



EARTHY (AR3B011), Q1:2018-2019

## SKILLS FOR THE FUTURE SKILL DEVELOPMENT CENTER

TEAM 2.0

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JEROEN DE BRUIJN

PRETHVI RAJ  
YAMUNA SAKTHIVEL

CONFIGURING  
**DESIGN GOALS**

## PROBLEME STATEMENT

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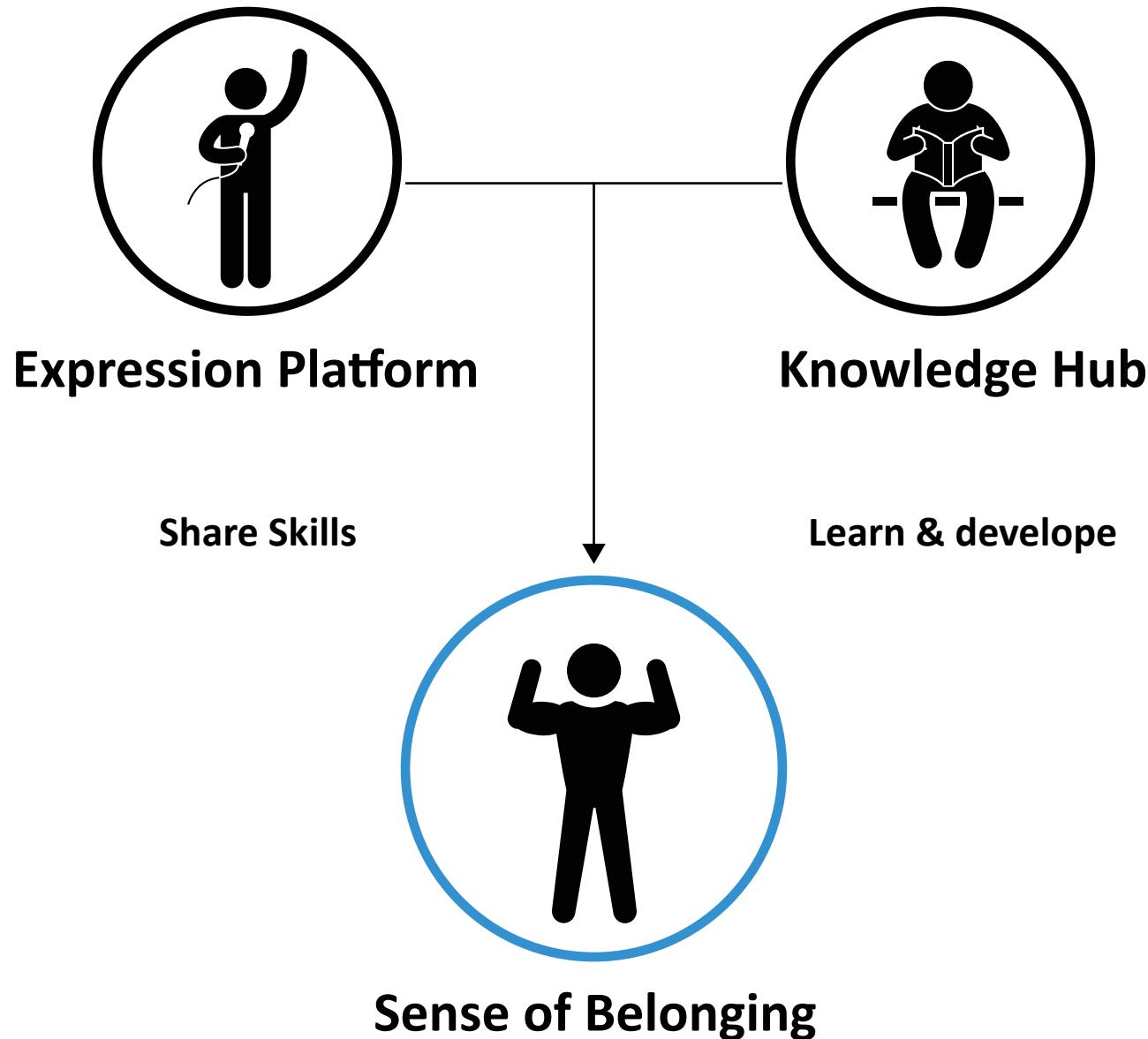
### DESIGN GOALS



## SOLUTION

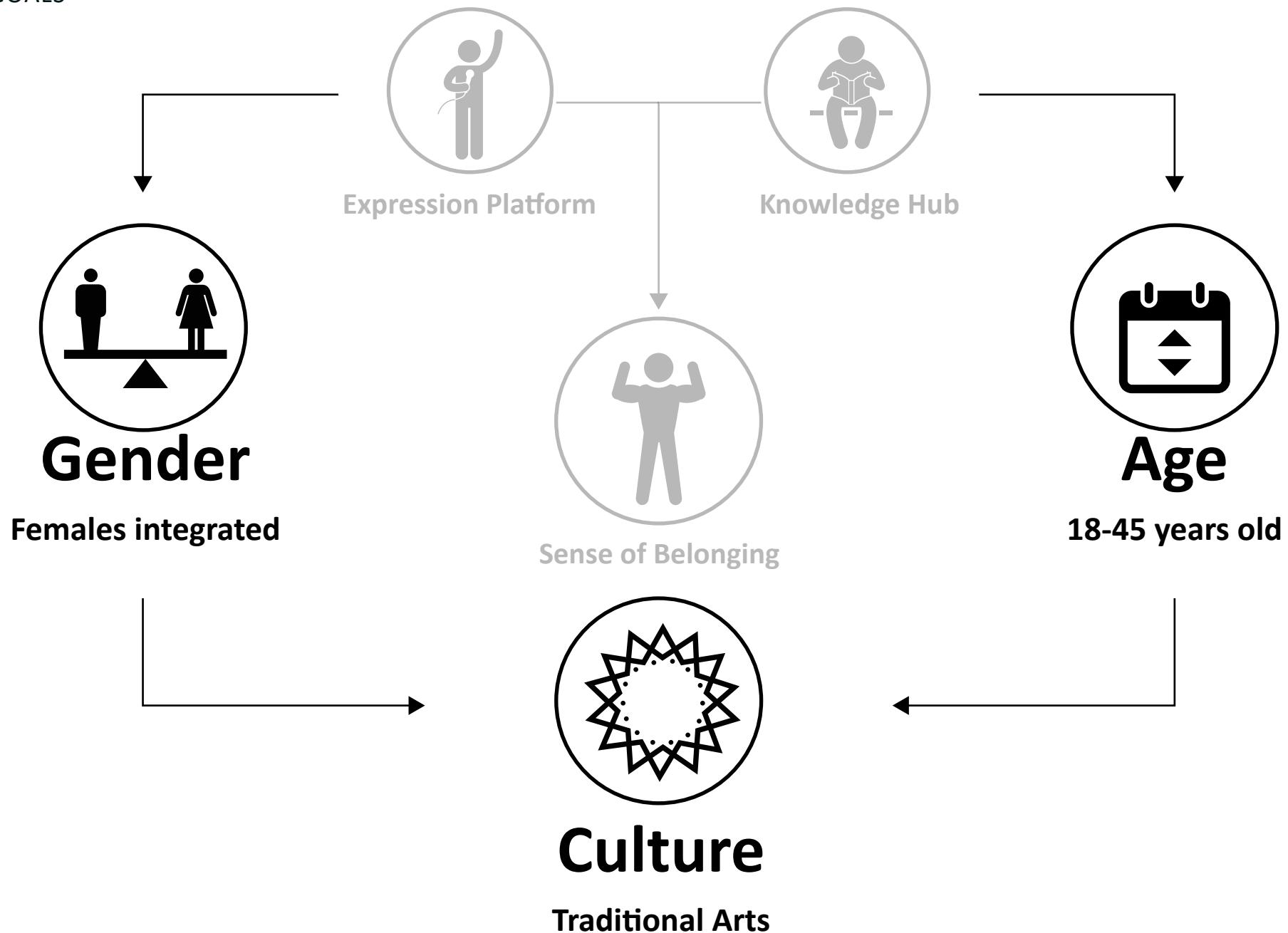
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### DESIGN GOALS



## DESIGN TARGET

## DESIGN GOALS

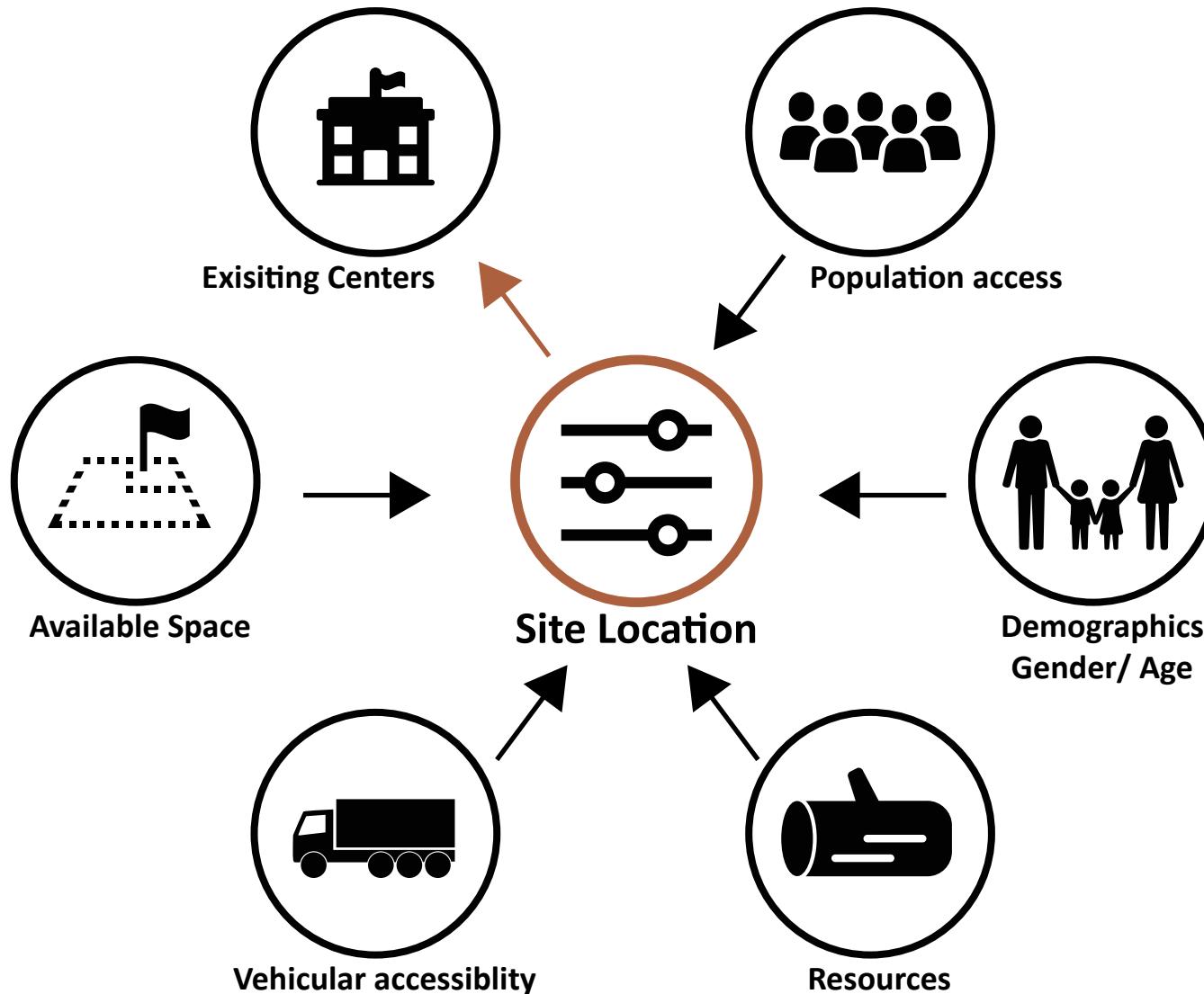


**CONFIGURING**

**SITE SELECTION**

## PARAMETERS

### SITE SELECTION



REBELLING & ATTRACTING PARAMETERS

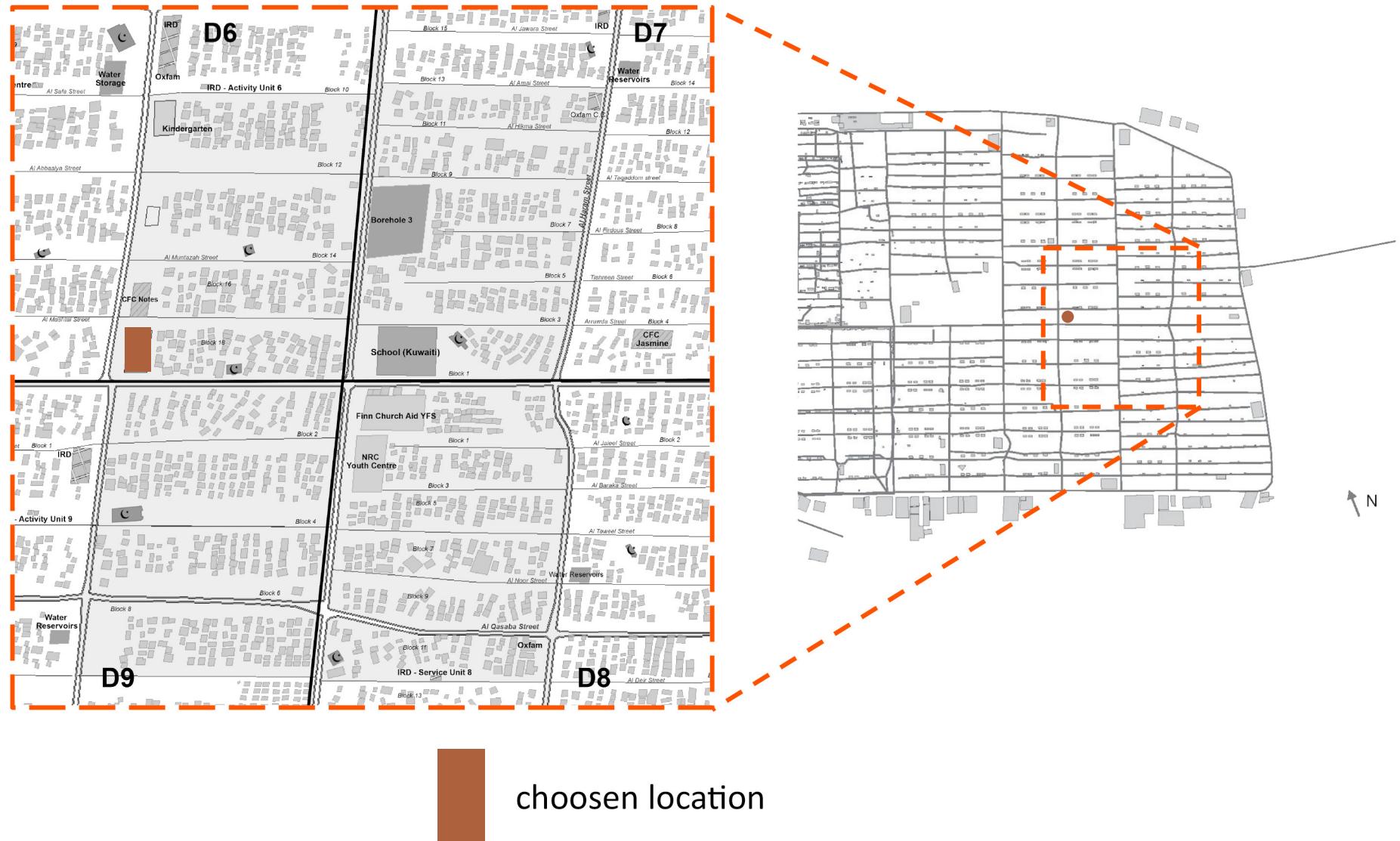
## WEIGHTED AVERAGE DENSITY

### SITE SELECTION



## SITE DECISION

### SITE SELECTION



**CONFIGURING**

**CONCEPTUAL CONFIGURATION**

## PROGRAMME

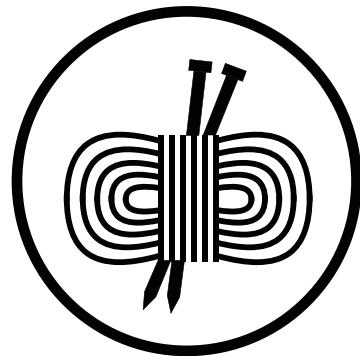
### CONCEPTUAL CONFIGURING

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**Construction**

Workshops



**Arts & Crafts**

courtyards - classes



**Business related**

Classes

## PROGRAMME

### CONCEPTUAL CONFIGURING

<b>CONSTRUCTION</b>	<b>Area</b>
Carpentry Workshop	60
Construction hall	40
Dry Laboratories (Electric/Plumbing)	30
Storage space (Tools and machines)	15
Open space	

<b>ARTS &amp; CRAFTS</b>	<b>Area</b>
Weaving hall + Storage	5
Art and craft workshop	20
Tailoring Workshop	10
Open Space(outdoor work)	

<b>BUSINESS RELATED</b>	<b>Area</b>
Computer Training Rooms	8
Audio Visual rooms	20
Language room	20
Open space (Reading/Gathering)	

<b>ADMIN.</b>	<b>Area</b>
Administrative office	20
Semi shaded waiting area	10
Trainers office / Staff rooms	12
Kitchnette	6

