Version 14 : September 2020

Machine Simulation Tutorials

Proprietary Notice

Creating a Sample Machine Model

The following material presents a detailed tutorial for creating a sample machine model with simulation bodies, using the Test Machine functions to validate the model at various points along the way.

Summary of Steps

Step 1: Start Machine Manager and initialize a new MDD

1. 

Go to Plug-Ins > Machine Manager. (If you see no such menu item, use Plug-In Manager to activate it.)

   Machine Manager opens, showing the most recent MDD.

2. Change the machine type to 3-Axis Vertical Mill.

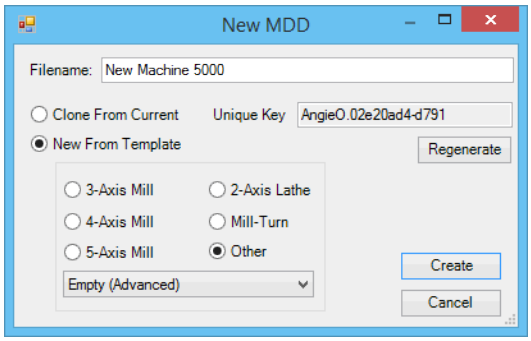
   This is the simplest machine to start with.

3. Click New to create a new MDD.

We now have a 3-axis mill MDD that we can customize.

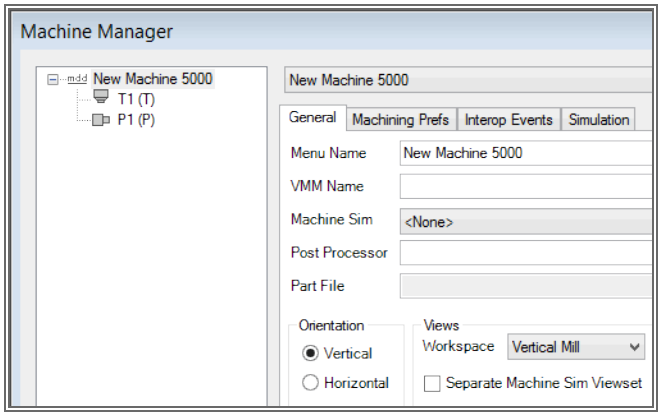
4. Type in Filename:New Machine 5000.

5. Choose bullet option New From Template.
6. Choose bullet option Other and from the dropdown that appears, select Empty.



7. Click Create. A new Machine Manager dialog opens for the New Machine 5000.

   The Kinematic tree contains the minimum it could possibly contain: one Toolgroup (T) and one Part Station (P), nothing else.

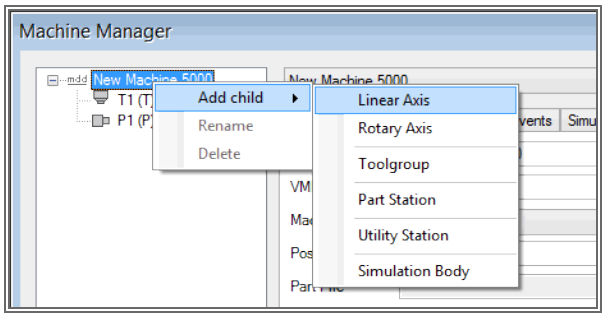


Step 2: Add and configure the three linear axes

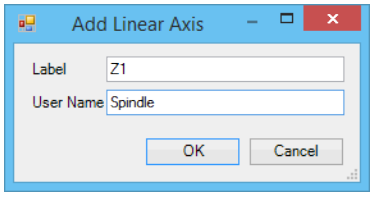
Z Axis

First we will add the Z axis. It is not necessary to add items in any particular order, we will begin with the Z axis because it is on the tool branch and it addresses the part.

1. Right-click the Root Node > Add child > Linear Axis.

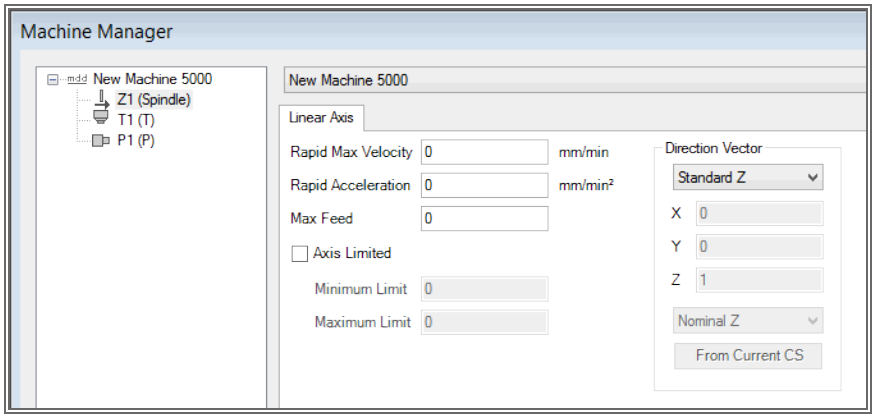


2. Enter details as shown. Label: `Z1`. User Name: `Spindle`. (The convention for Tool axes is to start with 1 and go up.)



Please Note: The User name of an axis entered here will appear throughout Machine Manager (including Test Machine and MTG) and also in Render Tracking.

3. Click OK and see the result:

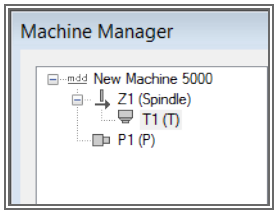


- Tree has Z1 directly below root (sibling with T1 and P1) and is selected.
- The Linear Axis tab opens and shows what options you have for a linear axis.

Now we will configure the Z axis.

4. In the Direction Vector area, a pulldown menu provides options for X,Y,Z, Standard and Reversed vectors, plus a Custom option. Retain the default (Standard Z).

5. In the tree, `click and drag` T1 onto Z1.



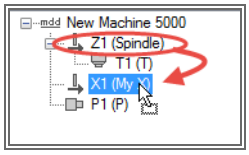
X Axis

Next, we will add the X axis.

`Right-click` Root > `Add child` > `Linear Axis`. Lable it `X1`, user Name: `My X`.

We will now configure the X axis:

6. In the `Direction Vector` area, again retain the default (`Standard X`) from the pulldown menu.
7. In the tree, drag Z1 onto X1.



Notice how the subtree (T1) comes along.

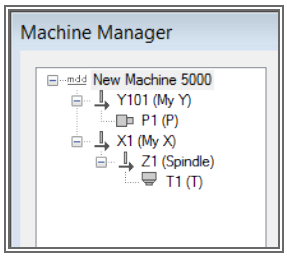
Y Axis

Finally we will add the Y axis.

8. `Right-click` Root `Add child`> `Linear Axis`. Label: `Y101`, (The convention for Part axes is to start with 101 and go up.) user Name is `My Y`.

We will now configure the Y axis.

9. In the `Direction Vector` area, pulldown menu, retain the default (`Standard Y`).
10. In the tree, drag P1 onto Y101.



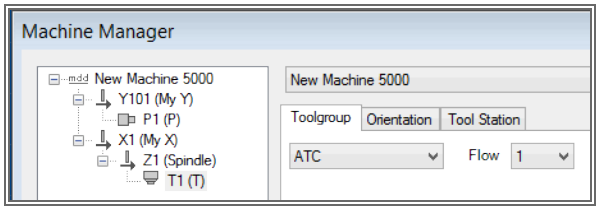
11. Save the MDD.

We have created a very basic 3-axis machine but it needs much more detail. The next item we will configure for this example machine, is an ATC toolgroup.

