

# **DIVERGENT TECTONICS**

*Design Optimization to Robotic Production Framework*

**DIA**

Dessau International Architecture School

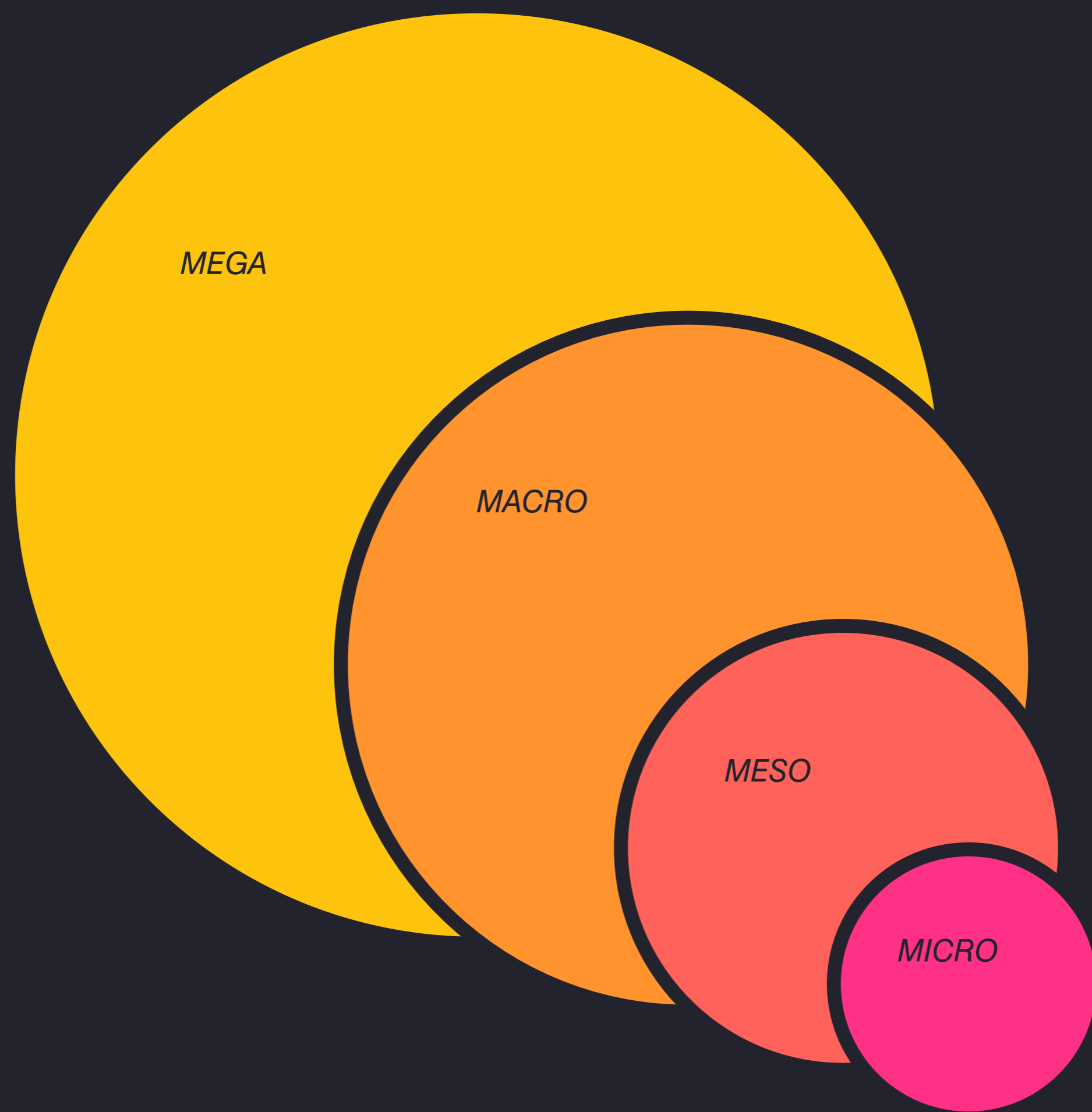
Anhalt University Department 3

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Sina Mostafavi



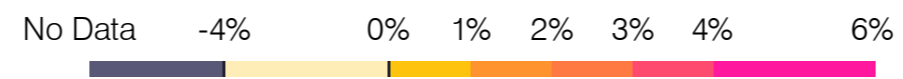
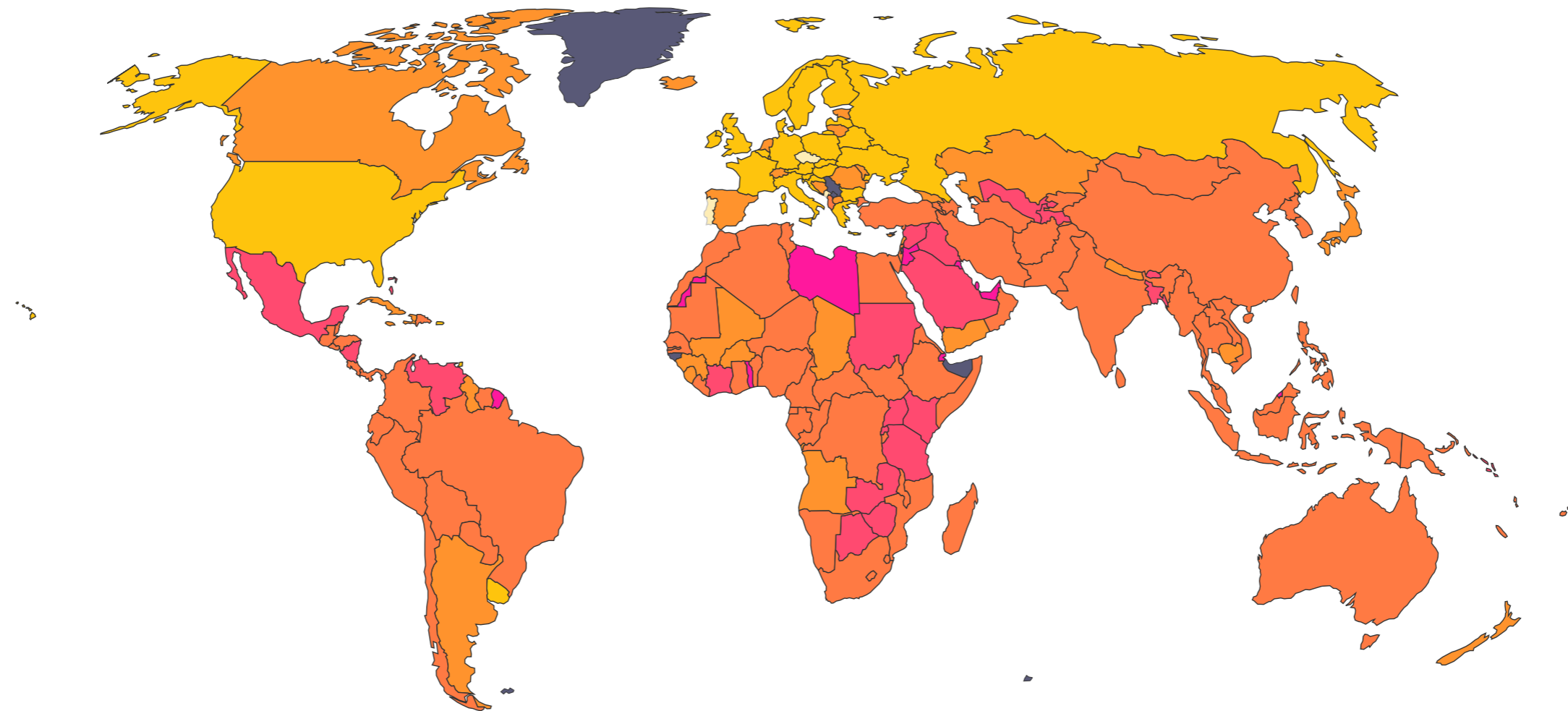
*MEGA*

*MACRO*

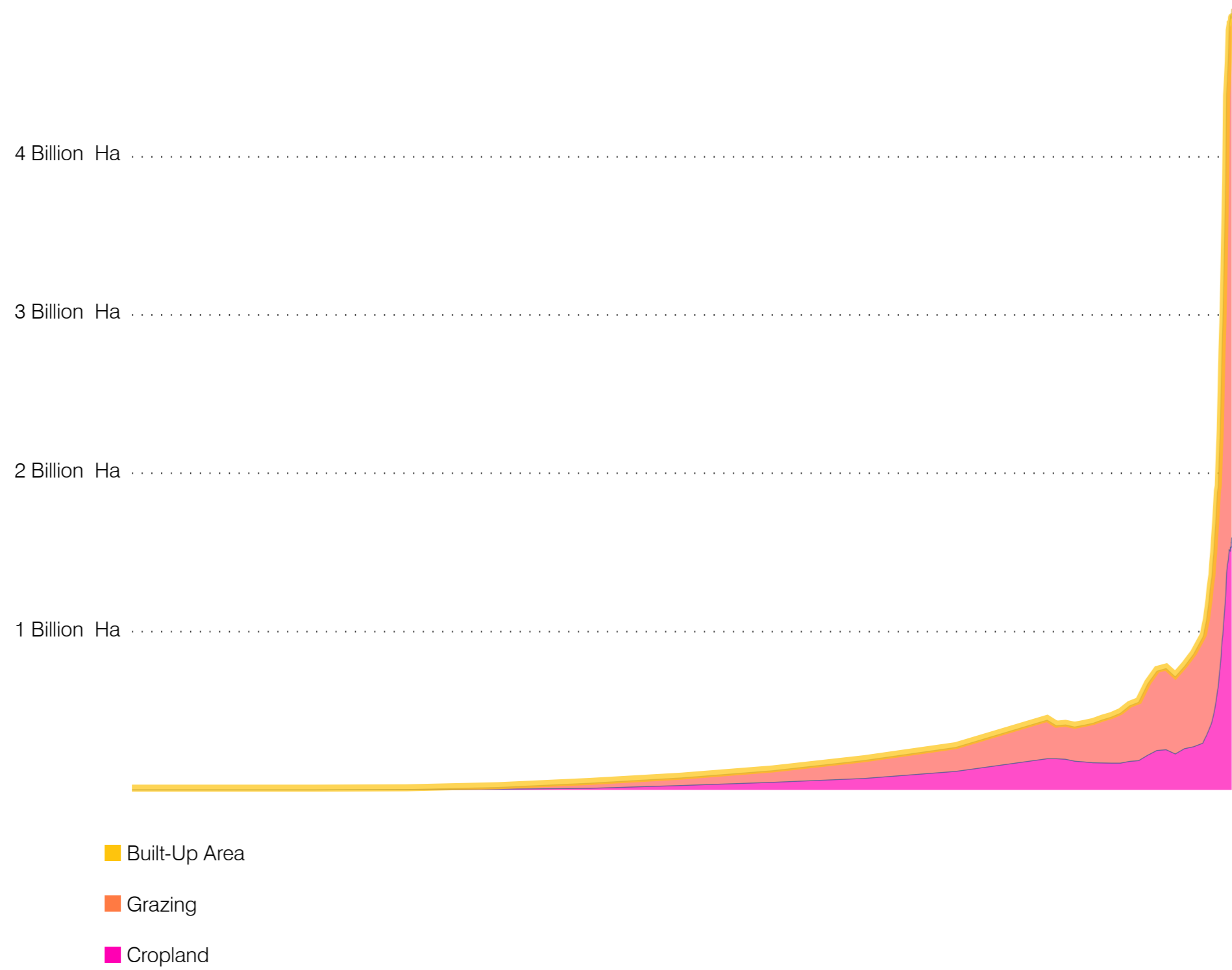
*MESO*

*MICRO*

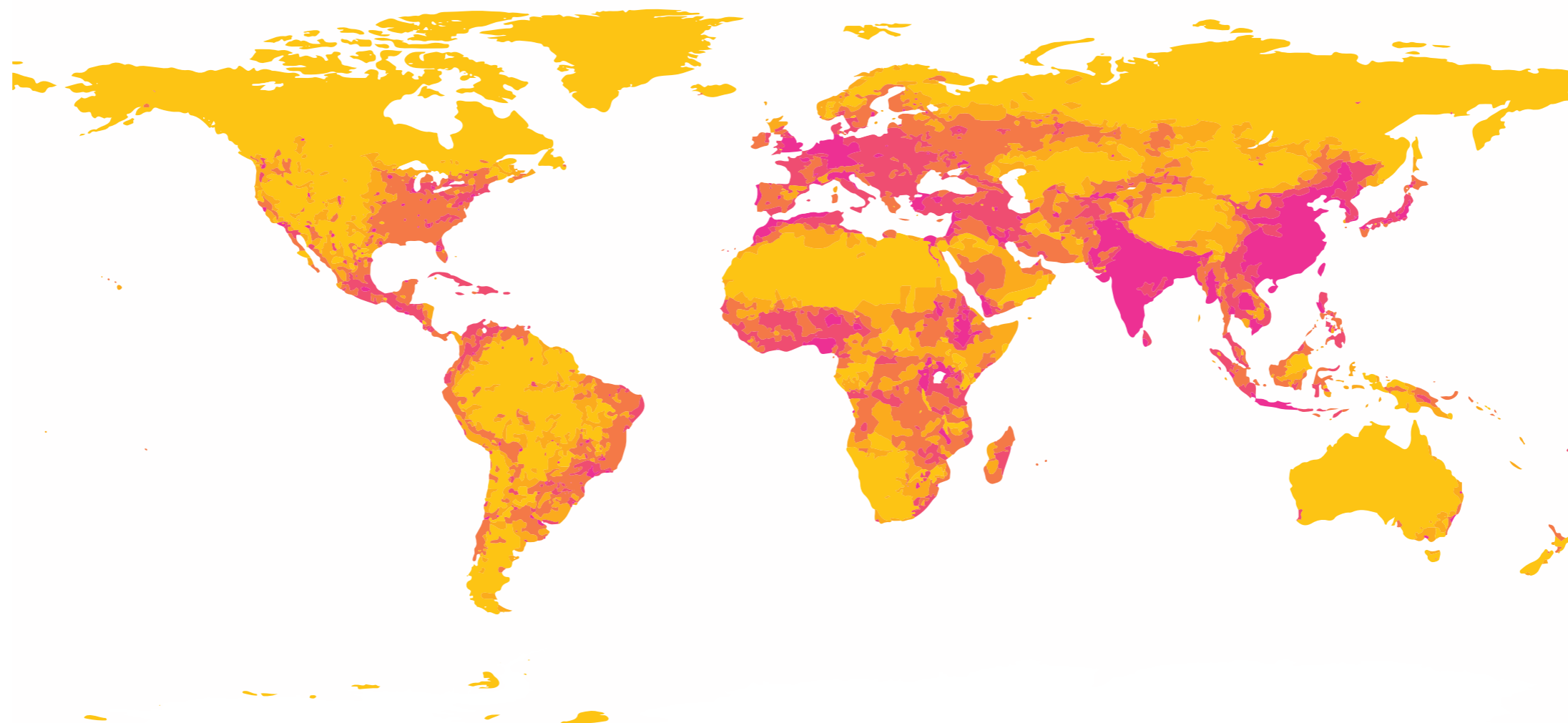
*MEGA Scale*



*Annual Global Population Growth Rates*

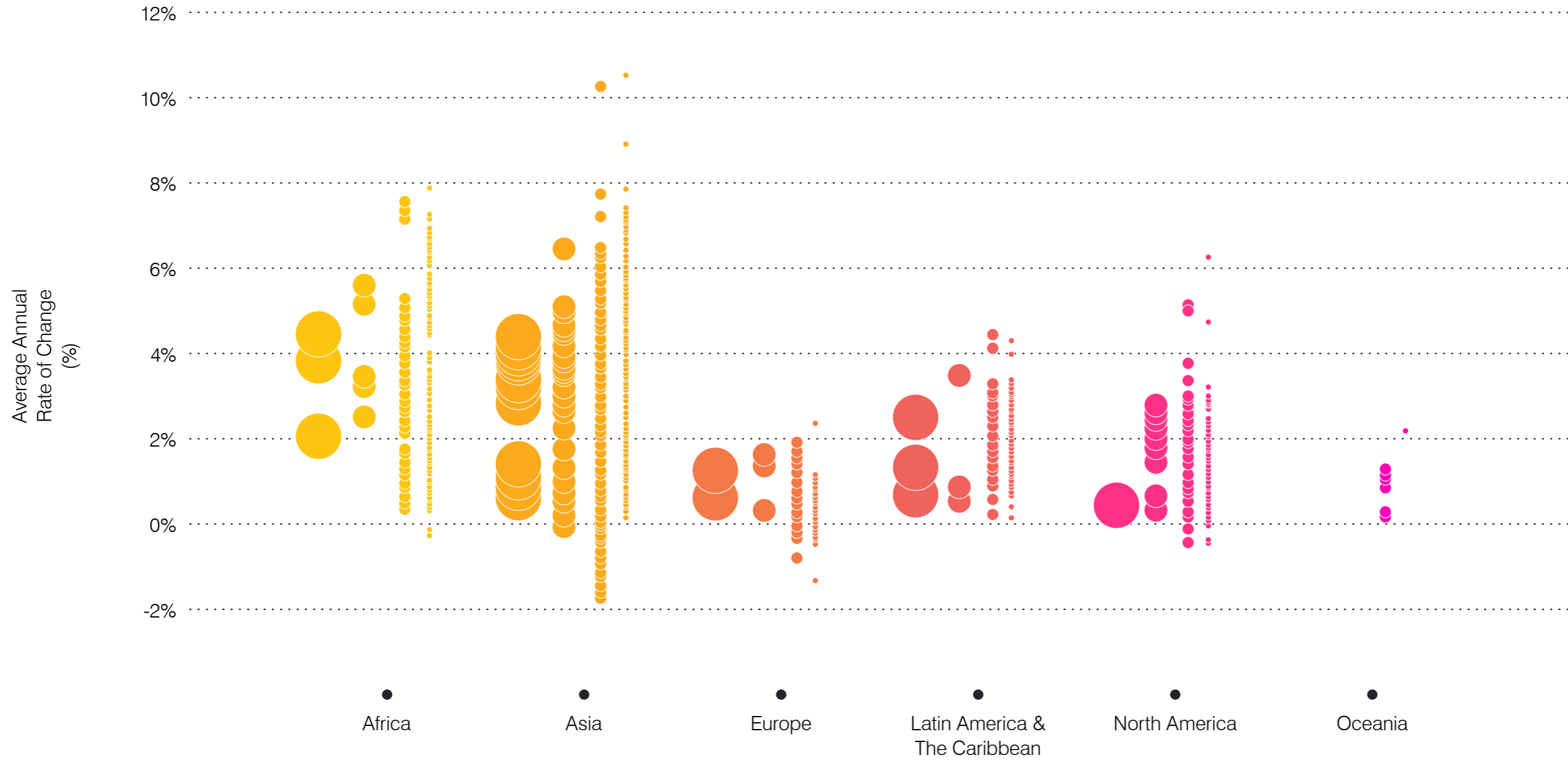


*Global Built-Up Area Growth*



- Under 1 Person/Km<sup>2</sup>
- 1 to 25 Persons/Km<sup>2</sup>
- 26 to 50 Persons/Km<sup>2</sup>
- 51 to 100 Persons/Km<sup>2</sup>
- Over 100 Persons/Km<sup>2</sup>

*Global Population Distribution*



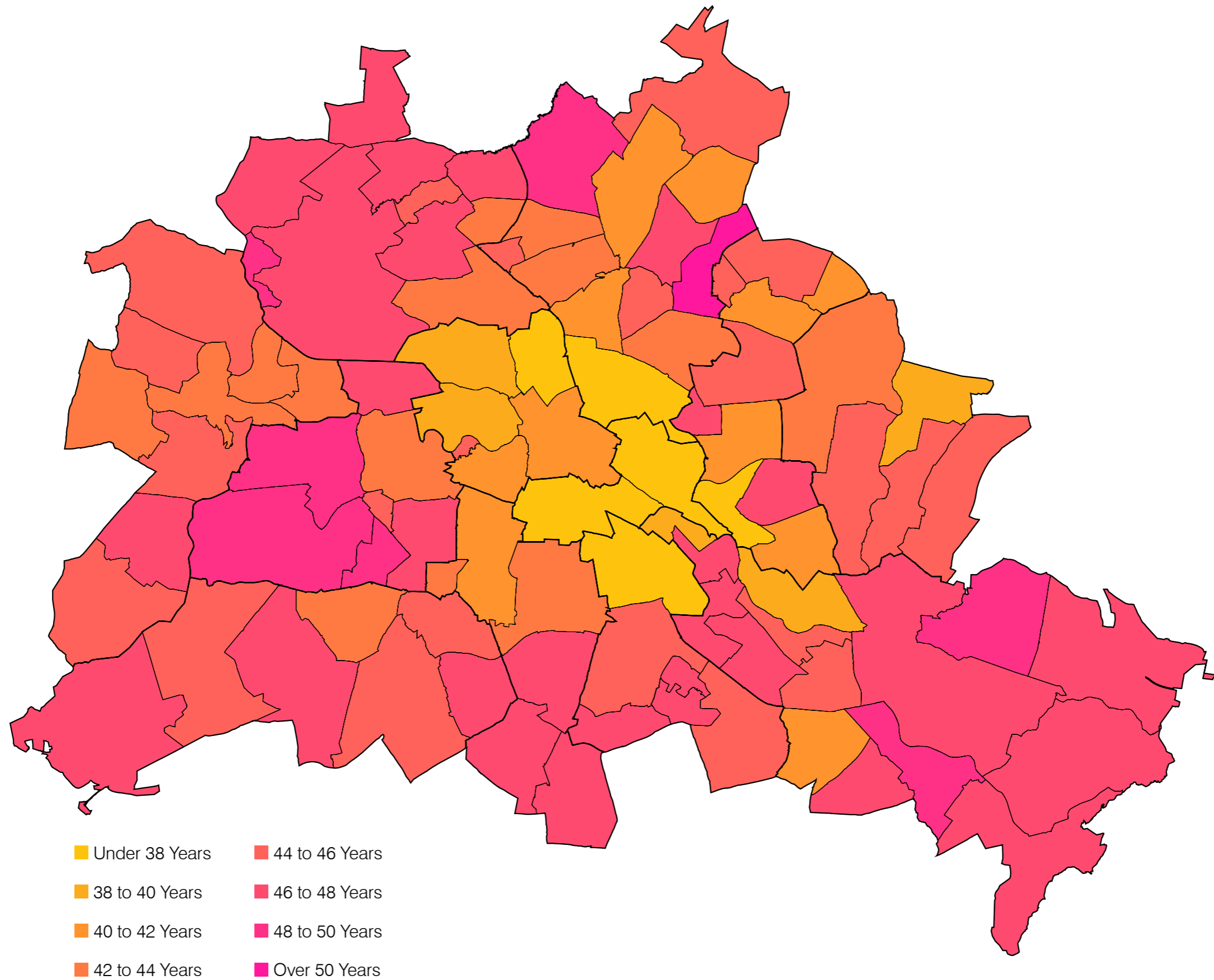
- 10 Million Residents or More
- 5 to 10 Million Residents
- 1 to 5 Million Residents
- 0.5 to 1 Million Residents

