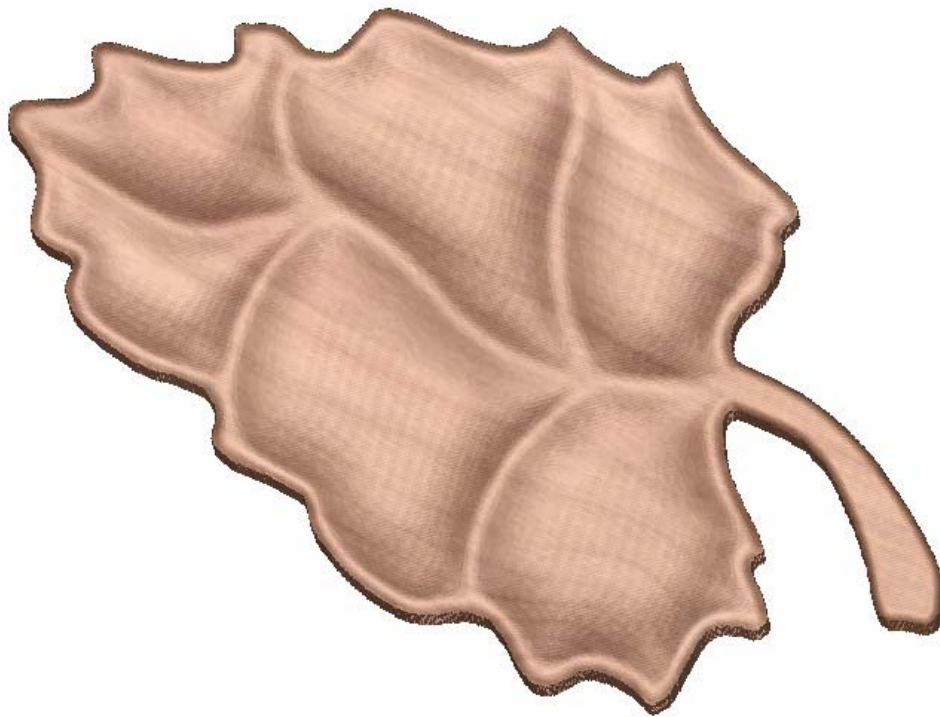


Getting Started
With
PartWorks 3D



Tutorial 1
Machining a 3D Bowl

PartWorks3D

Disclaimer

All CNC machines (routing, engraving, and milling) are potentially dangerous and because ShopBot Tools Inc has no control over how the software described in this manual might be used. ShopBot Tools Inc or any associated Resellers cannot accept responsibility for any loss or damage to the work piece, machine or any individual, howsoever caused by misusing the software. Extreme care should always be taken and the output from the software thoroughly checked before sending it to a CNC machine.

The information in this manual may be subject to change without any prior notice. The software described in this manual is supplied under the terms and conditions of the software license agreement and may only be used in accordance with the terms of this agreement.

© Vectric Ltd
26 Peterbrook Close
Redditch
B98 7YF
UK

www.vectric.com

E-mail info@vectric.com
Phone +44 (0) 1527 460 459
Fax +44 (0) 1527 460 459

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Introduction

Many businesses use their CNC machine for simply cutting out flat letters and shapes from plastic sheet, or engraving standard badges and nameplates, which are all based on simple 2D machining strategies. PartWorks3D adds another dimension to your CNC machine, allowing it to be used for more interesting and often higher profitable projects that would normally only be possible using expensive CAD/CAM software.

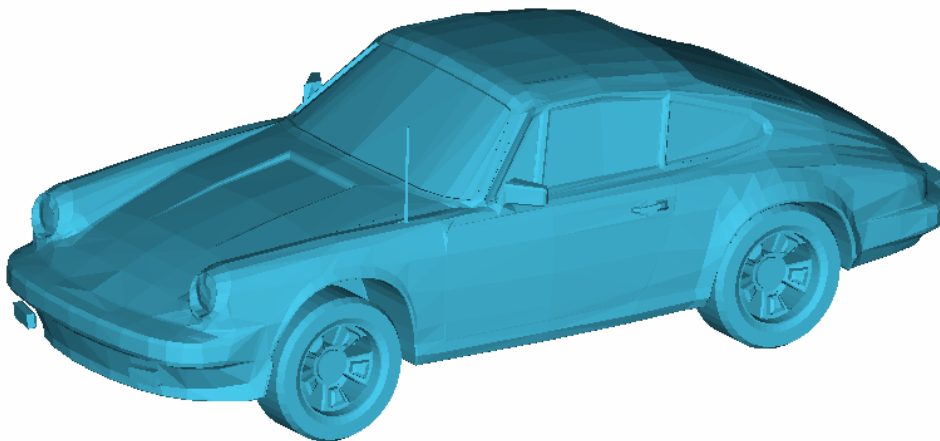
The manual takes you step-by-step through an illustrated tutorial that shows and explains exactly how to use the Software. Tips and tricks have also been included that will help you get the most from your CNC machine.

We hope you enjoy using the software.

What is PartWorks3D?

PartWorks3D has been developed specifically as a toolpath engine for machining 3D models that have previously been designed using another CAD or Graphics design product such as AutoCAD, Rhino3D etc.

The software calculates toolpaths that contain XYZ point data to move a cutter simultaneously in all 3 axes to cut the shape of a 3D model into the material being used.



Typical 3D Model designed using 3D Studio

What the software allows you to do

PartWorks3D can be used for the following applications,

Model making	3D models from foam, plastic, wood etc.
Rapid Prototyping	New product designs / Contract work
Sign making	Adding dimensional elements to signs
Wood Carving	Custom fireplaces, door panels
Engraving	Commemorative Brass plaques
Gifts	Personalised gifts
Stone cutting	Memorials, Commemorative engravings

What file formats can be used?

PartWorks3D will open 3D model files that have been saved in the following formats.

V3D	PartWorks3D and Vectric Cut3D files
STL	STL Mesh files - binary & ascii
V3M	Vector Art 3D files
3DS	3D Studio - binary & ascii
X	DirectX
DXF	AutoCAD 3D DXF
LWO	LightWave
TXT	MaxNC Digital Probe
SBP	ShopBot Digital Probe files
WRL	VRML
OBJ	Wavefront

Notes Although the design systems that are used to write the file formats all claim they output standard file formats, there are often many variations of each type. As a result Vectric cannot guarantee to read all of the file formats. There are many different file translation software products available from the internet that offers the tools needed to modify and convert 3D models into formats that are suitable for use with PartWorks3D.

For general file conversion and editing we recommend a product called **AccuTrans 3D** from **Micromouse Productions**. www.micromouse.ca

Getting Help

If you need assistance when using the software there are 5 primary places to look.

1. **Program Help File** - From the Main menu select Help or Press F1
2. **Video Tutorials** - These can be downloaded from the Vectric website.
3. **User Forum** - The Vectric user forum at www.vec tric.com/forum is a very useful resource for information on all Vectric products along with materials, cutters etc. and also to share knowledge and experiences.
4. **E-mail Support:** - The PartWorks 3D Support Team at support@shopbottools.com

5. **Frequently Asked Questions (FAQ)** - The support area on the Vectric web site at www.vectric.com maintains a list of the most frequently asked questions along with the answers.

Watch the supporting tutorial videos



The video camera icon indicates there is a video file for that particular section of the manual.

