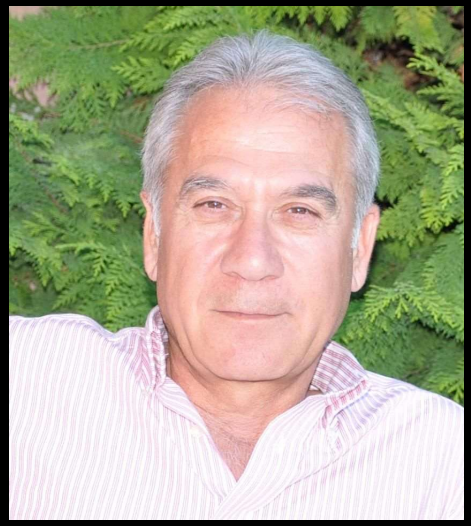
Lightweight Structures in Interior Design and Public Spaces



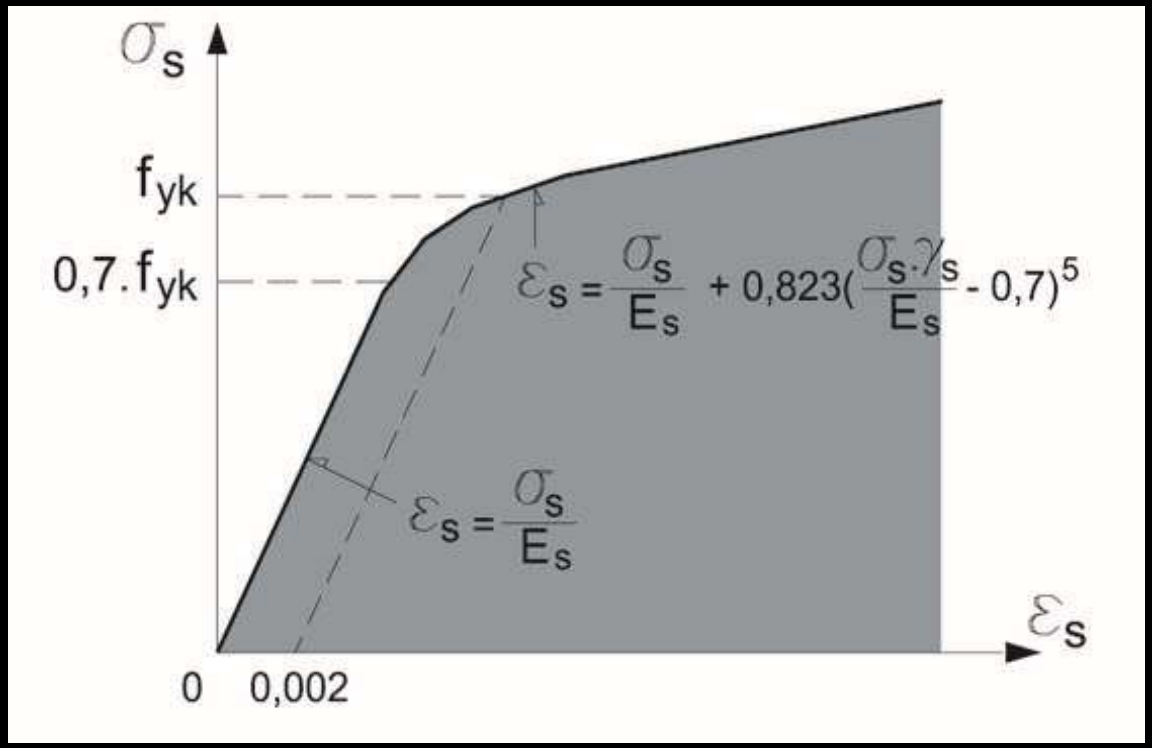
Sabah Shawkat

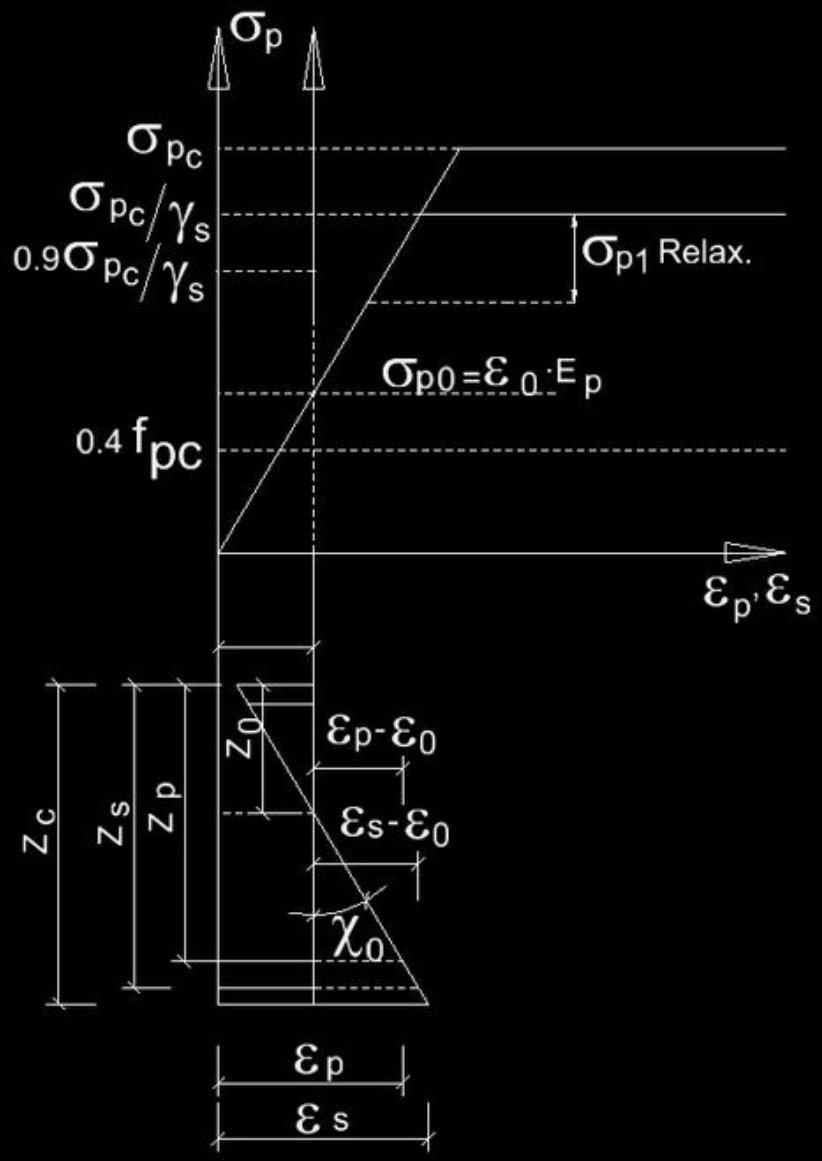
Modern Lightweight Constructions

- Tensile Integrity Structures
- Membrane Structures
- Reciprocal Frame
- Grid Shells
- Geodesic Dome
- Tensairity
- Suspension Bridges, Cable Stayed Bridges
- Pneumatic Structures
- Folding Structures

The idea of making objects using a minimum of material is practically as old as humanity itself.

The structural members can be as light as the tensile strength permits.





Form Follows Force

Frei Otto

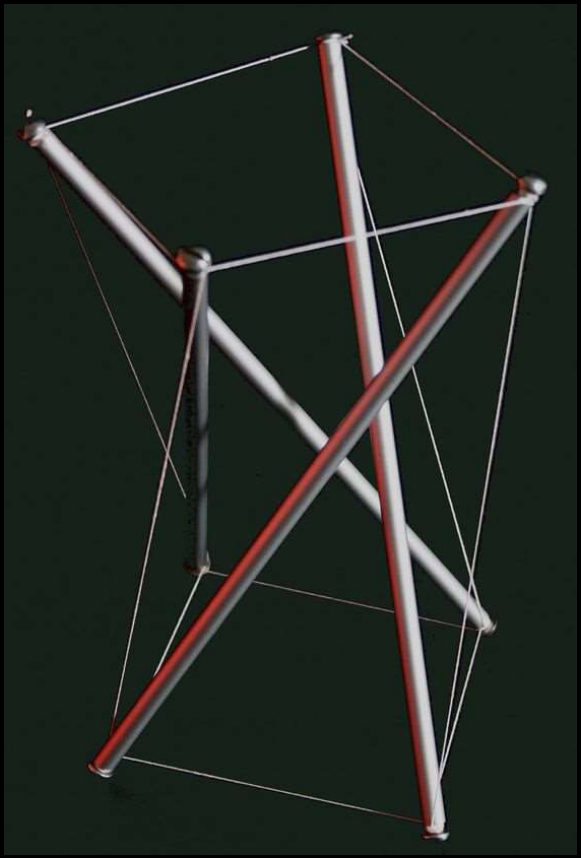
The Art of Tensegrity

History of Tensegrity

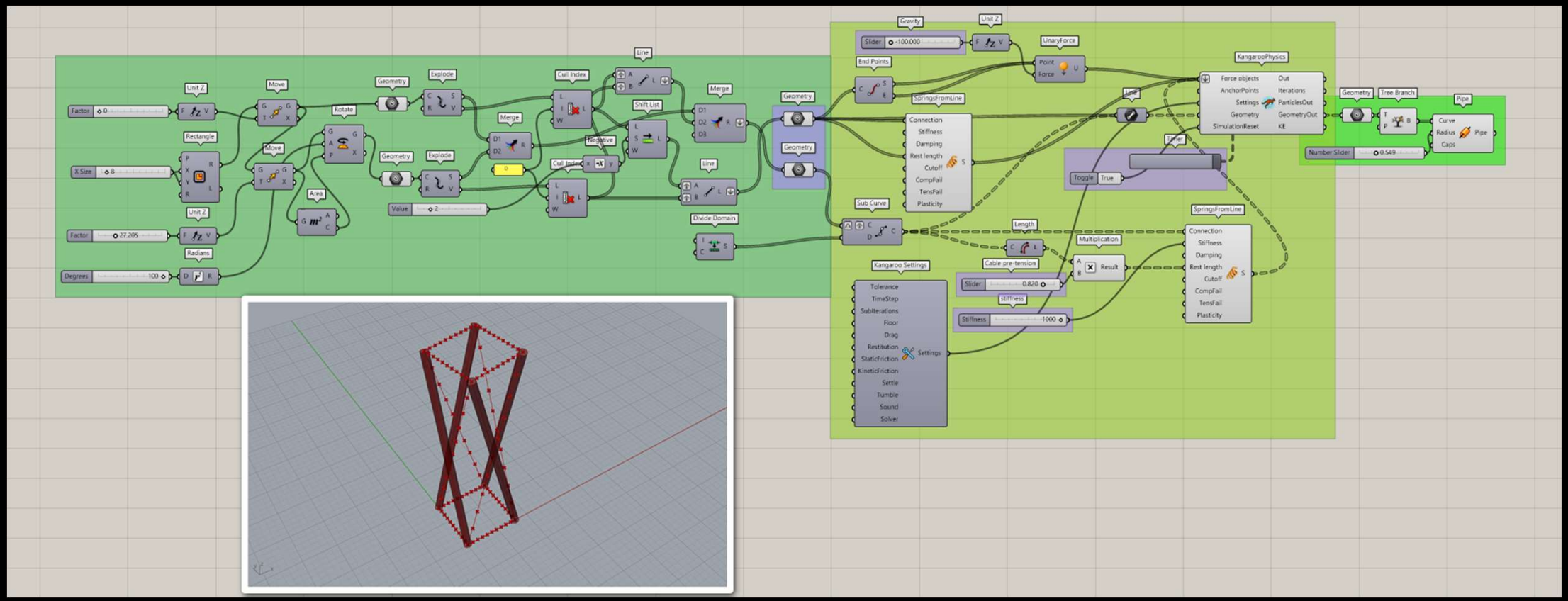
- Karl Ioganson 1920
- Richard Buckminster Fuller (1895-1983)
- Kenneth Snelson 1965
- Rene Motro 2003

Definitions of Tensegrity

- Connected set of tension members and a disconnected set of compression members
- Islands of compression in a sea of tension
- Free-standing pin-joined networks
- Tensile integrity structures
- Self-supporting structures

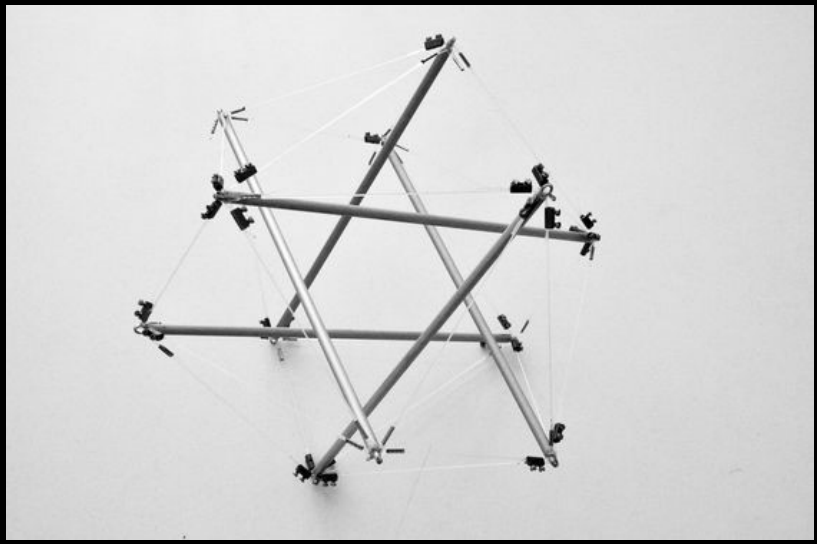


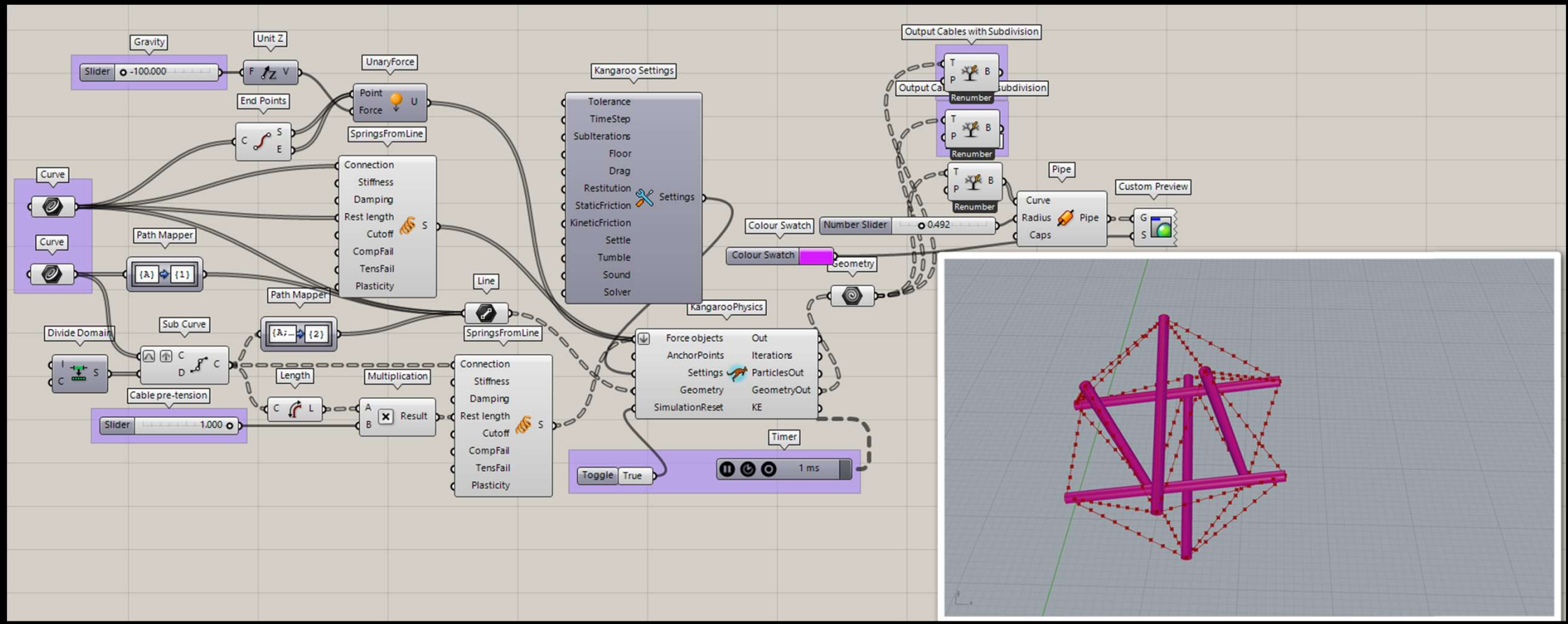
Tensegrity 4 Struts - Flow Chart of Grasshopper



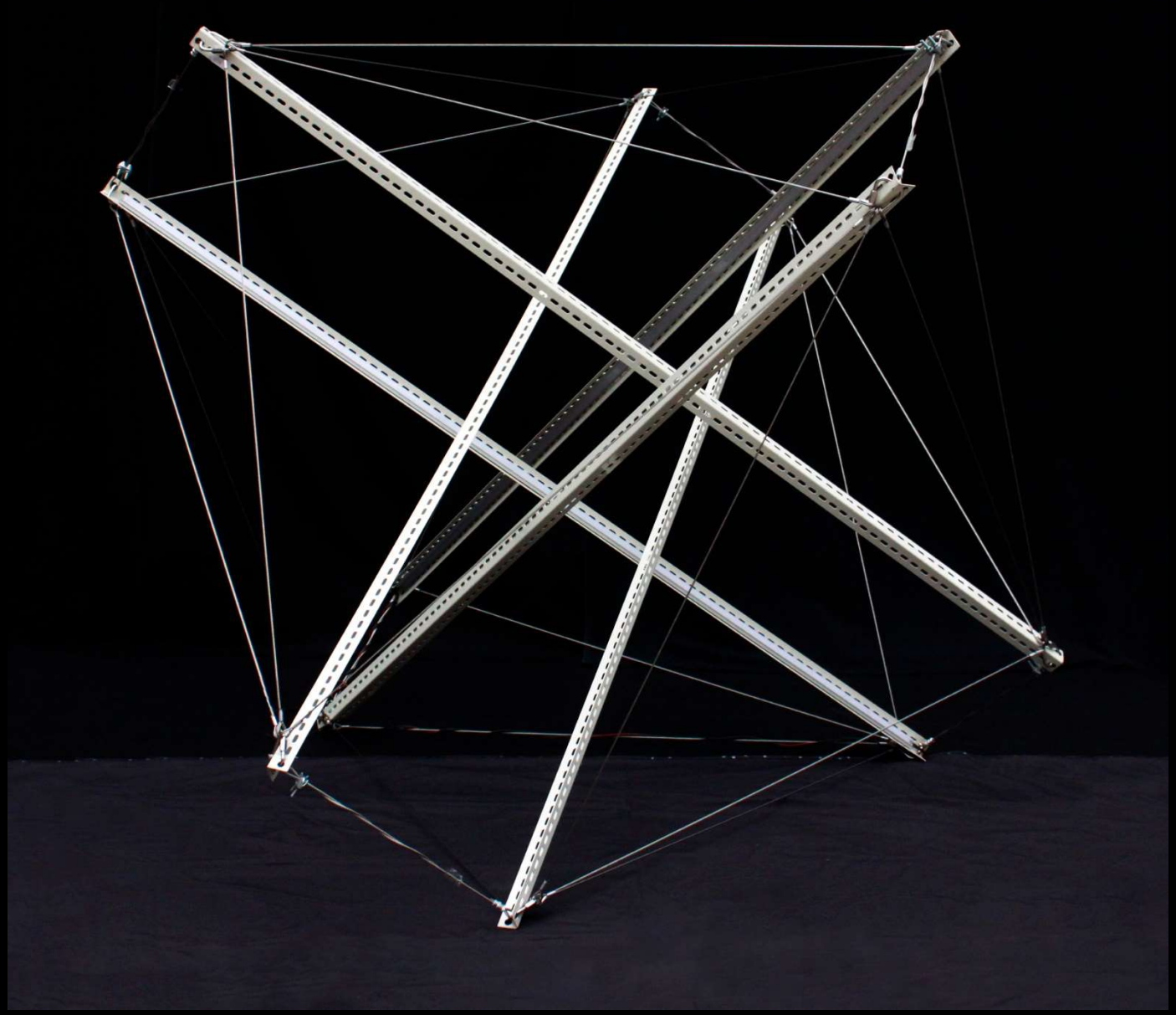
Tensegrities are all about tension and compression