*World Cities Sizes*

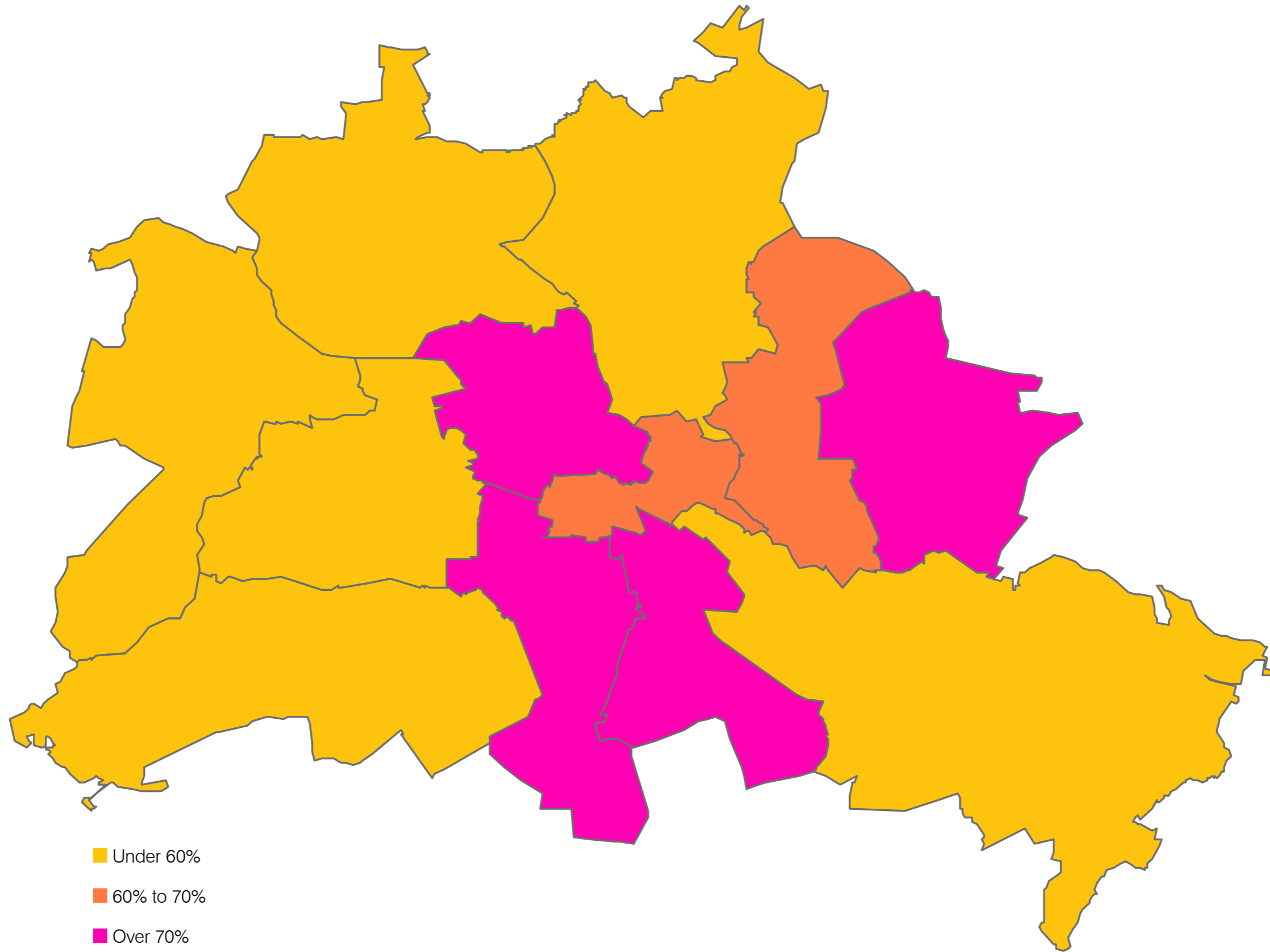
*Berlin*





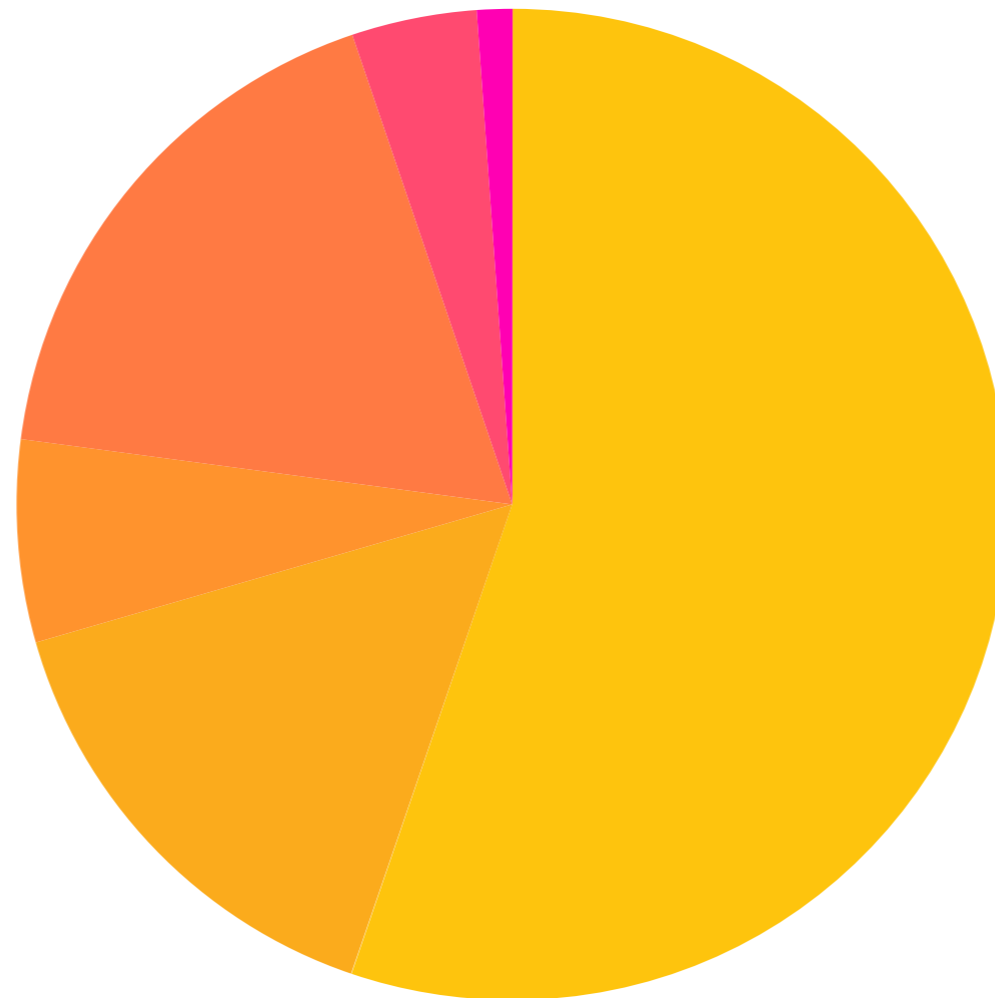


*Age Groups*



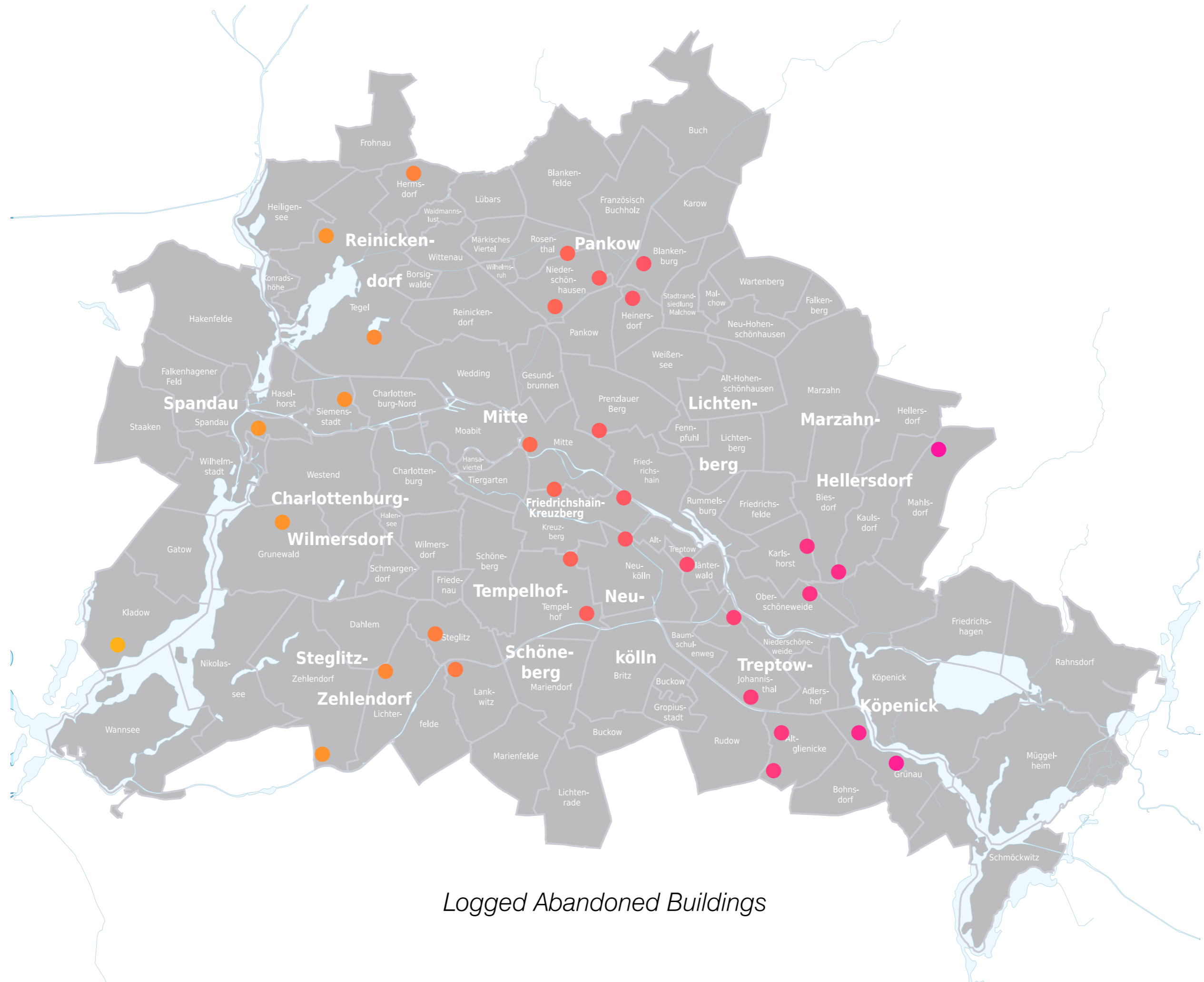
- Under 60%
- 60% to 70%
- Over 70%

*Percentages of Built-Up Areas*

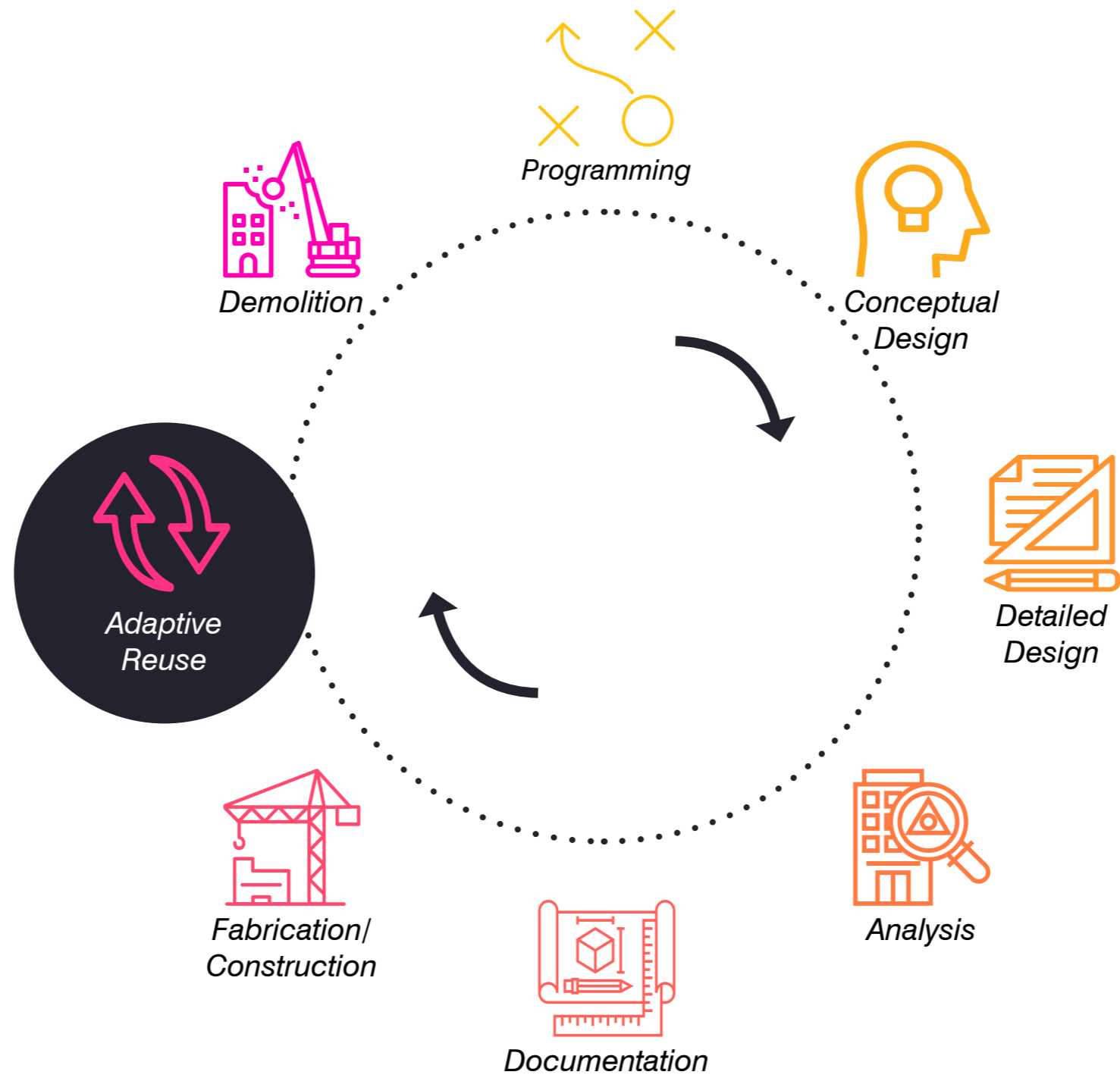


■ Settlements: 49,242 Ha	■ Forests: 15,756 Ha
■ Roads: 13,582 Ha	■ Landscape: 3,633 Ha
■ Water: 5,886 Ha	■ Vegetation: 1,013 Ha

*Land Use Distribution*



*Logged Abandoned Buildings*



*“Building within a building”*

*Architectural space as a valuable asset that should benefit its local society*



*From Passively Unused*



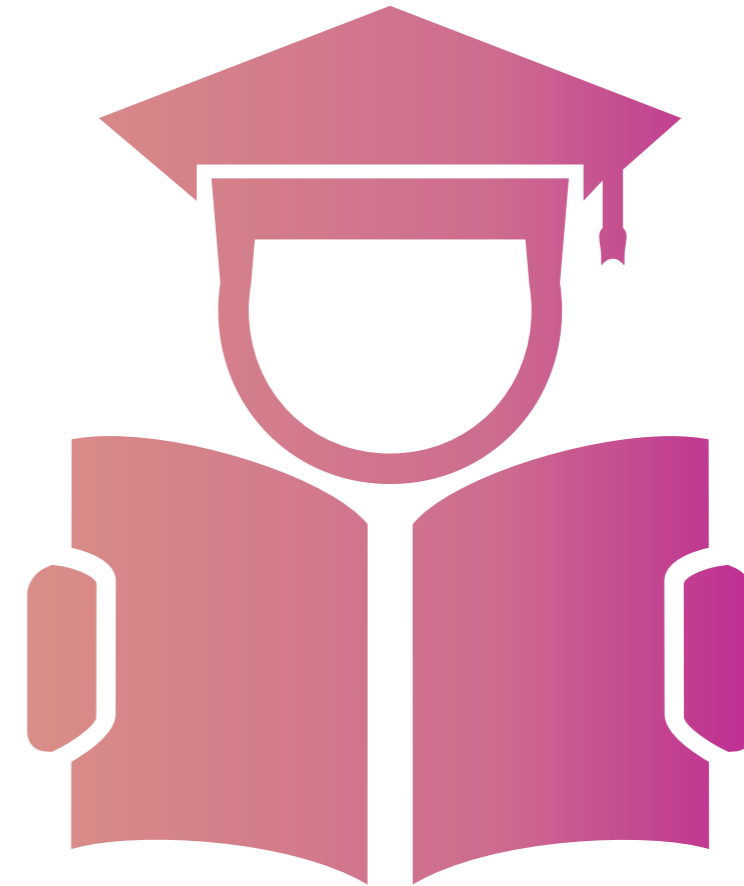
*To Actively Serving Society*



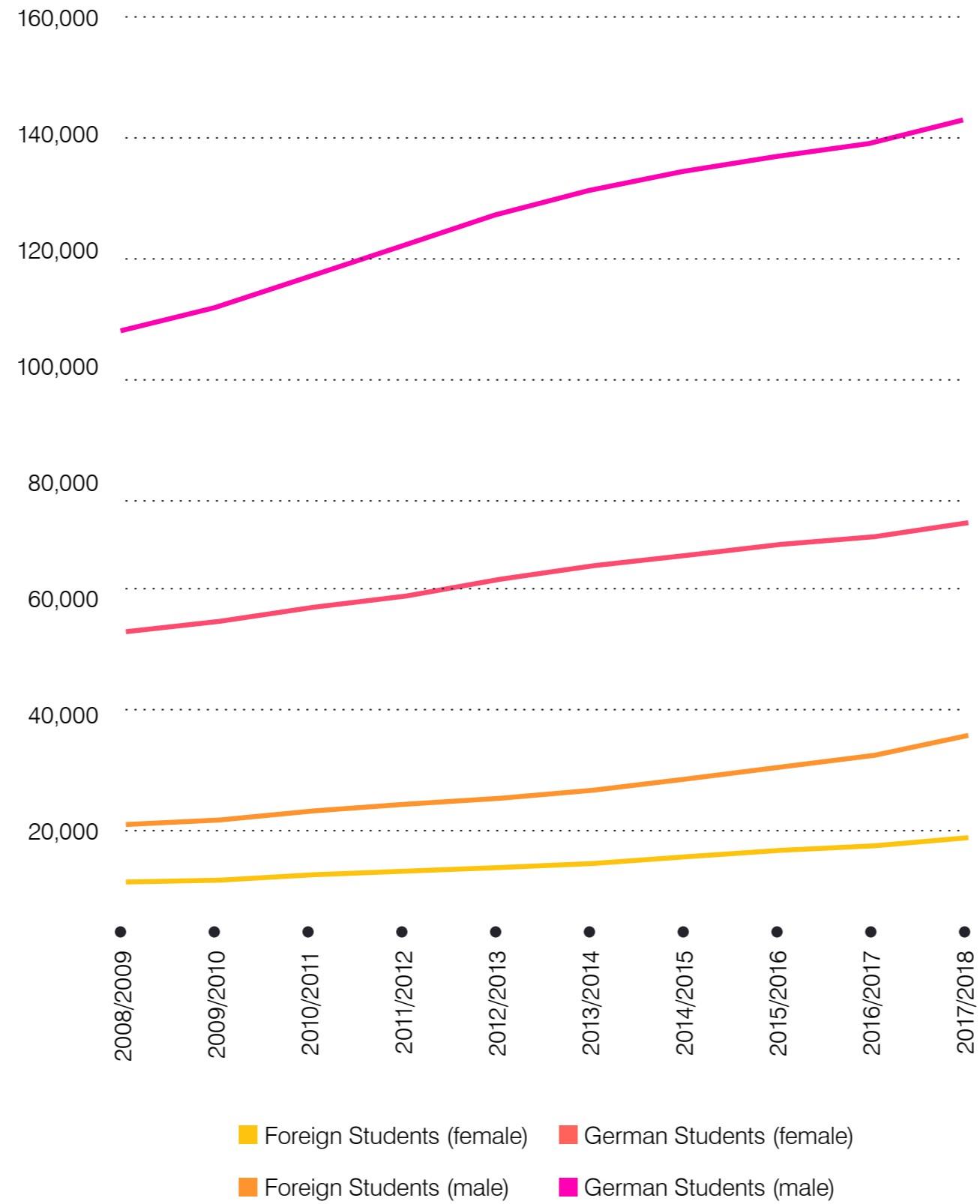




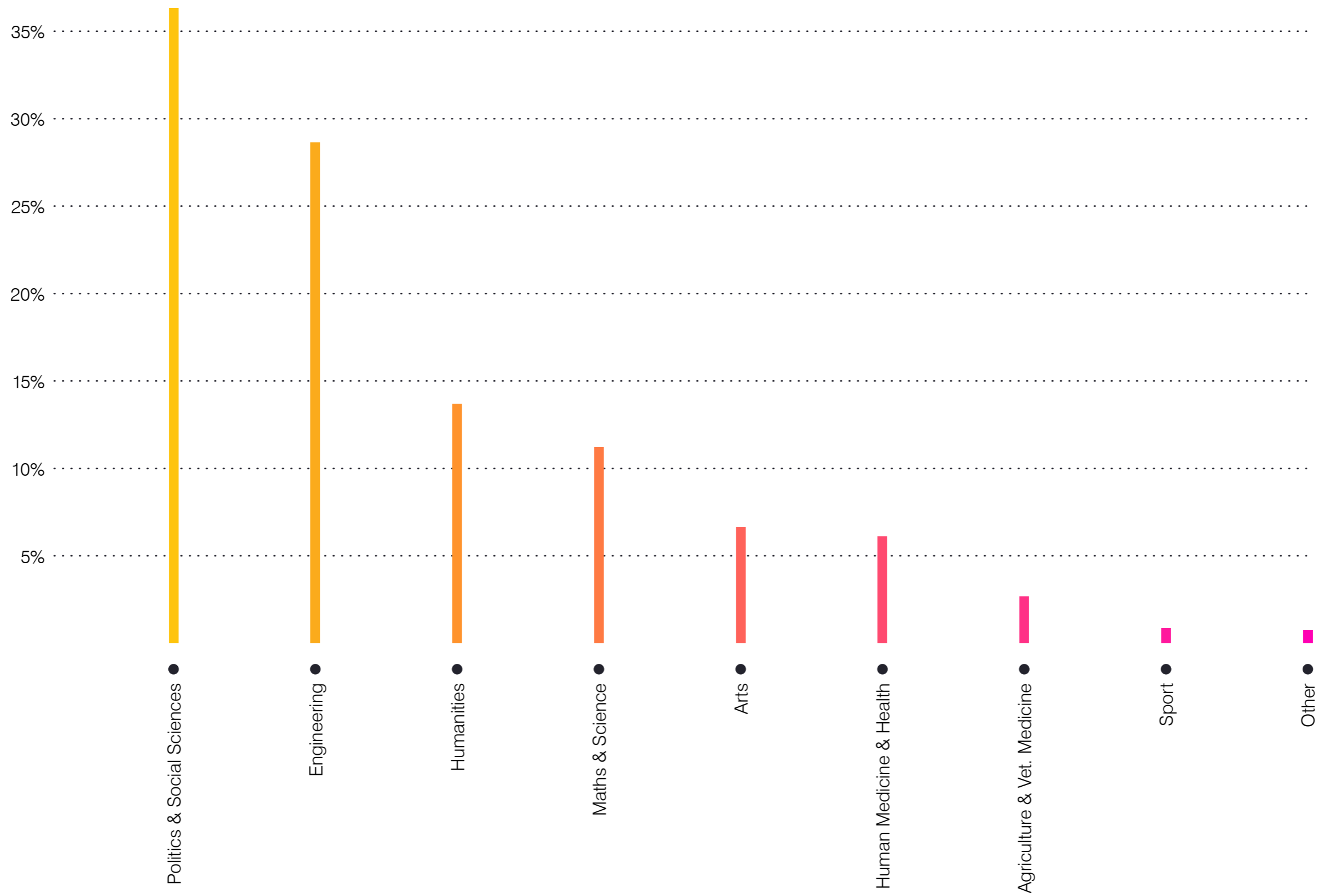
Berlin has **4** public research universities and **27** private, professional and technical colleges (Hochschulen), offering a wide range of disciplines.



**188,000** students were enrolled in the Winter semester 2017/2018, **20%** of which have an international background.



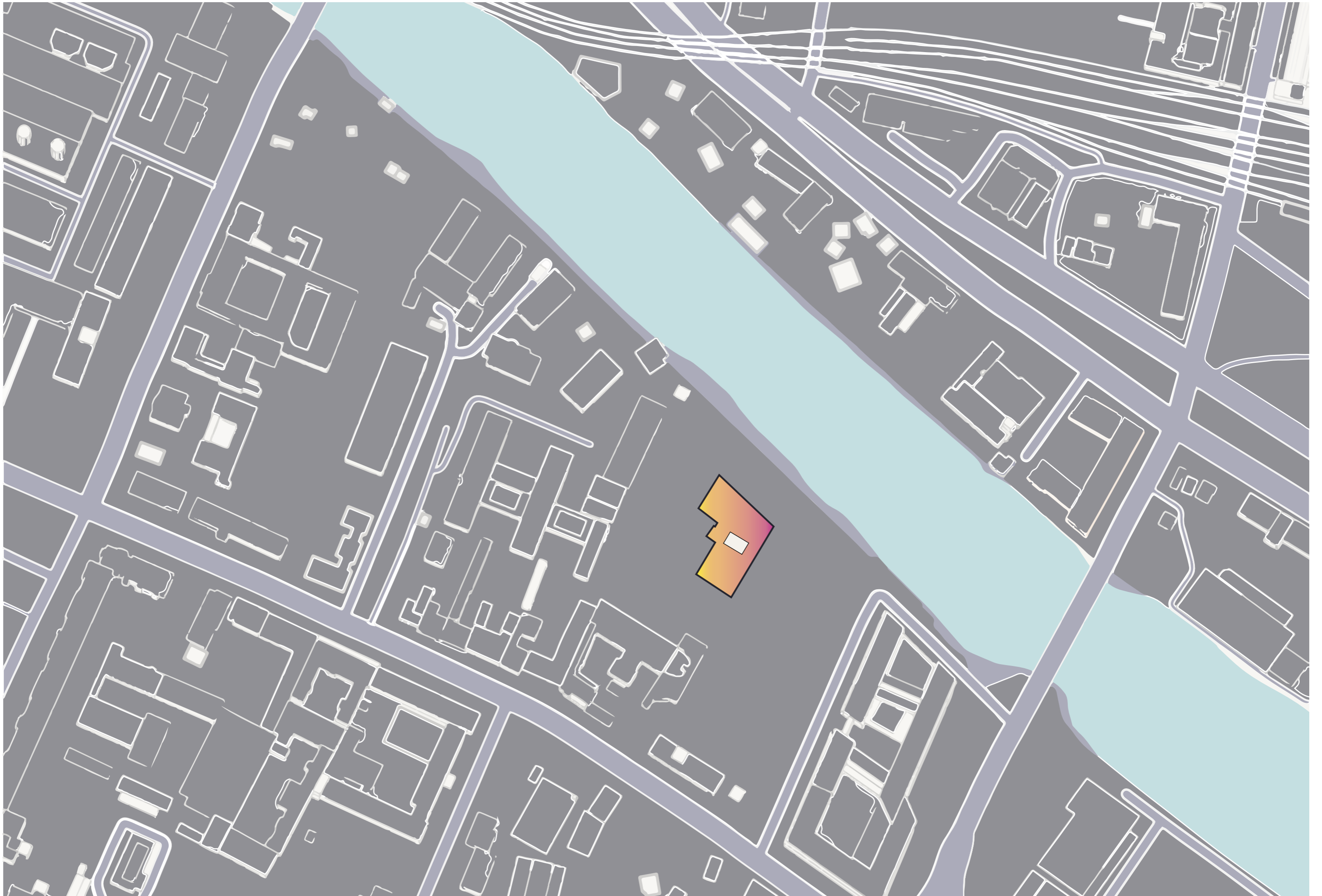
*Students Enrolled in Higher Education Institutions*



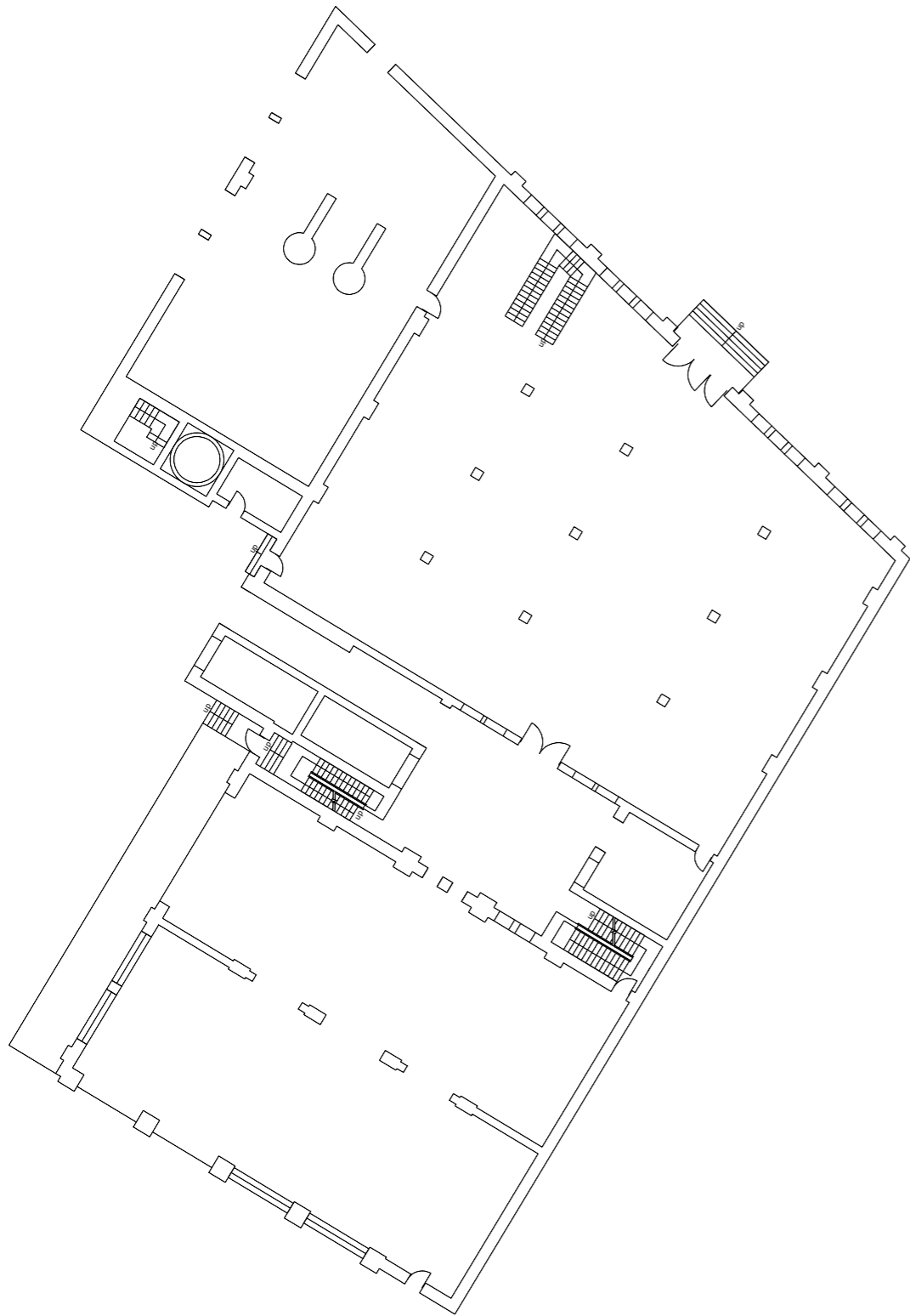
*Fields of Study in Higher Education Institutions*

*MACRO Scale*

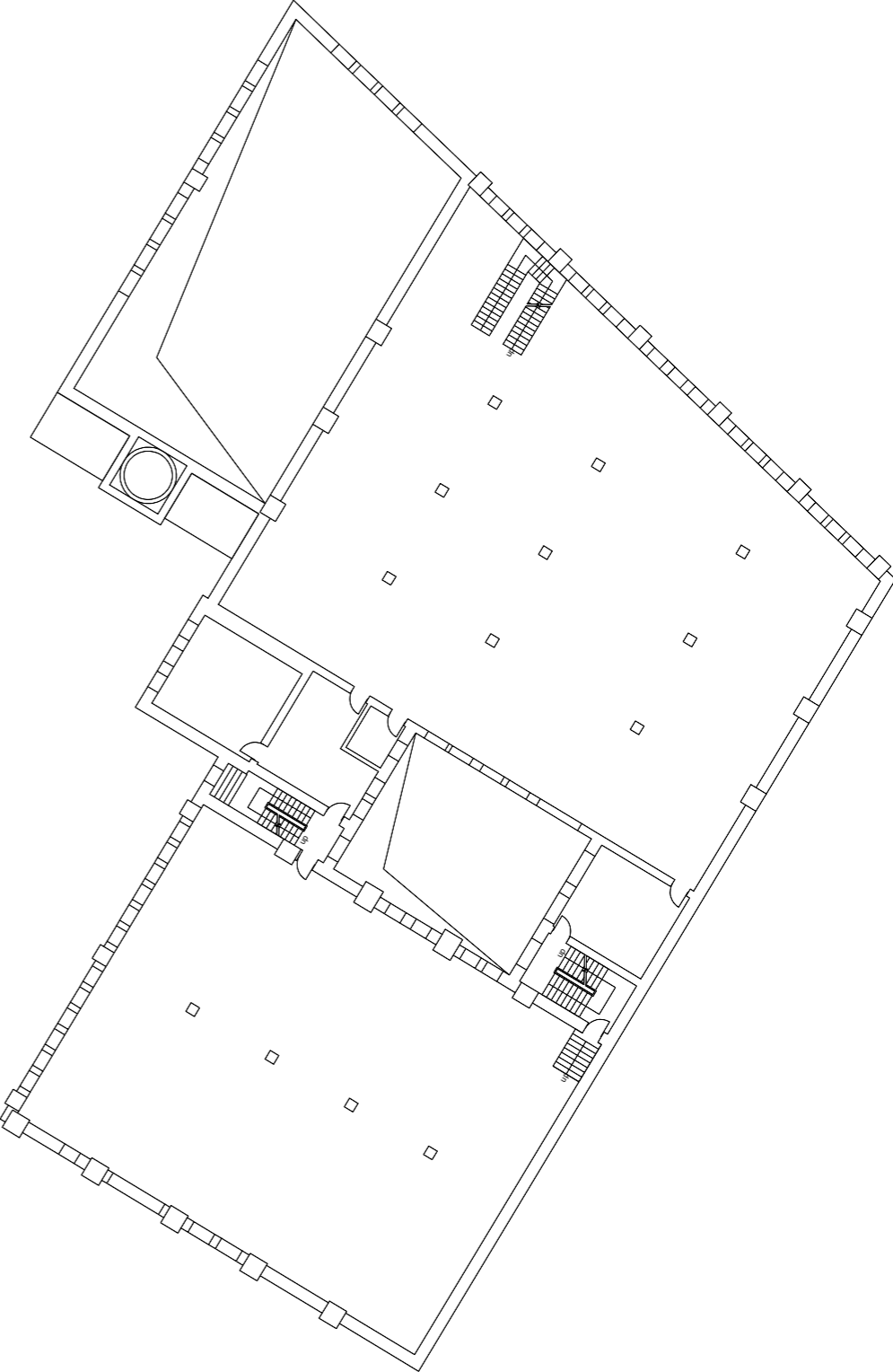




*Die Berliner Eisfabrik*



*Ground Floor Plan*



*First Floor Plan*



*“Building within a building”*

*Repurposing the abandoned ice factory to become **A Center for Divergent\* Collaboration***

\* In Psychology (of thought) using a variety of premises, especially unfamiliar premises, as bases for inference, and avoiding common limiting assumptions in making deductions.



