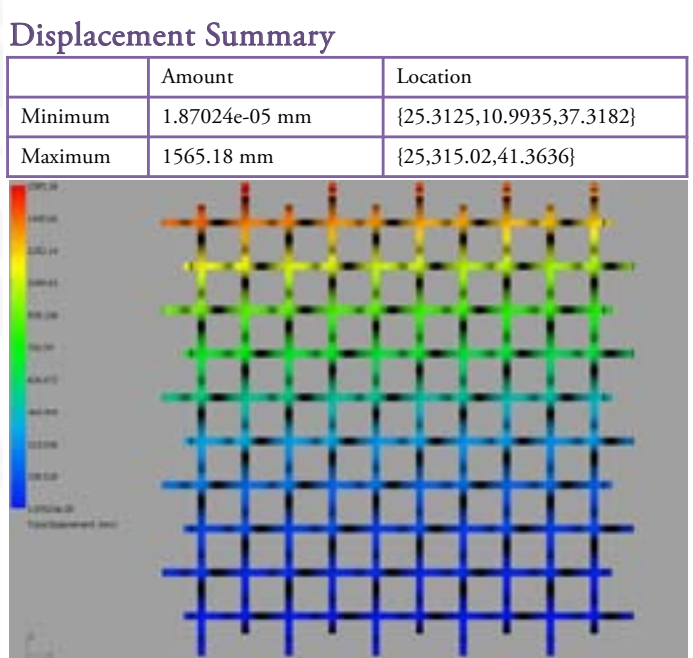


# BENDING ARC

## Parametric Design Optimization and Digital Fabrication for the Units of Dynamic Surfaces

### □ *Process Flow*

1. Select the material and value (adjust partial curvature and thickness...).
2. Adjust the parameters with Grasshopper , and output 2D graphics.
3. Process acrylic elements with the laser cutting.
4. Embed flat elements into a cross fixture holder to form modular matrix unit.
5. Multiple modular matrix units can be assembled into large-sized surface.
6. Use fastenings or screws to fix the position and angle.



### Materials

used for the  
8'W x 8'T x 2'D partition

#### 1. Polymer:

Acrylic plates (5mm thick)  
– two pieces of 5' x 10' and  
one piece of 4' x 4'

#### 2. Fabrics:

A bundle of 60-pound  
nylon line (mesh type)

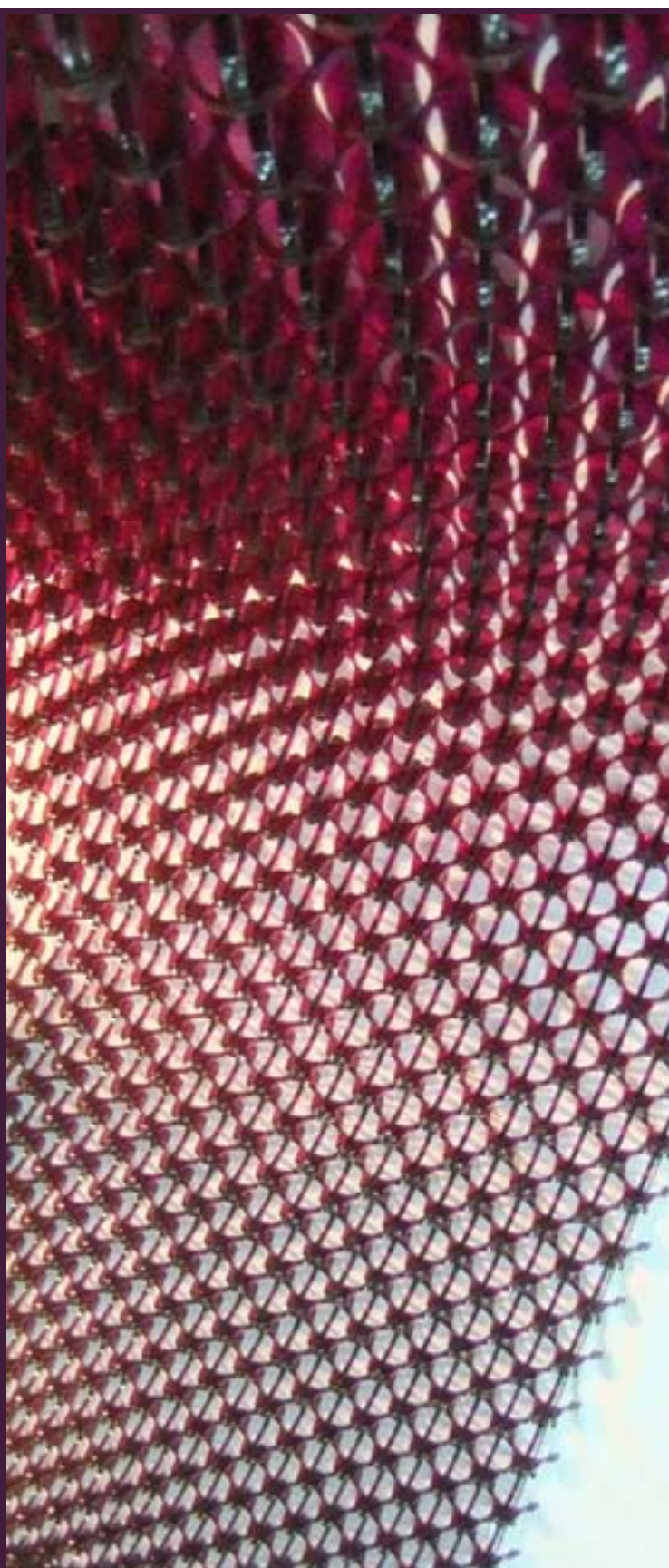
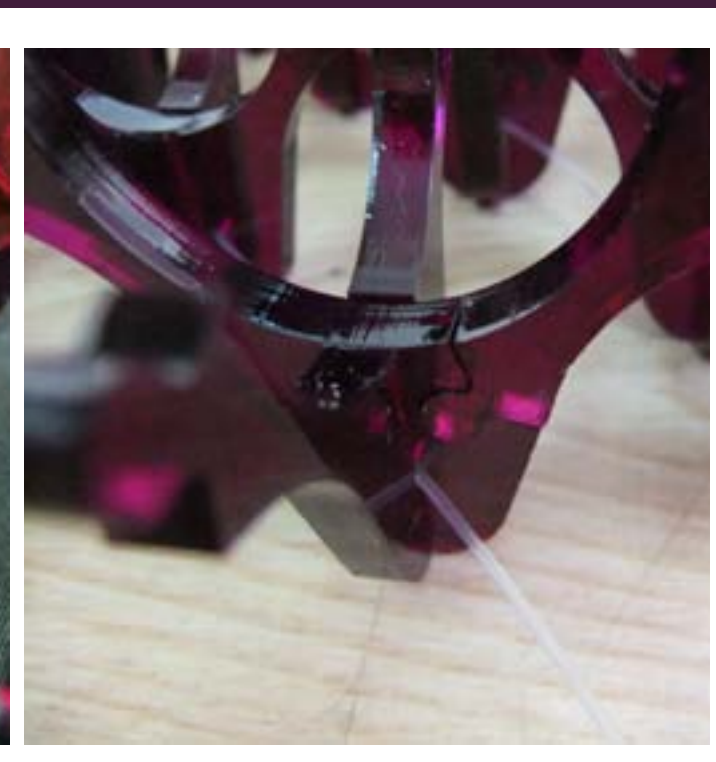
#### 3. Alloys:

Steel cable of 5mm thick,  
36' long.

## Modularized Extension Mechanism

### □ *Technical Features*

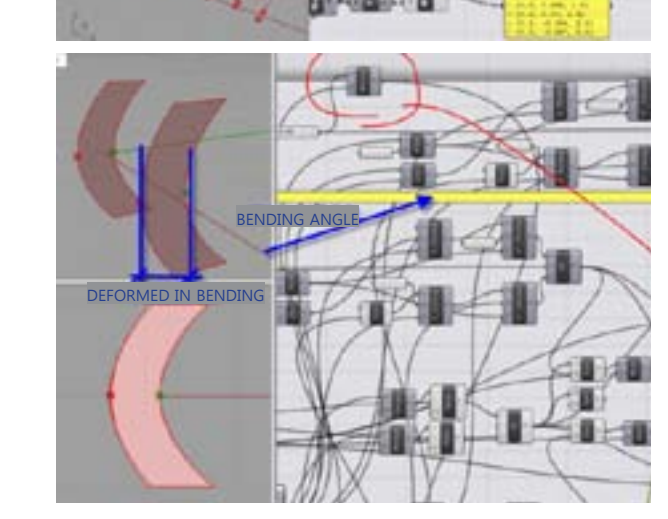
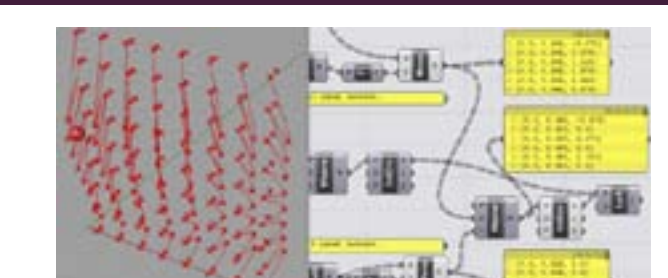
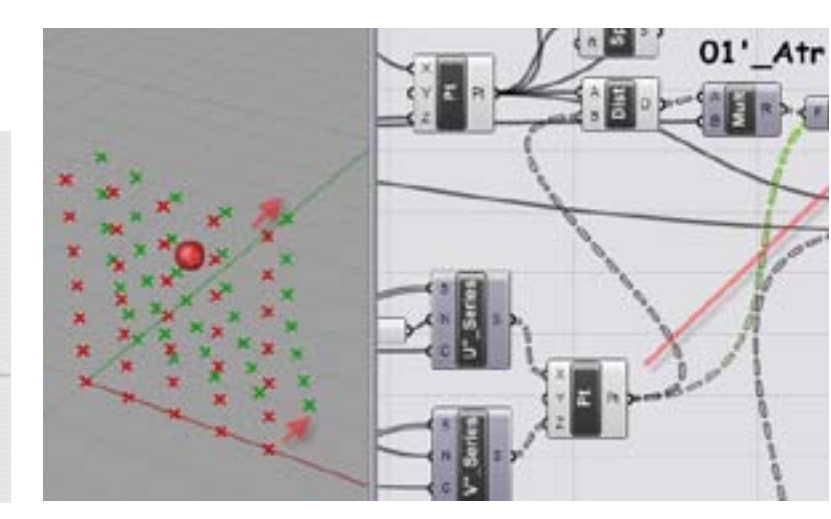
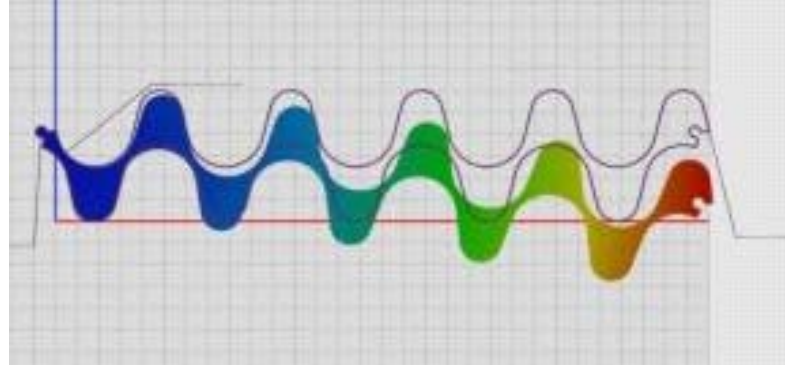
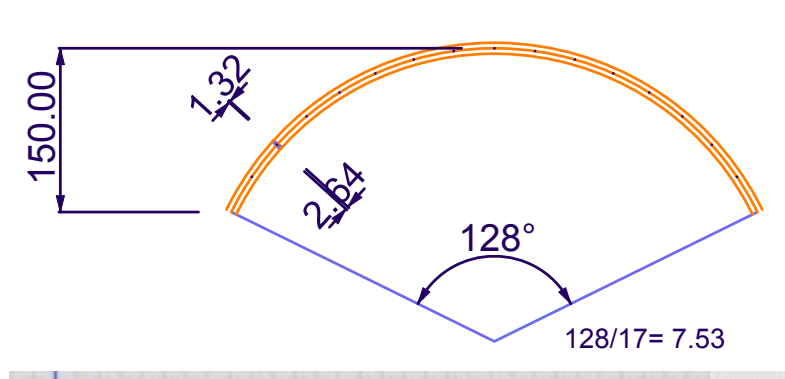
1. Relations of Modules  
Small (1' \* 0.2' arc element) /  
Medium (1' \* 1' \* 0.2' modular matrix unit) /  
Large (N' \* N' \* 0.2' curving surface).
2. With latches on the edges of modular matrix units  
interlocked to one another, it allows continual  
assembly for extension in four directions.
3. The modules can be fixed on the ceiling or wall, or  
assembled in a modeling framework, to compose a  
structure of curving surfaces.