# REL CHART

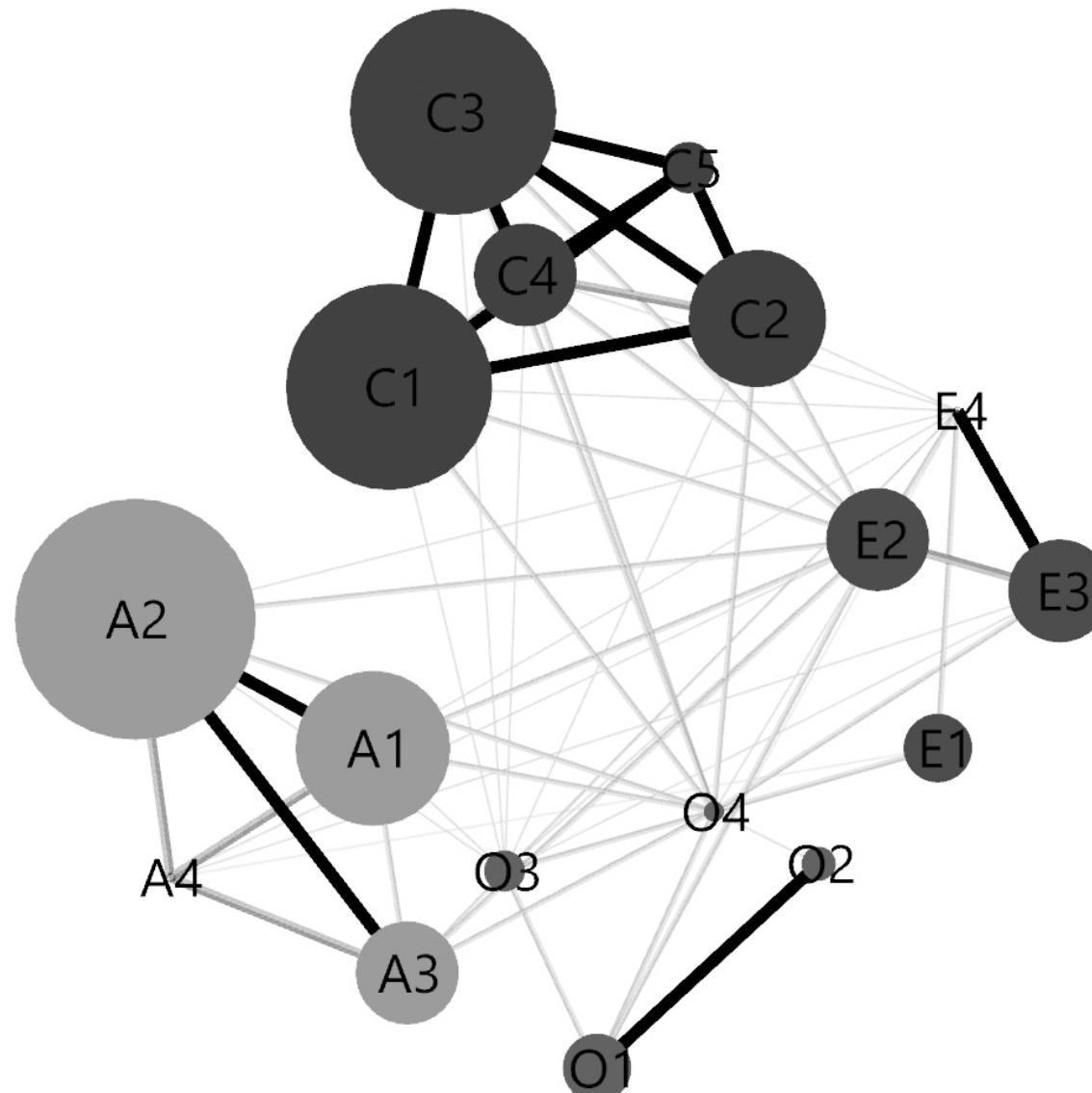
## CONCEPTUAL CONFIGURING

Nr	Room	L1	L2	CB	L3	SL	A1	A2	A3	CA	R1	R2	R3	CR	O1	O2	O3
60	Area																
40	Carpentry Workshop	1															
60	Construction hall		1														
30	Courtyard (Building area)			1													
15	Dry Laboratories				1												
15	Storage space					1											
45	Weaving hall + Storage	0	0														
70	Art and craft workshop	0	0														
30	Tailoring Workshop	0	0														
20	Courtyard (Arts)	0	0	1	0												
30	Computer Training Rooms	0	0														
30	Audio Visual rooms	0	0														
30	Language room	0	0														
20	Courtyard (Reading)	0	0														
20	Administrative office	0	0														
12	Trainers office / Staff rooms	0	0														
16	Kitchnette	0	1	0													

Direct connection	1
Unimportant	0

## BUBBLE DIAGRAM

### CONCEPTUAL CONFIGURING

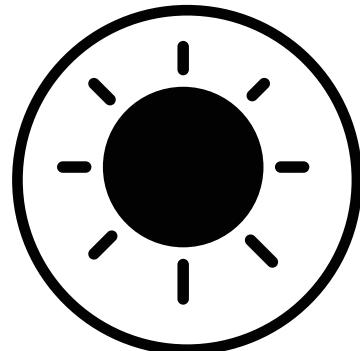


rooms connectivity and areas representation

## DESIGN PRINCIPLES

### CONCEPTUAL CONFIGURING

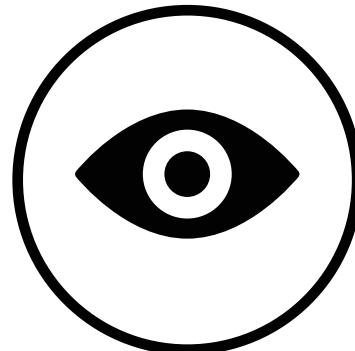
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**Passive Design**



