3D Geospatial Modeling and Visualization Trends

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Contents

Definitions

3D geospatial techniques (modeling, visualization, and simulation) are used to represent and analyze real-world geographic features and their attributes in three dimensions. The data used is geo-referenced.

- Modeling – the process of replicating real-world objects or creating designed objects

- Visualization – the process of extracting data from the model and representing them

- Simulation – refers to the dynamic sense of visualization
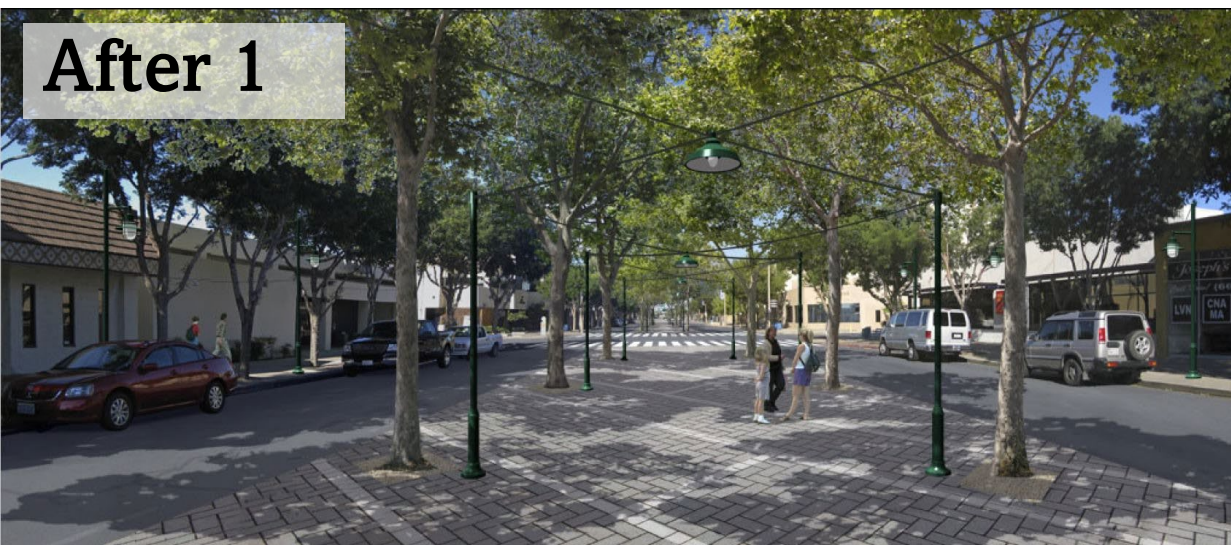
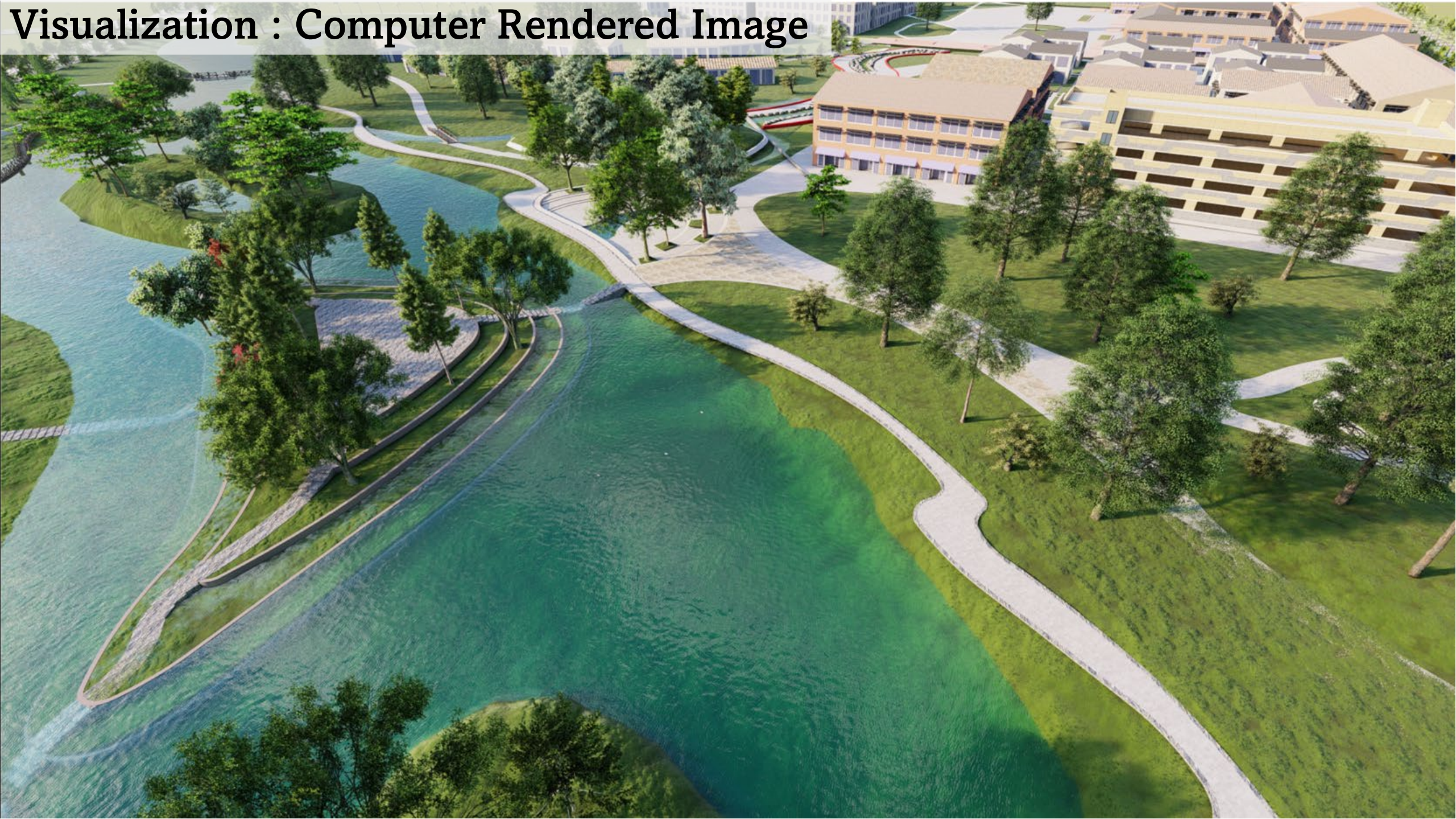Physical Model

Singapore Downtown physical model

Digital Model

Visualization: Photomontage

Before

After 2

After 1

After 3

Visualization : Computer Rendered Image

Visualization: Webscene (a 3D scene that is created for web-based applications)

