

Detailing Plate Forming Operations




This task shows you how to detail shell plate forming operations.

Plate forming transforms flat plates into formed plates and in so doing consumes roll lines. This operation may use production templates to assist production workers in forming the desired shape for the plate.


To detail a plate forming operation, you can do the following:

- Specify the number of roll lines that mark the plate to be formed (informing the operator where to apply the roll).
- Detect and control surface distortion for the downstream forming process.
- Create a set of templates.

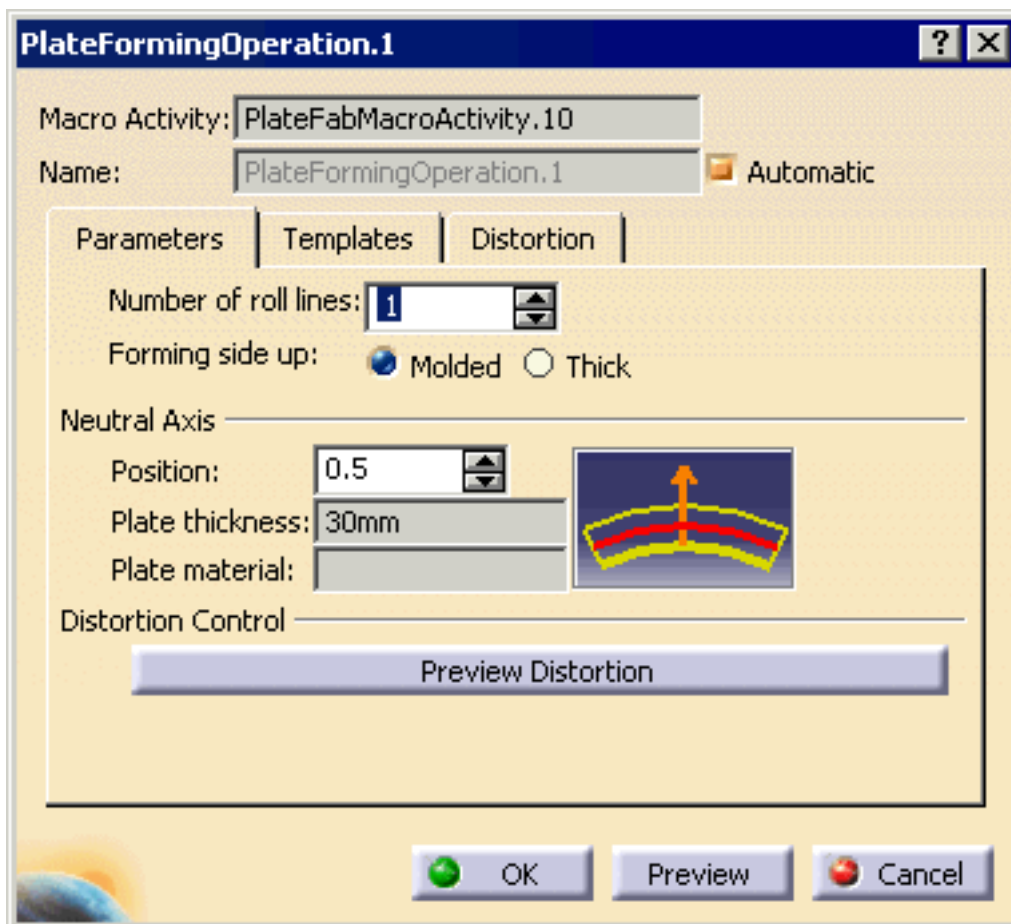


You must have already run **Build Activity List**  for Shell_STB_1 and inserted a part containing all the reference planes you need.



1. Select **Plate Forming Operation** .
2. Select Shell_STB.1 in the ProductList of the PPR tree.

The **Plate Forming Operation** dialog box opens, and the **Parameters** tab is active:



PlateFormingOperation.1 ? X

Macro Activity: PlateFabMacroActivity.10

Name: PlateFormingOperation.1 ☒ Automatic

Parameters | Templates | Distortion

Number of roll lines: 1

Forming side up: ☒ Molded ☐ Thick

Neutral Axis

Position: 0.5

Plate thickness: 30mm

Plate material:

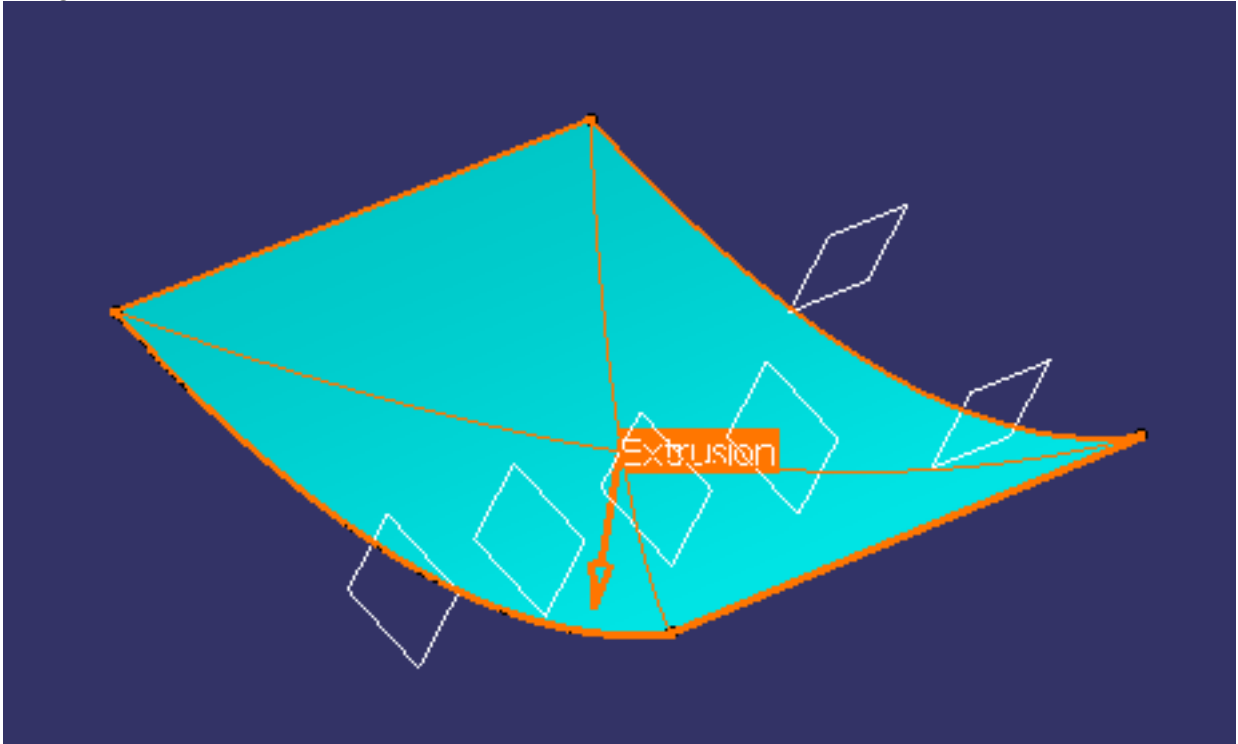
Distortion Control

Preview Distortion

OK Preview Cancel

The plate is highlighted in the geometry area and the surface that will be marked is identified in a different color. An

orange vector identifies the direction of extrusion.



You are now ready to [specify the number of roll lines](#) to be generated.

[Generating Roll Lines](#)
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[Create a Set of Templates and Plate Distortion Data](#)

Generating Roll Lines



Roll lines can be generated automatically when building the operation list (see **Tools > Options > Digital Process for Manufacturing > DPM - Structure Lofting** or **DPM - Structure Manufacturing Preparation > Activities**).

This task shows you how to specify the number of roll lines that mark the plate to be formed.



1. Specify the number of roll lines needed: enter 3 for this example.

Number of roll lines:

2. Specify on which side the plate will be marked (Forming side up): molded or thick side.

By default, it is the molded side that is marked. The corresponding surface is highlighted in the geometry area for easier identification.

Forming side up: ☒ Molded ☐ Thick

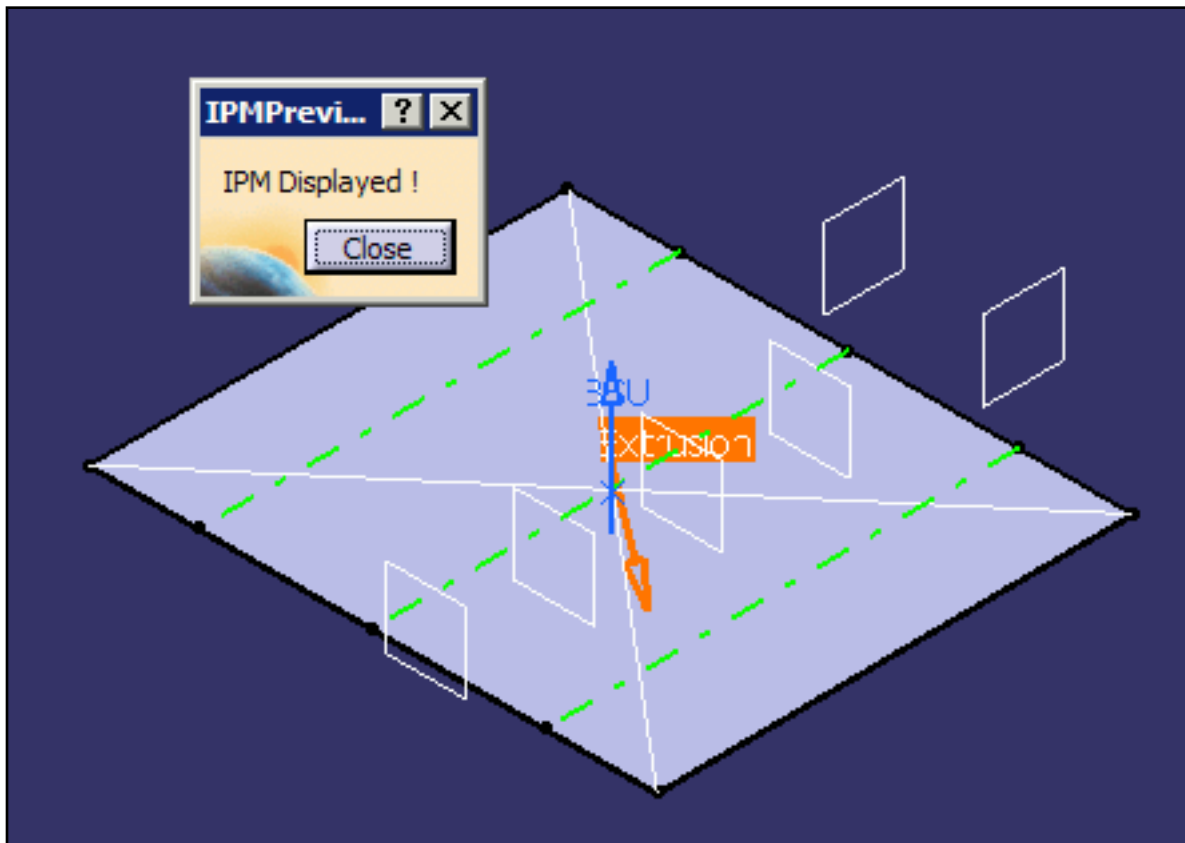
3. Specify the position of the neutral axis:

The neutral axis is an imaginary line (in red on the dialog box image) that defines the surface taken into account for the flattened surface. It is positioned with respect to the molded surface (orange vector indicates direction of extrusion) and is typically located at half the plate thickness. The position is defined on a scale from 0 to 1.



Leave a value of 0.5 for the neutral axis position. You will be able to re-iterate with different values later in the scenario and view the results on the IPM part.

4. Click **Preview** to see a preview of the flat with the specified number of roll lines.



5. Click **Close** in the IPM Preview dialog box to return to the Plate Forming dialog box.

You are now ready to [check distortion](#).



The number of roll lines created for the curved middle surface depends on the value selected in **Tools > Options**. Select only one roll line for multi-surfaced curved plates, so that there is only one roll line created for curved middle surface. The software does not restrict the number of roll lines, so if you select a value more than 1, that many roll lines will be created.

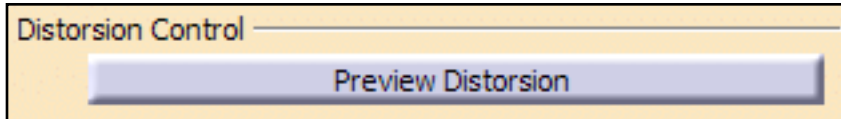
Check and Control Distortion



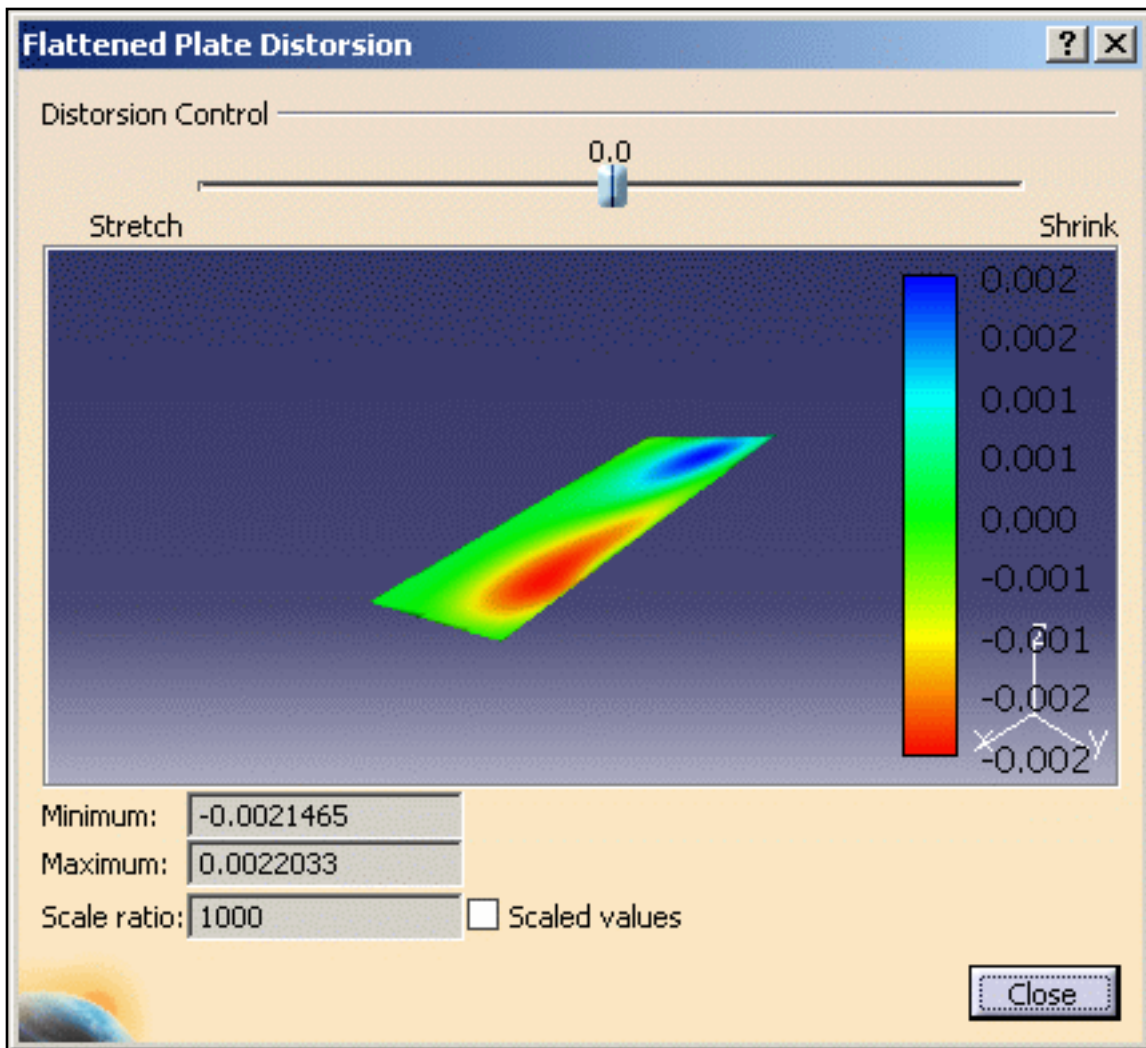
This lets you optimize the tradeoff between stretch and shrink techniques used in plate forming.



