3DReshaper Meteor Practical Exercise

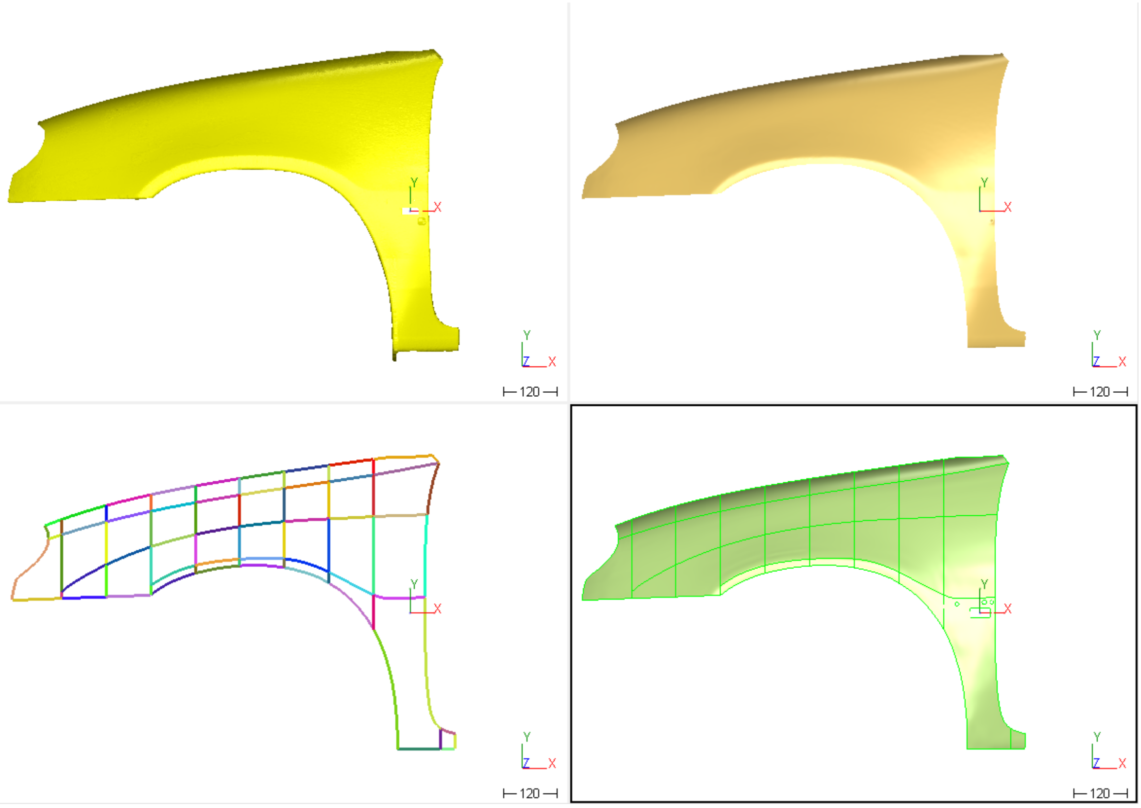
Ex13 - Reverse engineering of a car body

Introduction

The polygonal mesh modeling generates quality models, made up of hundreds or thousands of triangles. These 3D mesh models are ready for rapid prototyping, tool path generation, simulation, analysis…

In order to use measured/scanned data (point clouds) in modern computer-aided design (CAD), manufacturing (CAM) or engineering (CAE) software, you may need to generate a CAD-model, such as IGES or STEP, which can be manipulated with those.

This process is called reverse engineering. The software is a complete solution for the modeling of typical CAD objects, by providing you all the necessary functions for the construction and the processing of BSpline and Nurbs surfaces.



Exercise overview

In this exercise, we will see how to convert a mesh model into a CAD model. The process will be as follows:

- Extracting the holes of the cloud
- Meshing the point cloud
- Smoothing the mesh
- Drawing polylines on a mesh
- Running the BSpline curves and Nurbs surfaces generation
- Doing restrictions on the CAD model

The file used in this tutorial is **CarBody.rsh**

You can also read and follow the Ex5 - Reverse Engineering.

1 Extracting the holes of the cloud

Show Only the cloud **CarBody**. You see that the cloud has some holes. To create the CAD model of a cloud it is better to create a mesh without holes and to integrate the holes at the end of the process, as restrictions of the CAD faces. We need to prepare this by extracting the borders of the holes first.

Select the cloud **CarBody** and launch Construct \ Circle \ Using Nominal Circle. Click 3 points on the hole (with the mode **Vertex / End** of the Entering point procedure) as on following image to create a rough circle.

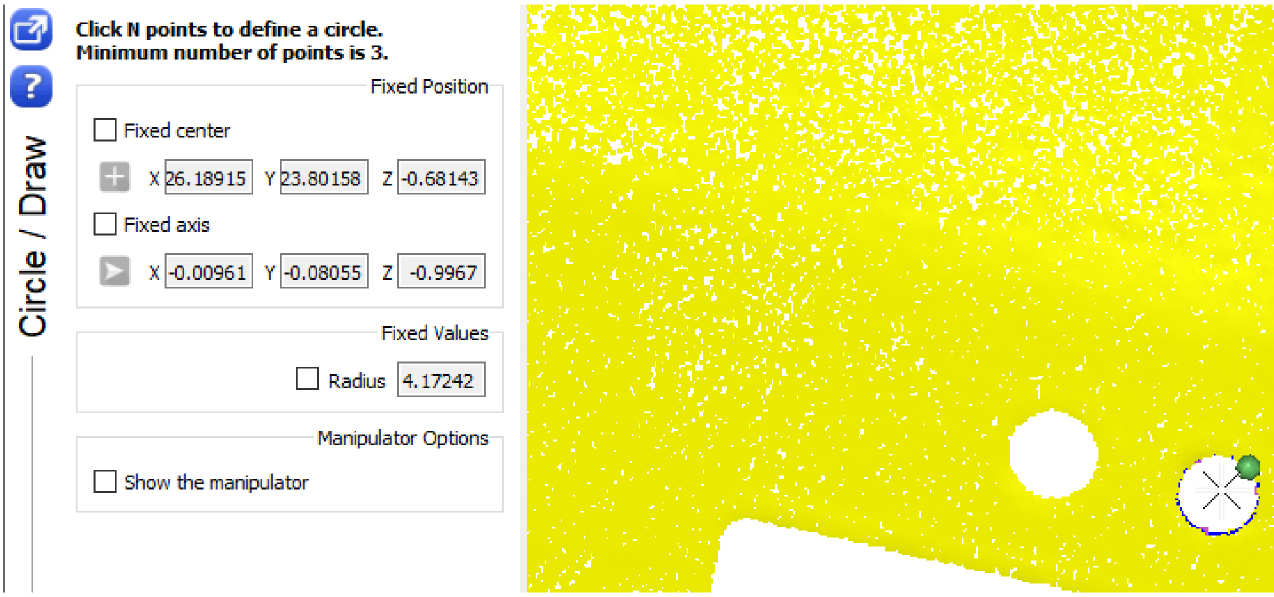


Figure 1: Draw a circle

Validate by selecting **OK**. Set the options of the next dialog as shown in the following illustration and click **Preview**. You have a precise circle fitting the border of the hole.

