3DXpert™

3DXPERT-WARPAGE EXERCISE

3DXpert 15

Tutorial_V1 - Updated: 15,0202,1774,850(SP2P2)

3D SYSTEMS

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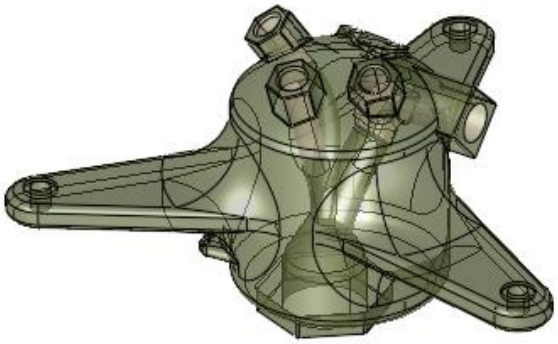
Introduction

In this exercise, we will use various tools of the 'Part Correction' process. These tools allows comparing the actual printed part (either by manufacturing the part and scanning it, or from a simulation system), to the designed part, and changing the design of the CAD model to compensate for warpage, so that the final printed part fits the required dimensions and tolerances.

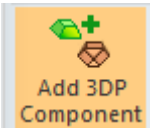
Part 1 Auto Alignment

The Auto Alignment tool is used to help with the alignment of 2 objects. This is usually useful when you import a scan of a manufactured part and compare it with the designed model to look for deviations or for the Warpage Compensation process.
In this exercise, we will use a compensated model from the build simulation system, however, let's go over the auto alignment option first, while importing a scan of a manufactured part to be compared with the designed model.

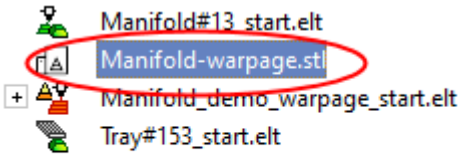
1. Unpack the **Manifold_demo_warpage_start_Auto Alignment.ctf** and load the assembly.



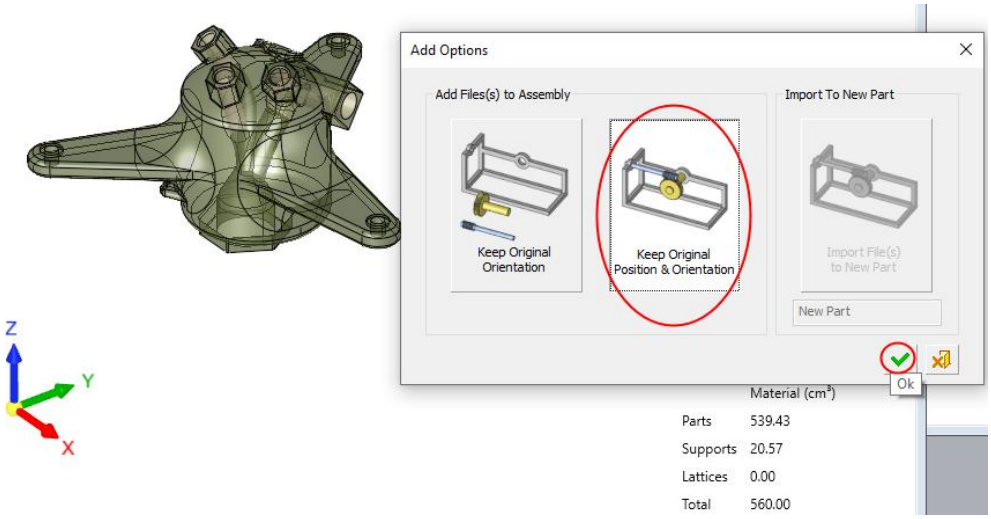
2. Add the compensated model, select **Add 3DP Component** from the guide.

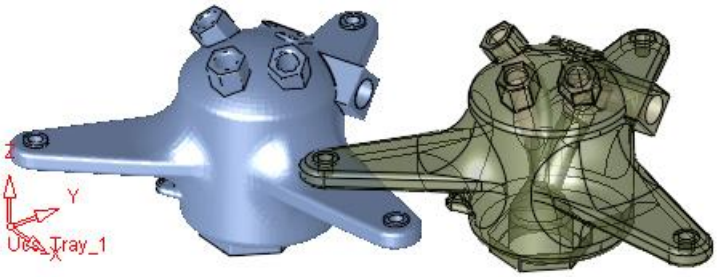


3. Select the **Manifold-warpage.stl.** This file resemble a scan of a manufactured part.

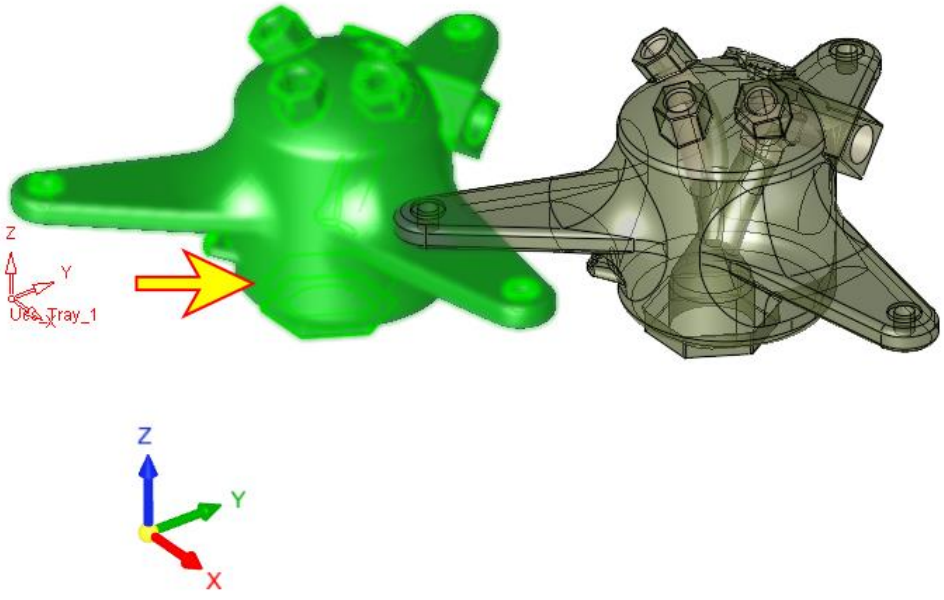


4. Accept the default placement option and select **OK**.

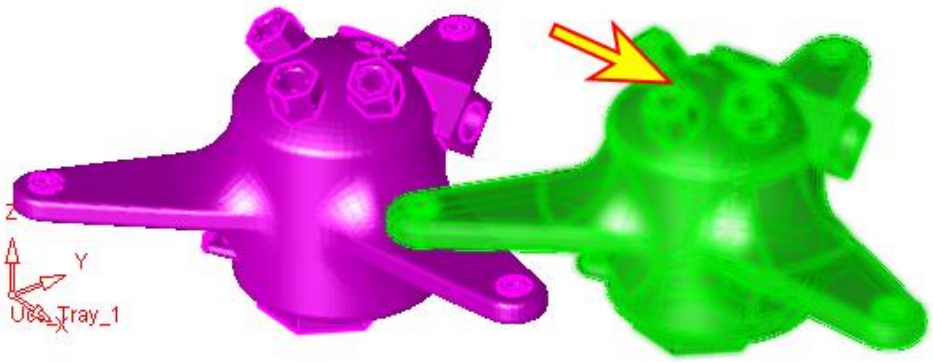


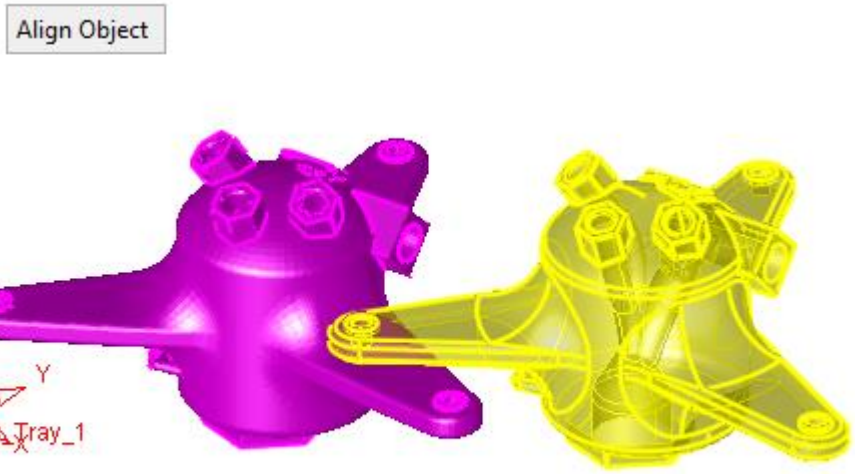


5. Pick the object (B-rep or Mesh) to be aligned.



6. Pick the reference (target position) object (B-rep or Mesh). The alignment of this object is fixed. The object selected in stage 1 is aligned to the object selected in stage 2.

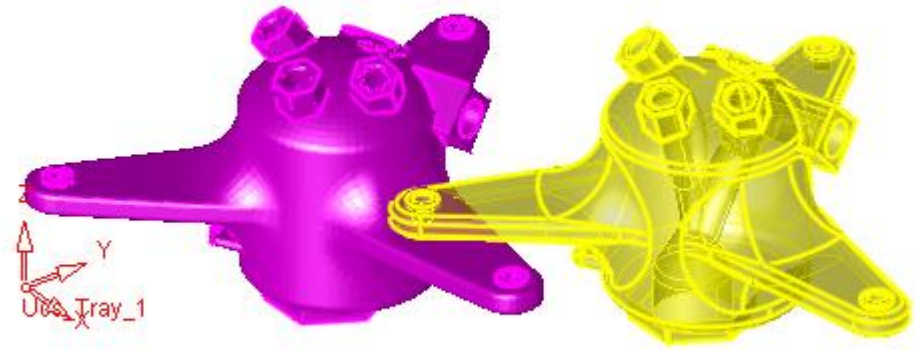




7. Accept the default option: **Align Object**. This aligns the object selected in stage 1 to the orientation of the object selected in stage 2 .

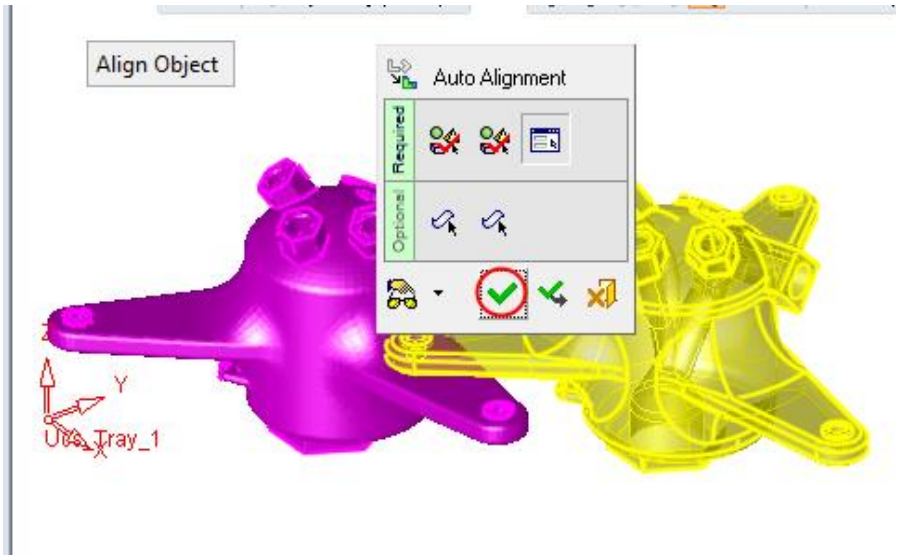
You may toggle between the '**Align Object**' options 

to '**Create UCS**' in order to define the alignments by UCS.

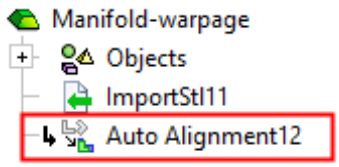


Note that you can also use the optional stage to pick faces (for B-rep) or facets (for Mesh) from the object selected in stage 1 or 2 to be used for the alignment calculation. The selected entities will be used instead of the main object.

8. Select **OK**.



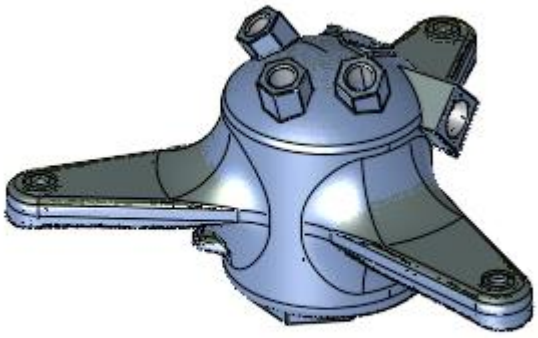
9. When completed, the **Auto Alignment** feature will appear in the feature tree.



