DIVERGENT TECTONICS

Design Optimization to Robotic Production Framework

DiA

Dessau International Architecture School

Anhalt University Department 3

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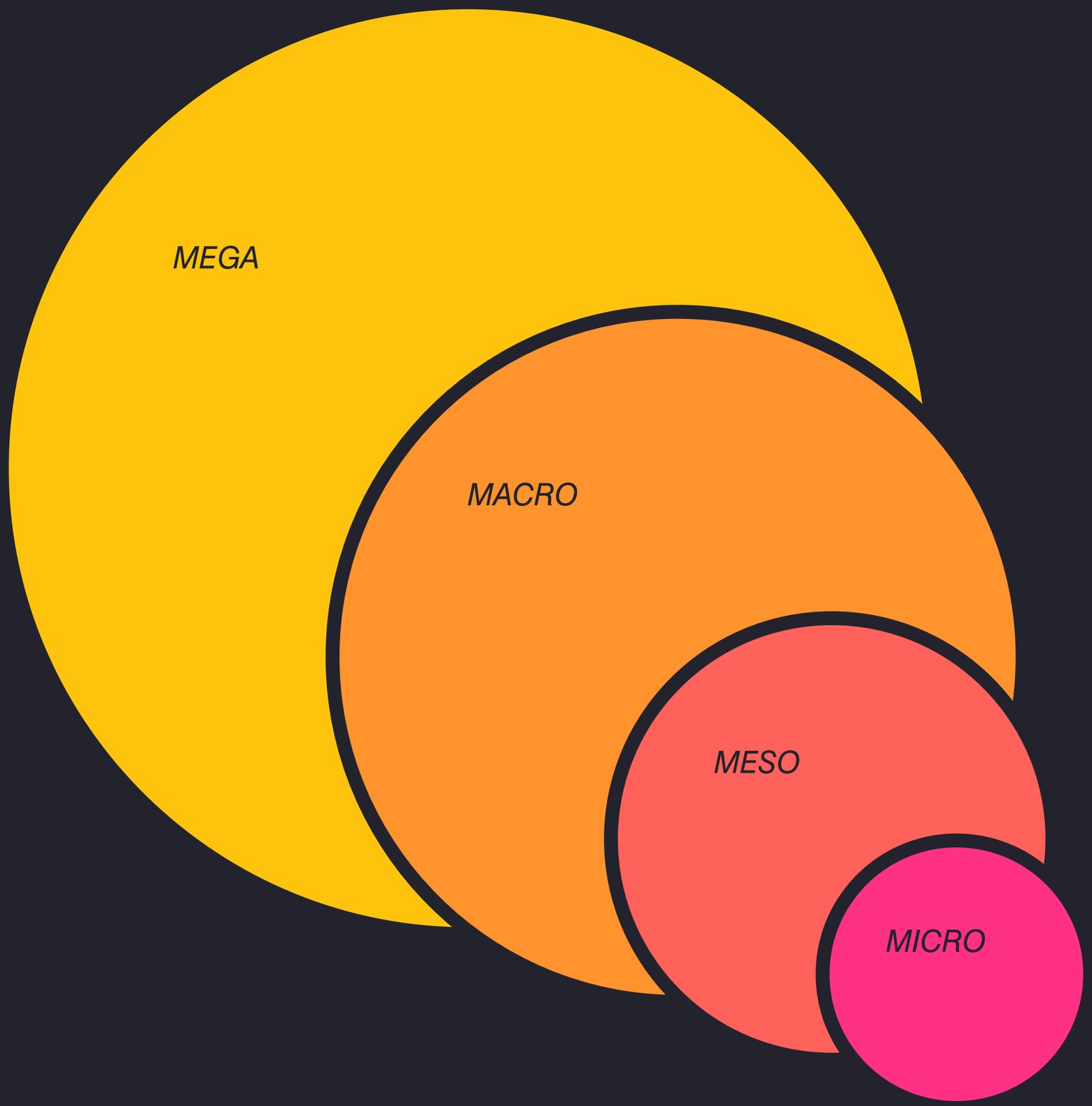
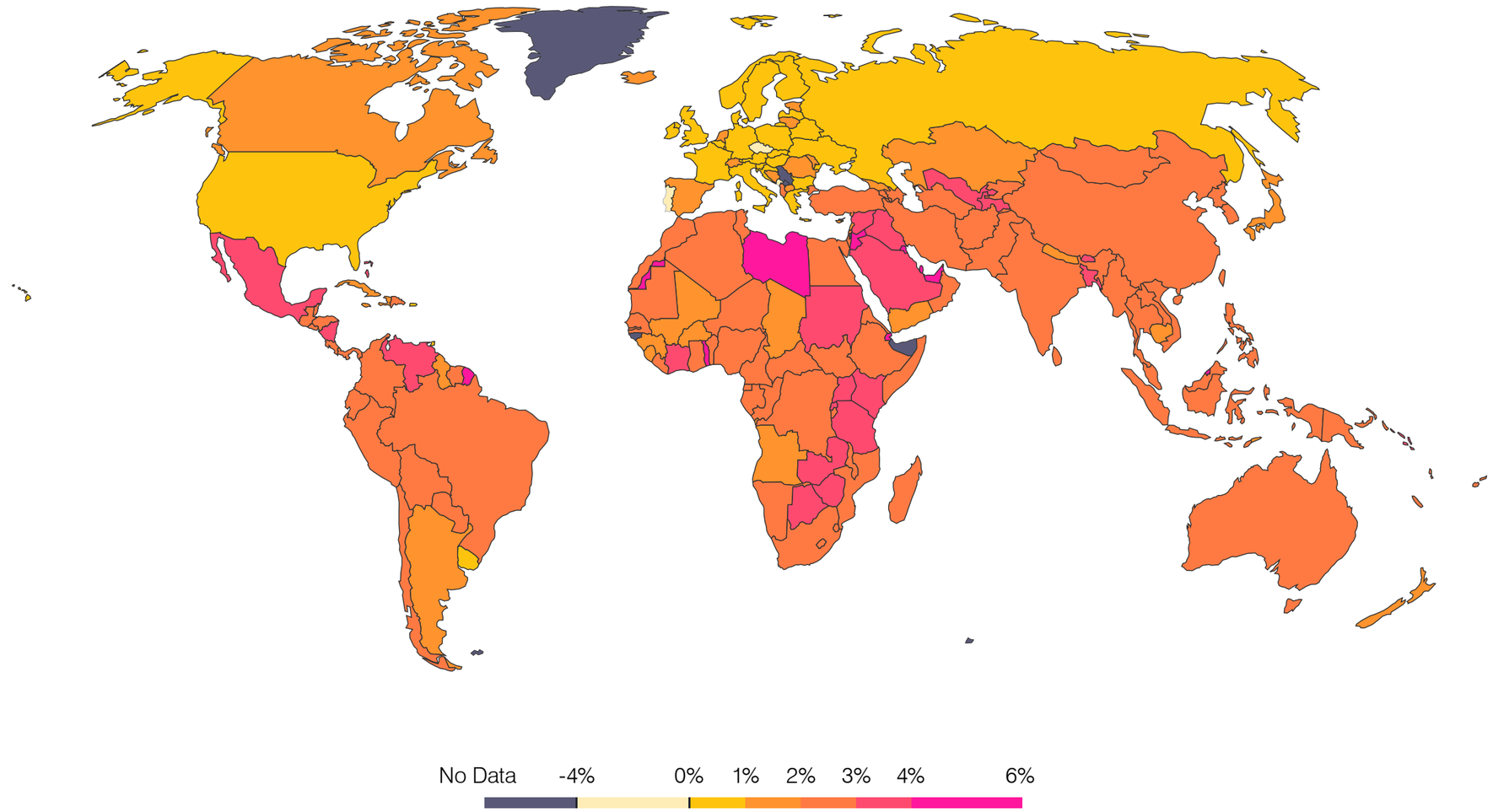
Thesis Presentation by: Mahmoud Meligy

Supervision by: Henriette Bier

Sina Mostafavi

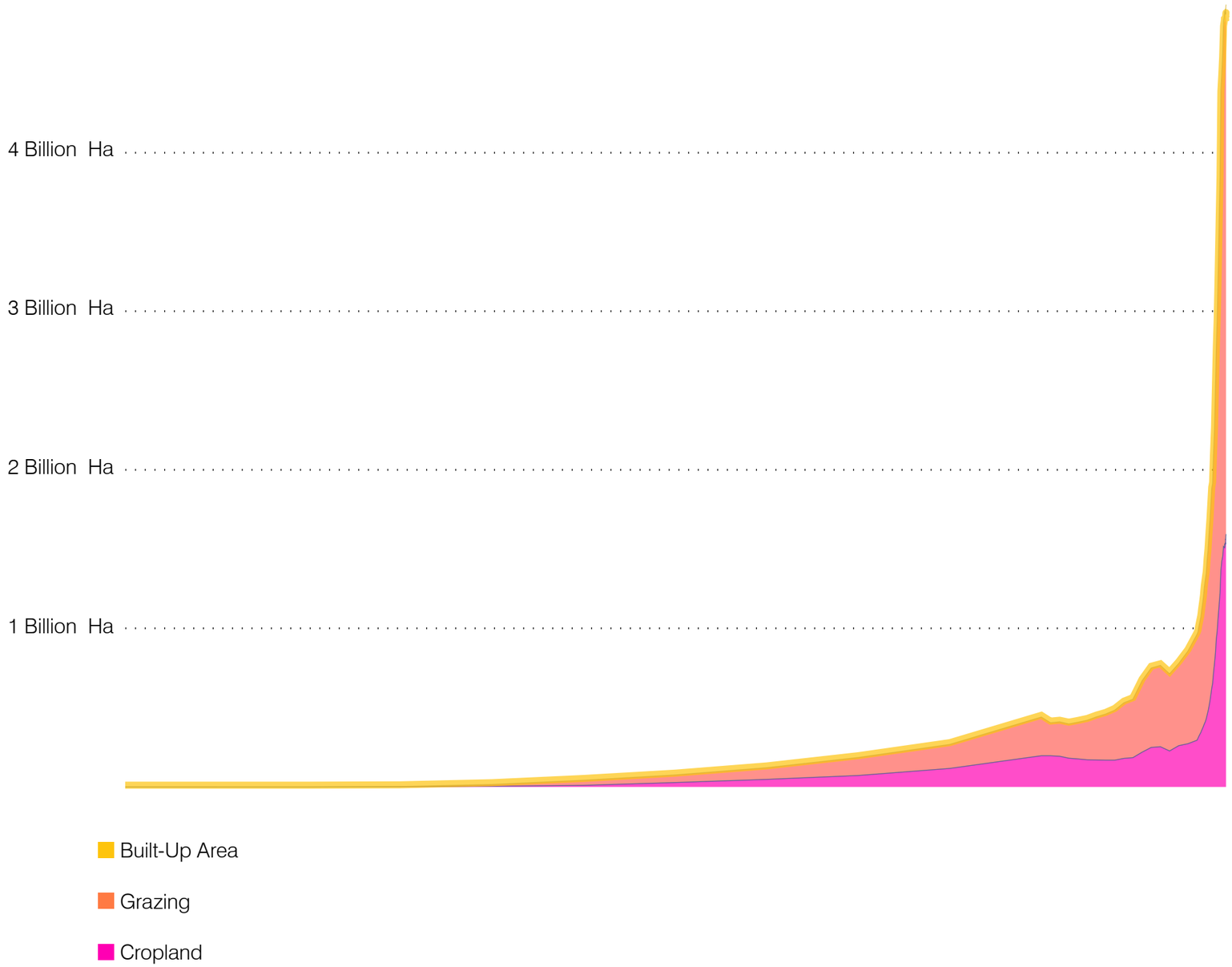

MEGA
MACRO
MESO
MICRO

MEGA Scale



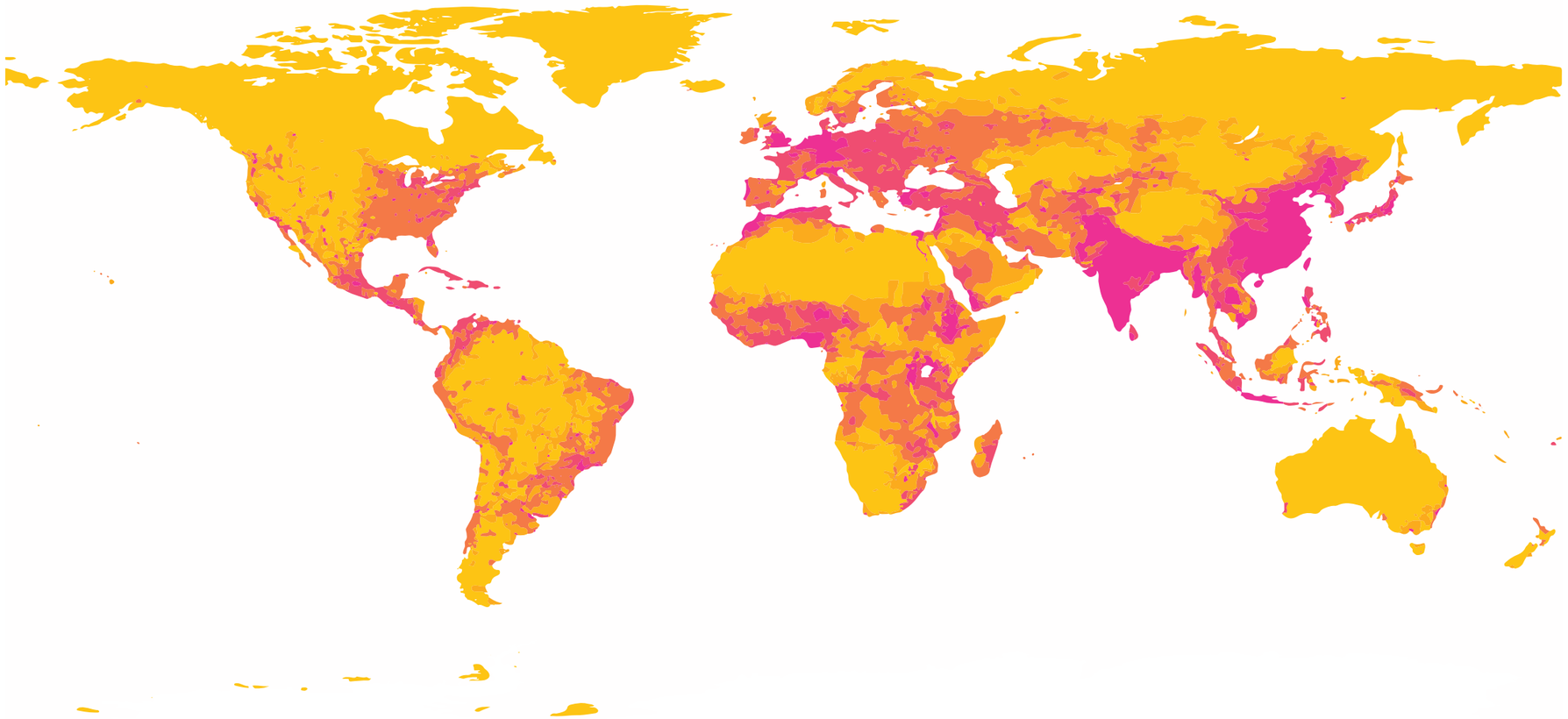
Annual Global Population Growth Rates

United Nations, 2016



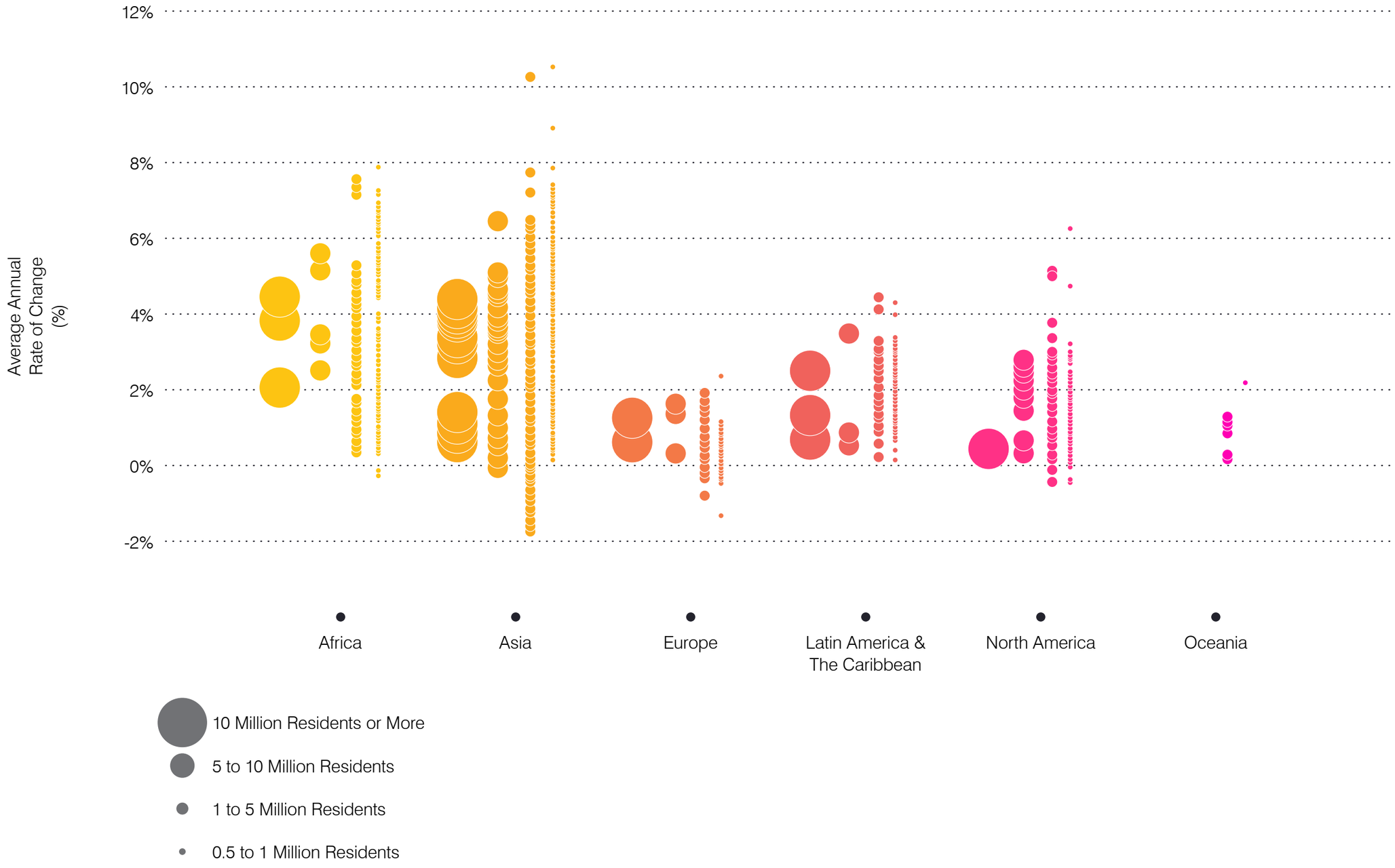
Global Built-Up Area Growth

United Nations, 2016



Global Population Distribution

NASA Earth Observations, 2015

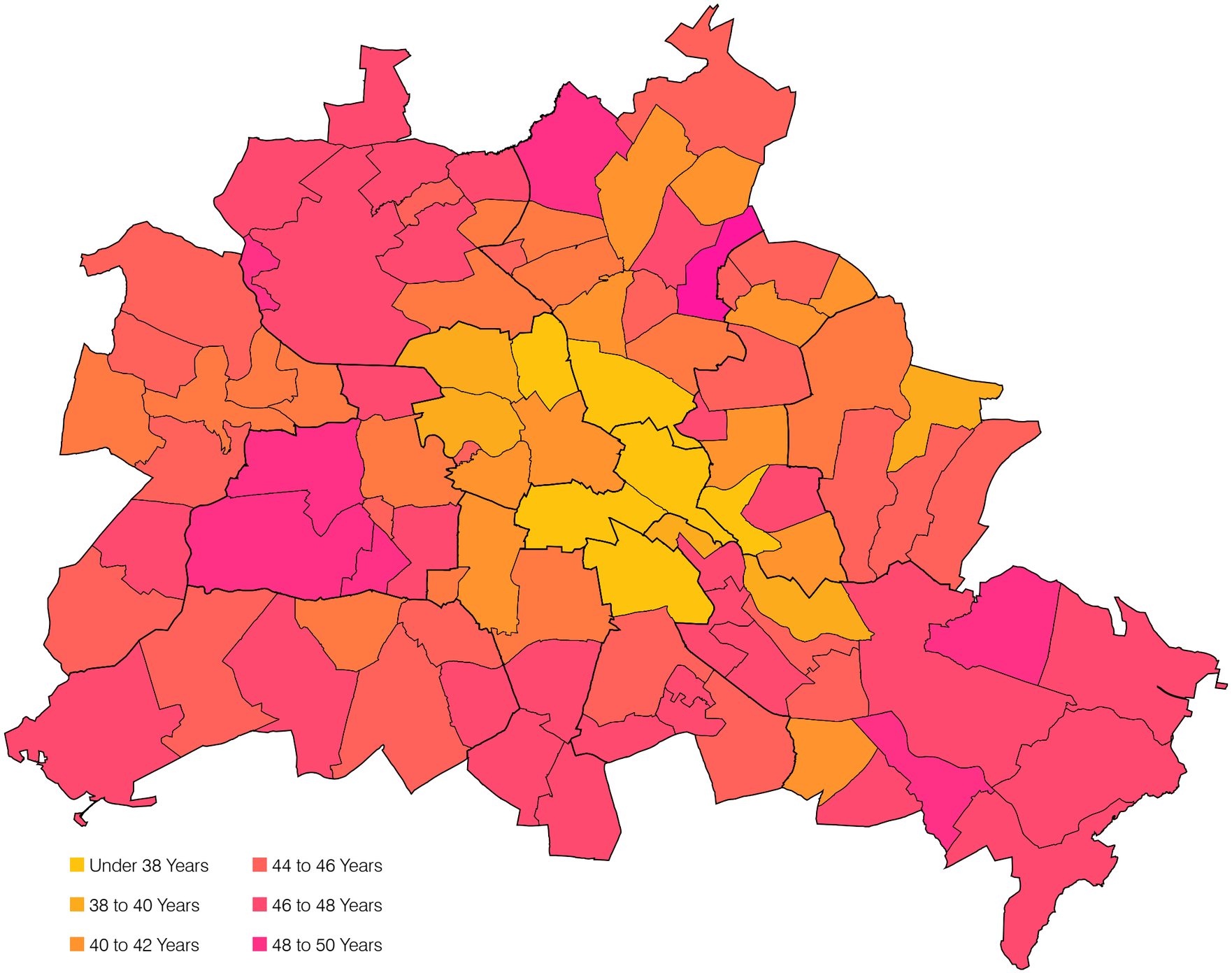


World Cities Sizes

United Nations, 2016

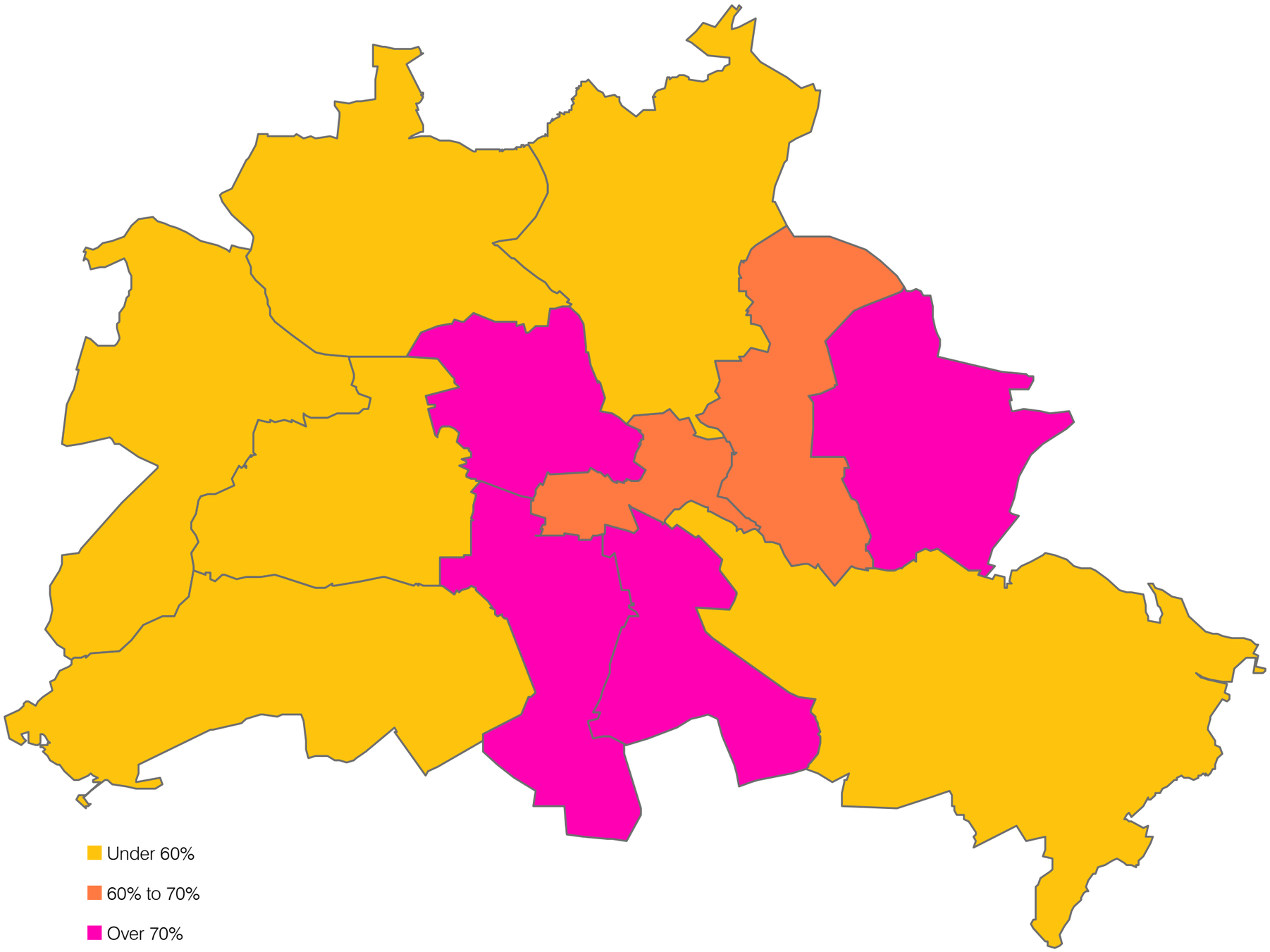
Berlin

Wikimedia.org, 2018



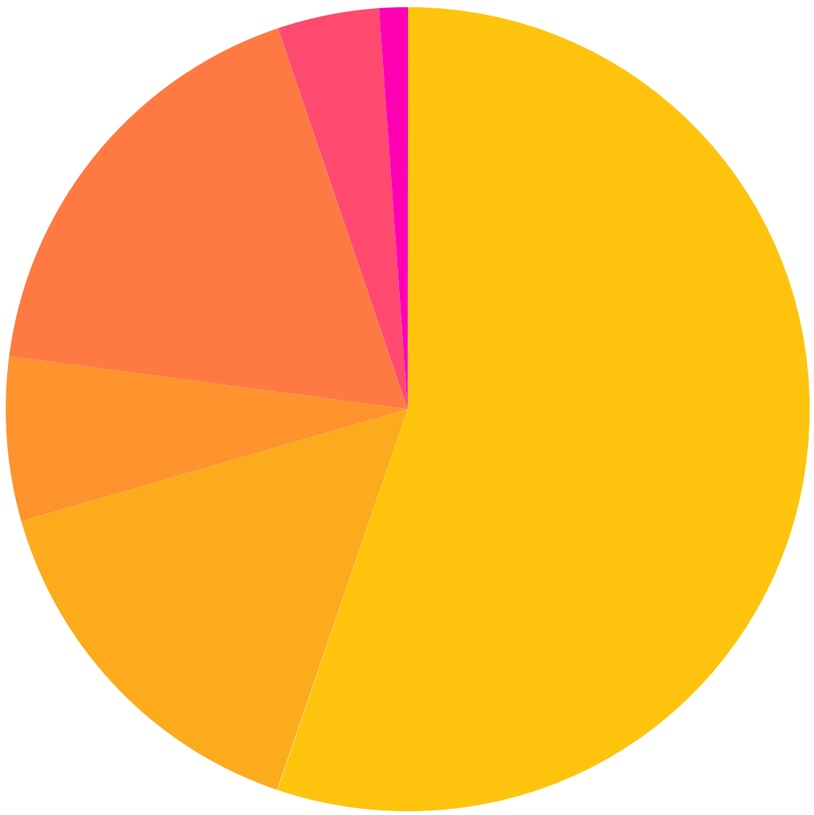
Age Groups

Amt für Statistik Berlin-Brandenburg, 2017



Percentages of Built-Up Areas

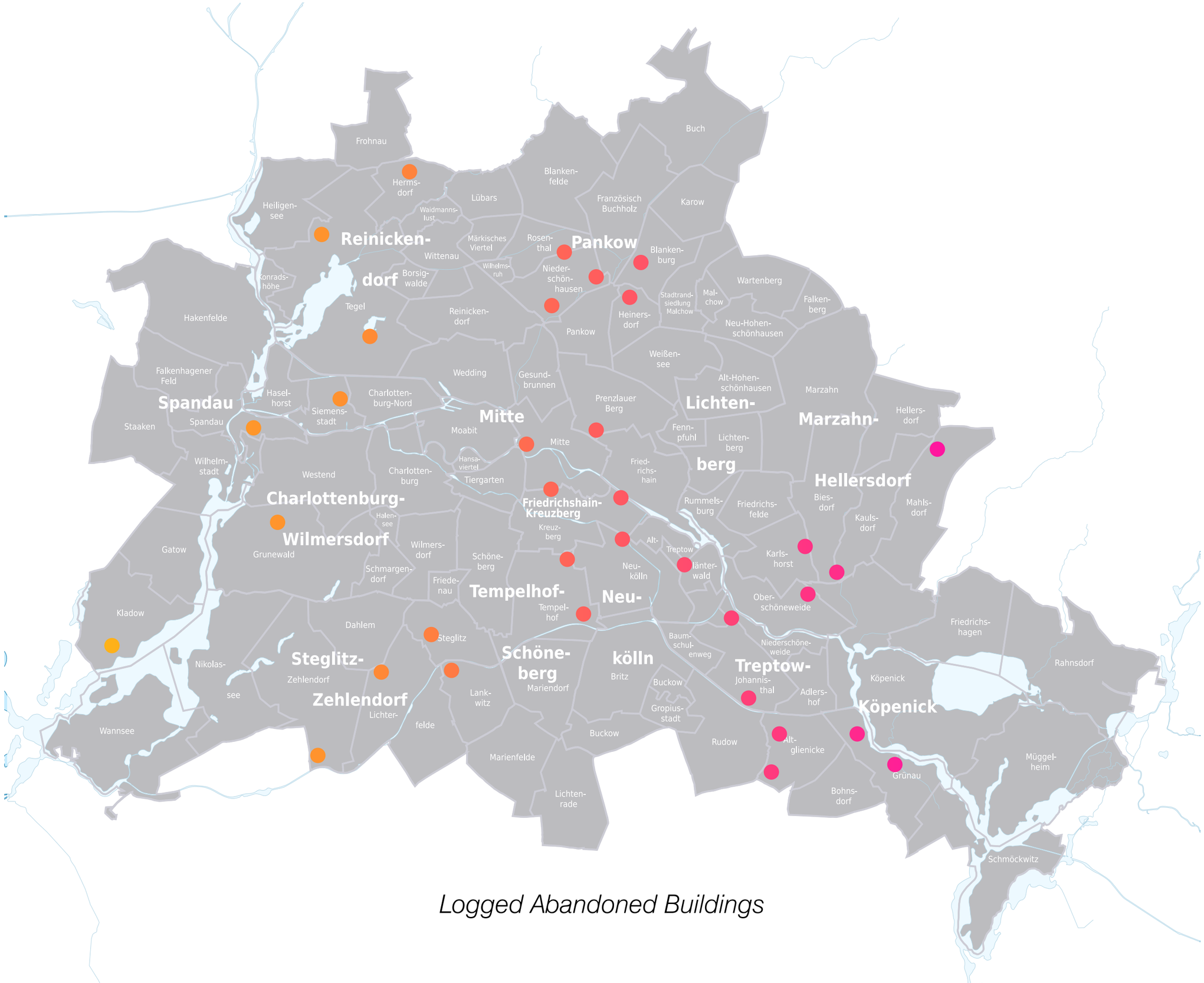
Amt für Statistik Berlin-Brandenburg, 2017



