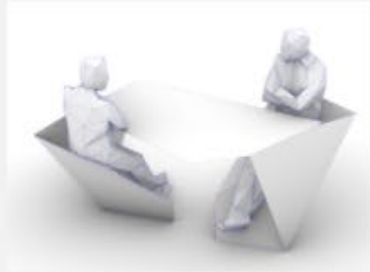
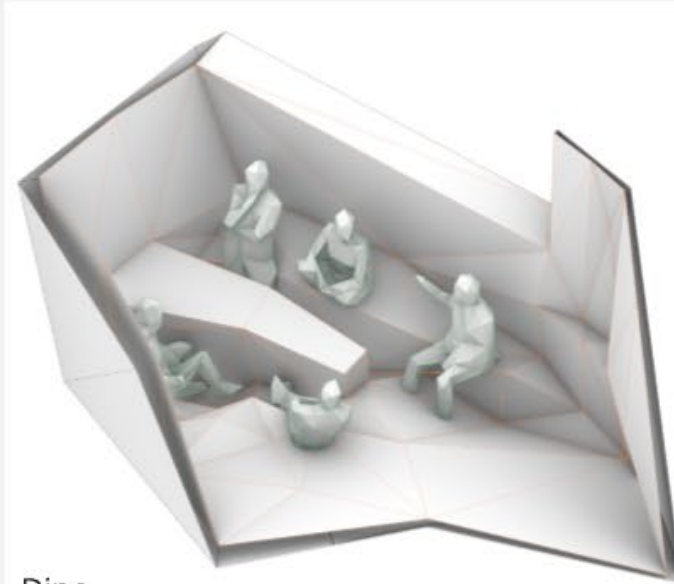


Eat

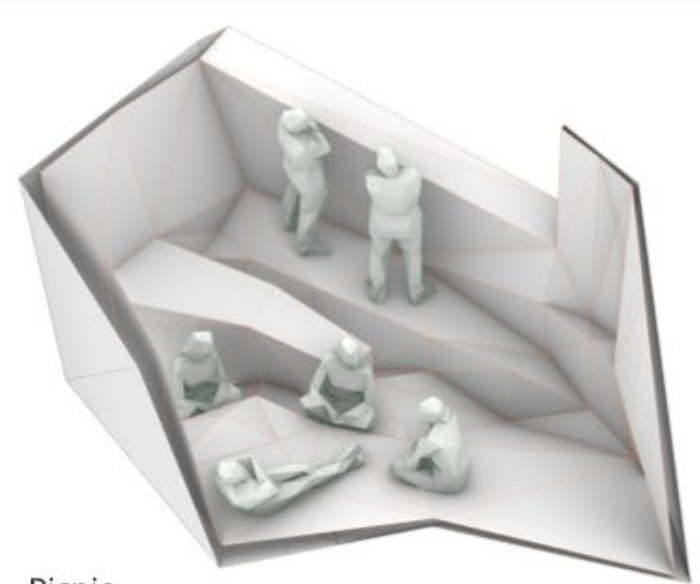
Dine



Picnic



Dine



Picnic

Work

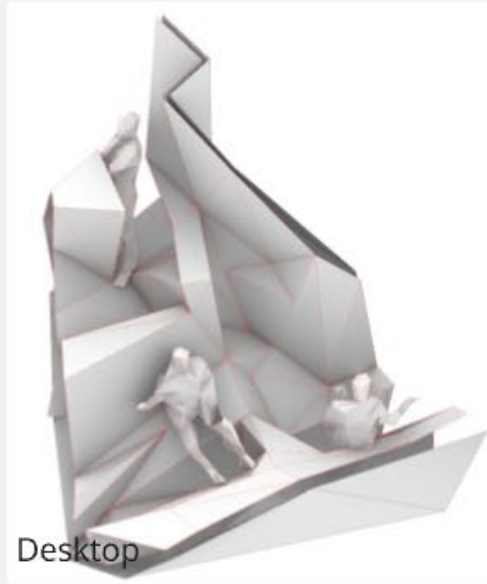
Desktop



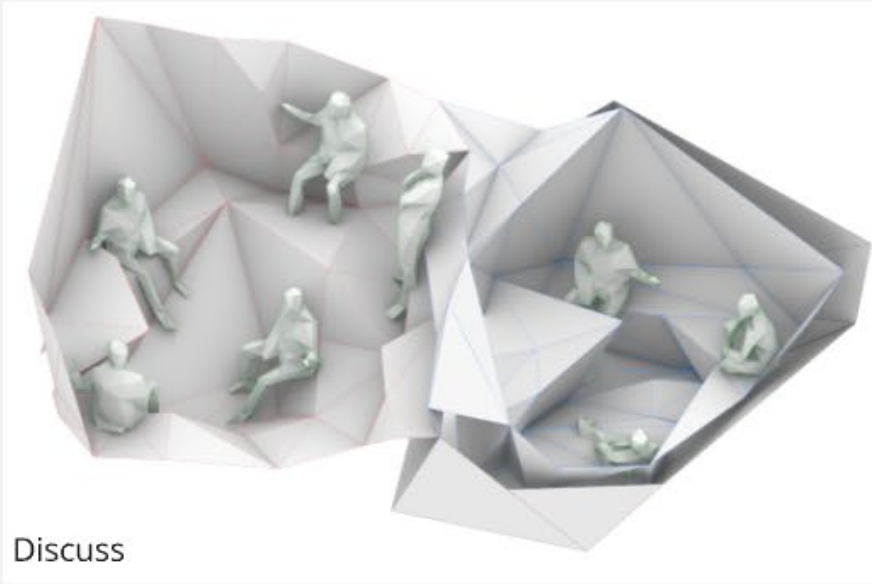
Discuss



Desktop

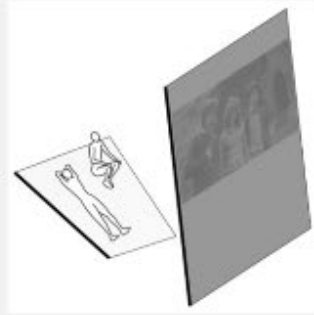


Discuss

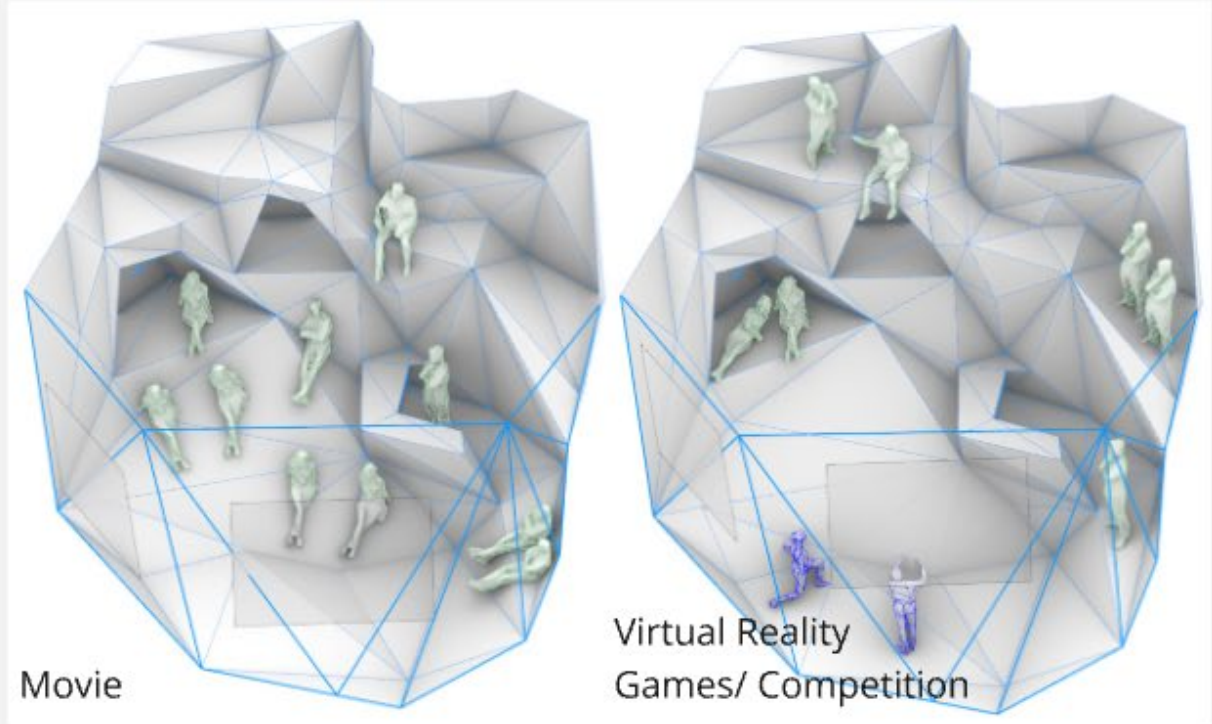


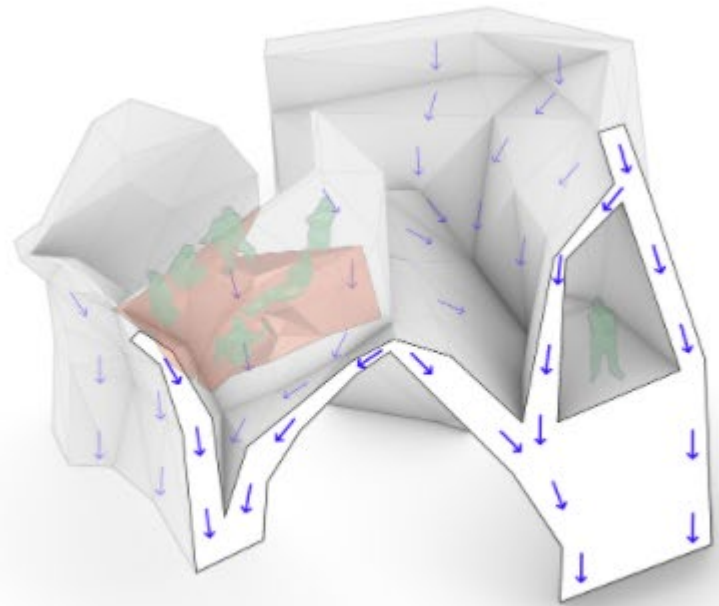
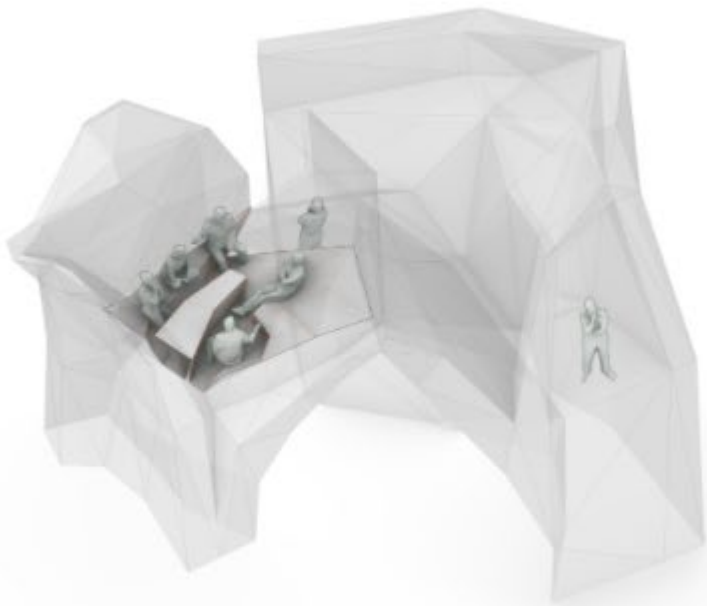
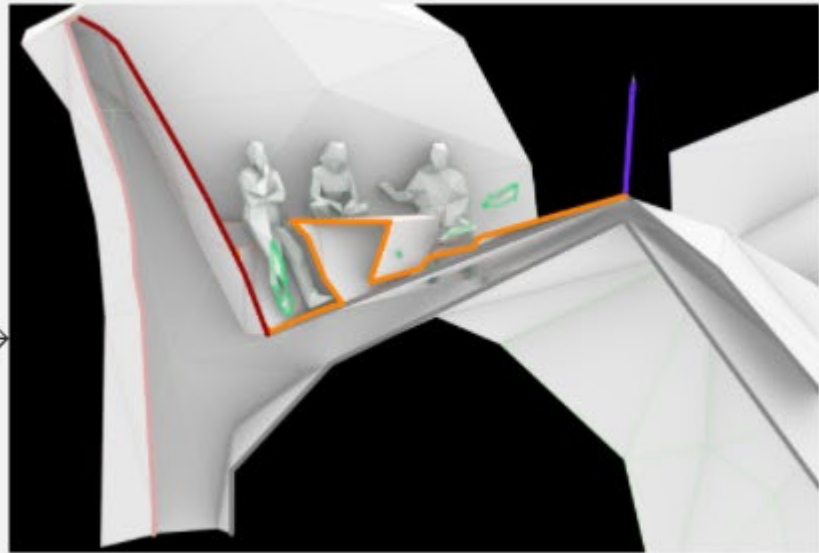
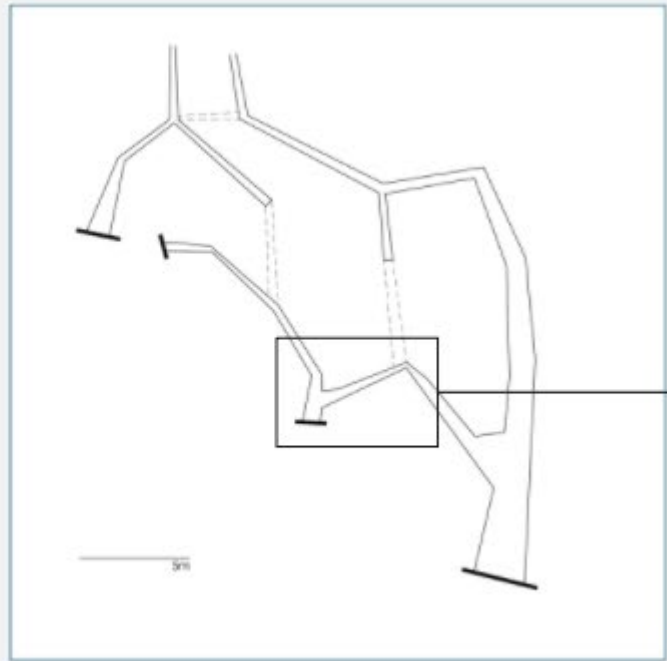
## Social

Movie



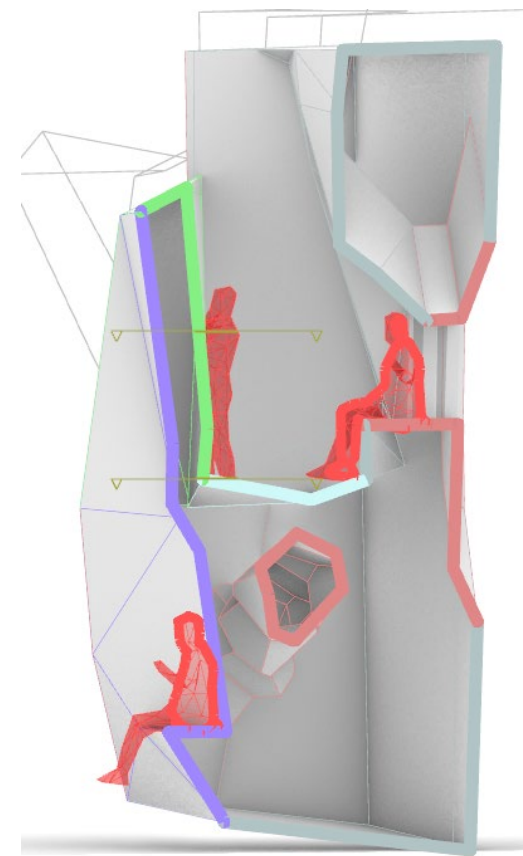
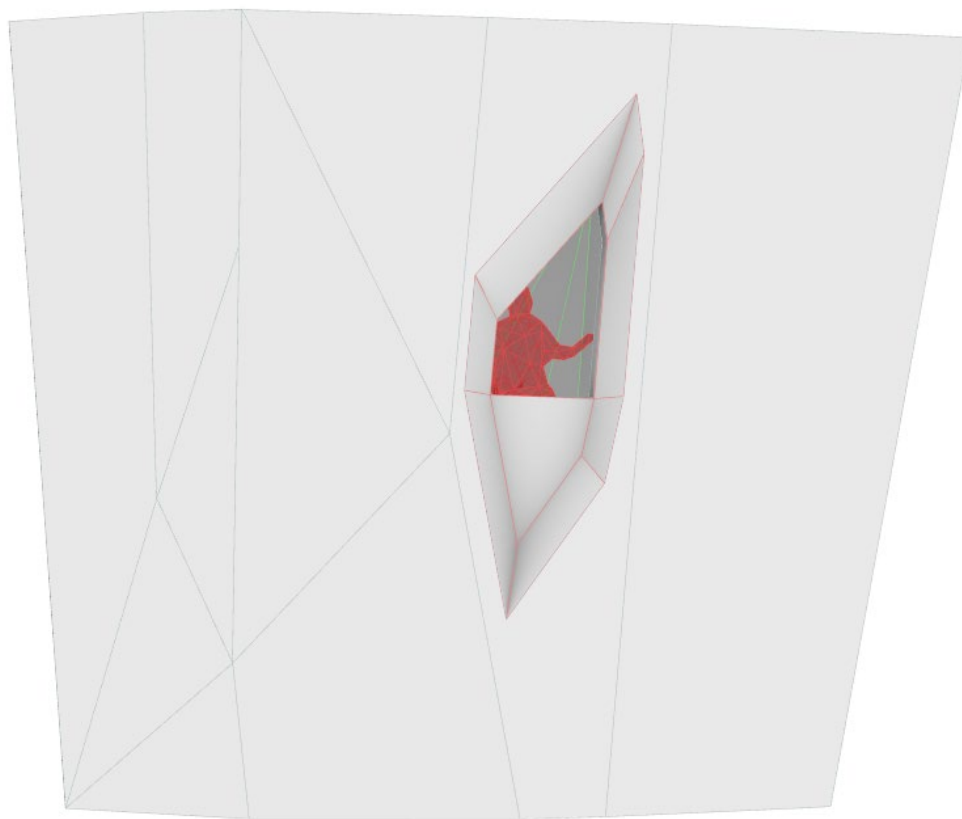
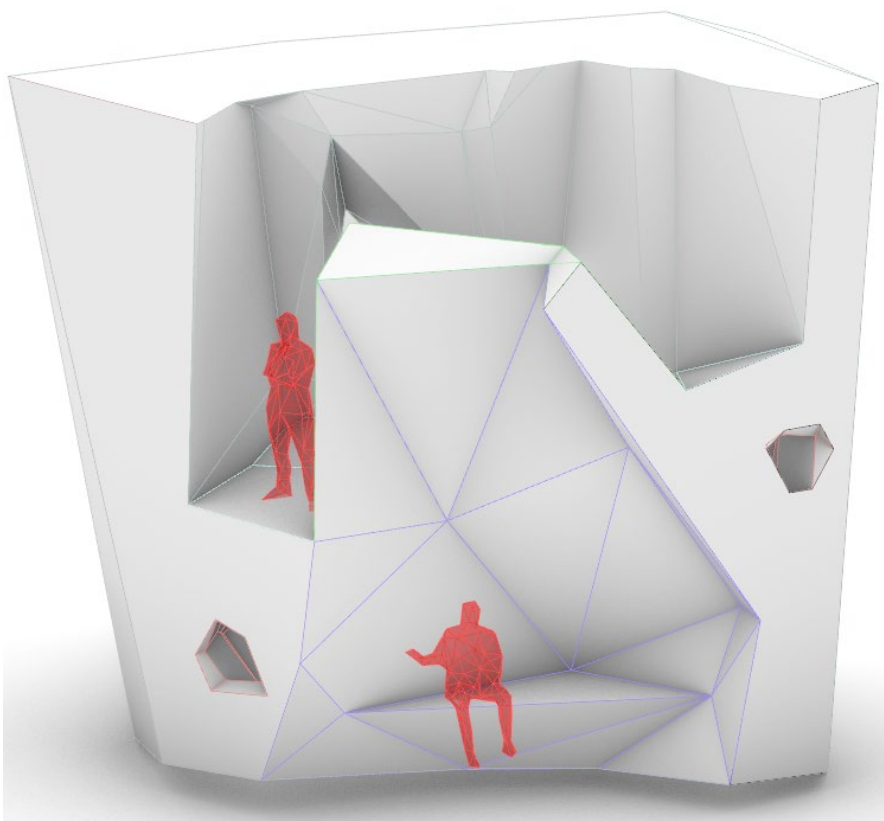
Virtual Reality  
Games/ Competition

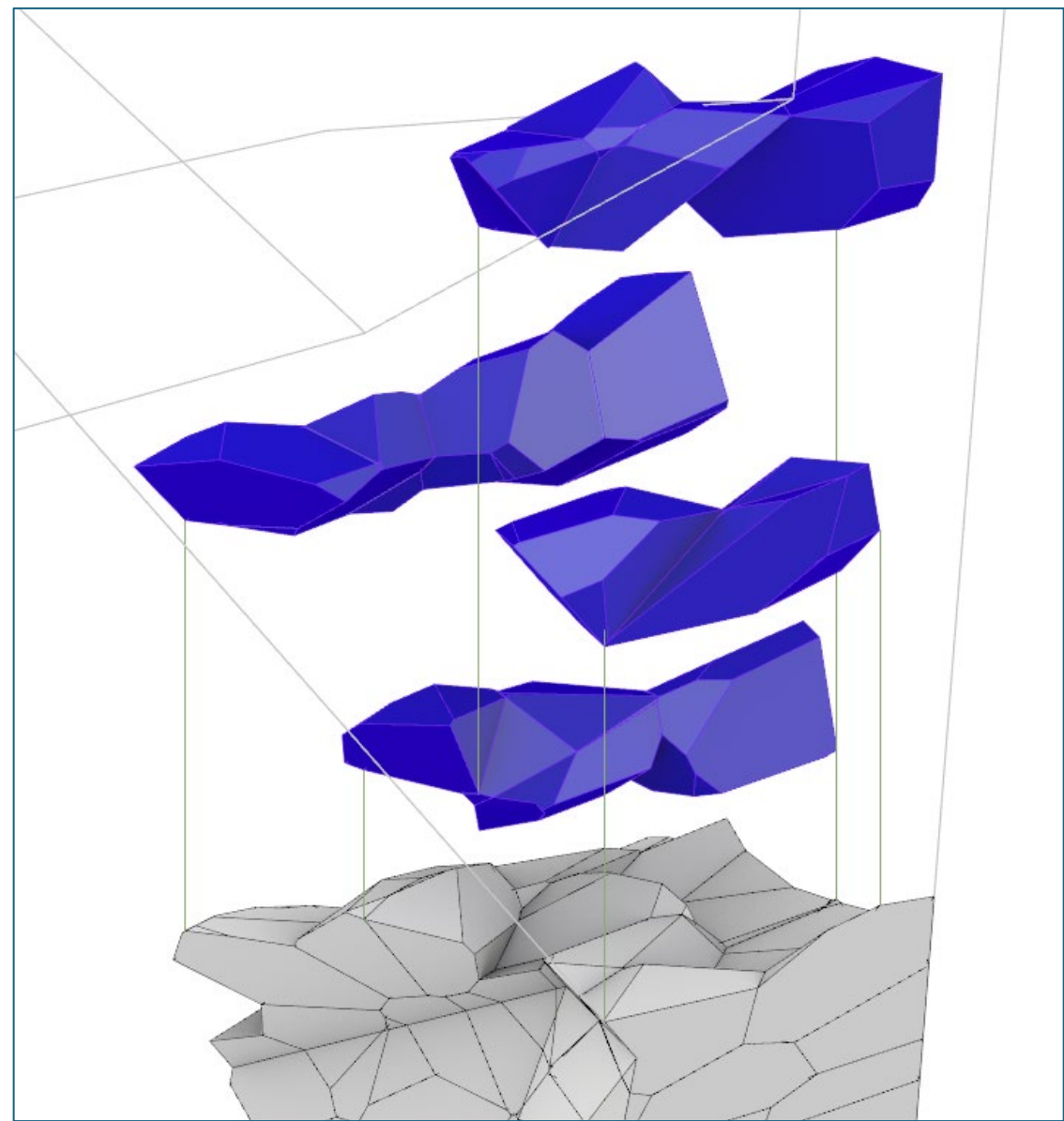
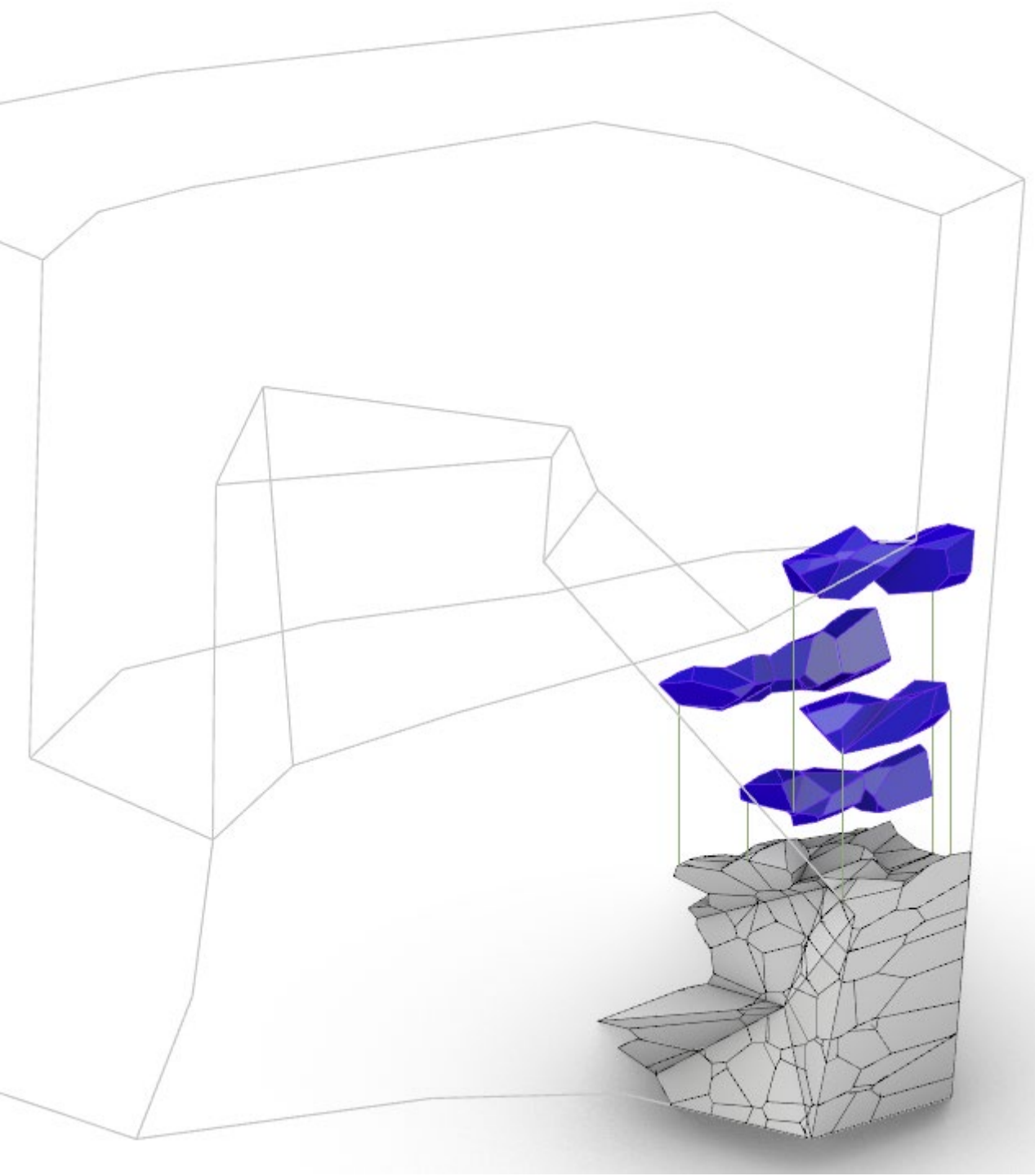


