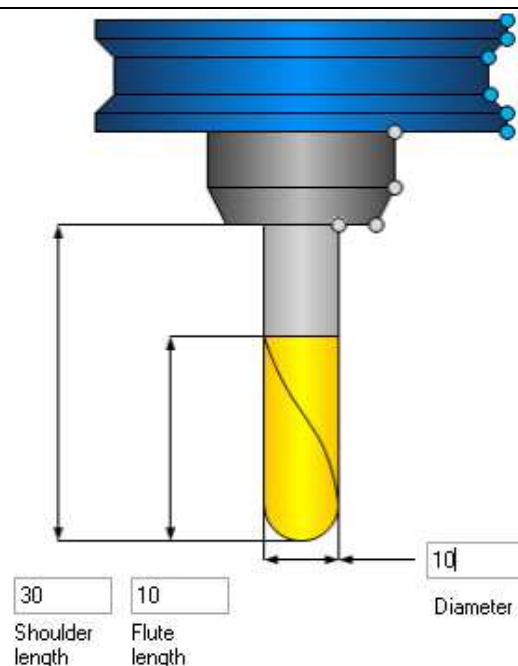


Using Simulation to analyse and remove axis reversal motion

This example looks at how simulation can be used as a tool to optimize surface finish. Simulation is used to analyse and then remove axis reversal motion resulting from the tool axis tilt during the machining process. These axis reversals can lead to surface marking on the final component so are best avoided if possible.

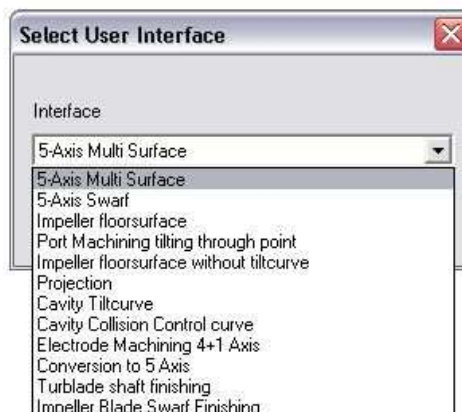
Screenshots and graphical images are taken directly from the extensive ModuleWorks test harness application supplied to all of customers. Depending on implementation the target application may use different user interfaces and graphical display methods.

This example uses a 10mm ball nose tool as shown in the dialog to the left.



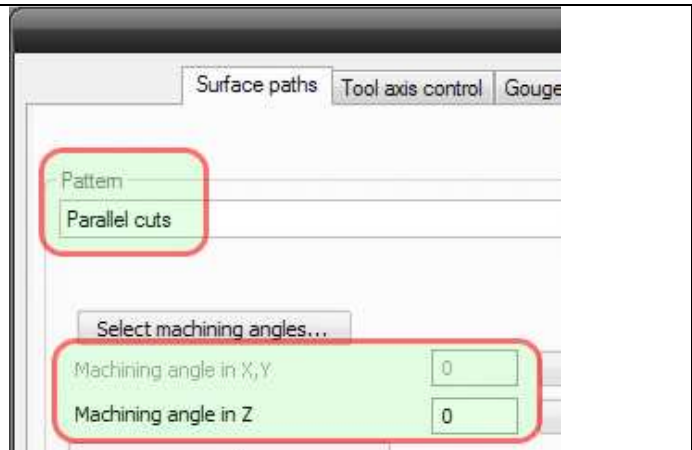
The next stage is to open the native geometry file, in this case "axis_reversal.igs" and select the 5-Axis Multi Surface interface.

As can be seen in the dropdown options, ModuleWorks has a number of strategies each tuned to specific applications.



Having selected the user interface, the next step is to select machining strategy. Move to the *Surface Paths* tab and select *Parallel cuts* for the toolpath pattern. XY and Z *machining angles* are both set to 0.

