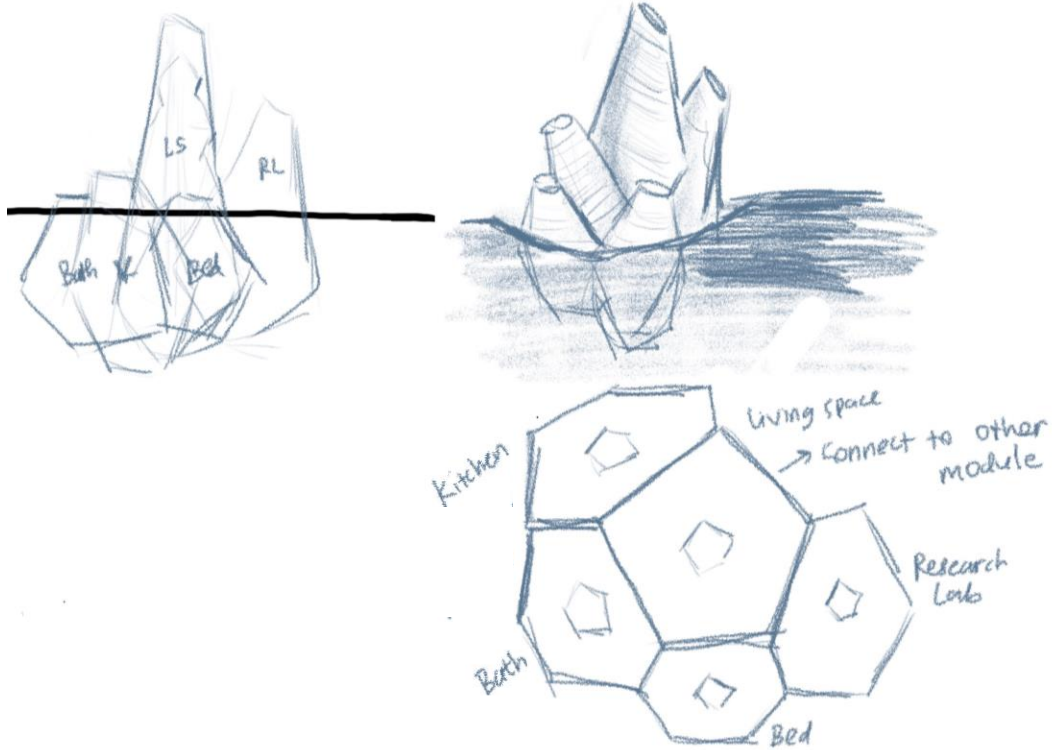
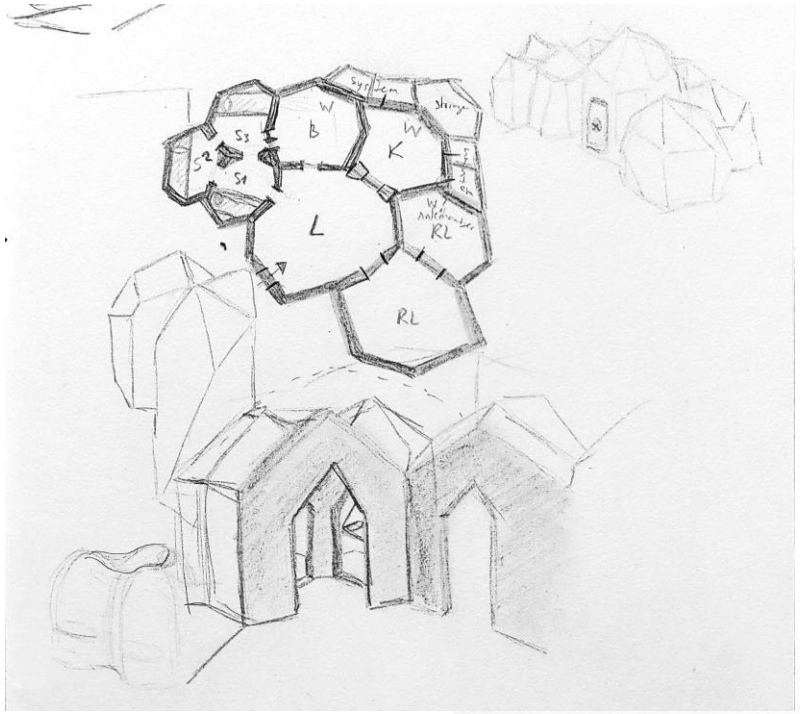
TuliPOD

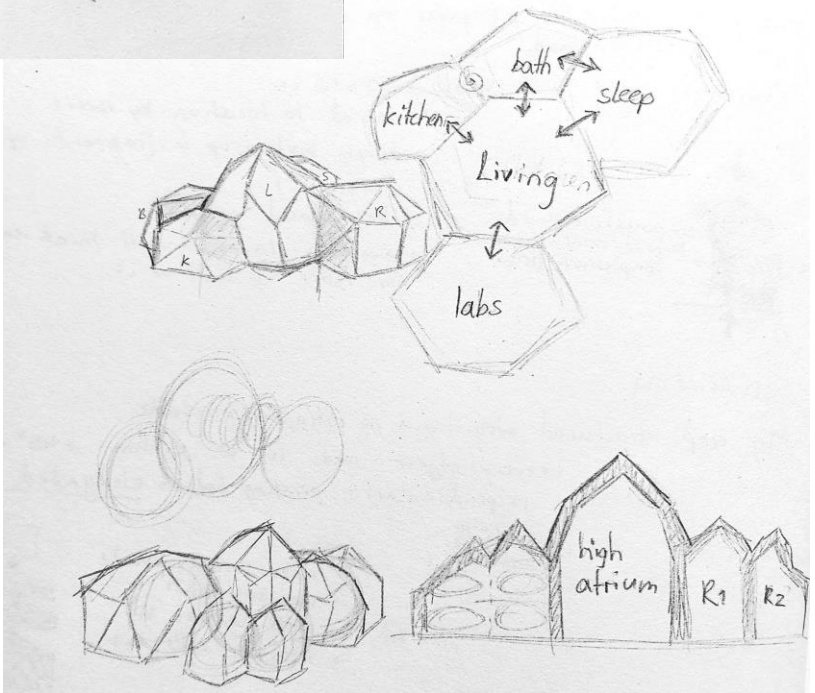
Exploring Clustered Compound on Moon

Workshop 1

Initial Sketches

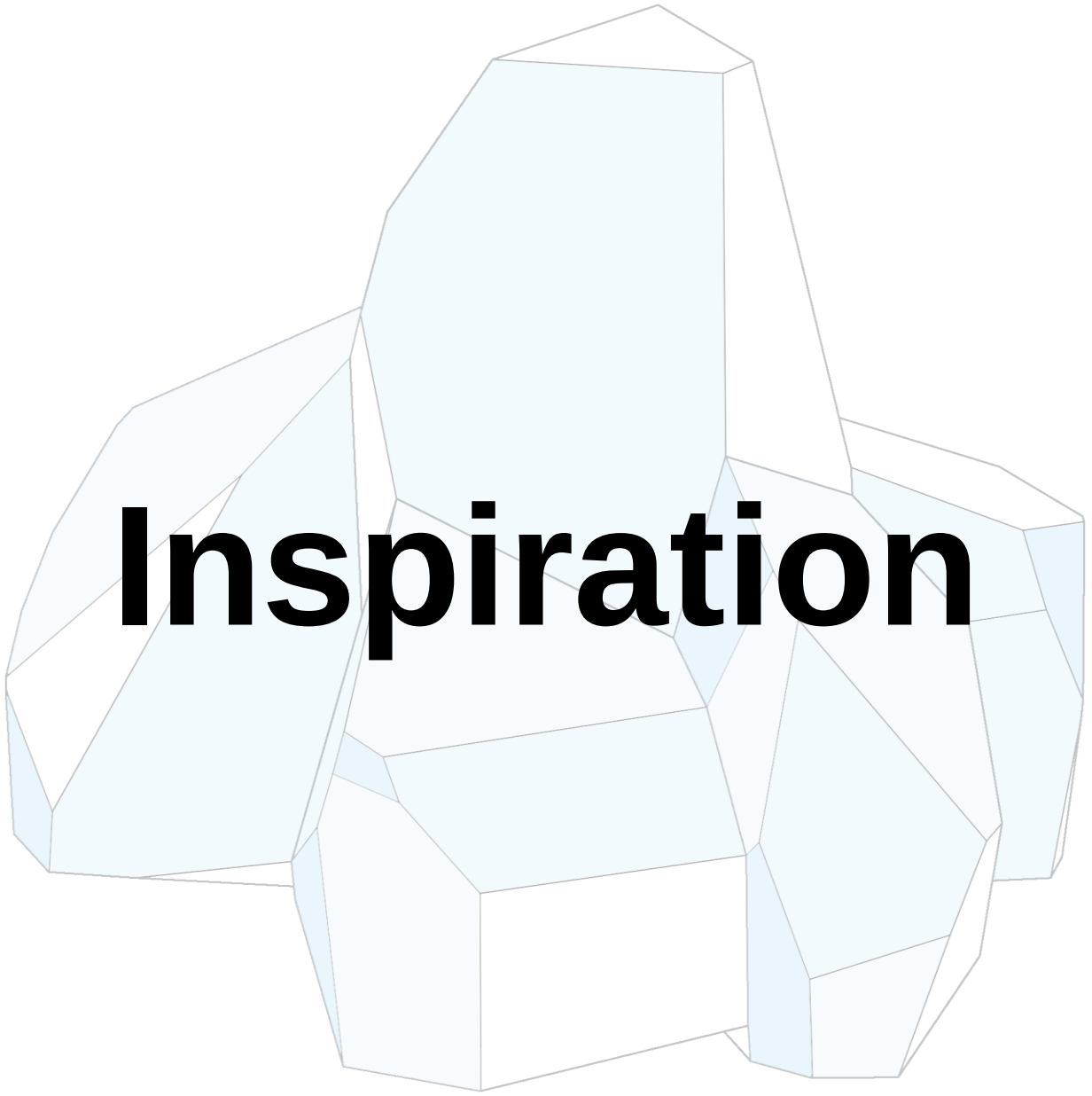

LS
RL
Bath
Bed
Skylight
Kitchen
Living space
Connect to other module
Research Lab
Bath
Bed


