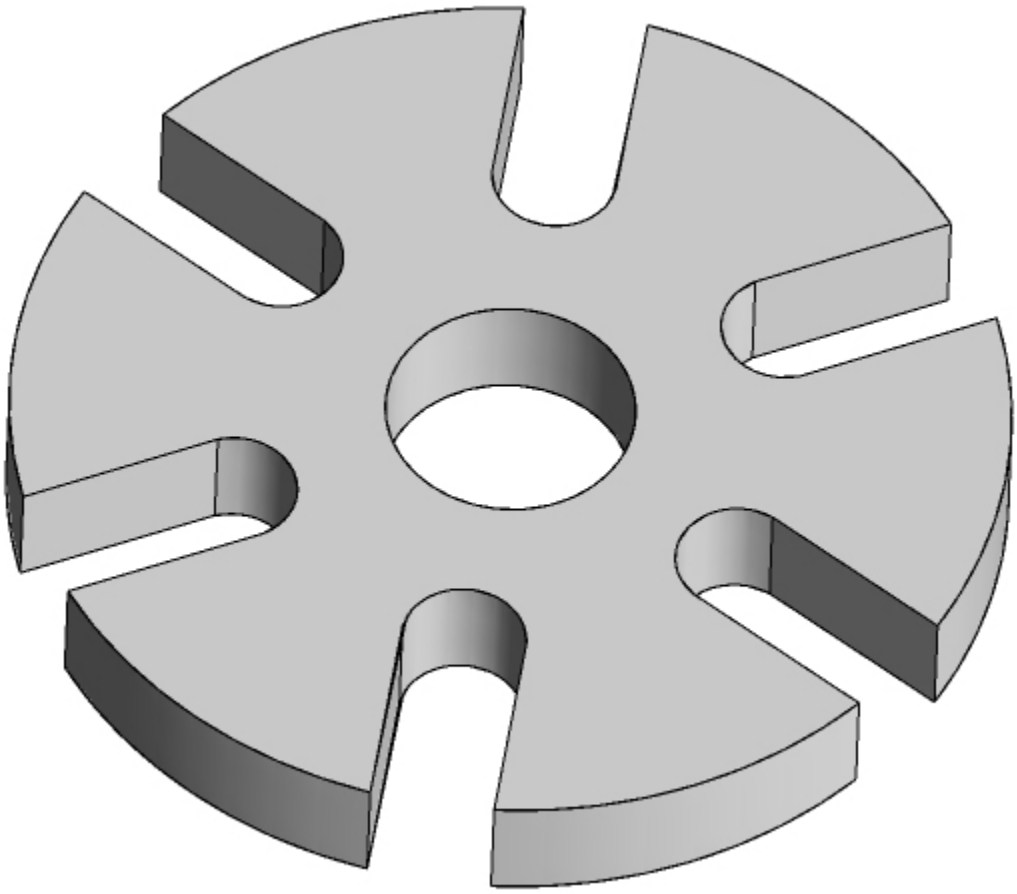
Tutorial 2: Machining a Slotted Gear



Using
2½ Axis Profiling & Engraving
Toolpath methods

Introduction

This tutorial will introduce the usage of 2 ½ axis profiling and Engraving Machining Operations of Alibre CAM. We will be using the SlottedGear.AD_PRT part file.

It should be noted that, even though the part file contains a 3-D geometry representing the part, we could machine this entirely by using just 2D Sketches due to the prismatic nature of this model.

The stepped instructions are accompanied by explanatory and introductory text. Reading this text will help you understand the tutorial methodology and provide information about additional options available.

Don't forget to save your work periodically! You may want to save the file under a different name so that the original file will be preserved.

Strategy to Machine the Slotted Gear

- We will machine the gear completely using 2 ½ axis-machining operations.
- We will use the Profiling operation to cut the outer shape of the gear and the Engraving operation to cut the slots. The engraving option is preferred in situations where the cutter can be driven to create a slot that conforms to the shape of the tool trajectory. This is because of the computational efficiency as well as the accuracy of this method.
- The part itself will be machined out of a 3 inch x 3 inch x ½ inch poplar wood sheet.
- The wooden sheet will be held to the machine table or the spoil sheet on the table using double-sided tape.
- The part will be machined using a single ¼ inch flat end mill.

Main Programming Steps

In creating programs for each setup, the following steps will be followed:

- Create the Stock geometry
- Set the Machine zero point with respect to the machine coordinates
- Create / Select the tool used for machining
- Set the feeds and speeds
- Set the clearance plane for the non-cutting transfer moves of the cutter
- Select the machining regions for containing the cutter to specific areas to cut
- Select the machining operations and set the parameters
- Generate the toolpath
- Simulate the toolpath.

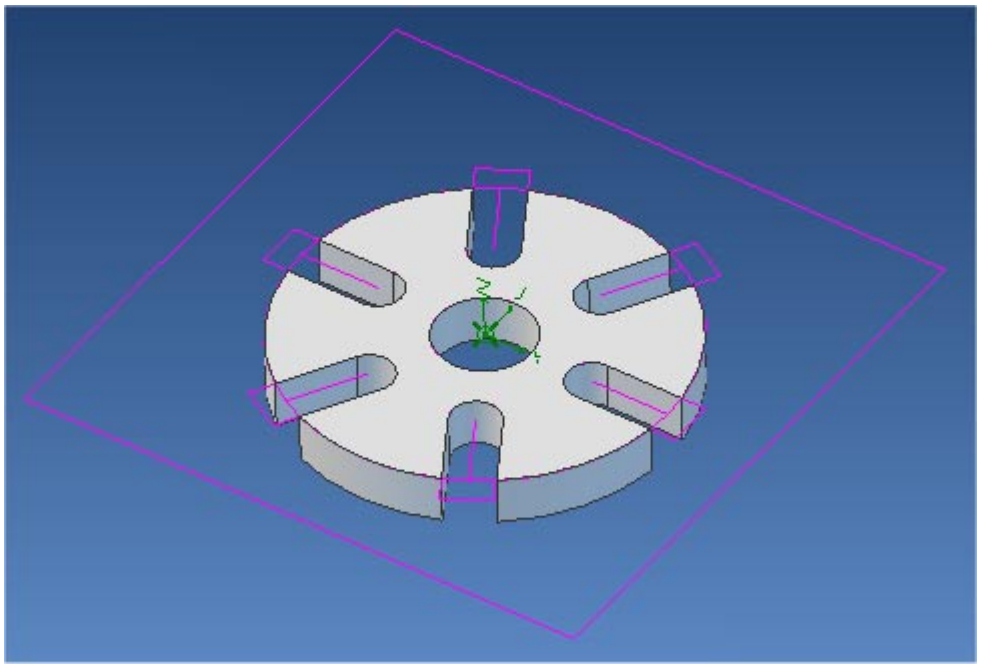
You may have to repeat either all or part of these steps for subsequent operations.

Loading the Part Model

"Part" refers to the geometry that represents the final manufactured product. Typical you would create this in Alibre Design. Use the Alibre Design menu bar or the Standard toolbar buttons to create, load and save part geometry.

1. Select File / Open Part, or click the Open Part icon from the Alibre Design standard toolbar.
2. From the **Open** dialog box, select the **SlottedGear.AD_PRT** file from the **Tutorials** folder in the Alibre CAM installation folder. (Default location C:\Program Files\MecSoft Corporation\Alibre CAM 2.0\Tutorials)

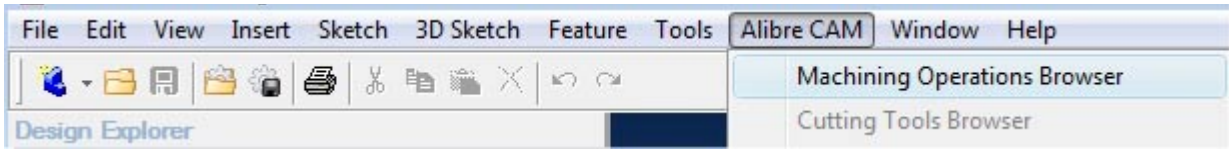
The loaded part appears as shown below.

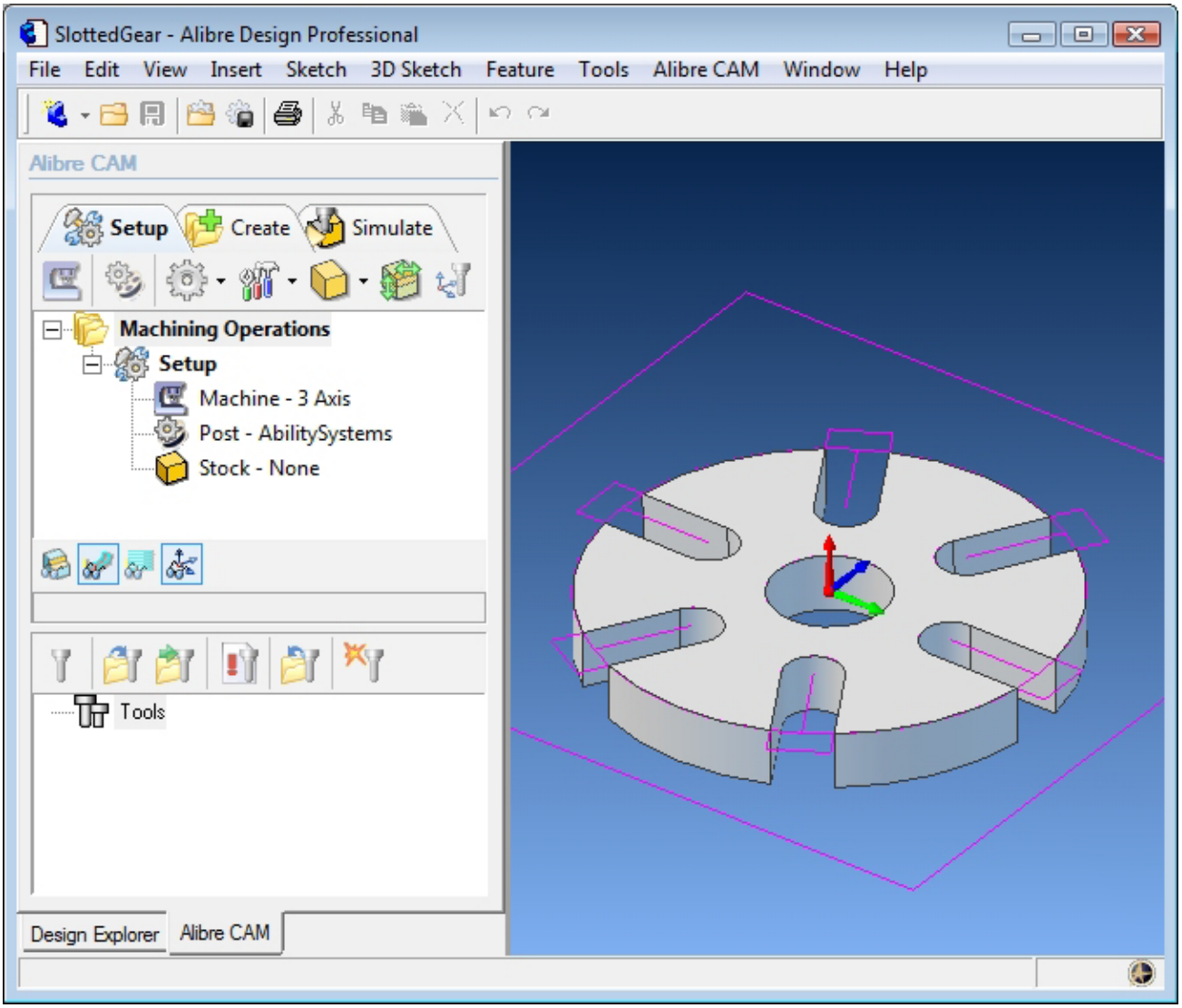


Note: You must work in shaded mode in order to be able to visualize toolpaths created in Alibre CAM. It is suggested for best visual performance with Alibre CAM to work with only one view port open and the view port operating in shaded mode.