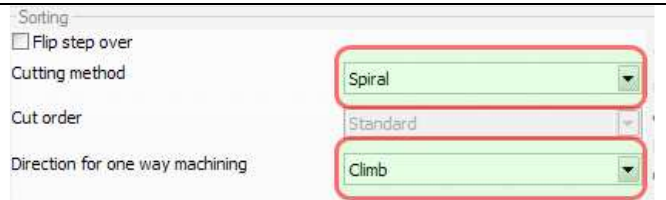
This machining strategy will generate passes parallel to each other with the direction of the cuts defined by the two angles.



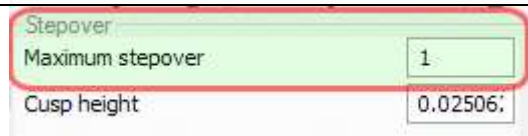
Specify the *Drive Surface* by clicking the button and selecting the blue surfaces as shown in the illustration to the right.



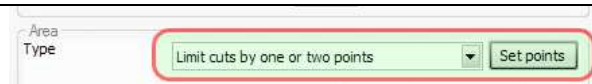
Select the cutting method to *Spiral* to generate spiral cuts on the drive surface. For *Direction for one way machining* select climb milling to direction of toolpath.



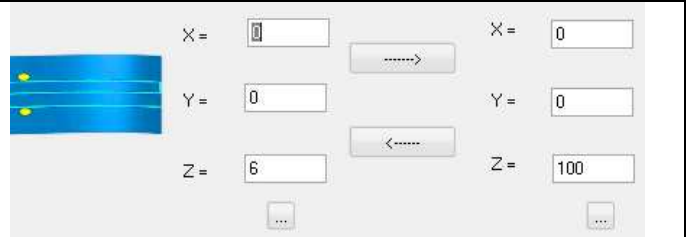
Next specify the *stepover* to control the distance between cuts. In this case a *maximum stepover* of 1mm is used with a target *Cusp height* also specified



This example constrains the toolpath by specifying two Z heights to ensure the toolpath does not hit the floor of the part. Select the *Set Points* button to specify the containment zone.

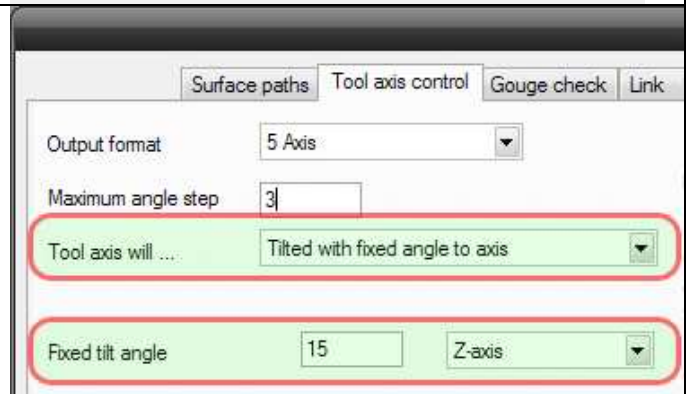


Two points are specified in the resultant dialog to constrain the toolpath between Z6 and Z100.



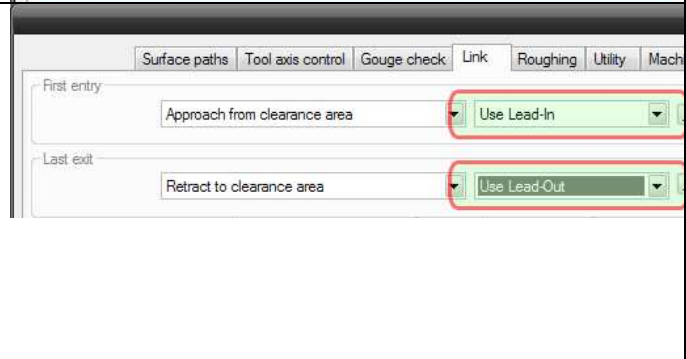
The next stage is to specify the tool axis control parameters. Move to the *Tool axis control* tab and specify a *Fixed tilt angle* of 15 degrees relative to the Z Axis for tilt angle to avoid collisions between the tool holder and work piece.