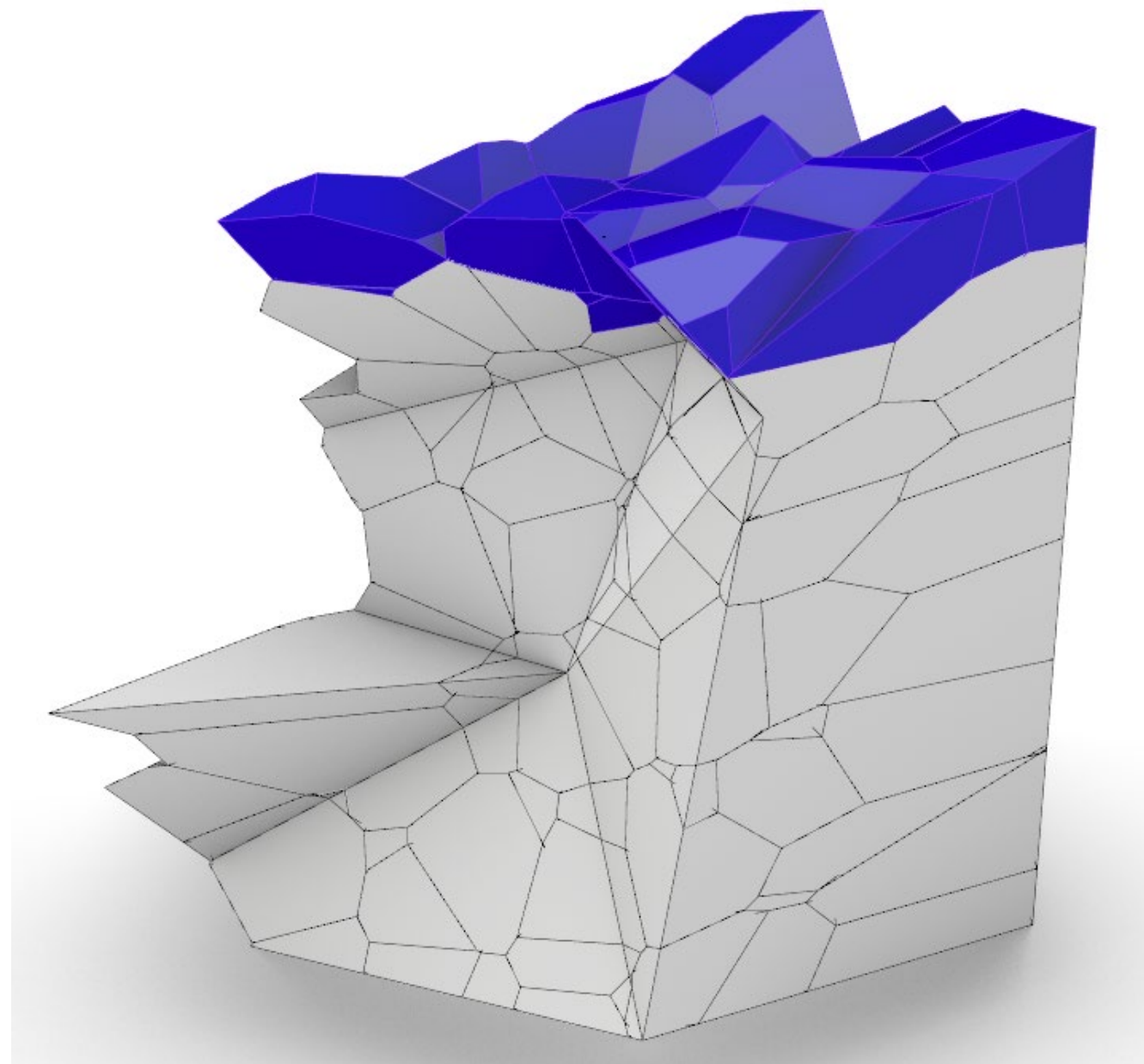


Thickness -> Optimisation

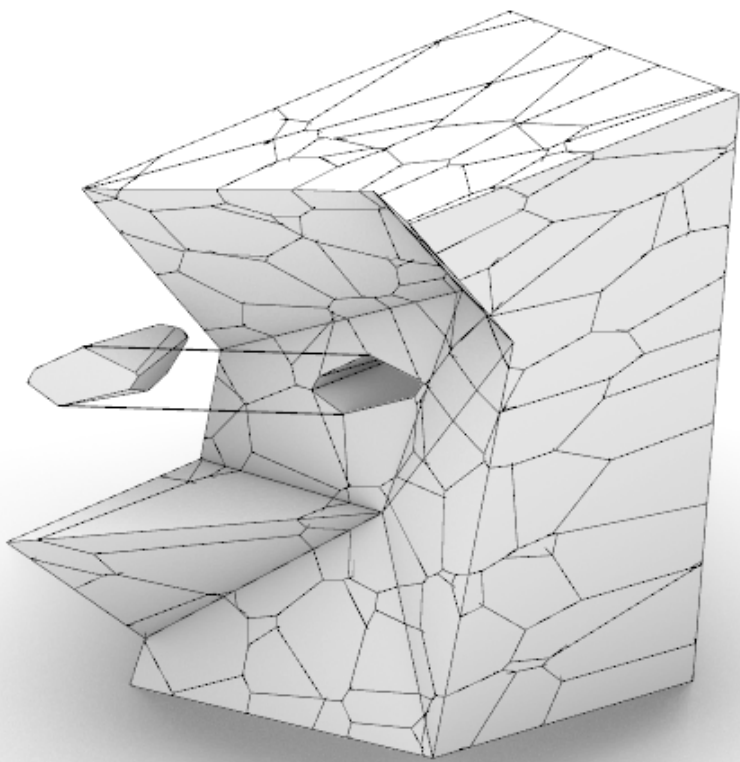




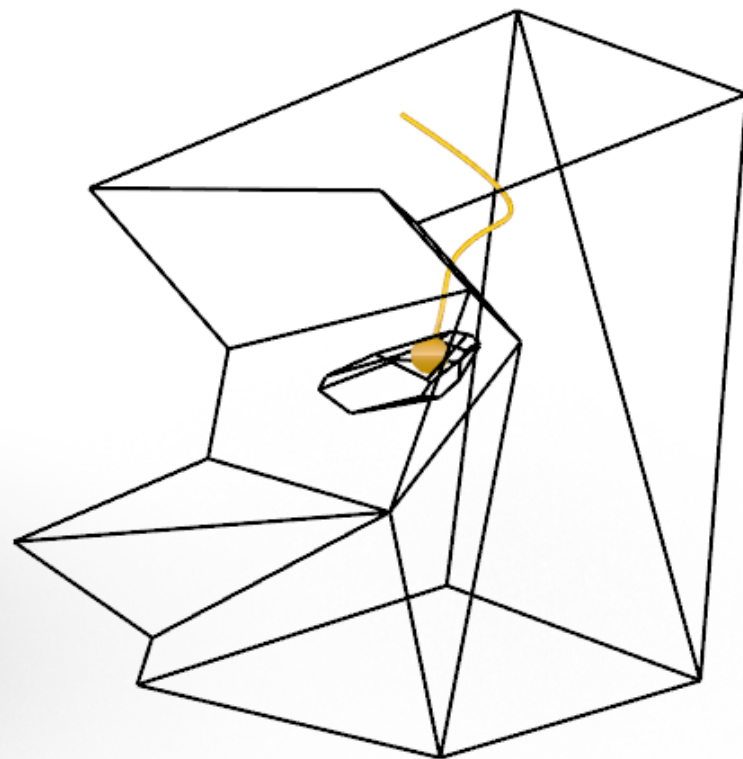




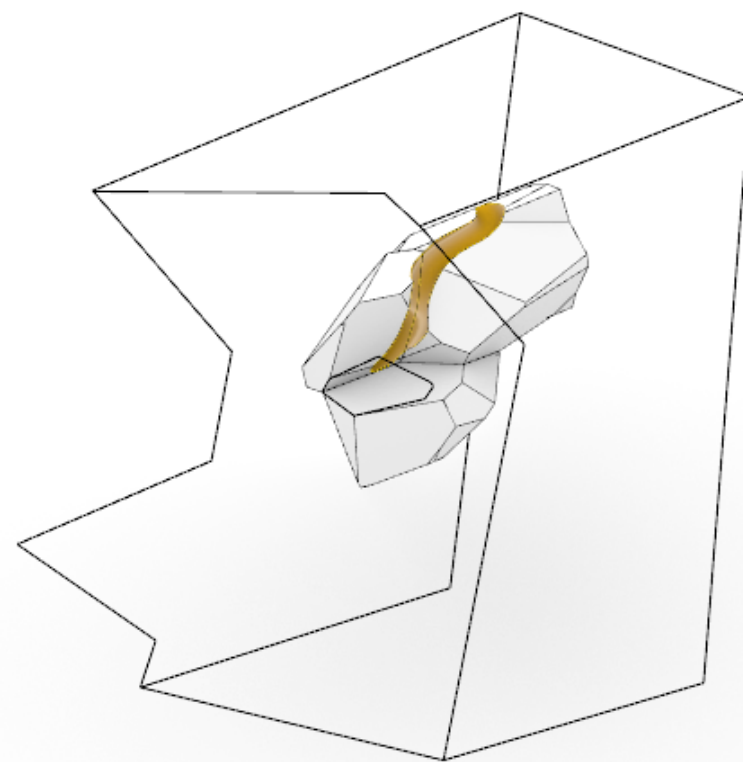
1. Holes on wall are created by removing components



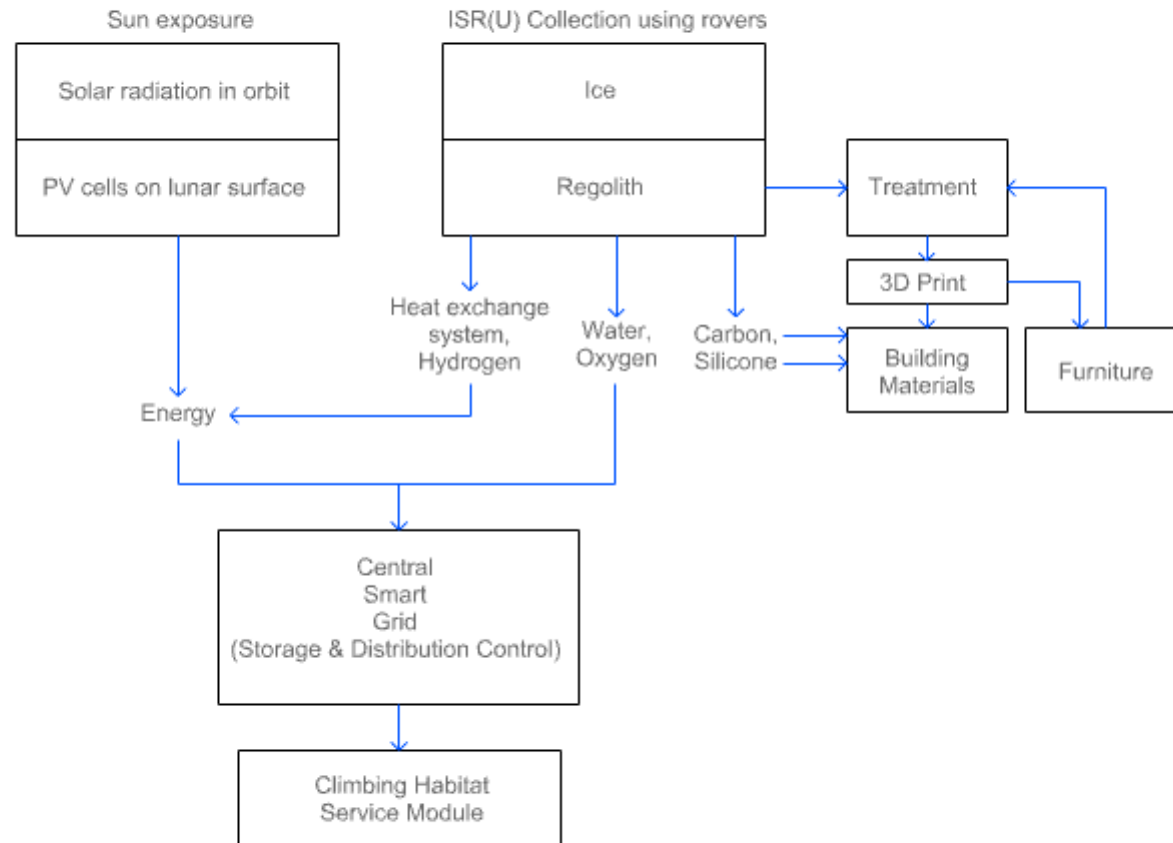
2. Holes are used as climbing holders and lighting fixtures



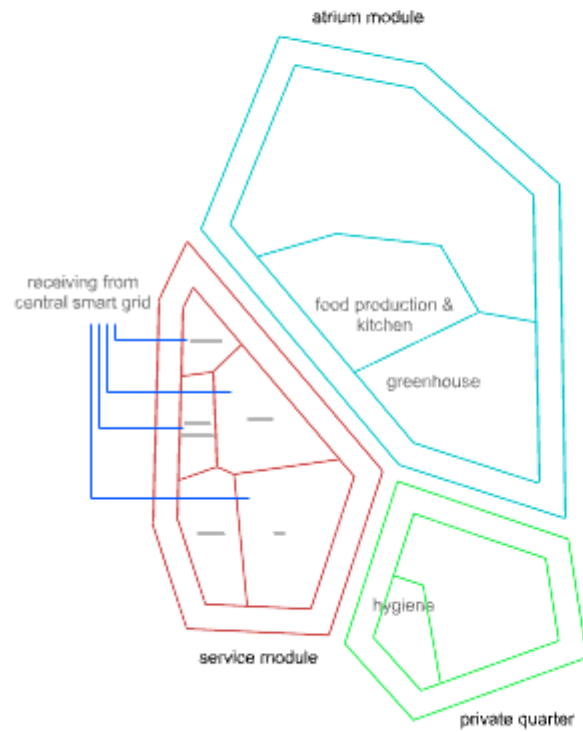
3. Pipe and cable sub-channels are integrated in the components design & printing process



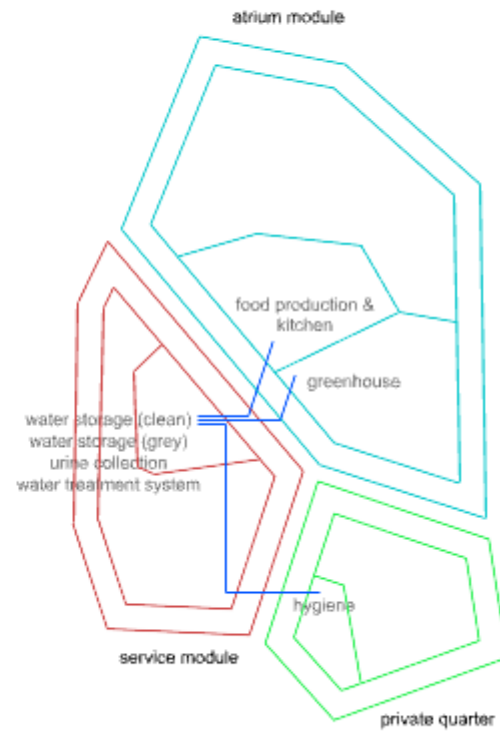
## Energy & Resources Collection/Distribution



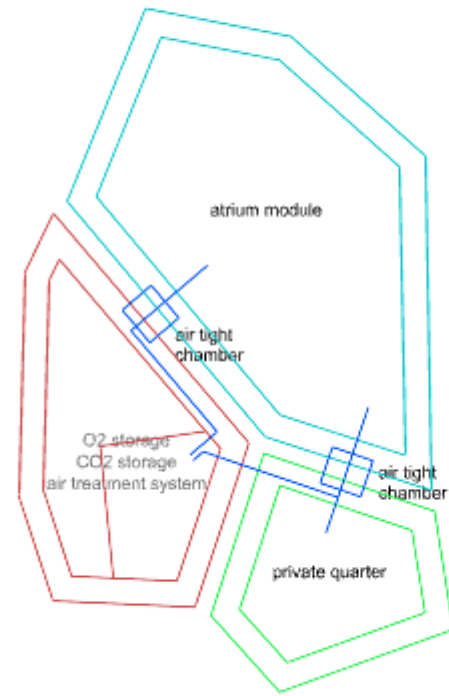
## Overall Building Service System Components



## Water



## Air

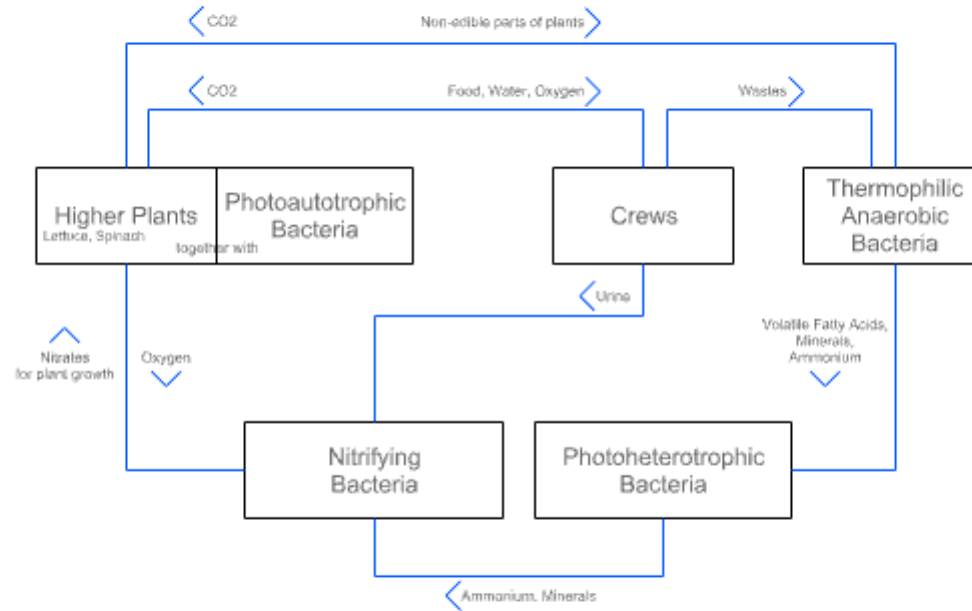


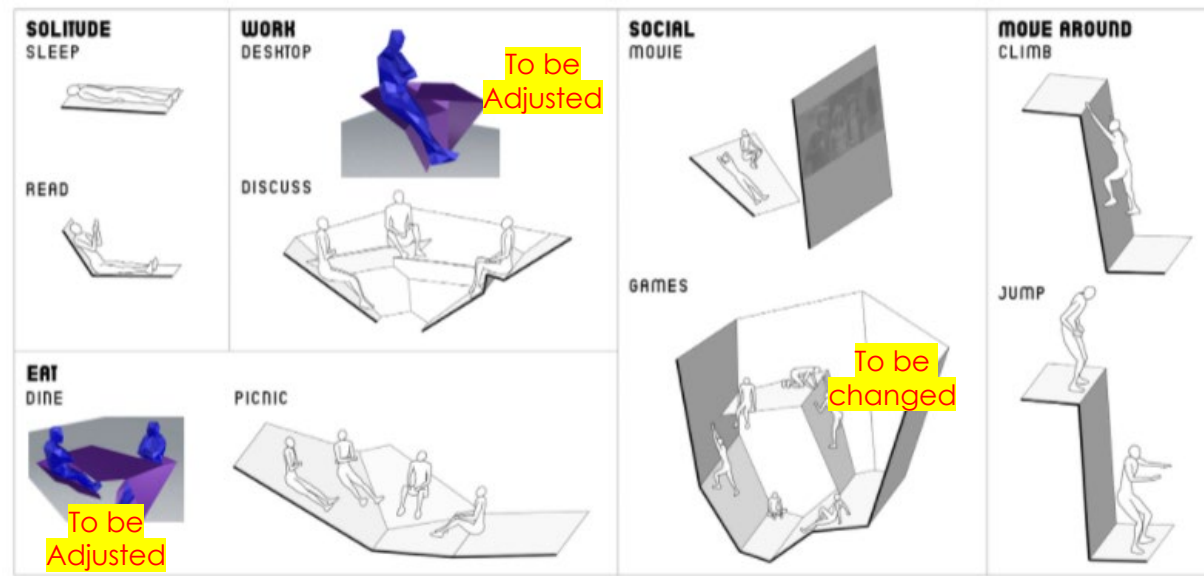
## Temperature

1. Heat exchange system for heating and cooling
2. Site & Building envelope (Lava tube, thick regolith, silica aerogel)
3. Furniture integrated heating system
4. Suit/ clothing integrated heating system