Loading the Alibre CAM Browser

1. Select Alibre CAM from the menu bar and click Machining Operations Browser.





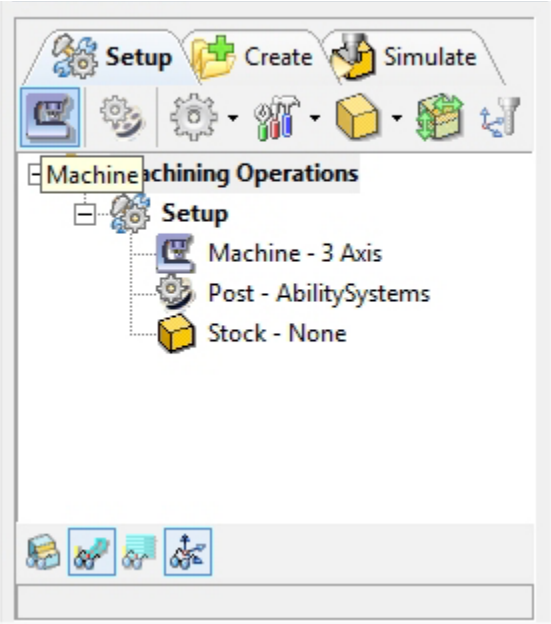
The Alibre CAM browser (MOPs and Cutting Tools) is now loaded and is docked over the Design Explorer. You can toggle between the MOPs browser and the Design Explorer from the tabs at the bottom of the window. It can be hidden by un-checking Browser on the Alibre CAM menu bar. To re-display the hidden Browser window, you can re-check **Browser** from the Alibre CAM menu entry. You can also resize it by dragging one of its sides.

Preparing the part for Machining

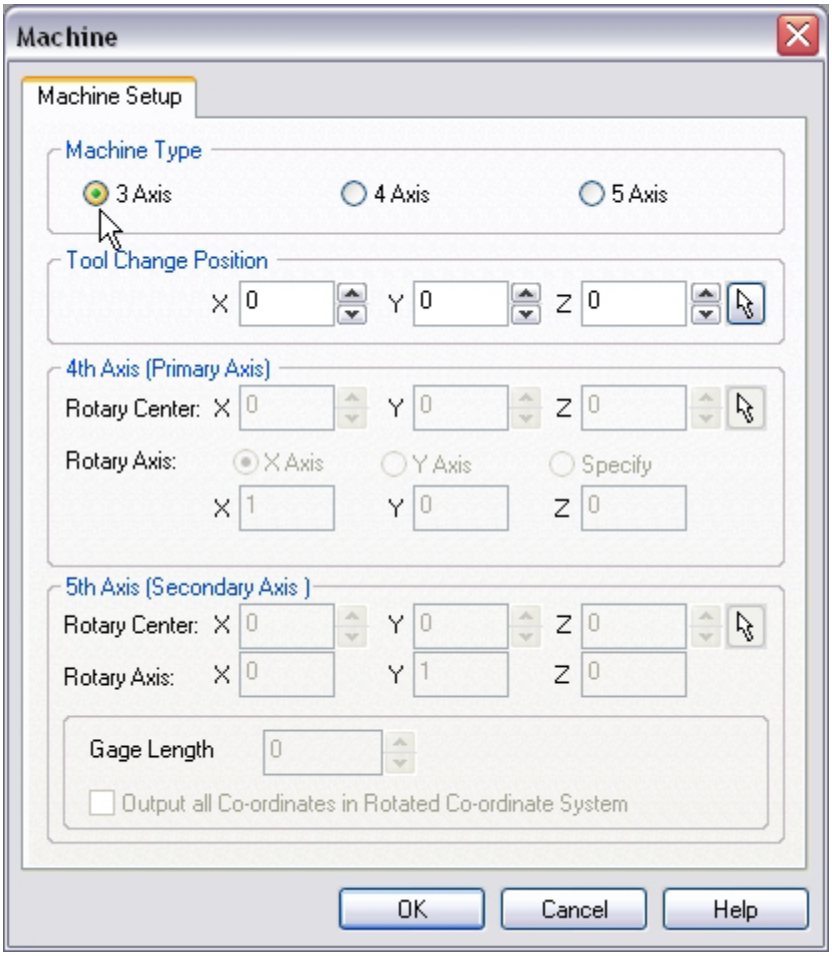
The Setup tab allows the user to specify Machine Setup, Select Post Processor, Stock Geometry, Machine Coordinate System (Machine Zero) & Preferences.

Setup Tab

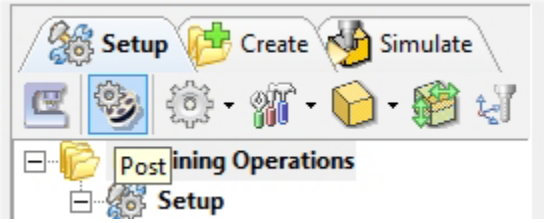
1. Click on the Setup tab located under the MOPs Browser and select Setup Machine



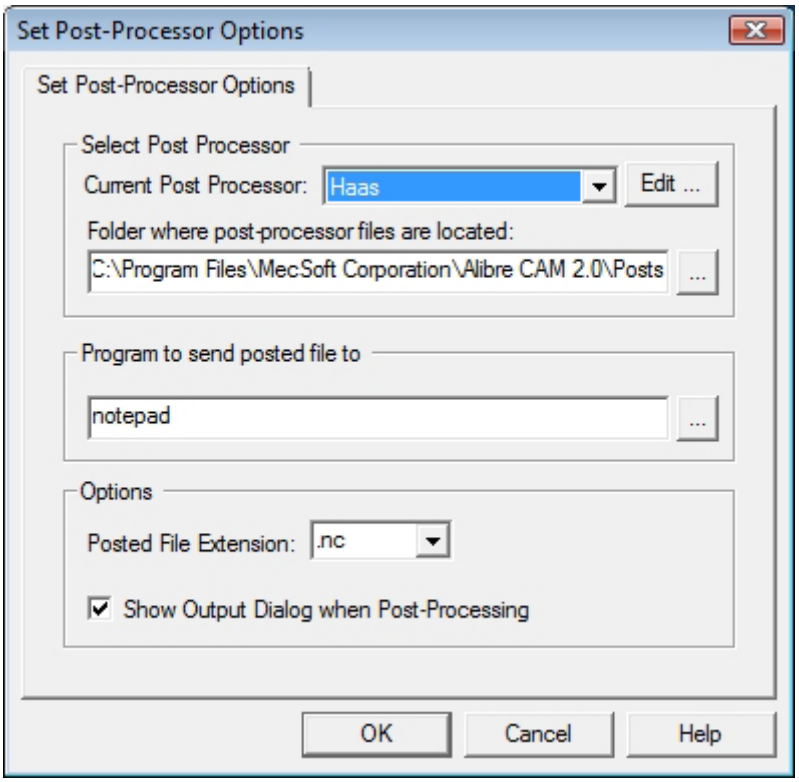
2. Set the Machine type to 3 axis



1. Select **Post** from the setup tab to specify the post processor options



2. Set the current post processor that is on your controller. We will select Haas as the post processor for this exercise. Set the posted file extension type to .nc

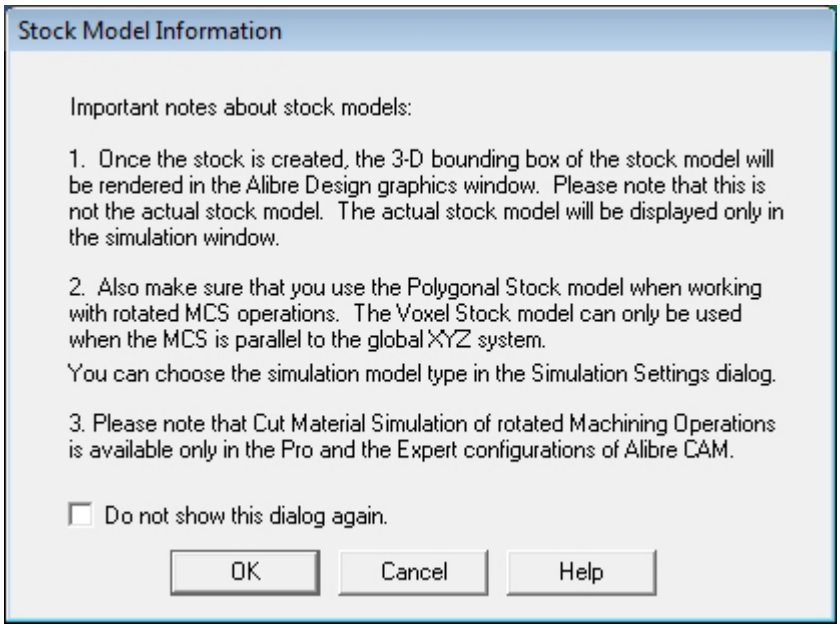


Note: By default post processor files are located under
C:\Program Files\MecSoft Corporation\Alibre CAM 2.0\Posts
The program to send the posted output is set to notepad. This would output the G code to a notepad.

Create Stock Geometry

1. Select Create/Load stock from the setup tab and create a Part Box Stock

The stock model information dialog may be displayed when a stock geometry is created.

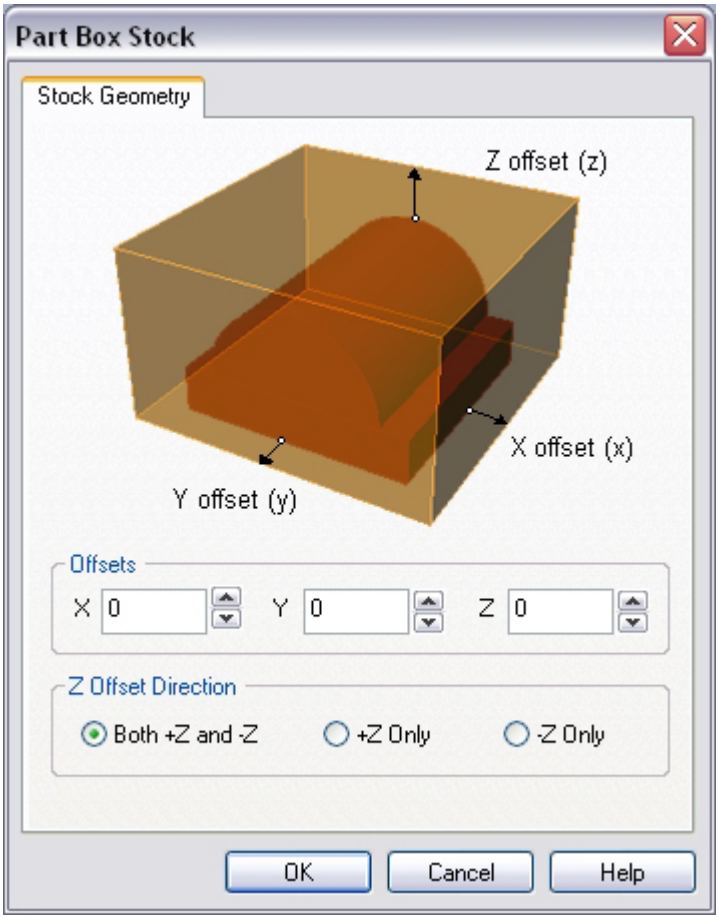


Click OK

User can turn off this dialog by selecting Do not show this dialog again located on the bottom of the message window.

To display this dialog during stock creation, select Alibre CAM Preferences->Simulation Preferences and select Invoke 'Stock Model Information' dialog.

