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Autodesk® PowerMill®

# User Guide

Simulation Analysis





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# Introduction

Use the Simulation Analysis plugin to interrogate the linear and rotary axis movements of the machine tool for a specific toolpath. The plugin checks for any potential issues, such as axis reversals and poor surface finish caused by dwell marks.

The Simulation Analysis plugin is available with PowerMill Premium.



*You must have an active machine tool and active toolpath to use this plugin.*

# Installing the Simulation Analysis plugin

- 1 In Windows Explorer, right-click `PowerMillSimulationAnalysisPluginxxx.msi` and select **Install**.



*You must have administrator rights to install a plugin.*

- 2 Follow the instructions in the installation wizard.
- 3 Start PowerMill.




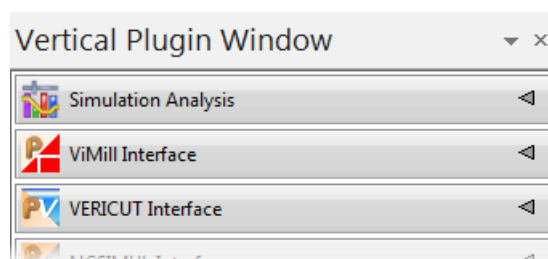
*It may take longer to start PowerMill when installed plugins are loaded.*



*PowerMill displays an **Information** dialog showing the **Simulation Analysis** plugin is enabled.*

PowerMill starts with the **Simulation Analysis** plugin displayed in the plugin pane.

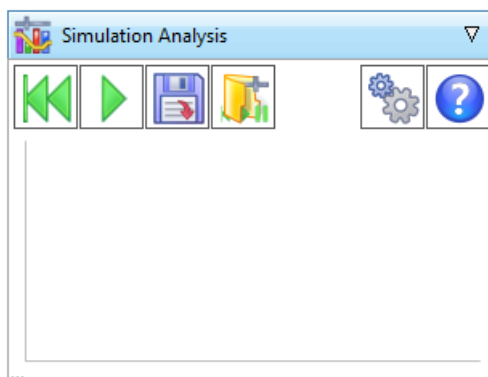
- If the plugin pane is not displayed, click View tab > Window panel > User Interface Vertical Plugin Window.
- If you can see only the header, click  to expand the plugin.



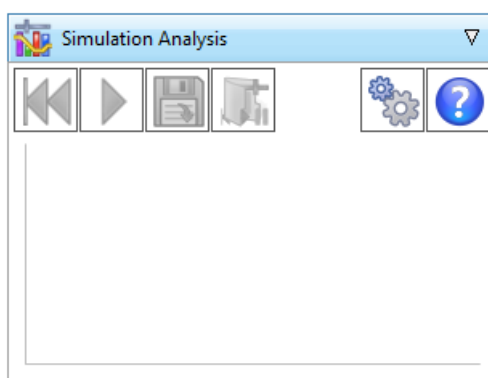
For more information, see Using plugins in the main PowerMill online reference help.

# Using the Simulation Analysis pane

The **Simulation Analysis** plugin is a visual tool to check for unwanted machine tool behaviour, such as axis reversal over a small distance, that adversely affects the surface finish of a part.



Initially the plugin is not available.



To use this plugin in PowerMill, you need to:

- Activate the toolpath you want to analyse.
- Import the relevant machine tool, and activate it.

The Simulation Analysis pane contains the following buttons:



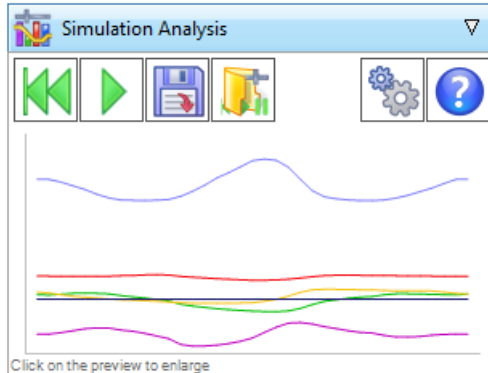
— Click to attach the machine tool to the start of the toolpath.



— Click to play the simulation.



— Click to save the simulation. When saved, the plugin displays the preview graph of the machine tool motion during the simulation.



— Click to open a saved simulation.



— Click to display the **Options** dialog.

The figure shows an "Options" dialog box. Under the "Analysis" section, there are two input fields: "Axis limits tolerance (rotary axis)" with a value of "5" and the unit "degrees", and "Axis limits tolerance (linear axis)" with a value of "50" and the unit "mm". At the bottom of the dialog are "OK" and "Cancel" buttons.

**Axis limits tolerance (rotary axis)** — Enter the angular tolerance to detect an axis limit. For example, if the machine tool has a maximum angular limit of  $\pm 90^\circ$  and you enter a value of **5** here, the simulation analysis shows an axis limit is reached at  $\pm 85^\circ$ .

**Axis limits tolerance (linear axis)** — Enter the distance tolerance to detect an axis limit. For example, if the machine tool has a maximum distance limit of  $\pm 1000$  mm and you enter a value of **50** here, the simulation analysis shows an axis limit is reached at  $\pm 950$  mm.



— Click to display the online help.

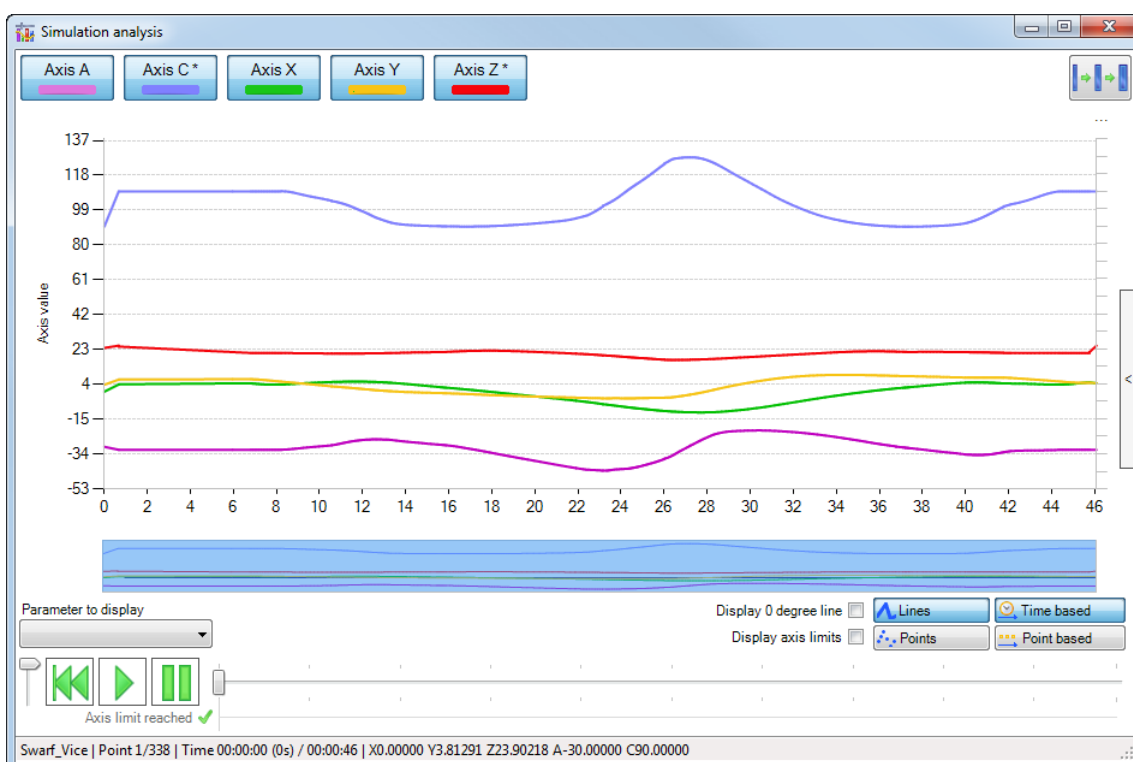


*Click the preview graph to display the **Simulation Analysis** (see page 5) window.*