**Gathering Points**



**Connectivity**



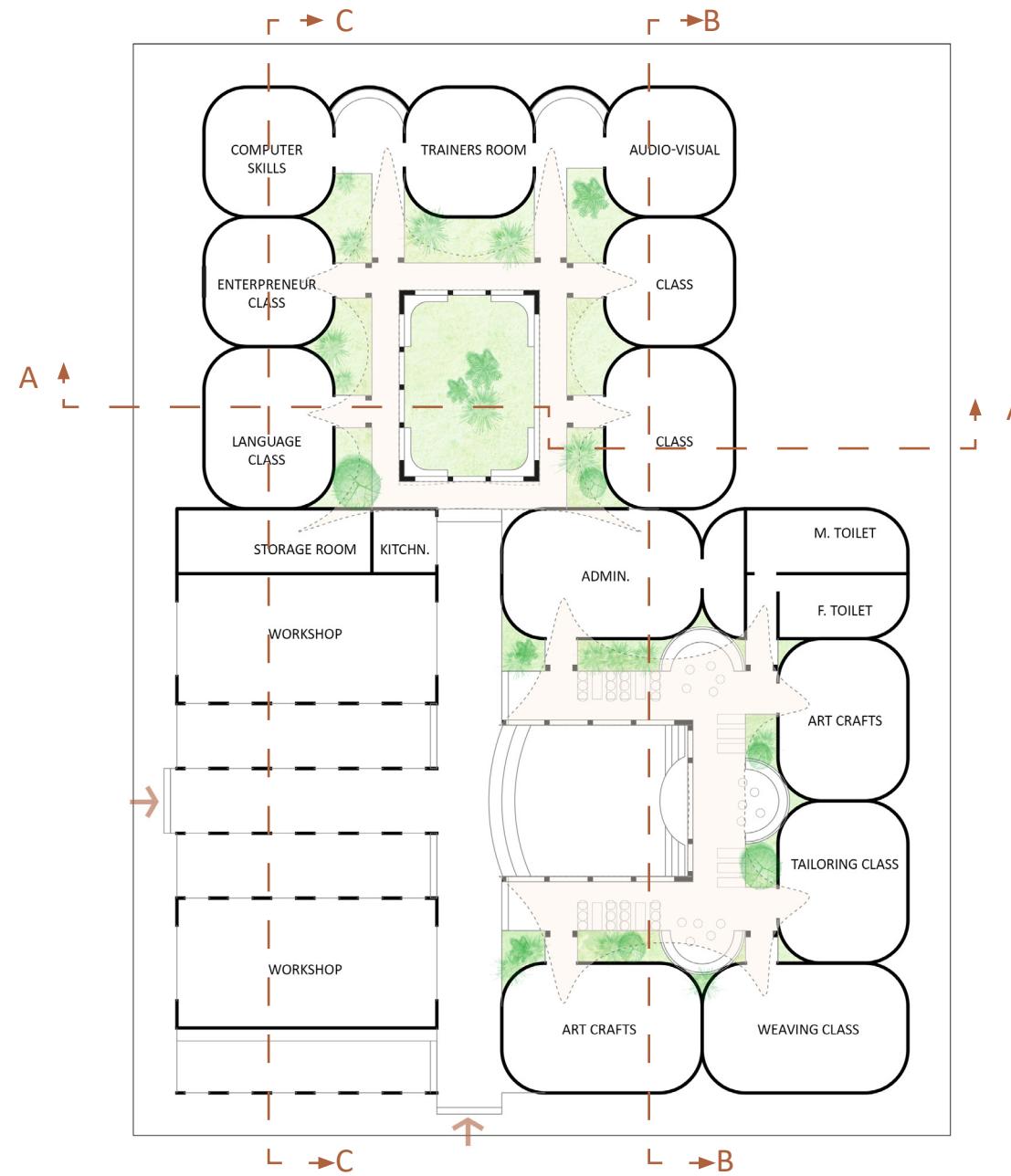
**Neighbourhood integration**

FORMING + STRUCTURING

**ARCHITECTURE DESIGN**

## FINAL PLAN

### ARCHITECTURE DESIG`N



## MODULARITY

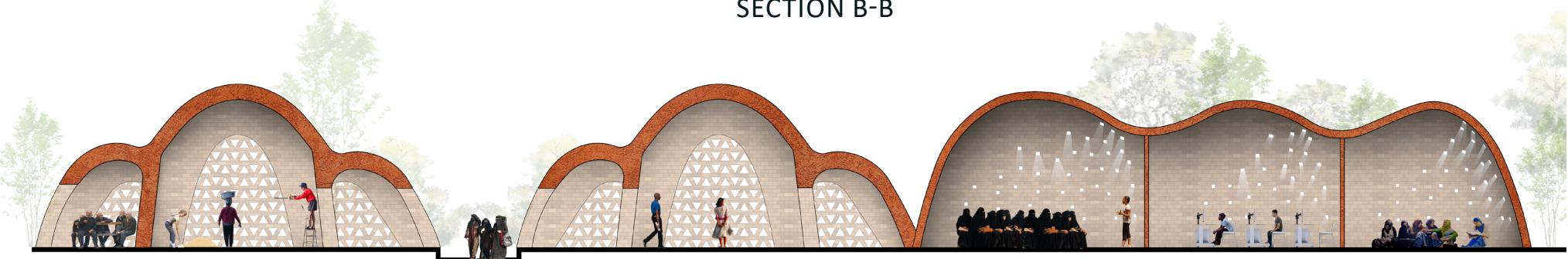
## ARCHITECTURE DESIGN



SECTION A-A



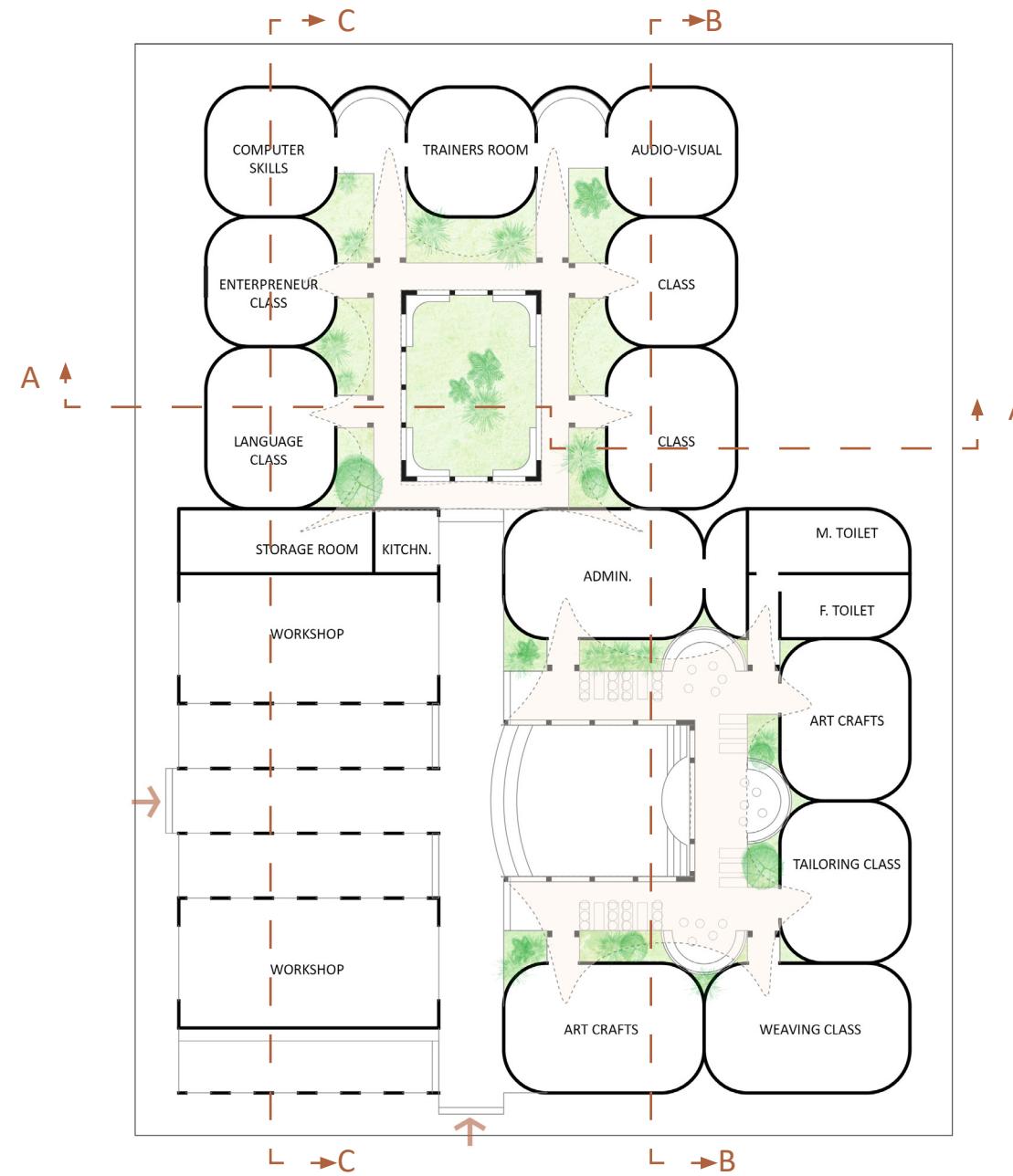
SECTION B-B



SECTION C-C

## FINAL PLAN

### ARCHITECTURE DESIG`N



## INTERACTION

### ARCHITECTURE DESIGN



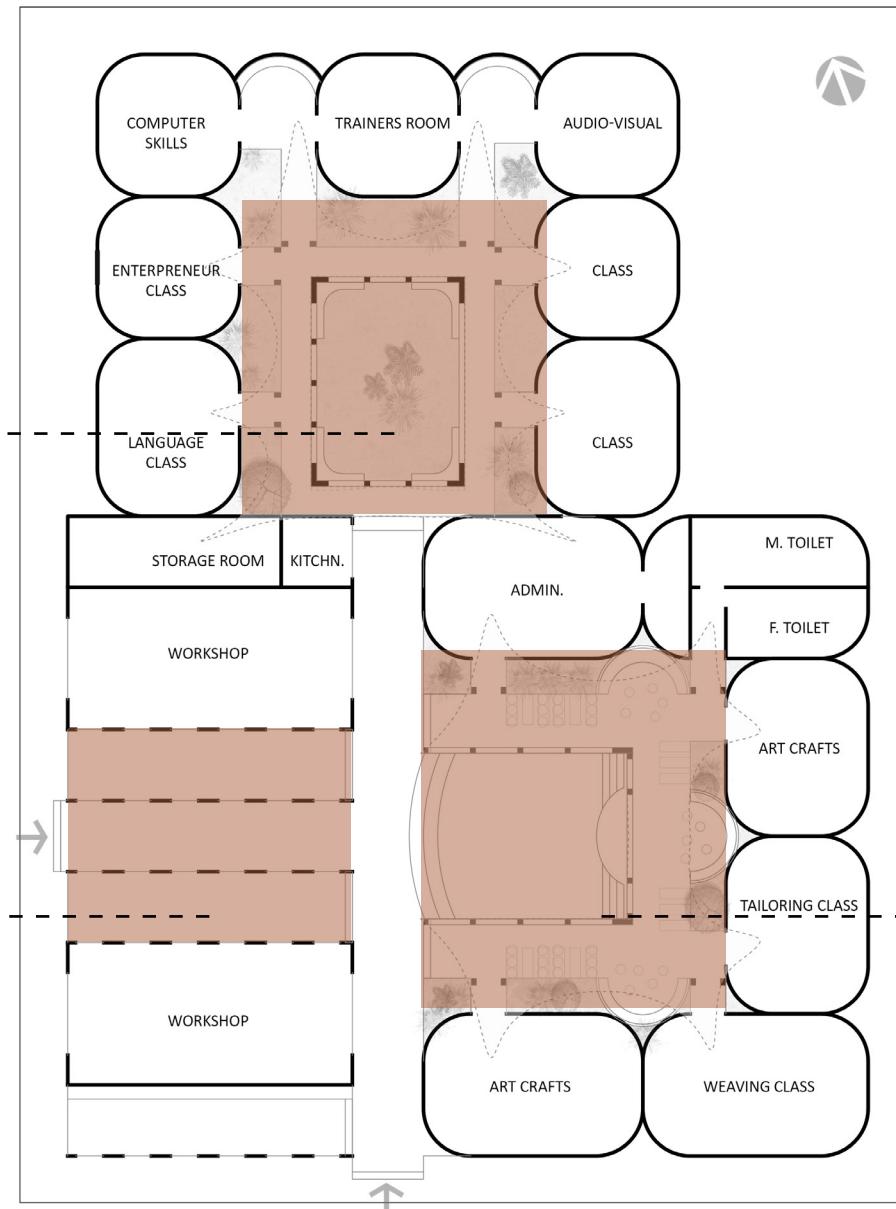
Gathering Courtyard



Working Courtyard

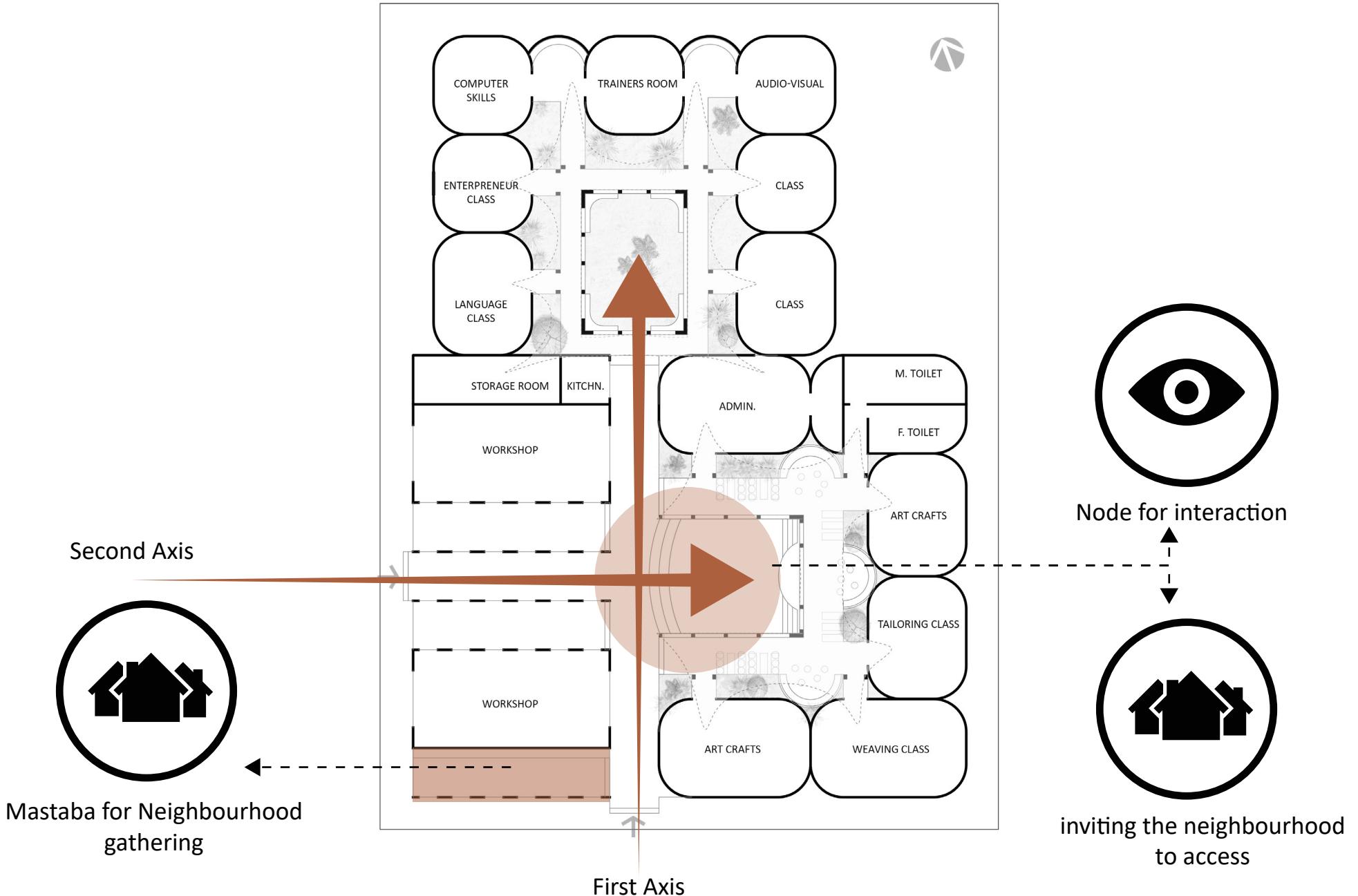


Performing Courtyard



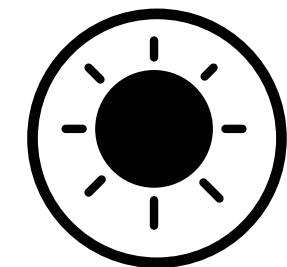
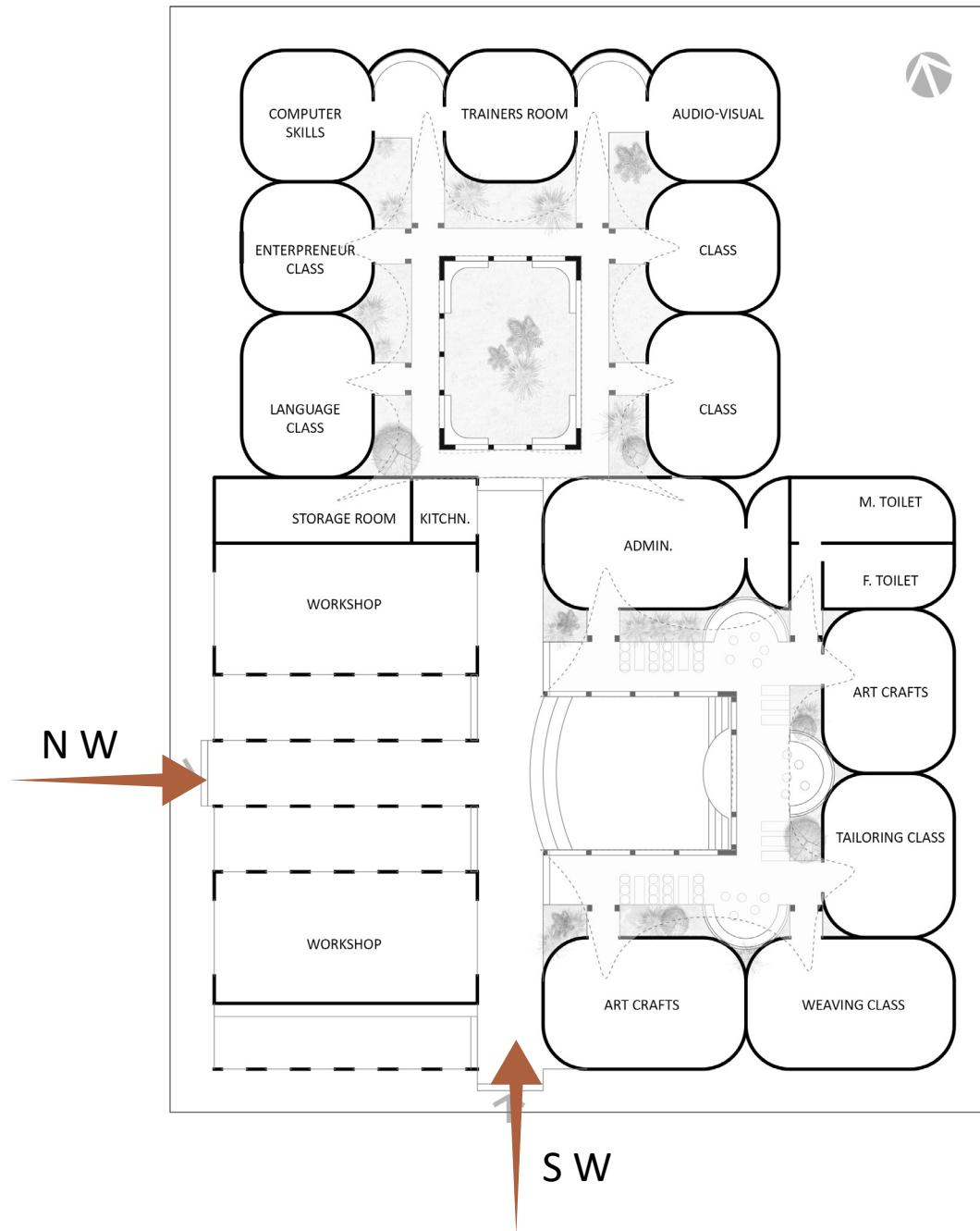
## ACCESSIBILITY | INTERACTION

### ARCHITECTURE DESIGN



## PASSIVE DESIGN

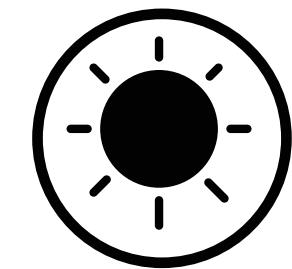
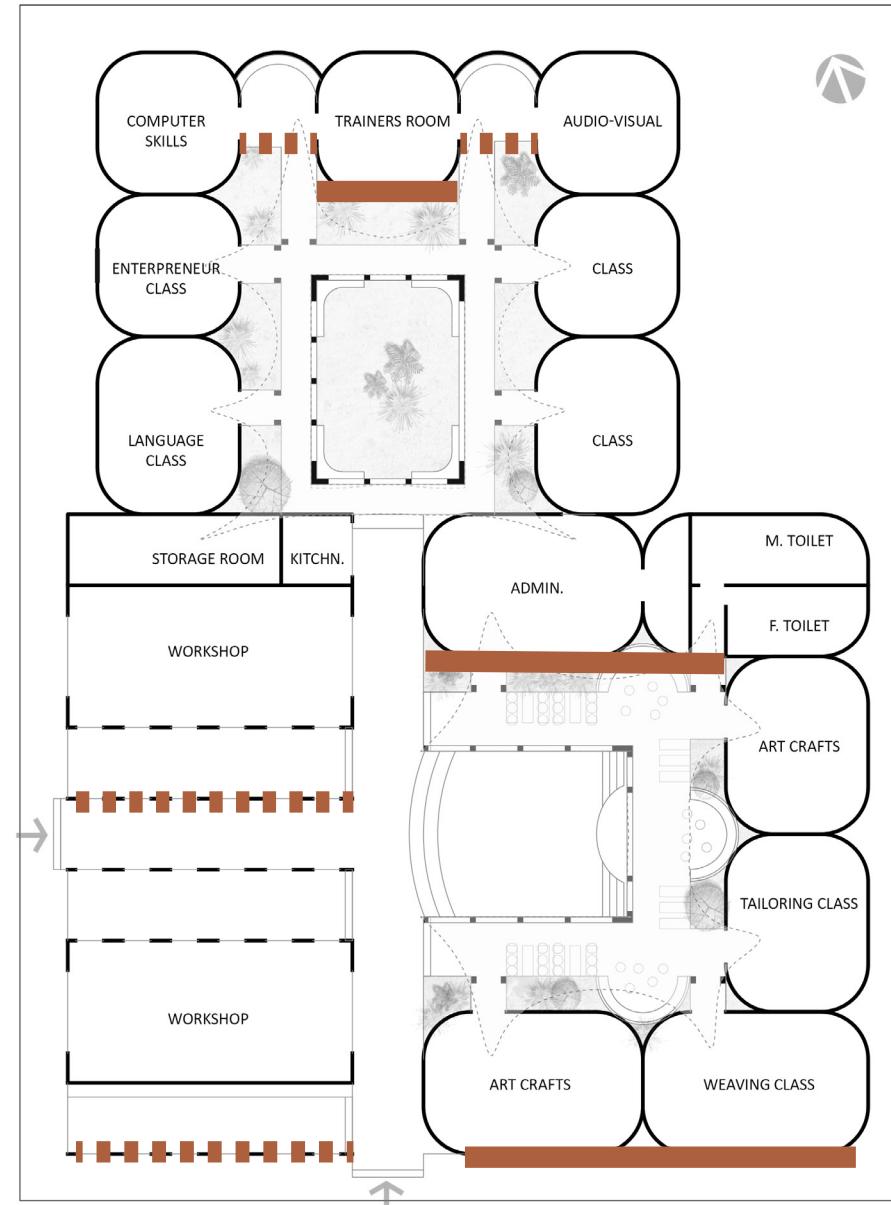
### ARCHITECTURE DESIGN



Two prevailing wind directions

## PASSIVE DESIGN

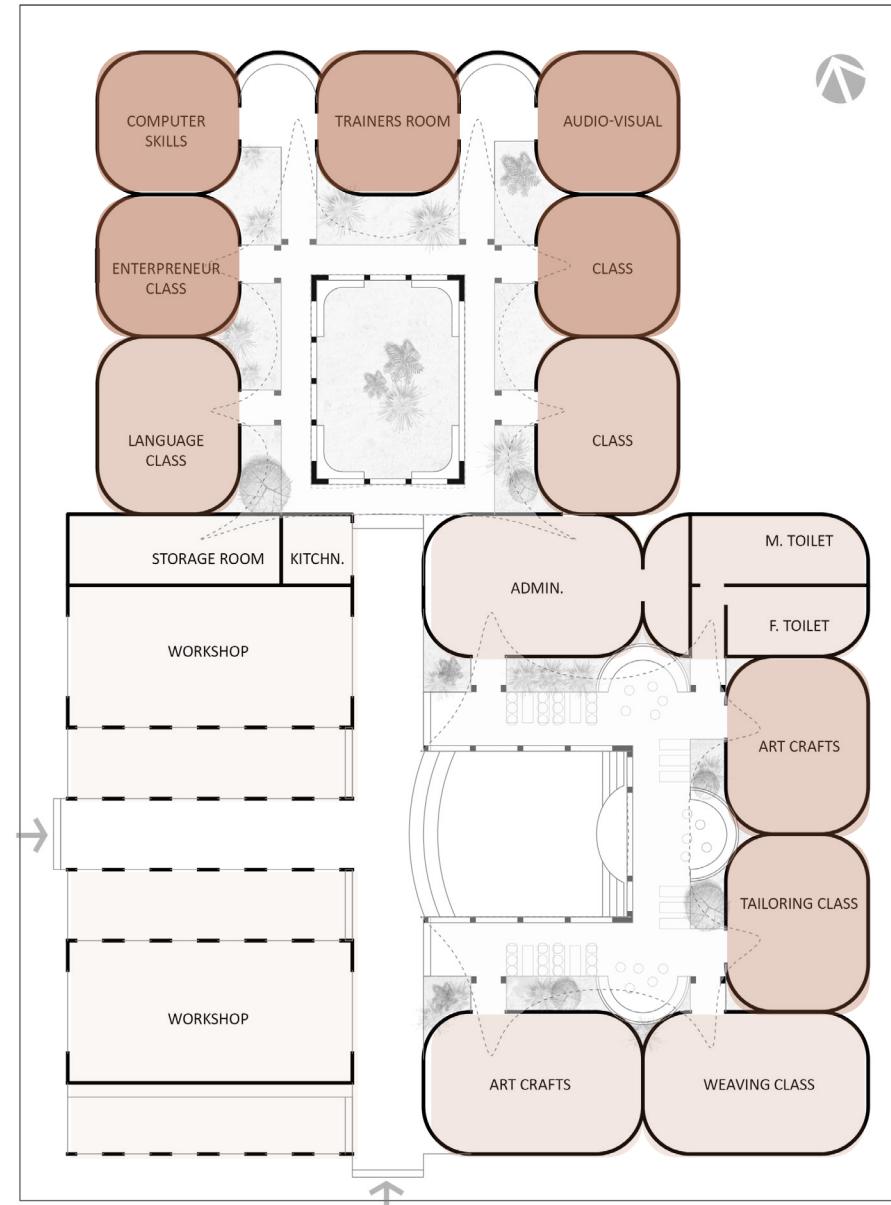
### ARCHITECTURE DESIGN



Reducing the south exposed facades

## MODULARITY

## ARCHITECTURE DESIGN



Modular units to ease  
construction

## ENTRANCE: MASTABA

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## DAY: ART CLASSES

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## NIGHT: NEIGHBOURHOOD GATHERINGS

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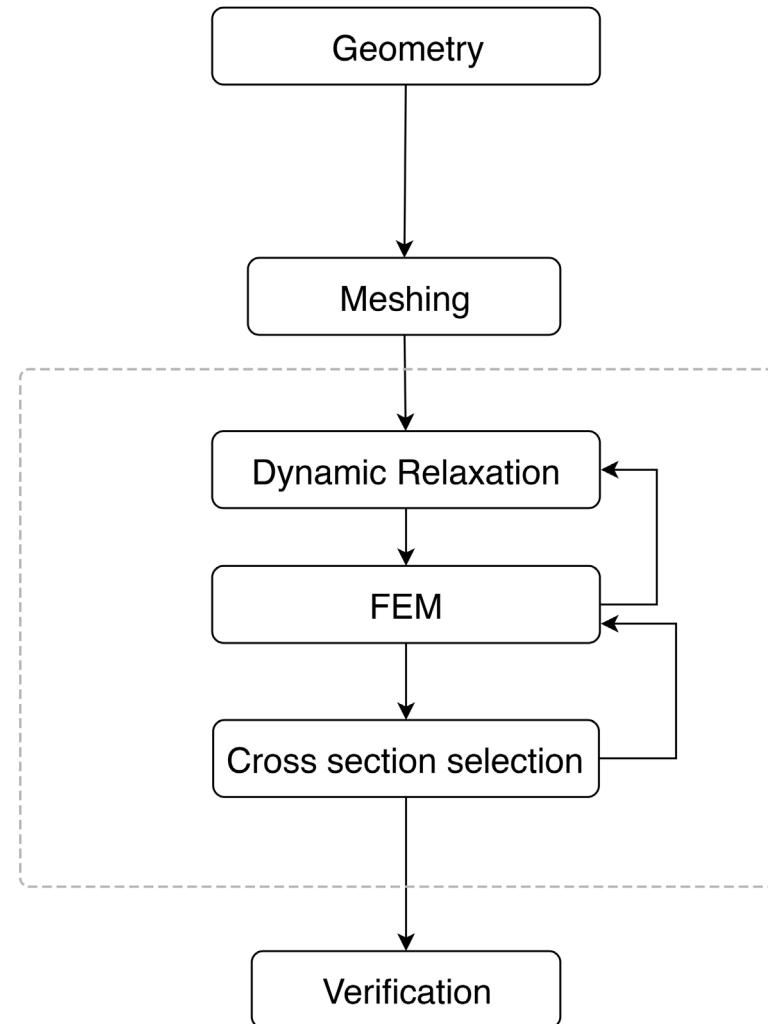
FORMING + STRUCTURING

