

JANUARY

2024

# PORTFOLIO

KAMYAB

HOSEIN

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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.



## 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

6

Fabrication

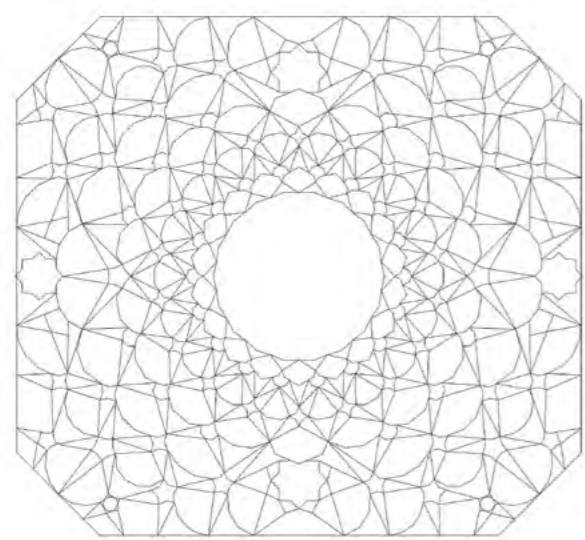
01

# STRUCTURAL MUQARNAS

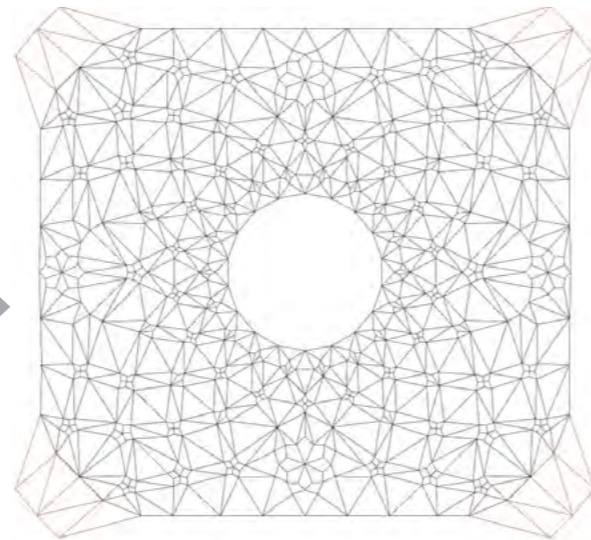
MASTER'S THESIS PROJECT

[PUBLISHED PAPER IN IASS 2022](#)

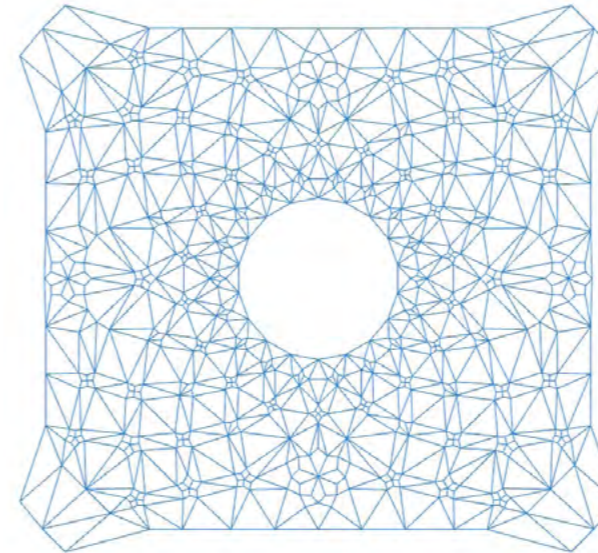
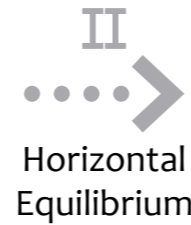
# PROCESS OF GENERATING STRUCTURAL MUQARNAS



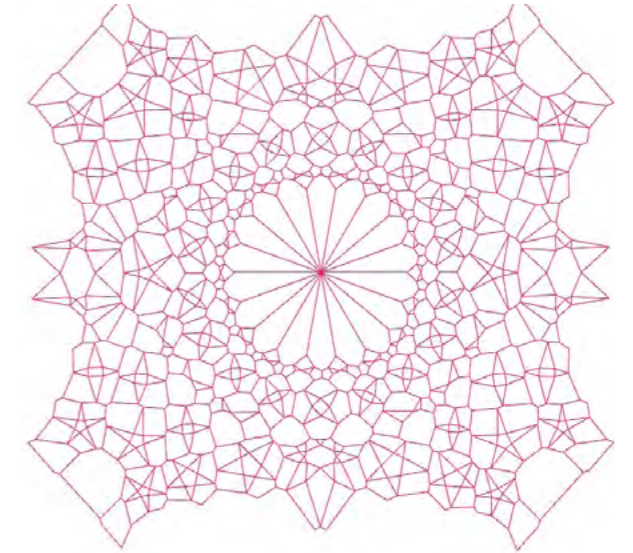
ORIGINAL PATTERN



MODIFIED PATTERN



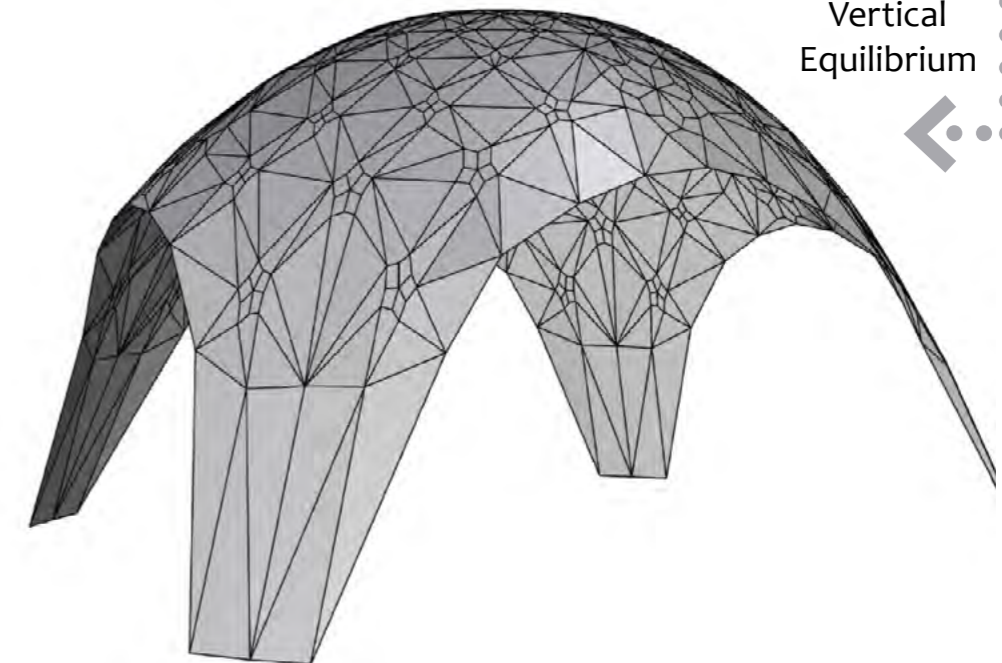
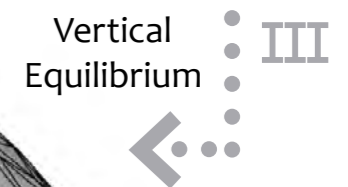
FORM DIAGRAM



FORCE DIAGRAM



STRUCTURAL MUQARNAS



THRUST LINES

## 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

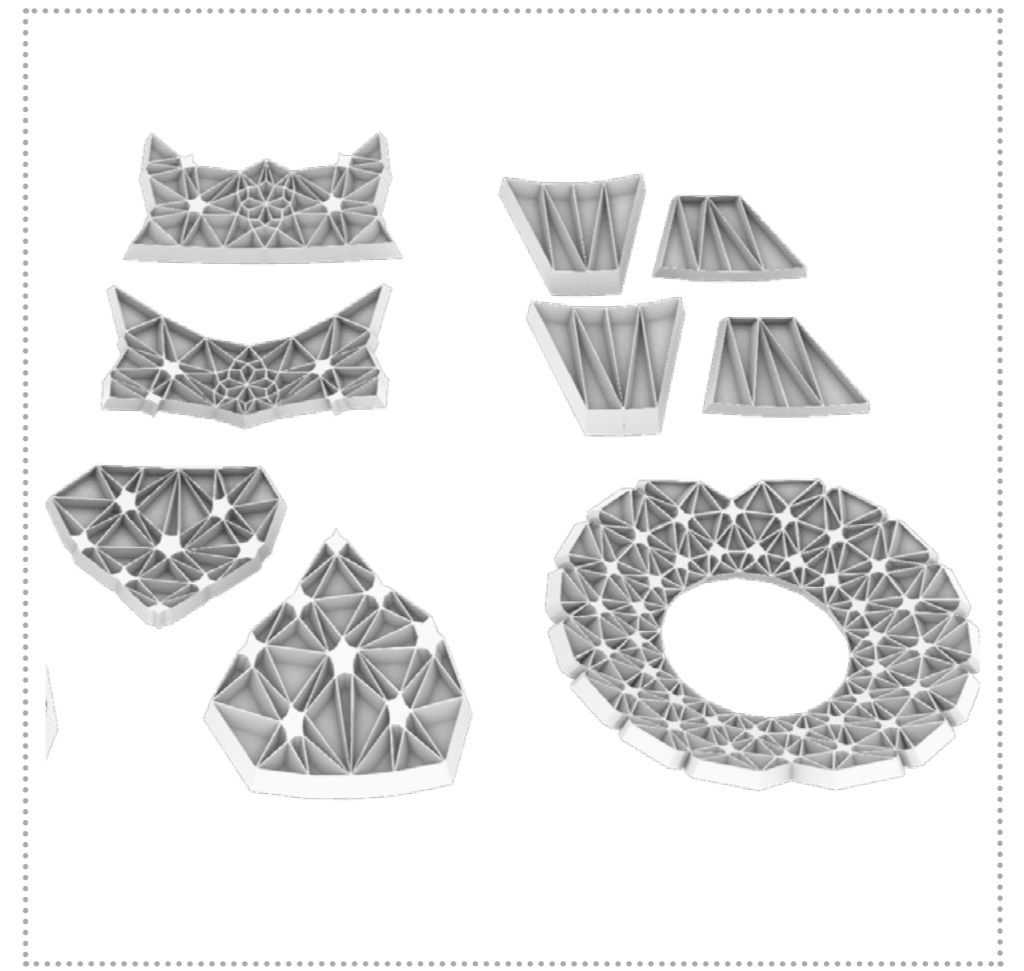
Finding the 3D thrust line based on form and force diagrams by providing the final height as well as supporting points.

## IV MATERIALIZATION

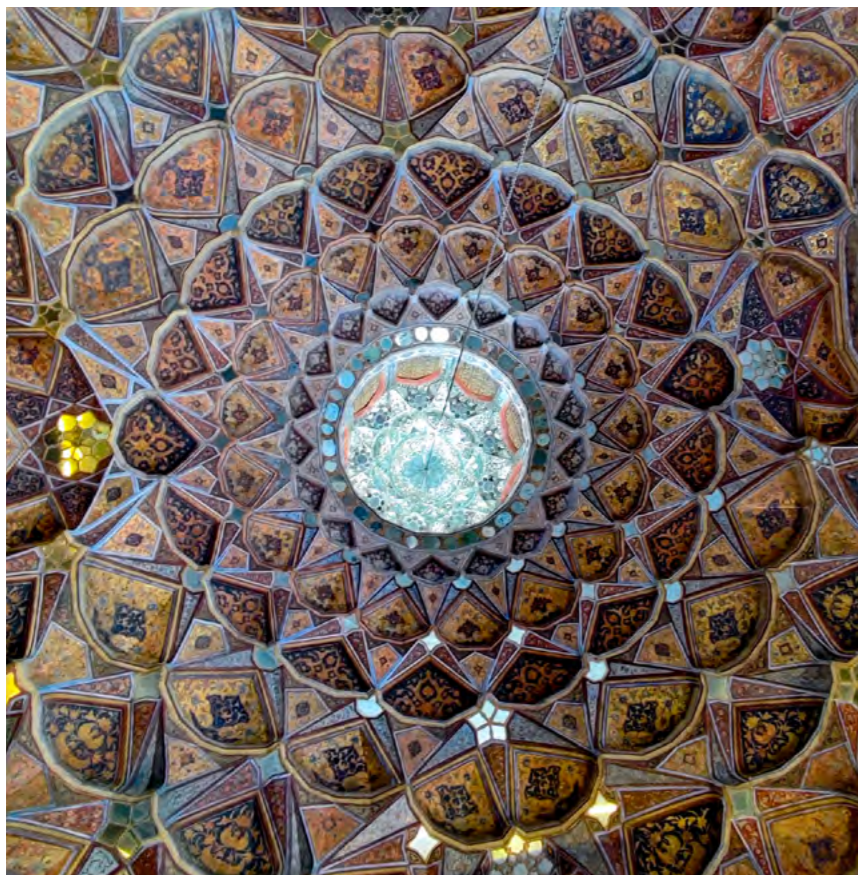
Selecting a curved profile to reduce the usage of material while having a more similar look to the original muqarnas.



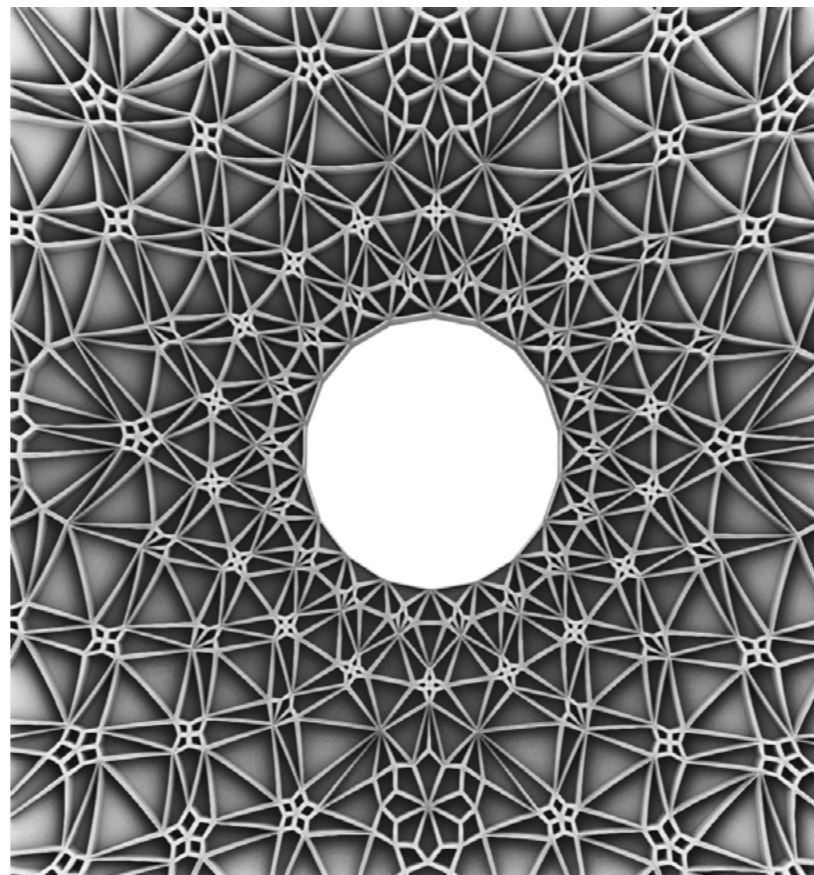
Structural muqarnas of hasht behesht palace



