CREAFORM

VXmodel Tutorial - Scan-to-CAD 1

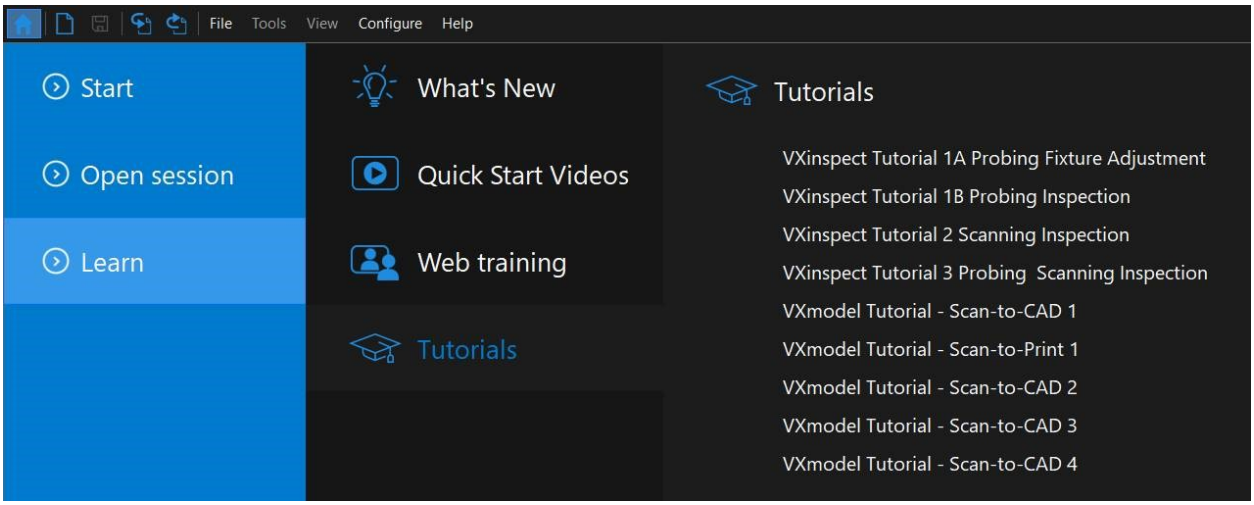
June 2018

Introduction

This tutorial is intended for users who need to become familiar with VXmodel. It will guide you through a Scan-to-CAD workflow by cleaning and aligning the mesh, then extracting required entities in order to transfer to a CAD software.

Importing data file

Data files associated with this tutorial can be downloaded directly from the **Learn** panel of VXelements home page.



The **session file** and **CAD file** will automatically open but can also be found here after download: ***\Documents\VXelements\Tutorials\VXmodel_1_CAD_DataSet**

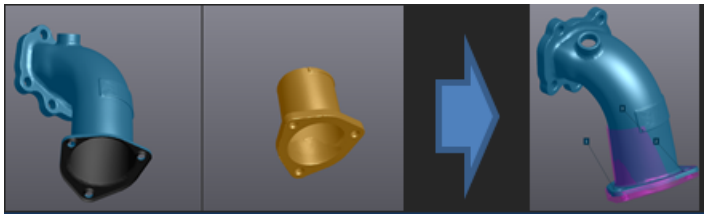
*The sample data for this tutorial is provided by Creaform. It is the property of Creaform and is used for informational purposes only.

After completing the scan, click on **Send to VXmodel**. For this tutorial, the scan data has been already transferred to the VXmodel node of VXmodel. As good practice, hide the **Scan** and **Positioning targets** node to avoid confusion in display. To do so, click on the eye icon to hide or show.

What will this tutorial cover?

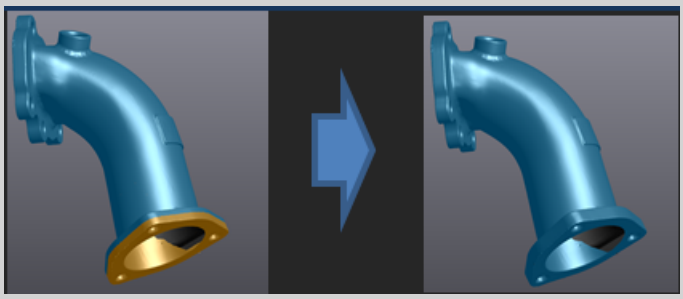
Step 1.

Best-fit alignment of the meshes.



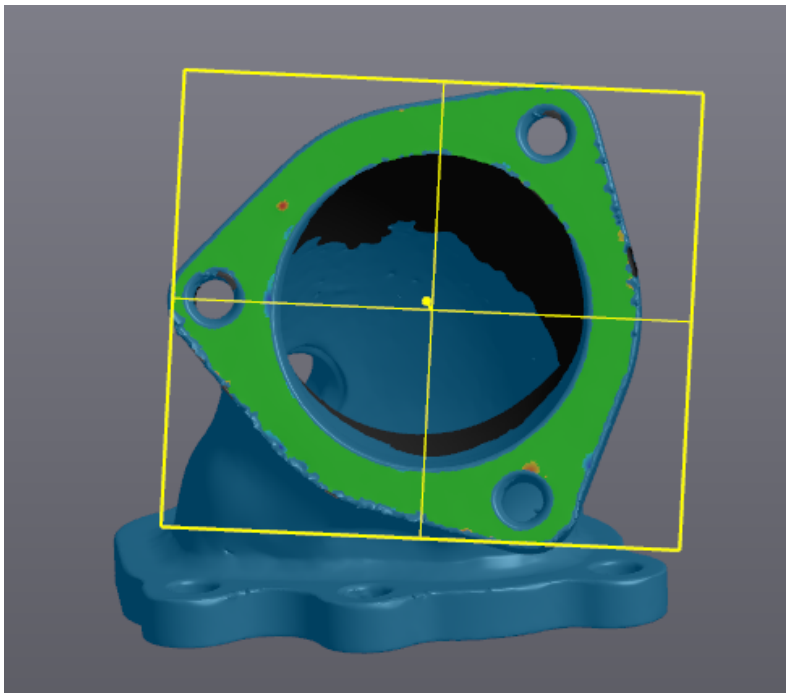
Step 2.

Merge meshes together.



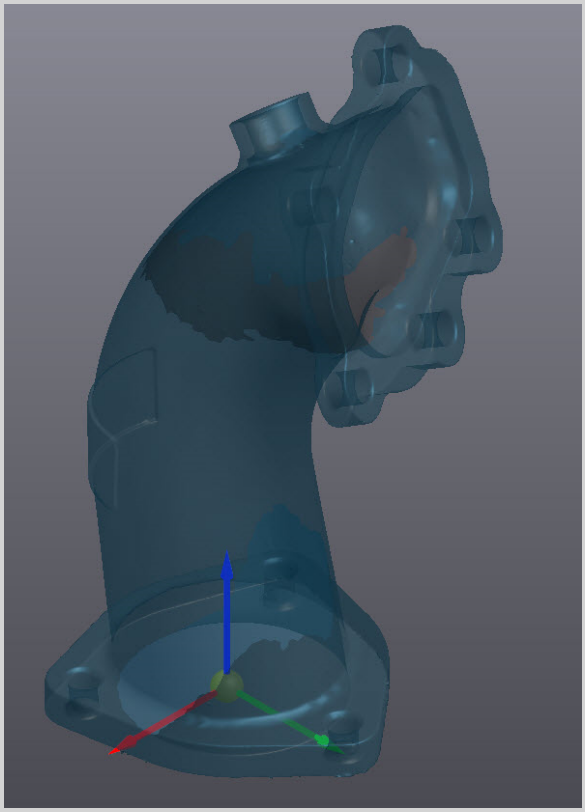
Step 3.

Extract entities for alignment.



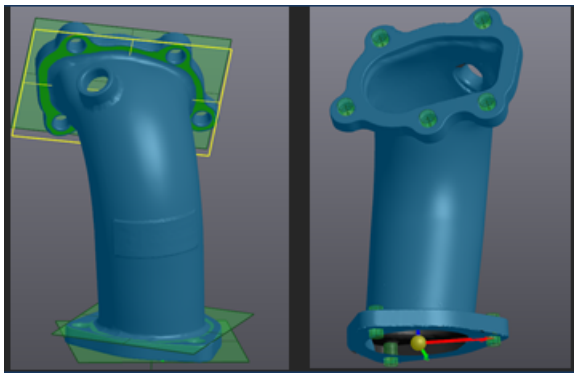
Step 4.

Align the mesh to origin.



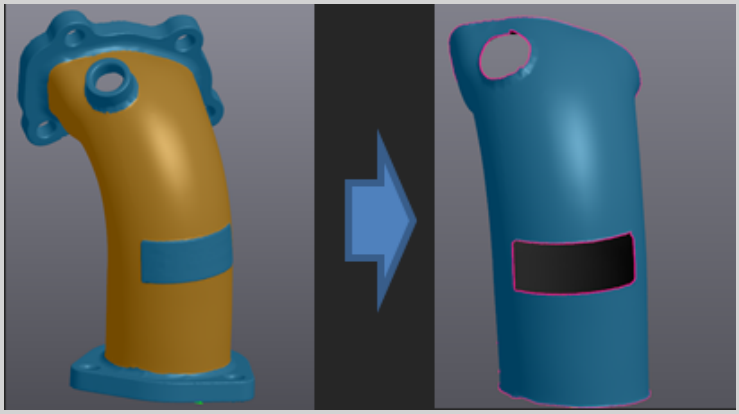
Step 5.

Create entities for reverse engineering.



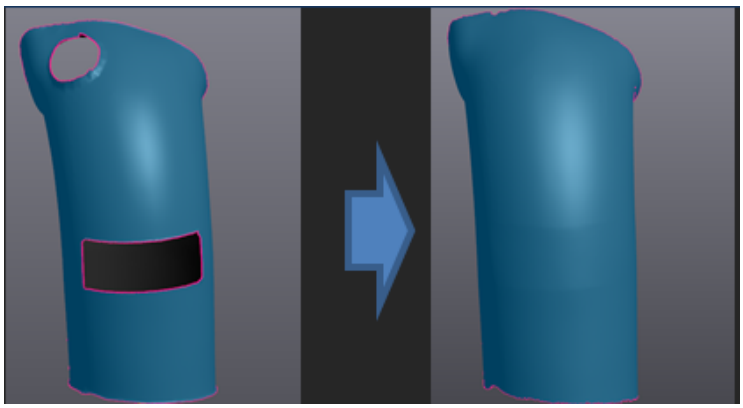
Step 6.

Duplicate the middle section of the pipe and create a new mesh.



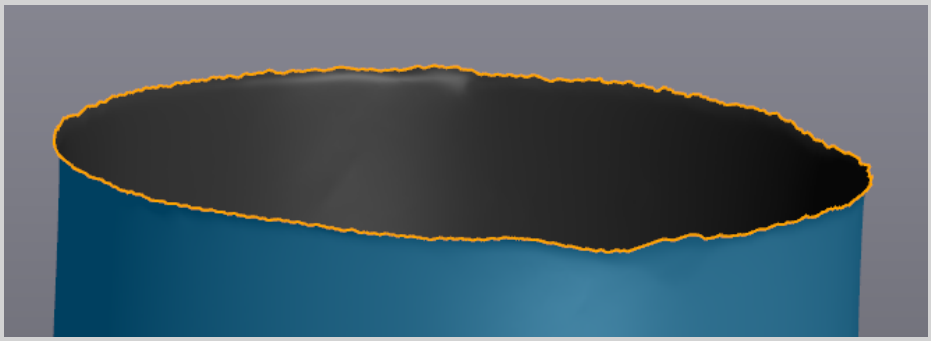
Step 7.

Clean the mesh & fill holes.



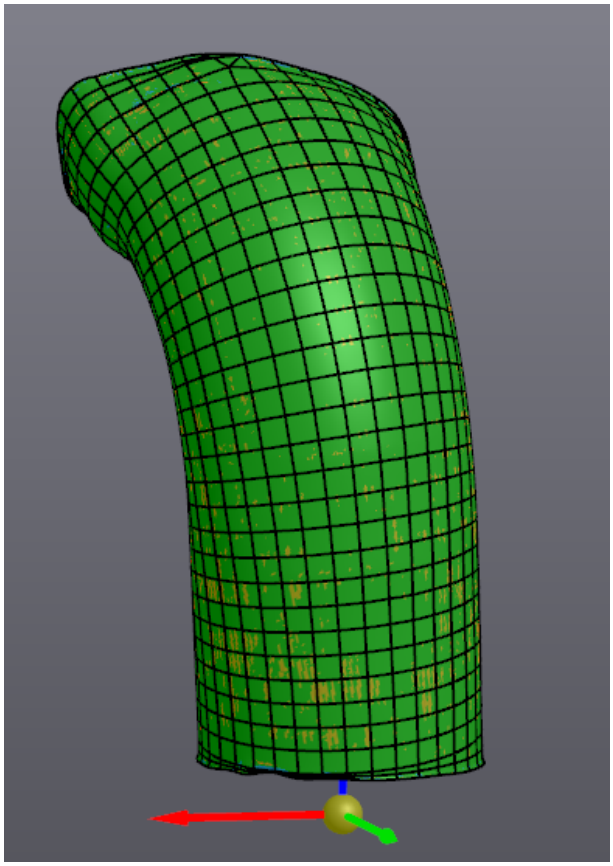
Step 8.

Clean openings using edit boundary and cut mesh.



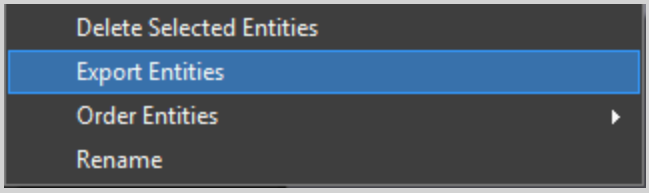
Step 9.

Complete the inner surface and create the auto-surface.



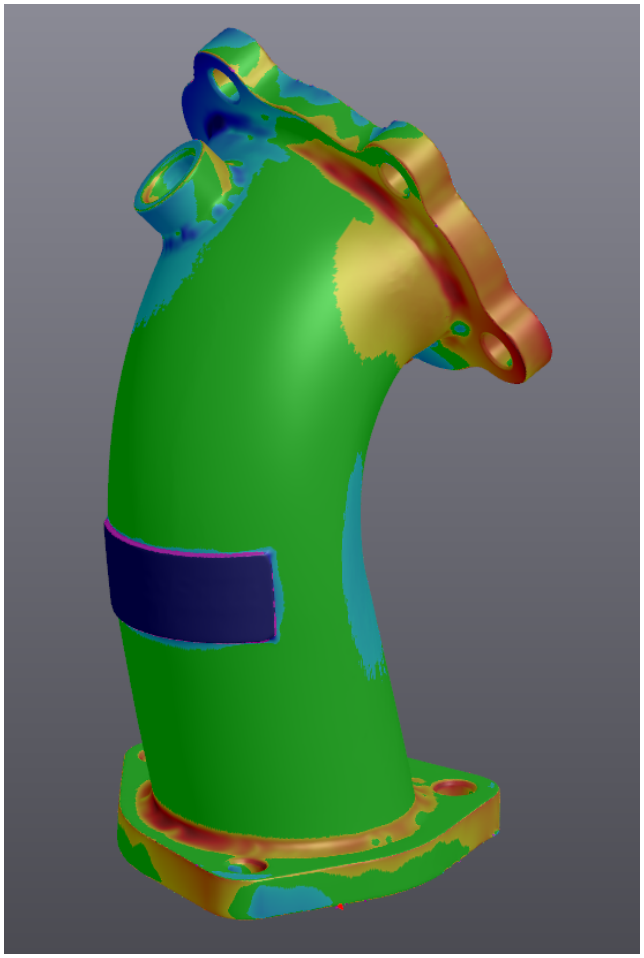
Step 10.