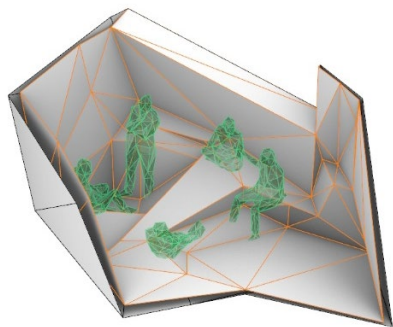


## Life Cycle/ Loop (Melissa)

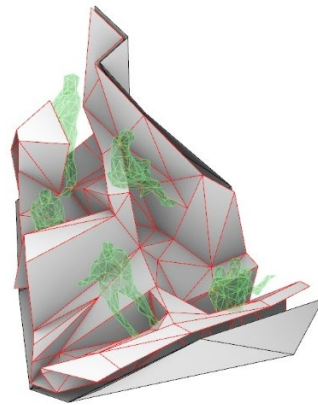




Dine

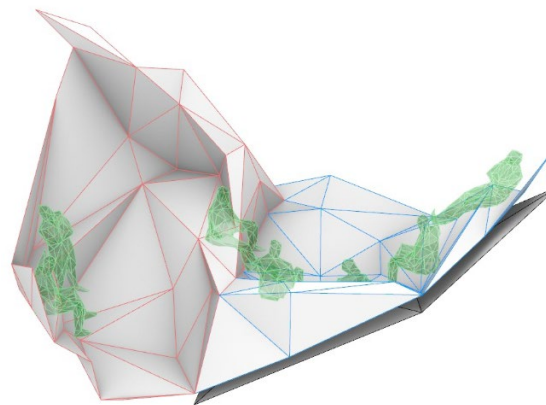


Work



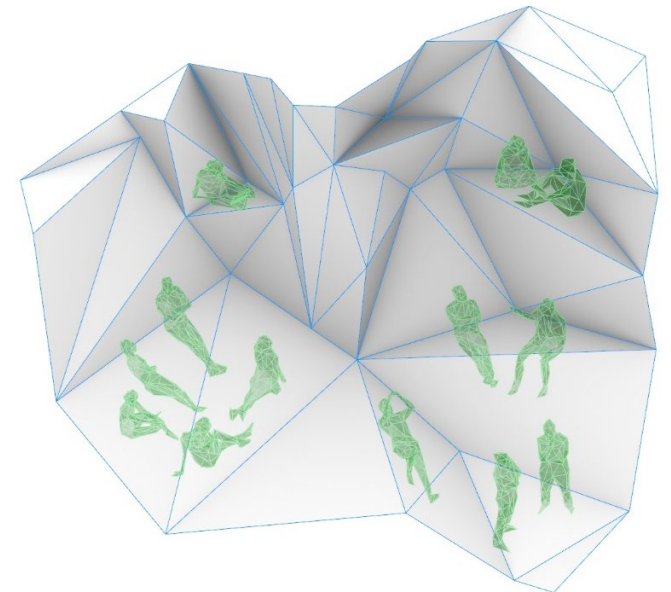
Personal/  
Focused

Work

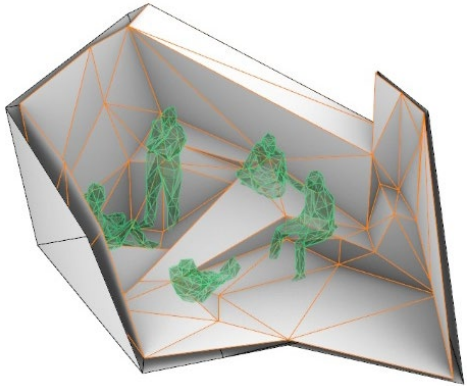


Communal/  
Discussion

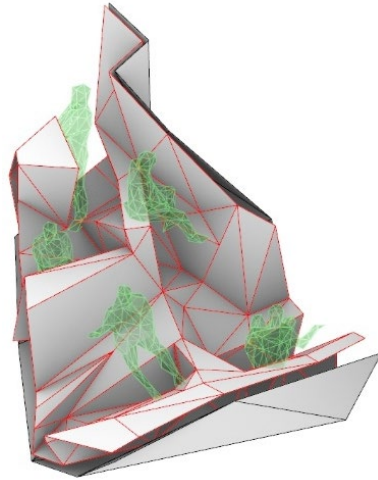
Socialize



**Dine**

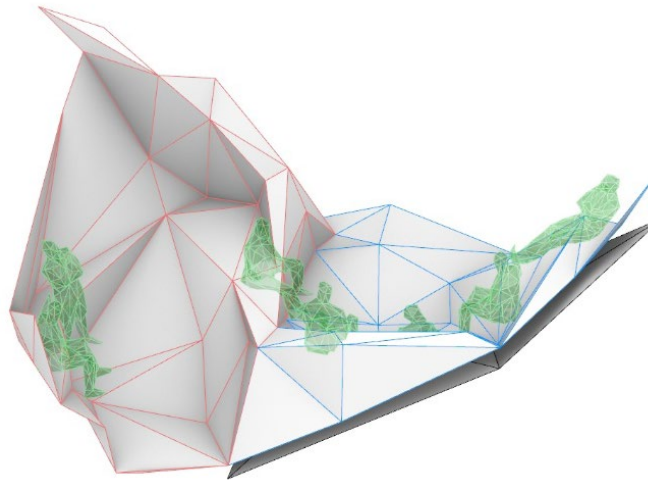


**Work**



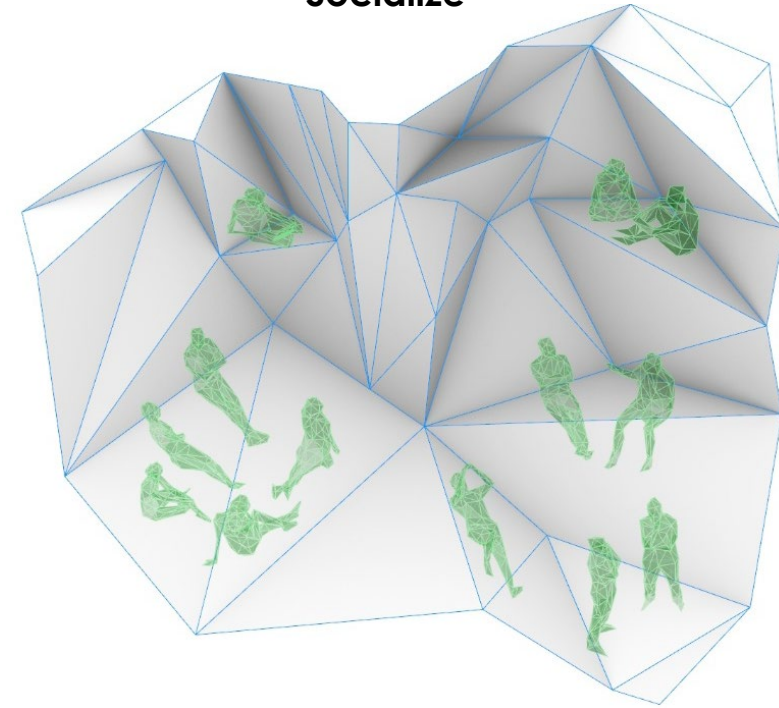
Personal/ Focused

**Work**



Communal/ Discussion

**Socialize**



**Design Objective**

Furniture integration **vs** landscape adjustment/ extension

**Resolution/ Specificity of Surfaces**

Stable surfaces i.e. for food/ laptop

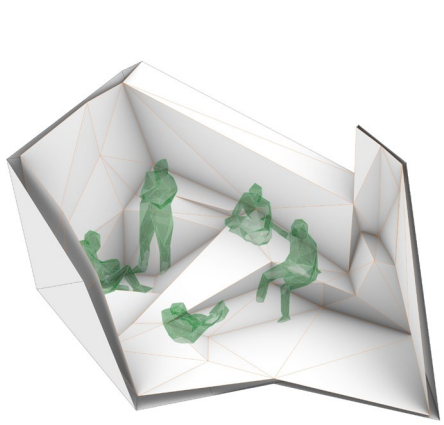
**Spatial Zoning**

Privacy levels  
Specific predetermined function **vs** flexibility for further development

**Space <-> Body**

Size, level difference, degree of openness

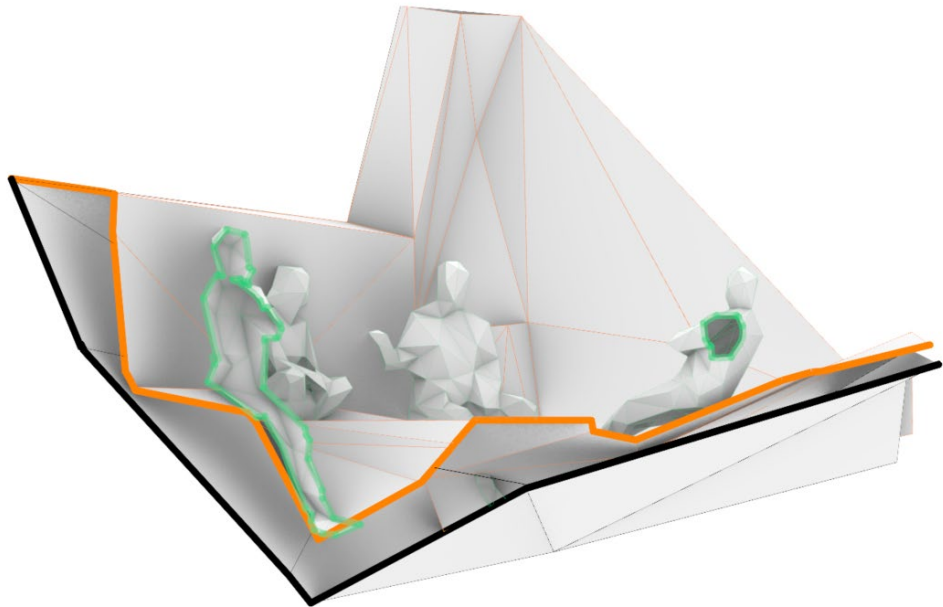
## Dine



Isometric

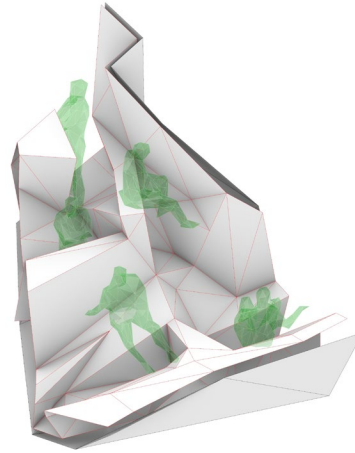


Plan

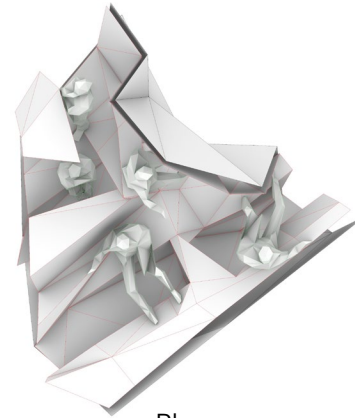


Section

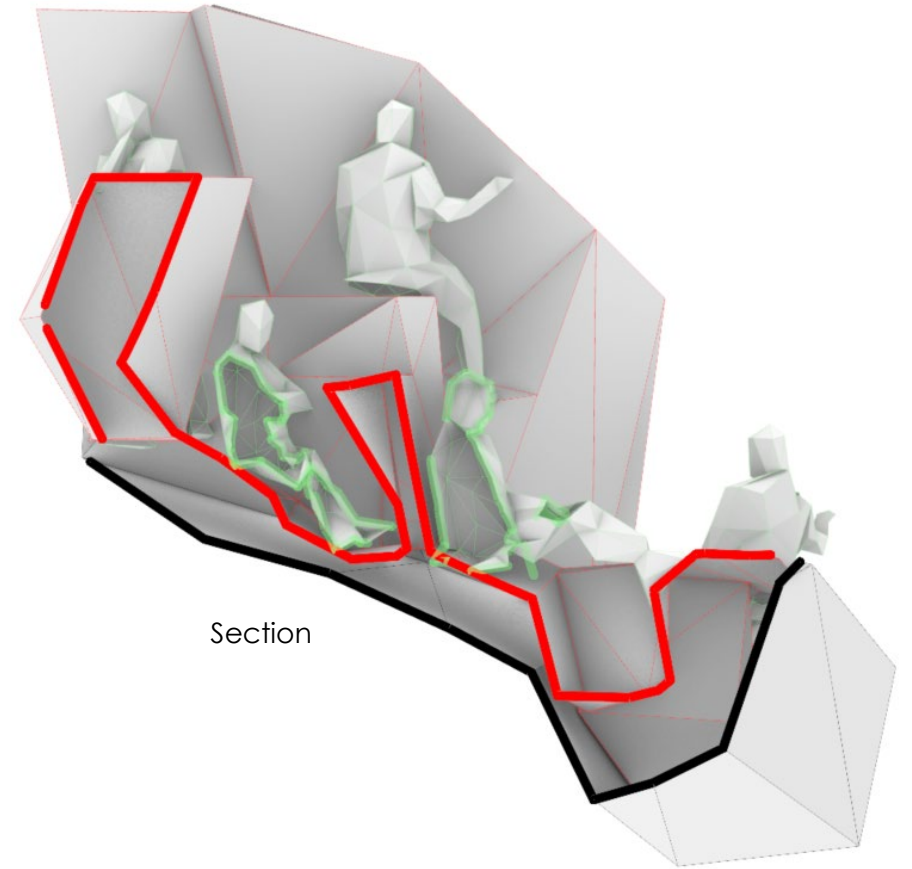
## Work



Isometric



Plan



Section



# Life cycle Diagram

## Energy

radio frequency to Earth

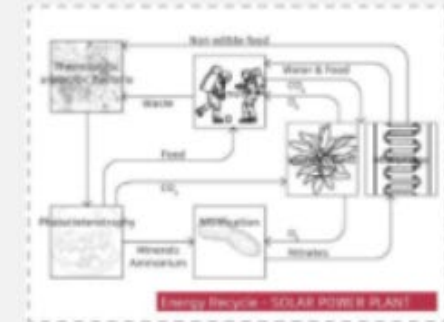
Solar Radiation in orbit

Photovoltaic PV cells (on surface) for Beam Capture

Electricity

Smart Grid

Energy Transmission with rovers



## Ice/ Water Collection

Distribution -> Storage

Smart grid and swarm rovers  
see: water storage system by ESA

Main areas of habitats (Living, Working)  
Planters (Food Gallery/Greenhouse)

Grey water treatment

## Climate

Body Integrated Climate adaptation

Localized suit/ sensors

Habitat Zoning Climate Control

Localized suit/ sensors

## Physical integration in design process



Planters

Wall planters  
Ground planters

Food  
Oxygen  
Water

Human products  
CO2 -> collected  
Urine -> Drinkable Water  
Feces -> Compose

Furniture

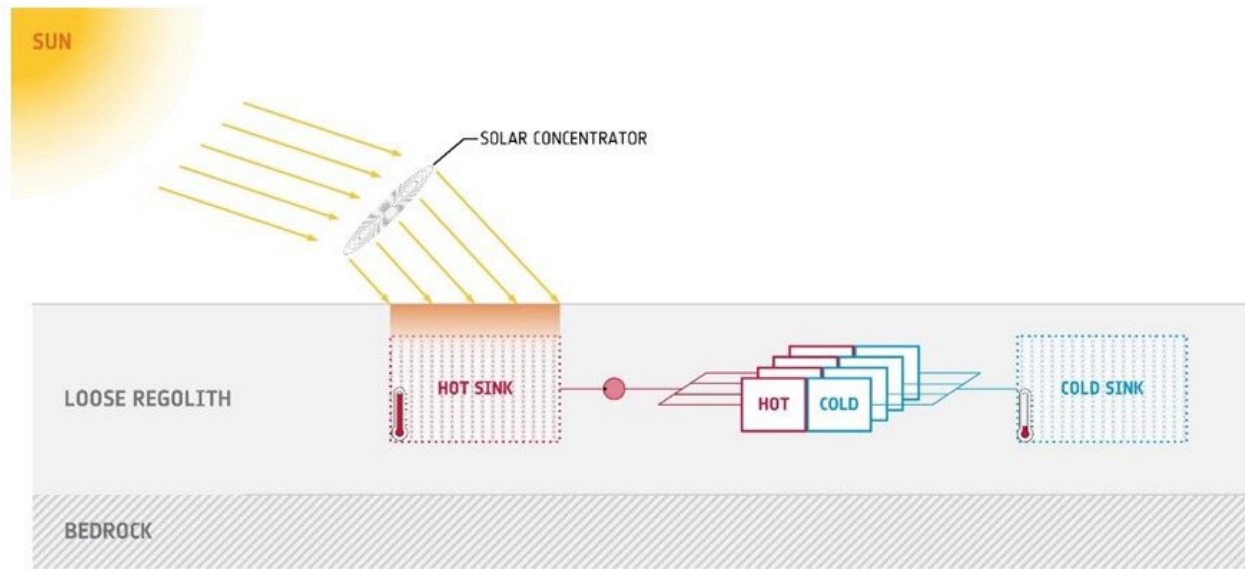
Re-use  
(Re)Up-cycle

Melt & Print from materials of previous furniture

Life support services

Water  
Electricity

Pipes, Wires



### External/active system

(Scalable solution)

Heat exchange system comprising multiple mirrors, processed lunar soil, a heat engine and heat pipes (ESA)

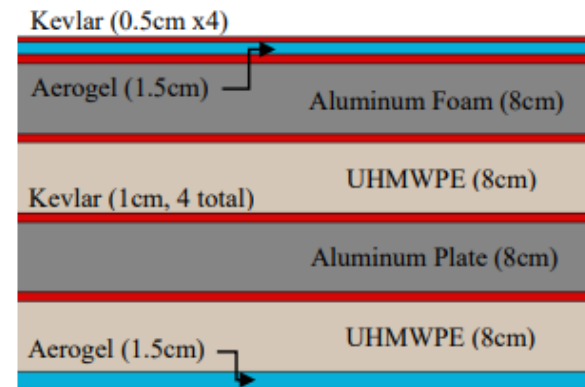
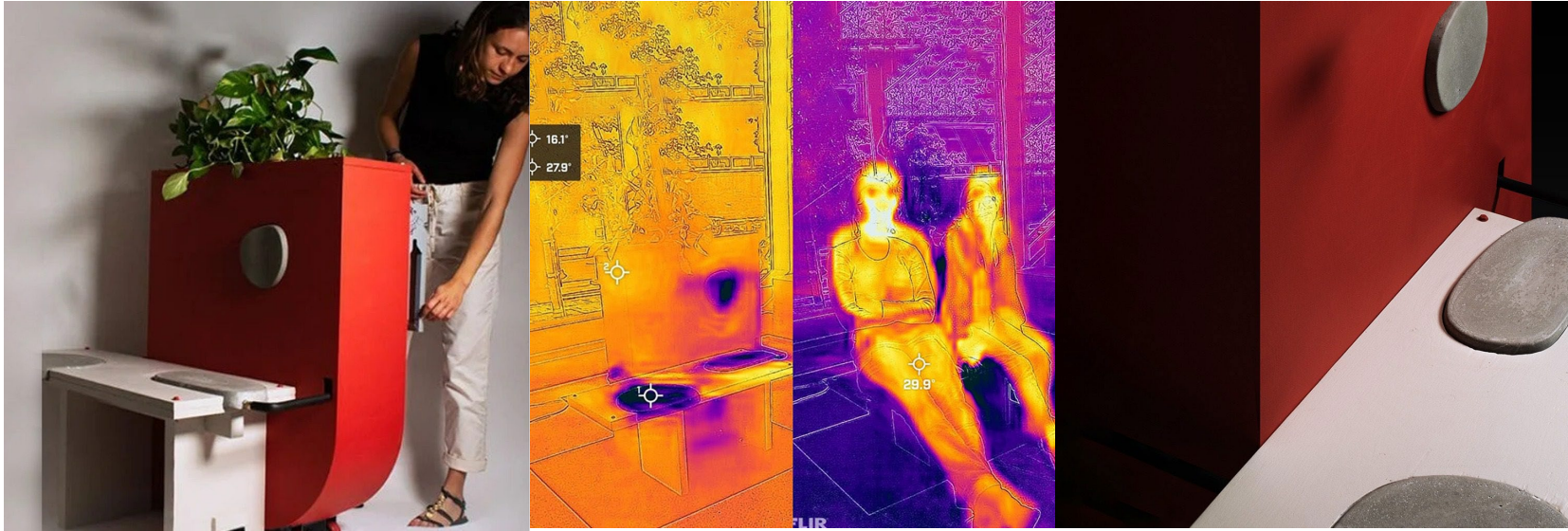


Figure 9 – Proposed Multi-Layer configuration throughout wall thickness

### Integrated/passive system (Building level)

- Placed in Lava Tube
- Covered with Thick Regolith
- Habitat Zoning Climate Control
- Proposed multi layer building skin construction (NASA)



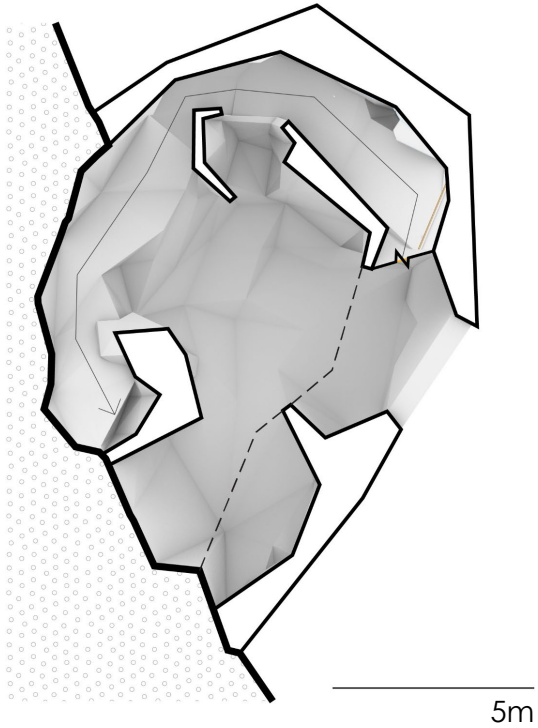
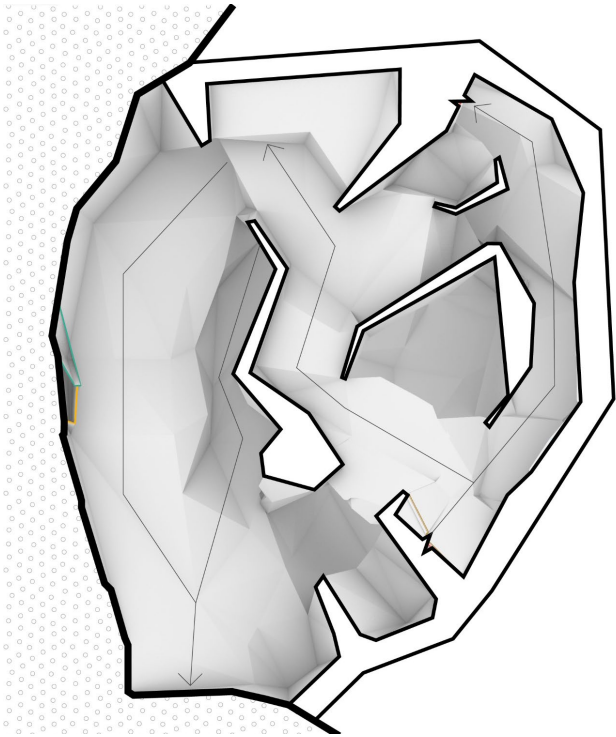
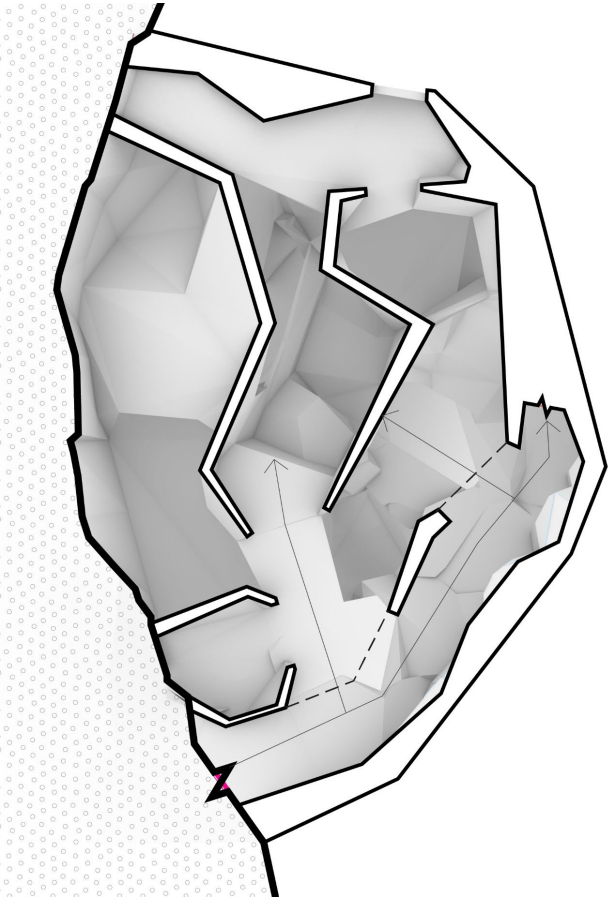


### **Integrated system (Furniture level)**

- Integrated layer of thermal control in several furniture such as beds and lounge chairs  
(on earth example: Harness the Heat by MIT)  
Embedding thermal control system onto concrete surfaces