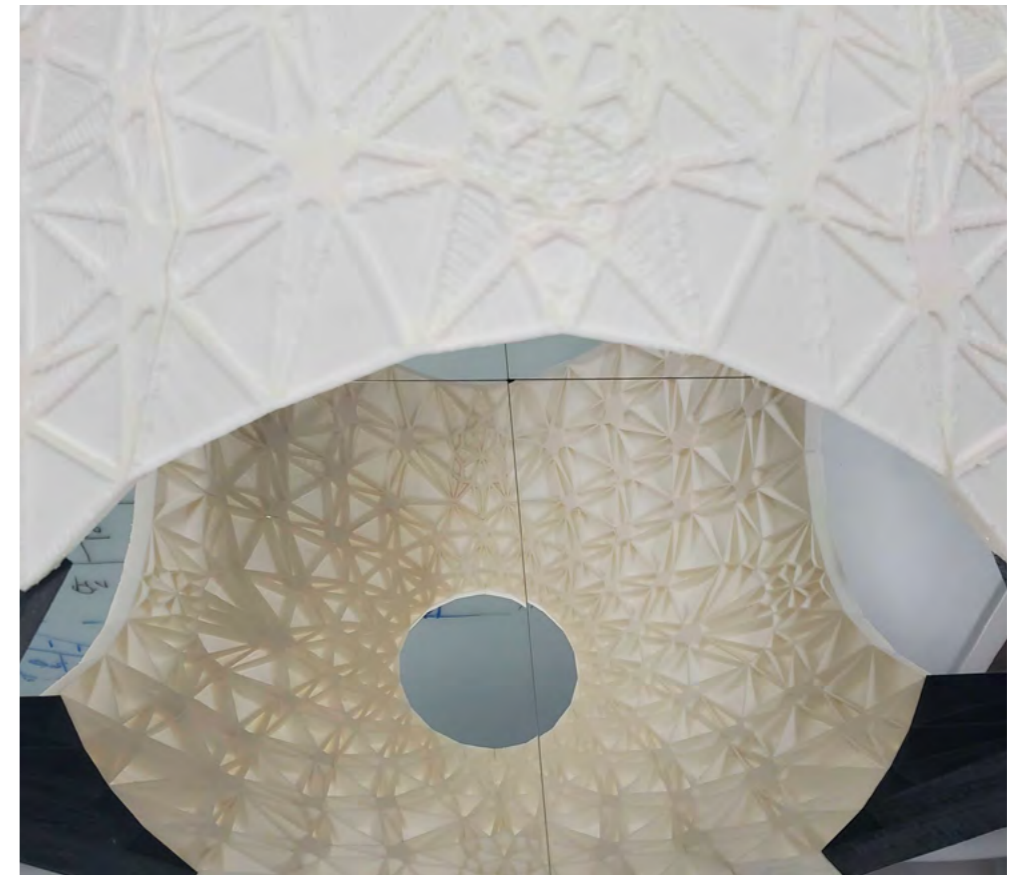
Modeled elements for 3d printing



original muqarnas of hasht behesht palace



structural muqarnas of hasht behesht palace



3d printed structural muqarnas of hasht behesht palace



## WHAT?

Structure

Kinetic

Tensegrity

## WHY?

modularity

Compression and tension only

Easy  
installation

Flexibility

Affordability

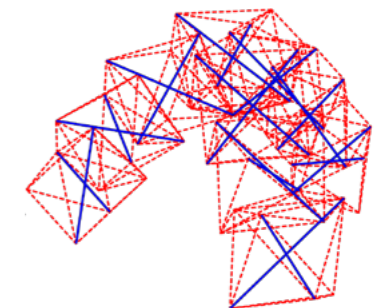
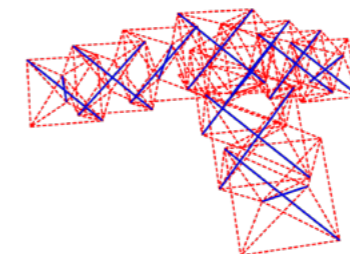
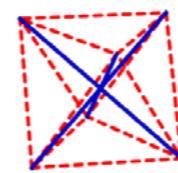
Complexity in simplicity

## HOW?

Three compression  
and three tension  
elements form a  
module

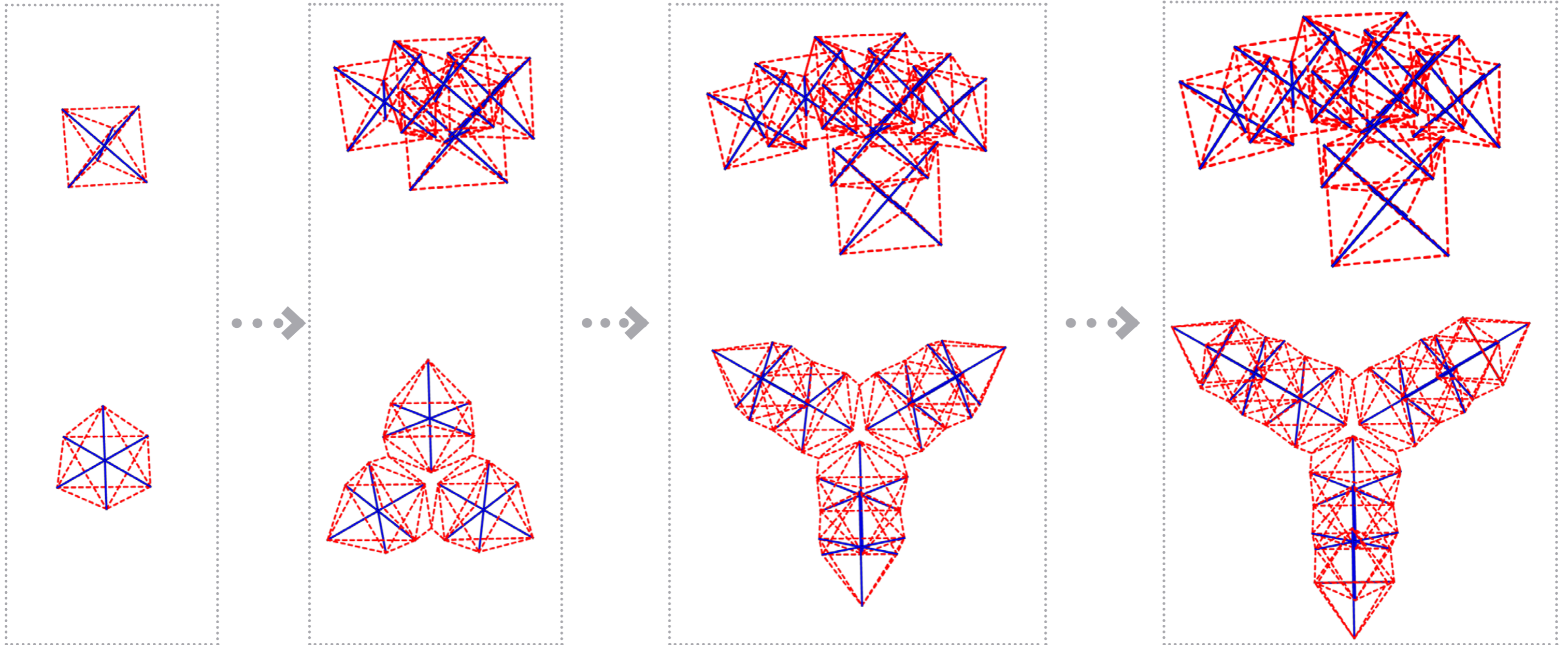
The module  
extends in three  
directions in  
several layers

