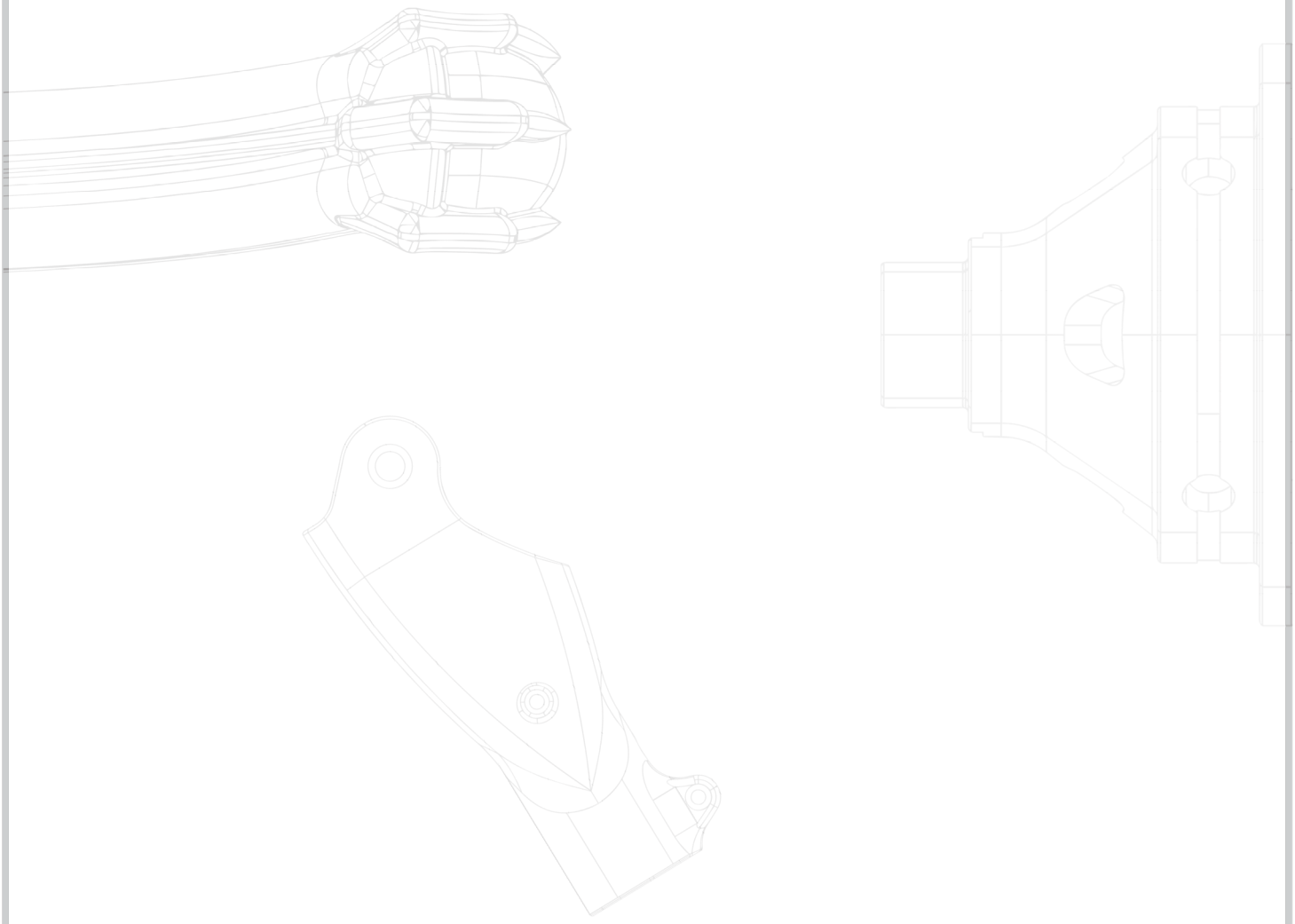
MASTERCAM MACHINE SIMULATION TUTORIAL

June 2018



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Mastercam

MASTERCAM MACHINE SIMULATION TUTORIAL

June 2018

Software: Mastercam 2019

Terms of Use

Be sure you have the latest information!

Information might have changed or been added since this document was published. The latest version of the document is installed with Mastercam or can be obtained from your local Reseller. A ReadMe file (ReadMe.PDF) – installed with each release – includes the latest information about Mastercam features and enhancements.

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INTRODUCTION

Mastercam Machine Simulation is a safe, cost-effective way of proving out 3-axis, 4-axis, or 5-axis Mill or Router toolpaths. Machine simulation helps you detect collisions between your stock, tool, and machine components before sending code to your machine tool. You can use Machine simulation to test possible fixture scenarios and find the ideal location for machining a particular job. It is an additional tool to help you make clean, efficient, and accurate toolpath programs.

Goals

- Introduce you to the machine simulation workspace.
- Illustrate the machine simulation workflow.
- Show the benefits of using machine simulation.
- Analyze toolpath motion with machine simulation.
- Simulate both 3-axis and multiaxis toolpaths.

WARNING: Screen colors in the tutorial pictures were modified to enhance image quality; they may not match your Mastercam settings or the tutorial results. These color differences do not affect the lesson or your results.

Estimated time to complete this tutorial: 2 hours

General Tutorial Requirements

All Mastercam 2019 tutorials have the following general requirements:

- You must be comfortable using the Windows® operation system.
- The tutorials cannot be used with Mastercam Demo/Home Learning Edition. The Demo/HLE file format (`emcam`) is different from Mastercam (`mcam`), and basic Mastercam functions, such as file conversions and posting, are unavailable.
- Each lesson in the tutorial builds on the mastery of the preceding lesson's skills. We recommend that you complete them in order.
- Additional files may accompany a tutorial. Unless the tutorial provides specific instructions on where to place these files, store them in a folder that can be access from the Mastercam 2019 workstation, either with the tutorial or in any location that you prefer.
- You will need an internet connection to view videos that are referenced in the tutorials. All videos can be found on our YouTube channel: www.youtube.com/user/MastercamTechDocs
- All Mastercam tutorials require you to configure Mastercam to work in a default metric or inch configuration. The tutorial provides instructions for loading the appropriate configuration file.

Machine Simulation Tutorial Requirements

In order to run Machine Simulation, you must have the following:

- Mastercam Mill or Router
- A Mastercam part file with at least one toolpath and a surface or solid model of the workpiece.
- A properly configured MachSim machine definition for the desired machine.

The following toolpaths or functions are *not* currently supported in Machine Simulation:

- Lathe
- Wire
- Transform operations
- Block drill
- Axis substitution
- Aggregate head
- Non-motion Feature Based Machining (FBM) preparation operations

CAUTION: Machine Simulation uses the NCI data from Mastercam to simulate your toolpaths. It is not a G code simulation product. Also, Machine Simulation does not use the machine definition associated with each toolpath. This allows you to choose any available machine model and quickly simulate your toolpath.

CHAPTER 1

WELCOME TO MACHINE SIMULATION

This chapter introduces you to the Machine Simulation interface, including selecting a machine for simulation, running a simulation, and selecting options for displaying your part.

Goals

- Starting Machine Simulation
- Navigating through the Machine Simulation interface
- Selecting a different machine

Exercise 1: Opening the part file

1. Start Mastercam using your preferred method:
   a. Double-click Mastercam's desktop icon.

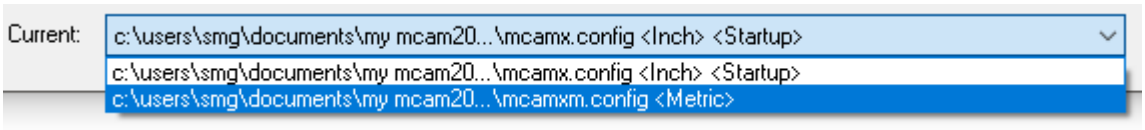
   

   OR

   b. Launch Mastercam from the Windows Start menu.
2. Select the default metric configuration file:
   a. Click the **File** tab.
   b. Choose **Configuration** to open the **System Configuration** dialog box.

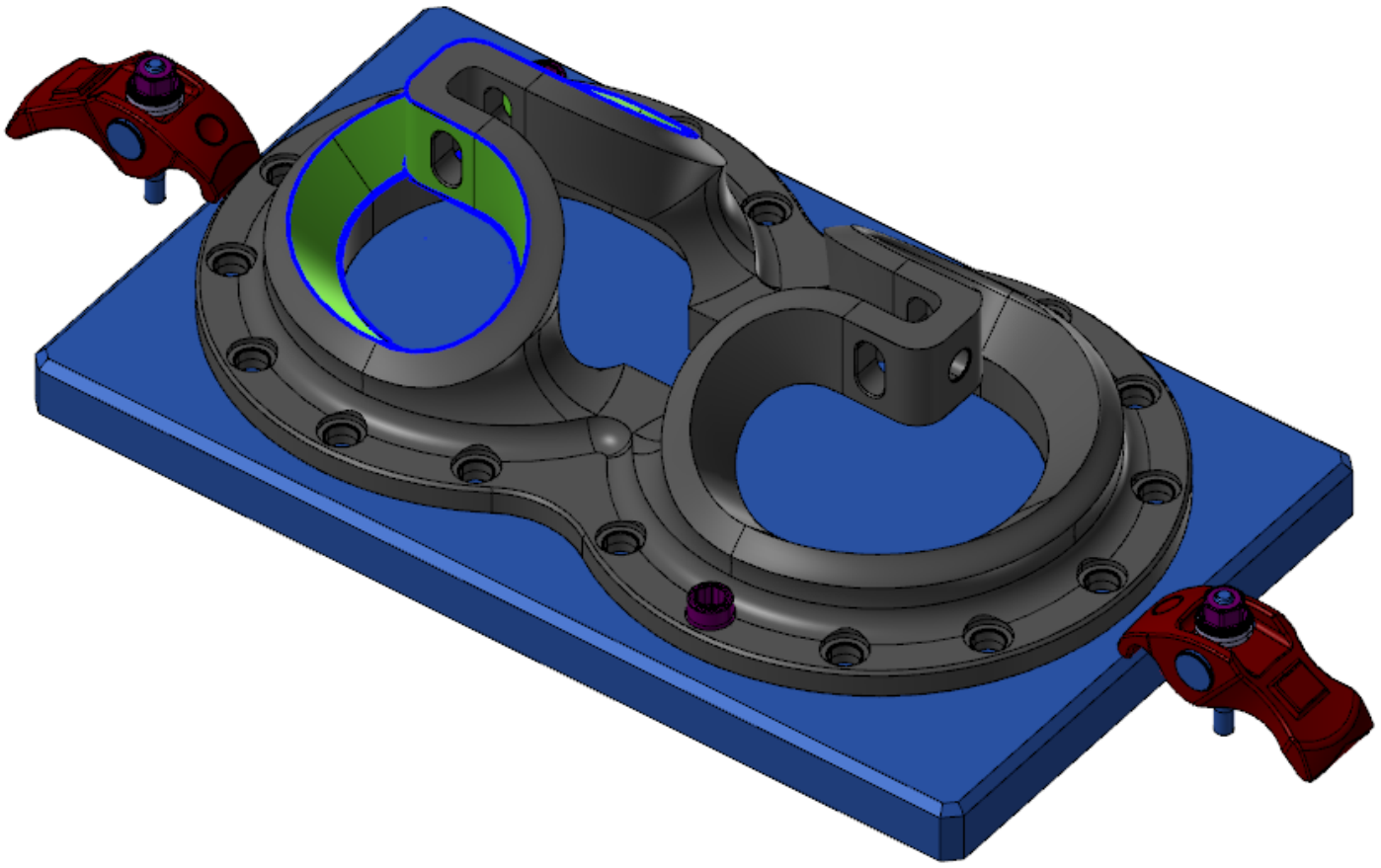
   

   c. Choose `...\mcamxm.config <Metric>` from the **Current** drop-down list.

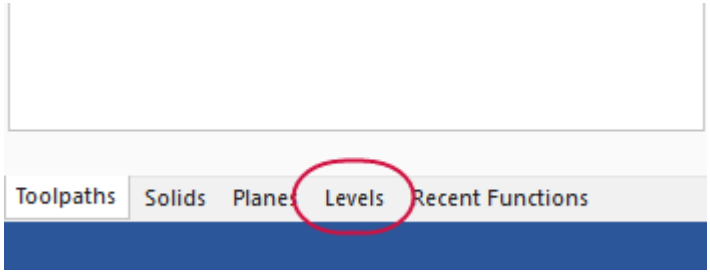
   d. Click **OK**.

3. Open the `SWARF` part file that was provided with this tutorial.

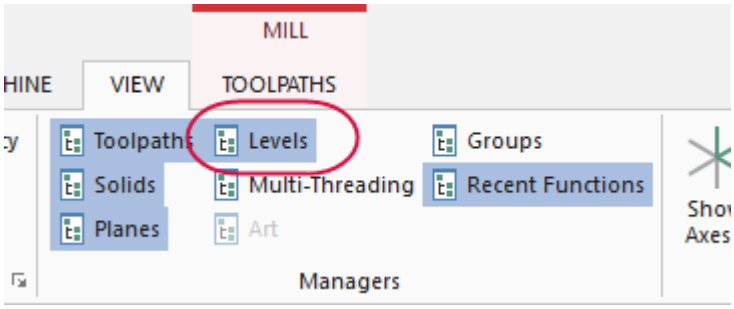


Note: Machine Simulation requires a Mastercam file with solids and/or surface geometry.

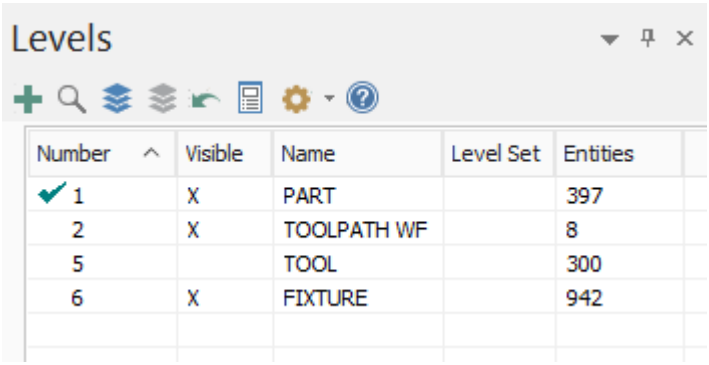
4. Select **Levels** located with the Toolpaths Manager tab to open the Levels Manager.



If the Levels Manager is not displayed, select **Levels** on the **View** tab to toggle the display.

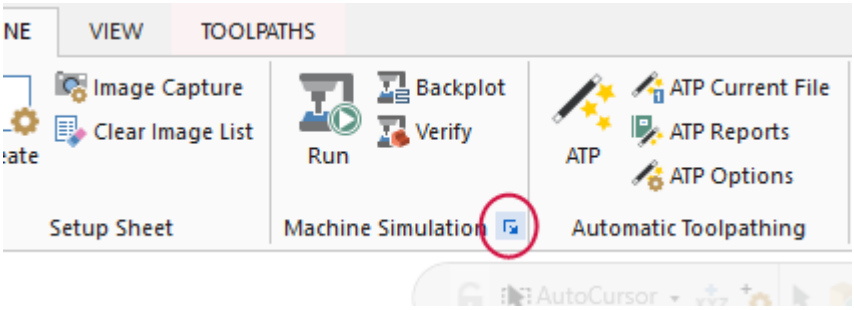


5. Notice that the part is located on the main level and the fixture is on level 6.



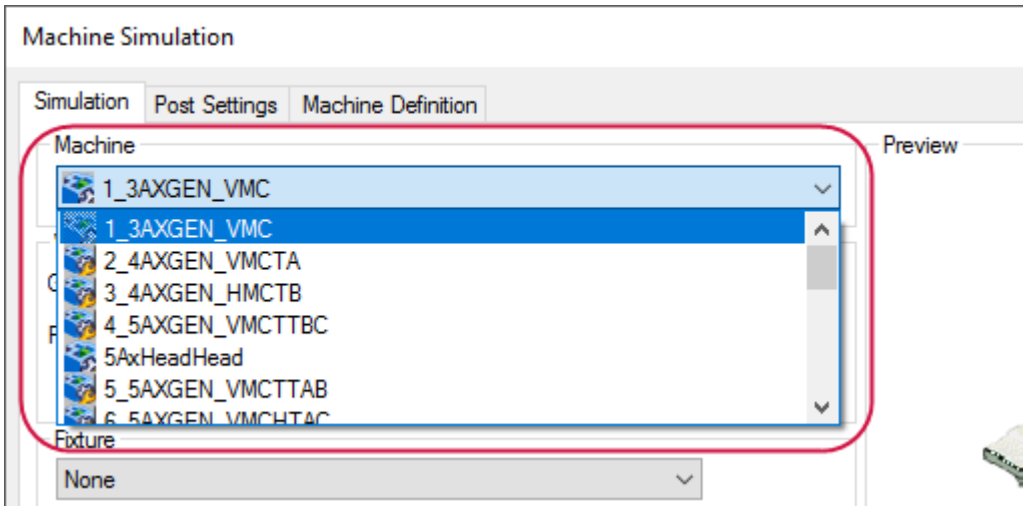
Exercise 2: Preparing the Simulation Environment

1. Select the dialog box launcher in the Machine Simulation group on the **Machine** tab.



The **Machine Simulation** dialog box displays.

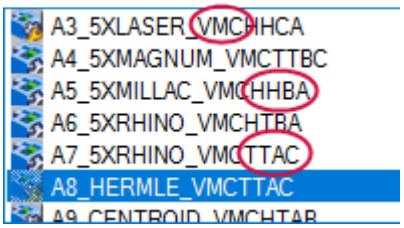
2. To see all the machine configurations installed with Mastercam, select the **Machine** drop-down list at the top of the dialog box.

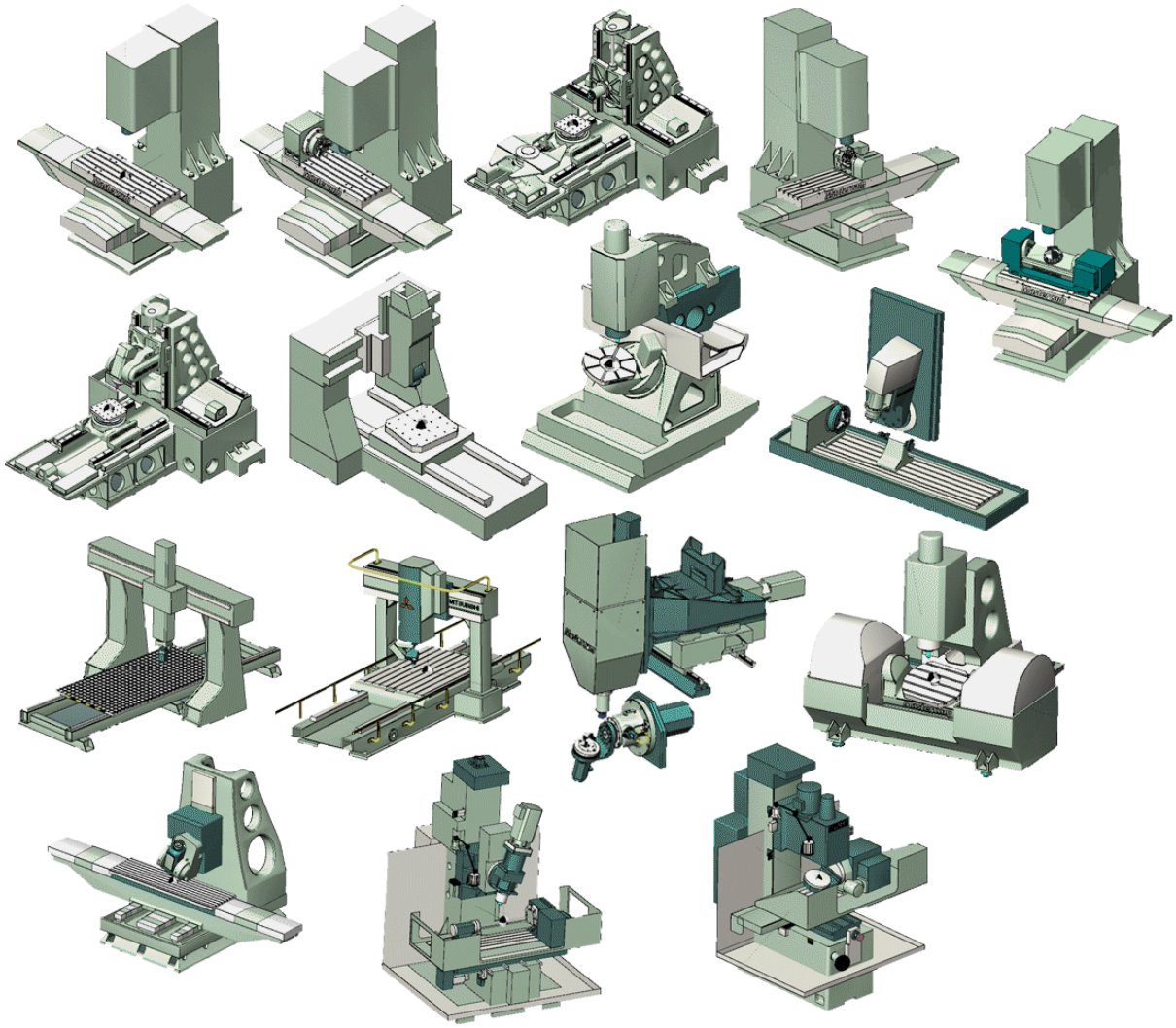


Mastercam includes models of the most popular mill and router machines in the industry, including examples of all three major 5-axis machine groups.

- Table/Table
- Table/Head
- Head/Head

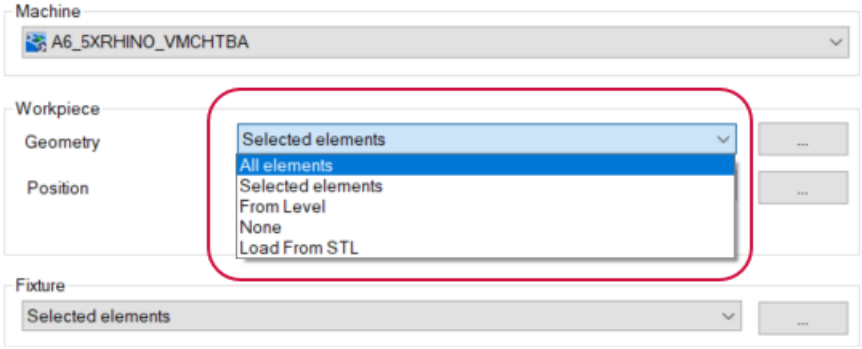
The machine names are abbreviated to include information about the configuration:





3. Select **A6_5XRHINO_VMCHTBA** from the machine list.
4. Click the **Geometry** drop-down list.

By default, Machine Simulation loads all visible surface and solid geometry as the workpiece, but you can control this by selecting one of these options.



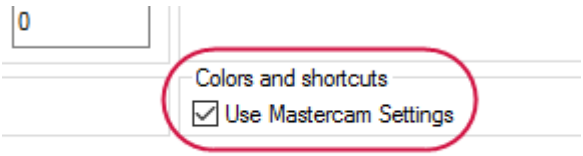
5. Select **All elements** from the list.
6. Click the **Fixture** drop-down list. Select **From Level** and select level **6**.