The tilt angle is relative to the surface normal at any given point on the toolpath.

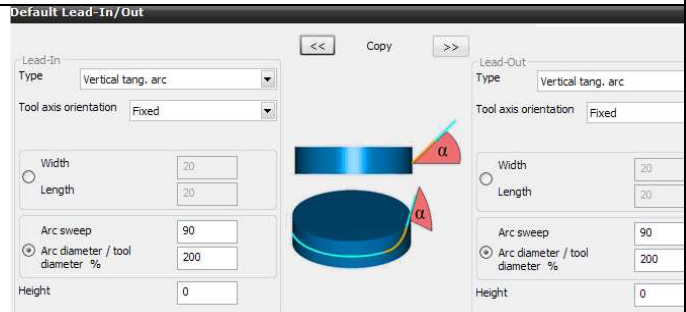


Now move to the link page and activate the lead in and lead out for the first entry and last exit.

The leads are parametric entry and exit movements to and from the machining surfaces and can be set for all link motion types. By default link types use the *Default Lead-In/Out* parameters.

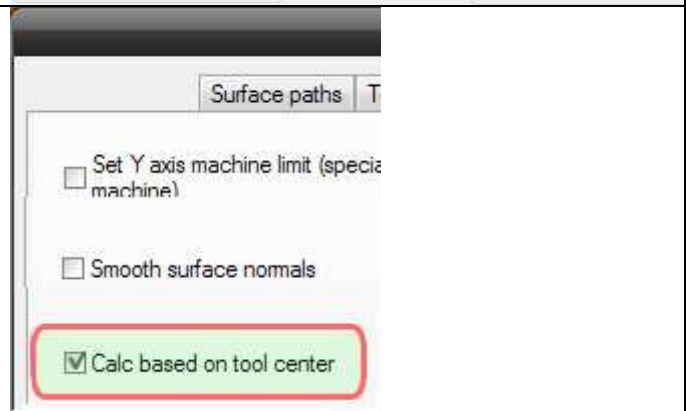


In the dialog, specify a *type of Vertical tangential arc* and use the default values as shown. With this lead type, the tool plunges with a vertical arc onto the drive surface.

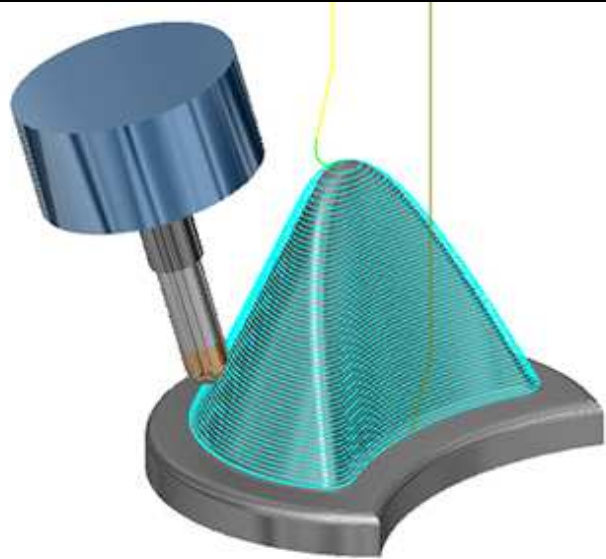


Move to the *Utility* tab and check the *Calc based on tool centre* option. This will calculate the toolpath based on the tool centre rather than surface contact point.