Taking different  
positions Due to  
the flexibility of  
tension elements



02 **KINETIC + TENSEGRITY**  
STUDIO DESIGN 3- MASTER'S

# PROCESS OF ASSEMBLING THE STRUCTURE



An octagon as the First module

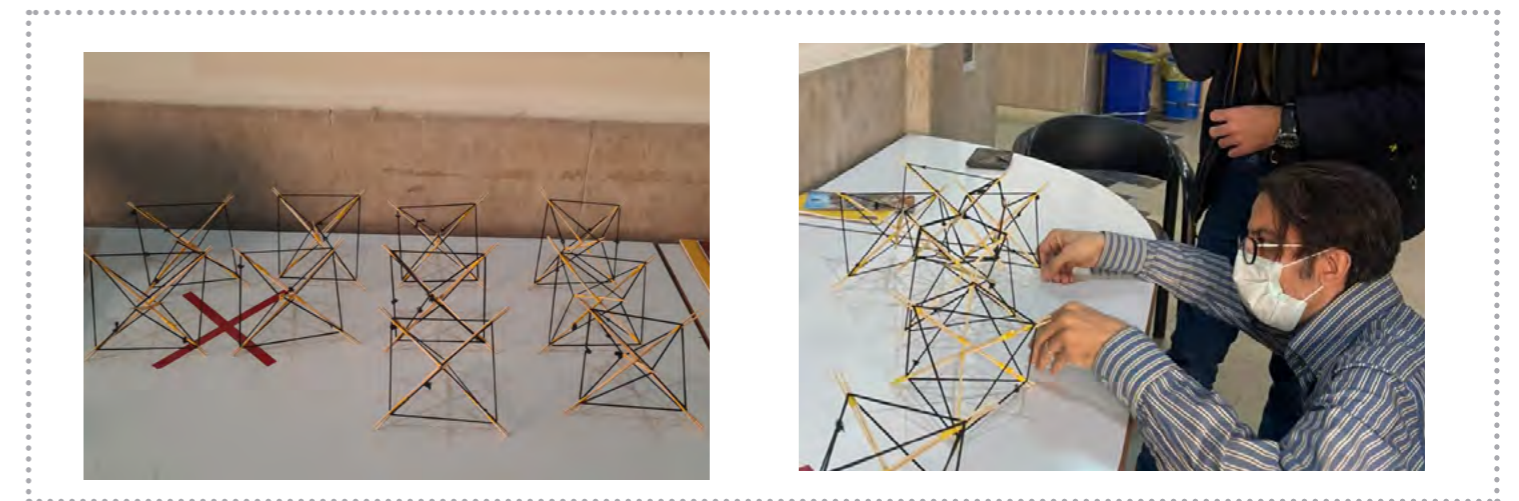
Addition of Second layer

Addition of Third layer

Addition of Forth layer

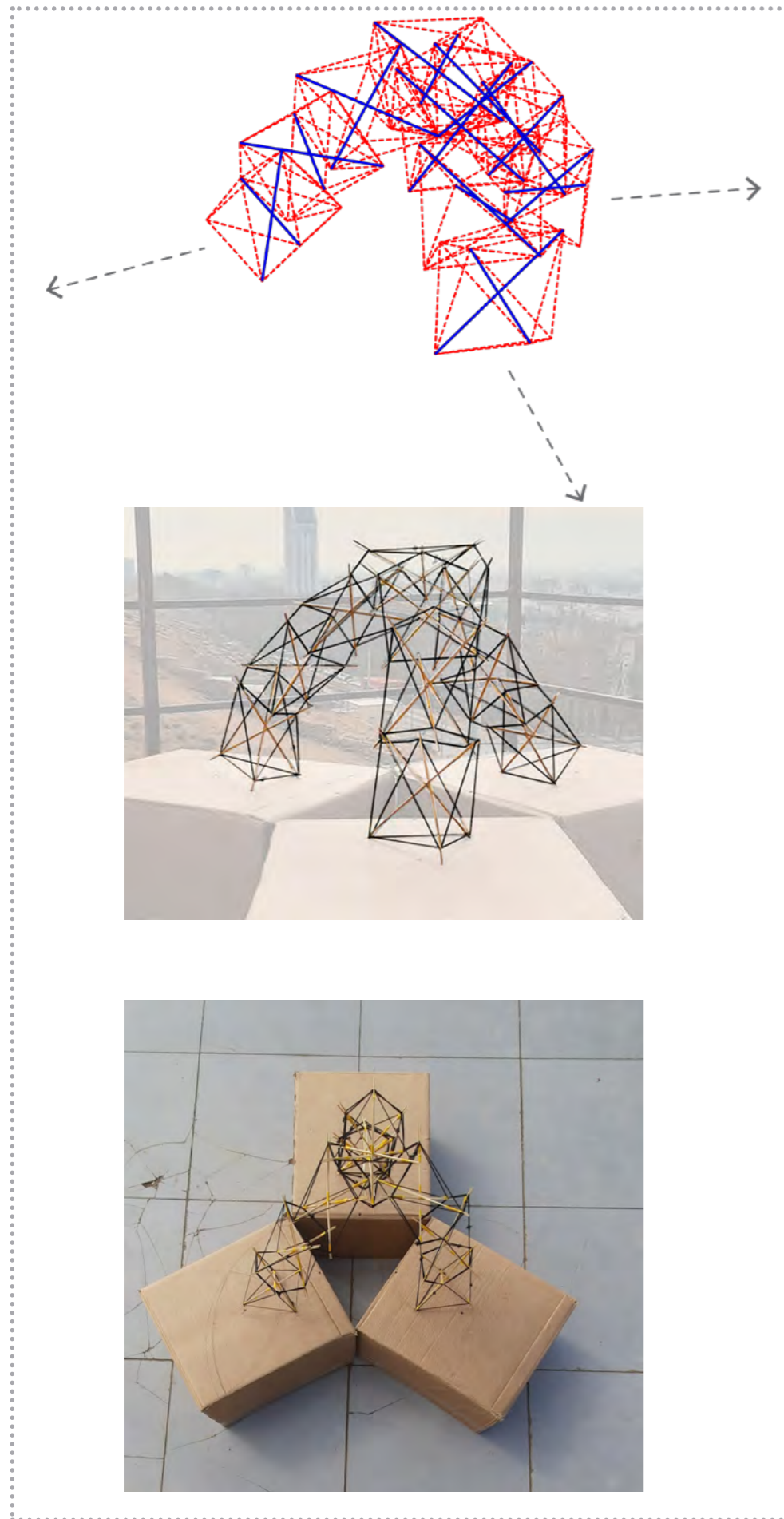


An octagon as the First module

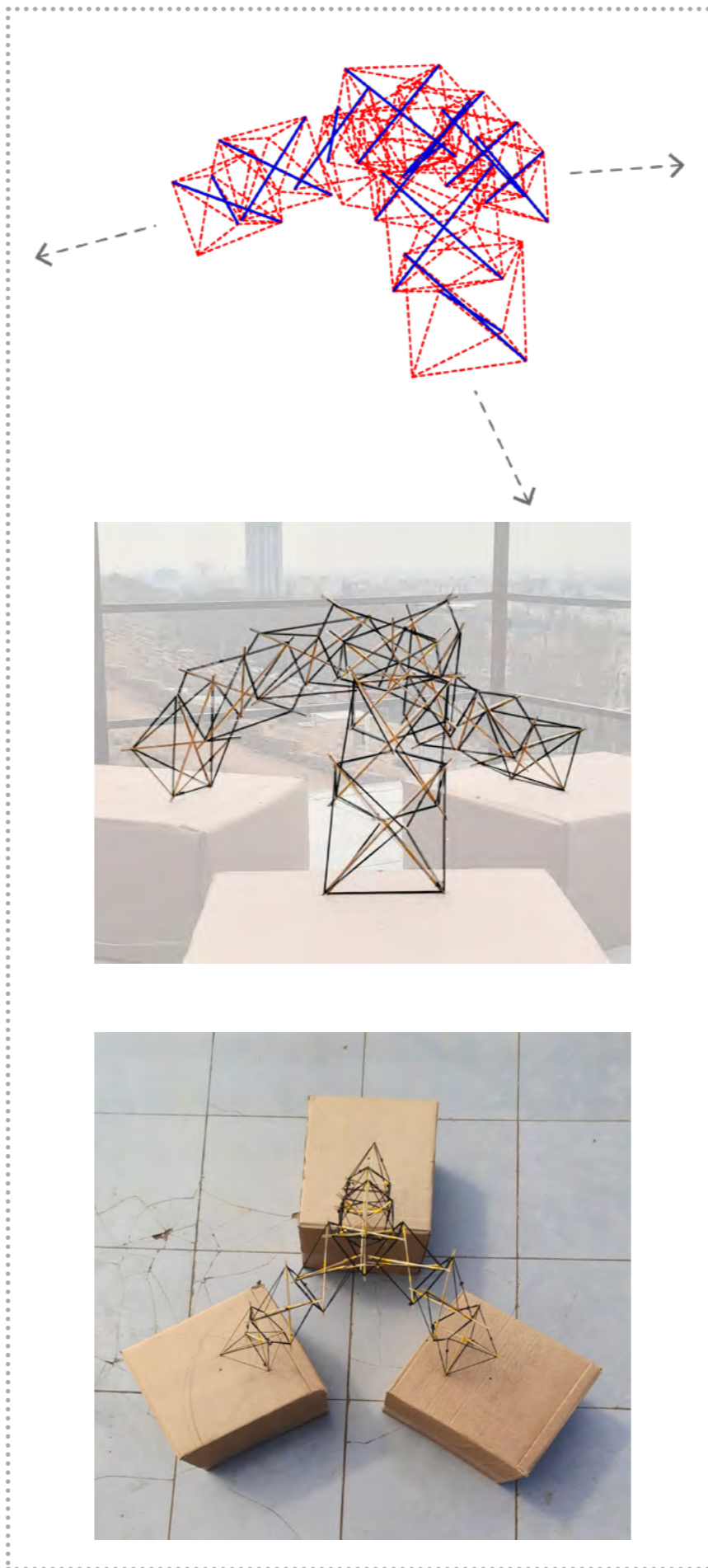


Combination of modules in several layers to generate the final structure

# PROCESS OF OPENING THE STRUCTURE



First phase  
Height: 50 cm



Second phase  
Height : 30 cm



Third phase  
Height: 10 cm





## 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

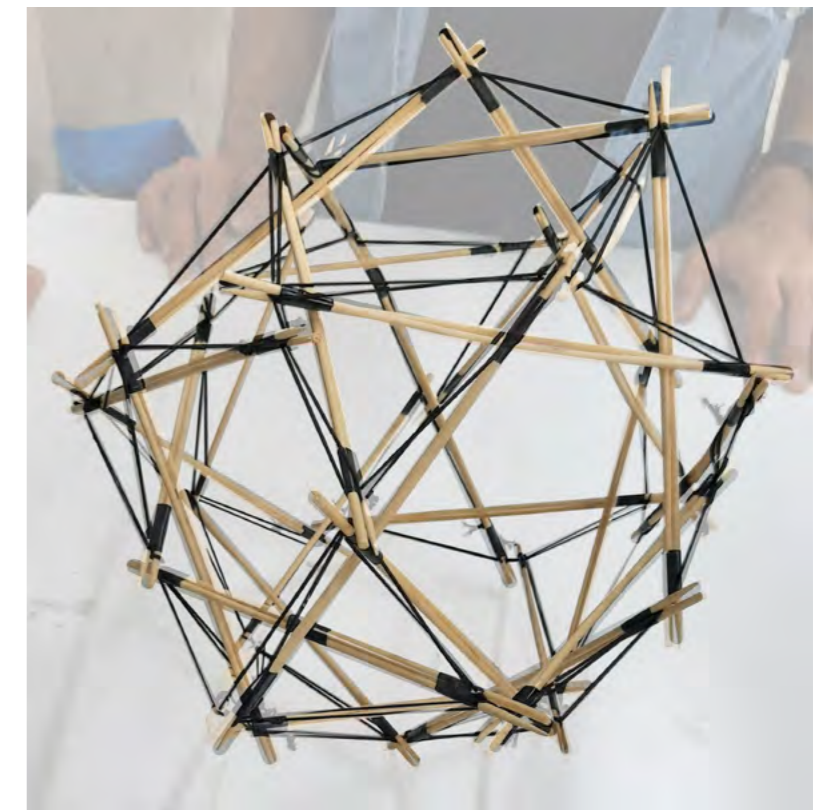
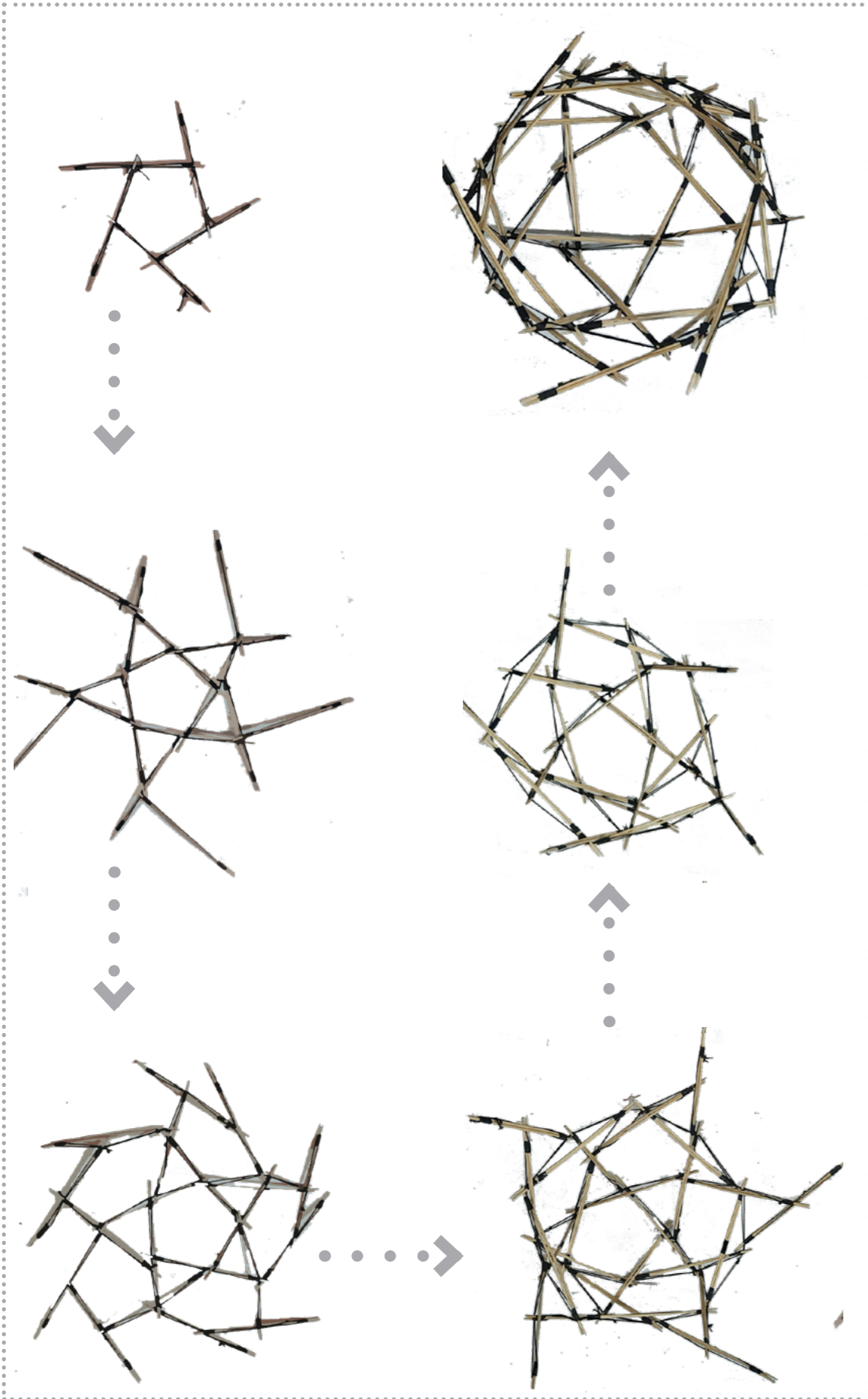
Continuing making pentagons until reaching a closing pentagon on the top

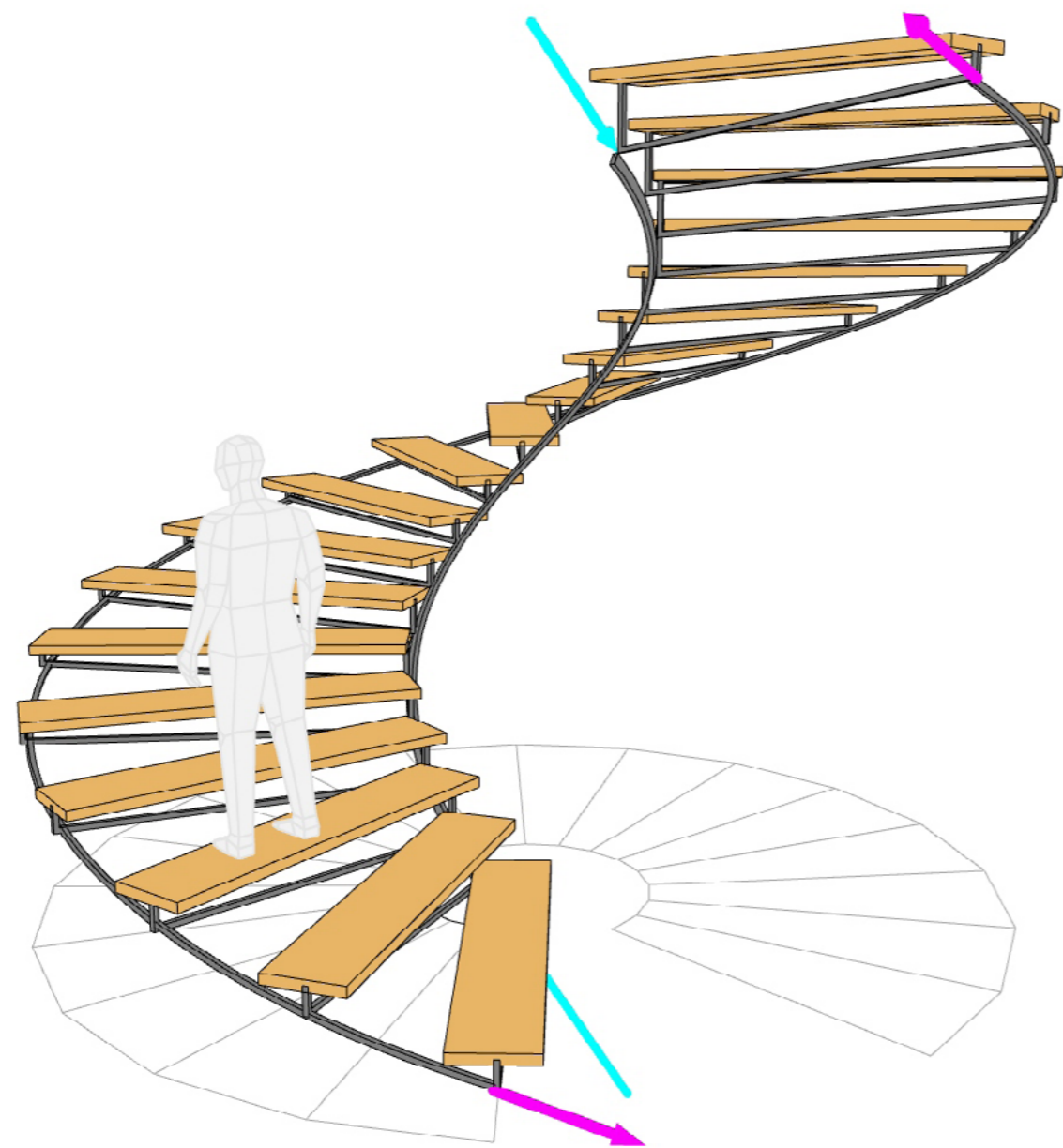


# 03 TENSEGRITY WORKSHOP

FARAHBAKHSG VOCATIONAL HIGH SCHOOL

# PROCESS OF GENERATING THE TENSEGRETY 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 be build using this structural design method, will be very stable because of that there 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 constrain points

5

Form finding with constrain points

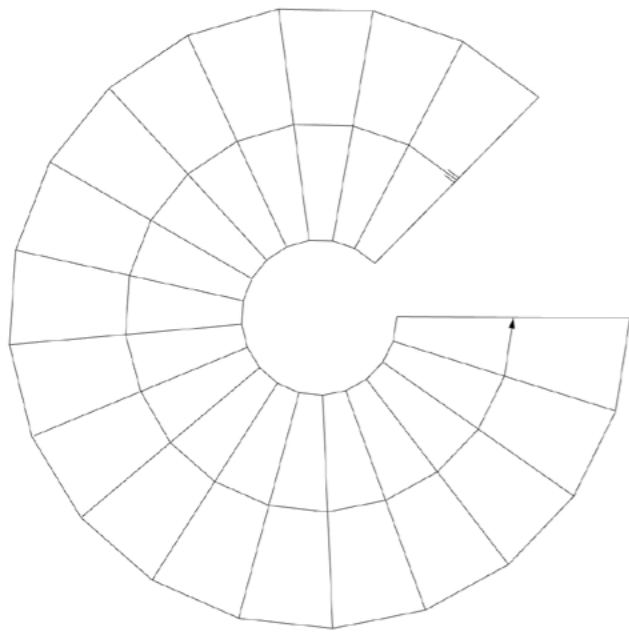
# 04 SPACIAL STAIRACASE

ACADIA 2021

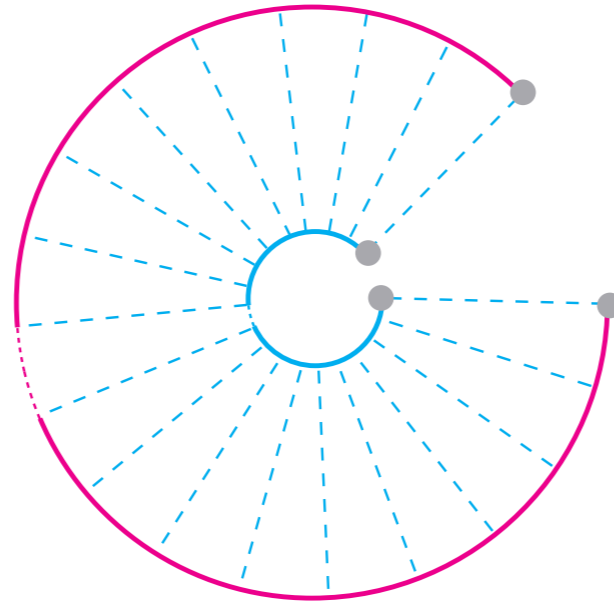
SUPERVISORS: RAFAEL PASTRANA, ISABEL OLIVEIRA, PATRICK OLE OHLBROCK, PIERLUIGI D'ACUNTO

