

P2

# HOW TO INTEGRATE SOFT ROBOTICS INTO BUILT ENVIRONMENT?

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5103908



*"The future of architecture will be soft and hairy." - Salvador Dalí*

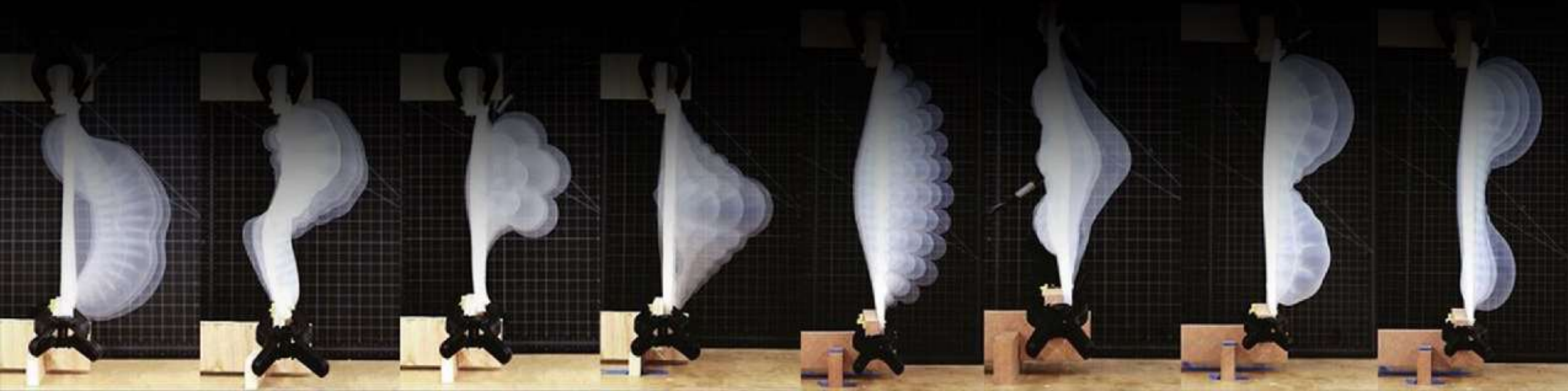
*"In listening to me, Le Corbusier had the look of one who had swallowed gall."*

*The occasion was a self-reported conversation that the ubiquitous surrealist artist had with that other unavoidable figure, Le Corbusier, in 1922.*

# SOFTSCAPE



*“Soft robotics is a general term that covers all types of active and reactive compliant systems ranging from soft actuators, soft stretchable sensors, soft energy harvesting, and even soft electronics. These machines are largely constructed from soft materials (e.g. silicone) and most commonly powered by flow of fluids (e.g. air and liquid).”*





ROBOTICS IN ARCHITECTURE

INFLATABLE ARCHITECTURE

**B**OLD

**P**LAYFUL

**I**NTERACTIVE

ATION

CIRCULATION

EXPERIENCES

FUNCTIONAL

FIGURABLE

SENSOR CONTROL

PHYSICAL + TEMPORAL

CIRCULATION

STATIC + DYNAMIC

HARD + SOFT

COMPUTATION

MOVEMENTS

FUNCT

ENCES

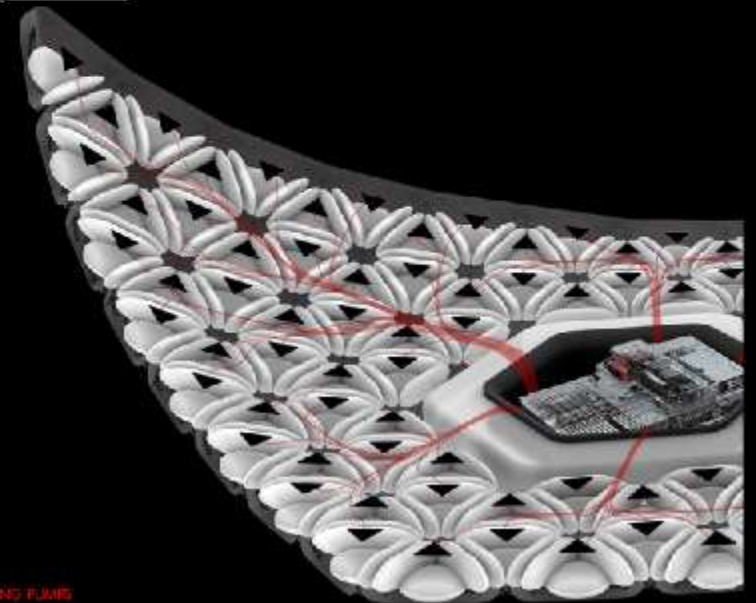
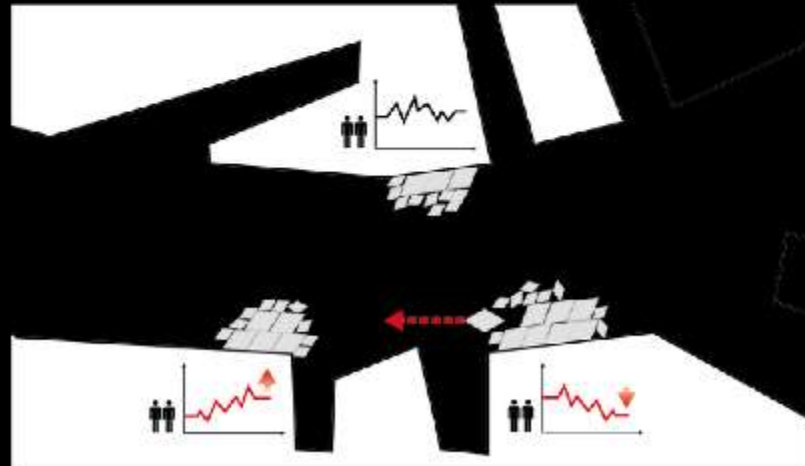
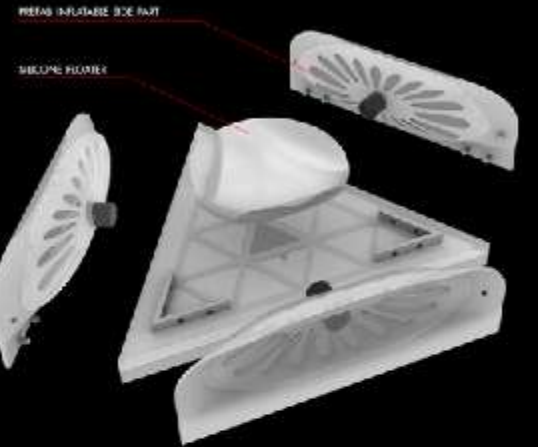
RECONFIGURABLE



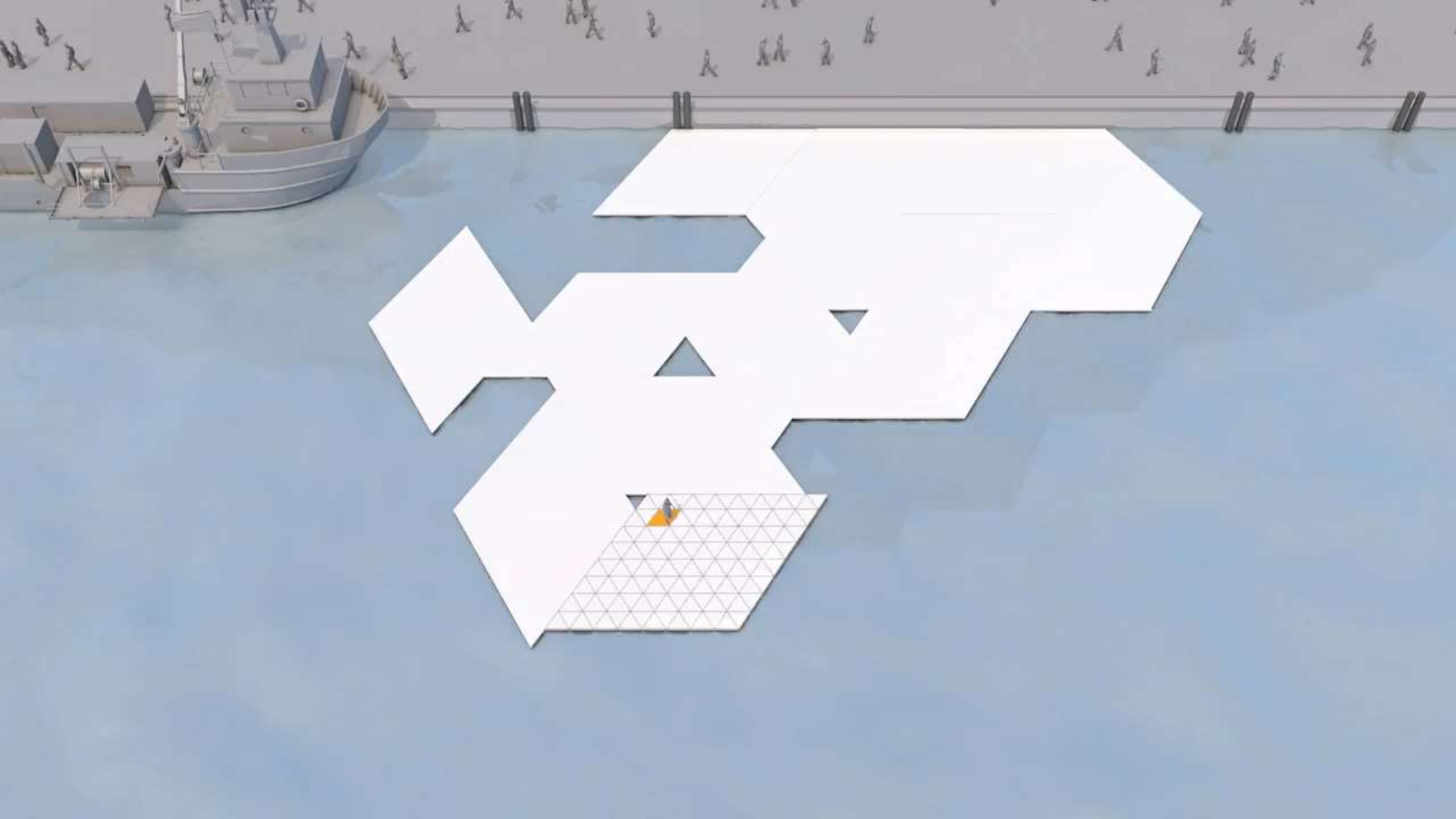




## SINGLE SEGMENT INGULMING



GLING PLAINS



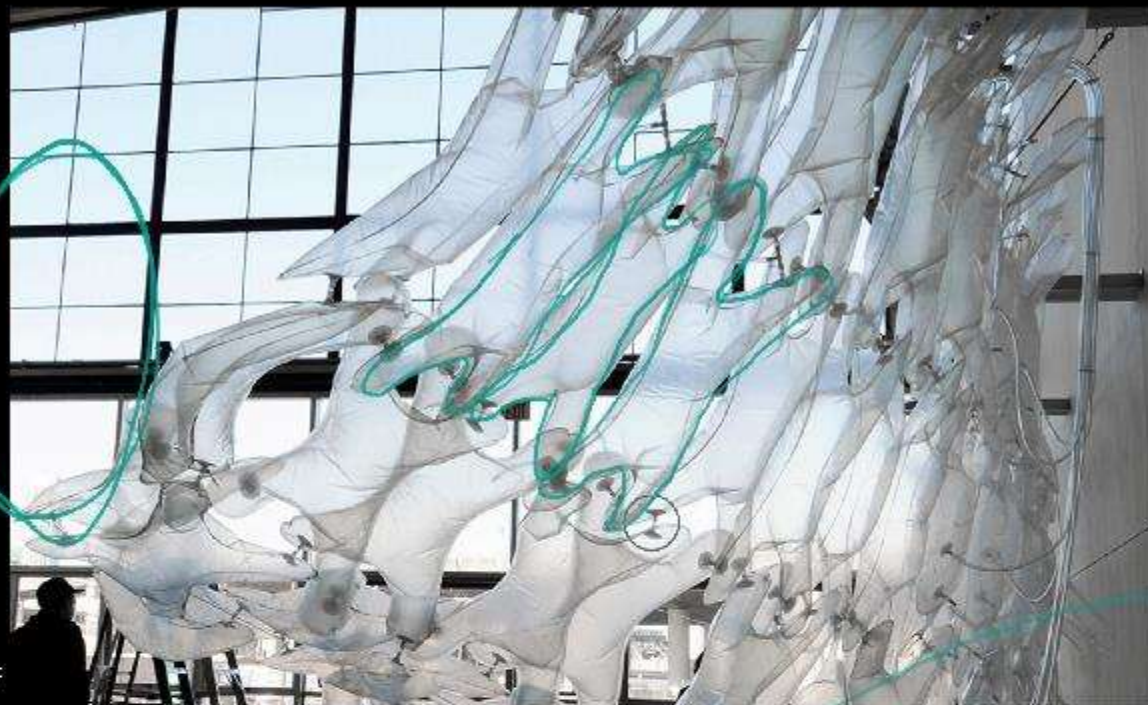
EXQUISITE CORPSE, ΔΔ



VOID FORMATION

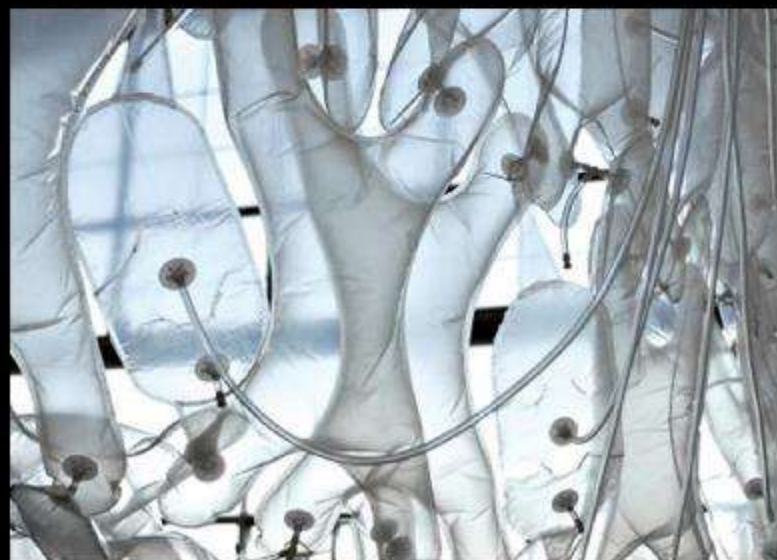


# NERVOUS ETHER

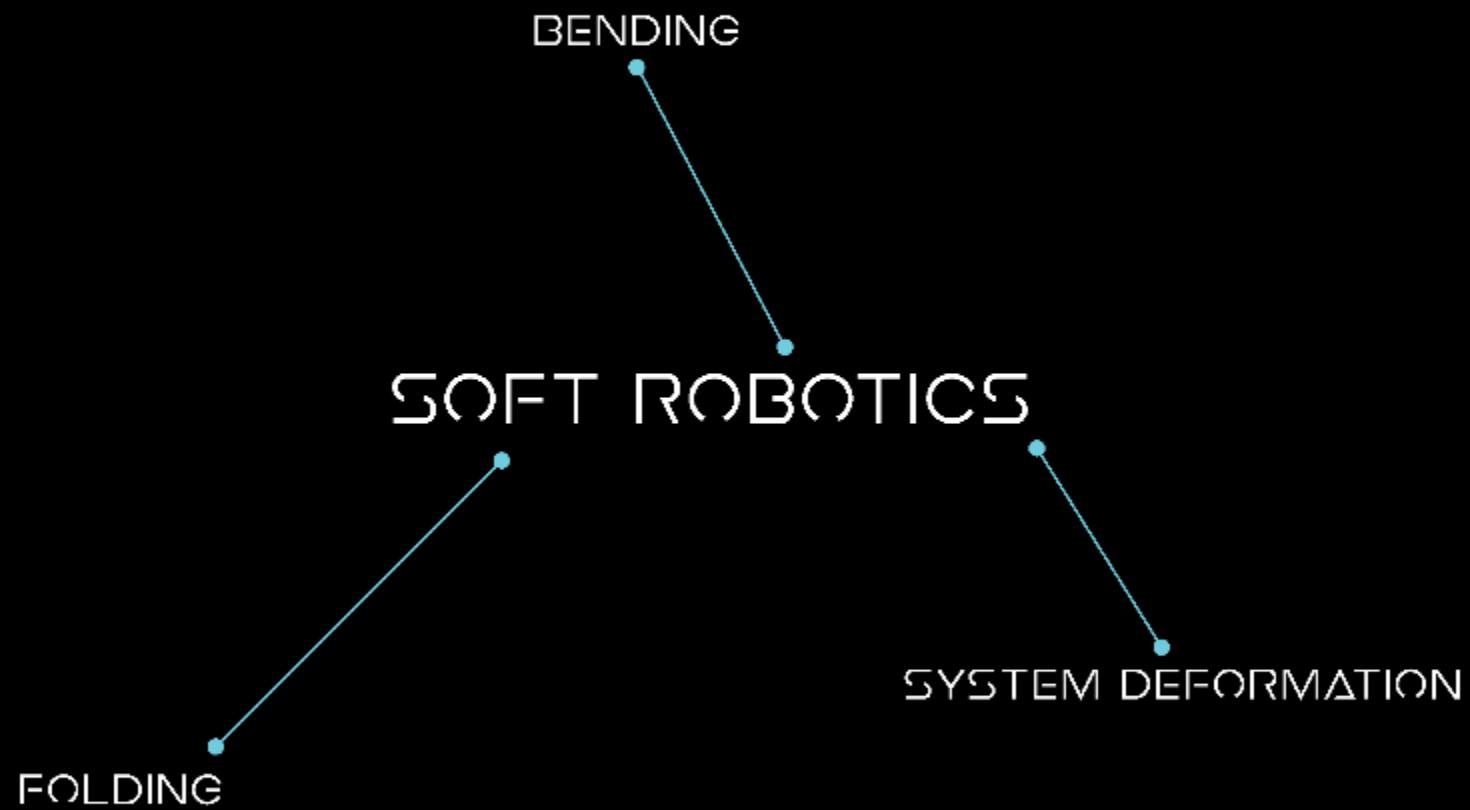


333 Summer Studio at the California College of the Arts in San Francisco, August 2013.

AIR PRESSURE SENSORS



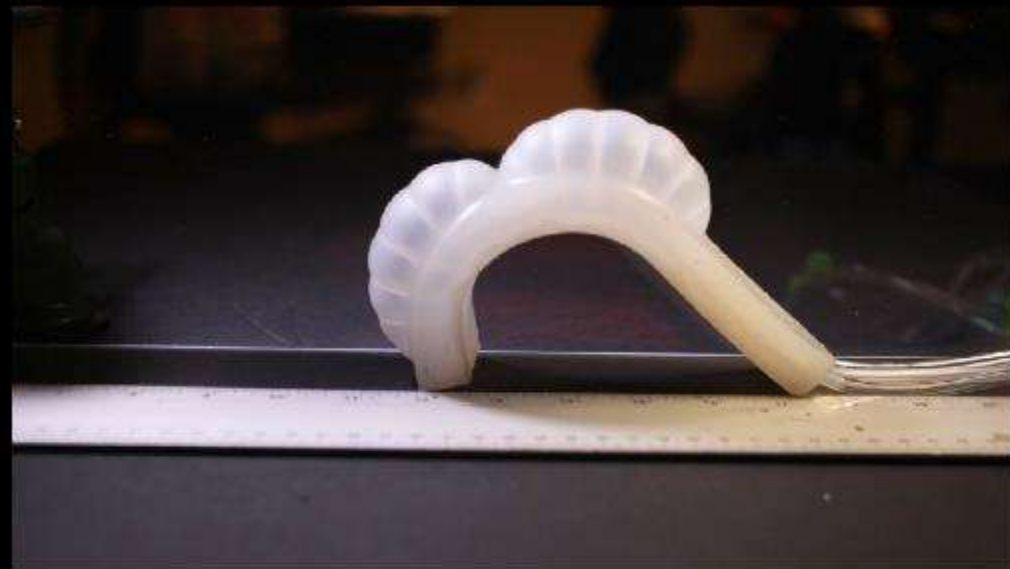
PROXIMITY SENSOR ON THE WINGS

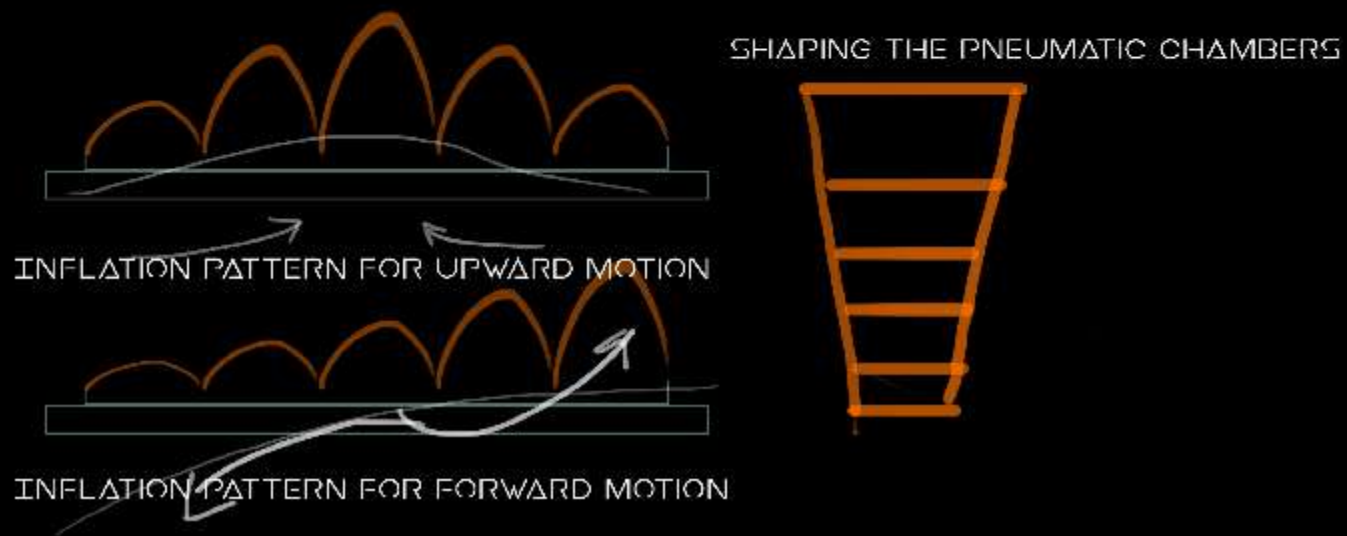
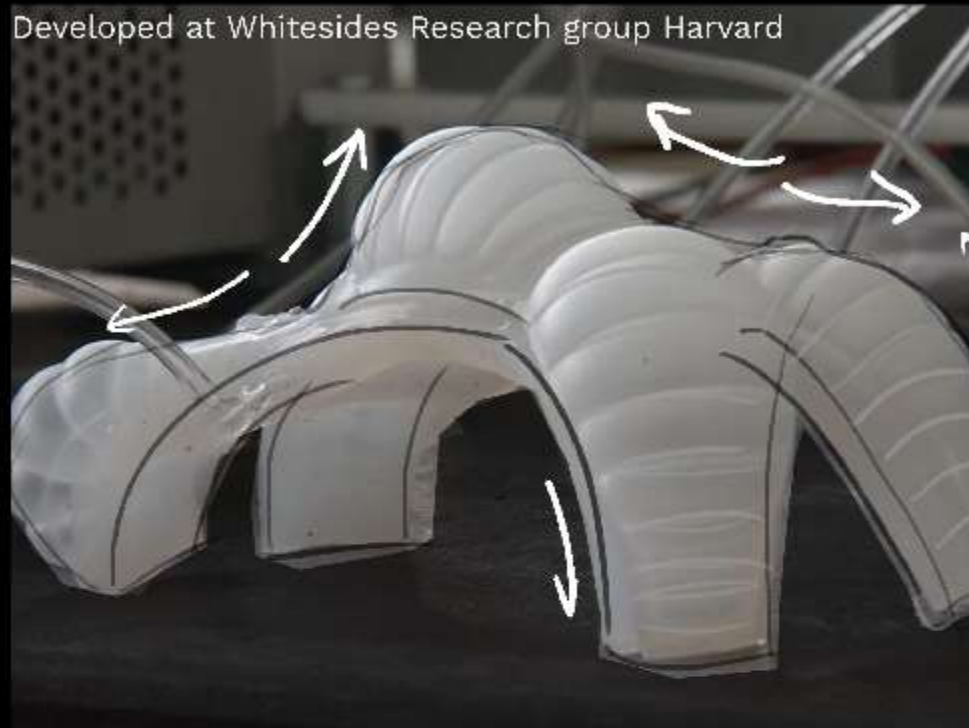
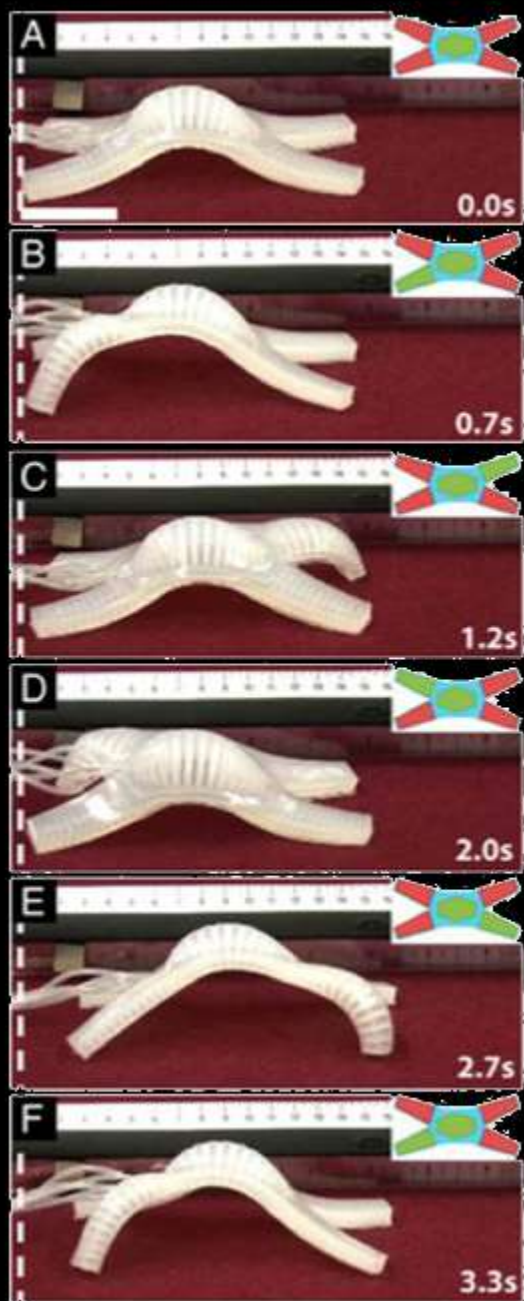