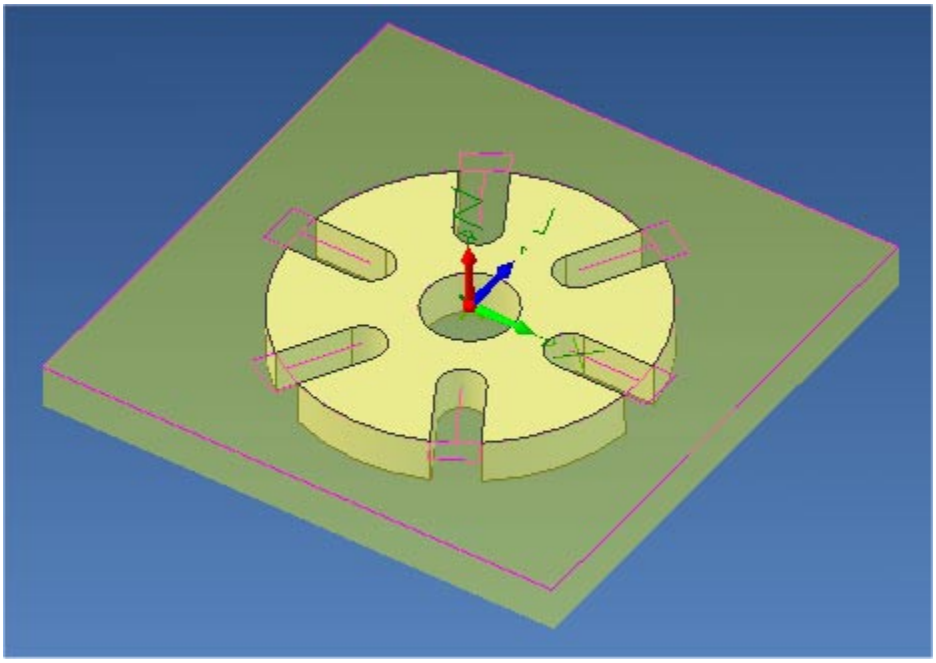
2. This brings up the Part Box Stock Parameters.



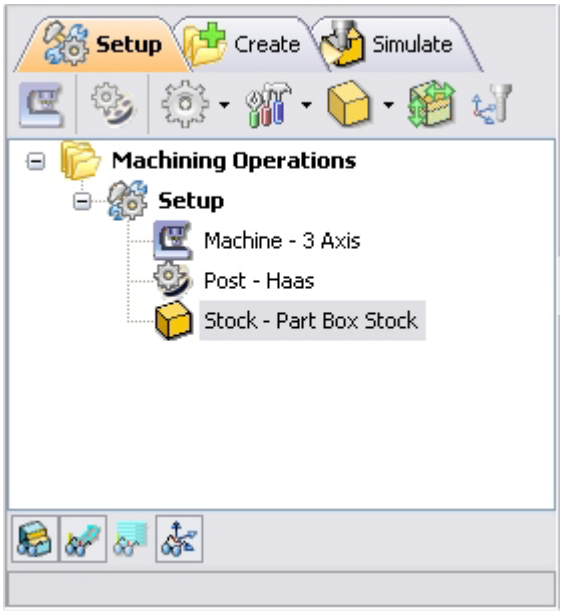
The system calculates the bounding box of the part model as the XYZ extents of geometry of the part model. The user can then define offsets in any of the three coordinate directions to apply to the computed bounding box.

3. Set the offsets for X, Y and Z =0 and click OK.

The stock geometry is now created, and a semi-transparent stock box is displayed on top of the part geometry.



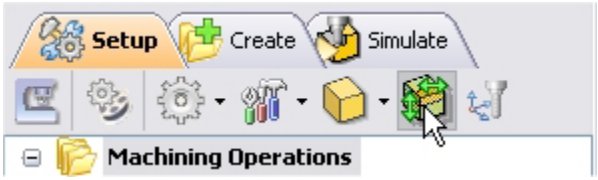
4. The setup tab now displays the following information: Machine Type, Post Processor, and Stock type as show below.



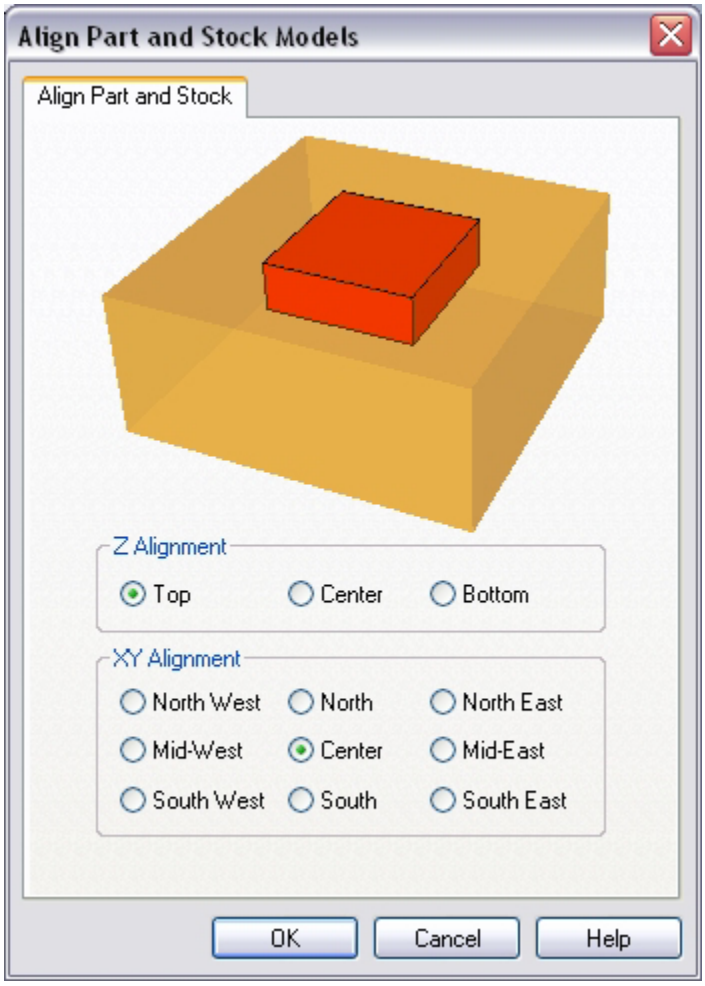
Align Part and Stock

Once the stock model is created, user can move the stock geometry relative to the part geometry and use the stock box to specify the machine zero (home position).

1. Select Align Part and Stock from the Setup tab



2. Set Z alignment to **Top** and XY alignment to **Center.** (This would align the stock to the top of the part in Z and center in XY)

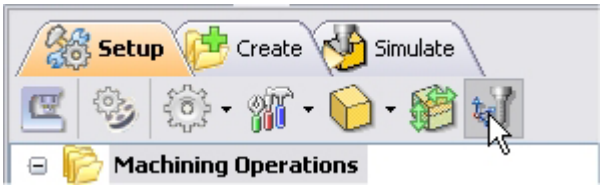


Set Machine Coordinate System (MCS)

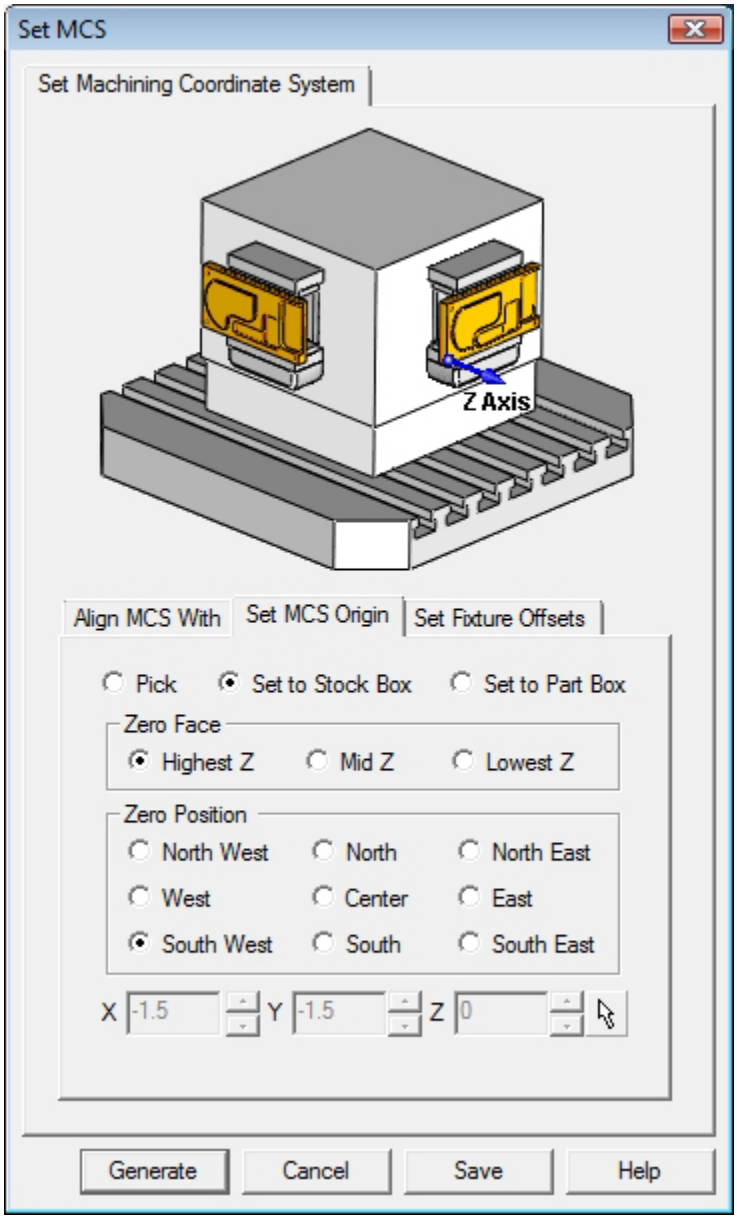
The steps below help you determine the machine home (also known as machine zero or tool touch off point) for the part/stock geometry.

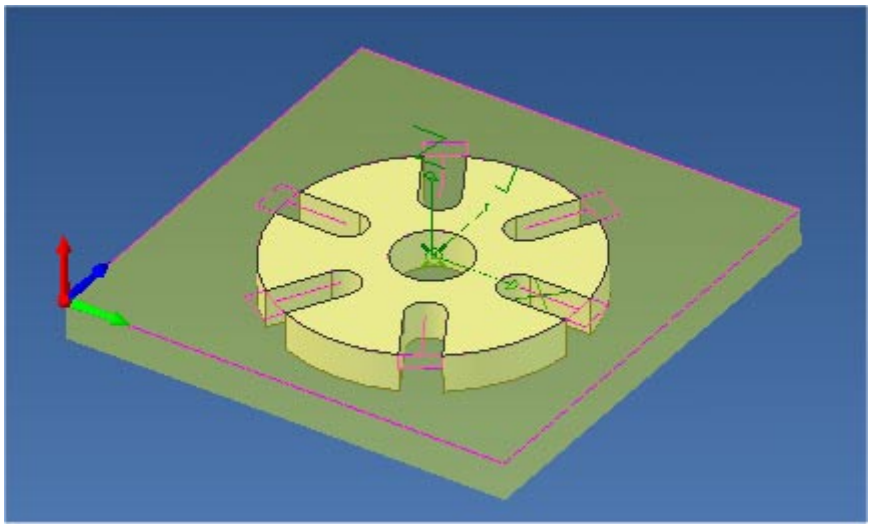
The MCS is represented as a triad with 3 arrows, the Green arrow indicating X axis, Blue the Y axis and Red the Z axis. It is always a good practice to set the machine zero before generating a toolpath.

1. Select Set MCS from the Setup tab



2. Switch to SetMCS Origin tab and choose **Set to Stock Box**, the Zero Face to **Highest Z,** and Zero Position to **South West** corner. This sets the machine home to the top of the stock material and the southwest corner of the part geometry.


Set MCS
Set Machining Coordinate System
Z Axis
Align MCS With
Set MCS Origin
Set Fixture Offsets
Pick
Set to Stock Box
Set to Part Box
Zero Face
Highest Z
Mid Z
Lowest Z
Zero Position
North West
North
North East
West
Center
East
South West
South
South East
X -1.5
Y -1.5
Z 0
Generate
Cancel
Save
Help



(This sets the machine home to Southwest corner and top of the stock material).

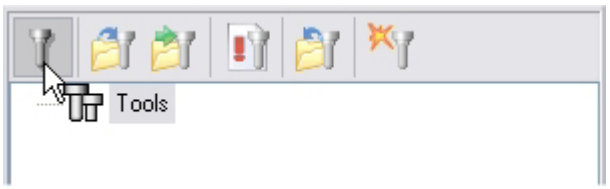
Note: You can change the stock model transparency under standard mode by selecting Simulation Preferences that is located at the bottom of the MOps browser.

Click Save As to save the work and specify a file name as SlottedGear-Rev1.

