

# FREEFORM VASE

Material and Technology  
Prof. Dr. Manuel Kretzer



**What you are about to learn:**

How to use lofts and surface manipulation tools  
model a freeform vase for 3D printing.

**Further info and credits**

For more tutorials visit:

<https://www.rhino3d.com/learn/>

<https://www.rhino3dhelp.com/>

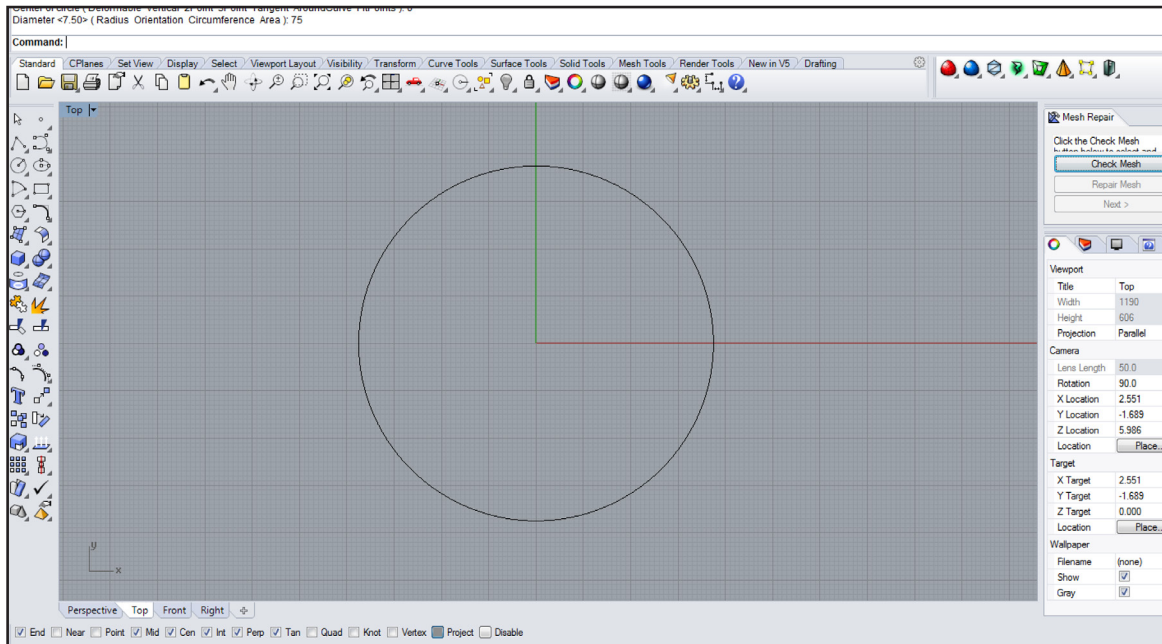
Youtube is also a great source for Rhino tutorials.

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## 1. Draw a Circle

Start by drawing a circle. Either pick the command from the toolbar on the left side (third row from top, left) or by entering `_circle` into the command line. Use 0,0 as center of the circle and 60 mm as radius.

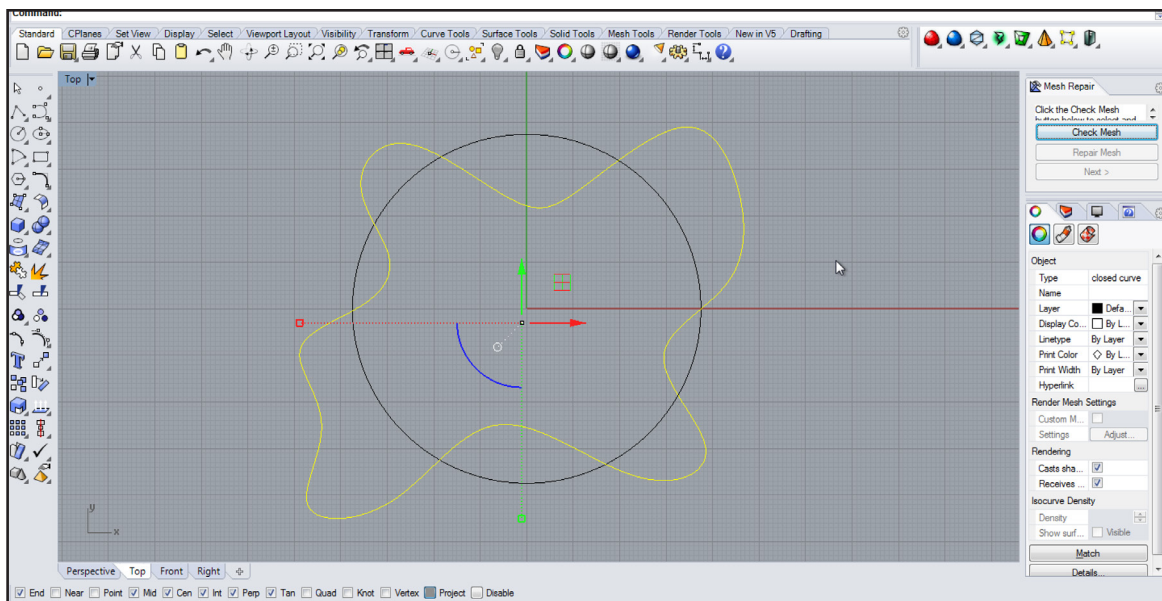
Make sure to set your drawing dimensions to mm.



