ARMAN KHALILBEIGI

Computational Designer
Lecturer and Tutor
Portfolio

Arman Khalilbeigi

Arman KhalilBeigi is a digital architect. he holds a Master's degree in Architectural Technologies (Computational design) from the University of Tehran (Ranked #1 among the nation). He Defines himself as a Design Technician as his career and teaching are focused on 'Design Computation' and integration of cutting-edge or customized fabrication technologies into the design process. He pushesh the boundaries of his designs to the intersection of computer science, digital fabrication and material technologies.

He is one of the co-founders of 'Paragen Creative Studio' where he involved in providing design and fabrication solutions for different design firms internationally. he has been Director and Computational Tutor for digital fabrication courses hosted by highest-ranked universities in Iran and also a guest lecturer and keynote speaker in the field of multi-disciplinary algorithmic design.

He is co-author of the 'Parakeet' Project; a cross-platform digital tool focusing on construction problems. through all his endeavors, he explores the implications of 'Data-Driven Design' where his greatest passion is working with data, algorithms, and machines.

Education

2013-2015 **MA, Architectural Technology (Computational Design)** *Tehran, Iran*
University of Tehran, Faculty of Fine Arts

2009-2013 **BS, Architecture Engineering** *Tabriz, Iran*
Tabriz University

Work Experience

2014 to Present **Co-Founder and Lead Computational Designer** *Tehran, Iran*
"PARAGEN Creative Studio"
Paragen is a Research-Based Creative Studio, providing B2B solutions in design and fabrication, a number of projects are:

2014
- **Furniture and accessory design for Deco 8** *Tehran, Iran*
  Designs include several computational approaches for form-finding and were associated with customized fabrication solutions.

2016
- **Saman Ehteshami Music Academy** *Tehran, Iran*
  Application of digital fabrication techniques to design, rationalize and fabricate fluid geometries in interior design.

2017
- **Zollanvari Corp. Interior Design** *Tehran, Iran*
  The design process was integrated with the assembling process via AR technology. furthermore, parts of the design were derived from mathematical equations.

2017
- **Queen Center Jewellery Store** *Tehran, Iran*
  Design process initiated with an aggregation algorithm and later optimized to be fully manufacturable with conventional CNC milling machines.

2019
- **Kia Cam Design and Fabrication Toolkit** *Tehran, Iran*
  A digital was developed to facilitate design to fabrication process in the woodworking industry. Design, optimization, nesting, and G-Code extraction were parts of the tool.

2019 to present **Invited lecturer**
Modules include: Structural Systems for Architects (for Undergrad BA Students)
Computation Design Courses and Workshops (for Postgrad MA Students)
University of Tehran, Tehran, Iran

2017 to 2019 **Full-time Researcher and Educational Planner**
Projects/Tasks include scientific supervision for events in the field of computational design, organizing seminars and conferences, directing digital fabrication workshops
Center of Excellence in Architecture Technology,University of Tehran, Tehran, Iran

Teachings

Lecturer *'Memaraneh' Private Architecture School, Tehran, Iran*

2015
- **Algorithmic Design Basics**
  A lecture series followed by a software flash course about basics of computation design and digital fabrication.

Teaching Assistant *University of Tehran, Tehran, Iran*

2015
- **Algorithmic Thinking And Toolbox**
  A lecture series followed by a software flash course about basics of computation design and digital fabrication.

2015
- **Fabrication Basics: Flash Course**
  A short course focused on digital fabrication, covering conventional methods, requirements, and limitations.

Tutoring Team Member *'Memaraneh' Private Architecture School, Tehran, Iran*

2015
- **Emergent Prototyping Workshop**
  A workshop on material behavior and physical simulations. profound studies with physical models were conducted and developed computationally for architectural applications.

Lecturer and Course Teacher *'Memaraneh' Private Architecture School, Tehran, Iran*

2015
- **Algorithmic Urbanism**
  A lecture-based course introducing possible computational problem-solving algorithms in urban design focused on how to design, analyze, and predict the city algorithmically.

Invited lecturer and Fabrication Tutor *Amirkabir University of Technology, Tehran, Iran*

2016
- **Architecture-Geometry Winter School**
  Invited as a member of the Computational Geometry research group, I directed research on developable surfaces which eventually formed a mid-size pavilion named 'Steel Dome'.

Invited lecturer *University of Tehran, Tehran, Iran*

2016
- **Computational Design Paradigms**
  A course in Architecture Technology Master's Degree which covers basics of algorithmic thinking, computational design, and digital fabrication.

Tutor

2016
- **Tehran CRAFT** *University of Tehran, Tehran, Iran*
  Tehran Craft is a project on the exploration of digital design and fabrication. in Craft 2016, structural shells were studied elaborately and a pavilion built eventually by Robotic arms.

2015
- **Introduction to Computational Design and Digital Fabrication** *Pars University, Tehran, Iran*
  A course in Architecture Technology Master's Degree which covers basics of algorithmic thinking, computational design, and digital fabrication.

2016
- **Introduction to Computational Design and Digital Fabrication** *Pars University, Tehran, Iran*

Computational Tutor *University of Tehran, Tehran, Iran*

2014
- **CAAD Studio [Computer Aided Architectural Design]**
  In this design studio, it was intended to shift from the conventional design process to algorithmic problem-solving approach;

2015
- **CAAD Studio [Computer Aided Architectural Design]**

2016
- **CAAD Studio [Computer Aided Architectural Design]**

2017
- **ADVANCE COMPUTATION APPLICATIONS IN DIGITAL ARCHITECTURE**
  A university course focused on paper-less conceptualization; a bottom-up approach for creating 'Design Tools' based on multiple disciplines.

2017
- **ADVANCE COMPUTATION APPLICATIONS IN DIGITAL ARCHITECTURE**
  A university course based on algorithms derived from several disciplines, adapted are re-designed to perform in architectural problem solving.

Workshop Director *University of Tehran, Tehran, Iran*

2017
- **Digital Fabrication 'Boot-Camp' 2017**
  A project focused on proposing a method for the construction of arbitrary spatial structures with low-tech 2D machinery and geometrical solutions. ['TwistedArc' Project]

2018
- **Digital Fabrication 'Boot-Camp' 2018**
  A bootcamp on customized adaptable fabrication methods. a versatile molding mechanism was designed to cast parts of an algorithmically generated geometry. ['DiamondWall' Project]

2019
- **Digital Fabrication 'Boot-Camp' 2019**
  A digital fabrication project, focusing on proposing a rational fabrication method for complex concrete geometries. ['ConCreate' Project]

Teacher *University of Tehran, Tehran, Iran*

2017
- **Structural Systems for Architects**
  A course in B.Sc. and B.A. of Architecture on structural systems. Providing a general understanding about basic principals of statics, strength of material and structural analysis.

2017-18
- **Structural Systems for Architects**

2018
- **Structural Systems for Architects**

2019
- **Structural Systems for Architects**

Academic Experiences

Keynote Speaker

2017
- **ArchiMath!: Computation; Design; Math (Lecture Series)** *Arasbaran Cultural Center, Tehran, Iran*
  As a keynote speaker, my presentation covered applications of mathematics and geometry in Design. Namely topics on graph theory and topology were presented.

Mentor

2017
- **ArchiTech; Architecture Startup Weekend** *University of Tehran, Tehran, Iran*
  As an inter-disciplinarian mentor, I consulted groups through their business development process from an academic and technical point of view.

M.A. Dissertation Advisor

2018
- **Form Variety Assessment in High-rise Buildings Regarding the Governing Lateral Loads** *University of Tehran, Tehran, Iran*

2018
- **Algorithmic design of student interactive space in the central campus of University of Tehran using user data processing** *Iran University of Science and Technology, Tehran, Iran*

Invited Lecturer *Ab-Anbar Gallery, Tehran, Iran*

2017 **GSS 2017 [IaaC global Summer School/Tehran]**
As an invited lecturer in IaaC global summer school, a delivered a lecture on residual complexity in the digital design process. and how it can emerge into new material properties.

AWARDS, HONORS & RECOGNITIONS

2013 **National University Entrance Exam**
Ranked 8 within 140,000 applicants in the national university entrance exam.

2015 **First Honored Degree**
Graduated with first honor degree from University of Tehran

2018 **Letter of gratitude from Iran's Ministry of Architecture, Road and Urban Developments (Deputy of Architecture)**

2018 **Letter of gratitude from Head of Architecture Faculty,** University of Tehran

2018 **Letter of gratitude from Head of CEAT,** Center of Excellency in Architecture Technology

Independent Researches

2018 - Present **Parakeet**
In 2018, We Developed a Plugin for Grasshopper ® Focusing in Geometrical Form-Finding and Pattern Generation Called 'PARAKEET'. This Design Platform was Programmed by us in Paragen entirely.
PARAKEET has nearly 18000 Active user since its release.
[More information about PARAKEET: https://www.food4rhino.com/app/parakeet]

PUBLICATIONS

Proceeding ***A Geometrical Approach to Mitigate High-tech Machinery Requirement for Construction of Irregular Concrete Structures***

Proceeding ***Twisted Arc; Low-tech Geometry-based Node Design for Spatial Structures***

Proceeding ***Interdisciplinary Computer-aided and Simulation-based Architectural Design Program***

2018 ***Computational Revision of 'Space Syntax' Theory,*** author, 2018, IAU Periodical journal on Urban Management and development

2018 ***A computational design method for architectural plans based on constructability and space connectivity optimization,*** author, 2018, 5th Civil engineering, Architecture and Urban Development

2017 ***A Computational method for optimization of Tall buildings based on evacuation simulations,*** author, 2017, 3rd International Conference on Tall Building

2017 ***A Computational method for optimization of Tall buildings with modular constructability,*** author, 2017, 3rd International Conference on Tall Building

Language

English
Advanced

Farsi
Native

Skills

Hard Skills
- Programming
  - Python [Advanced]
  - Processing [Intermediat]
- Scripting
  - Grasshopper [Expert]
- Rhino [Advanced]
- Working With CNC's (Milling Machines), 3D Printers [Good]
- Electronics (Arduino/Raspberry Pi) [Intermediate]

Soft Skills
- Problem-Solving Attitude
- Algorithm Development
- Learning Discipline
- Effective Communication
- Teaching Patiently

CV

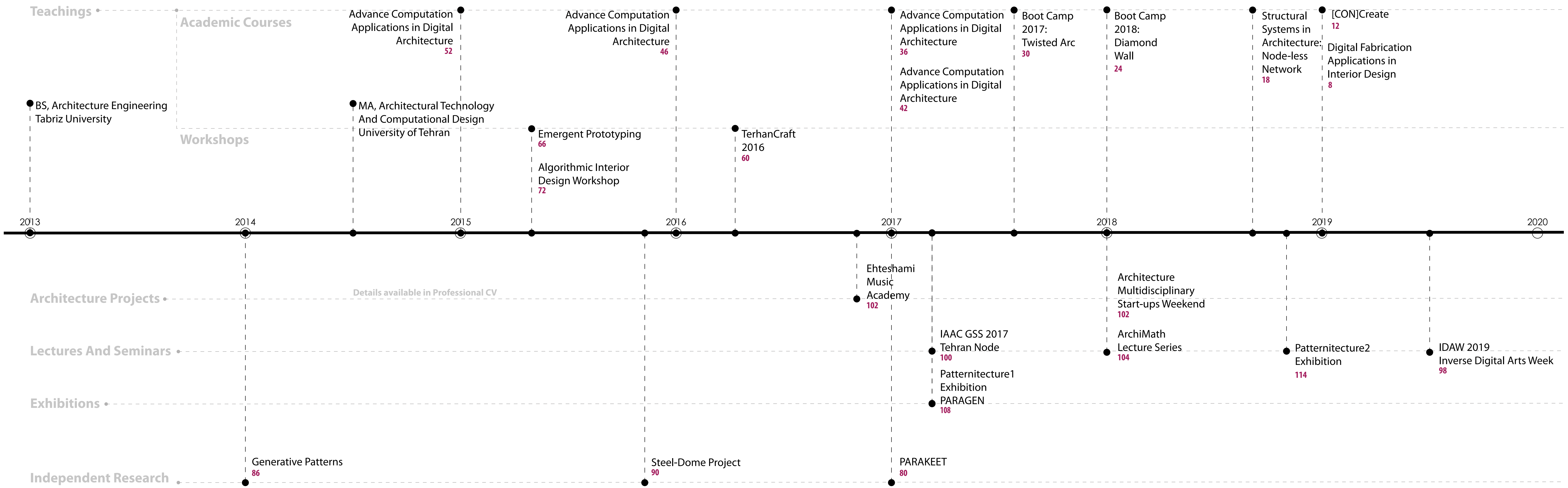
Academic
And Professional
2009-2020

Timeline

Academic
And Professional
2013-2020

Timeline

Academic
And Professional
2013-2020



TEACHINGS:

ACADEMIC COURSES

COURSE DIRECTOR / COMPUTATIONAL TUTOR

ACADEMIC COURSES	Course Director / Computational Tutor
WORKSHOPS	Workshop Director / Computational Tutor
INDEPENDANT RESEARCH	Researcher
ARCHITECTURE PROJECTS	Principal / Chief Architect
LECTURES AND SEMINARS	Key-Note Speaker / Invited Lecturer
EXHIBITIONS	Artist

ACADEMIC COURSES

DIRECTOR

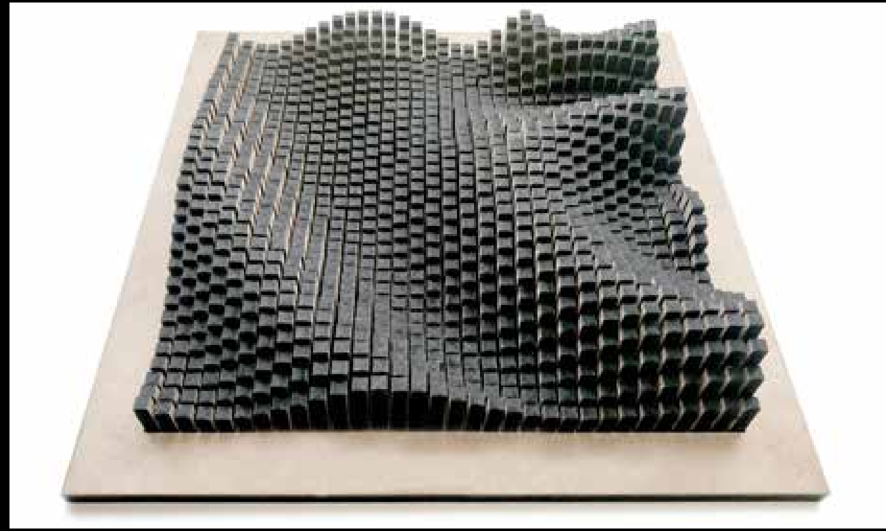
- Computational Design,
- Digital Fabrication.

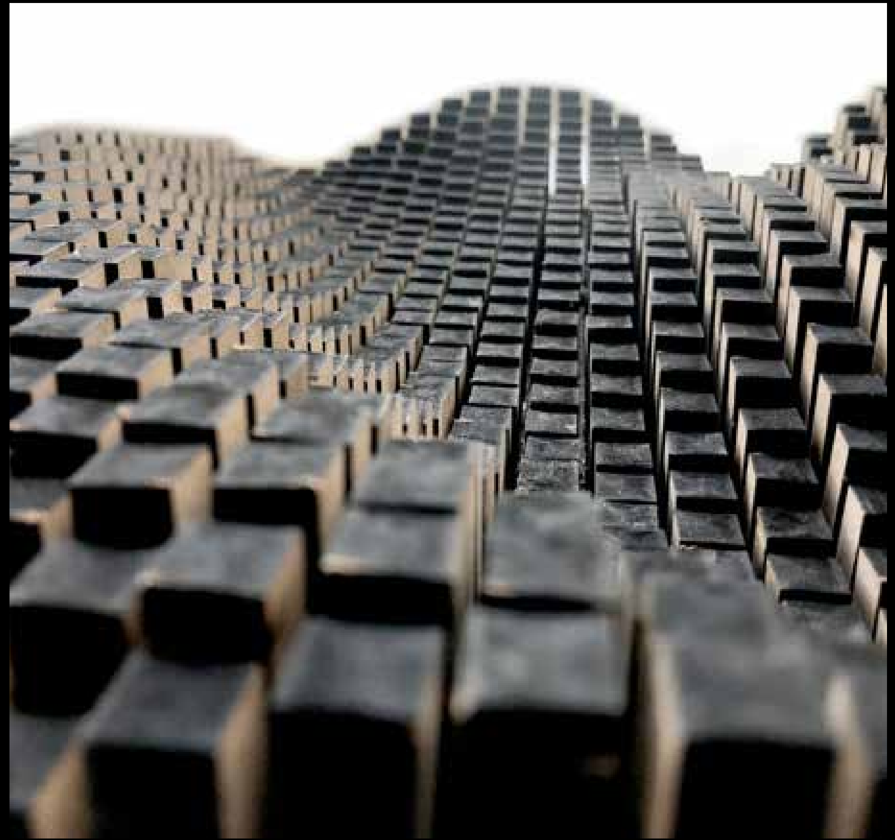
DIGITAL FABRICATION APPLICATIONS IN INTERIOR DESIGN

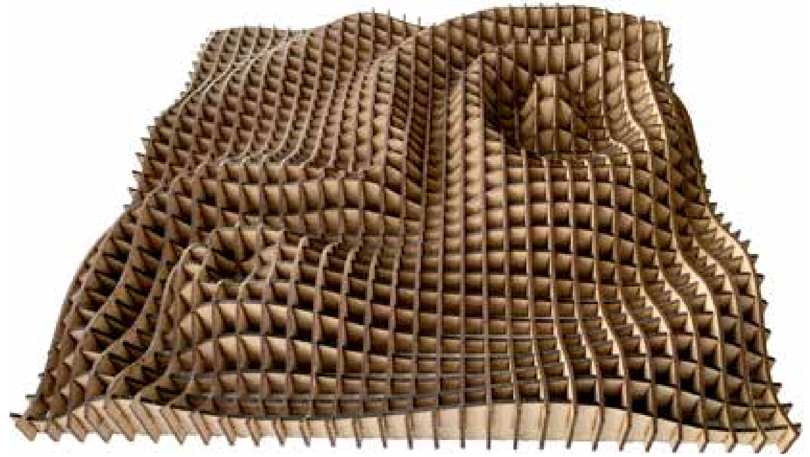
Instructors: Arman KhalilBeigi, Esmaeil Mottaghi
Year: Winter 2019
Host: Pars University of Art and Design, Tehran, Iran
Students: M.A Post Grad Students in Interior Design

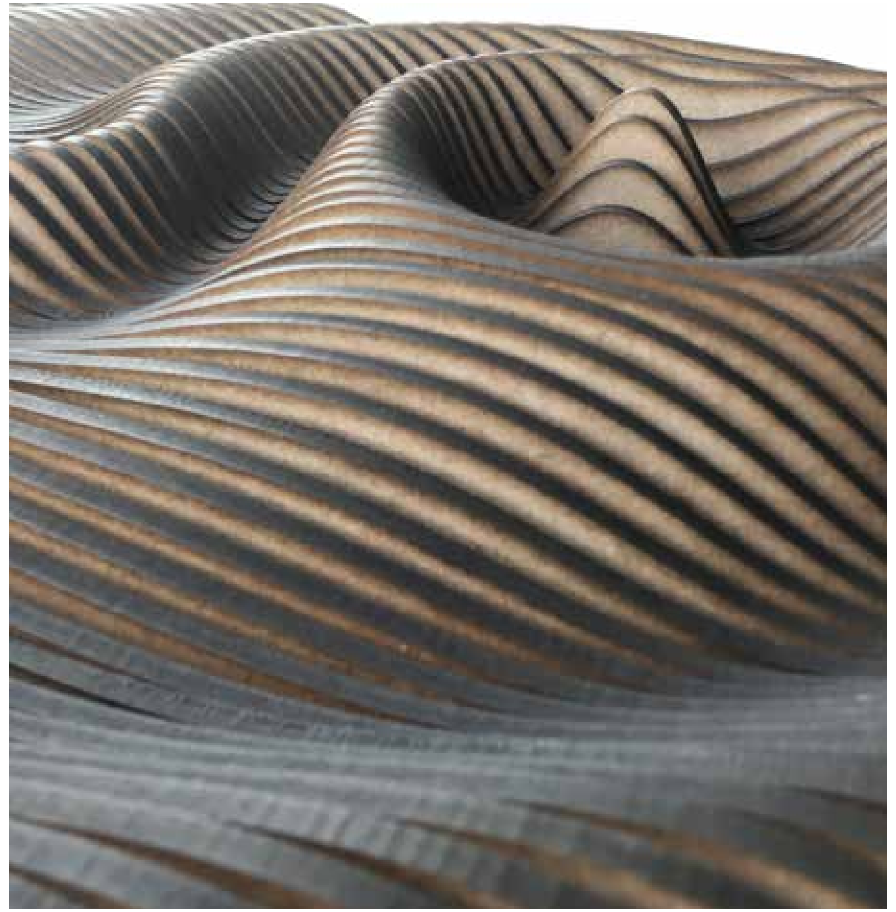
A university short course about potentials of common digital fabrication methods in interior design.

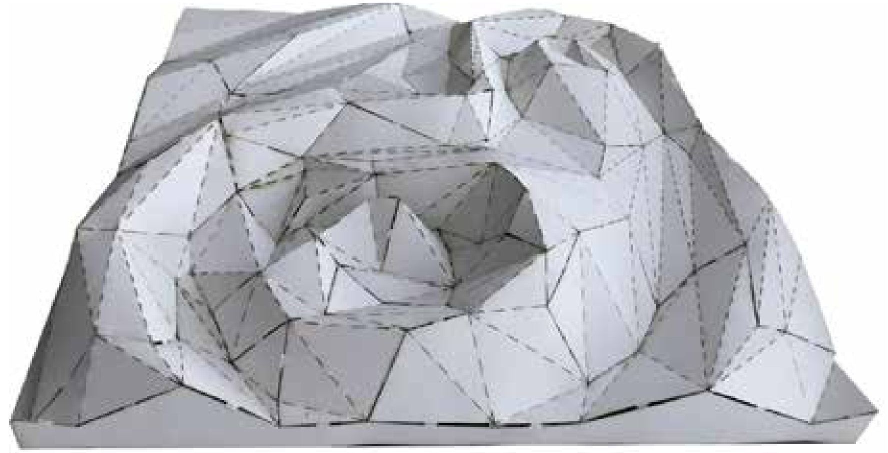
In this short course for MA post-grad students, we were invited to lecture about common digital fabrication techniques; the course focused on two main issues: digital form-finding and numerical fabrication. course agenda design to comprehend several origins for the design process rooted in computation and followed by introduction about a number of rapid prototyping methods. in the design phase, eventually, methods based on 'coherent-noises' selected to shape the final prototypes. furthermore, students were acquainted with post-rationalization processes were they were asked to re-think the assembling process and minimize waste of material and fabrication time.

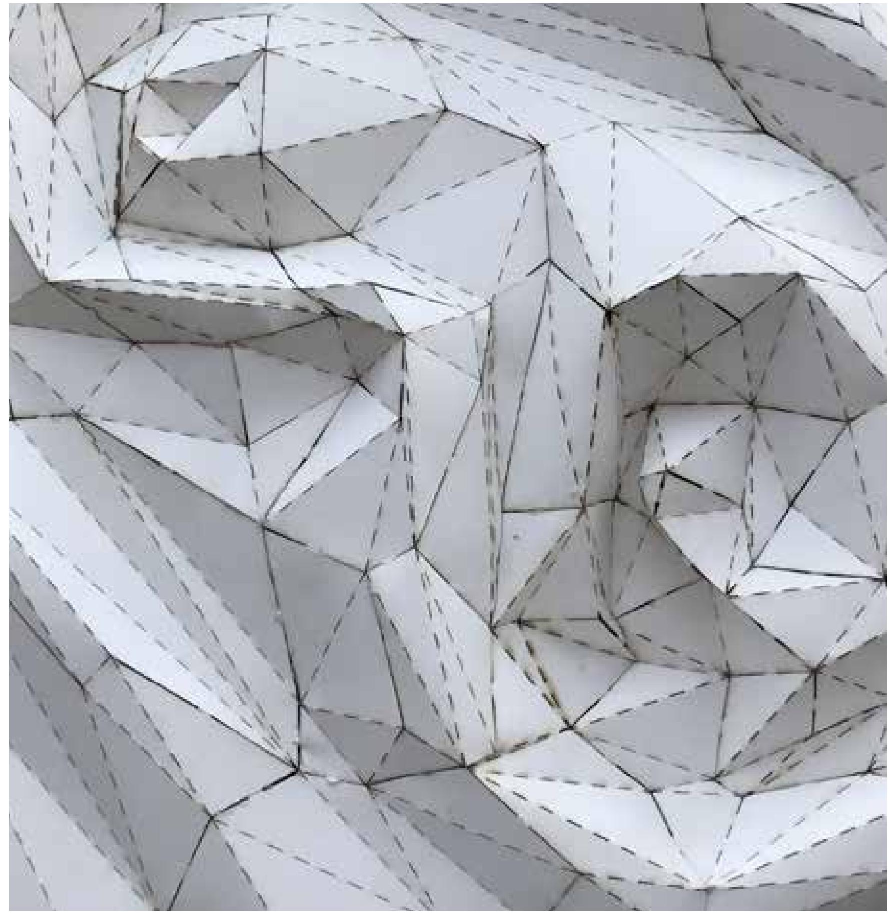












Digital Fabrication Applications in Interior Design

Academic
Director
Winter 2019

ACADEMIC COURSES

DIRECTOR

- Computational Geometry,
- Computational Design,
- Digital Fabrication,
- Concrete Technology.

[CON]CREATE:
A DIGITAL FABRICATION PROJECT

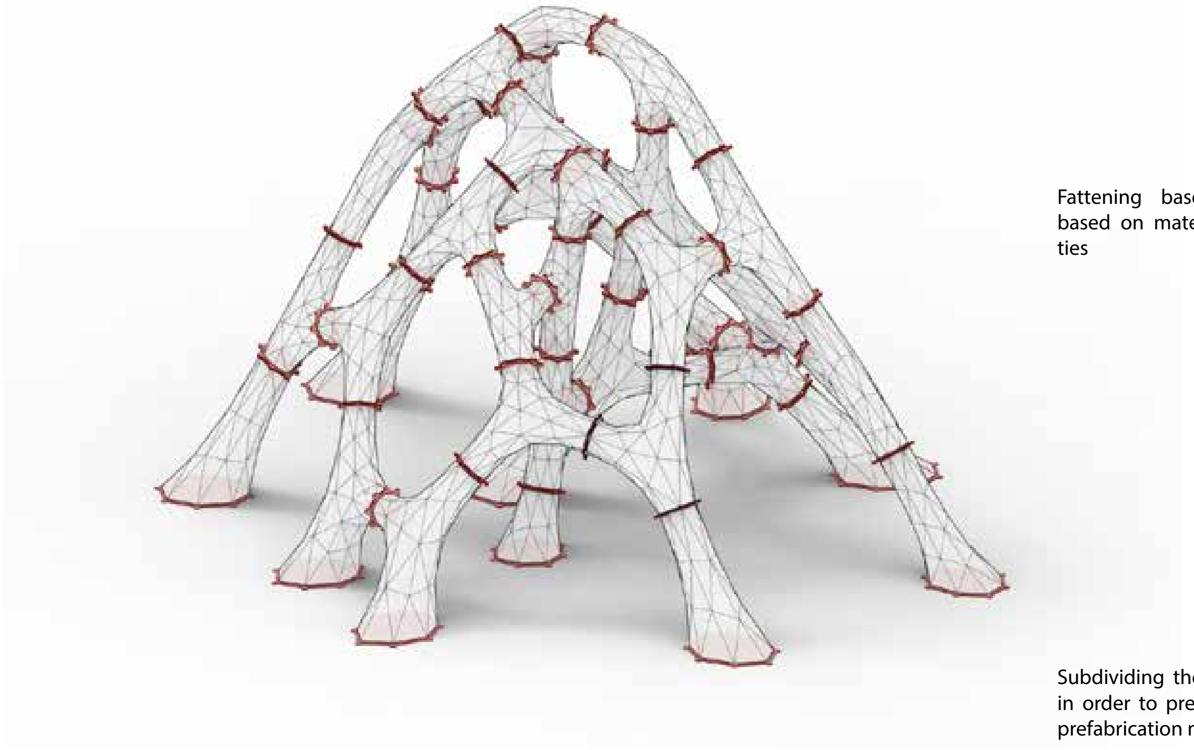
Instructors: Arman KhalilBeigi, Esmaeil Mottaghi, Saeedeh Kalantari, Sina Salimzadeh
Year: Winter 2019
Host: Science and Technology Park of University of Tehran, Tehran, Iran
Students: M.A Post Grad Students in Architecture Technology
Photographer: Shayan KhalilBeigi, Sara Ahmadi

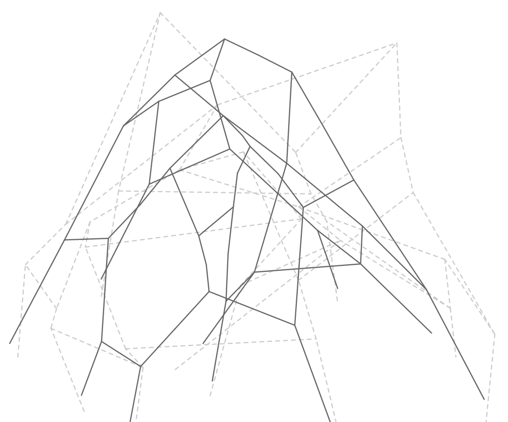
A digital fabrication project, focusing on proposing a rational fabrication method for complex concrete geometries.
In Collaboration with CEAT - Center of excellency in Architecture Technology -

This research project, emphases on re-thinking and re-designing common construction methods of concrete structures using benefits of 'Computational Design' tools and 'Digital Fabrication' potentials. The primary issue in this project is to propose a method to numerically fabricate these elements. Any proposal should have these properties: 1. Precision, to make sure minimum deviation occurs in concrete molding and assembly 2. Efficiency, in terms of minimizing waste of material on molds, minimizing cost and time of 3D CNC machinery. Eventually a hierarchical system of steel members developed inside each element that fulfilled the above statements. These steel members, a) are designed to be fabricated using common 2D laser cutting CNCs. b) perform as arming bars in ordinary concrete elements to bear tension forces and c) orientation of these members ensure that the outer shell is fabricated correctly thus rectifies any inaccuracy of outer mesh.

Design Process

In this effort in early stages of design process, values driven from Context and project's agenda develops basic data for form-finding process. Project was hosted by a Science-Park (start-up's acceleration complex) and located in a plain and uneventful site, in contrast to functionality of the space - which required users to actively participate and engage from different working groups and specialties – . hence one of the main objectives was to create a monument to act as social hub or attraction point to stimulate these multi-disciplinary dialogues and encourage interaction among different teams. by running a computer simulation, suitable areas where marked and based on this heatmap - representing presence of users, - Base-Nodes for geometry were selected. An interconnecting network on this set of points was created and later this network modified in terms of node-valance, connecting topology and architectural needs, later, through an 'Incremental loading' process, 3D network was generated. This form-finding process ensures that the resulting form will undergo Compression forces only (in case of applying dead loads) and also to improve this process, a 'Dynamic relaxation' method was also combined with that, in which firstly relaxes nodes and moderates the angels and secondly using different masses for each node, enables to control the geometry intuitively to comply to architectural requirements.

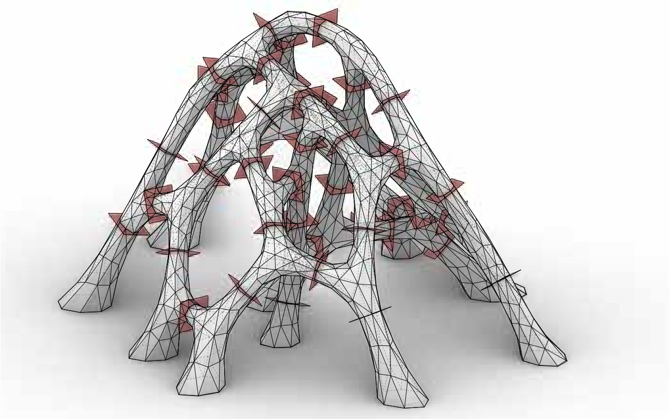




Form finding based on structural analyses

Primary line network

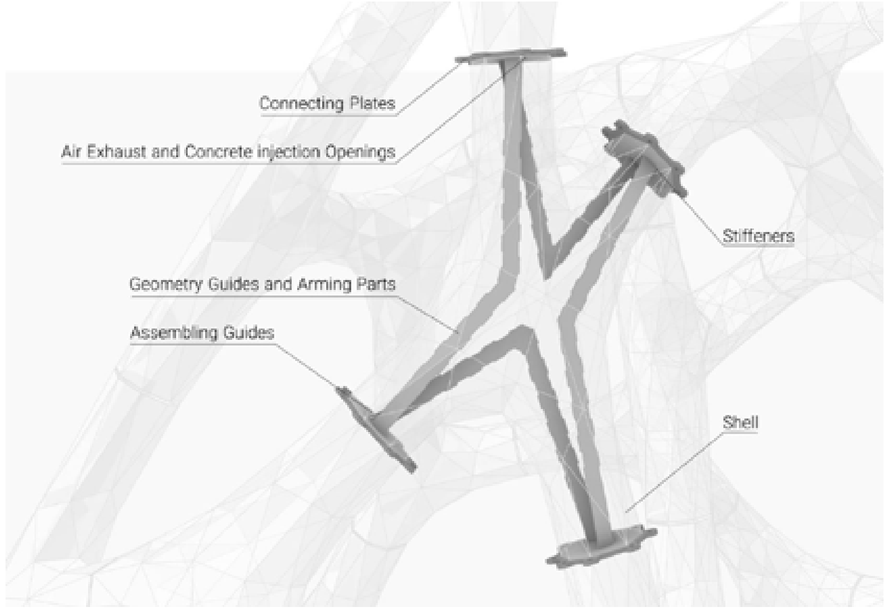
Fattening base elements based on material properties

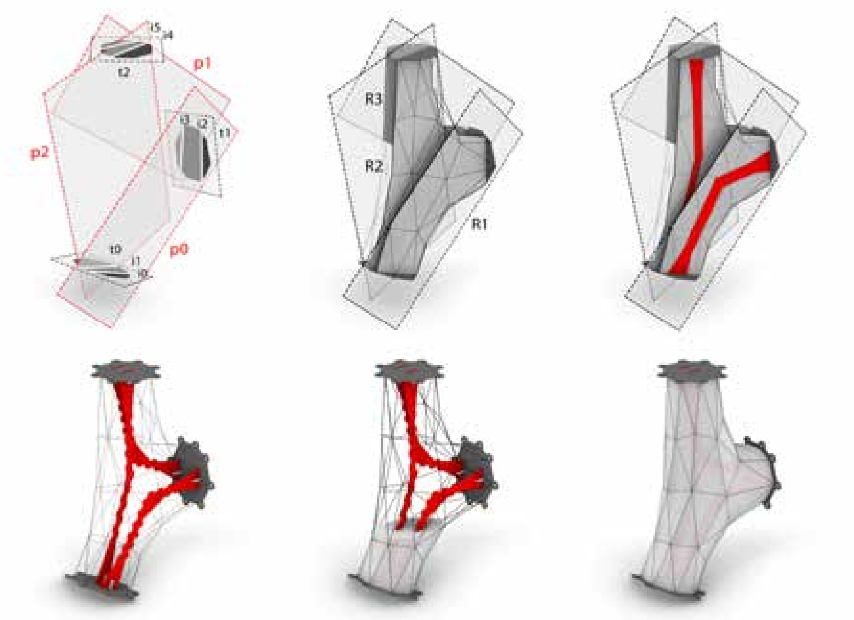


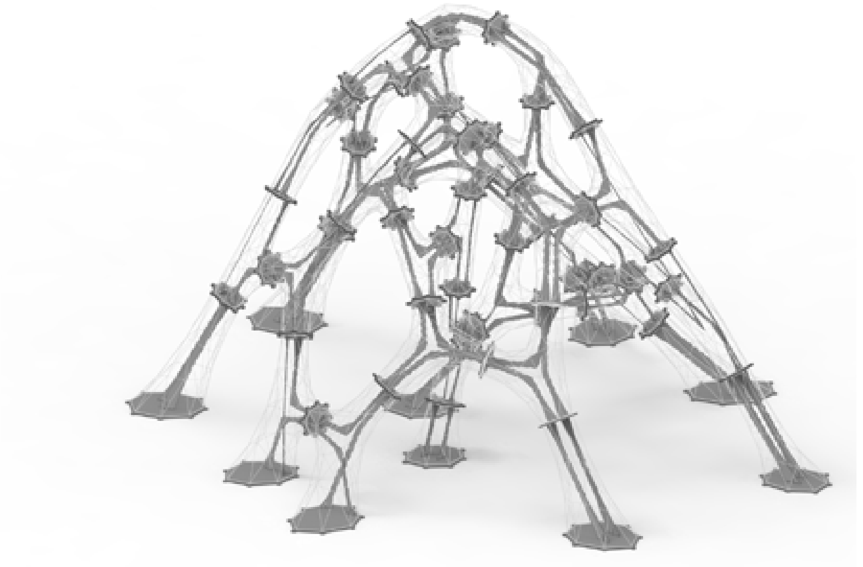
Subdividing the base form in order to preparation for prefabrication method

Technical Study

This basic 3D networks creates a variable Mesh, different radius in this mesh is corresponding to a) Forces in each element b) Construction limit of concrete. In order to make the structure able to be disassembled and assembled again this basic mesh was subdivided accordingly. This subdivision process was done recursively because any state of subdivision is closely related to position and orientation of other connecting [steel] elements and therefore not all possible subdivisions were practically valid.
The important issue in this project is presented in this stage; to propose a method to numerically fabricate these elements. Any proposal should have these properties: 1. Precision, to make sure minimum deviation occurs in concrete molding and assembly 2. Efficiency, in term of minimizing waste of material on molds, minimizing cost and time of 3D CNC machineries
Eventually a hierarchical system of steel members developed inside each element that fulfilled the above statements. These steel members, a) are designed to be fabricated using common 2D laser cutting CNCs. b) perform as arming bars in ordinary concrete elements to bear tension forces and c) orientation of these members ensure that the outer shell is fabricated correctly thus rectifies any inaccuracy of outer mesh.



