

Cathedral Brasilia Part 1



Introduction:

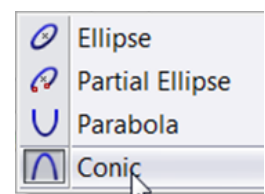
The lesson involves the start of making a representative model an iconic cathedral in Brasilia. The Cathedral Brasilia, designed by Oscar Niemeyer, is a hyperboloid structure constructed from 16 hyperbolic concrete columns. This exercise demonstrates the practical use of conic sections and parabolic structures in civil engineering. For more information see below:

- <https://www.youtube.com/watch?v=ZKlhOG04ncw>
- GPS co-ordinates: 15°47'54.4"S 47°52'31.1"W



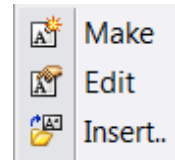
Learning Intentions:

This lesson will focus on using the use of the **conic** and **block** command. The lesson will also use the following commands: **segment**, **block**, **loft**, **circular pattern**, **cut with surface**,



¹ <https://upload.wikimedia.org/wikipedia/commons/8/8c/Brasilia_Cathedral_by_Adonai_Rocha.png>

Prerequisite knowledge: Knowledge of the following commands are required in this lesson: **Sketching, Loft, Extruded Boss/Base, Adding Appearances,**



Assembly Folder

Create a folder called Cathedral Brasilia and save **Cathedral Brasilia Frame**. This folder will be used to save all related files; parts, assemblies, drawings etc.

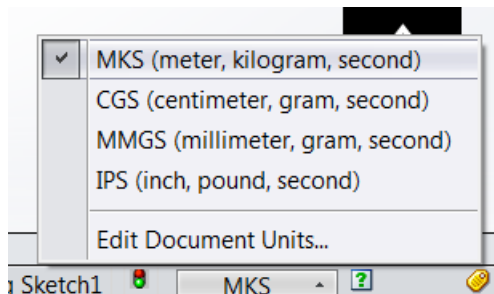
New Part

Start by creating a **New Part** and saving this part as “**Cathedral Brasilia Frame**” in folder created earlier



Note: this part will be used in a later exercise to complete the building

Change Units

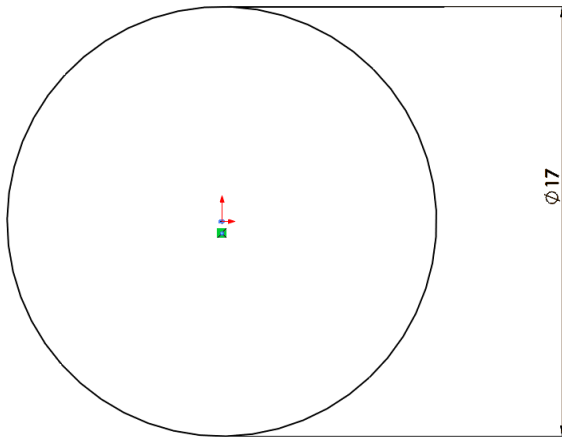


Create the throat circle sketch

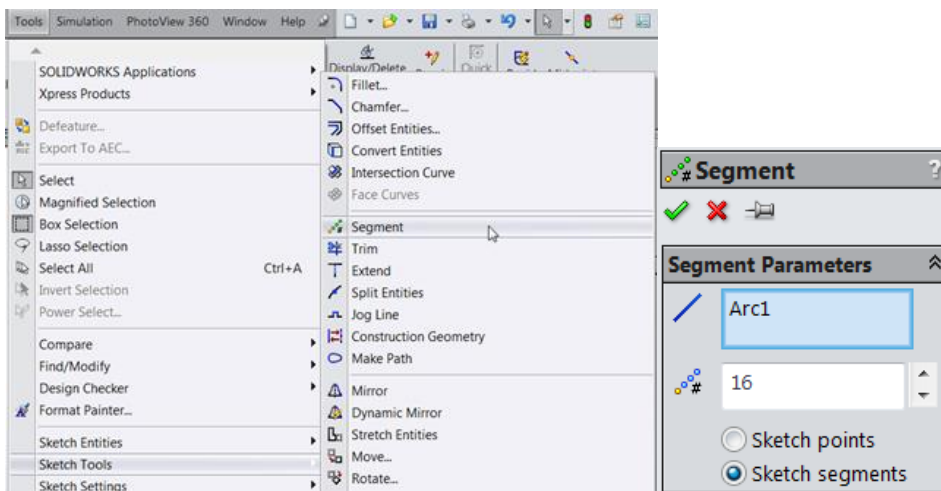
Start by creating reference plane **26metres** above **Top Plane**

