

JANUARY

2024

# PORTFOLIO

KAMYAB

HOSSEINI

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# BIO

Hossein is a computational designer with a keen interest in structural design. He studied architecture for both his bachelor's and master's degrees. In his master's, he showed a great interest in the application of structural design in architecture. He is interested in pure compression-tension structures, as can be seen in his most recent design projects. As a registered teacher in the Ministry of Education of Iran, Hossein used to share his passion for such structures with his vocational high school students in some workshops. Hossein participated in a few workshops on computational design, which helped him find his field of interest in research. For his master's thesis project, Hossein conducted deep research on structuralizing muqarnas, an ornamental element in Islamic architecture, under the supervision of Dr. Damon Bolhassani from the City College of New York. The result of this project was partially presented at the IASS 2022 conference. Besides his structural design projects, Hossein worked on several architectural design projects during his master's and bachelor's studies, where he was focused on different aspects of architecture, including the relation of a building with its environment, the functionality of the building, and the compatibility of the architecture with the structure. Hossein has good sketching skills, which aid him in being able to freely think about his design projects in different aspects.



01

## STRUCTURAL MUQARNAS

MASTER'S THESIS PROJECT

[PUBLISHED PAPER IN IASS 2022](#)

## WHAT?

Structural  
muqarnas

Structural reconstruction of an ornamental element in  
Islamic architecture called muqarnas

## WHY?

Bridging  
Traditional and Modern  
Architecture

Having access to the  
computational tools,  
to generate complex  
geometries

The possibility of  
making complex  
geometries that are  
structural efficient

## How?

1

Finding the pattern of  
selected muqarnas

2

Modifying the muqarnas  
pattern according to the  
Graphic statics principles

3

Finding the 2D form  
and Force diagrams  
(horizontal equilibrium)

4

Finding the vertical  
equilibrium

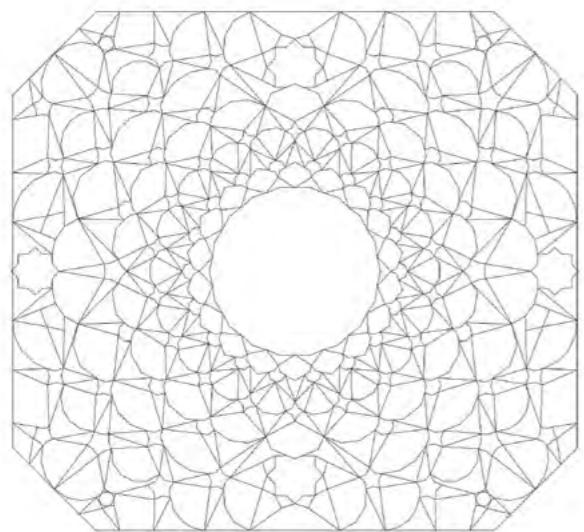
5

Specify a profile to the  
generated form

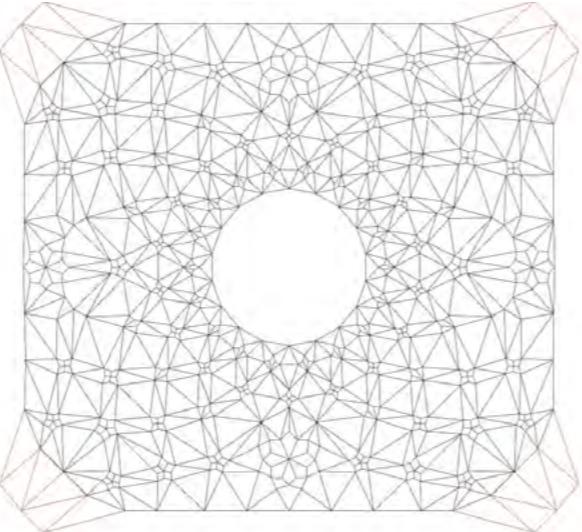
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Fabrication

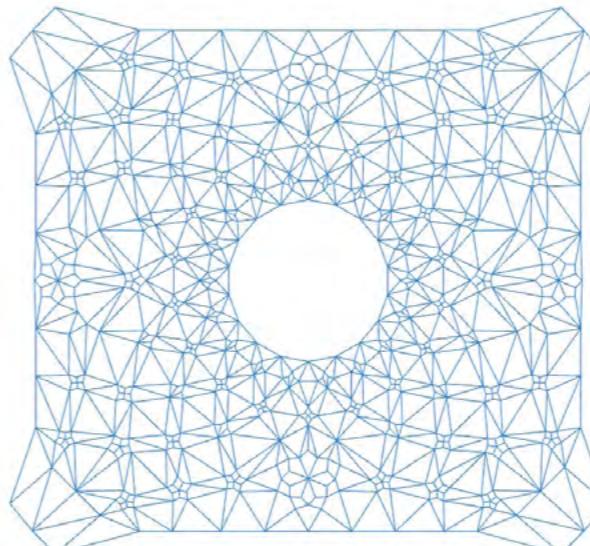
# PROCESS OF GENERATING STRUCTURAL MUQARNAS



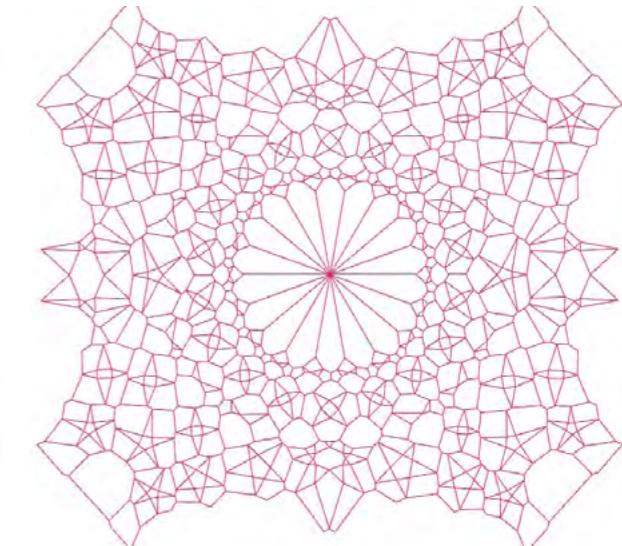
I  
.....  
Modification



II  
.....  
Horizontal Equilibrium



FORM DIAGRAM

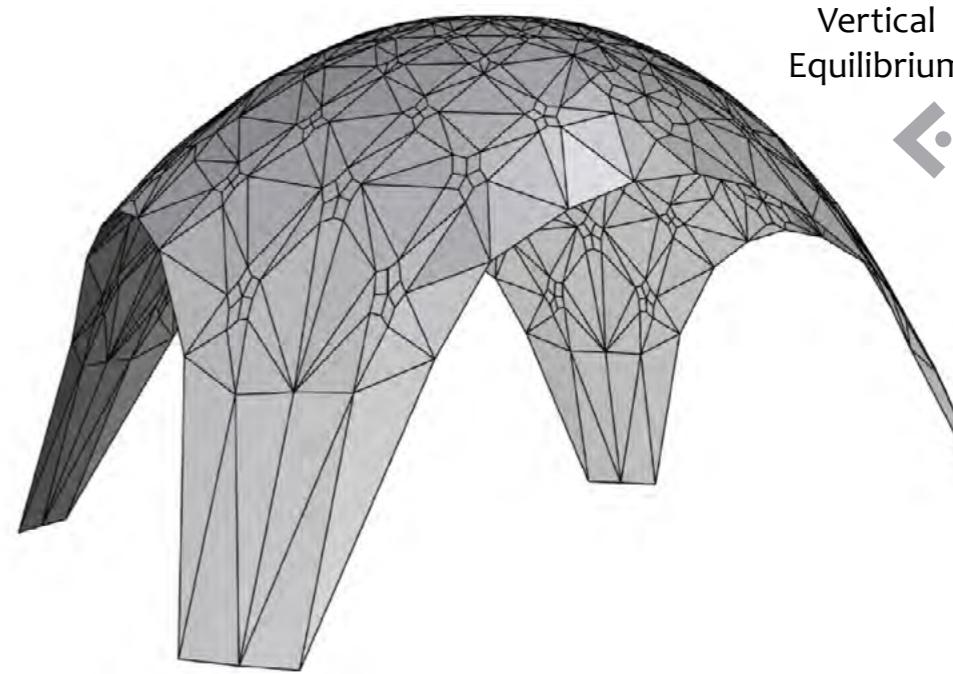


FORCE DIAGRAM



STRUCTURAL MUQARNAS

IV  
.....  
Materialization



THRUST LINES

Vertical  
Equilibrium  
III  
.....

## I MODIFICATION

Following graphic statics principles is essential for generating form and force diagrams, which means not including curved lines or concave geometries in the initial pattern. Pedestals were also added in the very first pattern to make sure they also followed the load path.

## II HORIZONTAL EQUILIBRIUM

Generating the 2D equilibrium by finding the reciprocal force diagram for the existing form diagram using the RhinoVAULT tool.

## III VERTICAL EQUILIBRIUM

Finding the 3D thrust line based on form and force diagrams by providing the final height as well as supporting points.

## IV MATERIALIZATION

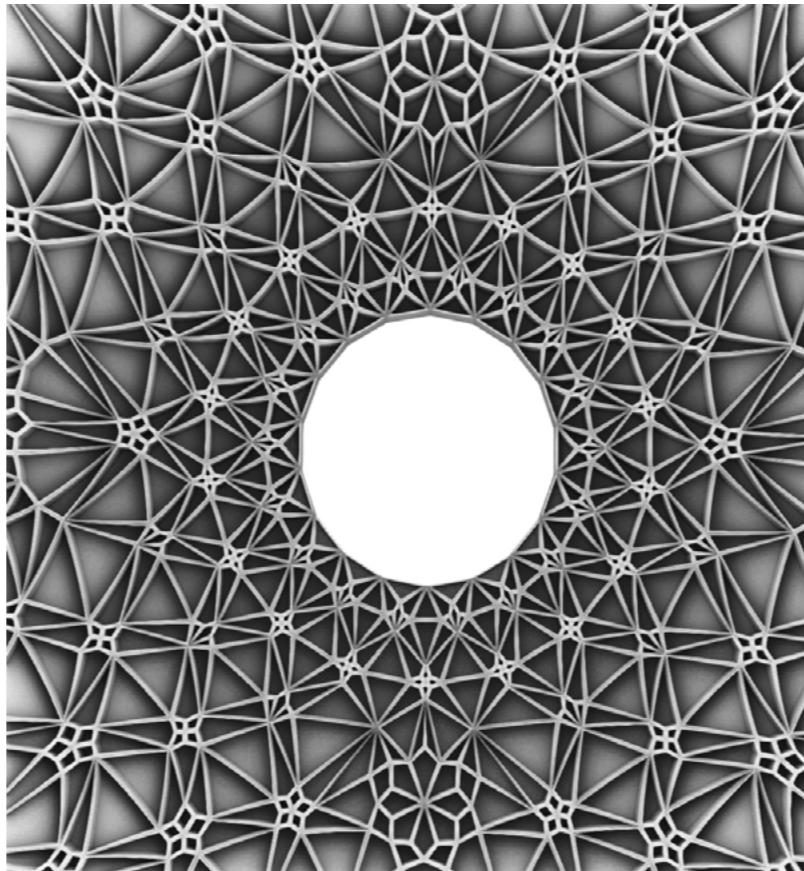
Selecting a curved profile to reduce the usage of material while having a more similar look to the original muqarnas.



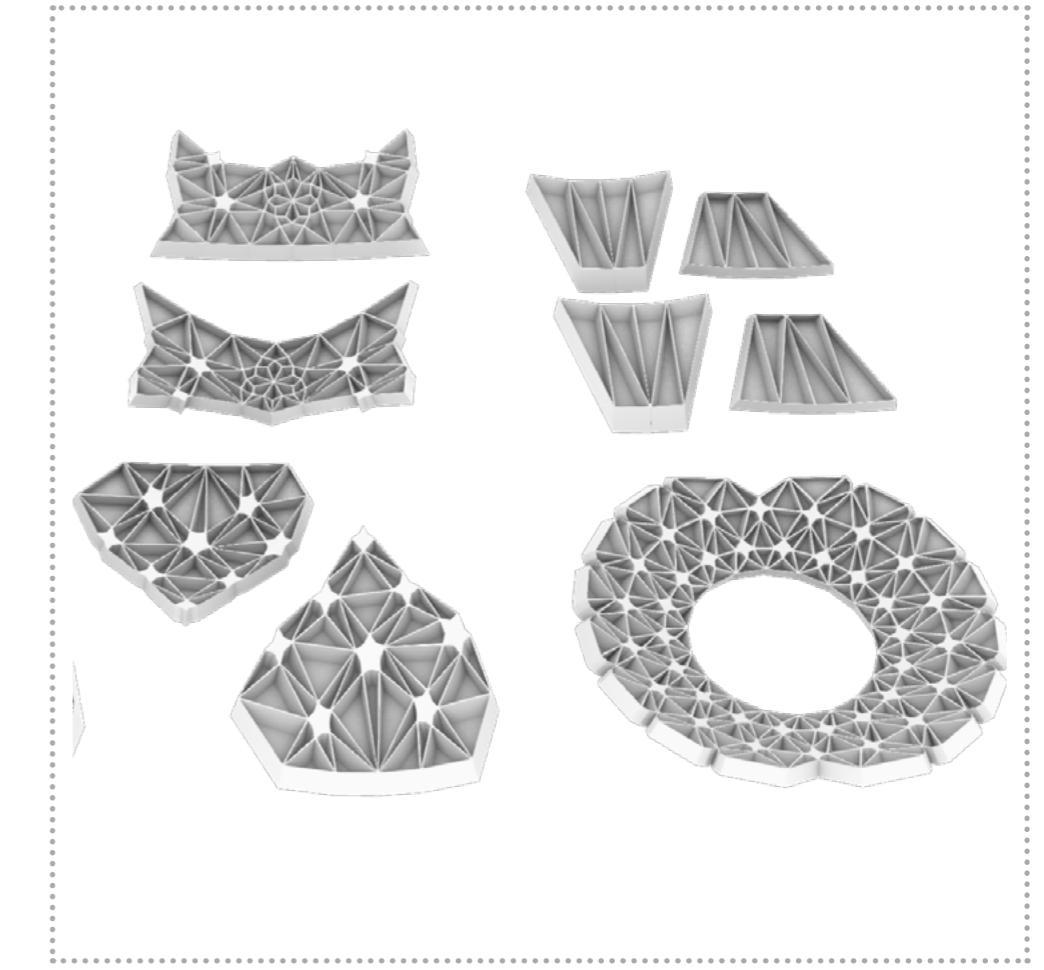
Structural muqarnas of hasht behesht palace



original muqarnas of hasht behesht palace



structural muqarnas of hasht behesht palace



Modeled elements for 3d printing



3d printed structural muqarnas of hasht behesht palace



## 02 KINETIC + TENSEGRITY

STUDIO DESIGN 3- MASTER'S

### WHAT?

Structure

Kinetic

Tensegrity

### WHY?

modularity

Compression and tension only

Easy installation

Flexibility

Affordability

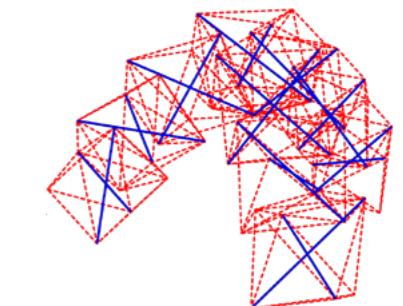
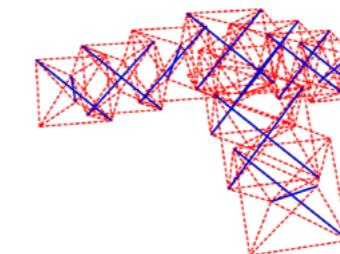
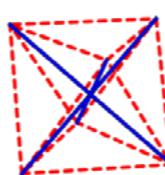
Complexity in simplicity

