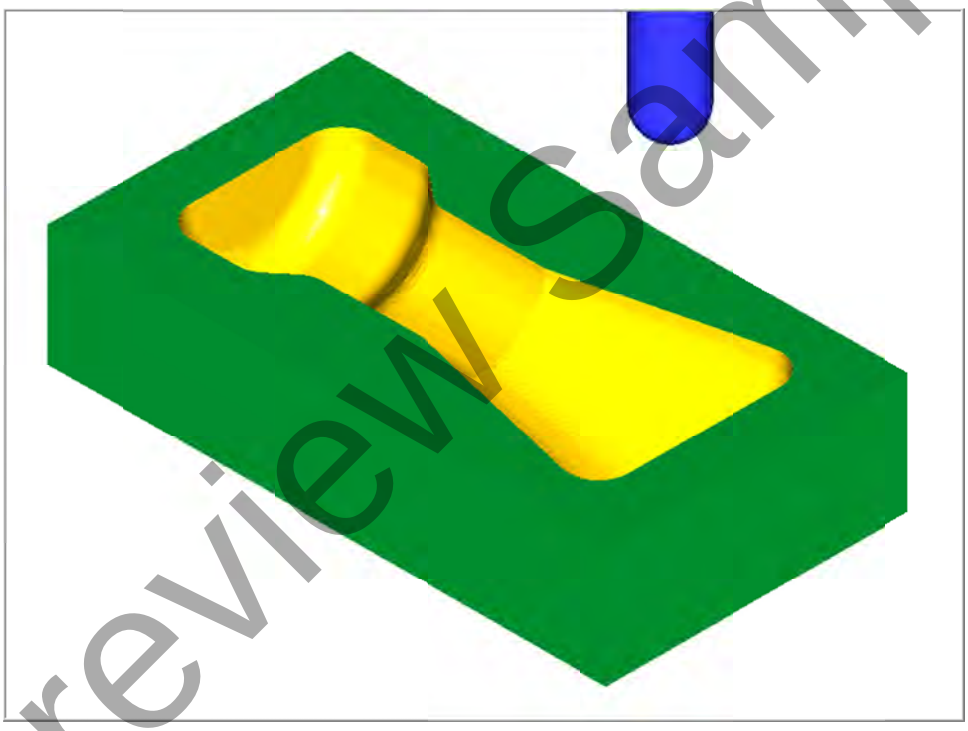
Mastercam X

TRAINING GUIDE



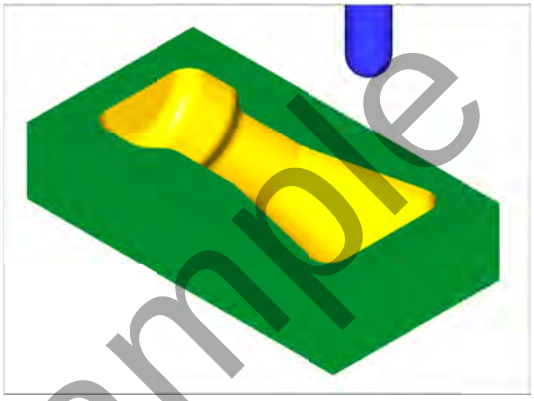
MILL-LESSON-9

SURFACE POCKET AND SURFACE HIGH SPEED WATERLINE

camInstructor

Objectives

You will create the geometry for Mill-Lesson-9, and then generate the toolpaths to machine the part on a CNC vertical milling machine. This Lesson covers the following topics:



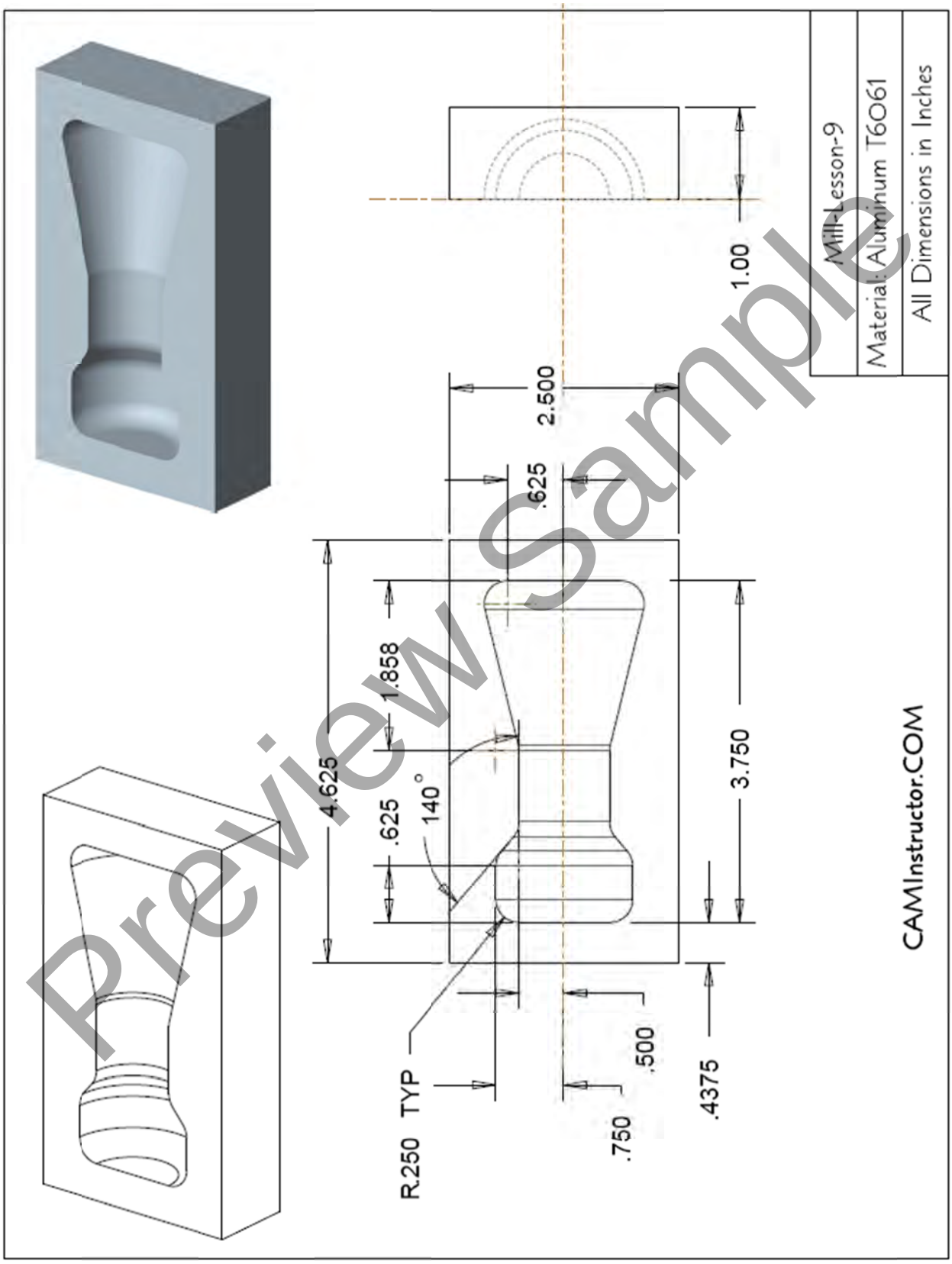
➲ **Create a 3-dimensional drawing by:**
Creating lines.
Creating arcs.
Trimming geometry using Divide / Delete.
Creating a revolved surface.

➲ **Establish Stock Setup settings:**
Stock size using Bounding Box.
Material for the part.
Feed calculation.

➲ **Generate a 3-dimensional milling toolpath consisting of:**
Surface Pocket.
Surface High Speed Waterline.

➲ **Inspect the toolpath using Mastercam's Verify and Backplot by:**
Launching the Verify function to machine the part on the screen.
Generating the NC- code.

MILL-LESSON-9 DRAWING



TOOL LIST

- 0.500 diameter bull end mill with a 0.125 corner radius to rough machine the pocket.
- 0.500 diameter ball end mill to finish machine the pocket.