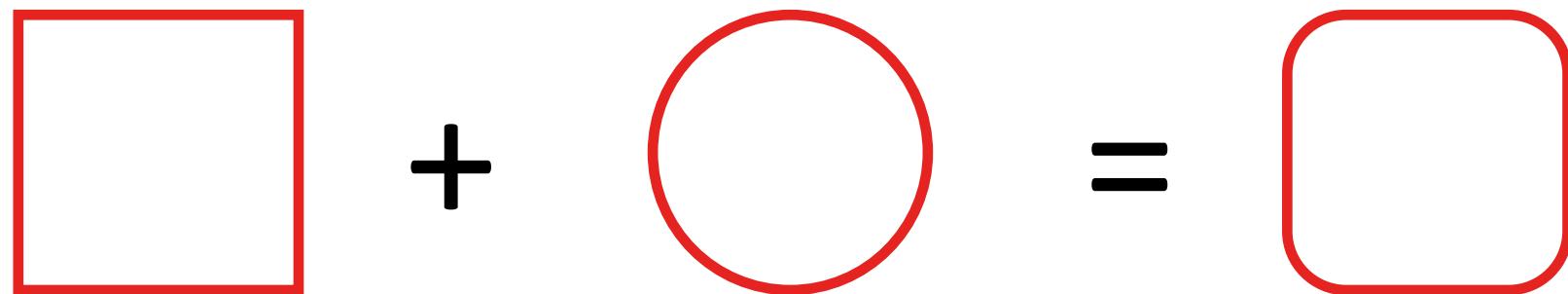
**FORM FINDING**

## PROCESS: FLOW CHART

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### FORM FINDING





Reducing Leftover

Interactive Teaching

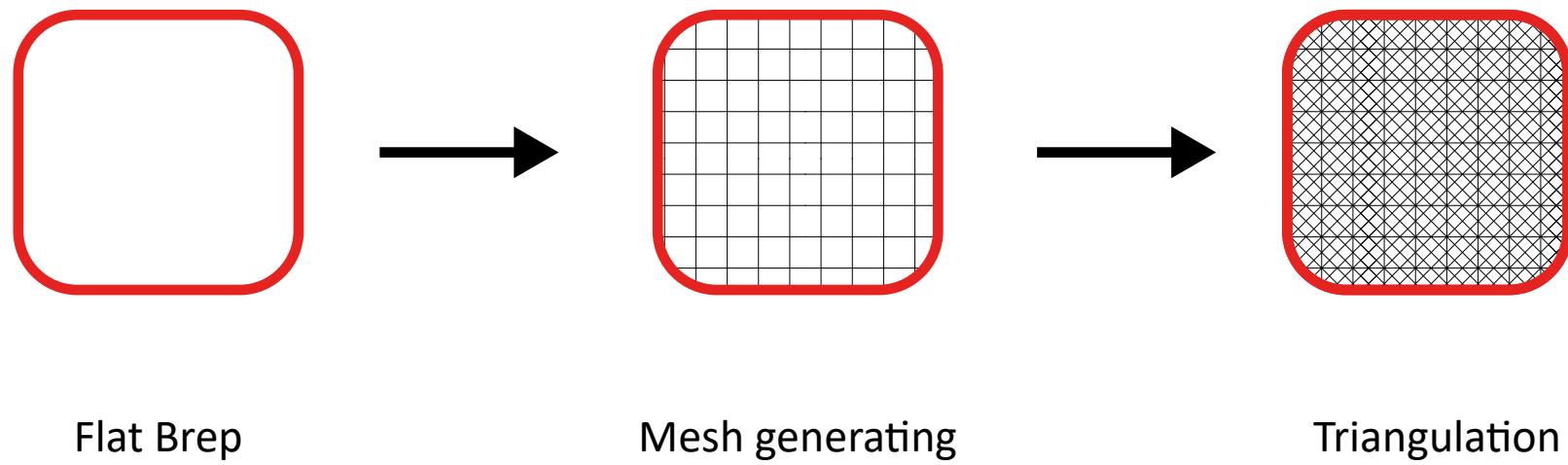
Final Topology

**Classes**

## MESHING

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### FORM FINDING



Flat Brep

Mesh generating

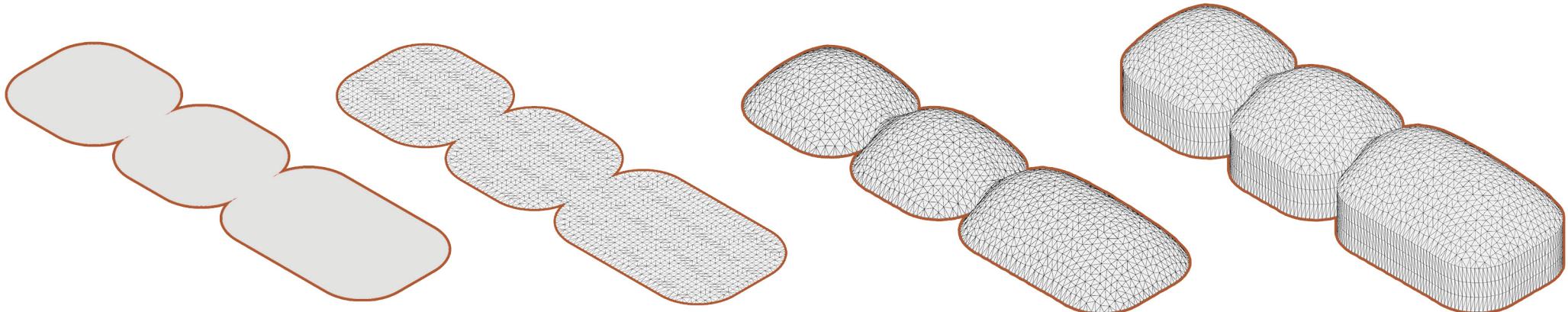
Triangulation

**Using Karamba & Weaver bird**

FORMING + STRUCTURING  
**CLASSROOMS**

## DYNAMIC RELAXATION | APPROACH 1

### FORM FINDING | CLASSROOMS



1. Roof surface from the profile of the plan

2. Meshing the roof surface

3. Dynamic Relaxation of the roof

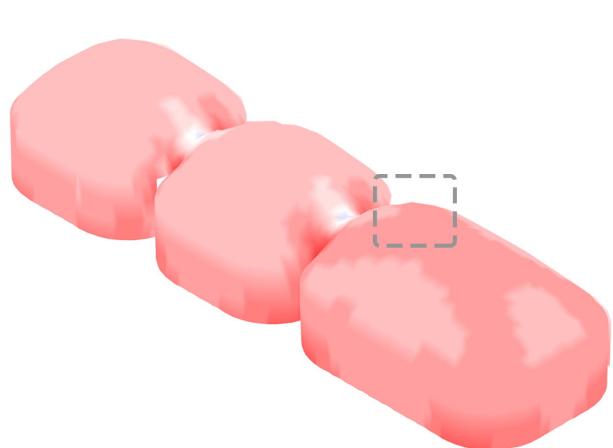
4. Meshing the wall based on the inclusive points from the roof



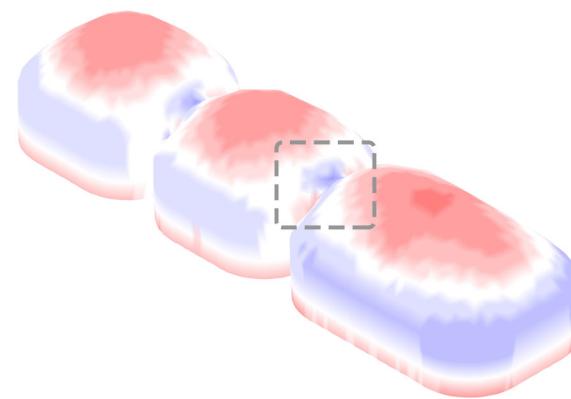
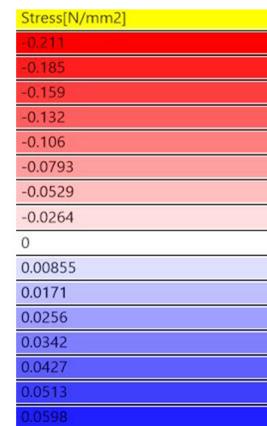
S.No	Cross-section (mm)	Weight of adobe per (Kg/m <sup>3</sup> )	Weight of the Material per grid (0.25 * 0.25) (Kg)	Load factor per vertex of the mesh (N)
1	120	1693	12.6	3.15
2	240	1693	24.3	6.0
3	360	1693	38.0	9.5
4	480	1693	50.9	12.7

## STRUCTURE VALIDATION | APPROACH 1

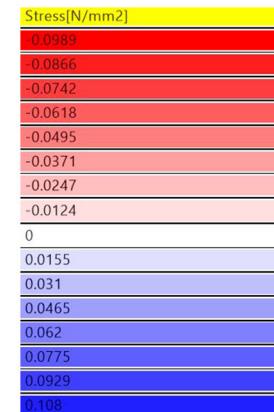
### FORM FINDING | CLASSROOMS



Principal Stress in v direction



Principal Stress in u direction

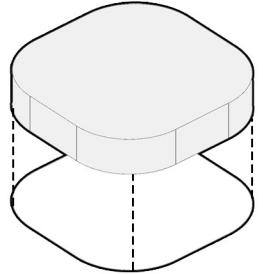


S.No	Cross section (mm)	Displacement (mm)	Tensile Stress (MPa)	C.Stress (MPa)
1	240	8.0	0.21	0.28
2	360	7.8	0.16	0.25
3	480	7.0	0.14	0.23
4	800	5.0	0.10	0.20

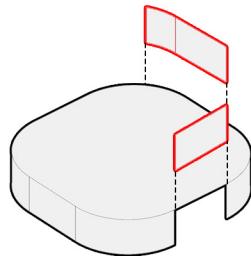
C.Section = 800mm  
Maximum Span : 6 m  
Max allowable deflection : 15 mm  
Load Case 1 = 1.2 x Self-weight

## DYNAMIC RELAXATION | APPROACH 2

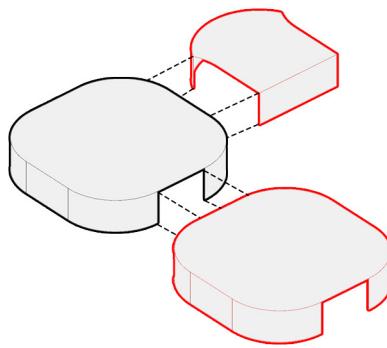
### FORM FINDING | CLASSROOMS



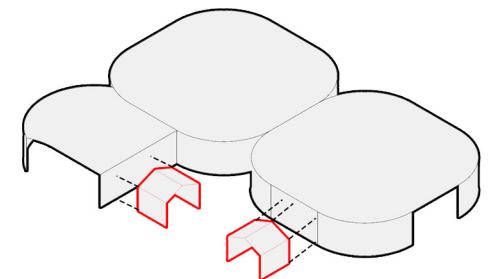
1. Extruding the plan



2. Eliminating adjacent overlapping walls



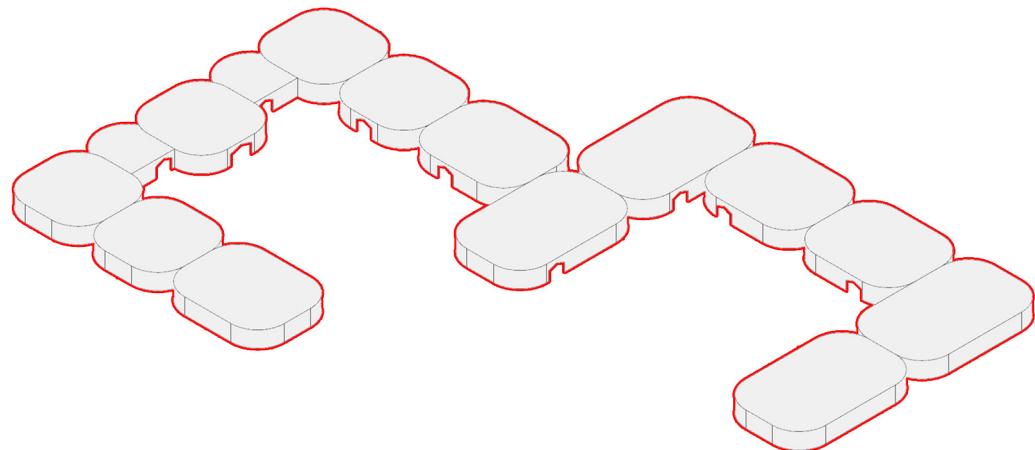
3. Connecting the adjacent units



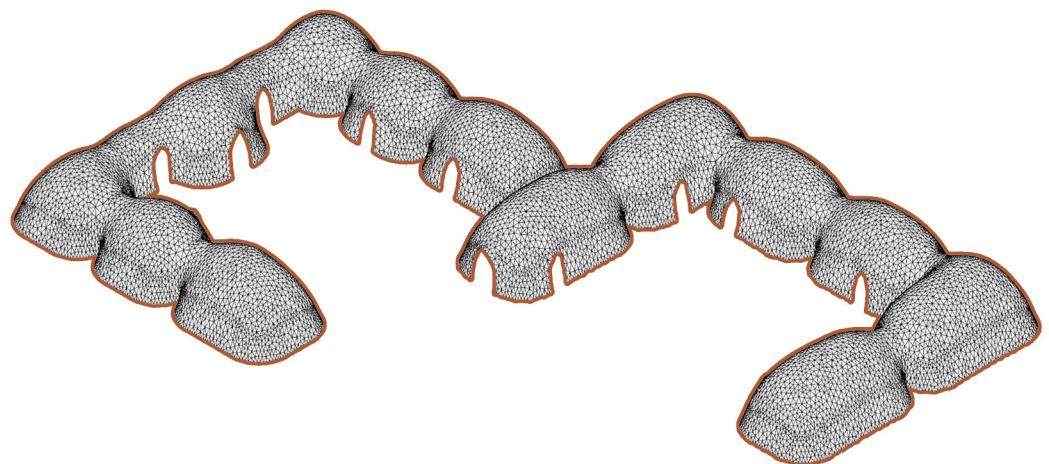
4. Puncturing the openings on Brep

## DYNAMIC RELAXATION | APPROACH 2

### FORM FINDING | CLASSROOMS



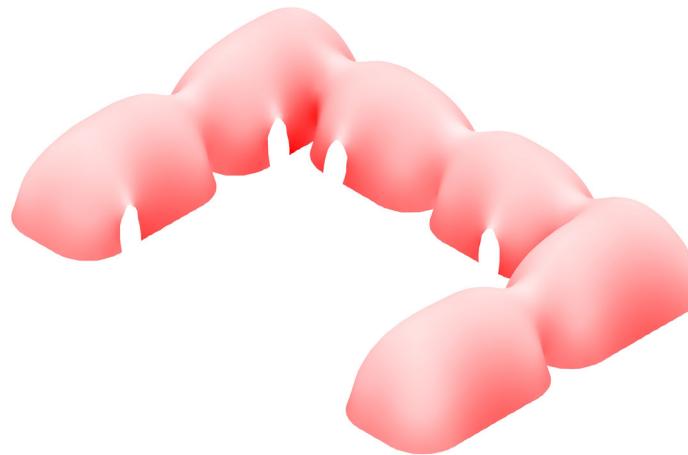
5. Input Brep as relaxation base



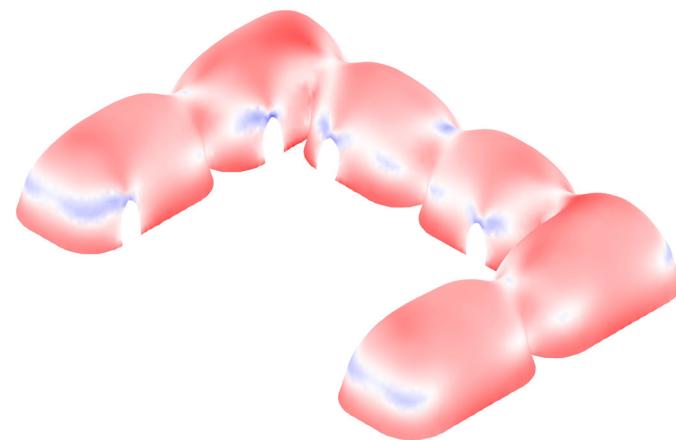
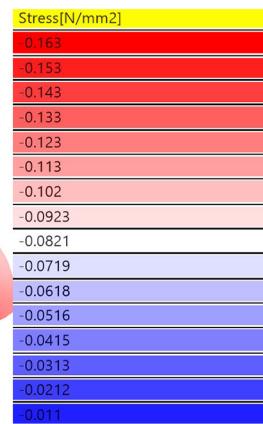
6. Mesh generated after dynamic relaxation

## STRUCTURE VALIDATION | APPROACH 2

### FORM FINDING | CLASSROOMS



Principal Stress in v direction



Principal Stress in u direction

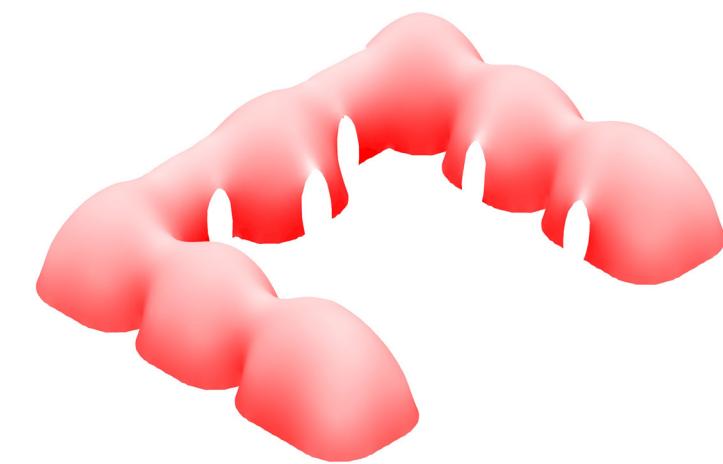


S.No	Cross -Section (mm)	Displacement (mm)	Tensile Stress (Mpa)	Compressive Stress (Mpa)
1	120	3.0	0.03	0.14
2	240	2.5	0.017	0.136
3	360	2.8	0.018	0.15
4	480	2.7	0.016	0.15

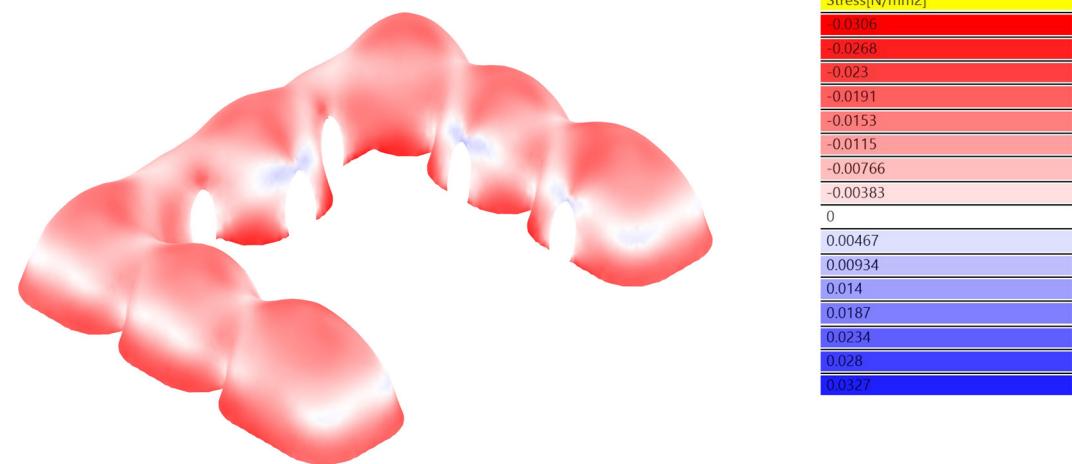
C.Section = 240 mm  
 Maximum Span : 6 m  
 Max allowable deflection : 15 mm  
 Load Case 1 = 1.2 x Self- weight

## STRUCTURE VALIDATION | APPROACH 2

### FORM FINDING | CLASSROOMS



Principal Stress in v direction



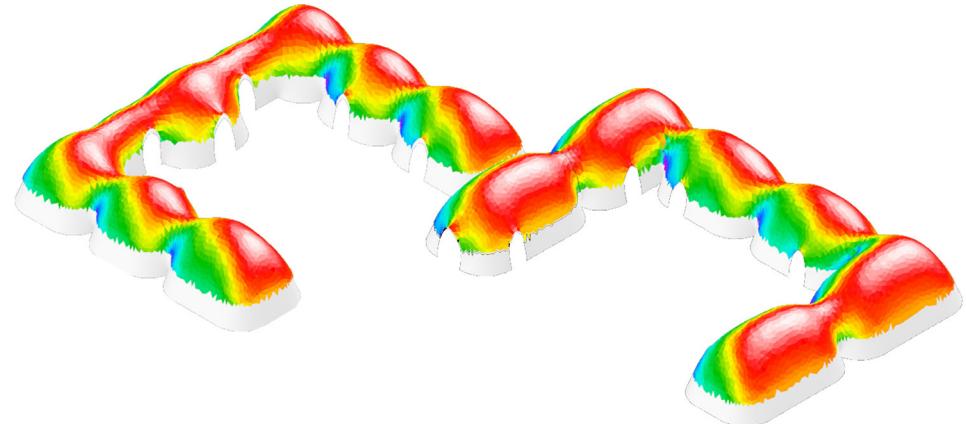
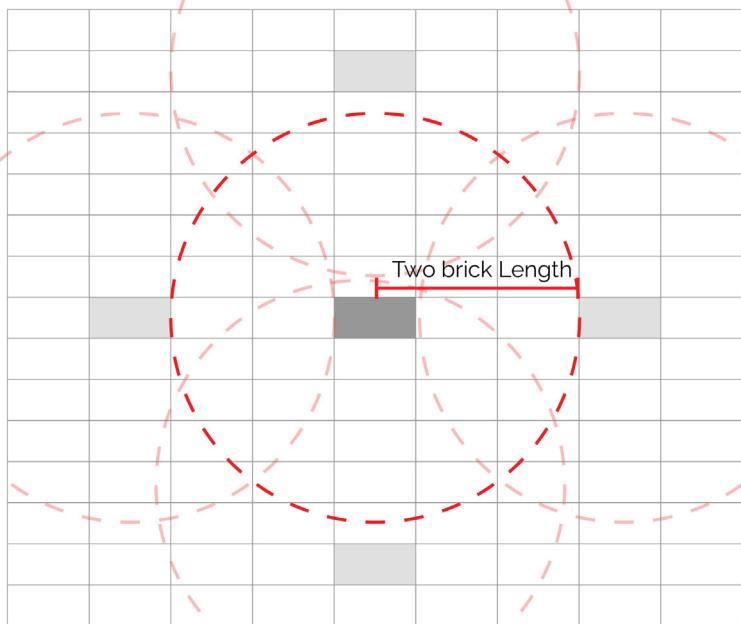
Principal Stress in u direction