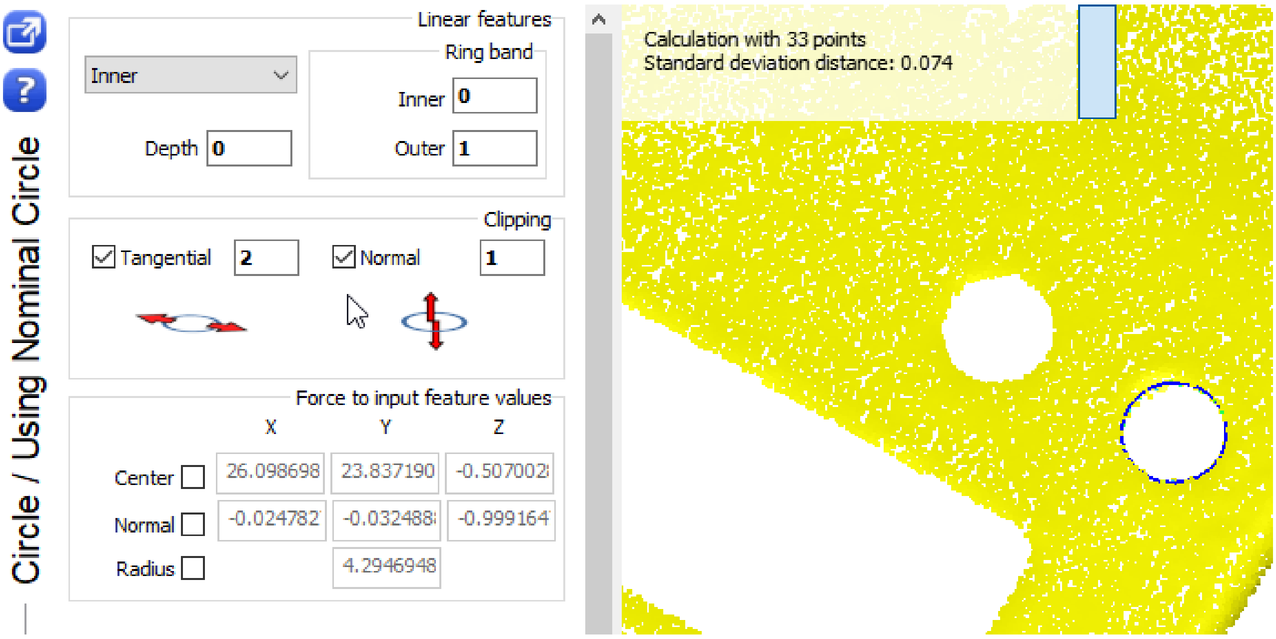


Figure 2: Extract a circle using a nominal one

Same process can be used for the 2 other holes of the cloud.

Then, the big hole, similar to a square slot, can be extracted with the command Construct \ Square Slot \ Using Nominal Square Slot.

To simplify the task, the shapes are already present in the **Geometric Group folder** so, this first step can be skipped.

2 Meshing the point cloud

Select the cloud **CarBody** and launch the command Mesh \ 3D Mesh.

Select the mode **Meshing in two steps** and enter 4 the **Average distance between points**. As we want to close the holes, choose **Try to keep only the external border**. . Click **Preview**.

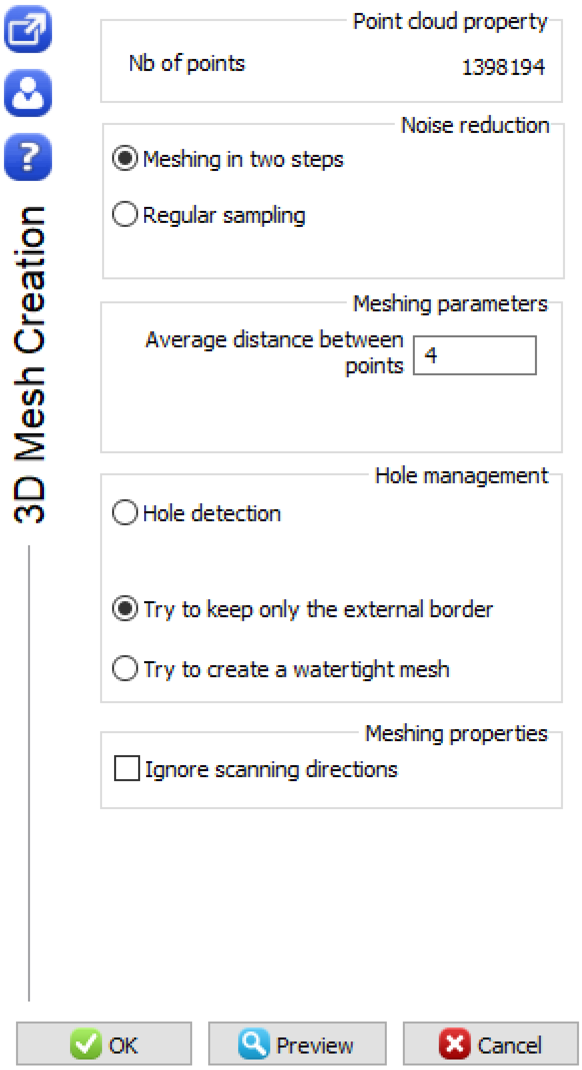


Figure 3: Creation of a 3D mesh

Click **OK** to continue with the second step.

Use the method **Interpolate new points**, set the **Deviation error** to 0.1 and check the **Local reorganization** option. Set the **Maxi number of triangles** to 1000000 and the **Minimum triangle size** to 0.2.