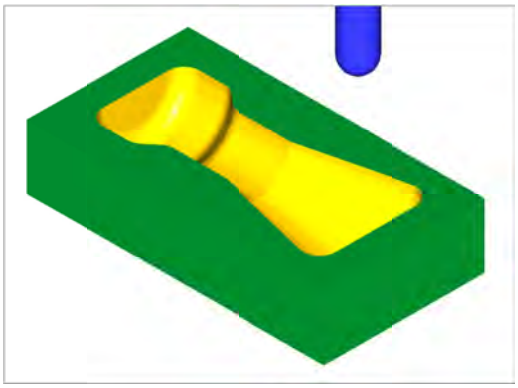
Tool List of MILL-LESSON-9.MCX-5

Proj./Part No.: 0 Date : 05/25/10
Drawing No. : 1 Customer : -
Prog. No. : 9 Programmer : 1

Tool type	:	0.5 Endmill3 Bull 1/2 BULL ENDMILL 0.125 RAD					
Manufact.code	:						
Chuck	:						
Tool Number	:	1				Feedrate	: 12
Diameter	:	0.5	RPM	: 2500		Plunge feed r.	: 12
Corner radius	:	0.125	Tip angle	: 0		Diam. offset	: 1
Flute length	:	1	Material	: ALUMINUM ...		Length offset	: 1
Overall length	:	3	No flutes	: 4			

Tool type	:	0.5 Endmill2 Sphere 1/2 BALL ENDMILL					
Manufact.code	:						
Chuck	:						
Tool Number	:	2				Feedrate	: 15
Diameter	:	0.5	RPM	: 2500		Plunge feed r.	: 15
Corner radius	:	0.25	Tip angle	: 0		Diam. offset	: 2
Flute length	:	1	Material	: ALUMINUM ...		Length offset	: 2
Overall length	:	3	No flutes	: 4			

MILL-LESSON-9 - THE PROCESS



Geometry Creation

TASK 1: Setting environment
TASK 2: Create geometry
TASK 3: Trim the geometry
TASK 4: Create the revolved surface
TASK 5: Create boundary curves
TASK 6: Save the drawing

Toolpath Creation

TASK 7: Define the rough stock using stock setup
TASK 8: Rough the pocket using surface pocket
TASK 9: Finish the pocket using surface high speed waterline
TASK 10: Verify the toolpath
TASK 11: Save the updated Mastercam file
TASK 12: Post and create the CNC code file

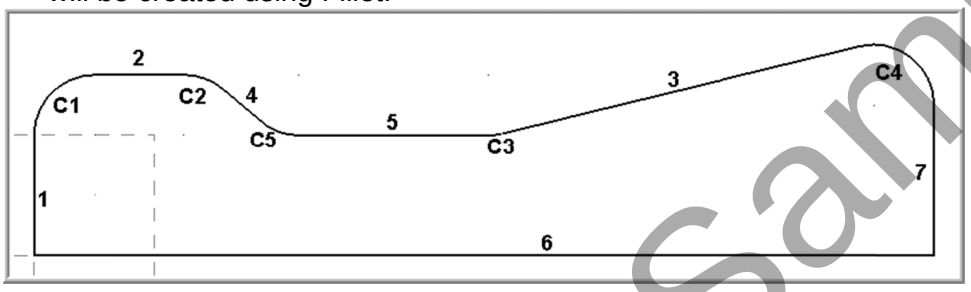
TASK 1:
SETTING THE ENVIRONMENT

Before starting the geometry creation you should set up the grid, toolbars and machine type as outlined in the **Setting the environment** section at the beginning of this text:

1. Set up the Grid. This will help identify the location of the origin.
2. Customize the toolbars to machine a **3D part**.
3. Set the machine type to a Haas Vertical Spindle CNC machine.

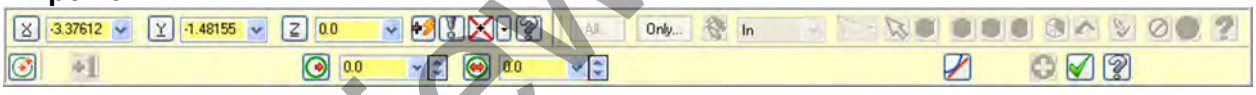
TASK 2:
CREATE GEOMETRY - X0 Y0 LOWER LEFT CORNER

➲ In this task you will create the geometry that will be used to create the revolved surface. First you will create the circles, C1 through C4 and then create the lines 1 through 7. The arc C5 will be created using Fillet.



➲ **Create Circle #1**

1. **Select Create>Arc>Circle Center point…**
2. The **Circle Center Point** ribbon bar appears and you are prompted to **Enter the center point**.



3. Before moving on, click in the space for **radius** and enter a value of **0.25**. Next **click on the icon for radius** on the ribbon bar as shown below. This **locks** in the radius for the circles. To **unlock** click on the icon for diameter.

4. To satisfy this first prompt click on the **FastPoint** Icon on the Auto Cursor ribbon bar  .
5. In the space input the **X (0.25) and Y (0.5)** values for the center of the circle and **hit enter**. **Note** that you can use a variety of formats to enter coordinates here. This is very helpful when cutting and pasting coordinate values from another document. You do not need to input the Z value for this example.
6. On the ribbon bar click on **Apply**  to fix the entity.

➲ **Create Circle #2**

7. To satisfy the prompt **Enter the center point** click on the **FastPoint** Icon on the Auto Cursor ribbon bar.
8. In the space input the **X (0.625) and Y (0.5)** values for the center of the circle and then hit the **enter** key.
9. On the ribbon bar click on **Apply**  to fix the entity.

➲ **Create Circle #3**

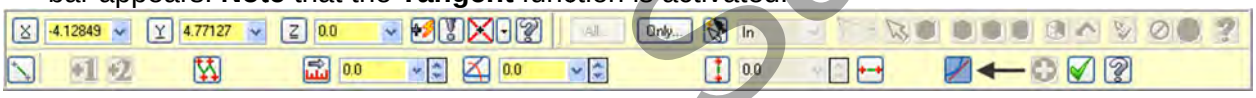
10. To satisfy the prompt **Enter the center point** click on the **FastPoint** Icon on the Auto Cursor ribbon bar.
11. In the space input the **X (3.750-1.858) and Y (0.5+0.25)** values for the center of the circle and then hit the **enter** key.
12. On the ribbon bar click on **Apply**  to fix the entity.

➲ **Create Circle #4**

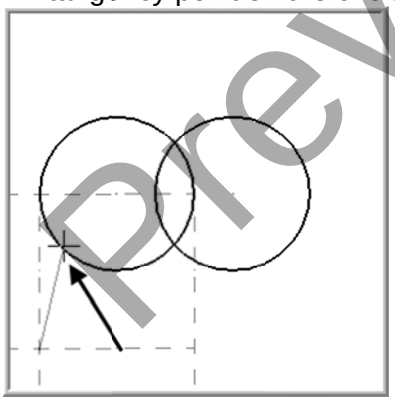
13. To satisfy the prompt **Enter the center point** click on the **FastPoint** Icon on the Auto Cursor ribbon bar.
14. In the space input the **X (3.750-0.25) and Y (0.625)** values for the center of the circle and then hit the **enter** key.
15. Click on the OK icon  to complete this feature.
16. Now select the **Fit to screen** icon  .

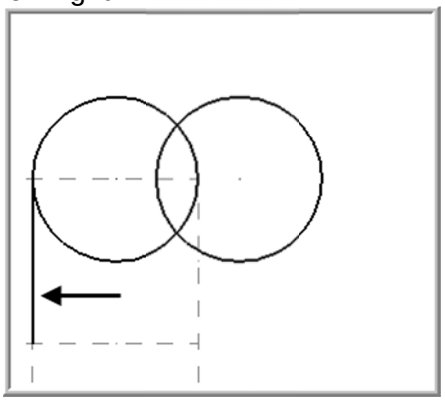
➲ **Create Line #1**

17. Select from the pull down menu: **Create>Line>Line Endpoint…**
18. On the graphics screen you are prompted: **Specify the first endpoint** and the Line ribbon bar appears. **Note** that the **Tangent** function is activated.