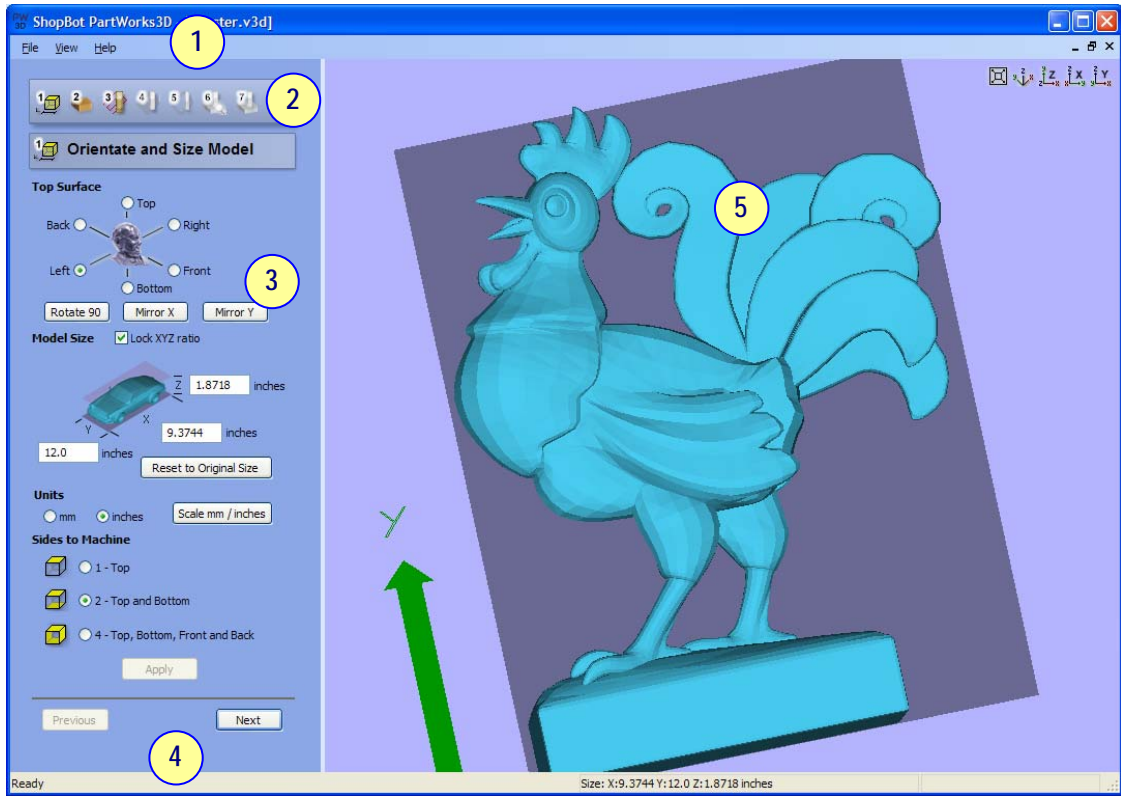
Many of the tutorial documents have associated video footage that will make learning to use this software more interesting and enjoyable. These can be downloaded from the web site.

If you experience problems running these files or need assistance please visit the technical support area on the web site and follow the links.

Overview of the interface

The screen area is split into 5 main regions.

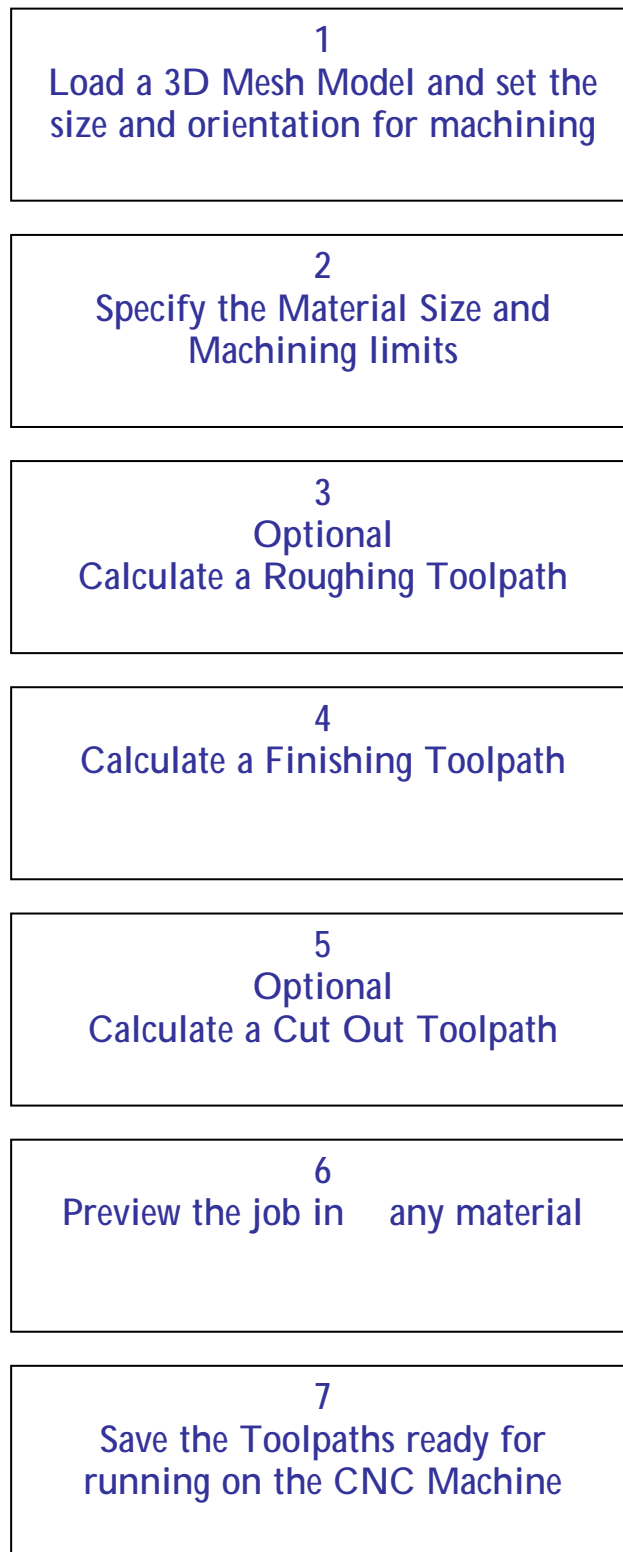
1. The **Main Menu bar** along the top of the screen provides access to the primary functionality such as File Open / Save plus the Help and License options.
2. The **Navigation Toolbar** gives easy access to each of the steps when working.
3. The **Step-by-Step Forms** on the left side of the screen lead you through each of the steps.
4. The **Navigation Buttons** are used to step forward or backwards through each of the steps.
5. The **3D Window** shows the 3D model, calculated toolpaths and the colour shaded machined preview of the model. In the top right corner of the 3D window is the **3D View Menu** for selecting pre-set views of the 3D model.



The User Interface






The PartWorks3D Logic


PartWorks3D has been developed to make machining 3D models as simple as possible. The general work flow logic to apply to most jobs is explained in the diagram below.