8 Struts Tensegrity - Flow Chart of Grasshopper

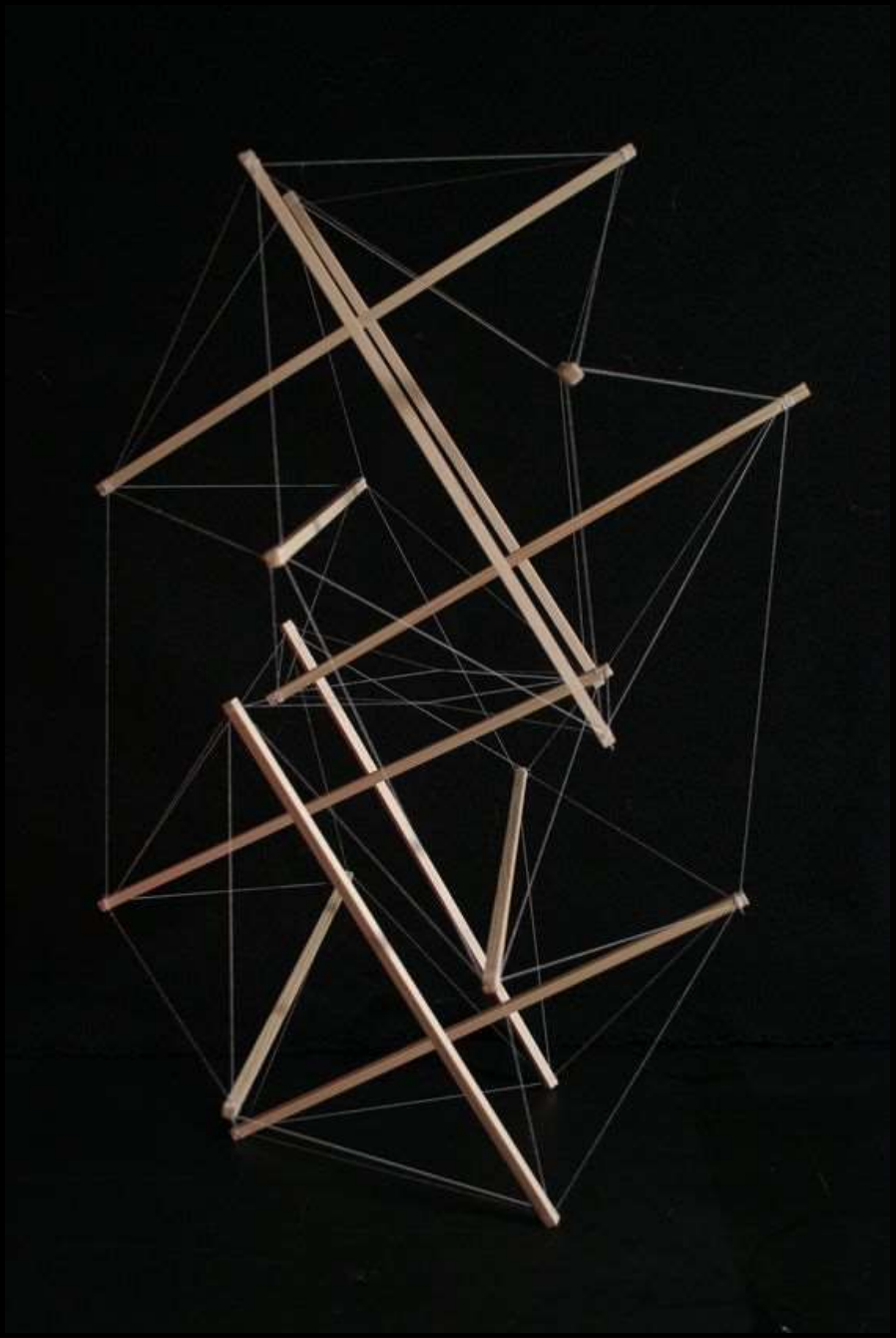




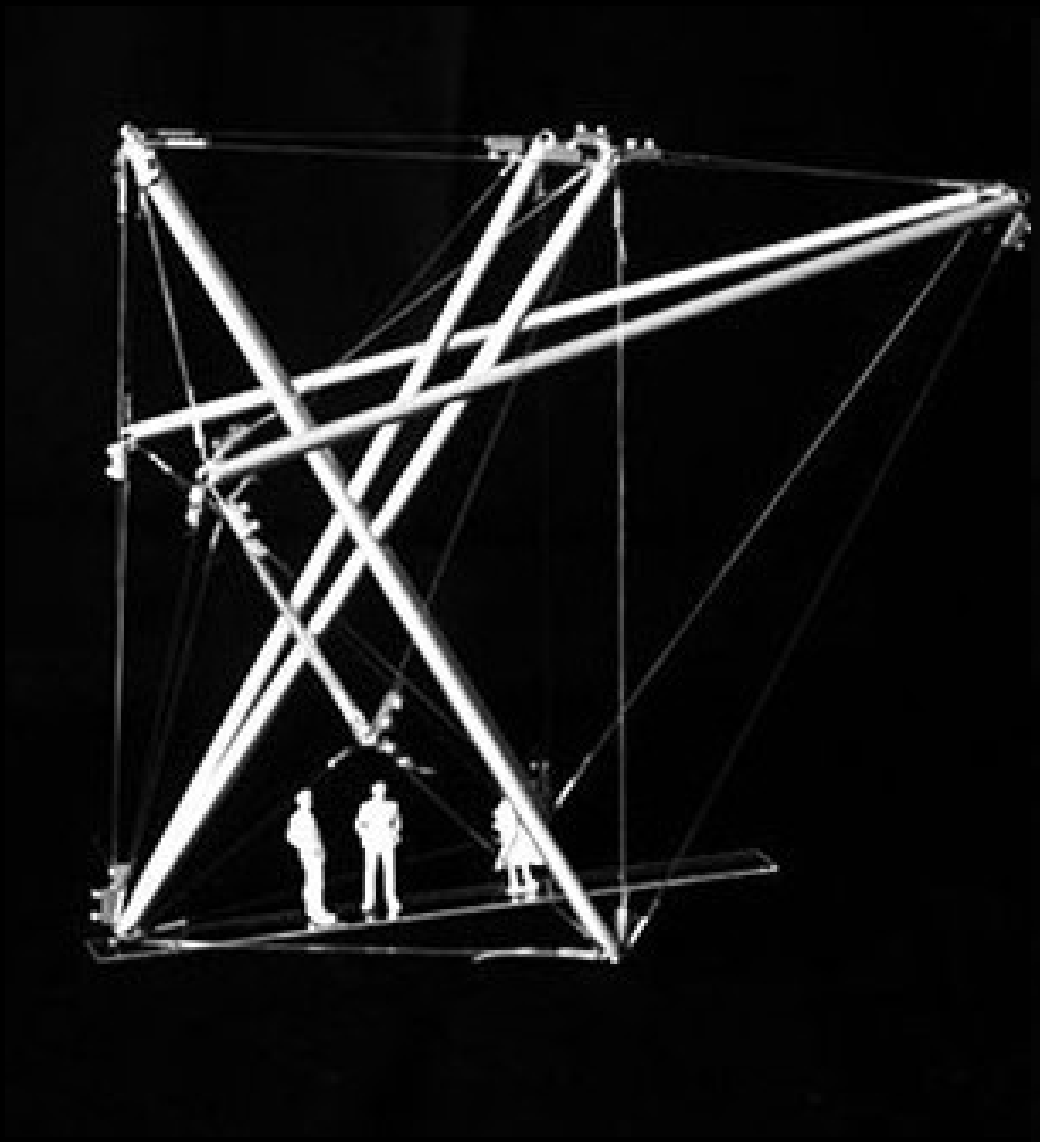
Tensegrity as a Sculpture

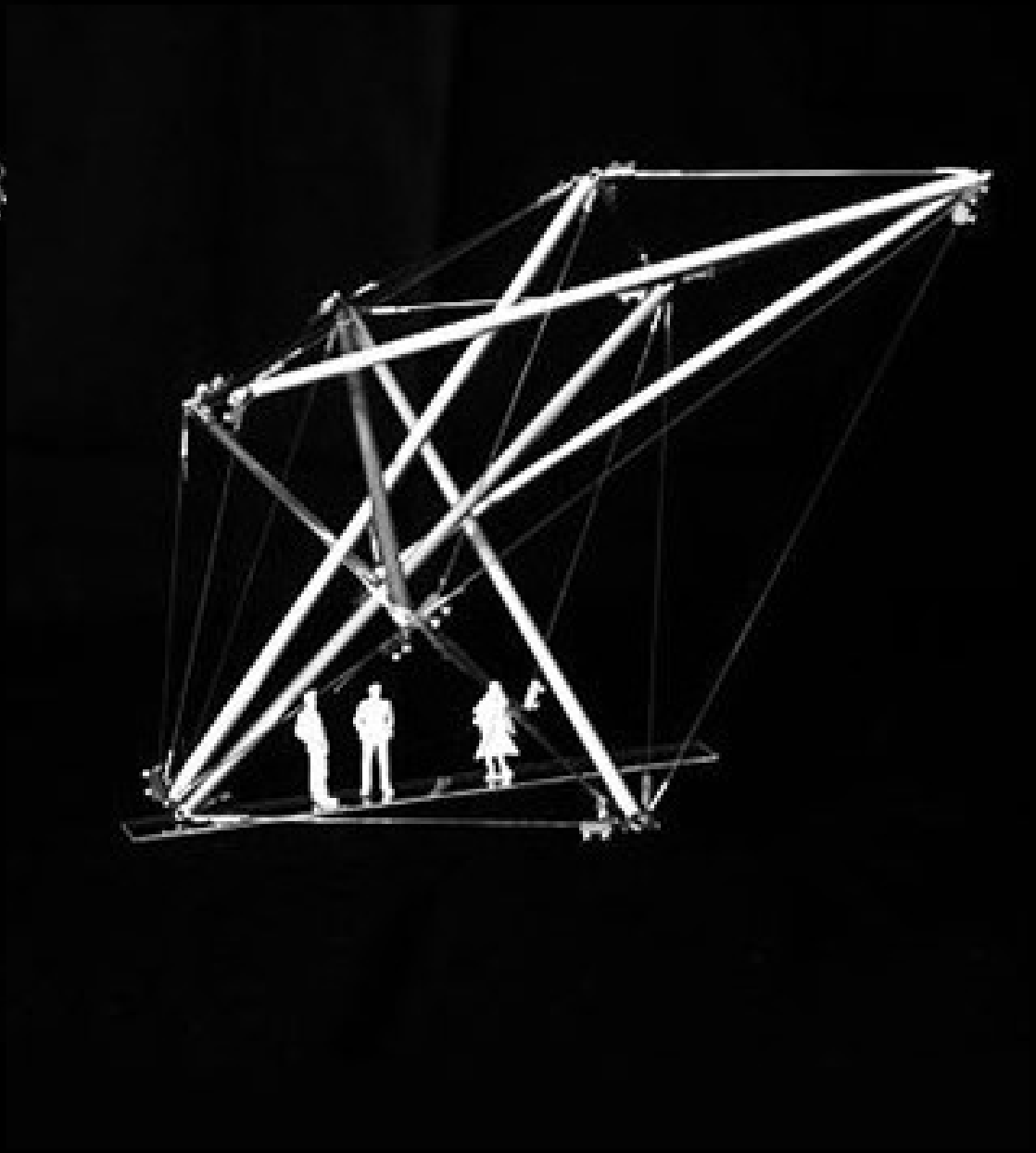


Characteristics of a Tensegrity Structure

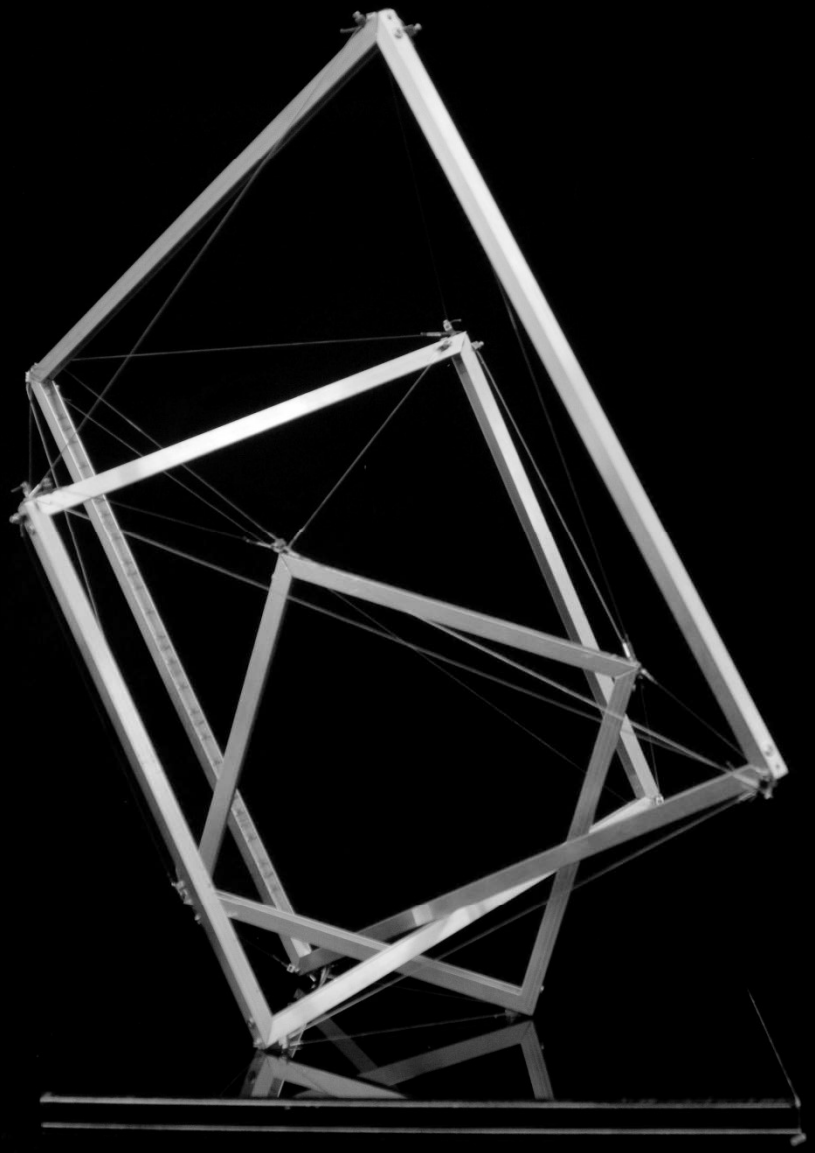


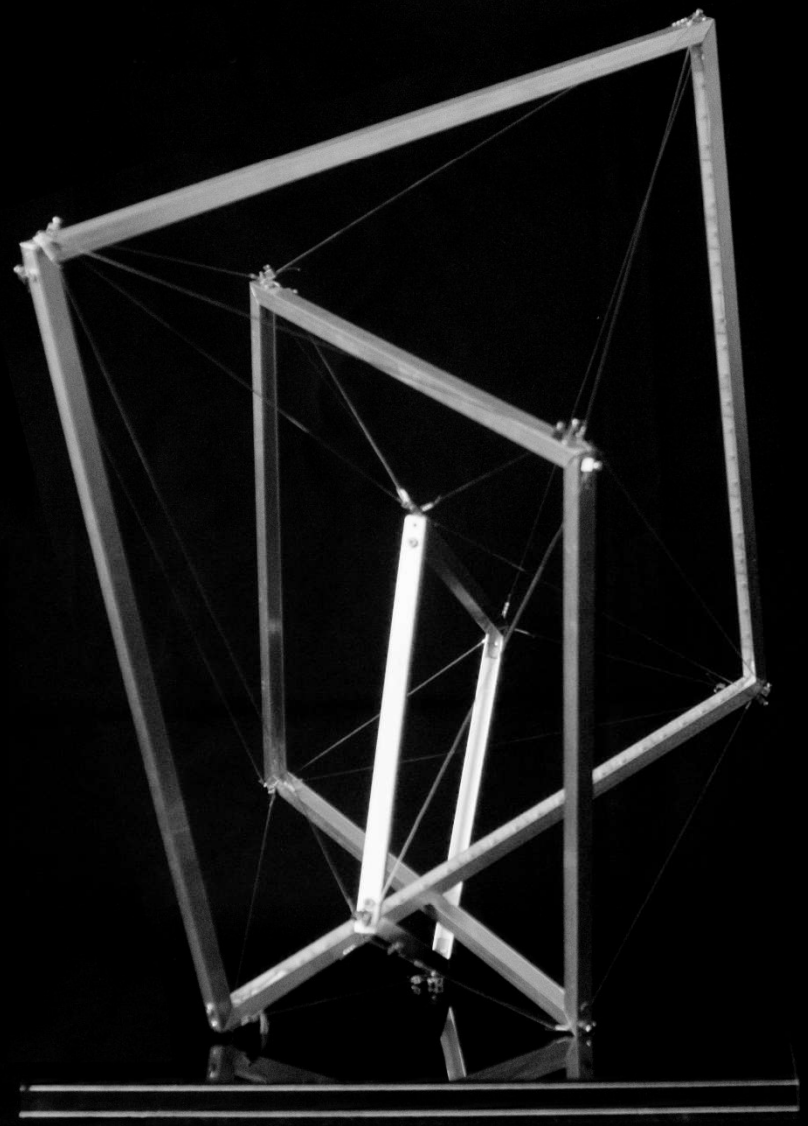
Tensegrity as a Sculpture



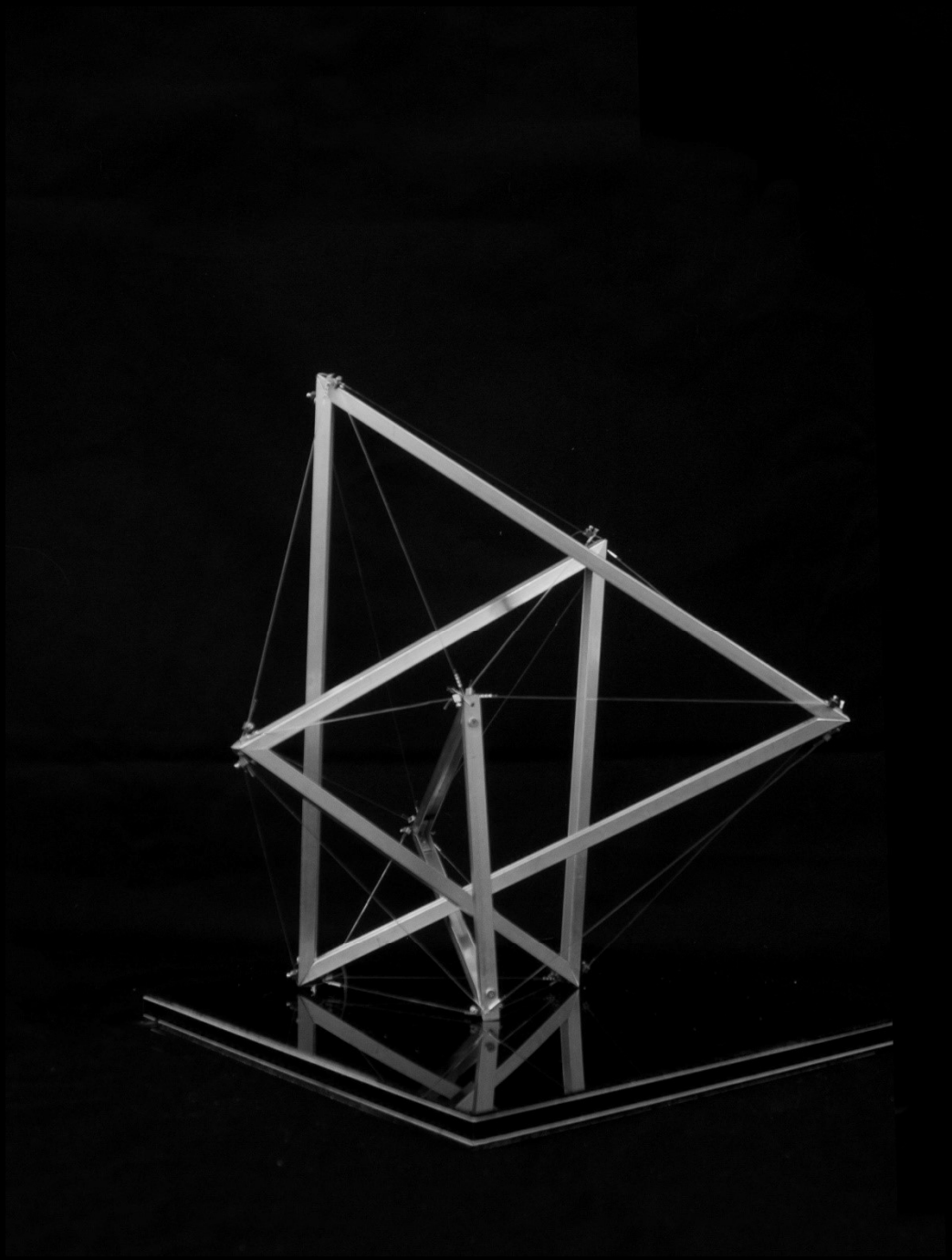


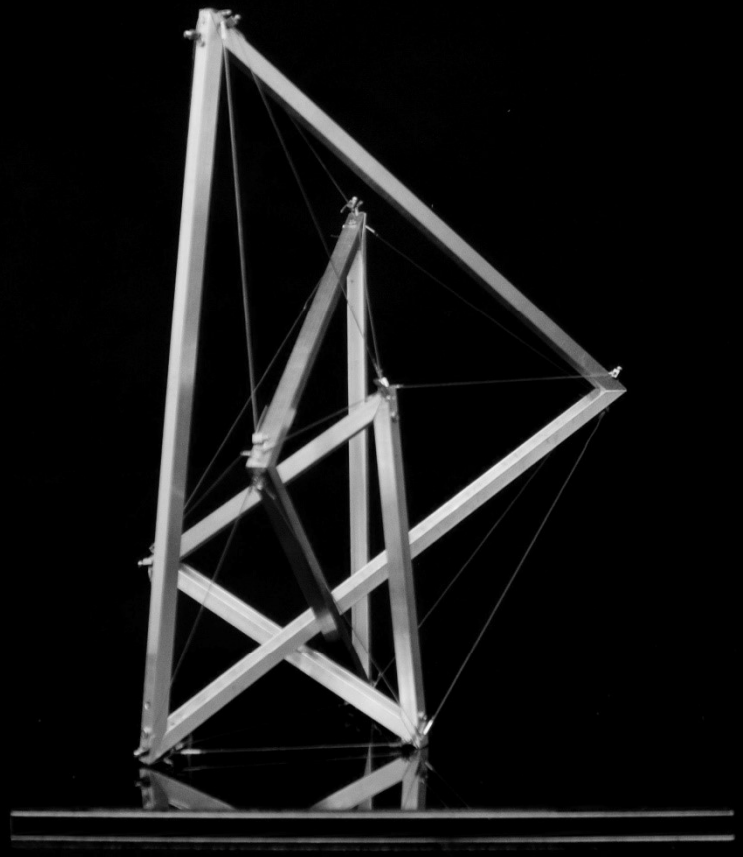
Tensegrity as a Sculpture





Tensegrity as a Sculpture





Tensegrity as a Sculpture

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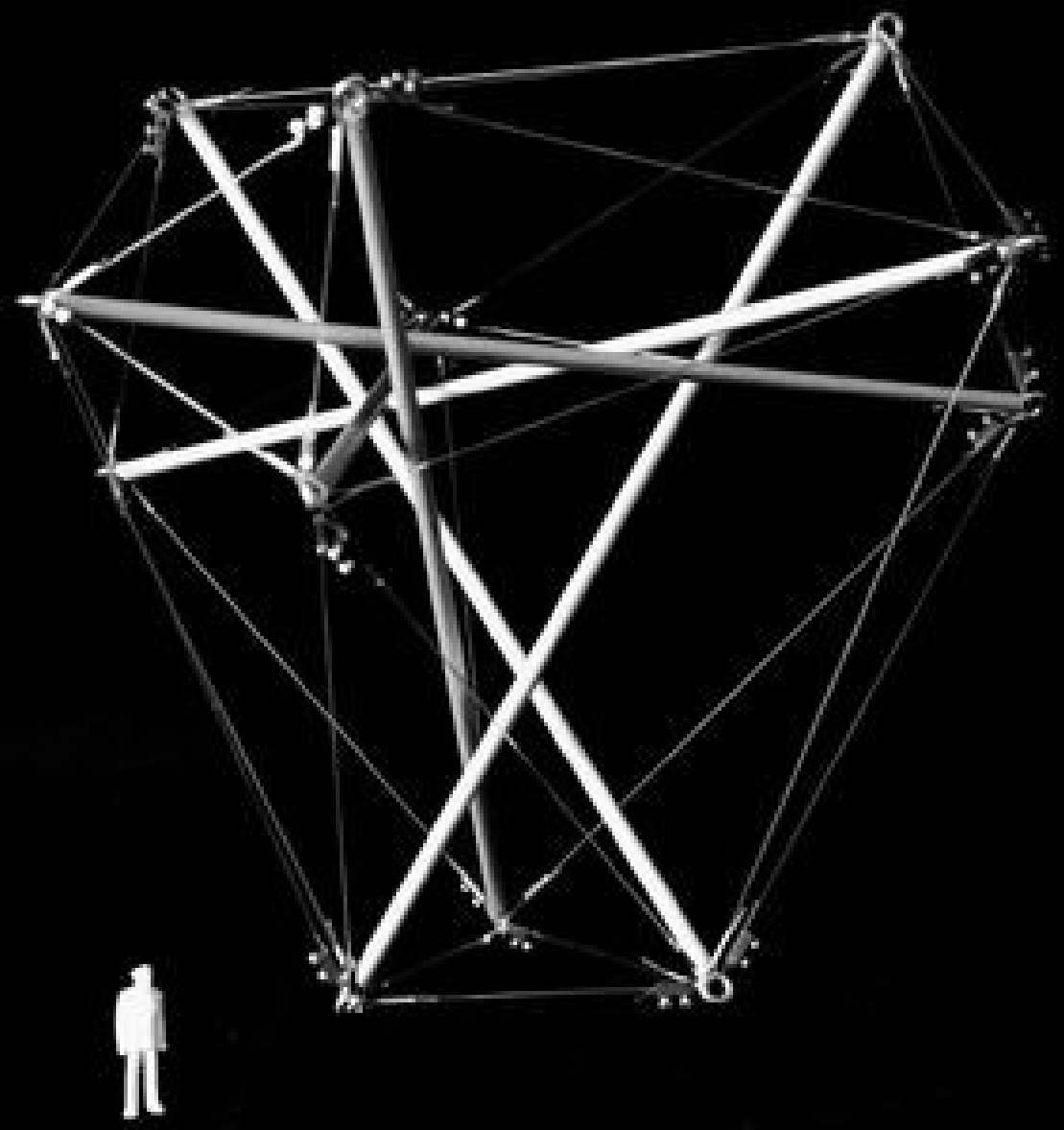
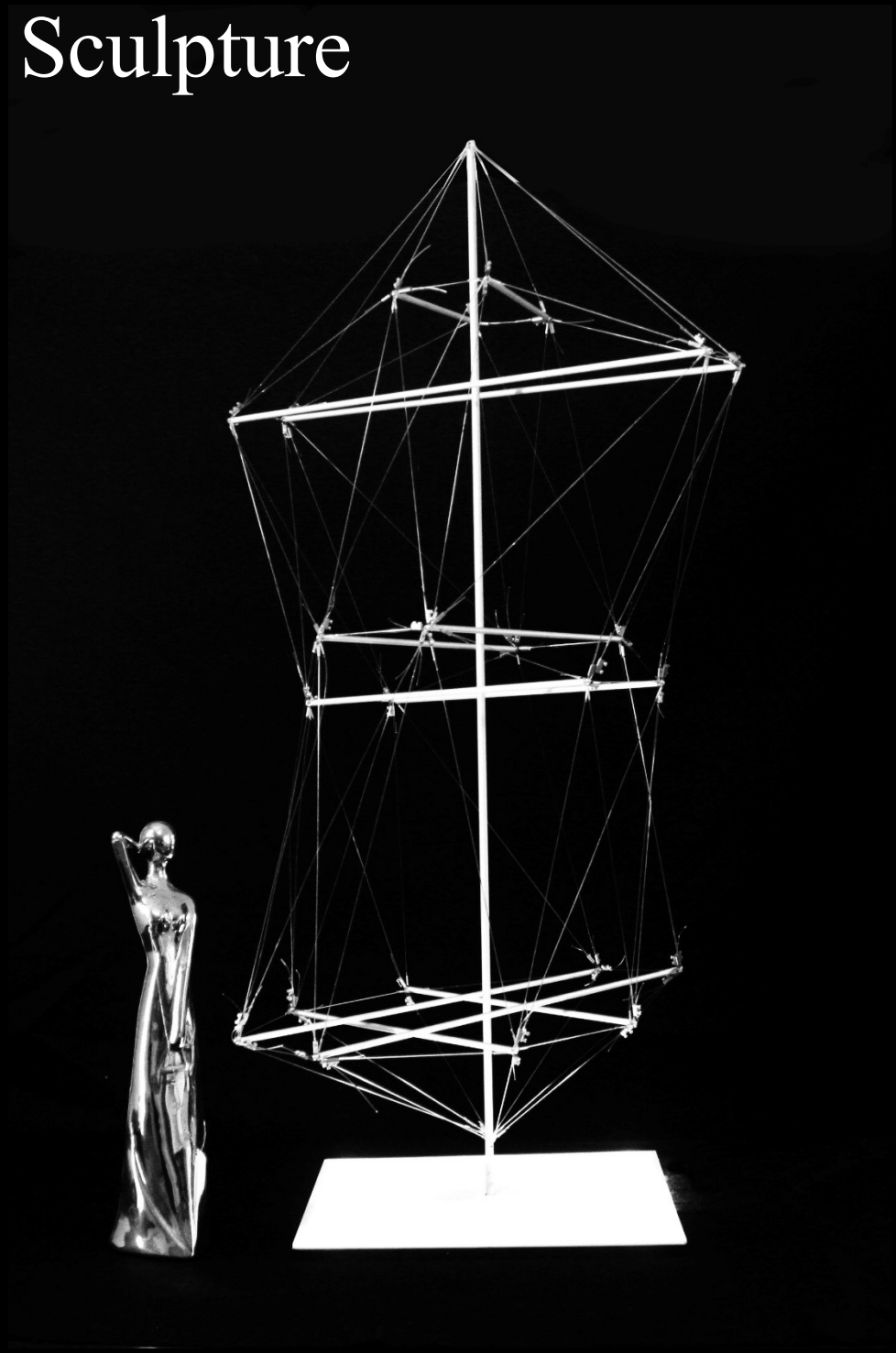


Tensegrity as a Sculpture



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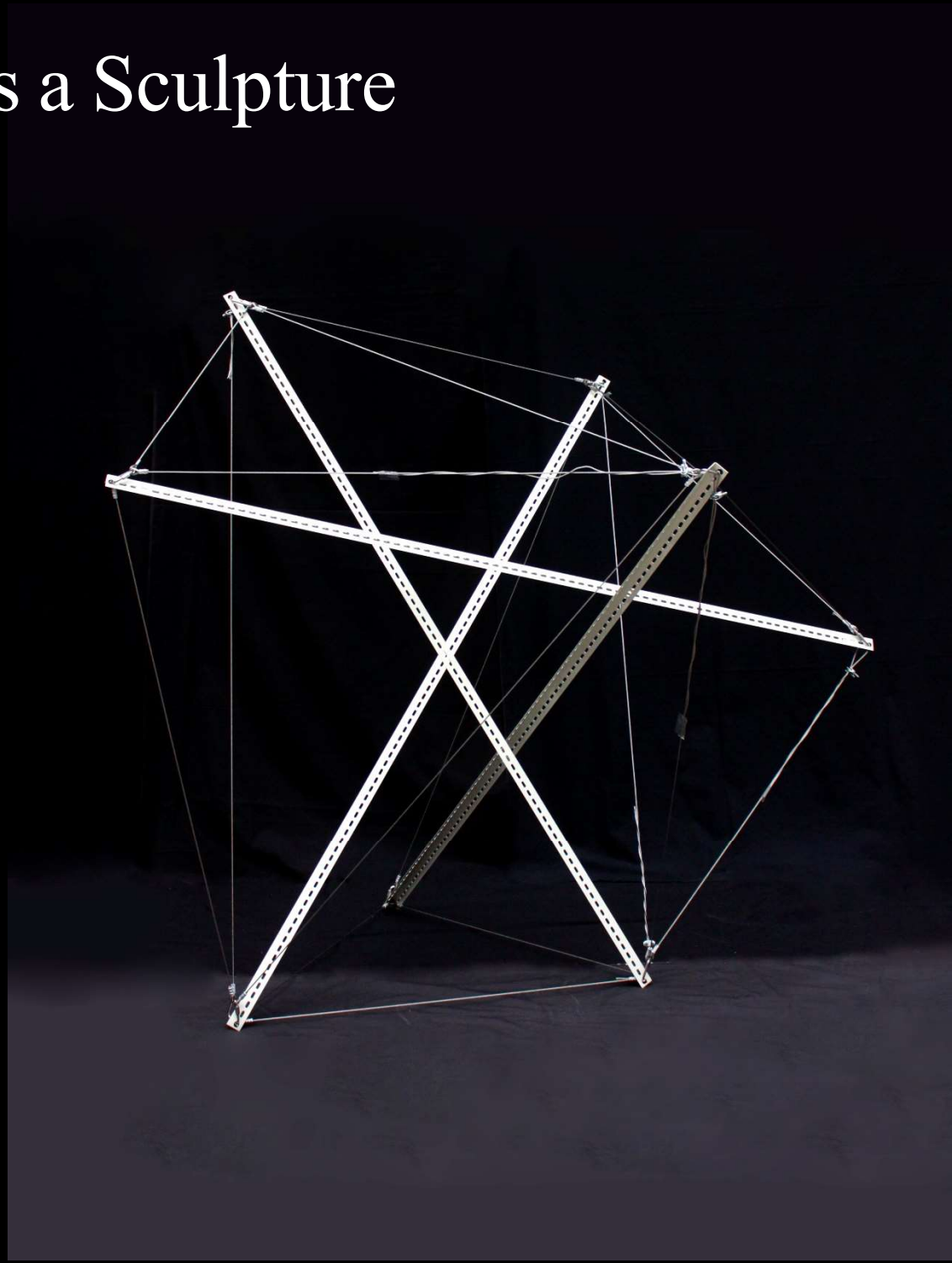