Philadelphia Redevelopment

SHARE   HELP   SIGN IN   ARCGIS ONLINE

Layers

Environment
- Pictometry
- Visibility

Redevelopment
- Proposal
- As Built

Streets

Street Furniture

Trees

Ground
- Satellite
- Basemap
- Right to Light

Comments

Philadelphia Redevelopment

Ref: https://www.arcgis.com/apps/CEWebViewer/viewer.html?3dWebScene=86f88285788a4c53bd3d5dde6b315dfe

Visualization: 360-degree Panorama: an unbroken view of the whole region surrounding an observer

1 - Panorama

Landscape Components: Tree, Berm, Trail, Animal, Flower, Water feature, Seat area

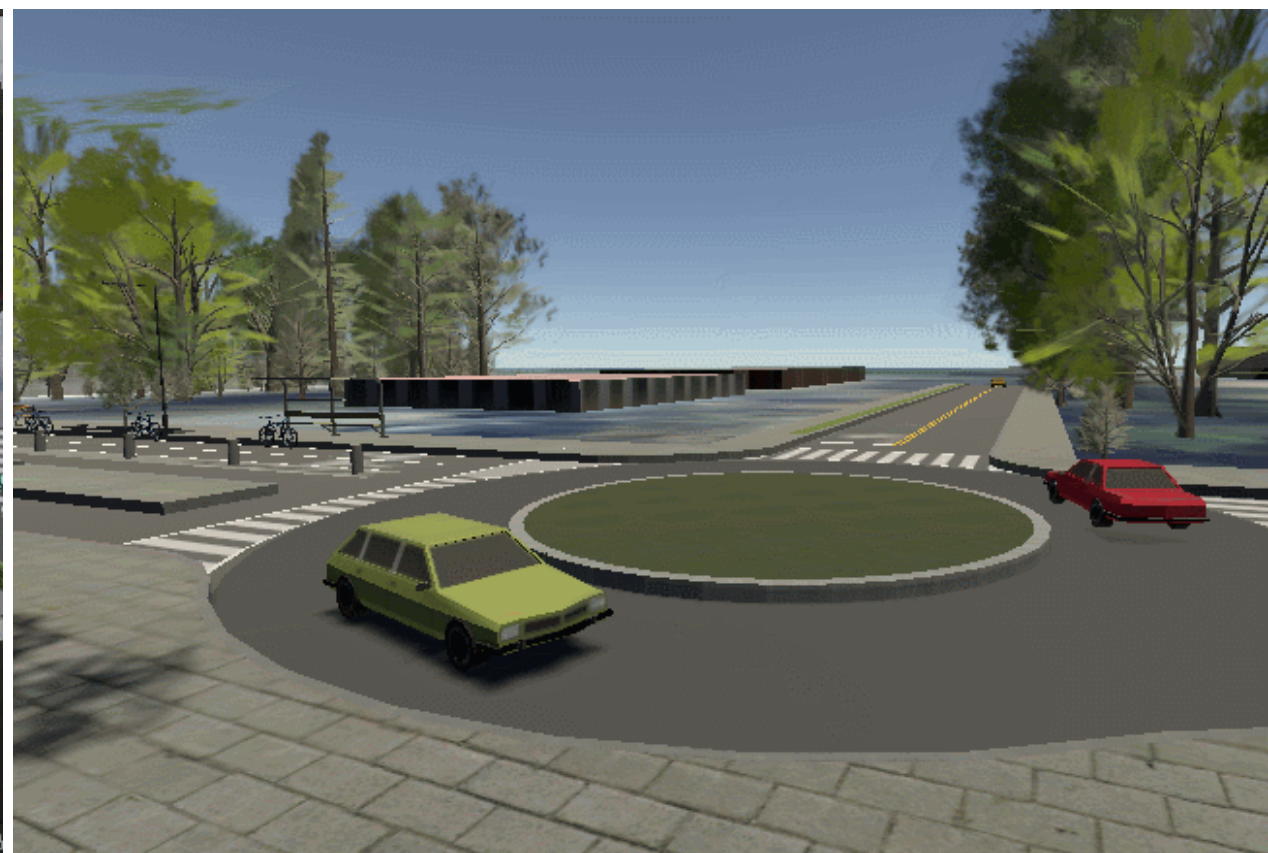Campus Landscape Rendering
UF research

Visualization: Virtual Reality

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Simulation: Transportation

Unity Traffic Simulation
UF research

Modeling & Visualization Development Directions

- Photo realistic rendering

- Real time visualization

- Web-based

- Convergence between different software (CAD, GIS, BIM, etc.)

- Rule-based modeling: Automation in constructing 3D models

- The need of large-scale urban simulation for urban planners

- XR Reality (Virtual Reality, Augmented Reality, Mixed Reality)

- AI – object recognition, image reognition, content creation, etc.

Evaluation Criteria for 3D Geospatial Modeling & Visualization

- **Accuracy**

The ability to represent the location of the model as closely as possible to its location in the real world.

- **Realism**

The degree to which simulation represents the details of the real world.

- **Representativeness**

The kinds of information that simulation is capable to provide and the level of interaction with the information provided

Advantages and Limitations of 3D geospatial techniques

- **Advantages**

  - Imitate closely real-life experience of built environments

  - Accurate representations

  - Ability to represent dynamic complex information

  - Help sharing and participation

- **Limitations**

  - High cost for high quality results

  - Technology limitations

  - Learning curve for advanced applications

Software Tools (examples)