The options are similar to the Geometry drop-down list.

7. Enter **0.3** for the **Simulation tolerance**.

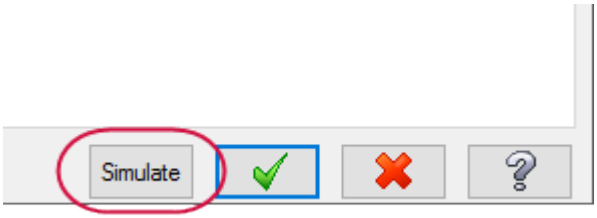
This parameter sets the tolerance for detecting collisions between the part or stock and the machine.

8. Select **Use Mastercam Settings**.



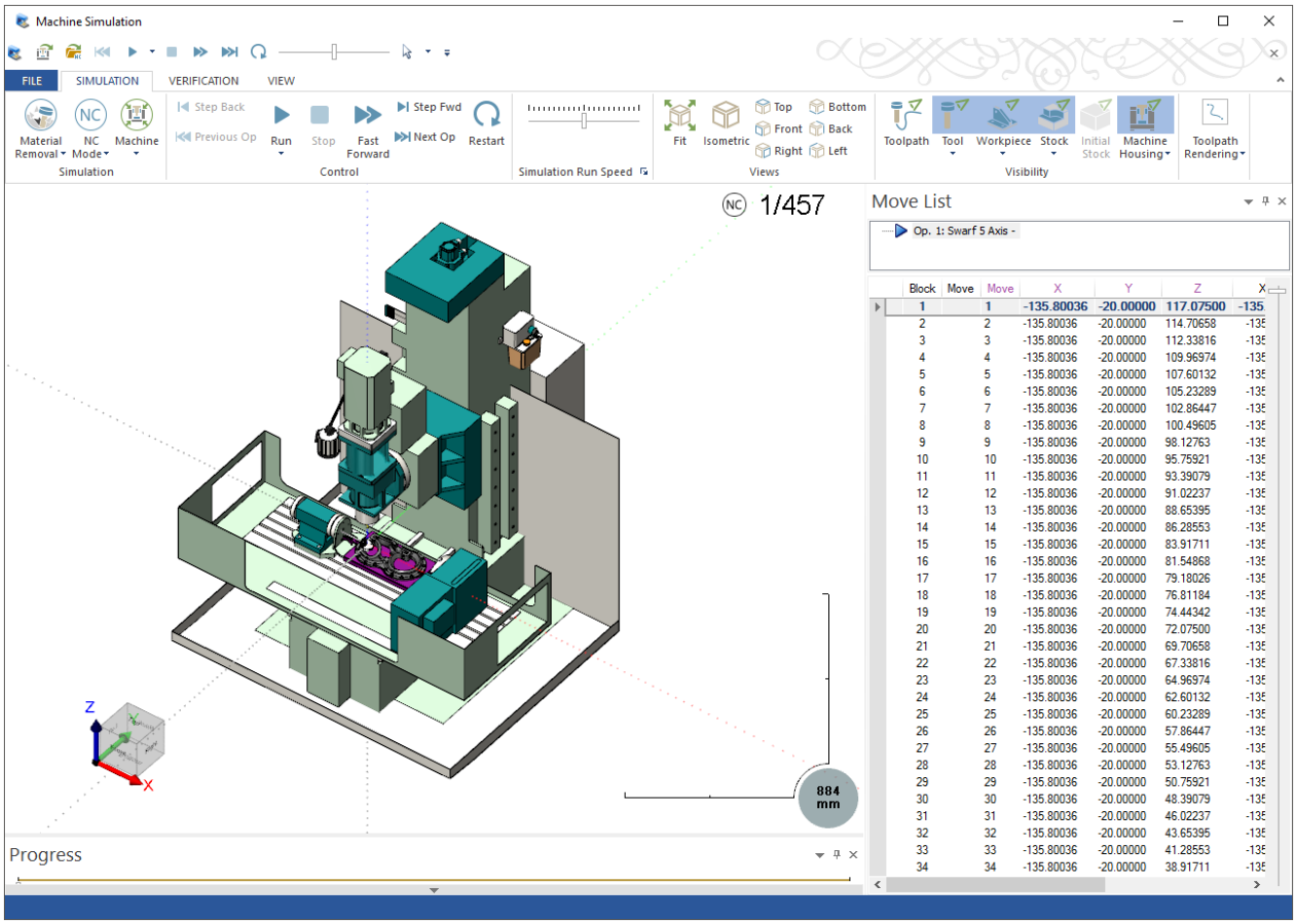
You can configure Machine Simulation's display colors and shortcut keys independent of the Mastercam environment. Selecting this option reads the Mastercam configuration file and sets the colors and shortcut keys to match Mastercam.

9. To go directly to the simulation, click **Simulate** at the bottom of the dialog box.



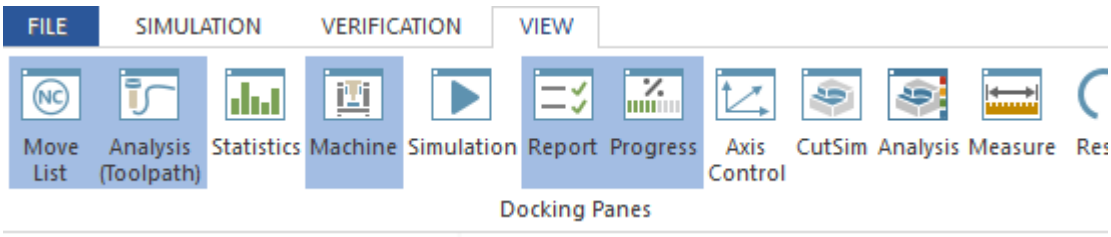
Mastercam stores the simulation startup settings in the part file when you save the file after running simulation. The next time you open this file, you can go directly to running the simulation.

The simulation interface lies on top of the Mastercam interface and shows the part positioned in the machine.

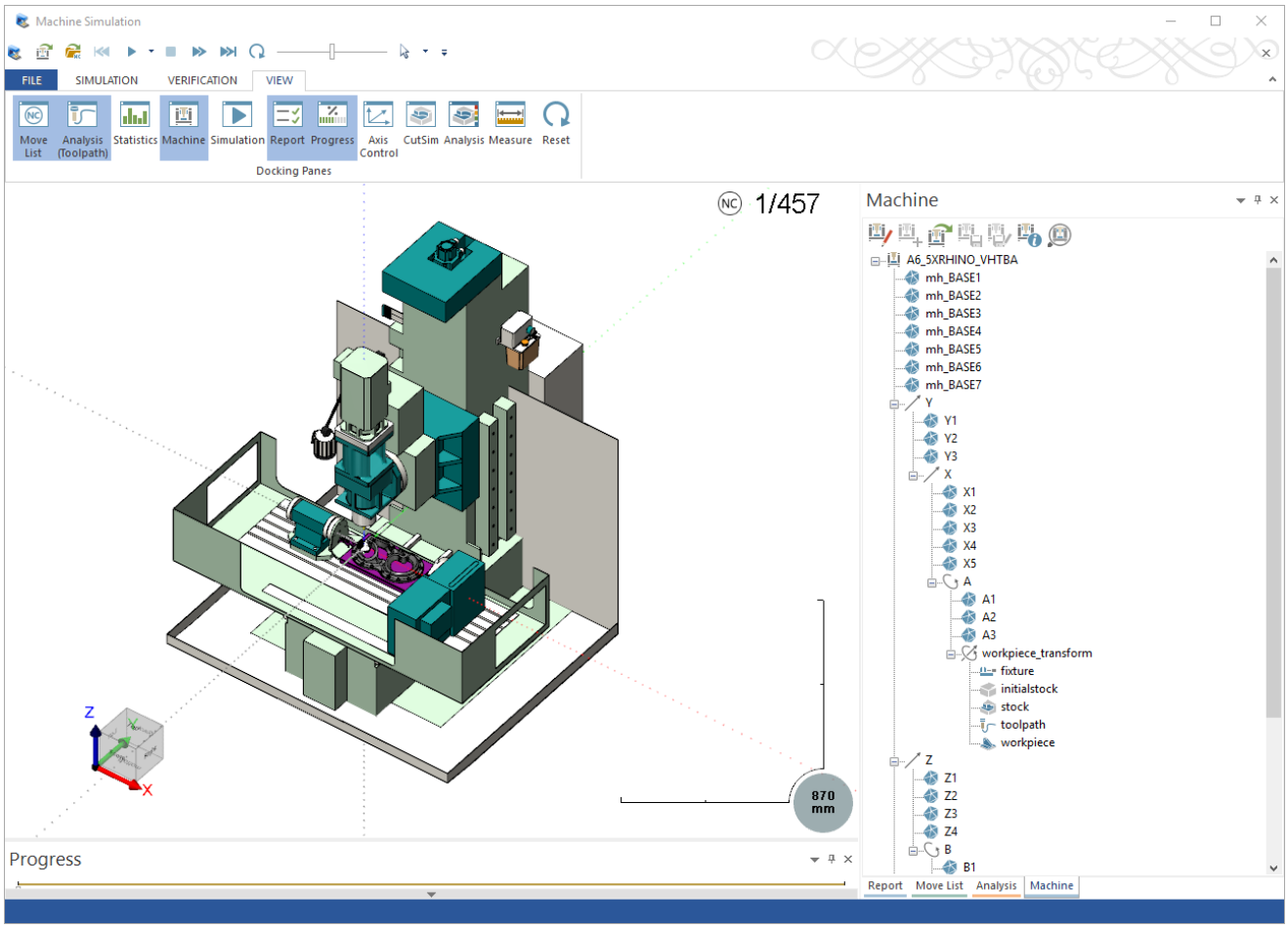


If you cannot see your part, click **Workpiece** in the **Simulation** tab to display it. If your display includes additional windows, choose **View**, **Reset** to match the picture shown above.

10. Select the following Docking Panes from the **View** tab:
    a. **Move List** (If not already displayed)
    b. **Progress** (If not already displayed)
    c. **Analysis (Toolpath)**
    d. **Machine**
    e. **Report**



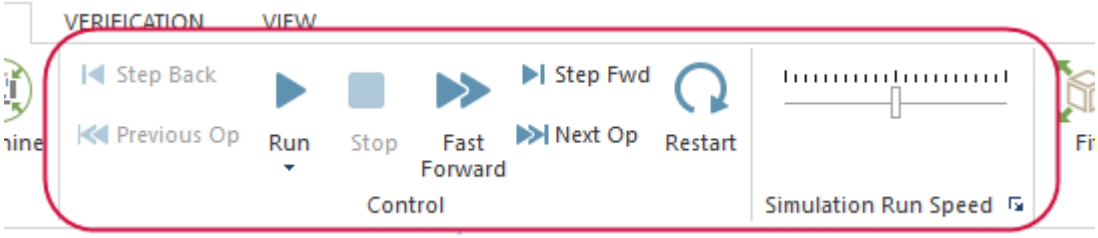
All of these windows will be used during the tutorial. The window layout should now look like the following image:



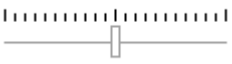
You may have to dock single tabs with the other tabs, as it may appear above the others.

Exercise 3: Viewing the Simulation

Machine Simulation provides several options for viewing and analyzing your toolpath motion in your machine. The playback bar controls and the slider bar are located in the Simulation tab.



1. Select the **Simulation** tab.
2. Move the indicator to the middle of the slider bar.

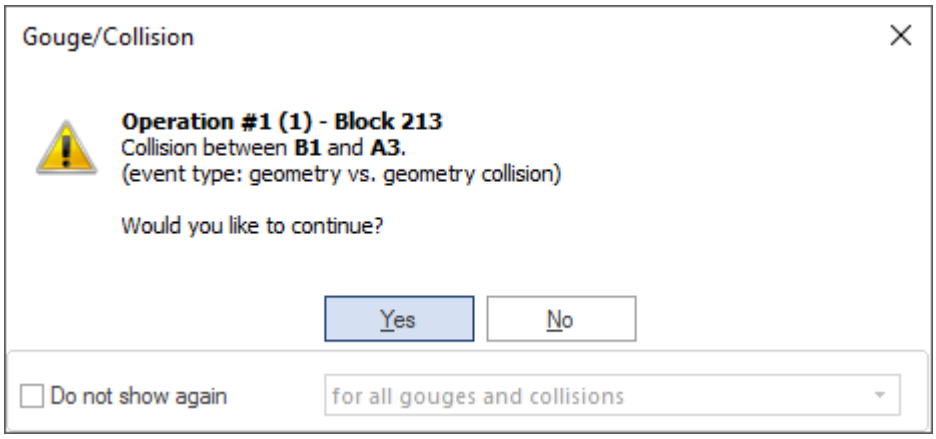


- Moving the slider bar to the left side decreases the speed, but increases the detail of the simulation.
- Moving the slider bar to the right side increases the speed of the simulation, but decreases the detail. The simulation skips more steps, but if a collision occurs in the skipped steps, it is still reported.

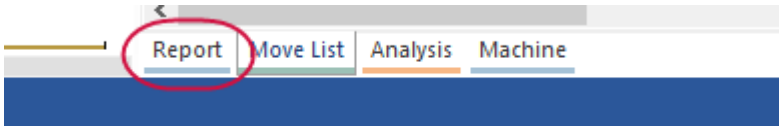
3. Click **Run** to begin the simulation.

   The simulation steps through the toolpath. The progress bar along the bottom of the screen and the Move List in the upper-right corner both update as the simulation continues.

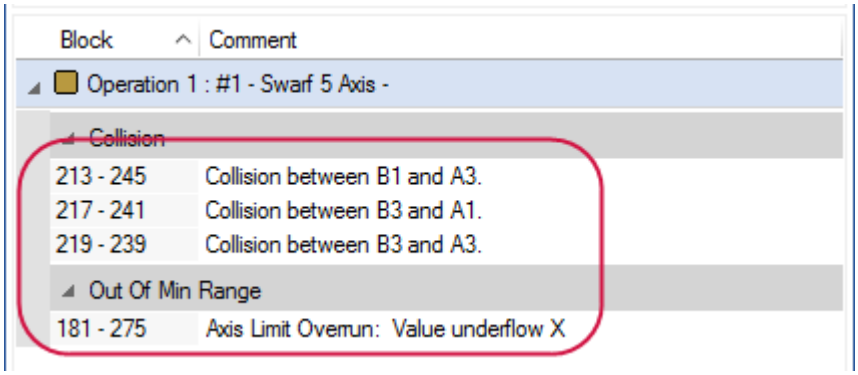
4. An error message displays, notifying you of a collision. Click **Yes** to continue running the simulation.



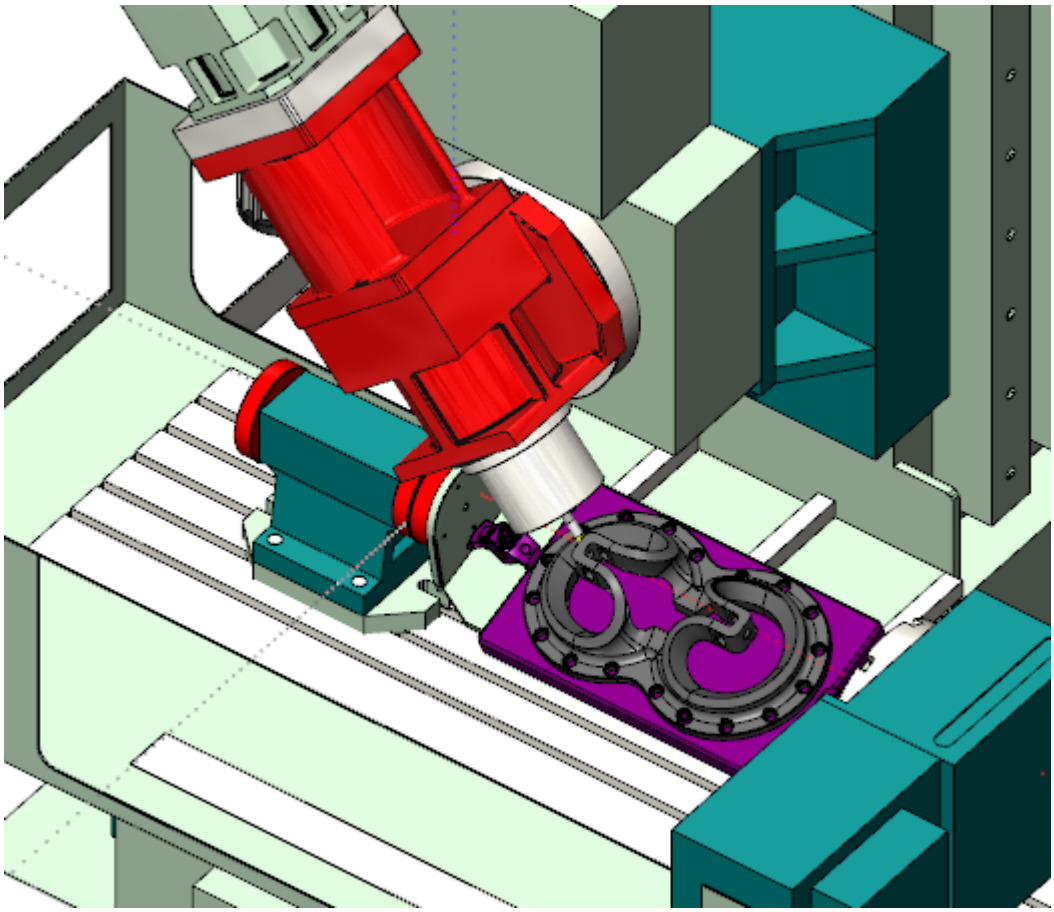
5. Click the **Report** tab.



   The **Report** tab lists events that happened during simulation. In this exercise, the report indicates that the B and A axes collided. Also, **Value underflow X** tells you that the X axis position was below the axis limits for the indicated tool moves.

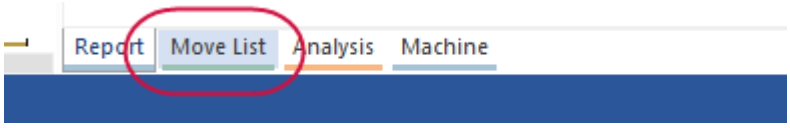


6. Click on **Collision between B1 and A3** in the **Report** tab and Machine Simulation jumps to where the problem occurs. The two axes that collide display in red.

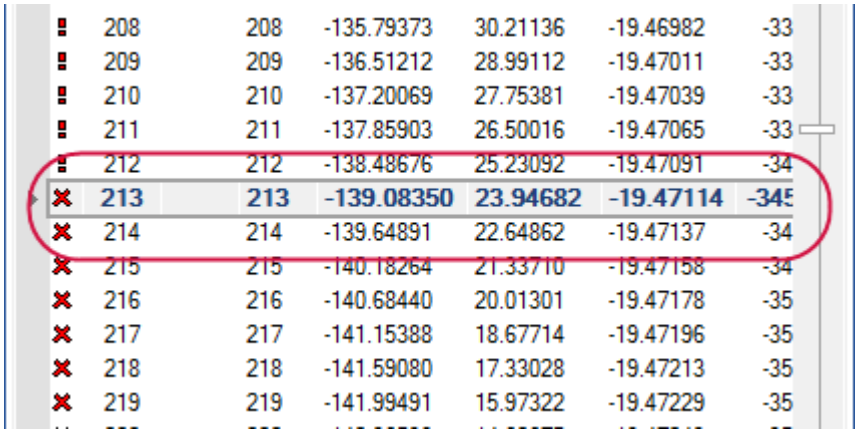


To look more closely at the motion, move your mouse to the workpiece center and roll your mouse wheel to zoom in.

7. Click the **Move List** tab at the bottom of the report window to display the list of coordinates for each toolpath move.



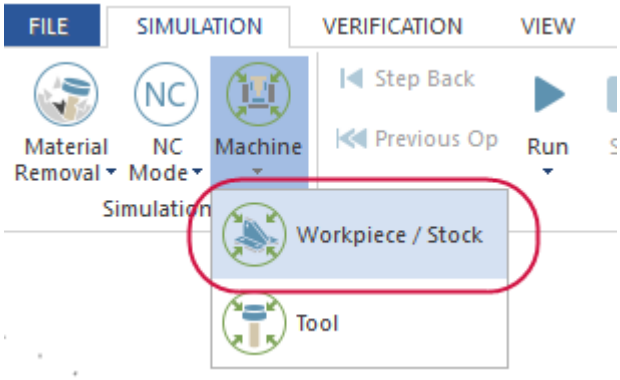
8. In the **Move List**, scroll to line 213, which is where the collision begins, and press the down arrow on your keyboard to step through the next several moves in the toolpath.



	208	208	-135.79373	30.21136	-19.46982	-33
	209	209	-136.51212	28.99112	-19.47011	-33
	210	210	-137.20069	27.75381	-19.47039	-33
	211	211	-137.85903	26.50016	-19.47065	-33
	212	212	-138.48676	25.23092	-19.47091	-34
	213	**213**	**-139.08350**	**23.94682**	**-19.47114**	**-345**
	214	214	-139.64891	22.64862	-19.47137	-34
	215	215	-140.18264	21.33710	-19.47158	-34
	216	216	-140.68440	20.01301	-19.47178	-35
	217	217	-141.15388	18.67714	-19.47196	-35
	218	218	-141.59080	17.33028	-19.47213	-35
	219	219	-141.99491	15.97322	-19.47229	-35

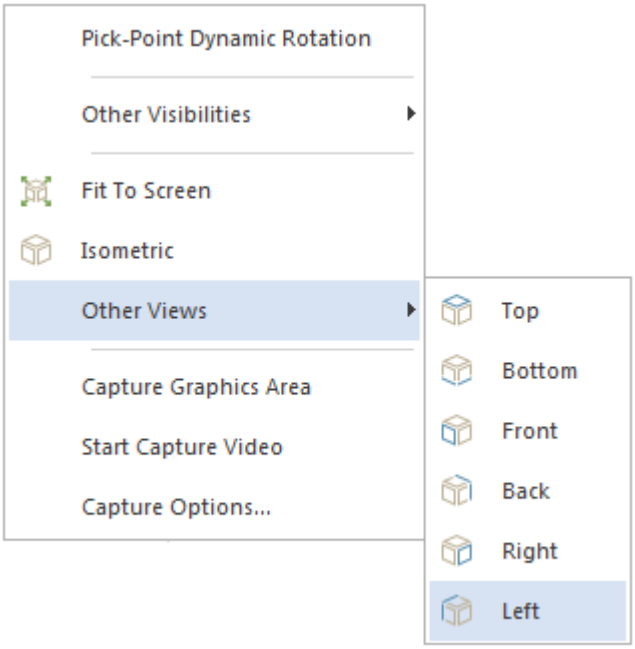
You can also move the slider on the right side of the Move List up and down to move through the tool motion.

9. Move the slider on the **Progress** bar at the bottom of the screen all the way to the left to start at the beginning of the toolpath.
10. Click the arrow below **Machine** in the **Simulation** tab and select **Workpiece/Stock** to show only the tool and the workpiece.

