PORTFOLIO

Introduction to 3D Modelling and Parametric Design [ART801]

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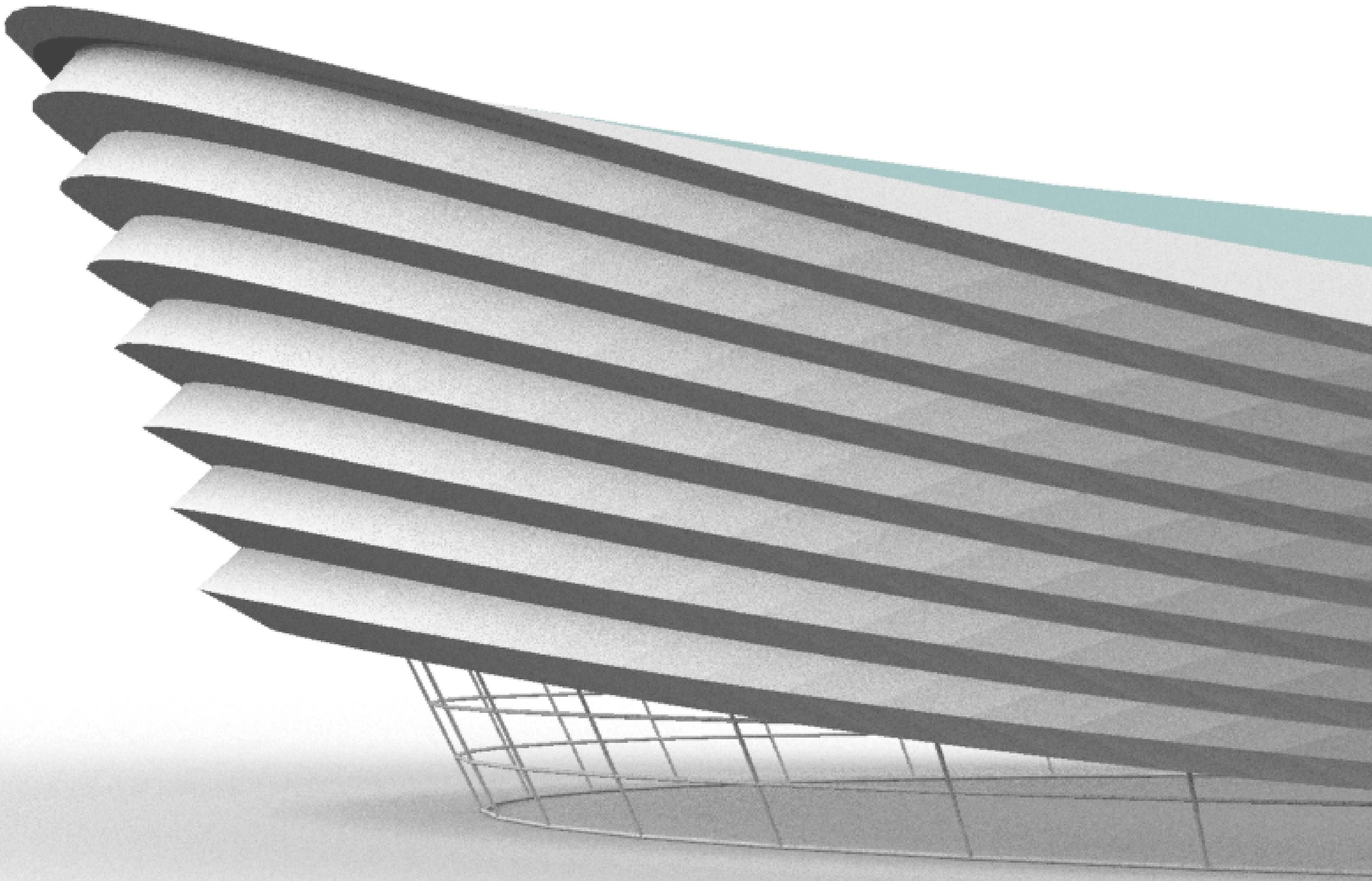
INTRODUCTION

The portfolio presents a more efficient and efficient method for designing parametric structures. As we know, creating parametric models can be a challenging and a time-consuming task.

This portfolio demonstrates the use of a tool like Grasshopper, which allows for easy computation of data and provides the user with complete control over the design process. The ability to modify any parameter, even in the initial stages, enables the user to easily transform the design as desired.

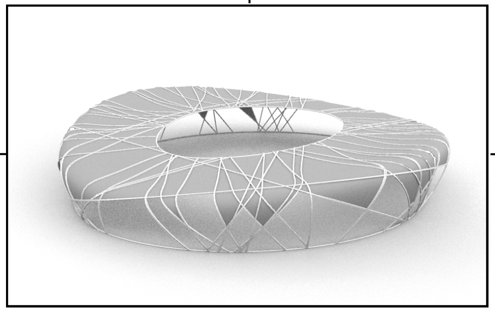


It displays various designs developed entirely using Grasshopper for Rhino, where the control points have been fully utilized. The portfolio illustrates how the design evolves and adapts with different iterations when changes are made to a minimal number of control points.

Additionally, the portfolio focuses on the niche theme of stadiums, showcasing various designs that demonstrate the capabilities of Grasshopper and parametric design methods in creating unique and innovative solutions for this specific building type.

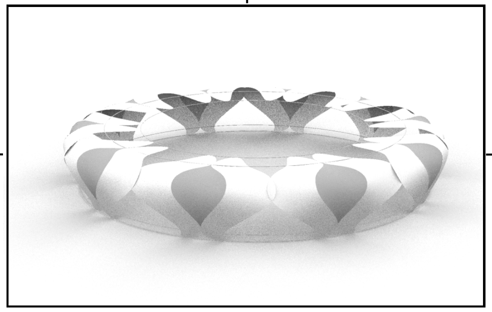
Beijing Stadium

Undulating curves and a randomized geometry on the facade



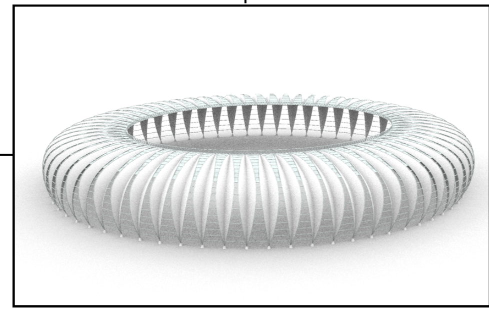
Hangzhou Olympic Stadium

Creating a more controlled geometry on the facade



Estadio Beira-Rio

Using knowledge from the previous project in a more complex form of geometry



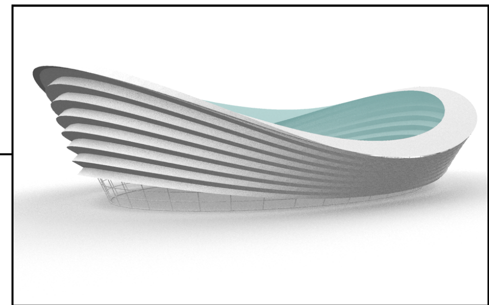
This process demonstrates the chronological sequence in which the structures were created, highlighting how learnings from each previous stage were applied to inform the design of the next one.

AT A GLANCE

AT A GLANCE

Al Wakhra Stadium

This structure utilizes the concept of the previous structure in a more intricate geometric design.



Wanda Velodrome

The method used in previous projects relied on the creation of curves, but was enhanced by the additional use of graphs

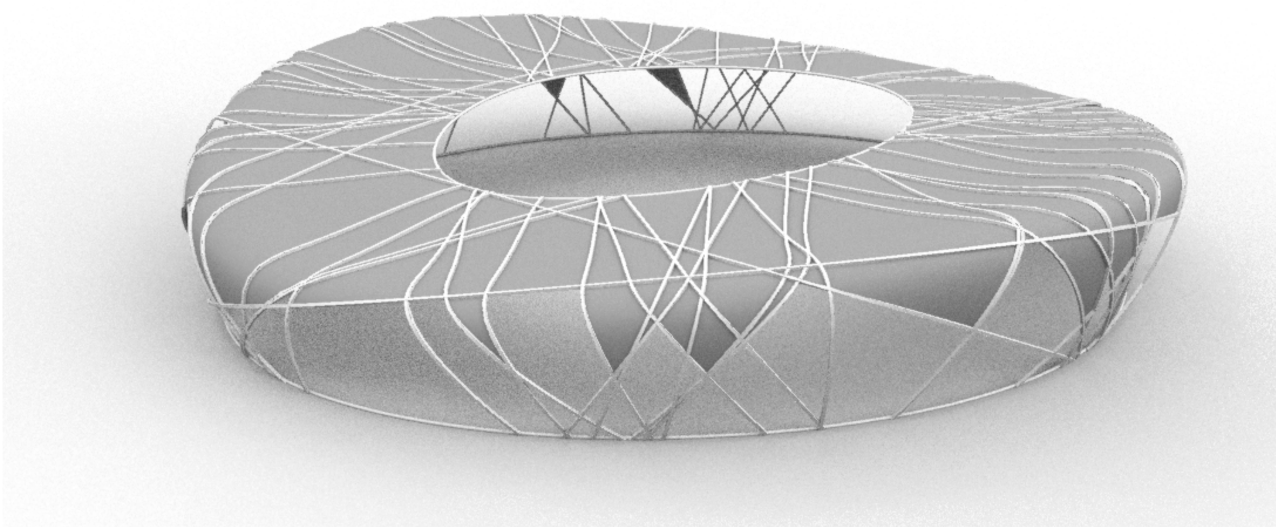
BEIJING NATIONAL STADIUM.