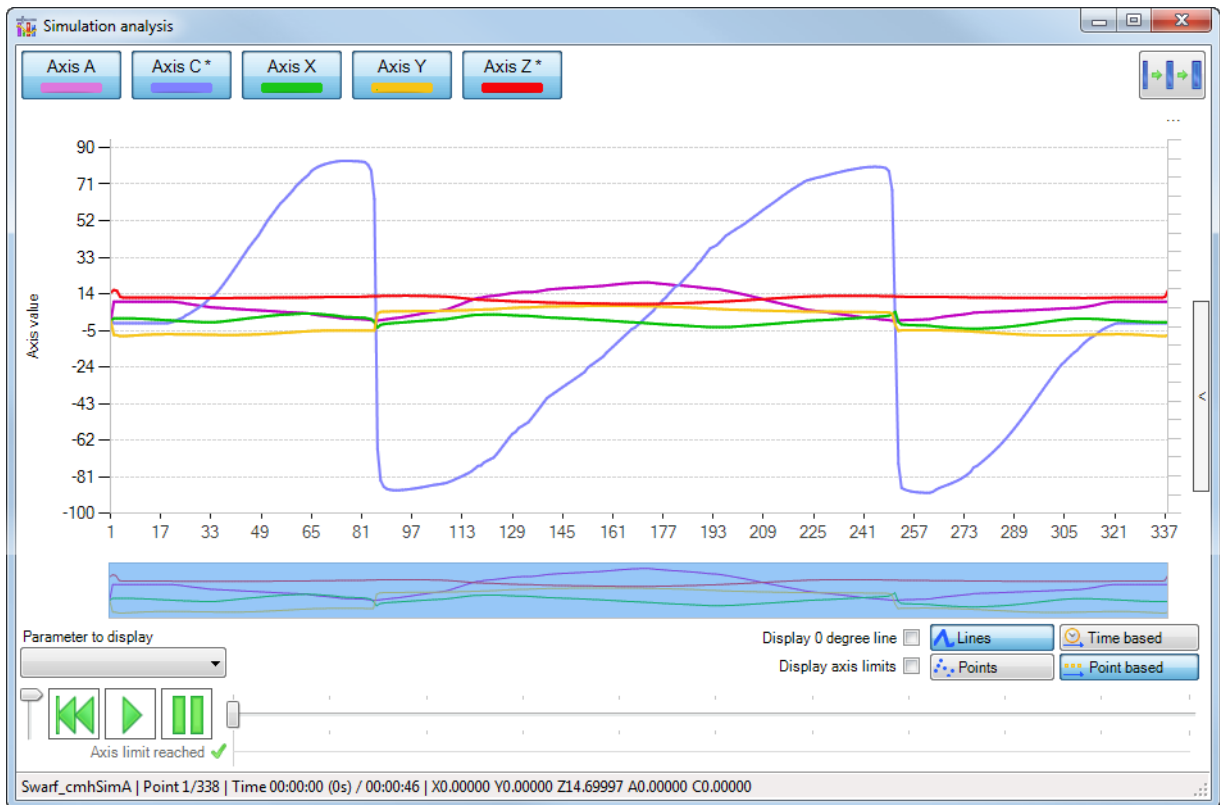
# Using the Simulation Analysis window

Click the preview graph in the **Simulation Analysis** (see page 3) plugin to display the **Simulation Analysis** window.



**Axis A** **Axis C\*** **Axis X** **Axis Y** **Axis Z\*** **Display axis** — Click to display the axis in the graph. These buttons toggle between displaying and not displaying the line graph.

With all axes displayed:



Deselecting **Axis C** by clicking on the **Axis C** button (1) to toggle its display in the graph.



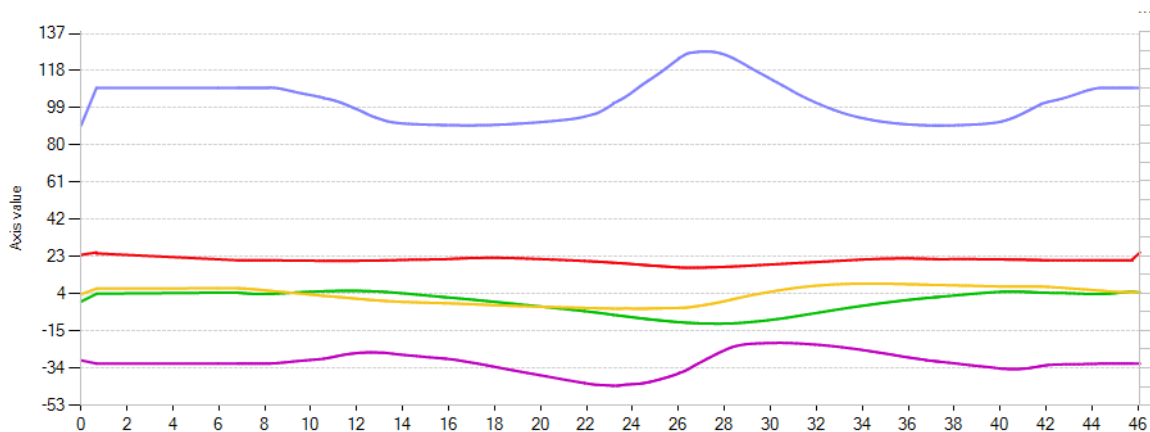
The **Axis Value** (2) automatically adjusts depending on the axes displayed.



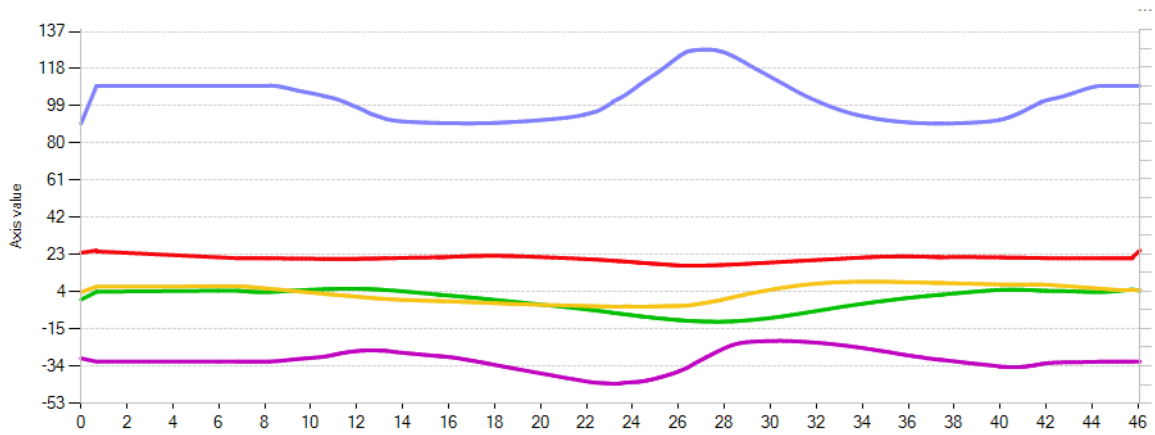
**Line thickness** — Click to change the line thickness of the graph. This toggles between three different line thicknesses.