19. To satisfy the prompt **Specify the first endpoint** move the cursor over to the **center of the grid** and as you get close to the **Origin** (X0Y0) a visual cue appears.  This is the cue that will allow you to snap to the origin, with this visual cue highlighted **pick the origin**.
20. To satisfy the prompt **Specify the second endpoint** move the cursor over the area of the circle shown below. Ensure there is **no visual snap cue** being displayed and click on this point. As **Tangent** is activated on the line ribbon bar the line will snap to the closest tangency point on the circle as shown below right:

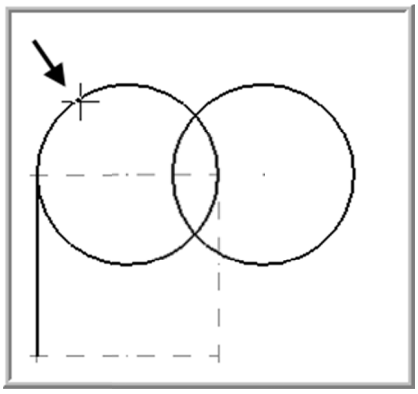




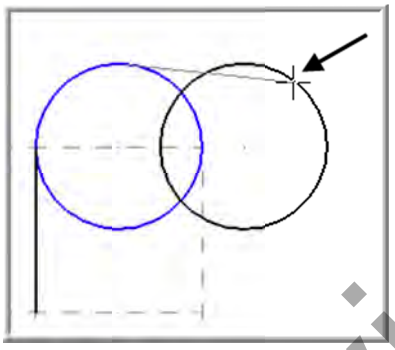
21. On the ribbon bar click on **Apply**  to fix the entity.

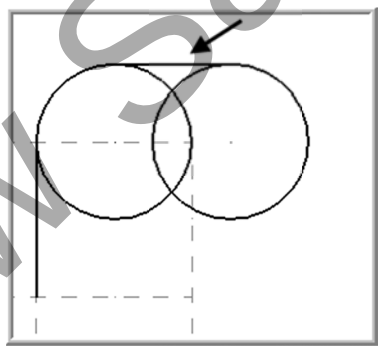
➲ **Create Line #2**

22. To satisfy the prompt **Specify the first endpoint** move the cursor over the area of the circle shown below. Ensure there is **no visual cue** being displayed and click on this point. As **Tangent** is activated on the line ribbon bar the line will snap to the closes tangency point on the circle.



23. To satisfy the prompt **Specify the second endpoint** move the cursor over the area of the circle shown below. Ensure there is **no visual cue** being displayed and click on this point. As **Tangent** is activated on the line ribbon bar the line will snap to the closest tangency point on the circle as shown below right.

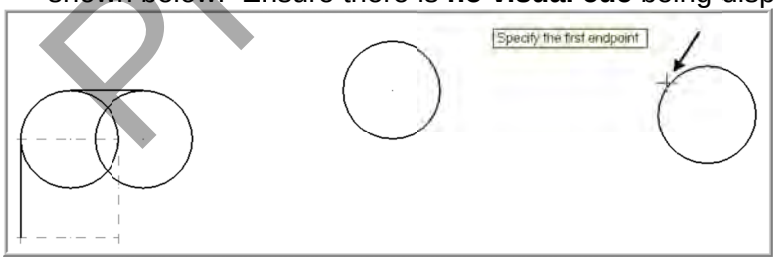




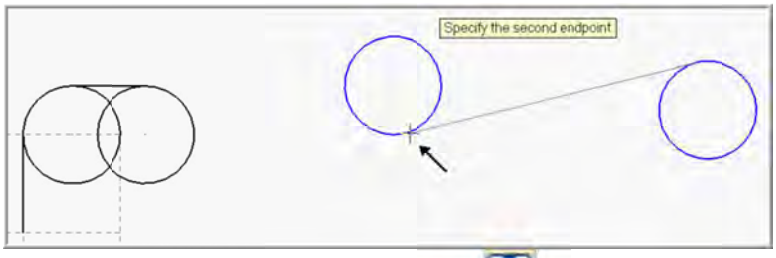
24. On the ribbon bar click on **Apply**  to fix the entity.

➲ **Create Line #3**

25. To satisfy the prompt **Specify the first endpoint** move the cursor over the area of the circle shown below. Ensure there is **no visual cue** being displayed and click on this point.



26. To satisfy the prompt **Specify the second endpoint** move the cursor over the area of the circle shown below. Ensure there is **no visual cue** being displayed and click on this point. As **Tangent** is activated on the line ribbon bar the line will snap to the closest tangency point on the circle.

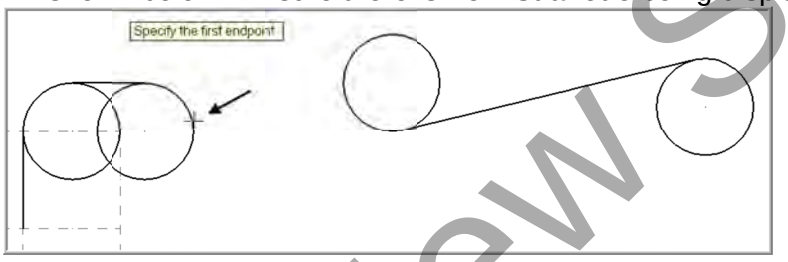


27. On the ribbon bar click on **Apply** to fix the entity.

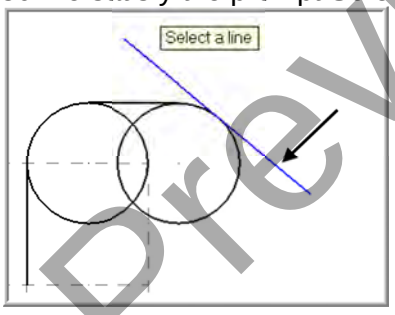
➲ **Create Line #4**

28. Click in the space for **Length** and enter a value of **0.5** and then hit the tab key. In the space for **Angle** and enter a value of **-40.0** and hit enter.

29. To satisfy the prompt **Specify the first endpoint** move the cursor over the area of the circle shown below. Ensure there is **no visual cue** being displayed and click on this point.



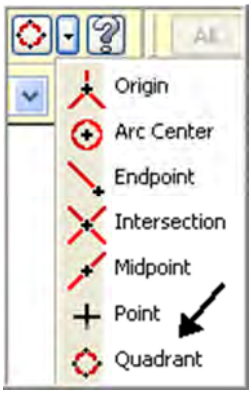
30. To satisfy the prompt **Select a line** pick the lower line as shown below:

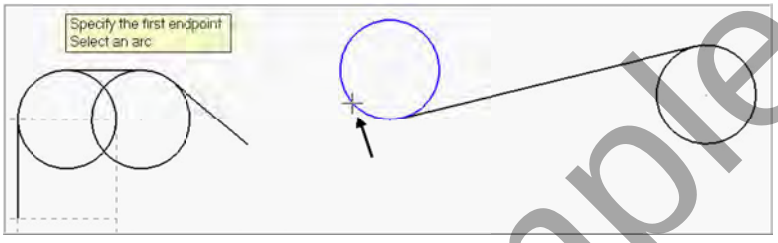


31. On the ribbon bar click on **Apply** to fix the entity.

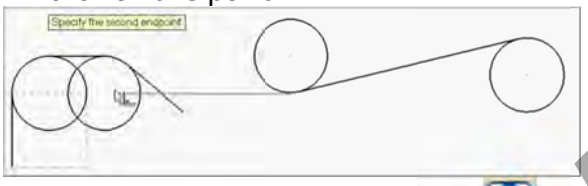
➲ **Create Line #5**

32. To satisfy the prompt **Specify the first endpoint** use the **AutoCursor ribbon bar Override drop down list**. Open the drop down and select **Quadrant**. Move the cursor over the area of the circle shown below right and click on the circle:





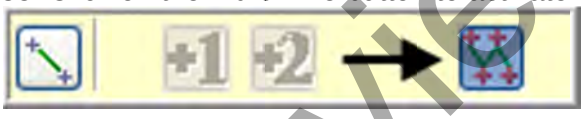
33. To satisfy the prompt **Specify the second endpoint** move the cursor over to the left of the circle shown below. Ensure the visual cue for **Horizontal/Vertical**  is displayed and click on this point.



