## PowerMILL 2010

# What's New

*Draft issue 1*

## PowerMILL

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### Patents

The Raceline smoothing functionality is subject to patent applications.

> Patent granted: GB 2374562 Improvements Relating to Machine Tools
>
> Patent granted: US 6,832,876 Machine Tools

Some of the functionality of the ViewMill and Simulation modules of PowerMILL is subject to patent applications.

> Patent pending: GB 2 423 592 Surface Finish Prediction

### Licenses

Intelligent cursor licensed under U.S. patent numbers 5,123,087 and 5,371,845 (Ashlar Inc.)

PowerMILL Version 2010. Published on 11 January 2010

# Contents

# Summary of new features

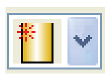
PowerMILL is the leading specialist NC CAM software for manufacturing complex shapes typically found in the toolmaking, automotive, and aerospace industries. PowerMILL 2010 offers all of the original features of PowerMILL 10.0, but with numerous improvements. The most significant improvements are described in this document.

This document is still in the process of being written. This is not a complete list of all the improvements. A complete What's New will be available in time for the full release of PowerMILL 2010.

## Toolpath preparation

There are several changes to the **Tool axis**  dialog (see page 6).

- There are two new tilt methods on the **Collision avoidance** tab (see page 7) and a new smoothing option.
- You can now smooth (see page 10) the tool axis different ways.
- There is a new tab of **Orientation vector** (see page 14). This enables you to control the orientation of the tool which is particularly useful when working with an asymmetric machine head.

There are several changes to the **Tool**  dialog (see page 19).

- There are improvements to **Overhang** in the **Tool Holder** tab (see page 19).

- There is a new tab of **Holder Profile** (see page 21) which gives a fast way of collision checking.

A new **Workplane Editor** toolbar (see page 29) replaces the **Workplane** dialog and the workplane options on the **Curve Editor** toolbar in previous versions.

There are additions to the **Curve Editor** toolbar (see page 47). You can:

- Edit points;
- Reverse selected items;
- Interactively edit simple curves (lines, arcs, circles, and polylines);
- Input coordinates on the status bar;
- Use context menus for simple curves.

There are several improvements to boundaries (see page 72).

- The calculation of 3D offsetting is run in multiple threads. So it is noticeably faster on multi-core machines.
- You can now create two types of boundary offsets (see page 72).
- There is a new option on the **Silhouette Boundary** (see page 73) which prevents spikes occurring on near vertical surfaces.

Models now have a date (see page 74) showing when they were imported into the project.

There are a couple of enhancements to stock models (see page 75).

- There are additional options to the individual stock model menu.
- There is a new Stock Models tool state menu (see page 78).

# Toolpath generation

Many of the existing machining strategies now use the new style machining strategy dialog (see page 85). This is a tabbed dialog where the pages are selected from the tree in the left hand panel. It is simpler to use and provides an easier way to create toolpaths.

Most of the **Area clearance** dialogs (see page 86) now use the new style strategy dialog. As well as converting them to the new style, there has also been a change in the way strategies are displayed in the **Strategy Selector** dialog. Other enhancements include:

- Avoiding the machining of thin slivers (see page 88) of material which appear on the block edge towards the end of machining an area.

- Improved ordering (see page 89).

There is a new **Steep and shallow finishing** strategy (see page 90) which calculates a shallow boundary, and then creates **Constant Z** toolpath in the steep areas of a model and **Raster** or **3D offset** toolpath in the shallow areas.

There is a new **Corner finishing** strategy (see page 109) which removes material left in corners. The toolpath is generated such that the rest material is removed in successive stages, using horizontal and vertical stitch movements, or along passes.

Finishing strategies now have the option to allow the tool centre to go outside the block (see page 122).

The **Cusp height** and **Stepover** (see page 124) are now linked on finishing dialogs.

There is a new option of **Smoothing** (see page 126) on the **3D offset finishing** dialog.

There are a couple of new options on the **Constant Z finishing** dialog (see page 127):

- **Machine down to flats** (see page 129).
- **Unsafe segment removal** (see page 132).

You can now view a single Z height (see page 136) of a toolpath.

**Surface finishing** has a new option of **Degouge tolerance** (see page 142).

You can now create Holes (see page 142) from the **Drilling** dialog.

**Disc profile finishing** now has the option to lift or trace for gouge avoidance.

As with PowerMILL 10.0 one of the most important, but least visible improvements in PowerMILL 2010 is the use of parallel processing (see page 149).

# Toolpath verification

There are several enhancements to toolpath verification (see page 150):

- When verification splits a toolpath, the leads and links are preserved where appropriate, on the resulting toolpaths.
- Simulation can now synchronise the movement of two axes of a robot.
- ViewMill now allows a negative overhang.
- The **Table attach point** at the top of an .mtd file now defines the position of the PowerMILL origin.

# Toolpath output

This topic has not been fully documented yet.

# User interface

All the **Open** and **Save** dialogs now have customisable buttons (see page 152).

Entities in lists are shown using the same folder structure (see page 153) and icons as in the explorer.

# General enhancements

You can now create a custom toolbar (see page 156) which can contain: menu options; toolbar buttons; commands; and macros; that you use frequently.

The user definable values available under **Tools > Options** are system parameters (see page 162).

There is a new **Expression Editing** toolbar (see page 163) which provides a fast and easy way to create and calculate expressions in PowerMILL fields.

Typed coordinates are now entered in the **Status** bar (see page 167) rather then on the **Curve Editor** toolbar.

When you start PowerMILL 2010 for the first time you are asked if you want to upgrade to the new tool database (see page 155).

# Preview

This topic has not been fully documented yet.

# Toolpath preparation

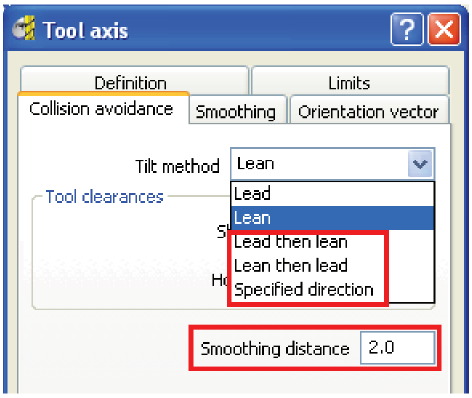
## Tool axis

There are several changes to the **Tool axis** dialog.

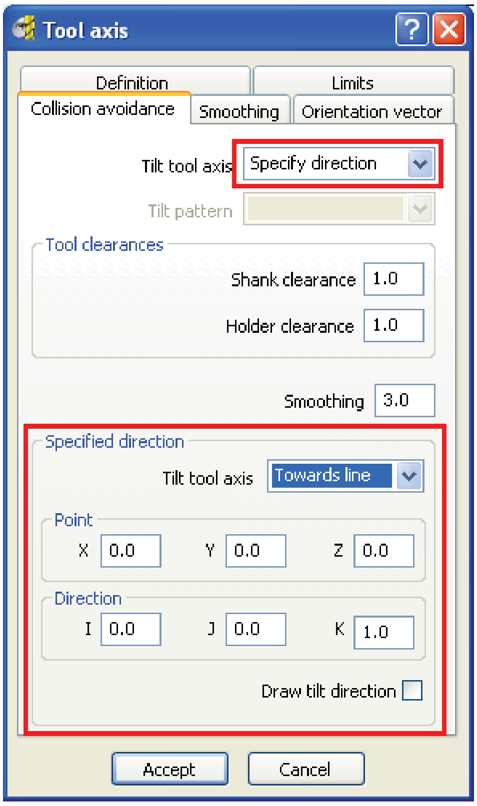
- There are two new tilt methods on the **Collision avoidance** tab (see page 7) and a new smoothing option.
- You can now smooth (see page 10) the tool axis different ways.
  - You can smooth the **Elevation** and **Azimuth** angles independently.
  - There are new stepped smoothing options which keep the elevation or azimuth angle constant without changing the angle by more than a specified amount.
- There is a new tab of **Orientation vector** (see page 14). This enables you to control the orientation of the tool which is particularly useful when working with an asymmetric machine head.
- To enable the **Orientation vector** there is an extra option on the **Definition** tab (see page 18).
- Collision avoidance works better for disc cutters.

## Collision avoidance (Tool axis)

There are several changes to the **Collision avoidance** tab:




- There are two new **Tilt methods** (see page 8).
- The tilt tool axis options remain unchanged, but have been reorganised. The **Specify direction** option replaces all the individual direction options. Selecting this option means that if a collision is detected, the tool will tilt such that the tool tip tries to point towards or away from geometry specified in the **Specified direction** frame.




The **Specified direction** frame only becomes available when you select a **Tilt method** of **Specify direction**. The options displayed in this frame are exactly the same as those available in previous versions.

- There is a new option of **Smoothing distance** which enables smooth tool axis changes. To prevent sudden changes in the tool axis, the tool starts tilting before the collision is detected. This distance is the **Smoothing distance**. For more information see **Smoothing** (see page 10).

## Tilt method (Tool axis)

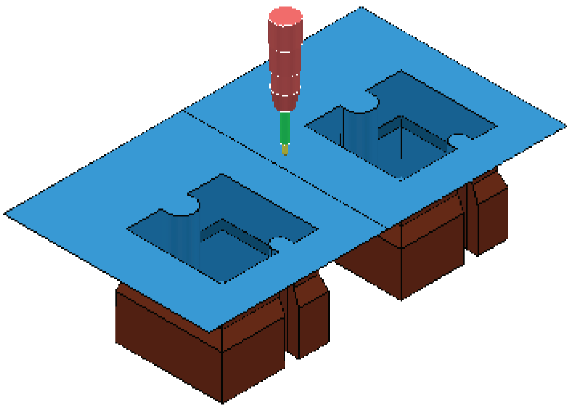
There are three new **Tilt method** options:

**Lead then Lean -** if a collision is detected, the tool will tilt from the original axis in the **Lead** direction until the collision is avoided. If the collision can't be avoided by tilting the tool in the **Lead** direction, the tool will tilt in the **Lean** direction until the collision is avoided.

**Lean then Lead -** if a collision is detected, the tool will tilt from the original axis in the Lean direction until the collision is avoided. If the collision can't be avoided by tilting the tool in the **Lean** direction, the tool will tilt in the **Lead** direction until the collision is avoided.

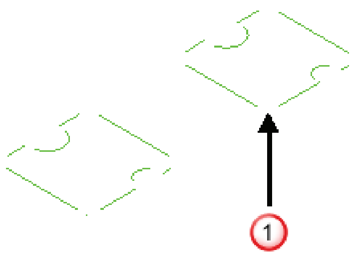
These two new options minimise the need to use the **Specify direction** option. They enable you to create a single toolpath over areas with several pockets and you no longer need to create individual toolpath for each pocket or the geometry to define the tool axis.

This is best shown by example.



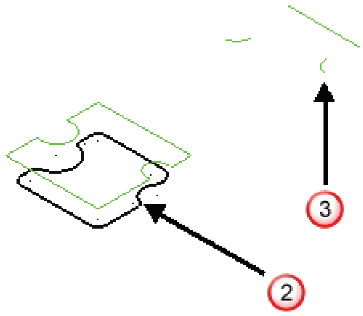
In PowerMILL 10.0 the only options were:

**Tilt method - Lean**



(1) - shows the toolpath isn't created in the corners.

or **Tilt method - Specified direction** and **Tilt direction - From curve**.



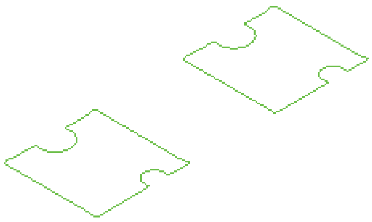

(2) - the curve used to generate the toolpath.

(3) - an incomplete toolpath.

The only way to resolve this would be to create a curve in each pocket and generate a separate toolpath for each pocket.

In PowerMILL 2010 there is an additional option of:

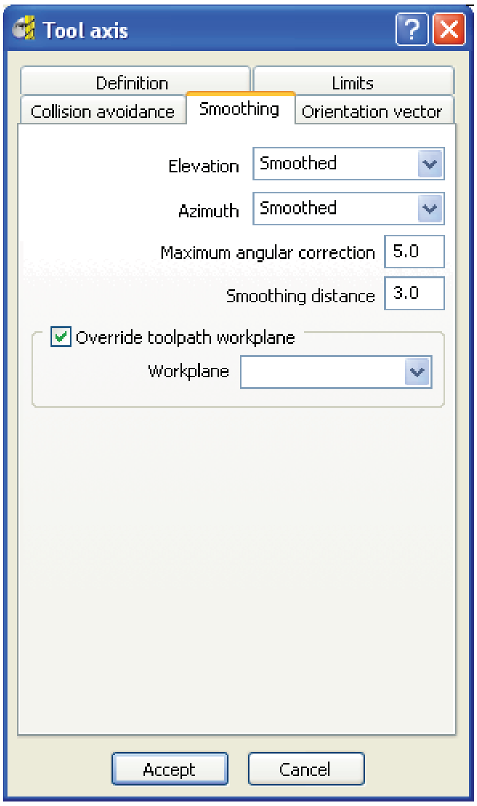
**Tilt method - Lead then lean**



This creates the desired result with one toolpath and there is no need to create any additional geometry.

# Smoothing (Tool axis)

The **Smoothing** tab on the **Tool axis** dialog smooths any changes in velocity or direction of the tool axis. This minimises judder on the machine tool.




This tab is only available if you select **Tool axis smoothing** on the **Definition** tab.

**Elevation -** determines whether and how to smooth the elevation angle of the tool axis. An elevation of $\pm 90^\circ$ means that the tool is aligned with the Z axis, and an elevation of $0^\circ$ means the tool is in the XY plane.

**None -** no smoothing takes place. The tool axis orientation moves as and when it needs to move.

**Smoothed -** the tool axis angle changes smoothly over the **Smoothing distance**. The change in angle will not be more than the **Maximum angular correction** unless the angle of the unsmoothed toolpath varies by more than the **Maximum angular correction** in less than **Smoothing distance**. In such regions, the angle may change by more than the **Maximum angular correction** to give a smooth result.

**Stepped on surface -** the tool axis angle changes by up to the **Maximum angular correction** to form steps of constant value. To avoid sharp tool axis movements, a smooth transition between steps is made starting at the **Smoothing distance** away from the possible ends of neighbouring steps. The tool always remains in contact with the surface.

**Stepped with links -** as for **Stepped on surface**, the tool axis angle changes by up to **Maximum angular correction** to form steps of constant value. In this case, the toolpath segments are subdivided at the end of each step, and link moves are inserted so the tool axis changes when the tool is not in contact with the model. This means that tool axis angle of each toolpath segment is constant.

**Azimuth -** determines whether and how to smooth the azimuth angle of the tool axis. Azimuth is the angle between the +X axis and the projection of the tool in the XY plane.

**None -** no smoothing takes place. The tool axis orientation moves as and when it needs to move.

**Smoothed -** the tool axis angle changes smoothly over the **Smoothing distance**. The change in angle will not be more than the **Maximum angular correction** unless the angle of the unsmoothed toolpath varies by more than the **Maximum angular correction** in less than **Smoothing distance**. In such regions, the angle may change by more than the **Maximum angular correction** to give a smooth result.

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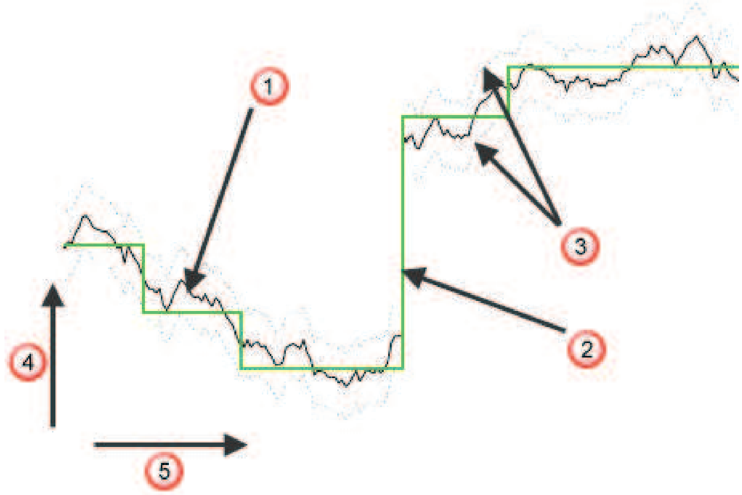



1 - original toolpath, no smoothing.

2 - stepped toolpath.

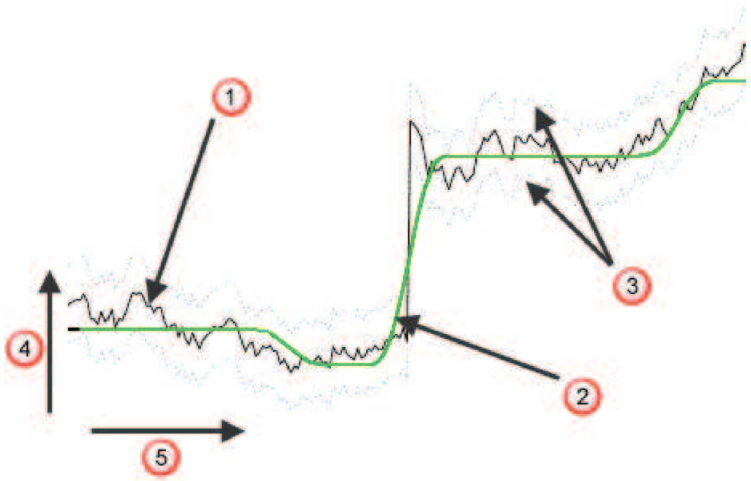
3 - maximum angular correction limits.

4 - azimuth or elevation

5 - toolpath distance

**Maximum angular correction -** smooths the azimuth and elevation angles of the tool axis by up to the angle specified here.

**Smoothing distance -** smooths the tool axis movement over the specified distance. When using a smoothing of **Stepped on Surface**, or when you get sudden changes in direction in the original toolpath (such as a right angled corner), you get rapid changes of orientation of the tool axis which leaves dwell marks. To prevent this, the **Smoothing distance** blends the change in orientation and gives a much improved surface finish.




1 - original toolpath, no smoothing.

2 - smoothed stepped toolpath.

3 - maximum angular correction limits.

4 - azimuth or elevation

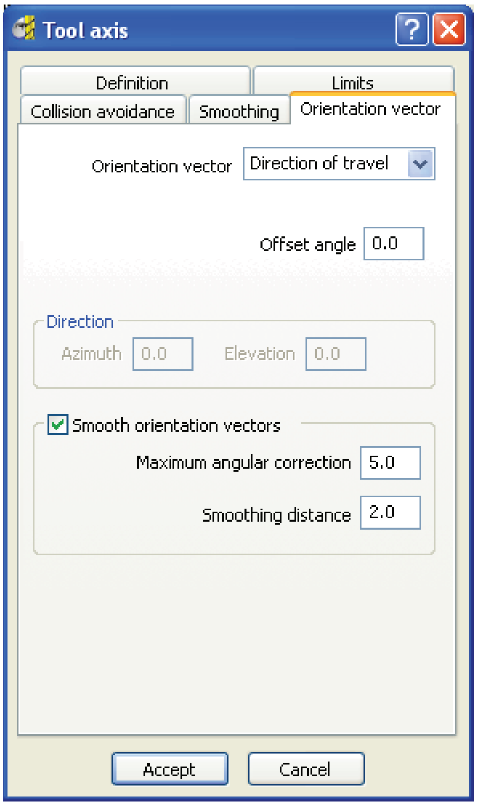
5 - toolpath distance

**Override toolpath workplane -** a different workplane to the workplane used to generate the toolpath is used to define elevation and azimuth for smoothing.

**Workplane -** the workplane used when smoothing. If no workplane is selected, the global coordinate system is used.

# Orientation vector (Tool axis)

**Orientation vector** steers the tool by aligning the vector in a particular orientation. The contact track of the tool remains unchanged, but the contact position on the tool is affected as the tool orientation changes.




This is useful when:

- Machining with an asymmetric machine head.
- Using the C-axis rotation of the machine tool to machine a part which otherwise wouldn't fit within the machine tool limits.
- Controlling the orientation of the end of the arm of a robot.

This tab is only available if you select **Orientation vector** on the **Definition** tab.

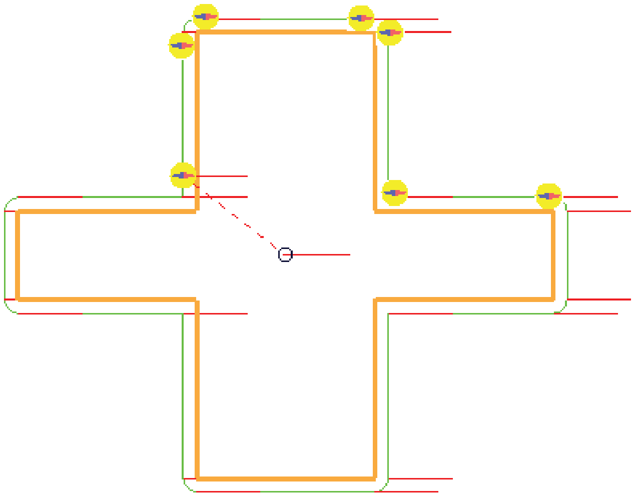
**Orientation vector -** determines the orientation of the tool.

These options are easiest to see if you draw the orientation vectors ( on the **Toolpath** toolbar) and then simulate the toolpath (**Simulate from start** on the individual toolpath menu).