*Critical Spaces*



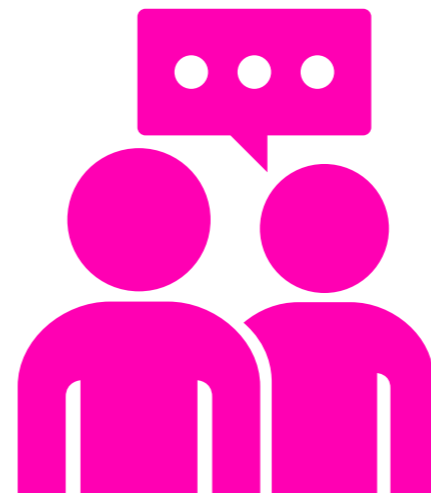
*Creative Spaces*



*Provocative Spaces*



*Relaxation Spaces*



*Interaction Spaces*

## *Mapping User Activities*



**Humanities**

24,195 Students - 12.8%

**Sport**

1,192 Students - 0.7%

**Politics & Social Sciences**

63,893 Students - 34%

**Maths & Science**

19,448 Students - 10.5%

**Human Medicine & Health**

10,765 Students - 5.7%

**Agriculture & Veterinary Medicine**

4,579 Students - 2.5%

**Engineering**

50,519 Students - 26.8%

**Arts**

11,754 Students - 6.2%

**Other**

1,589 Students - 0.8%



*Critical*



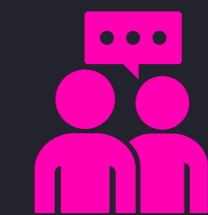
*Creative*



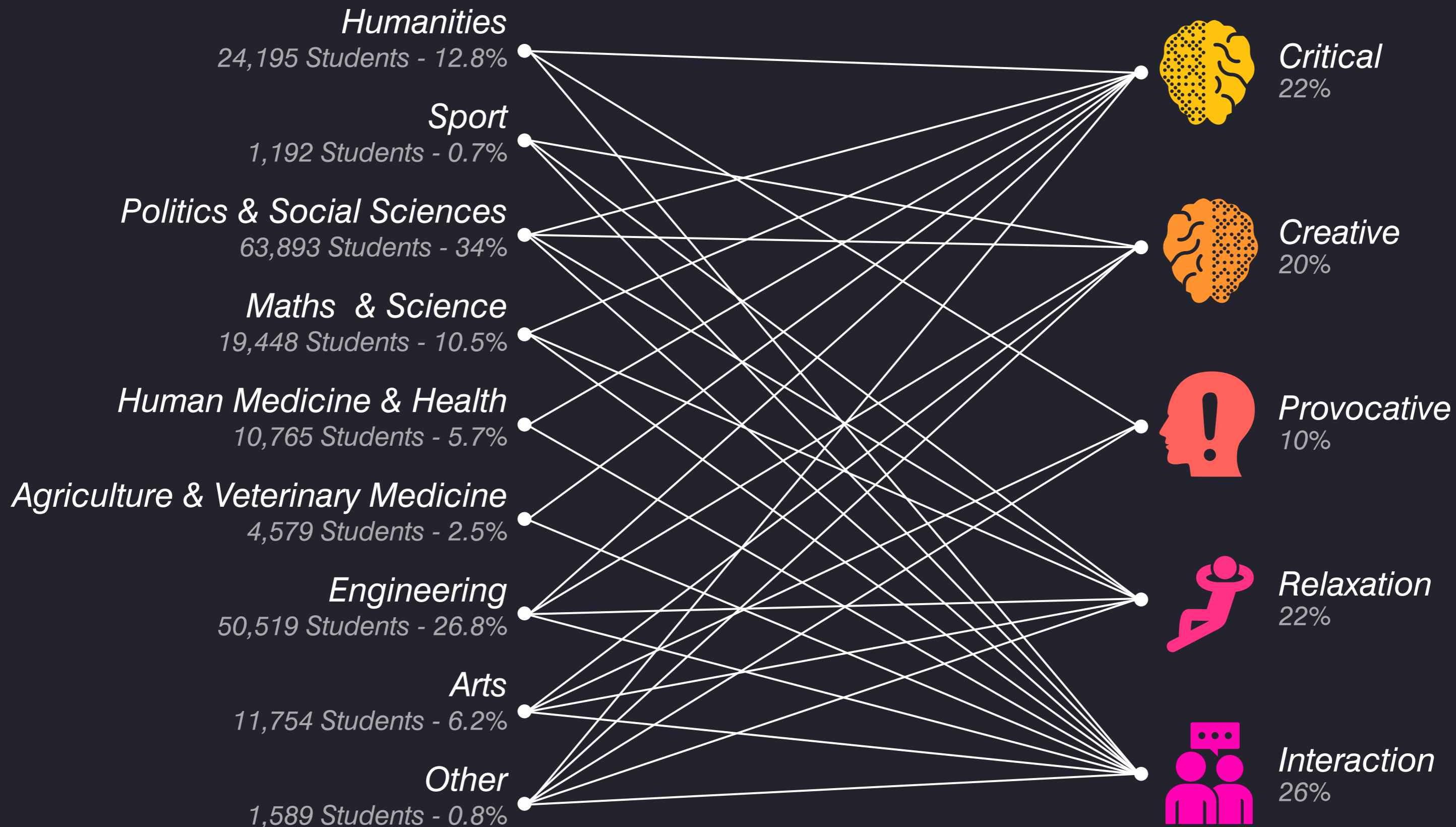
*Provocative*



*Relaxation*



*Interaction*



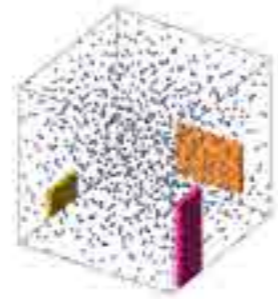
*Computational Strategy*  
*Agent-Based Spatial Optimization*



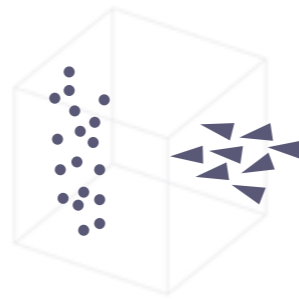
1  
*Define  
Intervention  
Domain*



2  
*Extract Spatial  
Parameters*



3  
*Embed Data in  
Point Cloud*



4  
*Specify  
Point-Agent  
Relationships*



5  
*Set Agents  
Behaviours*

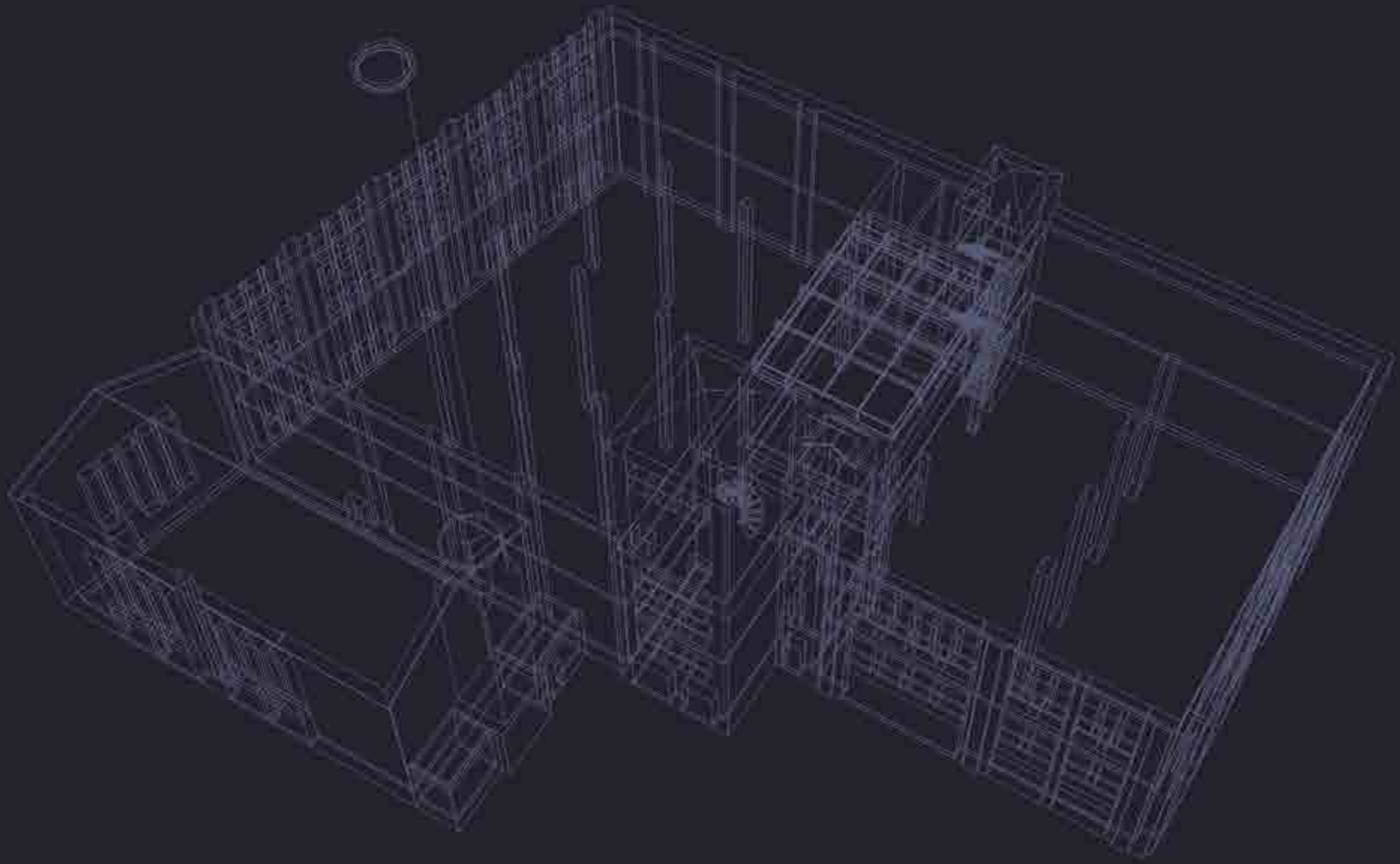


6  
*Release Agents  
Swarm*



7  
*Wrap Optimized  
Space*



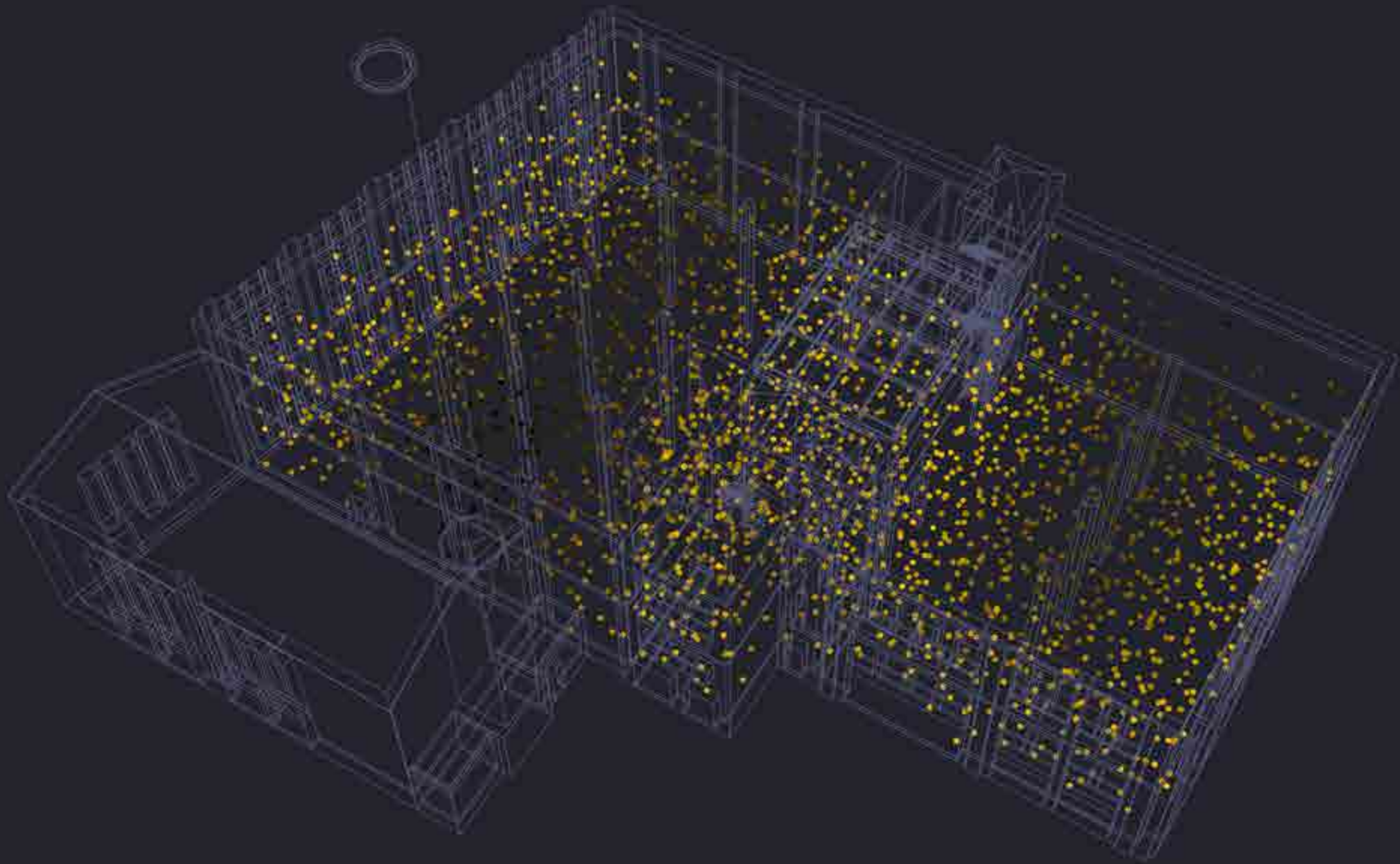


0  
*Existing Building*





- P1: Direct Daylight
- P2: Indirect Daylight
- P3: Isolation
- P4: Events Proximity
- Atrium Proximity

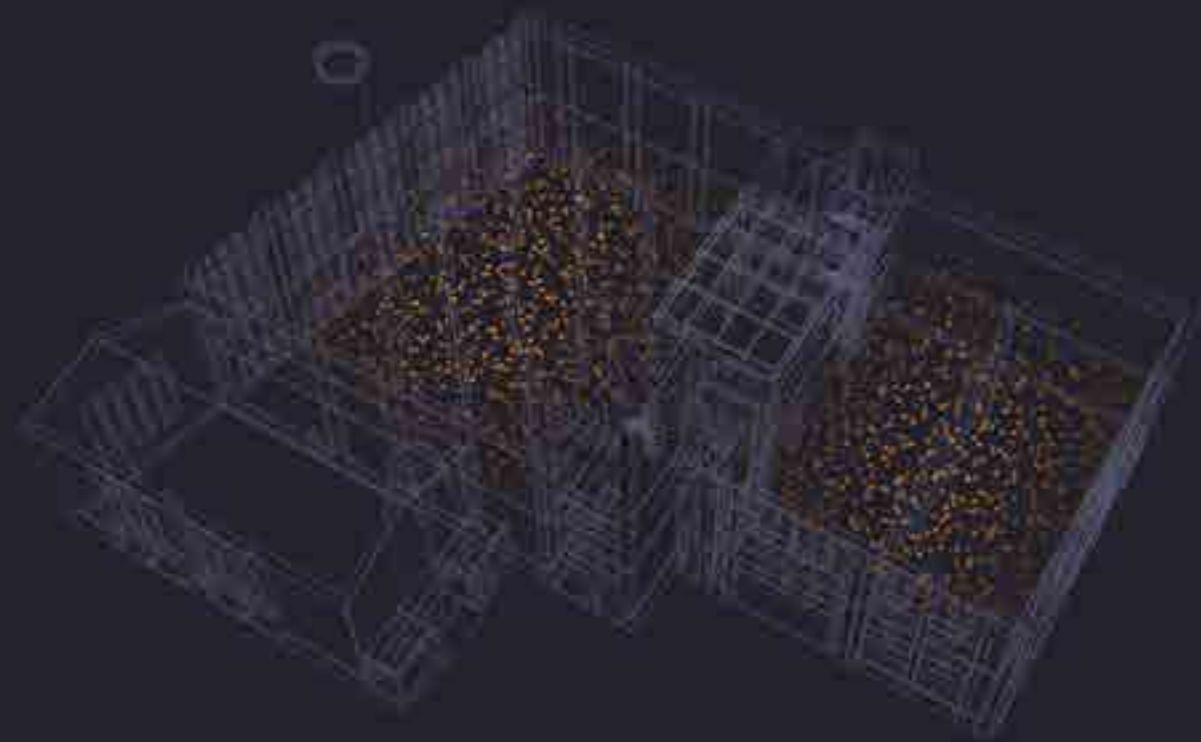


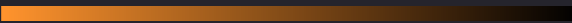
High  Low

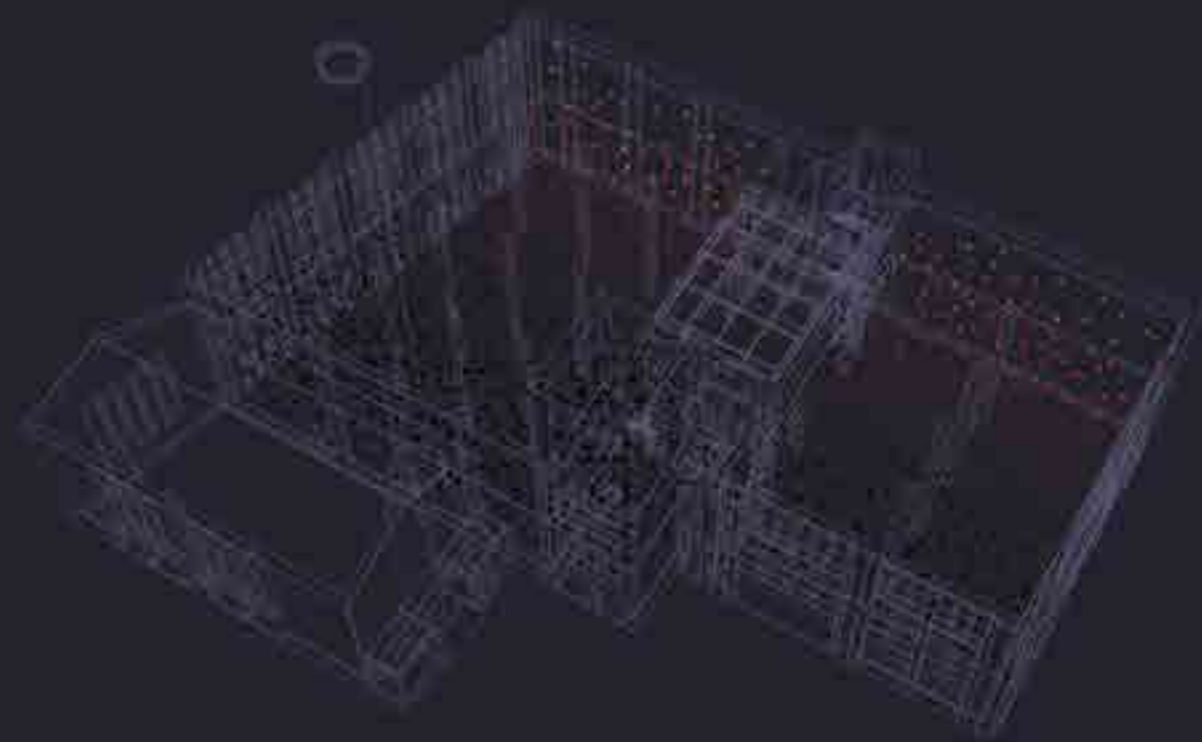
P1: Direct Daylight


3

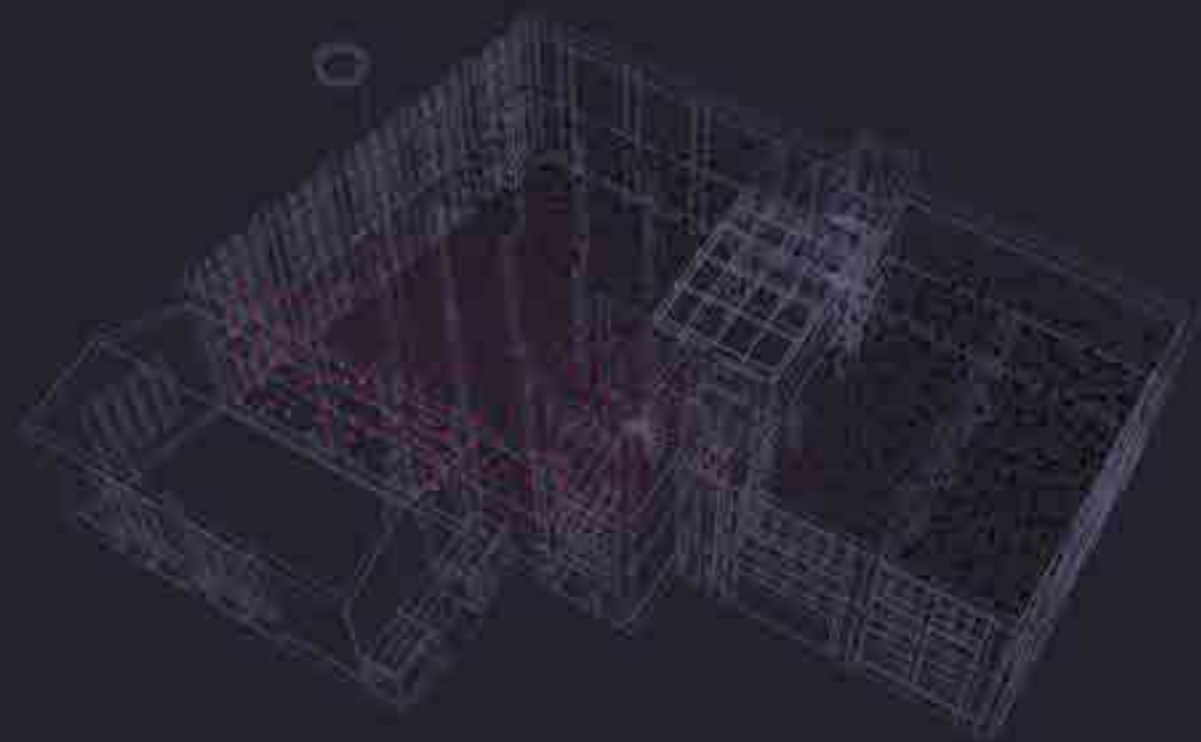
*Embed Data in Point Cloud*



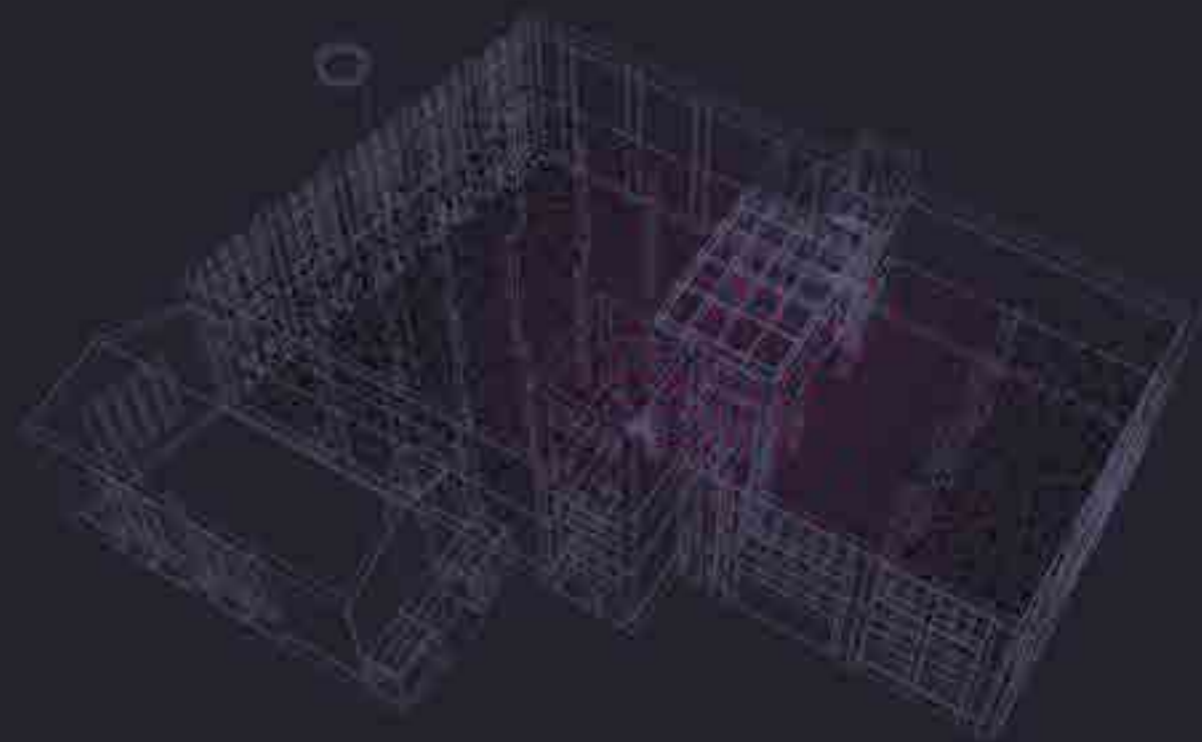
High  Low  
P2: Indirect Daylight




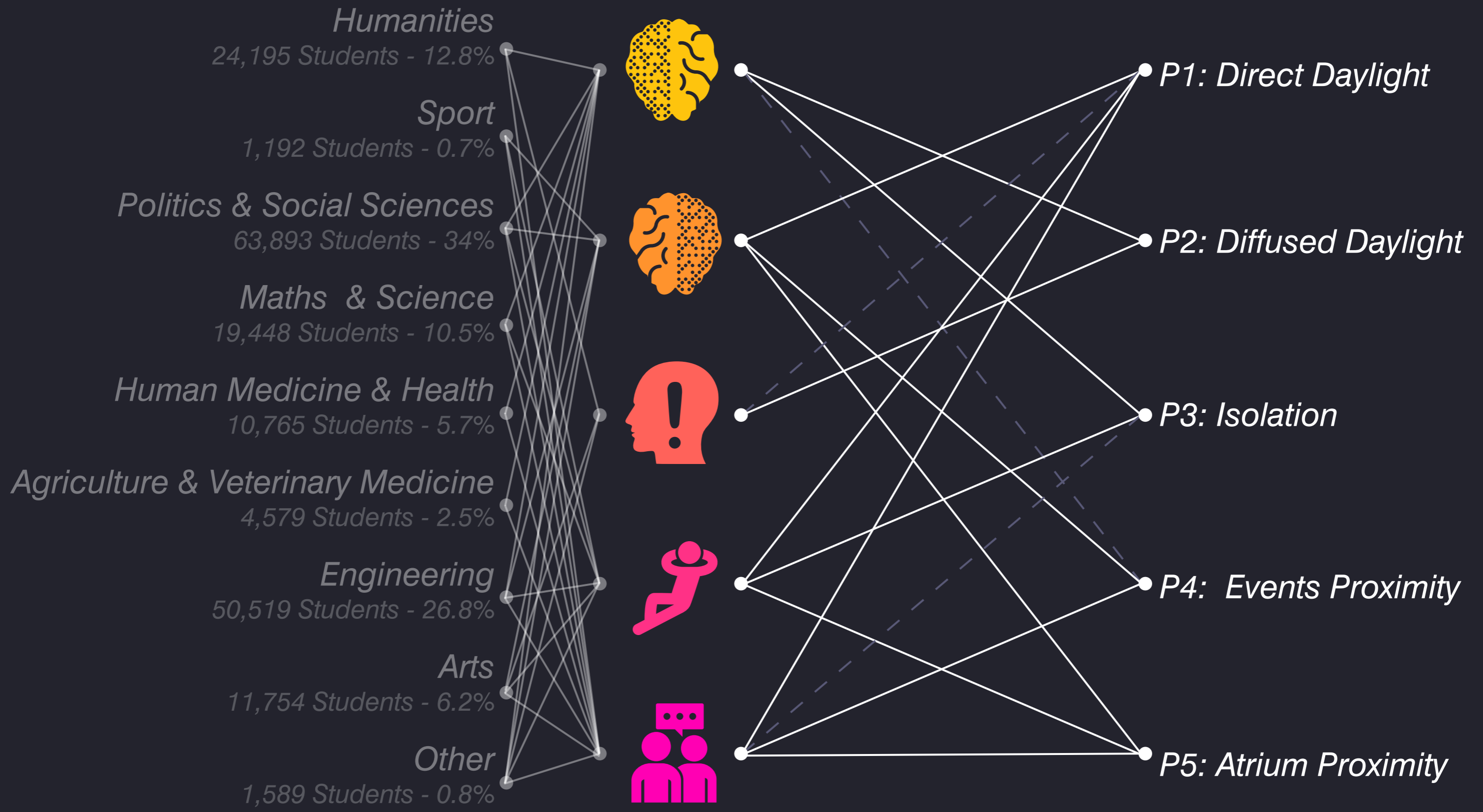
High  Low  
P3: Isolation



High  Low  
P4: Events Proximity



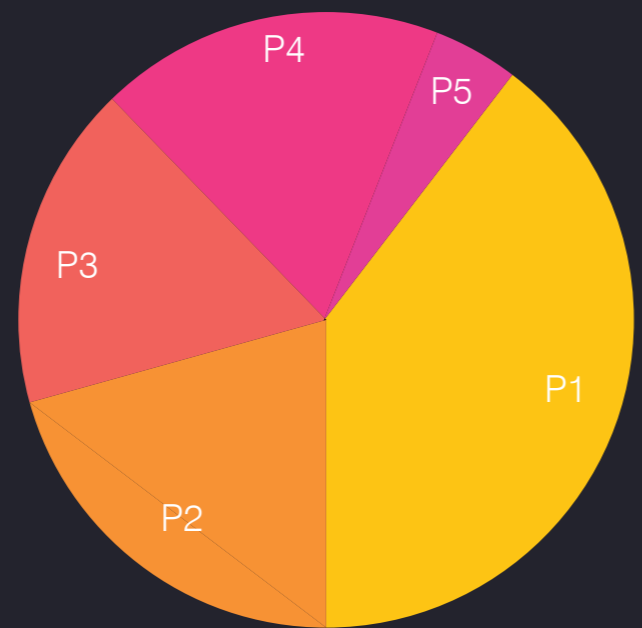
High  Low  
P5: Atrium Proximity



4

Specify Point-Agent Relationships

———— Direct Relationship  
- - - - Inverse Relationship



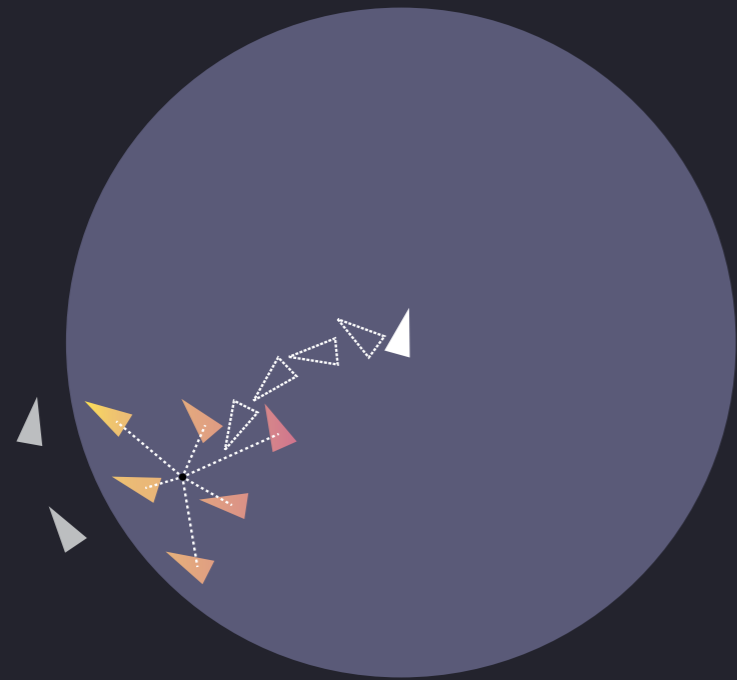
*Points*  
*(all parameters data embedded)*



