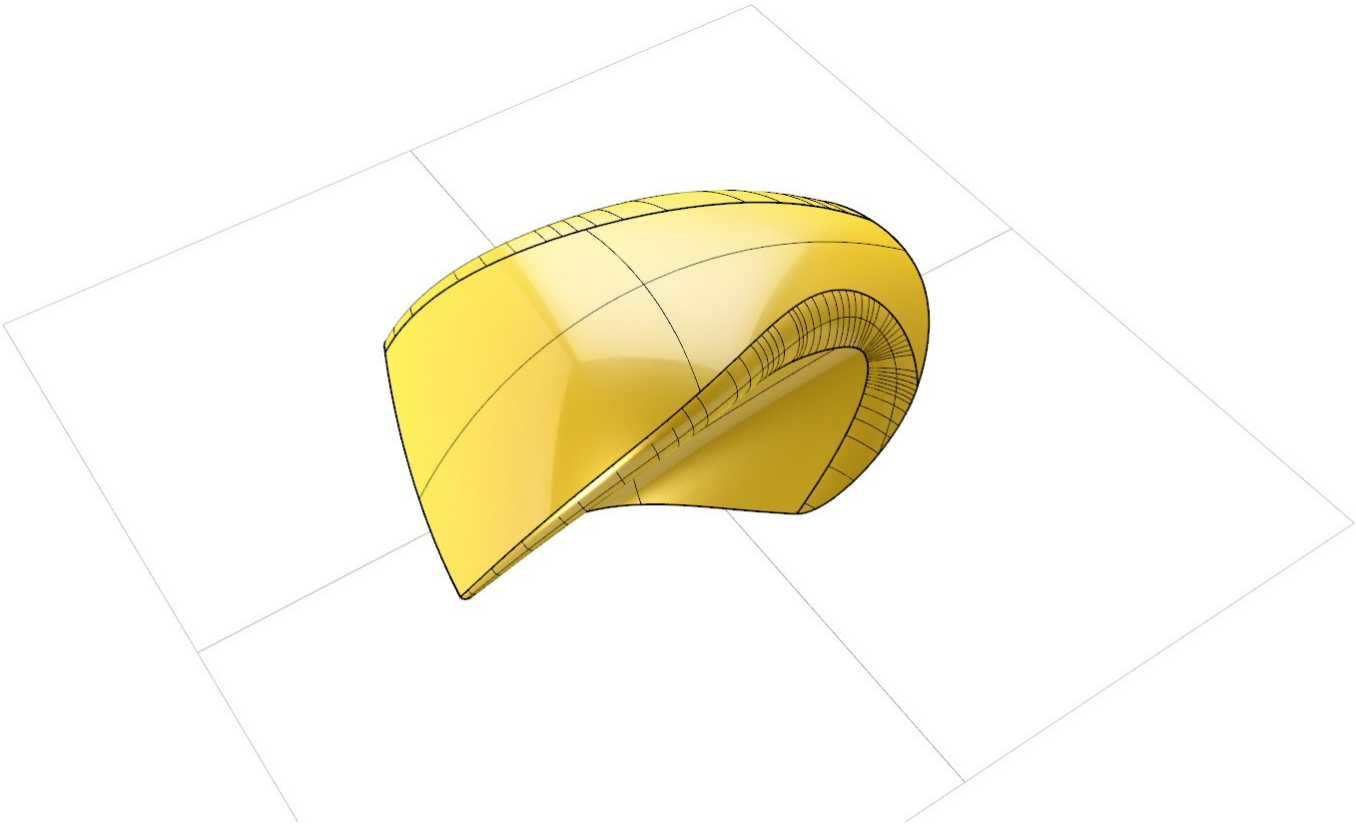
Modeling a Computer Mouse in Rhino

File: mouse.3dm



In this tutorial you will learn how to model a complete solid model by using Rhinos surfacing tools.

The goal is to show a work flow for creating the high quality surface models. Oversized crossing surfaces control the basic shape, and further surface transitions like blends and sweeps are used to round off corners. Sweeping, lofting and blending surfaces are concepts you will get experience with in this tutorial.

If you are new to Rhino modeling, it is recommended that you read the compendium “Rhino Basics” before going through this tutorial. “Rhino Basics” can be downloaded from www.pivot.no.

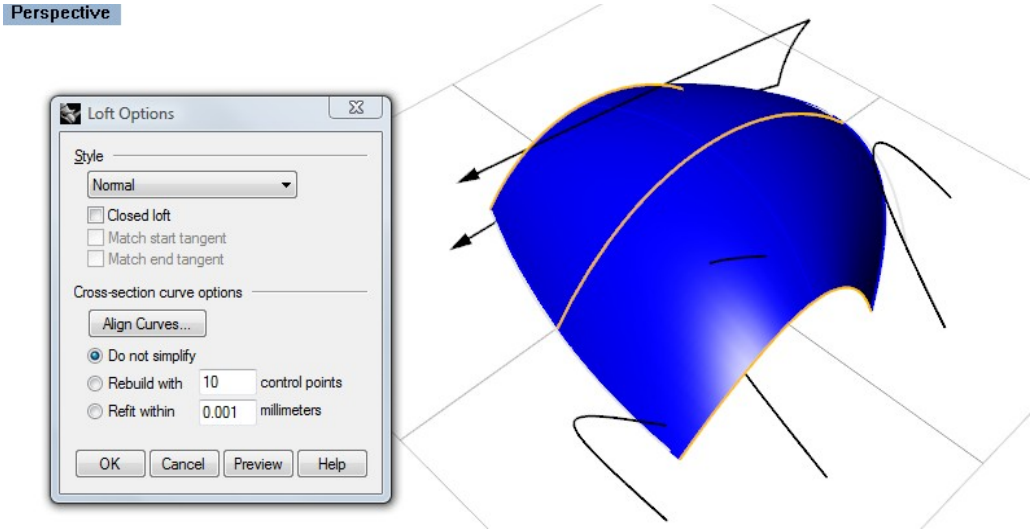
We assume you are already familiar with Rhinos interface. To save paper, we will just write the **commands** with bold letters. We don't show their whereabouts in the list menus and the icon menus. This will make you learn to use the command line if you are not already accustomed to that.

1 Open the file mouse.3dm.
It should look something like this:

Turn the points on with **POn** on all of the curves, and of again with **POff** when you have seen the control points. Notice how few control points are needed to create these shapes.

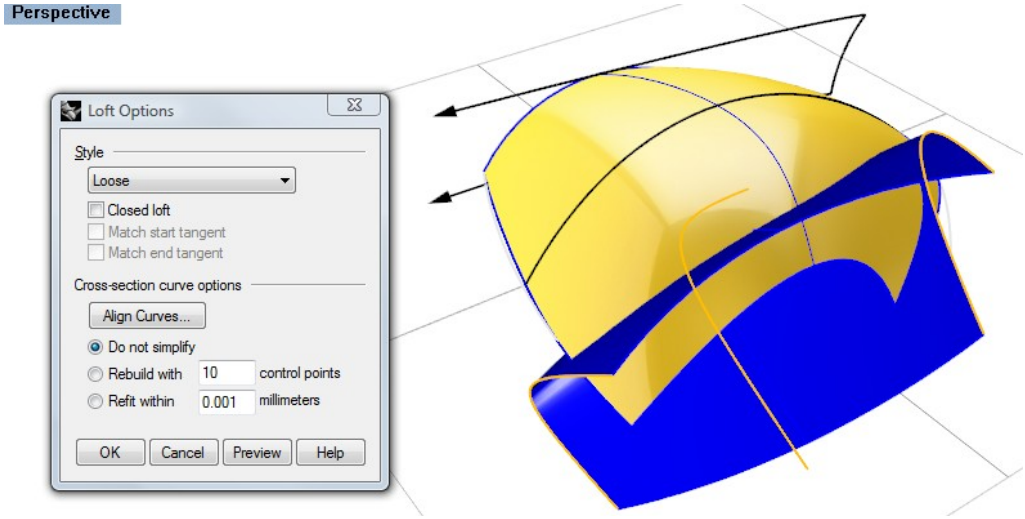
2 *Goal for this step: Use the loft and sweep commands to create the top and side surfaces. Loft is an easy way of creating surfaces that are controlled by consecutive profile shapes. Sweep2 "sends" one or more profiles along two guide curves.*

Loft the three curves that define the top surface as shown below, using the **Normal** option in the command.



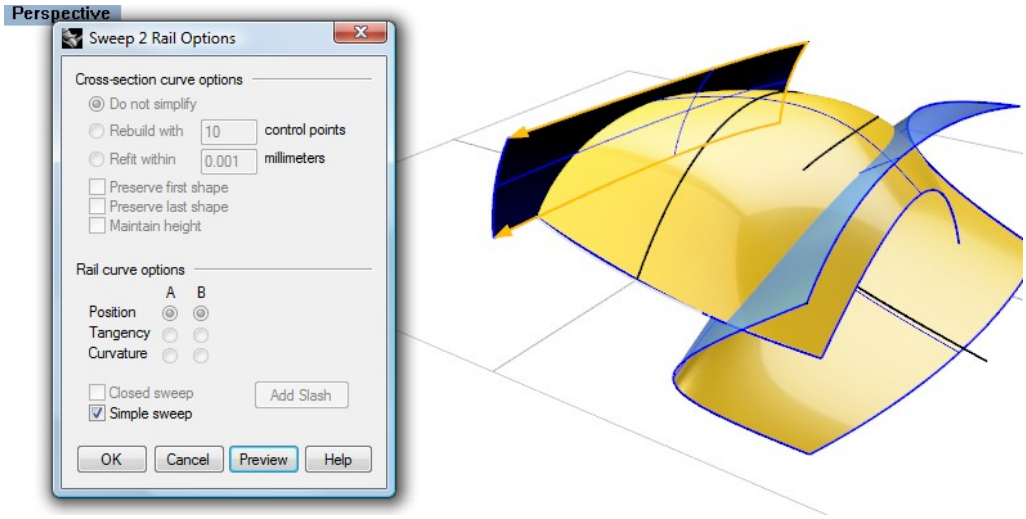
The Normal option makes the surface pass through the profiles within the current file tolerance (0.001 mm). For creating smooth surfaces, this generally works best using few profiles. When using more than 6 or 7 profiles, the surface does pass exactly through them but tends create unpleasant wiggles in between the profiles.