View Controls

The View Control options available when working in the 3D Windows are,

	3D Twiddle	Click and drag Left mouse button in the 3D window
	Zoom	Right mouse button – Push / Pull Mouse with Middle Wheel – Push / Pull
	Pan	Click and drag Right mouse button + Ctrl Click and drag Right and Left mouse button
	Plan View	Looks directly down the Z axis onto the design in 3D window
	Isometric View	Shows the model in a 3D isometric view in the 3D window

 Mouse with Middle Wheel can be used to interactively zoom in / out.

Tutorial 1

Single Sided 3D Machining



We recommend that you watch the **5 minute Video** for this Tutorial before proceeding. The video can be found on the installation CD or downloaded from the web site at www.vectric.com

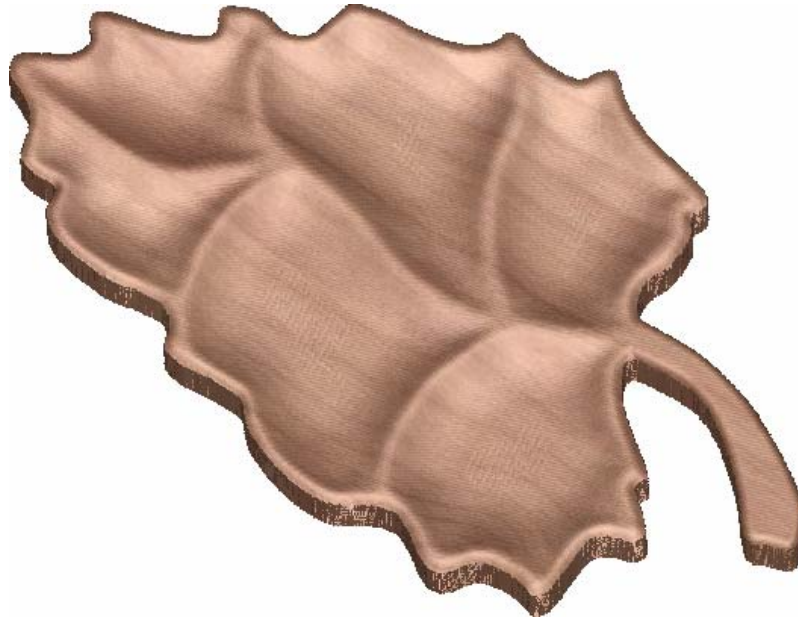
We estimate that this tutorial should take you approximately **10 minutes** to complete.

Introduction

This tutorial will show you how to Machine a 3D Decorative Carved Bowl into a piece of material that's approximately 13" x 8" x 3/4" thick using a 1/4" diameter End Mill for roughing a 1/4" Ball nose cutter for finish machining and a 1/4" diameter End Mill to cut out the bowl.

Note The 3D model can be resized to suit whatever material and cutter sizes you have available.

This 3D model has be designed using 3D Graphics packages such as Rhino, 3D Studio, Silo, Strata, ZForm etc. and then saving the design as a Mesh format that can be opened in the software.



The finished Carved Bowl

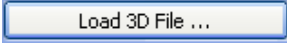
The key steps in calculating the toolpaths for this sample are,

1. Open the 3D Model and set the Size
2. Specify the Material dimensions and cutting depths
3. Calculate the Roughing toolpath - Optional
4. Calculate the Finishing toolpath
5. Calculate the Cut Out toolpath - Optional
6. Preview the completed job and Estimate the machining time
7. Save the Toolpaths ready for cutting

The file required for this tutorial are installed on your PC in the folder,

C:\Program Files\ShopBot\PartWorks3D\Samples\Bowl.v3d

1. Opening the 3D Model

1. On the front page click on the Load 3D File  button.
2. Navigate to the folder - C:\Program Files\ShopBot\PartWorks3D\Sample Files\
3. Select the file named - **Bowl.v3d** and click the **Open** button



The 3D model will be drawn in the 3D view as shown below.

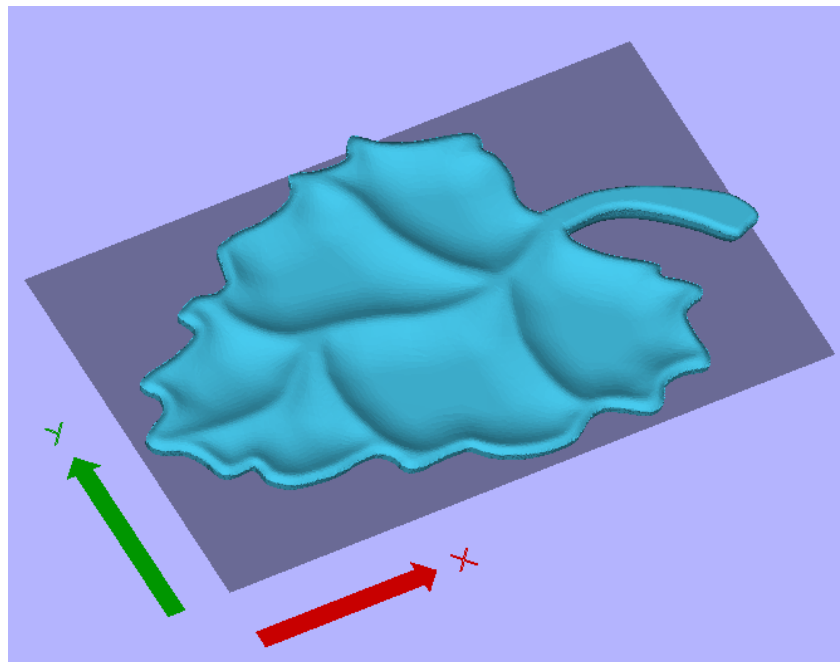
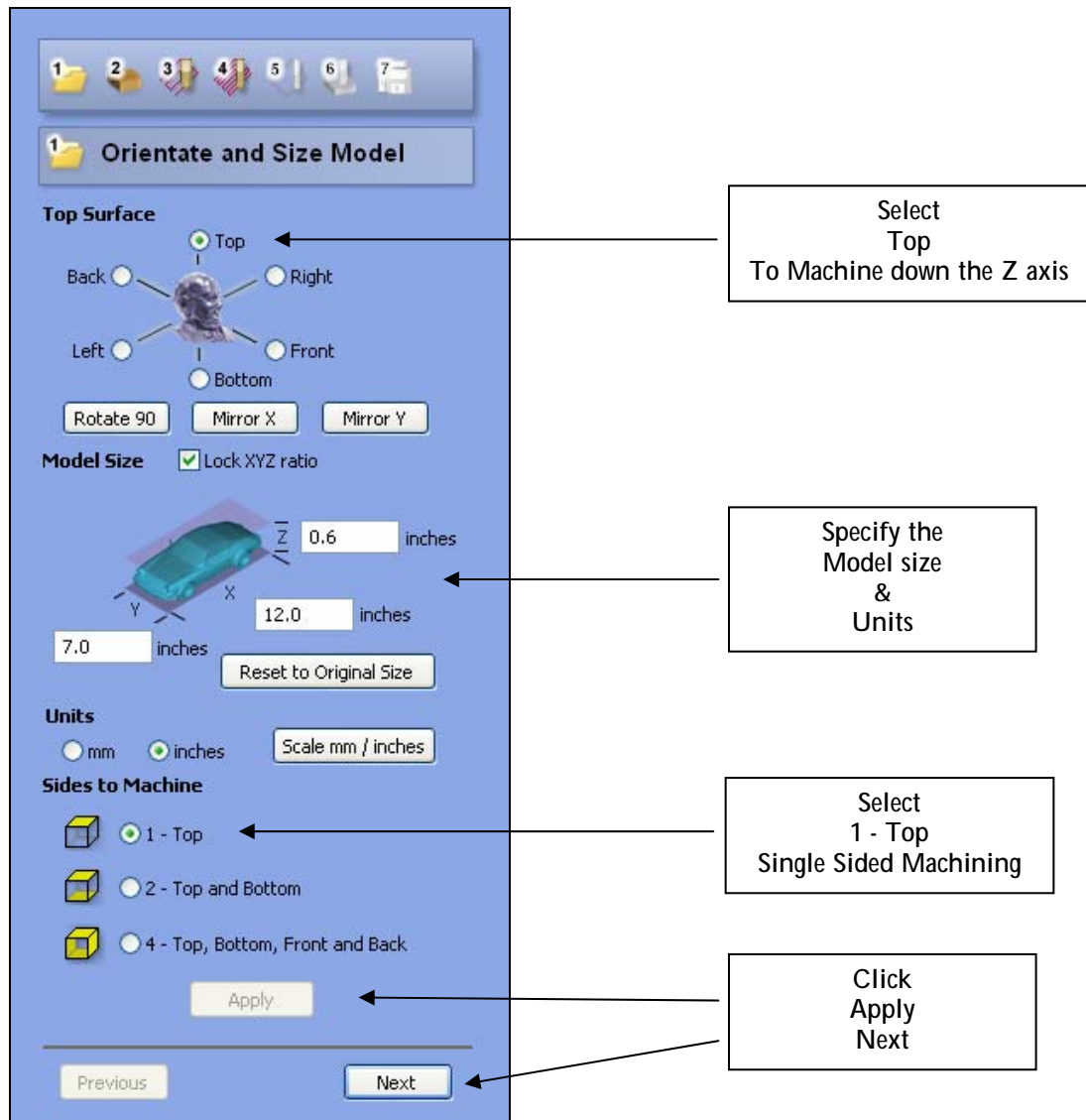