Export files for CAD software.



Step 11.

Inspect the reverse engineered part.



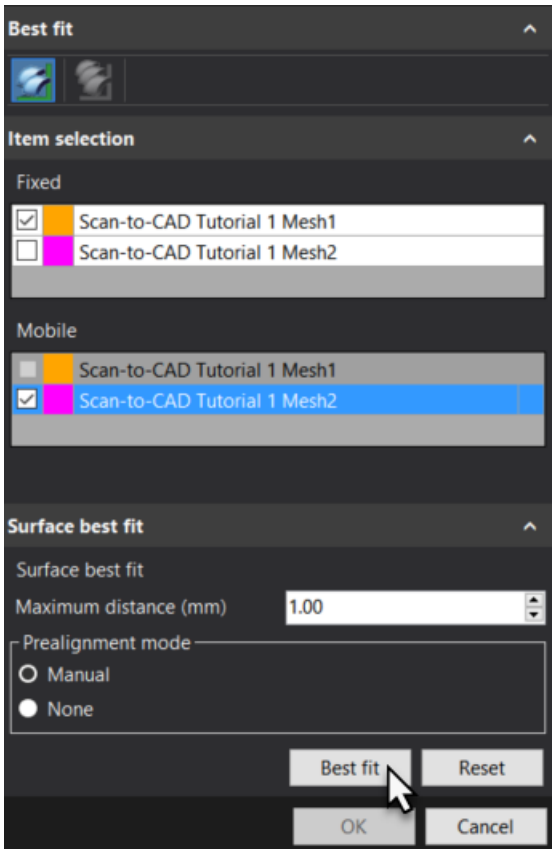
Best fit alignment of meshes

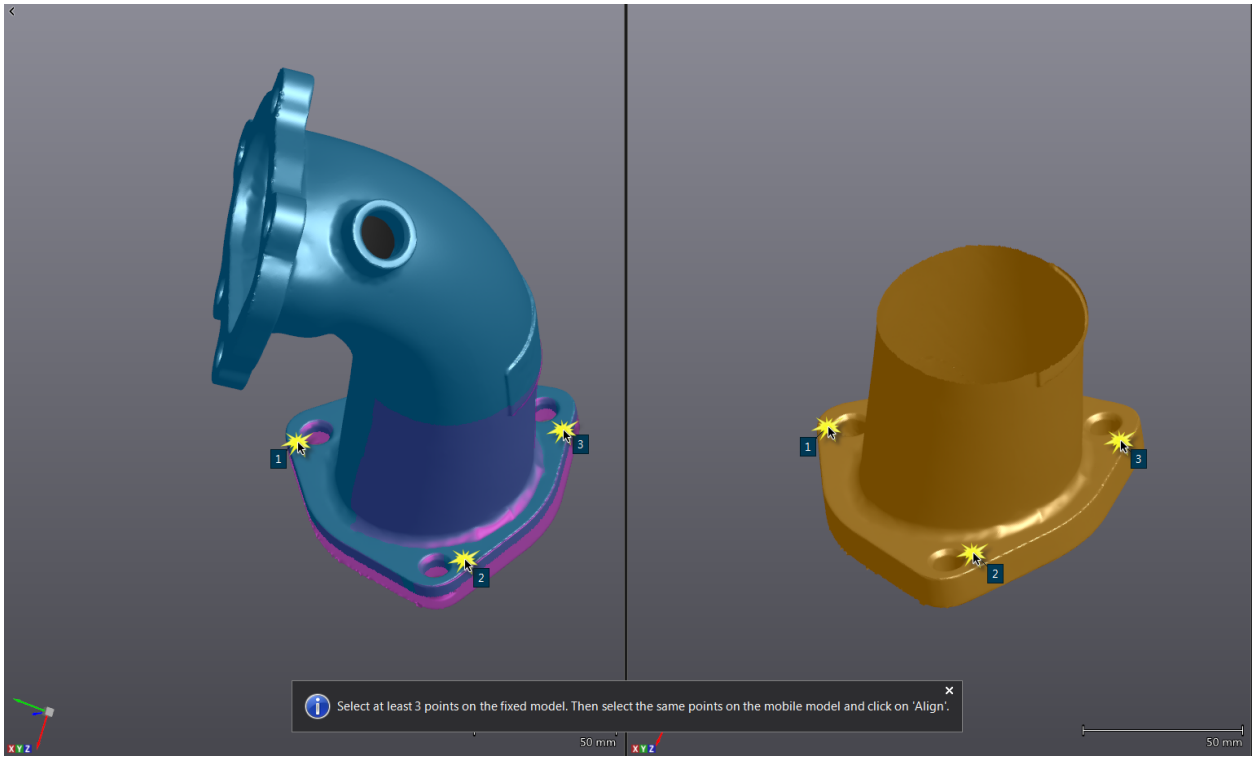
VXmodel allows the user to align two or more meshes together by best fit. This operation is also useful when you want to align different meshes of the same part and compare them together or, like the example in this tutorial, to merge two meshes together.

» Click on the mesh **Scan-to-CAD Tutorial 1 Mesh 1** to see VXmodel functions.

Best Fit Alignment

- Click on the mesh **Scan-to-CAD Tutorial 1 Mesh2** and then the **Best fit** icon.
- The fixed and mobile items can be switched if needed.
- Set **Maximum distance** to 1 mm.
- Select 3 common points on each mesh.





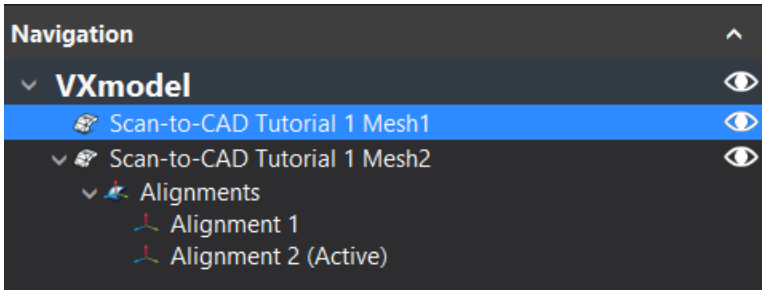
Note: As soon as 3 points are selected on each meshes, a preview of the alignment will appear on the split screen left side.

- Click on **Best fit**, look at the result.
- If not satisfied, it's possible to click on reset to reselect 3 common points on each mesh.
- Click **OK**.

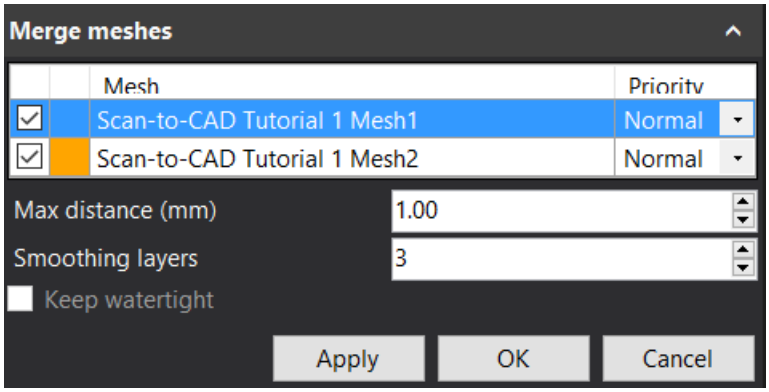
Merge meshes together

Since the two meshes are aligned together it is now possible to merge the two meshes. This step is necessary in order to have a complete mesh in order to extract all the entities for the reverse engineering of this part.

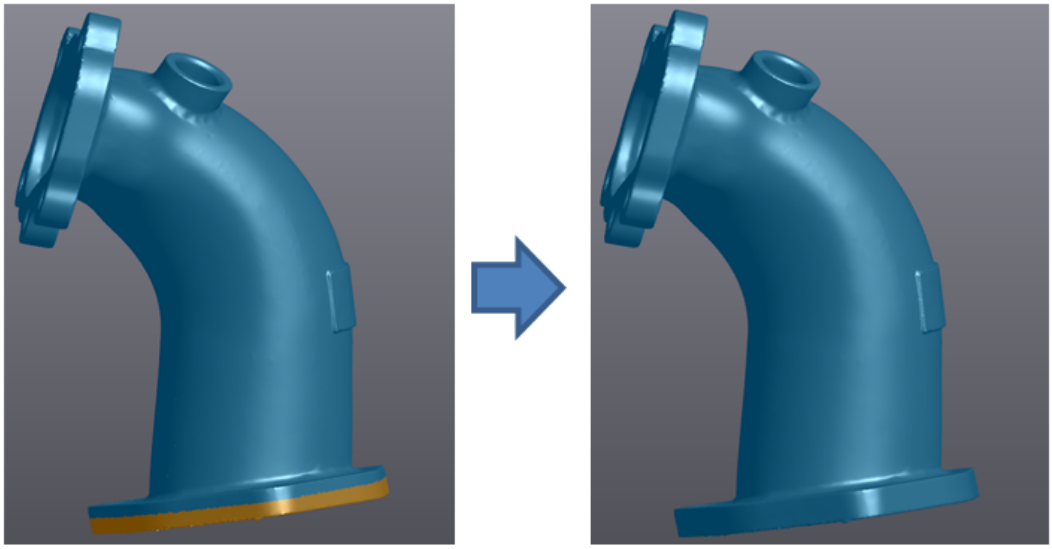
- Click on the mesh **Scan-To-CAD Tutorial Mesh 1** to see **VXmodel** functions.



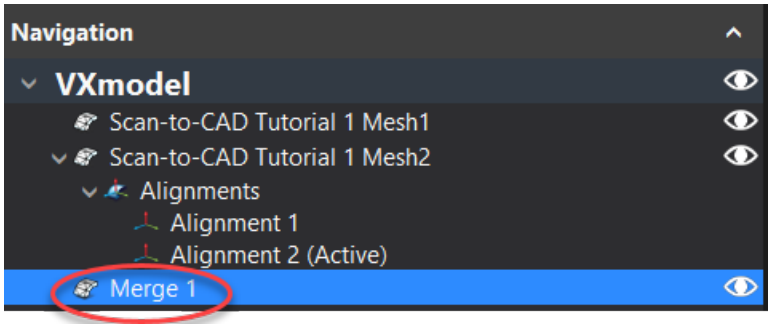
- Click on the **Merge** icon.
- Check both meshes and leave **Max. distance** at **1 mm**.
- Set the **Smoothing layers** to **3**.
- Set the **Priority** to **Normal** for both meshes.



» Click on **Apply** and look at the result then click **OK**.



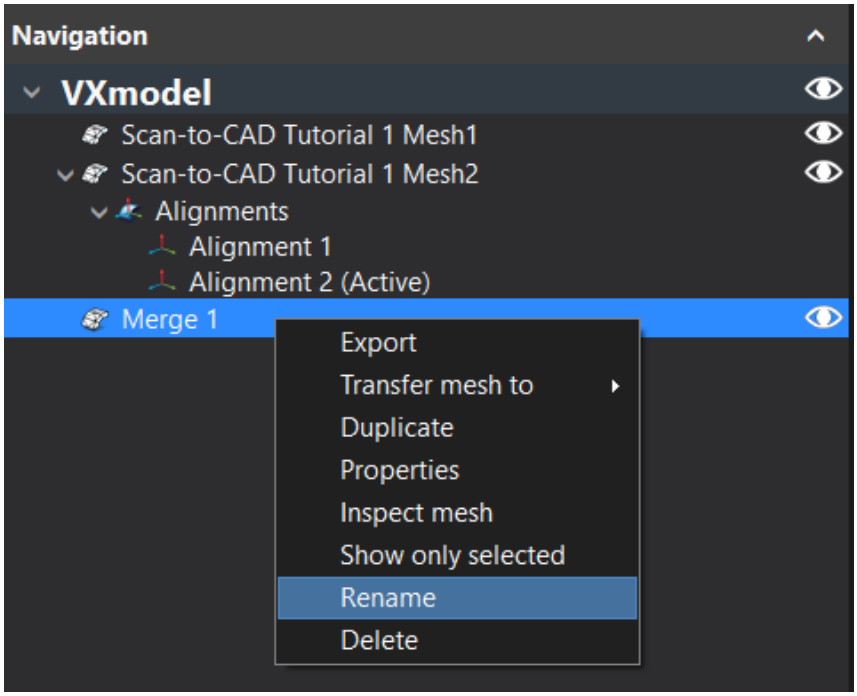
Note: Once the merging is completed, a new **Mesh** is created in the **Navigation** tree under the VXmodel node.



Extract entities for alignment

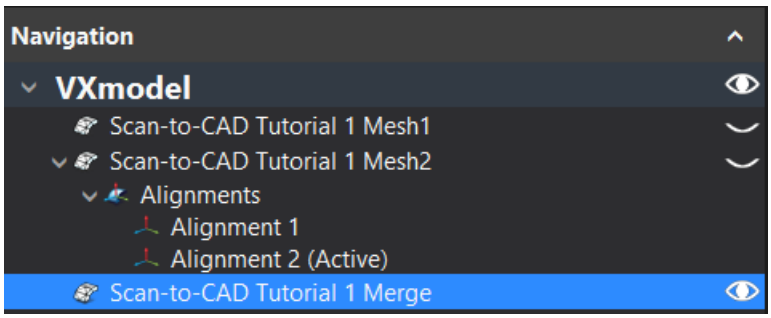
Creating geometric entities based on the mesh will be used for alignment; therefore it is important to choose the most relevant entities for the alignment.

» Right-click on **Merge 1** in order to rename it and avoid possible confusion. Rename it to **Scan-to-CAD Tutorial 1 Merge**.



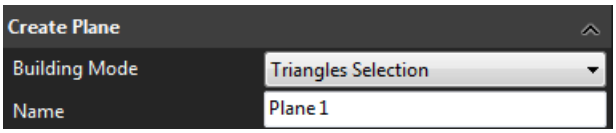
Note: There are many different options in the contextual menu (right-click). Meshes can be duplicated, which is useful when editing it. It can serve as a reference the user can go back to.

» Click on the eye icons to hide the **Scan-to-CAD 1 Mesh 1** and **Scan-to-CAD 1 Mesh 2**.
» Click on the mesh **Scan-To-CAD Tutorial 1 Merge** to see **VXmodel** functions.

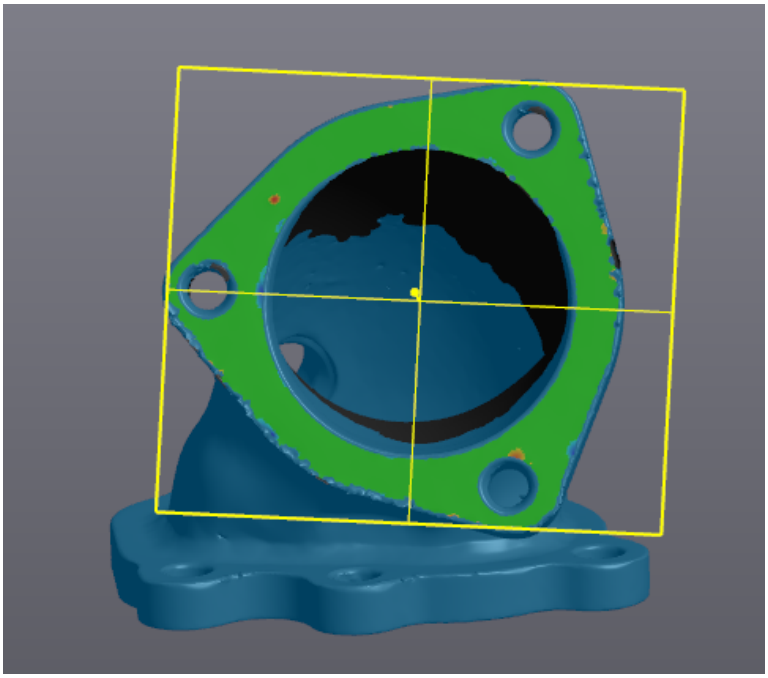


Add a Plane

- Click on the **Add a plane**  icon.
- Set the **Building mode** to **Triangles selection**.