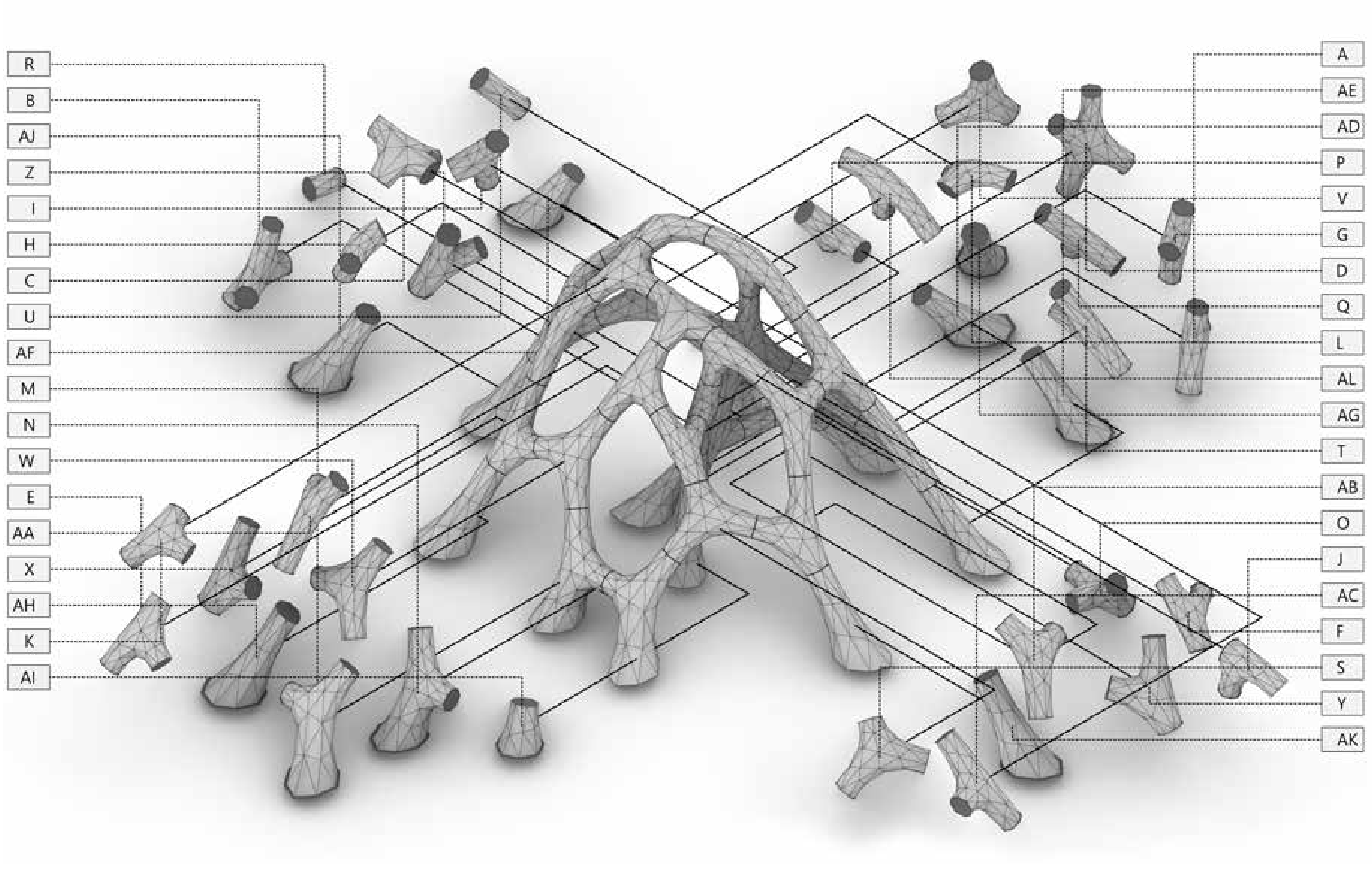




Material Study

Material study in this research focused on proposing a concrete which is, a) light so that each part can be maneuvered by hand, b) has Mechanical durability and, c) has adequate strength. By using expanded light aggregations, weight was reduced significantly but by nature weakens the concrete, this problem compensated by adding steel and glass micro fibers and mineral admixtures. Plasticizers were also added to increase workability with the material.

Fabrication & Assembling



Eventually the assembling process was also subject of computational study, aiming to minimize deflection of unsupported elements during assembly and avoid imposing unpredictable tensions on the structure.
All the connections in this structure is dry-connected and therefore able to be dismantled and reused in another location. Total volume of the fresh concrete is less than 1.5 m3. proposed concrete weighs about 30% less than common concretes used in construction and has ~95% higher maximum strength. Assembling process was completed less that 26 hours. The structure covers ~38 m3 of space.

ACADEMIC COURSES

DIRECTOR

- Computational Design,
- Digital Fabrication,
- Augmented Reality,
- Virtual Reality.

STRUCTURAL SYSTEMS IN ARCHITECTURE

Instructors: Arman KhalilBeigi, Esmaeil Mottaghi
Year: Fall 2018
Host: University of Tehran, Tehran, Iran
Students: B.A Undergrad Students in Architecture

A digital fabrication project based on eliminating node from node-based spatial structures and making design and fabrication process compatible with 2D common fabrication methods. AR/VR technologies were implemented in part forming and assembling process.
In Collaboration with CEAT - Center of excellency in Architecture Technology.

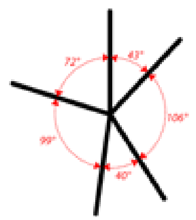
A fabrication Project for "Structural Systems" BA Course, to Design and Fabricate a Node- Less 3D" Structure and Using Augmented Reality to Control Manufacturing and ."Assembling Processes Students in this course received several lectures on the various structural systems. throughout the course, they came up with an idea of how to eliminate the 'Node/Joint' in a 3D structure based on the fact that a large portion of costs and fabrication time is allocated to the manufacturing of Nodes in common 3D structures.

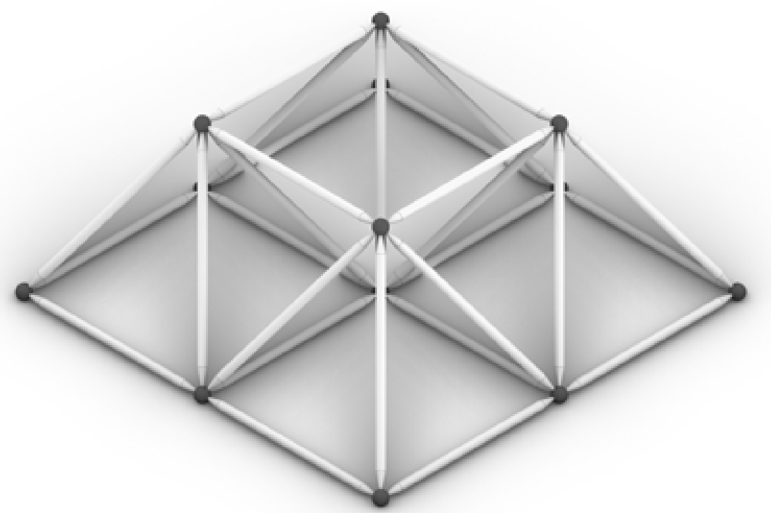
Structural Systems In Architecture

Academic
Director
Fall 2018

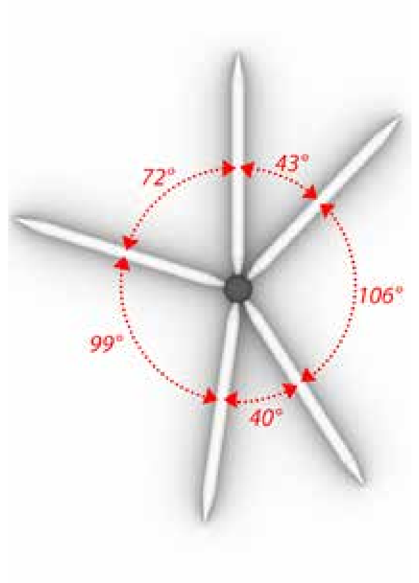
Fabrication Strategy

The project started while exploring potentials of Augmented reality in real-word construction projects. At the time we were concerned with the problem of how to instruct ordinary construction workers to build and assemble a parametric wall. having that in mind through my class of 'Structural Systems' I stated the fact that a large portion of time and money in the construction of Space Frames and Space trusses is allocated to the fabrication of its 'Joints'. and that formed the key idea behind the Node-less Network workshop and that is 'What is the cheapest way of constructing a 3D Spatial Structure?'.
We tackled that question in many aspects; A) by using recycled materials, B) by omitting dependency on CNC machinery, and C) Controlling the process with augmented reality.
Normal cold/hot bending CNCs can be used to bend a rod or strut to a certain angle also there are ongoing researches on Robotic rod-bending, but these are not available nor affordable in ordinary day to day constructions. Therefore, a simple non-motorized machine was designed to bend the rod, and to control and measure the process AR model was used. naturally, but using this bending technique Nodes or Joints are omitted which leads to a significant drop in costs. Eventually, after forming all the pieces, the assembling process was done with the help of AR as well.

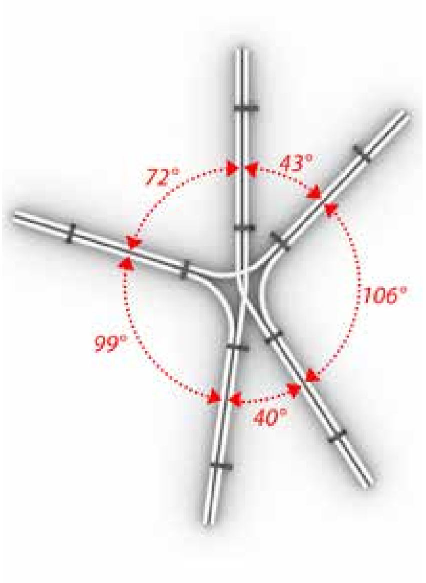




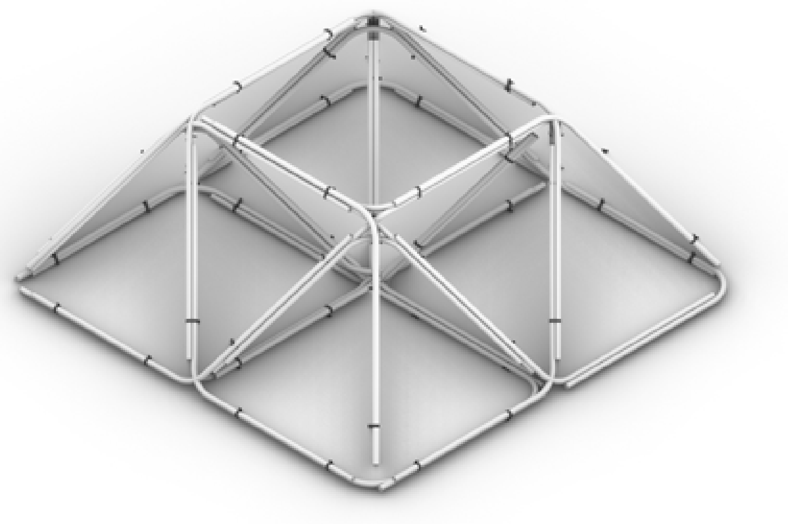
Regular space frame structure with 3d Nodes



Make a connection between elements with 3D nodes.



Make a connection between elements without nodes.



Recommended Node-less space frame structure

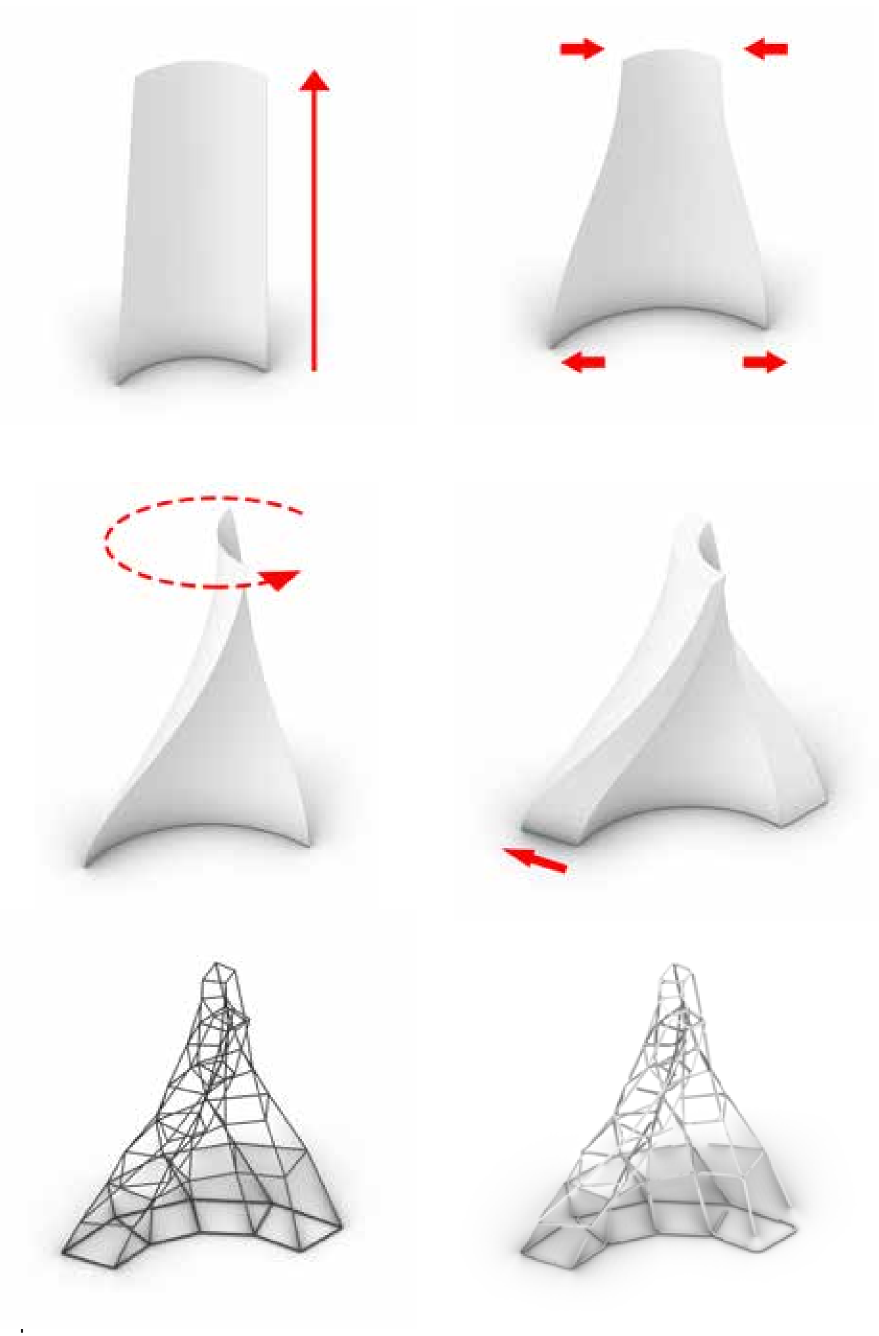
Material : Useless pipes

Fabrication Tools

Physical ;Bending Tool | Cable Tie

Digital ; Augmented Reality

Design Process



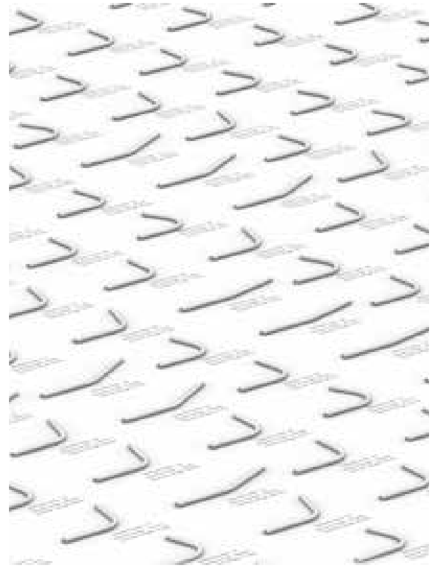
Structural Systems In Architecture

Academic
Director
Fall 2018

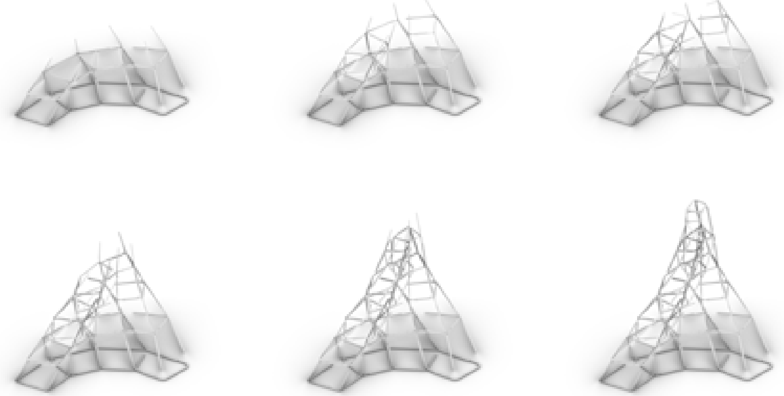
Structural Systems In Architecture

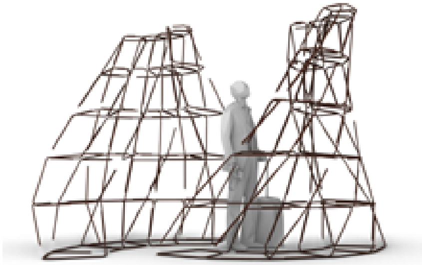
Academic
Director
Fall 2018

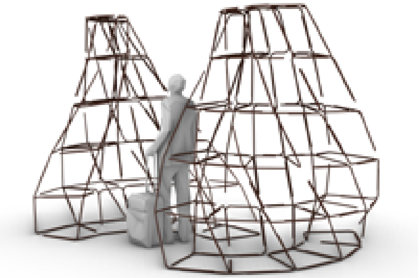
Bending Process



Assembling Process







Structural Systems In Architecture

Academic
Director
Fall 2018

ACADEMIC COURSES

DIRECTOR

- Generative Design,
- Digital Fabrication

DIAMOND WALL

Instructors: Arman KhalilBeigi, Esmaeil Mottaghi, Sina Salimzadeh
Year: Winter 2018
Host: University of Tehran, Tehran, Iran
Students: M.A Post Grad Students in Architecture Technology
Photographer: Sara Ahmadi

A digital fabrication workshop on creating customized adaptable fabrication methods. a responsive versatile molding mechanism was designed to cast parts of an algorithmically generated geometry.
In Collaboration with CEAT - Center of excellency in Architecture Technology -

Based on a profound study of geometrical patterns, two classified matrices of pattern were generated based on two key parameters; a) similarities in method of pattern/network generation [which formed the first table (matrix A)] and b) geometrical characteristics of the resulting shapes [formed the second table (matrix B)]. The objective was to design a customized fabrication mechanism corresponding to the method that the pattern was originally drawn.

As using a customized machine is more efficient rather than using universal CNC machines, (in term of construction time, compatibility, expenses, developability and etc) mechanisms were proposed based on each class of patterns (from matrix A). These mechanisms were cross-referenced against the matrix B. Suitable features from matrix B like node-valency, angle deviation, continuity type and range of areas of each cell were parameters that performed as benchmarks that evaluated the alternatives.

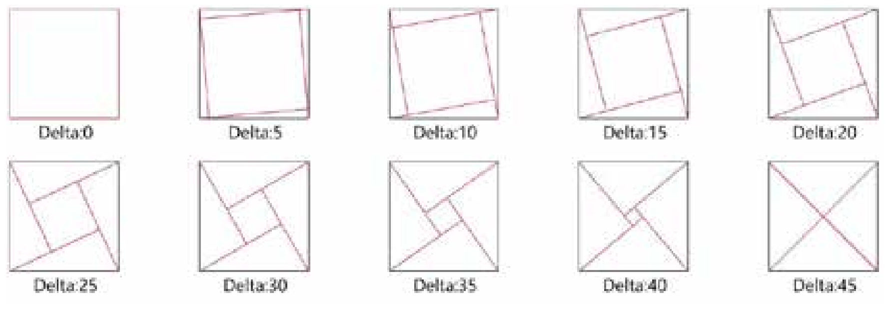
Eventually a mechanism is selected in which is fully integrated and compatible with the method that the pattern was drawn and secondly the resulting geometry has suitable geometrical properties.

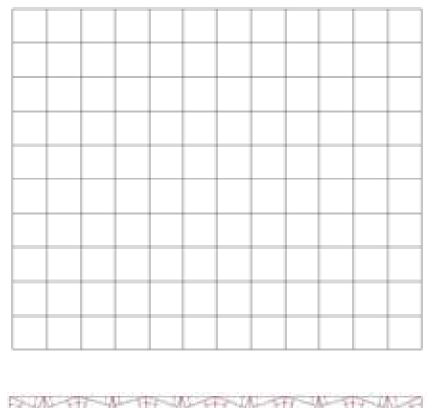
Based on the mechanism and pattern selected, a heterogeneous shape was designed (a 200x240 cm wall) comprised of 120 modules. The mechanism provides a kinetic mold that adapts to each module with a real-time connection to design software using an Arduino Uno kit and servo-motors coded with C# in grasshopper.

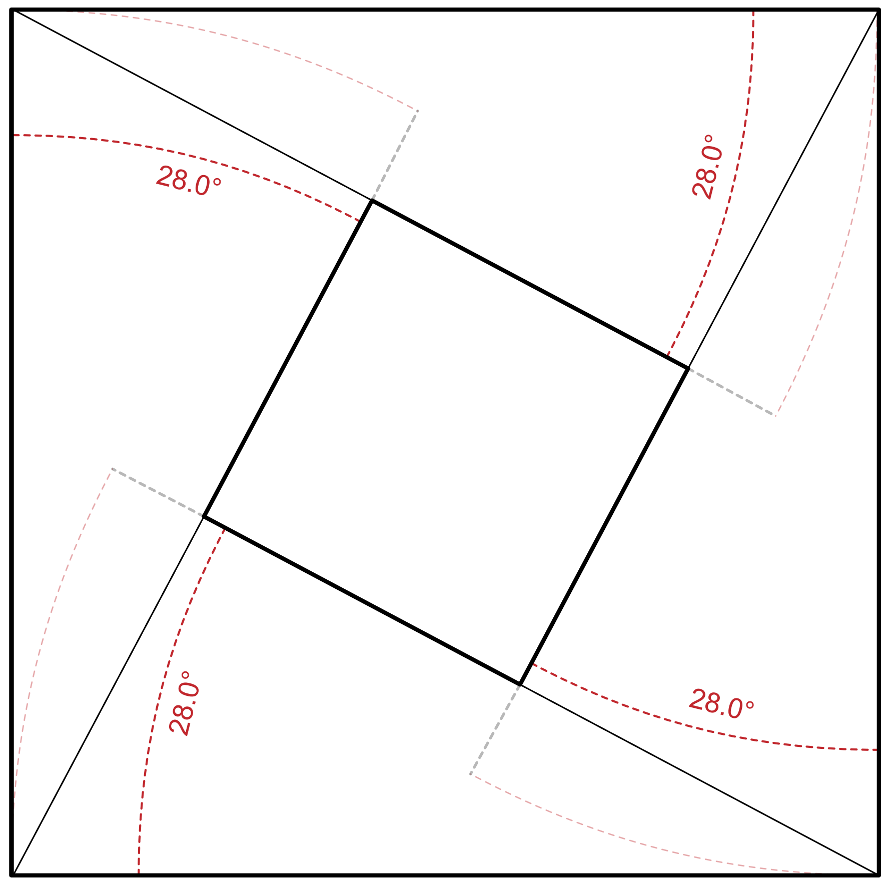
Subsequently on phase of material research, material strength and time of material setting was two key issues. A mixing scheme for concrete was concluded from various trial and errors, comprised of fast-setting cement, micro glass fibers, molding gypsum and construction gypsum. This mixture enabled to cast each module in total time of 9 minutes. Casted modules rested for 48 hours and assembled within a steel frame on a concrete bed.

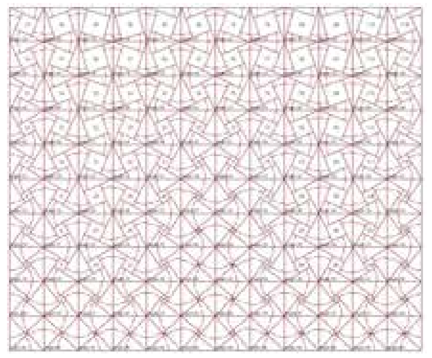
Geometry Study

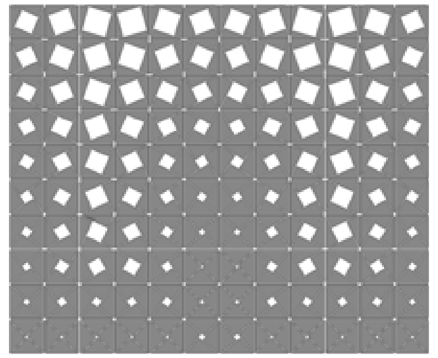
Based on a profound study of geometrical patterns, two classified matrices of pattern were generated based on two key parameters; a) similarities in method of pattern/network generation [which formed the first table (matrix A)] and b) geometrical characteristics of the resulting shapes [formed the second table (matrix B)]. The objective was to design a customized fabrication mechanism corresponding to the method that the pattern was originally drawn.





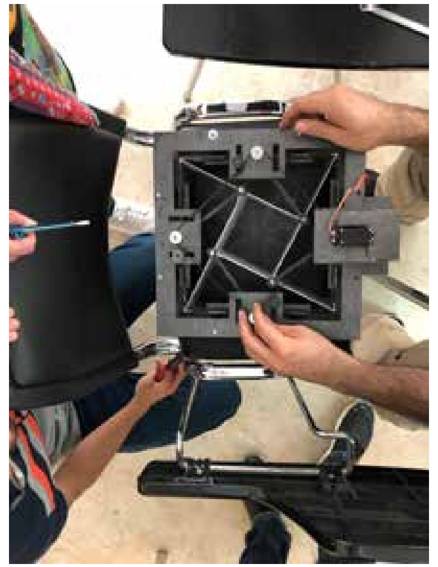


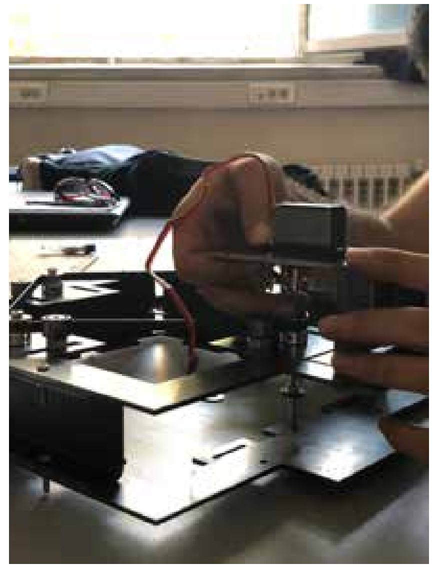


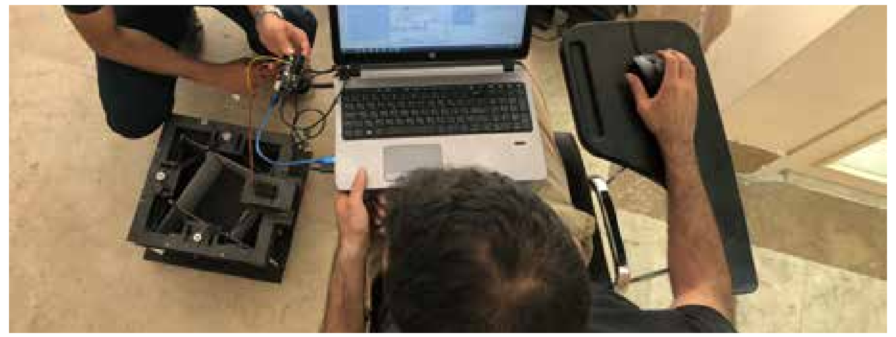


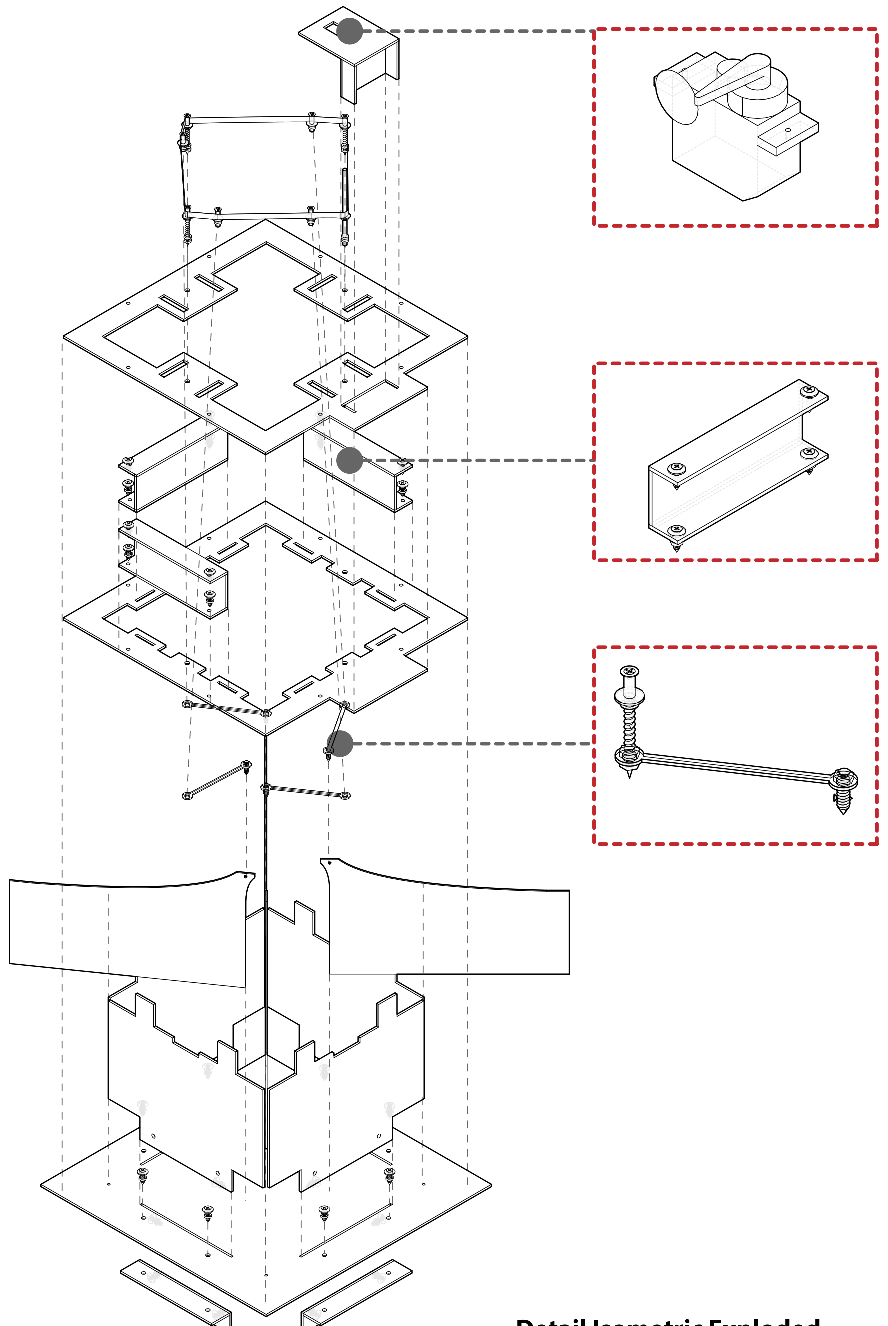
Technical Study

As using a customized machine is more efficient rather than using universal CNC machines, (in term of construction time, compatibility, expenses, developability and etc) mechanisms were proposed based on each class of patterns (from matrix A). These mechanisms were cross-referenced against the matrix B. Suitable features from matrix B like node-valency, angle deviation, continuity type and range of areas of each cell were parameters that performed as benchmarks that evaluated the alternatives.