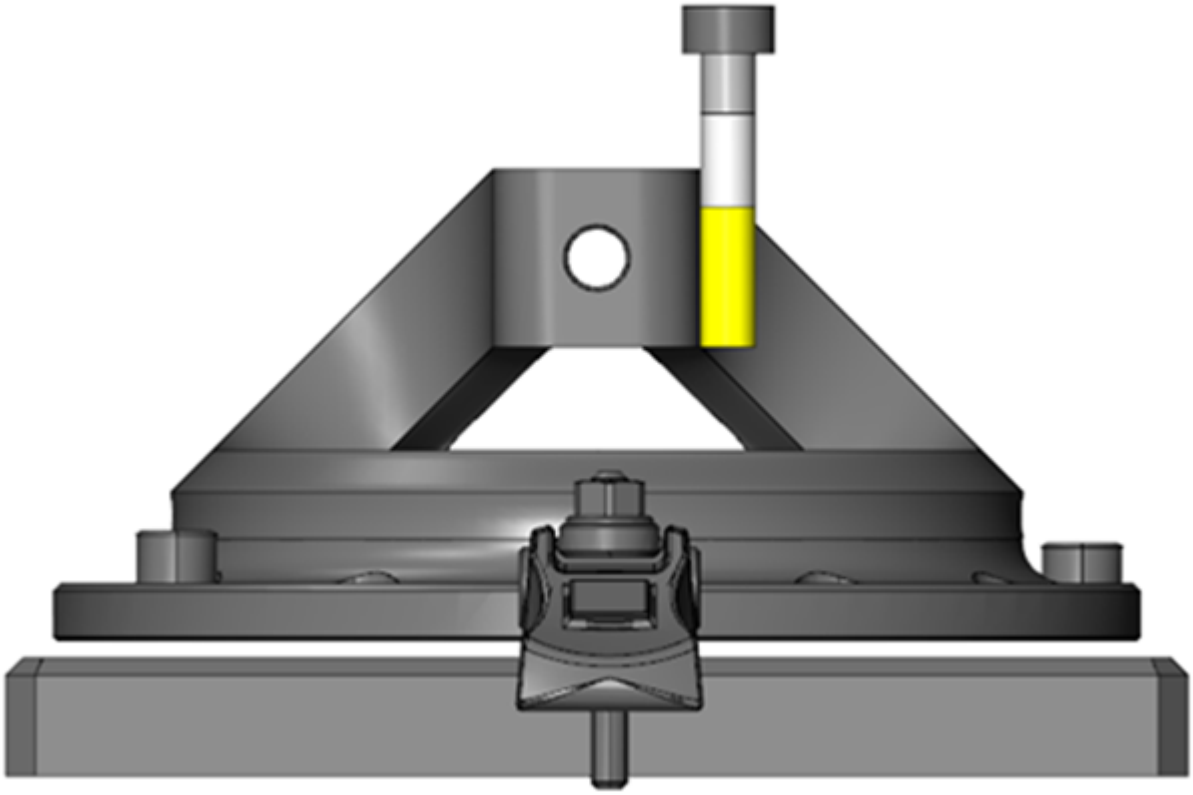


This focus option moves the tool around a stationary workpiece.

11. Scroll the mouse wheel to zoom out.
12. Right-click in the graphics window and select **Other Views**, **Left** to rotate the part to the left view.

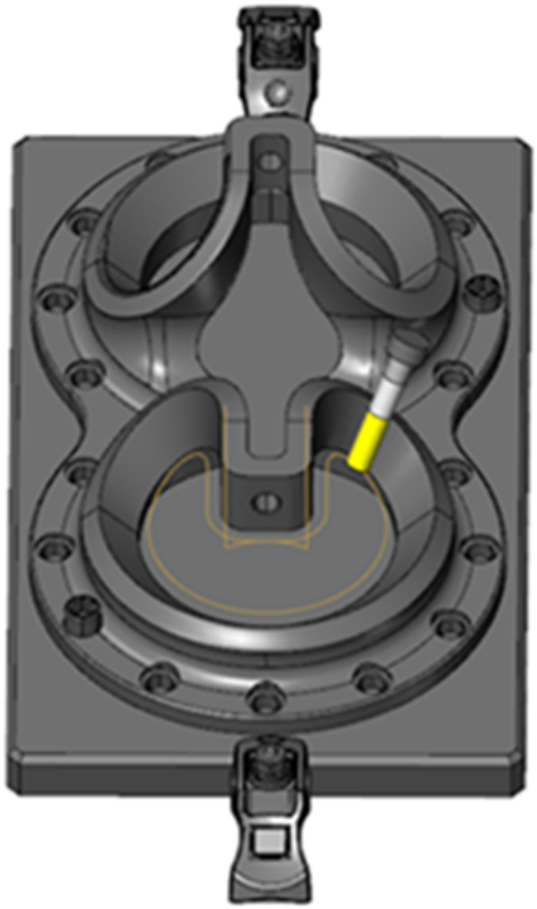


Machine Simulation includes many standard Mastercam views.



13. Click and hold the left mouse button while moving the cursor down in the simulation window. This action rotates the part down and allows you to see the toolpath more clearly.
14. Click **Run** to play the simulation again.

    The workpiece focus mode lets you concentrate on just the tool motion.



15. Set the focus back to **Machine** and set the view to **Isometric**.
16. Click **Fit** to center the machine in the simulation window.

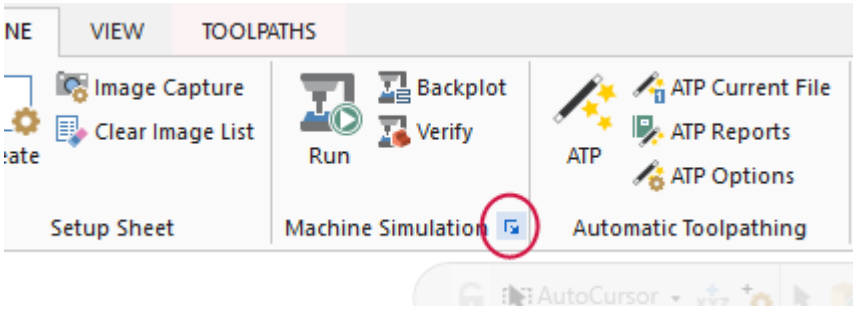
17. Exit the Machine Simulation and return to the main Mastercam screen.

    This exercise includes just a few of the possible viewing options in Machine Simulation. You try more in the following chapters.

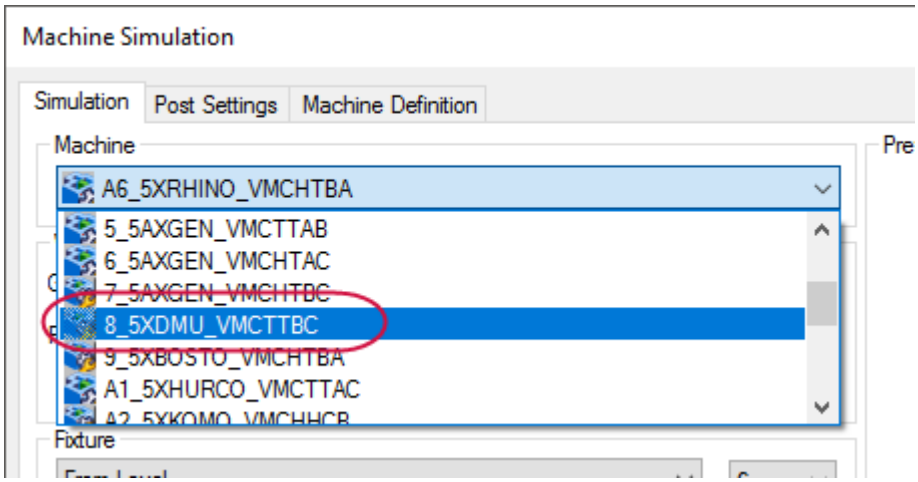
Exercise 4: Selecting a Different Machine

One of the benefits of Machine Simulation is being able to prove out a program without using machine time. Finding issues early can save you time and money. In this exercise, you select a different machine for simulation based on collisions and underflow issues found in the previous exercise.

1. Select the dialog box launcher in the Machine Simulation group on the **Machine** tab.



2. Select the **8_5XDMU_VMCTTBC** machine from the **Machine** drop-down list.



3. Enter **0.3** for the **Simulation tolerance**, if necessary.
4. Click **Simulate** at the bottom of the dialog box to return to simulation.
5. Increase the simulation speed with the slider (as shown in Exercise 2) and then click **Run**.
6. When the simulation is complete, click the **Report** tab to see the results. No collisions are reported.
7. Exit Machine Simulation and return to the main Mastercam screen.

Testing your parts in different positions and on different machines is an integral part of the machine simulation process. The next chapter goes into more detail on this process, including backplot and material removal verification as part of the recommended workflow.

CHAPTER 2

USING THE MACHINE SIMULATION WORKFLOW

Now that you have a basic idea of how Machine Simulation works, this lesson goes into more detail on how Machine Simulation can fit into your machining process. Adding Machine Simulation to your workflow helps you choose the best setup for each part and machine.

Goals

- Backplotting toolpaths to analyze toolpath motion
- Simulating toolpaths to check fixturing and machine motion
- Verifying toolpaths to confirm material removal

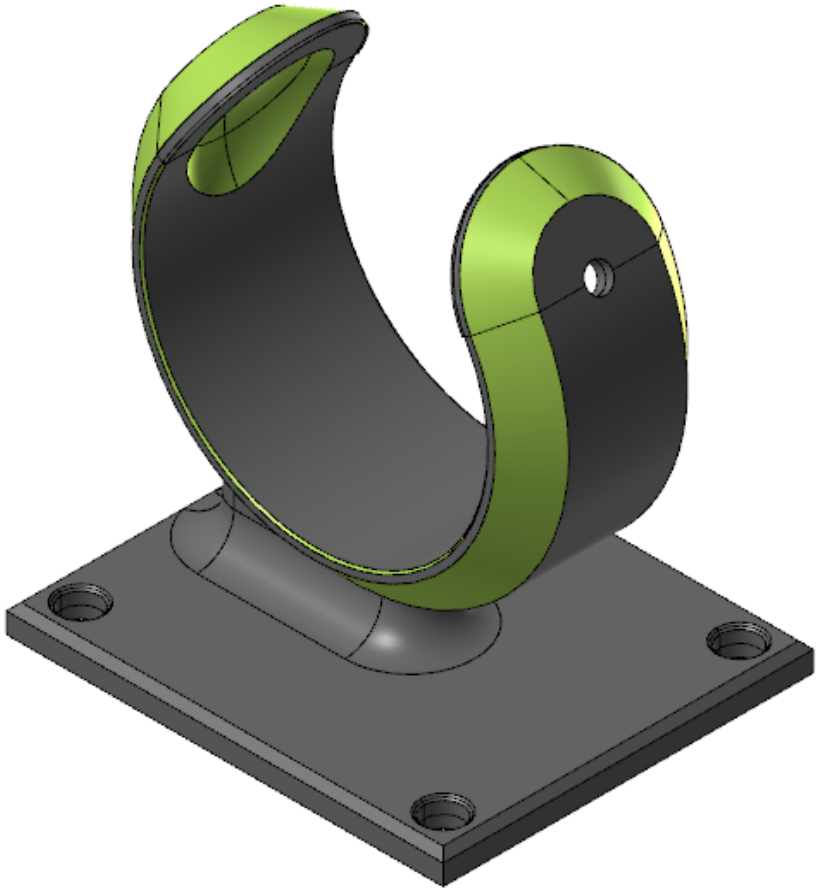
Exercise 1: Backplotting the Toolpaths

The first step is to check the quality of the toolpath motion using Mastercam's Backplot function, which lets you closely examine the tool motion to make sure it meets your needs.

1. From Mastercam, choose **File**, **Open** and open the part file, `VISERING`, provided with this tutorial.

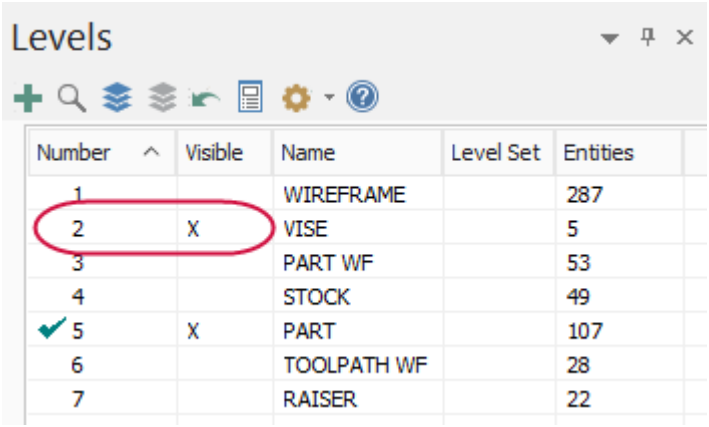
   This part is configured in inches, so you are prompted to switch from metric to inch. Choose **All settings** and click **OK** to continue.

2. If necessary, press [**Alt+S**] to shade the part.

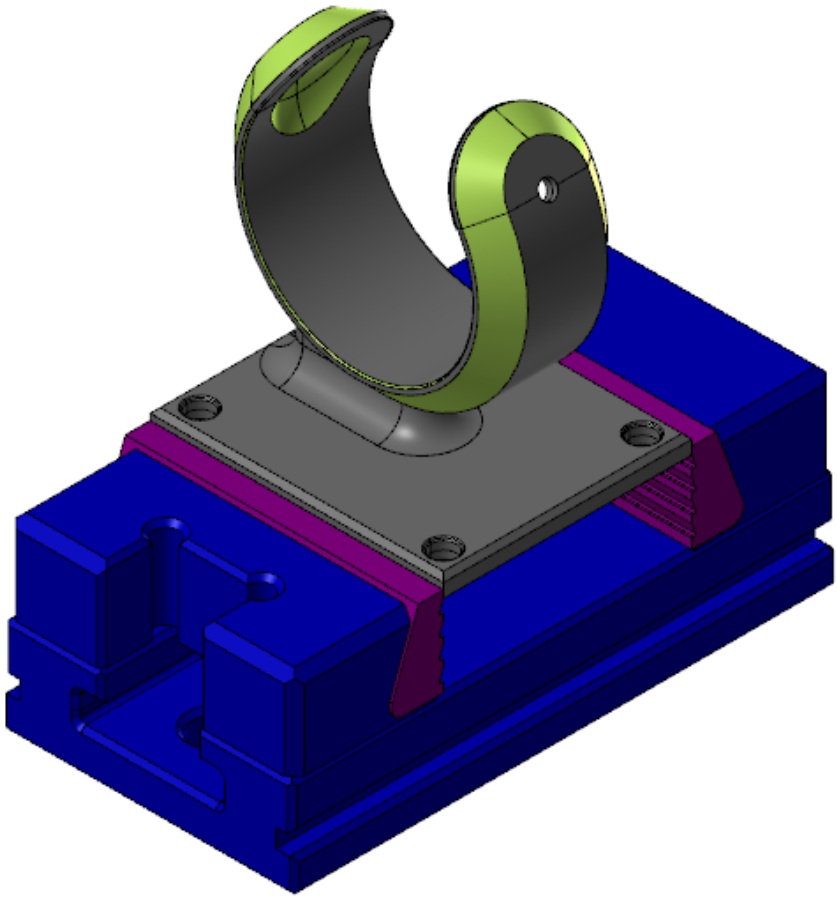


The toolpaths included in the part file machine the green faces on the part. This part is ideal for 5-axis toolpaths, because you can potentially machine the whole part in one setup. This would be difficult on a 3-axis machine.

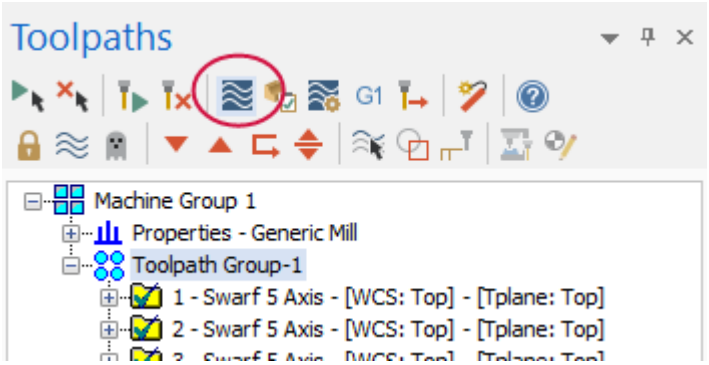
3. Use the Levels Manager to display the vise on Level 2.



This is just one possible fixturing solution for this part. In every case, you must decide how to hold the part in the machine.

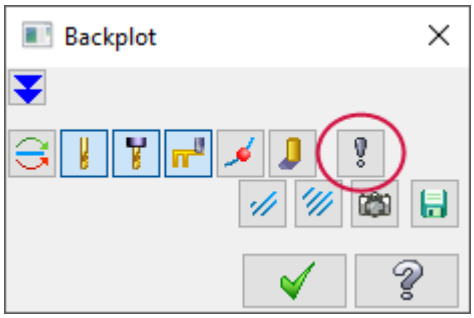


4. Select all the toolpaths in the Toolpaths Manager by selecting **Toolpath Group-1**, and click **Backplot selected operations**.

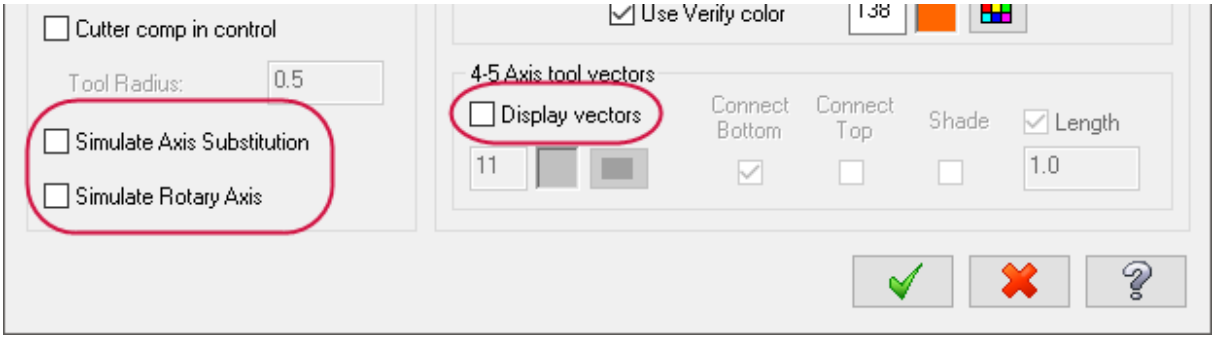


The Backplot dialog box displays.

5. Click **Options** on the Backplot dialog box to adjust the display settings before running the backplot.



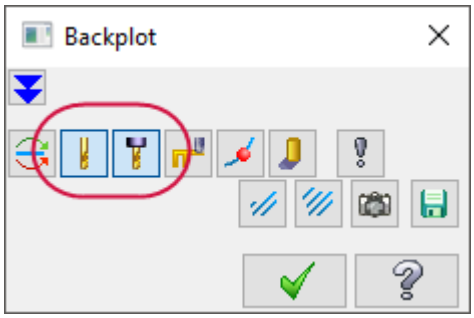
6. Deselect the following parameters on the Backplot Options dialog box:
   a. **Simulate Axis Substitution**
   b. **Simulate Rotary Axis**
   c. **Display vectors**



Turning these options off keeps the part stationary in the graphics window and moves the tool around the part.

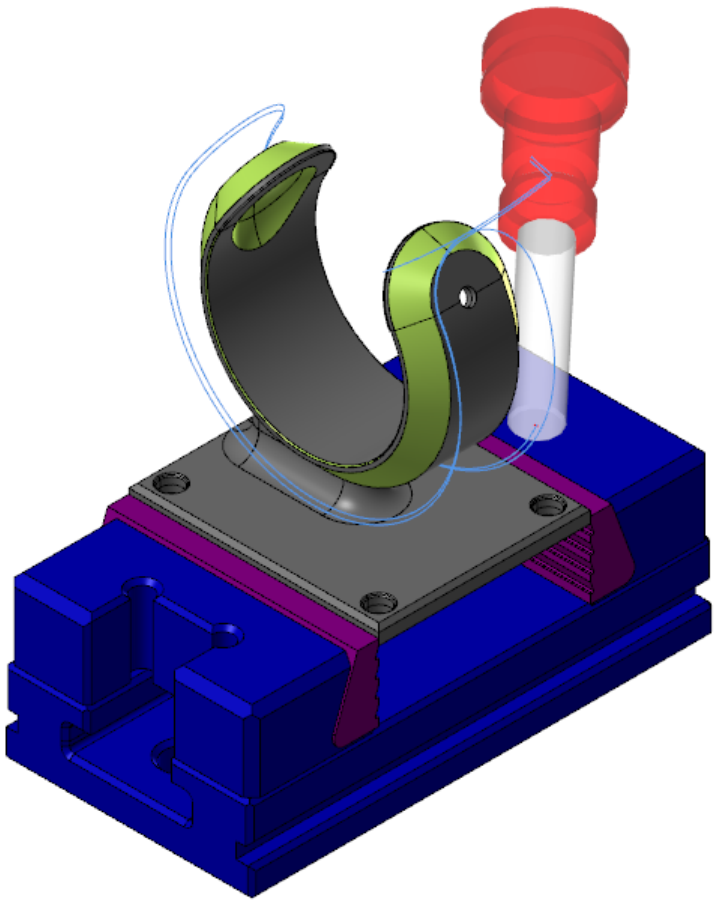
7. Click **OK** to close the Backplot Options dialog box.

8. Turn on **Display tool** and **Display holder** on the Backplot dialog box to see the tool and holder during the backplot.



9. Click **Play** on the Backplot VCR bar to run the backplot.

   As the backplot progresses, watch the tool and holder for any collisions with the part or fixture. Rotate the part or zoom out if necessary to get a better view of the tool motion.



10. Click **OK** on the Backplot dialog box when the backplot is complete.

The tool motion looks good so far. The next step is to simulate the motion on a machine.

Exercise 2: Preparing and Simulating the Toolpaths

Backplotting toolpaths is a good initial step to check the tool motion, but it can only display the tool and holder. It cannot show you how the rest of the machine components move around the part. Machine Simulation lets you visualize how all parts of the machine move when processing the toolpaths.

Before you begin the next exercise, you add a new machine to select for simulation. This procedure is helpful if you create a new machine that matches one in your shop. For more information on additional machines for simulation, please contact your local Mastercam Reseller.

