

3D Celtic Knot



Here, we will explore the use of the 3D tools (specifically the Sweep Two Rails tool) to create a relief. We will also demonstrate the Layers feature and the use of the Jigsaw Weld tool. The drawing tools were used to create the contours we will use to create the 3D Celtic Knot.

Note: These instructions include the selection of specific tools and setting cut parameters such as depth, passes, and feed rates. Our choice of these parameters was based on our machine, our tools, and the material we were cutting. You must always choose parameters that are appropriate for your machine, tooling and material.

1. Define the Plate – Enter these parameters and click OK.

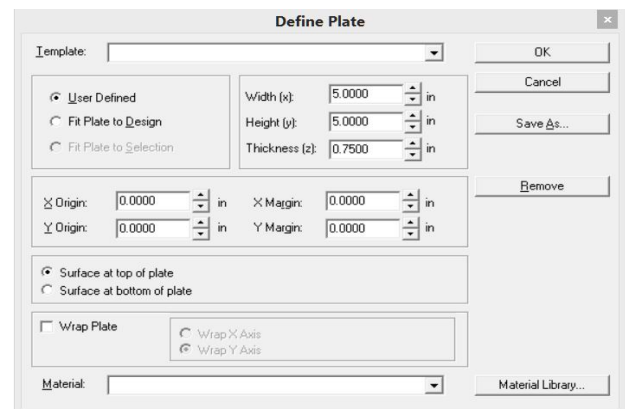
Width 5.00

Height 5.00

Thickness .75

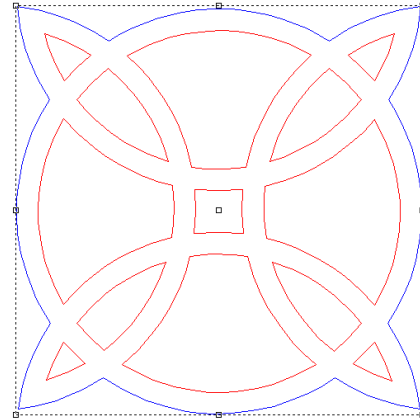
Surface at the top of Plate.

The material that is being used for the female part of the inlay is a smaller thickness than the male part.



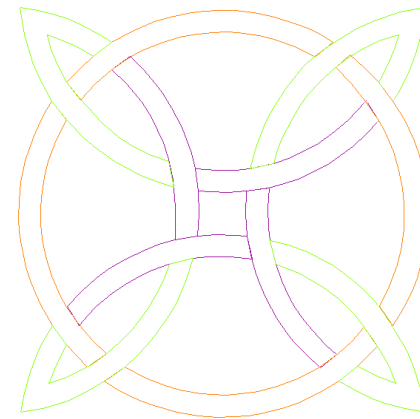
EnRoute Step-by-Step Series

2. This is the design that we are starting with to develop the 3D Relief.



3. The design must be modified in order to create the effect of the weaving of the knot.

Refer to the Celtic Knot Introduction tutorial for a more complete description of creation the geometry for this example.




4. Now, if you will take a look at the design once again, you can see that somehow we need to get the center of each of the contours to be higher in the relief. The end portion of each of the contours passes under, so that would be the low point on each contour.

To do this we will create open contours that outline each of the contours.

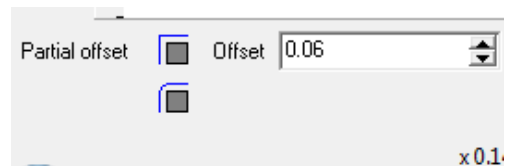
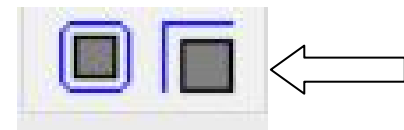


5. Create an offset for each of the long portions of the contours on each of the 3 layers.

To do this click and hold the Offset Icon.  This will open the flyout menu.

Click on the Offset Segments Icon. 

Enter the parameters .06 in the Partial Offset Dialog.