Press **F** to see plane

Sketch circle on plane and make **for construction**

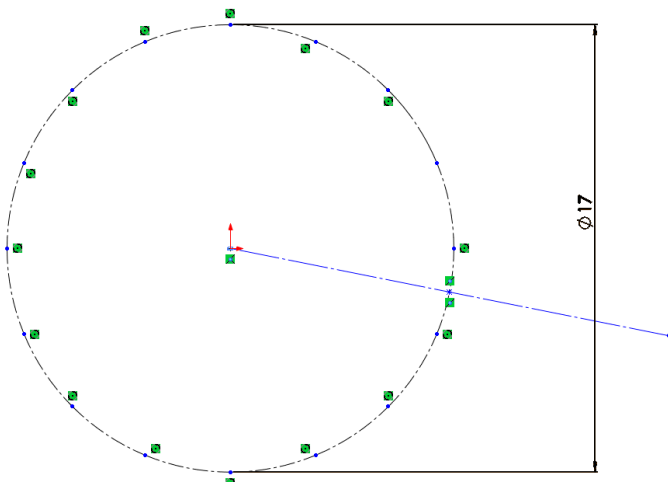


Select **Segment** command. Select circle and divide into 16 points



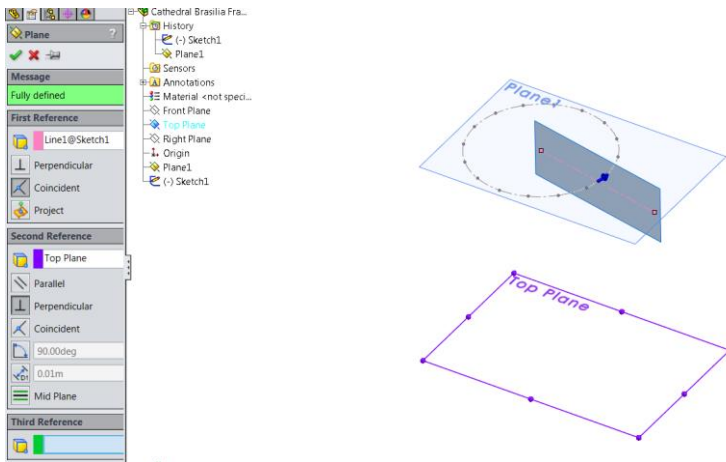
Draw a **midpoint line** through the midpoint of one of the segments to the centre of the circle.

Make for construction

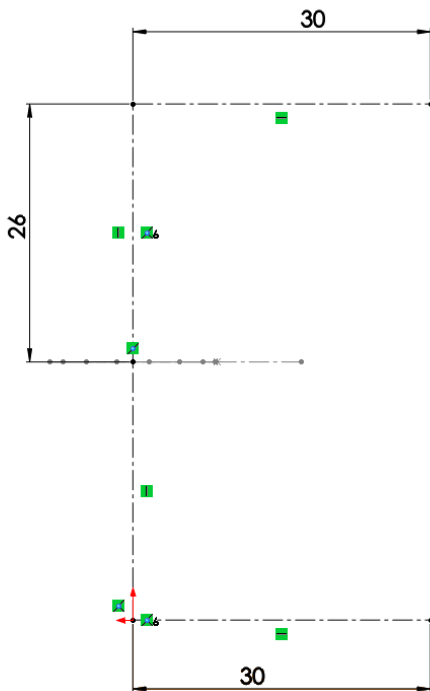


Creating the Hyperbolic sketch path

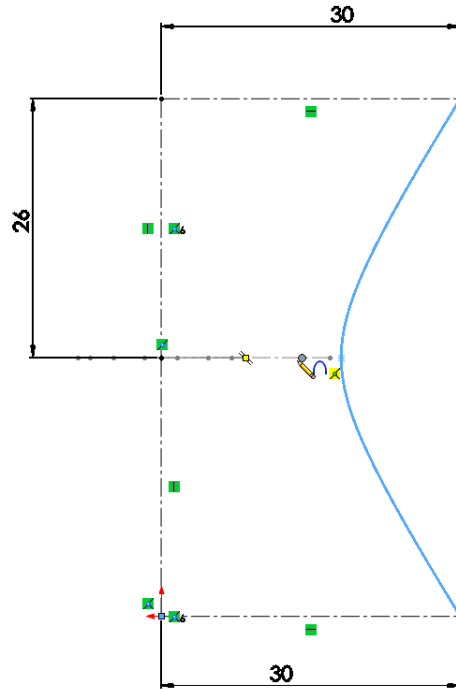
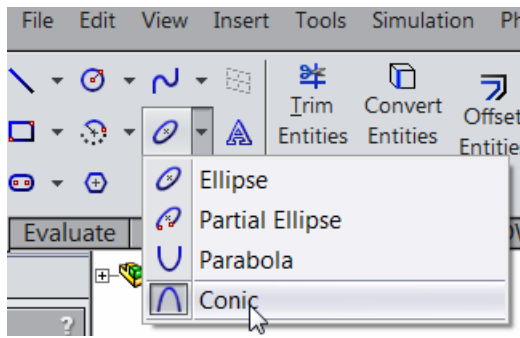
Exit sketch and select **Reference Geometry Plane** using the midpoint line and Top Plane as references.