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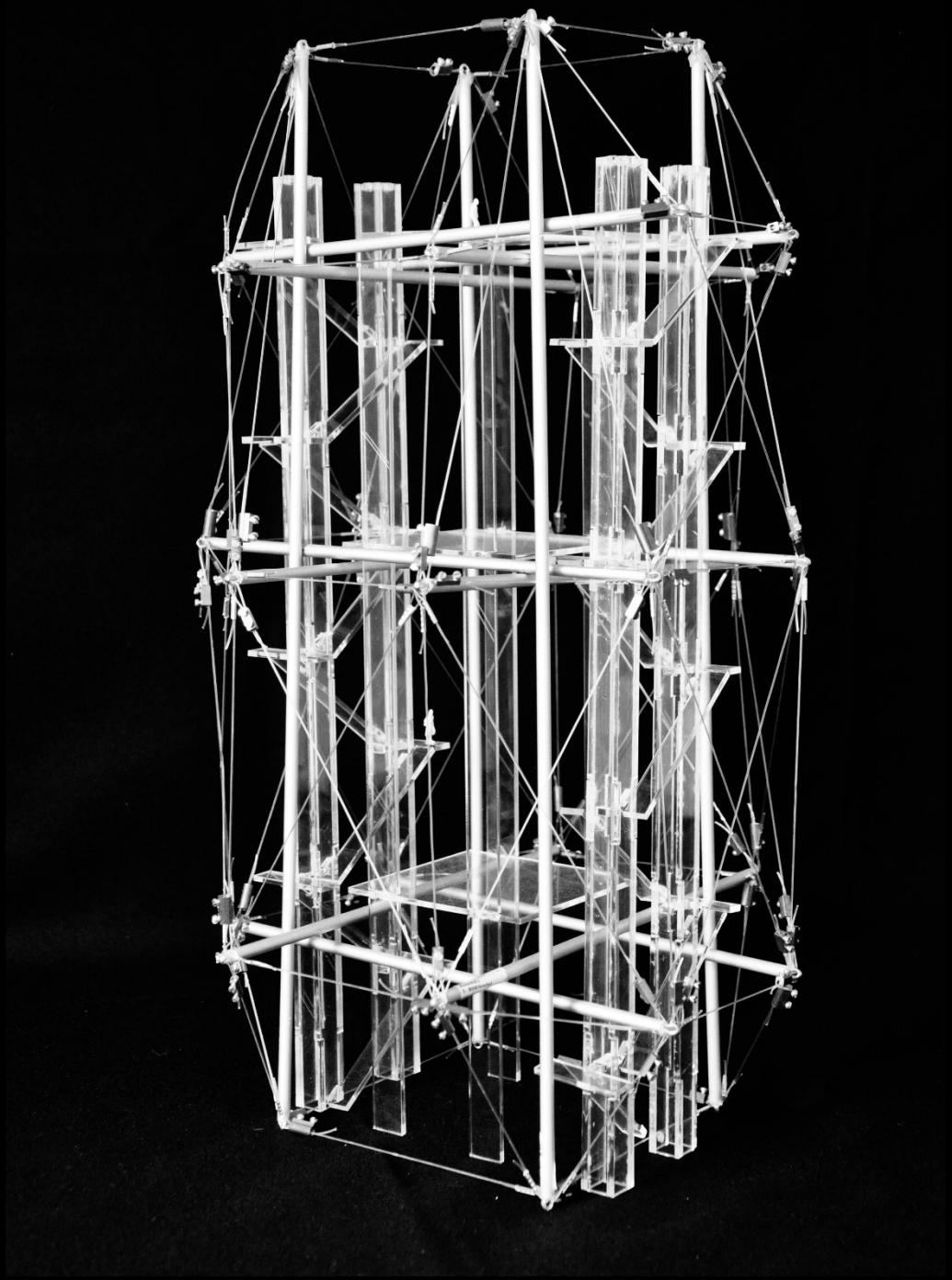
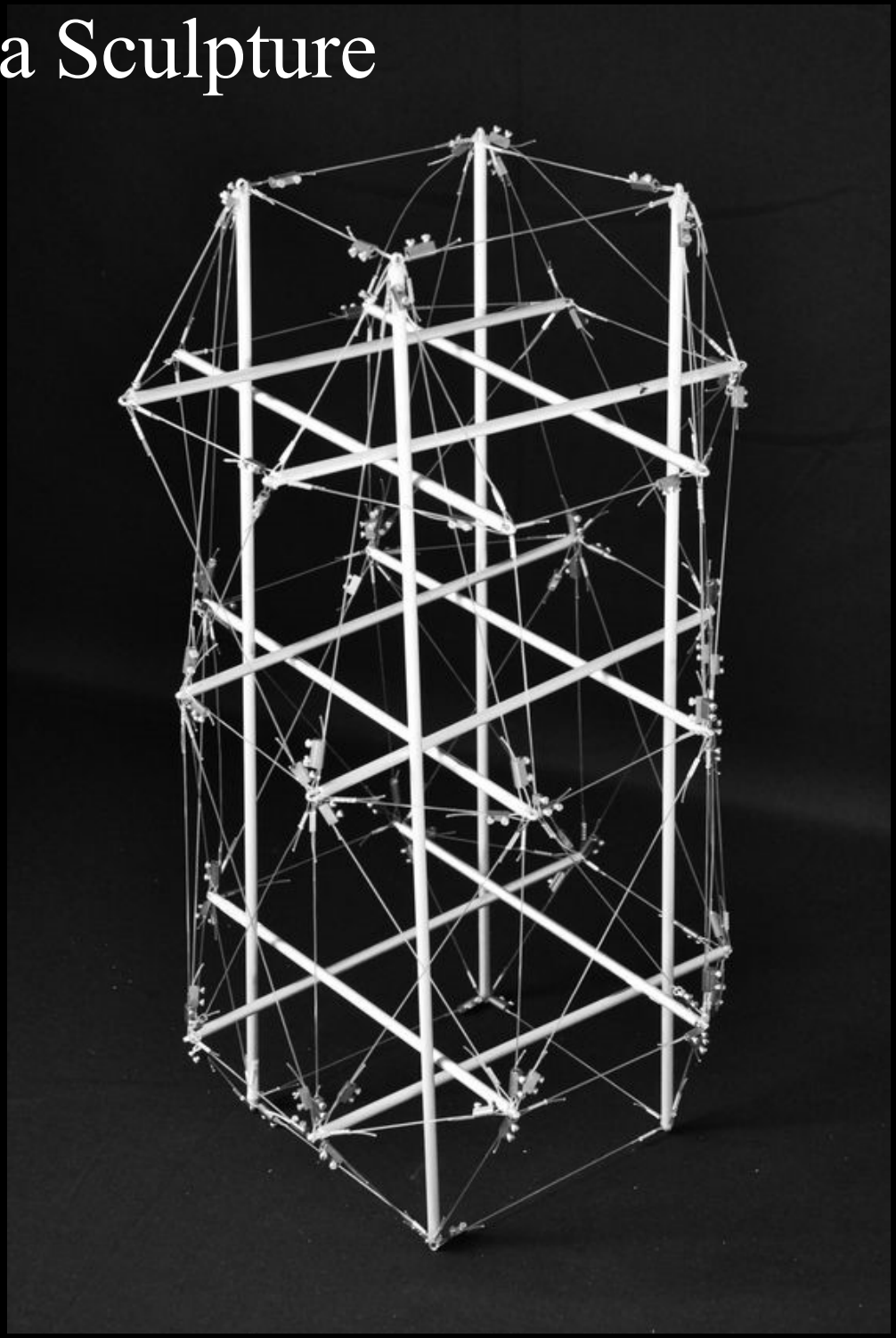
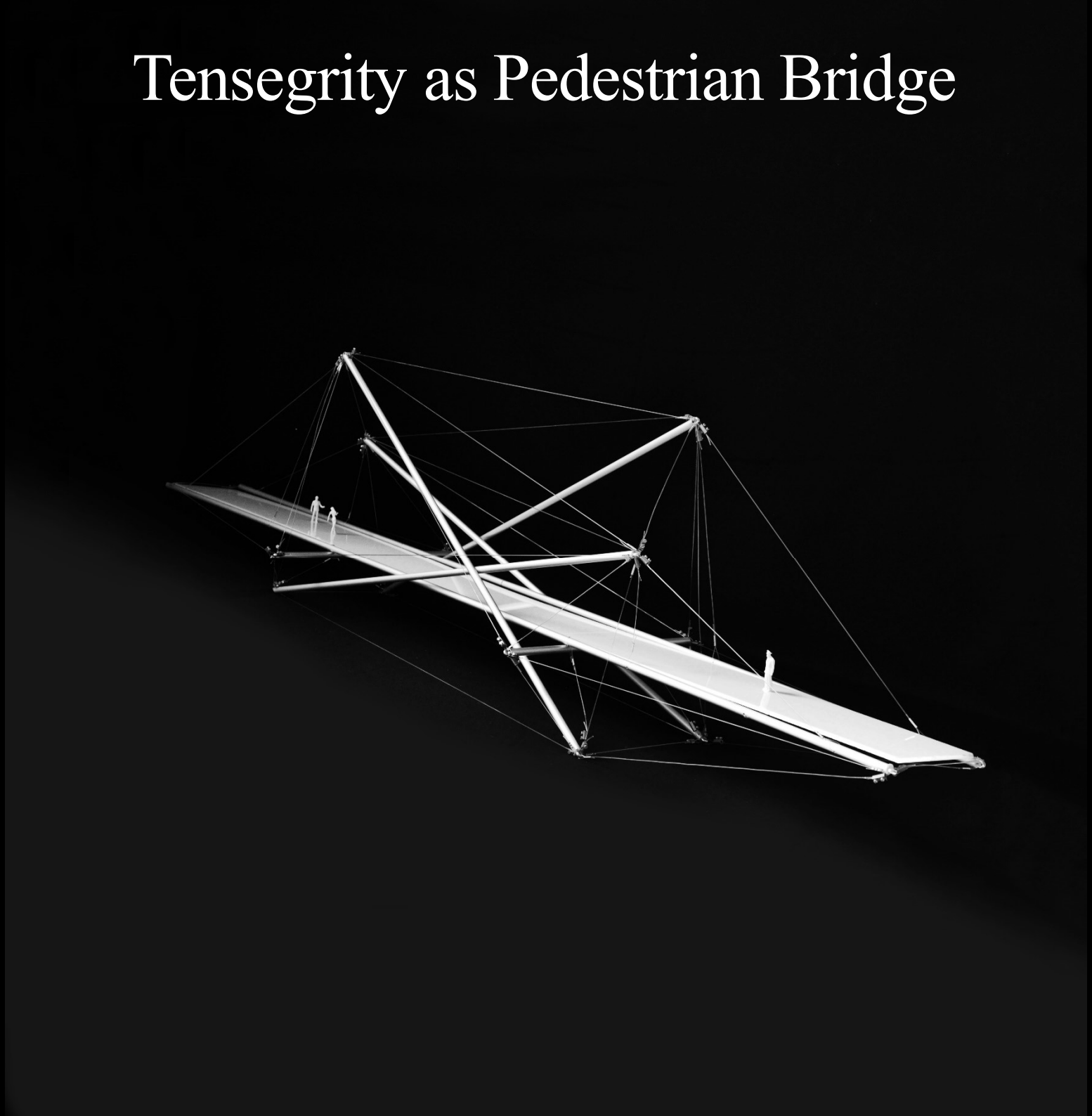




Tensegrity as Pedestrian Bridge

Tensegrity as Pedestrian Bridge



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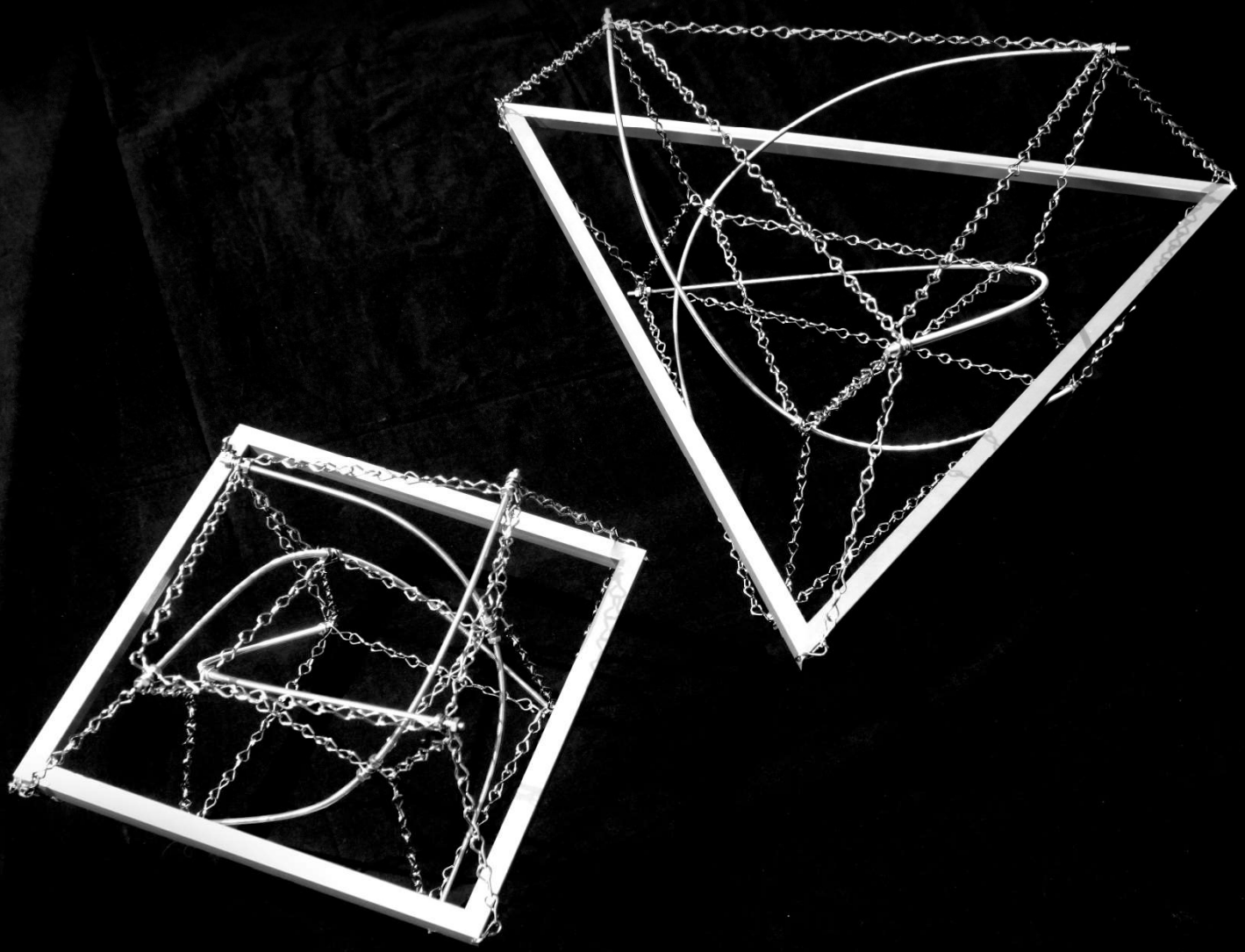

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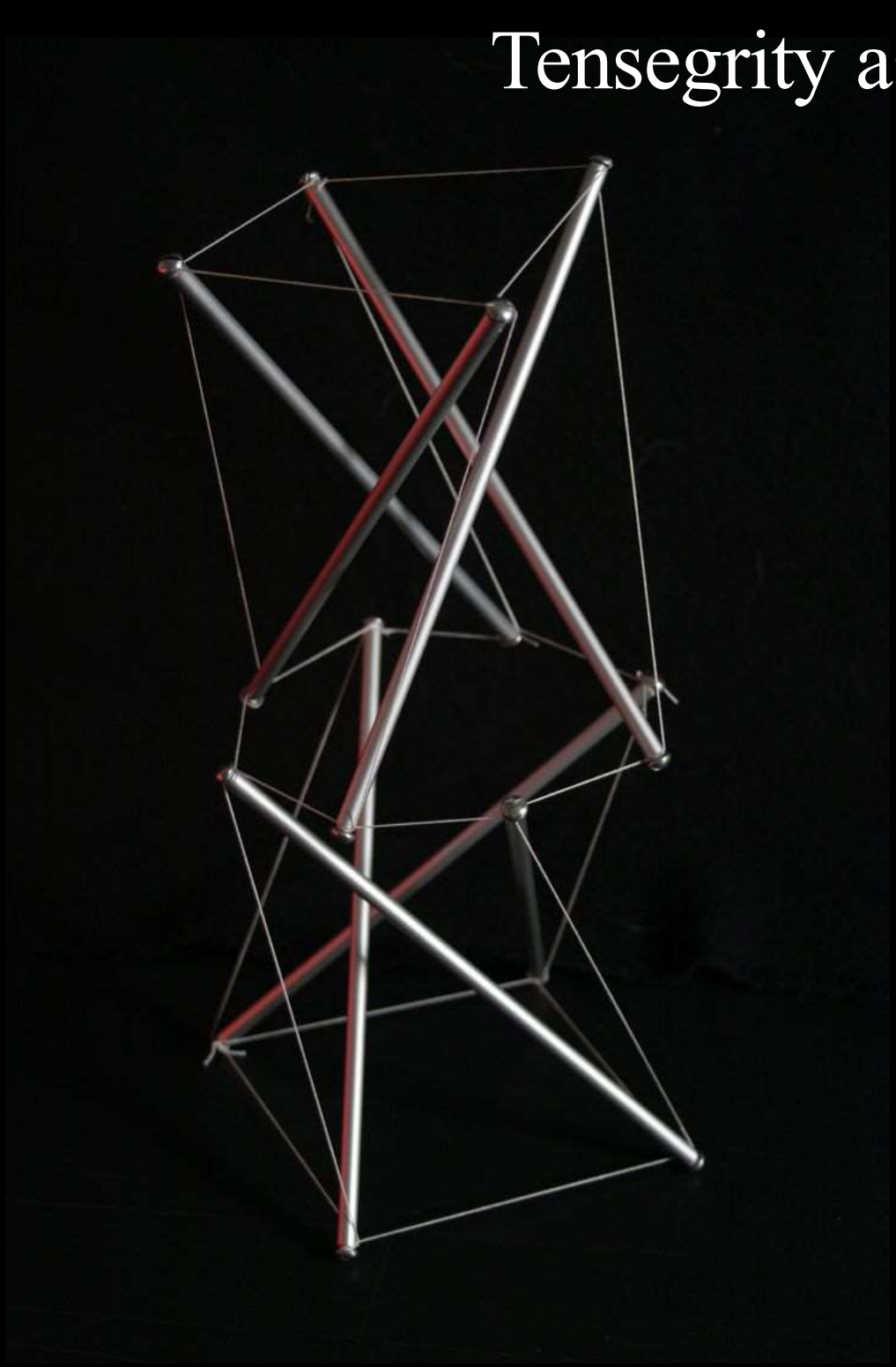

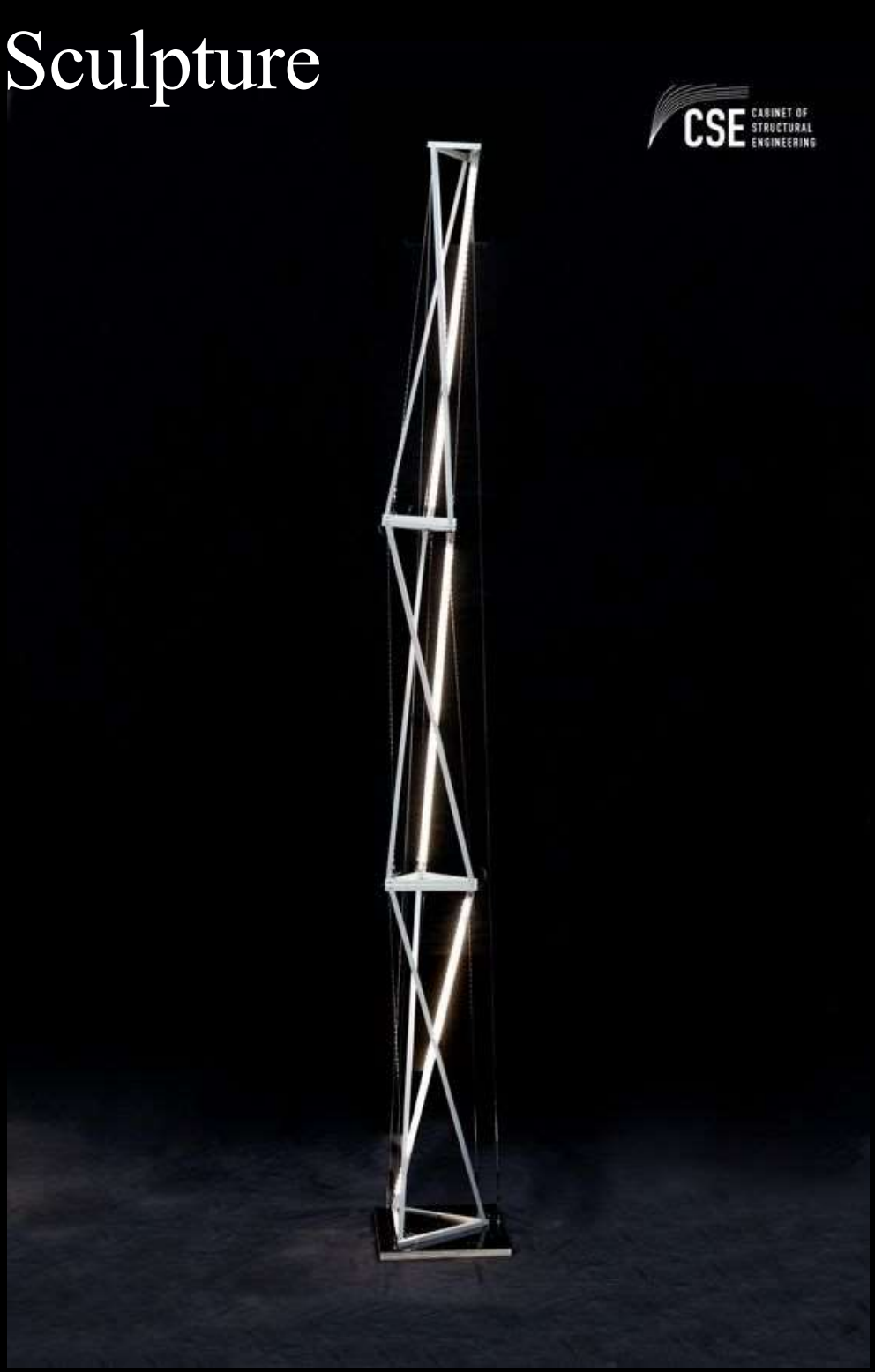

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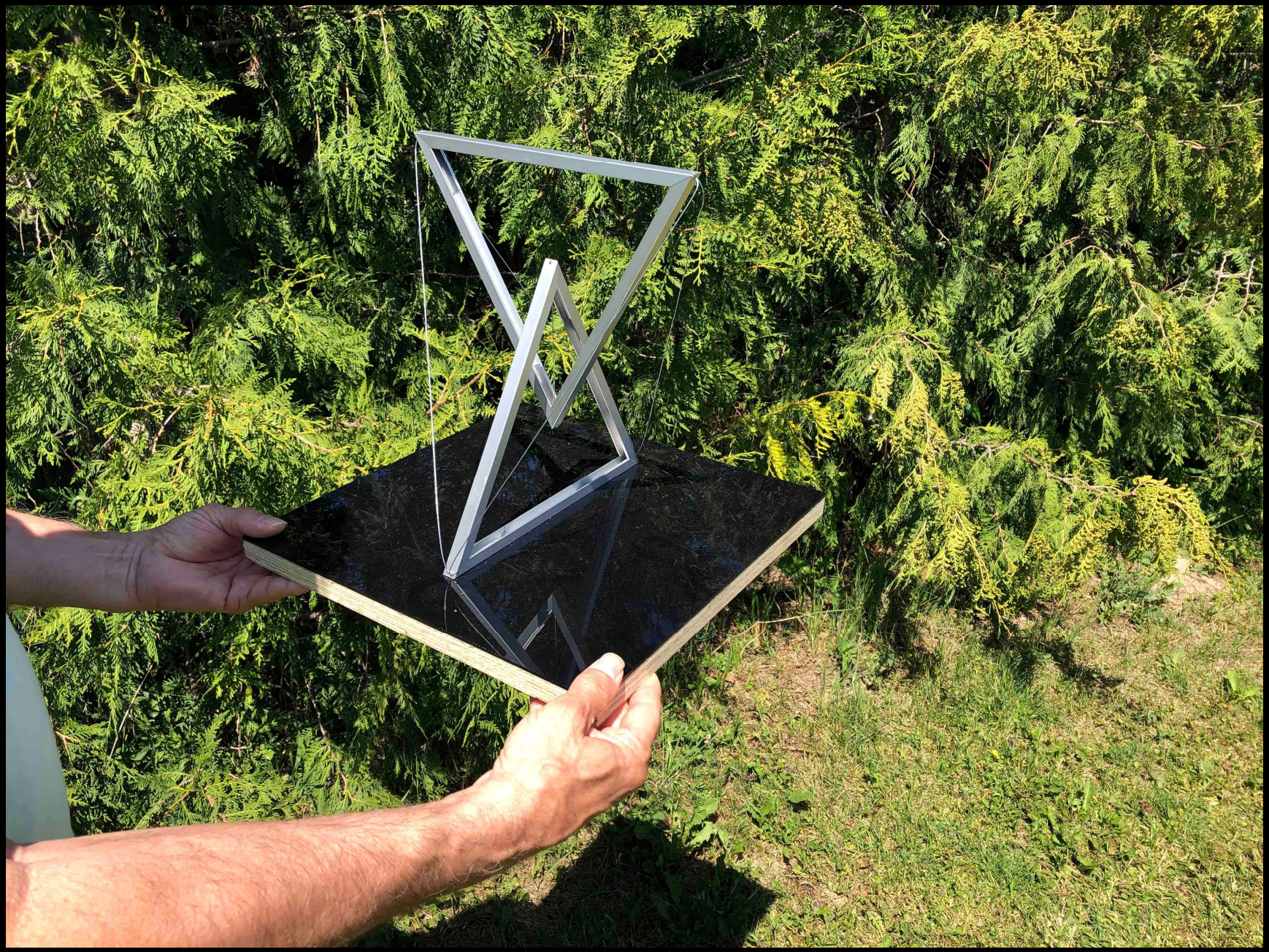