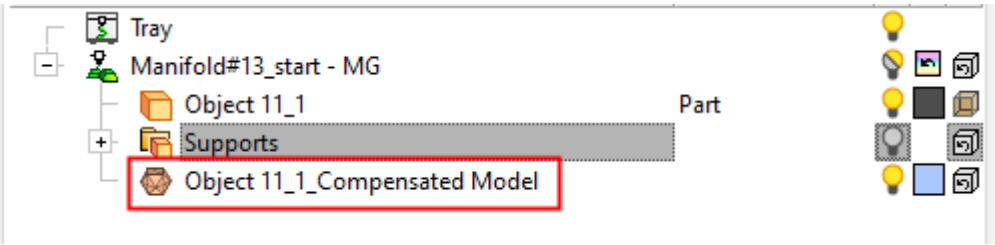
10. Exit the project.

Part 2 Deviation Map

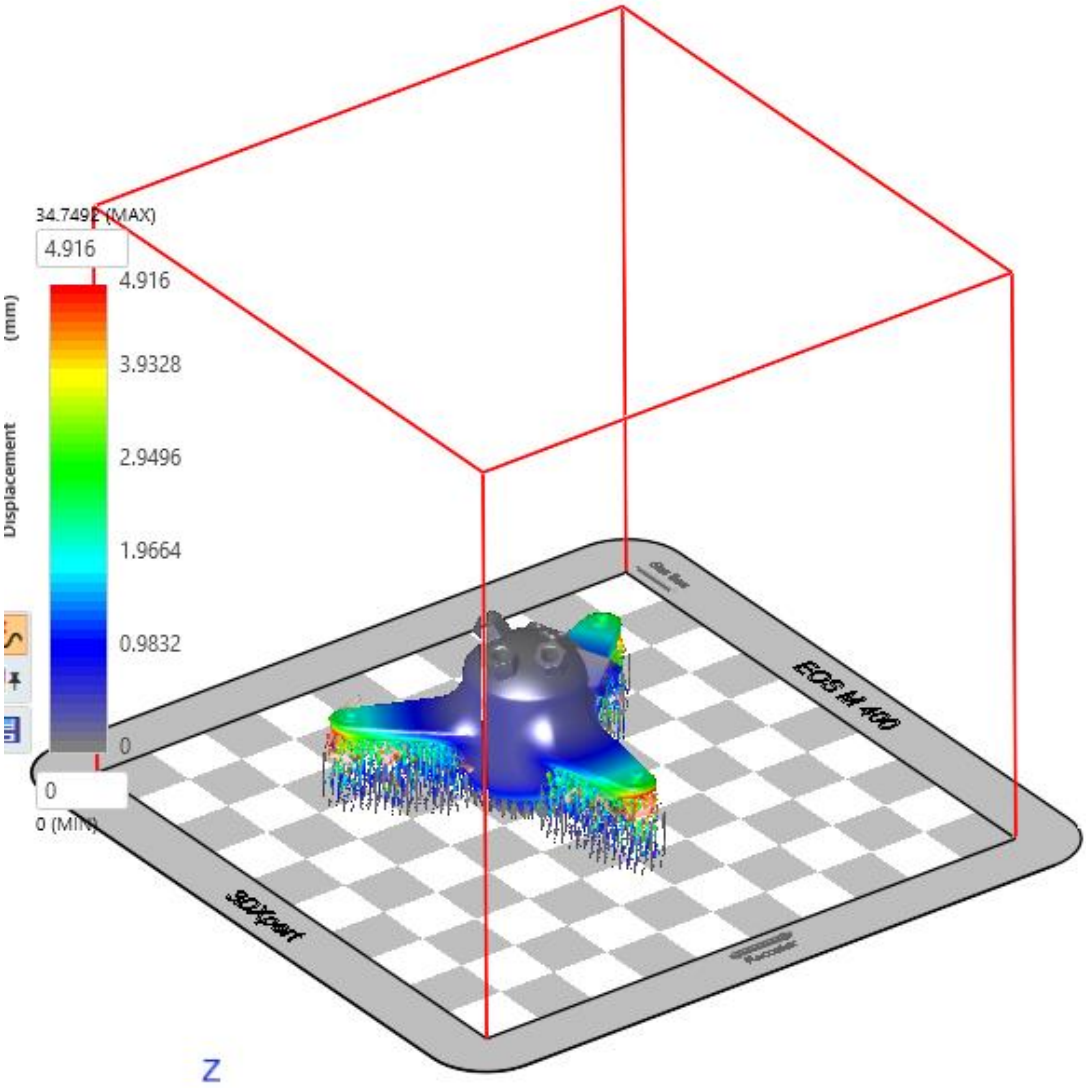
1. Unpack the **Manifold_demo_warpage_start.ctf** and load the assembly. As mentioned before in this exercise, we will use a compensated model from the build simulation system.



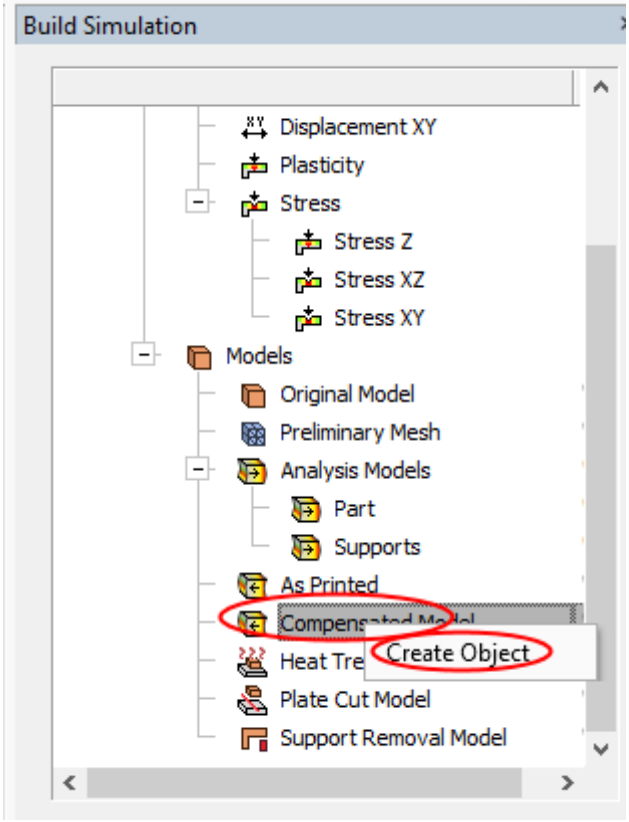
2. Notice the Compensated Model object in the feature tree.



This object was created in the build simulation environment. The system calculates the Compensated Model during the build simulation. The compensated model represents the geometry of the model as it should appear when printed; after compensating for all the deviations to produce the original part as designed.

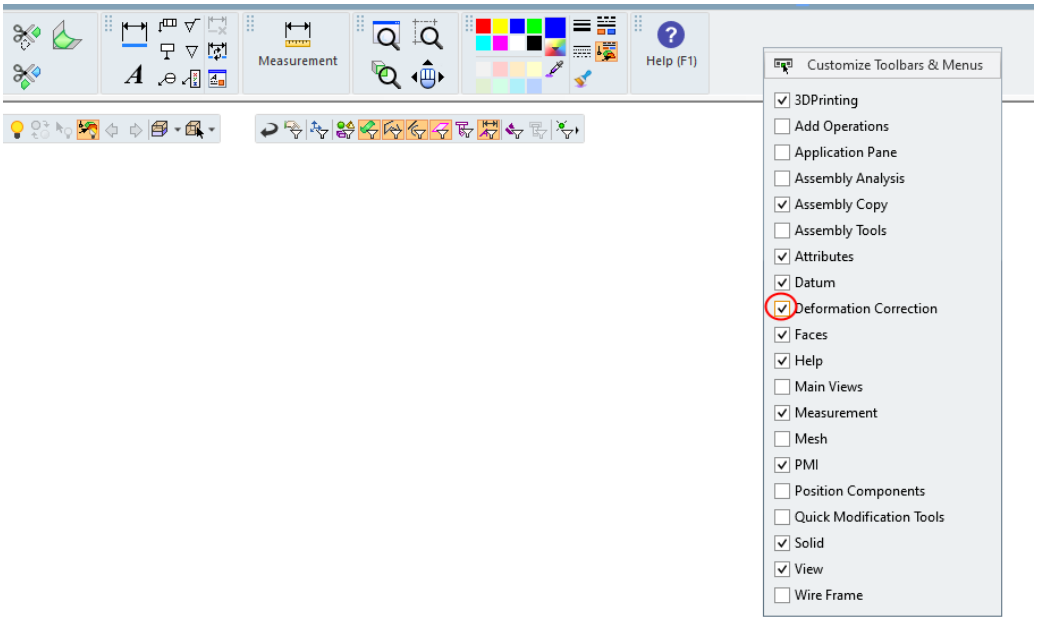


The compensated model was imported into the part, using the '**Create Object**' option.

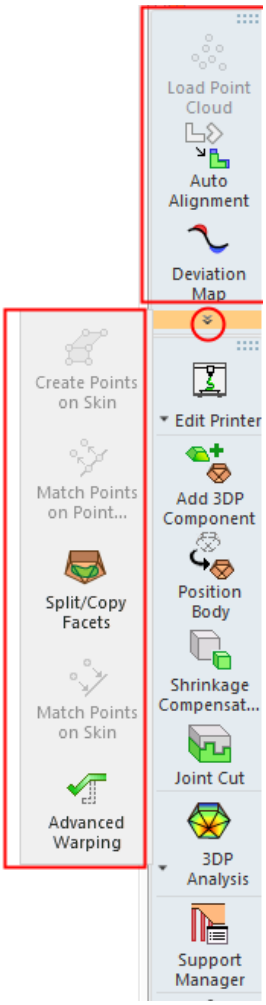


Before Proceeding with the exercise, show the Deformation Correction toolbar. This toolbar lists the appropriate functions in a logical order to guide you through the deformation correction process, from start to finish. This toolbar contains commands related to importing, aligning and fixing of deformation data.

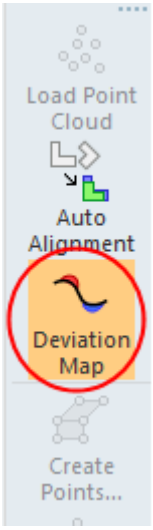
3. To show the **Deformation Correction Toolbar**, right-click a currently displayed toolbar and select the **Deformation Correction** checkbox from the popup list of available toolbars.



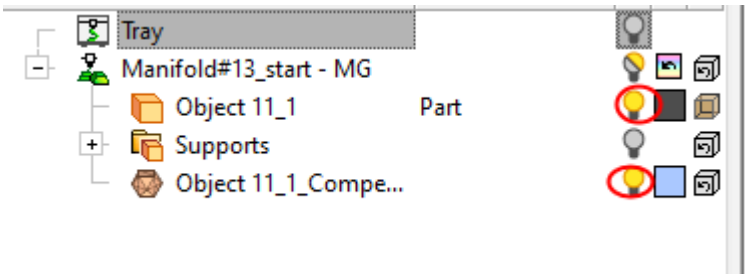
4. See the additional functions in the guide:



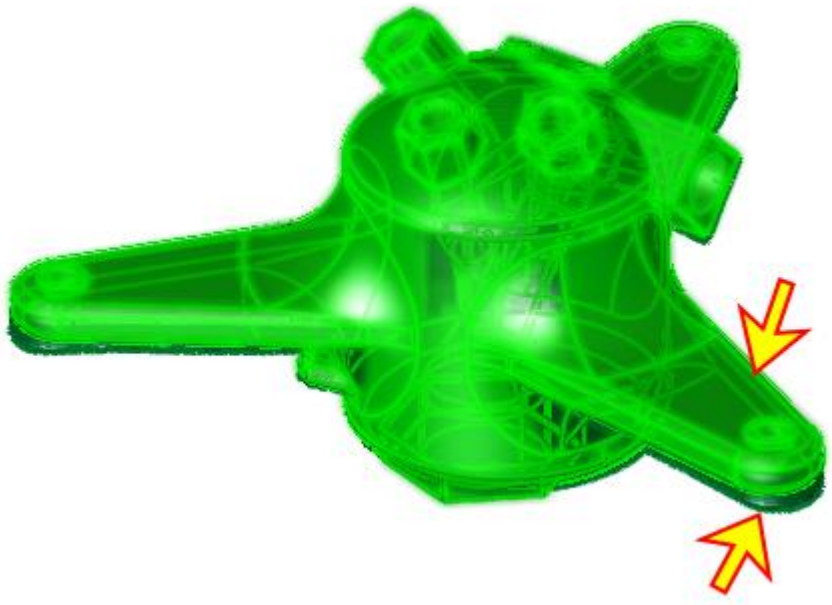
5. Click the **Deviation Map** option to calculate the distances between two parts.