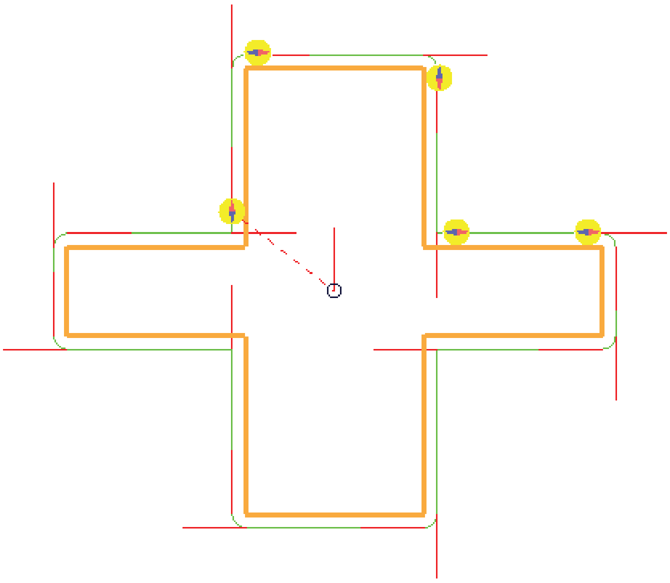
*shows the tool orientation.*

**Free -** the orientation vector is not controlled.

**Fixed direction -** the orientation vector always points in the same direction.



**Direction of travel -** the orientation of the vector is determined by the direction of travel.

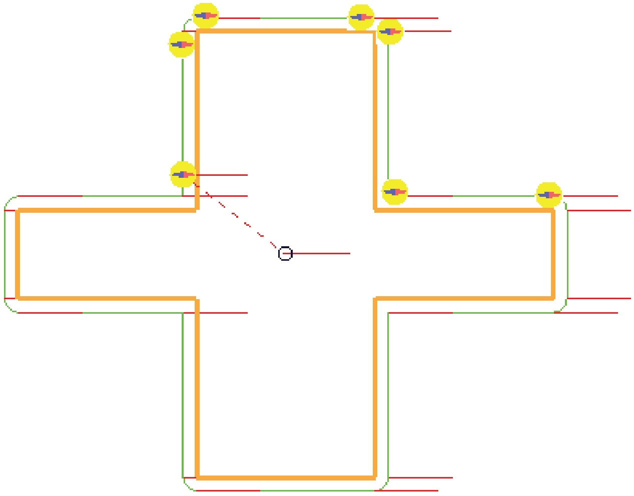


**Offset angle -** changes the orientation angle of the vector. This is used to orient the machine head correctly.

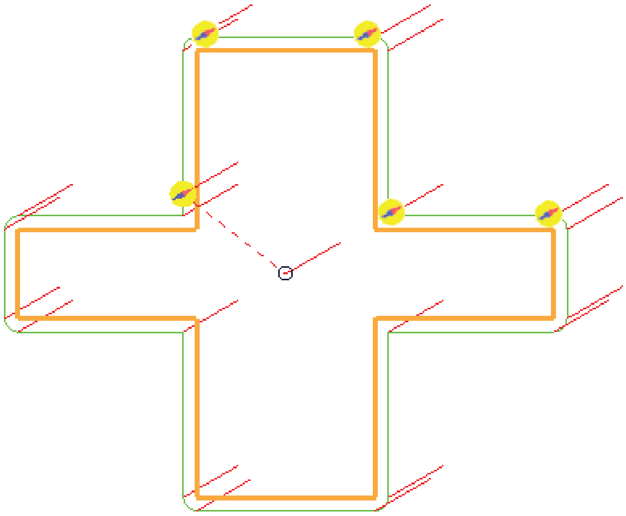
These options are easiest to see if you draw the orientation vectors ( on the **Toolpath** toolbar) and then simulate the toolpath (**Simulate from start** on the individual toolpath menu).

*shows the tool orientation.*

**Offset angle -** 0



**Offset angle -** 30



**Direction -** defines the vector of the line. The orientation vector is always perpendicular to the tool axis. When you have a non-vertical tool axis, the only way to specify the direction accurately is to specify the **Azimuth** and **Elevation** angles. This option is only available if you have an **Orientation vector** of **Fixed direction**.

**Azimuth -** determines the angle of the line in the XY plane. The rotation is measured anti-clockwise about the Z axis with 0 at the X axis.

**Elevation -** determines the angle of the line relative to the vertical (Z).

**Smooth orientation vectors -** avoids sharp changes in the tool orientation.

**Maximum angle of correction -** smooths the azimuth and elevation angles of the tool orientation by up to the angle specified here.

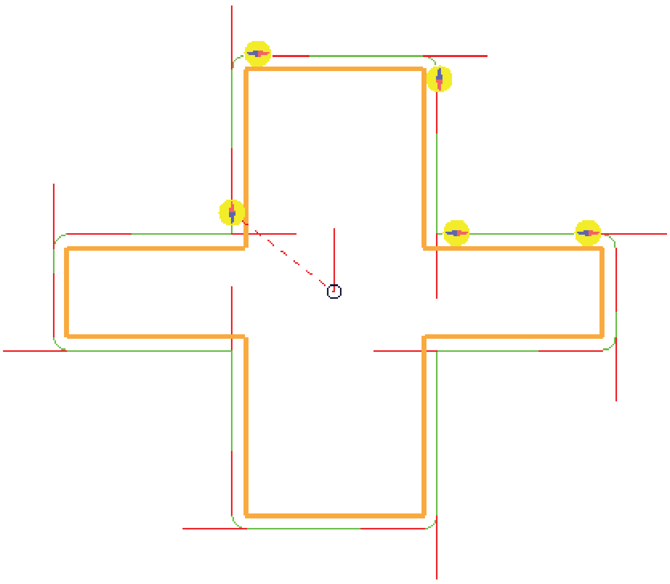
*This is similar to the* ***Maximum angle of correction*** *on the* ***Smoothing*** *tab (see page 10), except that this works on the tool orientation and not the tool axis.*

**Smoothing distance -** smooths the tool orientation over the specified distance. When you get sudden changes in direction in the original toolpath (such as a right angled corner) you get rapid changes of orientation of the tool which leaves dwell marks. To prevent this, the **Smoothing distance** blends the change in orientation and gives much improved surface finish.

These options are easiest to see if you draw the orientation vectors ( on the **Toolpath** toolbar) and then simulate the toolpath (**Simulate from start** on the individual toolpath menu).

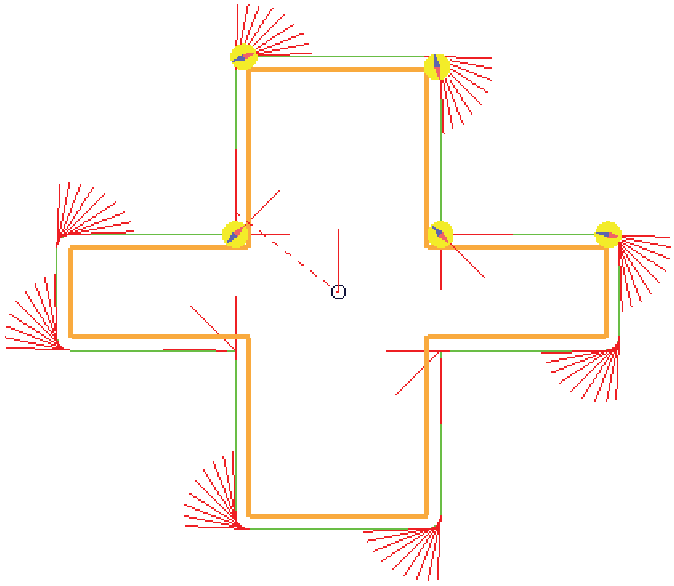
*shows the tool orientation.*

**Smooth orientation vectors -** deselected:



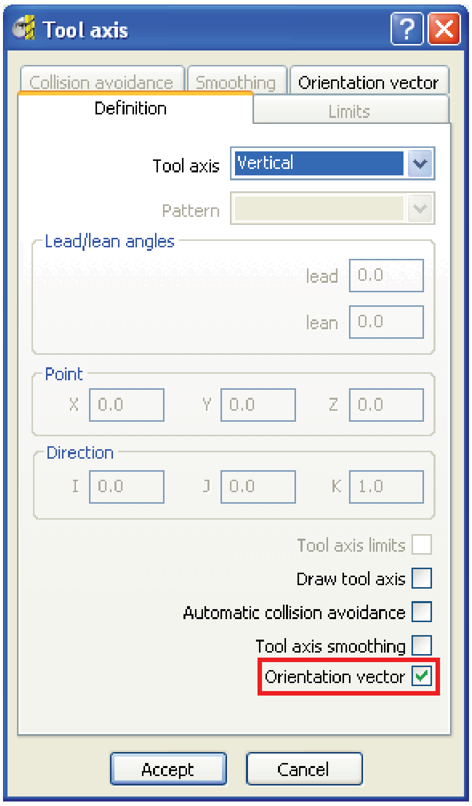
**Smooth orientation vectors -** selected

**Smoothing Distance - 5:**



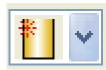
*This is similar to the **Smoothing distance** on the **Smoothing** tab (see page 10) , except that this works on the tool orientation and not the tool axis.*

## Definition tab

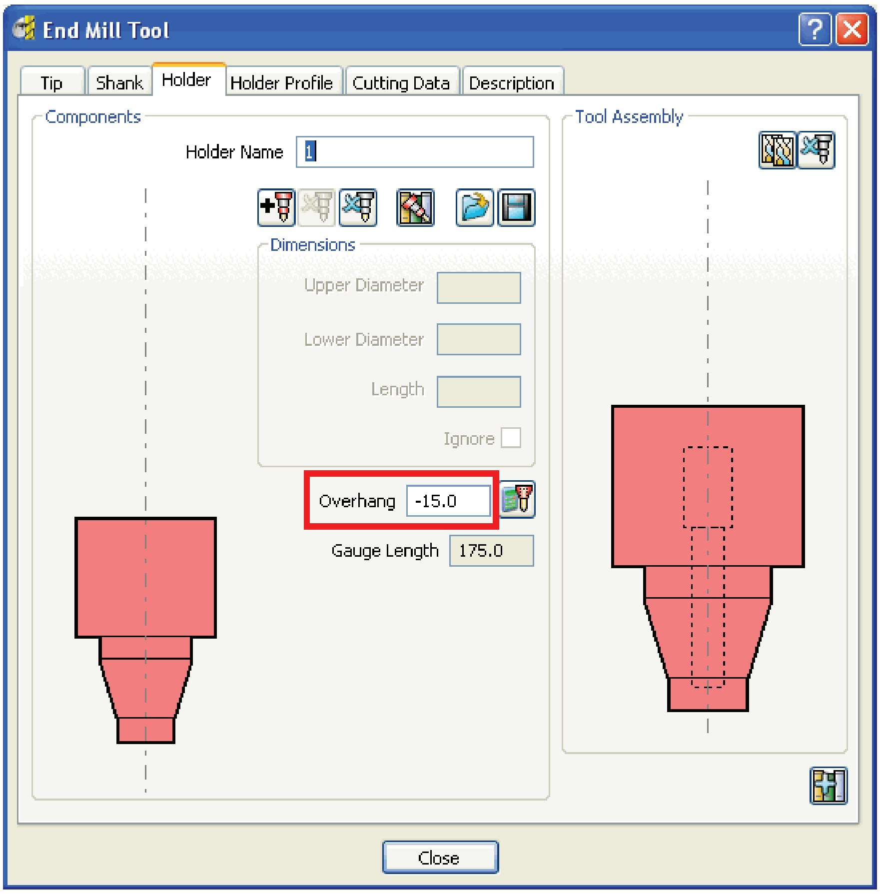


**Orientation vector -** enables the **Orientation vector** tab, which controls the tool axis orientation and displays the orientation vector  on the tool. When this option is selected,  is displayed on the **Tool** toolbar.

# Tool improvements

There are several changes to the **Tool**  dialog.

There are a couple of changes to the **Tool Holder** tab:



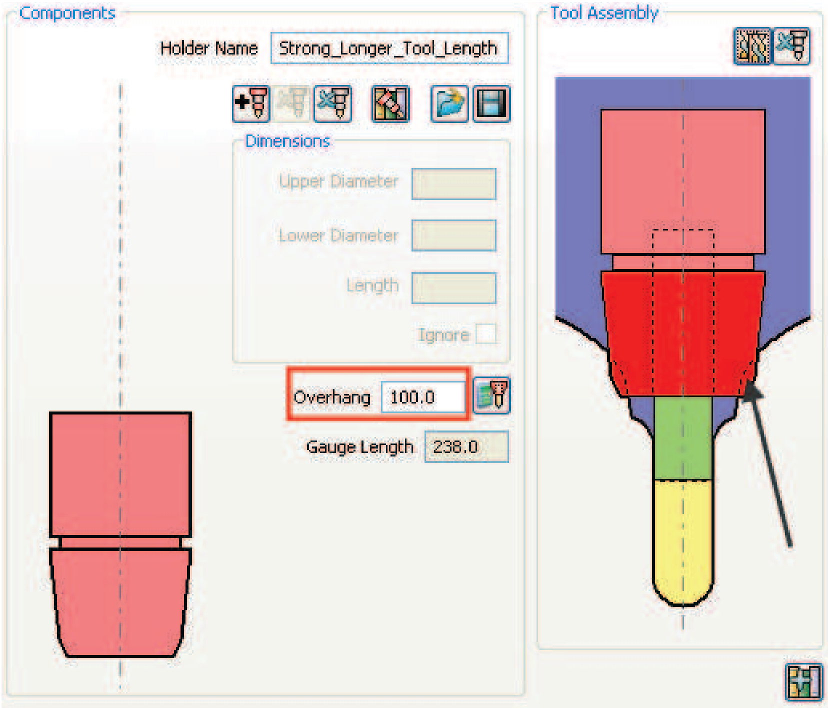

- You can now have a tool holder with a negative overhang.

You can have a negative **Overhang**, so the cutting part of the tool is above some of the holder elements. This is particularly useful when using a grinding wheel where the locking plates and lock nuts are below the cutting part of the tool.

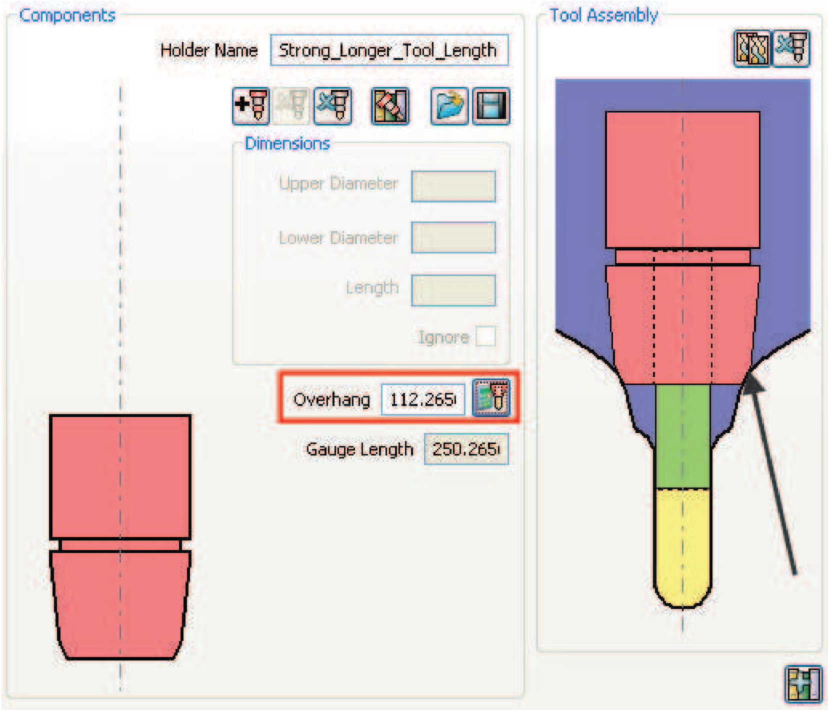
This enables you to define a grinding wheel as a tipped disk or routing tool.

- The **Overhang** button automatically calculates the overhang value, based on the tool's holder profile, to give the smallest, non-colliding value.

In this case, with an **Overhang** of **100** the tool holder collides with the model:



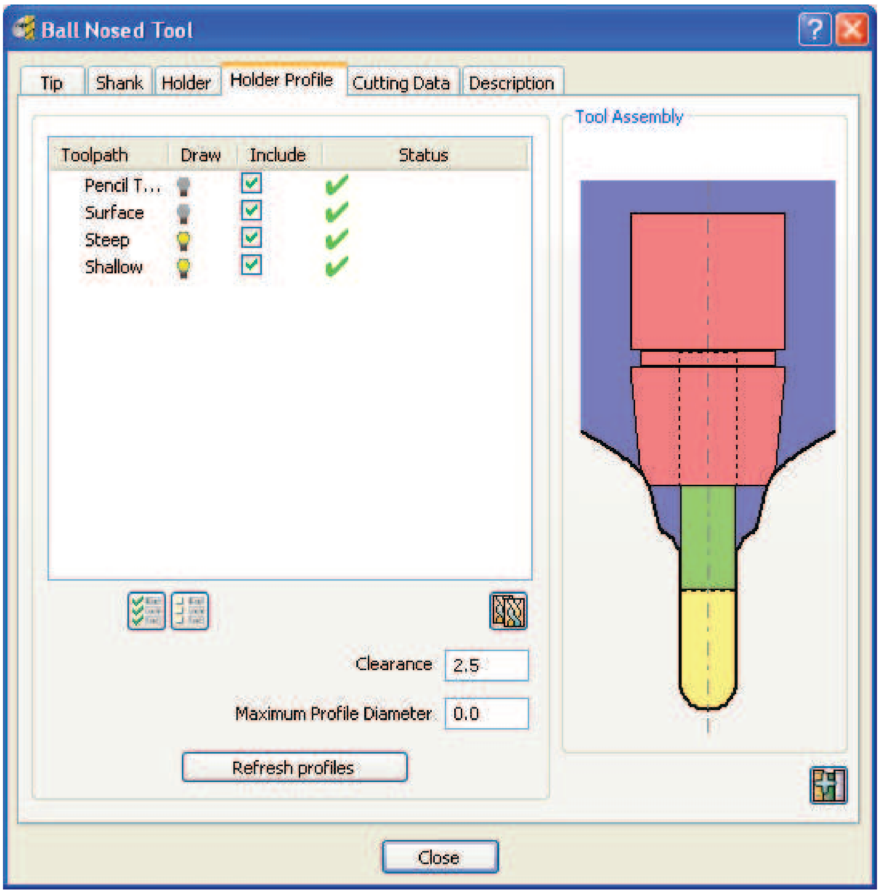

Clicking calculates the smallest overhang to avoid collisions:



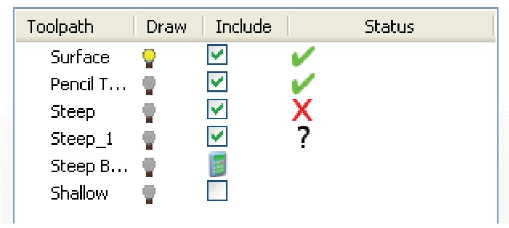
There is a new tab of **Holder Profile** (see page 21) which gives a fast way of collision checking.

## Tool Holder Profile

The **Tool Holder Profile** tab of the **Tool** dialog calculates the maximum shape of a tool holder and shank on a toolpath during toolpath calculation. After the calculation, you can check that specific holders and shanks lie inside the maximum shape and are therefore capable of machining the part, without having to go through collision checking.




**Toolpath list -** lists all the toolpaths that use this tool and shows whether the tool can machine the part.




**Toolpath -** all the toolpaths which use this tool.

**Draw -** draws (or undraws) the toolpath. This has the same state as the toolpath in the explorer.

**Include -** includes the toolpath in the tool profile calculation.

**Status -** shows whether the tool can machine the part without the holder colliding.

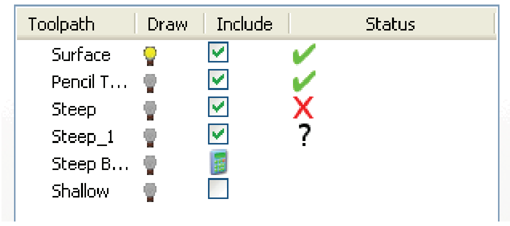
✔ the tool can machine the part without the holder colliding.

✘ - the tool holder collides with the part. The colliding component is shaded red.

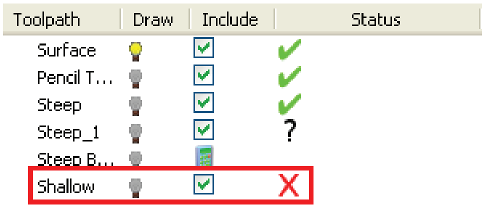
? - the toolpath profile hasn't been calculated.

**Include All Toolpaths -** selects all the calculated toolpaths.

Converts this:

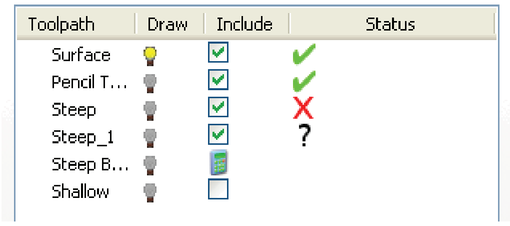



to this:

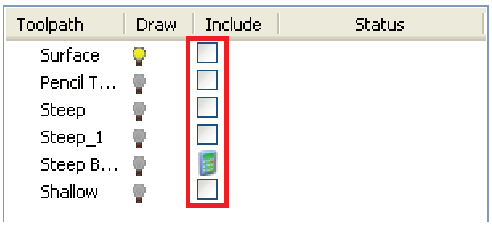



**Exclude All Toolpaths -** deselects all the calculated toolpaths.

Converts this:



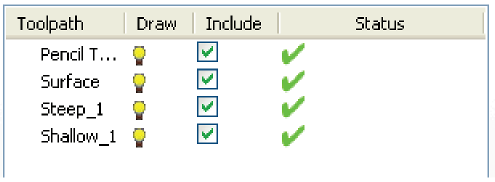

to this:



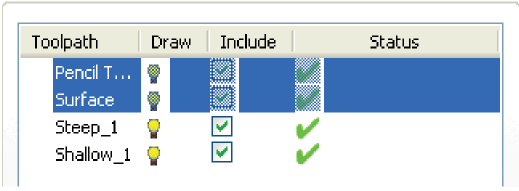

**Copy Tool Profile -** creates a copy of the tool and associates the selected toolpaths which were associated with the old tool with this new tool.