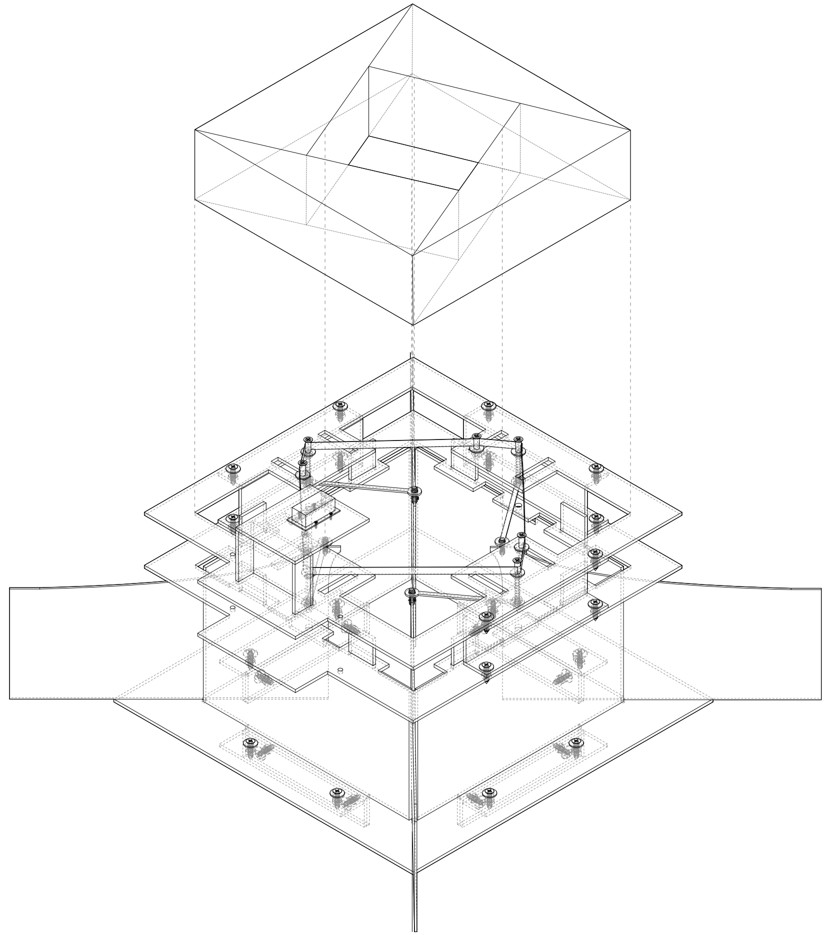
Detail Isometric Exploded

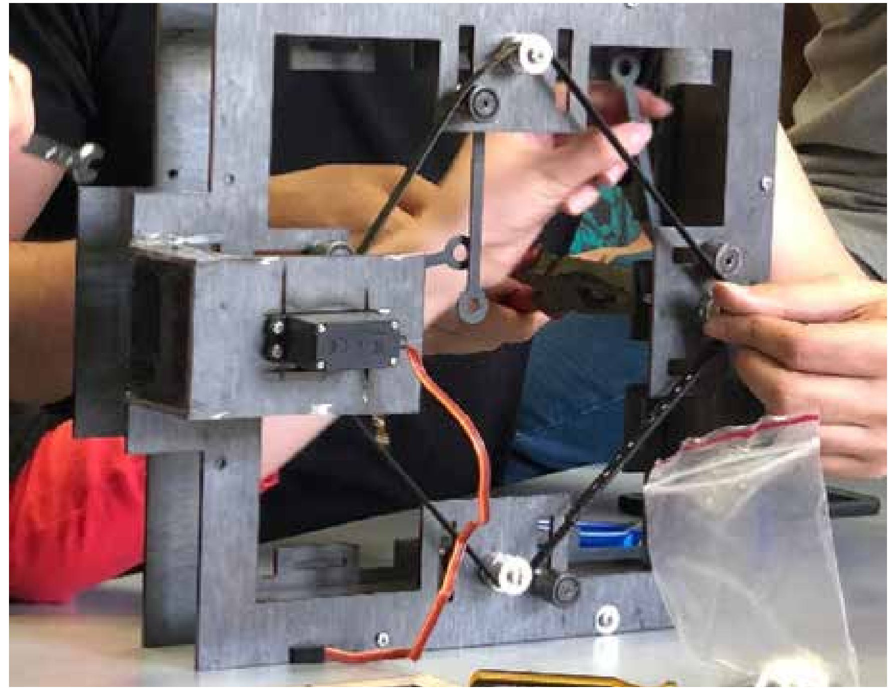
Diamond Wall

Academic
Director
Winter 2018

Technical Study

Eventually a mechanism is selected in which is fully integrated and compatible with the method that the pattern was drawn and secondly the resulting geometry has suitable geometrical properties.
Based on the mechanism and pattern selected, a heterogeneous shape was designed (a 200x240 cm wall) comprised of 120 modules. The mechanism provides a kinetic mold that adapts to each module with a real-time connection to design software using an Arduino Uno kit and servo-motors coded with C# in grasshopper.





Material Study

Subsequently on phase of material research, material strength and time of material setting was two key issues. A mixing scheme for concrete was concluded from various trial and errors, comprised of fast-setting cement, micro glass fibres, molding gypsum and construction gypsum. This mixture enabled to cast each module in total time of 9 minutes. Casted modules rested for 48 hours and assembled within a steel frame on a concrete bed.

Diamond Wall

Academic
Director
Winter 2018

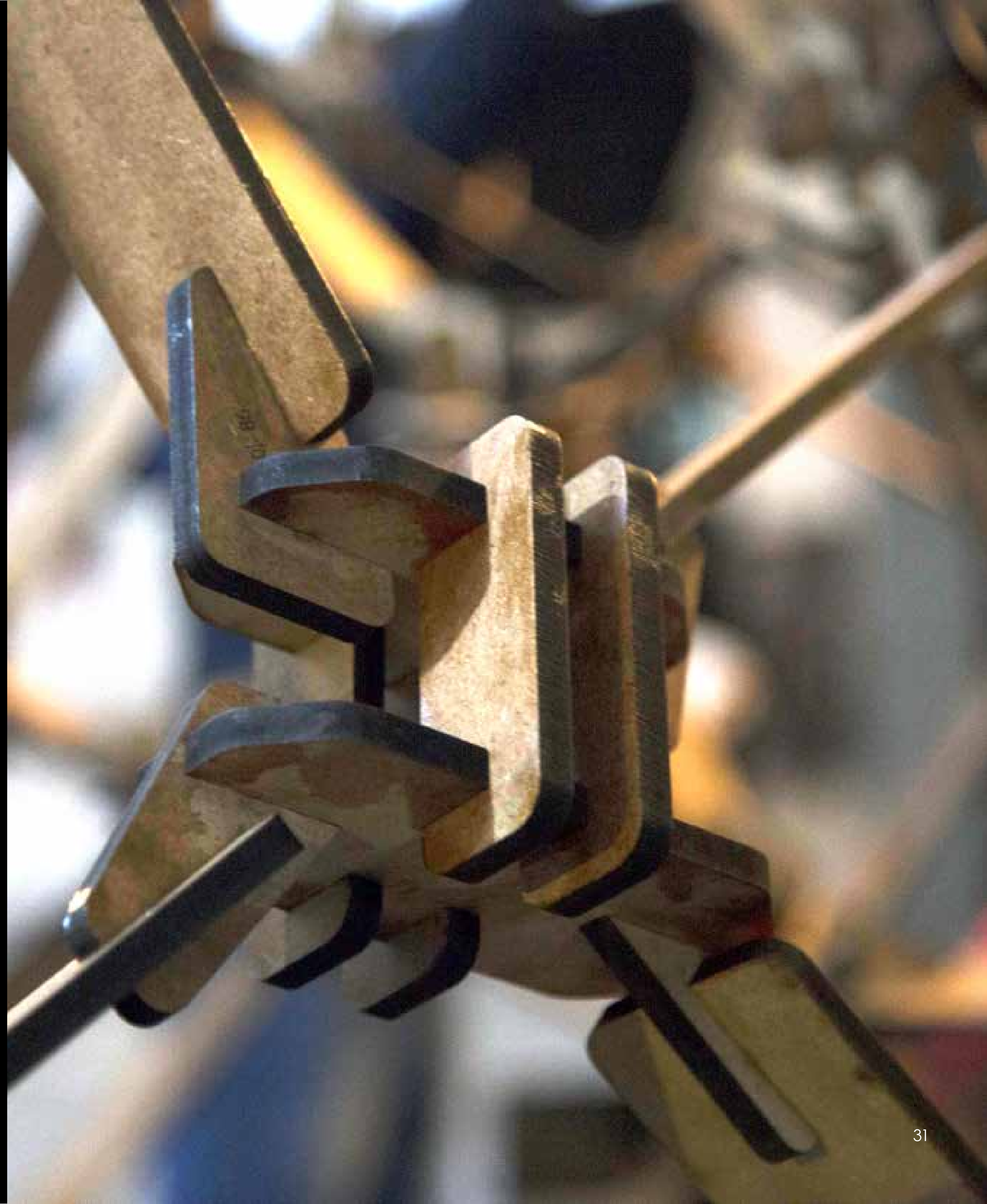
- Computational Design,
- Structural Design,
- Digital Fabrication,
- Computational Geometry,

TWISTED ARC

Instructors: Arman KhalilBeigi, Esmaeil Mottaghi
Year: Fall 2017
Host: University of Tehran, Tehran, Iran
Students: M.A Post Grad Students in Architecture Technology
Photographer: Sara Ahmadi

A project focused on proposing a method for the construction of arbitrary spatial structures with low-tech 2D machinery and geometrical solutions.

The “Twisted Arc” research pavilion is an outcome of a 40-hour workshop held by university of Tehran. The agenda concerns about fabricating a 3d structure with two-dimensional components and low-tech 3-axis machinery. In common types of 3d structures (for instance space trusses and space frames) a large portion of cost and time is allocated to fabrication of 3D Nodes. Therefore, the key question in this flash course of how to optimize this step. Shifting the complexity from high-tech machinery towards complex computational design can solve this issue efficiently, as with a thorough geometrical study the 3D nodes can be replaced with a number of 2D interlocking elements.

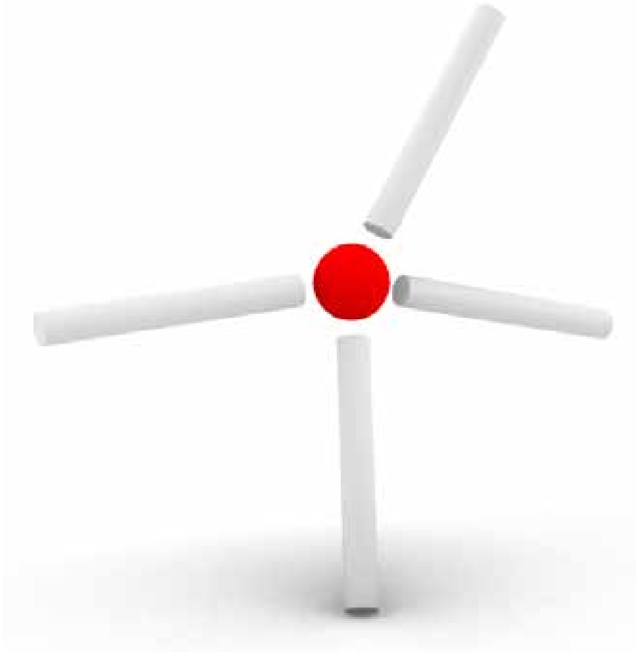


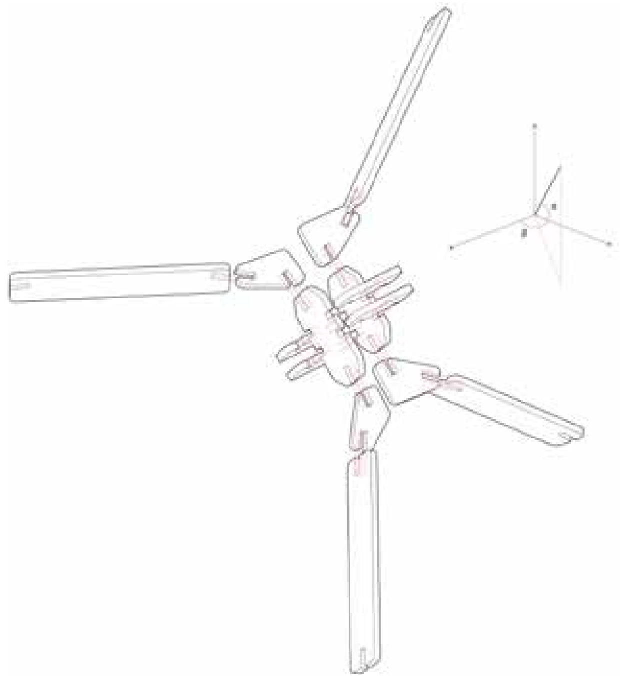
Twisted Arc

Academic
Director
Fall 2017

Technical Study

In design process of this interlocking nodes, it was intended to minimize the parts. Thus, possible scenarios considered about how various bars connect to each node. To handle the position and rotation of each bar, corresponding elements were generated. These parts not only respond to orientation of the bar connecting to it but also the topological hierarchy of the bar in elements network (since elements in Support area and edging area need to behave differently).
By designing this method of node generation, it was applied on several geometries of different curvature and boundary conditions. One of these geometries that was self-supported and double curved was selected for prototyping in large scale. The location of each element was determined based on curvature of the based geometry and relative location of the neighboring elements so that all nodes and bars have reasonable sizes and lengths.





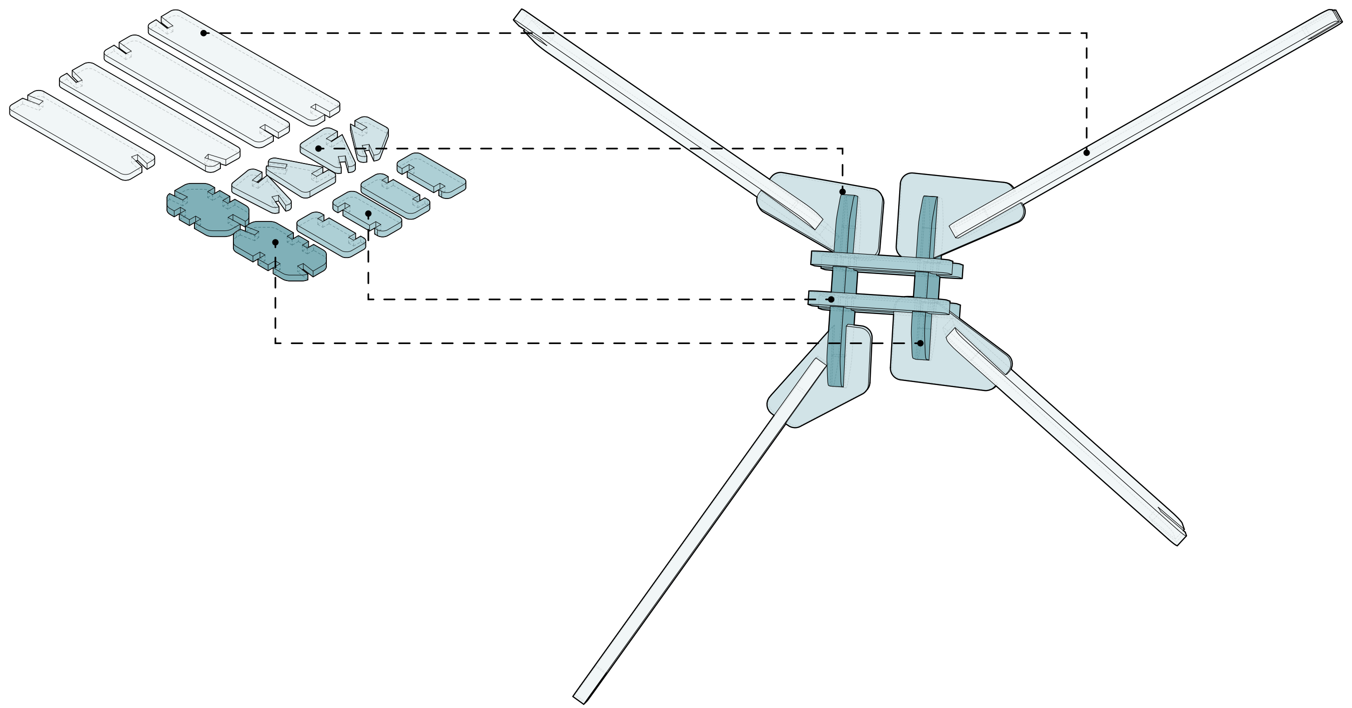
Technical Study

Subsequently an indexing method was used to determine which parts are connected each other. And by using a conventional 3-axis plasma/laser cutter, parts were fabricated from 8mm MDF wood.

The assembling process started by drawing the foot prints of the pavilion on the ground by surveying methods. Each node was assembled by press-fit finger joints and the process started with supported areas up to the keystone top of the pavilion.

Twisted Arc

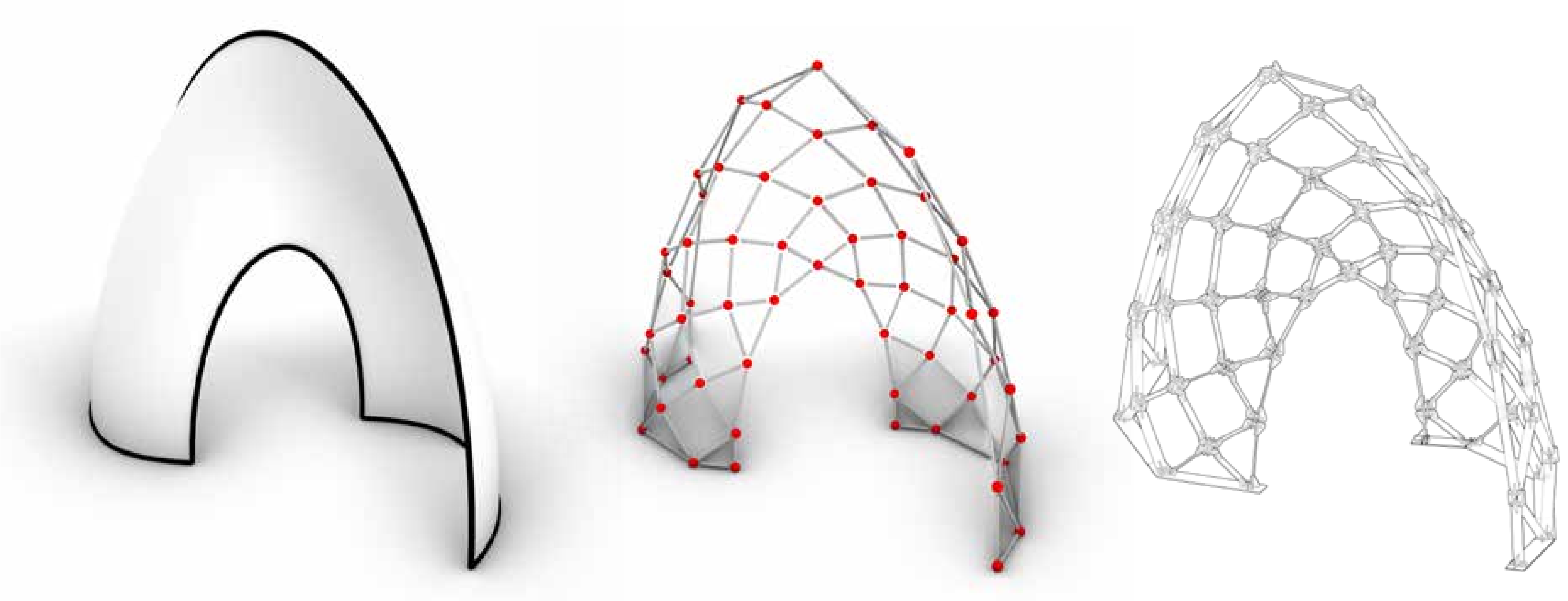
Academic
Director
Fall 2017



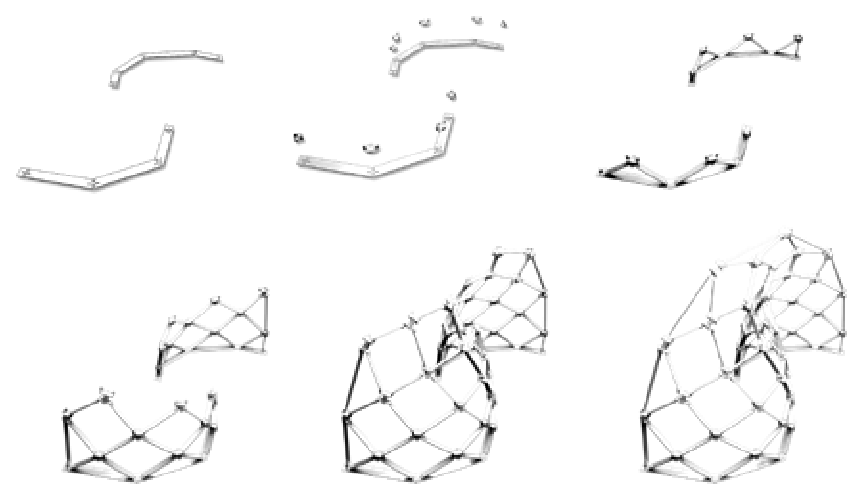
Geometry Study

Another important point is that among several possible patterns that could create a stable structure, the impact of the pattern and the resulting elements was examined; patterns with maximum node-valance of 4 can lead to smaller and simpler joints. (Node Valance is maximum number of linear elements connected to each node)

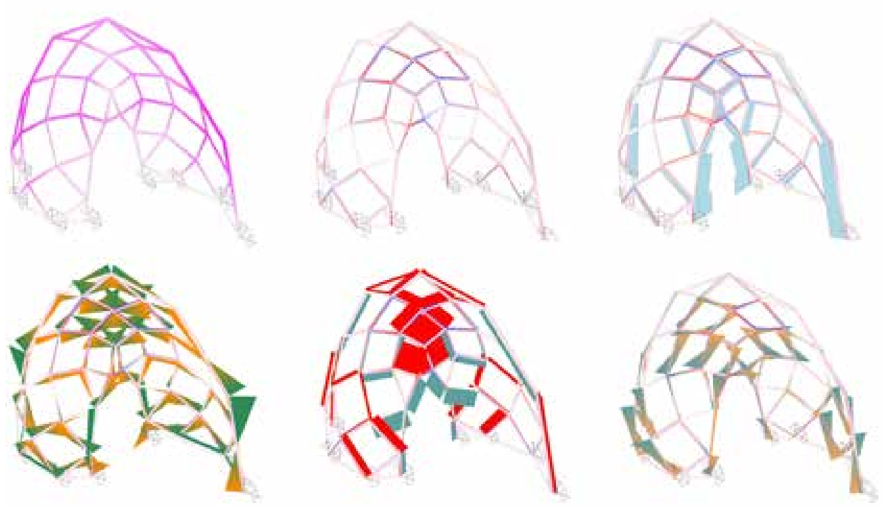
By having a self-supporting stable form with double curvatures, and a structural pattern consisting of quadrilateral cells, final parts were designed; design of the node was the main challenge. Each node had to be able to receive 4 (or 3) bars with different orientations, and because of the fabrication technique, the node should have a part exactly perpendicular to its connecting bars. In areas with higher curvature, the bars are close and dens so there was a high risk of self-collision and error in parts of each node. By using a parametric model and algorithmic approach in detailing, each node is shaped based on conditions of its neighbors and was eventually checked for any problems.



Assembly Process



Structural Analysis



Twisted Arc

Academic
Director
Fall 2017

ACADEMIC COURSES

DIGITAL DESIGN AND FABRICATION TUTOR

- Computational Design,
- Design Rationalization,
- Physical Modeling,
- Computational Geometry

ADVANCE COMPUTATION APPLICATIONS IN DIGITAL ARCHITECTURE

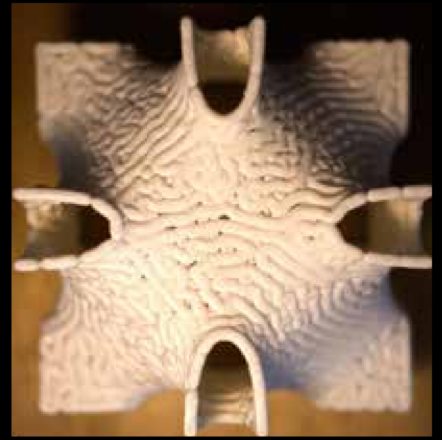
Instructors:	Arman KhalilBeigi, Esmaeil Mottaghi
Year:	Winter 2017
Host:	University of Tehran, Tehran, Iran
Students:	M.A Post Grad Students in Architecture Technology

A University course focused on paper-less conceptualization; a bottom-up approach for creating 'Design Tools' based on multiple disciplines.

The studio was intended to explore the potentials of using computational algorithms and simulations as the initiative of the design process in architectural design and also the tool by which students develop their ideas. Participants examined disciplines associated with design in order to apply their methodology and problem solving processes into architectural design. Interdisciplinary fields such as physics, math, geometry, biology and mechanics were designated to be studied in this process. This studio was held in Fall 2017 and joined by 17 students.

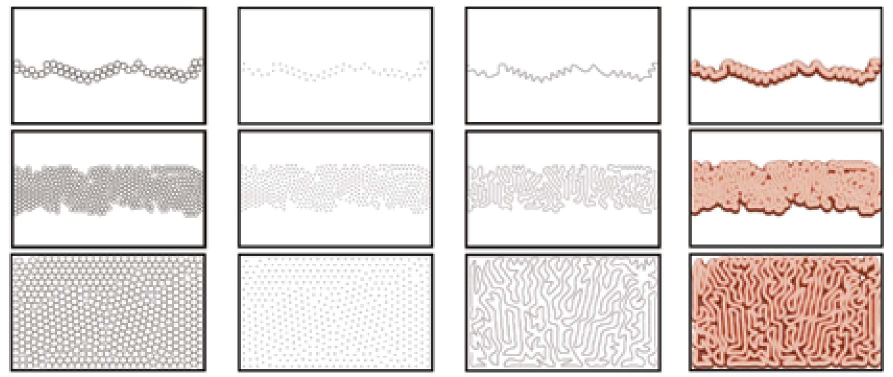
The program started by lectures about introduction to computational design followed by more detailed lectures in the connections among each field of art and science and architectural design, number of featured projects were Designed based on 1) physics simulations 2) Mathematical expressions 3)Rule-based Computations 4)bionics simulations



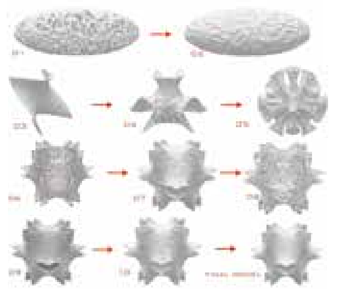
Team #1

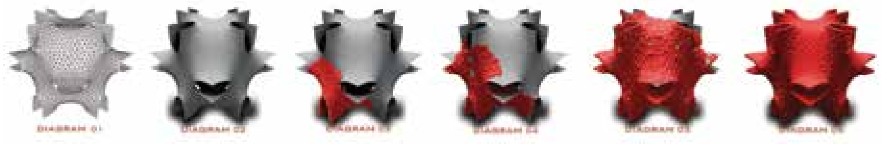
Physical Simulation

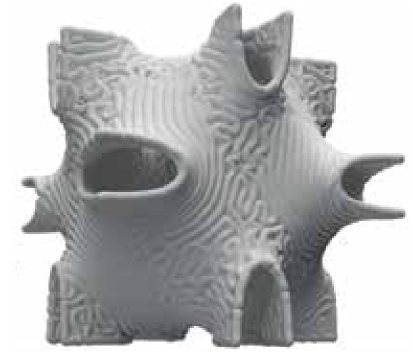


Design Algorithm

The basic idea was to mimicate a differential growth pattern without getting into numeral iterative process of it therefore Circle Packing on a surface using kangaroo physical engine was the alternative. A minimal surface was selected as the base geometry. And the polyline connecting centers of the packed system forms a single line probing covering the surface. These trajectories formed the base mesh for next step.





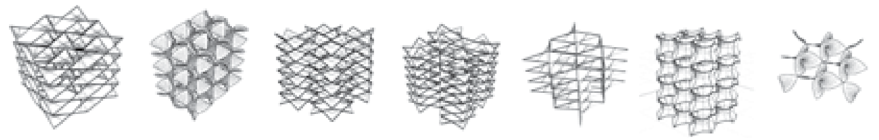


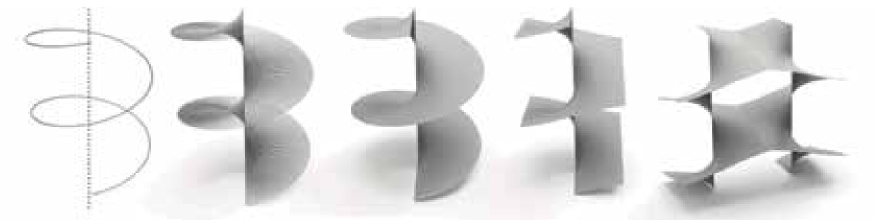
Team #2

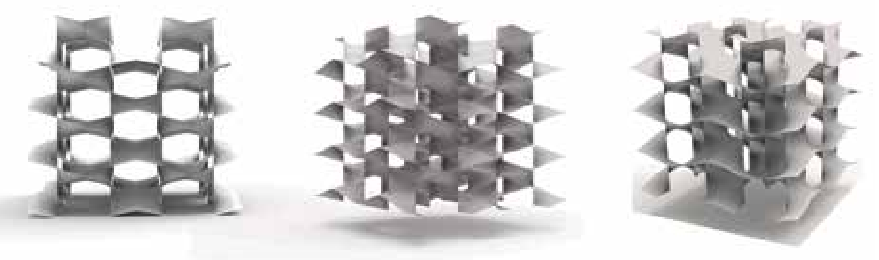
Mathematical Modeling

Ruled Surfaces

A ruled surface is defined by the property that through every point in the surface, there is at least one straight line which also lies in the surface. A Ruled surface may be though of as one 'swept out' by a straight line moving in space.







Team #3

L-System

L-systems are sets of rules and symbols that model growth processes.

L-systems were introduced in 1968 by Aristid Lindenmayer as a theoretical framework for studying the development of simple multi-cellular organisms, and subsequently applied to investigate higher plants and plant organs ("The Algorithmic Beauty of Plants", by P. Prusinkiewicz and A. Lindenmayer.)

A L-system consists of a premise (axiom) and rewriting rules (production rules):

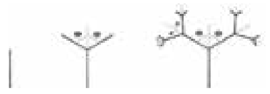
w = premise

p1 = rule 1

p2 = rule 2

:

pN = rule N



In L-systems, geometry is described using turtle geometry which has been developed by the Logo Group at MIT since 1970 with the use of computers in education in mind. ("Turtle Geometry" by Abelson and DiSessa for more about turtle geometry.)

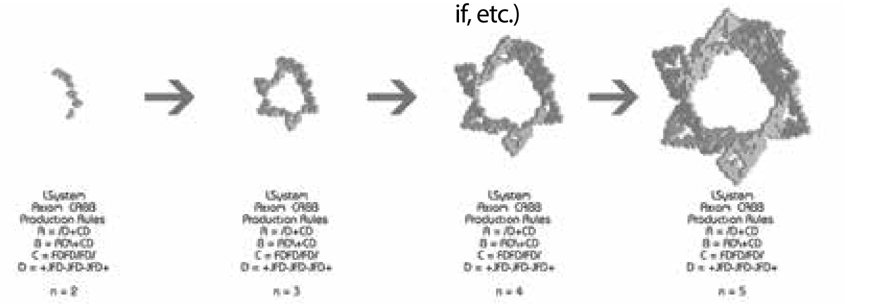
Turtle Geometry

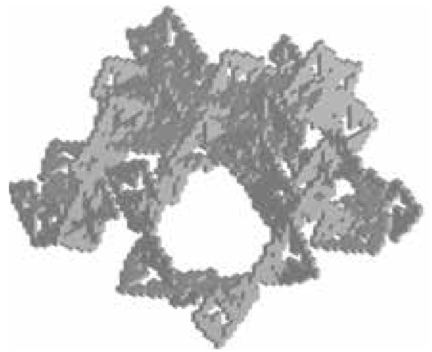
The turtle knows:

1. Direction that it is pointing
2. Position.

Turtle geometry's operations:

1. Move forward
2. Changing directions (turn, pitch, and roll)
3. Control structures (conditions, loops, if, etc.)

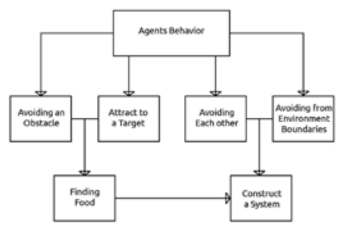


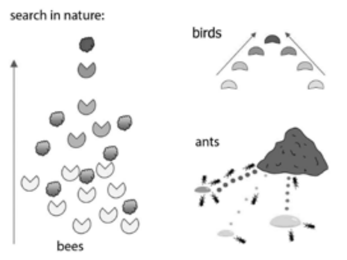


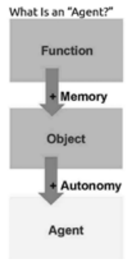
Team #4

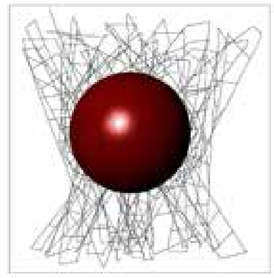
ABM

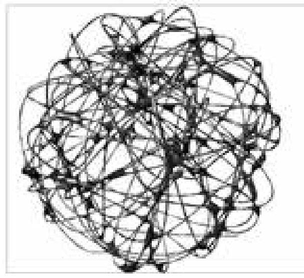
Swarming behaviour in Nature can be simply approximated by Agent based models (ABM) or SPP Self-propelled particles

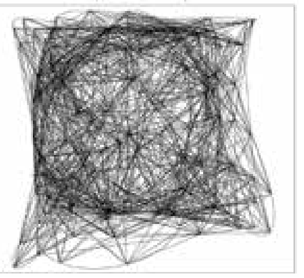




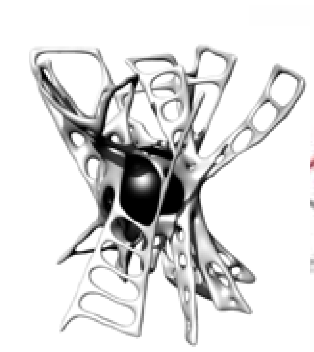








Separating emitted agents into two parts that act as obstacle for another. [middle]
An obstacle to avoid in the path for target points [left]
Corresponding Nonincestous network between agents [right]



ACADA Course

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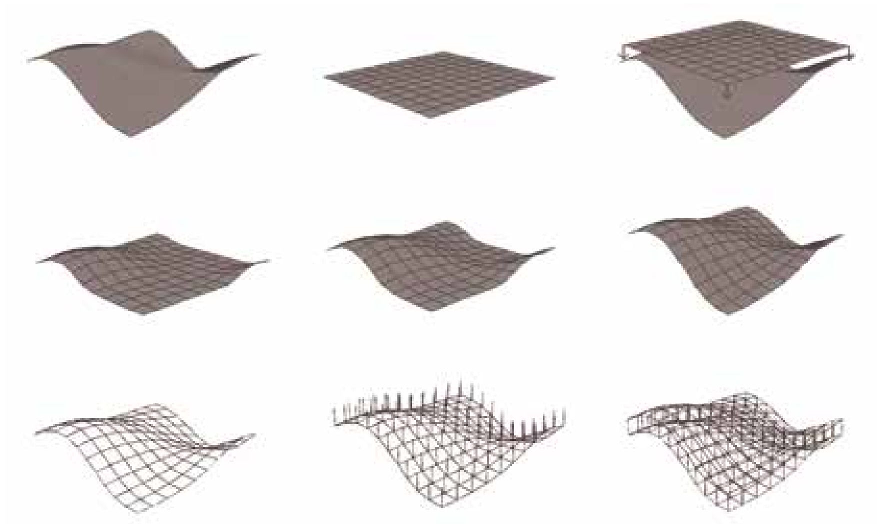
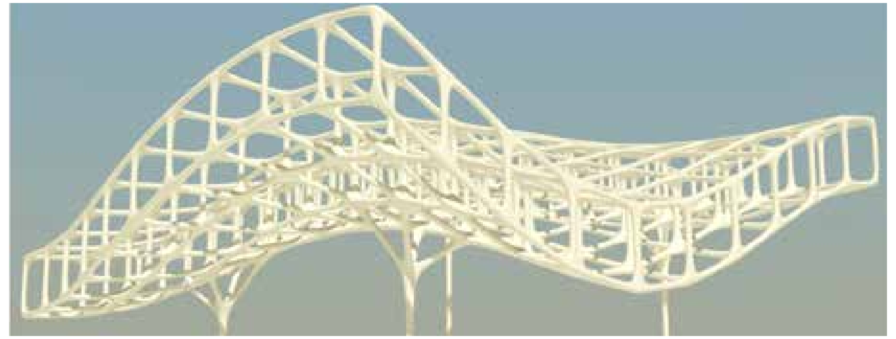
Team #5

Topology Optimization

A number of other methods were also explored to create a rational grid, such as a geometric algorithm also known as 'pivoting ball'. Which starts by placing a sphere on the border of the surface which intersects that edge in two points, on those two points two new spheres are placed and their intersection adds the third point our collection which form a rational triangle. Repeating these steps can cover the surface with relatively similar triangle with low deviation





Team #6

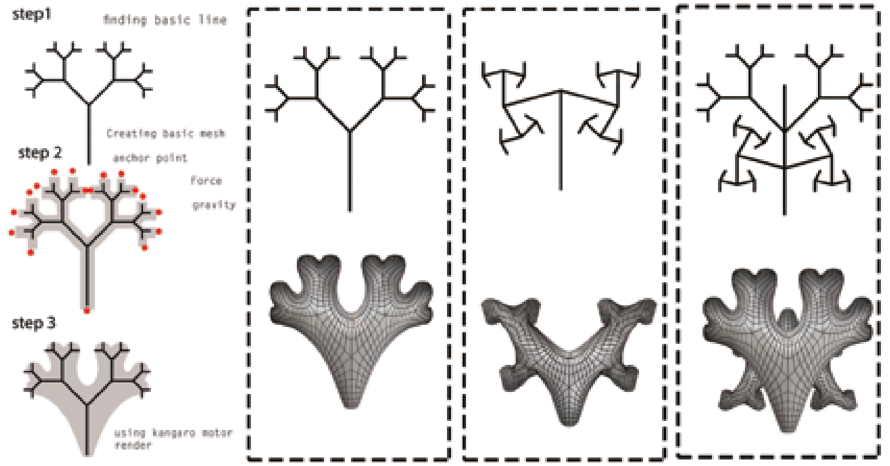
Physical Simulation

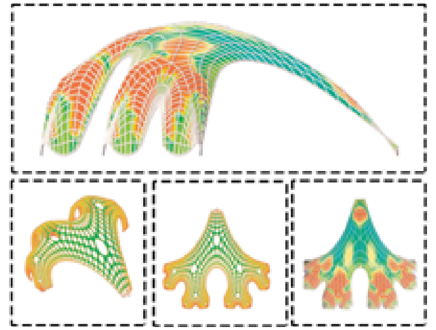
Using real-world information as the material from which a design's final outcome is made, seems to offer the opportunity to ground design in the solidity of reality. It's what we say Physical Simulation.