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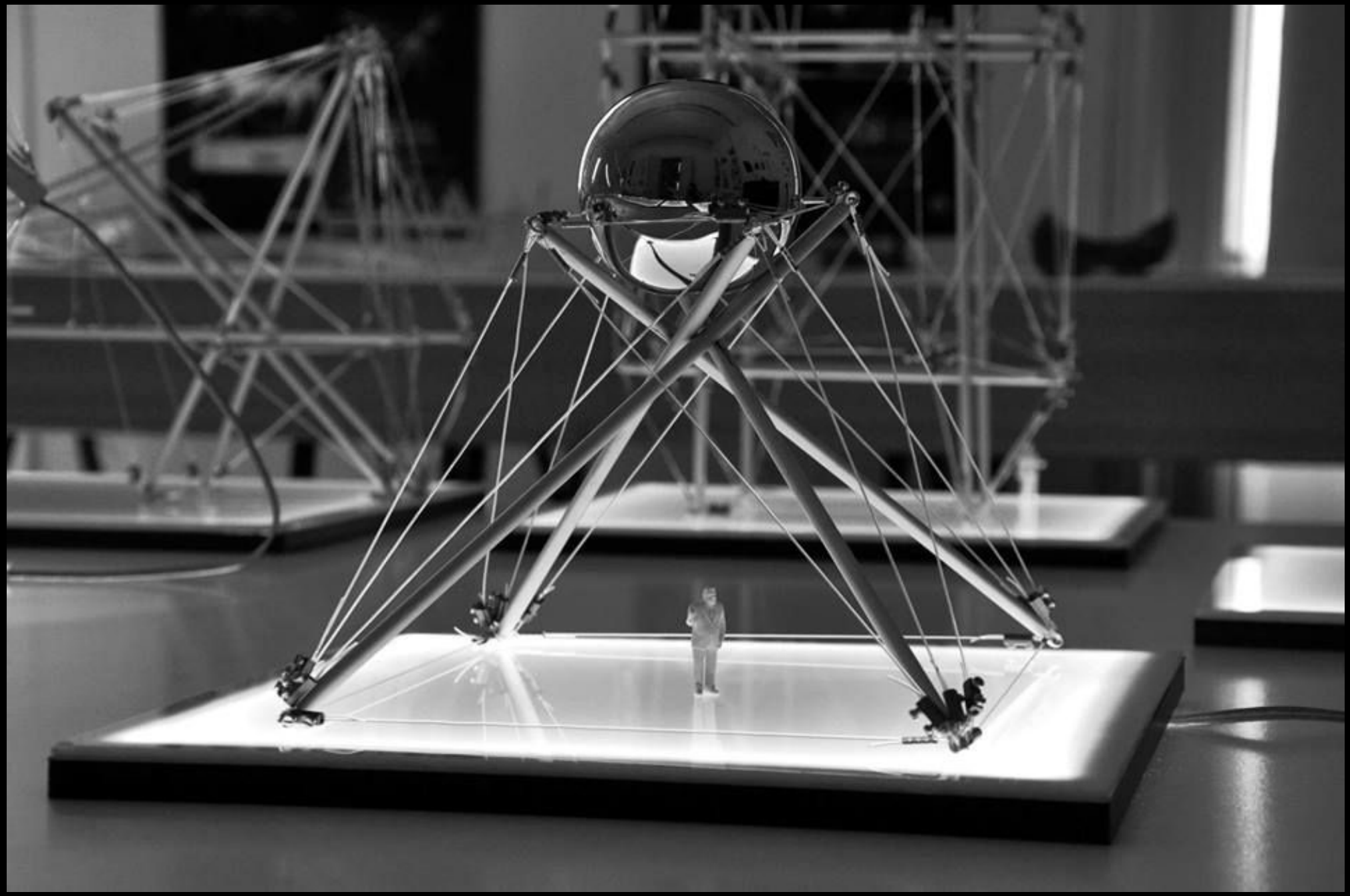
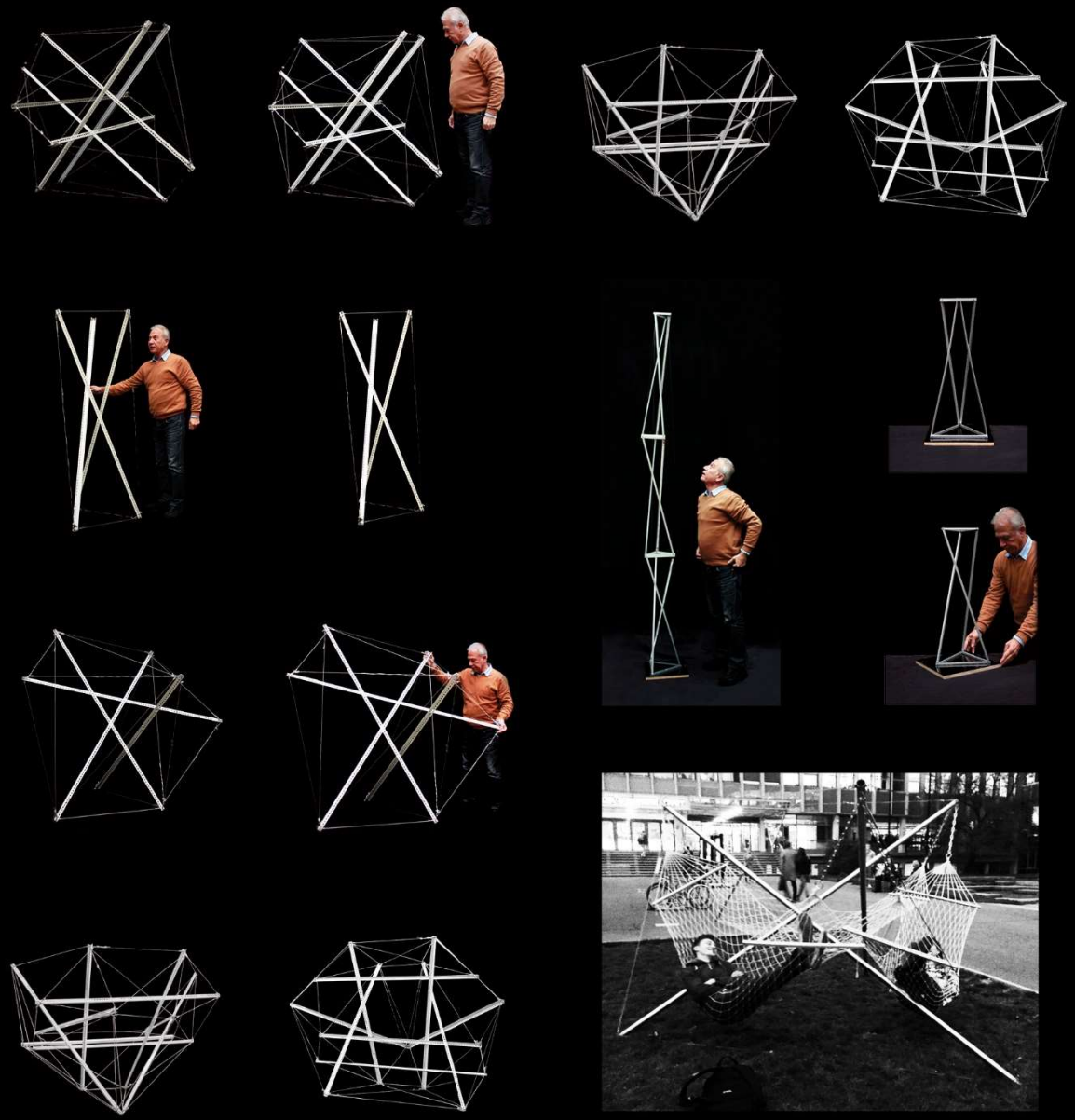
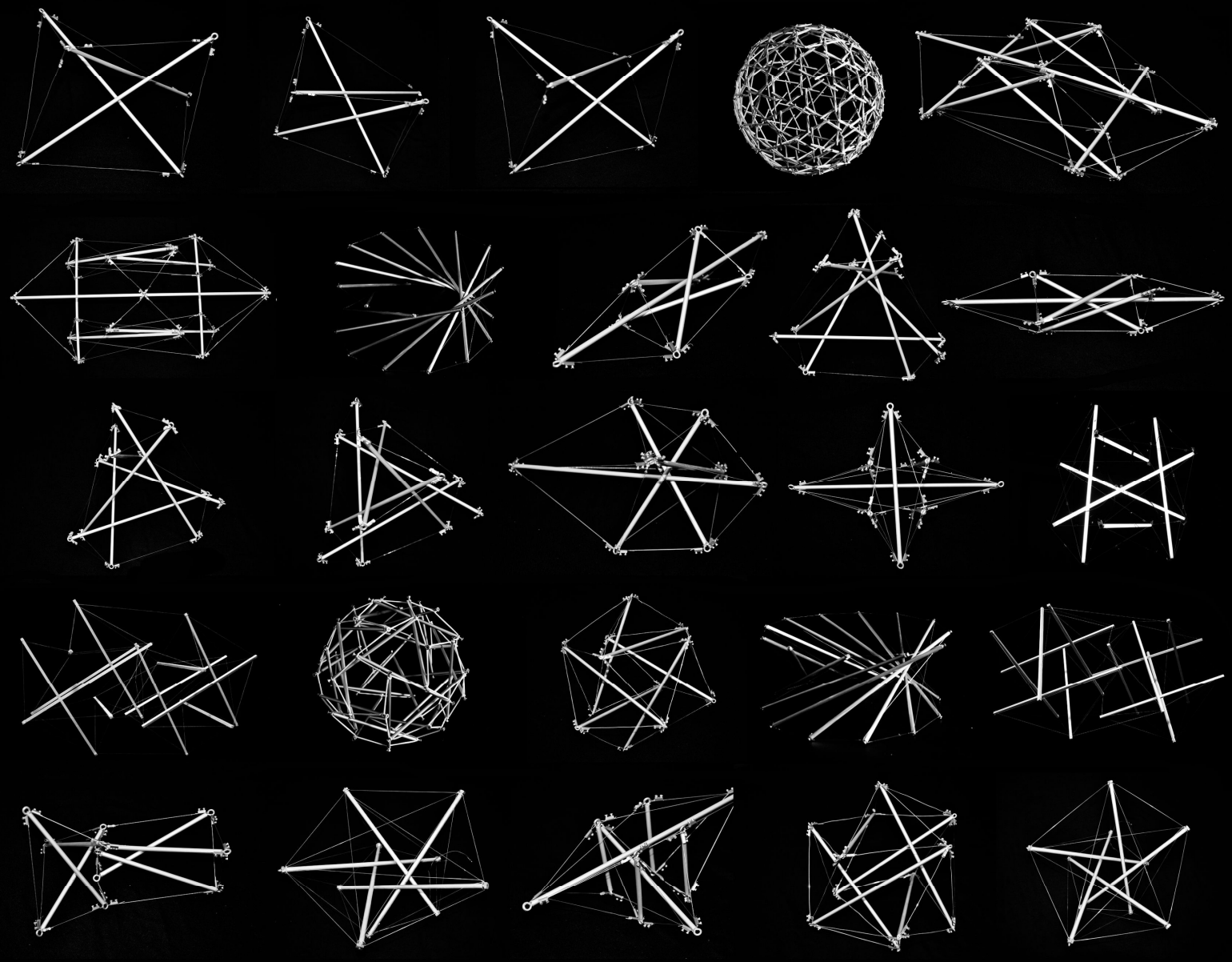




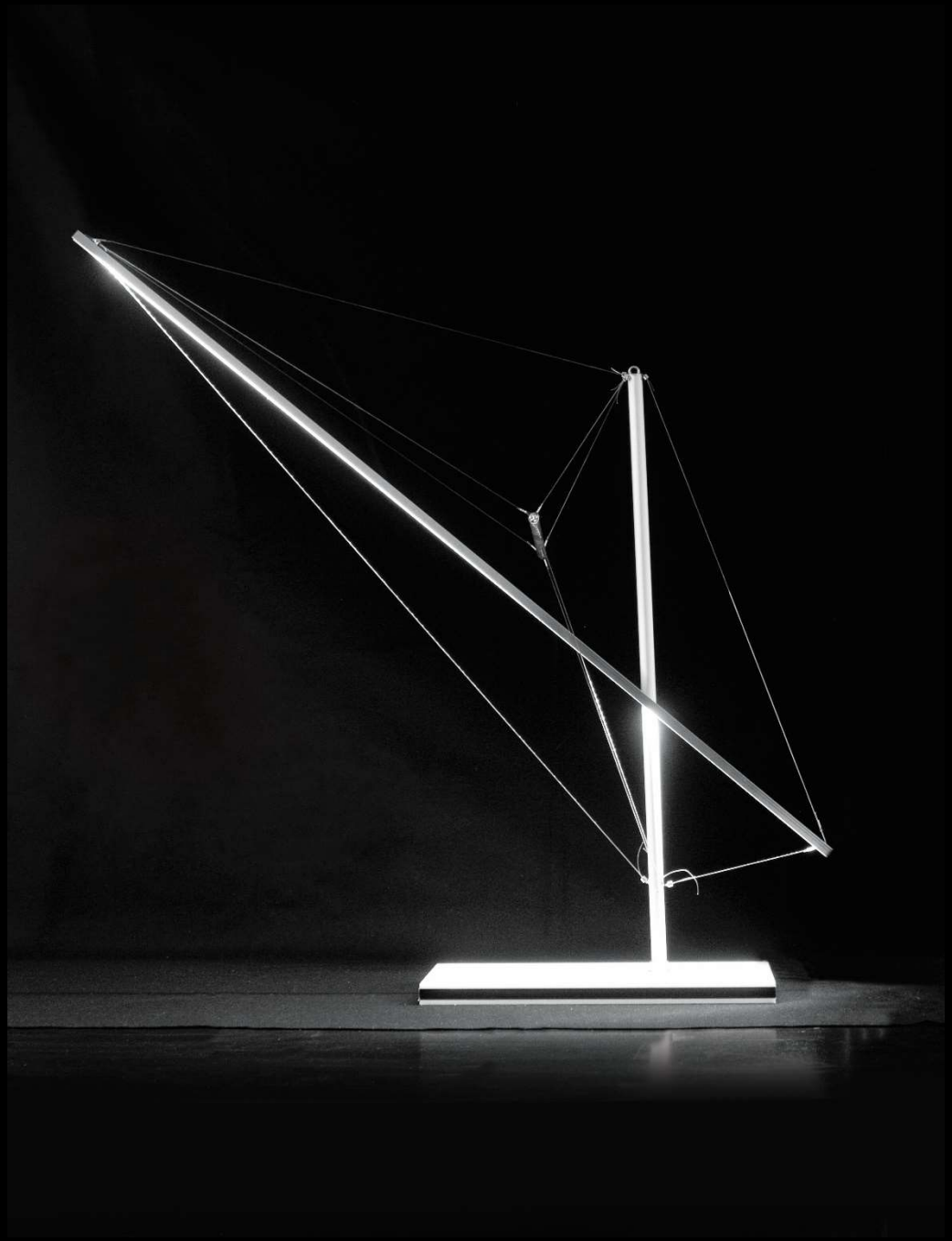
Tensegrity Models

Tensegrity as Models

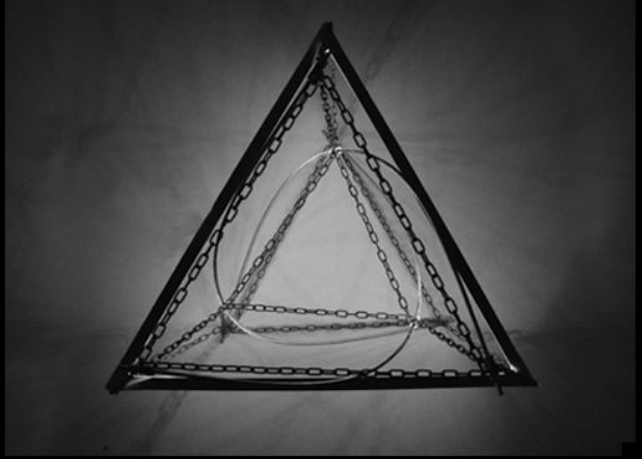


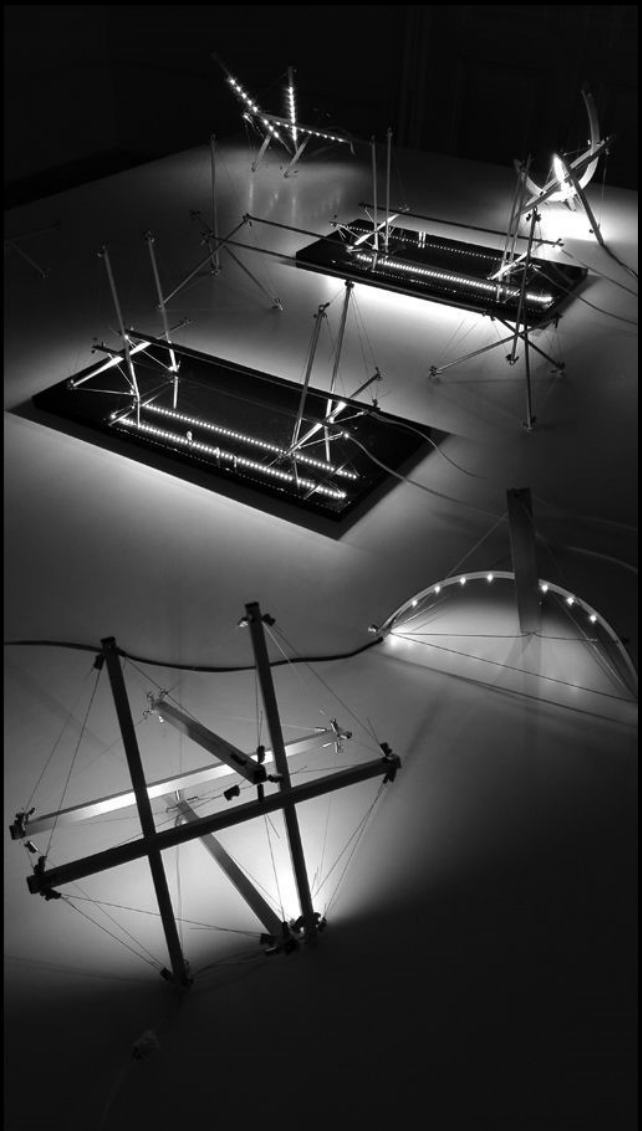
Tensegrity as Lightings

Tensegrity as Lightings



Tensegrity as Lightings





Tensegrity as Lightings

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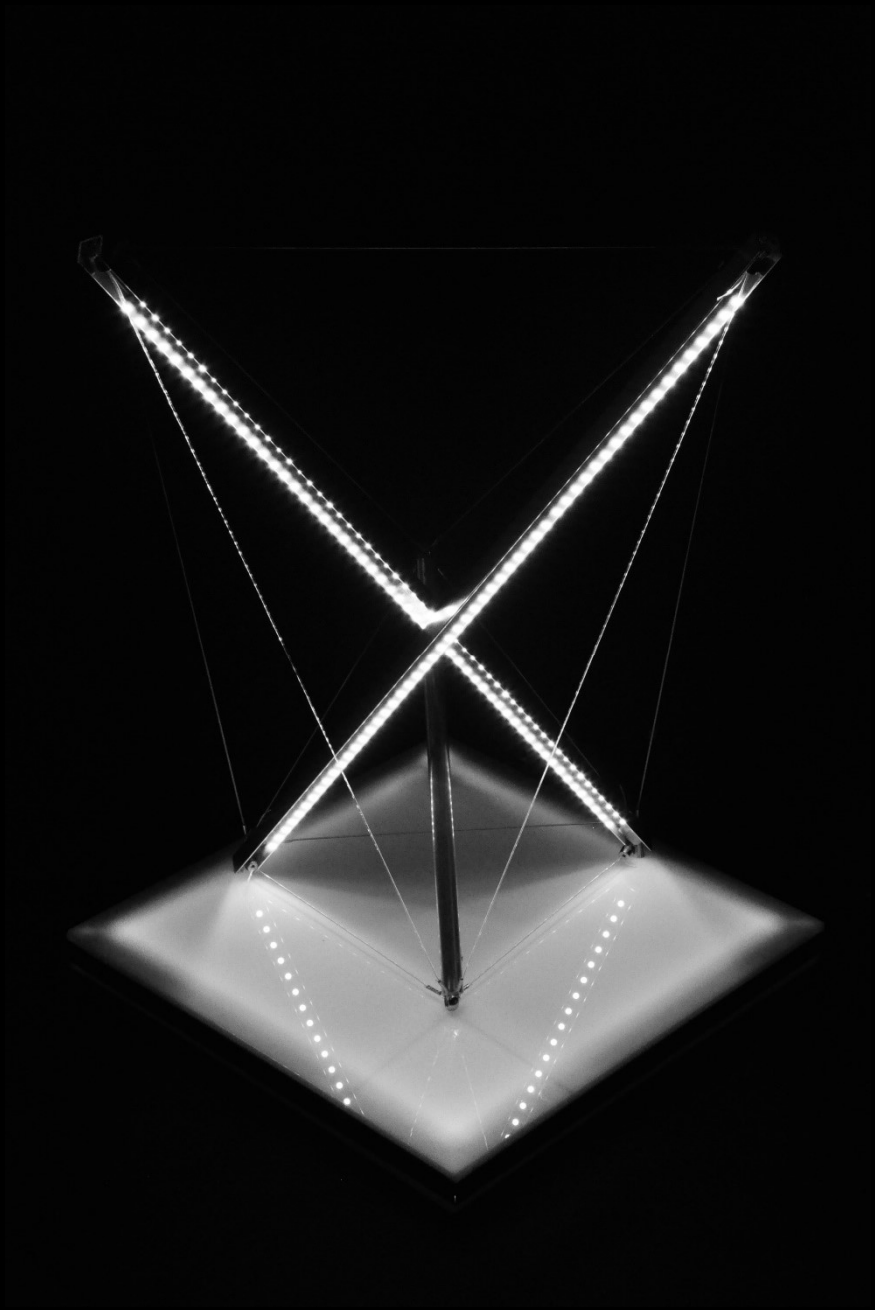

