

Warp features are a fairly new addition to Pro Engineer Wildfire that allows global modifications to be made to a solid model. It is like having the ability to turn your solid model into a lump of plasticine and then bend twist and stretch the whole model into shape. These techniques allow you to make some very complex shapes which you could not make by any other method within a solid modeller. The tools you have for the control of these shapes are fairly versatile (if a little tricky to use at first) but due to the global nature of the modifications the control may not be as precise as with other functions you are used to in Pro Engineer Wildfire. That said, as you can see from Figure 1 you can make some very unusual shapes.



Figure 1 : Completed Lamp

Creating the Bracket

Create a new part called Lamp_Bracket and choose mmns_part_solid as the initial template. In this part create the simple extruded hexagon shown in Figure 2. To help you draw the hexagon in the sketcher draw a 25 circle then right click on it and choose CONSTRUCTION. The circle will then be shown dotted as a construction line and you can draw the six lines making up the hexagon inside this circle. Make three of the lines equal in length to ensure it really is a hexagon. Extrude it to 300mm length.

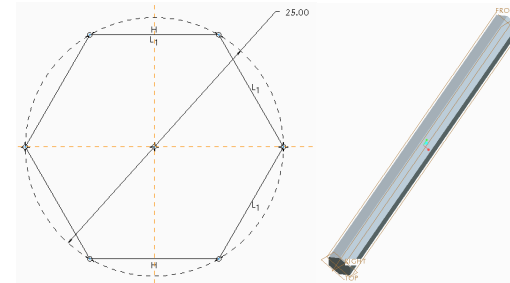


Figure 2 : Initial Extrusion

Now its time to warp this simple shape into something more interesting. Choose INSERT > WARP and you will see the warp dashboard displayed at the bottom of the screen. This has several for the different warp functions and a series of menus which hide functions which are very useful.



Figure 3 : The Warp Dashboard

The different warp functions are summarised in Figure 4. The functions all operate by allowing the operator to interactively change the geometry. This is done by dragging control points on the geometry around with the mouse.

	TRANSFORM - Rotate, scale or translate the model.		BEND – Bends the geometry along an axis. You can control the bend angle, the range of bend, pivot point, and the bend radius.
	WARP - Uses edges and corners of a surrounding box to change the shape of the geometry.		TWIST – Twists the geometry around an axis. You can control the angle of the twist and the range of the twisting effect.
	SPINE – Use a curve to adjust the overall shape of the model either linearly or radically.		SCULPT – Use a mesh of control points to adjust the overall shape of the model.
	STRETCH - Stretches the geometry along an axis. You can control the range and scale of the stretch.		

Figure 4 : Warp Functions

Your First Warp

We will introduce the warp functions by working on the hex bar we have just created to make it taper along its length. If you have just issued the INSERT > WARP command Pro Engineer should be waiting for you to select the solid to be warped so pick the extruded hex bar and click on OK in the select dialog on the right of the screen. You will immediately be asked to pick a reference for the warping so pick the coordinate systems PRT_CSYS_DEF. The warp tools should now be active in the dashboard - press on the second button . The bar should now be surrounded by a box (known as a marquee) with square 'grab handles' with which you can drag the model. Try dragging the model now to see what effect each of the drag handle has – when you click on a corner you will get additional drag arrows to play with

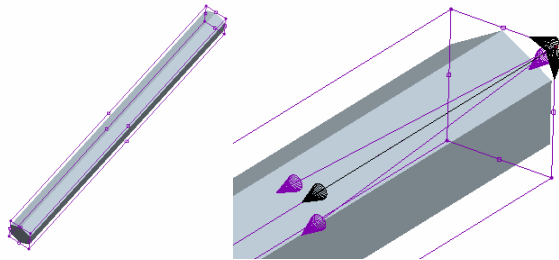


Figure 5 : Warp Drag Handles

When you have played with the drag handles your model may well be distorted. We need to restore its shape – this is no problem because the warp function has its own history under the LIST menu. Click on this menu now and use the delete icon to delete all of your modifications except the first WARP : REFERENCE function. The dialog should look like Figure 6.