Establishment Date: 28 June 2008
Also known as the "BIRD'S NEST" due to the web of twisting steel sections that form the roof.
Location: Beijing, China
Architect: Herzog & de Meuron

The innovative structure was designed by Herzog & De Meuron Architekten, Arup Sport and the China Architecture Design and Research Group, and has been nicknamed the "bird's nest" due to the web of twisting steel sections that form the roof.

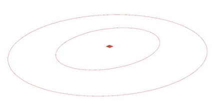
The process of generating the structure's identity, the intricate and dynamic pattern on its facade, was accomplished through the use of parametric design techniques in Grasshopper. To achieve this, the 3D populate component was utilized to randomly distribute points on a circular geometry. These points were then projected onto the previously created lofted surface, using the Brep Plane component.

This projection created a series of intersecting lines on the surface, resulting in the randomized pattern seen on the facade. By using parametric techniques, the design is able to respond to different inputs, such as changes in size or geometry, and adapt itself to the specific needs of the project. This level of control and flexibility allows for greater design exploration and experimentation, resulting in a unique and dynamic structure.

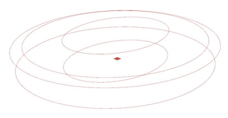


BEIJING NATIONAL STADIUM.

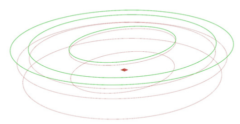
Grasshopper Script
https://me-qr.com/data/image-pack/44909480



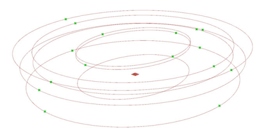
Step 1:
Create two ellipse with radius 67, 90 and 142, 155 respectively



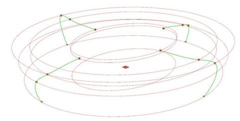
Step 2:
Move the ellipse to form the curves with help of the section of the stadium



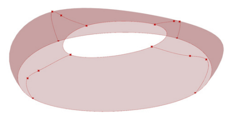
Step 3:
Since the curves on opposite sides are varied, create another set of ellipses to make the other section



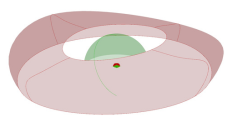
Step 4:
Select points on the curves using point on curve



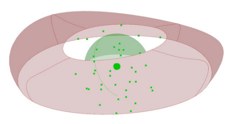
Step 5:
Interpolate all the related points to form the section



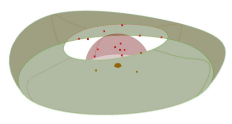
Step 6:
Loft the sections



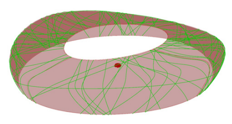
Step 7:
To Create the Pattern on the Facade, start by creating a a sphere which will act as the base geometry



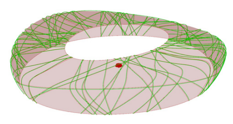
Step 8:
Populate the geometry with points using 3D populate component



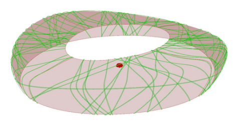
Step 9:
Offset the surface by 0.9



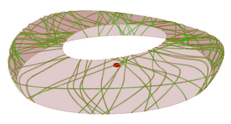
Step 10:
The pattern will be projected on the loft



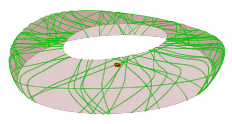
Step 11:
Offset the projected pattern



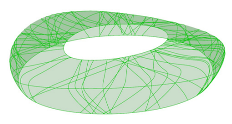
Step 12:
Loft the Offset curve with the projected curve to give it thickness



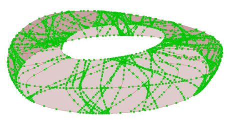
Step 13:
offset the surface to give it a 3rd dimension



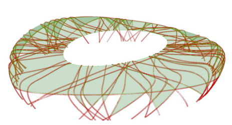
Step 14:
Weave all the lofts together



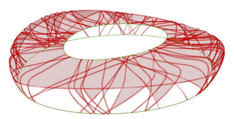
Step 15:
Split the curve to create the panels



Step 16:
Divide the curves that were split in the previous step

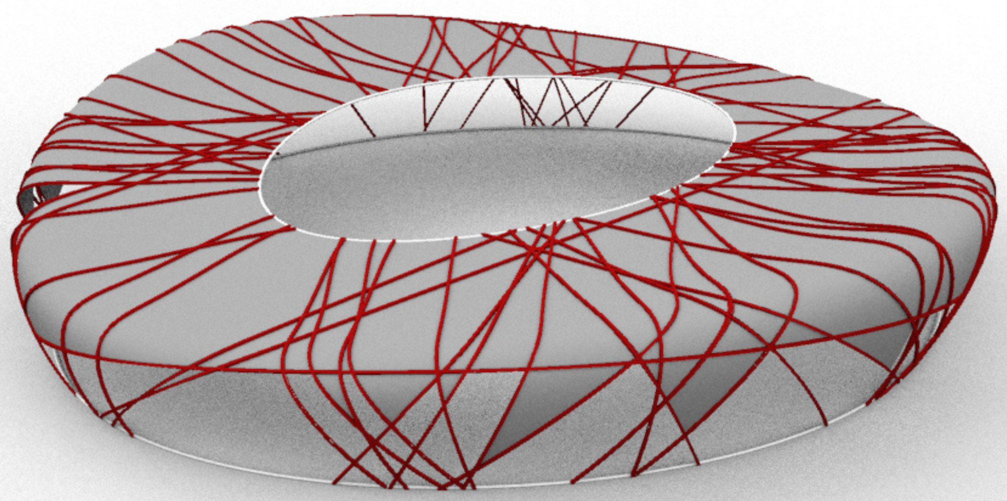


Step 17:
Make use of the average and larger than component to the height of the stadium cull the patterns wanted

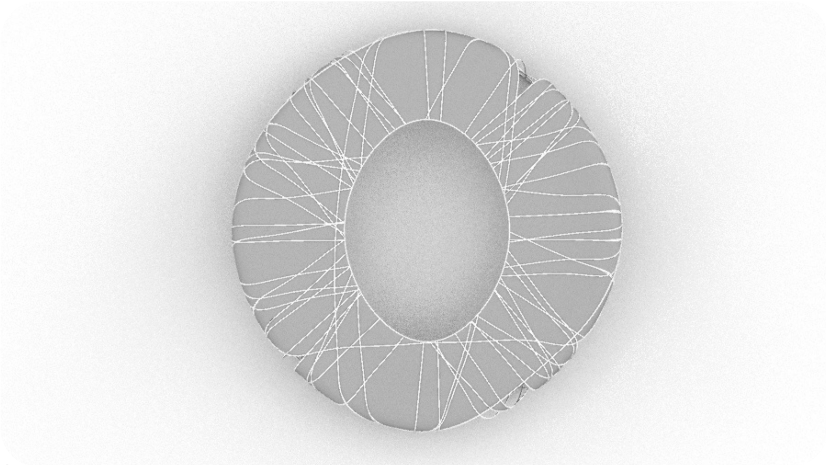


Step 18:
Cull the unwanted panels

Step 19:
Add the details wanted like the pipe component and the custom preview component to give the curves at the base and the top a thickness and customize the design.

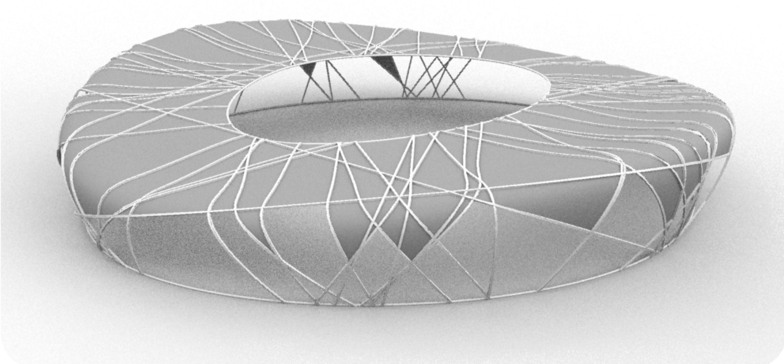


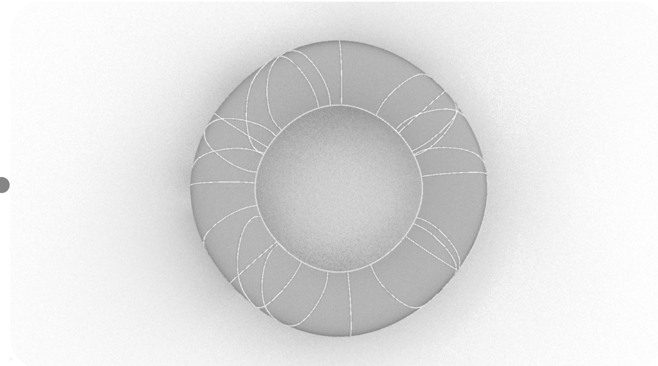
BEIJING NATIONAL STADIUM.