1. Copy the `HERMLE800` folder provided with this tutorial to the following location:

   `C:\Users\Public\Public Documents\shared Mcam2019\MachineSimulation\MachSim`

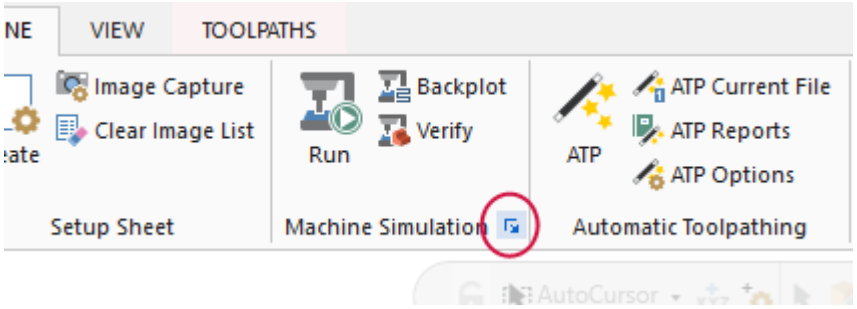
   Each folder represents a machine and contains the files needed to simulate that machine:

   a. XML file with the kinematic machine structure

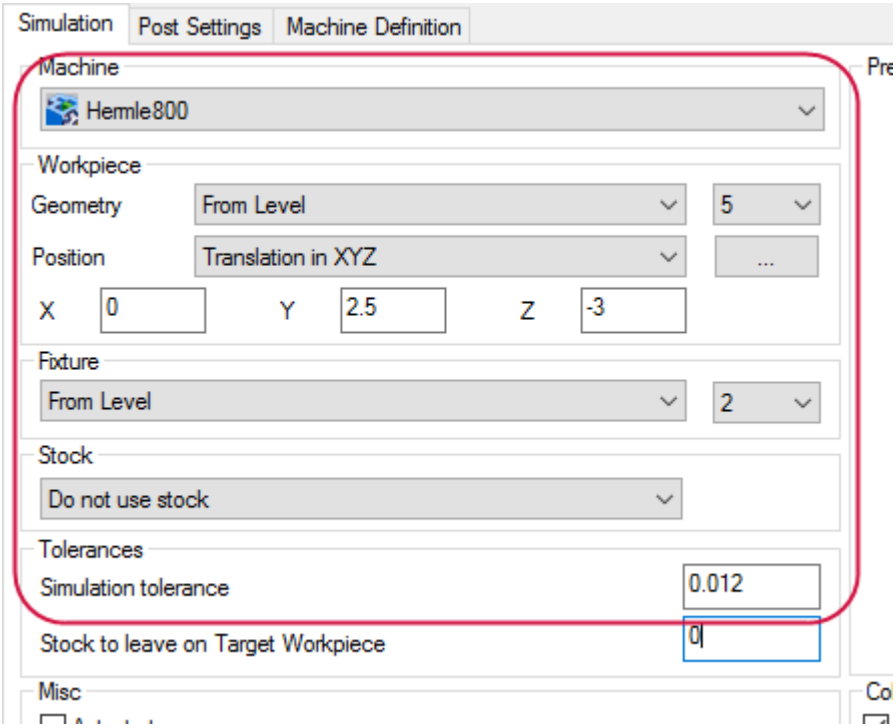
   b. GIF file that displays in the startup settings dialog box

   c. STL models that represent the machine's physical components

2. Select the dialog box launcher in the Machine Simulation group on the **Machine** tab.



3. Set the following parameters:



   a. Click the **Machine** drop-down list and select the **Hermle800** machine that now appears in the list.

   b. Set **Geometry** to **From Level** and **5**.

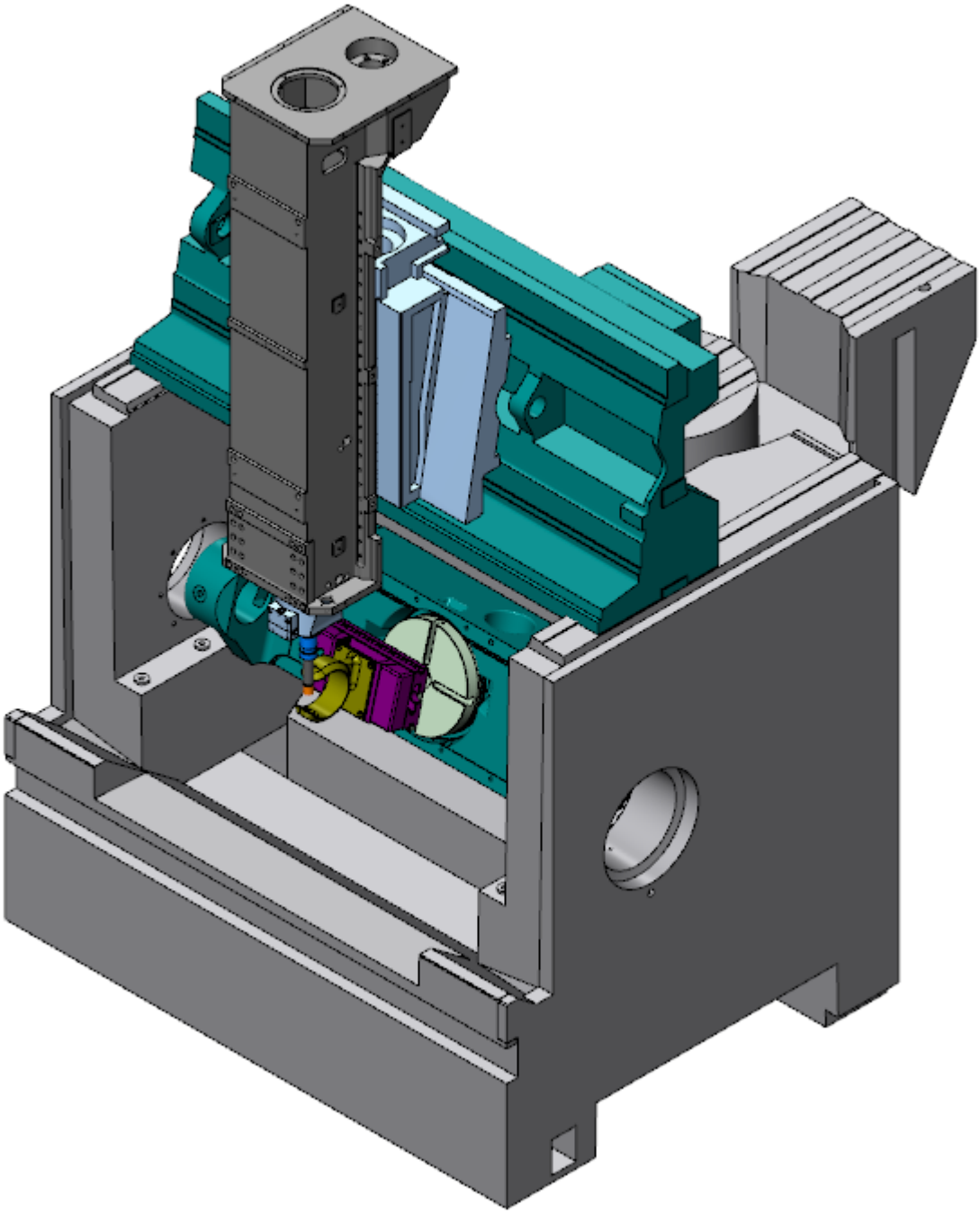
   c. Set **Position** to **Translation in XYZ**.

   d. Set **Y** to **2.5** and **Z** to **-3**.

e. Select **From Level** and select level **2**.

f. Enter **0.012** for the **Simulation tolerance**.

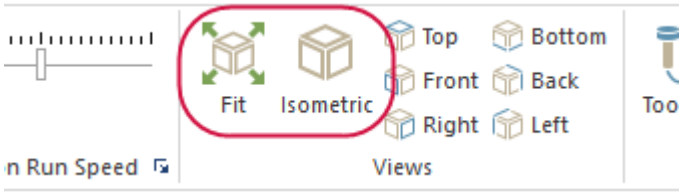
4. Click **Simulate** to display the part in the machine.



If necessary, set **Machine Housing** to **Show**.

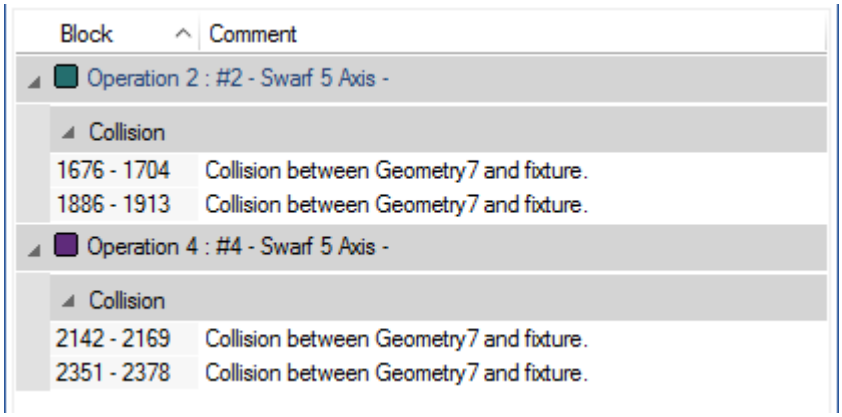
5. Set Simulation to focus on the **Machine**.

6. Click **Isometric** and **Fit** to display the entire machine in the simulation window.

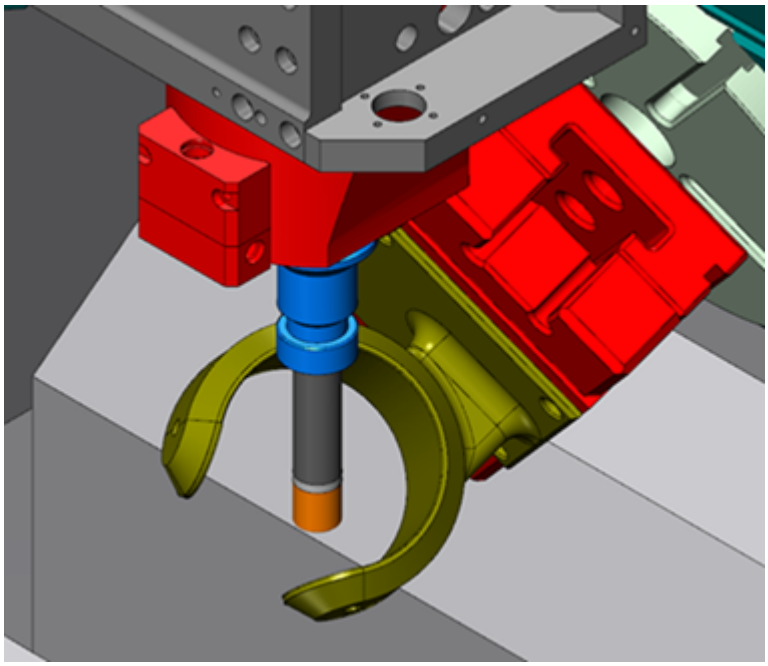


Exercise 3: Viewing the Simulation

1. Click **Run** to begin the simulation.
2. Click **Yes** in the Gouge/Collision dialog box. There will be four collisions total.
3. The Report tab displays collisions in operations 2 and 4.

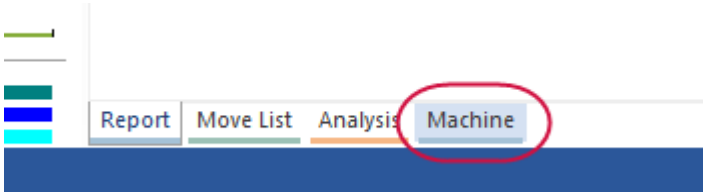


4. Click on the first collision in the Report tab to jump to that toolpath section.
5. Zoom in to the collision by scrolling your mouse wheel.

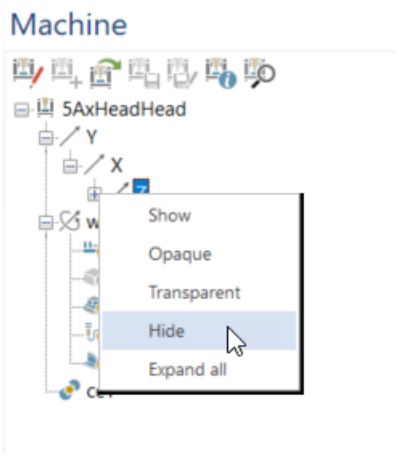


The fixture is colliding with a section of the tool spindle.

6. To get a better view of what components are colliding, click the **Machine** tab.

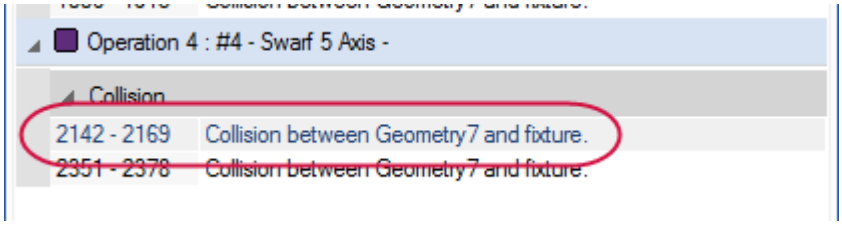


7. Right-click the **Geometry5** component under the Z axis and choose **Transparent**.

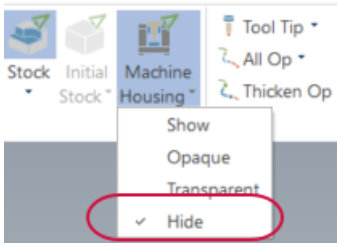


You can now see through the spindle housing to get a better view of the collision.

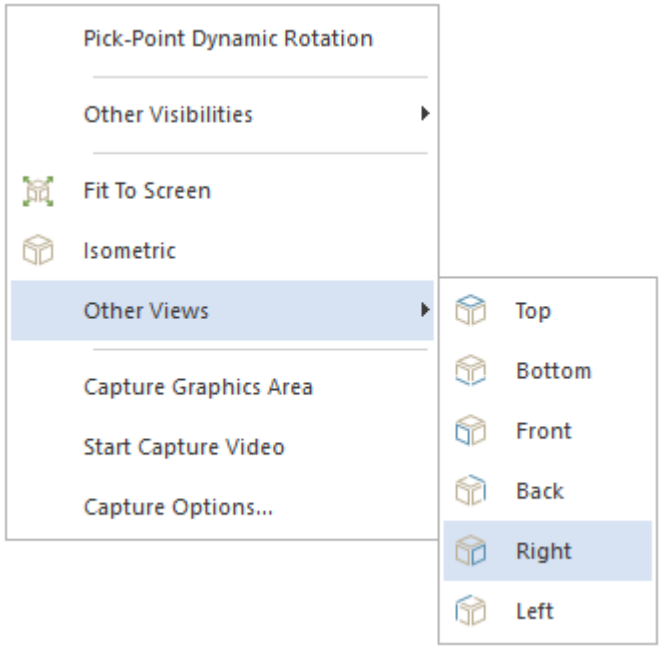
8. Right-click the **Geometry7** component and choose **Transparent** to provide even more visibility.
9. Select the **Report** tab to return to the operation list.
10. Click on the first collision in Operation 4.



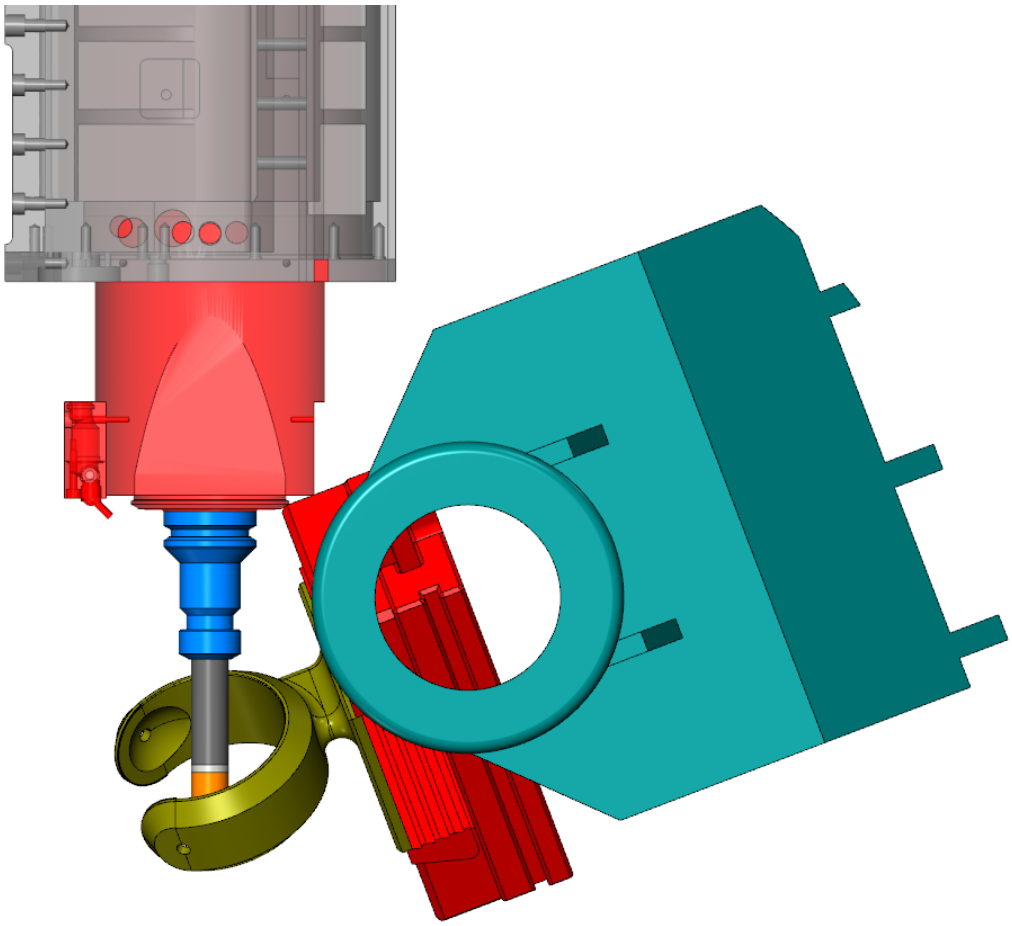
11. In the **Simulation tab**, click the drop-down list below **Machine Housing** and select **Hide** to simplify the machine display.



12. Right-click in the graphics view and select **Other Views**, **Right** to move to the right side view.

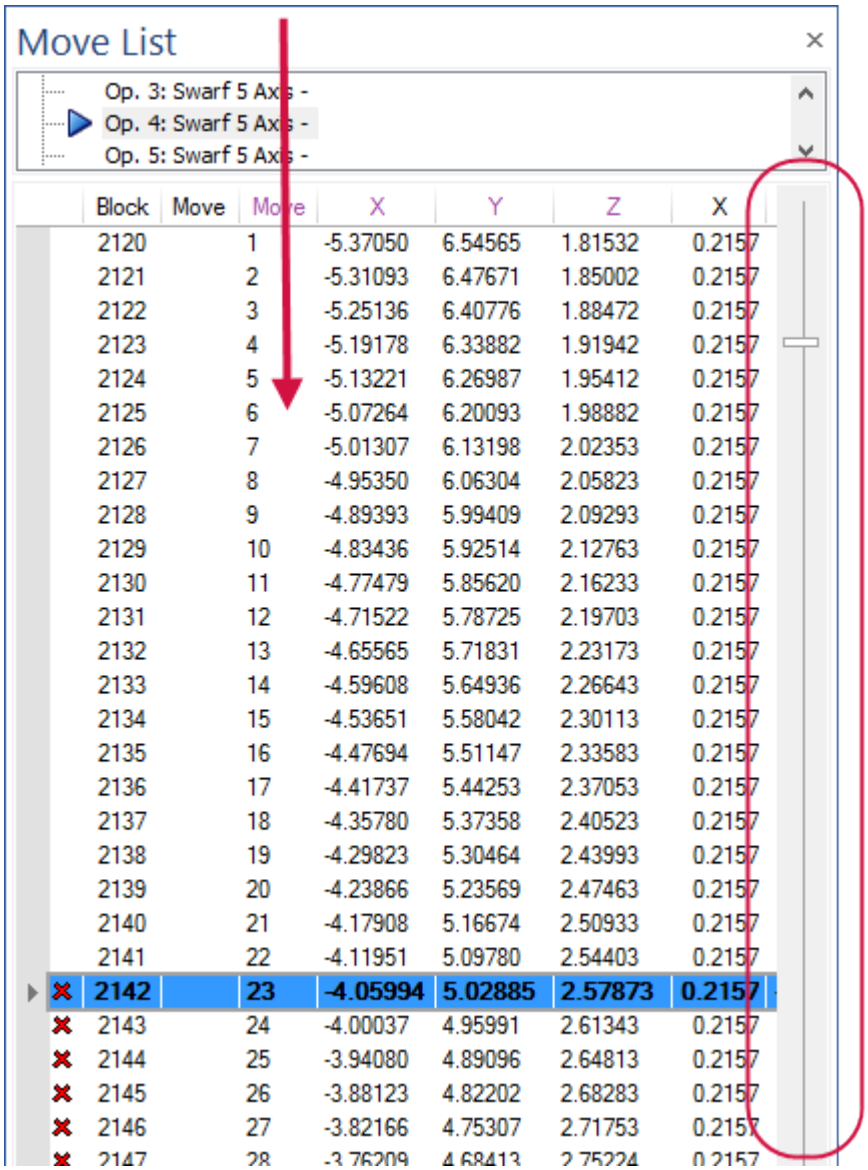


This position gives you a better view of the collision between the spindle and the fixture.



13. Select the **Move List** tab.

14. On the side of the **Move List**, pull the slider bar down to step through the two collisions in this operation.



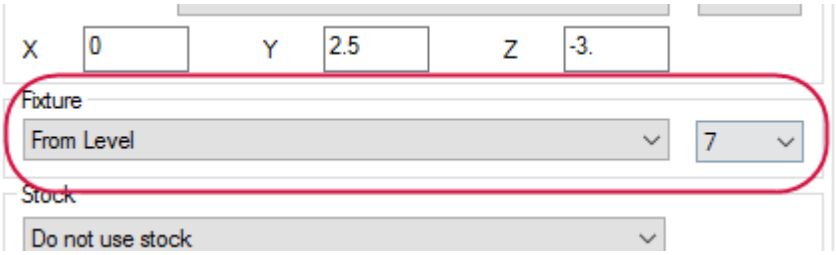
Block	Move	Move	X	Y	Z	X
2120		1	-5.37050	6.54565	1.81532	0.2157
2121		2	-5.31093	6.47671	1.85002	0.2157
2122		3	-5.25136	6.40776	1.88472	0.2157
2123		4	-5.19178	6.33882	1.91942	0.2157
2124		5	-5.13221	6.26987	1.95412	0.2157
2125		6	-5.07264	6.20093	1.98882	0.2157
2126		7	-5.01307	6.13198	2.02353	0.2157
2127		8	-4.95350	6.06304	2.05823	0.2157
2128		9	-4.89393	5.99409	2.09293	0.2157
2129		10	-4.83436	5.92514	2.12763	0.2157
2130		11	-4.77479	5.85620	2.16233	0.2157
2131		12	-4.71522	5.78725	2.19703	0.2157
2132		13	-4.65565	5.71831	2.23173	0.2157
2133		14	-4.59608	5.64936	2.26643	0.2157
2134		15	-4.53651	5.58042	2.30113	0.2157
2135		16	-4.47694	5.51147	2.33583	0.2157
2136		17	-4.41737	5.44253	2.37053	0.2157
2137		18	-4.35780	5.37358	2.40523	0.2157
2138		19	-4.29823	5.30464	2.43993	0.2157
2139		20	-4.23866	5.23569	2.47463	0.2157
2140		21	-4.17908	5.16674	2.50933	0.2157
2141		22	-4.11951	5.09780	2.54403	0.2157
2142		**23**	**-4.05994**	**5.02885**	**2.57873**	**0.2157**
2143		24	-4.00037	4.95991	2.61343	0.2157
2144		25	-3.94080	4.89096	2.64813	0.2157
2145		26	-3.88123	4.82202	2.68283	0.2157
2146		27	-3.82166	4.75307	2.71753	0.2157
2147		28	-3.76209	4.68413	2.75224	0.2157

15. Exit Machine Simulation by clicking the [X] in the upper right corner, and return to Mastercam.

Exercise 4: Adjusting the Fixture

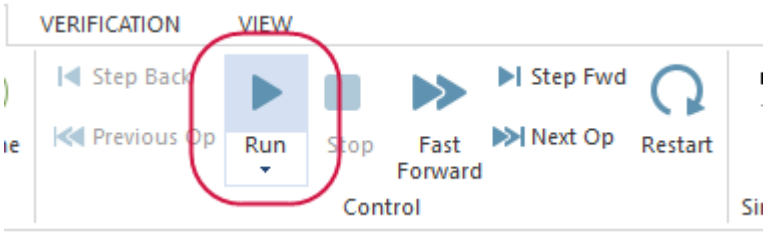
By using Machine Simulation, you can see that this fixture is not optimal for the selected machine. Machine Simulation makes it easy to try different types of fixturing and avoid costly mistakes while running the machine.