## Material Attributes and Parameterization

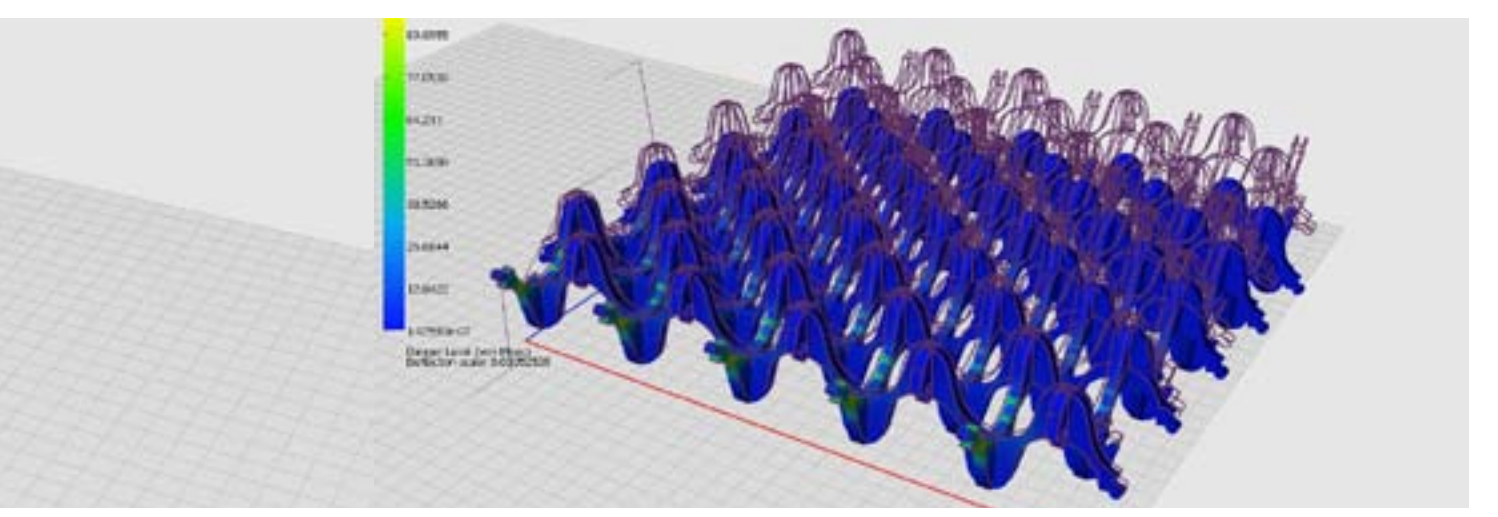
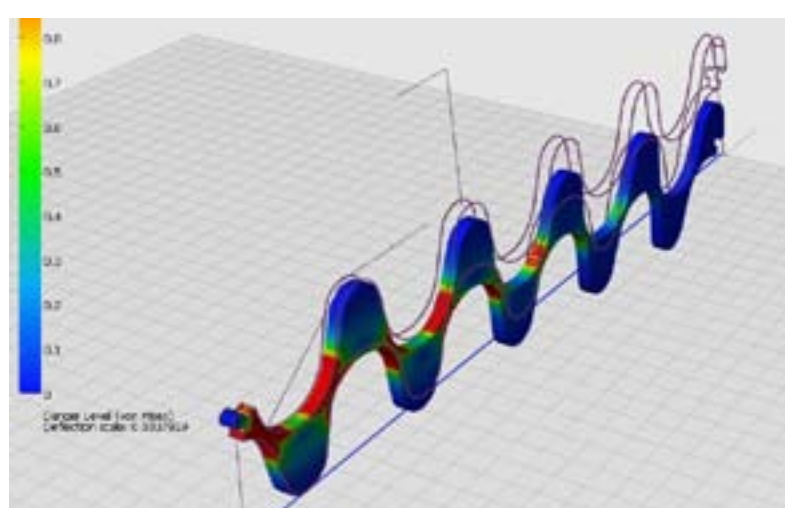
Parameters

1. Criteria Setup :  
A decision on material coefficient, thickness and  
colors.
2. Values :  
Adjust the module's size, quantity, bending angle and  
stress-bearing value
3. Digital Manufacturing :  
Permute the elements into the processed drawings that  
fit the material size