This is best shown by example.

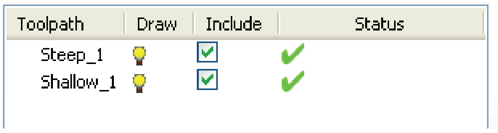
1. Initially the tool has four toolpaths associated with it:



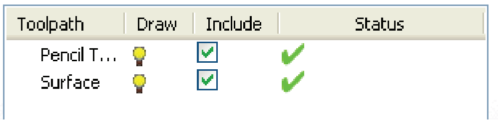

2. Select two of the toolpaths




3. Click . This leaves two toolpaths associated with the original tool:




and two toolpaths associated with the new tool:



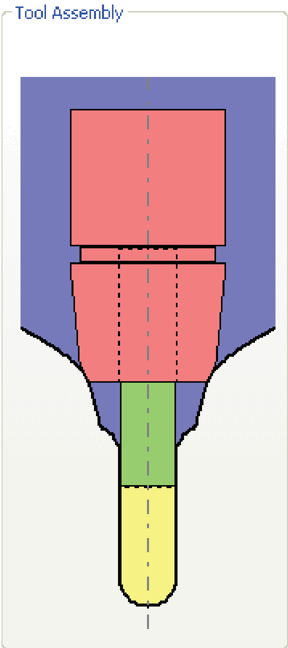

*If you don't select any toolpaths, then all the toolpaths are associated with the new tool.*

*This is similar to , as it creates a new tool entity based on the current one. With  the selected toolpaths which used the old tool, now use the new one. With , all the toolpaths, except for the active toolpath, still use the original tool.*

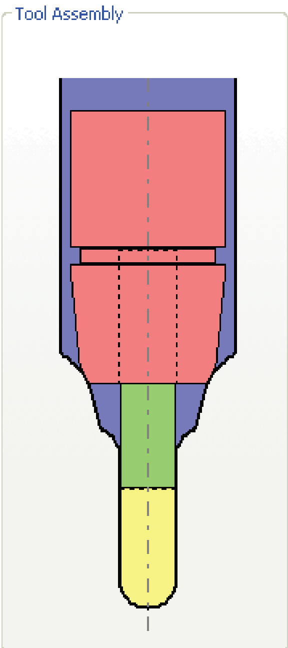
**Clearance -** the minimum allowable distance between the model and the tool profile.

**Maximum Profile Diameter -** limits the maximum diameter of the profile to the value set here. 0.0 means that no maximum diameter is set.

**Maximum Profile Diameter -** 0.0 (unlimited):

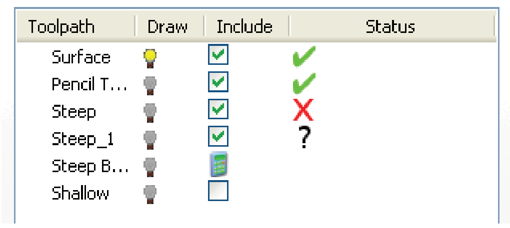



**Maximum Profile Diameter -** 90:

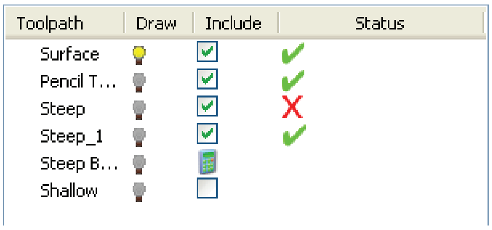



**Refresh Profiles -** calculates the profiles for any toolpath which has a status of ?.

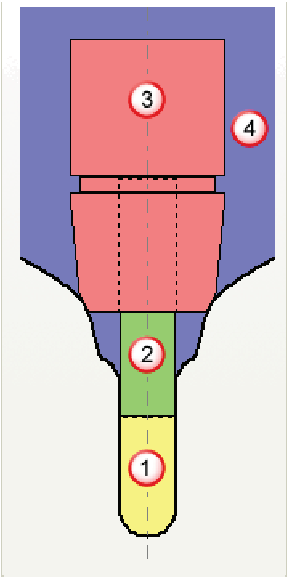
Converts this:



to this:




**Tool Assembly -** displays the defined tool tip, tool shank, tool holder, and tool holder profile.




1 - tool

2 - shank

3 - holder

4 - holder profile

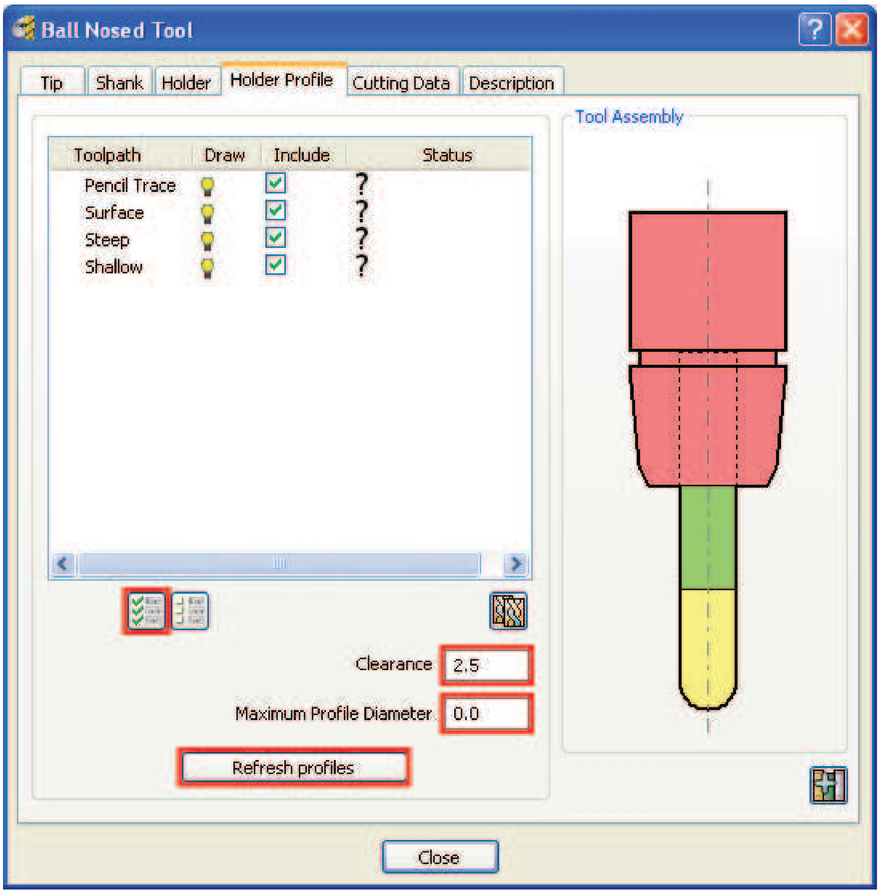
**-** adds this tool to the tool database. The **Tool Database Export** dialog is displayed.

## Creating a Tool Holder Profile

This example shows you how to create a tool holder profile for several toolpaths.

1. Calculate a variety of toolpaths using the same tool.
2. From the individual tool context menu, select **Settings**.

3. Select the **Holder Profile** tab.



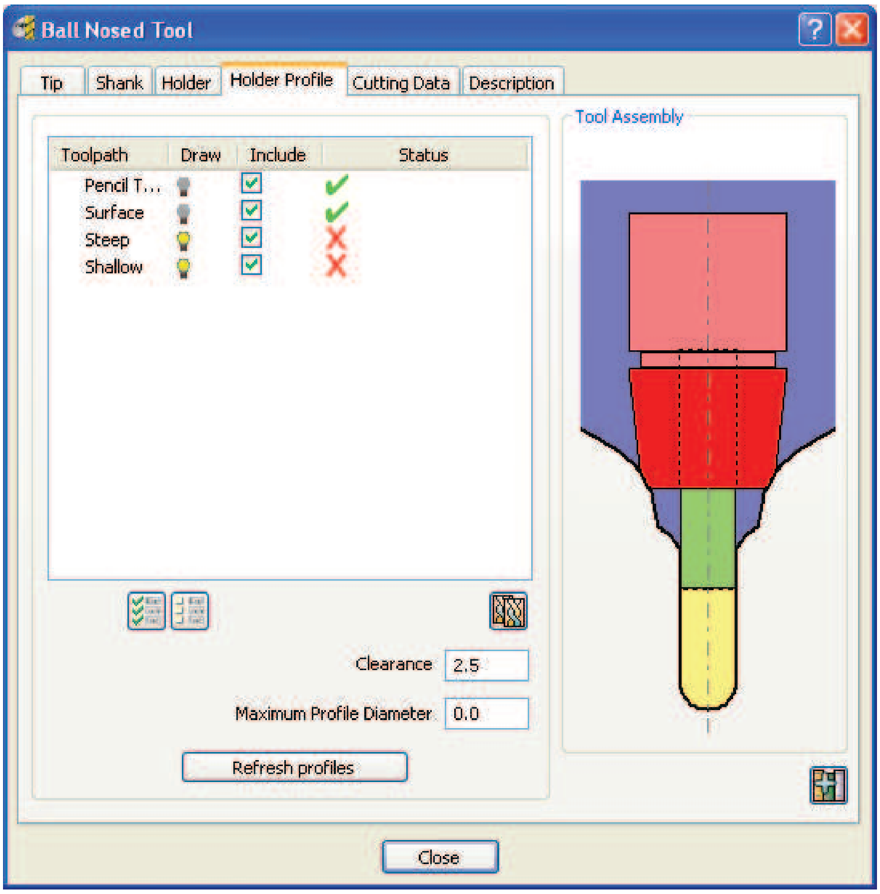

a. Click  to include all the toolpaths.

b. Enter a **Clearance** of 2.5.

c. Enter a **Maximum Profile Diameter** of 0.0.

d. Click **Refresh Profiles** to calculate the holder profile and see if the holder collides with the model.

In this case, two toolpaths are fine and two have collisions between the lowest portion of the holder and the model.

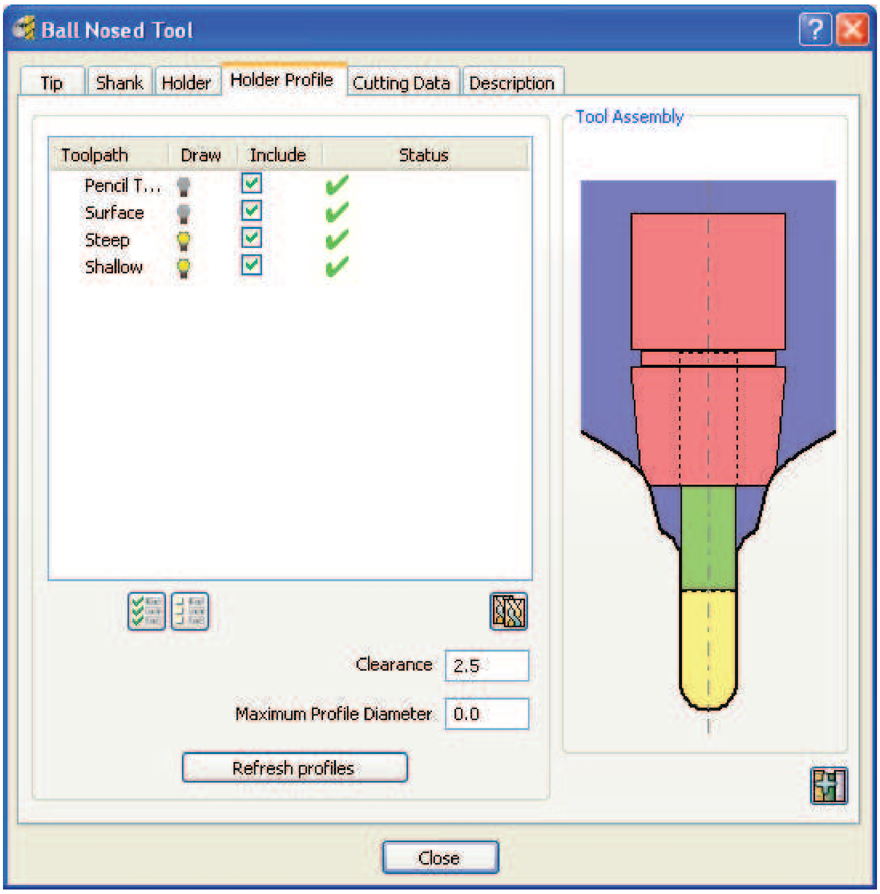



The red component of the tool holder shows the colliding portion.

4. Select the **Holder** tab.

5. Click  to automatically calculate a more appropriate **Overhang**.

6. Select the **Holder** tab to see the effect of lengthening the **Overhang** value.



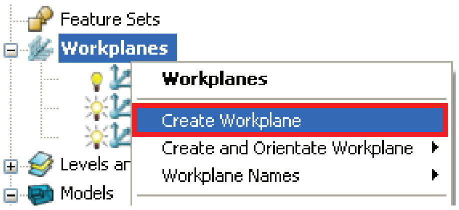

*You can calculate the tool holder profile automatically as part of the toolpath calculation by selecting* ***Calculate holder profile*** *on the* ***Tool*** *page of the strategy dialog.*

# Workplane Editing improvements

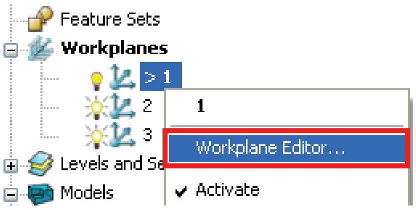
A new **Workplane Editor** toolbar (see page 29) replaces the **Workplane** dialog and the workplane options on the **Curve Editor** toolbar in previous versions.

The **Workplane Editor** is available from:

- The **Workplanes** context menu, select **Create Workplane**.




- The individual workplane context menu, select **Workplane Editor**.




## Workplane Editor toolbar

The **Workplane Editor** toolbar allows you to create and edit workplanes.

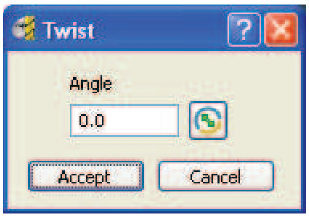
*Whilst in the Workplane Editor, no other entities can be edited, including other workplanes. As with the Curve Editor, PowerMILL enters a graphic mode where most of the user interface is greyed out.*


**Transform Copy -** transforms a copy of the workplane, leaving the original in its current location and orientation. Clicking changes the button to which transforms the workplane without leaving the original workplane.

**Name -** the name of the workplane. You can edit the name here.

**Position** (see page 37) **-** aligns the workplane using typed coordinate input rather than using the cursor.

, , or **Twist -** rotates the workplane around the selected axis by the specified angle.

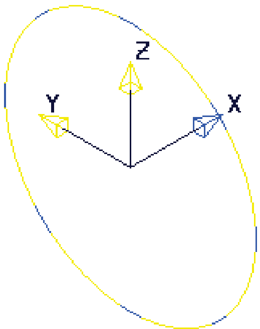



**Angle -** the rotation required.

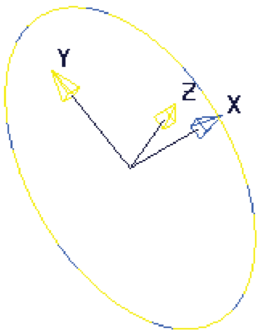
**Invert Angle -** changes an anti-clockwise rotation to a clockwise rotation. So, an angle of 30° becomes 330°.

*The axis that is fixed (the axis the workplane is being rotated around) is drawn in blue to show that it won't be modified.*

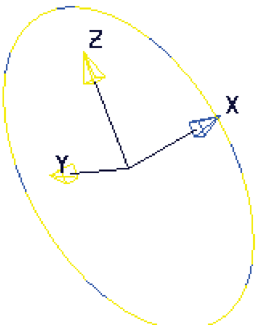
**Angle -** 0°:




For a rotation about X, **Angle -** 30°:




For a rotation about X, **Angle -** 330°:



, , or **Axis direction** (see page 41) **-** determines the direction of the specified workplane axis.

**Rotate -** rotates the workplane around the origin of the selected workplane by the selected angle. The **Twist** option rotates the workplane about itself. This option allows you to rotate the workplane about another workplane.


**Angle -** the required rotation angle in degrees.

**Reposition Rotation Axis -** when selected, enables you to move the origin of the rotation axis either graphically or by entering coordinates in or on the **Status** toolbar.

**Finish -** accepts the changes and closes the toolbar.

For more information, see the Rotate workplane example (see page 43).

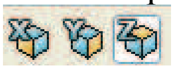
**Swap axes -** switches the direction of the workplane axes. For example, this enables you to orientate the Z axis along what is currently the X axis.

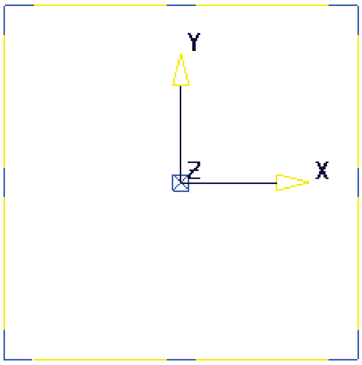

Clicking one of these buttons allows you to specify a new direction for that axis.

For more information, see the Swap axes example (see page 44).

**Align with -** orientates the workplane with the view, model, tool, or block.

> **Align with view -** orientates the workplane so that it is aligned with the current graphics view.

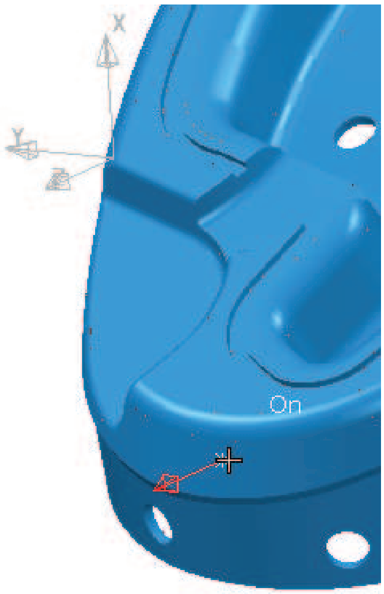
The workplane is aligned with respect to the principal editing plane  that is selected on the **Status** bar. In this example,  is the principal editing plane.



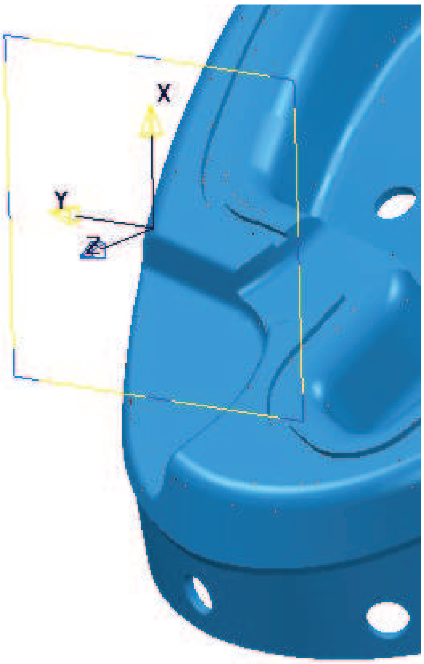

 **Align with geometry -** orientates the workplane so that it is normal to the surface at that point.

The workplane is aligned with respect to the principal editing plane  that is selected on the **Status** bar. In this example,  is the principal editing plane.

Moving the cursor over the model changes its orientation.



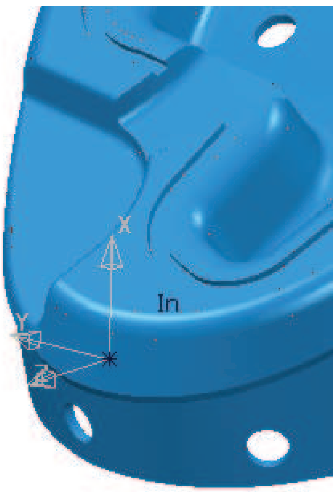
Click on the model to reorientate the workplane.



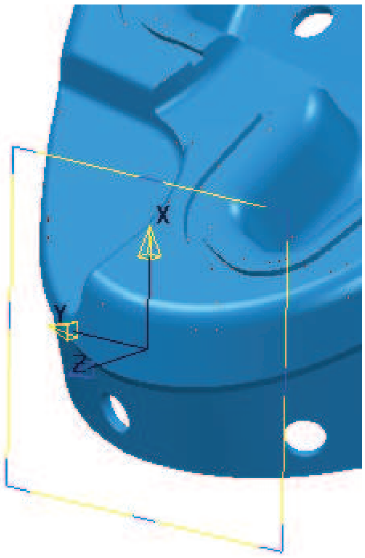

 **Align with geometry and reposition -** orientates the workplane so that it is located where you select the surface and is normal to the surface at that point. The workplane changes its orientation and its position.

The workplane is aligned with respect to the principal editing plane  that is selected on the **Status** bar. In this example,  is the principal editing plane.

Moving the cursor over the model moves the workplane and changes its orientation.

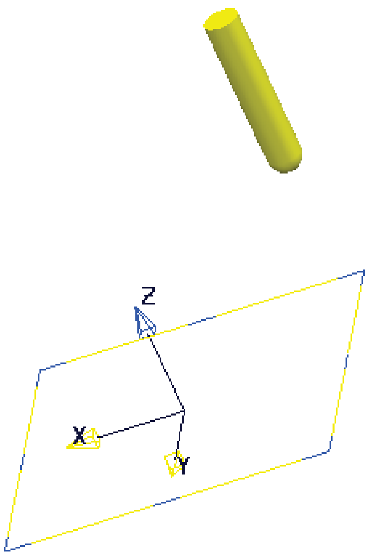


Click on the model to relocate and reorientate the workplane.