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

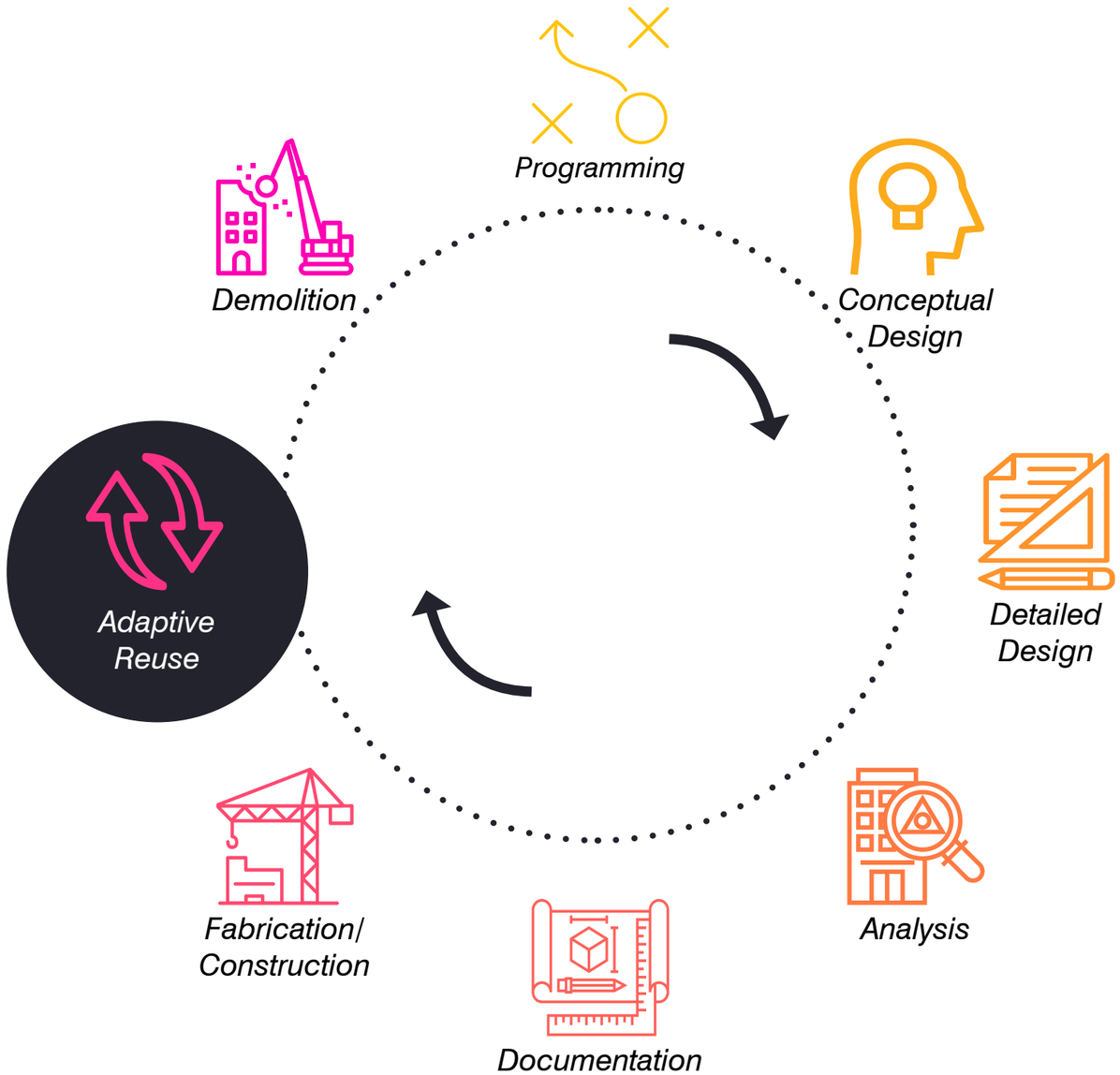
Land Use Distribution

Amt für Statistik Berlin-Brandenburg, 2017



Logged Abandoned Buildings

Abandonedberlin.com, 2018


Programming
Demolition
Conceptual Design
Detailed Design
Adaptive Reuse
Fabrication/ Construction
Documentation
Analysis

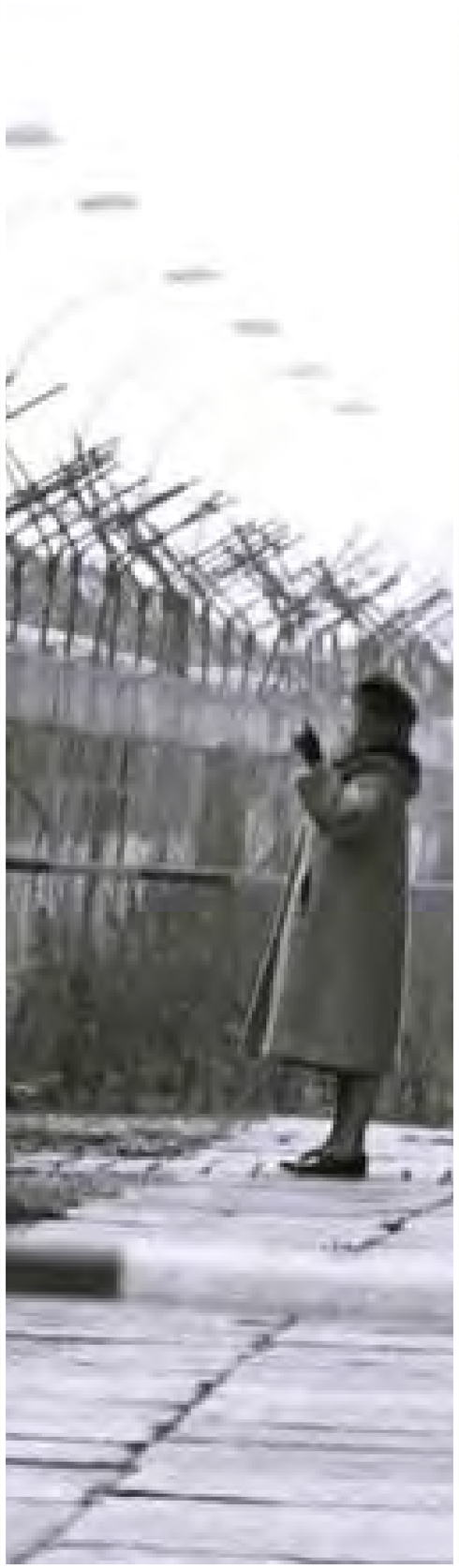
“Building within a building”

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

From Passively Unused

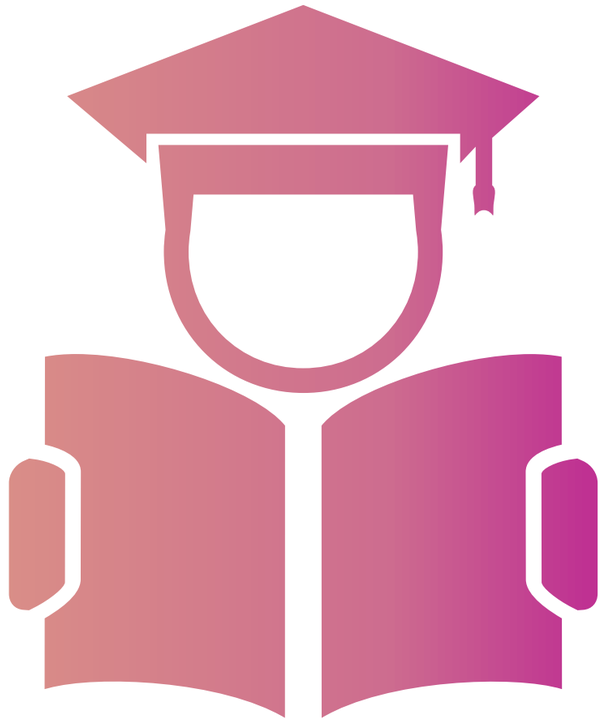
To Actively Serving Soceity


TAXI



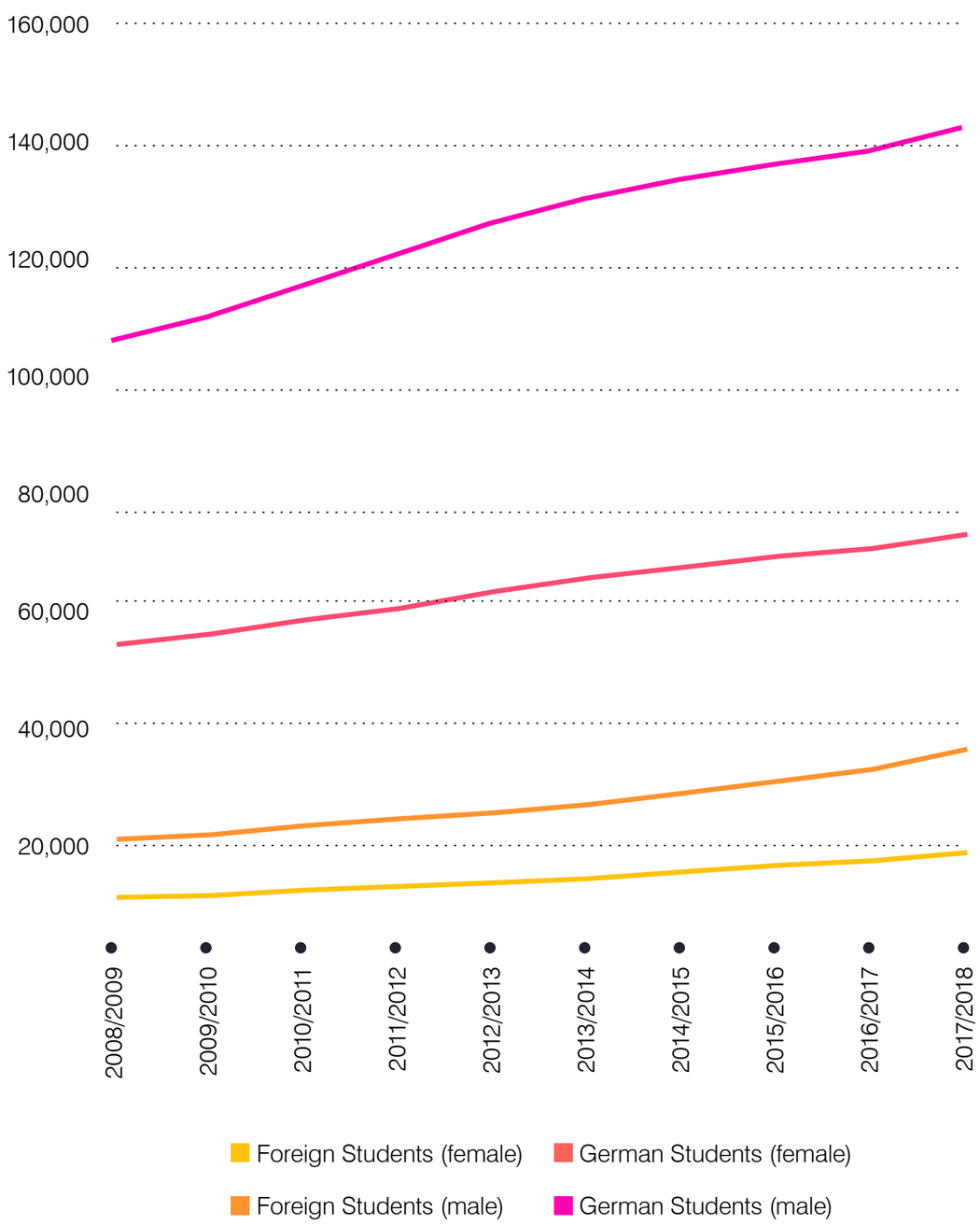

Mirco and
DONAU

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



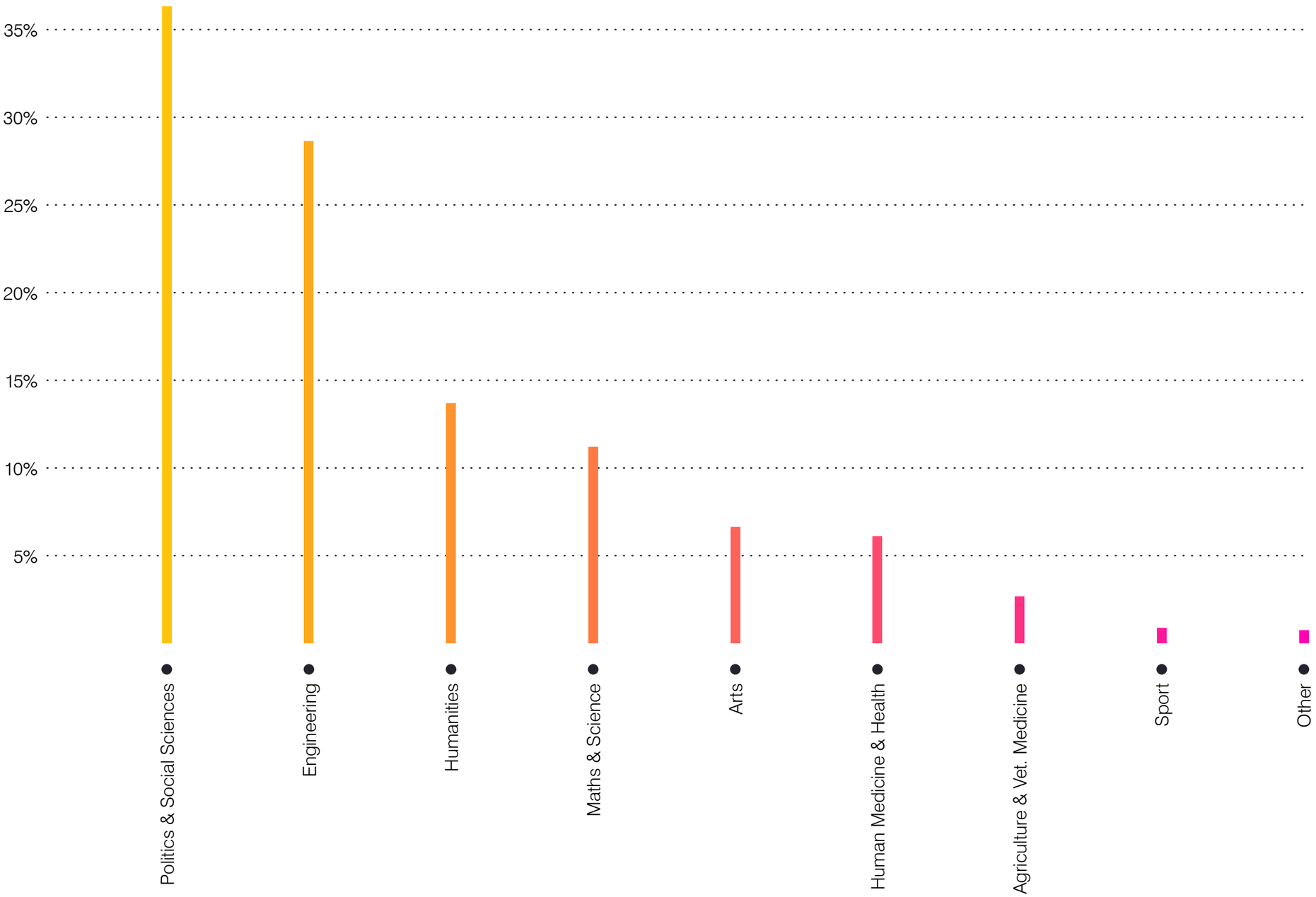
188,000 students were enrolled in the Winter semester 2017/2018, **20%** of which have an international background.

Amt für Statistik Berlin-Brandenburg, 2018



Students Enrolled in Higher Education Institutions

Amt für Statistik Berlin-Brandenburg, 2018

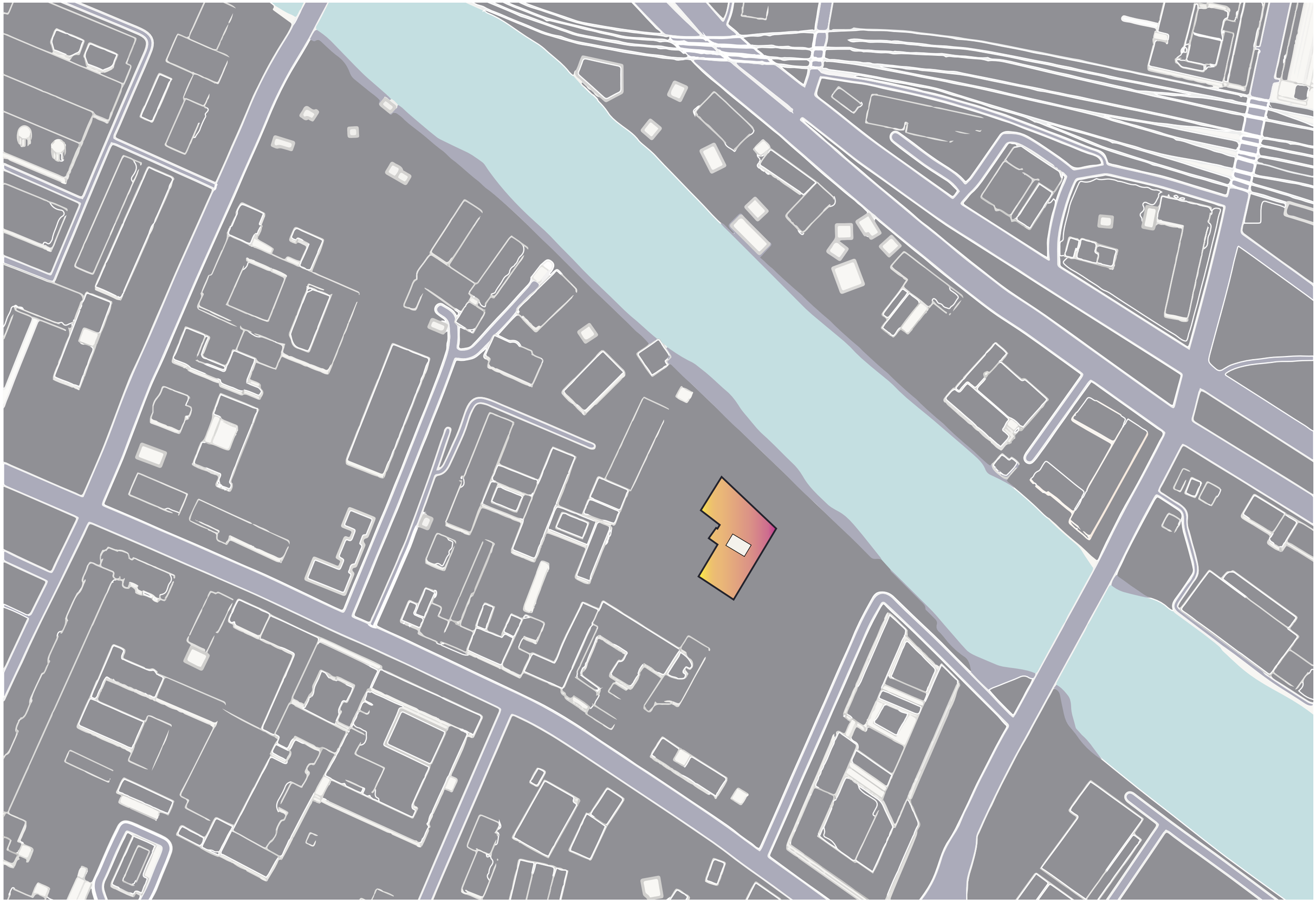


Fields of Study in Higher Education Institutions

Amt für Statistik Berlin-Brandenburg, 2018

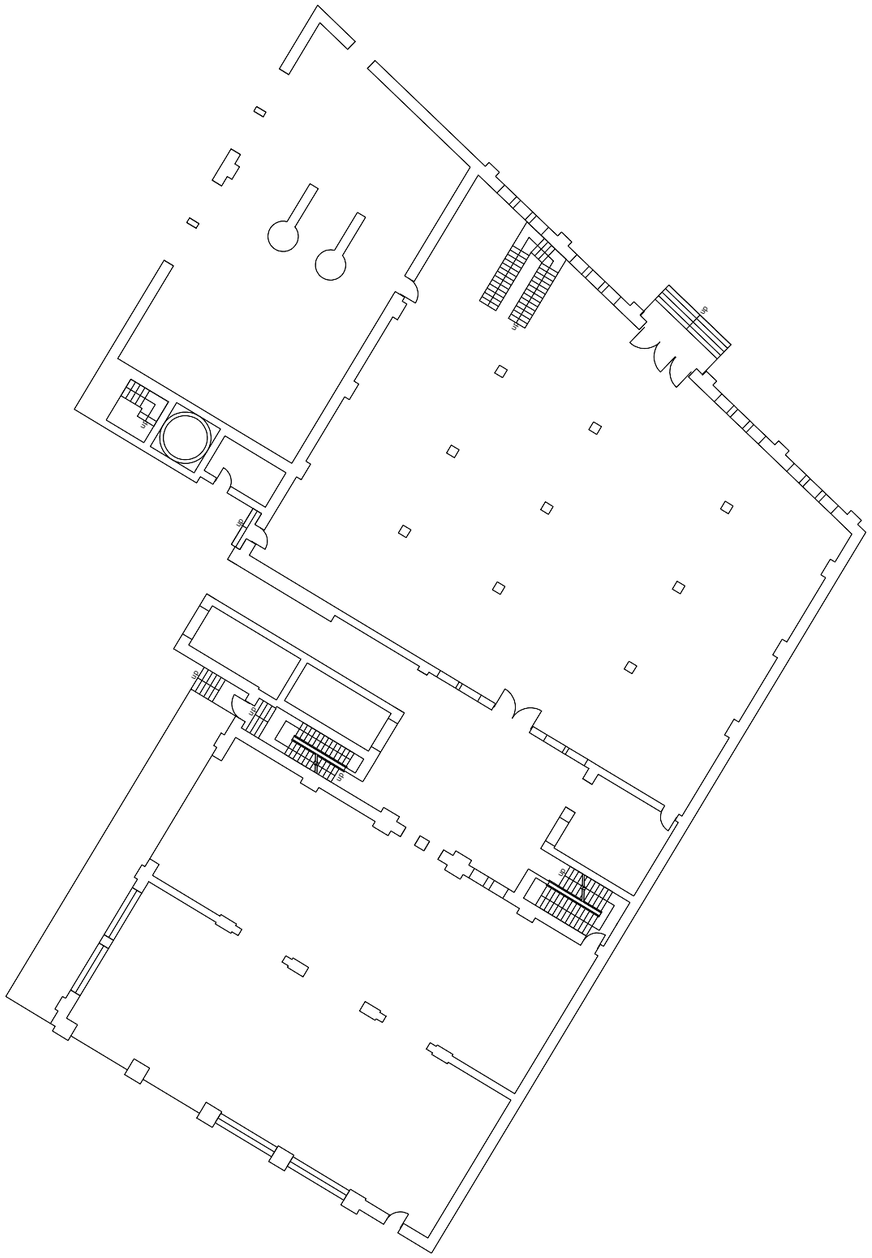
MACRO Scale


Frohnau
Buch
Hermsdorf
Blankenfelde
Heiligensee
Lübars
Waidmannslust
Französisch Buchholz
Karow
Reinickendorf
Märkisches Viertel
Rosenthal
Pankow
Wittenau
Blankenburg
Wilhelmsruh
Nieder-schönhausen
Konradshöhe
Borsigwalde
Wartenberg
Stadtrandsiedlung Malchow
Malchow
Falkenberg
Tegel
Hakenfelde
Reinickendorf
Heinersdorf
Neu-Hohenschönhausen
Pankow
Weißensee
Falkenhagener Feld
Wedding
Gesundbrunnen
Alt-Hohenschönhausen
Marzahn
Spandau
Haselhorst
Charlottenburg-Nord
Prenzlauer Berg
Lichtenberg
Siemensstadt
Mitte
Hellersdorf
Staaken
Spandau
Moabit
Fennpfuhl
Marzahn-Hellersdorf
Mitte
Lichtenberg
Wilhelmstadt
Hansaviertel
Friedrichshain-Kreuzberg
Rummelsburg
Friedrichsfelde
Biesdorf
Kaulsdorf
Mahlsdorf
Charlottenburg-Wilmersdorf
Tiergarten
Halensee
Kreuzberg
Alt-Treptow
Treptow
Karlshorst
Gatow
Grunewald
Wilmersdorf
Schöneberg
Neukölln
Plänterwald
Schmargendorf
Friedenau
Tempelhof-Schöneberg
Tempelhof
Oberschöneweide
Kladow
Dahlem
Steglitz
Baumschulenweg
Niederschöneweide
Friedrichshagen
Rahnsdorf
Nikolassee
Steglitz-Zehlendorf
Zehlendorf
Schöneberg
Mariendorf
Britz
Buckow
Johannisthal
Adlershof
Treptow-Köpenick
Köpenick
Lankwitz
Gropiusstadt
Lichterfelde
Wannsee
Buckow
Rudow
Altglienicke
Müggelheim
Marienfelde
Grünau
Bohnsdorf
Lichtenrade
Schmöckwitz

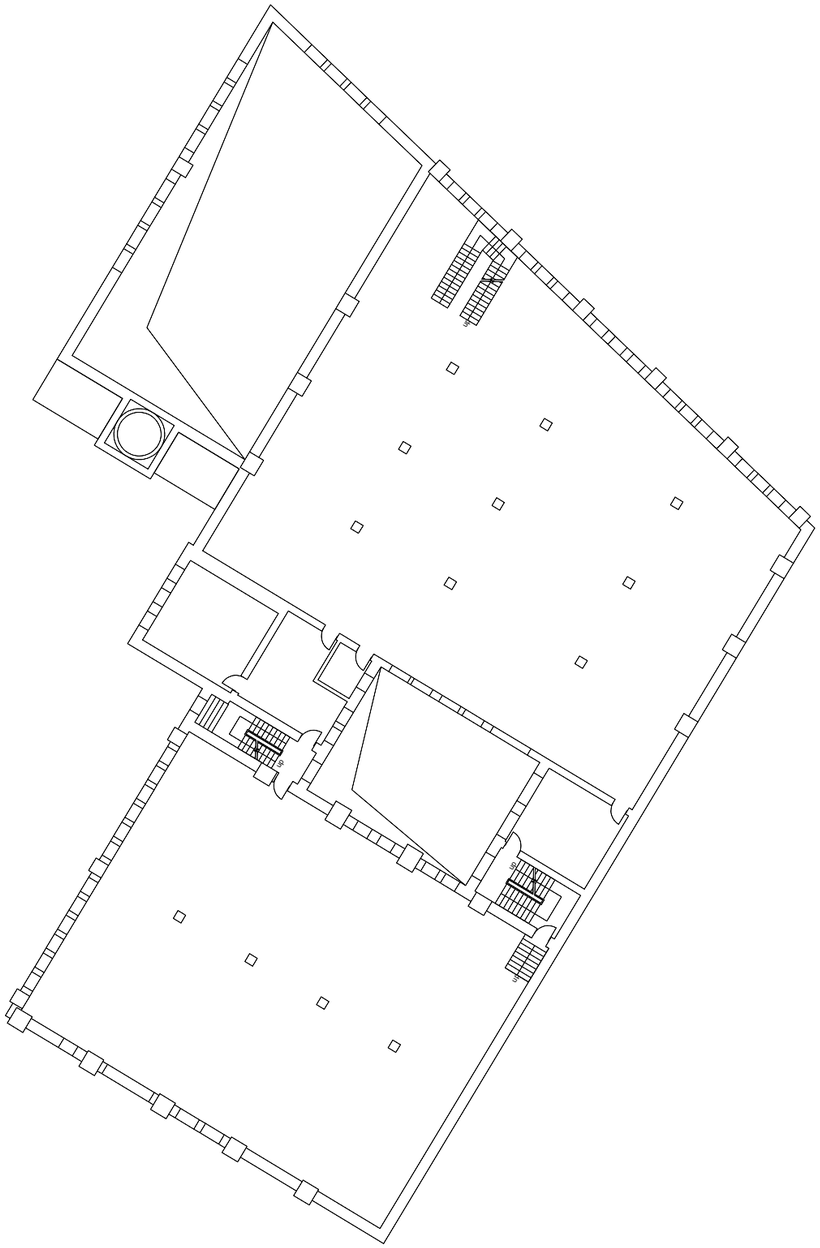


Google Maps, 2018

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***

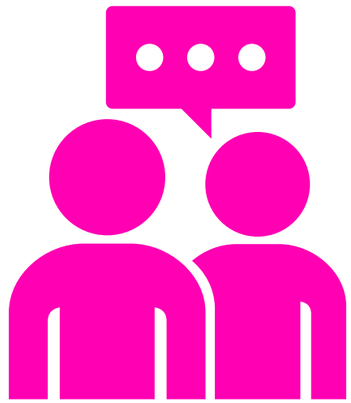
** In Psychology (of thought) using a variety of premises, especially unfamiliar premises, as bases for inference, and avoiding common limiting assumptions in making deductions.*

