Procedural and automation techniques for design and production of Sunset Overdrive

## David Santiago

Principal Technical Artist - Insomniac Games

PRESENTATION OVERVIEW
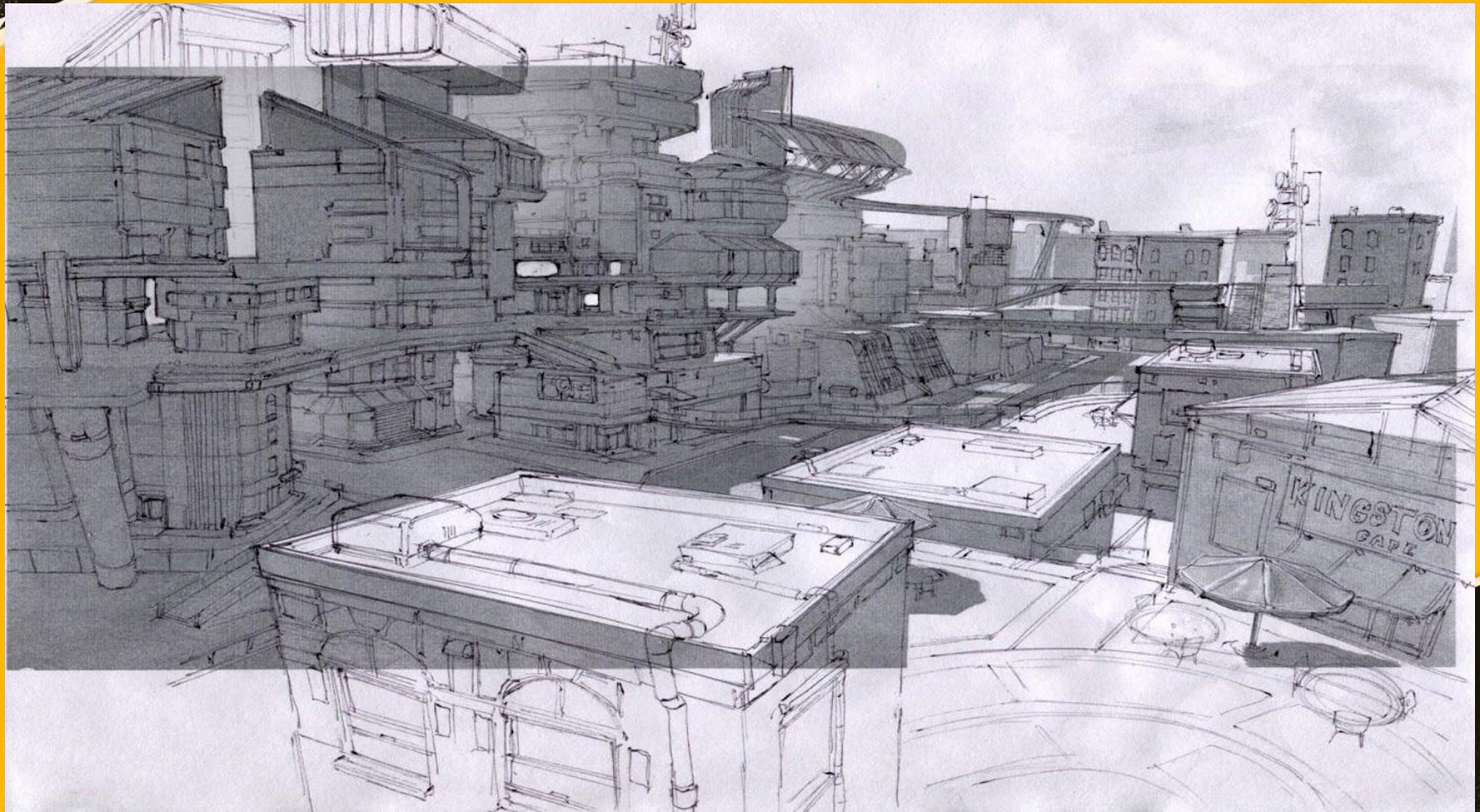
- Introduction to complex environment challenges of Sunset City

- Initial traditional type solution used for pre- production

- Procedural and automated system designs and methods

- Practical Production decisions

- Efficiency of procedural systems used in production

- Q/A

CONCEPT ART
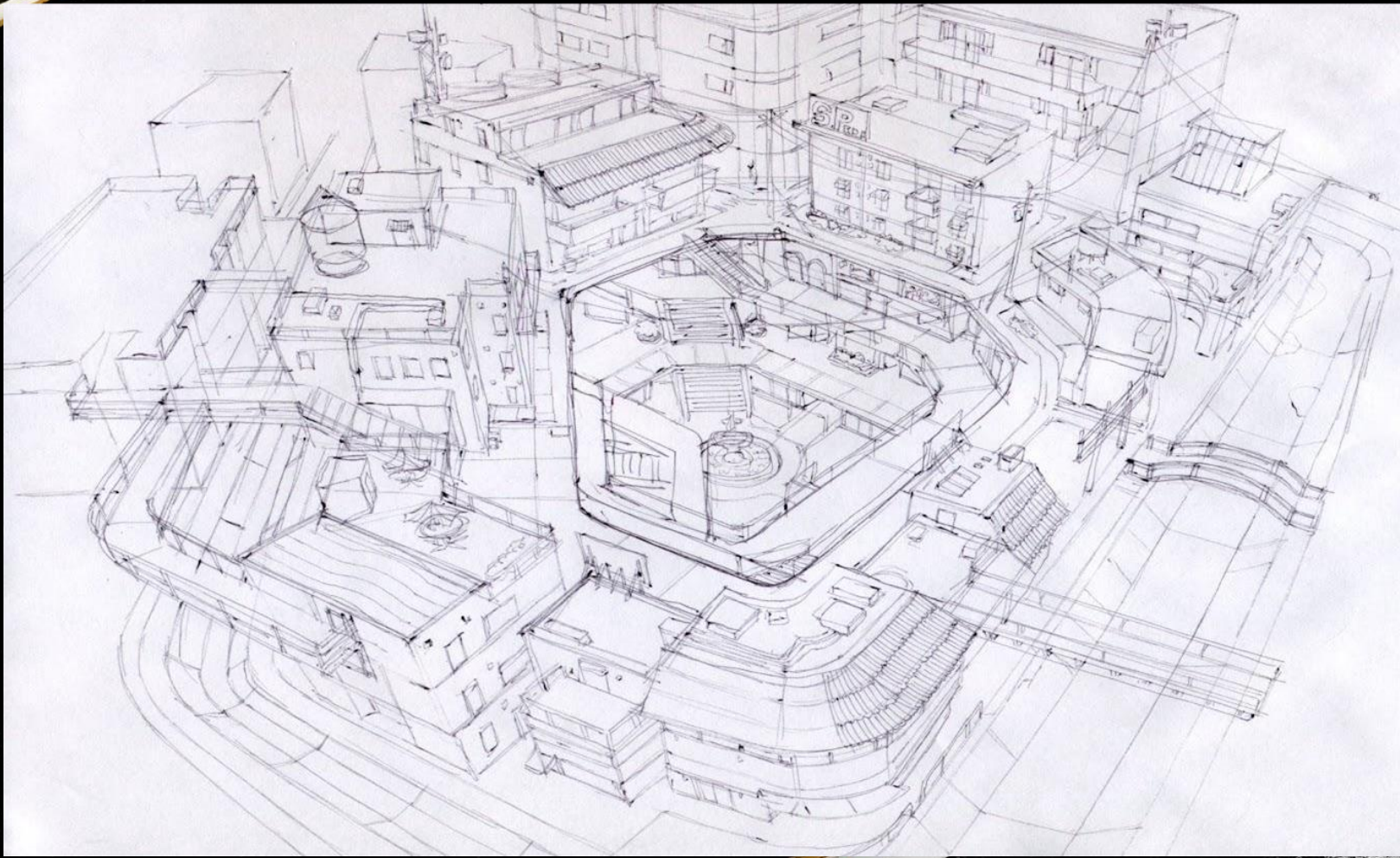
CONCEPT DESIGN FOR SUNSET CITY

- Large city with several distinct areas
- Lots of verticality & levels of traversal
- Terrain from beach to mountains so elevation changes in ground
- Environment dynamic and changeable
- Again, open world!

TRANSLATE DESIGN TO NEEDS

- Large city with several distinct areas
- Lots of verticality & levels of traversal
  - Need components to create a variety of architectural styles
  - Need components for variety of traversal
  - Optimize number/size assets for streaming*

TRANSLATE DESIGN TO NEEDS (CONTINUED)

- Terrain from beach to mountains...
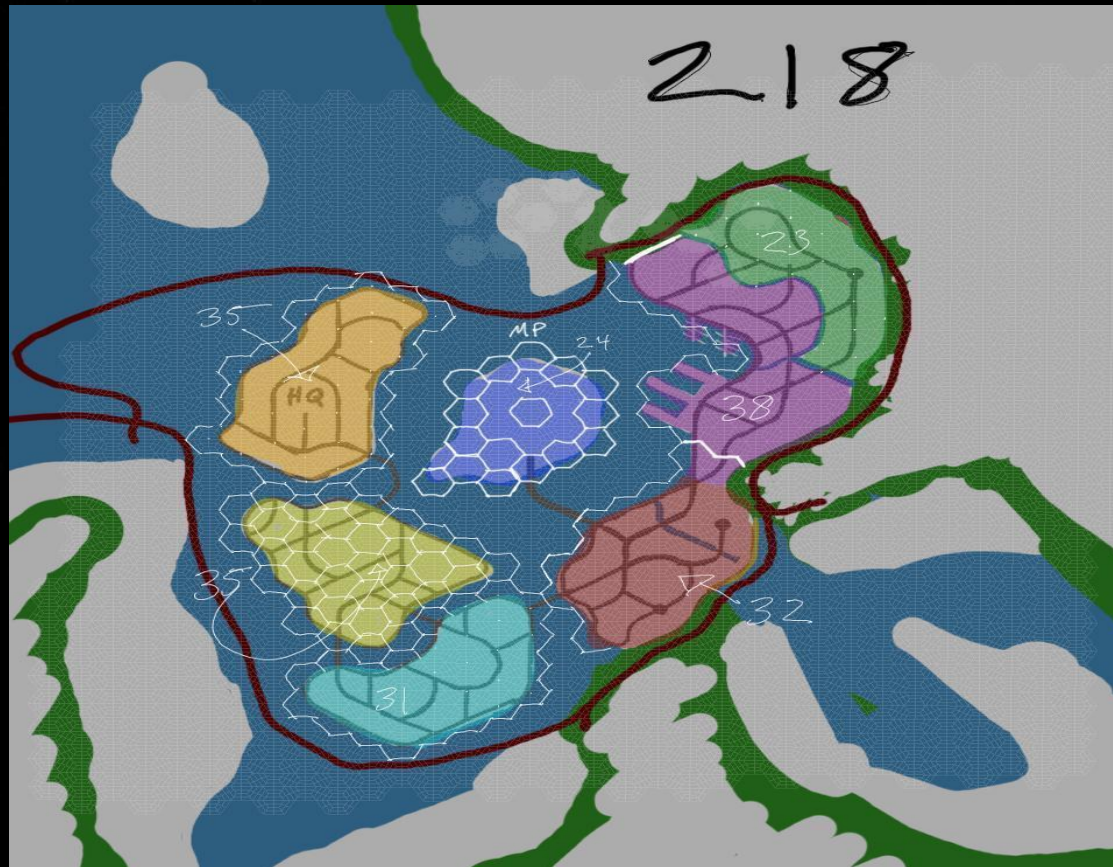 - Sloped areas & components
  - Define metrics of slopes for gameplay

TRANSLATE DESIGN TO NEEDS (CONTINUED)

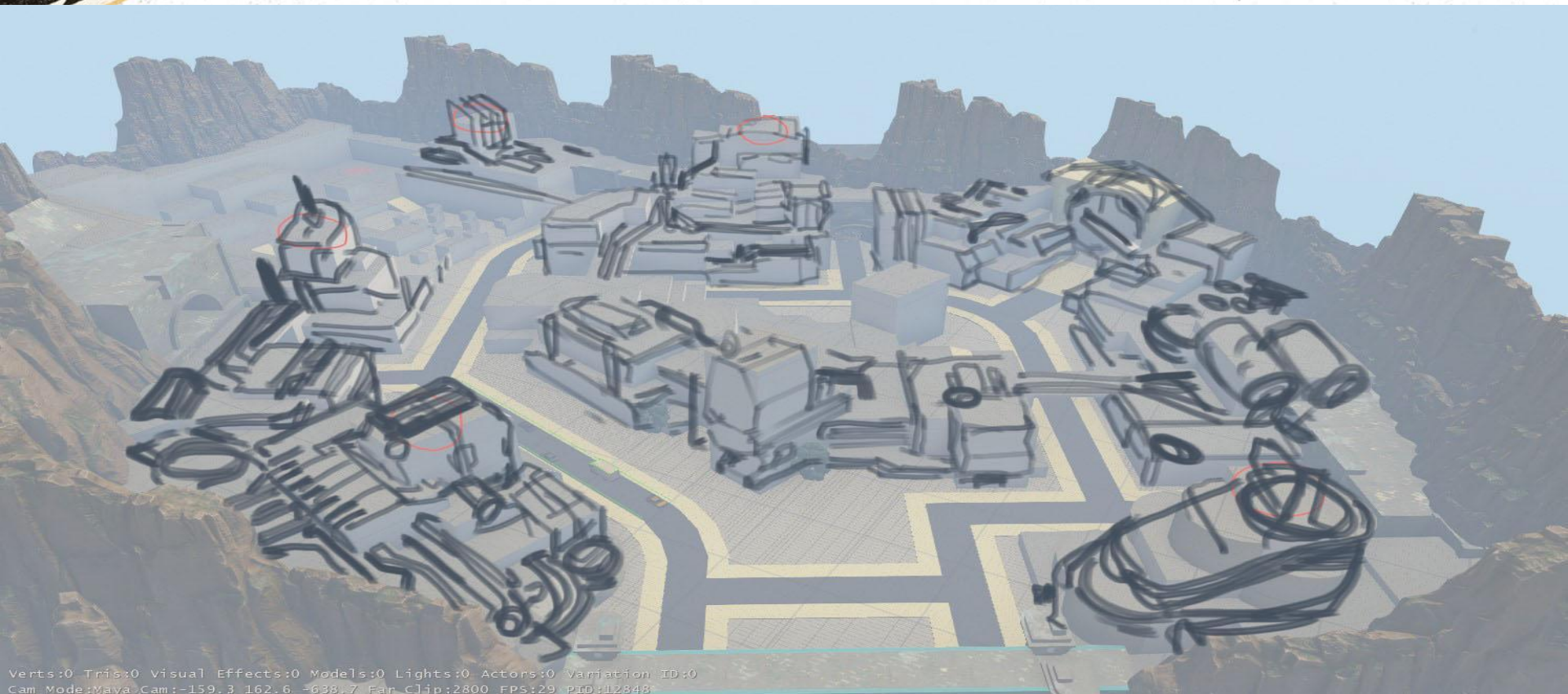- Environment dynamic and changeable
  - In game, replace or overlay regions
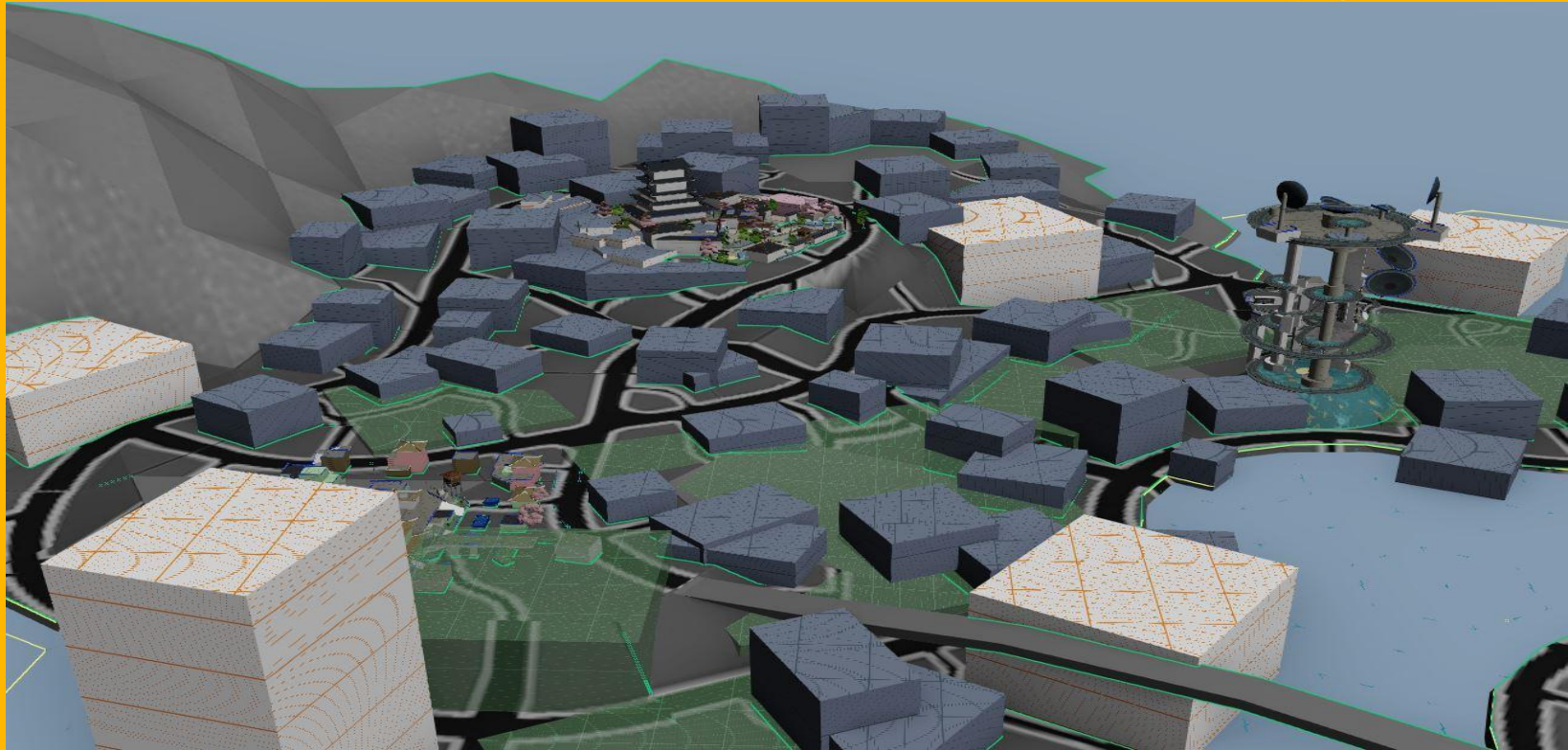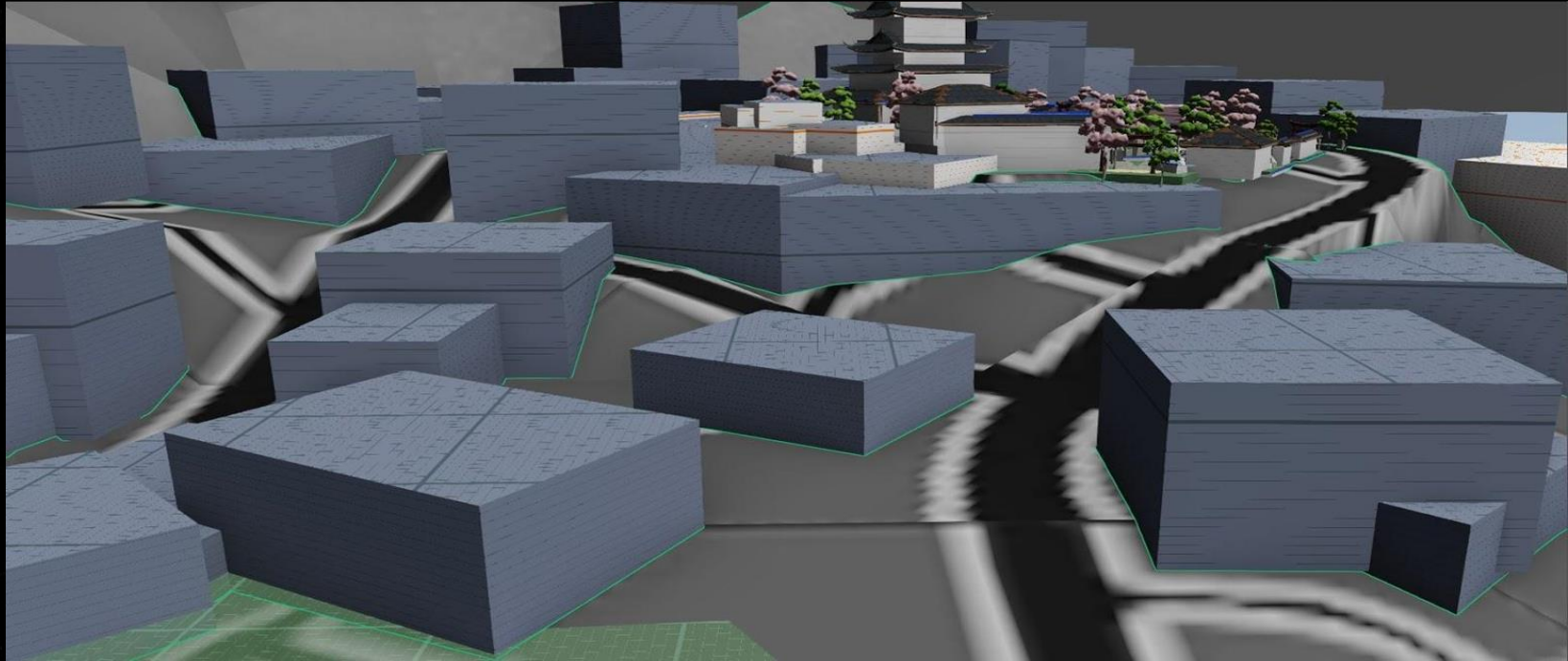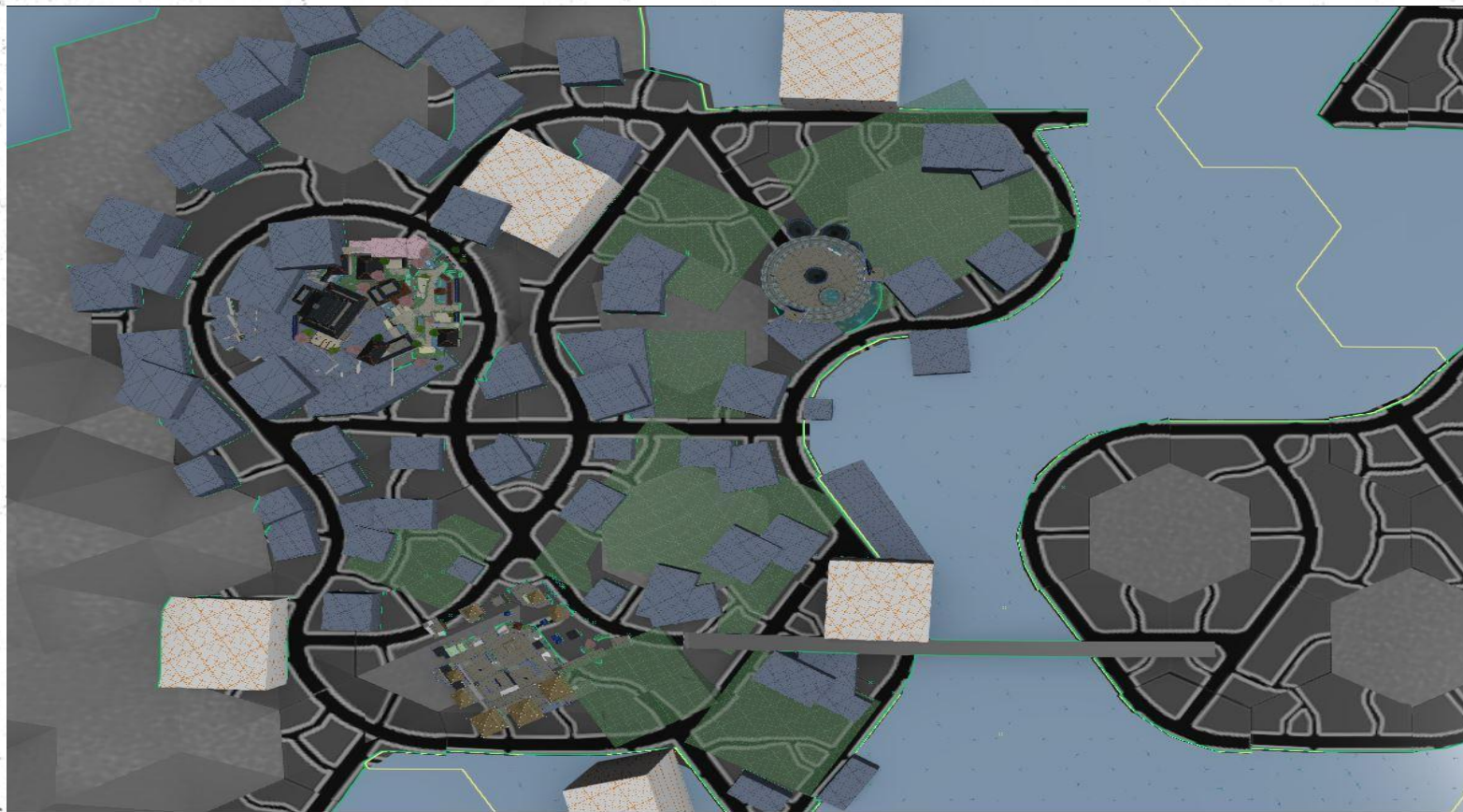 - During design, support iterations of wild ideas for game