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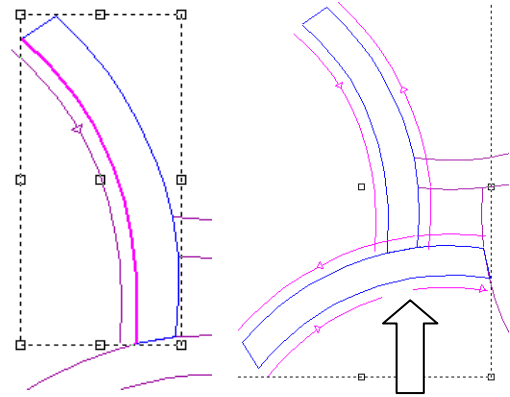
6. Move the cursor to the contour that you wish to offset. Click on the contour and click again on the side you wish to offset. This will create the offset segment.

If you look at the second diagram, you can see that this portion of the contour has 3 separate segments. Create each of the segment offsets.

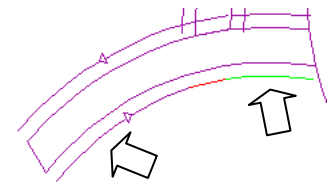
Next, you will need to join the segments together

with the join tool.  Open the join tool, move the cursor over the contour. The contour will turn a bright green. Click to select the end point of that contour. Move the cursor to the contour that you wish to join with. This contour will now turn bright green. Click to join the two contours.

Note: An alternative to this method would be to use the offset tool to offset a closed contour and then use the Edit Points tool and select the end points and cut the contour at each end. You would also need to reverse the direction of one of the open contours.

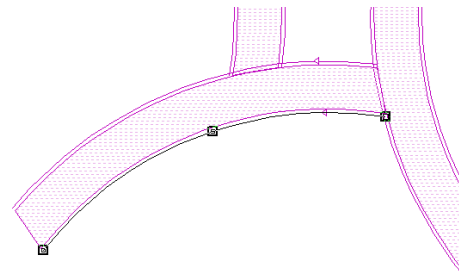


Use the join tool to connect two contours together.



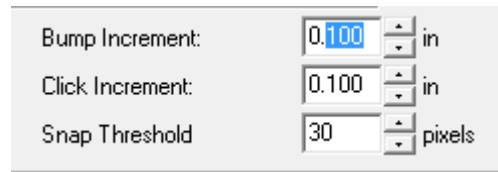
7. Last, you want to edit the points of each contour so that there are only 3 points. One on each end and one in the center of the contour.

The reason for this is that we will be changing the plane of the center point in the front view. This in combination with the Sweep Two Rails tool will allow us to make the relief change levels so that it gives the illusion of the rope passing above and below itself.



8. Before we begin to edit the center points...check the setting for the bump increment in the preferences section.

Go to the Setup Menu, the Preferences, and then the General tab. Set Bump Increment at .100.




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9. Open the 4 view by double clicking on “Top”.

The view that you are working in will have the name of the view in **bright blue highlight**.

While working in the top view, click on the Edit

Points icon  and select the point in the center of the contour.

10. Click on the “Front” tab to change your workspace to the front view.

11. Click on the up arrow key to move those points that you have selected up 3 clicks or .3. You can see in the front view that these points have been moved to a different plane.

When we create the relief, we will use the Sweep Two Rails tool to follow the profile of the contours.

Go to each layer and finish moving all of the points that need to be at the high point in the relief.

12. The next step is to create the relief.

Open the layers to show one section of the contours and the outlines that go with them.

Select each of the closed contours. Click on the Add Relief Icon to add a flat relief to those contours.

Enter parameters:

Add

Flat


Normal

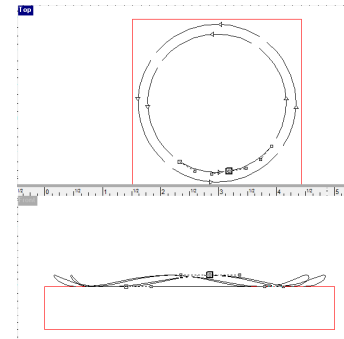
Height = 0

Resolution = 100

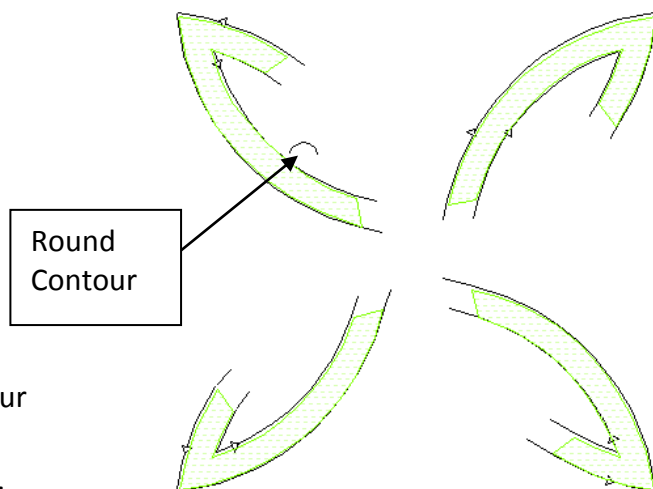
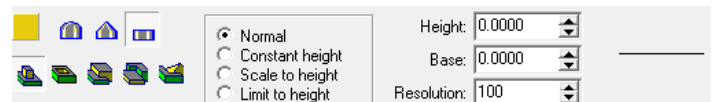
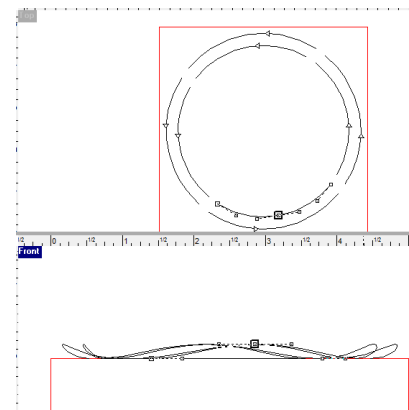
Click Apply to create the flat reliefs.

13. After creating the reliefs, create a round contour to use as the profile for the reliefs.

Use the Arc tool  to create a round contour.




Front




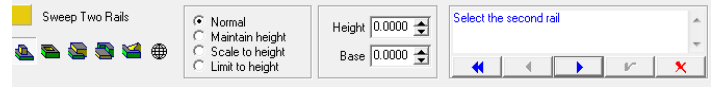
EnRoute Step-by-Step Series

14. The next step is to use the Sweep Two Rails tool to create the raised part of the relief. Click on the first relief.



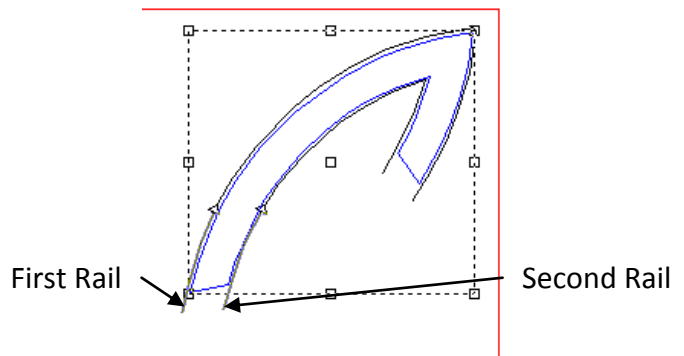
Click and hold the Revolve Icon.  This will open the flyout menu.



Click on the Sweep Two Rails Icon.  This will open the Sweep Two Rails Dialog.

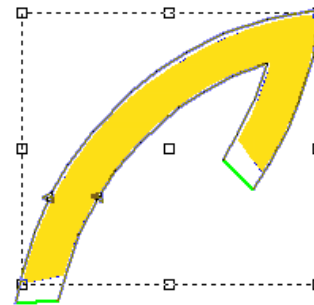


15. Click on the first rail. Click the forward arrow. Click on the second rail. As you do this, the contours will change color.

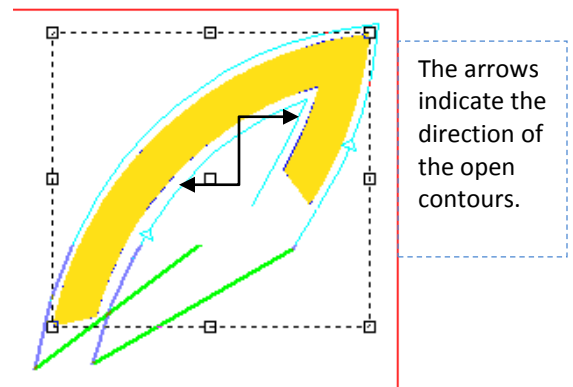
Click on the forward arrow.