# PROCESS OF FORM FINDING OF A STAIRCASE USING CEM METHOD

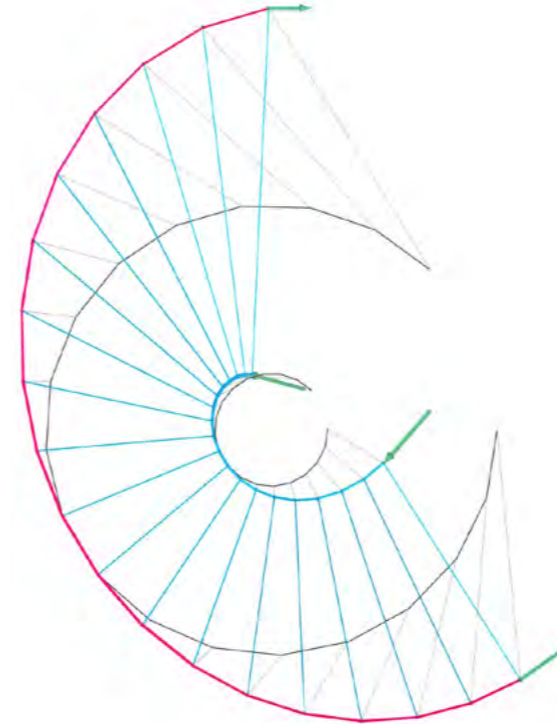
Step 1:  
staircase Topology



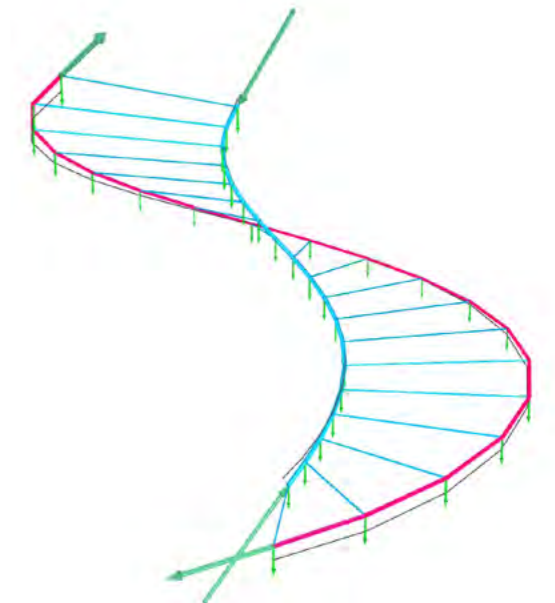
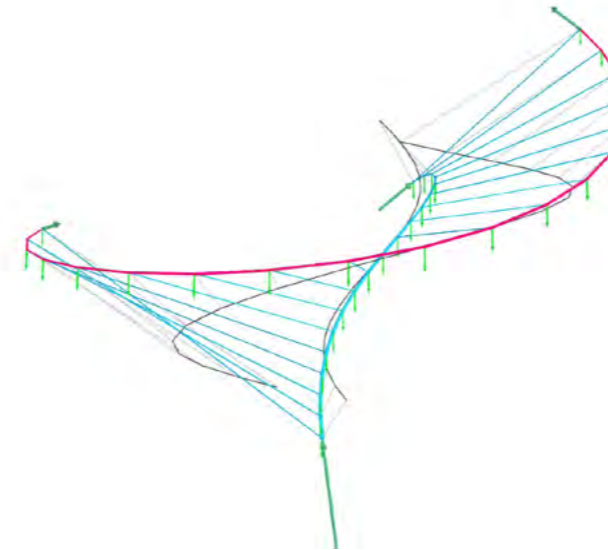
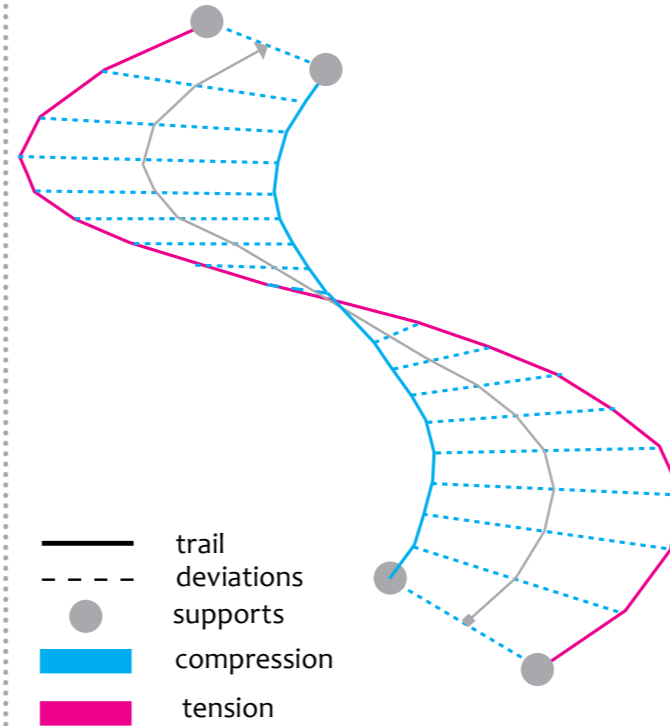
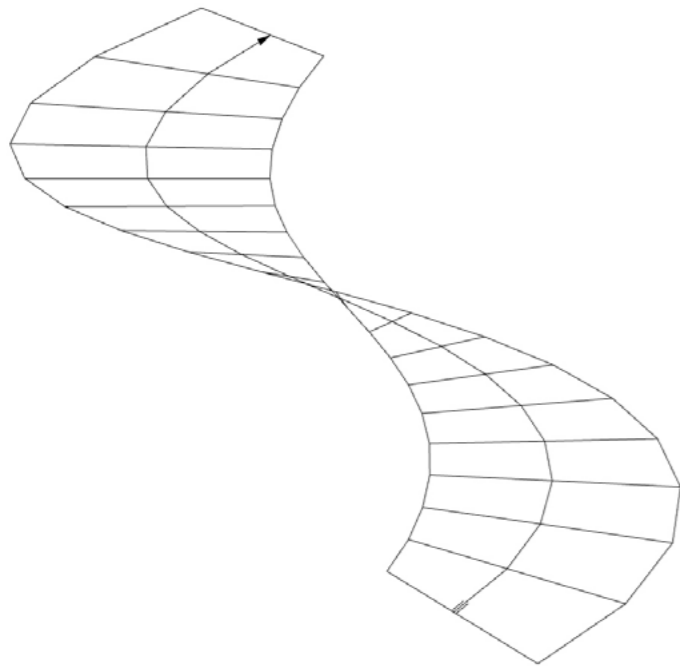
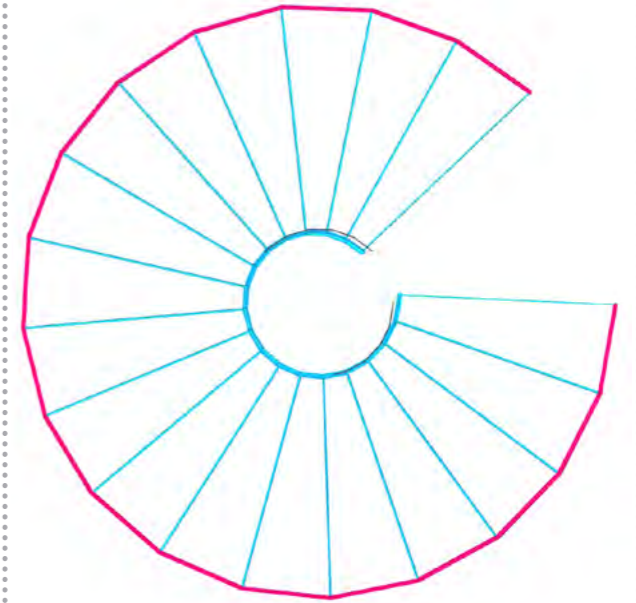
Step 2:  
Elements Function determination



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

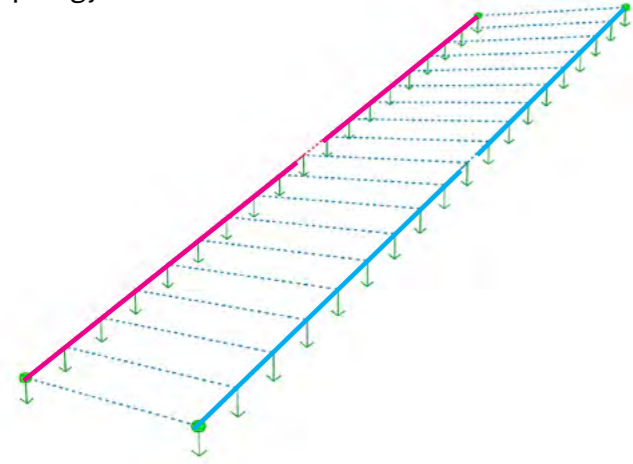
Form finding by considering the constrained points

# EXPLORING OTHER STAIRCASE ALTERNATIVES

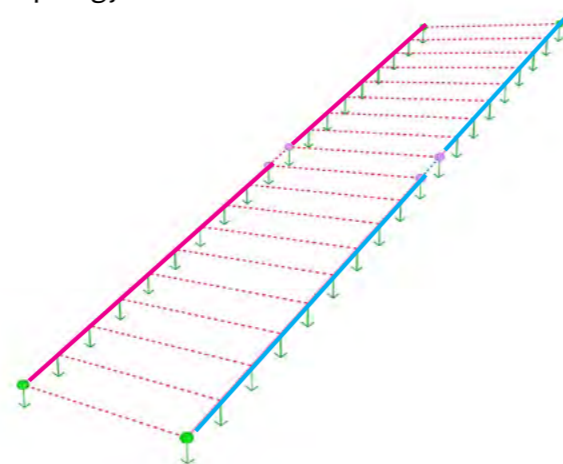
Structure with Tension and Compression elements