Then **Loft** the three curves that define the side surface, this time using the **Loose** option:



The Loose option makes a surface that has its control points at the exact same locations as the control points of the input curves. The resulting surface does <u>not</u> pass through the profiles, but it's start and end edges coincide with the first and last profile curve.
So using the Loose option can result in surfaces with very few control points, which is usually a good thing. The loose option results in smoother surfaces, but on the other hand does not pass exactly through the profiles.

Run the **Sweep2** command, an use the two curves marked with arrows as rails: Tick of the Simple Sweep option.



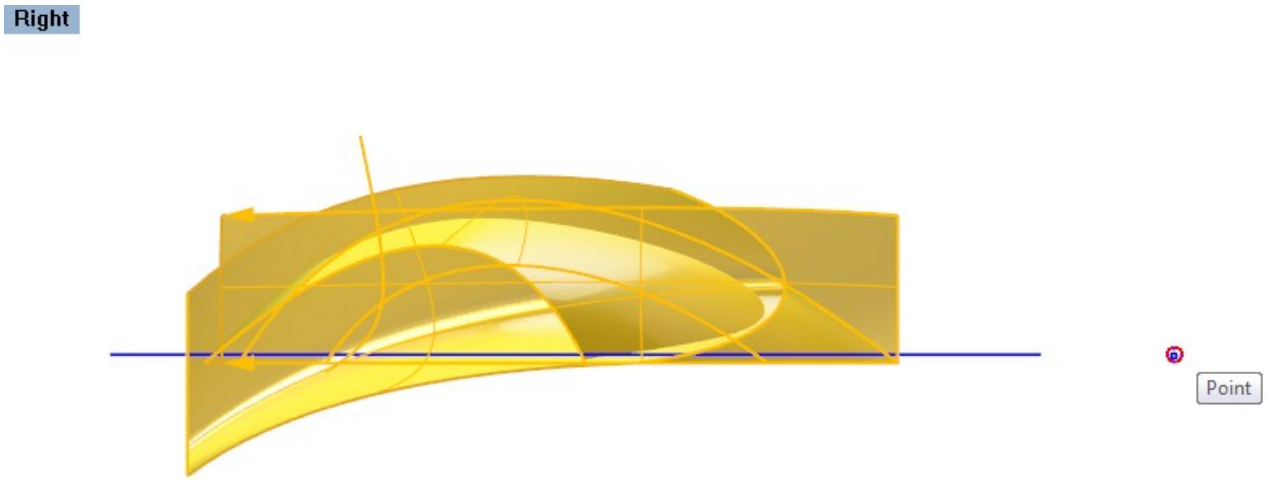
Note: The Simple Sweep option is only available when these criteria are fulfilled:
The input curves ends coincide, the curves have the same number of control points in each direction, and there are no interior profiles in the sweep. The resulting surface inherits the point structure of the input curves just like in the Loose option in Loft.

3 *Even if the surfaces we have made might not look like it, we are actually only two commands away from having finished the basic shape. The goal for this step is to create the basic shape from our surface collection. We will then trim away the parts of surfaces that do not share a closed volume.*

The first thing we will do is to create a flat surface that is going to be the bottom of our mouse.

Go to the right view, and check the Point object snap. Type **CutPlane** in the command line.
When prompted "Select objects for cut planes:", select all objects.
(You can do this by typing SelAll, dragging a selection rectangle from the left or using the Windows-shortcut Ctrl+A).
When prompted "Start of cut plane:" snap to the red point and drag straight to the left. Hold in Shift or activate Ortho to drag exactly in the horizontal direction.

The CutPlane command makes a plane that goes through all the selected objects:



The final thing we have to do to end up with a solid basic shape is to cur out the closed volume. In a simple surface setup like this, is should be possible to do this automatically with the command **CreateSolid**.

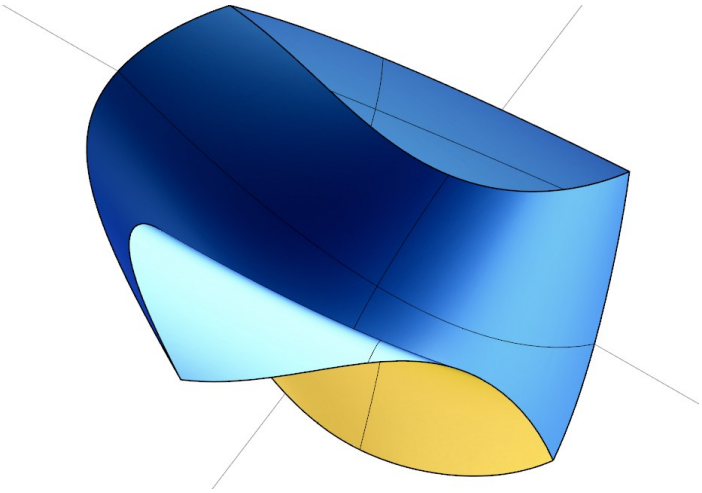
If it works, the result should look like this:

Note: If it did not work, it might be that your surface collection does not create a closed volume, or that many surfaces cross each other more than one time.

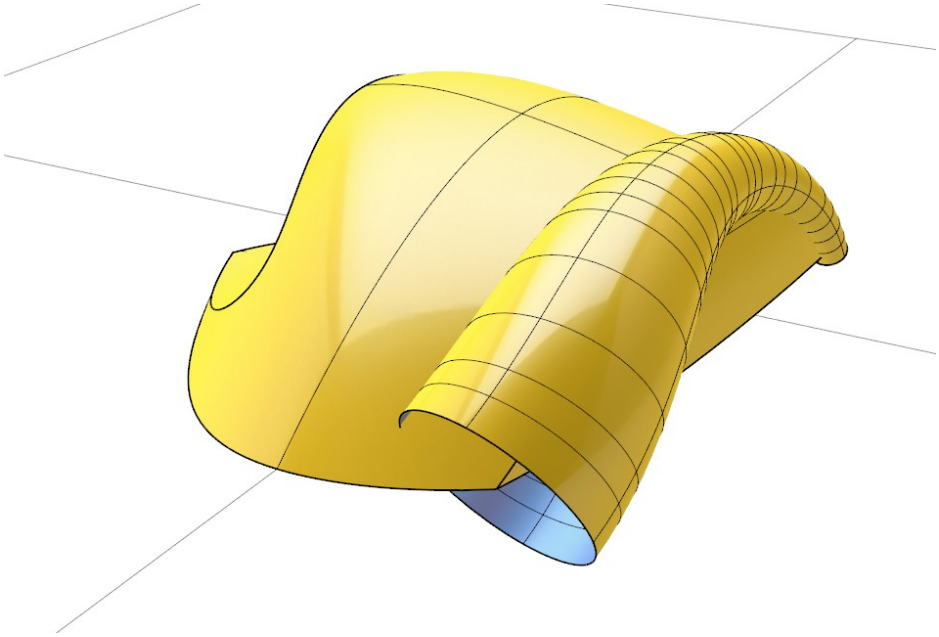
Advice: Before going further with making fillets on a basic shape like this, it can be a good idea to save a copy of the original basic shape without fillets. It's often much harder to take away fillets than to create them. Depending on your preferences you can save a copy on a separate layer and turn it of, just hide it or use Save As.
-You don't have to do it now though, since this is just a tutorial.

4 *Goal for this step: we will do "manual filleting" that is sometimes necessary to create exactly the type of smooth fillet we want. Rhinos automatic fillet function does unfortunately not create a curvature continuous fillet.*

First we will take away the flat bottom surface; It was an effective way to keep the bottom of our fillet flat in the previous step. Right now it's a bit in the way but we will recreate it later. Use **ExtractSrf** to release the bottom surface, and **Delete** it so it's open at the bottom:

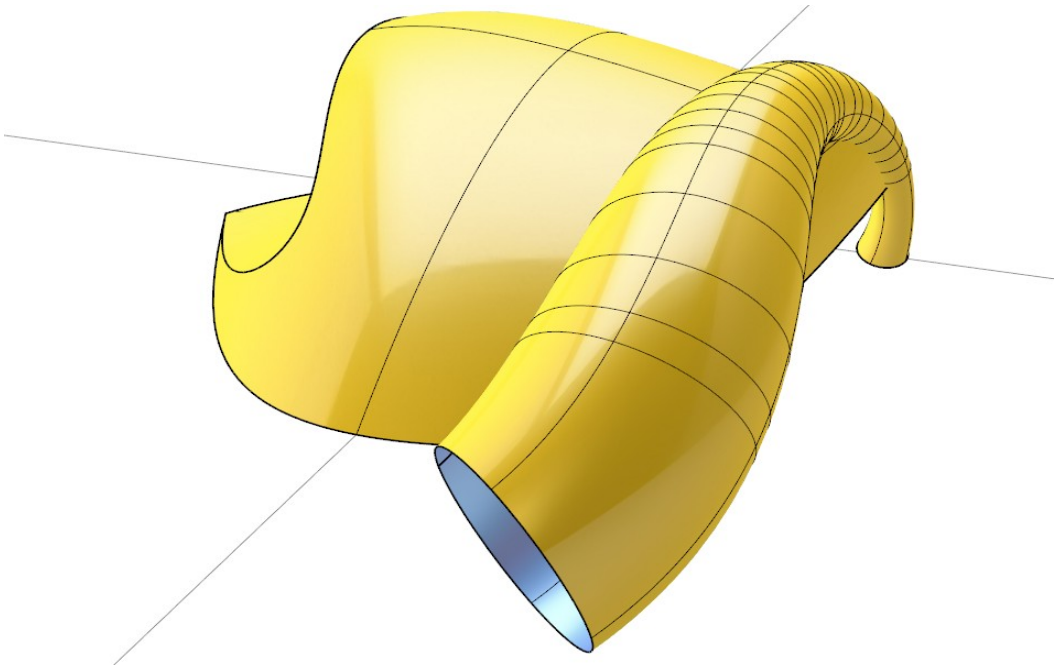


We will now make a cutting object to cut out a gap between the two surfaces at the other side. Use **Pipe** and select the edge**.** Set the front radius to **1**, and the radius at the backside of the mouse to **5**. Set **Cap=None** in the pipe command options.