- Select the **Similar normal**  button.
- To select the surface where a plane will be generated, hold the **CTRL** key and left-click on the flange.

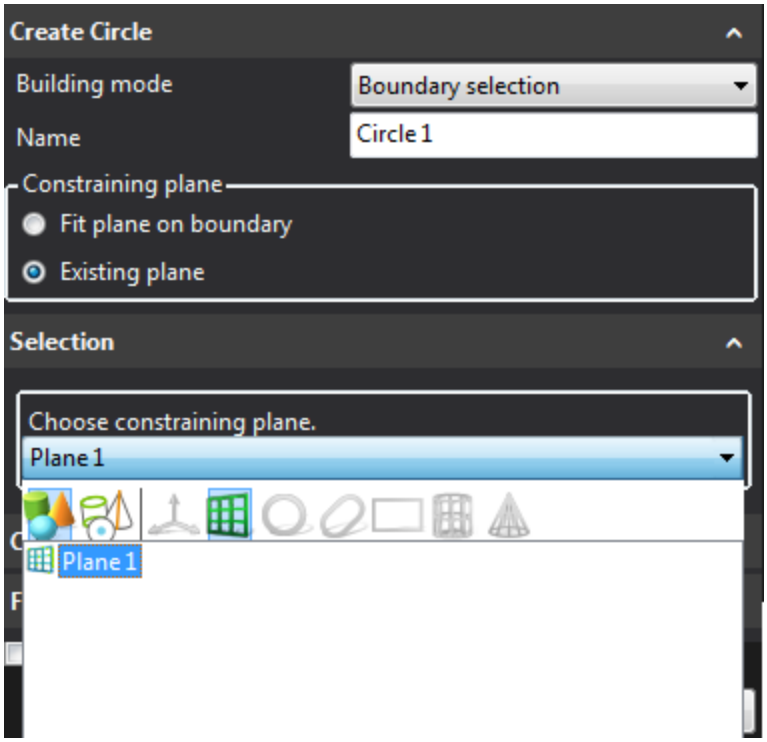


Note: The new plane is displayed with a deviation color map of the surface selected to the best fitted plane. The tolerance of the color map can be edited in the **Error distribution** parameter.

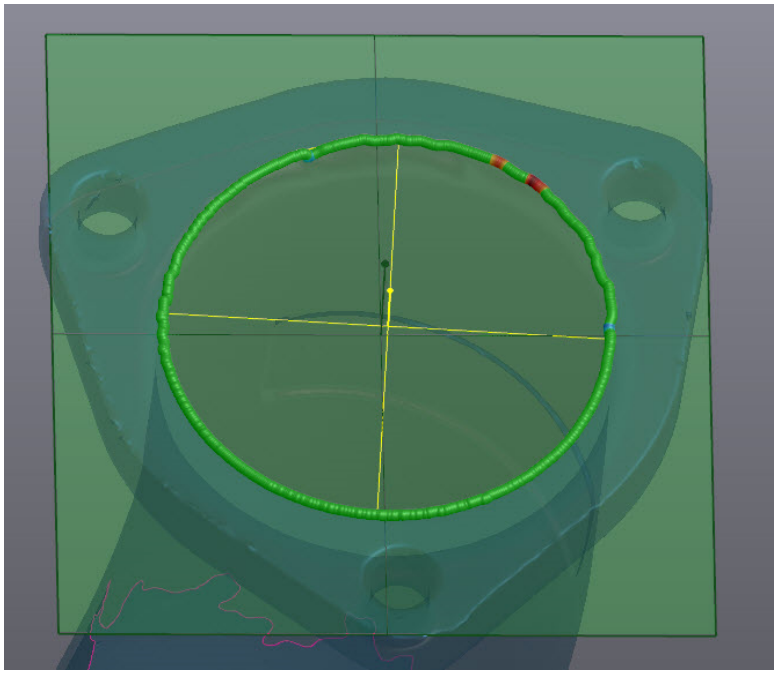
Click on **Create** to finalize and then **Close**.

Add Circles

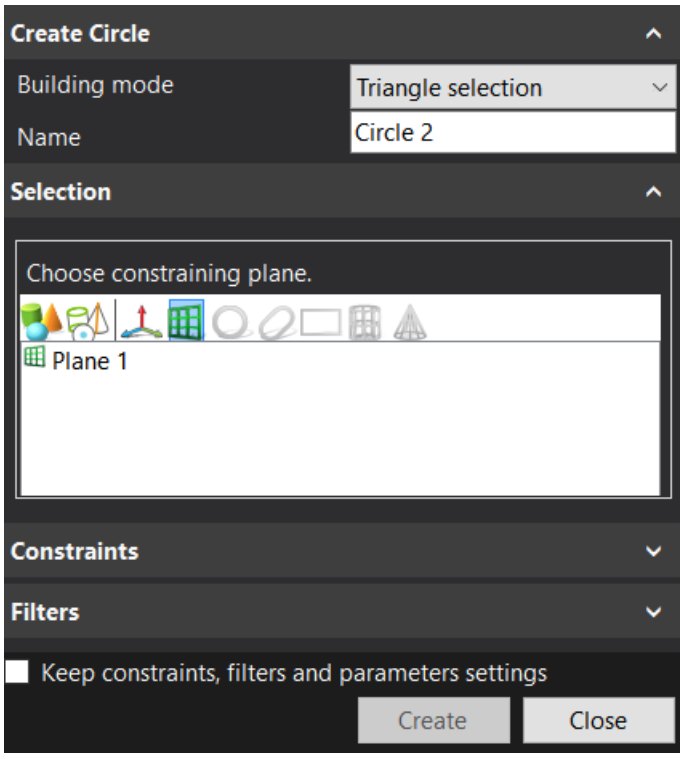
- Click on the **Add a circle** icon.
- Set the **Building mode** to **Boundary selection**.
- Choose the **Existing plane** as the **Constraining plane** and select the **Plane 1** in the drop-down menu.



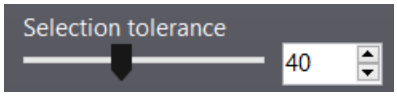
» Select the boundary where the circle should be generated.



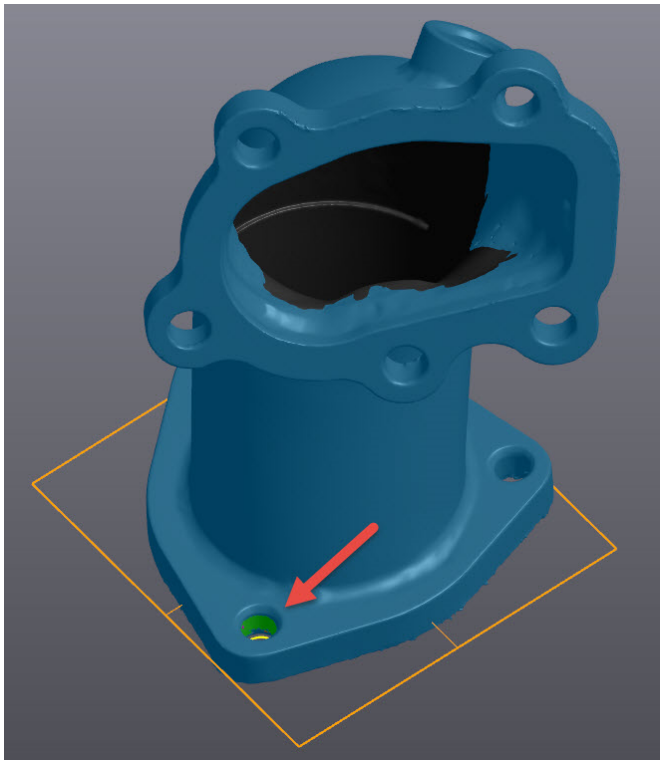
» Click on **Create** to finalize.
» We will now generate a second circle using the constraining **Plane 1**.
» Set the **Building mode** to **Triangles selection** and choose **Plane 1** for the **Constraining plane**.



- Select the **Similar curvature** icon.
- Change the Selection tolerance to **40**.



- Hold the **CTRL** key and left-click to select the inner surface of the following cylinder located on the bottom flange.
- Click **Create** to finalize then **Close**.

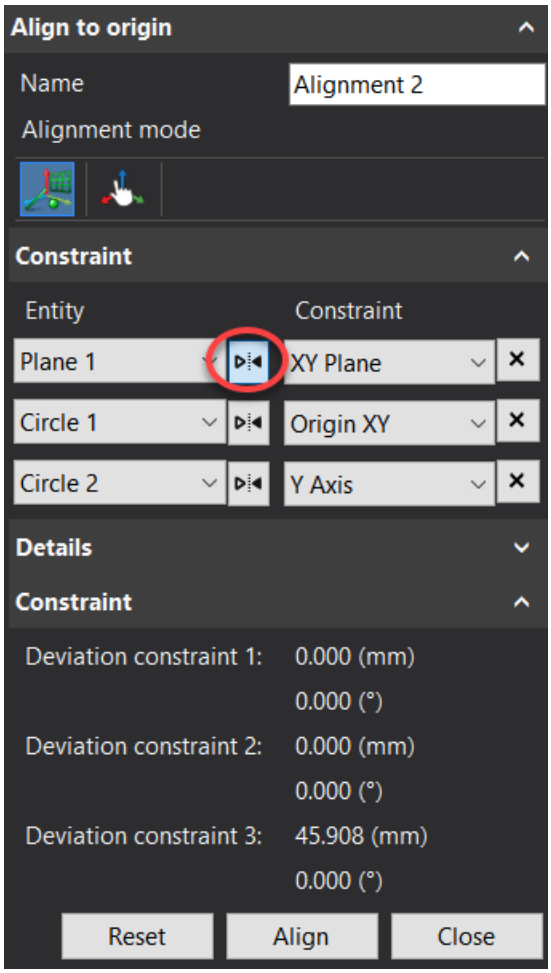


Align the mesh to origin

Mesh alignment

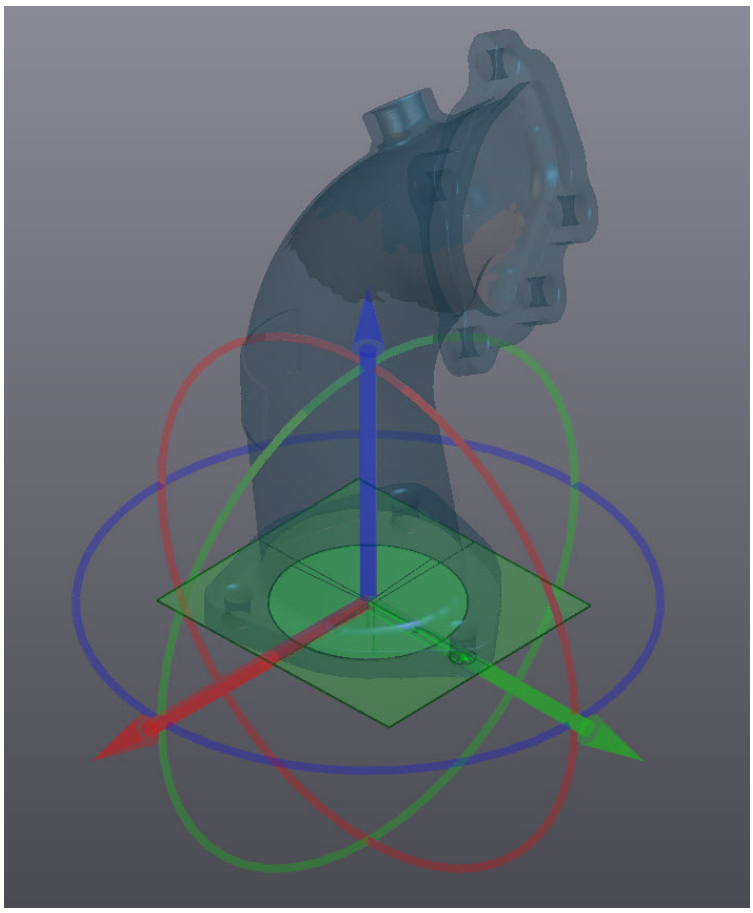
In this step, we will use the three generated entities, one plane and two circles, to align the surface to the origin. Alignment is done by pairing entities previously created with the XYZ reference frame.

- Click on **Align to origin** icon.
- From the **Constraint selection** menu, under **Entity**column, select **Plane 1** in the first drop-down menu and pair it with **Plane XY** under the **Constraint**column.
- Repeat to pair **Origin XY** with **Circle 1 - Center**, then **Axis Y** with **Circle 2 - Center**.
- Use the flip icon to invert **Plane 1 - Normal**.



Note: On the right side of the **Entity** column, the flip button flips the normal of paired entities.

» Click **Align** to close the dialog box.

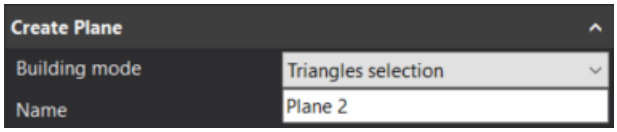


Create entities for reverse engineering

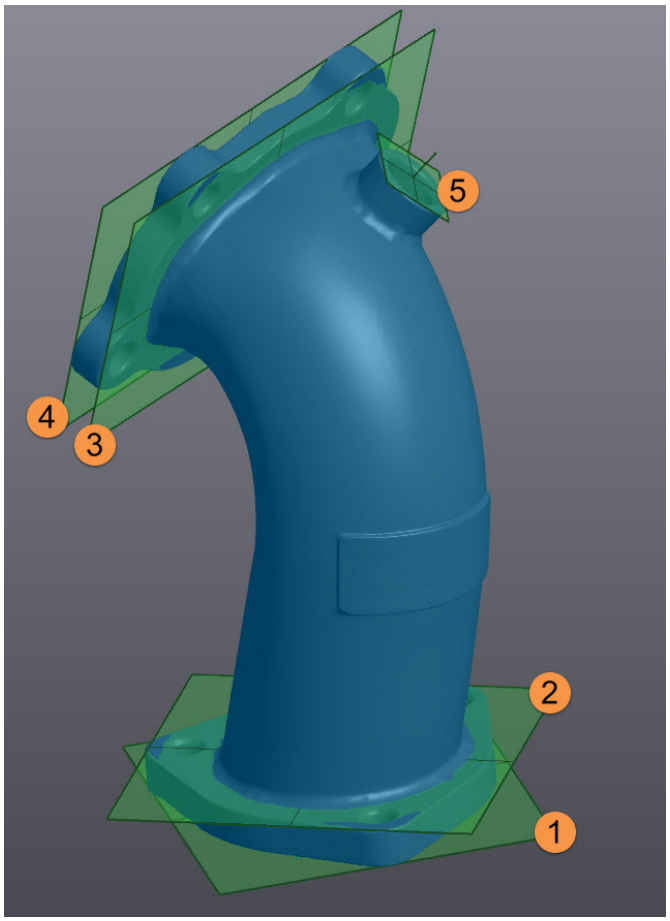
Now that our surface is aligned to the origin, we can proceed with reverse engineering portions of the pipe's surface. Various geometries will be extracted in preparation for the CAD software.