DESIGNED BEHAVIOUR

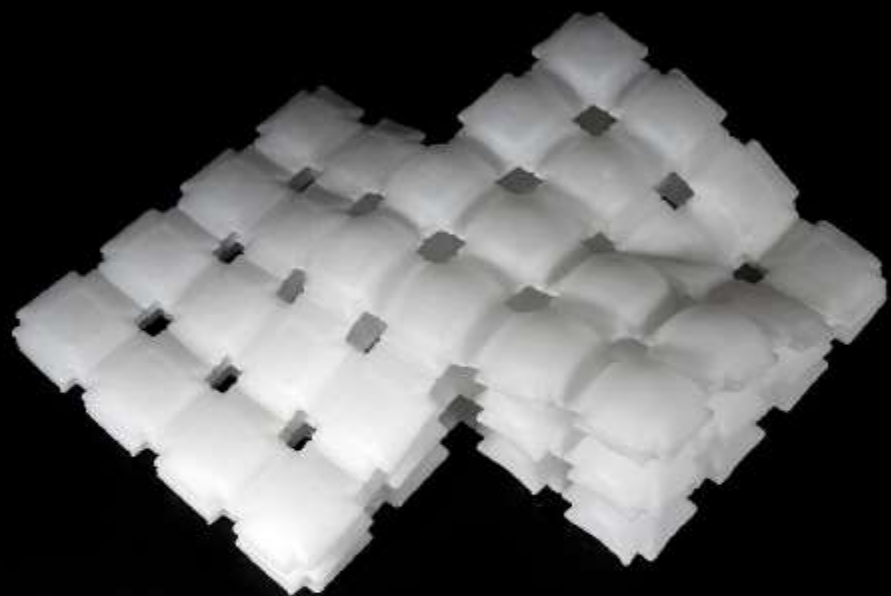


BENDING





DESIGNED BEHAVIOUR

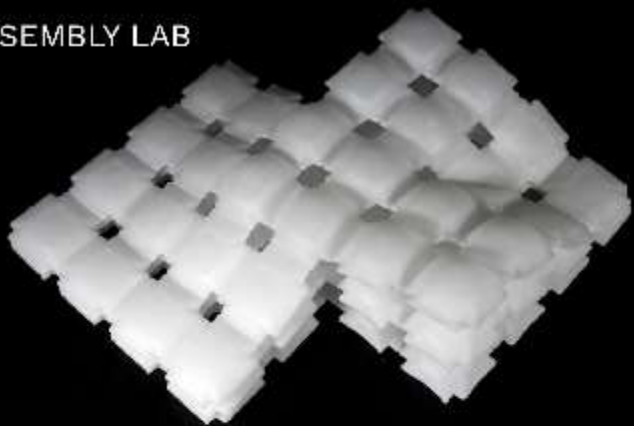


SYSTEM DEFORMATION





MIT SELF ASSEMBLY LAB



LAYERING OF INFLATABLE NETWORKS

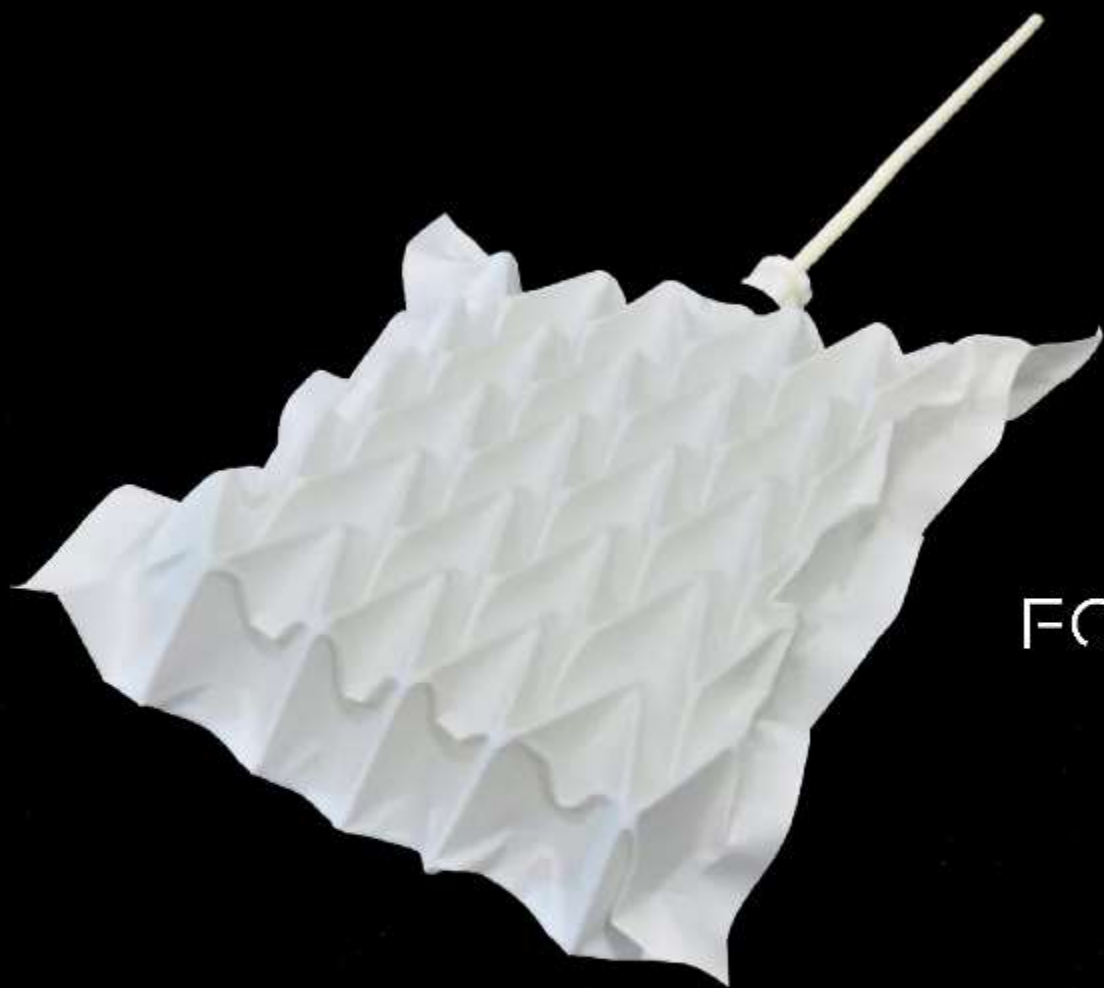


SPECULATED



VERTICAL CONNECTION

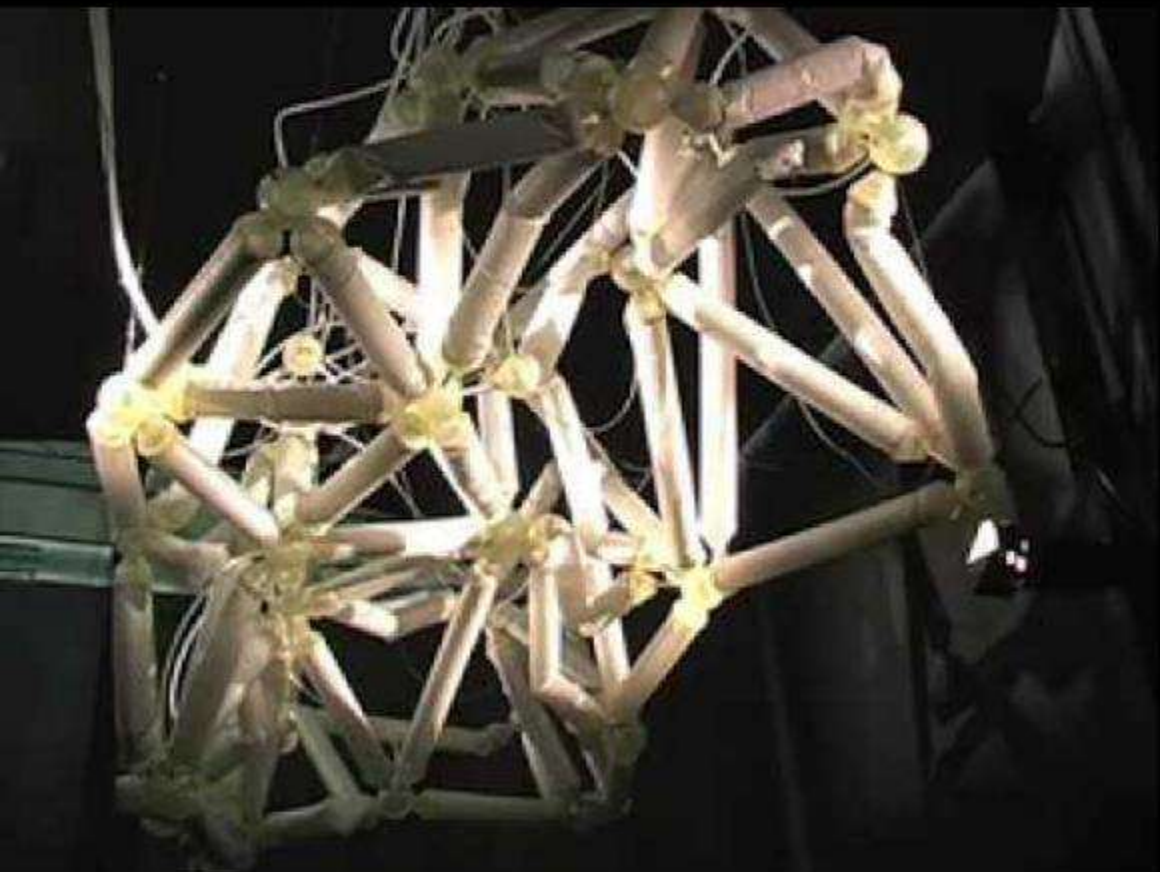




FOLDING

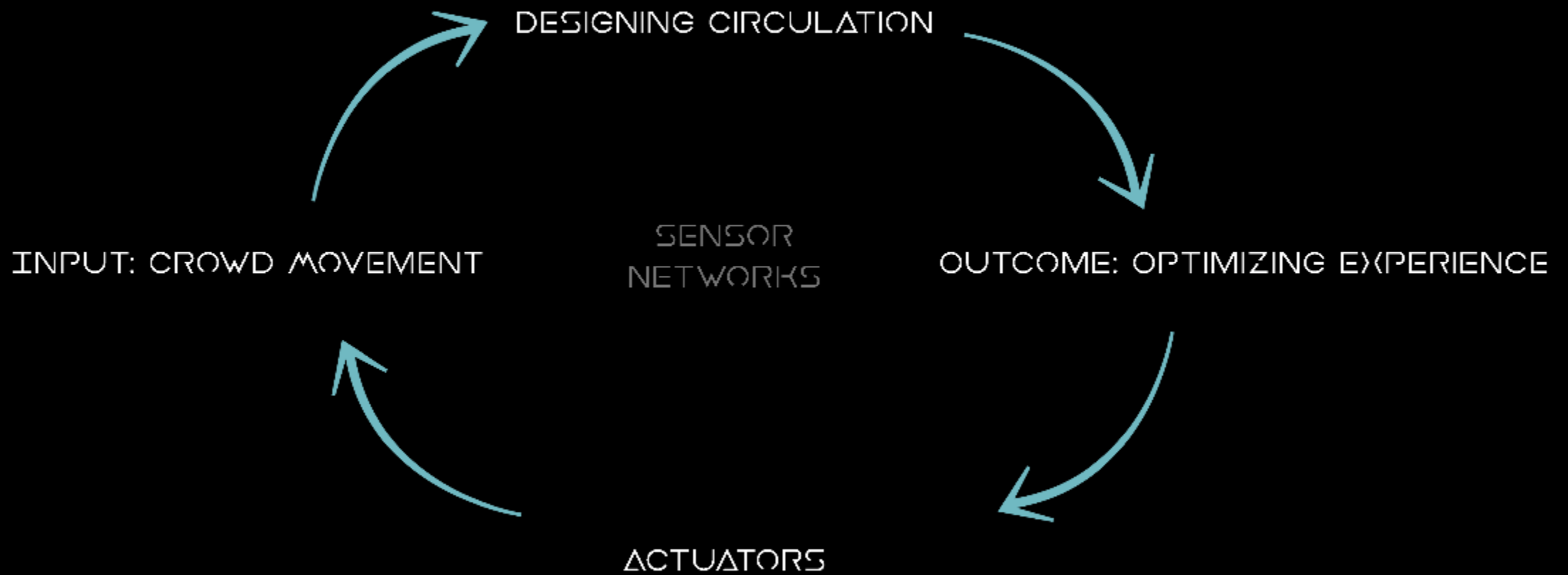


# SOFT ROBOTIC SYSTEM FOR SPATIAL DEFORMATION

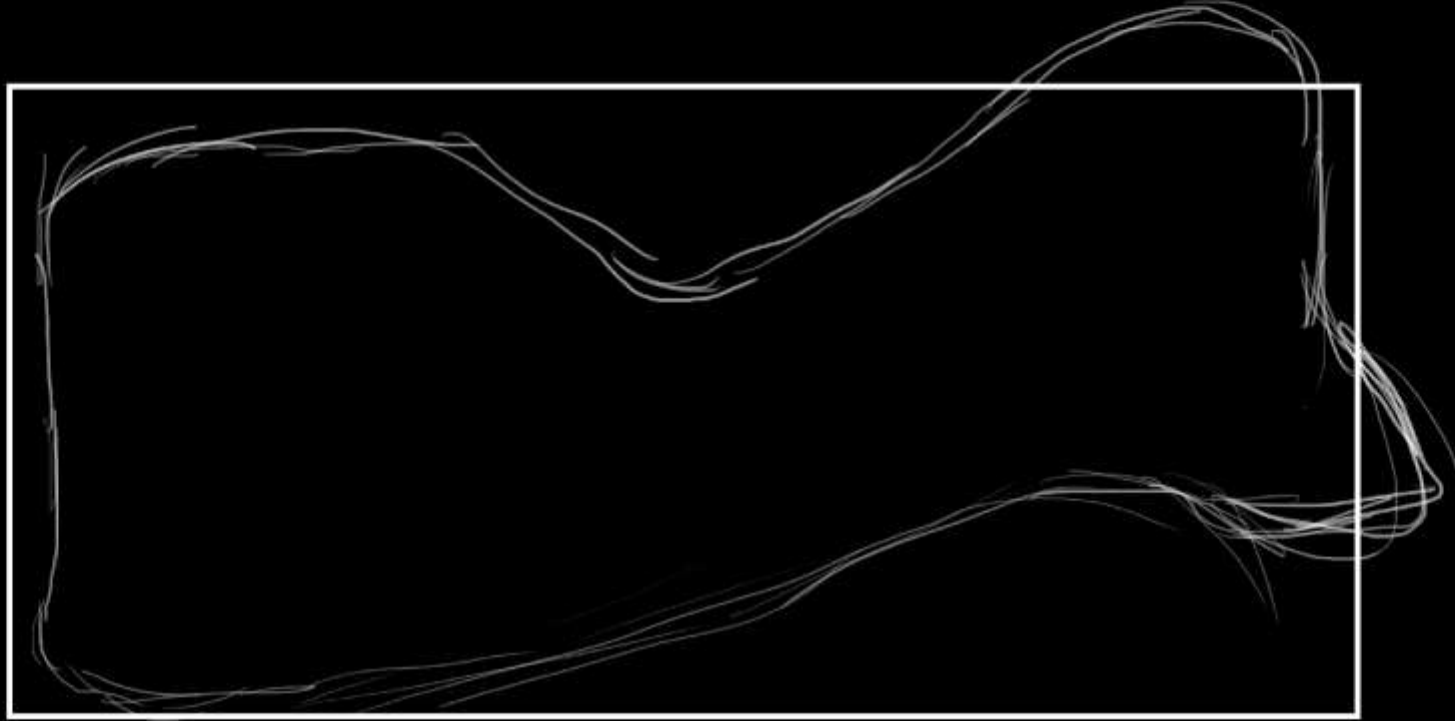




# ESTABLISHING A FEEDBACK LOOP



# SPATIAL HYBRIDITY INFORMED BY INDIRECT HUMAN INTERACTION







# LAYERS OF SPATIAL HYBRIDITY

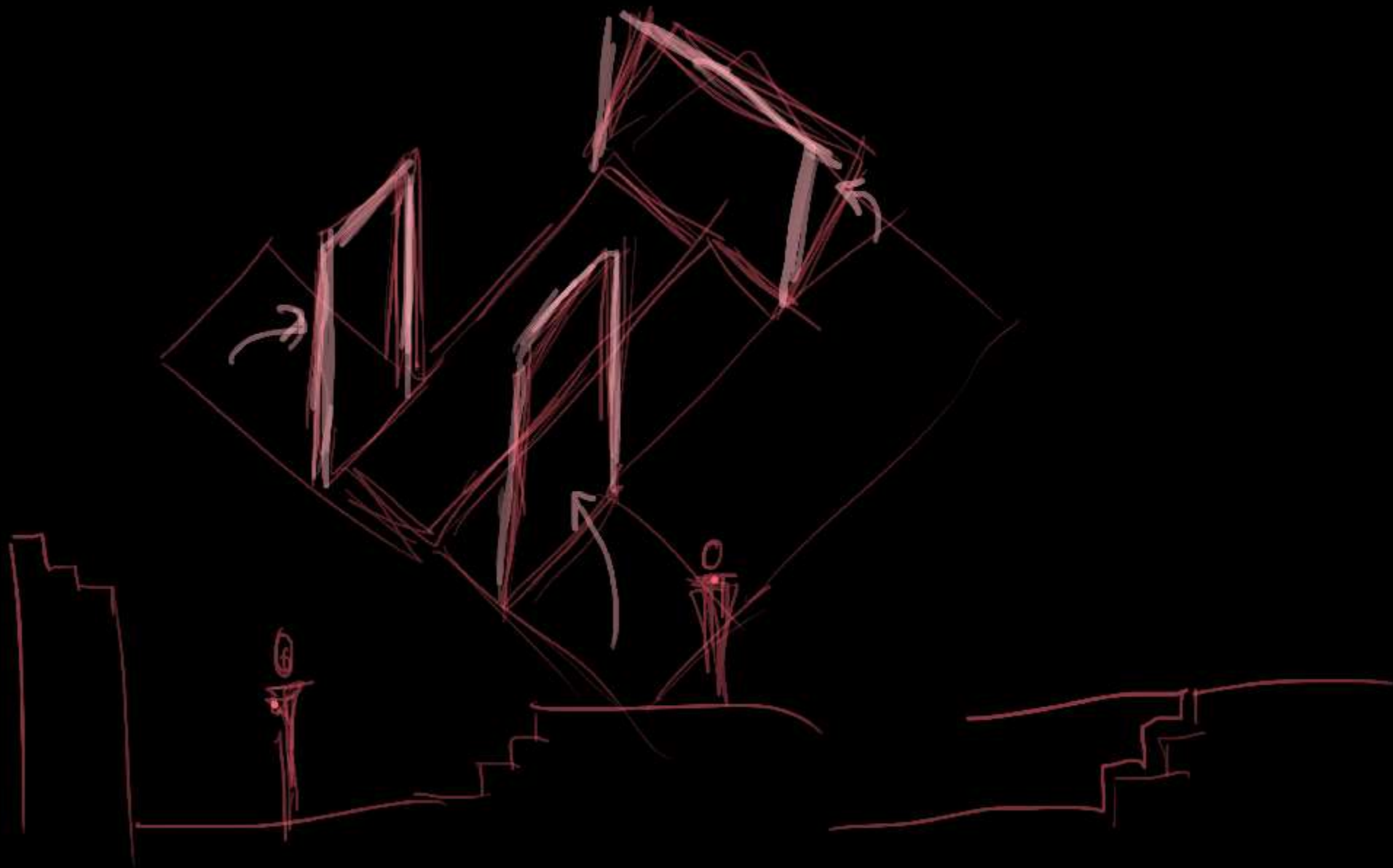
1. MATERIAL INTELLIGENCE

2. RESPONSIVE

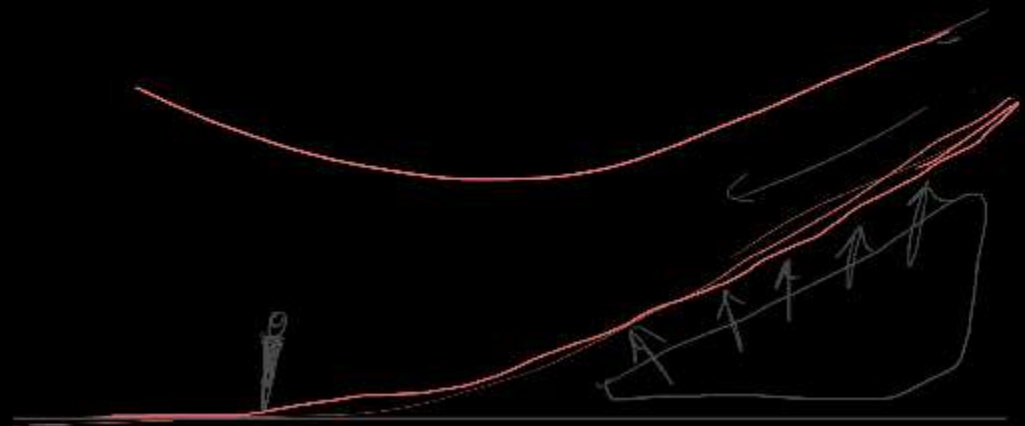
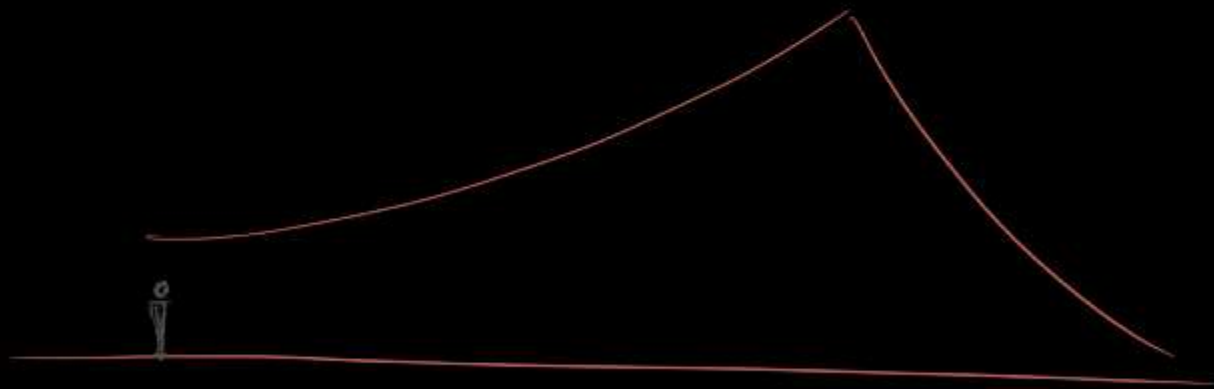
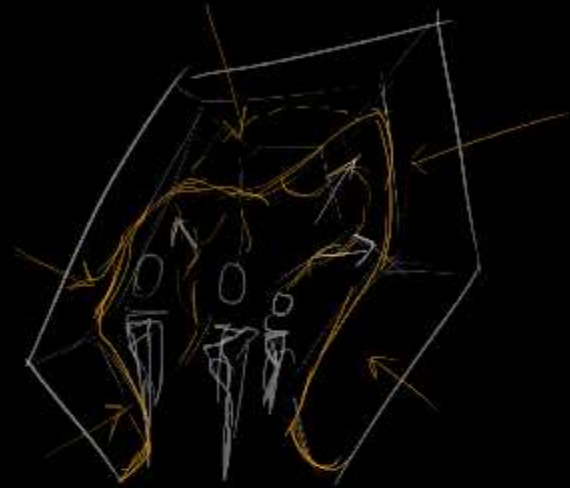
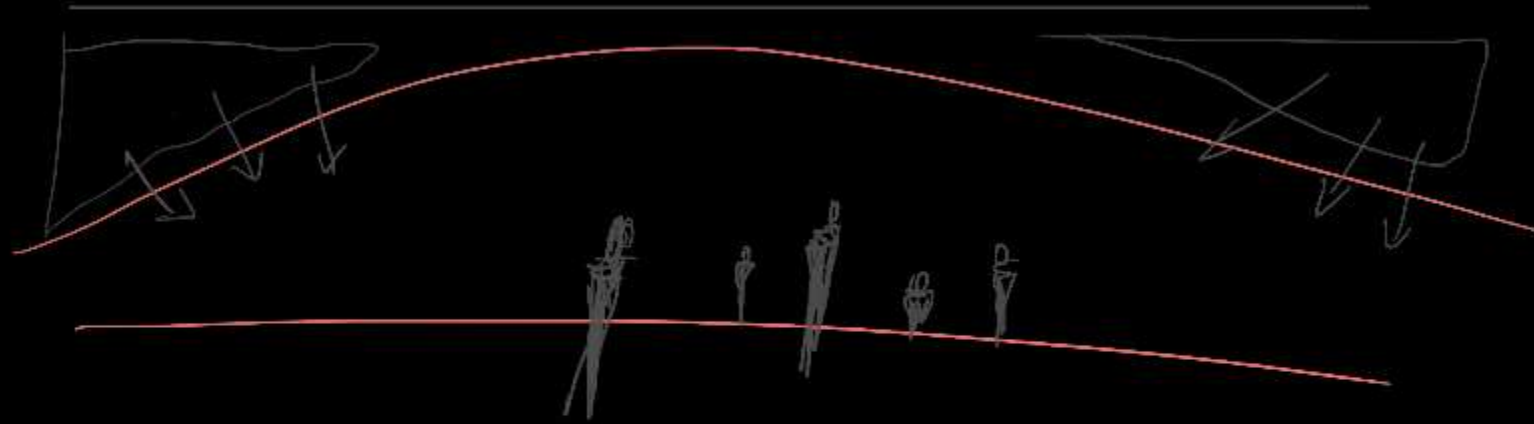
3. IMMERSIVE

4. INTERACTIVE

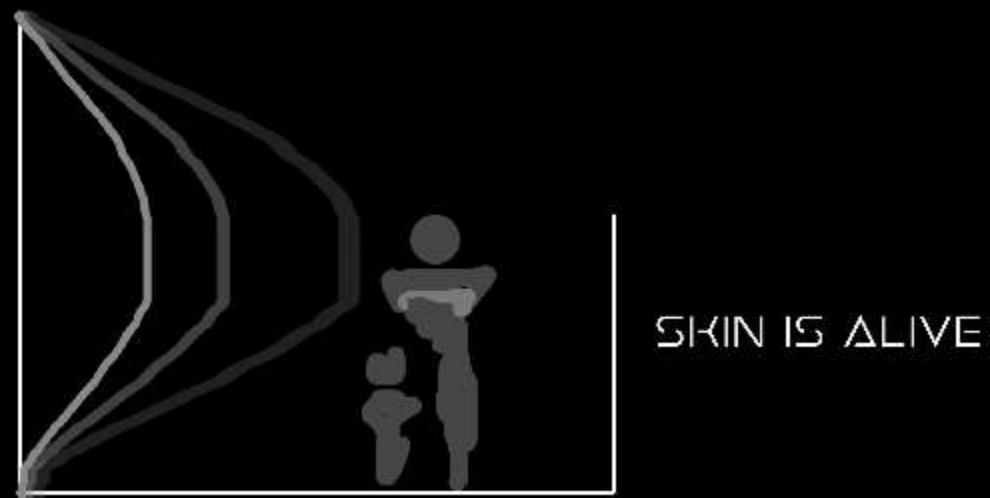
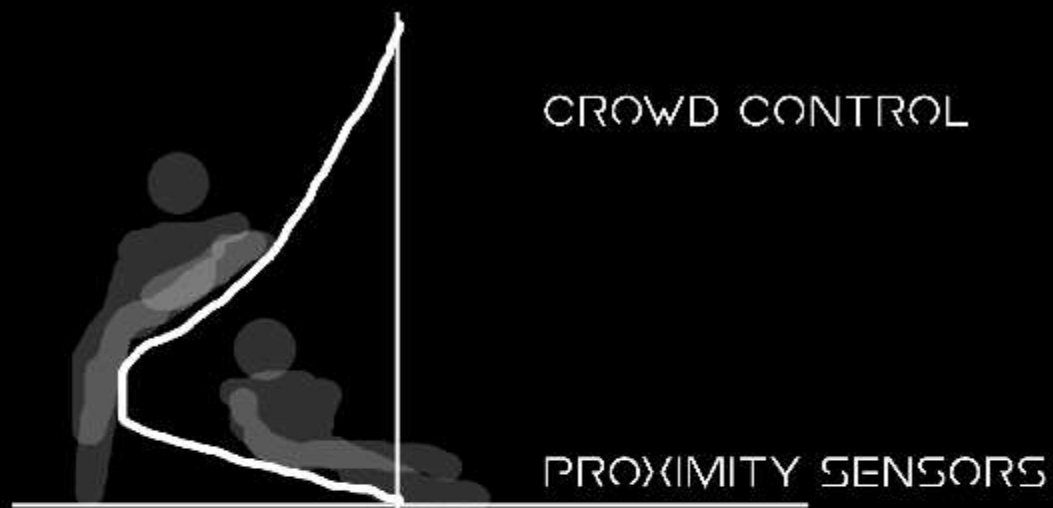
# RECONFIGURABLE WALLS