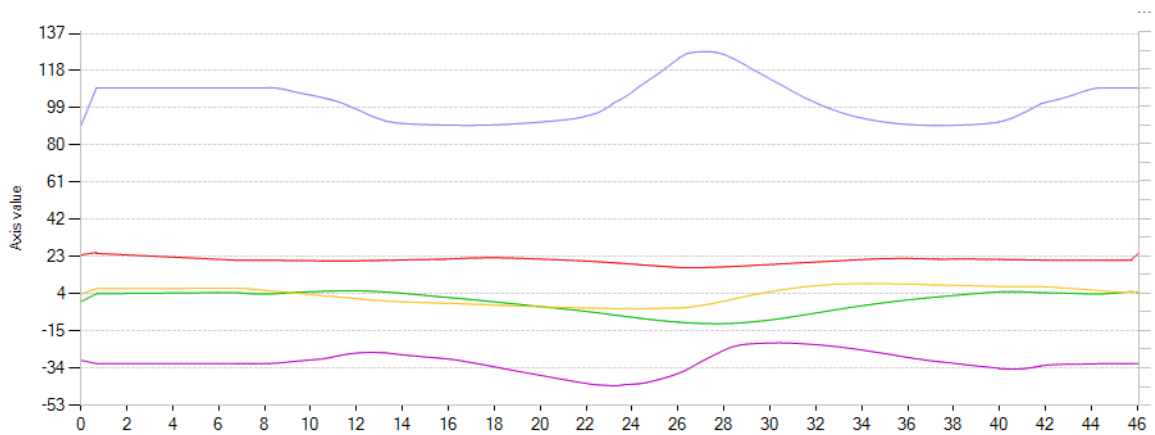
Clicking toggles the graph between:



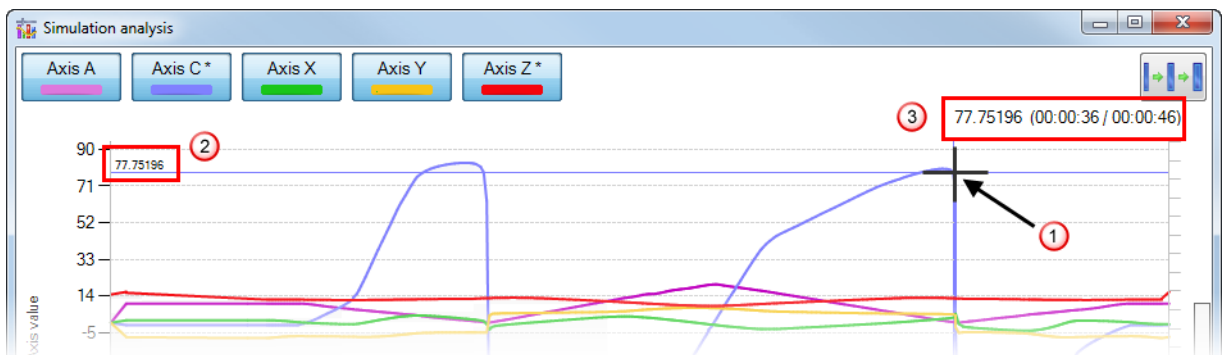
this:



and this:



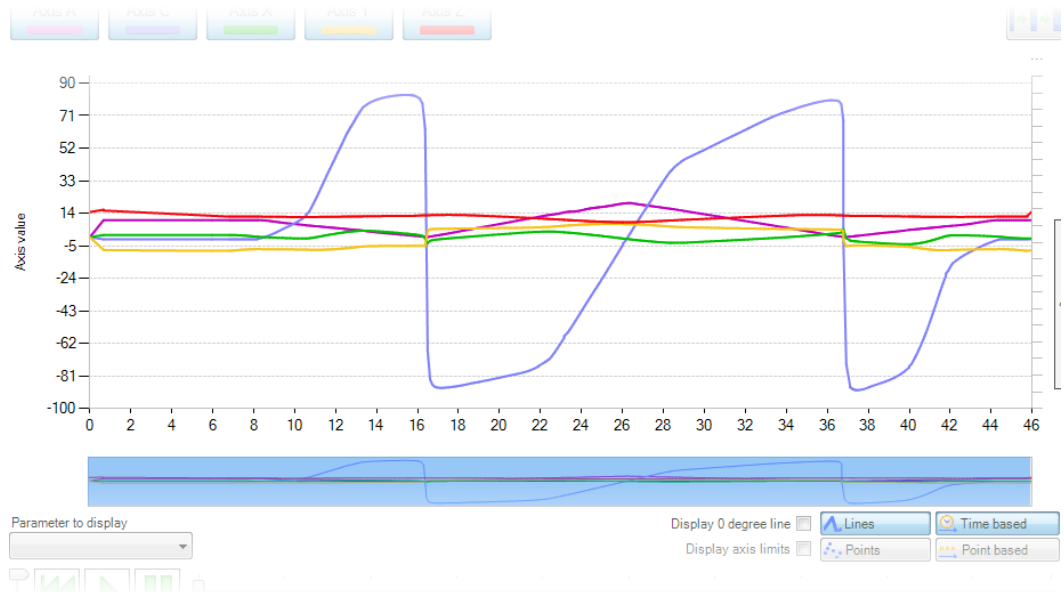
**Graph** — Displays a line graph of each machine tool (or robot) axis. Each axis is drawn in a different colour. Move the cursor over the line graph to display its point information.



- ① Cursor location
- ② The axis value at the cursor location
- ③ The axis value, the time into the toolpath and the total time of the toolpath at the cursor location

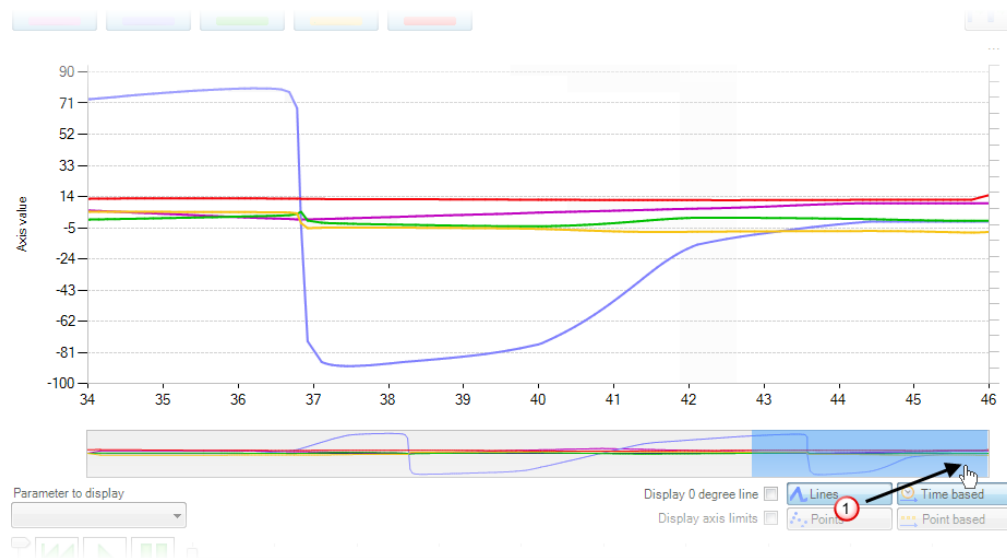
**Zoom area** — The section of toolpath displayed in the graph depends on the zoom area. This strip always displays the whole toolpath. The area shaded blue is displayed in the graph. By default, the whole toolpath is displayed.

Initially the graph displays the whole toolpath.

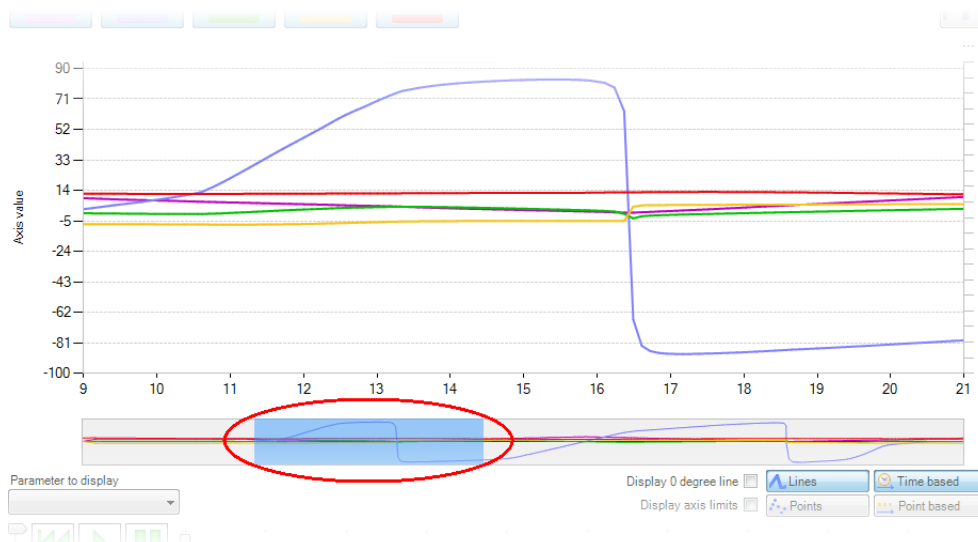


To zoom into an area of interest:

- 1 Place your cursor on the right side of the strip near **1** and drag it to the left. This zooms into a portion of the toolpath.