6. Ensure that both the original object and the compensated object are shown.

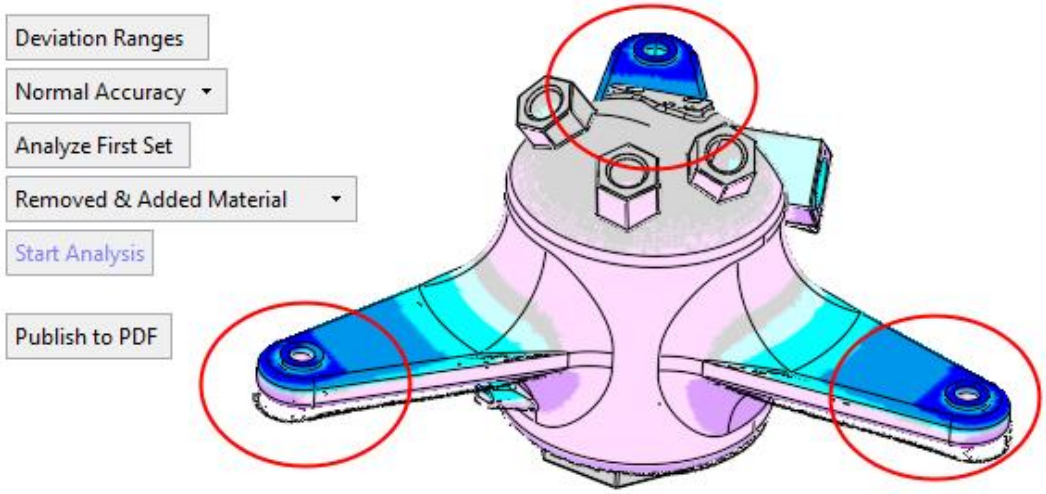


7. Pick the original object and then pick the mesh compensated object.

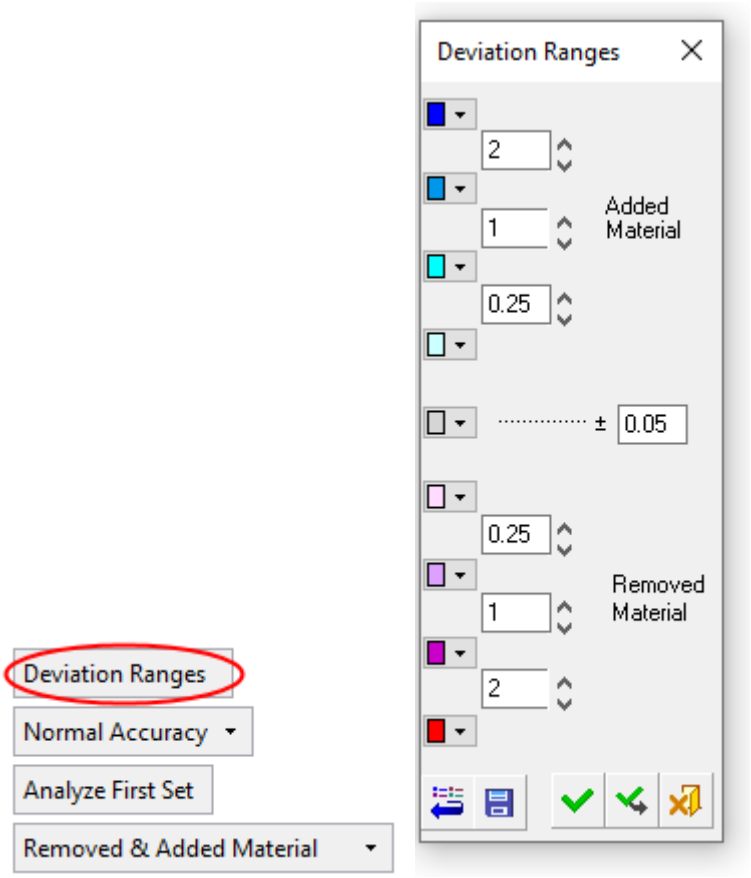


8. Accept the default parameters and press the **Start Analysis** option.

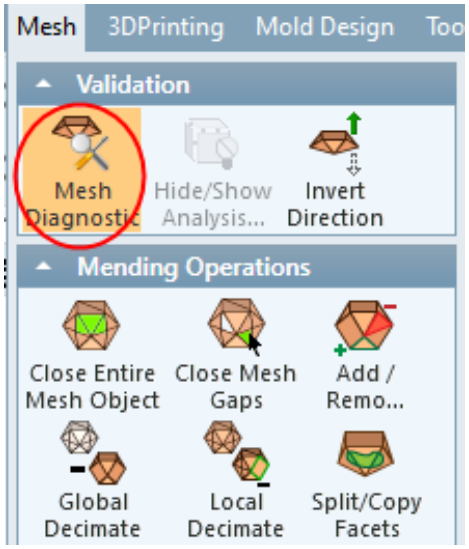
9. The result is a color-coded map of the distances between the original and target parts. Notice the problematic areas.



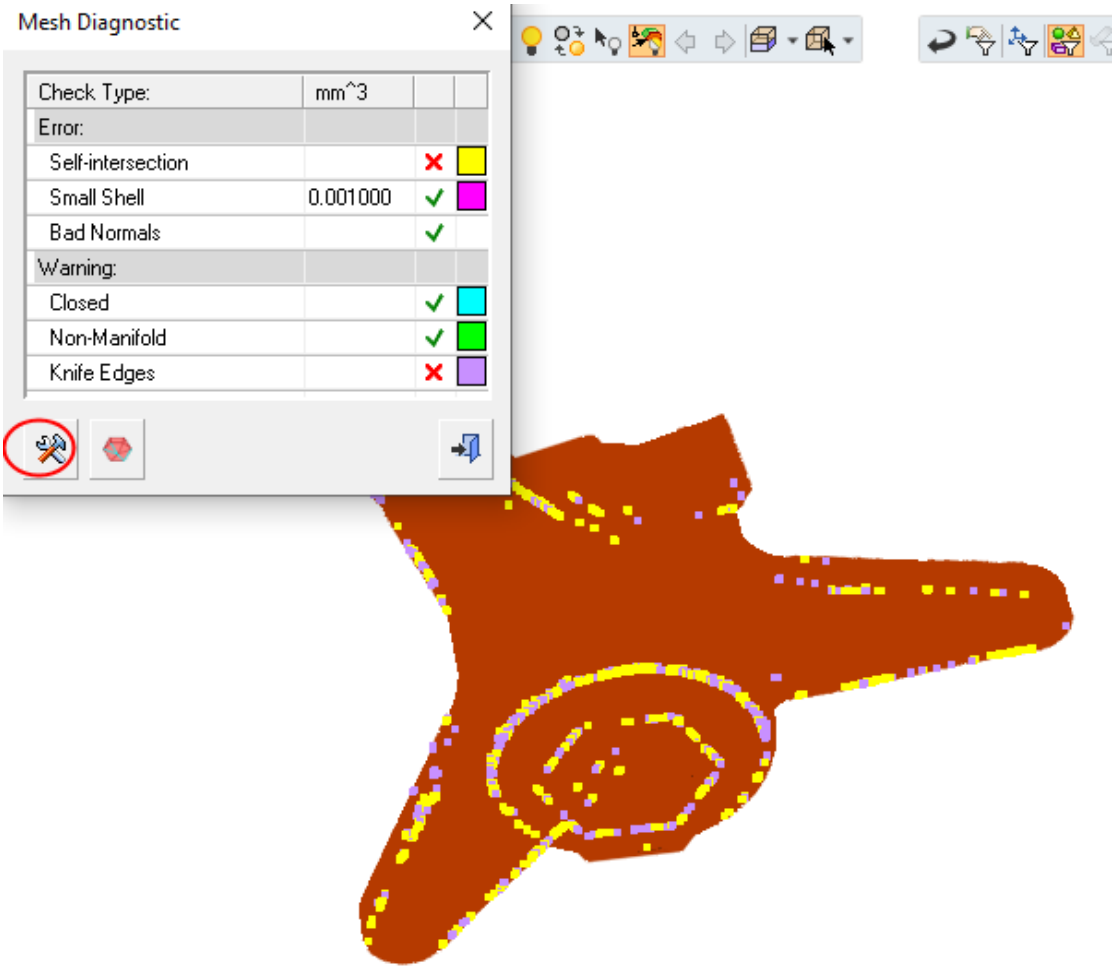
11. Click the Deviation Range button to display the dialog showing the color-coded deviation ranges.



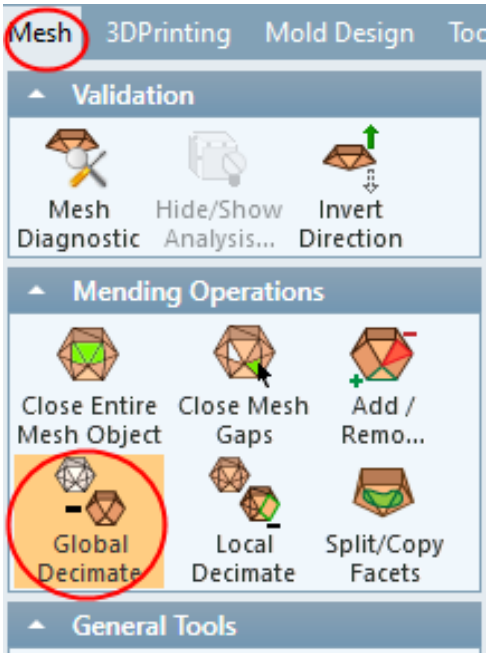
12. Exit the dialog.
13. Next, we will check the mesh object and apply corrections if needed. From the Mesh dialog, select the option: Mesh Diagnostic and pick the mesh object.

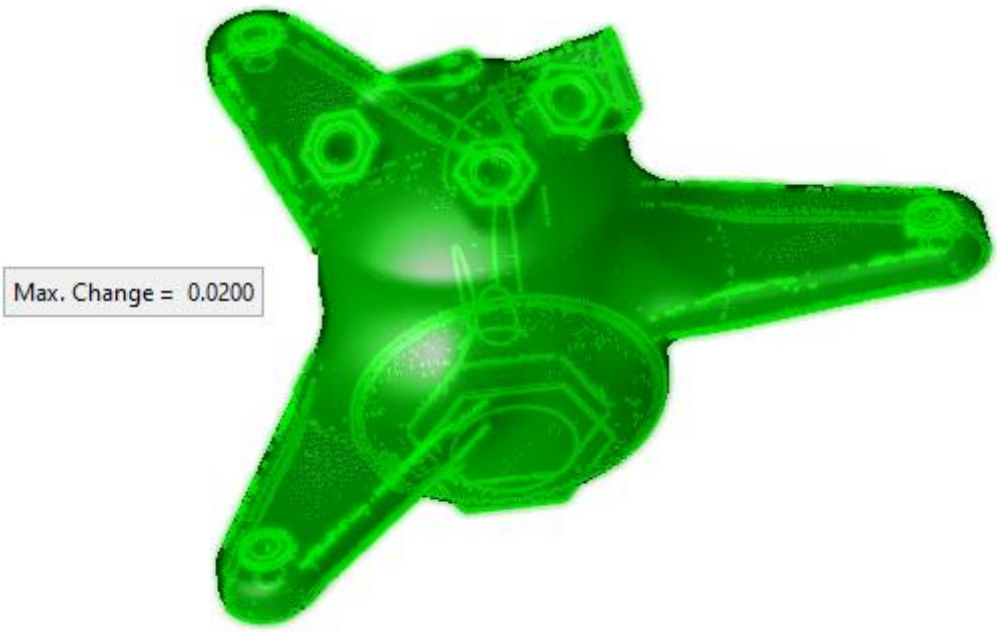


14. Some errors were detected. Click the **Fix** icon.



15. **Exit** the dialog. Invoke the **Global Decimate** option to simplify the entire mesh object. Accept the default parameters and select **OK**.