W
B
K
L
RL
RL


bath
sleep
kitchen
Living
labs
high atrium
R1
R2

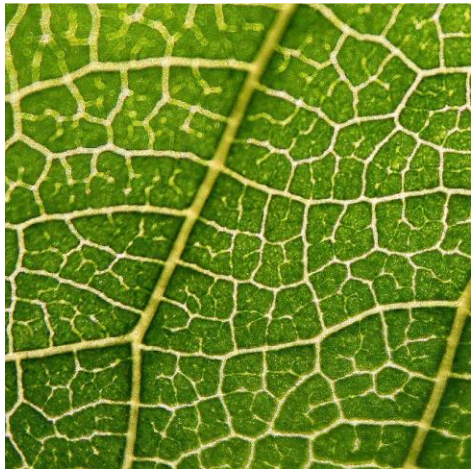
Vertical Strategy

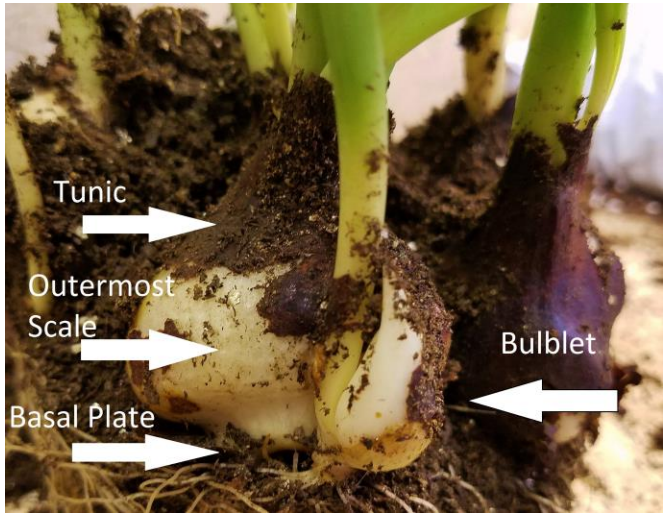
Horizontal Strategy



Inspiration

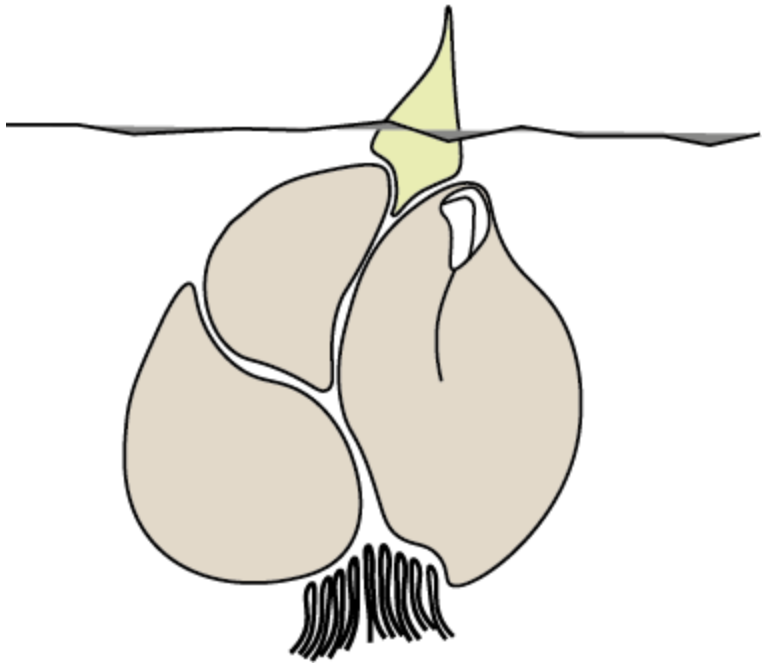
Voronoi geometry in nature

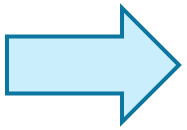


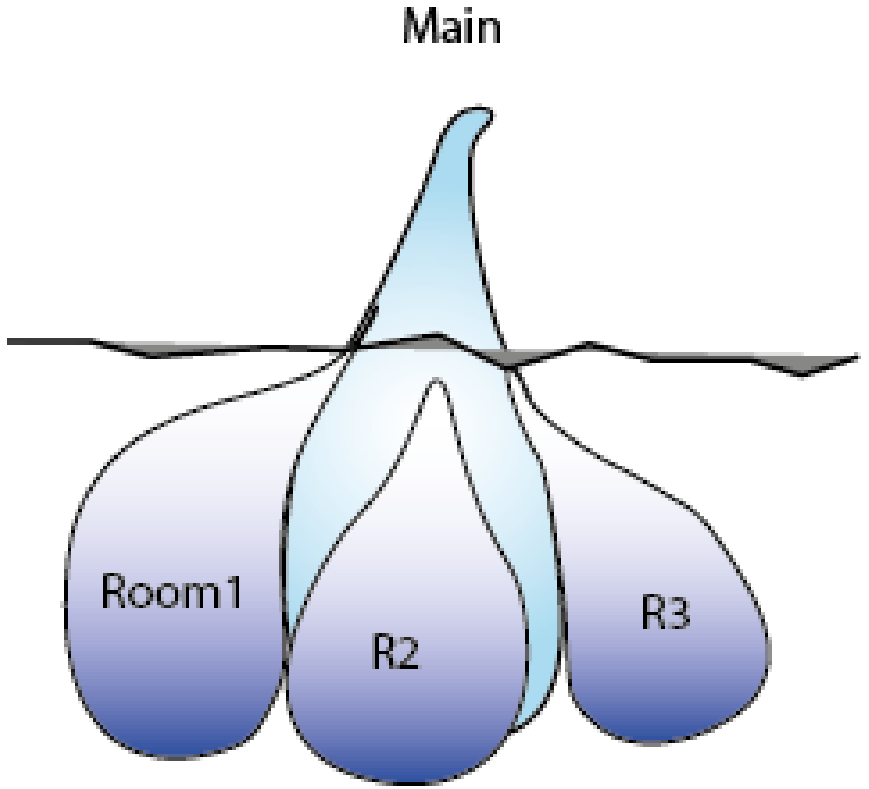


Finished tulip bulb, with bulblets

Synthesis tulip bulblets concept | Concept diagrams

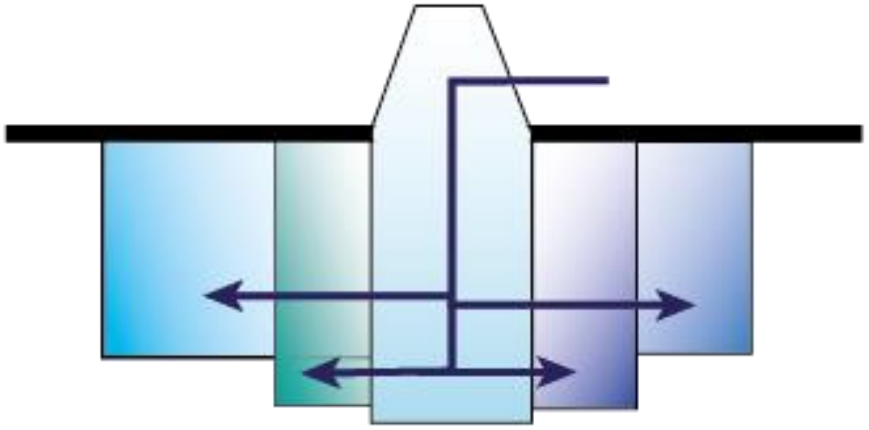




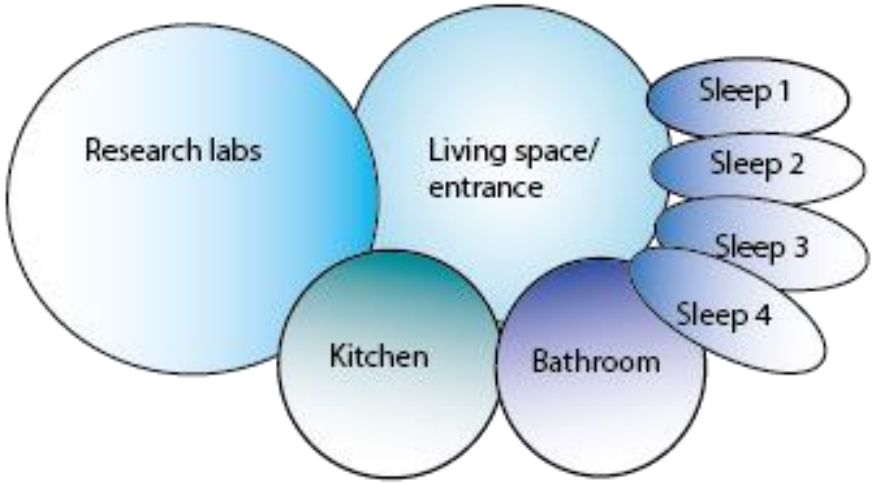


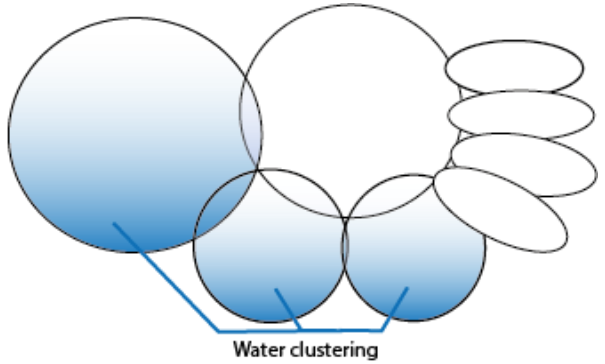
Synthesis tulip bulblets concept | **Concept diagrams**