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## 2. Draw a Free-form Curve

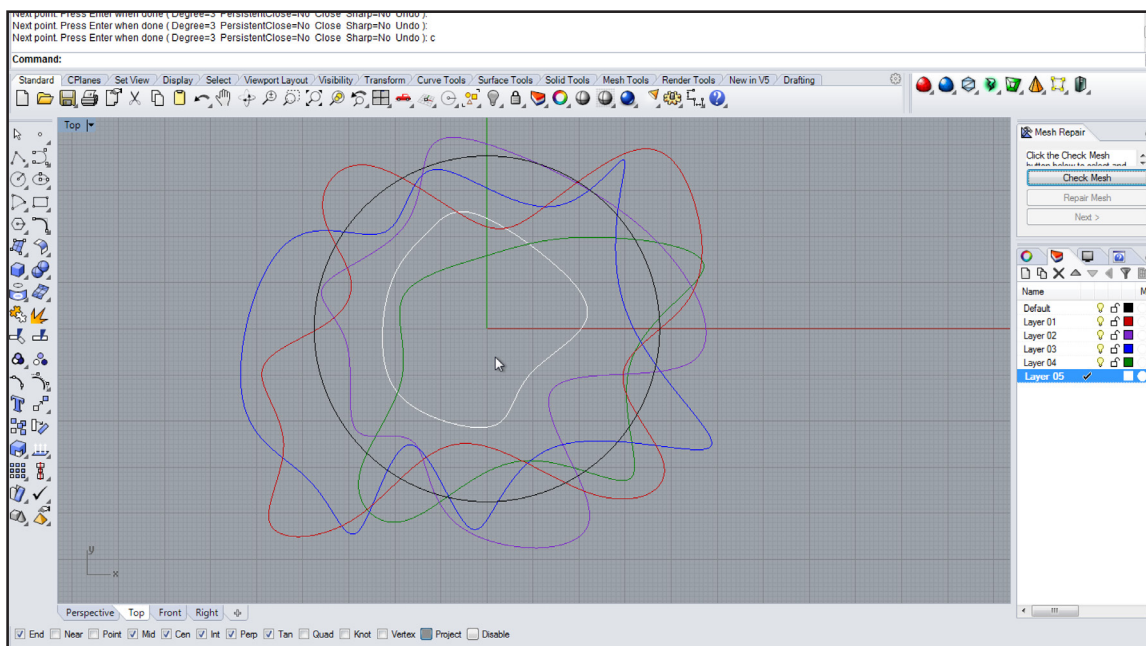
Use control point curve (second row, right / `_curve`) to draw a free-form curve. Use the circle as a guide for proportions. It is important to make a closed curve – meaning that where the curve ends must be at the same point as where it started. This can be done by entering 'c' when you're done drawing



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### 3. Draw More Curves

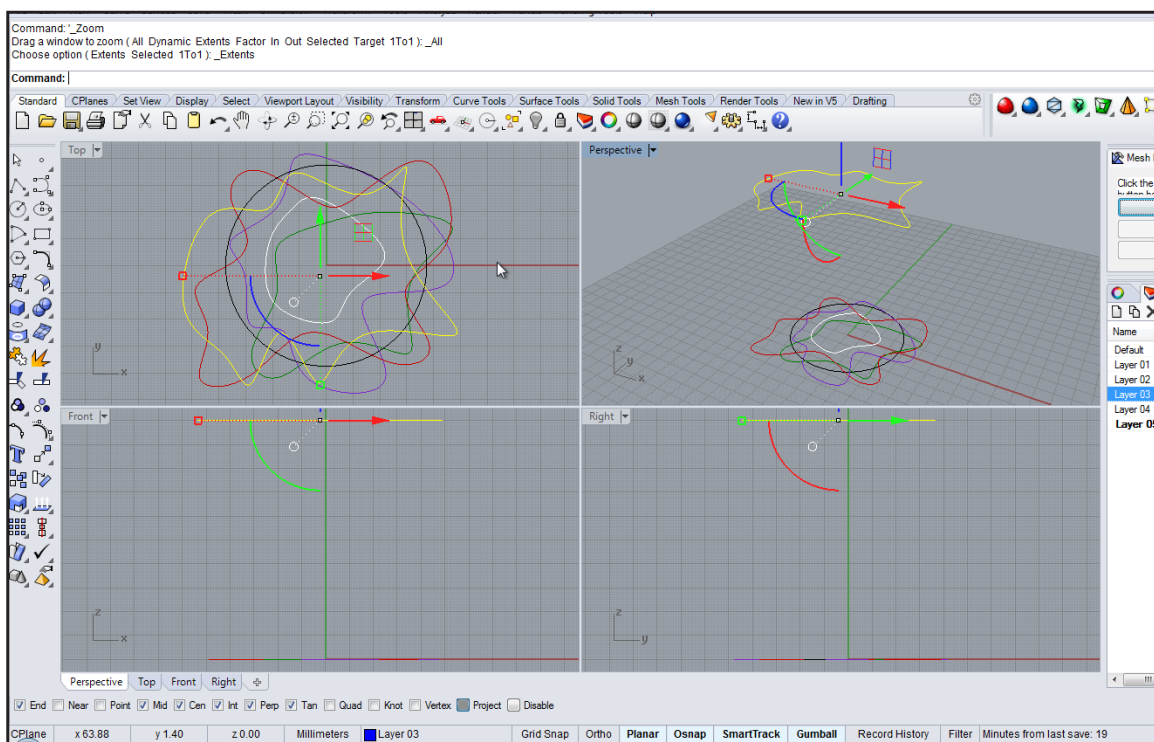
Add as many different variations as you like around the first drawn circle. You may want to put different curves on separate layers so that they are easier to distinguish later. The layers tab is on the right side of the screen (Pie symbol). Change a shape's layer by selecting the shape, right-clicking on the respective layer and choosing 'change object layer'. It might also help to turn off the 'Object Snap' located at the bottom of the screen so the curves don't snap to previously used control points.