# SPATIAL ALTERATION SPECULATION SKETCHES



CHARACTER\_PERFORMATIVE\_RESPONSIVE



# FUNCTIONAL APPLICATIONS

TERRAIN

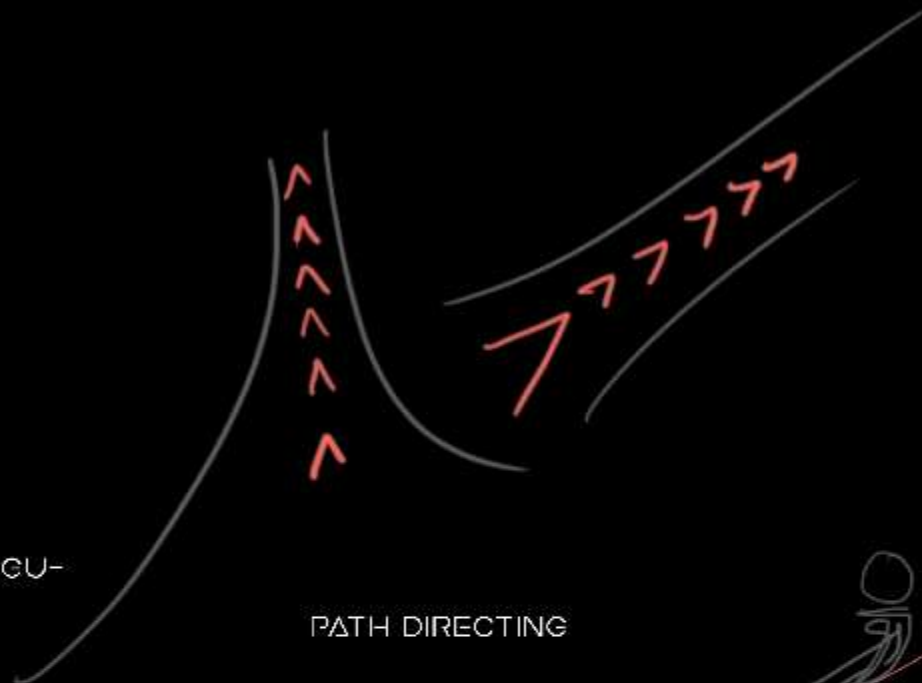
SEATING

CORRIDOR

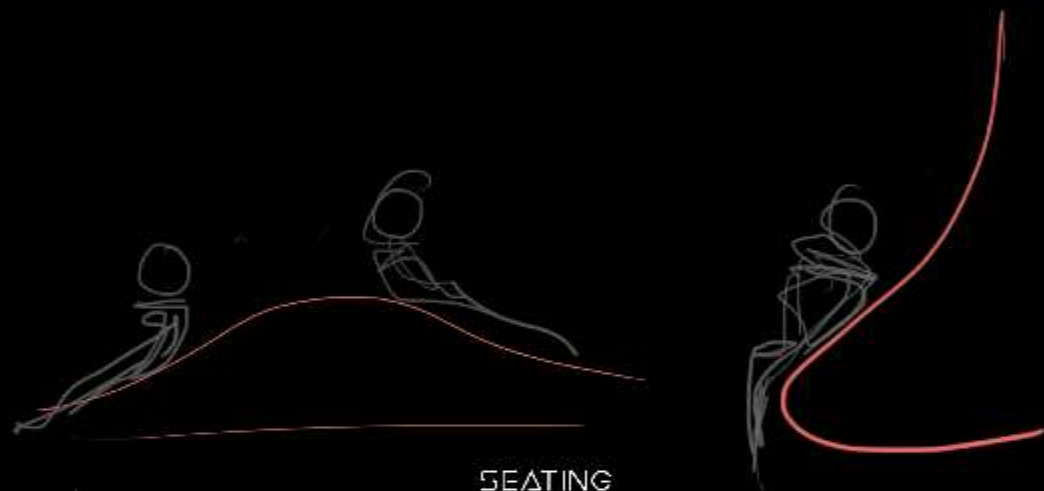
PATH DIRECTING

PLAYGROUND

INSIDE TO OUTSIDE EXPERIENCE / RECONFIGURABLE WALLS



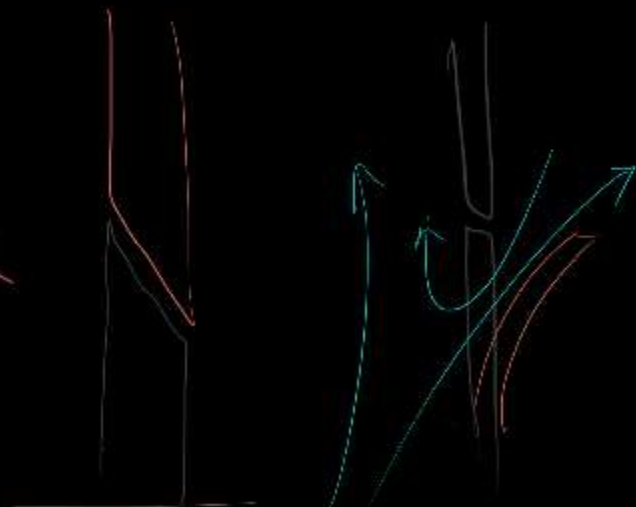
PATH DIRECTING



SEATING



TERRAIN

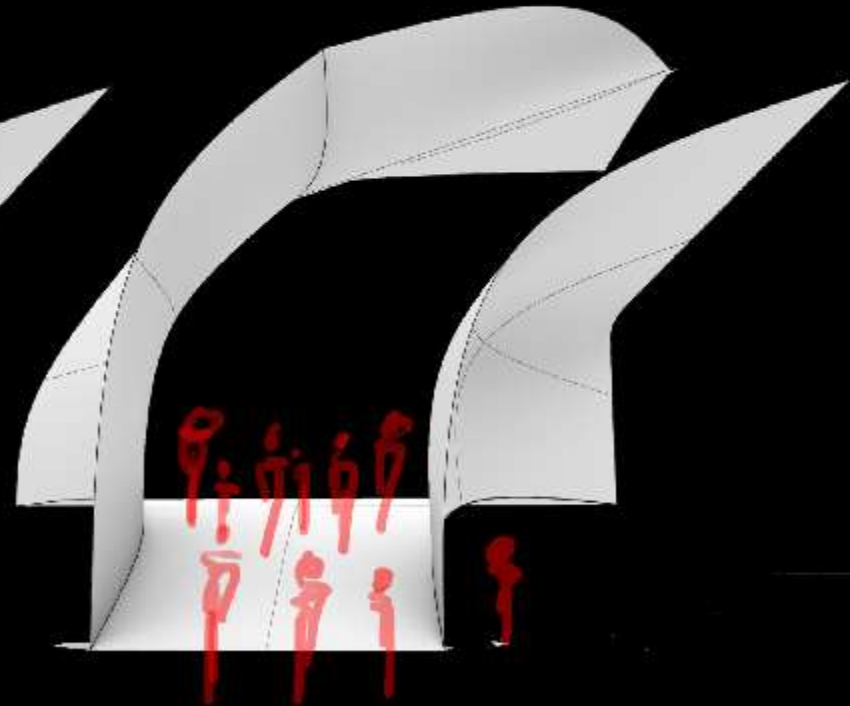
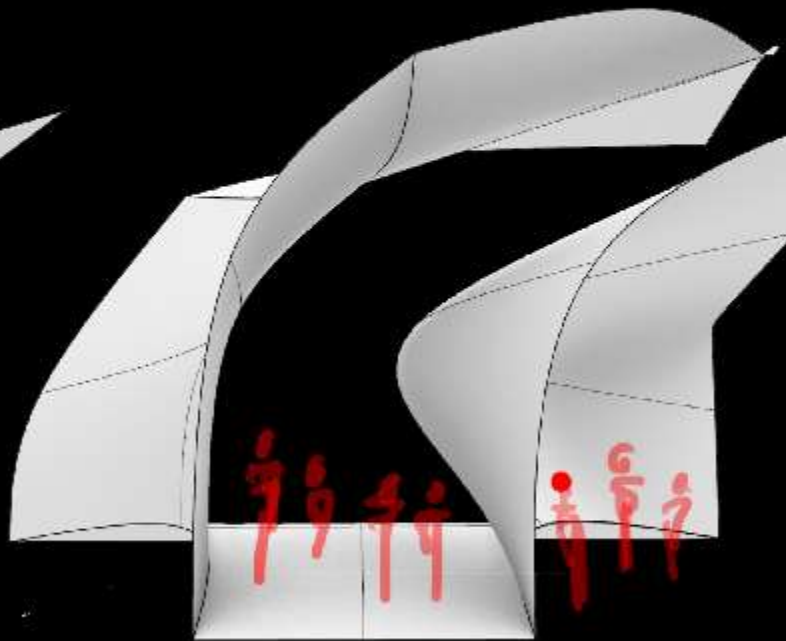
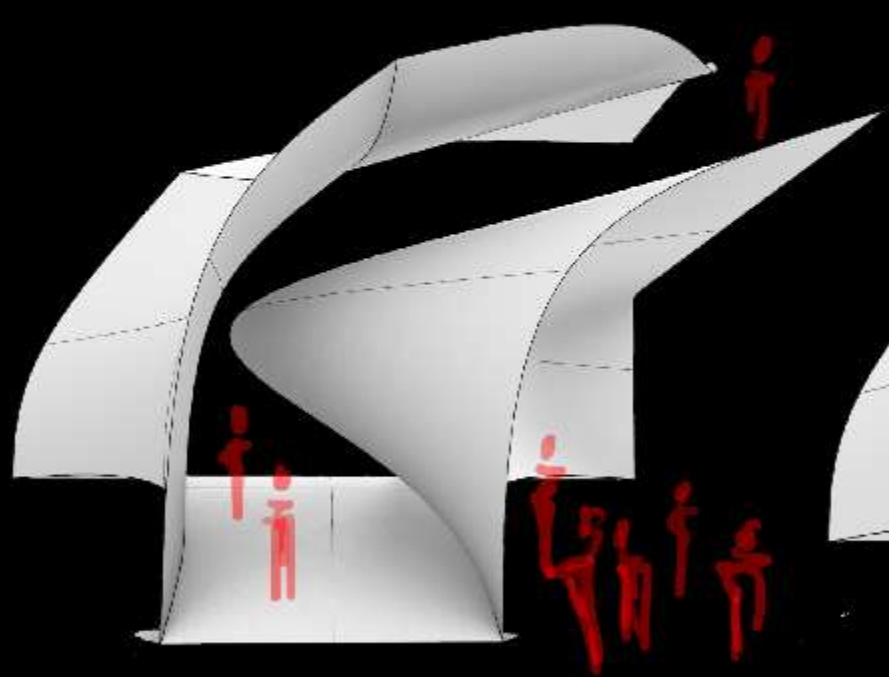


RECONFIGURABLE WALLS



PLAYGROUND

# MATERIAL AS AN INTERFACE

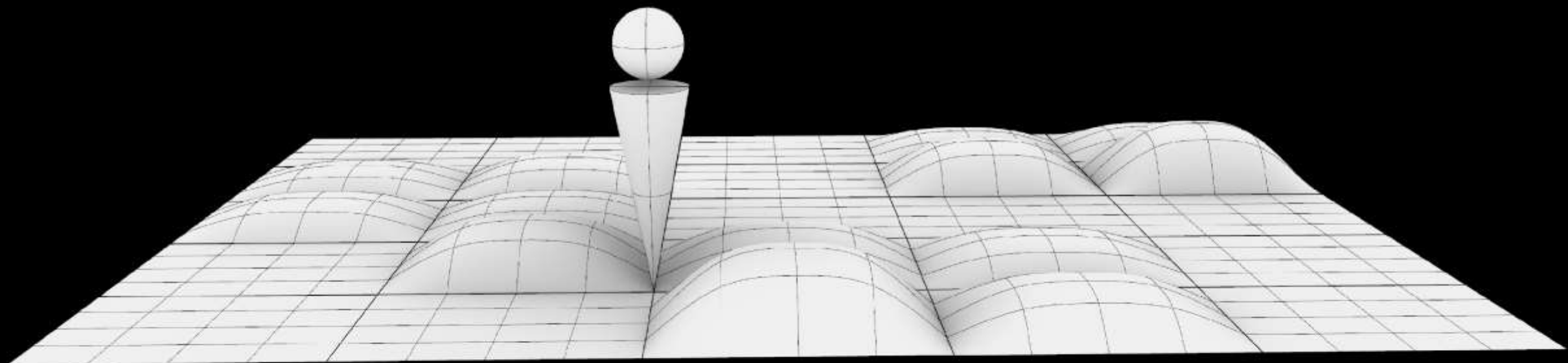


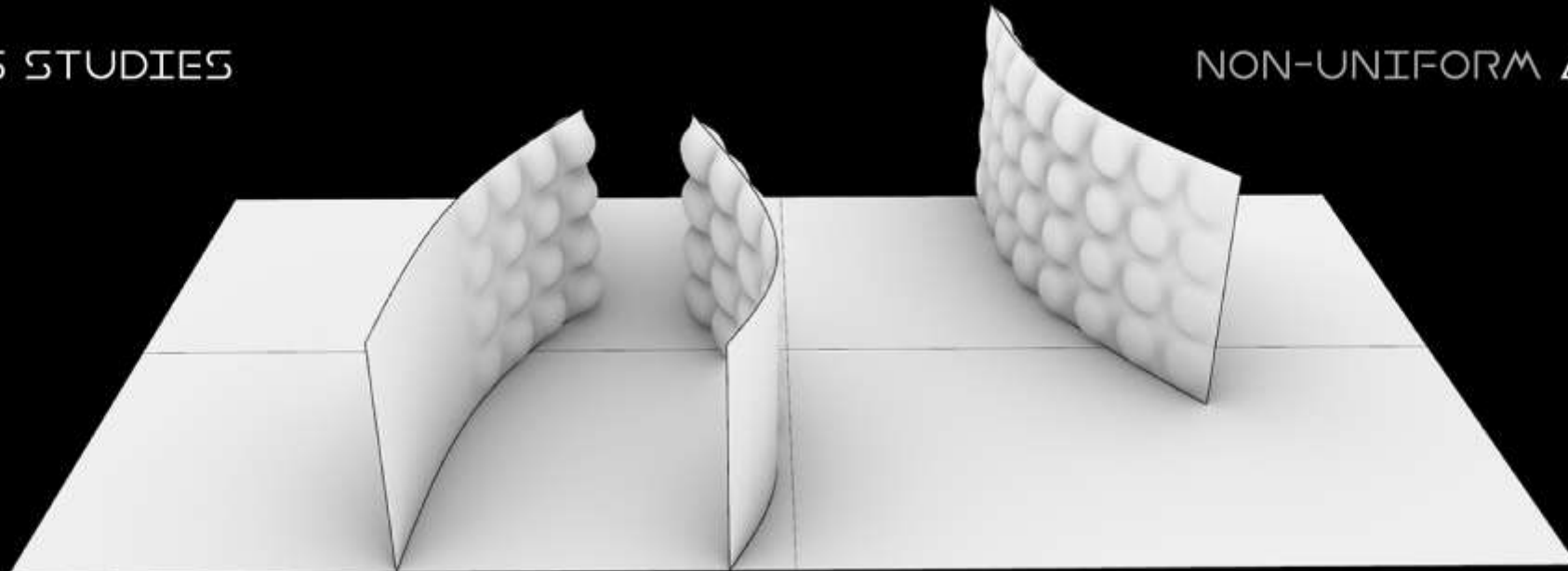
# SOFT ROBOTICS STUDIES



UNIFORM ACTUATION

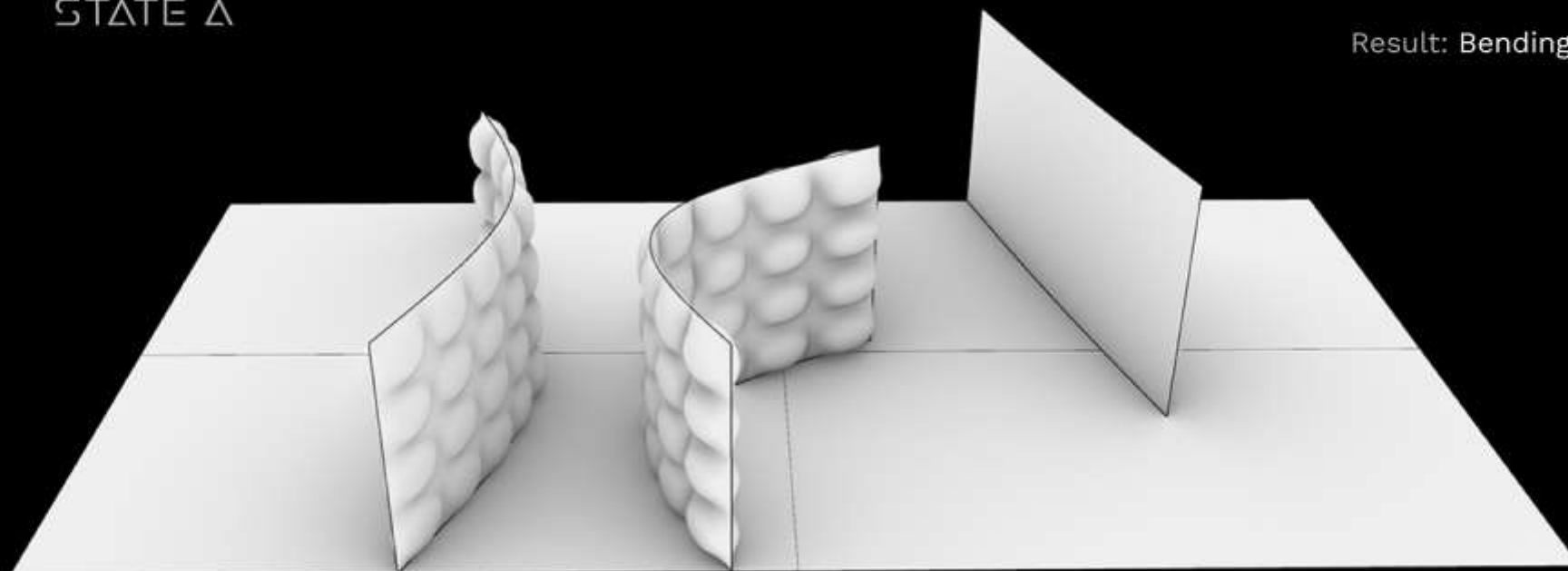
Result: Landscape





STATE A

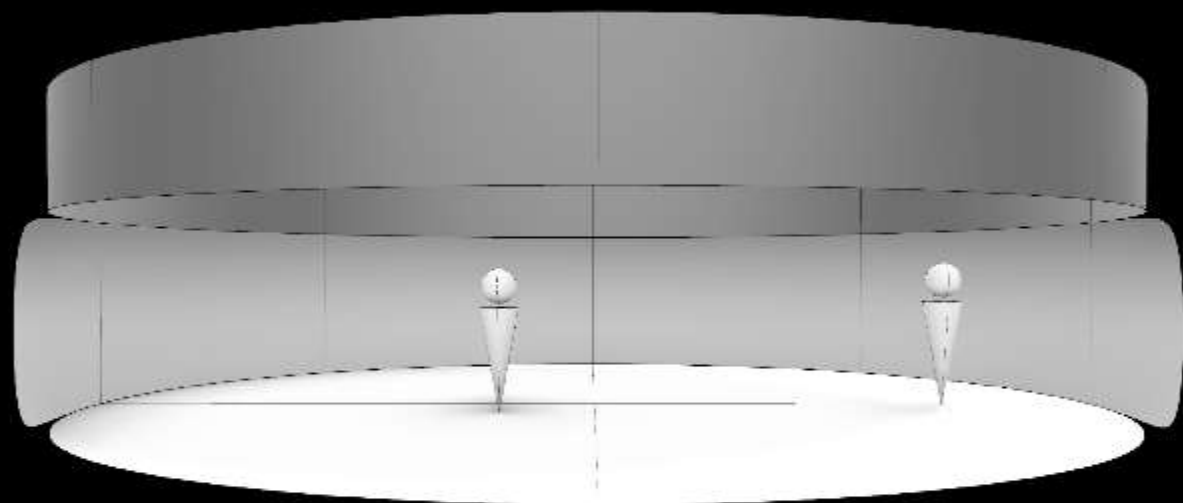
Result: Bending



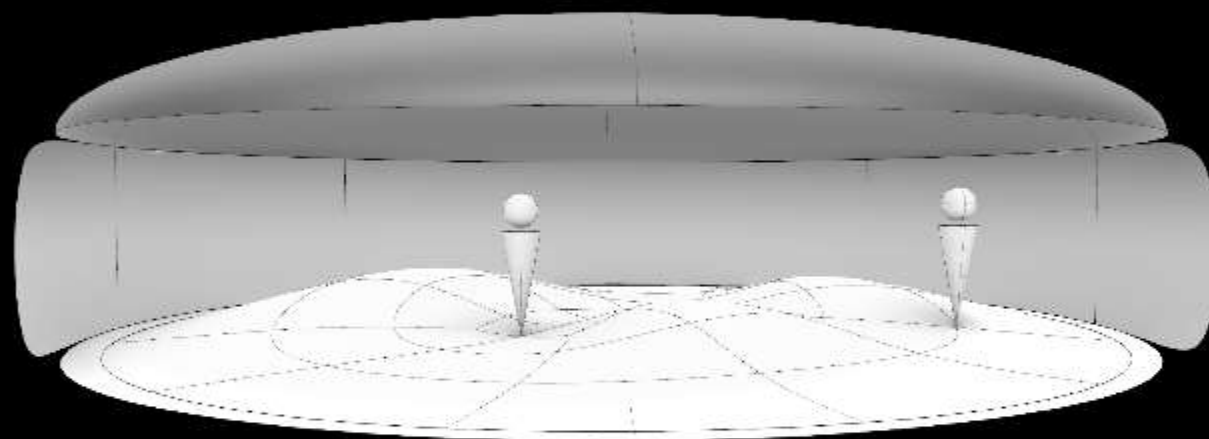
STATE B

# ACTUATION: VOLUME ELEMENTS

Result: Dome formation  
Interactive Volume



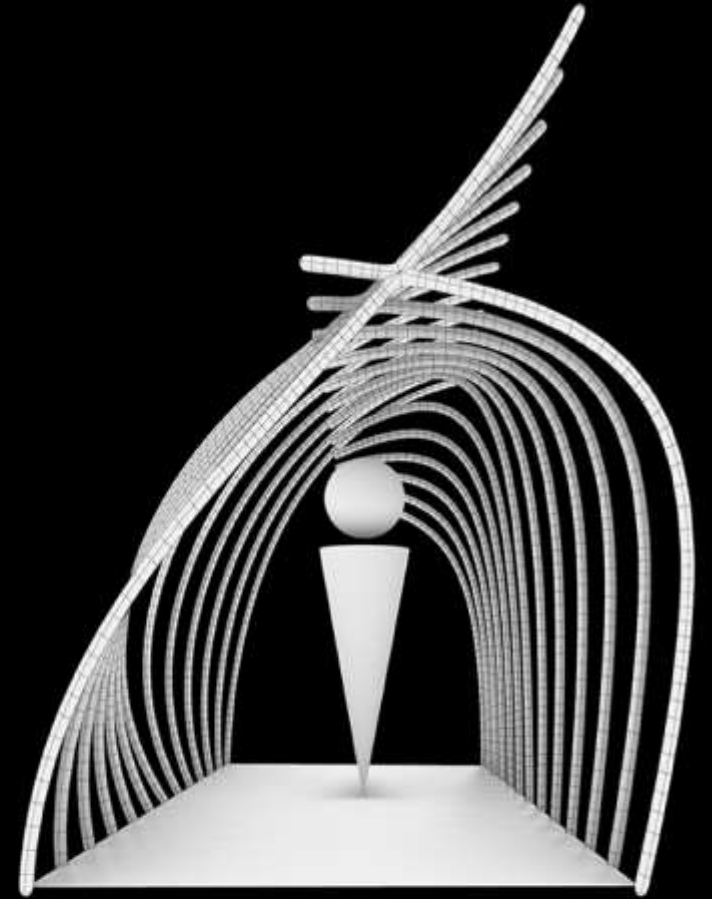
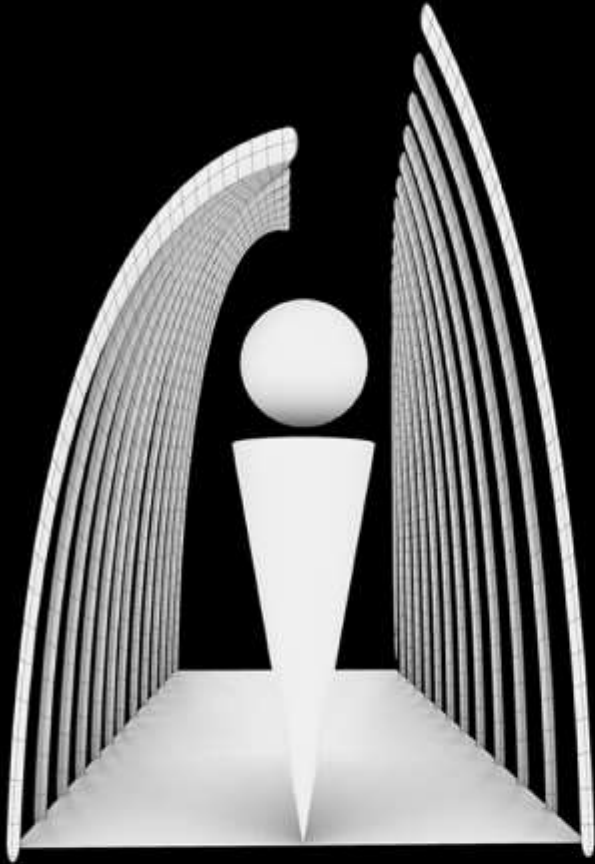
STATE A