Figure 2 Original 3D Model

 CNC
the Z axis

Note: The arrows showing the X and Y axes that relate to the coordinates on the machine. The model is automatically positioned looking directly down onto the XY plane.

- Specify the required size for the model to be machined.



The screenshot shows the 'Orientate and Size Model' dialog box. It has a top toolbar with icons numbered 1 to 7. The main area is divided into sections: 'Top Surface' with radio buttons for Top, Back, Right, Left, Front, and Bottom; 'Model Size' with a 'Lock XYZ ratio' checkbox and input fields for X (7.0 inches), Y (12.0 inches), and Z (0.6 inches); 'Units' with radio buttons for mm and inches; and 'Sides to Machine' with radio buttons for 1 - Top, 2 - Top and Bottom, and 4 - Top, Bottom, Front and Back. There are 'Apply', 'Reset to Original Size', 'Previous', and 'Next' buttons at the bottom. Callout boxes on the right point to the 'Top' radio button, the Z input field, the '1 - Top' radio button, the 'Apply' button, and the 'Next' button.

Click **Apply Button** to set the model size and select the Single Sided Machining option

- Click the **Next** button to go to **Step 2 - Material Size and Margins**

Notes The Model size should be set to fit inside the material you have available.

The Model can be scaled / squashed to fit into a specific material Thickness by,

- Set the X Length and Y Height for the model
- Uncheck the **Lock XYZ ratio** option
- Enter the required Z thickness to fit the material

Clicking the **Reset to Original Size** button will return the model back to the original size.

2. Material Size and Margins

Step 2 is where the actual material size and cutting depths are specified. For single sided machining the material dimensions are not critical, but for multiple (2 and 4) sided machining the material must first be machined to an exact size and thickness.

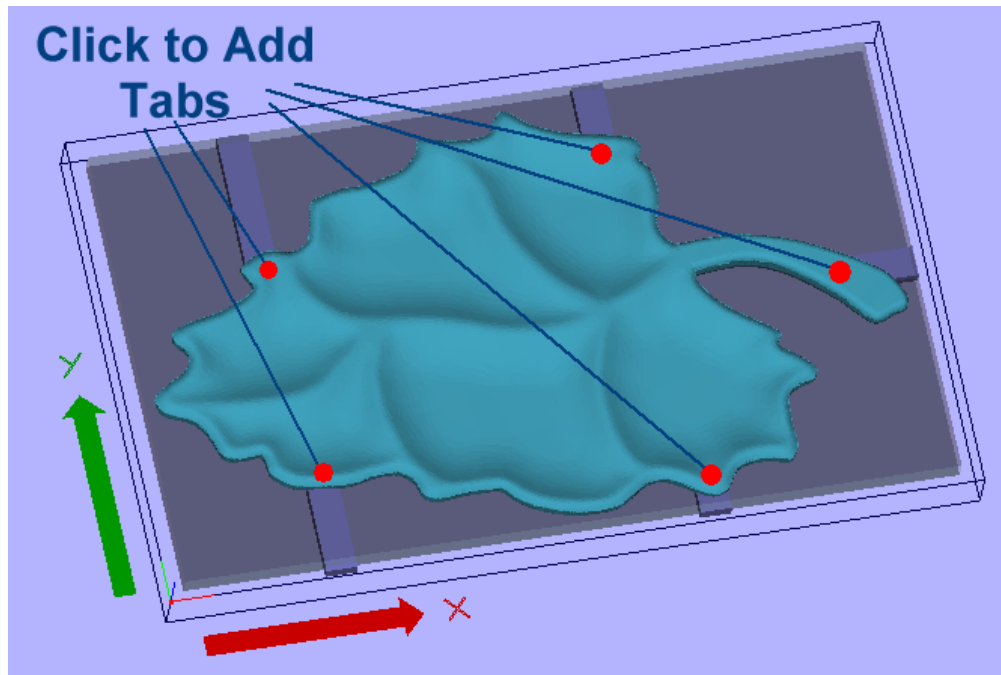
6. Enter the size for the material you are going to machine the design into.
7. Complete the form as shown below

The screenshot shows the 'Material Size and Margins' dialog box. It includes a toolbar at the top with icons 1 through 7. The main section is titled '2 Material Size and Margins'. Under 'Material Size', there are input fields for Length (X): 13.0, Width (Y): 8.0, and Thickness (Z): 0.75. A 3D coordinate system (X, Y, Z) is shown. Below this is 'XY Origin Position' with X: 0.0 and Y: 0.0. The 'Z Zero' section has a red dot on a 3D model. The 'Machining Margins around Model' section shows a 3D model of a car with a blue outline. It has checkboxes for 'Symmetrical' (checked) and 'Use Model Silhouette' (checked), with a value of 0.2. A 'Fit to Material' button is next to it. The 'Depth of Model below Surface' section has a value of 0.04 and an 'Add Tabs ...' button. The 'Cut Plane Position in Model' section has a vertical slider set to 0.3, with 'Centre' and 'Bottom' buttons. A 'Depth Below Surface: 0.34' label is shown. An 'Apply' button is at the bottom. At the very bottom are 'Previous', 'Slice Model ...', and 'Next' buttons. Callout boxes on the right point to these settings with the following text:

- Specify the Material size
- XY Origin Position
Z0 Origin
- Enter the Machining boundary around the 3D Model
- Machine 0.2" around the 3D model boundary
- Move the 3D Model into the Material
- Set the Cut Plane at 0.3" into the Model

Notes: Click the **Apply** button to update the design settings in the 3D Window

8. Select a **Symmetrical** boundary of 0.2" and **Model Silhouette** to reduce machining times.
9. Position the **Cut Plane Position** using the vertical slider or enter 0.3"
10. Click the **Add Tabs** button and **Click On the model** to snap tabs between the model surface and the material edge as shown below. These tabs will hold the job in place during machining.