Critical Spaces

Creative Spaces

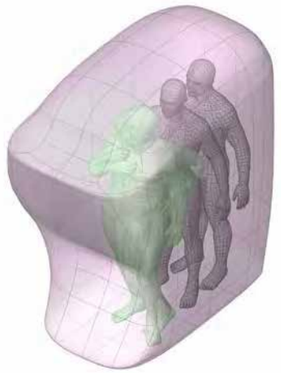
Provocative Spaces

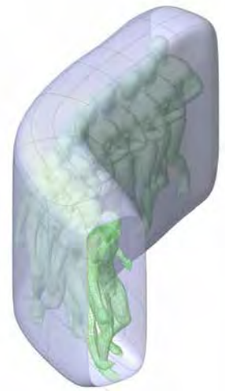
Relaxation Spaces

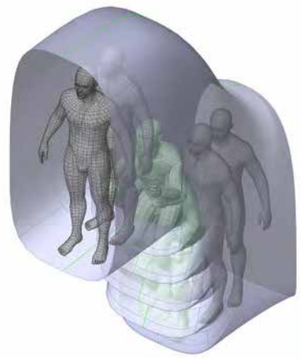


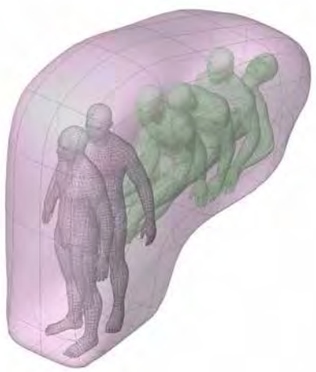
Interaction Spaces

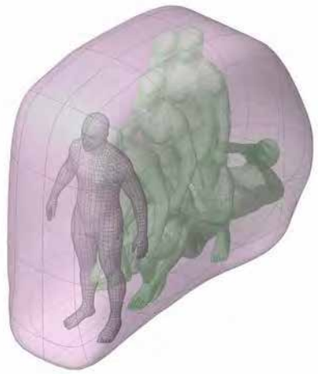
Mapping User Activities

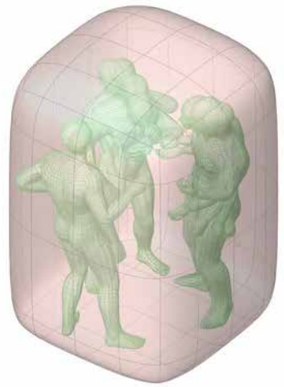


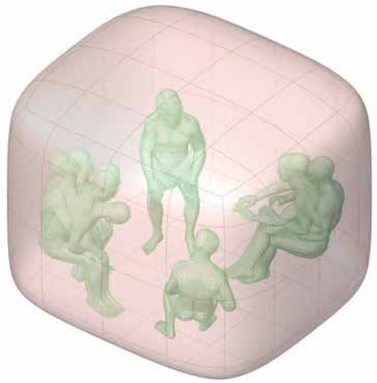












Humanities
24,195 Students - 12.8%

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%

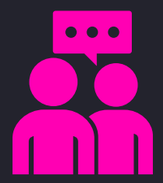
Other
1,589 Students - 0.8%

Critical

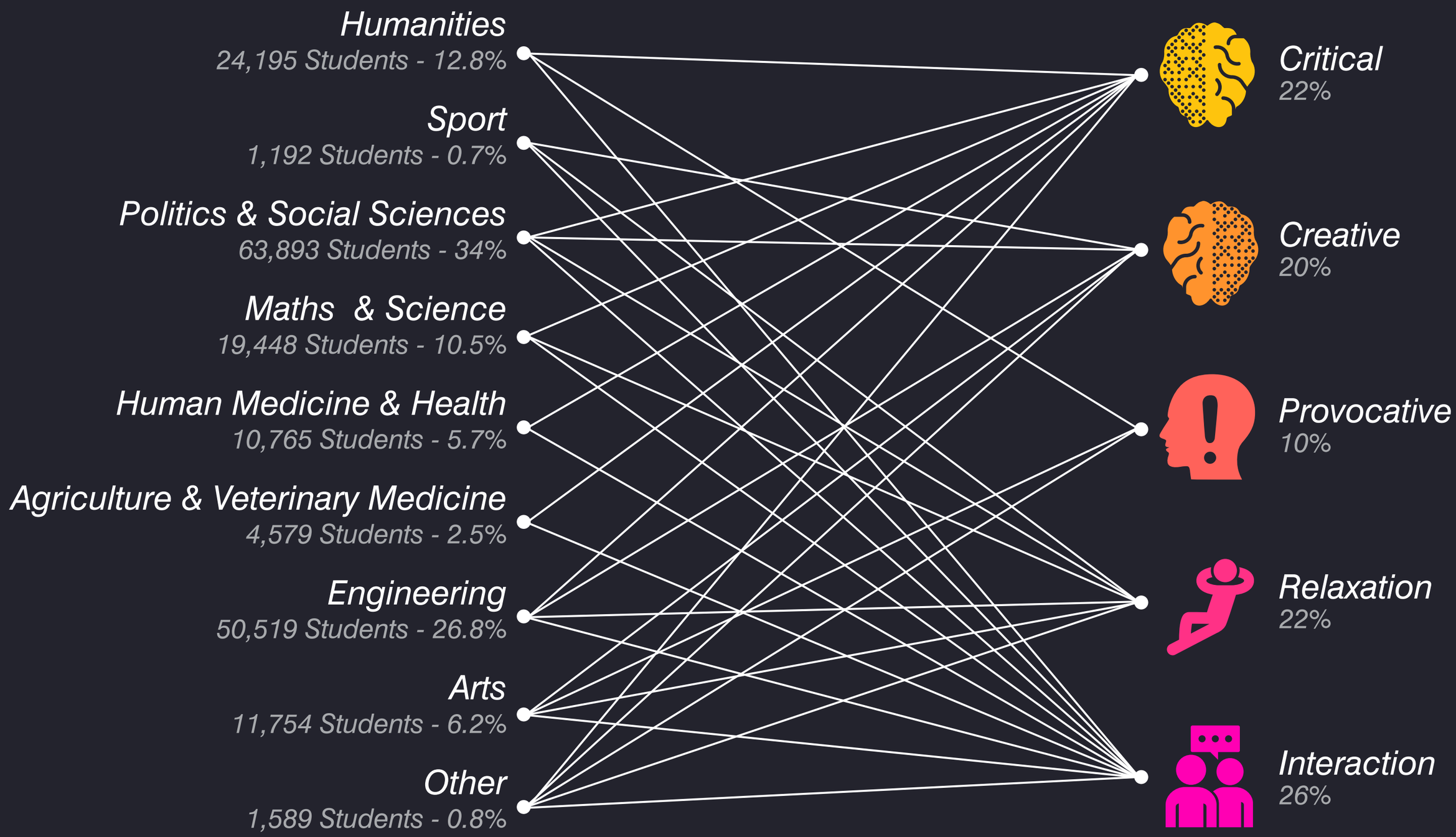
Creative

Provocative

Relaxation



Interaction


Humanities
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Maths & Science
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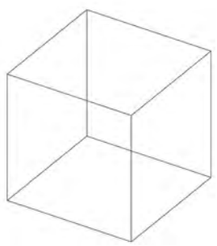
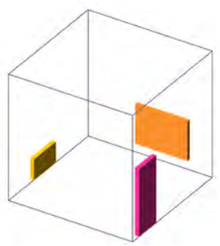
Human Medicine & Health
10,765 Students - 5.7%
Agriculture & Veterinary Medicine
4,579 Students - 2.5%
Engineering
50,519 Students - 26.8%
Arts
11,754 Students - 6.2%
Other
1,589 Students - 0.8%
Critical
22%
Creative
20%
Provocative
10%
Relaxation
22%
Interaction
26%