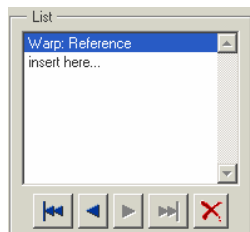


Figure 6 : Warp History

So how do you use this to add a taper? The drop down list box on the warp dashboard will probably be set to OPPOSITE – change this to CENTRE. Now drag the arrow handle highlighted in Figure 7 to create a tapered bar.

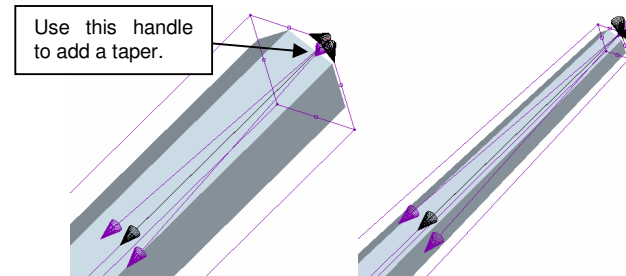


Figure 7 : Warp taper

As you drag a handle you get visual feedback of the changing shape. There is also a numeric value that you can change which appears in the OPTIONS menu. The higher this number the greater the effect of the warp command and the more the shape tapers – change this value to 6. If you tick the adjacent box the value can be changed later using the EDIT command like any other dimension. Press the green tick to finish the warp feature creation.

The Twist Warp

You should now have a tapered hexagonal bar. Let's twist it around its length. Choose INSERT > WARP again and pick the extruded hex bar and click on OK in the select dialog on the right of the screen. You will immediately be asked to pick a reference for the warping so pick the coordinate systems PRT_CSYS_DEF. The warp tools should now be active in the dashboard - press on the sixth button . A numeric input window should appear in the dashboard into which you can type a twist value in degrees. Type a value of 360 and tick the adjacent box to export the value as an editable value. After entering this value the shape on the screen will be unrecognisable! This is because it is twisting around the wrong axis. Press the to cycle through the 3 axis until the shape is correct. The icon changes the direction of the twist.

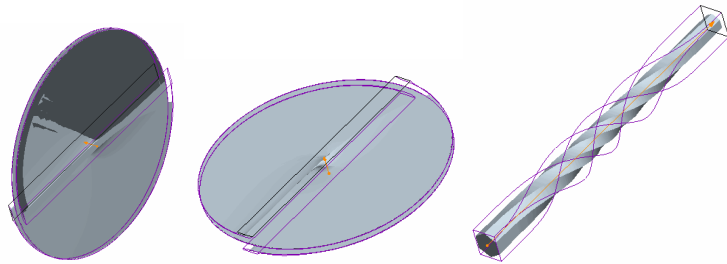


Figure 8 : Different Twist Axes

Press the green tick to finish the warp feature creation.

The Bend Warp

To finish the bracket we will add a bend. Choose INSERT > WARP again and pick the twisted hex bar and click on OK in the select dialog on the right of the screen. You will immediately be asked to pick a reference for the warping so pick the coordinate systems PRT_CSYS_DEF. The warp tools should now be active in the dashboard - press on the fifth button . A numeric input window should appear in the dashboard into which you can type a bend value in degrees. Type a value of 90 and tick the adjacent box to export the value as an editable value. After entering this value the shape on the screen will be as expected! This is because it is bending around the wrong axis. Press the to cycle through the 3 axes until the shape is correct. The icon changes the direction of the bend and the icon rotates the shape by 90 degrees around the bend axis.

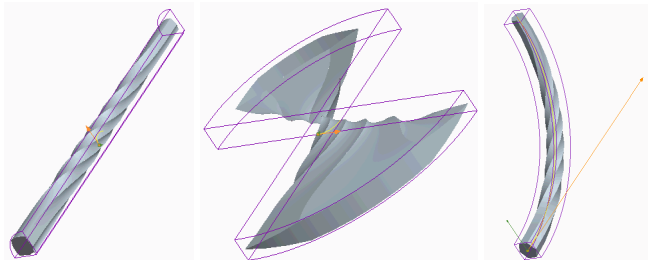


Figure 9 : Different Twist Axes

Press the green tick to finish the warp feature creation.

To complete this part go back (move the insert here icon) and add an extruded hole for the electric wires to go through (Extrude 3) and a lug to aid assembly.