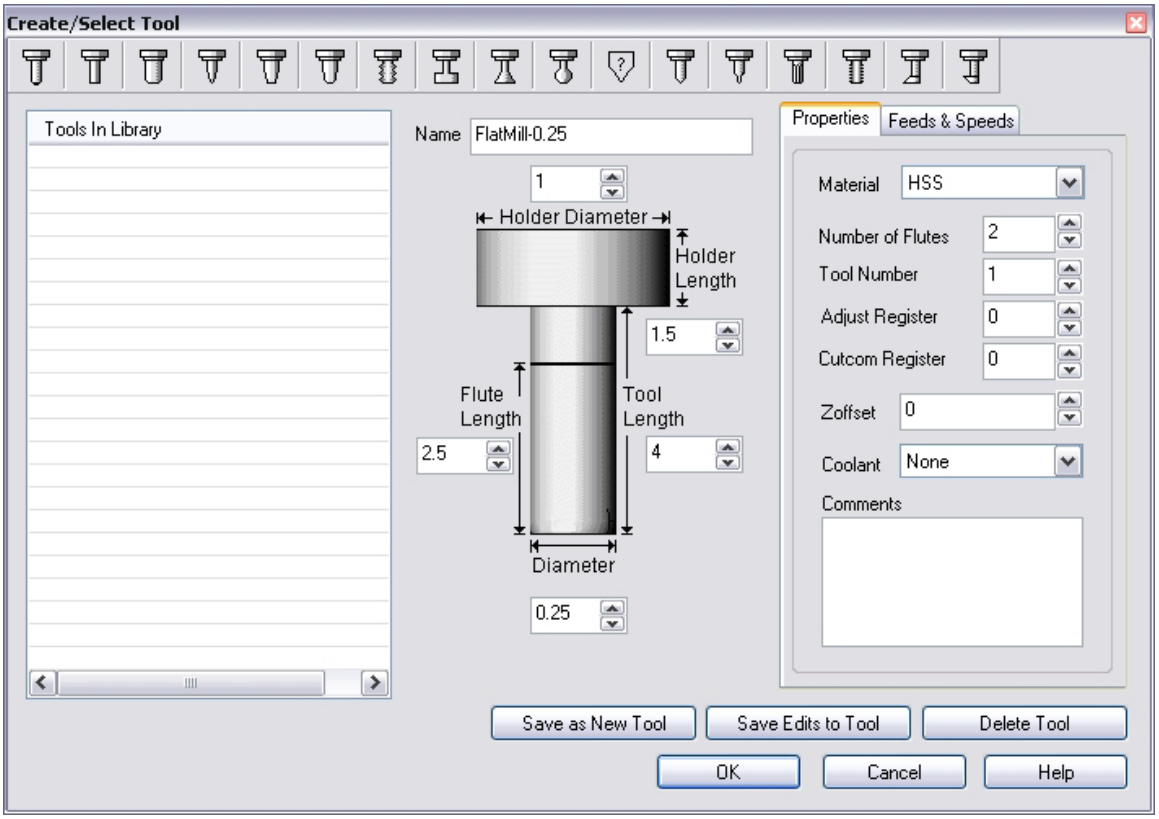
Create Tools

To machine the above part we will now create a ¼ inch (0.25”) Flat End Mill.

1. Go to the Alibre CAM-Tools browser that is located below the MOps browser and select Create/Edit Tools. Select the Tool Type to Flat End Mill.



2. Set the tool name as **FlatMill-0.25**, Tool Diameter = **0.25.** Under the Properties tab, set Tool Number = **1**.

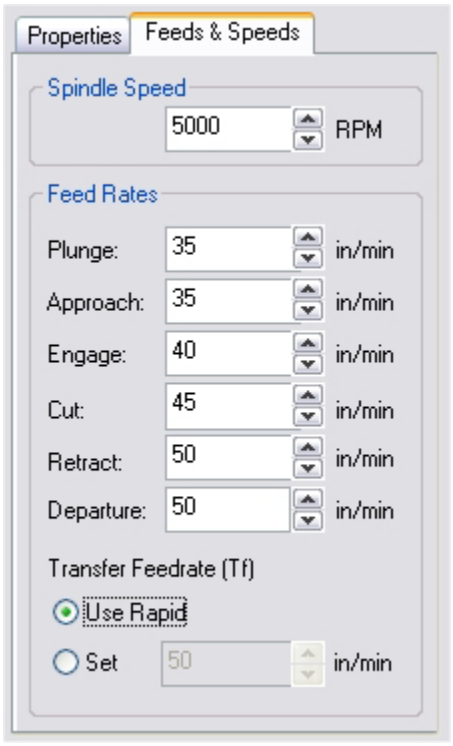


Setting Feeds and Speeds

You can assign Feeds & Speeds to a tool or you can load from a table. In this exercise, we will assign feeds and speeds to the tool.

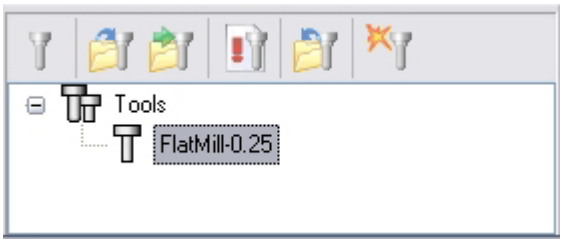
3. Switch to the Feeds & Speeds tab inside the create/select tool dialog.

4. Use the following settings for feeds and speeds.



5. Click **Save as New Tool**. The tool is now created and listed under Tools in Library. Click OK to close the dialog.

Note: You can edit the tool properties and click Save Edits to Tool to save the changes. You can create additional tools by assigning a different name and specify the tool parameters.



The created tool is now listed under the Alibre CAM Tools browser.

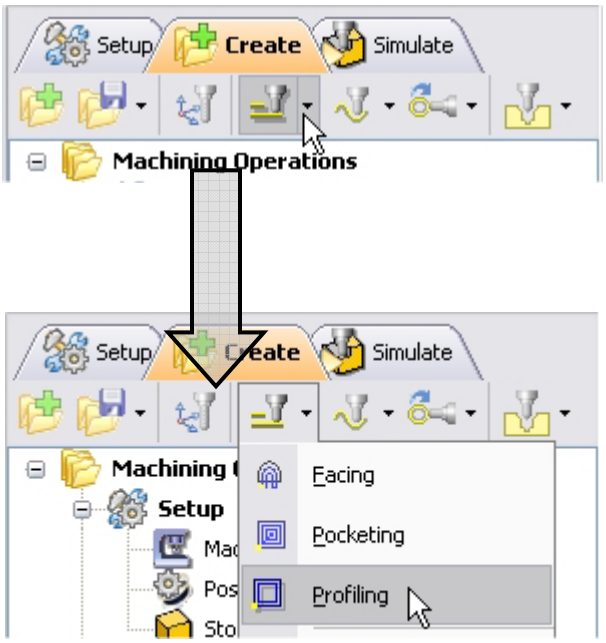
Create Machining Operations

In this process we will create a 2.5 axis profiling operation.

1. Switch to the Create Operations tab in Mops browser.

2 ½ Axis Profiling

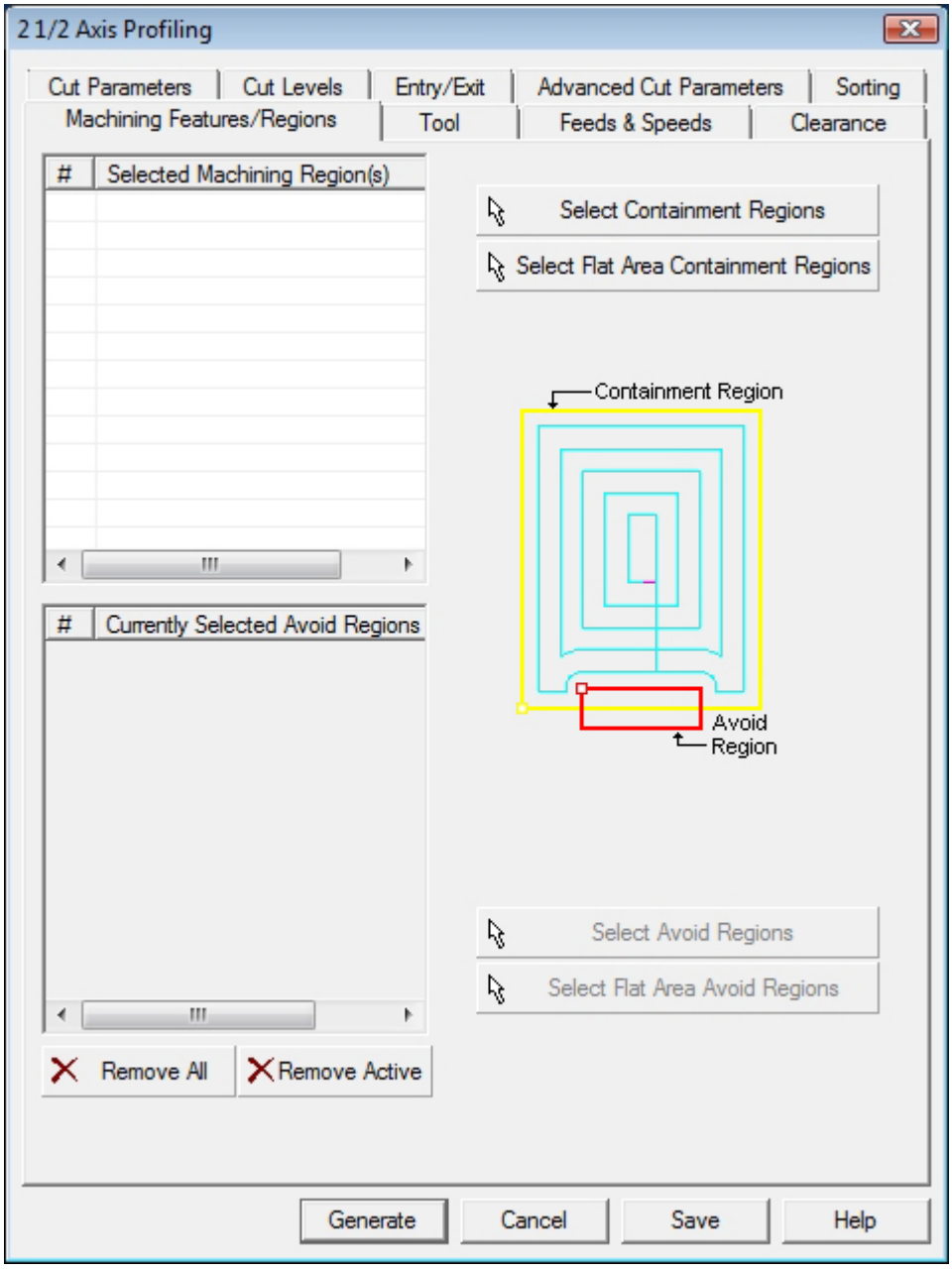
2. Select 2 ½ Axis Milling and choose **Profiling**



This brings up the 2 ½ Axis Profiling Operations dialog. We will go over the steps for creating the profile operations.

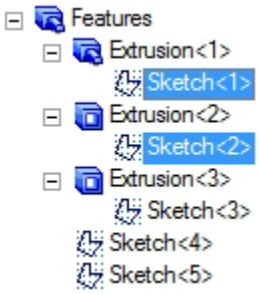
Select Machining Features/Regions

3. Go to the **Machining Features/ Regions** tab and click **Select Containment Regions.** The Profiling operation dialog is now minimized and allows selection of the sketch geometry.



We will now select the inner circle first and then the outer circle.

4. Switch to Design explorer and select **Sketch2**. This selects the inner circle.
5. Hold the Ctrl key and select **Sketch1**. This selects the outer circle.