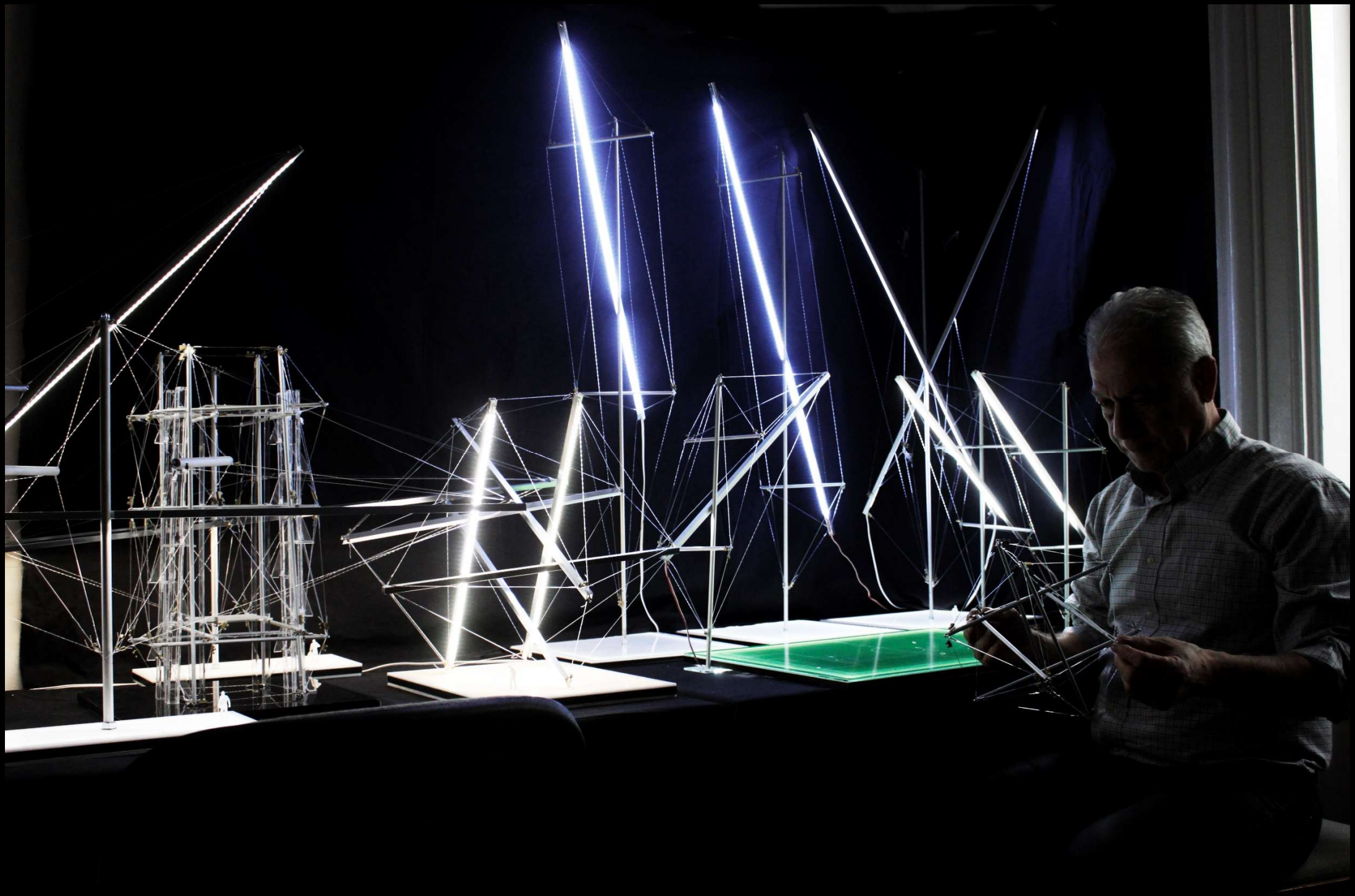

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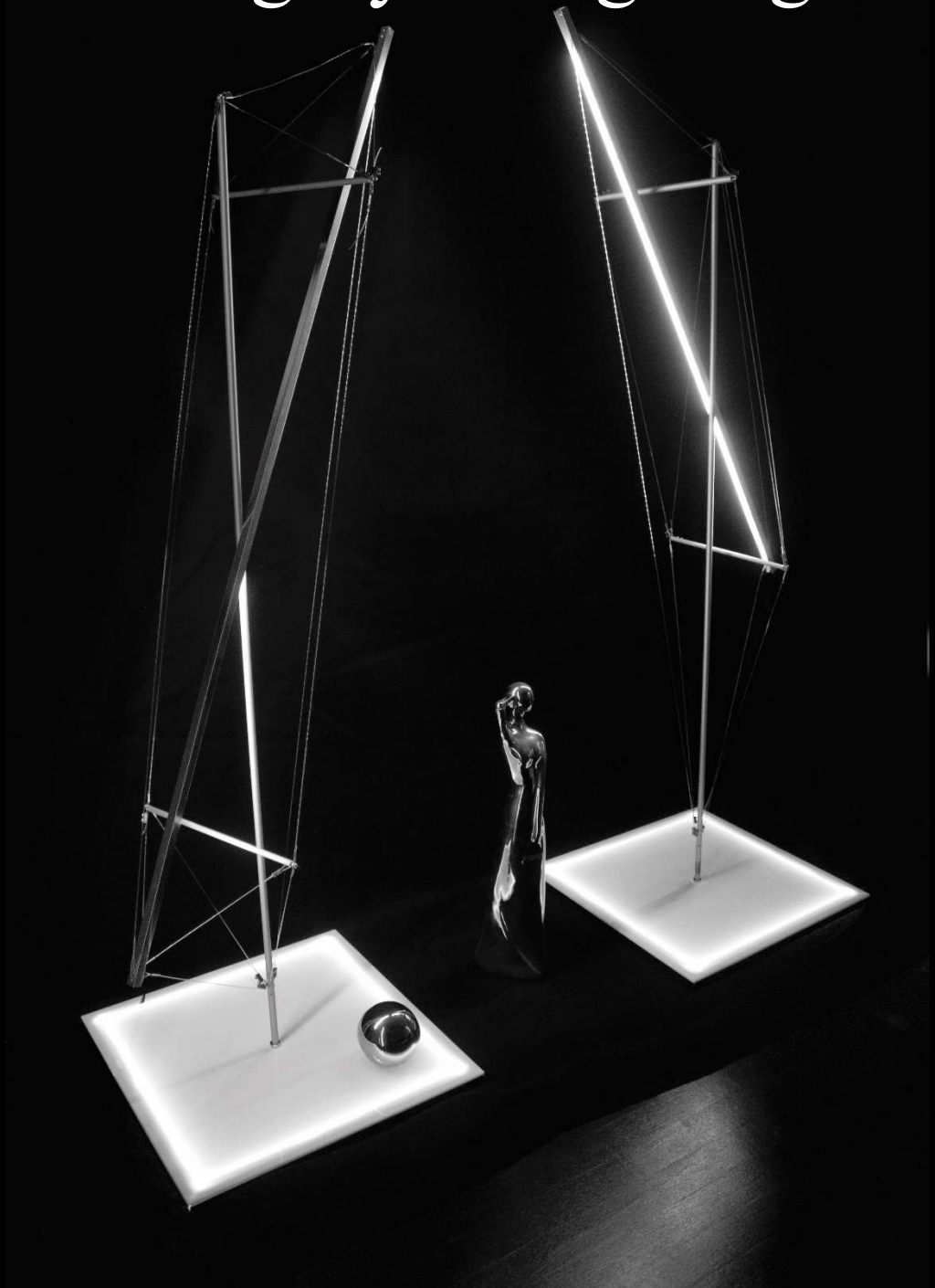
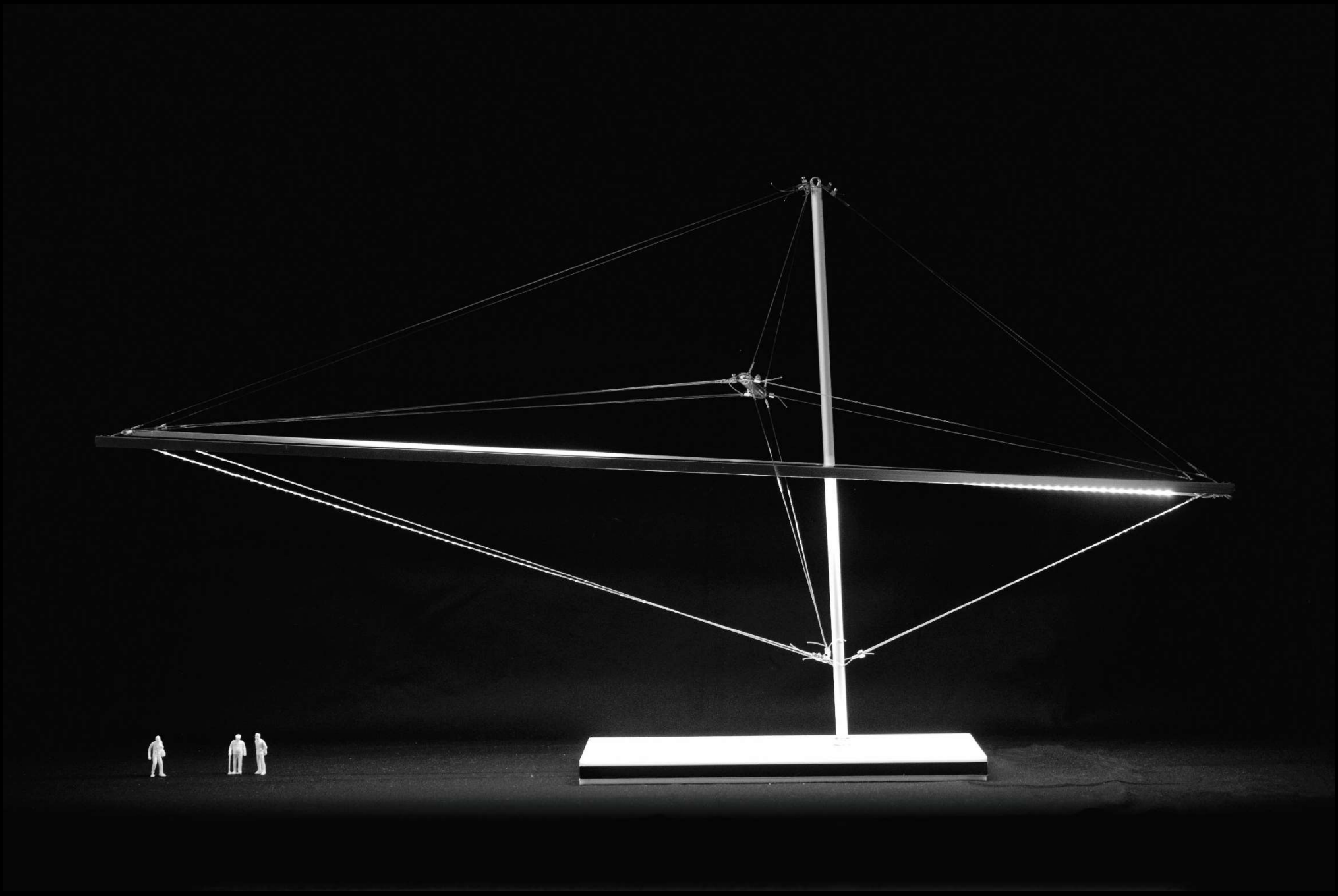
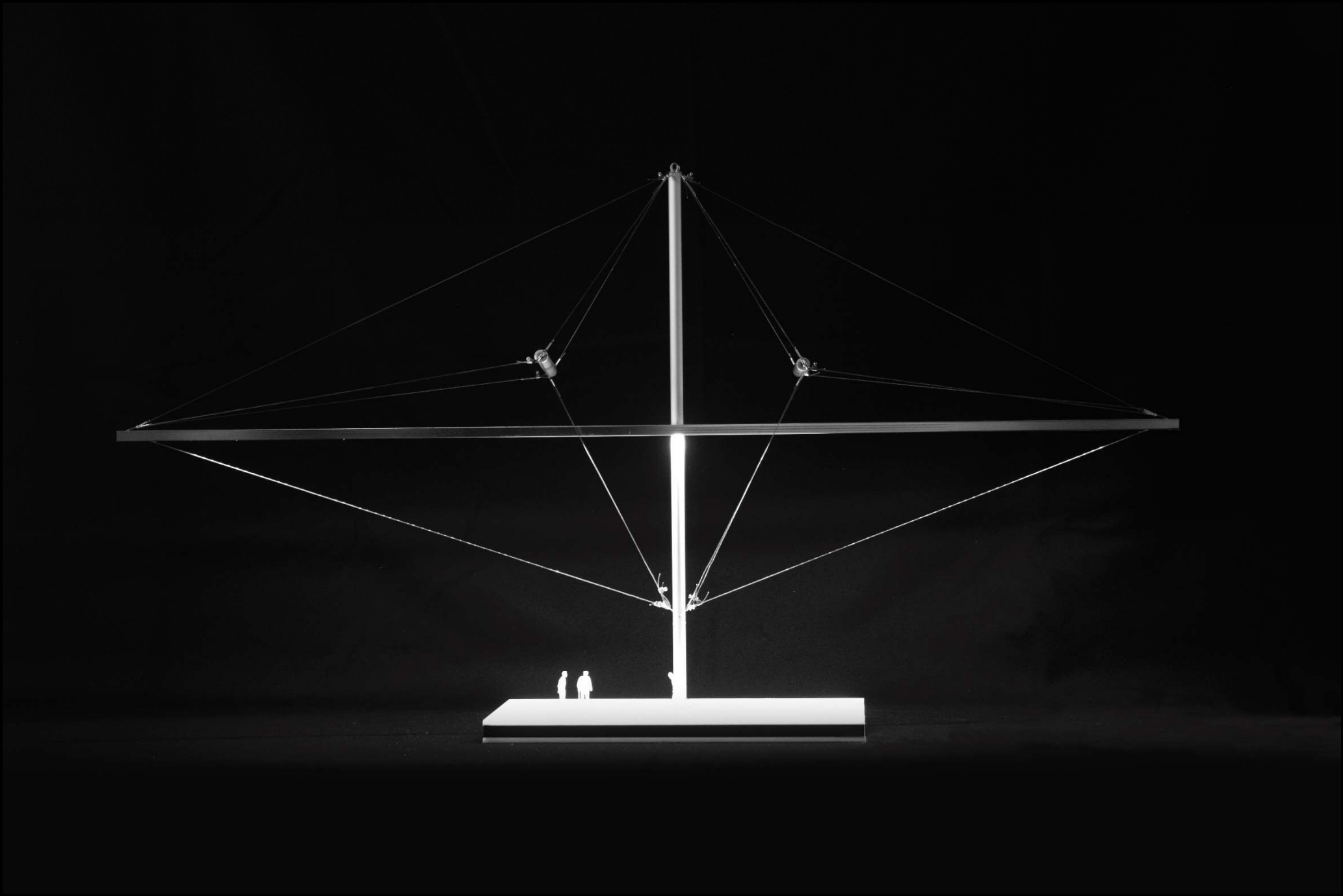


Tensegrity as Lightings



Tensegrity as Lightings



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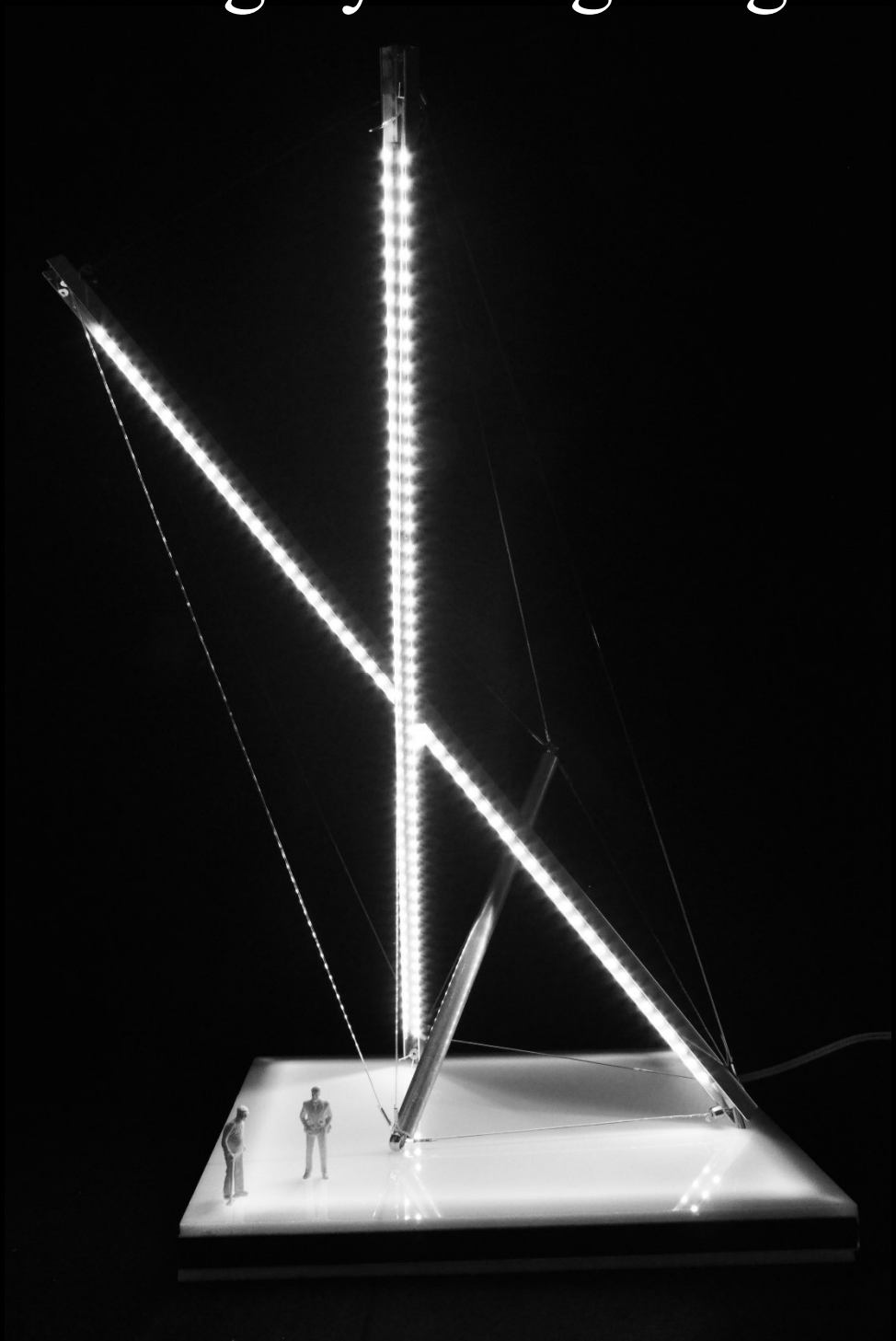
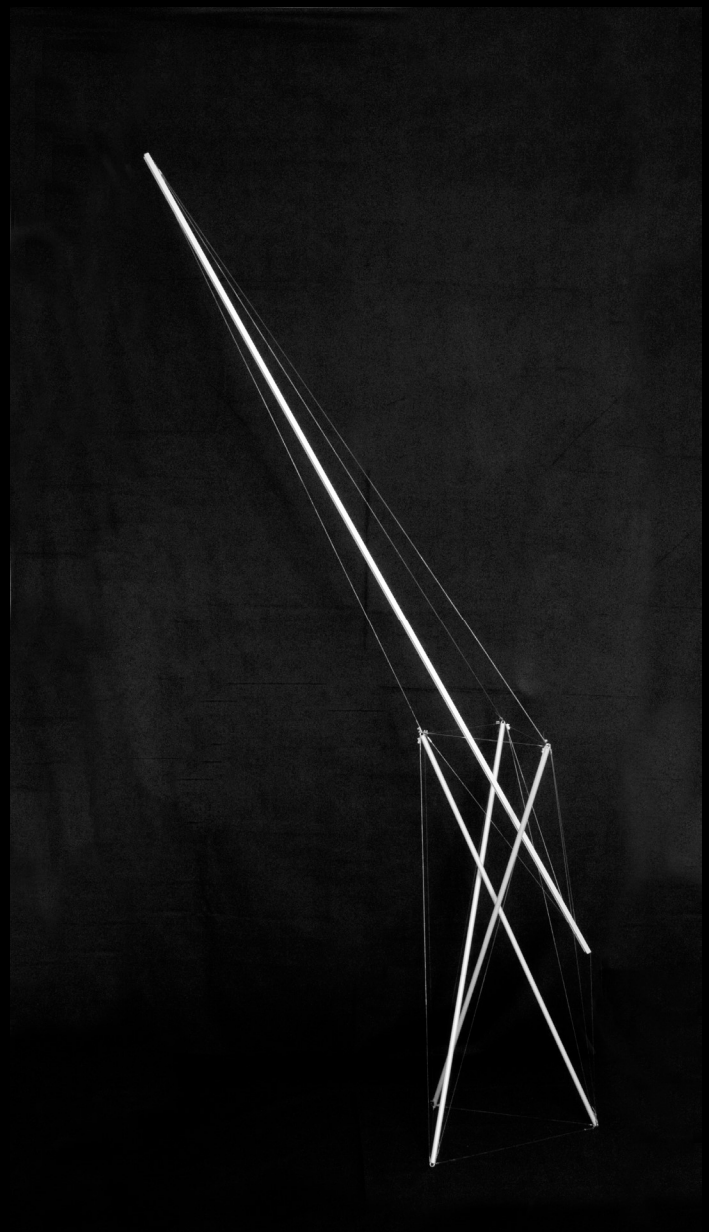


Tensegrity as Lightings



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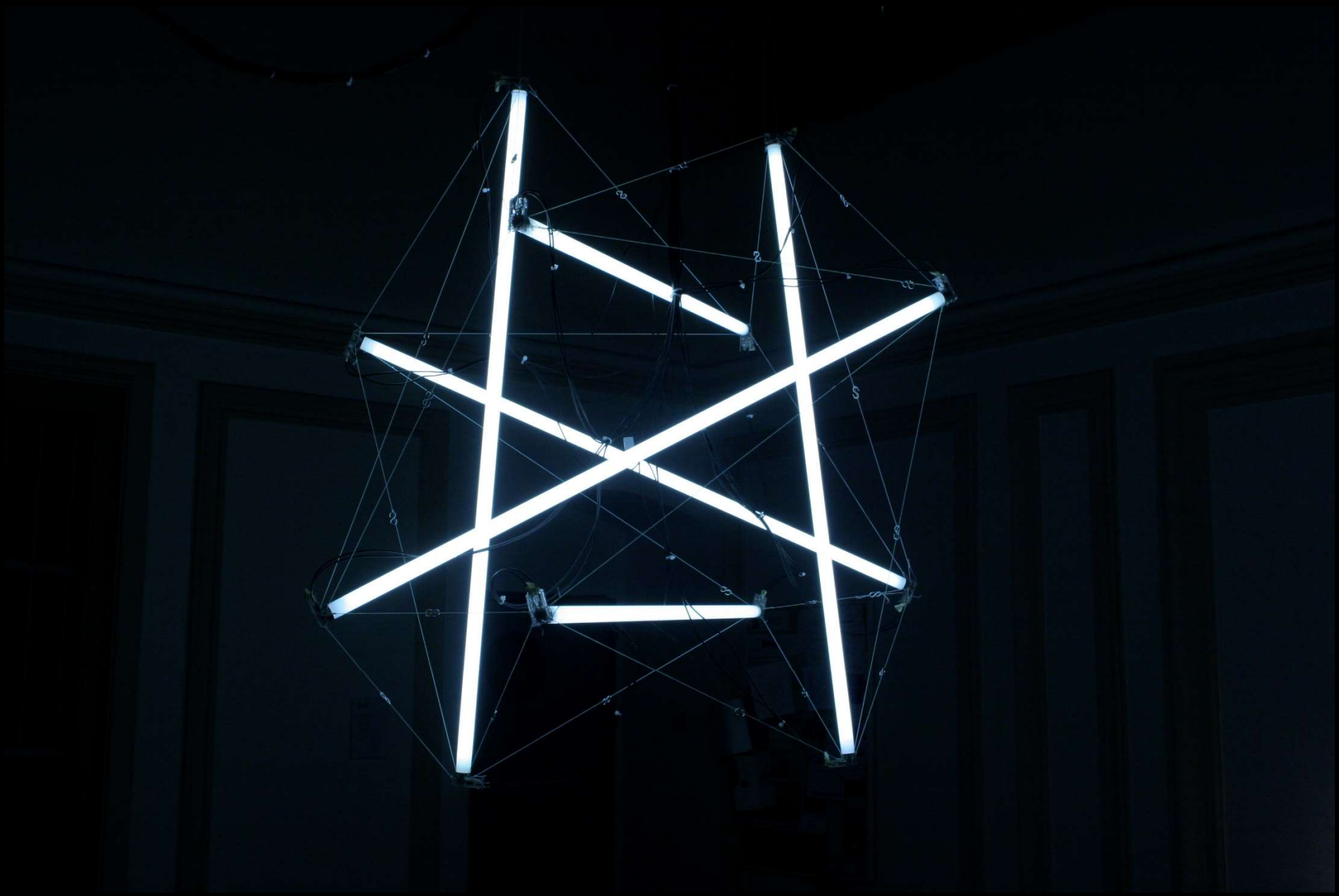
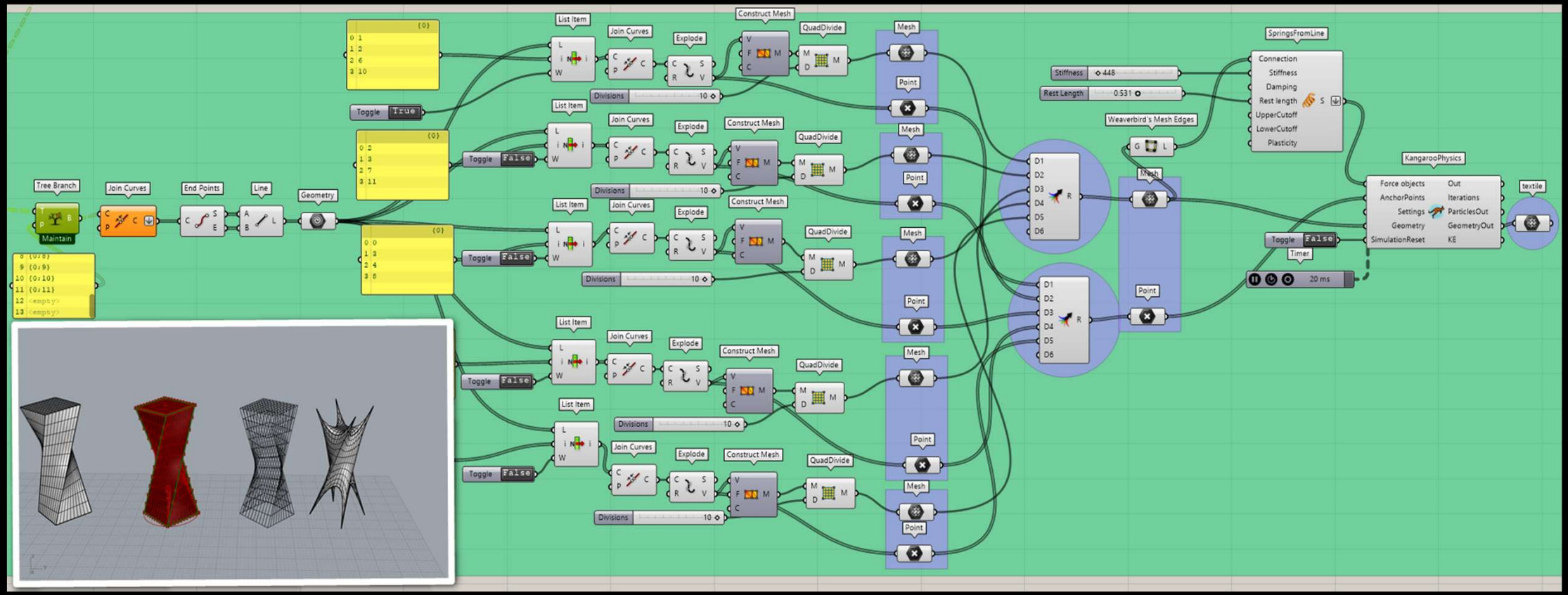


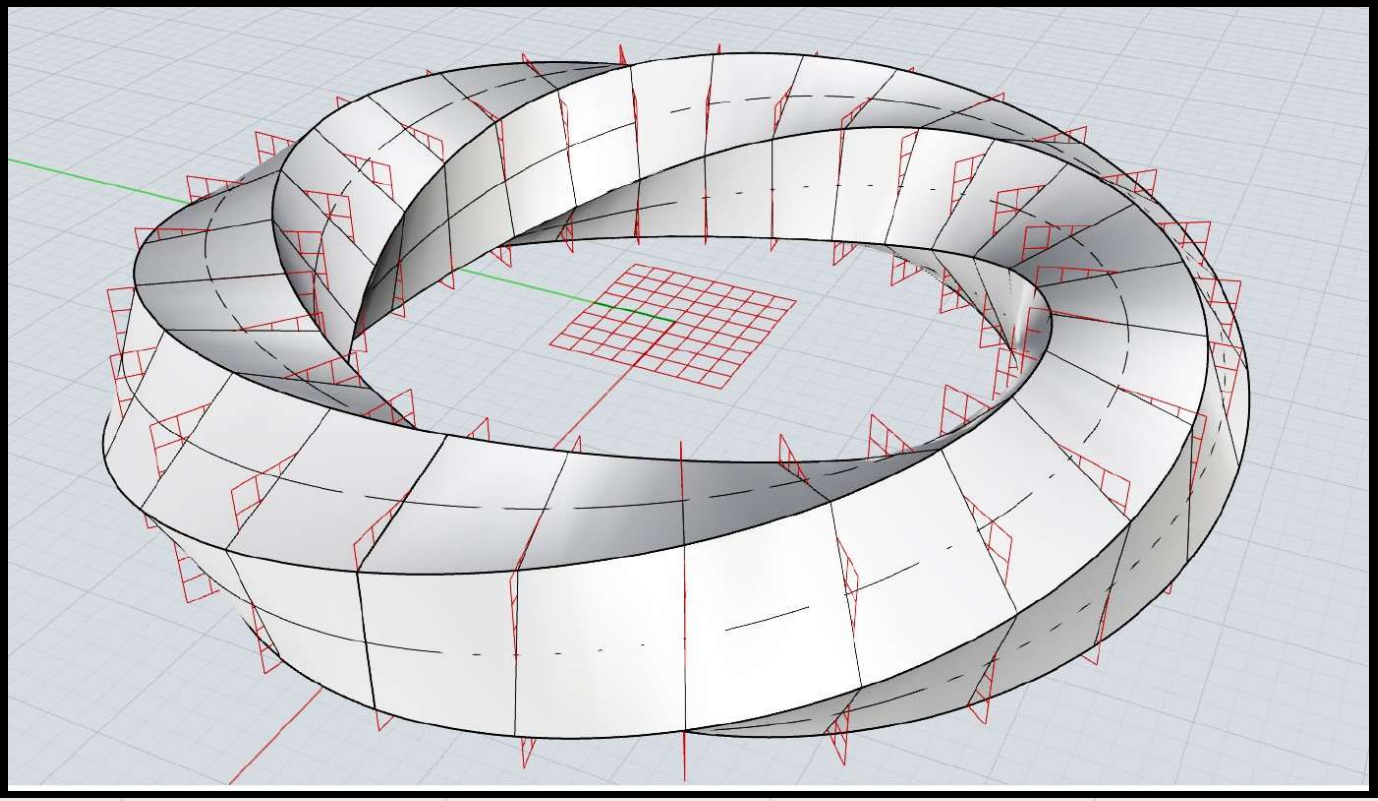
4 Struts Membrane Tensegrity - Flow Chart of Grasshopper