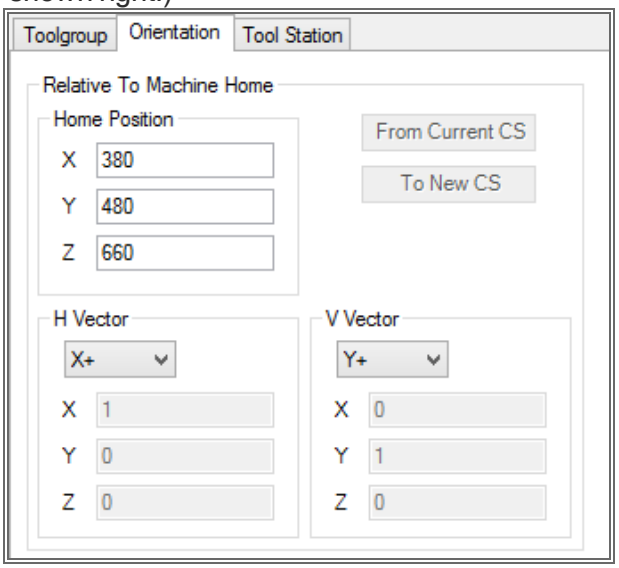
Step 3: Configure the toolgroup

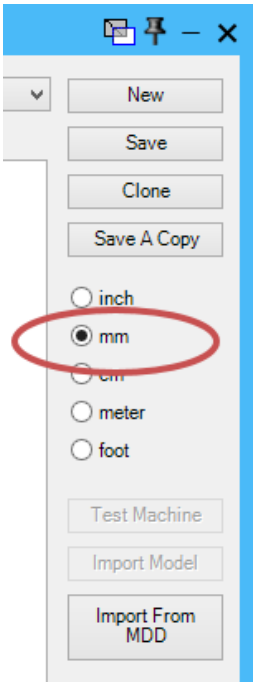
1. In the Kinematic tree, click T1.

   The dialog presents three toolgroup-specific tabs.



2. Select the second tab (**Orientation**) and enter the following: (double check that the dimension selector is set to mm as shown right.)





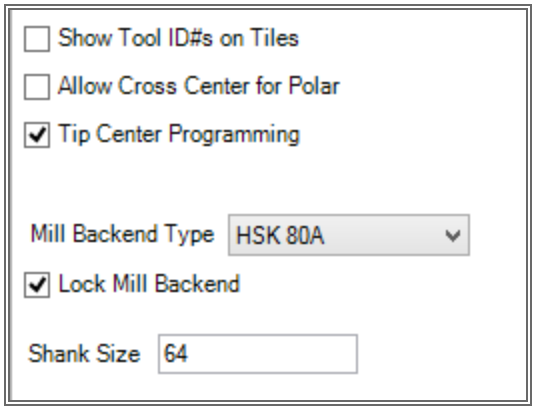
   Retain the H Vector and V Vector defaults.

   Select the first tab (Toolgroup) and:

3. In the pulldown menu, change the type to ATC (Automatic Tool Changing head).

   Notice that many other controls on the tab just go away, as they are not needed.

4. Change the other options as shown below:



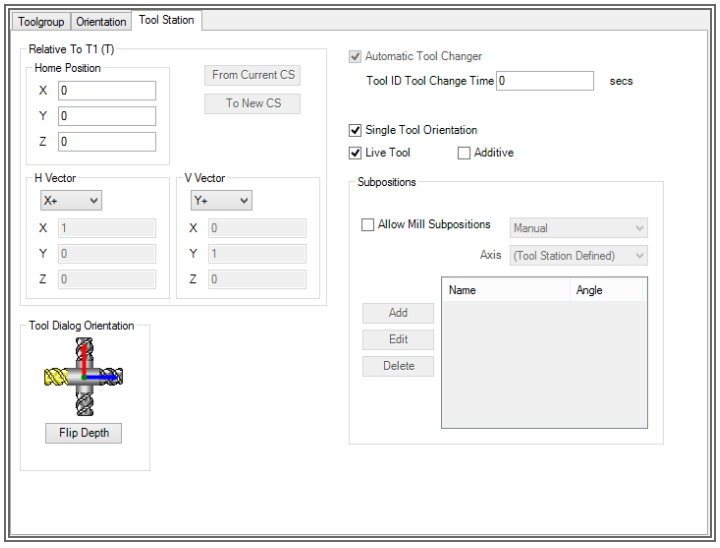
We checked the box for Lock Mill Backend since only one backend will ever be encountered (as is the usual case). The value entered into the Shank Size box represents a maximum shank size. ie. in this case no greater than 64mm.

5. Select the Tool Station tab and enter the following:

- Retain values for "Home Position".
- Select the checkbox for Single Tool Orientation.

  This means that when users see the tool dialog, they will not have to choose from the stations on the tool cross.
- Retain the selected status for the Live Tool checkbox.
- Retain default choices for vectors.

  Note: If your machine had right-angle heads, these would have to be configured. In this case it is not necessary.



6. Save the MDD.

We still have the rotary axes to add, but before that we will create some Simulation bodies so that we can start using Test Machine.

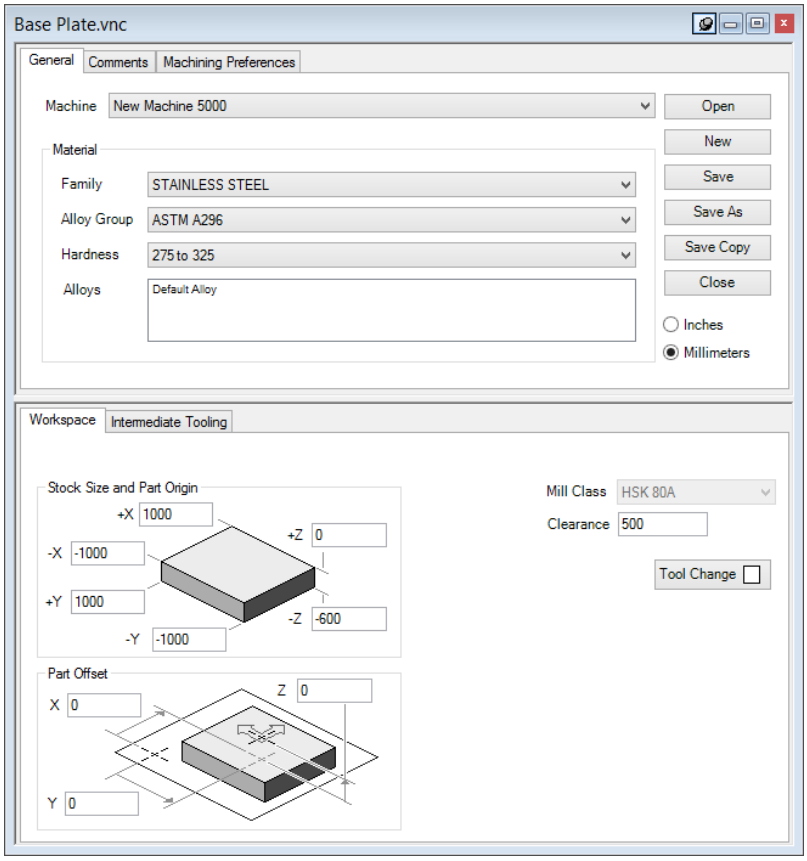
First we will add a base plate and color it black, and then add a cylinder to represent the spindle, which will be red.

Move the Machine Manager dialog to the top of the workspace and `Click` the roll-up icon  on the title bar to hide the dialog.

Step 4. Add the first two simulation bodies and test the machine

First we will make a black Base Plate which will be used only for simulation purposes.