BEIJING STADIUM

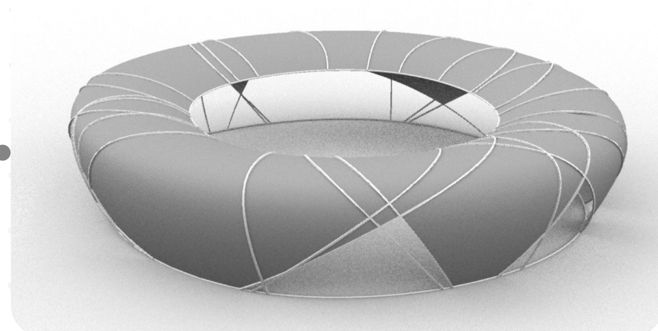
NO. OF LINES: 40
LINES MOVED USING 3 NUMBER SLIDERS

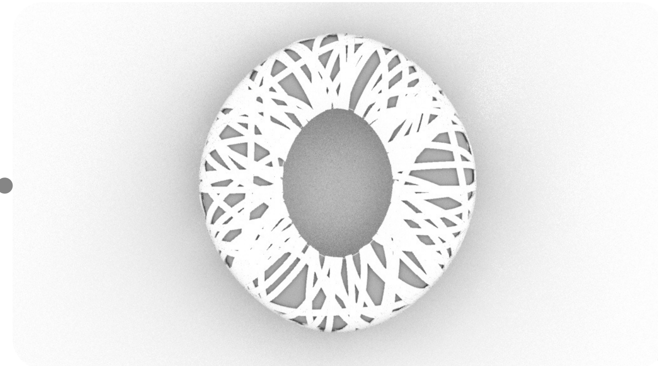




ITERATION 1

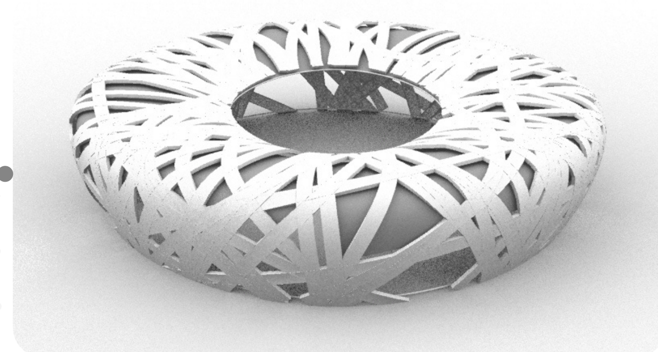
NO. OF LINES: 10
LINES MOVED USING 3 NUMBER SLIDERS





ITERATION 2

NO. OF LINES: 60
THE THICKNESS OF THE PROJECTED LINES INCRESED

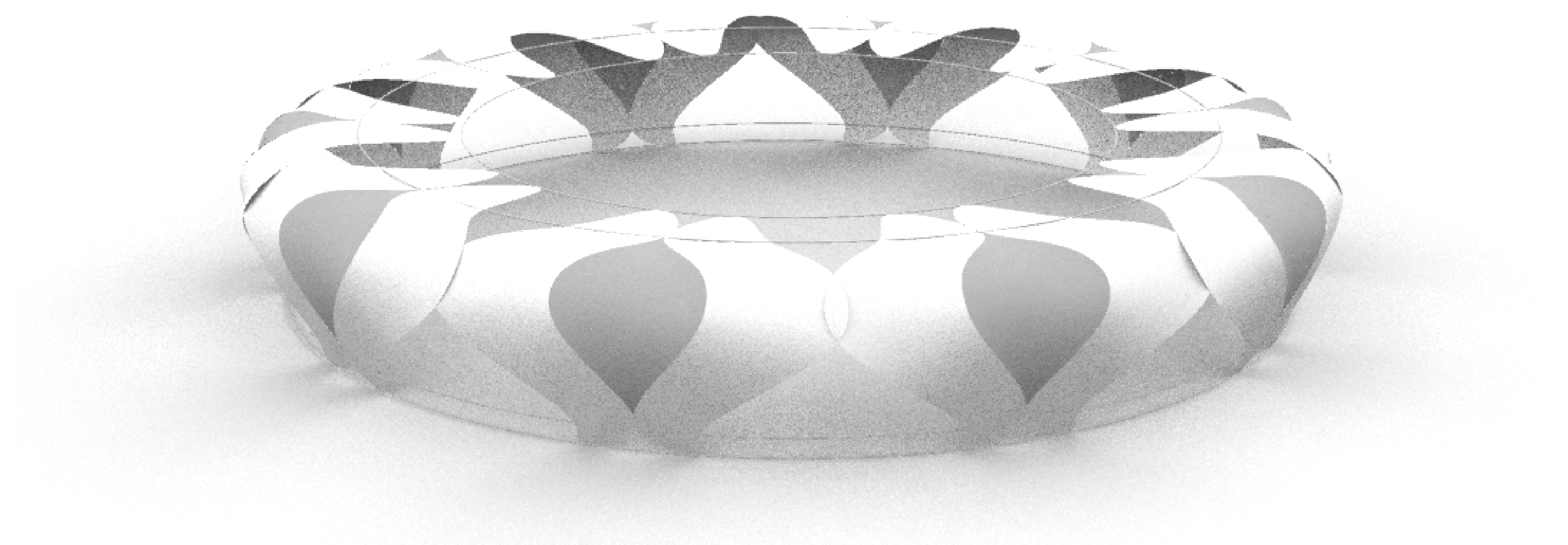


HANGZHOU OLYMPIC STADIUM

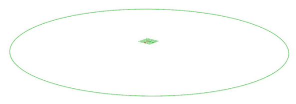
Establishment Year: December 2018
Also known as the 'BIG LOTUS'
Location: Binjiang District, China
Architectural Firm: NBBJ, in partnership with CCDI

The design of the Hangzhou Olympic Stadium is unique and modern, featuring a large circular opening at the top of the structure that allows natural light to flood the interior. The stadium's circular shape is intended to symbolize unity and continuity, while the opening at the top is meant to represent the connection between the stadium and the surrounding natural environment.

The Hangzhou Olympic Stadium was designed using parametric techniques in Grasshopper. Simple components such as Divide Curve, Cull, and Interpolate were utilized to create the initial leaf-like elements on the facade. The geometry was then shifted on a circular path with the aid of the Shift Data component and a series of control sliders, which allows the user to adjust the number of leaf-like patterns on the facade, increasing or decreasing them as desired. This use of parametric design not only allows for greater design exploration and experimentation but also gives users the flexibility to adjust the design according to their needs.

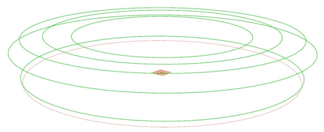


Grasshopper Script
https://me-qr.com/data/image-pack/44909606



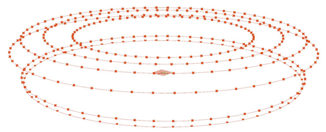
Step 1:

Create a circle of radius 75



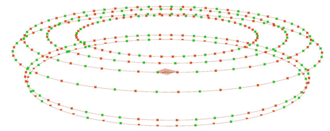
Step 2:

Move the circles as desired to create the section



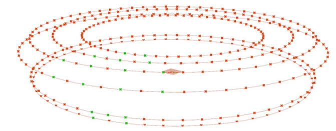
Step 3:

Divide the Curve



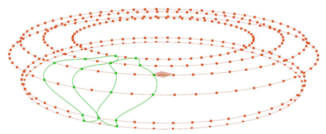
Step 4:

Cull the Points not needed and dispatch two separate lists



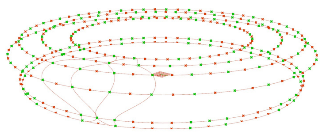
Step 5:

Select and Merge the points needed to form the pattern in correct order



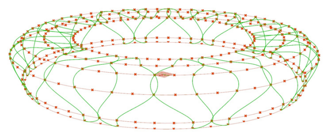
Step 6:

Interpolate them



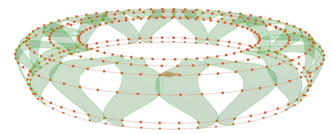
Step 7:

Create a shift component to shift the point to the next part and place a series component to control the number of shifts



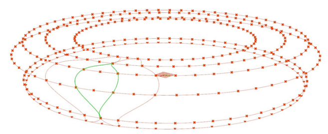
Step 8:

Interpolate them



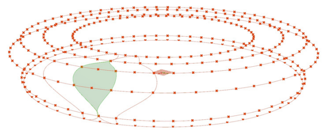
Step 9:

Loft or Patch the interpolated curves



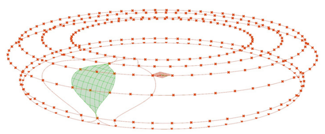
Step 10:

To form the Glazing. split the inner two curves



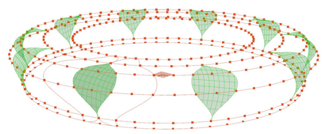
Step 11:

Patch the two curves



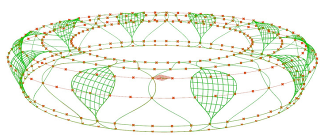
Step 12:

Rotate and copy them using array curve



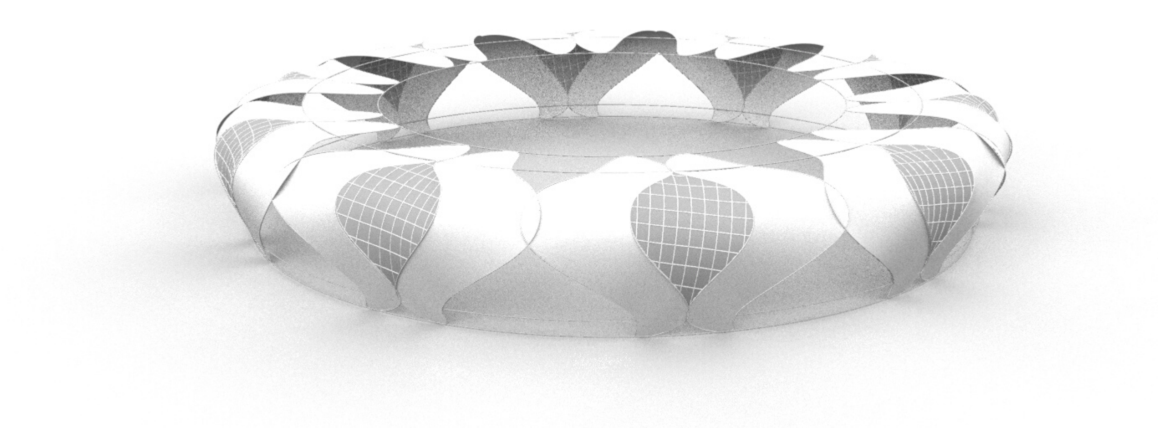
Step 13:

Extract the face of the glazing



Step 14:

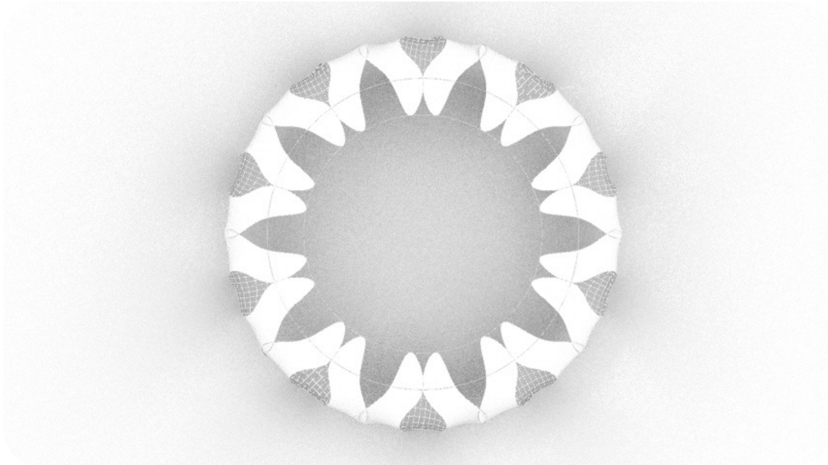
Create panels using Lunchbox's Quad surface



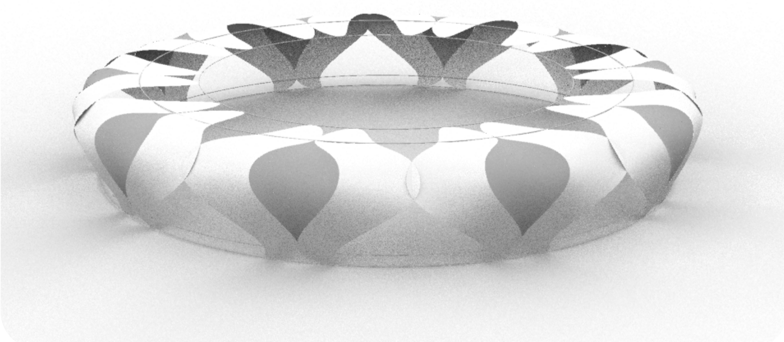
Step 15:

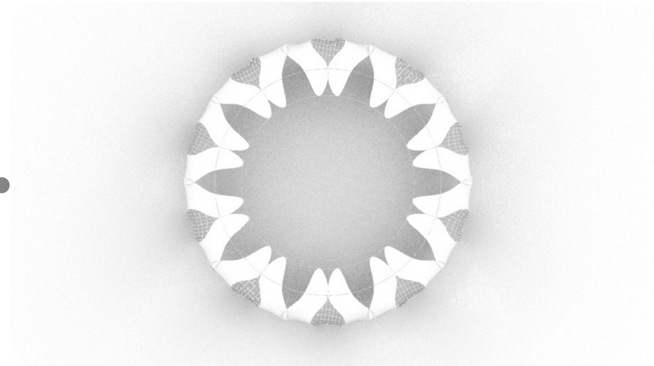
Add the details wanted like the pipe component and the custom preview component to give the curves at the base and the top a thickness and customize the design.

HANGZHOU OLYMPIC STADIUM

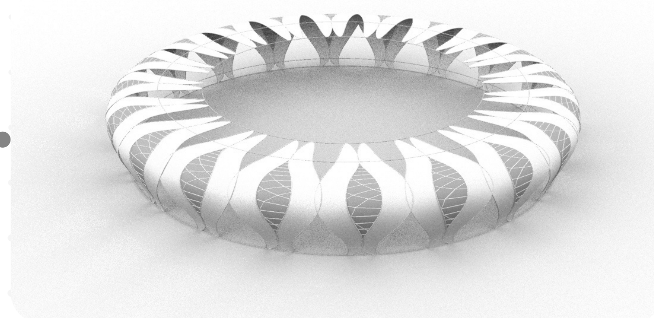


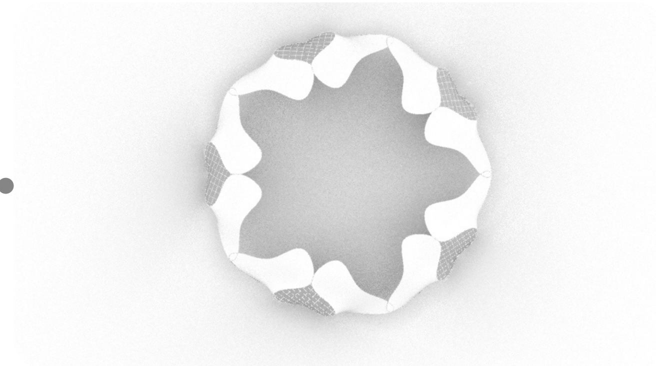
HANGZHOU STADIUM
NO. OF LEAVES: 10
RADIUS: 75
MOVED ELLIPSES:
(22.3,23.6,23,2,17,3)



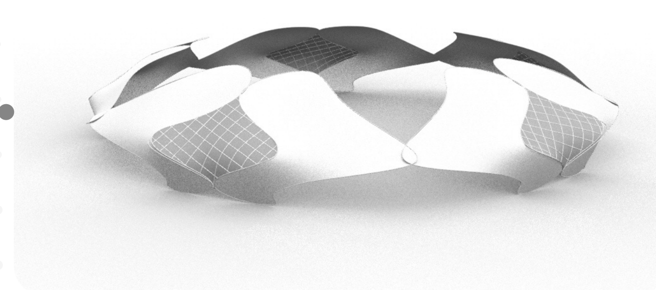


ITERATION 1
NO. OF LEAVES: 20
RADIUS: 75
MOVED ELLIPSES:
(22.3,23.6,23,2,17,3)



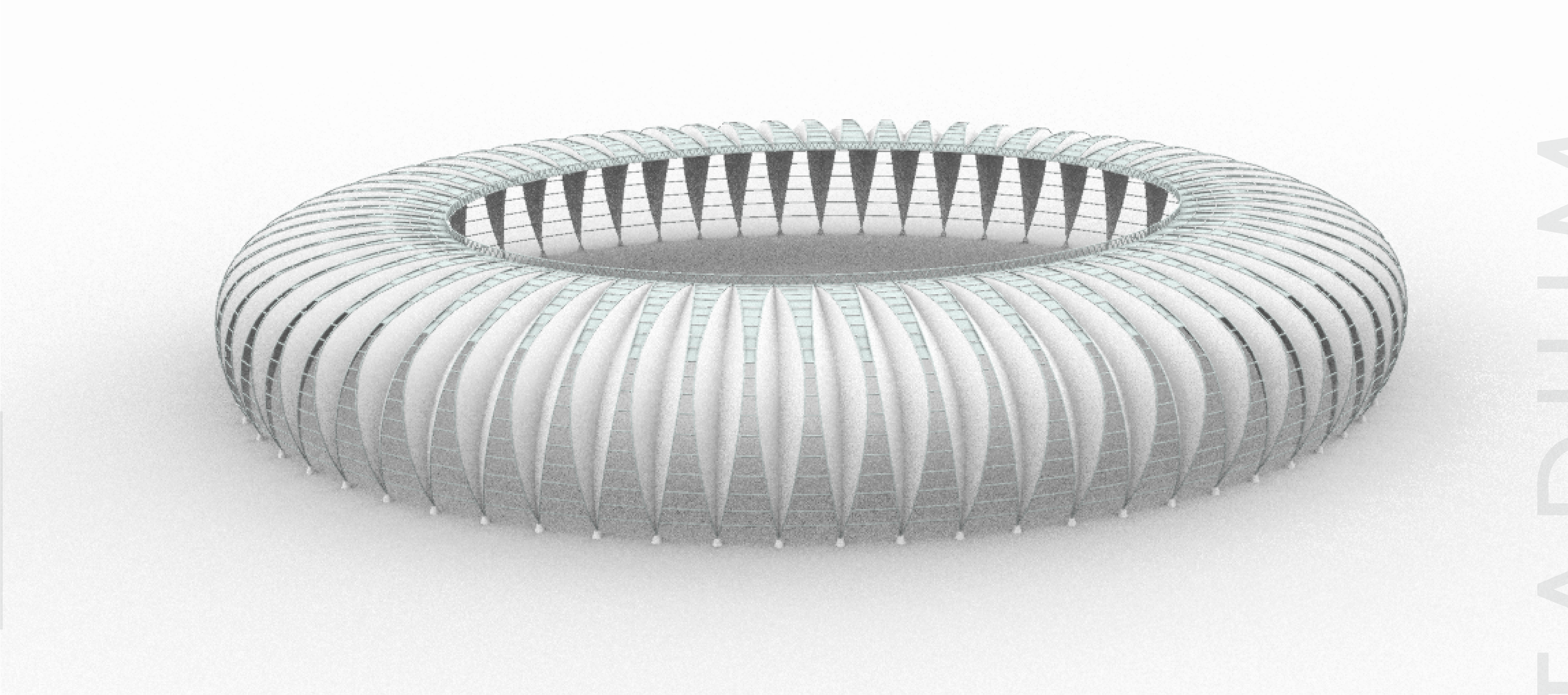


ITERATION 2
NO. OF LEAVES: 5
RADIUS: 75
MOVED ELLIPSES:
(28,23.6,15,12,3)



BEIRA-RIO STADIUM

Established in Year 1969 & was later renovated in year 2013.
Location: Brazil
Architectural Firm: Rui Tedesco
Renovated by:Hype Studio



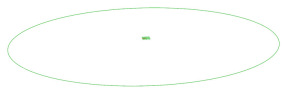
BEIRA-RIO STADIUM

The Beira-Rio Stadium, also known as the José Pinheiro Borda Stadium, is a football stadium located in the city of Porto Alegre, Brazil. It has a seating capacity of 51,300 and is the home stadium of the football club Internacional. The stadium was originally built in 1969 and underwent a major renovation in 2013, which included the installation of a new roof, new seating, and improved facilities for players and fans.