16. Next, click on the rounded contour twice.  This will place the highlighted green showing the start and finish position of the rounded contour. Click on the Green arrow in the dialog to create the surface.  Notice that the highlighted green is at each end of the contour. If the highlighted areas do not look like this, it means that the open contours are not going in the same direction. Both open contours must be going the same direction. You can tell by looking at the direction of the arrows on the contour.



17. If the open contours that the profile is following are in opposite directions, this is how it will look when you click on each end for the start and finish for the contour placing. Do not click on the green arrow until you make the correction to the direction of one of the open contours.



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18. To change the direction of one of the contours to match the direction of the other contour:

- Select the contour.
- Open the Transform Menu
- Click on Reverse Open Contour.

Notice that the highlighted contour has changed direction.

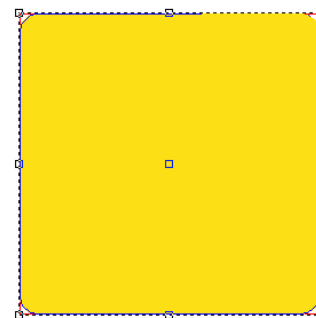
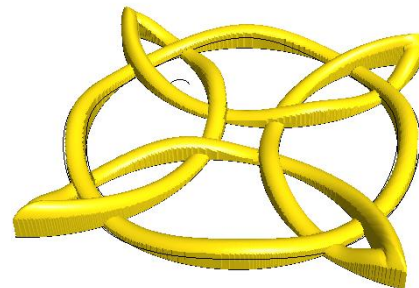
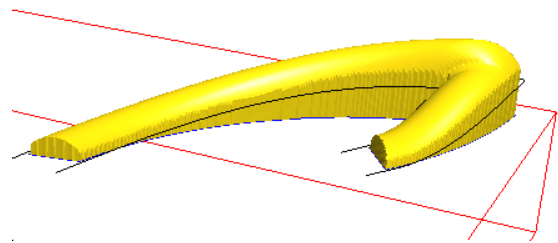
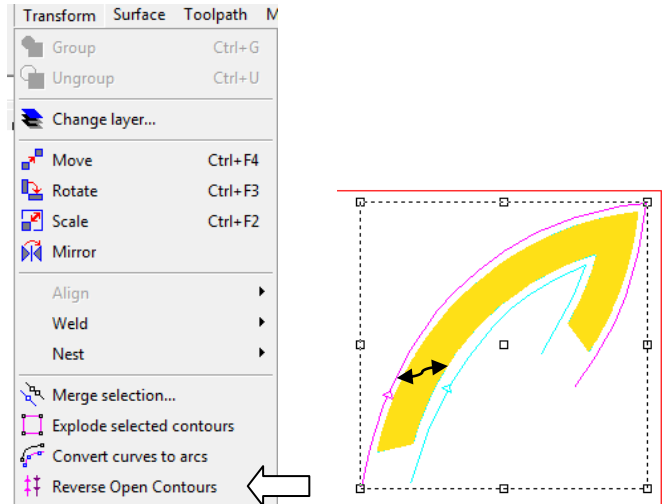
19. Make sure that the open contours are going in the same direction then continue with step 26.

20. This is an image showing the results of the Sweep Two rails procedure. Continue to do this with each of the contours that make up the knot.

21. Once you have gone through the steps to create each of the reliefs, turn on the 3 layers together to see your results. If you view it in the perspective view you can get a good idea of how they all fit together.


22. The next step is to build the background. Add a new layer and copy the outline contour to that layer.

Select that contour and create a flat relief using the same procedure as we used for the Celtic Knot parts.



EnRoute Step-by-Step Series

23. Copy and paste the reliefs for the Celtic Knot to this same layer.

Click on the Merge Relief Icon.  This will open the Merge Reliefs Dialog.

24. The steps to merge the reliefs together are as follows:

Set the parameter to Merge Highest.