1. File > New. Call the file `Base Plate` and save it in your preferred tutorial directory.
2. In the DCD enter the following mm values:

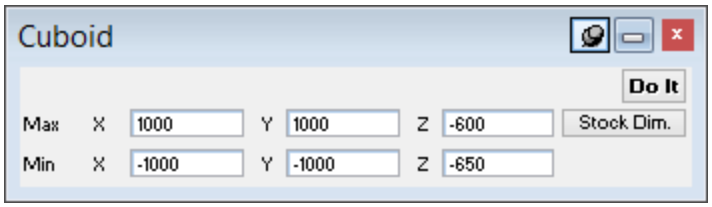


3. Close the DCD dialog.

   In the part file, make sure you are in isometric view. We will now create a large cuboid.

4. Open the Create Solid dialog and choose Cuboid. (Solid Modeling > Create Solid > Cuboid).

5. In the Cuboid dialog, click the "Stock Dim" button. This will supply most of the dimensions you need. Now change Max Z = `-600` and Min Z = `-650`.



6. `Click` Do It.

7. Right-click on the unselected body and choose > User Color from the menu.

8. Change the color of #0 (Body) to Color #25 (black), then close the attribute dialog.

9. Open the CS list dialog. You will be watching it in the next step.

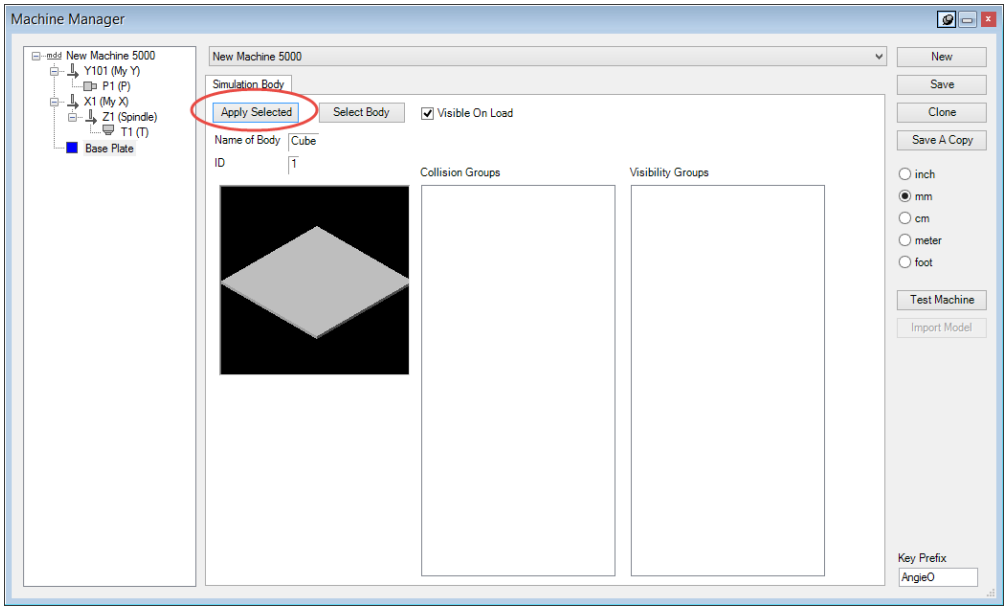
10. Save the part file.

We will now add the base plate body as a Sim body in Machine Manager.

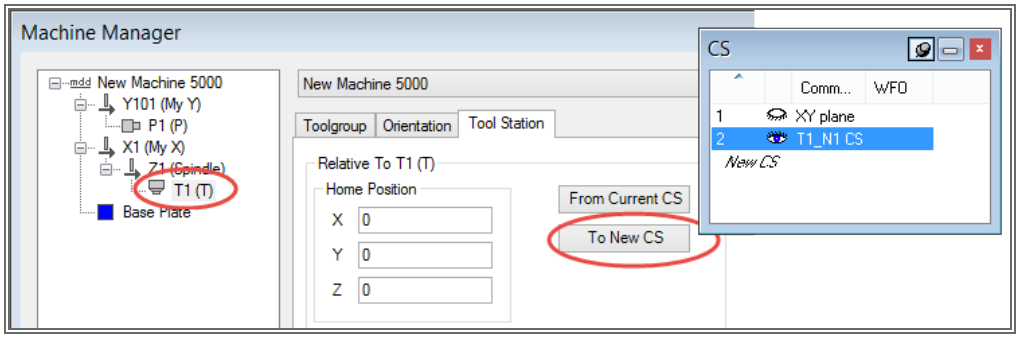
11. Unroll Machine Manager by hovering over the visible title bar.
12. Right-click the Root and choose Add child > Simulation Body.
13. Label the shape Base Plate and click OK.

The Simulation Body tab opens, prompting you to configure the body.

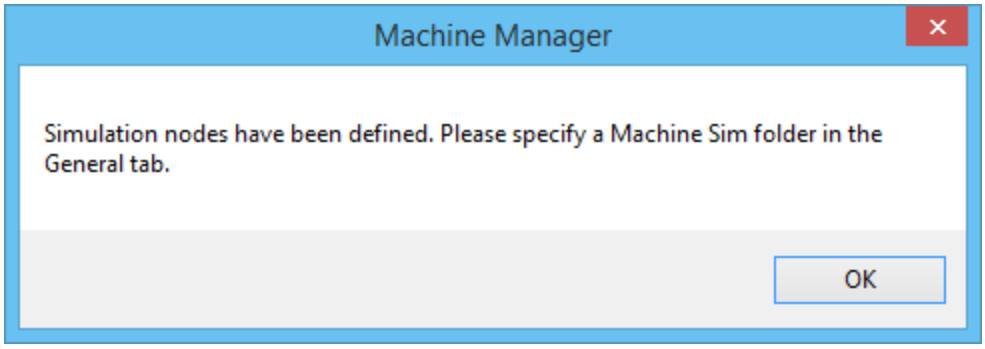
14. Ensure the body in the workspace is selected, then click Apply Selected. The image appears in the first column.



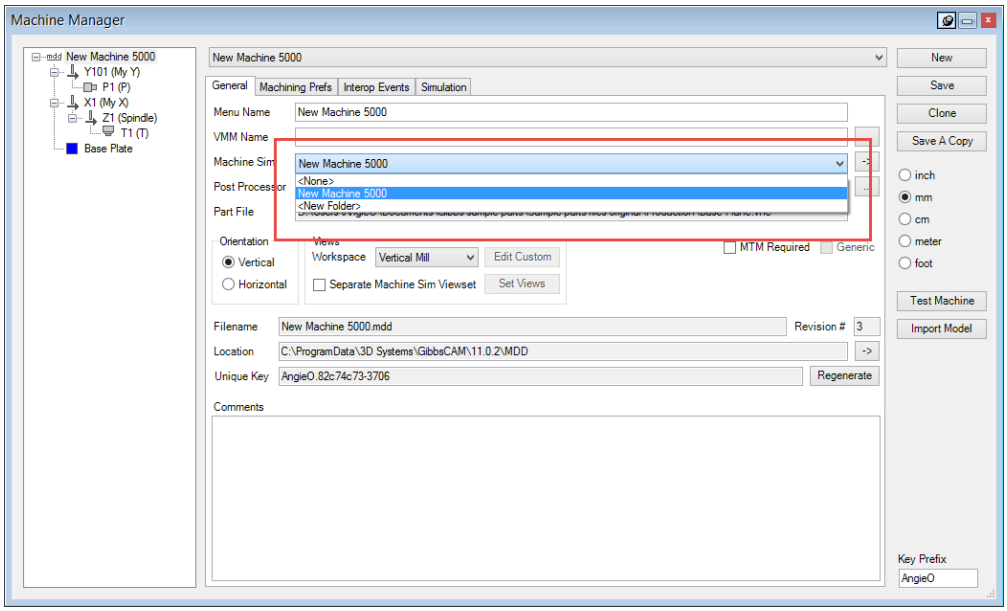
15. Click toolgroup node T1, and in the Tool Station tab click To New CS. Notice a new CS named T1_N1 CS is created.