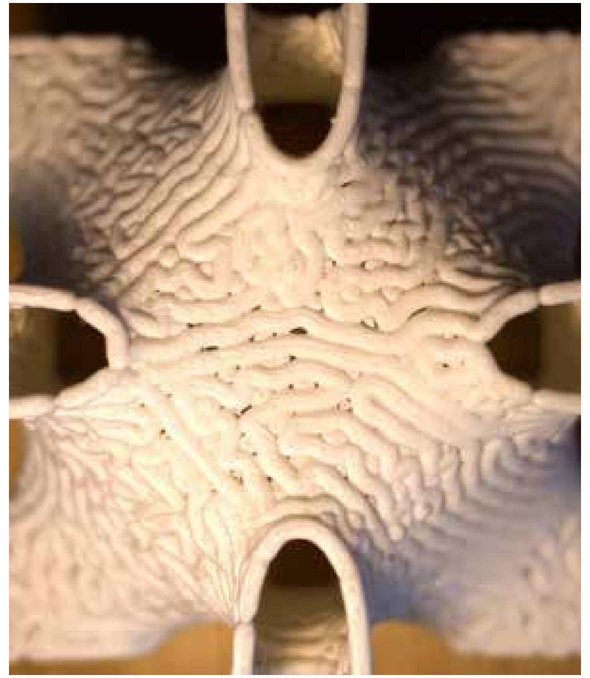
Physical simulation does not represent reality, and only approximates it with the utmost care on the part of the user.

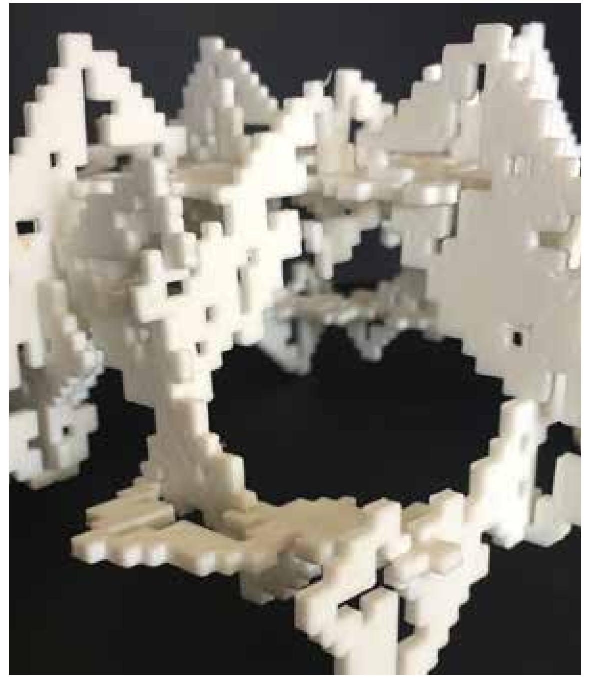
1.Generating base Polyline
2. Generating base Mesh
3. Form finding
4. Forming Design Space

In this project a recursive fractal-like method was used to generate the based geometry [1]. The reason for that as to minimize post-processing efforts to topologically manipulate the mesh as it is far more simpler and less time/processing power consuming to generate the desired topology through the initial stages of design. This mesh [2] undergoes the form-finding process [3] so a design space of possible form with suitable topological properties is made [4]









ACADA Course

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Tutor
Winter 2017

ACADEMIC COURSES

DIGITAL DESIGN AND FABRICATION TUTOR

- Computation Design,
- Digital Fabrication,
- Computational Geometry,
- Geodesics

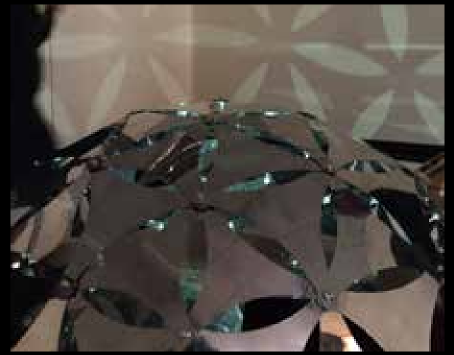
ADVANCE COMPUTATION APPLICATIONS IN DIGITAL ARCHITECTURE

Instructors:	Arman KhalilBeigi, Esmaeil Mottaghi, Ali Andaji
Year:	Winter 2017
Host:	Pars University of Art and Design, Tehran, Iran
Students:	M.A Post Grad Students in Architecture Technology

A university course focused on the geometry of Geodesics and spatial structures.

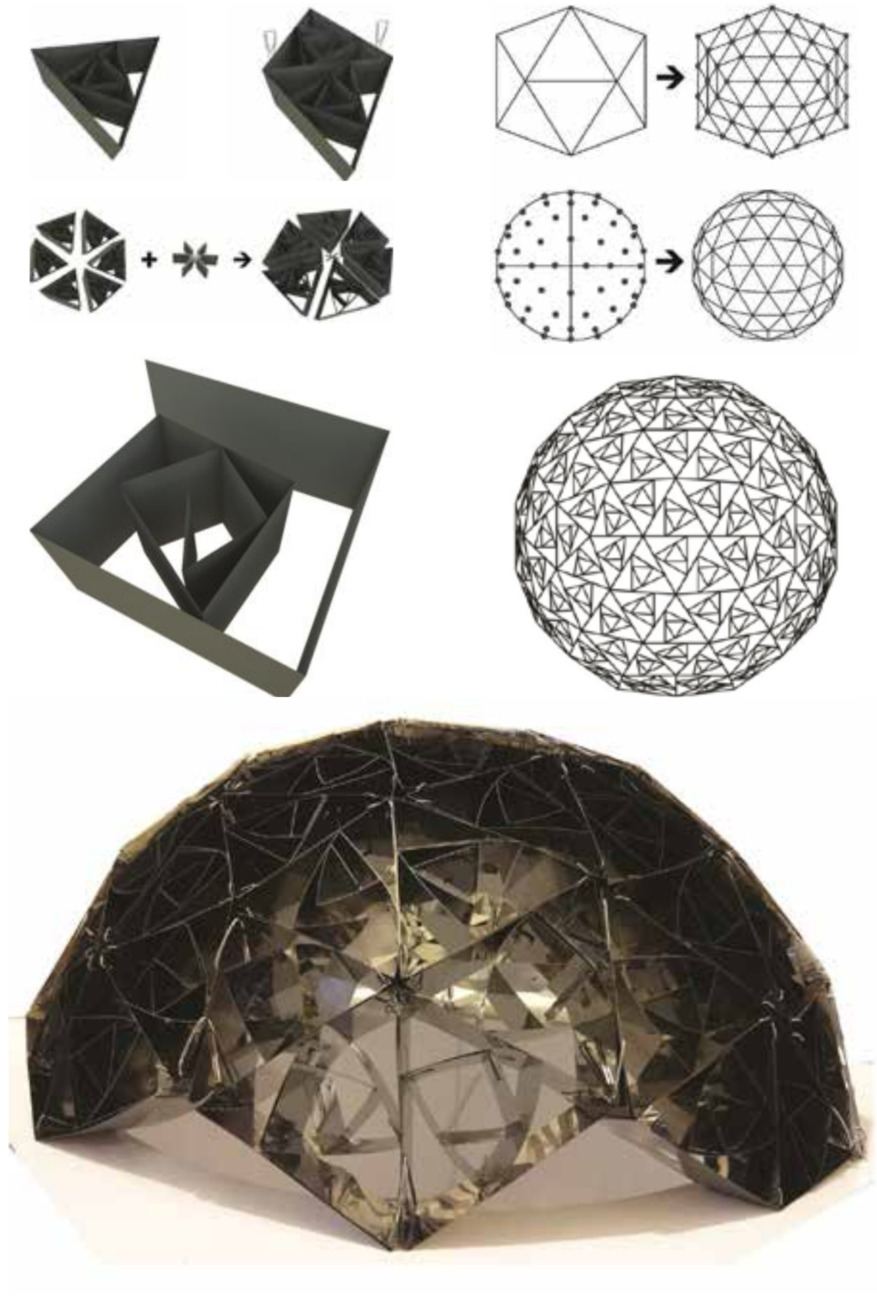
In this class, Computational Geometry was chosen as the resolution of the course. We started by introducing the basics of CG followed by additional operations and functions to modify them. we assigned a specific [platonic] shape to each group of students and asked to develop this shape in a manner that can cover a certain area structurally and it should have integrated fabrication strategies. meaning that geometrical decisions that they made have to be in regard to structural stability and constructability of the results.

Through a series of projections, subdivisions and substitutions and relaxation algorithms, basic ideas developed. At this point, we asked [some of our] students to integrate another layer of data upon their design; environmental data. They were asked to make their design performative corresponding to the heat gain or shadow, the rest of the students were focused on designing joinery and fabrication methods.

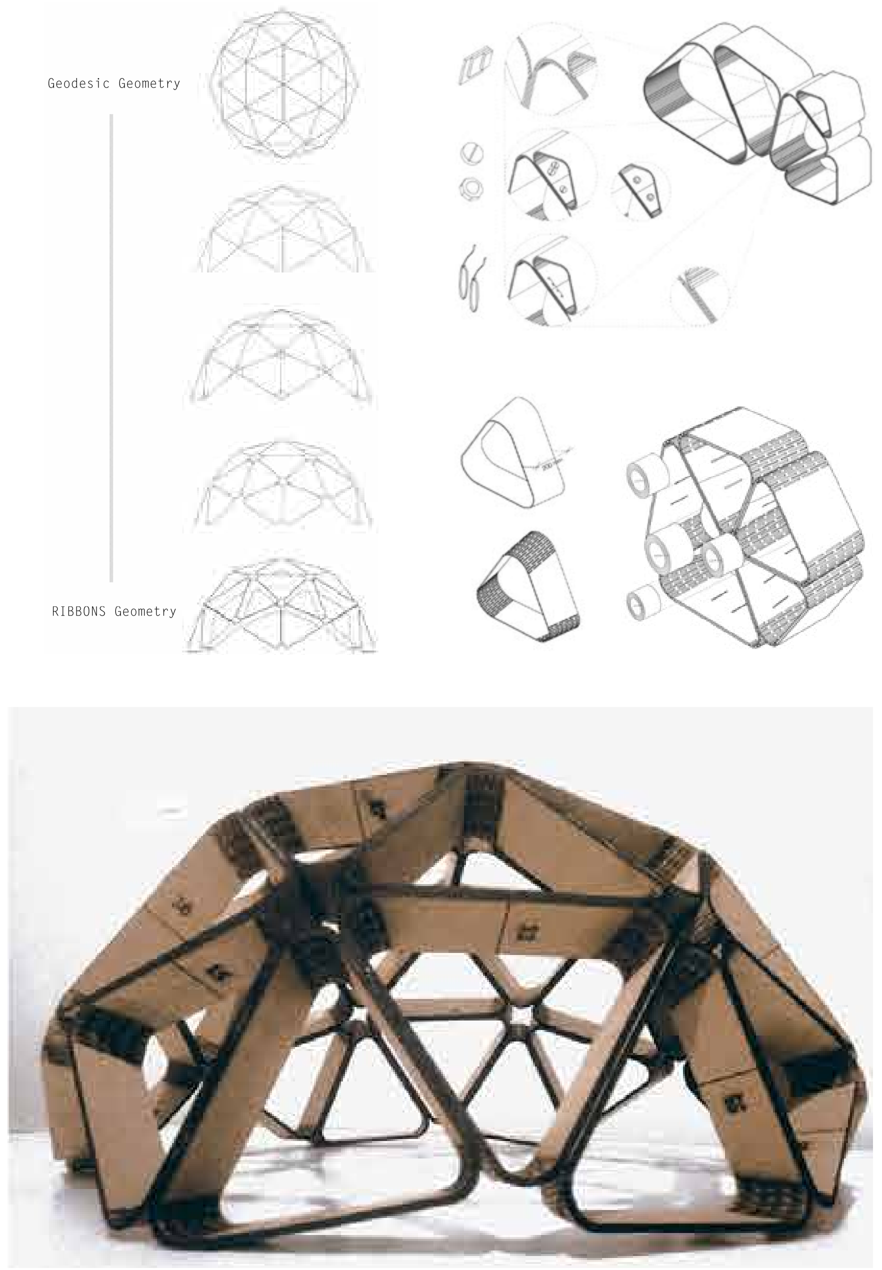


Namo Dome

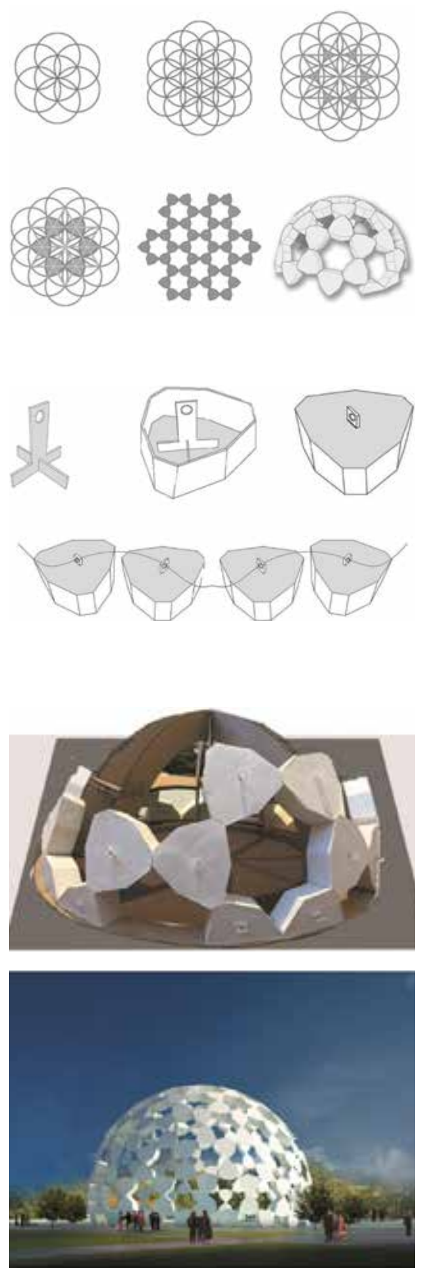
Helical Spring Dome



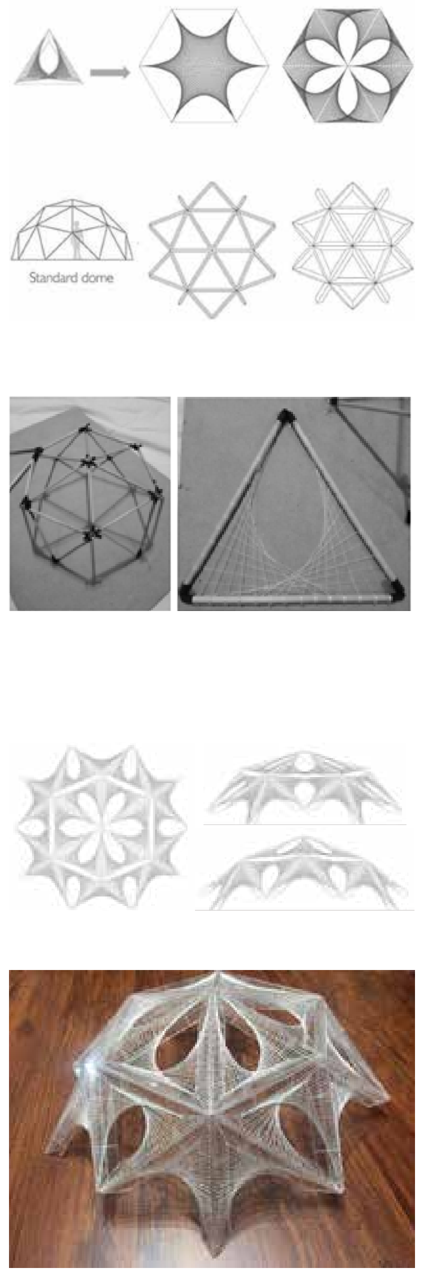
Ribbons



Hexahedron Pavilion



Sky Pavilion



ACADA Course

Academic
Tutor
Winter 2017

ACADEMIC COURSES

DIGITAL DESIGN AND FABRICATION
TUTOR

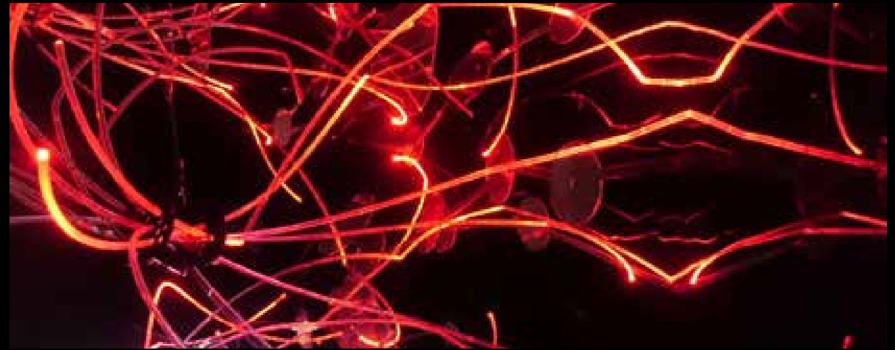
- Computational Design,
- Design Rationalization,
- Physical Modeling.

ADVANCE COMPUTATION APPLICATIONS IN DIGITAL ARCHITECTURE

Instructors:	Arman KhalilBeigi, Esmaeil Mottaghi, Sina Salimzadeh, Katayoon Taghizadeh
Year:	Winter 2016
Host:	University of Tehran, Tehran, Iran
Students:	M.A Post Grad Students in Architecture Technology

A university course based on algorithms derived from several disciplines, adapted are re-designed to perform in architectural problem solving

Starting the new era in architecture which is considerably close to other fields of art and science including structure, physics, mathematics, computer science and bionics, a remarkable growth could be observable in learning interdisciplinary topics among architectural students. There is also required for new generation of architects to achieve skills by which they would design paperless concepts, Furthermore many professional projects show that a modern approach for designing is needed for newcomers in the field of AEC – Architecture, Engineering and Construction - industries; a research-based approach Thus, it is of high importance for master level students to be familiarized by utilizing other fields of art and science and take advantage of them in their design processes. This was the key idea behind this research-based computer-aided studio.



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Course

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Winter 2016

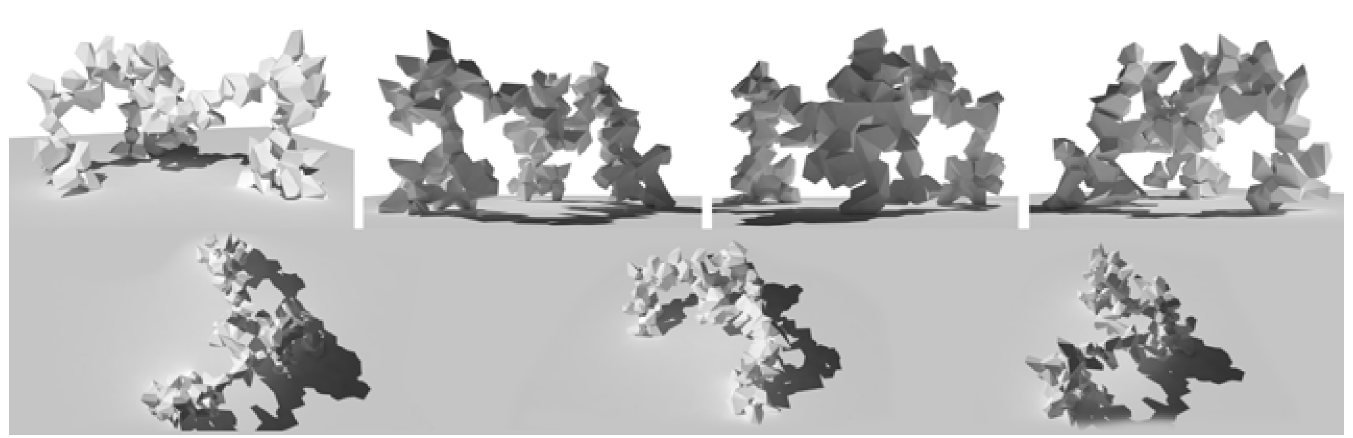
Team #1
Crystallization

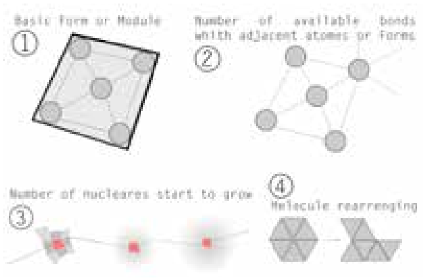
Idea/inspiration
Natural Crystallization, Bio-proliferation

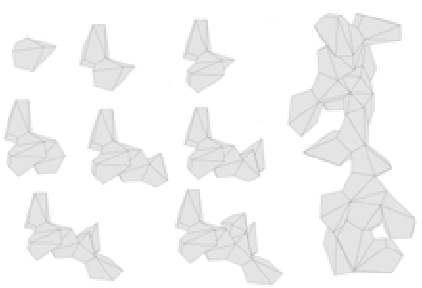
Modeling
3D Aggregation

Parameters/Acts
Material Density (Food), Self-Supporting stability

Fabrication Technique
Unrolling







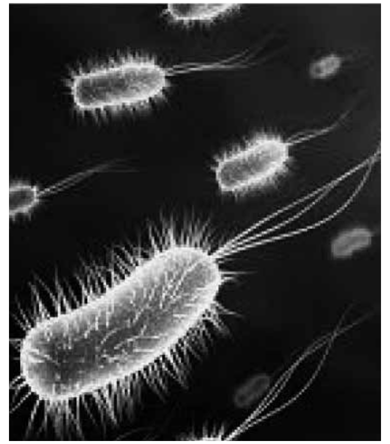
Team #2
Bacteria

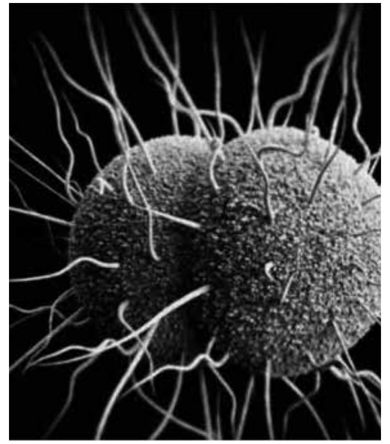
Idea/inspiration
Bacteria, Micro Organism

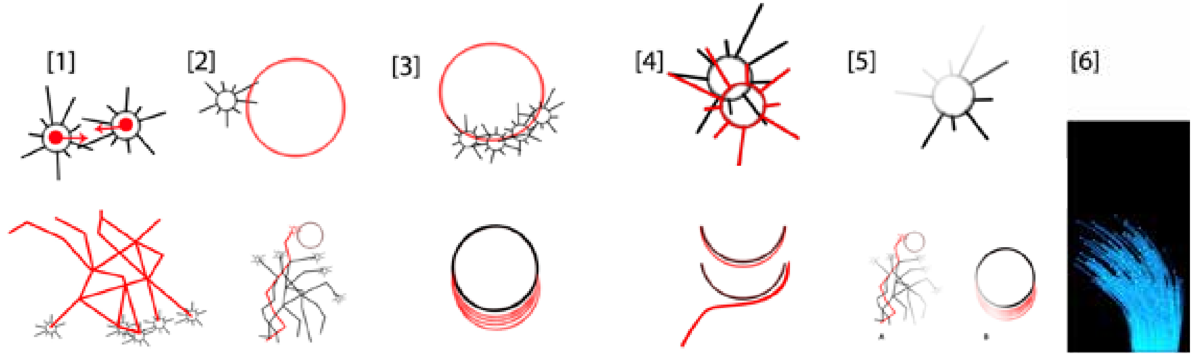
Modeling
Agent-based modeling

Parameters/Acts
Foods, Crossover, Death, Talent

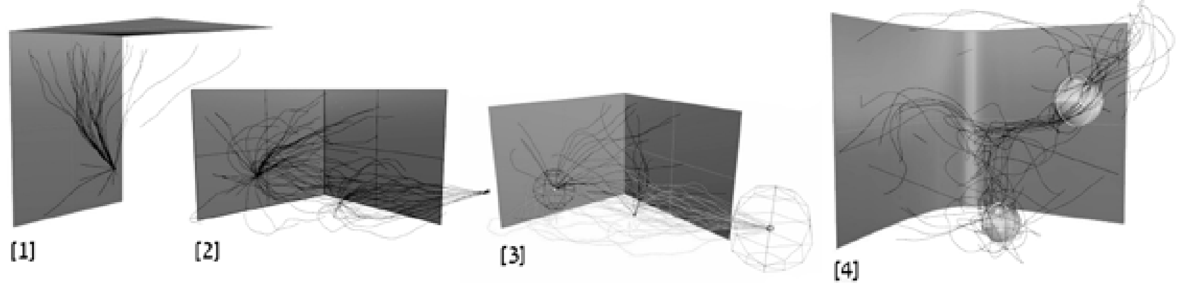
Fabrication Technique
Customized 2D guides







The project's structure is based on behaviour of a particular bacteria. These particles or agents use a conventional schooling methods in their movement [1] and lay a trail behind which accumulates where food is found [2] which form a growing group of them circumscribing the food and shaping a layer around it [3]. Particles who consume enough food have the energy to reproduce [4] and the ones who don't eventually die [6], running this simmulation and modifying agent's properties and food and environment parameters lead to the final geometry that was fabricated using fibers.



ACADA
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Team #3
Swarm

Idea/inspiration
Flocking, Swarm/Schooling behavior

Modeling
Agent-based modeling

Parameters/Acts
Geometrical Orientation, Food

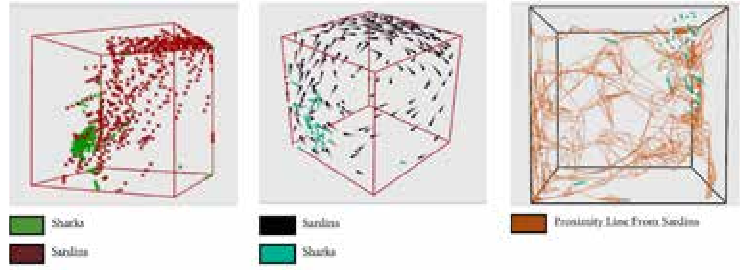
Fabrication Technique
2D Laser-cut, Finger joints

This project was developed around the idea of creating a compound swarm 'system'. A single swarm is a fairly conventional particle system widely known and studied, yet in this study the goal was to explore the inter-relation between two or more swarm systems and how they affect each other. As in nature Sardines and sharks form such dual systems for it is obvious that two swarms system have impacts on one another and behave more complex than two separate ones.

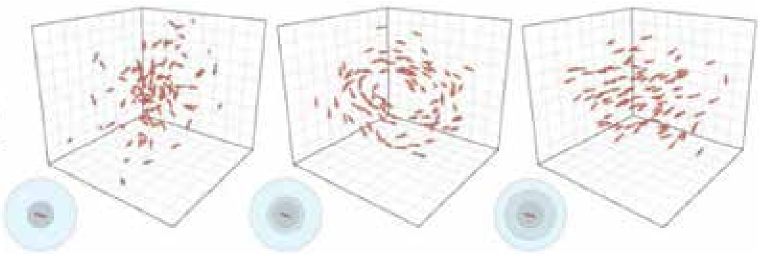
Metric Distance Model | **Topological Distance Model**

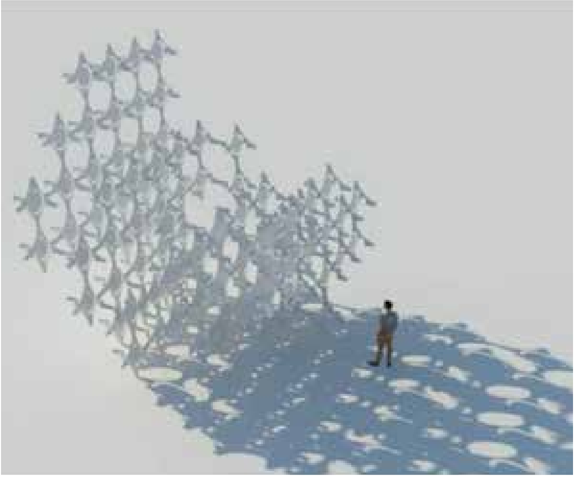
Focal fish pays attention to all of the fish within a certain distance

Focal fish only pays attention to the 6 or 7 fish closest to itself regardless of distance



Process of simulating each swarm system. A conventional method is based on 3 Rules of Repulsion, Alignment and Attraction. Eventually multiple systems of this kind where studied in a single environment simultaneously.





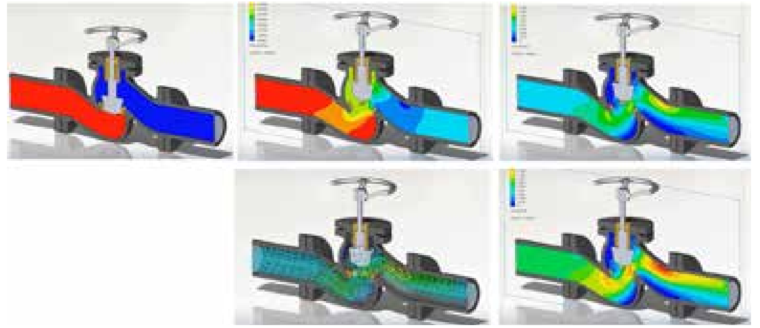
Team #4
Thermal Iso Mesh

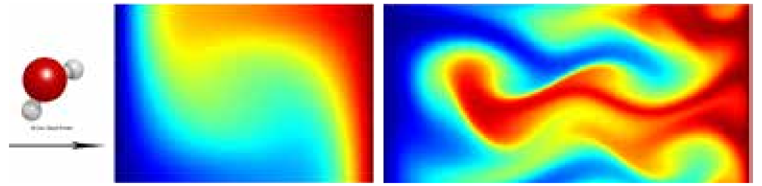
Idea/inspiration
Fluid behavior

Modeling
Iso-Surfaces based on Velocity field

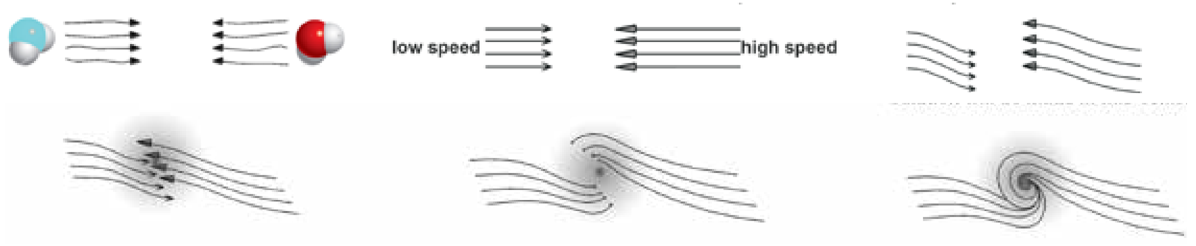
Parameters/Acts
Fluids insertion and exhaustion, Fluid Temperature

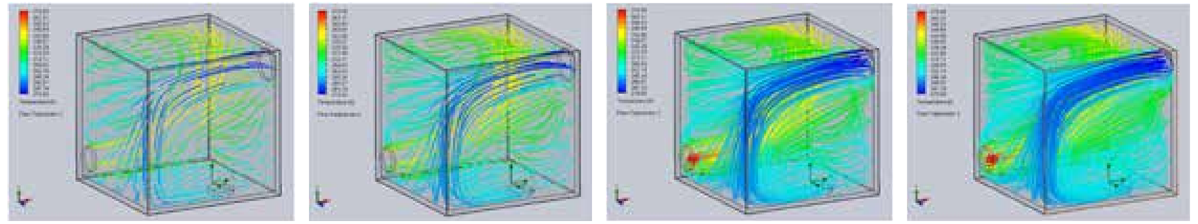
Fabrication Technique
Mesh Unrolling, 2D Guides





The project was a study to propagate the design from the root of a simplified liquid system obtaining thermal equilibrium. There are several example of using real world physical behaviour and adjusting it as a design strategy. For example Vortex systems are widely used in weather forecasts yet a simplified version of it is used to create tensor field like magnetic fields. That said the behaviour of two liquids of different temperature, velocities and density was the seed forming the initial data for design. Later with iso-meshes and iso-surfaces these geometries were represented.