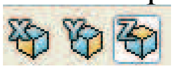


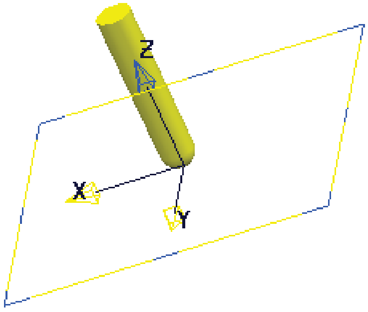

 **Align with tool -** orientates the workplane so that it is aligned with the tool axis. The workplane changes its orientation but not its position.

The workplane is aligned with respect to the principal editing plane  that is selected on the **Status** bar. In this example,  is the principal editing plane.



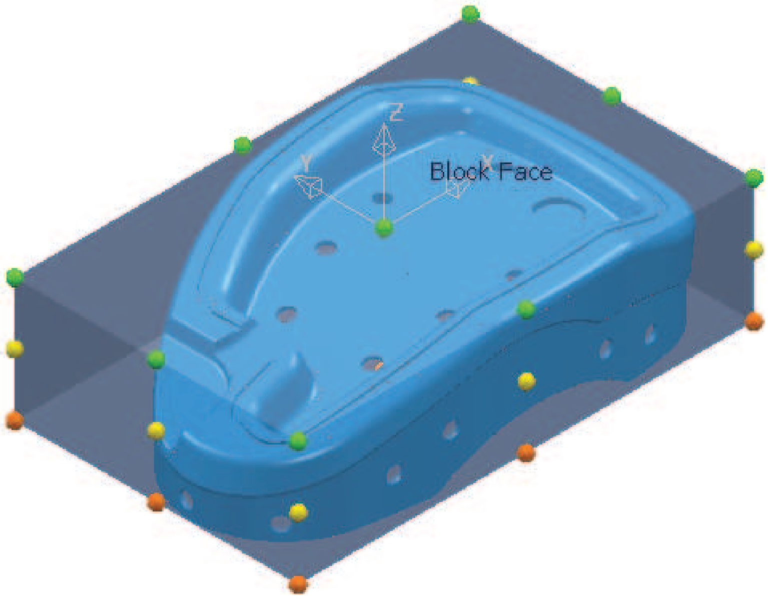

 **Align with tool and reposition -** orientates the workplane so that it is located at the tool centre with the Z axis aligned with the tool axis. The workplane changes its orientation and its position.

The workplane is aligned with respect to the principal editing plane  that is selected on the **Status** bar. In this example,  is the principal editing plane.



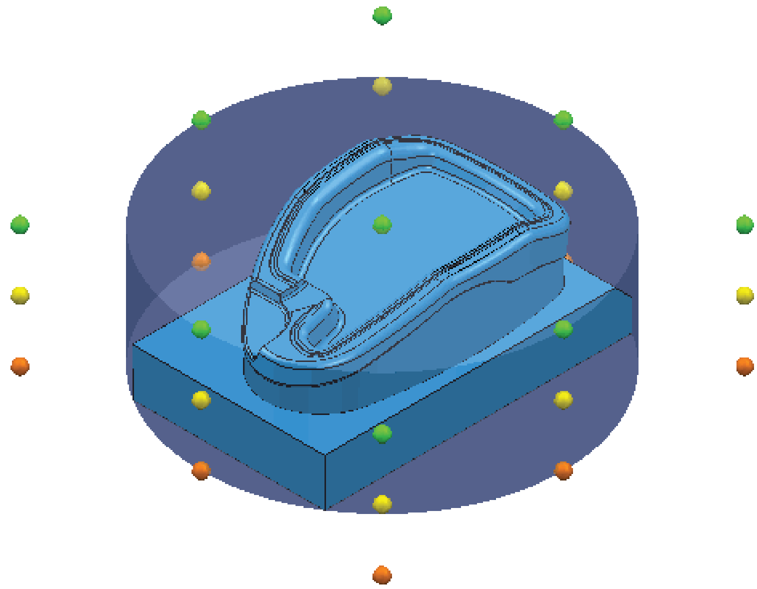

 **Align with block and reposition -** orientates the workplane so that it is aligned with the selected control on the block. The workplane changes its orientation and its position.

The block is drawn with a number of handles.




Click any of these handles to create a workplane at that point, with the same orientation as the active workplane.

*If the block isn't a rectangular block then a bounding box is placed around the block and the handles are placed on the bounding box.*



***Workplane Align to Block*** *is only available if you have a block defined.*

**Undo -** reverts to what it was before the last change. If you rotate the workplane by say 30°, then **Undo** undoes this transformation.

*This option is only available once you have edited (transformed) the workplane.*

**Redo -** reinstates the edit you have just undone.

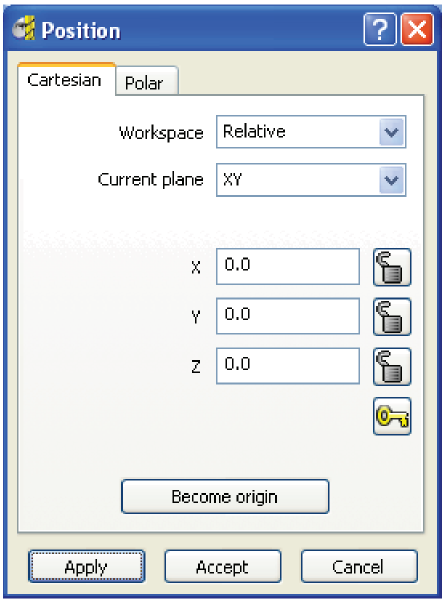
*This option is only available once you have undone a transformation.*

**Accept Changes -** accepts and keeps workplane orientation. The **Workplane Editor** toolbar is closed and normal PowerMILL functionality is enabled.

**Cancel Changes -** the workplane orientation reverts to what it was before you started editing it. The **Workplane Editor** toolbar is closed and normal PowerMILL functionality is enabled.

## Position dialog

The **Position** dialog locates the item using typed coordinate input, though you can also use the cursor.



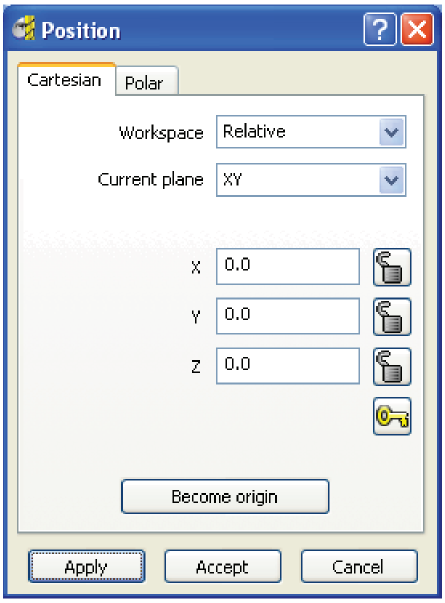

There are two tabs:

- **Cartesian** (see page 38) **-** define the item position using cartesian coordinates.
- **Polar** (see page 39) **-** define the item position using polar coordinates.

The **Cartesian** and **Polar** tabs are always synchronised. This means that there is a single underlying point represented in two different ways.

## Position - Cartesian

The **Cartesian** tab of the **Position** dialog displays the coordinates of the item location. You can use either the cursor, or typed coordinate input to specify the location.




**Workspace -** determines which workspace you are working in.

**World -** moves the item to the coordinates (in the global coordinate system) specified in the lower half of the dialog.

**Workplane -** moves the item to the coordinates (in the active workplane) specified in the lower half of the dialog.

*This option is only available if an active workplane exists, and, if you are editing a workplane, you're editing a non-active one.*

**Relative -** moves the item to the coordinates specified in the lower half of the dialog.

*If any items are locked, the locks are discarded when you select a different workspace.*

**Current Plane -** select one of the three principal planes. The current plane is relative to the selected **Workspace** option.

**X**, **Y**, **Z -** the typed coordinates.

**Locks -** clamps values and prevents you from editing them.

**Unlocked -** the field is unlocked and so can be edited.

**Locked -** the field is locked and so cannot be edited.

These two buttons work as a toggle. So, if you click the **Unlocked** button it locks the field and changes the button to **Locked**, and similarly, if you click the **Locked** button, it unlocks the field and changes the button to **Unlocked**.

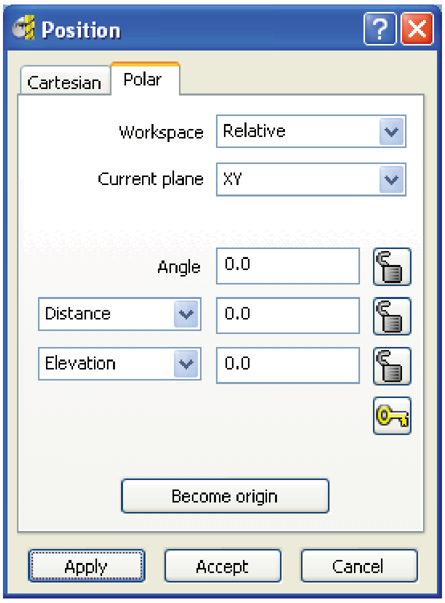
**Unlock All Limits -** unlocks all the locked parameters.

*The locks on the **Polar** and **Cartesian** pages are not independent. Say, for example, you lock the angle to 45° with the current plane set to XY. If you then change X, Y will also change so that it respects the lock.*

**Become Origin -** the coordinates defined above become the item origin. Any relative coordinates are then measured from this origin.

## Position - Polar

The **Polar** tab of the **Position** dialog displays the coordinates of the entity location. You can use either the cursor, or typed coordinate input to specify the location.




**Workspace -** determines which workspace you are working in.

**World -** moves the item to the coordinates (in the global coordinate system) specified in the lower half of the dialog.

**Workplane -** moves the item to the coordinates (in the active workplane) specified in the lower half of the dialog.

*This option is only available if an active workplane exists, and, if you are editing a workplane, you're editing a non-active one.*

**Relative -** moves the item to the coordinates specified in the lower half of the dialog.

*If any items are locked, the locks are discarded when you select a different workspace.*

**Current Plane -** select one of the three principal planes. The current plane is relative to the selected **Workspace** option.

**Angle** - the polar angle from the origin in the **Current Plane** and **Workspace**.

**Distance**

**Distance** - the distance from the workplane origin.

**X**, **Y**, or **Z** - the distance on either of the axes of the **Current Plane**.

**Elevation**

**Elevation** - the angle of elevation above the active plane from the origin of the workspace.

**Height** - the distance perpendicular to the selected plane. For example, the **Z** component when the **XY** plane is selected.

**Locks -** clamps values and prevents you from editing them.

**Unlocked -** the field is unlocked and so can be edited.

**Locked -** the field is locked and so cannot be edited.

These two buttons work as a toggle. So, if you click the **Unlocked** button it locks the field and changes the button to **Locked**, and similarly, if you click the **Locked** button, it unlocks the field and changes the button to **Unlocked**.

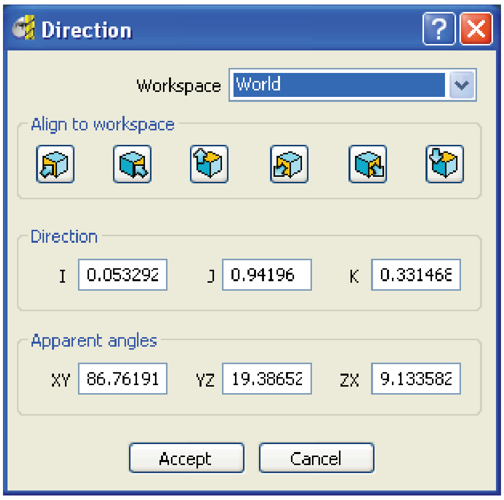
**Unlock All Limits -** unlocks all the locked parameters.

*The locks on the **Polar** and **Cartesian** pages are not independent. Say, for example, you lock the angle to $45^{\circ}$ with the current plane set to XY. If you then change X, Y will also change so that it respects the lock.*

**Become Origin -** the coordinates defined above become the item origin. Any relative coordinates are then measured from this origin.

## Direction dialog

Edits the direction of the item. A direction is defined in terms of a unit vector.




**Workspace -** determines which workspace you are working in.

**World -** moves the item to the coordinates (in the global coordinate system) specified in the lower half of the dialog.

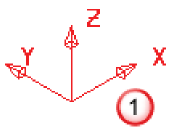
**Workplane -** moves the item to the coordinates (in the active workplane) specified in the lower half of the dialog.

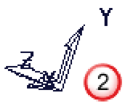
*This option is only available if an active workplane exists, and, if you are editing a workplane, you're editing a non-active one.*

**Align to workspace -** aligns the selected workplane axis to the chosen axis of the global coordinate system.

The effect of this option is best shown by example.

If you start with this:

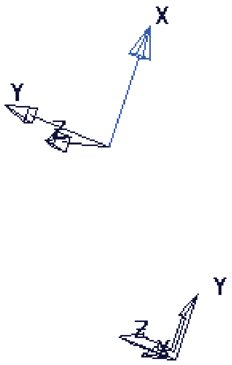


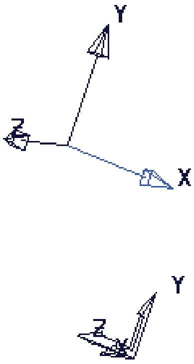

1 - the workplane that you are editing

2 - the active workplane (or the global coordinate system if there is no active workplane).

1. On the **Workplane Editor** toolbar click .
2. In the **Direction** dialog click . The workplane changes to:

   The X axis of the workplane is aligned with the Y axis of the global coordinate system.
3. In the **Direction** dialog click . The workplane changes to:

   The X axis of the workplane is aligned with the -Z axis of the global coordinate system.

 positive X-axis

 positive Y-axis

 positive Z-axis

 negative X-axis

 negative Y-axis

 negative Z-axis

**Direction -** the **I, J**, and **K** coordinates for the unit vector.

**Apparent angles -** the apparent angle of the unit vector from the axis of the plane shown by the icon.

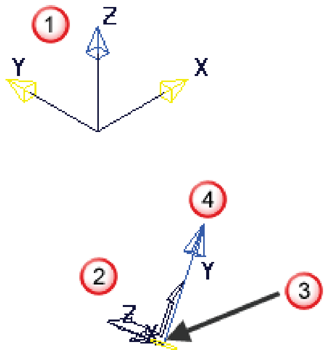
## Rotate workplane

This example shows you how to rotate a workplane.

1. Click the **Rotate**  button from the **Workplane Editor** toolbar. This displays the **Rotate Workplane** toolbar.

   It also show the point about which the workplane will be rotated.

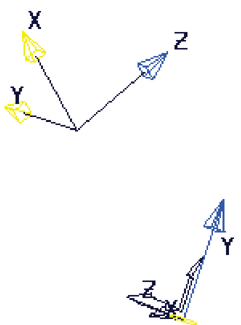
   1 - the workplane that you are editing

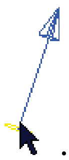
   2 - the active workplane (or the global coordinate system if there is no active workplane).

   3 - the rotation point

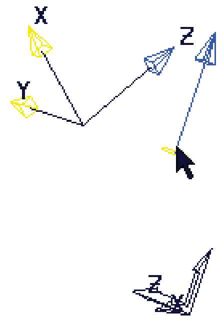
   4 - the rotation axis.

2. Enter an **Angle** of 90.

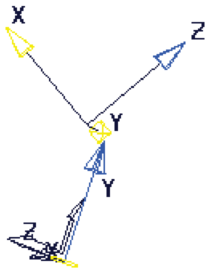
   
   

3. The cursor changes to  .

4. Either click in the graphics area to locate the new origin or enter the required coordinates in or on the **Status** toolbar.




5. Enter an **Angle** of 45.




*If you click the **Position** dialog (see page 37) becomes available on the **Status** bar.*

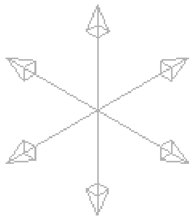
## Swap axes

This example shows you how to swap the axes a workplane.

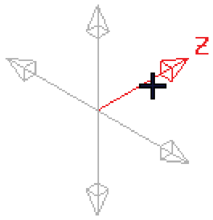
1. Click the **Swap axes** button from the **Workplane Editor** toolbar. This displays the **Swap Axes** toolbar with the **Specify Z axis** button selected.

   *If you want to change the axis you are currently selecting, simply select the relevant button on the **Swap Axes** toolbar. So if you want to specify the Y axis click .*

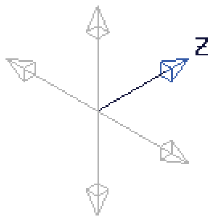
The workplane is now displayed as 8 arrows, to indicate the possible options.



2. Hover over any of the arrows to highlight the arrow, display the axis label, and remove the opposite arrow.

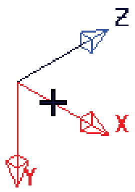



3. Selecting the arrow makes the label permanent.

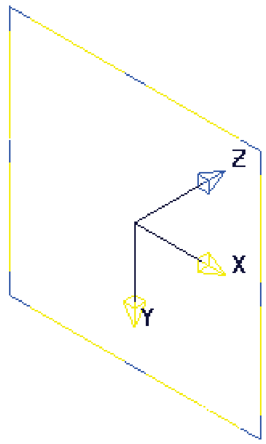



The **Specify X axis**  button is now selected.


4. Hover over one of the four remaining axis to highlight it and to label the two remaining axes.



5. Selecting the arrow makes the label permanent and closes the **Swap axes** toolbar.

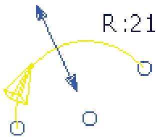


# Curve editor enhancements

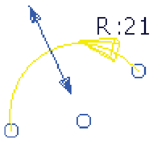
There are additional buttons on the **Curve Editor** toolbar.

 **Reverse Selected Items -** reverses the direction of the selected items.

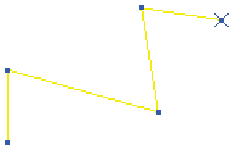
Converts this:




to this:



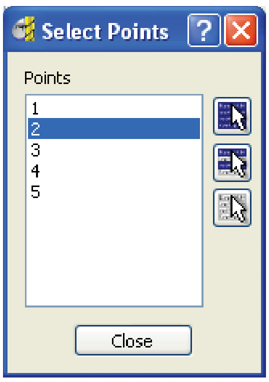

If you select a polyline there is no arrow on the line, but the X marks the end of the polyline.



For more information, see **Reverse selected item example** (see page 49).

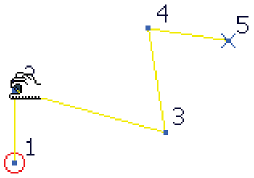
 **Select Points on Curve -** selects points which you can then edit or delete.

Displays the **Select Points** dialog (see page 50).




You can select a point by either:

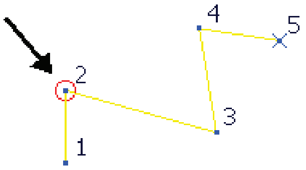
- Selecting it graphically.




or:

- Selecting it from the **Select Points** dialog.

A red circle is placed on the selected point.

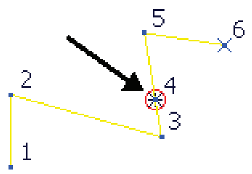



*You can select additional points graphically using the Shift key. You can deselect points using the Ctrl key. Shift plus a drag box selects all the points in the box and Ctrl plus a drag box deselects all the points in the box.*

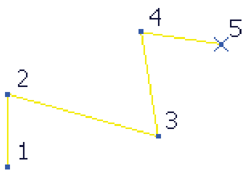
 **Insert Point** (see page 51) **-** adds a point between a pair of selected points.

 **Delete Points -** deletes the selected point.

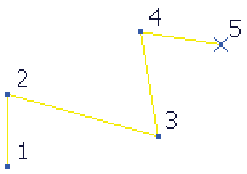
Converts this:




To this:




 **Number Points -** numbers the points on the selected curve.




There are new interactive editing capabilities for:

- **Lines** (see page 52) **-** enables you to move the start or end point of a line.
- **Arcs and circles** (see page 55) **-** enables you to change the radius and the arc length.
- **Continuous lines** (see page 57) **-** enables you to move individual points on the polyline.

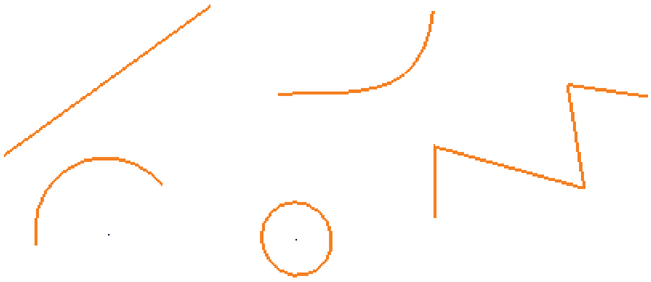
All coordinate input that used to appear on separate sub-toolbars is now available on the **Status** bar (see page 167).

Context menus are now available from the graphics window. When the **Curve Editor** toolbar is displayed, right click in the graphics area to display the **Curve Editor** menu (see page 58). Similarly right click on a **Line** (see page 62), **Arc** (see page 64) or **Continuous line** (see page 67) to display their menus.

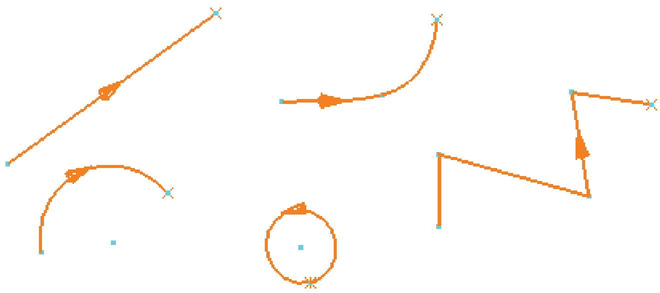
## Reverse selected items example

To see the effect of **Reverse selected items**  you must **Instrument**  the curve.