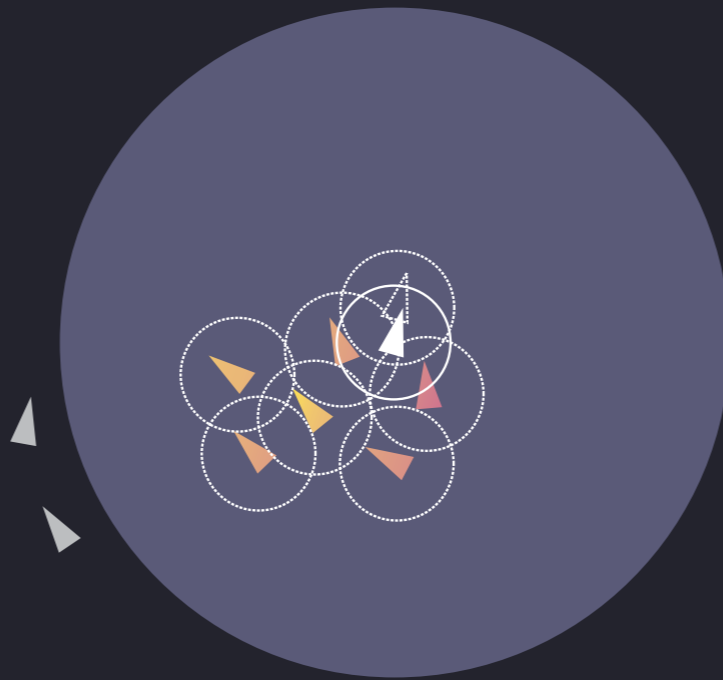
*Agents*

4

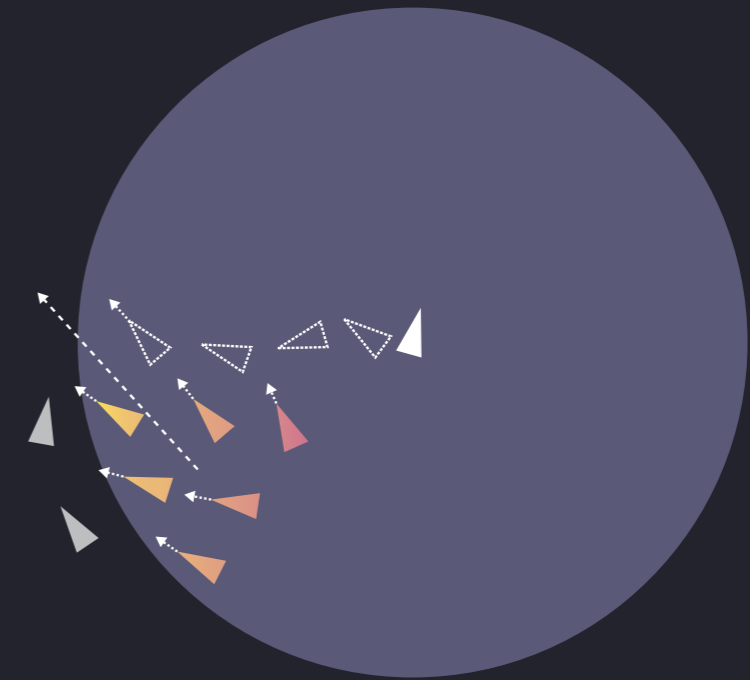
*Specify Point-Agent Relationships*



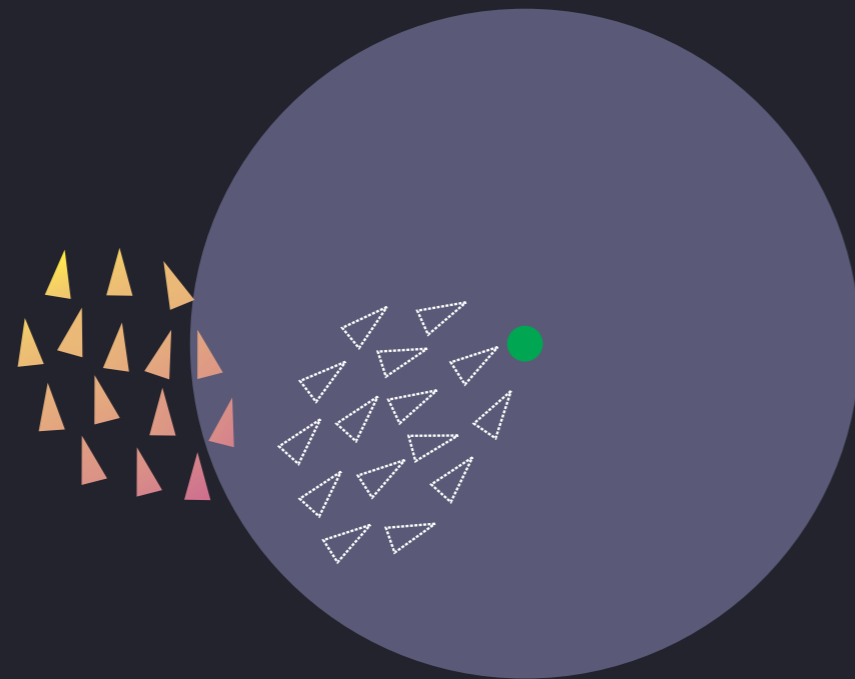
*Cohesion*



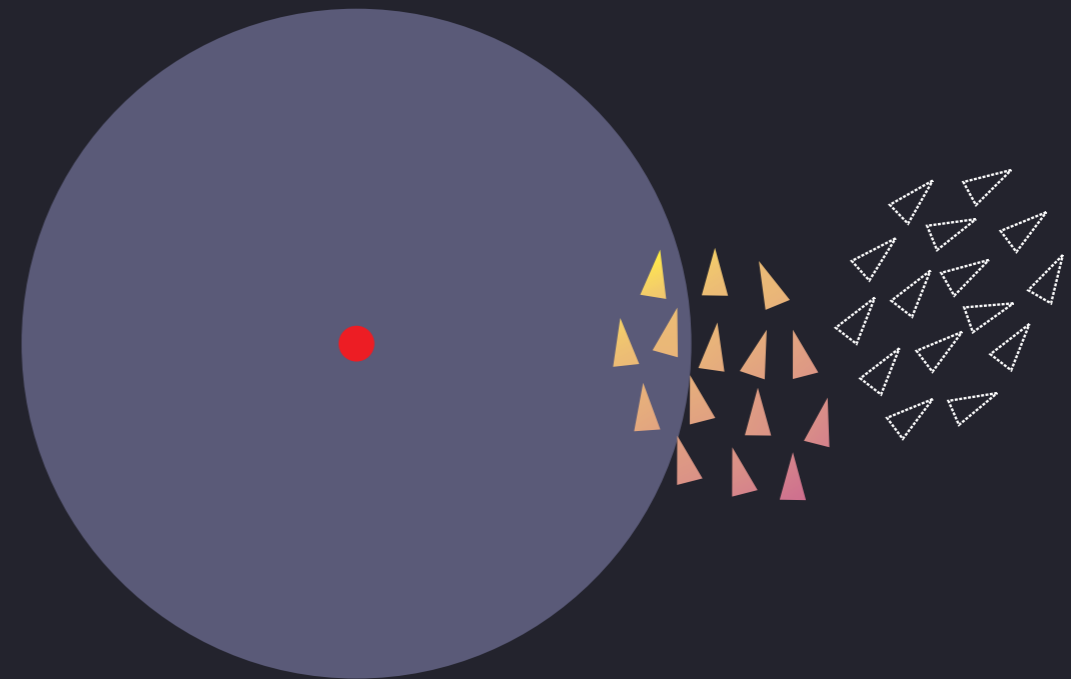
*Separation*



*Alignment*

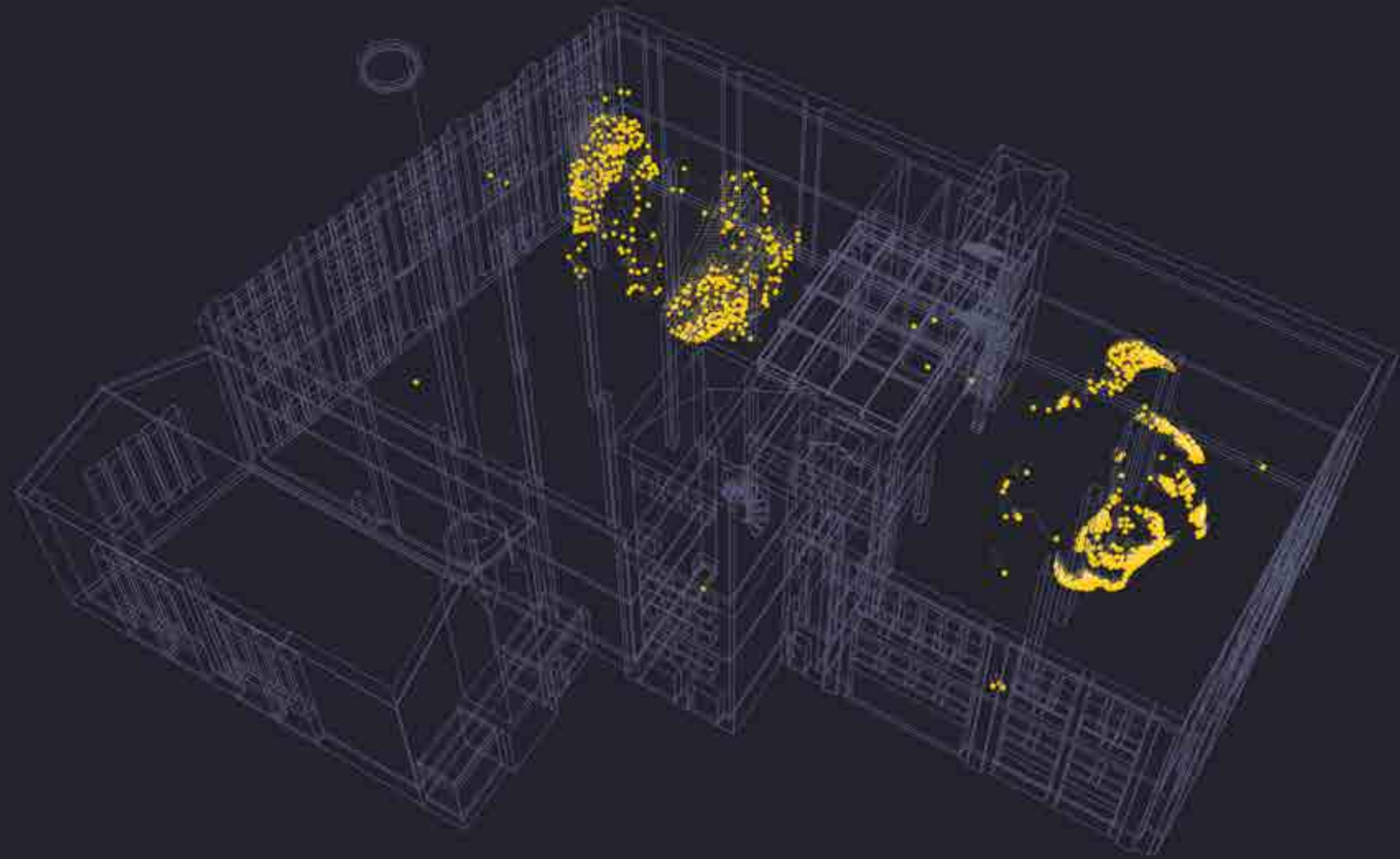


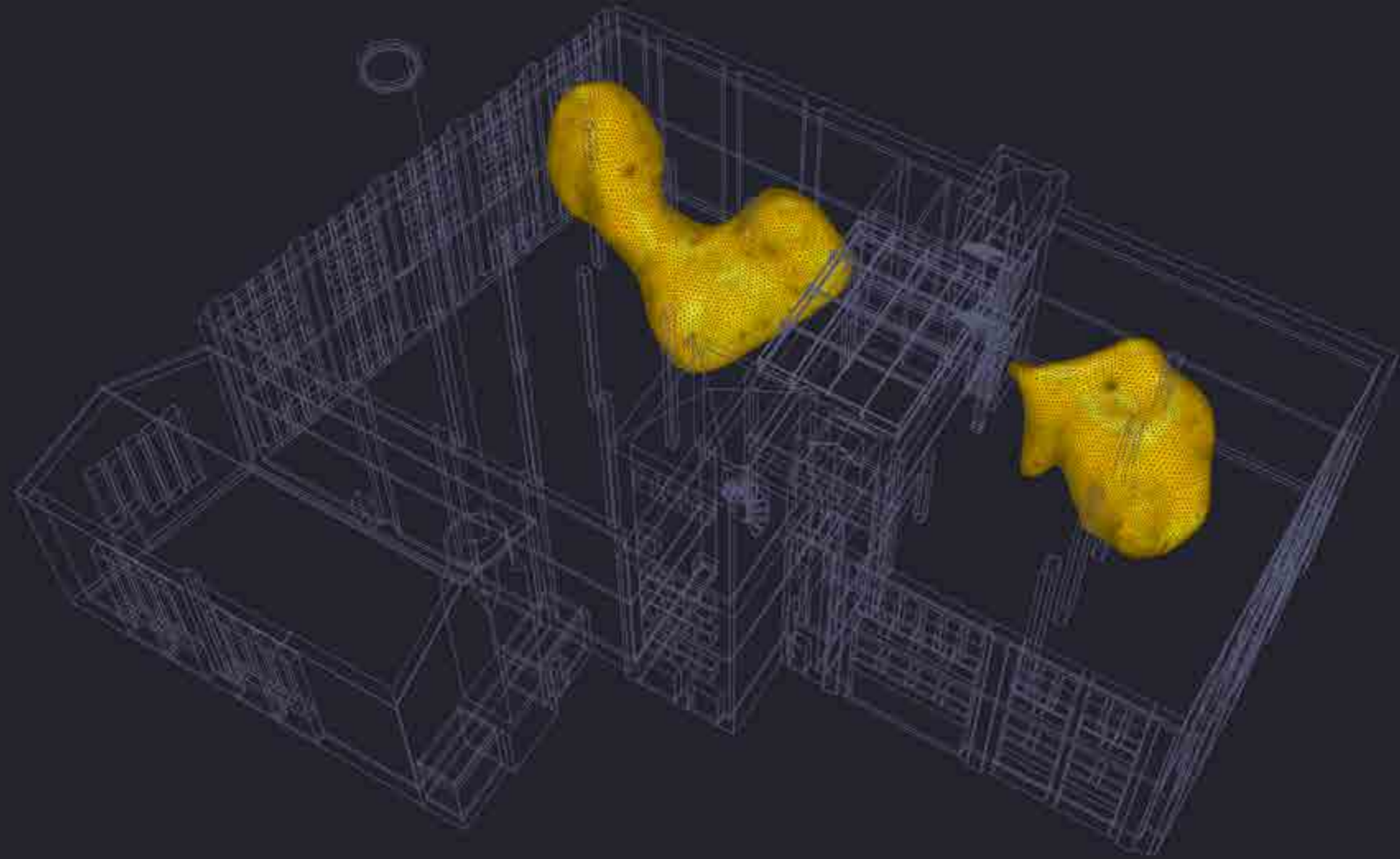
*Attraction*



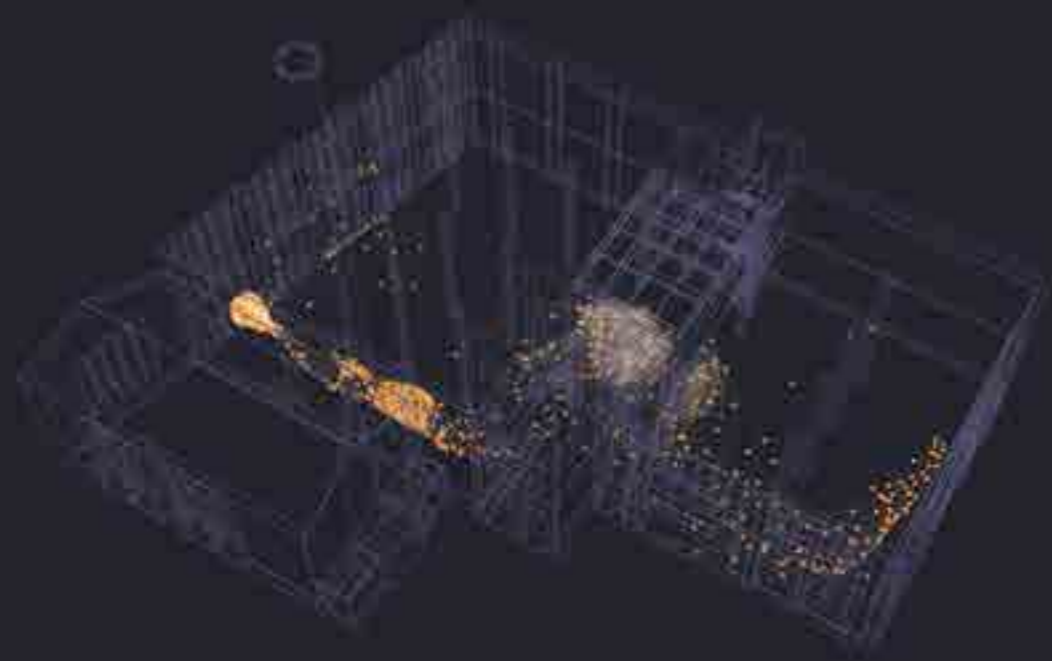
*Repulsion*



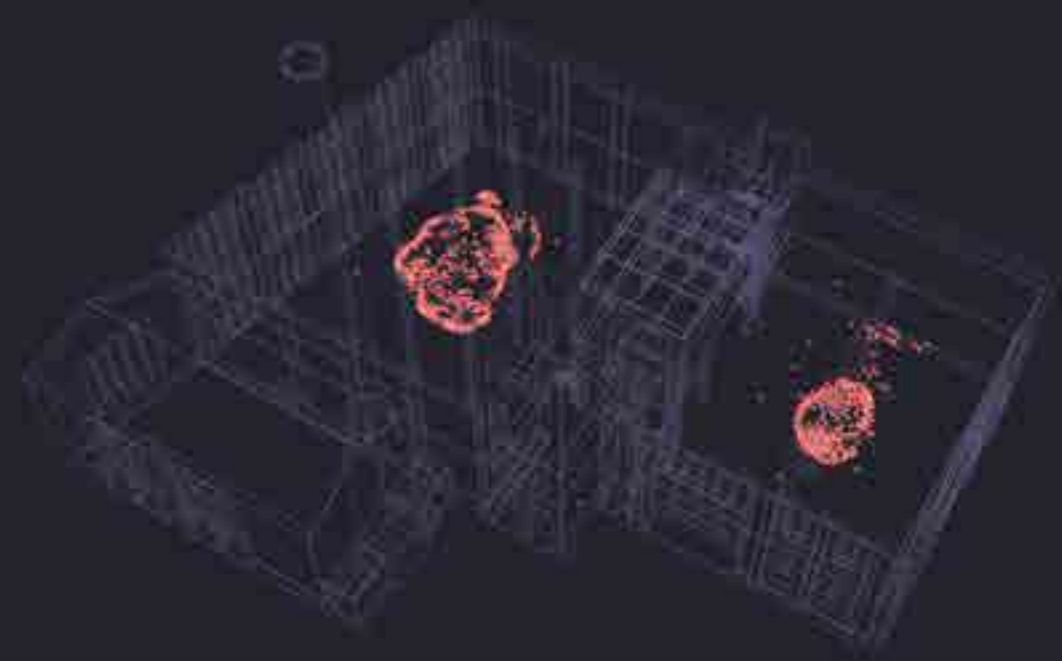




Creative Space Stable Agents & Trails



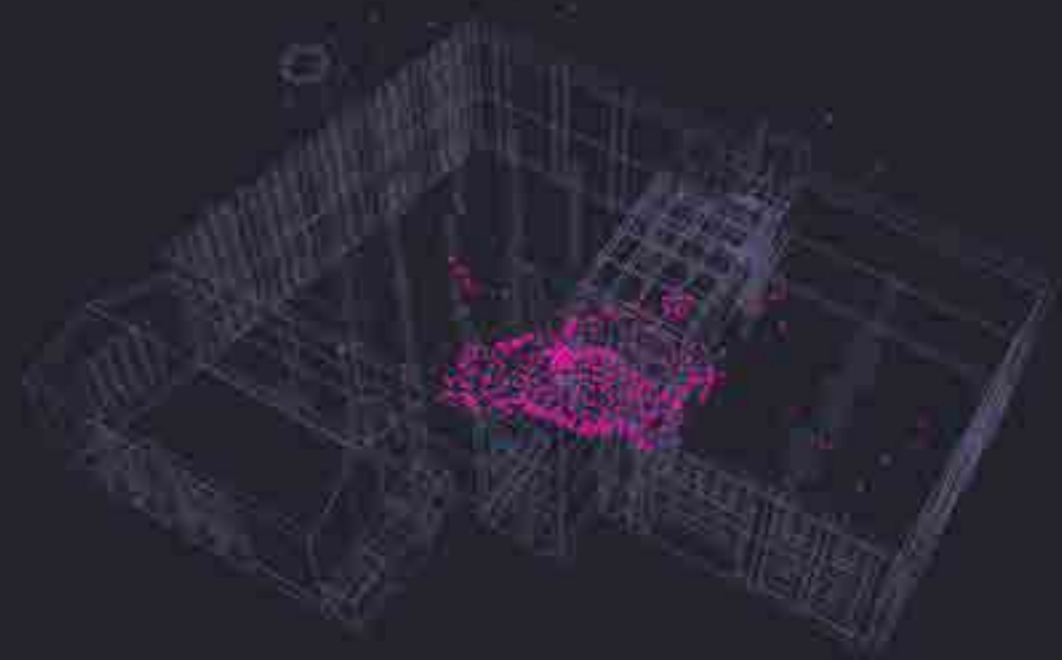
Provocative Space Stable Agents & Trails



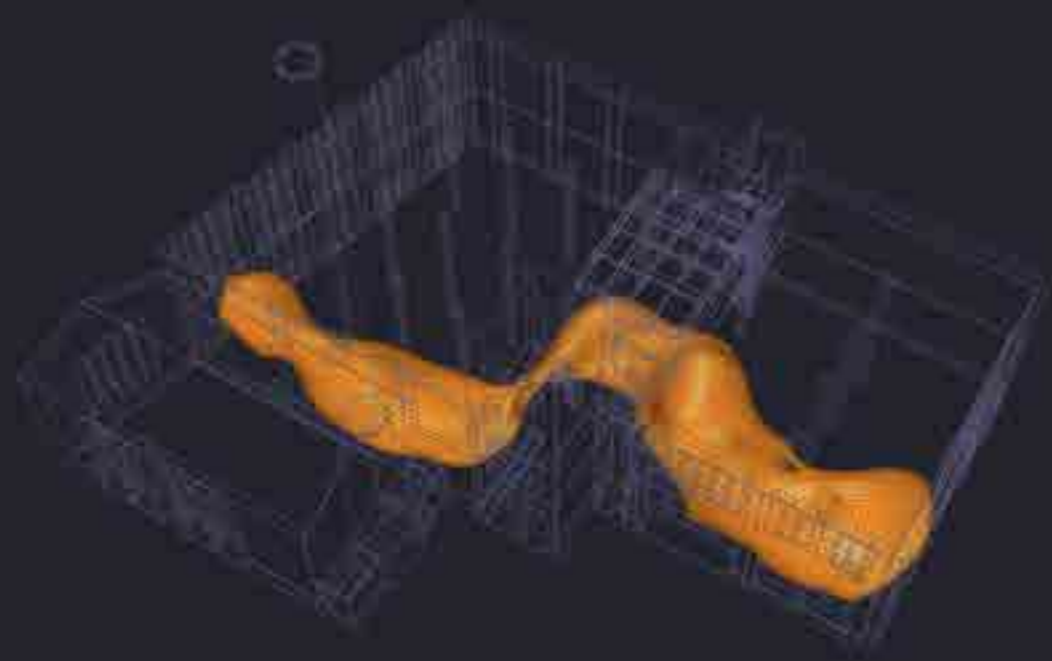
Relaxation Space Stable Agents & Trails



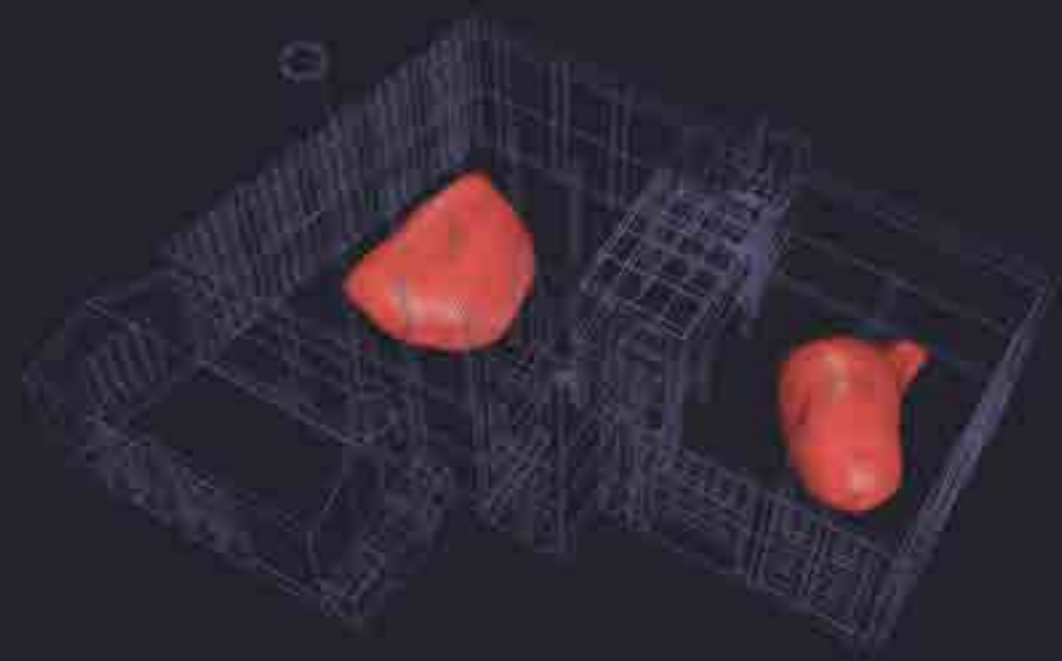
Interaction Space Stable Agents & Trails



Creative Space Stable Wrapped Geometry



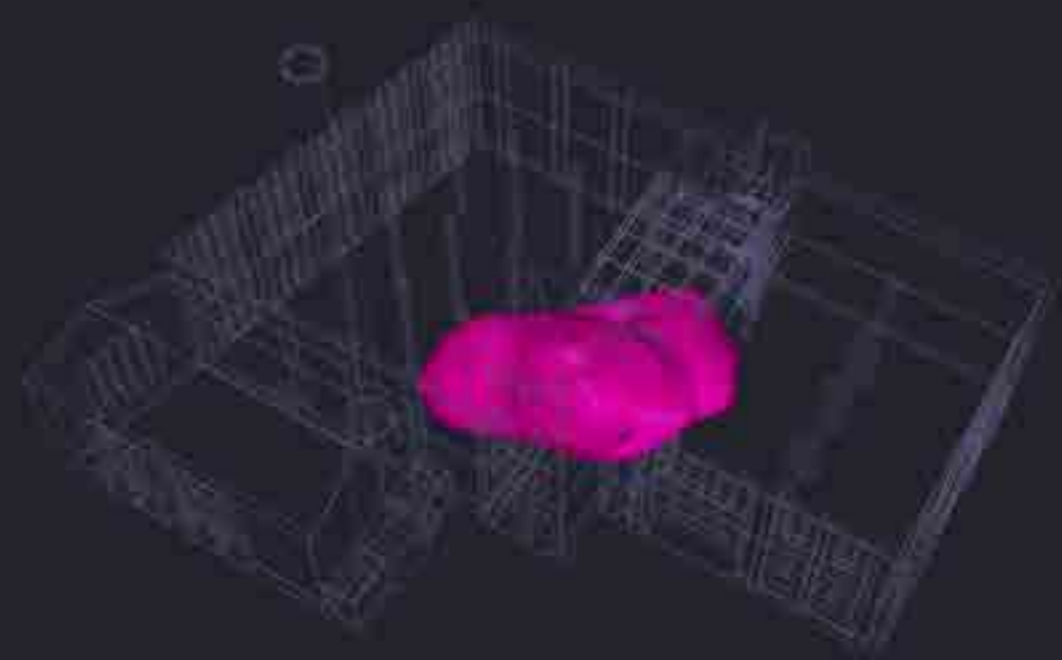
Provocative Space Stable Wrapped Geometry