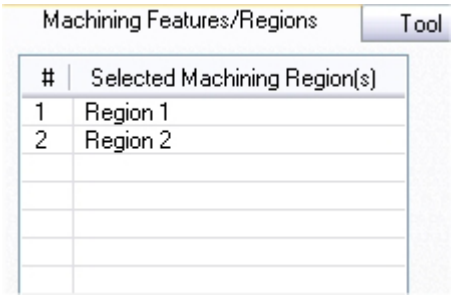


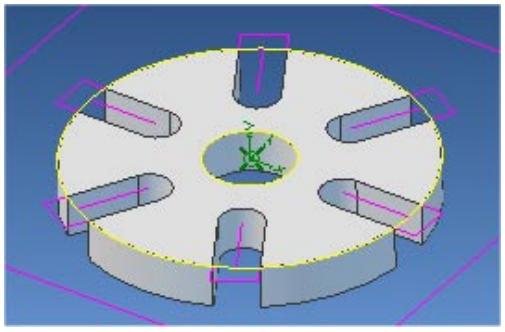
Note: You can also select the sketch from Alibre Design View. When select containment region is selected, Alibre CAM turns on Sketch selection filter to allow the user to select sketches. Hold the Shift key down to select multiple sketches.

6. Click 

to complete the selection.

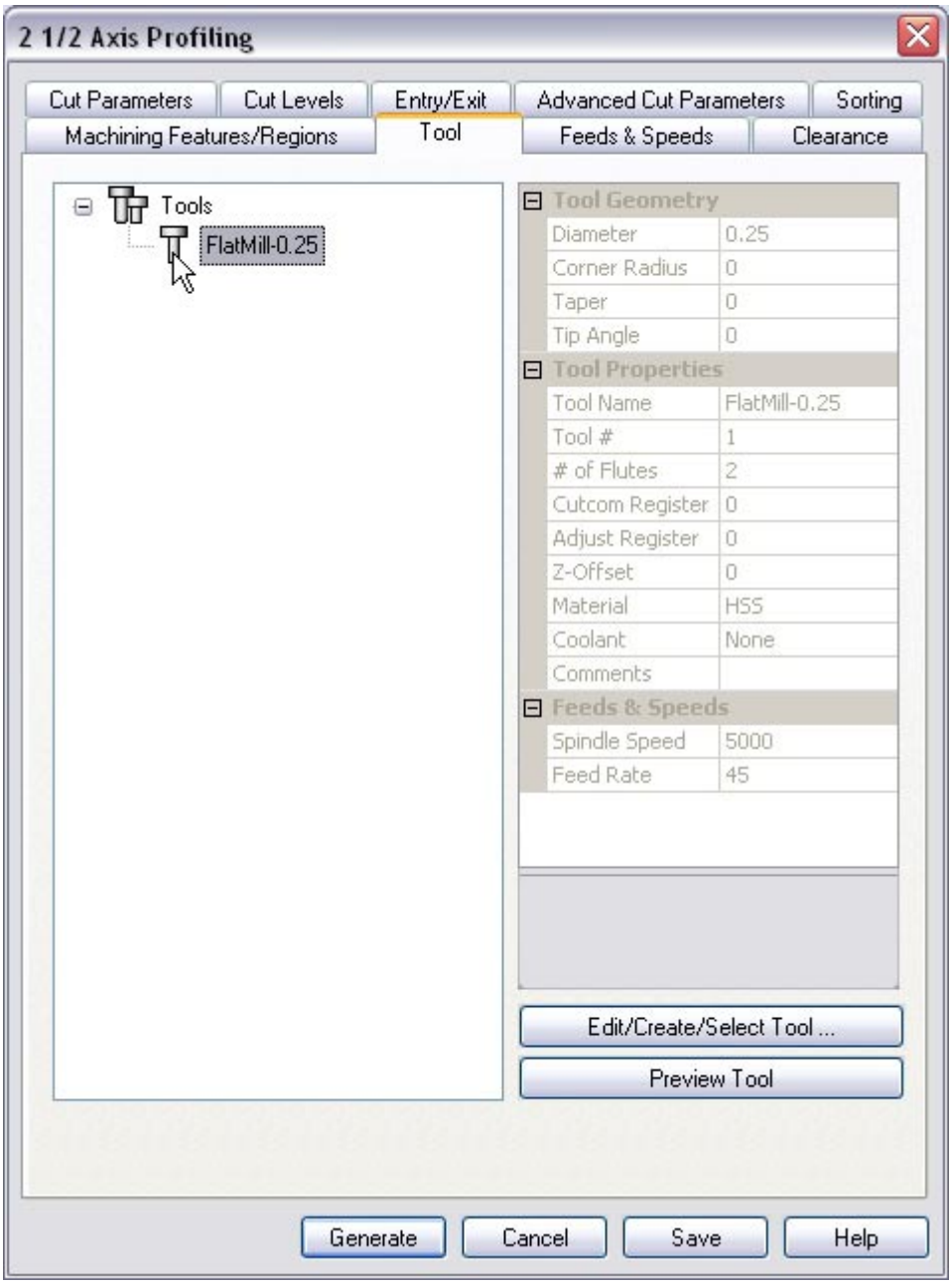
The 2 ½ Axis Profiling operation dialog comes back up displaying the selected regions. The selected regions are also highlighted on the part.





Selecting the Tool

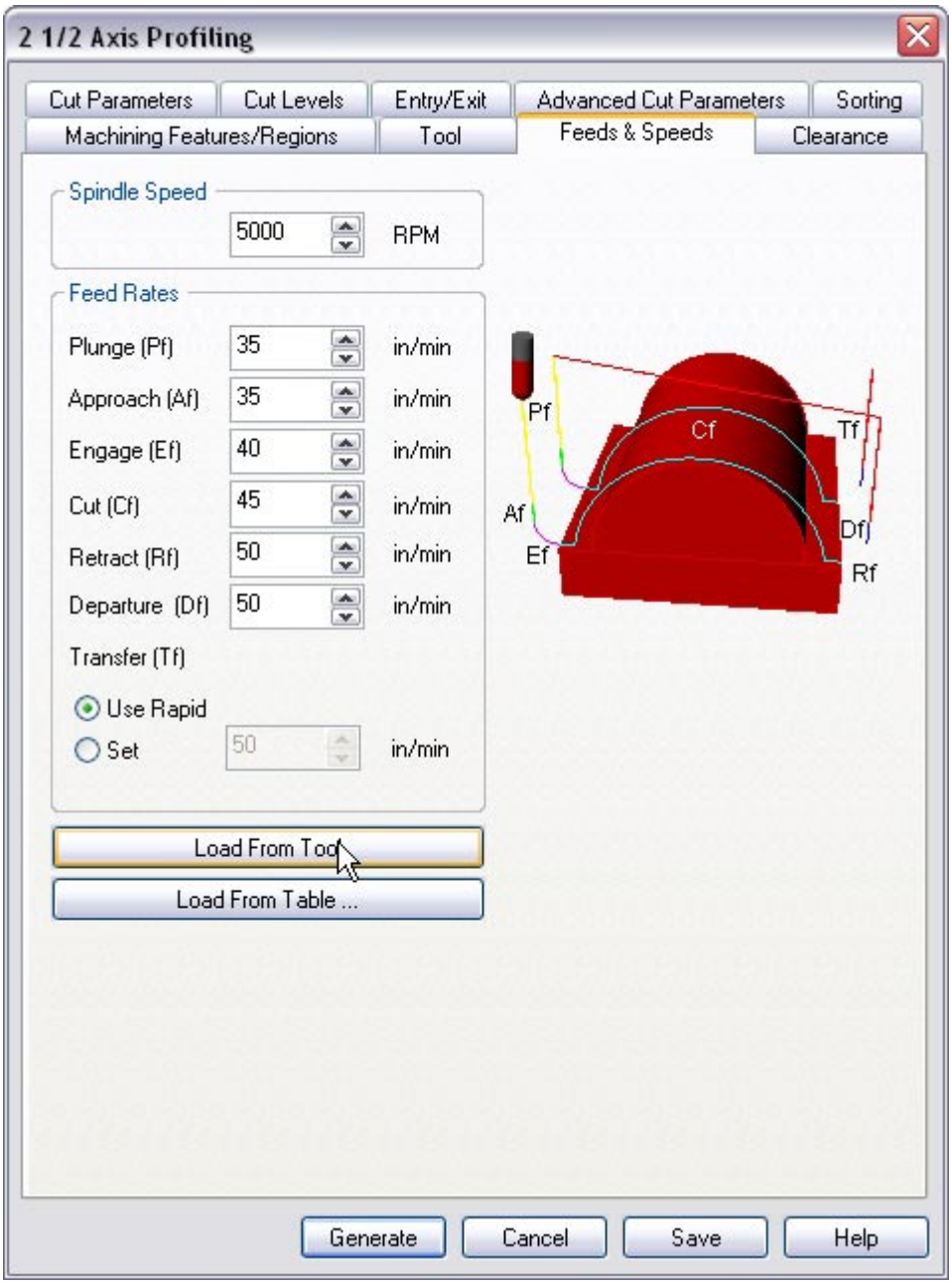
7. Switch to the Tools tab inside the 2 ½ Axis Profiling operation.



8. Select the FlatMill-0.25. The 0.25” Flat End mill is now selected as the active tool, and the Tool parameters are displayed to the right of the Tools window.

Set Feeds and Speeds

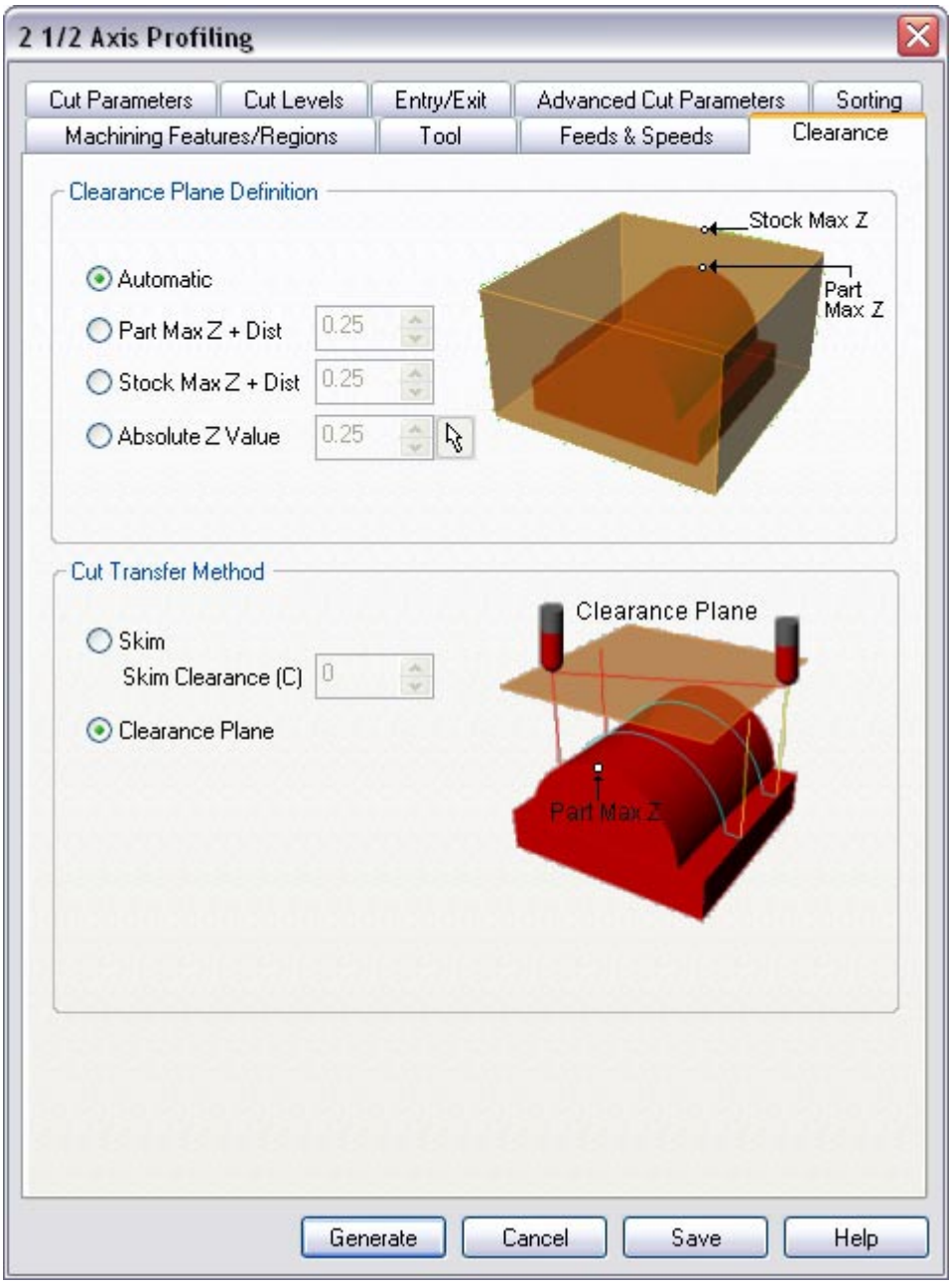
9. Click on the Feeds and Speeds tab.