Computational Strategy

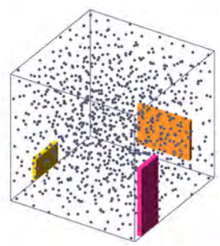
Agent-Based Spatial Optimization



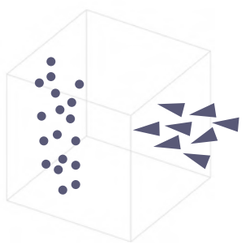
1
Define Intervention Domain



2
Extract Spatial Parameters

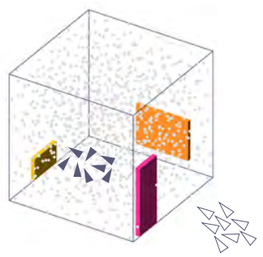


3
Embed Data in Point Cloud

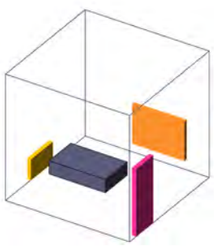


4
Specify Point-Agent Relationships

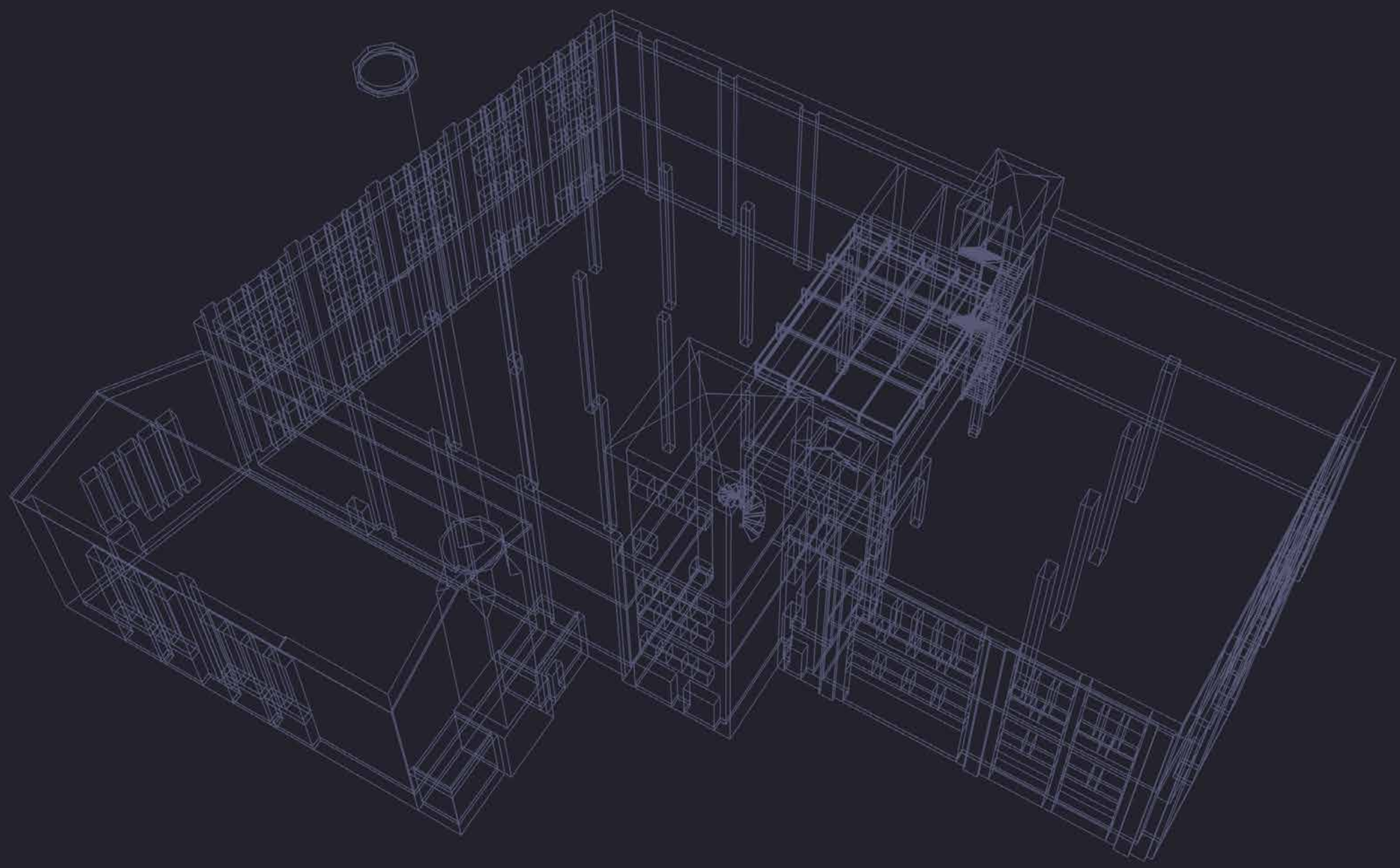
5
Set Agents Behaviours



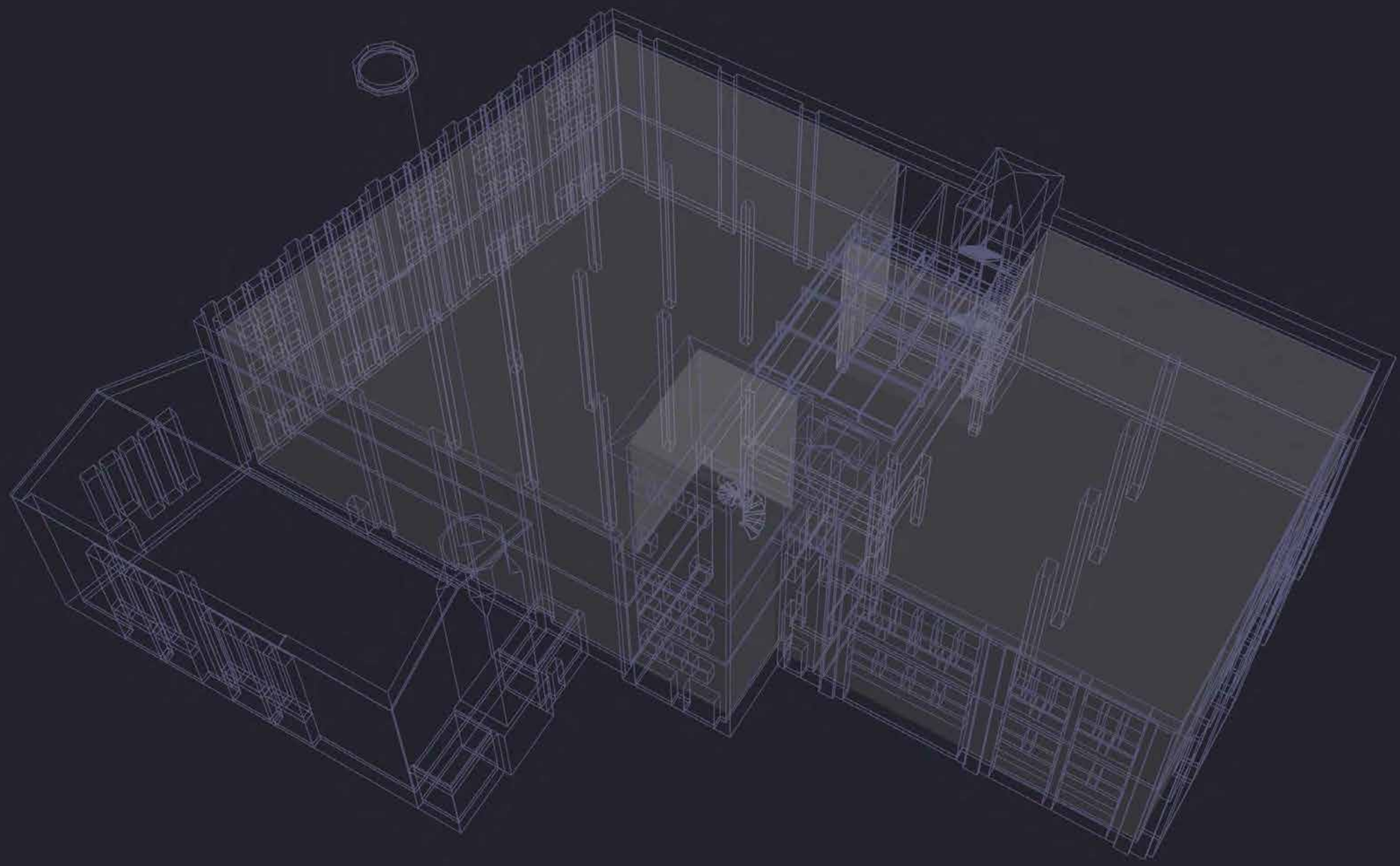
6
Release Agents Swarm



7
Wrap Optimized Space

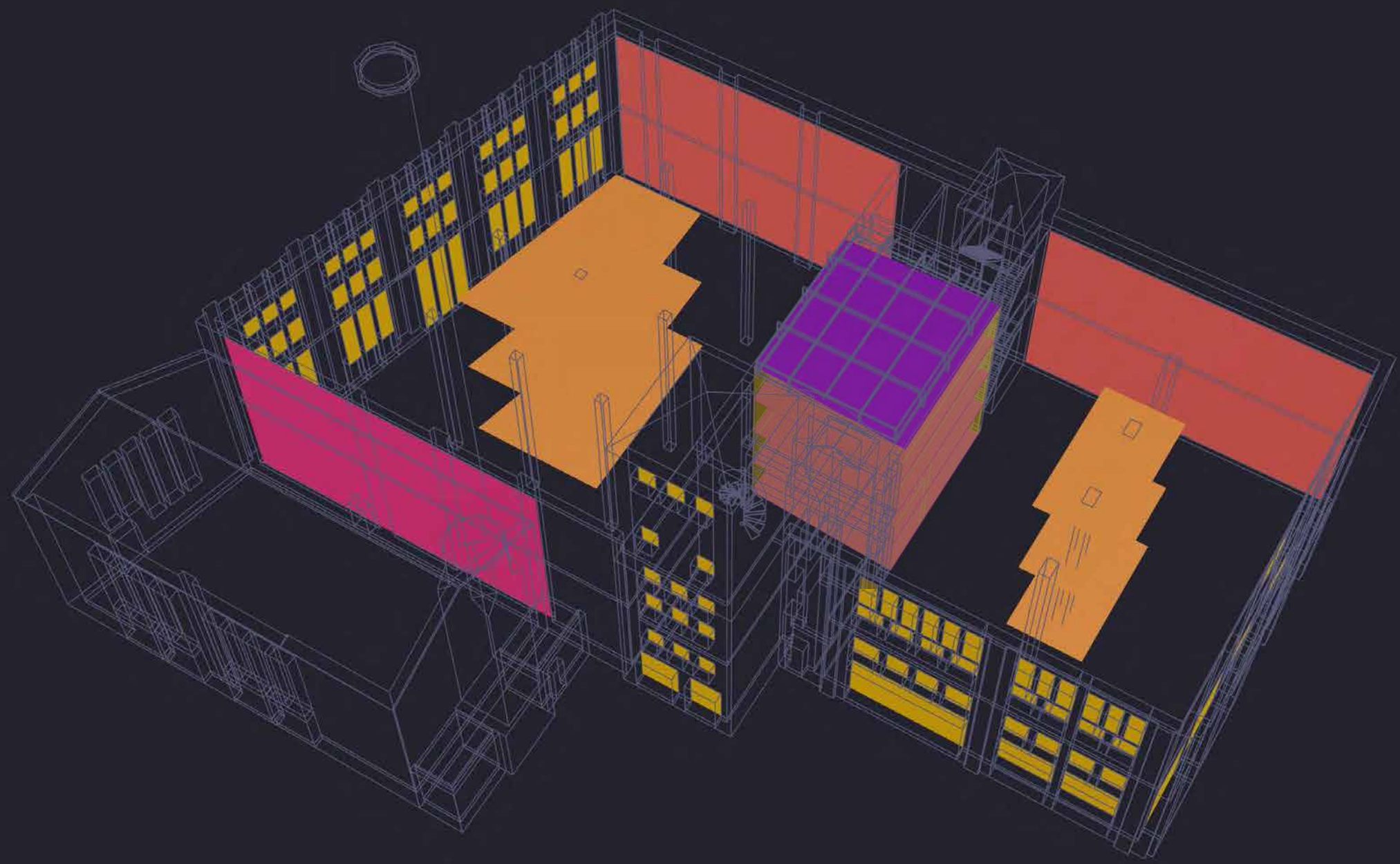


0
Existing Building



1

Define Intervention Domain



2

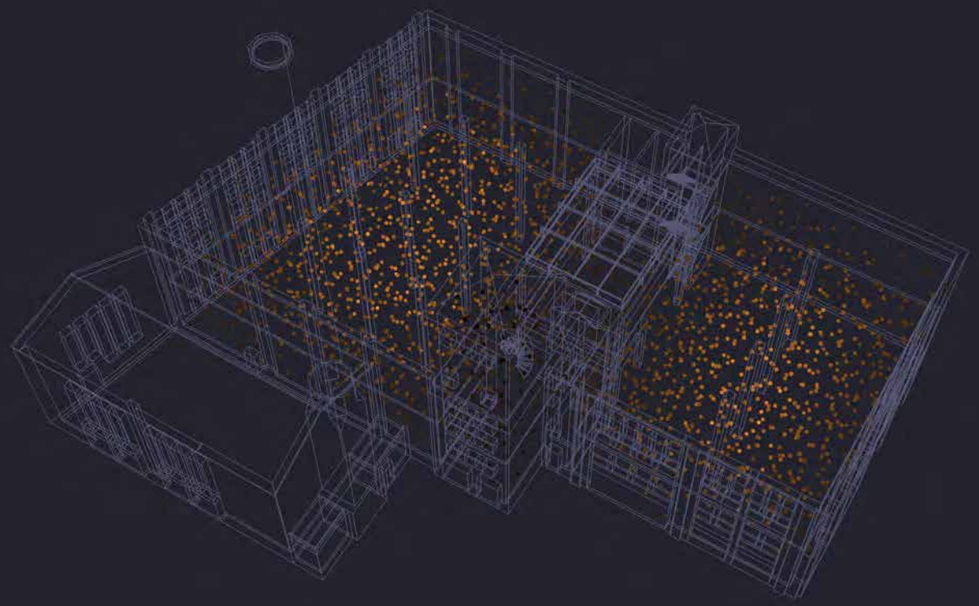
Extract Spatial Parameters

High Low

P1: Direct Daylight

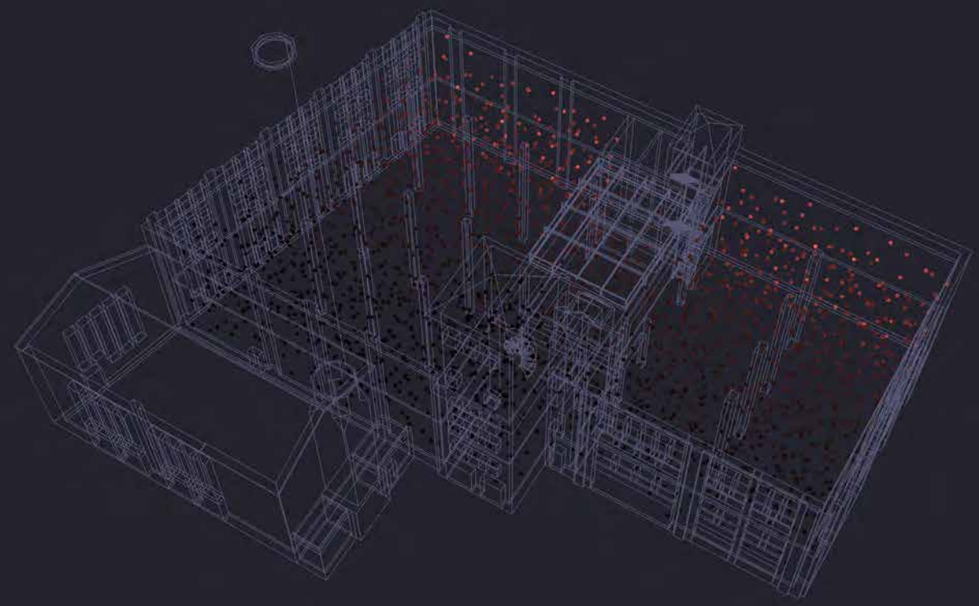
3

Embed Data in Point Cloud



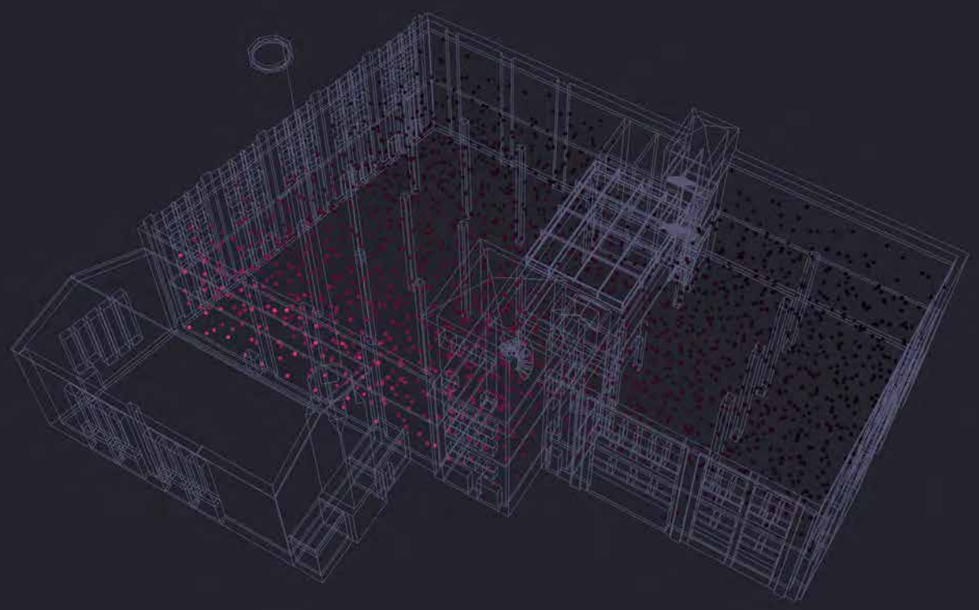
High Low

P2: Indirect Daylight



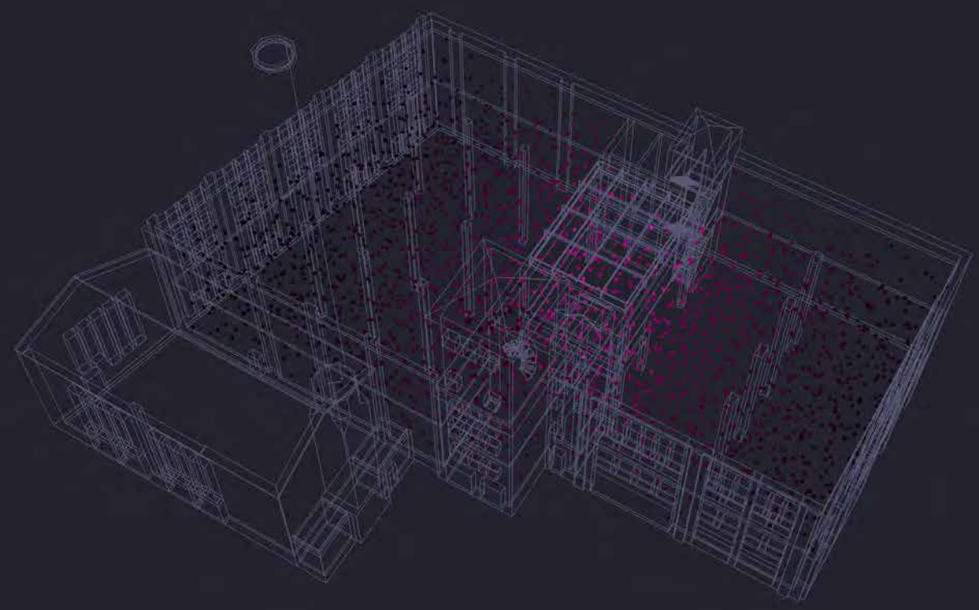
High Low

P3: Isolation



High Low

P4: Events Proximity

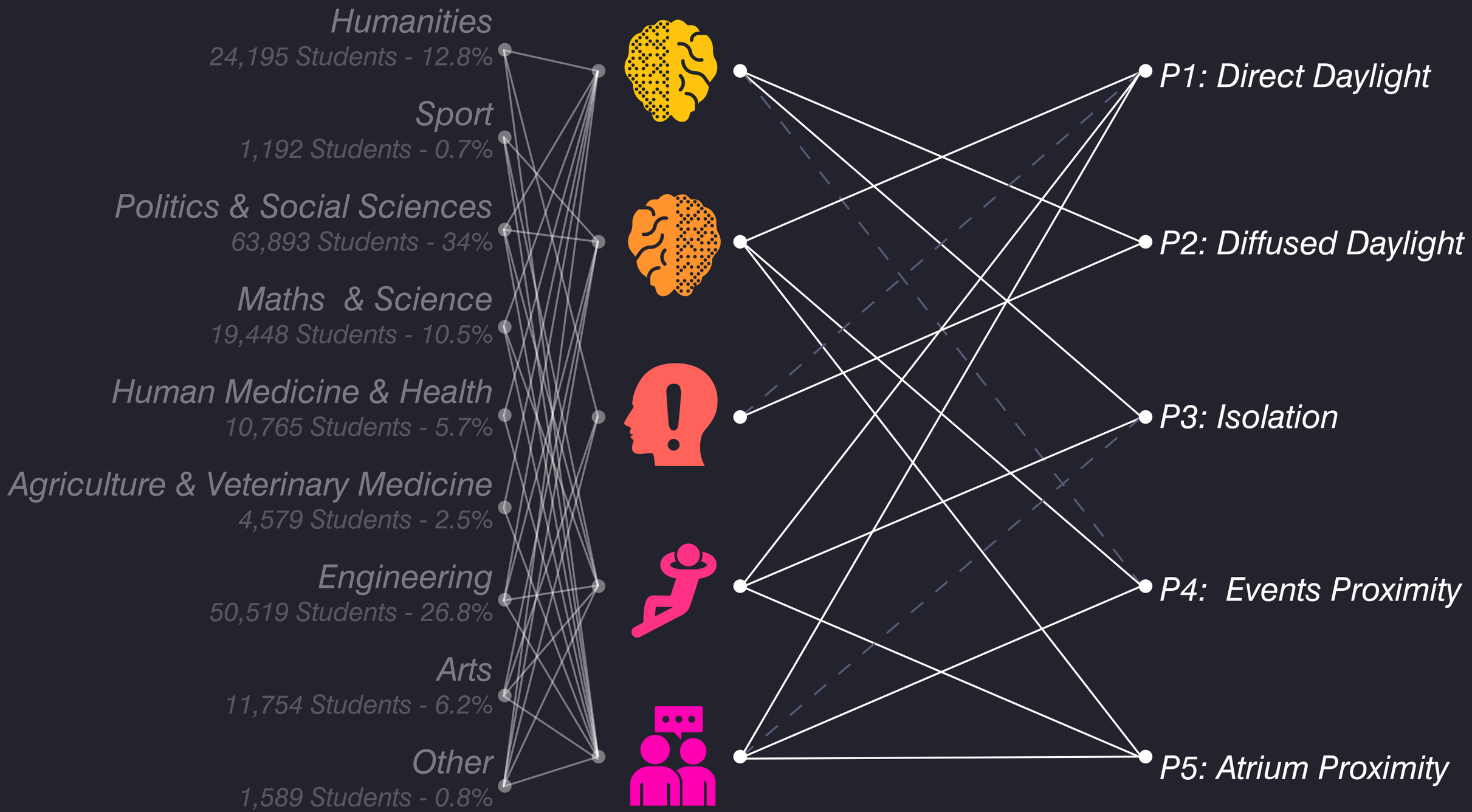


High Low

P5: Atrium Proximity

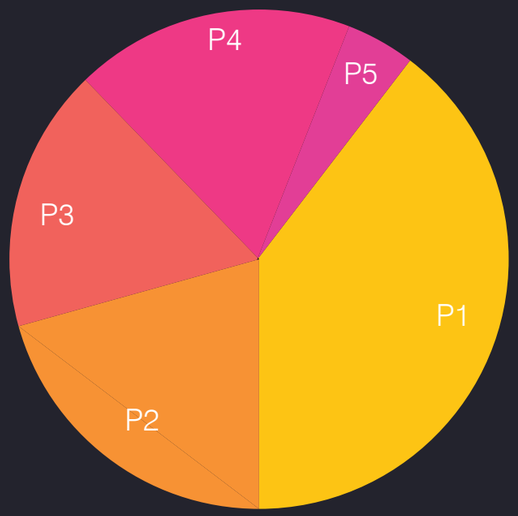
3

Embed Data in Point Cloud



4

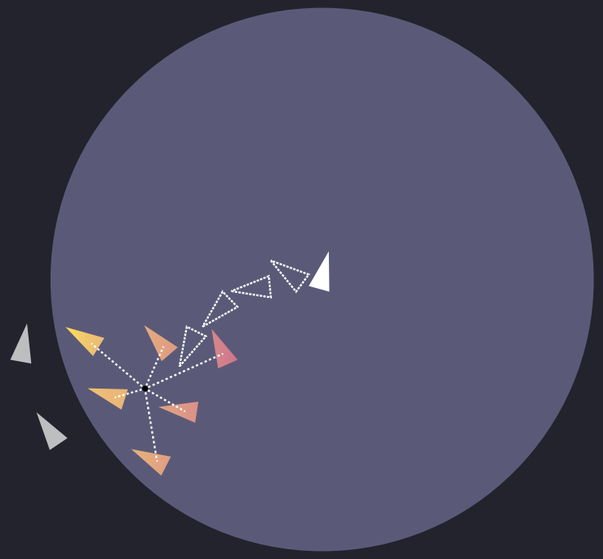
Specify Point-Agent Relationships



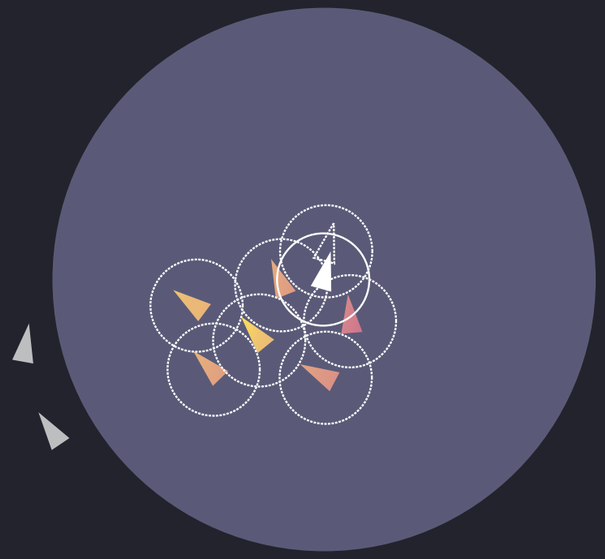
Points
(all parameters data embedded)

Agents

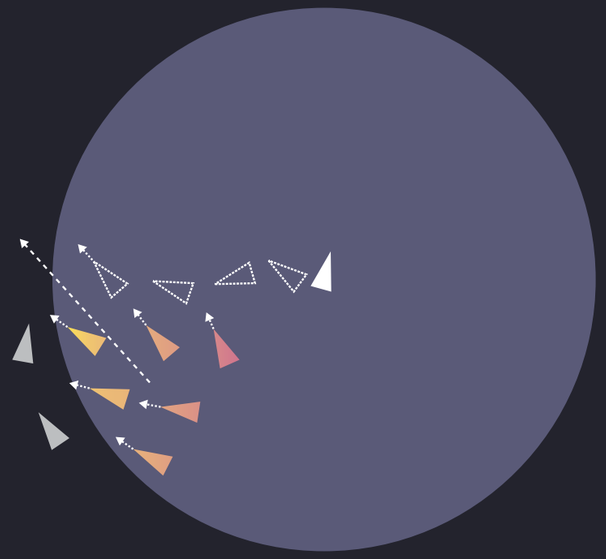
4
Specify Point-Agent Relationships



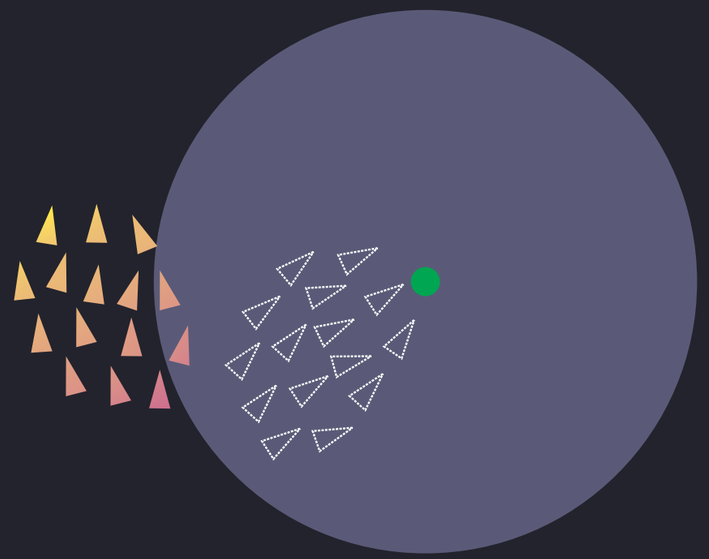
Cohesion



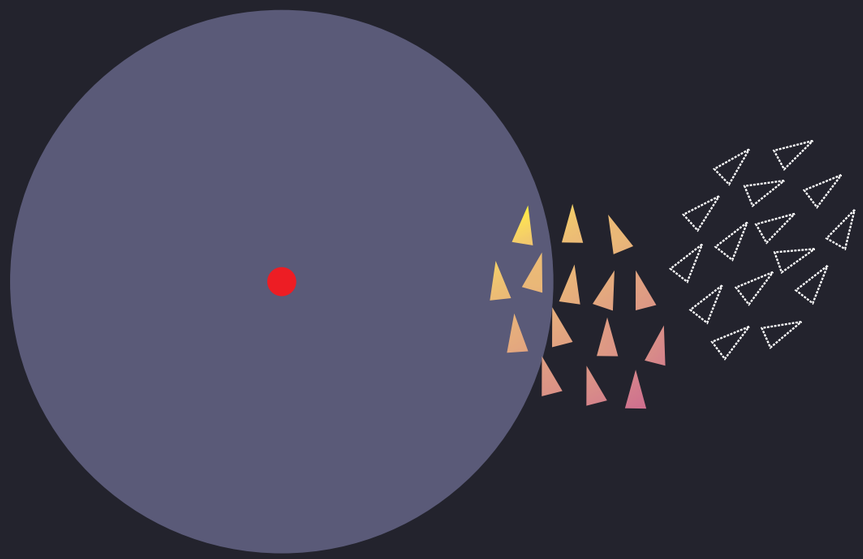
Separation



Alignment



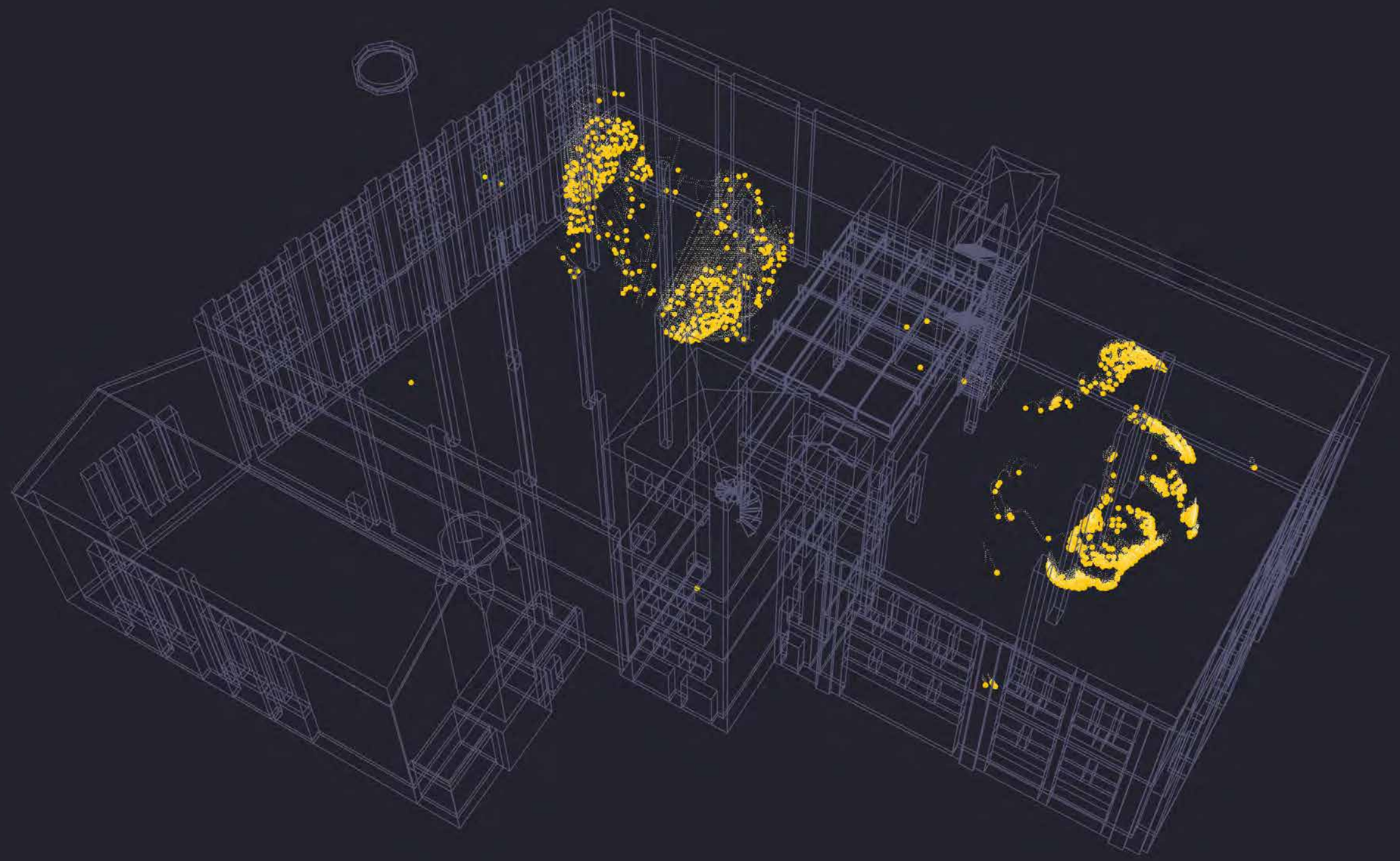
Attraction



Repulsion

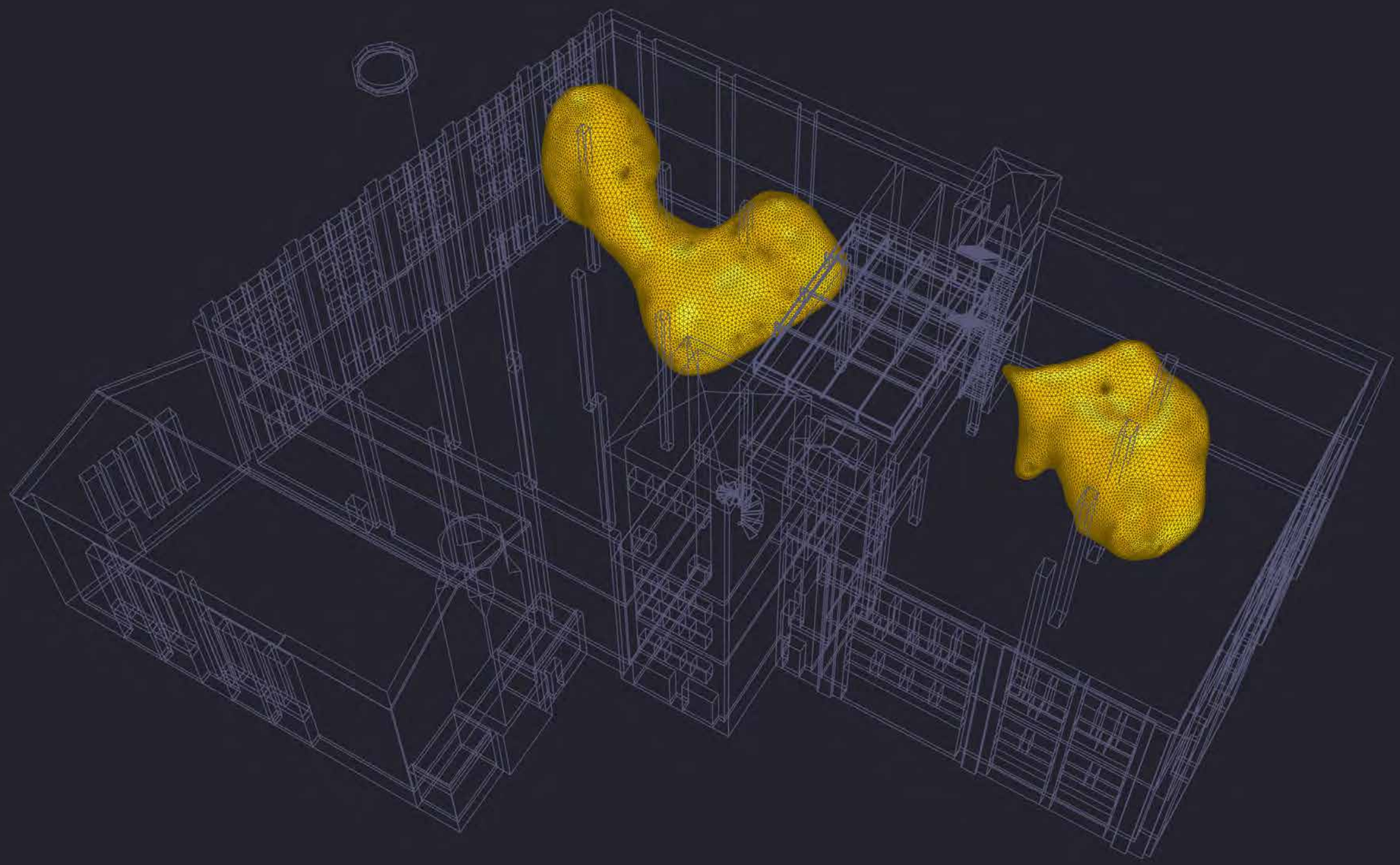
5
Set Agent Behaviours

Critical Space Stable Agents & Trails



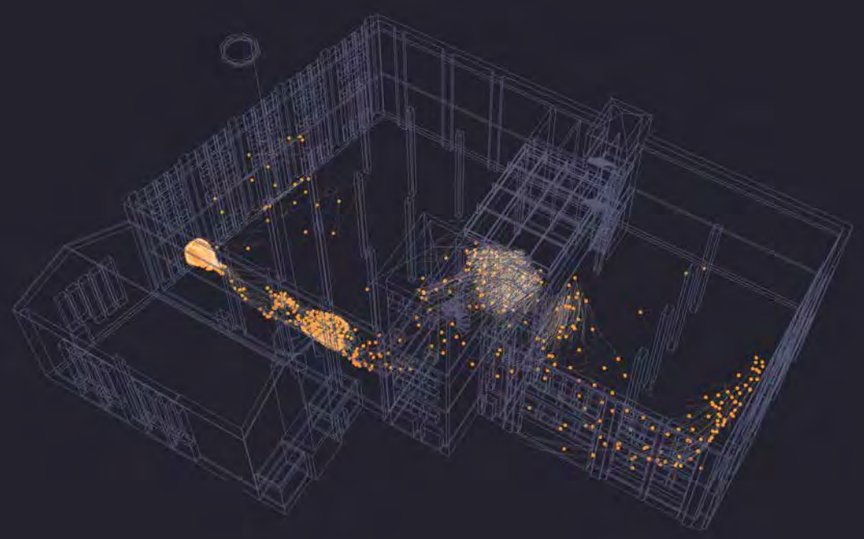
7
Wrap Optimized Space

Critical Space Stable Agents & Trails

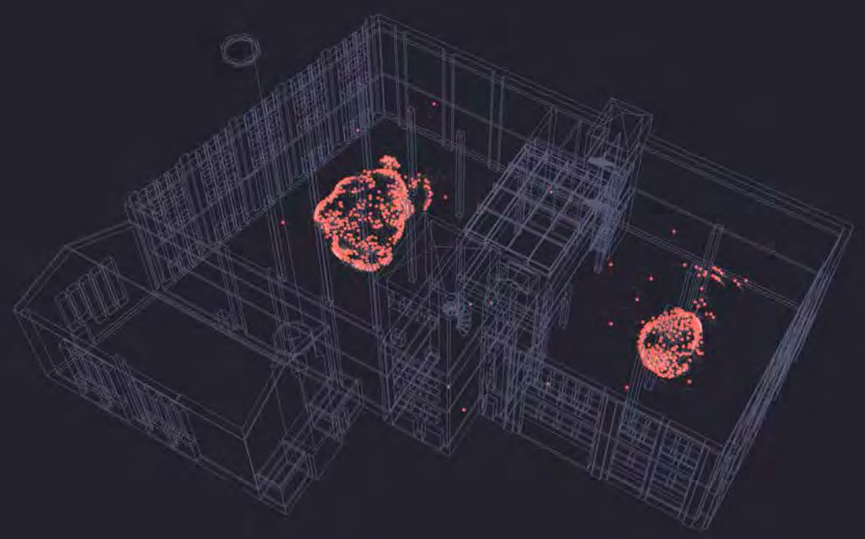


7
Wrap Optimized Space

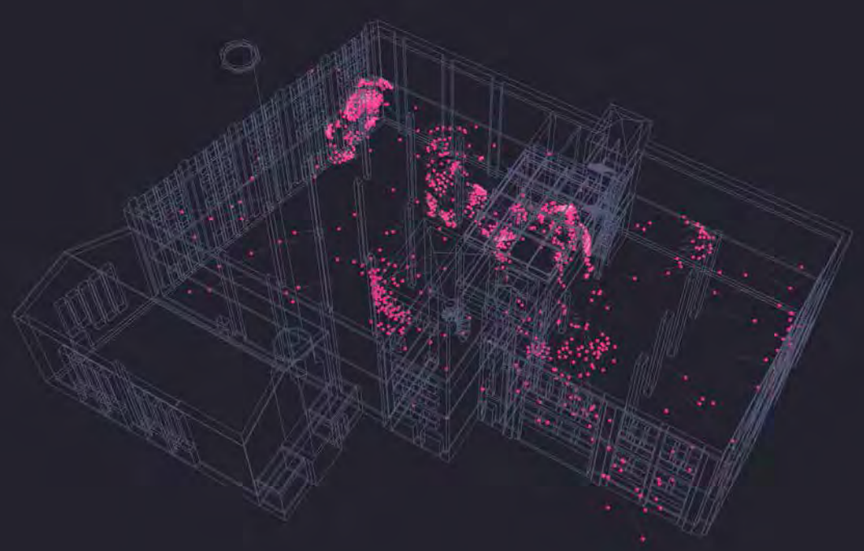
Creative Space Stable Agents & Trails



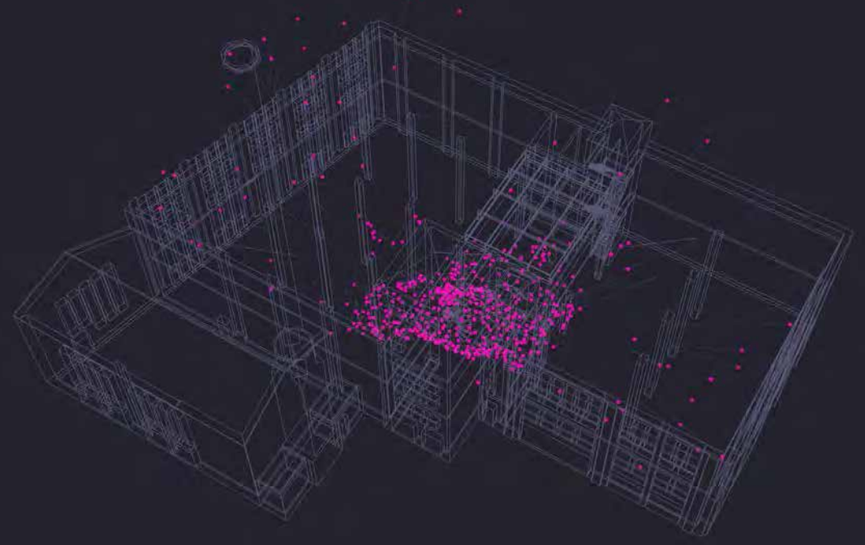
Provocative Space Stable Agents & Trails



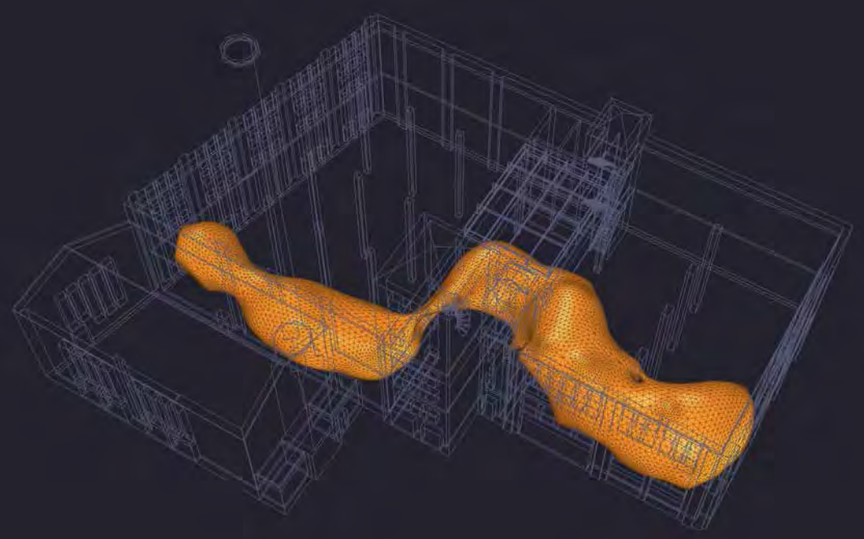
Relaxation Space Stable Agents & Trails



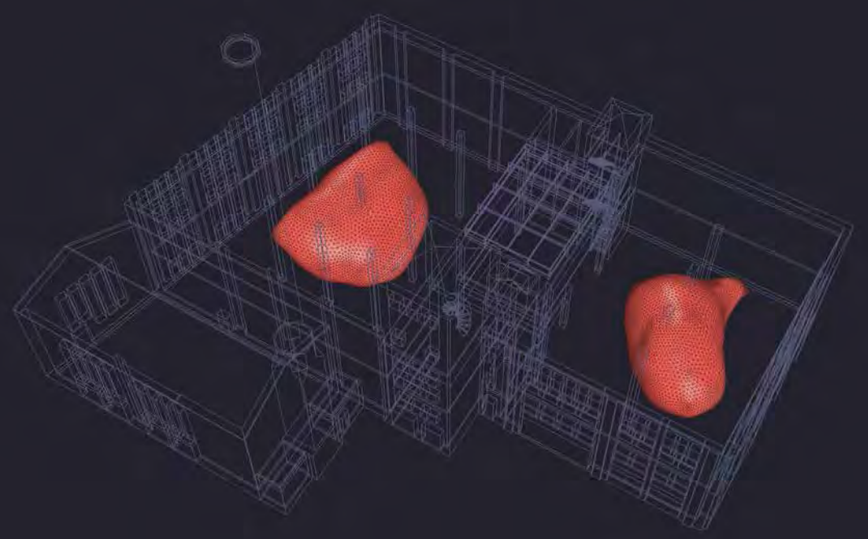
Interaction Space Stable Agents & Trails



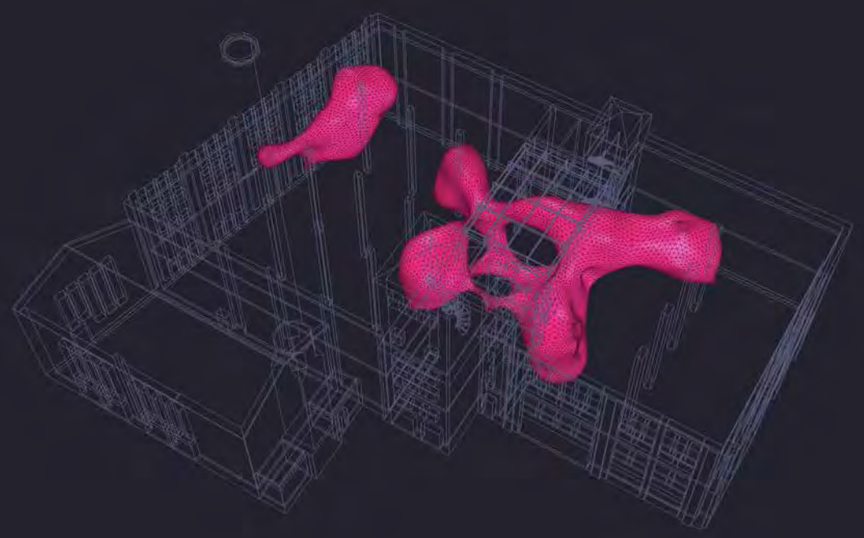
Creative Space Stable Wrapped Geometry



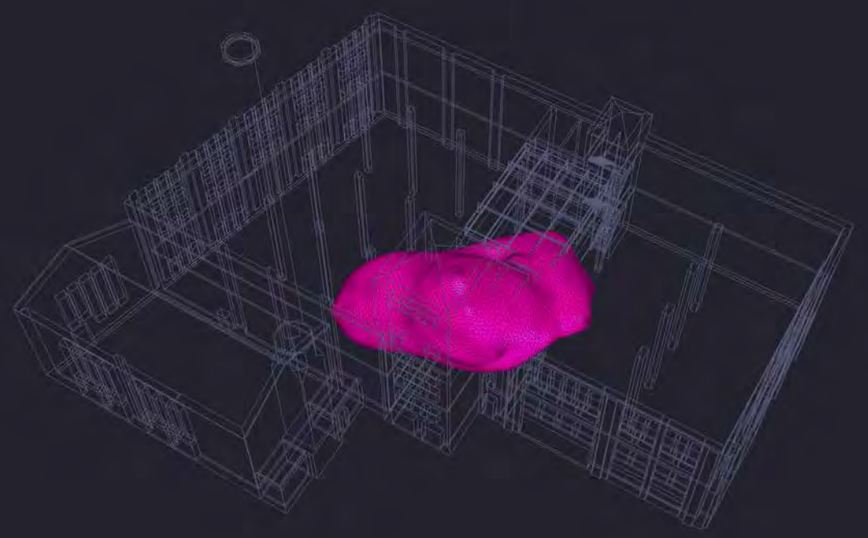
Provocative Space Stable Wrapped Geometry