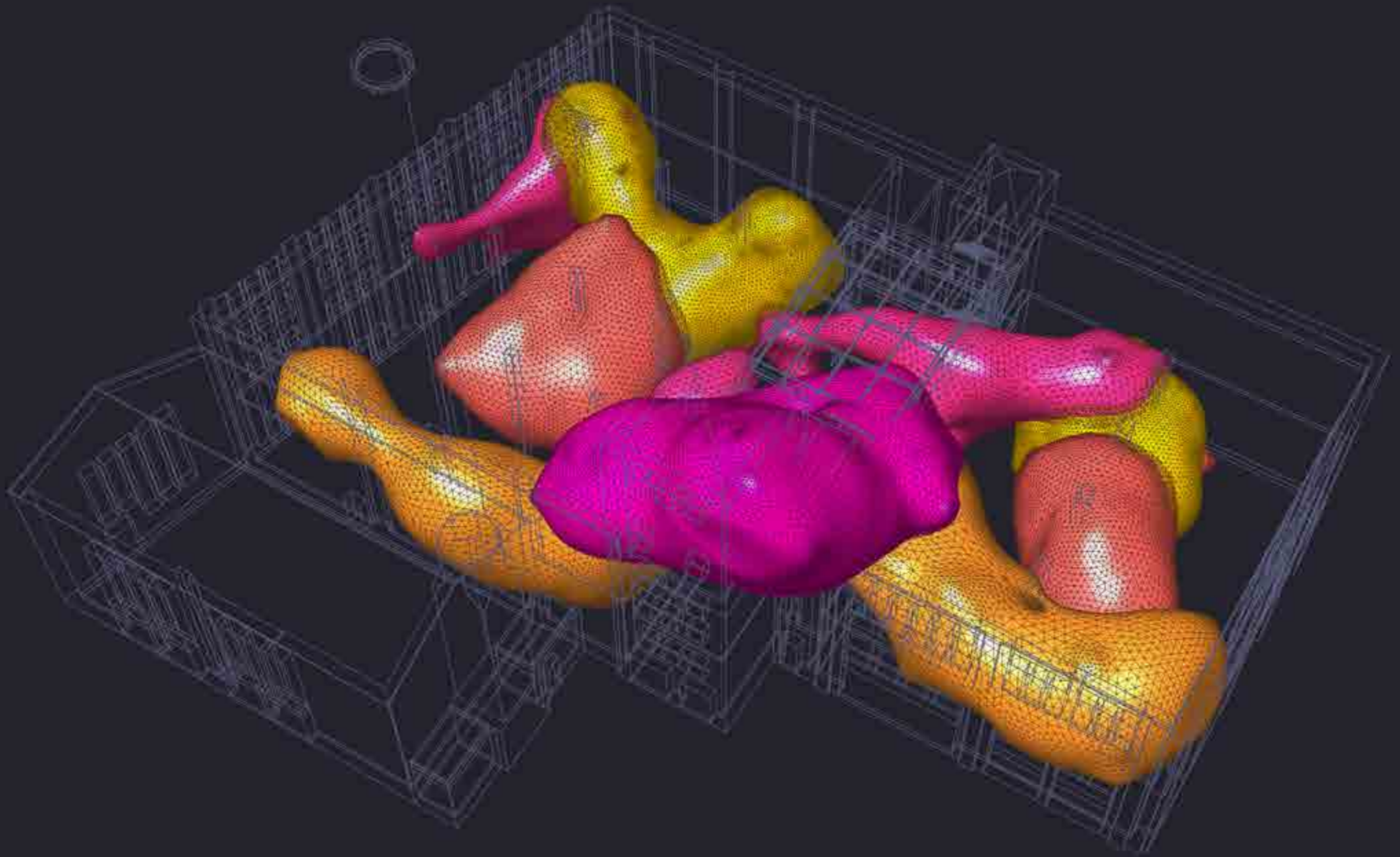


Relaxation Space Stable Wrapped Geometry

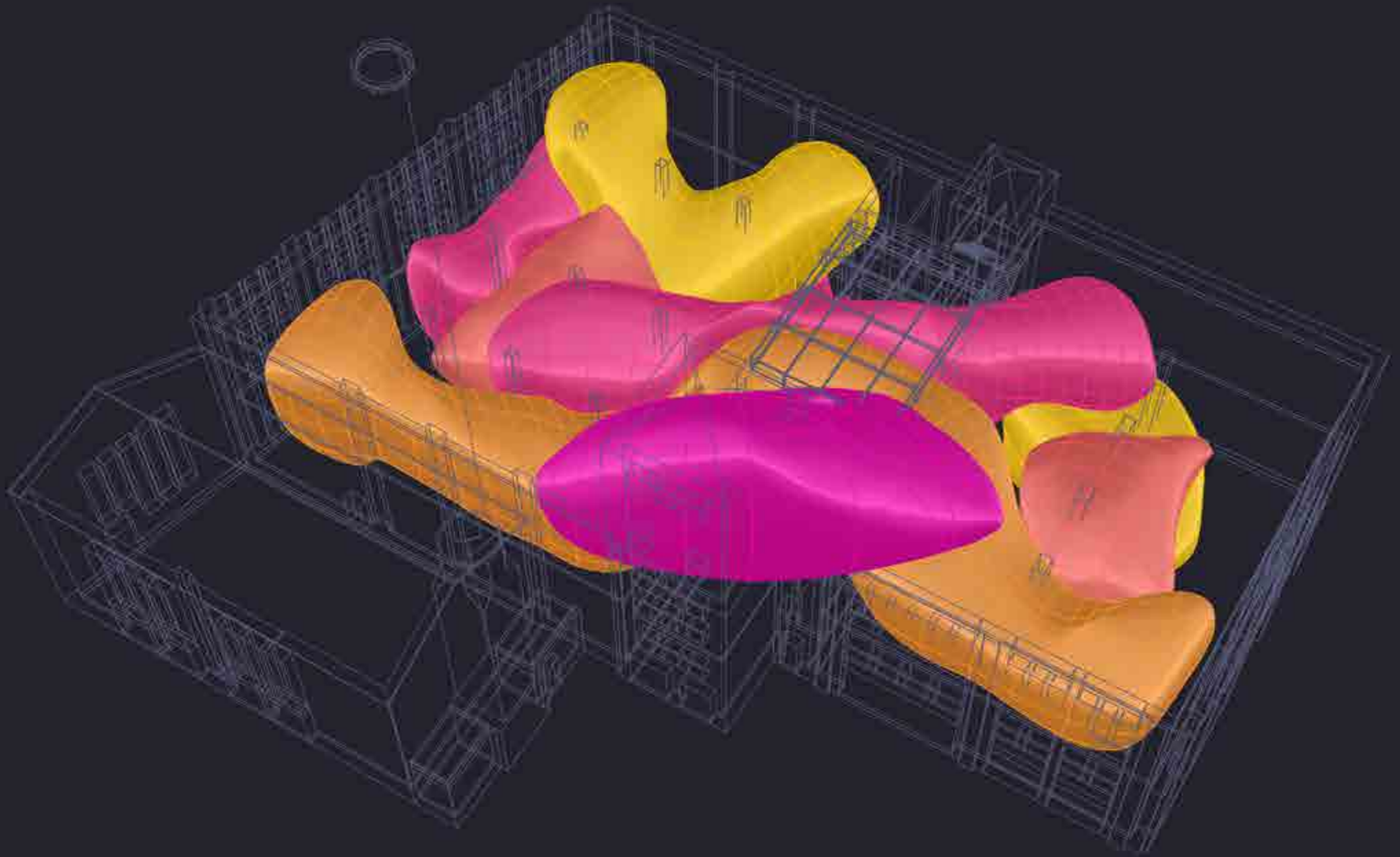


Interaction Space Stable Wrapped Geometry

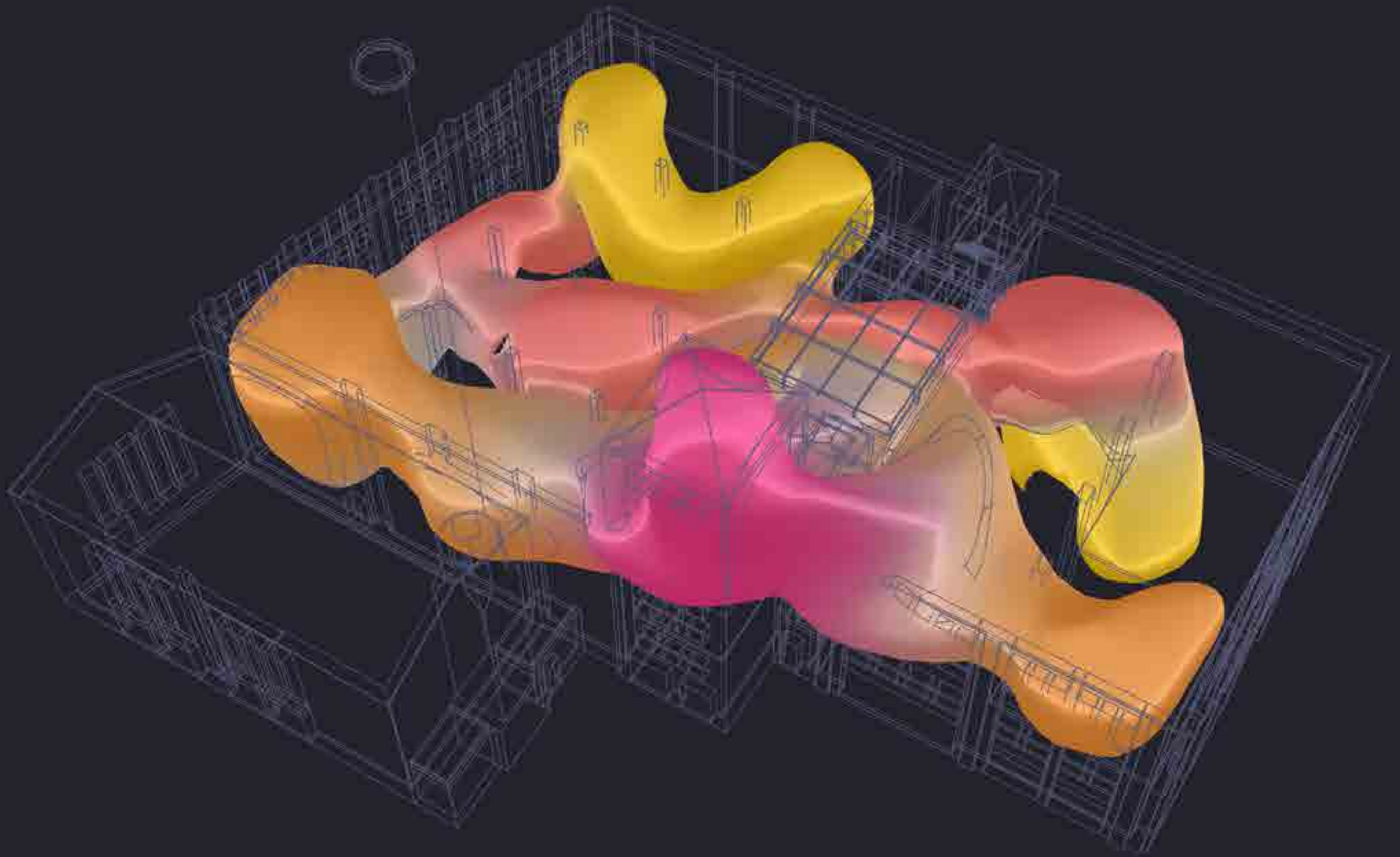




*Optimized Spaces Together*



*Spaces Rationalization*



*Spaces Fusion*

1

2

3

X



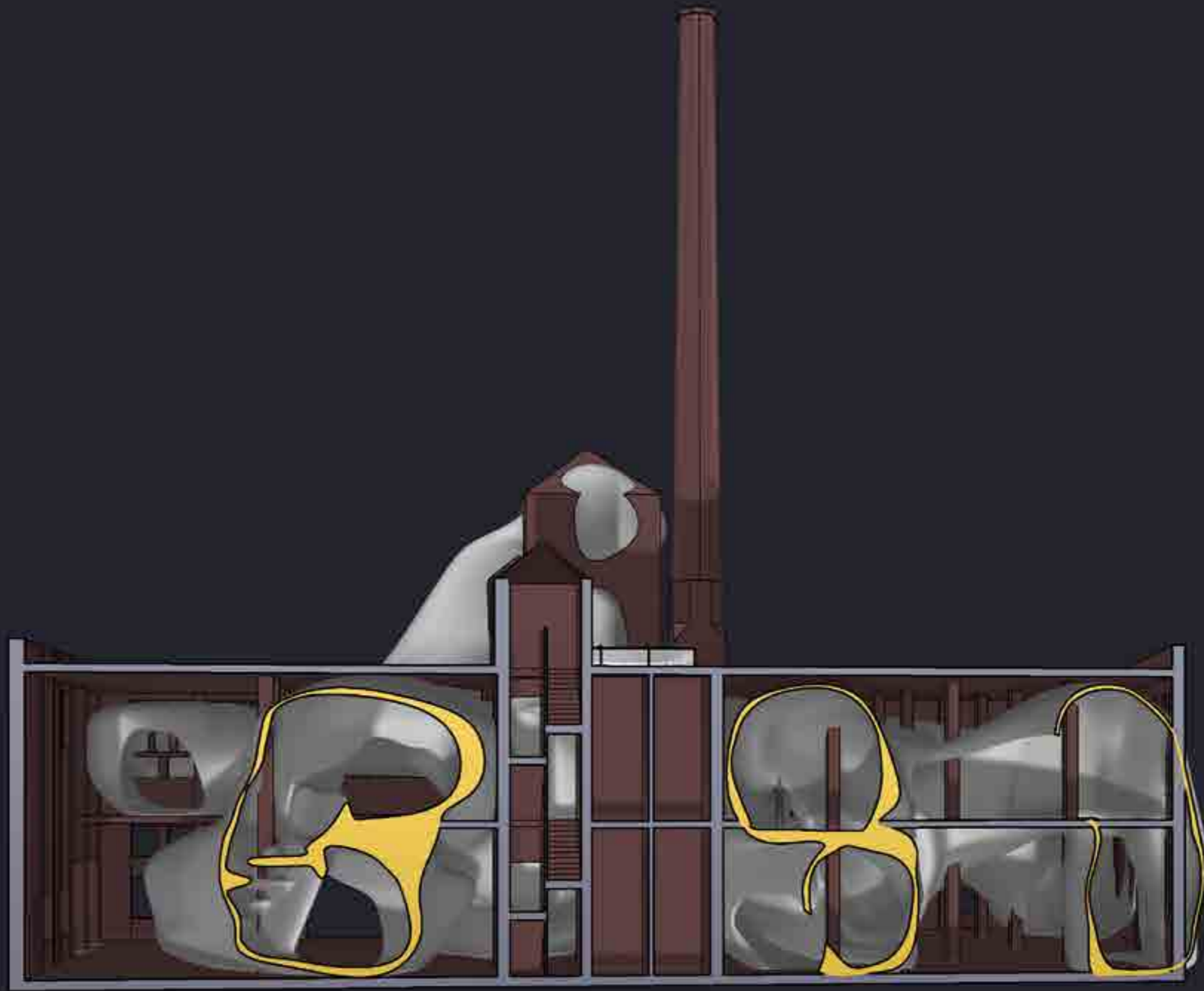
Y



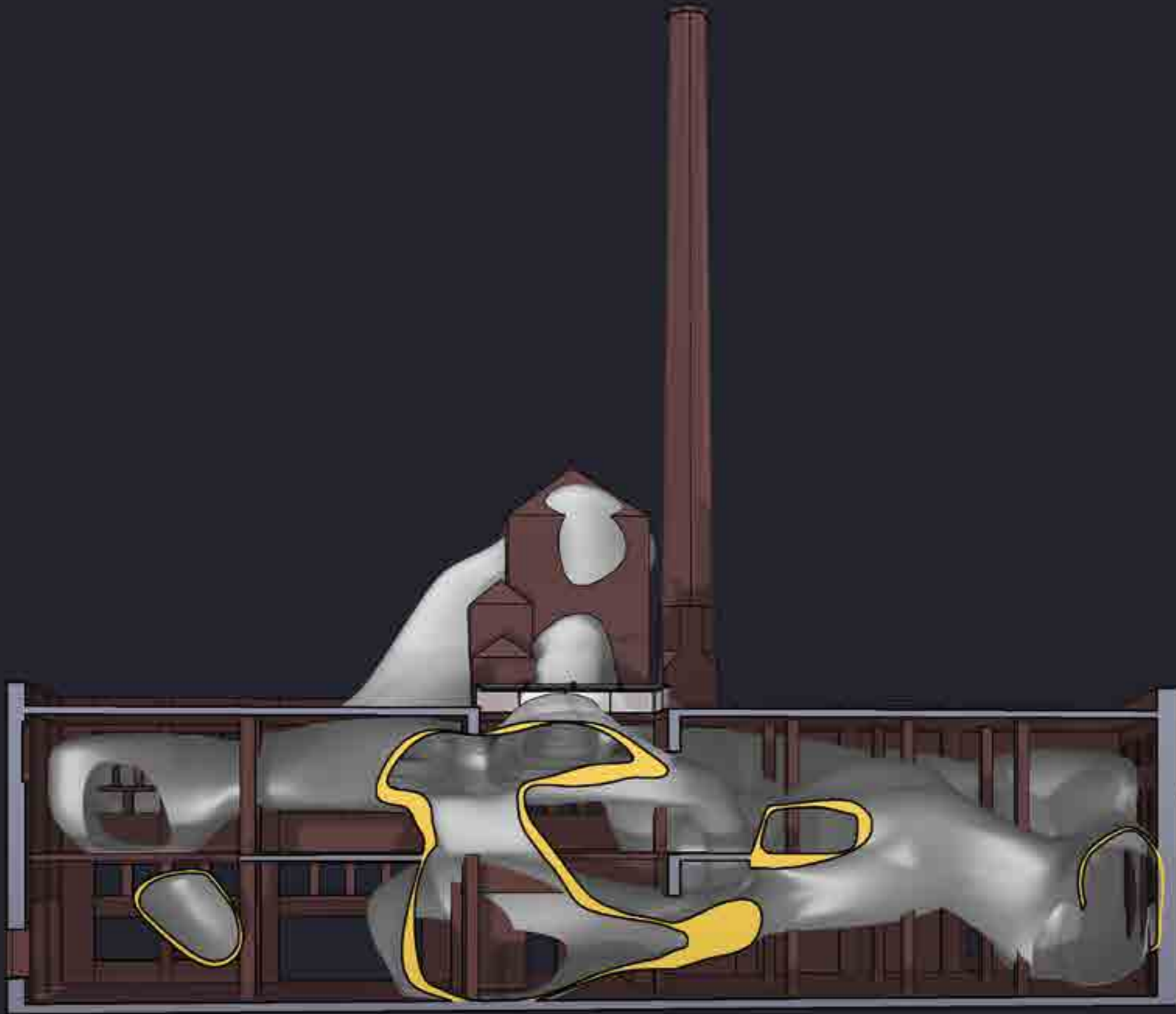
Z



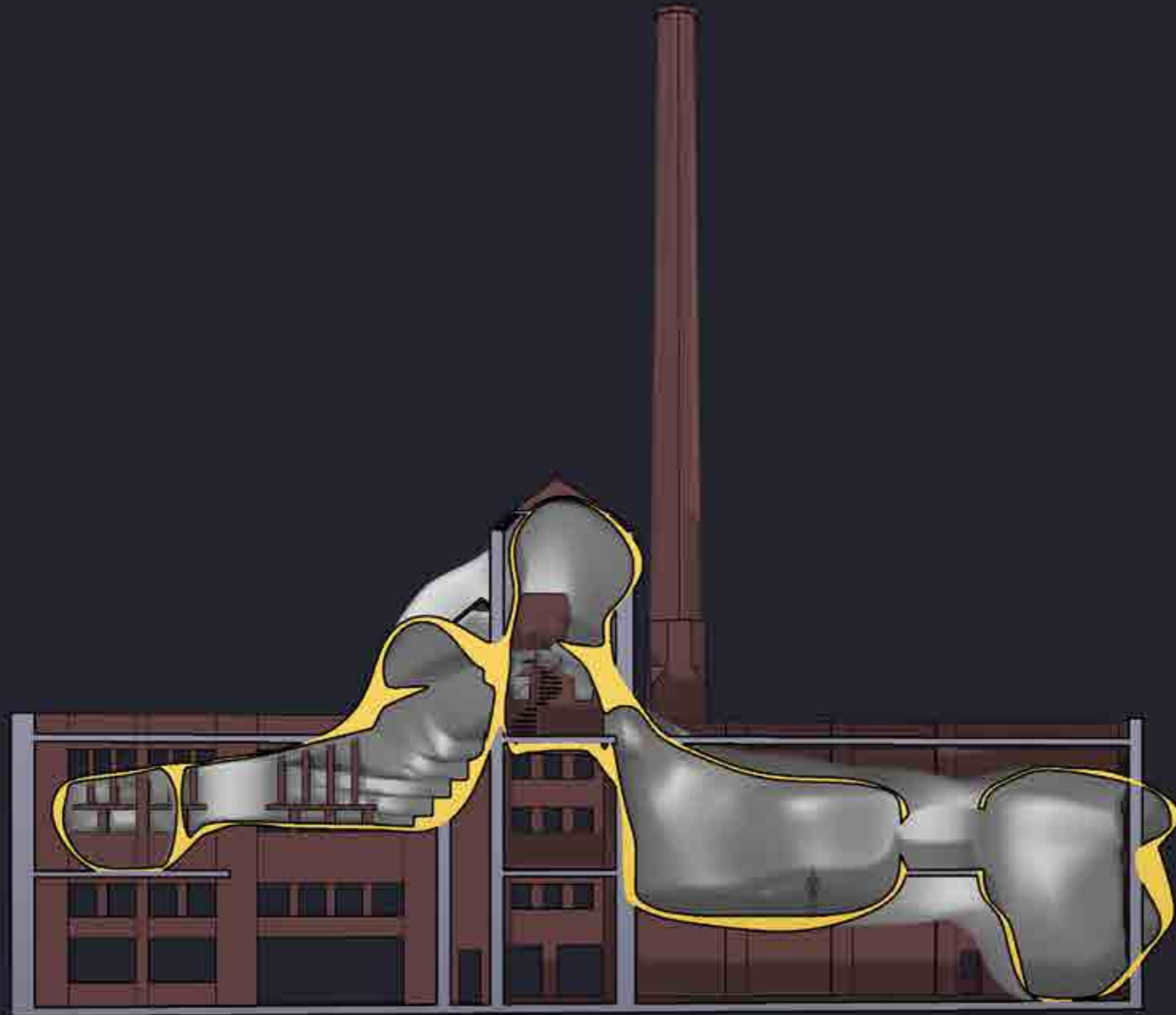




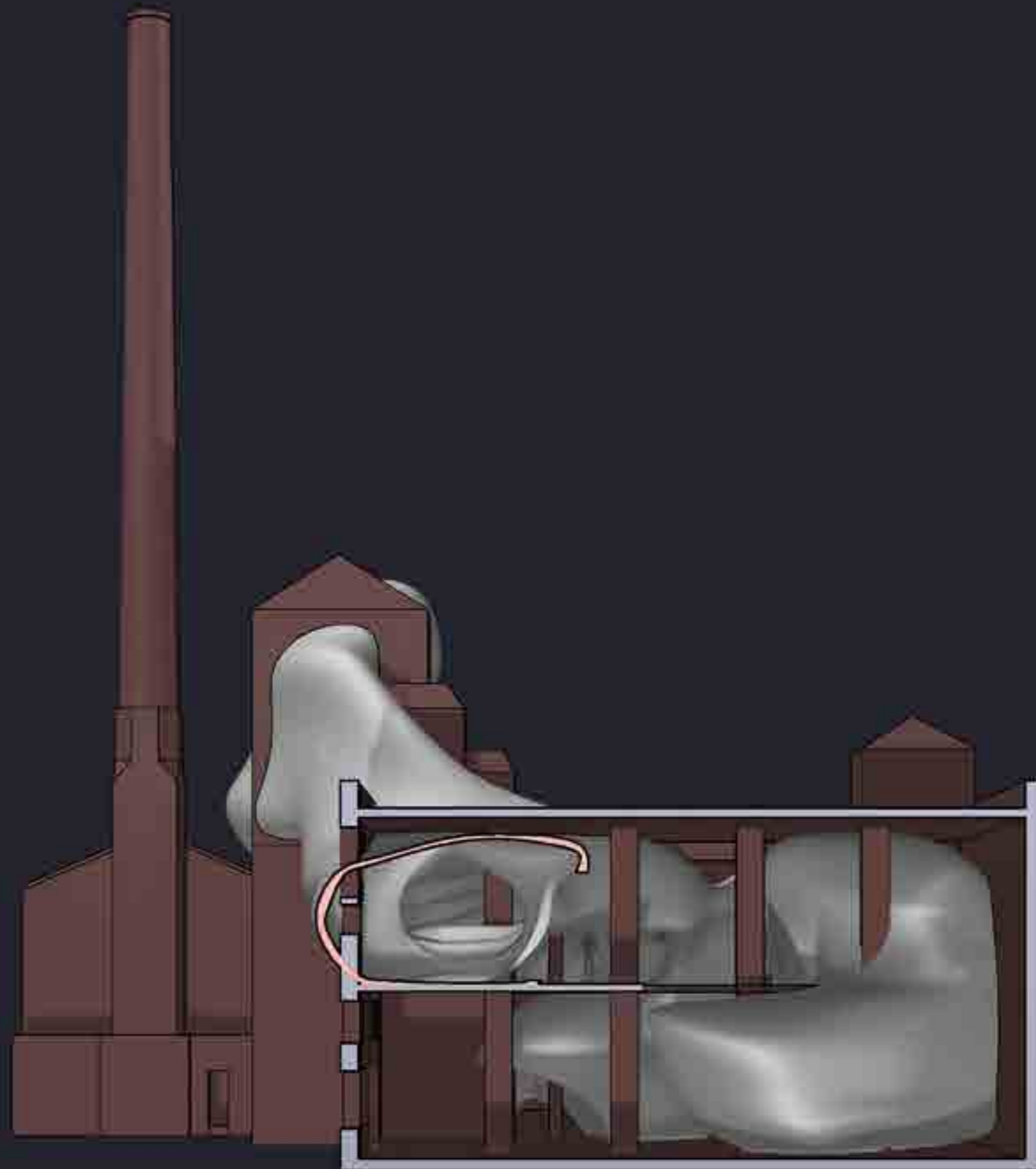
*Section X-1*



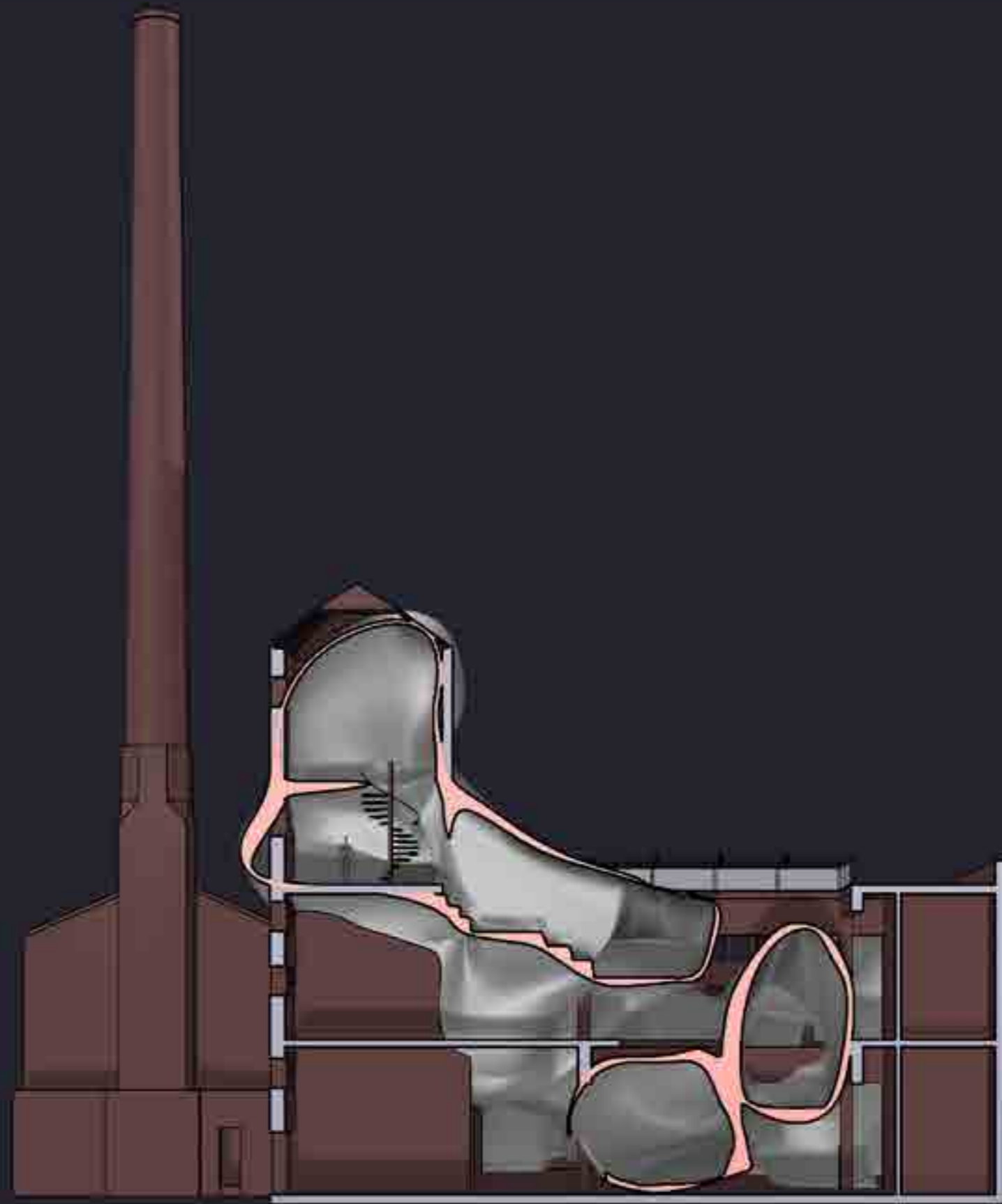
Section X-2



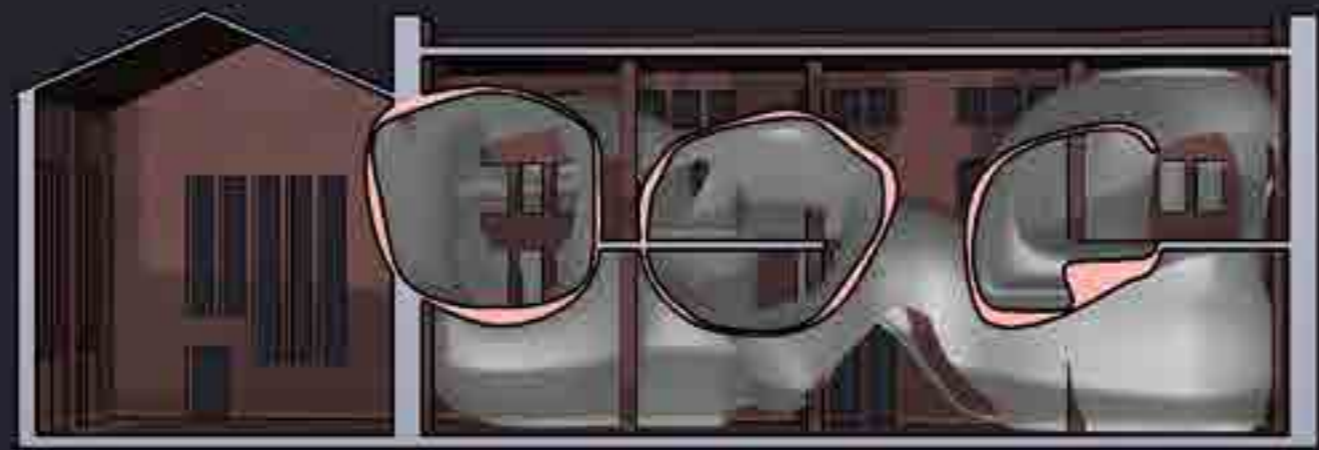
*Section X-3*



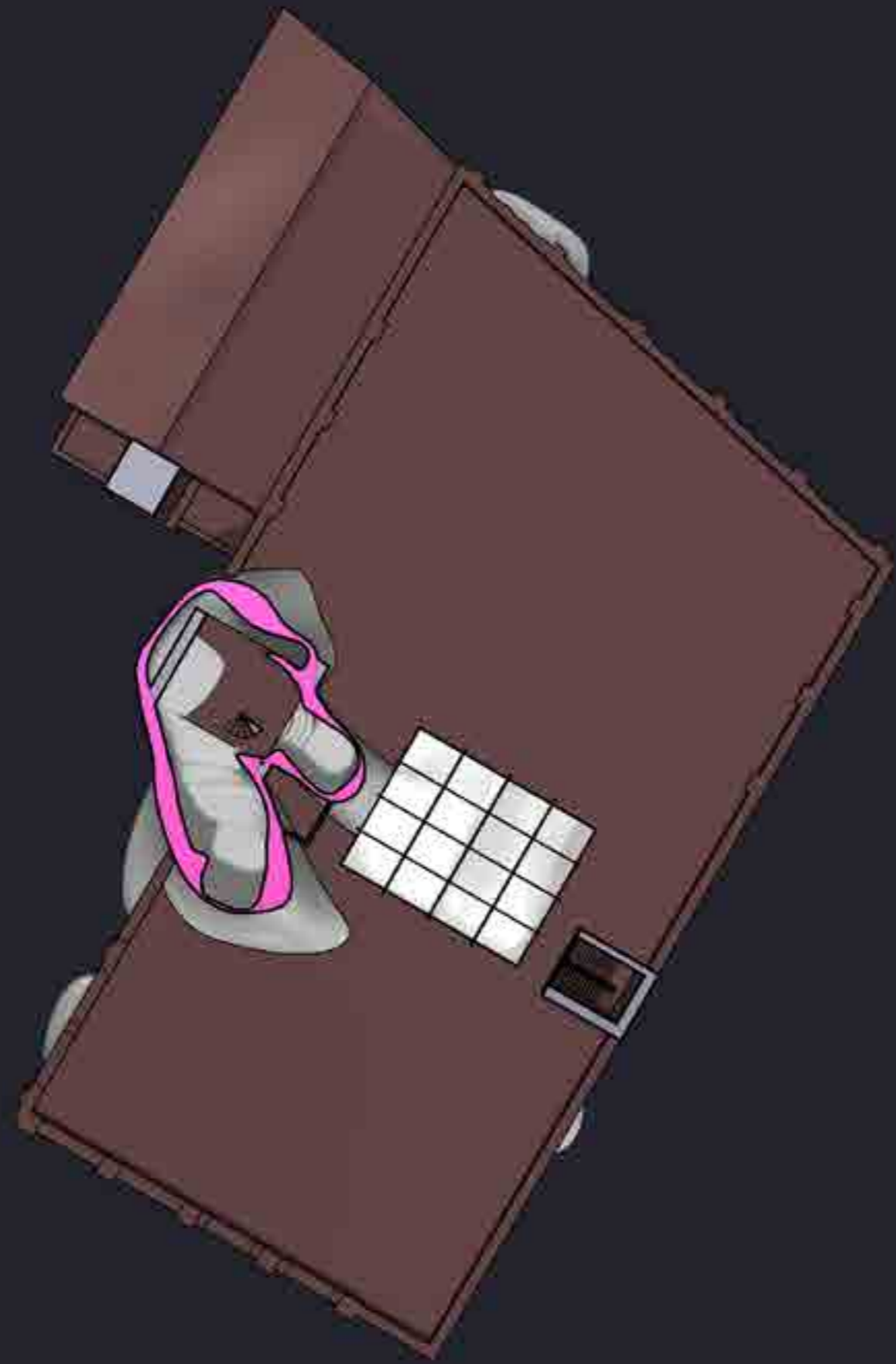
*Section Y-1*



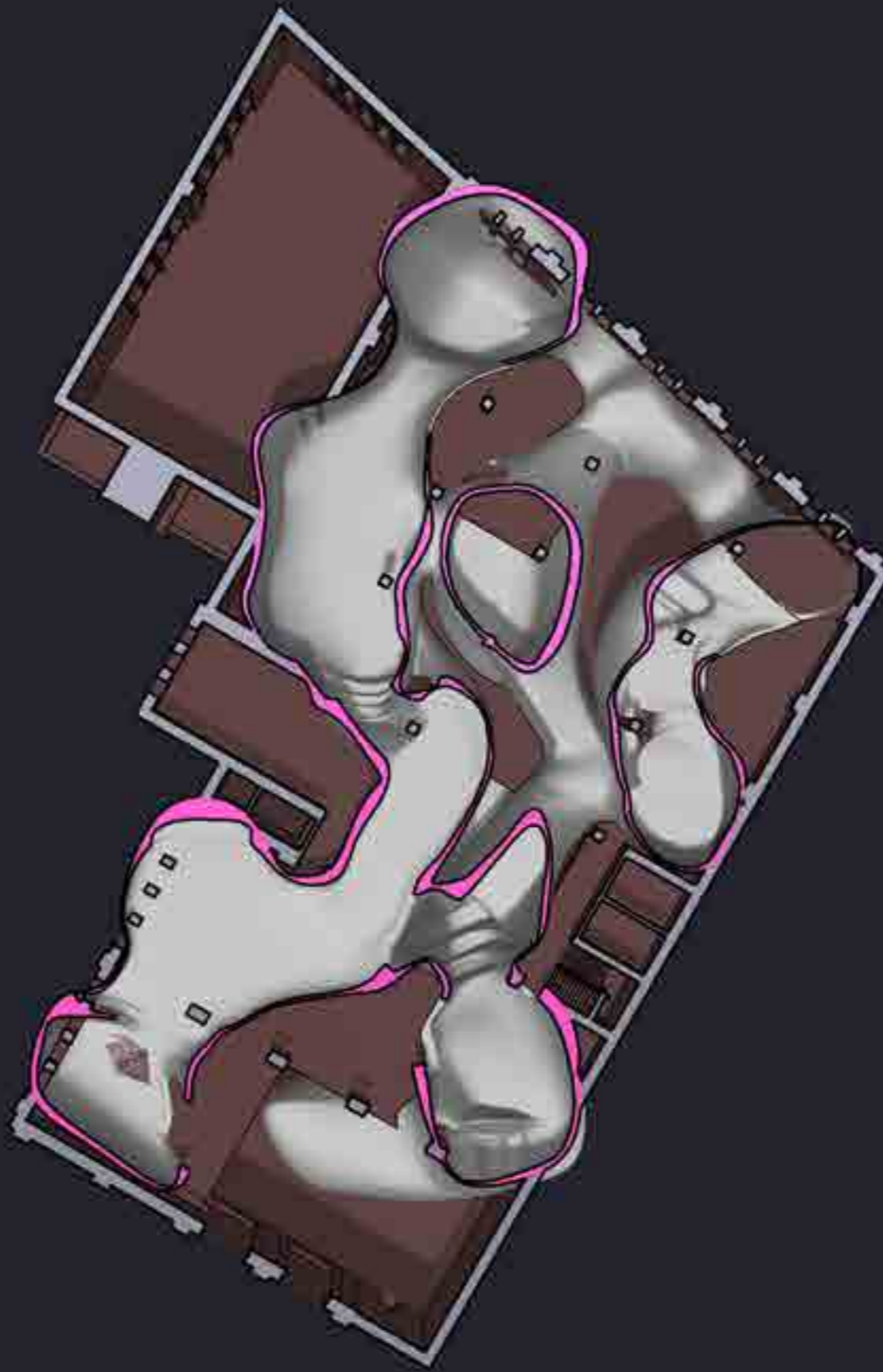
*Section Y-2*



*Section Y-3*

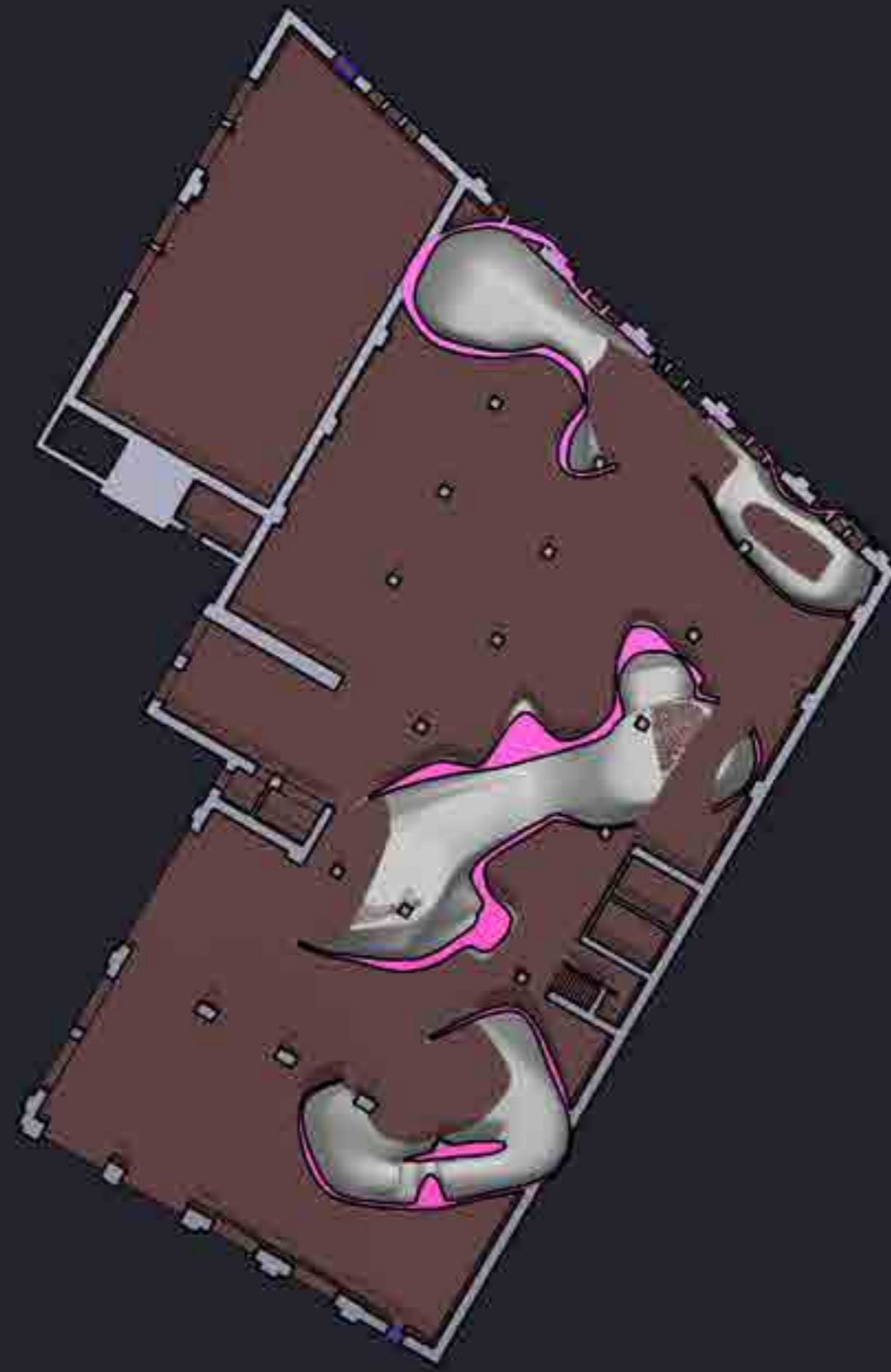


*Section Z-1*



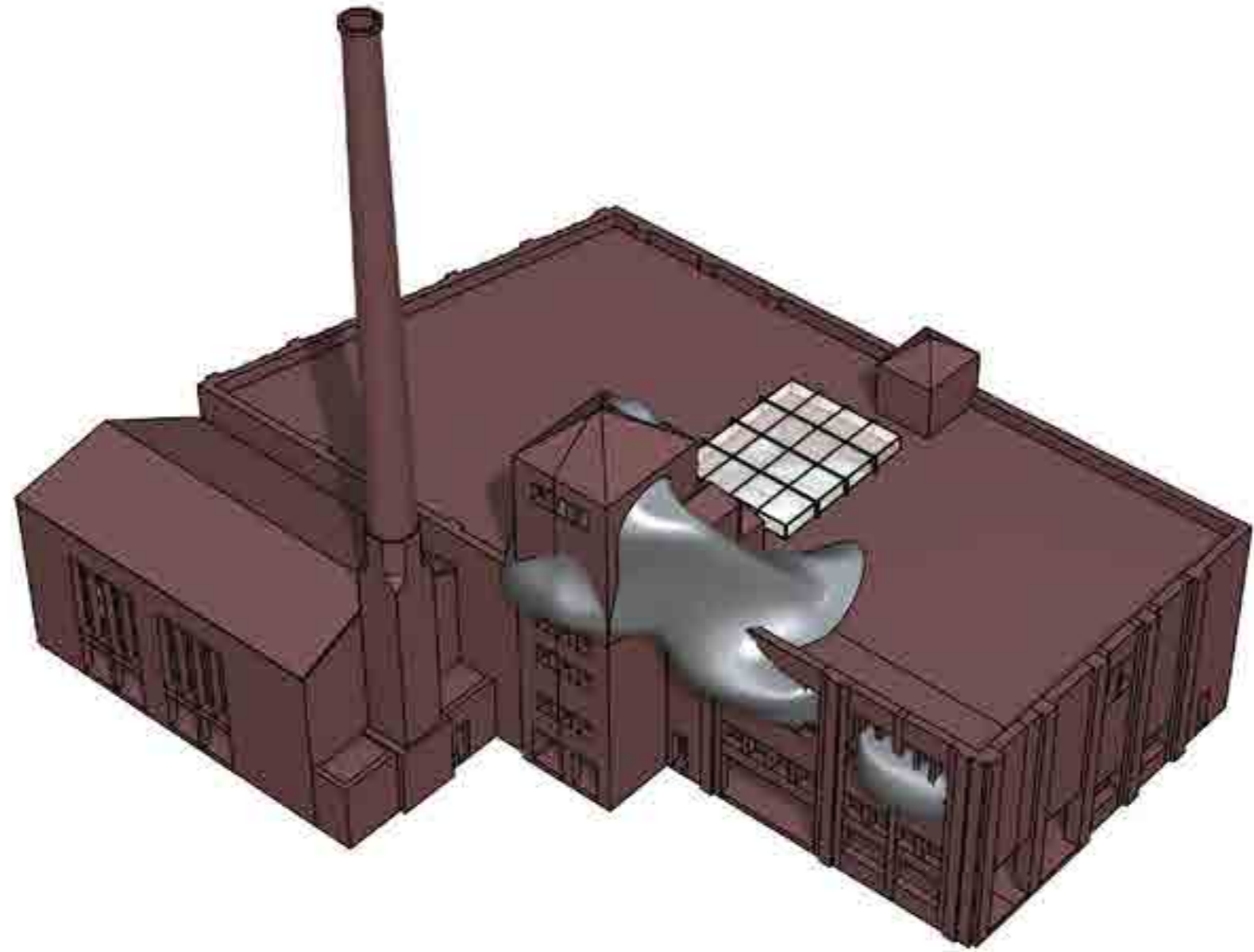
Section Z-2

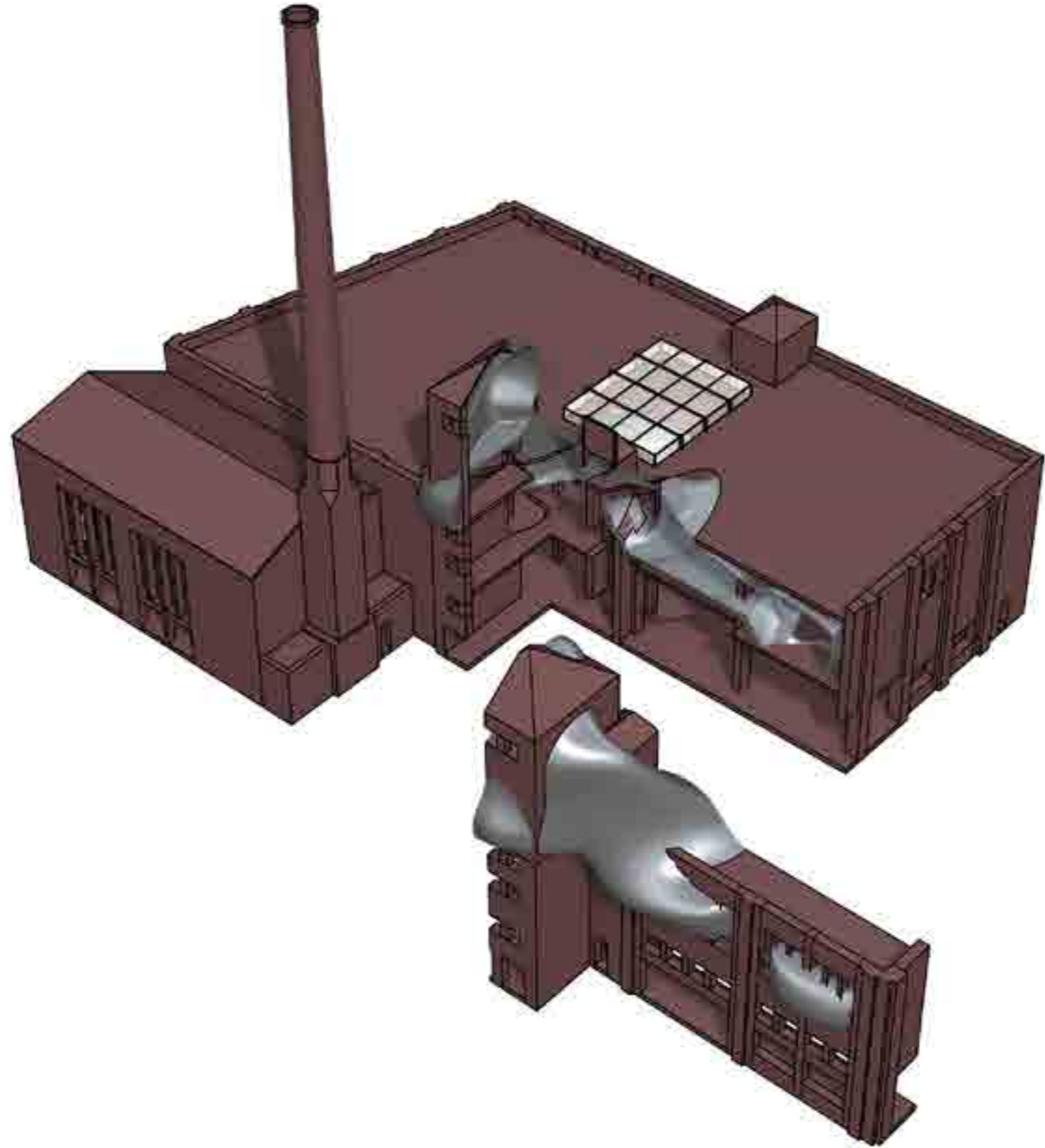




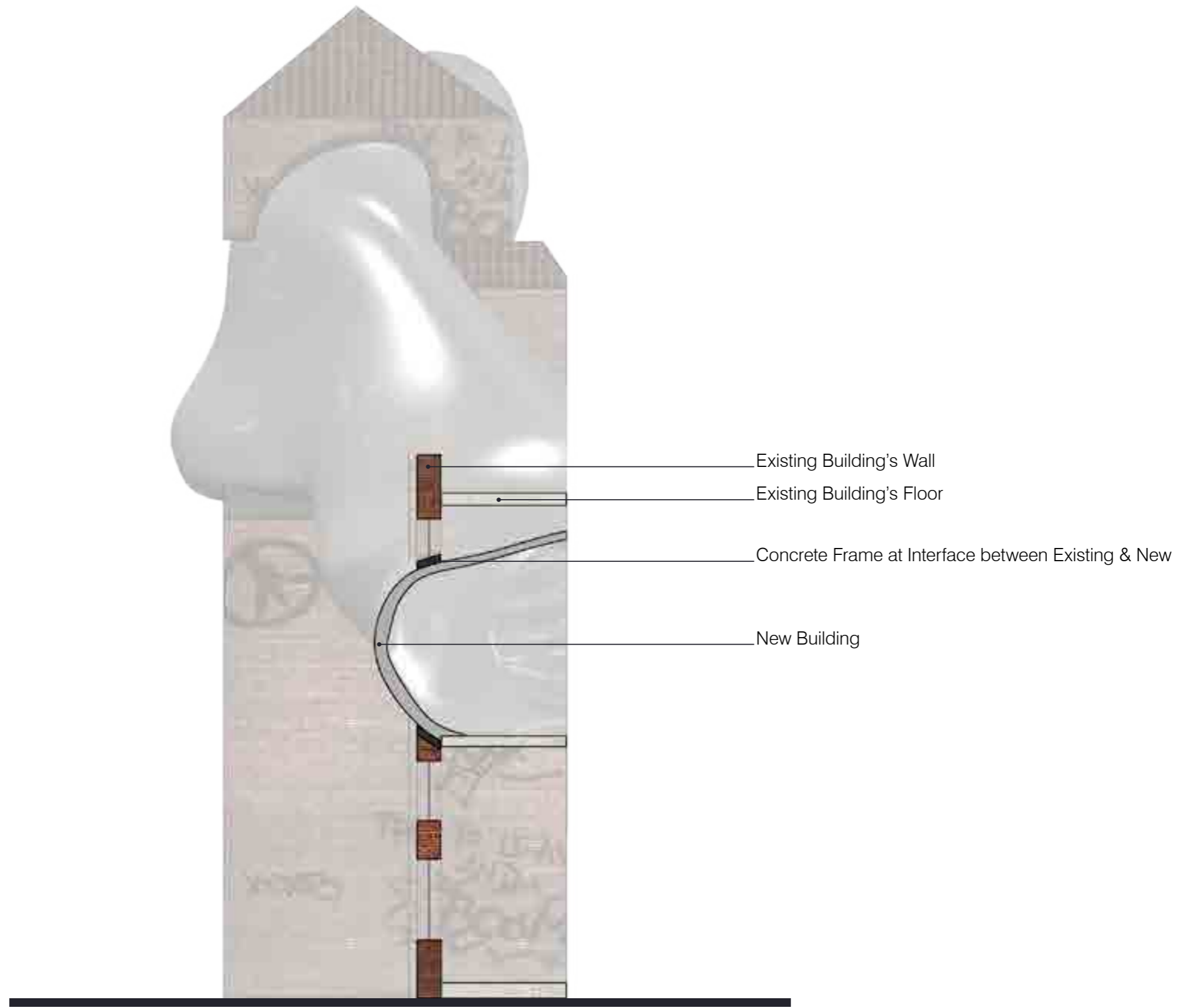
Section Z-3

*MESO Scale*





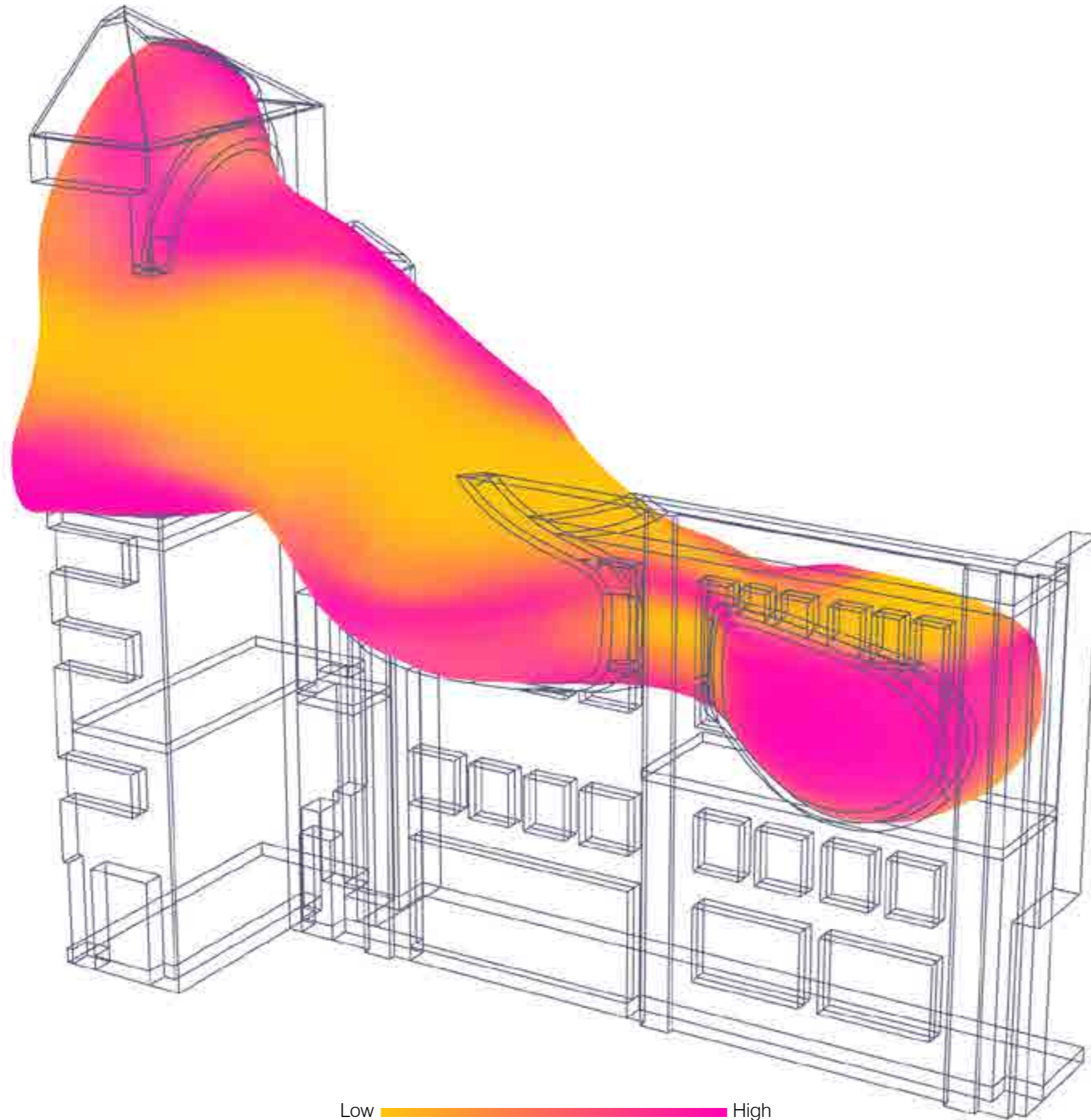
*Fragment Architectural Studies*



*Integration Strategy*



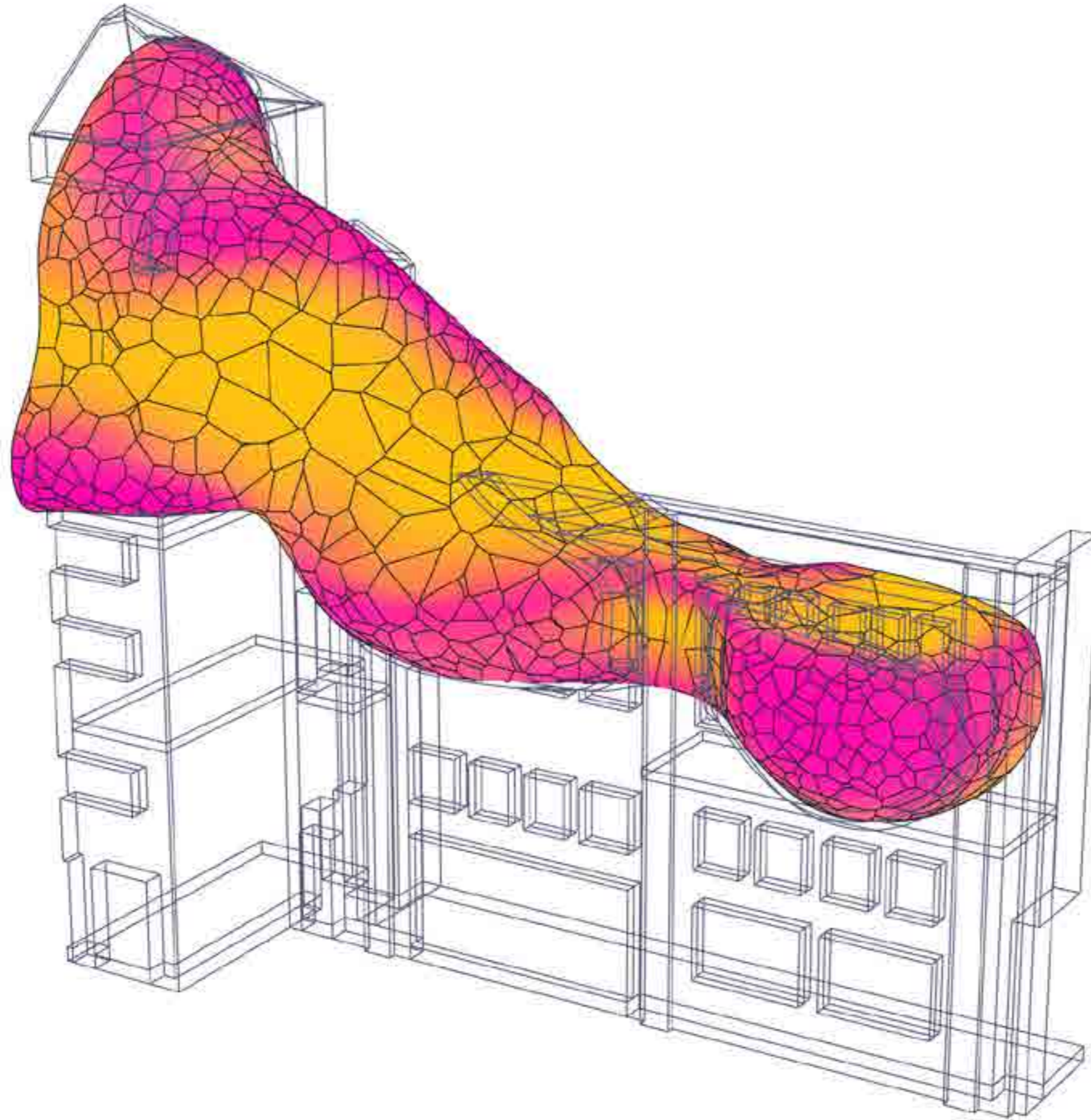
*Integration Strategy*



Low  High

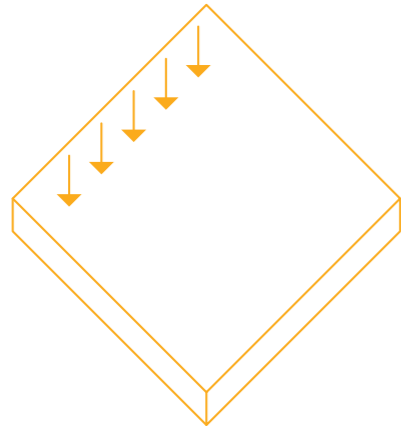