- 2 Click in the central area of the blue rectangle and drag it to the area of interest.



- 3 Double click in the blue area to reset to the full view.

**Parameter to display** — Select an option to display a second graph showing the variation of the selected parameter over the toolpath. This list contains the toolpath point parameters.





— Drag the slider to control the speed of the simulation.

Dragging the slider up increases the simulation speed; dragging the slider down reduces the speed.



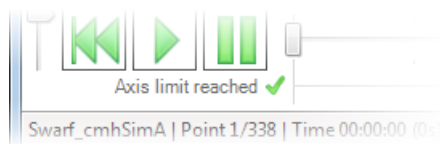
— Click to attach the machine tool to the start of the toolpath.

 — Click to play the simulation.

 — Click to pause the simulation.

**Axis limit reached** — Displays whether any axis limits are reached. If axis limits are reached, the dialog displays where the toolpath reaches the axis limits.

Axis limits not reached:



✓ Shows the axis limits are not reached.

Axis limits reached:





① ⚠ Shows the axis limits are reached.

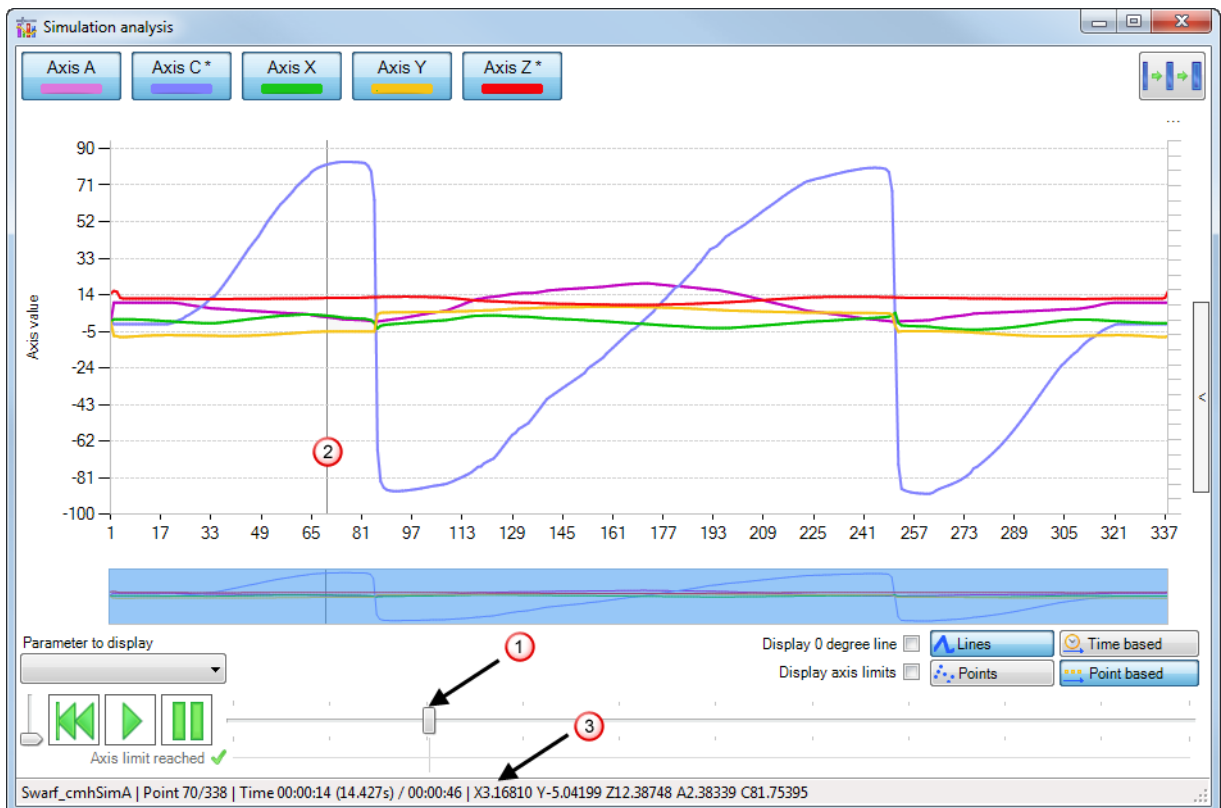
② Shows the portion of the toolpath where the axis limits are reached.



*This displays the part of the toolpath that reaches the axis limits within the tolerance specified in the **Options** (see page 3) dialog. That is why this line is longer than the overlapping portion of the graph.*

③ Selecting the **Display axis limits** option makes it easy to see the problem area of the toolpath (④).

 — When playing the simulation, this slider moves to the right and displays a vertical line on the graph. You can also drag the slider to a point of interest. When clicking  the simulation resumes from the current location of the slider.



Moving the slider to position ① displays the location on the graph (②) and details of the location are displayed at the bottom of the window (③).

When the slider has the focus,  you can use the arrow keys to move it by a specific number of points.



## Key

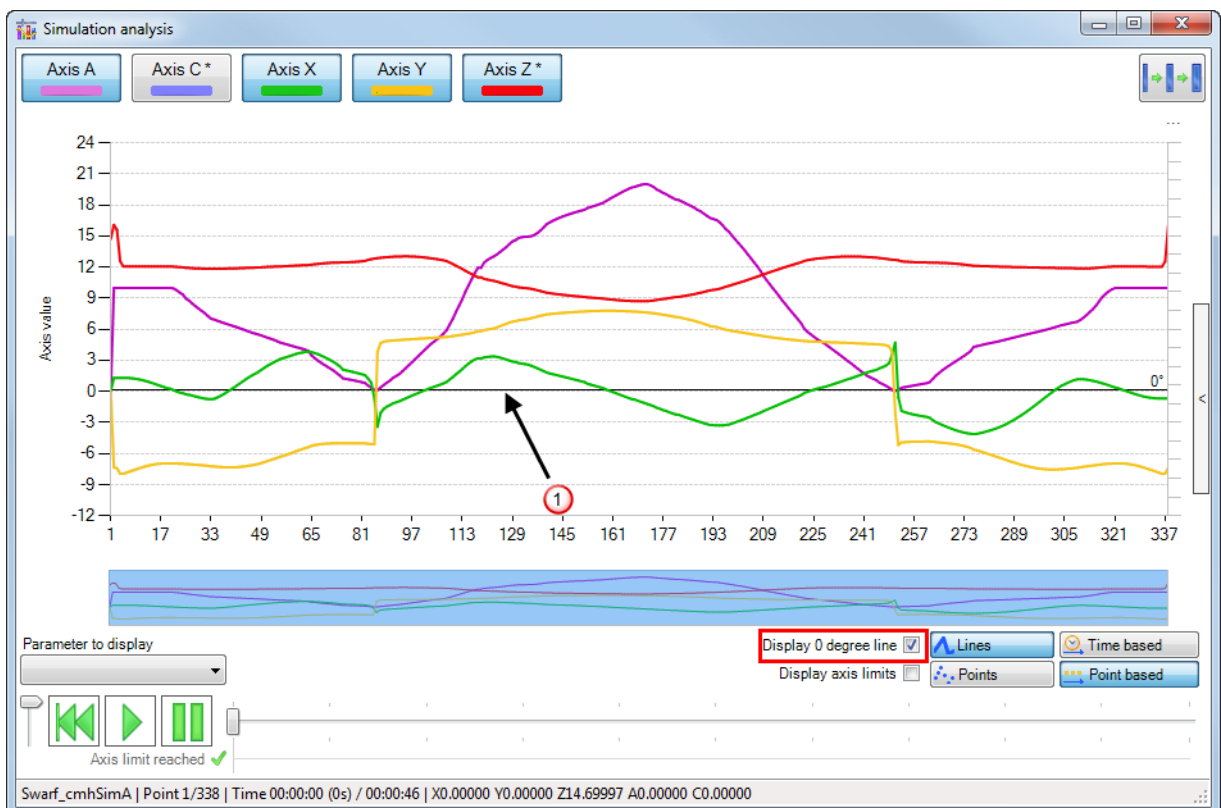
- 
- + **Ctrl**
- + **Shift**
- ←
- ← + **Ctrl**
- ← + **Shift**

## Description

- moves the slider to the next toolpath point.
- moves the slider forward 10 points.
- moves the slider forward 50 points.
- moves the slider to the previous toolpath point.
- moves the slider back 10 points.
- moves the slider back 50 points.