34. On the ribbon bar click on **Apply**  to fix the entity.

➲ **Create Line #6**

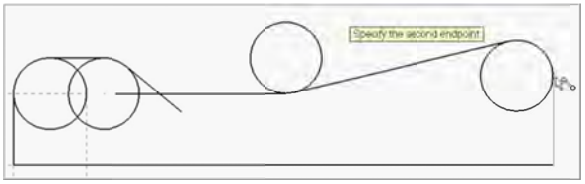
35. Click on the **Multi-line** button to activate it.



36. To satisfy the prompt **Specify the first endpoint** move the cursor over to the **center of the grid** a visual cue appears.  With this visual cue highlighted **pick the origin**.
37. Click in the space for **Length** and enter a value of **3.75** and then hit the tab key. In the space for **Angle** enter a value of **0** and hit enter.

➲ **Create Line #7**

38. To satisfy the prompt **Specify the second endpoint** move the cursor over to the right of the circle shown below. When the visual cue for Endpoint  is displayed click on this point.

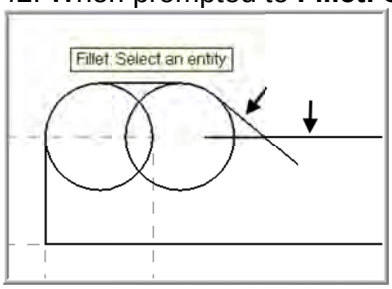


39. Click on the OK icon  to complete this feature.

➲ **Create Circle #5**

40. **Select Create>Fillet>Fillet Entities…**
41. On the Fillet ribbon bar enter **.25 for the radius**. Ensure the **Style** of radius is set to **Normal** and the trim button is depressed to turn the **trim on**.

42. When prompted to **Fillet: Select an entity,** select the two lines shown below:



43. Click on the OK icon  to complete this feature.

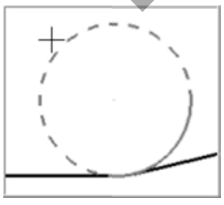
TASK 3:
TRIM GEOMETRY

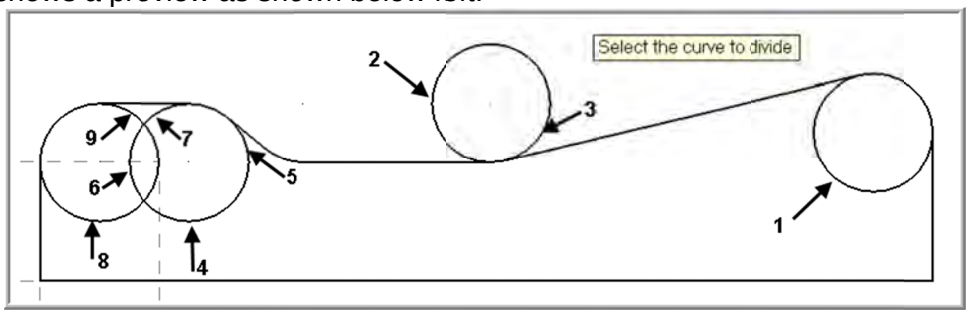
➲ In this task you will trim the geometry using **Divide / Delete**. There are many different ways to accomplish this trimming operation, this is just one method. If you make a mistake using **Divide / Delete** use the **Undo** button to start over.

➲ **Trim the circles**

1. Select **Edit>Trim/Break>Trim/Break/Extend**
2. The Trim / Extend / Break ribbon bar appears and you are prompted to **Select the entity to trim/extend**.

3. Click on the **Divide / Delete**  icon to activate it as shown above. Ensure the icon is pressed down to signal that it is activated.
4. The prompt changes to **Select the curve to divide / delete.** Move the cursor over the various circles and select in order and position as shown below. The arc is trimmed back to the two closest intersections/end points as shown below. Placing the cursor over the entity to divide / delete shows a preview as shown below left.

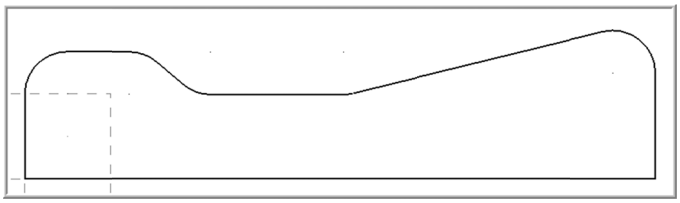




Note: On some of the circles you will need to select them more than once to completely trim them.

5. Click on the OK icon  to complete this feature.

The completed geometry is shown below:



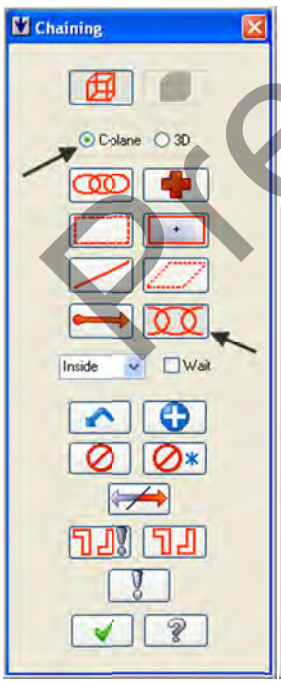
TASK 4:
CREATE THE REVOLVED SURFACE

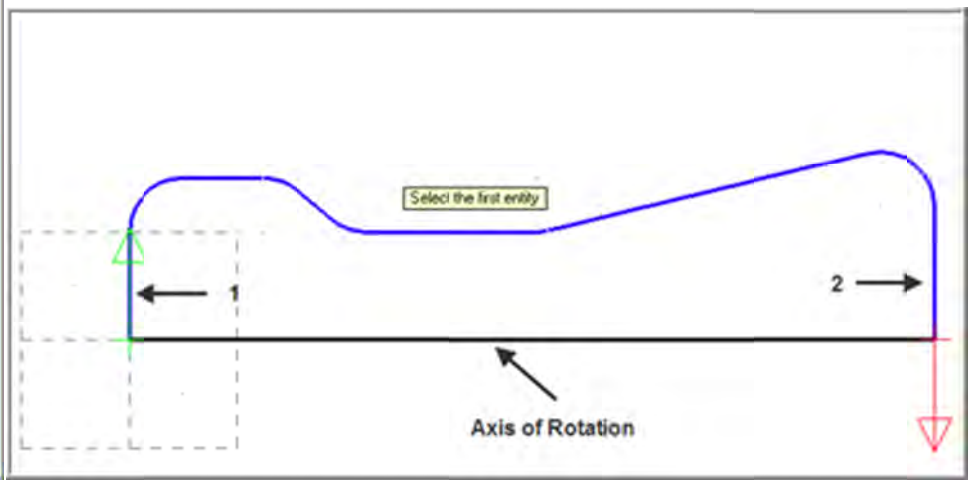
➲ In this task you will create a revolved surface using the geometry you have just created and revolve the geometry 180 degrees about the X axis.

Revolved surfaces are circular in one direction. You will be prompted to chain an entity that the revolved surface will use as a profile. You may choose multiple entities to create many revolved surfaces at a time.
You are then prompted to choose a line to use as the axis of rotation and the revolved surface is created.
If you have chosen multiple entities, a surface for each entity will be created, each having a different profile and position and all using the same axis of rotation. Click Apply or Enter when done.