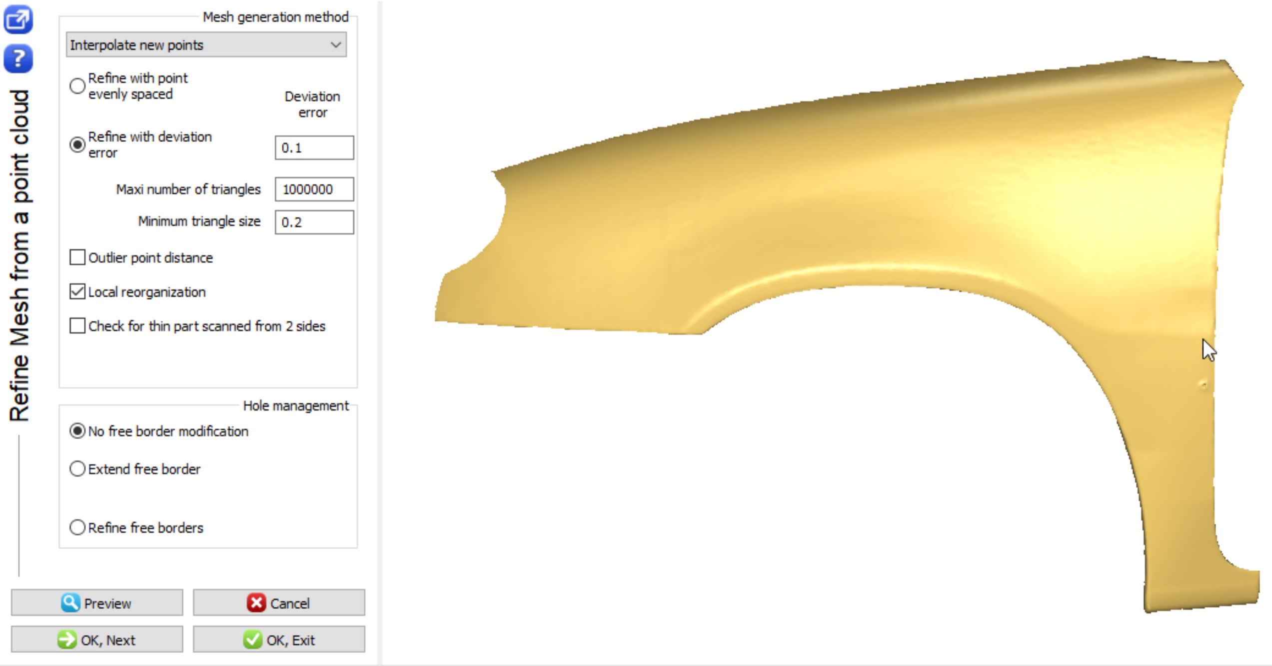


Figure 4: Refine the mesh

Validate by selecting **OK, Exit**.

Change the representation of the mesh **CarBody** to **Flat**. You see that the mesh is not very smooth and has a "Orange peel" effect.

3 Smoothing the mesh

Select the mesh **CarBody** and launch the command Mesh \ Smooth \ Regular smoothing.

Use the option **Smooth noise** with an intensity of 2, and select **Smooth Free Border(s)**. This will make the border more regular.

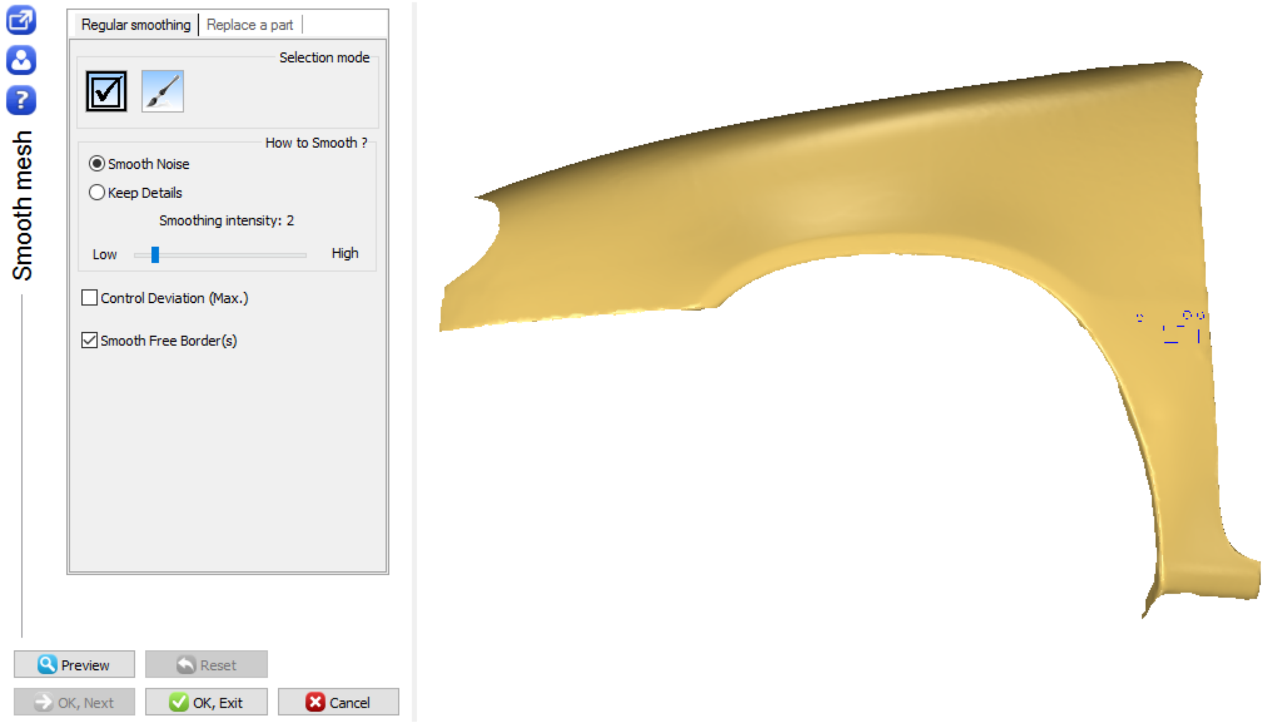


Figure 5: Smooth the mesh

Click **Preview**. You see that the reflection of the light is more uniform, meaning that the surface is smoother.

Validate by **OK, Exit**. The input mesh is now in the trash. The output mesh has the name of the previous one, **CarBody**.

Now, we need to create a network of polylines before creating the CAD patches.

4 Creating a set of polylines

4.1 Improve external border

Select the mesh **CarBody** and launch the command Polyline > External Contour. Enter a suitable direction for the contour extraction: you can enter manually the direction (-0.05, -0.28, -0.95) as in the figure 6 or use the tool to enter another direction (for example you can rotate the 3d scene and use the screen normal as a direction). Select options **2D contour** and press **Preview** to compute the contour. If the contour is ok, press **OK** to validate the command. If not, adjust the direction and press **Preview** again.

Figure 6: External contour of the 3d mesh

The goal is to improve the border of the mesh by cutting the mesh with a new border. In order to remove all the noise on the border, we will create a new border a little bit inside the one extracted above.

Select the contour **External Contour** and launch the command Transform > Offset to compute a parallel border. Enter **5** mm for the distance of the offset. Check that the parallel is inside the external contour. If not, press the reverse button. Press **OK** to validate.