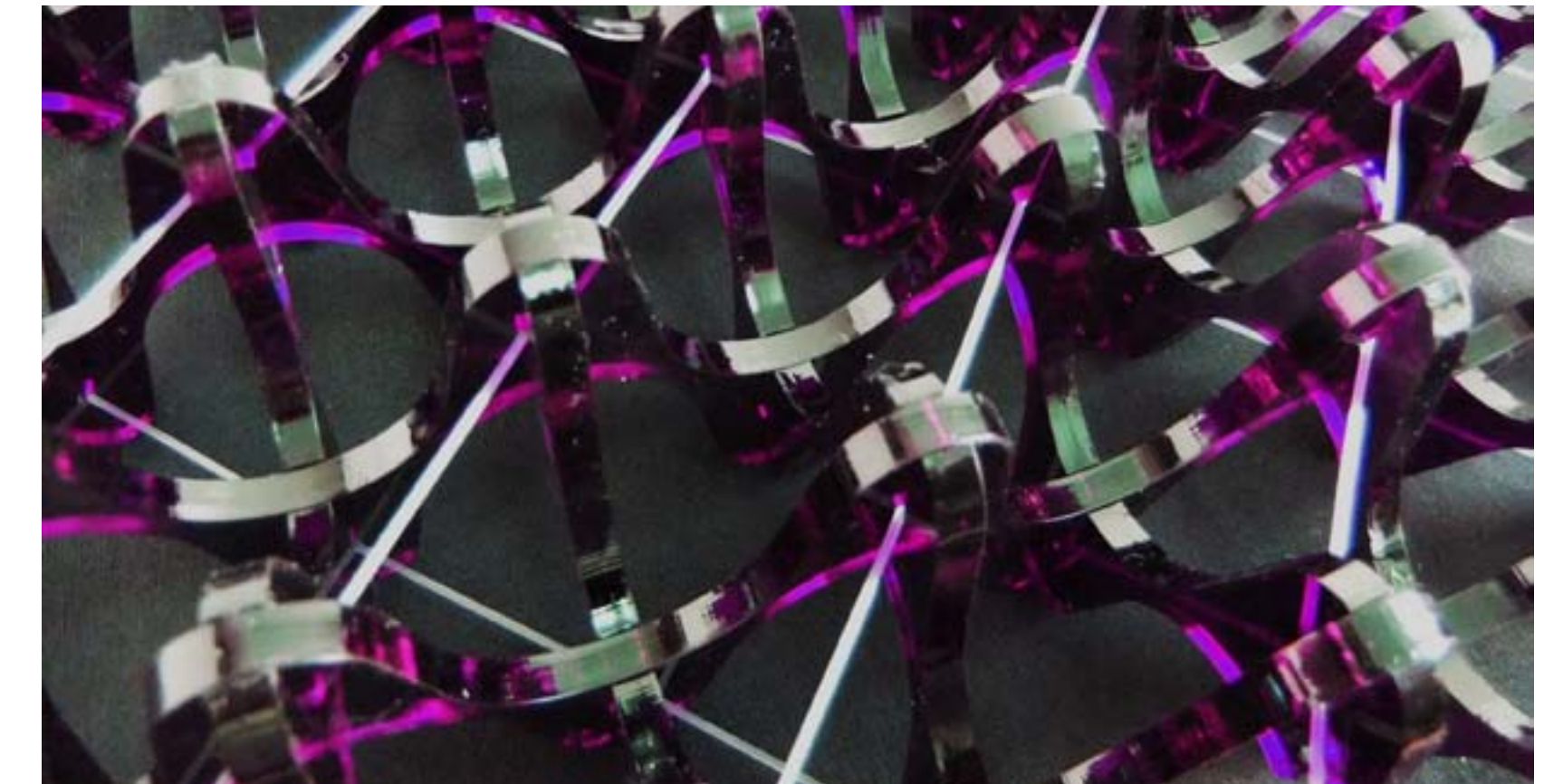
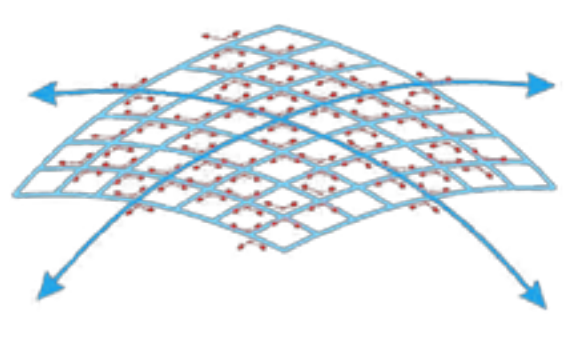