16. Click `Save` in the Machine Manager dialog. You may be presented with an error message:



17. Click OK and use the dropdown menu in Machine Manager to choose the Machine Sim subfolder `...\<version>\MachineSim\NewMachine5000`. All Simulation parts will now be saved to this location.

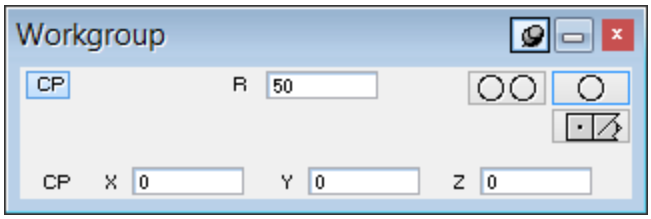


18. Roll up Machine Manager by moving your cursor out of the dialog.

We will now make a second Sim body in the `Base Plate` file, a basic spindle:

19. Change CS to the newly created, `T1_N1 CS`.

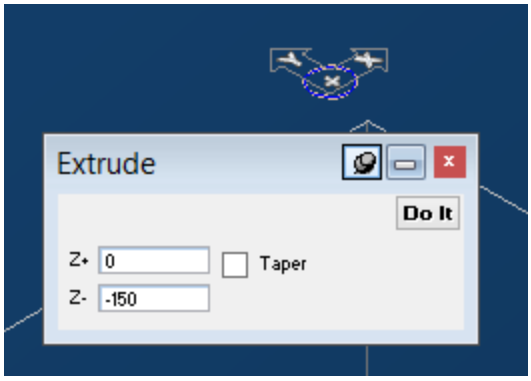
20. Create a circle as shown below  Geometry >  Circle >  (center and radius).



This circle will be used to create an extruded body to represent the spindle.

21.  Create Solid >  Extrude:

22. Select the circle. Enter the following values and click Do it.



23. Right-click the unselected body and choose User Color. Set the color of #0 (Body) to Color #10 (red).
24. Select the new solid body.
25. Save the part file.

Now we will add the cylinder as a Sim body in Machine Manager.

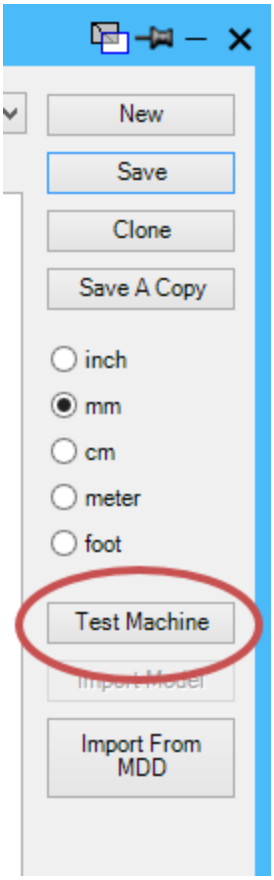
26. Hover over the rolled up Machine Manager to open it.
27. Right-click Z1 Add child > Simulation Body. Call it `Tool Spindle` and ensure Apply Selected is checked, then click OK.
28. Verify that the image is as you expected.
29. Save the MDD.

We are now able to use the Test Machine function for a very basic test.

1. Click Test Machine. (If prompted to do so, save the current MDD.)

   Move the cursor out of the Machine manager dialog to re-pin it. The Test Machine dialog and Machine Sim Rendering palette will be visible.

   - On the Test Machine dialog, slide the X1 slider and the Z1 slider and see how the "spindle" moves and the base plate does not.
   - Slide the Y101 slider and see how nothing moves.
   - Close the Test Machine dialog.

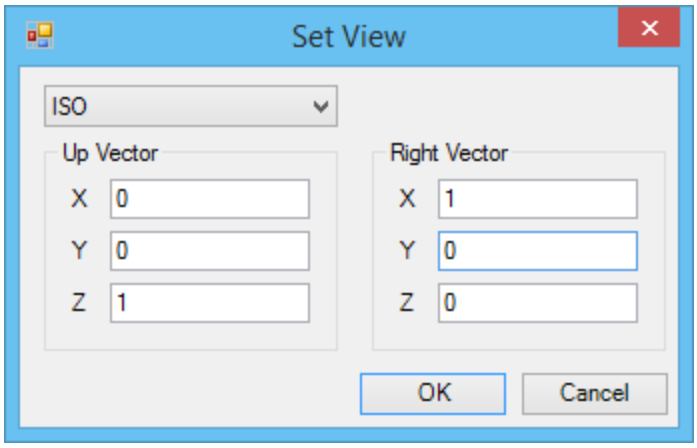


You may have noticed that the machine's ISO view is different from GibbsCAMs .

We will be fixing this in the next step.

Step 5 Set the machine's ISO view to reversed

1. In Machine Manager, click the Root node (and then, if necessary, the General tab).
2. Click the Workspace pull-down in the Views section and select Custom.
3. Click the Edit Custom button, enter the following, then click OK.

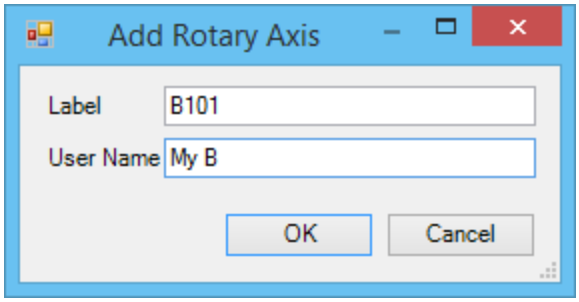


4. Save the MDD.
5. Click `Test Machine` and press `CTRL+I` to change to the new machine-ISO view.
6. Slide the X1 slider and note the corrected behaviour. Close the Test Machine dialog.

Steps 6 Add another axis and Sim body, and test the machine

Now we will add the first rotary axis.

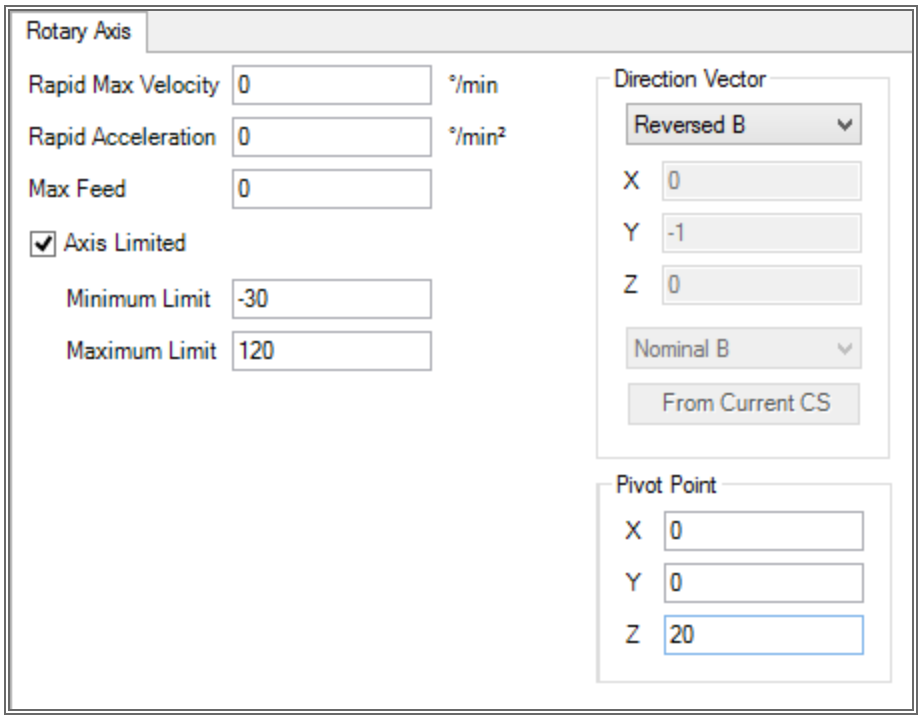
1. In Machine Manager, right-click Y101 and `Add child > Rotary Axis`. Enter details as follows then click `OK`.