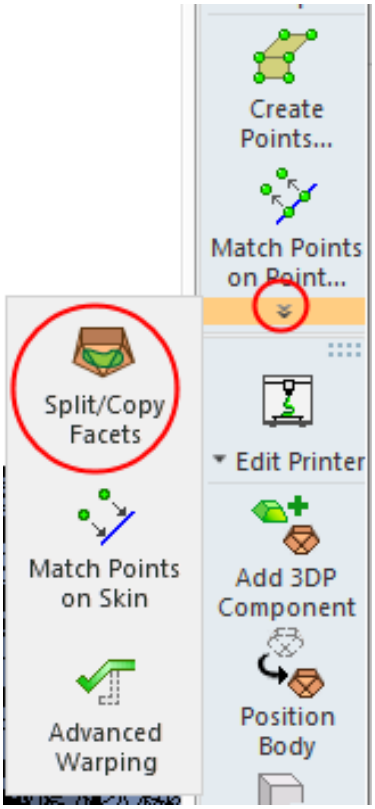




Part 3 Split/Copy Facets

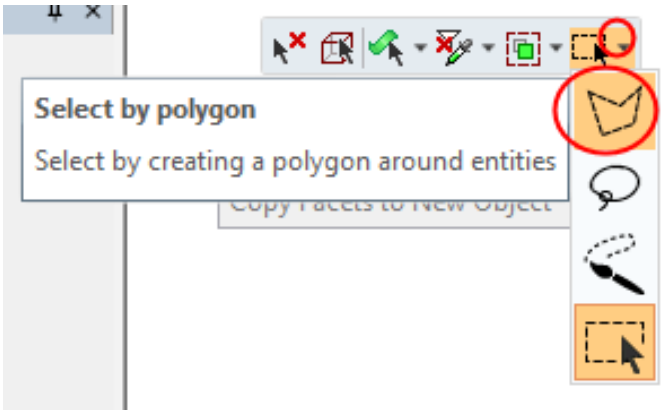
We will now split the areas where deformation correction is required.

16. Invoke the **Split/Copy Facets** option.

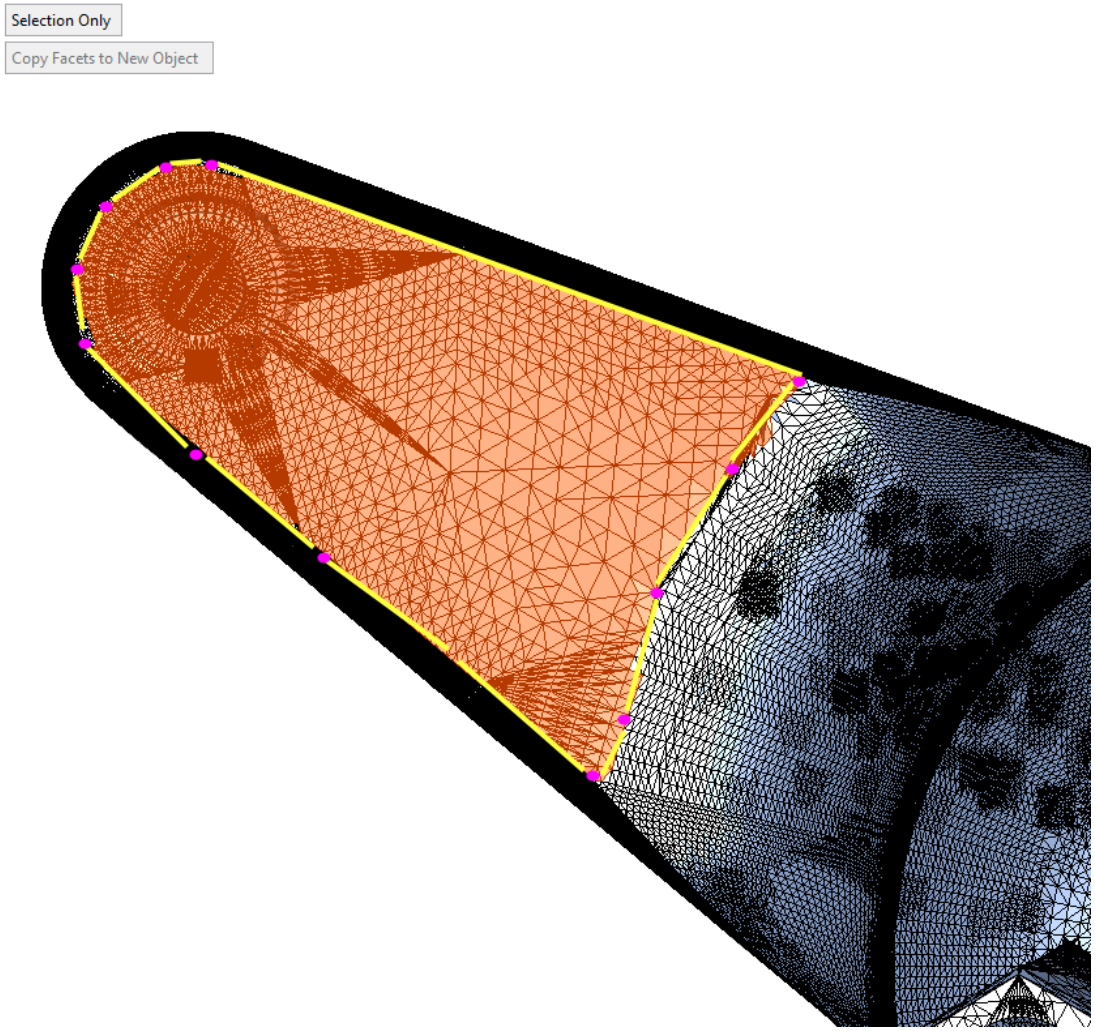


17. Show only the Mesh object in the tree.

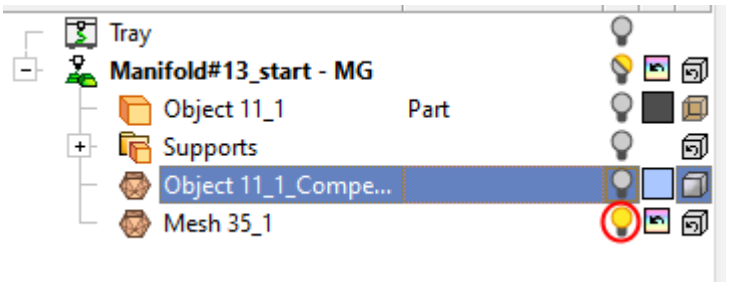
18. Use the **Select by polygon** option.