## Structural Features

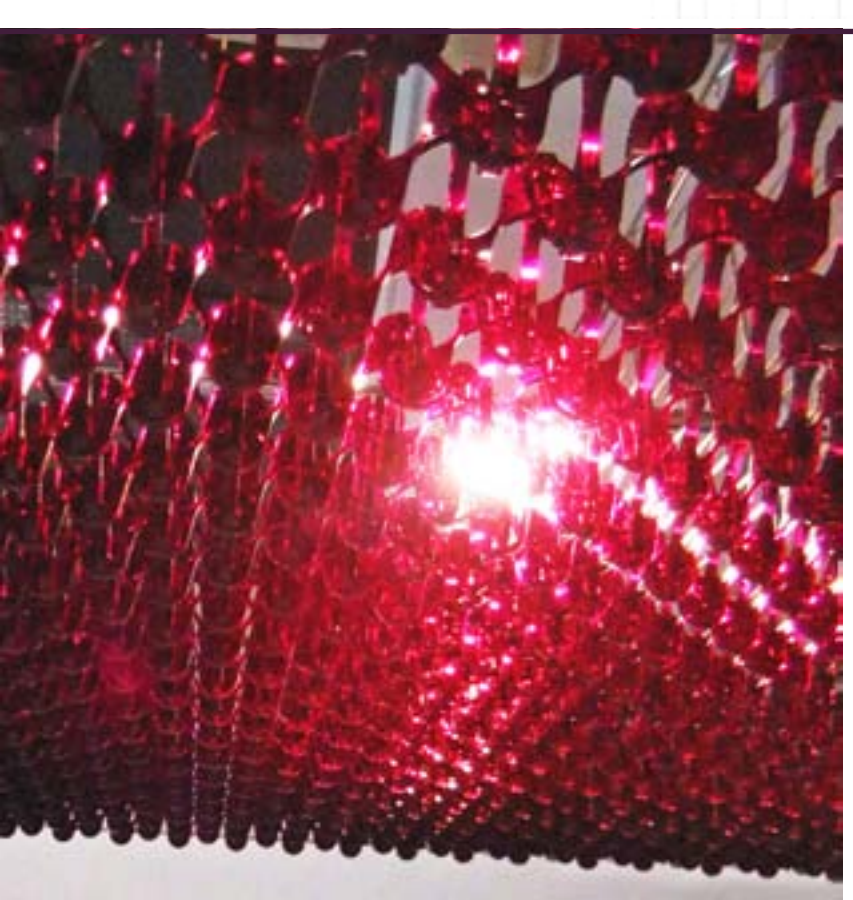
1. Collective Structure  
The flat element after stress can be deformed and  
stretched, but its structure will be broken (left).  
Consequently, when it is composed into a unit (right),  
the stress will be distributed to the surrounding elements,  
which nevertheless reinforces the overall strength.



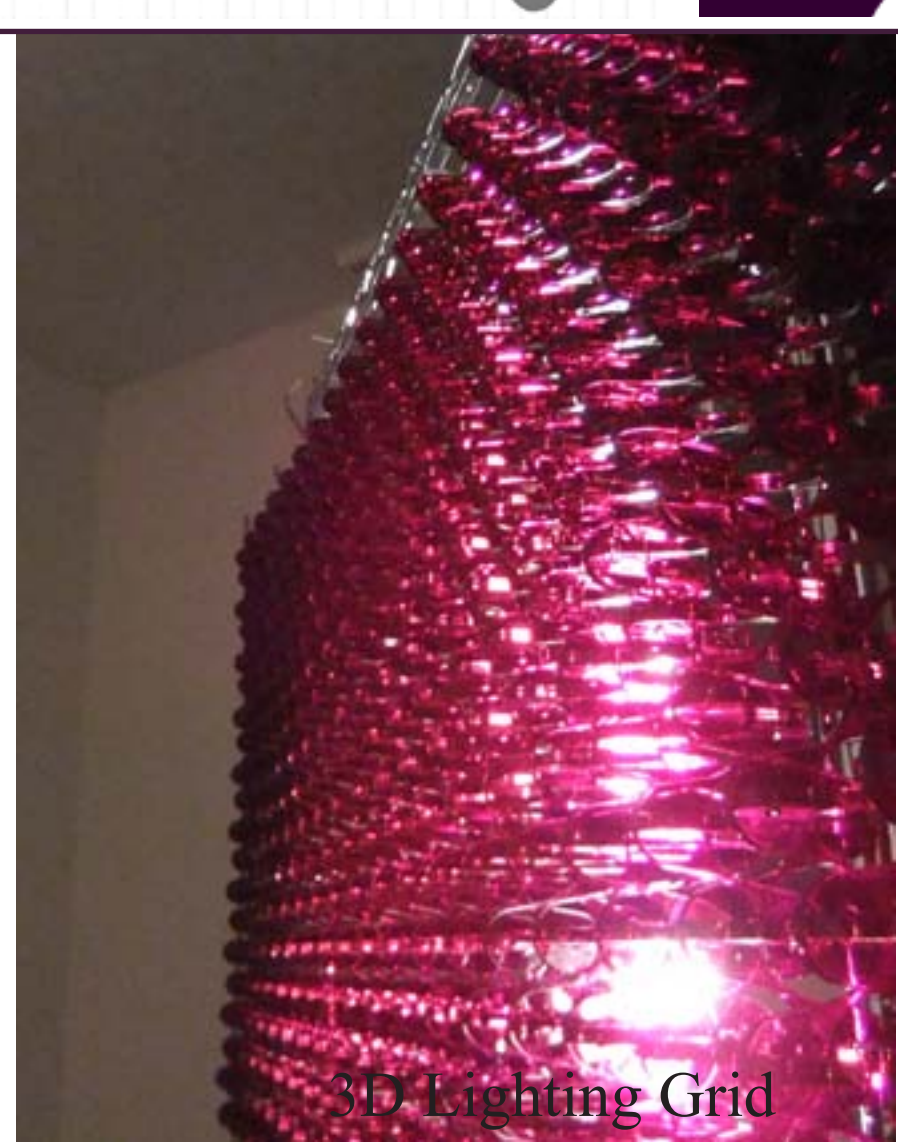
2. Structure System  
Every 1' \* 1' unit is composed of 20 flake-shaped  
elements inter-woven, which uses grid arrangement  
to evenly distribute the stress, and also preserve the  
material ductility.



When the modular matrix  
extends into a larger curving  
surface, piercing through  
obliquely interleave-woven  
elastic mesh made with a  
special latch, an anti-shear  
force stratified structure can be  
formed.