Tension only or Compression only structure

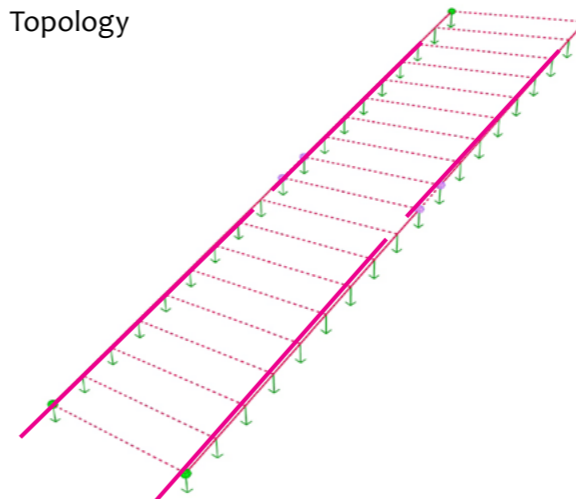
Topology



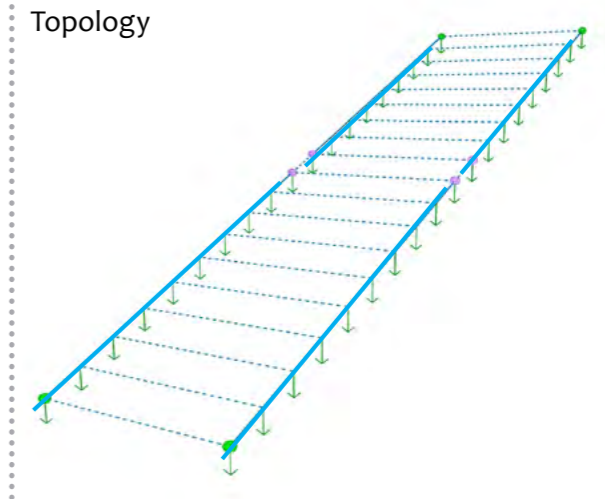
Topology



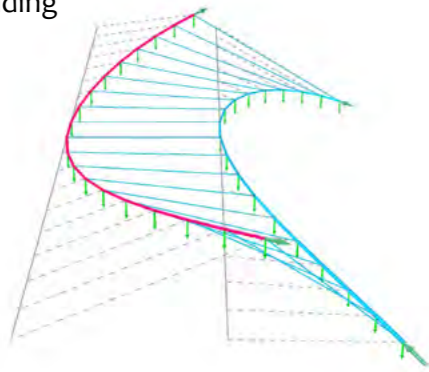
Topology



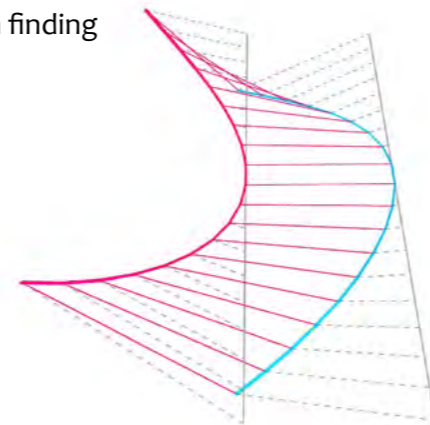
Topology



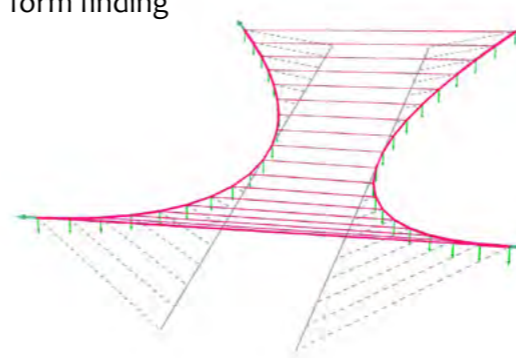
form finding



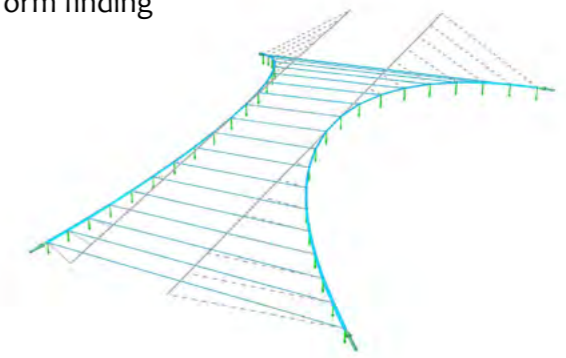
form finding



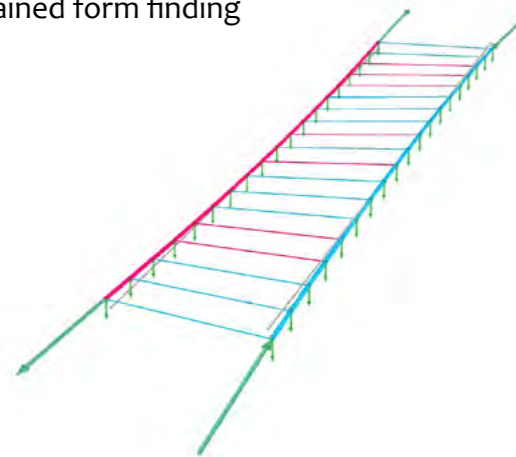
form finding



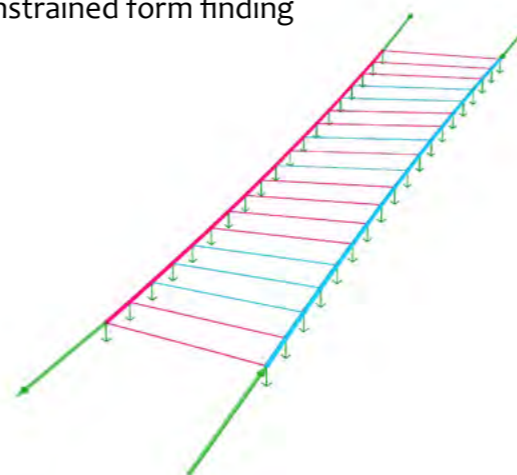
form finding



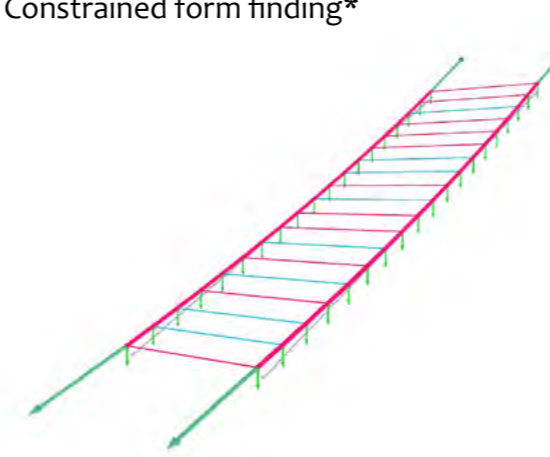
Constrained form finding



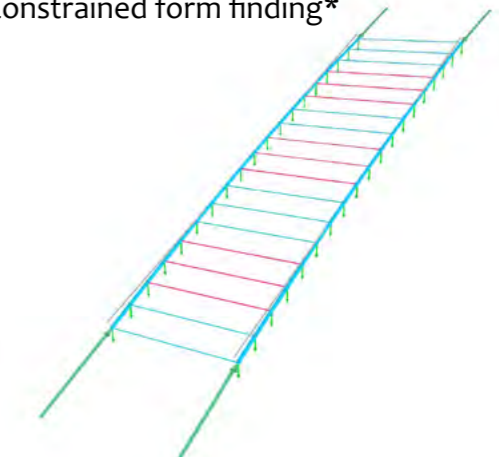
Constrained form finding



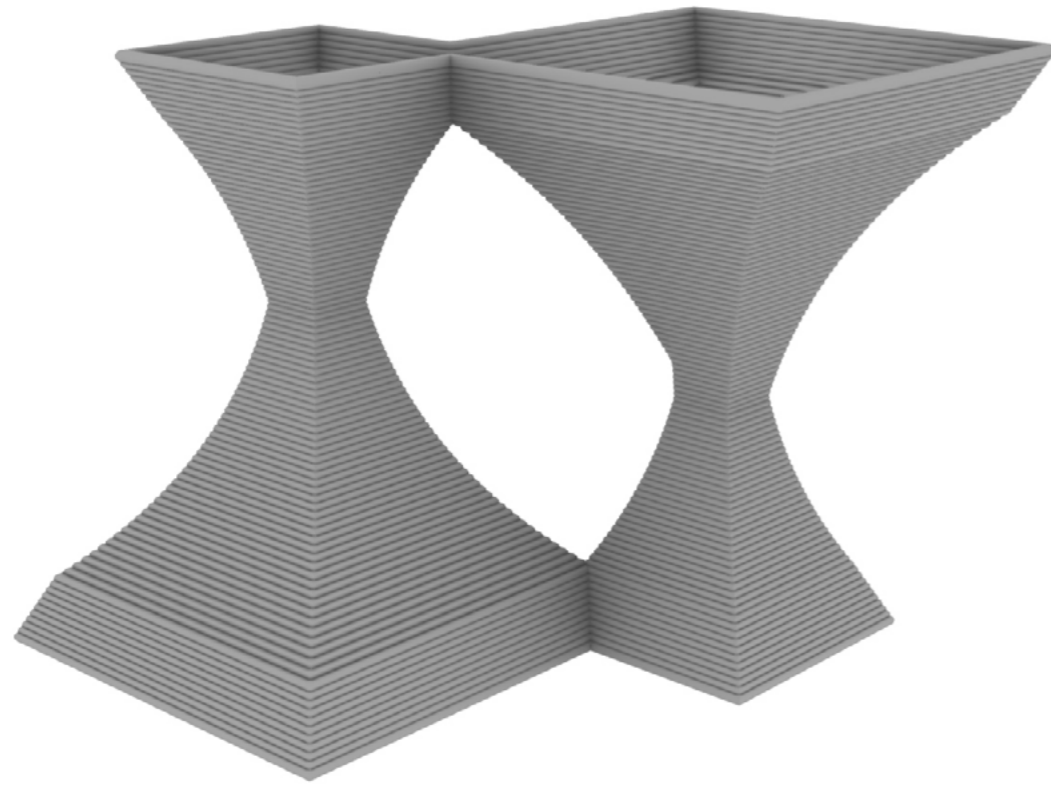
Constrained form finding\*



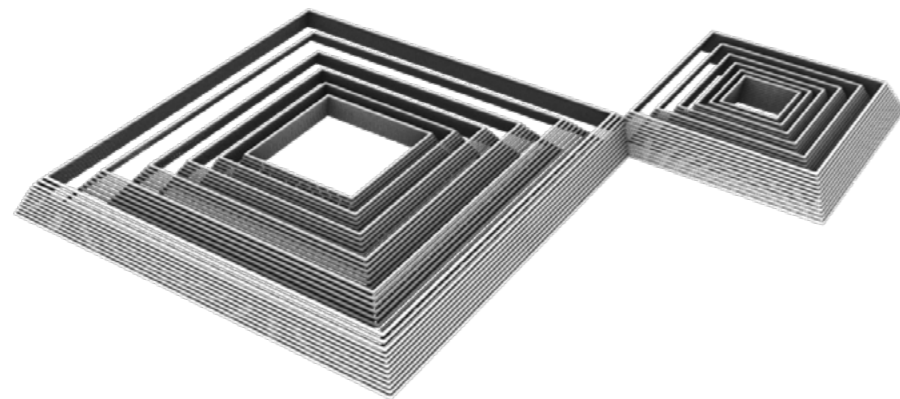
Constrained form finding\*



\* 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

## 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

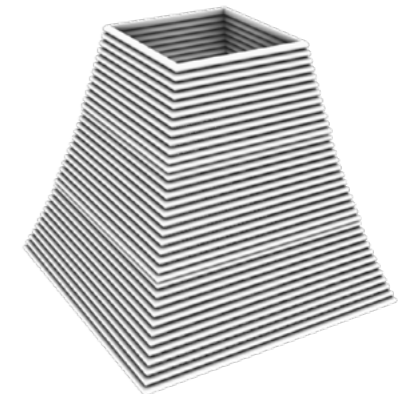
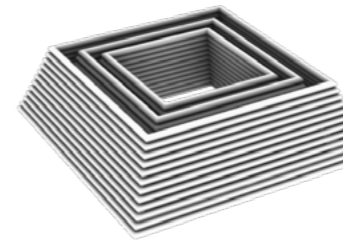
Splitting the printing task into few smaller ones

## HOW?

Printing the first piece

Separating the pieces

Putting the pieces on top of each other



Each piece should have a angle more than 90 degrees

Printing with an offset from the previous piece

With the help of a support structure in the core

05

# Print in Print Workshop

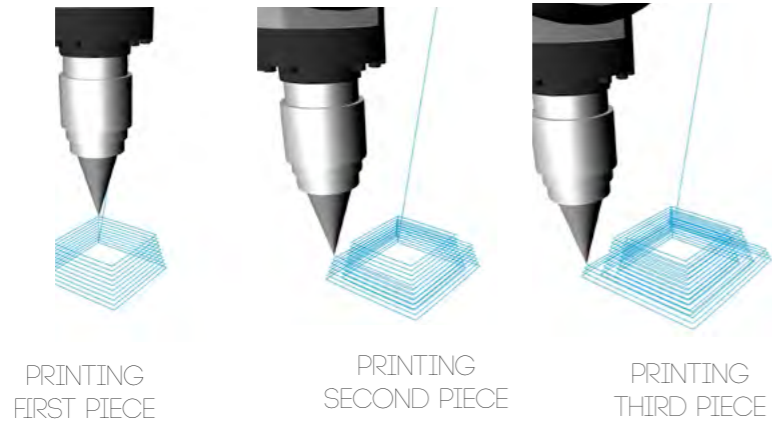
Digital future 2021

SUPERVISIERS:

NEGAR KALANTAR, ALI BAHRANI, MEHDI FARAHBAKHS

# APPLICATION OF THE METHOD ON THE DESIGNED PROJECT

Simulating the printing process of a robotic arm



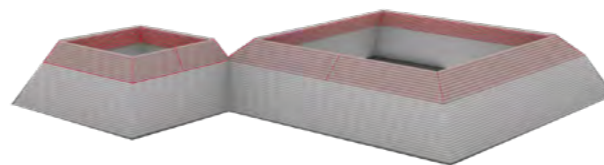
layer 1



layer 15



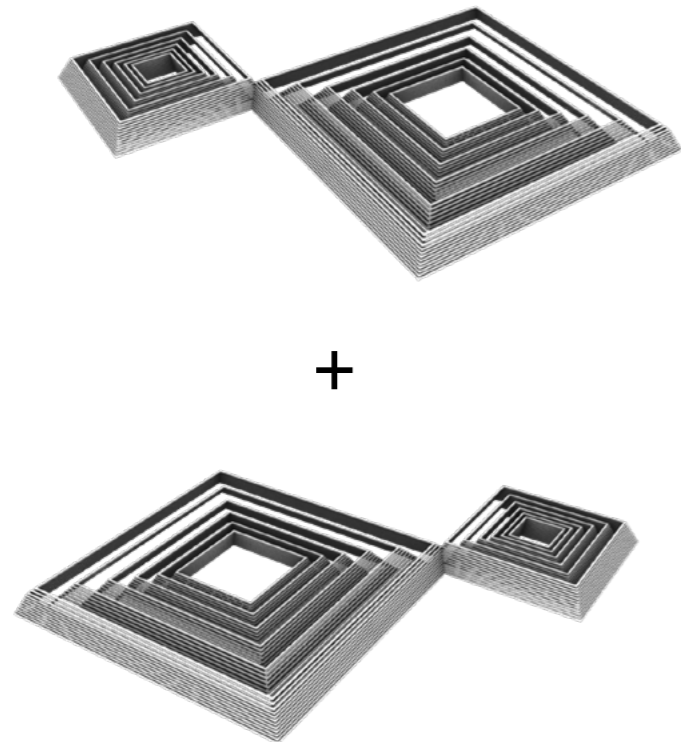
layer 3



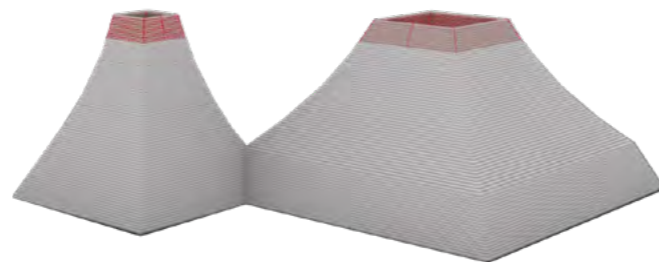
layer 17



Printing the structure in two sets



layer 8



layer 19





## 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

# 06 INDUSTRIAL HERITAGE

STUDIO DESIGN 1- MASTER



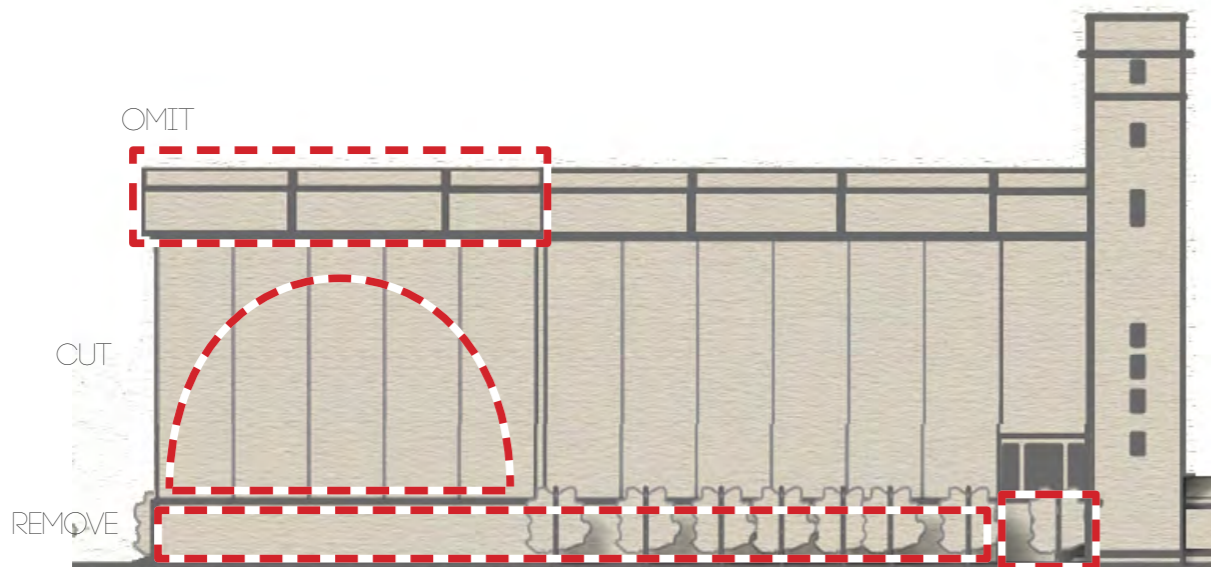
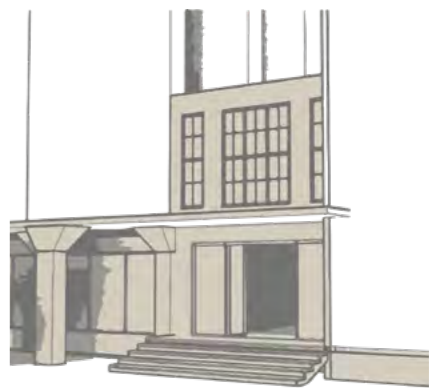
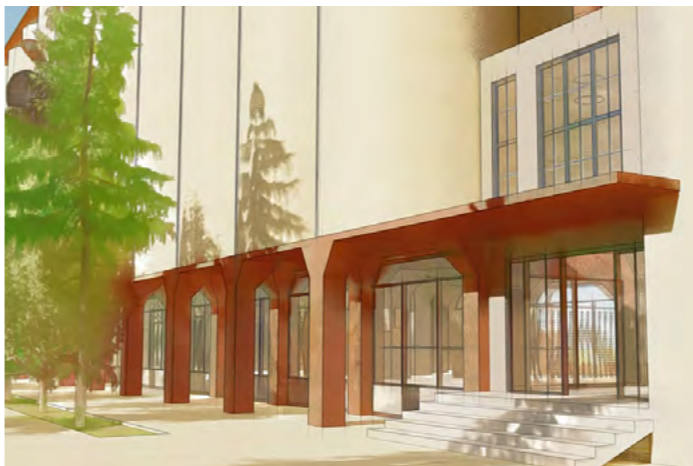
# MODIFICATIONS OF THE ORIGINAL BUILDING



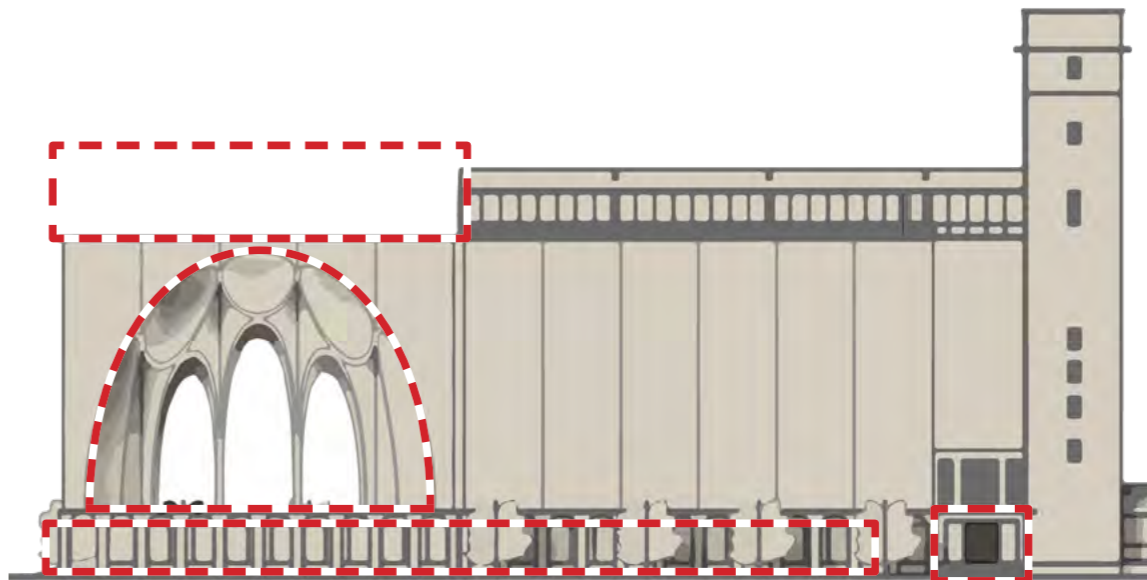
● ● ● ➤  
CUTTING THE  
GRAIN SILO AND  
MAKING IT VISIBLE



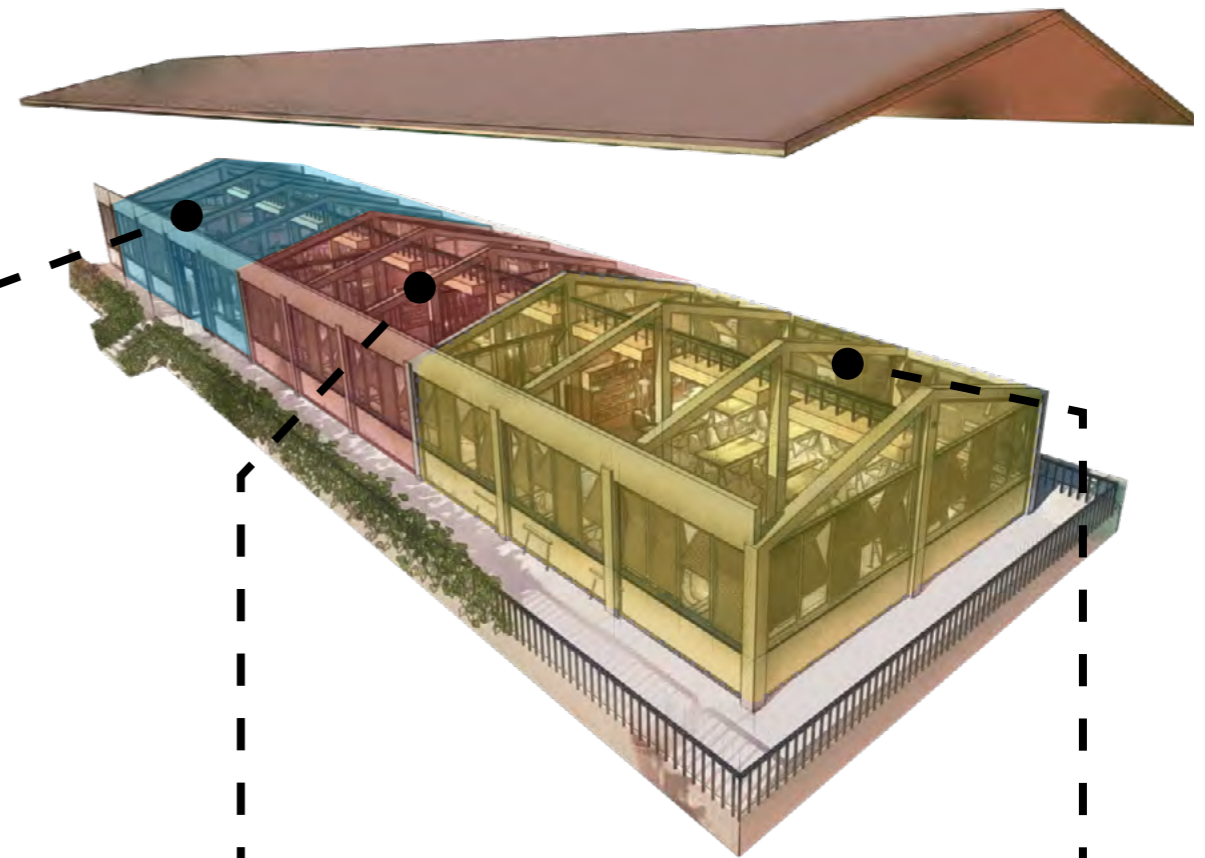
● ● ● ➤  
ALLOCATING A  
WELCOMING  
ENTRANCE FOR  
THE BUILDING