### How?

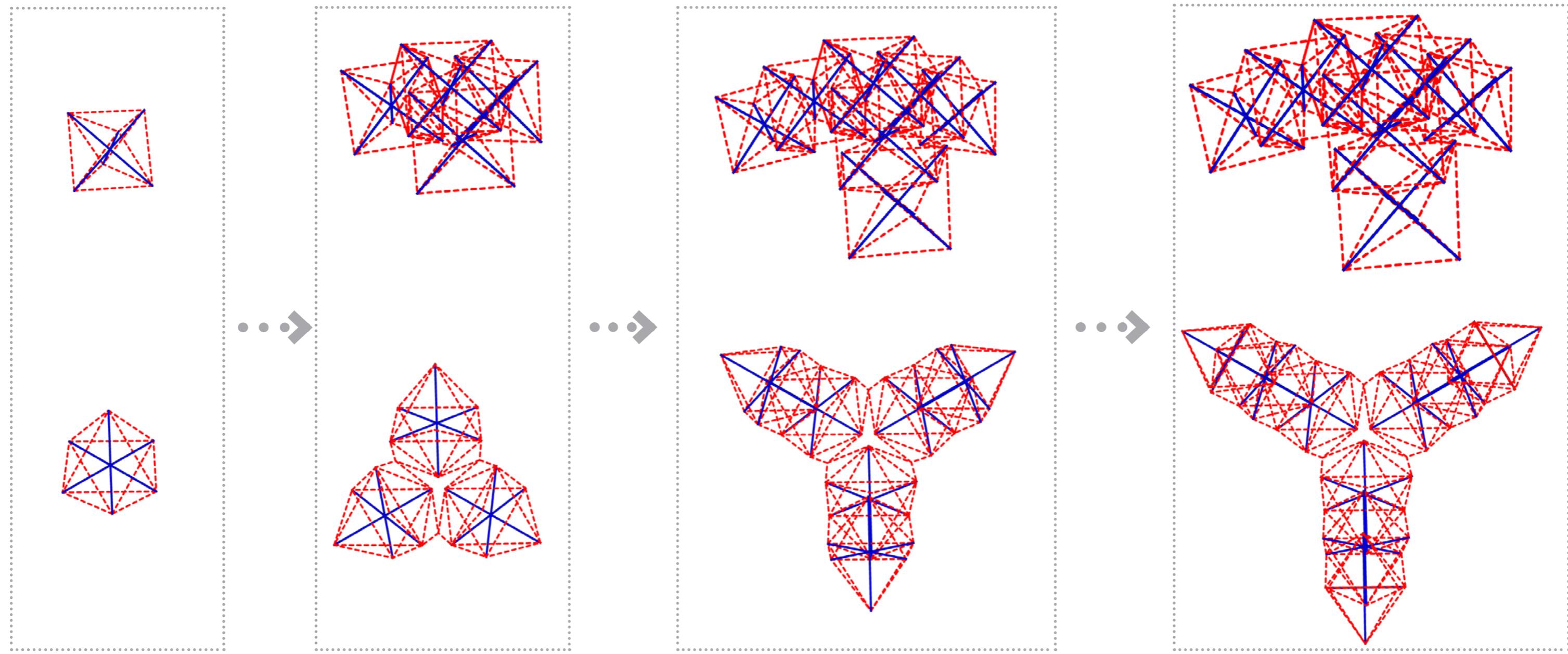
Three compression and three tension elements form a module

The module extends in three directions in several layers

Taking different positions Due to the flexibility of tension elements



## PROCESS OF ASSEMBLING THE STRUCTURE



An octagon as  
the First module

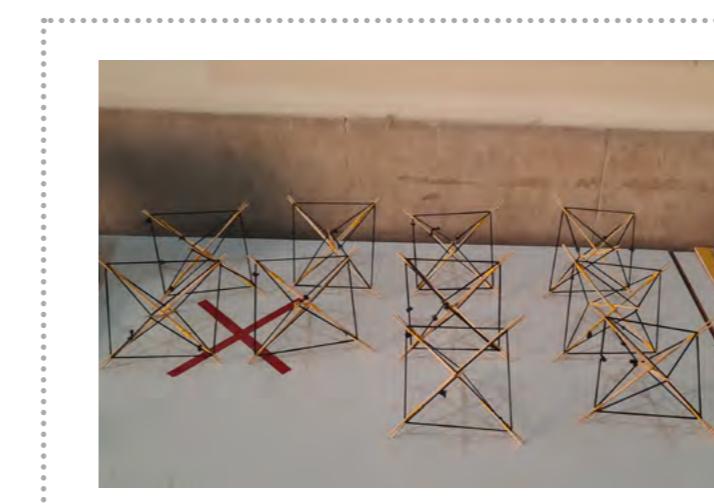
Addition of  
Second layer

Addition of  
Third layer

Addition of  
Forth layer



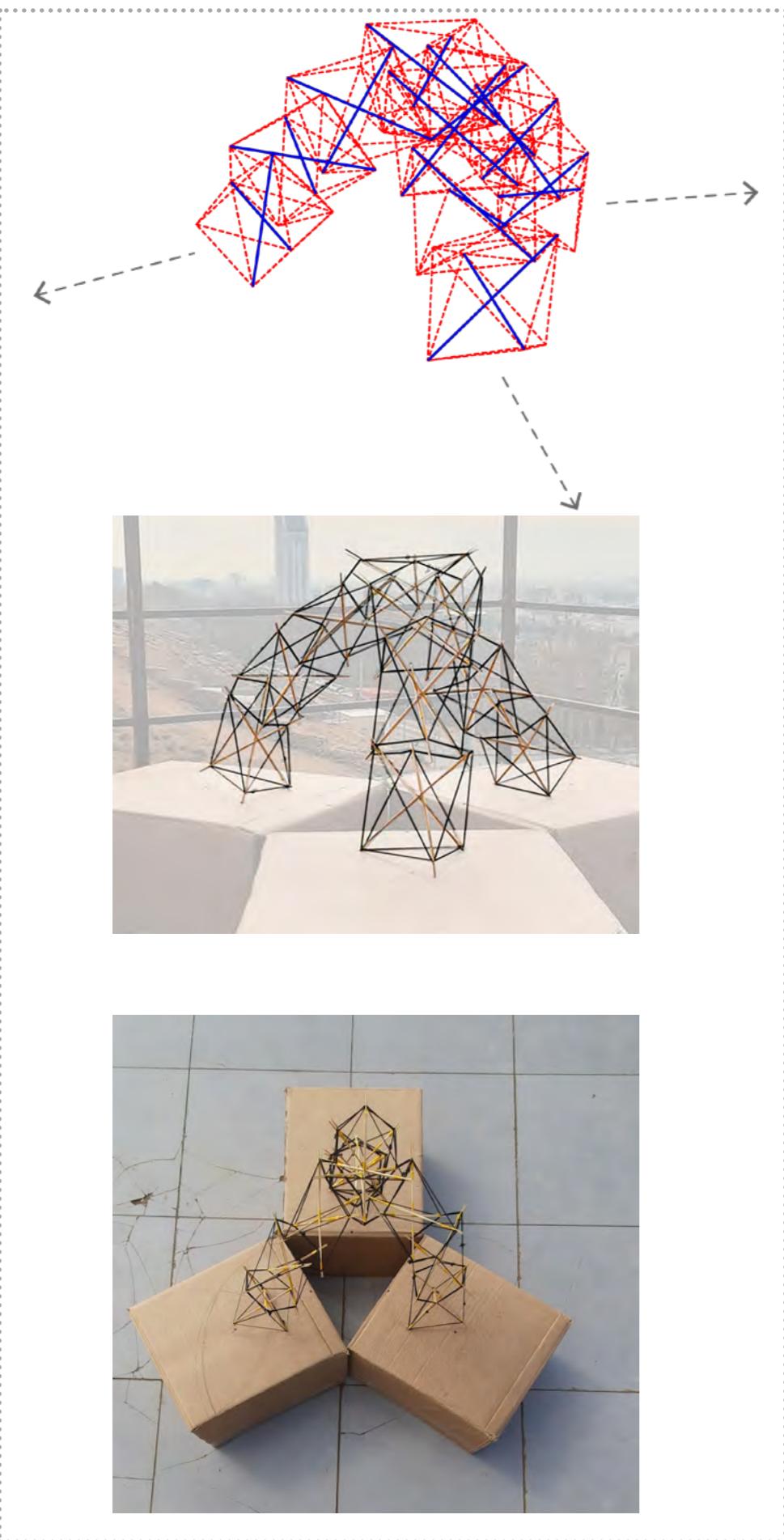
An octagon as the First module



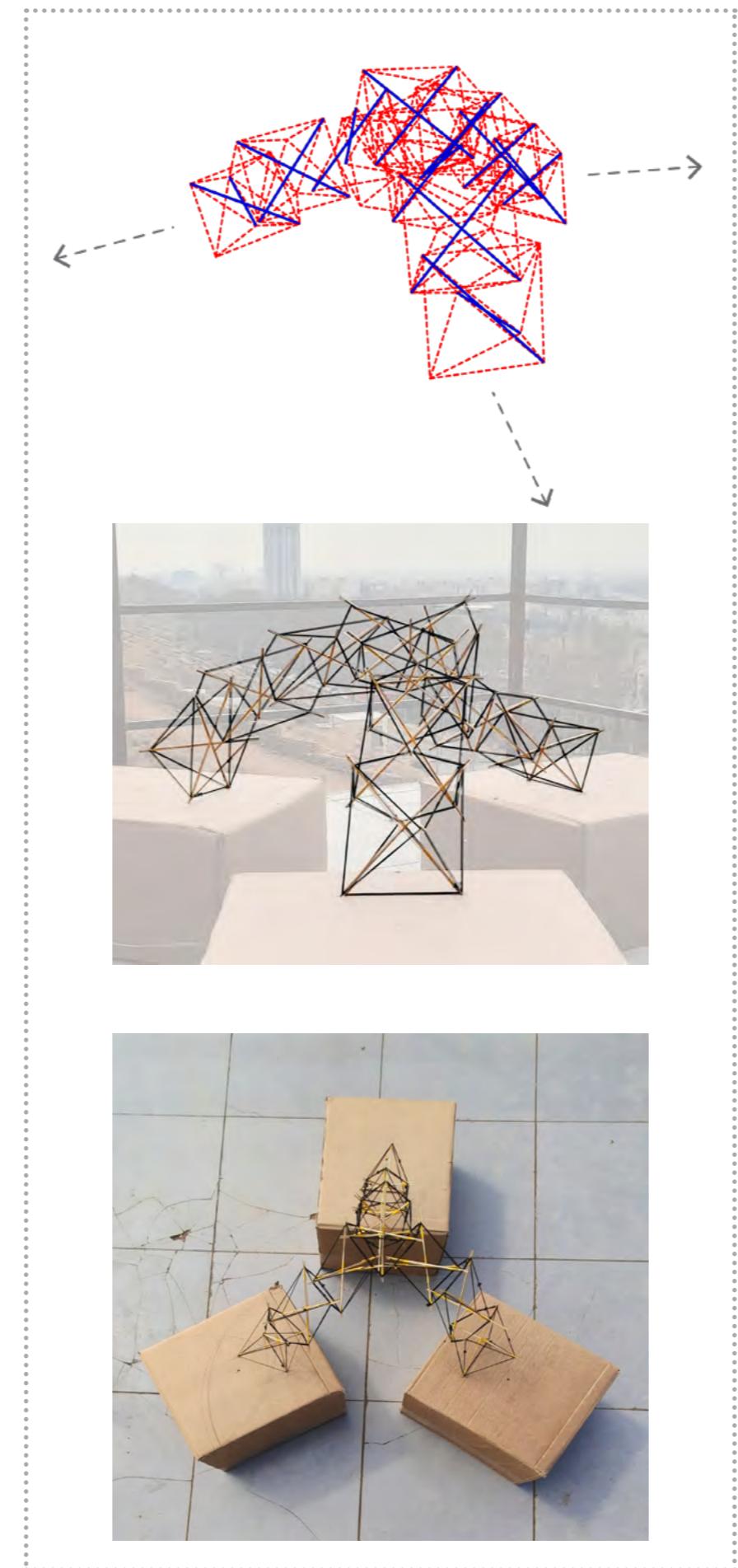
Combination of modules in several layers to generate the final structure



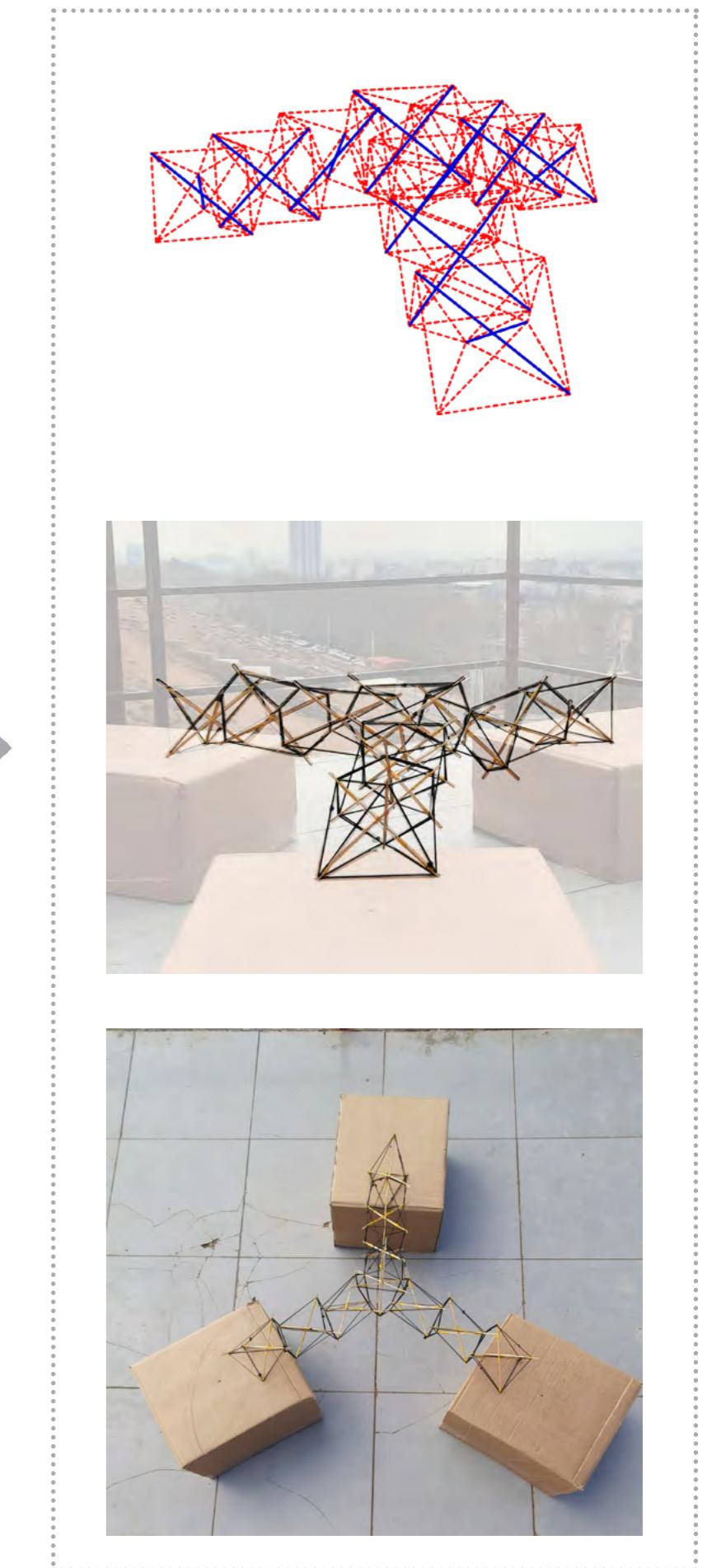
## PROCESS OF OPENING THE STRUCTURE



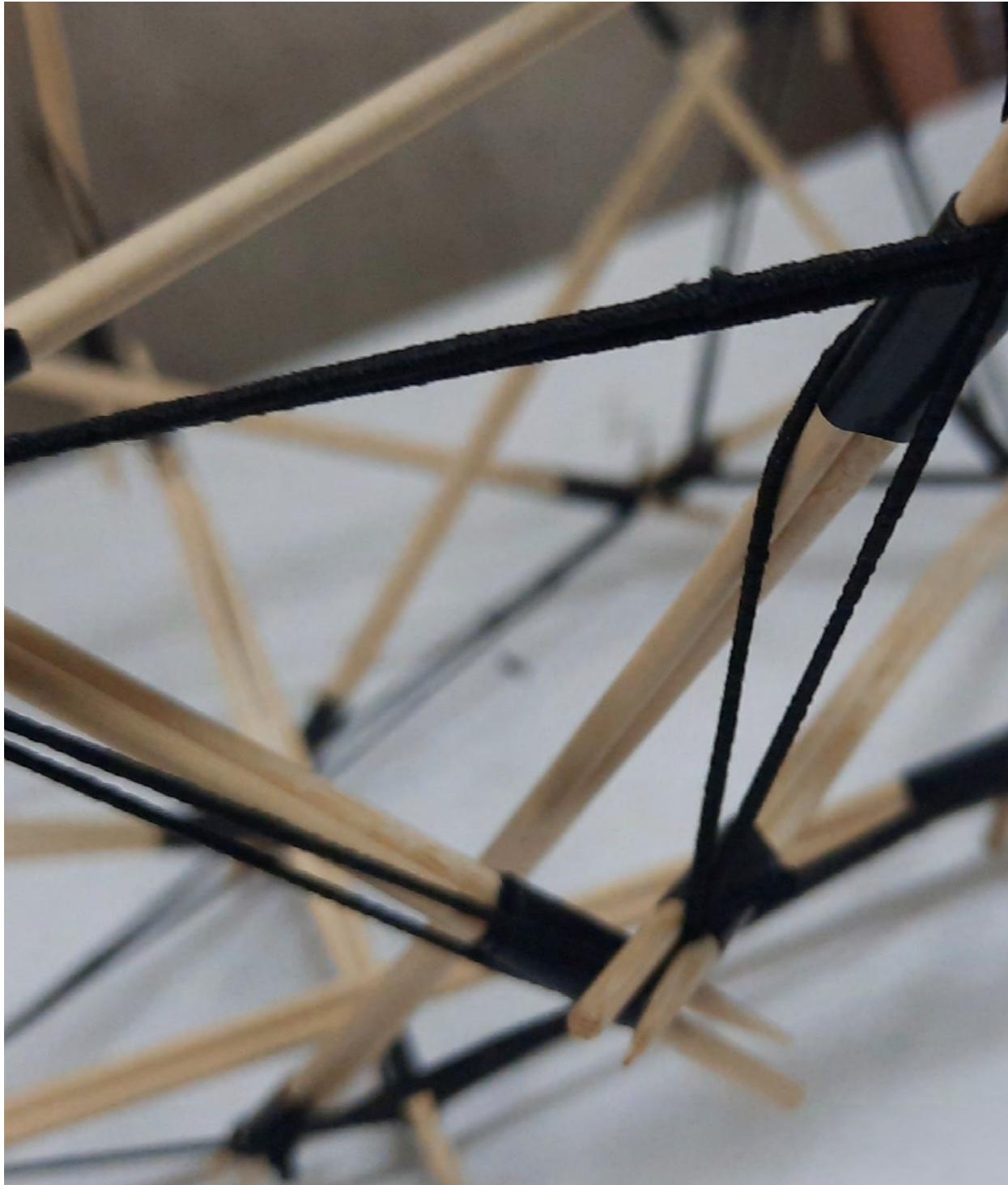
First phase  
Height: 50 cm



Second phase  
Height : 30 cm



Third phase  
Height: 10 cm



## 03 **TENSEGRITY WORKSHOP**

FARAHBAKHSG VOCATIONAL HIGH SCHOOL

### WHAT?

Tensegrity ball

a Pentagon based structure which consists of pure tension and compression elements