10. Select Load From Tool. Alibre CAM will now get the feeds and speeds information that was set when the tool was defined.

Clearance Control

11. Switch to Clearance Tab.

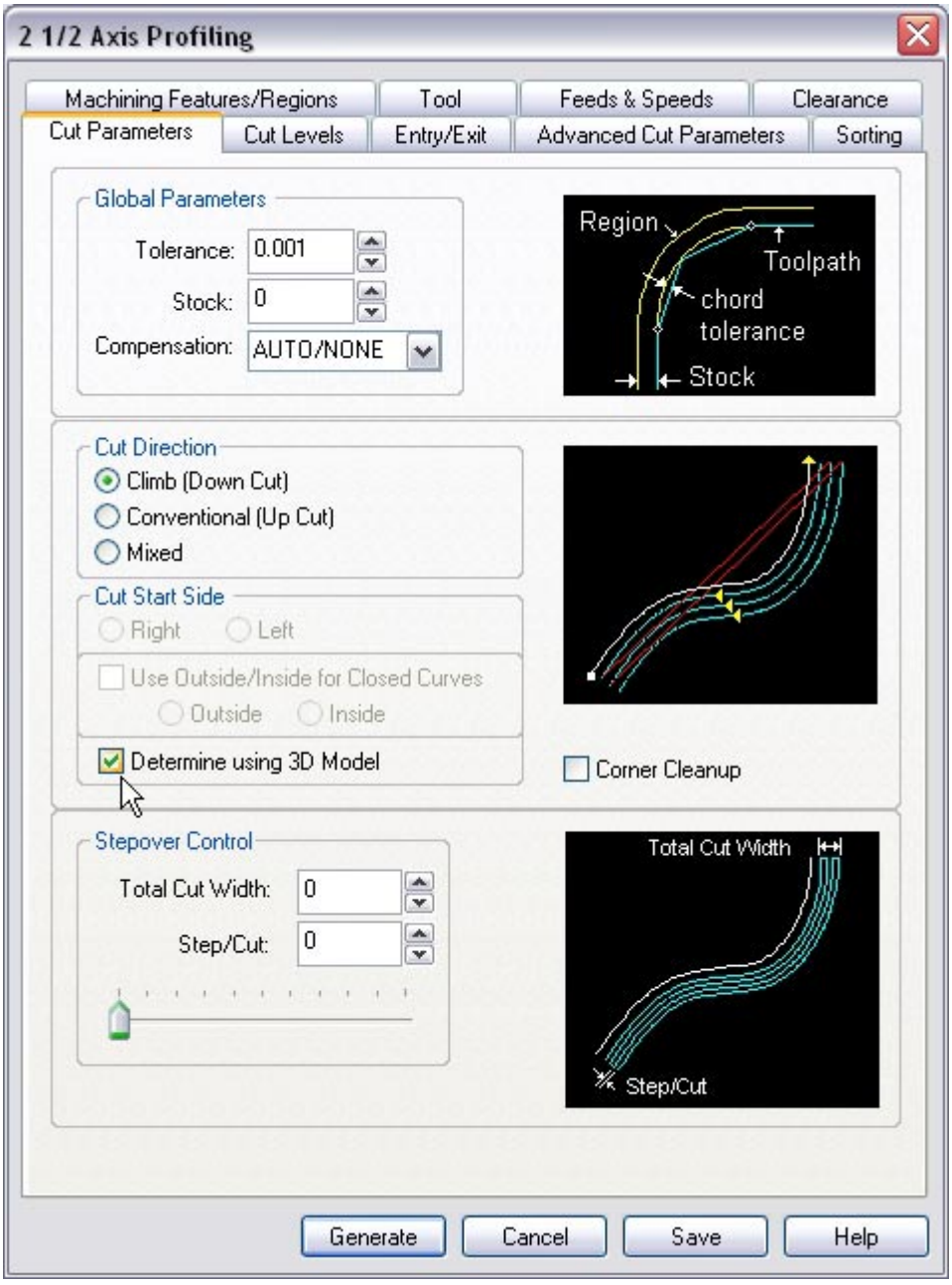


12. Set the Clearance Plane Definition to Automatic and Cut Transfer Method to Clearance Plane.

Alibre CAM will determine a safe Z height for the Entry & Exit when set to automatic. Setting Cut Transfer to Clearance Plane would apply the automatic Z clearance between transfers when the tool moves from a machining region to another.

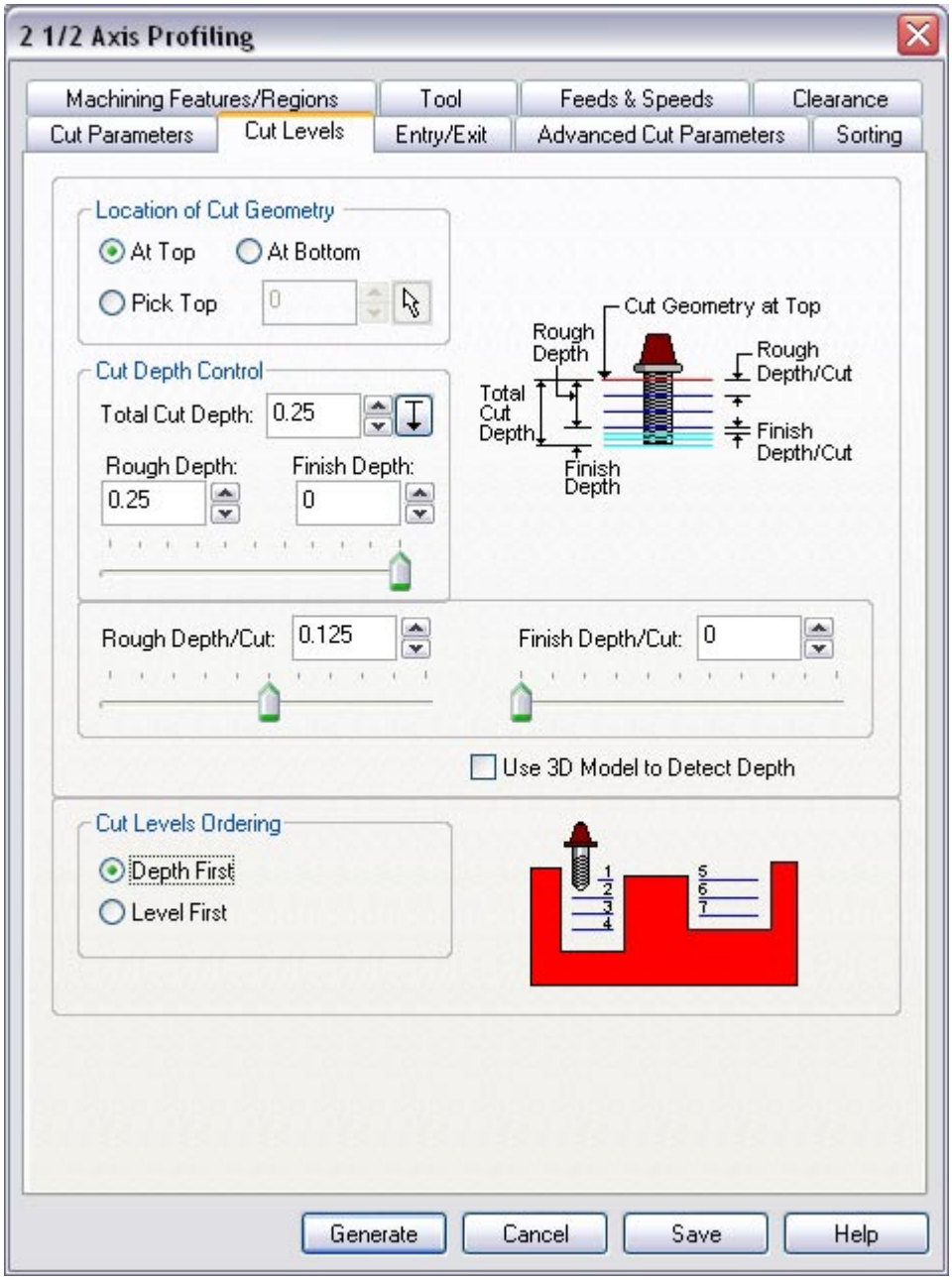
Specifying Cut Parameters

13. Switch to Cut Parameters tab.



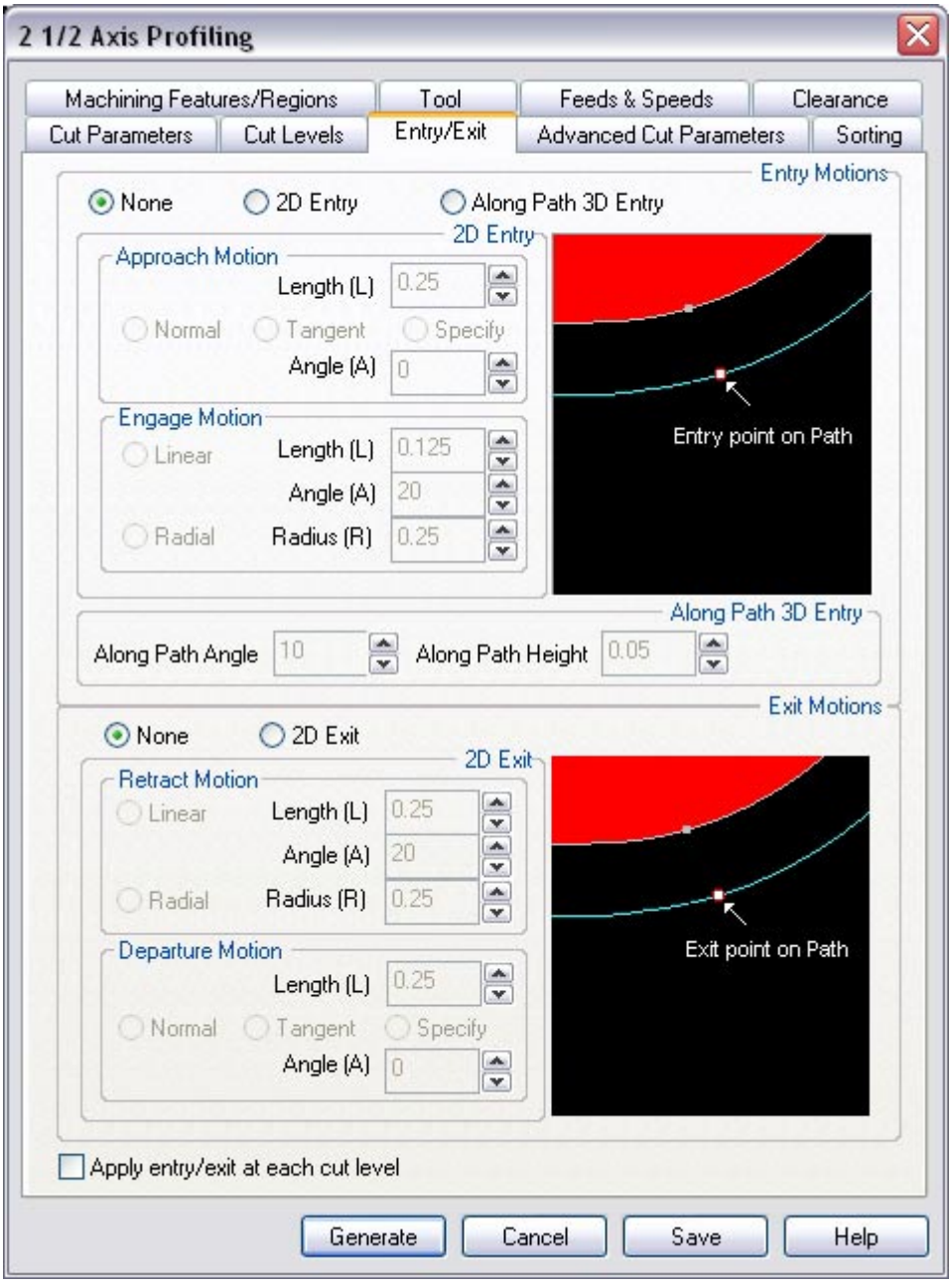
14. Set the Stock = **0**, cut start Side as **Determine using 3D Model**.