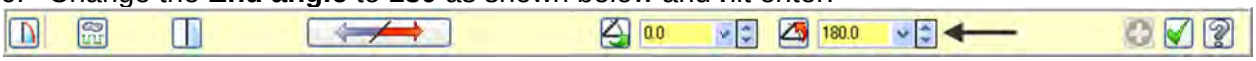
➲ **Create Revolved Surface**

1. Select from the pull down menu: **Create>Surface>Revolved…**
2. On the graphics screen you are prompted: **Select profile curve(s) 1.** In the **Chaining** dialog window select **Partial Chain** as shown below:
3. Select **line 1** and ensure the arrow is pointing upwards. If not click on the reverse icon.
4. Then select **line 2** as shown below:

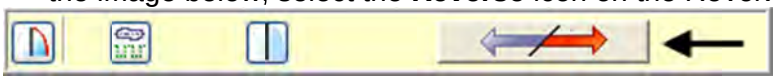


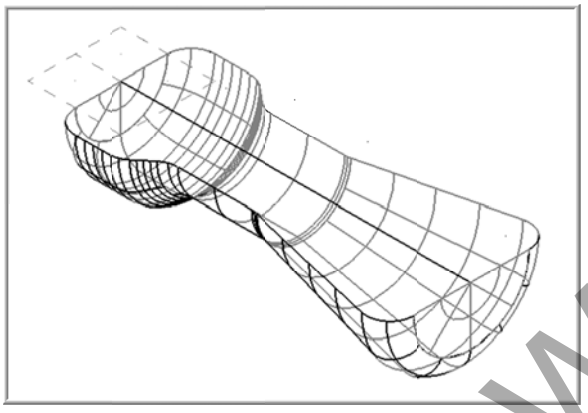


5. Click on the OK icon  in the Chaining dialog window.
6. Change the **End angle** to **180** as shown below and hit enter:



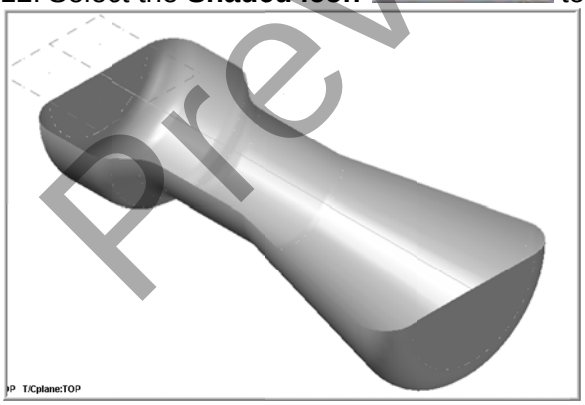
7. Change the graphics view to **Isometric**  .
8. The prompt now changes to **Select axis of rotation**, select the line shown in the diagram above in step 4.
9. Select the **Fit to screen** icon  .
10. The arrow should be pointing **downwards** and the newly created surface should look like the diagram below: If the arrow is not pointing downwards or the surface does not look like the image below, select the **Reverse** icon on the Revolved surface ribbon bar.



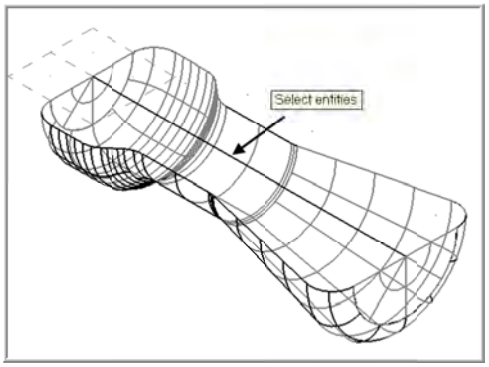


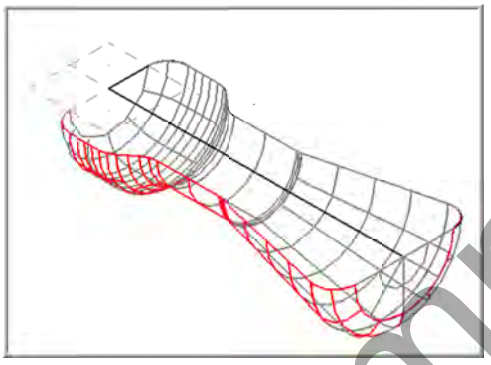
11. Click on the OK icon  to complete this feature.

12. Select the **Shaded icon**  to display the part in shaded mode.



13. Select the **Wireframe icon**  to return to wireframe display.
14. **Delete the axis of rotation** as this will not be required anymore. Select the **Delete entities** icon  and when prompted to **Select entities** pick the line shown below and then hit enter.





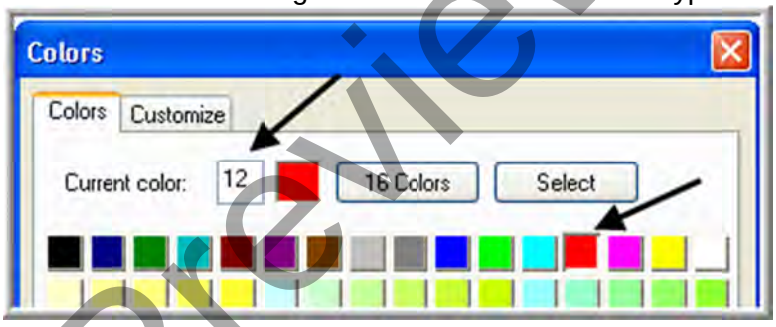
TASK 5:
CREATE BOUNDARY CURVES

➲ When you machine the Revolved surface you will be prompted to chain an entity that the revolved surface will use as a profile, this task will create that profile.

➲ **Change the current color to enable better visibility of the entities**

1. Select **System color** from the Status bar at the bottom of the screen.

2. In the **Colors** dialog box select the **red** color or type in **12**.

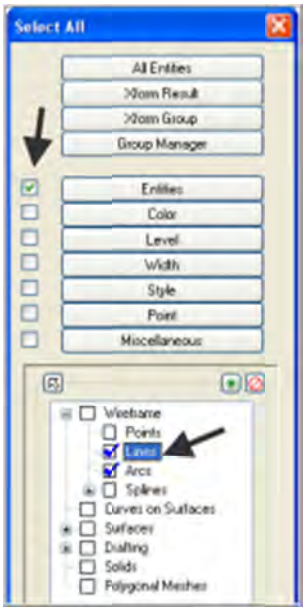


3. Click on the OK icon  to complete this feature.

➲ **Mirror the initial contour geometry**

4. Select **Xform>Mirror…**
5. You are first prompted to **Mirror: select entities to mirror**. First select the **All** button on the **General Selection** ribbon bar as shown below:

6. The **Select All** dialog box appears on the left of the screen. Check mark the **Entities** box and then check mark **Lines** hold the **Ctrl** key down and then select **Arcs**.



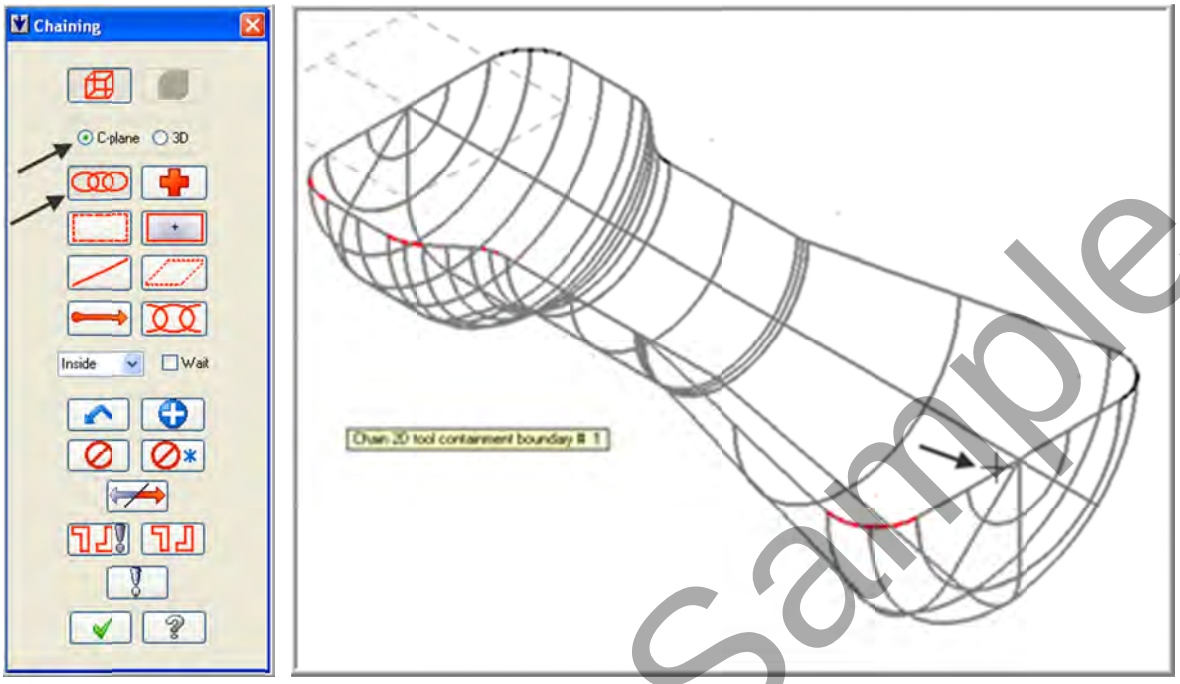
7. Click on the OK icon  to complete this feature.