**Display 0 degree line** — When selected, displays the 0° line on the graph.

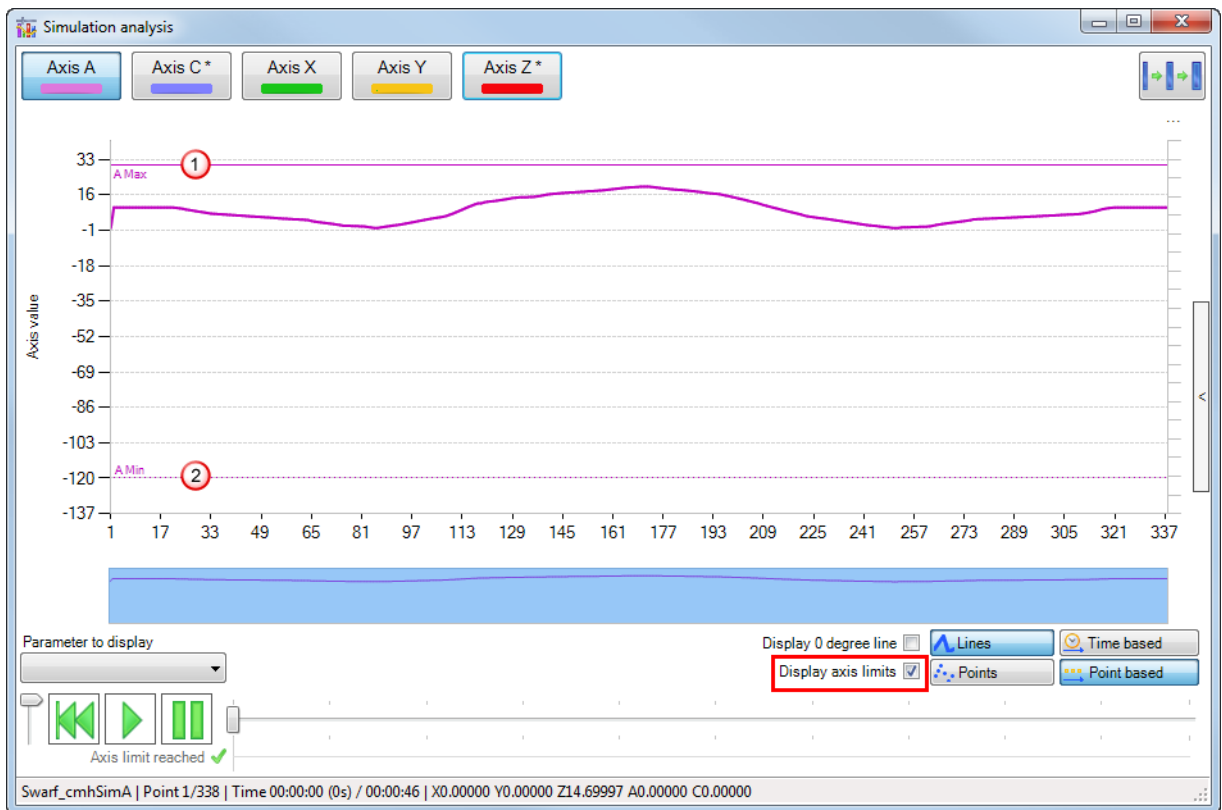
**Display 0 degree line selected:**



① 0° line

**Display axis limits** — When selected, displays the minimum and maximum limits of the selected axes.

## Display axis limits selected:



① Maximum axis limit

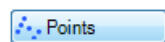
② Minimum axis limit



*Displaying the axis limits changes the **Axis value** scale.*



— Click to see a line-based graph.

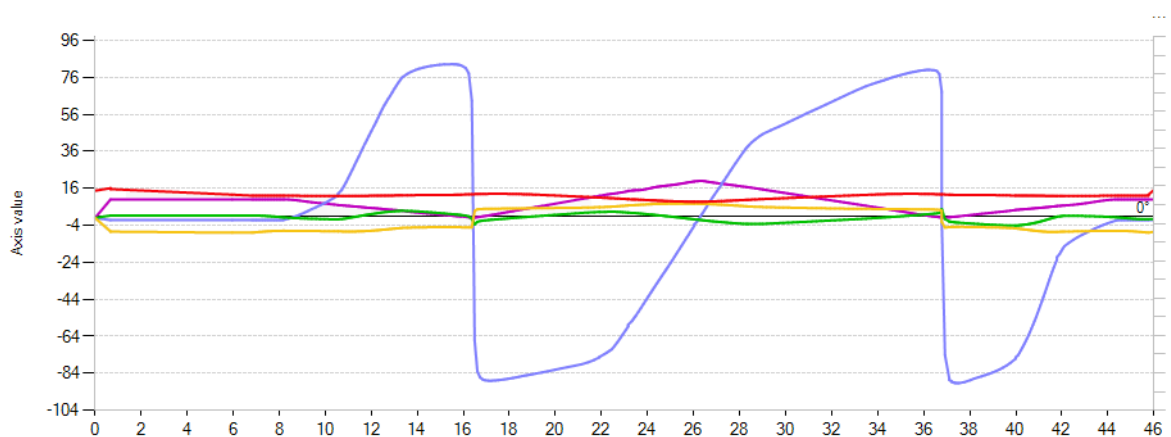


— Click to see a point-based graph.

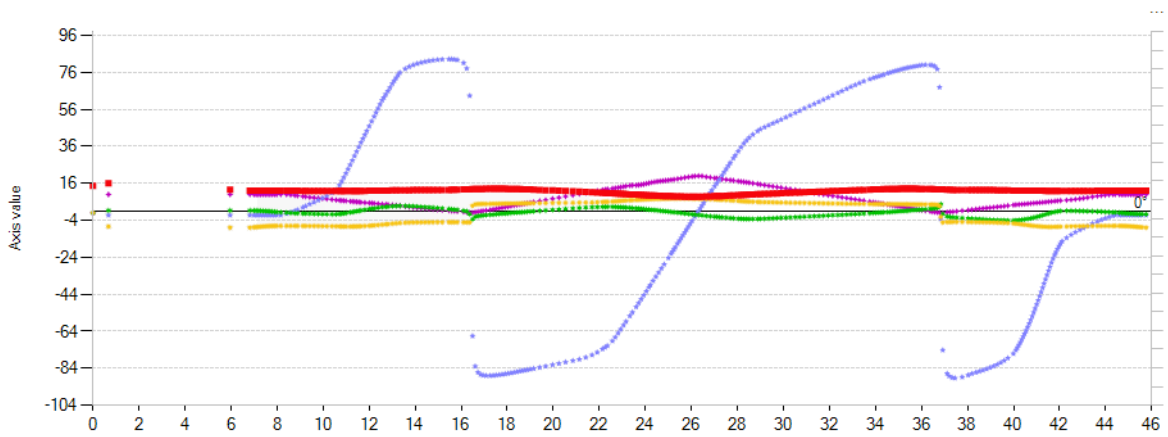



*You can display the graph as either a line-based or point-based graph.*


Line-based:



## Point-based:



 **Time based** — Click to have the X axis of the graph as time-based.

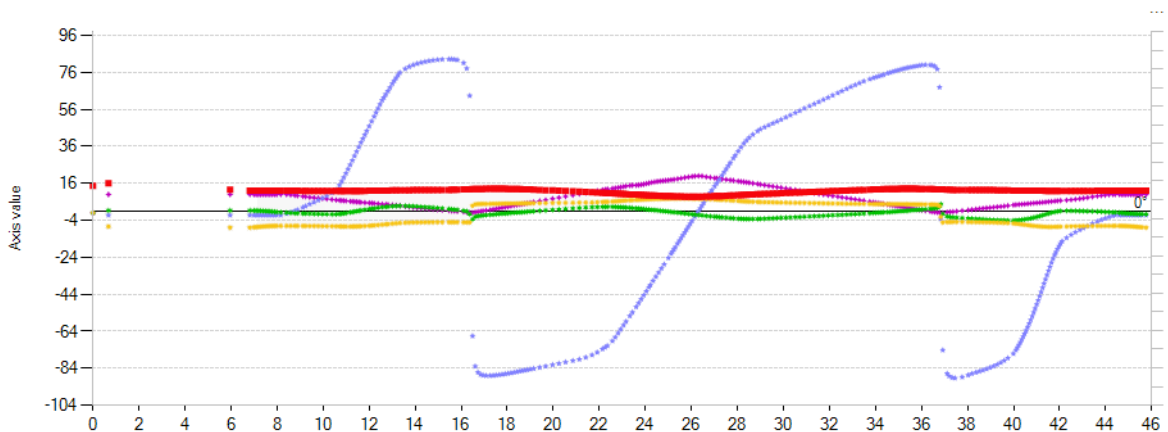
 **Point based** — Click to have the X axis of the graph as point-based.