### WHY?

Complexity

working with complex geometries and gather skills to deal with them

Pedagogical

A better understanding of compression and tension elements

Group working

Practicing group working and collaboration

Affordability

Using inexpensive materials which are affordable for the students

### How?

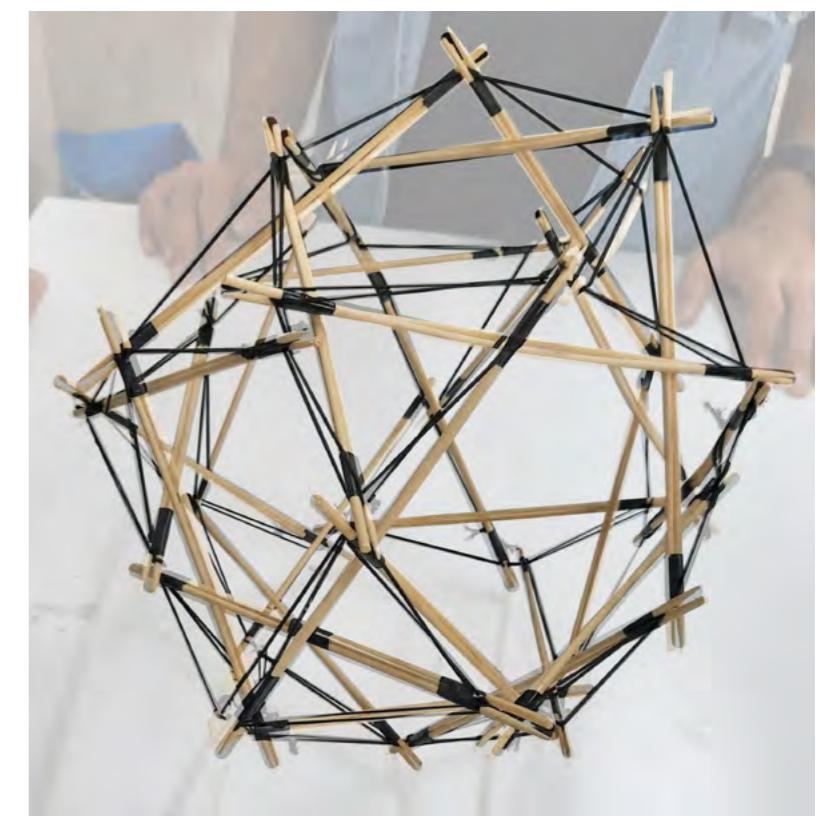
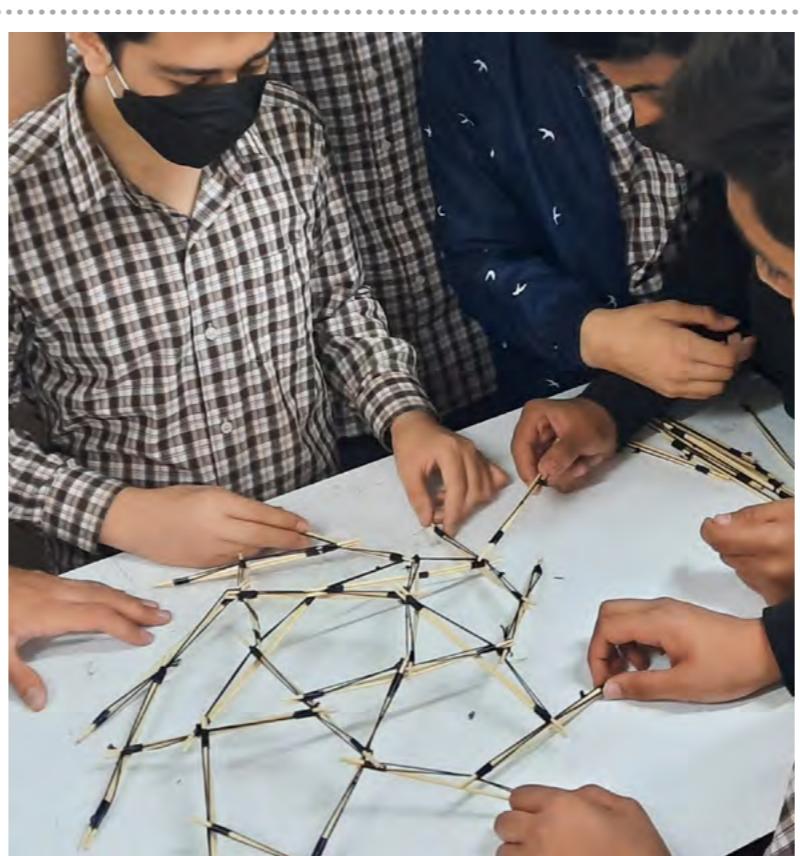
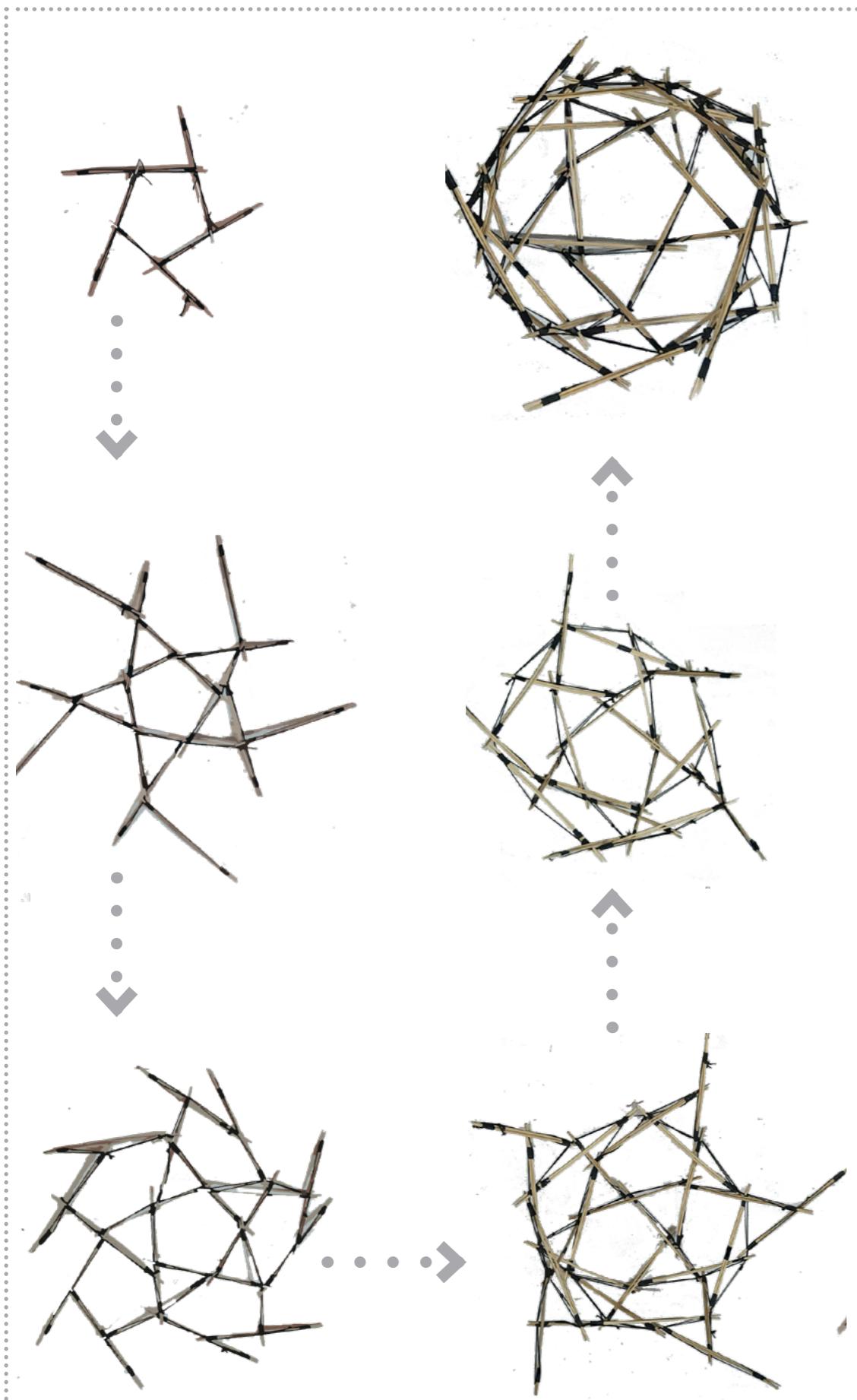
Making a pentagon by putting each stick in the middle of the adjacent one

Making five pentagons each shares a side with the primitive pentagon

Continuing making pentagons until reaching a closing pentagon on the top



## PROCESS OF GENERATING THE TENSEGRITY BALL



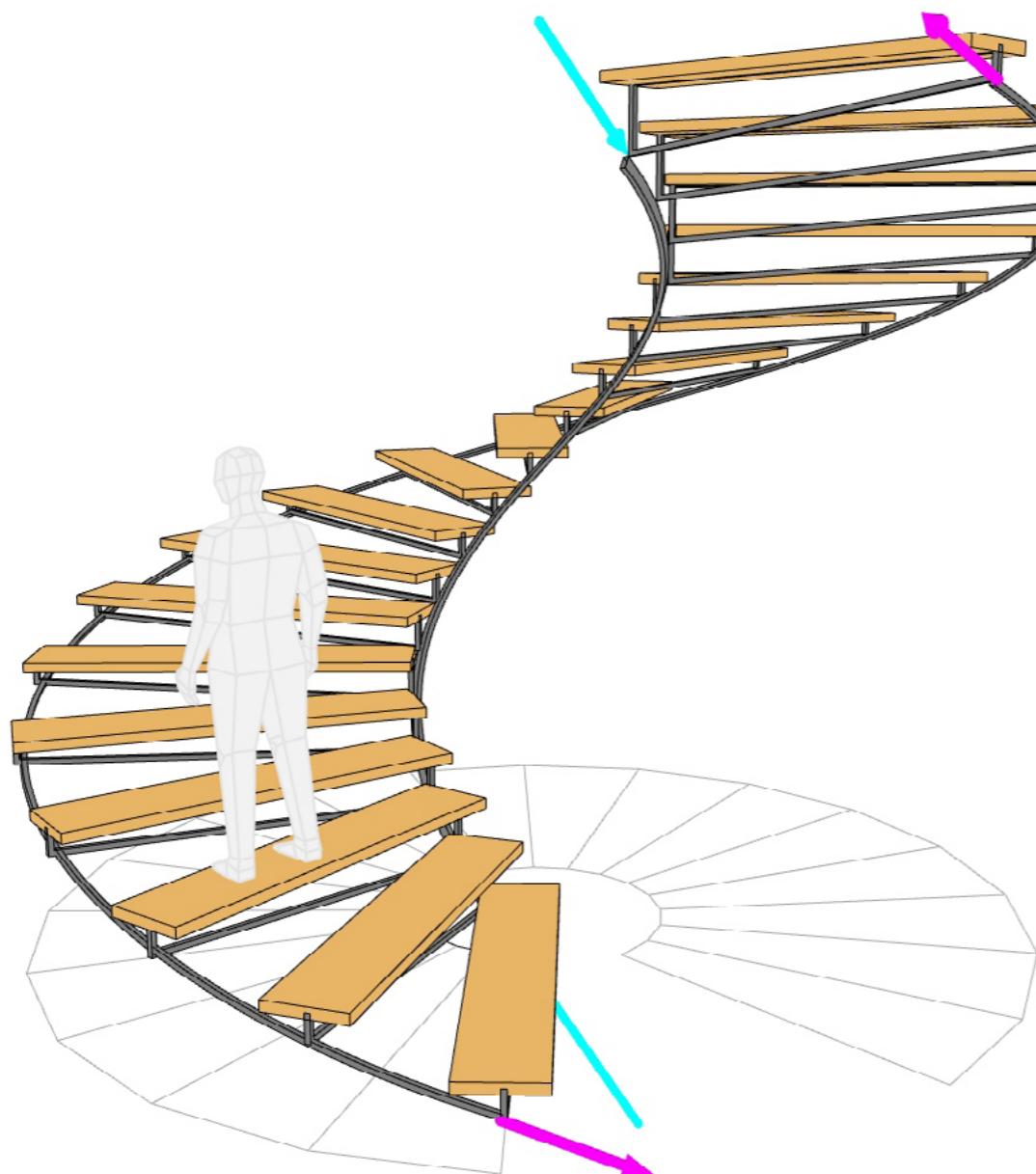
# WHAT?

Form-finding  
Staircase

Application of Combinatorial Equilibrium Modeling (CEM)  
in form finding a staircase

Combinatorial  
Equilibrium Modeling  
(CEM)

A form-finding method based on vector-based  
graphic statics



# WHY?

Material-efficiency

Due to the pure tension and compression loads applied  
in these structures they will need the minimum amount  
of material to carry loads

Elegance

Using this method, makes it possible to design very  
elegant structures based on applied loads

Stability

Structures that are built using this structural design  
method, will be very stable because of that their  
geometry is based on the loads applied to them

# How?

1

Determining the main  
topology of the structure

2

Determining supports and  
applied loads

3

Determining the  
compression or tension  
function of each element

4

Form finding without any  
constraint points

5

Form finding with constraint  
points

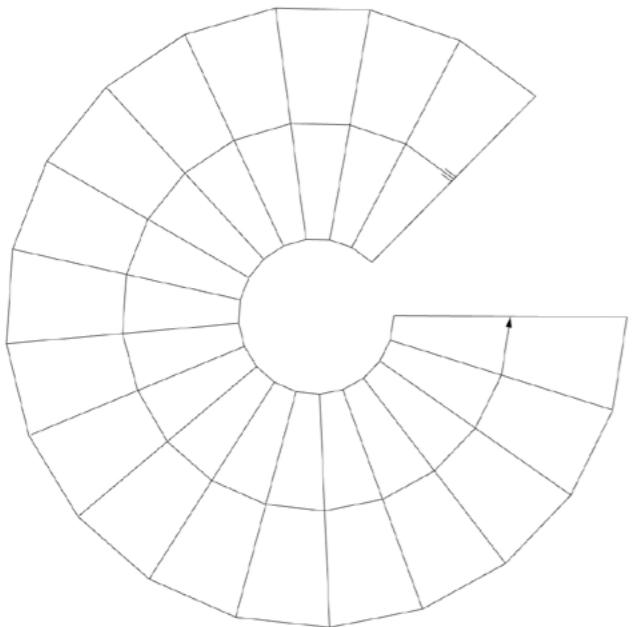
## 04 SPACIAL STAIRCASE

ACADIA 2021

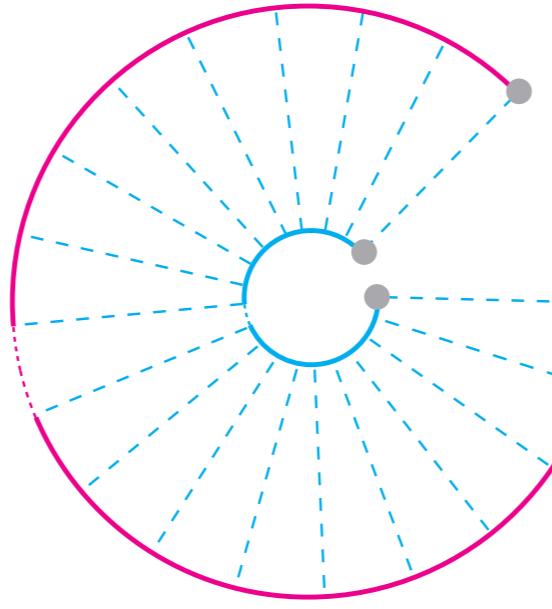
SUPERVISORS: RAFAEL PASTRANA, ISABEL OLIVEIRA, PATRICK OLE OHLBROCK, PIERLUIGI D'ACUNTO