The process of creating the main fins on the facade of the Beira-Rio Stadium in Grasshopper involves the use of the software's parametric design capabilities. This means that the design can be easily modified and changes can be made quickly by adjusting certain parameters.
In this case, the main fins on the facade are created by placing planes on several points along a curve. These planes act as control points, determining the number of fins on the facade. By adjusting the number of planes placed on the curve, the number of fins can also be adjusted. If more planes are added, the number of fins will increase, and if fewer planes are used, the number of fins will decrease.
Once the planes have been placed on the curve, they are then connected as an axis, which allows them to be rotated to create a valley fold-like pattern on the facade. This valley fold-like pattern is a result of the rotation of the curves along the axis created by the planes, giving the facade a unique and interesting visual appearance.
This process allows for a great degree of flexibility and control in the design, enabling the designer to quickly make changes and explore different options, while keeping the facade in a parametric way.

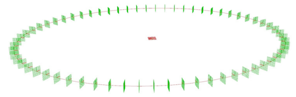
Grasshopper Script
https://me-qr.com/data/image-pack/44909566

BEIRA-RIO STADIUM



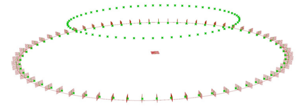
Step 1:

Create an ellipse of radius 140 and 110



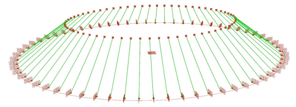
Step 2:

Place planes on the curve



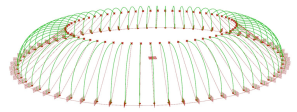
Step 3:

Create the second inner ellipse by placing point on the plan using point oriented



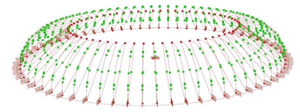
Step 4:

Joint the two points in a line



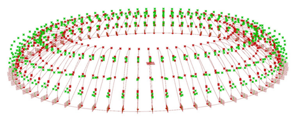
Step 5:

Do the same but this time create an arc



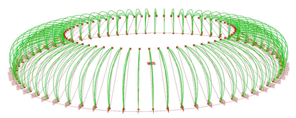
Step 6:

Place points on the line and arc



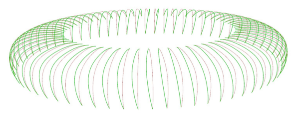
Step 7:

Move the points to the desired locations



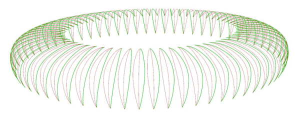
Step 8:

Interpolate them to create two separate curves to rotate



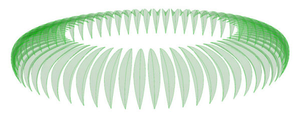
Step 9:

Rotate the first curve to the left (X direction)



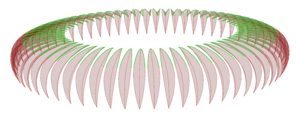
Step 10:

Rotate the second curve to the right (Y direction)



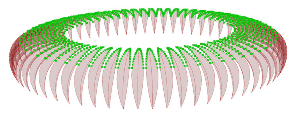
Step 11:

Loft the curves



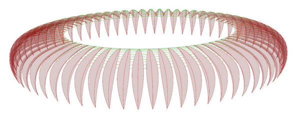
Step 12:

Split the curve to create the paneling above



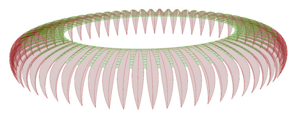
Step 13:

Divide the curve



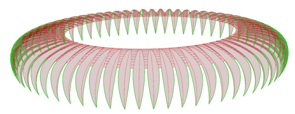
Step 14:

Join them with lines unsing line component



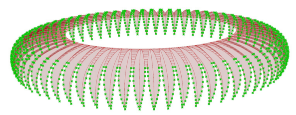
Step 15:

Loft the two curves to form the glazing



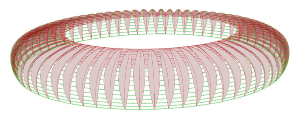
Step 16:

Select the second part of the split curve in step 12



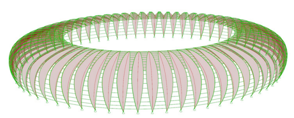
Step 17:

Similarly, divide the curve



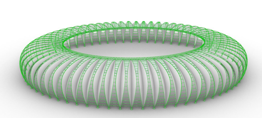
Step 18:

Similar to Step 14, join the point with a line



Step 19:

Create a number slider to control the number of lines which is the number slider used for the number of points in divide curve in step 17

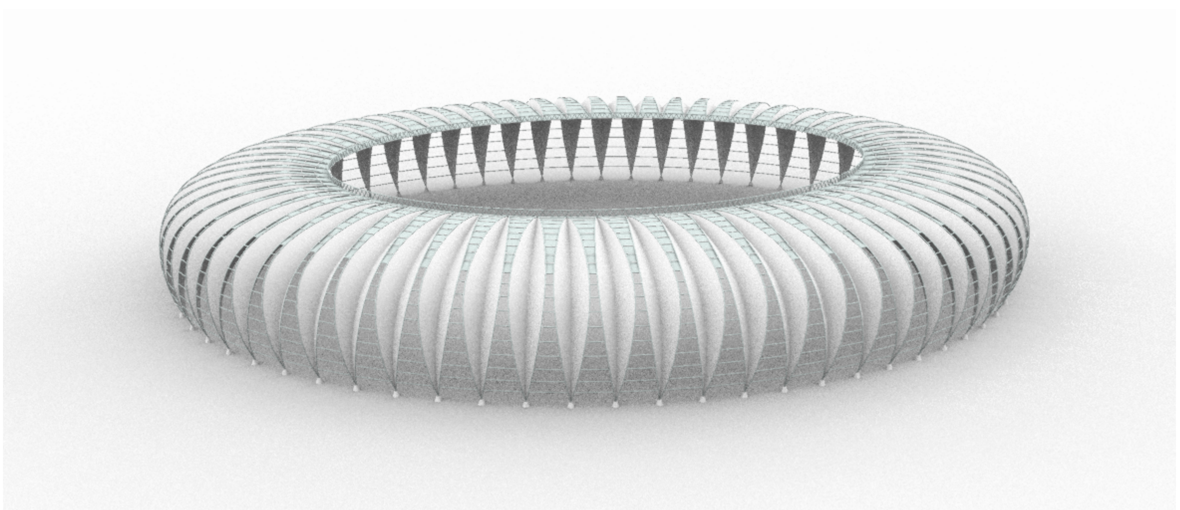


Step 20:

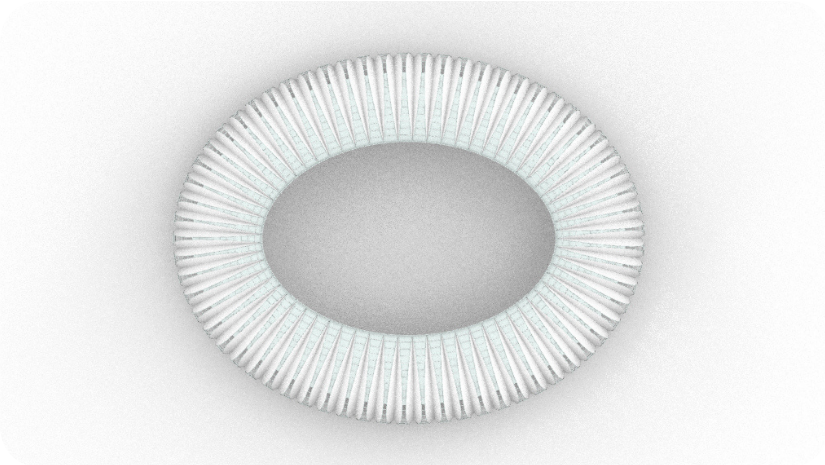
Add the truss using lunchbox's 2d truss and details like caps using the same planes created before so that the caps increase along with the fins

Step 21:

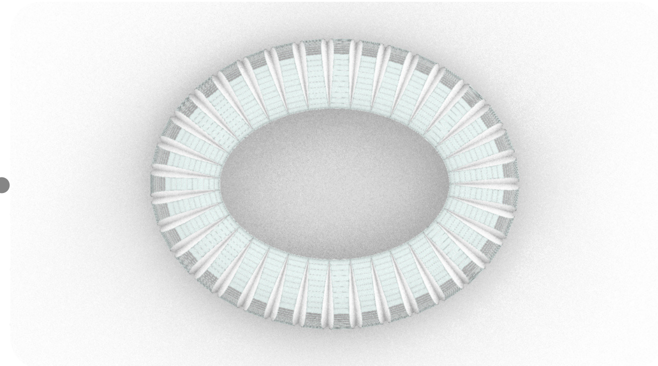
Add the details wanted like the pipe component and the custom preview component to give the curves at the truss and the horizontal line elements a thickness and customize the design.