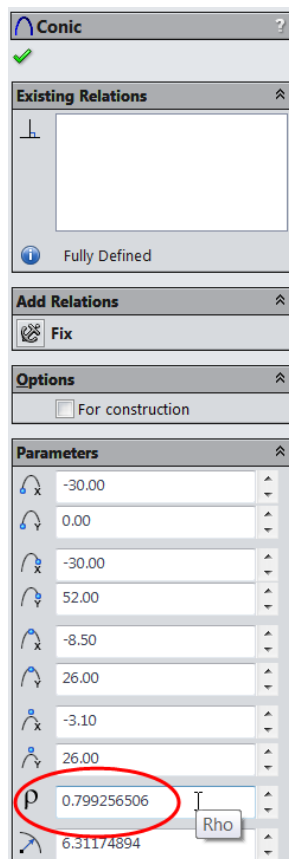
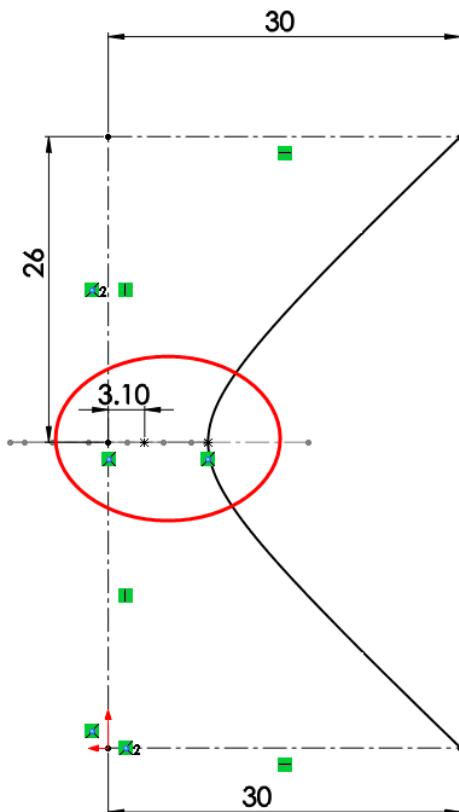
Create the following sketch on plane (in metres)



Select **Conic** command and draw conic using the 30m lines 1st, then centre line for the vertex and finally the “x” co-ordinate

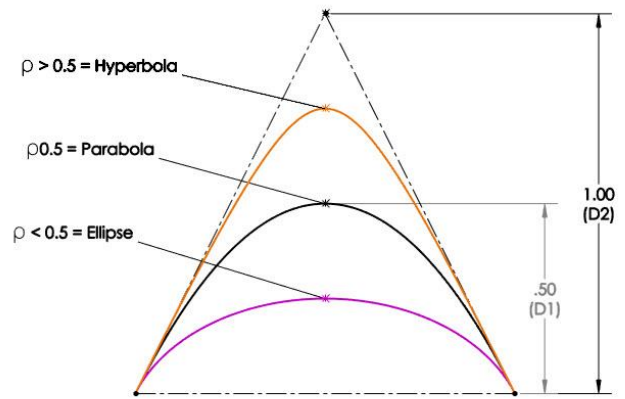


Define the **top vertex “x” co-ordinate** by adding a dimension.



RHO VALUE:

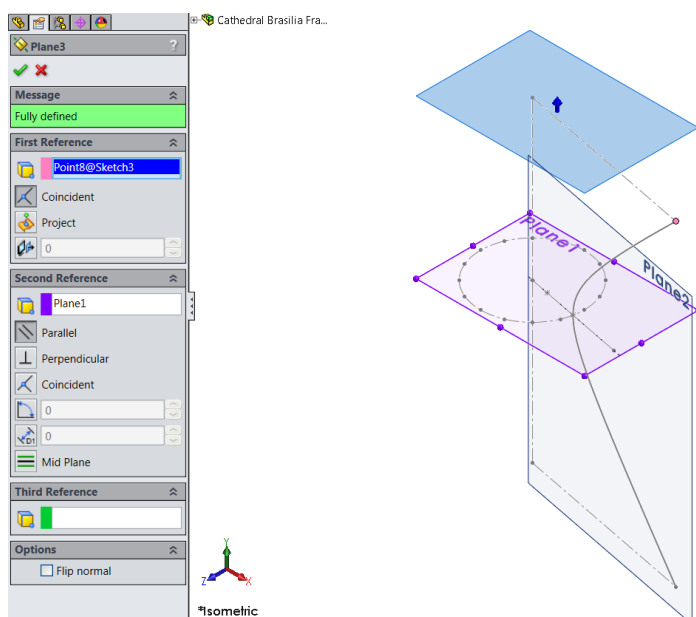
If you click on a conic in SolidWorks you will see a list of properties/relations. If you imagine the conic as a rounded corner, then Rho is the ratio of the distance of the peak of the rounded corner to the sharp corner (D1/D2). If Rho is 0.5, then the conic is a parabola. If Rho is greater than 0.5, then the conic is a hyperbola. If Rho is less than 0.5, then the conic is an ellipse



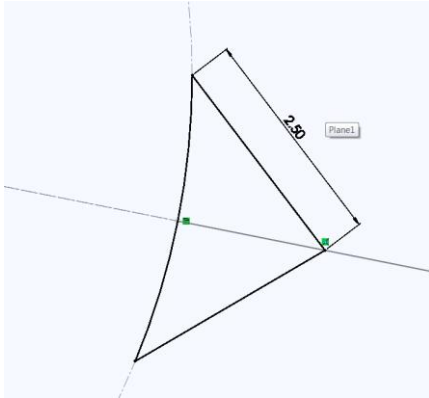
Exit the sketch

Create the Loft Profile Sketches

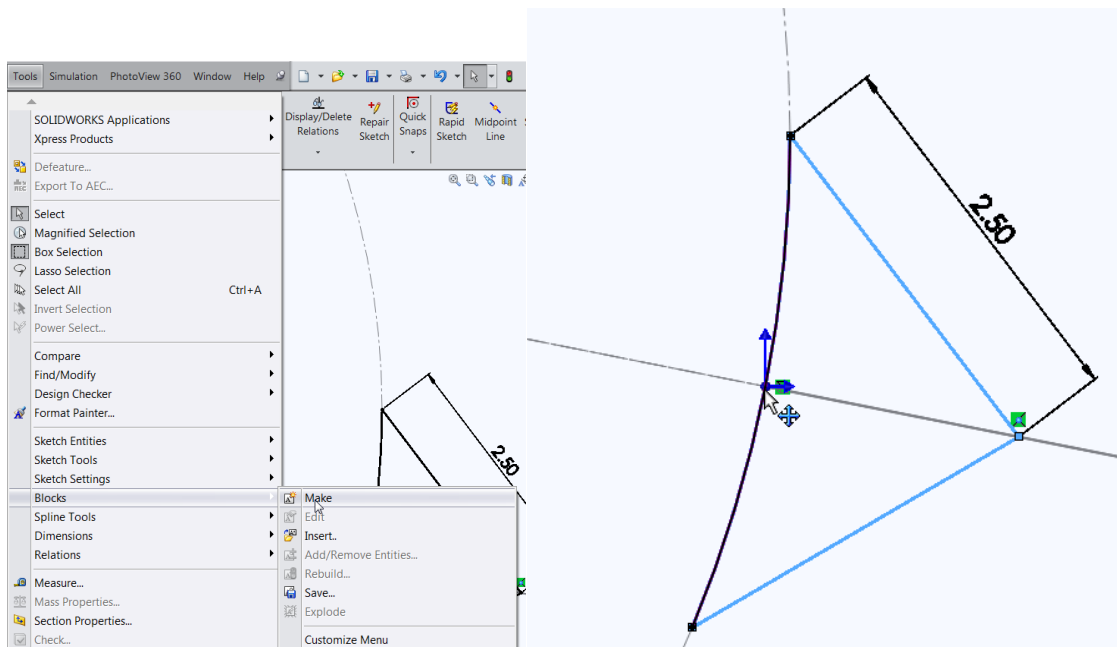
Create another reference plane coincident with the **top** of the hyperbolic sketch and **parallel** to **Plane 1**