Figure 7: Parallel border we will use to cut the mesh

Show only the new border **External Contour** and the mesh **CarBody.** Select the polyline and launch the command Construct > Projection. Click the mesh in order to define that the polyline will be projected on the mesh. Select the option **User defined** in order to manually enter the direction of the projection. Enter the same direction as the one used to create the external border.

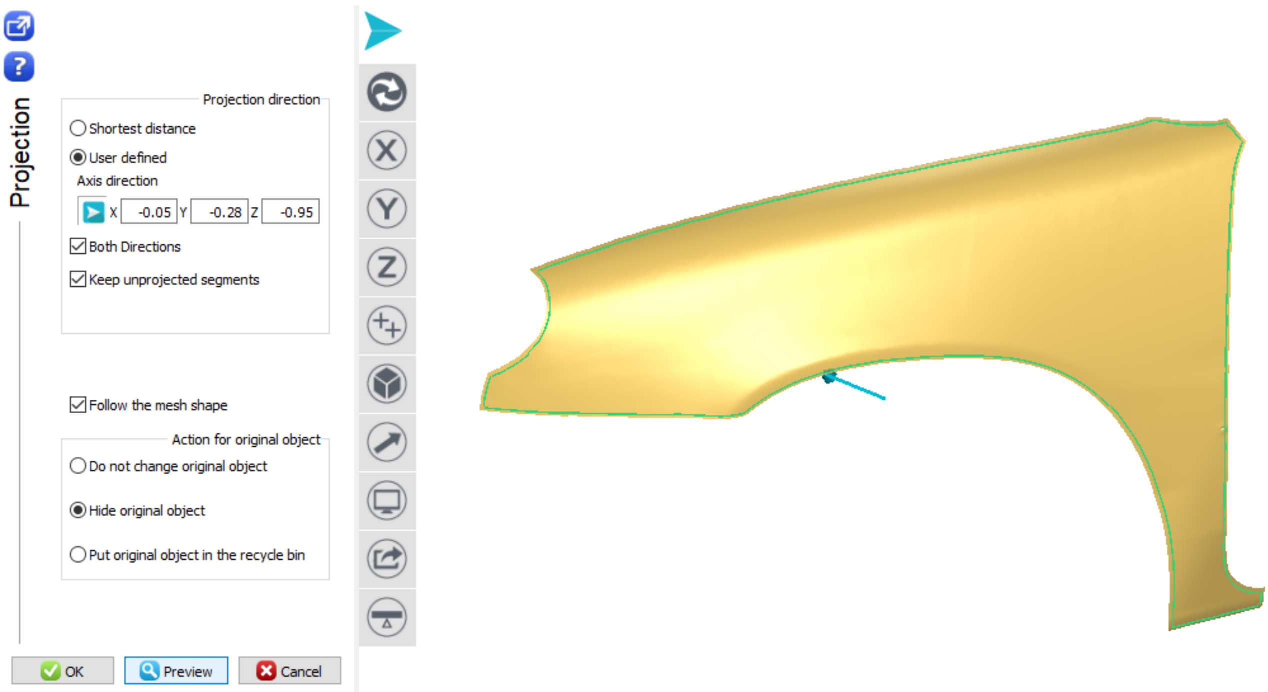


Figure 8: Project the new border on the mesh

We will now cut the mesh according to this new border. Show only the new border **Projection External Contour** and the mesh **CarBody.** Select them and launch the command Mesh > Constraint Meshing. Select options **No direction, 3D Computation** and **Cut the mesh along the polylines.** Press **Preview**, you should obtain 2 meshes. Press **OK** to validate and delete the part outside the contour. Rename the mesh **Part 1** to **CarBody**.

Figure 9: Mesh with the improved border

4.2 Draw smoothed polylines following curvatures

We will now draw 3 polylines following the 3 main curvatures of the mesh, in order to have a good reverse engineering of the shape. Select the mesh **CarBody** and launch the command Polyline > Projected Polyline . Select the direction **Shortest distance** and click points on the mesh to draw polylines as shown in the figure 10. Be sure to start and end lines on the border of the mesh (the clicked point is a dark green ball when the point is on the border of the mesh). You can move the control points to adjust lines. Once the three lines are drawn, press **OK** to validate.