# PROCESS OF FORM FINDING OF A STAIRCASE USING CEM METHOD

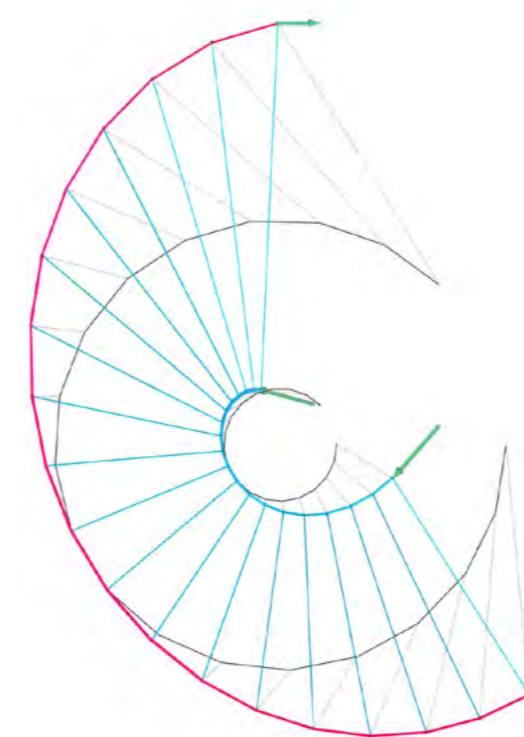
Step 1:  
staircase Topology



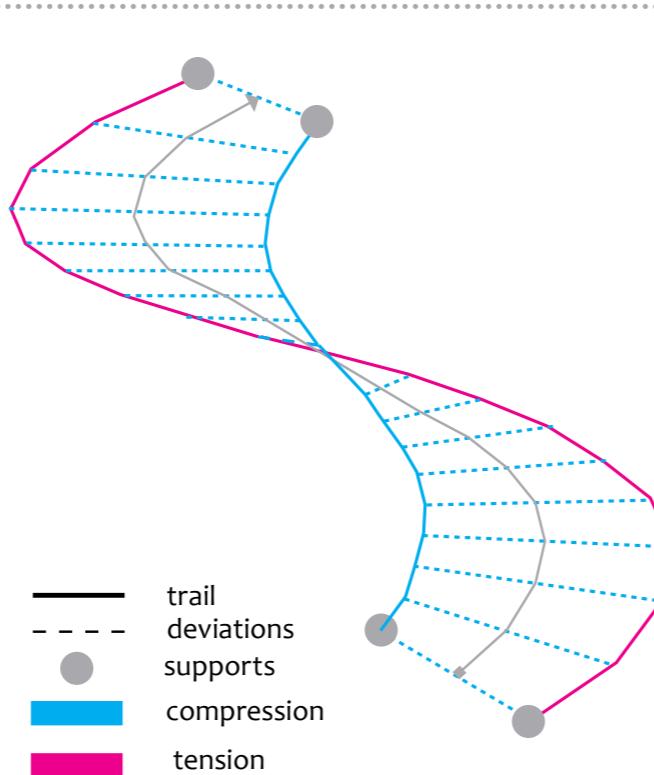
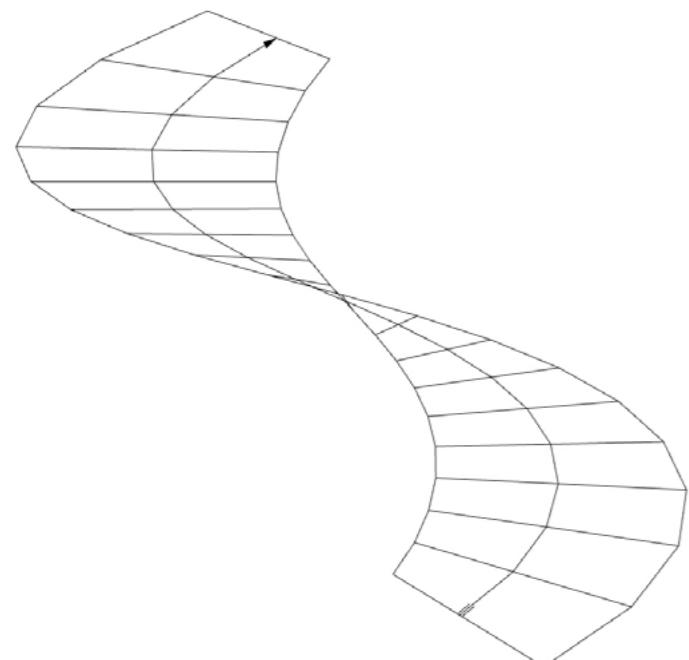
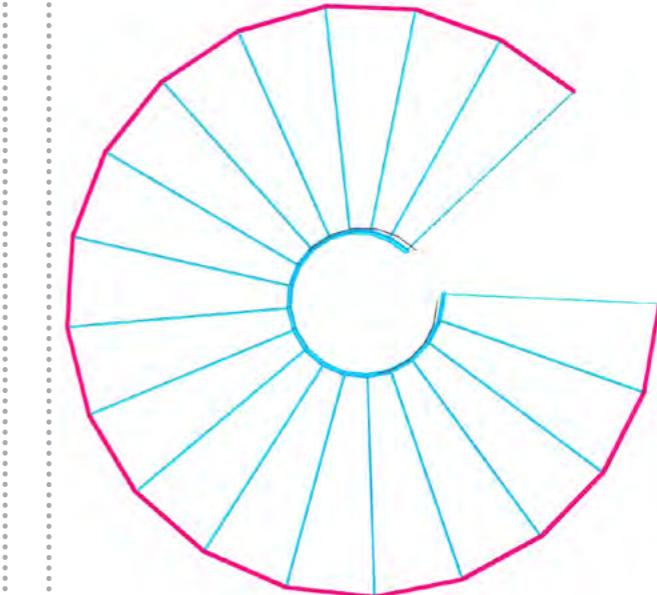
Step 2:  
Elements Function determination



Step 3:  
Form finding

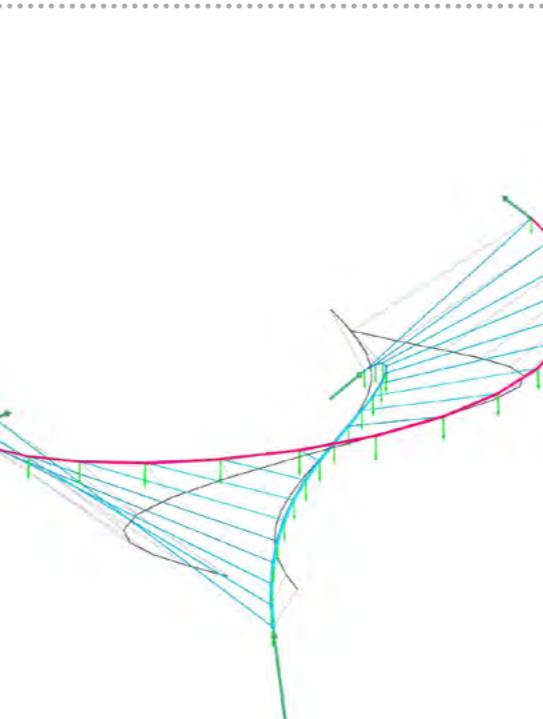


Step 4:  
constrained Form finding

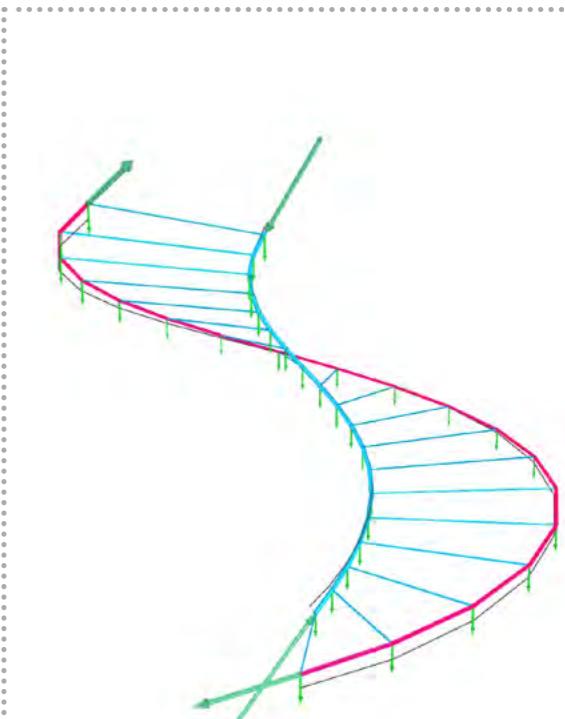


General topography of staircase including 2D shape, Width, Each step height, Total height

determining support points and each element compression and tension functions



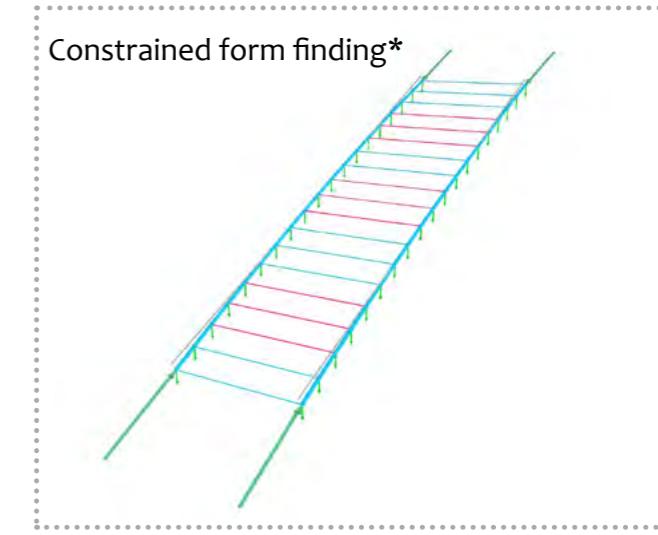
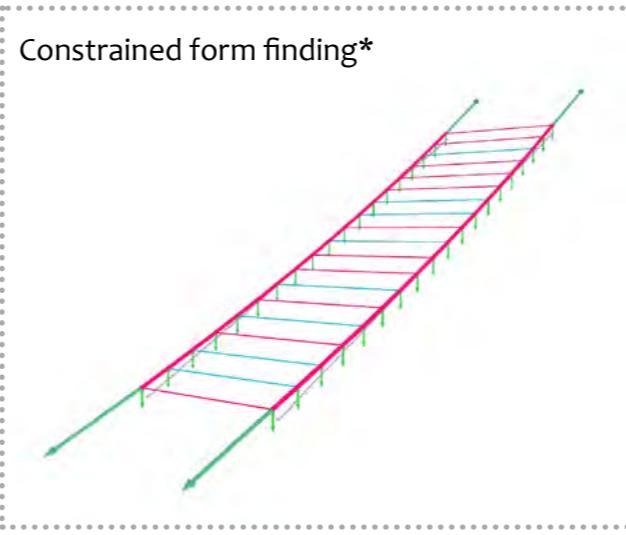
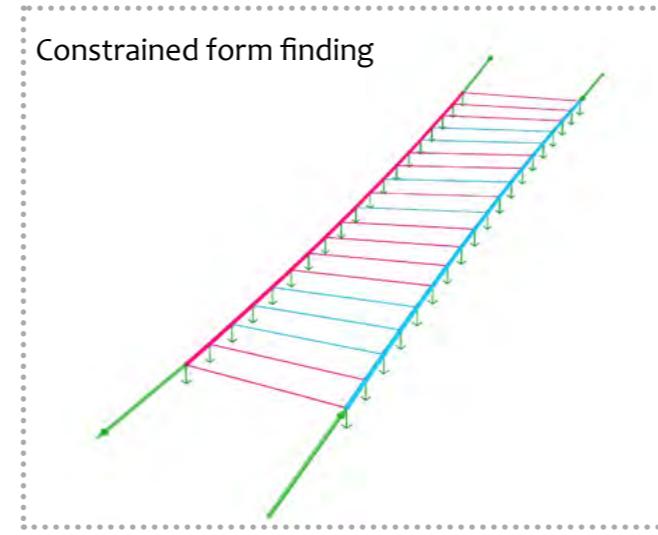
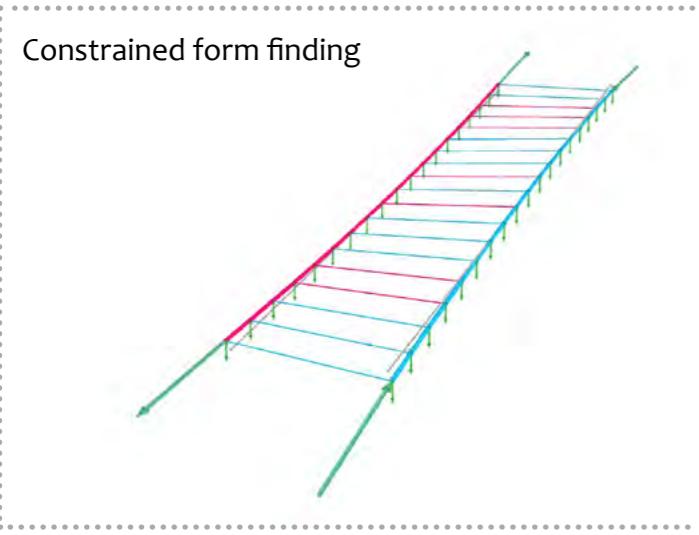
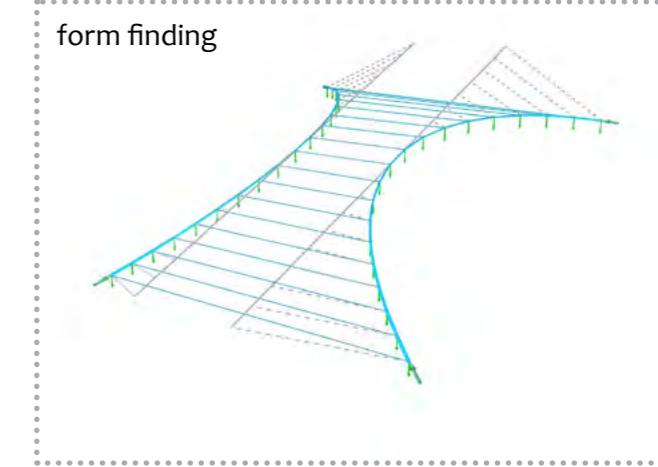
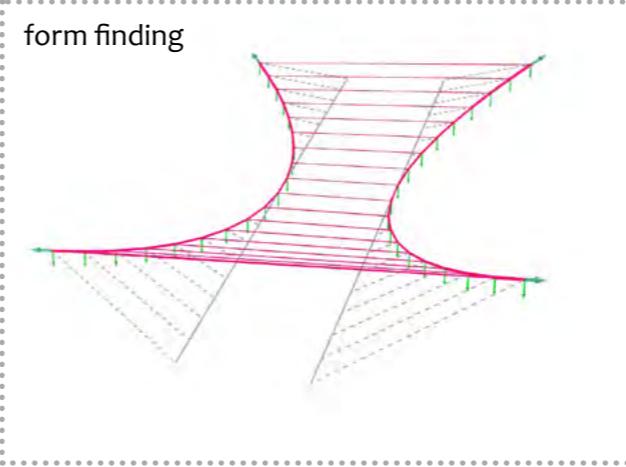
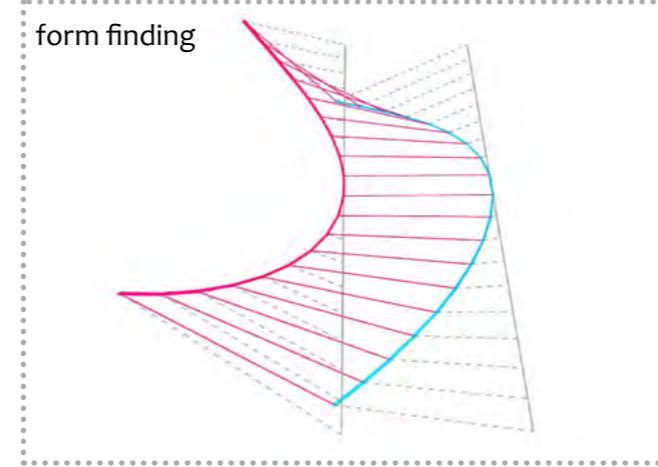
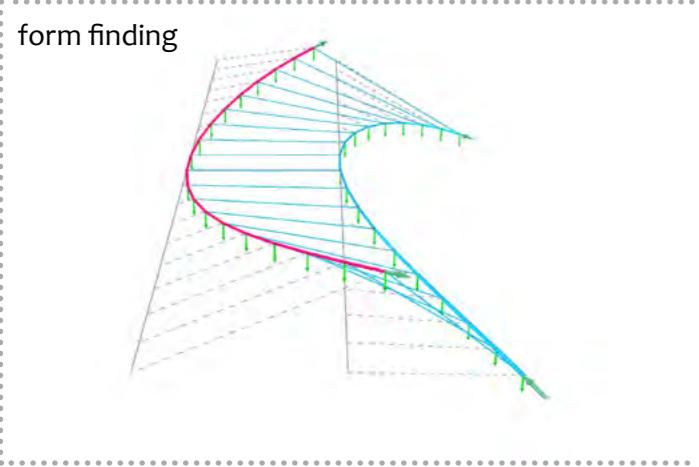
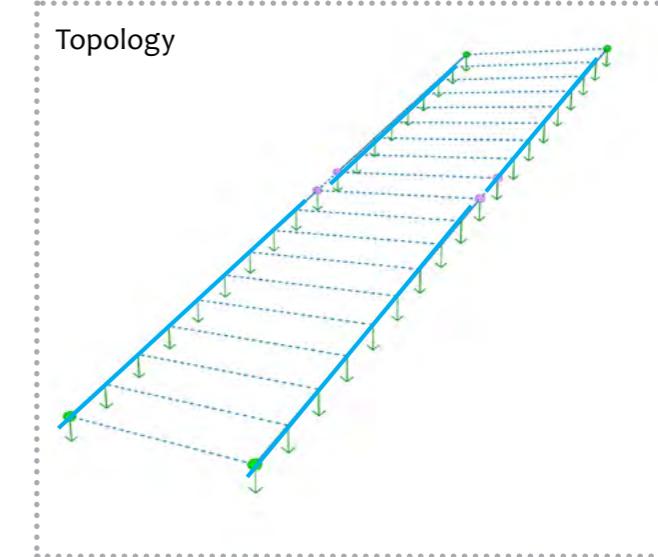
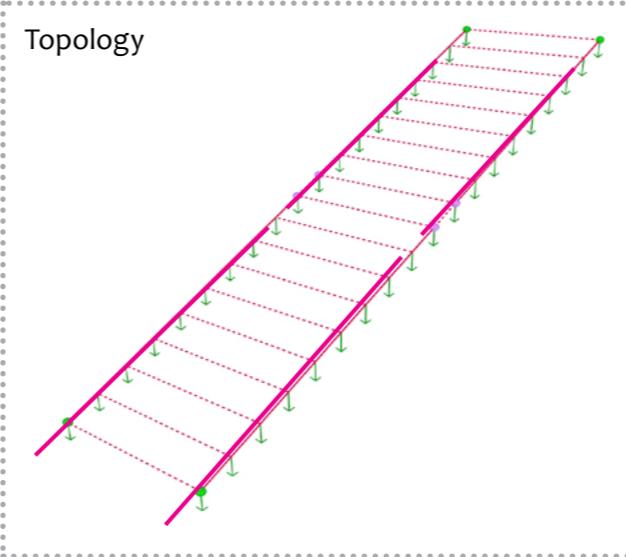
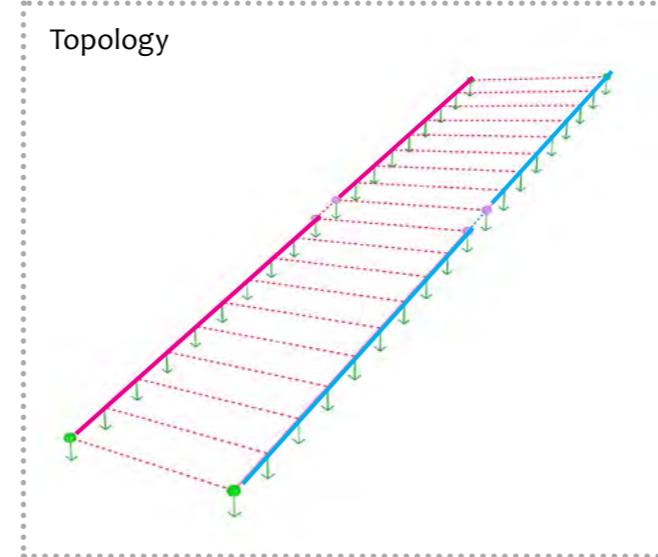
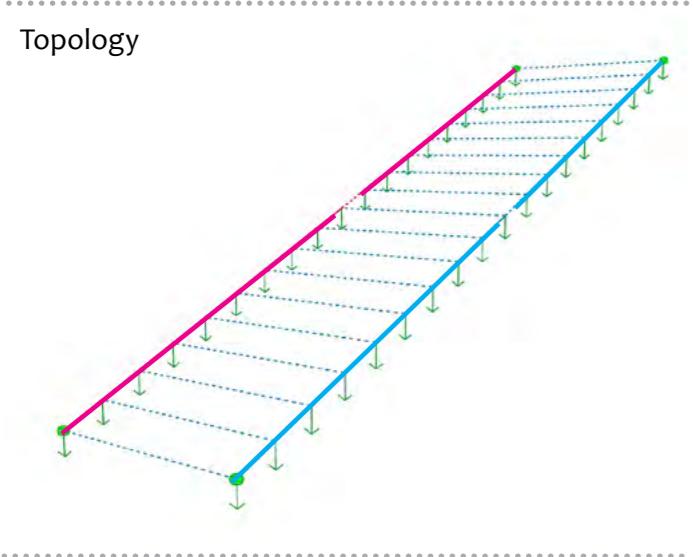
Form finding based given topology and applied forces