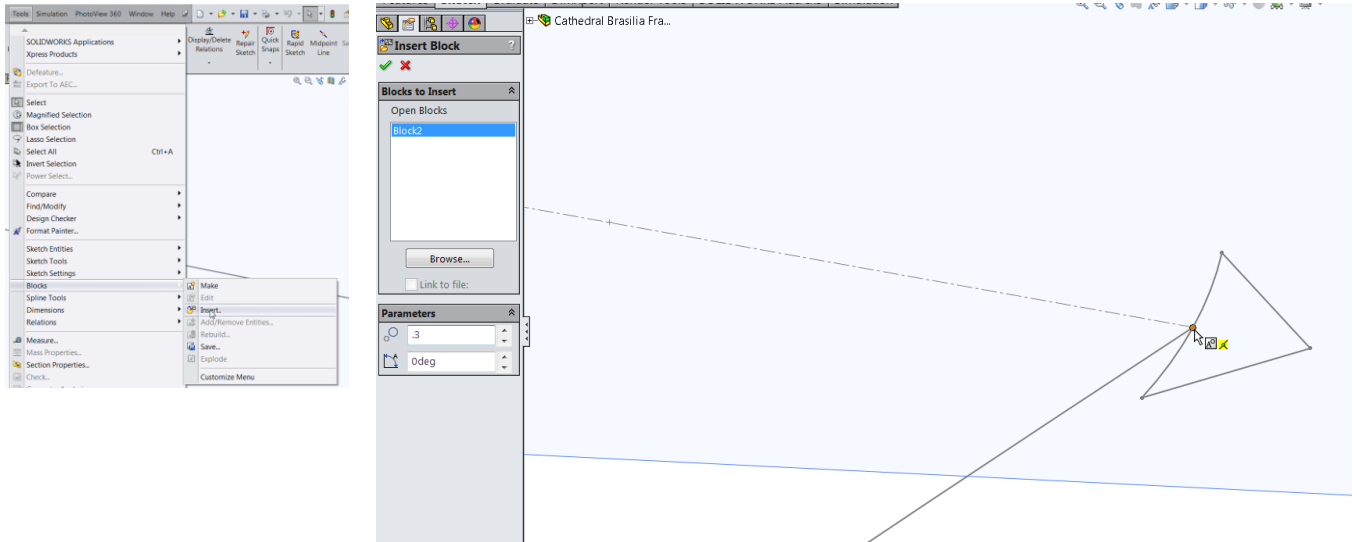
Create another sketch as shown below on **Plane 1**(where the throat circle was drawn earlier). Use the **convert entities** command to select a segment of the circle constructed earlier.



To use this profile sketch again on the top and bottom of the hyperbolic path, make a **block**. Select the three lines of the sketch and select the midpoint of the arc as the **insertion point**.



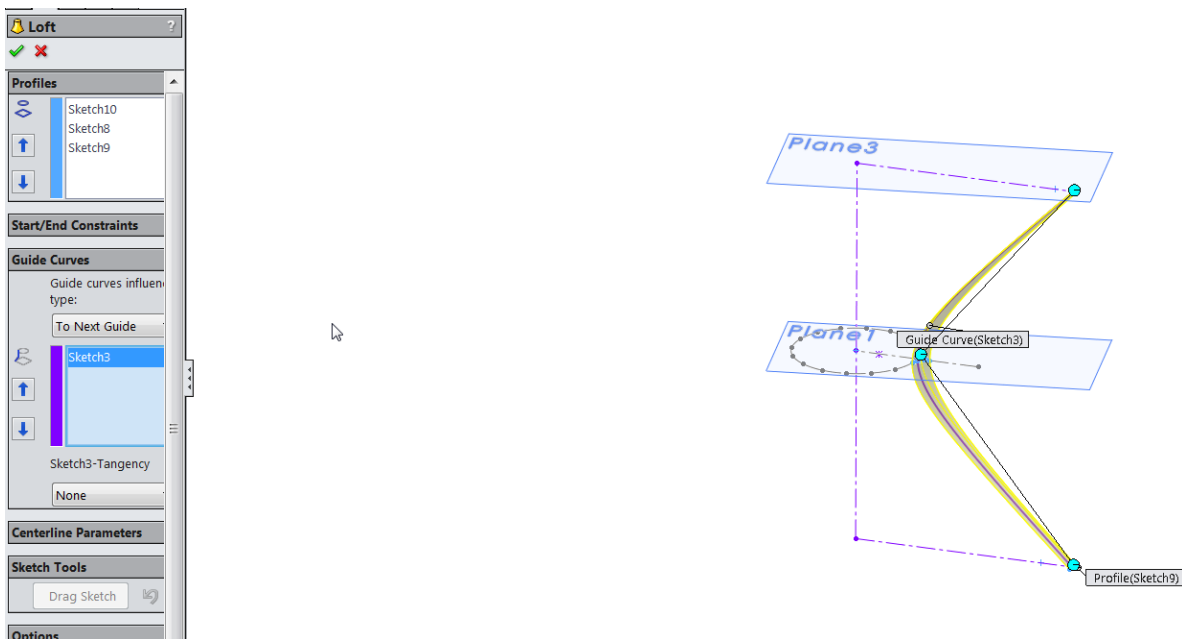
Create a sketch on the **Top Plane**. Insert the block, changing the scale to **0.5** and coincident with the end of the hyperbolic sketch.