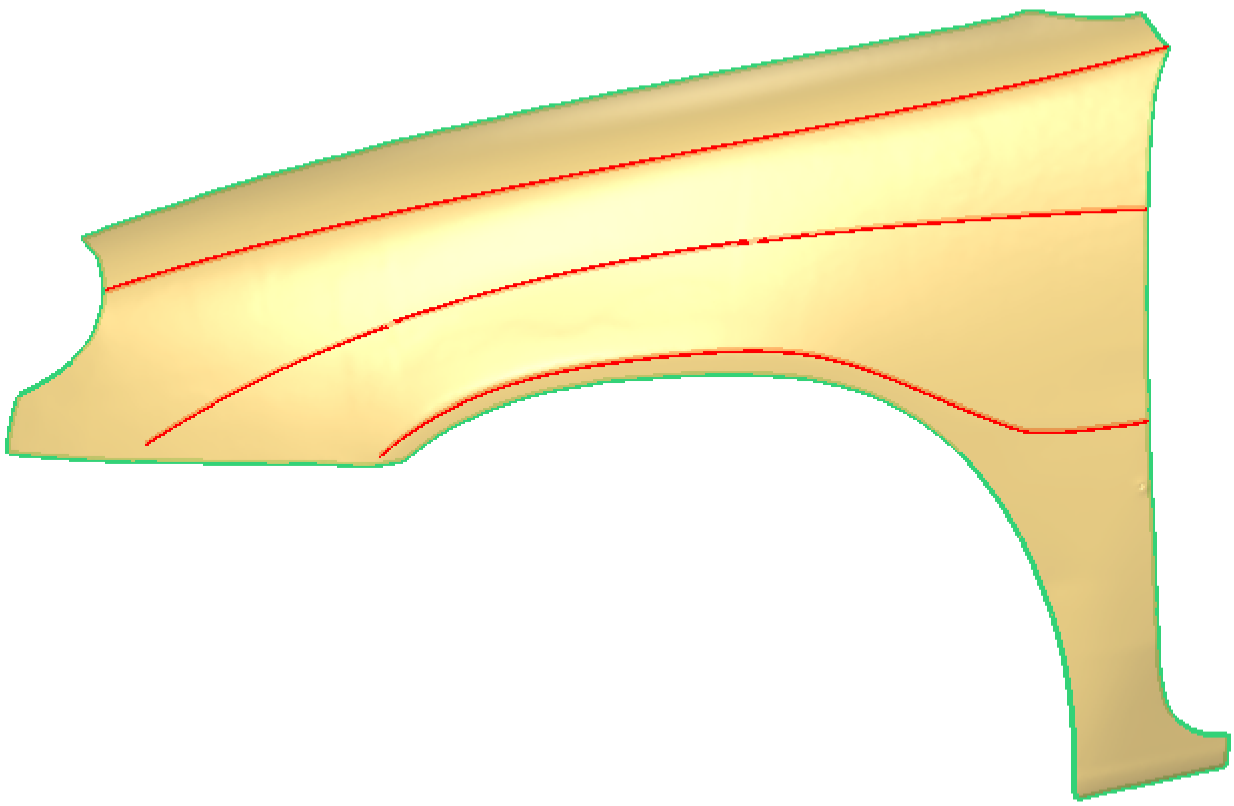


Figure 10: Projected polylines following main curvatures

4.3 Compute planar sections

To get a full polyline network, we need now vertical polylines in order to have a full grid on the mesh. Select the mesh **CarBody** and launch the command Polyline > Planar sections. Select the option **All over** to compute sections all over the mesh. Enter **50** for the **step between sections.** Select **X** for the **Plane direction.** To get a better result, set the origin as described in the figure 11: press the button

, select option **Vertex / End** and click the corner of the mesh.

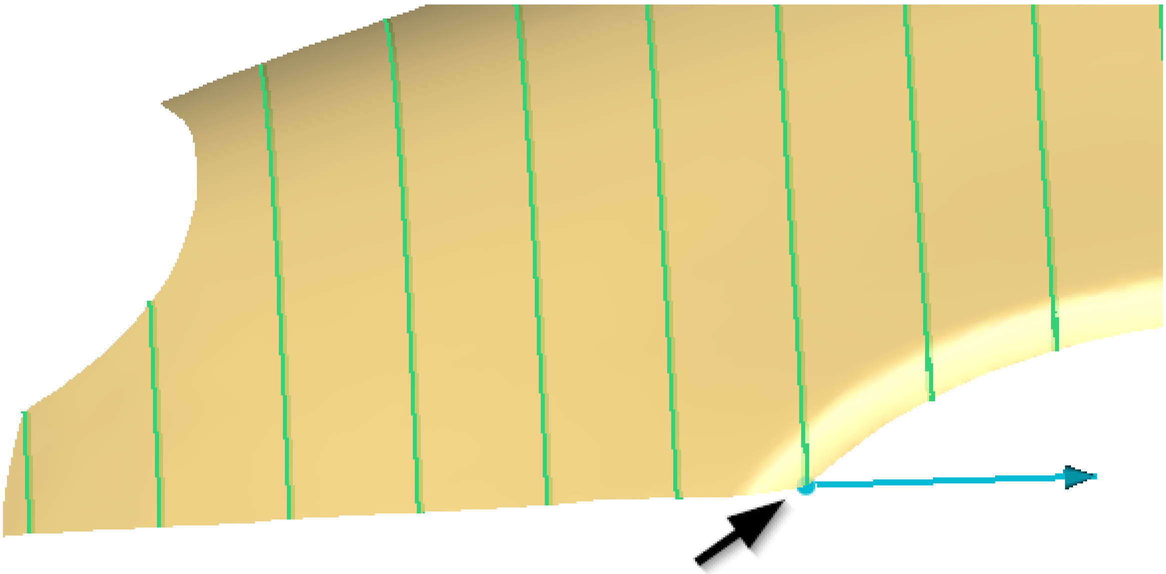


Figure 11: Set the origin on a corner of the mesh

Press **Preview** to compute the sections and **OK, Exit** to validate the command.

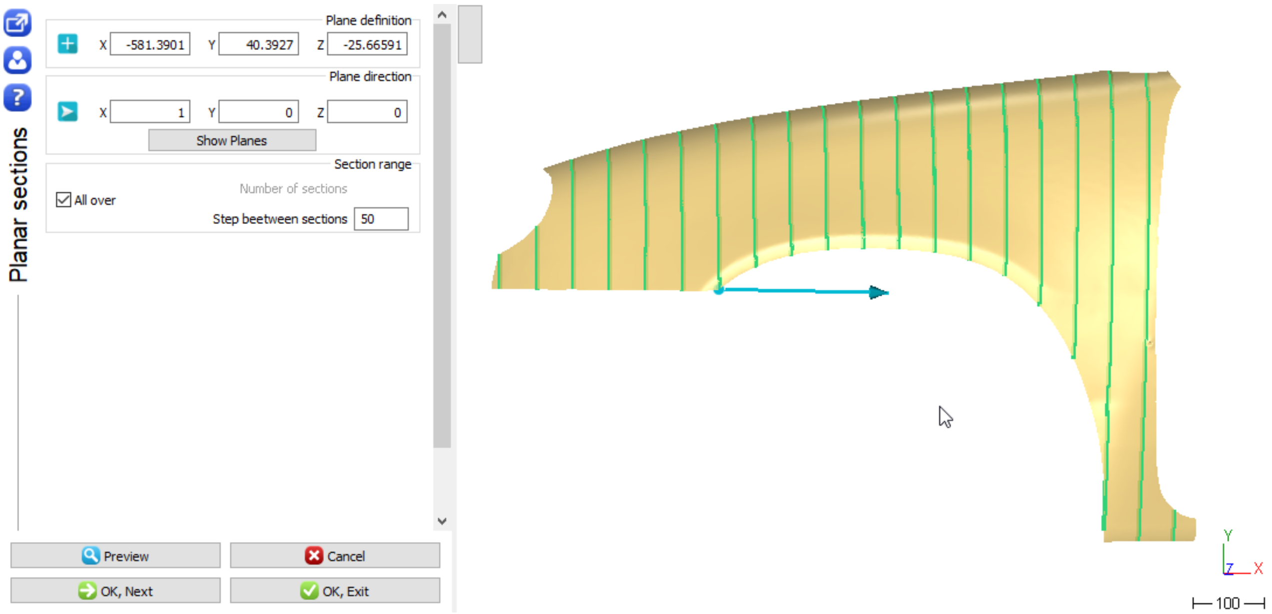


Figure 12: Planar sections along X each 50 millimeters

The more sections we have, the more patches we will have at the end in the CAD model. We can delete some sections here in order to lighten the model. Delete unwanted sections to get the result of figure 13.