*Mean Curvature Analysis*





*Mean Curvature Analysis*

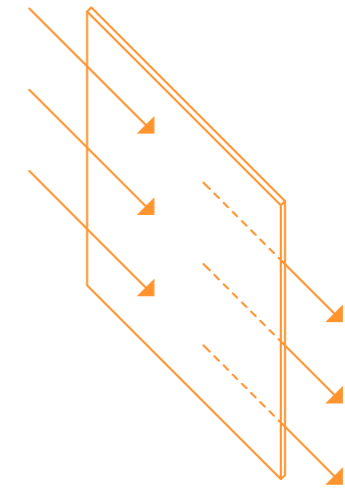
## *Building Performance Mapping*



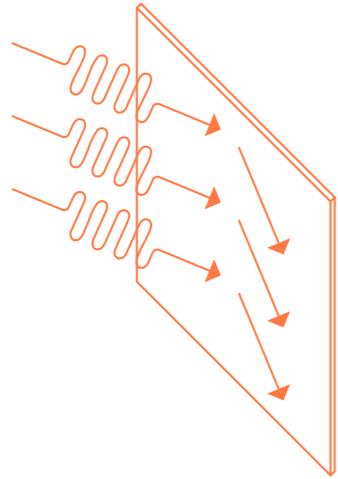
*Heavy Duty Structural Performance*



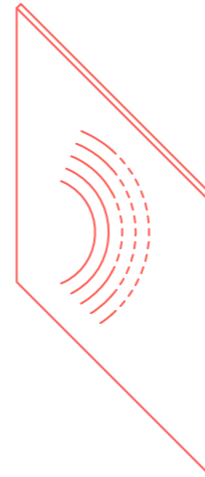
*Light Duty Structural Performance*



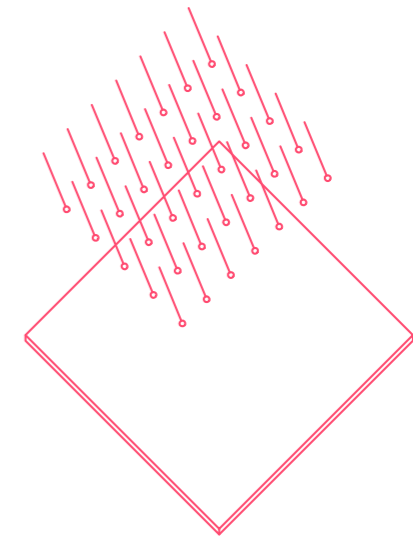
*Translucency*



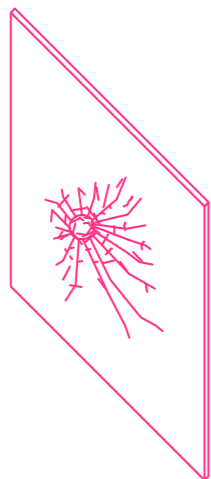
*Thermal Insulation*



*Acoustic Insulation*



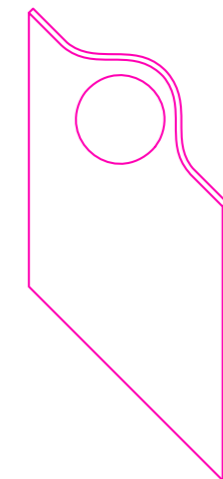
*Water Insulation*



*Impact Protection*



*Fire Protection*



*Softness / Rigidity*

*Heavy Duty  
Performance*

*Light Duty  
Performance*

*Translucency*

*Thermal  
Insulation*

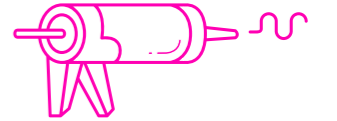
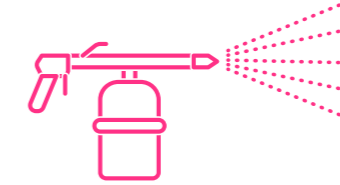
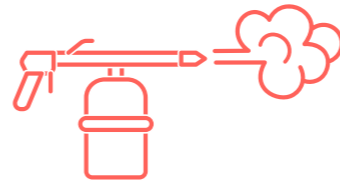
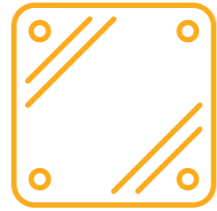
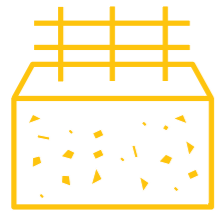
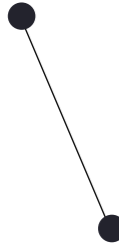
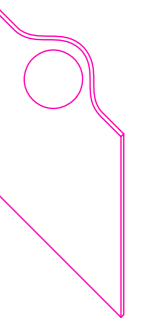
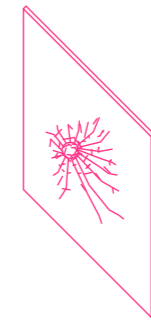
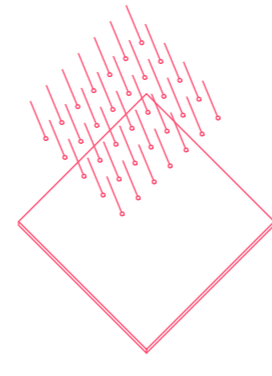
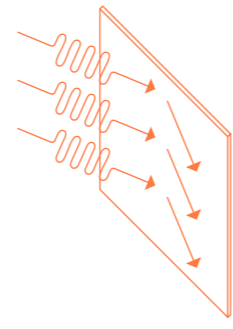
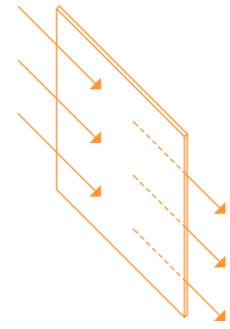
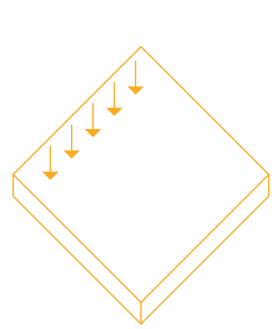
*Acoustic  
Insulation*