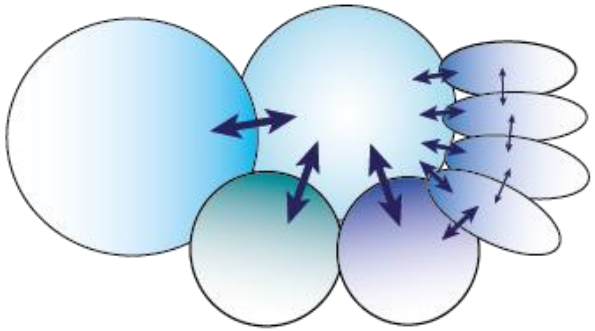
Section

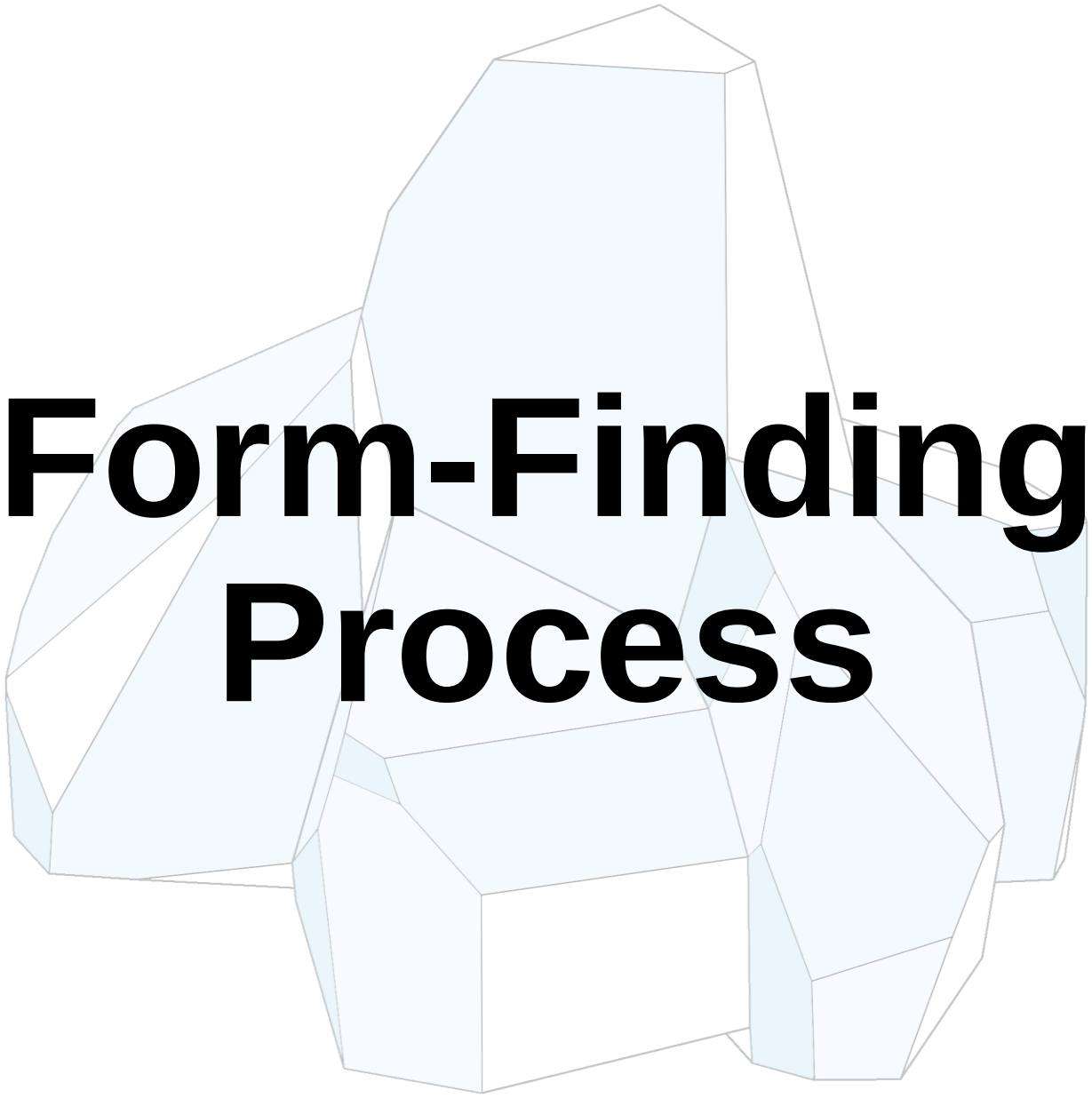


Topview



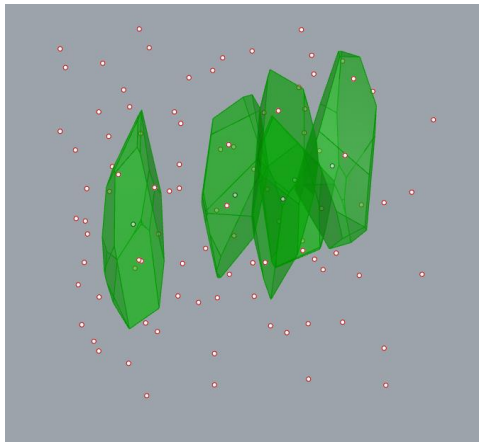




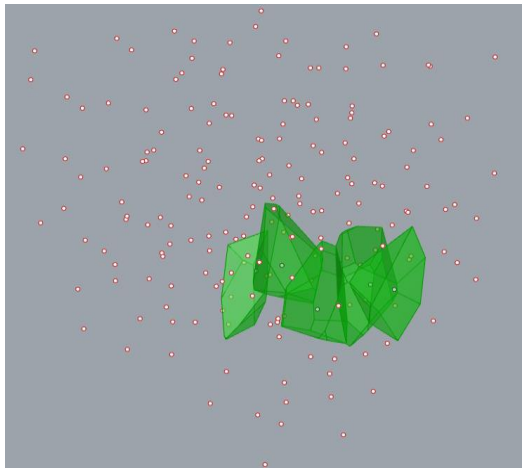


Form-Finding Process

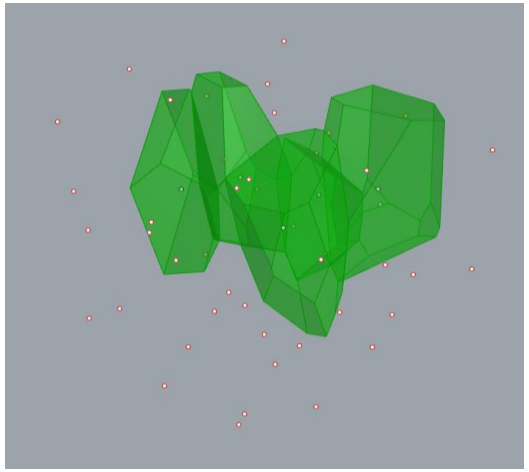
Code-generated Iterations | **Strategy**



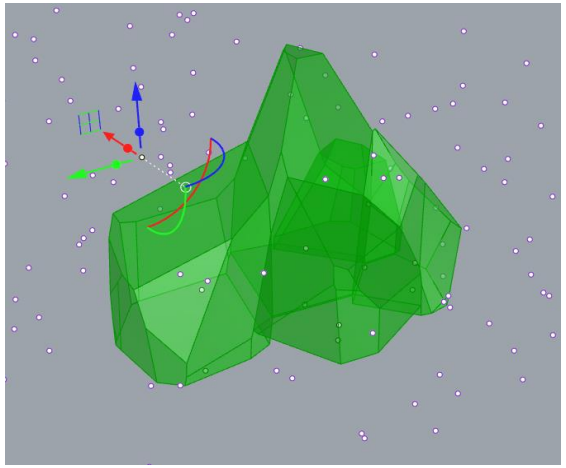
Initial Shape
100 points

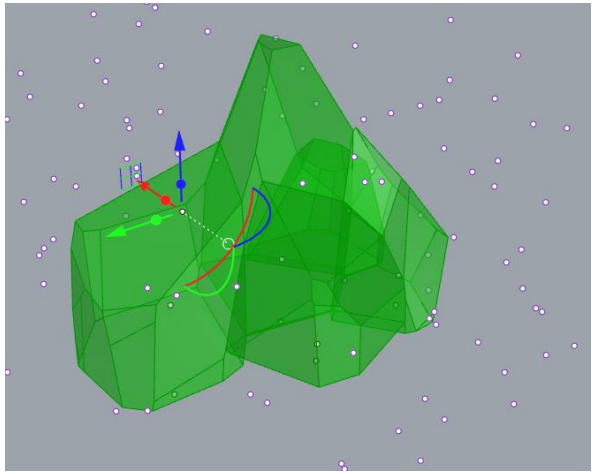


Increase Point Cloud
200 points
More variative iterations

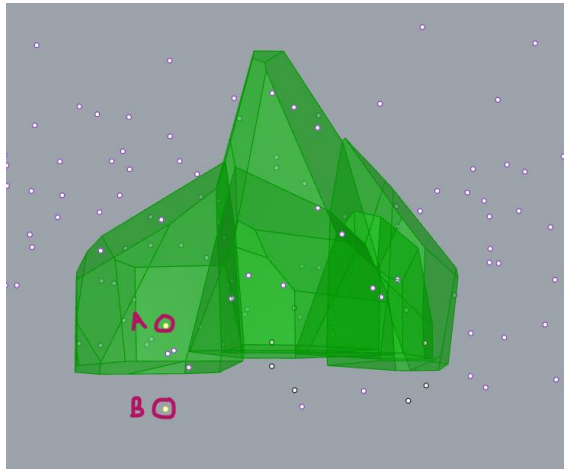


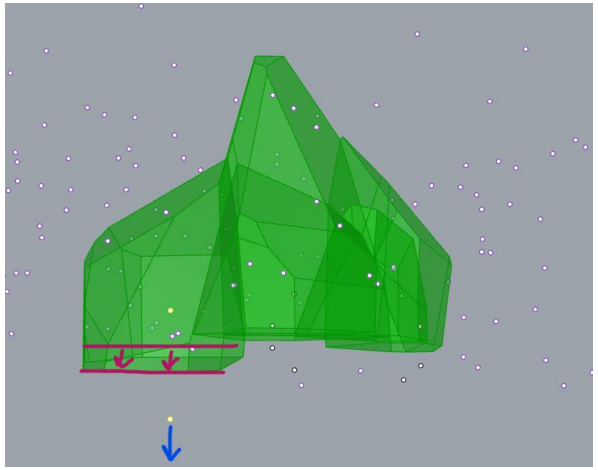
Decrease Point Cloud
50 points
Better control





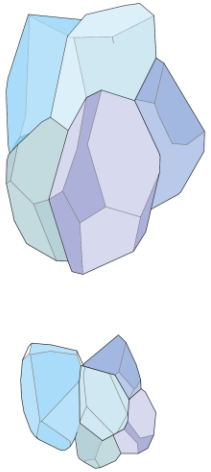
Most effective controlling shapes:
Manually moving points



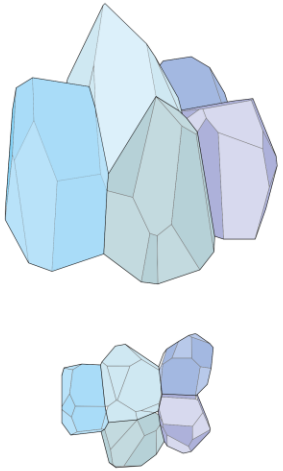


Controlling bottom surface:
Copy main point under volume

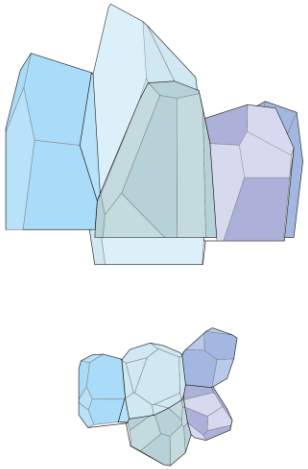
Form-finding process | **Iterations**



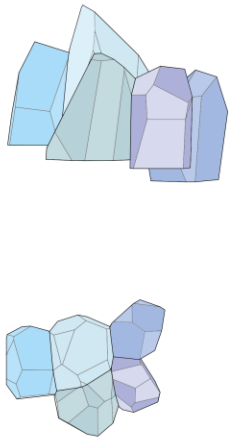
Starting shape: vertical cluster



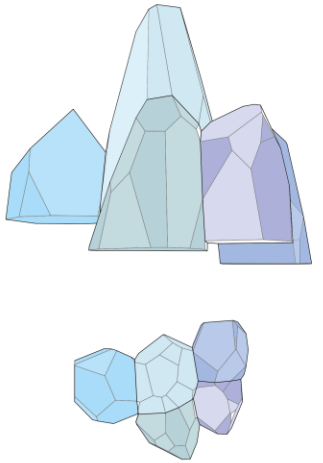
Iteration 1: flat bottom and central atrium