ACADA Course

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ACADEMIC COURSES

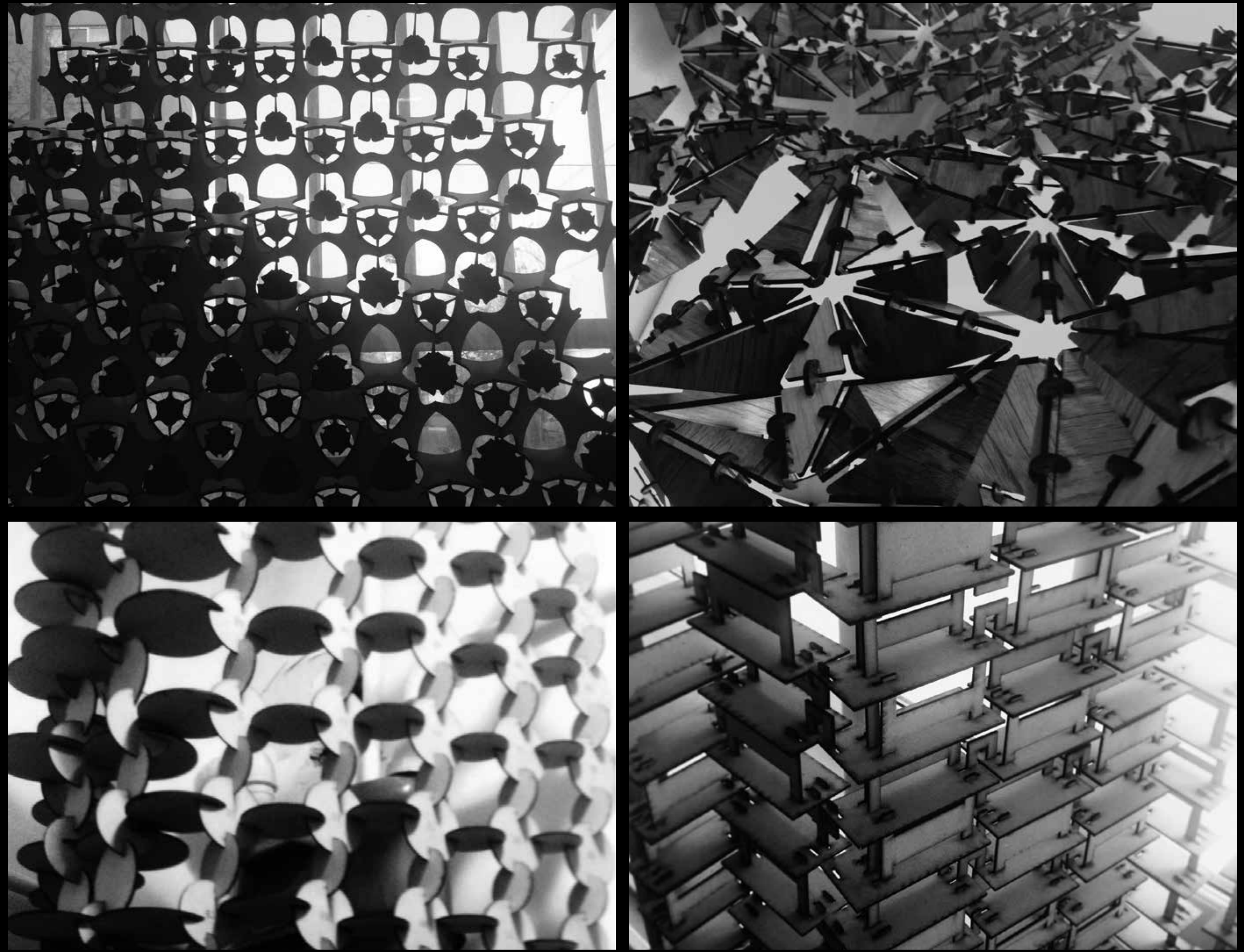
DIGITAL DESIGN AND FABRICATION
TUTOR

- Aggregation,
- Computational Design,
- Digital Fabrication,
- Agent Based Modeling

ADVANCE COMPUTATION APPLICATIONS IN DIGITAL ARCHITECTURE

Instructors: Arman KhalilBeigi, Esmaeil Mottaghi, Sina Salimzadeh
Year: Winter 2015
Host: Pars University of Art and Design, Tehran, Iran
Students: M.A Post Grad Students in Architecture Technology

A project based on Aggregation Systems, and hierarchical Design thinking to fabricate heterogeneous passive light shaders



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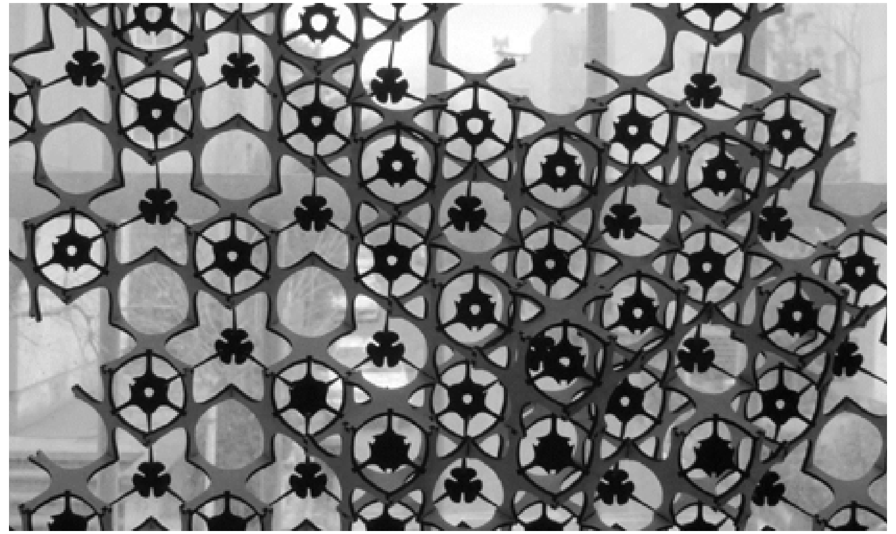
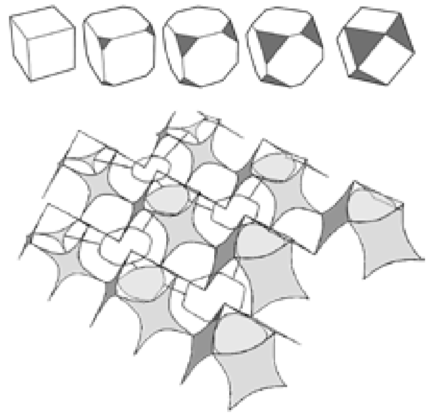
Team #1

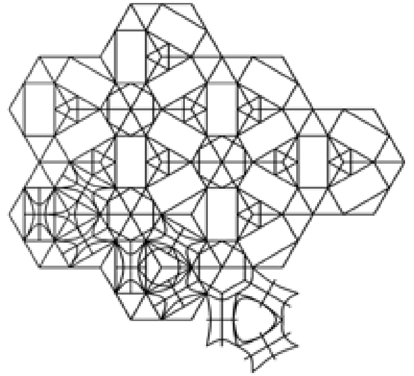
Kittle Cubes

In order to design an aperture to reshape and illumination of Northern indirect light that pass through the window and framing the sight depending to the visitors location, the 3.3 m2 folded surface aggregated from 966 fish scale-shape agents that concatenated by four side Bi-lateral Joints. The fabricated surface performs beyond the light shader by transformation of spatial rigidity into a heterogeneous space by reorganizing the spatial directionality of agents derived from uv (surface attribute) parameters of surface's curvatures.

Agent/Module	: Cut Off Cubes
Joints	: Edge
Controls gradient of modules area	: Bottom - up
Behavior pattern	: The height of every catenary curves changes by the different angle of sunrays.
Fabrication Method	: Unfold



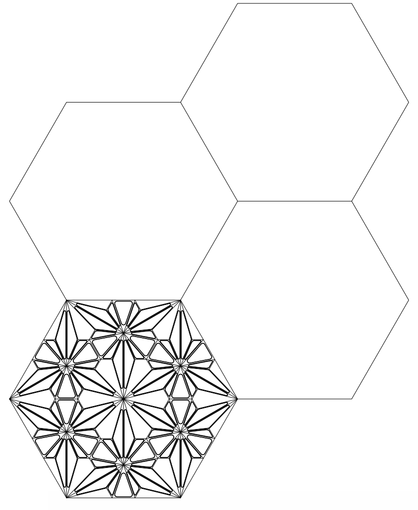


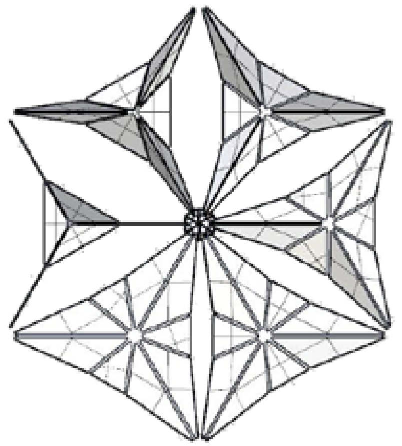


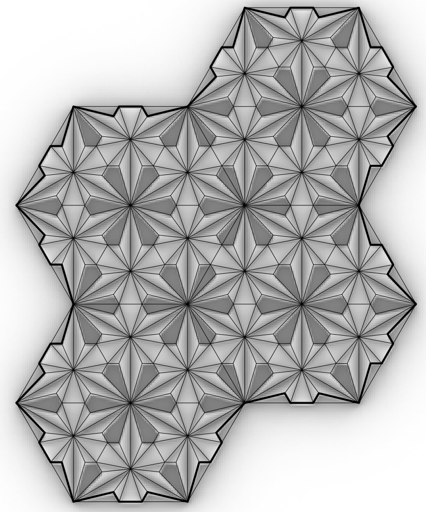
Team #2

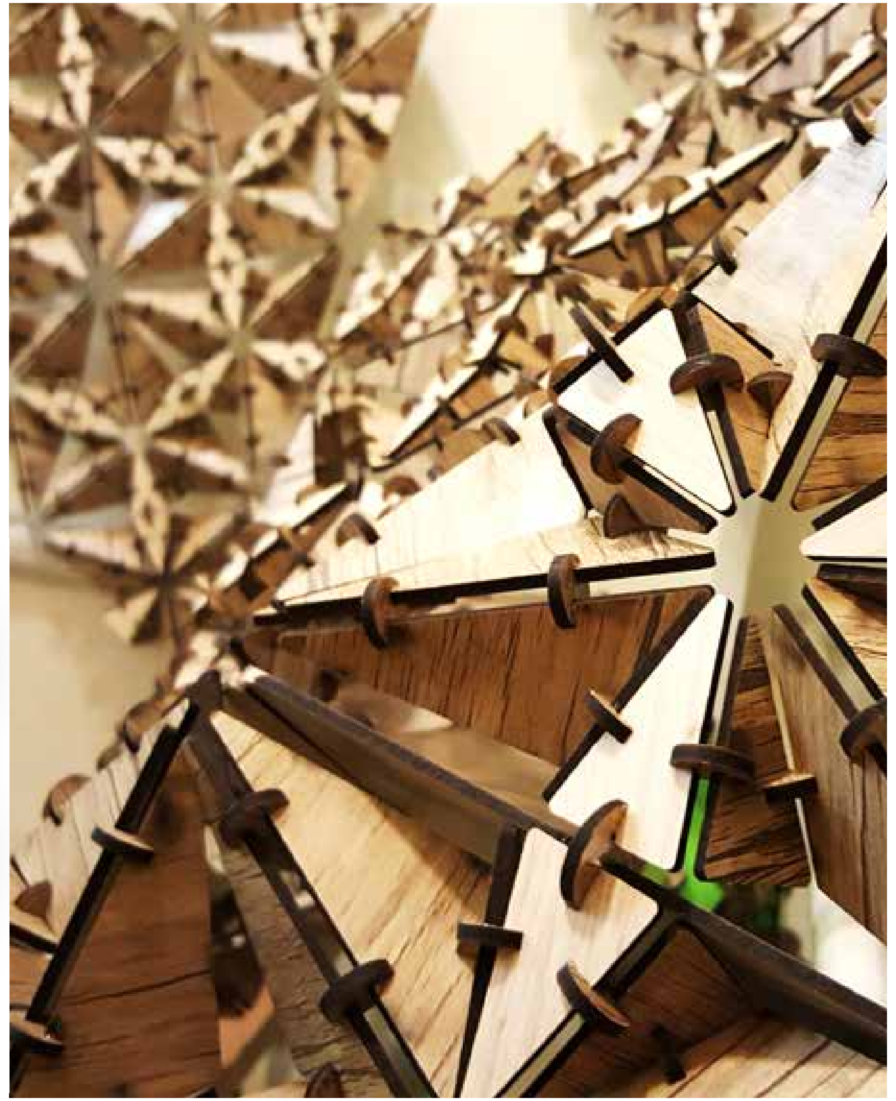
Triangle Cascade

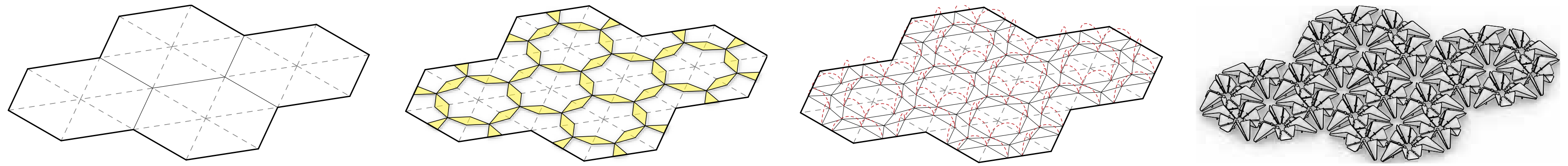
The hexagon is one of the Architecture geometrical shapes that covers all the surface when it is made into a grid ,we used small triangular parts ,which were put together by a specific type of connection which is named " knot " , in the circular shape. By these small triangles, we achieved triangular modules that make hexagonal and control the light penetration by various angles of triangles side. according to a special pattern Which was defined by Grasshopper and Rhinoceros , in order to form a hexagonal grid.











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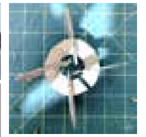
Team #3
Bionics Me

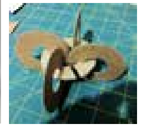
Agent/Module: Fluctuating Frames
Controls: Length of tongues and position of grooves
Behavior pattern: Controllers (length of tongues and position of grooves) determines area and depth of virtual trap doors formed by tongues and plates containing grooves.
Fabrication Method: Running

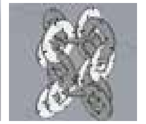
Team #3
Floating Scales

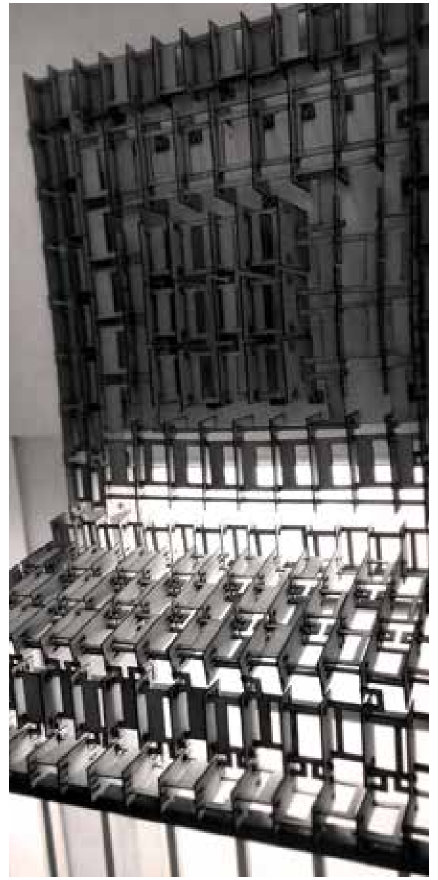
Agent/Module: Scale
Joint: Bi-Lateral
Controls: Scale's Radios
Behavior pattern: Curvature-Scale Relationship
Fabrication Method: Unfold







TEACHINGS:

WORKSHOPS

WORKSHOP DIRECTOR / COMPUTATIONAL TUTOR

	ACADEMIC COURSES	Course Director / Computational Tutor
TEACHINGS	WORKSHOPS	Workshop Director / Computational Tutor
INDEPENDANT RESEARCH		Researcher
ARCHITECTURE PROJECTS		Principal / Chief Architect
LECTURES AND SEMINARS		Key-Note Speaker / Invited Lecturer
EXHIBITIONS		Artist

WORKSHOPS

DIGITAL DESIGN AND FABRICATION
TUTOR

- Digital Fabrication,
- Composite Material Systems,
- Structural Analysis,
- Robotic Fabrication.

TERHANCRAFT 2016,
RE-ENVISIONING FELIX CANDELA

Instructors:	Arman KhalilBeigi, Esmaeil Mottaghi, Zubin Khabbazi, Mehran Davari, Yasamin Khalilbeigi, Kunaljit Chadha, Sina Salimzadeh
Year:	Summer 2016
Host:	University of Tehran, Tehran, Iran
Students:	Architects and Designer

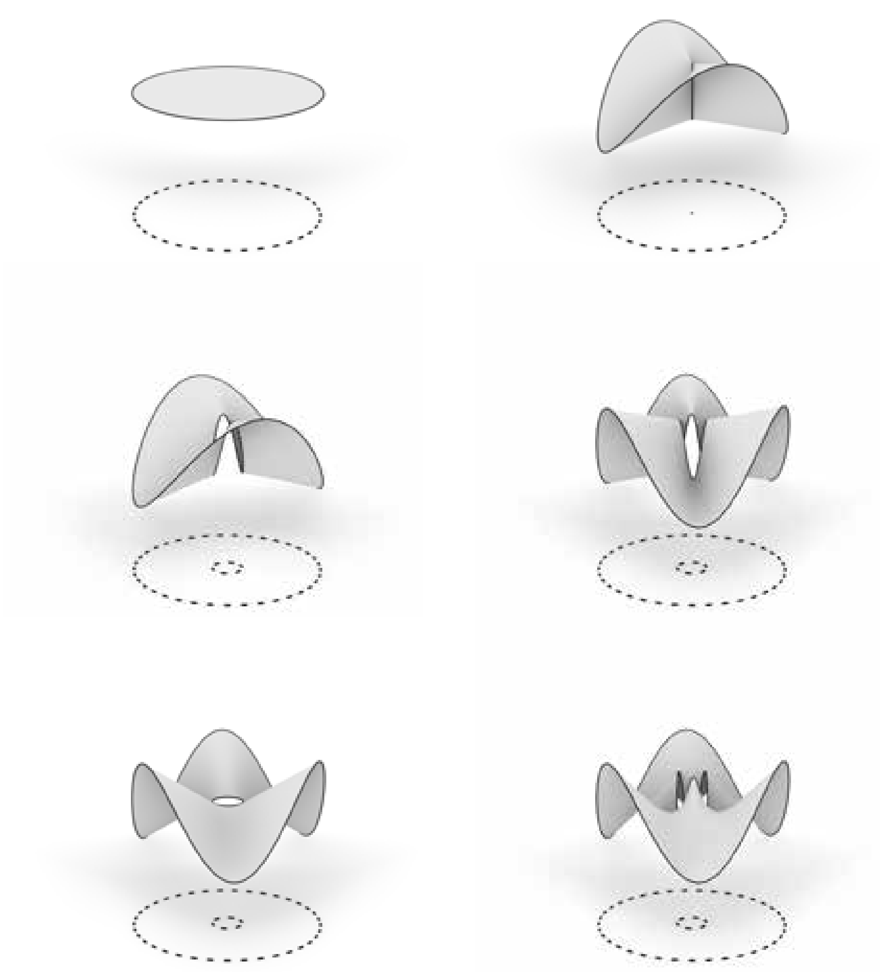
A Digital fabrication project rooted in Geometry and Math, Rethinking Felix Candela's research on Thin-shell structures and combining it with Computational Design Tools, and Robotic Fabrication

In CRAFT 2016, the agenda is to further push the fabrication of curved surfaces with composite materials. by 're-envisioning candela', the idea is to study the intricacy as well as technicality and methodology of his work and to push it towards further computational design of the shell/surface geometries. using the strategies like hyperbolic paraboloid geometries and ruled surfaces to generate ultra-thin shell structures, the aim is to see the potentials and embed them in the design of composite surface geometries.

In terms of material system, focus is on sandwich-structured composites; using a low-density core with hi-density coating, the result would be similar to industrial sandwich panels, and the fabrication process is tailored around the needs and necessities of the project. thus making relevant tools, and development of the techniques are part of the work, parallel to the design development. robotic arm is used to fabricate the pavilion and regarded strategies are followed during the design process. this is helping to fabricate more complex products, where in combination with the material system of the project, is led towards the realization of the customized robotically fabricated, sandwich-structured composites.

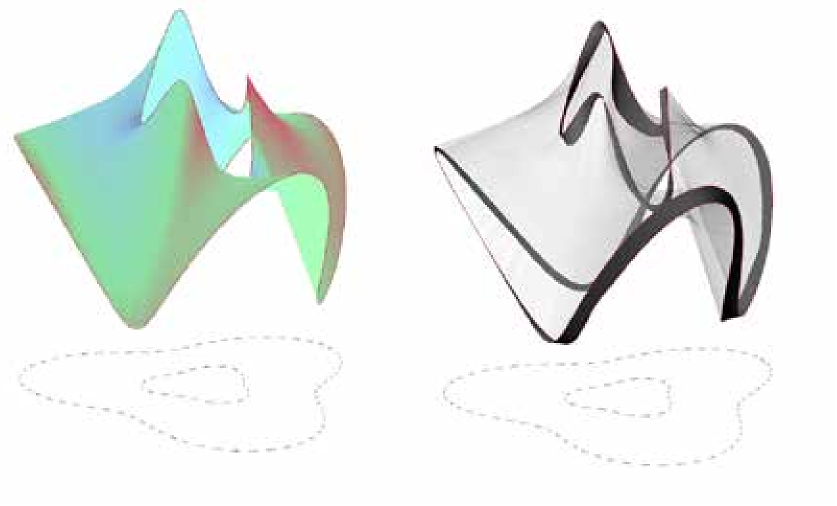
Geometry Study

A well known use of ruled surfaces in architecture is found in the works of Felix Candela .he took advantage of the fact that through every point on a ruled surface runs at least one straight line lies on this surface. therefore he constrained his thin concrete shells to combinations of hypars which then could be built using form-work out of linear elements CRAFT.2016 titled "Re.Envisioning Felix Candela" and was trying to adapt to his works and design process. The design featured a Plücker conoid as a ruled surface being manipulated to shape the pavilion



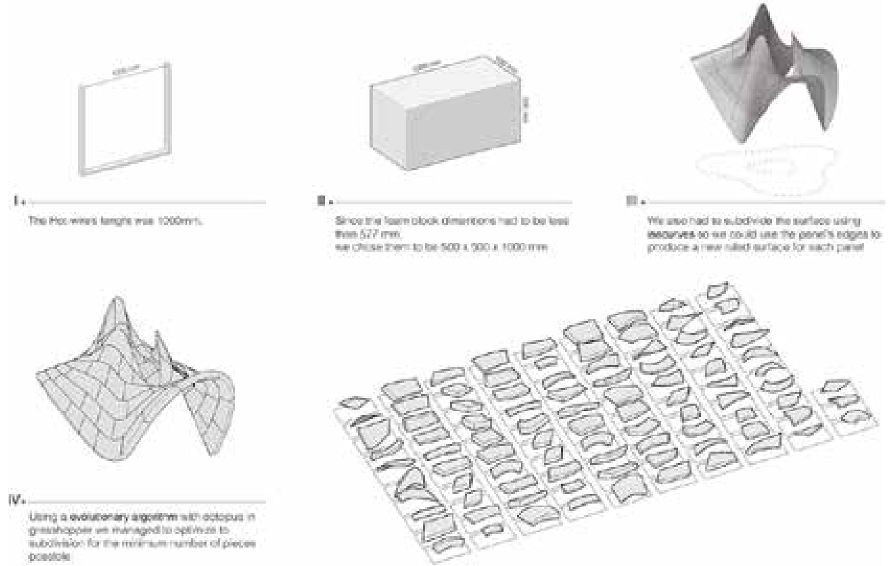
FE Analysis of Shell Structure

In the finite element stress analysis use is made of newly developed linear, quadratic, and cubic, variable thickness, C(0) elements based on axisymmetric Mindlin-Reissner shell theory. An integrated approach is used to carry out the whole shape optimization process in a fully automatic manner. A robust, versatile and flexible mesh generator is incorporated with facilities for generating either uniform or graded meshes, with constant, linear, or cubic variation of thickness, pressure etc. The midsurface geometry and thickness variations of the axisymmetric shell structure are defined using cubic splines passing through certain key points. The design variables are chosen as the coordinates and/or the thickness at the key points. Variable linking procedures are also included. Sensitivity analysis is carried out using either a semi-analytical method or a global finite difference method. The objective of the optimization is the weight minimization of the structure

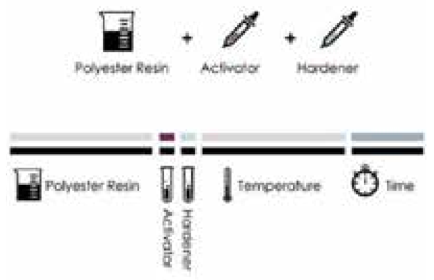


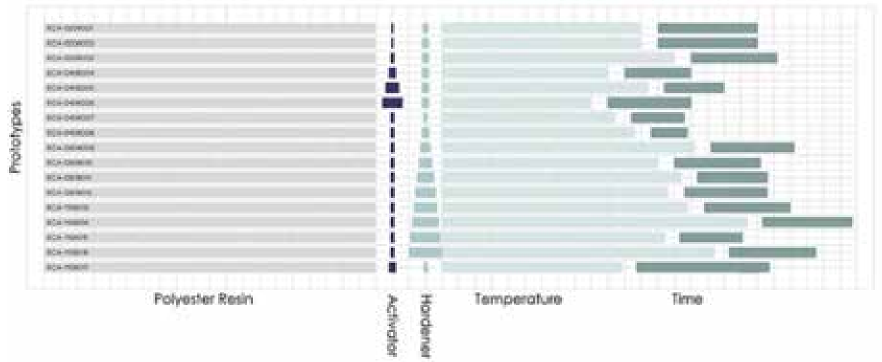
Material Study

In terms of material system, this year's focus is on sandwich-structured composites, which is one step further than the normal fiber composite surface. sandwich structured composite are helping to strengthen the load-bearing/bending-resistance capacities of the composite and make it a suitable method for making functional curved surfaces. using a low-density core with hi-density coating, the result would be similar to industrial sandwich panels. but here, based on the fabrication strategy, customized sandwich-structured composites would be used for the construction of the project.



The polyester resin consists of two essential components ; a base resin and hardener to initiate the reaction by which the liquid material will solidify into a hard durable plastic. The material research was mostly focused on the optimum proportions and the measurement of these components. the proportions has direct impact on the duration of hardening process, as much as the quality of resin concern with bubble and cracks on the surface of panel. So the goal was to achieve a mixture that balances the time, durability and workability.



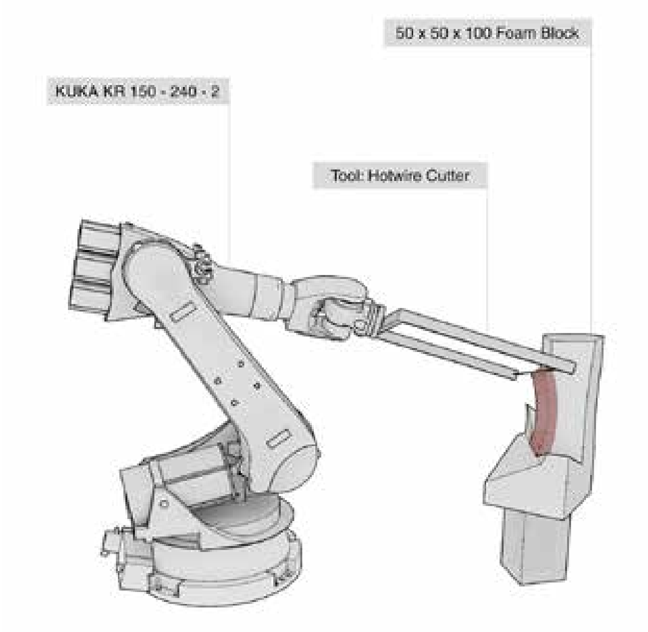


TerhanCraft

Workshops
Tutor
Summer 2016

Fabrication Strategy

As it is always an integral part of the craft programs, analogue and digital would be incorporated again, and the fabrication process is tailored around the needs and necessities of the project. thus making relevant tools, and development of the techniques are part of the work, parallel to the design development. in this year's fabrication strategy, robotic arm is used to fabricate the pavilion and regarded strategies are followed during the design process. this is helping to fabricate more complex products, where in combination with the material system of the project, is leaded towards the realization of the customized robotically fabricated, sandwich-structured composites.



WORKSHOPS

DIRECTING ASSISTANT

- Material Study,
- Material behavior,
- Computational Design.

EMERGENT PROTOTYPING

Instructors: Arman KhalilBeigi, Esmaeil Mottaghi, Mohsen Marizad, Marziah Luis Rajabzadeh
Year: Spring 2015
Host: Memaraneh (Private Architecture Institute), Tehran, Iran
Students: Architects and Designer

Emergent Prototyping is an experiment in materiality and material systems to use as design strategy.

Emergent Prototyping is an experiment in materiality and material systems. The goal is to manipulate the natural and inherent behavior of any given material to respond in a controlled and intelligent manner to external and internal forces and stimuli. it was intended to conduct a profound study of certain behaviors, and extract a Design Computational Design strategy that can be conformed to a variety of design problems. this approach implies a great integration in de-sign process and since it is numerical in nature, it can efficiently be developed to Complex Digital morphogenesis computational simulation proceses. also in this design strategy, the unpredictability and chaotic nature of (some of) these behaviors presented additional challenges in Computational simulations and thus required more advanced Coding to create a sustainable, versatile design tool.

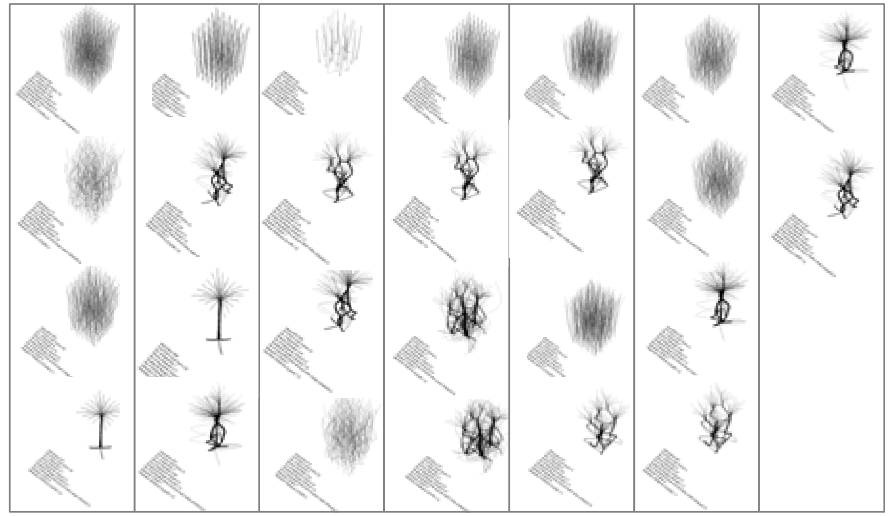
Team #1
Fiber

Experimentation Method and First Experiments

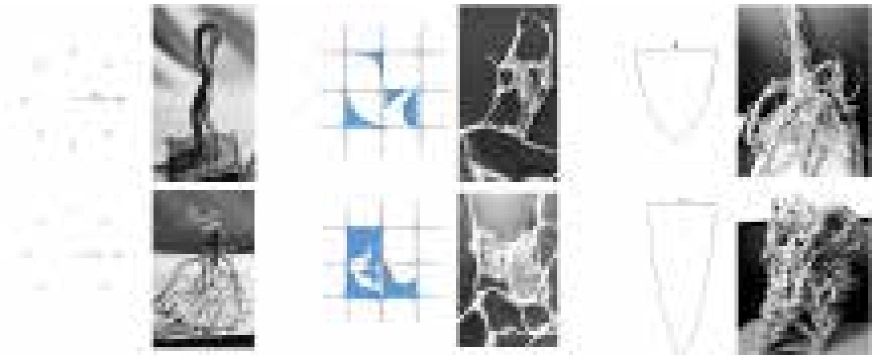
Experiment Parameters
Other than internal forces and fixing points which form the fibers, fixing the result was a main issue in exploiting the structural possibilities of the material.
Controls
- Material Weight,
- Gravity,
- Material Texture,
- Fixing Points,
- Fiber Length

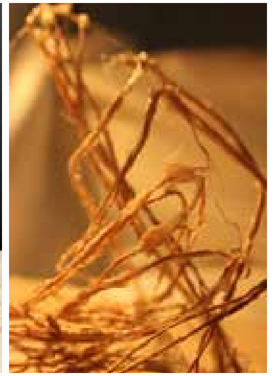
Material Behavior
Internal forces and gravity create catenary curves when fixed at two ends. When only one end is fixed fiber entwines to return to original state

Visualizations of Material Behavior



Material Behavior and Control System





Final Prototype

Team #2
Foam

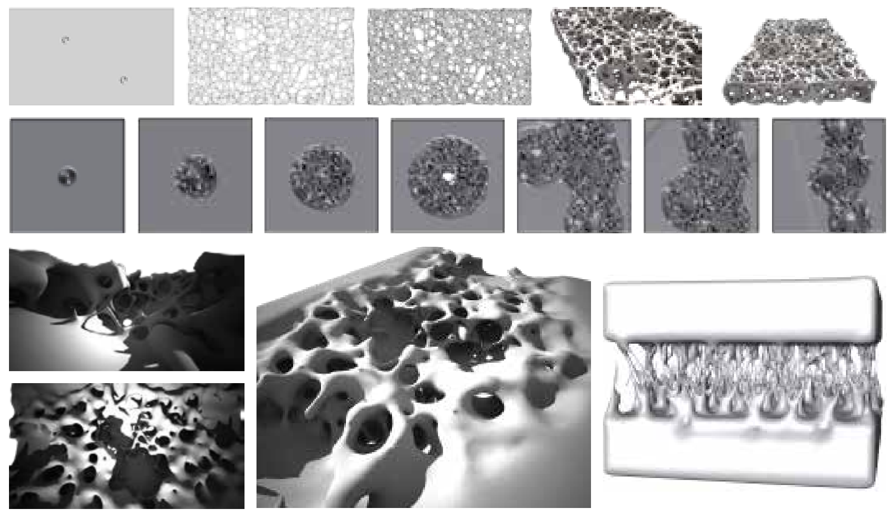
Experimentation Method and First Experiments

Experiment Parameters
- Parameters take place in final form
- Dose of acetone injection
- Depth of acetone injection
- Foam density

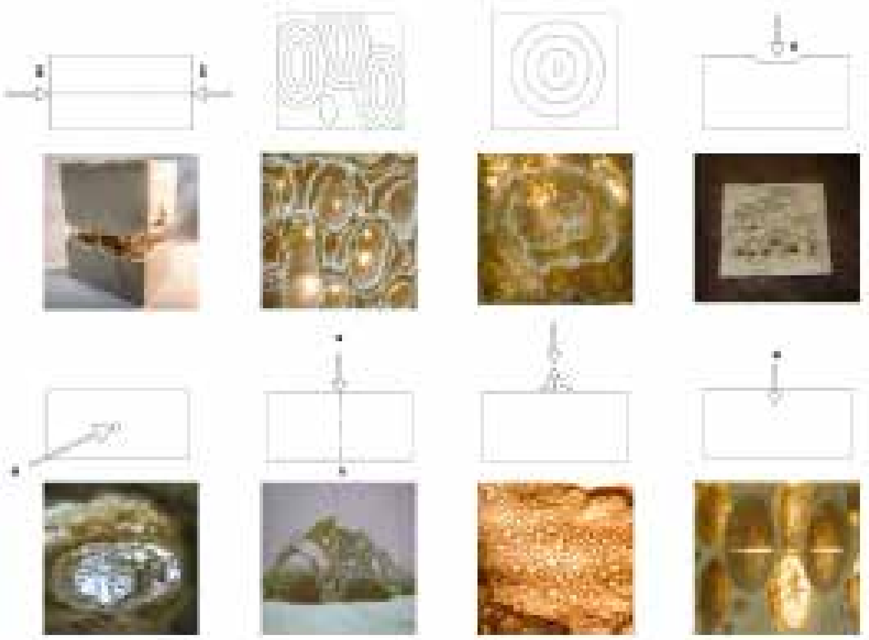
Controls
- Dose of acetone is controlled by ml
- Depth of injection is also controlled by syringe needle

Material Behavior
Erosion is appear when foam & acetone start to be connect with each other. After the drying process is complete, foam is get stoned at the connection surface; and it cannot be effected twice by acetone. Heat can also effect on foam, and it can be controlled by it power and distance.