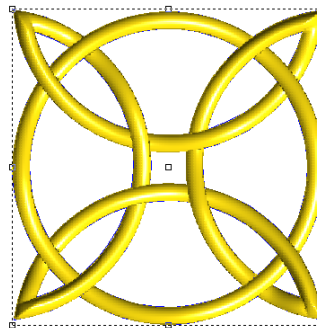
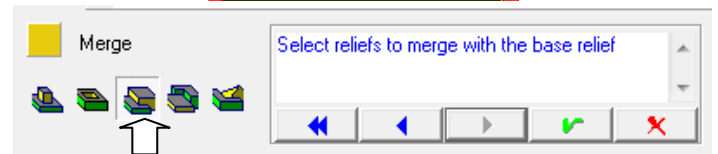
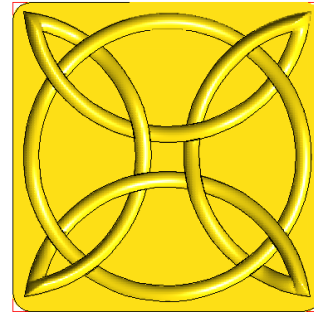
Select the background relief. The relief will highlight as you select it.

Click the forward arrow.

Hold down the shift key and select each of the reliefs to add to the base relief. The reliefs will highlight in pink as you select them.

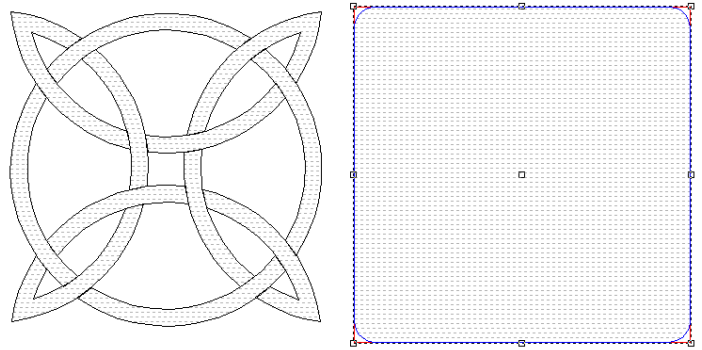
Click on the green arrow to merge the reliefs.

25. At this point, the original pieces are still separate reliefs. Draw a selection box around just the pieces and move them to another location.

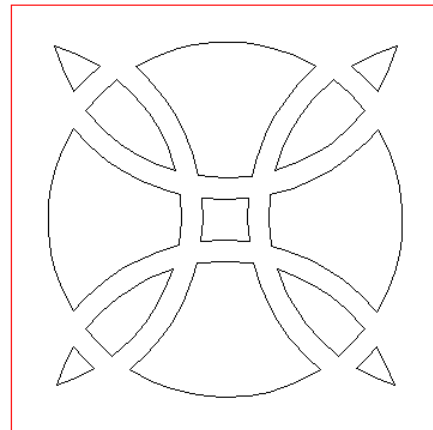


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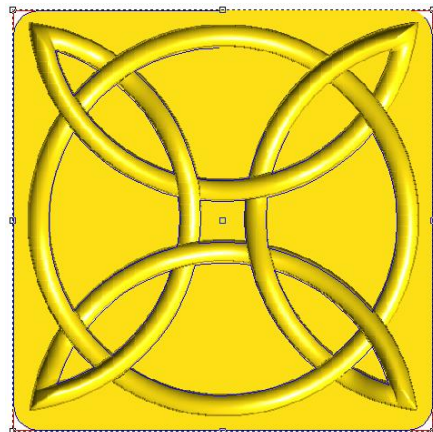
26. If we turn off the rendering, you can see that the reliefs have been merged to form only one relief.




27. The next thing that we have done here is to “scoop out” the background area within the knot.
On another layer, we have the contours that make up that area.



28. Open the Define Layers and turn on the two layers to create the background of the relief. The current Layer is the layer that contains the relief that you just created.
Select both the Relief and the contours for the background. You can do this by drawing a selection box around all of them.



Click on the Add Relief Icon. 

This will open the Add Relief Dialog.

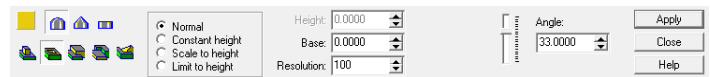
29. Enter parameters:

Subtract

Normal

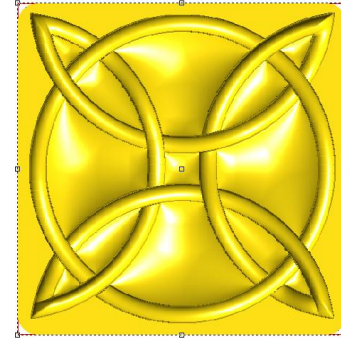
Angle = 33

Click Apply.