Add New Plane

- Click on the **Add a plane** icon.
- Set the **Building mode** to **Triangles selection**.



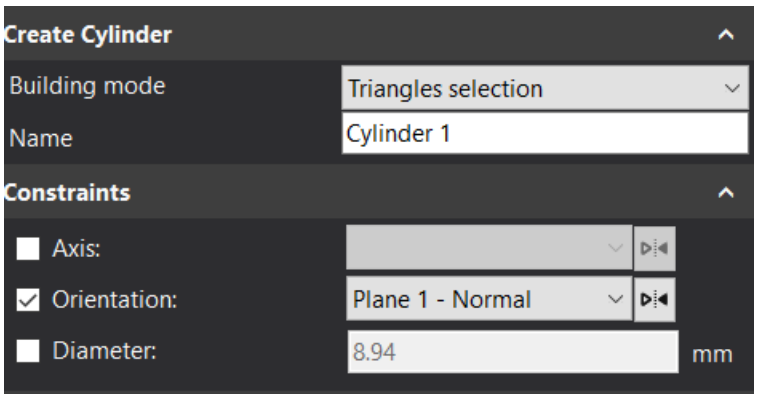
- Select the **Similar normal** icon.
- Hold the **CTRL** key and left-click to select the top planar surfaces of the bottom flange (**Plane 2**) and the plane that had been used for alignment (**Plane 1**).
- Repeat these steps for the other flange (**Planes 3** & **4**), as well as the top surface of the extruded cylinder near the top flange (**Plane 5**); five planes should be created in total.



Note: Planes should be built on each side of both flanges, and on top of the outside cylinder of the pipe.

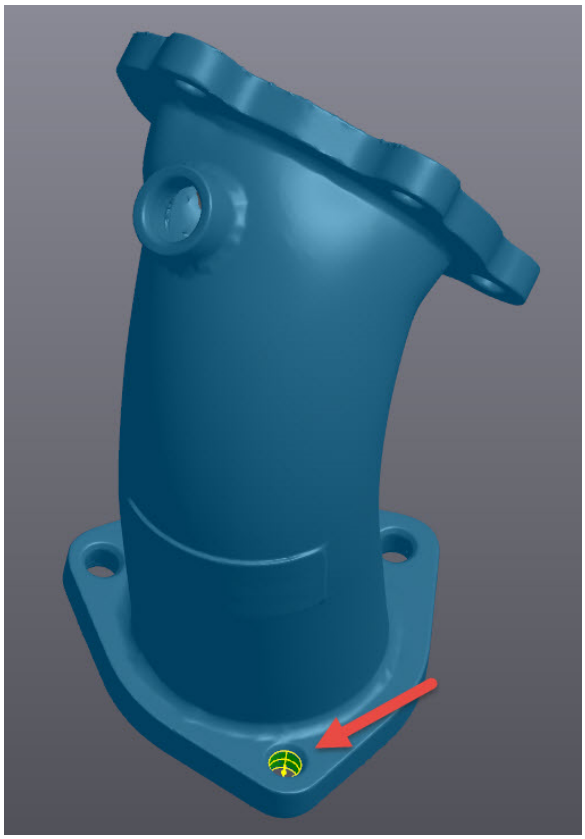
Add a new cylinder

- Click on the **Add a cylinder** icon.
- Set the **Building mode** to **Triangles selection**.
- Set to **Orientation** to **Plane 1 - Normal** to have the cylinder axis parallel to the plane normal

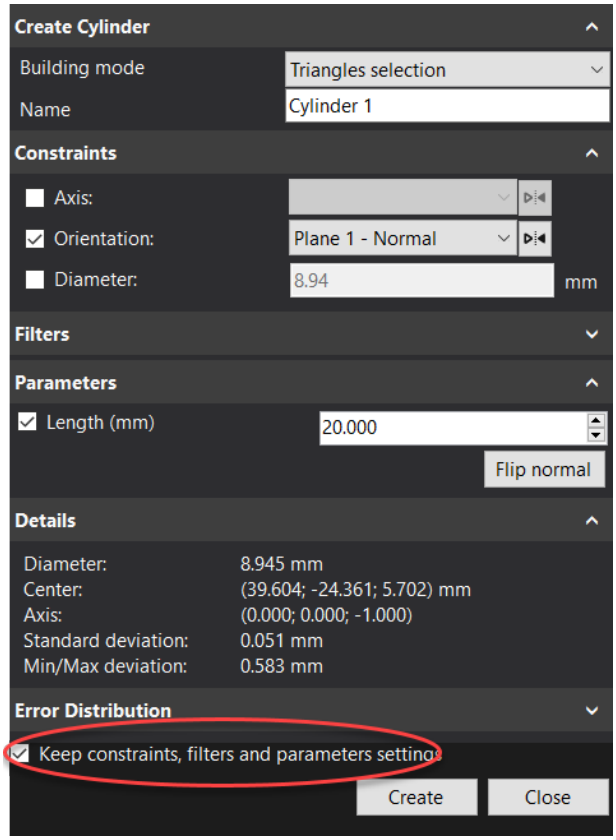


- Set the **Selection tolerance** to **35**.

- Hold the **CTRL** key and left click to select the inner surface of the following cylinder located on the bottom flange.

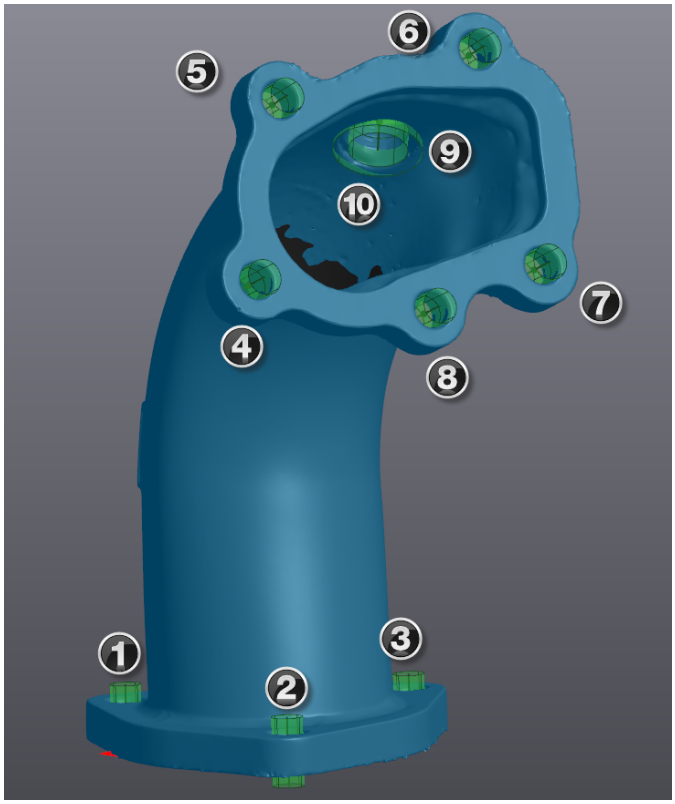


- Set the **Length** of the cylinder to **20 mm** in the **Parameters** menu.
- Check the box **Keep constraints, filters and parameters** in order to keep the same length for every other cylinder that will have to be created.
- Click **Create** to finalize.



Note: Cylinder length should be longer than the flange thickness in order to use it as cutting tool in the CAD software.

- Repeat these steps for each hole on both flanges to create **Cylinders 2-8**;
- also create cylinders on the inner and outer surface of the cylinder located on the pipe to create **Cylinders 9 & 10**.

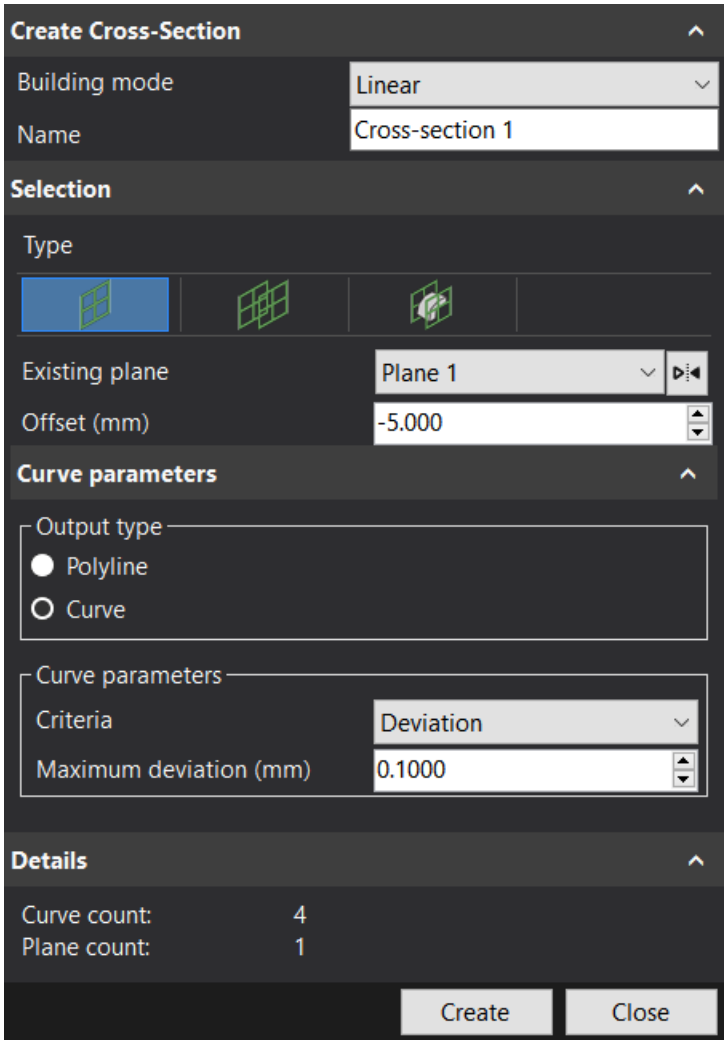


Note: **Cylinders orientation 4-8** should be set to **Plane 3 - Normal**.

Note[2]: 10 cylinders should be created on the mesh.

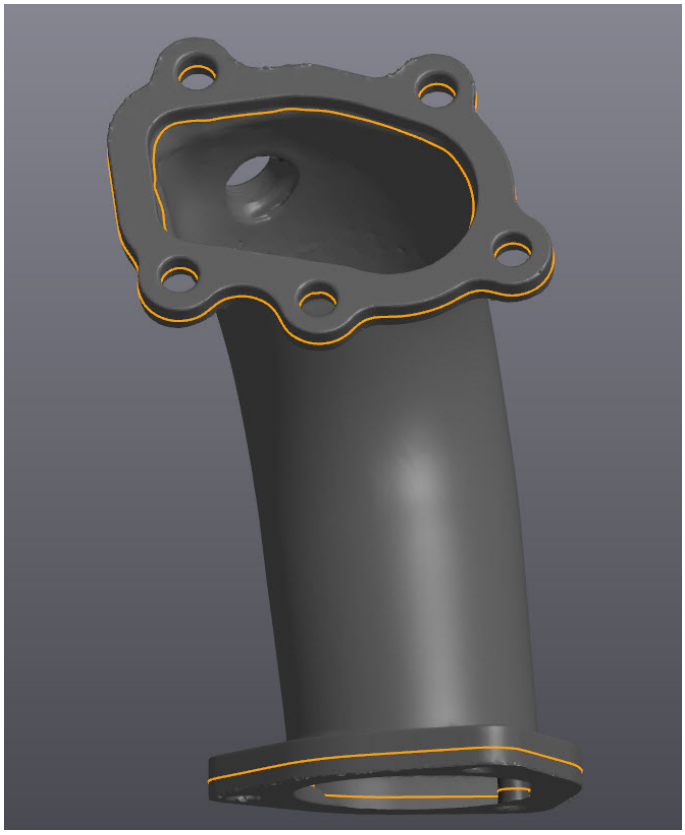
Create cross-section

- Click on **Add a cross-section** icon.
- Set the **Building mode** to **Linear**.
- Select **Plane 1** in **Existing plane** and put **-5 mm** to **Offset**.
- Set the **Output type** to **Curve** and **Criteria** to **Deviation** with a value of **0.1 mm**.



Note: Make sure the position of the cross-section is in the middle of the flange. If not, set a positive value for the position.

- Click on **Preview** and then **Create** to finalize the cross-section.
- Repeat these steps to create a cross-section on the other flange, using **Plane 3** as the existing plane this time.
- Click **Close** to exit the function.



Note: One linear cross-section should be created on each flange.

Create new mesh from the pipe surface

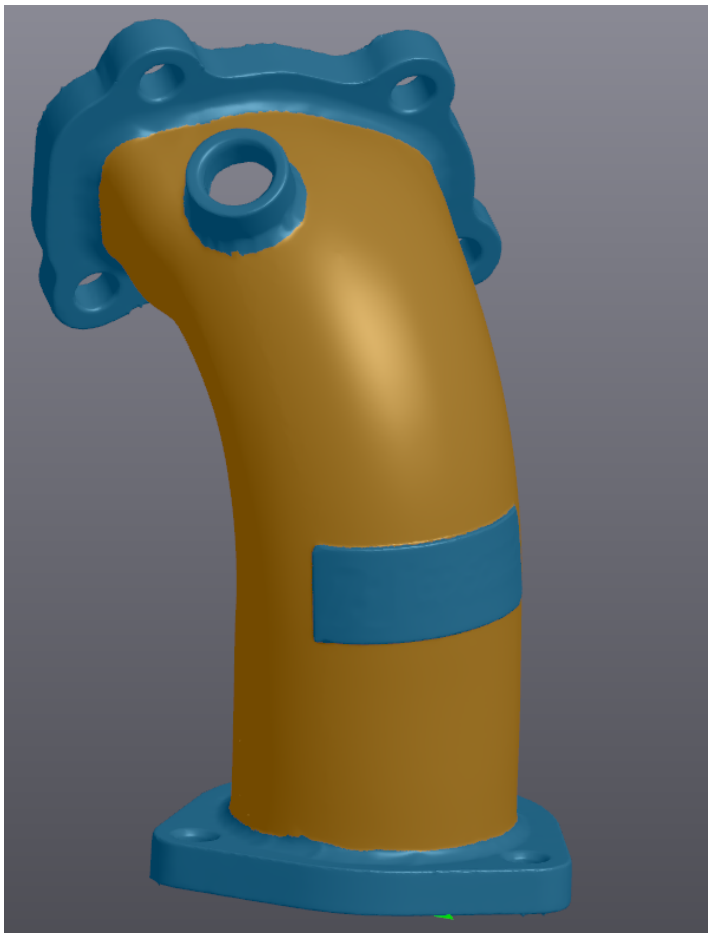
In order to extract a CAD surface from the pipe surface, a new mesh will be created by selecting and copying the pipe surface.

Copy the selected part

- Click on the **Sudden change** icon from the selection tools and set the **Selection tolerance** to **10**.

Note: Depending on where the selection is made upon the first click, the global selection can differ from the tutorial. Always look at your global selection prior of executing an function.

- Select the mesh middle area, between the two flanges.
- Use the **Grow selection** icon (about 4 times) from the selection tools to make sure the desired area is completely selected.



Note: Only the surface of the pipe must be selected.