1. Click **Preview Distortion** to view distortion distribution.



The Flattened Plate Distortion viewer shows minimum and maximum distortion values. For more information about the Flattened Plate Distortion, see below.



2. Use the slider in the Flattened Plate Distortion dialog box to adjust the stretch and shrink and see the results in tThe slider is graduation from -1 to +1; a value of -0.6 means 60% stretch and 40% shrinkage.
3. If needed, select Scaled values to have the system define a scale ratio to optimize the display.
4. Click **Close** in the Flattened Plate Distortion viewer when done.

Distortion is an attribute stored on the operation and can be viewed in the **Properties** dialog box.

You are now ready to [generate a set of plate forming templates](#).

About the Flattened Plate Distortion Dialog Box

The slide, seen in the dialog box, helps to control the distortion. The range of the scale is $[-1,1]$, where:

- -1 corresponds to only stretching (i.e. the distortion at 100% of the computation points is positive, which means that the distortion is positive at all the points). This means the flattened body is larger than the input body.
- 1 corresponds to only shrinking (i.e. the distortion at 0% of the computation points is positive, which means the distortion is negative at all the points). This means the flattened body is smaller than the input body.
- 0 corresponds to even distortion (i.e. there are as many (50%) points with stretching distortion as there are with shrinking distortion)
An intermediate value, say -0.6, means 80% of the points have stretching distortion, which implies 20% points have shrinking distortion.

Minimum and **Maximum** values of distortion are displayed in the dialog box. These values are not the percentages, but the percentages converted into decimals. A minimum value of -0.0021465 (seen in the panel) corresponds to - 0.21465%. A scale ratio of 1000 is provided to scale the distortion value before display.

Default flattening values are 50% stretch and 50% shrink. Once the **Flattened Plate Distortion** dialog opens, it shows the flattening result (flat surface) based on 0.5 shrink/stretch. If the flattening result is not satisfactory you can control the distortion (through slider) and update the flattened surface after clicking on the **OK** or **Preview** button of the **Forming** dialog box.