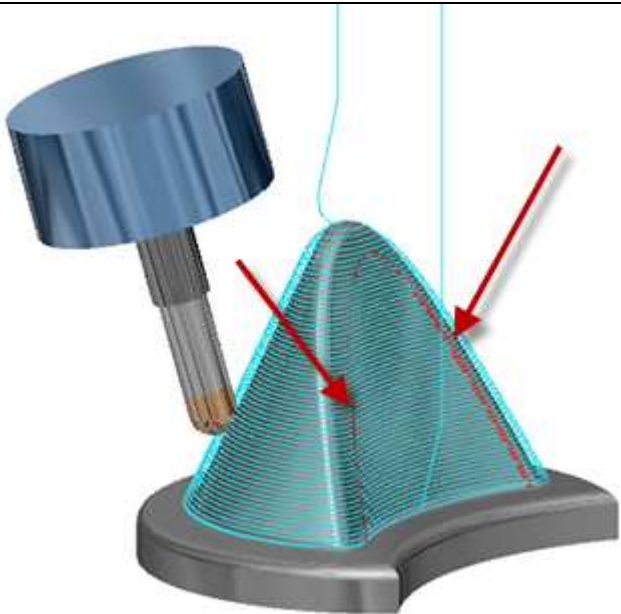
Finally hit the OK button to calculate the toolpath.



The toolpath is displayed as shown. It looks good with spiral motion in Z and smooth entry and exit movement.

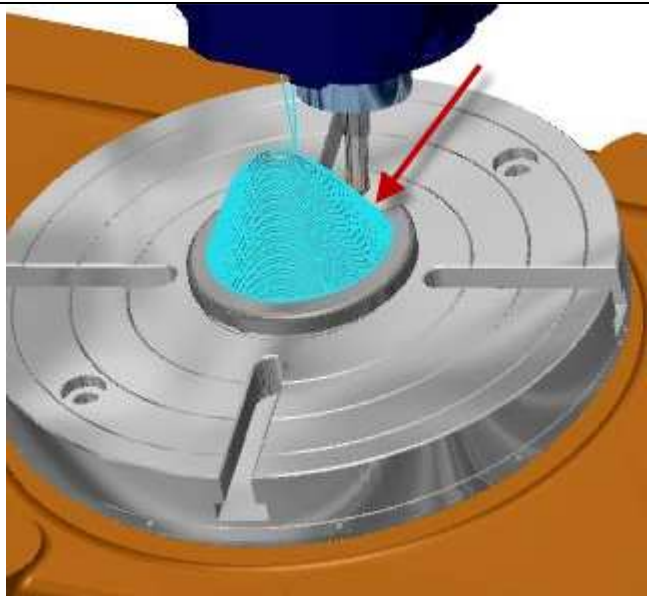


However by using the Simulator analysis tools we can see the axis reversal motion shown in red as the toolpath moves to the concave portion of the part.



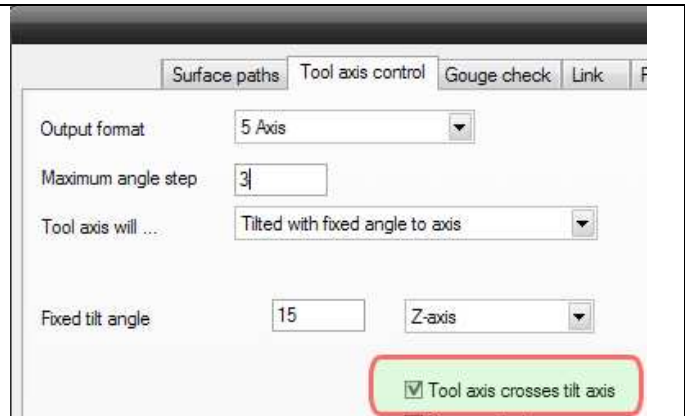
By running the animation in the machine simulator we can clearly see the axis reversal so can now go back to our machining strategy and modify the parameters to eliminate the potentially damaging movement

The axis reversal is caused by the tool axis tilt parameter. Although a 15 degree Z axis tilt has been used, the side angle is still relative to cutting direction and results in the tool tilting through the rotation axis in the concave portion of the part.



To remove the axis reversal, we need to tilt the tool axis towards the rotational axis on the machine tool. This can be done on the *Tool axis control tab* by selecting the *Tool axis crosses tilt axis* check box.

Recalculate the toolpath and re-run the simulation.



This time the toolpath is calculated with the tilt angle leaning towards the rotational axis and the axis reversals are avoided.

This can clearly be seen using the analysis tool in Simulation or by running the full animation.

This example is available as an AVI or full executable as part of this download.