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### 4. Select First Curve

Once all curves are drawn, select the curve which you want topmost and use `_move` to move the curve along the Z axis. Use 0,0 as starting point and 0,0,80 as end point. This will set the vase height at 80mm. Make sure you're in top or perspective view.



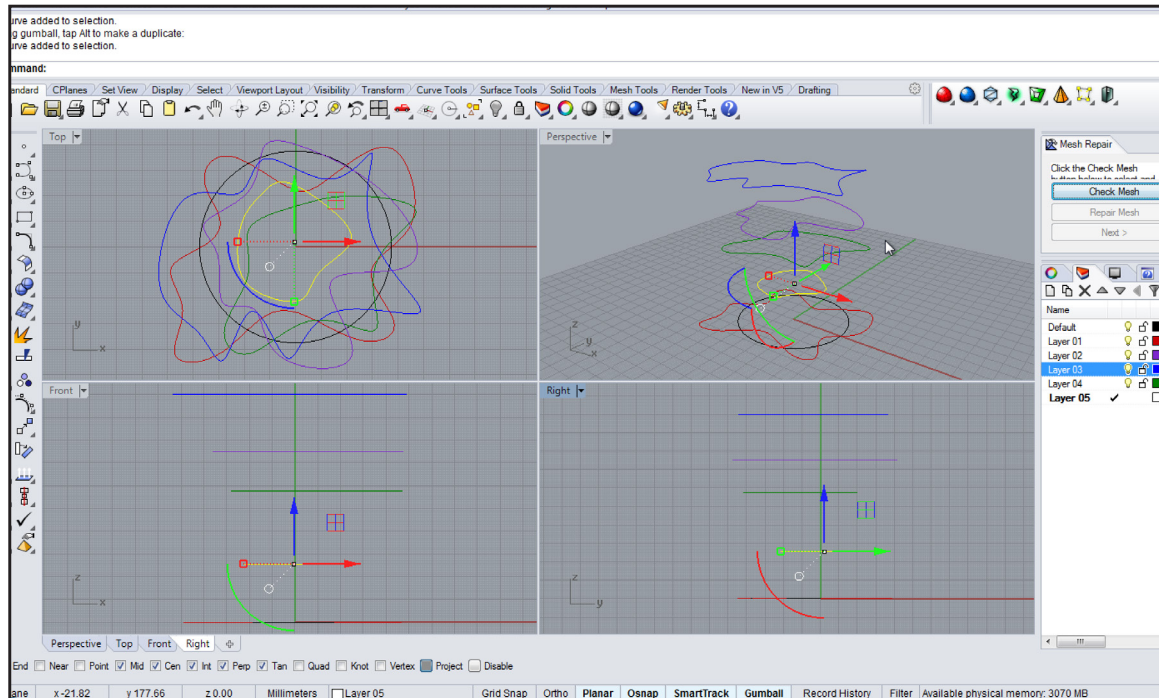


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## 5. Move More Curves

Select the curve you want to have next and use the Gumball Tool in perspective view to move the curve along its Z axis. Gumball can be switched on and off at the bottom. Repeat this step for all remaining curves.

There is a lot of trial and error with this type of design so you can experiment with different heights of how far apart from each curve you want them to be spaced.



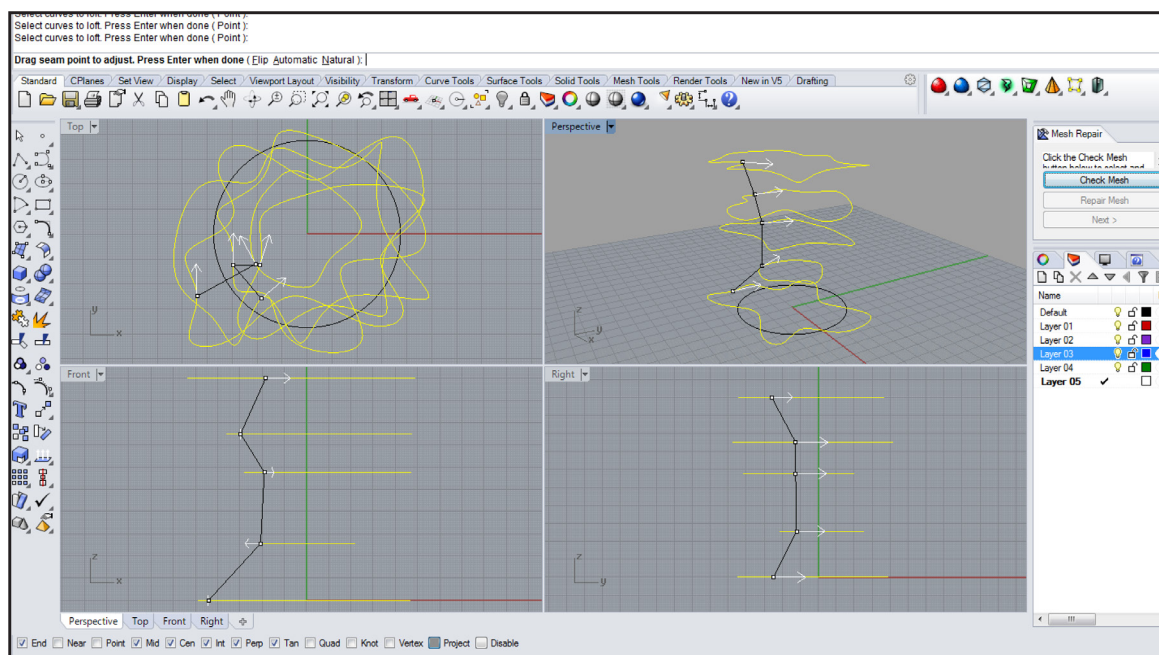
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## 6. Loft Curves

Switch 'Record History' on, which can be found at the bottom next to 'Gumball'.