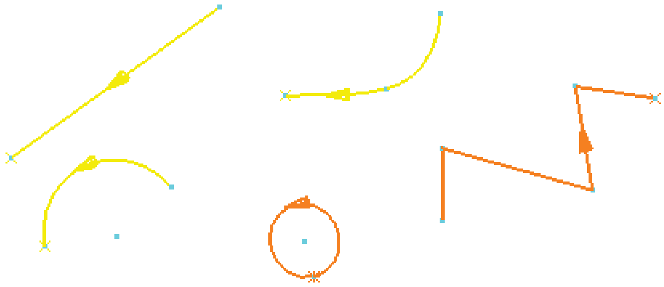
If you start with these curves:



1. Click  to instrument the curve.

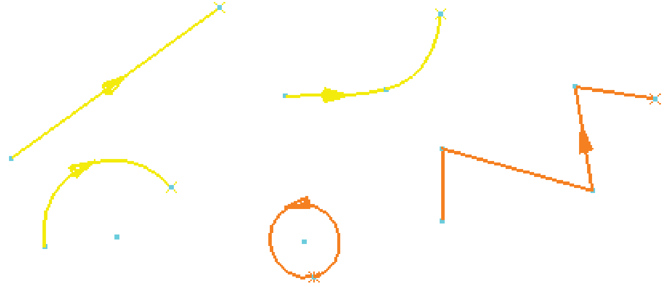


2. Select the curves you want to reverse.



The selected curves turn yellow.

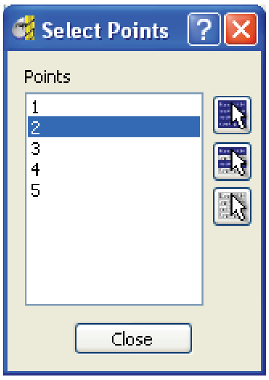
3. Click to reverse the selected curves.



*You must select the curve before you can reverse it. The yellow curves (the selected curves) are reversed and the orange ones aren't.*

*If you just select a single curve, you don't need to instrument the curve first.*

## Select Points dialog




You can select points from the list on the left hand side of the dialog. This lists supports normal Windows multi-selection options.

- selects all the points.

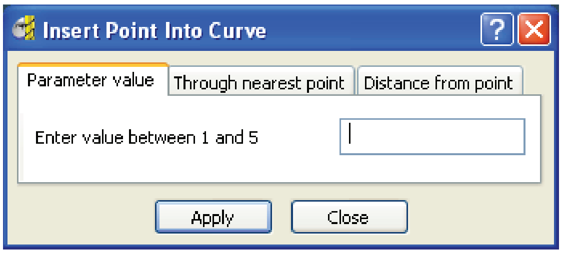
- toggles the selection. So it deselects selected points and selects the deselected ones.

 - deselects all the points.

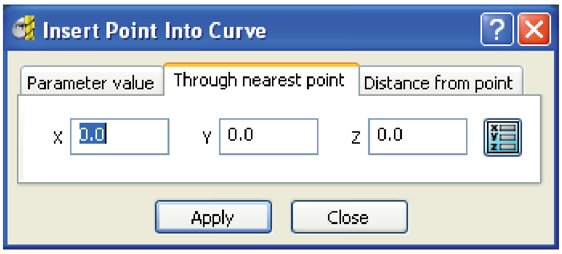
# Insert Point into Curve dialog

There are three ways of inserting points:

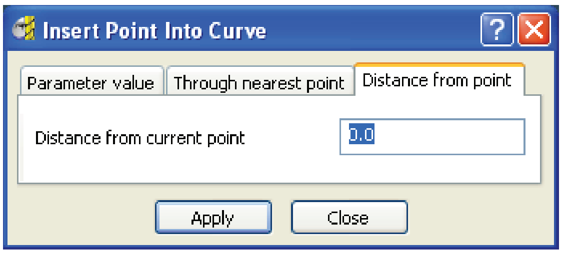
- At a specified parameter value.



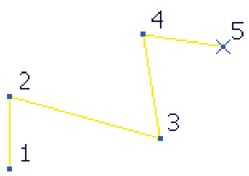

- At the closest point on the curve to the specified point.




- At a distance along a curve, from the specified point.

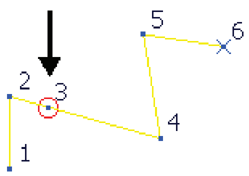



These options are shown using this curve.



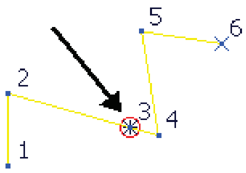

## Parameter value

Entering a value of 2.25 and clicking **Apply**, inserts a point 1/4 of the way between point 2 and point 3.

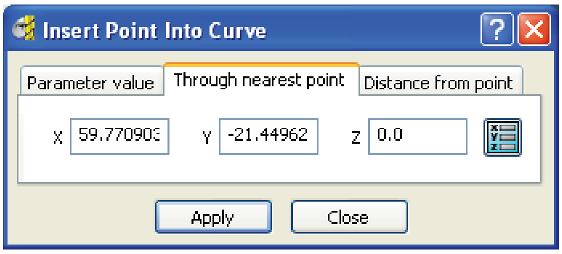


### Through nearest point

Entering a value of **X - 60**, **Y - -21**, **Z - 0**, inserts this point:



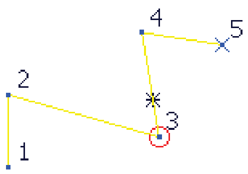
and updates the dialog with the actual coordinates of the point.



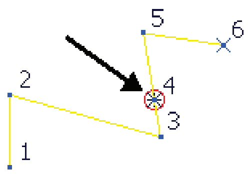

*You can use the* ***Position*** *dialog (see page 37) to enter the coordinates, or select a point graphically.*

### Distance from point

Select point 3.

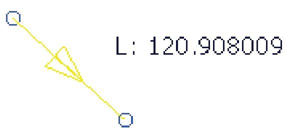


Entering a **Distance from current point** of 10 and click **Apply**.



## Editing a line

1. Select a line to edit it.

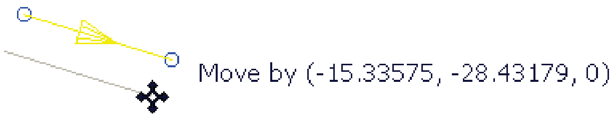



The line is yellow and has a blue handle at each end.

*If you aren't in curve editing mode select the line to edit it.*

2. Selecting one of the handles (the cursor changes to ) and dragging it to a new position changes the length and angle of the line.


3. Selecting the line (the cursor changes to ) and dragging it to a new position changes the location but not the length or orientation.

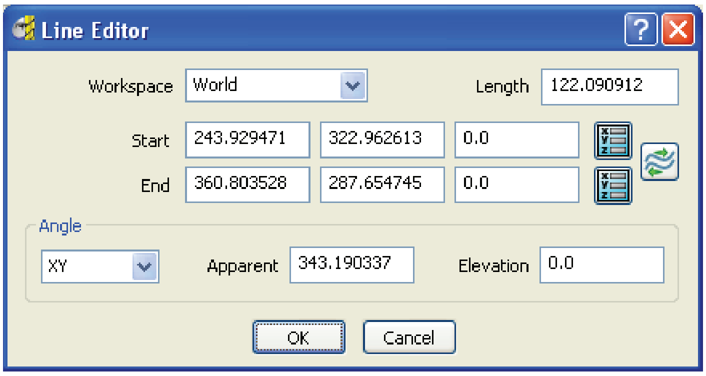



4. A **PowerMILL Query** dialog asks you to confirm the drag.

*Double clicking the line displays the* ***Line Editor*** *dialog (see page 53).*

## Line Editor dialog

This dialog edits a line.




**Workspace -** edits the line in world, workplane, or relative workspace.

*The relative workspace has its origin at the start of the line and its axes aligned with the current workspace*

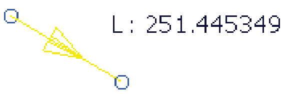
**Length** - the length of the line so that it extends or shrinks from its end.

**Start** - the start coordinates of the line.

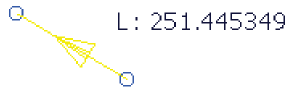
**End** - the end coordinates of the line.

**Reverse the line -** reverses the direction of the selected line.

Converts this:



to this:

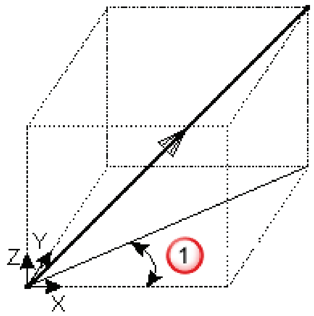



**Start / End point position** (see page 37) **-** use the **Position** dialog to enter the coordinates.

**Angle** - the angle of line is defined in terms of apparent and elevation angles on the selected plane.

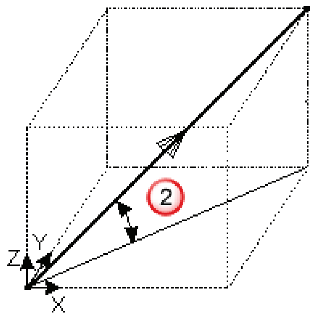
XY - the selected plane.

**Apparent** - the angle measured between the projection of the line onto the selected plane and an axis of the plane. The axis used is the X axis if the selected plane is XY, Y if it is YZ and, Z if it is ZX.




1 - Apparent angle on the XY plane.

**Elevation** - the angle measured between the line and the projection of the line onto the selected plane.

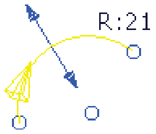



2 - Elevation angle in the XY plane.

*You can still graphically edit the line whilst the* ***Line editor*** *dialog is displayed, but you can't deselect the line or select anything else.*

## Editing an arc

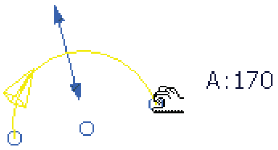
1. Select an arc to edit it.

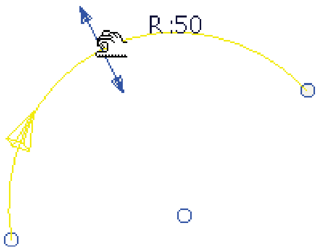
   The arc is yellow, has a blue handle at each end, and arrows indicating the radius.

   *If you aren't in curve editing mode, select the arc to edit it.*

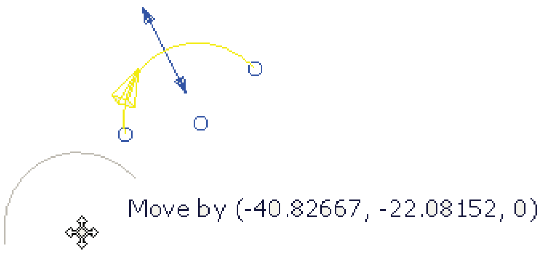
2. Selecting one of the handles (the cursor changes to ) and dragging it to a new position changes the span angle.

3. Selecting the arrows (the cursor changes to ) and dragging it to a new position changes the radius.

4. Selecting the origin (the cursor changes to ) and dragging it to a new position changes the location but not the span or radius.

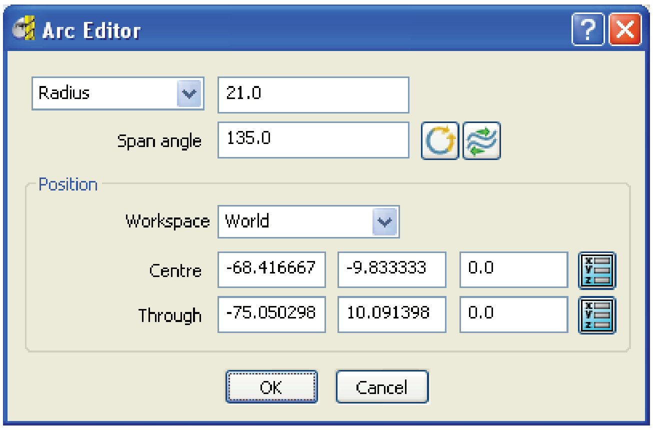
   
   

5. A **PowerMILL Query** dialog asks you to confirm the drag.

*Double clicking the arc displays the* ***Arc Editor*** *dialog (see page 56).*

# Arc Editor dialog

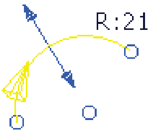
This dialog edits an arc or circle.



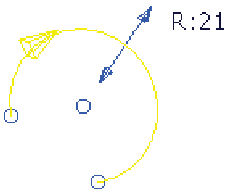

**Radius/Diameter -** determines whether you are specifying the radius or diameter of the arc/circle. The actual radius/diameter is specified in the next field.

**Span angle -** the span of the arc in degrees.

**Span angle -** 135°:

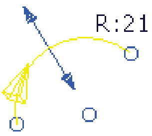



**Span angle -** 270°

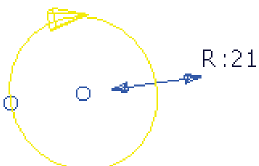



 **Make full arc -** converts an arc to a circle.

Converts this:

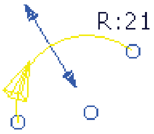



to this:

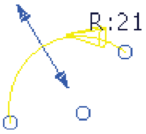



 **Reverse the arc -** reverses the direction of the selected arc.

Converts this:




to this:




**Workspace -** edits the arc in world, workplane, or relative workspace.

**Centre** - the centre coordinates of the circle.

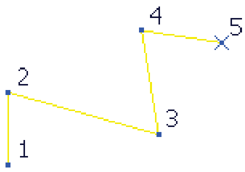
**Through** - the coordinates of a point on the circumference of the circle.

**Centre / Through position** (see page 37) **-** use the **Position** dialog to enter the coordinates.

*You can still graphically edit the arc whilst the* ***Curve editor*** *dialog is displayed, but you can't deselect the arc or select anything else.*

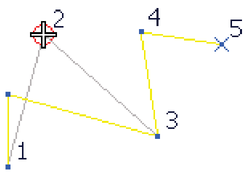
## Editing a polyline

1. Select a polyline to edit it.

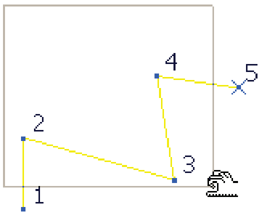



*If you aren't in curve editing mode, select the poyline to edit it.*

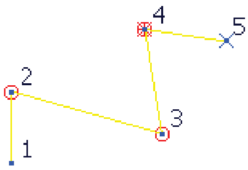
2. Selecting one of the points (the cursor changes to ) and dragging it to a new position changes the point location.



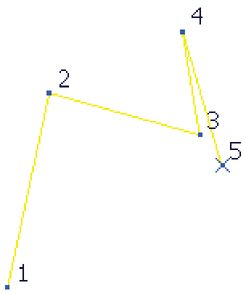
3. Use **Shift** and place a drag box around the middle points.




The middle points are selected.



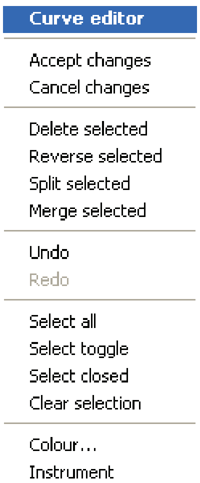

4. Toggle  on the **Status** bar so  is displayed.
5. In on the **Status** bar enter 20 30 0 and click enter. The middle points are moved.




 *You could also use the* ***Position***  *dialog rather than entering coordinates.*

# Curve editor menu

The **Curve editor** context menu is raised by right clicking in the graphics area when the **Curve editor** toolbar is raised.



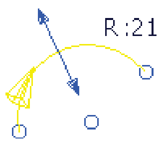
**Accept Changes -** accepts and keeps all the created curves. The **Curve editor** toolbar is closed and normal PowerMILL functionality is enabled. This is the same as on the **Curve editor** toolbar.

**Cancel Changes -** deletes all the created curves. The **Curve editor** toolbar is closed and normal PowerMILL functionality is enabled. This is the same as on the **Curve editor** toolbar.

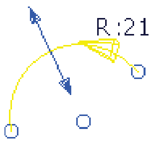
**Delete selected -** deletes the selected items. This is the same as on the **Curve editor** toolbar.

**Reverse selected -** reverses the direction of the selected items. This is the same as on the **Curve editor** toolbar.

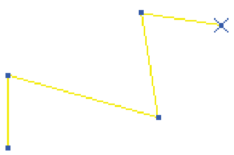
Converts this:




to this:




If you select a polyline there is no arrow on the line, but the X marks the end of the polyline.



For more information, see **Reverse selected item example** (see page 49).

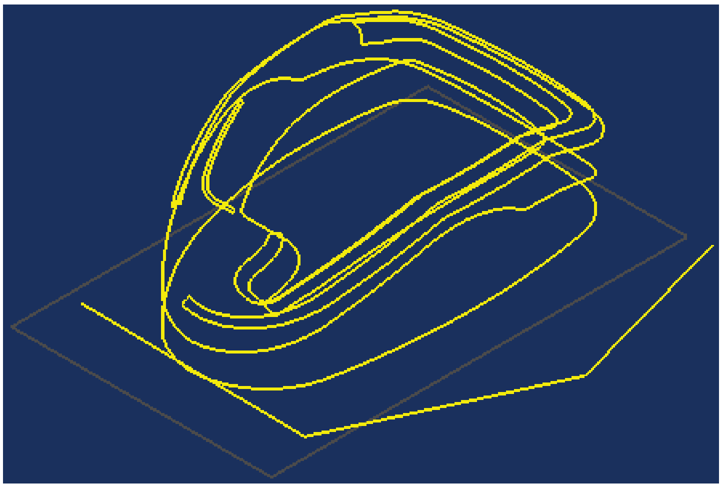
**Split Selected -** breaks the selected segments into the individual curves used to create the curves. This is the same as on the **Curve editor** toolbar.

**Merge selected -** merges individual selected segments into one curve. This is the same as on the **Curve editor** toolbar.

**Undo -** reverts to what it was before the last change. This is the same as on the **Curve editor** toolbar.

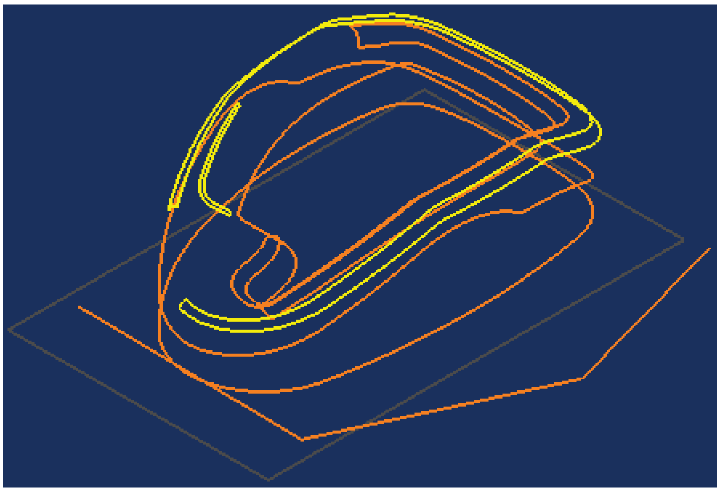
**Redo -** reinstates the edit you have just undone. This is the same as on the **Curve editor** toolbar.

**Select all -** selects all the curves. This is the same as  on the **Curve editor** toolbar.

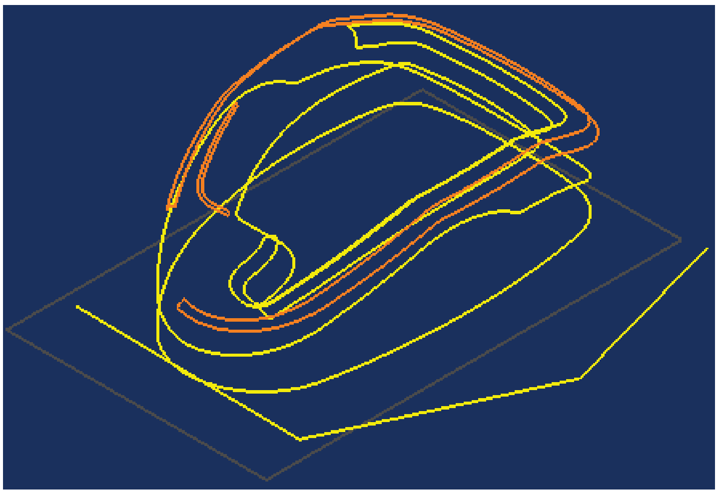


**Select toggle -** deselects the selected curves and selects the deselected curves. This is the same as  on the **Curve editor** toolbar.

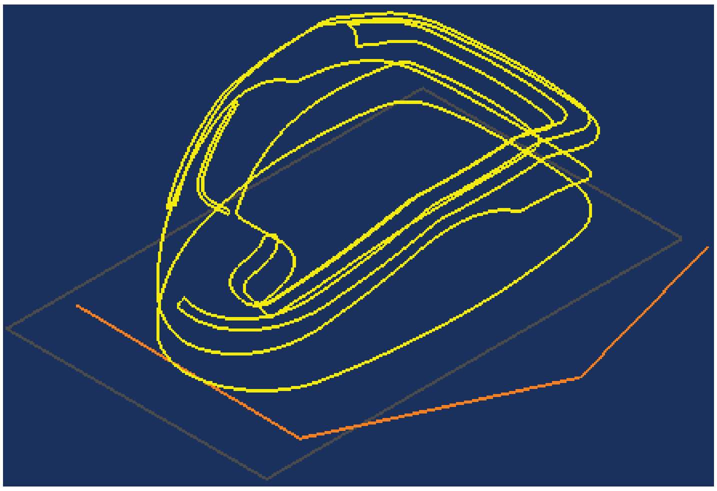
Converts this:



to this:



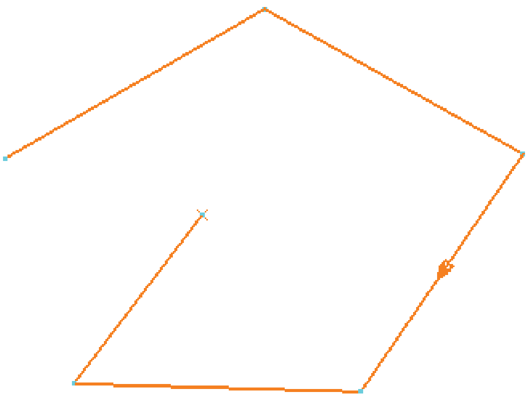
**Select closed -** selects all the closed curves and deselects the open curves. This is the same as  on the **Curve editor** toolbar.