- **Traditional Digital Modeling**

SketchUp 3DS Max Rhino

- **Rule-based Modeling**

CityEngine InfraWorks

- **Building Information Modeling**

Revit

- **Large Scale Geospatial Modeling**

ArcGIS Pro ArcGIS Urban CityEngine

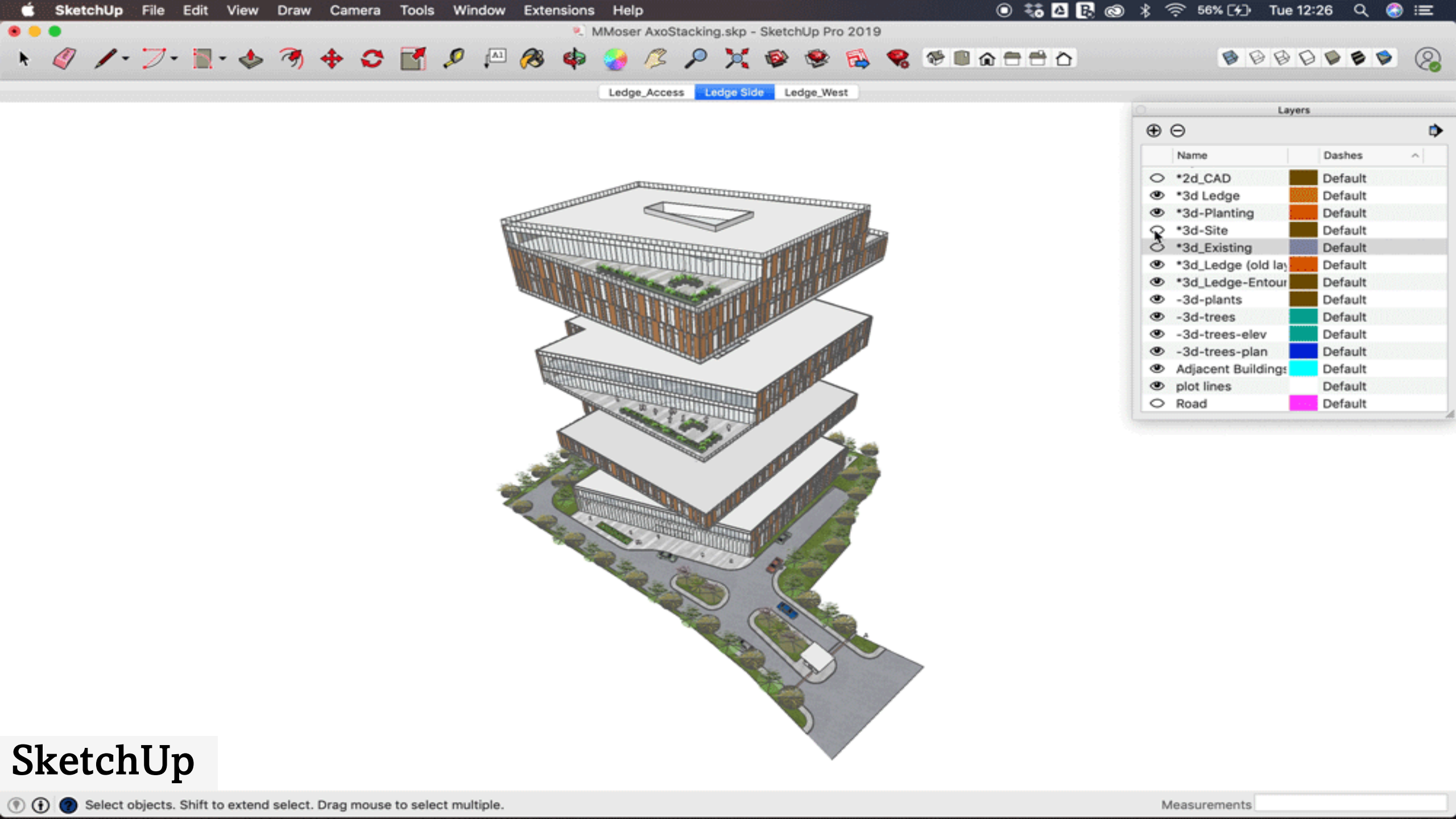- **Realistic Rendering**

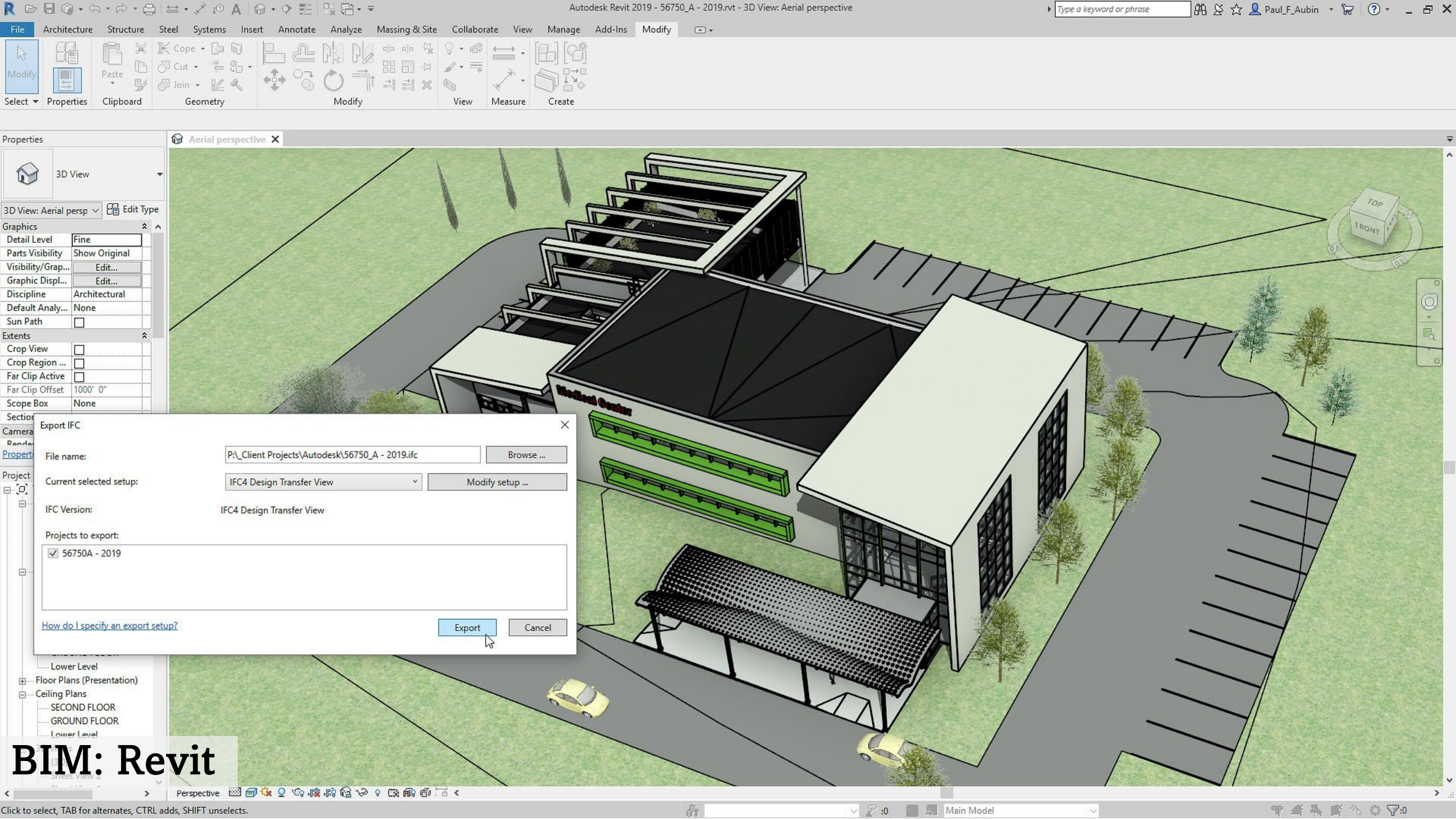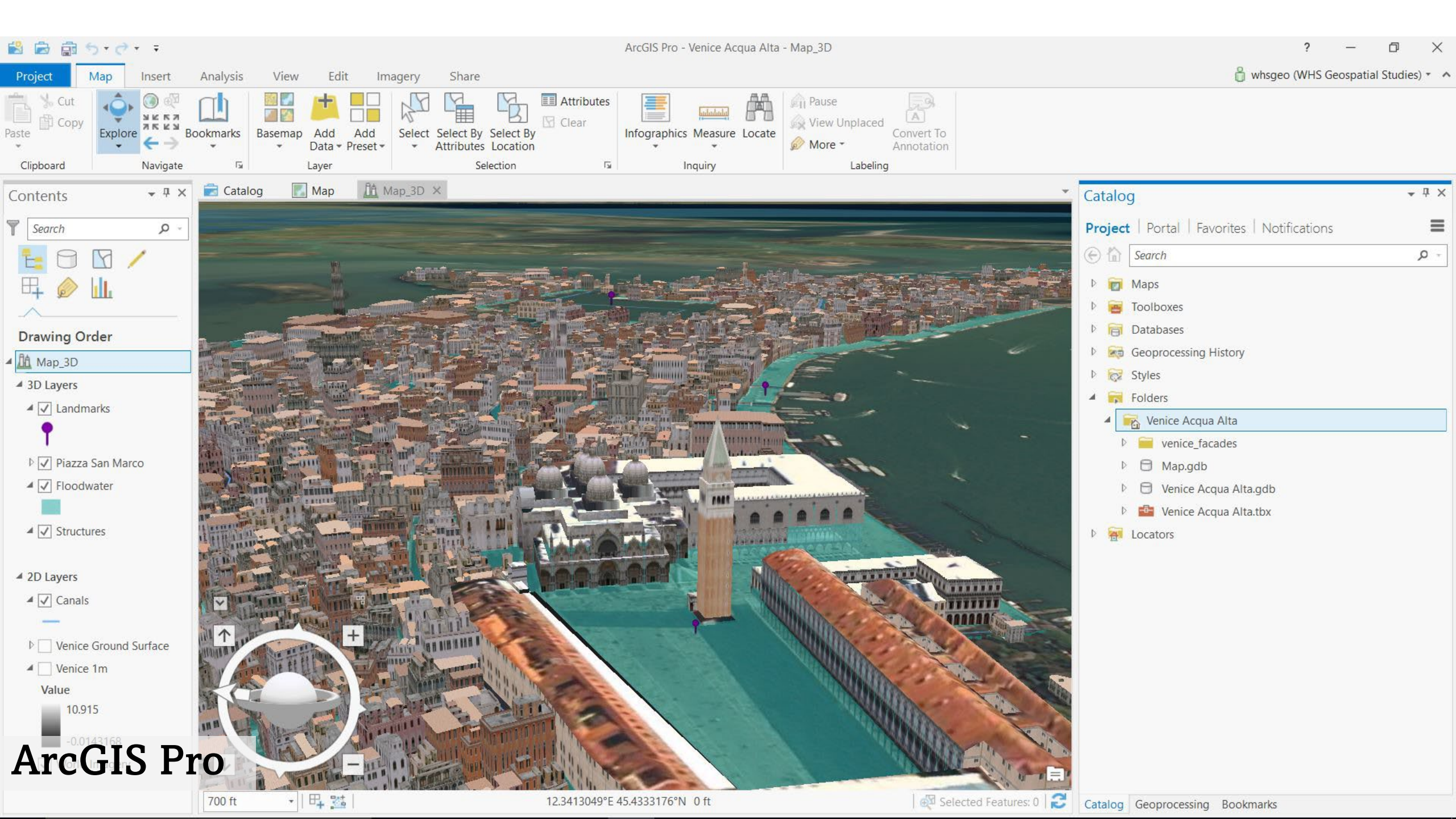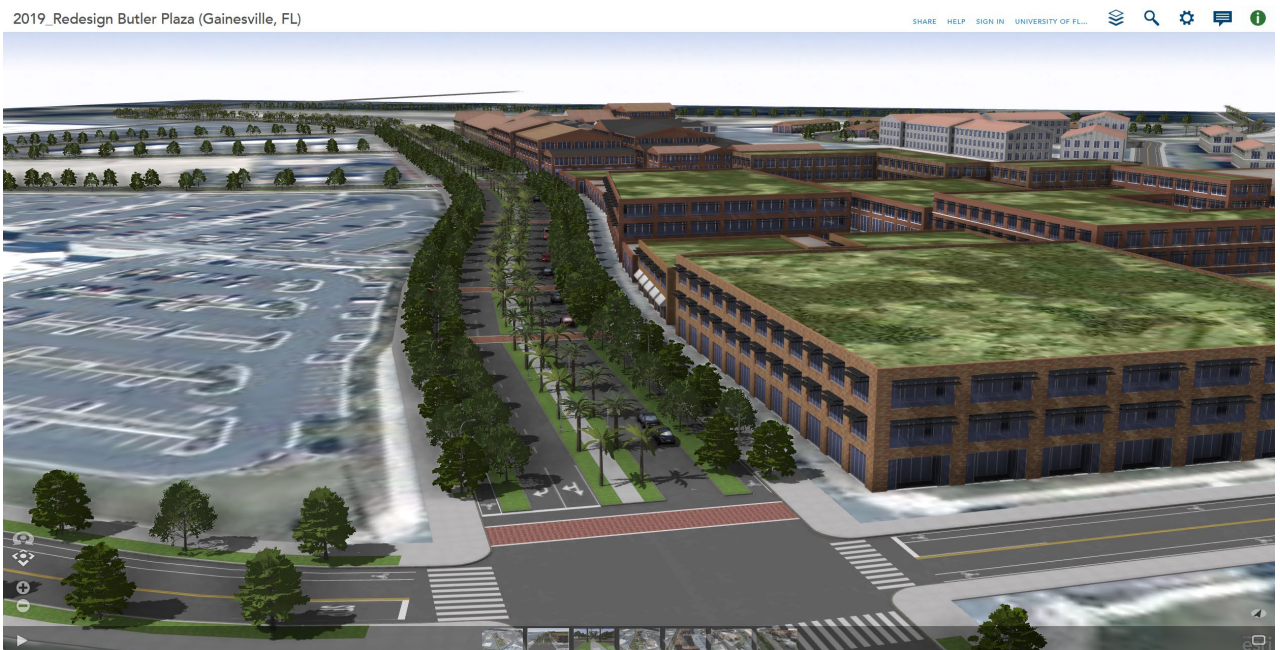Lumion V-ray Enscape

- **Immersive Experience**

Unreal Unity

BIM: Revit

Project   Map   Insert   Analysis   View   Edit   Imagery   Share

whsgeo (WHS Geospatial Studies)

Cut
Copy
Paste
Clipboard

Explore
Bookmarks
Navigate

Basemap   Add Data   Add Preset
Layer

Select   Select By Attributes   Select By Location
Attributes
Clear
Selection

Infographics   Measure   Locate
Inquiry

Pause
View Unplaced
More
Convert To Annotation
Labeling

Contents

Search

Drawing Order

- Map_3D
  - 3D Layers
    - Landmarks
    - Piazza San Marco
    - Floodwater
    - Structures
  - 2D Layers
    - Canals
    - Venice Ground Surface
    - Venice 1m
      - Value
        - 10.915
        - -0.0143168