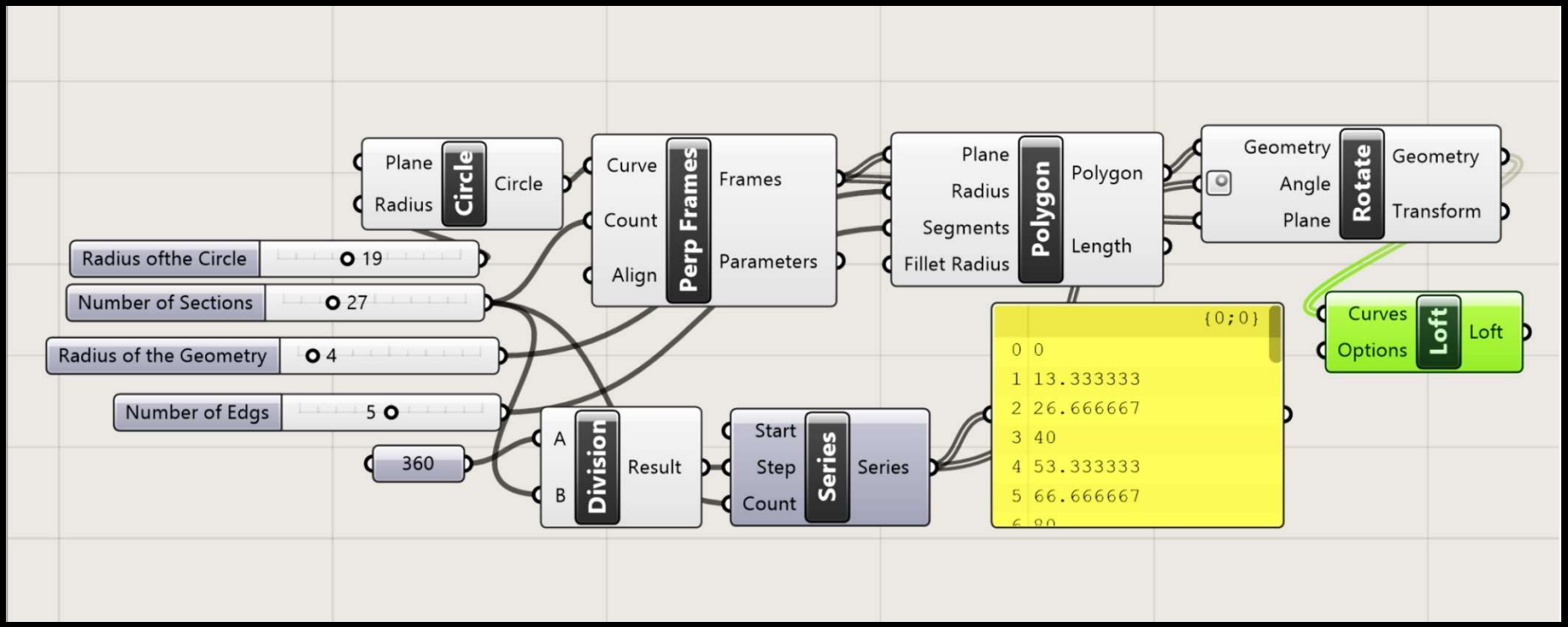


Tensegrity as Lightings

Tensegrity as Lightings

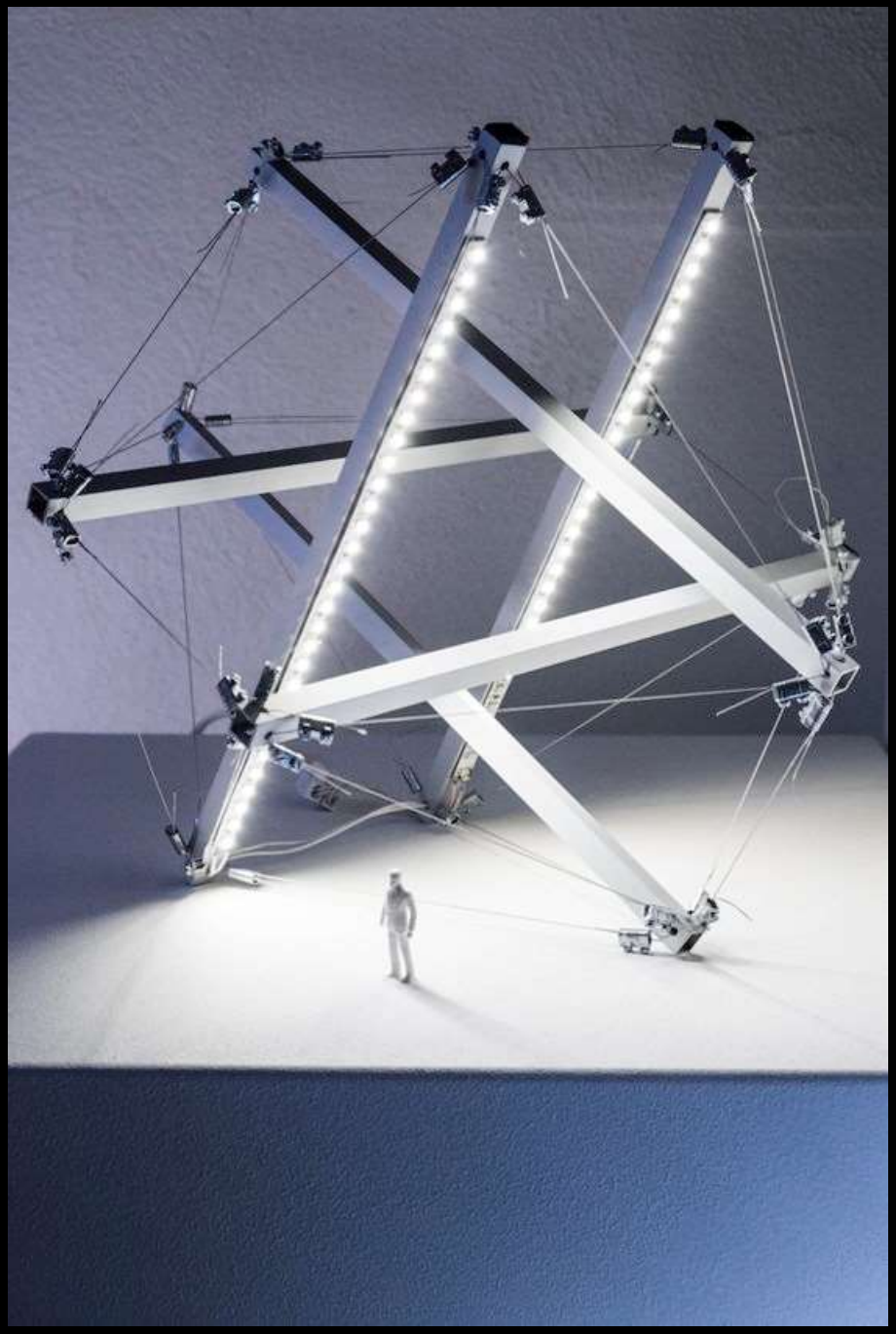
Tensegrity as Table Lamp



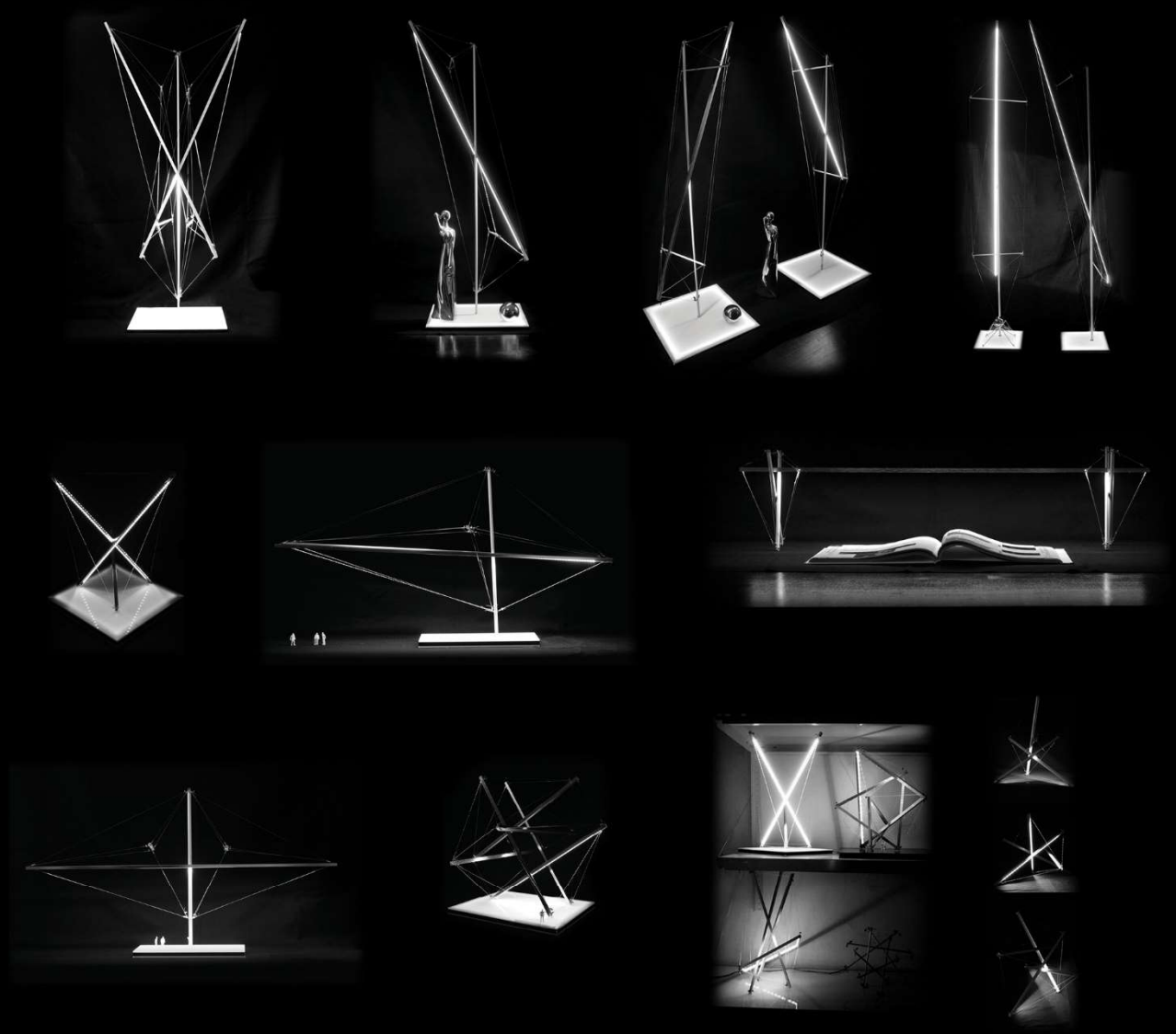

Plane
Radius
Circle
Circle
Curve
Count
Align
Perp Frames
Frames
Parameters
Plane
Radius
Segments
Fillet Radius
Polygon
Polygon
Length
Geometry
Angle
Plane
Rotate
Geometry
Transform
Radius ofthe Circle
19
Number of Sections
27
Radius of the Geometry
4
Number of Edgs
5
360
A
B
Division
Result
Start
Step
Count
Series
Series
{0;0}
0 0
1 13.333333
2 26.666667
3 40
4 53.333333
5 66.666667
Curves
Options
Loft
Loft

Tensegrity as Mobius Strip, Table Lamp

Tensegrity as Lightings

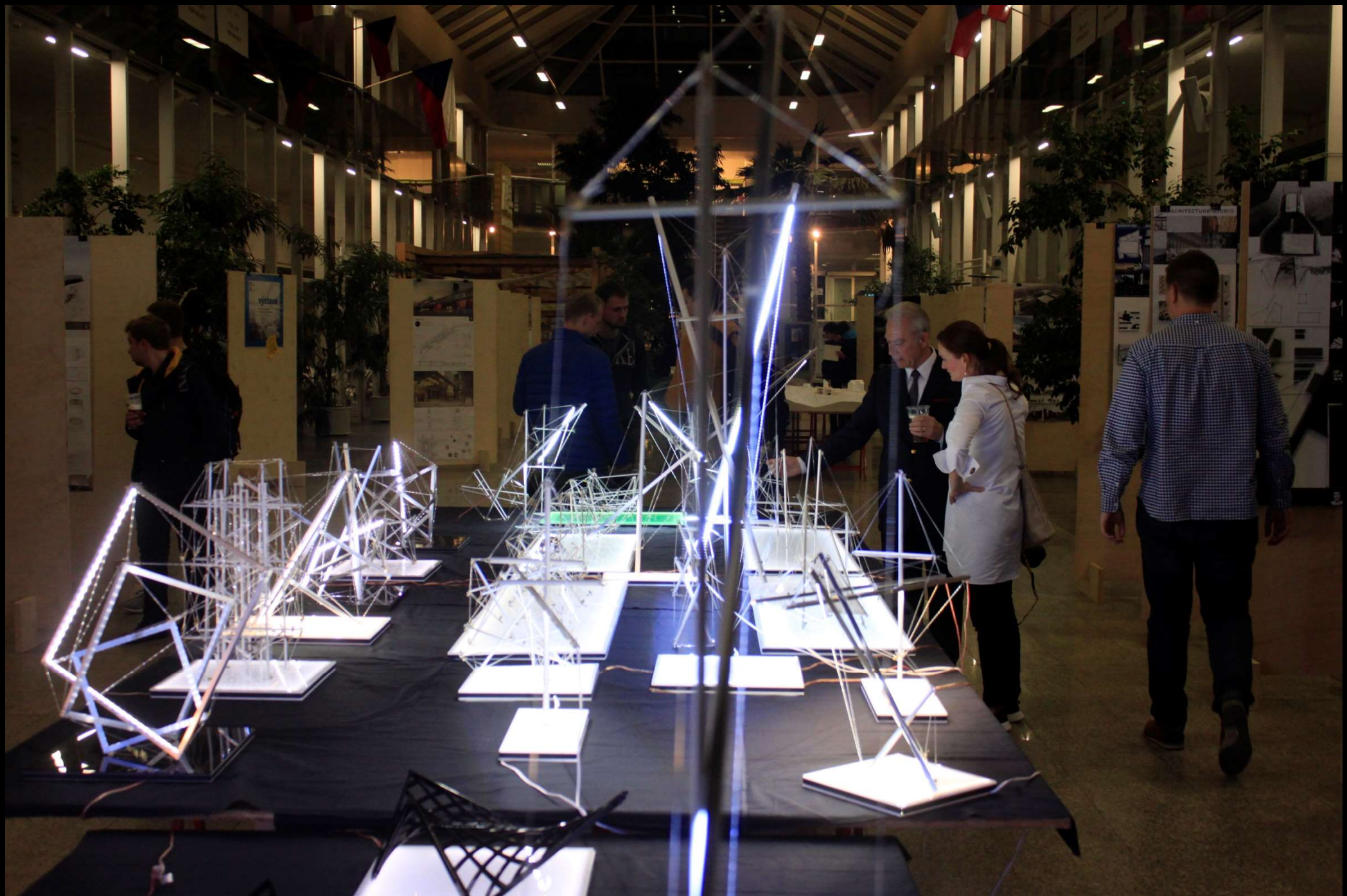


Tensegrity as Lightings



Tensegrity Lightings

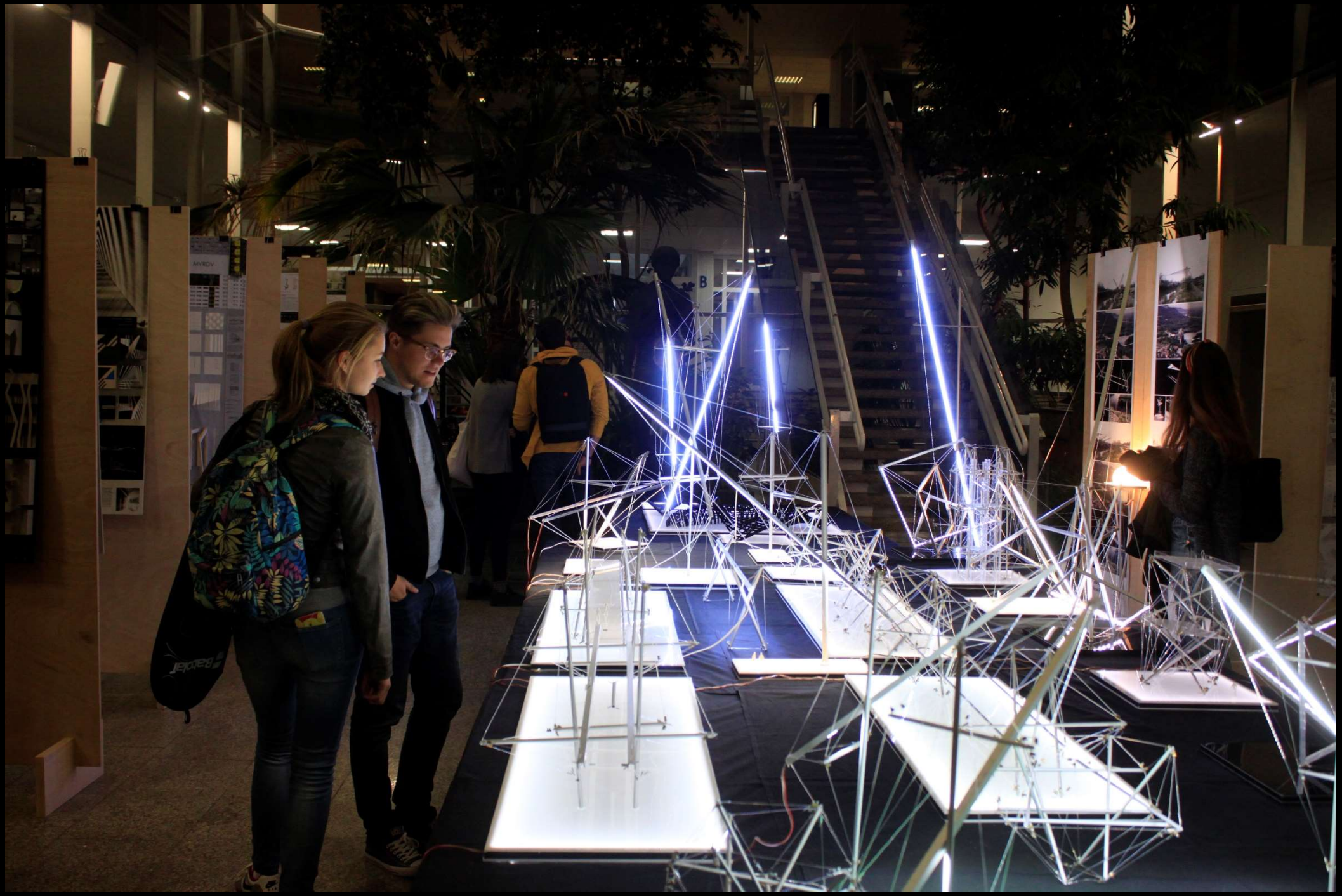
Exhibition Prague 2018



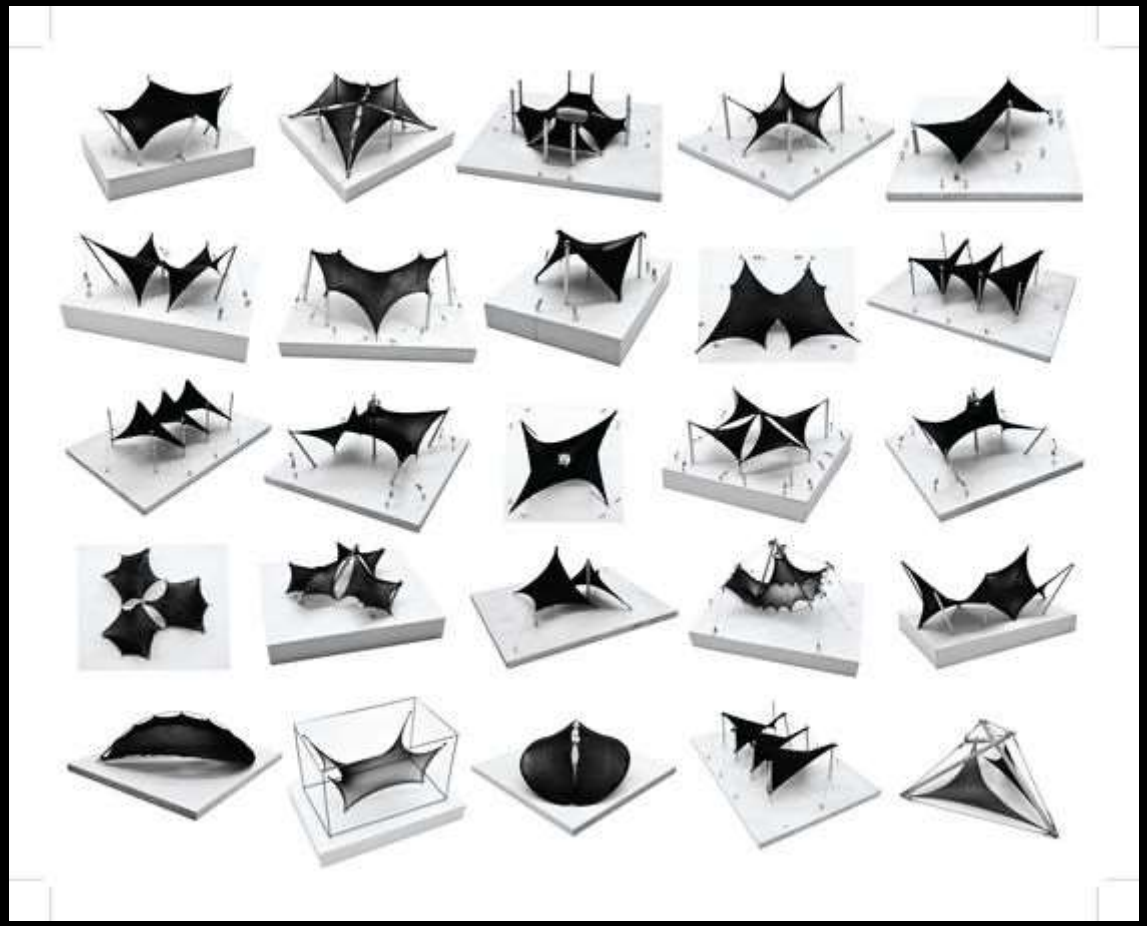
Exhibition Bratislava

Exhibition Prague 2018

Exhibition Prague 2018



Exhibition Ostrava 2021



Our passion for creating innovative solutions in the field of design of anti-gravity tensegrity models, which bring beauty and elegance to our spaces, led me to design these tea tables. The structures of these models are made of wood or aluminium gives me a sense of freedom while the models fly in the air thanks to the suspension steel ropes which ensure the stability of entire system, It's really beauty of physics and the elegancy of tensegrity.

The optical illusion is my favourite part of the end result when I have replaced the main parameters such as the middle cable with magnets and the best part is that it does not require a lot of time or complex materials, so anyone can start producing something like that. Very nice application of the basic Tensegrity structure; simple in principle, finicky to build.

According to Anti-Gravity models that were made by the author in the studio to serve as tea tables the load carrying capacity of the structure is equal to the tensile capacity of the string. Since only one string is provided at the centre aesthetically it is elegant. It's just a matter of achieving the right tension strings to centre the structure and then connect them in place, It works beautifully. The centre string provides tension and the other strings provide balance it follows that all strings are necessary, not just the centre one but the centre string is the most important one. Take any of them out and the whole thing falls apart.

Tendon is a tension component of a tensegrity structure and can be divided into active tendons and passive tendons. Passive tendons are tension elements that are deployed without any method of modulating their characteristics. Passive tendons are intended to be adjusted, or tuned, periodically. Active tendons are tension elements that have the ability to alter their behaviour. These may include mechanisms to change length, and rigidity.