The **Black Wireframe** represents the **Material Block**

11. Click the **Apply** button to accept the settings on the form
12. Click the **Next** button to proceed to **Step 3 - Roughing Toolpath**

i In this example there is no need to incorporate Tabs into the design because the Bowl is simply being machined onto a flat background. If the Bowl was being double sided machined and or cut out of the material then Tabs would be required to hold the job in place during machining

Note The large arrows indicate the axes on the CNC machine that the design will be machined a long. The model can be rotated and mirrored by pressing the **Previous** button and orientating the model as required.

3. Roughing Toolpath

A Roughing Toolpath is optional and will only be needed when machining hard materials or the finishing cutter cannot be used to cut to full depth in a single pass. For example, the roughing toolpath is not when cutting soft materials such as foam with a cutter has sufficient flute cutting length.

13. Click the option to calculate a Roughing Toolpath

Create Roughing Toolpath

14. Click the **Select...** button and select a suitable cutter for Rough machining the bowl.

15. Complete the Roughing form as shown below,

The screenshot shows the 'Roughing Toolpath' dialog box with the following settings and annotations:

- Create Roughing Toolpath:** (Annotated: Select a 1/4" End Mill cutter from the Tool Database)
- End Mill (0.25 inch):** End Mill (0.25 inches) (Annotated: Select a 1/4" End Mill cutter from the Tool Database)
- Cutting Parameters:**
 - Pass Depth: 0.2 inches
 - Stepover: 0.1 inches, 40.0 %
- Feeds and Speeds:**
 - Spindle Speed: 12000 r.p.m.
 - Feed Rate: 100.0 inches/min
 - Plunge Rate: 30.0
- Tool Number:** 1 (Annotated: Edit the cutting parameters to suit the material being machining)
- Toolpath Parameters:**
 - Rapid clearance gap: 0.1 inches
 - Machining Allowance: 0.04 inches (Annotated: Remember to leave sufficient material on the job for the Finishing Toolpath)
- Strategy:** Z Level (Raster X), Profile ... Last
- 3D Raster (Along X)
- Side Displayed ...:** Top
- Estimated mc time ...:** 5 minutes
- Buttons:** Calculate (Annotated: Calculate the Roughing Toolpath), Previous, Next

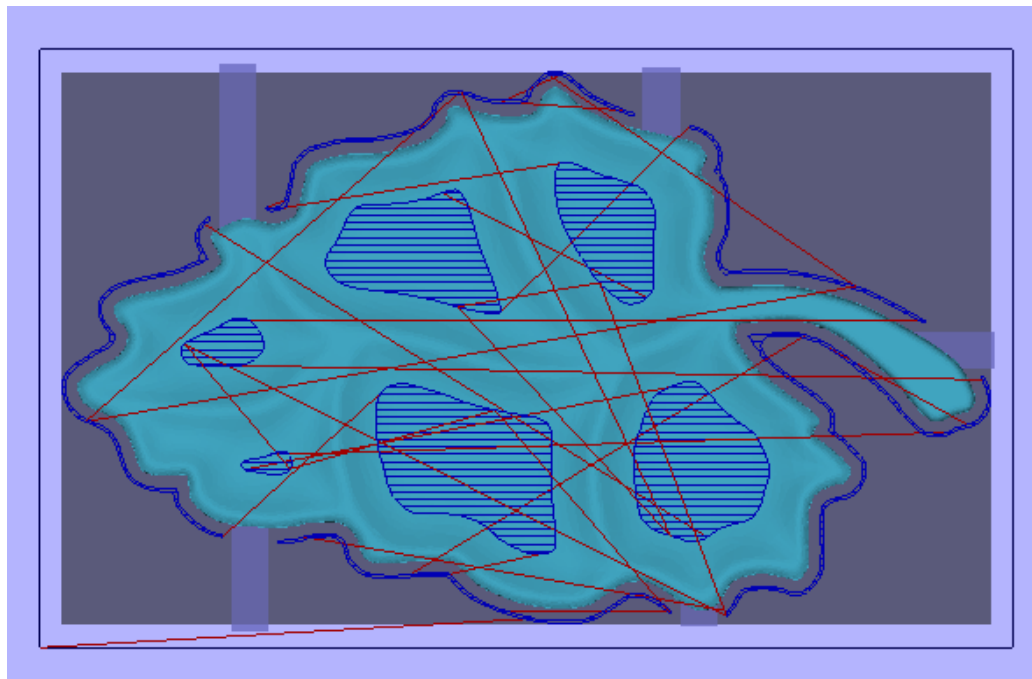
Notes

This model could also be Rough and Finish machined using the same 1/4" Ball Nose

The Cutting parameters and Spindle Speed / Feed rates shown above are for general guidance only and should be set to suit the material you are cutting. Clicking the **Edit Parameters** button allows the values to be changed. Depending upon what material is being machining, you may wish to run faster or slower and with deeper cuts.

16. Click the **Calculate button** and the progress bar will run along the bottom of the screen to indicate that the toolpath is being calculated.

17. Click the **View Down Z button** in the Top Right corner of the 3D window.



Multiple Z Level Roughing



Z Level Roughing will very quickly machine planar passes around the model to the unwanted stock.

Profile passes before or after each roughing pass may not always be necessary, especially when cutting soft materials.

The **Red lines** show where the cutter will retract and move at rapid feed rate.

18. Click the **Next button** to proceed to **Step 4 - Finishing Toolpath**

4. Finishing Toolpath

The Finishing Toolpath machines the model to the required size using a Ball Nose cutter. A Raster toolpath will run over the specified area to be machined, along the X axis, the Y axis or at 45 degrees.

19. Click the **Select...** button and select a suitable cutter for Finish machining the design
20. Complete the Finishing Toolpath form as shown below,