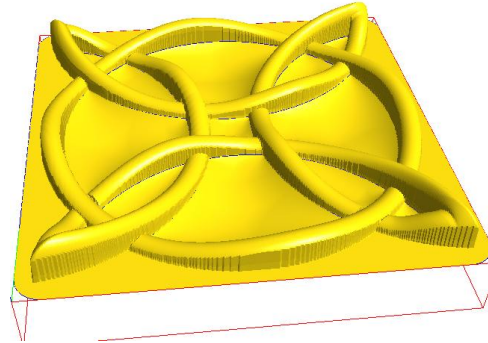


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30. This is an image of the results of “scooping out” the background area of the knot.



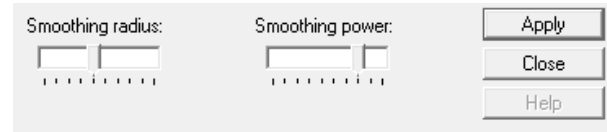
31. Here is the relief shown in perspective view.



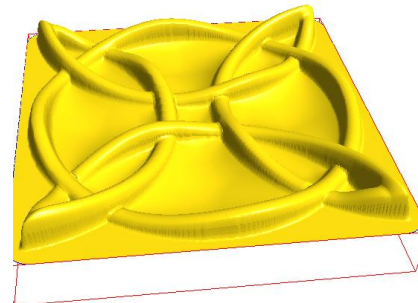
32. To make the relief a bit smoother, we used the Smooth Relief Tool. Select the relief.

Click on the Smooth Relief Icon.  This will open the Smooth Relief Dialog. Set the parameters.

Click Apply.



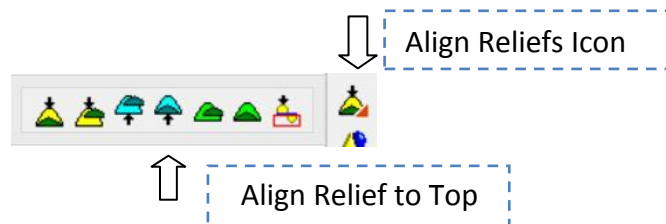
33. This image shows the results of the Smooth Tool. You can work with changes in these parameters until you get your desired results.



34. Before we can cut the relief, we must move it into the plate. Select the relief.

Click and hold the Align Reliefs Icon. This will open the Align Reliefs Flyout Menu.

Click on the Align Relief to top icon.



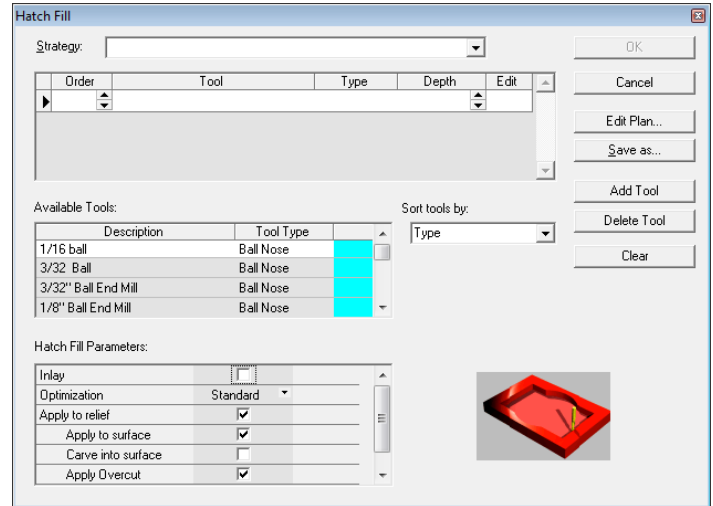
35. This is the Front View of the relief. You can see that it has been moved so that the top of the relief is located at the top of the plate.



36. Now we will create the toolpaths to cut out the relief. In this example, we used a Hatch Fill Toolpath.
Select the Relief.

Click on the Hatch Fill Icon.

This will open the Hatch Fill Dialog.