Visualizations of Material Behavior



Material Behavior and Control System



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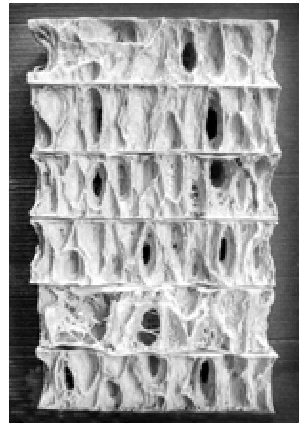
Final Prototype



Team #3
Magnet

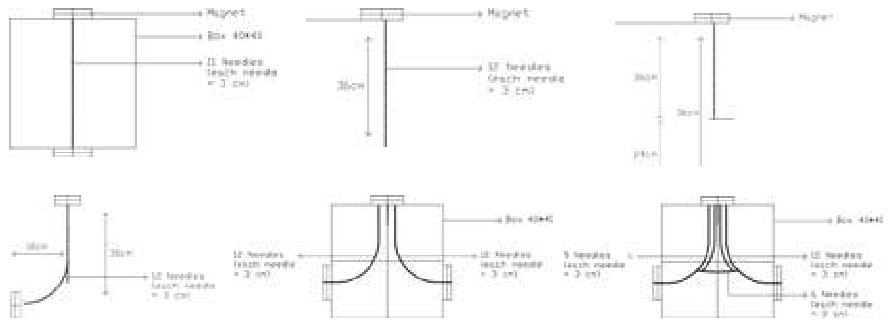
Experimentation Method and First Experiments

Experiment Parameters and Protocols
Behavior of metal agents were analyzed relative to the magnetic field which was created through a specific distance between two or more magnets

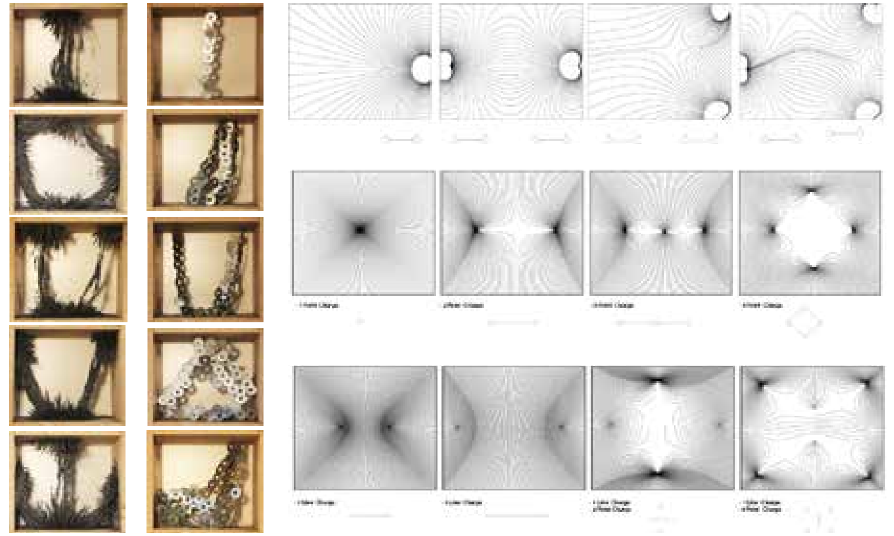
Controls
Magnet Power, Agent, Magnet Distance, Magnetic Charge

Material Behavior
The agents are attracted or deflected from the magnetic field based on the charge. According to their shape some agents created structures between magnets while others simply aggregated around the magnets.

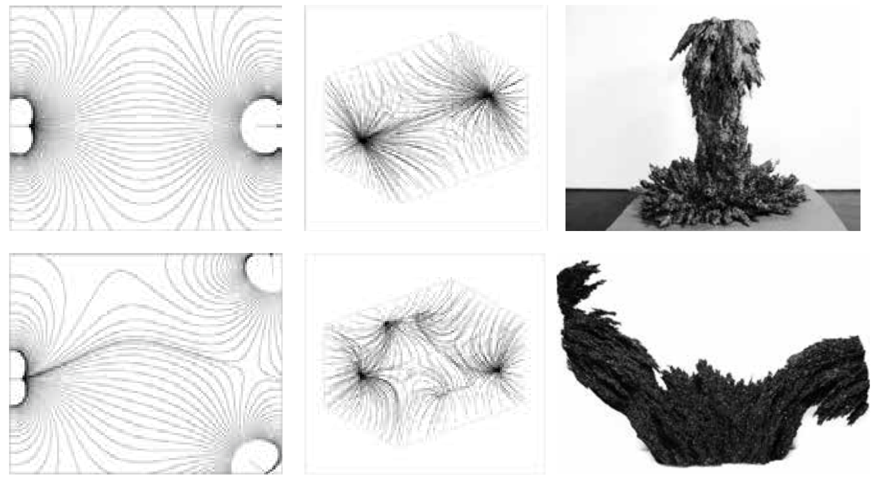
Analysis of Material Behavior and Forces



Catalogue of Material Behavior and Control System



Visualizations of Material Behavior



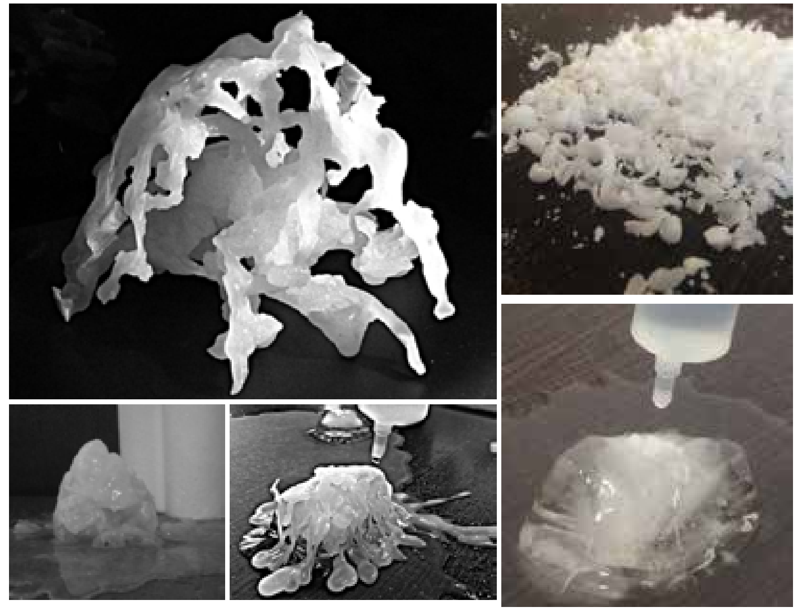
Final Prototype

Team #4
Paraffin

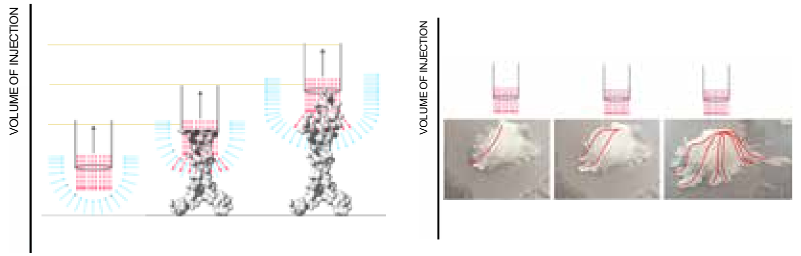
Experimentation Method and First Experiments

Controls
- Liquid type
- Temperature
- Height
- Obstacle
- Digits
- Aperature

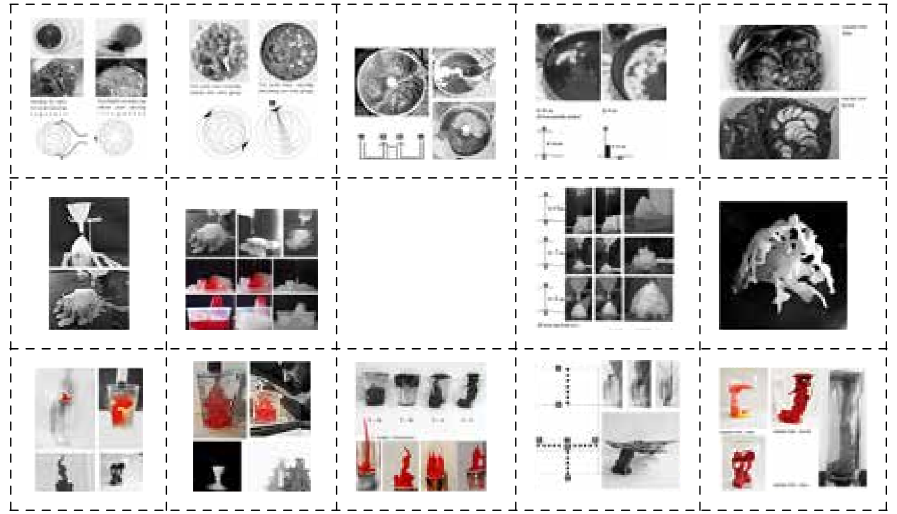
Material behaviour
Heat causes deformation in material which reforms itself according to pressure applied from external materials.



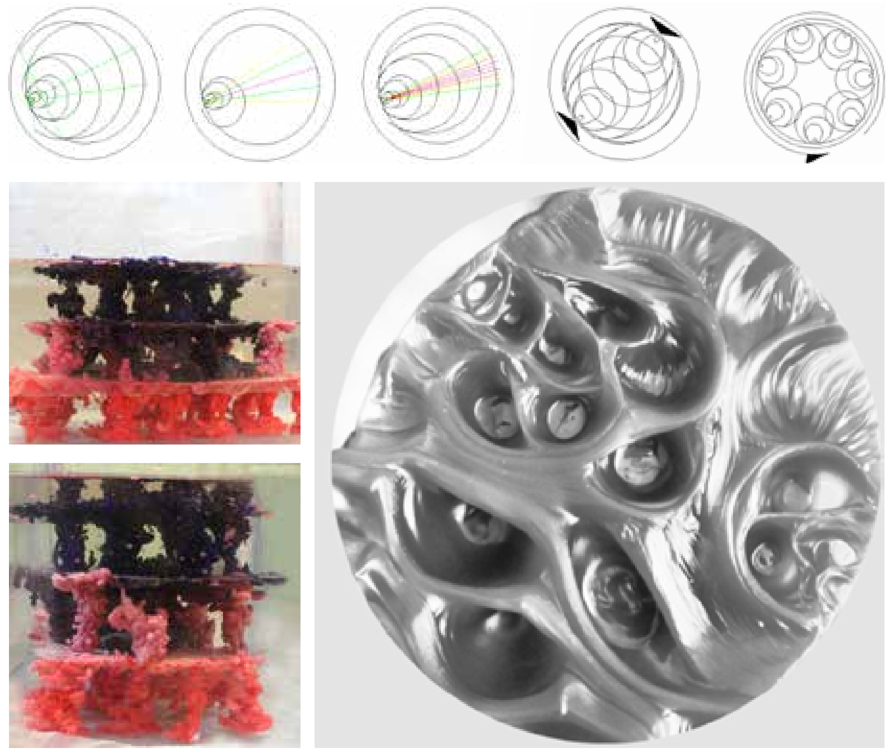
Analysis of Material Behavior and Forces



Catalogue of Material Behavior and Control System



Visualizations of Material Behavior



WORKSHOP DIRECTOR

- Digital Fabrication,
- Interior Design,
- Image Processing,
- Computational Design.

ALGORITHMIC INTERIOR DESIGN WORKSHOP

Instructors:	Arman KhalilBeigi, Esmaeil Mottaghi, Sina Salimzadeh
Year:	Summer 2015
Host:	Iranian Architecture Center, Tehran, Iran
Students:	Architects and Designer
Photographer:	Shayan KhalilBeigi

A Short Workshop to bridge between Digital Fabrication Techniques and interior design problems, centered around image processing

In this 4-day workshop. We aimed to explorer algorithmic design potentials in interior and product design. The agenda is related to use data matrix driven from Raster Data (Images) for the design process, to design and fabricate an algorithmic Architectural Element responding (Passively) to light. Raster images that can be imported from various inputs (Light heatmap, shading pattern, textures, PointClouds, …) were the initial point of the process, later this data was translated to numerical data and undergo further modification; subsequently, these data were translated into Geometry. And according to this geometrical representation, proper fabrication methodology was planned.

Students were presented with lectures about how to extract data from Raster images and post-process them to be used in form-generation. Researchers were encouraged to add additional layers of data on top of this basic information for example data for user-reaction with the object, or structural stability or secondary responses with the reflected light. Results are elements responding to light (controlling light passage) and also create additional effects using absorbed/reflected light such as creating a pattern on the wall/facade or directing the suitable light to the depth of the space.

Team #1

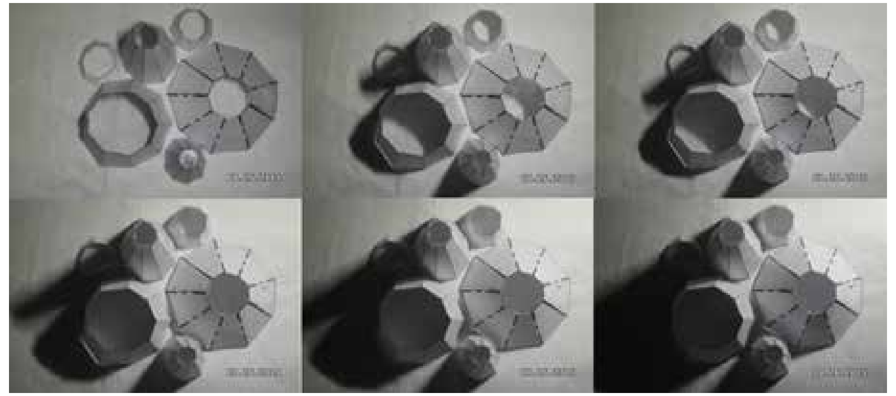
Barnacle

Agent/Module
Polygonal Agent

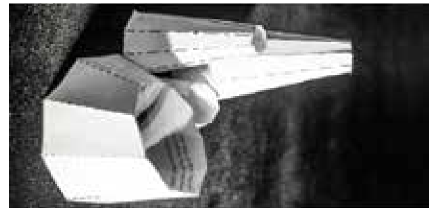
Controls
- Cell Size
- Extrude
- Cap Rotation

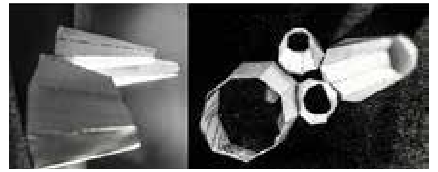
Behavior pattern
- Cell Size Based On view
- Extrude Based On Shadow Analysis
- Cap Rotation Based On Sun Path

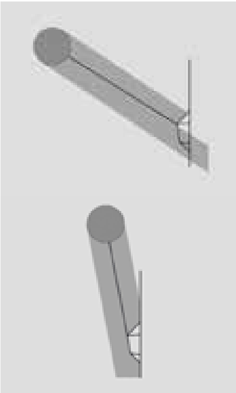
Gene Pool (Alternatives):

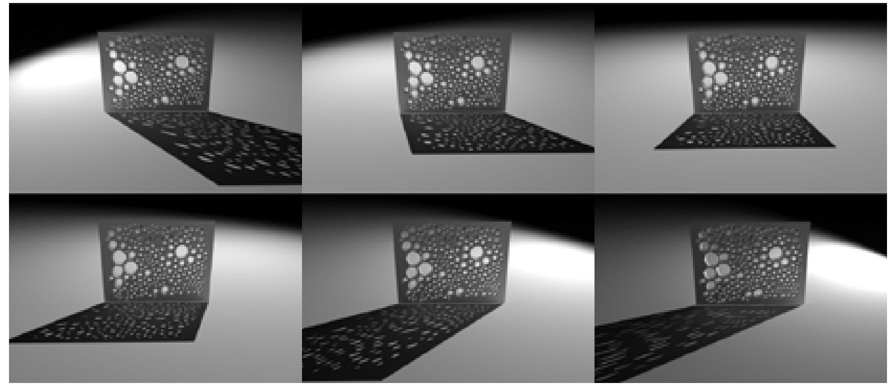


Agent Mechanism

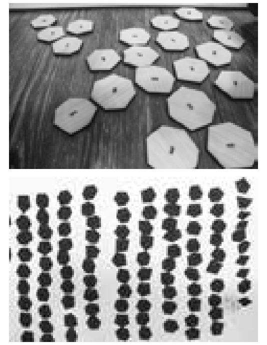




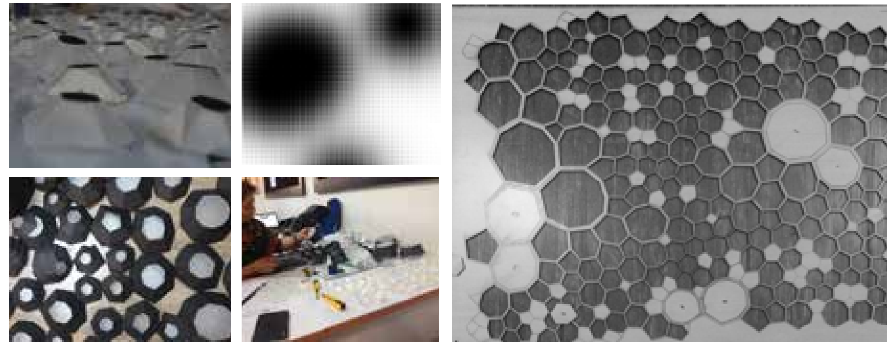




Fabrication Method : Folding



Fabrication Method : Folding



Team #2

Intelligent Eye

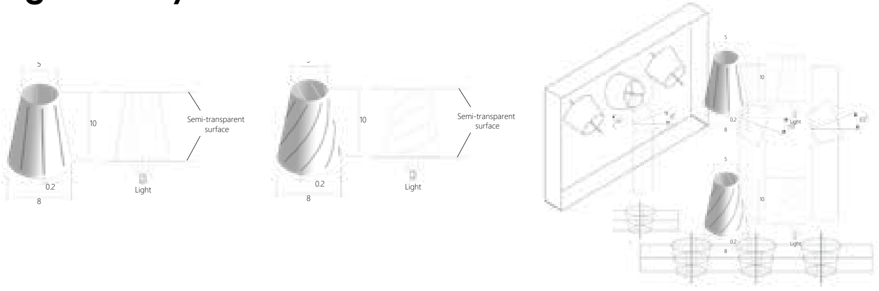
Agent/Module
Variable Conic Agent

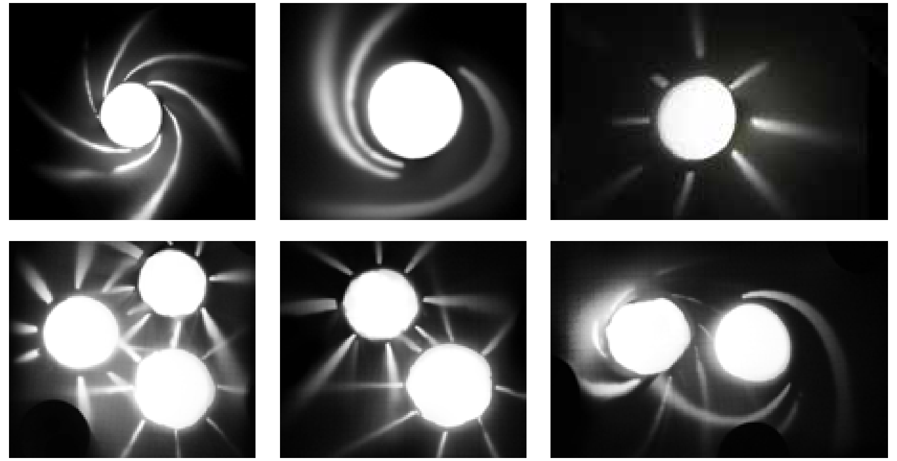
Controls

Behavior pattern
Linear transforms in conic properties

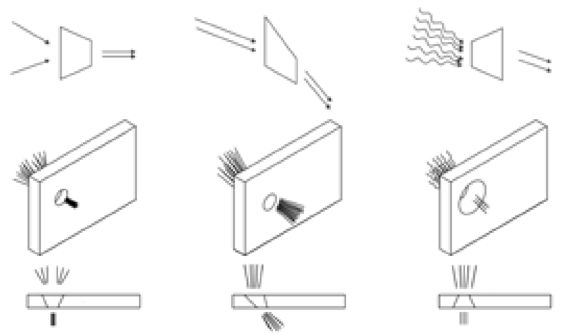
Using the eye mechanism (diaphragm) to control light and vision and creating an integrated pattern.

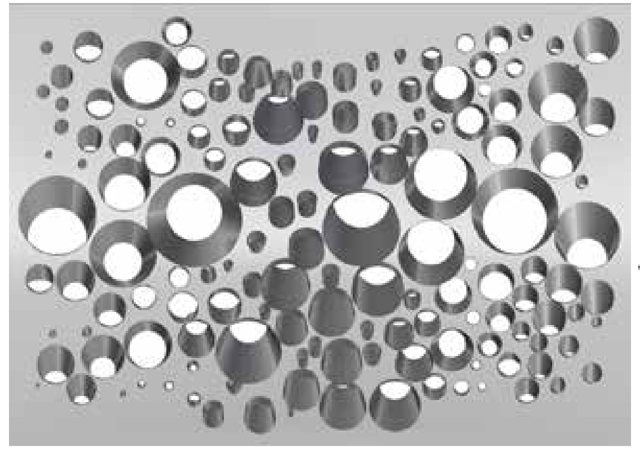
Agent Study

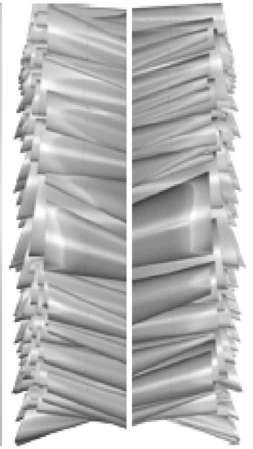




Agent Mechanism







Final Prototype

Algorithmic Interior Design Workshop

Workshops Director
Summer 2015

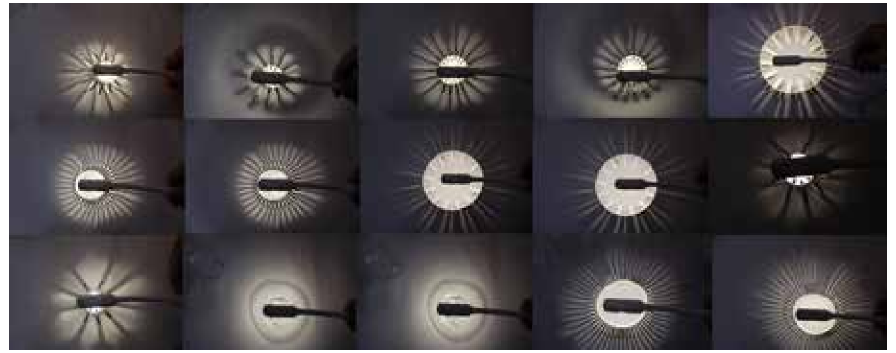
Team #3

Responsive Curtain

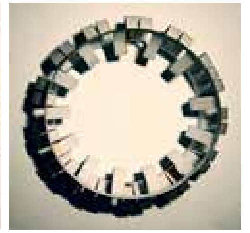
Agent/Module
Tri-mode circular agent
Controls
- The height | The thickness of the
- Ribbons| The radius of the circle

Behavioral pattern
The thickness of the ribbons: increasing the thickness of the ribbons decreases the number of segments shaping the agent and constrains the bending of the ribbons. The radius of the circle: when the radius is at about 22cm, excessive slender H to R ratio causes instability in the agent.

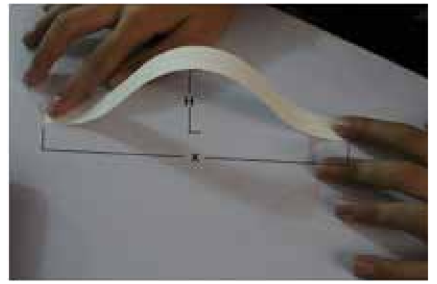
What was asked was to design an interior component that could control the amount of light passing through and what is within sight.

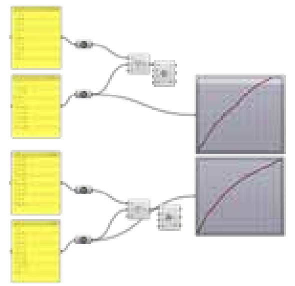


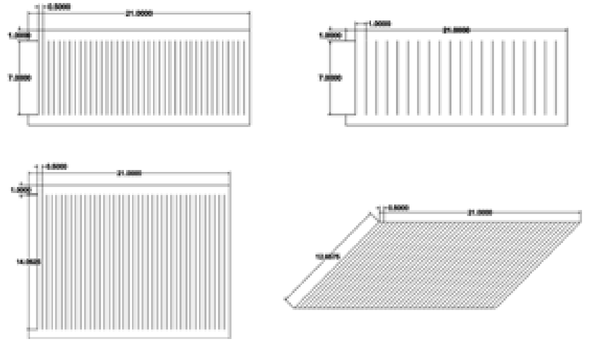




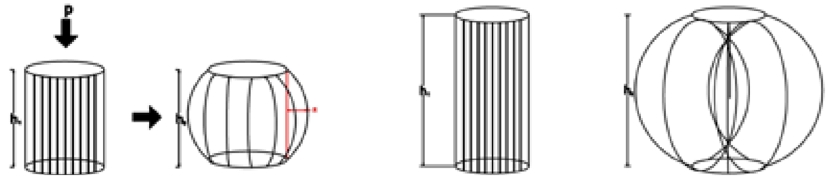

The relation between variations in the length of the ribbons and deflection

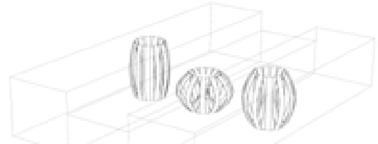






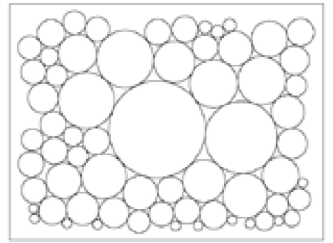
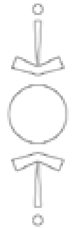
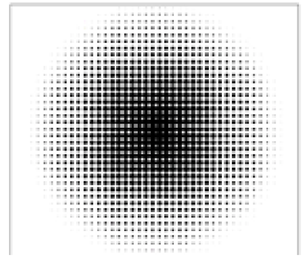
Agent/Module Mechanism



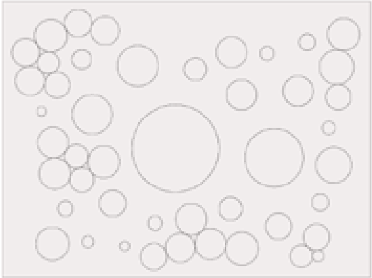
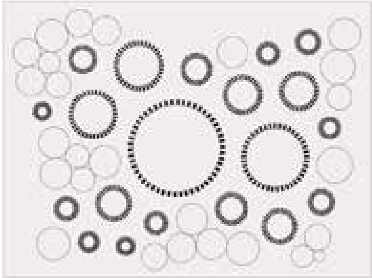
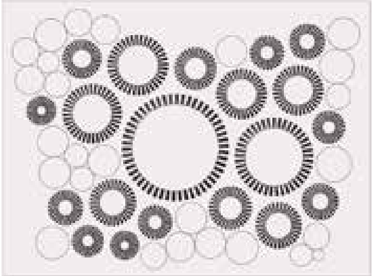
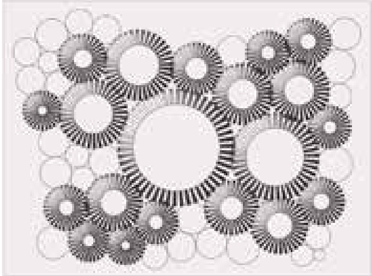


By dividing the enclosing glass walls of the partition, we can exert more control over the view behind the partition and amount of light passing through it.

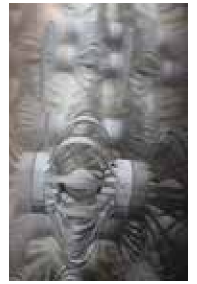
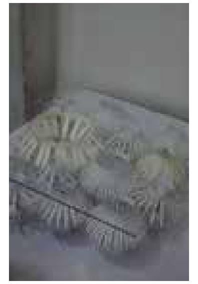
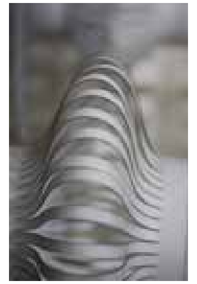
Form Finding

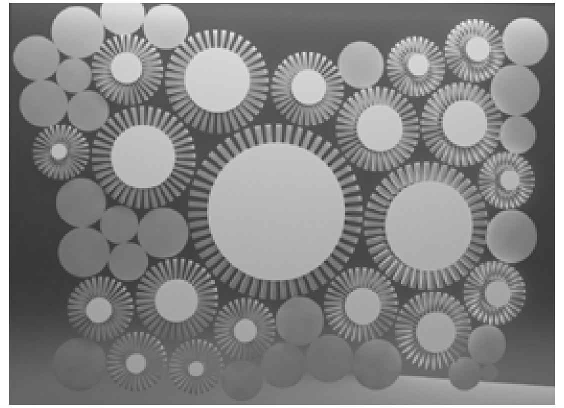
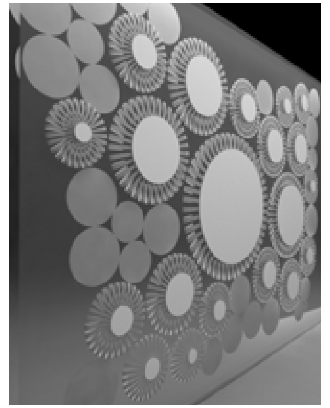




Gene Pool (Alternatives):

Final Prototype

Algorithmic Interior Design Workshop

Workshops
Director
Summer 2015

INDEPENDANT RESEARCH

RESEARCHER

TEACHINGS	ACADEMIC COURSES	Course Director / Computational Tutor
	WORKSHOPS	Workshop Director / Computational Tutor
INDEPENDANT RESEARCH		Researcher
ARCHITECTURE PROJECTS		Principal / Chief Architect
LECTURES AND SEMINARS		Key-Note Speaker / Invited Lecturer
EXHIBITIONS		Artist

INDEPENDANT RESEARCH

AUTHOR & DEVELOPER

- Generative Design
- Pattern

PARAKEET

Authors & Researchers: Esmaeil Mottaghi ,Arman Khalilbeigi

Year: 2019-present

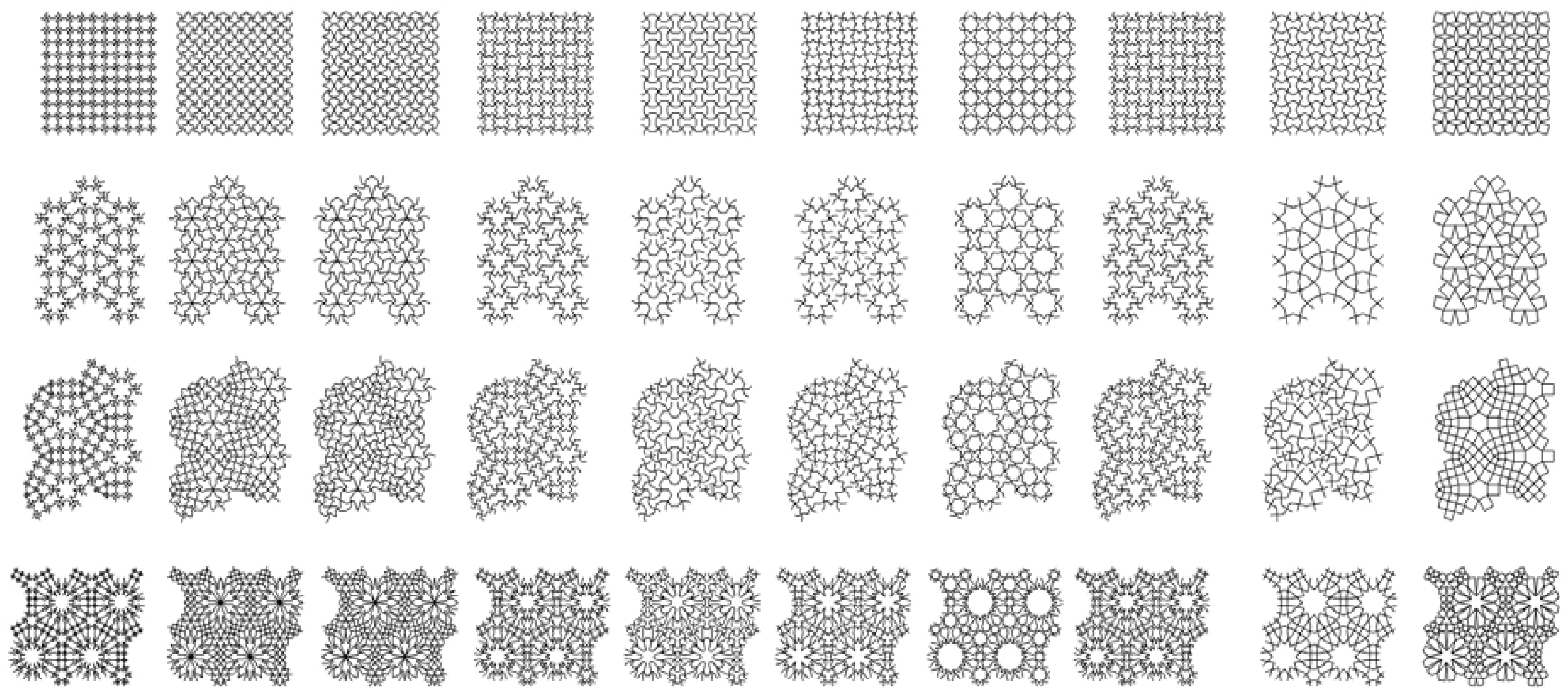
Parakeet is a Grasshopper3d Plugin which has a collection of components focusing on Algorithmic Pattern Generation; it offers a Unique and easy-to-use approach that Generates Geometrical and Natural Patterns/Networks.