Verts:0 Tris:0 Visual Effects:0 Models:0 Lights:0 Actors:0 Variation ID:0
Cam Mode:Maya Cam:-159.3 162.6 -638.7 Far Clip:2800 FPS:29 PID:12848

HEX BASED ZONES DECISION

- **Streaming areas**
  - 7 hexes fully loaded at a time

- **Division of labor**
  - assign sets of hexes to different artists

- **Modular components**
 - few models used in many combinations

TRADITIONAL ROAD SYSTEM

- Roads and the ground created using a small set of assets that are instanced and tiled to complete surfaces

- Satisfying the design requires a fairly complex set of hex based assets or unique models

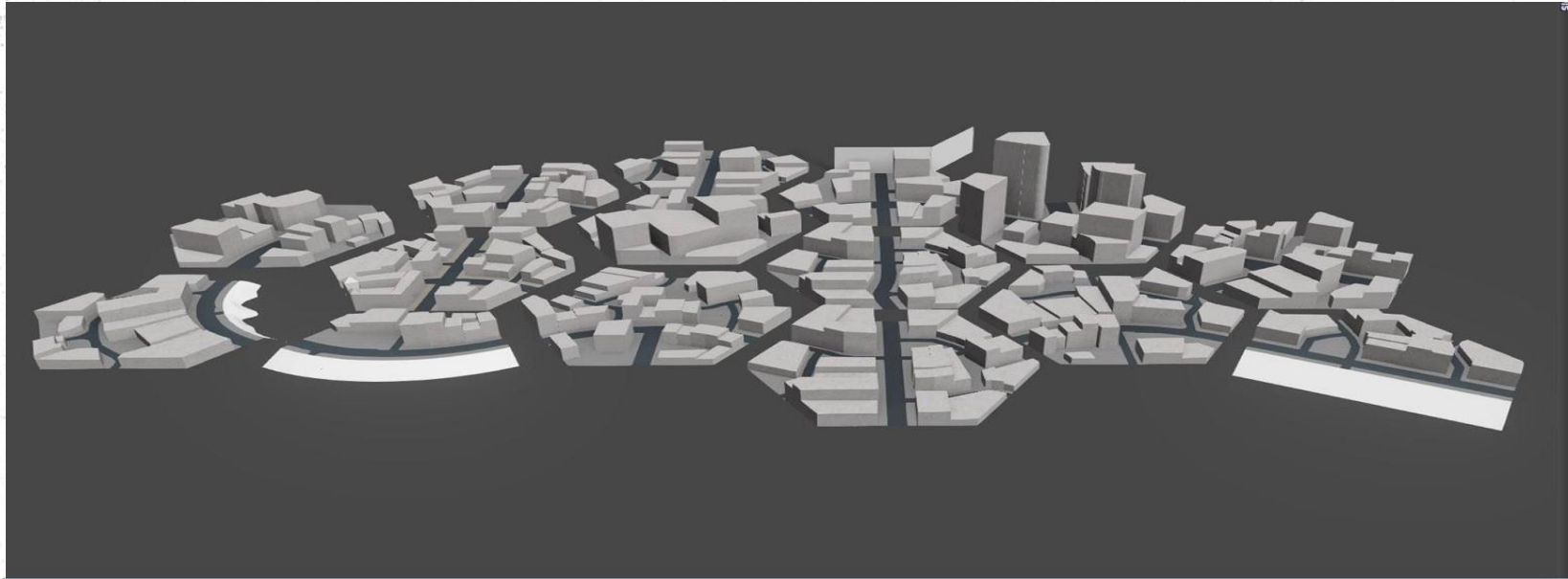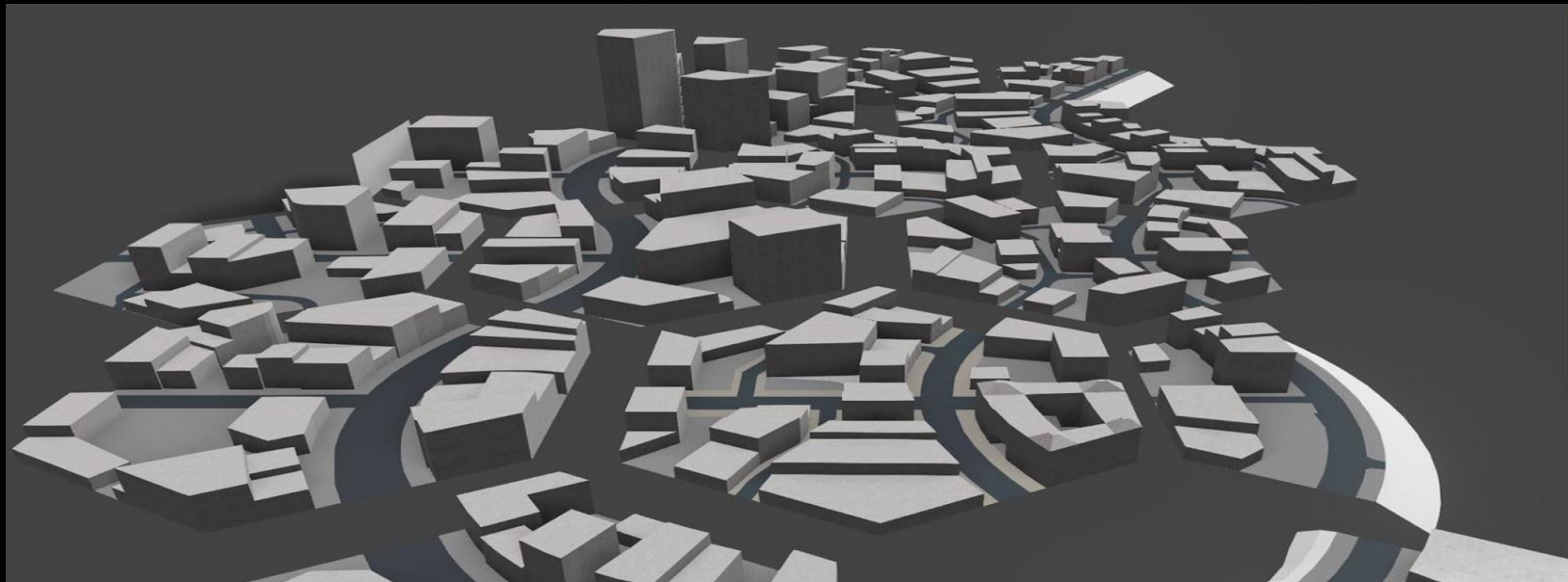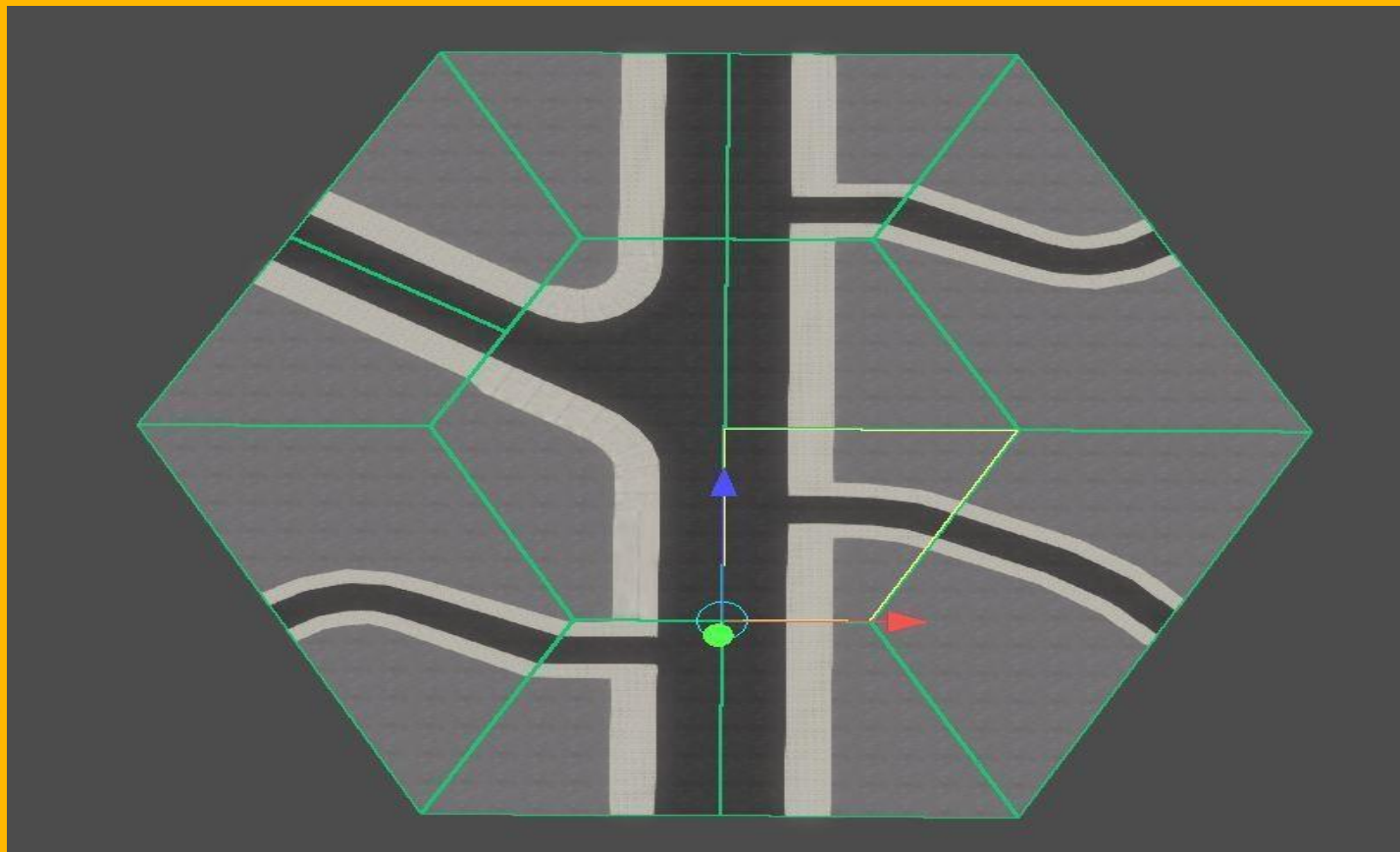# TRADITIONAL ROAD SYSTEM (CONTINUED)

- Smaller component assets form a hex

- Slope pieces need to be defined or custom made as needed
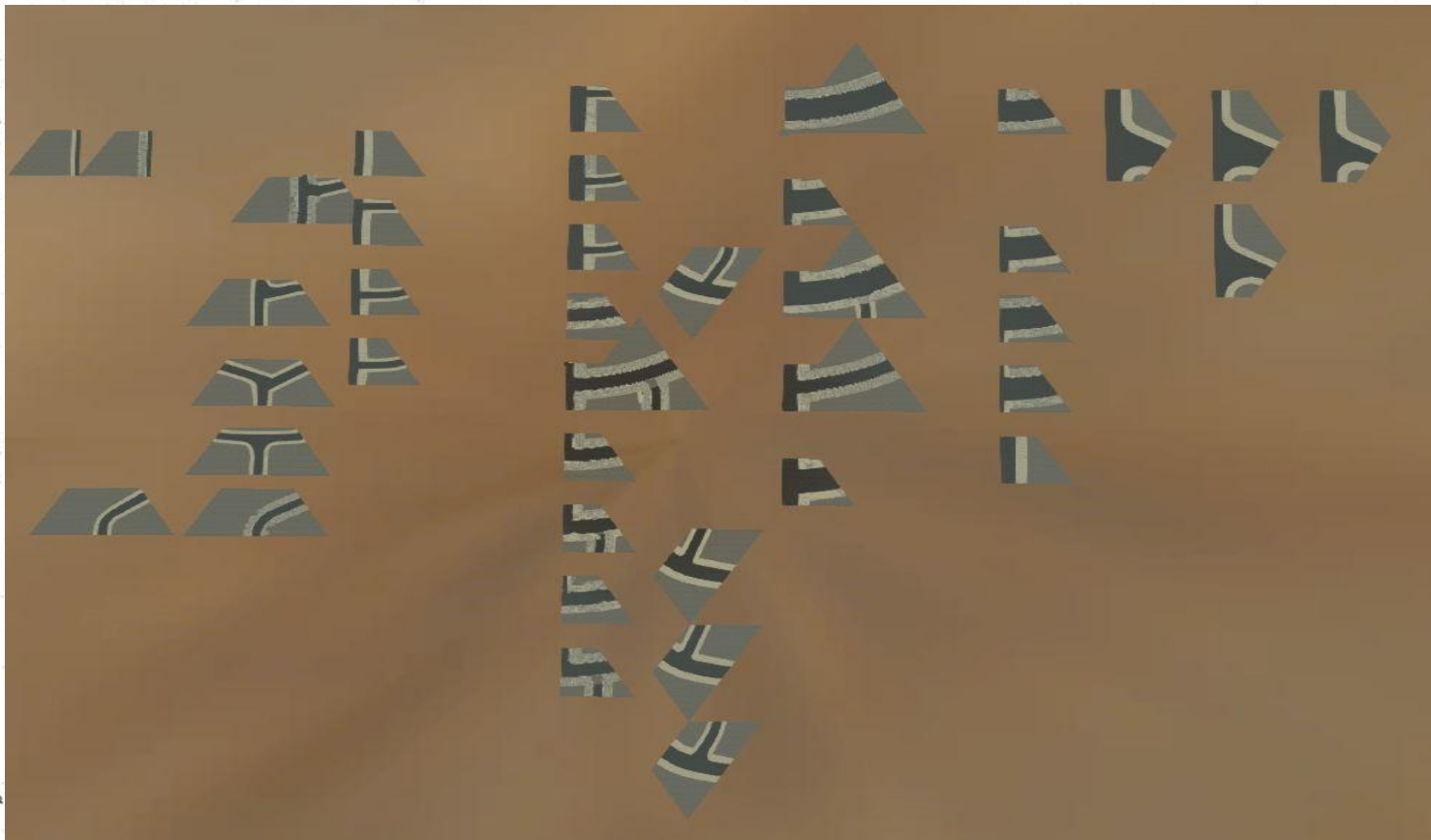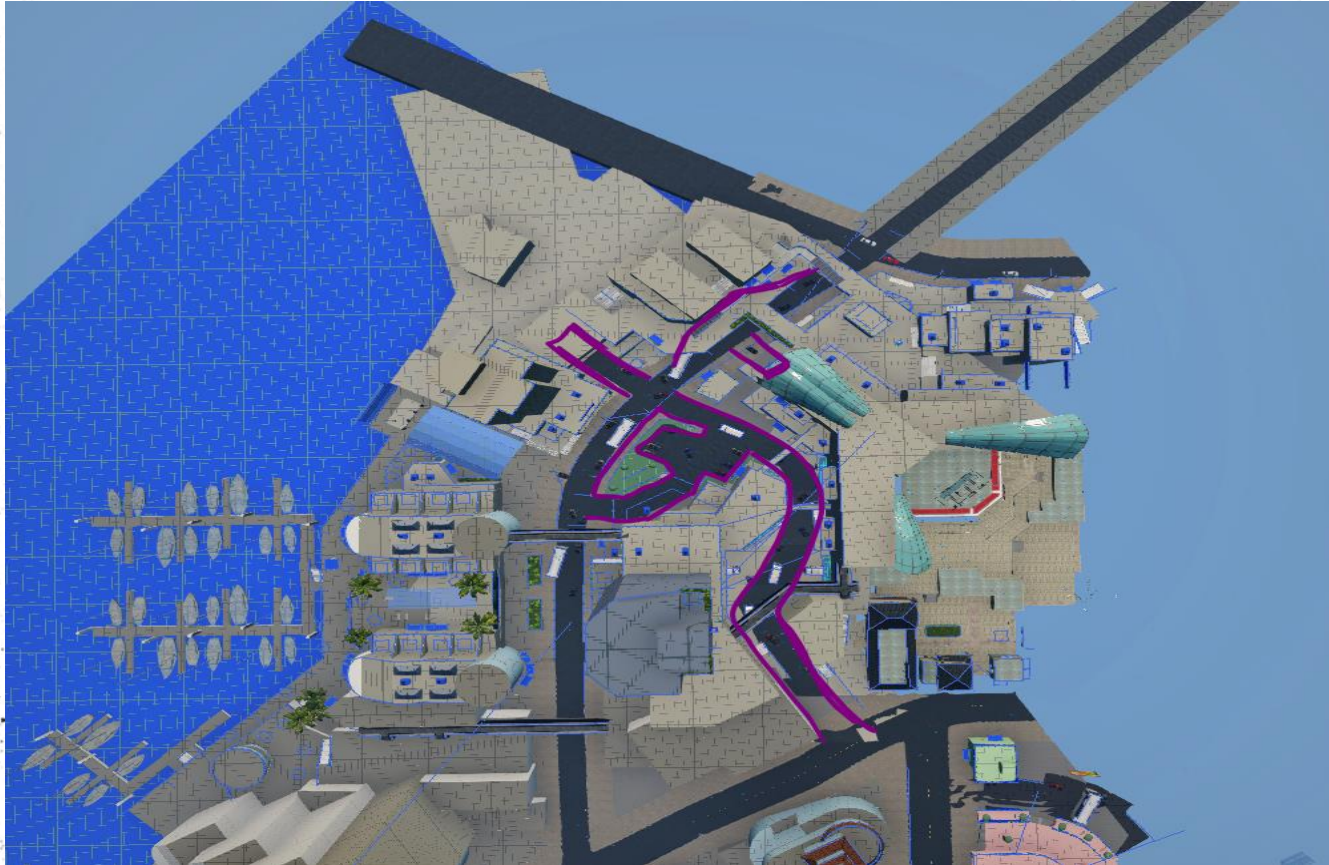
Original