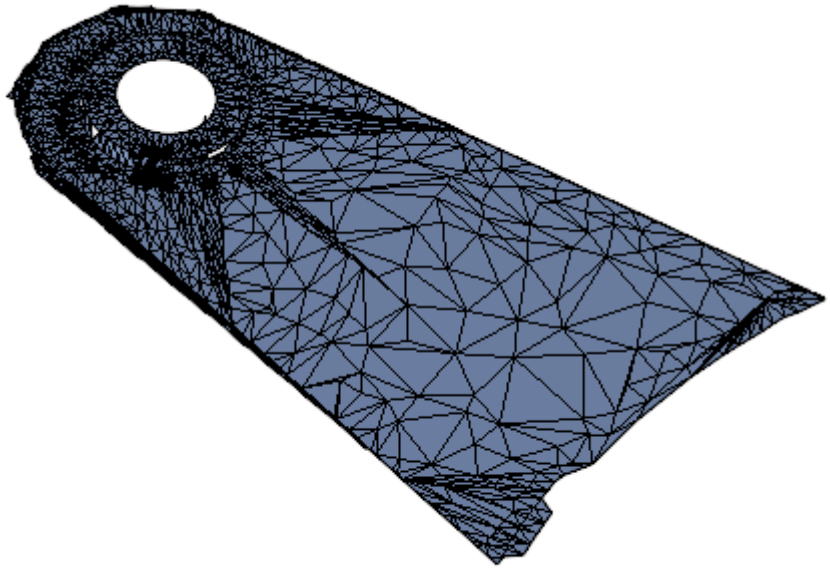


19. Select the poligon as shown in the picture below and click **OK.**

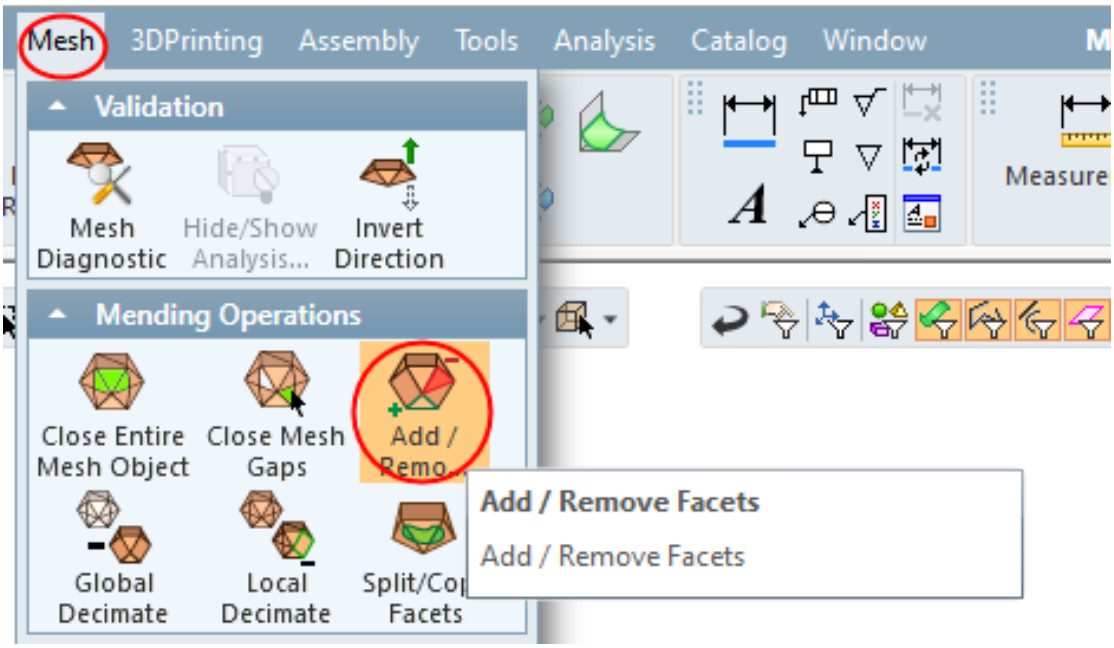


20. A new mesh object was created in the tree. Show only the new object.

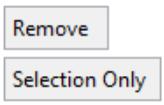


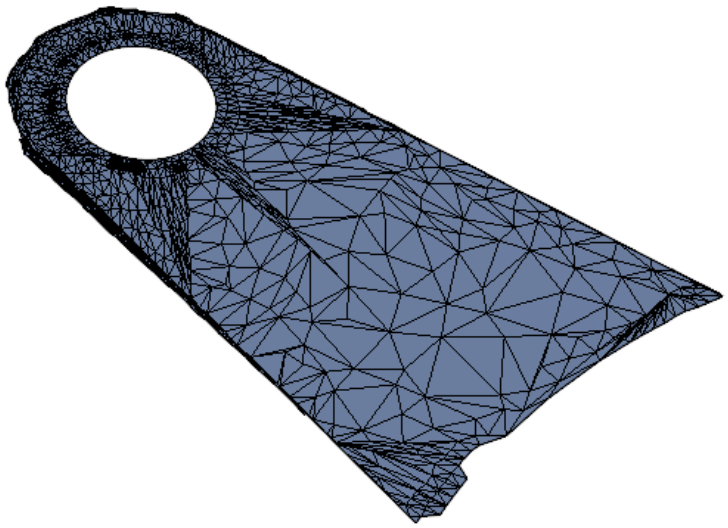


21. From the Mesh menu, invoke the **Add/Remove Facets** option.

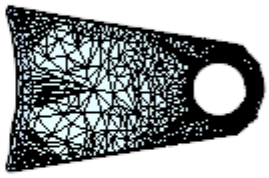


22. Remove the extra facets as shown in the picture below:

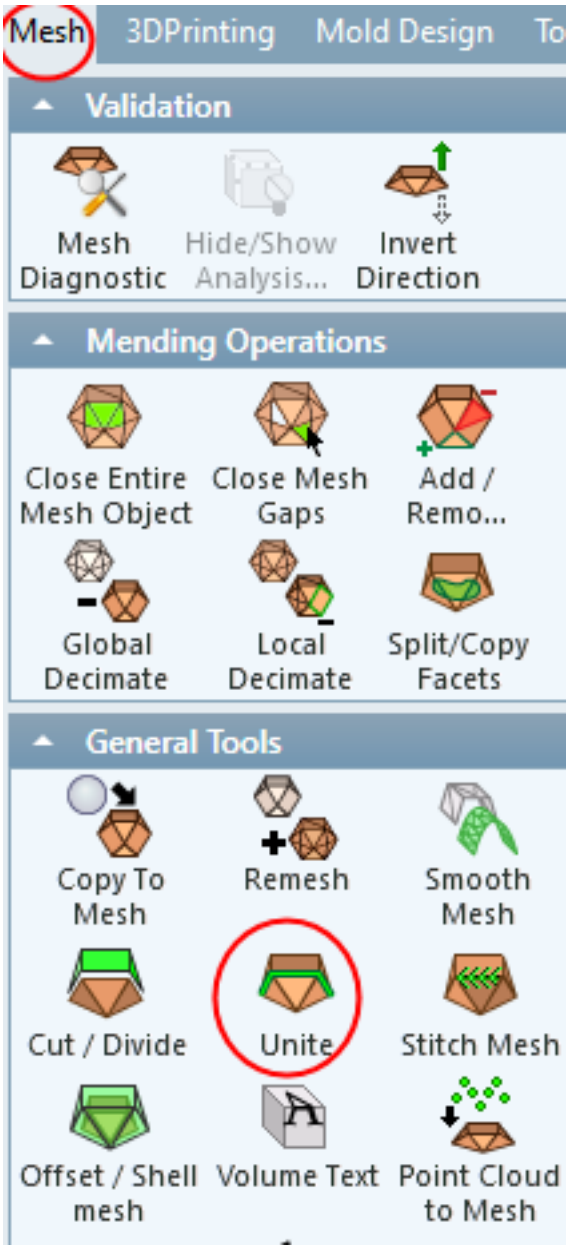




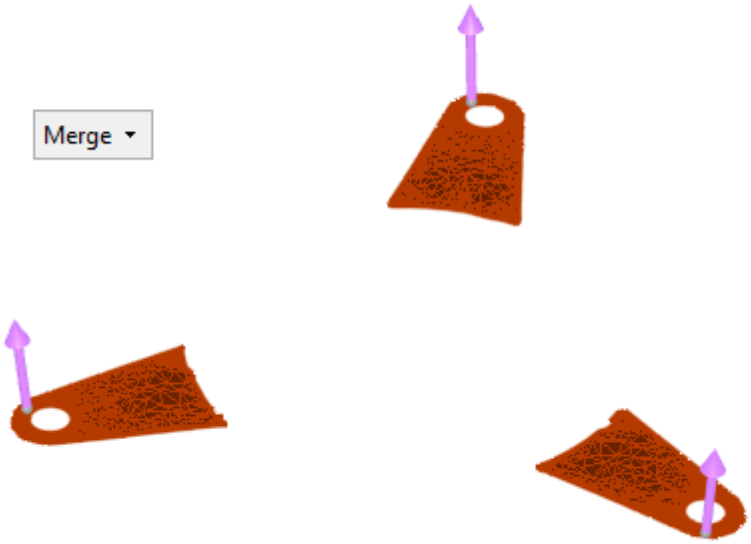
23. Repeat the same proccess for the other “wings”.



24. Unite the 3 “wings” using the **Mesh/Unite** option.



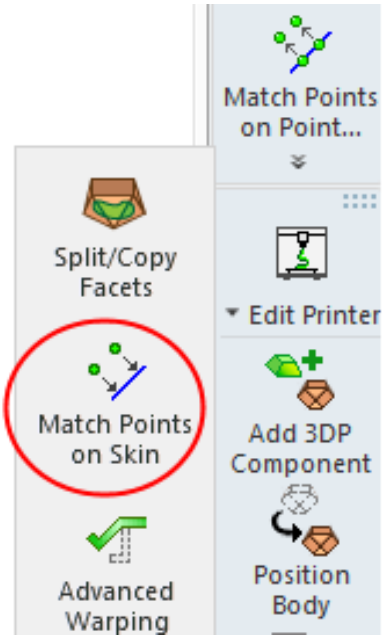
25. Merge the 3 objects and select **OK**.



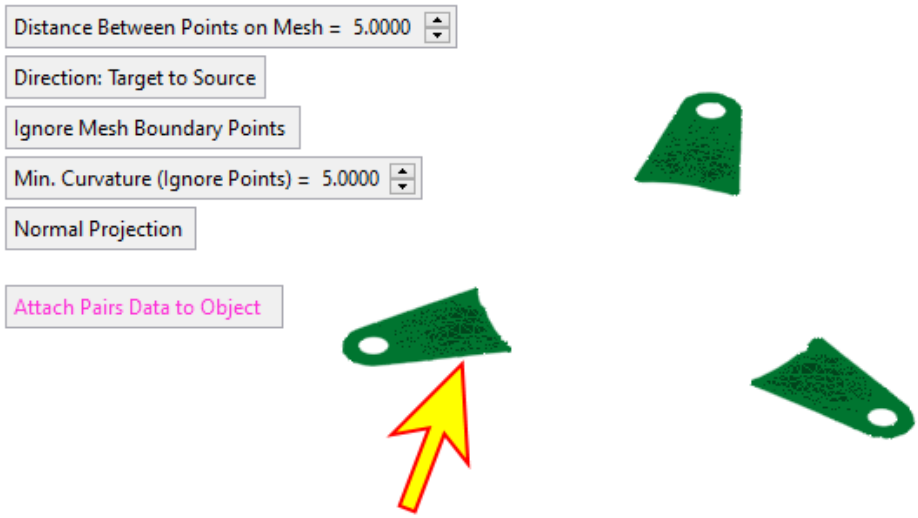
Part 4 Match Points on Skin

To compensate for warpage, create pairs of vectors between a source body (a mesh, a point cloud or regular points) and their projection onto the skin of a target body (B-rep or mesh). The result is paired data between the source and target and can either be saved within the 3DXpert file or saved in an external CSV file.

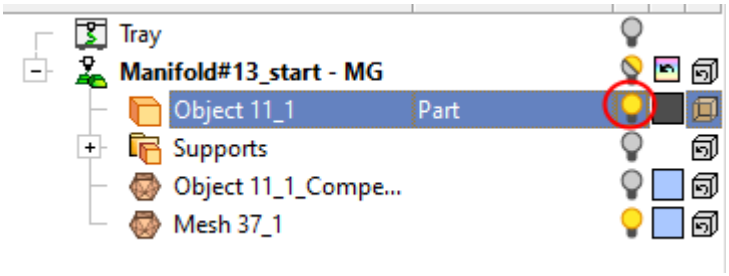
26. Activate the part. From the guide, select the option: **Match Points on Skin.**

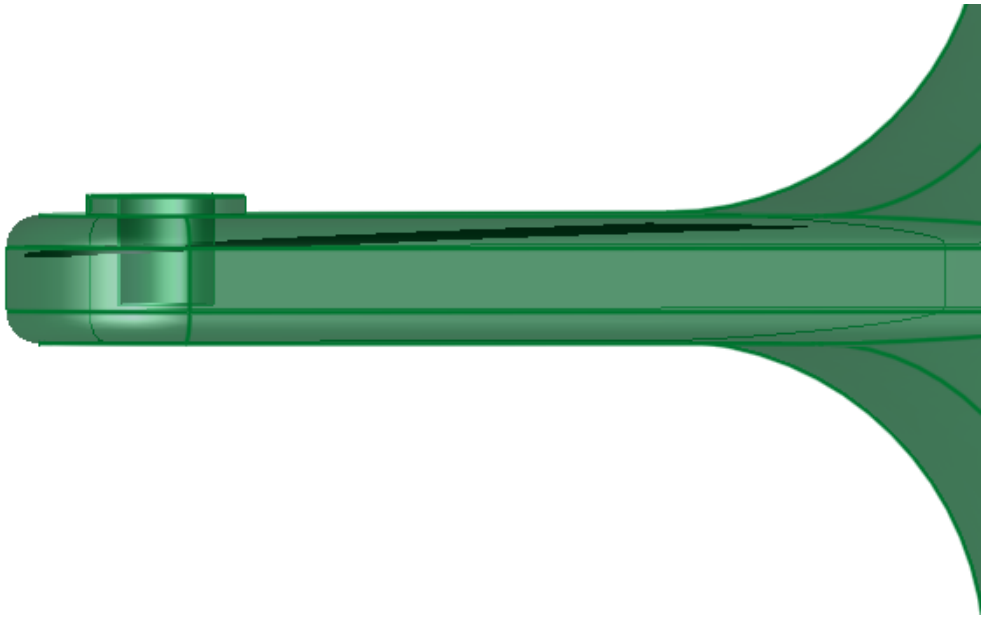


27. Pick the 3 “wings” as the source body to be projected onto the target skin and then exit. (The source body can be a mesh, a point cloud or regular points).



28. Show the main object in the tree.

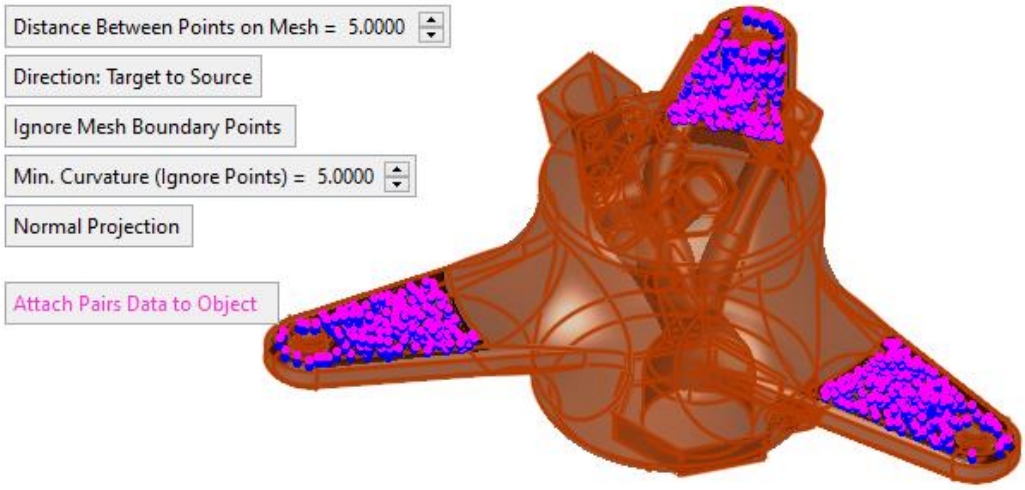




29. Pick the main object as the target body. The target body is a skin body (B-rep or mesh).
30. Set the parameters as shown in the picture below to define the pair creation method. The parameters displayed depend on the source body (a mesh, a point cloud or regular points) selected in step 1.

Note that the **Attach Pairs Data to Object** is the default option. The resultant pairing between the source and target is saved in the model.

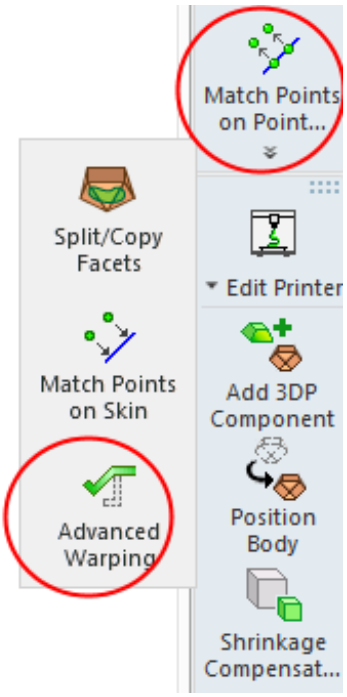
31. Click Preview to examine the result. Select **OK.**



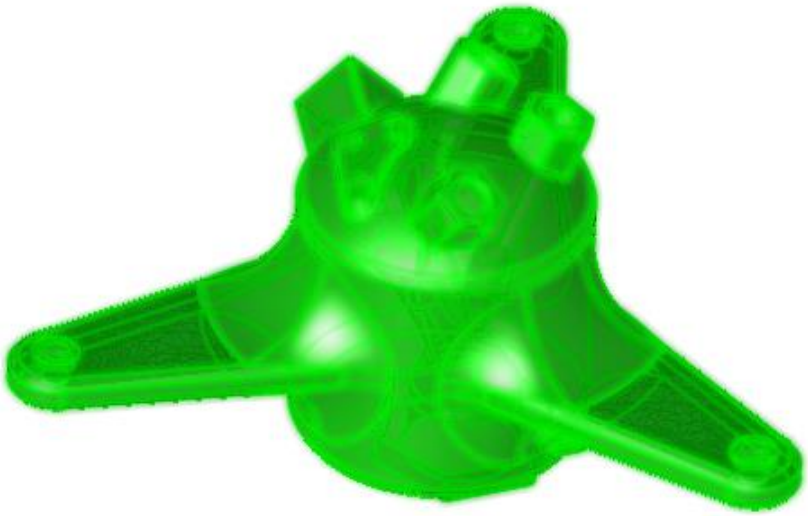
Part 5 Advanced Warping

The **Advanced Warping** option allows changing the design of the CAD model to compensate for warpage so that the final printed part fits the required dimensions and tolerances.