ArcGIS Pro

Catalog   Map   Map_3D

Catalog

Project | Portal | Favorites | Notifications

Search

- Maps
- Toolboxes
- Databases
- Geoprocessing History
- Styles
- Folders
  - Venice Acqua Alta
    - venice_facades
    - Map.gdb
    - Venice Acqua Alta.gdb
    - Venice Acqua Alta.tbx
- Locators

700 ft

12.3413049°E 45.4333176°N   0 ft

Selected Features: 0

Catalog   Geoprocessing   Bookmarks

ArcGIS Urban

2017_UF water network

2018_Miami_sea level rising

2017_Lady's Island_SC_FBCs

2019_Redesign Butler Plaza (Gainesville, FL)
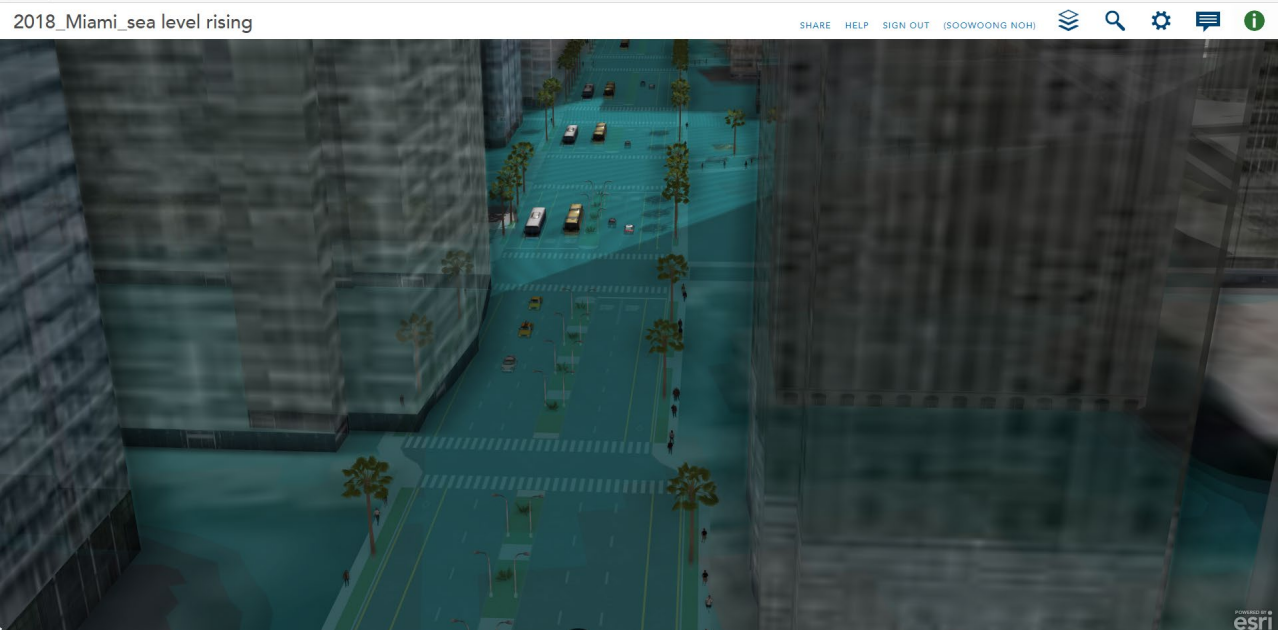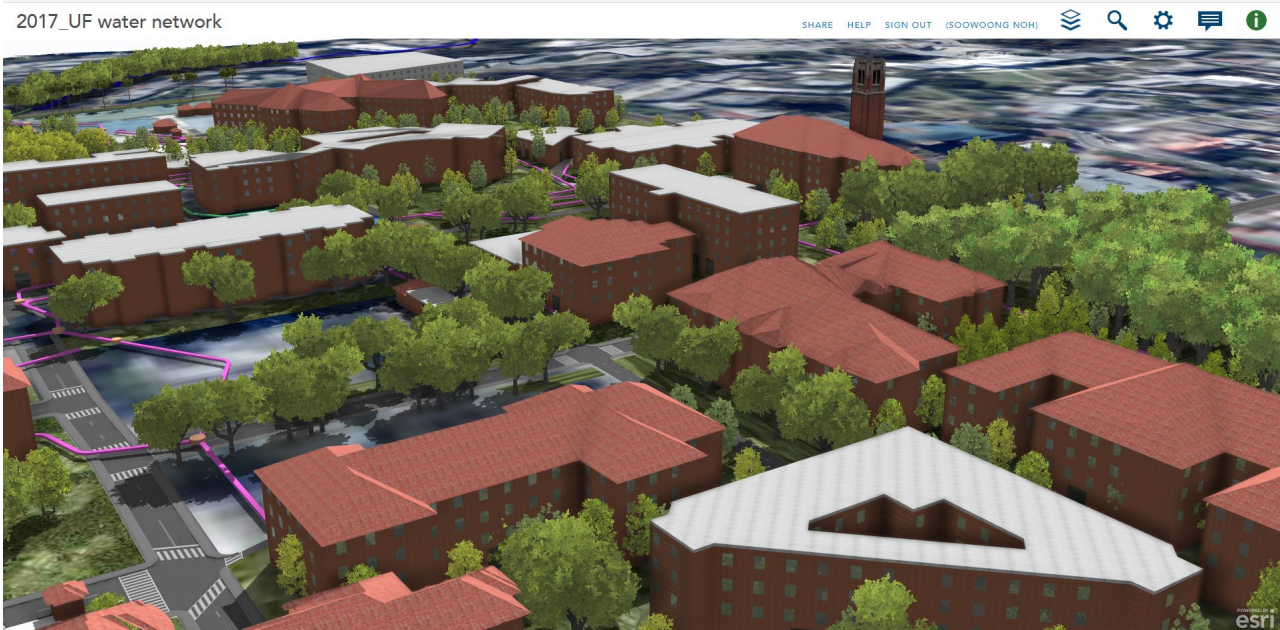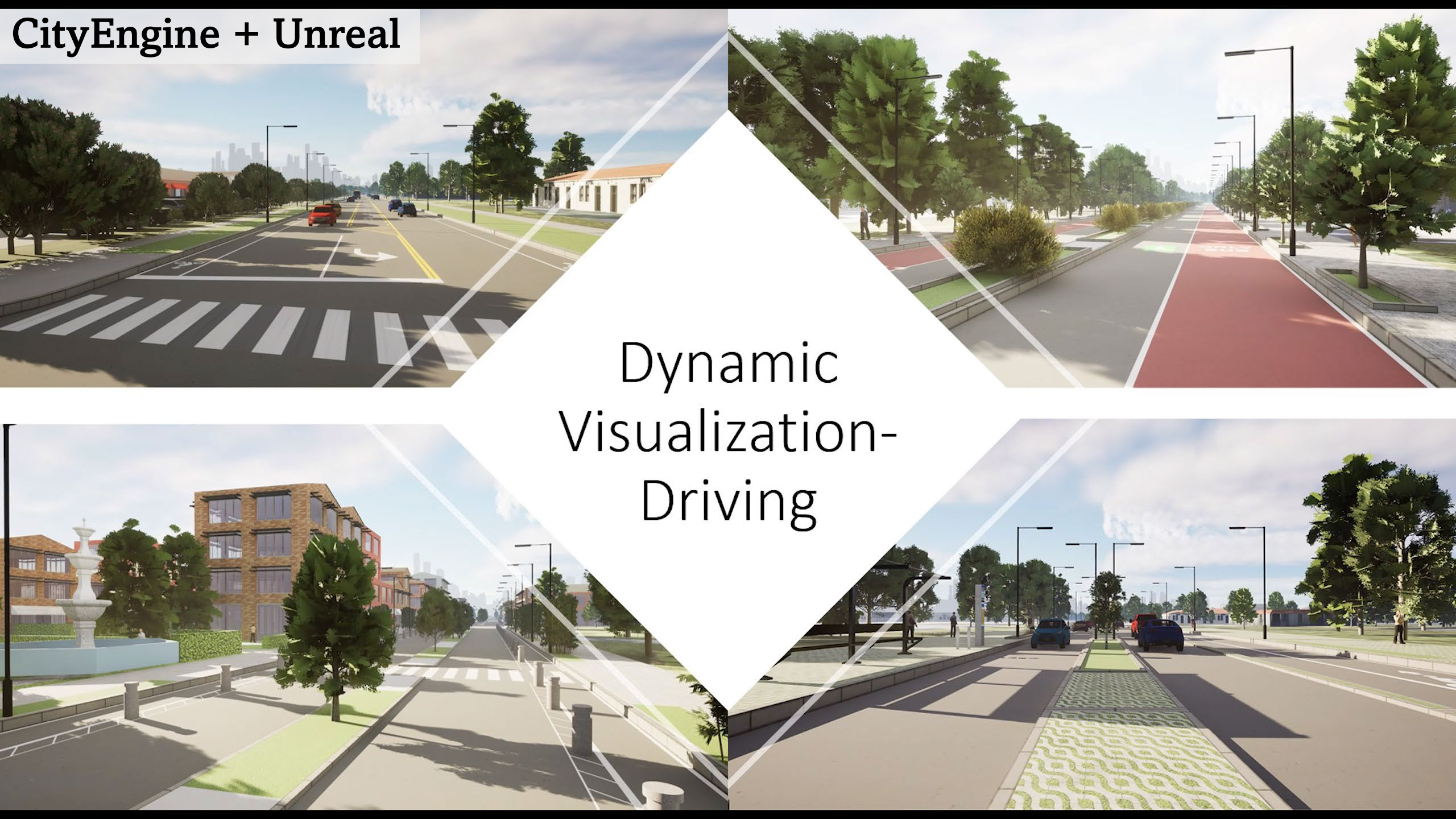
ArcGIS CityEngine