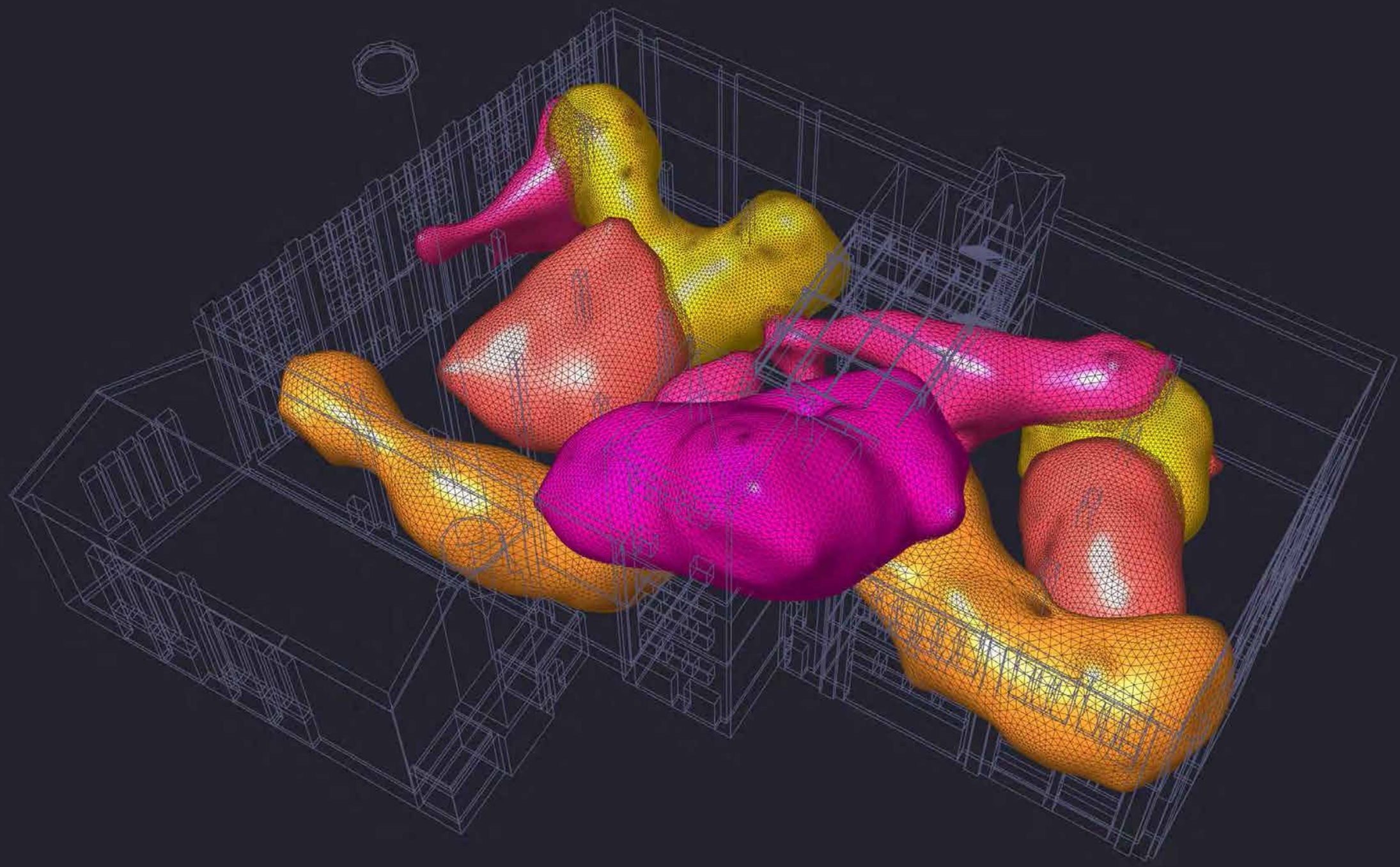


Relaxation Space Stable Wrapped Geometry

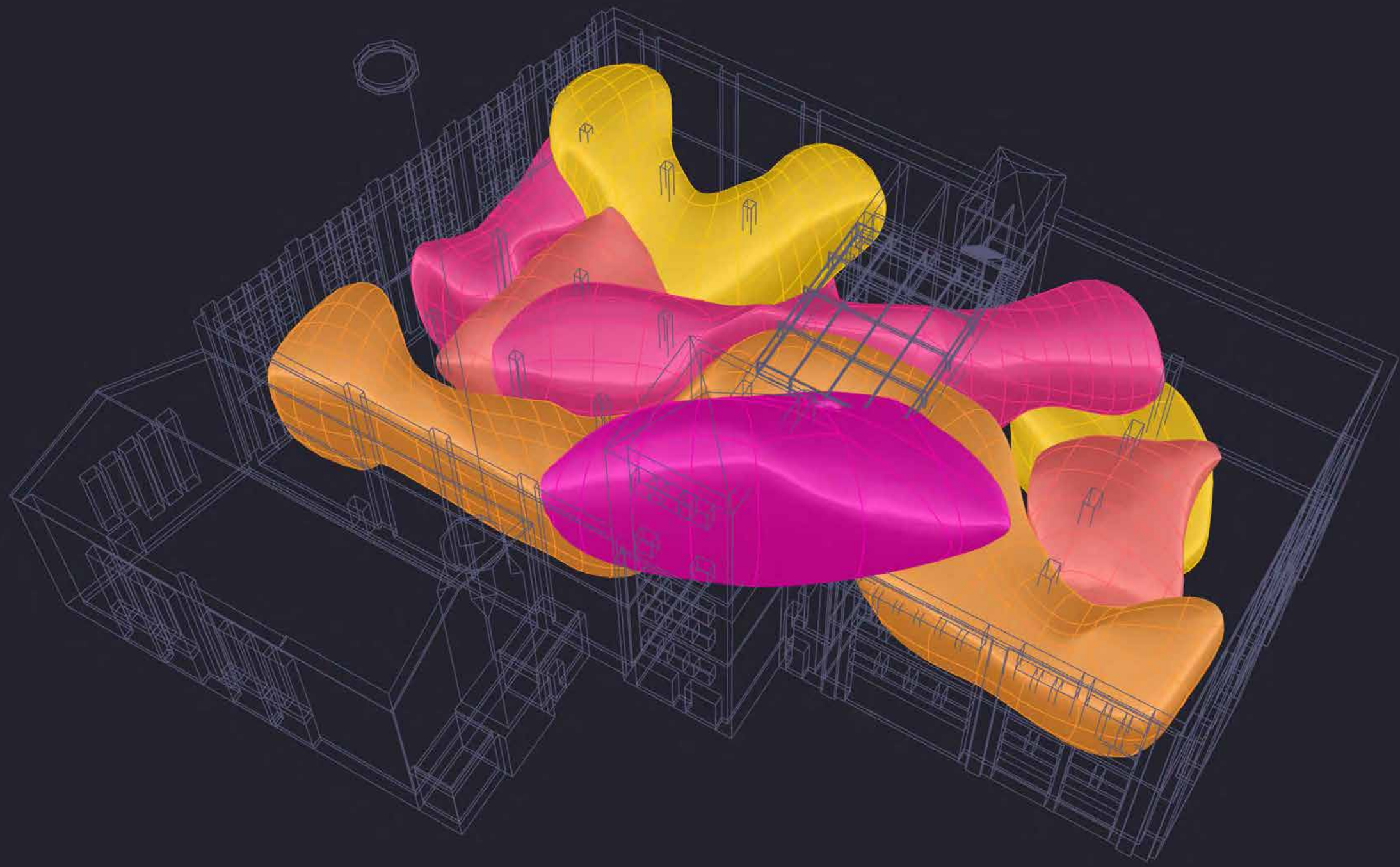


Interaction Space Stable Wrapped Geometry

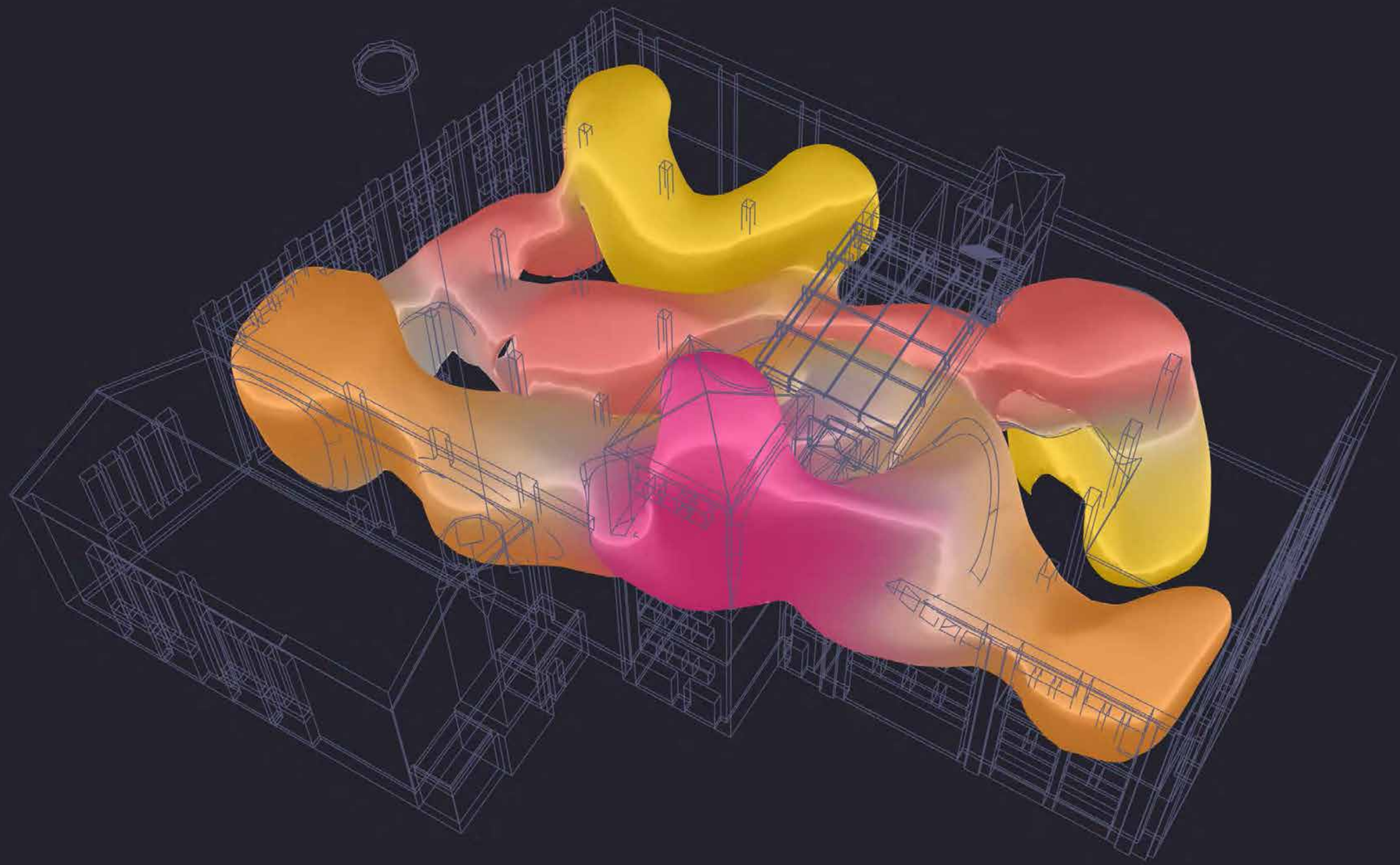




Optimized Spaces Together



Spaces Rationalization



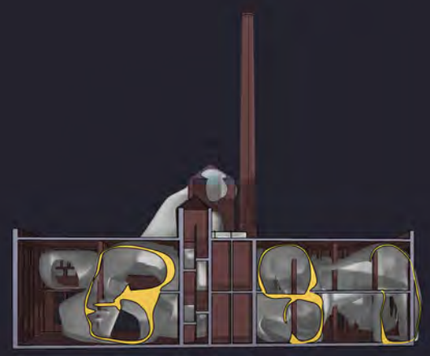
Spaces Fusion

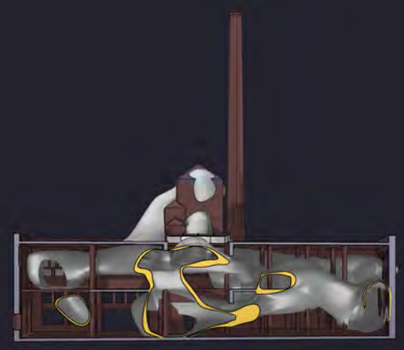
1

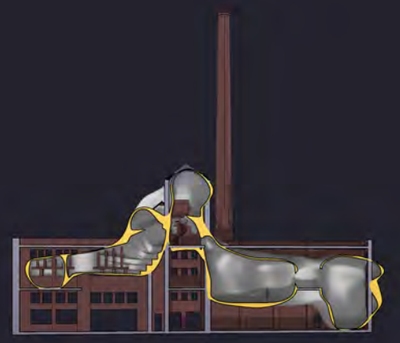
2

3

X

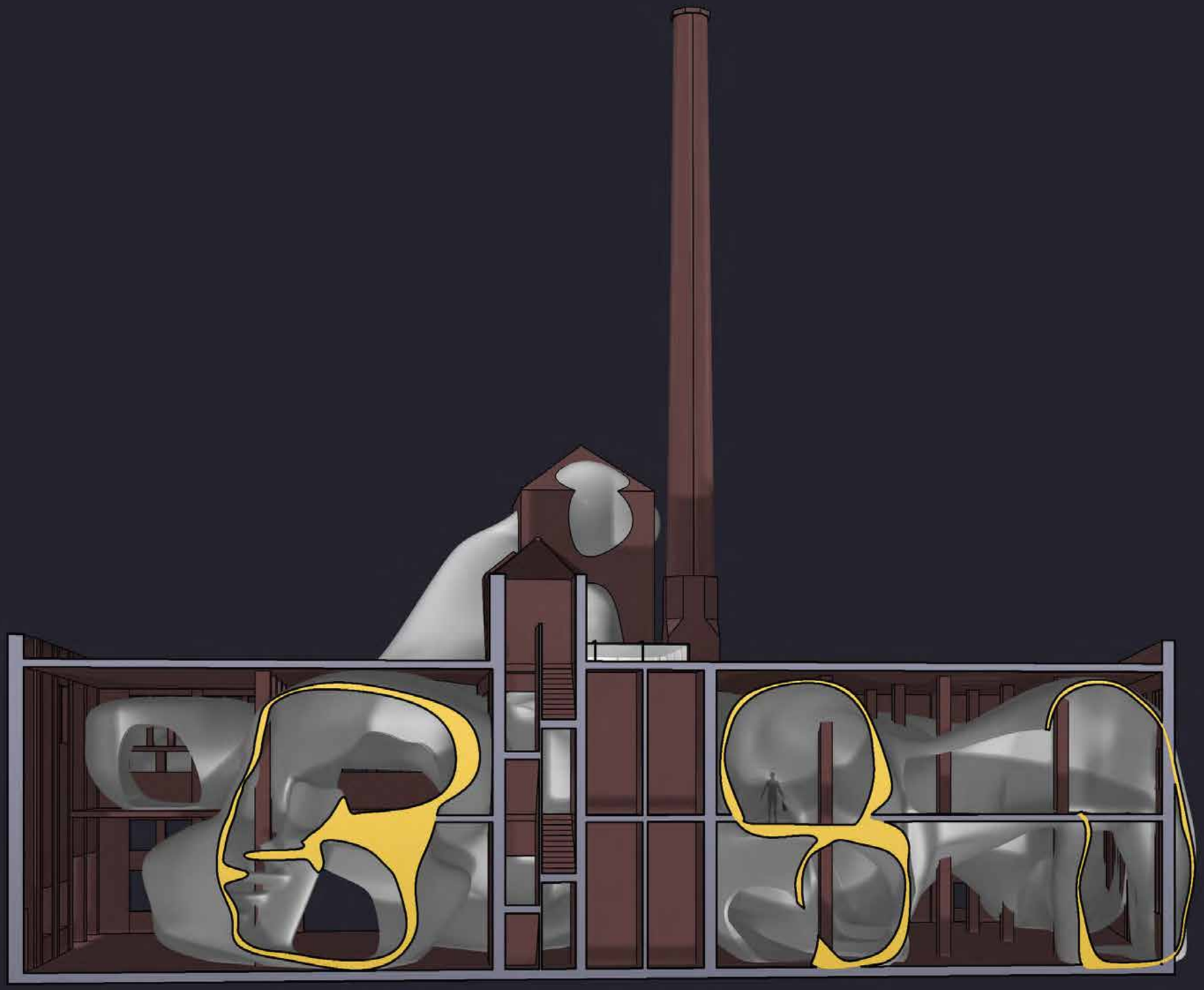




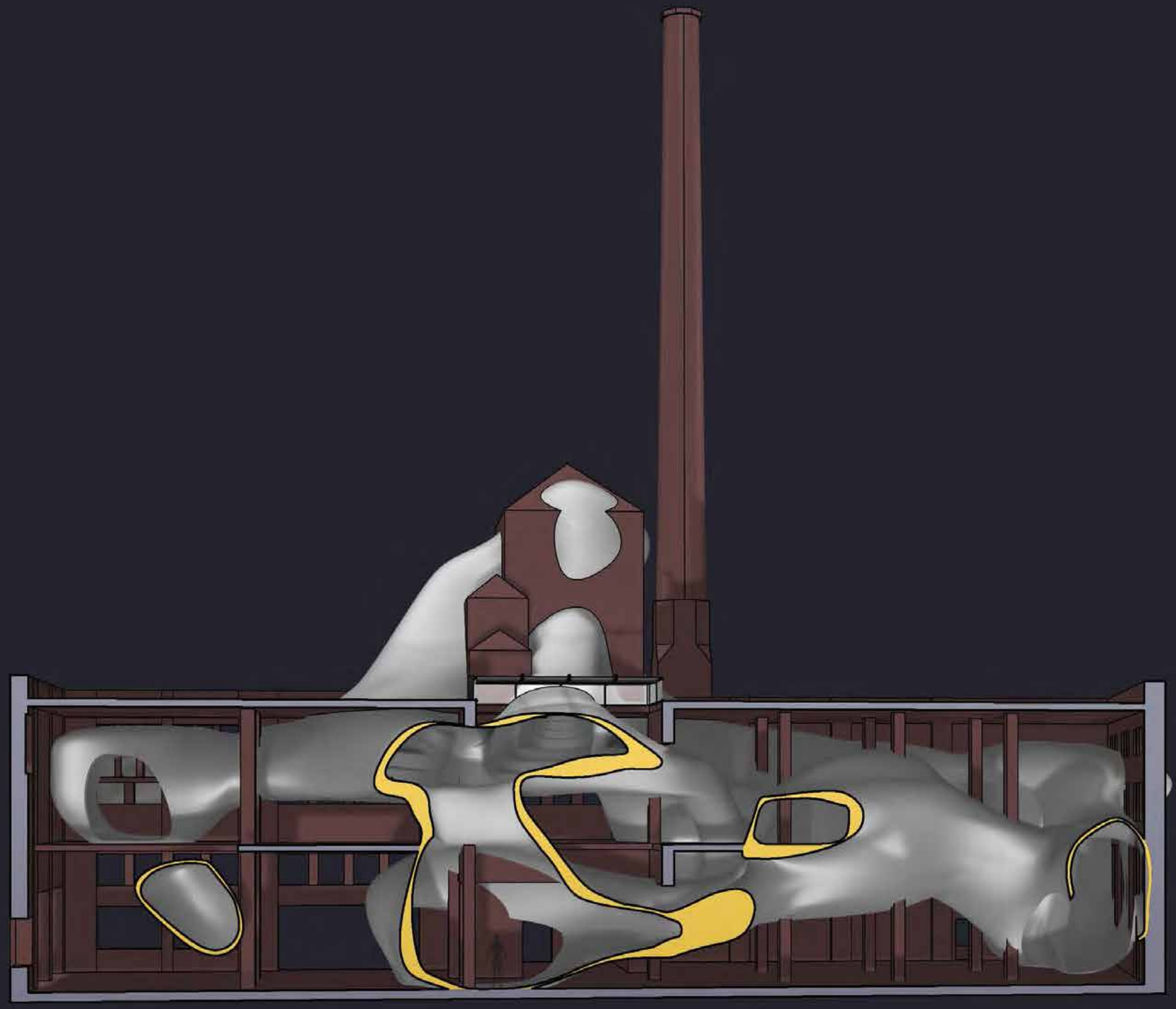


Y

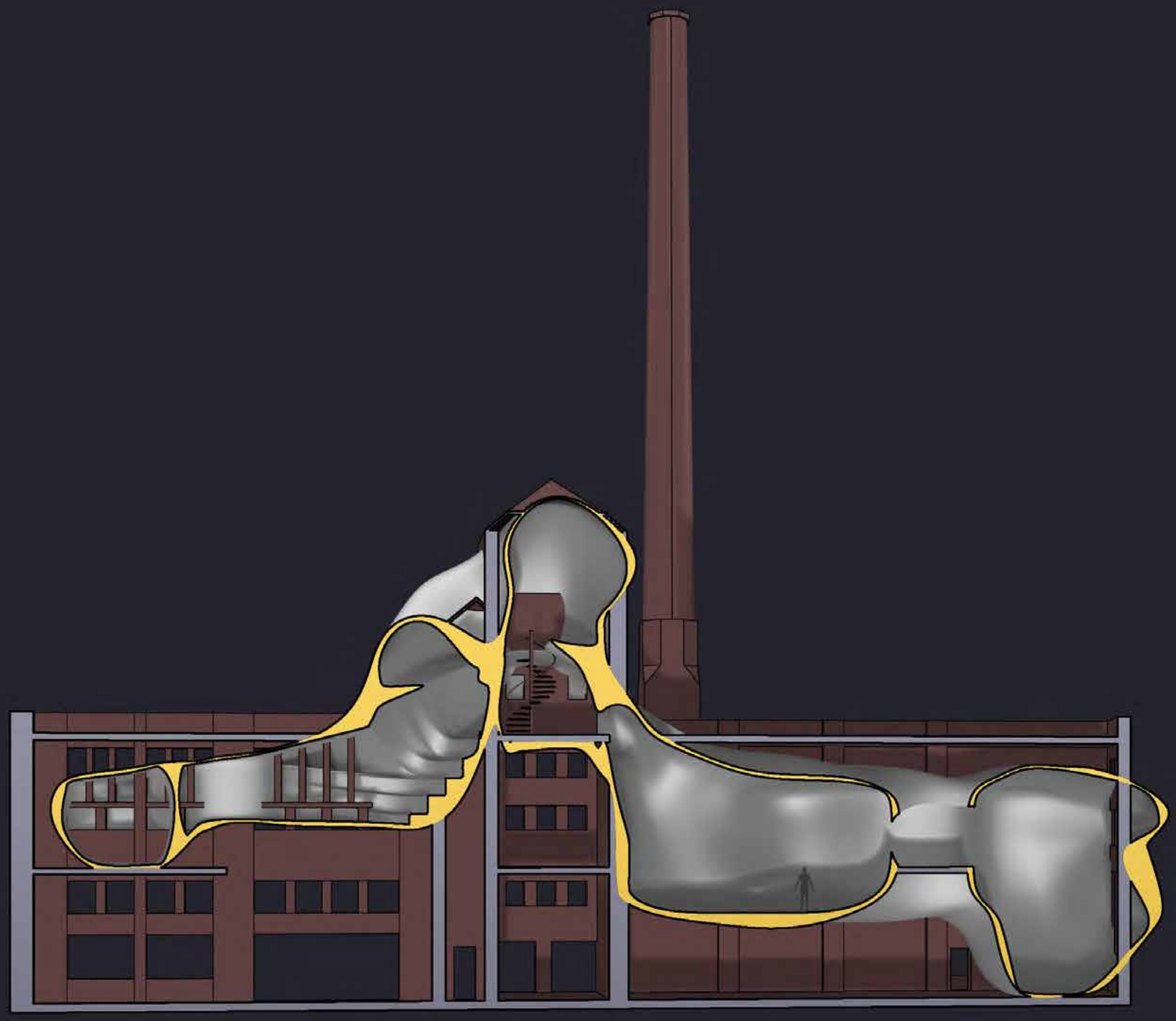
Z



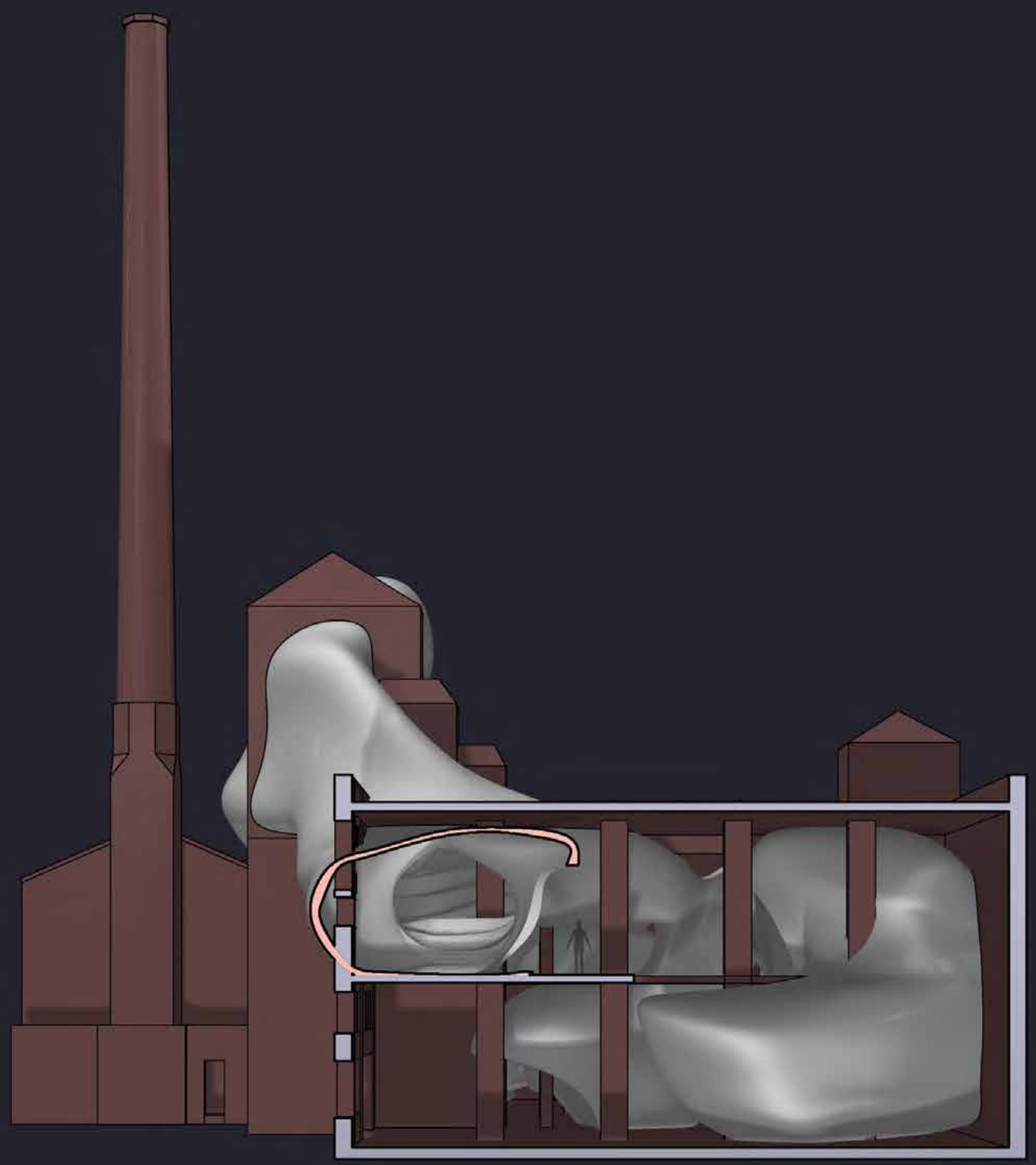
Section X-1



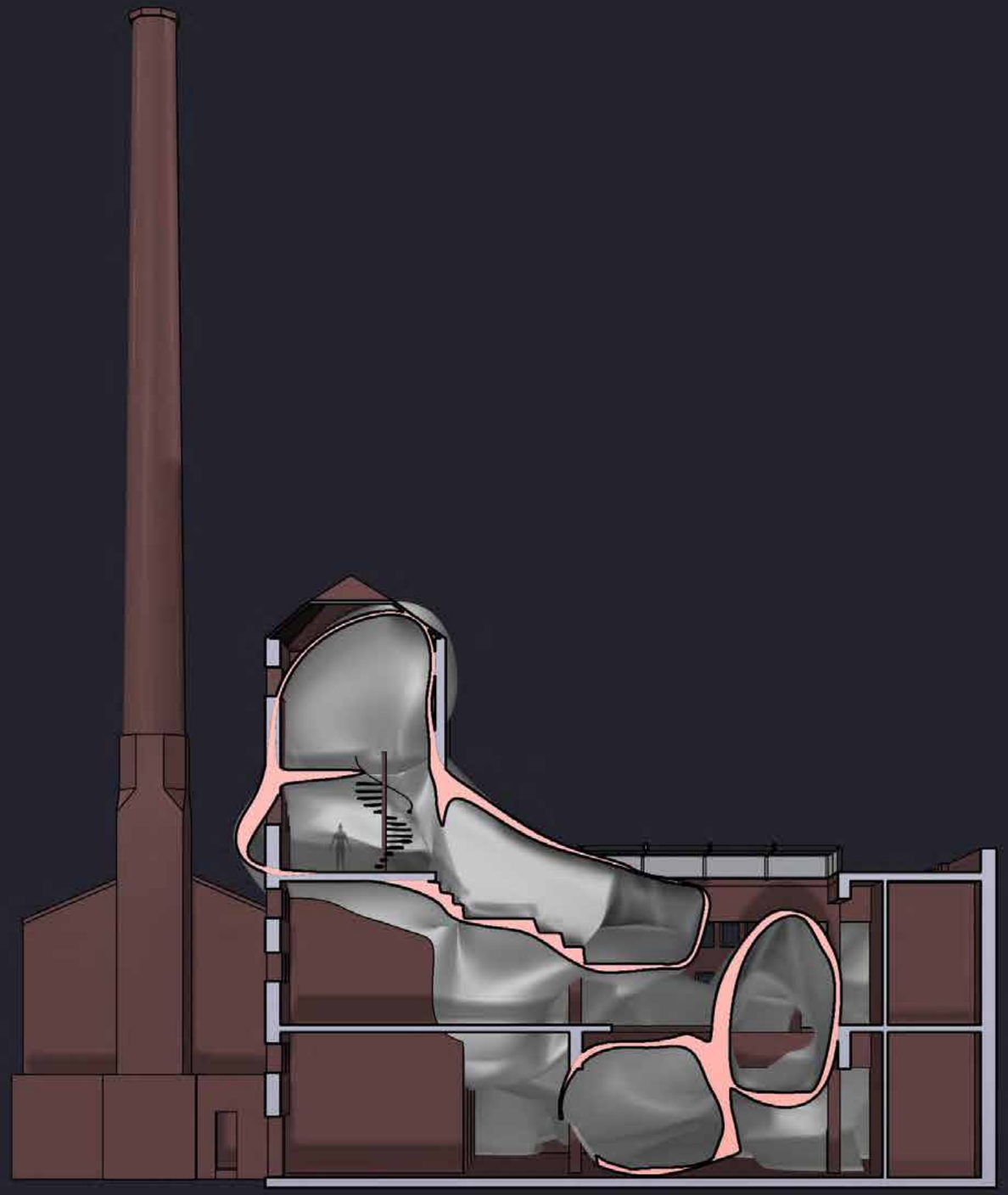
Section X-2



Section X-3



Section Y-1

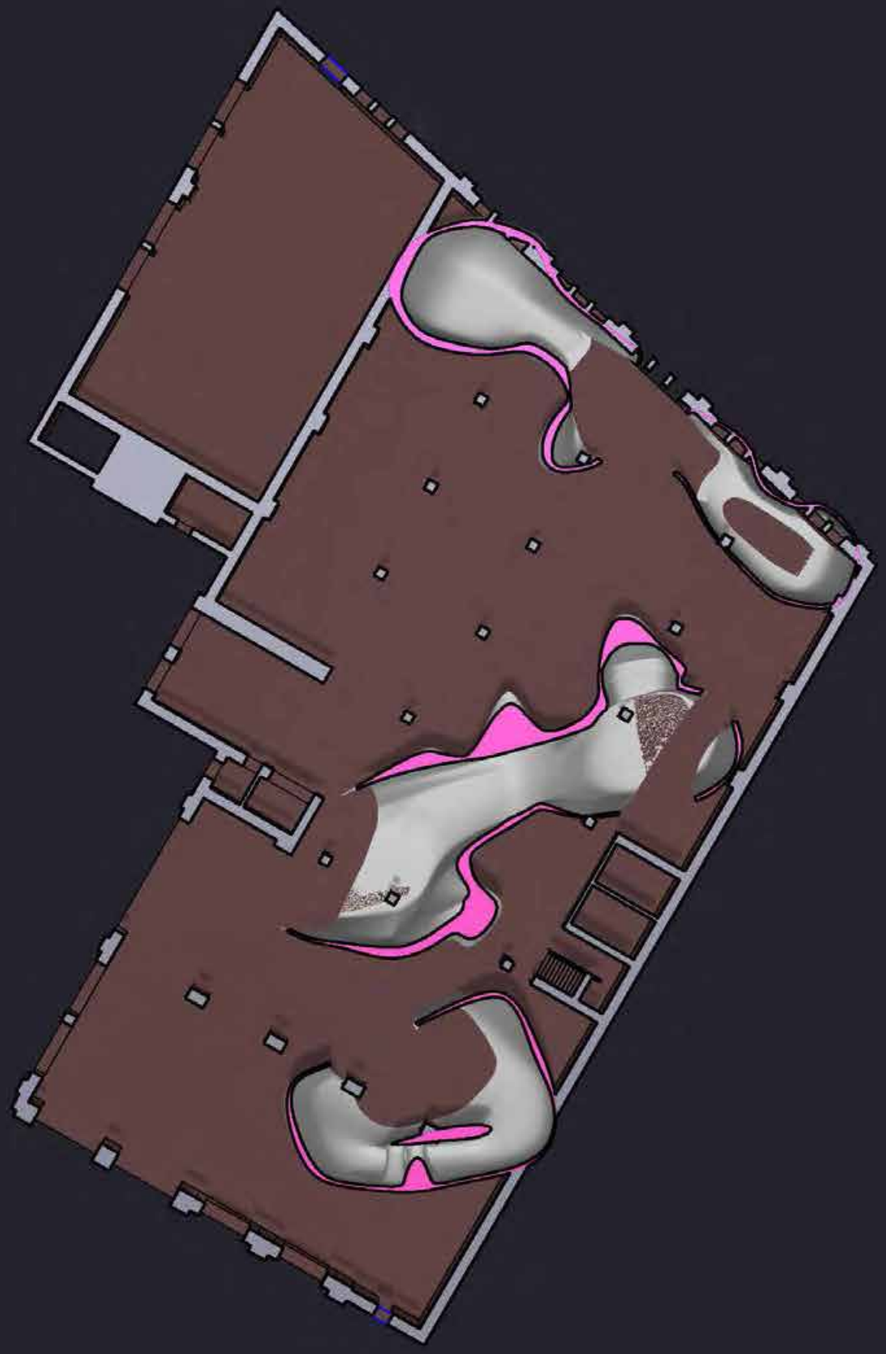


Section Y-2

Section Y-3

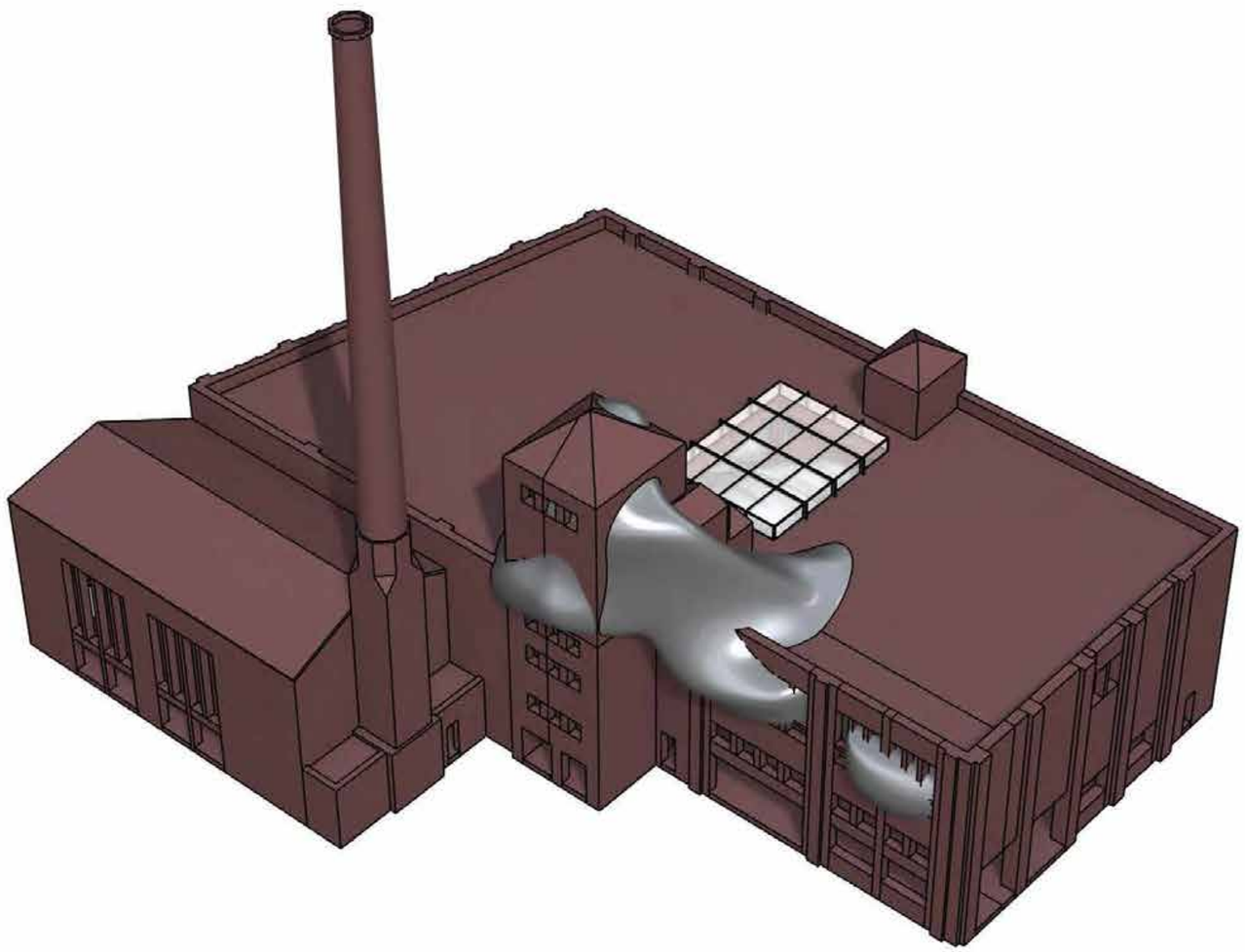
Section Z-1

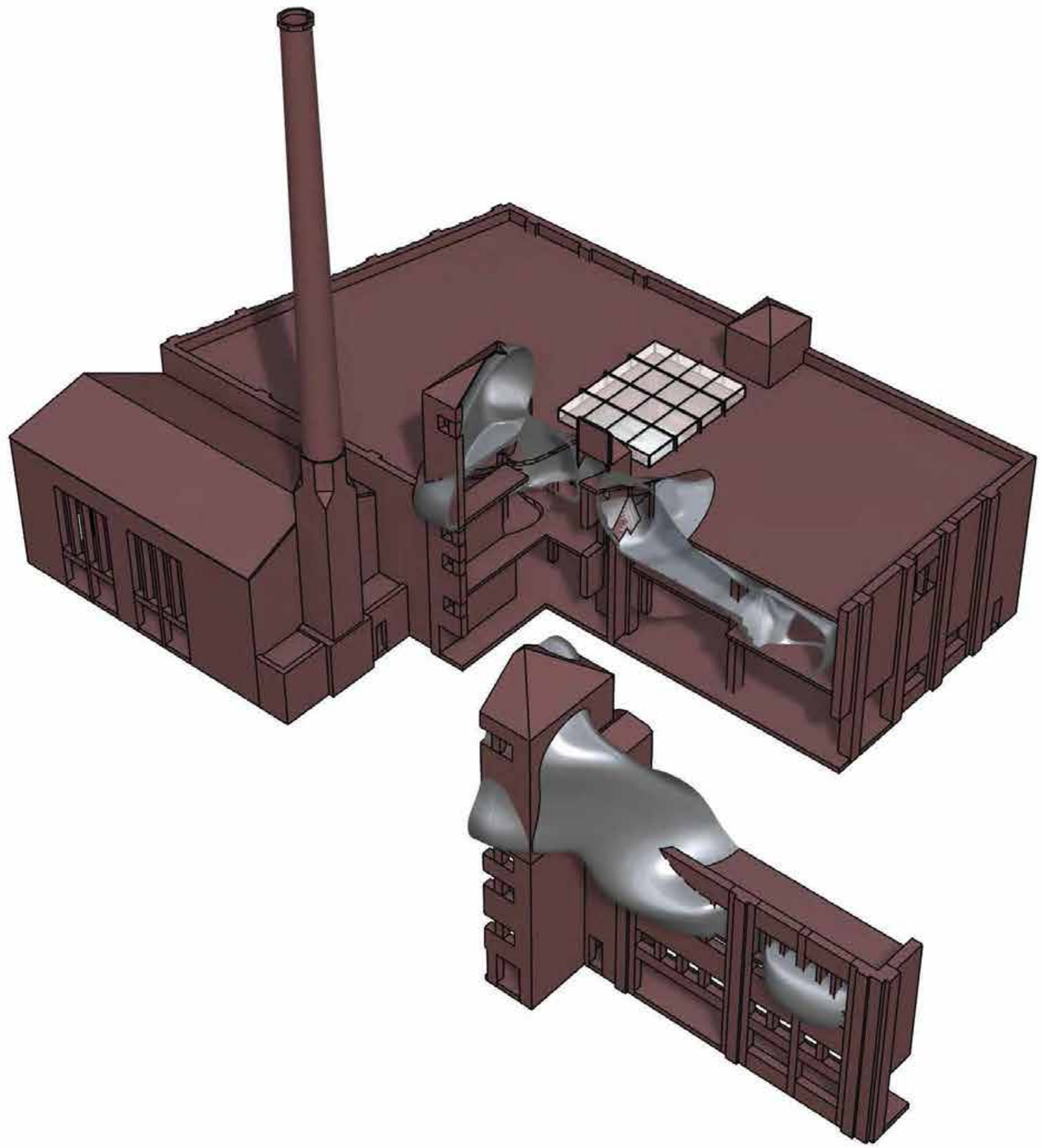
Section Z-2



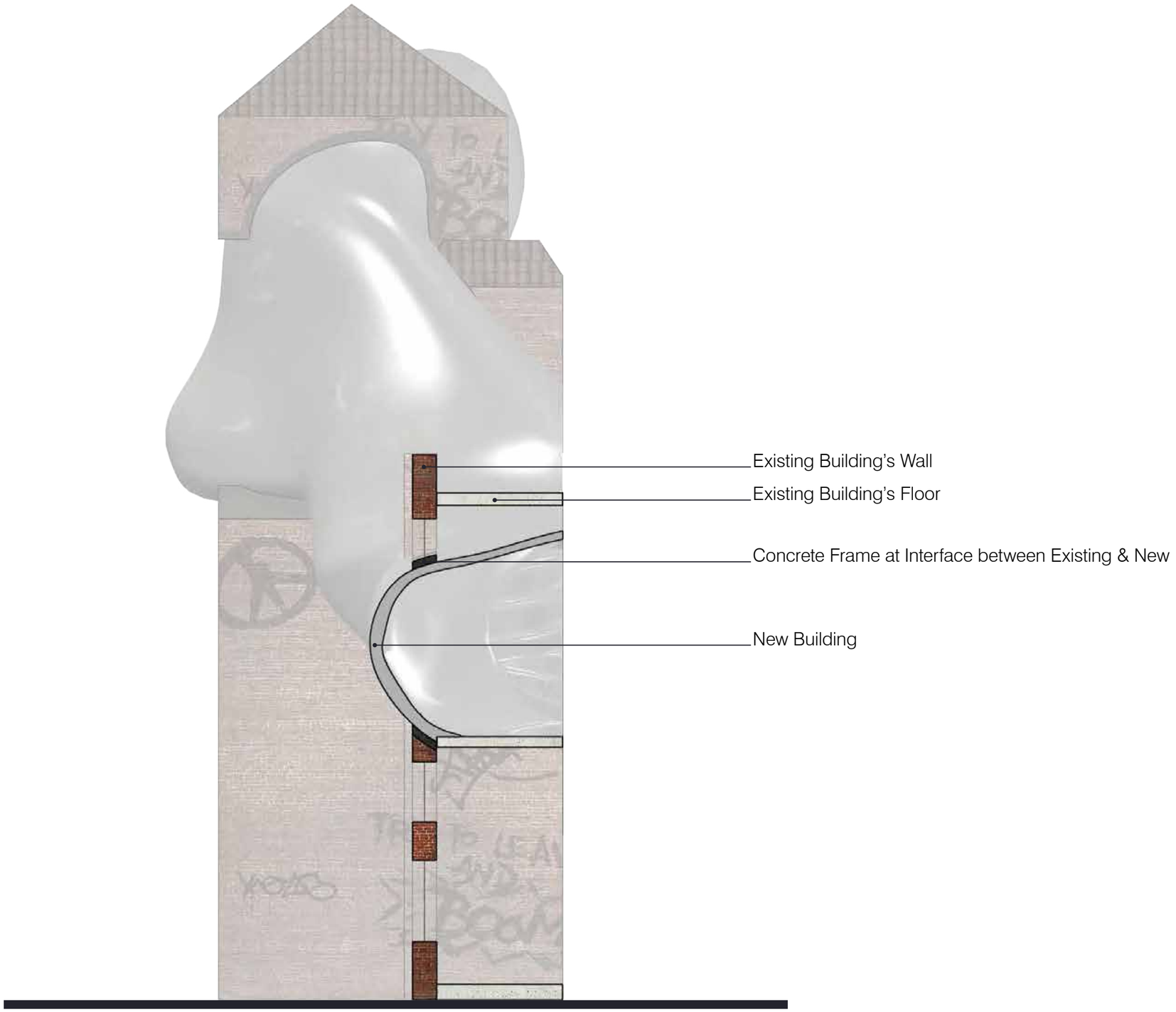