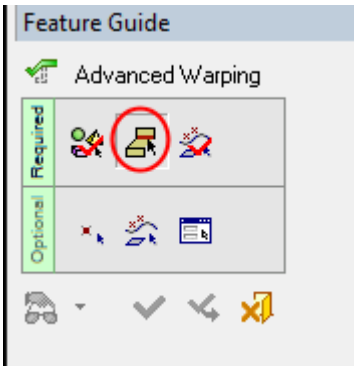
32. Invoke the **Advanced Warping** option.

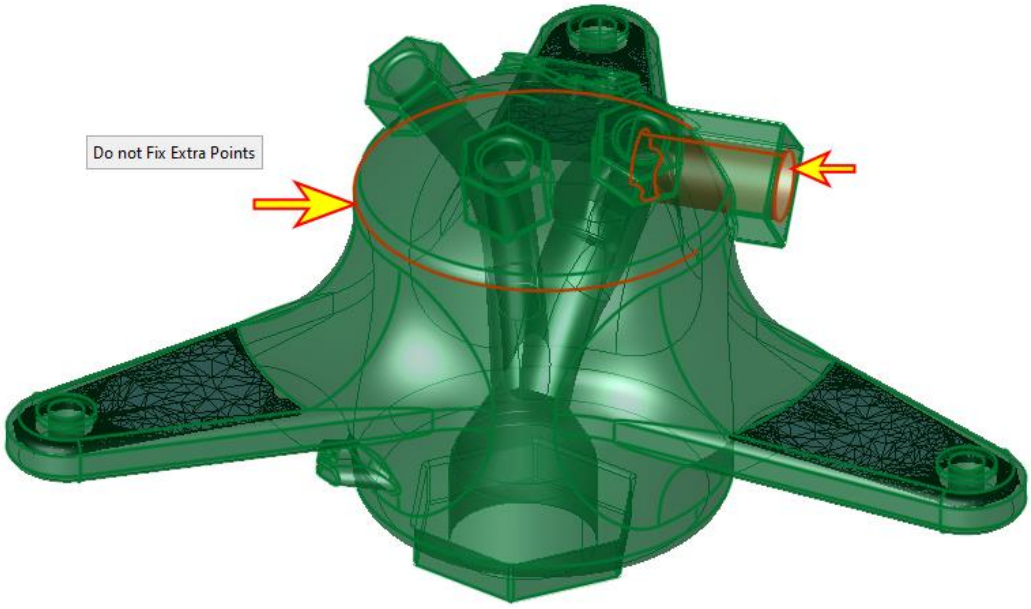


33. Select the original body.

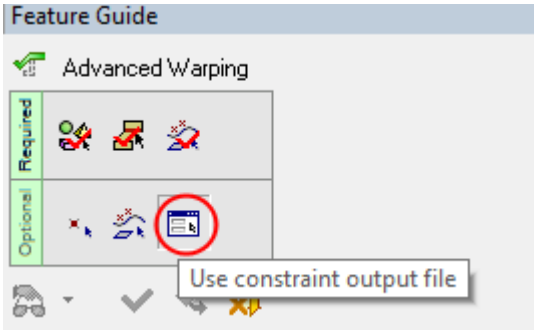


34. In the second stage, pick fixed constraints.
35. Select the constraint as indicated by the arrows in the picture below:

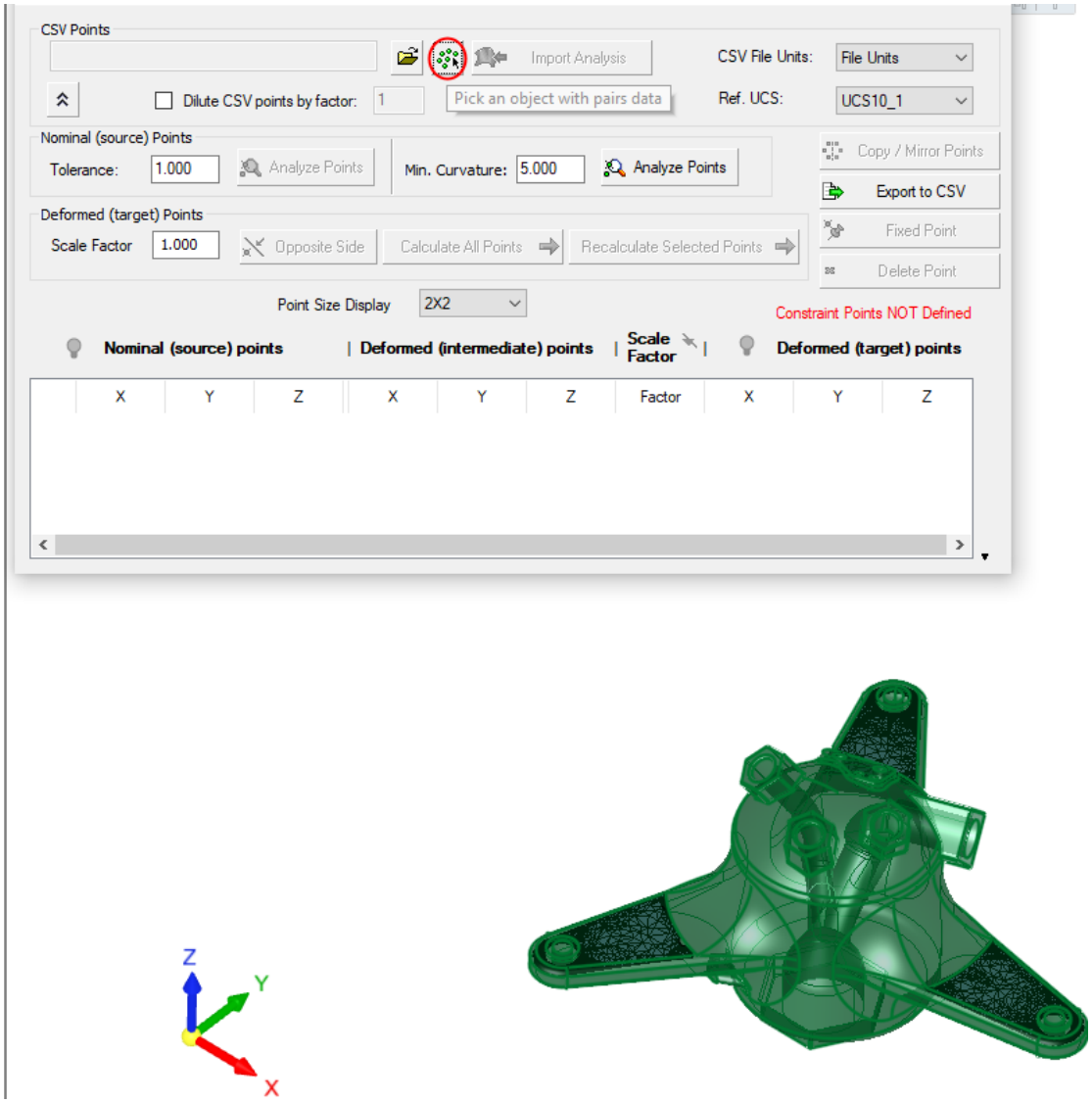




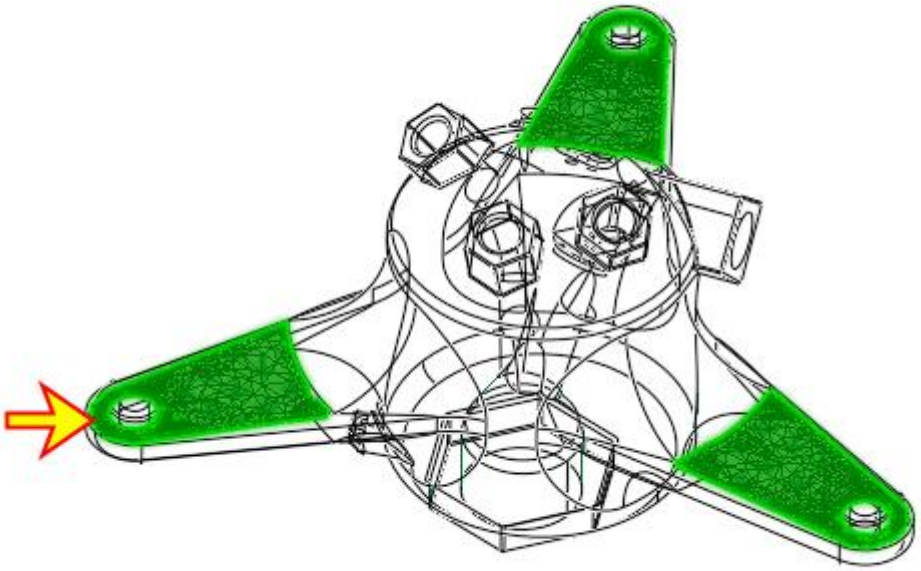
36. Enter the 3rd optional step: **Use constraint output file.**



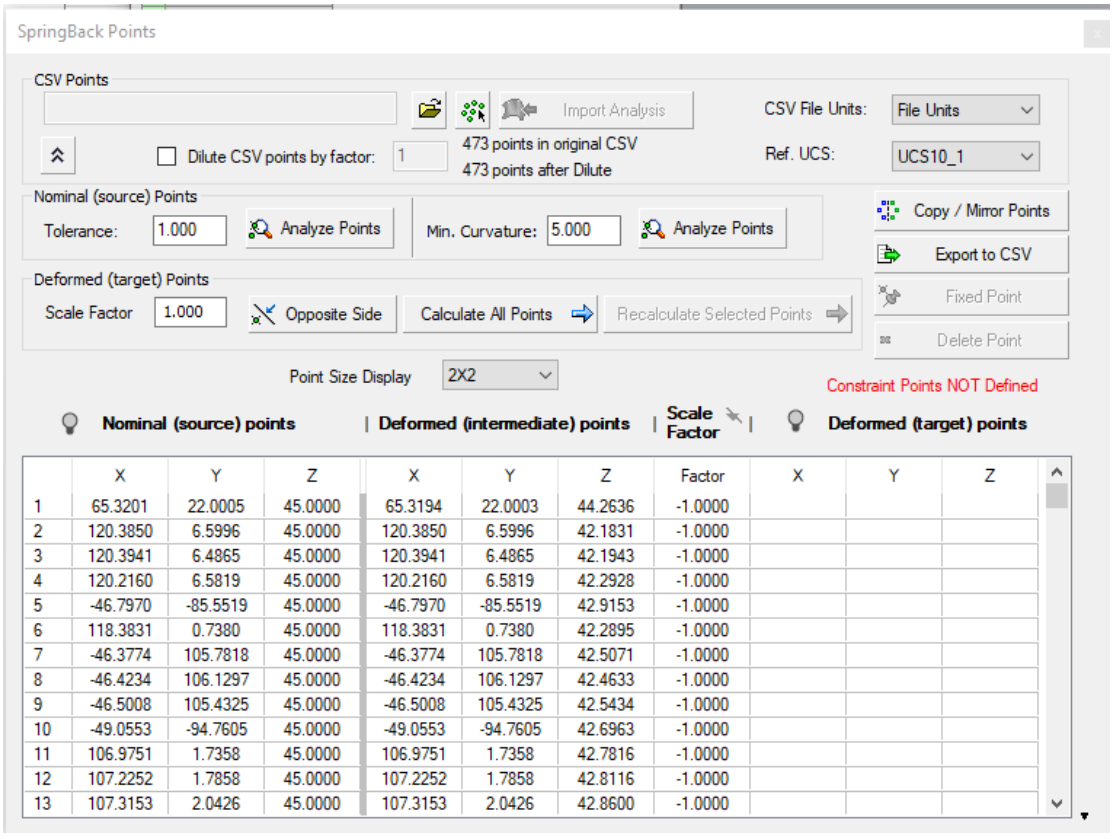
37. Toggle the option **None** to **By Table to** display the **Springback Points** dialog**.**
38. Initially, the **Springback Points** dialog is displayed empty. In this dialog you may either load a CSV file (table of points) or import a predefined springback analysis and then adjust the source and target points (defined from the previous steps of this function) to set the final target points.
39. Click the '**Pick an object with paired data**' button. When this button is pressed, all objects with paired data are displayed with a texture.