1. Select the dialog box launcher in the Machine Simulation group on the **Machine** tab.
2. Set the fixture to **Level 7**.



3. Click **Simulate**.

4. Set **Machine Housing** to **Show**.
5. Click **Isometric** and **Fit** to display the entire machine in the simulation window.
6. Click **Run** to simulate the toolpaths.



The new, smaller fixture causes no collisions.

7. Exit Machine Simulation when you are satisfied to return to the main Mastercam screen.

Exercise 5: Verifying Material Removal

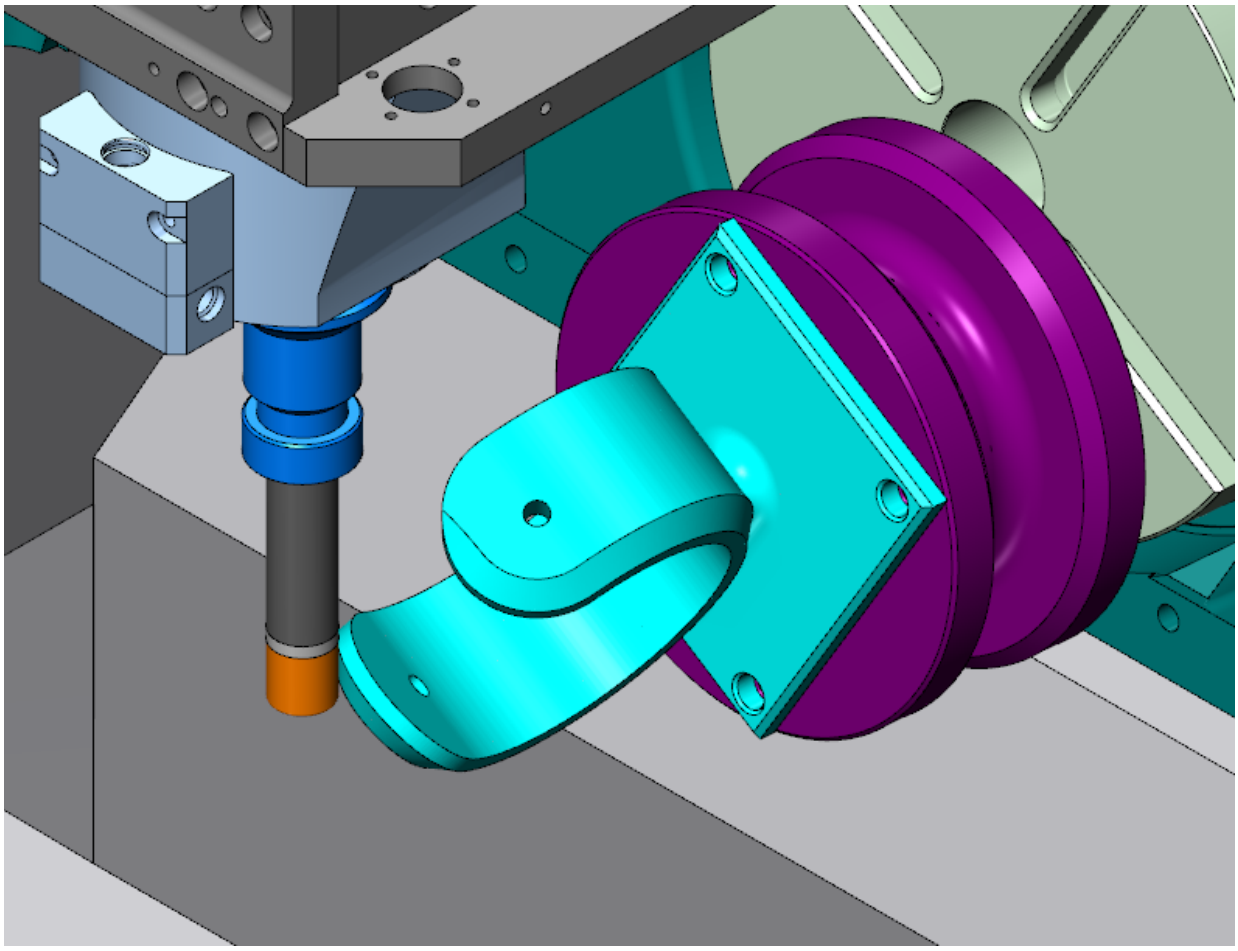
Now that you feel confident running the toolpaths on this machine, the final step is to check the stock's shape after running the toolpaths. Machine Simulation includes the necessary material removal verification tools.

1. Select the dialog box launcher in the Machine Simulation group on the **Machine** tab.
2. Set the stock to **From Level** and set it to level **4**.

3. Click **Simulate**.

   Because you selected stock in the simulation settings, Machine Simulation automatically opens in material removal mode.

4. Click **Run** to simulate the toolpaths.



You can see the tool actually removing material from the part as it moves through the toolpaths.

Flute collisions are reported on two of the operations. One way to fix this issue would be to return to Mastercam and extend the tool shank length for the tool that is used by these operations.

5. Exit Machine Simulation when you are satisfied to return to the main Mastercam screen.

The final workflow step is to cut the part on the actual machine. Since you have tested this machining strategy in several ways, you can feel confident that the part will cut correctly

WARNING: While Machine Simulation lets you experiment with multiple cutting strategies and fixture combinations without using valuable machine time, there is no substitute for the first run of a part on a machine. Always be alert and cautious when running a part for the first time on a real machine.

The next chapter provides information about additional toolpath analysis in Machine Simulation.

CHAPTER 3

TOOLPATH ANALYSIS

Mastercam's Machine Simulation provides several tools for evaluating your toolpath efficiency and accuracy. These tools can help you determine the best cutting strategy, fixturing, and positioning for your parts.

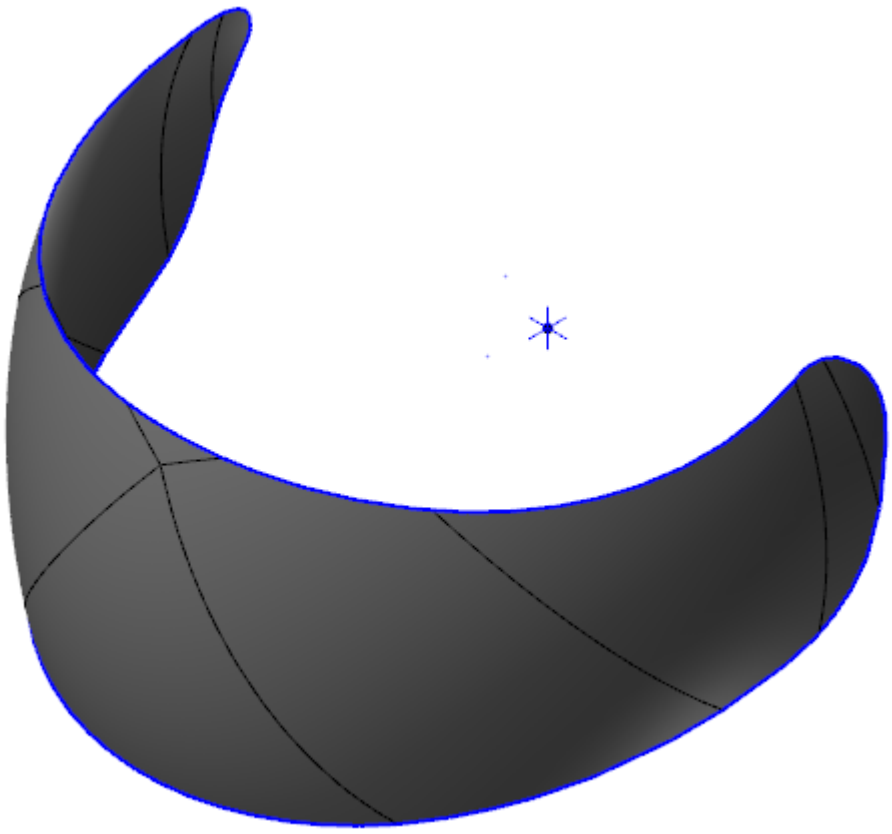
Goals

- Inspecting the part position
- Analyzing tool motion
- Adjusting analysis options

Exercise 1: Analyzing Before Fixturing

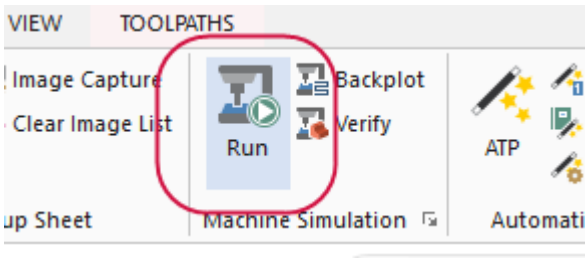
Machine Simulation's toolpath analysis can provide useful information even before you select a method for holding your part in your machine. You can see if the tool motion works in a virtual environment before using valuable machine time.

1. From Mastercam, choose **File**, **Open**. Open the part file, `CURVE_5X`, provided with this tutorial.

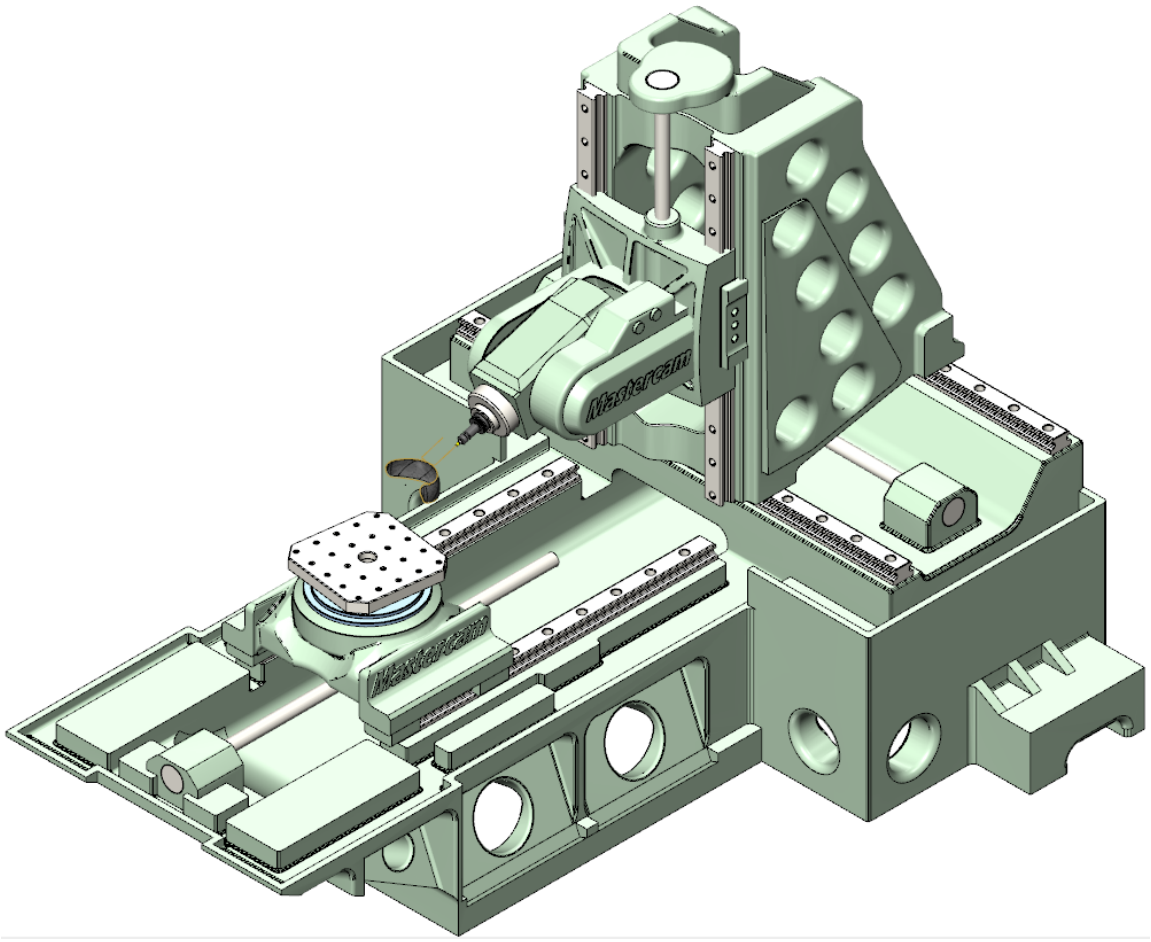


   This is a metric part. Choose **All settings** when prompted to switch units and click **OK** to continue.

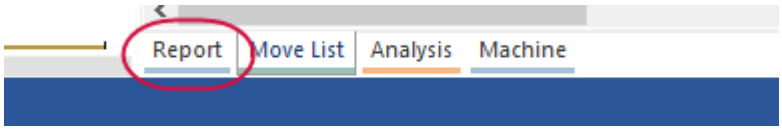
2. Click **Run** on the **Machine** tab.



The part file has a simulation machine and position already assigned.

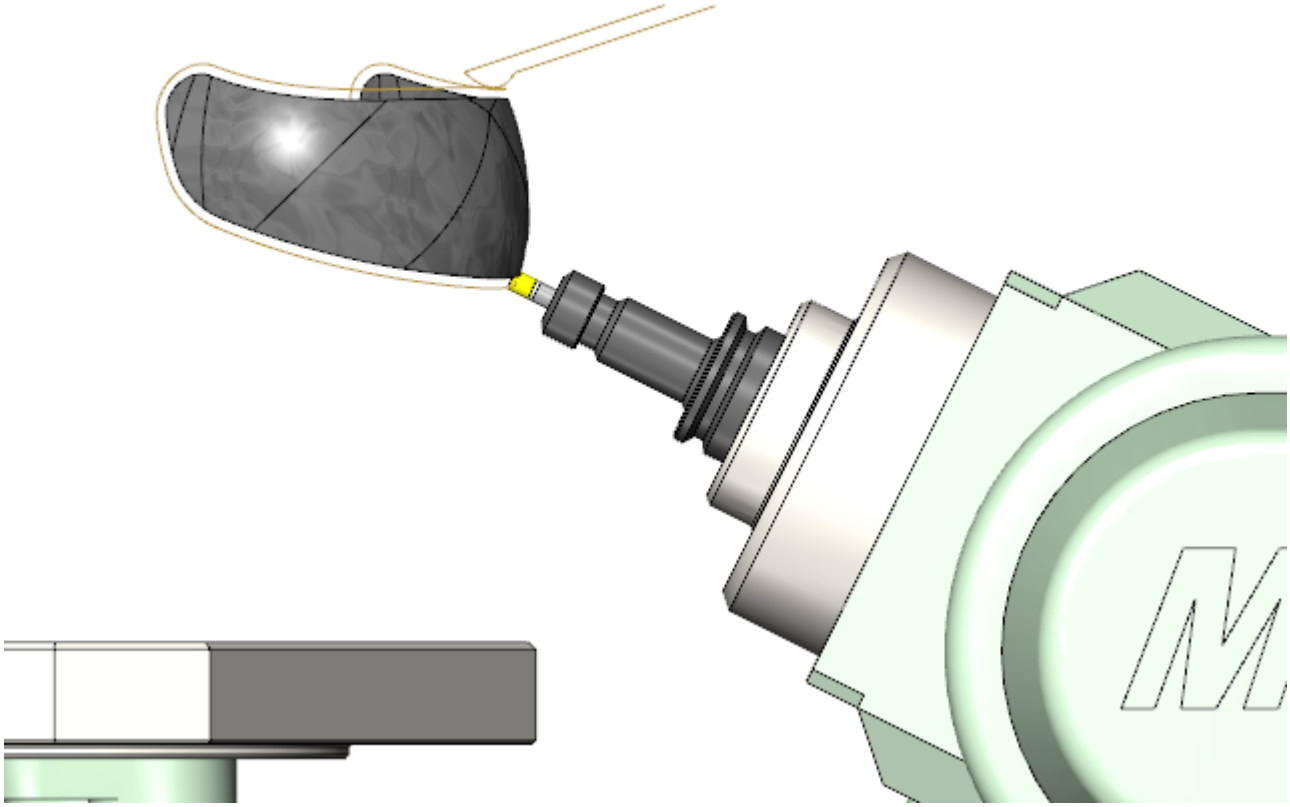


3. Click **Run** to begin the simulation.
4. Select the **Report** tab.



Machine Simulation reports a value underflow in the Z axis. This means that the Z tool exceeded the Z-axis travel limit.

5. Click on the issue in the **Report** tab and Machine Simulation jumps to where the problem occurs.
6. Zoom in on the part and click **Right** on the **Simulation** tab to get a clearer view.



7. Step through the toolpath's problem section.

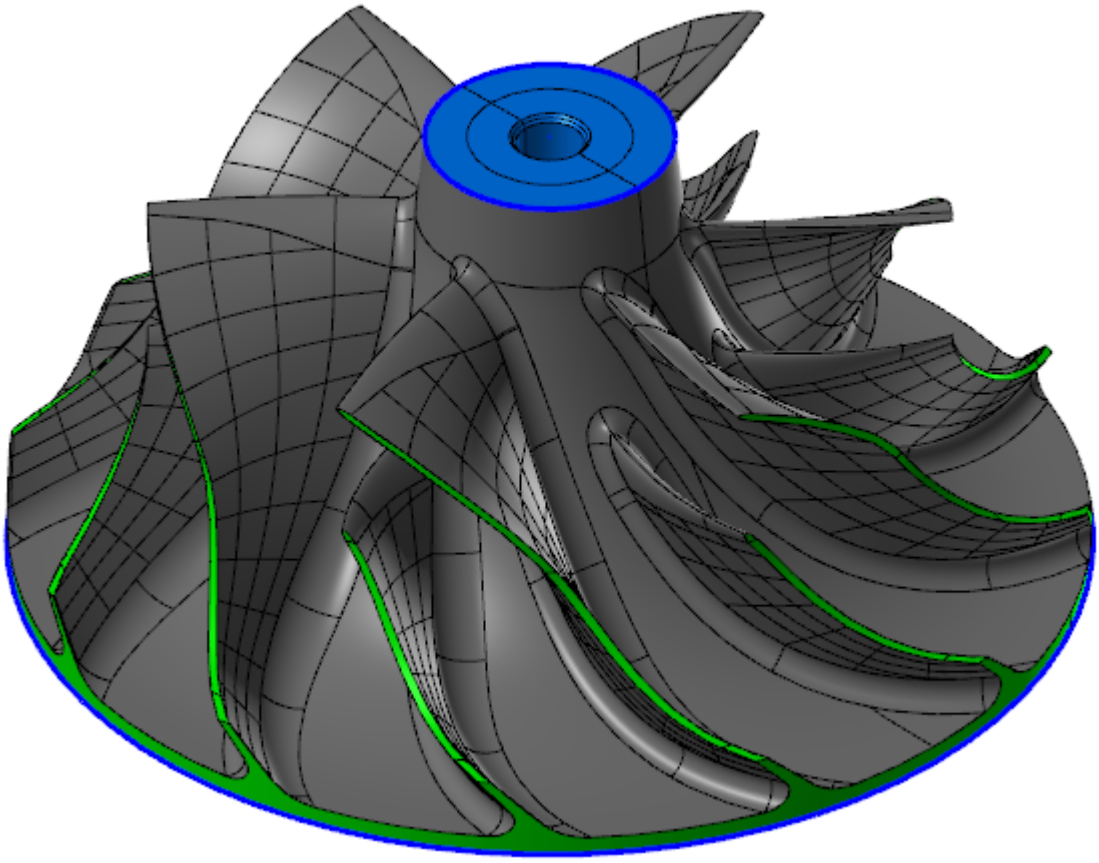
   Before you even select a fixture for the part, you can see that the part has problems on this machine. You may need to select a different machine in your shop or move the part closer to the table.

8. Click **Exit** to close Machine Simulation.

Exercise 2: Analyzing Before Machine Selection

No matter what machine you select, Machine Simulation includes analysis tools that provide additional details on your toolpaths. These details may affect what machine you select for your part.

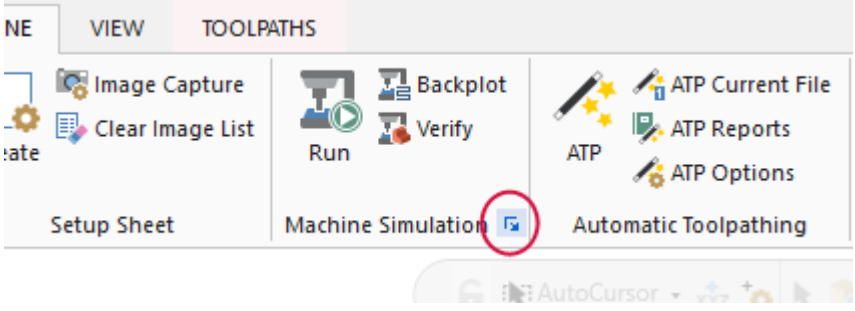
1. From Mastercam, choose **File**, **Open**. Open the part file, `SPLIT_IMPELLER`, provided with this tutorial.