Same pieces rotated
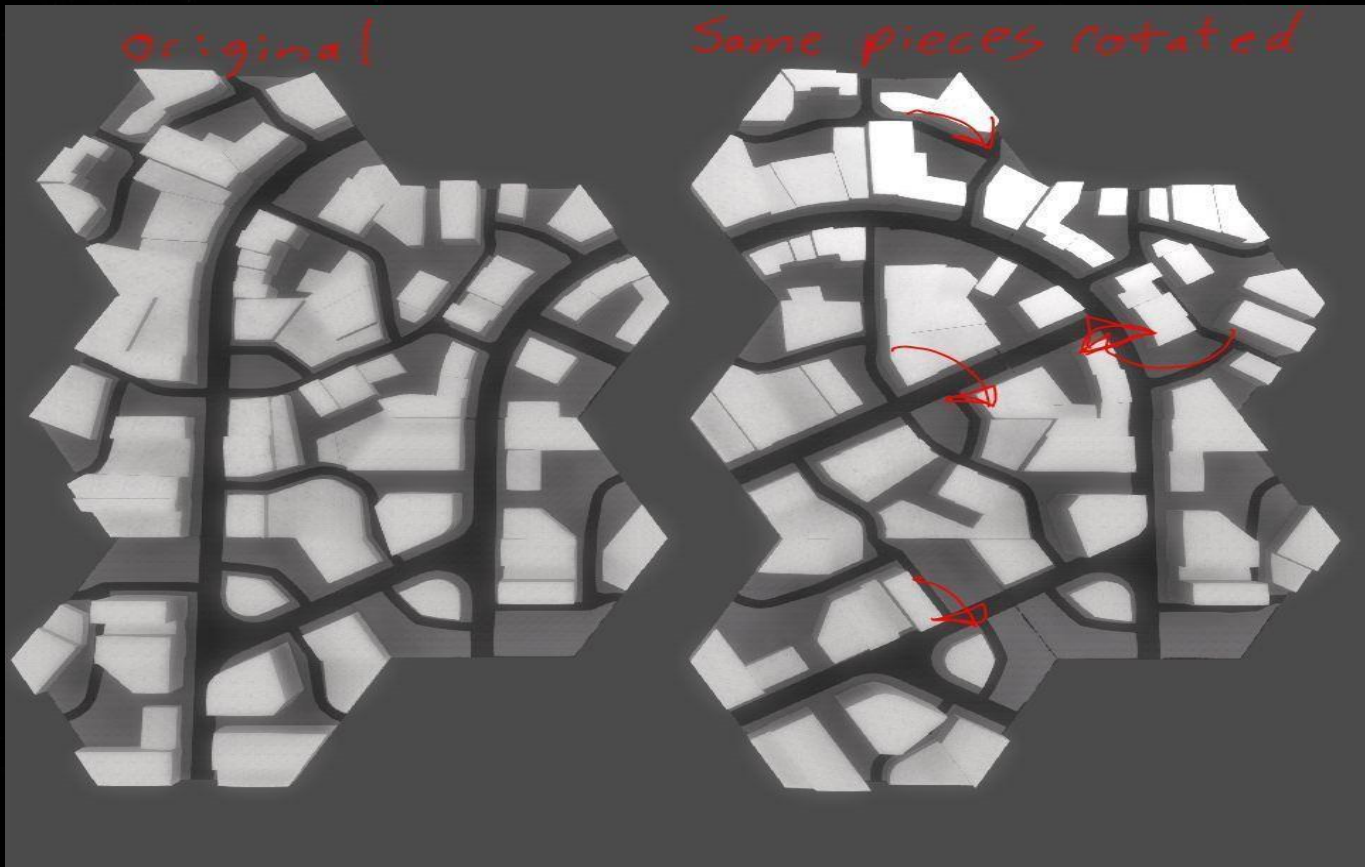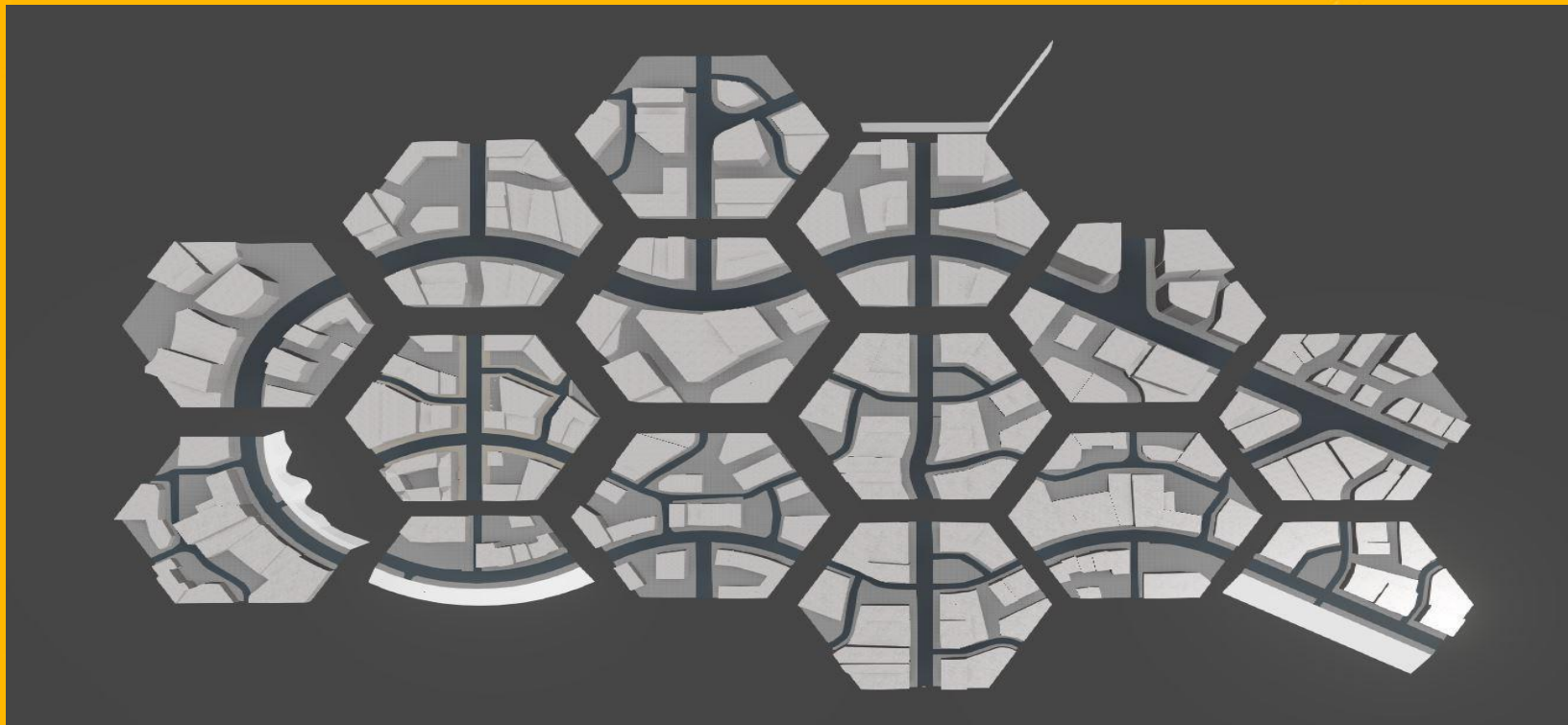
LIMITATIONS OF HEX ROAD KIT SYSTEM

- Unable to scale the widths of roads
- Unable to create hills or elevation changes
- Unable to create roads that curve outside of the predefined paths
- Adding essential props manual process
- Very challenging to keep "clean"
- Slow - Days for original layout of an area; Hours to days per iteration
- The streets looked modular, not natural with realistic variations and imperfections
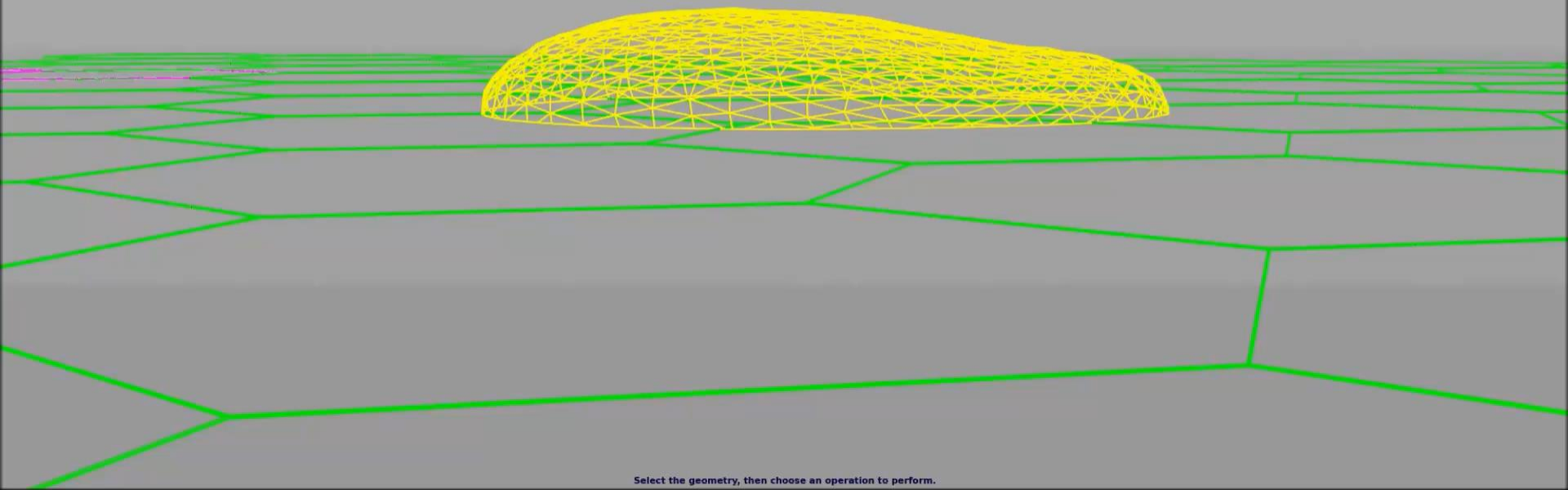
PROCEDURAL ROAD LAYOUT TOOL

- "Gray-space-centric" system uses curves to layout roads defining "gray-spaces" from which sidewalks grow to meet street area

- Skip plan view step

- Intersections, streets, sidewalks and gutters, gray spaces automatically created

- Road attributes individually controllable, not only per road, but per road vertex if desired. - road_width, sidewalk_width, curb height/width, elevation above terrain , materials, ...
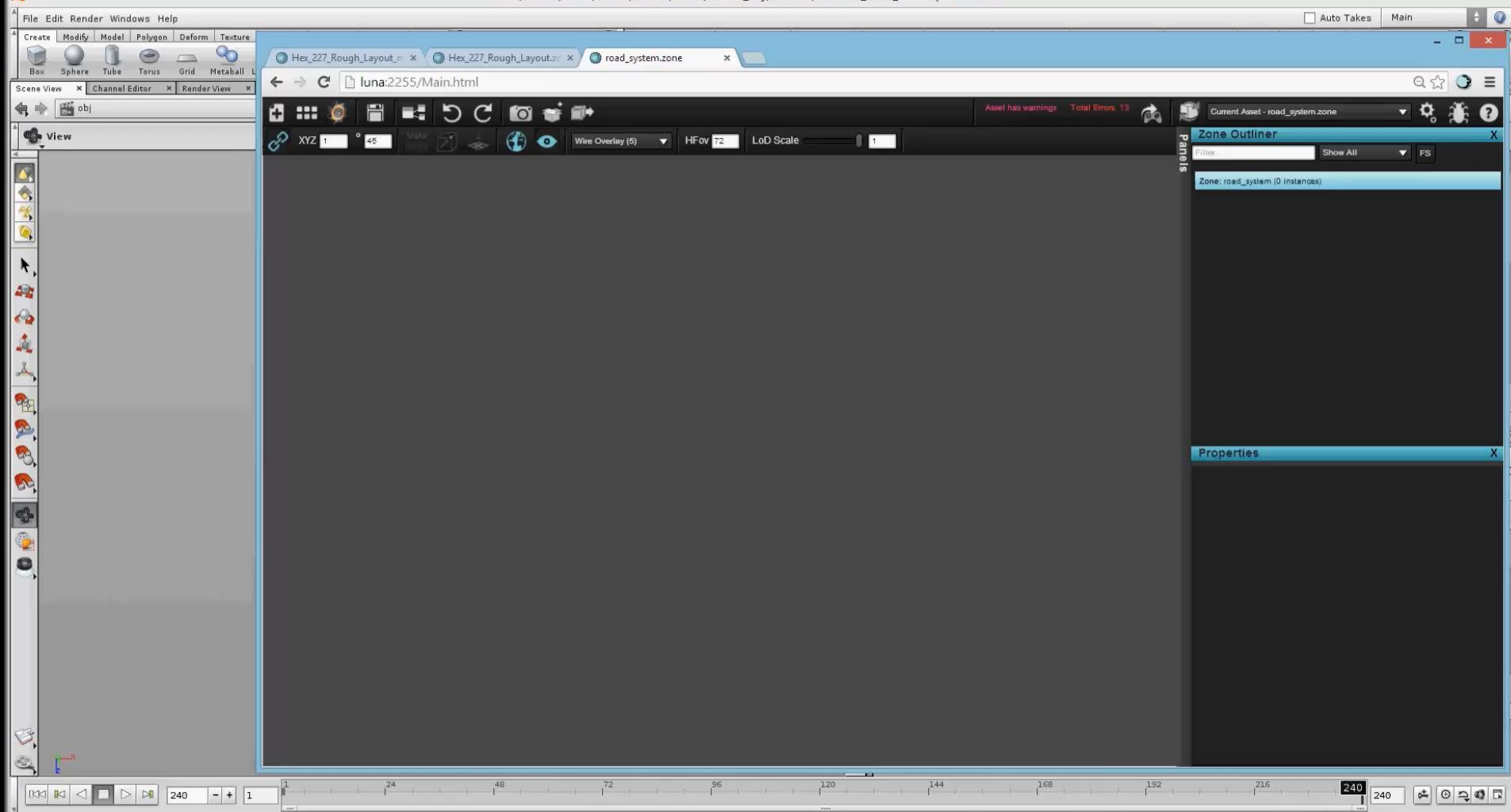
PROCEDURAL LAYOUT TOOL (CONTINUED)

- Easily modified: by curves and attributes
- More organic looking with realistic irregularities
- Export a ground model per hex including street, sidewalk, curb, and gray-space material groups, AV materials and collision attributes.
- Decoration and traversal instances (models, prefabs, decals) can be regularly distributed along roads and exported as a prefab or zone.

Select the geometry, then choose an operation to perform.

Auto Takes   Main

File Edit Render Windows Help

Create Modify Model Polygon Deform Texture

Box Sphere Tube Torus Grid Metaball

Scene View   Channel Editor   Render View

View   obj

Hex_227_Rough_Layout_r   Hex_227_Rough_Layout.zc   road_system.zone

luna:2255/Main.html

Asset has warnings   Total Errors: 13   Current Asset - road_system.zone

Zone Outliner

XYZ 1   45   SNAP   Wire Overlay (5)   HFov 72   LoD Scale   1

Filter   Show All   FS

Zone: road_system (0 instances)

Properties

240   240   240

1

240

Left mouse tumbles. Middle pans. Right dollies. Ctrl+Alt+Left box-zooms. Ctrl+Right zooms. Spacebar-Ctrl-Left tilts.

Auto Update

ADDITIONS TO ROAD SYSTEM

- Corners identified and exported with a different material

- Adding elevation attribute creates overpasses with railings for non-intersecting roads.

- Decorations can be randomly or regularly distributed on road system surfaces.
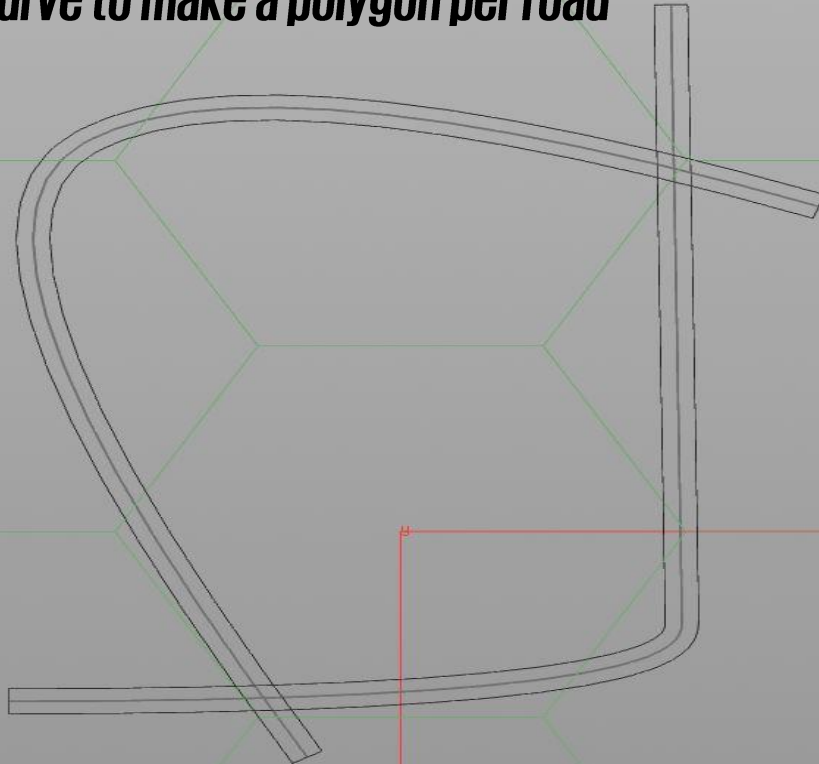
BASIC METHODOLOGY