Section Z-3

MESO Scale



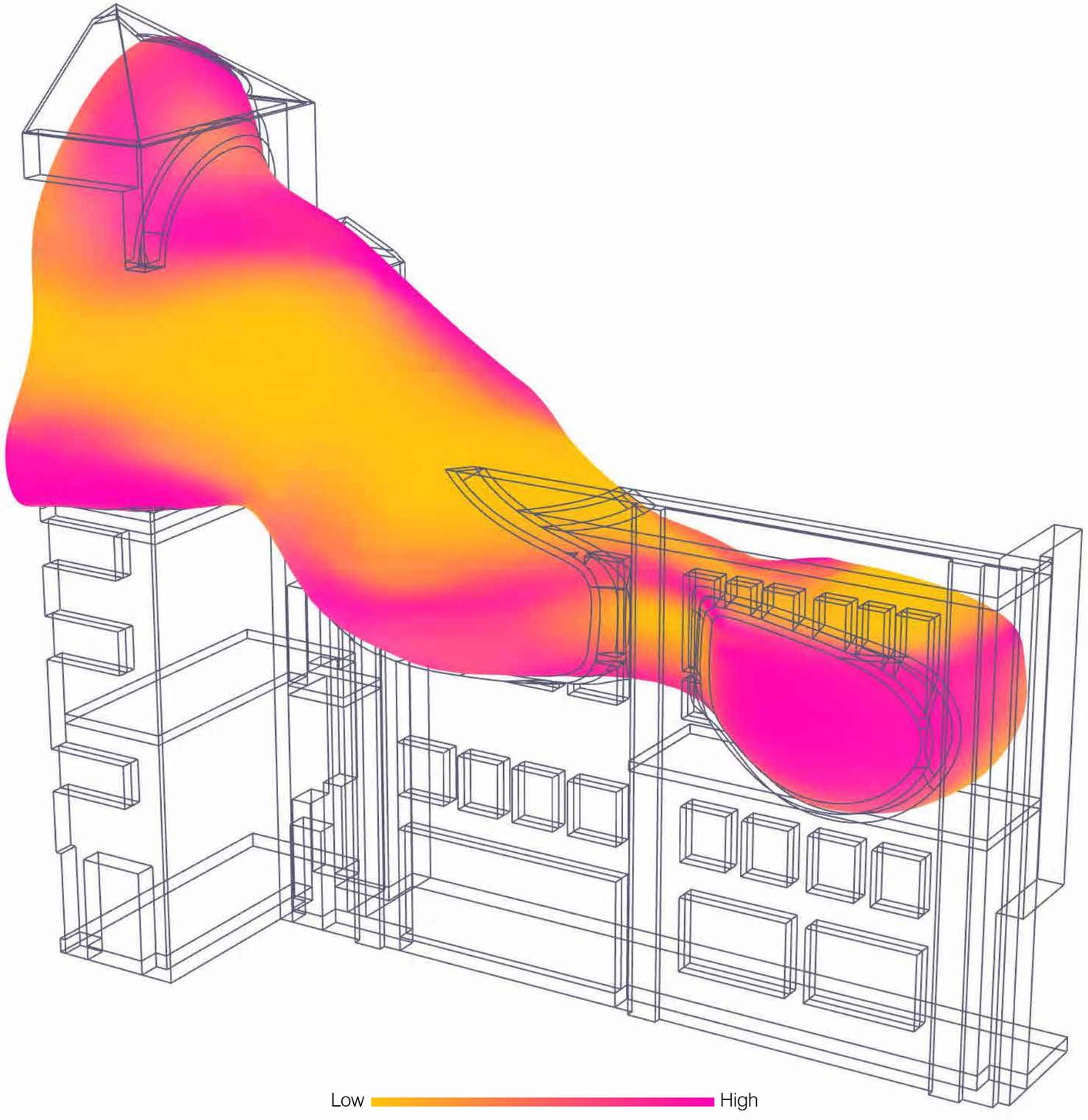


Fragment Architectural Studies

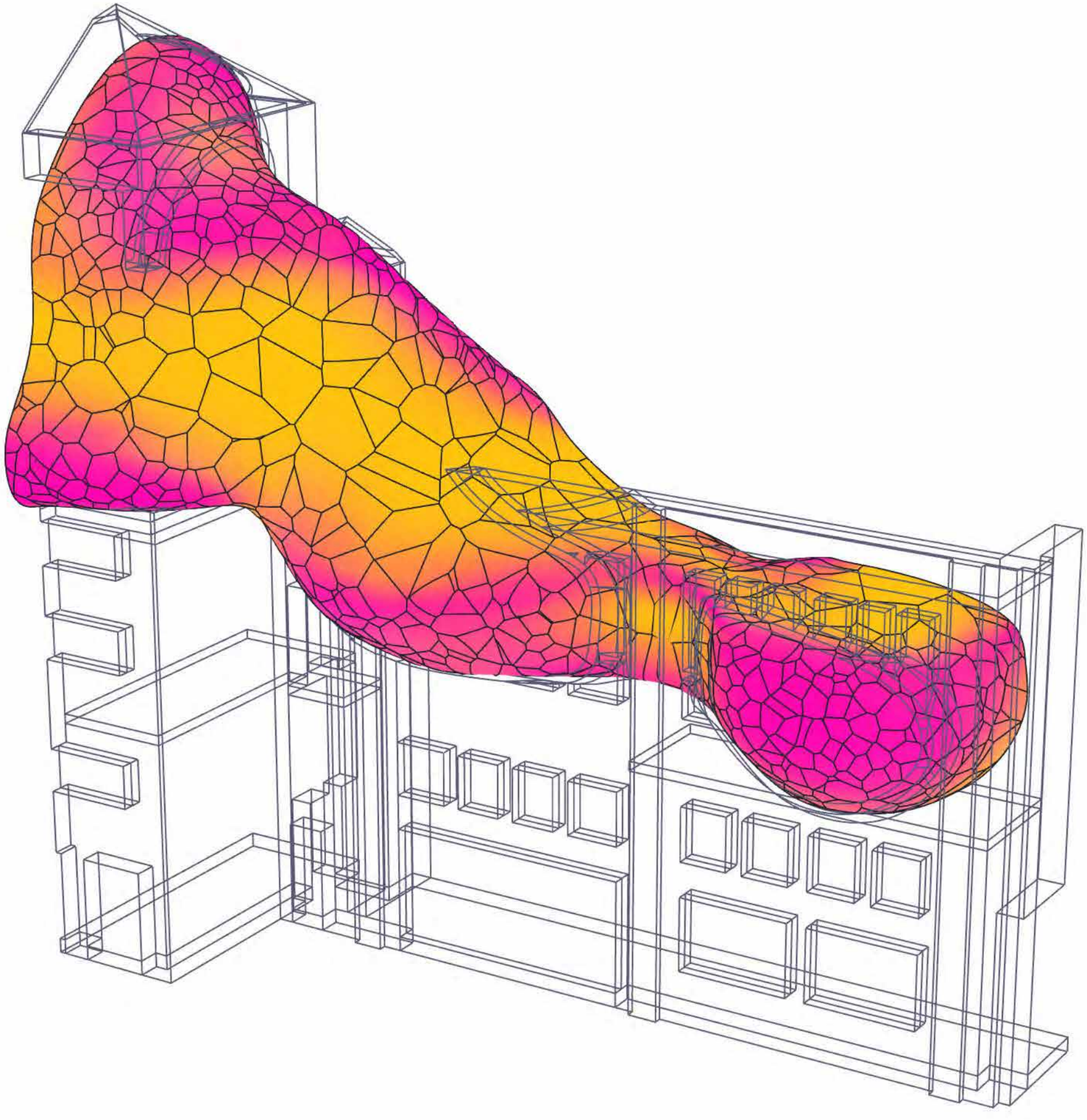


Integration Strategy

Integration Strategy

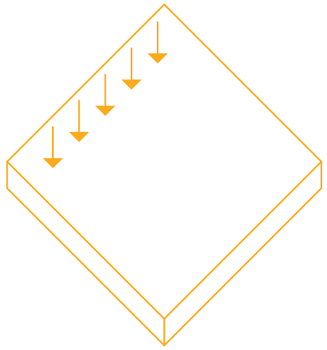


Mean Curvature Analysis



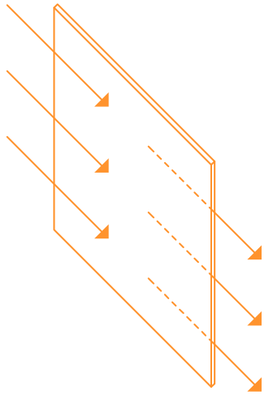
Mean Curvature Analysis

Building Preformance Mapping

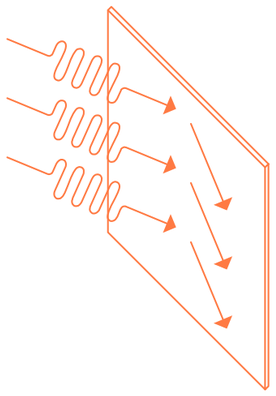


Heavy Duty Structural Performance

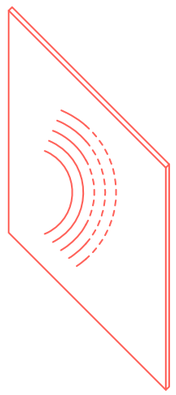
Light Duty Structural Performance



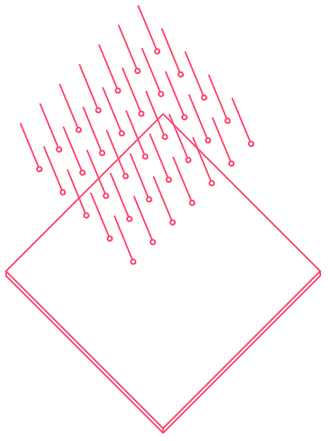
Translucency



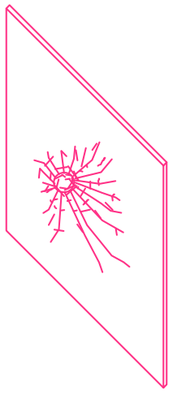
Thermal Insulation



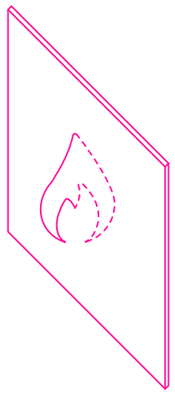
Acoustic Insulation



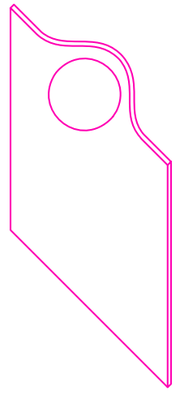
Water Insulation



Impact Protection



Fire Protection



Softness / Rigidity

Heavy Duty Performance

Light Duty Performance

Translucency

Thermal Insulation