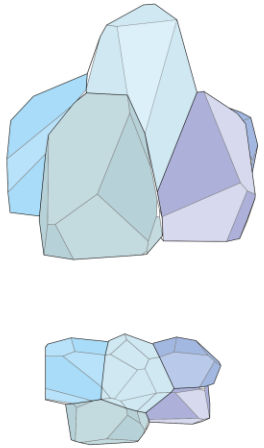
Iteration 2: different levels



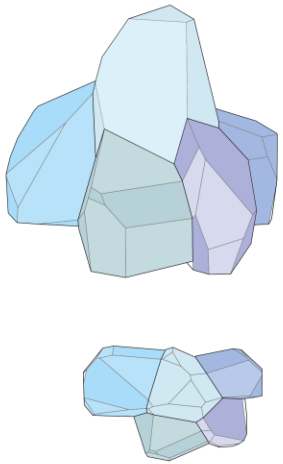
Iteration 3: levels spiral upward



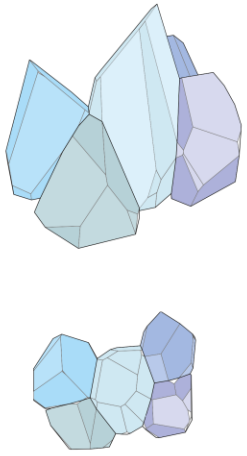
Iteration 4: enlarge atrium



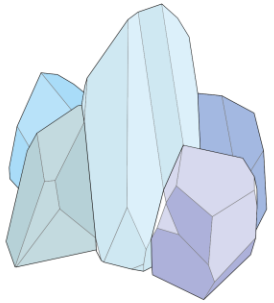
Iteration 5: bring together



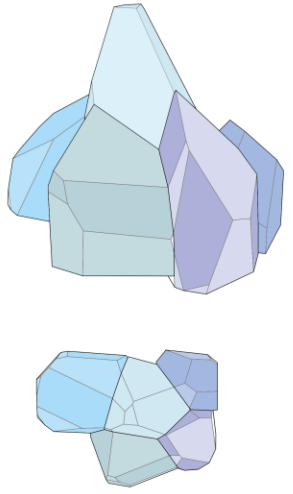
Iteration 6: change proportions



Iteration 7: 2-sided cluster



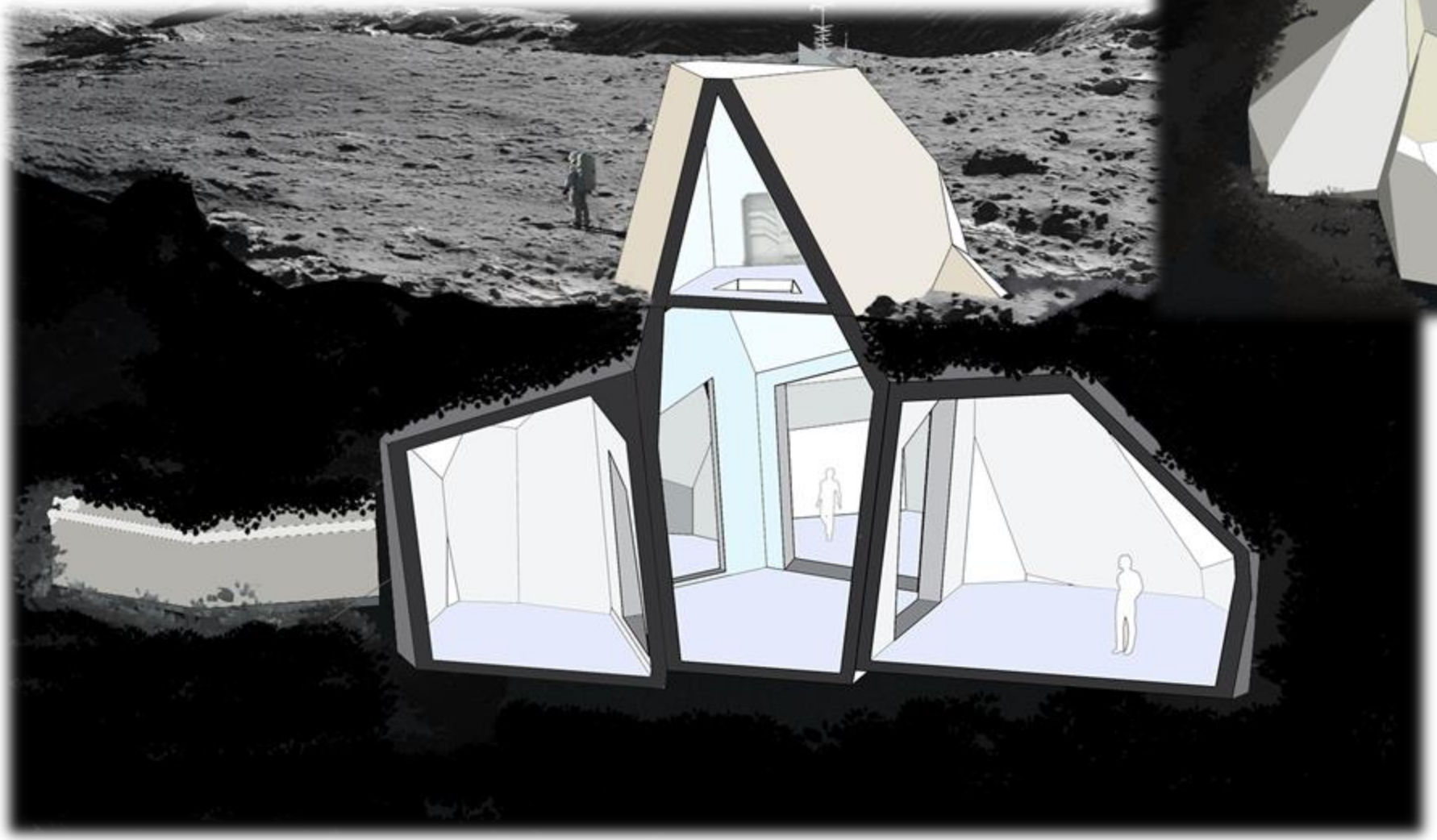
Iteration 8: change proportions

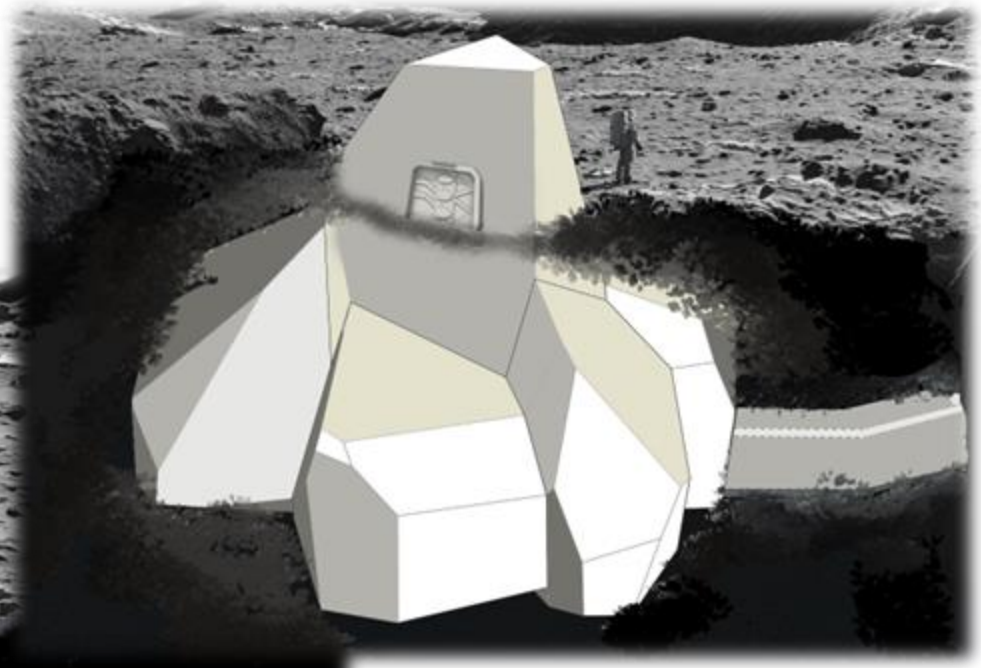


Iteration 9: create a more cohesive bulb shape

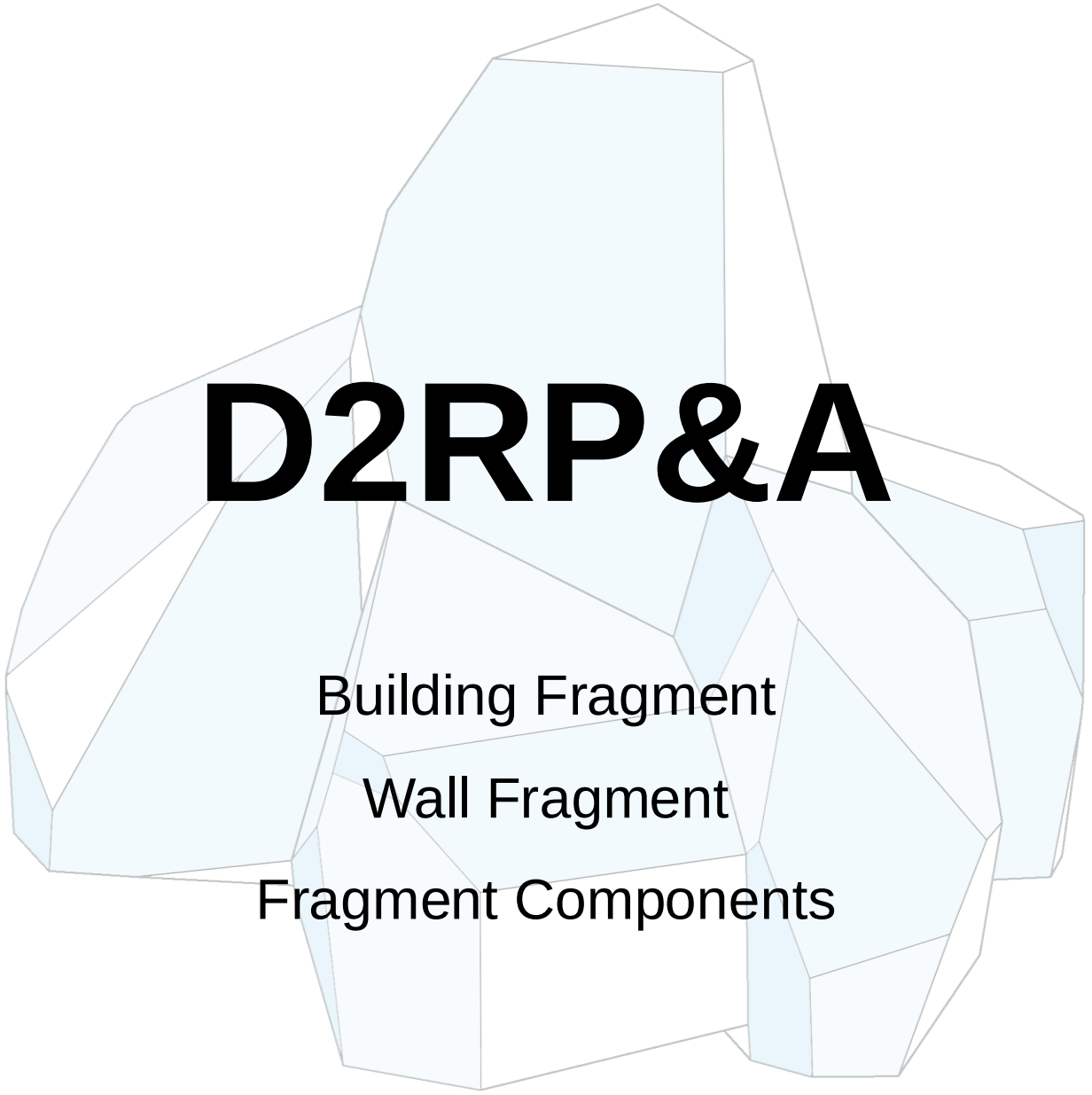
Form-finding process | **Final Design**

Front view - section





Back view - closed pod underground



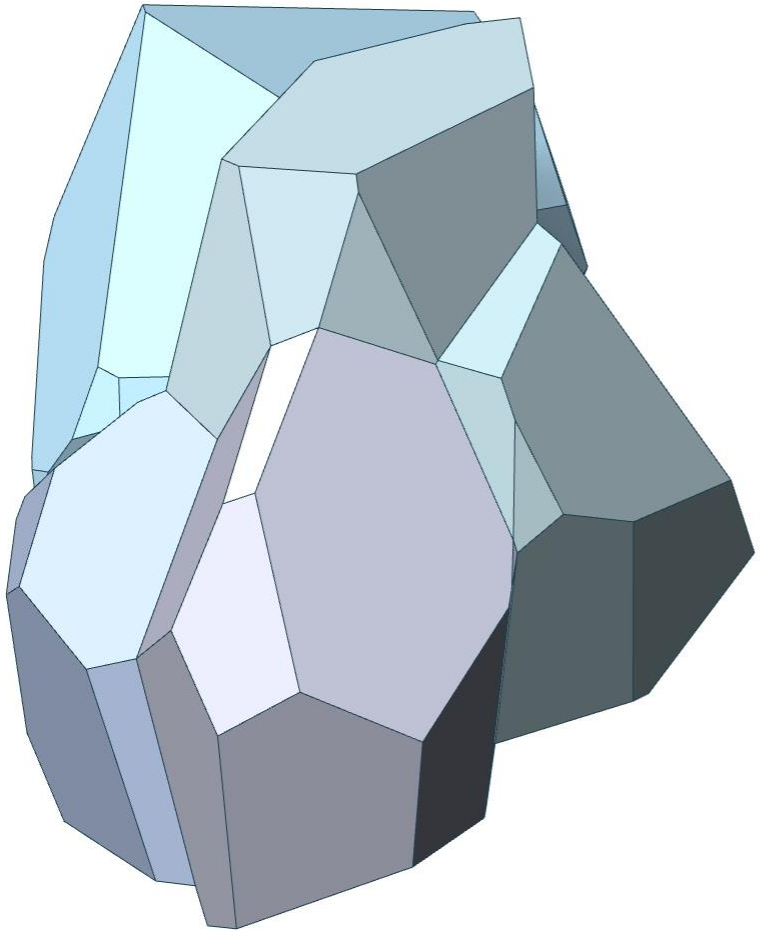
D2RP&A

Building Fragment

Wall Fragment

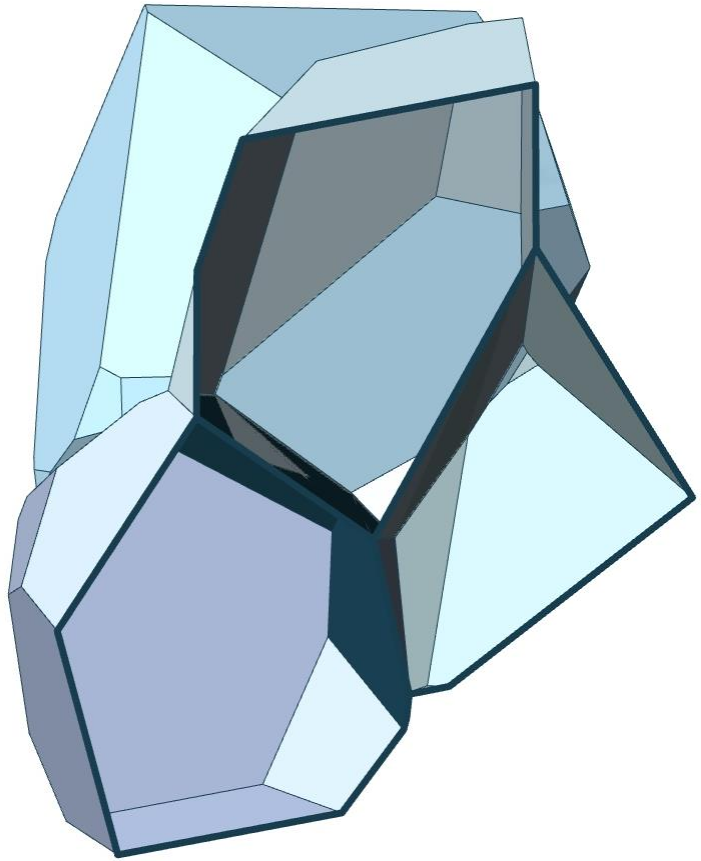
Fragment Components

Choosing Representative Fragment



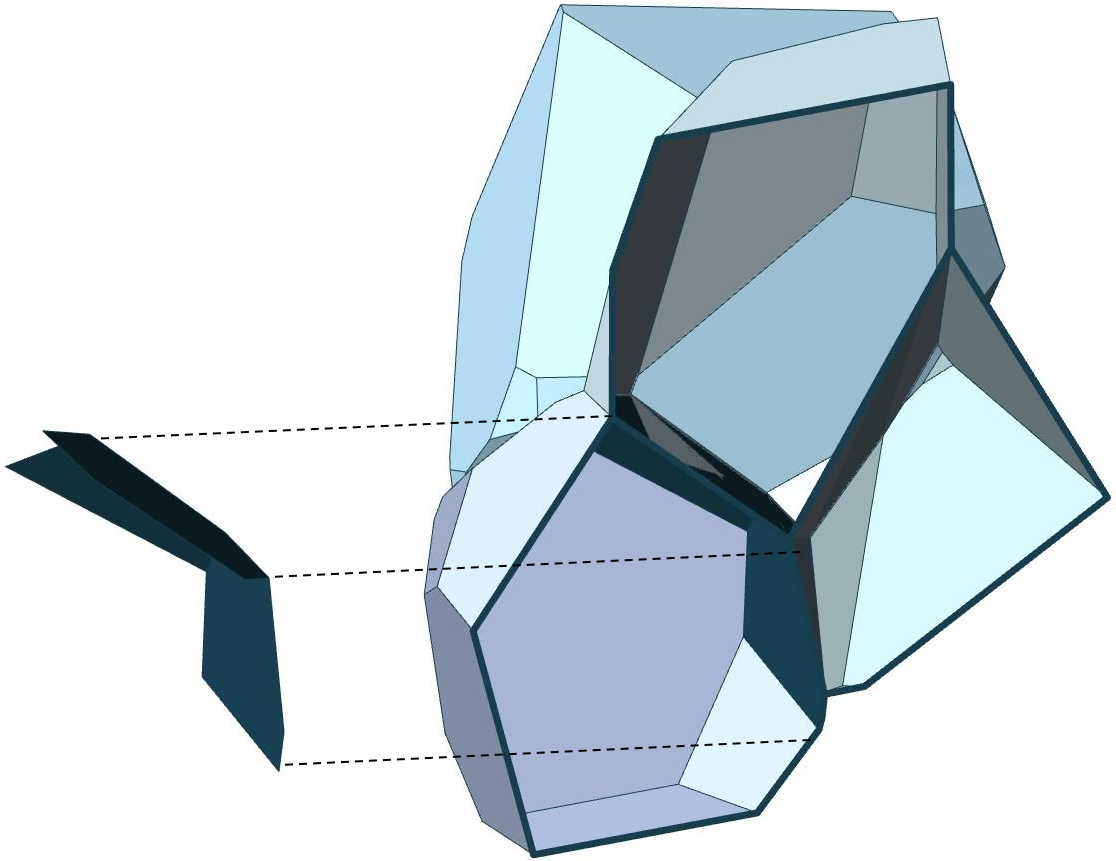
D2RP&A
Building Fragment
Wall Fragment
Fragment Components

Choosing Representative Fragment



D2RP&A
Building Fragment
Wall Fragment
Fragment Components

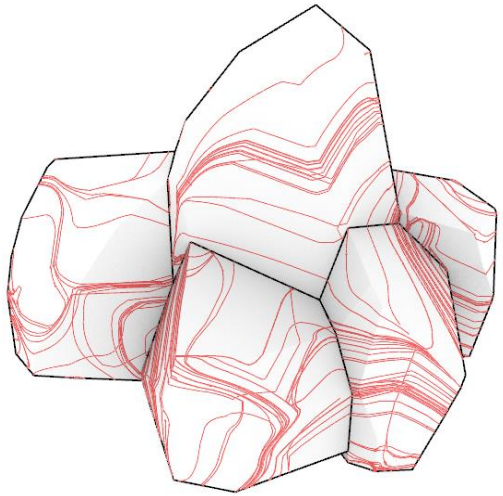
Choosing Representative Fragment

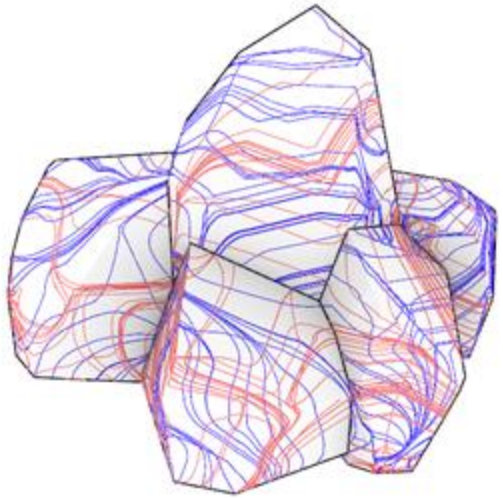


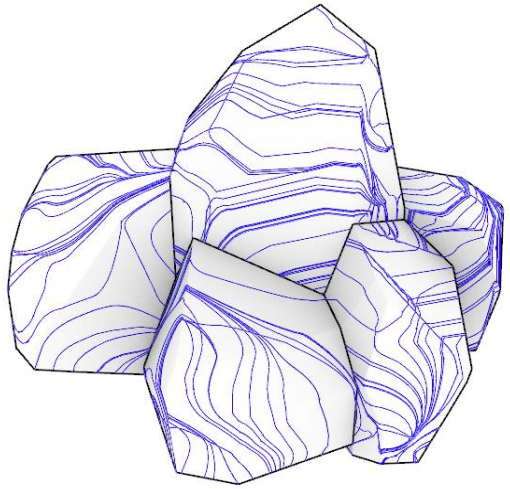
D2RP&A
Building Fragment
Wall Fragment
Fragment Components

Stress Diagram

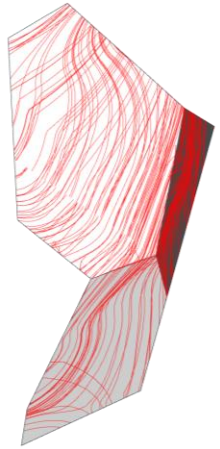