Ceiling Backlight



3D Lighting Grid



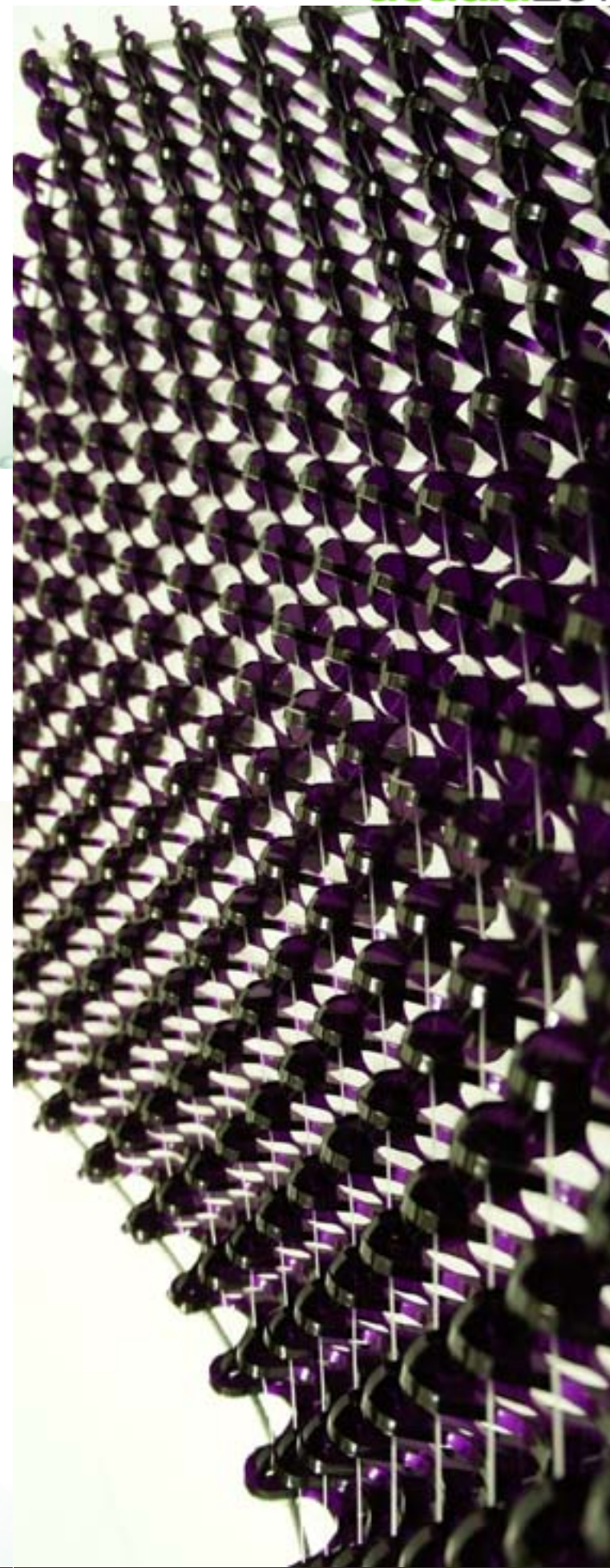
Outdoor Theater Awning:  
Providing Acoustic /  
Resist Visual and Light