**Clear selection -** deselects the selected curves.

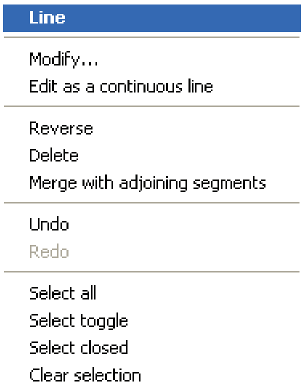
**Colour -** changes the colour of the selected segments. This displays a standard Windows colour dialog, selecting a colour here changes the colour of the selected curves. If no segments are selected, this option sets the default colour for all new segments. This is the same as  on the **Curve editor** toolbar.

**Instrument -** all curves in a pattern have a direction. If you instrument a pattern, it will place an arrow on each segment (pointing towards the end of the segment) and an "X" at the end of each segment. This is the same as  on the **Curve editor** toolbar.



# Line menu

The **Line** context menu is raised by right clicking on a line when the **Curve editor** toolbar is raised.




**Modify** (see page 52) **-** selects the line and displays the **Line Editor** dialog (see page 53) so you can edit the location or length of the line.

**Edit as continuous line** (see page 57) **-** selects the line so you can edit the location, or length of the line in the same way as a continuous line.

**Reverse -** reverses the direction of the selected items. This is the same as  on the **Curve editor** toolbar.

Converts this:


to this:

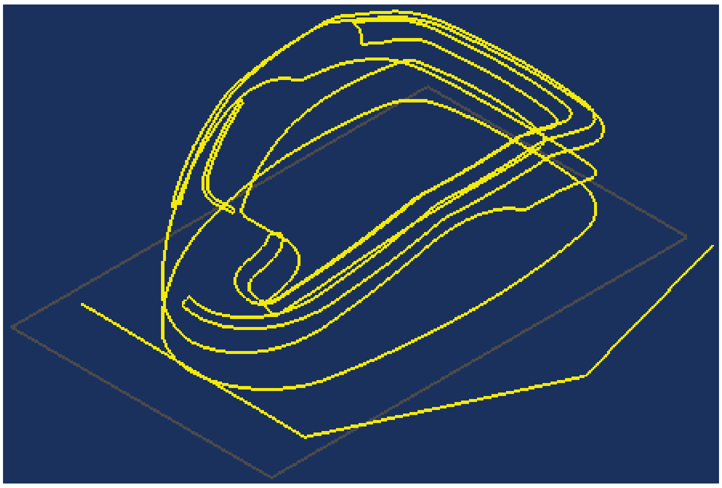

**Delete selected -** deletes the selected line. This is the same as  on the **Curve editor** toolbar.

**Merge with adjoining segments -** merges all the segments adjacent to the picked segment. The curve editor automatically searches for segments that join the picked segment, at either end, and merges them. The search then starts again on this new segment, to see if any segments join it. If they do, then they are merged. This continues until no more merges are possible. Where there is a choice of curves to merge, the curve with the smallest tangent angle discrepancy is chosen. This is the same as  on the **Curve editor** toolbar.

**Undo -** reverts to what it was before the last change. This is the same as  on the **Curve editor** toolbar.

**Redo -** reinstates the edit you have just undone. This is the same as on the **Curve editor** toolbar.

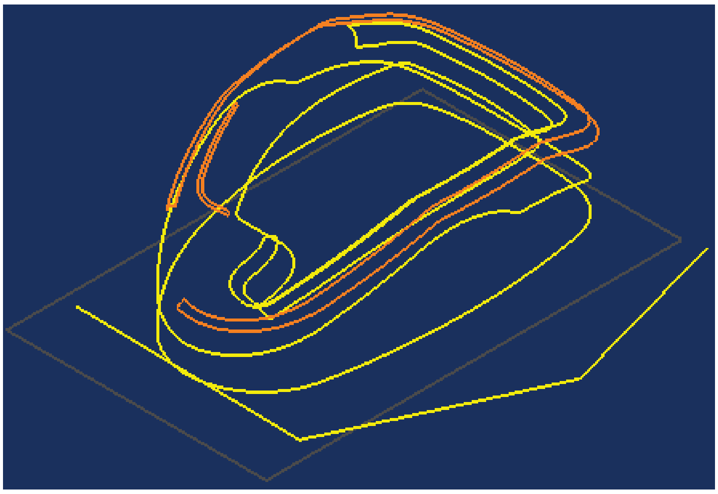
**Select all -** selects all the curves. This is the same as on the **Curve editor** toolbar.



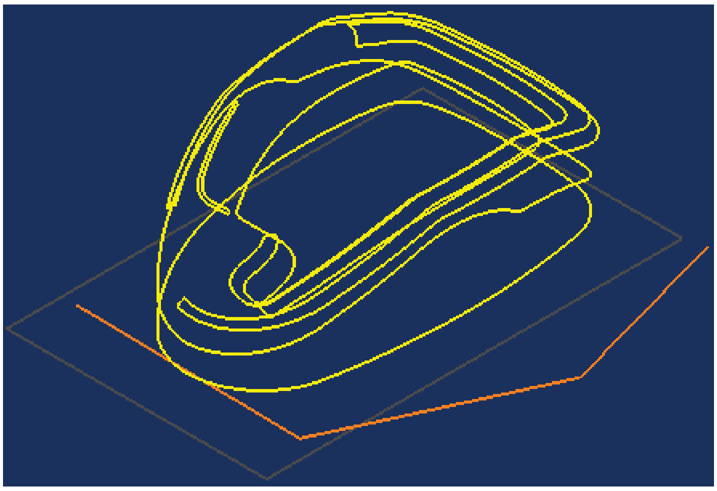
**Select toggle -** deselects the selected curves and selects the deselected curves. This is the same as on the **Curve editor** toolbar.

Converts this:

to this:



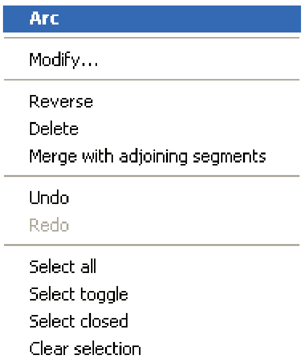
**Select closed -** selects all the closed curves and deselects the open curves. This is the same as  on the **Curve editor** toolbar.



**Clear selection -** deselects the selected curves.

## Arc menu

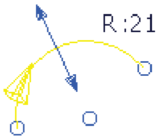
The **Arc** context menu is raised by right clicking on an arc when the **Curve editor** toolbar is raised.



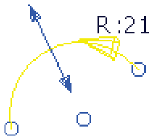
**Modify** (see page 55) **-** selects the line and displays the **Arc Editor** dialog (see page 56) so you can edit the radius or span of the arc.

**Reverse -** reverses the direction of the selected items. This is the same as  on the **Curve editor** toolbar.

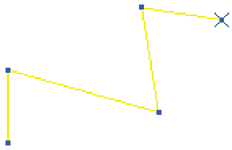
Converts this:




to this:




If you select a polyline there is no arrow on the line, but the X marks the end of the polyline.



For more information, see **Reverse selected item example** (see page 49).

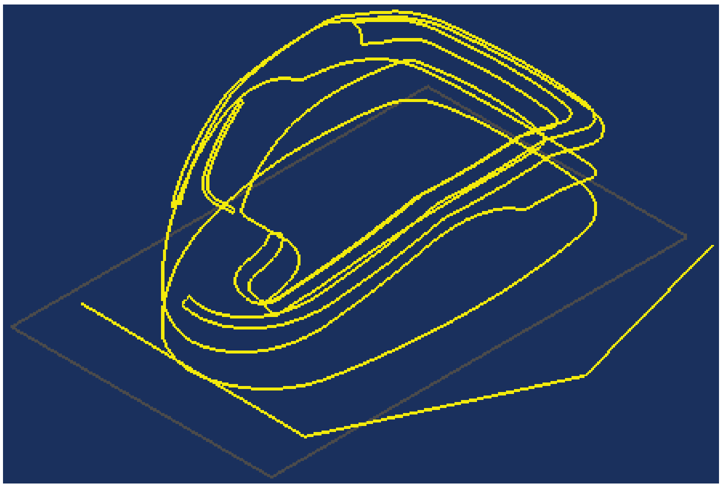
**Delete selected -** deletes the selected arc. This is the same as  on the **Curve editor** toolbar.

**Merge with adjoining segments -** merges all the segments adjacent to the picked segment. The curve editor automatically searches for segments that join the picked segment, at either end, and merges them. The search then starts again on this new segment, to see if any segments join it. If they do, then they are merged. This continues until no more merges are possible. Where there is a choice of curves to merge, the curve with the smallest tangent angle discrepancy is chosen. This is the same as  on the **Curve editor** toolbar.

**Undo -** reverts to what it was before the last change. This is the same as  on the **Curve editor** toolbar.

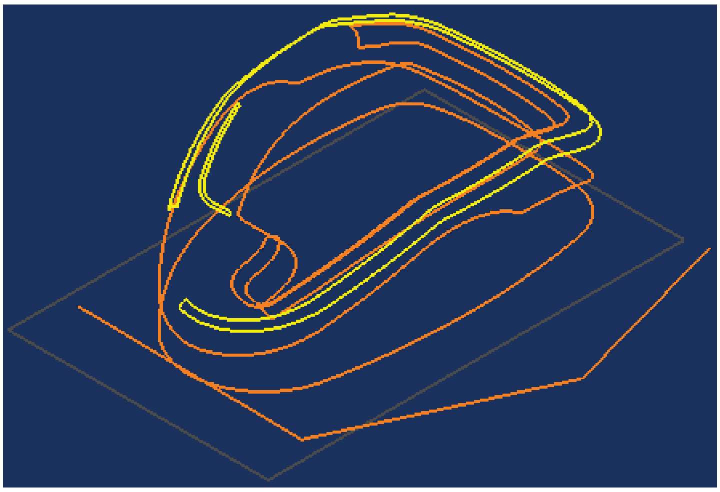
**Redo -** reinstates the edit you have just undone. This is the same as  on the **Curve editor** toolbar.

**Select all -** selects all the curves. This is the same as  on the **Curve editor** toolbar.



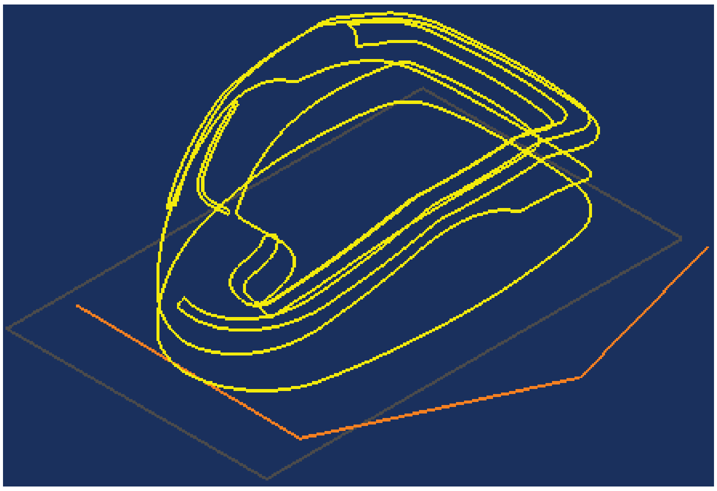
**Select toggle -** deselects the selected curves and selects the deselected curves. This is the same as  on the **Curve editor** toolbar.

Converts this:



to this:

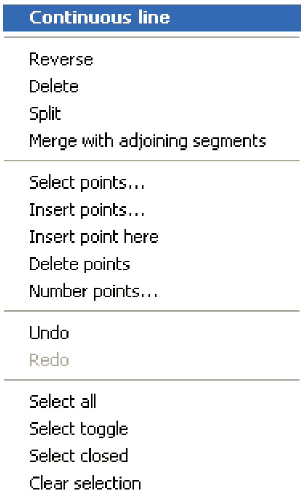
**Select closed -** selects all the closed curves and deselects the open curves. This is the same as  on the **Curve editor** toolbar.



**Clear selection -** deselects the selected curves.

## Continuous line menu

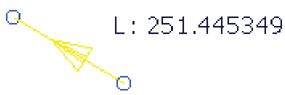
The **Continuous line** context menu is raised by right clicking on a continuous line when the **Curve editor** toolbar is raised.




**Reverse -** reverses the direction of the selected items. This is the same as  on the **Curve editor** toolbar.

Converts this:


to this:



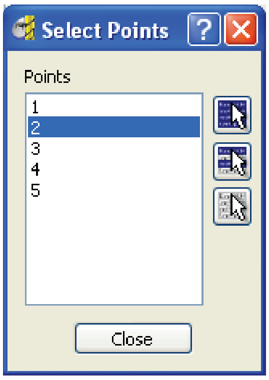
**Delete selected -** deletes the selected line. This is the same as  on the **Curve editor** toolbar.

**Split -** breaks the selected segments into the individual curves used to create the curves.

**Merge with adjoining segments -** merges all the segments adjacent to the picked segment. The curve editor automatically searches for segments that join the picked segment, at either end, and merges them. The search then starts again on this new segment, to see if any segments join it. If they do, then they are merged. This continues until no more merges are possible. Where there is a choice of curves to merge, the curve with the smallest tangent angle discrepancy is chosen. This is the same as  on the **Curve editor** toolbar.

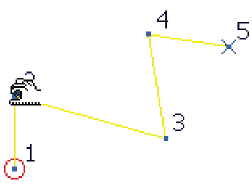
**Select points -** selects points which you can then edit or delete. This is the same as  on the **Curve editor** toolbar.

Displays the **Select Points** dialog (see page 50).




You can select a point by either:

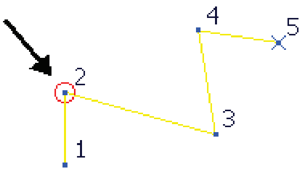
- Selecting it graphically.




or:

- Selecting it from the **Select Points** dialog.

A red circle is placed on the selected point.



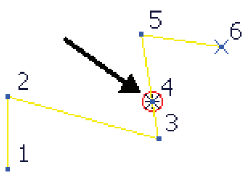
*You can select additional points graphically using the Shift key. You can deselect points using the Ctrl key. Shift plus a drag box selects all the points in the box and Ctrl plus a drag box deselects all the points in the box.*

**Insert points** (see page 51) **-** adds a point between a pair of selected points.This is the same as on the **Curve editor** toolbar.

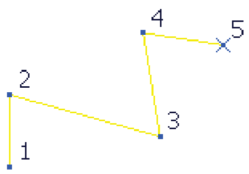
**Insert points here -** adds a point where you selected the continuous line. This is the same as on the **Curve editor** toolbar and then selecting the **Through nearest point** tab on the **Insert Point into Curve** dialog (see page 51).

**Delete points -** deletes the selected point. This is the same as on the **Curve editor** toolbar.

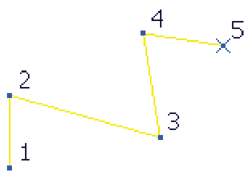
Converts this:




To this:



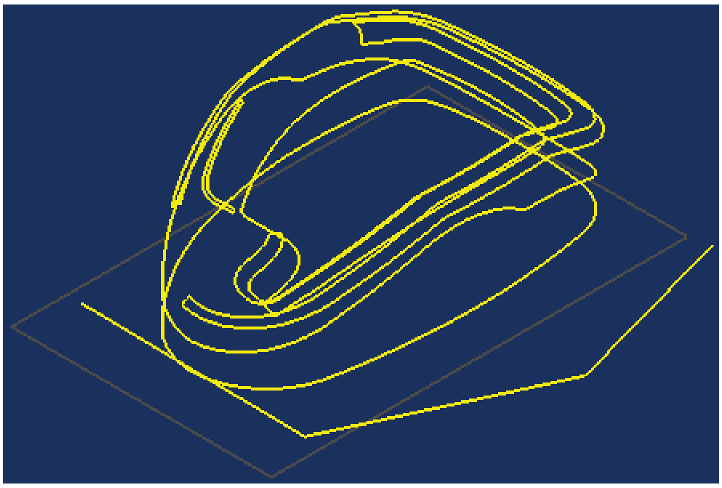

**Number points -** numbers the points on the selected curve. This is the same as on the **Curve editor** toolbar.




**Undo -** reverts to what it was before the last change. This is the same as on the **Curve editor** toolbar.

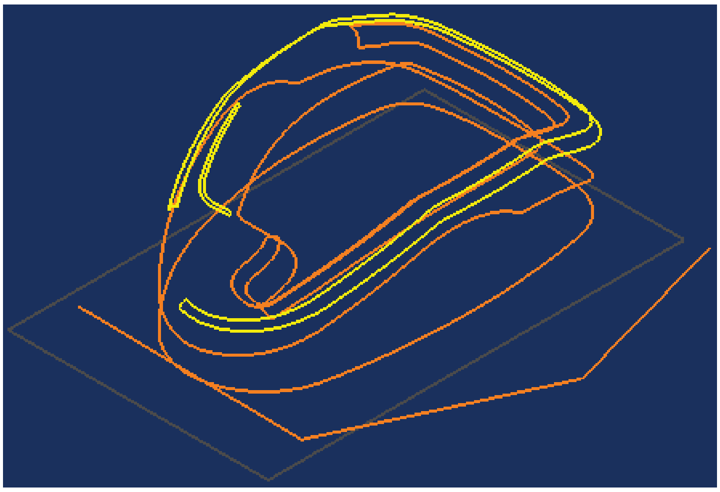
**Redo -** reinstates the edit you have just undone. This is the same as on the **Curve editor** toolbar.

**Select all -** selects all the curves. This is the same as  on the **Curve editor** toolbar.



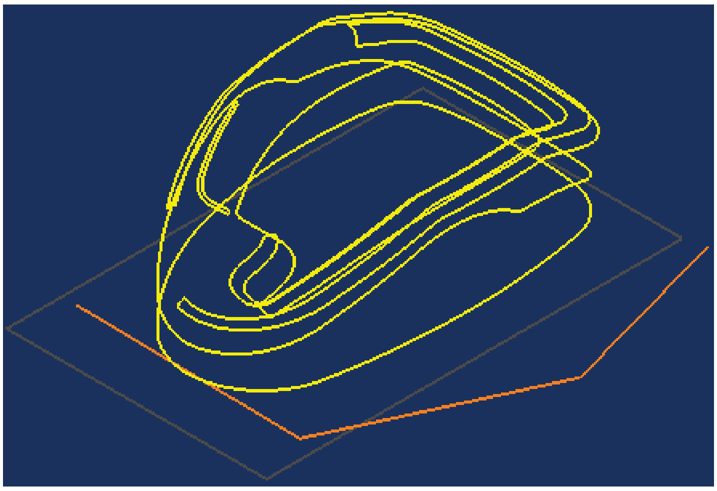
**Select toggle -** deselects the selected curves and selects the deselected curves. This is the same as  on the **Curve editor** toolbar.

Converts this:



to this:

**Select closed -** selects all the closed curves and deselects the open curves. This is the same as  on the **Curve editor** toolbar.



**Clear selection -** deselects the selected curves.

# Boundary improvements

There are several improvements to 3D offsetting of boundaries.

- The calculation is run in multiple threads. So it is noticeably faster on multi-core machines.
- You can now create two types of boundary offsets (see page 72):

**Offset 3D (Smooth) -** offsets a 3D boundary by a specified distance. A positive value offsets the boundary outwards, a negative valued offsets the boundary inwards.

**Offset 3D (Round Corners) -** this is very similar to **Offset 3 (Smooth)** except that the offset pattern isn't smoothed. This was the only option available in previous versions.

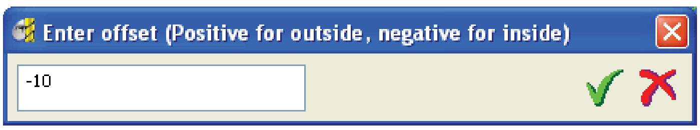
There is a new option on the **Silhouette Boundary** dialog (see page 73) of **Vertical Tolerance** which prevents spikes occurring on/near vertical surfaces.

## Smooth 3D boundary offsets

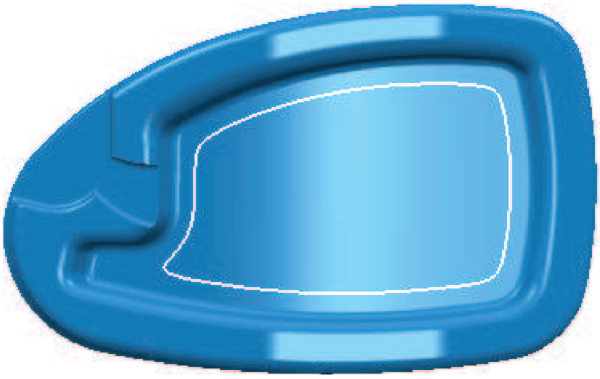
You can now create two types of boundary offsets from the individual boundary context menu, and selecting **Edit > Offset 3D (Smooth)** or **Edit > Offset 3D (Round Corners)**.

Starting with **5axisModel.dgk** in the examples file with a selected surface boundary:

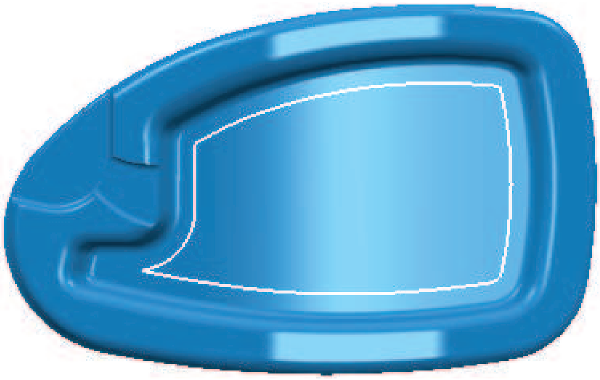
You are then asked for an offset distance.