Building

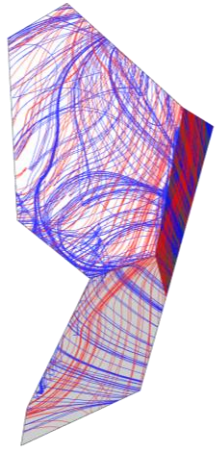


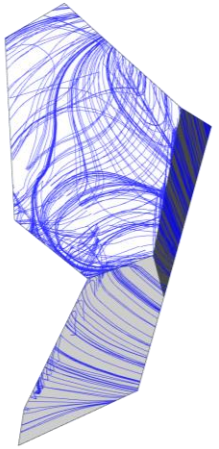




Fragment



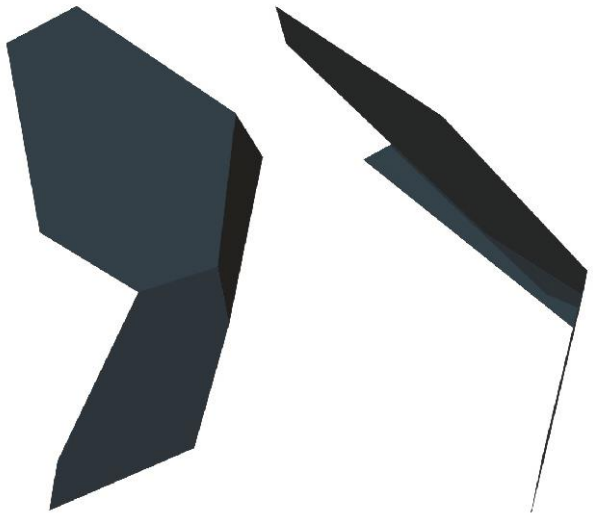




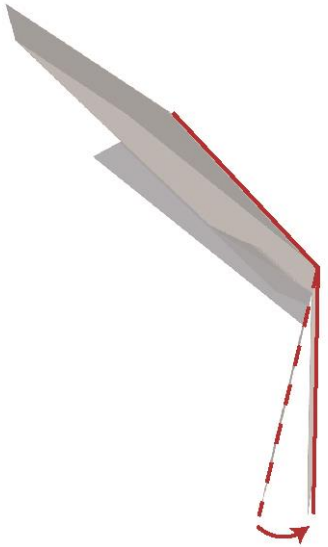
Compression **Overall** **Tension**

D2RP&A
Building Fragment
Wall Fragment
Fragment Components

Fragment Extraction Process

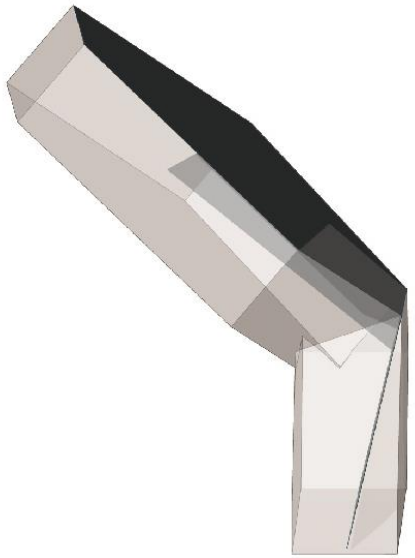


Extracted
wall fragment

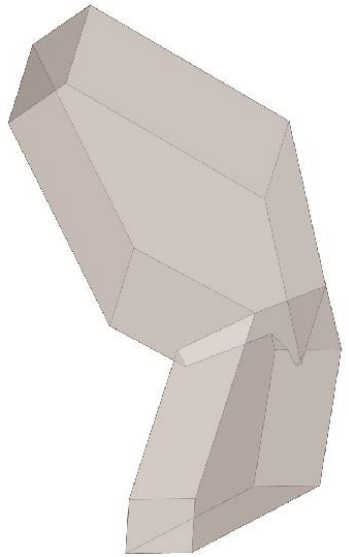


Adjust angle to ensure proper
support in turning point

Fragment Extraction Process



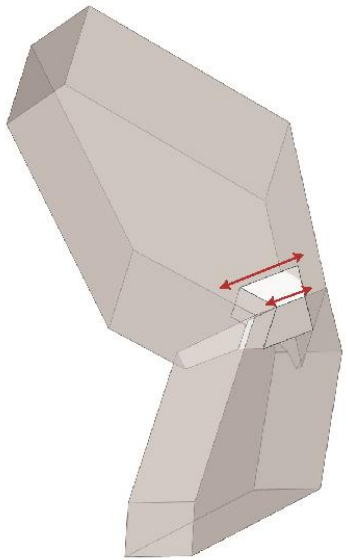
Add wall thickness



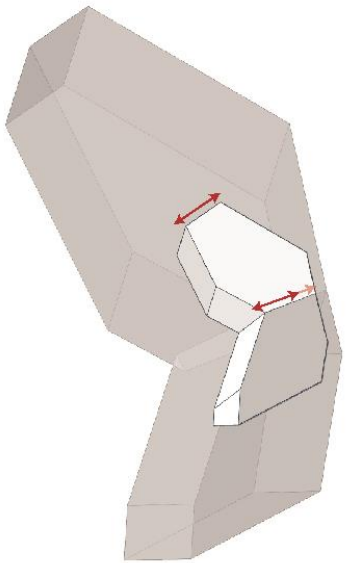
Adjusted wall

D2RP&A
Building Fragment
Wall Fragment
Fragment Components

Fragment Extraction Process

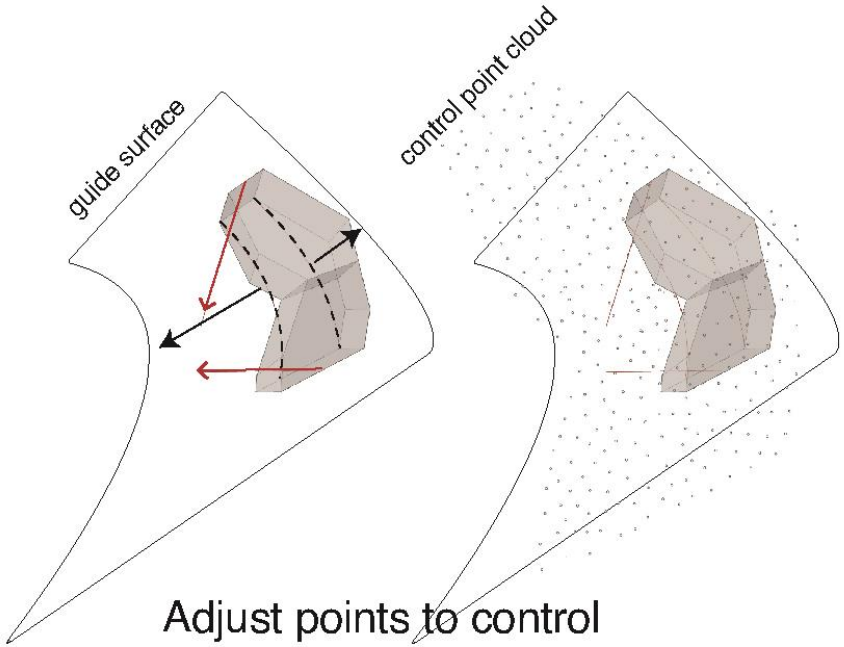


Choose wall fragment for robotic production

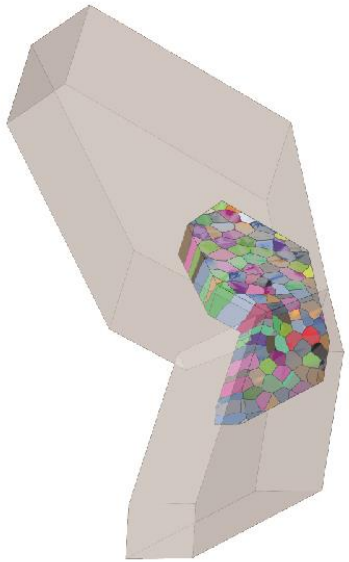


Refine wall fragment shape, ensure the fragment width change is not extreme

Fragment Extraction Process



Adjust points to control voronoi shape



Wall fragment after iterations of voronoi structure

D2RP&A
Building Fragment
Wall Fragment
Fragment Components

Fragment Iteration

Variations of voronoi stretch angle

Conclusion: different based on seed. Should be adjusted for walls with extreme angles. Either top or bottom angle should be kept at 0 for the voronoi geometry to properly merge in the turning point.