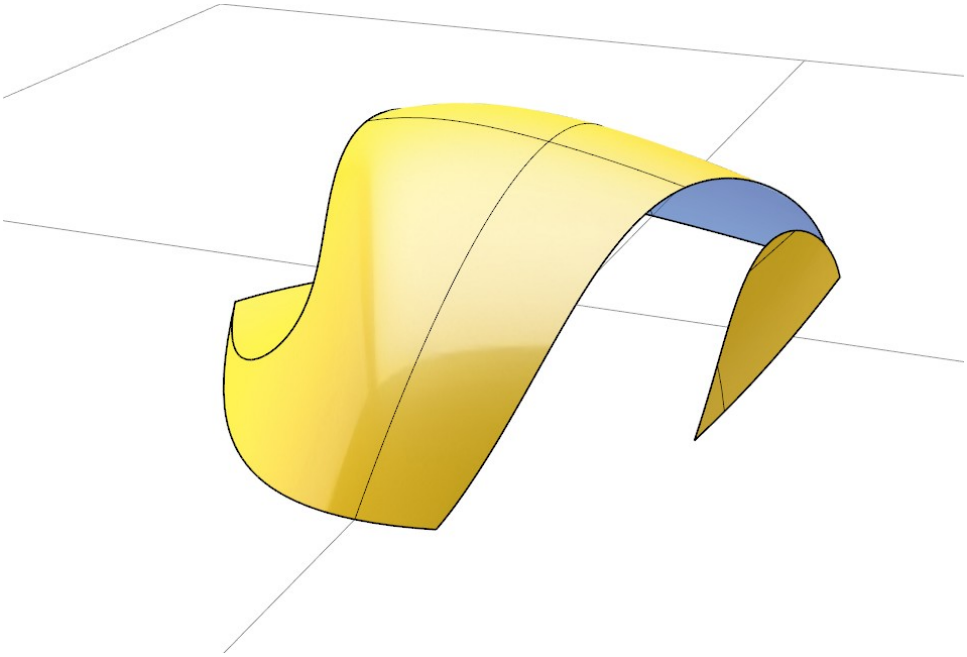


As you see on the previous picture, the pipe does not extend beyond the edges of the mouse polysurface. To be able to cut out the gap, we must go completely through its edges.

We can extend the edges of the pipe with the ExtendSrf command to extend the surface by a distance. Run **ExtendSrf Type=Smooth** and use a distance of **5** units (this is a parametric distance, and does not correspond exactly to the geometric distance in Rhino).



Now it goes through, so we should be able to trim out a gap:

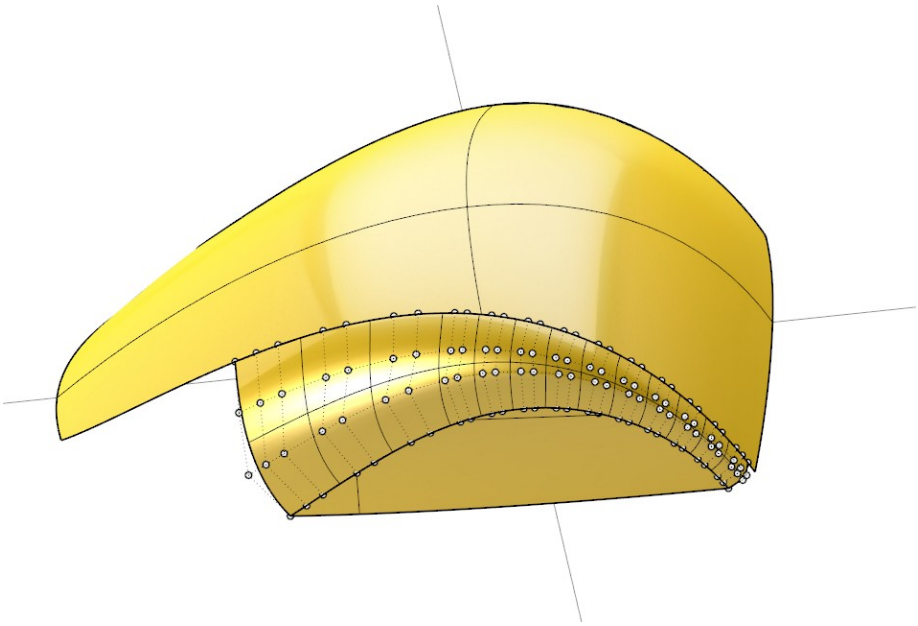


Goal for this step: You will now see how we can create a creased fillet that starts in a corner and ends in a smooth round shape. We will use the BlendSrf Command to blend surface over the gap. Then we rebuild it and re-match it to make it even smoother.

Command: **BlendSrf Continuity_1=G1** on both sides.
Use the end snap, and snap over the edge on the lower side, so the blend is confined by the length of the shortest edge (the lower one):

Tip: Check and uncheck the same height shapes option will re-scale the blend.

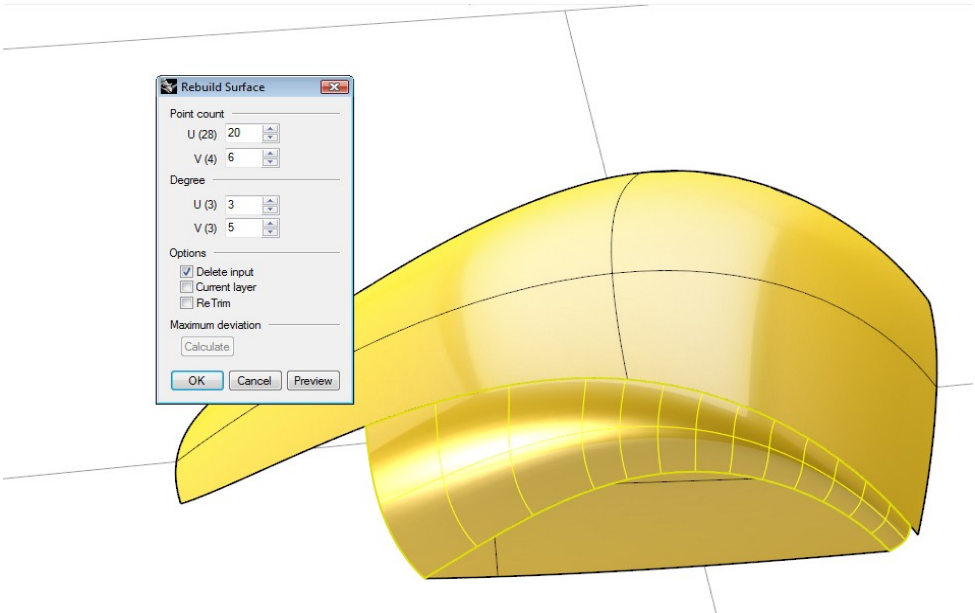
Now your surface should look like this:



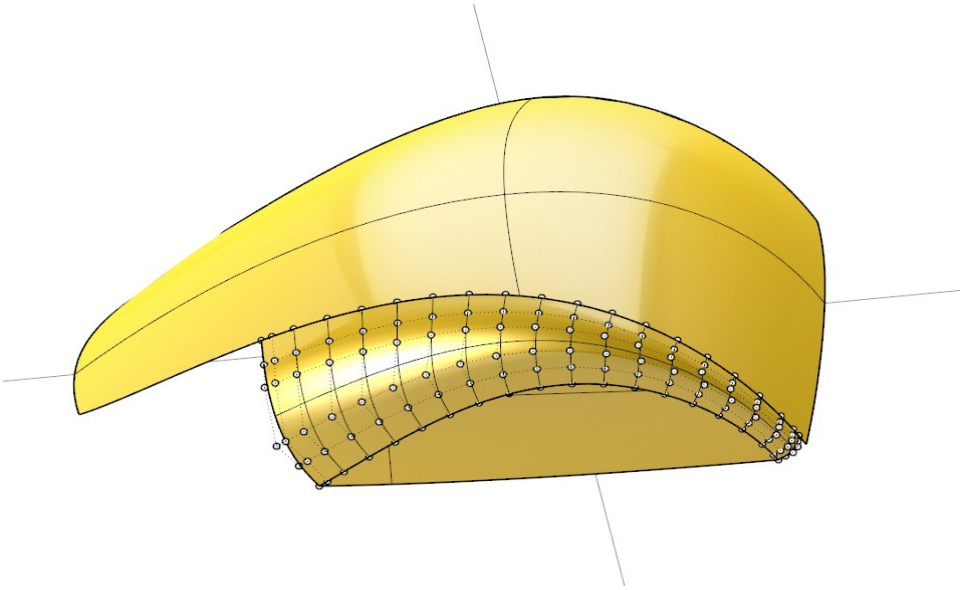
Since we used G1 in the blend option, the surface is only tangent at this stage. We need to introduce more points across it in order to match it with curvature continuity (G2).

The reason we didn't use G2 in the blend right away is only that we avoid a bit of sliding in the points this way, as the G1 blend does not pick up the curvature from the surfaces. The matching command we will do now has other options fit the surface to the adjacent edges.

First, rebuild it using the options below:

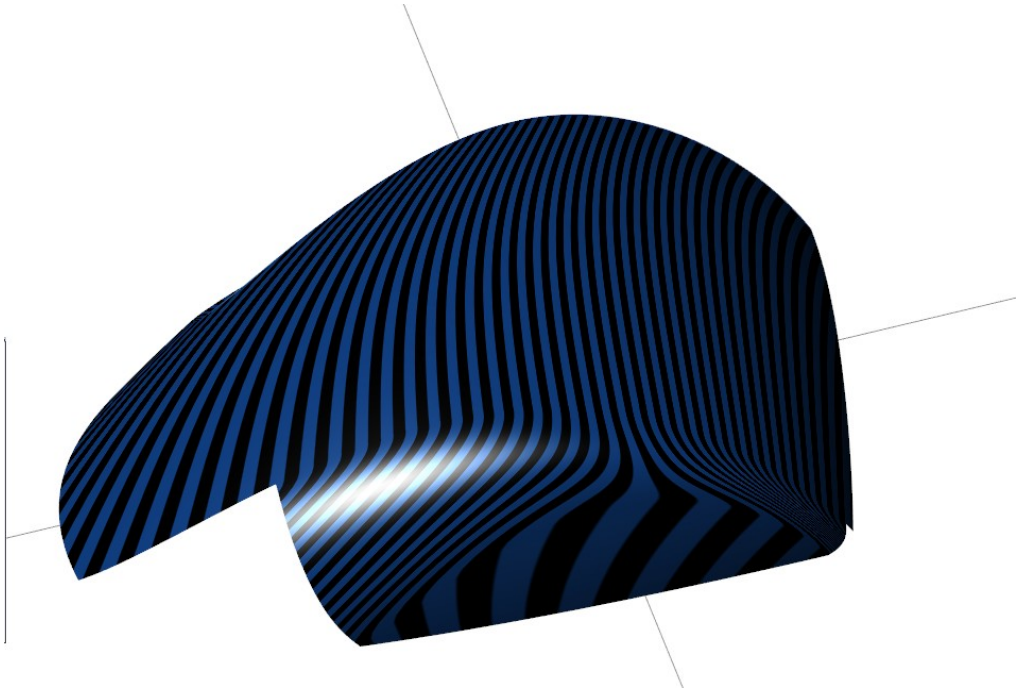


Notice now that the surface has six points across, which is good because we need them to make the surface curvature continuous on both sides. The points are also more evenly spaced.