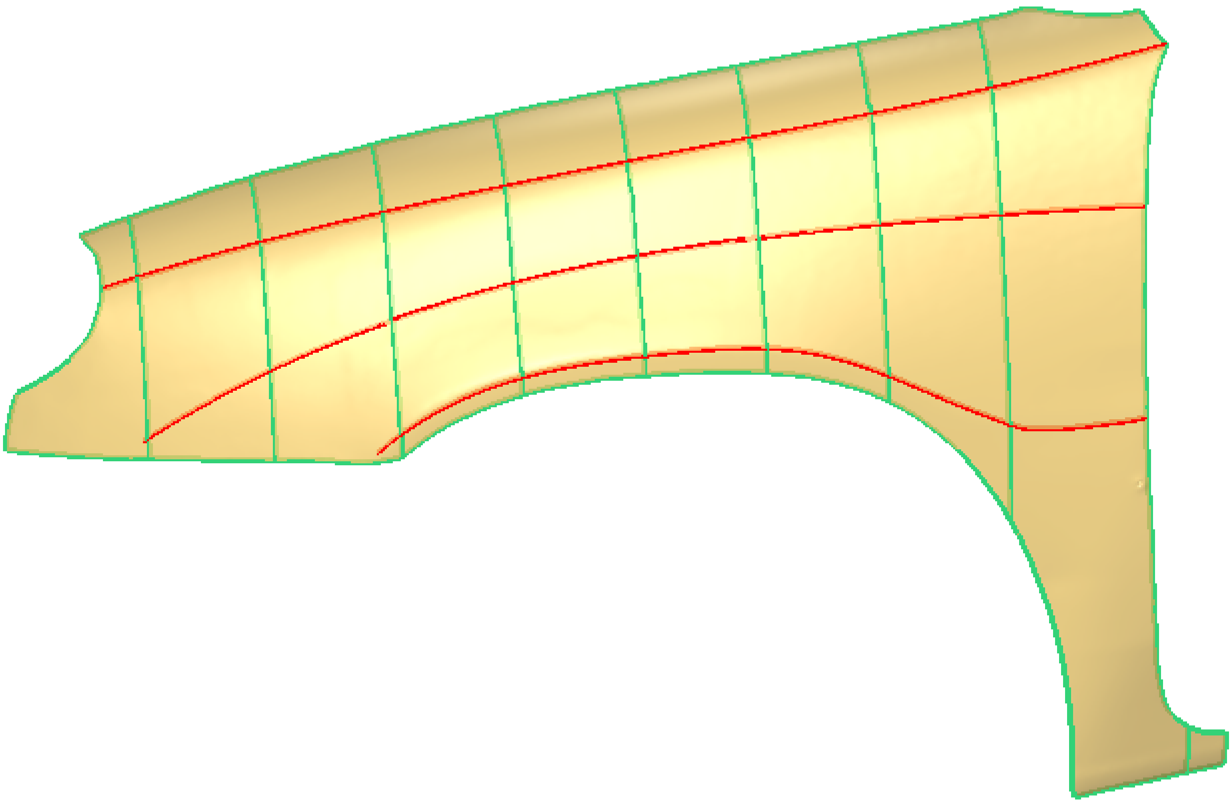


Figure 13: Delete unwanted sections

Finally, we will cut the external border in several parts. Indeed, if we compute the CAD model based on this border, it will be seen as one curve. But this external border can be divided in several connected parts. Run the tool Polyline > Cut Polyline(s). Select the **Vertex / End** option and click points as shown in the figure 14 in order to get 6 pieces of border.

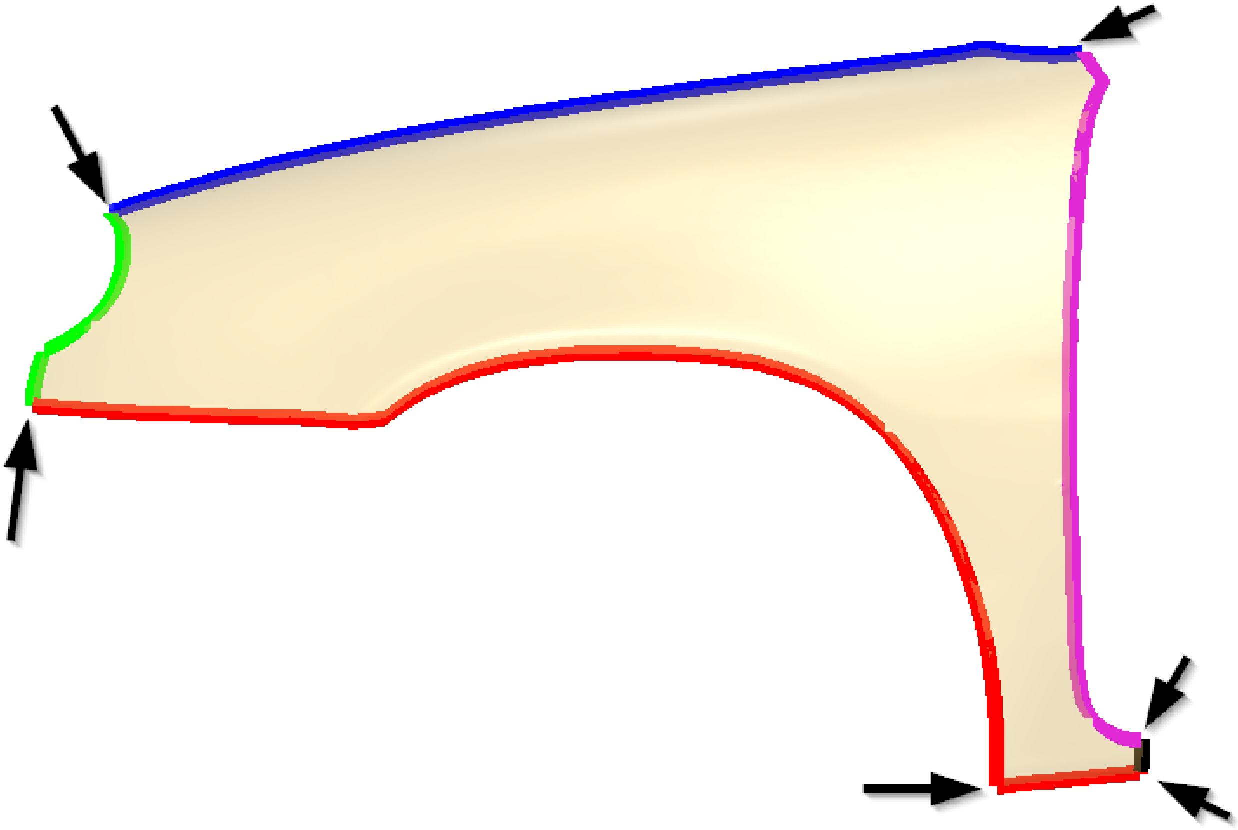


Figure 14: Cut the external border in 5 pieces

5 Running the BSpline curves and Nurbs surfaces generation

Select all created polylines (external border, the 3 projected polylines and the planar sections) and the mesh and launch the command CAD > Generate patch. During the first step, the command should detect 82 lines.

Click on button **Next Step: Create Curves**. All polylines are converted into BSplines.