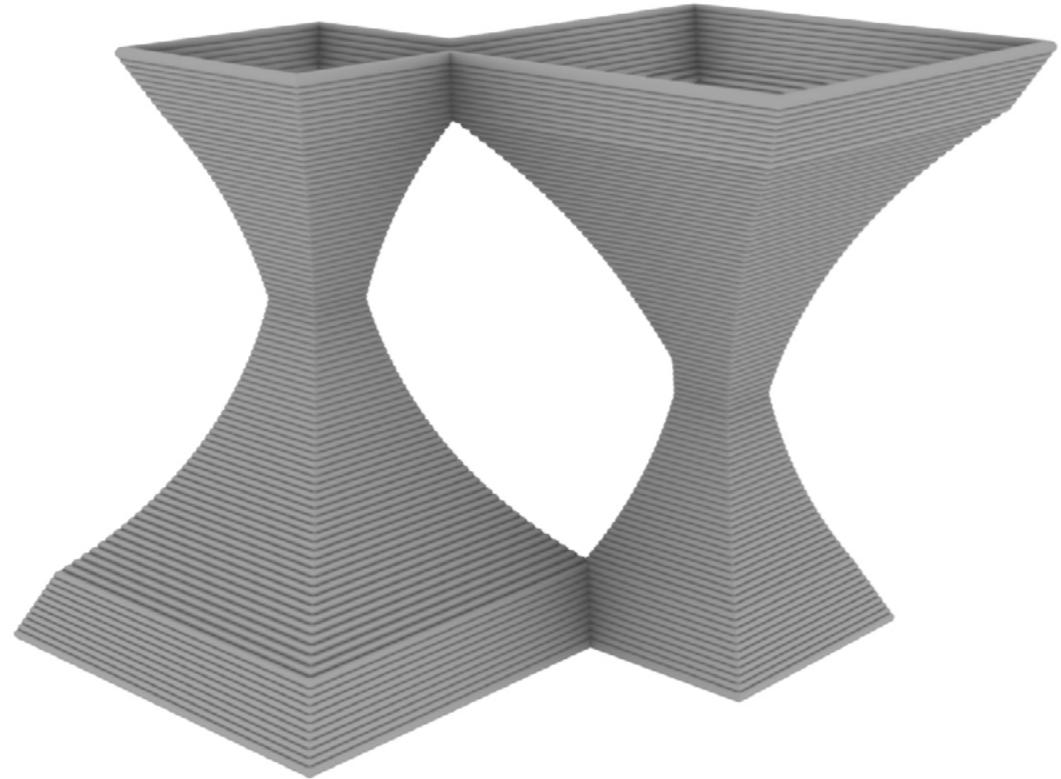
Form finding by considering the constrained points

## EXPLORING OTHER STAIRCASE ALTERNATIVES

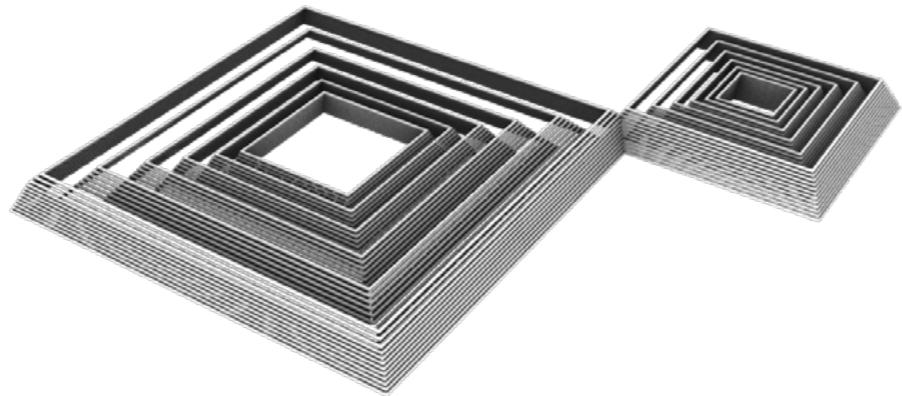
Structure with Tension and Compression elements



\* when we insist on having constrained points, even in the structures that were designed to be compression or tension only there would be some element that does not follow the same tensions



The final structure



Printing the element together

05

## Print in Print Workshop

Digital future 2021

SUPERVISIERS:

NEGAR KALANTAR, ALI Bahrani, MEHDI FARAHBAKHSH

### WHAT?

Print in Print

A novel method in 3D printing

### WHY?

Affordability

Printing big structures using a small robotic arm

Space limitation

Printing in a limited work place

Time consideration

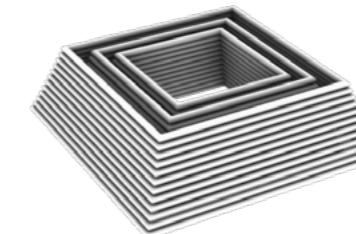
Splitting the printing task into few smaller ones

### How?

Printing the first piece

Separating the pieces

Putting the pieces on top of each other



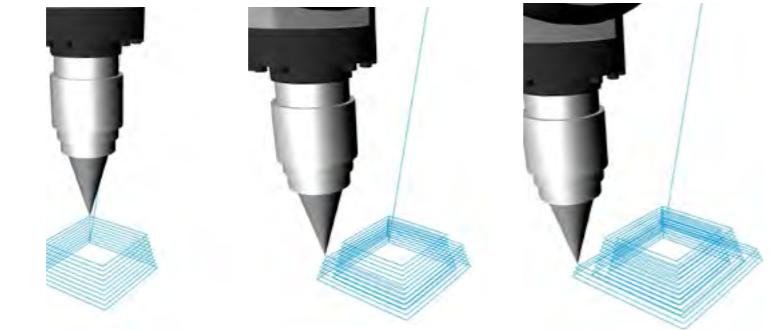
Each piece should have an angel more than 90 degrees

Printing with an offset from the previous piece

With the help of a support structure in the core

## APPLICATION OF THE METHOD ON THE DESIGNED PROJECT

Simulating the printing process of a robotic arm



PRINTING  
FIRST PIECE

PRINTING  
SECOND PIECE

PRINTING  
THIRD PIECE

layer 1



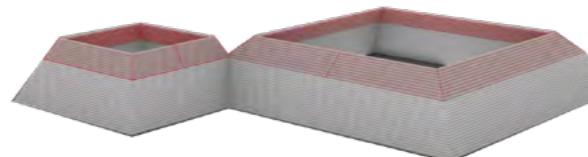
layer 15



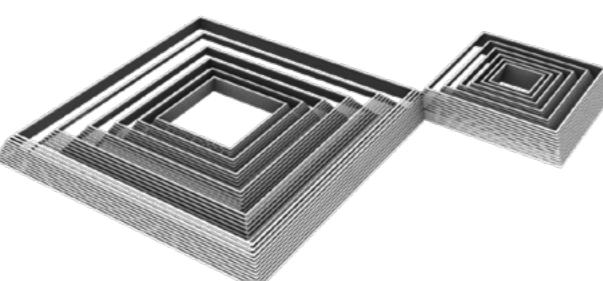
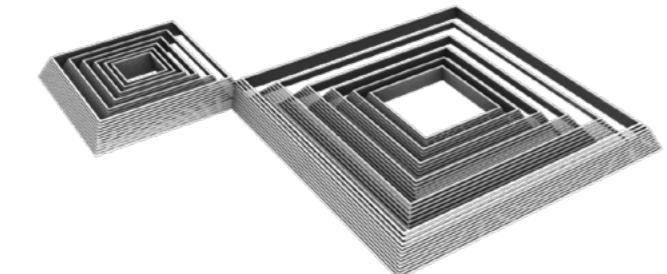
layer 3



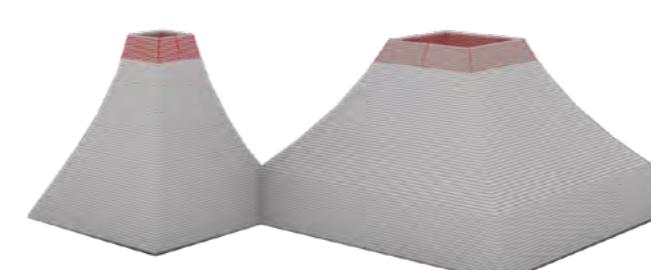
layer 17



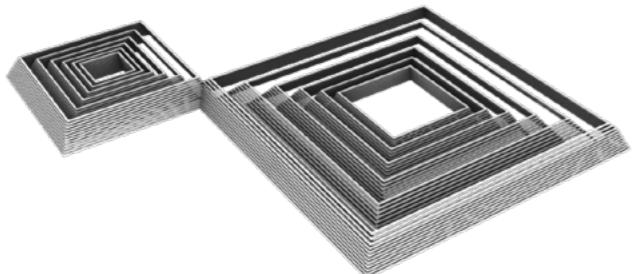
layer 8



layer 19



Printing the structure in two sets



+





## 06 INDUSTRIAL HERITAGE

STUDIO DESIGN 1- MASTER

### WHAT?

Industrial Heritage

Re-utilizing an old factory as a cultural center

### WHY?

Preservation

Preventing the damaging process of this building

Heritage

This building is one of the first concrete structures in Iran

Touristic Attractiveness

Located in a touristic zone of city, and can attract a lot of visitors

Pedagogical

Introducing of the concept of silo to people

### HOW?

Modifications

A welcoming entrance

Exposing the structure of the silo

Elimination of a part of silo head

Re-purposing :  
A new usage for spaces

Storage  
↓  
Library

Top of the silo  
↓  
restaurant

Grand floor  
↓  
Exhibition hall

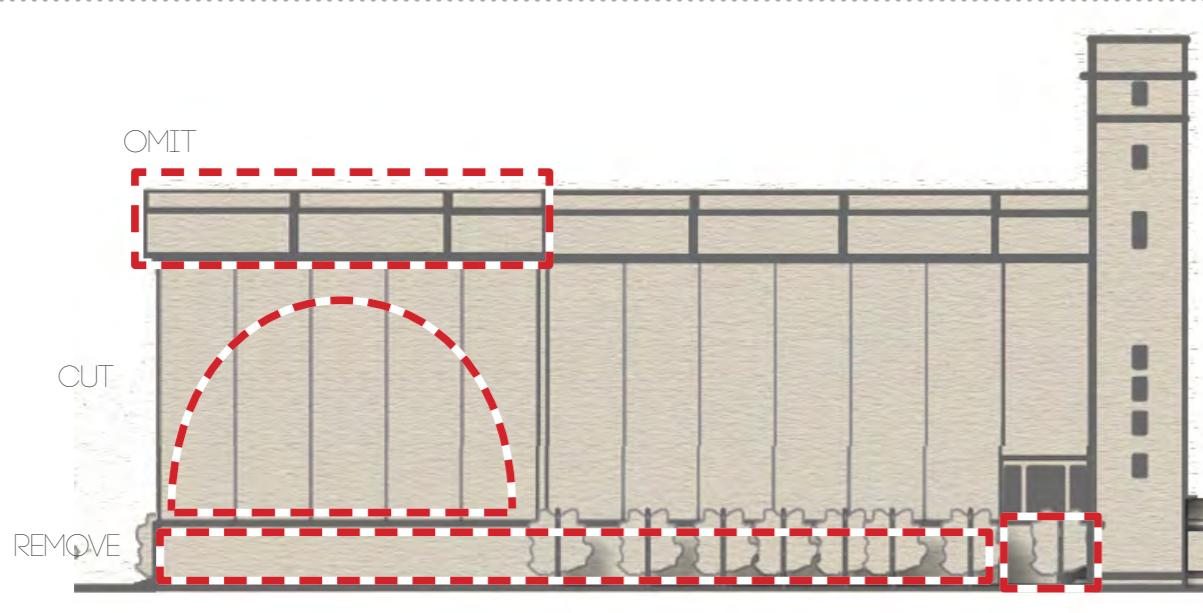
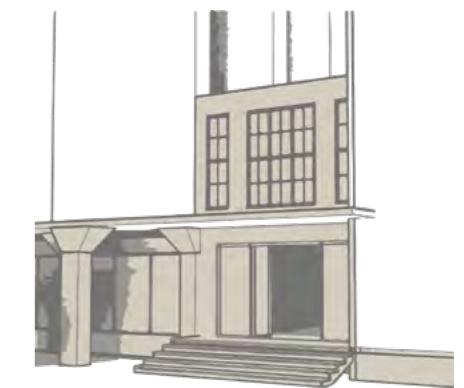
## MODIFICATIONS OF THE ORIGINAL BUILDING