2. In the Rotary Axis tab, change the `Direction Vector` to `Reversed B`.

   (Remember that this machine's ISO is reversed.)

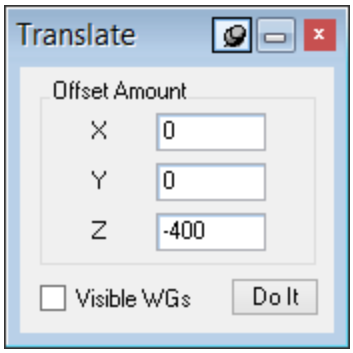
3. Select the "`Axis Limited`" checkbox and set the values as shown.



4. Save the MDD and roll up Machine Manager.

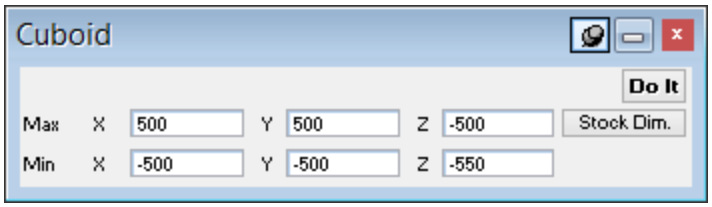
We will now create the third Sim body, the brown Table in the part file.

5. Select CS: XY plane.
6. Select the base plate, and move it down out of the way: using Modify > Translate as shown below. Do it.



Now we will create a cuboid to represent the table:

7. (Create Solid >) Cuboid as shown. Do It.



8. Right-click (unselected body) you just created> User Color and change the #0 (Body) to Color #20 (brown).
9. Save the part file.

Return to Machine Manager and add the new brown cuboid as a Sim body.

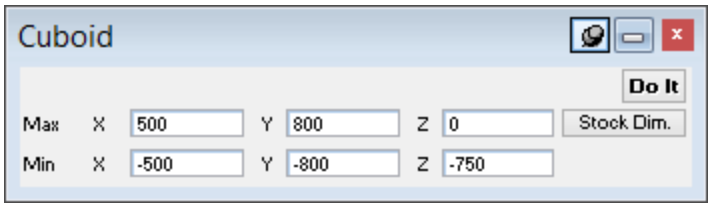
10. Select the brown body, and then unroll Machine Manager.
11. Right-click B101: Add child > Simulation Body. Call it Table and ensure Apply Selected is checked, then click OK.
12. Verify that the image is as you expected.
13. Save the MDD.

Click Test Machine again and notice the new B101 slider. Experiment with the B rotations and Y slides, and then close Test Machine.

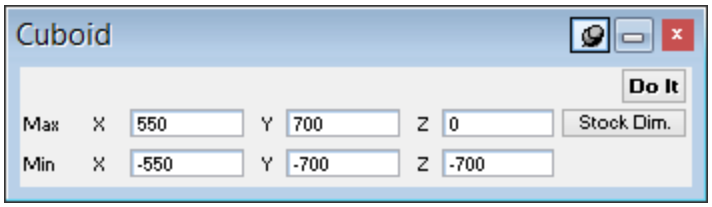
Step 7 Add remaining axis and sim body, and test the machine

In the part file we will create two cuboids whose intersection will represent the fourth Sim body, a trunion:

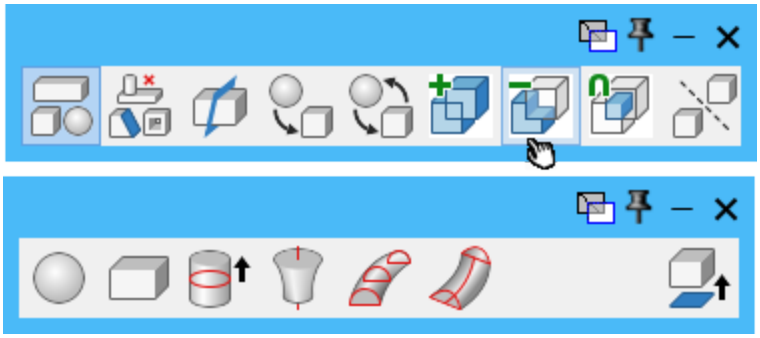
1. In the CS: XY plane, Create Solid > Cuboid as shown: Do it.



2. Now create a second cuboid as shown below: Do it.



3. Select big cube, then Ctrl-select the smaller, (in that order) and Subtract.



4. Right-click the unselected body you just created and change the color to Color #6 (green).
5. Save the part file.

In Machine Manager, we will add the green trunion as a Sim body:

6. Select the green body, and then unroll Machine Manager.
7. Right-click Y101: Add child > Simulation Body. Call it `Trunion` and ensure Apply Selected is checked, then click OK.
8. Verify that the image is as you expected.
9. Save the MDD.

And next we will add the second rotary axis:

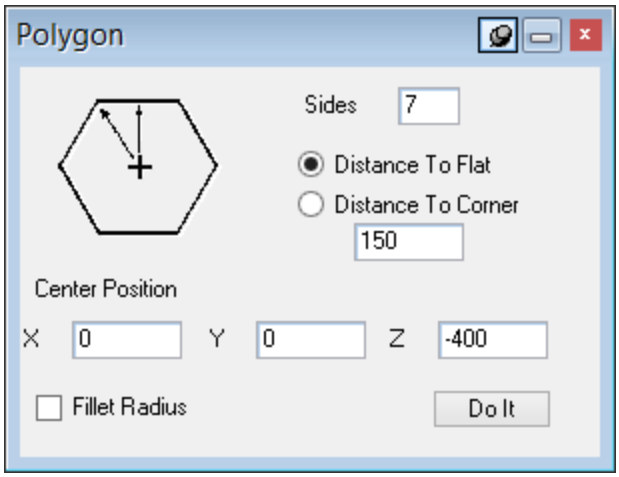
10. In Machine Manager, right-click B101 and Add child > Rotary Axis. Label it `C101`, user name `My C`, then click OK.

    Make sure the Direction Vector is set to Standard C.. The Pivot point can remain as `0,0,0`.

11. Drag P1 under C101.

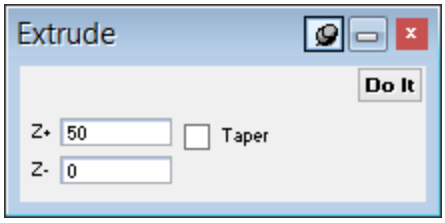
In the part file, we will create the fifth and final Sim body, a purple heptagon:

12. Geometry > Shape > Polygon:



Use this heptagon to create an extruded body representing the spindle:

13. (Create Solid >) Extrude:
14. Double-click the heptagon.

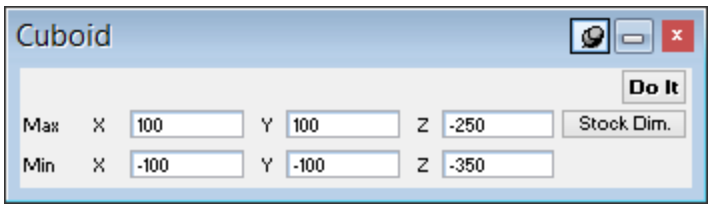


15. Right-click the body and change the color to Color #37 (violet).
16. Save the part file.

In Machine Manager, we will add the violet rotary table as a Sim body:

17. Select the violet rotary table and then unroll Machine Manager.
18. Right-click C101: Add child > Simulation Body and call it `Rotary Table`.
19. Verify that the image is as expected.
20. Save the MDD.