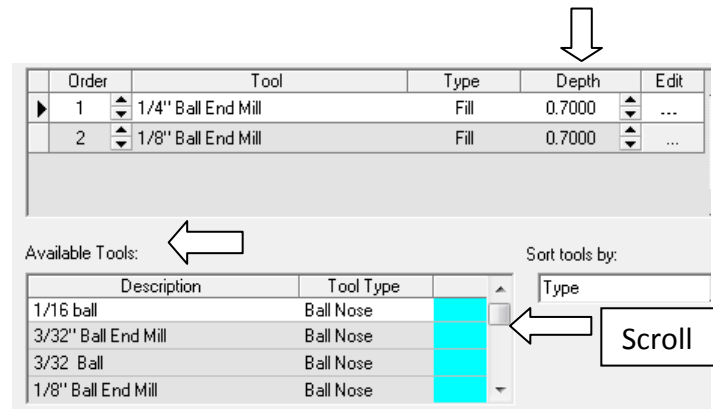
37. The next step is to select the tools that will be used to cut the material. In this example we have selected a 1/4" Ball End and a 1/8" Ball End.

Go to the Available Tools section of this dialog. Scroll down to find the 1/4" Ball End tool.

Double click on the tool to select the tool.

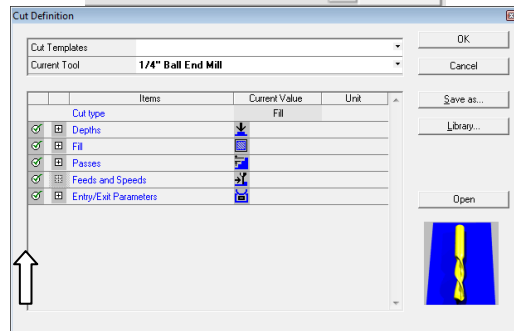
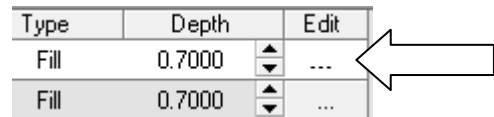
Add the 1/8" Ball End the same way.

Enter the Depth by typing in the parameter or using the arrows to scroll to the desired depth.



38. Click in the Edit box next to the tool to open the Cut Definition Dialog.

39. Notice that there are several parameters that can be set. To open each of the categories simply click on the + box.



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40. In the Depths category for the 1/4" Ball End tool we have set the Offset from surface parameter to .1000. The overlap to 70%.

This will allow the 1/4 inch tool to be used as a rough tool. It will clear away most of the material leaving just a small amount of material for the 1/8" Ball End tool to remove.

41. In this example we set the parameters:

Passes = 1

Feeds Rate = 90.0000

Plunge Rate = 50.0000

Spindle Speed = 14000

Click Ok. This will bring you back to the Hatch Fill Dialog.

Set the parameters for the 1/8" Ball End Tool.

Click on the Edit box next to the 1/8" Ball End tool to open the Cut Definition Dialog for that tool.

42. Set the parameters for this tool.

Overlap = 90%

Passes = 1

Feed Rate = 100.000

Plunge Rate = 50.0000

Spindle Speed = 14000

Click Ok. This will bring you back to the Hatch Fill Dialog.

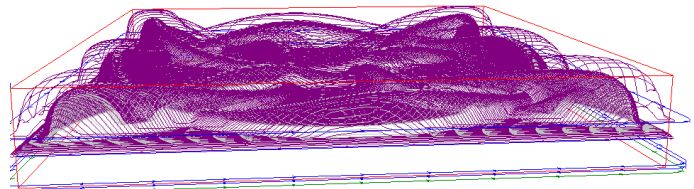
Click Ok. This will calculate the toolpaths.

43. This is a perspective view of the toolpaths. You can see that the 1/4" Ball End tool is offset from the surface of the relief. The tool will remove most of the material leaving just .10 for the 1/8" Ball End tool to remove. The overlap for the 1/8" Ball End tool was set higher so that the finished surface would not show the tool marks.