2. Select the second toolpath in the Toolpaths Manager.

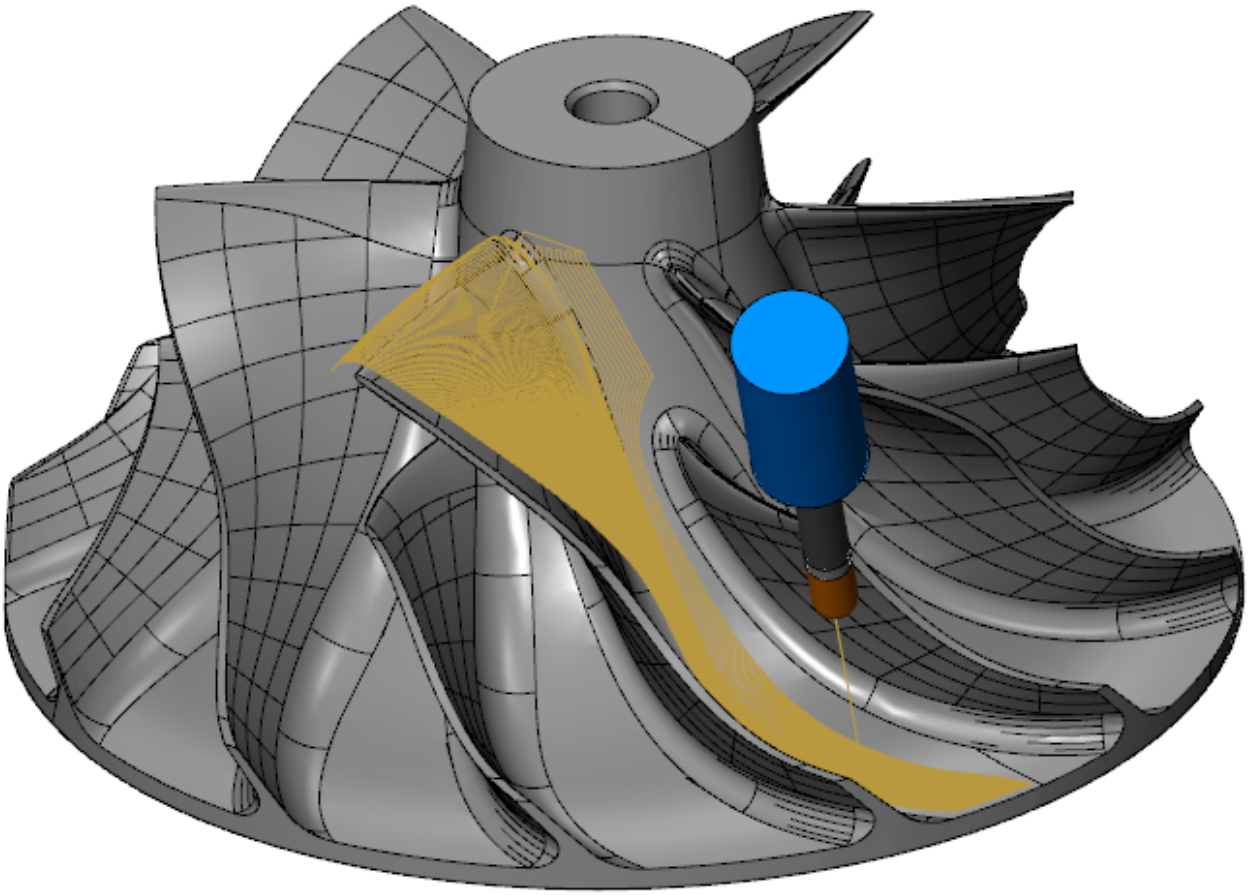
Mastercam displays the selected toolpath.

3. Select the dialog box launcher in the Machine Simulation group on the **Machine** tab.



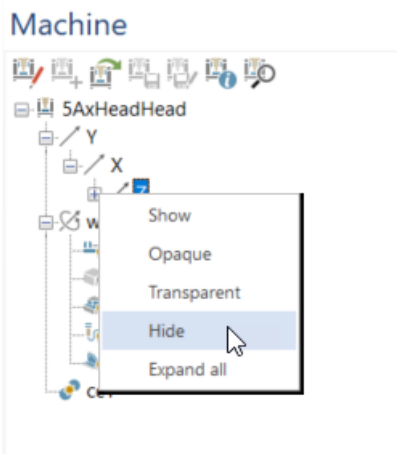
The basic 5AxHeadHead machine is selected by default.

4. Enter **0.3** for the **Simulation tolerance**.
5. Click **Simulate** to display the part. No machine displays.
6. Click **Run** to watch the toolpath motion on the part.

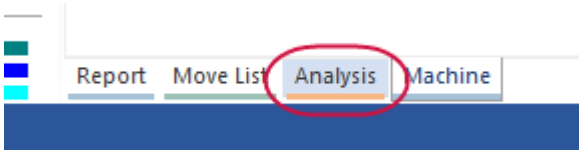


If the toolpath is not displayed, click **Toolpath** in the Visibility section of the **Simulation** tab.

7. To see the tool motion more clearly, click the **Machine** tab, right-click on the workpiece in the tree control, and choose **Hide**.

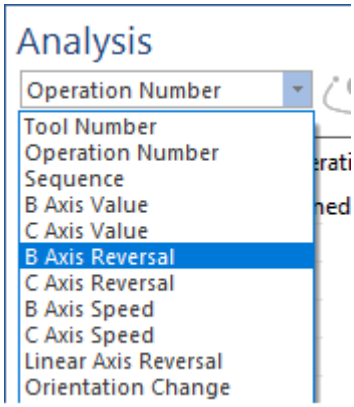


8. Click the **Analysis** tab.



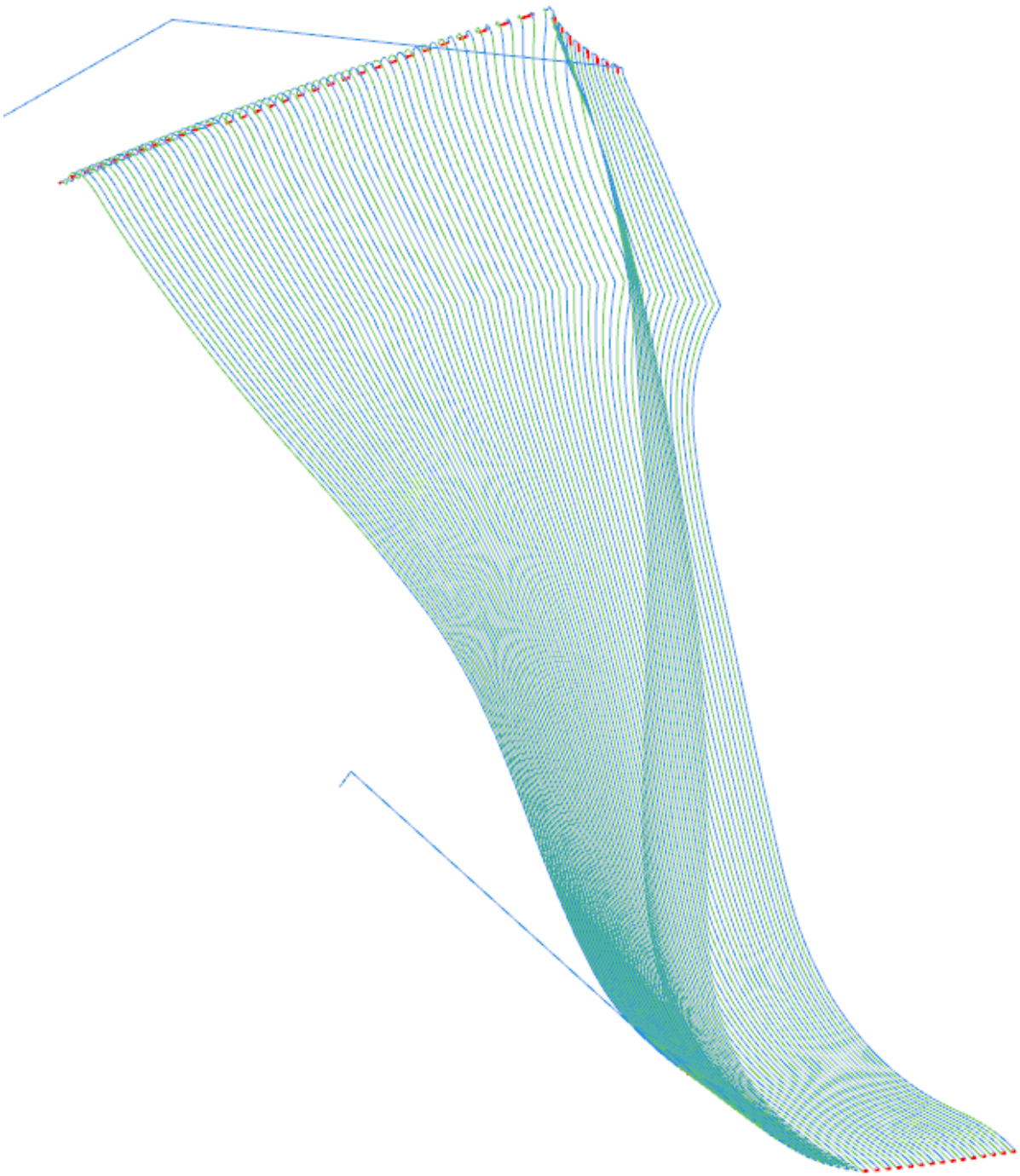
This tab includes many options for closely inspecting your toolpath motion.

9. Select **B Axis Reversal** from the drop-down list at the top of the tab.



This analysis option changes the toolpath color every time the rotation axis changes direction. The color changes can help you identify areas where direction changes could impact your surface quality.

10. Rotate the part and zoom in if necessary to get a better view of the color changes.

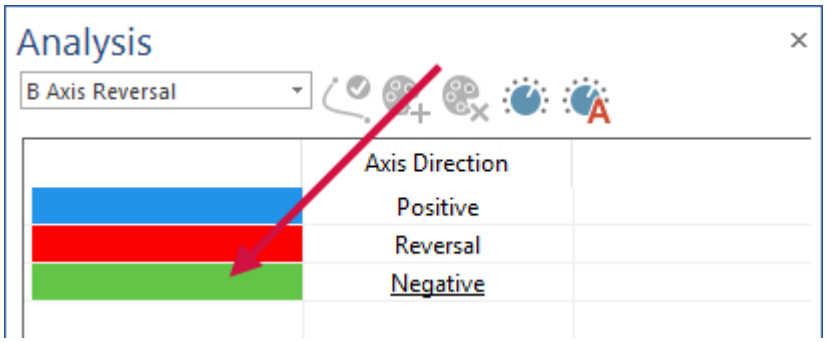


According to the color key in the Analysis tab:

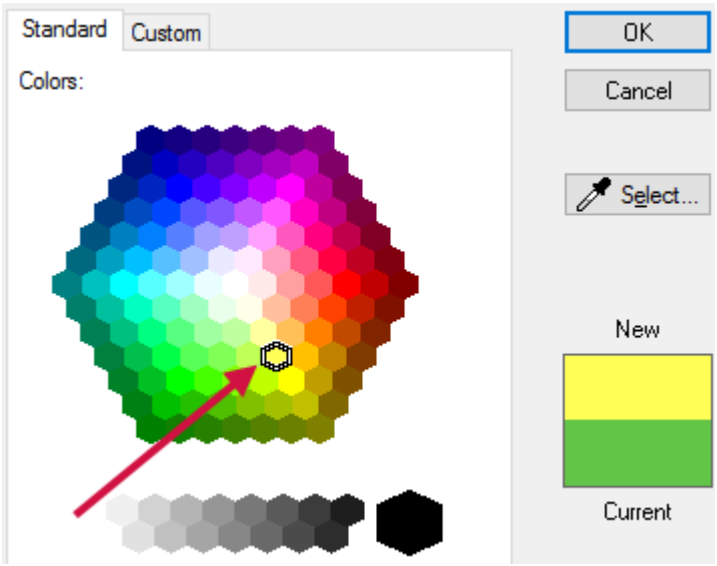
- **Blue**: Positive axis direction moves
- **Green**: Negative axis direction moves
- **Red**: Axis direction reversal

The red areas could create pattern marks on your surface if you are running an older machine. You may be able to work around these areas by adjusting the part in the machine.

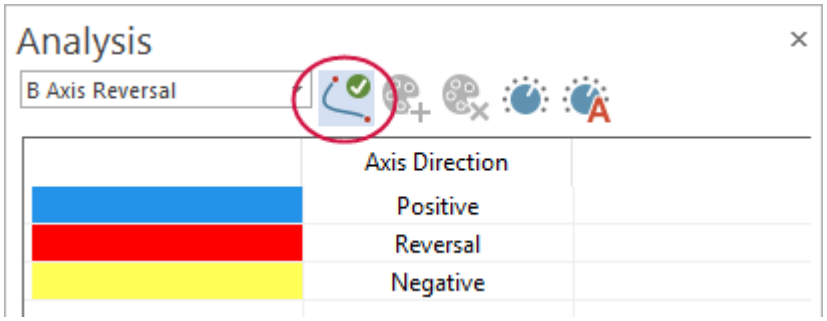
11. To change the color for negative axis direction moves and make them easier to see, double-click the green square to display the **Colors** dialog box.



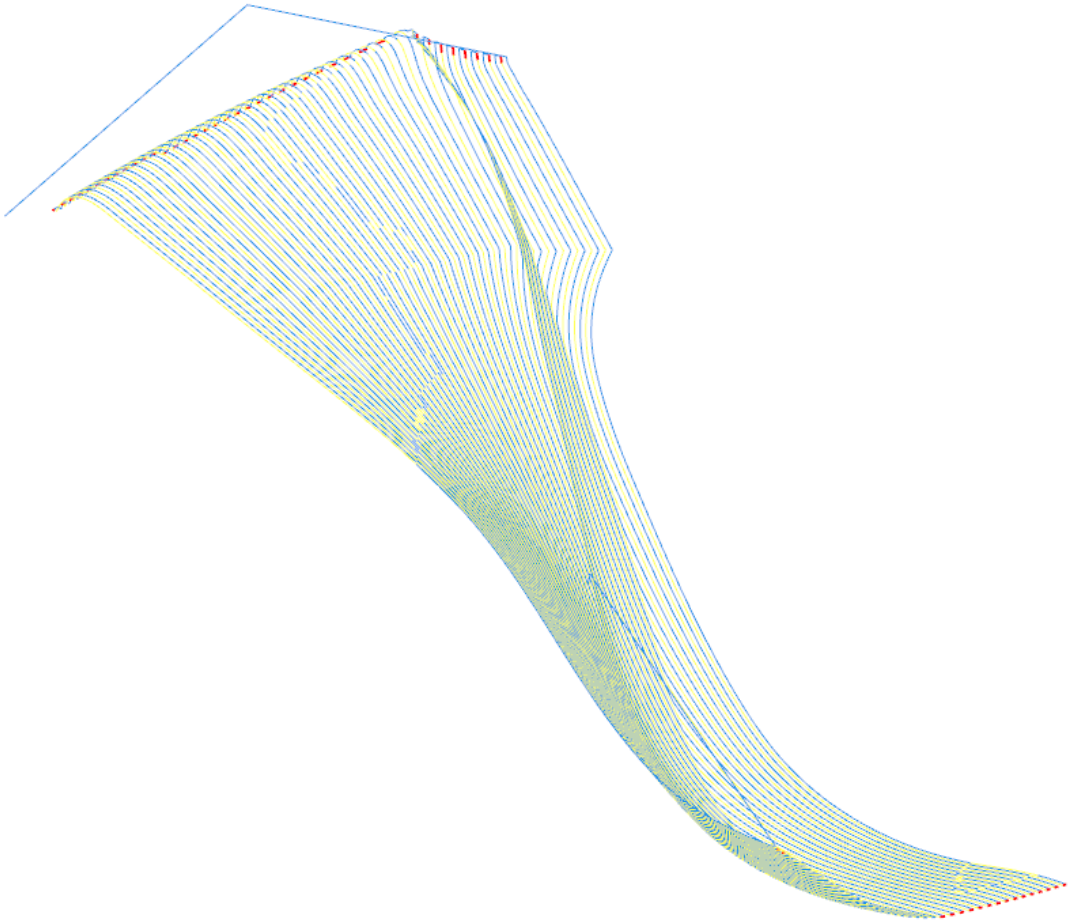
12. Select yellow and click **OK**.



13. Click **Refresh** on the **Analysis** tab to update the colors in the simulation window.



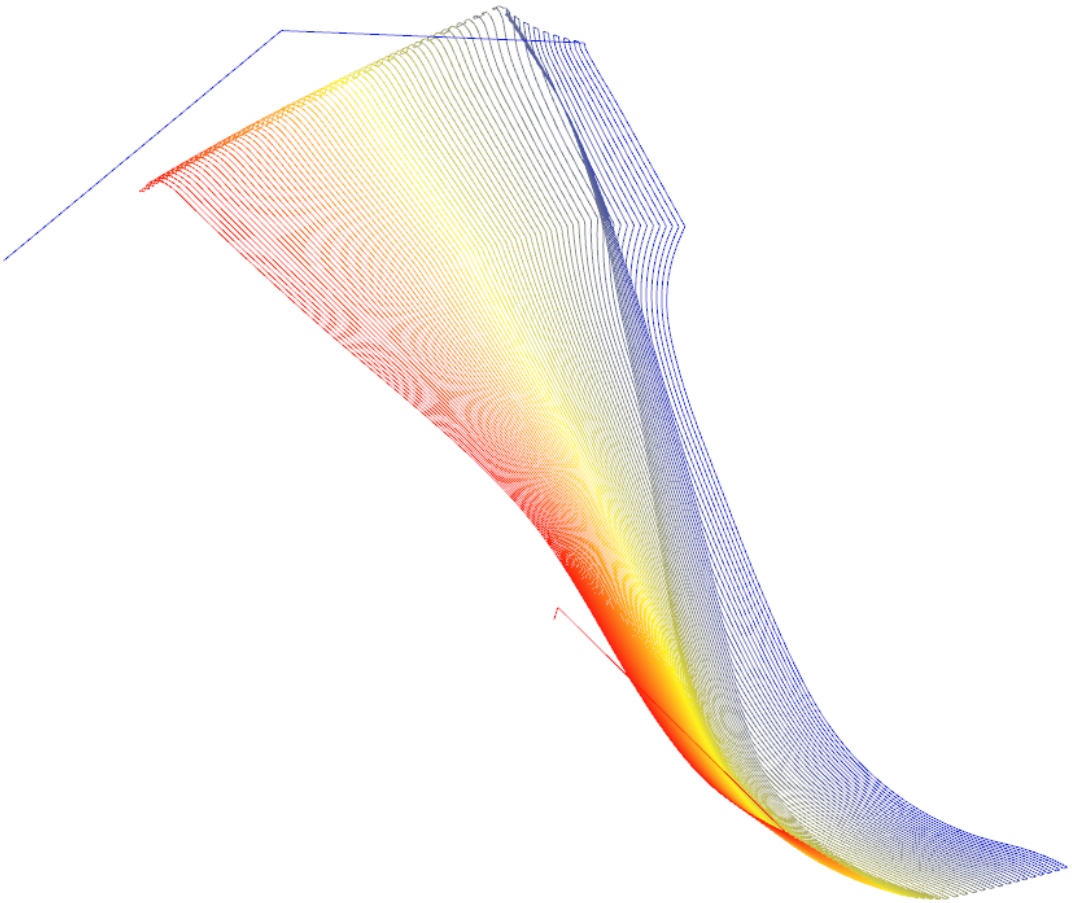
The new color provides a better contrast and makes it easier to see the direction changes.



14. Select **Sequence** from the drop-down list at the top of the **Analysis** tab.

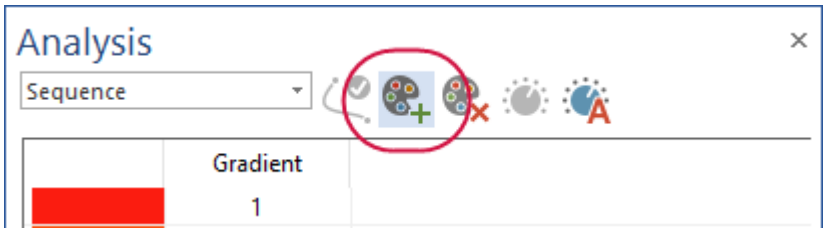
    This analysis colorizes the following attributes in a “hot to cold” gradient:

    - Machining start and end points
    - Cutting method (zigzag or one way)
    - Cut order (inside to outside, outside to inside)



The default colorization uses ten gradients, starting with red at the beginning of the toolpath and ending with blue. You can see where the toolpath begins and ends and that it moves in a zigzag pattern.

You can add more gradients by clicking the **Add** button at the top of the Analysis dialog box.



15. Click **Exit** to return to the main Mastercam screen.

These analysis options help you adjust your toolpaths to be more efficient and effective. To learn more about analysis options and about the Machine Simulation in general, press [**F1**] while in the Machine Simulation window to bring up the Mastercam Help.

CHAPTER 4

MACHINE SIMULATION FOR 3-AXIS TOOLPATHS

Whether you're creating 3-axis or 5-axis toolpaths for your parts, Machine Simulation lets you see your part being machined virtually so you can optimize your toolpath motion. Even 3-axis toolpaths can benefit from the stock removal and fixture testing that Machine Simulation offers.

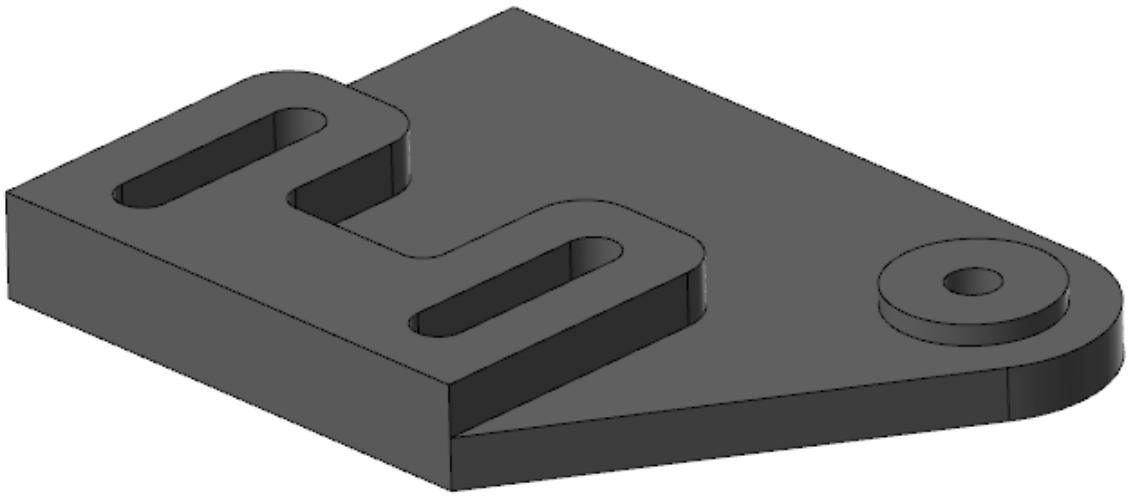
Goals

- Using an STL file to simulate stock removal
- Testing fixturing options in Machine Simulation
- Creating a presentation of simulation results

Exercise 1: Loading the Part in the Fixture

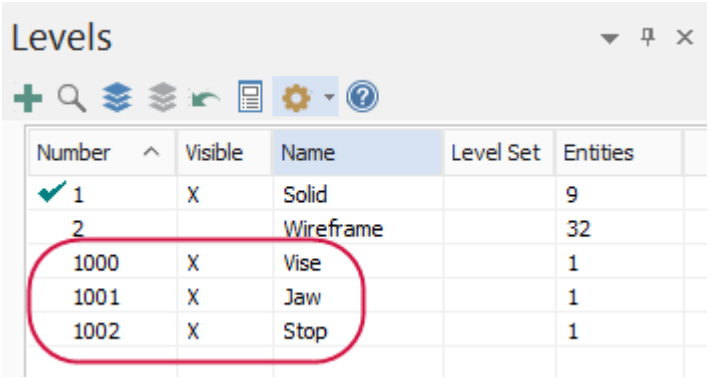
Besides simulating machine motion, Machine Simulation can show stock removal to confirm your final part shape.