8. To move onto the next step you now need to pick the **End Selection** icon  .

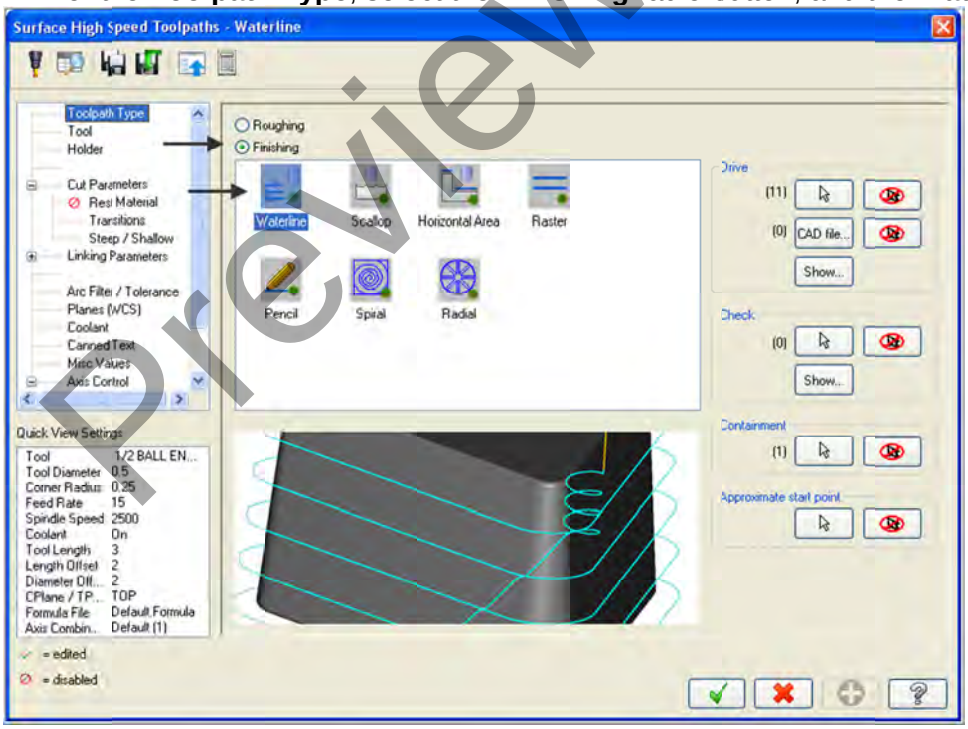
9. After selecting End Selection the **Mirror window** appears. Set the following values as shown below:

10. Click on the OK icon  to complete this feature.
11. Click on the **Clear Colors** at the top right hand corner of the screen.

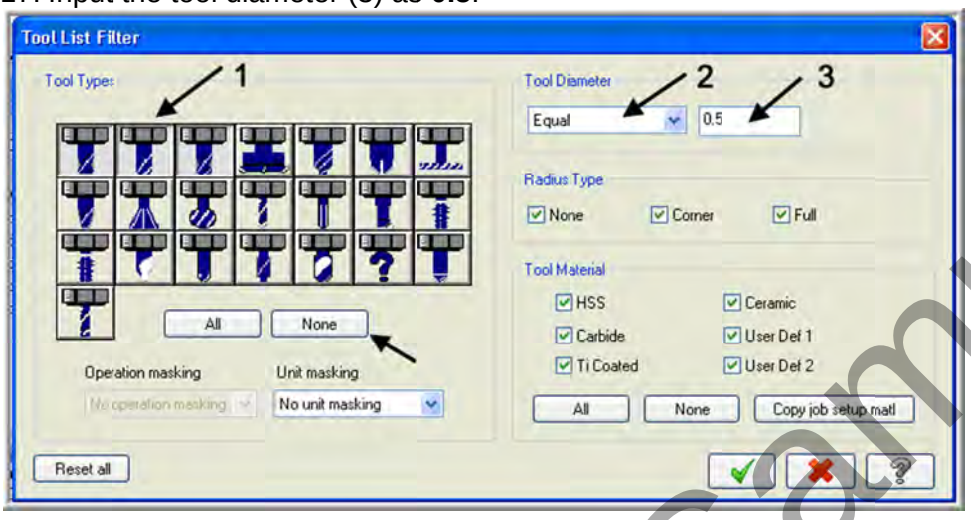
8. On the screen you will now see the **Chaining dialog box** with **Chain set** and in the graphics screen a prompt to **Chain 2D tool containment boundary #1**. Ensure the **C-plane** radio button is activated. Now select the line as shown below:



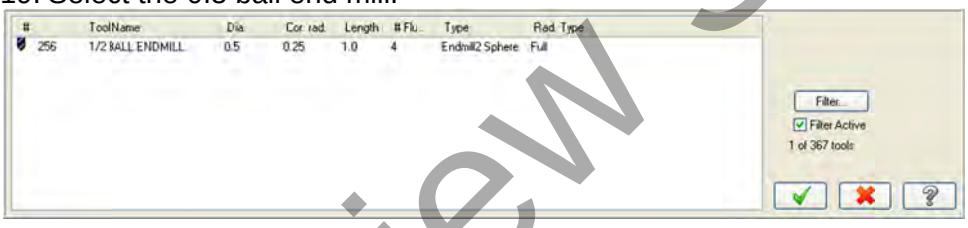
9. After the boundary has been successfully chained select the OK button  .
10. Select the OK button  to exit the **Toolpath/surface selection** dialog box.
11. For the **Toolpath Type**, select the **Finishing** radio button, and the **Waterline** toolpath.



12. Select the **Tool** selection page, then **Select library tool…** button.
13. Select the **Filter** button on the right side of the **Tool selection** dialog box.
14. Select the **None** button in the Tool Types section.
15. Click on the **Endmill2 Sphere** type icon as shown in the picture (1) below:
16. Select the drop down arrow in the **Tool diameter** (2) field and set it to **Equal**.
17. Input the tool diameter (3) as **0.5**.