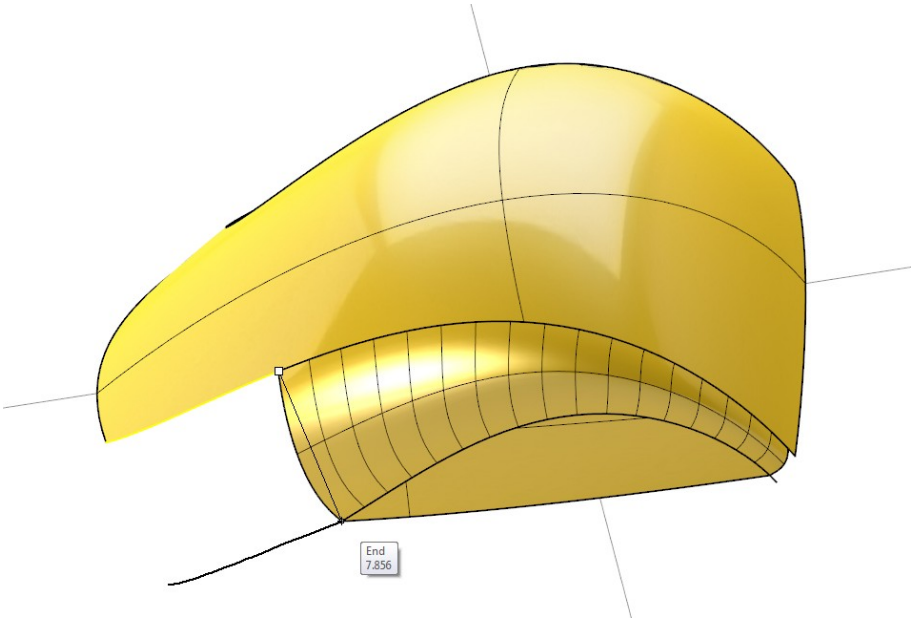
Command: **MatchSrf,** and select **MultipleMatches, and** check **Curvature, "Match edges by closest point"** and **"Preserve isocurve direction"**.

Now, join the surfaces and Zebra it to check the smoothness. Use Thin stripes.
If they are smooth like below, you're fine.

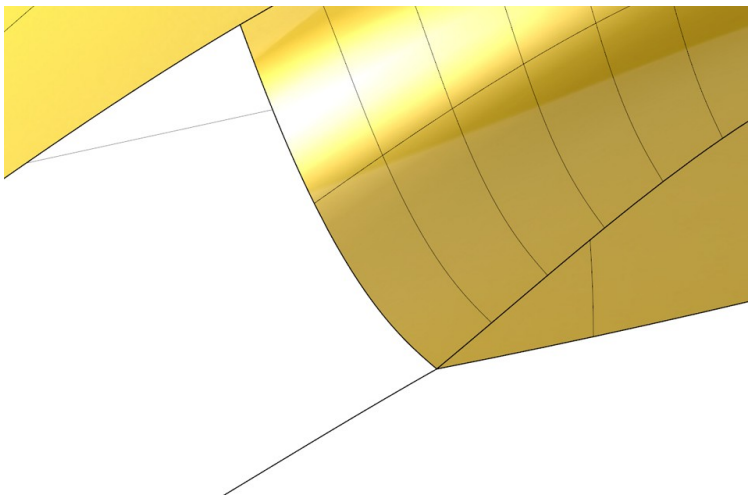


5 *Goal: At this point we are clearly missing parts of the surface in order to create a reasonably nice table surface on the mouse. Like an archaeologist reconstructing bones, we will have to make use of what we have at hand in order to extend the blend surface in a smooth and natural way.*

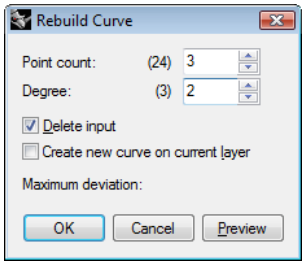
*Use **DupEdge** to duplicate both the upper edges, and use Move to move them down to the lower edges.*

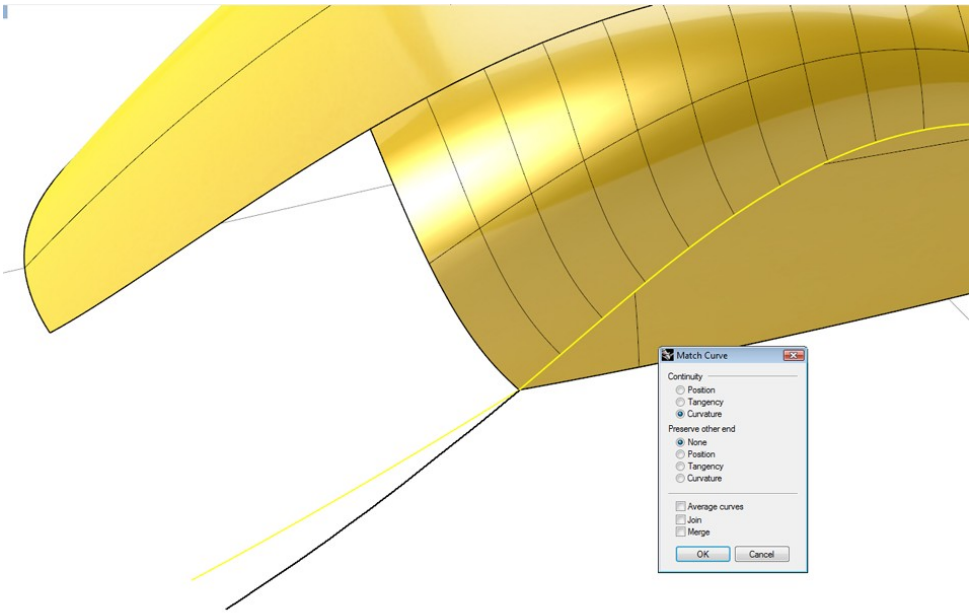


Now, if we zoom in on this we will see that this edge does not connect smoothly with the surface edge:



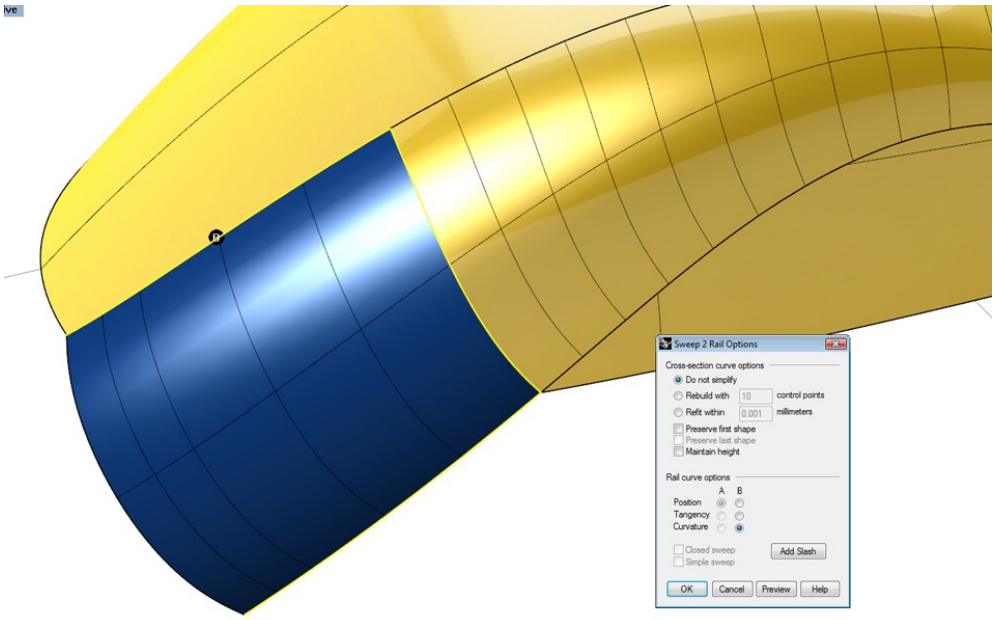
To correct that we must first **Rebuild** the curve so it has only three points, and then use the Match command and match the to the edge, using the settings shown below:



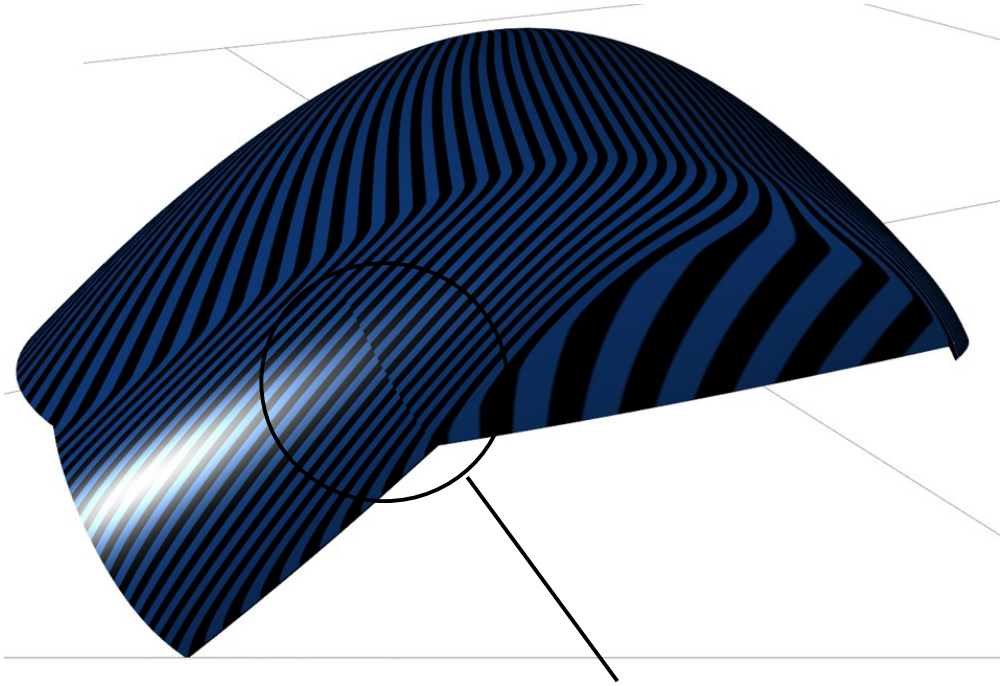


In the Match dialog, check **curvature**, and be sure to check **None** in the **“Preserve other end option”**. This wil cause the whole curve (which is now a conic section after the rebuild) to jump and align with curvature continuity to the edge curve. Since we “stole” it from the upper side, we also know that it has the linear same length. A perfect setup for a Sweep2.