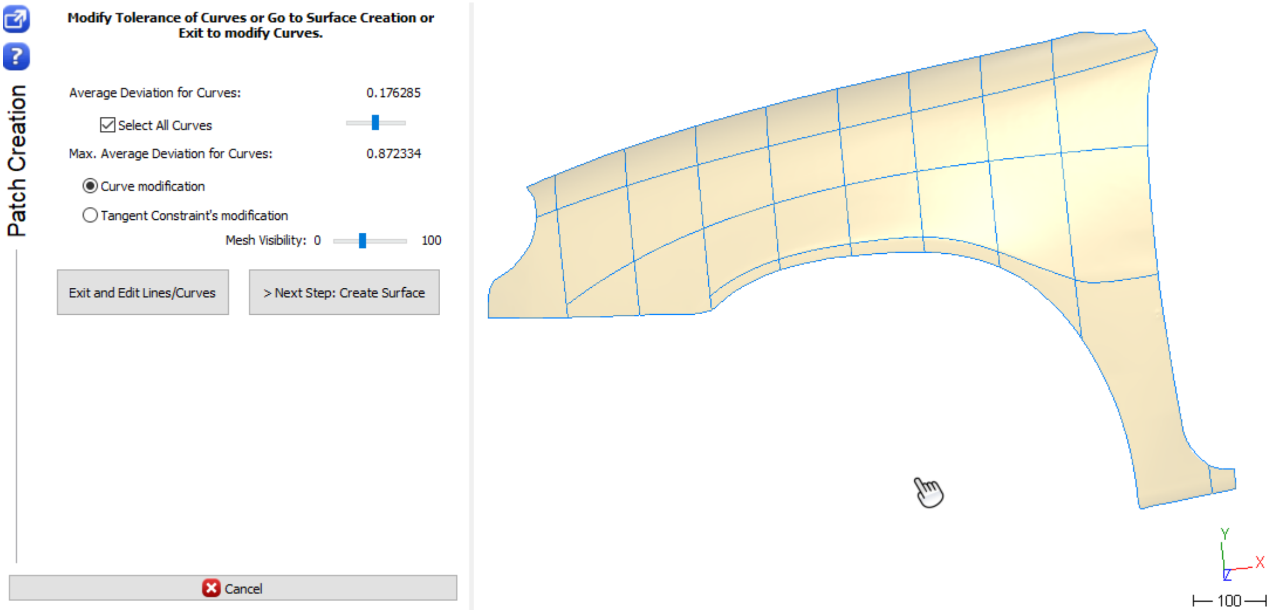


Figure 15: Generate the patches

Launch the next step by clicking on **Next Step: Create Surface**.

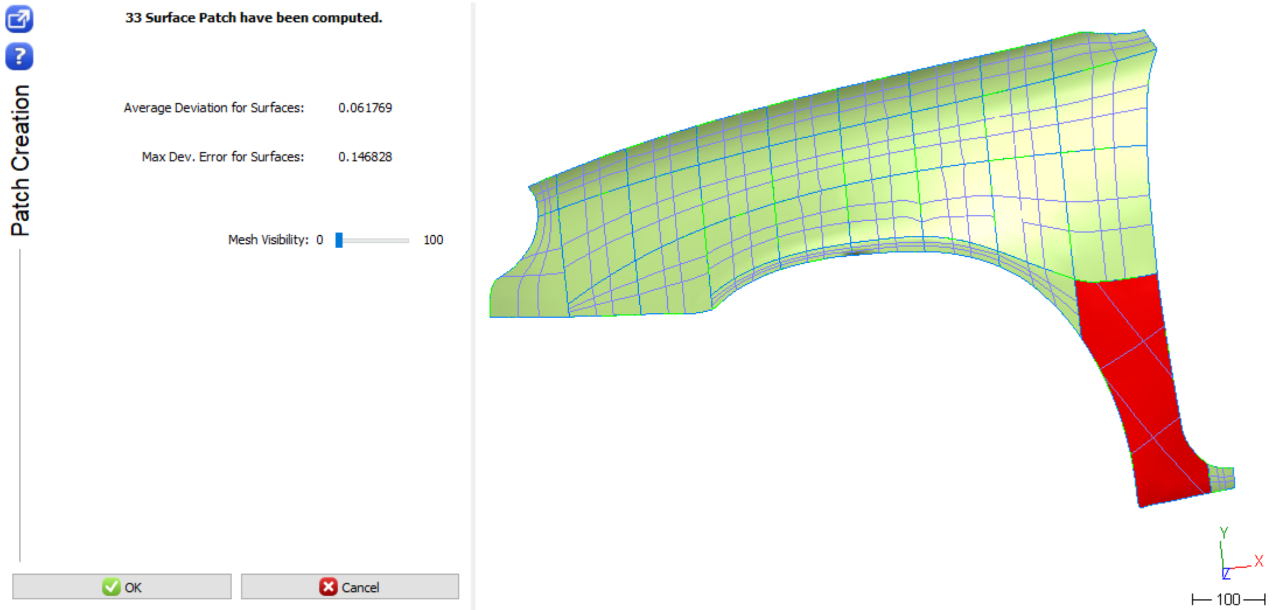


Figure 16: Result of the patch generation

You see that one surface is red, meaning that the surface is restricted by more than 4 edges (refer to the Ex5 - Reverse Engineering for the full explanation).

Validate by **OK**.

Use a **Show only** on the group **CarBody: Faces** in the **CAD Group** to better visualize the result of our workflow. Select all the patches, change the representation to **Smooth**. You have now the following result.