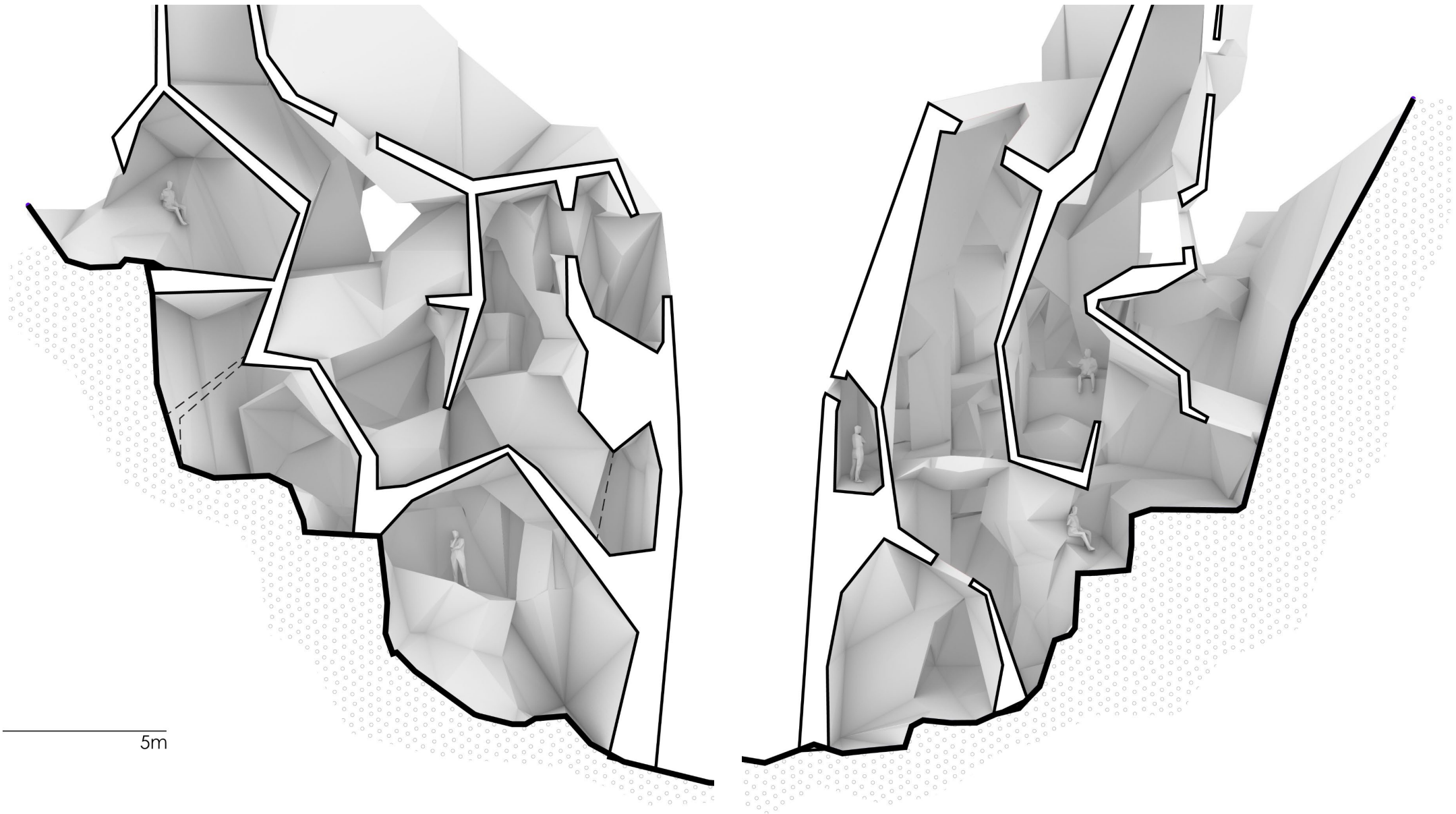
### **Body integrated system**

- Localized suit layers & sensors

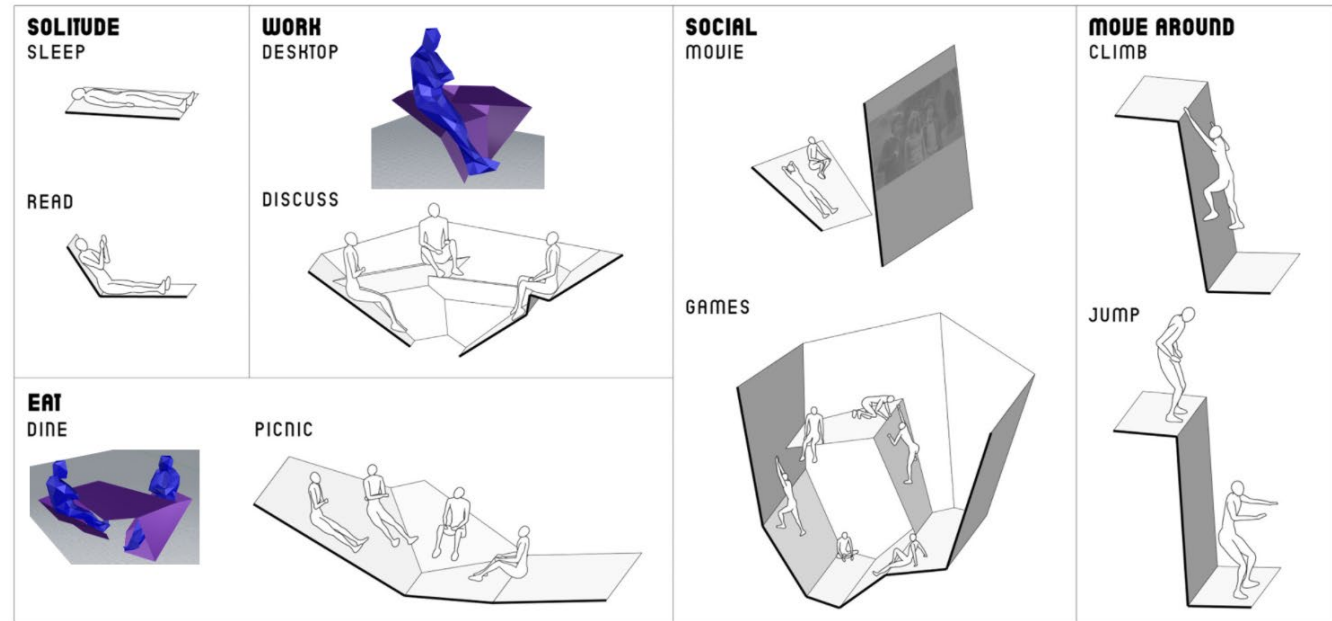


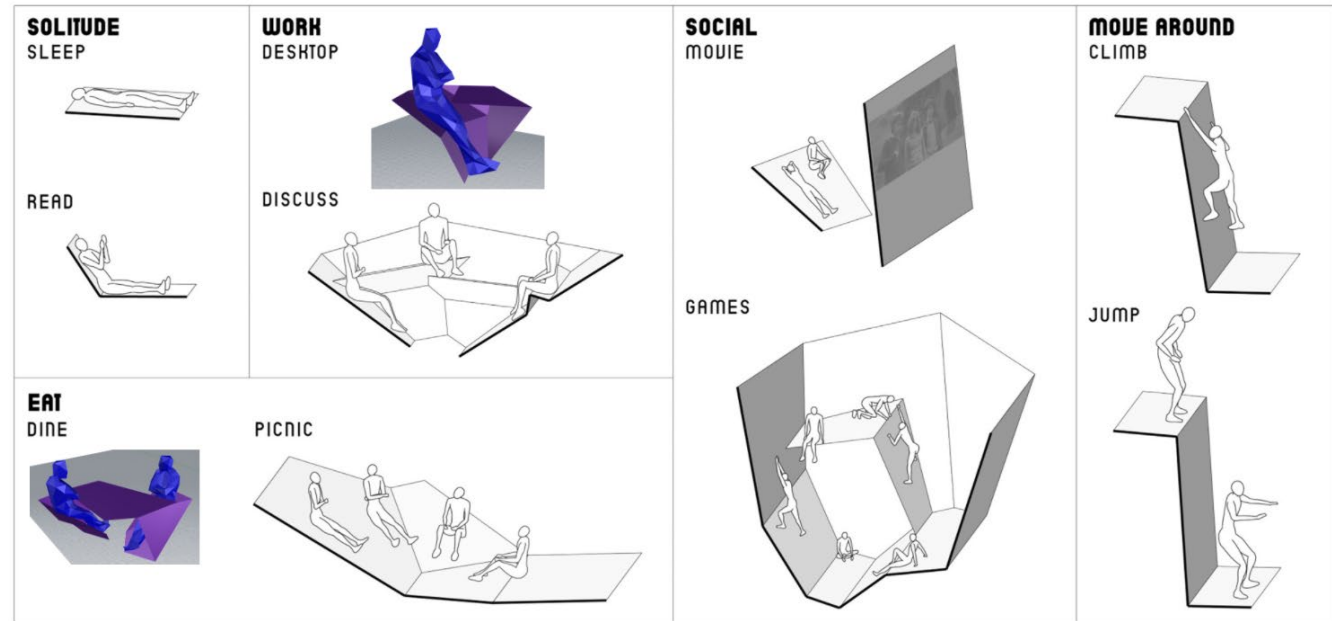
Upper level ← → Lower level

Sections

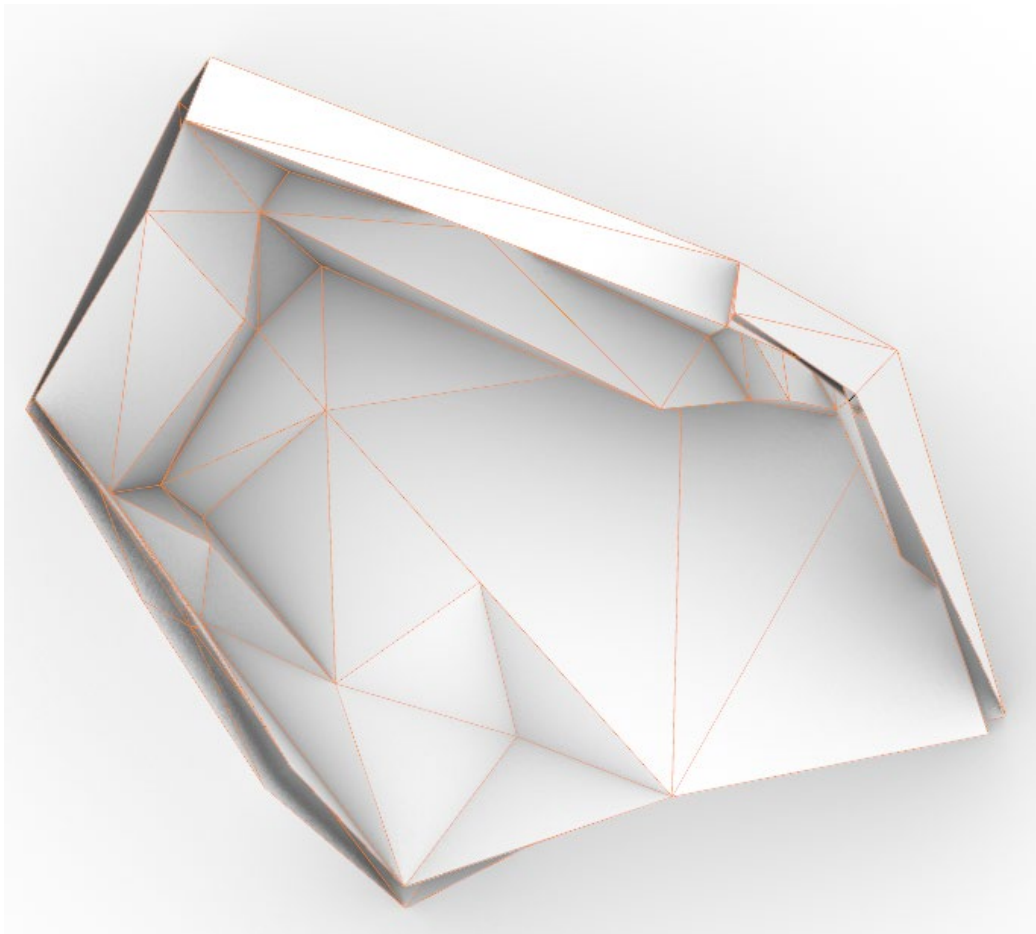




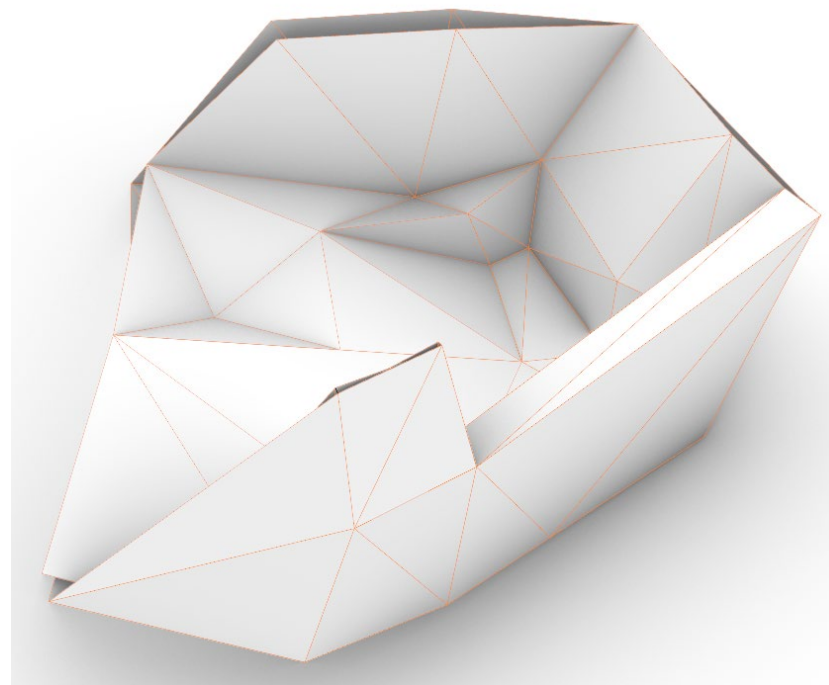
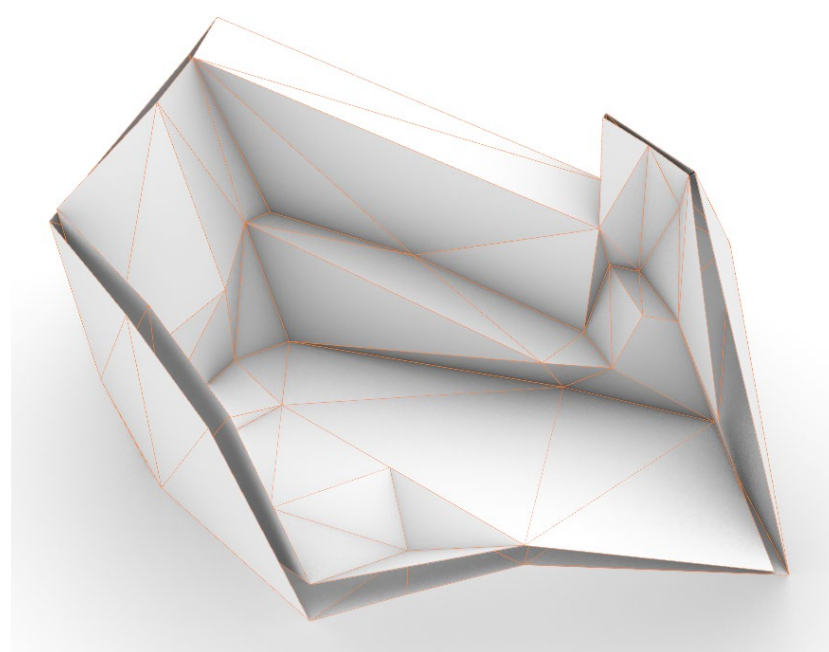




Eat

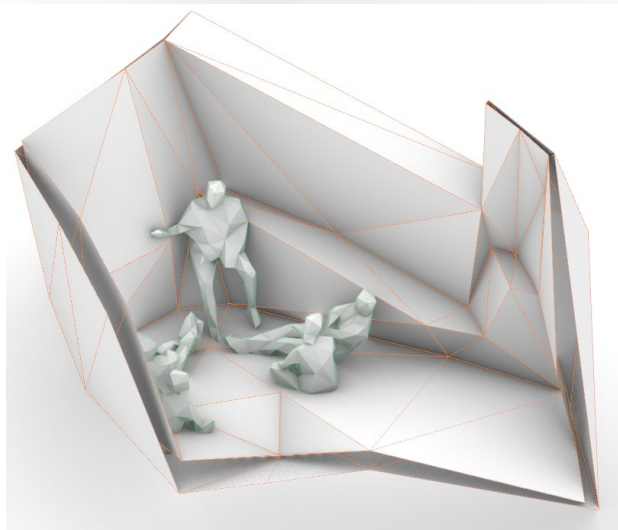
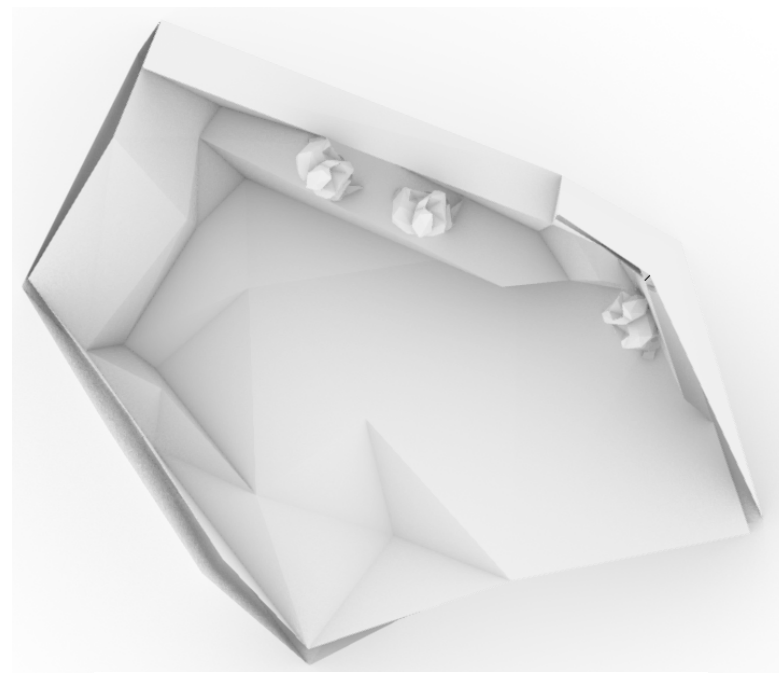
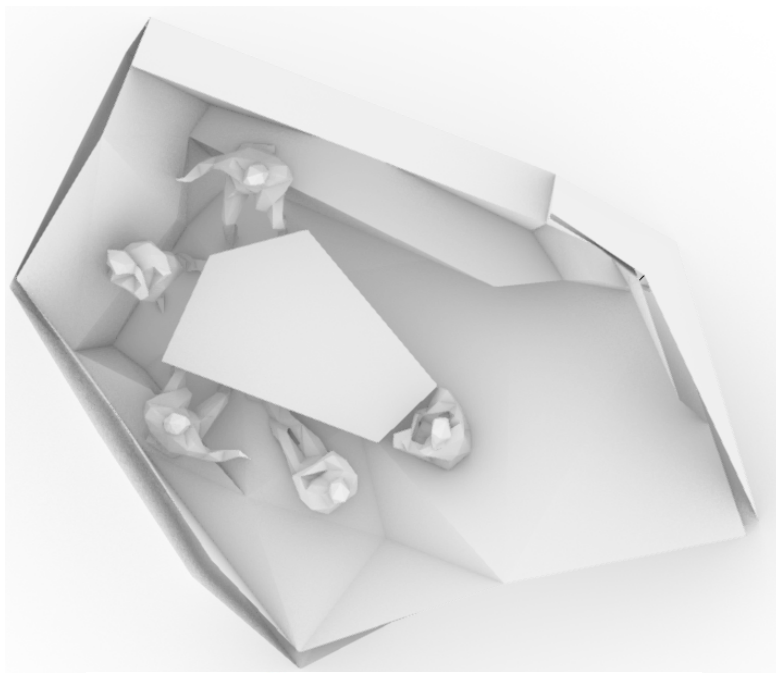
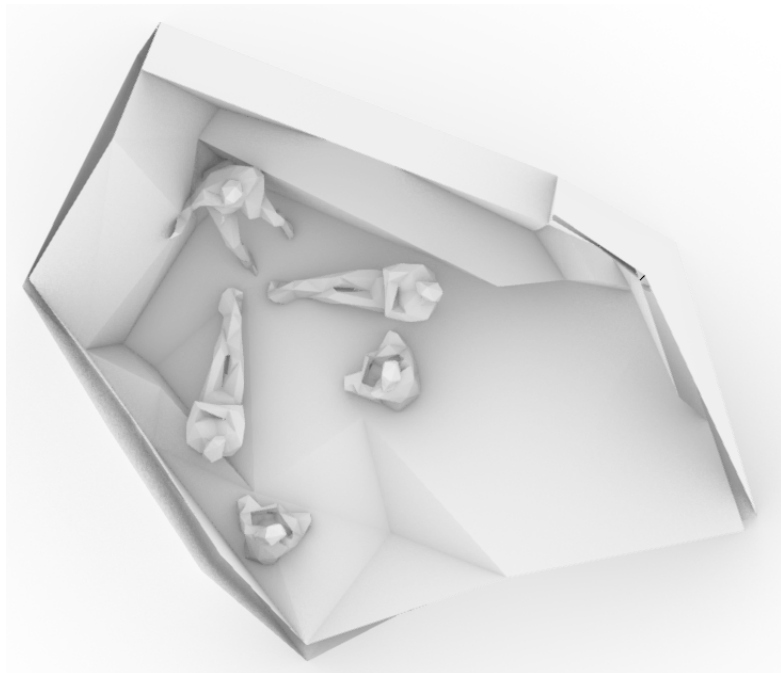


Plan

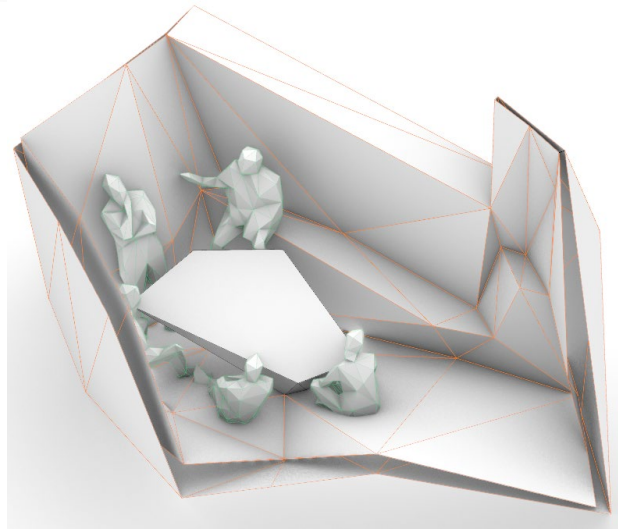


Isometric

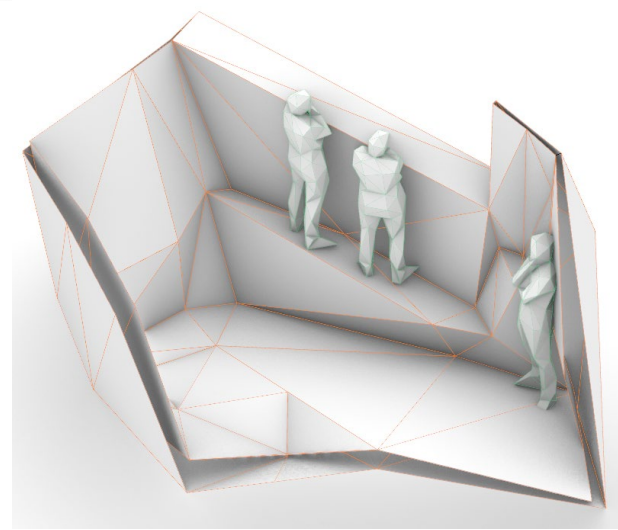




1

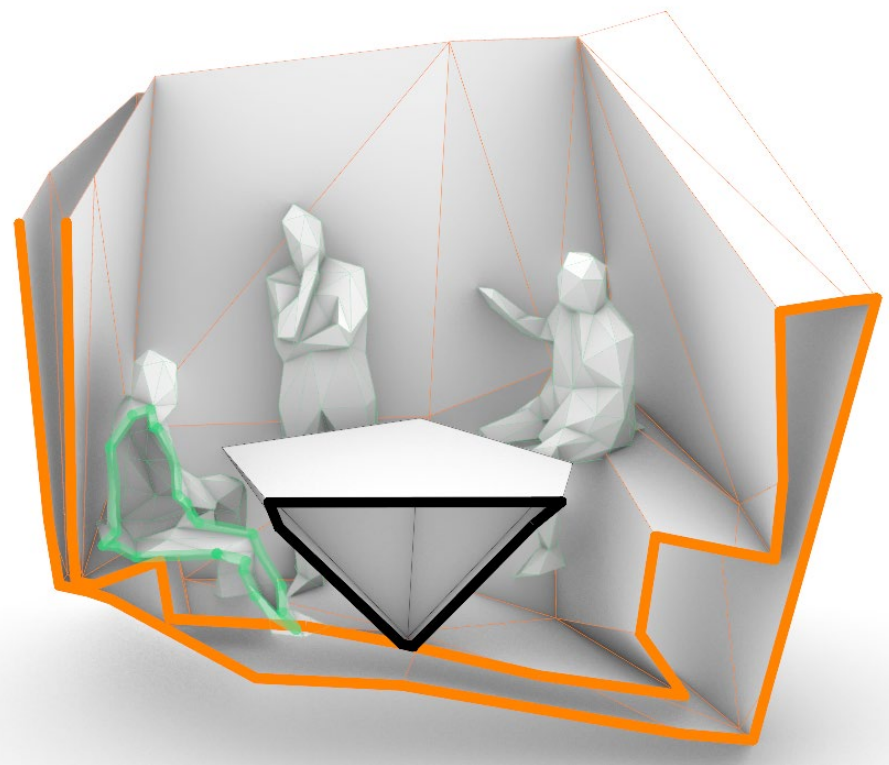
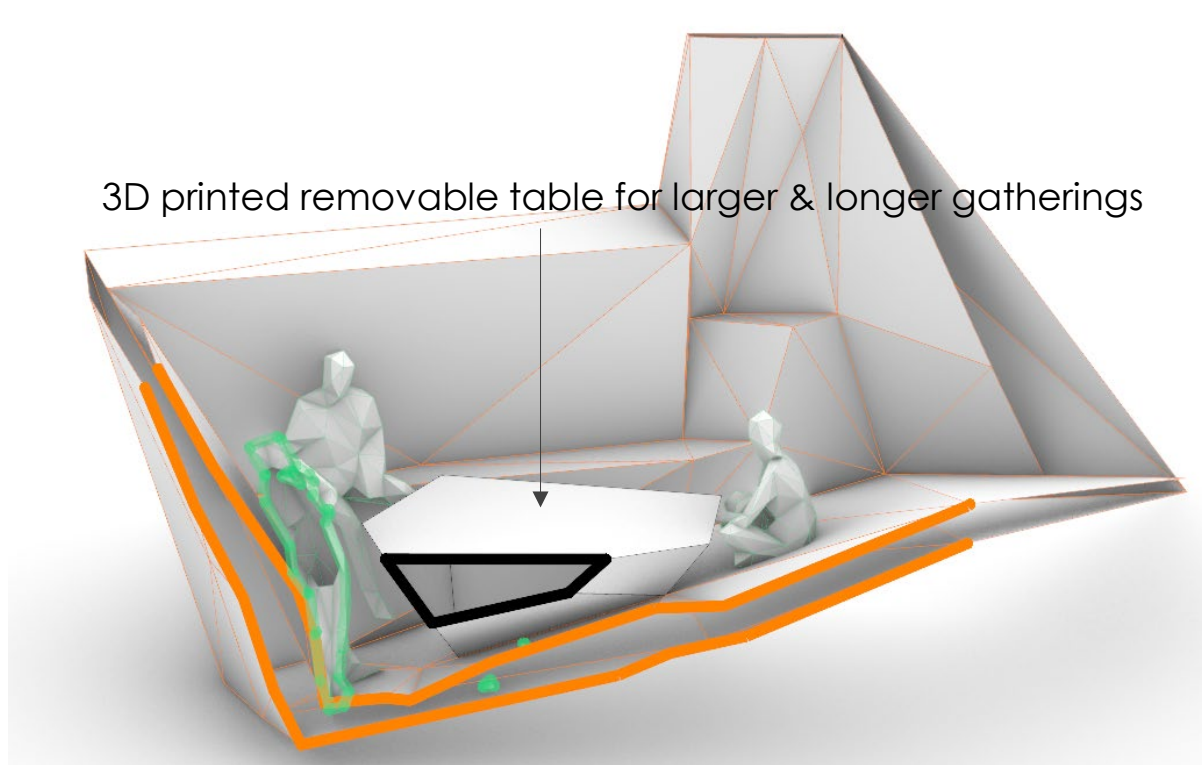