● ● ● ➤  
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

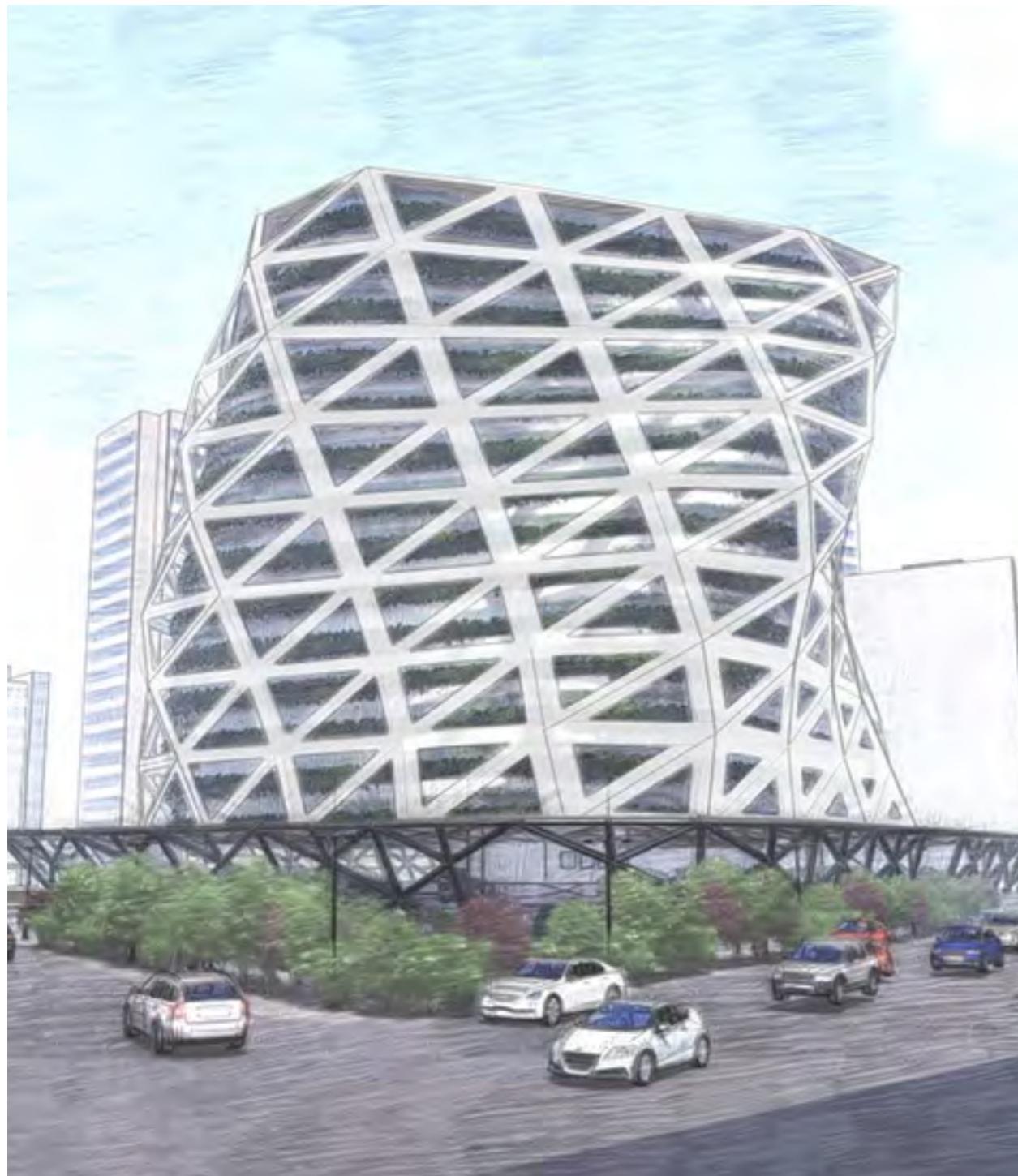
MAIN STRUCTURE

NON LOAD BEARING WALL

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

## HOW?

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

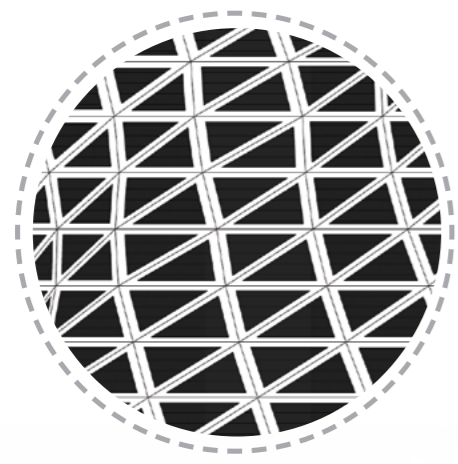
Sharing a lot of units in each floor but prevent a lot of interactions

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

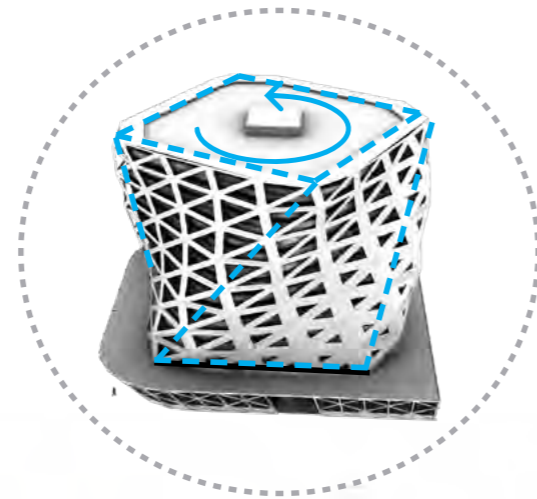
# 07 07 TURNING TOWER

STUDIO DESIGN 2- MASTER'S

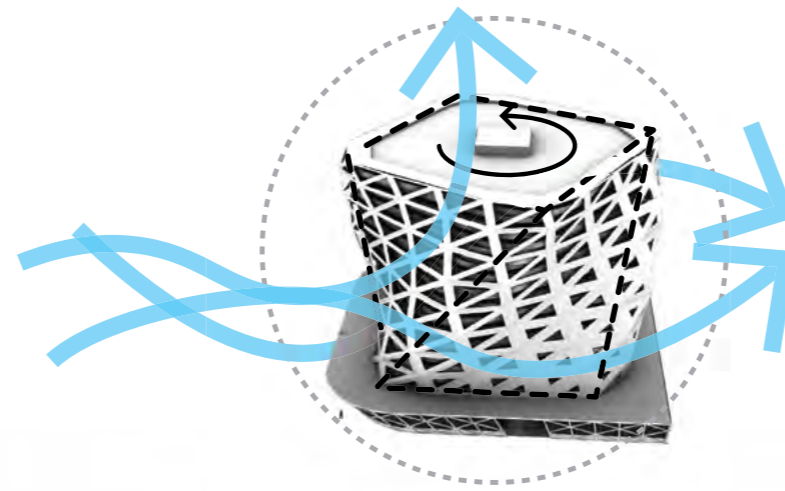
# ENVIRONMENTAL DESIGN OF THE TURNING TOWER