The **Offset 3D (Smooth)** boundary becomes:

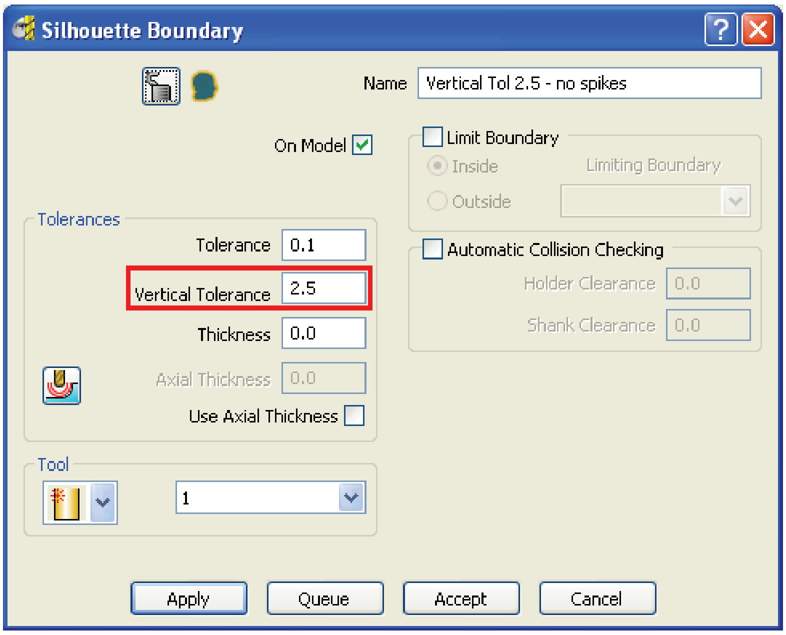


The **Offset 3D (Round Corners)** boundary becomes:

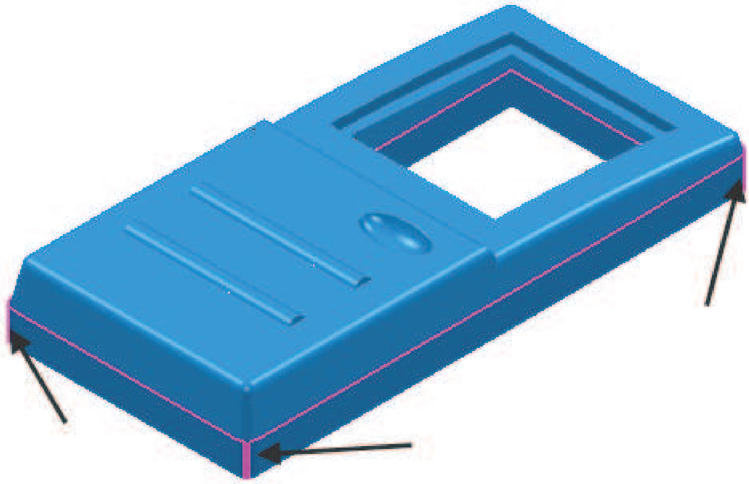


## Silhouette boundary improvements

When creating silhouette boundaries on near-vertical surfaces, very spiky boundaries are sometimes produced. There is a new option on the **Silhouette Boundary** dialog of **Vertical Tolerance** which prevents these spikes occurring.

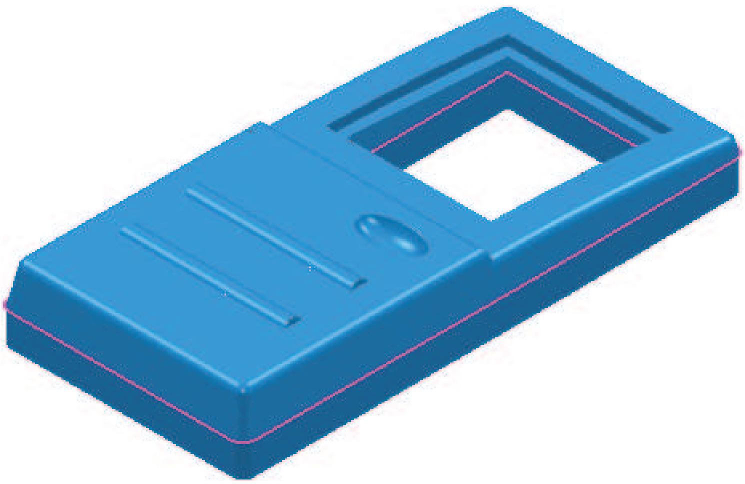


**Vertical Tolerance -** 0:



This is theoretically correct as the silhouette boundary is where the tool touches the outside edge of the model when viewed from above, but isn't what you want.

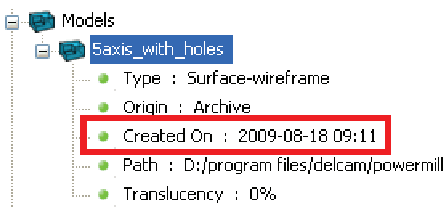
**Vertical Tolerance -** 0.2:



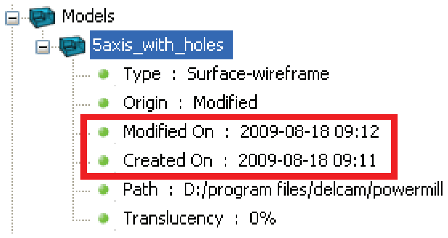
*The* **Vertical Tolerance** *must be less than the tool radius.*

# Date on Models

Models now have a date showing when they were imported into the project. This is displayed in the explorer:

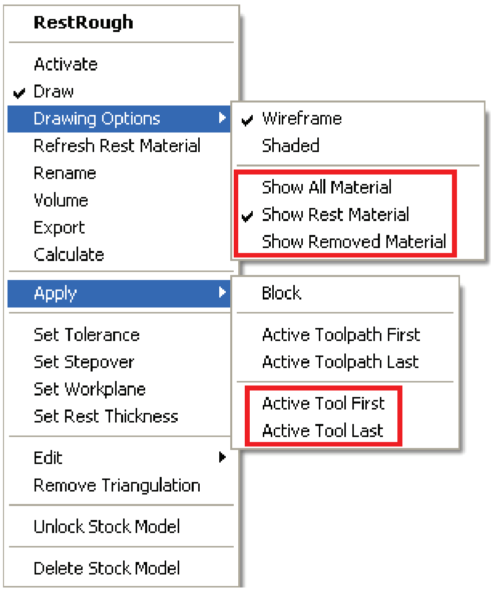


If you edit the model, a modified date is also displayed:




# Stock model enhancements

There are additional options to the individual stock model menu.

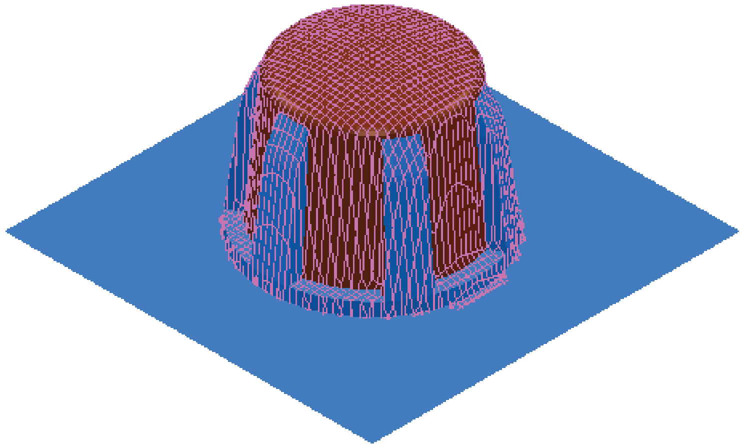



The **Drawing Options** menu has three additional options:

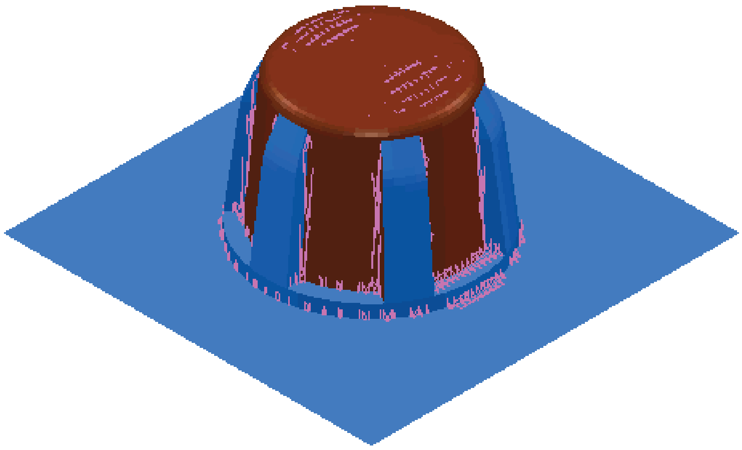
**Show All Material -** shows the underlying stock model.

**Show Rest Material -** compares the stock model with the actual model. It shows the areas of the stock model where additional material is present to a thickness greater than the **Rest Thickness**. This is useful to indicate where excessive material has been left on, especially to spot areas on a vertical face where the stepover was set so that it just got missed. This option has moved from the main individual stock model context menu to the **Drawing Options** menu.

Taking a stock model of a couple of finishing toolpaths:

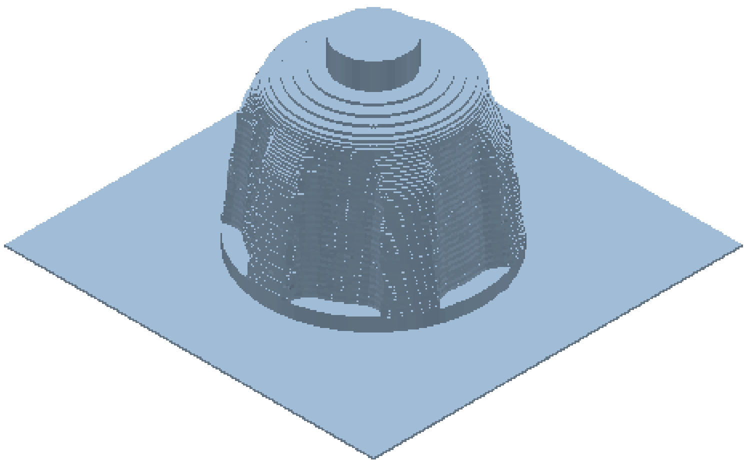


If you **Show the Rest Material** you can see where excess material still remains:

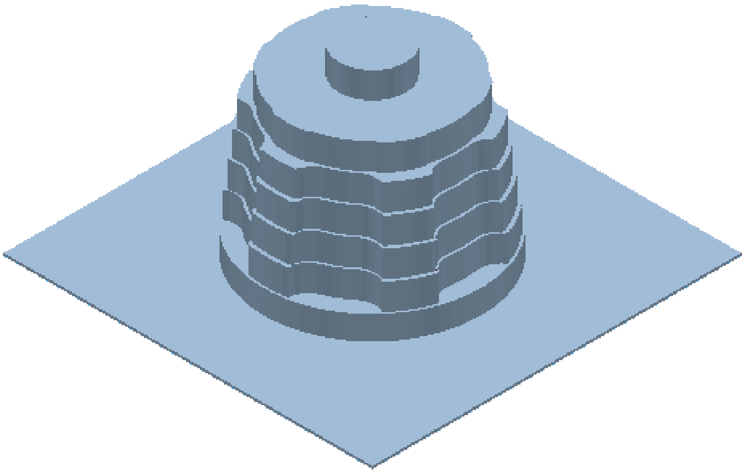


**Show Removed Material -** shows the stock that has been removed by the active stock model state. It is the difference between the stock remaining after the current state is taken away from the stock remaining after the previous state.

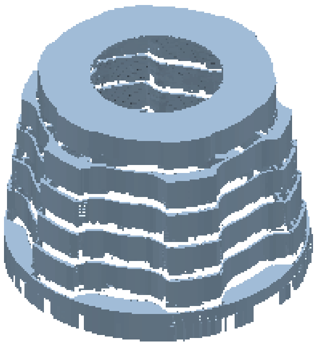
If the current state has a stock model of:



and the previous state has a stock model of:



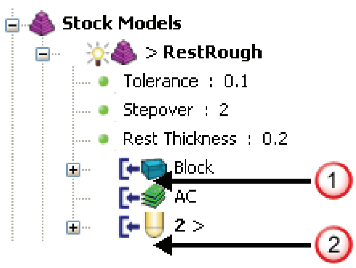
then **Show Removed Material** displays:



The **Apply** menu has two additional options:

**Active Tool First -** removes all material accessible by the tool in 3-axis and places the tool state at the top of the stock model list. If the stock model is newly created (no block has been applied) then the block is applied automatically.

**Active Tool Last -** removes all material accessible by the tool in 3-axis and places the tool state at the bottom of the stock model list. If the stock model is newly created (no block has been applied) then the block is applied automatically.



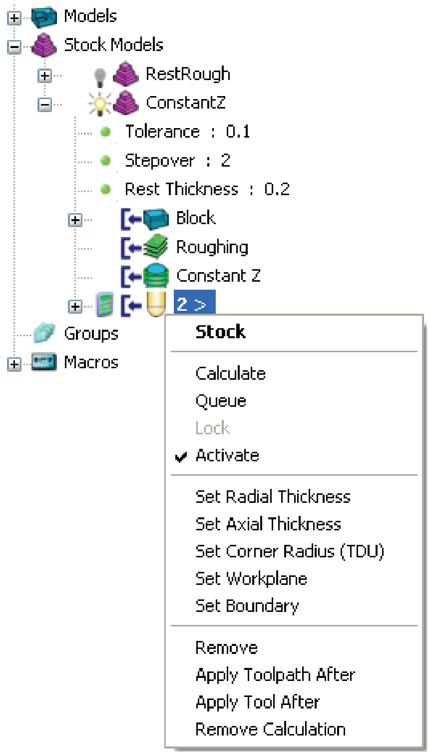

1 - insertion point if you select **First**.

2 - insertion point if you select **Last**.

The ability to add a tool to the stock model has introduced a new Stock Models tool state menu (see page 78).

## Stock Models tool state menu

The stock model tool state menu controls the state of the entities in the stock model.




**Stock -** this is the name of the menu.

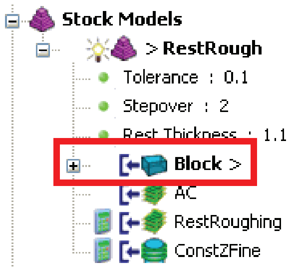
**Calculate -** calculates the stock model state.

**Queue -** checks that all the parameters used to calculate the stock model are acceptable, adds the stock model to the calculation queue and closes the dialog. The stock model is calculated in the background when PowerMILL would otherwise be idle.

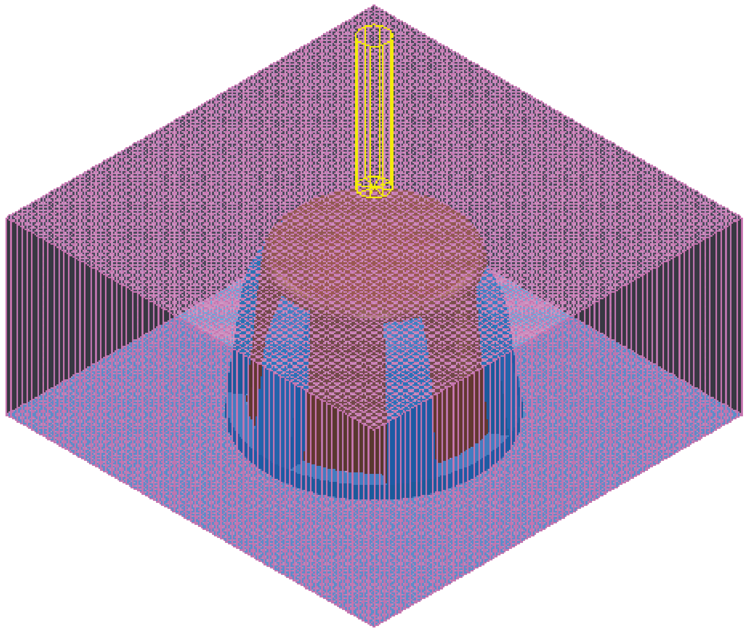
**Lock -** locks the tool so that you cannot edit the tool settings. If you try to edit the tool settings (from the **Settings** option of the individual tool context menu and then editing a value) you will see an error message.

**Activate -** becomes the active stock model state. If the stock model has been calculated, then you will see the state of the stock model after this entity has been applied. If you cannot see the stock model then you need to **Calculate** the stock model (from the individual context menu).

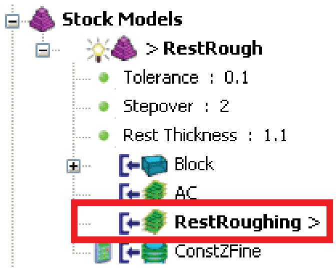
When the **Block** is activated:



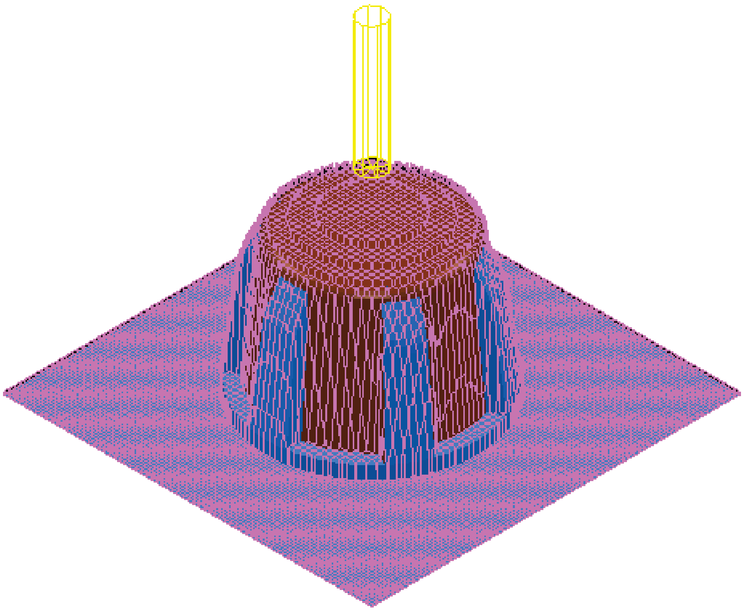

You will see the stock model of the block:



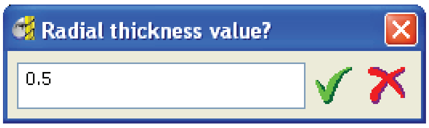
Similarly, when the **Rest Roughing** toolpath is activated:



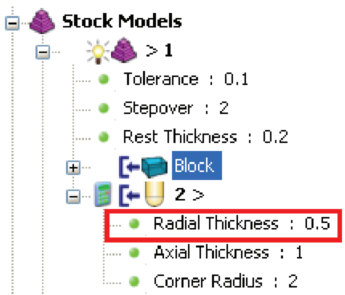
You will see the stock model after the rest roughing toolpath has been calculated:



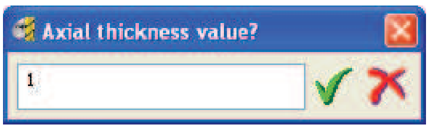
**Set Radial Thickness -** the radial thickness that is used to define the stock model state. You can't change this value after the stock model state has been calculated.



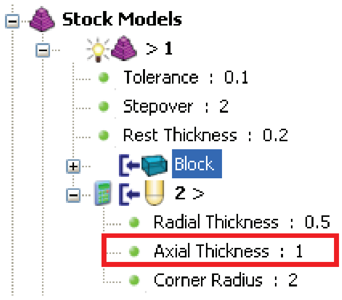

Enter a thickness and click .



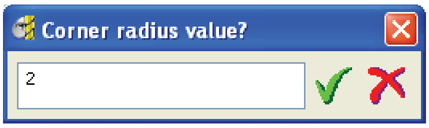

**Set Axial Thickness -** the axial thickness that is used to define the stock model. You can't change this value after the stock model state has been calculated.



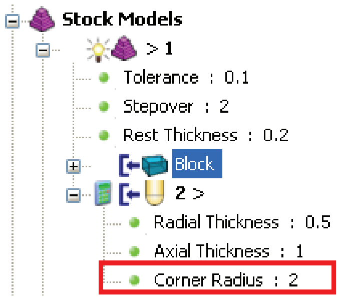
Enter a thickness and click ✓.



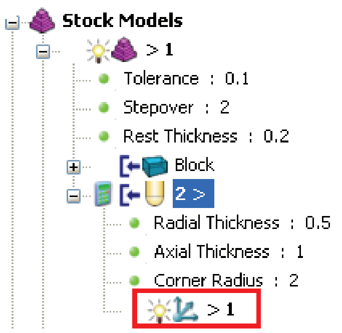

**Set Corner Radius (TDU) -** the corner radius that is used to define the stock model. You can't change this value after the stock model state has been calculated.



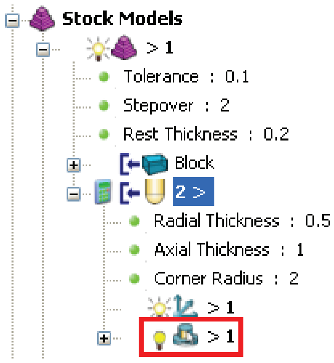

Enter a radius and click ✓.




**Set Workplane -** uses the active workplane to define the stock model state. If there is no active workplane, then any that has previously been set for this state will be removed. You can't set or change the workplane after the stock model state has been calculated.