2

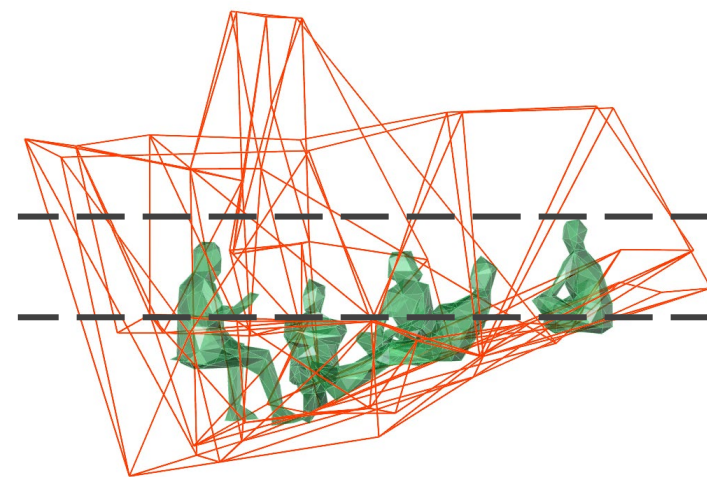
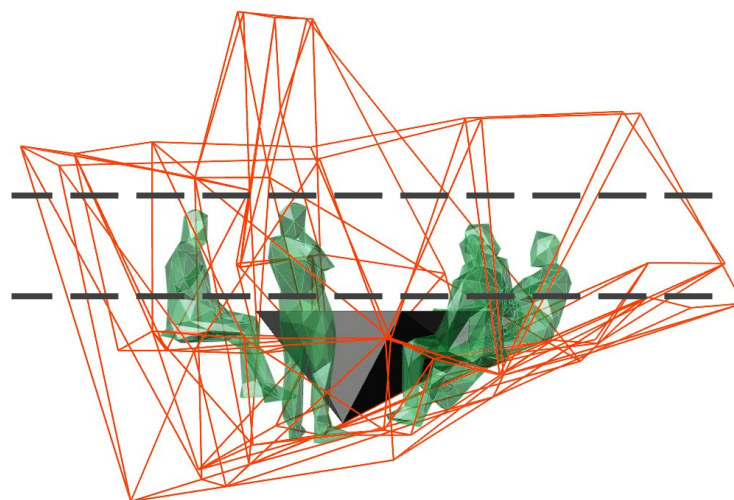


3

3D printed removable table for larger & longer gatherings

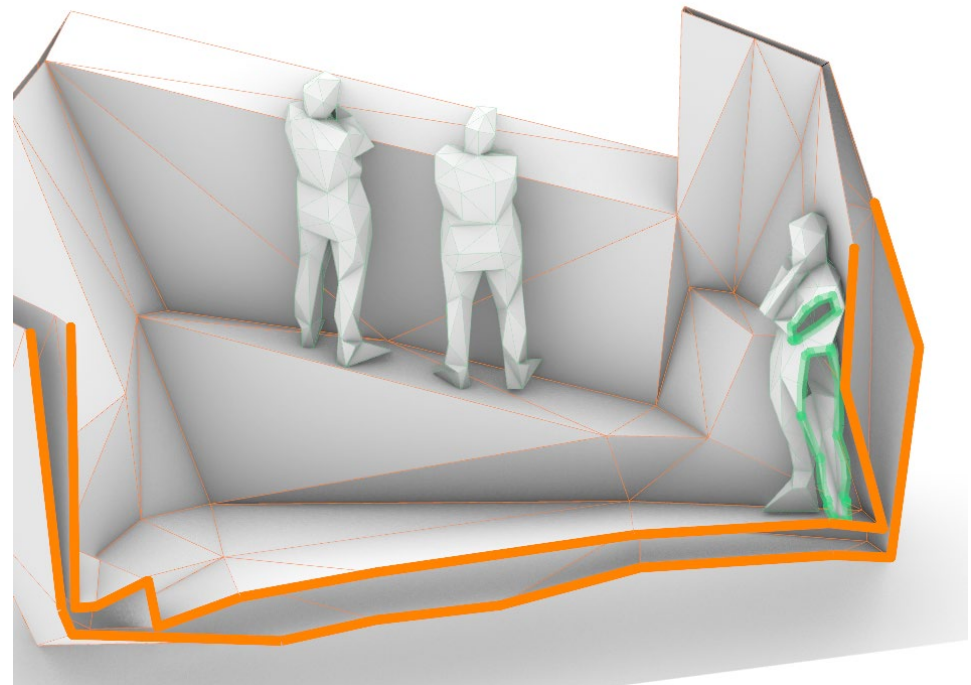
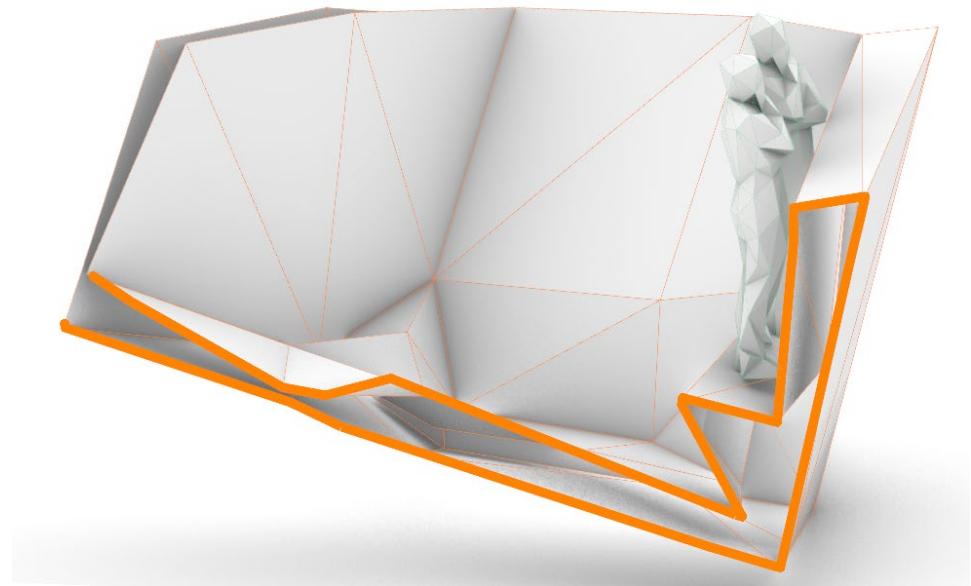
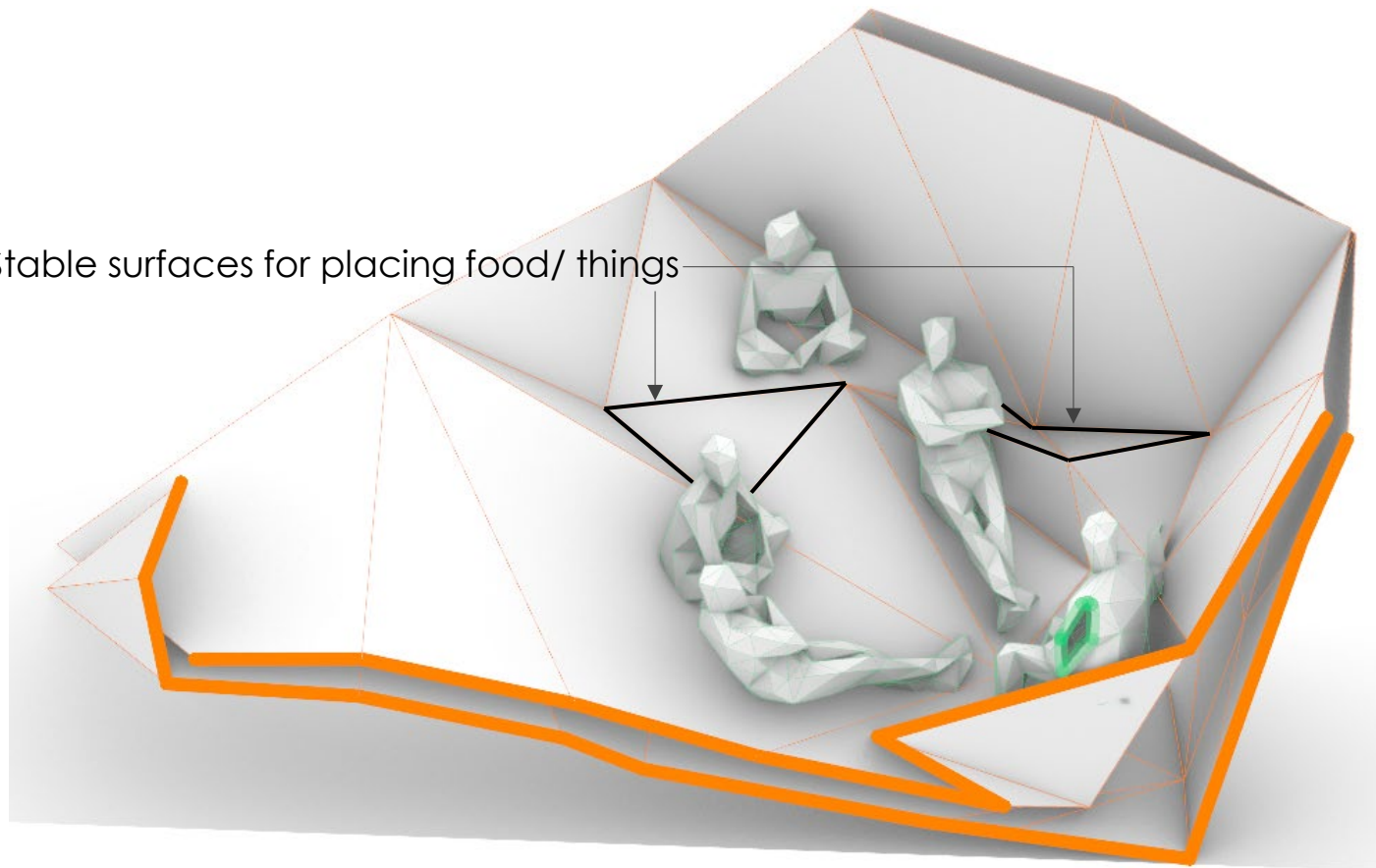


Different ground and seating height  
accommodate close eye levels  
and different body postures  
(important for meal gatherings)

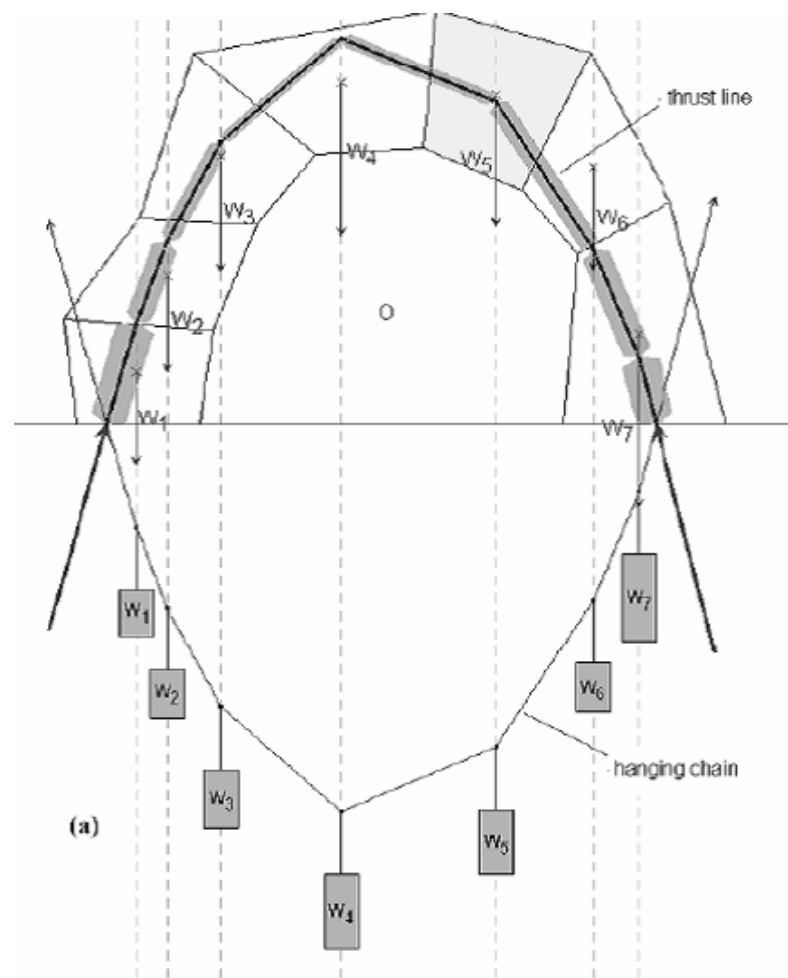




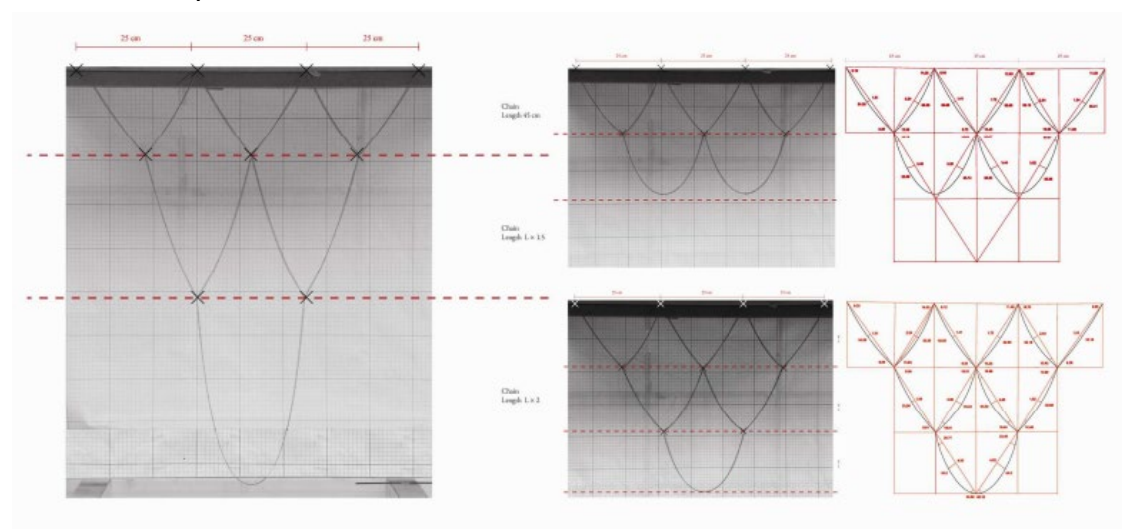
Stable surfaces for placing food/ things



Graphics will be adjusted and reproduced asap  
Photos will be cited asap

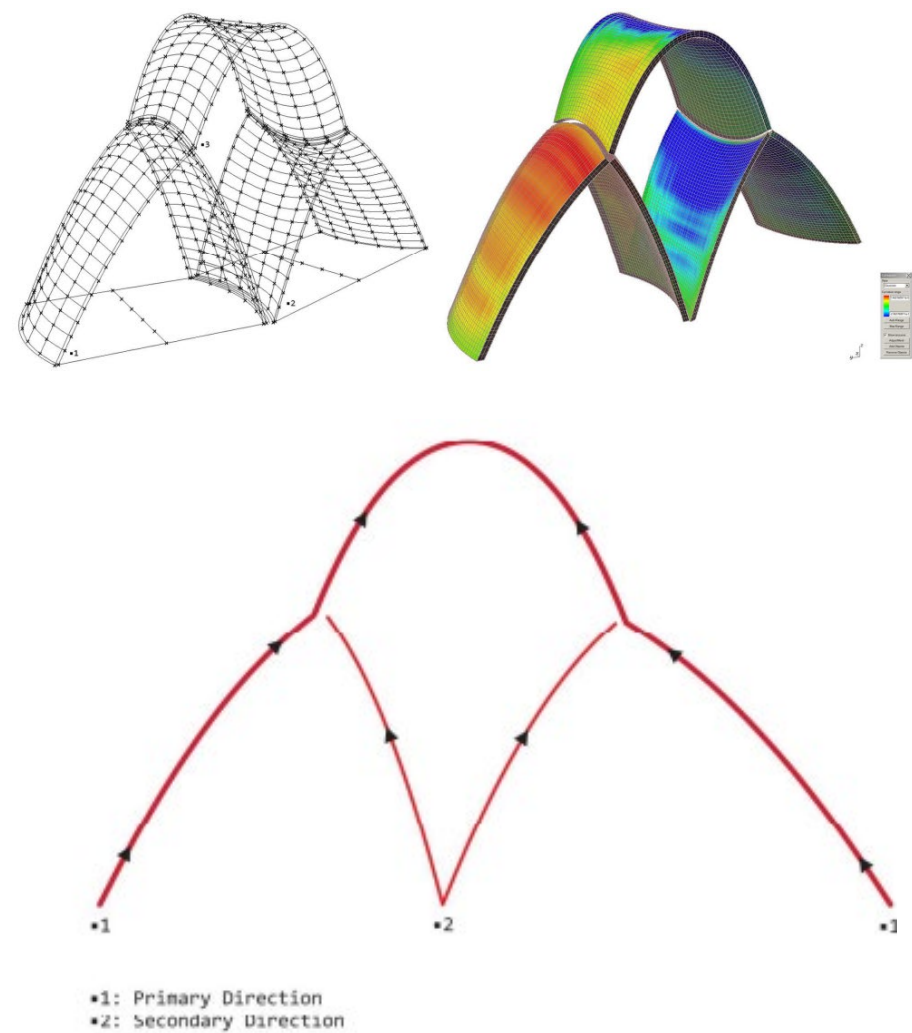


Nested Catenary Structure: Gaudi's Chain Model for Colonia Guell Chapel





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Photos will be cited asap





Graphics will be adjusted and reproduced asap  
Photos will be cited asap



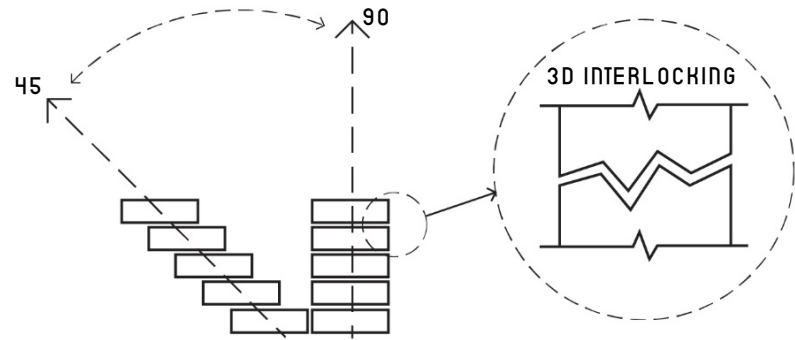
examined. Although not designed for a particular use, these structures provided the opportunity for experiencing the spatial qualities particular to nested catenaries. With its property to minimize the amount of material needed while maximizing the use of its material strength for structural stability and due to relative ease of formwork, this method proved to be economical and suitable for low-tech contexts.

In the design of complex nested catenaries systems, the potential of understanding the effect of geometry in the control of tension in the structure is critical. The effect of the transverse curvature combined with nesting strategy is a direct improvement of the stability and stiffness of the whole construction, making it capable to resist both non-uniform vertical and horizontal loads. The increase of hierarchical levels in the construction introduces high stiffness and provides robustness to the system against local failure. Nesting + Curvature + Branching by multiplication significantly improves shell behavior resulting from the three-dimensional distribution of the shells. The

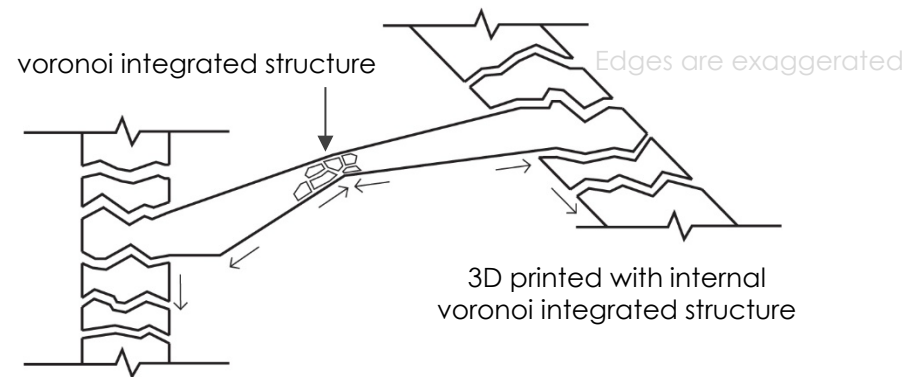
production of formwork with CNC-milling. As brick-laying is a manual process that can take considerable time and is associated with high-labor costs, it is difficult for brick construction to compete with other construction methods in developed countries. Therefore, it is important to develop procedures that can improve the process of brick-laying.