1. Curves

2. Create road surfaces

3. Create polygons for "gray-space" (block interiors)

4. Create sidewalk and gutters around gray space

5. Put them all together

"Gray space"
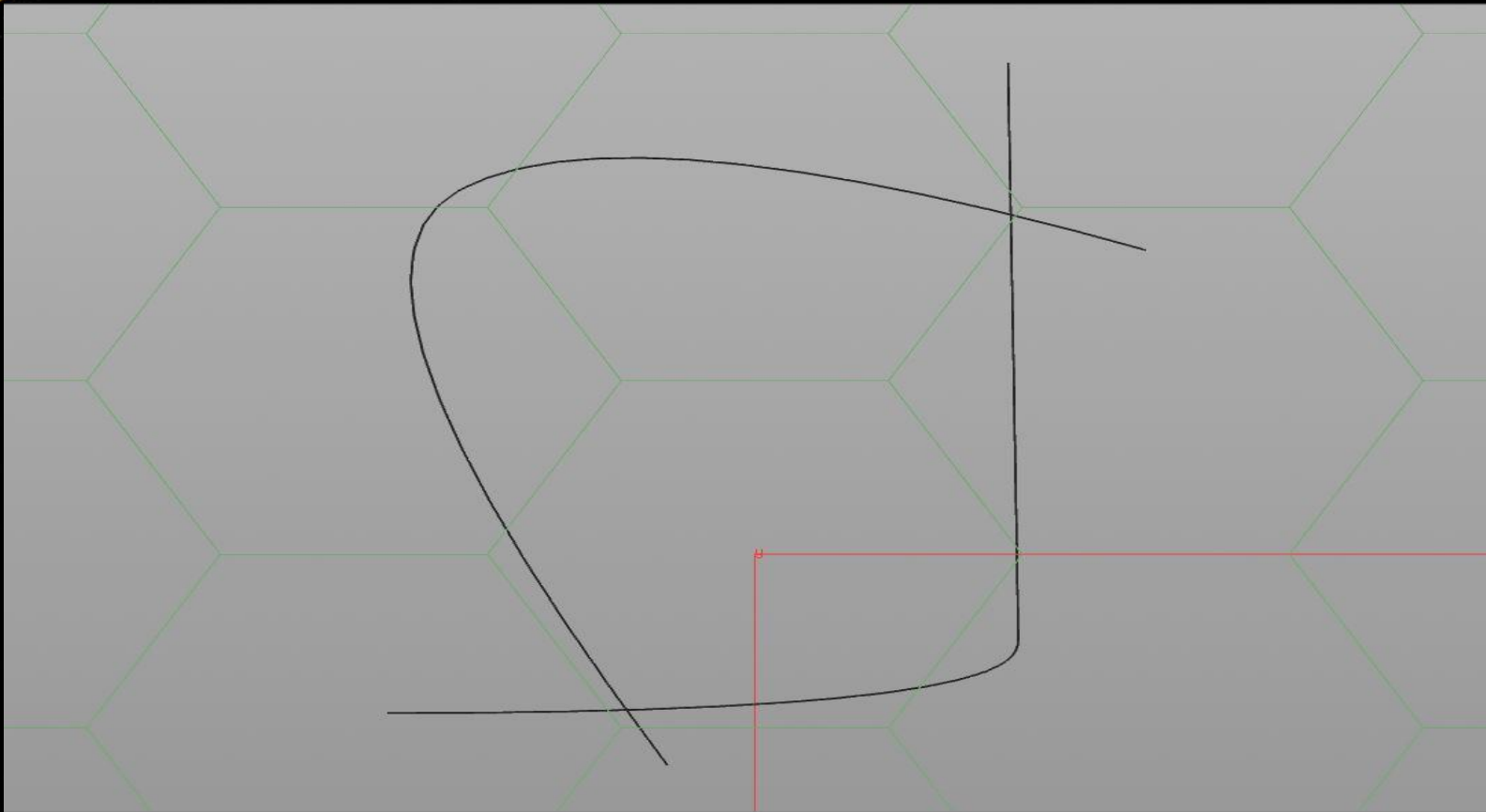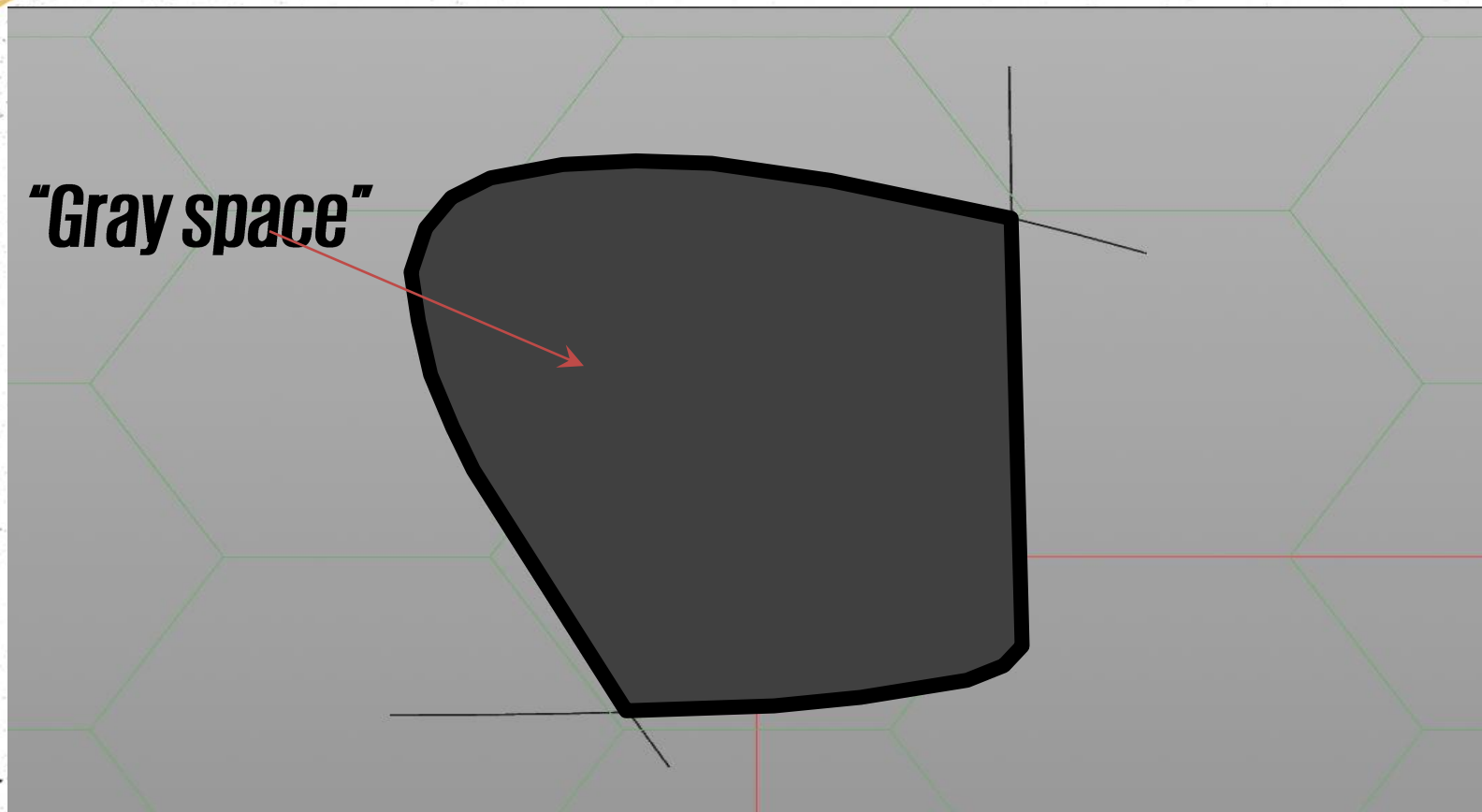
Sweep along each curve to make a polygon per road

Make street surface

- Cut polygons at intersections
- Delete interior curves
- Fuse vertices to create new polygons

OR ..
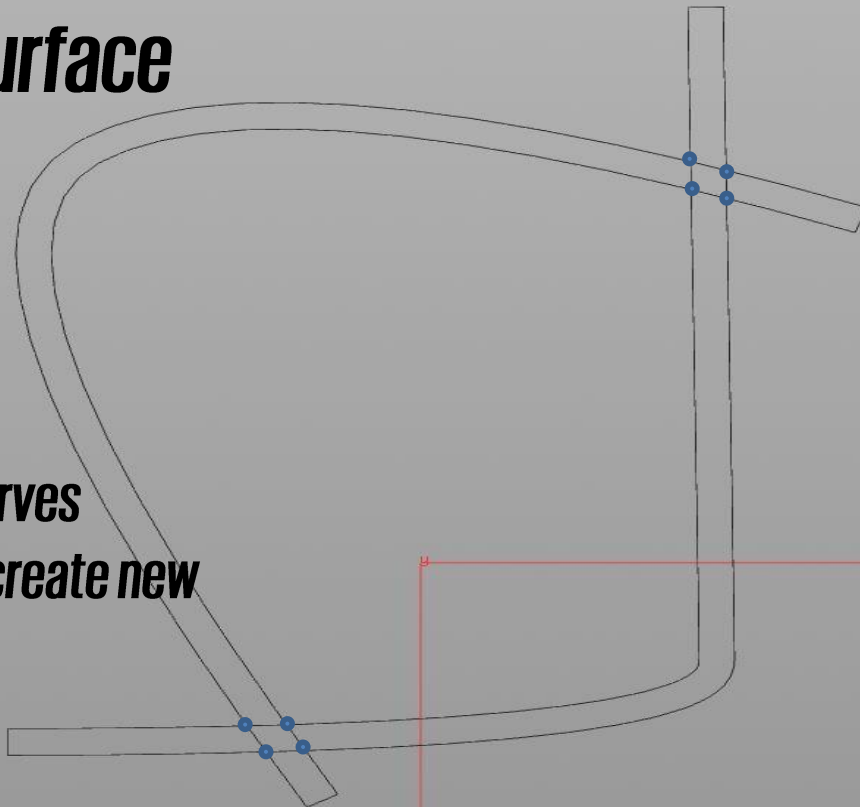
Make street surface

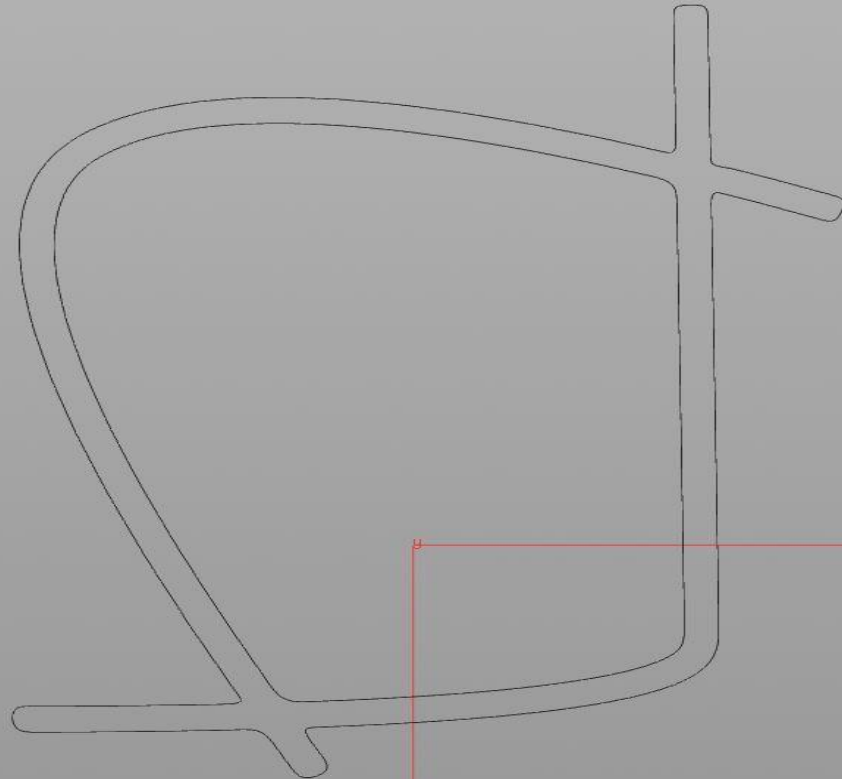## Use roads as stencils to Boolean together a complete surface
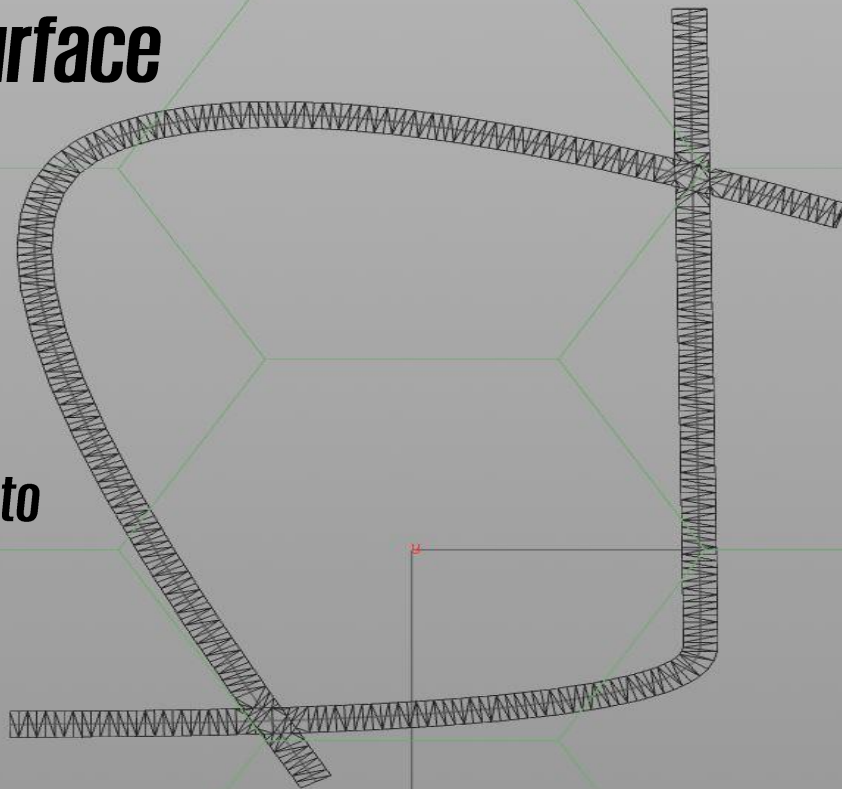
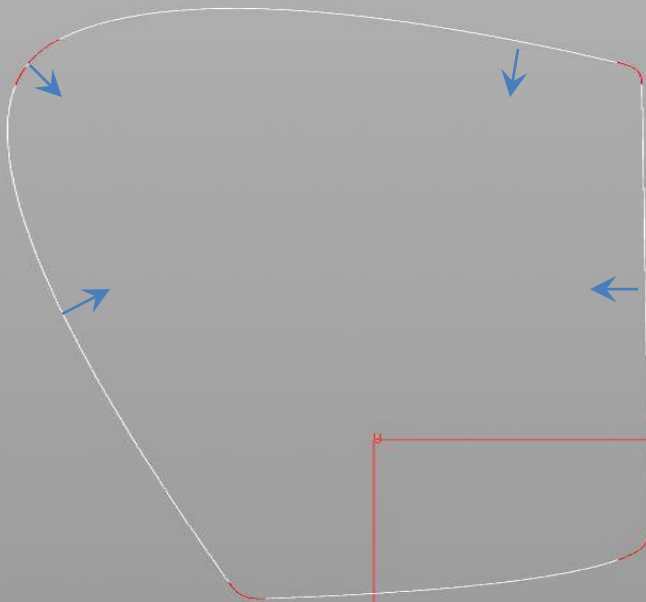*Single street surface comprised
of 2 (inner, outer) polygons*
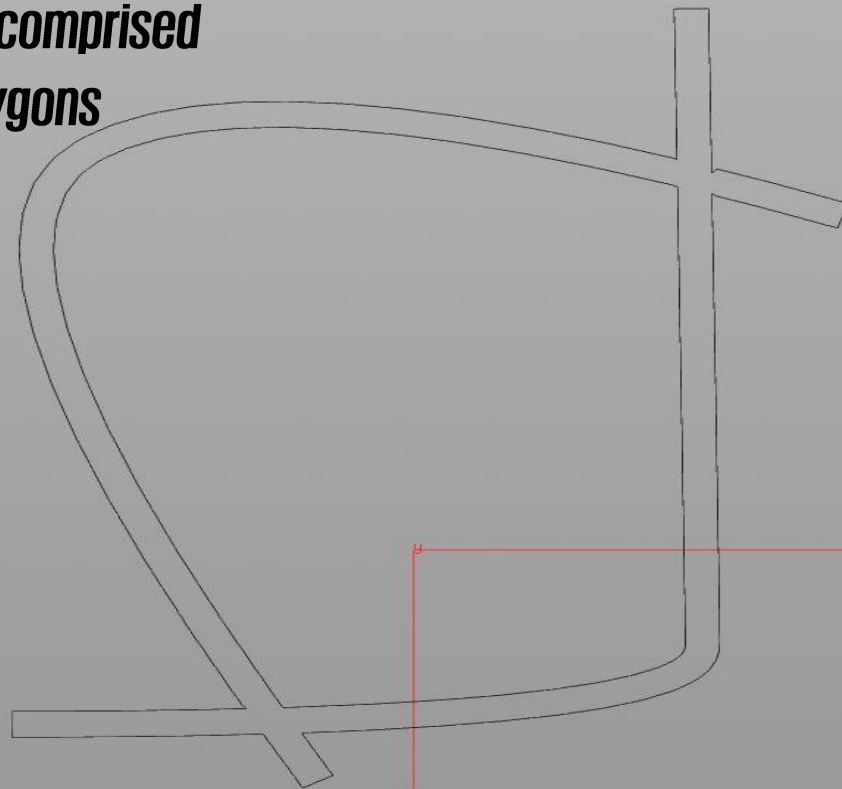
Smoothed

Intersection regions detected
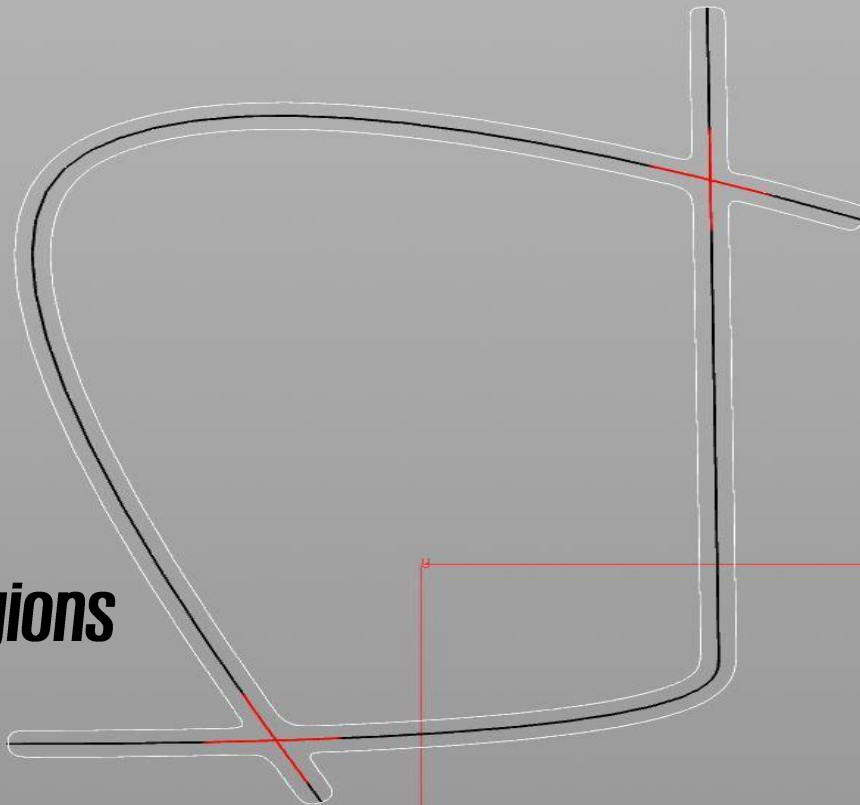
For each curve, step through vertices to calculate: texture coord, tangent, normal, curvature. All 2D.
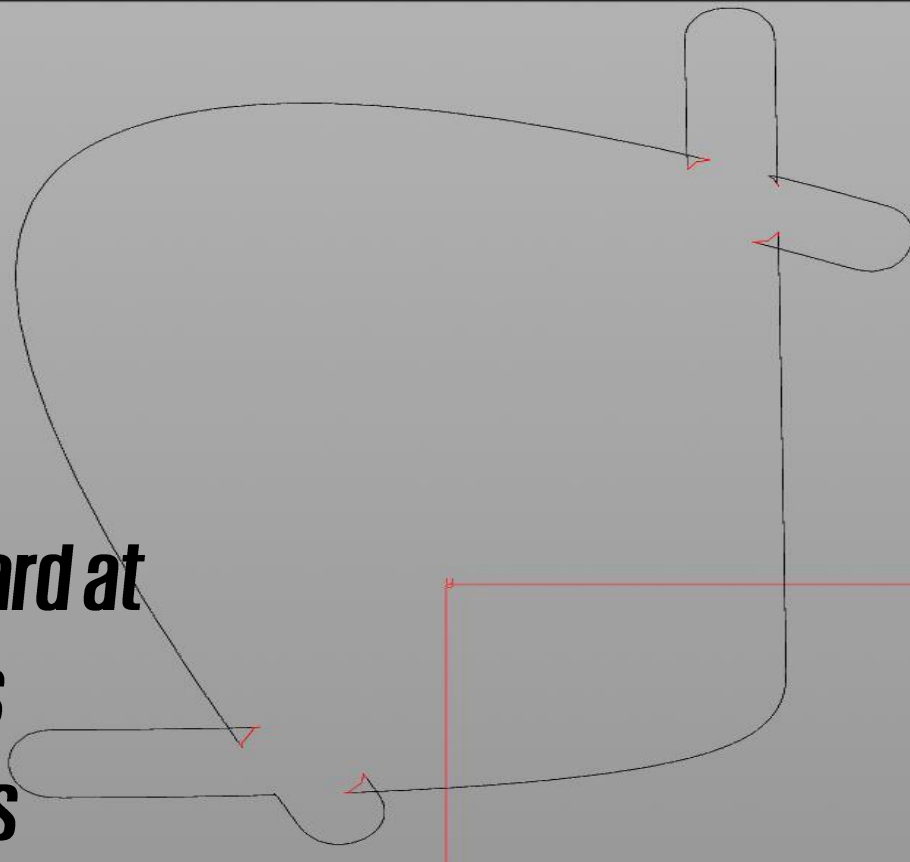Tag corner vertices