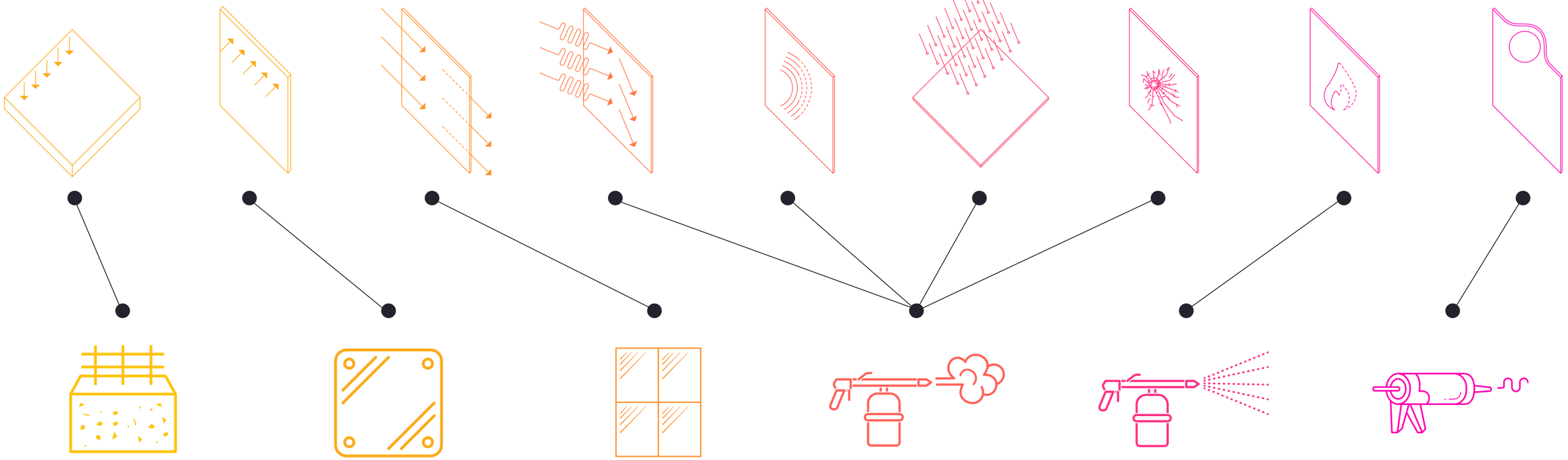
Acoustic Insulation

Water Insulation

Impact Protection

Fire Protection

Softnes / Rigidity



Structural Concrete

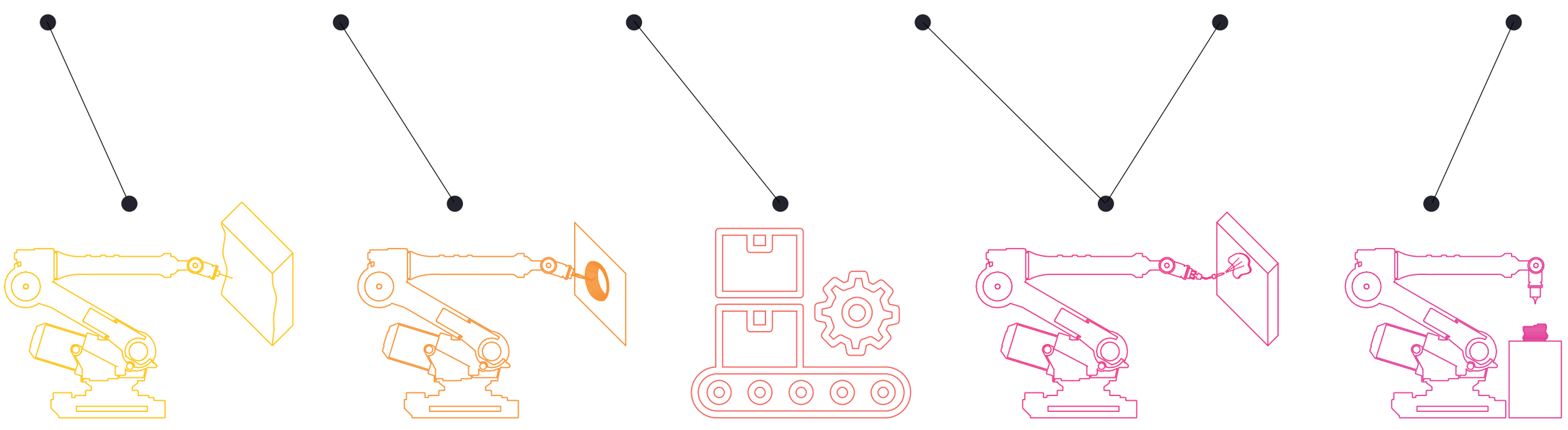
Stainless Steel Sheets

Tempered Glass

Polyurethane Foam

Latex-based Coating

Silicone



Robotically Milled EPS Molds

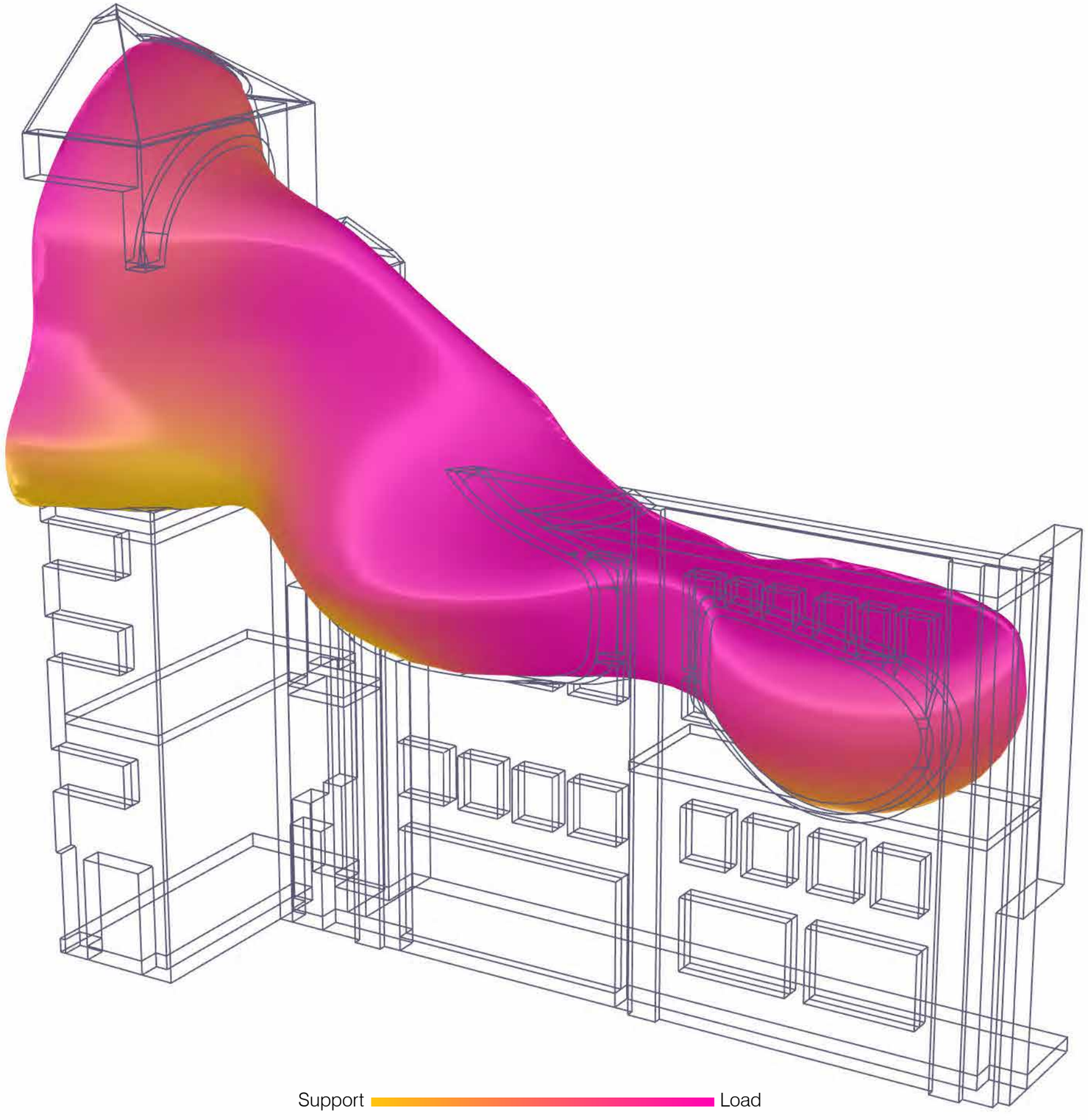
Robotic Incremental Sheet Forming

Standard Production

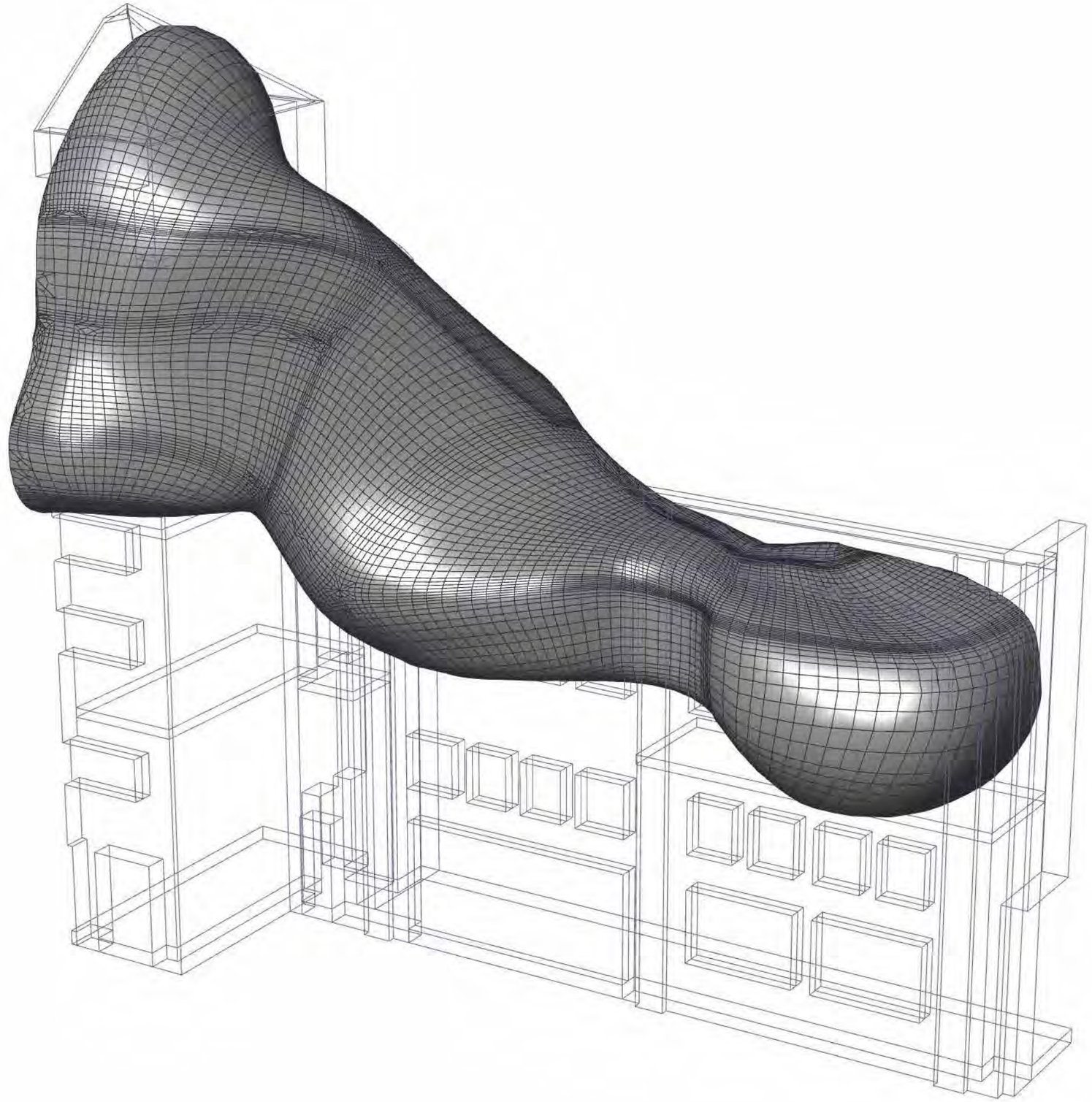
Robotically Assisted Sparaying

Robotic Additive Manufacturing

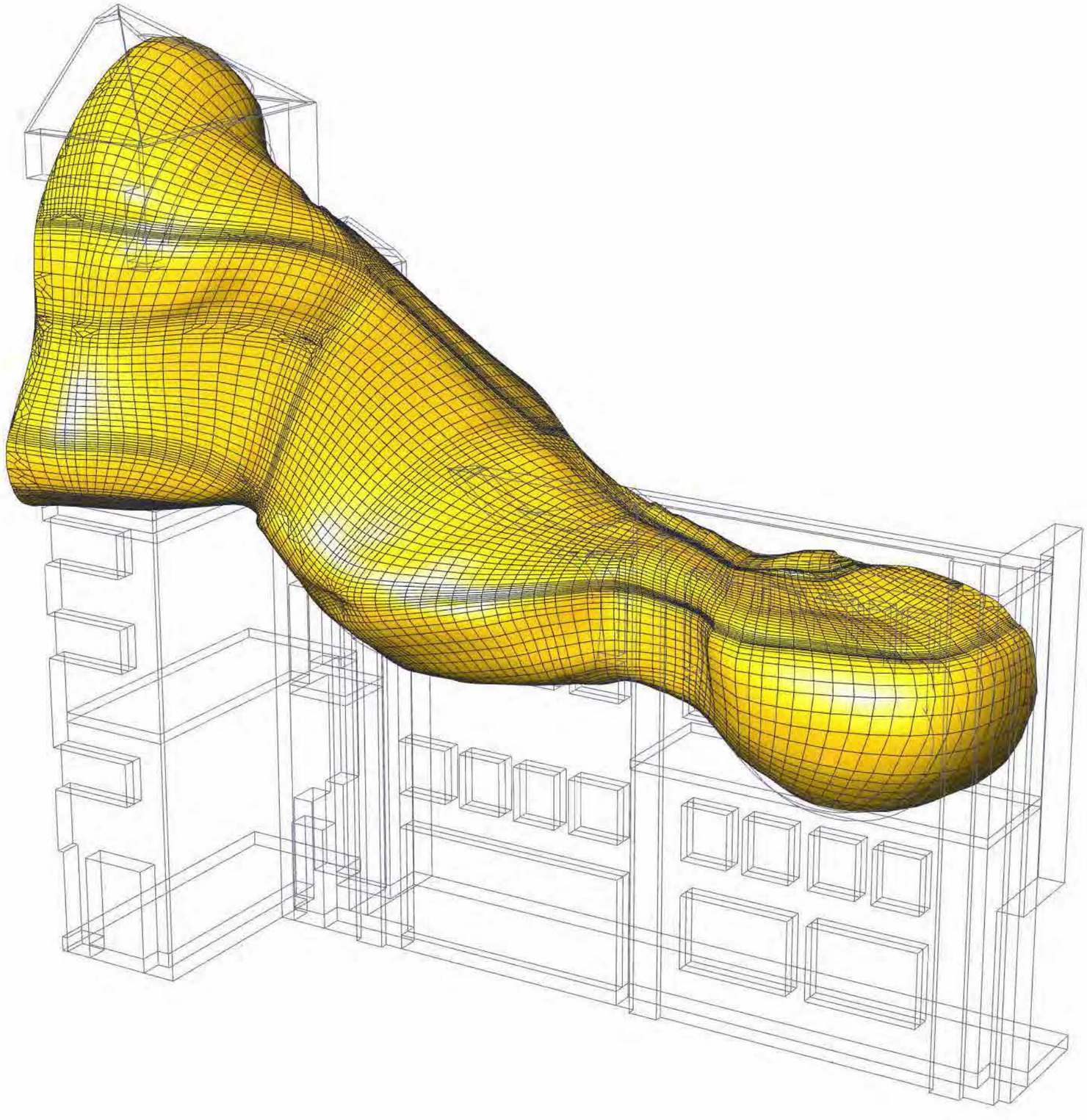
Fragment Structural Studies



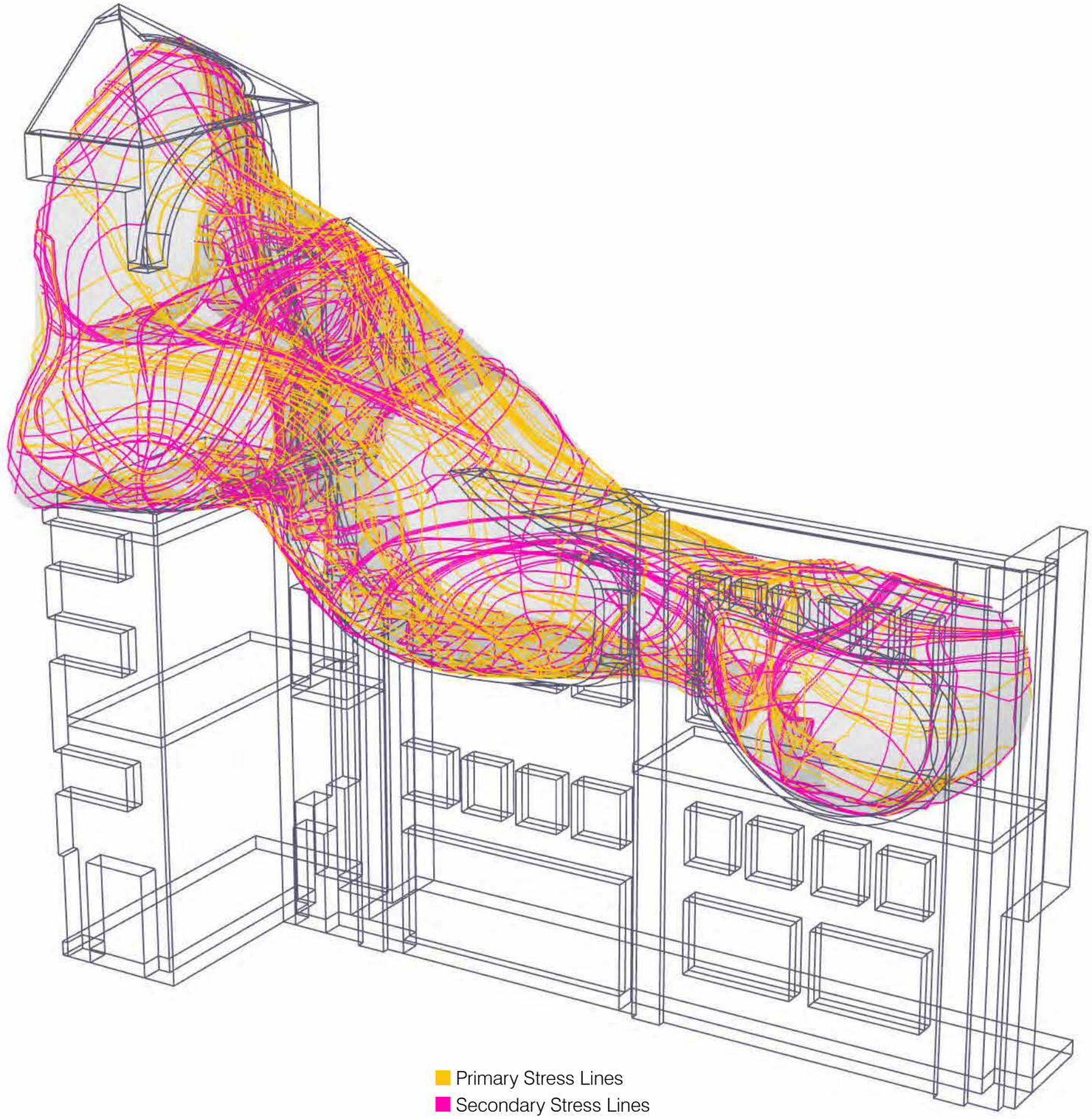
Supports and Loads Locations



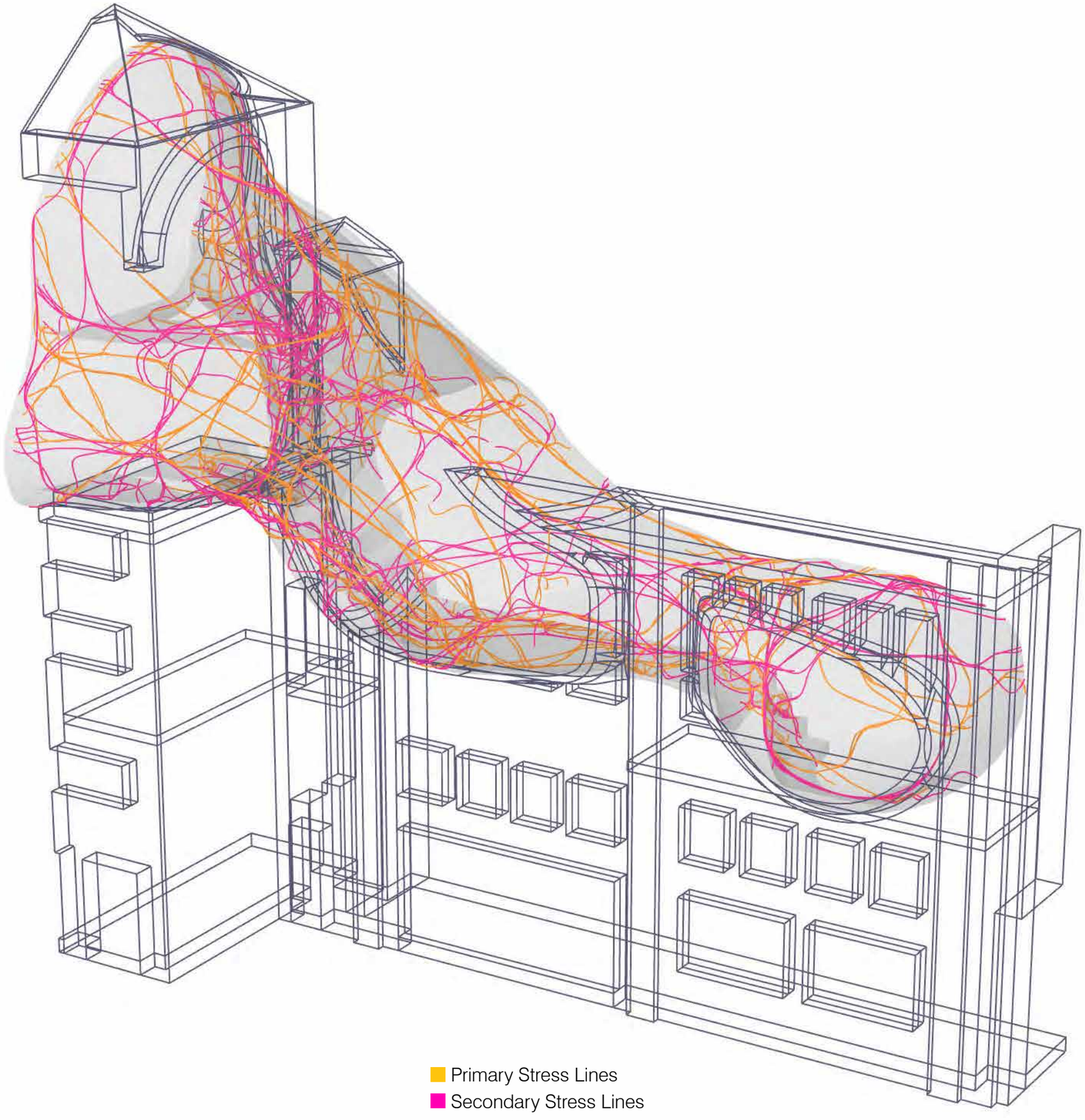
Topology Optimization I



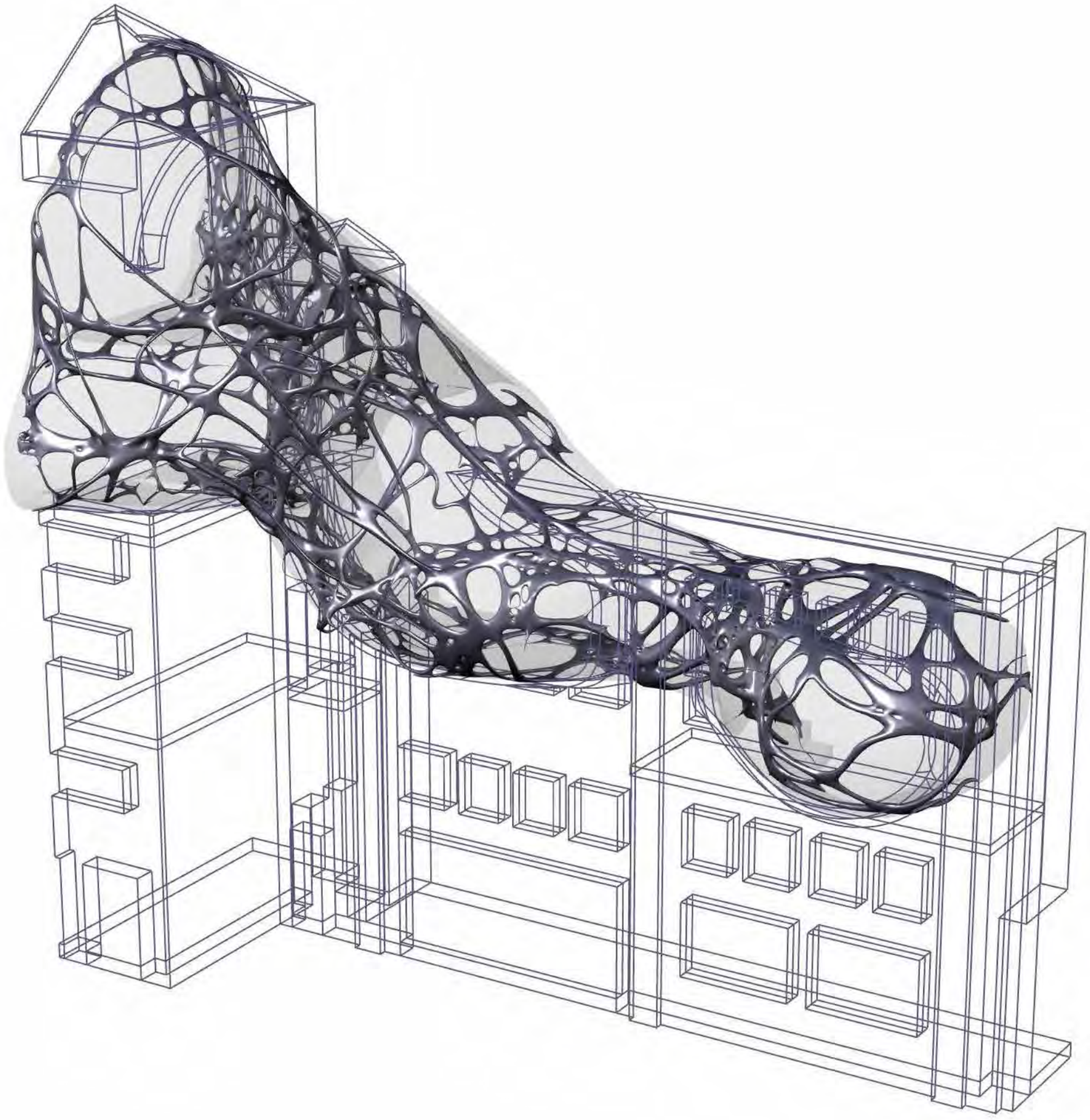
Topology Optimization I



Stress Lines Analysis

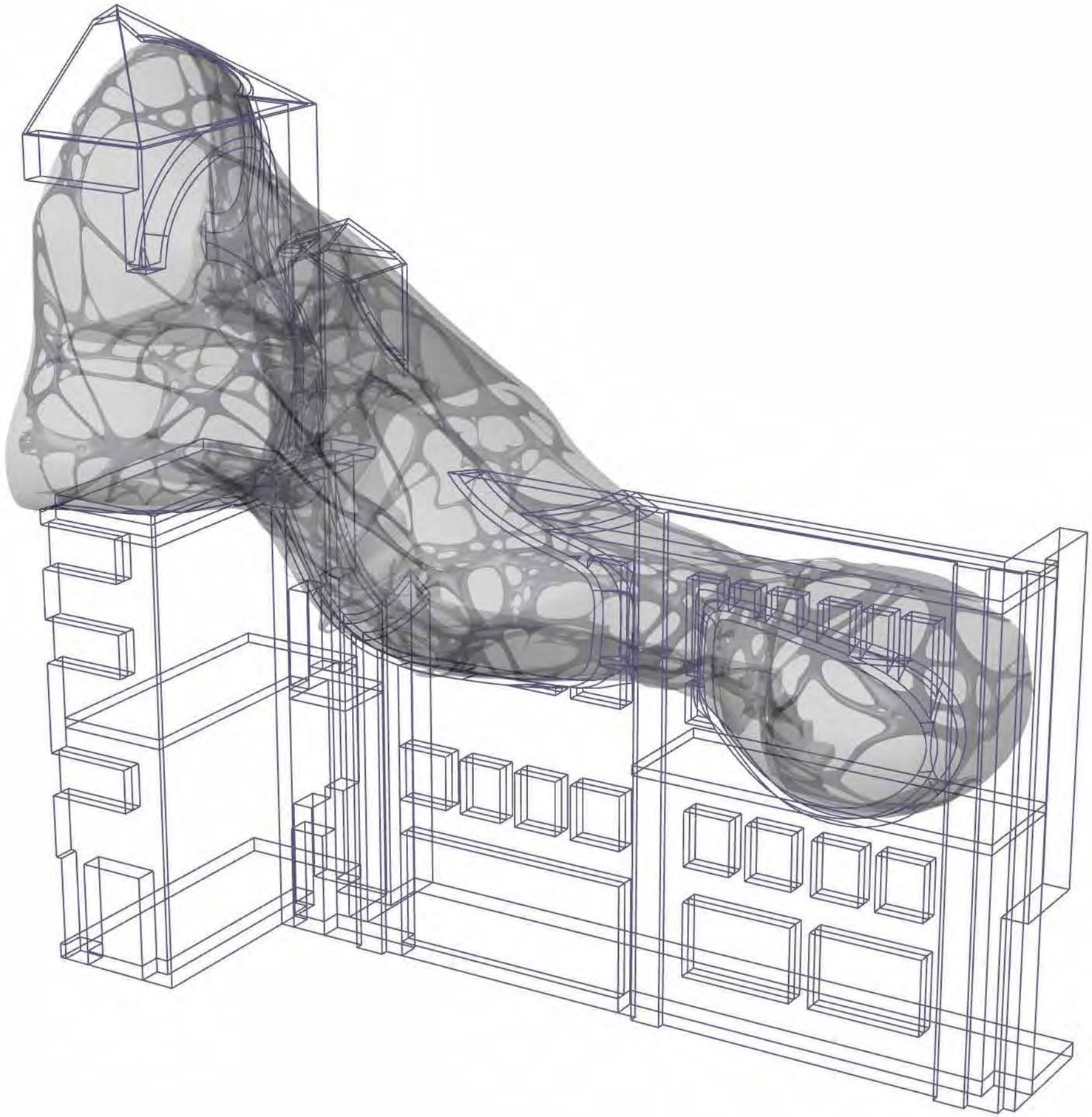


Stress Lines Bundling