15. Select the Cut Levels Tab and specify the Total Cut Depth = **0.25**, Rough Depth/Cut = **0.125**. This would cut the profile in 2 cuts of each 0.125”. Make sure the cut level ordering is set to **Depth First**. This would profile the inner circle and then the outer profile.


2 1/2 Axis Profiling
Machining Features/Regions
Tool
Feeds & Speeds
Clearance
Cut Parameters
Cut Levels
Entry/Exit
Advanced Cut Parameters
Sorting
Location of Cut Geometry
At Top
At Bottom
Pick Top
0
Cut Depth Control
Total Cut Depth:
0.25
Rough Depth:
0.25
Finish Depth:
0
Cut Geometry at Top
Rough Depth
Total Cut Depth
Finish Depth
Rough Depth/Cut
Finish Depth/Cut
Rough Depth/Cut:
0.125
Finish Depth/Cut:
0
Use 3D Model to Detect Depth
Cut Levels Ordering
Depth First
Level First
1
2
3
4
5
6
7
Generate
Cancel
Save
Help

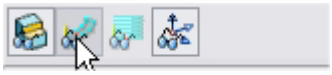
Entry/Exit

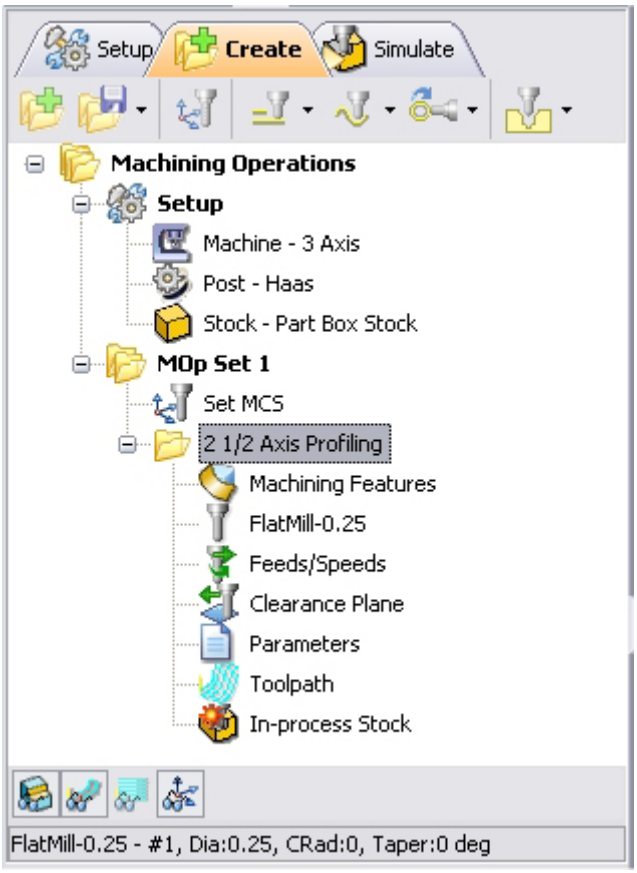
16. Switch to Entry/Exit Tab, and Set the Entry and Exit Type to None.

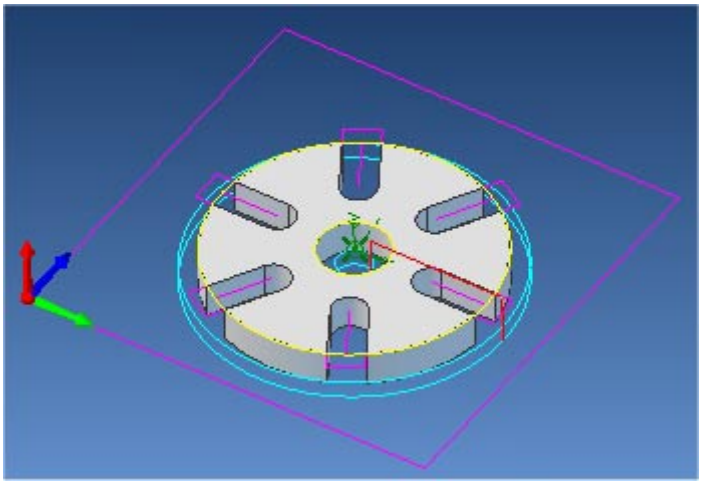


17. Click Generate. The 2½ Axis Profile toolpath is now generated, and the Operation is listed under the Alibre CAM-MOps browser.

Note: Toolpath display can be turned on/off by selecting Toolpath Visibility under the MOps browser.

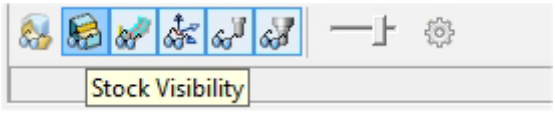



Setup
Create
Simulate
Machining Operations
Setup
Machine - 3 Axis
Post - Haas
Stock - Part Box Stock
MOp Set 1
Set MCS
2 1/2 Axis Profiling
Machining Features
FlatMill-0.25
Feeds/Speeds
Clearance Plane
Parameters
Toolpath
In-process Stock
FlatMill-0.25 - #1, Dia:0.25, CRad:0, Taper:0 deg

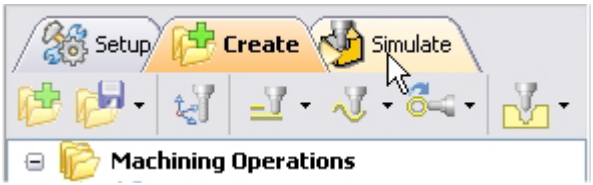


Simulate Toolpath

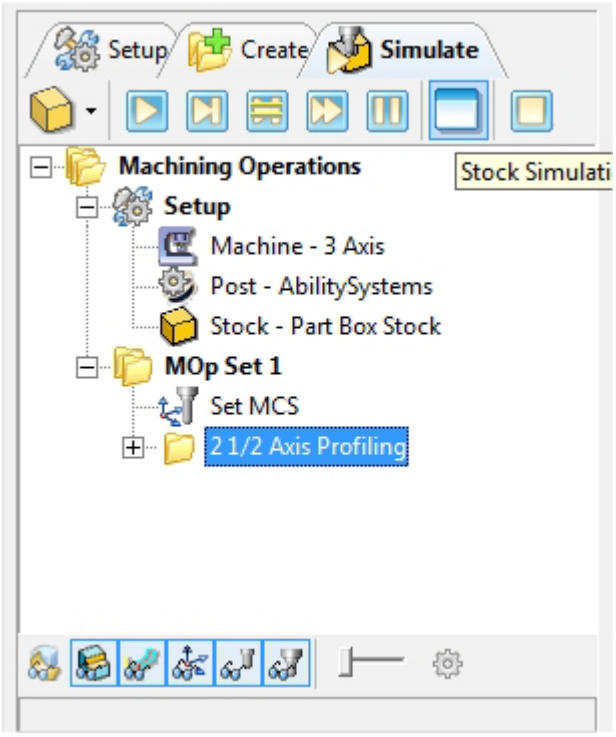
The generated toolpath can now be simulated. Make sure to turn on Stock Visibility under the Simulate tab.



1. Switch to the Simulate tab in the Alibre CAM -MOps browser.



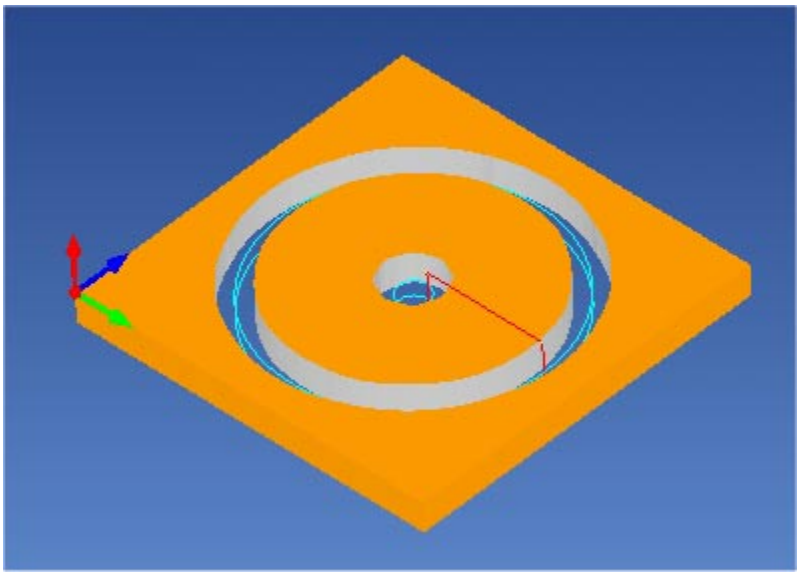
2. Select the 2 ½ Axis Profile Operation and click  to launch the Alibre CAM Stock Simulation window.



3. Click Simulate from the Stock Simulation window to run simulation.

The simulated part is as shown below.

Note: You can adjust the simulation speed by selecting Simulation Preferences that is located to the bottom right corner of the Simulate tab Alibre CAM-MOps browser or from the Stock simulation window.



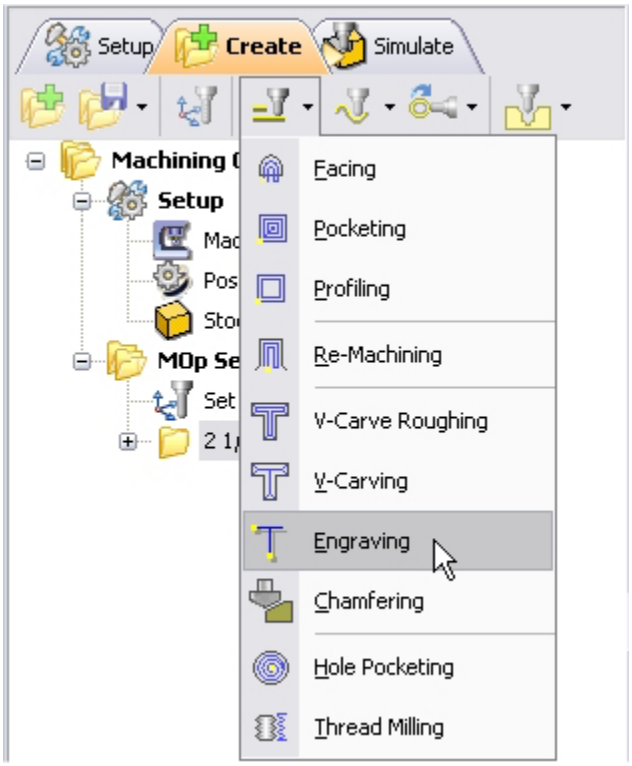
4. Once the simulation is complete, you can close the Stock Simulation window and return to the Alibre CAM browser.

Creating an Engraving Operation

Now we will use engraving operation to cut the slots of the gear by driving the 0.25” tool in the slot. As already mentioned, the most efficient way of machining slots is to use the Engraving option and drive the cutter along the center of the slot.

1. Switch to the Create Operation tab.

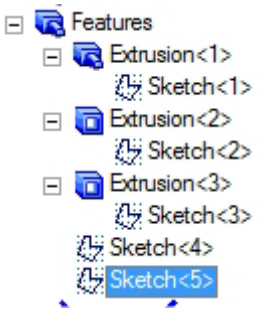
2. Select Engraving from the 2 ½ Axis operations menu.



Select Machining Regions

1. Under Machining Features/ Regions click on Remove All to deselect any regions that could have been selected from the previous machining operation.

2. Now click on Select Curves as Regions and select **Sketch5** from Design Explorer. This will select the 6 line segments on the slotted gear as shown below.