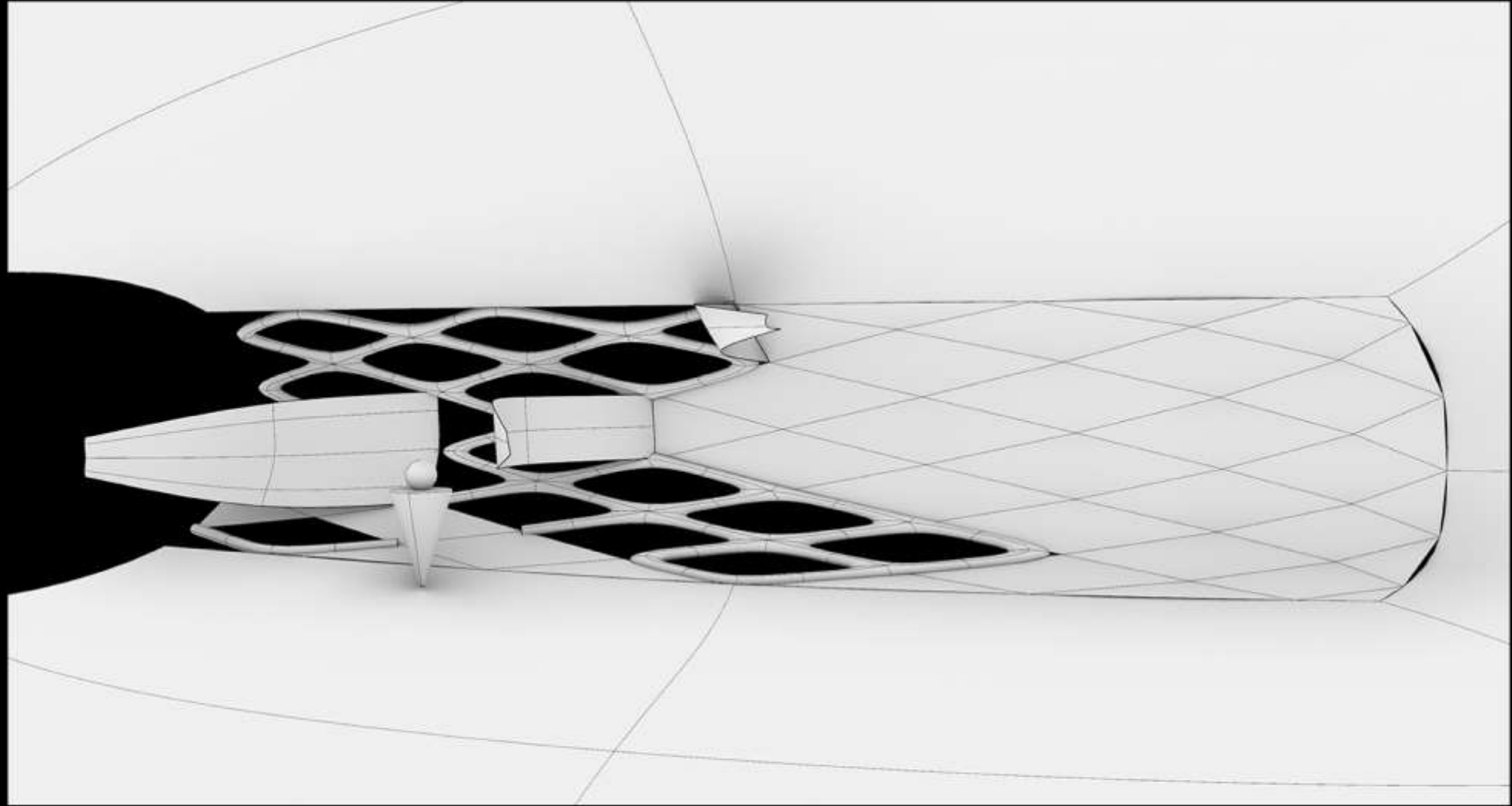
STATE B

## ACTUATION: SLENDER ELEMENTS

Result: Movement restricted to bending  
More combinations possible  
More responsive to user

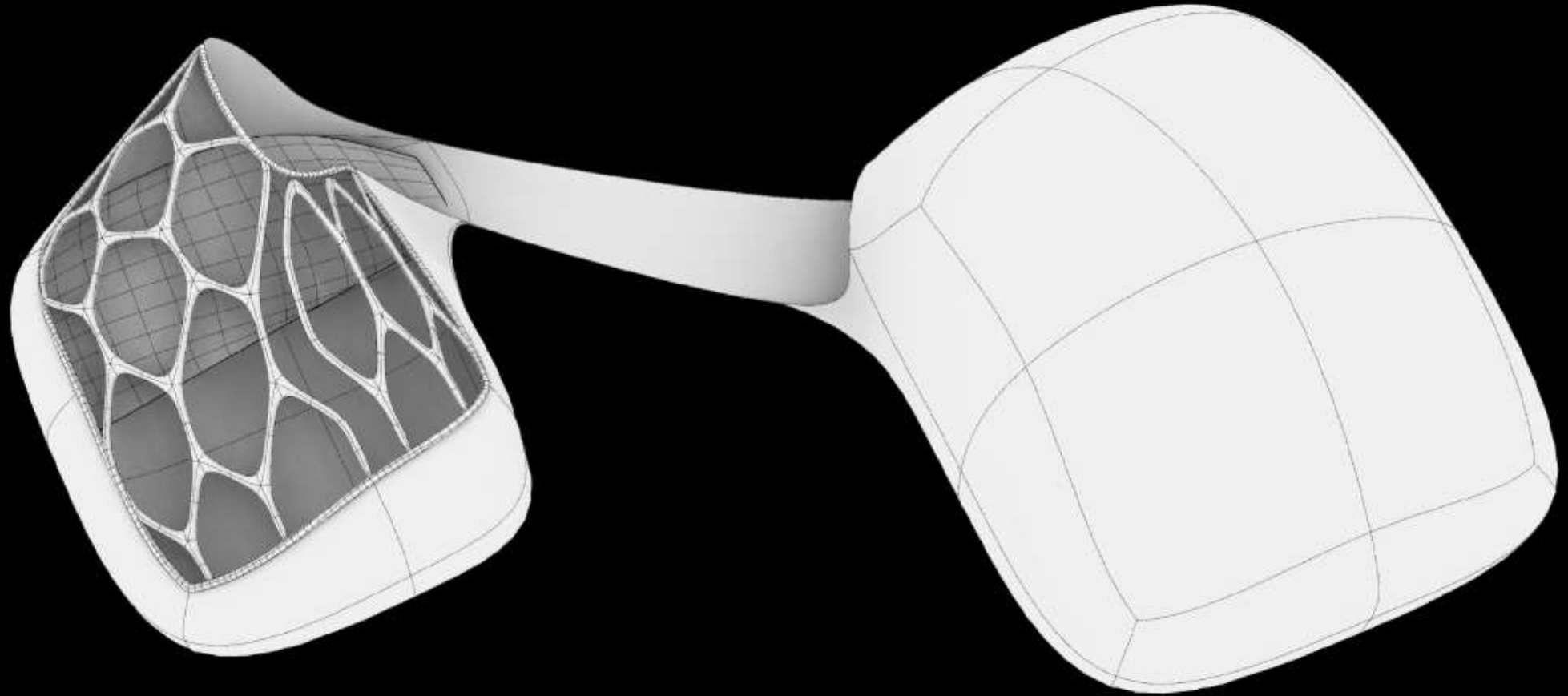


## ACTUATION: INTEGRATED GRID DEFORMATION



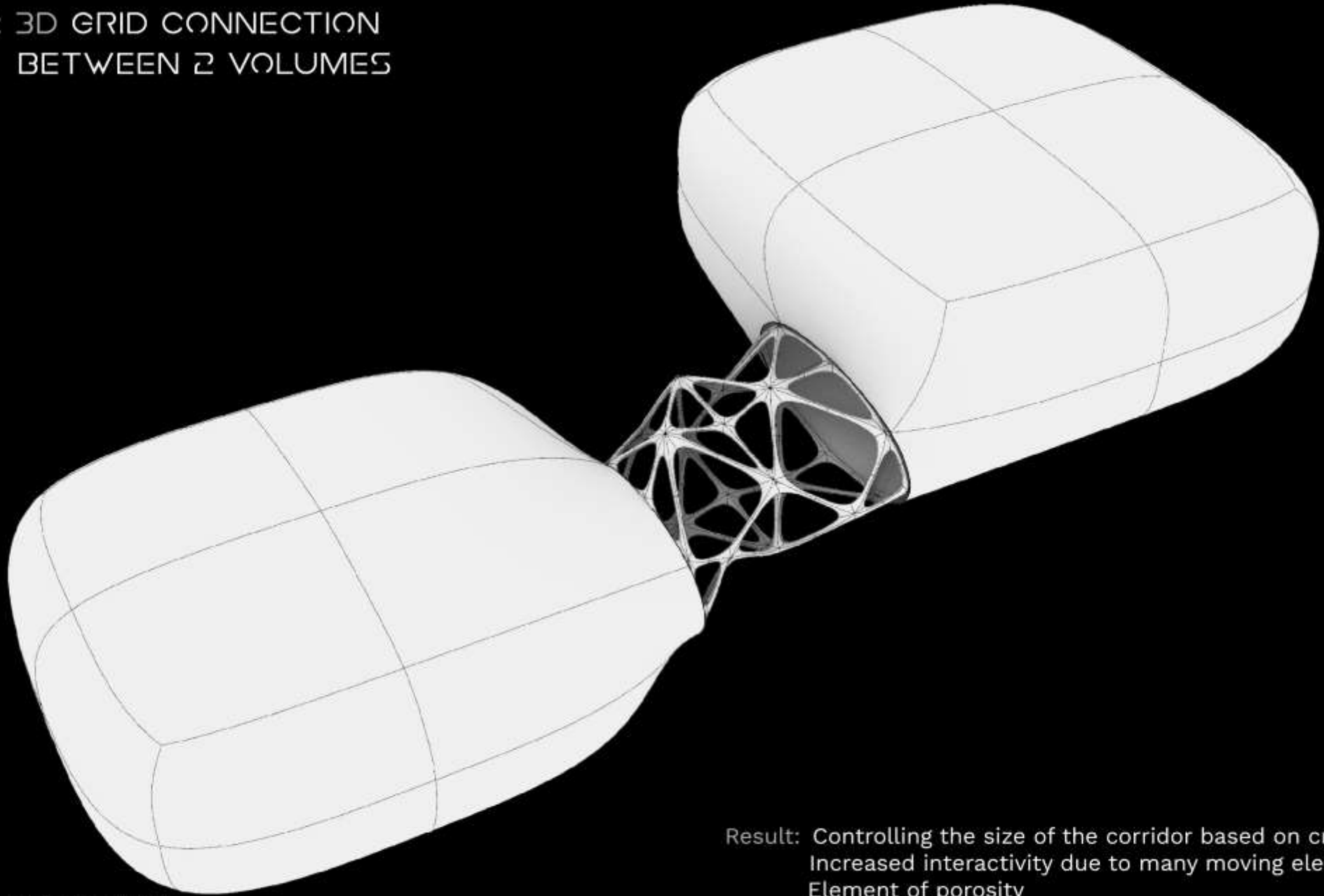
Result: Combination with bending motion  
Deformation of the grid + integration with the built space  
Visual connection of the space can be altered

ACTUATION: 2D GRID CONNECTION  
AS A ROOF



Result: Controlling light conditions of the space

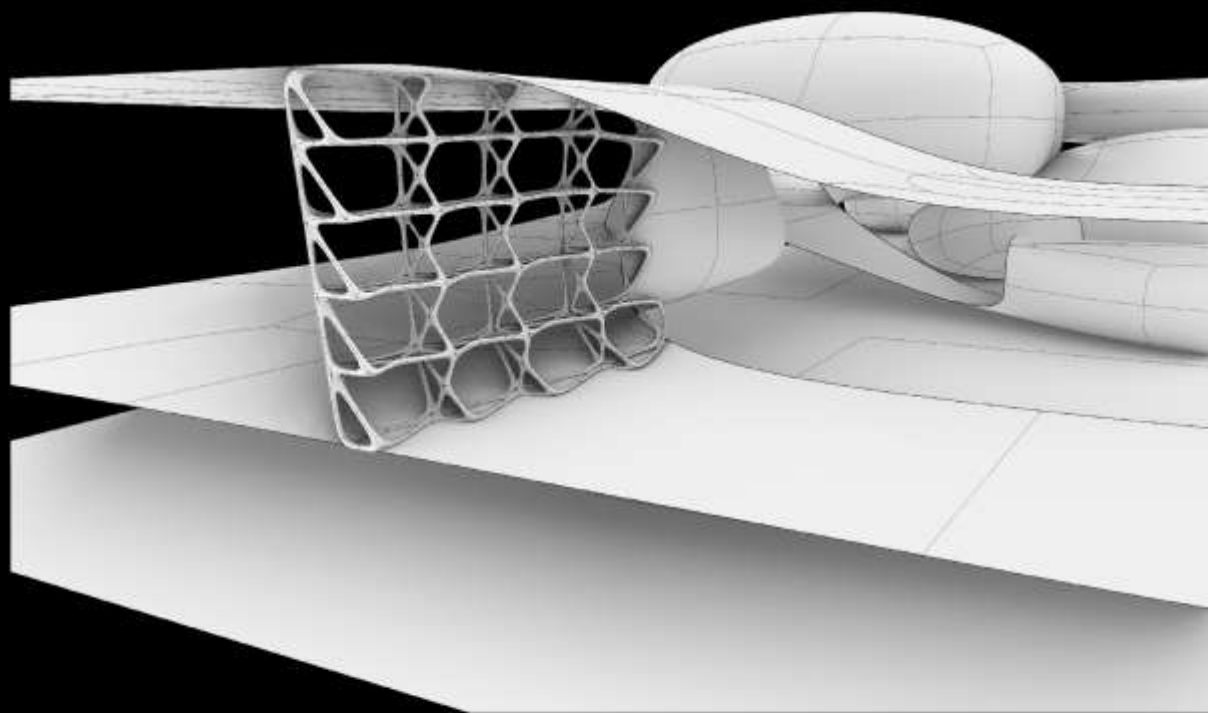
ACTUATION: 3D GRID CONNECTION  
BETWEEN 2 VOLUMES



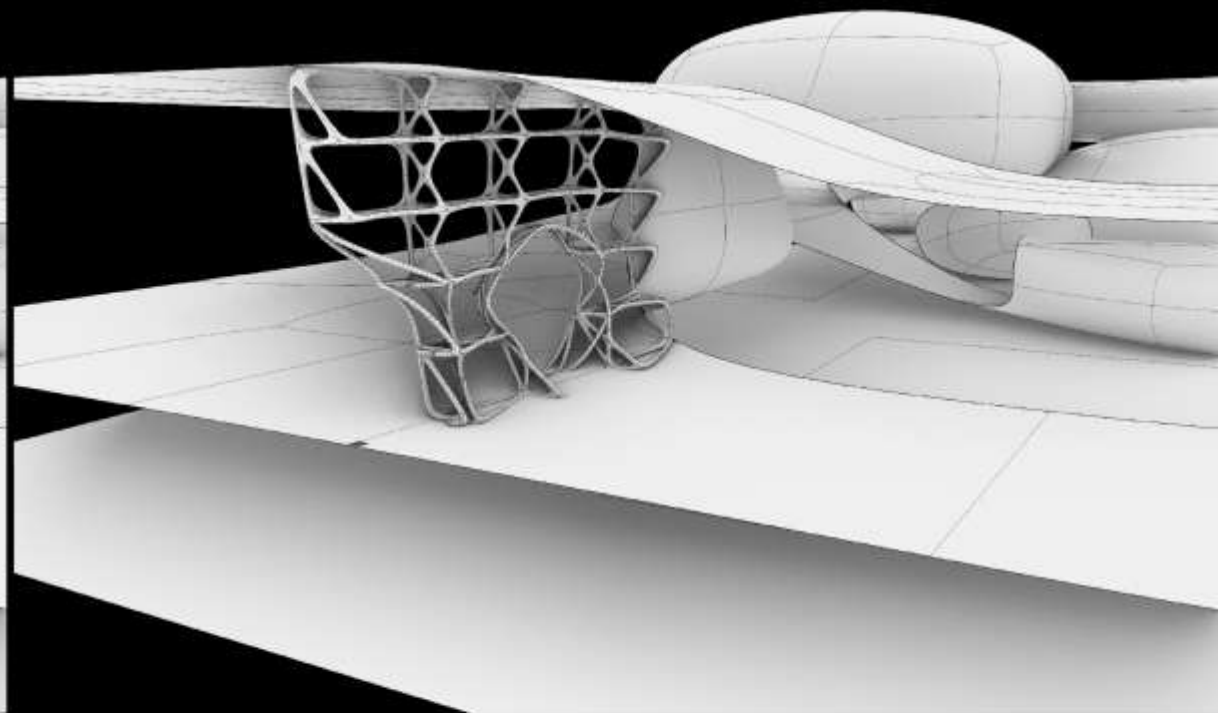
Result: Controlling the size of the corridor based on crowd flow  
Increased interactivity due to many moving elements  
Element of porosity

ACTUATION: 3D GRID CONNECTION  
AS A PARTITION

Result: Can control crowd flow and movement based on openings  
Limited capacity to affect the volume of a space  
Controls visual connectivity



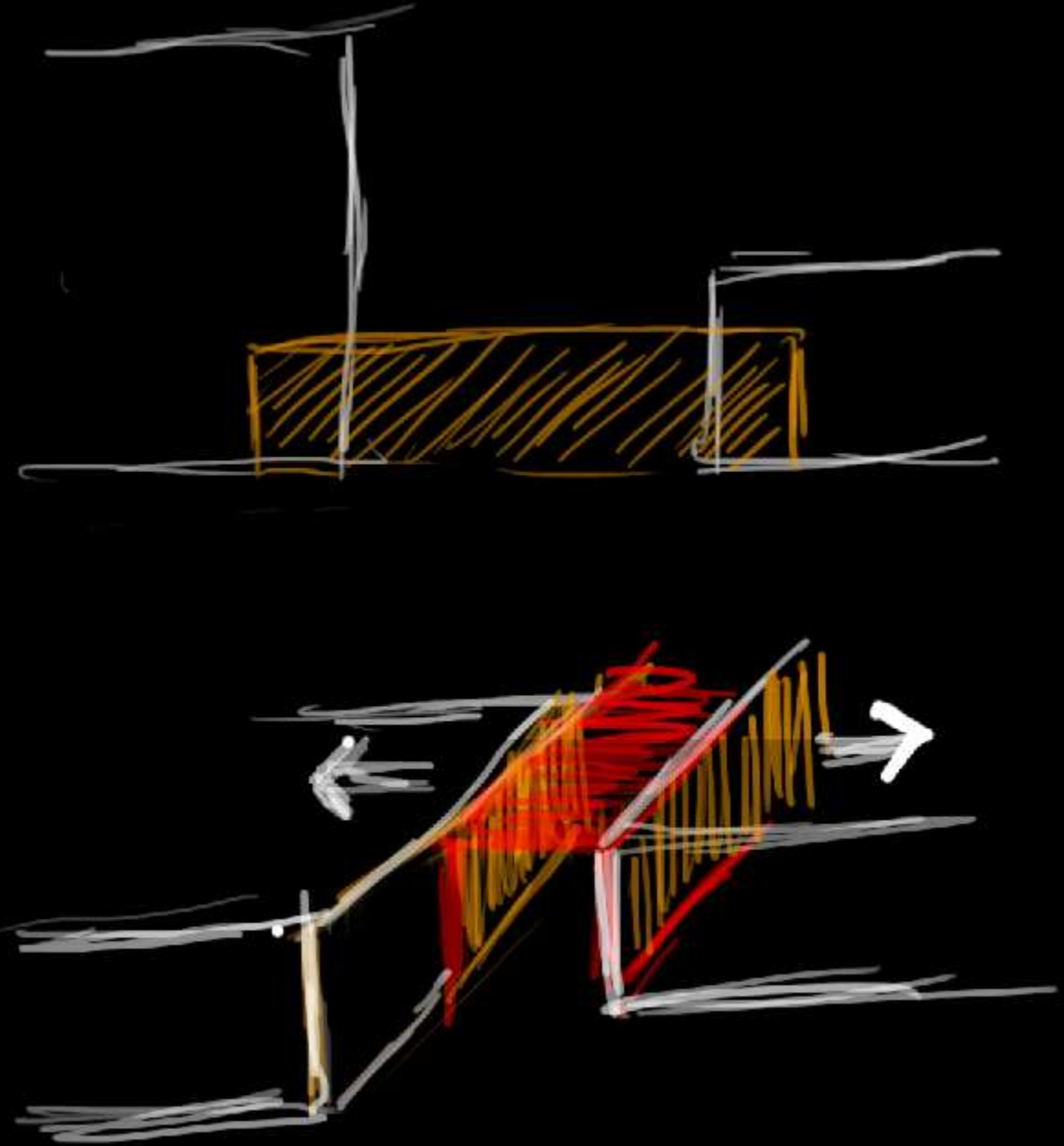
STATE A



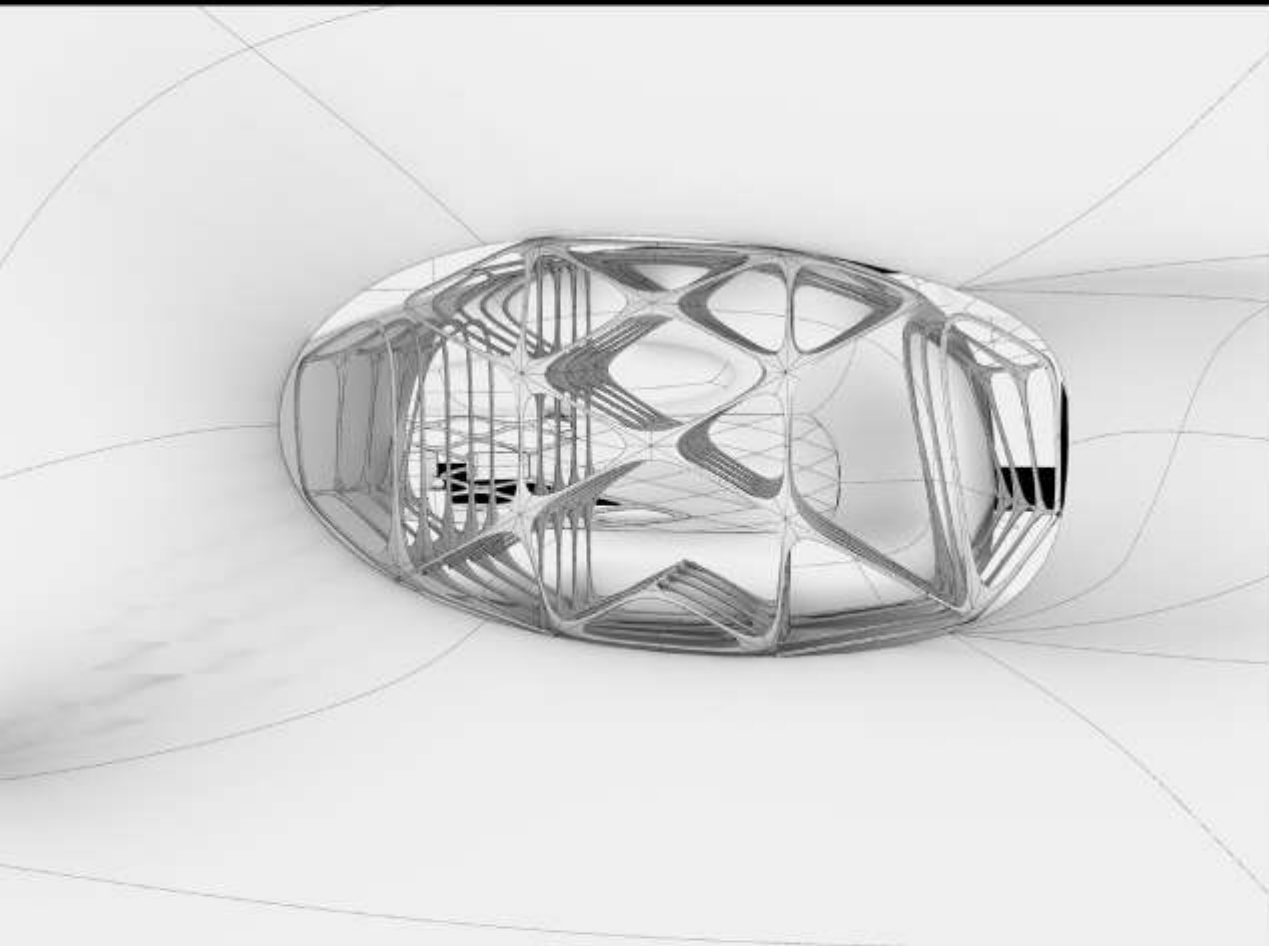
STATE B



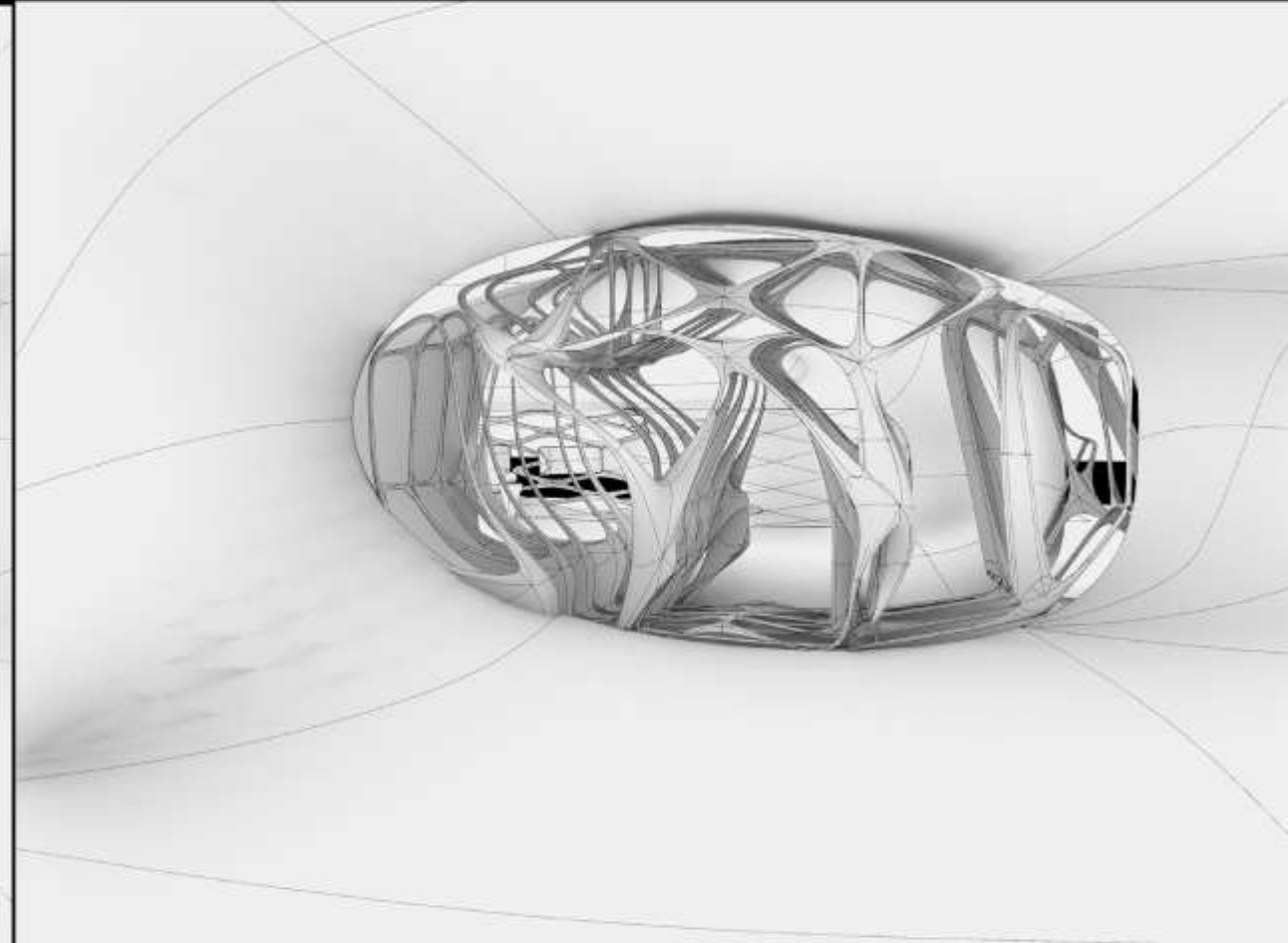
# LATTICE DEFORMATION



# LATTICE DEFORMATION



STATE A



STATE B

# WORKSHOP - CIRCULAR WOOD PAVILION

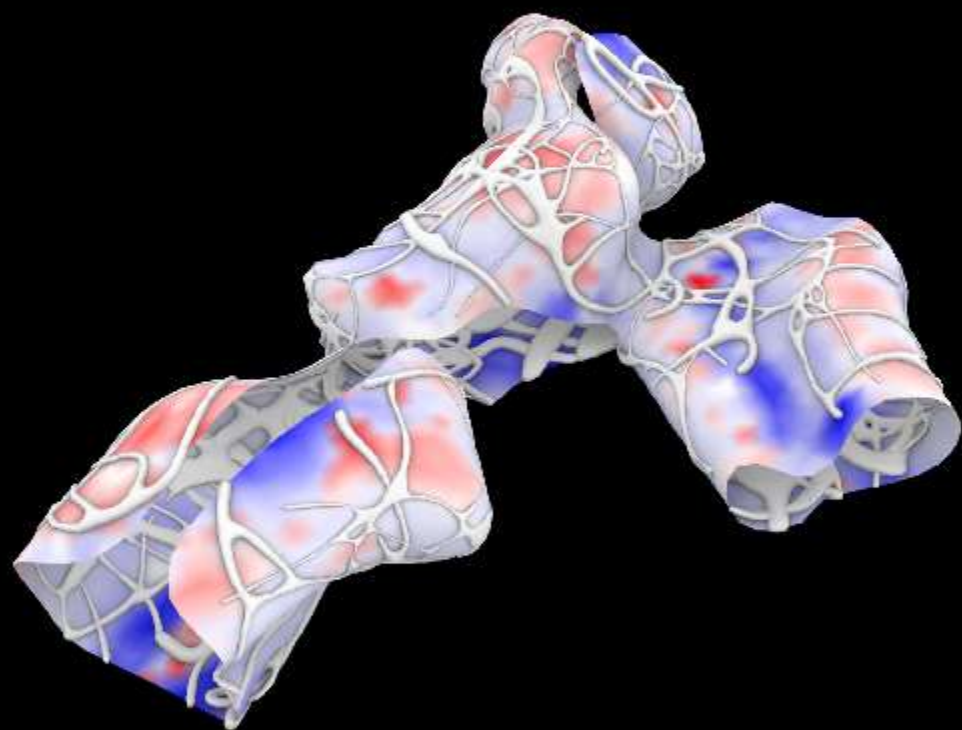
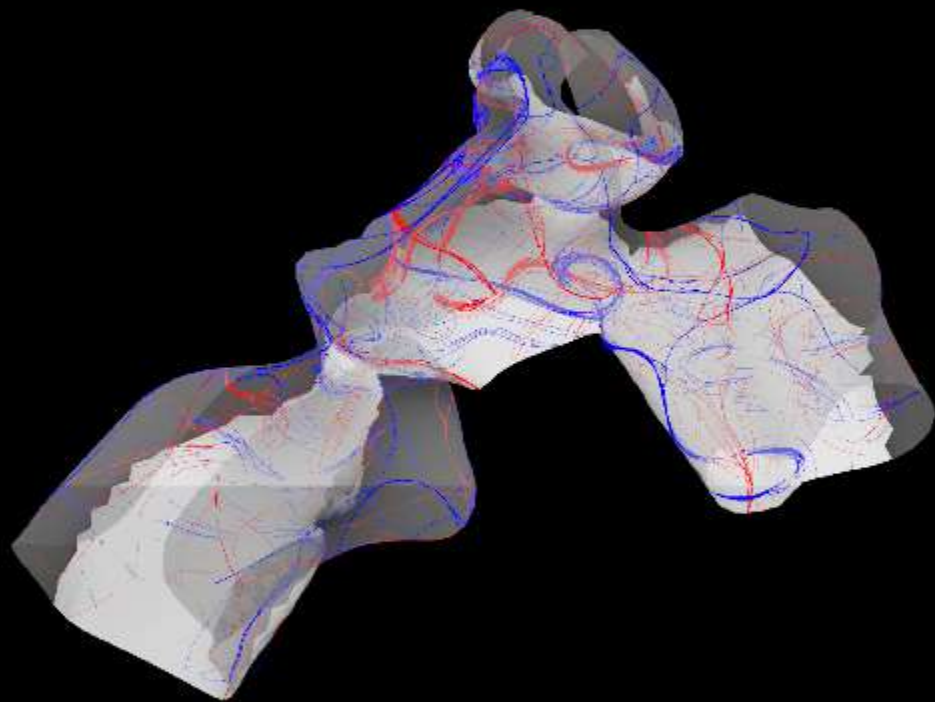