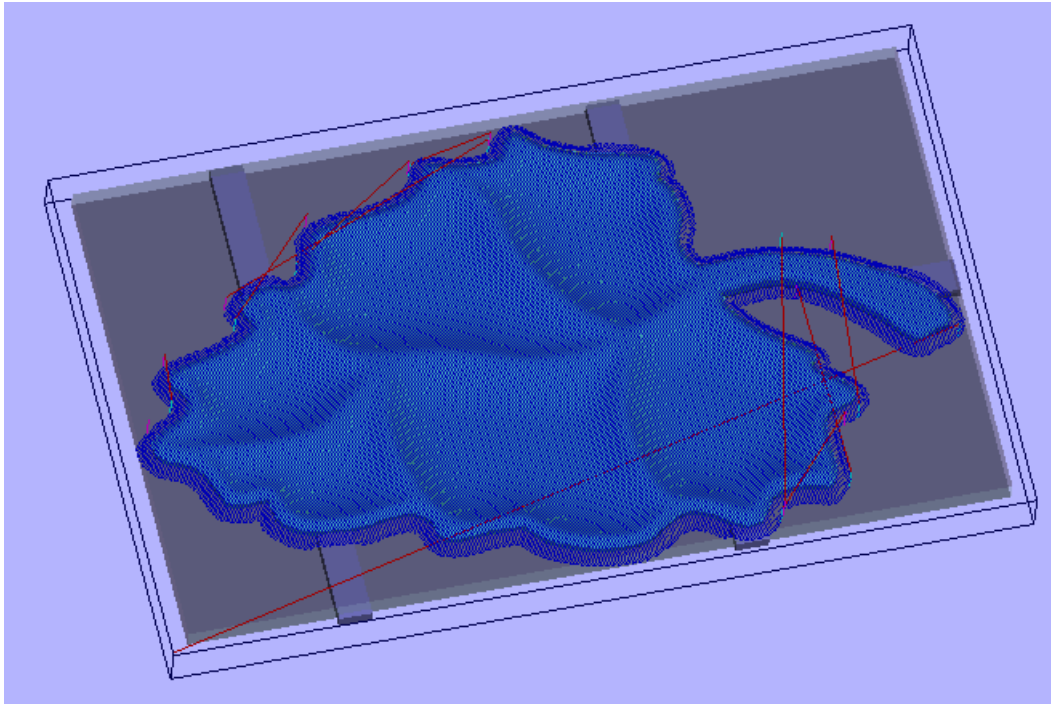
The image shows a software dialog box titled "Finishing Toolpath" with several sections and callouts:

- Tool Selection:** A "Select ..." button is pointed to by a callout: "Select a 1/4" Ball Nose cutter from the Tool Database".
- Cutting Parameters:** Includes "Stepover" (0.0375 inches, 15.0 %) and "Feeds and Speeds" (Spindle Speed: 12000 r.p.m., Feed Rate: 100.0 inches/min, Plunge Rate: 30.0). A callout points to this section: "Edit the cutting parameters to suit the material being machining".
- Toolpath Parameters:** Includes "Raster Angle" (45 Degrees) and "Rapid clearance gap" (0.1 inches). A callout points to the Raster Angle dropdown: "Select the cutting angle for the Finishing Toolpath".
- Side Displayed ...:** Radio buttons for "Top", "Bottom", "Front", and "Back".
- Estimated mc time ...:** Shows "22 minutes".
- Buttons:** "Calculate", "Previous", and "Next". A callout points to the "Calculate" button: "Calculate the FinishingToolpath".

Notes

Cutting at 45 degrees will help produce better surface finish on the vertical walls of the base on the particular model.

21. Click the **Calculate** button and the progress bar will run along the bottom of the screen to indicate that the toolpath is being calculated.



Finishing Toolpath only machines the model and doesn't waste time cutting unwanted regions.

22. Click the **Next button** to proceed to **Step 5 - Cut Out Toolpath**

5. Cut Out Toolpath

In this example the Cut Out Toolpath is not required because the design is being machined into a picture frame panel.

23. Click the option to calculate a Cut Out Toolpath and the form will become active.

Create Cut Out Toolpath

24. Complete the Cut Out Toolpath form as shown below,

The screenshot shows the 'Cut Out Toolpath' form with the following fields and callouts:

- Create Cut Out Toolpath:** A checked checkbox. Callout: "If a Cut Out Toolpath is required then click to switch the form On".
- End Mill (0.25 inch):** A dropdown menu showing "End Mill (0.25 inches)". Callout: "Select a 1/4" Ball Nose cutter from the Tool Database".
- Cutting Parameters:**
 - Pass Depth:** 0.2 inches.
 - Feeds and Speeds:**
 - Spindle Speed:** 12000 r.p.m.
 - Feed Rate:** 100.0 inches/min.
 - Plunge Rate:** 30.0 inches/min.
 - Tool Number:** 1. Callout: "Edit the cutting parameters to suit the material being machining".
- Toolpath Parameters:**
 - Material to leave:** 0.0 inches.
 - Profile Cutting Direction:** Radio buttons for "Climb" (selected) and "Conventional". Callout: "Select the cutting direction".
 - Rapid clearance gap:** 0.1 inches.
- Side Displayed ...:** Radio buttons for "Top" (selected), "Bottom", "Front", and "Back".
- Estimated mc time ...:** 3 minutes.
- Draw ...:** A "Calculate" button. Callout: "Calculate the Finishing Toolpath".
- Navigation:** "Previous" and "Next" buttons. Callout: "Click the Next button to continue".

Notes
the

To machine around the boundary silhouette of a 3D model first select the option on Material setup form in Step 2.

The screenshot shows the 'Machining Margins around Model' form with the following fields and callouts:

- Symmetrical:** A checked checkbox with a value of 0.3.
- Use Model Silhouette:** A checked checkbox. Callout: "If a Cut Out Toolpath is required select the Use Model Silhouette option on Step 2".
- Fit to Material:** A button.

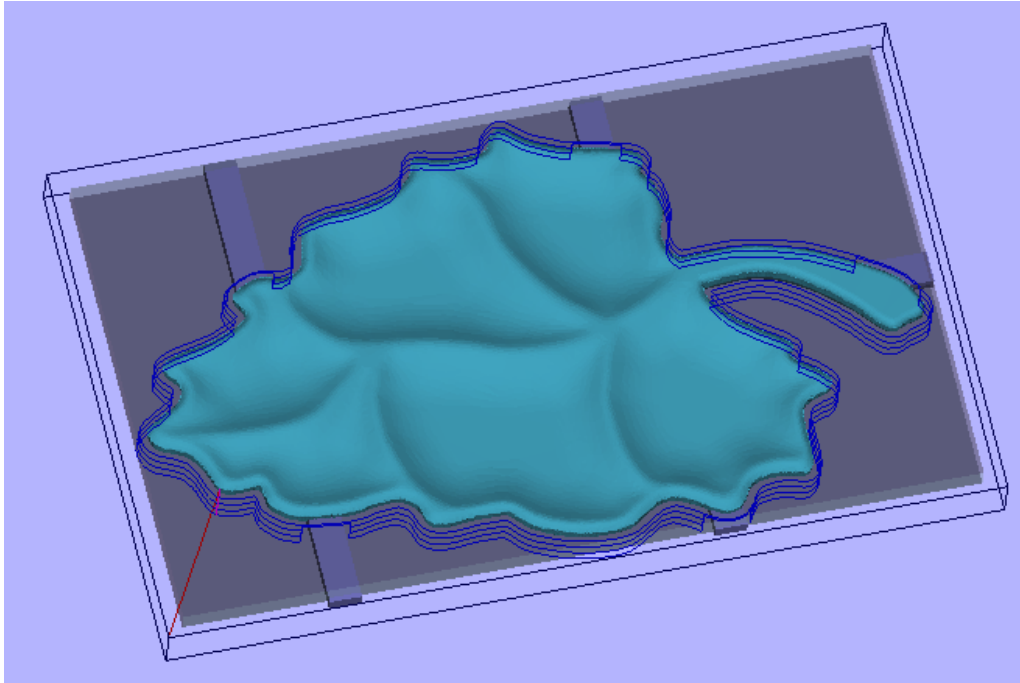
The **Material to leave** option is set to 0 and by default the Cut Out Toolpath will machine to the base of the material.