S.No	Cross -Section (mm)	Displacement (mm)	Tensile Stress (Mpa)	Compressive Stress (Mpa)
1	120	2.2	0.047	0.14
2	240	2.5	0.03	0.12
3	360	2.4	0.019	0.12
4	480	2.4	0.011	0.12

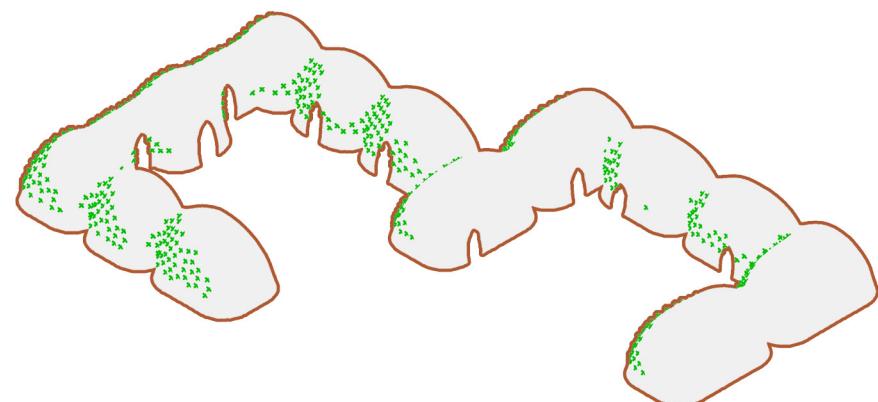
C.Section = 240 mm  
Maximum Span : 6 m  
Max allowable deflection : 15 mm  
Load Case 1 = 1.2 x Self- weight

## DAYLIGHT PERFORATIONS

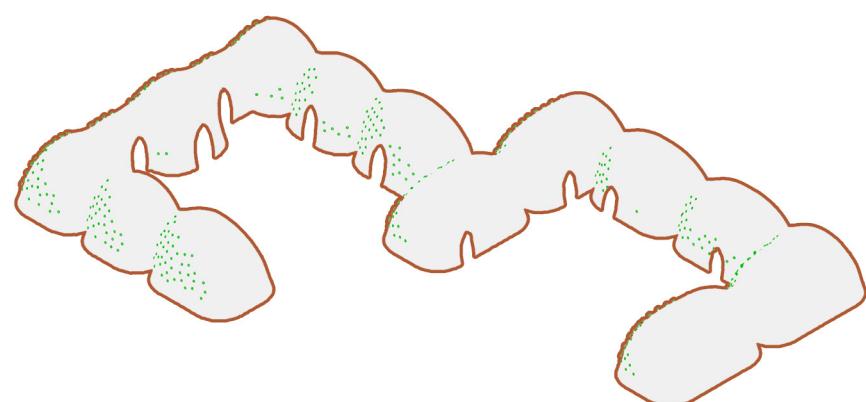
### FORM FINDING | CLASSROOMS



1. Solar radiation analysis on the built-up



2. Points with minimum solar radiation



3. Openings on the structure

## INTERIOR: CLASSES OPENINGS

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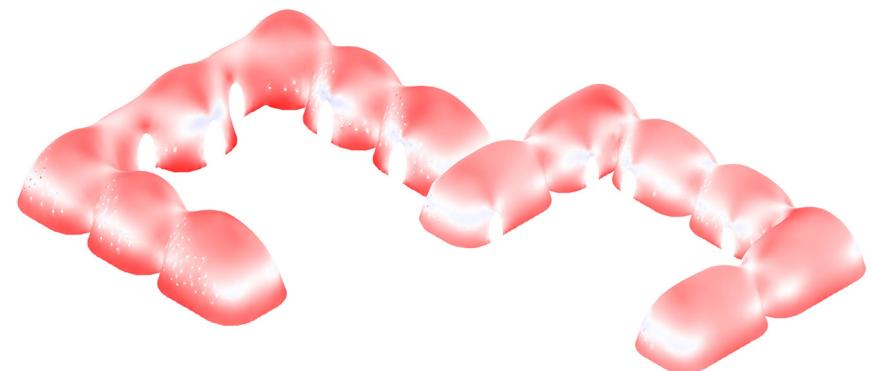


## DAYLIGHT PERFORATIONS

### FORM FINDING | CLASSROOMS



Principal Stress in v direction



Principal Stress in u direction

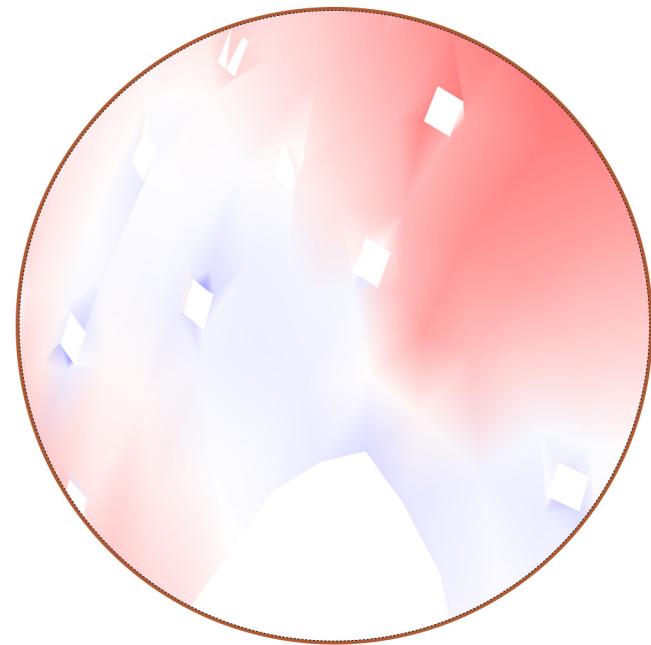
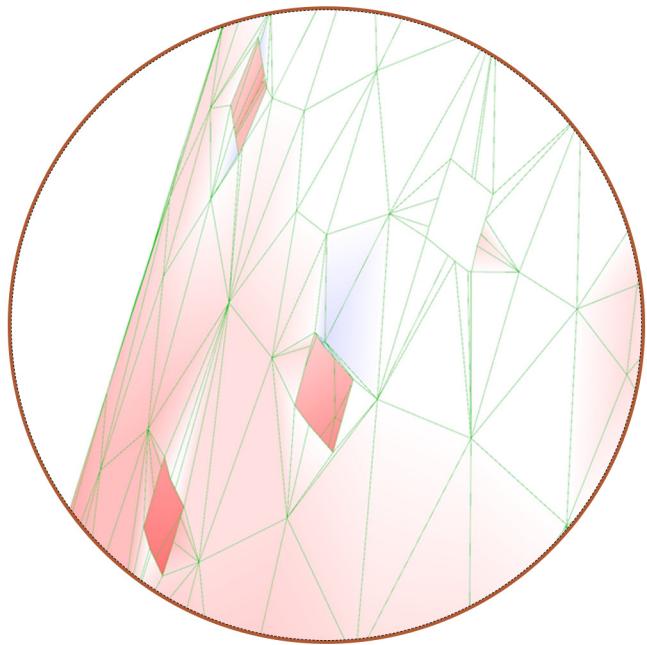
S.No	Cross -Section (mm)	Displacement (mm)	Tensile Stress (Mpa)	Compressive Stress (Mpa)
1	240	3	0.06	0.03
2	360	2.8	0.08	0.05
3	480	2.7	0.09	0.025

C.Section = 240 mm  
Maximum Span : 6 m  
Max allowable deflection : 15 mm  
Load Case 1 = 1.2 x Self- weight

Size of the Openings	Total no:of openings	Percentage % of openings
120 x 120 x 240 mm	682	0.97

## DAYLIGHT PERFORATIONS

### FORM FINDING | CLASSROOMS

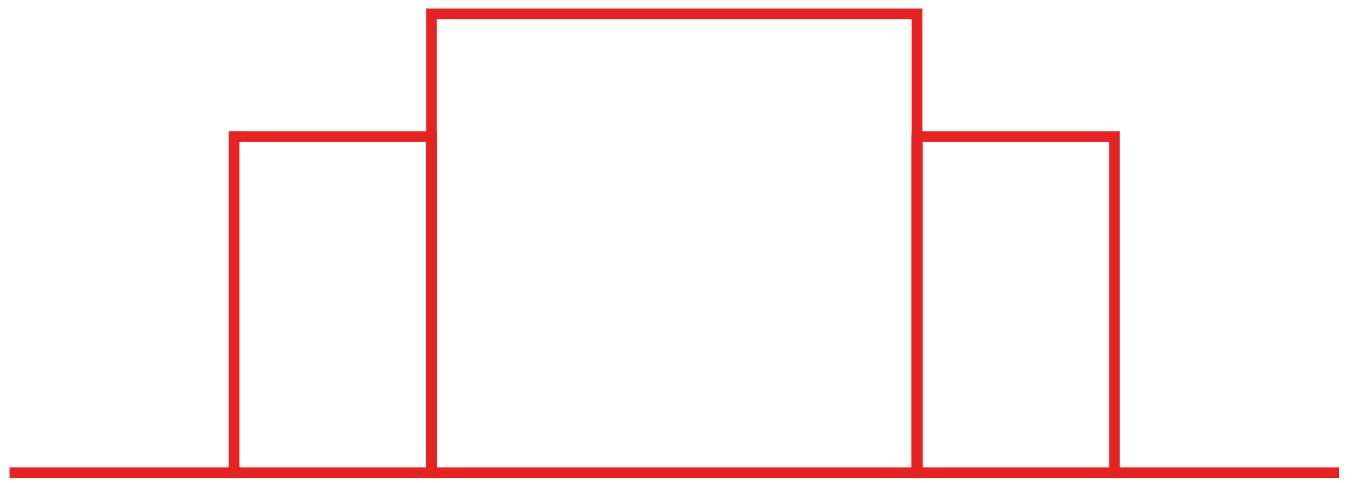


Local stresses due to :

1. Profile of the openings
2. Change in the mesh pattern
3. Openings smaller than mesh face

**FORMING + STRUCTURING**

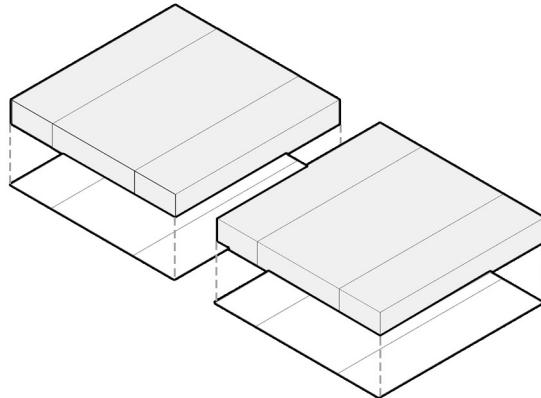
**WORKSHOPS**



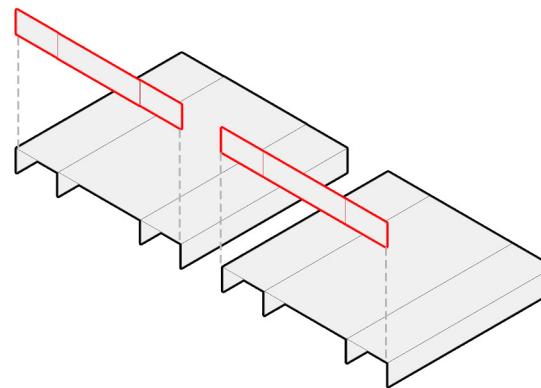
**Workshops**

## DYNAMIC RELAXATION

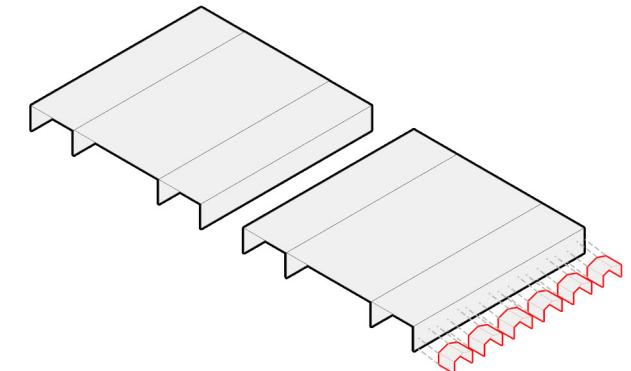
### FORM FINDING | WORKSHOPS



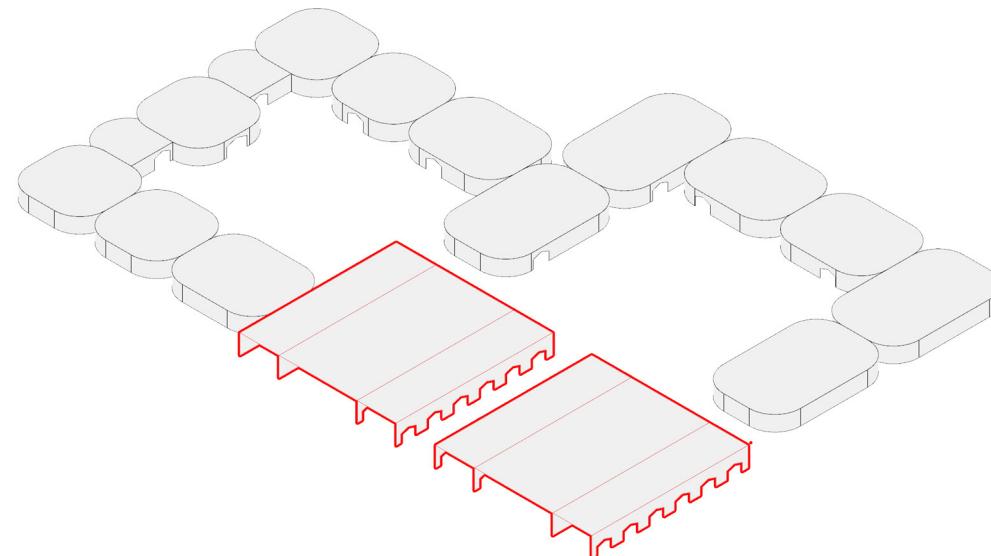
Extrusion of the plan



Elimination of Short edge walls supports



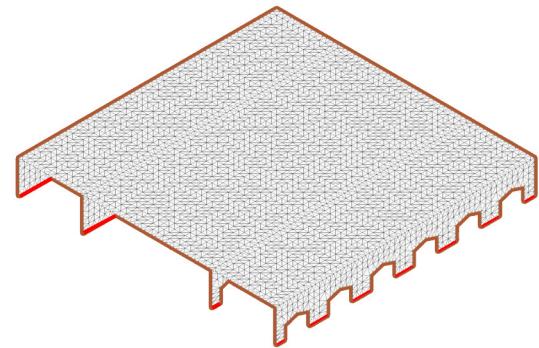
Subtraction of openings



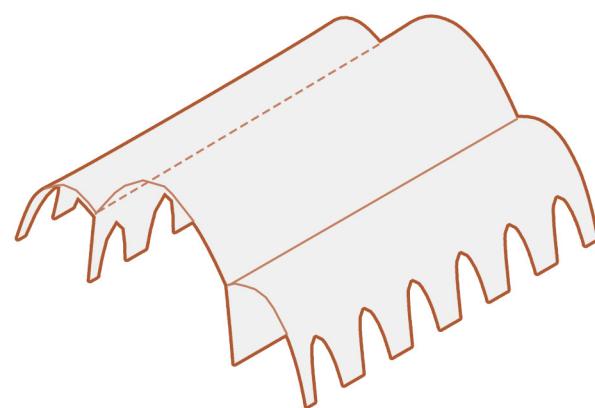
Final geometry to be meshed

## DYNAMIC RELAXATION

### FORM FINDING | WORKSHOPS



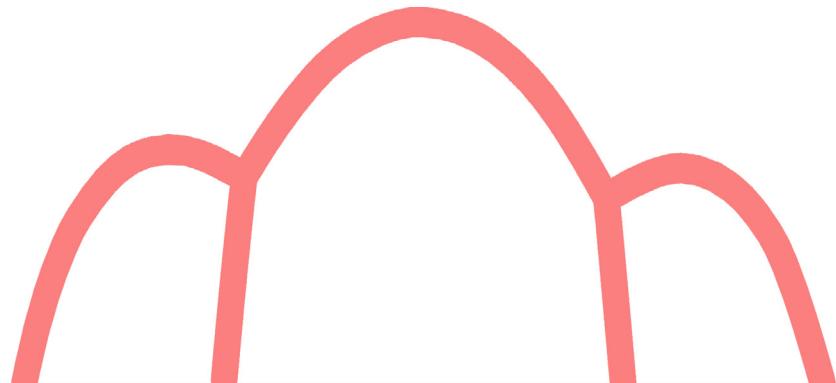
5. Meshing Before Relaxation



6. Final mesh to be structurally analyzed



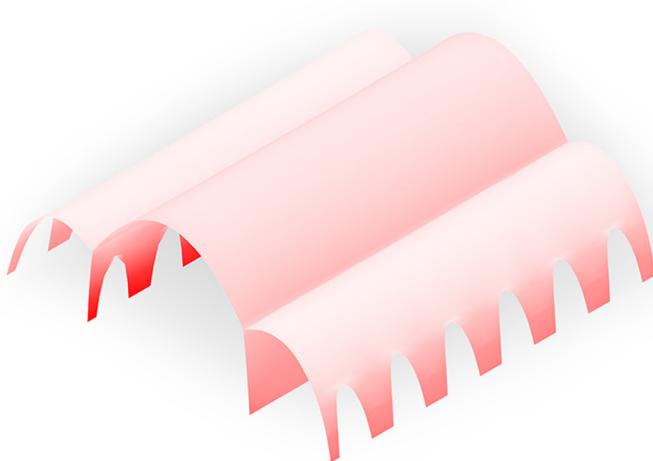
A regular vault where the corridors and workshops are treated independent meshes and relaxed.