Stylish Visor / Sound Absorbing Panels

### □ *Applications*





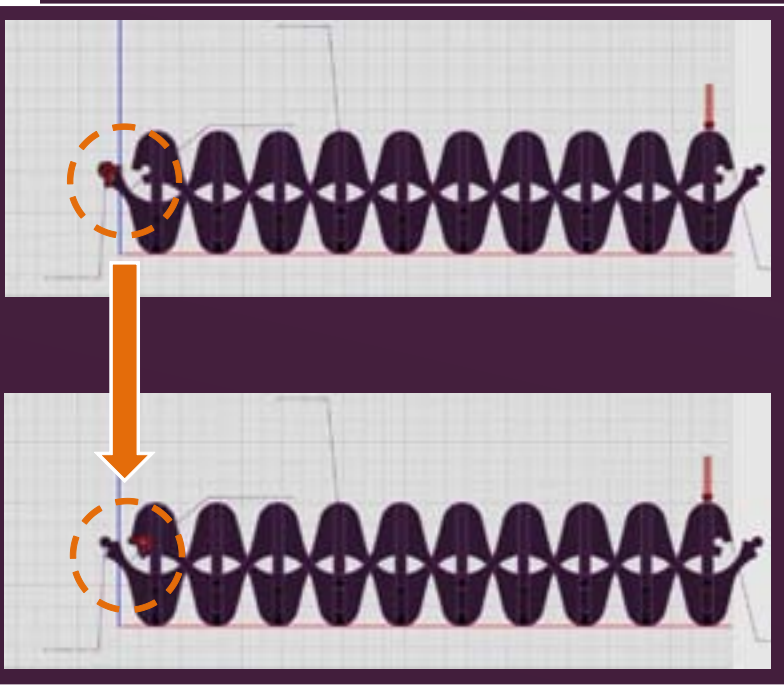
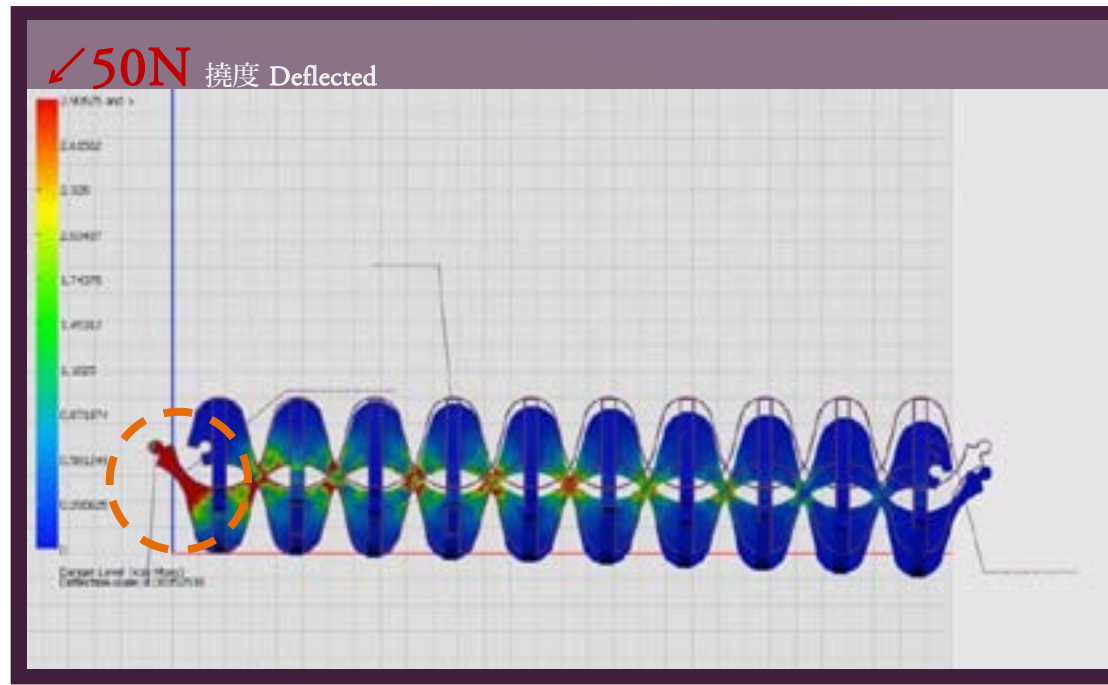
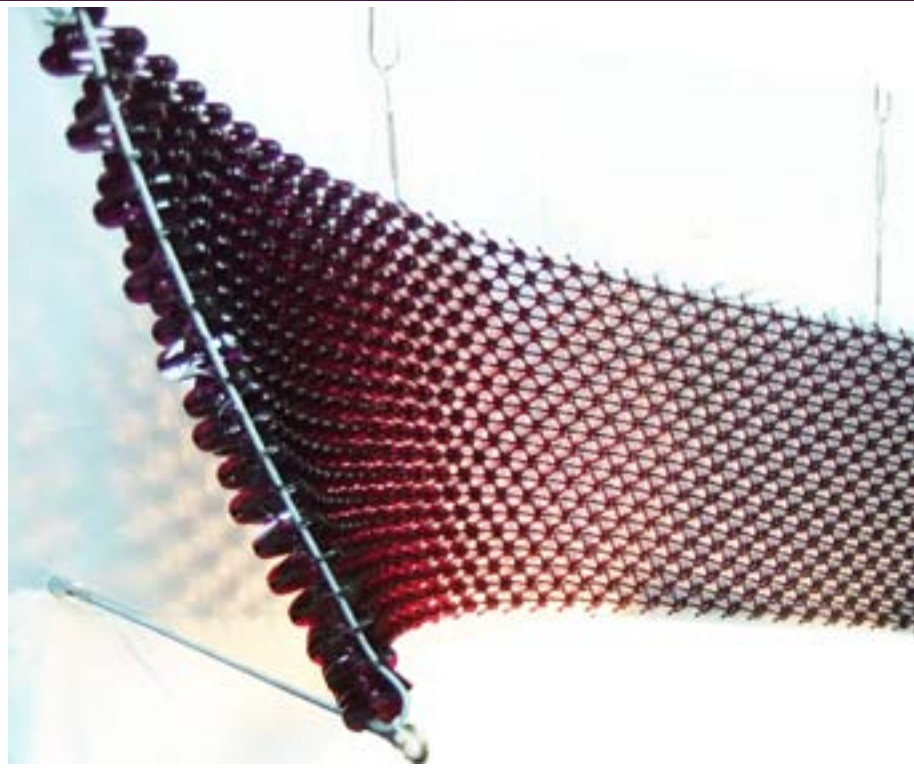
# BENDING ARC

Parametric Design Optimization and Digital Fabrication for the Units of Dynamic Surfaces



## Fixing

1. Use 2 to 4 fastenings to fix at the surrounding steel cables, and adjusting the buckling or hanging positions can change the curving surface style.
2. Partial topology deformation can be made by using nylon lines to inter-fasten on the nylon mesh.



## Manufacturing

Calculate the unit deformation scale out of 0.5' upper and lower bending amplitudes, and adjust about 1' \*0.2' radian of the plate element, to form an approximate 1' \*1' \*0.2' modular unit.

Modules are assembled with latches, and a 60-pound nylon line was used to thread through the middle of the latches, to constitute an anti-shear force bendable curving surface. By way of backlight, curving angle and hanging control, a variation of light reflection effects from acrylic can be observed.