Creating a Set of Templates and Plate Distortion Data

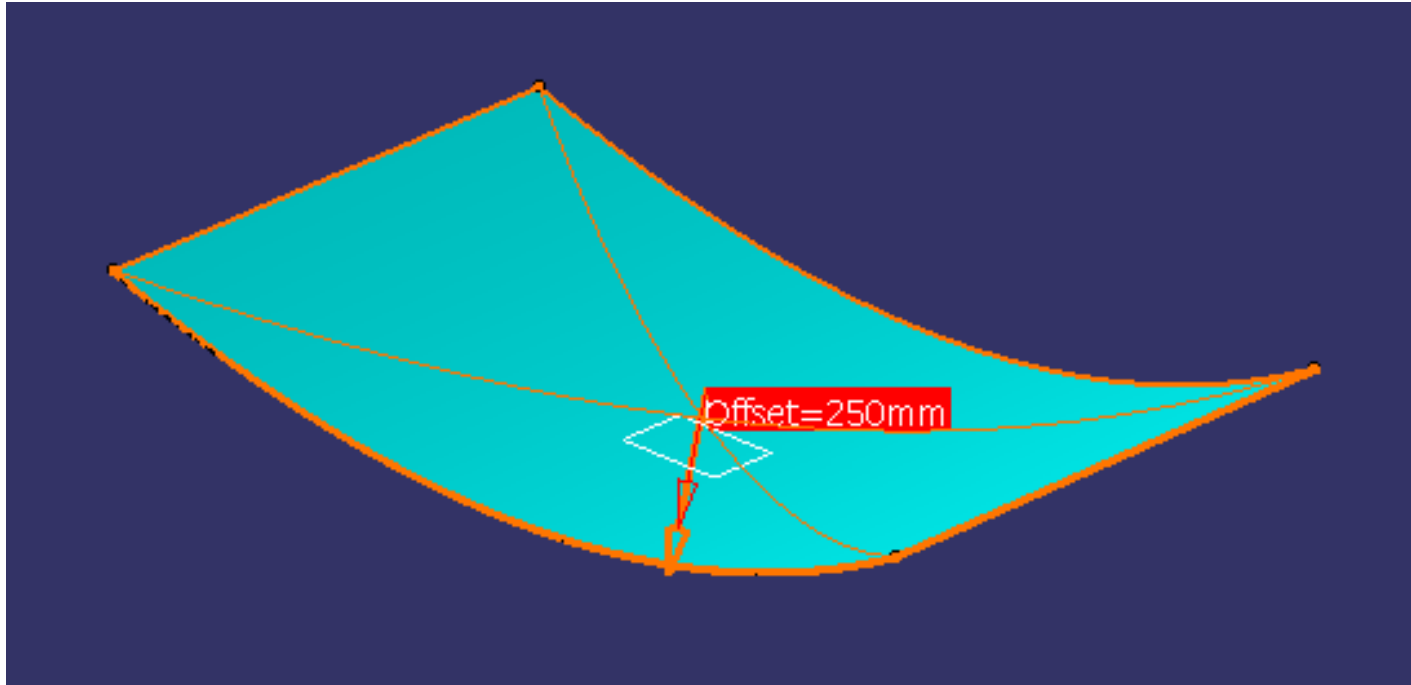


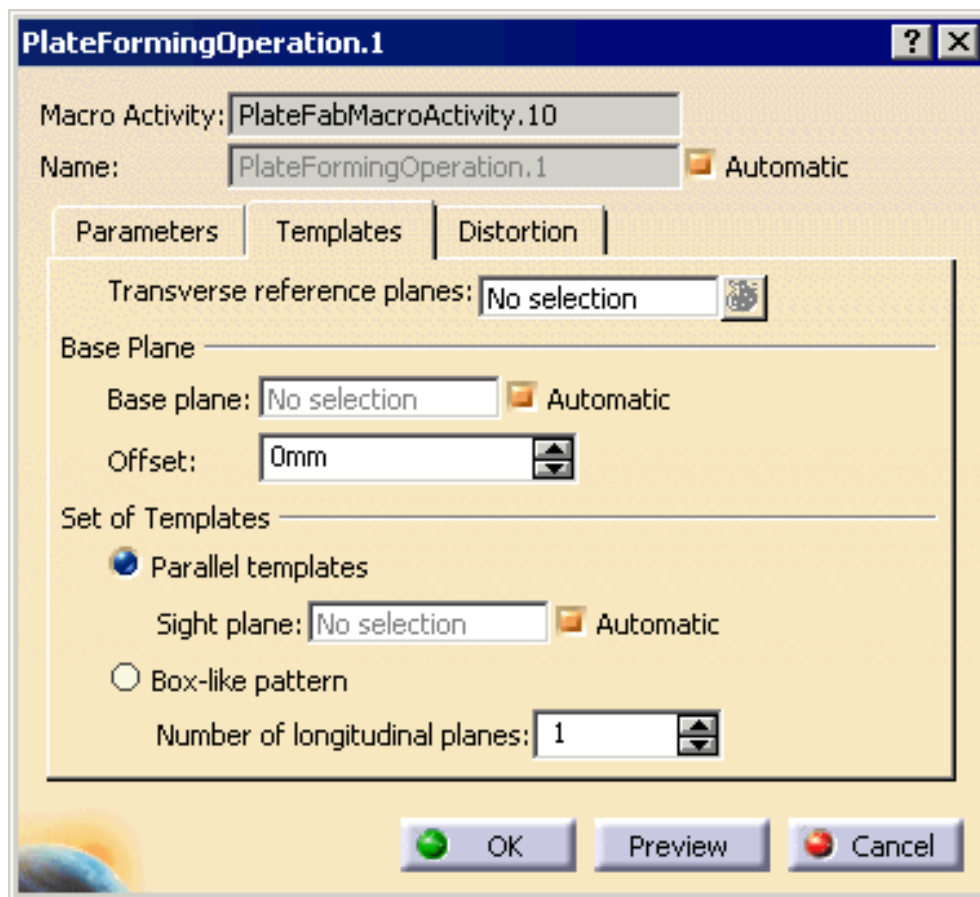
You can create templates for plate forming operations, and also capture plate distortion data.



1. Click the **Templates** tab.

The base plane (in white) and a red vector indicating the direction in which the base plane will be offset are shown in the geometry area. The red vector identifies on which side of the plate the templates will be located.