Repeat the block command using the same method and details on **Plane 3** on the top of the hyperbolic path

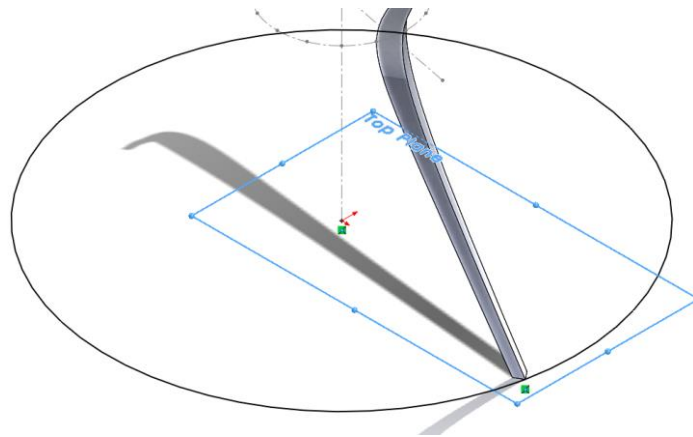
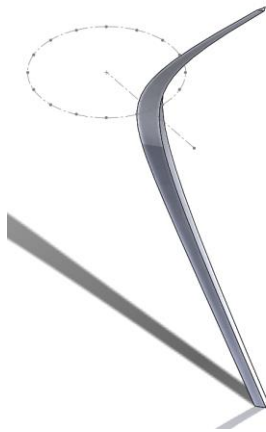
Create the Loft

Select the Loft command and use the hyperbolic curves as the path and the 3 triangular sketches as the profiles

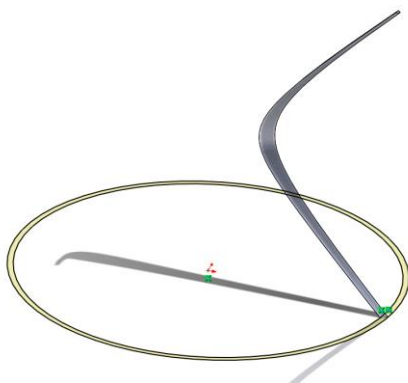


Create a Base circle

Create a sketch on the **Top Plane**. Draw two concentric circles coincident with its centre on the origin and their radii the base points of the hyperboloid

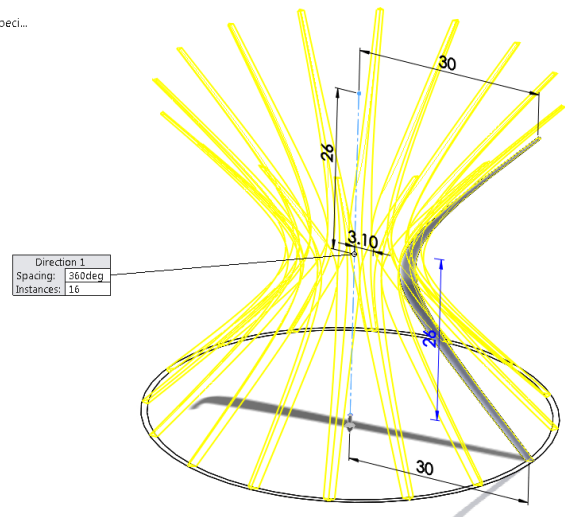
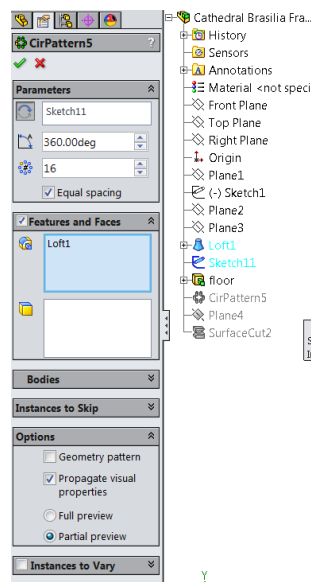