Magical Floating Tensegrity Tea Table

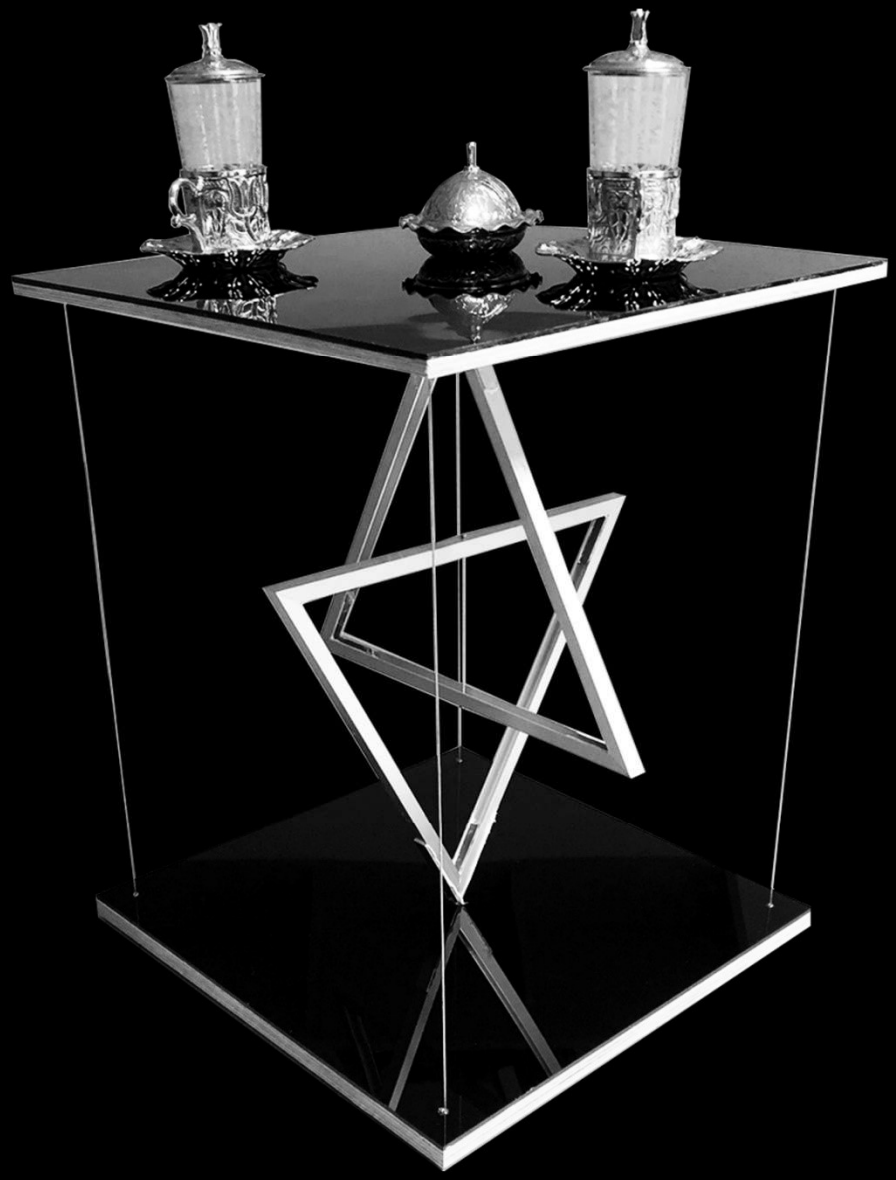
Tensegrity as Anti-Gravity Tea Table

Tensegrity as Anti-Gravity Tea Table

Tensegrity as Anti-Gravity Tea Table

Tensegrity as Anti-Gravity Tea Table

Tensegrity as Anti-Gravity Tea Table



Tensegrity as Anti-Gravity Tea Table

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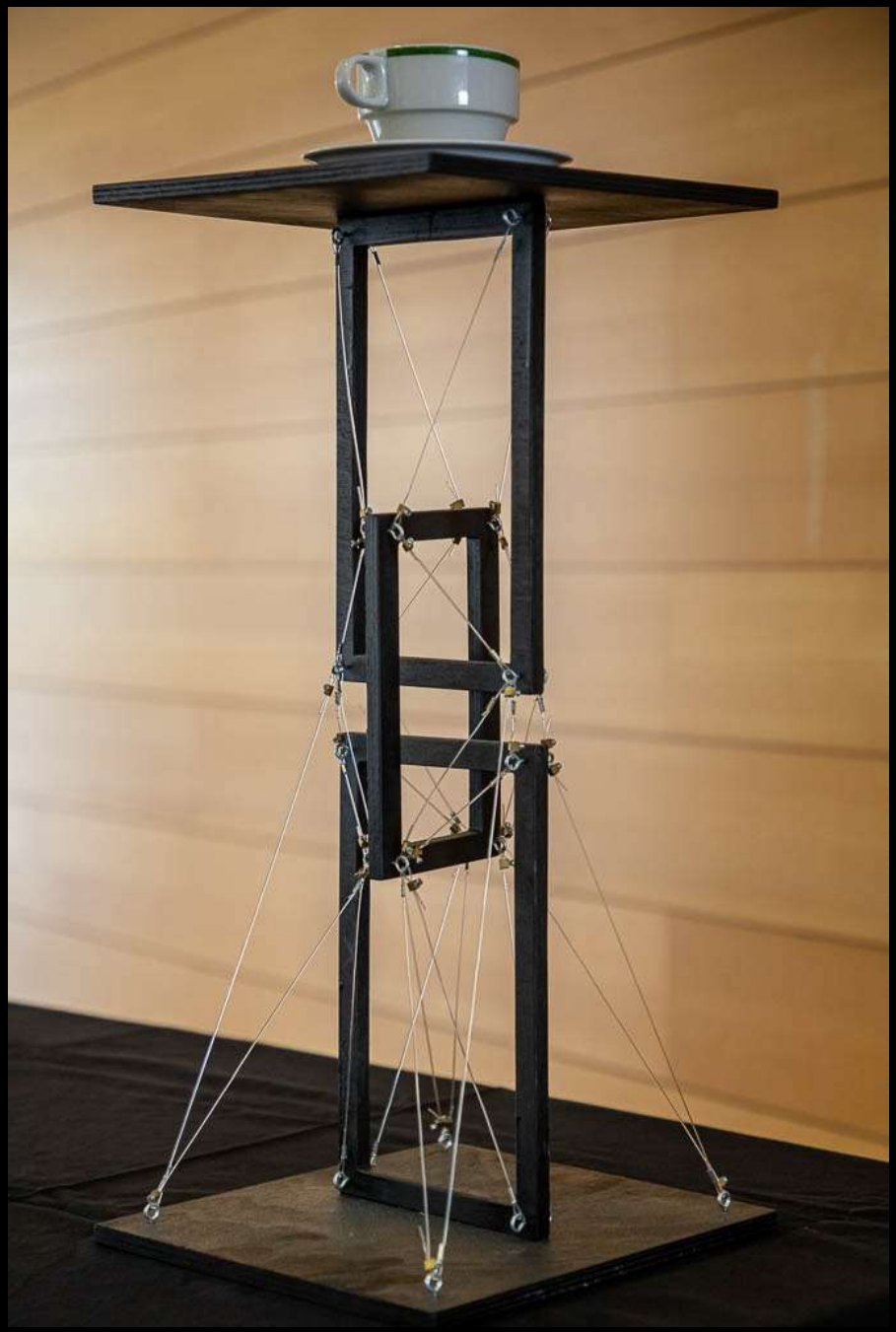
Tensegrity as Tea Table



Tensegrity as Tea Table

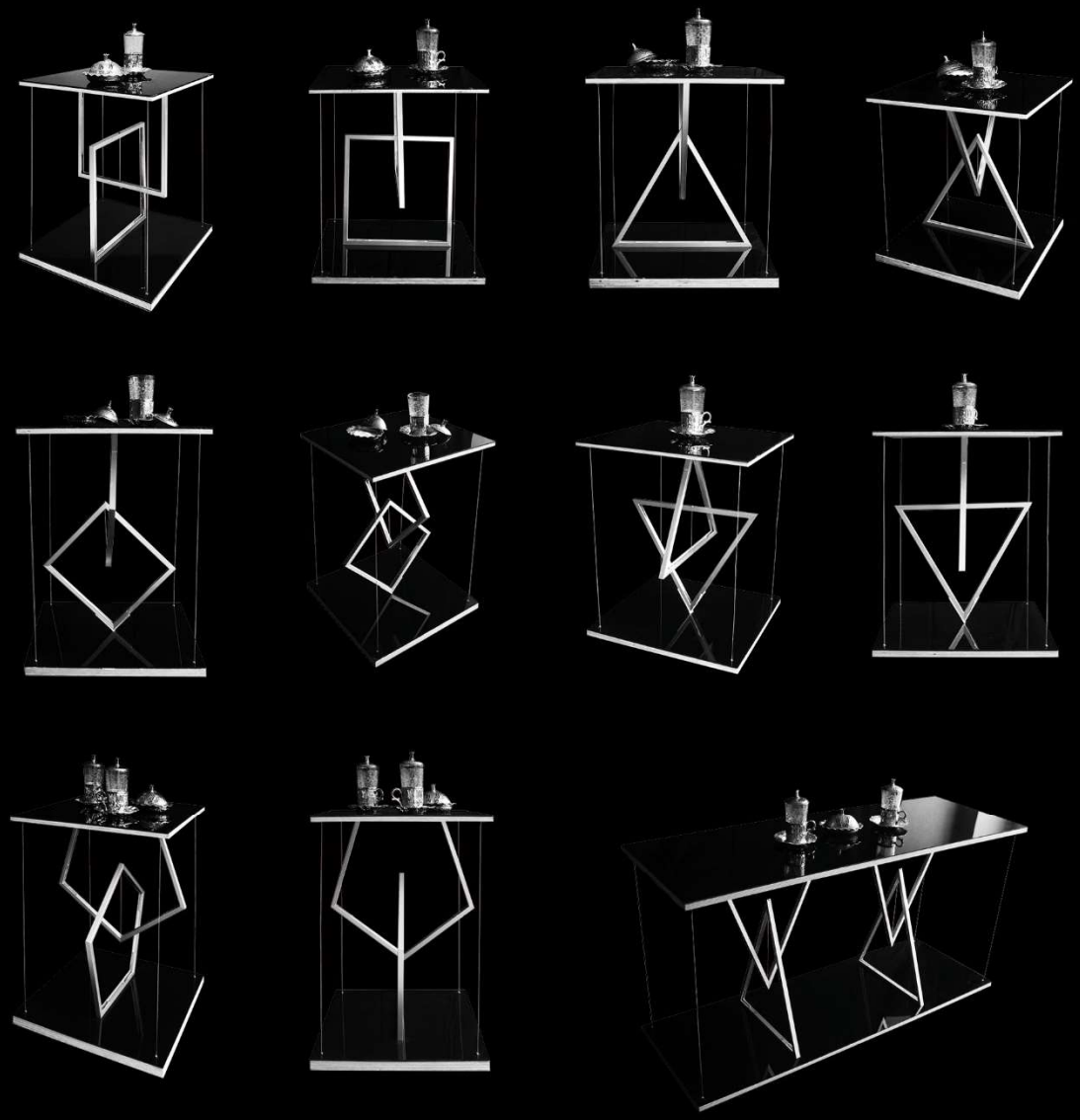
The Art in/of Nature - TIME SPACE EXISTENCE - Venice, Italy 2021

The Art in/of Nature - TIME SPACE EXISTENCE - Venice, Italy 2021


Art In
/ Of Nature
Sabah Shawkat
VŠVU BA
tensegrity
Definitions
- Connected set of tension members and
a disconnected set of compression members
- Islands of compression in a sea oftension
- Free-standing pin-joined networks
- Tensile integrity structures
- Self-supporting structures
Art In
/ Of Nature
VŠVU BA

Tensegrity as Anti-Gravity Tea Table

Tensegrity as Anti-Gravity Tea Table

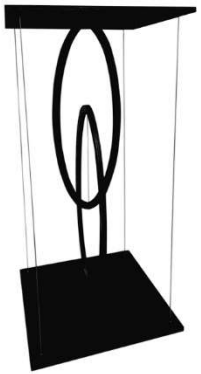


Magical Floating Tensegrity Tea Table

Magical Floating Tensegrity Tea Tables





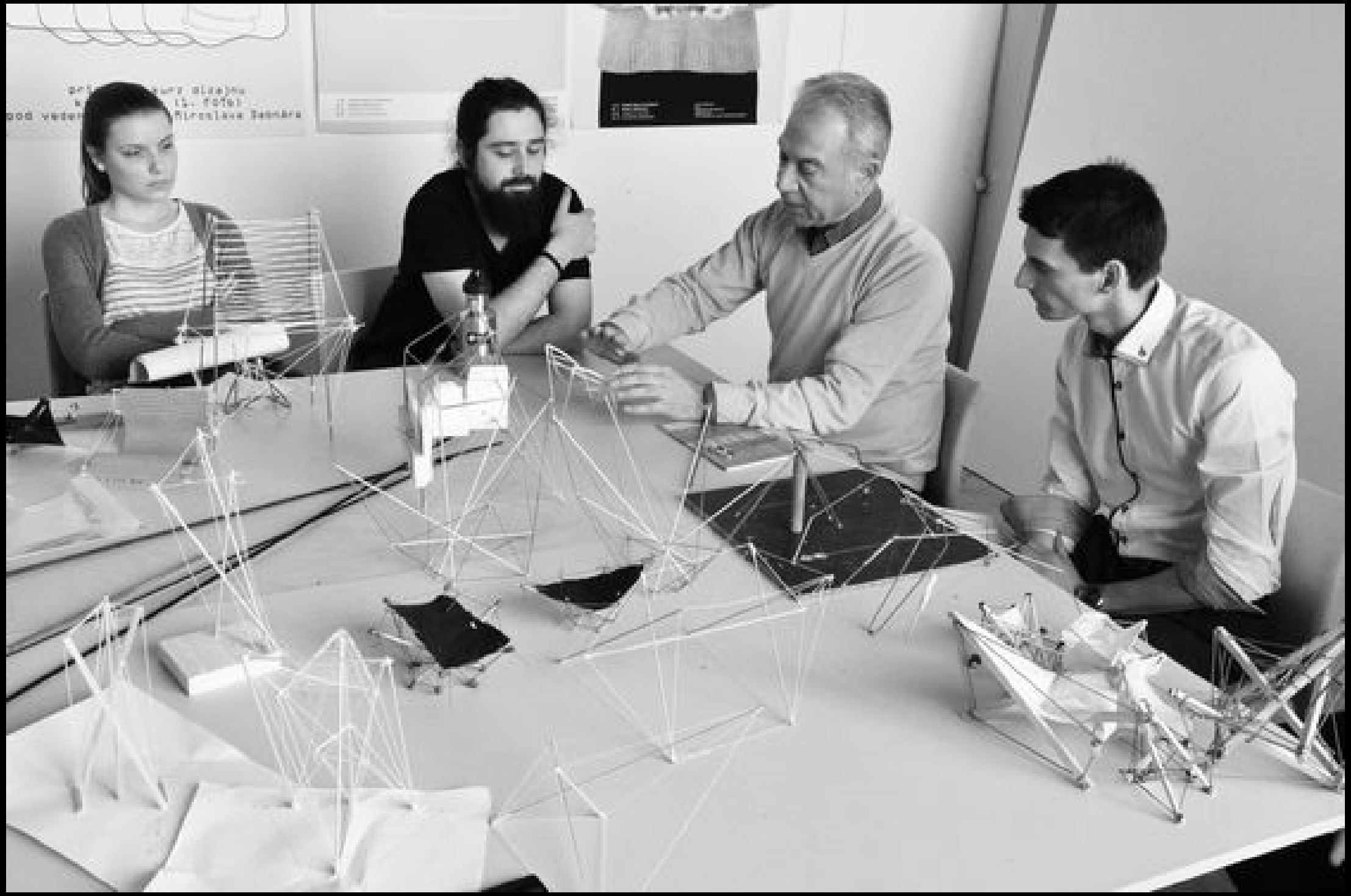





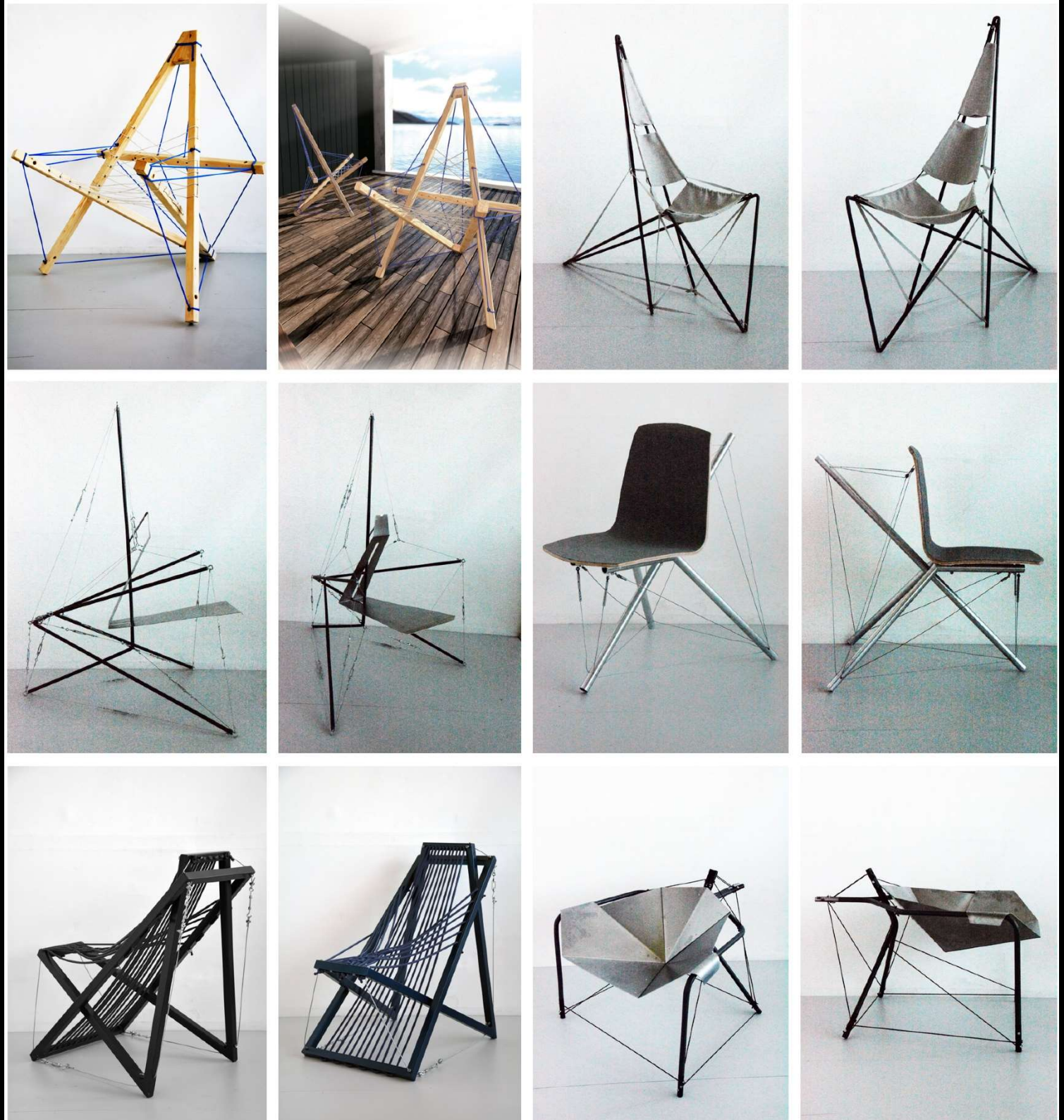

Tensegrity Tea Tables


Lightweight
Pedestrian Bridges
Tensegrity
Structures
Geodesic Parametric
Tensegrity Dome

Tensegrity as a Chair



Tensegrity as Chairs









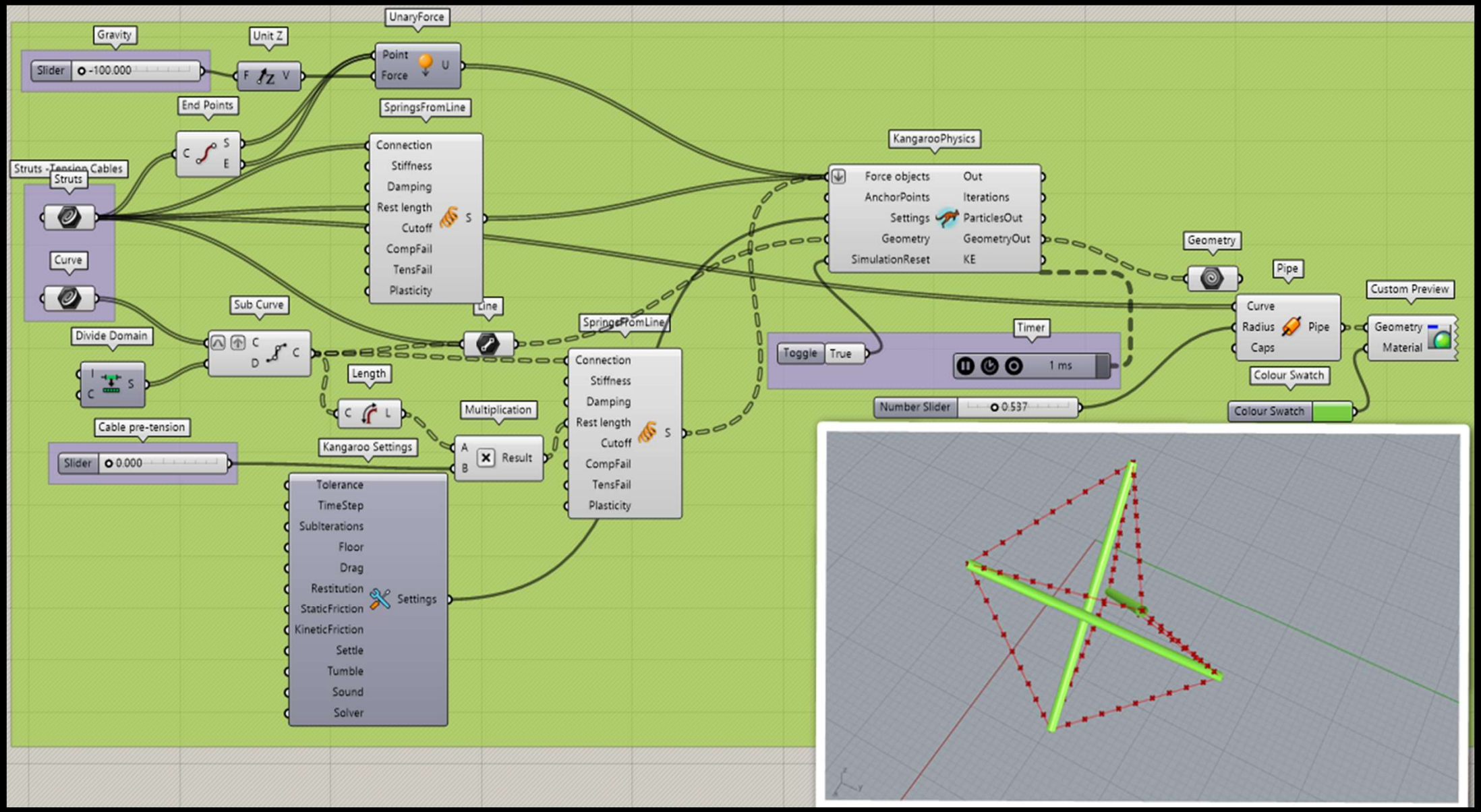

The pioneers of tensegrity structures were Karl Ioganson 1920, Richard Buckminster Fuller (1895-1983), Kenneth Snelson 1965, and Rene Motro 2003. The first patented definitions of tensegrity are very general. Fuller described tensegrity systems as “Islands of Compression in a Sea of Tension”. Snelson patented the system which he called “Continuous Tension, Discontinuous Compression Structures”. Emmerich added the condition of self-stress state (Snelson,1965, Emmerich,1964, and Fuller,1962). Tensegrity structures consist of struts mounted in such a way that the struts remain physically isolated in a continuous set of cables.

Tensegrity structures consist of compression members (struts) and tensile (cables) components which stabilize each other through pre-stress. A tensegrity system is a system in a stable self-equilibrated state comprising a discontinuous set of compressed components inside a continuum of tensioned components (Snelson,1965). The tensegrity network is a stable, at the same time an adaptable construction. The whole system reacts to an outside force with an adaptive tension distribution. Tensegrity structures are “internally pre-stressed, free standing pin-jointed networks, in which the cables or tendons are tensioned against a system of struts”. This description introduces the fact that the system is pre-stressed and pin jointed. This implies that there are only axial forces present in the system and there is no torque (Motro,1992). The Tensegrity concept offers a high level of geometrical and structural efficiency, when the external load acting on construction are transmitted to all elements of the structure in the same way. Once the external force is removed the elements will return to their original shape. Vibration in one part of the structure causes vibration in all other parts. Mechanical stability of structures does not depend on the strength of individual parts but on the whole structure distributes and balances mechanical strain.

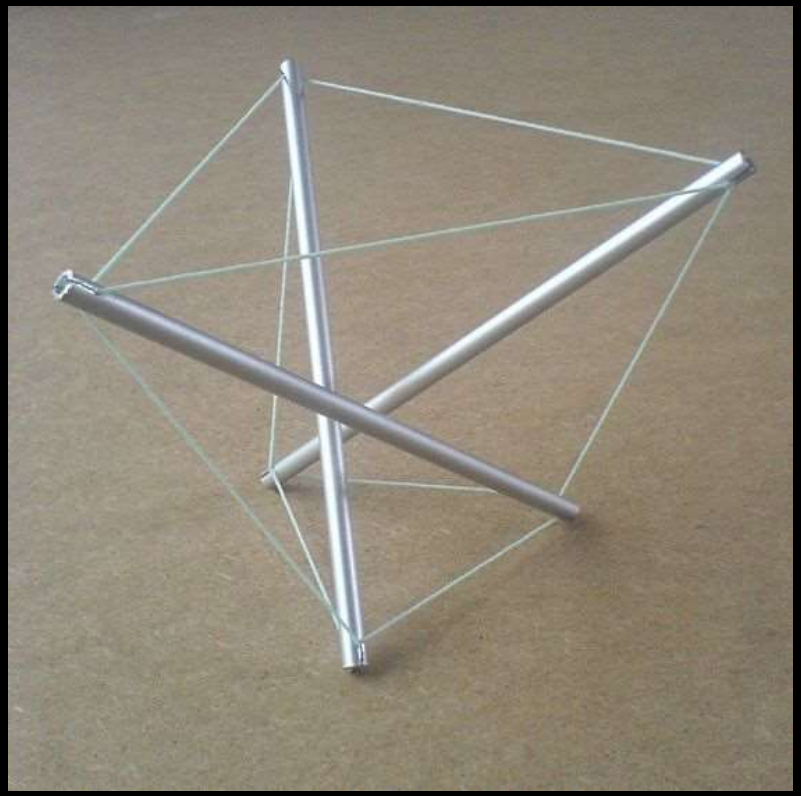
Our experience and way of thinking are conditioning the quality of our proposal. Similarly training conditions are also very important, and common training with other professions may contribute to increase the level of our art of engineering.

Tensegrity Structures

3 Struts Tensegrity- Flow Chart of Grasshopper



Lightweight Structures are Proposed with the Minimum Amount of Material.

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Divadla bratří Formanů

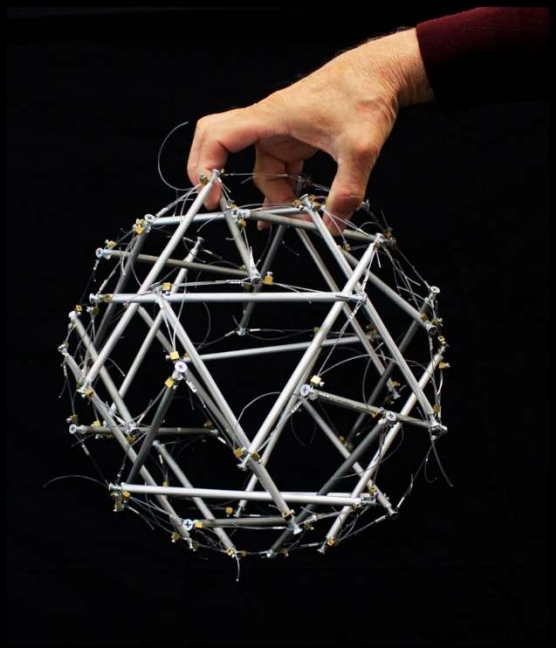

FAKULTA STAVEBNÍ ČVUT

Tensegrity as a Hammock

The term “geodesic” can be understood as the shortest distance between two points (Fuller,1962). Geodesic structure consists of as many struts of the same length as possible as well as congruent surfaces. It is a network of equal triangles whereby the cross points are always situated on the surface. This triangulation guarantees strength and rigidity of the ball-shaped structure. There is no direct contact between the compression elements as seen on the models on the figure bellow. The struts are combined to triangles, pentagons, or hexagons, whereby each strut is aligned in a way that each connection point is held in a firm position. This guarantees the stability of the whole structure.