40. Select the object as shown in the picture below:

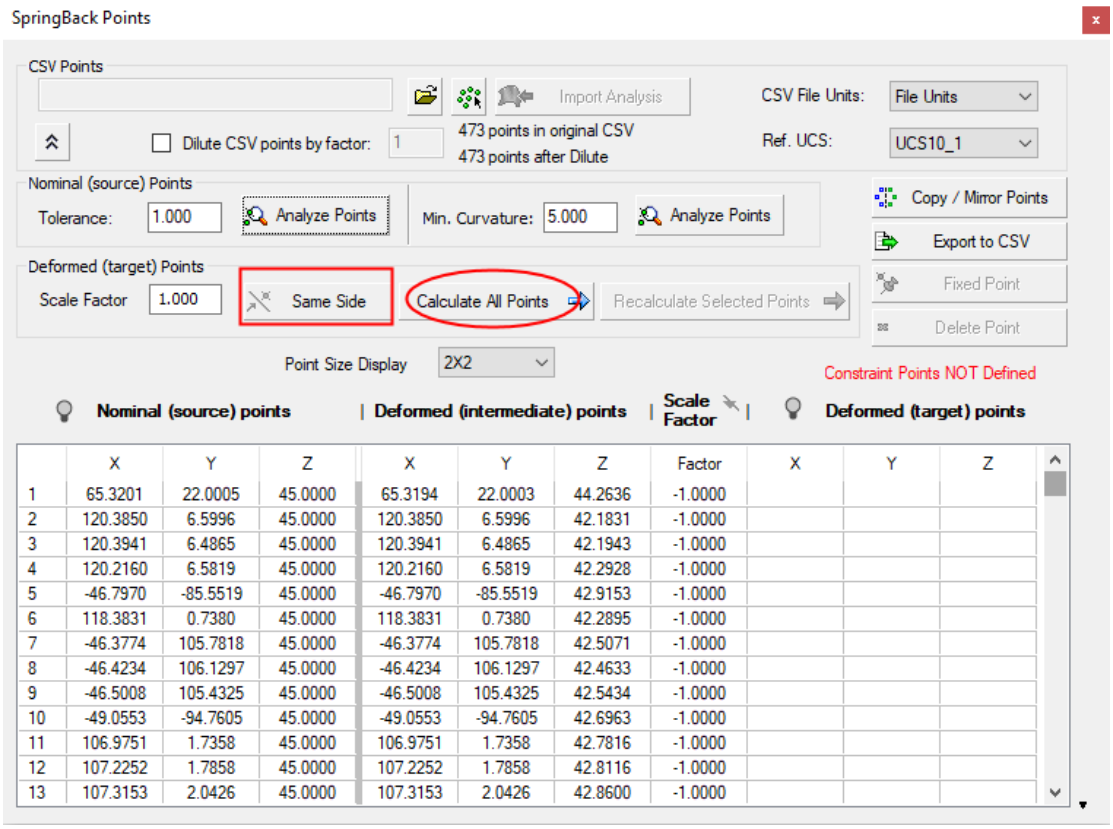


The dialog contains the coordinates of the source and target points defined from the selected objects. The target points are initially shown in this dialog as "intermediate".



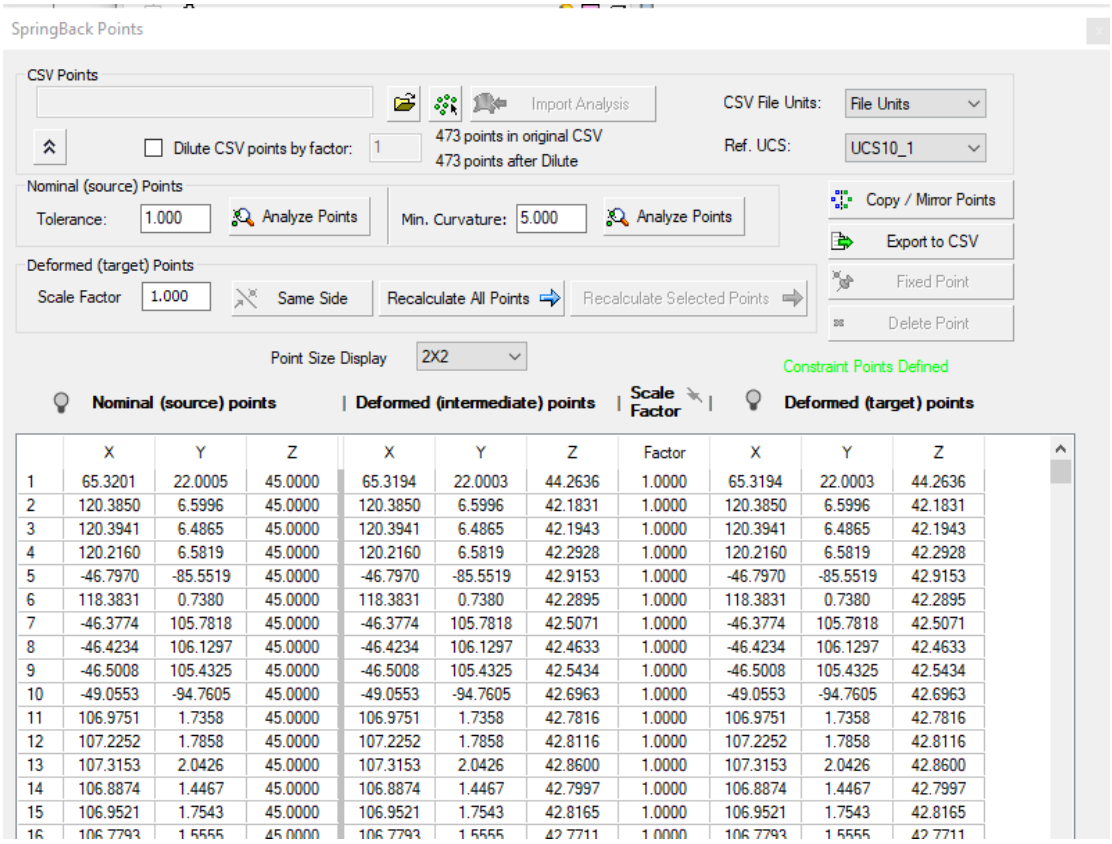
	X	Y	Z	X	Y	Z	Factor	X	Y	Z
1	65.3201	22.0005	45.0000	65.3194	22.0003	44.2636	-1.0000			
2	120.3850	6.5996	45.0000	120.3850	6.5996	42.1831	-1.0000			
3	120.3941	6.4865	45.0000	120.3941	6.4865	42.1943	-1.0000			
4	120.2160	6.5819	45.0000	120.2160	6.5819	42.2928	-1.0000			
5	-46.7970	-85.5519	45.0000	-46.7970	-85.5519	42.9153	-1.0000			
6	118.3831	0.7380	45.0000	118.3831	0.7380	42.2895	-1.0000			
7	-46.3774	105.7818	45.0000	-46.3774	105.7818	42.5071	-1.0000			
8	-46.4234	106.1297	45.0000	-46.4234	106.1297	42.4633	-1.0000			
9	-46.5008	105.4325	45.0000	-46.5008	105.4325	42.5434	-1.0000			
10	-49.0553	-94.7605	45.0000	-49.0553	-94.7605	42.6963	-1.0000			
11	106.9751	1.7358	45.0000	106.9751	1.7358	42.7816	-1.0000			
12	107.2252	1.7858	45.0000	107.2252	1.7858	42.8116	-1.0000			
13	107.3153	2.0426	45.0000	107.3153	2.0426	42.8600	-1.0000			

41. We will first calculate the target points, as the ‘same side’ target points. Press the **Calculate All Points** button.



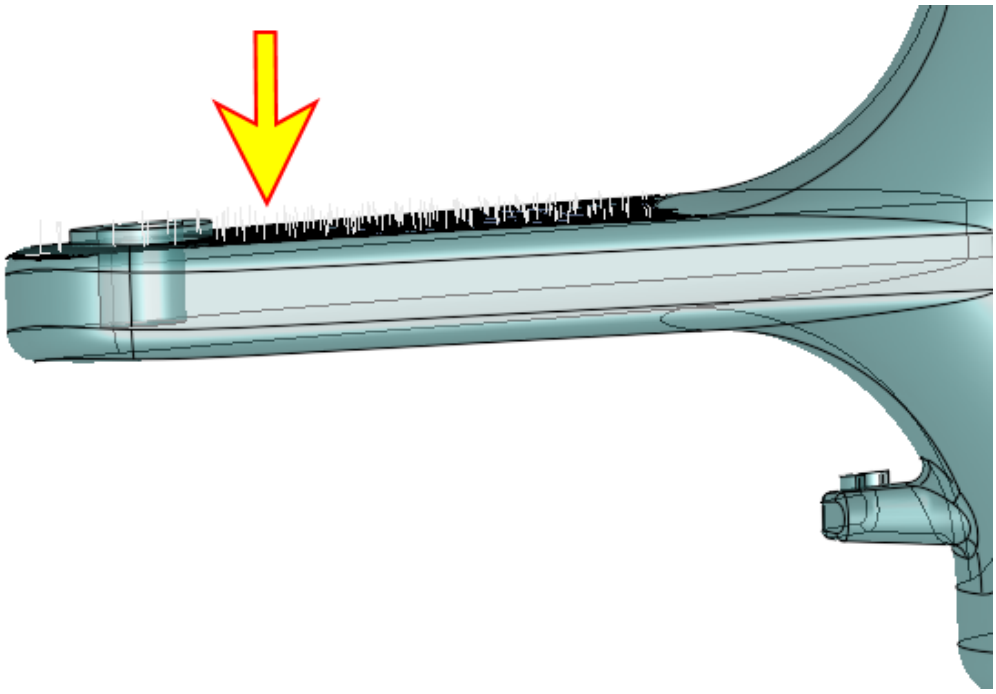
	X	Y	Z	X	Y	Z	Factor	X	Y	Z
1	65.3201	22.0005	45.0000	65.3194	22.0003	44.2636	-1.0000			
2	120.3850	6.5996	45.0000	120.3850	6.5996	42.1831	-1.0000			
3	120.3941	6.4865	45.0000	120.3941	6.4865	42.1943	-1.0000			
4	120.2160	6.5819	45.0000	120.2160	6.5819	42.2928	-1.0000			
5	-46.7970	-85.5519	45.0000	-46.7970	-85.5519	42.9153	-1.0000			
6	118.3831	0.7380	45.0000	118.3831	0.7380	42.2895	-1.0000			
7	-46.3774	105.7818	45.0000	-46.3774	105.7818	42.5071	-1.0000			
8	-46.4234	106.1297	45.0000	-46.4234	106.1297	42.4633	-1.0000			
9	-46.5008	105.4325	45.0000	-46.5008	105.4325	42.5434	-1.0000			
10	-49.0553	-94.7605	45.0000	-49.0553	-94.7605	42.6963	-1.0000			
11	106.9751	1.7358	45.0000	106.9751	1.7358	42.7816	-1.0000			
12	107.2252	1.7858	45.0000	107.2252	1.7858	42.8116	-1.0000			
13	107.3153	2.0426	45.0000	107.3153	2.0426	42.8600	-1.0000			

Note that the new target points are same as the intermidiate deformed points.