## Structural Assembly (concept diagram)

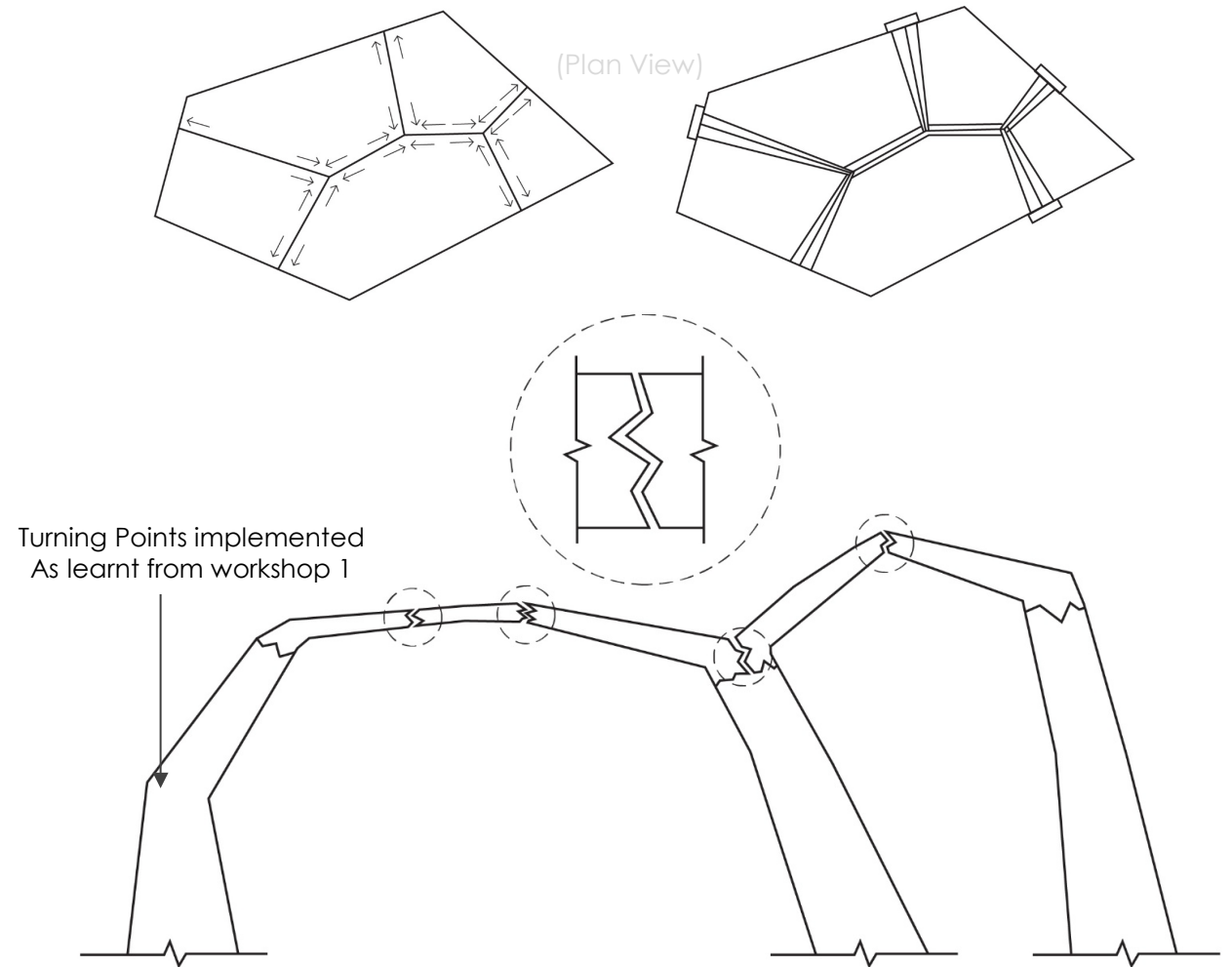
### 1. Stacking Method (-)45 to 90 degree



### 2. Stacking Method 0 to (-)45 degree

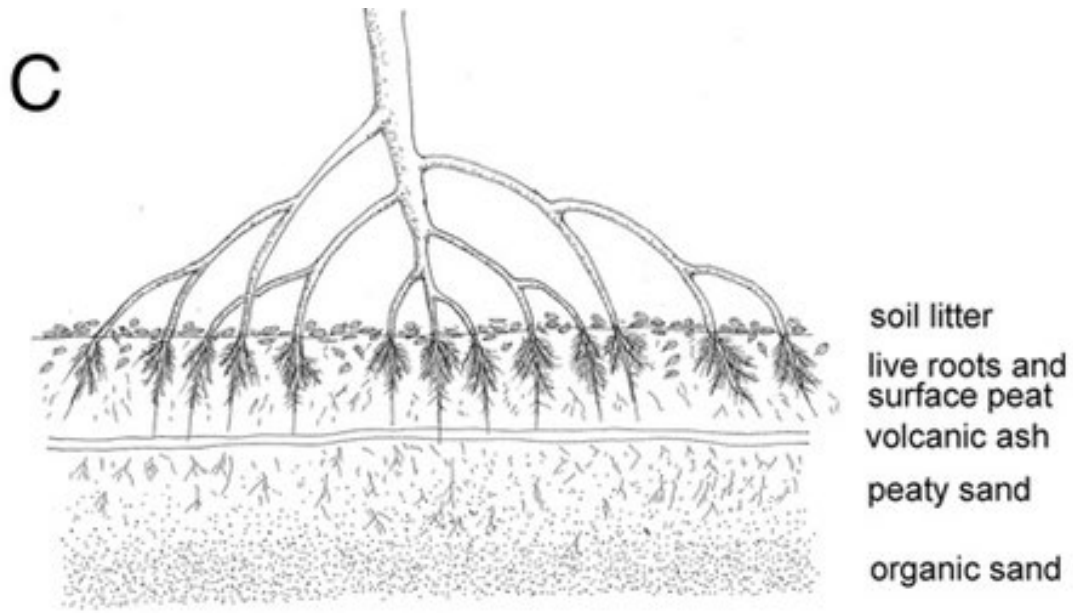
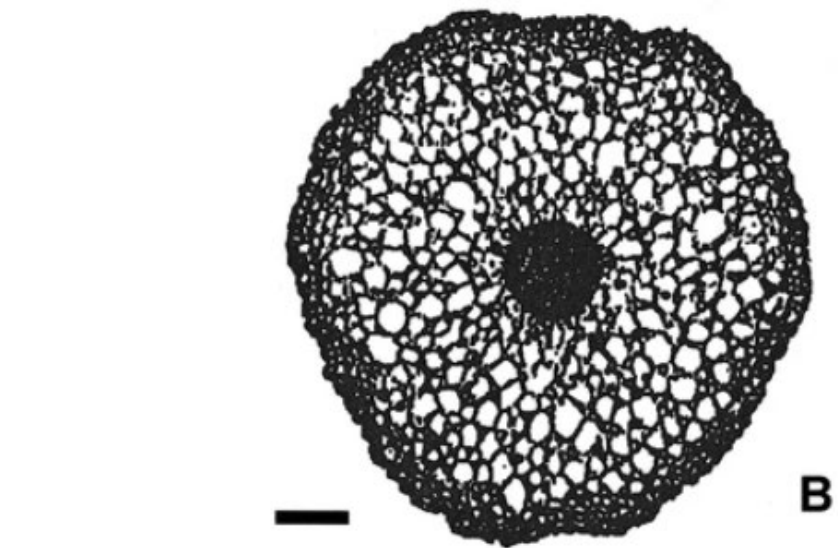


### 3. Long Span (>10m)

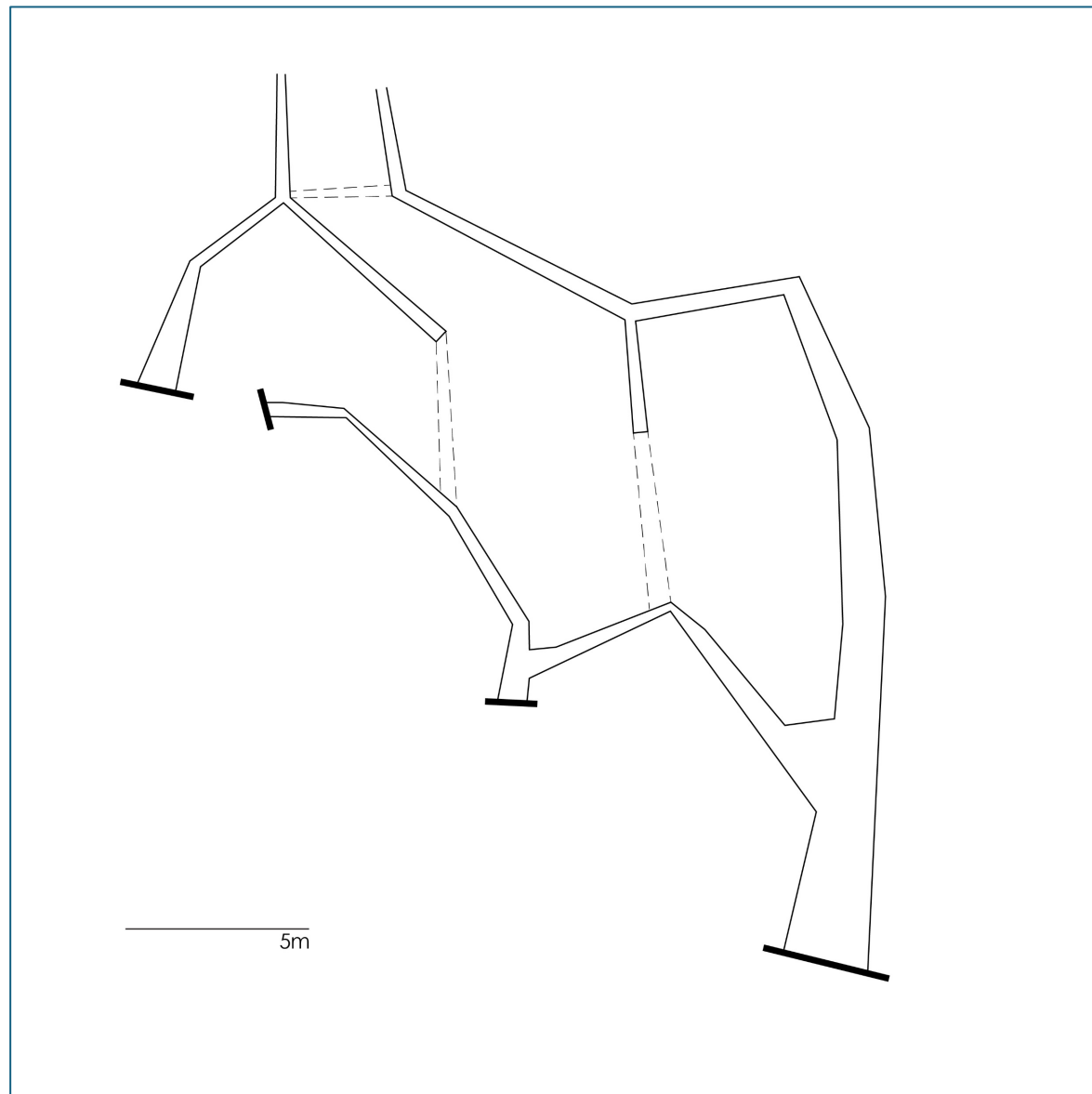
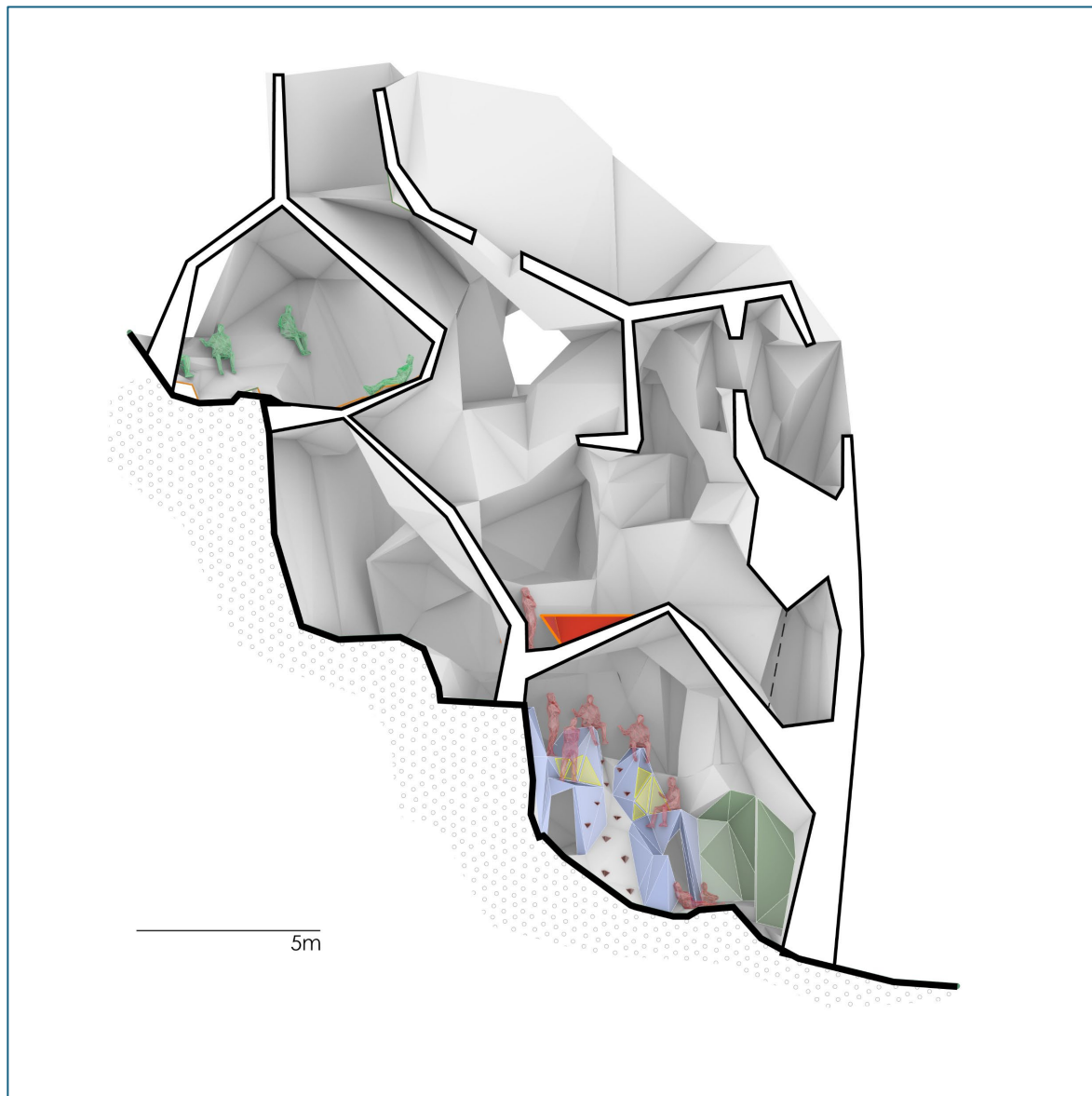


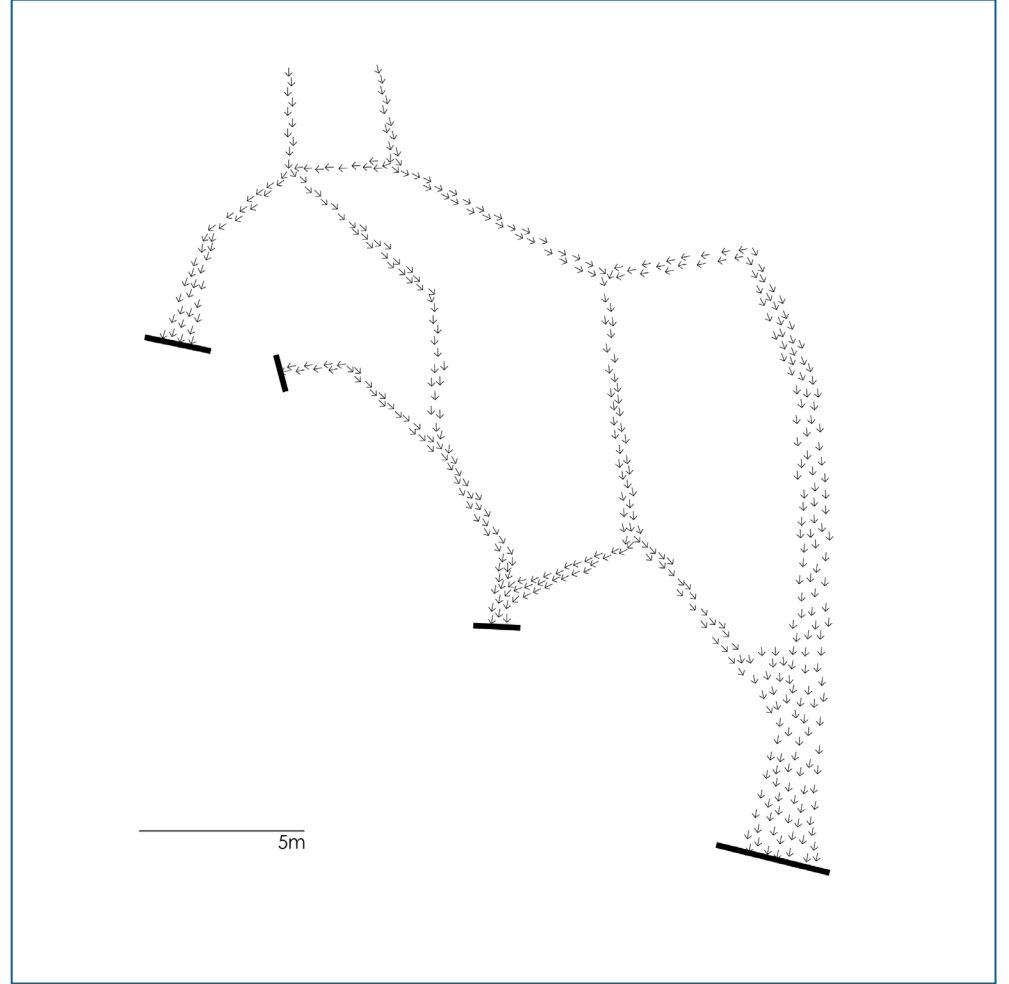
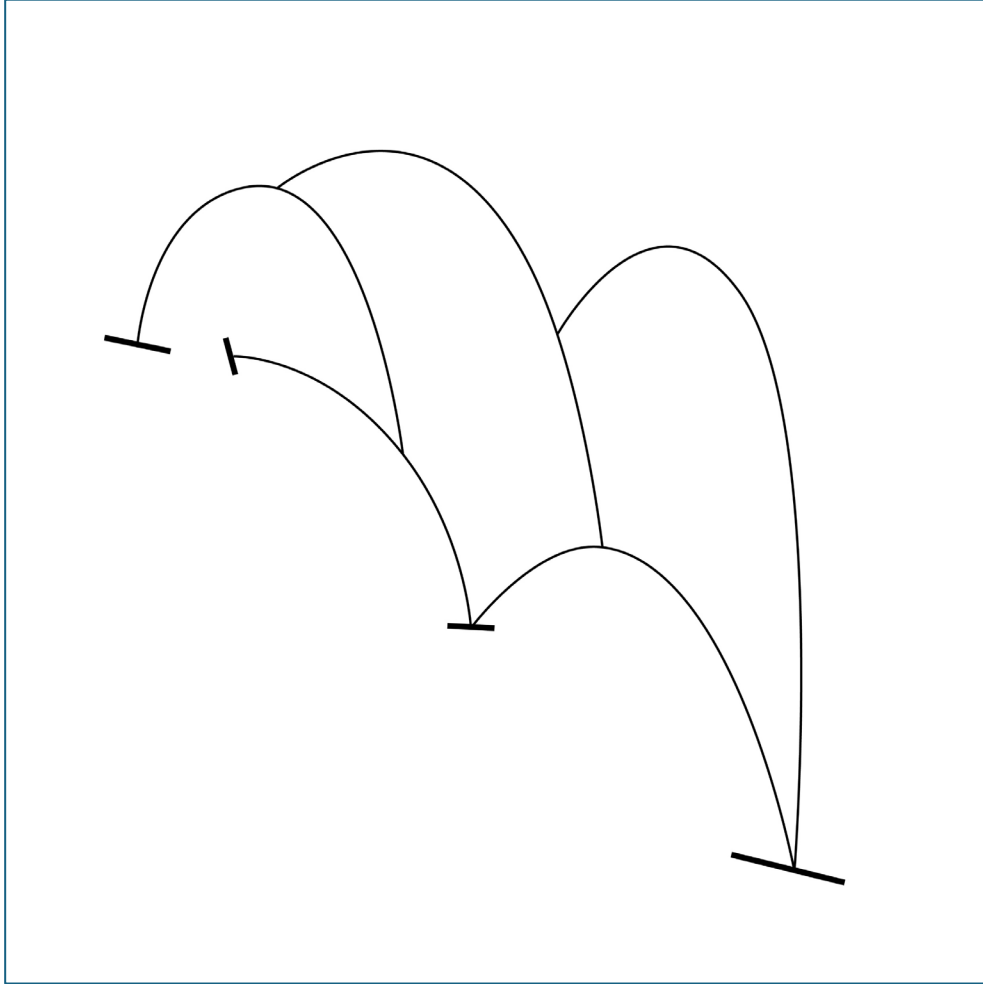
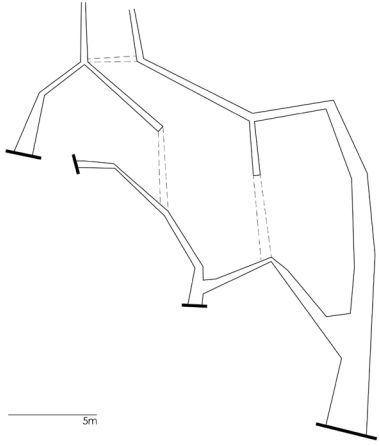


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Photos will be cited asap



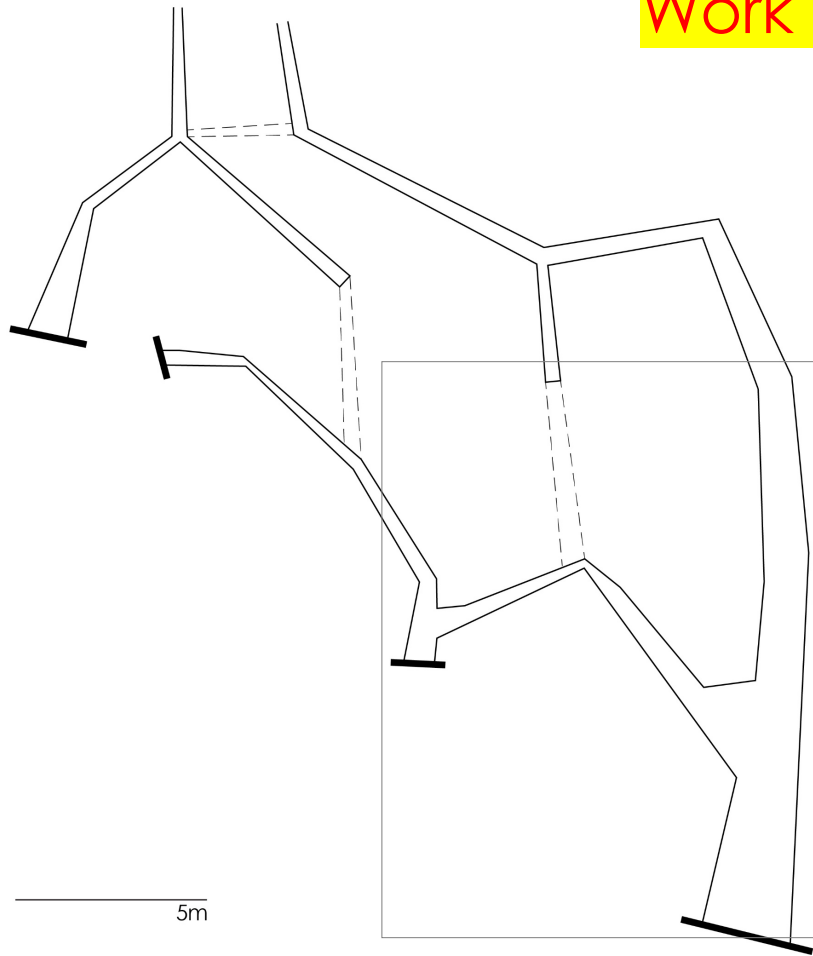
Stilt-Root | Structures that grow and expand over time