Transform vertices along normal to create sidewalk and gutter boundary polygons.
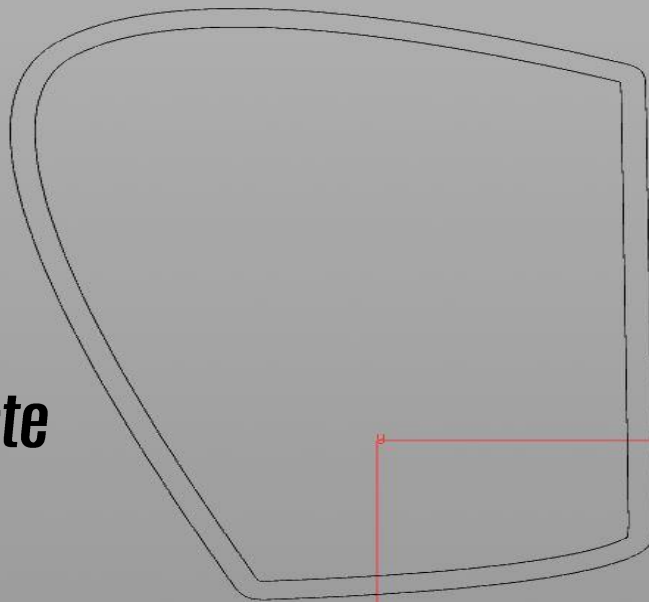
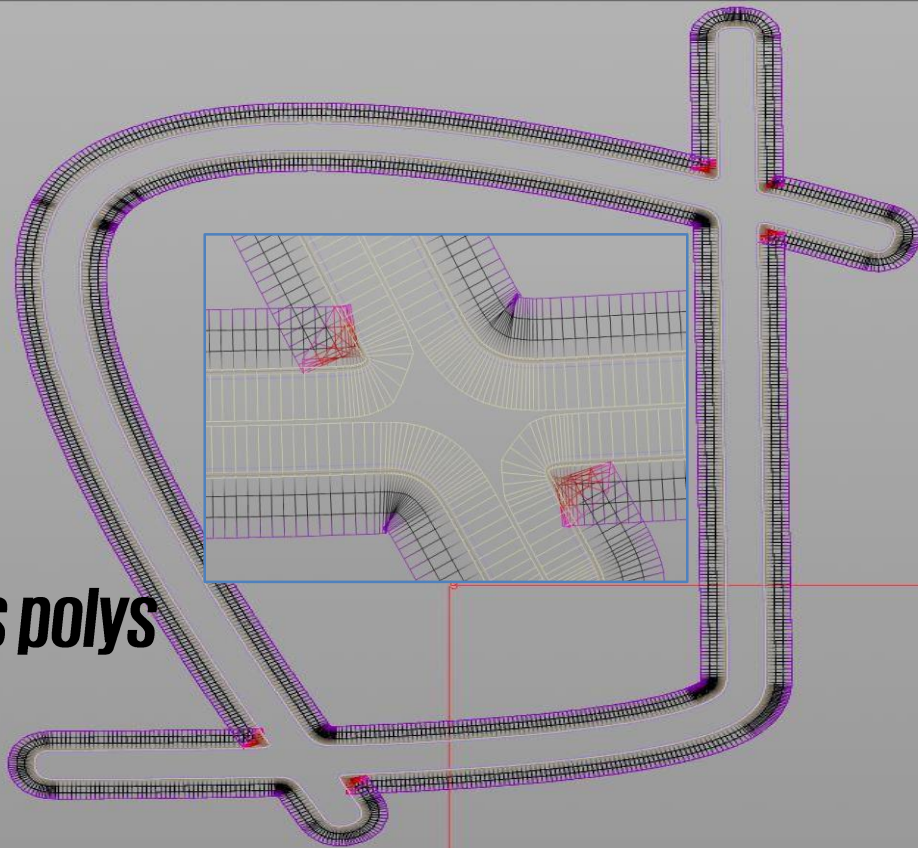**Marching inward at acute corners creates twists**

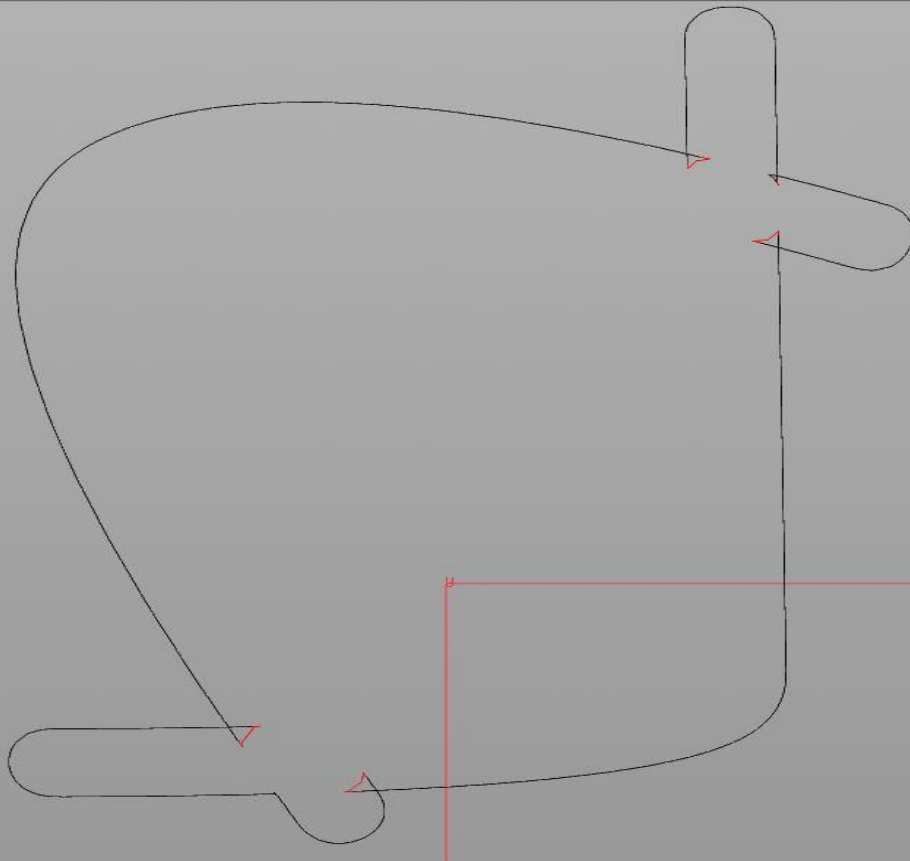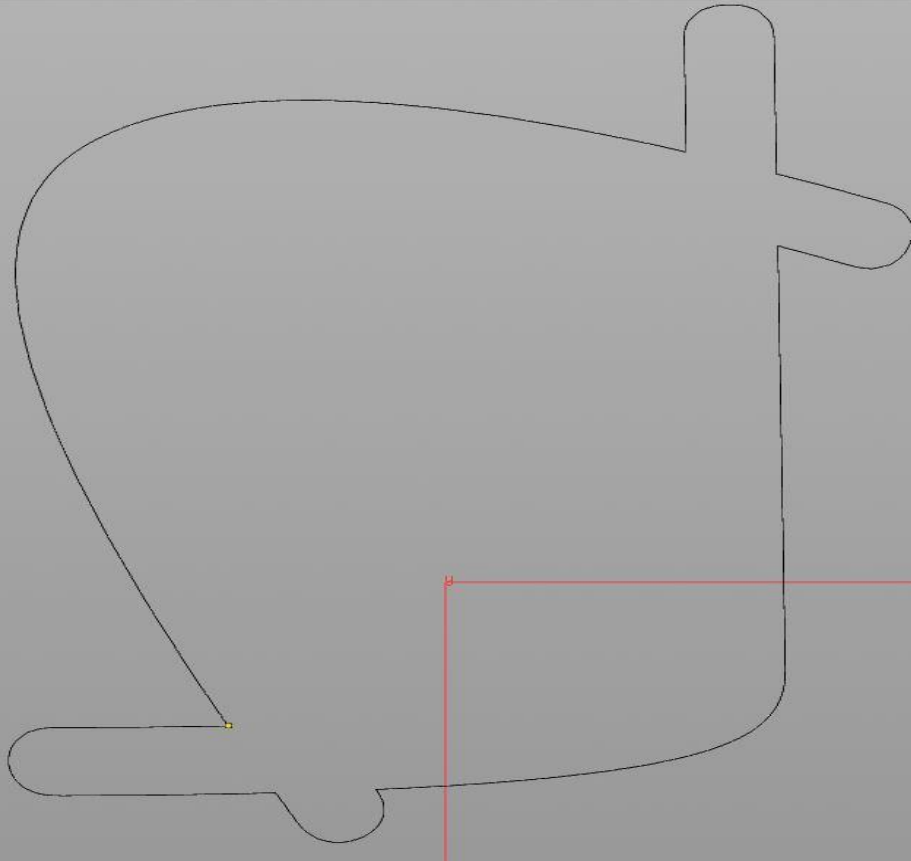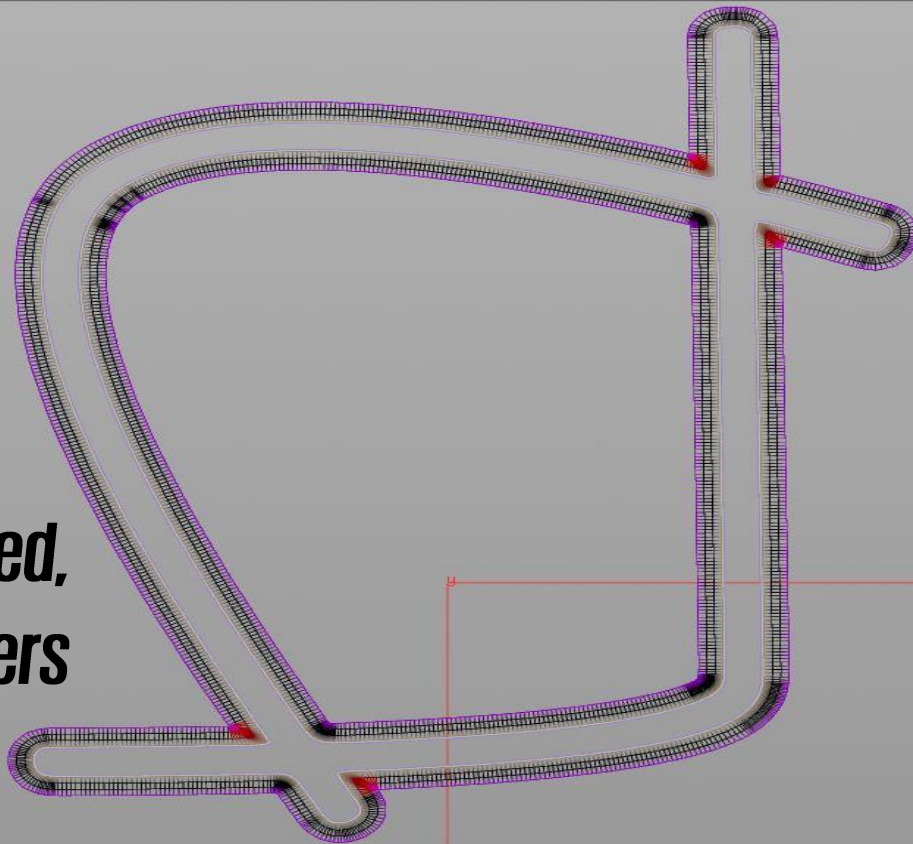*Skinning across polys with twists*

We snap those vertices to the intersection
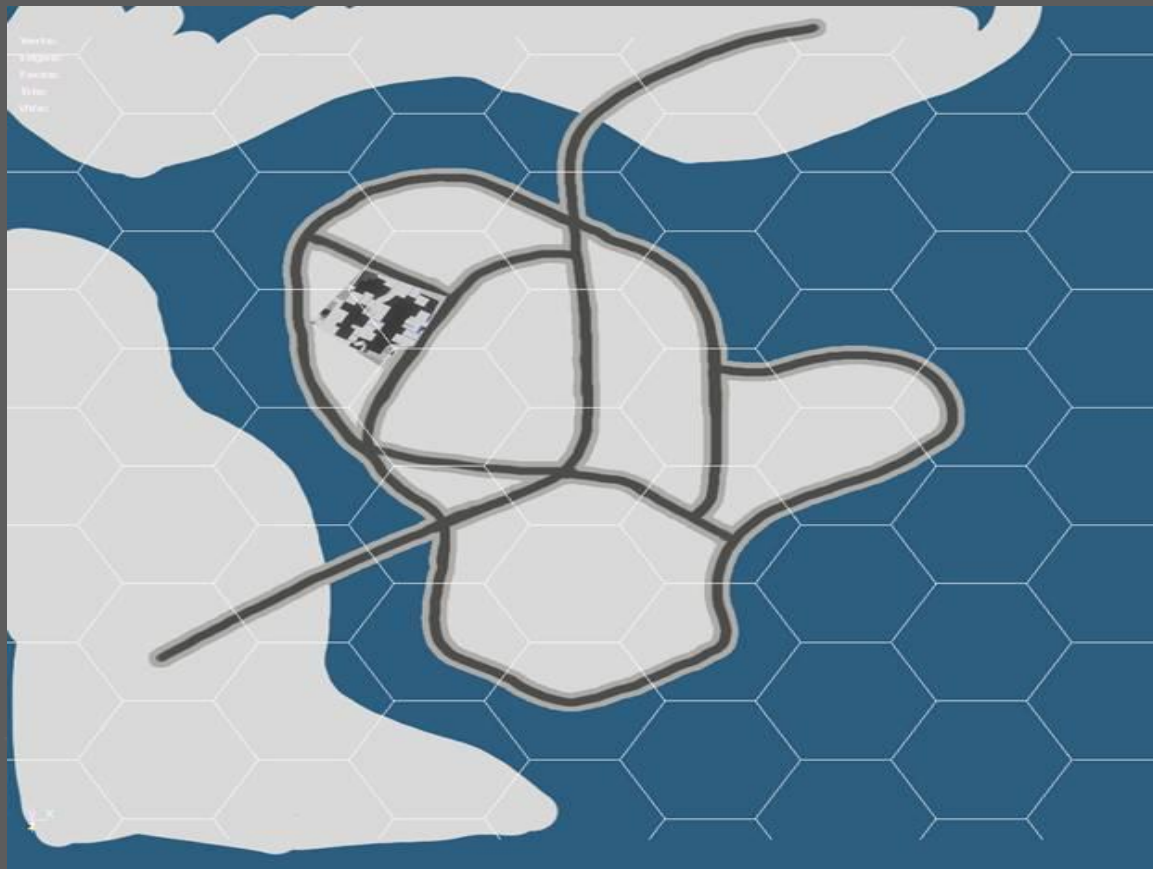
We snap those vertices to the intersection

Creating pinched, but clean corners

FINISHED GROUND

- Deform vertically based on elevation attributes
- Material attributes applied to polygons groups created automatically
- Based on attributes of completed geometry, apply props, decals and markup
- Export into prefabs and zones for game engine

ISSUES WITH INITIAL IMPLEMENTATION

- Roads and sidewalks can not be constructed if an enclosed "gray-space" is not created

- No dead-ends in gray spaces

- Overpasses can not intersect

- terrain can deform road resulting in "earthquake" areas on slopes

- Corners are smooth with little control

UPDATED PROCEDURAL GROUND SYSTEM

- "road-centric" system - roads and sidewalks most important
- Corners sharp or smooth driven by source curve vertex weight
- Markup/actors automatically placed/created for gameplay (railings, curbs, ...) based on metrics
- Roads can have cul-de-sacs and other terminations with auto-created defined decoration sets
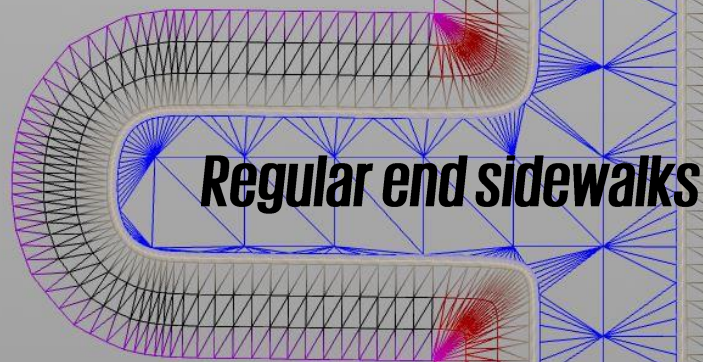
ROAD TERMINATION PROCESSING

top2 ▾ no cam ▾

Regular end

ROAD TERMINATION PROCESSING

Regular end sidewalks

ROAD TERMINATION PROCESSING

top2 ▾　no cam ▾

Cull de sac

ROAD TERMINATION PROCESSING

Driveway

ROAD TERMINATION PROCESSING
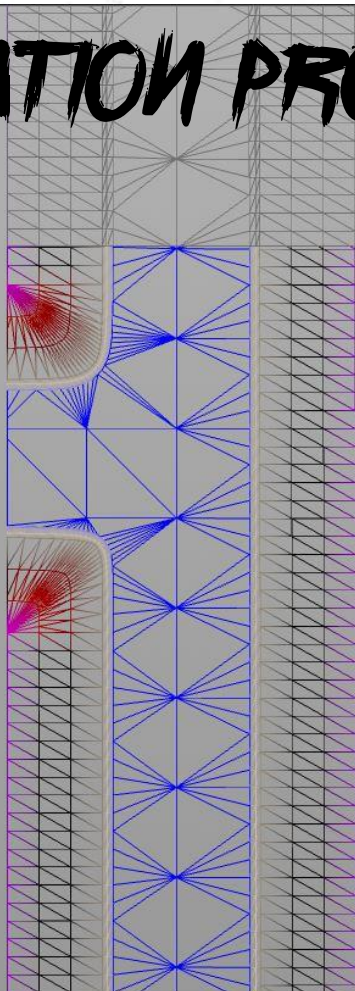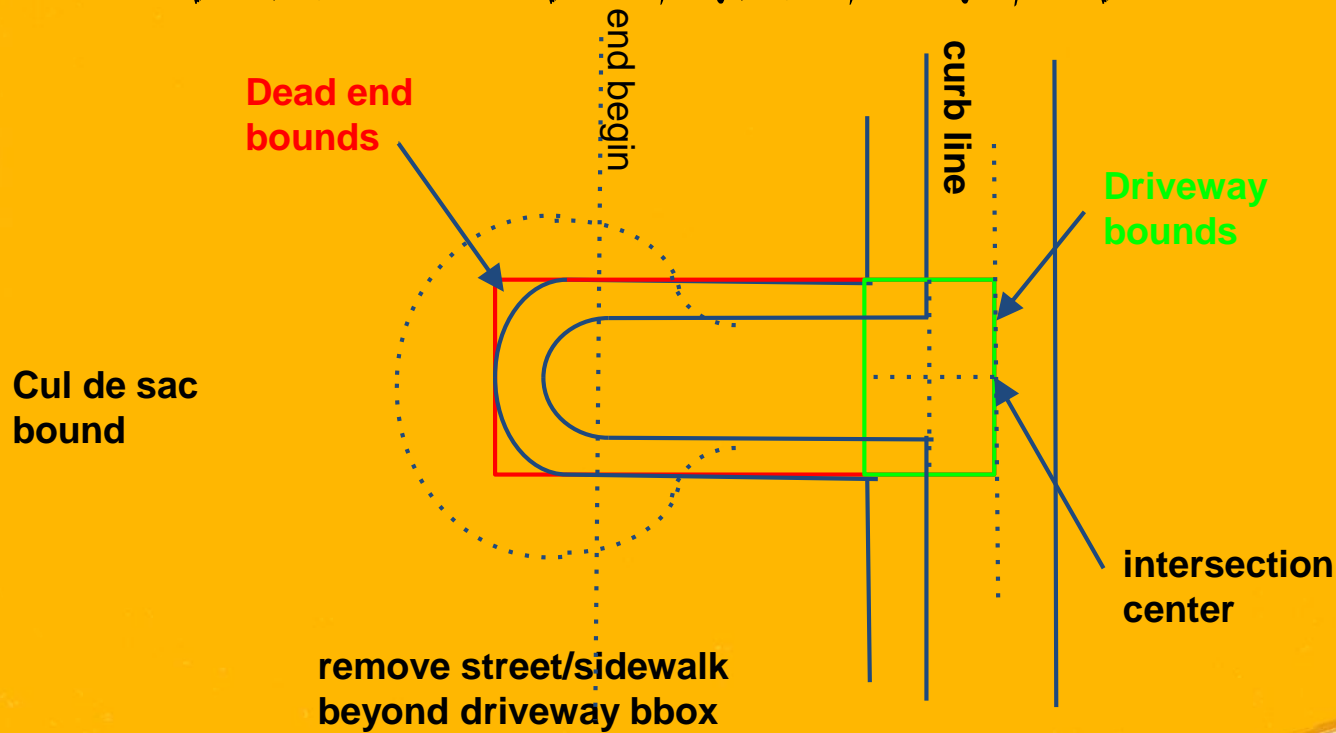
Driveway

sidewalk

ROAD TERMINATION PROCESSING

end begin

curb line

Dead end bounds

Driveway bounds

Cul de sac bound

intersection center

remove street/sidewalk beyond driveway bbox

NEW GROUND SYSTEM (CONTINUED)

- Road decorations can be restricted to regions of street, sidewalk, gutter, corners, overpasses, and gray-spaces.