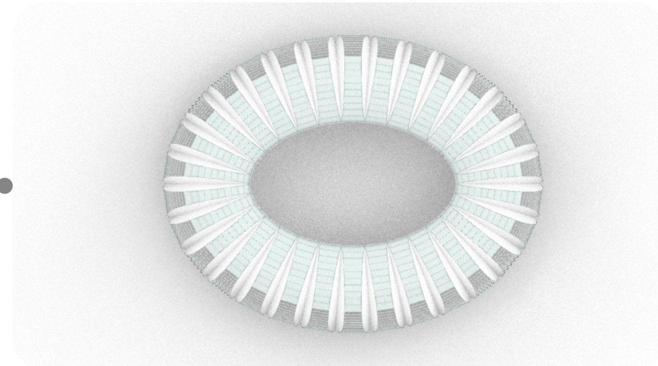
BEIRA-RIO STADIUM



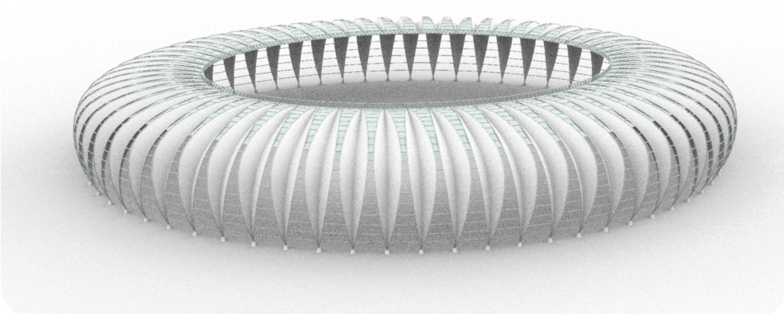
BEIRA-RIO STADIUM
NUMBER OF FINS: 65
NUMBER OF LOWER BARS: 10
POSITION OF ELLIPSE: (52,36,3)

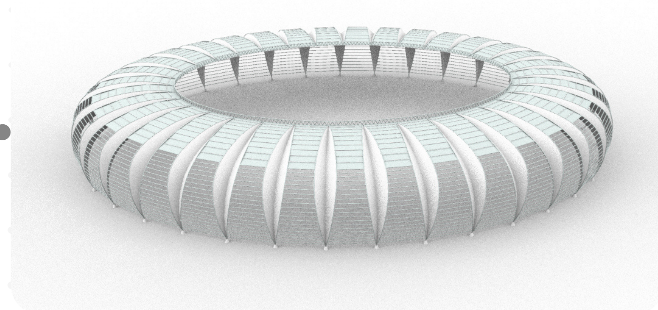


ITERATION 1
NUMBER OF FINS: 40
NUMBER OF LOWER BARS: 20
POSITION OF ELLIPSE: (52,36,3)



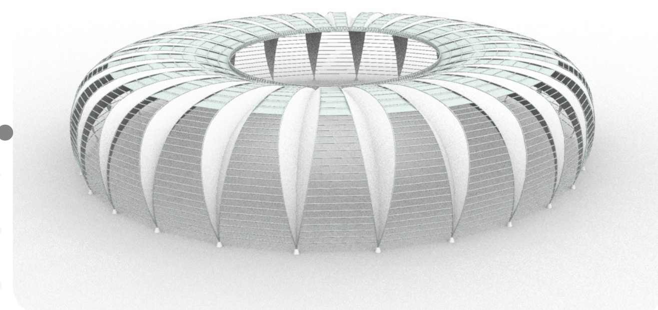
ITERATION 2
NUMBER OF FINS: 30
NUMBER OF LOWER BARS: 20
POSITION OF ELLIPSE: (65,36,5)





HEADLINE

LOREM IPSUM IS SIMPLY DUMMY
TEXT OF THE PRINTING AND



HEADLINE

LOREM IPSUM IS SIMPLY DUMMY
TEXT OF THE PRINTING AND

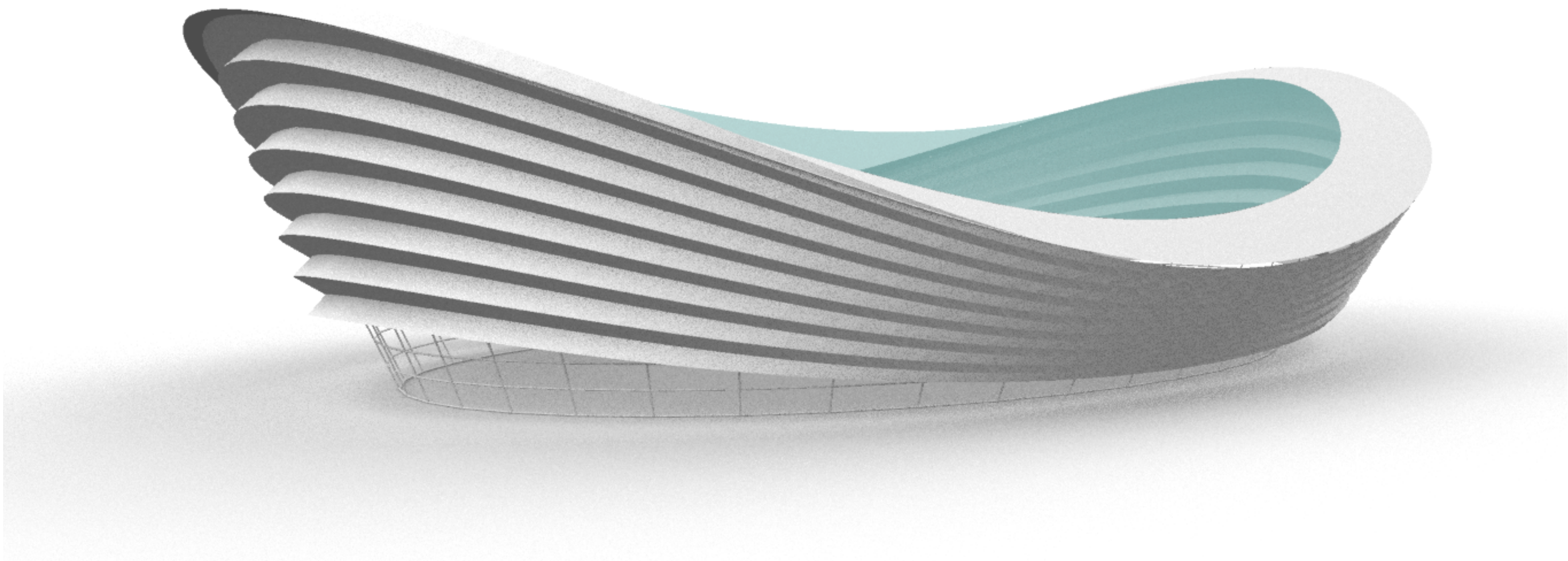
WANDA VELODROME STADIUM

Schematic Design By Wanda Cti and Ccdi,
Concept By Wanda Cti and Gdad

The Wanda Velodrome, a part of the masterplan for a regional sports facilities center, was commissioned by Wanda Group. This football stadium and basketball arena are designed to be integrated into a high-density residential area on a mountainous terrain site. It consists of a 250m long x 7m wide wooden cycle track that meets the requirements for UCI competitions and can accommodate 3,000 permanent and 3,000 temporary seats. Additionally, the field of play center area includes a multi-purpose playground that can be used for other sports or concerts to serve the local community during non-game events.

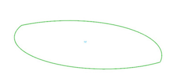
The design of the Wanda Velodrome was created using the Grasshopper tool, drawing on the knowledge gained from previous projects in the portfolio to form the undulating curves. The Graph Mapper component was utilized to generate the desired curve, which also served as a control point for modifying the design, providing the user with the flexibility to make changes as desired.

The creases on the facade were achieved by tweening the curves and dispatching two sets of alternate curves, one of which was then moved in the Z-direction and interpolated and lofted to create the creases. The creasing script was implemented using curves and clusters, allowing it to be reused multiple times, by taking two sets of curves as input and outputting the creased geometry. A detailed process is illustrated on the following pages.