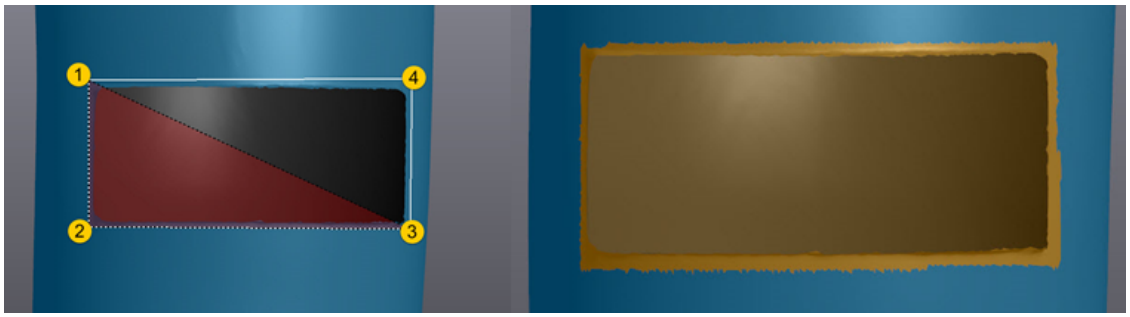
- Click the **Copy** button from the main toolbar. A new mesh, **Mesh 1**, will be created in the **Navigation** tree with the selection.
- Click on the eye icon to hide the mesh **Scan-to-CAD Tutorial 1 Merge** and **Entities** related.

Clean the mesh & fill holes

Fill holes

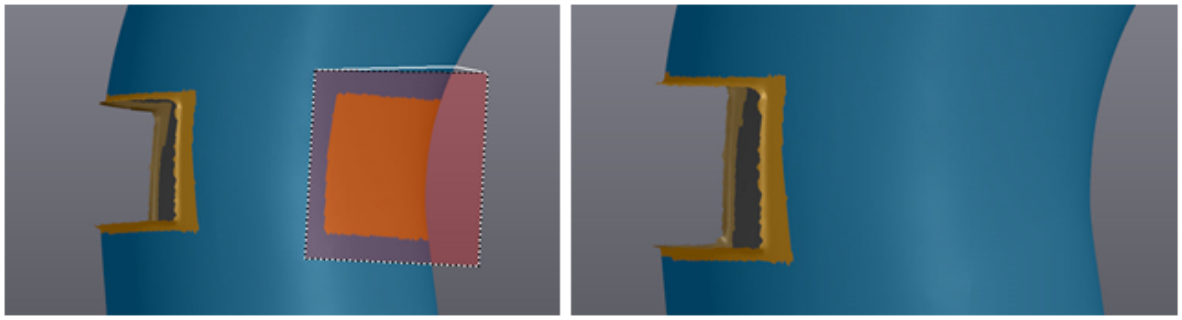
Filling holes is mainly used with mesh preparation for surfacing or 3D printing.

- Click on **Scan-to-CAD Tutorial 1 Merge - Copy 1**.
- Click on the **Free form** and the **Select through** icons in the selection tools.
- Select the exceeding edge near the hole. Hold Ctrl and left-click over each corner.



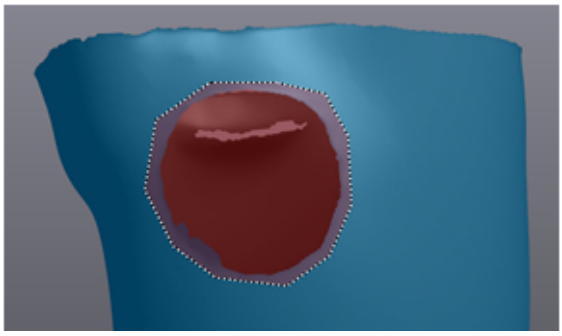
Note: Unwanted data has been selected due to the **Select through** button and has to be removed from the selection.

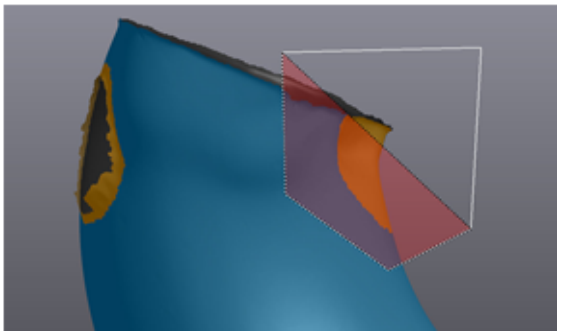
- Hold **Ctrl + Shift** button while selecting and right-click to remove any unwanted area that was previously selected.



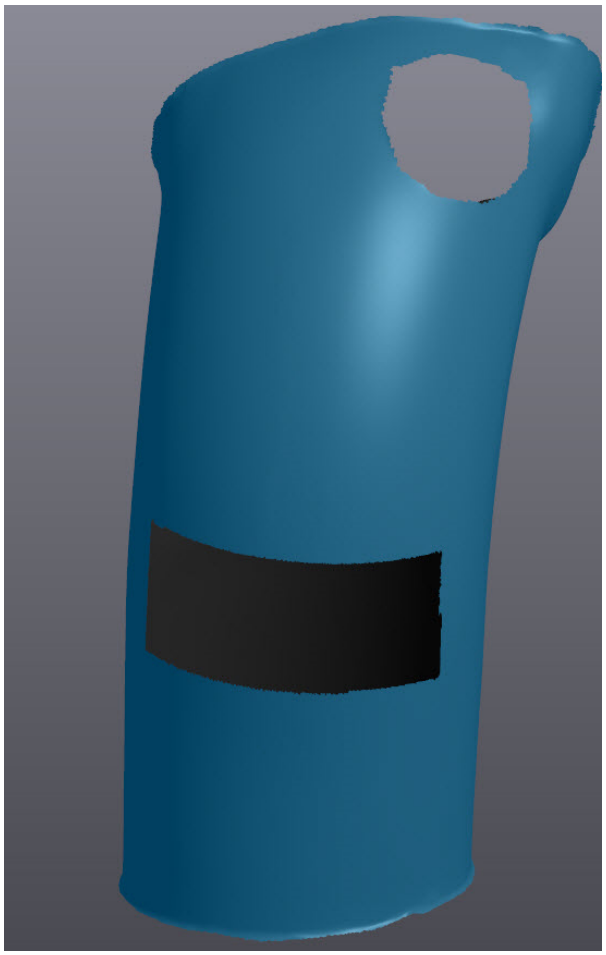
- Select the **Brush selection** and **Select through** and clean the circular hole by adjusting the size of the brush.

» Clean the circular hole using the same technique.

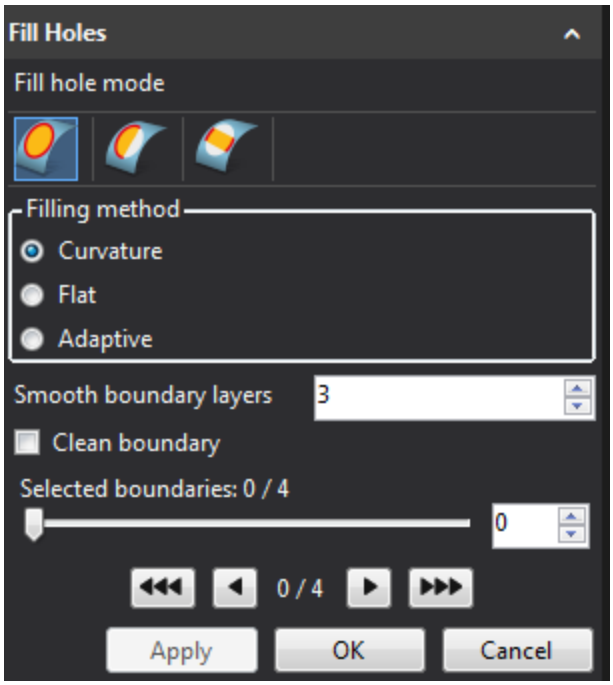




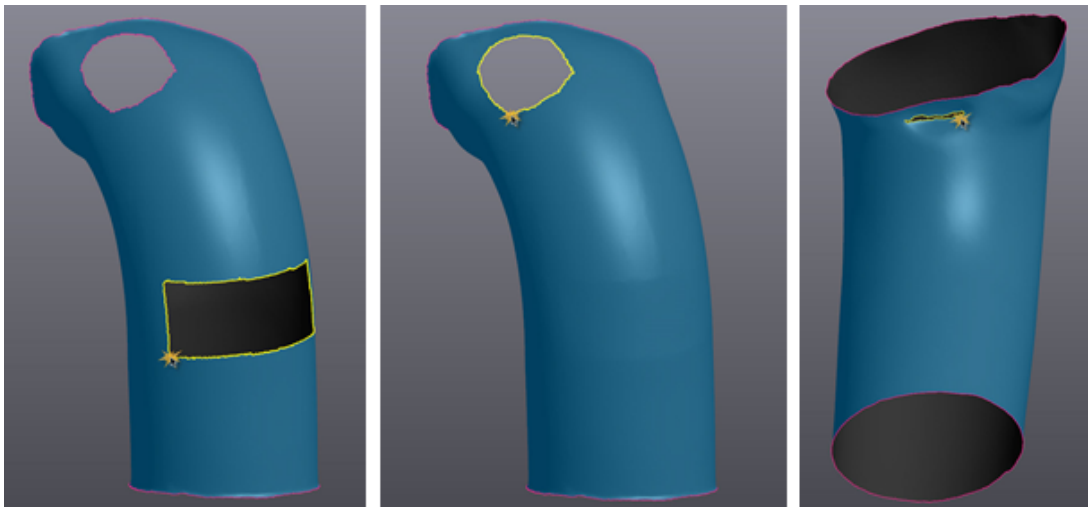
» Delete selected, unwanted data around each hole with the icon.



- Click the **Fill holes** icon.
- Set **Filling method** to **Curvature**.
- Set **Smooth boundary layers** to 3 and leave **Clean boundary** unchecked.
- Select **Whole** as **Filling method**.



- Click on the 3 boundaries on the pipe surface. Once selected, the boundary turns yellow and the hole is filled.
- Click **OK** to close the function.



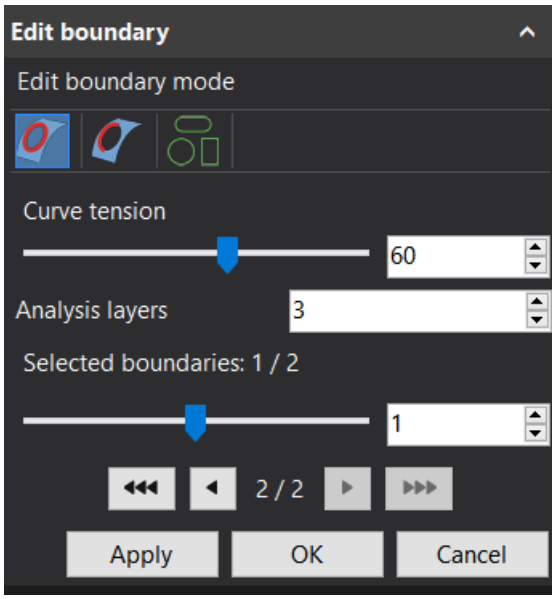
Edit boundary and cut mesh with plane

The boundaries of both openings needs to be cleaned in order to create a clean surface. Two different techniques will be used.

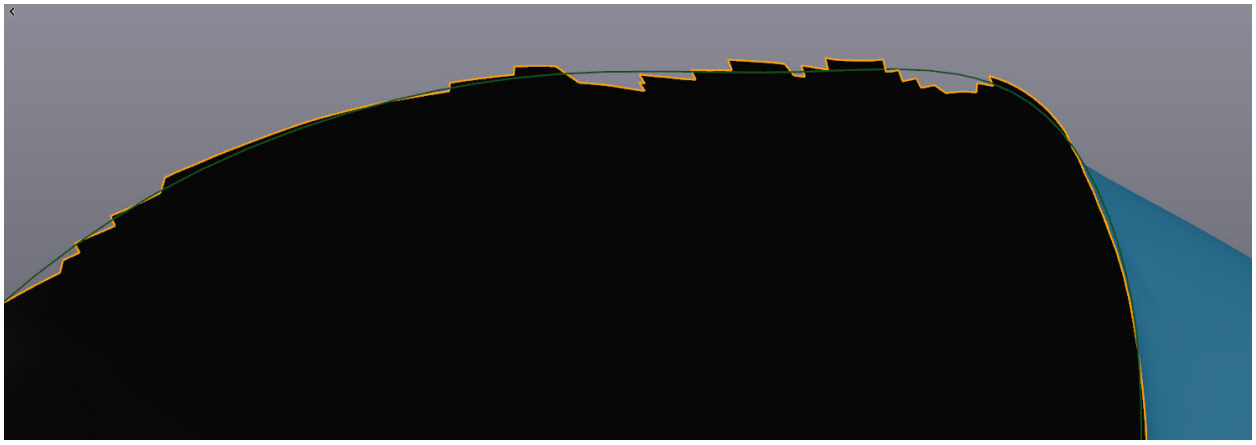
First technique:

The **Edit Boundary** function allows rebuilding and smooth boundaries using curve tension.

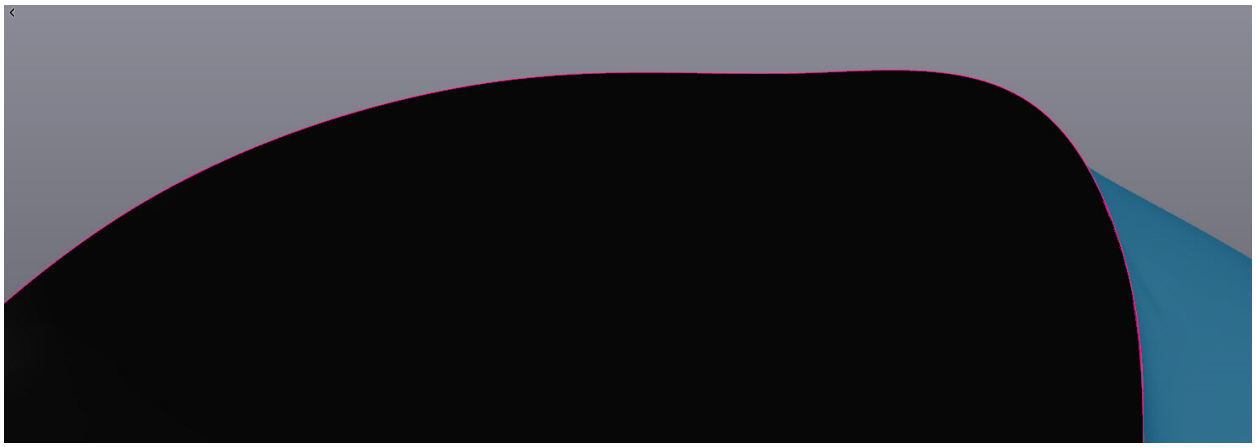
- Click the **Edit boundary** icon .
- Select **Multiple** and set the value of the curve tension to **60**.
- Enter **3** in **Analysis layers**.
- Select the top opening boundary.



- Check the preview of the curve.
- Click on **Apply** to accept the resulting curve.