- Elevation attributes allow intersecting overpasses (or tunnels)

- New uv-layout controls for sidewalk/gutters

NEW GROUND SYSTEM (CONTINUED)

- Multiple road layout nodes can be merged

- Perforce integration: hundreds of assets created or modified at once

- Automatically creates low resolution models for LODs

AUTOMATIC LOD'S

1. Edge polygons are grouped and connected for sidewalk, gutter and street components.

2. Polygons are simplified preserving contour (curvature) detail and vertices are consolidated.

3. New polygons are created to fill the simplified sidewalk, gutter and street surfaces.

4. Simplified groups are added as the lower res LOD's

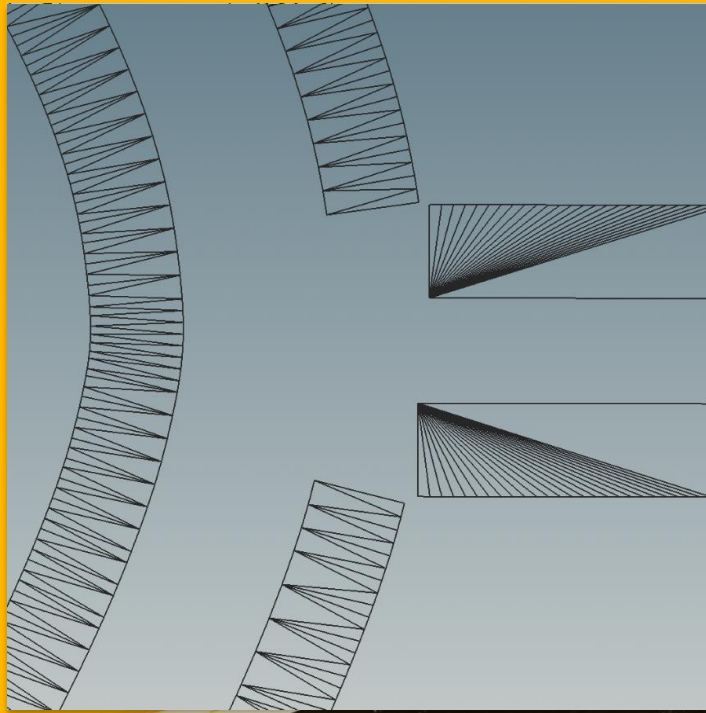# AUTOMATIC LOD'S
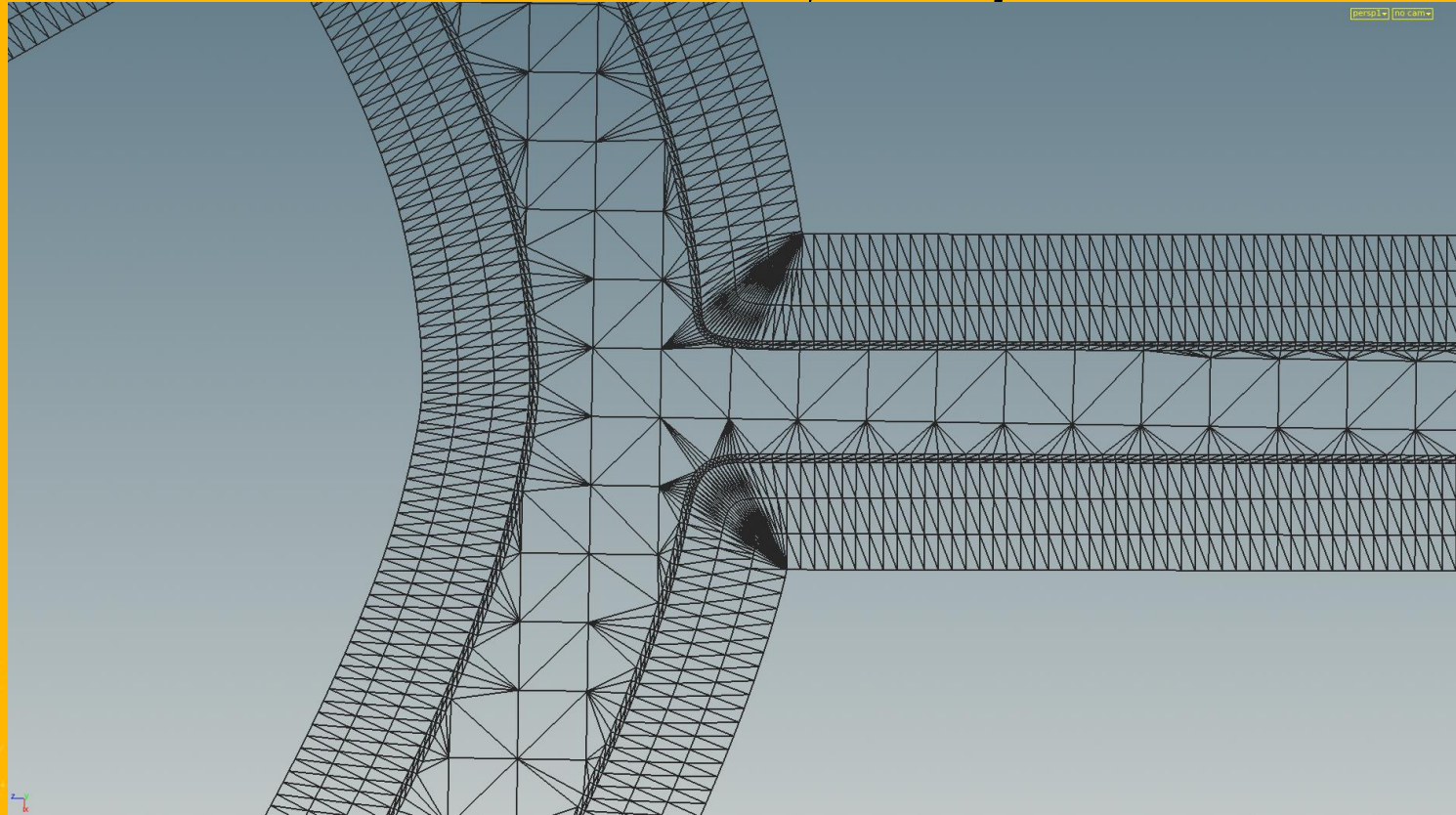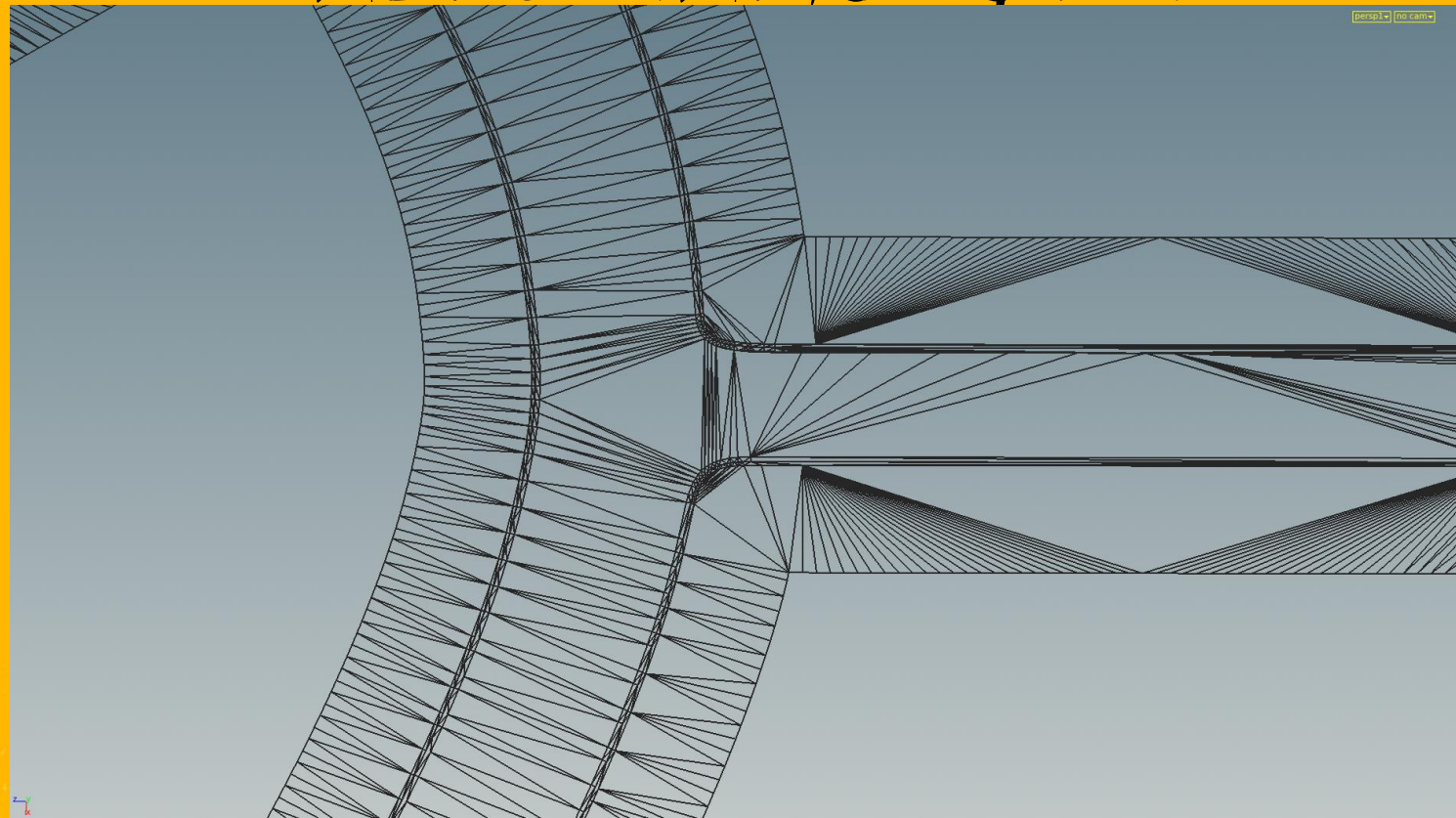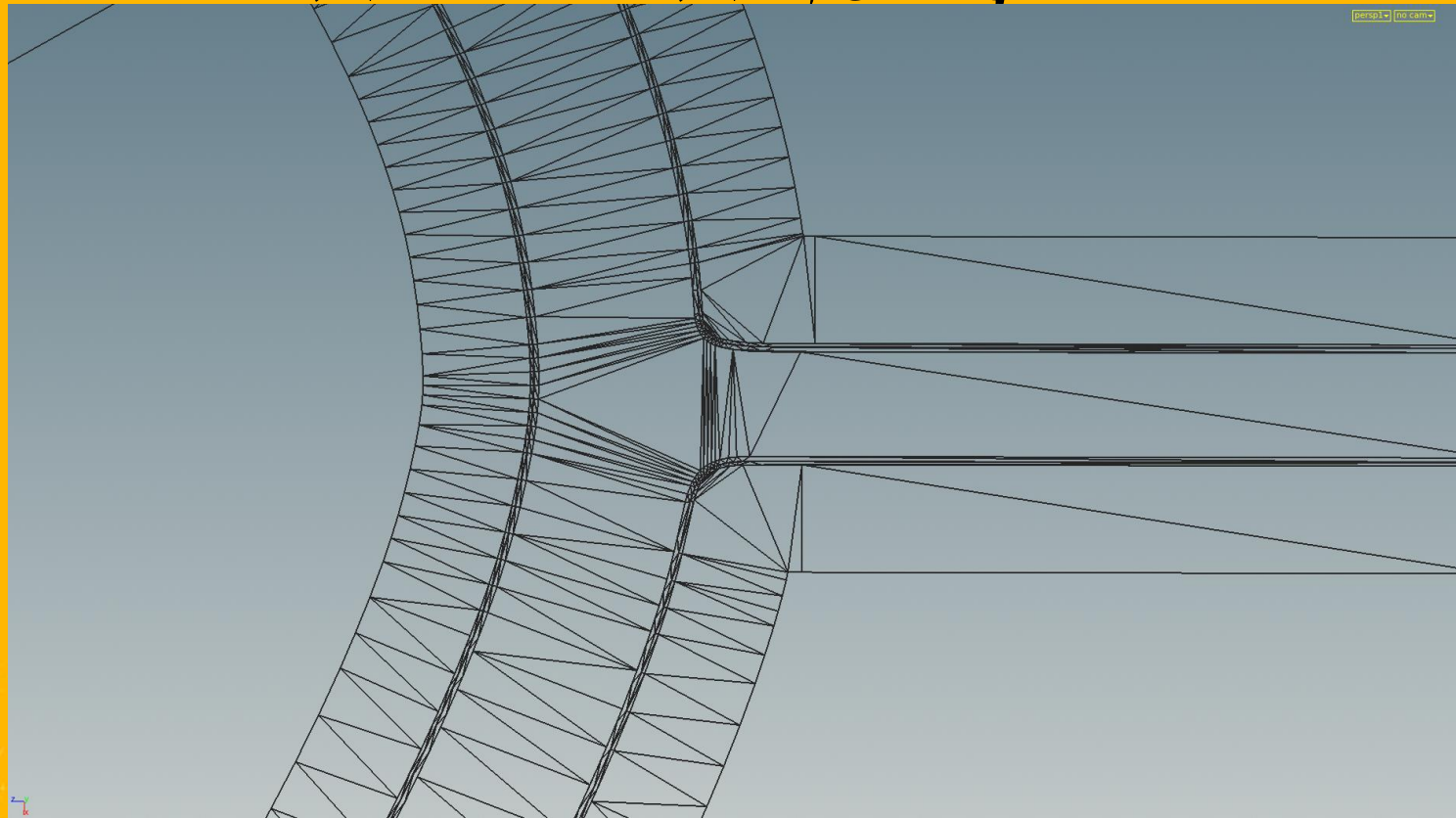
AUTOMATIC LOD'S
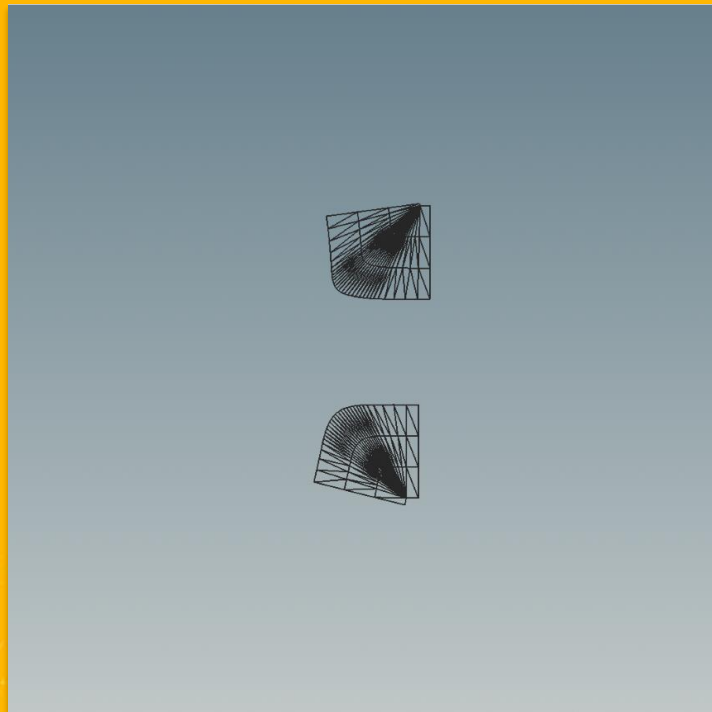
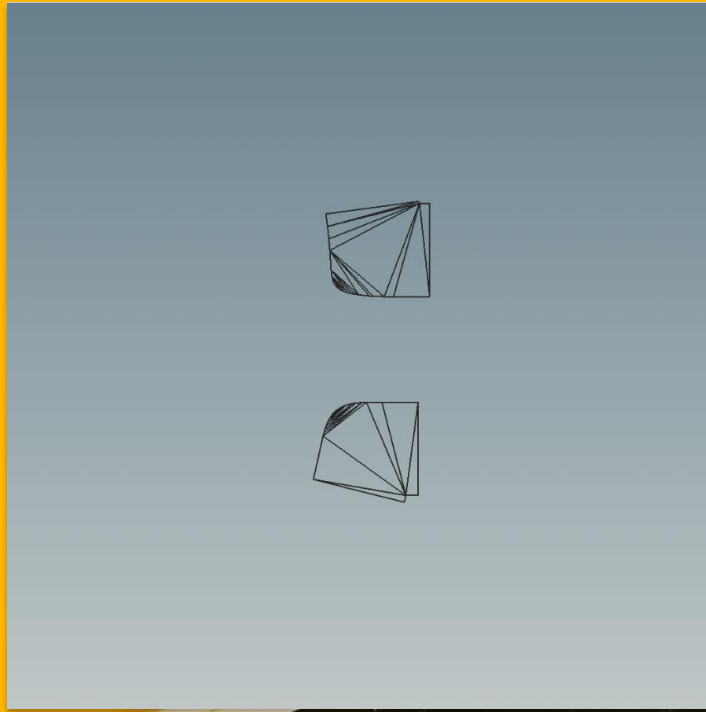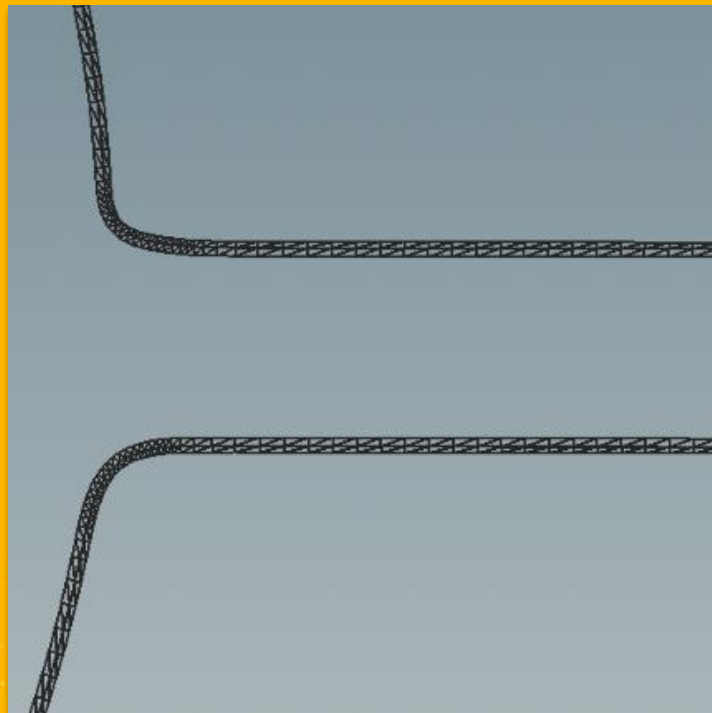# AUTOMATIC LOD'S