1. From the Mastercam menu, choose **File**, **Open**. Open the part file, `POCKET_VISE`, provided with this tutorial.

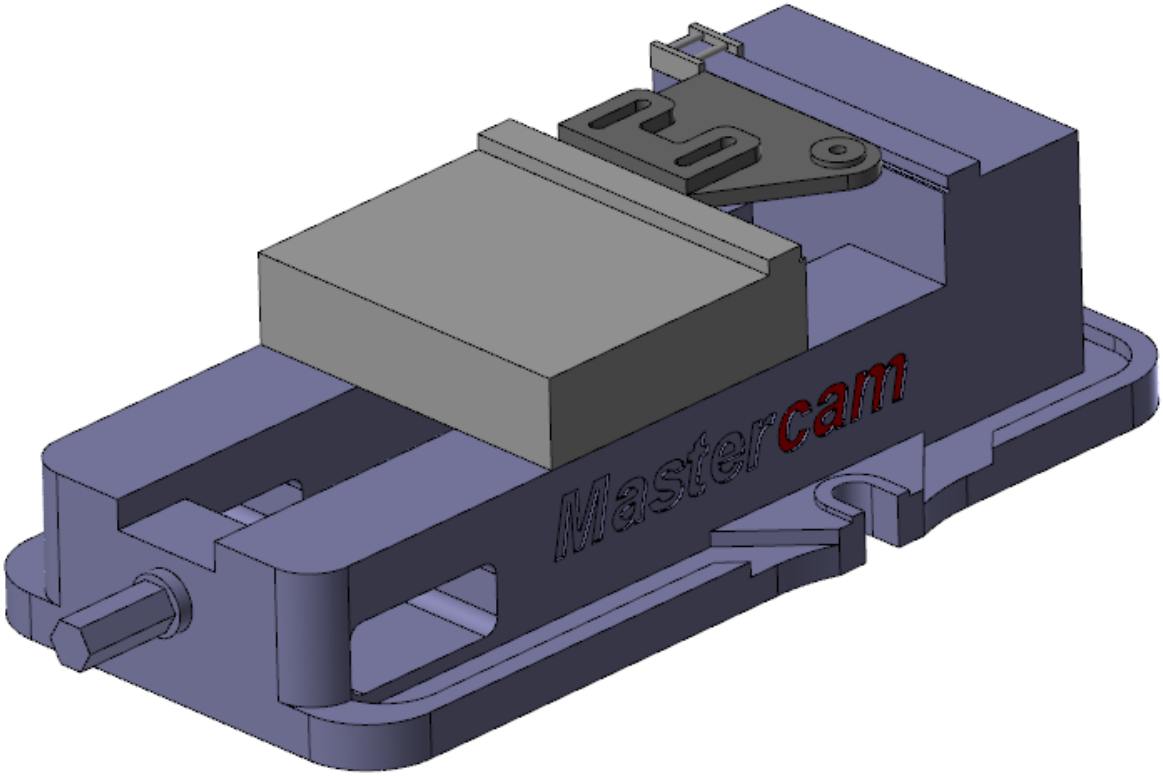


This part is configured in inches, so you are prompted to switch from Metric to Inch. Choose **All settings** and click **OK** to

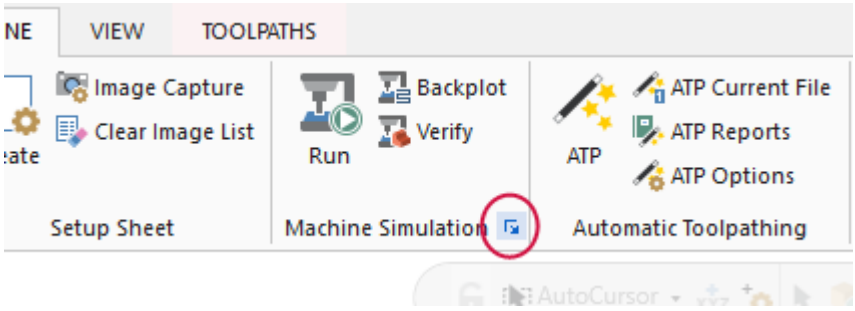
2. Use the Levels Manager to display the vise on level 1000, the jaw on level 1001, and the stop on level 1002.



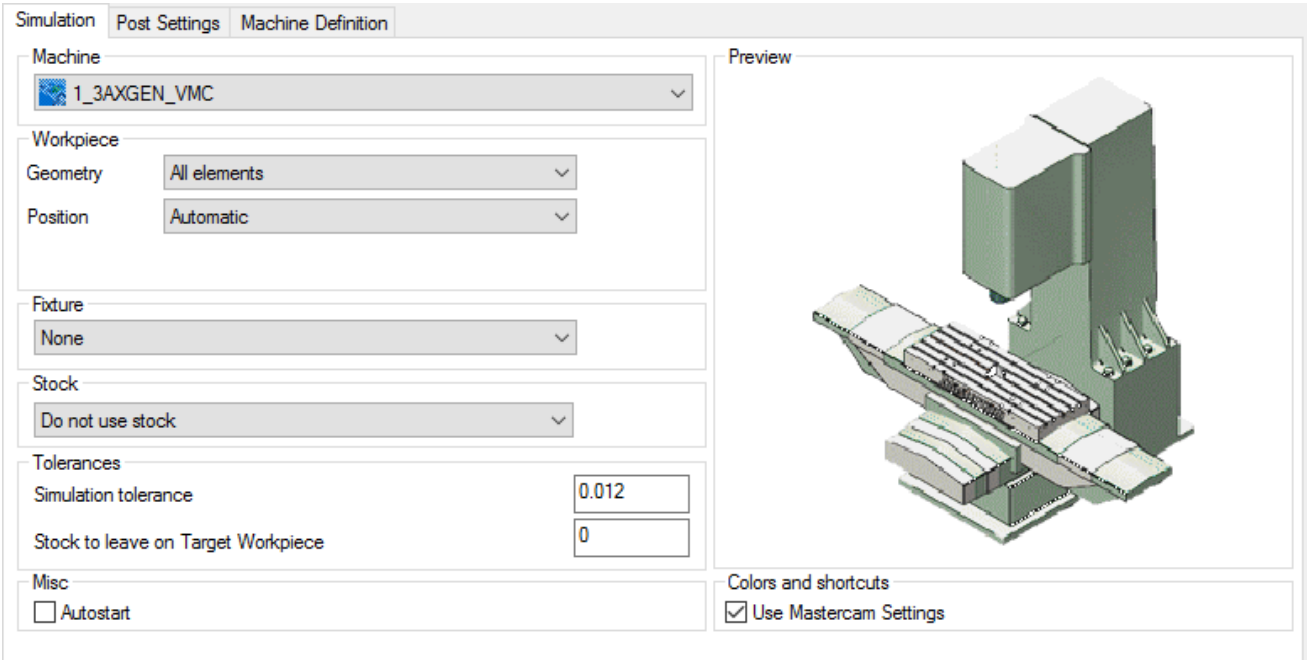
3. Fit the part and fixture in the graphics window.



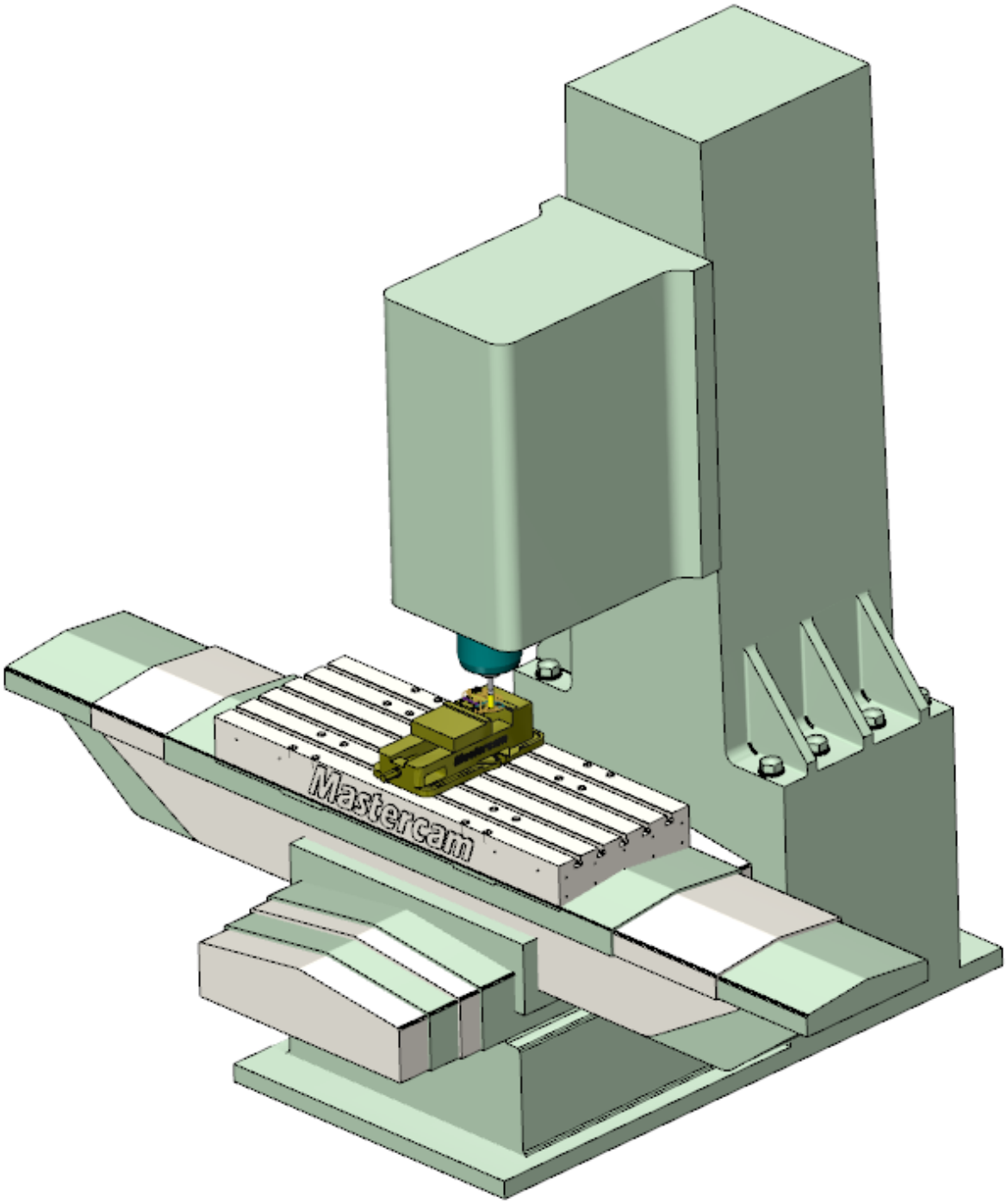
4. Select all the toolpaths in the Toolpaths Manager.
5. Select the dialog box launcher in the Machine Simulation group on the **Machine** tab.



6. Machine Simulation is already set to use a 3-axis vertical machining center.

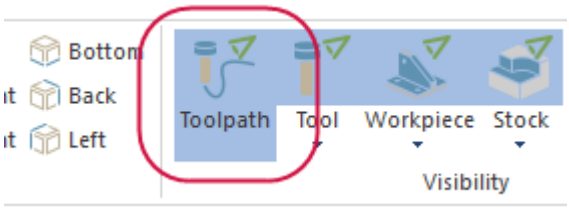


7. Click **Simulate** to display the part in the machine.

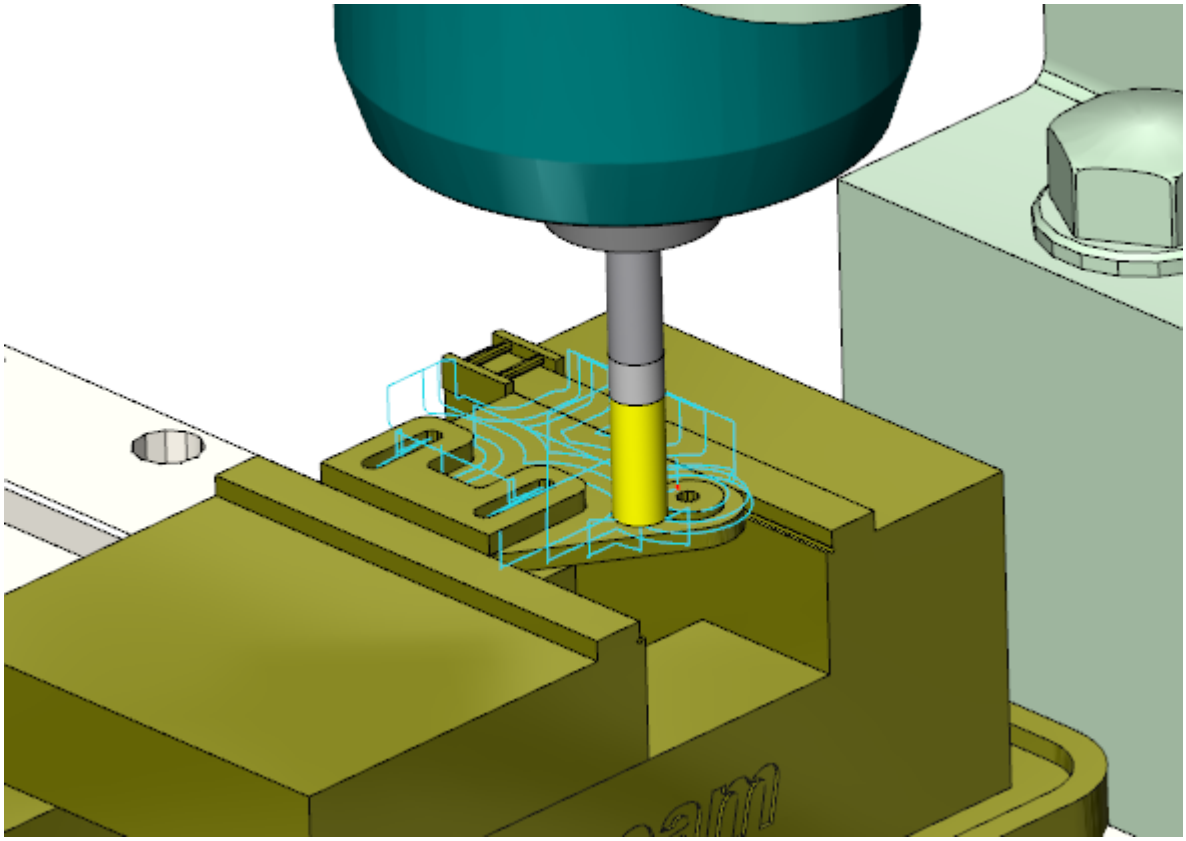


If you don't see the workpiece, click the drop-down arrow below the **Workpiece** button and select **Show**.

8. Confirm that **Toolpath** is selected to display the tool motion.



9. Zoom into the part and click **Run** to view the simulation.

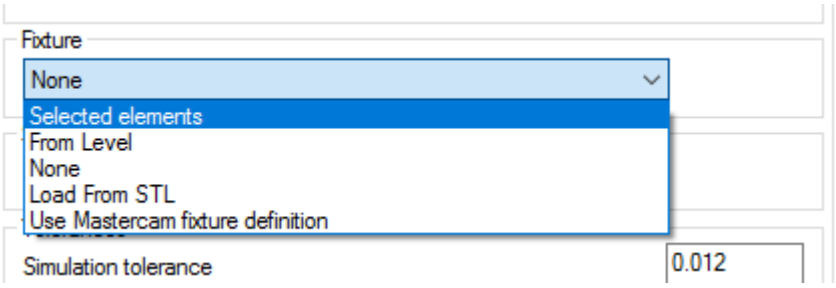


10. When the simulation is complete, click **Exit** to return to the main Mastercam screen.

Now that you've seen the basic tool motion, you can adjust the simulation environment to check stock removal and test fixturing.

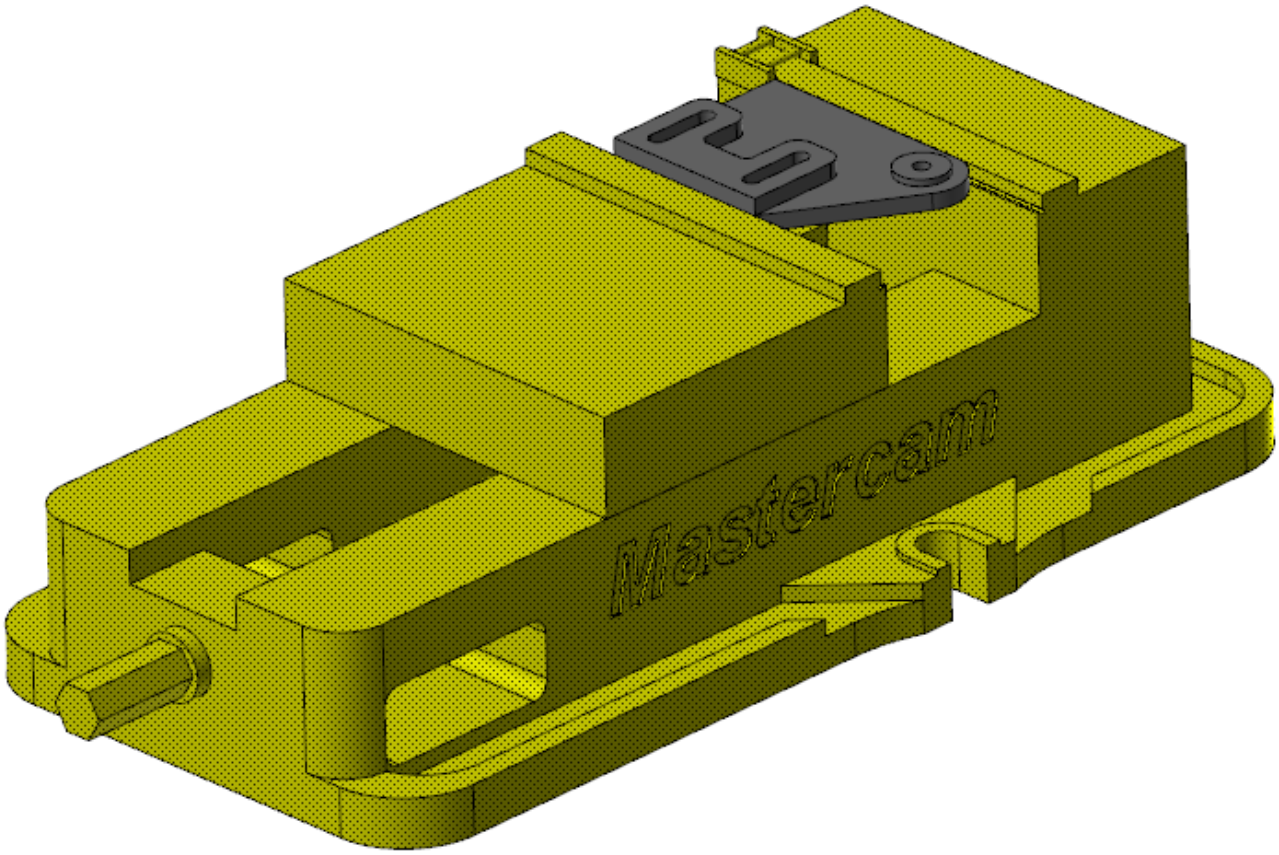
Exercise 2: Adding a Fixture and Stock

1. Select the dialog box launcher in the Machine Simulation group on the **Machine** tab.
2. Click the **Fixture** drop-down list and select **Selected elements**.

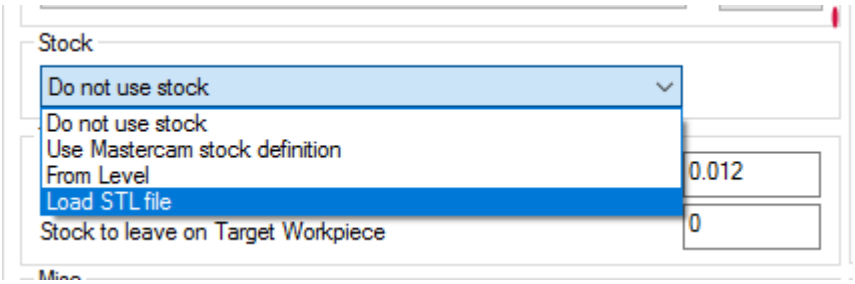


3. Click the button to the right of the **Fixture** drop-down list.

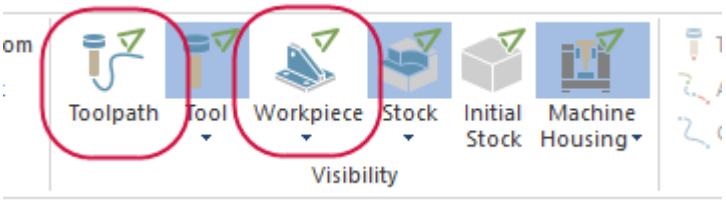
4. Select the vise, jaw, and stop in the graphics window and press [**Enter**], or **End Selection** to return to the dialog box.