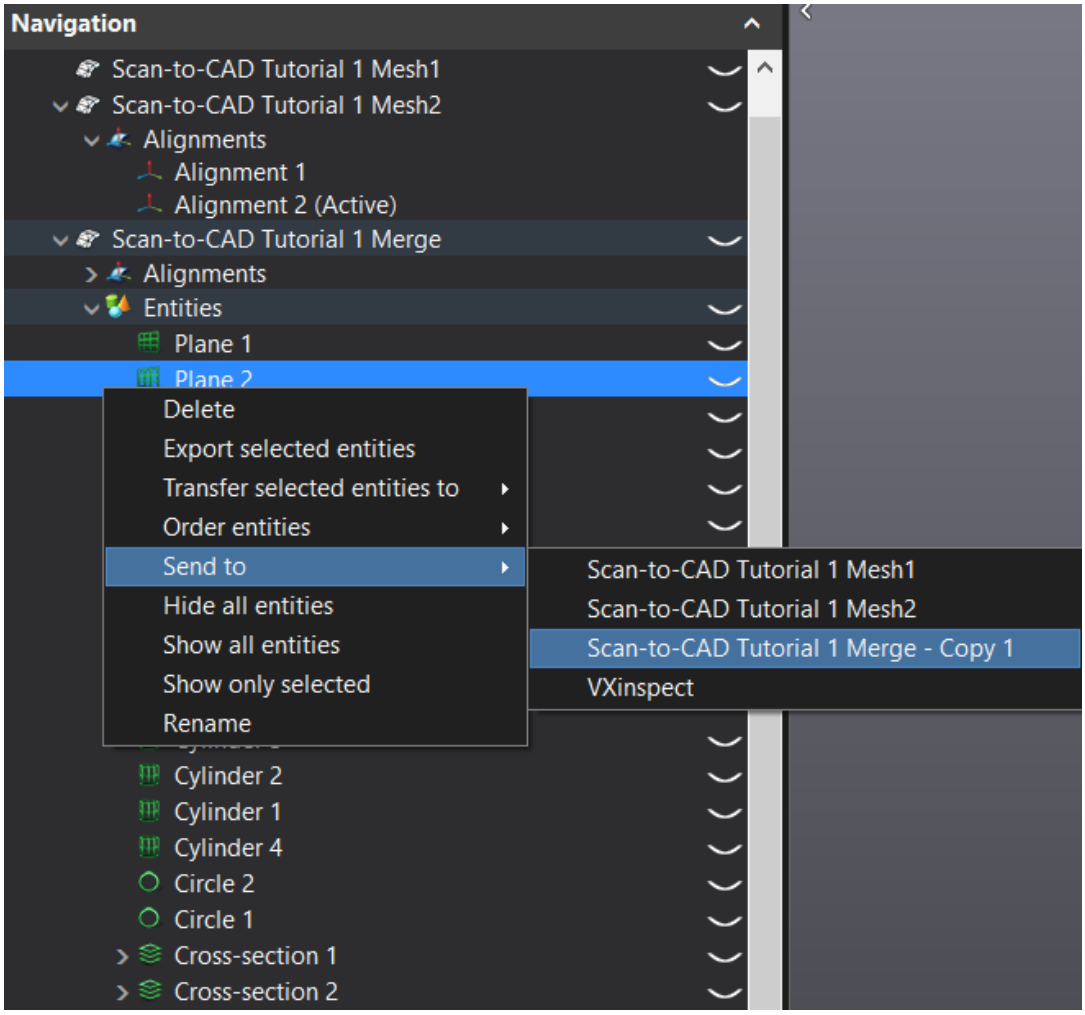
- Click on **OK** to exit the function.



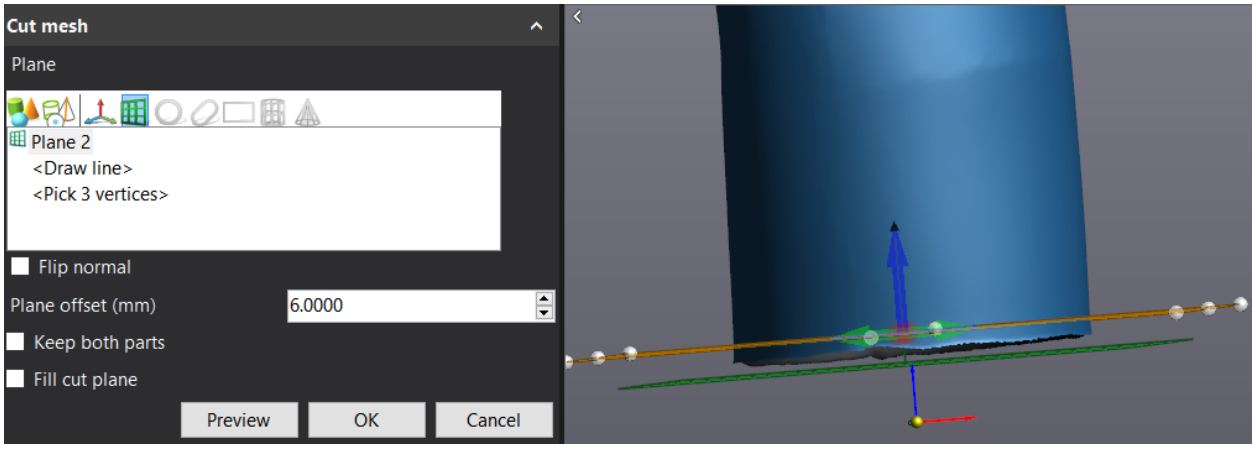
Second technique:

The second technique uses **Cut mesh**. This function allows cutting a mesh using a plane.

- First, select **Scan-to-CAD Tutorial 1 Merge** in the **Navigation** tree.
- Highlight and right click on **Plane 2** under **Entities** .
- Send **Plane 2** from **Scan-to-CAD Tutorial 1 Merge** to **Scan-to-CAD Tutorial 1 Merge - Copy 1**.



- Click the **Cut mesh** icon.
- Select **Plane 2**, set **Plane offset** to **6 mm** and leave **Keep both parts** box unchecked.



Note: The boundary created with the **Cut mesh** function will be cleaned and all the data below the selected offset plane will be permanently deleted.

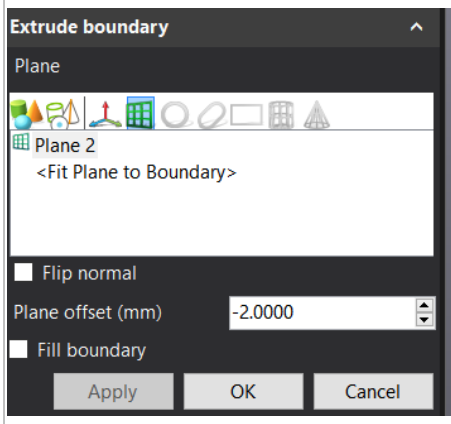
- Click **Preview** and then **OK** to close the function.

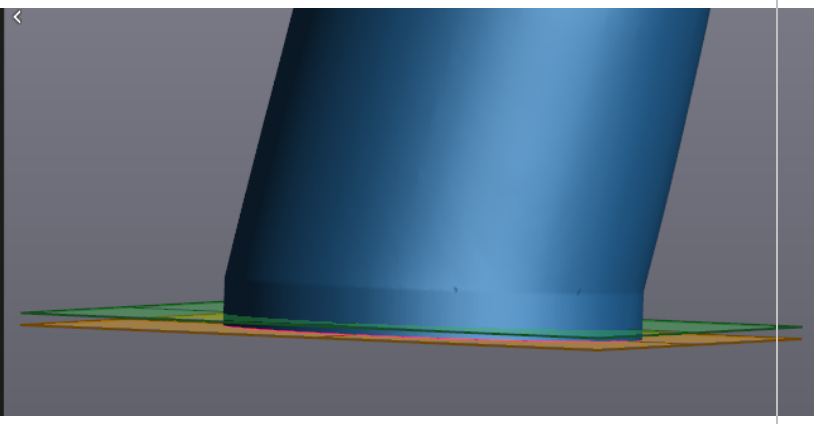
Create surface from mesh with auto-surface

At this step, we will create the inner pipe surface. First, the two boundaries will be extended and then the outer surface will be offset to replicate the pipe thickness. The **Extrude boundary** function increases the length of the surface making sure the pipe, in this case, will be in contact with the flange.

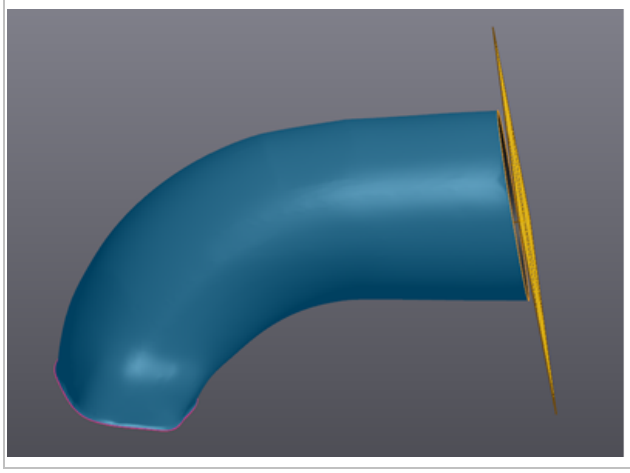
First Step

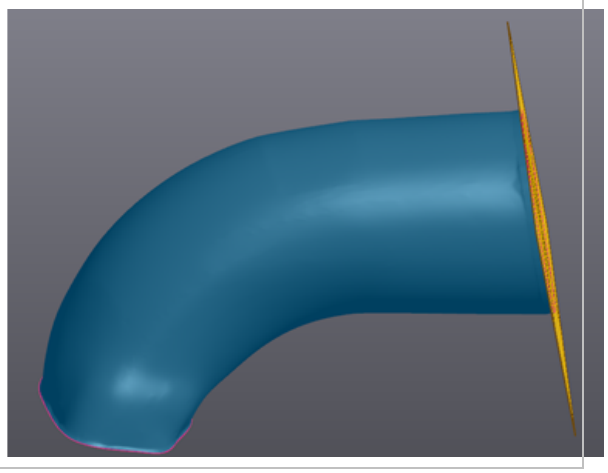
- Click **Extrude boundary**  icon.
- Select **Plane 2**, and make sure the **Fill boundary** box is unchecked.
- Set the **Plane offset**associated top at **-2 mm**.
- Then select the bottom boundary on the pipe.





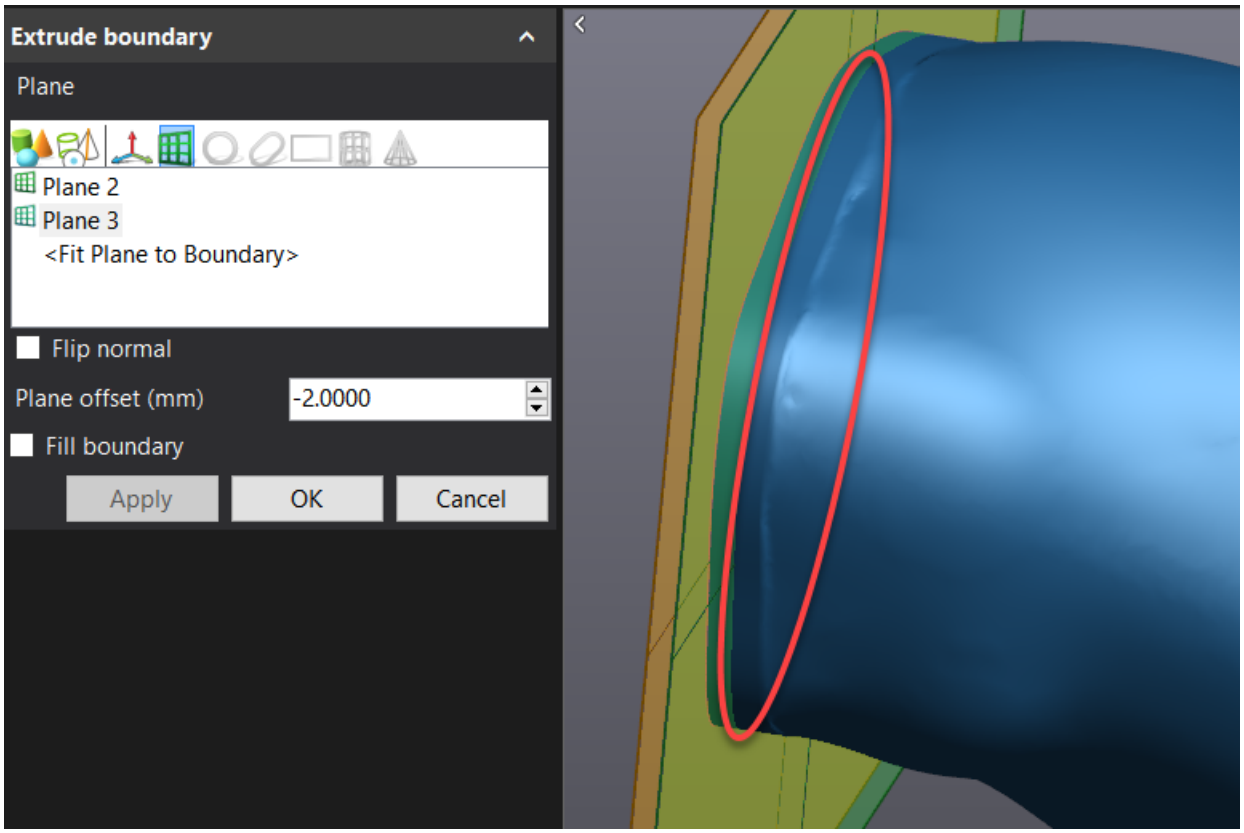
- Click **Apply**, and then **OK**
- This operation needs to be repeated with **Plane 3** at the other boundary.





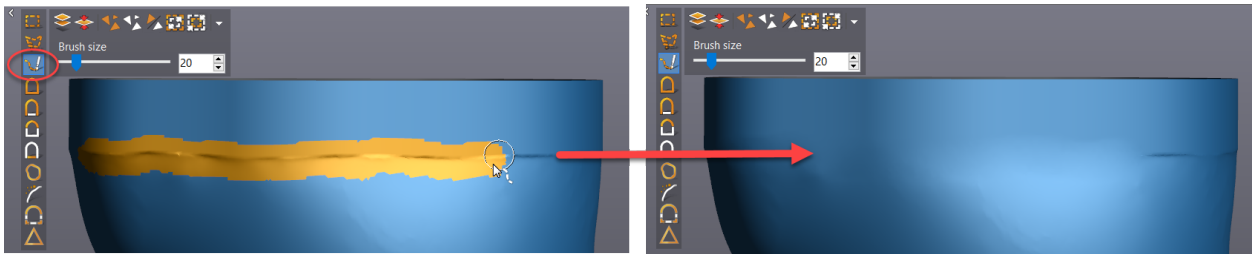
Note: **Plane 3** must be sent to **Scan-to-CAD Tutorial 1 Merge - Copy 1**.

The **Extrude boundary** function might not create a smooth transition from the boundary selected.



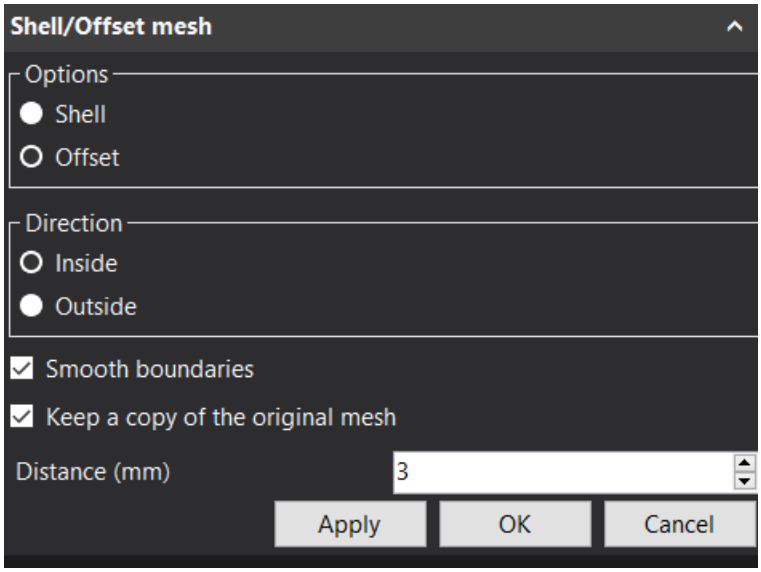
Second step

- To smooth the transition, the **Defeature** function can be used.
- Select the **Brush selection** and make a partial selection at the boundary by adjusting the size of the brush.
- Click on the **Defeature** icon to remove and fill the selected feature.
- Repeat the operation 5-6 times to clean the boundary all around the pipe.