AUTOMATIC LOD'S

High Res LOD
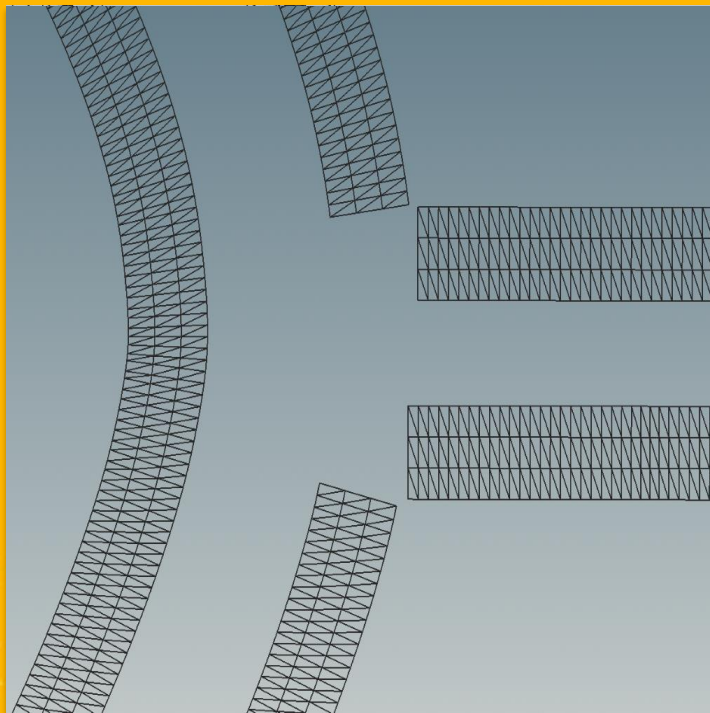
Low Res LOD

AUTOMATIC LOD'S

High Res LOD

Low Res LOD

AUTOMATIC LOD'S
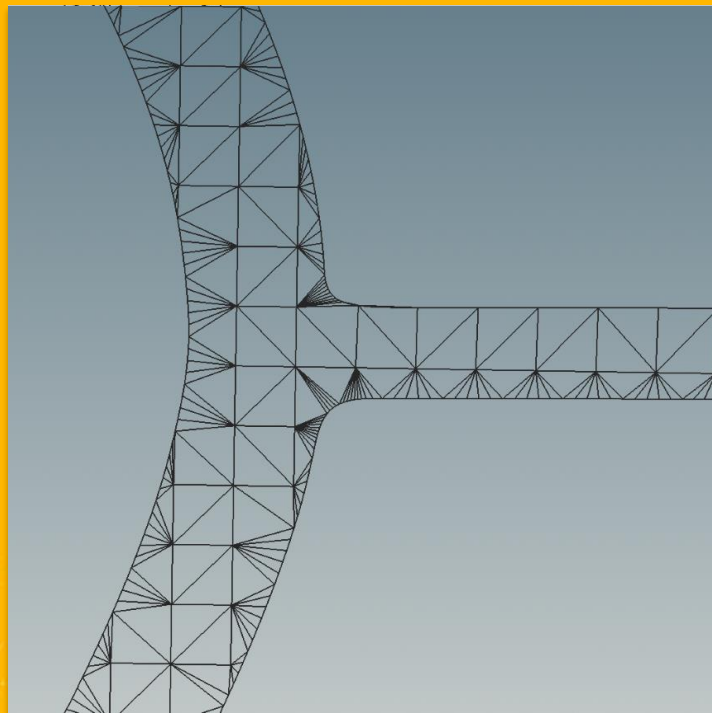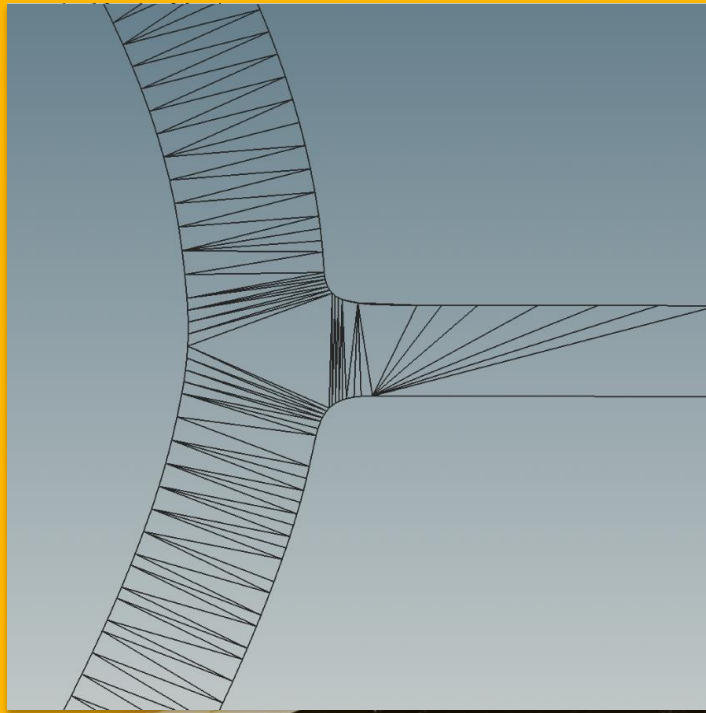
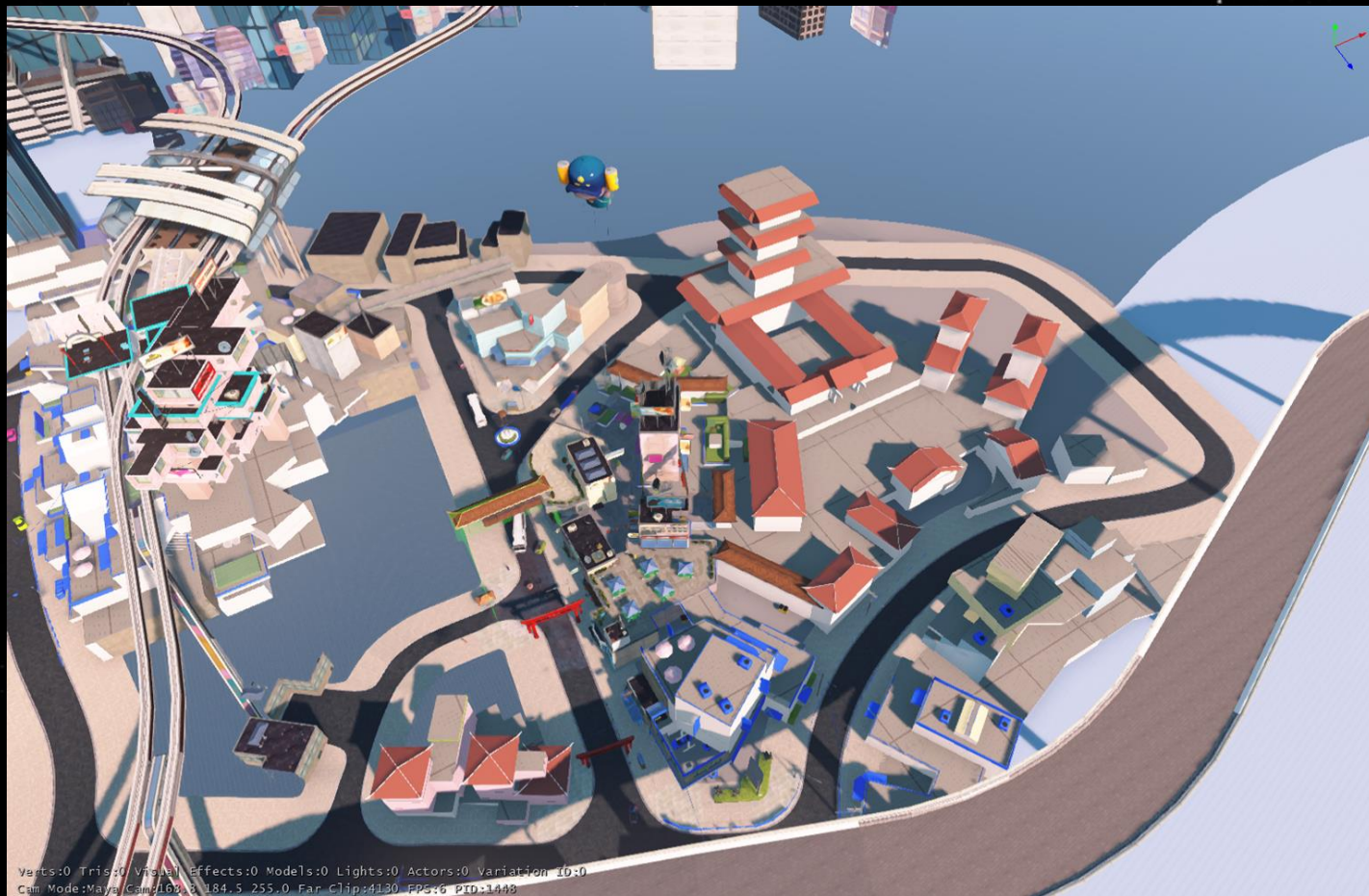## High Res LOD
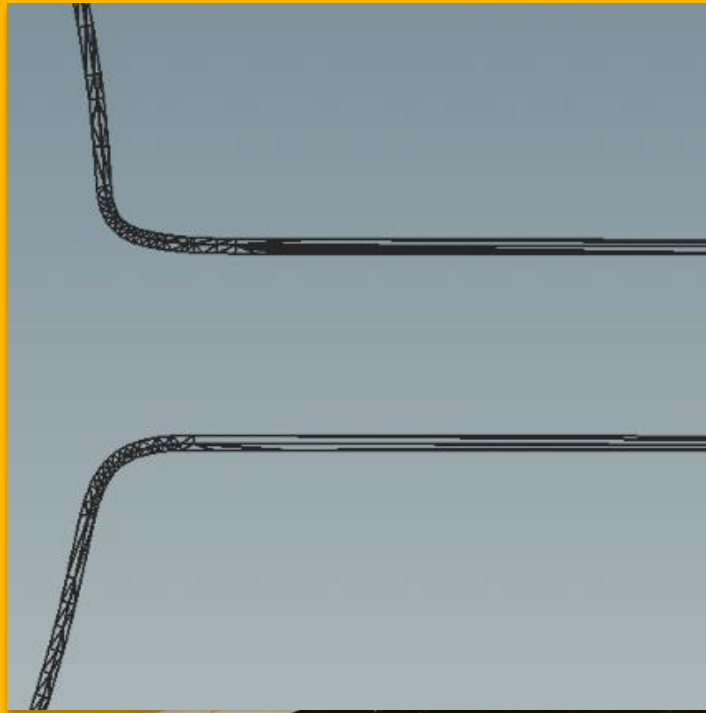
Low Res LOD

AUTOMATIC LOD'S

High Res LOD

Low Res LOD

Verts:0 Tris:0 Visual Effects:0 Models:0 Lights:0 Actors:0 Variation ID:0
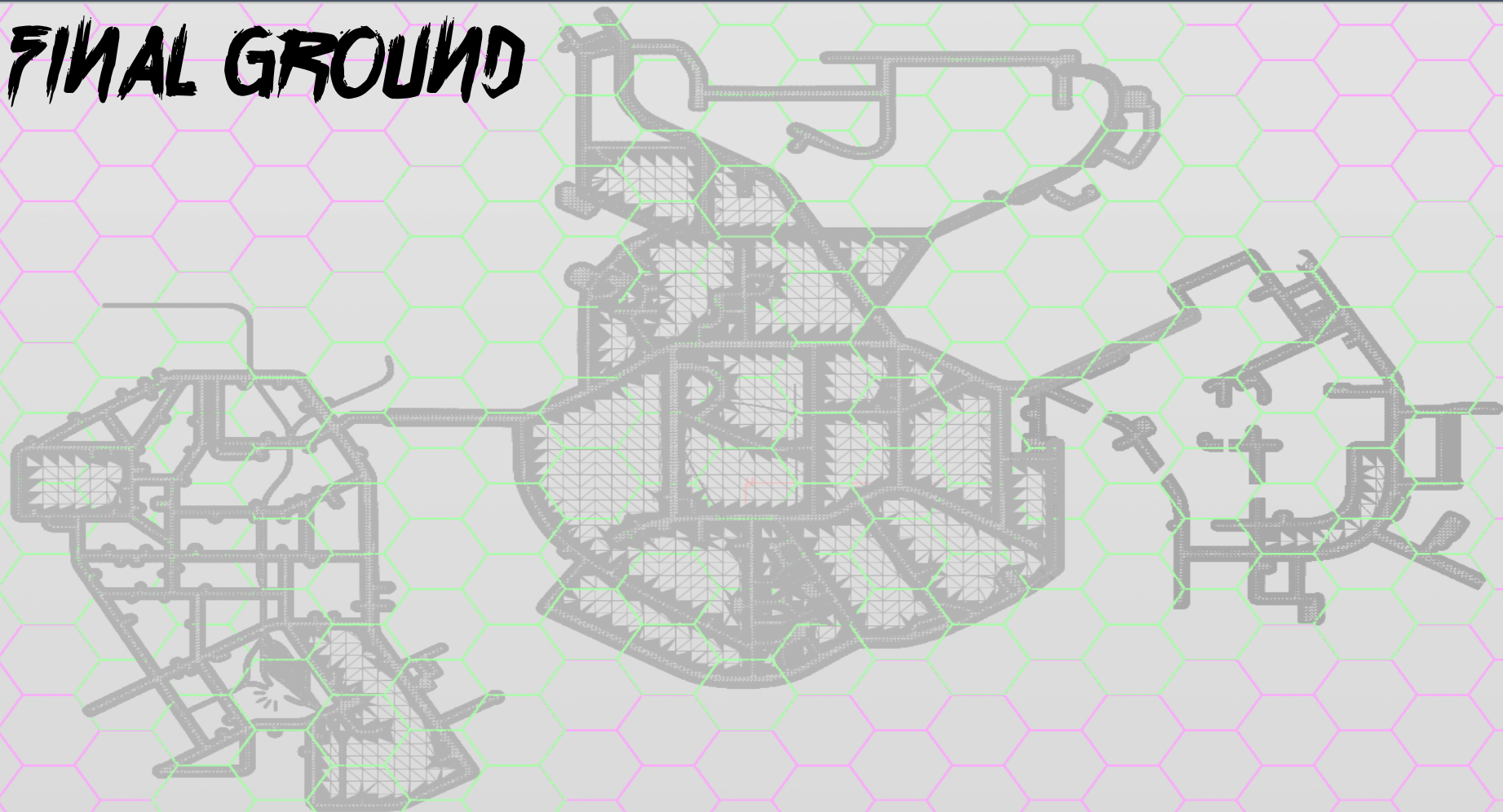Cam Mode:Maya Cam 168.8 184.5 255.0 Far Clip:4130 FPS:6 PID:1448

Hero Area after design change.

FINAL GROUND

IMPROVED EFFICIENCY

- Designer road layout change

  Hex kit system: 3-5 days env art time on flat terrain

  Procedural: first change took 30 minutes. Four additional iterations 60 minutes ➜ 15-25 days vs 90 minutes

- Custom ground creation for area 2

  Traditional: 3+ weeks of env art time

  Procedural: 15-60 minutes (matching reference sketch and terrain)

IMPROVED EFFICIENCY (CONTINUED)

- Road Decoration placement:

current system: 1 day env art time for Hero Area main street alone

Procedural: automatic- built in to road creation

PRODUCTION PRACTICALITY

- Critical that production processes serve all needs of Sunset Overdrive
  - Meet gameplay demands
  - Match designer layout with sufficient fidelity
  - Preserve integrity & quality of environment art
- Artists need sufficient control

MODIFIED IMPLEMENTATION

Some features not enough artist and designer control for the dynamic design process and game play

- Separate automatic overpass/tunnel/freeway system

- Curve height and/or terrain determine elevation

- Separate train track system

MODIFIED IMPLEMENTATION (CONT.)

- No signs, meters, lights

  Specific placement needed for gameplay

- No crosswalks

  - Complex intersections

  - Crosswalk gameplay markup ideas WIP

  - Eventually hand placed decals which could have been automated

PRODUCTION EFFECTIVENESS

- Streets, sidewalks and most gray spaces generated procedurally

- Were able to completely re-design an area well into production

- Designers relieved to be able to make changes and get quick updates

- Ground – 80x faster flat ground, 168x on varied terrain

OTHER PROCEDURAL SYSTEMS

- Highway- 25x faster than traditional methods
- Roller Coaster - 100x faster
- Elevated train - 80x faster
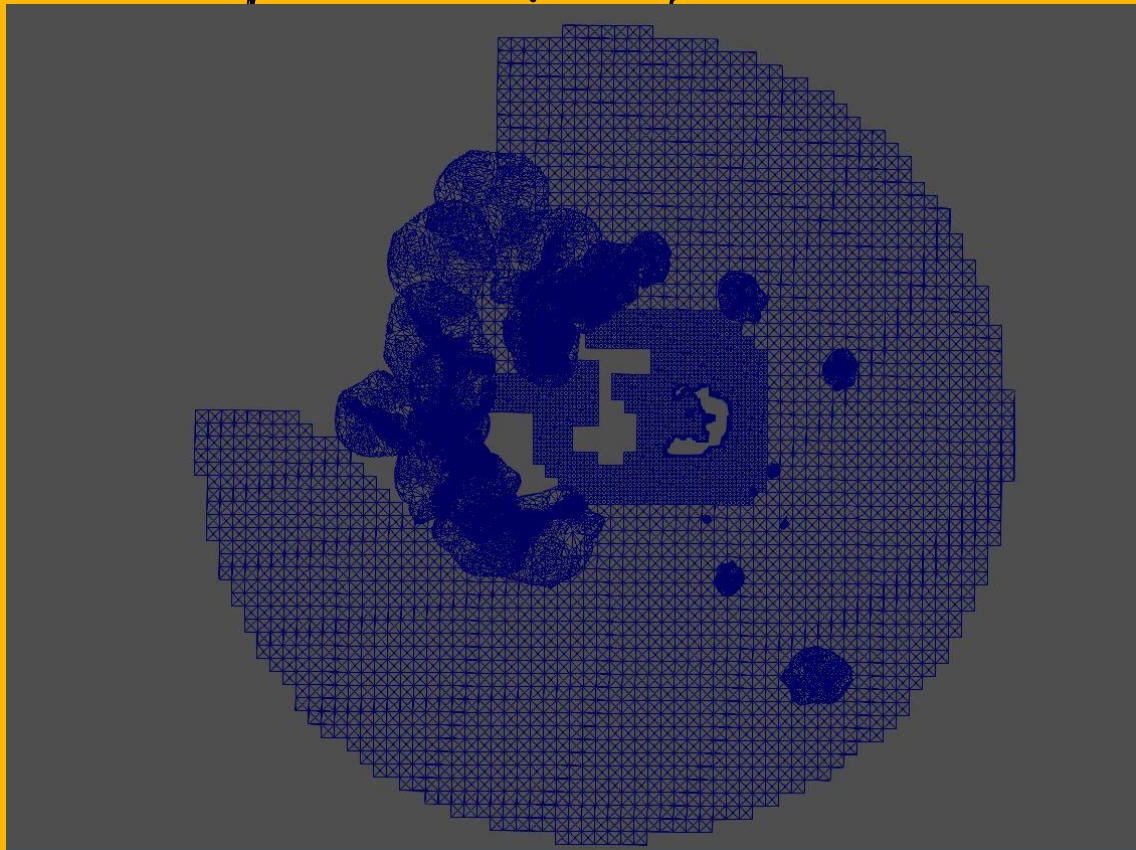- Ground train - 80x faster
- Ocean - >1000 faster
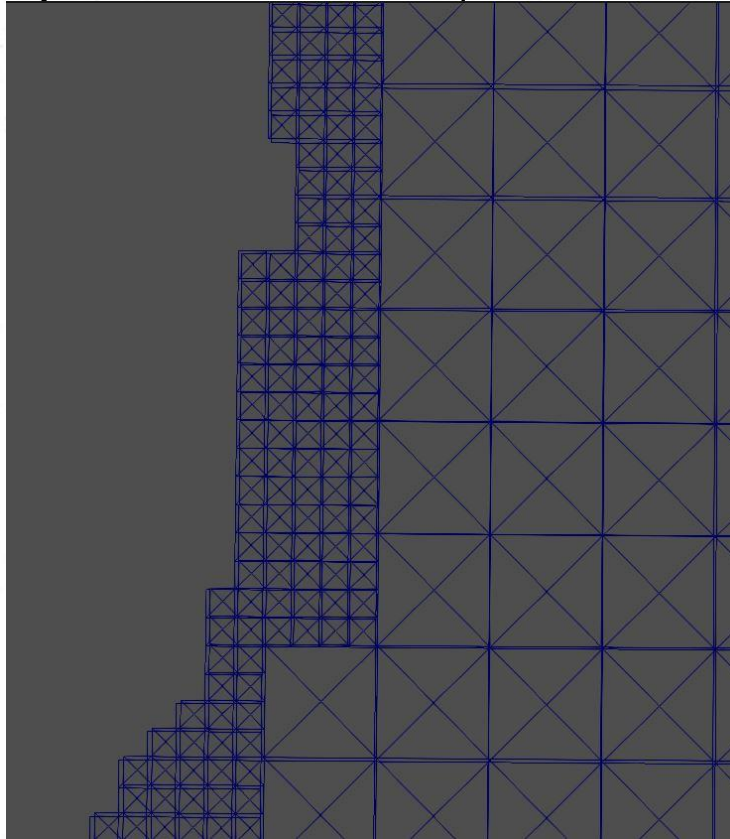- Lava - > 150x faster