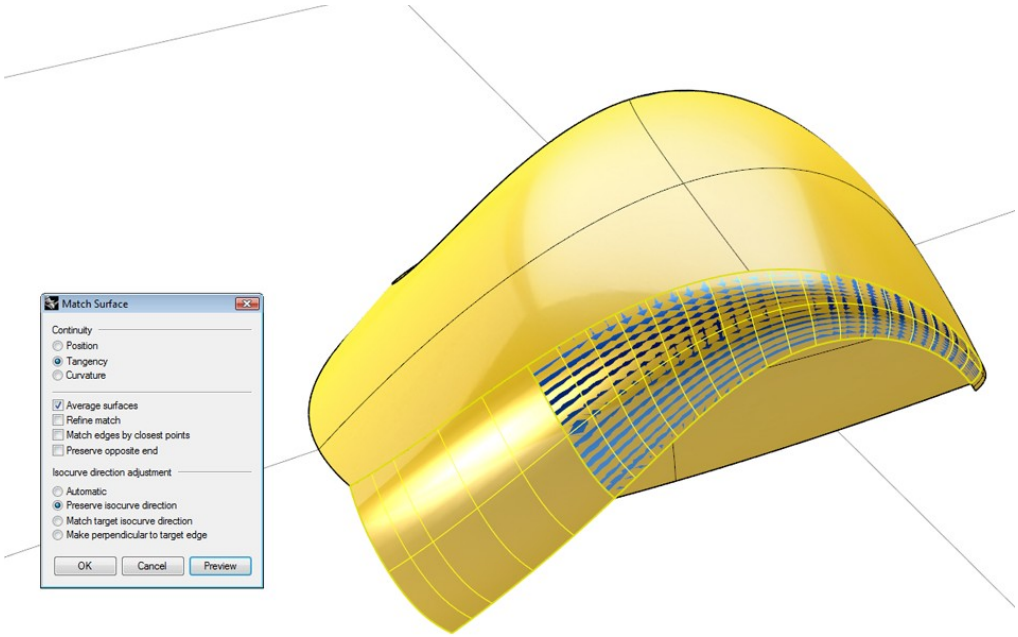
Command: **Sweep2,** with **curvature** option on the side going against the surface edge.



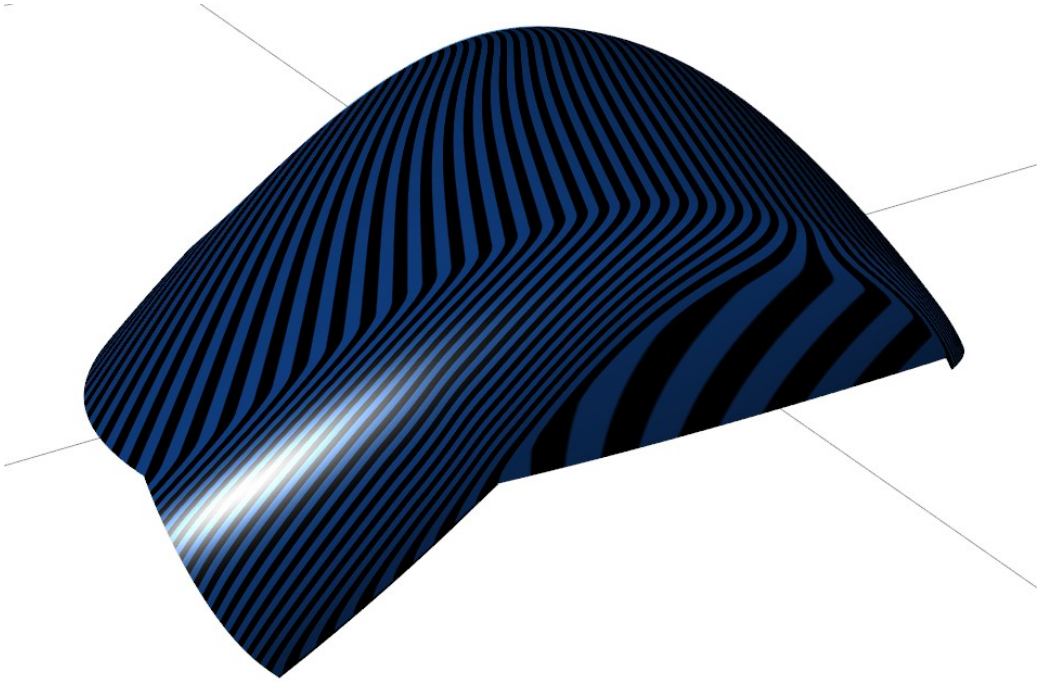
If we analyze the new surface wih zebra we see that there is a smoothness issue in the profile edge:



To fix this, we use the **MatchSrf** command with **Tangency** and **“preserve isocurve direction”,** and **“average”** options on.

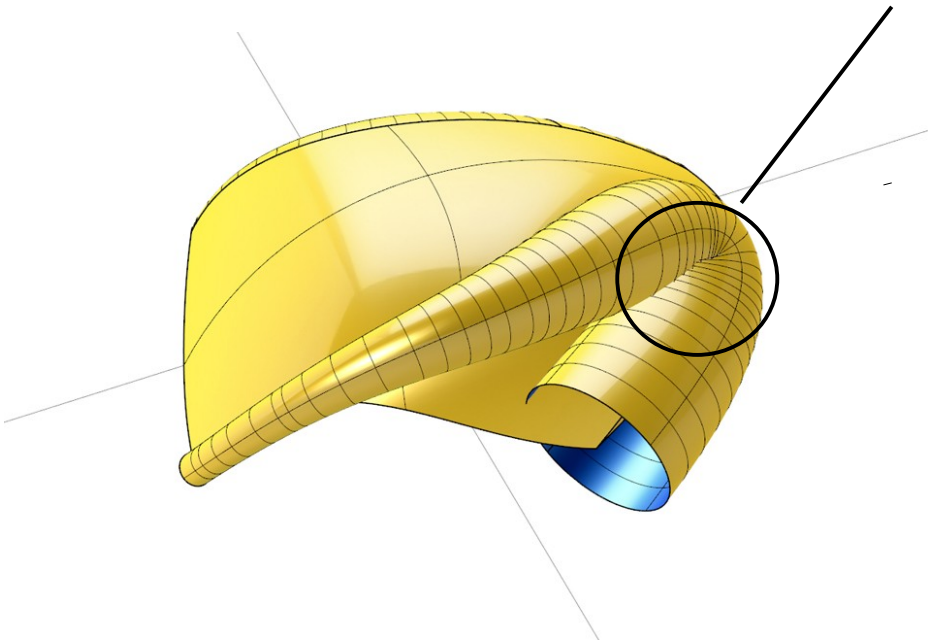


Now the zebra lines will appear quite smooth all over:

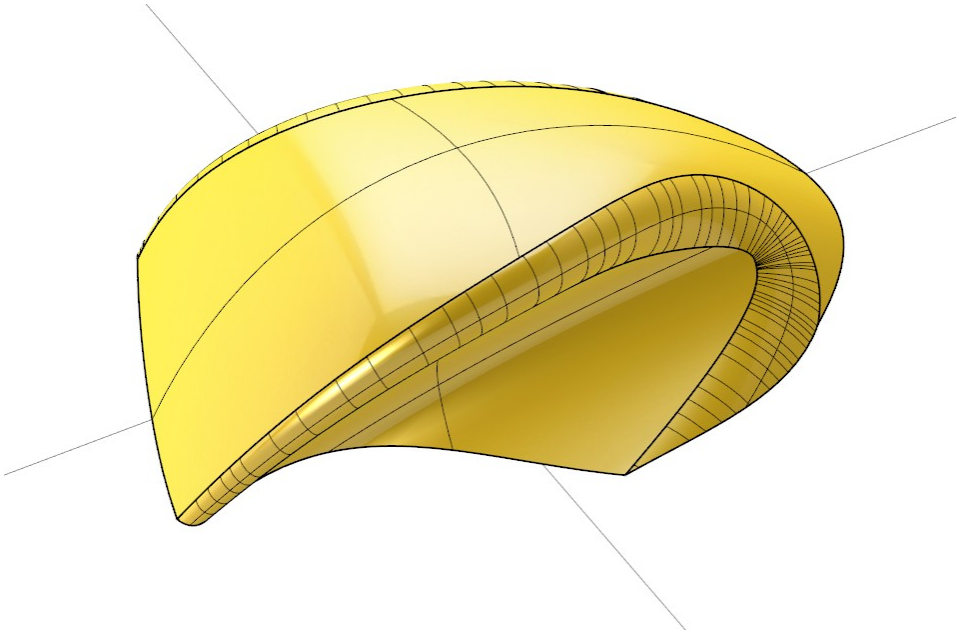


Then follow exactly the same steps on the front side.