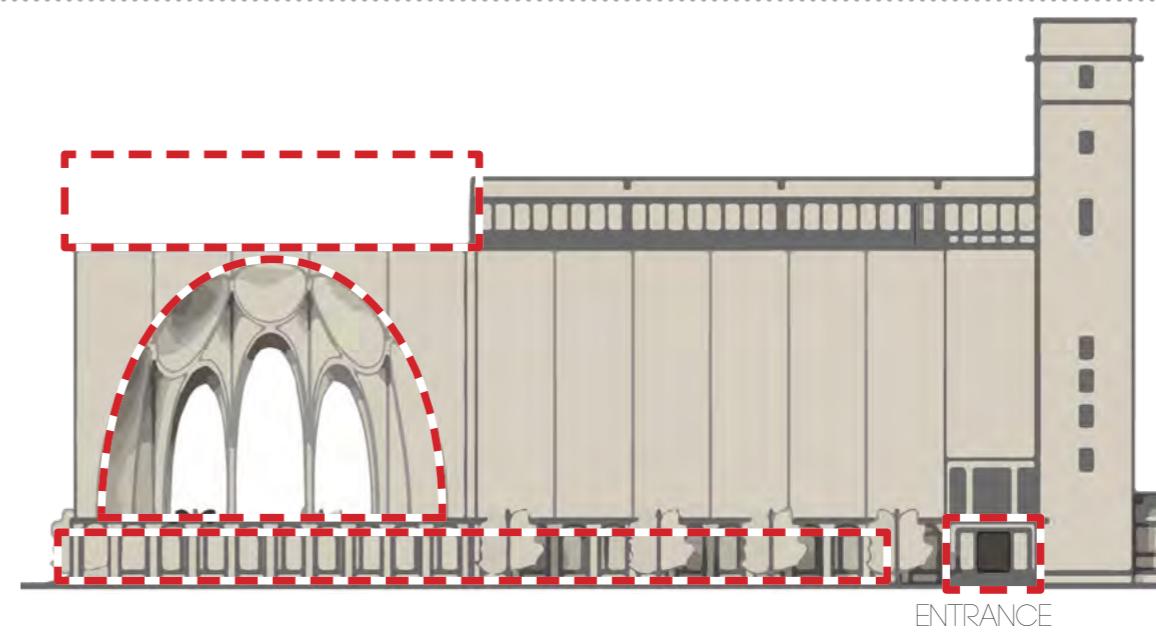
CUTTING THE  
GRAIN SILO AND  
MAKING IT VISIBLE



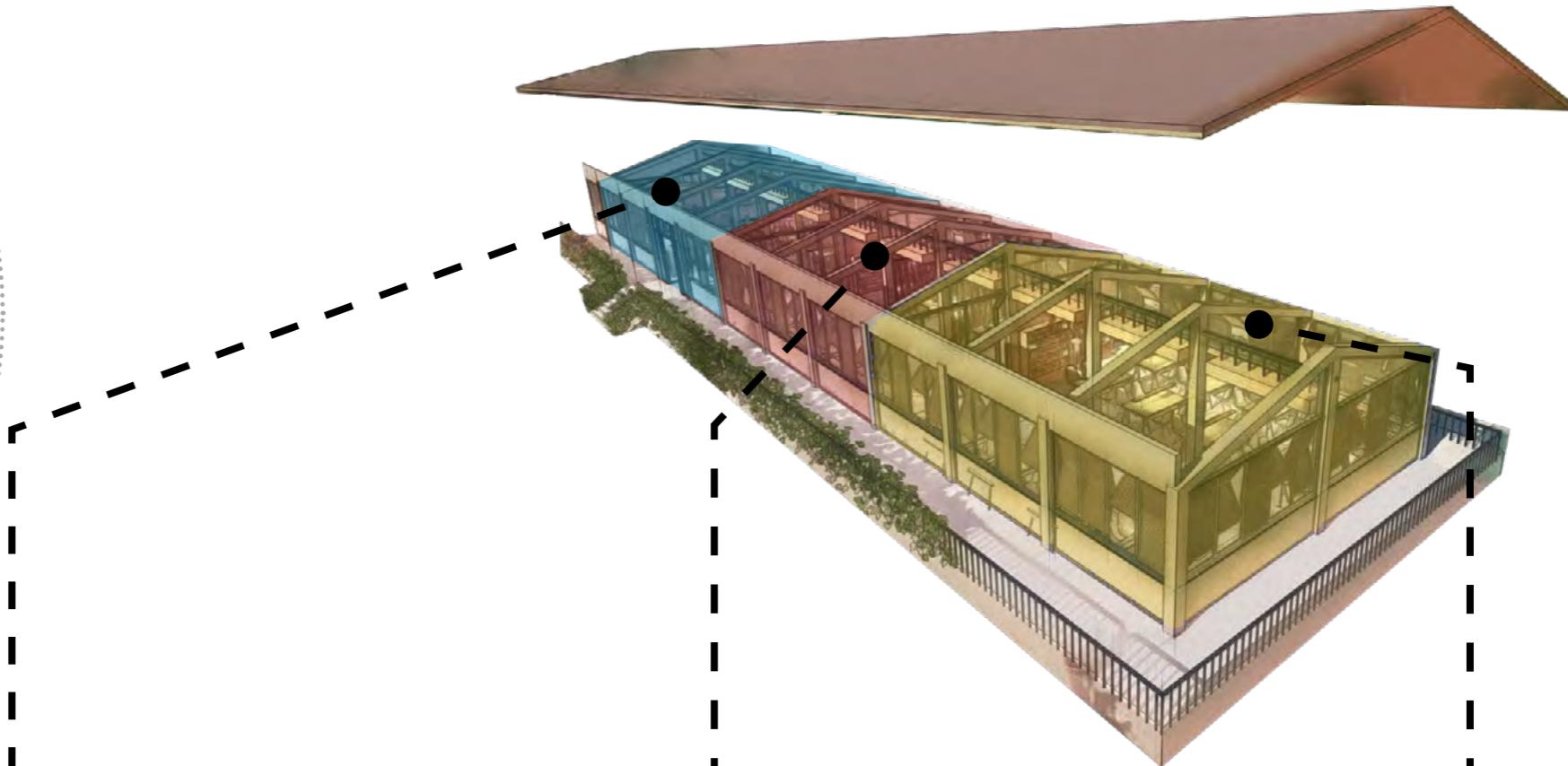
ALLOCATING A  
WELCOMING  
ENTRANCE FOR  
THE BUILDING



CHANGES DONE  
ON THE EXTERNAL  
BUILDING



# RE-PURPOSING : FROM **STORAGE** TO **BOOK CAFE**



ENTRANCE



BOOK CAFE



PUBLIC LIBRARY



PRIVATE LIBRARY



# RE-PURPOSING : FROM **SILO HEAD HOUSE** TO **RESTAURANT**



KEEPING PROMINENT ELEMENTS OF  
THE PREVIOUS USE OF THE BUILDING

• • • • •  
PROVIDING  
SHADOW

NON LOAD  
BEARING  
WALL

• • • • •  
WIDE AND  
TALL WINDOW

UNIQUE  
PERSPECTIVE OF  
THE CITY

GOOD SPACE  
FOR TABLES



MAIN STRUCTURE

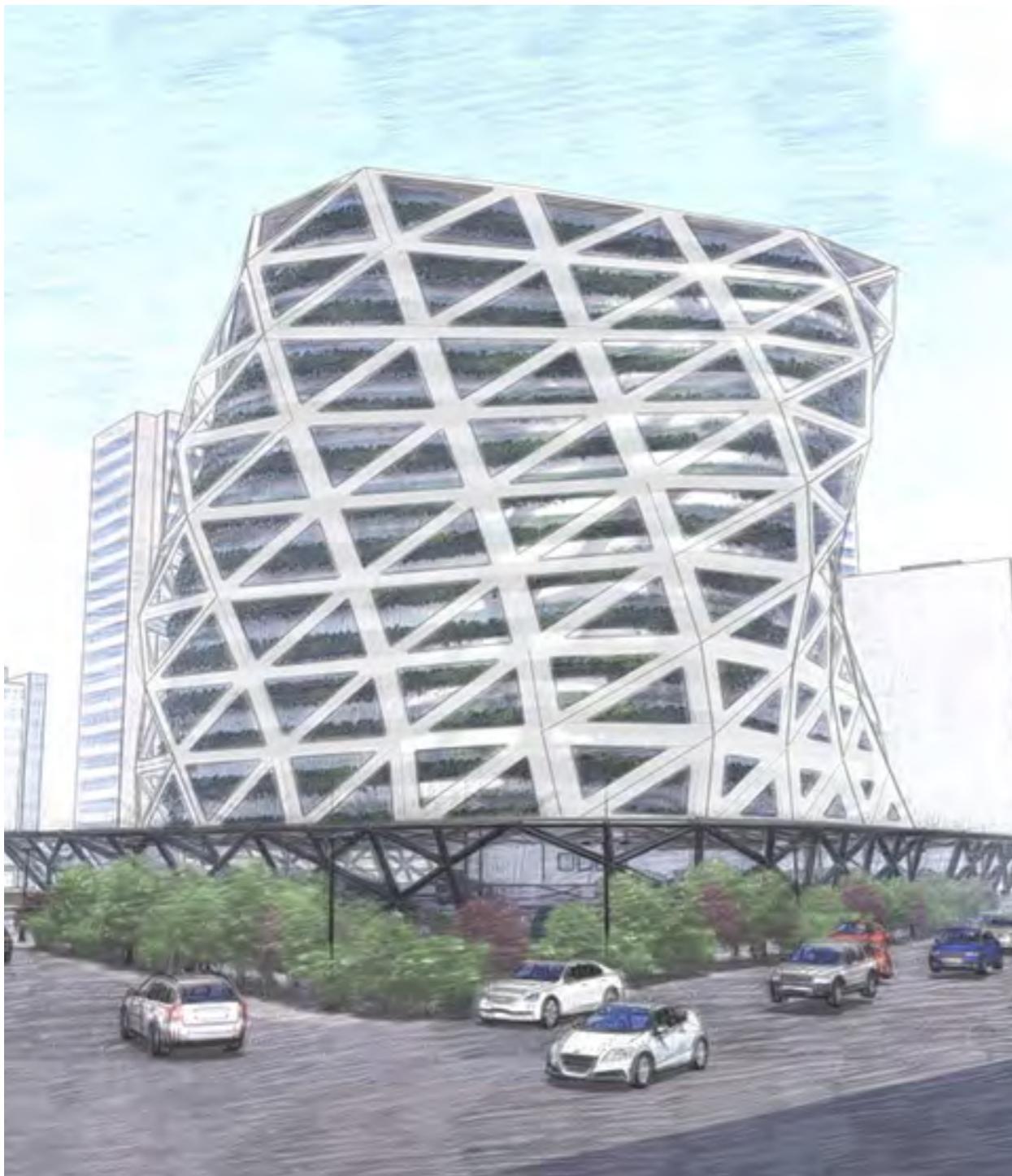
NON LOAD  
BEARING WALL

MAIN STRUCTURE

• • • • •  
PARTITION:  
PROVIDING  
PRIVATE SPACE

• • • • •  
WIDE AND TALL  
WINDOW:  
UNIQUE  
PERSPECTIVE TO  
THE CITY





## WHAT?

Turning Tower

A residential building in north west of Tehran, with a turning form

## WHY?

Urban perspective diversity

While all other buildings look similar, this building provides a different view to the street by having turning form

Having diverse views

Having turning view provide a unique perspective in each unit

Not blocking the airflow

The turning form of the building makes it possible for the air flow to pass the building without being blocked

A better usage of space

Using central core helped the building to save a lot of space , which can be used for other usages

Having well integrated living space

Connection between different spaces of each unit and units together and floors together was tried to be productive

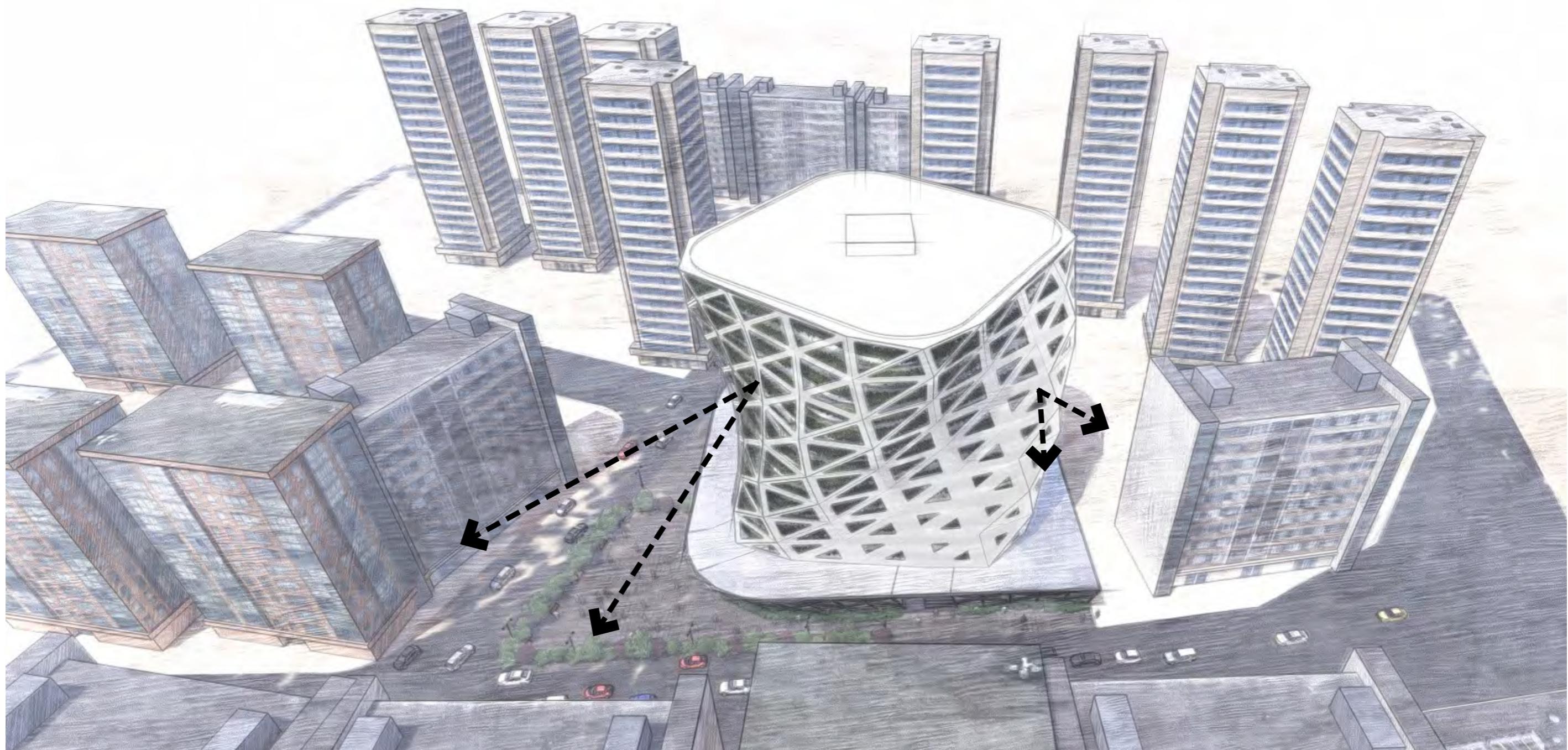
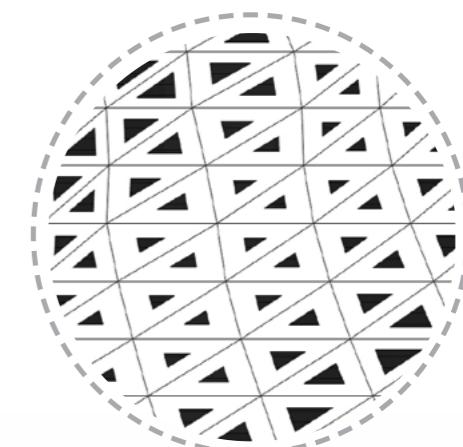
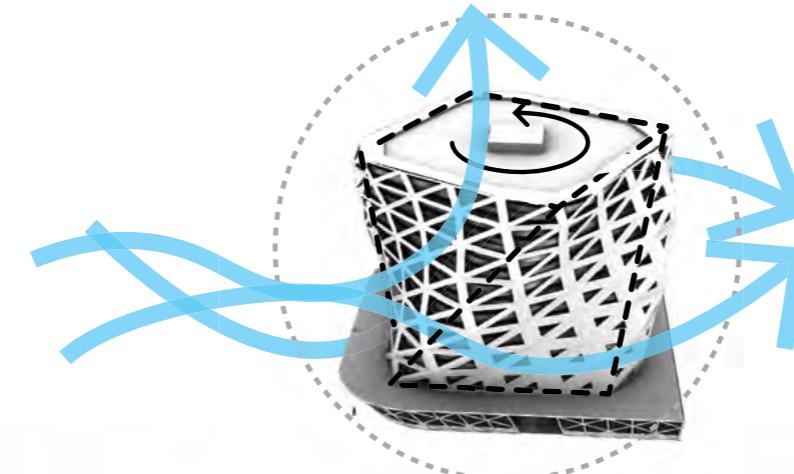
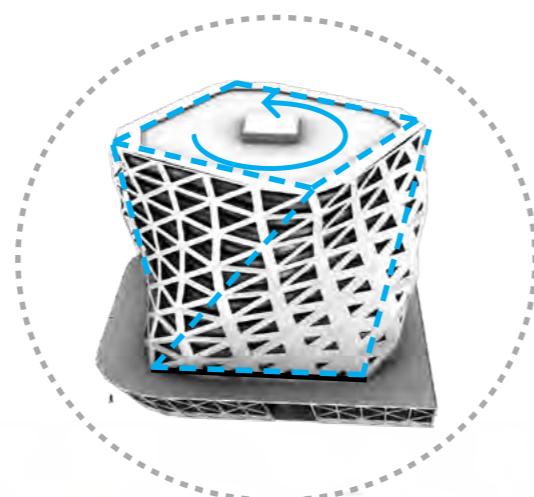
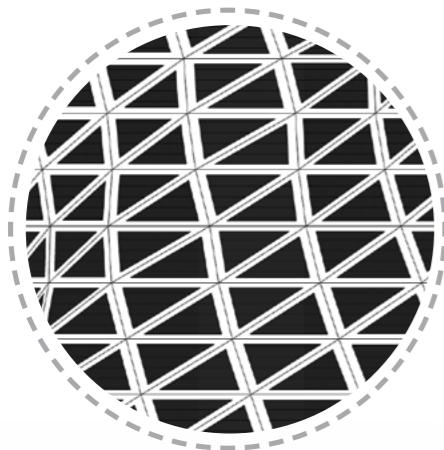
Sharing a lot of units in each floor but prevent a lot of interactions