Seed 7, plane 0

Seed 7, plane 45

Seed 7, plane 90

Seed 9, plane 90

Seed 9, plane 0

Seed 9, plane 45

Variations of surface normal vector

Conclusion: centrally located normal lines produce more even voronoi geometry on the turning point.

Seed 5, plane 45

Seed 5, plane 0

Seed 10, plane 0

Seed 10, plane 45

Seed 9, plane 45
Shift normal plane

Seed 9, plane 45
Shift normal plane

Variations of point count

Conclusion: Point cloud should be adjusted in proportion to the wall fragment size to keep the component at around 200mm vertical thickness.

Seed 7, plane 45
Shift normal plane

Seed 7, plane 45
Increase point count (115)

Seed 7, plane 0
Increased point count (125)

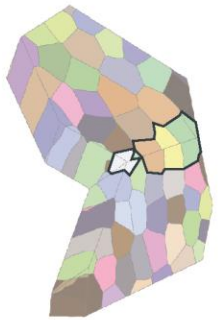
Seed 7, plane 0
Increased point count (170)

Seed 7, plane 45
Increased point count (170)

Seed 7, plane 90
Increased point count (170)

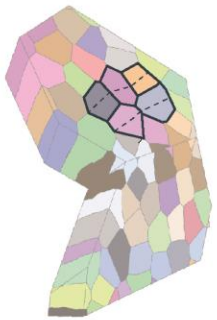
D2RP&A
Building Fragment
Wall Fragment
Fragment Components

Fragment Iteration



Seed 1

Component sizes too different



Seed 7

Regenerate seed

Components too big

Seed 10

Increase control point count

Good proportion for most components
Components in turning point too tapered
may be problematic in milling
Components too vertical
need shorter components for compressive strength

Seed 10*

Manually adjust points from the generated seed

Point count 130
Reference top angle 0,
bottom angle 90

Goal achieved:

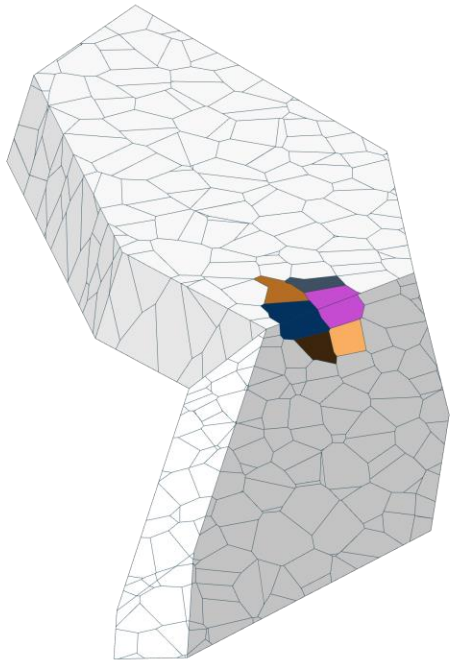
(1) Laterally stretched and vertically compressed components

(2) Generally even distribution and shape of voronoi geometry

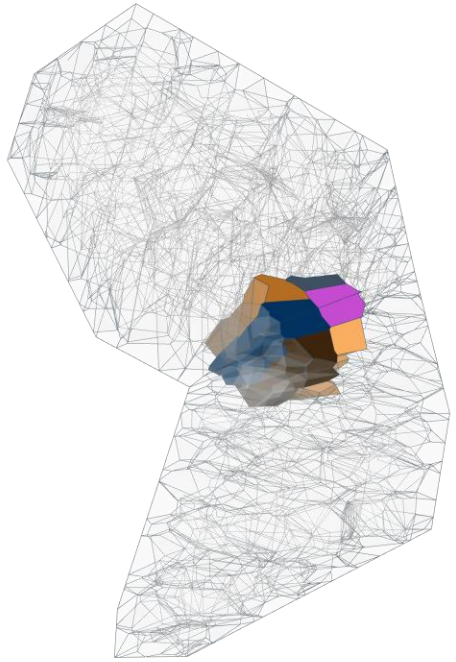
D2RP&A
Building Fragment
Wall Fragment
Fragment Components

Breakdown fragment into components

Chosen fragment

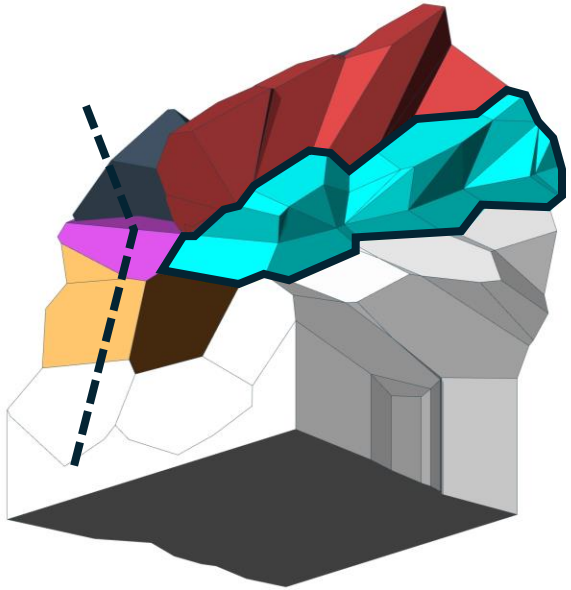


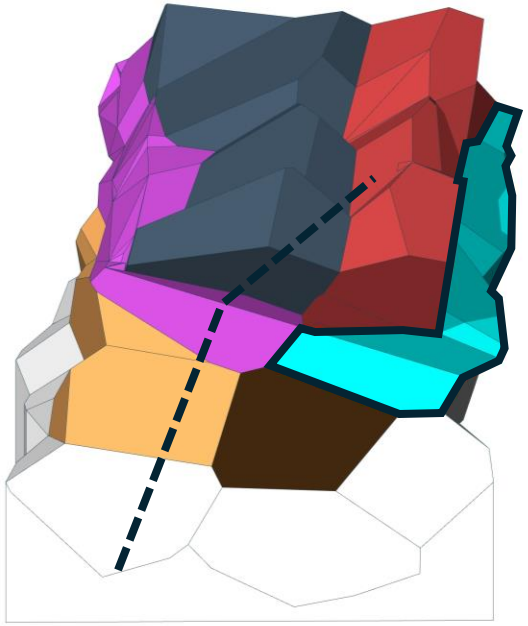
Representative component in turning point to test stability