For the other side, we cannot use the technique with the pipe, since it will turn around a radius that is smaller than the radius of the pipe, and therefore it will self-intersect:

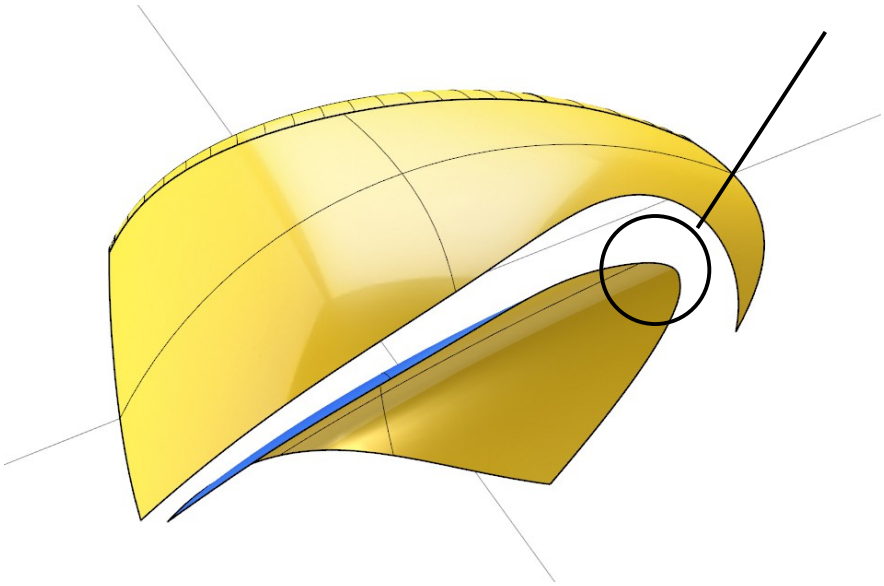


But we can use the **FilletEdge** command with **Distance Betwwen Rails** and a value of **1** in the front, and **5** in the back.

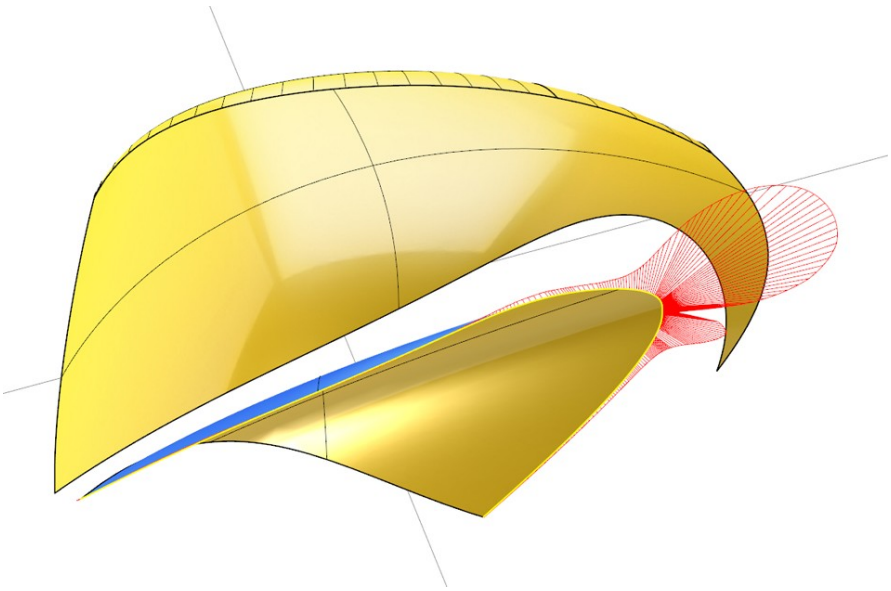


Hide the surface you just made, as we are use it as a basis for recreating a smooth version of it later on.

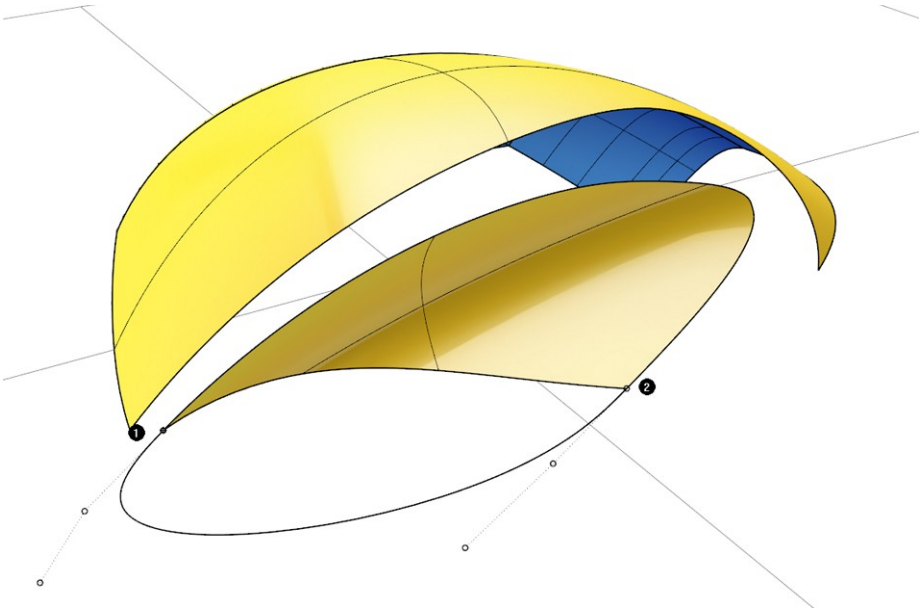
When we examine the edge, it appears to be slightly uneven in this area:



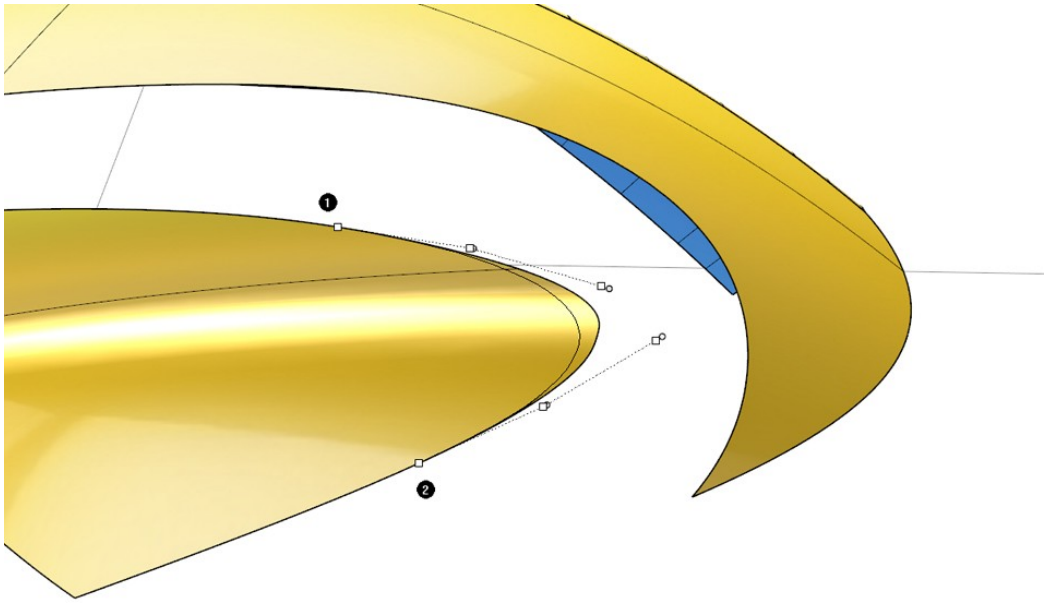
In situations like this it can be a good idea to analyze the edge with the **CurvatureGraph.**
We see clearly that this is an uneven trimming curve that can transfer into the surface we are about to make:



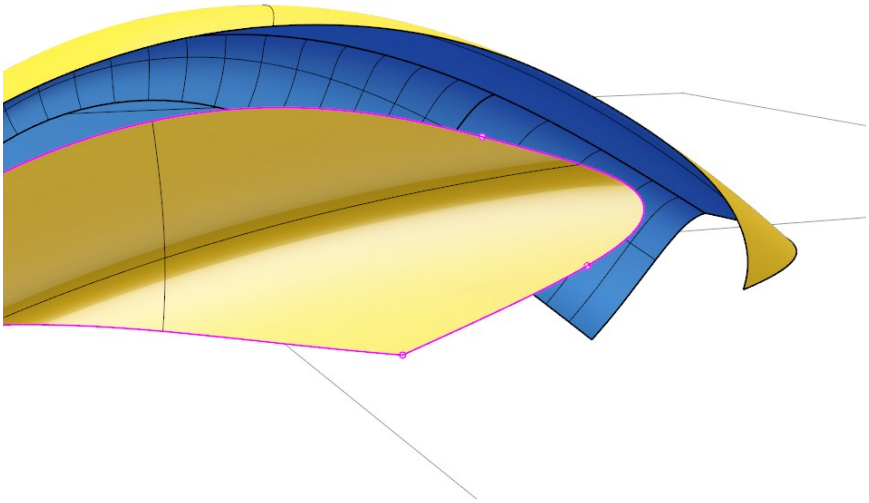
We need to cut this bad part away, and we can do this using **BlendCrv , G2, G2,** and trim:



Flip the blend curve and adjust it to go slightly over the problem area, and **Trim** that part of the surface away:

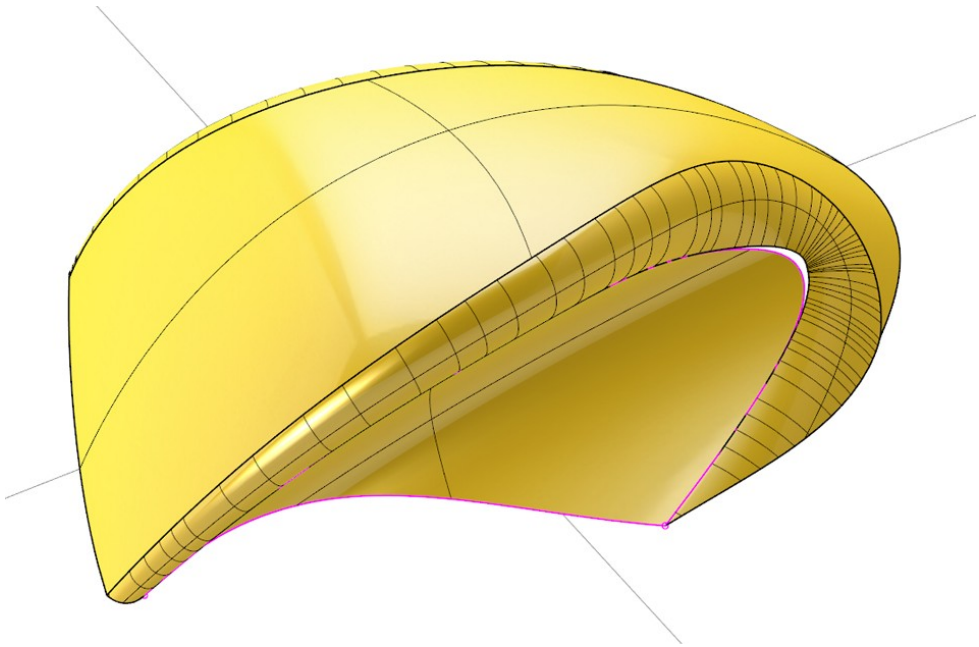


The last trim operation will caused this edge to be split. We can see marked as pink points this by using the **ShowEdges** command:

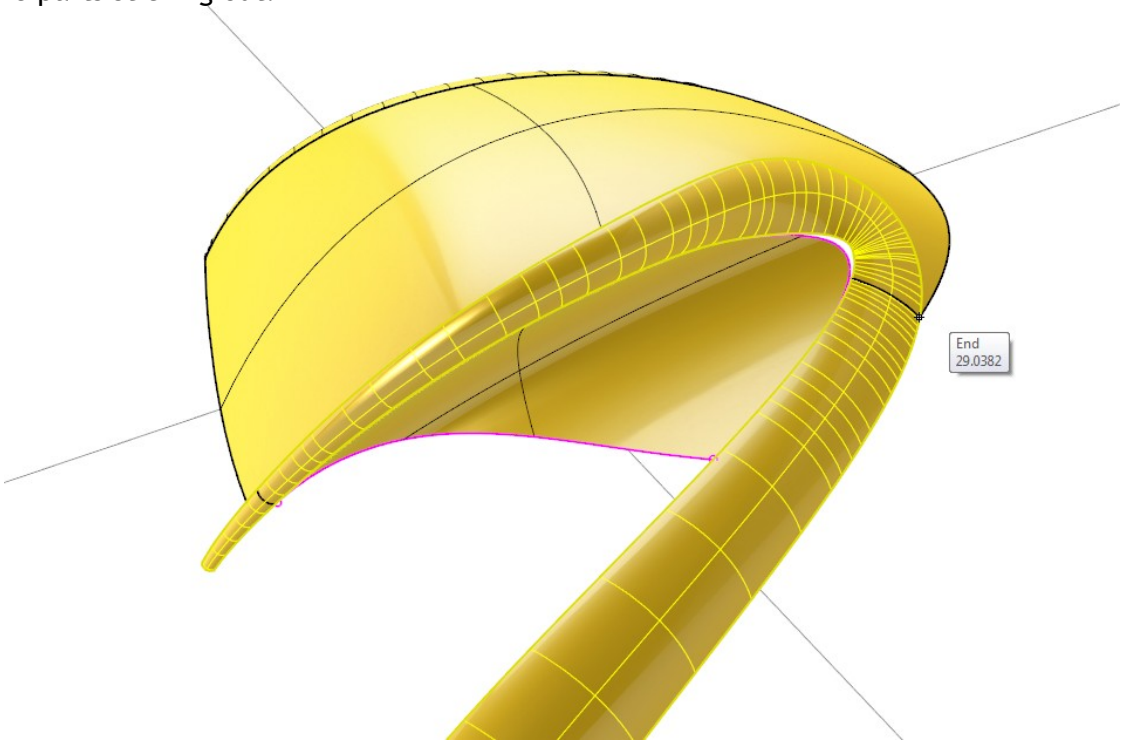


Use **MergeEdges** to merge it all into one edge.

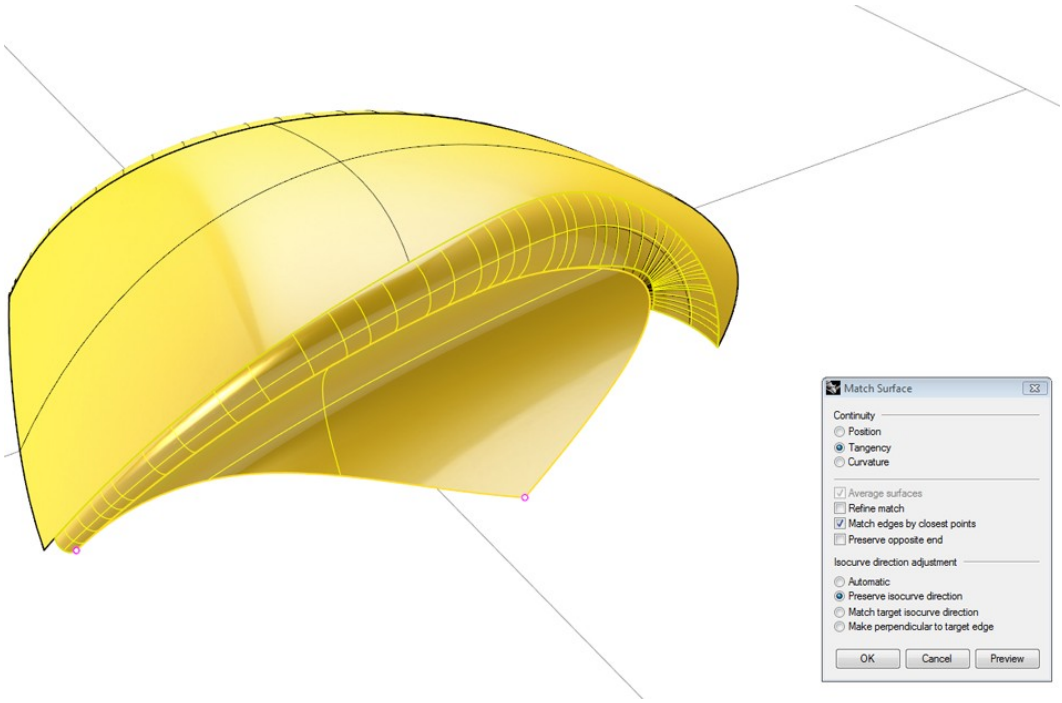
Now we are ready to make the surface, so use **ShowSelected** and click on the surface we hid.
We see that it doesn't fit quit any more, but it's still a good basis since it has isocurves that go nicely “perpendicular” to the surface edges:



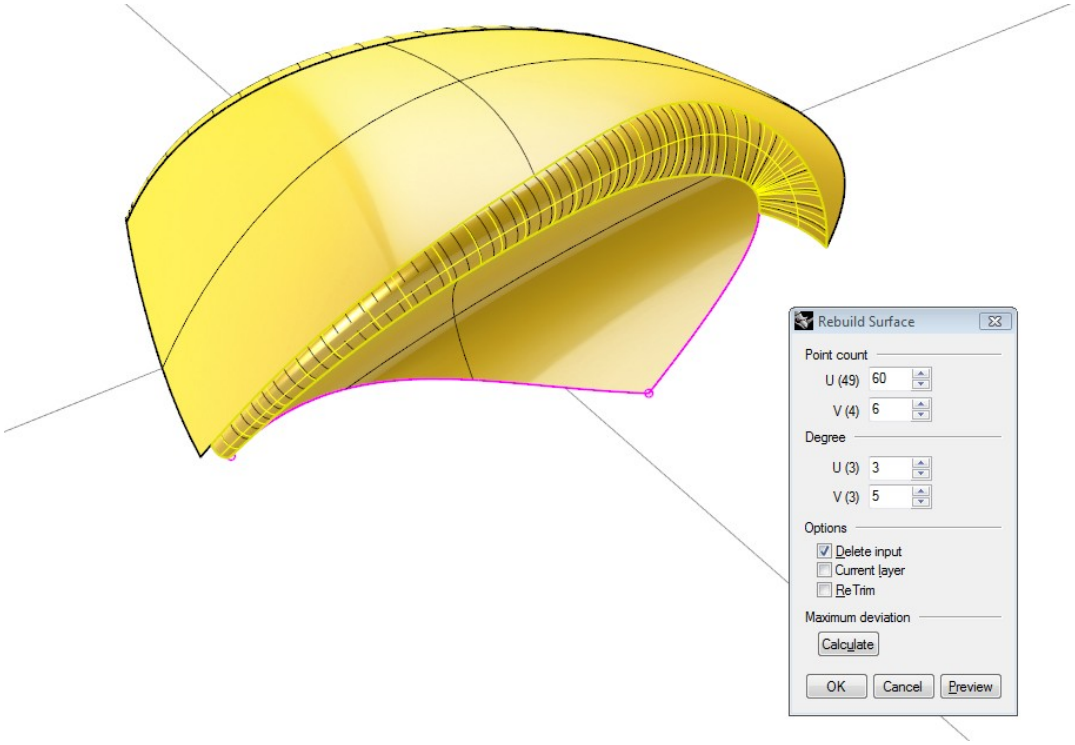
The first thing we will do is to **Untrim** it and **Split** the surface by using the **Isocurve** and **Trim=Yes** option in the command line. We split it to so it is all bounded by the edges.
Delete the parts sticking out.