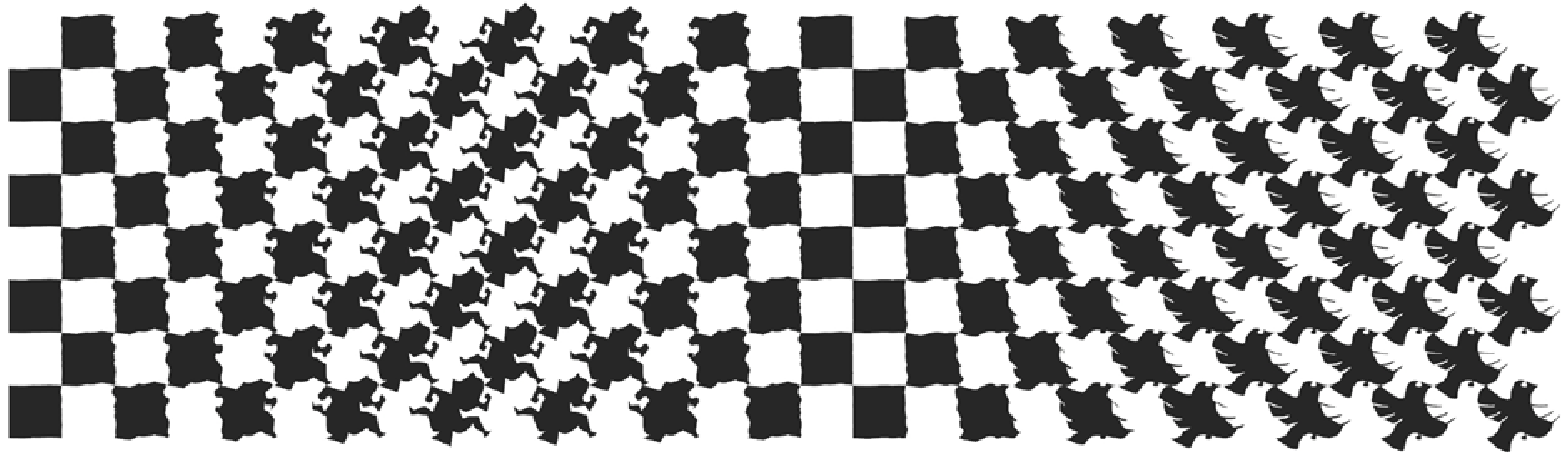





GENERATIVE PATTERNS

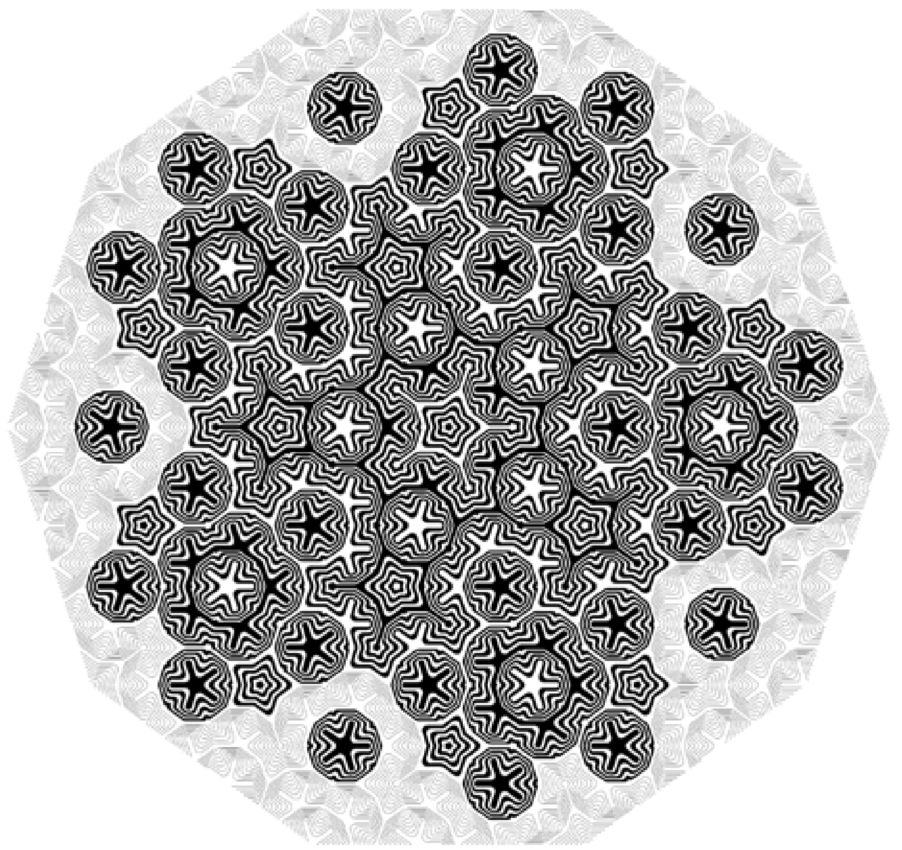
Independant
Research
2014-2017

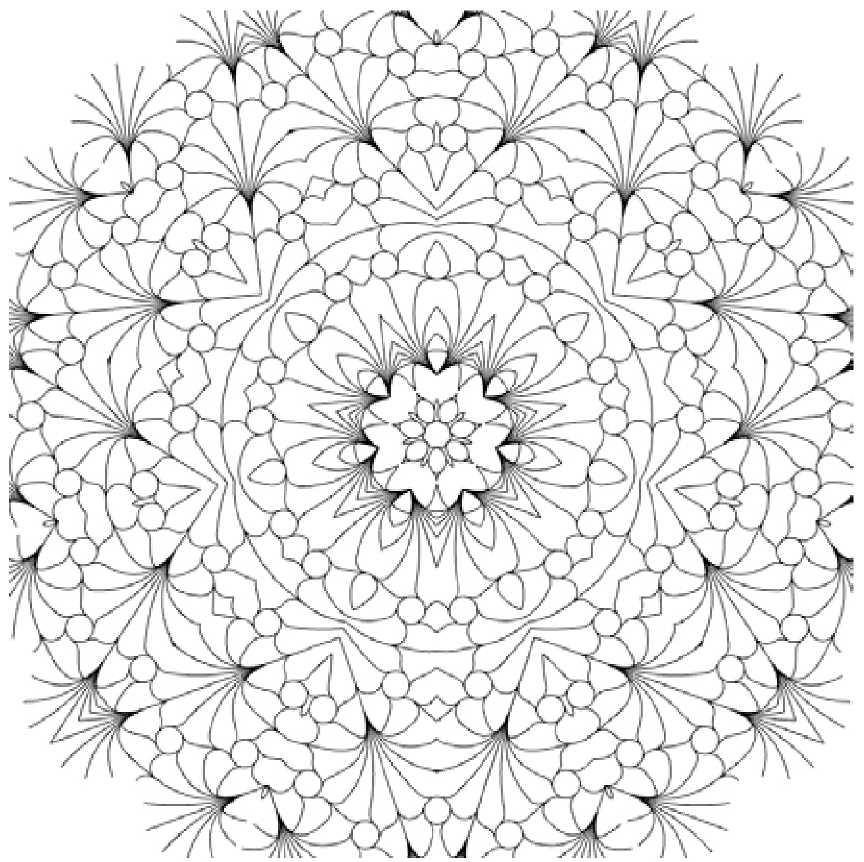


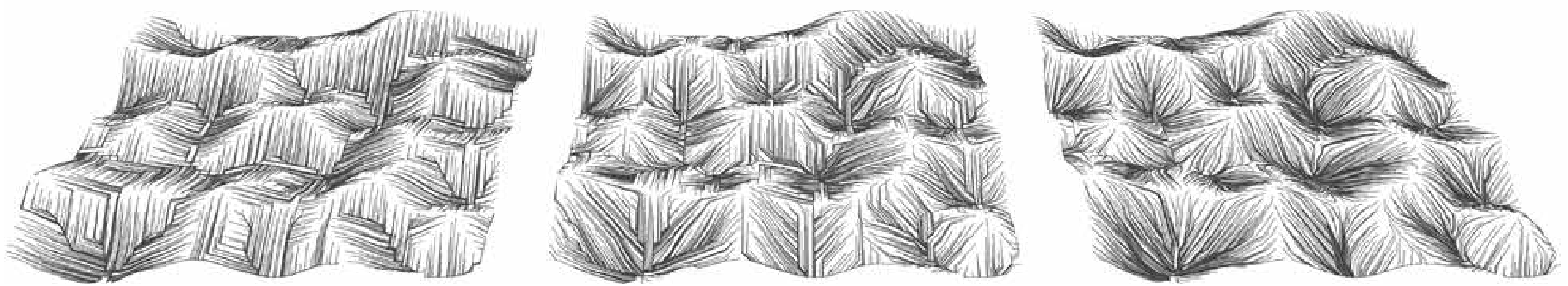


PARAKEET

Independant
Research
2017-Present





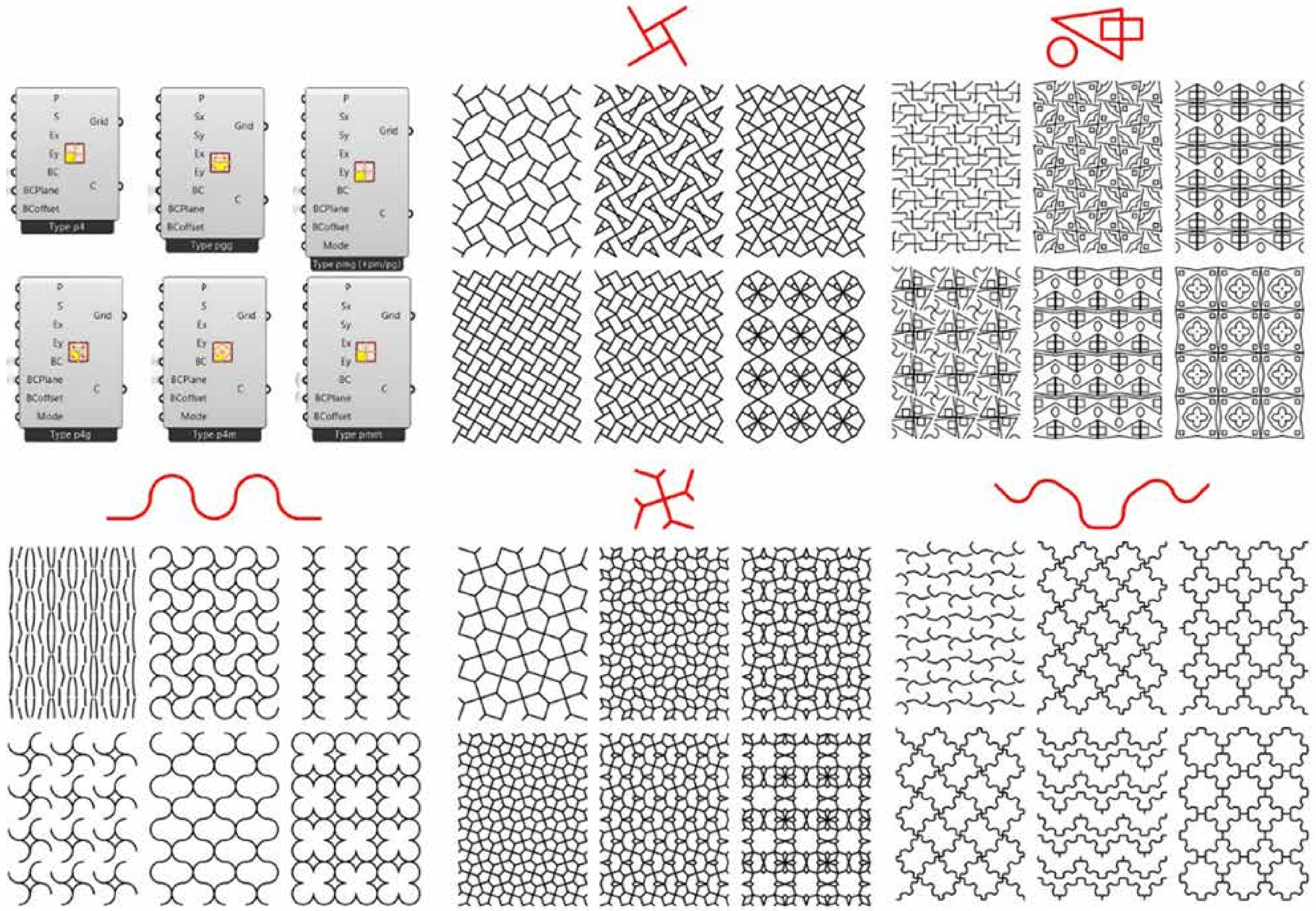


GENERATIVE PATTERNS

Independant Research
2014-2017

PARAKEET

Independant Research
2017-Present



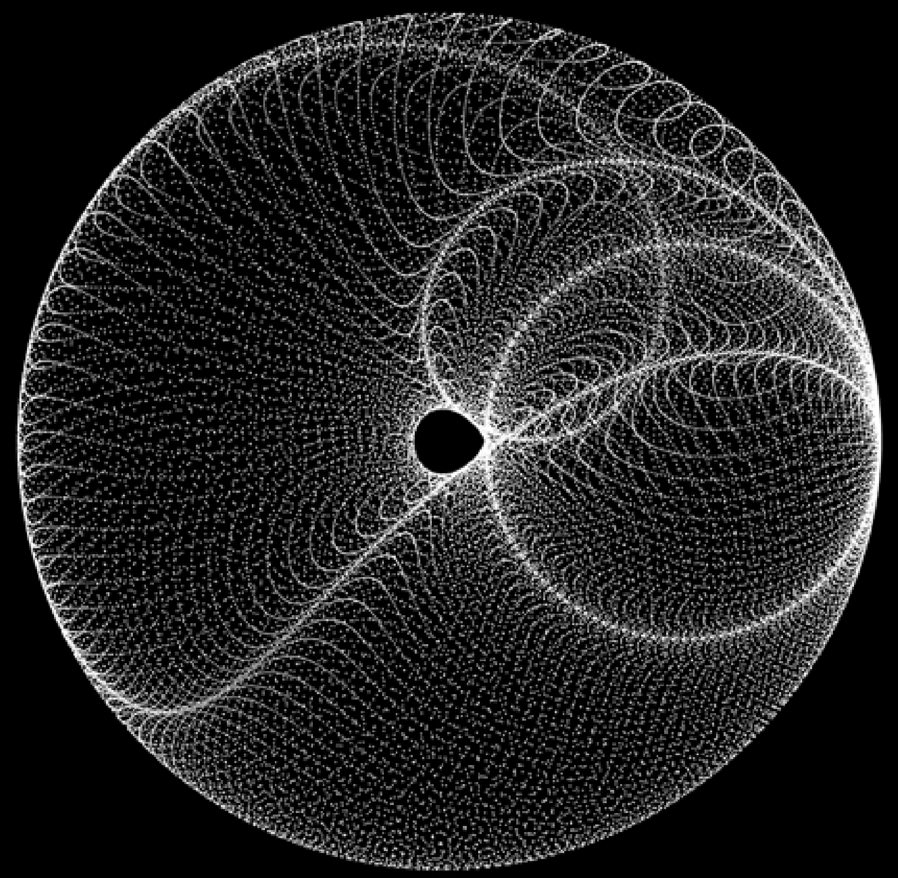
- Generative Design
- Pattern

GENERATIVE PATTERNS

Curators: Zubin Khabbazi , Esmaeil Mottaghi
Researchers: Zubin Khabbazi , Esmaeil Mottaghi , Arman Khalilbeigi, Ehsan Tamarabadi, Hanif Haghtalab ,Soroush Garivani, Dena Hasani , Ali Eslami
Year: 2014-2017

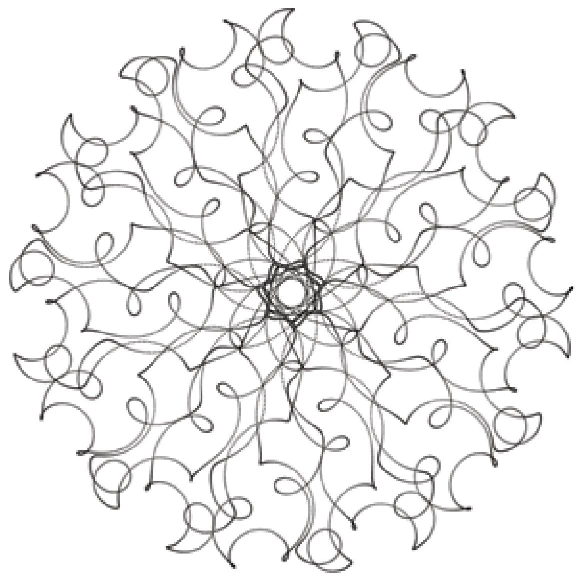
Generative Pattern is a repository trying to collect and categorize computationally generated patterns. in the time of the exhibition, a number of patterns were showcased in classes namely, Geometrical Patterns, Chaotic/Random Patterns, Substitutional patterns, and Bio-inspired networks. Generative Patterns is an ongoing project trying to expand into different areas of art and design.

Patternitecture is a platform that promotes and exhibits researches about pattern design. our independent project 'Generative Pattern' was invited to participate in the public fair. Generative Pattern is a repository trying to collect and categorize computationally generated patterns. in the time of the exhibition, several patterns were showcased in classes namely, Geometrical Patterns, Chaotic/Random Patterns, Substitutional patterns, and Bio-inspired networks. Generative Patterns is an ongoing project trying to expand into different areas of art and design. some outcomes can be found online (at ig:@ generativepatterns) and a comprehensive book is expected to be published in 2023. Generative patterns was designed to remain a public project meaning that designers from various disciplines have joined and worked on it. It was intended for this project to retain two key defining features, first, it welcomes new participants from every discipline and secondly, it accentuates on digital creation of these patterns. at the moment it is of great interest for us to unify these algorithms and present them in a proper design language with pseudo-codes.

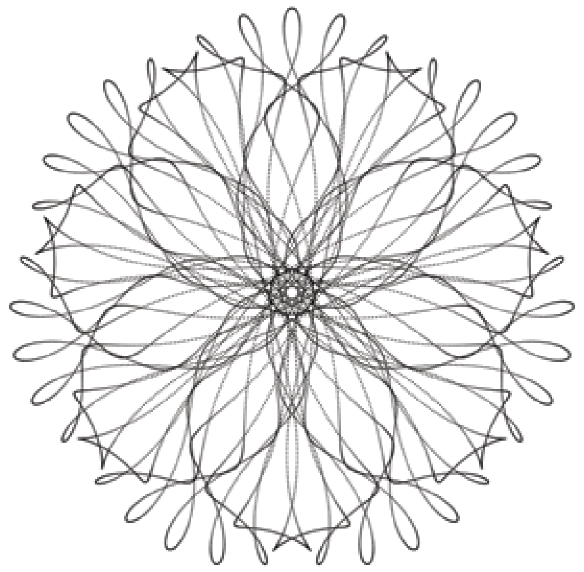


GENERATIVE PATTERNS

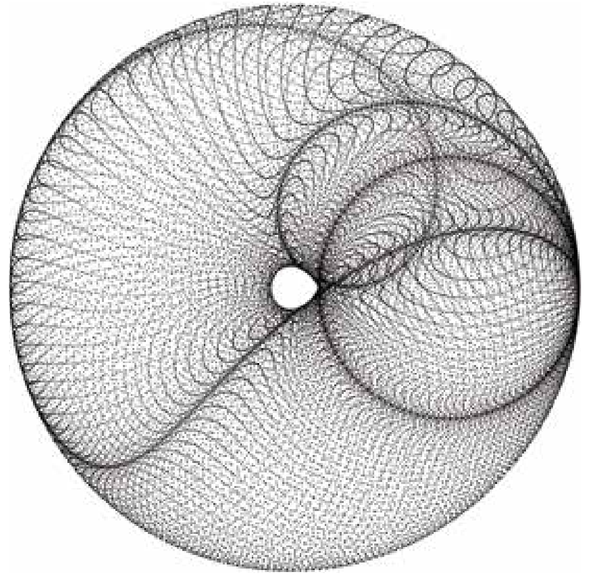
Independant Research
2014-2017



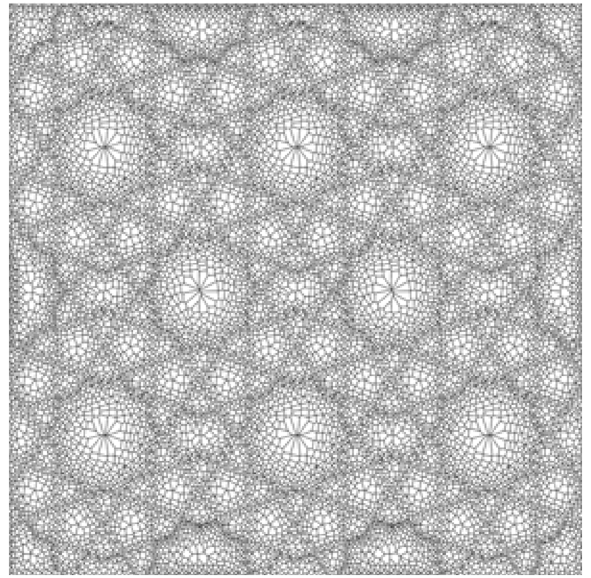
Guilloche _ 01



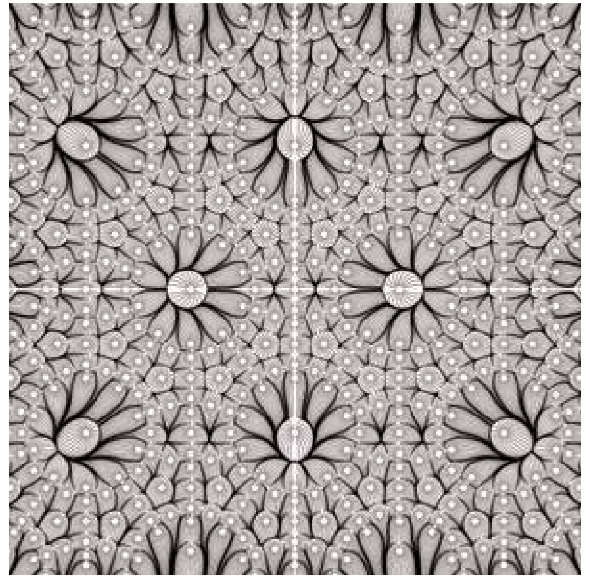
Guilloche _ 02



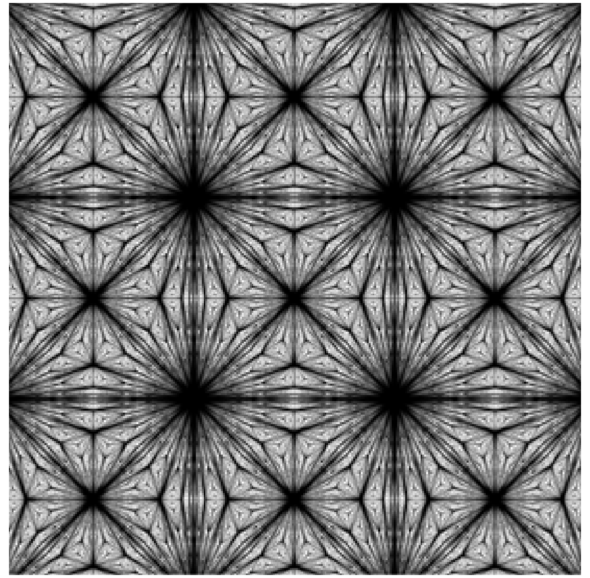
Guilloche _ 03



Girih _ 01



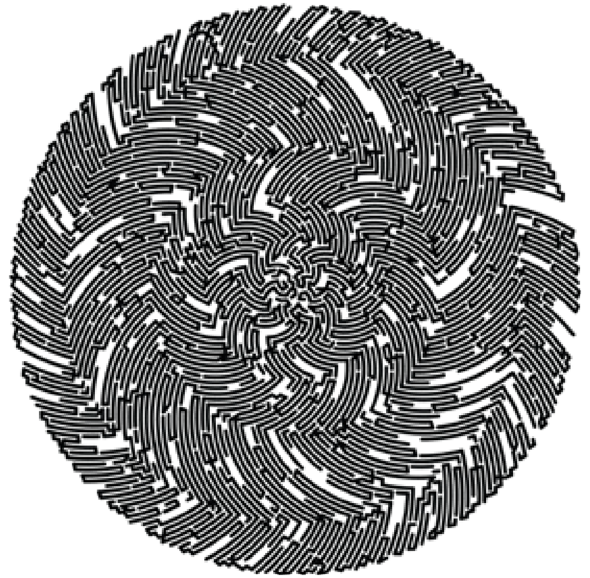
Tensor Field _ 02



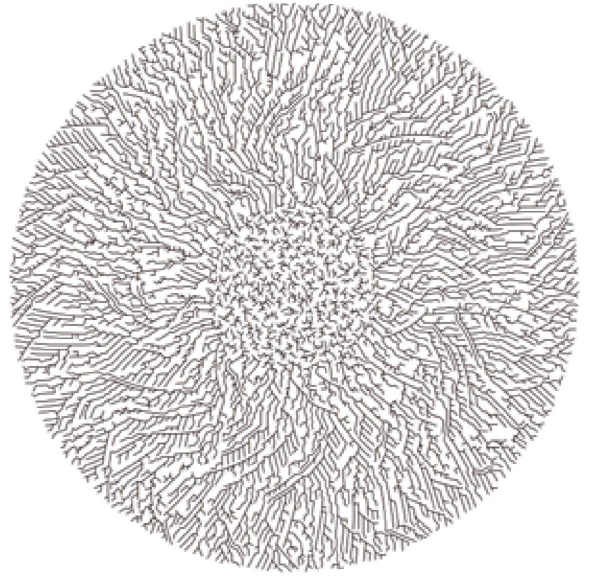
Substitutional _ 01

GENERATIVE PATTERNS

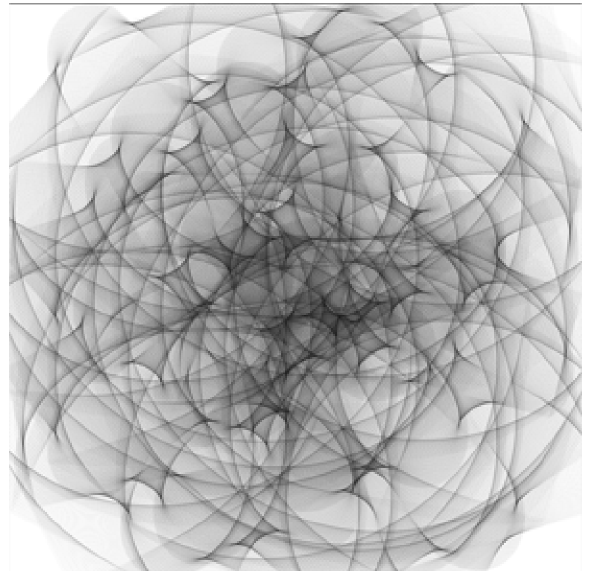
Independant Research
2017-Present



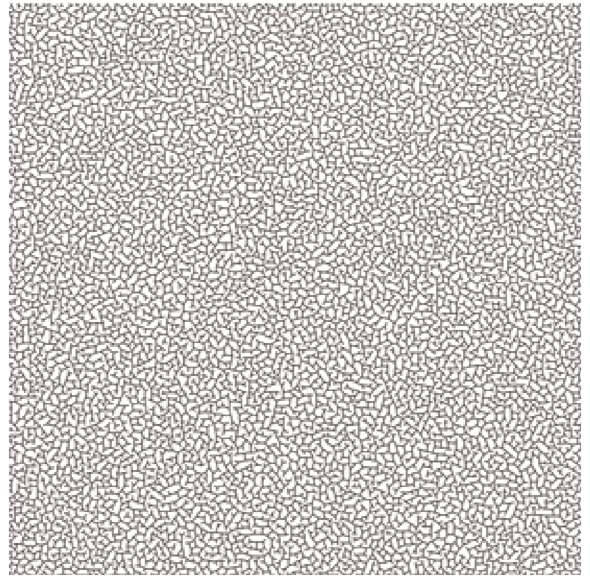
Reaction-Diffusion _ 01



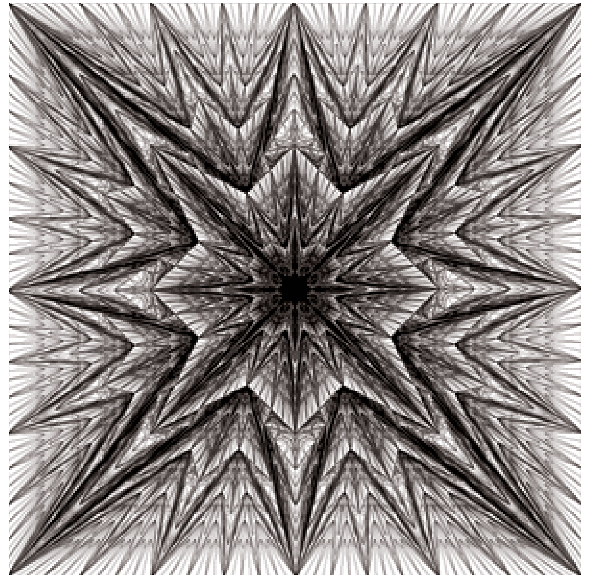
Reaction-Diffusion _ 02



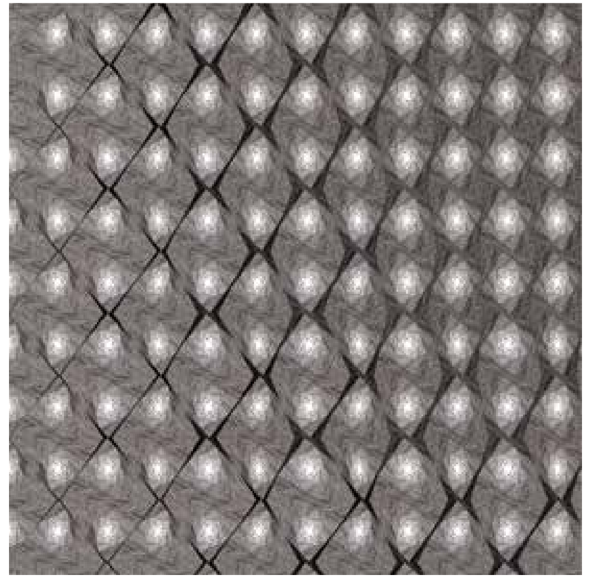
Point Cloud_04



Reaction-Diffusion _ 03



Substitutional _ 02



Substitutional _ 03

INDEPENDANT RESEARCH

COMPUTATIONAL DESIGN EXPERT IN CG RESEARCH GROUP, AND FABRICATION PROJECT DIRECTOR

- Computational Geometry,
- Computational Design,
- Digital Fabrication.

8TH WINTER SCHOOL ON COMPUTATIONAL GEOMETRY, RESEARCH GROUP (STEEL-DOME PROJECT)

Instructors:	Arman KhalilBeigi, Esmaeil Mottaghi, Sina Salimzadeh, Mehrdad Azizkhani
Year:	Winter 2015
Host:	AmirKabir University of Technology, Tehran, Iran
Students:	Architects and Designer, CG Post grad Students
Photographer	Shayan KhalilBeigi

A University course focused on paper-less conceptualization; a bottom-up approach for creating ‘Design Tools’ based on multiple disciplines.

Our research in the Computational-Geometry research group that followed by a fabrication project, presents a method to fabricate free-form geometries by dividing them into discreet, developable pieces. The pieces are developable, single-curved and as flat as possible and rational in terms of the total number of pieces. The aim is to make any arbitrary free-form manufacturable by 2D low-tech machinery with no need to use CNC/Robotic Folding and also minimizing the residual bending stress in each piece. Two geometrical Algorithms are developed to do so and as an example, have implied on two arbitrary geometries. These Geometrical/Architectural approaches offer advantages like being applicable to Triangular and Quadrilateral Meshes and also suggest a trade-off function that balances the flatness of pieces with the number of pieces. The intuitive nature of these approaches amplifies the geometrical perception of the base shape and elaborates its architectural aesthetics. The flatness of pieces and decreased bending stress leads to more axial behavior in structure and therefore the result is a thinner and lighter outcome; This statement was later examined in a real scale pavilion.