Depths		
Surface	0.0000	in
Final Depth	0.7000	in
Offset from surface	0.1000	
Step Rough	<input type="checkbox"/>	
Fill		
Overlap	70.0000	%
Hatch angle	0.0000	

Feeds and Speeds		
Feed Rate	90.0000	in/min
Final Pass Feed	0.0000	in/min
Plunge Rate	50.0000	in/min
Dwell	0.0000	sec
Spindle	14000	rpm

Depths		
Surface	0.0000	in
Final Depth	0.7000	in
Offset from surface	0.0000	
Step Rough	<input type="checkbox"/>	
Fill		
Overlap	90.0000	%
Hatch angle	0.0000	



44. A Routing Offset was used to cut the relief out. Select the relief.

Click on the Routing Offset Icon. This will open the Routing Offset Dialog.

Load the 1/4" End Mill tool by selecting it from the Available Tools section of the dialog. Scroll down to locate the tool and then double click on it to load it. In this example, we have used the 1/4" End Mill tool as the Rough cut and the Clean cut, so you need to load the tool twice.

Enter the Depth of cut. For the Rough tool the Depth is .71. For the Clean cut set the Depth at .75.

Click in the edit box next to the Rough tool. This will open the Cut Definition Dialog for this tool.

45. Enter the parameters for the Rough tool:

Passes = 3

Feed Rate = 100.0000

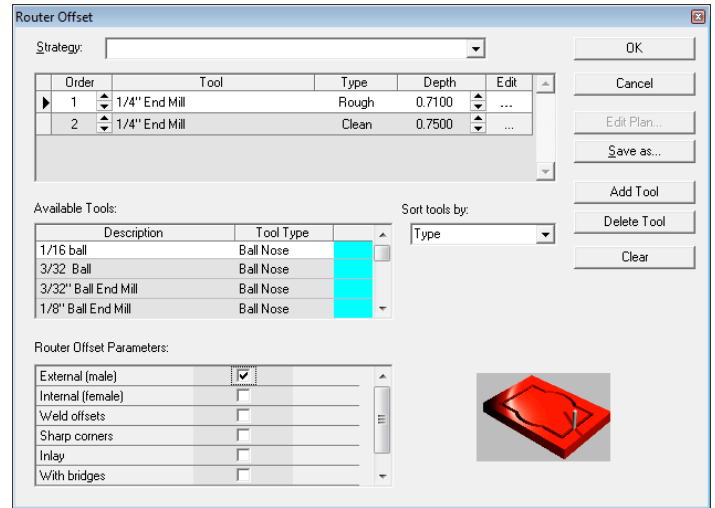
Plunge Rate = 50.0000

Spindle Speed = 14000

Click OK. This will bring you back to the Routing Offset Dialog.

Set the parameters for the Clean Tool.

Click in the Edit box for the Clean Tool. This will open the Cut Definition Dialog.



Cut type		Rough
<input checked="" type="checkbox"/>	Depths	
	Surface	0.0000
	Final Depth	0.7100
<input checked="" type="checkbox"/>	Passes	
	Number	3
	Maximum per Pass	0.7500
	Actual per Pass	0.2367
	Final Pass	<input type="checkbox"/>
	Final Pass Depth	0.0000

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46. Enter these parameters.

Passes =1

Width of cut =.02

Feed Rate = 100.0000

Plunge Rate = 50.0000


Spindle Speed = 14000

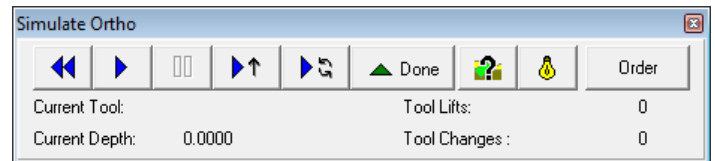
Click Ok.

Click Ok again in the Routing Offset Dialog to process the toolpaths.

Passes		
Number	1	
Maximum per Pass	0.7500	in
Actual per Pass	0.7500	in
Final Pass	<input type="checkbox"/>	
Final Pass Depth	0.0000	in
Widths		
Width of cut	0.0200	in
Number of steps	1	
Maximum step	0.2250	in
Actual step	0.0200	in
Shoulder?	<input type="checkbox"/>	

47. To preview the toolpaths use the Simulate Ortho

Tool.  This will open the Simulate Ortho Dialog.



48. There are several options in which you can view the toolpaths that you have created. The forward arrow will simulate all of the toolpaths so that you can see the final results.