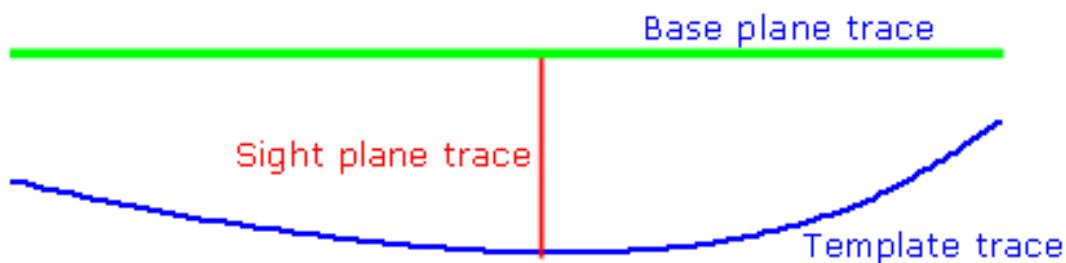




You can create either a set of parallel templates or a box-like pattern of templates. In this scenario, you will create a set of parallel templates.

2. Click the **Transverse reference planes** field and select the transverse planes you want to use as reference planes in the geometry area.

Template traces are shown in blue in the geometry area and the base plane traces in green:



- The template trace represents the intersection between the reference plane and the surface.
- The base plane trace represents the intersection between the reference plane and the base plane (including any offset), limited to the projection of the template trace onto the plate.

A red sight plane trace at the intersection of the sight plane and the reference plane, and trimmed to the two previous traces is also visible in the geometry area.

If a plane does not intersect the curved plate, no template will be created at this location.

3. If desired, clear the **Automatic** check box opposite **Base plane**, click the **Base plane** field and select a plane in the

geometry area.

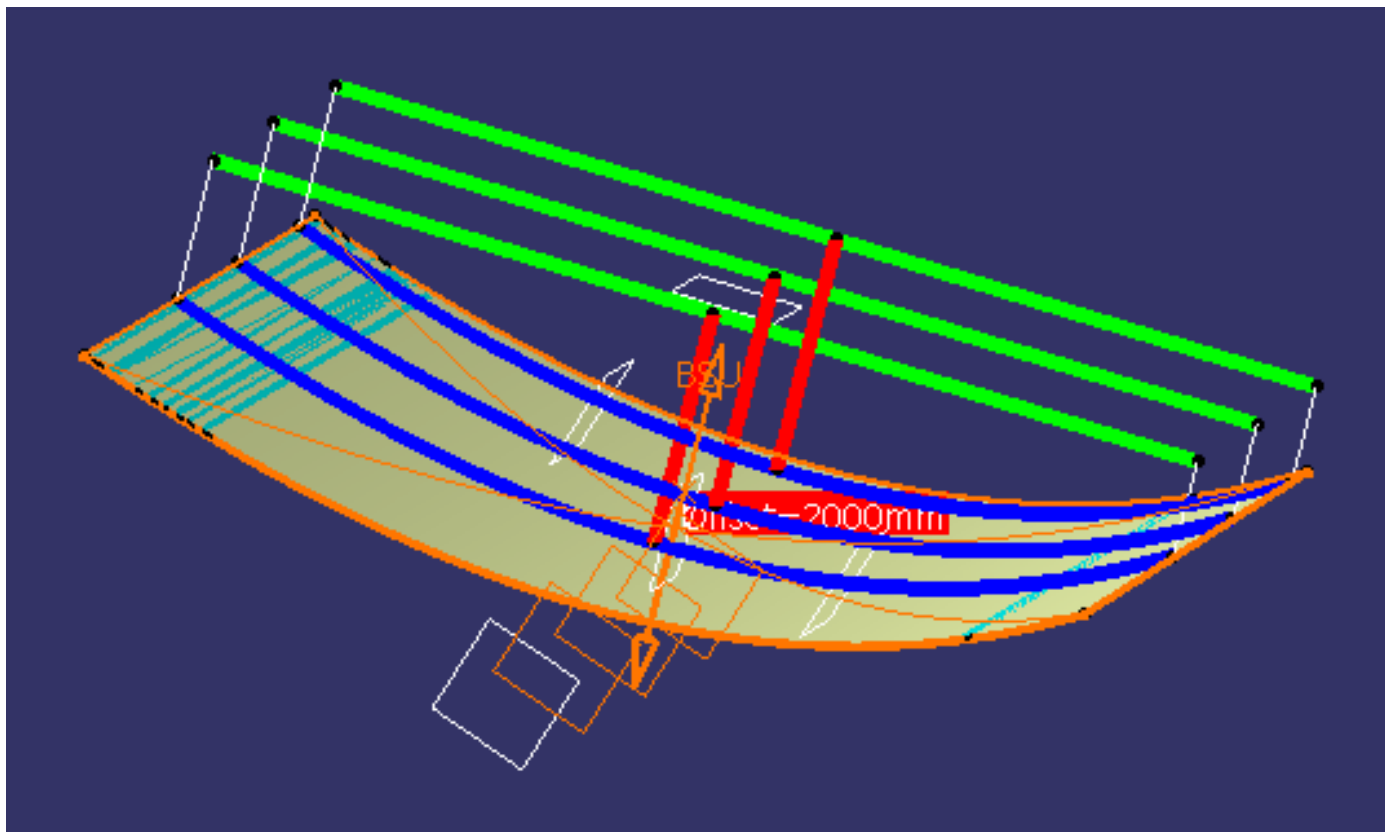
The system automatically computes the base plane from molded surface points using the least squares method.