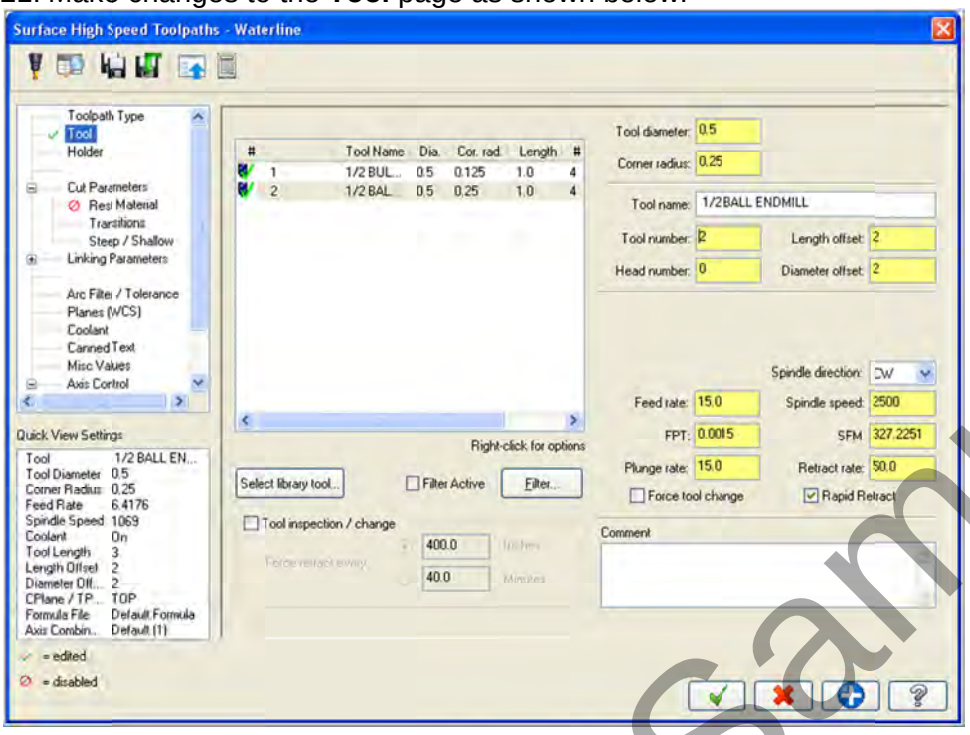


18. Select the OK button  to exit.
19. Select the 0.5 ball end mill.

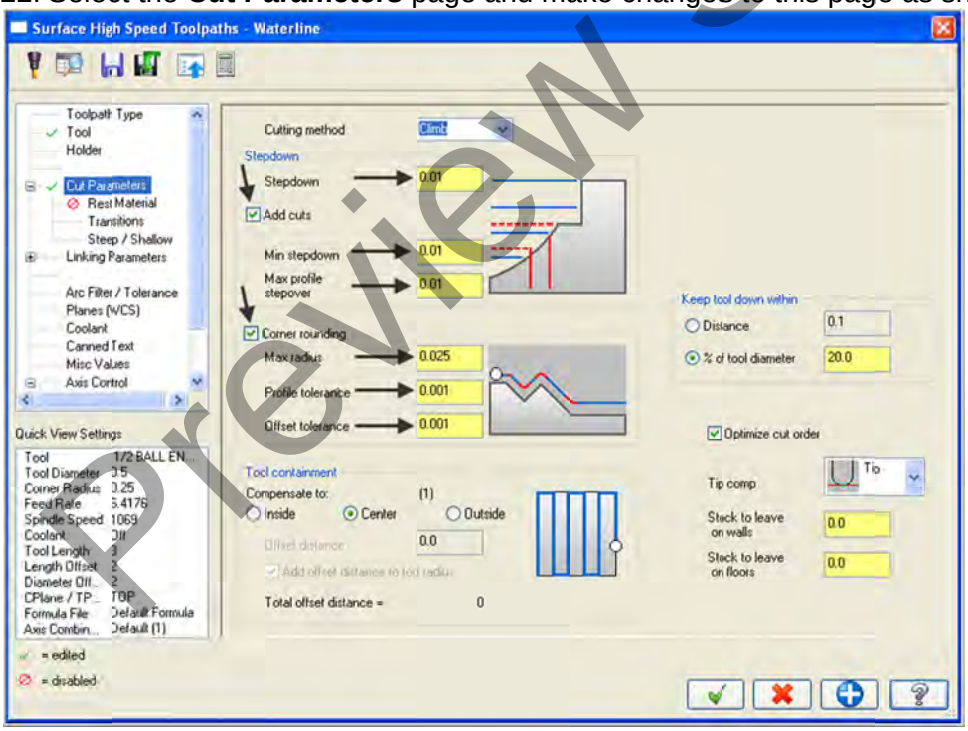


20. Select the OK button  to complete the selection of this tool.

21. Make changes to the **Tool** page as shown below:



22. Select the **Cut Parameters** page and make changes to this page as shown below:



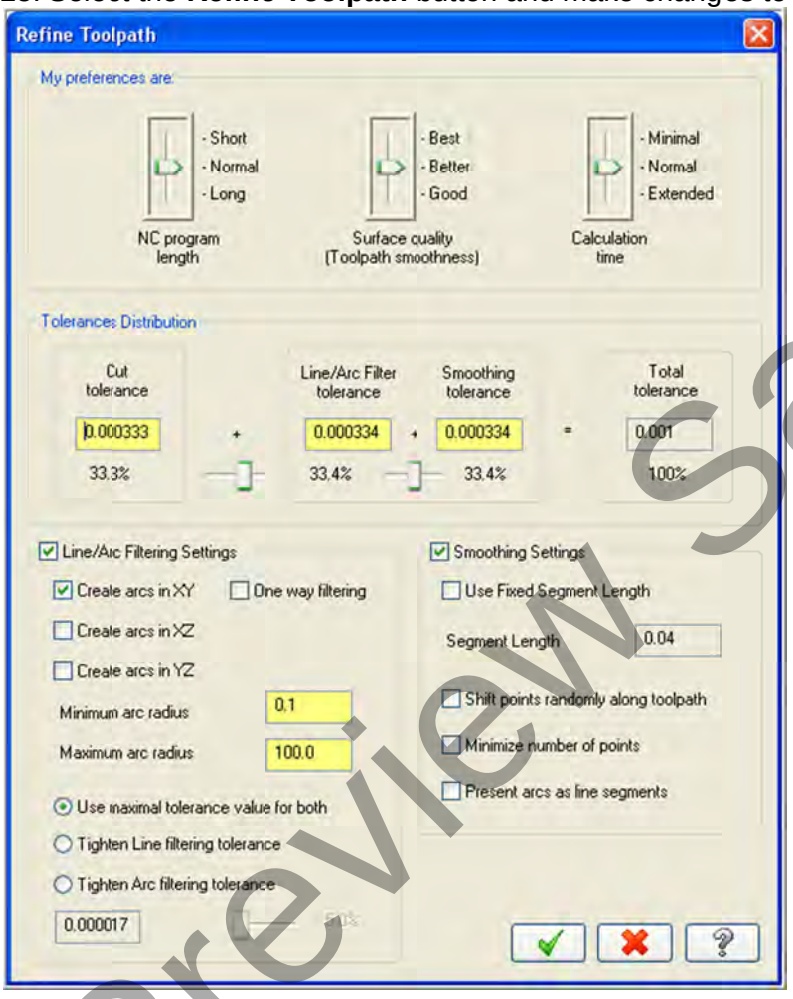
The **Add cuts** selection allows the user to add cuts in shallow areas to decrease the size of surface scallops.

The programmer should consider the tool corner radius, surface shape, and operation type (rough, semi-finish, finish) when making selections here.

Corner rounding Activates toolpath corner rounding, which replaces sharp corners with arcs for faster and smoother transitions in tool direction.

23. Select the **Arc Filter / Tolerance** page,
24. Set the **Total tolerance** to 0.001.

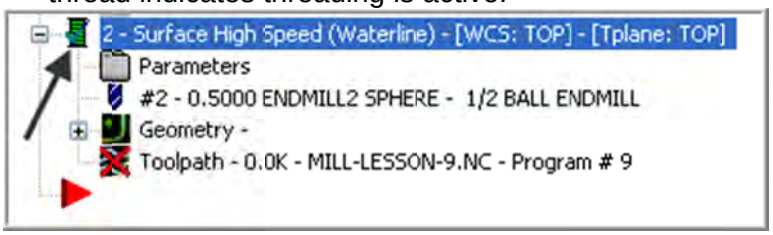
25. Select the **Refine Toolpath** button and make changes to this page as shown below:



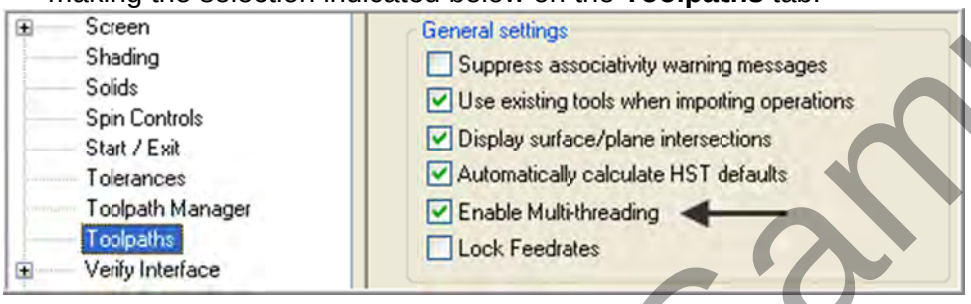
Refine Toolpath
Refine toolpath allows the user to make selections for toolpath calculation tolerance, arc filtering, and smoothness. The beginner programmer can simply adjust the sliders in the preferences section at the top. Advanced users can make selections manually in the windows below.
Tolerances Distribution allows the programmer to manipulate the extent to which the Filtering and Smoothing settings are applied in the toolpath calculation.
Line/Arc Filtering Settings Settings for creating arcs and lines from sections of linear moves.
Smoothing Settings will process the code in varied ways in order to present it to the CNC controller in the preferred way.