*Water  
Insulation*

*Impact  
Protection*

*Fire  
Protection*

*Softnes /  
Rigidity*



*Structural Concrete*

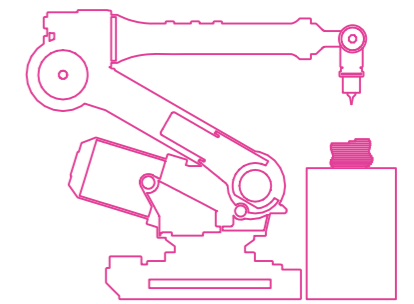
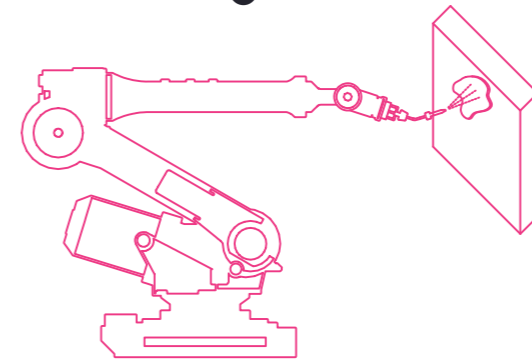
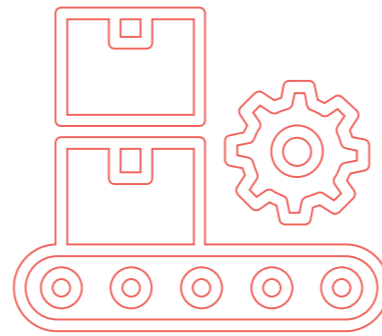
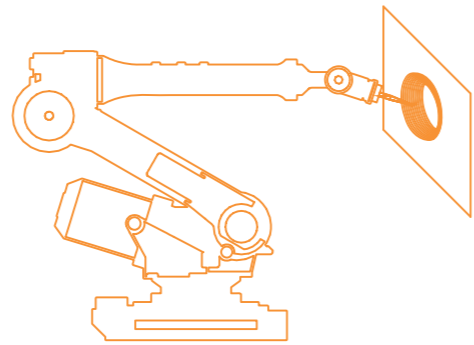
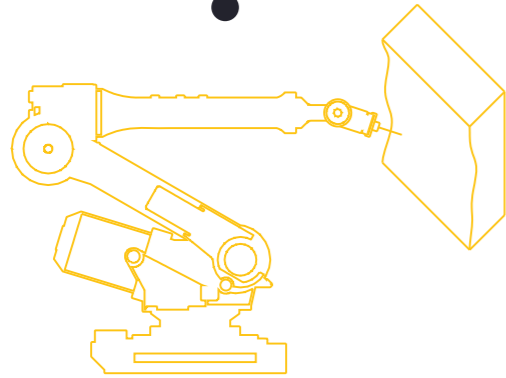
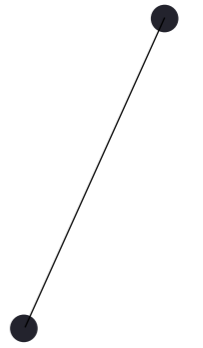
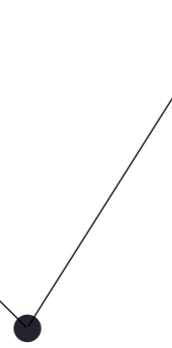
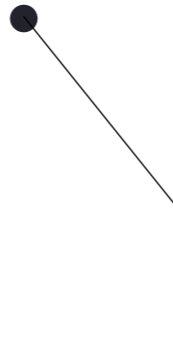
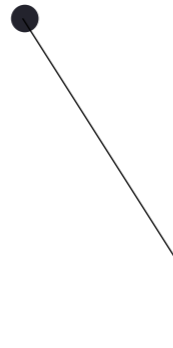
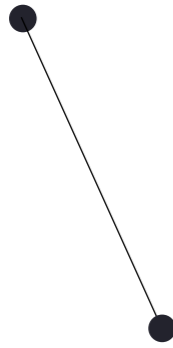
*Stainless Steel Sheets*