Allocating 4 different sets of elevation and stair cases in each floor to prevent unnecessary interactions

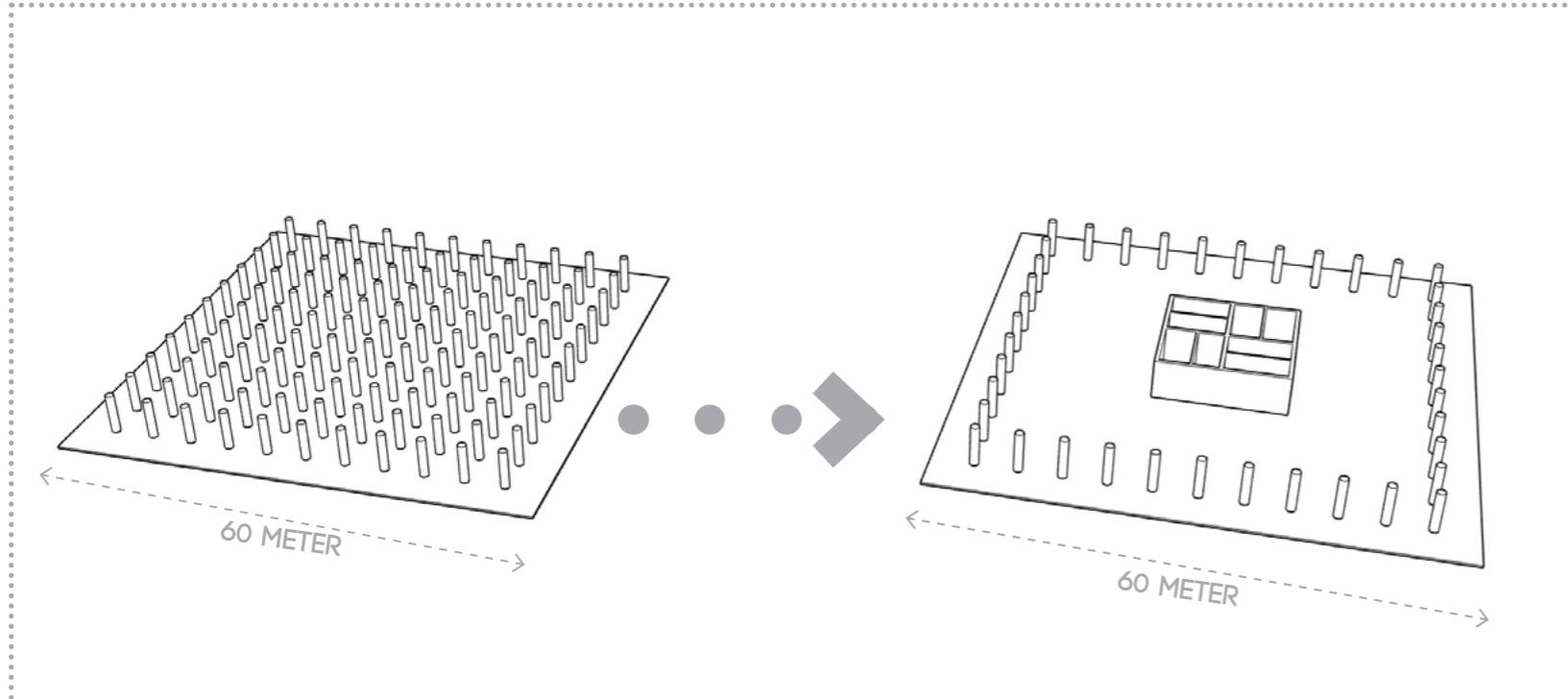
## 07 07 TURNING TOWER

STUDIO DESIGN 2- MASTER'S

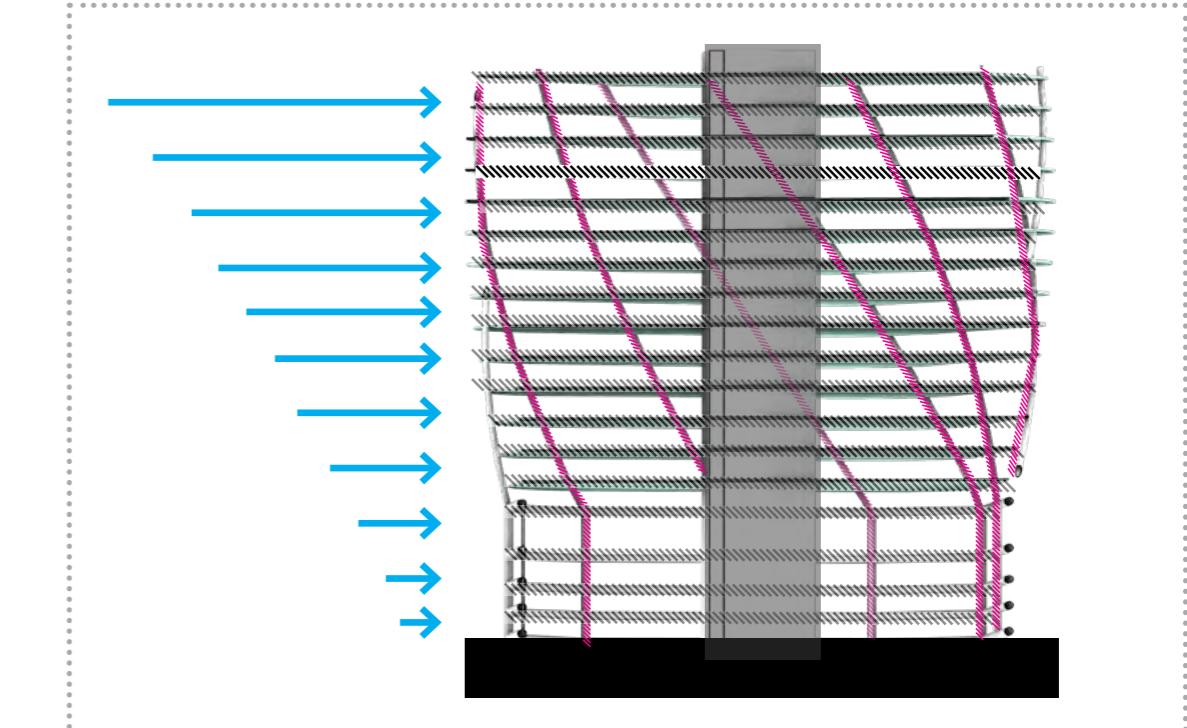
# ENVIRONMENTAL DESIGN OF THE TURNING TOWER



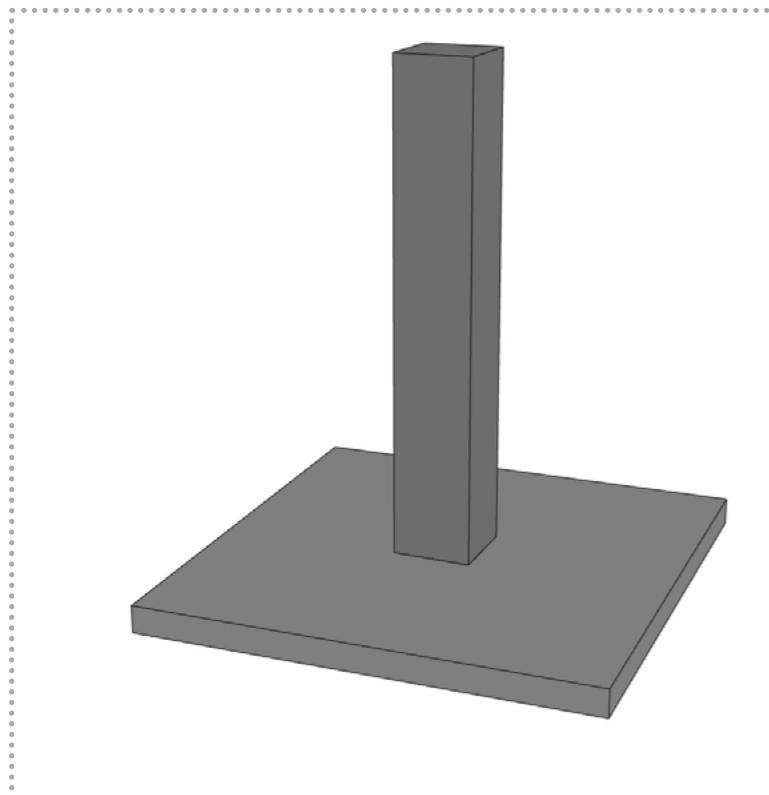
# STRUCTURAL DESIGN OF THE TURNING TOWER



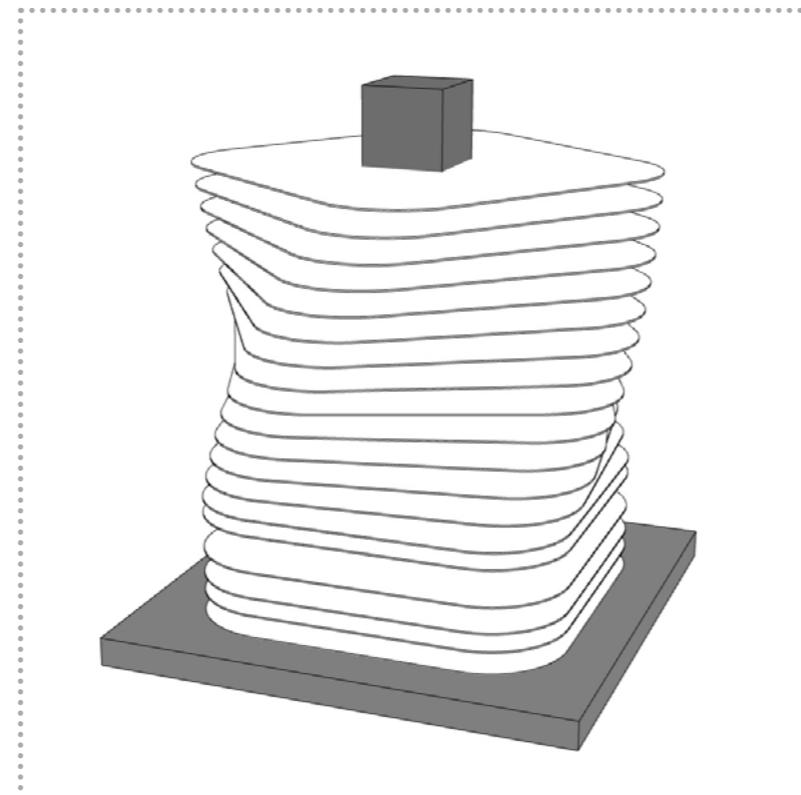
Omitting columns to make more free space



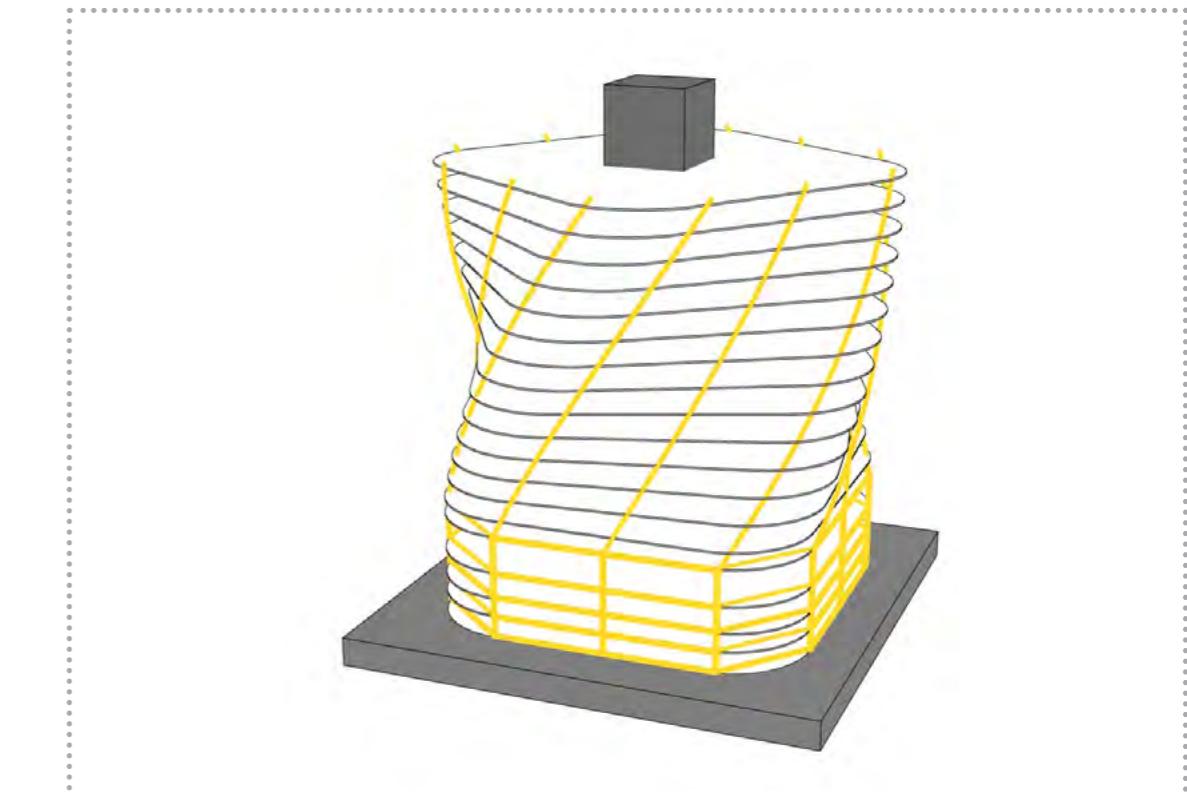
Stability of the building against wind force



Central Core

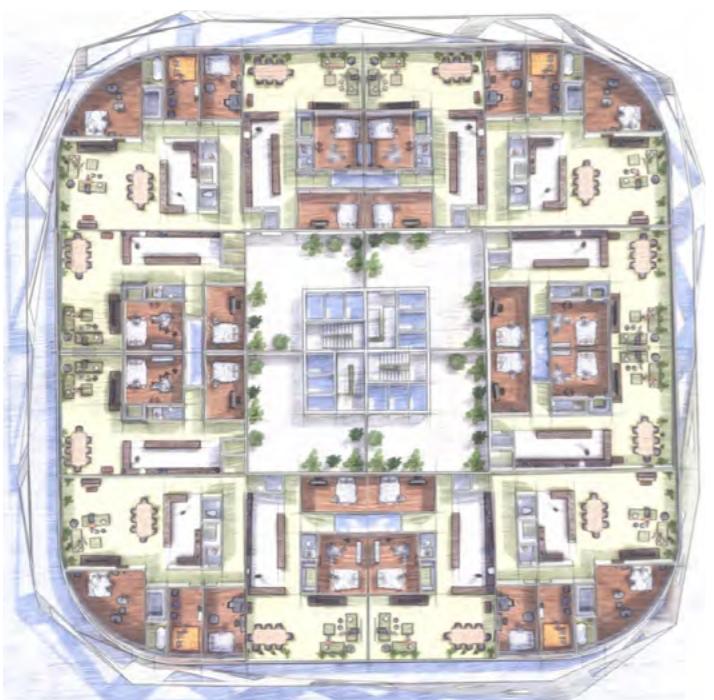


Central Core + Plates



Central Core + Plates + Space Frame

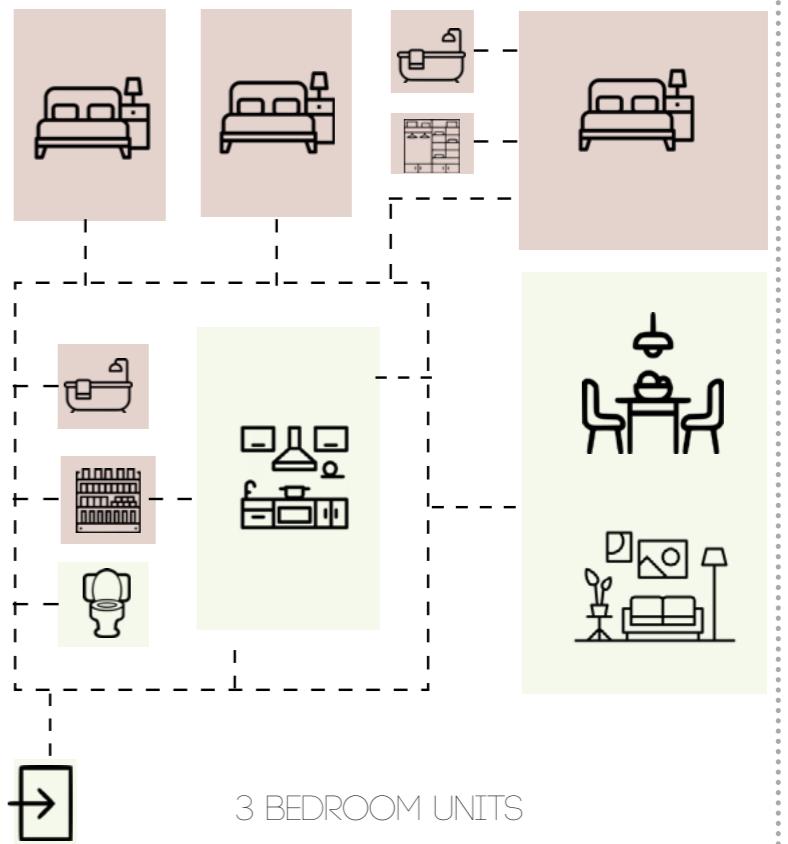
# ARCHITECTURAL DESIGN OF THE TURNING TOWER