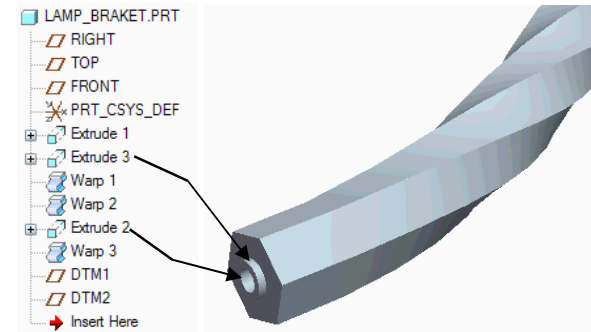


Figure 10 : Complete Bracket

Creating the Shade

Warpings can be applied to models which can contain more than a single feature. Making a lamp shade by the technique will show this.

Create a new part called Lamp_Shade and choose mmns_part_solid as the initial template. In this part create the simple extruded circle of 200mm diameter shown in Figure 11. Extrude it to 250mm length.

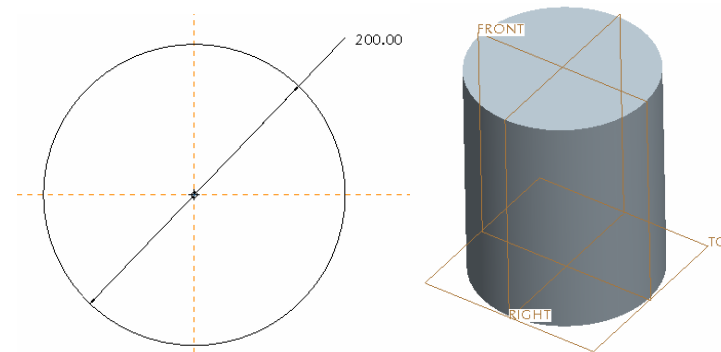


Figure 11 : Lampshade Feature 1

Next create a circular extrusion through the edge of the whole bar removing material.

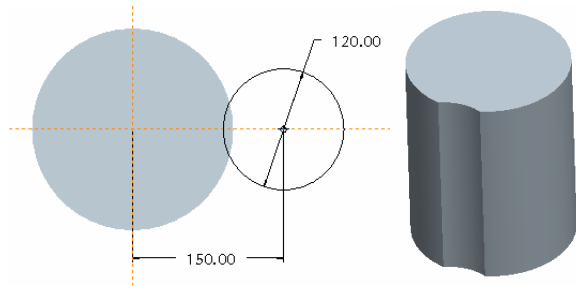


Figure 12 : Lampshade Feature 2

Make a pattern of 6 of the original extruded cuts at 60 degree intervals around the central axis (use the AXIS option).

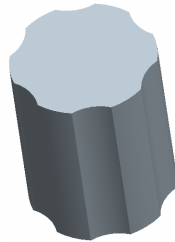


Figure 13 : Lampshade Pattern Feature

This is the basis of the lamp shade.

Combined Warp

The more interesting shape of the lamp will be created by a Spine, Warp and Twist Warps. These can be done as independent warps like we did with the bracket or they can all be combined into a single warp feature. This is what we will do here.

The Spine Warp

The spine warp lets us squash and stretch our 'lump of plasticine' into a new shape. Choose INSERT > WARP again and pick the lamp and click on OK in the select dialog on the right of the screen. You will immediately be asked to pick a reference for the warping so pick the coordinate systems PRT_CSYS_DEF. The warp tools should now be active in the dashboard - press the third button . This is the spine tool which controls

the shape by modifying an edge curve. Pick any one of the edges of the rounds as the control curve and click on OK in the select dialog on the right of the screen.

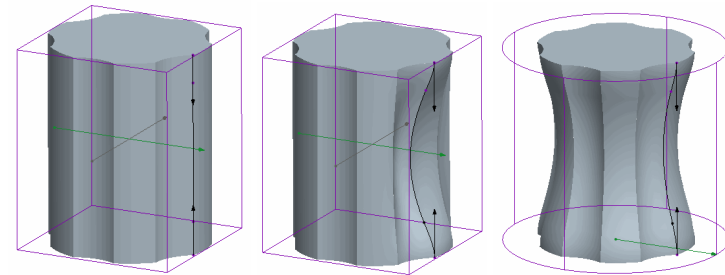


Figure 14 : Spine Warp

You can adjust the shape of this curve by dragging the control points (dots) and the arrows which control the start direction (Figure 14a). Try this now but don't be too ambitious in what you attempt! The results probably won't be what you expected (Figure 14b). This is because you are using the wrong TYPE of control. There are three types of control . Click on the last of the three buttons and pick the controlling curve again and edit it so that this time the effect of the curve is felt all around the shape (Figure 14c).