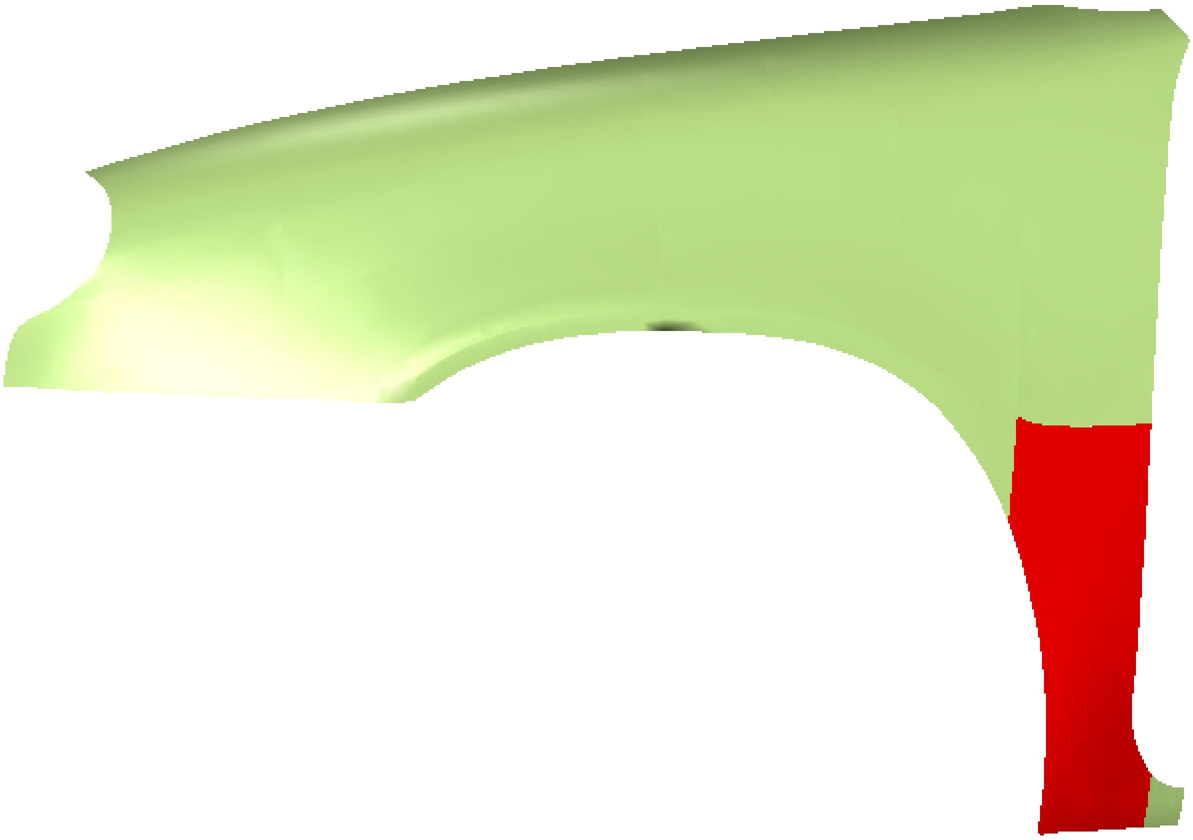


Figure 17: Display in smooth representation

6 Doing restrictions on the CAD model

CAD surfaces can be restricted by BSplines, contours or linear geometrical objects.

Select the 3 circles and the square slot (in the **Geometry group**) and the surface on which the restriction will be done, and launch the command CAD >Hole / Restriction. Since there is more than 1 contour, the command automatically understands that we want to apply the restrictions not on the boundary but inside the surface (The option **Hole** is automatically selected).

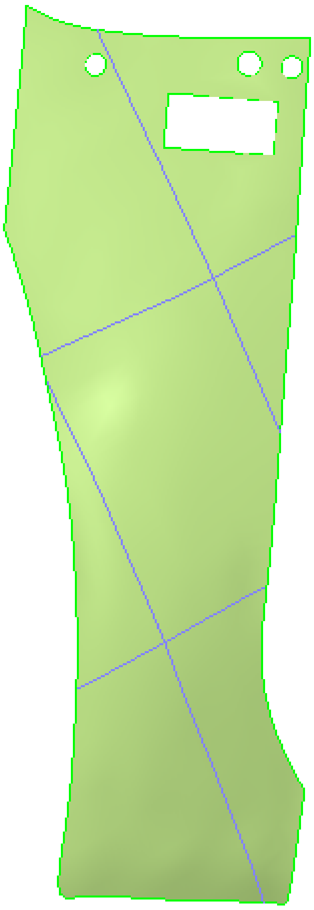


Figure 18: Doing the restriction

Validate with **OK**.

Now, **Show only** all the surfaces in group **CarBody: Faces** (including the orignal face before restriction). Hide the face without restriction and do a **Zoom All**. Select all and launch the command CAD > Create Compound. You have the final result: A CAD-model of the initial Point cloud.

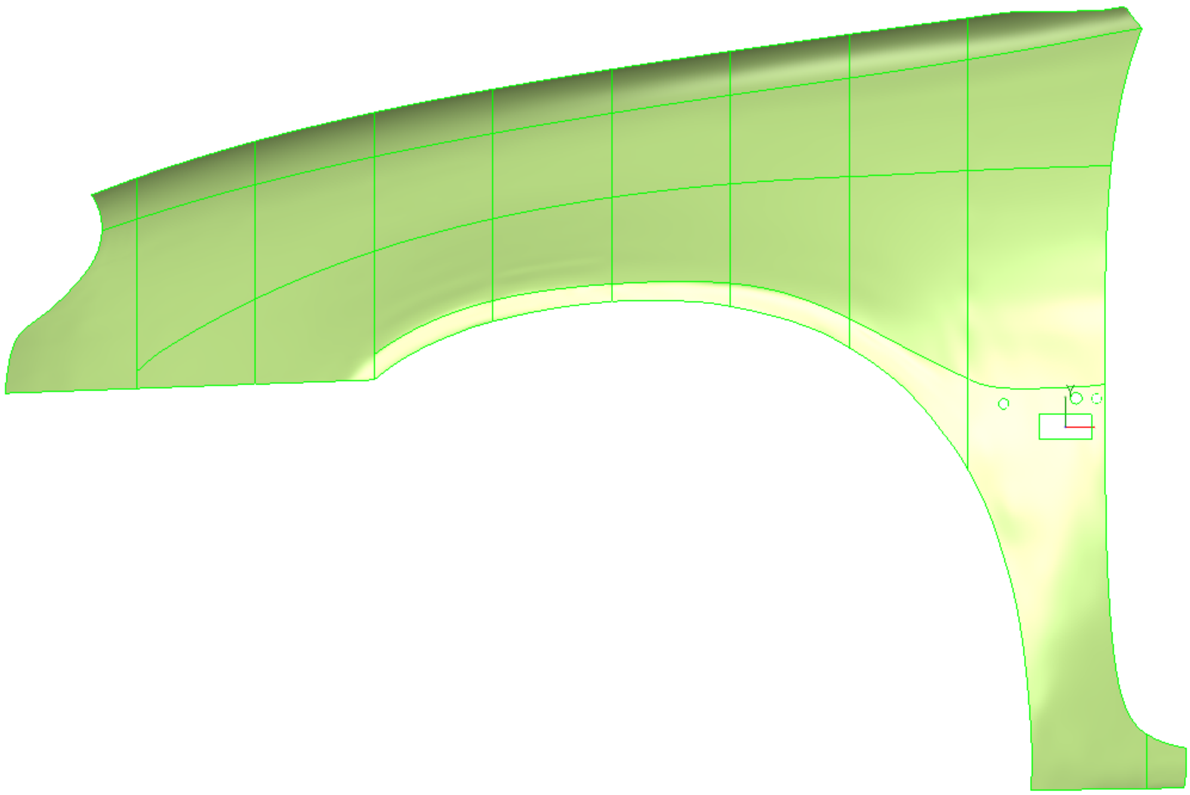


Figure 19: Final result in representation Smooth + Contours