In the part file, make a stock body, a cube:

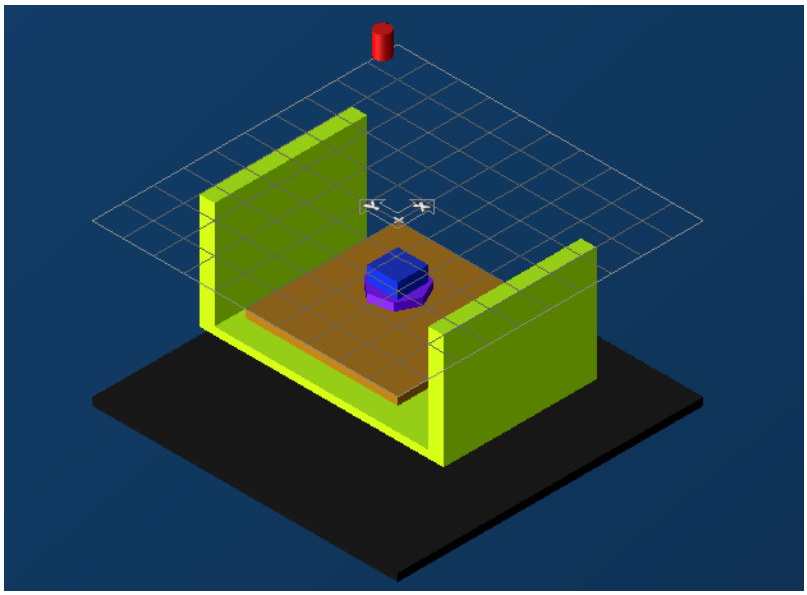


21. Right-click the new cuboid and designate it as stock > `Body type > Stock`.

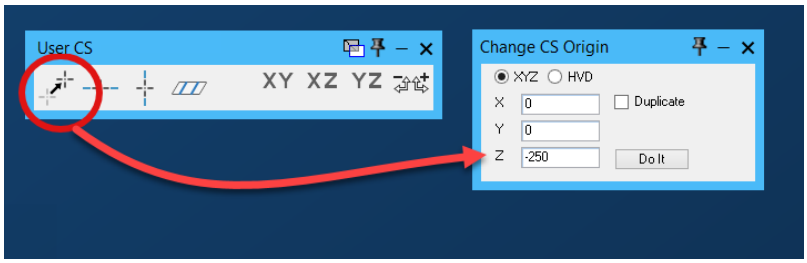
22. Save the part file.

Step 8 Create operations

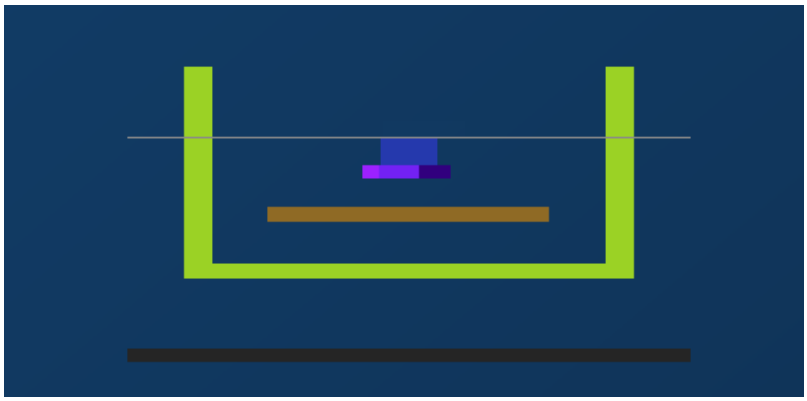
Now we will create a simple machining process that consists of pecking four holes in the stock, to demonstrate that the machine we just created works correctly.



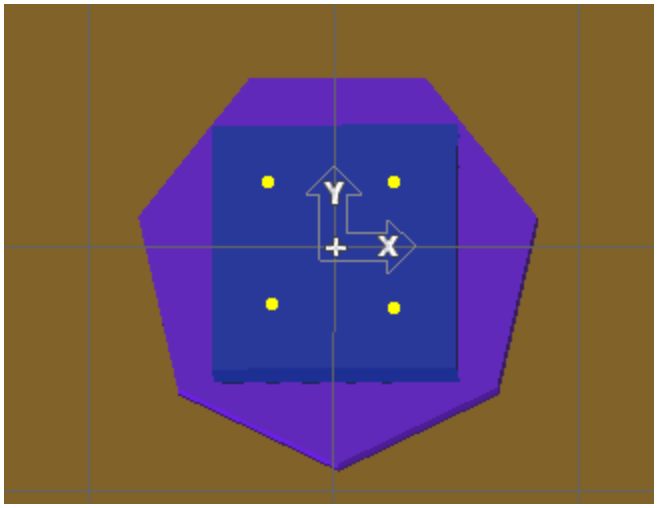
1. Create a new CS off the XY plane, to hold the geometry for the operation.
2. Move the origin to Z -250:



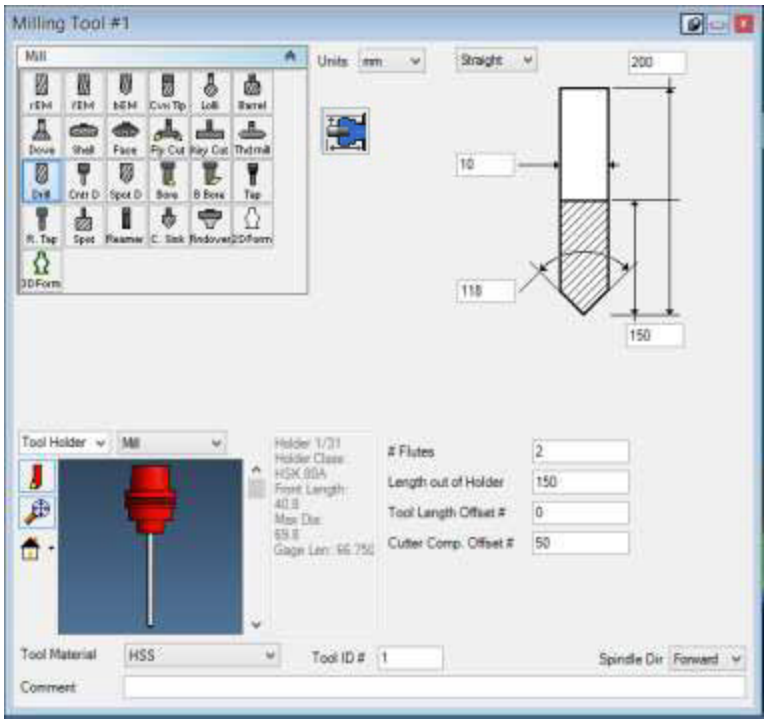
The CS is now on the stock surface



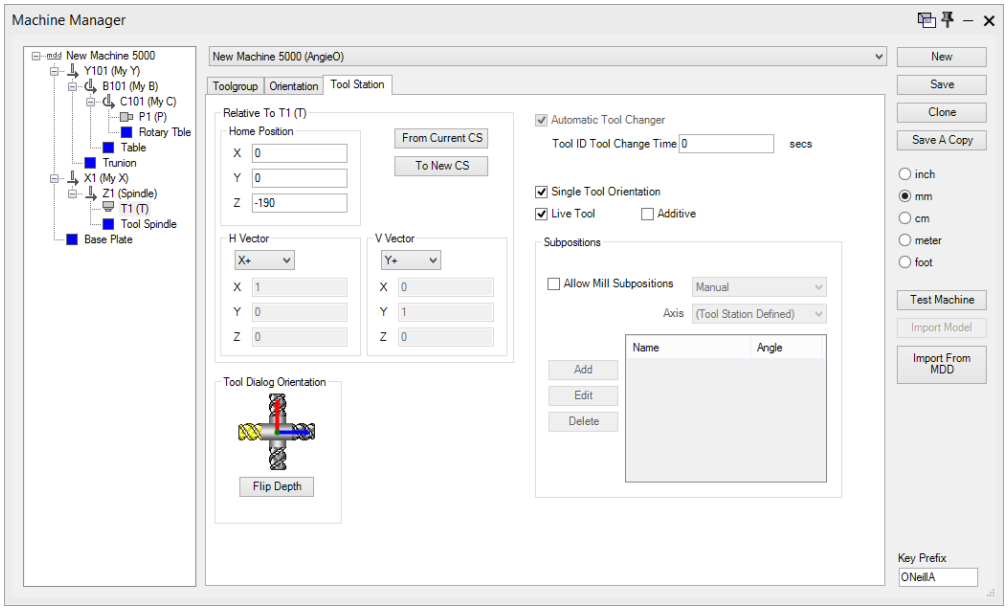
3. With the new CS selected, create four points.

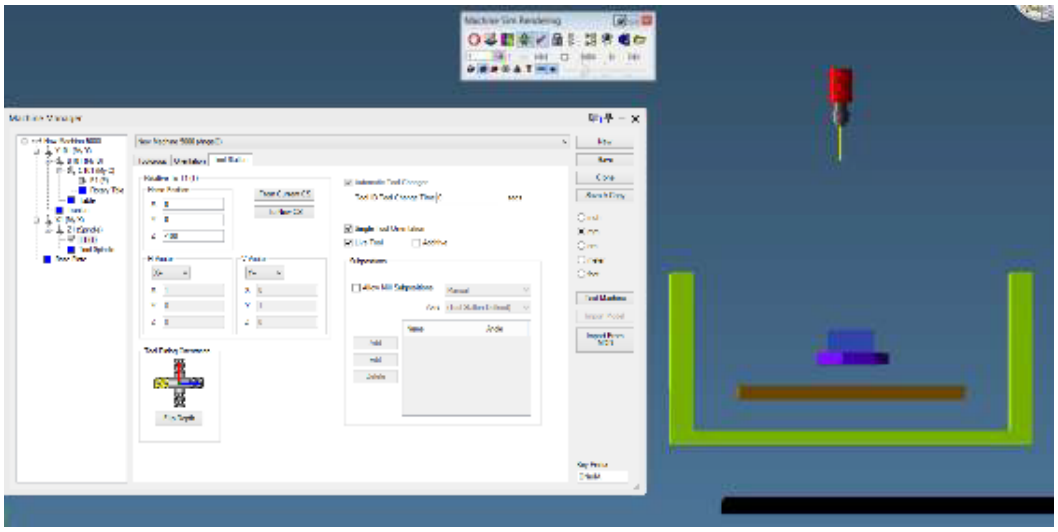


4. Create the tool, using values as shown:



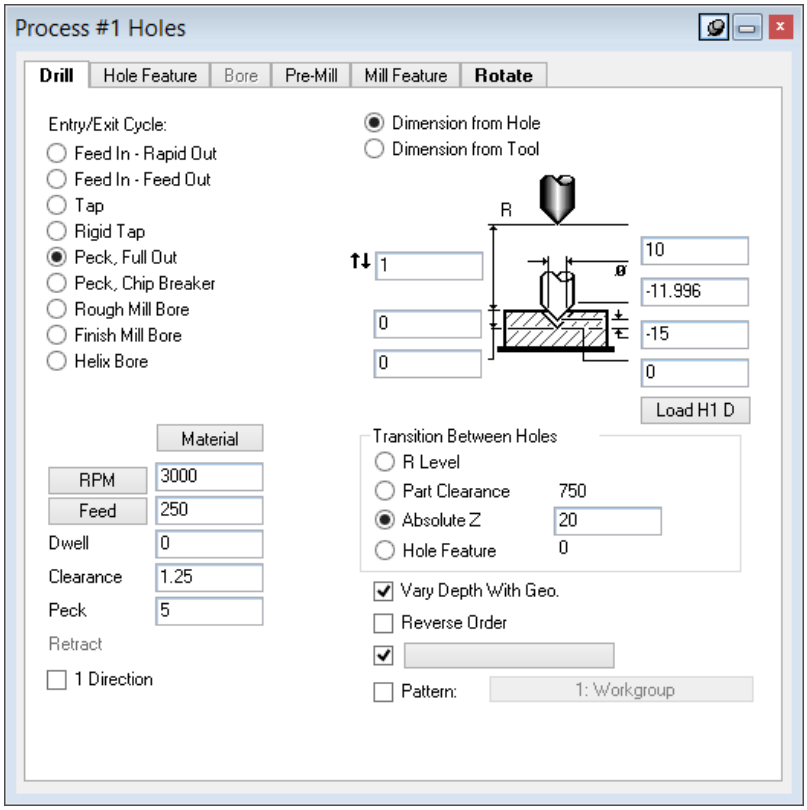
5. Now, set the Home position of the tool. In Machine Manager, T1 (Spindle) **Tool Station** tab, set the Home Position to `Z -190`. This should place the tool and tool holder right below the spindle.



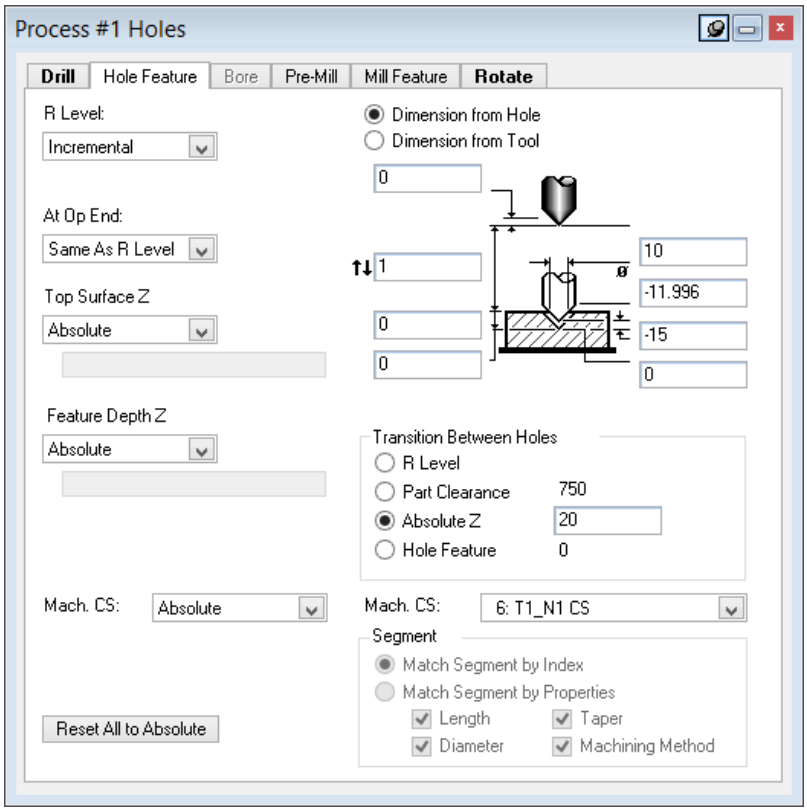


Next, we will set up a Holes process using the **Drill** tab, the **Hole Feature** tab, and the **Rotate** tab.