ArcGIS CityEngine

CityEngine + Lumion

CityEngine + Unreal

Dynamic Visualization-Driving
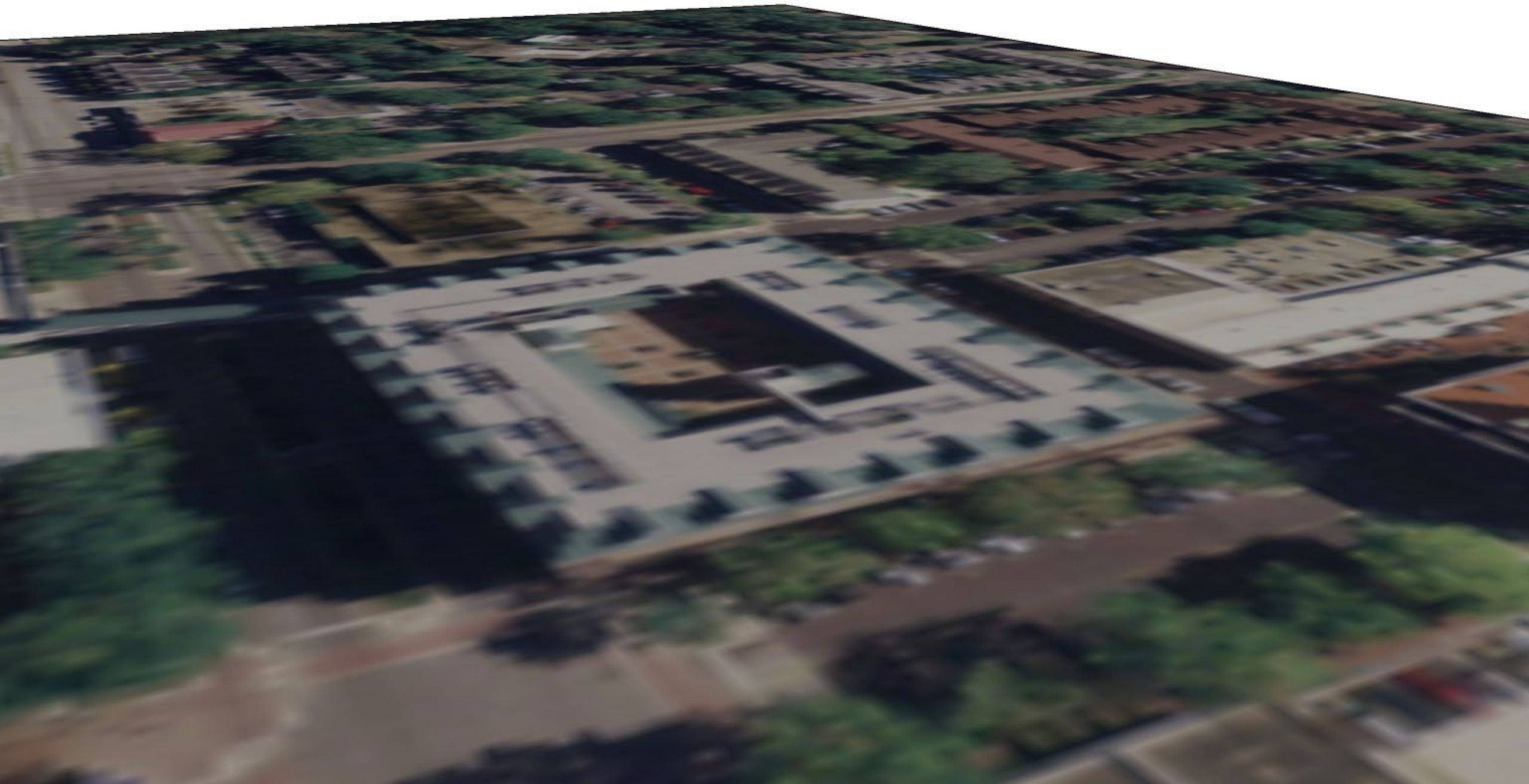
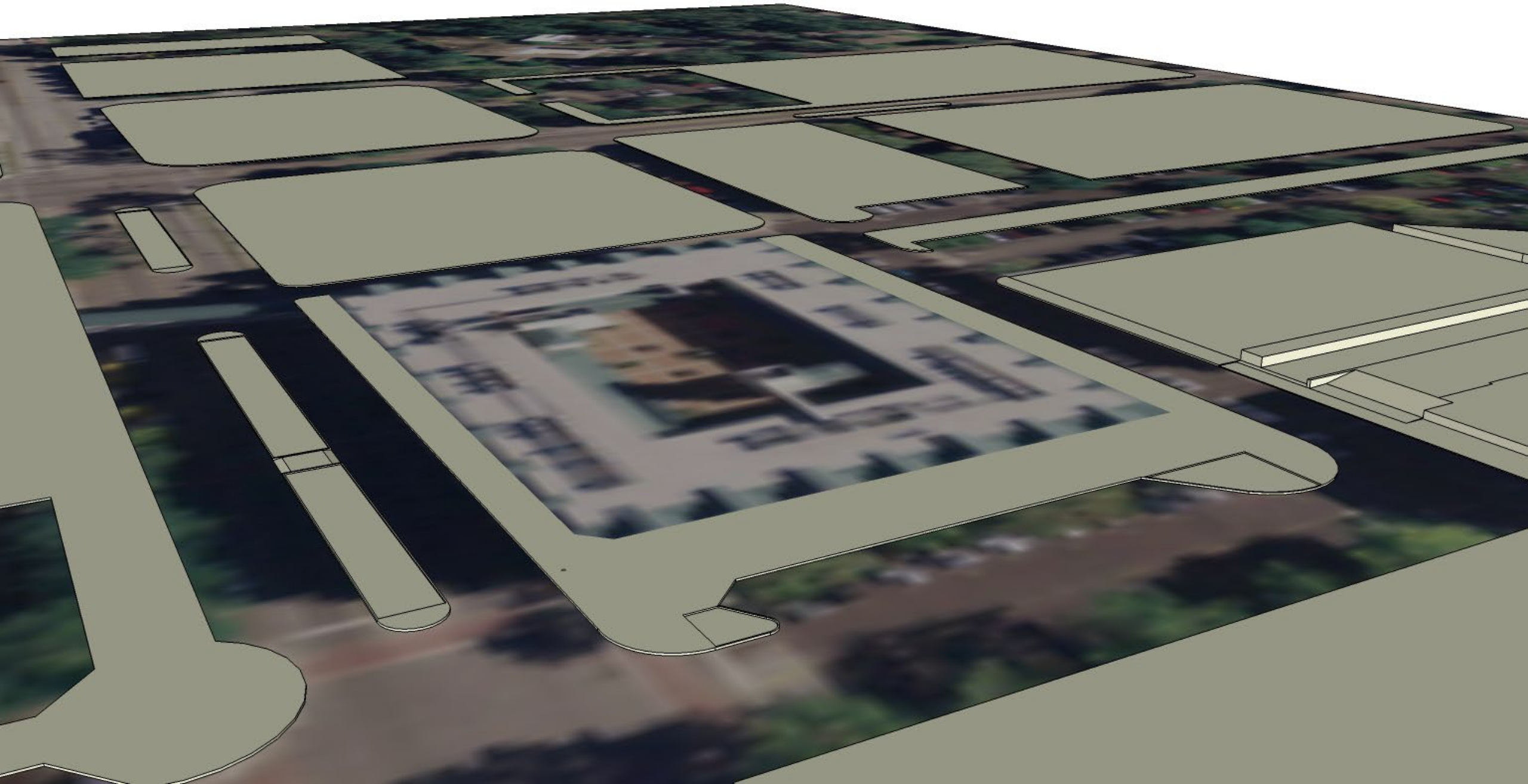CityEngine + Virtual Reality (VR)