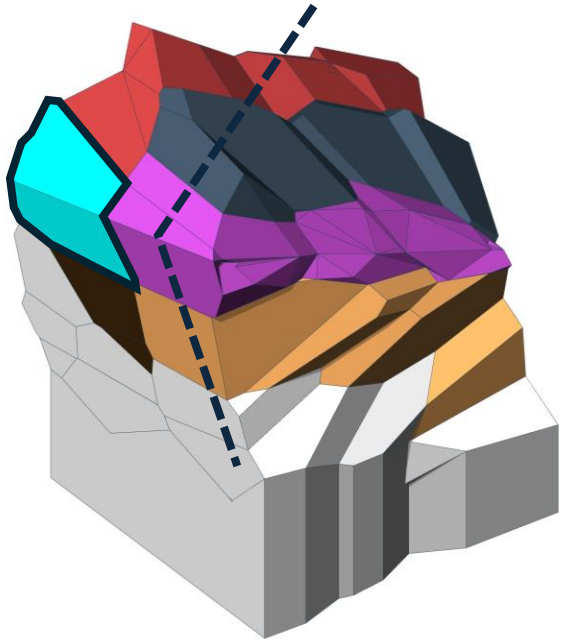


Chosen component to develop for production

D2RP&A
Building Fragment
Wall Fragment
Fragment Components



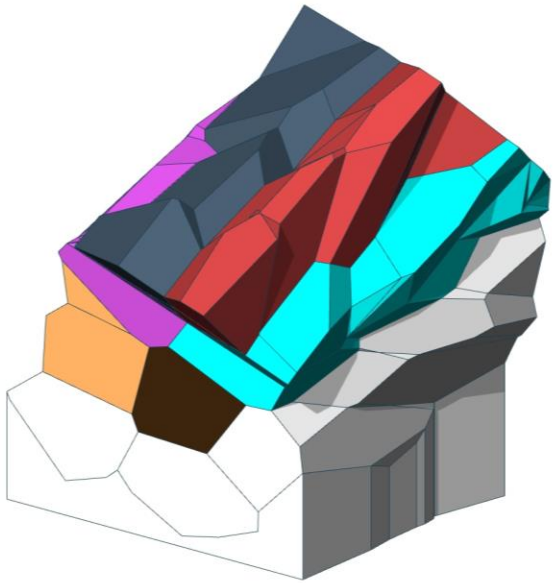


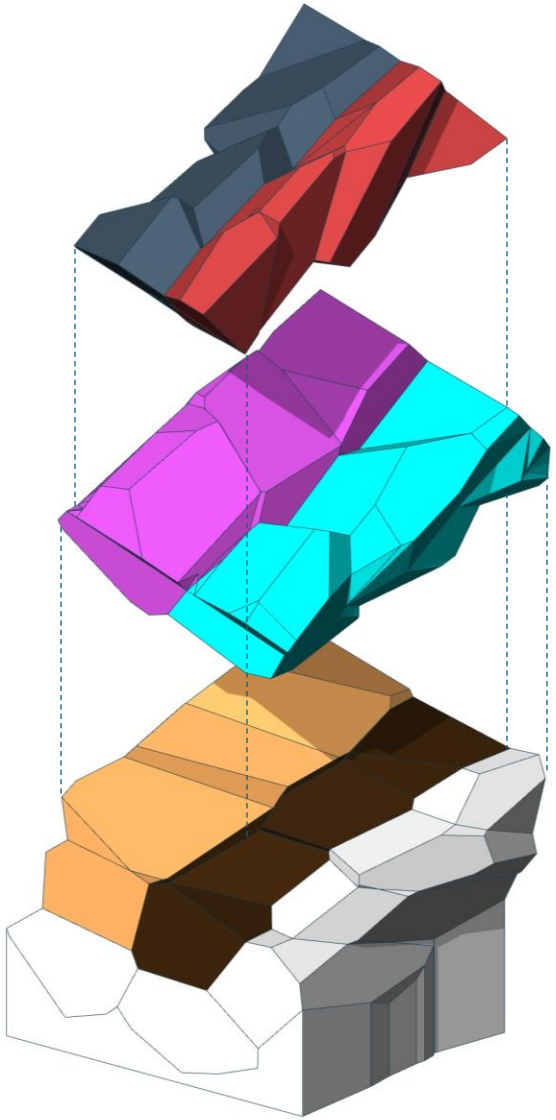


Chosen component for simulation

on the folding area, considering higher complexity for testing

Fragment of 6 Components





Connection

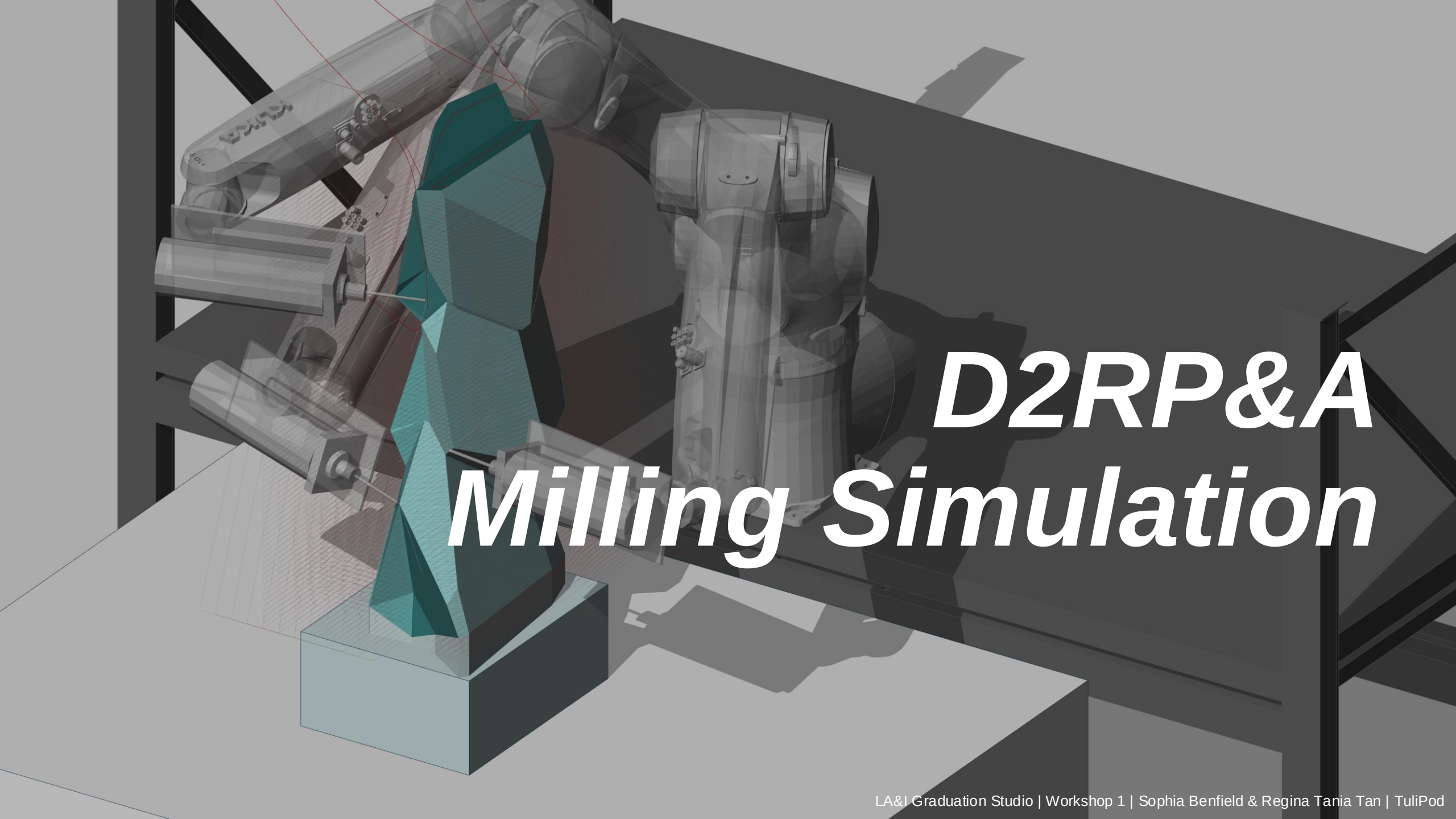
Milling Holes

D2RP&A

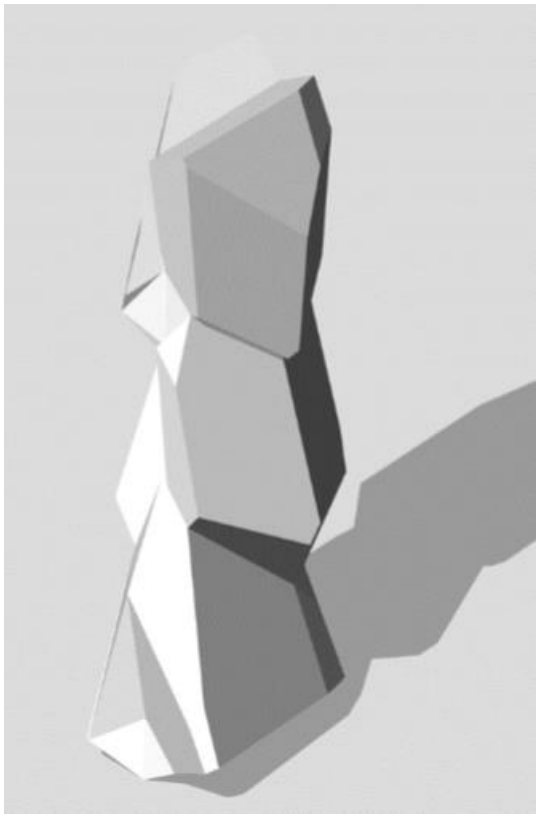
Building Fragment

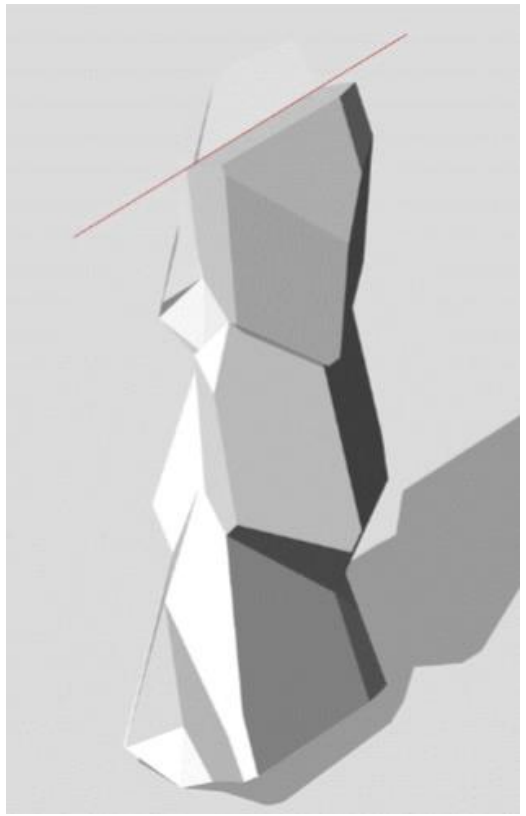
Wall Fragment