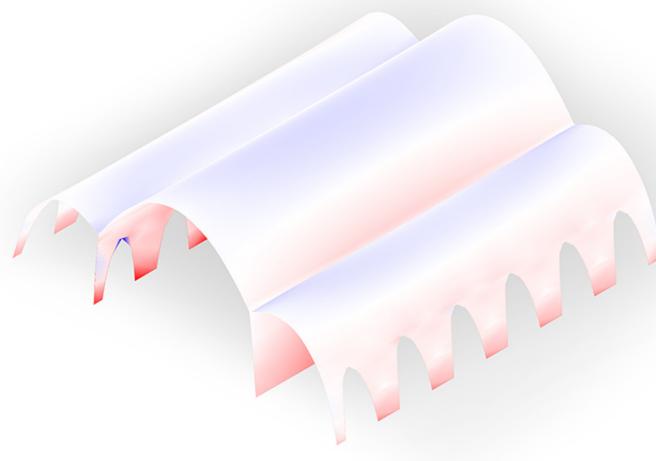
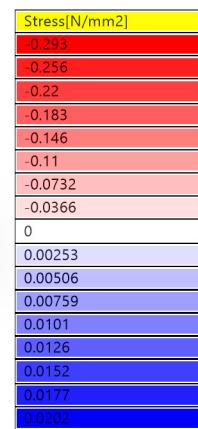
Evolution of the form into a monolithic structure when the meshes of the corridor and the workshop are unified.

## STRUCTURE VALIDATION

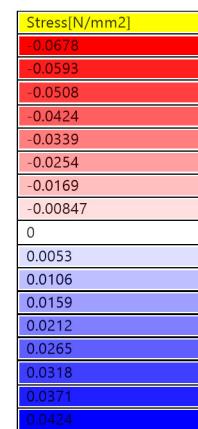
### FORM FINDING | WORKSHOPS



Principal Stress in v direction



Principal Stress in u direction



S.No	Cross -Section (mm)	Displacement (mm)	Tensile Stress (Mpa)	Compressive Stress (Mpa)
1	240	13.6	0.128	0.31
2	360	8.0	0.066	0.30
3	480	6.2	0.042	0.29

C.Section = 480 mm  
 Maximum Span : 6 m  
 Max allowable deflection : 15 mm  
 Load Case 1 = 1.2 x Self- weight

FORMING + STRUCTURING

**ADOBE 2.0**

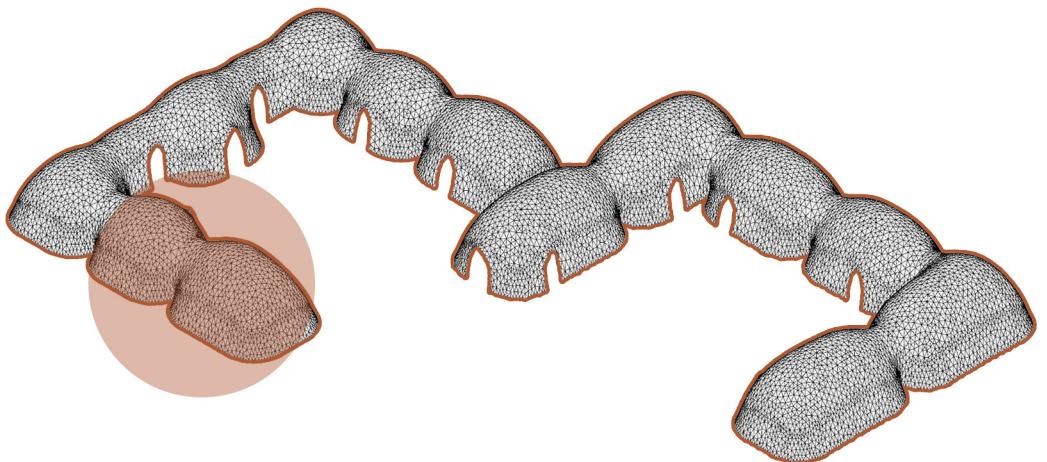
CLASSROOMS MESH

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ADOBE 2.0

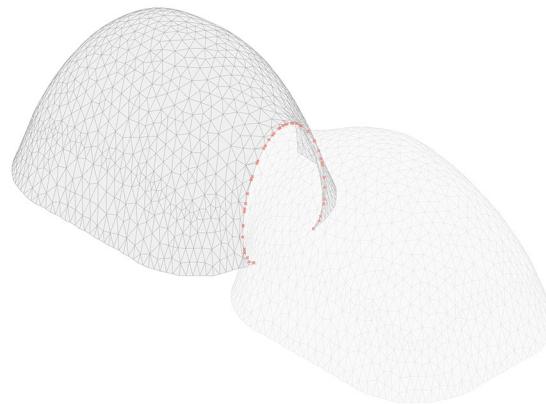
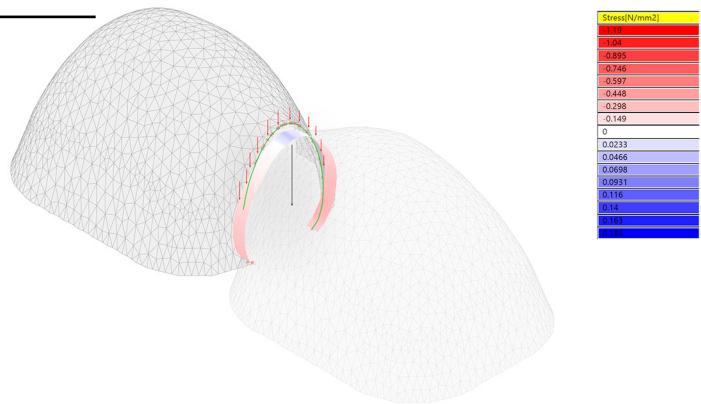


Main mass to analyse

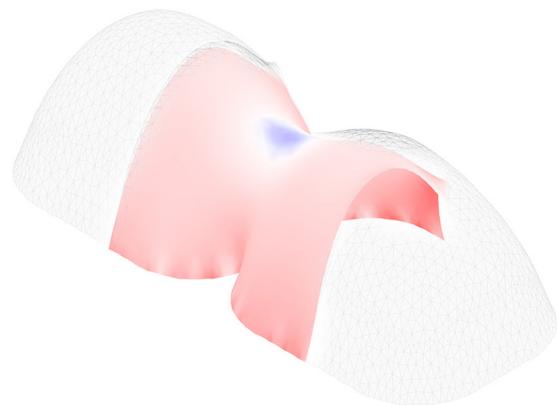


## STRUCTURE VALIDATION

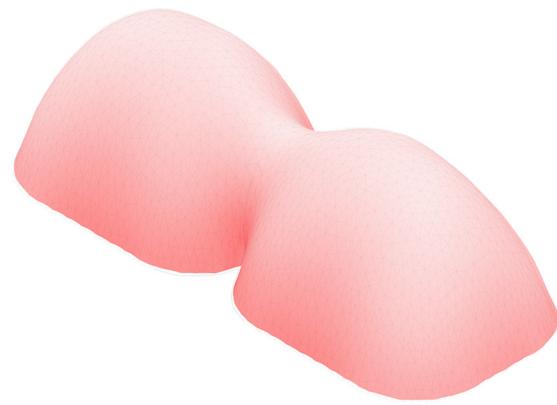
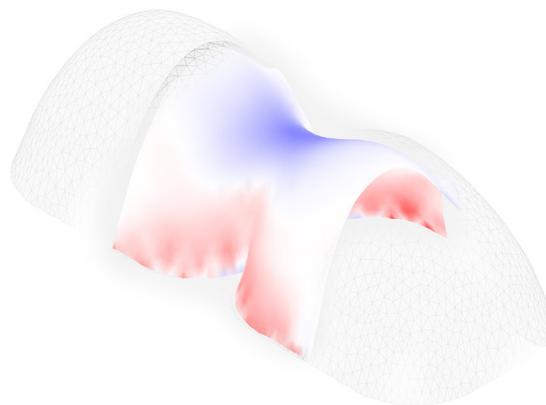
ADOBE 2.0



Analyzing the critical arch



Double curvature  
between 2 geometries



Structure as an overall shell



## EXTERIOR: CLASSES

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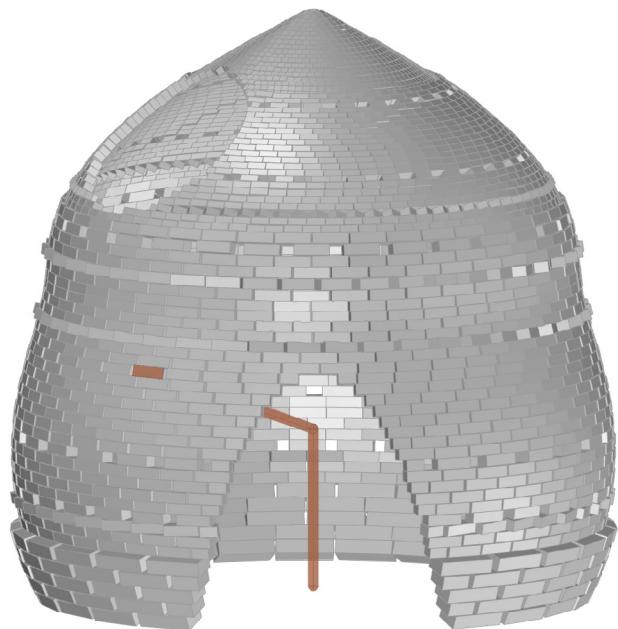
CONSTRUCTION TECHNIQUE

**APPROACHES**

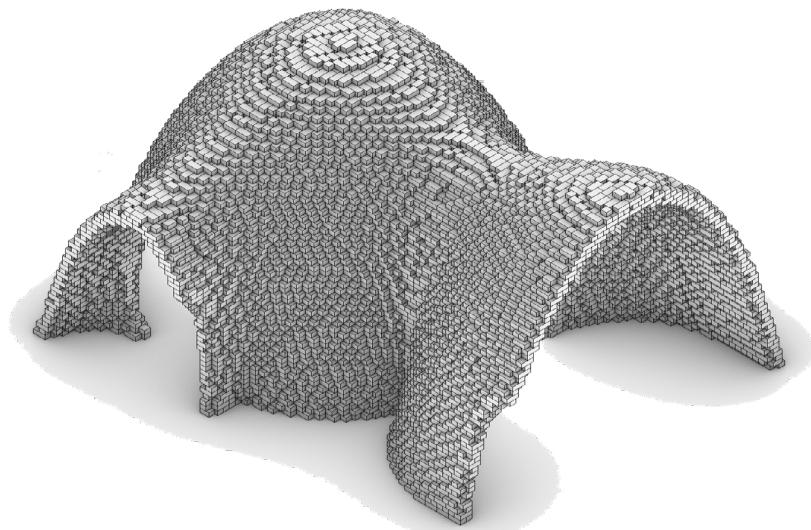
## DIFFERENT APPROACHES

### CONSTRUCTION TECHNIQUES

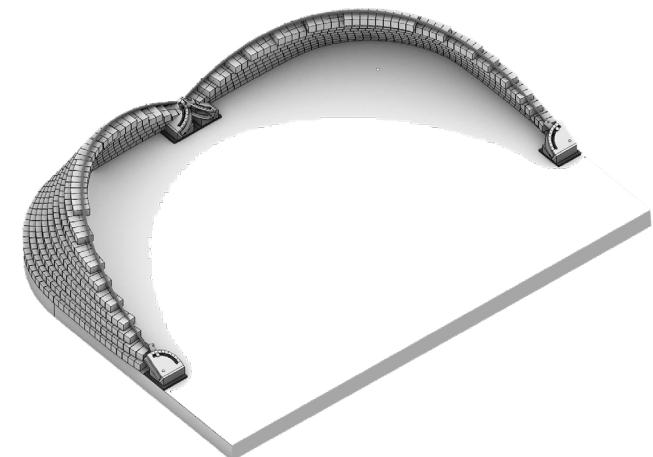
#### 3 POSSIBLE CONSTRUCTION METHODS



COMPASS



VOXELIZATION



GUIDING RODS

**CONSTRUCTION TECHNIQUE**

**COMPASS**

## CONCEPT

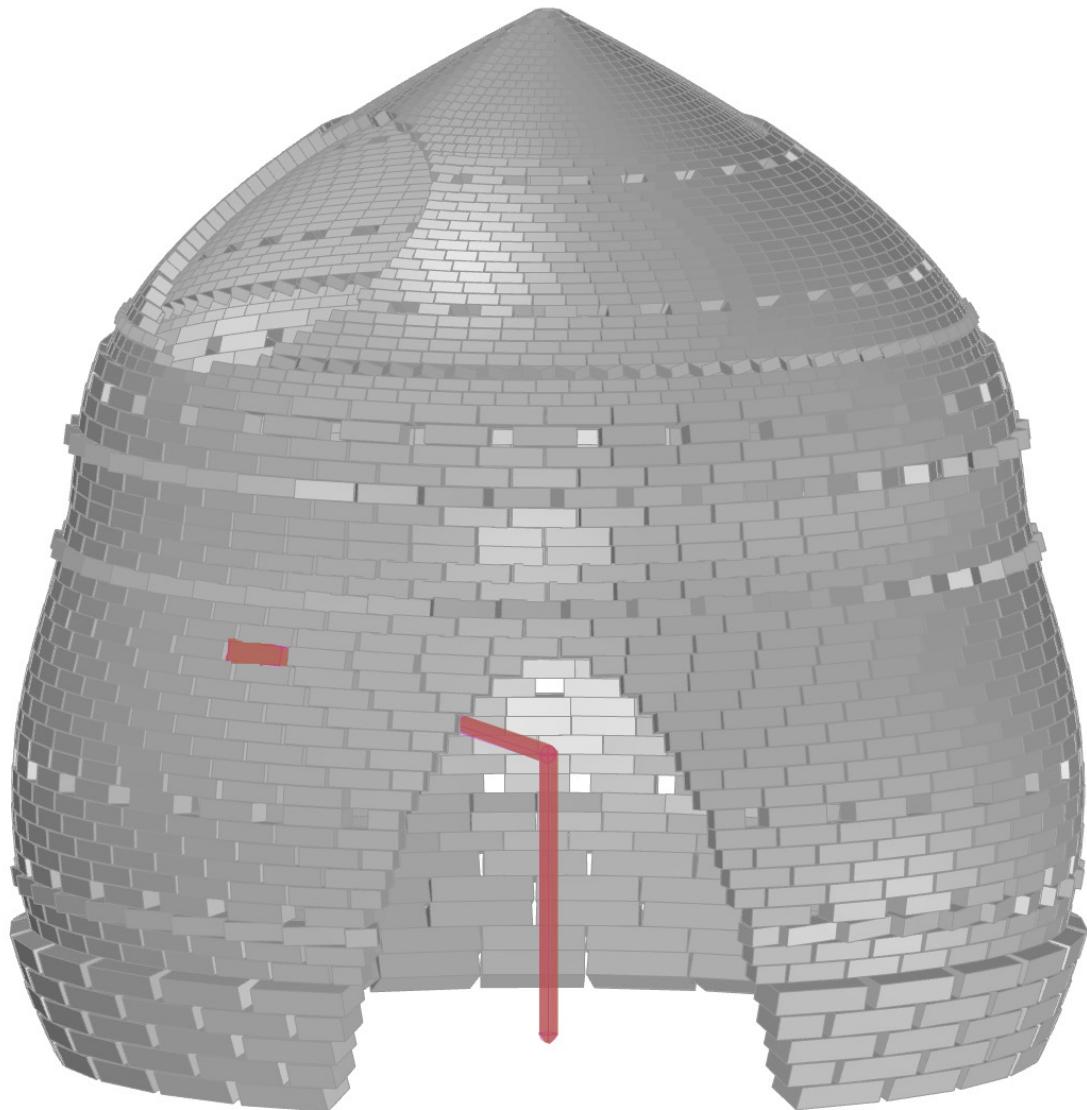
### DEVELOPED NUBIAN COMPASS



NUBIAN COMPASS TECHNIQUE  
MORE AXIS DEVELOPED

## INPUTS

### DEVELOPED NUBIAN COMPASS



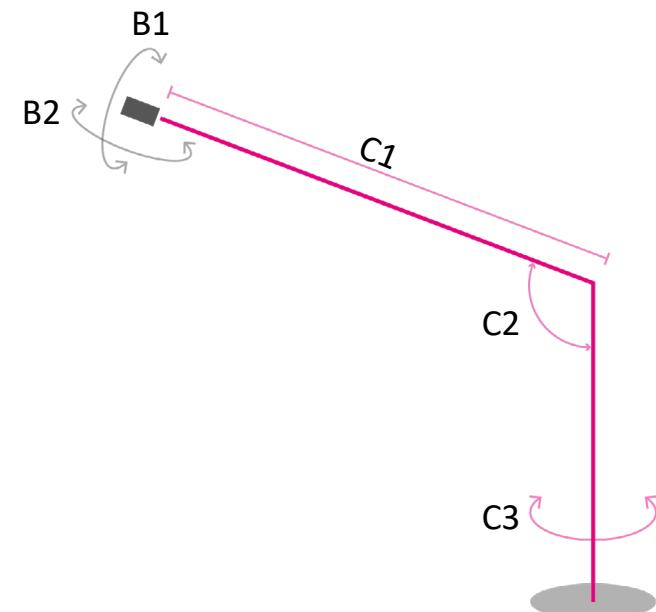
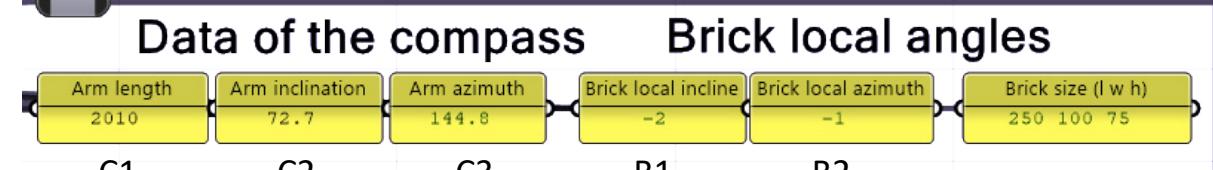
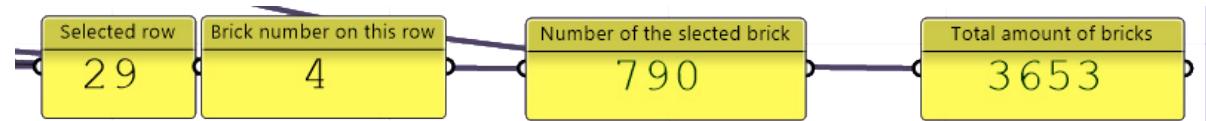
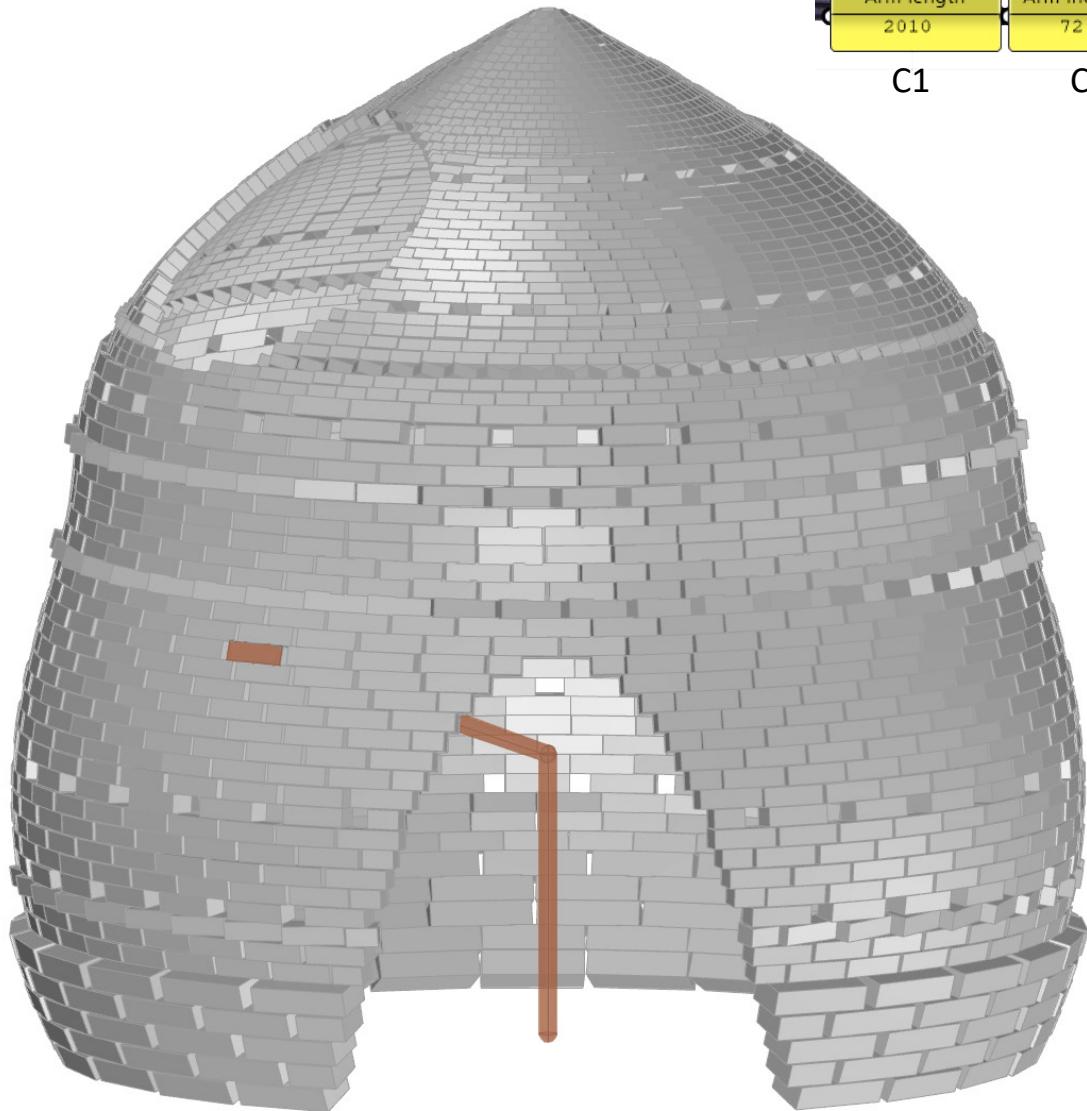
## BRICKS