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Modeling Process

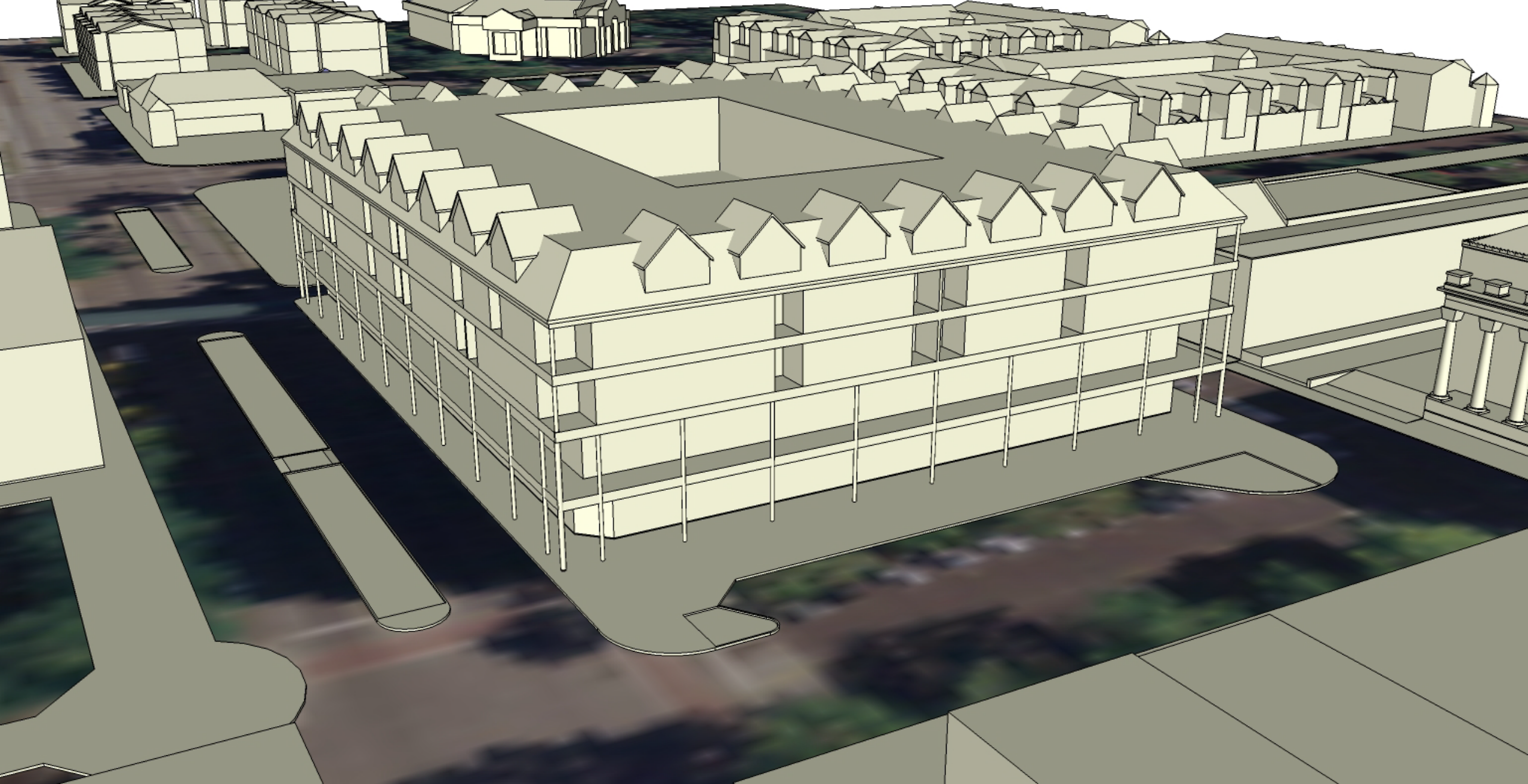Components of built environment organized as layers of the model:

- Blocks

- Streets

- Buildings

- Landscaping

- Street Furniture

Aerial image of the existing site

Define blocks of the study area

Buildings and Structures help to further define the urban environment by their form (design) and their function (use)

Landscaping provide both a functional purpose as well as an aesthetic characterization and quality.
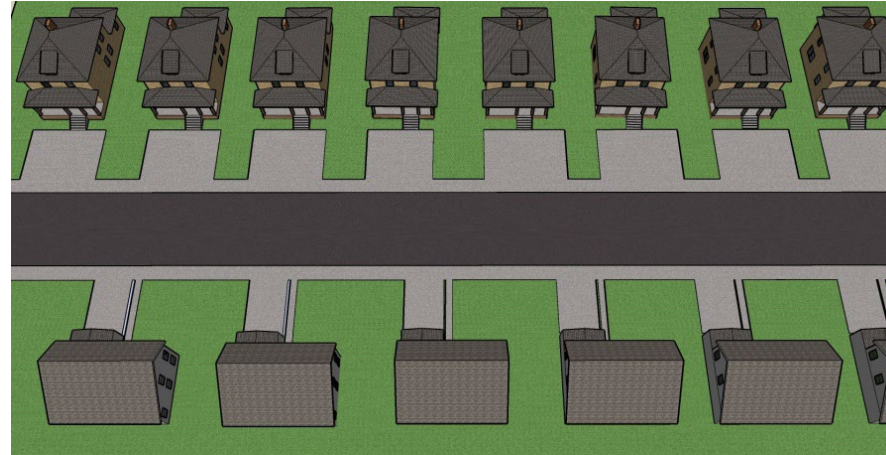
Street Furniture contributes to the identity, character, and functionality of urban spaces.

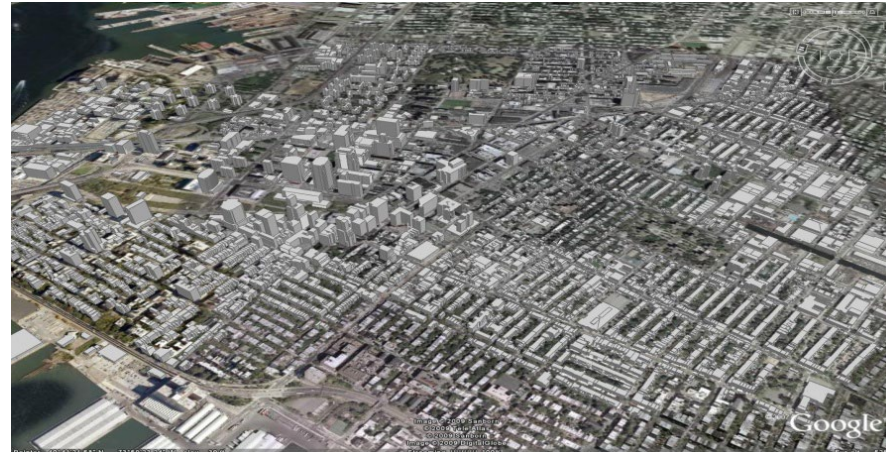# The Modeling Detail: Design scale

Street (most detail)

Neighborhood

Community

Region (least detail)

Select suitable detail levels: More detail when viewing models at smaller scales; less detail when viewing models at larger scales.

Managing the level of details helps to keep files sizes manageable and operating efficiently.

CityEngine vs. SketchUp

➢ Specifically designed for urban planning, suitable for large-scale urban models and cityscapes – can be detailed in certain ways and the software already includes many infrastructure texture/furniture packages

➢ Procedural / rule-based modeling: define the properties of a 3D projects relying on a set of rules and parameters

➢ Integrates geographic information systems (GIS) data and real-world data for city modeling. Has a strong integration with Esri's GIS software. Good for scenario-based analysis

➢ Can create and export 3D WebScenes and 360-degree panoramic images. The latter can be viewed in VR goggles.

Rule-based modeling


```
@Group("MULTIMODAL LANES LAYOUT", "Bike Lanes",5)
@Order(1)@Distance @Range(min=0,max=6)
attr Right_Bike_Lane_Width =1.8
@Order(2)@Distance @Range(min=0,max=6)
attr Left_Bike_Lane_Width =1.8                         [1]
@Order(3)@Enum("One-way","Two-way", ...)
attr Bike_Lane_Type ="One-way"
@Order(4)@Distance @Range(min=0,max=6)
attr Right_Buffer_Width = 1                            [2]
@Order(5)@Distance @Range(min=0,max=6)
attr Left_Buffer_Width = 1
@Order(6)@Enum("true","false")
attr Buffer_Protection = "true"
@Order(7)@Enum("true","false")
attr Parking_Protection = "true"
@Order(8)@Enum("Painted Stripes","Curb Buffer",...)
attr Buffer_Type = "Cycle Track with Buffer"
@Order(9)@Distance @Range(min=0,max=10)
attr Buffer_Object_Spacing = 4
@Order(10)@Distance @Range(min=1,max=304.8)
attr Bike_Symbol_Spacing = 24.5                        [3]
@Order(11)@Distance @Range(min=0,max=20)
attr Bike_Conflict_Spacing = 0
@Order(12)@Enum("green","black","red","blue","yellow")
attr Bike_Lane_Color = "green"
@Order(13)@Enum("Both","Right", "Left", "None")
attr Bike_Paint_Line_Sides ="Both"
@Order(14)@Enum("Rare","Moderate","Frequent")
attr Level_of_Blockage = "Rare"
```

Figure 1 (a). Rule script

Bike Lanes

Right_Bike_Lane_Width	**1.8 m**
Left_Bike_Lane_Width	**1.8 m**
Bike_Lane_Type	One-way
Right_Buffer_Width	**1 m**
Left_Buffer_Width	**1 m**
Buffer_Protection	true
Parking_Protection	true
Buffer_Type	**Cycle Track With Bollards**
Buffer_Object_Spacing	**4 m**
Bike_Symbol_Spacing	24.5 m
Bike_Conflict_Spacing	0 m
Bike_Lane_Color	**green**
Bike_Paint_Line_Sides	Both
Level_of_Blockage	Rare

Figure1 (b). Interface of Rule

Figure1 (c). Generated bike lane