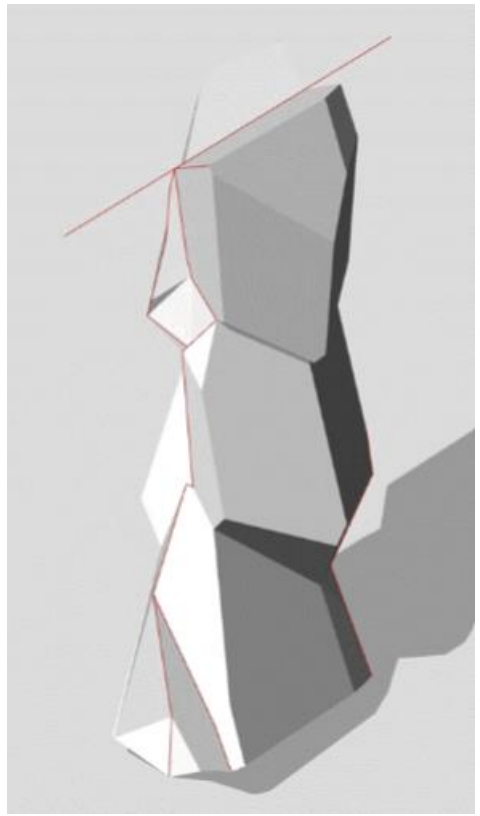
Fragment Components

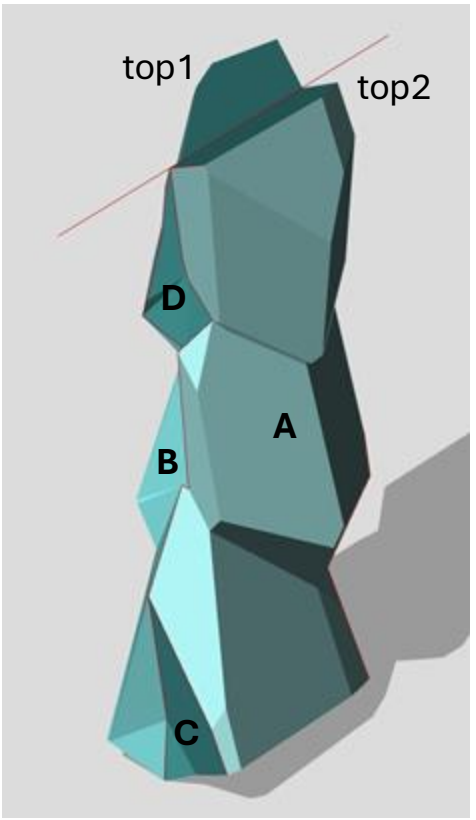


D2RP&A
Milling Simulation



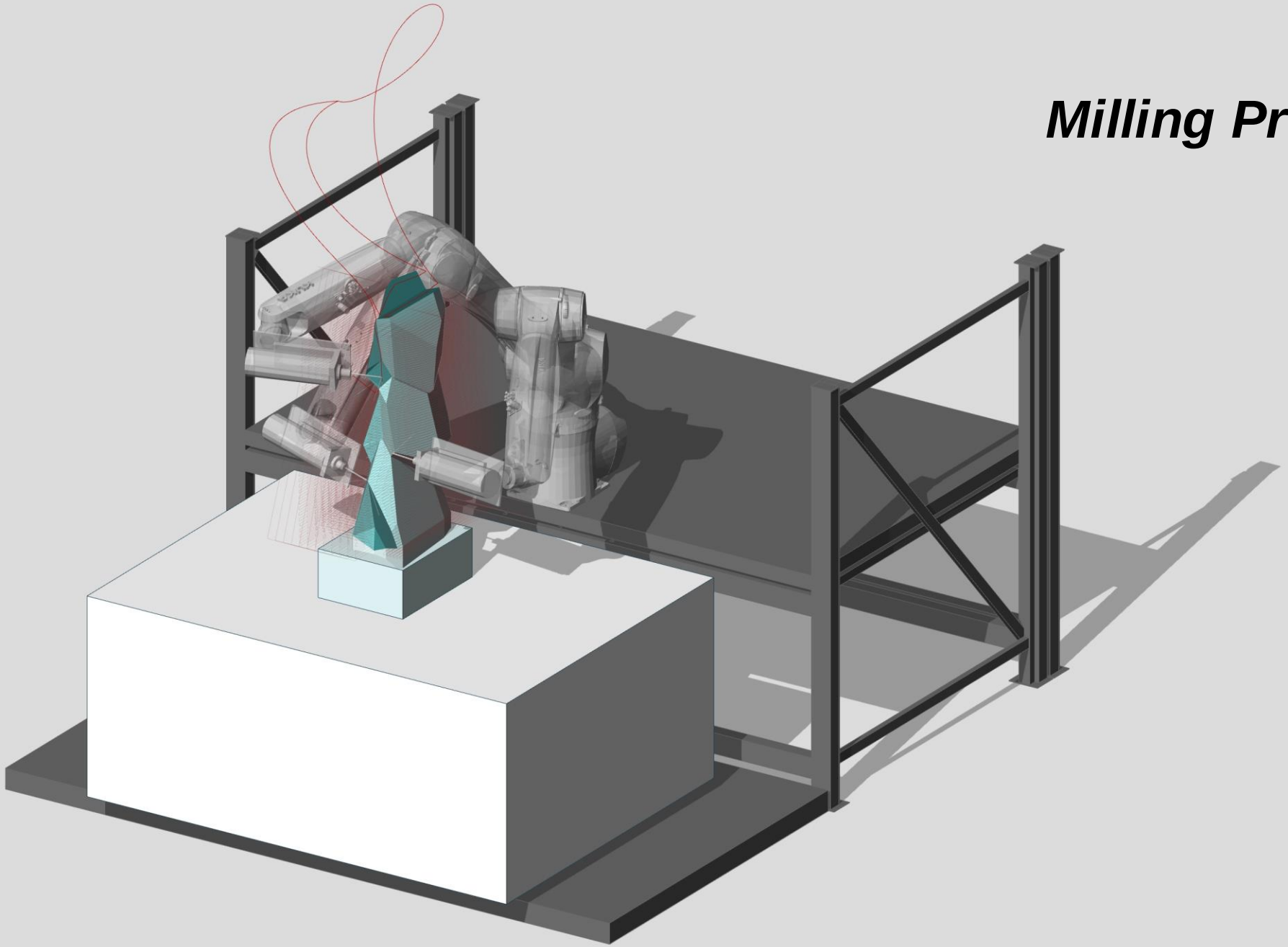




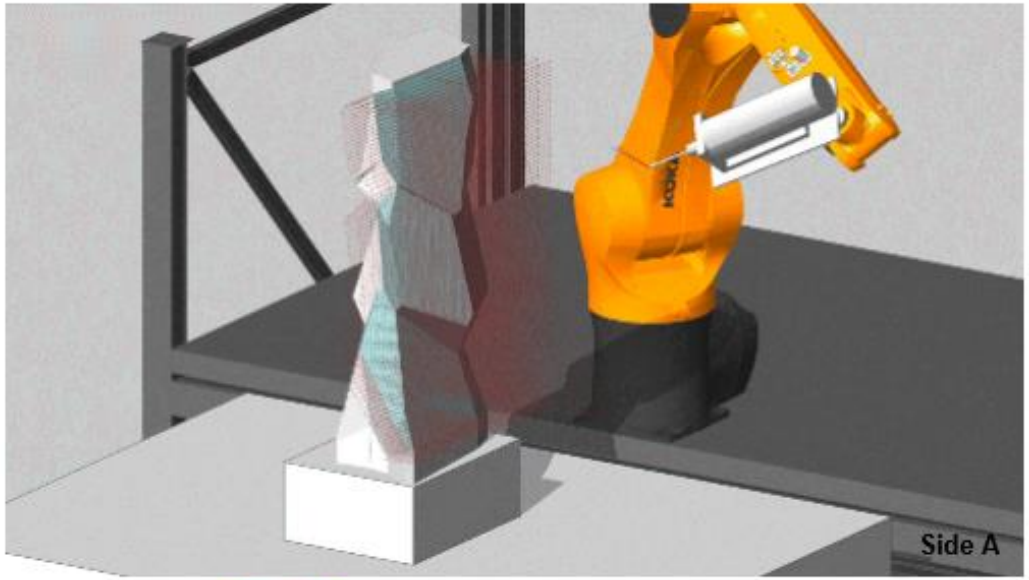


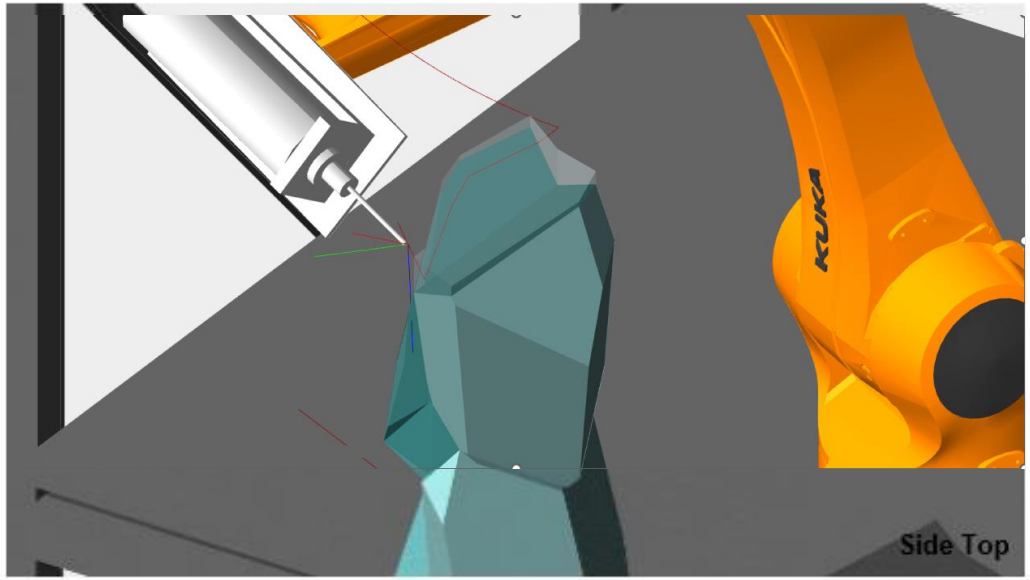
Surface Selection

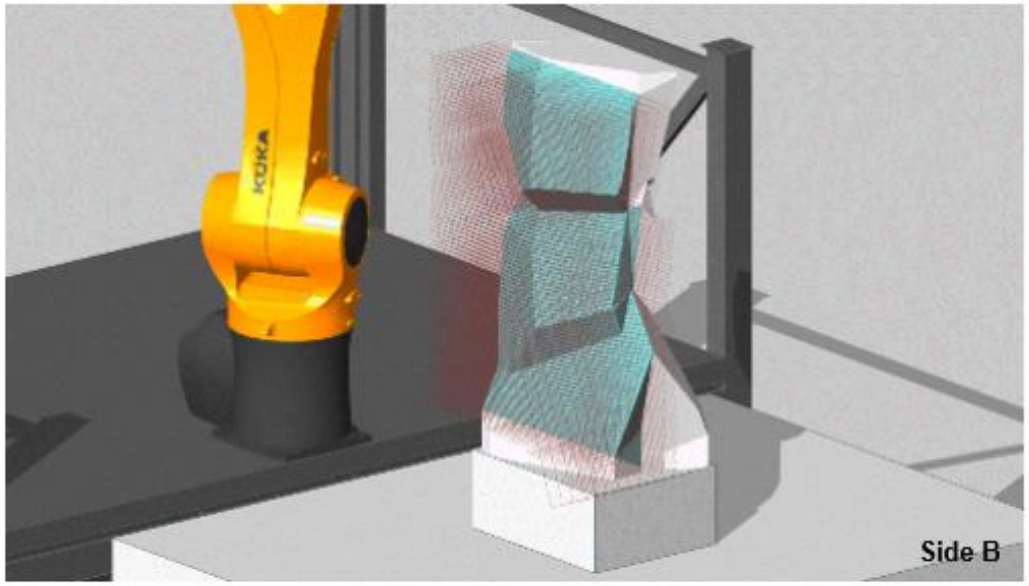
Milling Process

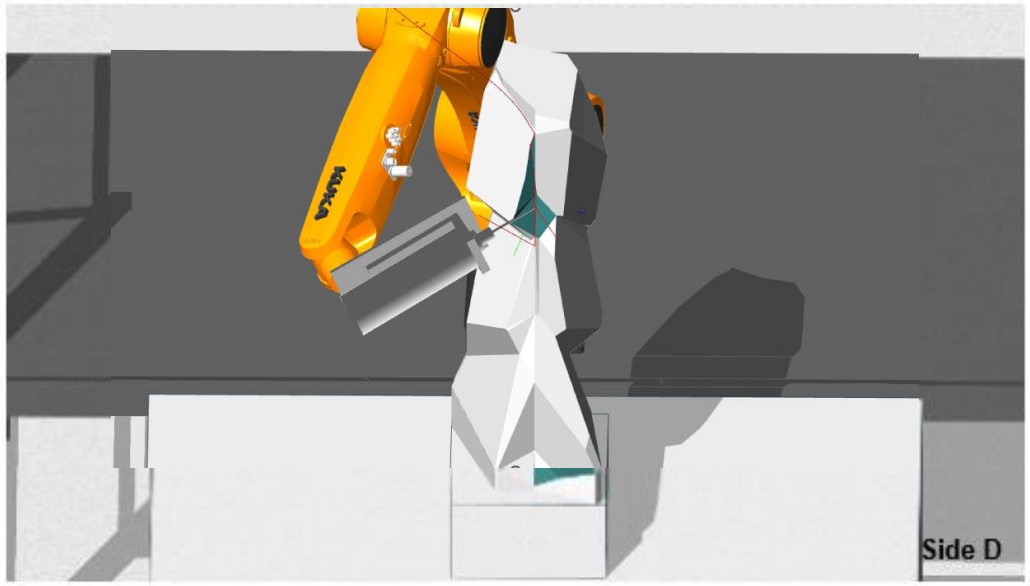


D2RP&A
Building Fragment
Wall Fragment
Fragment Components



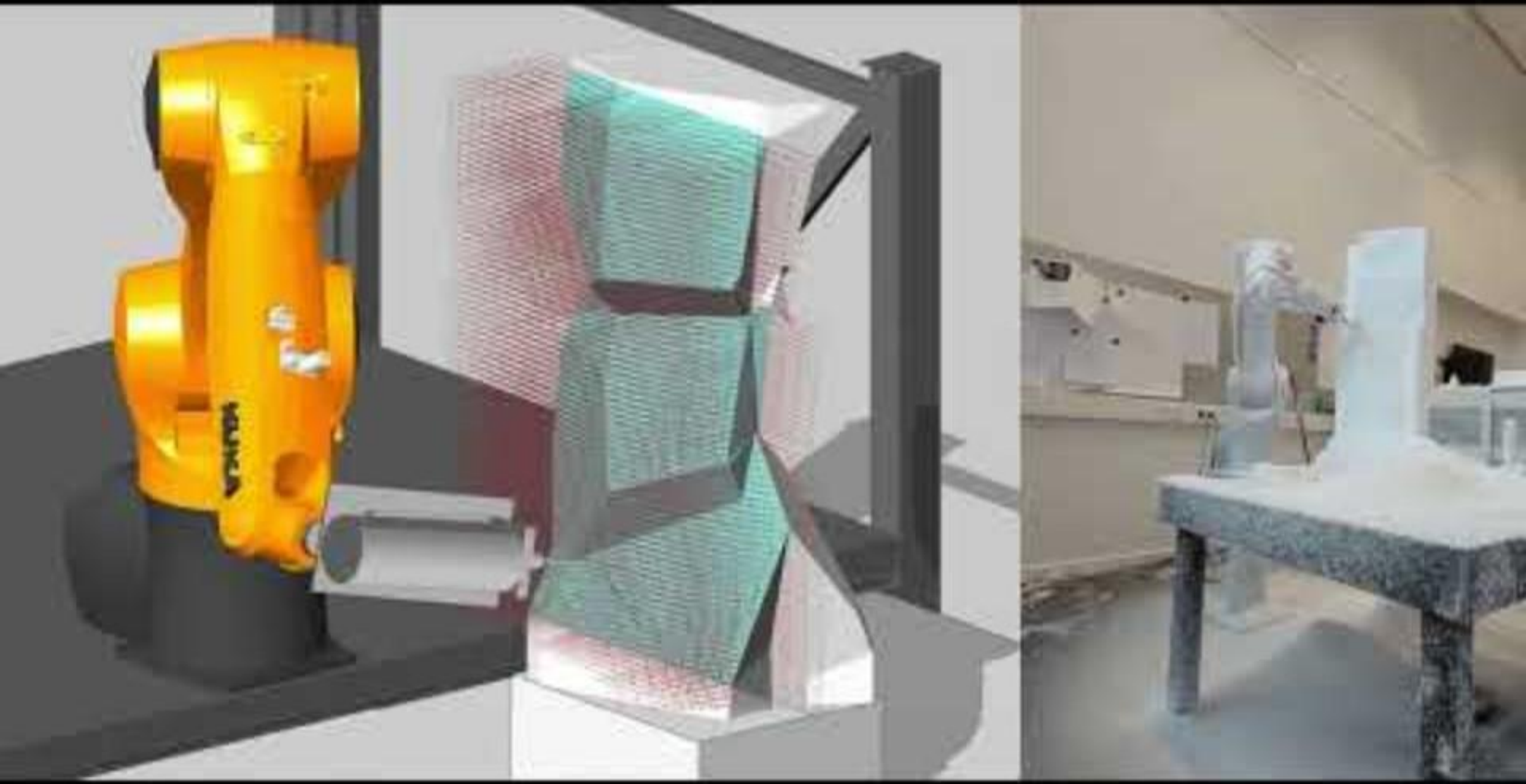






D2RP&A

Building Fragment

Wall Fragment

Fragment Components