Remember we are combining several warps so DON'T press the green tick yet. Next we will taper the lampshade so click on second button and drag one of the corners at the top of the lampshade and drag to a suitable taper (don't forget to set the CENTRE option - refer back to Your First Warp as a reminder).

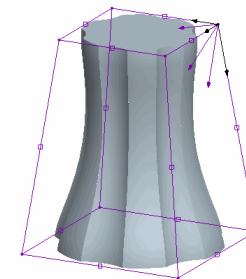


Figure 15 : Warp

We haven't finished so DON'T press the green tick yet. Next we will twist the lampshade so click on sixth button and type a twist angle of 60 degrees. Press the icon twice to cycle through the 3 axis until the shape is correct (refer back to The Twist Warp as a reminder).

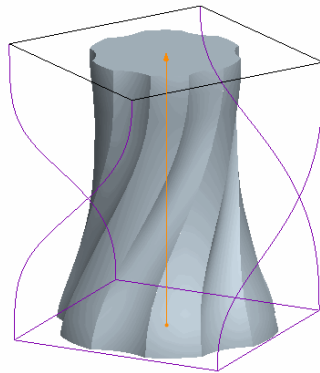


Figure 16 : Twist Warp

Take a look at the LIST menu and you should see the warp history of the commands you have just completed. You can use the buttons at the bottom to step backwards and forwards reviewing the procedure.

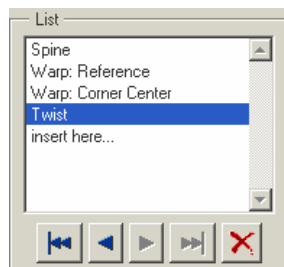


Figure 17 : Warp History

Press the green tick to finish the warp feature creation. All these warps appear as a single feature in the feature tree.

Finish the lampshade design off by adding rounds, a shell, a full round and an extruded cut.

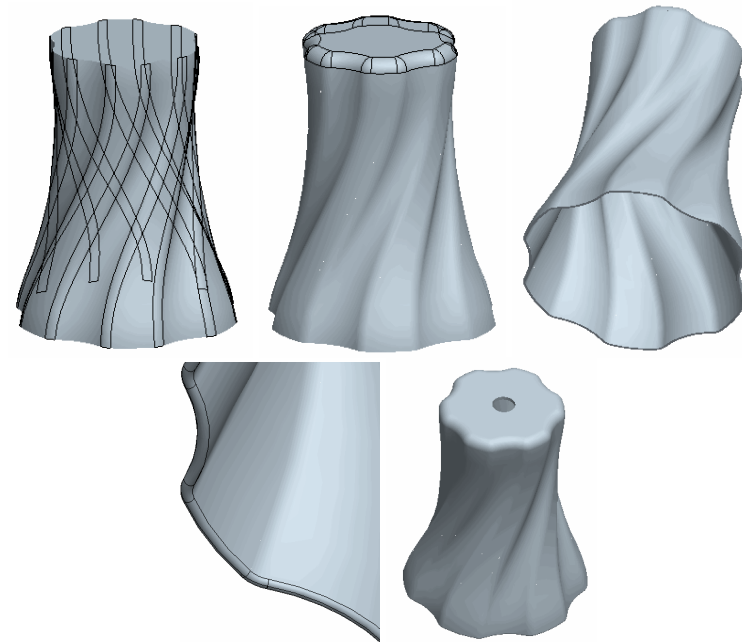


Figure 18 : Complete the Lampshade

The other parts of the lamp are made from standard extrude and revolve features. You may like to design these and create an assembly of all the parts to complete the exercise.

Review

So what should you have learnt?

- How to create individual warps
- How to combine warps into a single feature.
- Understand the limitations of using warp features

Any problems with these? Then you should go back through the tutorial – perhaps several times – until you can complete it without any help.

The Transform, Stretch and Sculpt Warps have not been discussed here. Experiment with these on your own models.