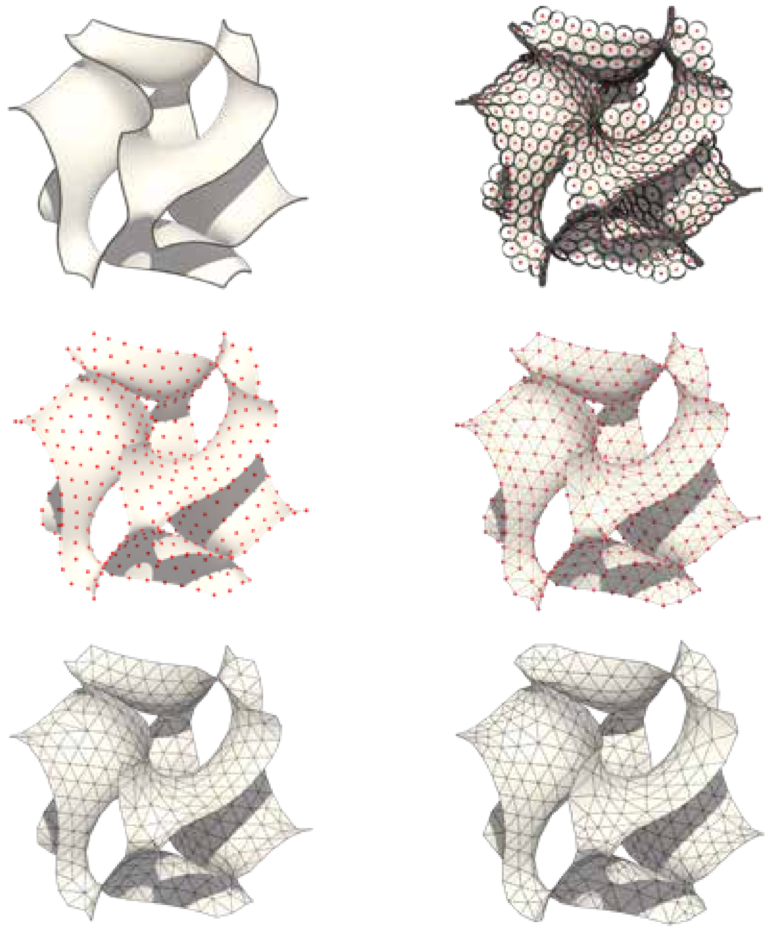
Steel-Dome

Independant Research
Winter 2015

Free Form Approximation by Developable Strips

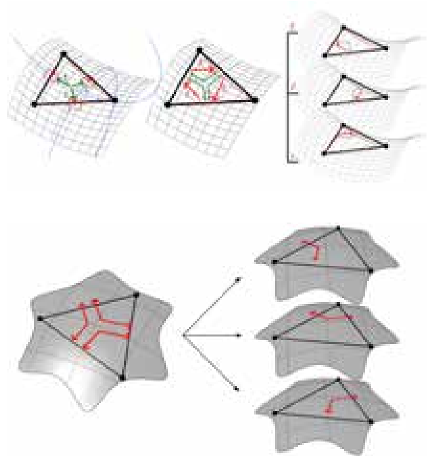
This research initiates by a given surface that by example is a double-curved minimal surface. This surface, forms the base mesh. This mesh through the path decision algorithm defines the pieces or strips. Note that only developable strips with minimum bending along themselves are acceptable.

Base mesh
Which determines the Geometry of the base Cell
Tri-angular or Quadrilateral and its topology
Deciding proper path on each cell
Top-down/General approach
Bottom-up/local approach
Generating strips based on paths derived from previous step
Adding connection Details



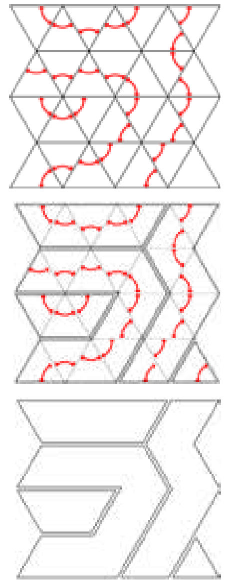
Method 1: General Approach / Triangular Mesh

The method starts with arbitrary surface, in this case a minimal surface. Then a Semi-equivalent triangular mesh approximates this geometry. Then, through localized refinement, irregular triangular mesh is created which approximates the initial base geometry, this mesh has smaller faces and edge-lengths in curved areas and larger faces is flatten parts. paths are created so that appropriate faces establish a single row of faces that is called strip.



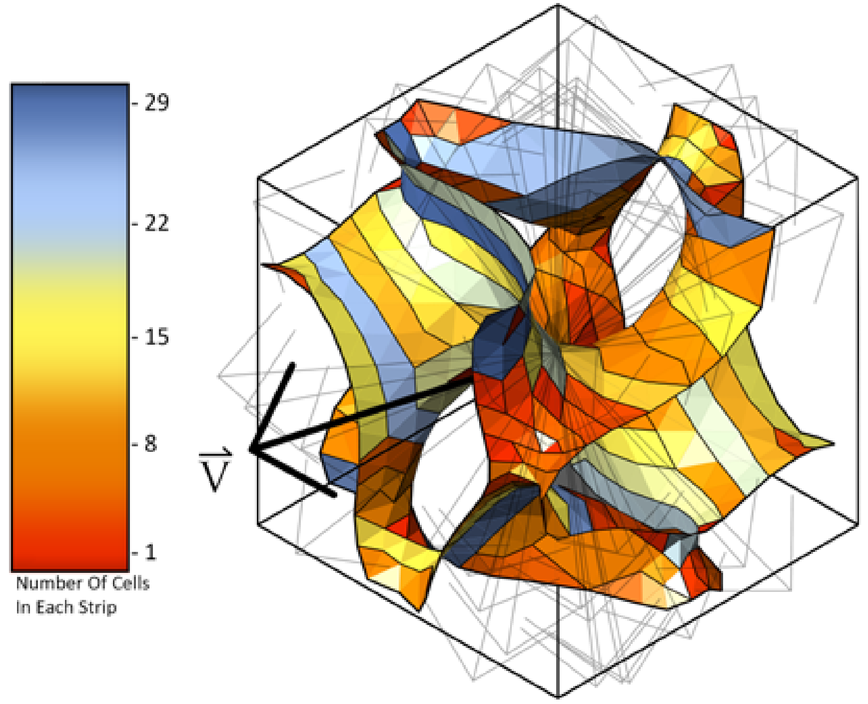
In the 'general approach', a single vector is chosen and all path decisions are made based on this vector. For each face of a triangular mesh, there are only three possible paths to choose from. These paths later determine the strips topology. By simple comparison between these path vectors and the main vector, This process is repeated for all the faces so that a single path is selected for every face. If these paths form a continuous polyline along faces, those faces belong to a single strip.

The Decision making process to determine possible paths on each mesh. The path with highest conformity to the main vectors selected to make the strips.

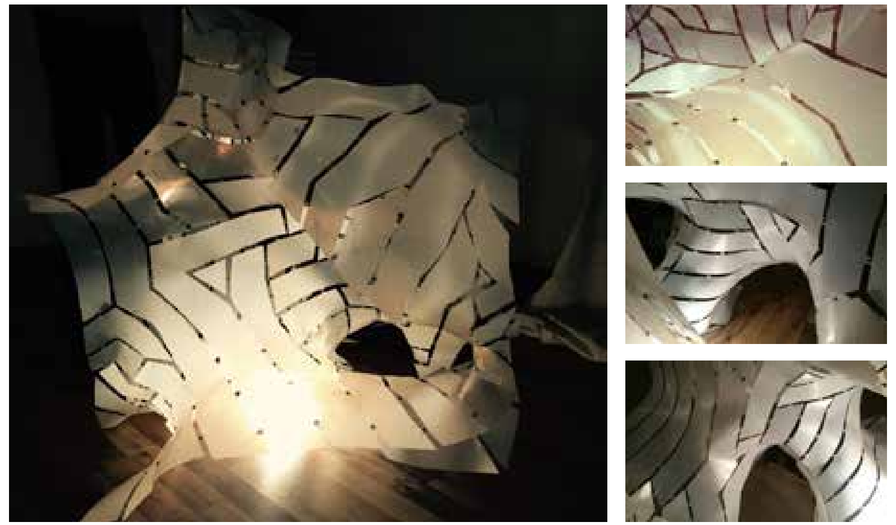


Later the process undergoes an optimization process. In this case, the Genetative algorithm tends to make very small strips that are not suitable for fabrication, so the Fitness was later changed to the sum of bending along each strip and the total number of strips. Thereby a balance is achieved between bending and the total number of strips.

By allocation of the most appropriate path to each cell, neighbor faces with similar paths (paths that share a common edge) indicate a single strip.



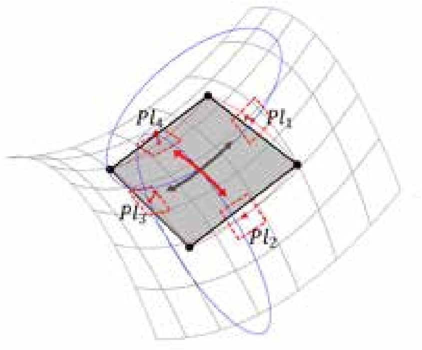
First prototype ; Mesh Division results using General approach on a triangular mesh; the result is a trade-off between minimizing bending along strips and minimizing total number (of pieces (using multi-fitness optimization

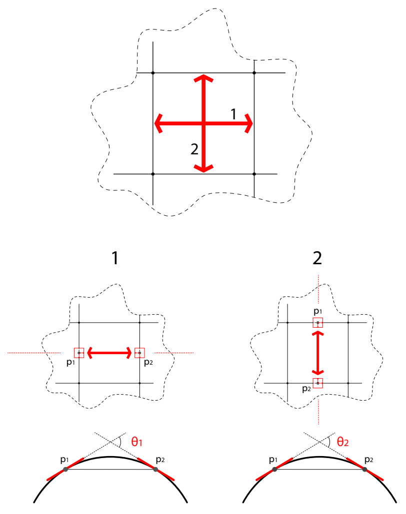


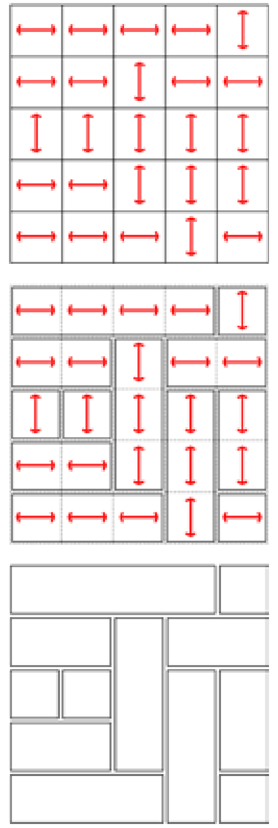
Physical result of first prototype

Method 2: Local Approach / Quad Mesh

This approach starts with an arbitrary geometry which is later converted to a Quadrilateral Planar Mesh.
In order to define paths on each face, similar algorithm is used: Mid-points of the mesh edges are projected on the base geometry, a tangent plane is constructed on the projected points. There are two possible paths to choose; between these two possible paths, the path with smaller angle between their planes (angle between normal vector of the planes) is selected, Based on paths selected for each cell, strips are defined.







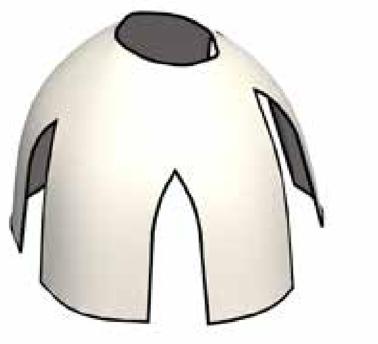
Based on paths allocated for each face, neighbor faces with similar paths form a strip.

Steel-Dome

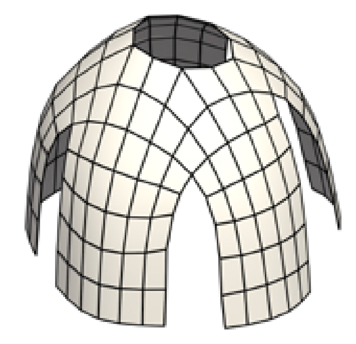
Independant
Research
Winter 2015

Final Prototype

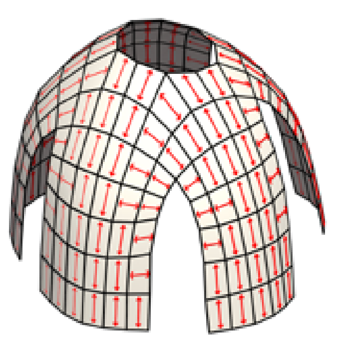
Schematic preview of all steps in Local approach on a quad mesh



Given arbitrary geometry

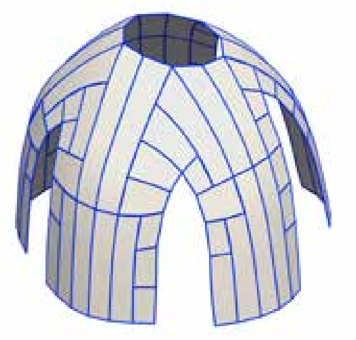


Quad and planar mesh based on given geometry each cell



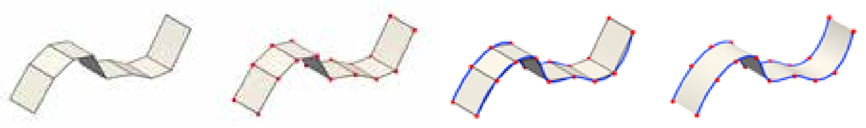
Path making process for each cell

Forming strips based on path

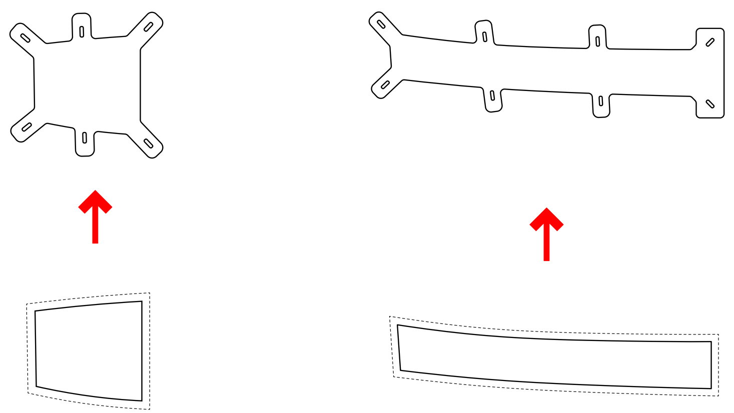


developable strips

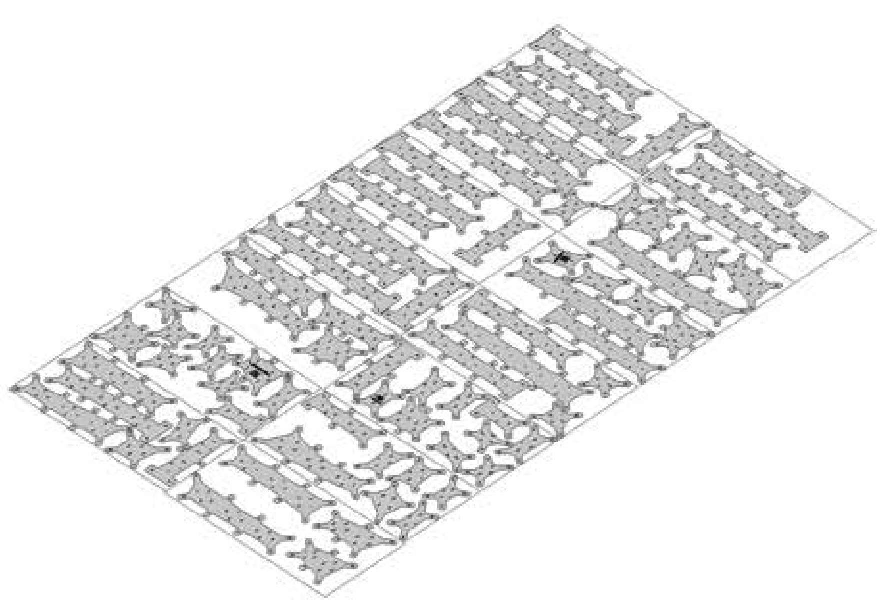
Post-process modifications in order to fabricate



interpolating vertices on each strip to have a smooth finishing



Modifications on each strip; offset to create an opening between strips and detail for screw and nut



These opening beautifully presents a perceptual map of the Steel-Dome base geometry and its curvature properties . The final prototype is laser cutted from one-millimeter-thick Steel-304 plates and assembled using simple screw and nuts

Steel-Dome

Independant
Research
Winter 2015

LECTURES AND SEMINARS

KEY-NOTE SPEAKER / INVITED LECTURER

TEACHINGS	ACADEMIC COURSES	Course Director / Computational Tutor
	WORKSHOPS	Workshop Director / Computational Tutor
INDEPENDANT RESEARCH		Researcher
ARCHITECTURE PROJECTS		Principal / Chief Architect
LECTURES AND SEMINARS		Key-Note Speaker / Invited Lecturer
EXHIBITIONS		Artist

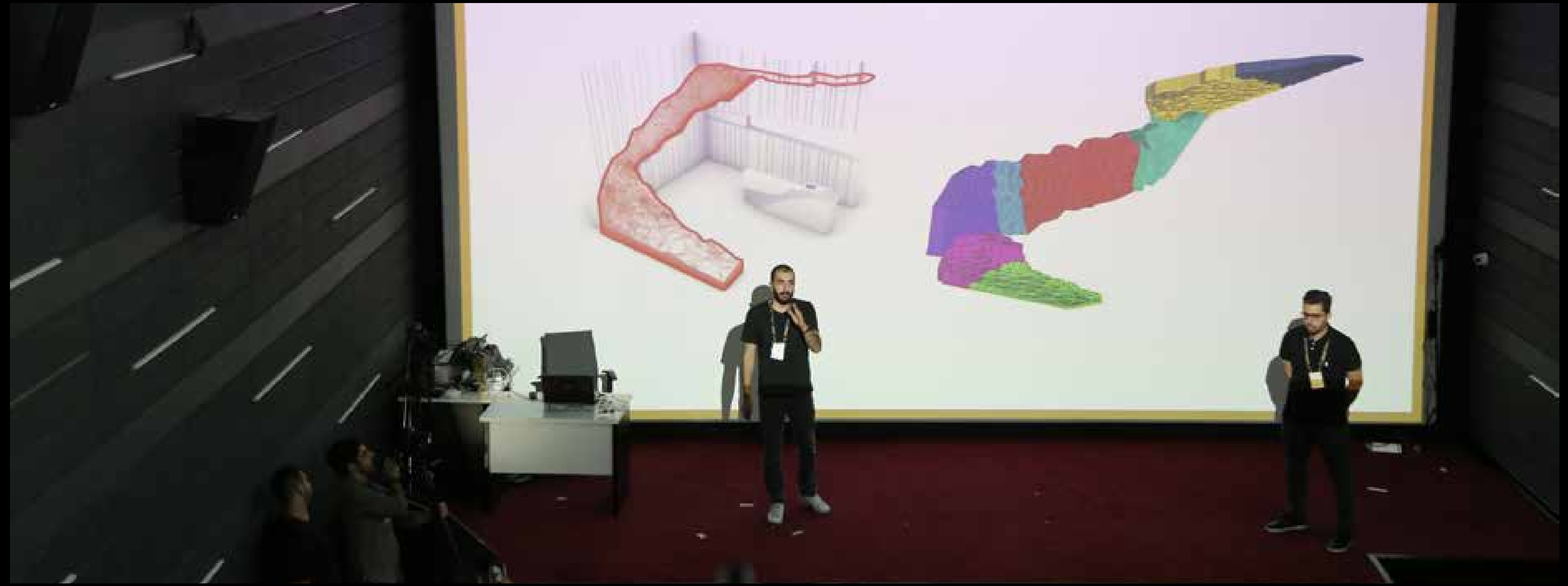
LECTURES AND SEMINARS

MENTOR AND LECTURER

- Computational Design
- Multi-Disciplinary Design
- Mathematics
- Geometry

IDAW 2019
INVERSE DIGITAL ARTS WEEK

Lecturer: Arman KhalilBeigi , Esmaeil Mottaghi
Year: Summer 2019
Host: Inverse School & Cinema Astara, Tehran, Iran
Audience: Architects and Designer



LECTURES AND SEMINARS

INVITED LECTURER

- Design Optimization,
- Algorithmic Design

IAAC GLOBAL SUMMER SCHOOL, TEHRAN NODE

Lecturer:	Arman KhalilBeigi
Year:	Summer 2017
Host:	Platform 28 Art Gallery, Tehran, Iran
Audience:	Architects and Designer

A workshop on integrated solutions for urban spaces; deriving data from citizens through sensors and recognitions, processing and visualizing them and create projects upon these data.

LECTURES AND SEMINARS

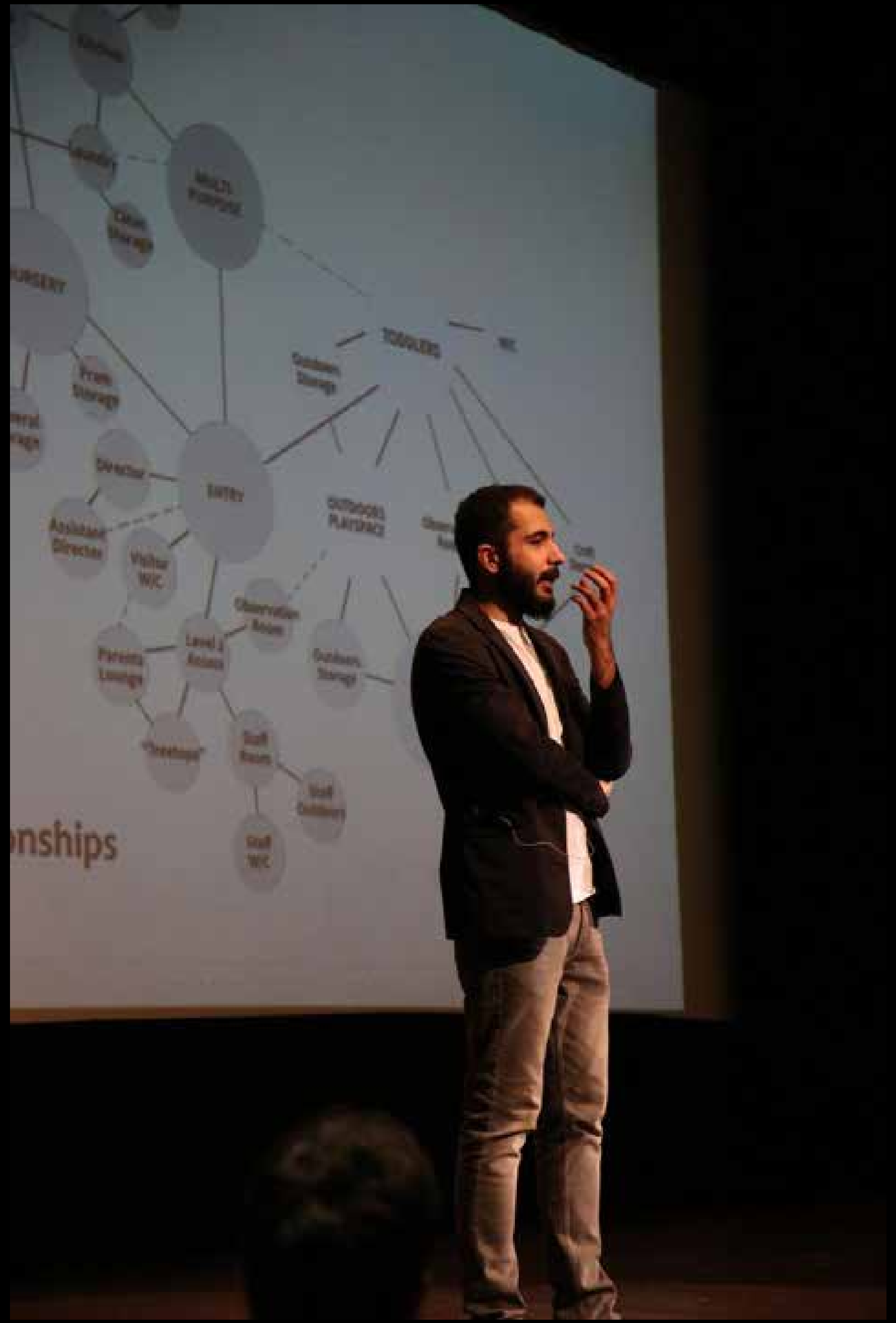
MENTOR AND LECTURER

- Computational Design
- Multi-Disciplinary Design
- Mathematics
- Geometry

ARCHITECTURE MULTI-DISCIPLINARY STARTUPS WEEKEND

Lecturer: Arman KhalilBeigi
Year: Winter 2017
Host: University of Tehran, Tehran, Iran
Audience: Public

A startup weekend focusing on promoting ideas for businesses on the intersection of technology and design.



LECTURES AND SEMINARS

INVITED LECTURER

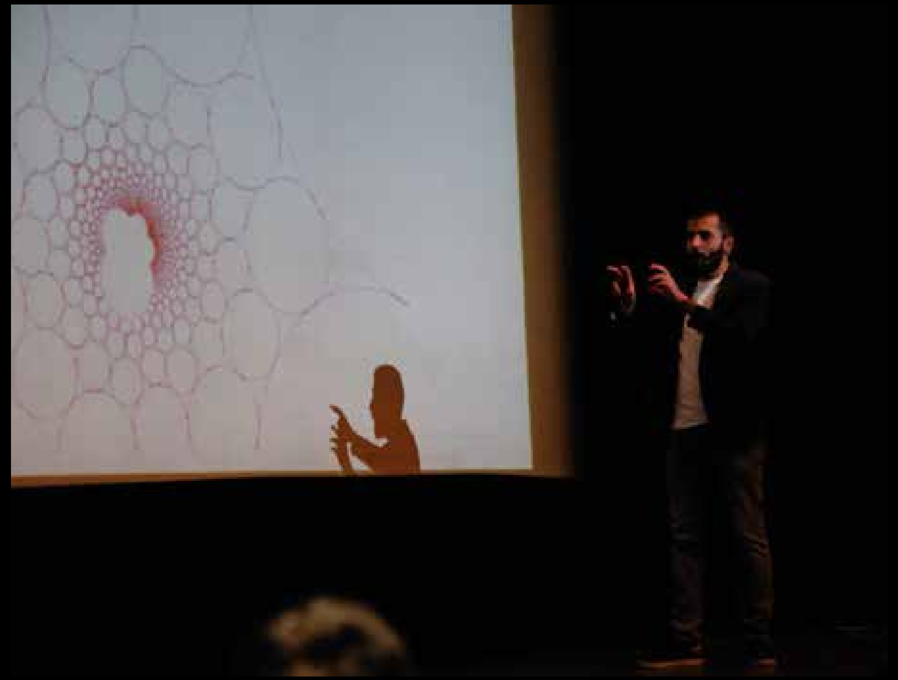
- Computational Design
- Multi-Disciplinary Design
- Mathematics
- Geometry

ARCHIMATH LECTURE SERIES

Lecturer: Arman KhalilBeigi
Year: Winter 2017
Host: Arasbaran Culture House, Tehran, Iran
Audience: Public

Series of discussions focusing on the investigation of Applications of Mathematics and Geometry in computation design and digital fabrication.
In Collaboration with Pars University of Art and Design

In our office 'Paragen Creative Studio' what we do is providing Design and Fabrication [computational] solutions for architecture firms and constructors. based on that I was invited to lecture about some architecture projects that we developed geometrical/mathematical solutions for. in these projects we were mainly involved with fabrication-aware redesigning of the projects and rationalizing the fabrication process. projects included complex heterogeneous brick façades, generating shop drawings for double-curved glass façades and structural optimization to obtain more efficient and slender structures. later I briefly presented specific fields of geometry that can have direct applications in the design process; namely 'Graph theory' and its relation to planning, 'Topology' and its application on complex Remeshing, 'Differential' Methods that can lead to rational discretization of surfaces and ...



EXHIBITIONS

ARTIST

TEACHINGS	ACADEMIC COURSES	Course Director / Computational Tutor
	WORKSHOPS	Workshop Director / Computational Tutor
INDEPENDANT RESEARCH		Researcher
ARCHITECTURE PROJECTS		Principal / Chief Architect
LECTURES AND SEMINARS		Key-Note Speaker / Invited Lecturer
EXHIBITIONS		Artist

EXHIBITIONS

ARTIST

- Generative Design,
- Pattern

PATTERNITECTURE EXHIBITION PARAGEN

Artists:	Arman Khalilbeigi, Esmaeil Mottaghi, Sina Salimzadeh
Year:	Summer 2017
Host:	Patternitecture Event, Tehran, Iran
Audience:	Artists and Designers

In the 'Patternitecture' Exhibition, Our Initial studies around patterns were showcased. also, several prototypes were fabricated to demonstrate the potential of designing the patterns three-dimensionally using various methods of cylindrical and spherical coordinates.

"Patternitecture" is the name for a project exploring relations between design practice and Geometrical Patterns, challenging pioneer architects and designers nationwide to gather, talk and study patterns in design.

In 2017, Algorithms for generating performative patterns were a topic of research for us. a profound study was done to create [digital] design tools rooted in geometrical patterns yet integrated with some advanced computational methods. therefore some of these outcomes were showcased in this event with the following description:

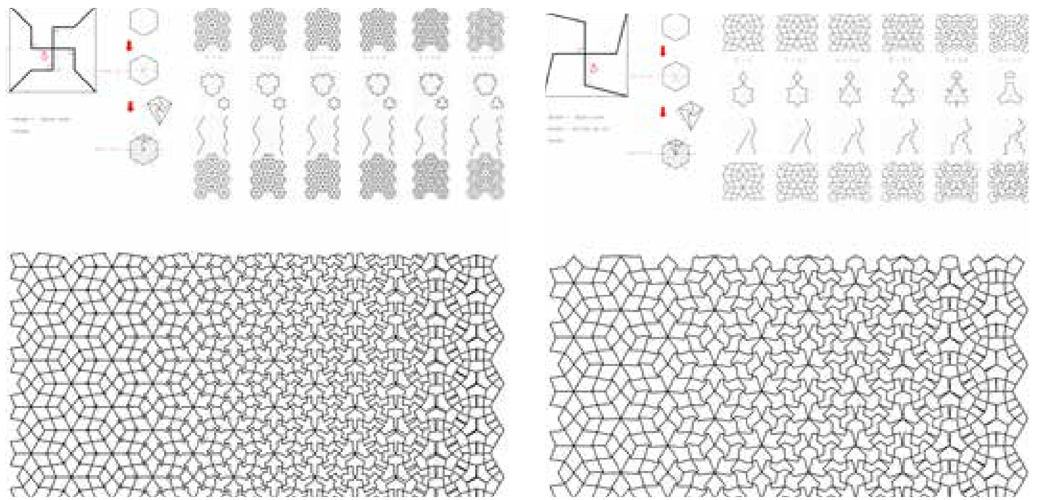
Patterns are intertwined into the fabric of art and design responding to a vast range of functions, from ornaments to spatial organization. each geometrical patterns not only exposes a morph or form but also [more importantly] has a process and a form of computation embedded in it. therefore studying and extraction of these underlying processes, re-coding, and adjusting them can lead to the creation of design tools compatible with modern architectural problems. the focal point for this project was the algorithms or processes behind the patterns. therefore this pattern study was not about 'what was' but more accurately was about 'what could have been' or ' what can be'.

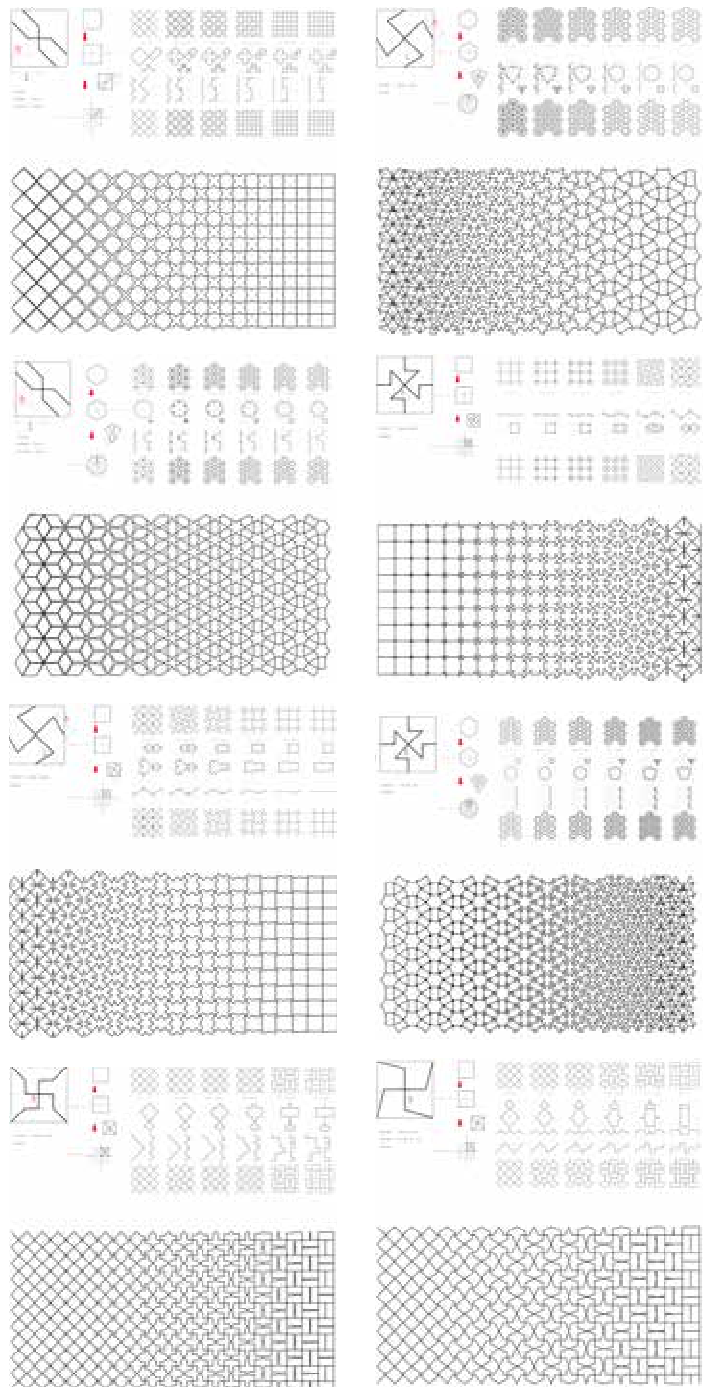
Subsequently, after the computational regeneration of these geometrical algorithms, they were conveyed to various less-conventional numerical spaces in which led to generation of novel extraordinary geometries.

Patternitecture

Exhibitions
Artist
Summer 2017

In this independent research, we conducted profound research on geometrical patterns. we aimed to redesign their generation methods algorithmically.
[Later the outcome of this research was stored in a Plugin Called Parakeet which is presented separately in this document]
We started by studying former methods of Pattern Generation (Hankin Lee & Craig S. Kaplan's methods) and redesign their logic for parametric modeling, later we developed our new logic, based on 3 main steps (A)Tilings, B)Pattern Generation Method, C)Modification algorithms). this way generating networks would be more intuitive and easy to apprehend and also this pipeline can conform to further complex developments like optimization. in each step, we included various topics, for example in the 'Tilings' section, we coded 'Regular tilings', 'K-uniform tilings' and 'Irregular tilings'. in Pattern Generation Methods, we studied more than twenty different methods derived from all over the world and in 'Modification' algorithms we created 'Transformations', 'Truncations', 'Dual-generation' and 'Relaxation' methods.
Later after incorporating a large portion of studies on two-dimensional patterns, we studied means of making these networks three-dimensional. to do so we integrated different positioning (coordinate) systems in pattern generation processes like Cylindrical, polar and spherical coordinates. results were showcased in Patternitecture Biennale Tehran. alongside these new methods of form-generation, we also categorized geometrical properties of each genotype, properties like constant area in every cell or constant angle between elements are examples that can be considered in the further fabrication-aware designs.





Patternitecture

Exhibitions
Artist
Summer 2017