26. Select the OK button  to exit Refine Toolpath.
27. Select the OK button  to exit Surface High Speed Toolpaths.

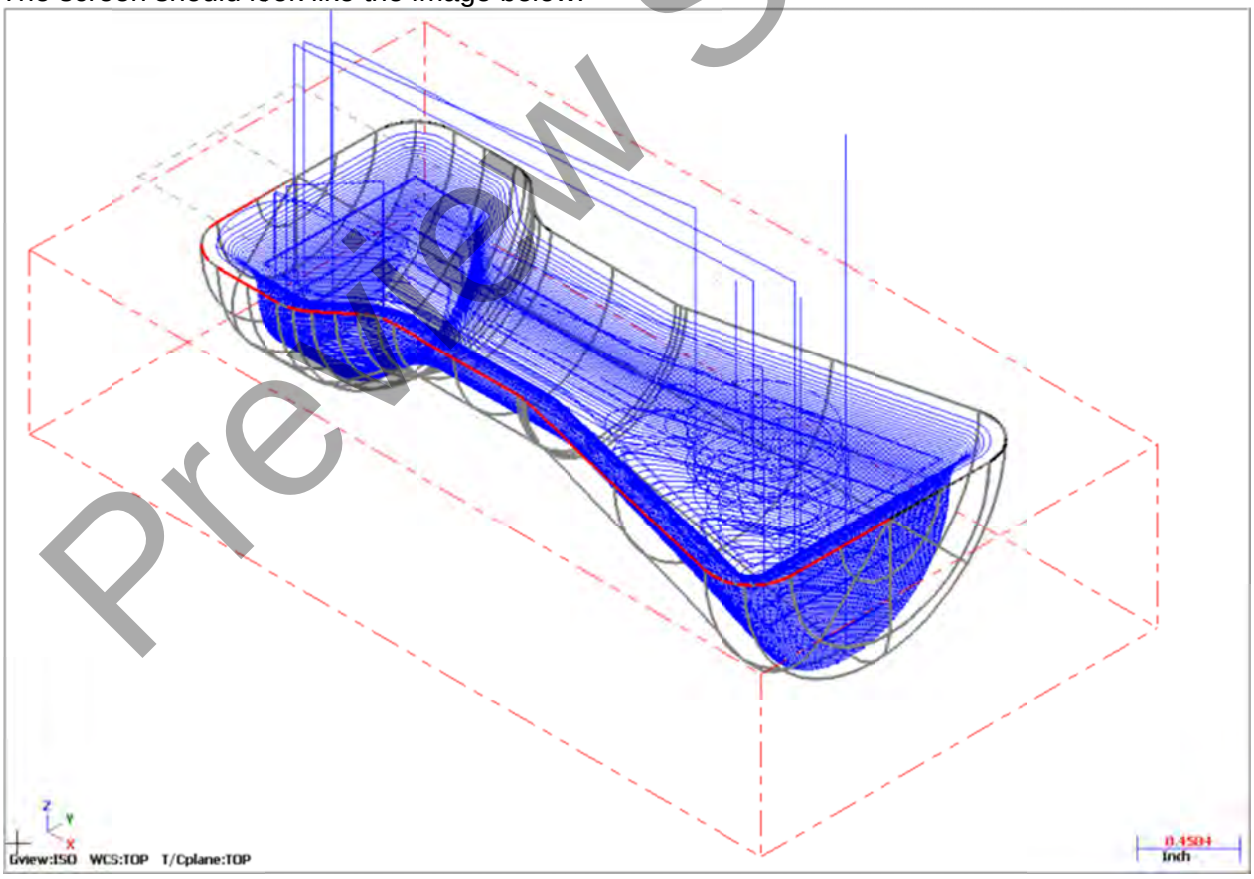
28. It may take a while for Mastercam to create the toolpath. Mastercam's multi-threading functionality will calculate the toolpath while you continue to work. The green spool of thread indicates threading is active.



29. If threading is not active, you can turn it on by selecting **Settings>Configuration...** then making the selection indicated below on the **Toolpaths** tab.

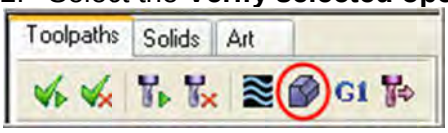


The screen should look like the image below:



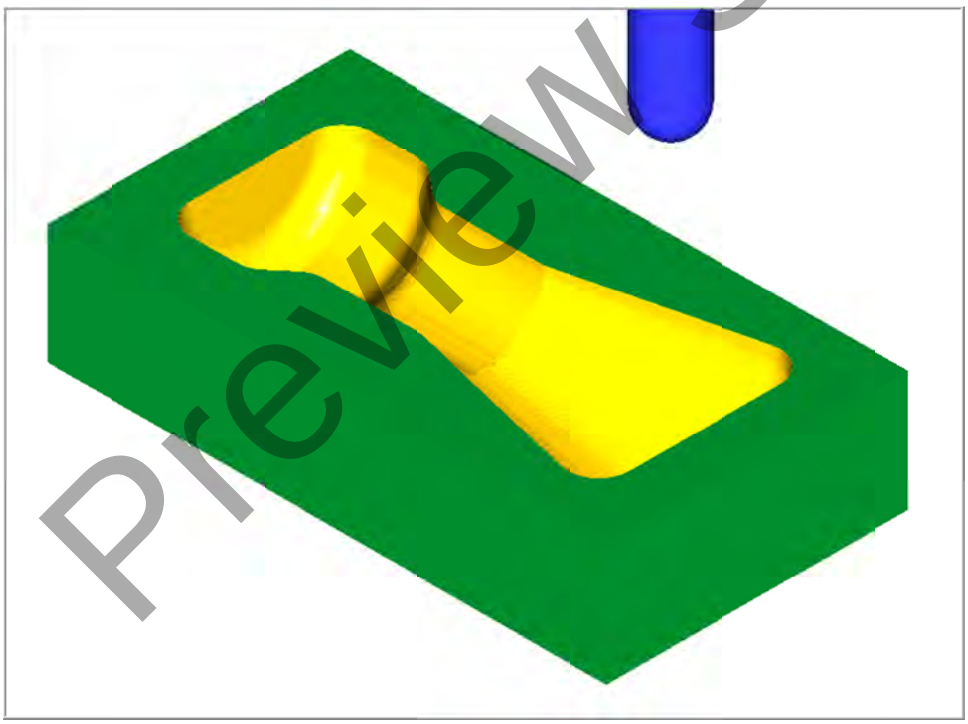
TASK 10:
VERIFY THE TOOLPATH

1. In the Toolpath Manager pick all the operations to verify by picking the **Select All** icon 
2. Select the **Verify selected operations** button circled below:



3. Adjust the Verify speed to fast.

4. Select the **Play** button to verify the toolpath. If it is taking too long to verify the toolpath click on the **Stop** button and go to step 5.
5. Select the **fast forward** button to speed up the verification of the toolpaths.



6. Select the OK button  to exit Verify.

TASK 11:
SAVE THE UPDATED MASTERCAM FILE

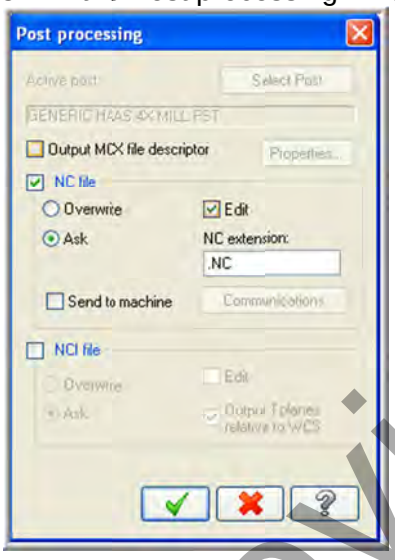
1. Select the save icon from the toolbar.

TASK 12:
POST AND CREATE THE CNC CODE FILE

1. Ensure all the operations are selected by picking the **Select All** icon  from the Toolpath manager.

2. Select the **Post selected operations** button from the Toolpath manager.
Please Note: If you cannot see **G1** click on the right pane of the Toolpath manger window and expand the window to the right.

3. In the Post processing window, make the necessary changes as shown below:



4. Select the OK button  to continue.
5. Enter the same name as your Mastercam part file name in the NC File name field **Mill-Lesson-9**.
6. Select the Save button.
7. The CNC code file opens up in the default editor:
8. Select the  in the top right corner to exit the CNC editor.

This completes Mill-Lesson-9.

MILL-LESSON-9 EXERCISES