TYPICAL FLOOR PLAN



3 BEDROOM UNITS



3 BEDROOM UNITS

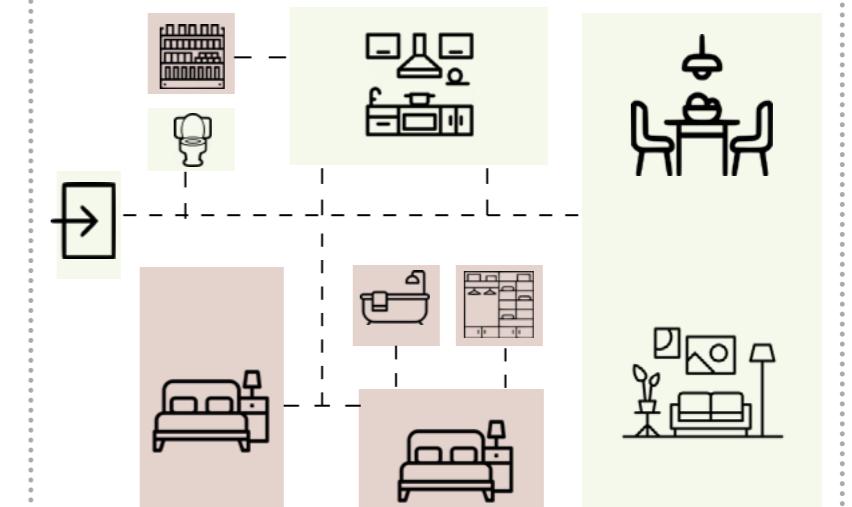


FOUR SEPARATED NEIGHBORHOODS

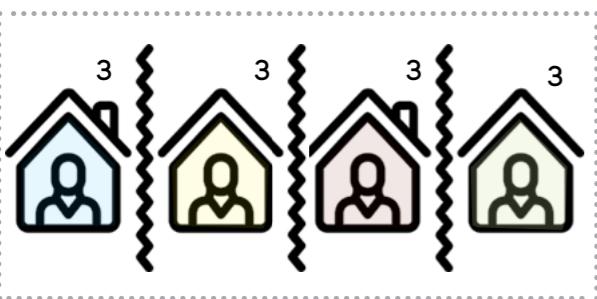
THREE UNITS IN EACH NEIGHBORHOODS



2 BEDROOM UNITS



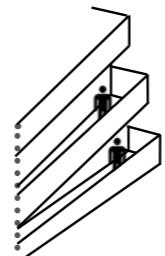
2 BEDROOM UNITS



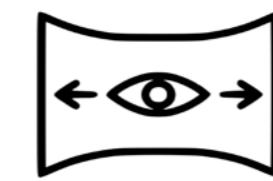
12 UNITS IN EACH FLOOR



SEPARATED STAIRCASE AND ELEVATION



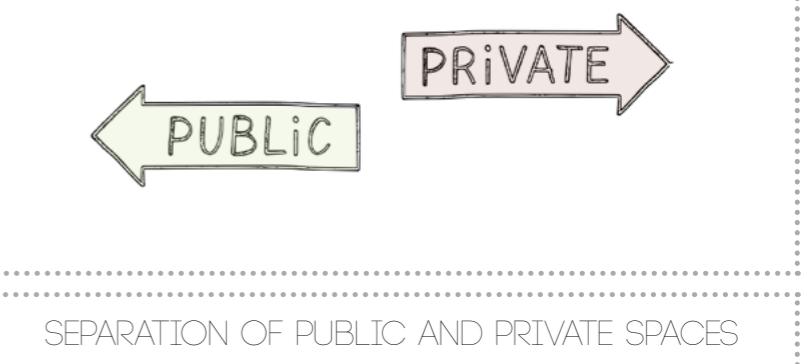
USING SPACE GENERATED BY ROTATION AS BALCONY



LANDSCAPE VIEW

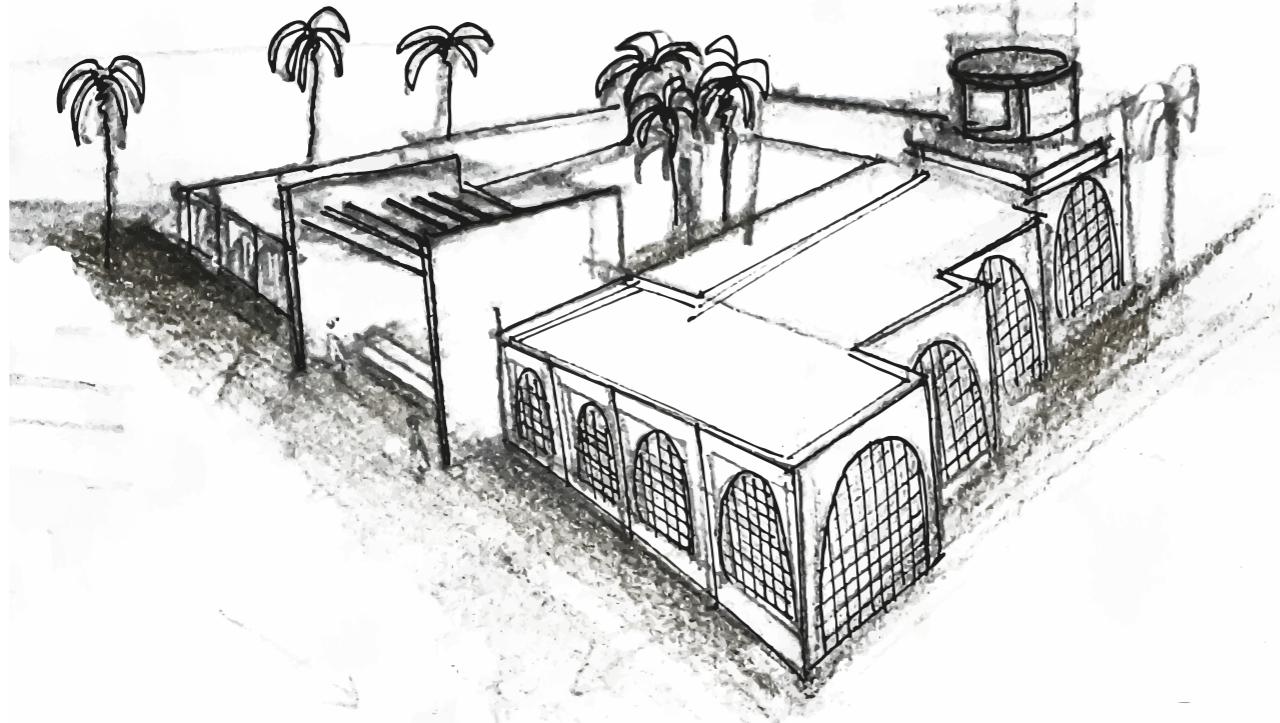


PRIVATE



SEPARATION OF PUBLIC AND PRIVATE SPACES

## WHAT?



windcather complex

an old building with some energy sustainability features in a desert region

## WHY?

Regional

to follow the main concept of a desert region building

Energy sustainability

to be energy efficient

Smart usage of elements

Trying to solve problems with building elements themselves, rather than energy consuming technologies

## HOW?

عمران  
بـدكـير

## 08 WINDCATHER COMPLEX

SKETCH- BACHOLER'S

Interplay of light and shadow.

Provide a welcoming entrance

Provide cooler area

Tall Palm tree in the middle of the yard

Shadowing

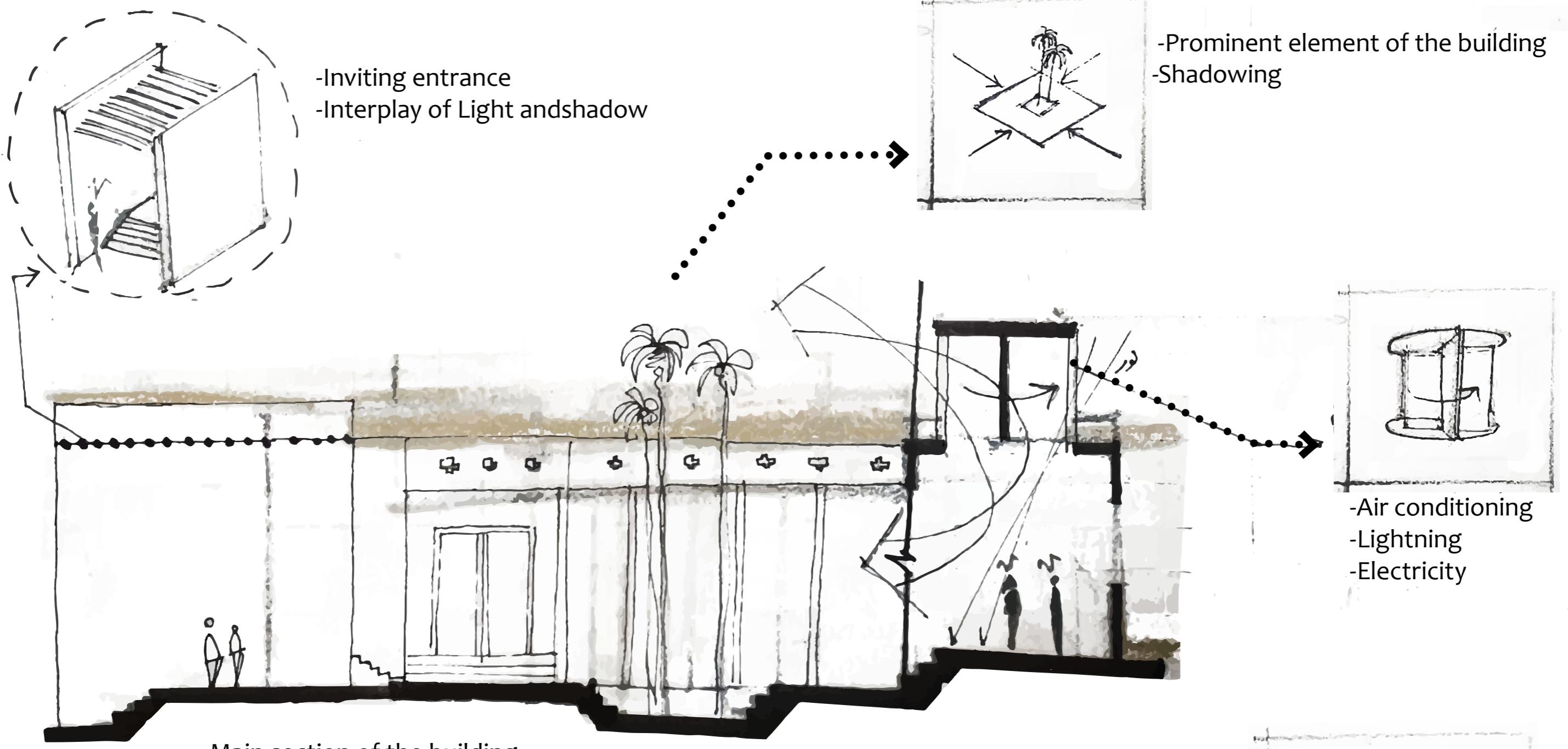
Prominent element of the building

Modernized windcather

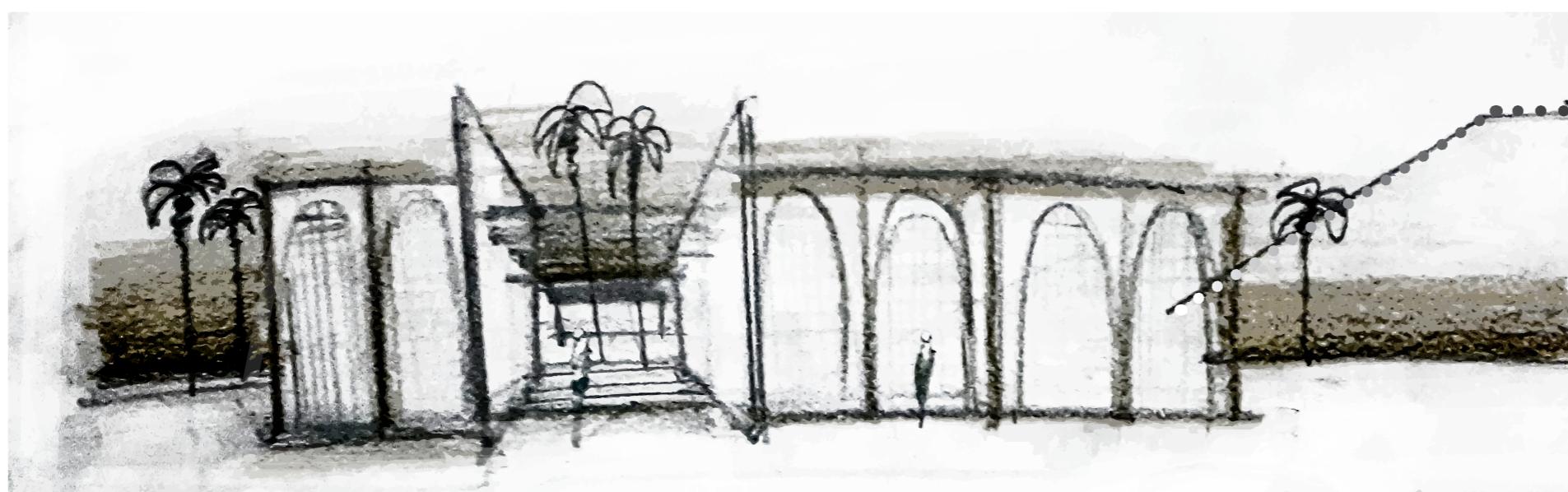
Air conditioning

Lightning

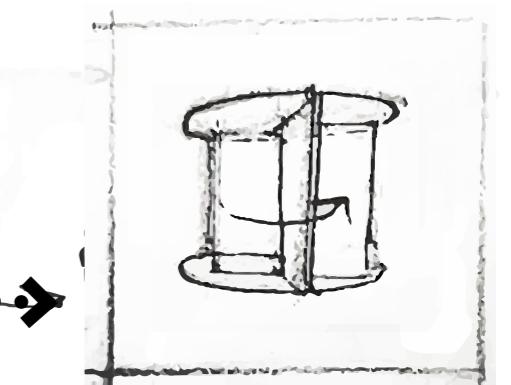
Generating electricity



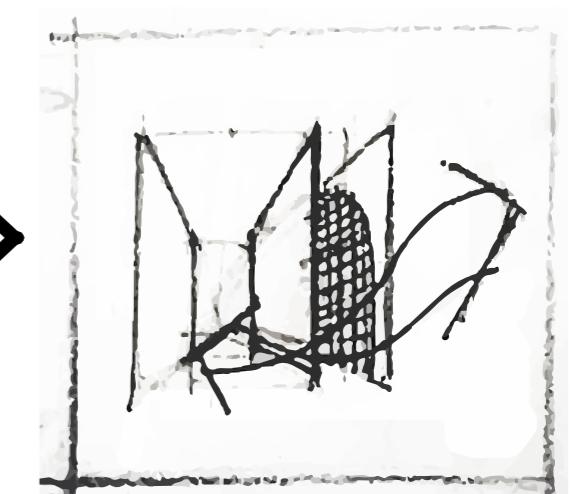
Main section of the building



Front perspective of the complex



- Air conditioning
- Lightning
- Electricity



- Air conditioning
- Lightning



**T H A N K S**