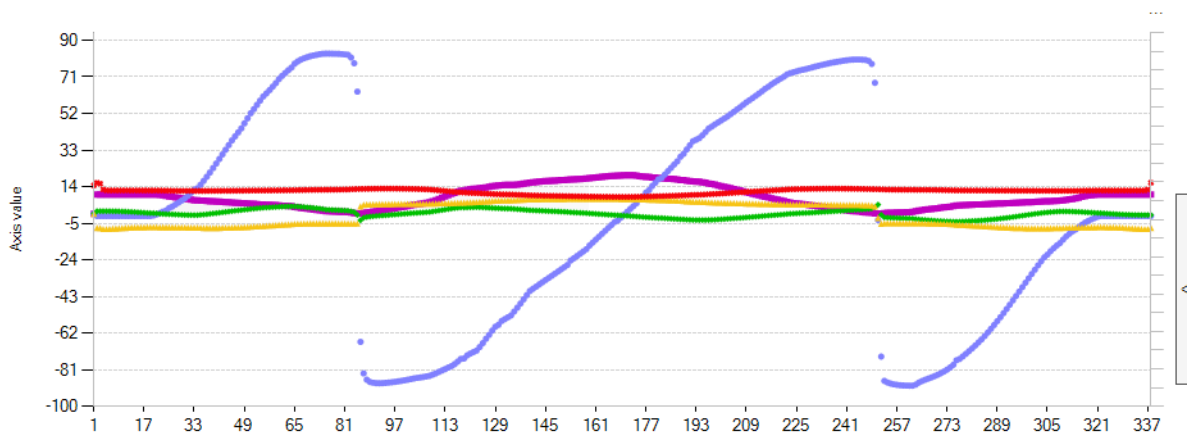
*The X axis can be either time-based or point-based.*

It is easier to see the effect of these options if you display the graph as a series of points by clicking .

Time-based (the X axis is in units of time):

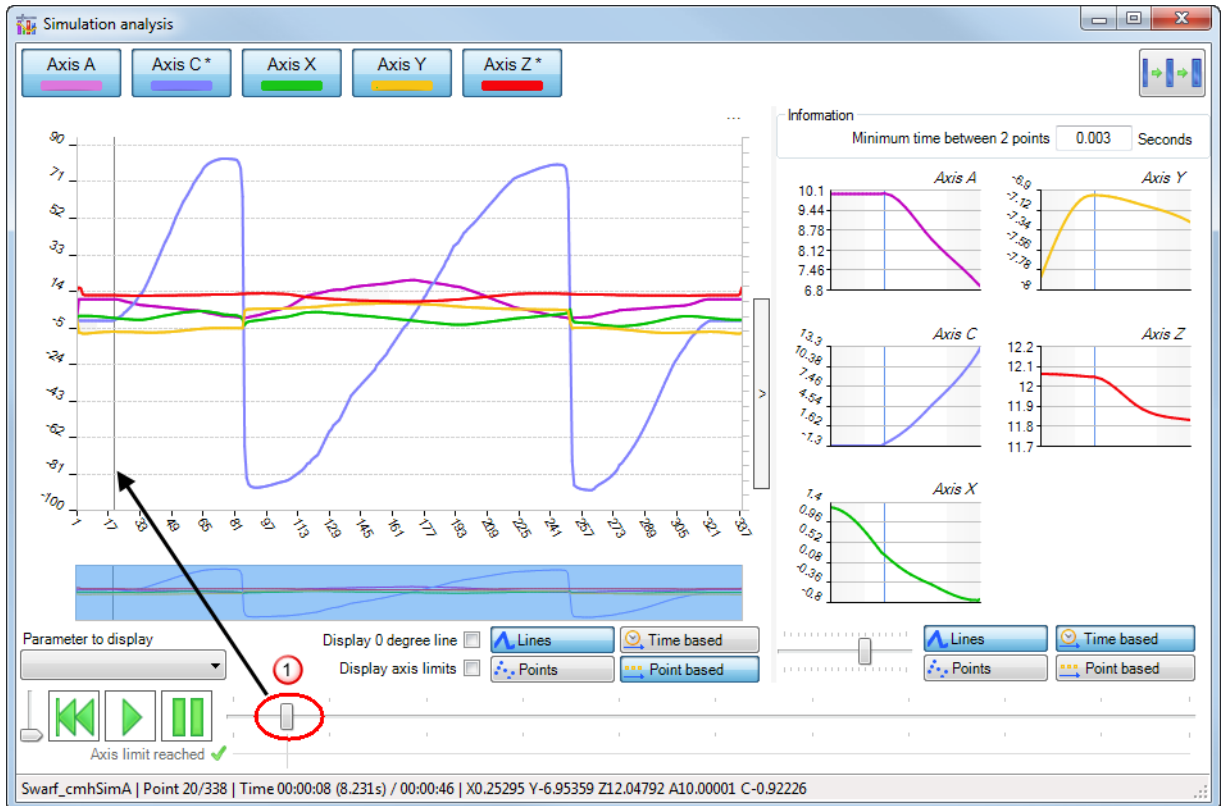


Point-based (the X axis has equispaced points):





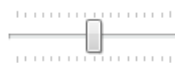
— Click to display more detail of the moves of each axis at the current point of the simulation.



The individual graphs show the axis movement around the current simulation position (1).

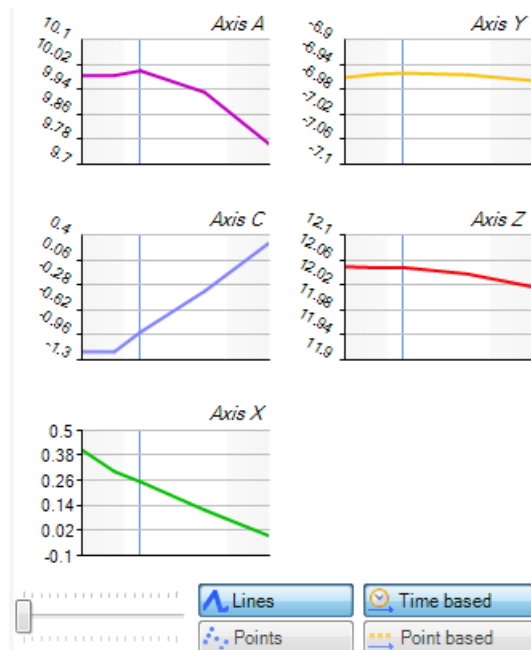
**Minimum time between 2 points** — Displays the time in seconds. This must be greater than the controller clock speed to avoid slow downs.

**Graphs** — Displays a line graph for each individual axis at the current simulation point.

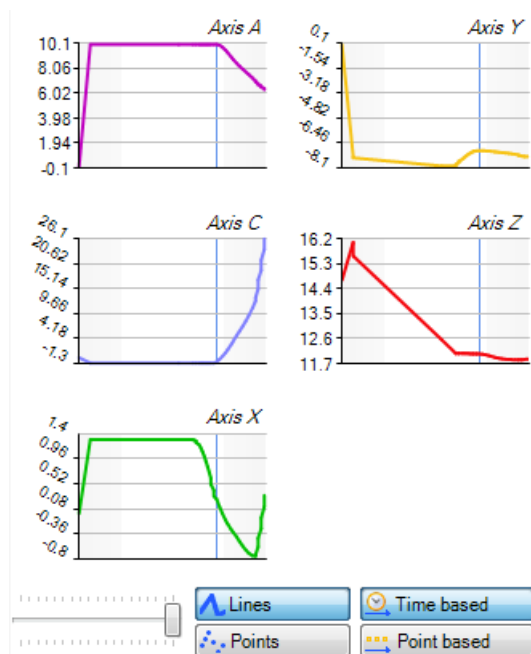


— Drag to change the time period of these graphs.