*Tempered Glass*

*Polyurethane Foam*

*Latex-based Coating*

*Silicone*



*Robotically Milled  
EPS Molds*

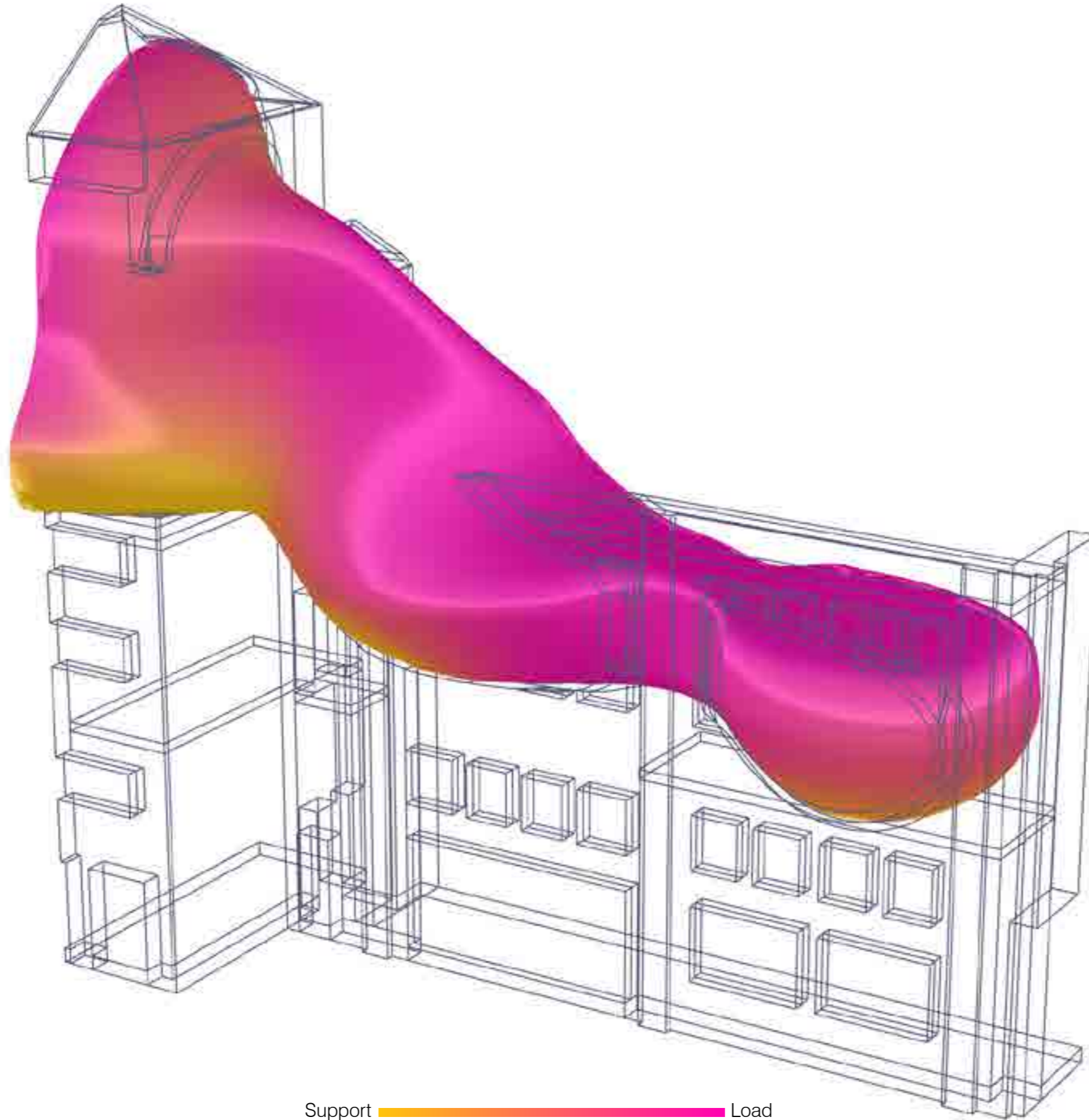
*Robotic Incremental  
Sheet Forming*

*Standard  
Production*

*Robotically Assisted  
Sparaying*

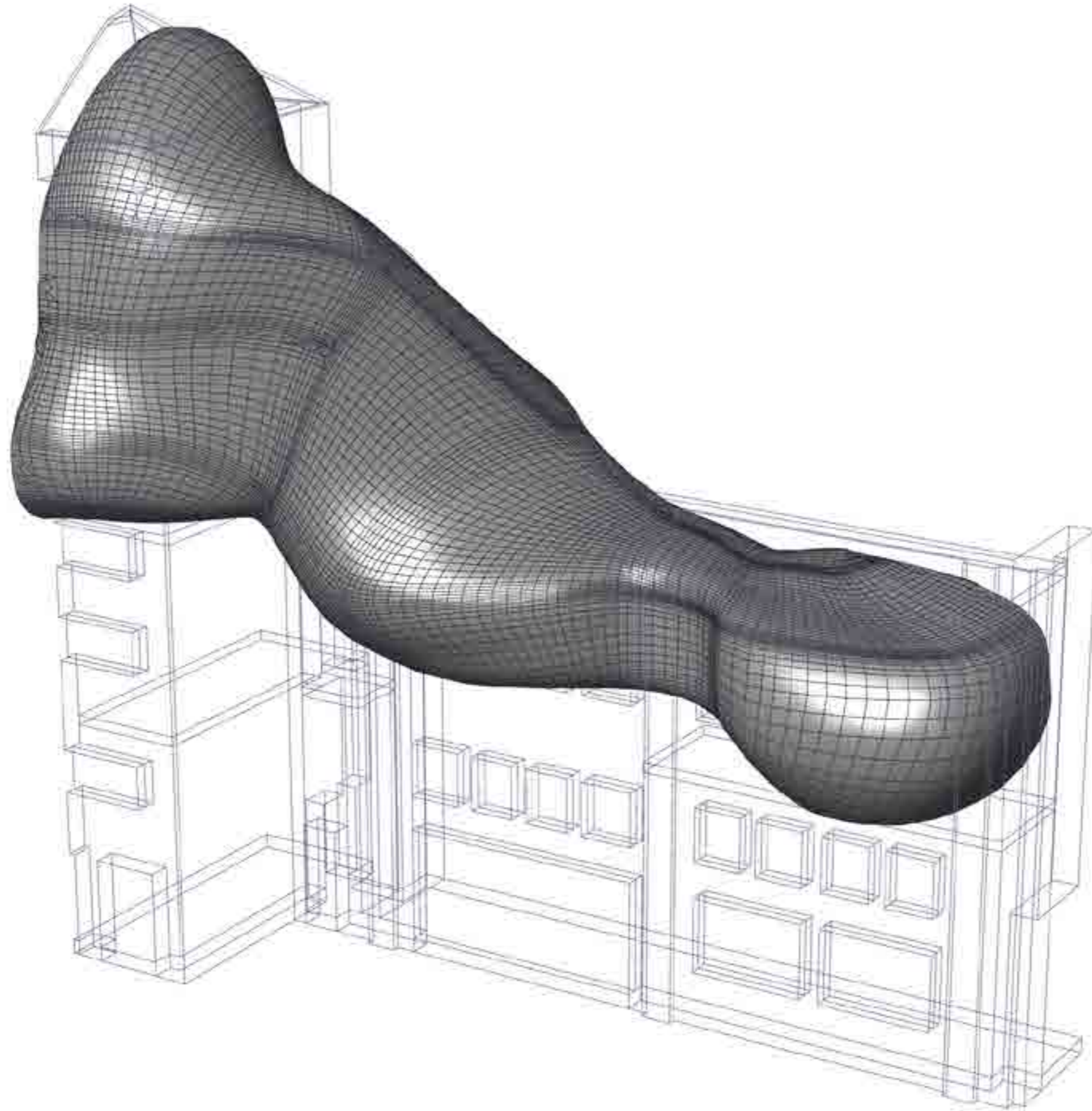
*Robotic Additive  
Manufacturing*

*Fragment Structural Studies*

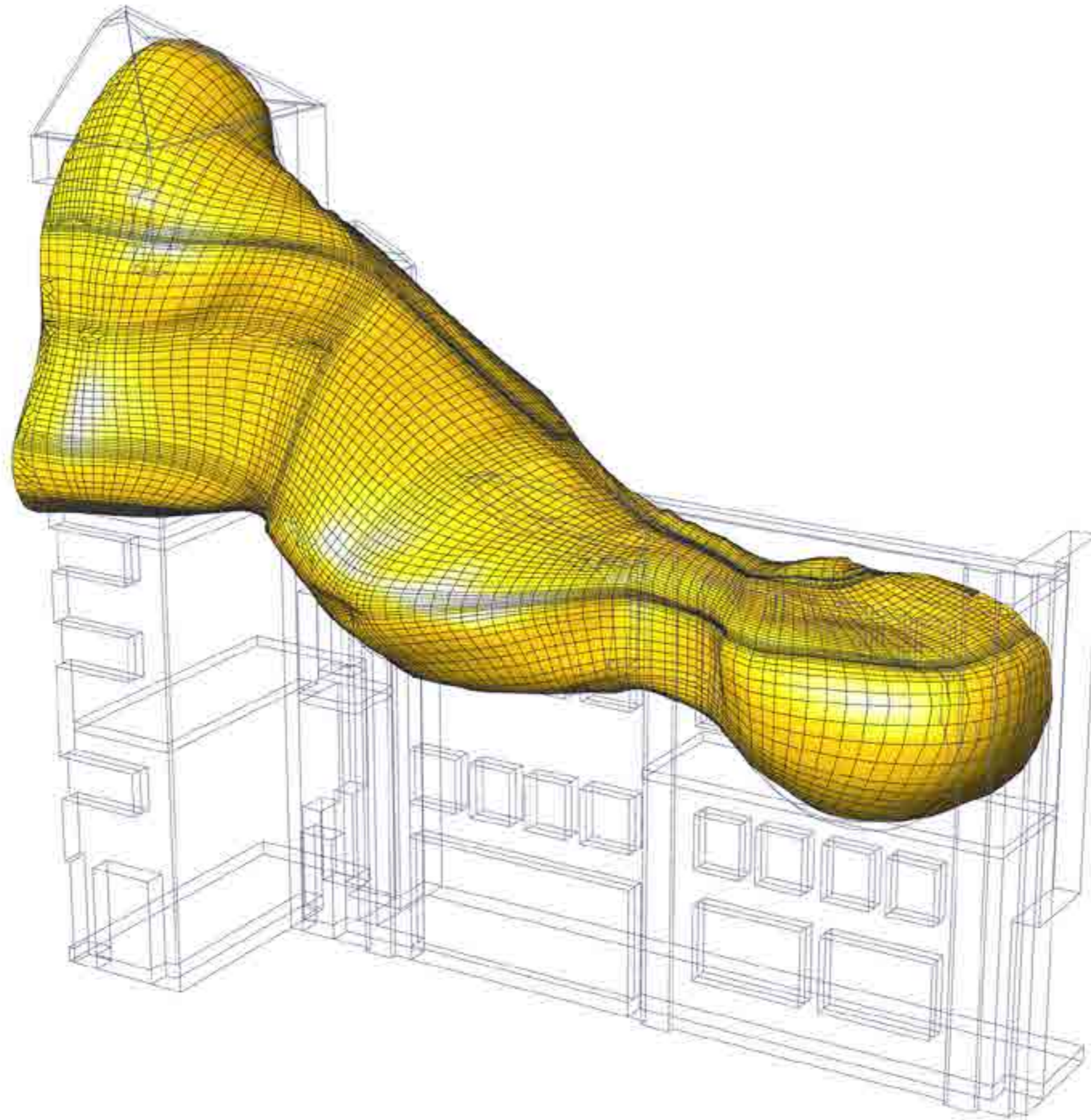


Support  Load

*Supports and Loads Locations*

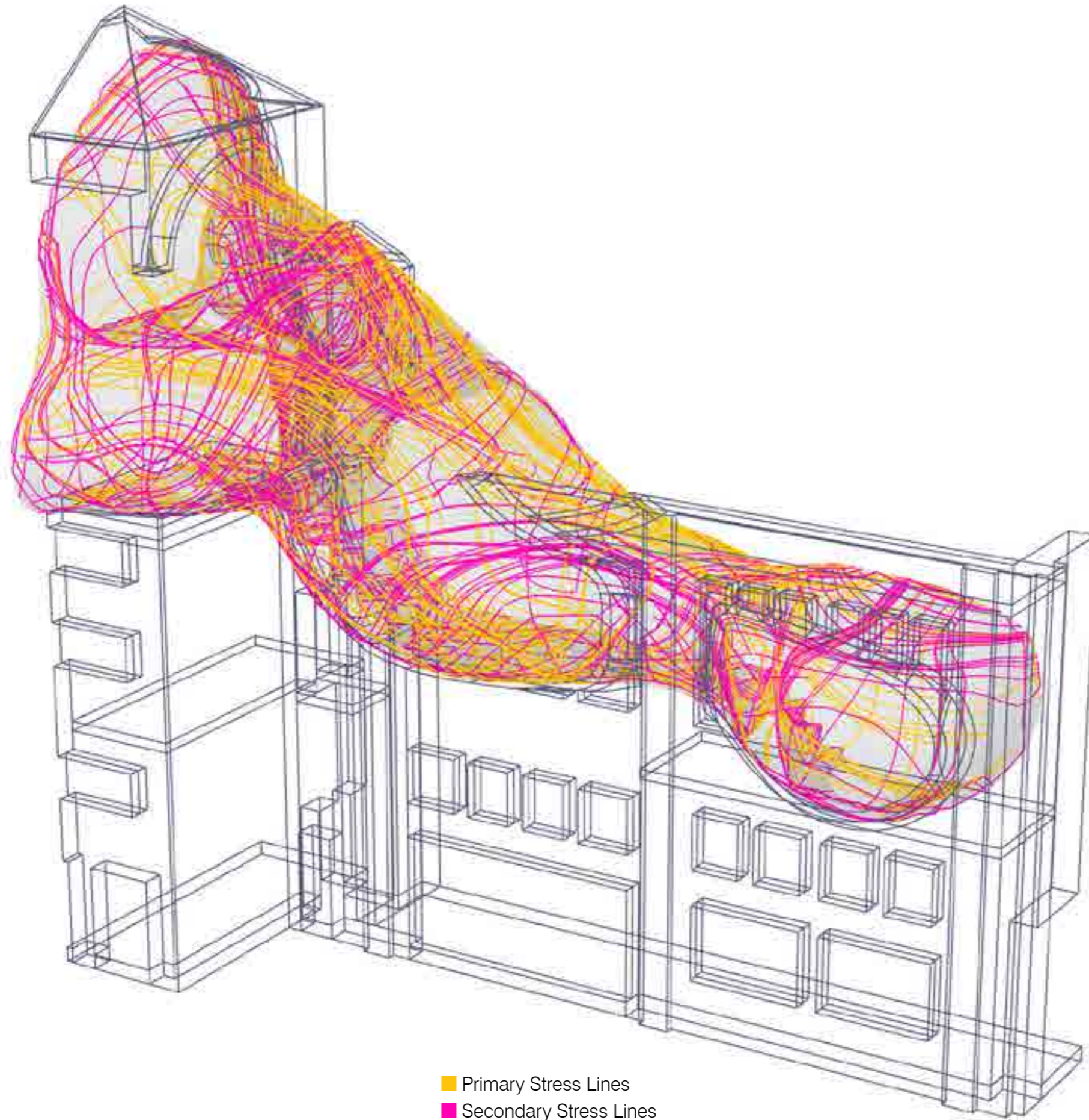


*Topology Optimization I*

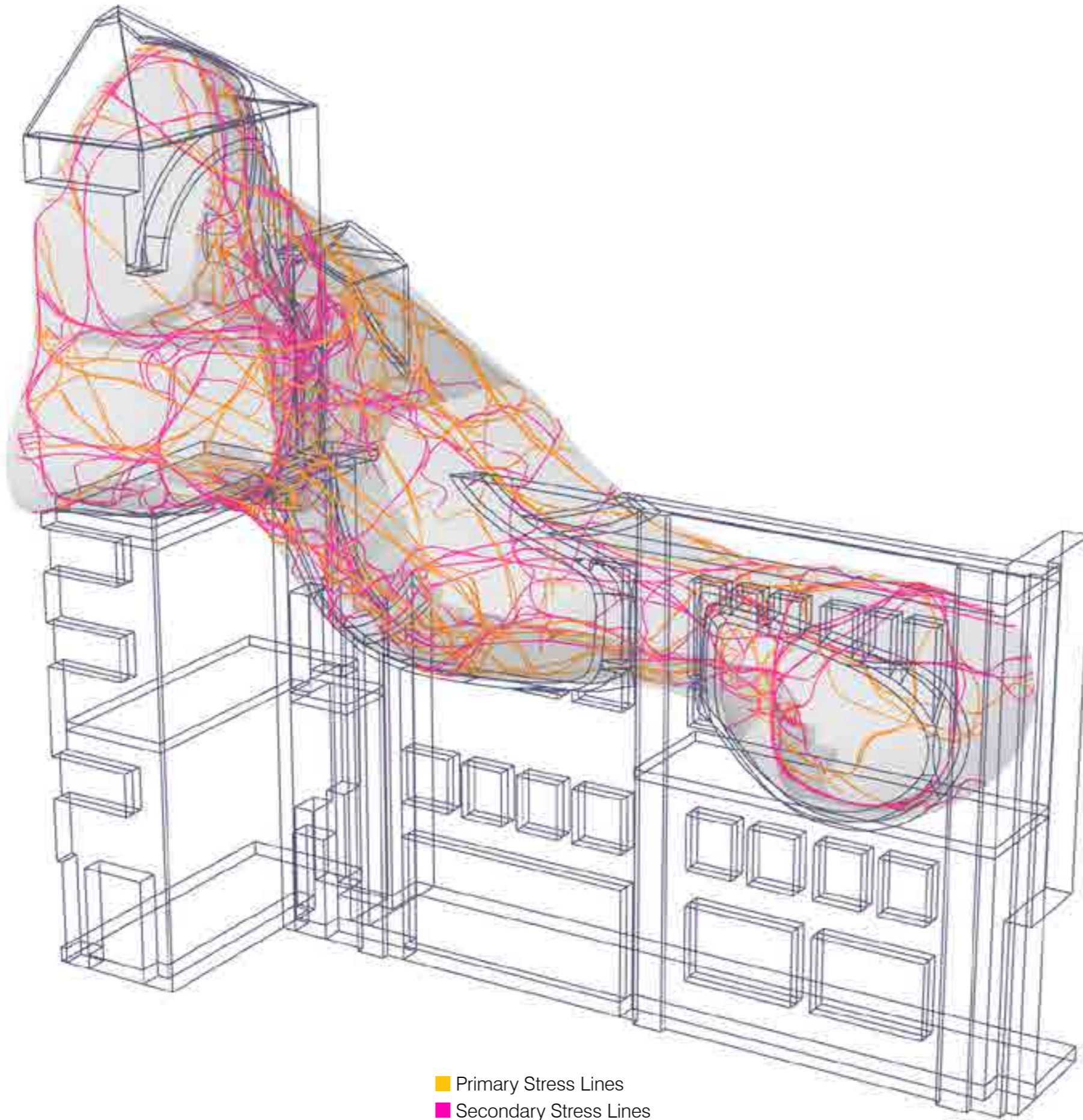


*Topology Optimization I*

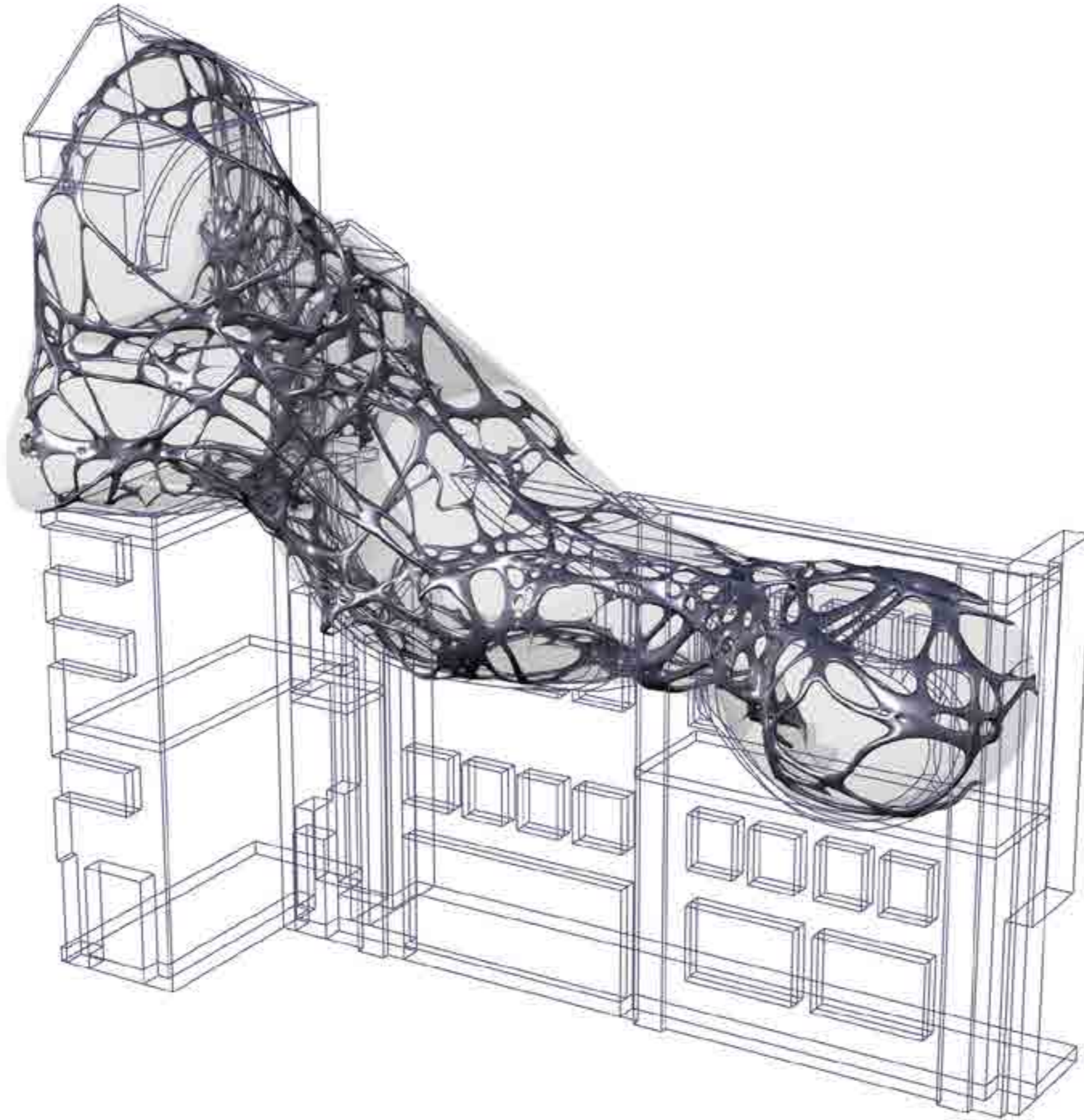




*Stress Lines Analysis*

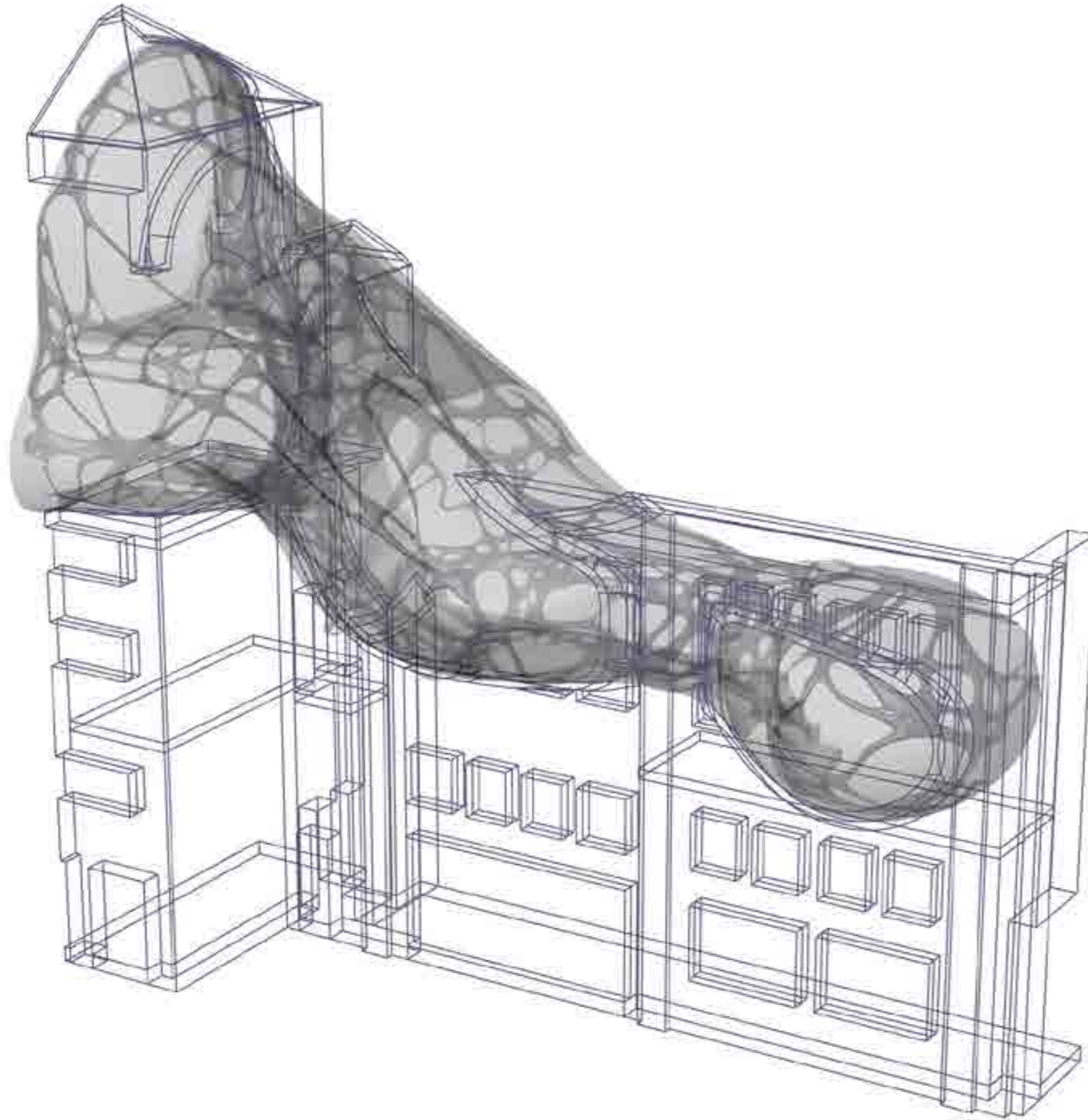


*Stress Lines Bundling*

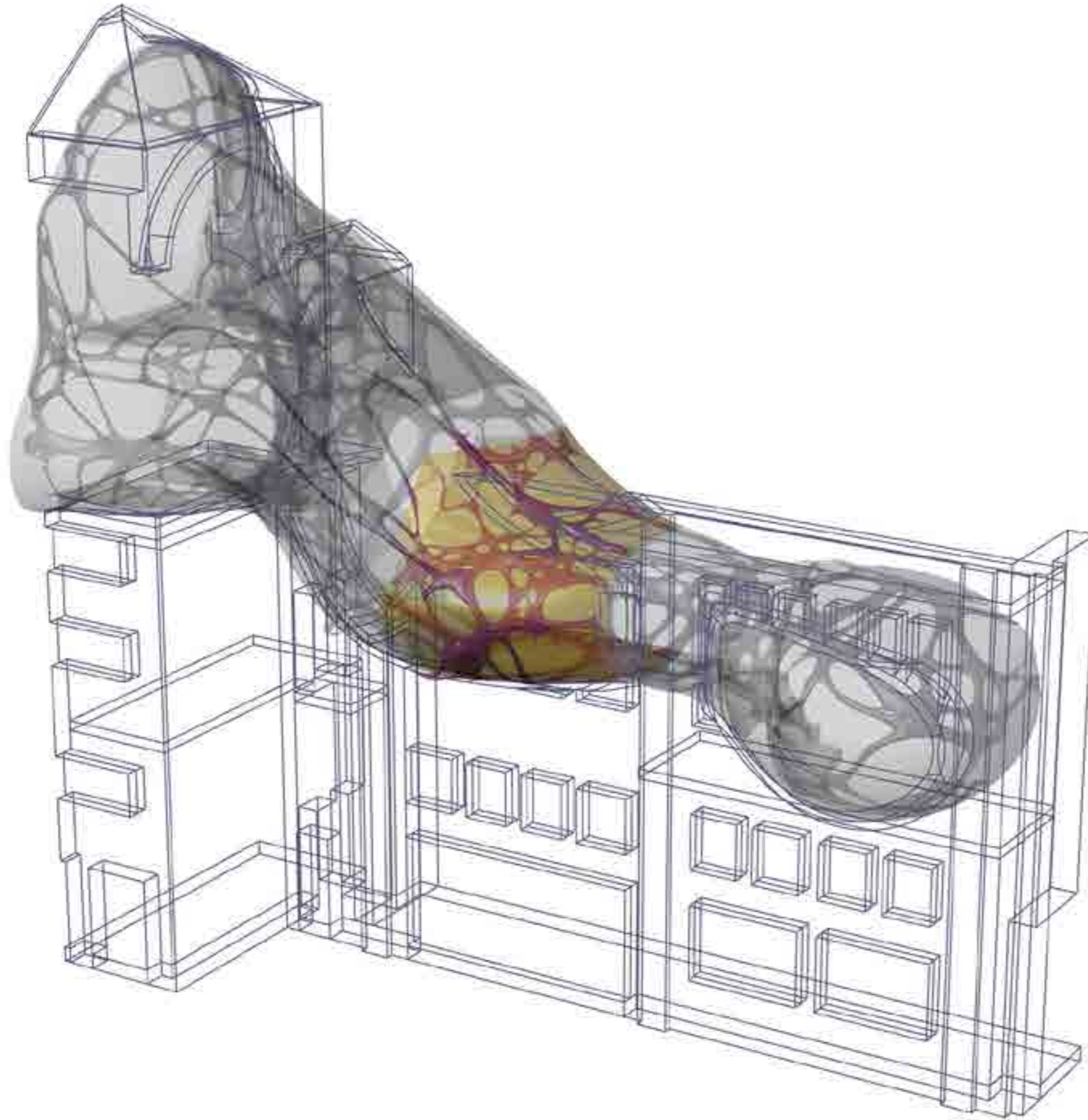


*Topology Optimization II*

*MICRO Scale*



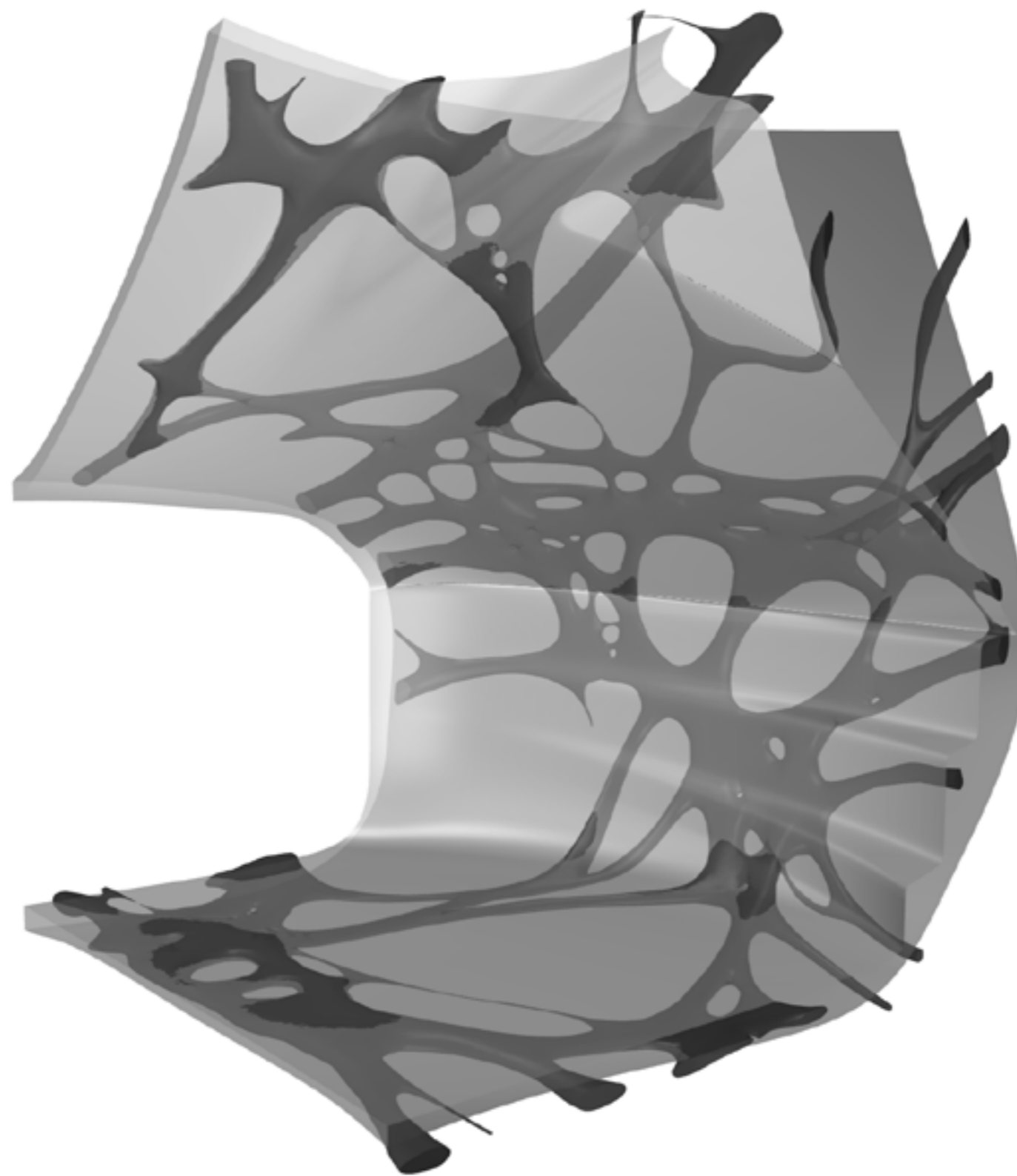
*Sub-Fragment Extraction*



*Sub-Fragment Extraction*

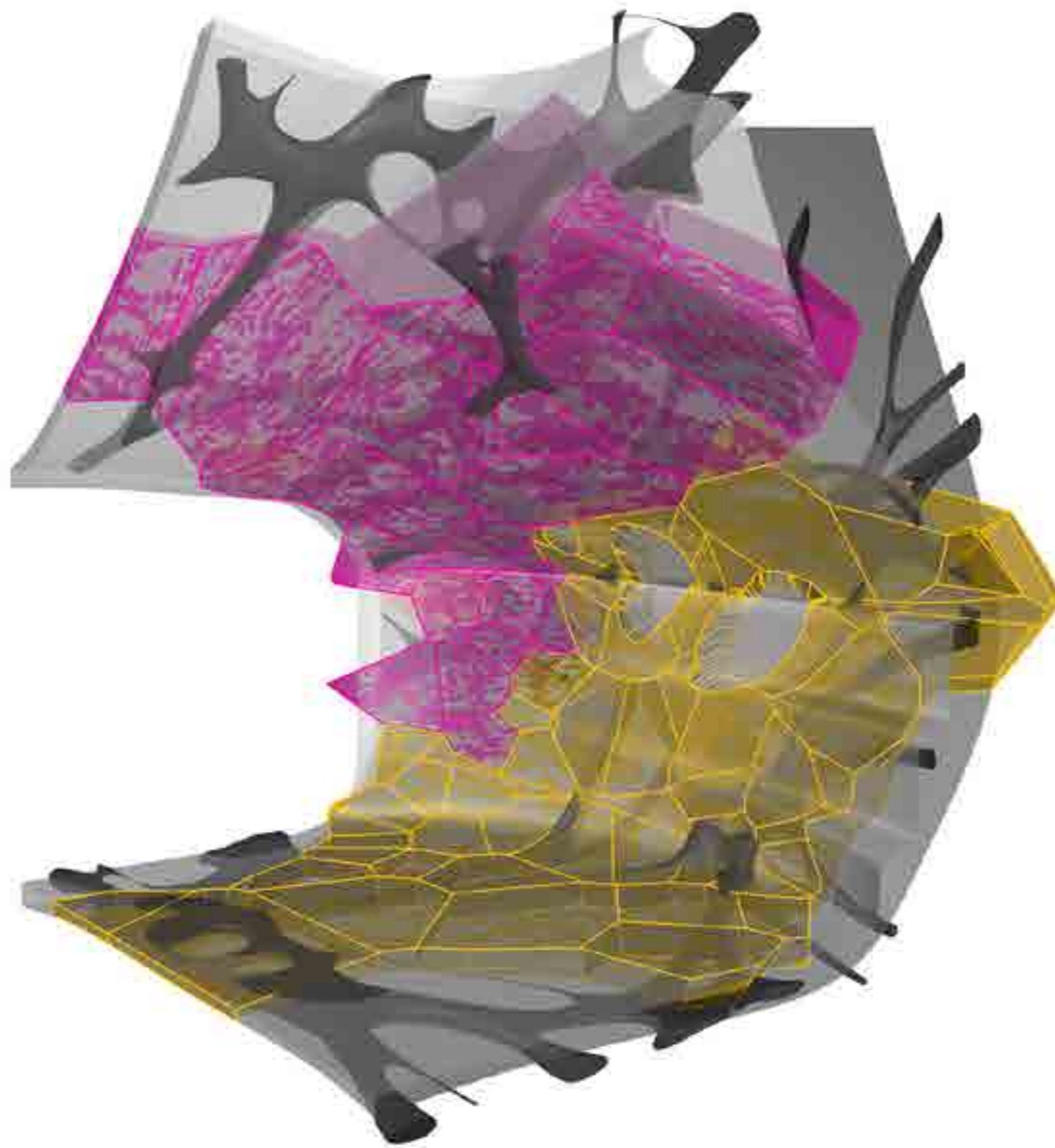


*Sub-Fragment Extraction*



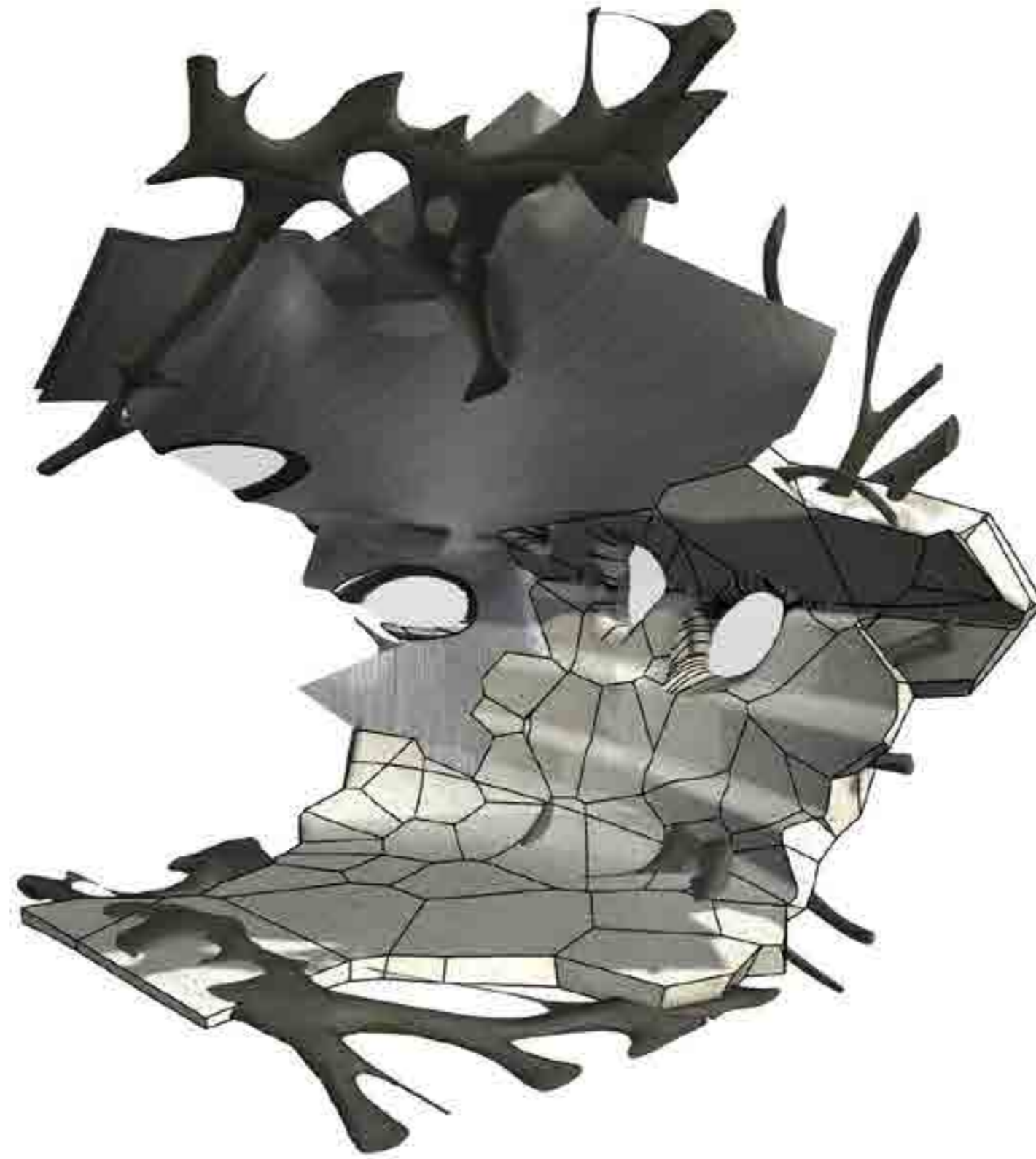
*Basic Geometry*



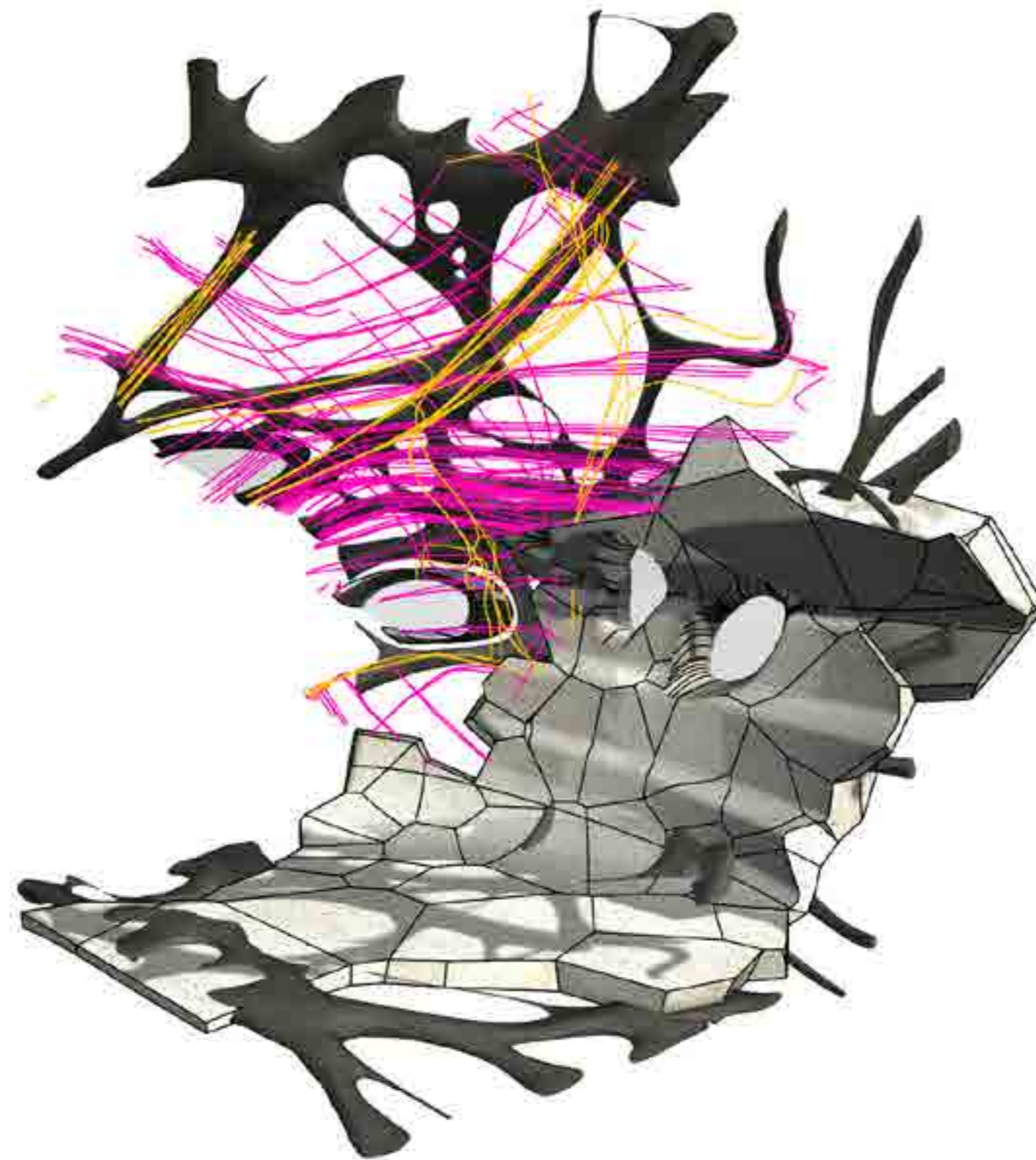


- Concrete
- Stainless Steel Sheets

*Mapping Projection*

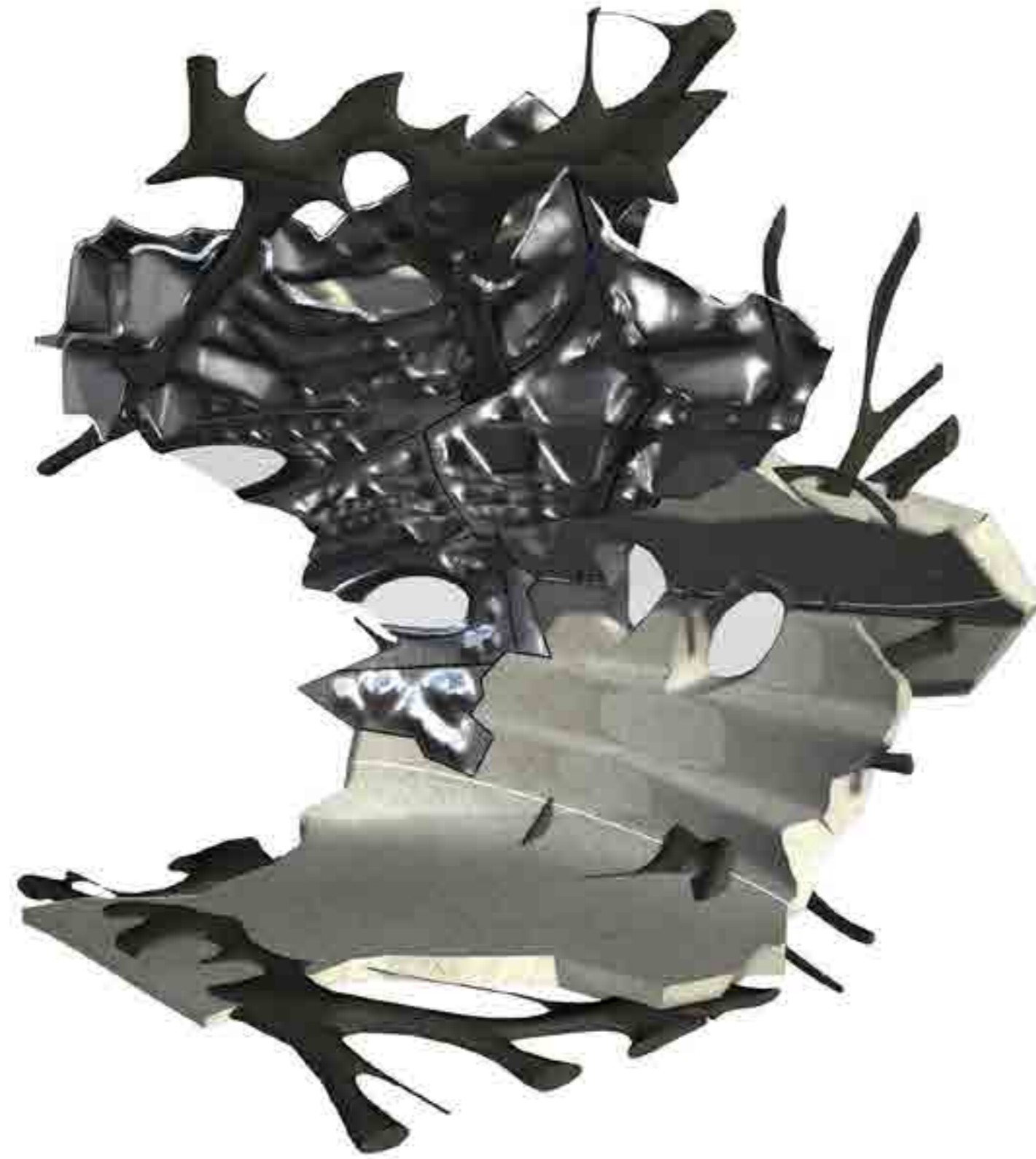


*Pre-Mapped Materials Integration*

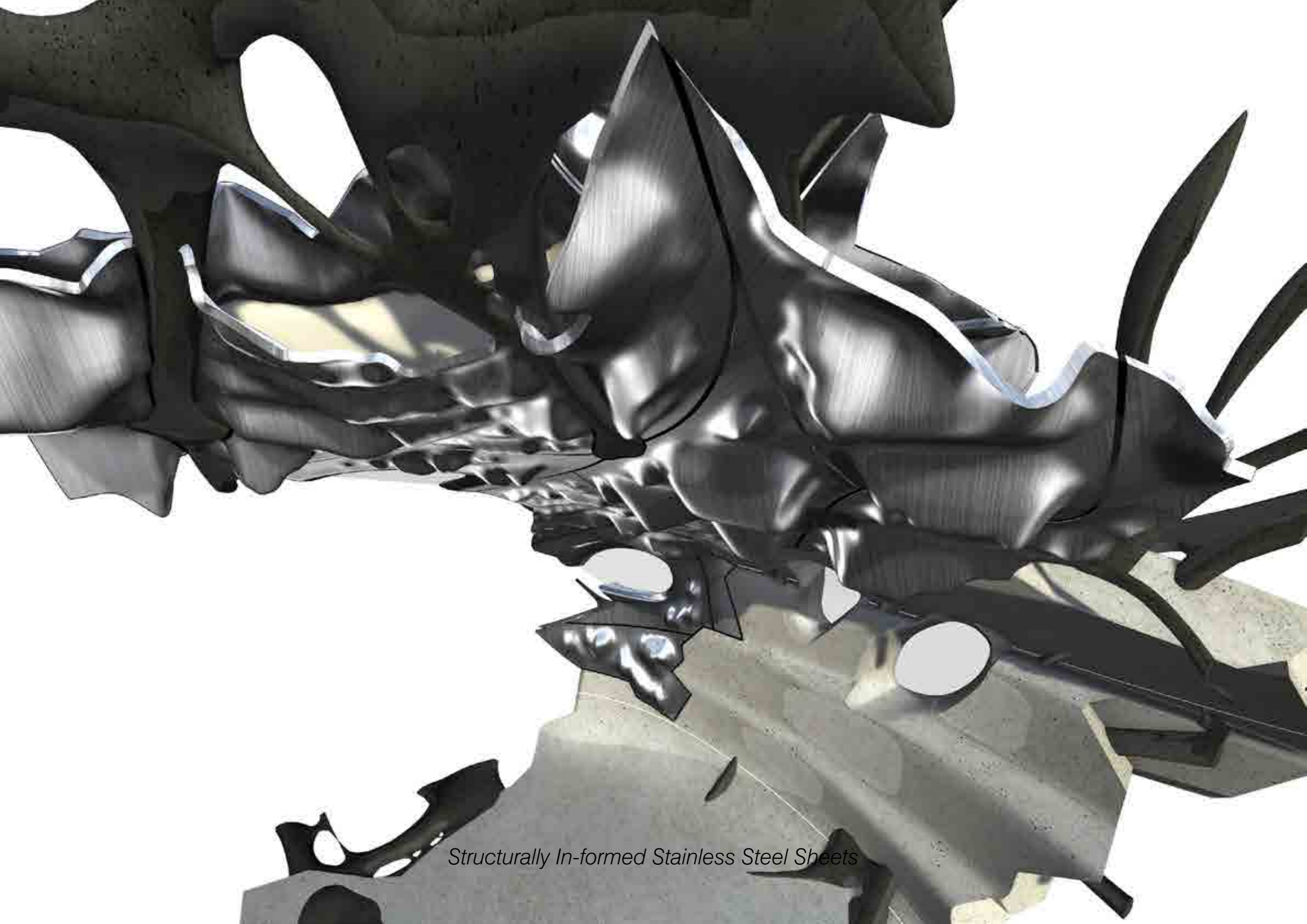


- Primary Stress Lines (Bundled)
- Secondary Stress Lines (Original)

*Stress Lines on Metal Sheets*



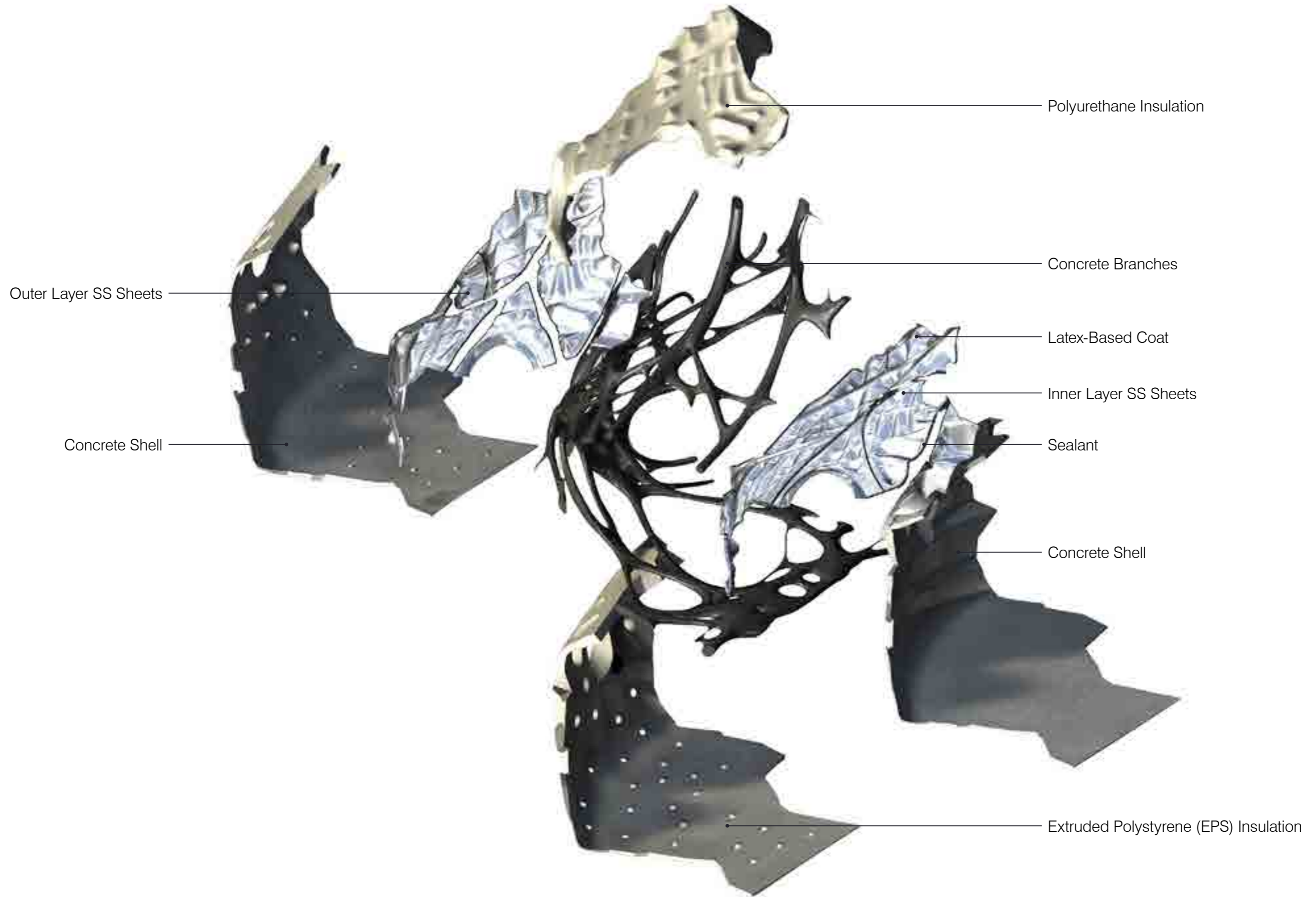
*Structurally In-formed Stainless Steel Sheets*



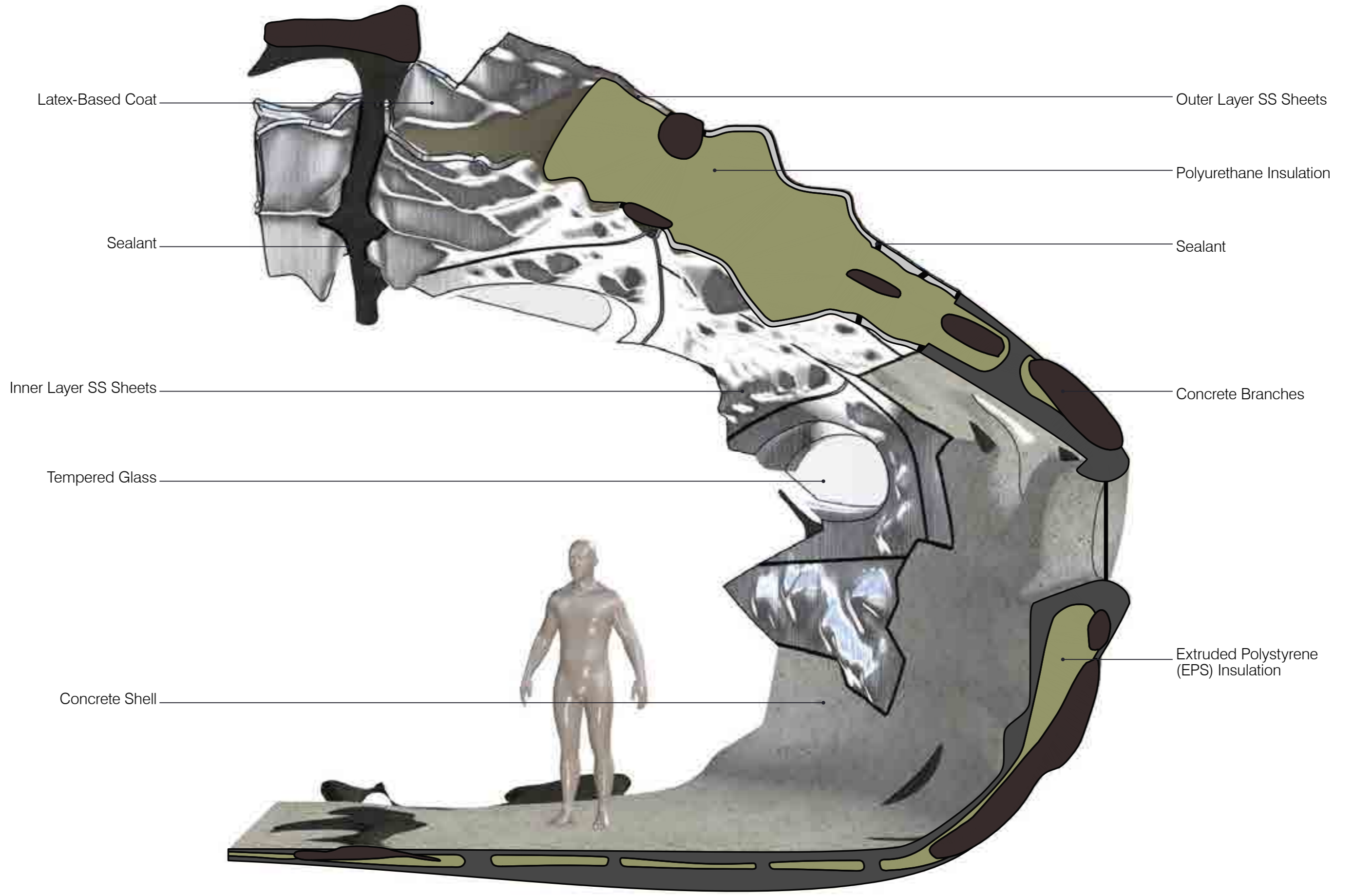
*Structurally In-formed Stainless Steel Sheets*



*Materials Heirarchy*



*Materials Heirarchy*



*Sub-Fragment Section*



**DIVERGENT TECTONICS**

*Design Optimization to Robotic Production Framework*