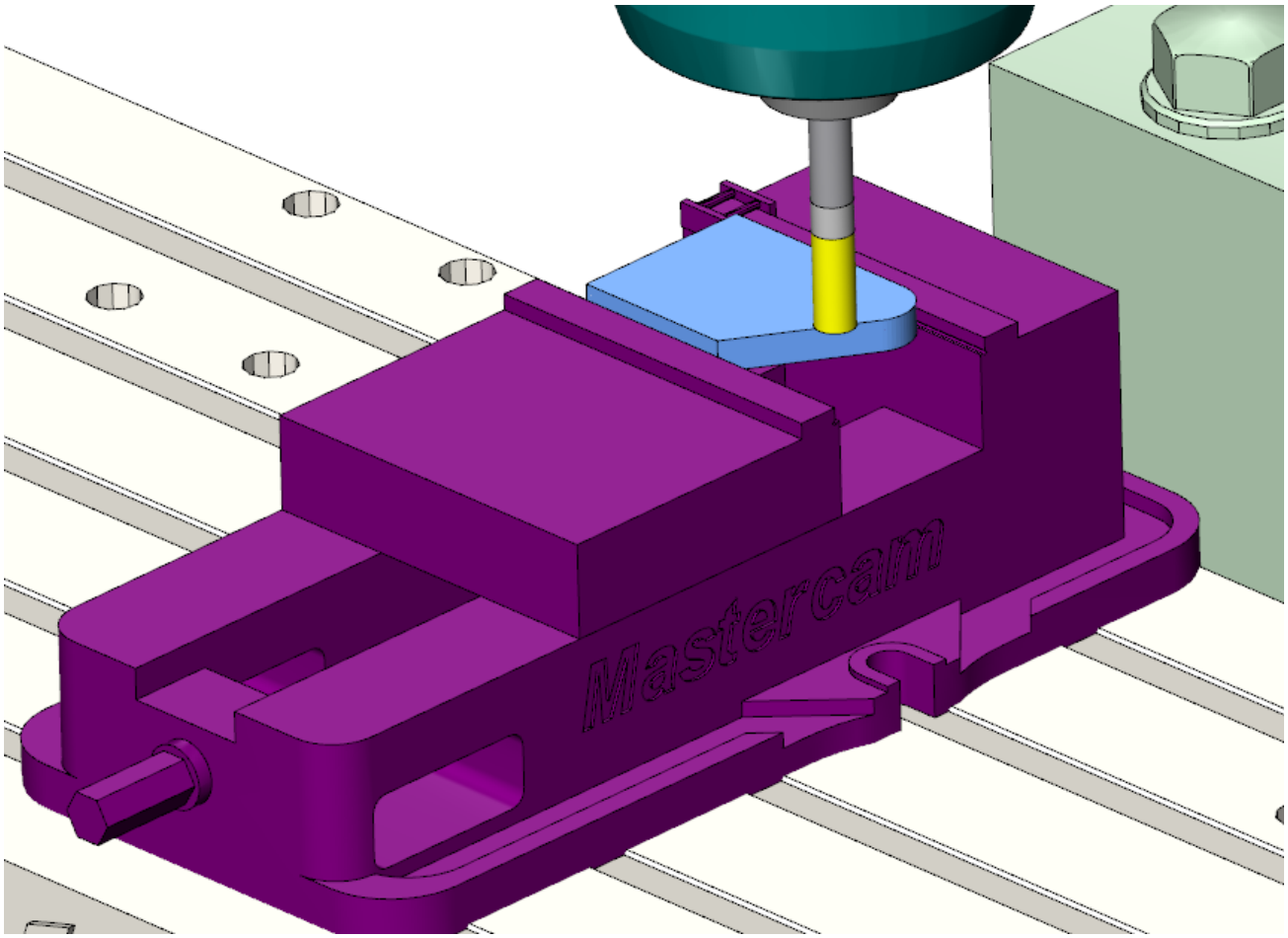
5. Click the **Stock** drop-down list and select **Load STL file**.



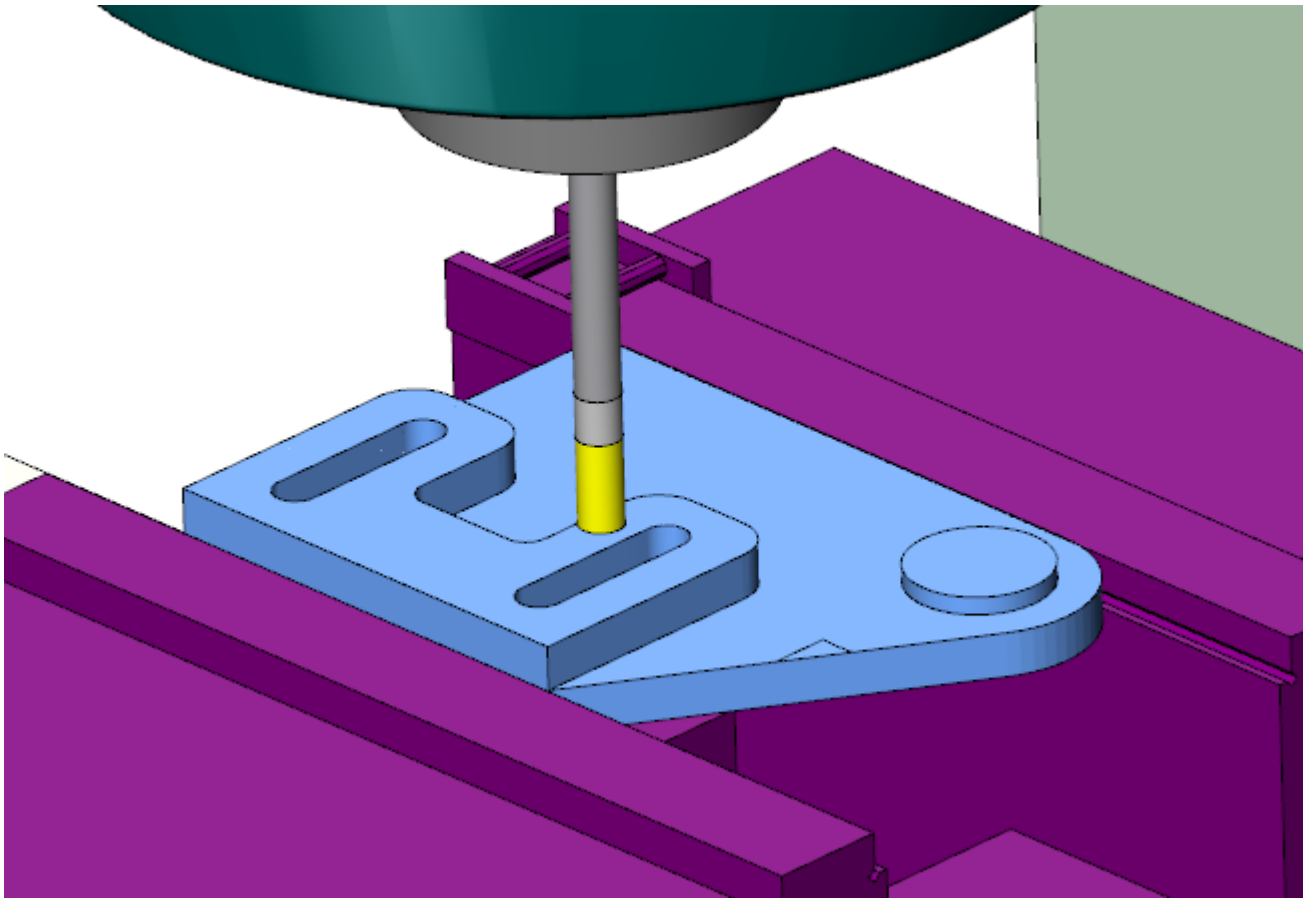
6. Click the button to the right of the **Stock** drop-down list and select `POCKET_STOCK.STL` that was provided with this tutorial.
7. Click **Simulate**.
8. Hide the **Workpiece** and the **Toolpath**.



9. Zoom in on the part in the machine. The STL file displays as blank stock.



10. Click **Run** to view the material removal.

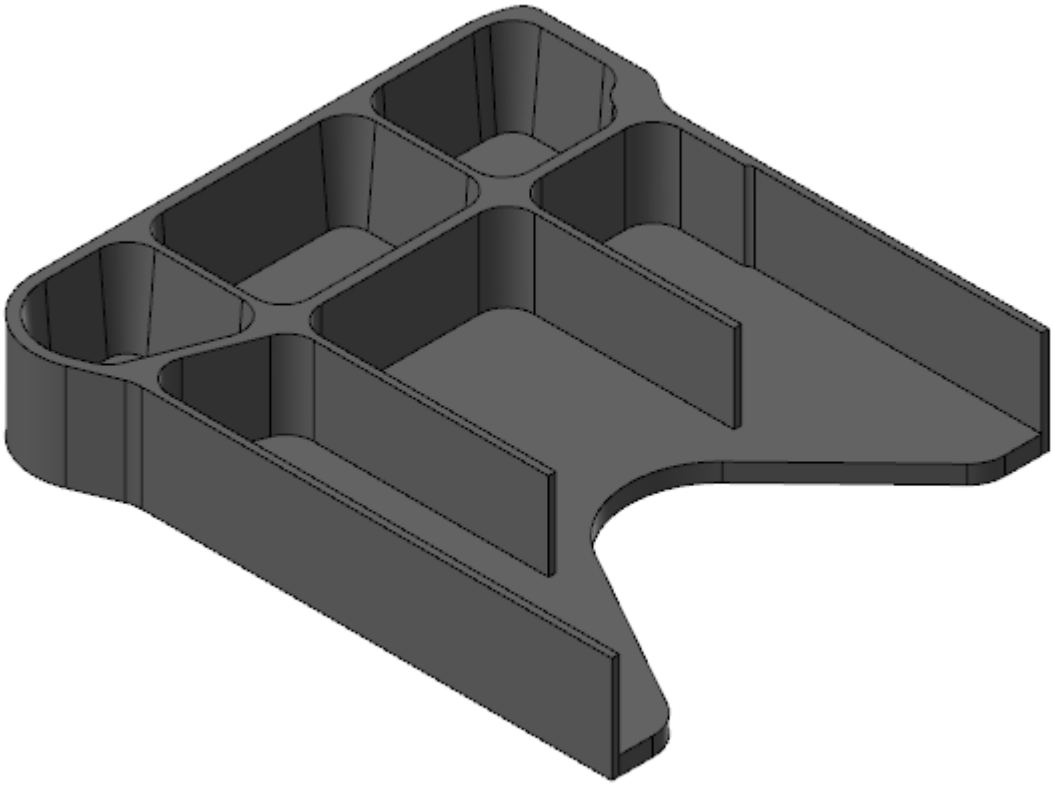


11. Click **Exit** to return to the main Mastercam screen.

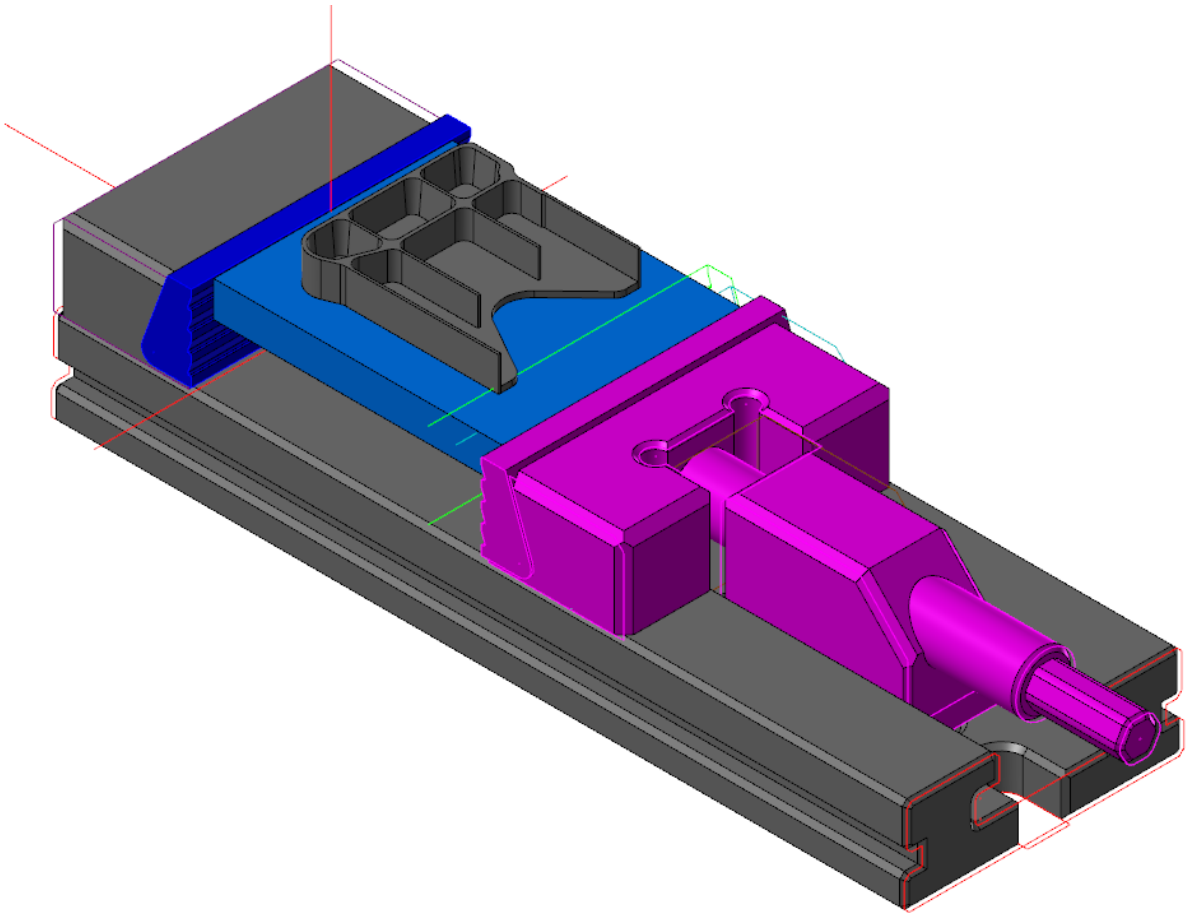
Exercise 3: Simulating with Different Fixtures

As you've seen with 5-axis toolpaths, using Machine Simulation to test out different fixtures can save you valuable time and money. You can do the same with 3-axis toolpaths.

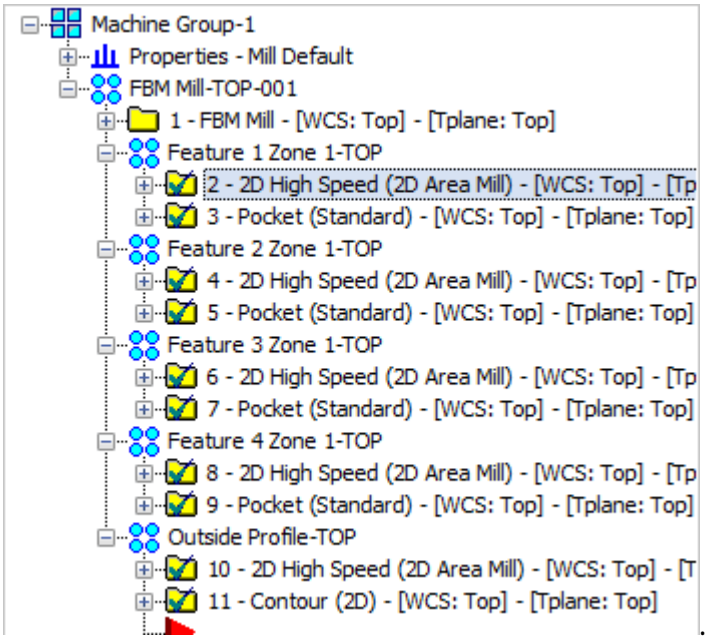
1. From Mastercam, choose **File**, **Open**. Open the part file, `PLATE`, provided with this tutorial.
2. Press [**Alt+S**] to shade the part, if necessary.



3. Use the Levels Manager to display the vise on level 999.
4. Fit the part and fixture in the graphics window.



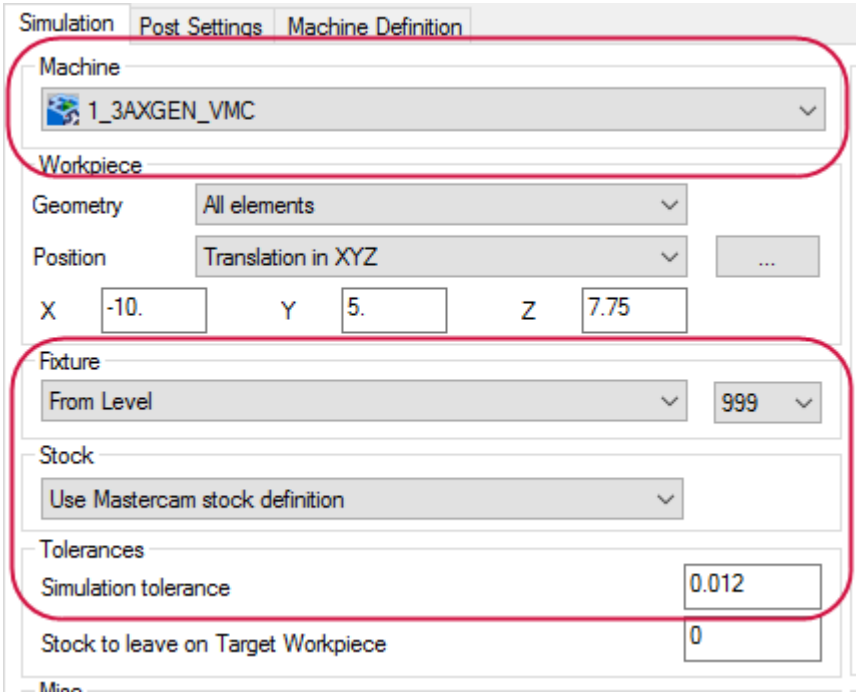
5. Select all the toolpaths in the Toolpaths Manager except the FBM Mill operation.



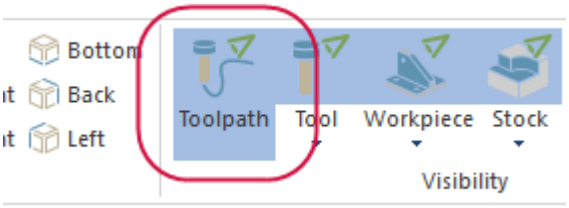
Note: Machine Simulation does not support non-motion FBM preparation operations.

6. Select the dialog box launcher in the Machine Simulation group on the **Machine** tab.

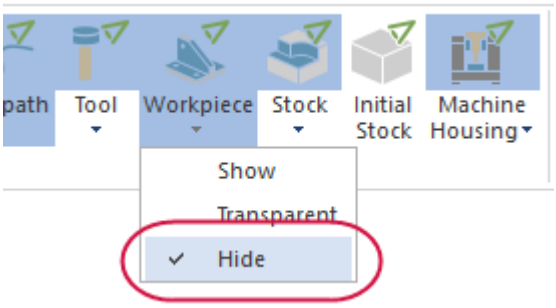
7. Use the following parameters on the Simulation tab:
    a. Select **1_3AXGEN_VMC** from the Machine drop-down list.
    b. Select **From Level** from the Fixture drop-down list and select **999**.
    c. Select **Use Mastercam stock definition** from the Stock drop-down list.
    d. Enter **0.012** for the **Simulation tolerance**.



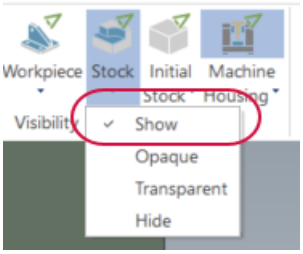
8. Click **Simulate** to display the part in the machine.
9. Use the following buttons on the toolbar to make it easier to see the toolpaths and stock removal:
    a. Click **Toolpath** on the Simulation tab to display the tool motion.



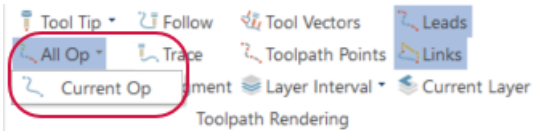
    b. Confirm that the **Workpiece** is hidden.



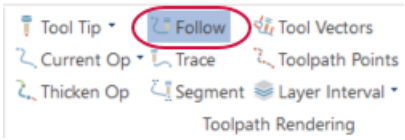
    c. Confirm that the **Stock** is displayed.



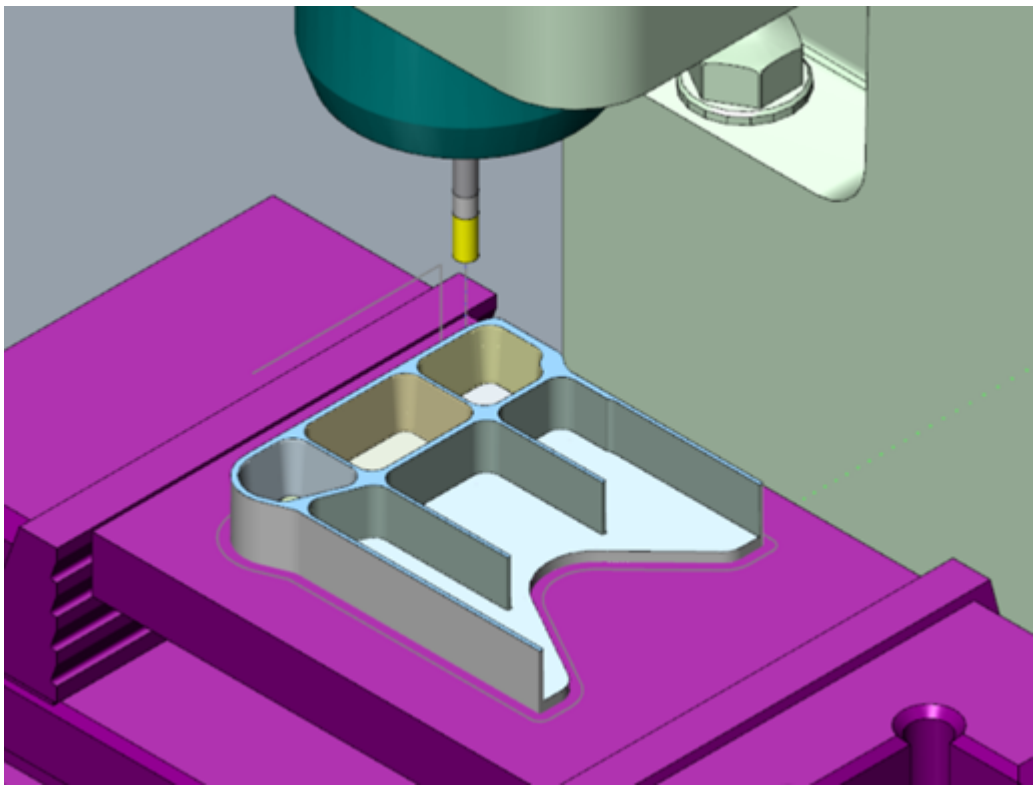
d. Click **Current Op**. This option displays one toolpath at a time using the color assigned to that operation.



e. Click **Follow**. This option displays the path that has been machined.



10. Zoom in on the part and click **Run** to view the simulation.



11. When the simulation is complete, click **Exit** to return to the main Mastercam screen.

CONCLUSION

Congratulations! You have completed the *Mastercam Machine Simulation Tutorial*! Now that you have mastered the skills in this tutorial, explore Mastercam's other features and functions.

You may be interested in other tutorials that we offer. Mastercam tutorials are being constantly developed, and we will add more as we complete them. Visit our website, or select **Help**, **Tutorials** from the **File** tab.

Mastercam Resources

Enhance your Mastercam experience by using the following resources:

- *Mastercam Documentation*—Mastercam installs a number of helpful documents for your version of software in the Documentation folder of your Mastercam 2019 installation.
- *Mastercam Help*—Access Mastercam Help by selecting **Help**, **Contents** from Mastercam's **File** tab or by pressing **[Alt+H]** on your keyboard.
- *Mastercam Reseller*—Your local Mastercam Reseller can help with most questions about Mastercam.
- *Technical Support*—Our Technical Support department (+1 860-875-5006 or support@mastercam.com) is open Monday through Friday from 8:00 a.m. to 5:30 p.m. USA Eastern Standard Time.
- *Mastercam Tutorials*—We offer a series of tutorials to help registered users become familiar with basic Mastercam features and functions. Visit our website, or select **Help**, **Tutorials** from Mastercam's **File** tab to see the latest publications.
- *Mastercam University*—Mastercam University, an affordable online learning platform, gives you 24/7 access to Mastercam training materials. Take advantage of more than 180 videos to master skills at your own pace and help prepare for Mastercam Certification. For more information on Mastercam University, please contact your Authorized Mastercam Reseller, visit www.mastercamu.com, or email training@mastercam.com.
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