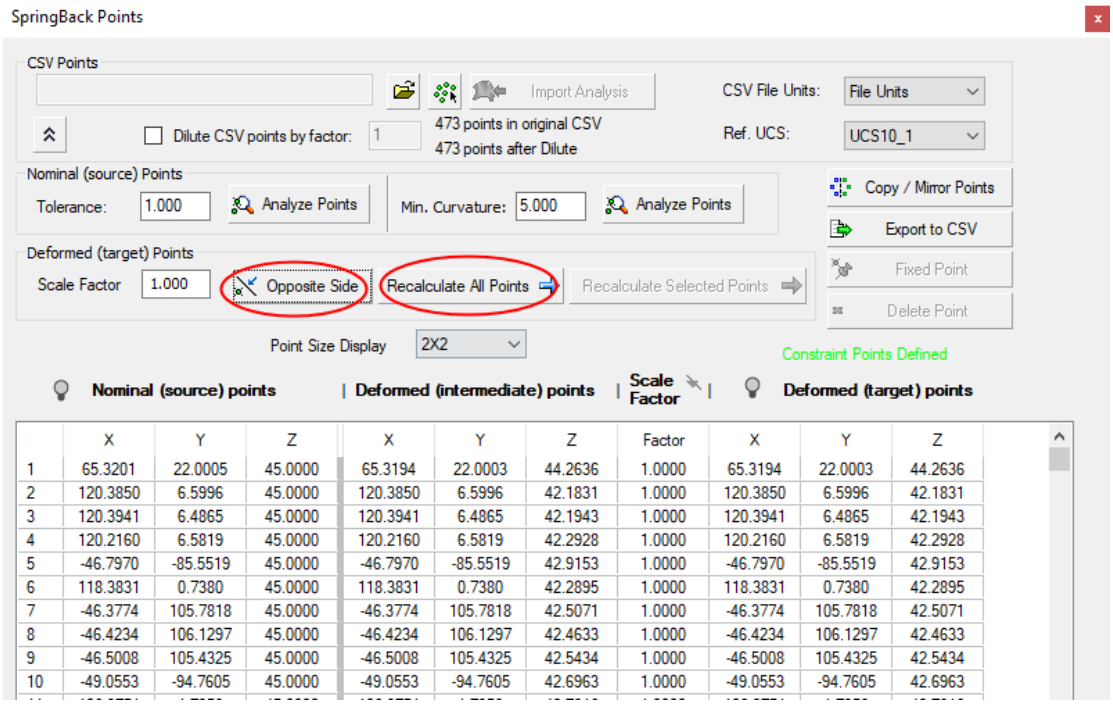


	X	Y	Z	X	Y	Z	Factor	X	Y	Z
1	65.3201	22.0005	45.0000	65.3194	22.0003	44.2636	1.0000	65.3194	22.0003	44.2636
2	120.3850	6.5996	45.0000	120.3850	6.5996	42.1831	1.0000	120.3850	6.5996	42.1831
3	120.3941	6.4865	45.0000	120.3941	6.4865	42.1943	1.0000	120.3941	6.4865	42.1943
4	120.2160	6.5819	45.0000	120.2160	6.5819	42.2928	1.0000	120.2160	6.5819	42.2928
5	-46.7970	-85.5519	45.0000	-46.7970	-85.5519	42.9153	1.0000	-46.7970	-85.5519	42.9153
6	118.3831	0.7380	45.0000	118.3831	0.7380	42.2895	1.0000	118.3831	0.7380	42.2895
7	-46.3774	105.7818	45.0000	-46.3774	105.7818	42.5071	1.0000	-46.3774	105.7818	42.5071
8	-46.4234	106.1297	45.0000	-46.4234	106.1297	42.4633	1.0000	-46.4234	106.1297	42.4633
9	-46.5008	105.4325	45.0000	-46.5008	105.4325	42.5434	1.0000	-46.5008	105.4325	42.5434
10	-49.0553	-94.7605	45.0000	-49.0553	-94.7605	42.6963	1.0000	-49.0553	-94.7605	42.6963
11	106.9751	1.7358	45.0000	106.9751	1.7358	42.7816	1.0000	106.9751	1.7358	42.7816
12	107.2252	1.7858	45.0000	107.2252	1.7858	42.8116	1.0000	107.2252	1.7858	42.8116
13	107.3153	2.0426	45.0000	107.3153	2.0426	42.8600	1.0000	107.3153	2.0426	42.8600
14	106.8874	1.4467	45.0000	106.8874	1.4467	42.7997	1.0000	106.8874	1.4467	42.7997
15	106.9521	1.7543	45.0000	106.9521	1.7543	42.8165	1.0000	106.9521	1.7543	42.8165
16	106.7793	1.5555	45.0000	106.7793	1.5555	42.7711	1.0000	106.7793	1.5555	42.7711

The model was deformed according to the compensated model.

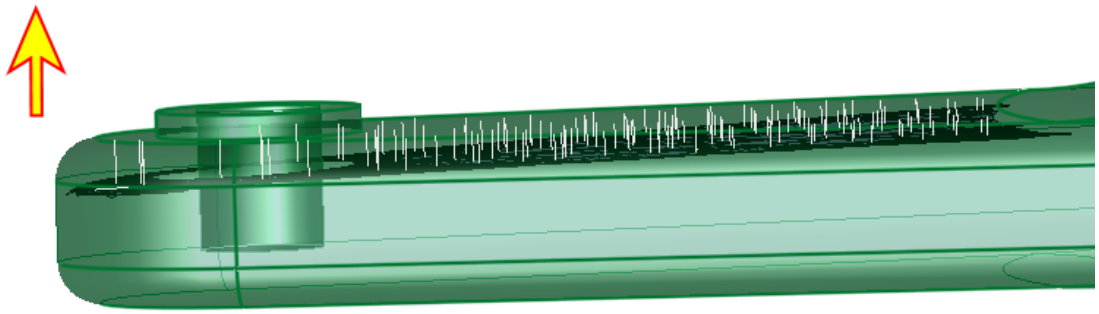


42. If we wish the final model to be the same as the original design, the appropriate calculation should consider the opposite side as the target points side. Toggle the Same Side option to **Opposite Side**. Press the **Recalculate All Points** button.



	X	Y	Z	X	Y	Z	Factor	X	Y	Z
1	65.3201	22.0005	45.0000	65.3194	22.0003	44.2636	1.0000	65.3194	22.0003	44.2636
2	120.3850	6.5996	45.0000	120.3850	6.5996	42.1831	1.0000	120.3850	6.5996	42.1831
3	120.3941	6.4865	45.0000	120.3941	6.4865	42.1943	1.0000	120.3941	6.4865	42.1943
4	120.2160	6.5819	45.0000	120.2160	6.5819	42.2928	1.0000	120.2160	6.5819	42.2928
5	-46.7970	-85.5519	45.0000	-46.7970	-85.5519	42.9153	1.0000	-46.7970	-85.5519	42.9153
6	118.3831	0.7380	45.0000	118.3831	0.7380	42.2895	1.0000	118.3831	0.7380	42.2895
7	-46.3774	105.7818	45.0000	-46.3774	105.7818	42.5071	1.0000	-46.3774	105.7818	42.5071
8	-46.4234	106.1297	45.0000	-46.4234	106.1297	42.4633	1.0000	-46.4234	106.1297	42.4633
9	-46.5008	105.4325	45.0000	-46.5008	105.4325	42.5434	1.0000	-46.5008	105.4325	42.5434
10	-49.0553	-94.7605	45.0000	-49.0553	-94.7605	42.6963	1.0000	-49.0553	-94.7605	42.6963

43. Preview the result.



Notice the difference betweeen the coordinates of the same side target and the opposite side target.

SpringBack Points

CSV Points

Import Analysis | CSV File Units: File Units

Dilute CSV points by factor: 1 | 473 points in original CSV | 473 points after Dilute | Ref. UCS: UCS10_1

Nominal (source) Points

Tolerance: 1.000 | Analyze Points | Min. Curvature: 5.000 | Analyze Points | Copy / Mirror Points | Export to CSV

Deformed (target) Points

Scale Factor 1.000 | Opposite Side | Recalculate All Points | Recalculate Selected Points | Fixed Point | Delete Point

Point Size Display 2X2 | Constraint Points Defined

	Nominal (source) points			Deformed (intermediate) points			Scale Factor	Deformed (target) points		
	X	Y	Z	X	Y	Z	Factor	X	Y	Z
1	65.3201	22.0005	45.0000	65.3194	22.0003	44.2636	1.0000	65.3194	22.0003	44.2636
2	120.3850	6.5996	45.0000	120.3850	6.5996	42.1831	1.0000	120.3850	6.5996	42.1831
3	120.3941	6.4865	45.0000	120.3941	6.4865	42.1943	1.0000	120.3941	6.4865	42.1943
4	120.2160	6.5819	45.0000	120.2160	6.5819	42.2928	1.0000	120.2160	6.5819	42.2928
5	-46.7970	-85.5519	45.0000	-46.7970	-85.5519	42.9153	1.0000	-46.7970	-85.5519	42.9153
6	118.3831	0.7380	45.0000	118.3831	0.7380	42.2895	1.0000	118.3831	0.7380	42.2895
7	-46.3774	105.7818	45.0000	-46.3774	105.7818	42.5071	1.0000	-46.3774	105.7818	42.5071
8	-46.4234	106.1297	45.0000	-46.4234	106.1297	42.4633	1.0000	-46.4234	106.1297	42.4633
9	-46.5008	105.4325	45.0000	-46.5008	105.4325	42.5434	1.0000	-46.5008	105.4325	42.5434
10	-49.0553	-94.7605	45.0000	-49.0553	-94.7605	42.6963	1.0000	-49.0553	-94.7605	42.6963
11	106.9751	1.7358	45.0000	106.9751	1.7358	42.7816	1.0000	106.9751	1.7358	42.7816
12	107.2252	1.7858	45.0000	107.2252	1.7858	42.8116	1.0000	107.2252	1.7858	42.8116
13	107.3153	2.0426	45.0000	107.3153	2.0426	42.8600	1.0000	107.3153	2.0426	42.8600
14	106.8874	1.4467	45.0000	106.8874	1.4467	42.7997	1.0000	106.8874	1.4467	42.7997

SpringBack Points

CSV Points

Import Analysis

CSV File Units: File Units

Dilute CSV points by factor: 1

473 points in original CSV
473 points after Dilute

Ref. UCS: UCS10_1

Nominal (source) Points

Tolerance: 1.000 Analyze Points

Min. Curvature: 5.000 Analyze Points

Copy / Mirror Points

Export to CSV

Deformed (target) Points

Scale Factor 1.000 Opposite Side Recalculate All Points Recalculate Selected Points

Fixed Point

Delete Point

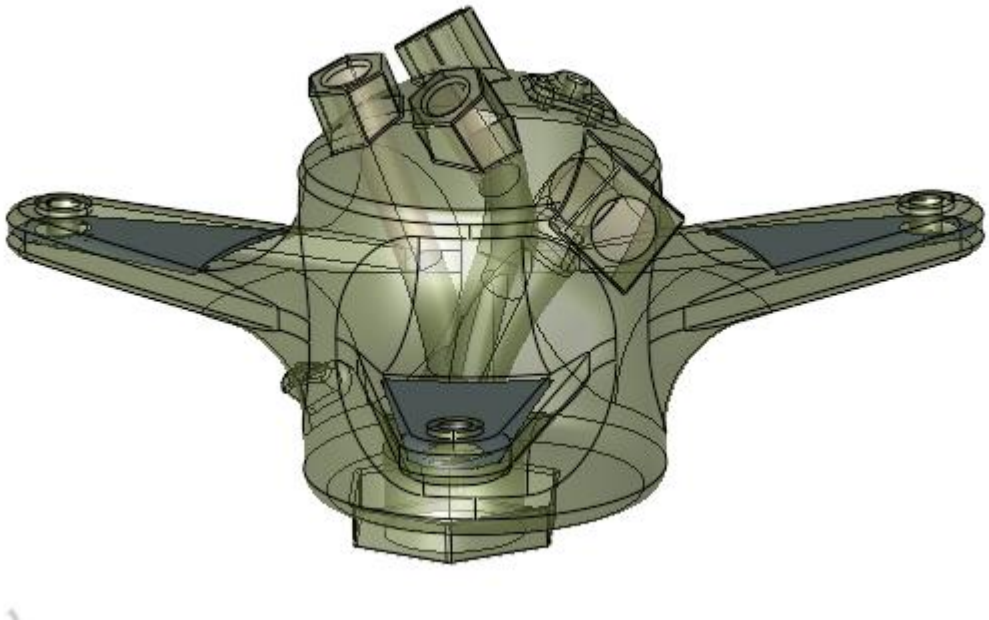
Point Size Display 2X2

Constraint Points Defined

Nominal (source) points | Deformed (intermediate) points | Scale Factor | Deformed (target) points

	X	Y	Z	X	Y	Z	Factor	X	Y	Z
1	65.3201	22.0005	45.0000	65.3194	22.0003	44.2636	-1.0000	65.3208	22.0006	45.7364
2	120.3850	6.5996	45.0000	120.3850	6.5996	42.1831	-1.0000	120.3850	6.5996	47.8169
3	120.3941	6.4865	45.0000	120.3941	6.4865	42.1943	-1.0000	120.3941	6.4865	47.8057
4	120.2160	6.5819	45.0000	120.2160	6.5819	42.2928	-1.0000	120.2160	6.5819	47.7072
5	-46.7970	-85.5519	45.0000	-46.7970	-85.5519	42.9153	-1.0000	-46.7970	-85.5519	47.0847
6	118.3831	0.7380	45.0000	118.3831	0.7380	42.2895	-1.0000	118.3831	0.7380	47.7105
7	-46.3774	105.7818	45.0000	-46.3774	105.7818	42.5071	-1.0000	-46.3774	105.7818	47.4929
8	-46.4234	106.1297	45.0000	-46.4234	106.1297	42.4633	-1.0000	-46.4234	106.1297	47.5367
9	-46.5008	105.4325	45.0000	-46.5008	105.4325	42.5434	-1.0000	-46.5008	105.4325	47.4566
10	-49.0553	-94.7605	45.0000	-49.0553	-94.7605	42.6963	-1.0000	-49.0553	-94.7605	47.3037
11	106.9751	1.7358	45.0000	106.9751	1.7358	42.7816	-1.0000	106.9751	1.7358	47.2184
12	107.2252	1.7858	45.0000	107.2252	1.7858	42.8116	-1.0000	107.2252	1.7858	47.1884
13	107.3153	2.0426	45.0000	107.3153	2.0426	42.8600	-1.0000	107.3153	2.0426	47.1400
14	106.8874	1.4467	45.0000	106.8874	1.4467	42.7997	-1.0000	106.8874	1.4467	47.2003

44. Select **OK**.



End of Exercise.