	Hanging Signs	Plaza

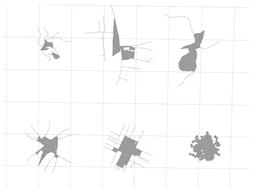
Conceptual Layout







City Engine Modeling



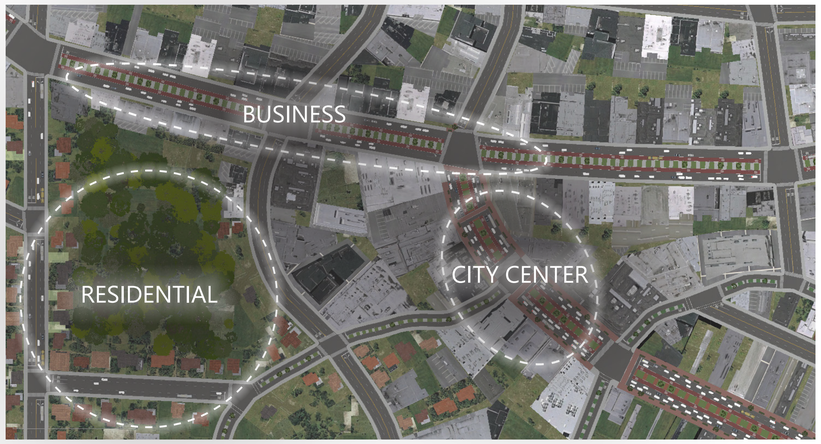
RESULTS + NEXT STEPS

The result of this process was a crude parametric model designed incorporating the Kevin Lynch Theories. Some workflow and modeling difficulties were discovered and addressed/noted to be improved in future iterations of the project.

A few next steps in preparing the model for user interface with research testing include:

1. *The landmarks listed in the design parameters should be modeled and placed strategically in the city.*
2. *Greater attention to detail should be completed to increase realism at the user interface level.*
3. *Movement systems like traffic and transit should be in motion rather than stationary. I suggest using the program Twinmotion for increased realism in modeling and movement systems.*

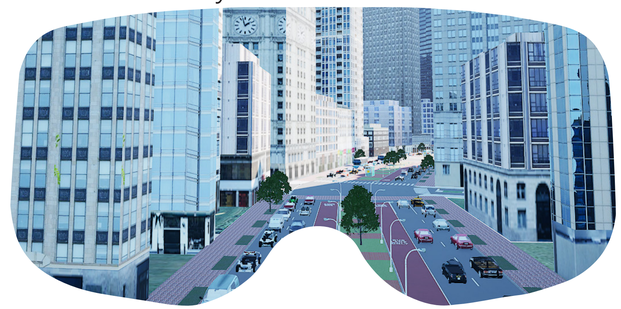
City Model Plan



Residential District

Business District

City Center District



DISCUSSION + CONCLUSIONS

Creating an entire city from scratch in a blank world presented some unique challenges and new perspectives. The main difficulty encountered was designing the constraints. Some examples of constraints were: the typology of the city, the various traffic and circulation systems connecting districts, the layout of city elements, the visual qualities of each district, the identifying landmarks, and the paths, edges, and nodes a user would encounter in the model. Parametric modeling helped speed the process of visualizing those things, but accuracy in detailed elements at the user scale decreased as a result. For the model to be ready for participants, more time will have to be spent refining the model at a user scale.

The future of this project is broad. After the model is refined and tested, the same general layout of elements used in this model could be replicated in a different environment, and spatial understanding similarities could be tested between the models. Overall, it will serve as a foundation piece in modeling for spatial memory.