Selected row number	<input type="text" value="29"/>
Selected brick number	<input type="text" value="5"/>
Total number of rows	<input type="text" value="86"/>
Bricks on selected row	<input type="text" value="16"/>
Start row	Dimensions (length width height)
0 0	0 400 175 100
1 5	1 250 100 75
2 35	2 125 75 50
3 58	3 50 50 50
Row	Rotation of each brick (degrees)
0 7	0 12.5
1 24	1 21
2 30	2 29
3 37	3 45
Row	Gap between bricks (half brick len)
0 8	0 0.3
1 13	1 0.4
2 33	2 0.3
3 42	3 0.9
4 55	4 0.8

DATA INPUT FOR SCRIPT

## OUTPUTS

### DEVELOPED NUBIAN COMPASS

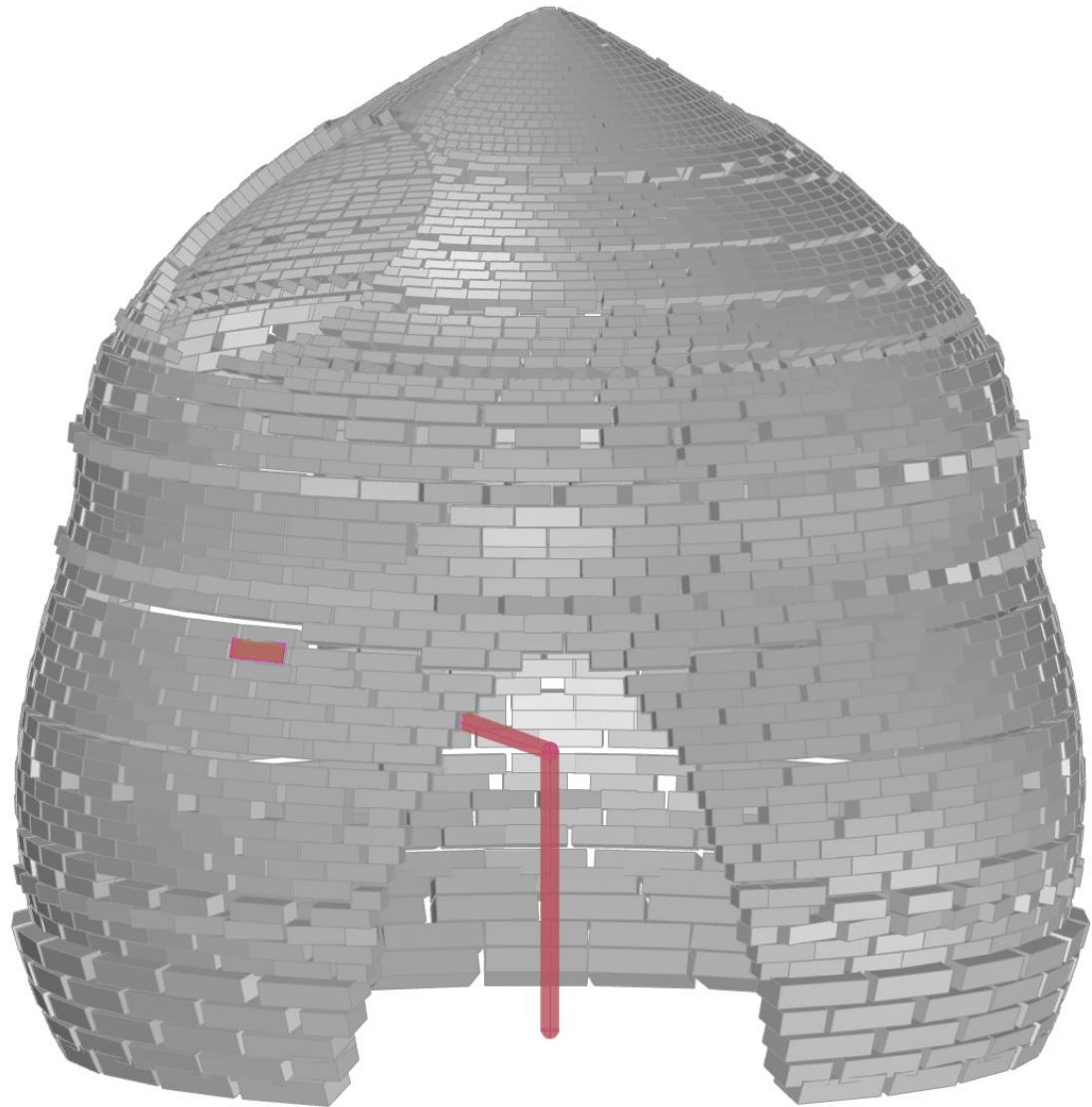


DATA OUTPUT FOR SCRIPT

## LIMITATIONS

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### DEVELOPED NUBIAN COMPASS



CONSTRUCTION TECHNIQUE

**VOXELIZATION**

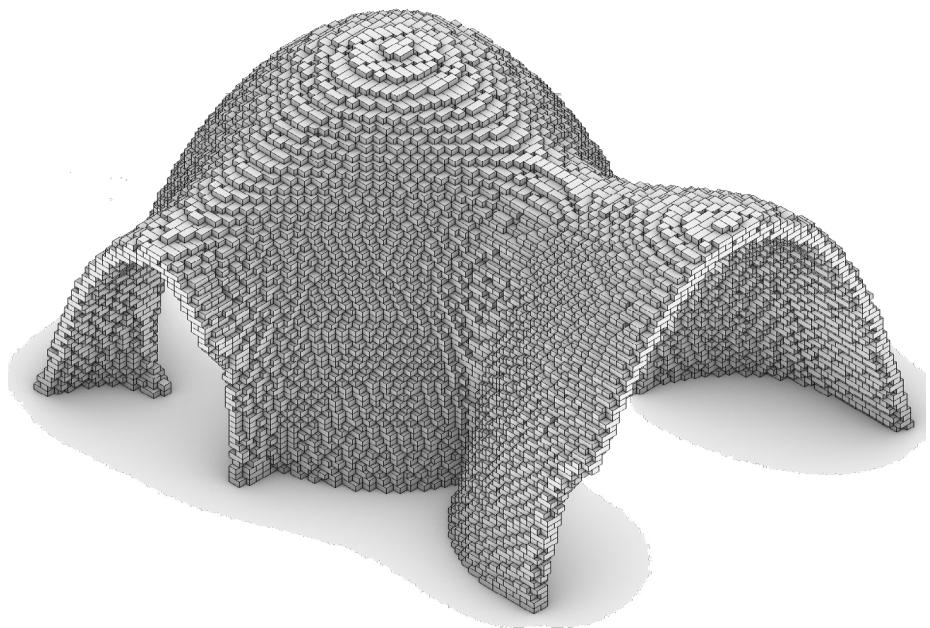
## CONCEPT

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### VOXELIZATION



BASIC OUTPUT OF DYNAMIC RELAXATION



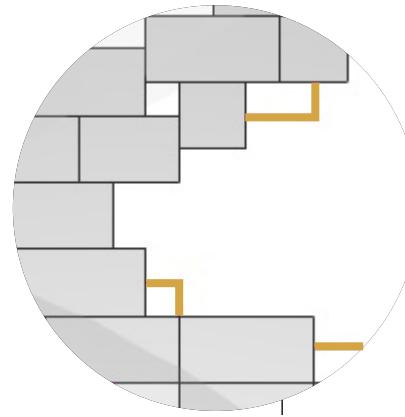
VOXEALIZED MESH

## OUTPUT

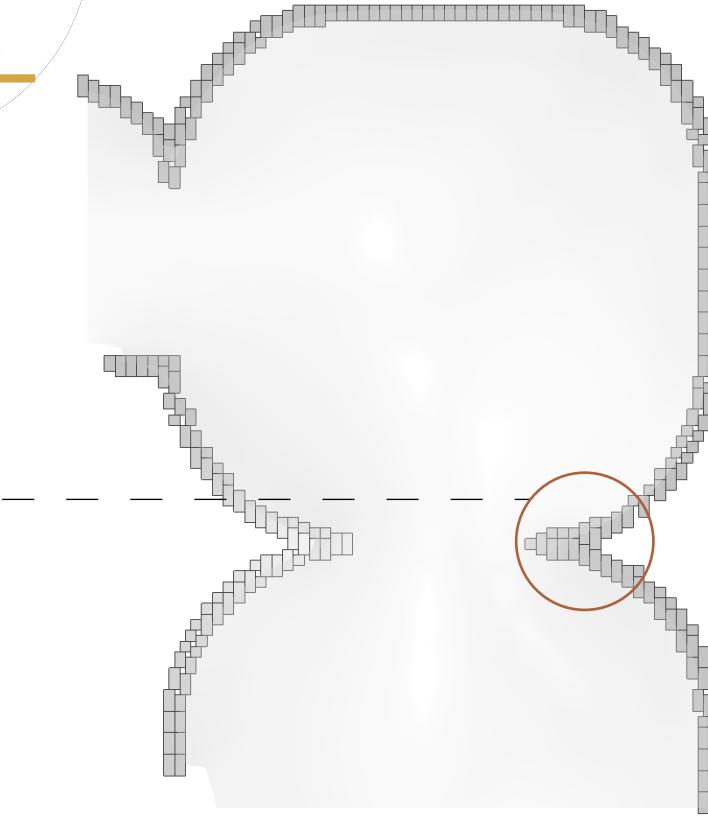
### VOXELIZATION



VOXEALIZED MESH 3D



VOXEALIZED MESH TOP VIEW



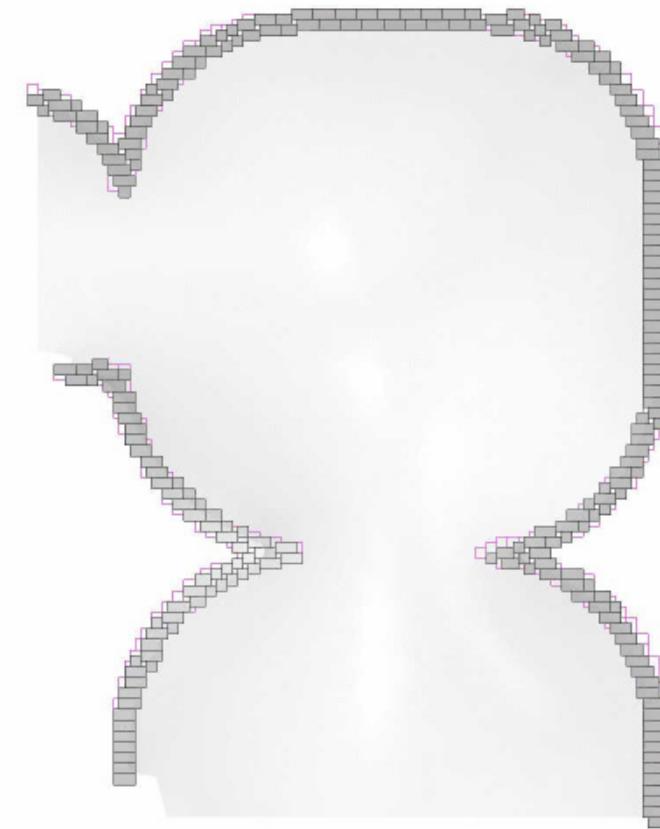
## OUTPUT

---

### VOXELIZATION



VOXEALIZED MESH 3D

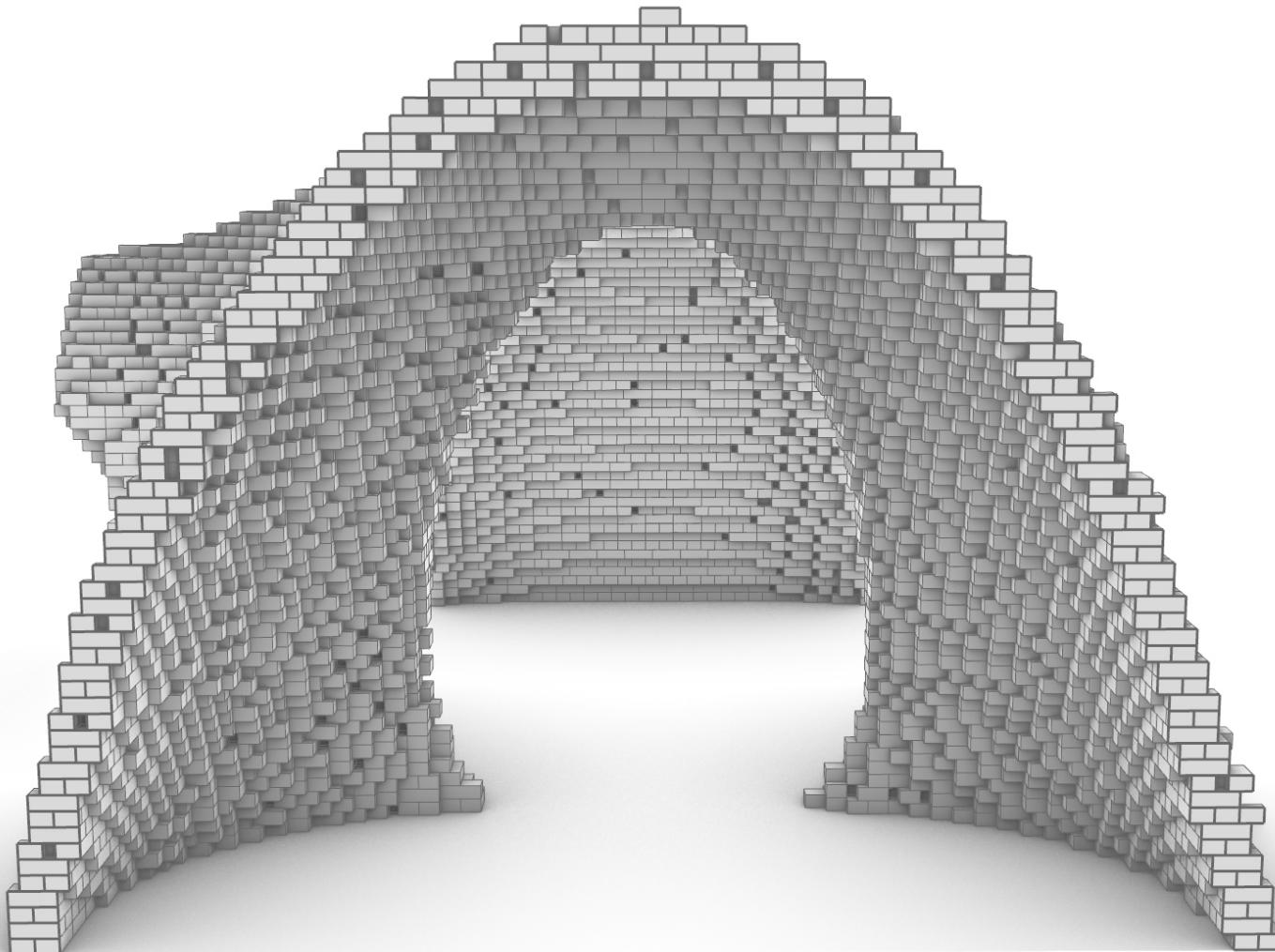


VOXEALIZED MESH TOP VIEW

## LIMITATIONS

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### VOXELIZATION



GAPS BETWEEN THE BRICKS

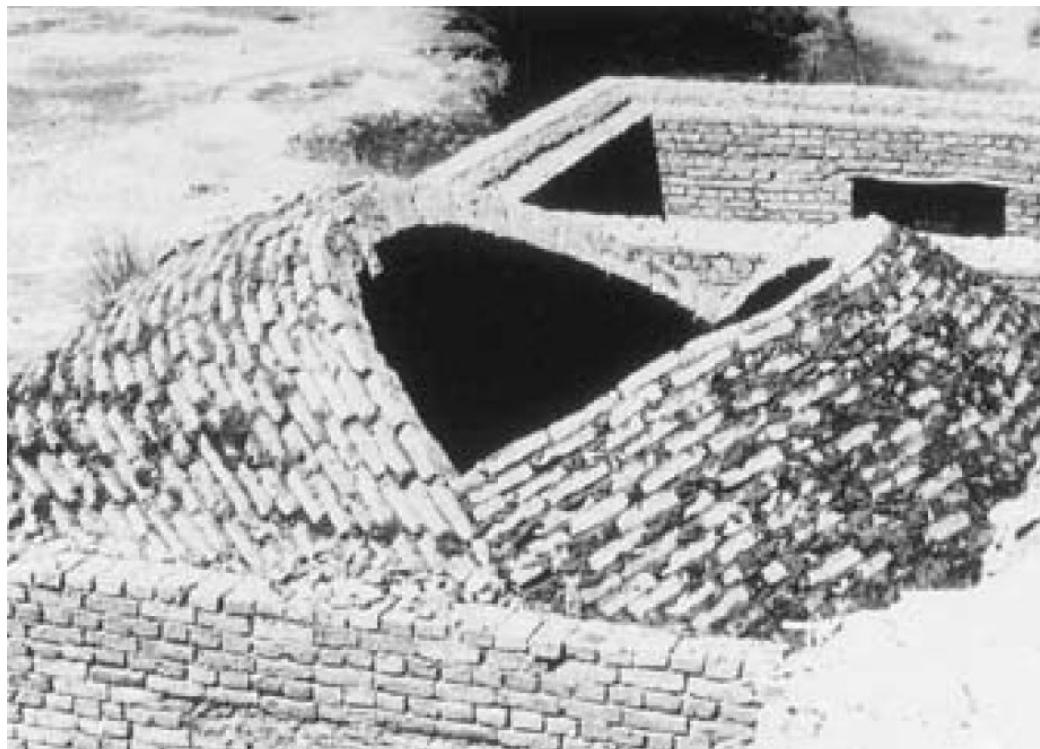
CONSTRUCTION TECHNIQUE

**GUIDING RODS**

## CONCEPT

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### GUIDING RODS



PERSIAN & AFGHAN DOME  
NUBIAN DEVELOPED TECHNIQUE

## CONCEPT

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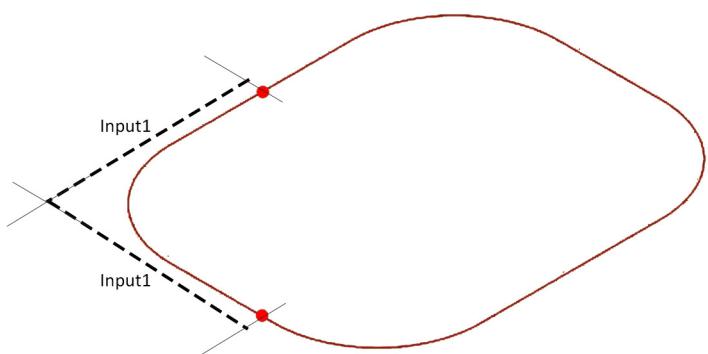
### GUIDING RODS