The base plane is shown in the geometry area alongside the direction of extrusion and offset vectors.

4. Specify an offset for the base plane to adjust the height of the final templates, for example 2000mm.

Note: You must enter a positive value. The **Change step** command in the contextual menu of the **Offset** field lets you enter a different increment by which the field is updated.

The red vector showing the direction in which the base plane will be offset and the offset value are shown in the geometry area.



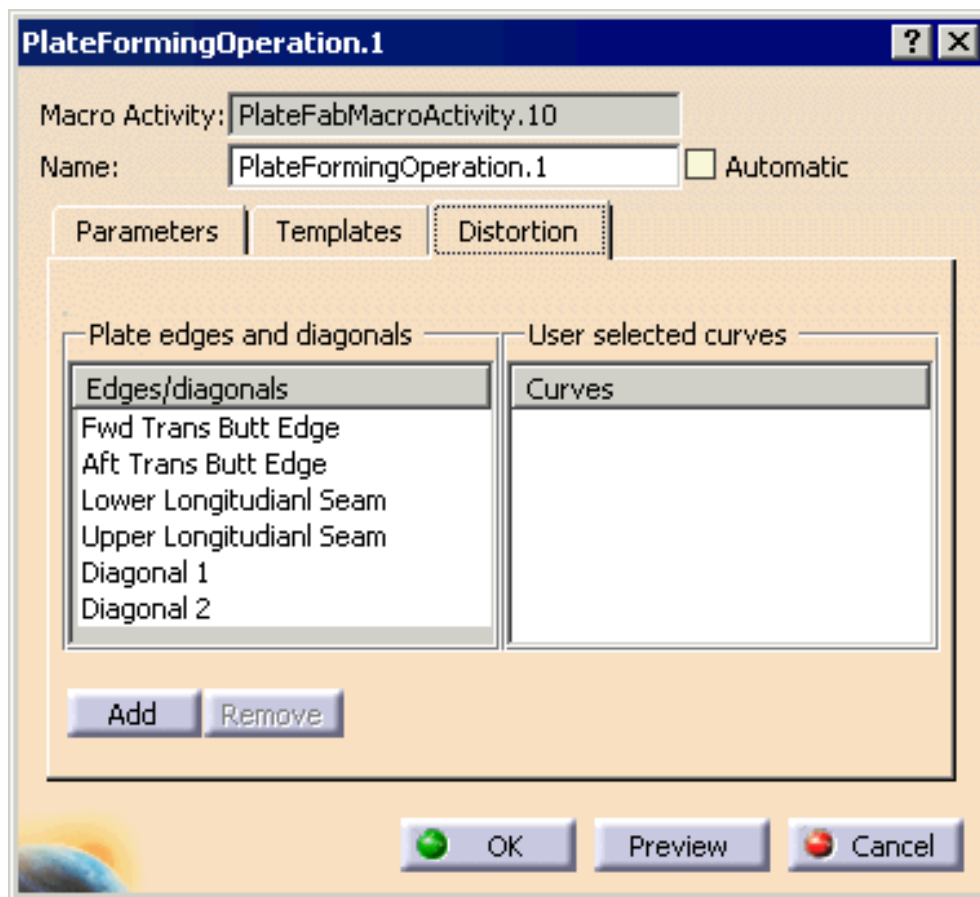
5. Select **Parallel templates** or **Box-like pattern** depending on the type of set you want to create. In this scenario, keep **Parallel templates**.

- If you select **Parallel templates**, the system defines the sight plane. To select your own sight plane, clear the **Automatic** check box, click the **Sight plane** field and select the desired plane in the geometry area.

The sight plane is the plane through the mid-points of the first and last template location lines. It is orthogonal to the base plane and may be orthogonal to the templates.


- If you select **Box-like pattern**, specify the number of longitudinal planes to define the longitudinal templates. One to three longitudinal planes are typically selected.

6. Click the **Distortions** tab.



7. Click the **Add** button.

The **Tools Palette** appears, which enables you to select one or more segments of any number of curves on a curved plate. For example, you can select the segments of a curve, segments of attachment line, and segments of all the four edges in one shot.

8. Select the curves you want and click **Finish**  in the **Tools Palette**.

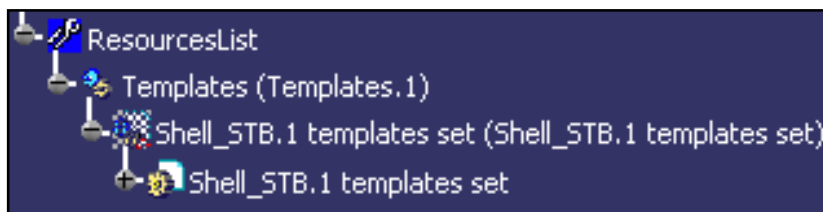
The selected curve appears in the **User selected curves** list.