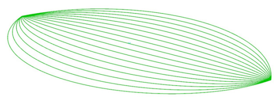


Grasshopper Script
https://me-qr.com/data/image-pack/44909638

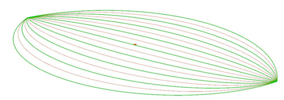
CREASE CLUSTER:



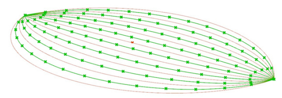
Step 1:
Create two 3pt Arc



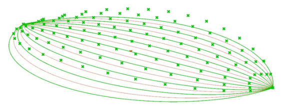
Step 2:
Tween the curves



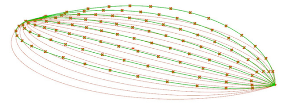
Step 3:
Cull the alternate curves and dispatch them into two separate curve component



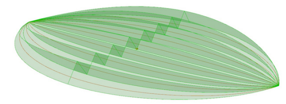
Step 4:
Divide the curve using divide curve component



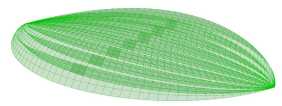
Step 5:
Move the points in the Z direction



Step 6:
Interpolate the points to form elevated curves

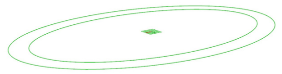


Step 7:
Loft the two curves, one of them is the other set list of curves obtained in step 3 and the second set of curves would be the interpolated curves in step 6



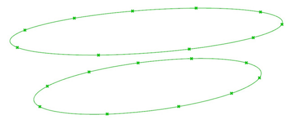
Step 8:
Divide the surface using lunchbox's Quad panels

MAIN STRUCTURE STEPS:

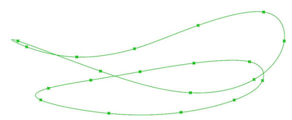


Step 1:
Create two ellipse of radius 70, 40 and 80, 50 respectively

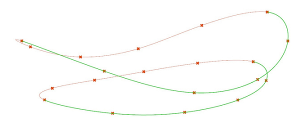
Step 2:
Move the curves at the desired height in the Z direction



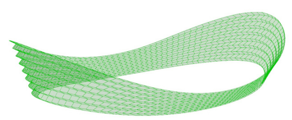
Step 3:
Divide the curve



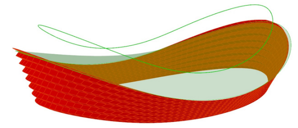
Step 4:
Build a vector between the points and use the graph mapper to shape the curves as desired



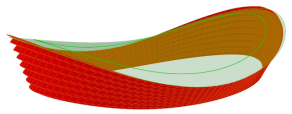
Step 5:
Split the two shaped ellipse in two parts



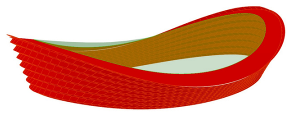
Step 6:
Use the crease cluster. Connect two curves of each side to the input of the cluster. This outputs the skin of the main body



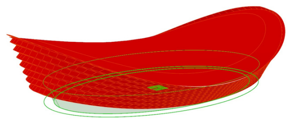
Step 7:
To create the glass above, use the same curve obtained in step 4 and loft it. Copy,scale and move the curve above the formed surface



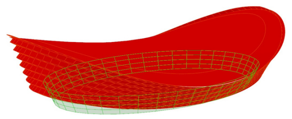
Step 8:
Project the curve placed above onto the curved surface



Step 9:
Split the surface to form the above outer roof ring and the glass panel in the center. Add lunchbox's quad panels if desired

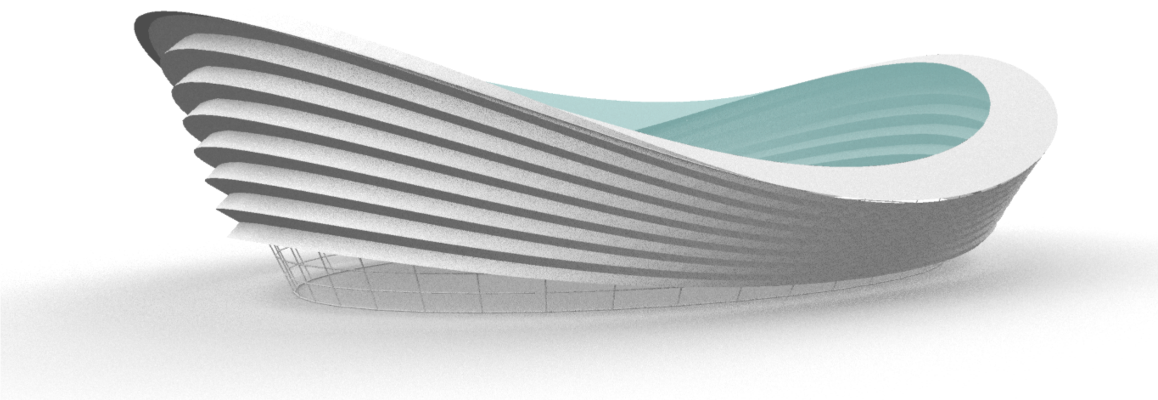


Step 10:
To create the lower glass glazing, loft the main curve and the moved curve to get a surface

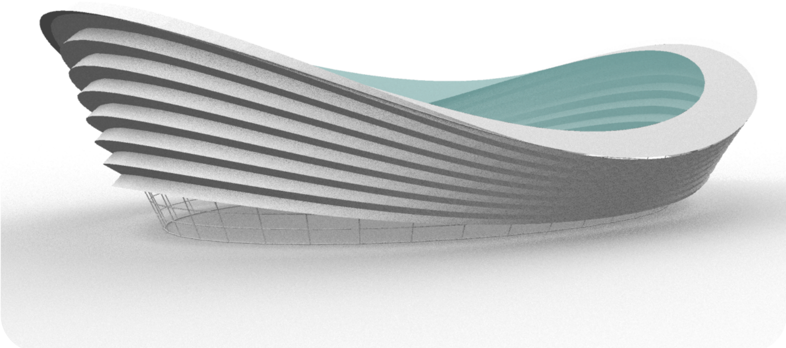


Step 11:
Divide the surface obtained in step 10 using lunchbox's quad panels

Step 12:
Add the details wanted like the pipe component and the custom preview component to give the panels thickness and customize the design.

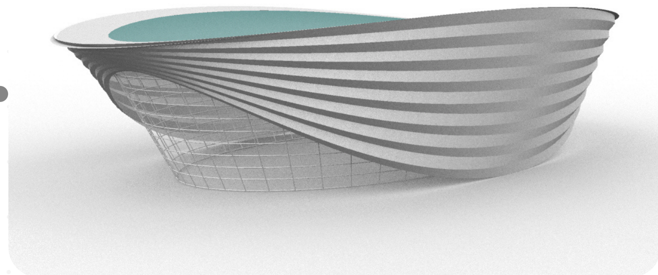


WANDA VELODROME STADIUM



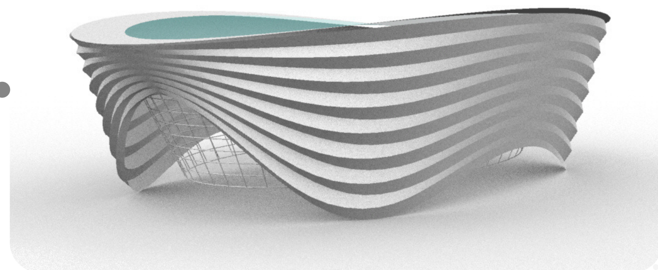
WANDA VELODROME STADIUM

USE OF GRAPH MAPPER
(PARABOLIC CURVE)
WINDOW PANELS (U,V): 4,10



ITERATION 1

USE OF GRAPH MAPPER
(PARABOLIC CURVE)
WINDOW PANELS (U,V): 10,50



ITERATION 2

USE OF GRAPH MAPPER
(LINE CURVE)
WINDOW PANELS (U,V): 10,50

AL WAKHRA STADIUM

Establishment Date: 16 May 2019
Location: Al Wakrah, Qatar
Architectural Firm: Zaha Hadid Architecture
Also known Al Janoub Stadium

The Al Wakrah Stadium is designed with a parametric approach, which allows for flexibility and control in the design process. The design of the stadium is inspired by the traditional boats of the area, known as "dhow", and the roof structure represents the sails of the boat. The parametric design allows for the precise control of the geometry of the roof, enabling the designers to adjust the shape and size of the roof based on the requirements of the project.

Additionally, the parametric design approach allows for the efficient coordination and collaboration between the design team, engineers, and contractors, enabling the project to be completed on time and within budget. The parametric design approach has been used to create the complex geometry of the stadium and to optimize the performance of the building. The use of parametric design in the Al Wakrah Stadium exemplifies how architecture and technology can come together to create beautiful and functional buildings.

The Al Wakrah Stadium project was designed using Grasshopper, a parametric design software that allows for flexibility and control in the design process. The Grasshopper script for this project is made up of two clusters, each with a specific function.
The first cluster utilizes the crease script, which was previously used in project 4 (Wanda Velodrome Stadium). The crease script allows for the creation of complex geometry and the formation of creases on the facade of the building. This script allows the designer to control the shape and size of the creases and make adjustments as needed.

The second cluster is used for forming the curve of the stadium. This cluster is responsible for creating the overall shape of the building and determining its form. It includes various number sliders outside the cluster which can be used to control the design and achieve the desired outcome.

The use of these two clusters in the Grasshopper script provides the designer with a high degree of flexibility and control in the design process. It allows the designer to make adjustments and explore different design options while keeping the overall design process parametric. The second cluster can be viewed on the following page for more detailed information.