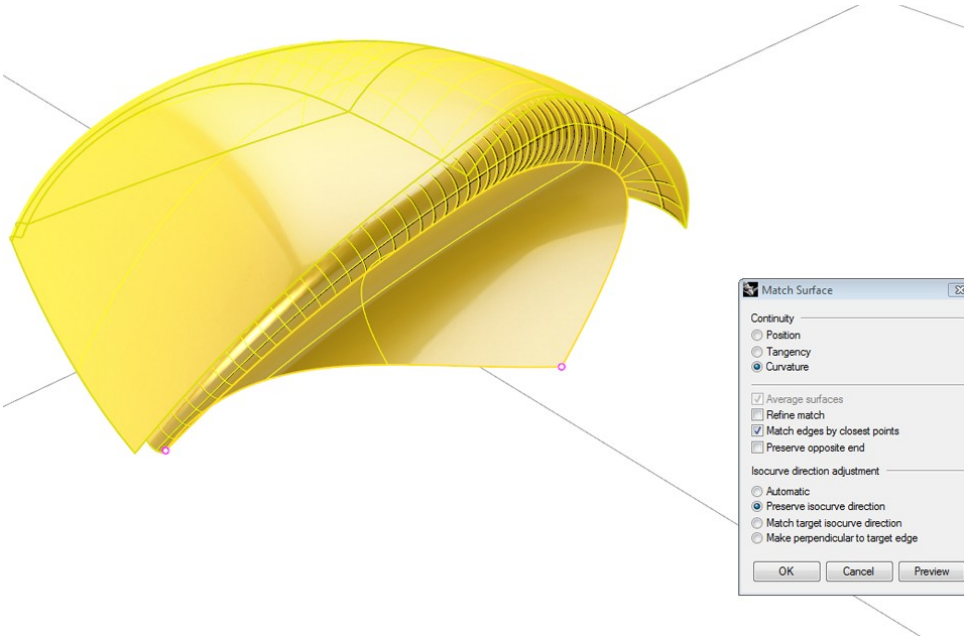
Then we need to mach it to the surface edges, using the options shown below:



Rebuild the matched surface to give it at least 6 points in the profile direction:



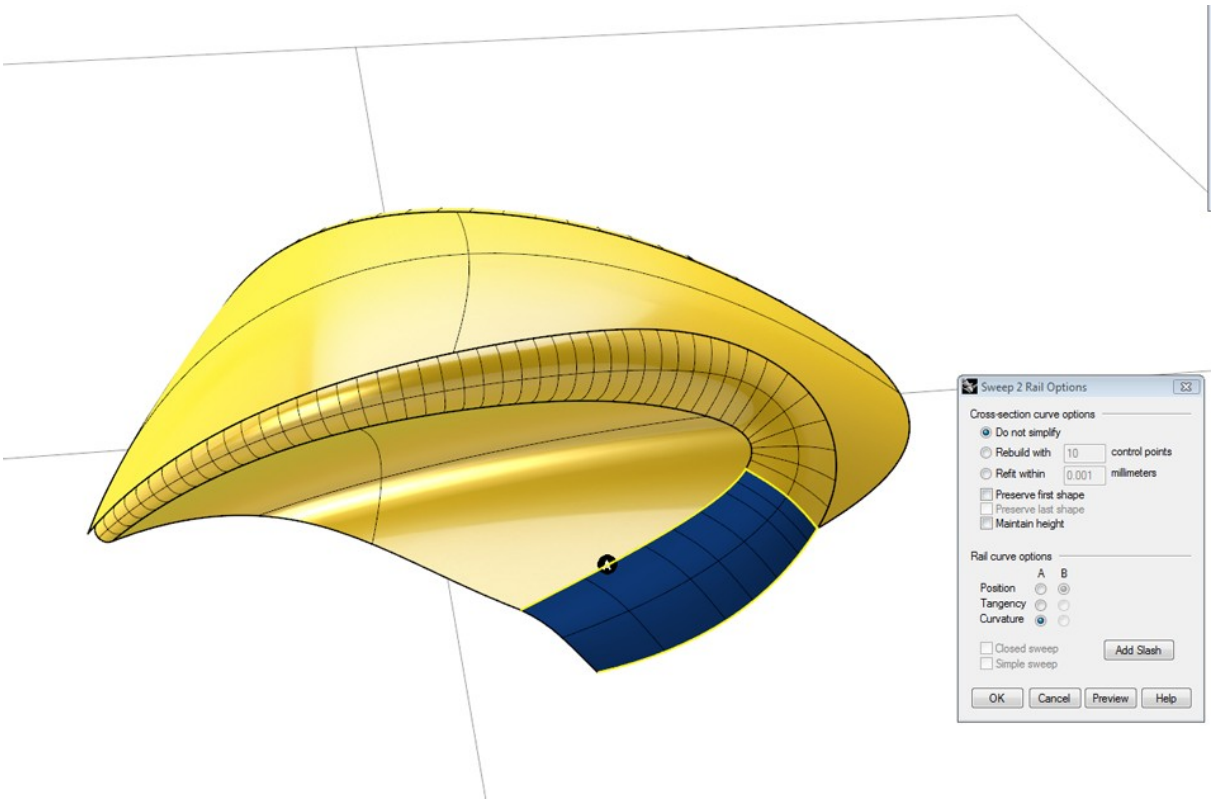
Then **MatchSrf, MultipleMatches** the surface to both of the edges using the options shown, and **Join** the surfaces:



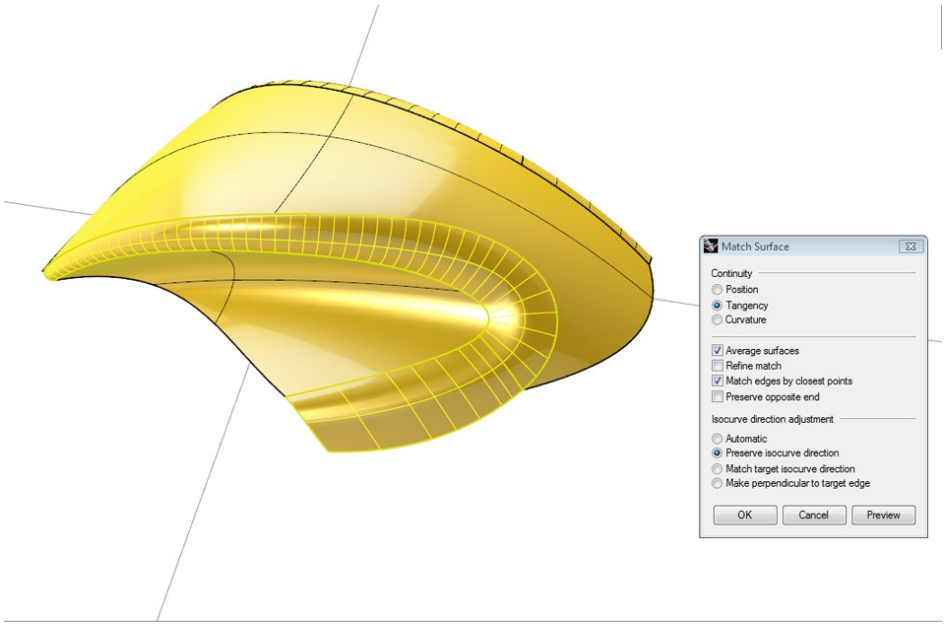
Now we have the same setup as we had a while ago on the other side, but we have to do it slightly differently. For the tiny surface on the front side, we **Copy** the edge and **Rebuild** it with **degree 2** and **3 points** like last time, and mach it with **Curvature** like we did last time.

For the curve on the rear we also duplicate the upper edge, **Rebuild** it with **degree 2** and **3 points. Only difference** is that we use Tangency when we match the curve.

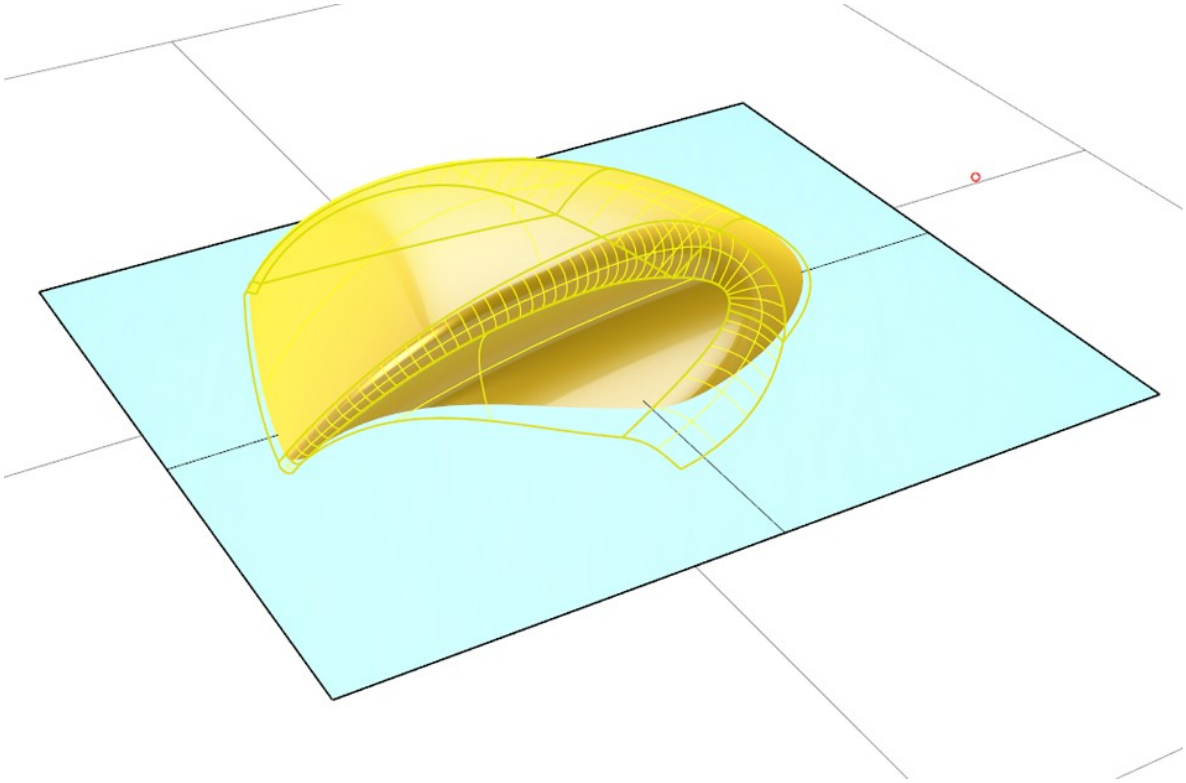
Then, Command: **Sweep2,** with **curvature** option on the side going against the surface edge:



Ans, like previously **MatchSrf** the two consecutive surface edges with **Tangency** and **Average.**
Note: Use **ExtractSrf** to extract the long surface before Matching to get acess to the **Average** option:



Join all the surfaces, and make a **CutPlane,** using the point like we did in the very start of the tutorial:



CreateSolid, and YES!
You are done.

Congratulations with finishing this tutorial. You have now been through almost all of rhinos advanced surfacing techniques!