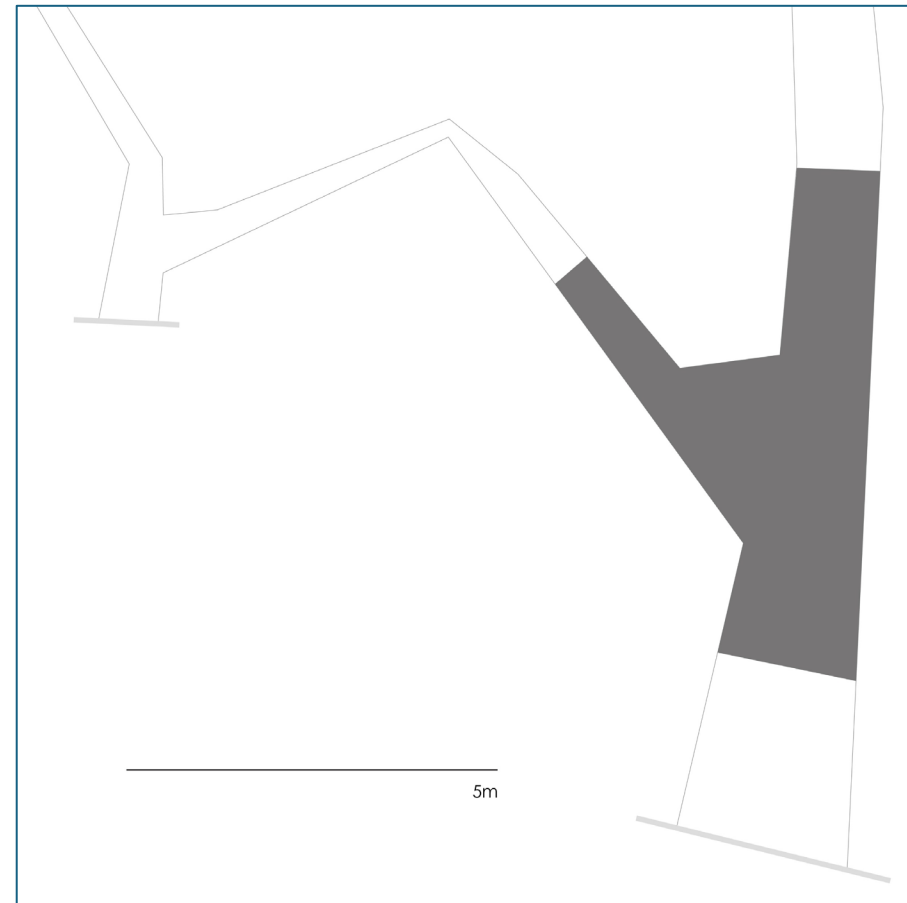
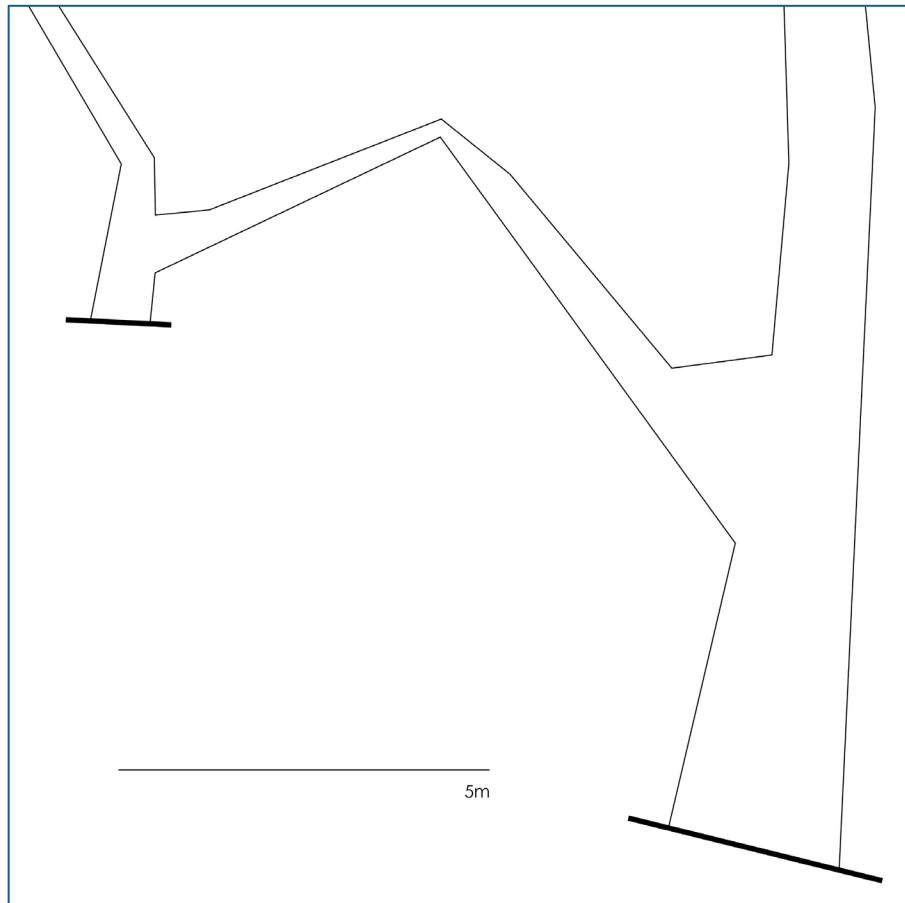
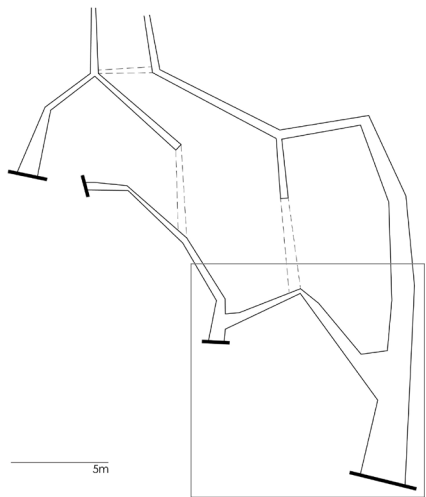






Work in Progress

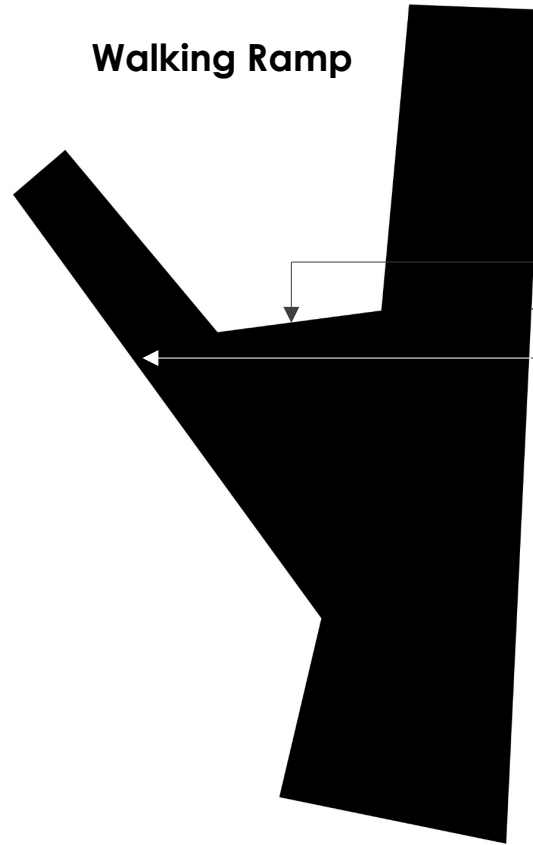




**Interior**

**Walking Ramp**

**Exterior**

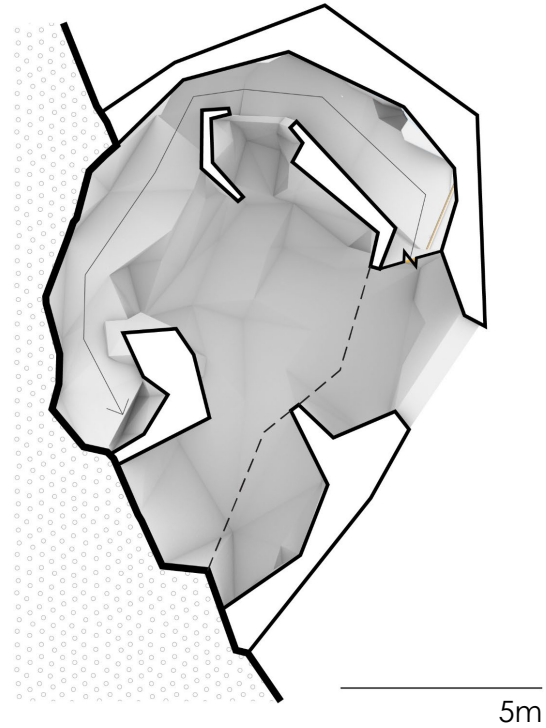
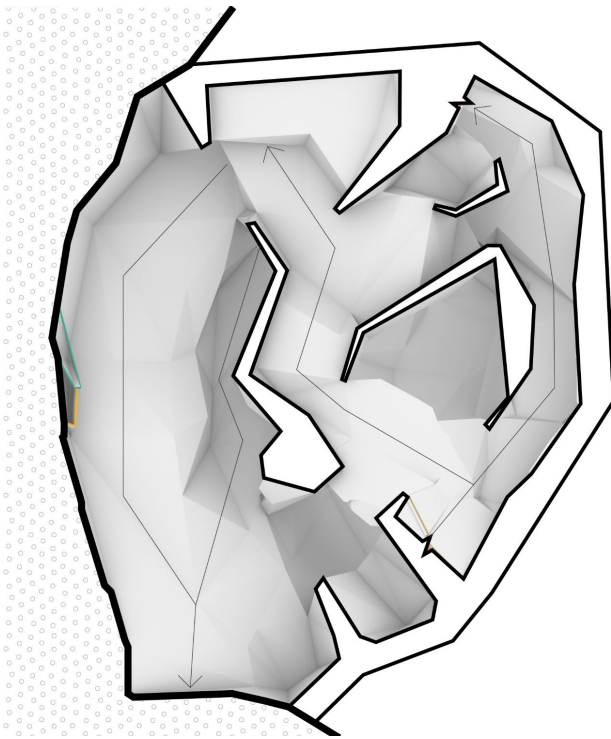
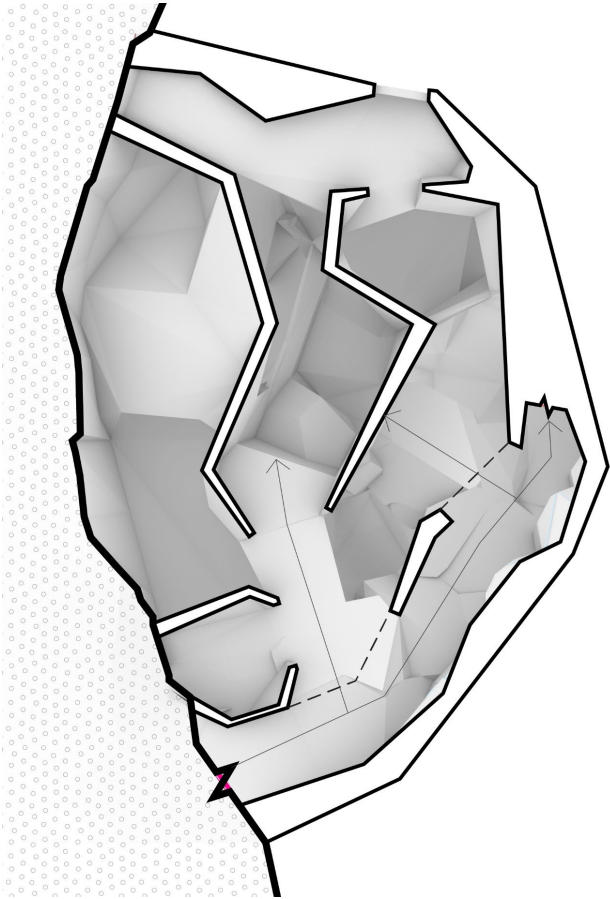


Branching of  
(close to) 90-deg. Surface  
(close to) 0-deg. Surface  
(close to) 45-deg. Surface

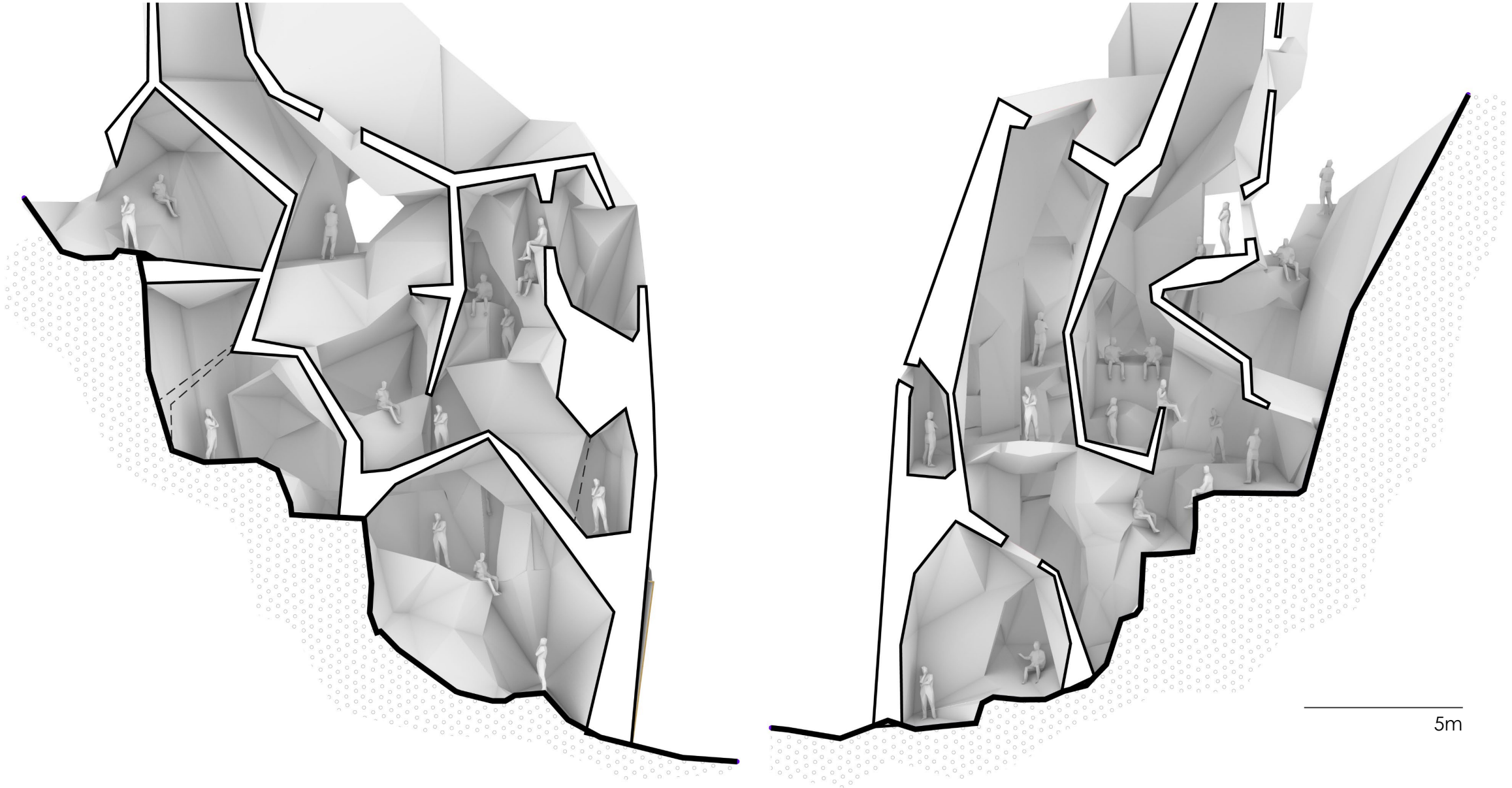
To be incorporated:

- 3-dimensional interlocking components
- Seating integration
- Climbing Boulder integration
- Lighting integration

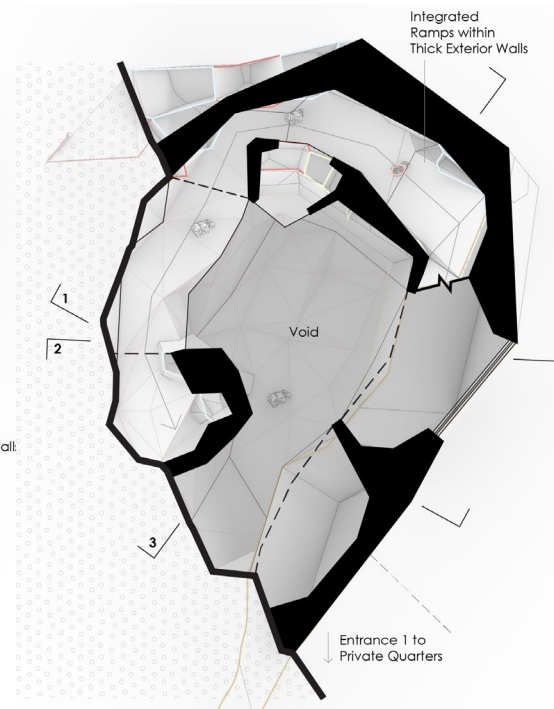
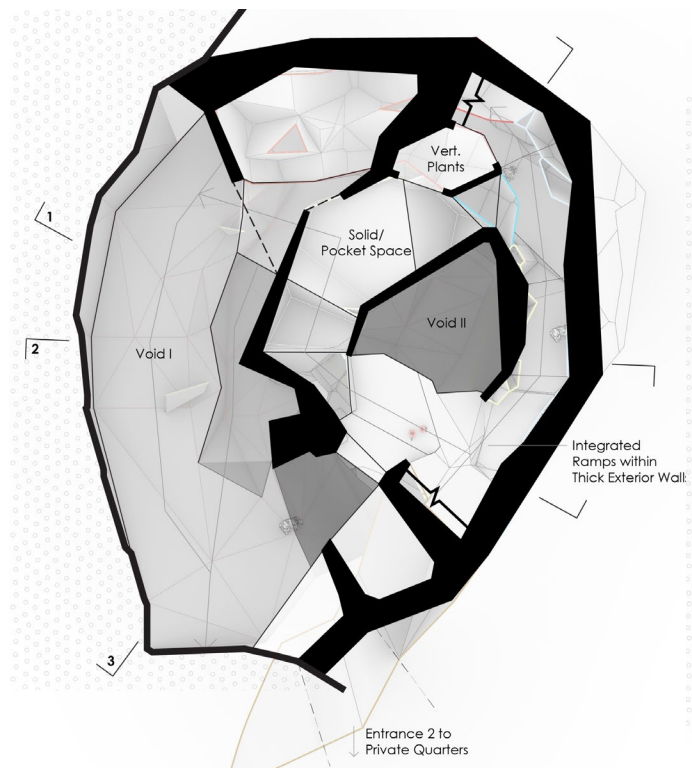
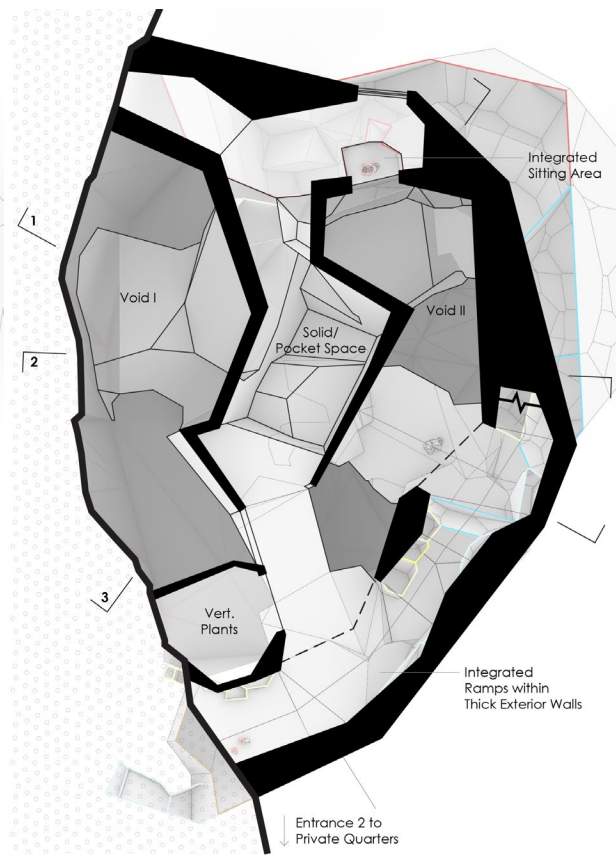
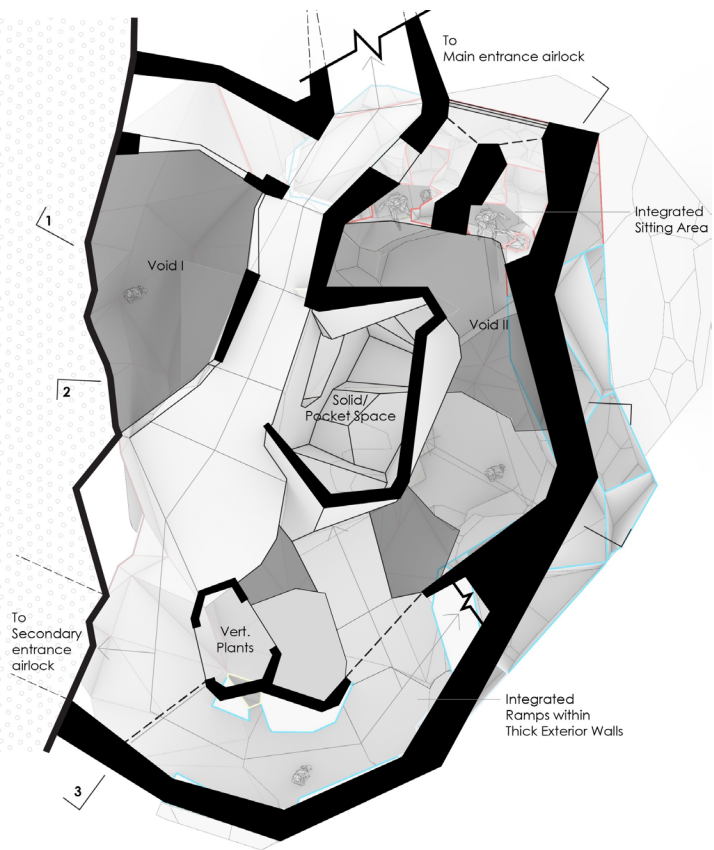
5m



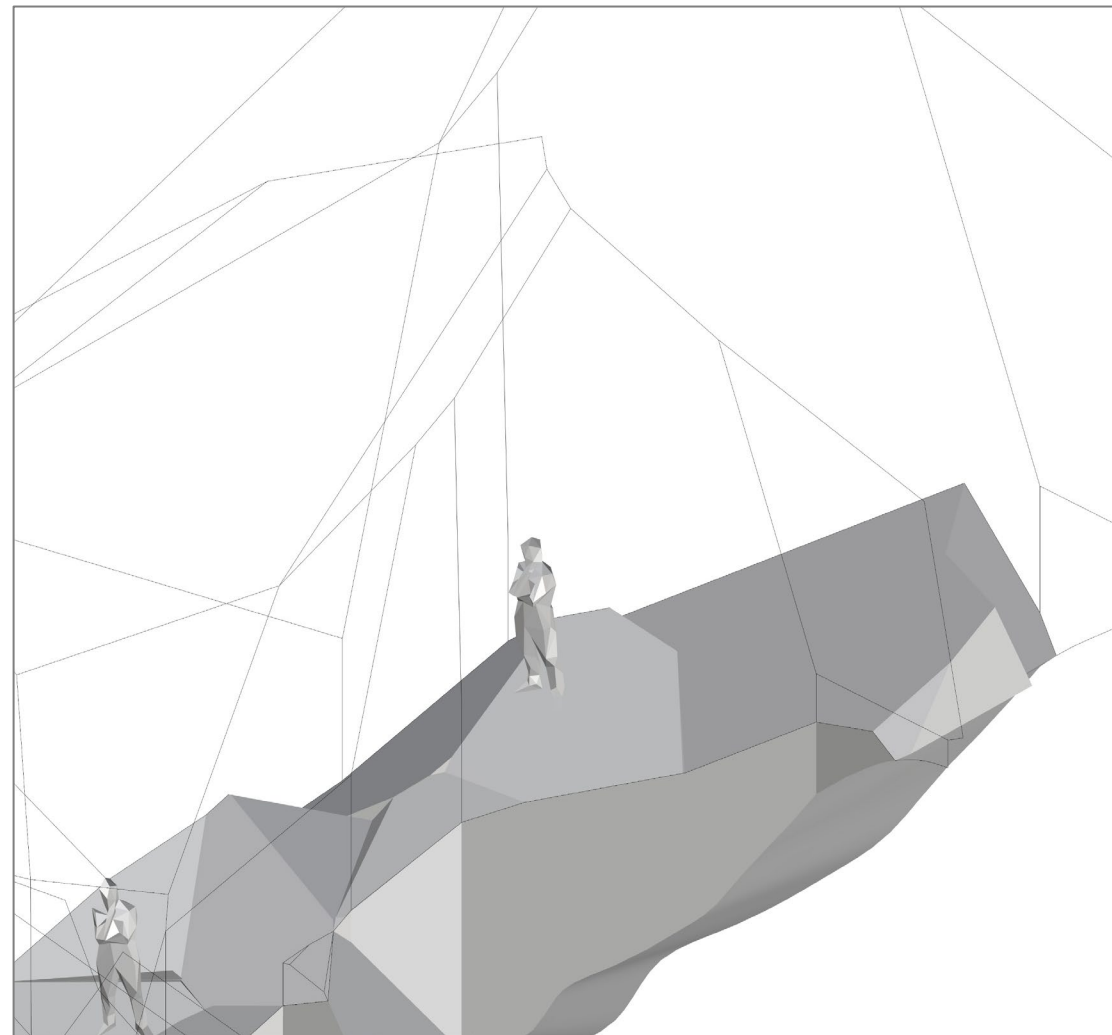
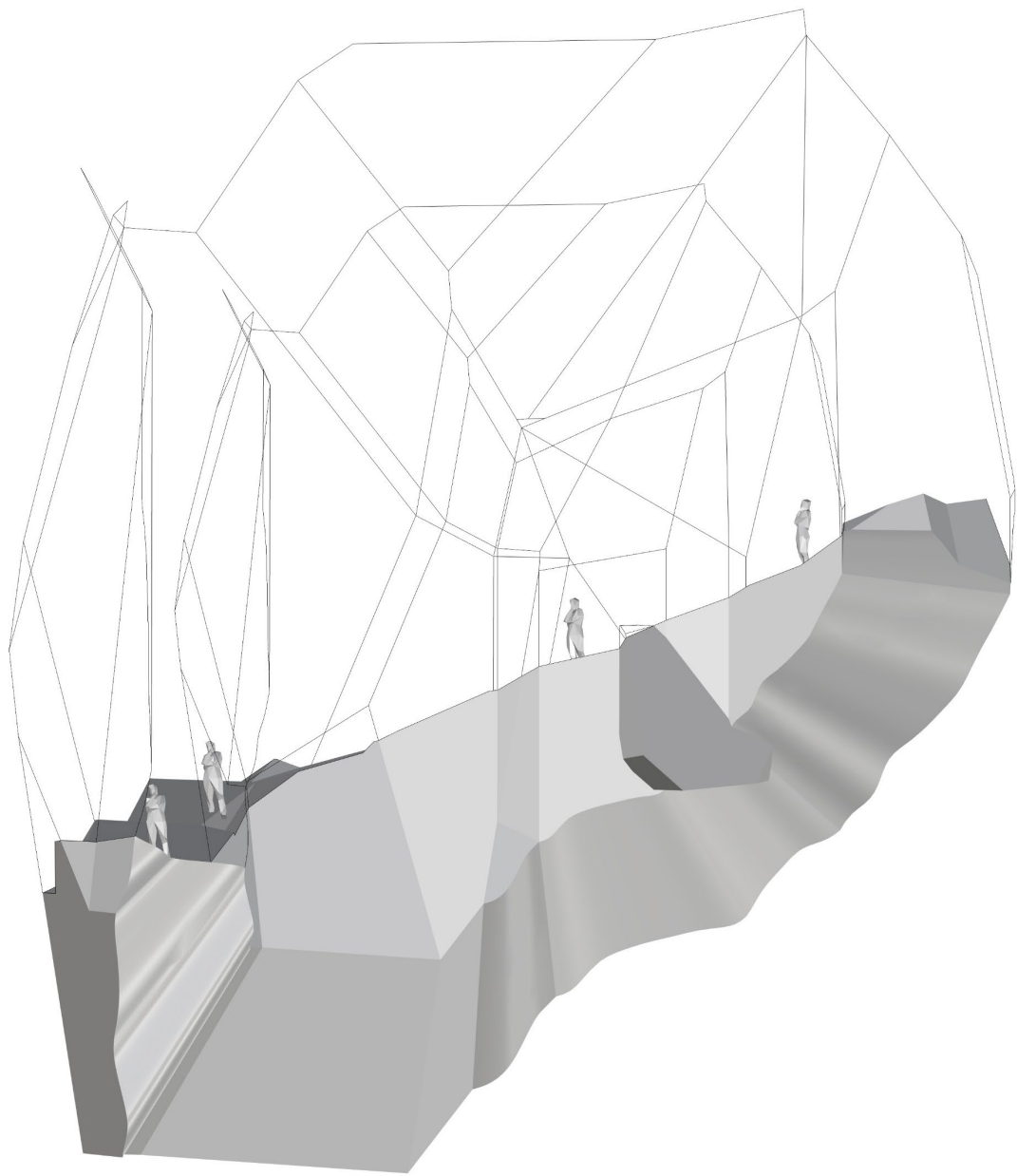
Sections