To leave a 0.020" skin on the bottom of the job

Material to leave = 0.020"

To cut 0.020" through the material

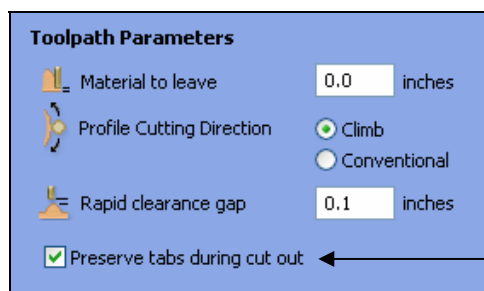
Material to leave = -0.020"



25. Click the **Next button** to proceed to **Step 6 - Preview Toolpaths**

Notes
by

The Tabs are retained when the Cut Out Toolpath is calculated. These can be removed un-checking / switching off the option to **Preserve tabs during cut out**



Un-checking this option will machine through any tabs positioned around the model

6. Preview Toolpaths

After calculating the toolpaths the **Preview Machining** form can be used to simulate each of the toolpaths in turn. The material type can also be selected to create realistic screen images.

26. Click the **Roughing Toolpath Preview** button and watch the Preview in the 3D window.

The image shows a software interface titled "Preview Machining" with several sections and controls:

- Animation Options:** A checked box for "Animate preview" and an unchecked box for "Draw tool during preview".
- Toolpaths:** A list of buttons: "Roughing Toolpath Preview", "Finishing Toolpath Preview", "Cut Out Toolpath Preview", "Reset Preview", and "Delete Waste Material".
- Material Selection:** A dropdown menu currently showing "Cherry".
- Estimated Machining Times:** A section listing times for "Roughing Toolpath" (5 minutes), "Finishing Toolpath" (22 minutes), "Cut Out Toolpath" (3 minutes), and a "Total Time" of 28 minutes. It also includes "Time estimates based on ..." with input fields for "Rapid Rate" (4.0 inches/sec) and "Scale Factor" (1.3).
- Side Display:** Radio buttons for "Top", "Bottom", "Front", and "Back", with "Top" selected.
- Navigation:** "Previous" and "Next" buttons at the bottom.

Callouts on the right side of the image point to these features:

- "Switch on / off the Preview animation options" points to the "Animate preview" and "Draw tool during preview" checkboxes.
- "Select the Toolpath to Preview" points to the "Roughing Toolpath Preview" button.
- "Select the required Material type" points to the "Cherry" dropdown menu.
- "The Estimated machining times for each set of toolpaths is displayed here" points to the "Estimated Machining Times" section.
- "Select the each side of the model to Preview when Multi-sided machining" points to the "Side Display" radio buttons.

Notes
will

If the toolpaths cut all the way through the material the Delete Waste Material button remove the excess material from around the remaining 3D model.

Clicking the **Reset button** returns the Preview model to a solid block.

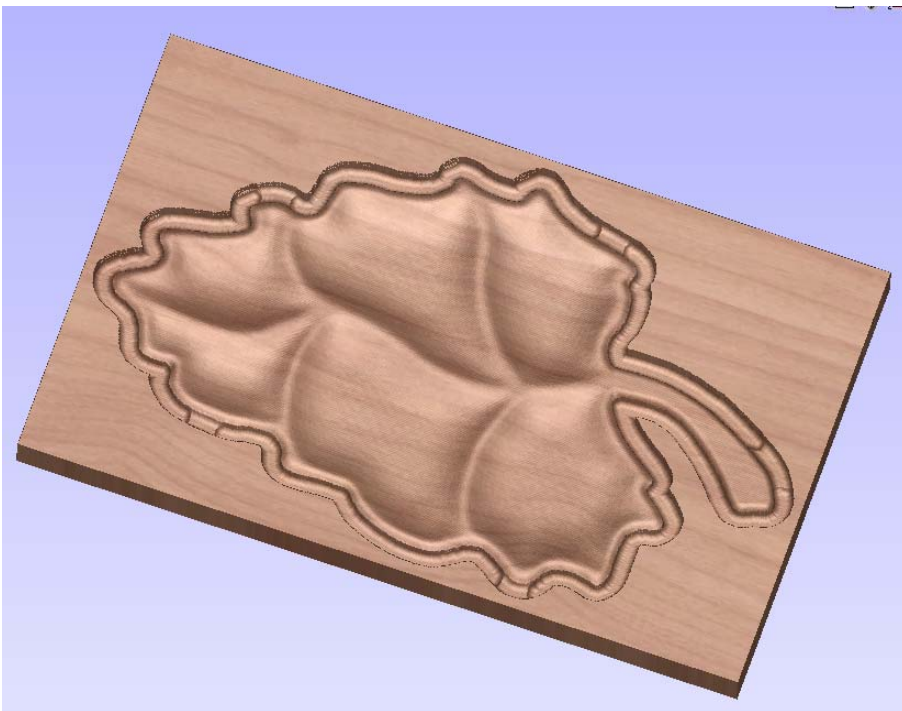


The estimated Machining times are based on the CNC machine running at the actual programmed feed rates. This is often not possible when cutting 3D work because the control systems and hardware work more slowly when computing the 3D moves.

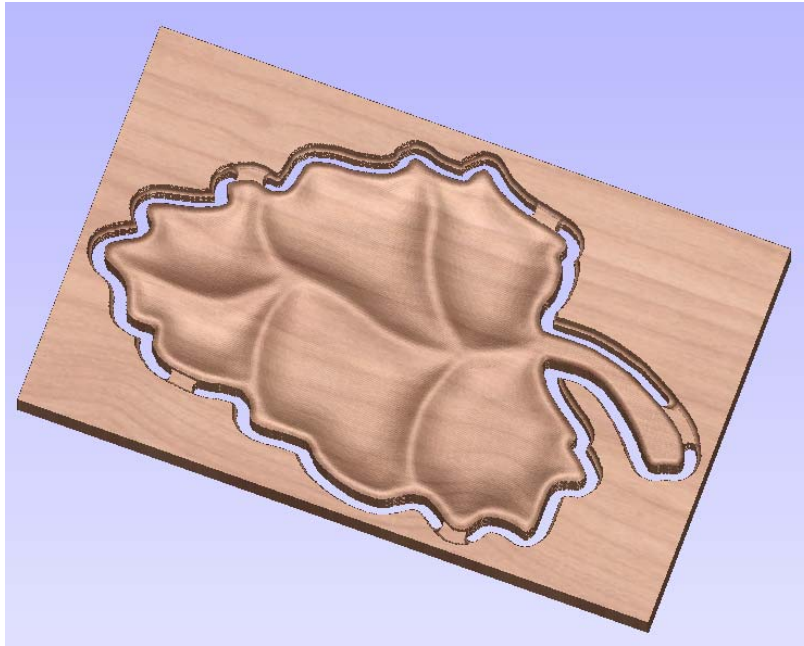
The Scale Factor allows the estimates to be more accurate and this value is remembered by the software for subsequent jobs.