Now the curves are joined into a surface using the \_loft command. When lofting curves it is very important to select the curves in order in which they are to be lofted. Select the bottom curve first and then select one by one each curve that is next in line above.

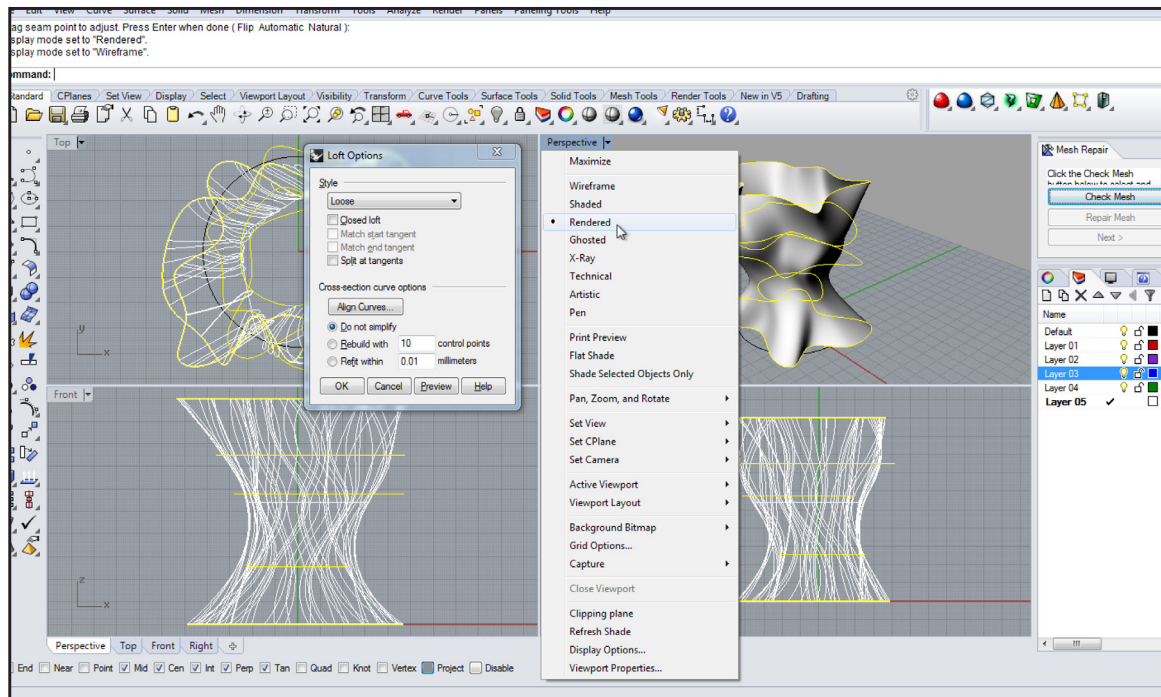
After the curves have all been selected and you pressed enter, there will be an option to 'Drag Seam Point to Adjust'. Choose 'Natural'.



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## 7. Loft Options

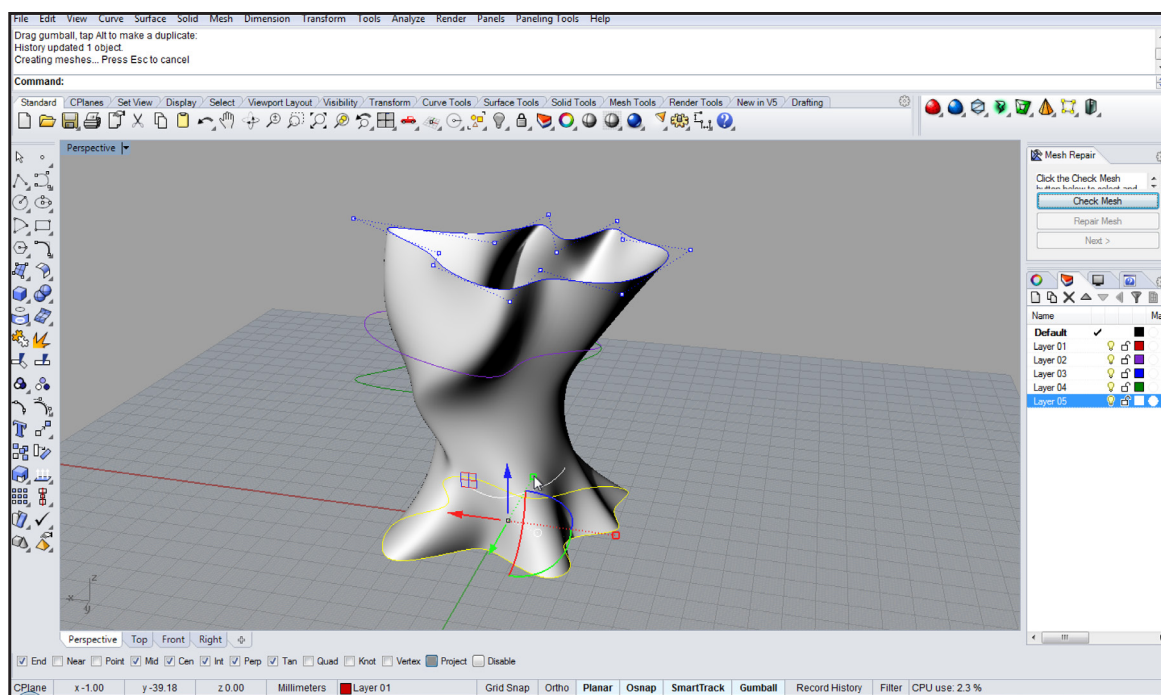
After pressing Enter, the Loft options box will appear. Set the viewing mode to 'Rendered' by clicking on the little triangle in the viewport window to see a preview of the lofted surface. Choose 'Loose' as the lofting style and press Enter.