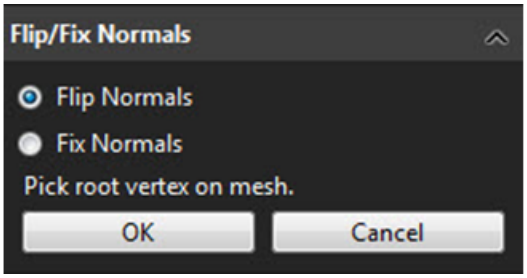


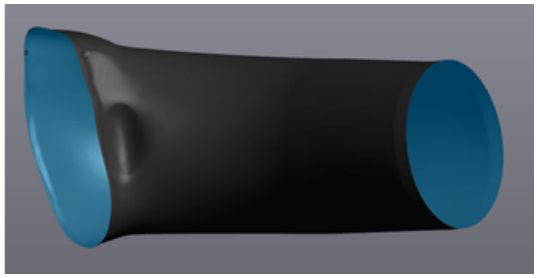
The **Shell/Offset mesh** function will create the inner surface of the pipe.

- Click **Shell/Offset mesh** icon.
- Select **Offset**, and chose the **Inside** direction.
- In the parameters section, check the **Smooth boundaries** and **Keep original mesh** boxes and enter **3 mm** in the distance box.



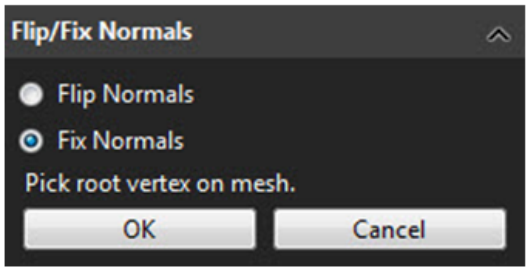
- **VXmodel** will now generate a new mesh-**Scan-to-CAD Tutorial 1 Merge - Copy 1 - Shell/Offset mesh 1**; this process will take some time.
- Click on **Apply** then **OK** to exit the function.

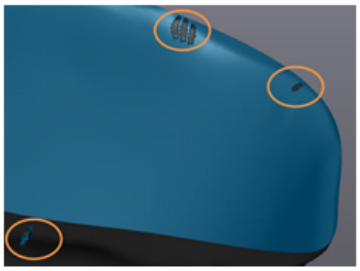


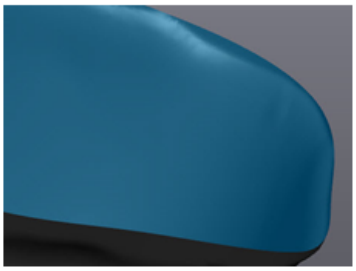


The inner surface has been created but the normal of the surface should be flipped and fixed.

- Click on the eye icon to hide **Scan-to-CAD Tutorial 1 Merge - Copy 1** and click **Scan-to-CAD Tutorial 1 Merge - Copy 1 - Shell/Offset mesh 1**
- Click on **Flip/Fix normals** icon.
- Select **Flip normals** and click on the mesh surface to inverse the normal of all triangles connected with the root vertex.
- **Optional**: If needed, select **Fix normals** and click on the mesh surface to harmonize the normal of all triangles connected.







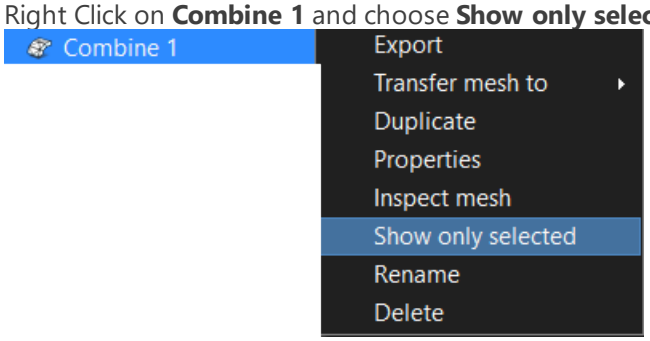
Before creating the auto-surface, combine the inner and outer pipe surfaces into a single mesh.

- Click on the **Combine** icon and choose with **Scan-to-CAD Tutorial 1 Merge - Copy 1**.
- Click **Apply** then **OK**.
- This will generate a new **Entity** called **Combine 1**.

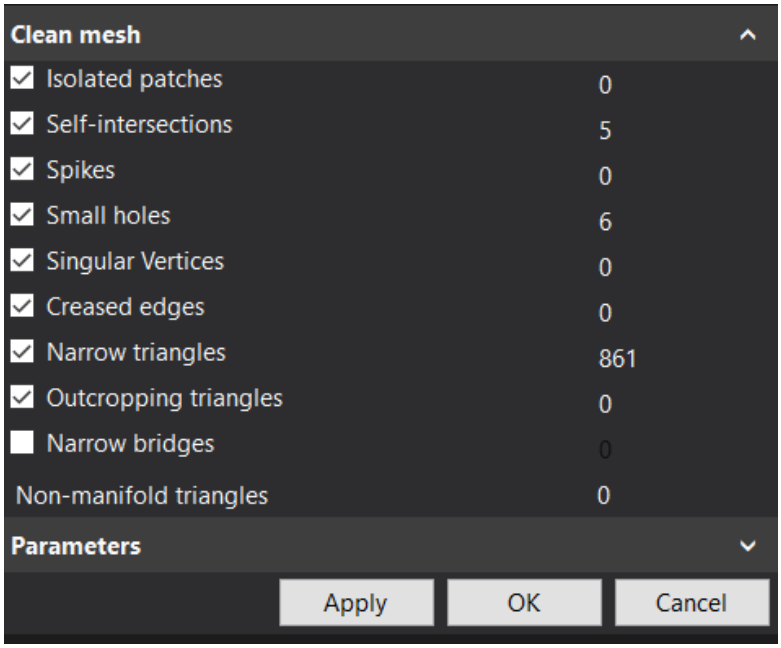
Third step: Create auto-surface from mesh

This function allows creating a surface with organized patch layout on the entire mesh or on specific selected triangles. To avoid bad surface reconstruction, it is recommended to fix small irregularities of the mesh with the **Clean mesh** function.

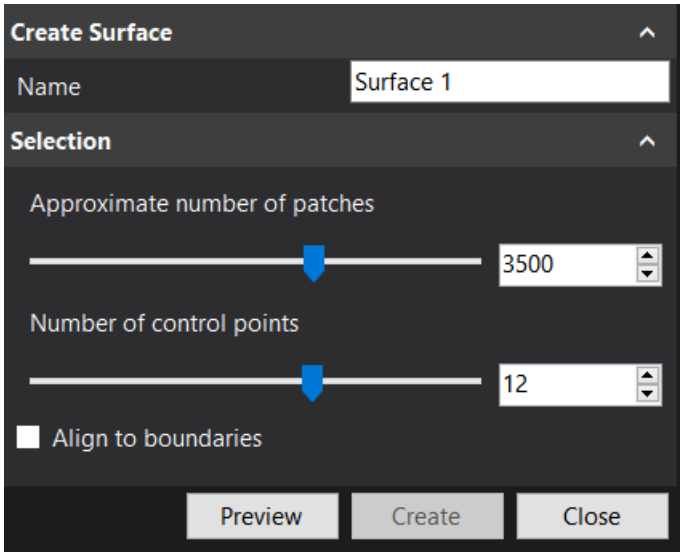
- Right Click on **Combine 1** and choose **Show only selected**



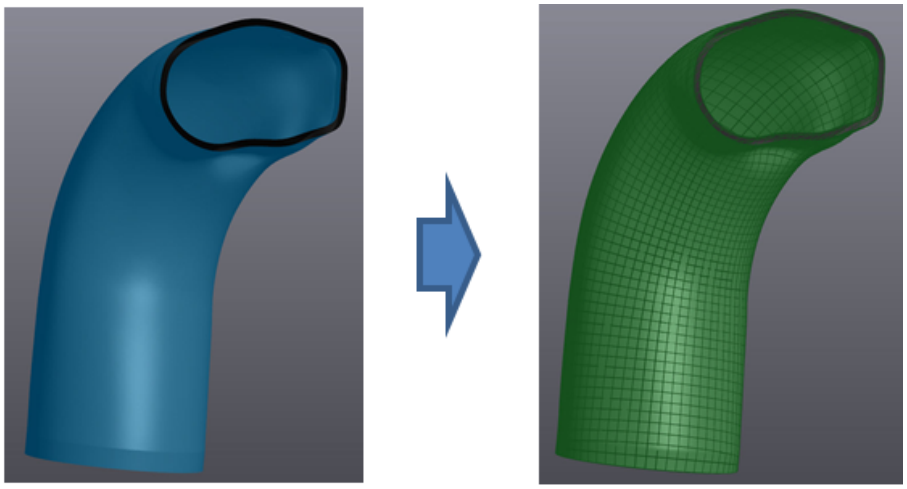
- Click on **Clean mesh** icon.
- Click on **Apply** then **OK**



- Click on the **Auto-surface** icon.
- Under the **Selection** menu, adjust the **number of patches** to **3500** and the **number of control points** to **12**.
- Leave Align to boundaries **unchecked**



- Click on the **Preview** button to validate the result.
- Click on **Create** and then **Close**.

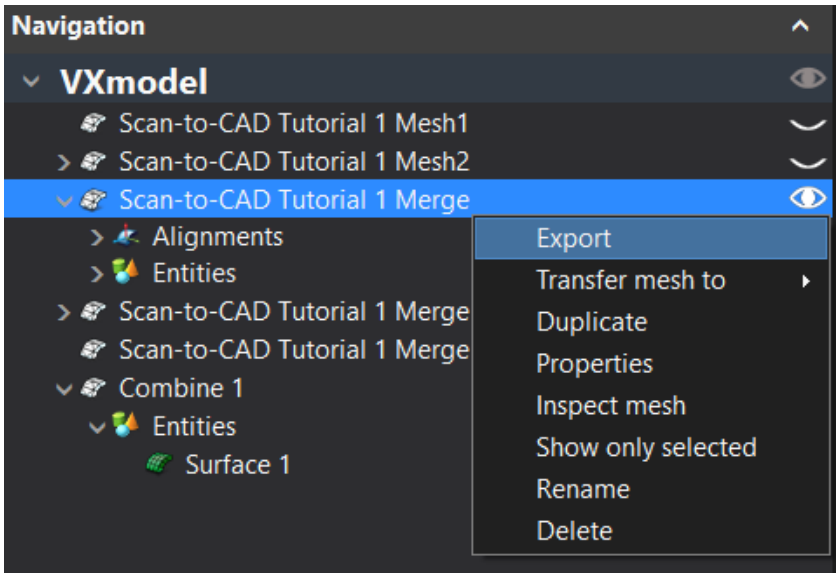


Export entities

At this step, the aligned mesh and the entities to use in the CAD software will be saved.

Save mesh model

- Highlight the **Scan-To-CAD Tutorial 1 Merge** mesh by clicking on it.
- Right click on the mesh and choose **Export**.

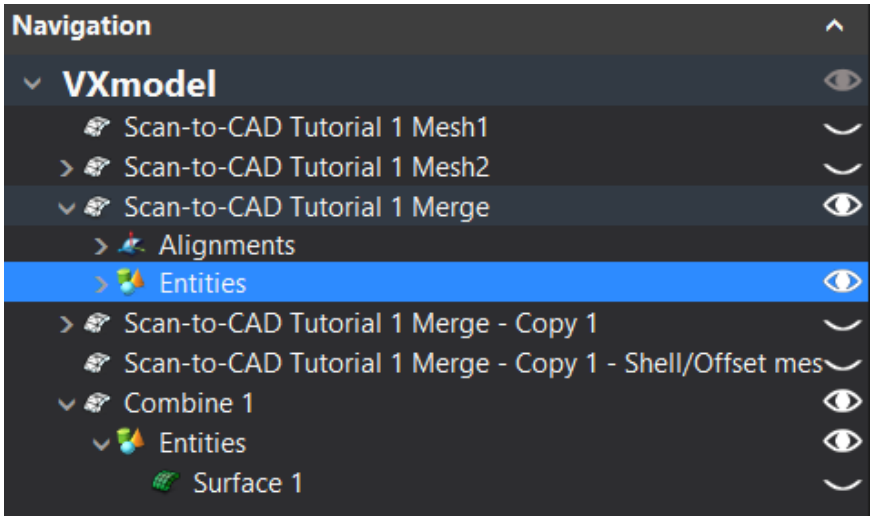


Note: You can also click on the **Export** icon.

Export entities

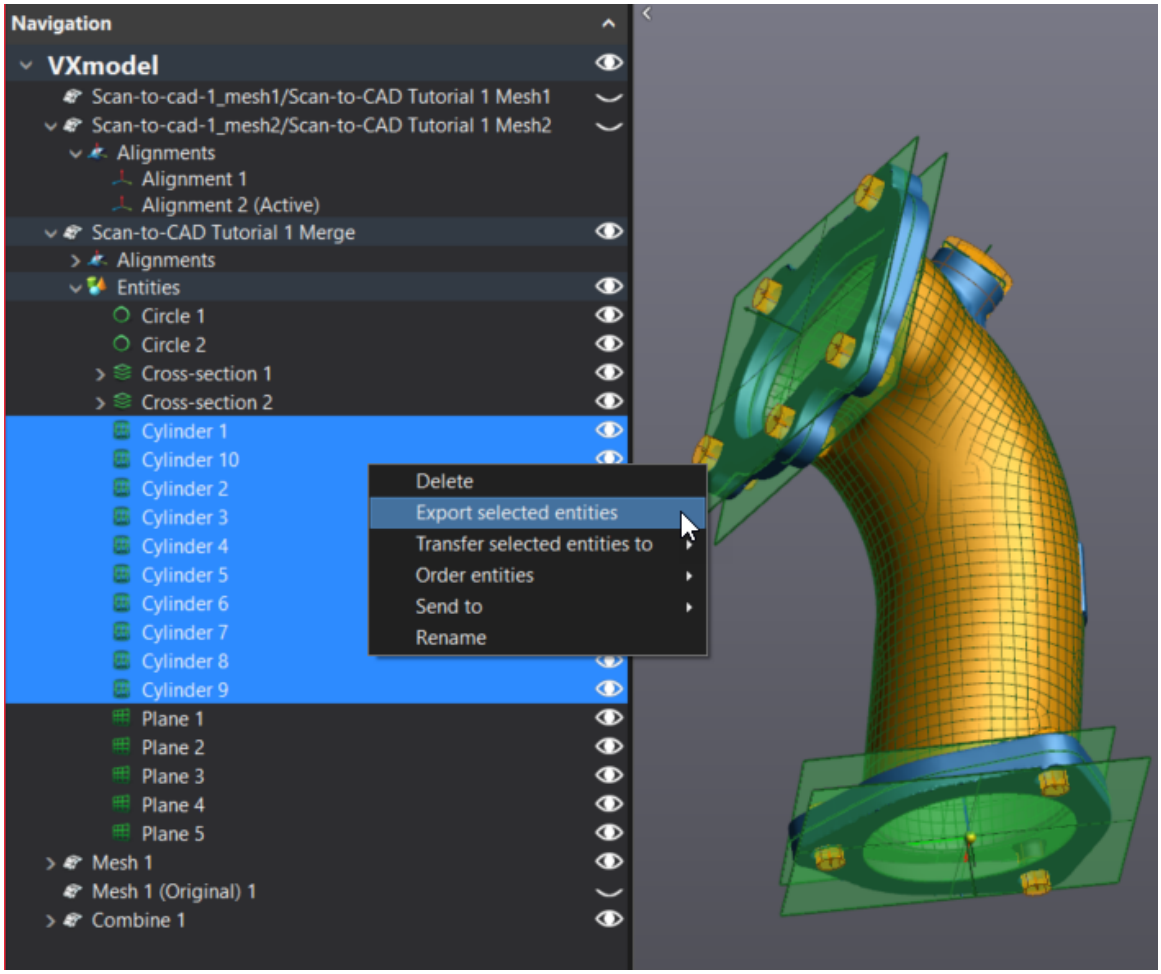
Export the entities in STP format to use in the CAD software:

- Highlight the **Entities** node under **Scan-To-CAD Tutorial 1 Merge**.
- Then, click the **Export** icon **OR** right click to **Export all entities**.