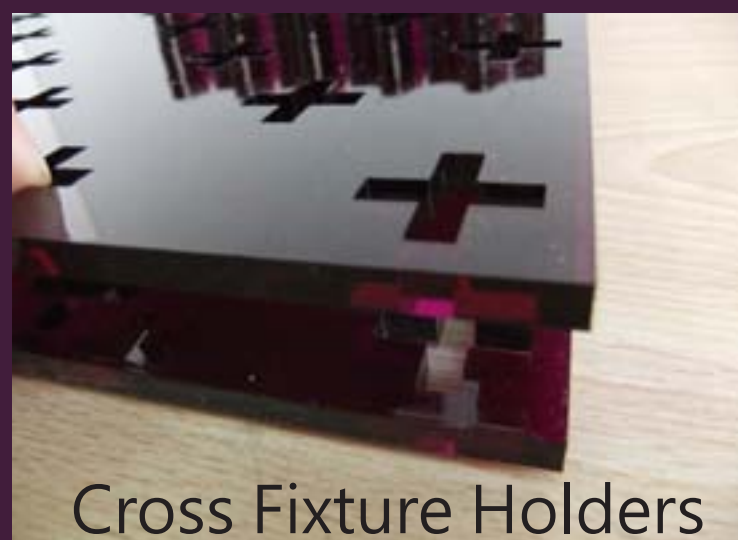
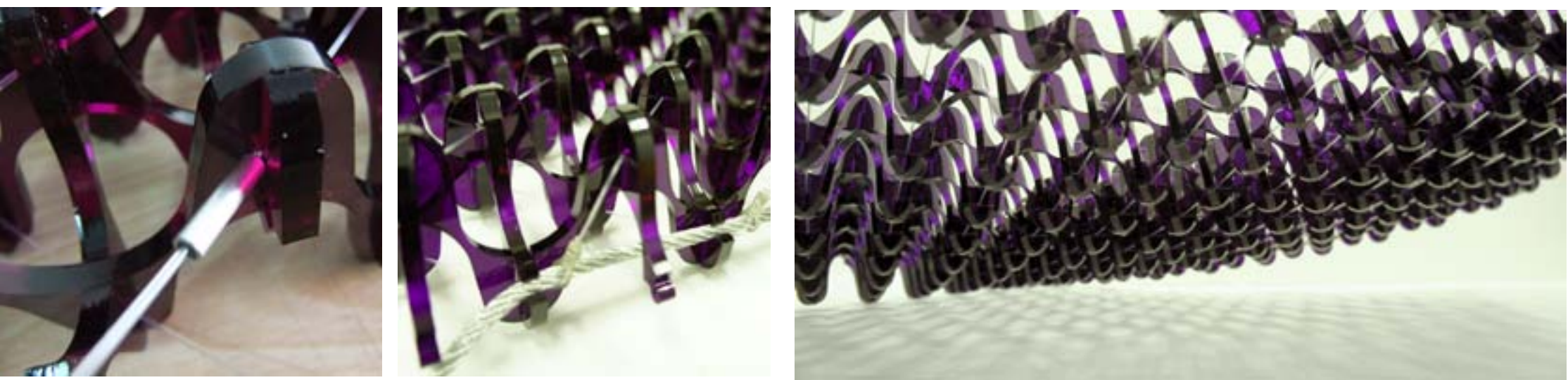
### 1. Digital Manufacturing

- A."Laser Cutting": Elements with different thickness can be customized to form units of different curving amplitudes.
- B."Thermoforming": Modularized framework system can be used for mass production.

### 2. Assembly of Units

- A. Vertically inter-embed flat elements into cross fixture holders.
- B. Pull off the fixture holder in the lower layer, and the press down the fixture holder on the upper layer to rip it off the mold.

One unit assembly takes about 2.5 minutes.



Cross Fixture Holders

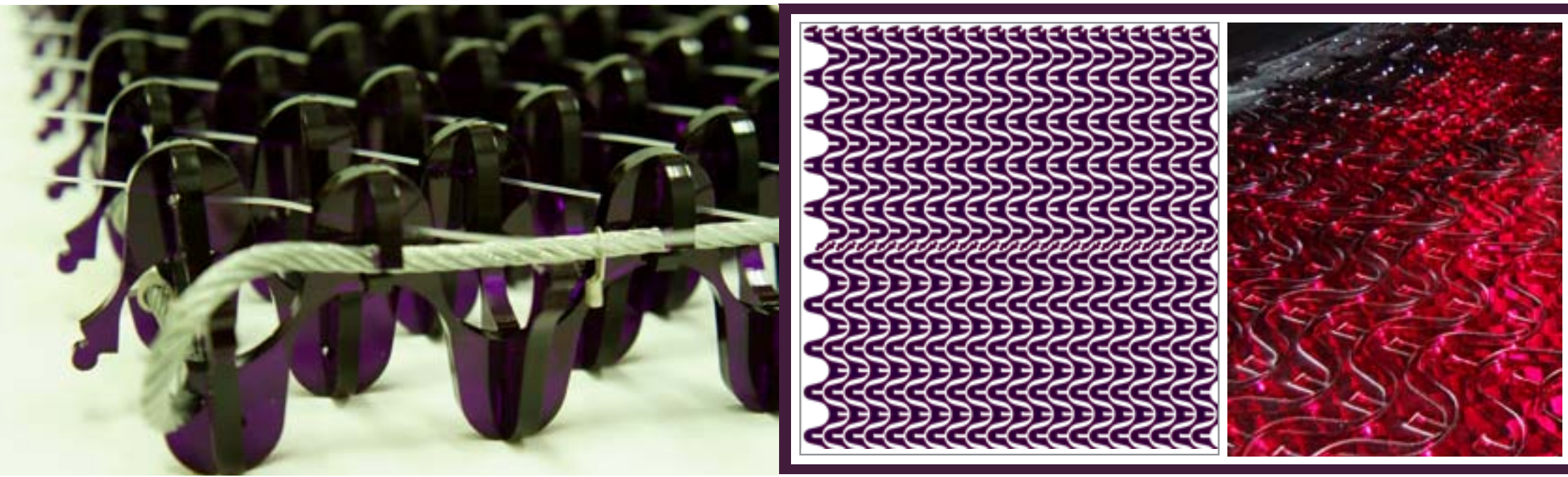


figure1 (left)  
Adjust for different curving quantity and material thickness, print out the graphics, and make another different modular matrix unit.

figure2 (left)  
One 2' \*2' acrylic plate can produce 40 arc elements (total processed area is 319 in<sup>2</sup>).

## Extension/Assembly of Modules

1. Based on structural analysis, adjust the round latch to the side of the circular arc.
2. Permute latches on the front side and back side alternately.
3. Interlace units and place them in the same plane.
4. Inter-embed the latches on the front and back of two units.
5. Thread the 5mm steel cable through the circular holes around the curving surface and fix the cable.
6. Thread the fixed-length nylon lines one by one through the circular holes of the upper interlocked latches.
7. Wind the nylon line around the steel cable, and pierce it in a 90 degrees angle through the circular holes in the lower layer.