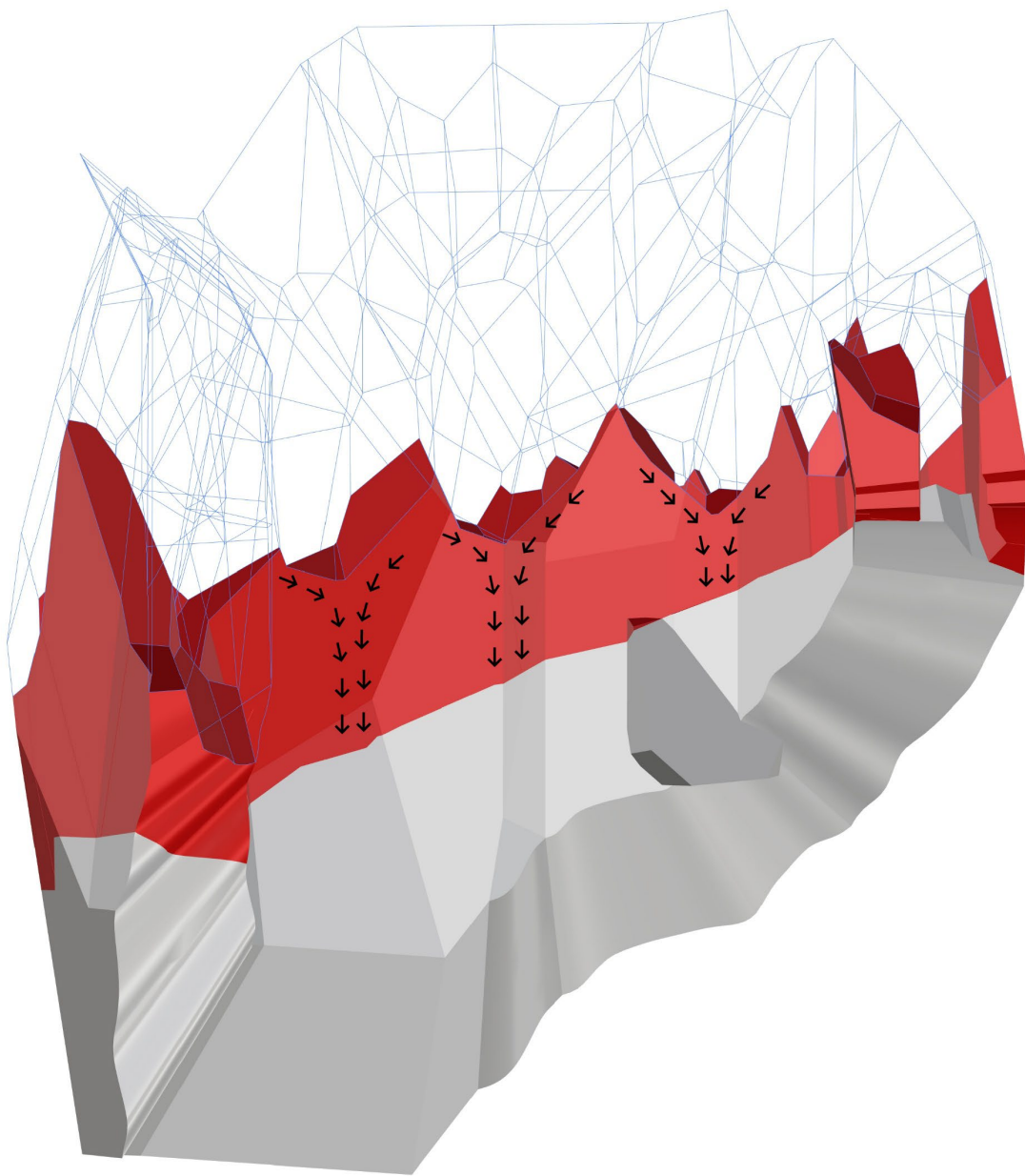
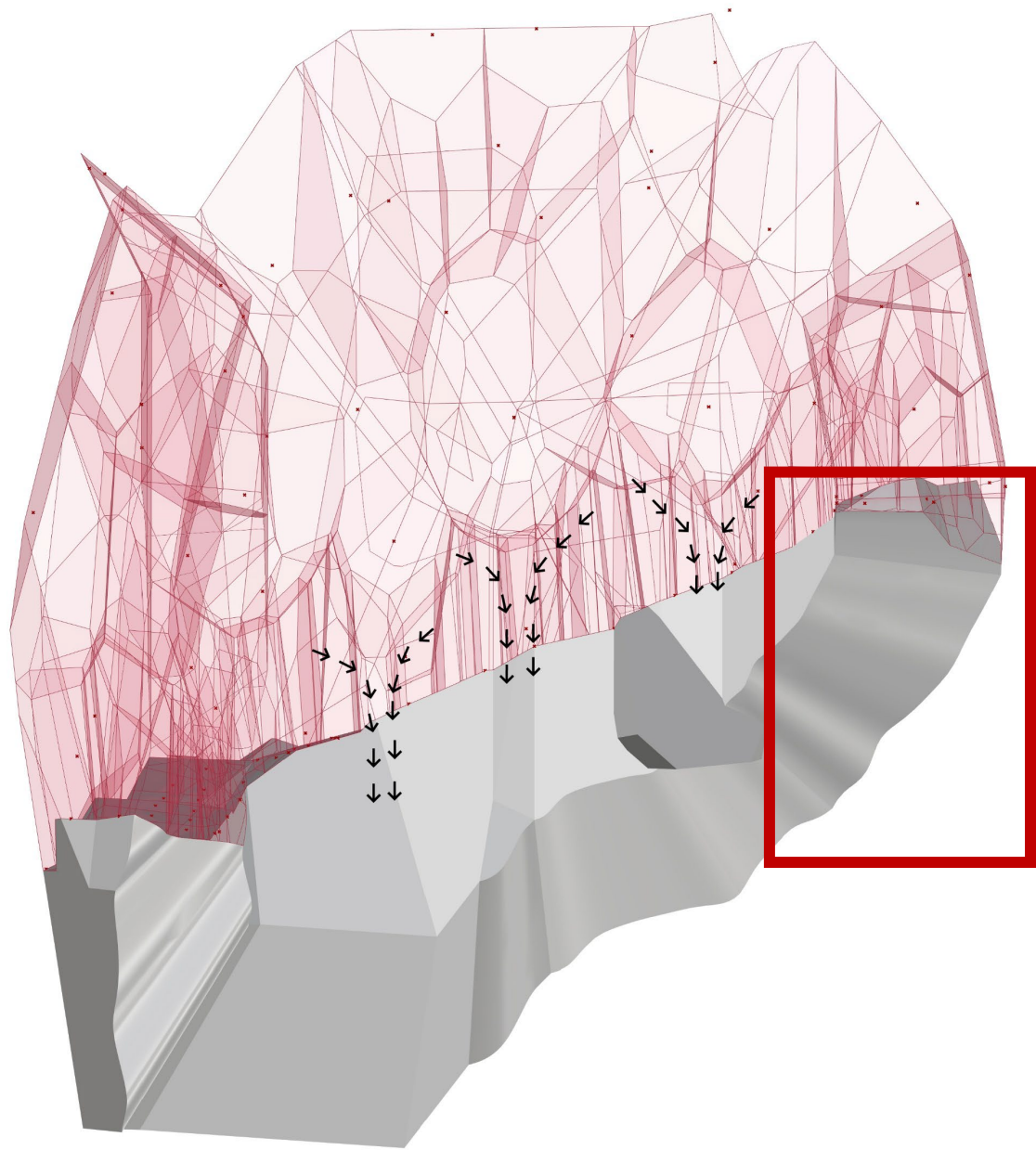


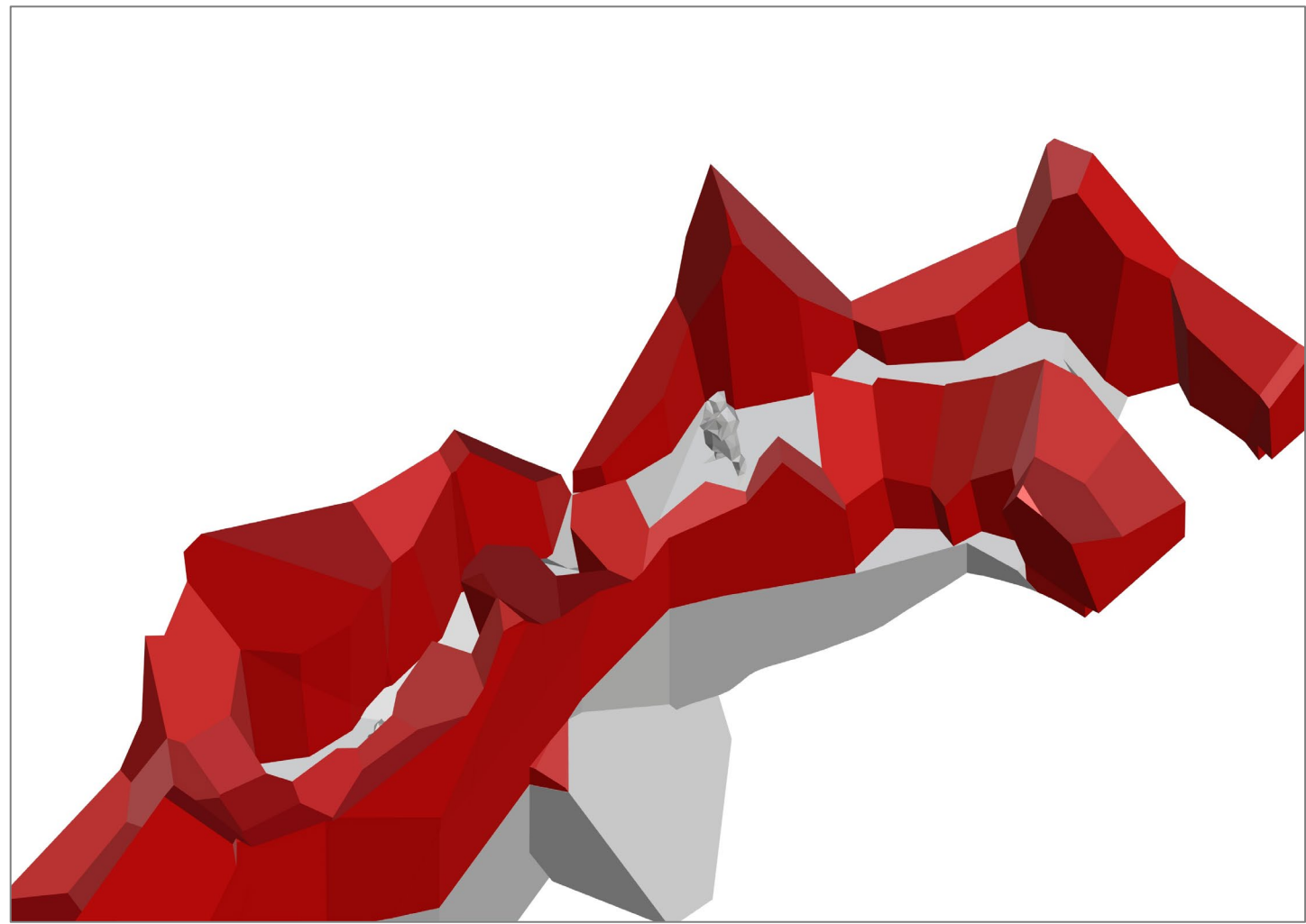
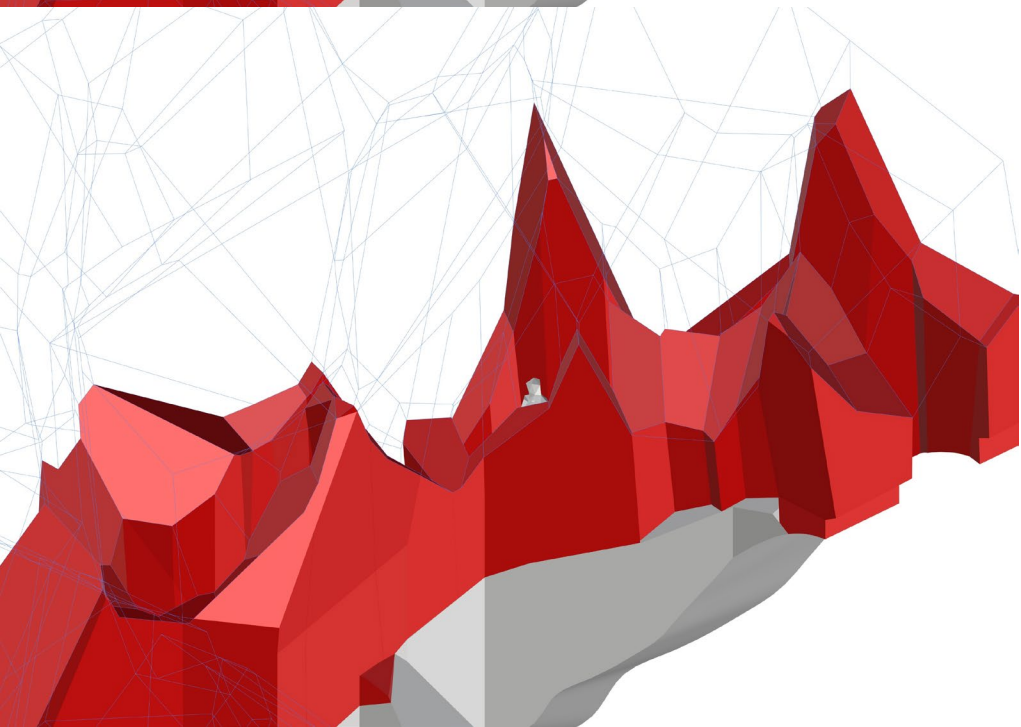
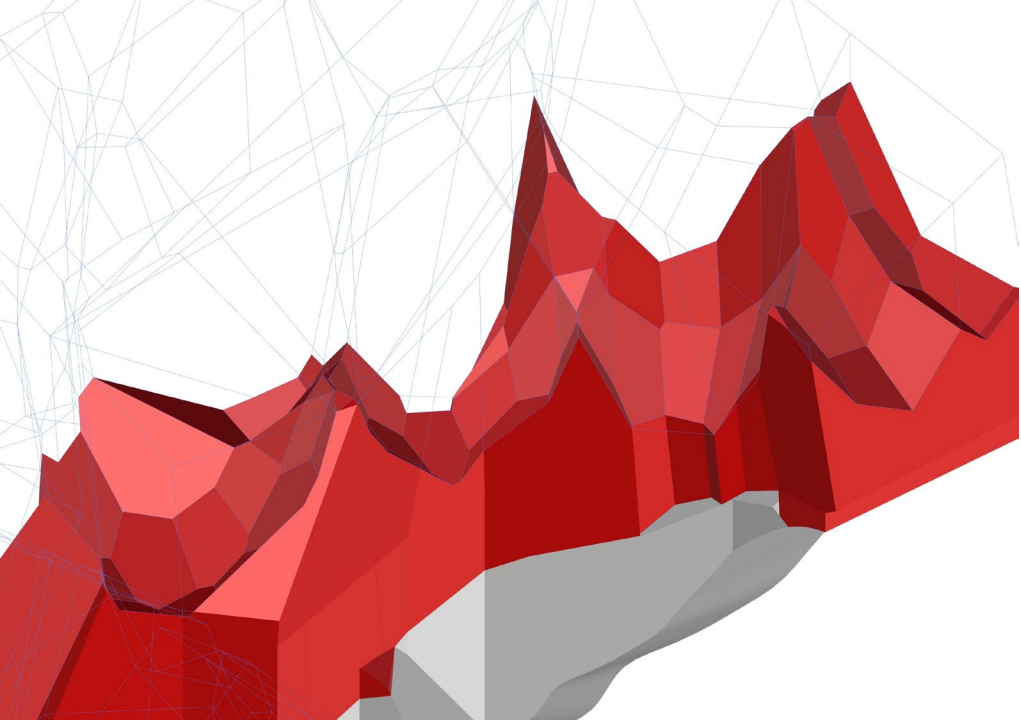




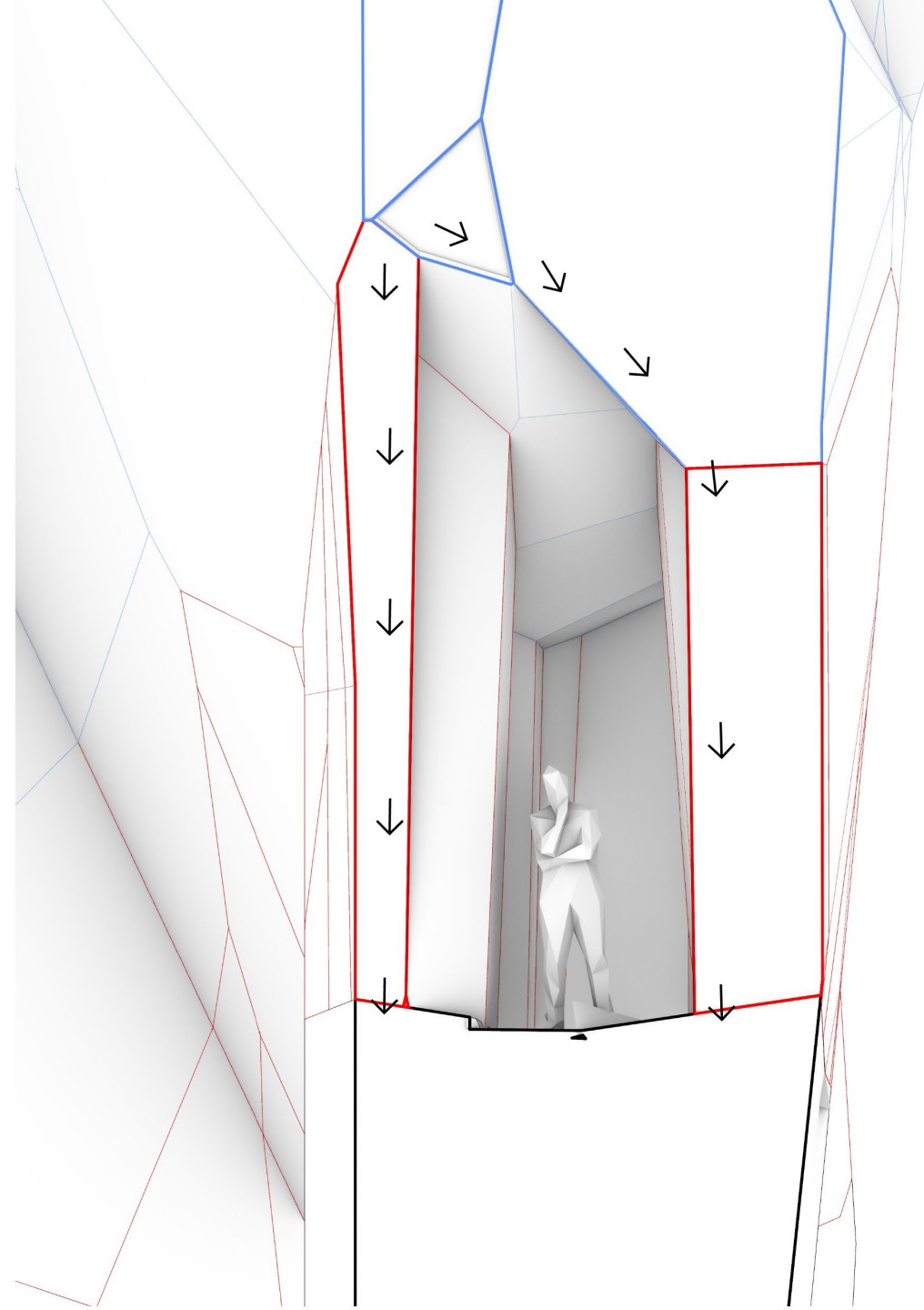
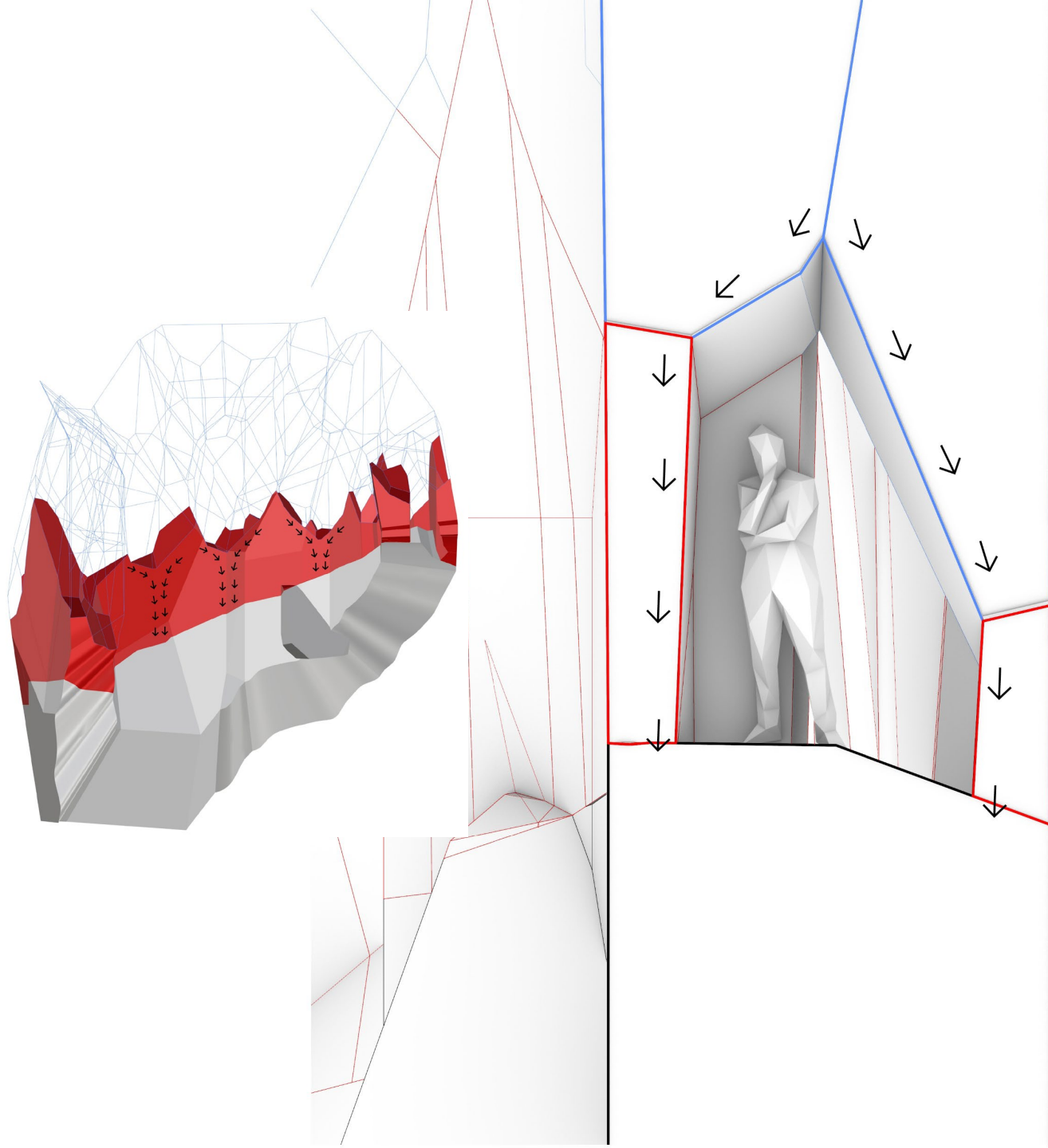














2m