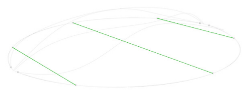
Grasshopper Script
https://me-qr.com/data/image-pack/44909360

WANDA VELODROME STADIUM

CURVE CLUSTER:

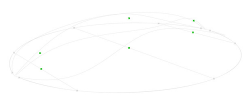
Step 1:

Divide the curve created in Step 1 of the Curve as input steps below, as input



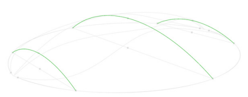
Step 2:

Join the points using the line component



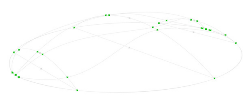
Step 3:

Use the point on curve component and elevated the point in the Z direction



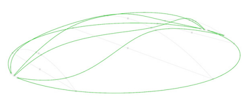
Step 4:

Interpolate the points using the 3pt Arc



Step 5:

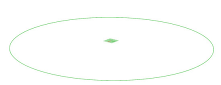
Using the Beizer graph add points on curve as needed with the guidance of an image (plan)



Step 6:

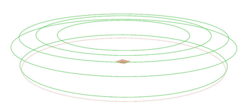
Interpolate the points once the points are placed in position

CURVE AS INPUT CLUSTER:



Step 7:

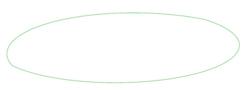
Create an ellipse of radius 274 and 240 respectively



Step 8:

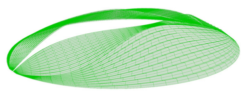
Move the curves as desired, using reference image as a guide

MAIN STRUCTURE STEPS:



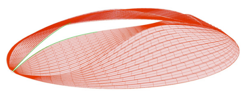
Step 1:

Using the Curves obtained as output in the curve cluster, input in the crease cluster from the previous project



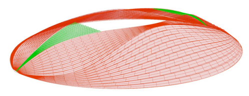
Step 2:

All the curves now will output with creased surface



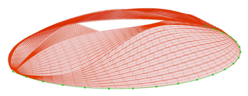
Step 3:

Divide the central curves and split them using split curve



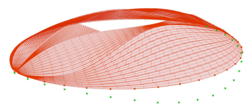
Step 4:

Run the curves through the same crease cluster



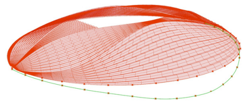
Step 5:

Divide the original bottom curve to split and divide the curve using split curve and divide curve respectively



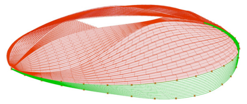
Step 6:

Form a vector between the points. Use graph mapper (Beizer graph) to make the desired bottom curve



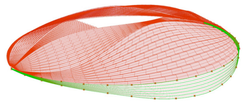
Step 7:

Interpolate the points. Set the graph again until desired curve is obtained



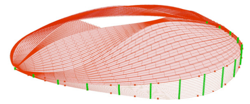
Step 8:

Tween the curve



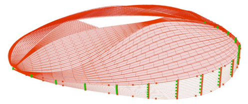
Step 9:

Cull and dispatch two sets of alternating curves



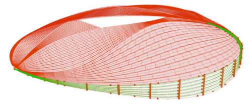
Step 10:

Divide the curves using divide curve



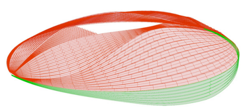
Step 11:

Move a set of list of points in the x direction (depending on the orientation of the structure)



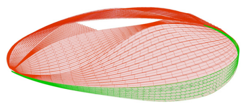
Step 12:

Interpolate the moved points (follow similar steps to the curve cluster script)



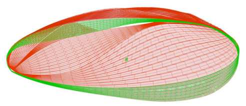
Step 13:

Loft the curves (same as the curve cluster)



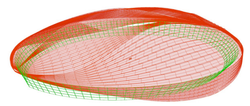
Step 14:

Divide the surface using lunchbox's quad panels



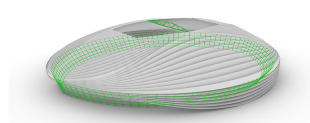
Step 15:

Do the same steps for the opposite end or mirror the geometry to obtain the desired symmetry



Step 16:

Make the glass panels following the same steps as Step 10 of the Wanda Velodrome Project

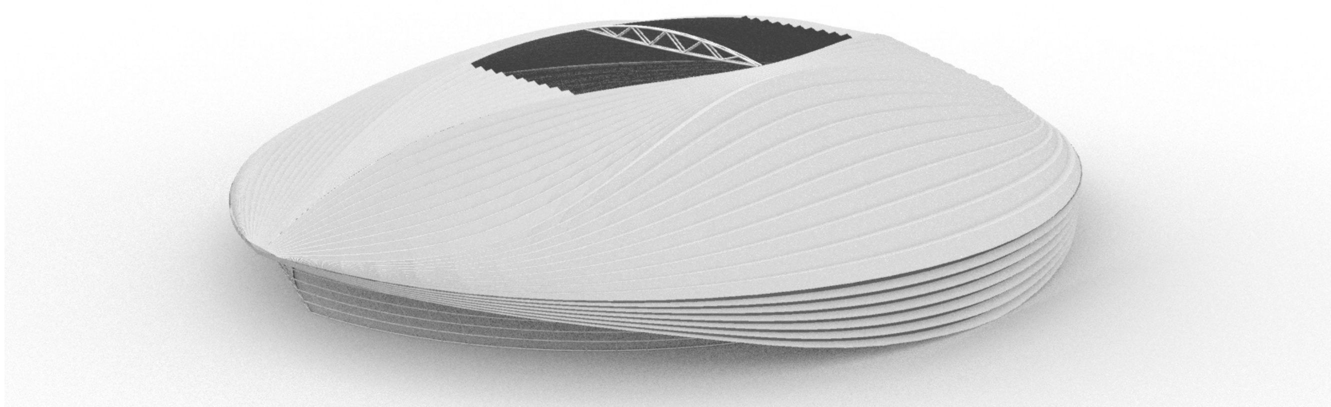


Step 17:

Add the desired details like the truss (lunchbox's 2d truss) and pipe to give the glass panels below thickness

Step 18:

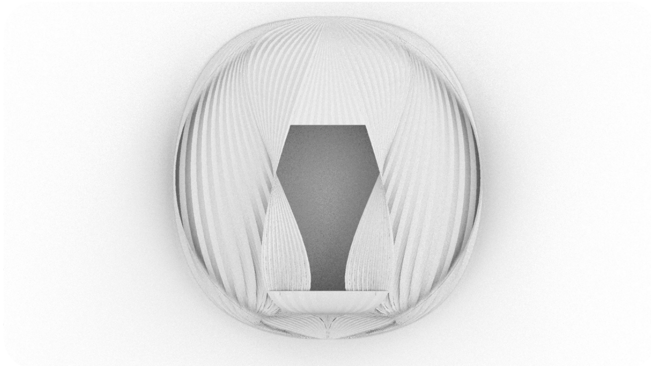
Add custom preview and other details to customize the design

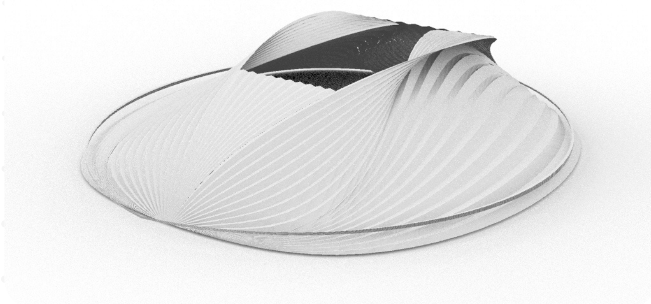


AL WAKHRA STADIUM

ITERATION 1

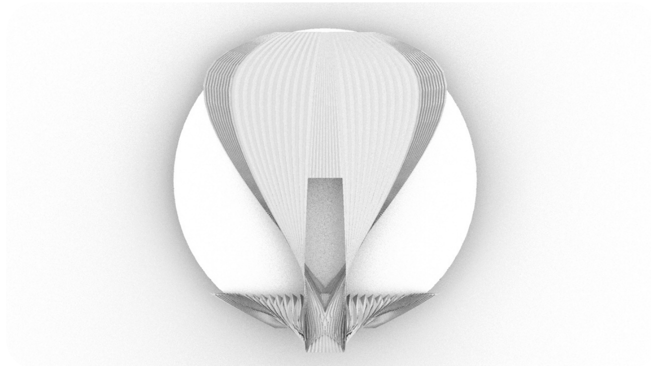
EVALUATION POINTS(CURVE
CLUSTER (1.2.3)): 0.02, 0.18, 0.80
LIFT FORM GROUND: 0

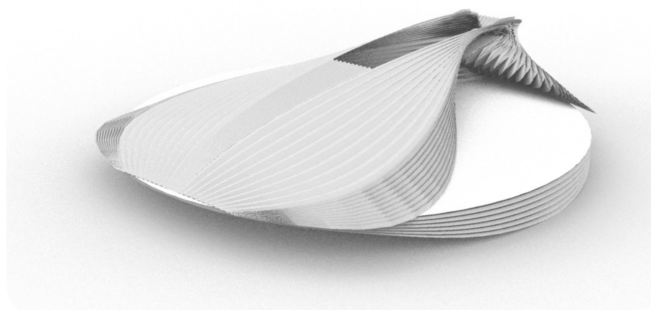


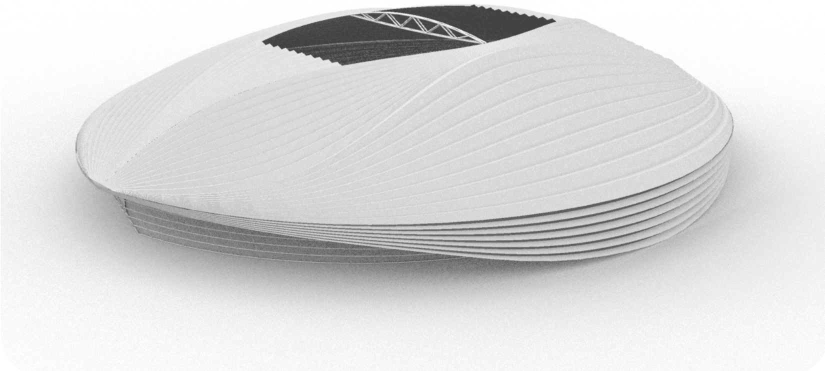


ITERATION 2

EVALUATION POINTS(CURVE
CLUSTER (1.2.3)): 0.1, 0.25, 1.00
LIFT FORM GROUND: 40







AL WAKHRA STADIUM

EVALUATION POINTS(CURVE
CLUSTER (1.2.3)): 0.02,0.18,0.8
LIFT FORM GROUND: 40

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