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## 8. Adjust Surface

Since 'Record History' stores the connection between a command's input geometry and the result the surface can now be adjusted by simply modifying the input curves, like deleting control points, scaling or moving. This can again be done with the aid of 'Gumball'.

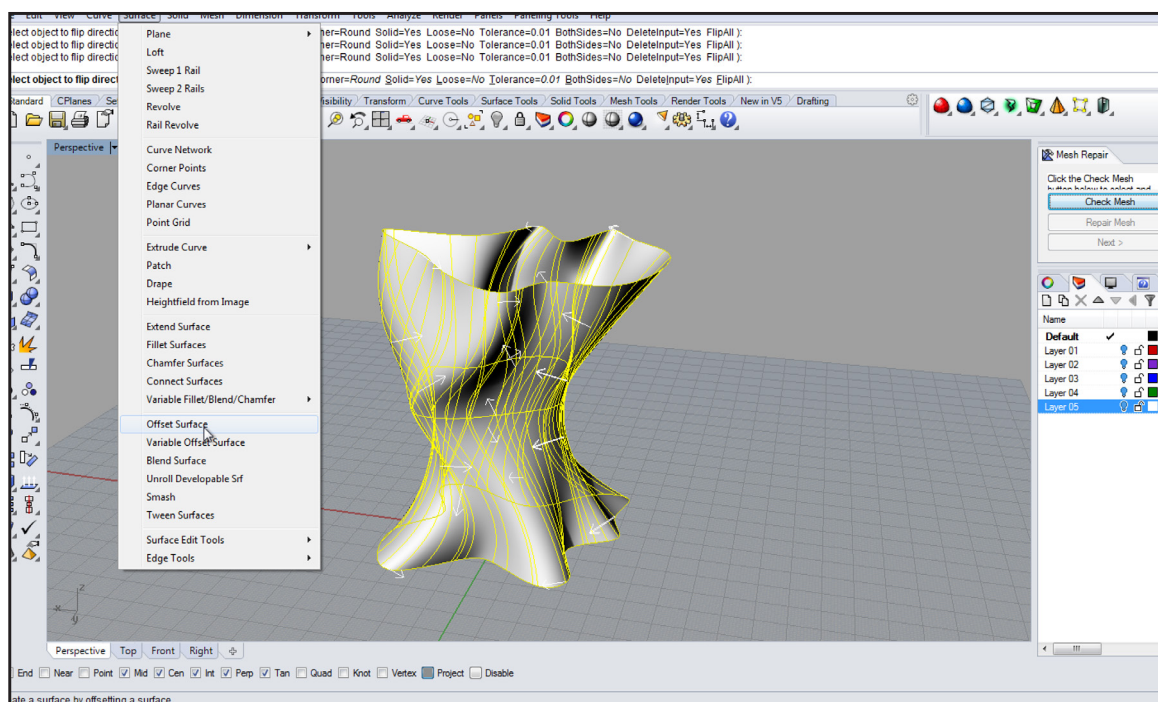




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## 9. Offset

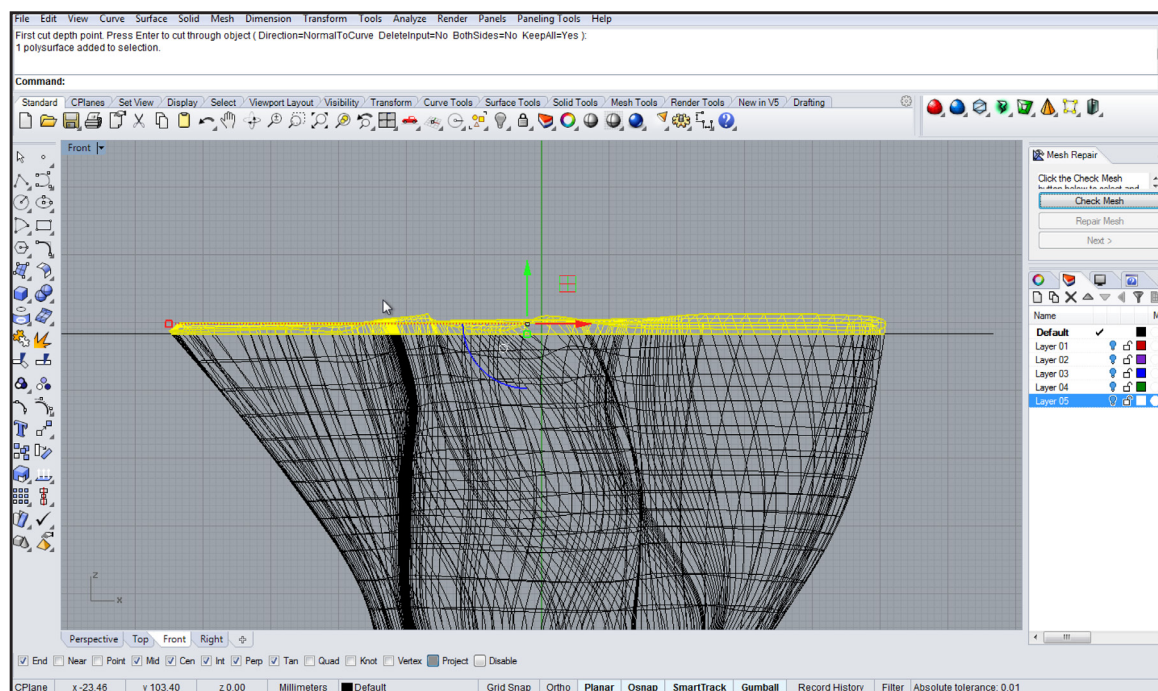
Now choose 'surface' from the menu bar and then 'offset surface'. Click on the surface to adjust the offset direction to the inside and enter 3 for distance. The wall thickness of the vase will be around 3mm.