3D MODEL



BEAMS GENERATED

# STRUCTURAL ANALYSIS



# PROTOTYPING

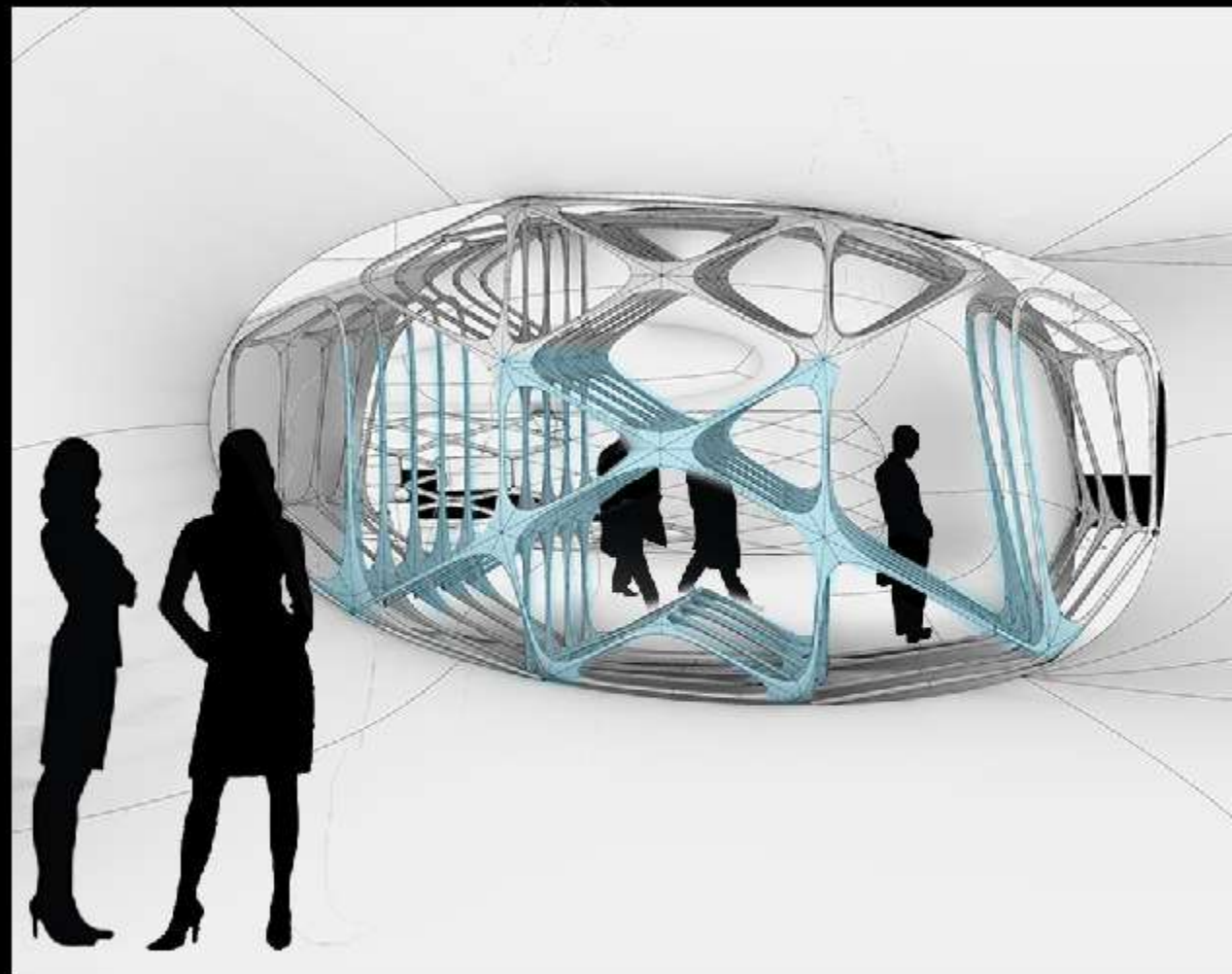
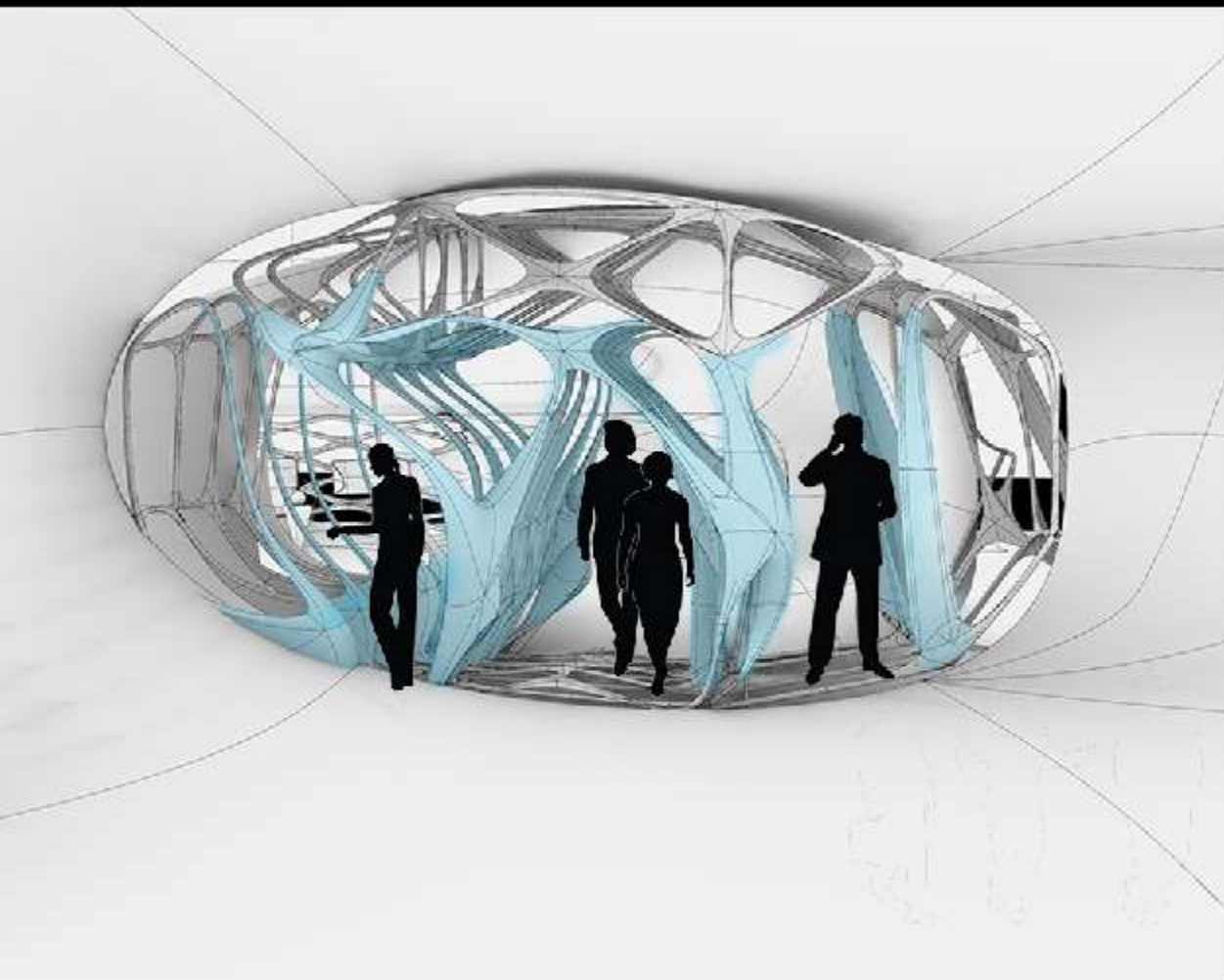


# CURVILINEAR WOODEN BEAMS



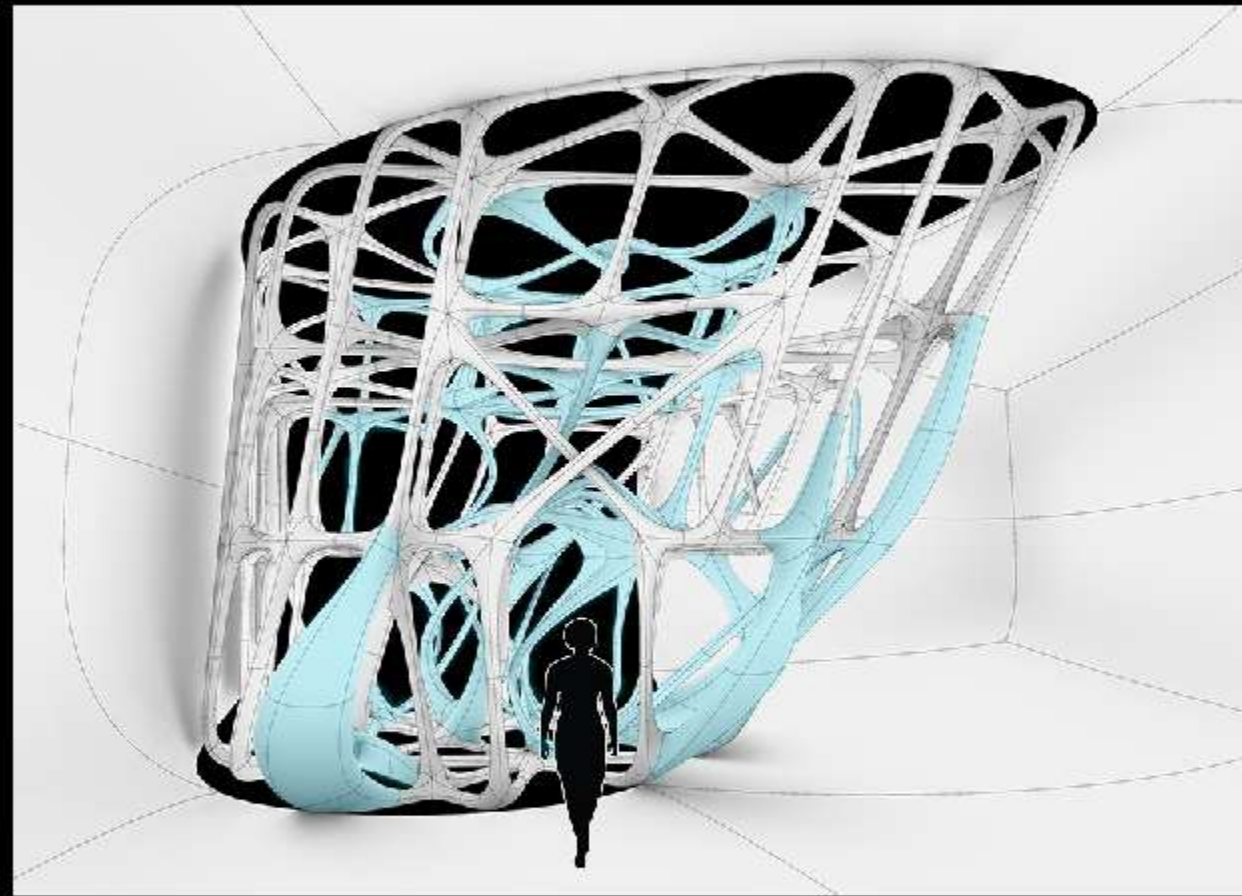
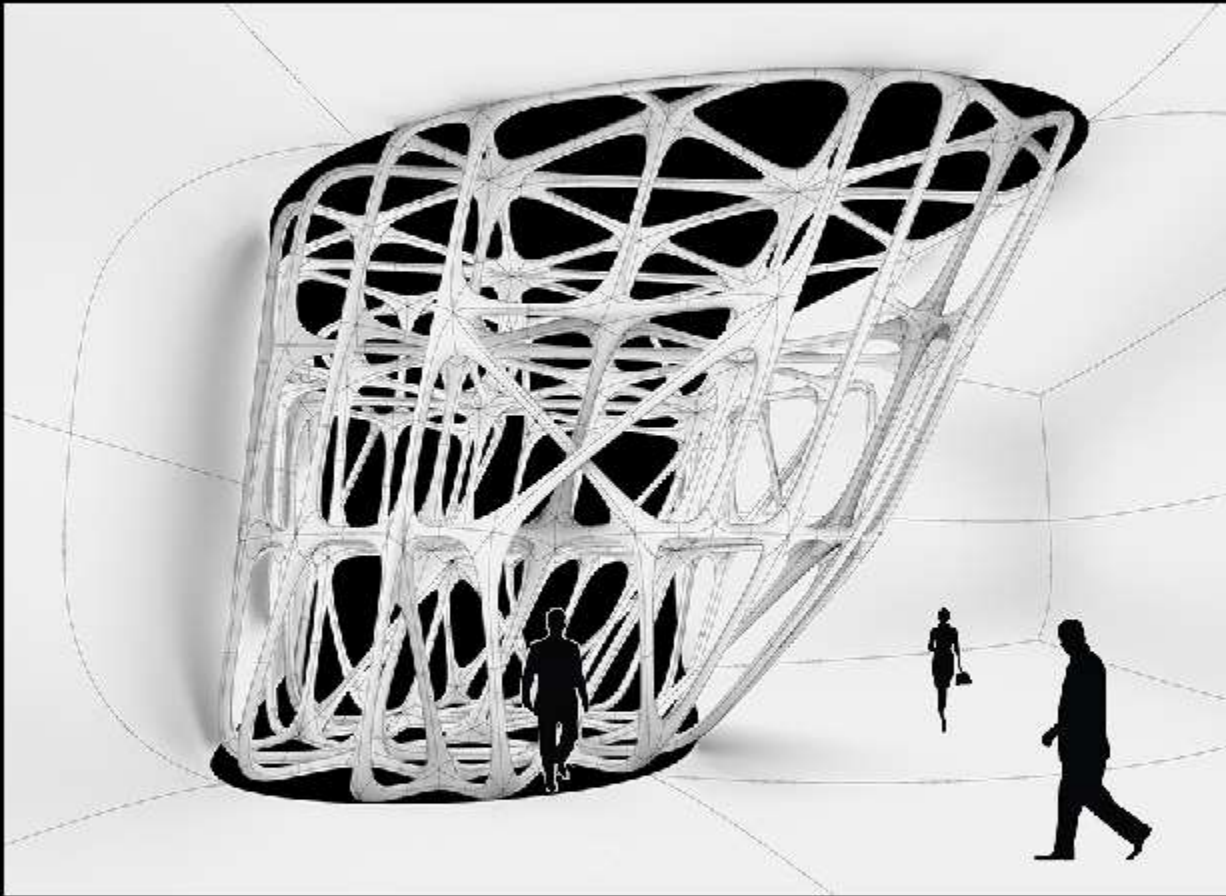
## RELATION BETWEEN STATIC AND DYNAMIC

CASE A

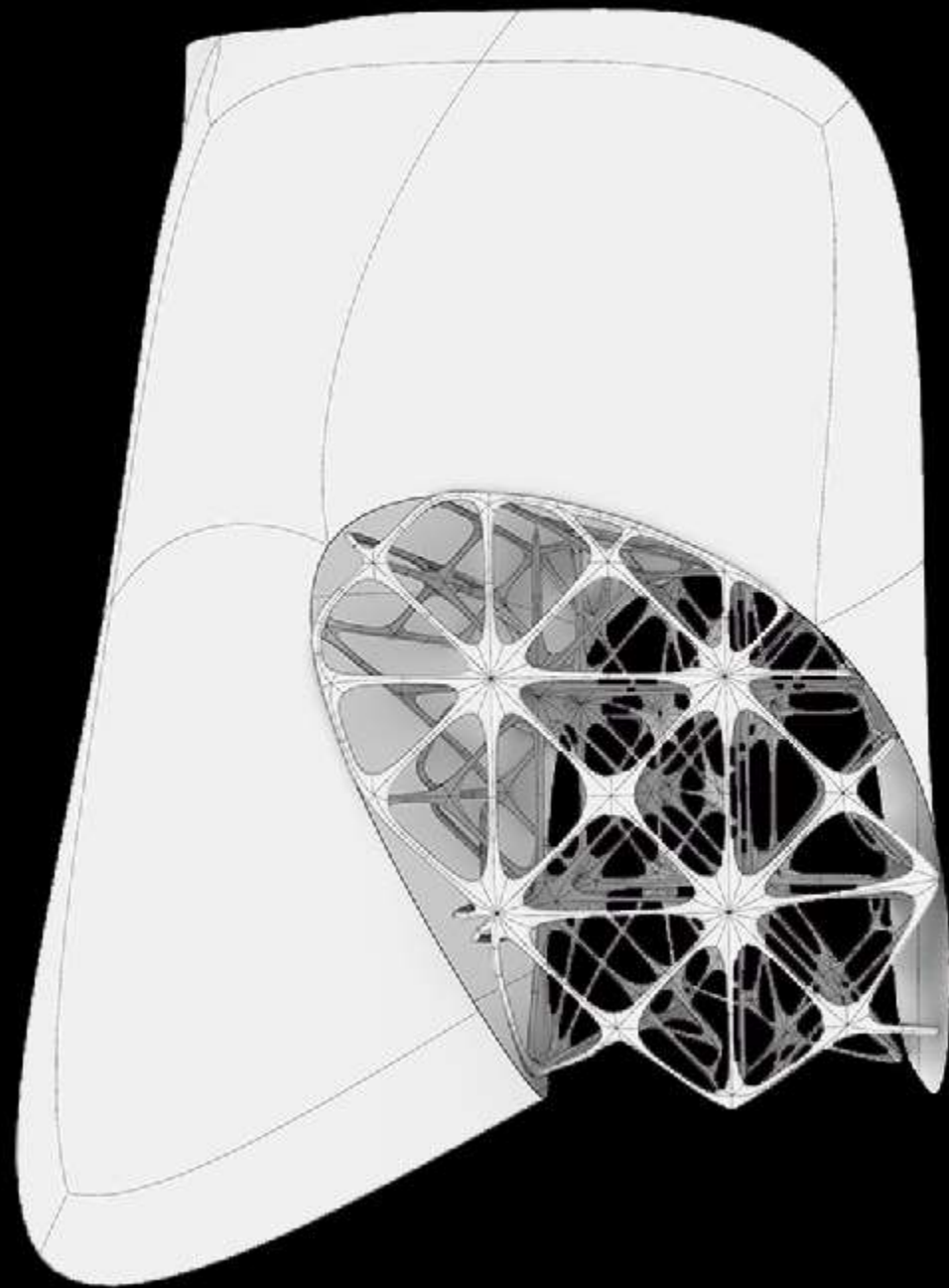
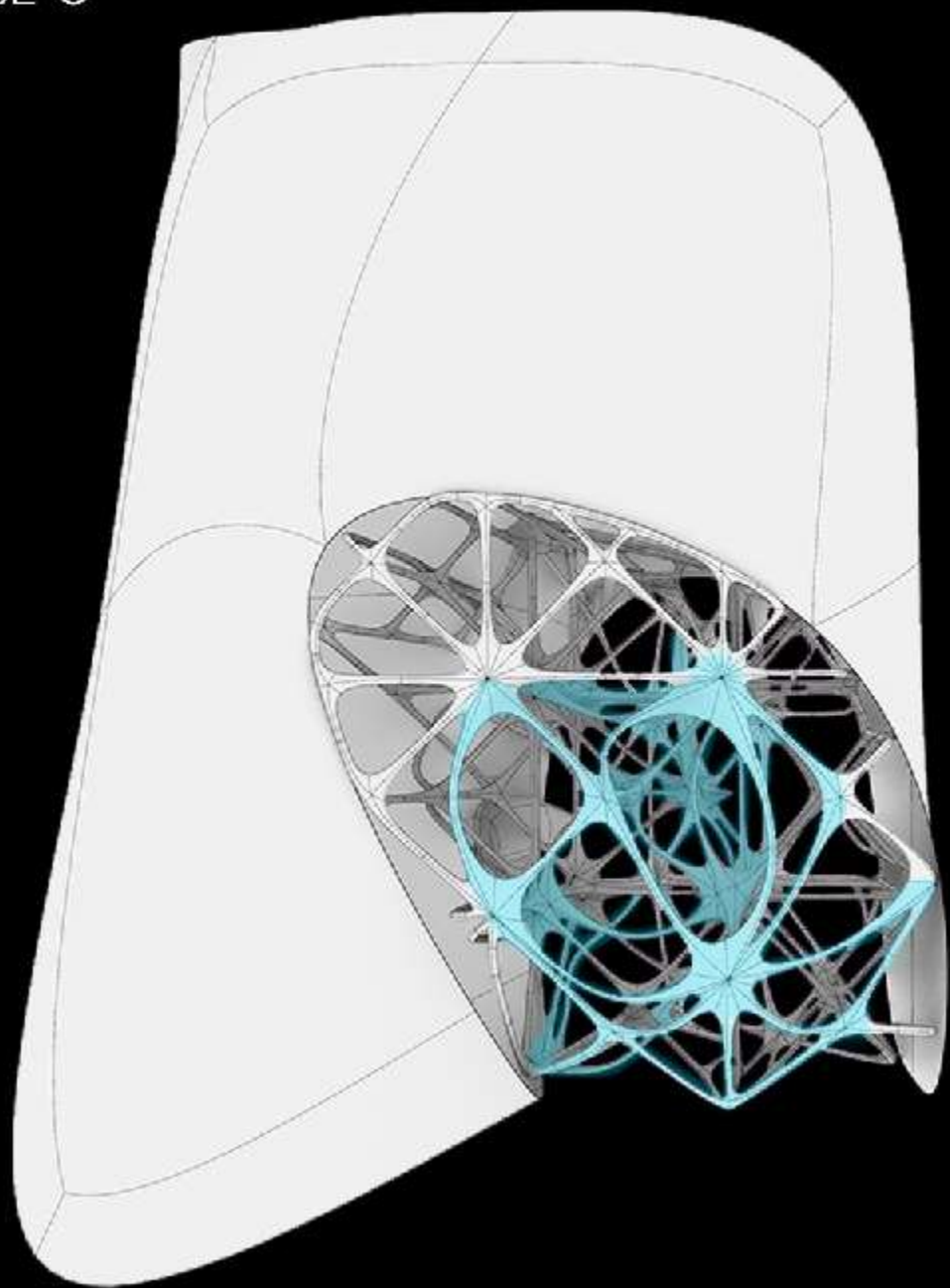




CASE B



CASE C



# SITE STUDY

# URBAN CONTEXT



MACHINEFABRIEK VAN DE SCHELDE  
GLACISSTRAAT 102  
4381 NK VLISSINGEN

SITE





# SITE PLAN

A site plan of an industrial complex. The plan shows various buildings, roads, and a central area highlighted with a red dashed rectangle. The highlighted area is labeled 'MACHINEFABRIEK VAN DE SCHELDE'. The plan is set against a dark background with white lines for buildings and roads, and a teal area representing water or a canal.