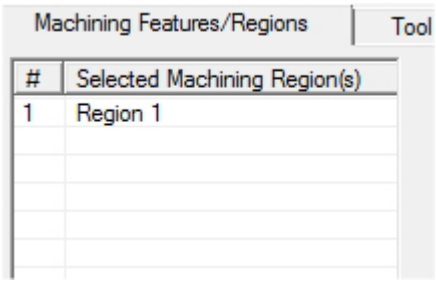


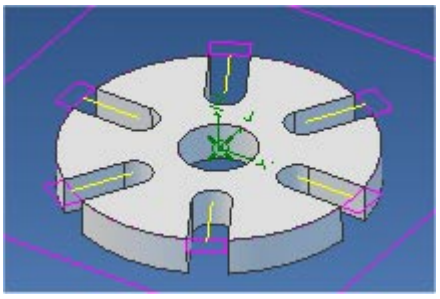
   Note: You can also select the sketch from Alibre Design View. When select containment region is selected, Alibre CAM turns on Sketch selection filter to allow the user to select sketches. Hold the Shift key down to select multiple sketches.

3. Click 

to complete the selection.

The 2 ½ Axis Engraving operation dialog comes back up displaying the selected region. The selected regions are also highlighted on the part.





Select Tool

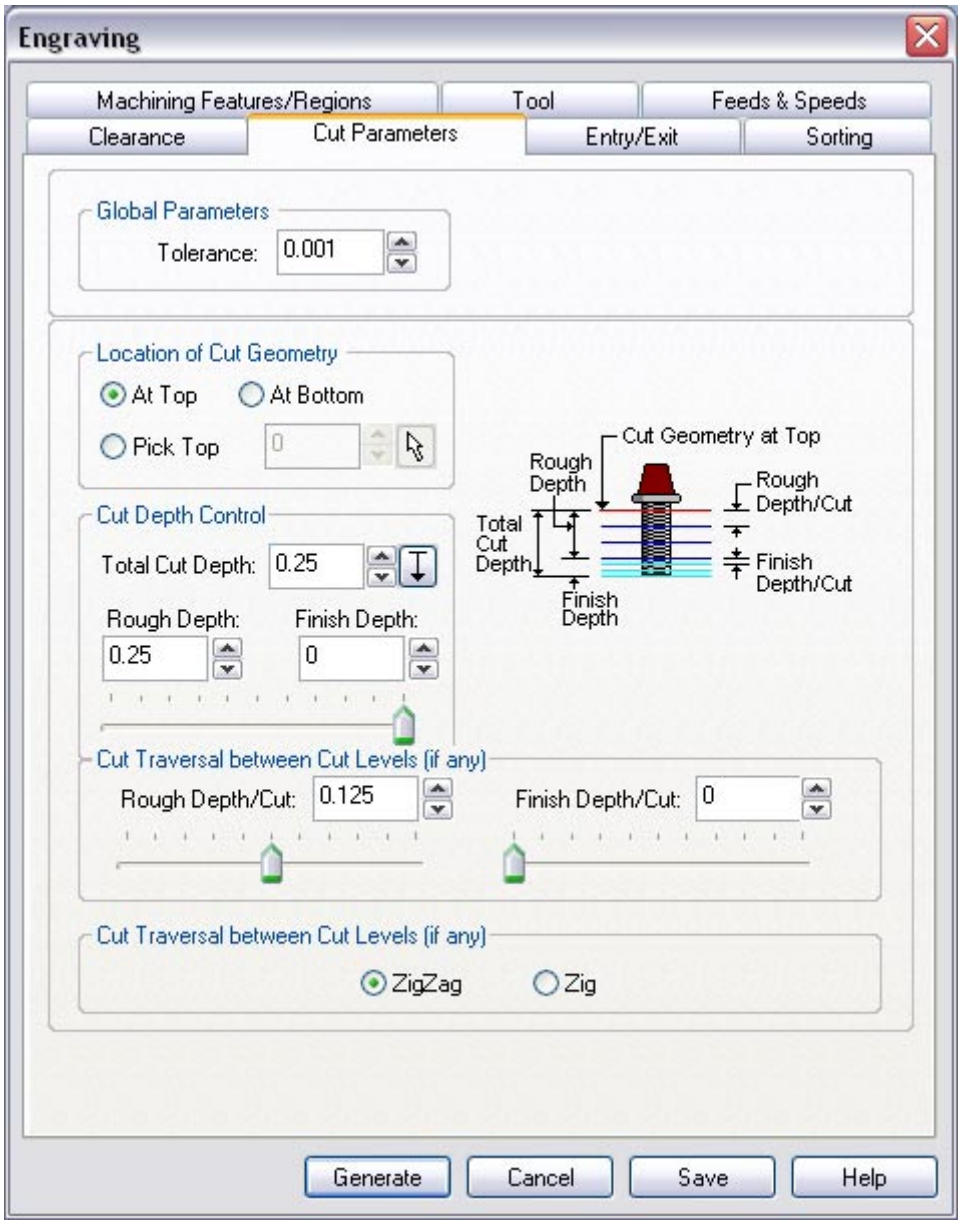
4. Switch to Tools tab and select **FlatMill-0.25** as the active tool.

5. Under Feeds/Speeds, select **Load from Tool.**

6. Set the Clearance control to **Automatic.**

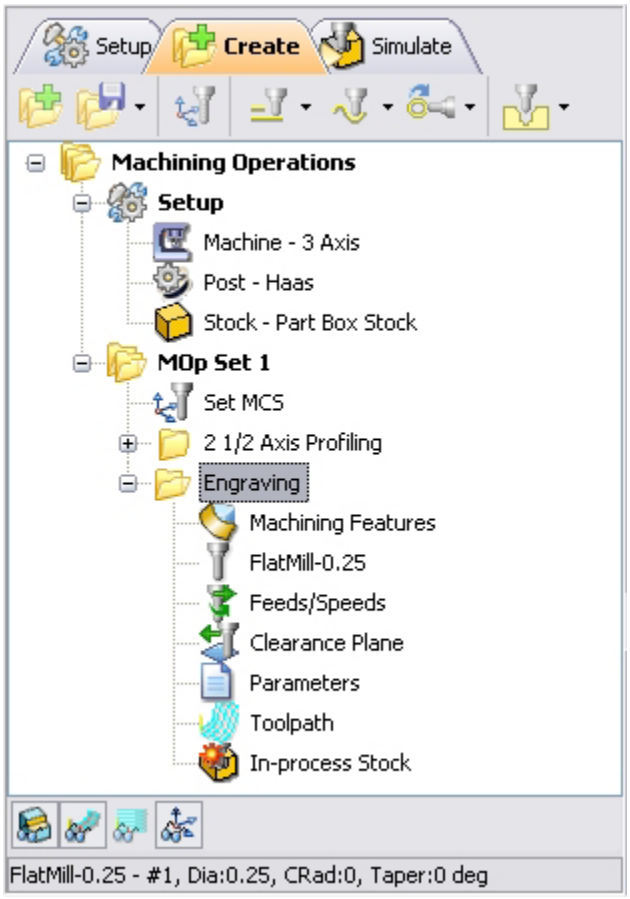
Specify Engraving Cut Parameters

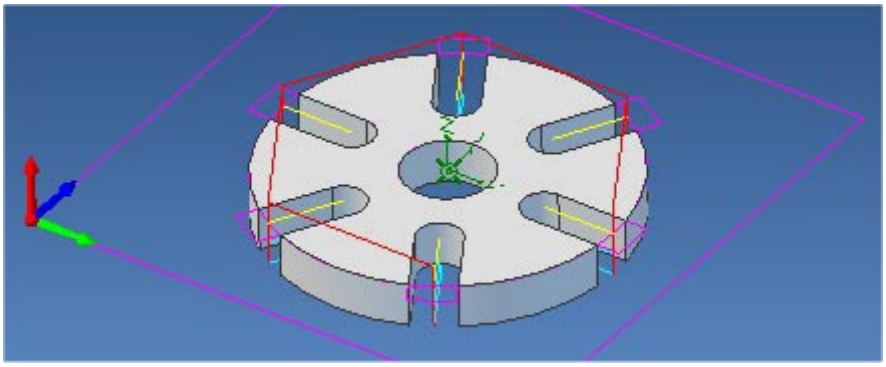
7. Switch to Cut Parameters tab. Under Cut Depth Control, set the Total Cut Depth = **0.25**, Rough Depth = **0.25**, and Rough Depth/Cut = **0.125**, Cut Traversal between cut levels = **ZigZag**.



8. Click **Generate** to Create the Engraving Toolpath.

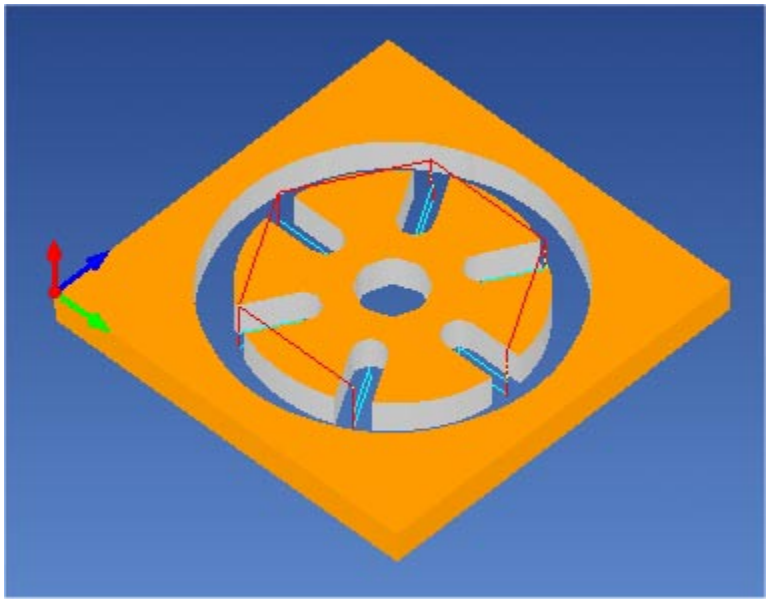
9. The Engraving Operation is now created and is listed in the MOps Browser.


Setup
Create
Simulate
Machining Operations
Setup
Machine - 3 Axis
Post - Haas
Stock - Part Box Stock
MOp Set 1
Set MCS
2 1/2 Axis Profiling
Engraving
Machining Features
FlatMill-0.25
Feeds/Speeds
Clearance Plane
Parameters
Toolpath
In-process Stock
FlatMill-0.25 - #1, Dia:0.25, CRad:0, Taper:0 deg



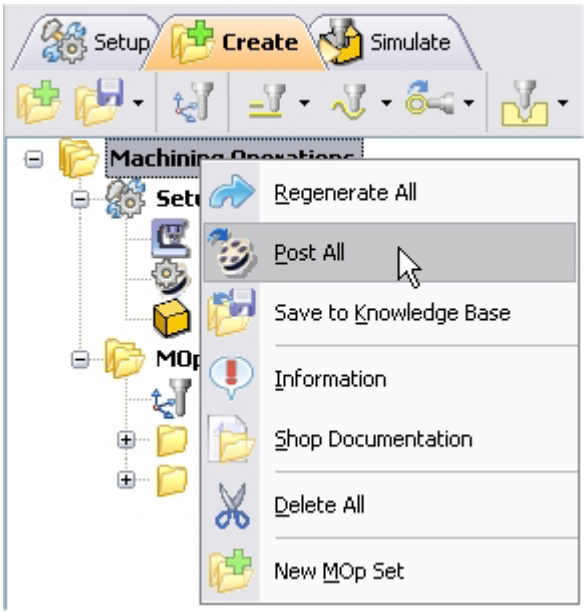
Simulate Toolpath

1. Switch to Simulate Tab, select Engraving, and click  to launch the Alibre CAM Stock Simulation window



Post Processing

1. Select Machining Operations from the Create Operations tab and right click and select post process.



2. Specify the File Name as **SlottedGear.nc** and click Save.

The post by default is set to Haas as specified under the Post processor setup. You can change the post processor by selecting a different one from the drop down menu in the list. The posted g code by default will be saved to the folder where the part file is located.