Extrude **0.1m**

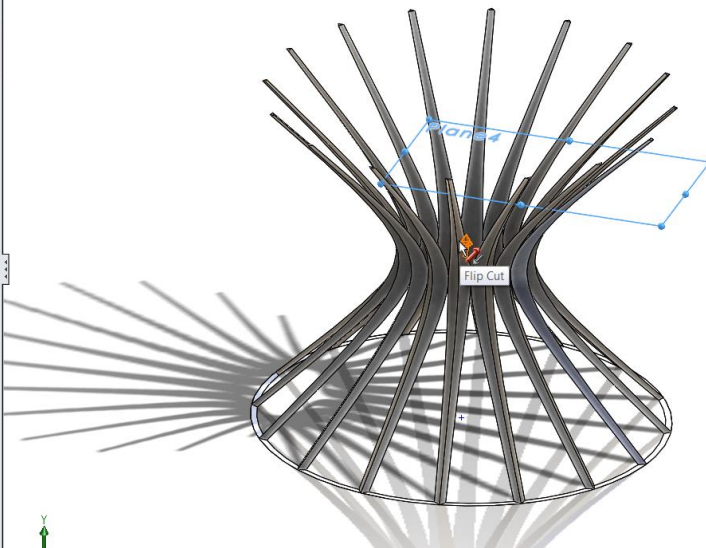
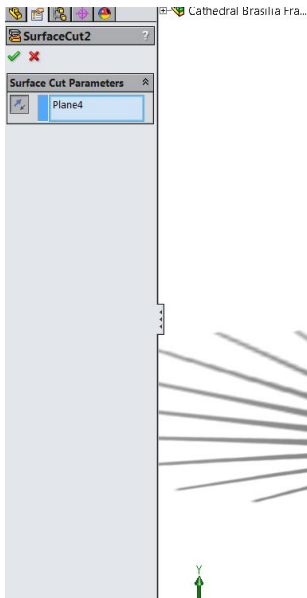
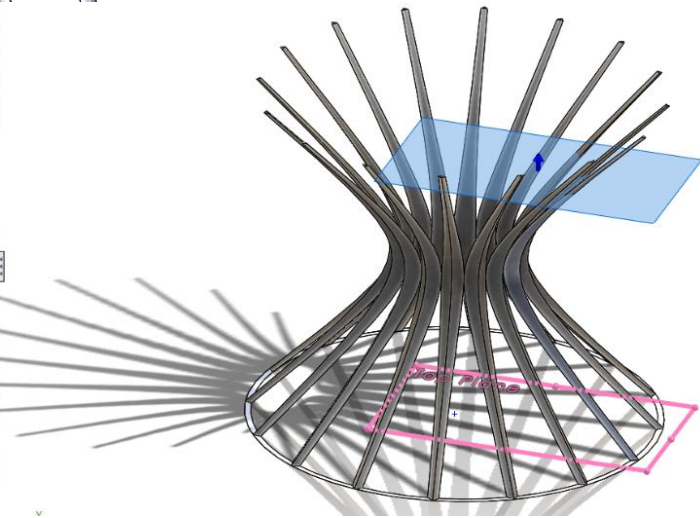
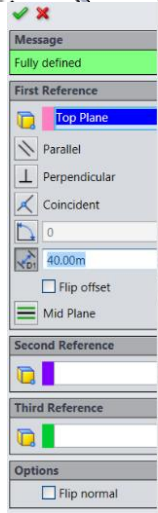
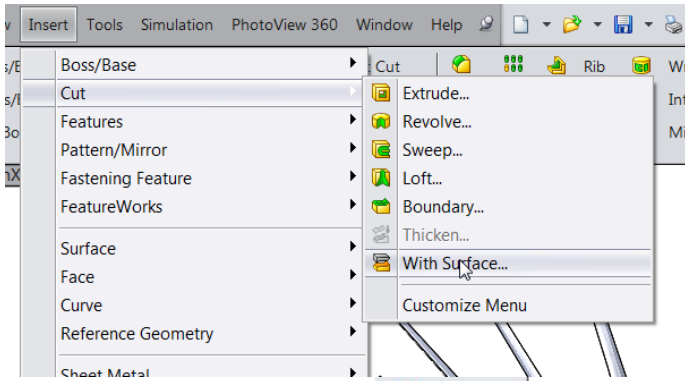