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## 10. Trim

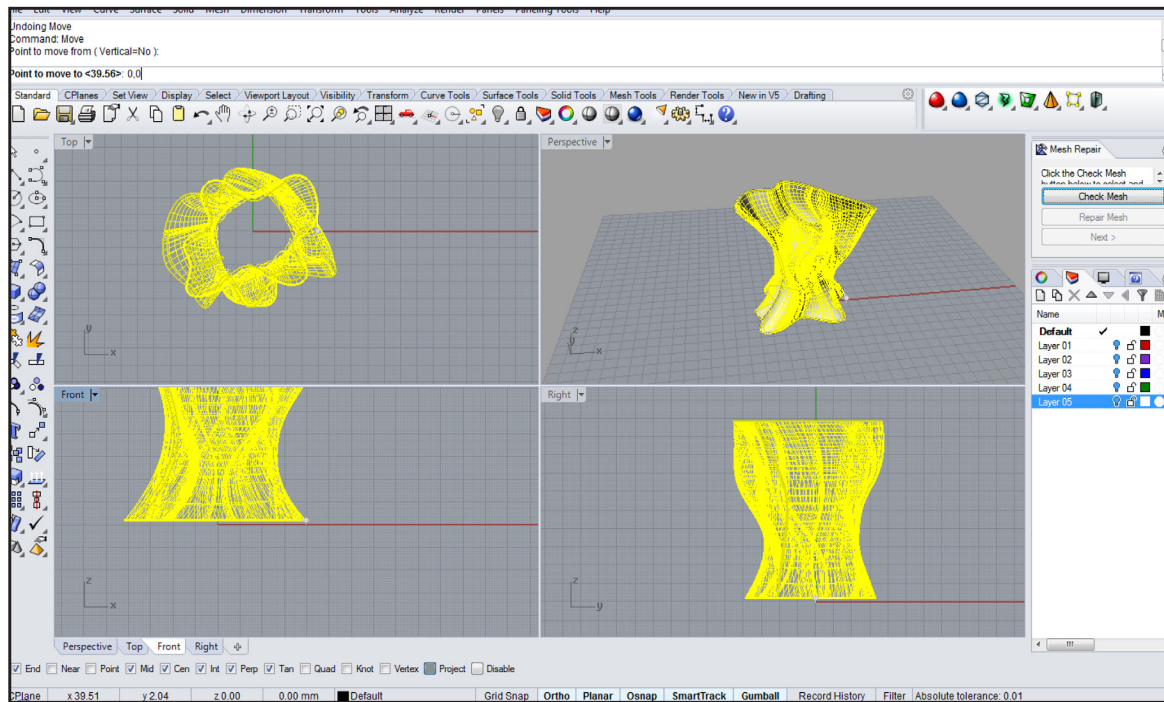
In front view draw a straight line across the geometry. Move the line towards the top of the shape, right before it gets a bit messy. In the command line type `_wirecut`, select the shape and press Enter. Press Enter again. Choose the top part and delete it. Do the same for the bottom part of the shape.