MACHINEFABRIEK VAN DE SCHELDE

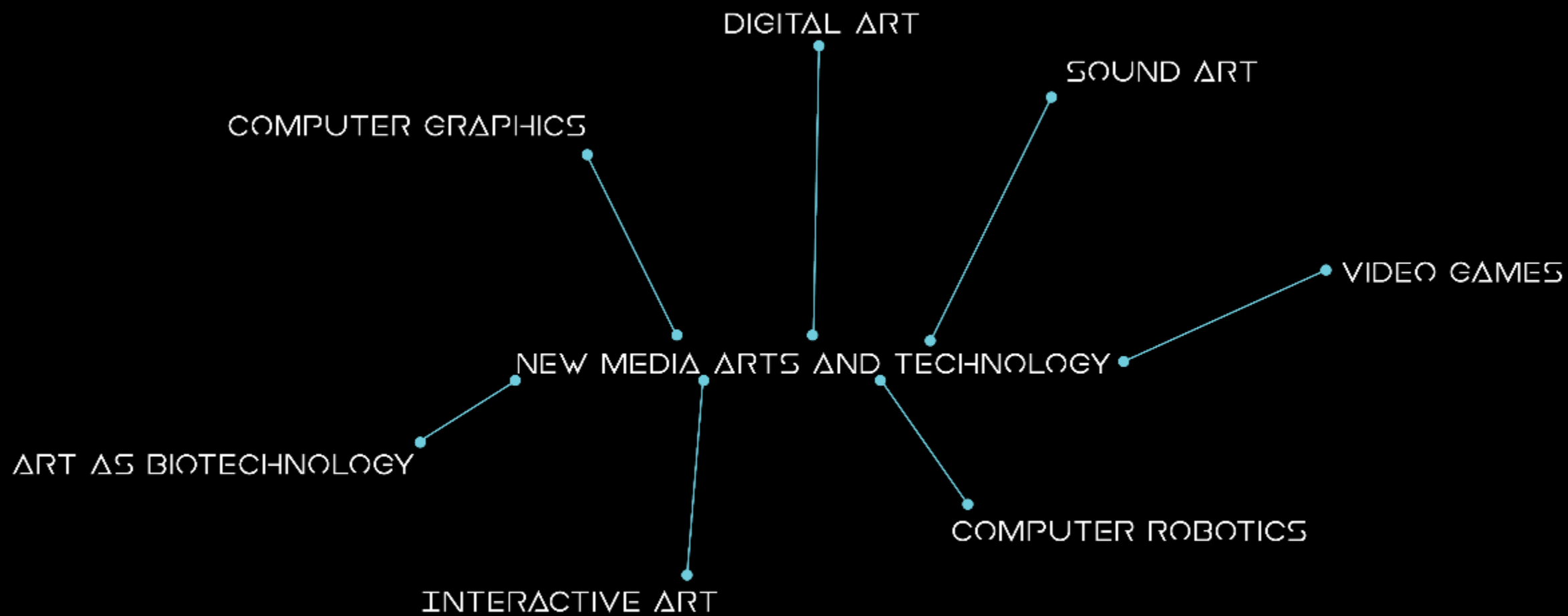
# MACHINE FABRIEK





INTERVENTION

NEW MEDIA ART AND TECHNOLOGY  
EXHIBITION SPACE









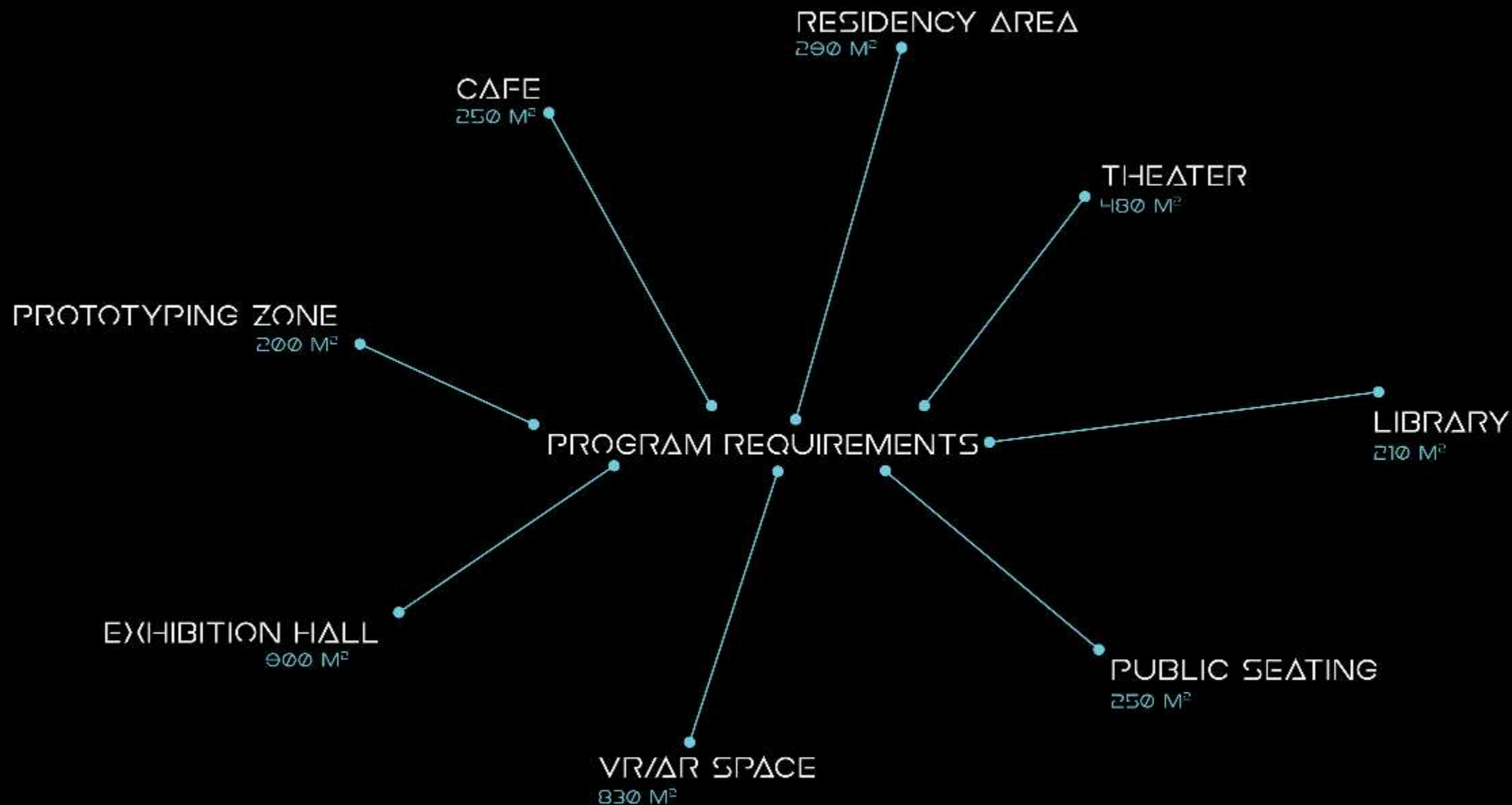
NXT MUSEUM



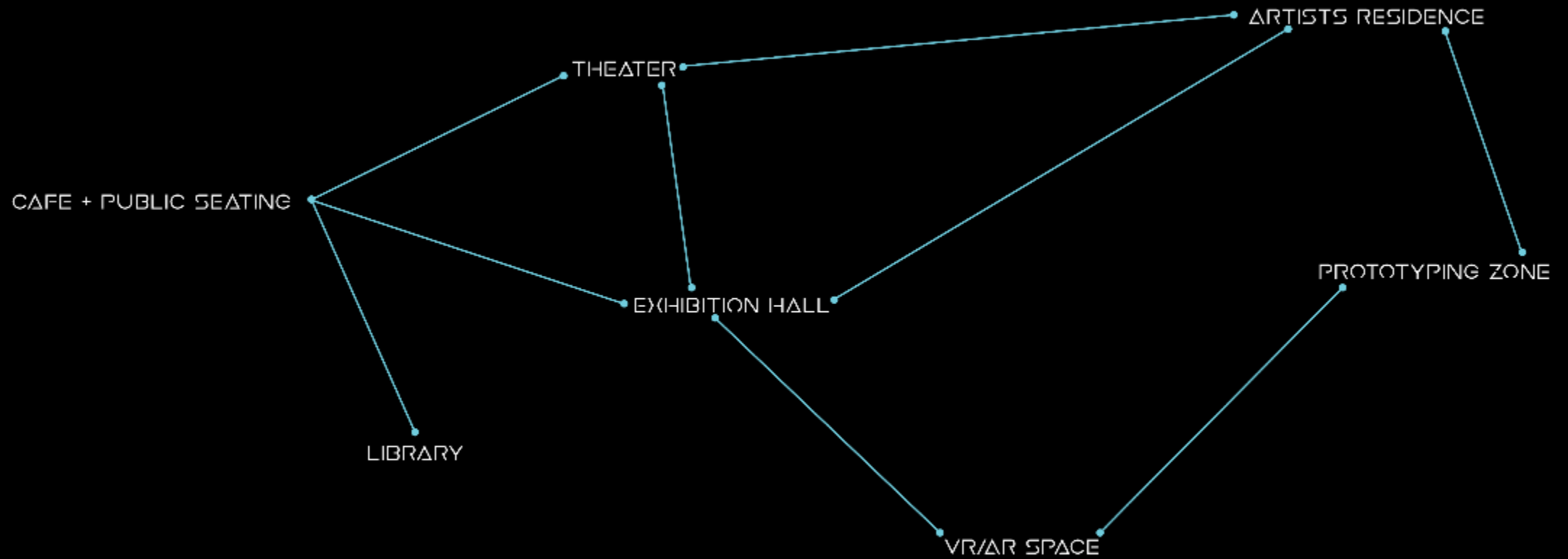
**RB** robotic building

**TU Delft** Delft University of Technology  
Faculty of Architecture  
and the Built Environment

MORI BUILDING DIGITAL ART MUSEUM

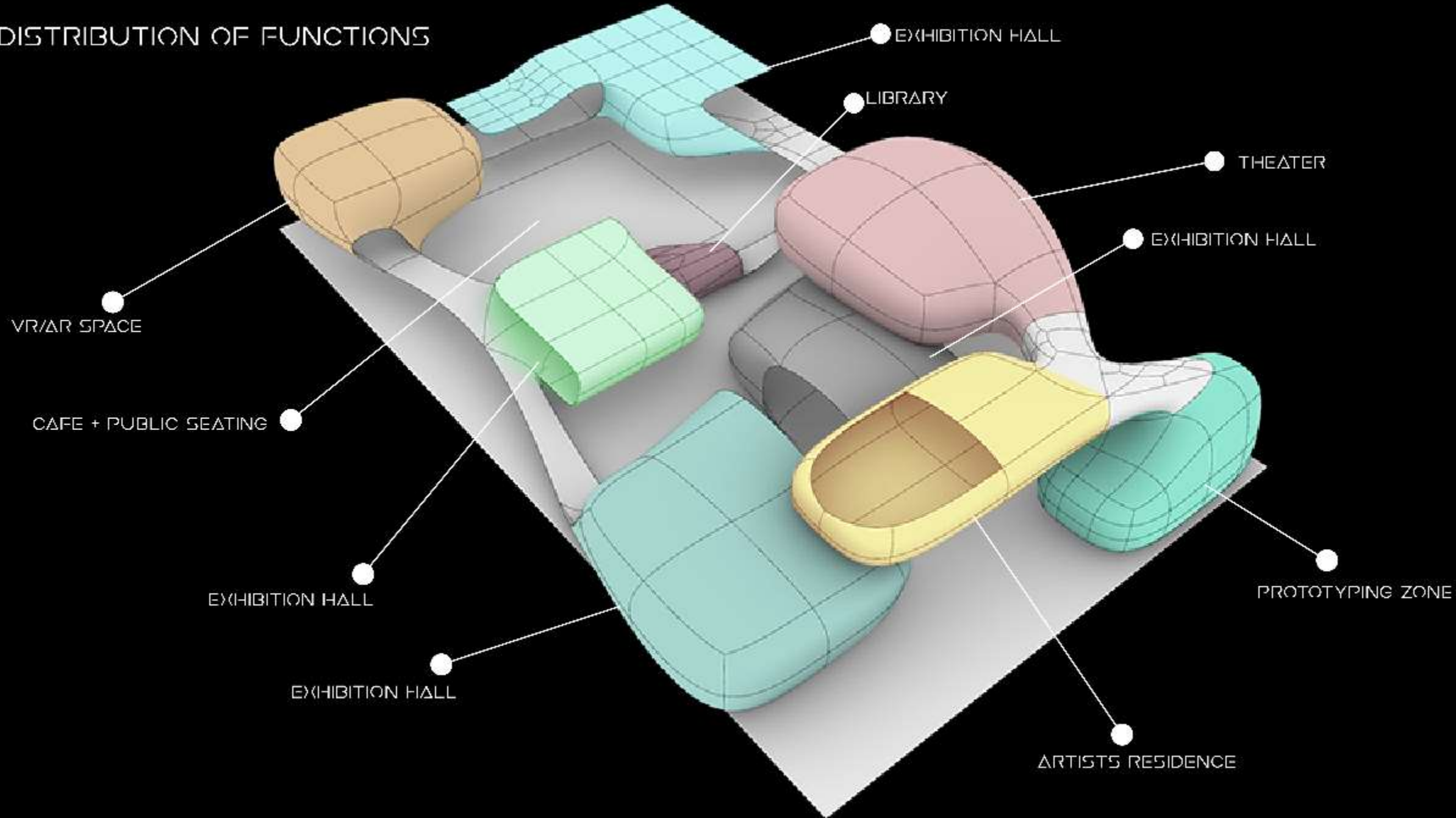


# ADJACENCY DIAGRAM

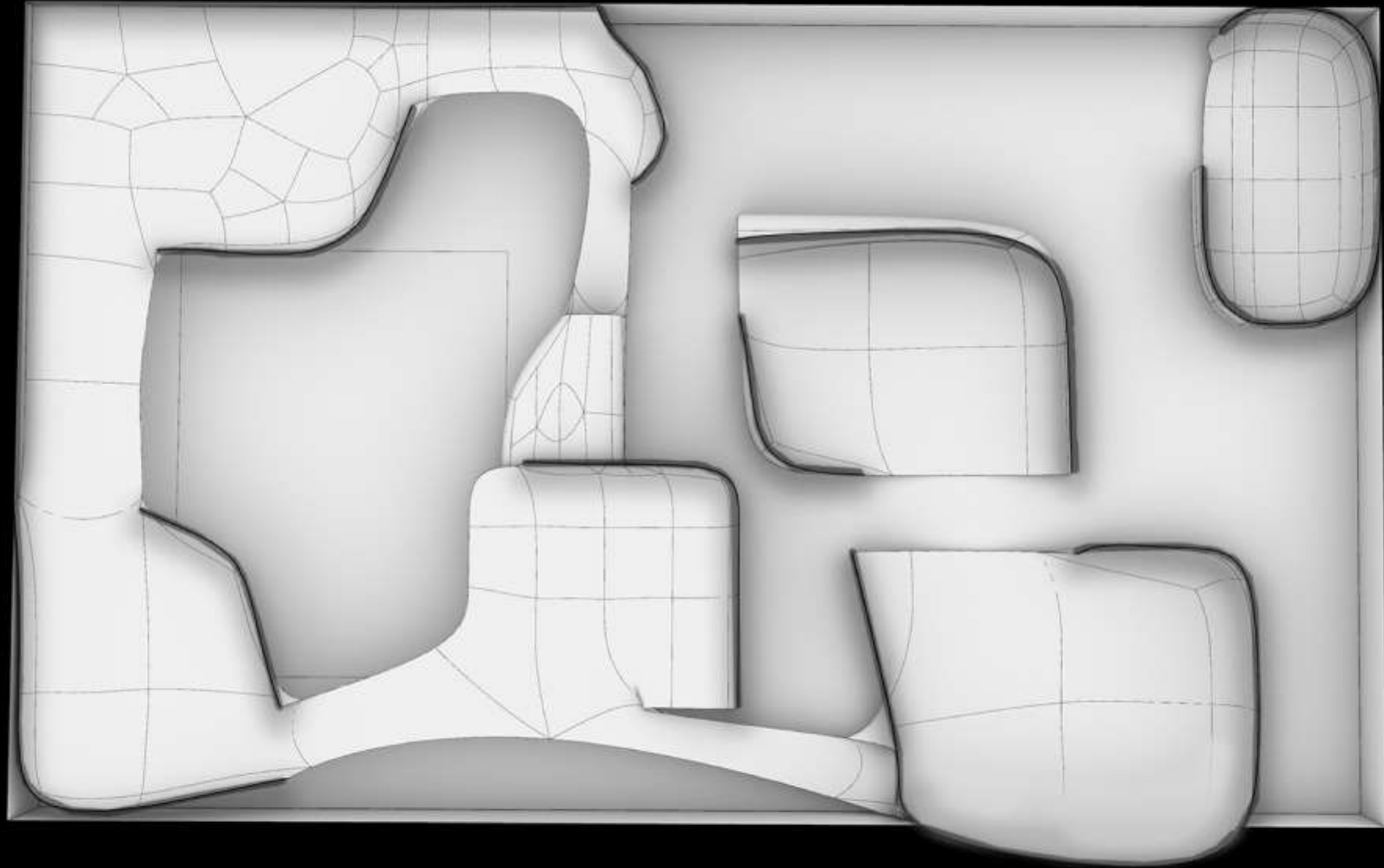




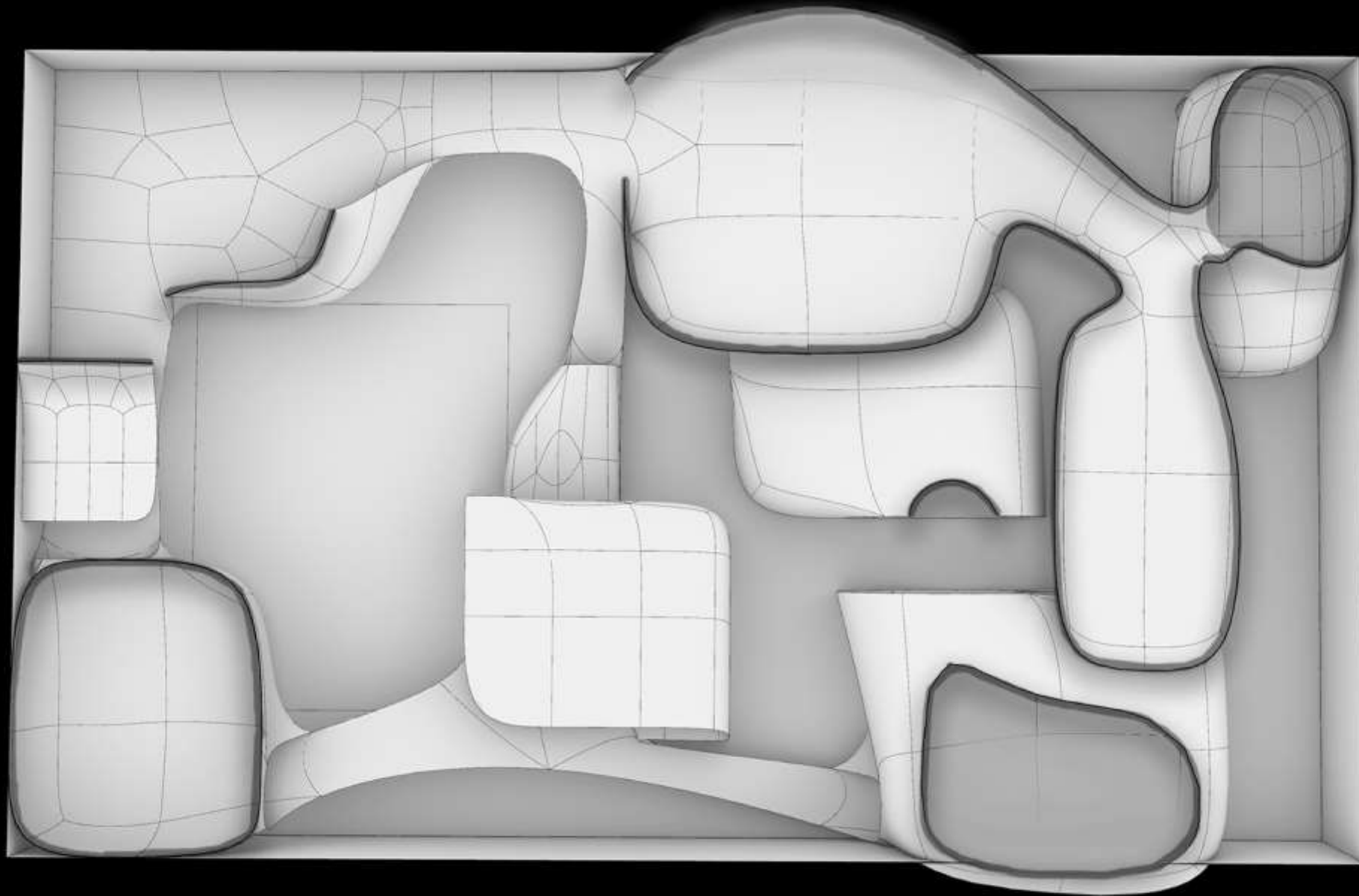
# DISTRIBUTION OF FUNCTIONS



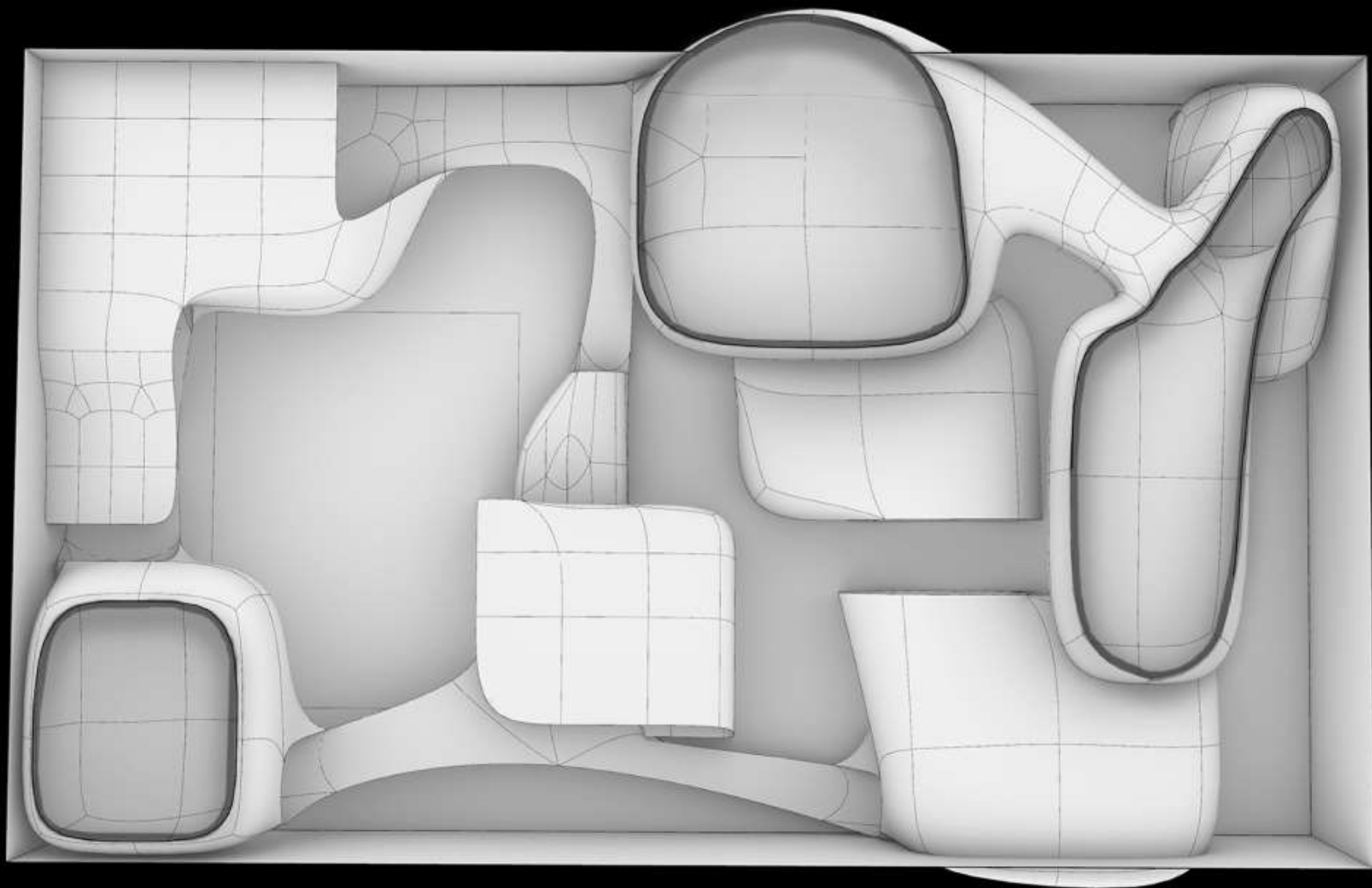
PLAN



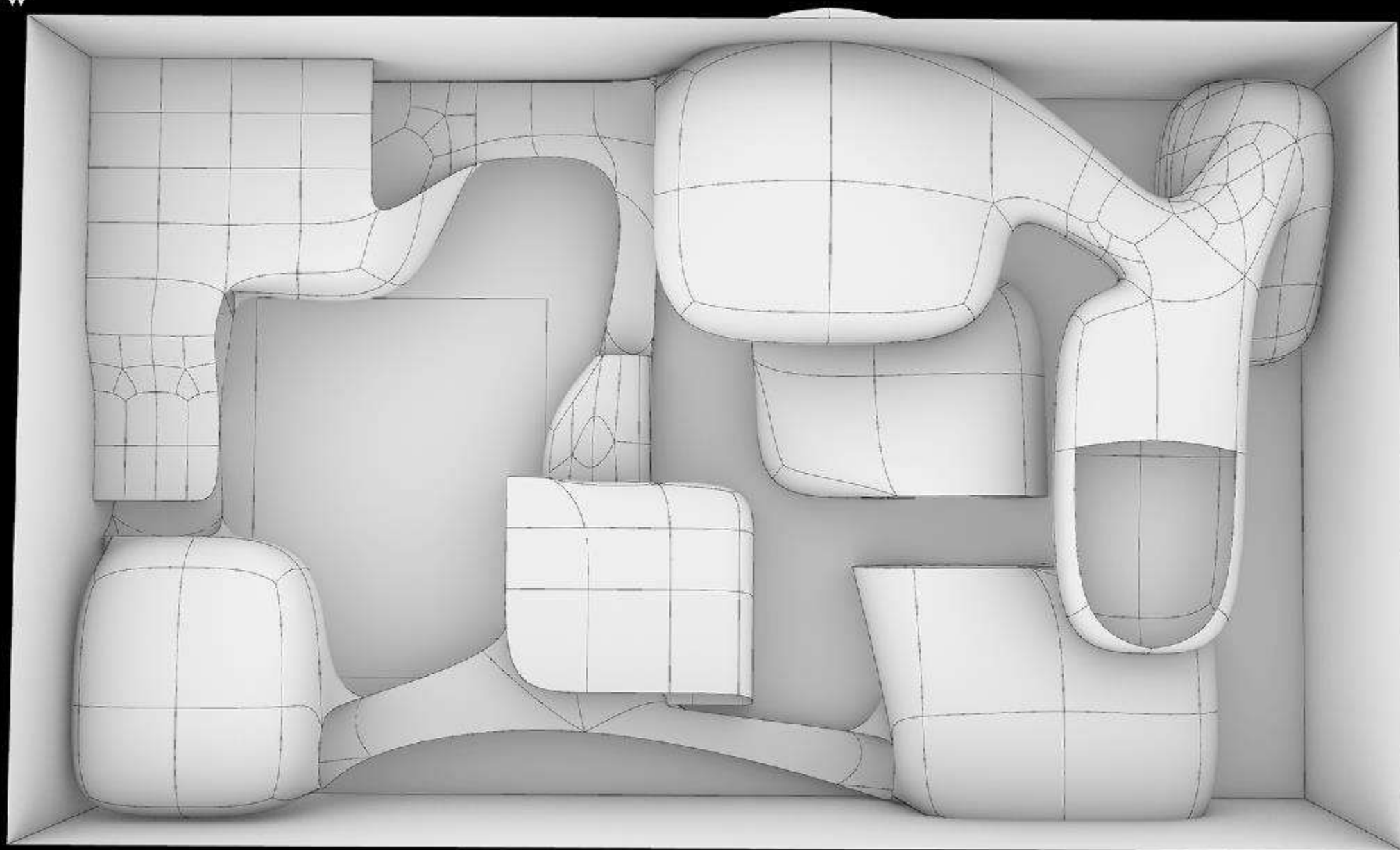
PLAN



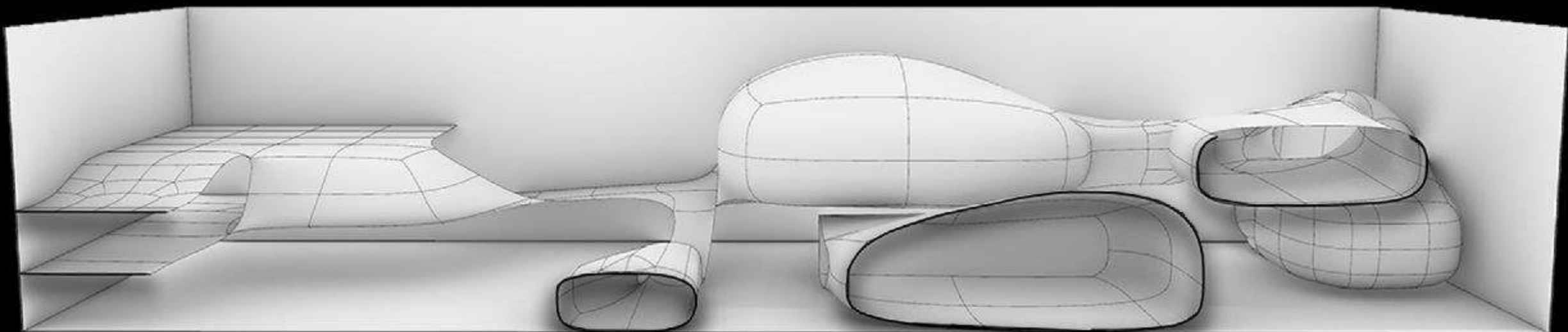
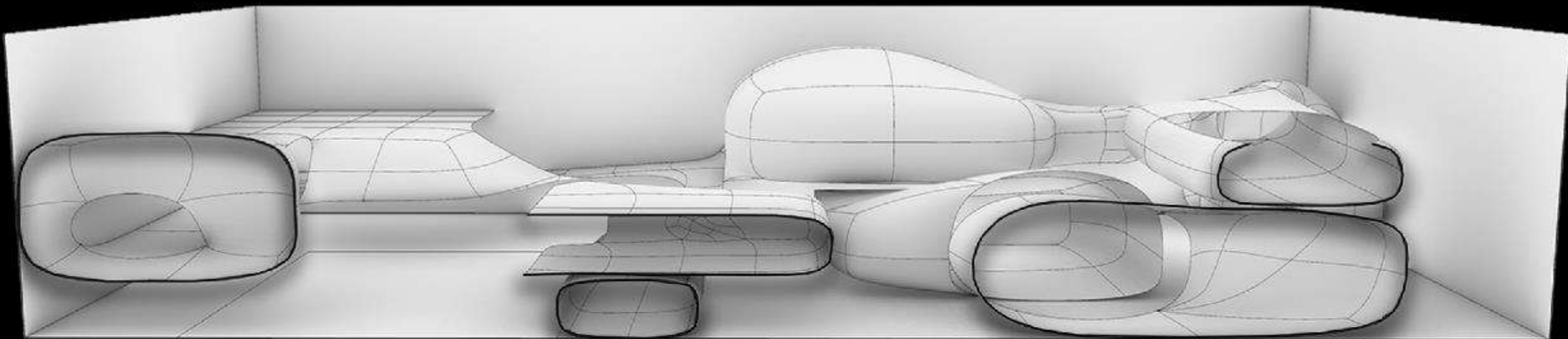
PLAN