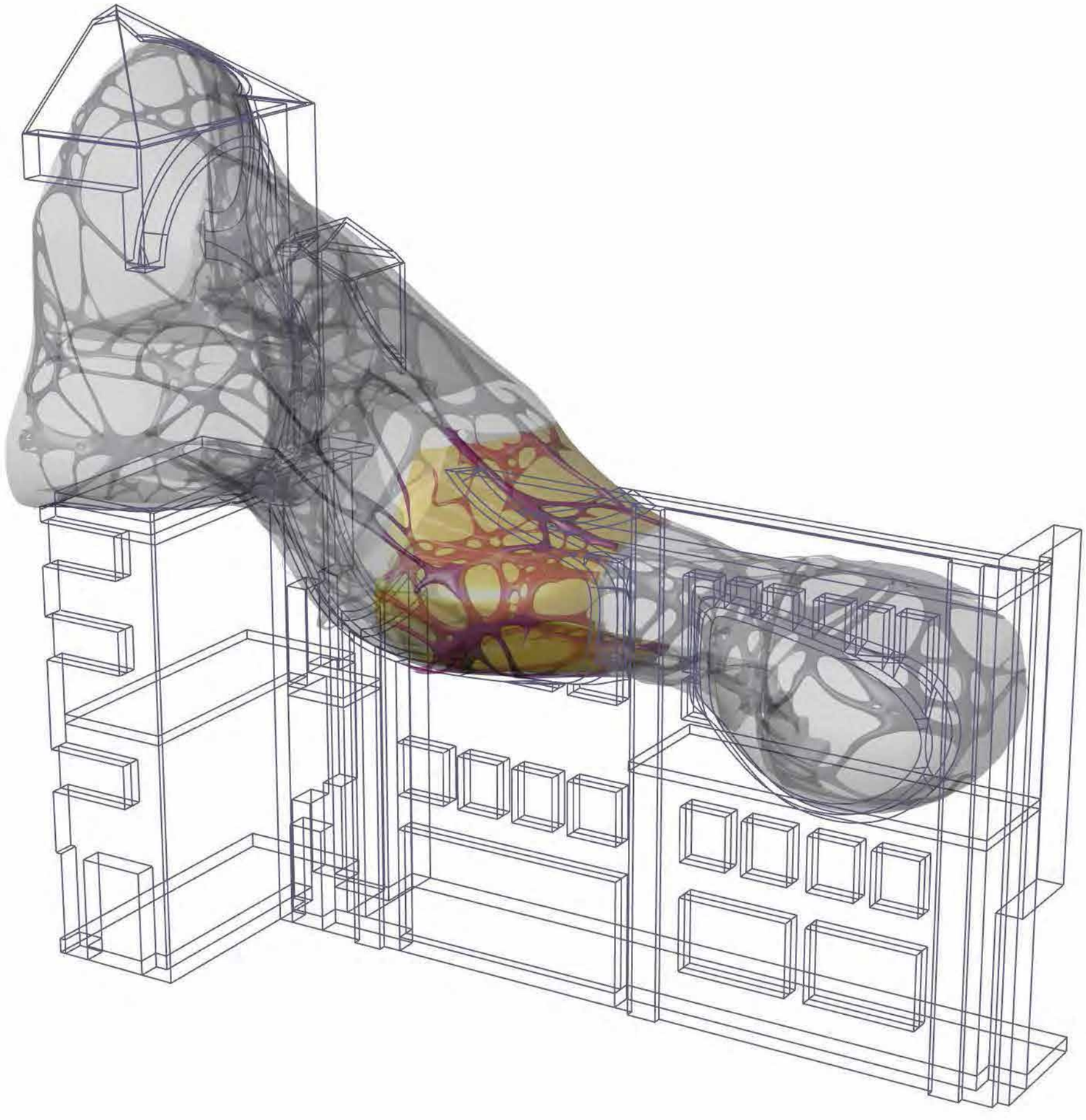


Topology Optimization II

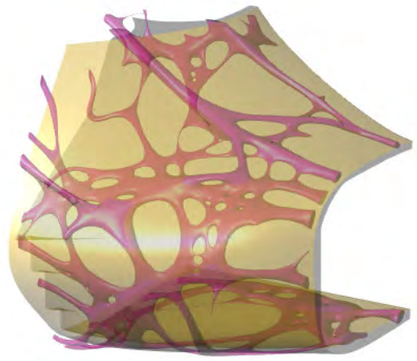
MICRO Scale



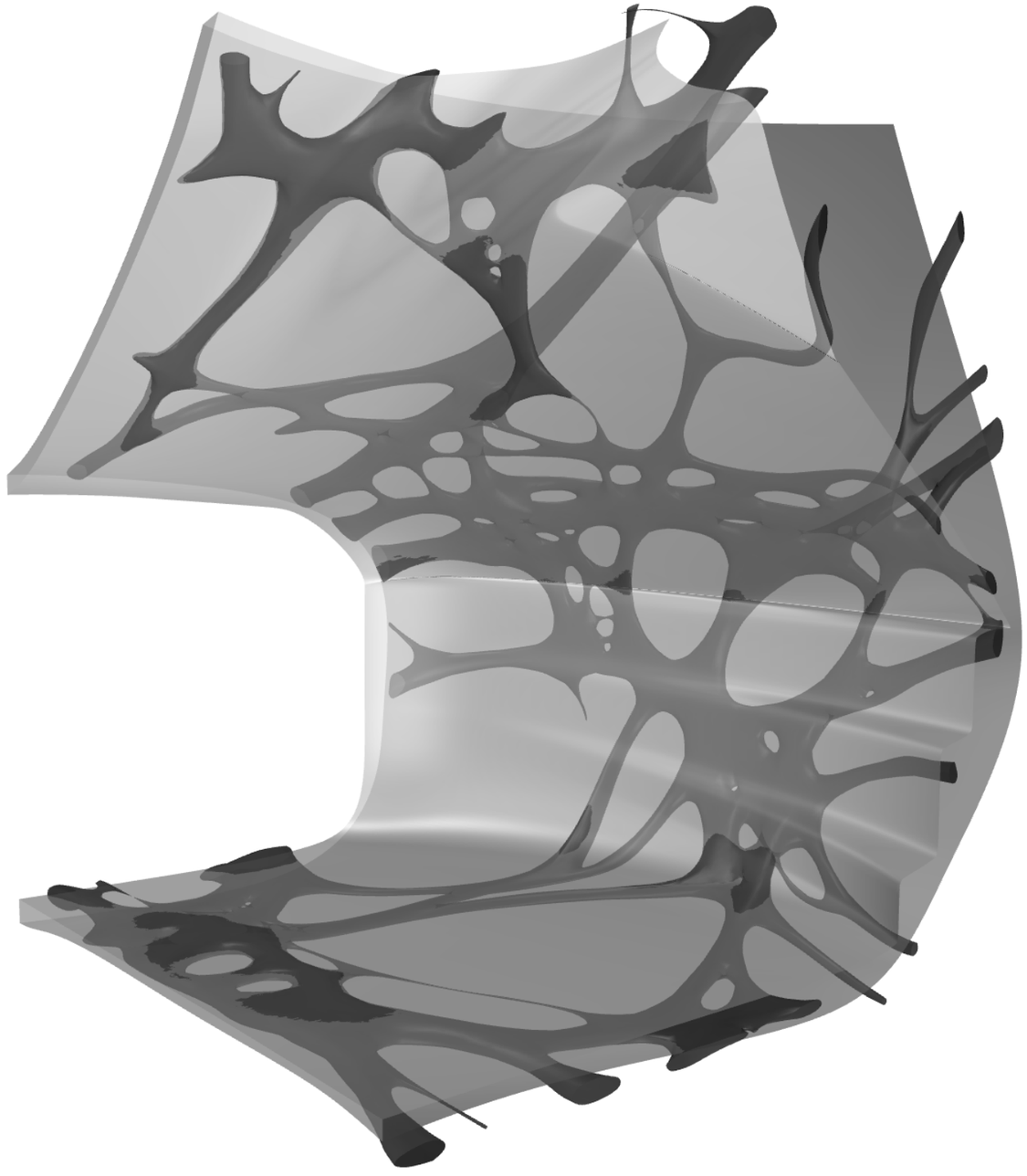
Sub-Fragment Extraction



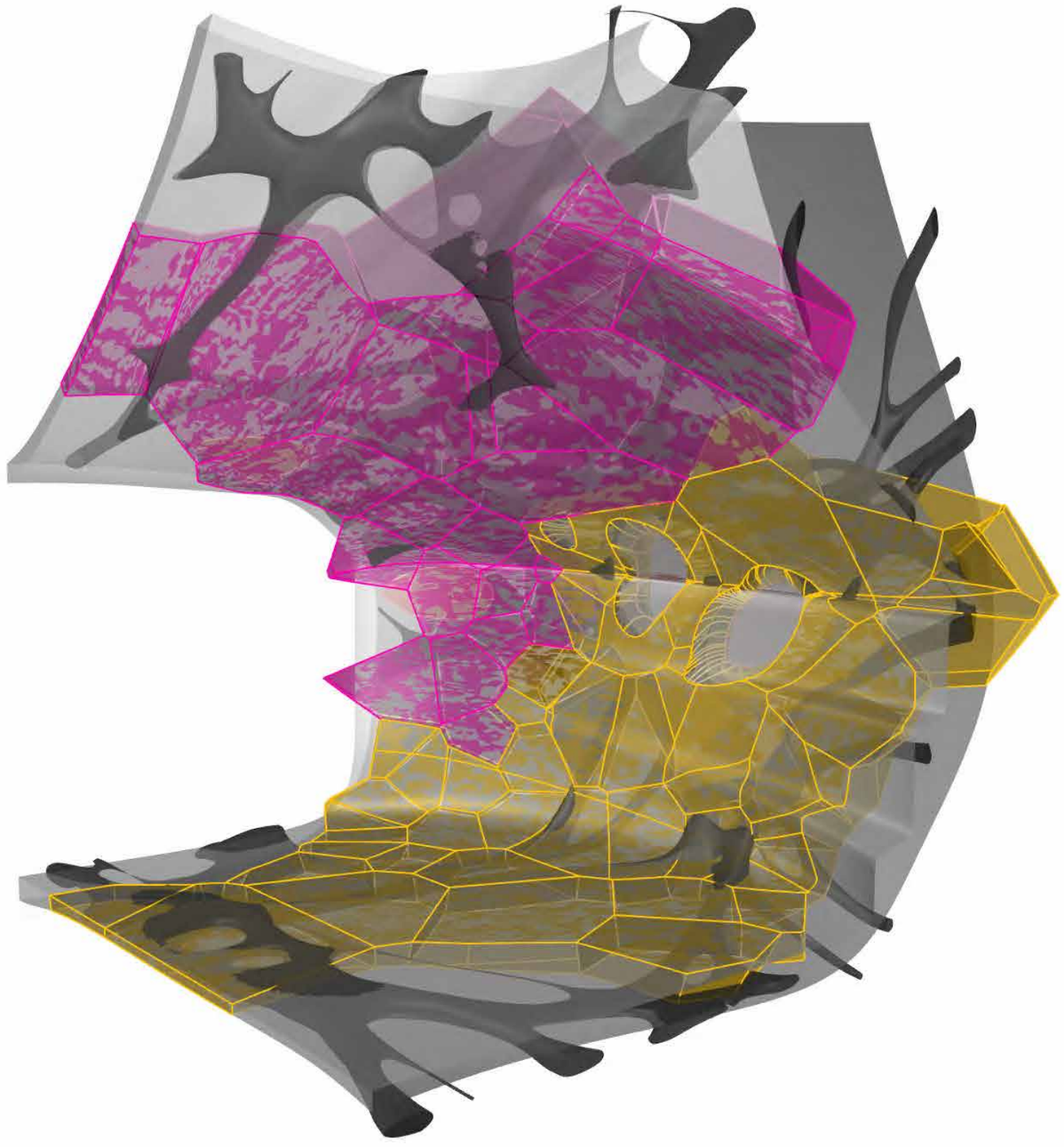
Sub-Fragment Extraction



Sub-Fragment Extraction

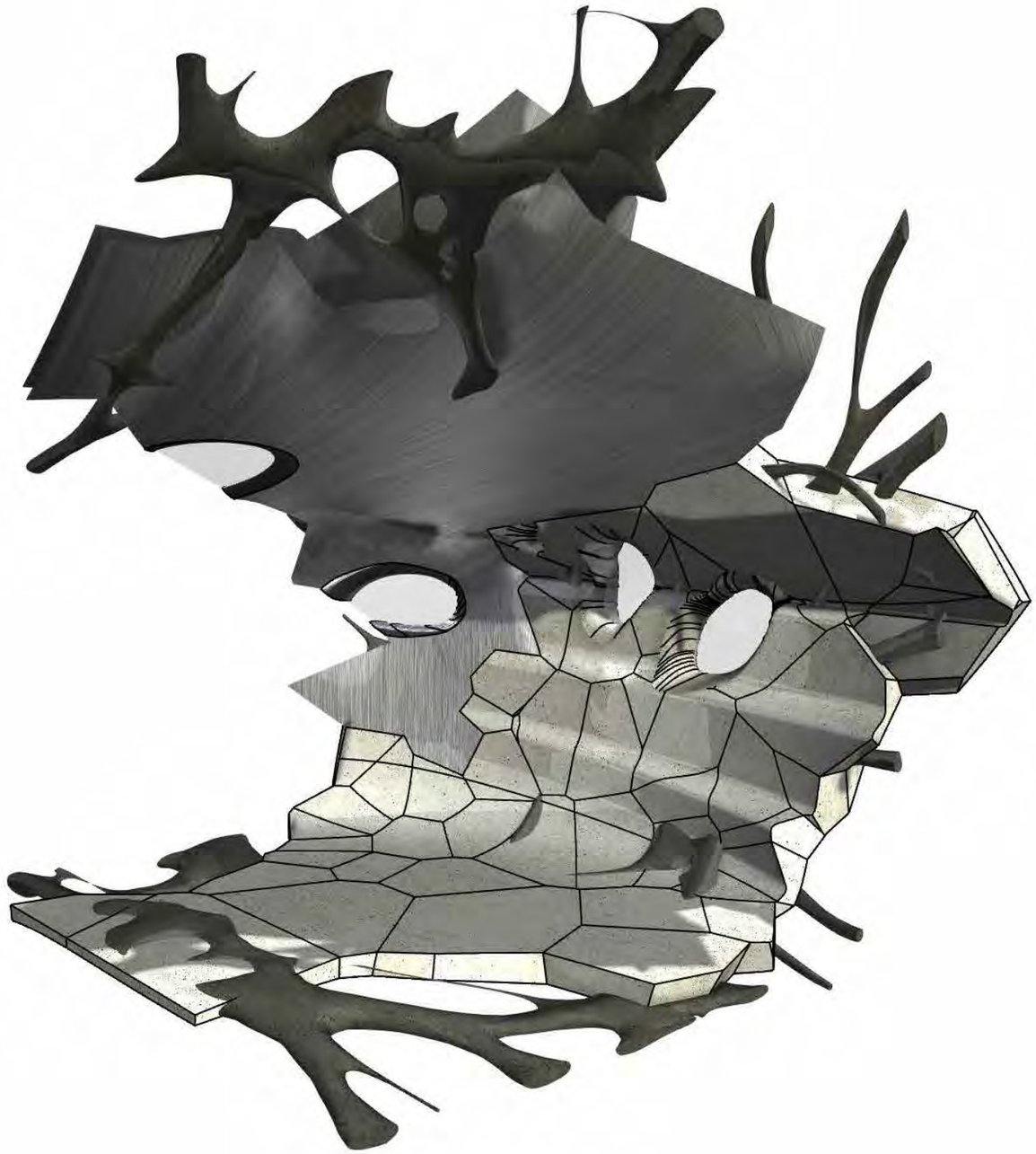


Basic Geometry

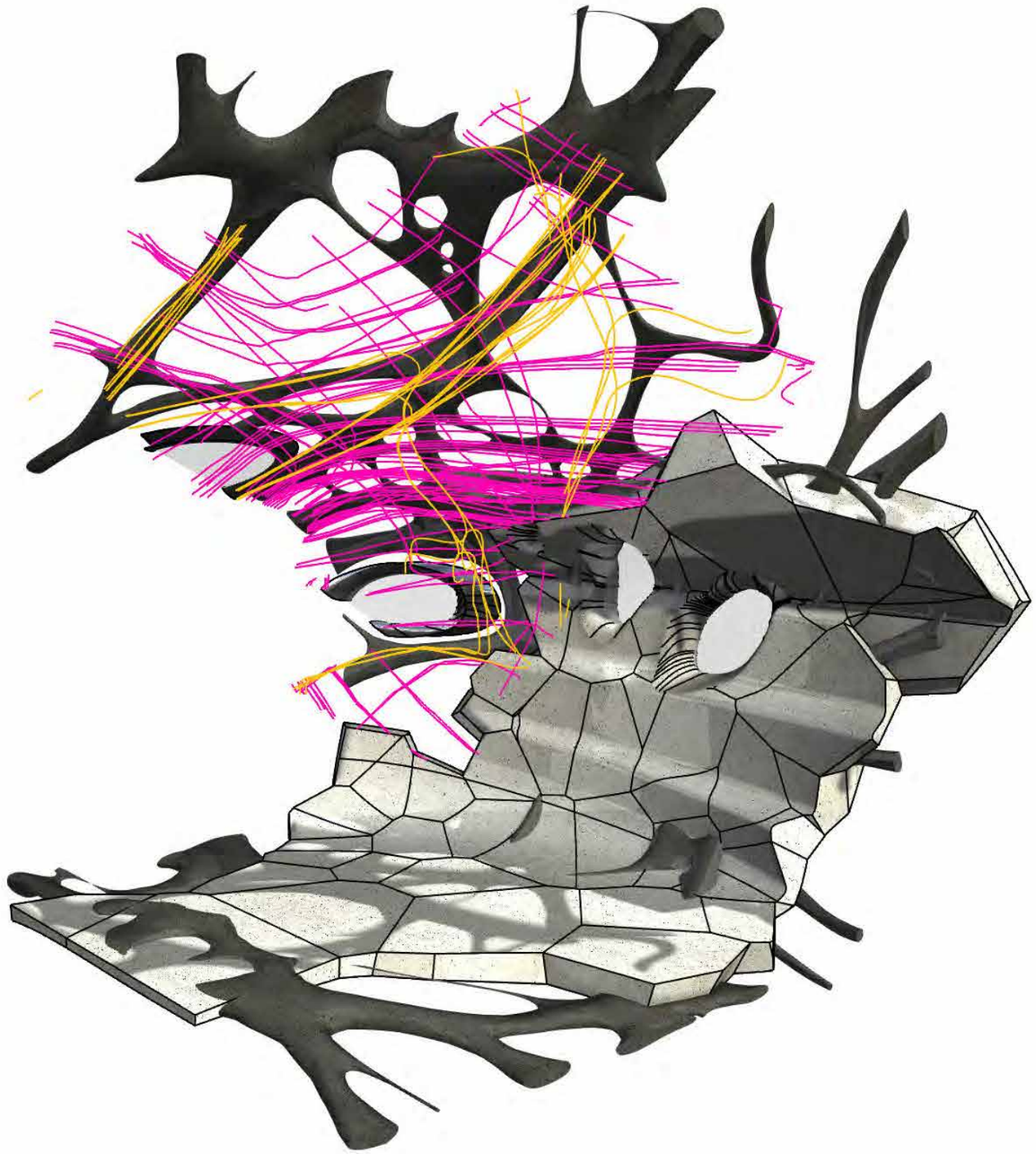


Concrete
Stainless Steel Sheets

Mapping Projection

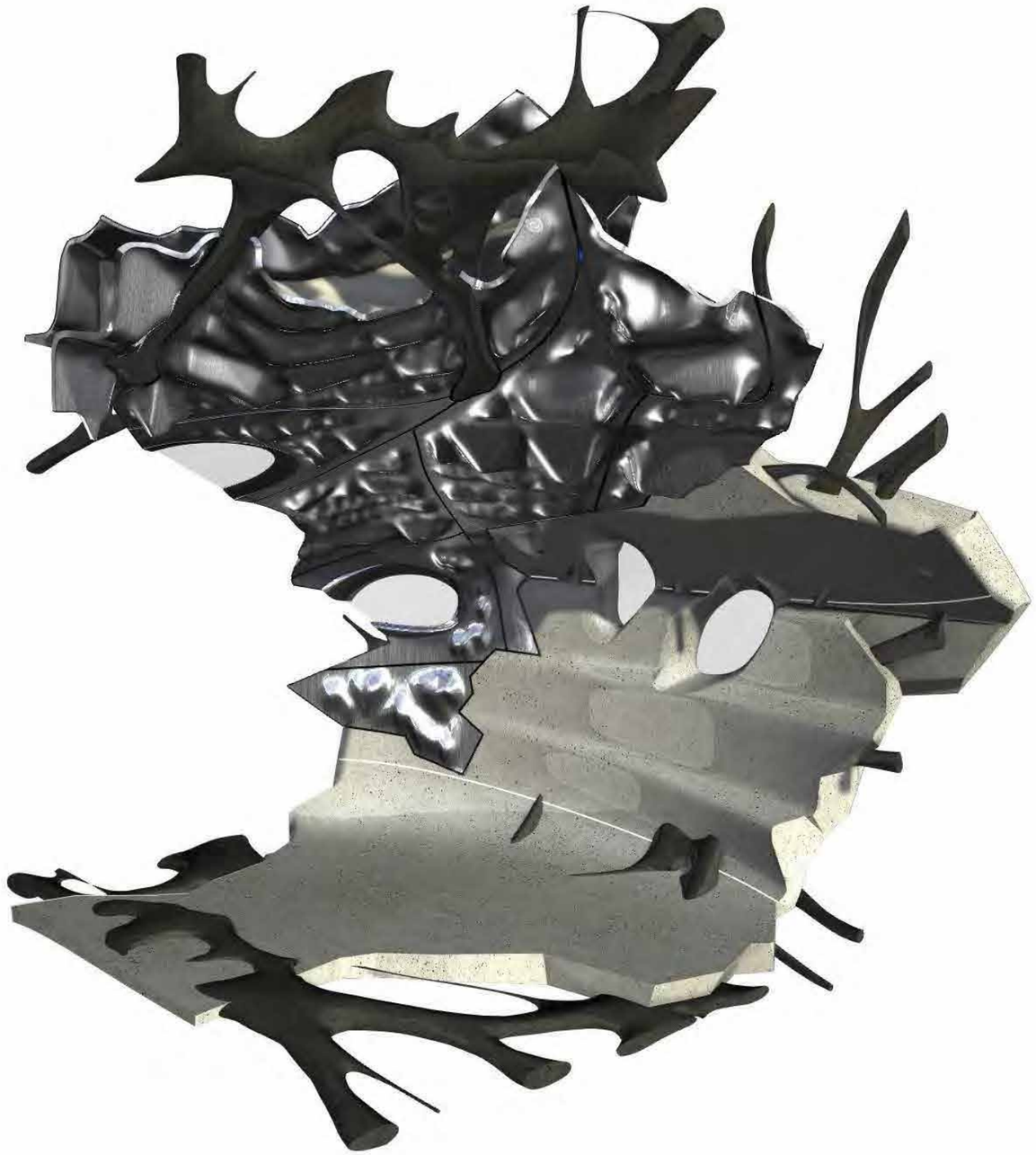


Pre-Mapped Materials Integration



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

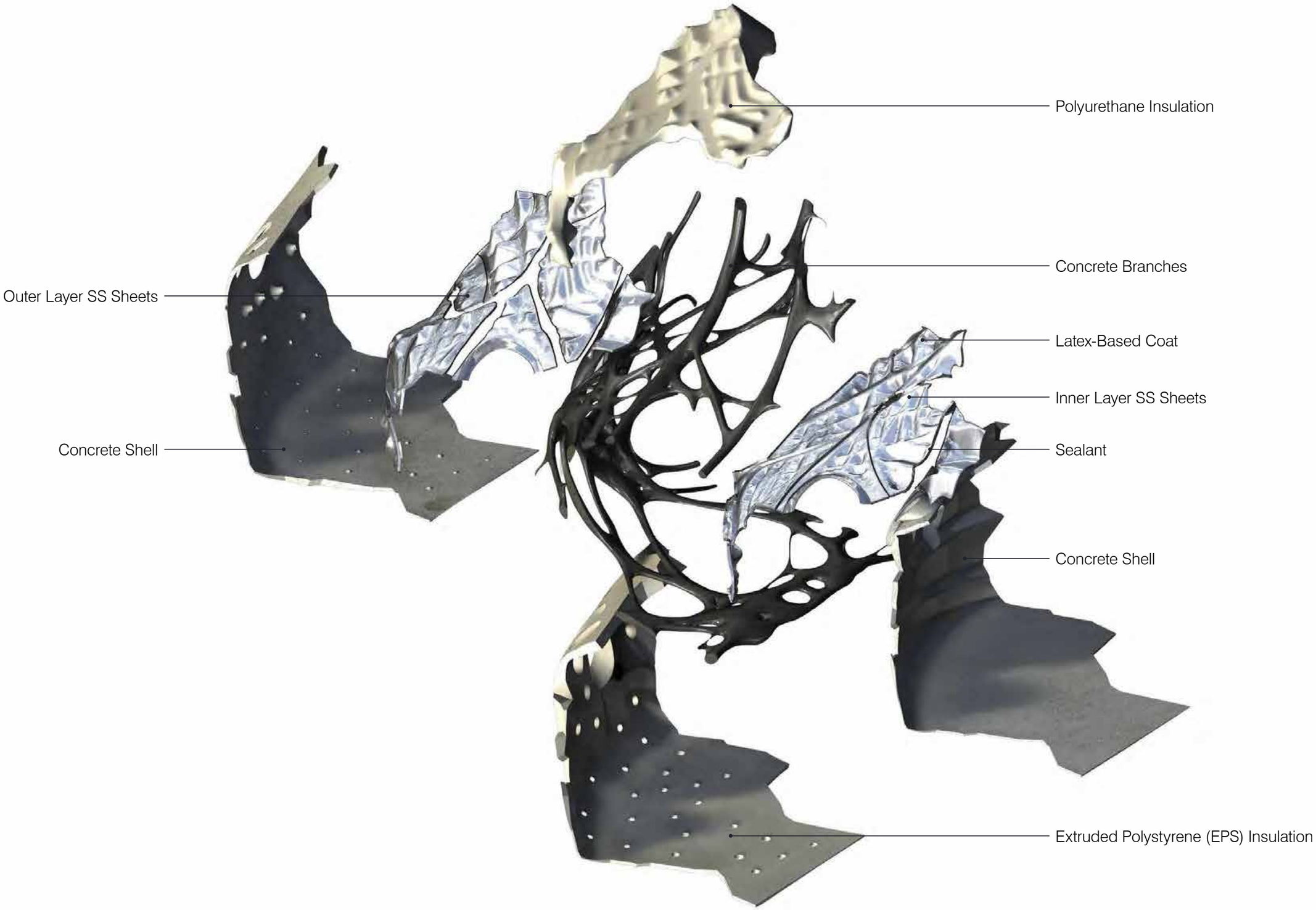
Stress Lines on Metal Sheets



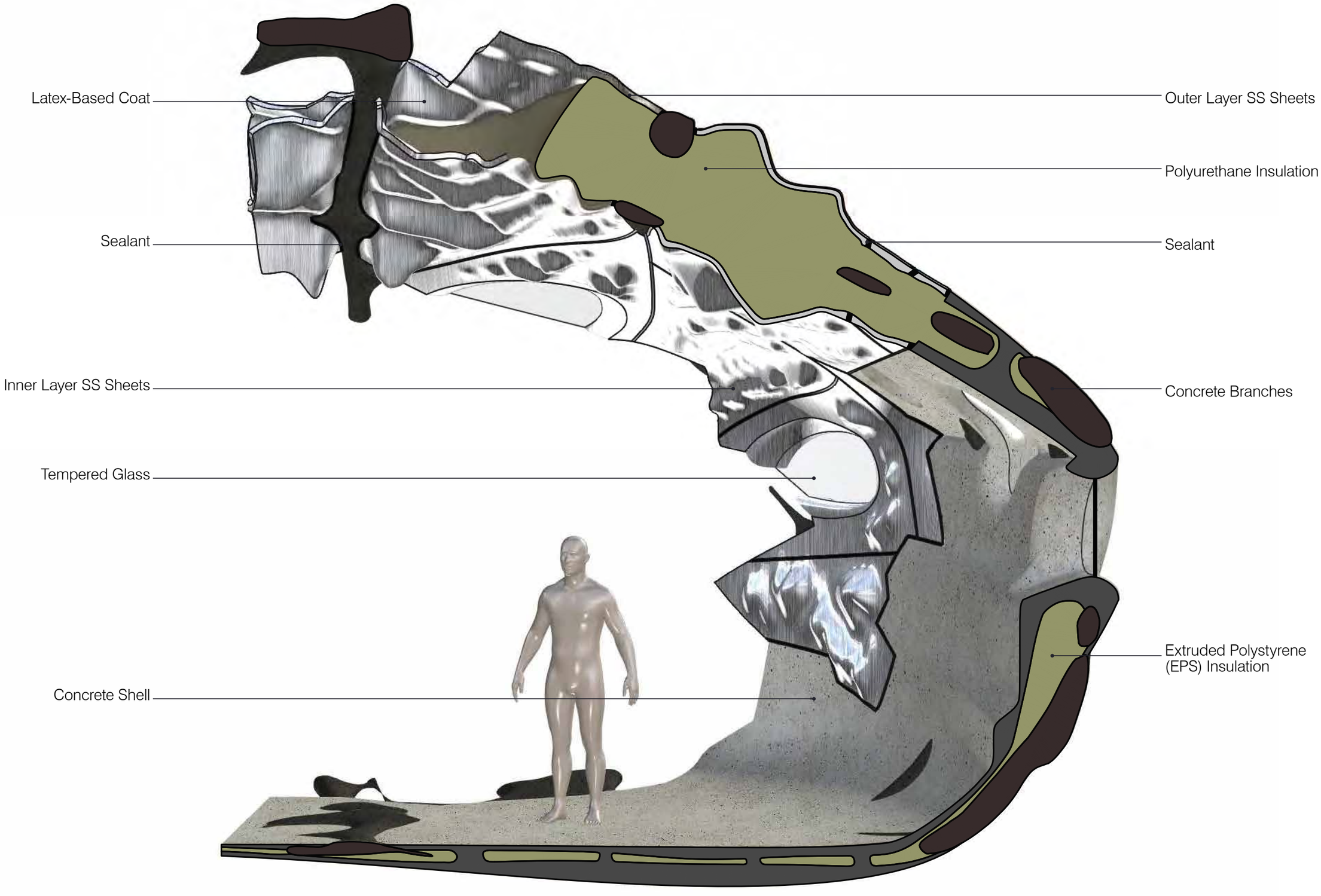
Structurally In-formed Stainless Steel Sheets

Structurally In-formed Stainless Steel Sheets

Materials Heirarchy



Materials Heirarchy



Sub-Fragment Section

DIVERGENT TECTONICS

Design Optimization to Robotic Production Framework