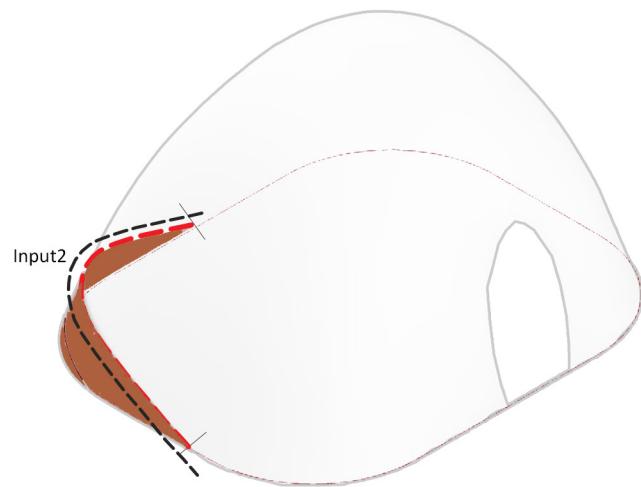
PERSIAN & AFGHAN DOME  
NUBIAN DEVELOPED TECHNIQUE

## ON-SITE MARKING

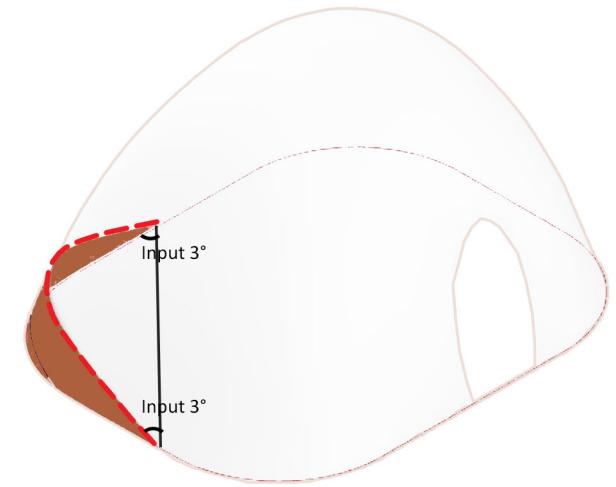
### GUIDING RODS



Input1 : Marking on the plan



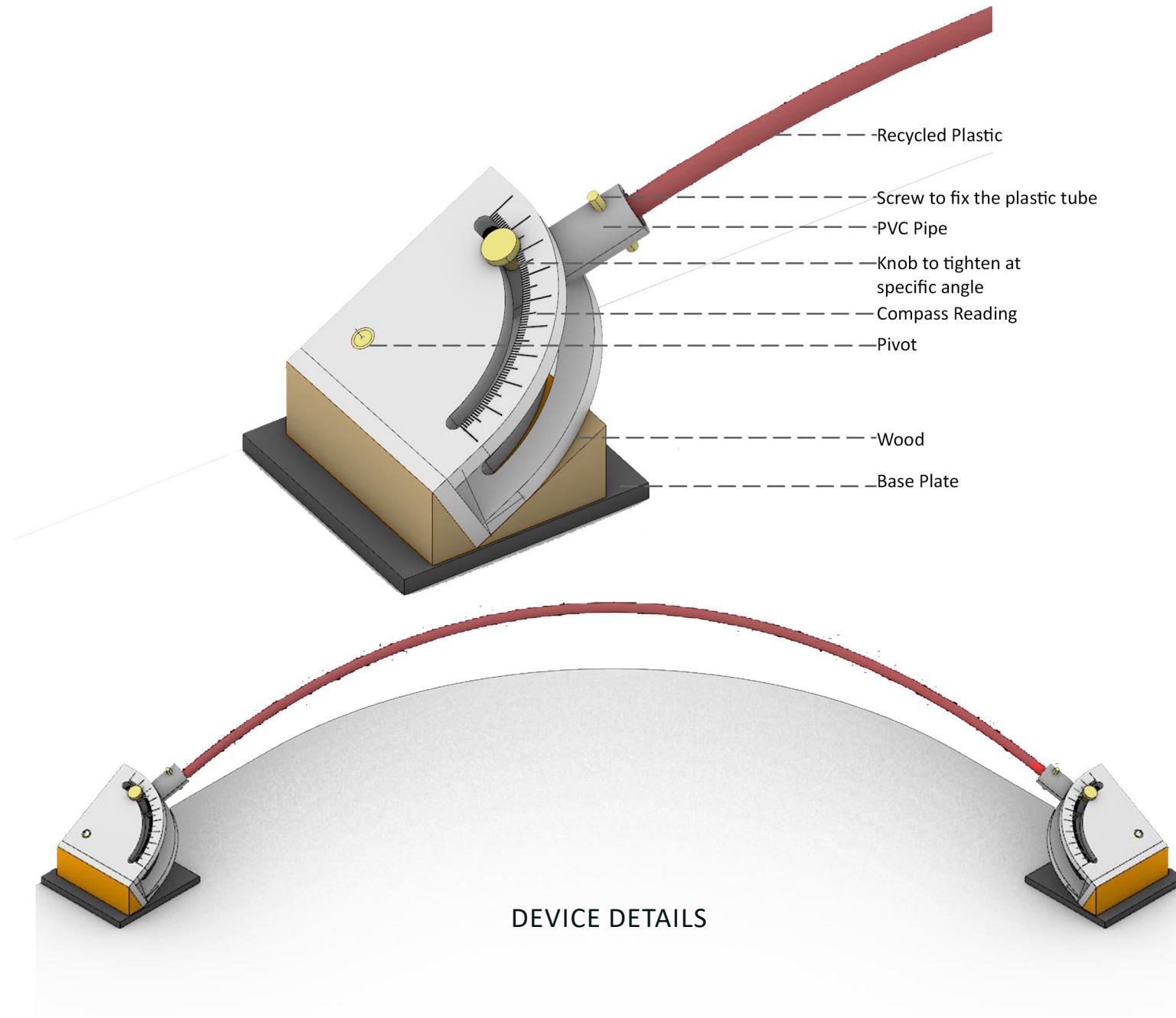
Input 2 : Length of the arc



Input 3 : Angle of the arc

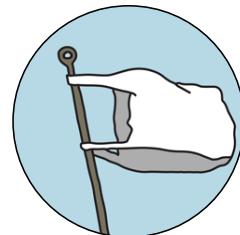
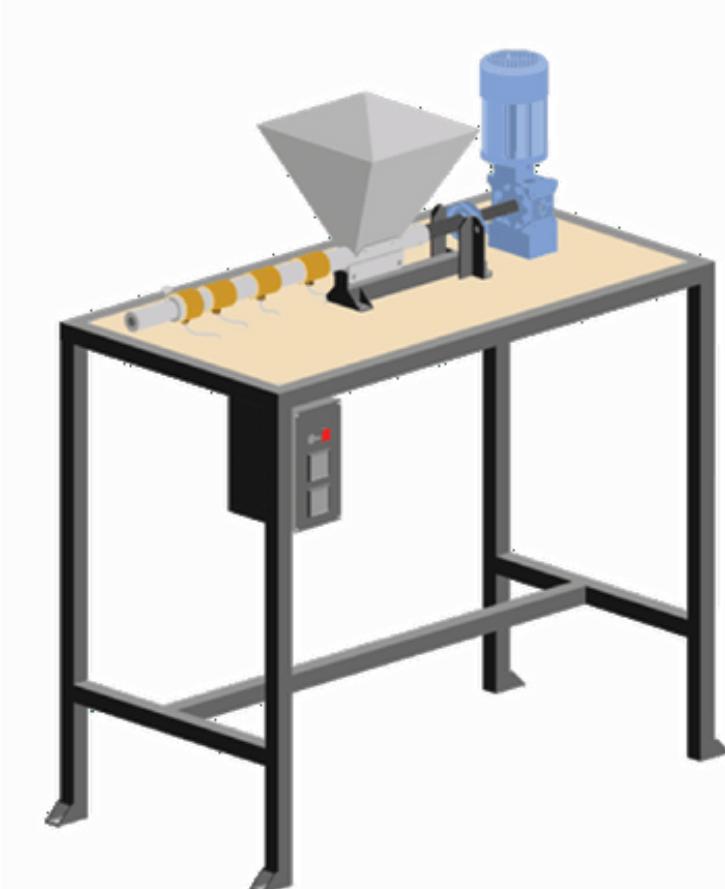
## DEVICE CREATED

### GUIDING RODS



## PLASTIC RESOURCE

### GUIDING RODS

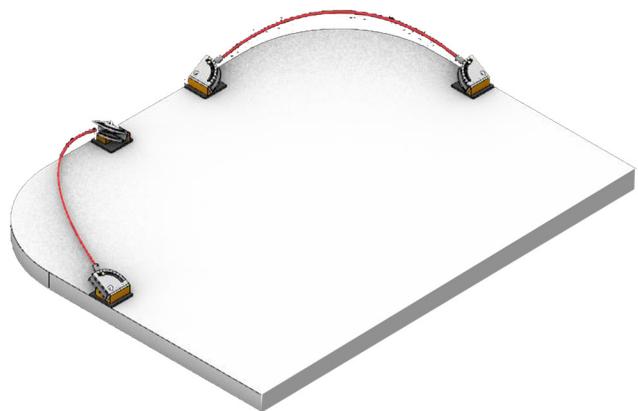


PLASTIC SHRED & INJECTION MACHINES  
“PRECIOUS PLASTIC” OPEN SOURCE

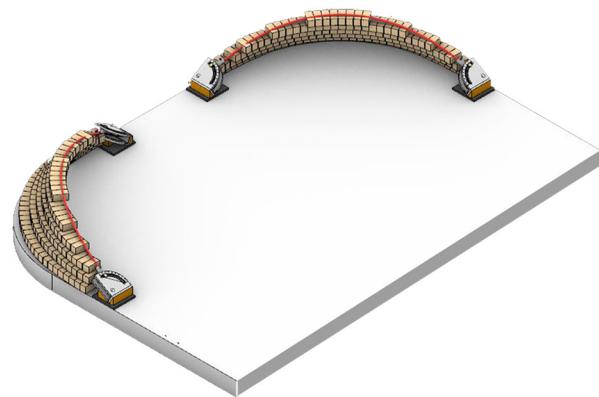


## ON-SITE BUILDING

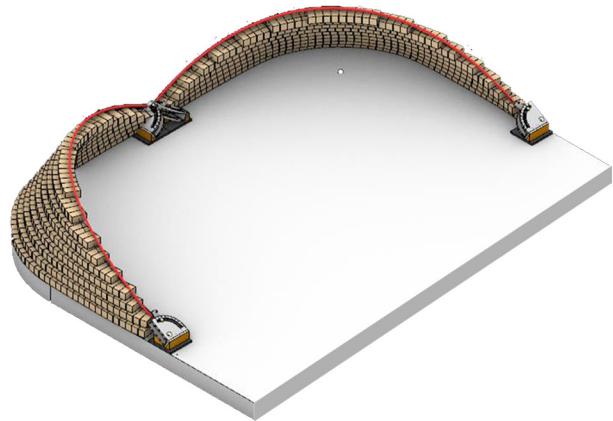
### GUIDING RODS



1. Positioning tool on the plinth



2. Laying of brick beneath the guide

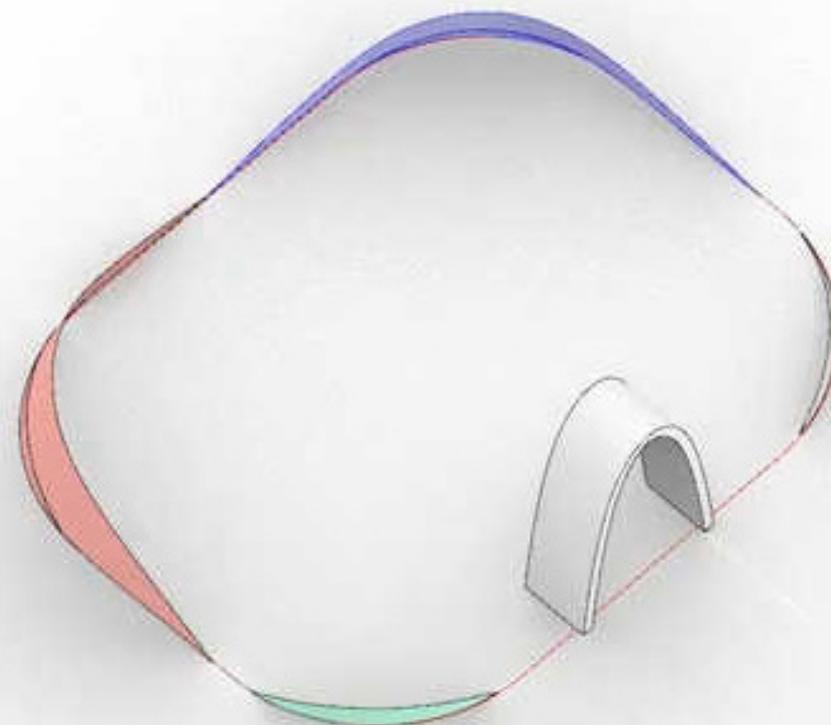


3. Move the guide and start laying the next row

## OVERALL OUTPUT

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### GUIDING RODS



## DIFFERENT APPROACHES

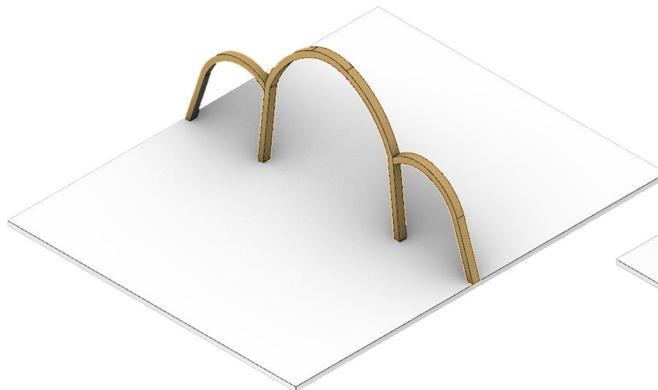
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### DECISION MATRIX

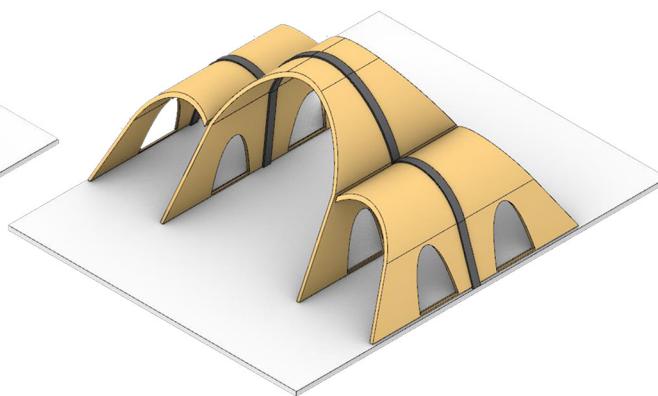
Decision matrix			Methods (rate from 1 = bad, to 5 = good)							
Specifications		Weight	Compass		Voxelization		Guiding rods			
			Rating	Weighted	Rating	Weighted	Rating	Weighted		
Objective evaluations	Constructability	5	3	15	5	25	4	20		
	Amount of info required on-site	3	1	3	2	6	3	9		
	Shape freedom	3	3	9	1	3	4	12		
	Low tool costs	4	2	8	5	20	3	12		
Subjective evaluations	Pattern	2	5	10	3	6	5	10		
	Aesthetics	1	5	5	2	2	4	4		
Total of the weighted ratings:			50		62		67			

## NUBIAN VAULT

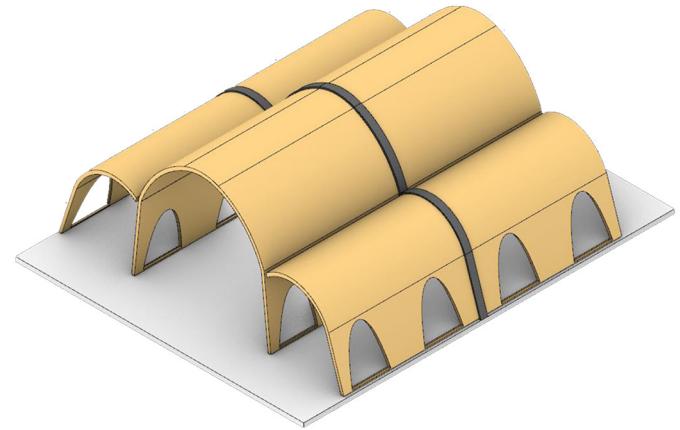
### WORKSHOPS



1. Central arch



2. Brick laid at 65 degree on both the sides



3. Workshop after construction



**THANK YOU!**