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## 11. Move to Origin

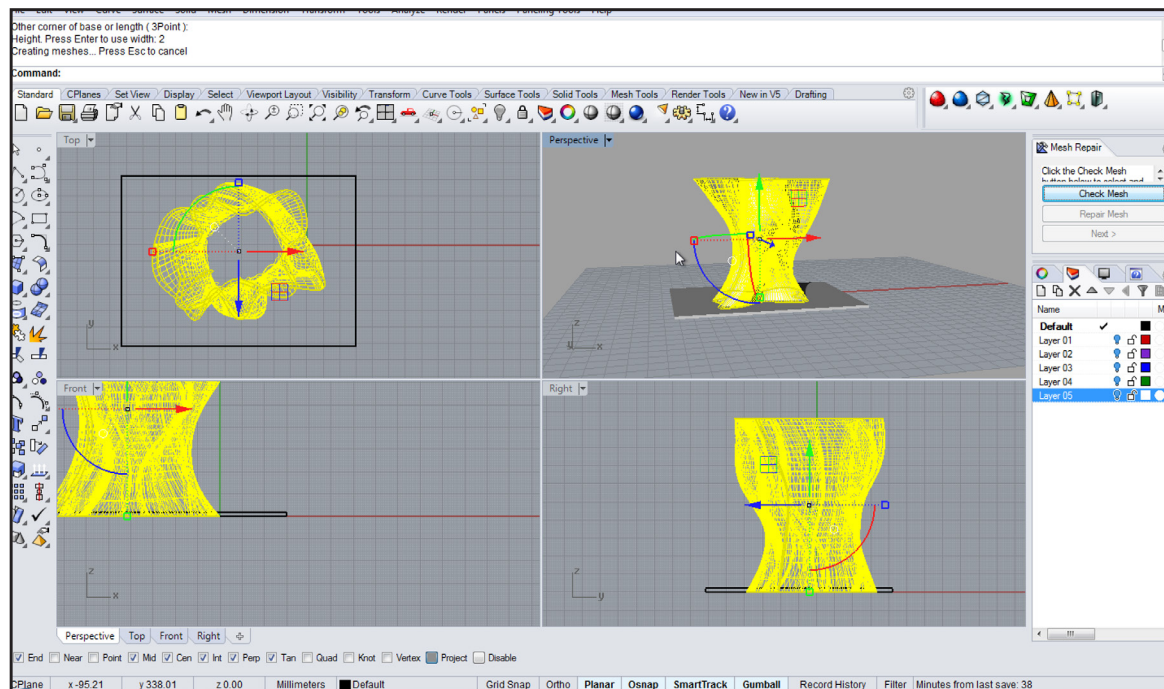
Type `_move`, select one of the bottom-most points of the shape and enter 0,0.



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## 12. Base

To create a Base for the Vase, draw a box (row 7, left / `_box`) with a height of 3mm.

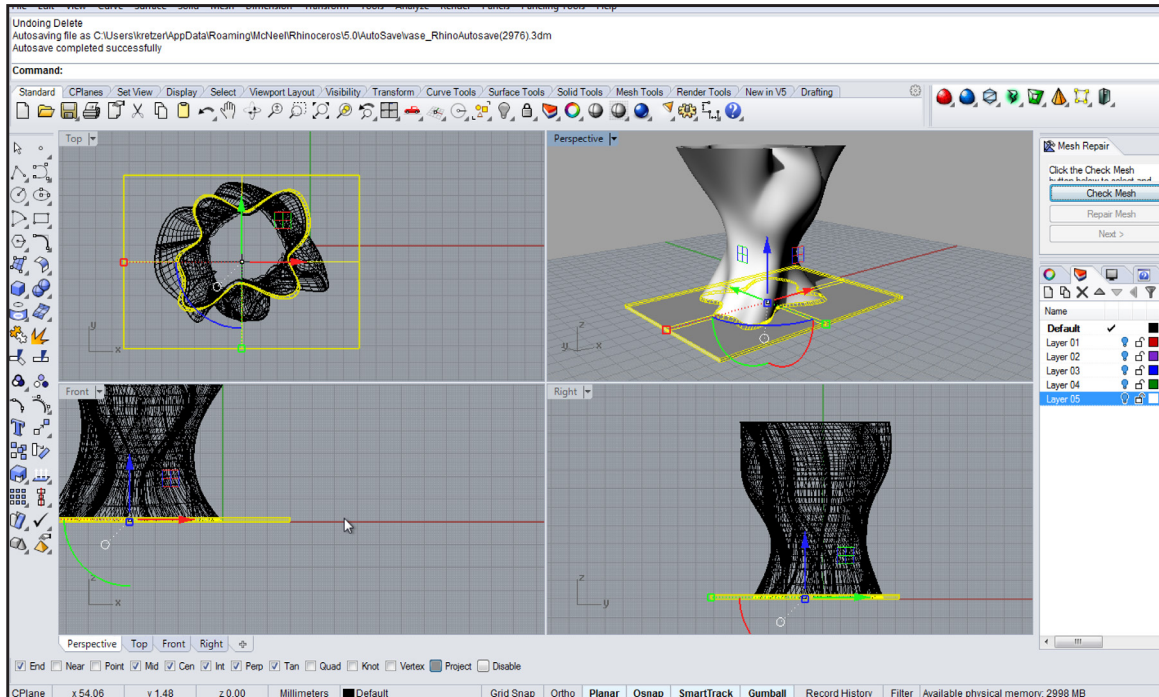




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### 13. Boolean Difference

To create the base so that it is just on the interior of the Vase, use Boolean Difference (menu bar – solid – difference). Select the box, press Enter and then select the shape and press Enter again. Delete the excess around the perimeter of the shape.