9. Click **OK** in the **Plate Forming Operation** dialog box.

Requested roll line items and templates are created. In addition, the system distinguishes between the segments and corresponding parent curve, and generates a manufacturing item called a **Distortion Curve Item** for the parent curves under plate forming operation. This item holds the information about the selected curve and corresponding selected segments under that curve. To review the data, see [Extracting Inverse Bending Curve and Plate Distortion Data in an XML File](#).



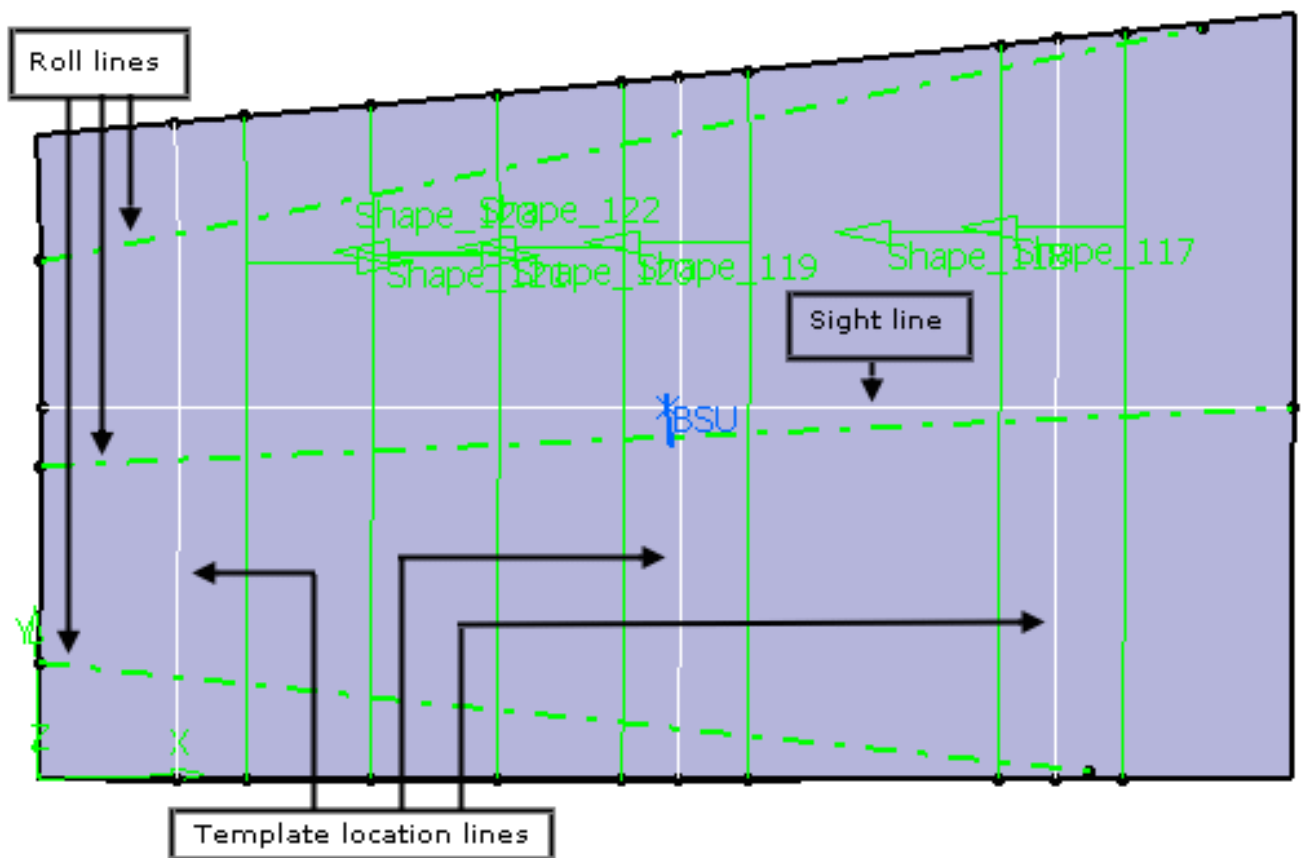
Templates are resources and as such are stored in a CATPart under the ResourcesList node in the PPR tree. The CATPart contains the skeleton geometry for the templates, each template being in a separate body. Templates are also identified under the Resources node of the appropriate operation.



To modify any templates that have been created, they must first be deleted from the ResourcesList.

10. Update the in-process model (using the **IPM Update** command).
11. Click **Preview** to view the IPM part corresponding to Shell_STB.1.

The curved shell plate is flattened and a flat plate obtained. Note that the IPM part contains all the necessary features for the downstream forming operation: roll lines, template location lines, sight lines as well as attachment lines and any added material on free edge.



12. Edit the plate forming operation and change the distortion and the neutral axis position, then update the in-process model and view the IPM part again.