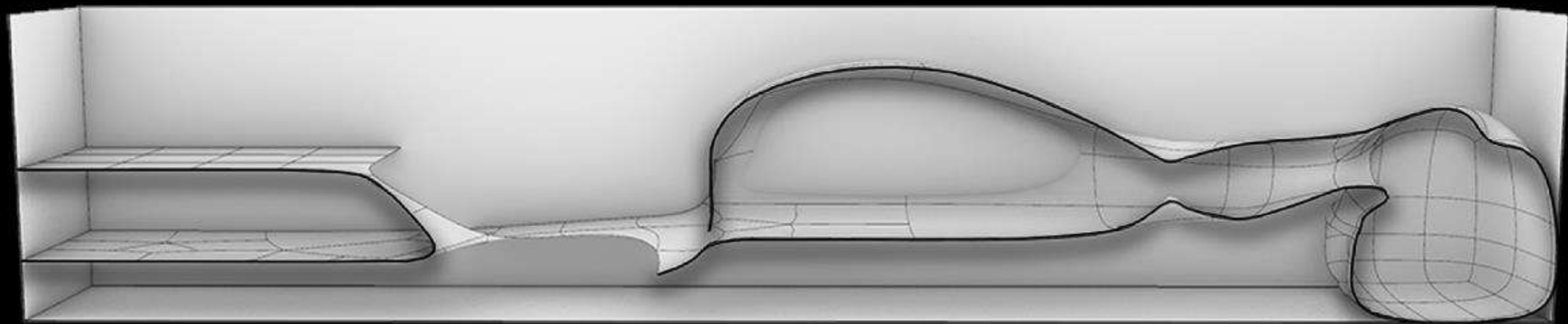
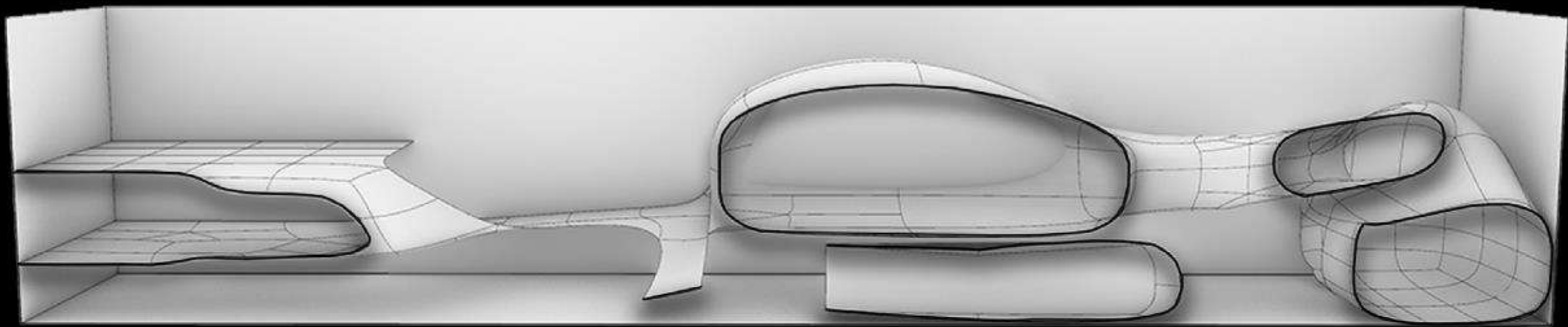
TOP VIEW



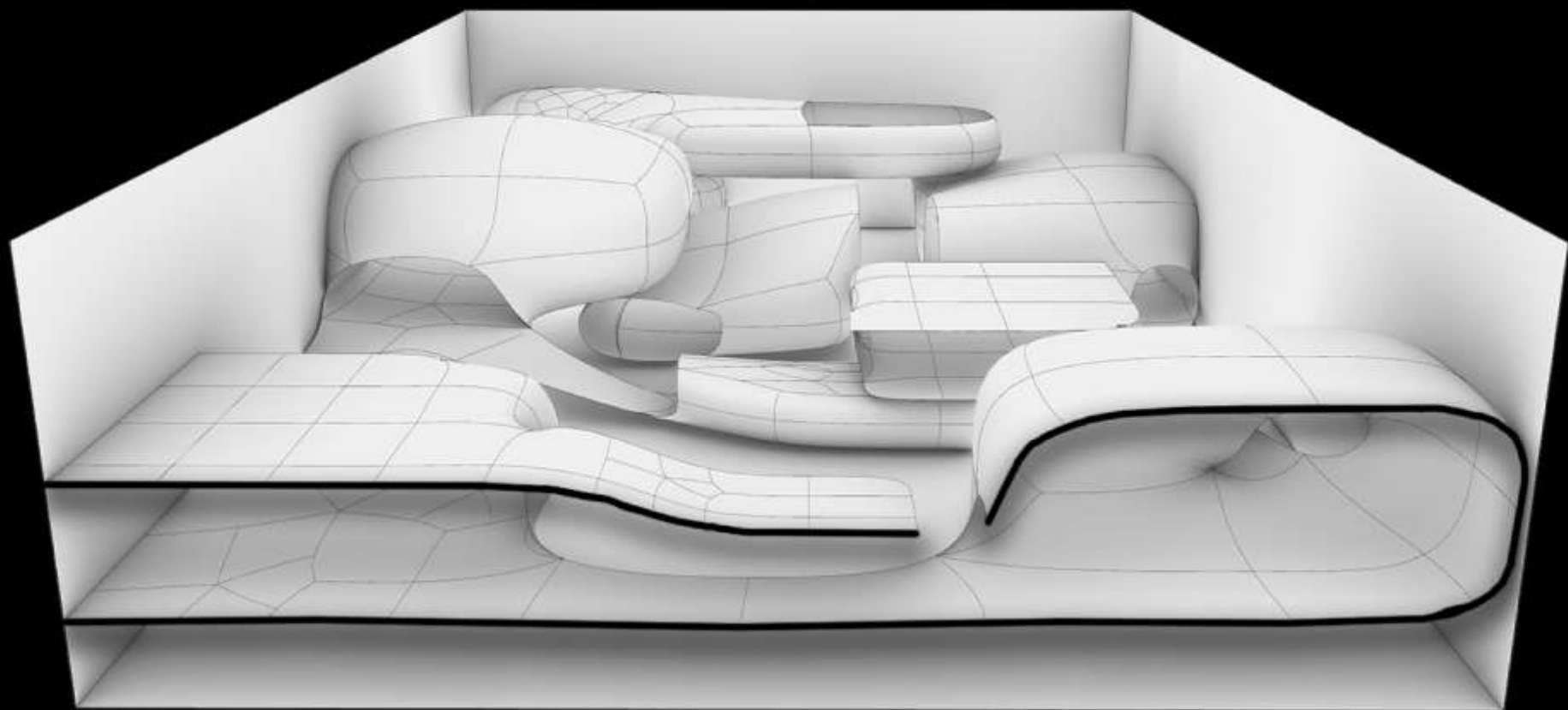
SECTION



SECTION

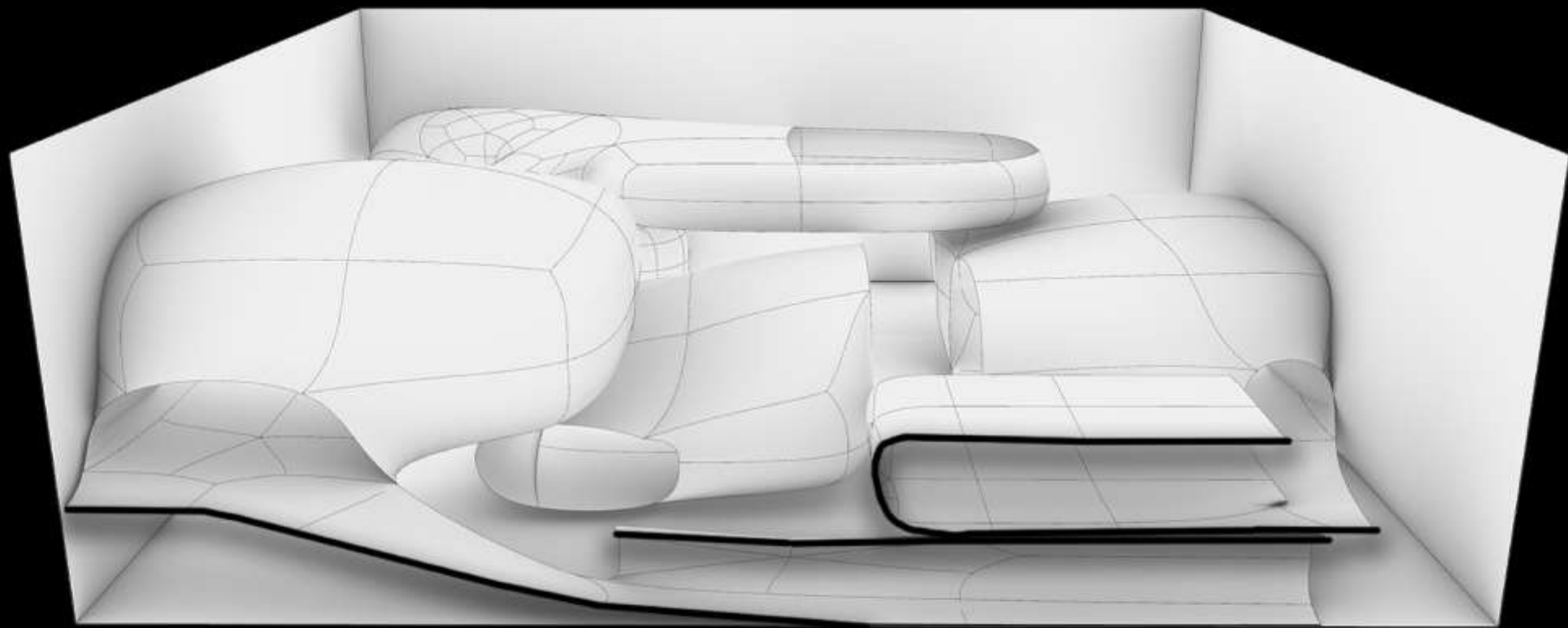


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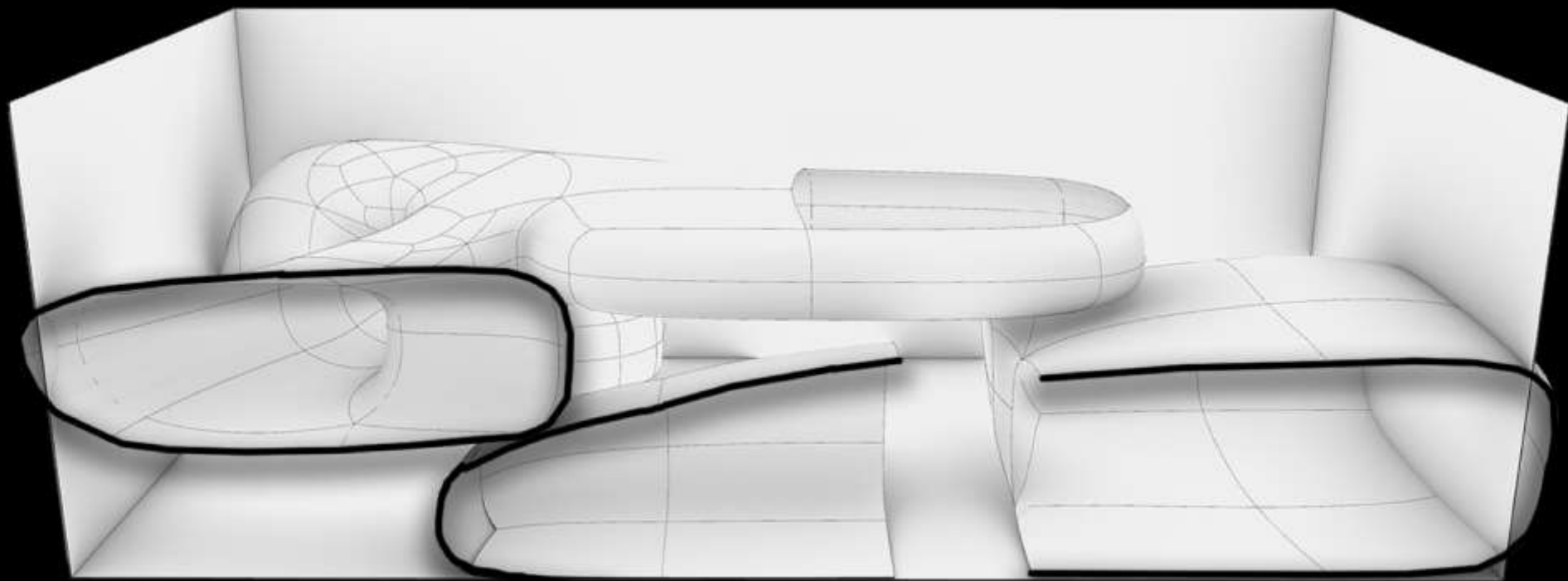




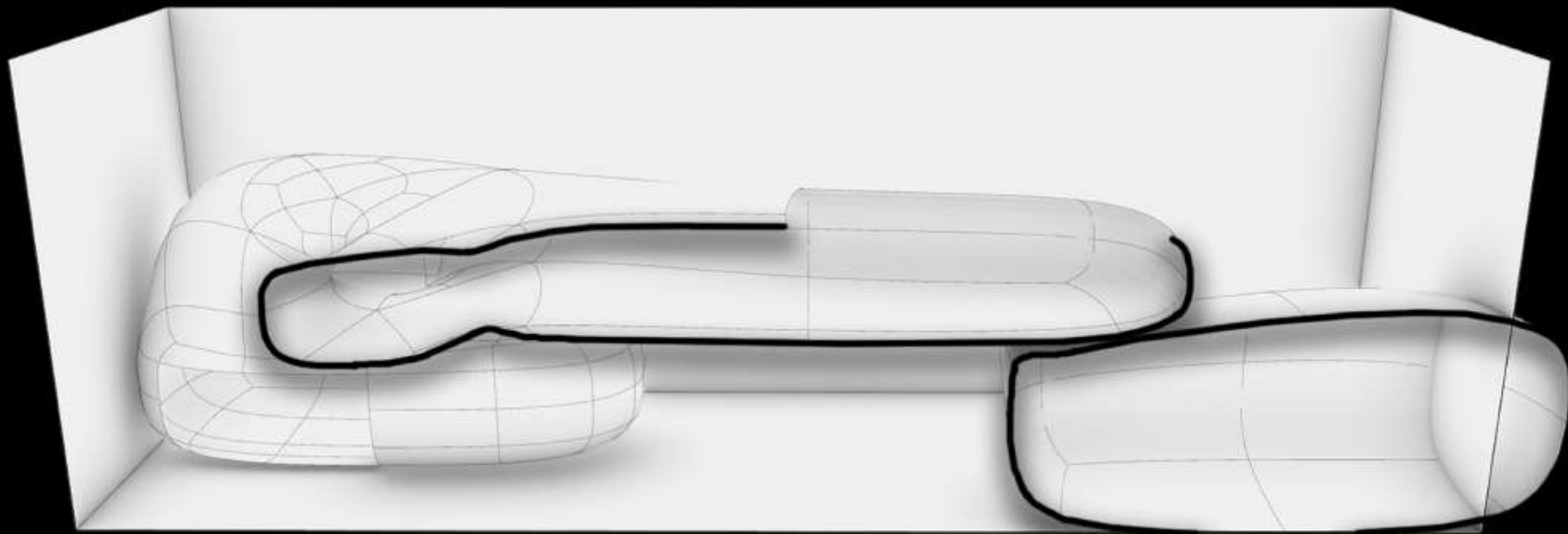
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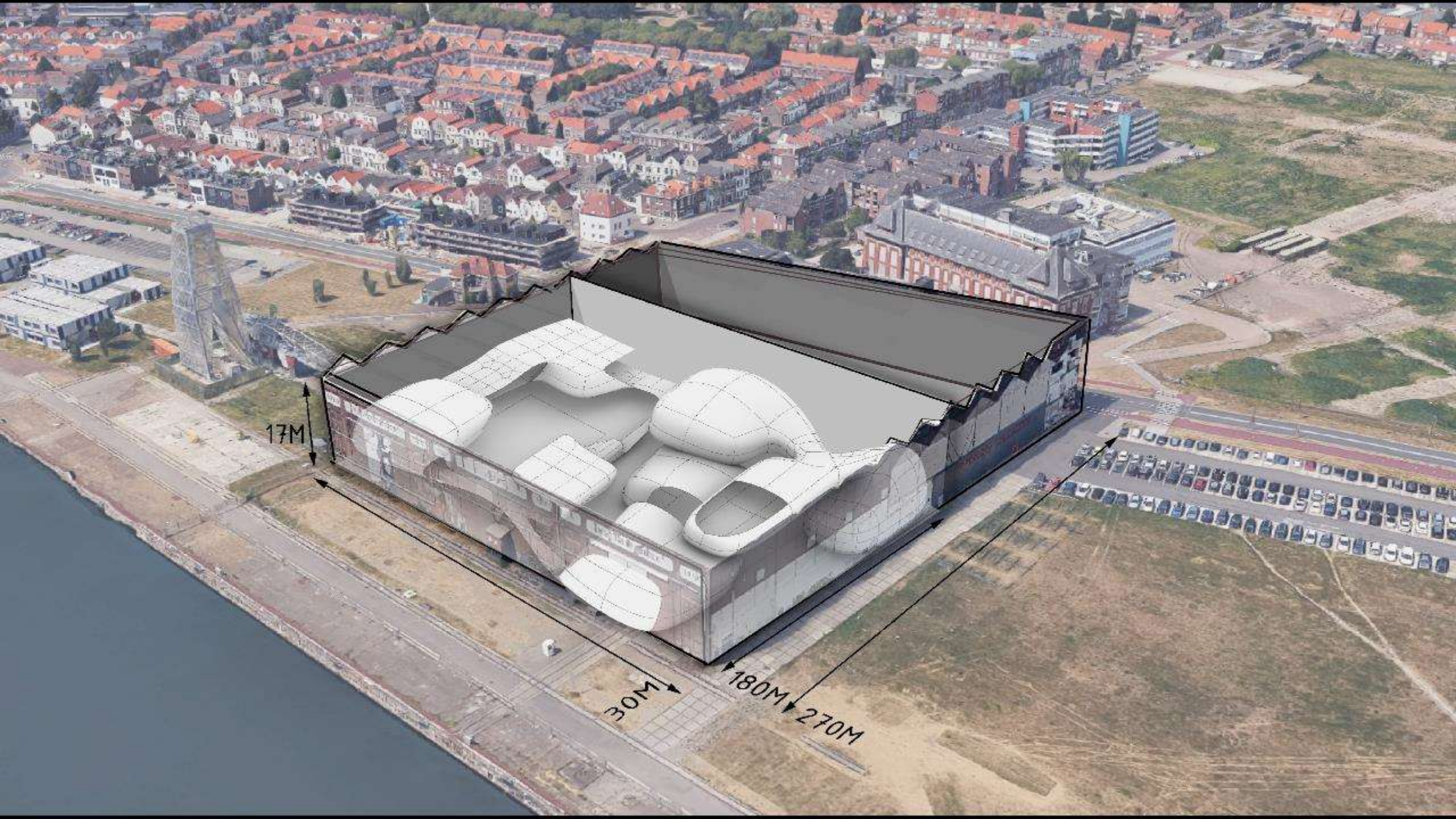


SECTION



SECTION



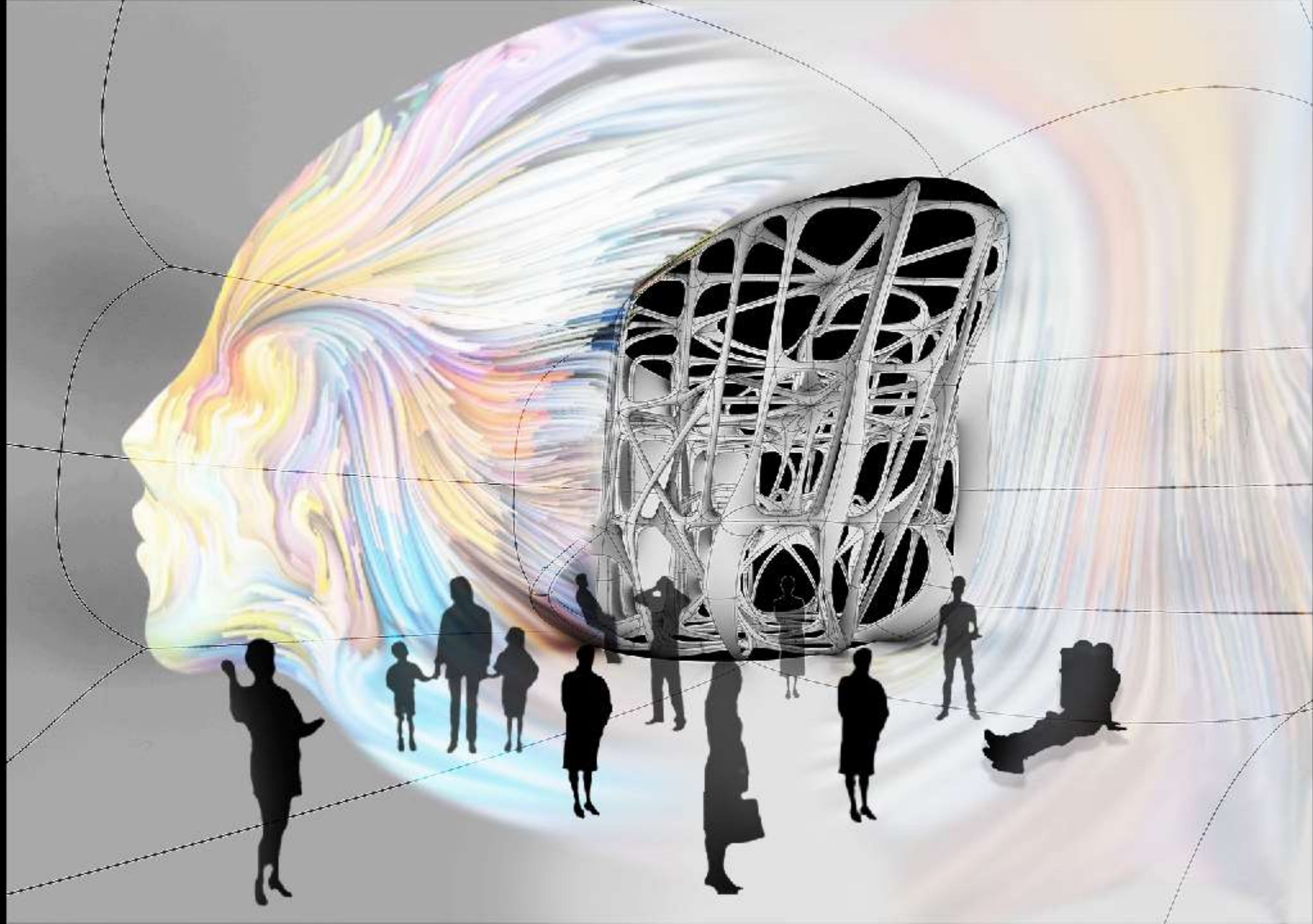


17M

30M

180M

270M



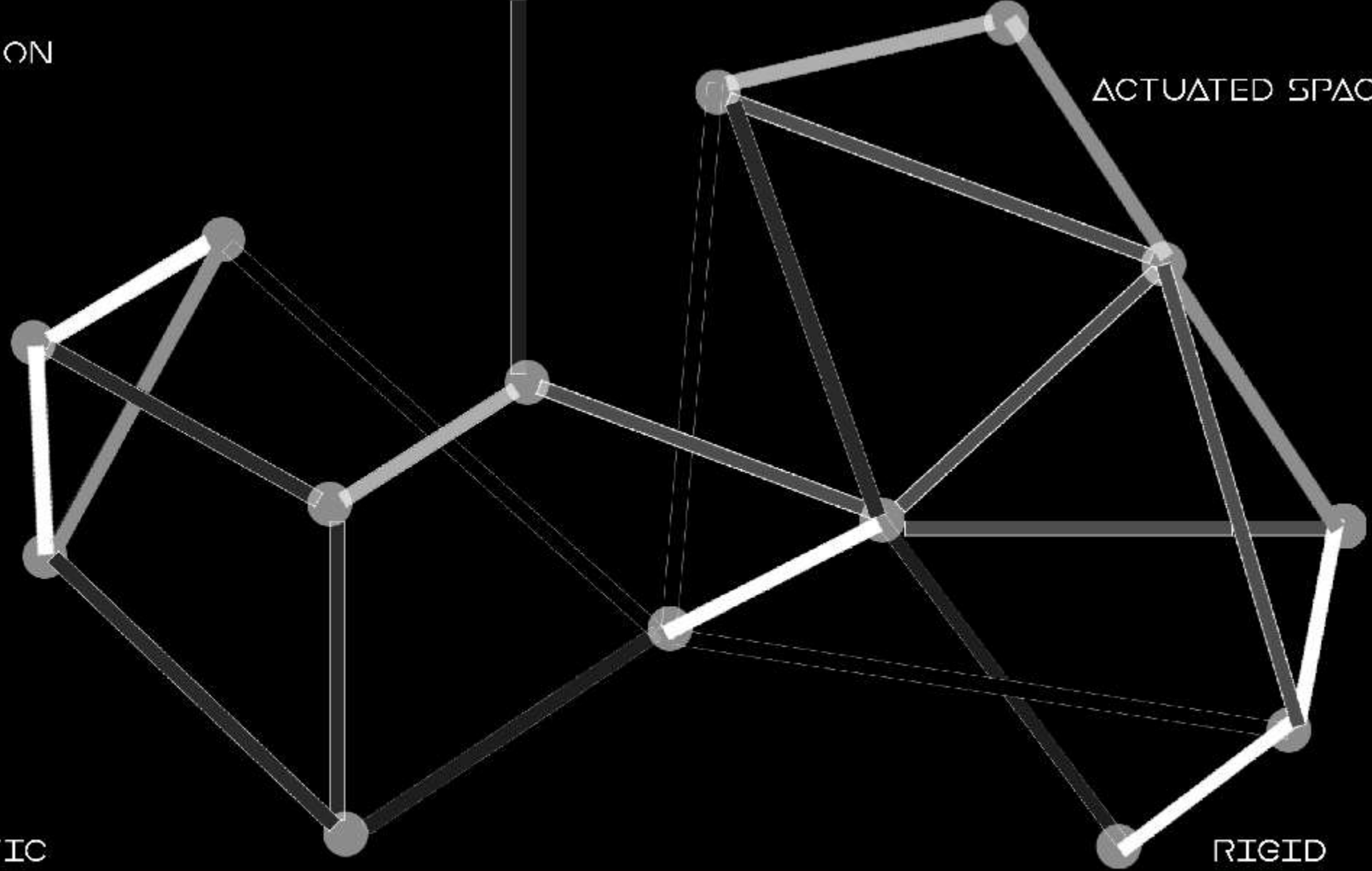
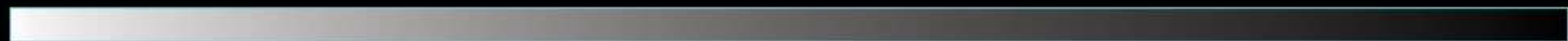
MATERIALIZATION