Having the slider at the left shows a small time period:



Moving the slider to the right elongates the time period:



The current location is shown by the vertical line.



— Click to change the line type of the graph and the X axis. These work in the same way as the buttons in the main window.

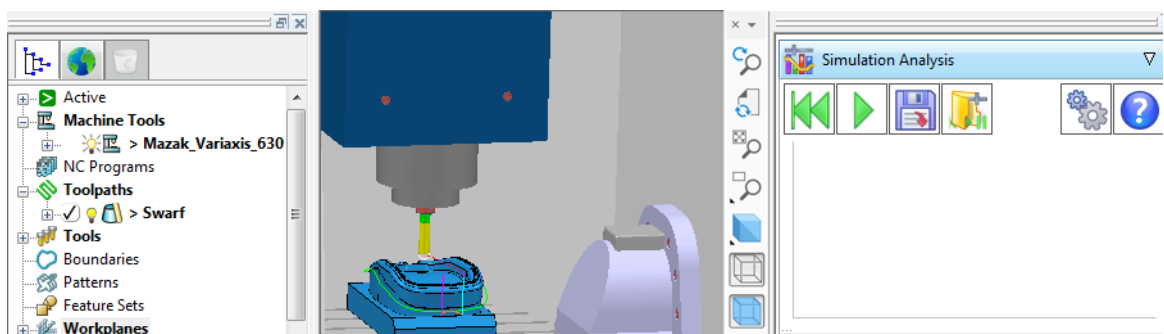
# Using the Simulation Analysis plugin

This example demonstrates how to use the **Simulation Analysis** plugin to check for unwanted machine tool behaviour, such as axis reversal over a small distance, which would adversely affect the surface finish.




This assumes you have installed the Simulation Analysis plugin (see page 2) and display it in the vertical plugin window.

You must start with a PowerMill project containing:

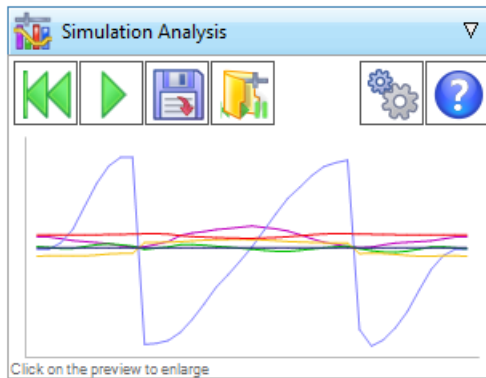
- An active toolpath
- An imported machine tool, which is also activated.



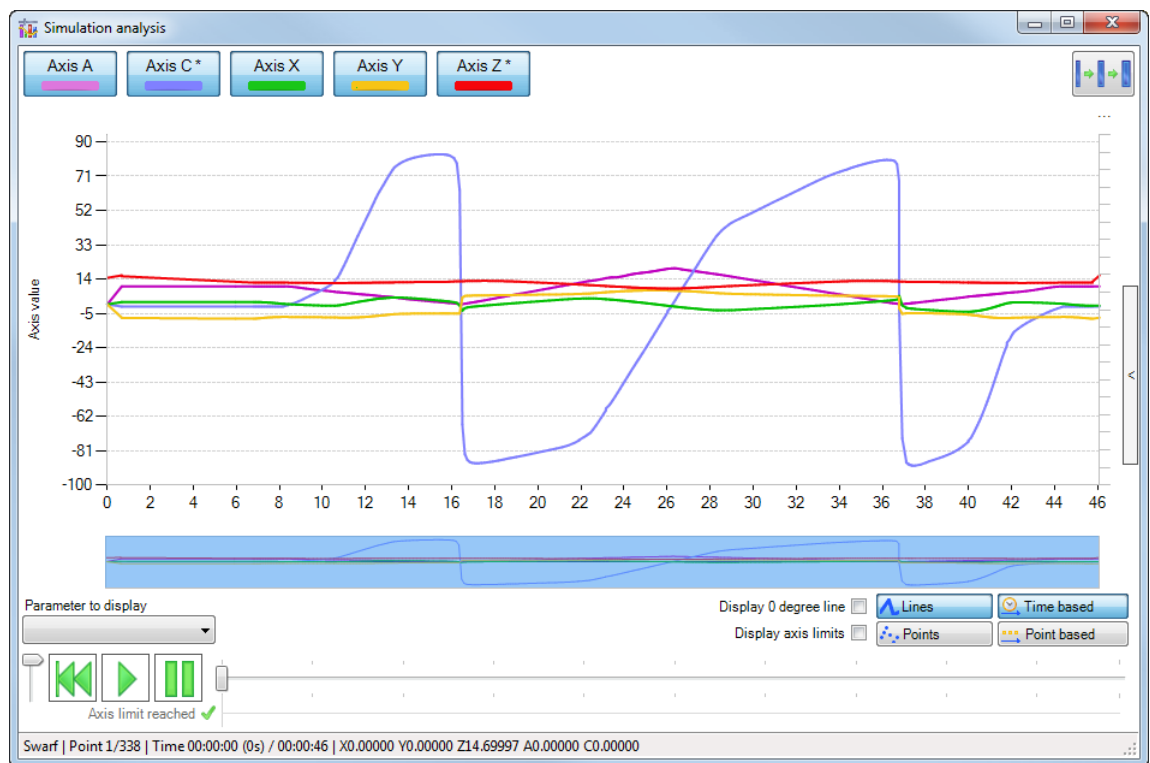
*If the buttons on the **Simulation Analysis** are not available, make sure the toolpath and machine tool are active.*

- 1 In the **Simulation Analysis** plugin, click **Attach to tool start** .
- 2 In the **Simulation Analysis** plugin, click **Play simulation** .
- 3 In the **Simulation Analysis** plugin, click **Save simulation**  this displays the **Save As** dialog. Move to an appropriate directory and enter a suitable file name.

Saving the simulation automatically displays the simulation preview graph in the plugin window.

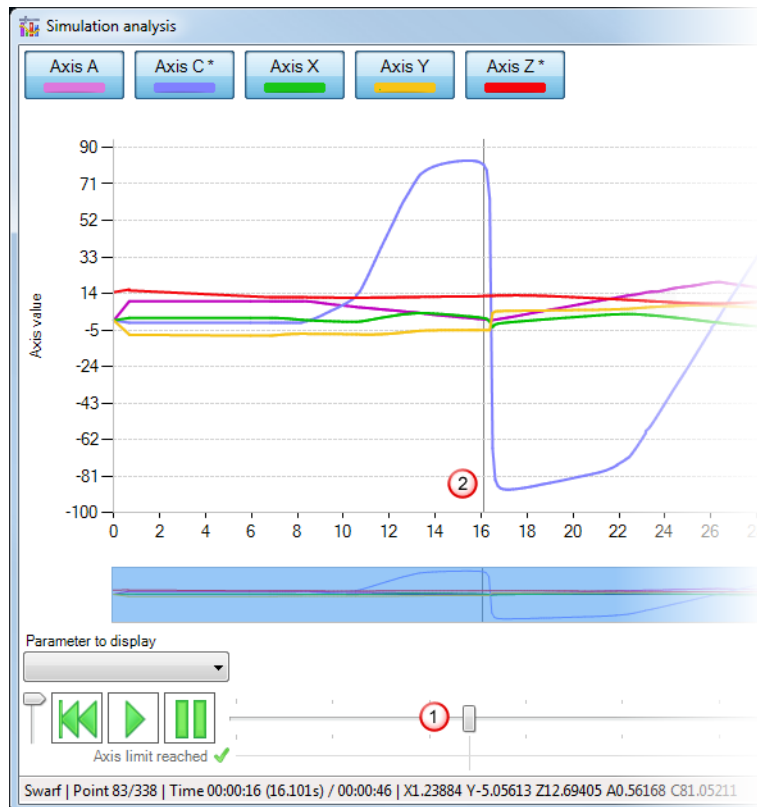


- 4 Click the preview graph to display the **Simulation Analysis** window.