OCEAN SYSTEM
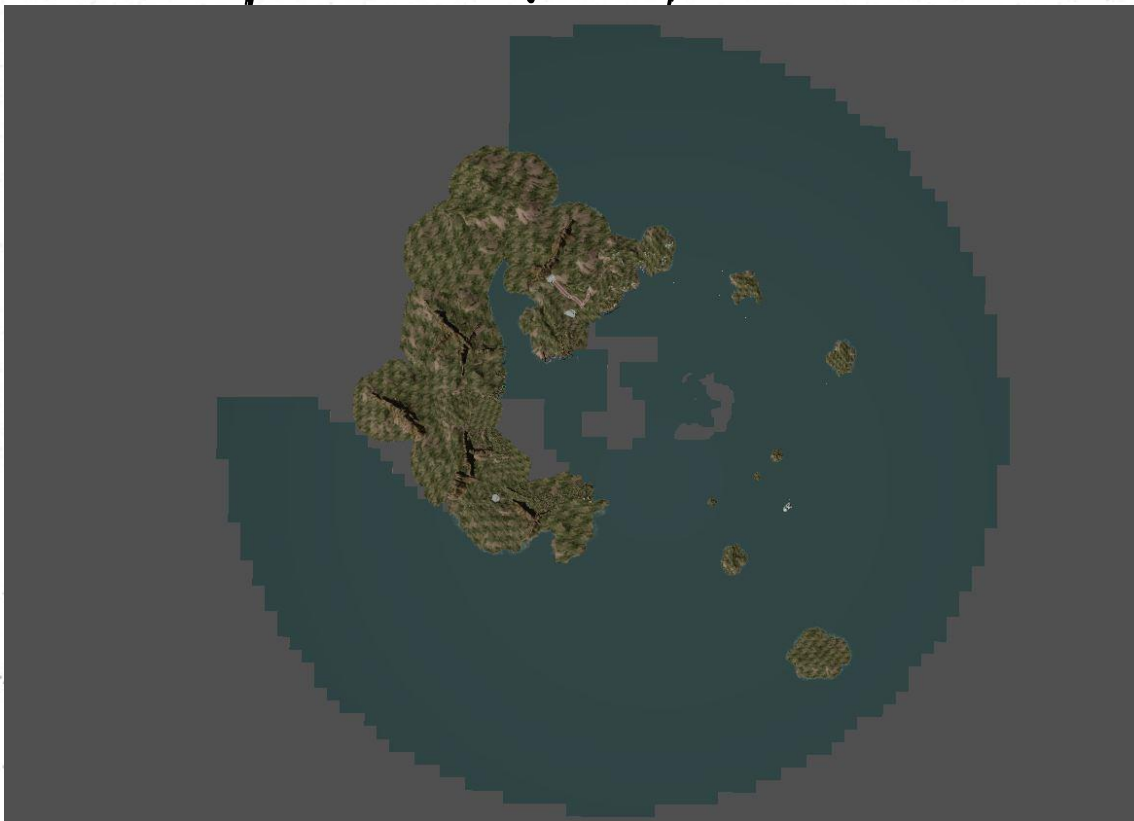
OCEAN SYSTEM
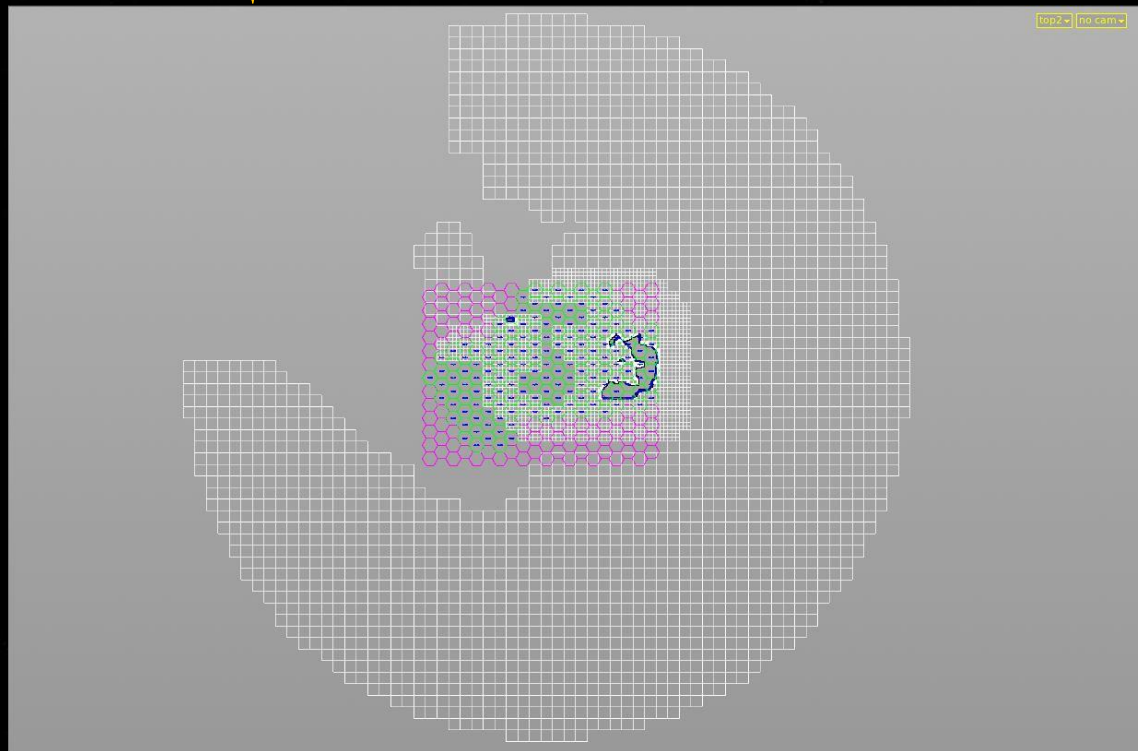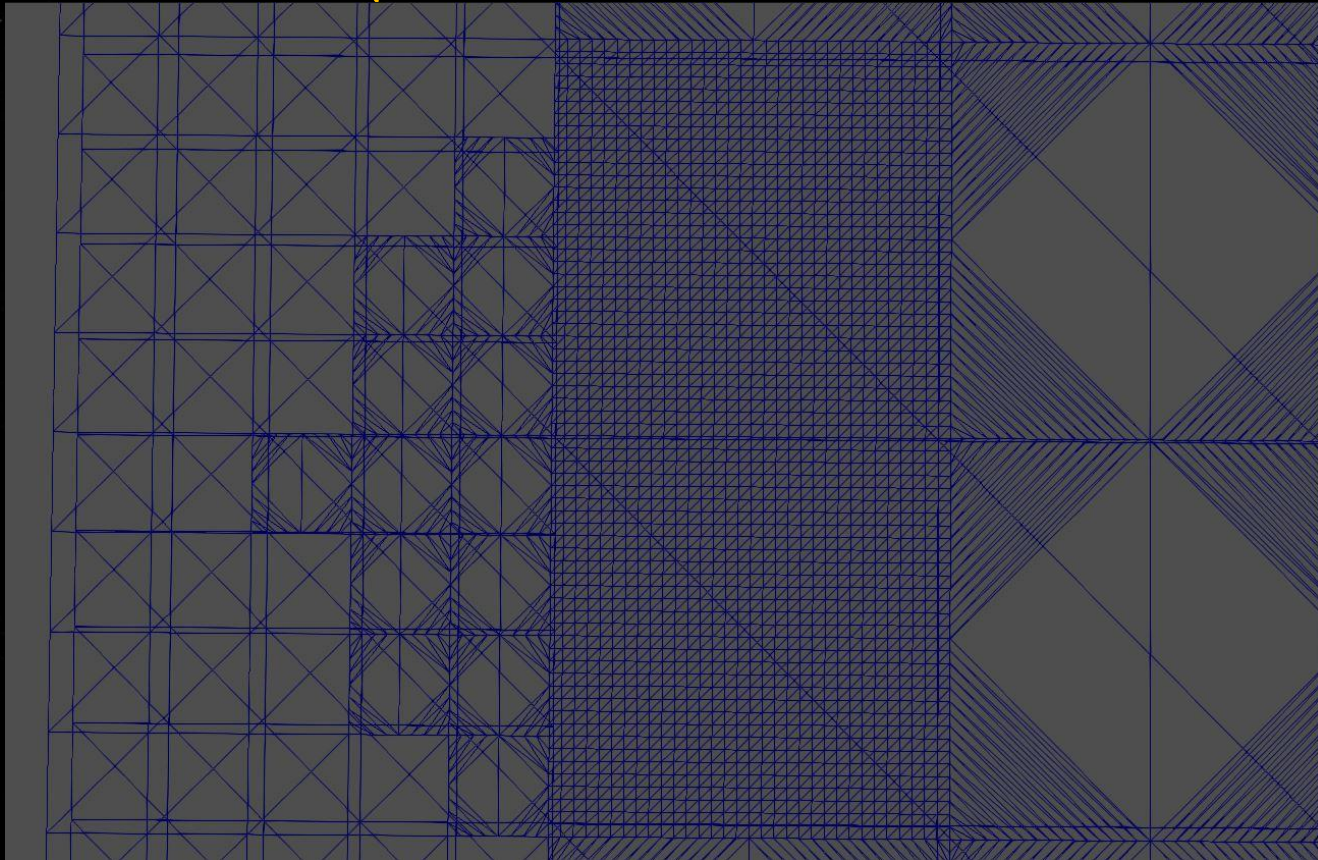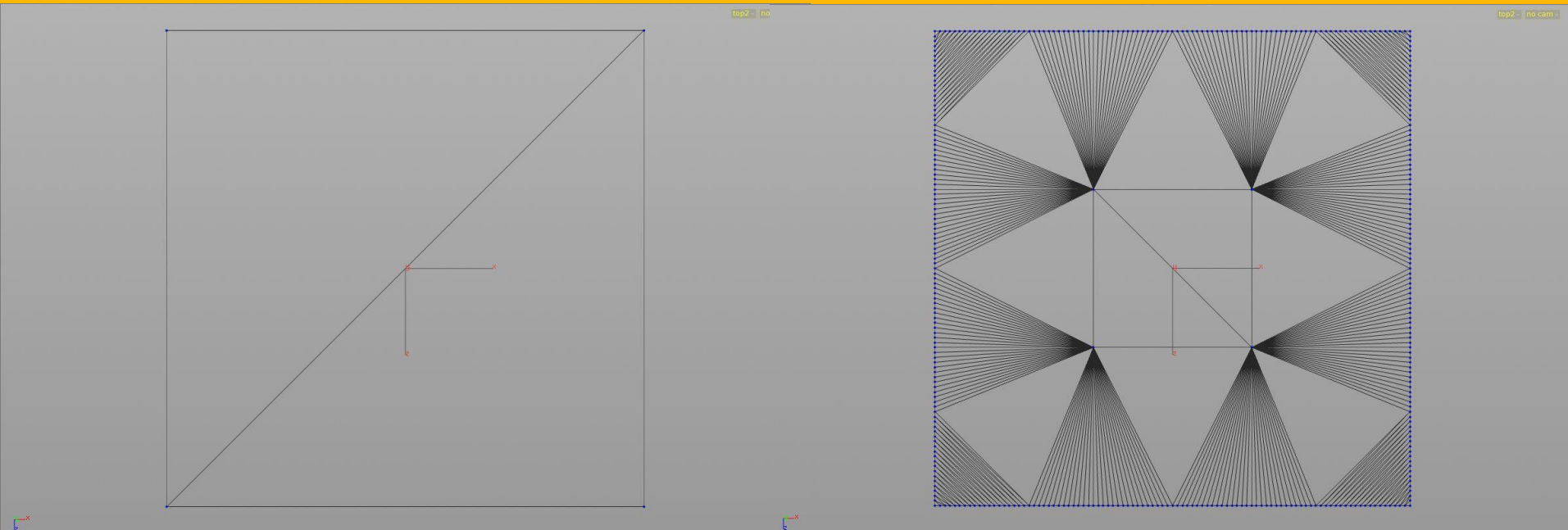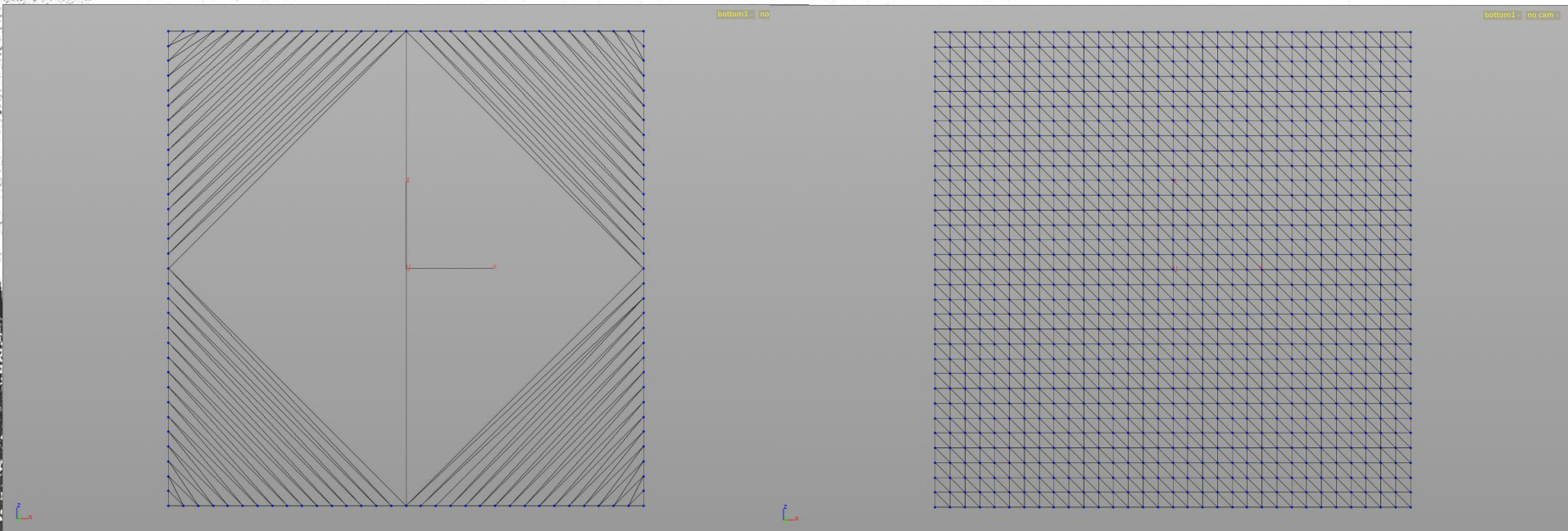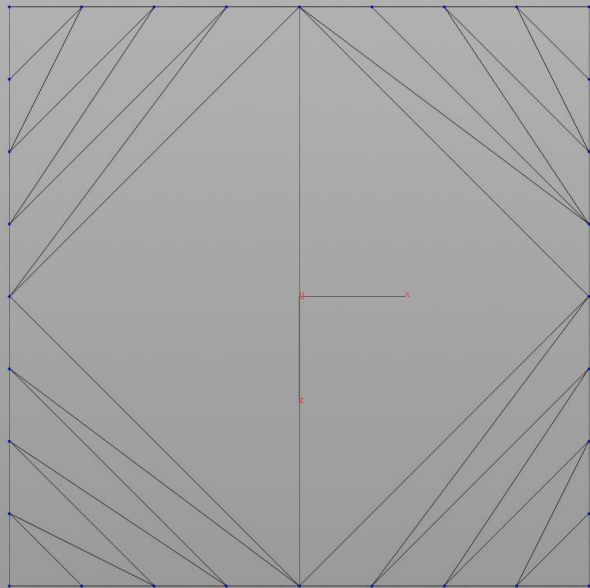
OCEAN SYSTEM

OCEAN SYSTEM

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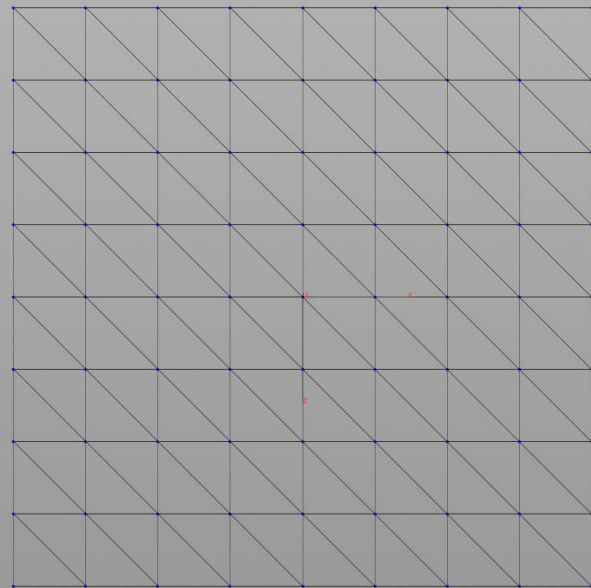
OCEAN SYSTEM

OCEAN SYSTEM
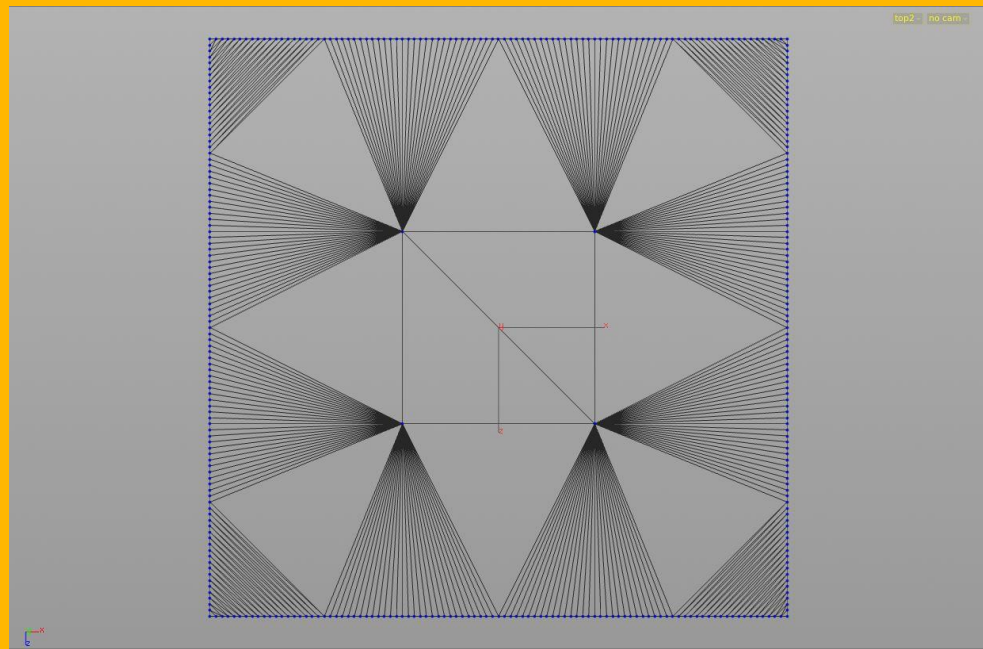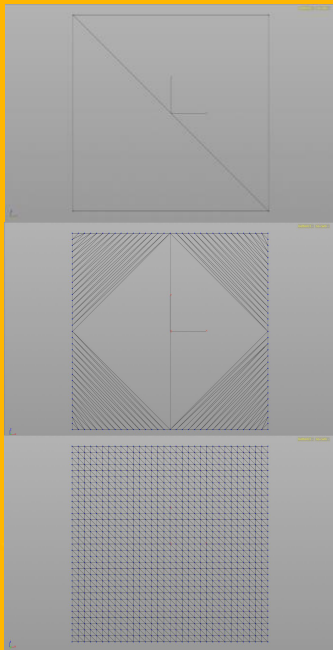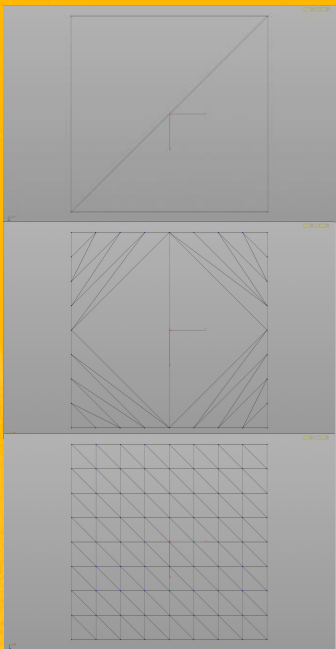
OCEAN SYSTEM

OCEAN SYSTEM

- 96m, 32m and 8m assets with LODs maintain coincident vertices so material displacement does not create rips
- Takes seconds - >1000x faster than manual placement

CONCLUSION

- All procedural systems minimum 20x faster – typically 100-300x

- Removed tedious work and allowed higher number of iterations

- Efficiency is from carefully meeting the needs of production

- Continue systems development to better meet future needs

THANKS

- Insomniac Games
- Side Effects Software

QUESTIONS?