ACTUATED SPACE FRAME

MODULAR

STATIC

RIGID

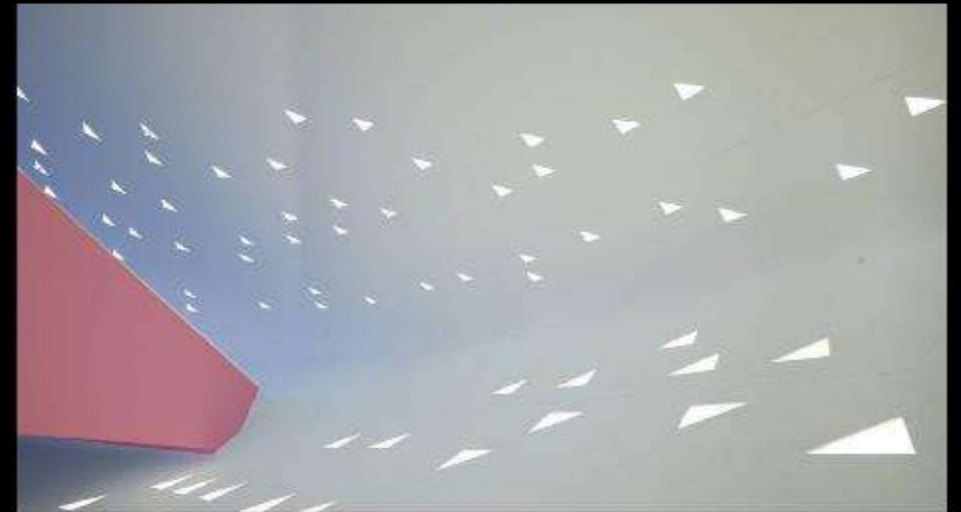
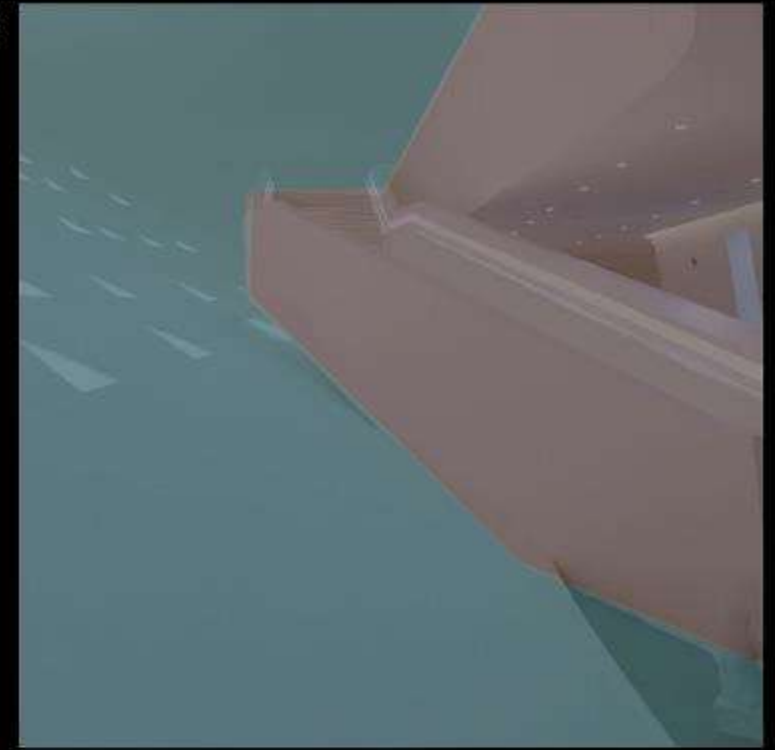


# RESEARCH TO DESIGN IMPLEMENTATION

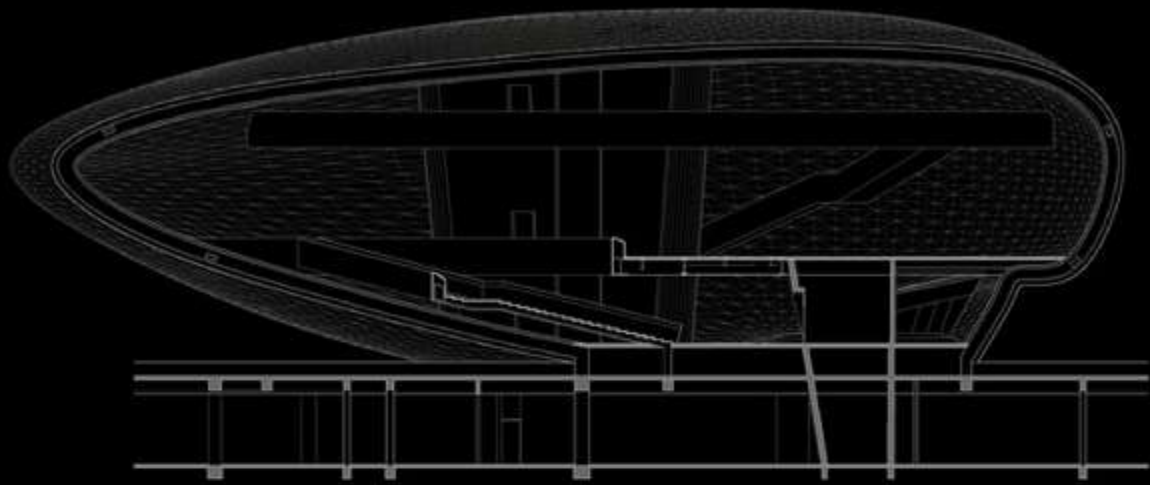
# OCT DESIGN MUSEUM

STUDIO PEI-ZHU

Goal:  
The goal was to create a space that is surreal to the subject matter but also transcendental in surrounding and feeling. The design of the interior relies on a continuous white curving surface that casts no shadows and has no depth.





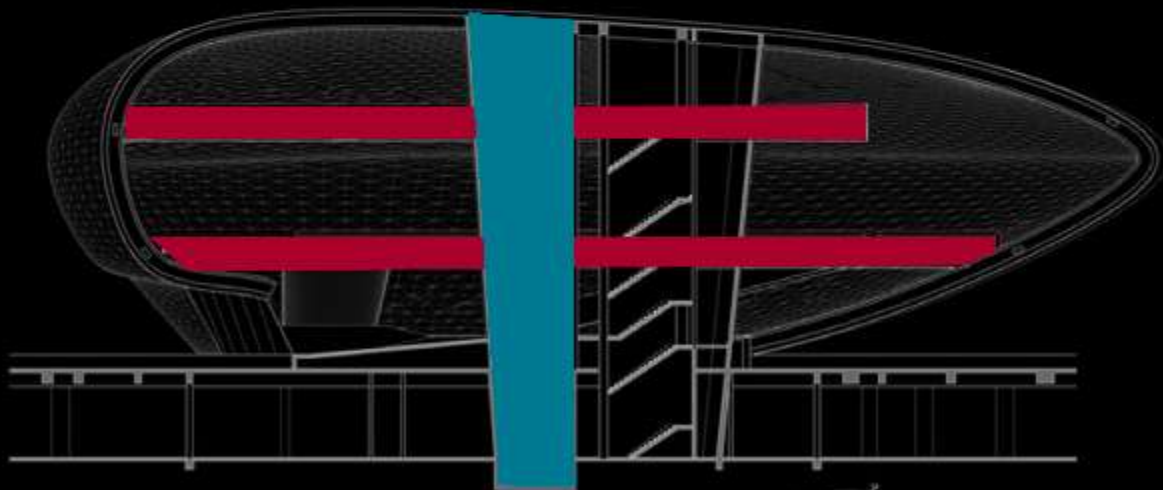


Section 1-1

0 1 2 5 10 m



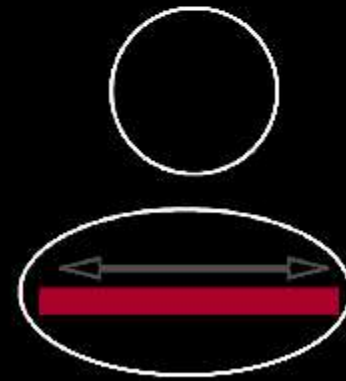
INTERACTIONS



Section 2-2

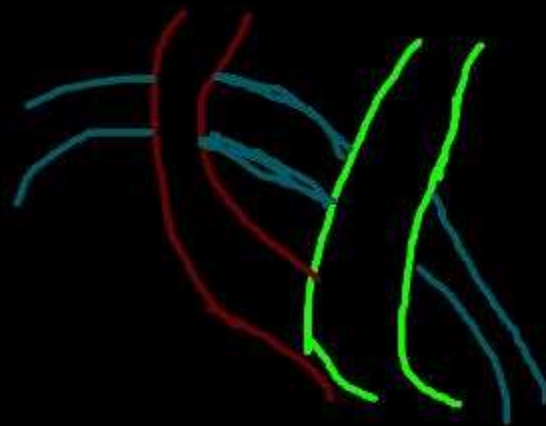
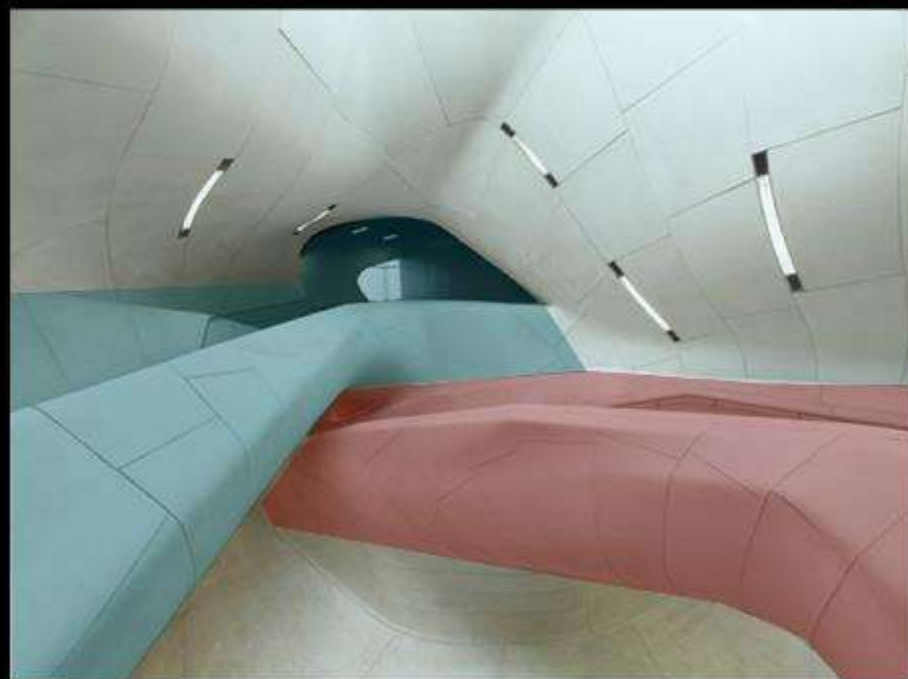
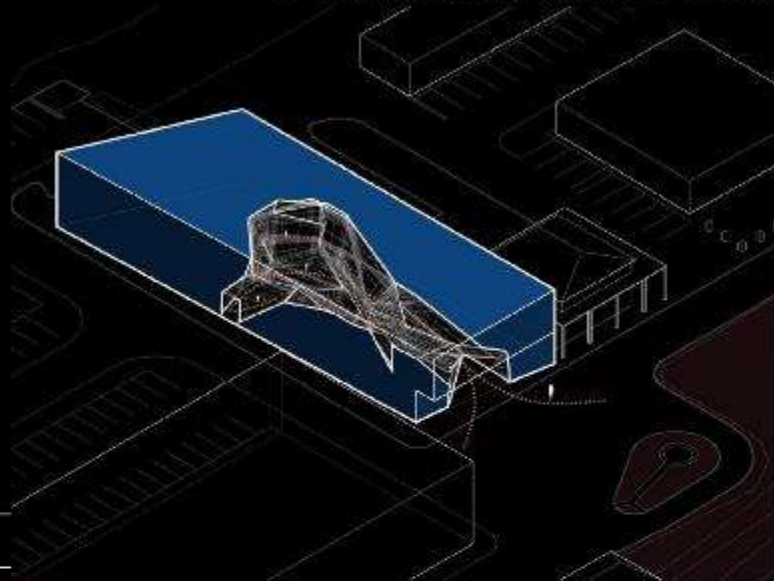
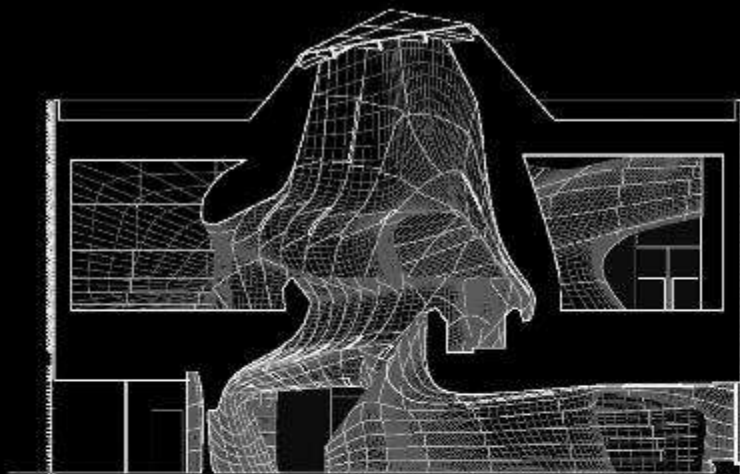
0 1 2 5 10 m

FORMATION OF THE ENVELOPE

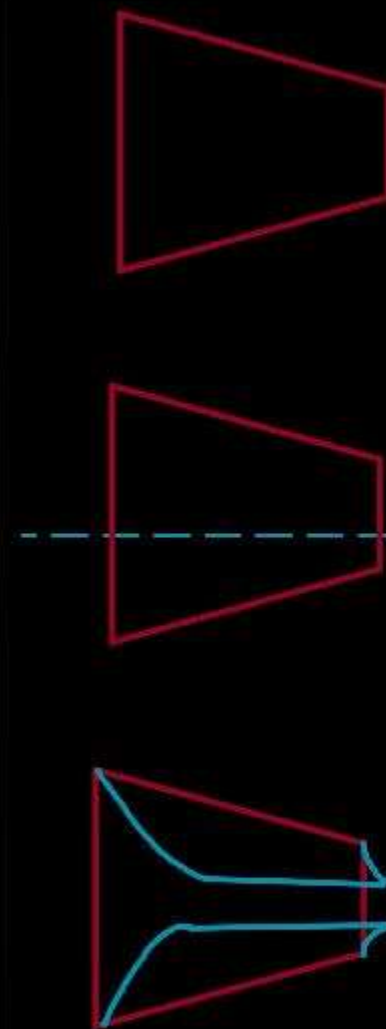


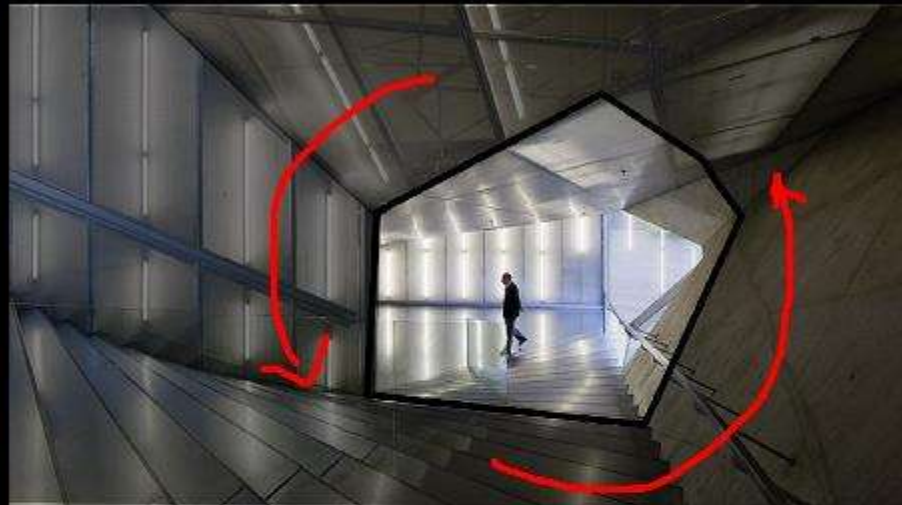
LOUISIANA STATE MUSEUM AND SPORTS HALL OF FAME

TRAHAN ARCHITECTS



FORMATION OF A "KNOT"





# ELBPHILHARMONIE HAMBURG



EXPERIENCING LENGTH THROUGH CIRCULATION



# HERZOG & DE MEURON

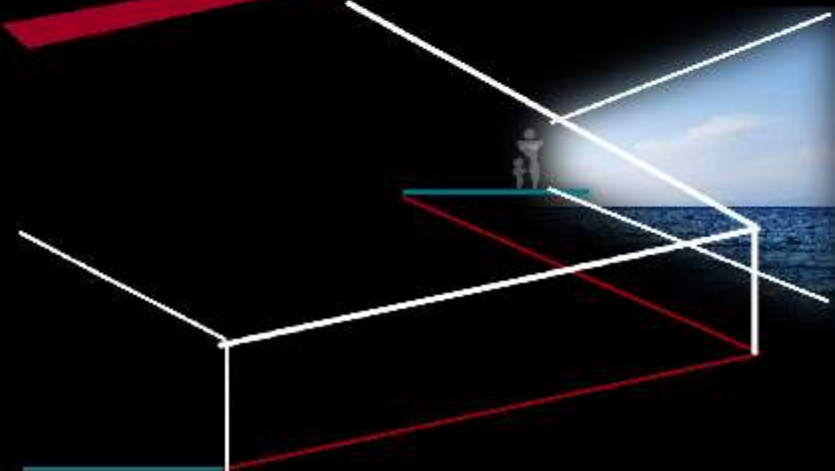


- Elbphilharmonie Hamburg  
Section
- 1 Main entrance
  - 2 Escalators
  - 3 Parking
  - 4 Performance space "Kammersaal"
  - 5 Conference area
  - 6 Restaurant
  - 7 Lookout
  - 8 Plaza
  - 9 Void Plaza
  - 10 Chamber Music Hall
  - 11 Foyer
  - 12 Main Concert Hall
  - 13 Canopy
  - 14 Air intake unit
  - 15 Construction space
  - 16 Hall
  - 17 Void tower
  - 18 Residential
  - 19 Void residential

SECTION 1  
scale 1:300



VANTAGE POINT

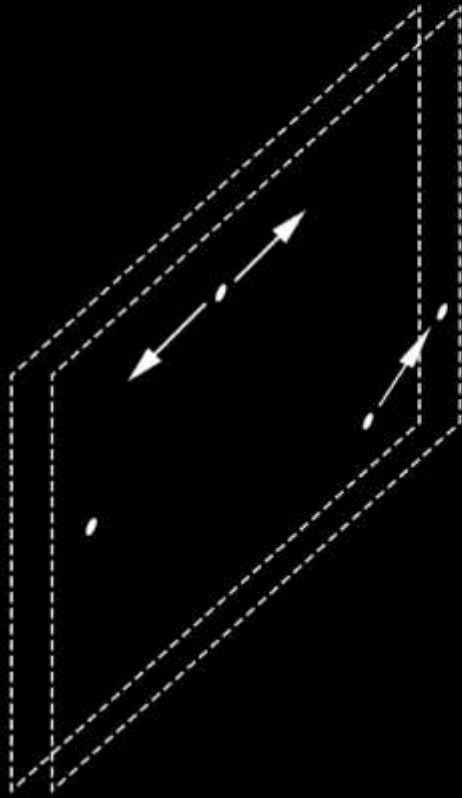


STREET CORNER

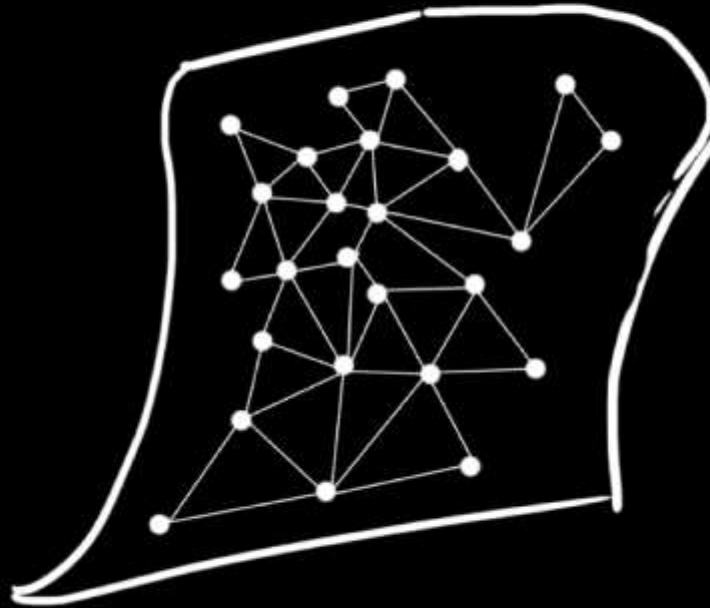
CARVING OUT CIRCULATION

# FURTHER STEPS

# SYSTEM OF JOINTS



- A. Fixed
- B. Moving in a fixed 2D plane
- C. Moving in 3D Space



Forming a point grid layout based on Levels of Interactivity

Connecting them using rules to form skeleton

A - A

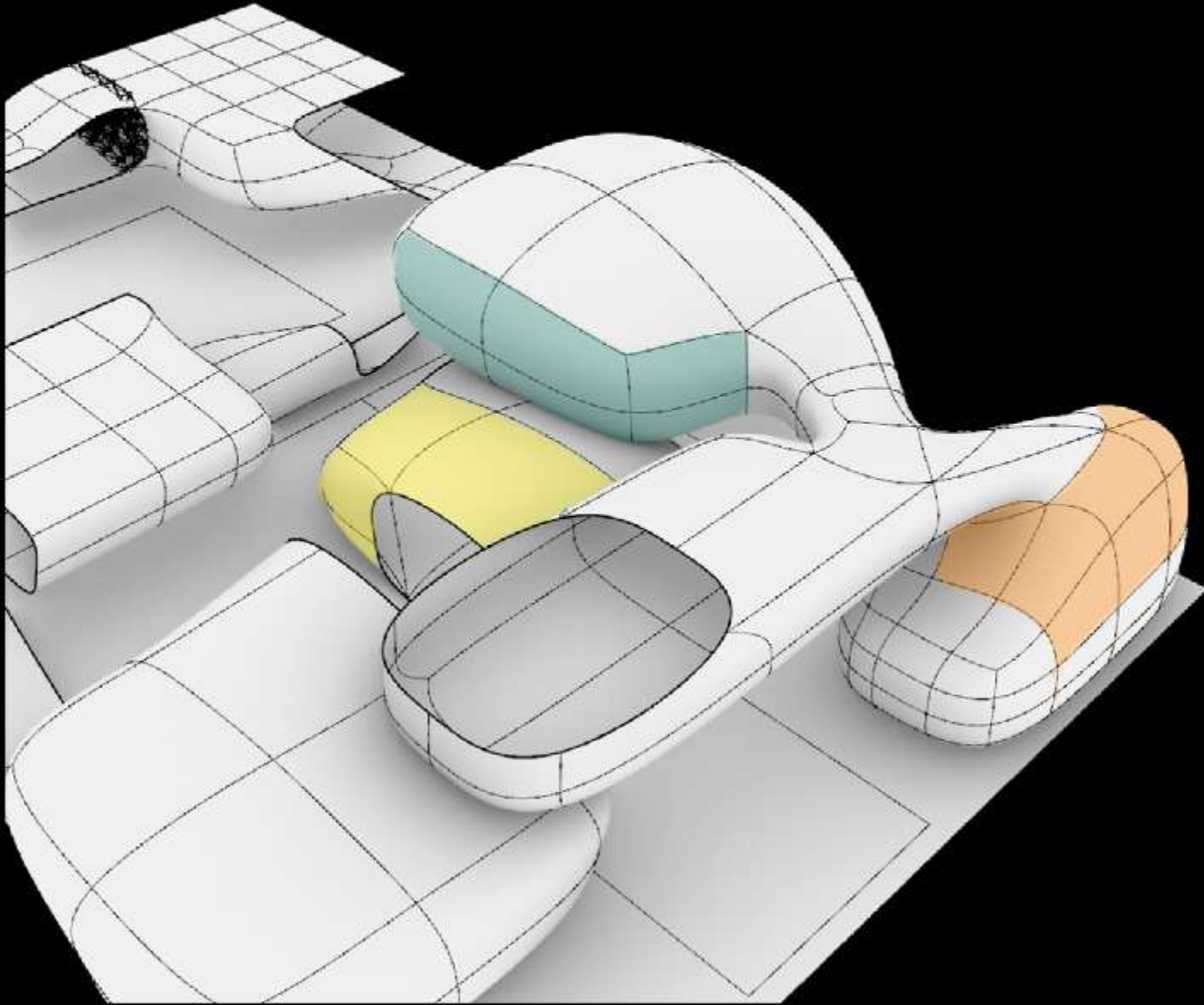
A - B

B - B

A - C

B - C

# SKELETON JOINT DISTRIBUTION STRATEGY



LIGHT CONDITIONS

INTERACTION TIME

VISIBILITY

FUNCTION

WALKABILITY

ACOUSTICS

STRUCTURE



USE SOFT ROBOTICS TO ENHANCE AND OPTIMIZE SPATIAL USER EXPERIENCES