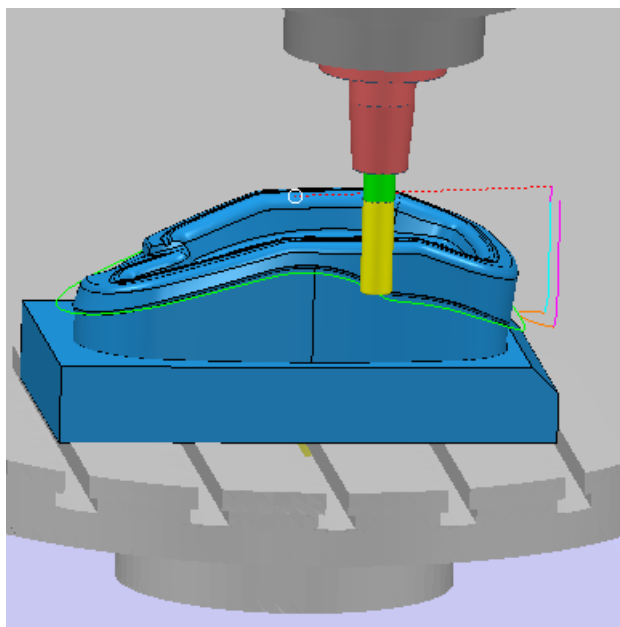
You can see a line graph for each individual axis. Each axis is drawn in a different colour. In this case most of the axes are well-behaved, except for the C axis which is the rotary table.

- 5 To see what happens where the C axis starts rapidly change its angle, use the simulation slider. In this case move the slider to around 16 seconds (1). The graph shows there is a rapid change in angle from  $82^{\circ}$  to  $-87^{\circ}$  in less than a second (2).



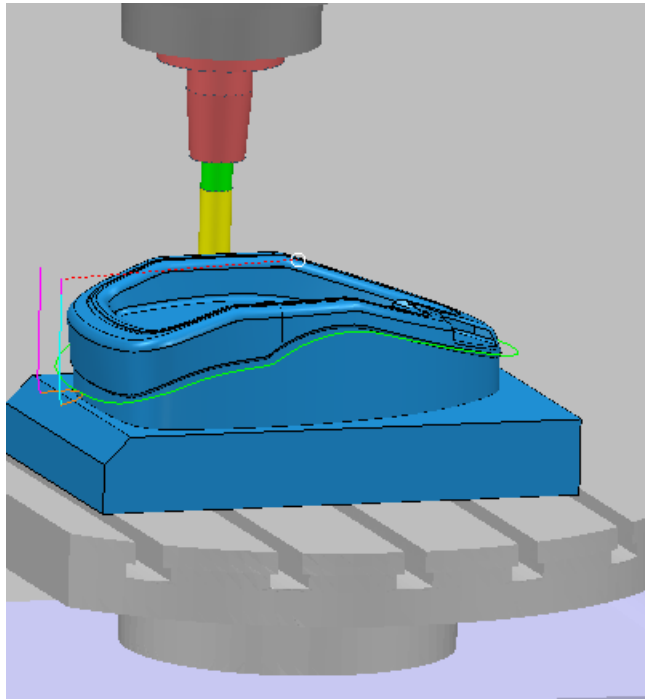
As you move the slider, the simulation is updated in the main PowerMill window. This shows an almost  $180^{\circ}$  swing of the C axis over a small distance on the part.

At 16 seconds:





At 17 seconds:



This leads to dwell marks on the part which impairs the surface finish.

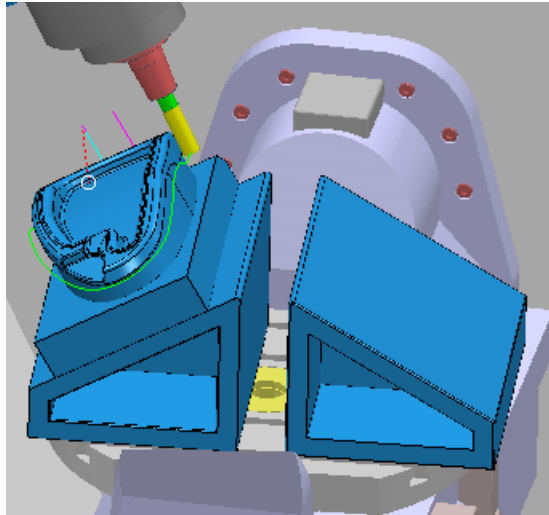
For more information on how to resolve this problem, see Resolving the axis reversal (see page 22).




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## Resolving the axis reversal

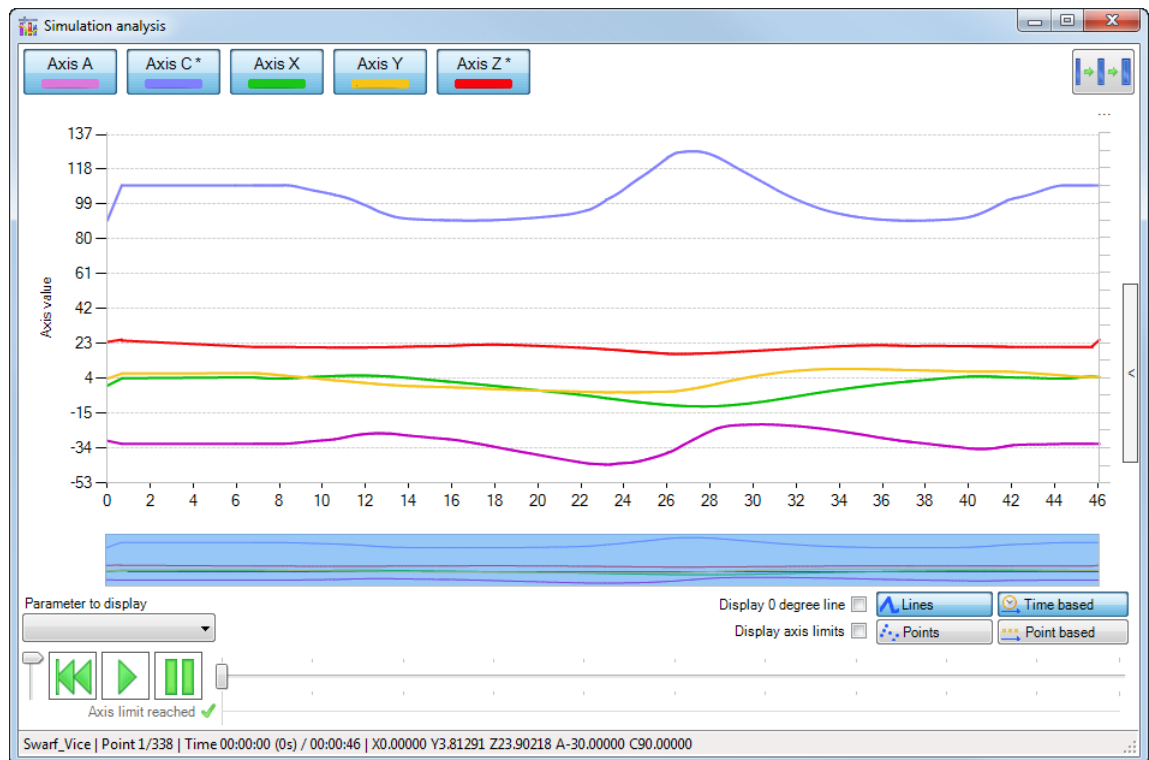
To resolve the axis reversal, change the orientation of the part on the machine tool. The alternative solution is to re-model the part which often isn't a possibility.

- 1 Place the part on an angled vice.



- 2 Click **Attach to tool start** .
- 3 Click **Play simulation** .
- 4 Click **Save simulation**  and save the analysis. The simulation preview graph is displayed.

- 5 Click the preview graph to display a larger **Simulation Analysis** window.



This produces better control of the C axis. Although the C axis rotates around 24 to 32 seconds, this is acceptable because it is controlled rotation around the part.

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