Note: It is recommended to export entities grouped by type, i.e. export the planes together, the cylinders together, etc.

Note: To export one or more entities, select only the ones to be exported holding the CTRL button before clicking **Export selected entities**.

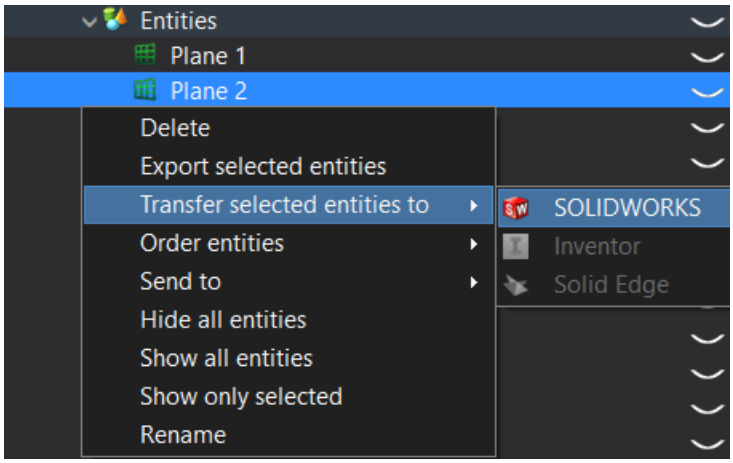


» The mesh and all entities exported are now ready to be opened in CAD software to do reverse engineering of the part or for an inspection.

Export entities – SOLIDWORKS/Inventor/Solid Edge/VXinspect users

If you use SOLIDWORKS, Inventor or Solid Edge. **VXmodel** has a built-in CAD transferring function that executes the previous steps of exportation directly to SOLIDWORKS, Inventor or Solid Edge.

- Click on the **Entities** node or on specific entities and click on **Transfer all entities to SOLIDWORKS, Inventor, Solid Edge** button or
- **Transfer selected entities to SOLIDWORKS, Inventor or Solid Edge** in order to directly export those entities to SOLIDWORKS, Inventor or Solid Edge
- Right-click on selected entities and **Transfer selected entities to SOLIDWORKS, Inventor or Solid Edge**



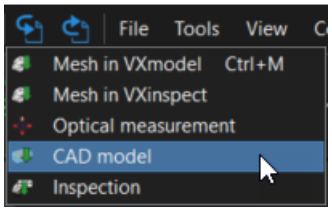
Note: If SOLIDWORKS, Inventor, or Solid Edge are not open, the function will open it and create a new part and import the entities. If SOLIDWORKS, Inventor, or Solid Edge are open, it will import, in the active part, the entities.

Inspect the reverse engineered part

Once the solid part has been created in CAD software with the entities previously created, it is possible to import the result to compare it with the mesh. To do this inspection, a color map will be created between the imported CAD and the aligned mesh.

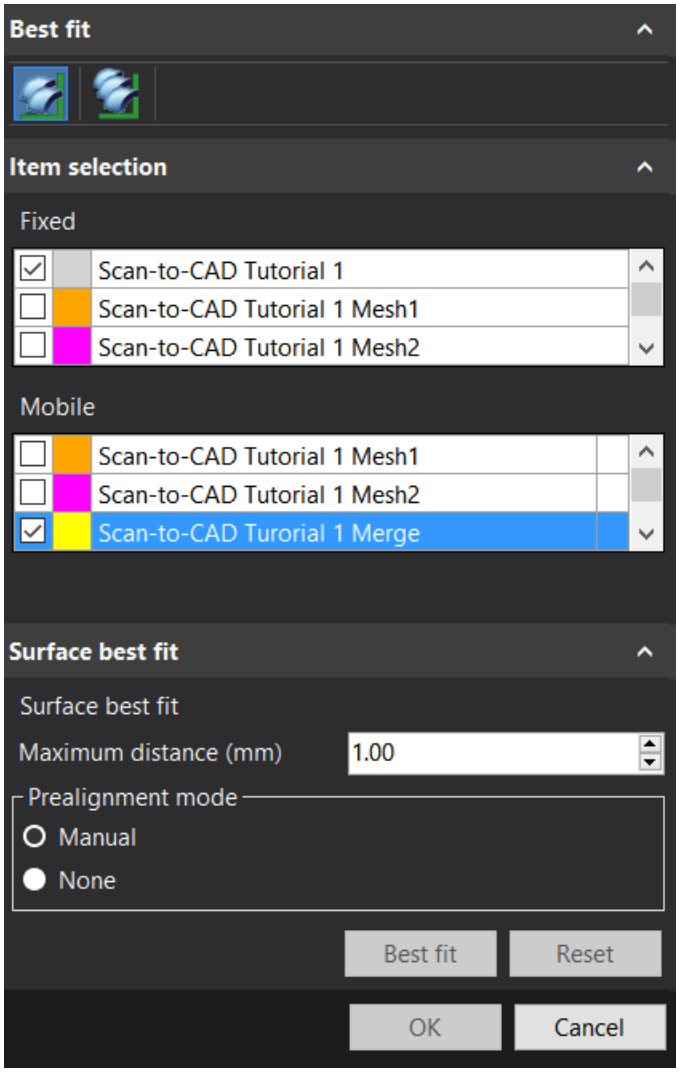
Best-fit alignment - CAD with mesh

» Click on **Import** and select **CAD model** from the list.



» Select the **Scan-to-CAD Tutorial 1.step** in the download folder: ***\Documents\VXelements\Tutorials\VXmodel_1_CAD_DataSet**

» Click on **Scan to-CAD Tutorial 1 Merge**.



If the mesh if not align perfectly with the CAD model, click on **Best fit on CAD** icon to align the CAD with the mesh **Scan to-CAD Tutorial 1 Merge**.

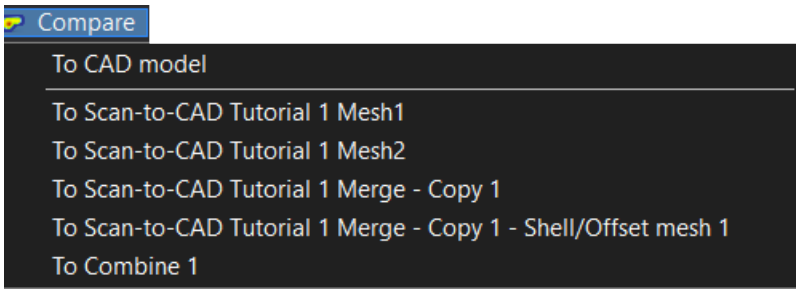
» Set the **Maximum distance** to **1** mm.

» Select at least 3 common points and look at the result. Click **Best fit**.

» Click **OK**.

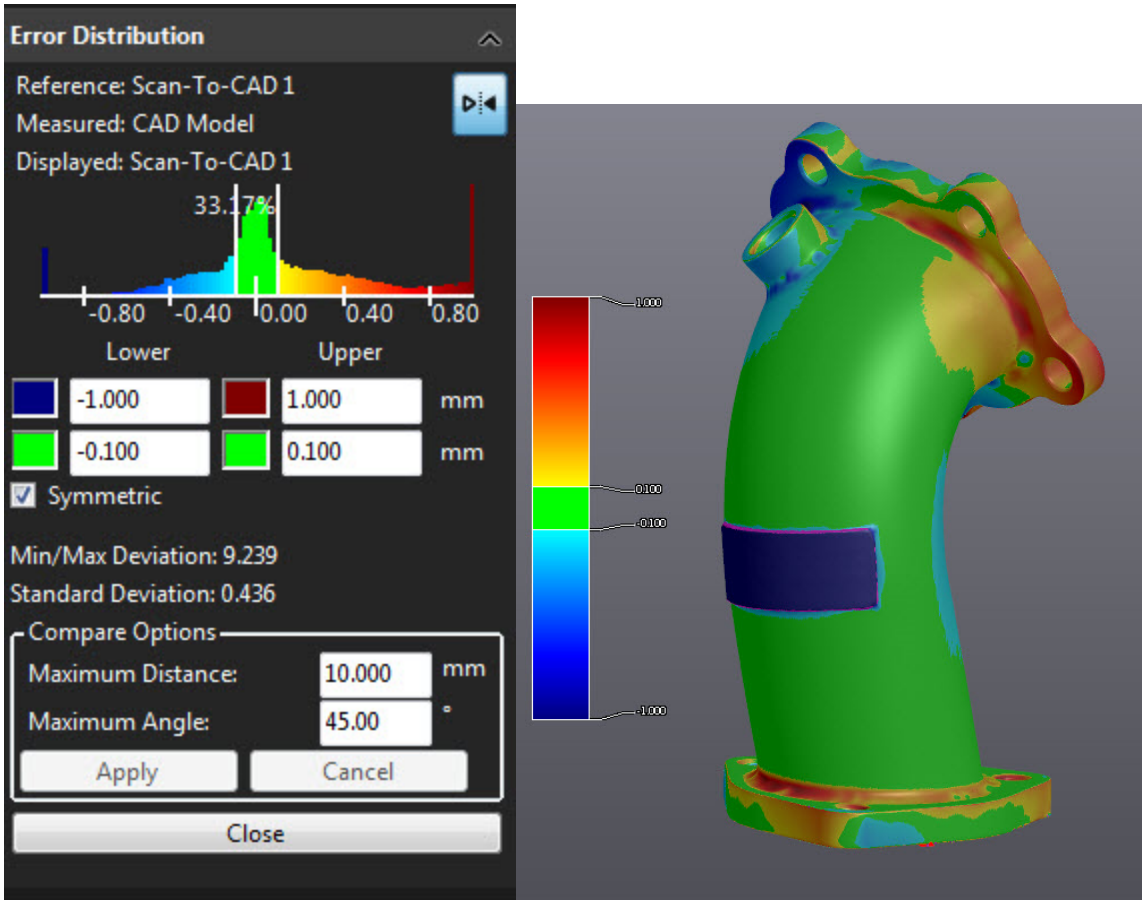
Color map comparison - CAD with mesh

- Click on **Scan-to-CAD Tutorial 1 Merge** Mesh.
- Click on **Compare** icon and select **To CAD Model**.



Note: It is possible to compare the last operation to another mesh or a surface created with the auto-surface function.

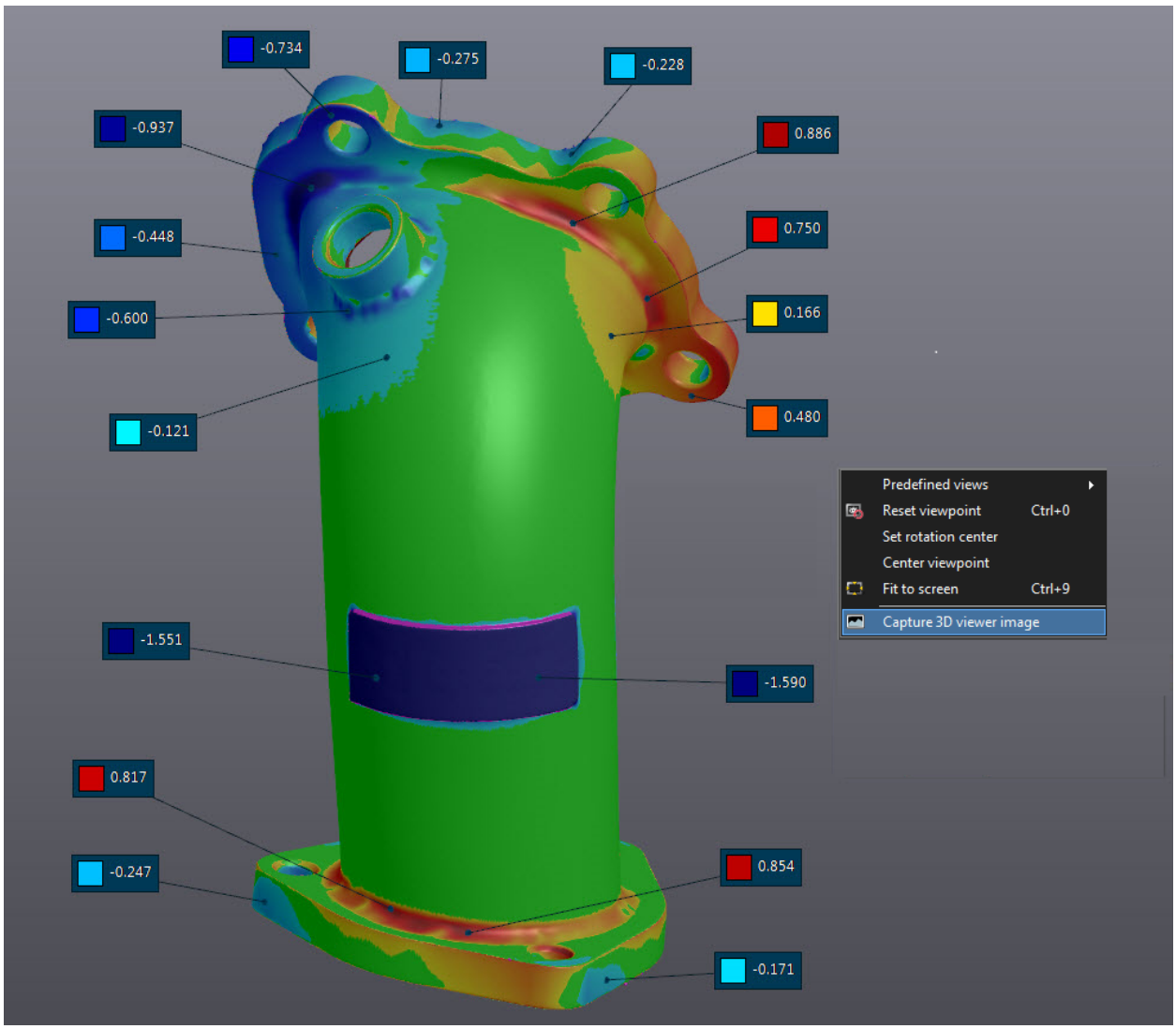
» Click on the **Flip** button to inverse the Reference and the **Measured** model and do an inspection of the reverse engineered part.



Note: It is possible to change the color map tolerance and/or the options of the comparison.

» You can add **annotations** by clicking on **Start adding 3D deviations annotations** icon.

Note: It is possible to export a snapshot with a right-click and choose **Capture 3D viewer image**.



Note: Right-click on a box to close one annotation or click **Close annotation** icon if you want to clear all annotations.

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