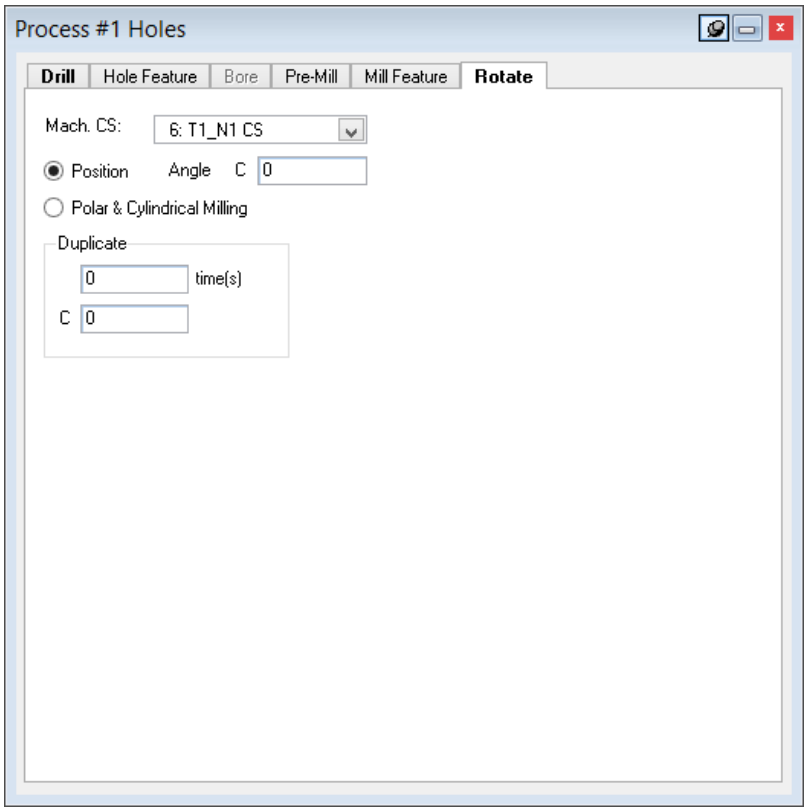
6. Specify settings and values in the **Drill** tab as follows:



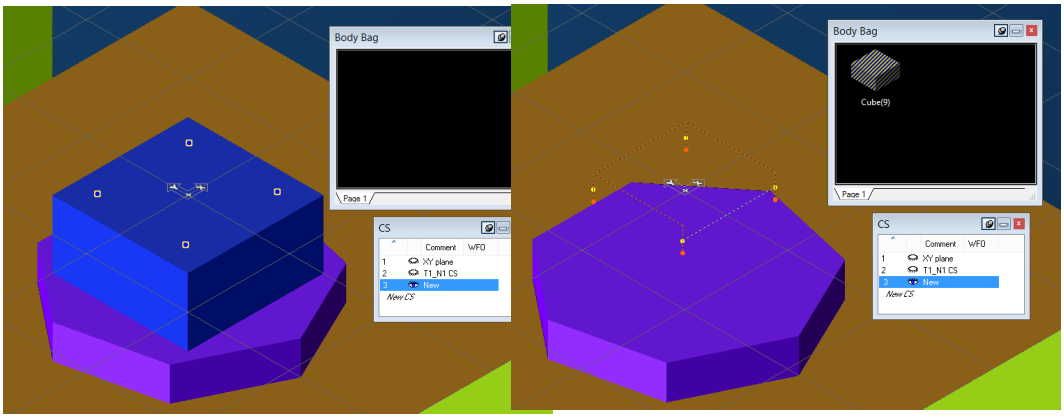
7. Specify settings and values in the **Hole Feature** tab as follows:



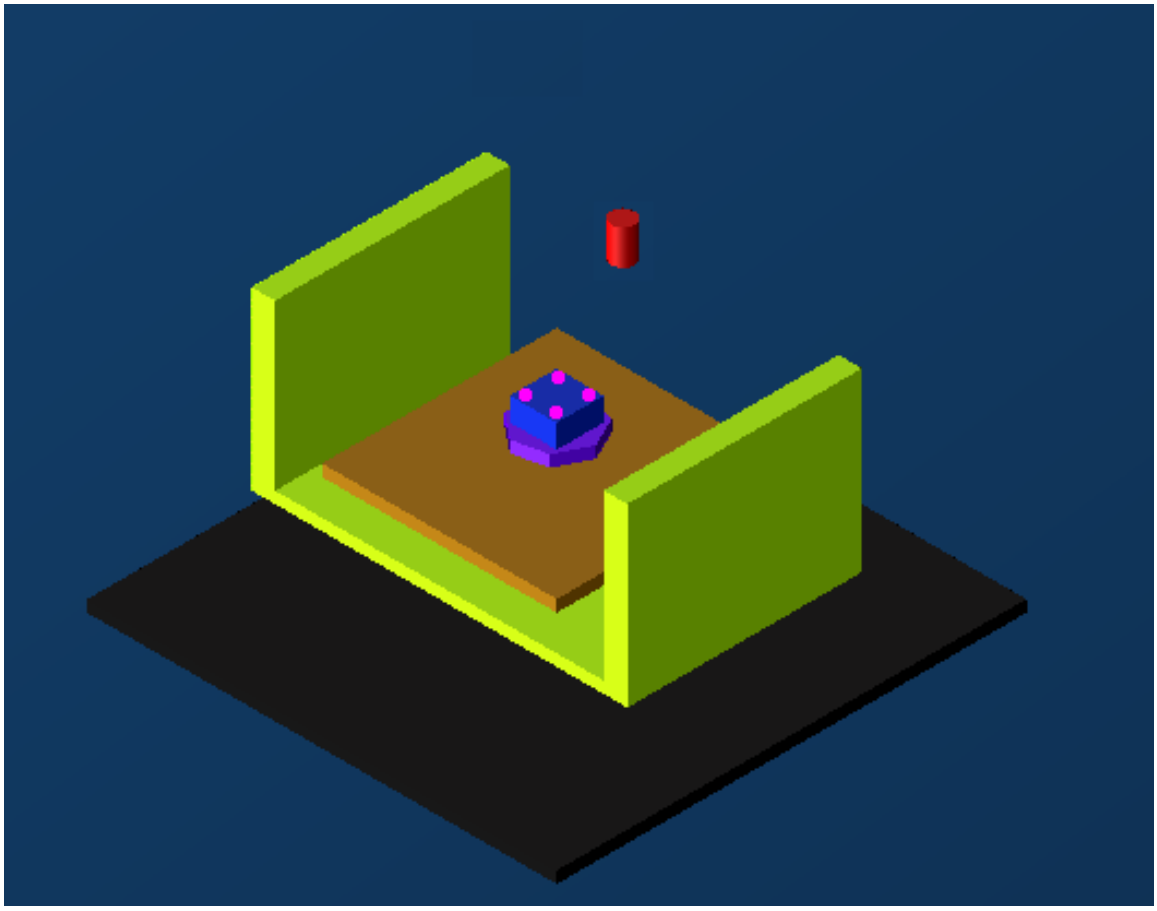
8. Specify settings and values in the **Rotate** tab as follows:



9. In the workspace, select all four of the points on the stock and click Do it. In the screenshot on the right, the stock has been placed in the body bag to show the toolpath.



10. Now render your operations with your new machine.



To use this machine for rendering operations, load your own Mill part file, select Machine Sim Rendering, then click the load machine icon on the Machine Sim palette. Now choose New Machine 5000 from the list and click Load Machine.