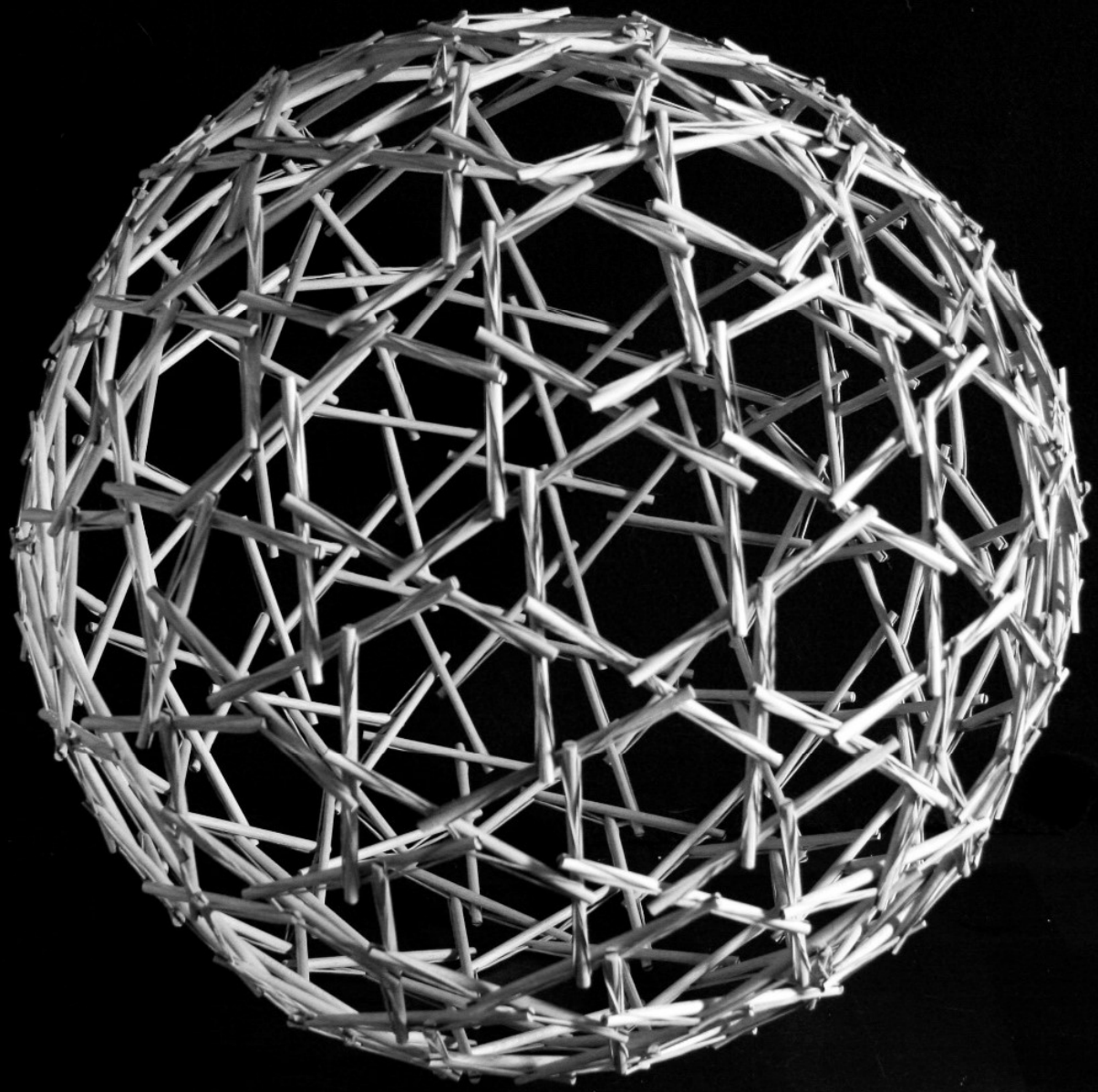
Tension is distributed equally to all parts of the whole construction. Increased tension in one part provides increased tension in all parts. A global increase of tension is balanced by an increase of tension in various parts. Whilst tension is thus distributed evenly in the whole system, only individual parts balanced by compression. There is a balance between tension and compression, we can define the system as “stable self-equilibrium”. The tensegrity network is a stable and at the same time an adaptable construction. The whole system reacts to an outside force with an adaptive tension distribution.

This type of structure depicted on the figure use separate elements for tension and compression as we can nicely see in this visual example. These tensegrity systems can be defined as spatial structures consisting of compression (struts) and tensile (cables) components which stabilize each other through pre-stress, tension and compression work together to resist the applied load.



Tensegrity as a Geodesic Dome (Shawkat)

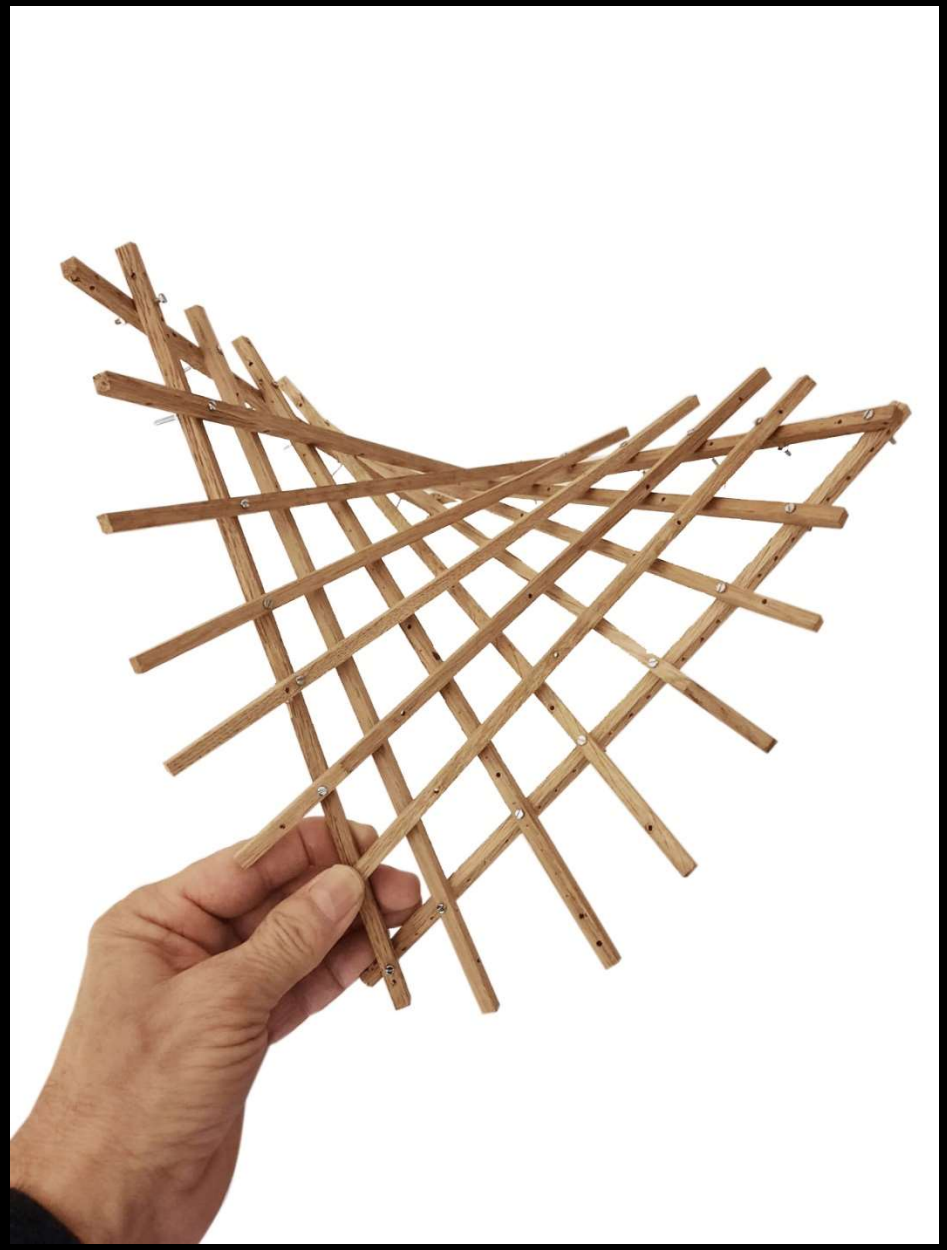
Geodesic Parametric Tensegrity Dome

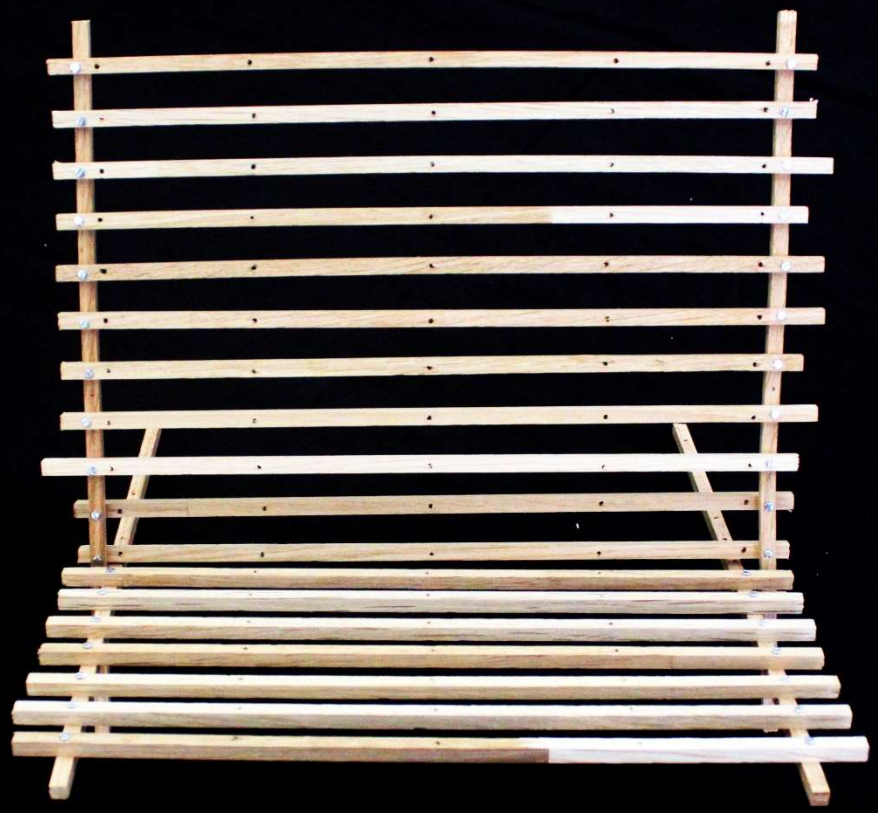


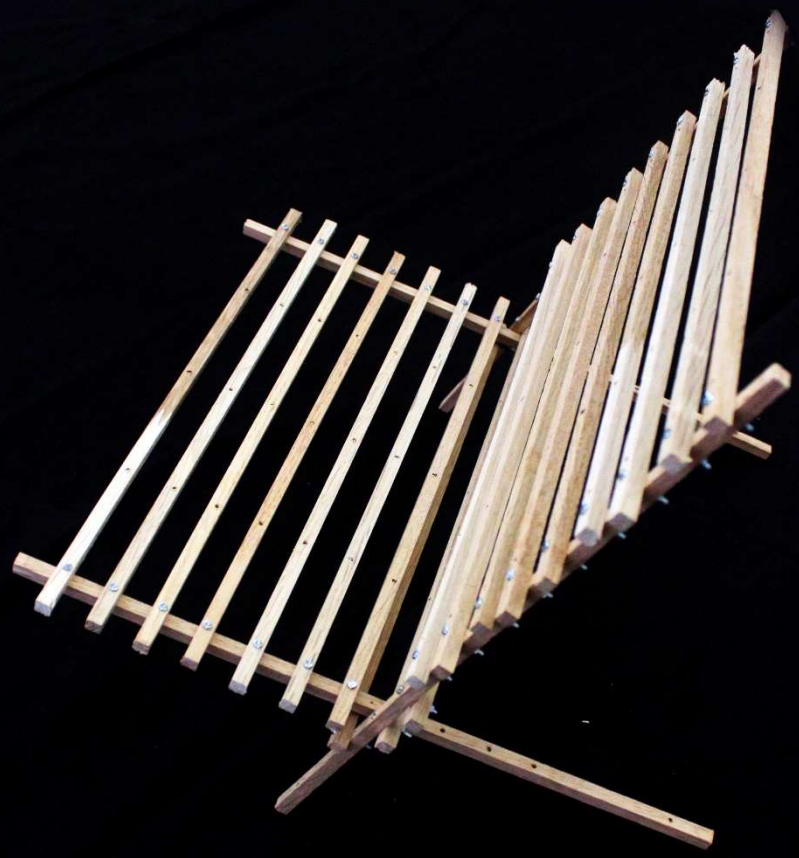
Geodesic Domes

Tensegrity as a Dome

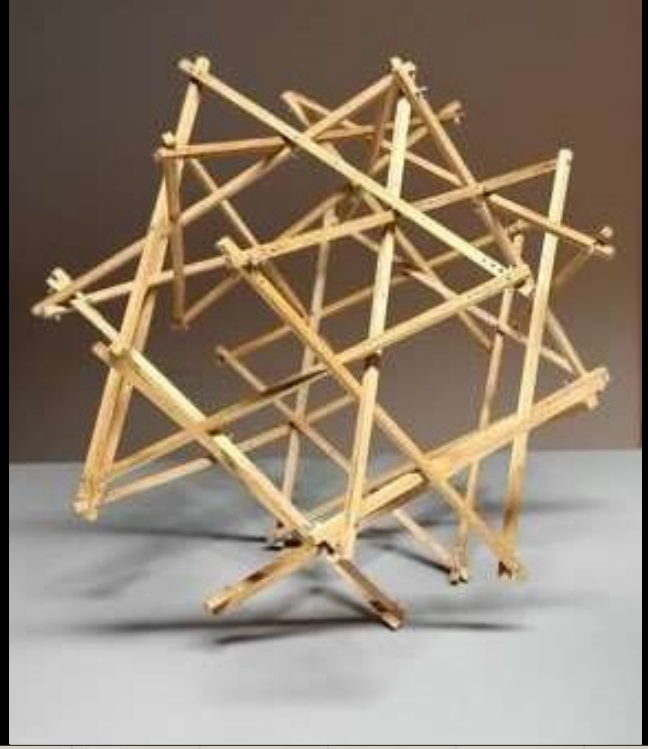
They produce aesthetic shapes, then shape governs the load-bearing capacity of the structure.

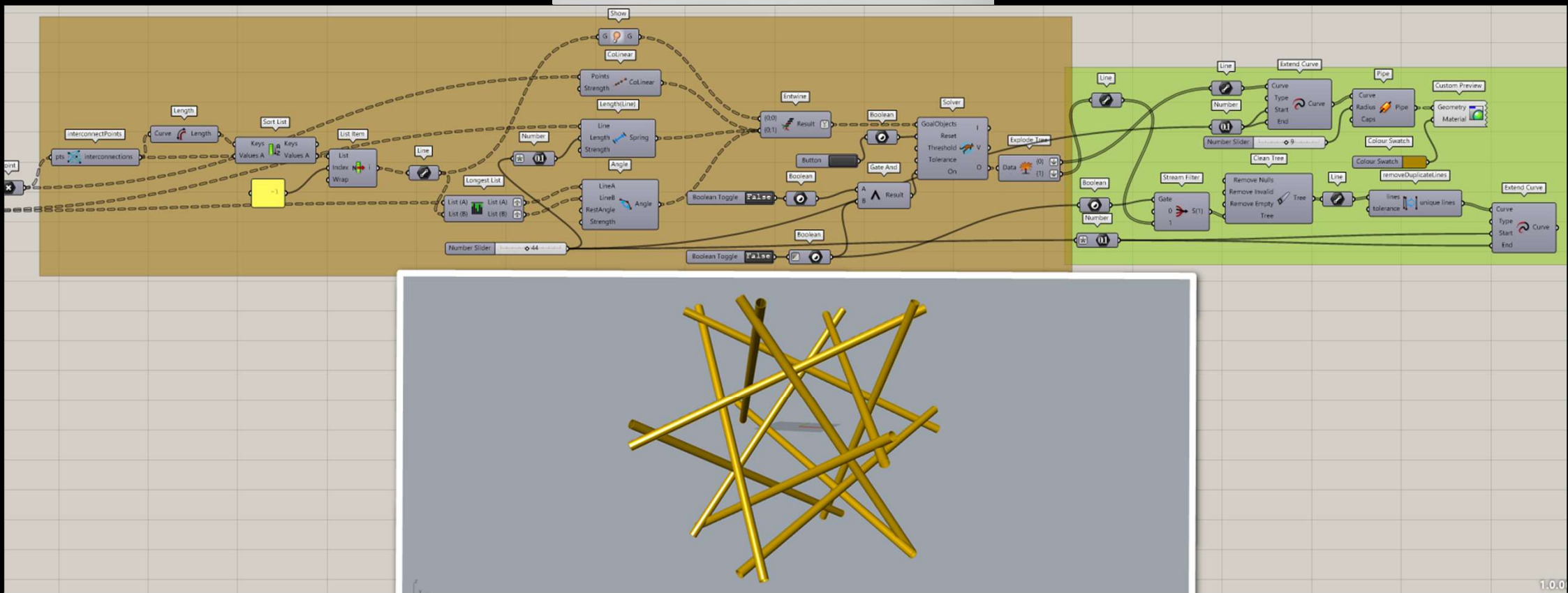






Reciprocal Frames for Interior Design




Show
CoLinear
Points
Strength
CoLinear
Length(Line)
Line
Length
Strength
Spring
Angle
LineA
LineB
RestAngle
Strength
Angle
Entwine
Result
Boolean
Solver
GoalObjects
Reset
Threshold
Tolerance
On
Explode Tree
Data
Button
Gate And
Result
Boolean Toggle
False
interconnectPoints
pts
interconnections
Length
Curve
Length
Sort List
Keys
Values A
List Item
List
Index
Wrap
Line
Number
Longest List
List (A)
List (B)
Number Slider
Line
Extend Curve
Curve
Type
Start
End
Pipe
Radius
Caps
Custom Preview
Geometry
Material
Colour Swatch
Clean Tree
Remove Nulls
Remove Invalid
Remove Empty
Tree
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Gate
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lines
tolerance
unique lines
Number Slider
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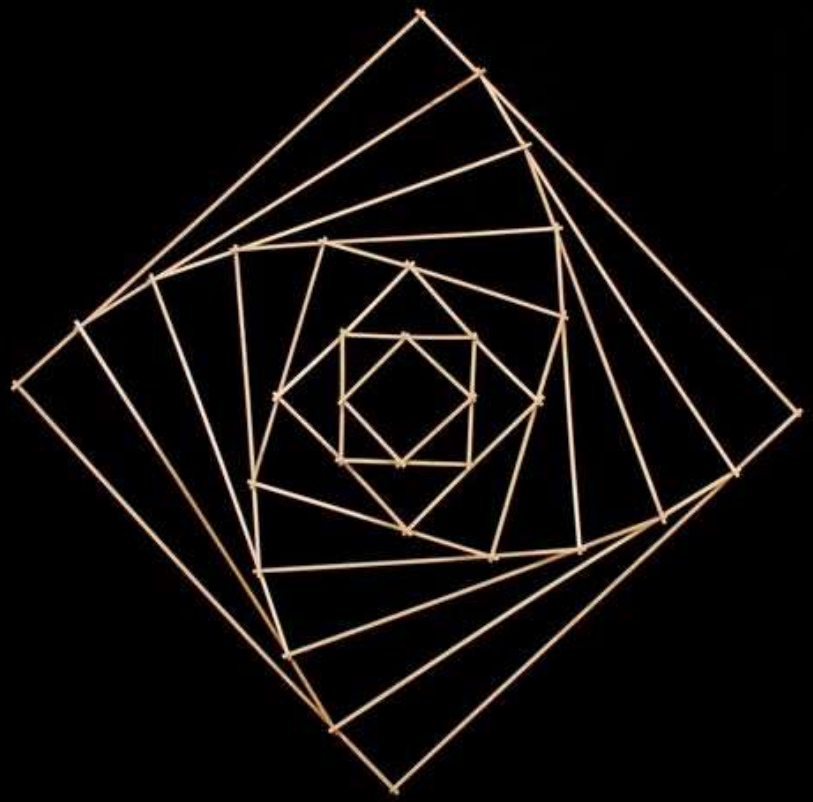
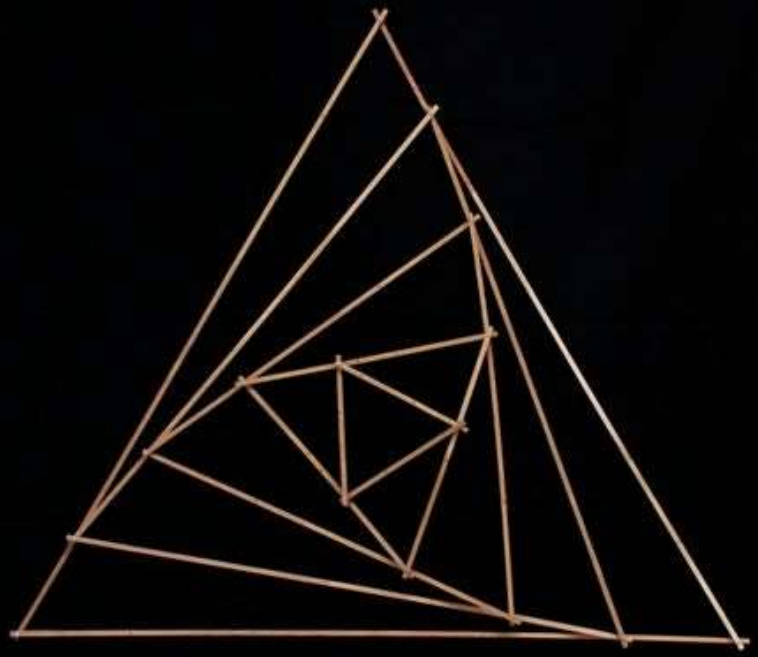
Reciprocal Frames for Interior Design


CSE



CSE CABINET OF STRUCTURAL ENGINEERING



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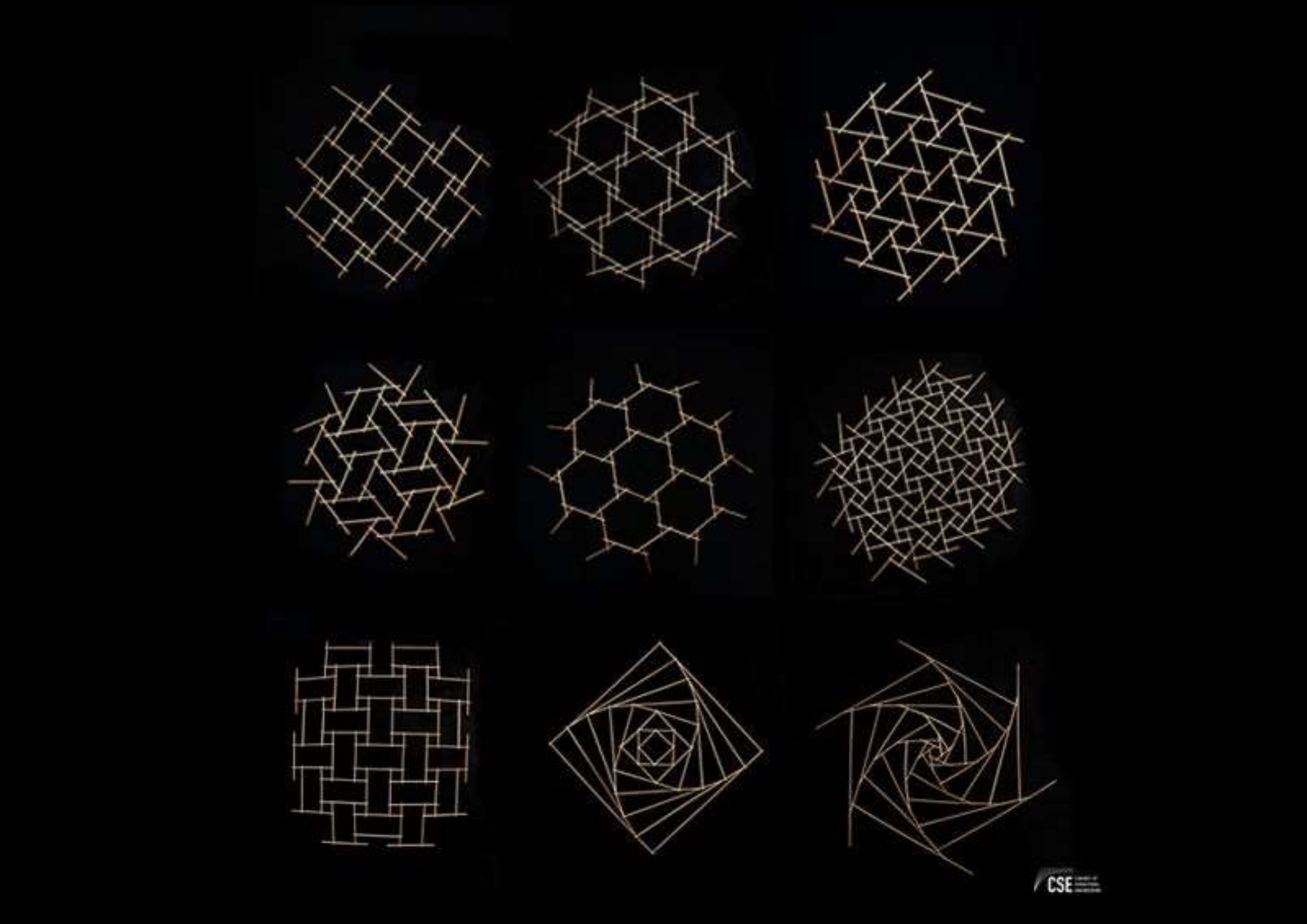
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THANK YOU

Any questions?