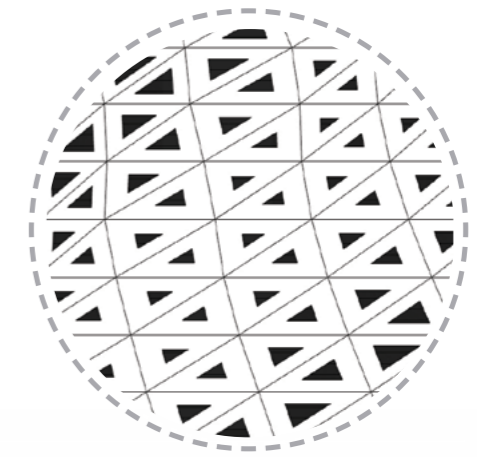
BIG OPENINGS



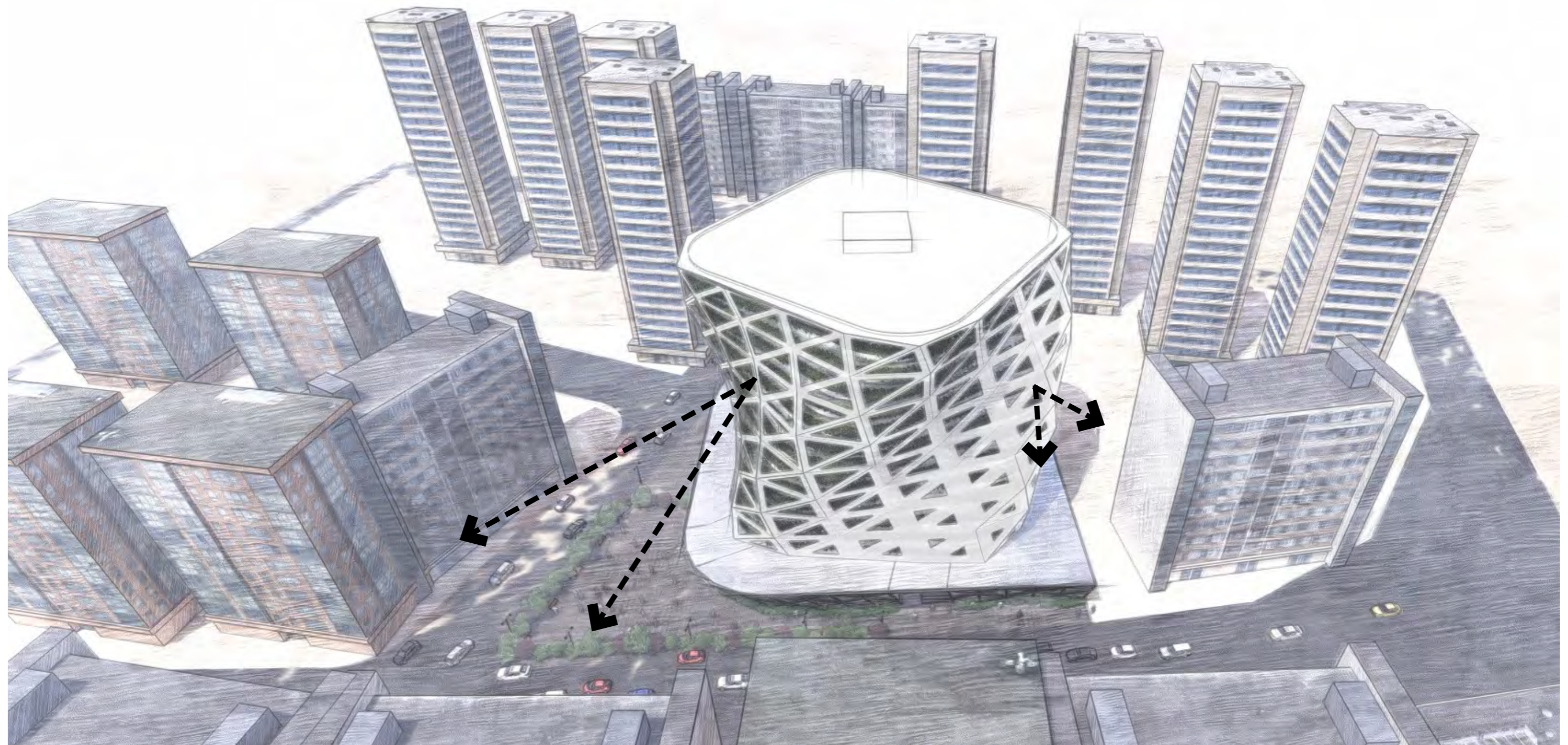
ROTATING OF THE BUILDING



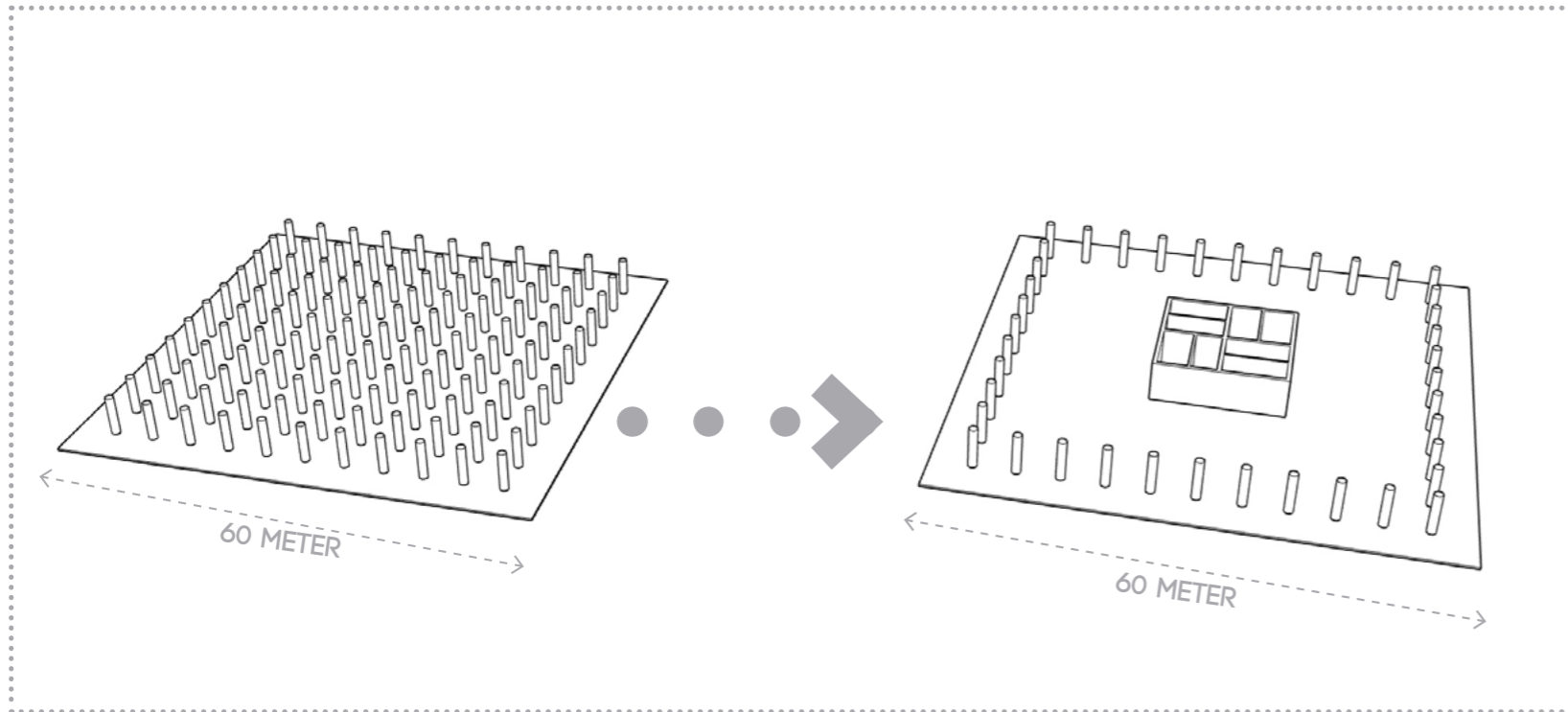
NOT BLOCKING THE AIRFLOW



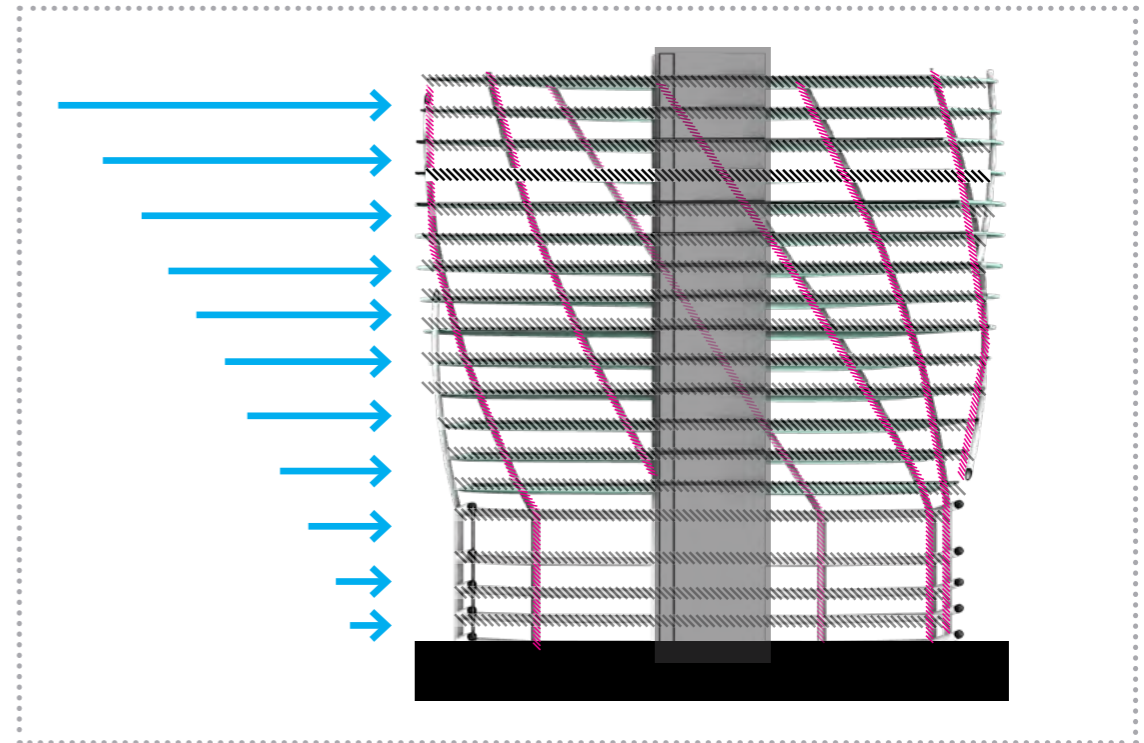
SMALL OPENINGS



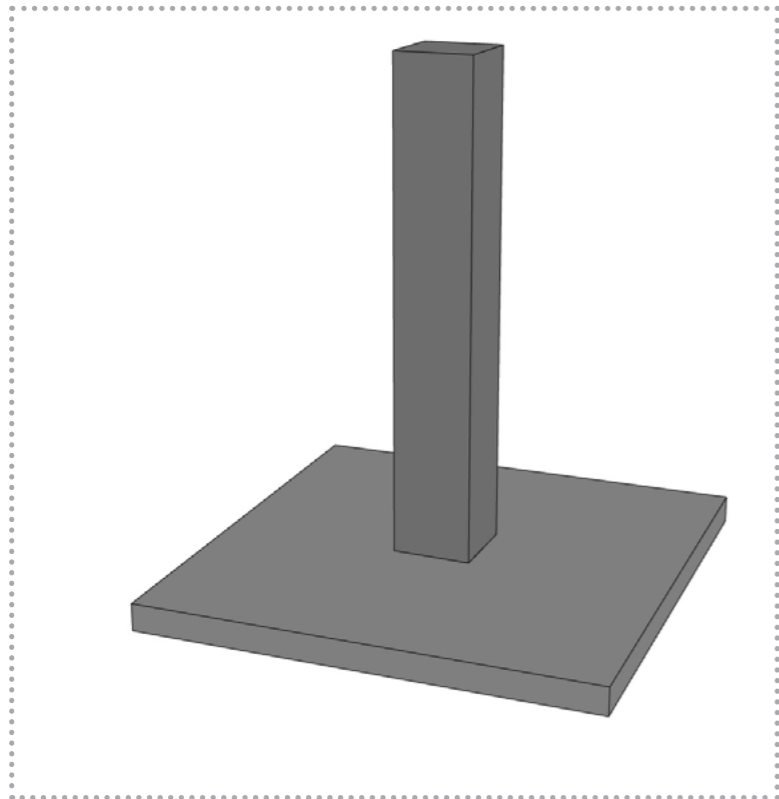
# STRUCTURAL DESIGN OF THE TURNING TOWER



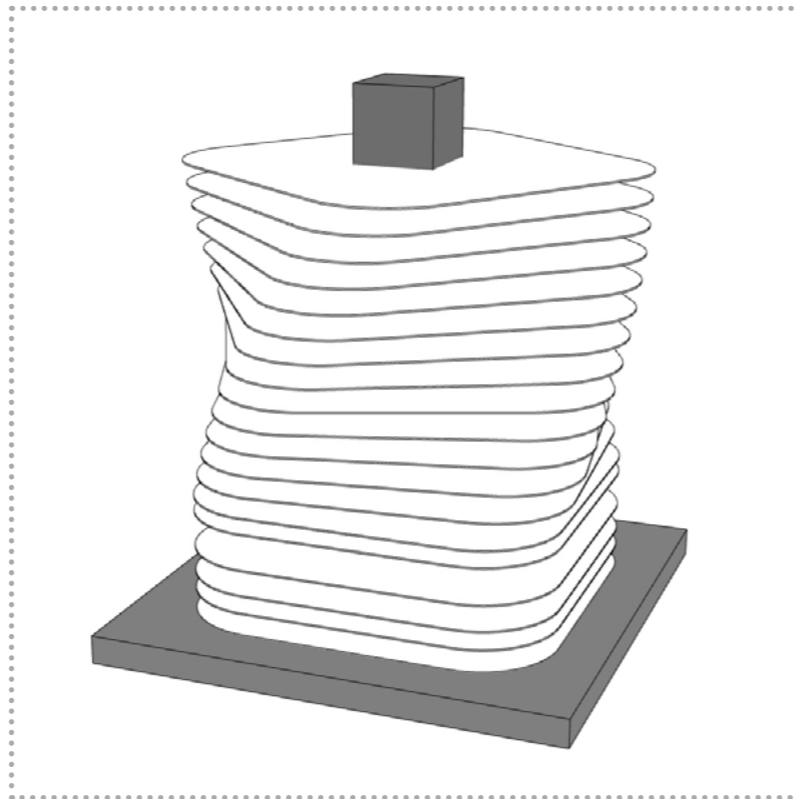
Omitting columns to make more free space



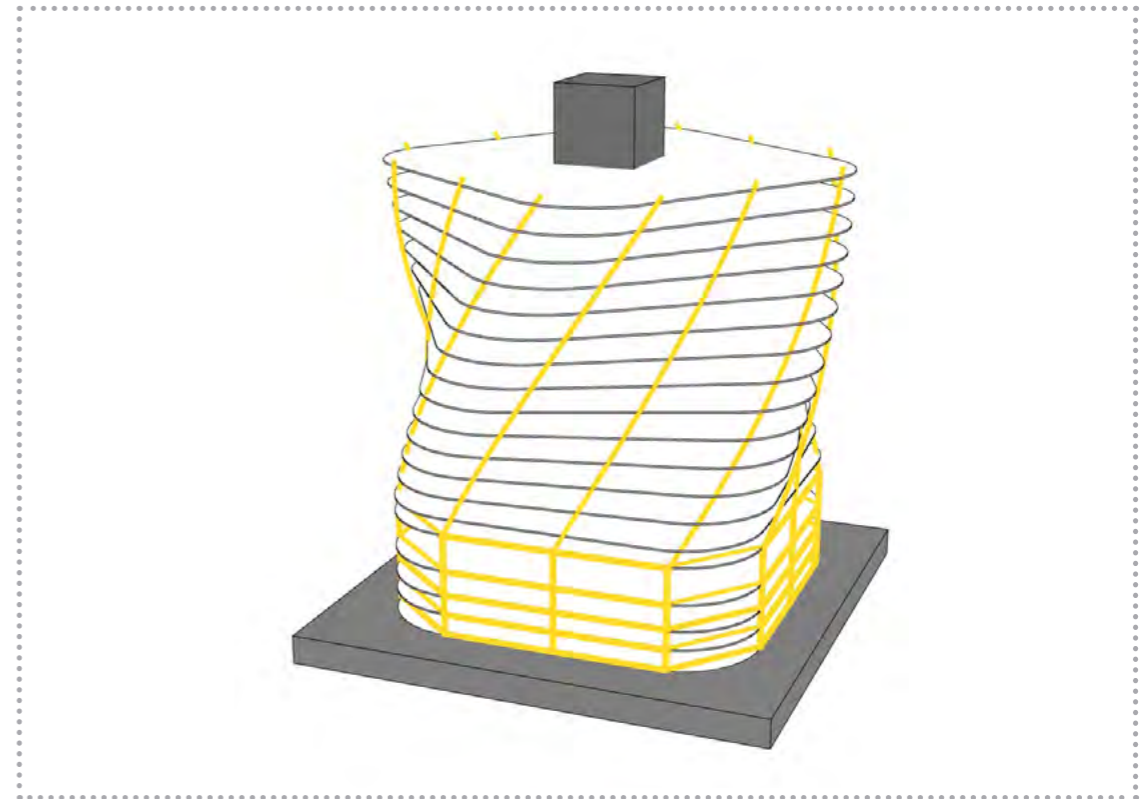
Stability of the building against wind force



Central Core

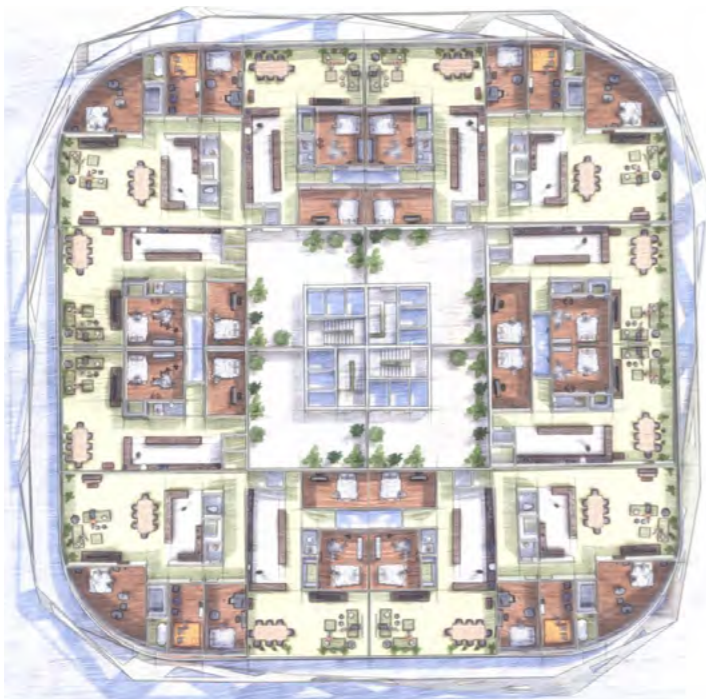


Central Core + Plates

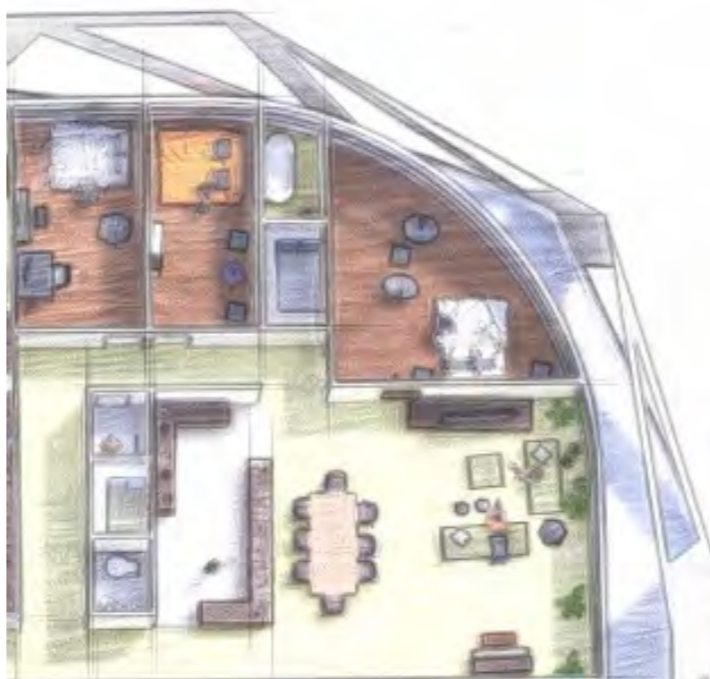


Central Core + Plates + Space Frame

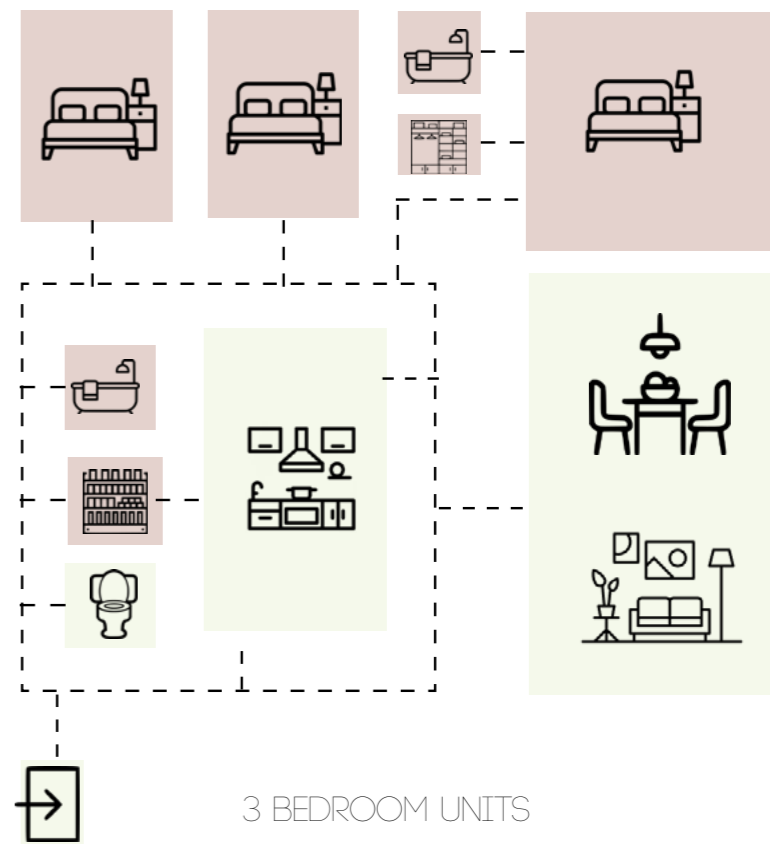
# ARCHITECTURAL DESIGN OF THE TURNING TOWER