Complete Structure

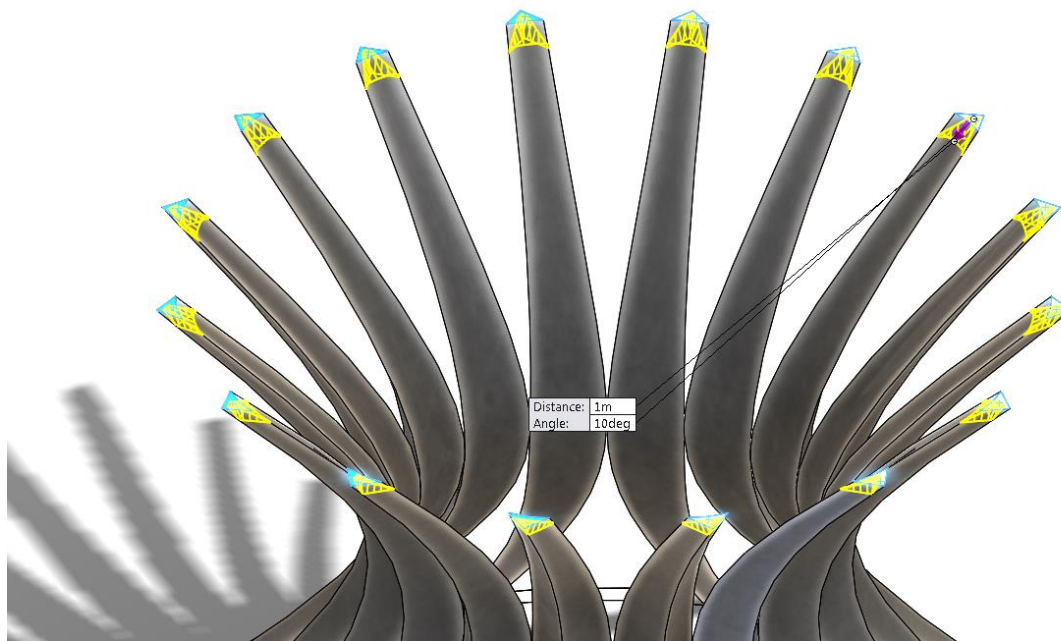
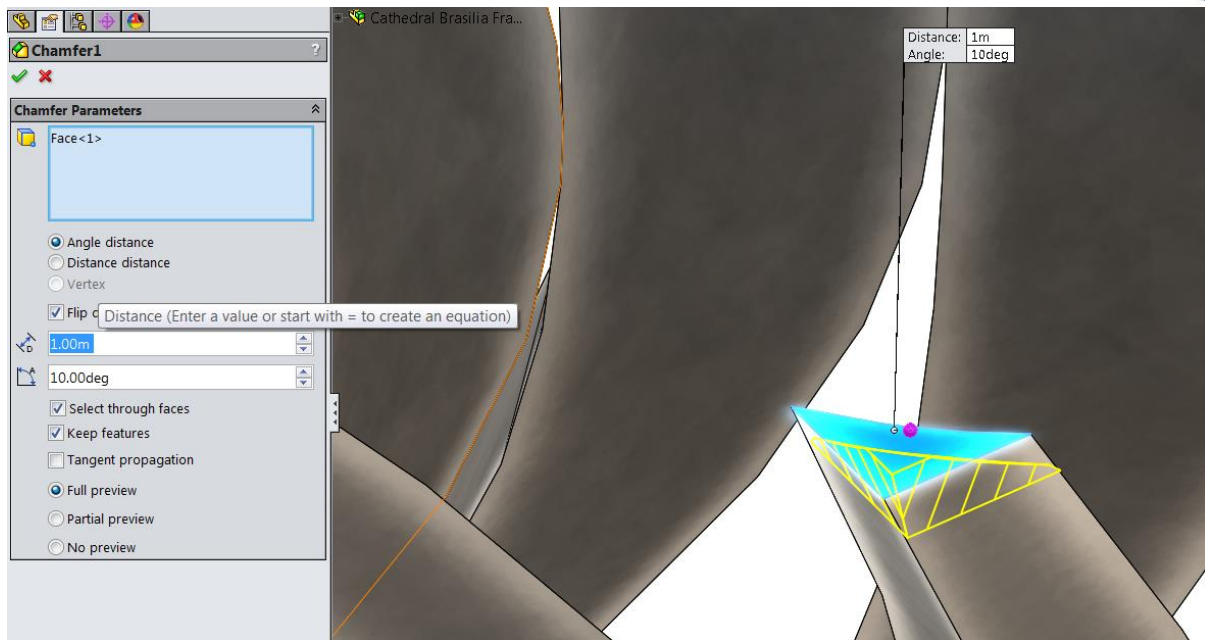
Create Circular Pattern by selecting the centre line as axis and loft as the feature to pattern **16 instances, equal spacing**



Insert a plane **40m** above the Top Plane. Use the **Cut with surface** command to remove the top of the structure with this surface plane



Chamfer the tops of the hyperboloids using the dimensions below.



The cathedral frame is now complete.