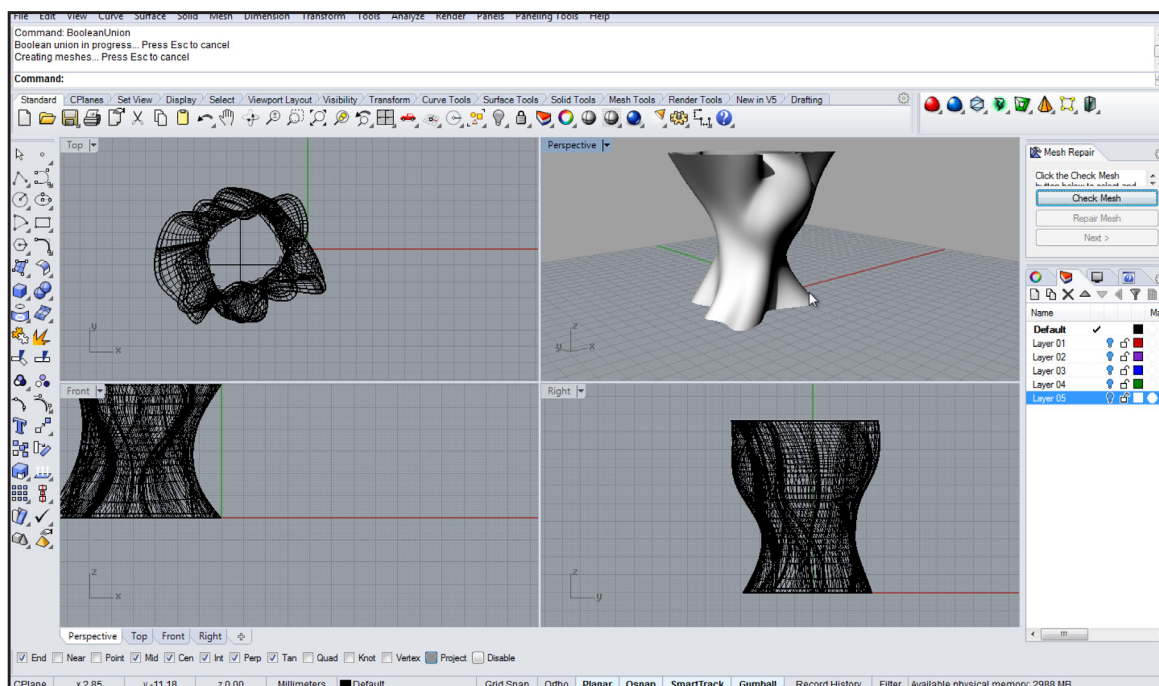


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### 14. Boolean Union

Select the newly created base and the shell of the vase and then Boolean Union (menu bar – solid – union) the two objects to create one solid, closed polysurface.

Type `_volume` to check if the surface is ready for 3D printing. Volume is a tool within Rhino that shows the estimated volume of an object. For the volume to be calculated, the object has to be a solid, watertight model with ideally no non-manifold or naked edges, just as for 3D printing. The volume tool is also very useful because you can make an estimate on how much plastic material will be needed when 3D printed.





## 15. Export

Select the shape, go to File – Export Selected and then choose STL.

To accommodate different 3D printer technologies the Max Dist Edge to Srf values should be less than half a printer's resolution. A setting of 0.01mm is good for a printer with a resolution of 0.03mm.

Max angle: 20

Max aspect ratio: 6.0

Min edge length: 0.0001

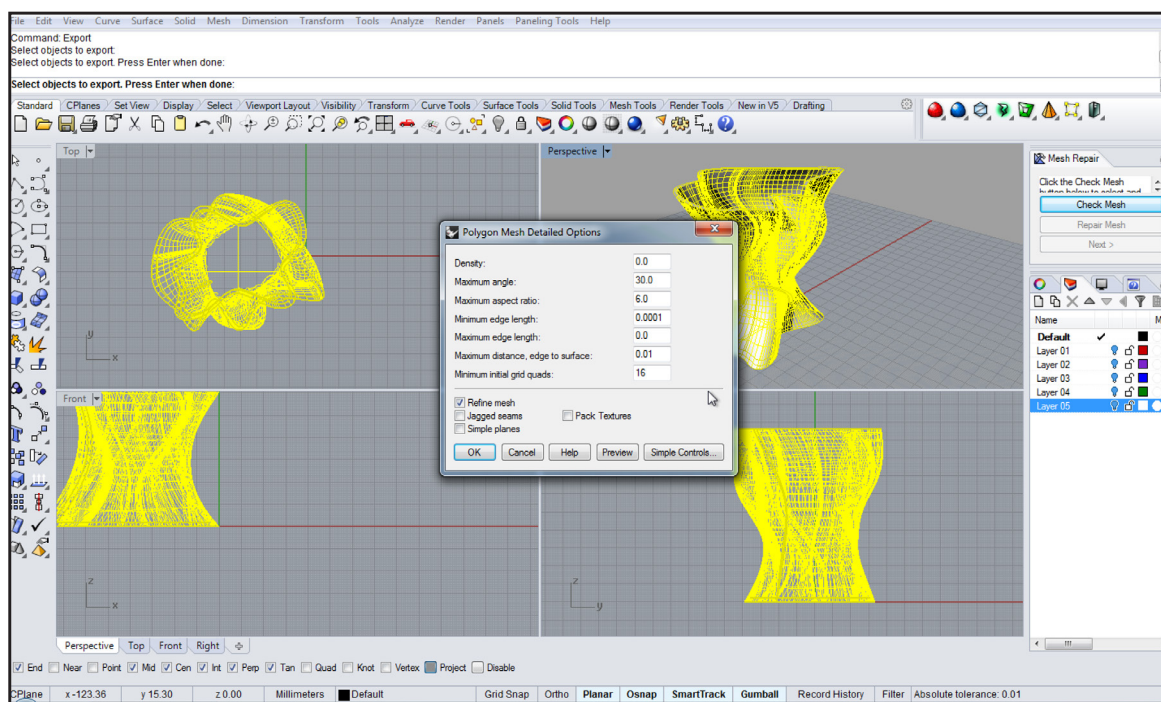
Max edge length: 6.0

Max dist edge to srf: 0.001

Initial grid quads 16

Refine checked, all others unchecked.

File Type: Binary



finished object