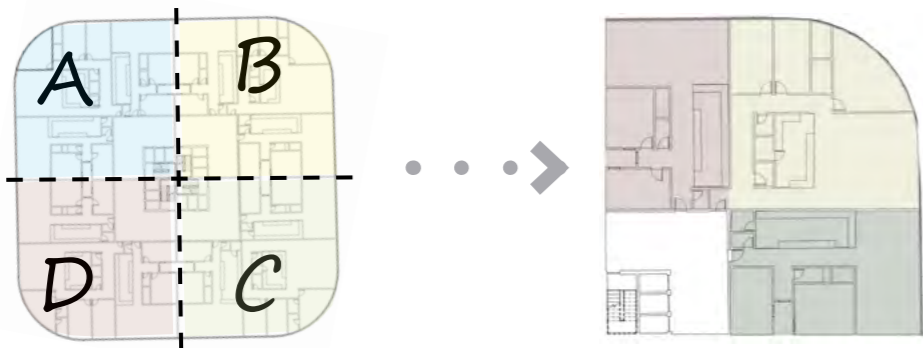
TYPICAL FLOOR PLAN



3 BEDROOM UNITS



3 BEDROOM UNITS

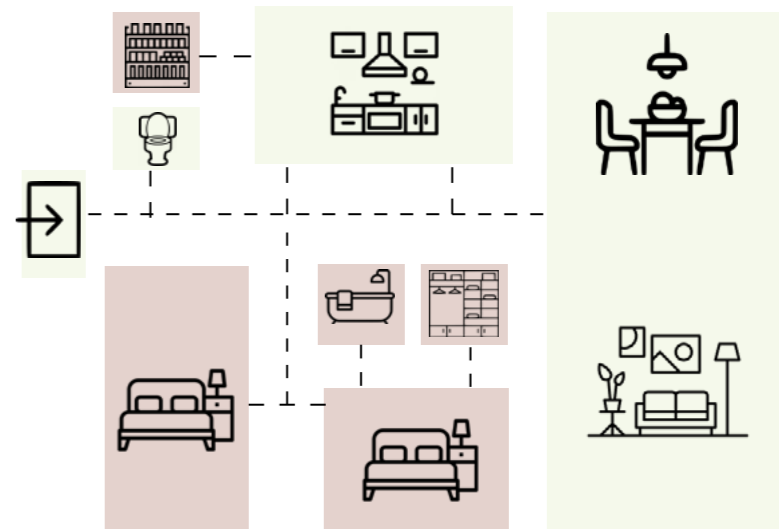


FOUR SEPARATED NEIGHBORHOODS

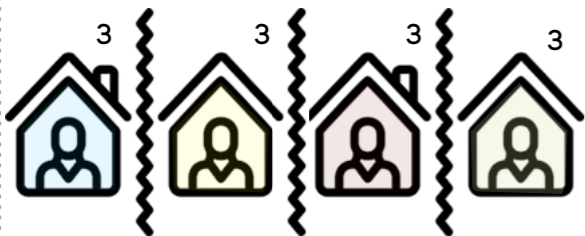
THREE UNITS IN EACH NEIGHBORHOODS



2 BEDROOM UNITS



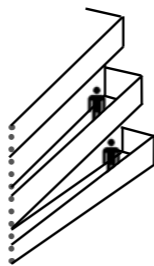
2 BEDROOM UNITS



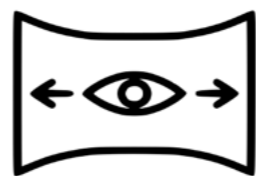
12 UNITS IN EACH FLOOR



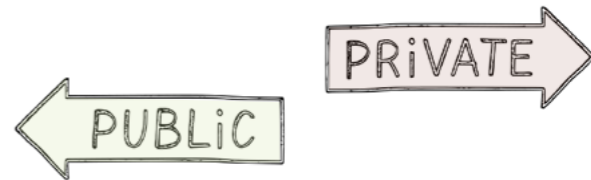
SEPARATED STAIRCASE AND ELEVATION



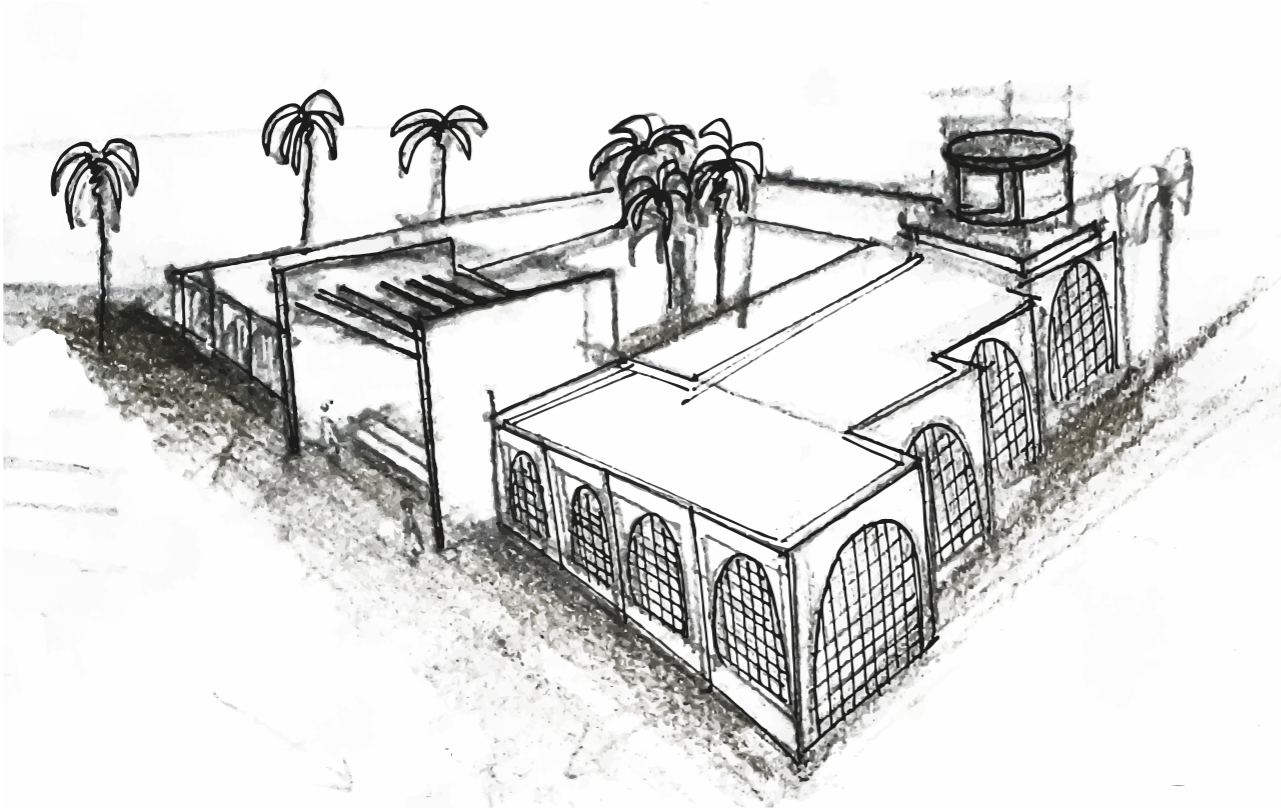
USING SPACE GENERATED BY ROTATION AS BALCONY



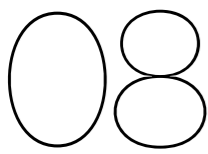
LANDSCAPE VIEW



SEPARATION OF PUBLIC AND PRIVATE SPACES



عمارت  
بادگیر



**WINDCATCHER COMPLEX**

SKETCH- BACHOLER'S

## WHAT?

windcather complex	an old building with some energy sustainability features in a desert region
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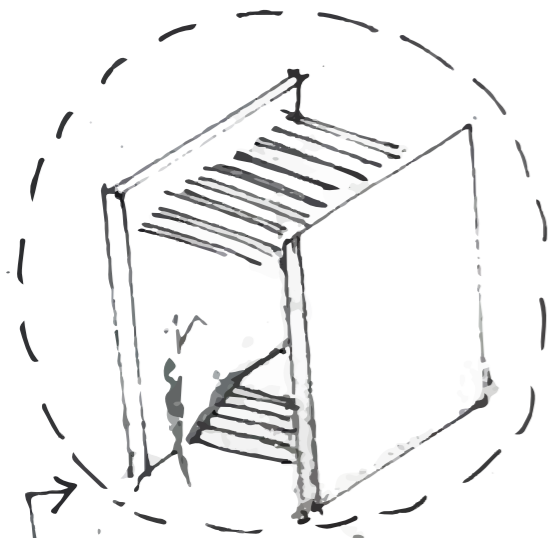
## WHY?

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

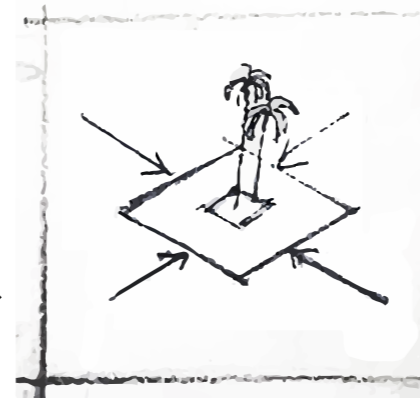
## HOW?

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

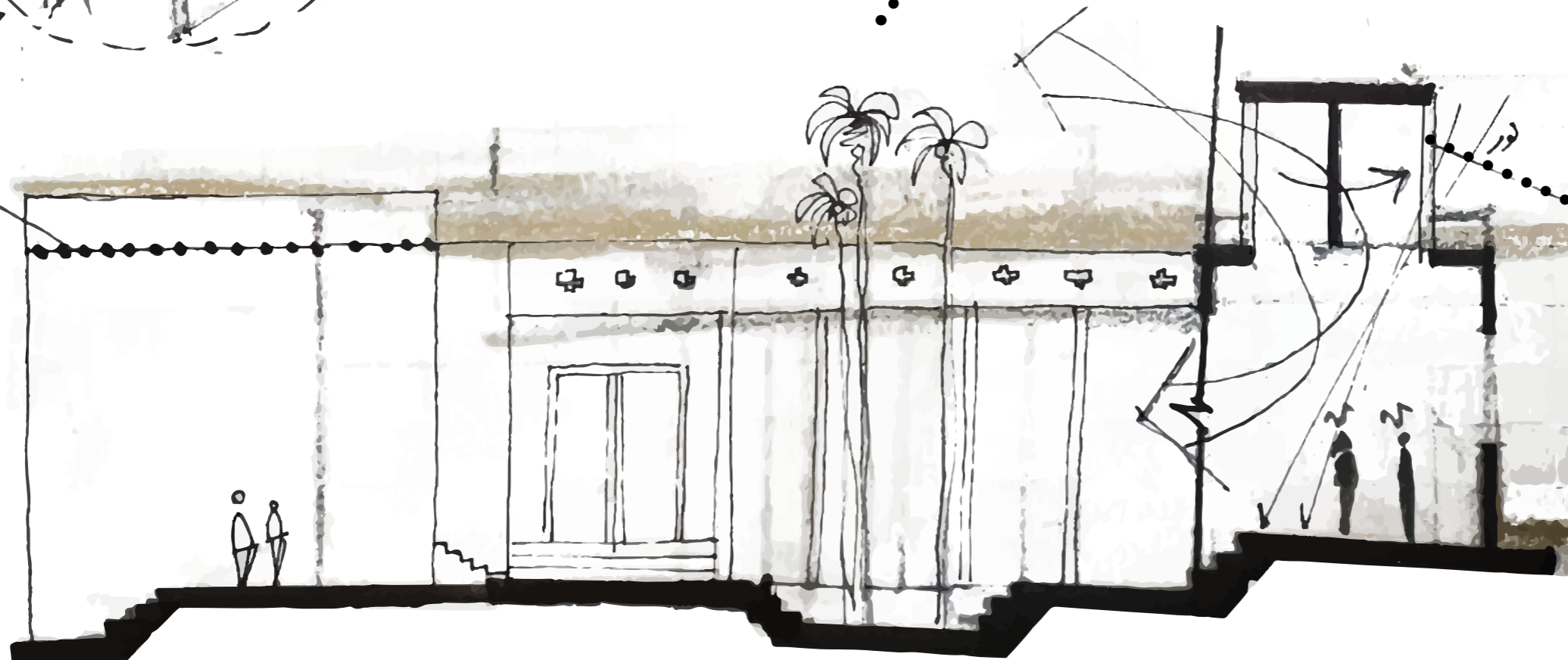




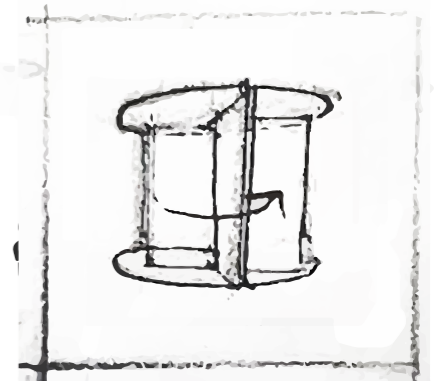
- Inviting entrance
- Interplay of Light and shadow



- Prominent element of the building
- Shadowing



Main section of the building



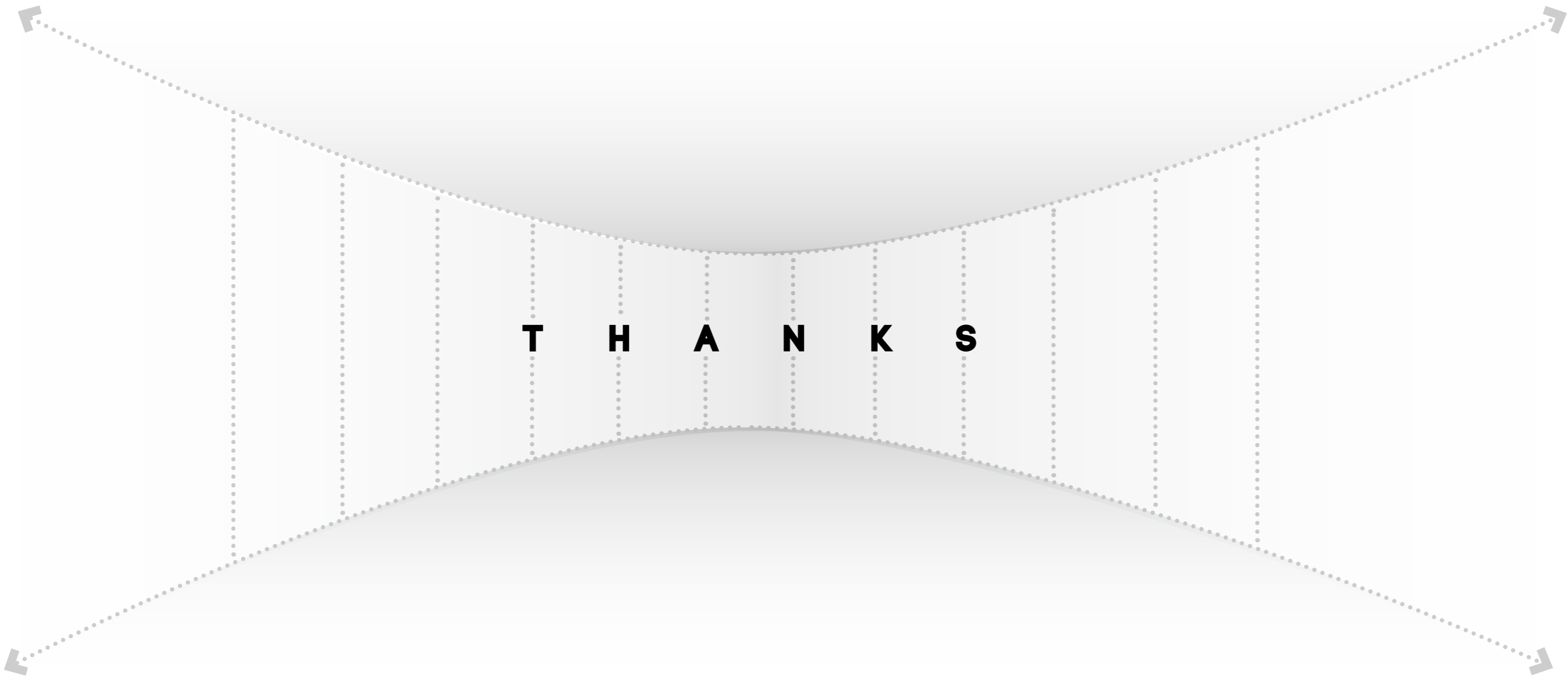
- Air conditioning
- Lighting
- Electricity



Front perspective of the complex



- Air conditioning
- Lighting



**THANKS**