Preview of the Z Level Roughing Toolpath

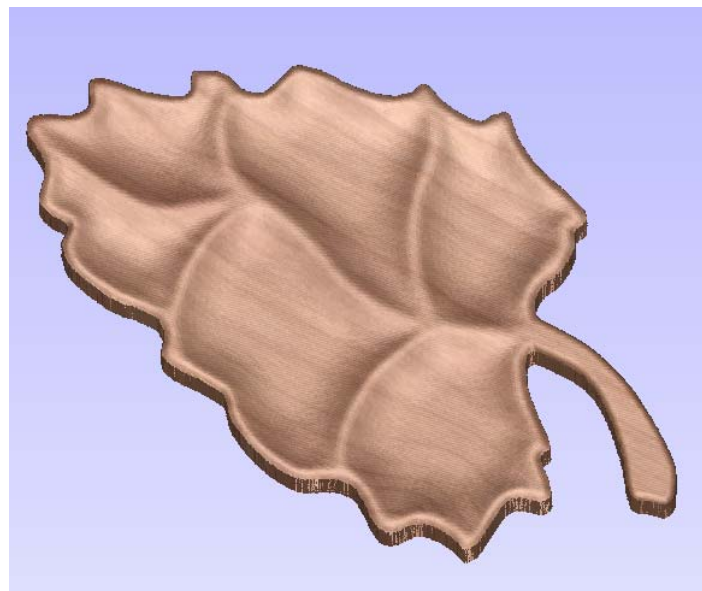


Preview of the Finishing Toolpath



Preview of the Cut Out Toolpath after **Deleting the Waste Material**

27. Click the **Previous button** to return to the Cut Out Toolpath and calculate a toolpath with the **Preserve Tabs option** switched off.
28. Click the Next button and Preview the Cut Out Toolpath again and it will show that the piece will be machined free of the material.
29. Click the Delete Waste Material button to show the finished job.



The finish machined Carved Bowl



The content of the 3D Window can be saved as an image file at any time by selecting from the main menu,

File > Save Shaded Image

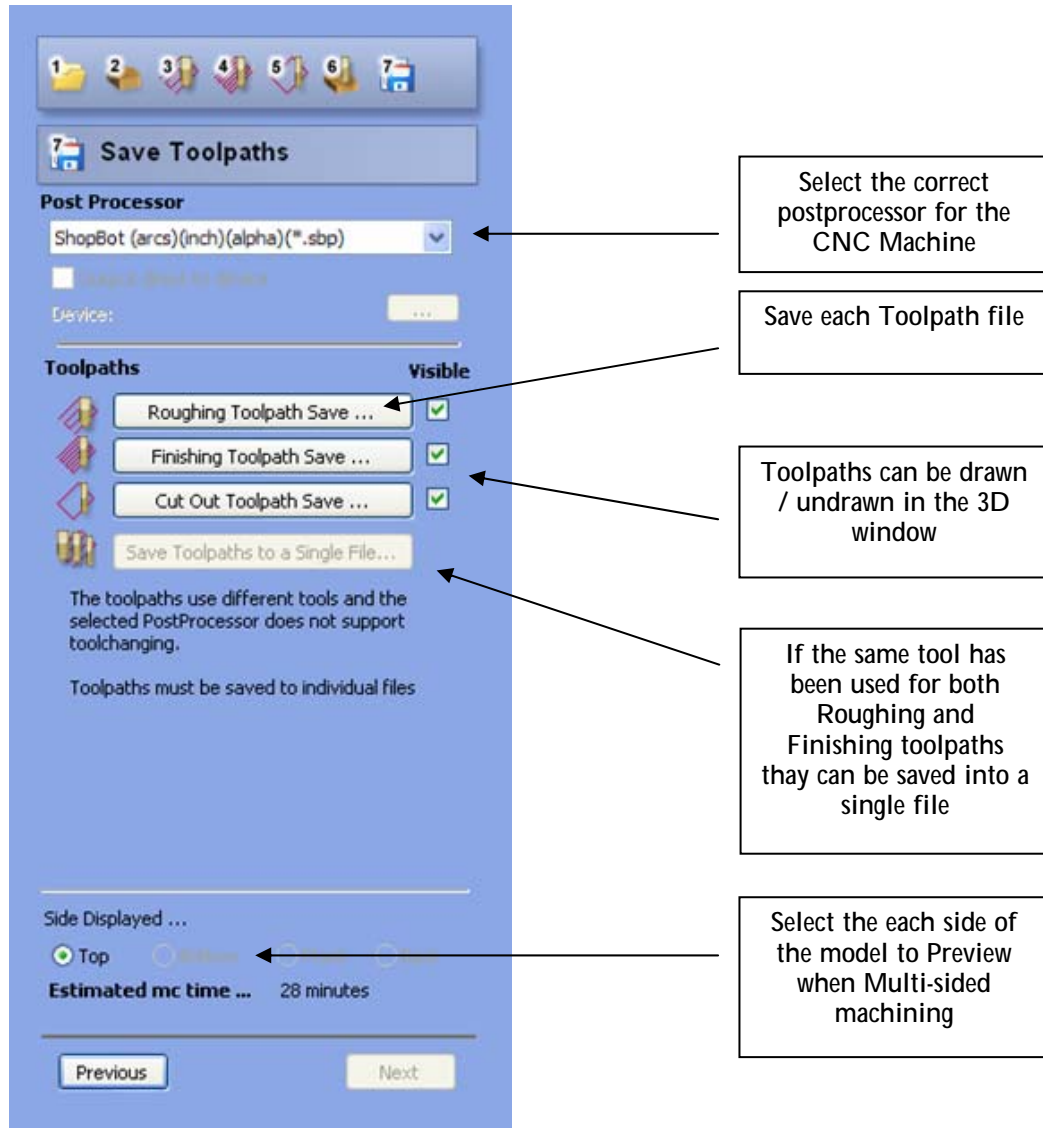
30. Click the **Next button** to proceed to **Step 7 - Save Toolpaths**

7. Save Toolpaths

The Toolpaths are now ready to be saved using the appropriate postprocessor for your CNC machine.

31. Click the pull-down list of **Postprocessors** and select the one for your machine.

32. Click the **Save Toolpath** button and enter a name to save the toolpath with.



The screenshot shows the 'Save Toolpaths' dialog box with the following elements and callouts:

- Post Processor:** A dropdown menu set to 'ShopBot (arcs)(inch)(alpha)(*.snp)'. Callout: 'Select the correct postprocessor for the CNC Machine'.
- Device:** A text field with a browse button (...). Callout: 'Save each Toolpath file'.
- Toolpaths:** A list of toolpaths with checkboxes in the 'Visible' column:
 - 'Roughing Toolpath Save ...' (checked)
 - 'Finishing Toolpath Save ...' (checked)
 - 'Cut Out Toolpath Save ...' (checked)
 - 'Save Toolpaths to a Single File...' (unchecked)Callouts: 'Toolpaths can be drawn / undrawn in the 3D window' (pointing to the checkboxes) and 'If the same tool has been used for both Roughing and Finishing toolpaths they can be saved into a single file' (pointing to the 'Save Toolpaths to a Single File...' option).
- Side Displayed ...:** Radio buttons for 'Top', 'Bottom', and 'Left'. 'Top' is selected. Callout: 'Select the each side of the model to Preview when Multi-sided machining'.
- Estimated mc time ...:** 28 minutes.
- Buttons:** 'Previous' and 'Next'.

i Take extreme care to ensure the material and cutter are setup correctly before using the toolpath.

8. Tool Database

The default Tool Database is preloaded with a selection of standard cutter sizes. This database can be modified to add New Tools, plus Copy or Delete existing cutters.

Important The **Cutting Parameters** should be set for the material you are cutting

Click the **Edit** button to modify the cutting parameters to match the tooling you are using