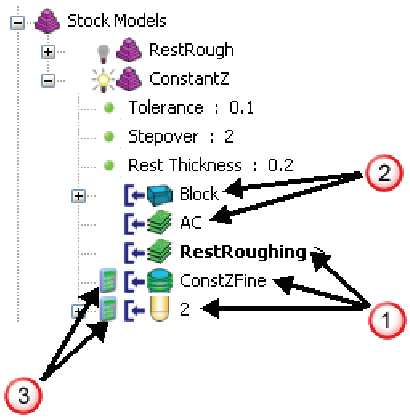
**Set Boundary -** uses the active boundary to define the stock model state. If there is no active boundary, then any boundary that has previously been set for this state will be removed. You can't set or change the boundary after the stock model state has been calculated.




**Remove -** removes this state from the stock model. This will only work if the tool is unlocked.

**Apply Toolpath After -** applies the active toolpath and places the toolpath after this tool state in the stock model list. This only works if the tool is unlocked.

If the **AC** and **RestRoughing** toolpaths are calculated but the **ConstZFine** toolpath is not then you can use the **Apply Toolpath After** option on the **RestRoughing** or **ConstZFine** toolpaths, but not on the **AC** toolpath or the **Block**.



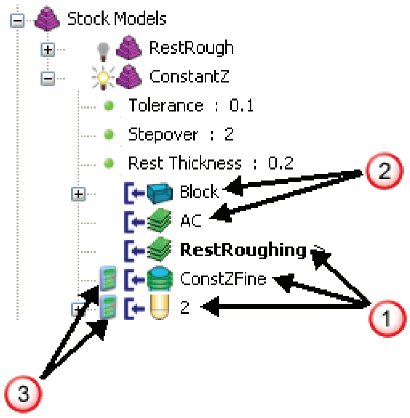

1 - toolpaths can be added after these states.

2 - toolpaths cannot be added after these states.

3 - not calculated.

**Apply Tool After -** applies the active tool and places the tool after this tool state in the stock model list. This only works if the tool is unlocked.

If the **AC** and **RestRoughing** toolpaths are calculated but the **ConstZFine** toolpath is not, then you can use the **Apply Toolpath After** option on the **RestRoughing** or **ConstZFine** toolpaths, but not on the **AC** toolpath or the **Block**.




1 - tool can be added after these states.

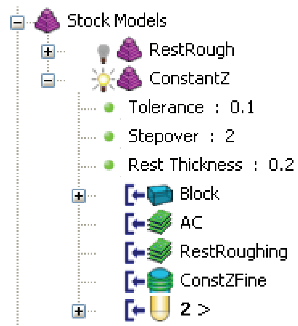
2 - tools cannot be added after these states.

3 - not calculated.

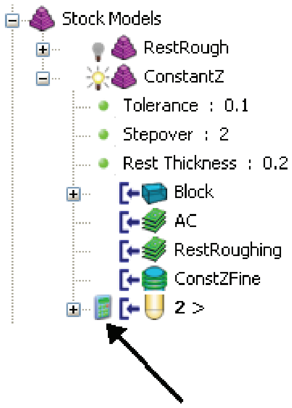
**Remove Calculation -** removes the calculation. It leaves everything else alone, so the stock model definition remains the same, but the pink stock model mesh (or the shaded stock model) disappears.

*If you remove the calculation of every state (you can do this by just removing the calculation of the block), then you are free to edit the stock model parameters (tolerance, stepover, workplane…). In this way, you can generate a stock model at different tolerances without having to reapply the toolpaths.*

Converts this:



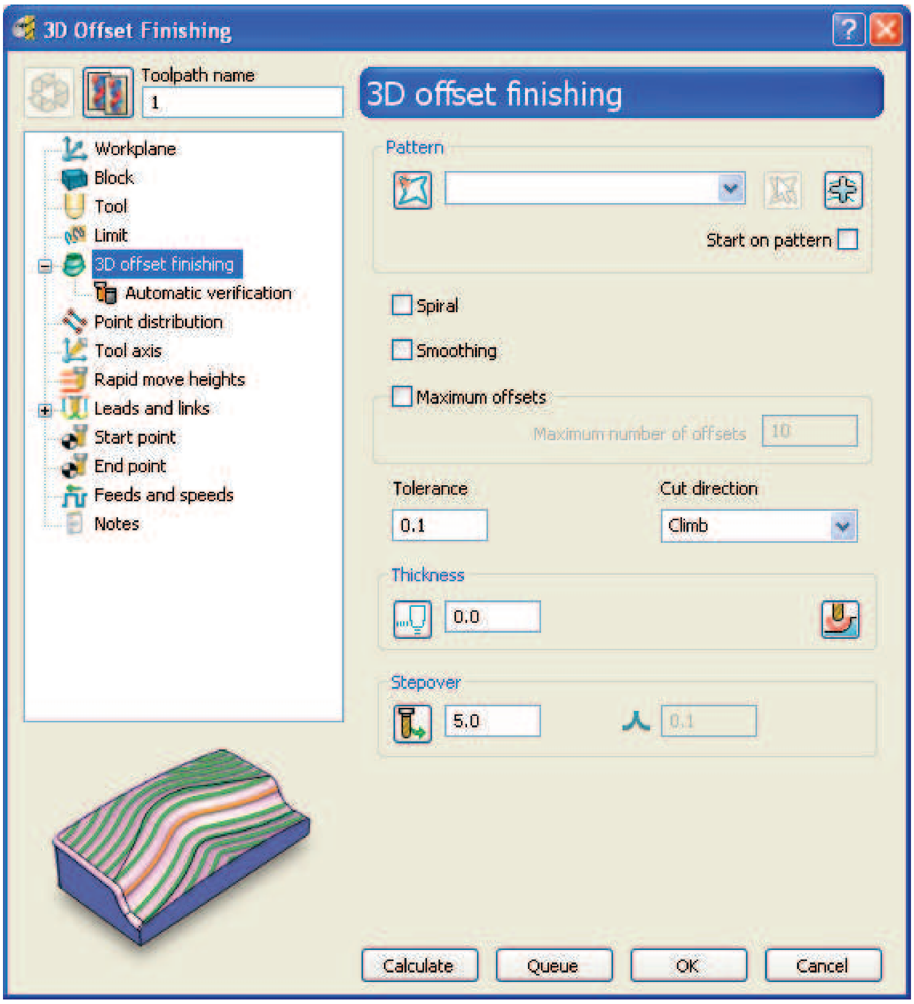
to this:


Stock Models
RestRough
ConstantZ
Tolerance : 0.1
Stepover : 2
Rest Thickness : 0.2
Block
AC
RestRoughing
ConstZFine
2 >

# Toolpath generation

## New machining strategy dialog

Many of the existing machining strategies now use the new style machining strategy dialog. This is a tabbed dialog where the pages are selected from the tree in the left hand panel. It is simpler to use and provides an easier way to create toolpaths.



The idea is that:

- Each strategy has a few pages which are specific to that strategy, but the majority of pages are the same for all strategies.
- The pages are placed in the same order for all strategies.
- The page order reflects the work flow that you are likely to use. The workplane, block, and tool pages are all above the actual strategy page as you will want to define these before defining the specific strategy options. The expert pages are placed towards the bottom of the list.
- The tabbed dialog uses a tree to control the separate pages and includes a diagram to give a visual description of the function of that page.
- The tree in the tabbed dialog looks the same as that in the explorer, it has the same icons, labels, and order.

# Area Clearance strategies

Most of the area clearance dialogs now use the new style strategy dialog. As well as converting them to the new style, there has also been a change in the way strategies are displayed in the **Strategy Selector** dialog.

The main changes are:

- **Raster** and **Offset Model** area clearance strategies are now combined into one strategy called **Model Area Clearance**. You can choose between **Raster**, **Offset model**, and **Offset All** machining in the **Styles** area on the main page of the **Model Area Clearance** strategy. The sub-pages displayed depend on the options selected on the main page. For example, if you select **Raster** as the machining **Style**, then a **Raster** page is displayed.
- **Raster** and **Offset Feature Set** area clearance strategies are now combined into one strategy called **Feature Set Area Clearance**. As in the **Model Area Clearance** strategy, you can choose between the **Raster, Offset model,** and **Offset Styles** of feature machining.
- There are separate **Rest** area clearance strategies for models and feature sets which contain rest machining options.
- There are some changes to the profile and 2D curve area clearance dialogs to improve consistency between all the strategy dialogs.
- There is a new **Corner Clearance** strategy (see page 109).

- The feature set options are still available on the **2.5D Area Clearance** tab and the model options are still on the **3D Area Clearance** tab.
- **Plunge Milling** still uses the old style dialog.
- Area clearance strategies have been improved to avoid creating thin slivers of material (see page 88).
- Area clearance strategies have also been improved to have better start points, minimising rapid moves (see page 89).
- Surfaces with a collision status are now treated the same when area clearing and finishing. In both cases, the segments of toolpaths which don't touch the collision mode surfaces (up to a previously defined thickness) are machined and those which touch are filtered out. In previous versions this was true of finishing toolpaths but not area clearance ones.

## Sliver removal

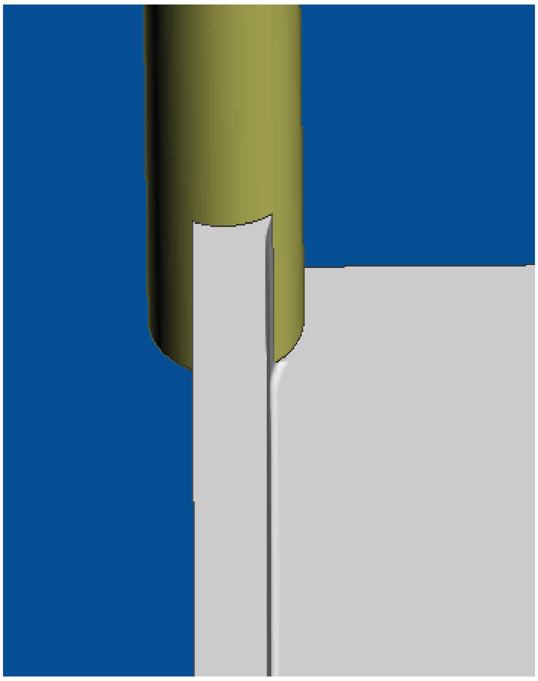
In PowerMILL 2010, area clearance strategies have been improved to avoid machining thin slivers of material which appear on the block edge towards the end of machining an area. Slivers occur when using the **Offset all** area clearance style with the **Maintain cut direction** option enabled.

Some offset area clearance toolpaths have a tendency to start machining from the innermost offset and finish with the outermost offset, which is usually in contact with the block edge. It is common to end up with a thin sliver of material to machine at the edge of the block. These thin slivers of material can damage both tool and stock edges and is an unwanted characteristic of area clearance strategies.

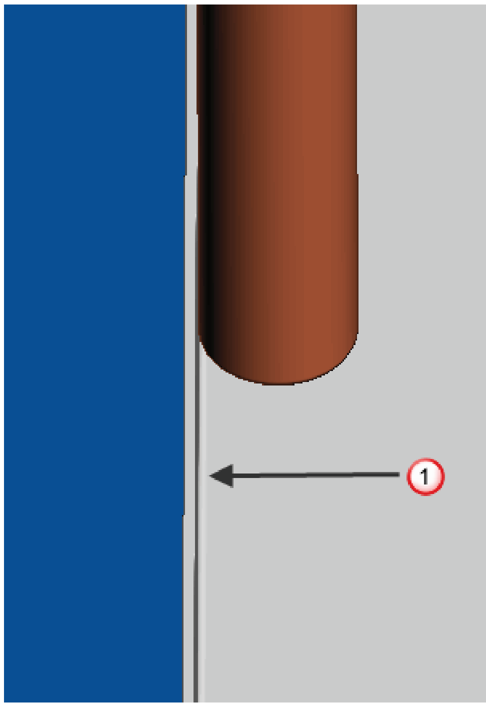
PowerMILL 2010 prevents these thin slivers and adjusts the stepover to ensure a reasonable amount of material is removed with the last pass.

Comparing a toolpath created in PowerMILL 10.0 with a toolpath created in PowerMILL 2010:

### In PowerMILL 2010



### In PowerMILL 10.0




1 - Sliver of left over material.

In PowerMILL 2010, the improved strategy creates toolpaths that avoids creating thin slivers of material.

## Toolpath start points and ordering

Area clearance toolpaths are more efficient and better structured.

The significant improvements are:

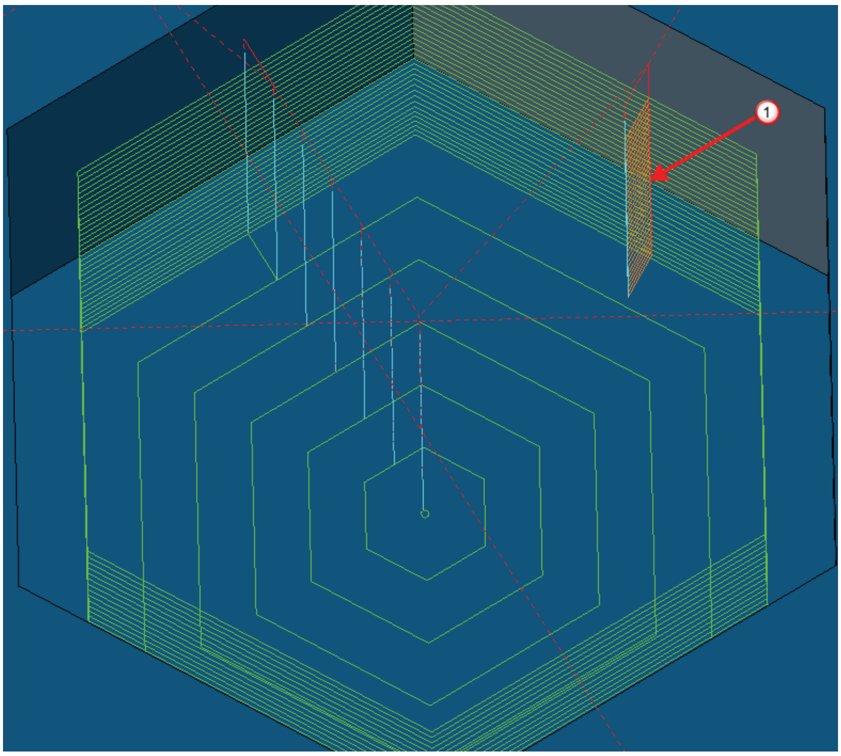
- Improvements to toolpath ordering when rest roughing areas. This significantly reduces the length of rapid moves between areas.
- General improvements to toolpath ordering in related drilling and curve profiling strategies.
- In rest roughing toolpaths, the positioning of start points on closed toolpath segments are much improved.

  For example, in previous PowerMILL versions, when thickness on a rest roughing toolpath was reduced in comparison to the reference toolpath, it created large numbers of closed segments with start points placed randomly. This resulted in inefficient toolpaths. In PowerMILL 2010, the start points are positioned as close as possible to the end point of the previous segment, reducing the length of rapid moves.

  *This change only affects closed toolpath segments in rest roughing, typically when the thickness has been reduced.*

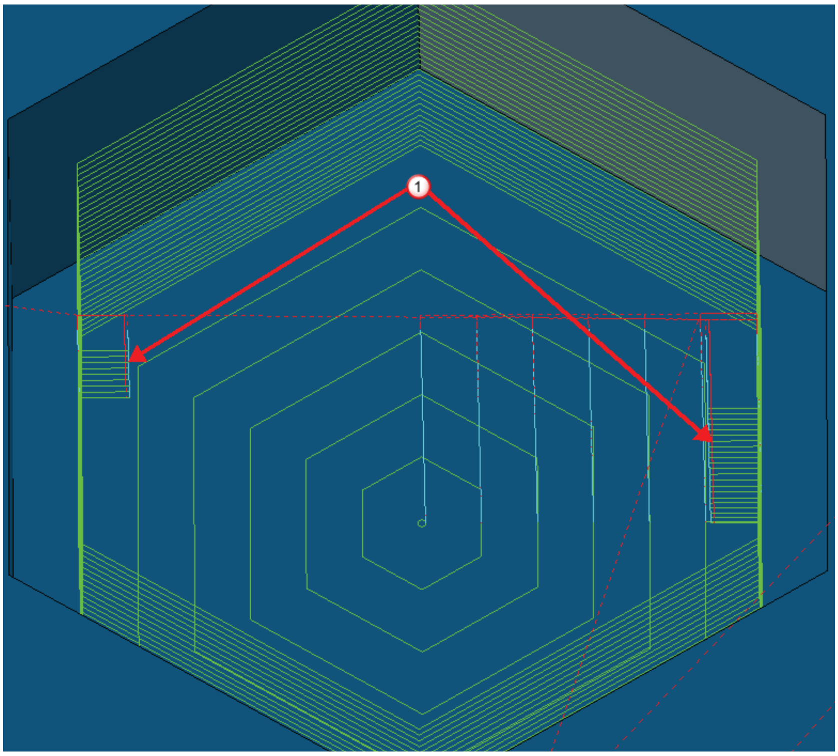
Comparing toolpaths from PowerMILL 10.0 and PowerMILL 2010:

### PowerMILL 2010 toolpath




1 - Toolpath start points in PowerMILL 10.0

### PowerMILL 10.0 toolpath




1 - Toolpath start points in PowerMILL 2010

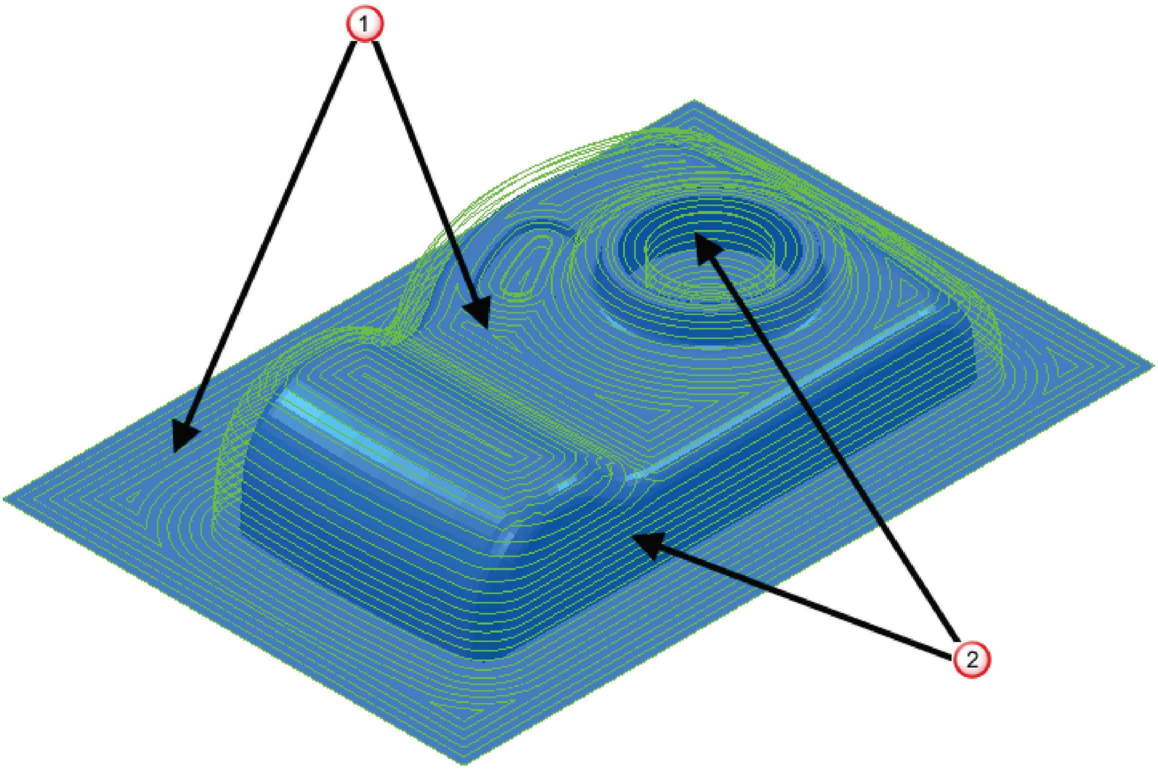
# Steep and shallow finishing - overview

There is a new **Steep and shallow finishing** strategy which calculates a shallow boundary, and then creates **Constant Z** toolpath in the steep areas of a model and **Raster** or **3D offset** toolpath in the shallow areas.

This replaces **Interleaved constant Z finishing** in previous versions which only allowed 3D offsets in the shallow areas.

This differs from **Optimised constant Z finishing** as you can specify the angle to change from 3D offset machining to constant Z machining.

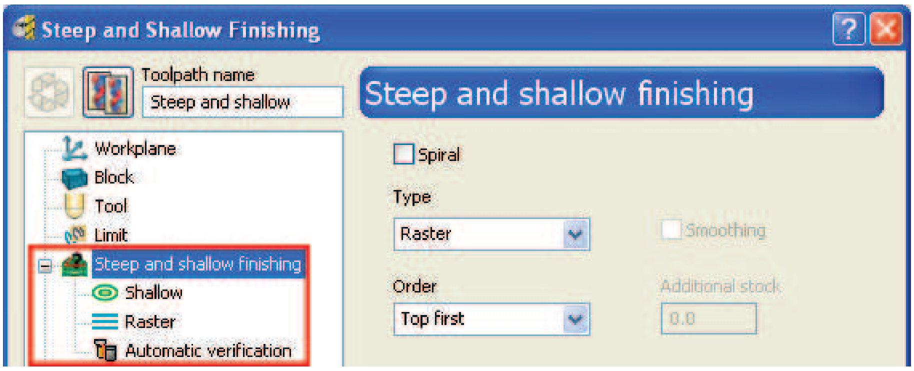
The addition of **Wall clearance** on the **Raster** page (see page 102) can be used to prevent dwell marks on the steep areas. This means that you no longer have to apply a thickness to steep walls.




1 - Shows the **3D Offset** toolpath in the shallow areas.

2 - Shows the **Constant Z** toolpath in the steep areas.

There are three tabs associated with **Steep and shallow finishing**:

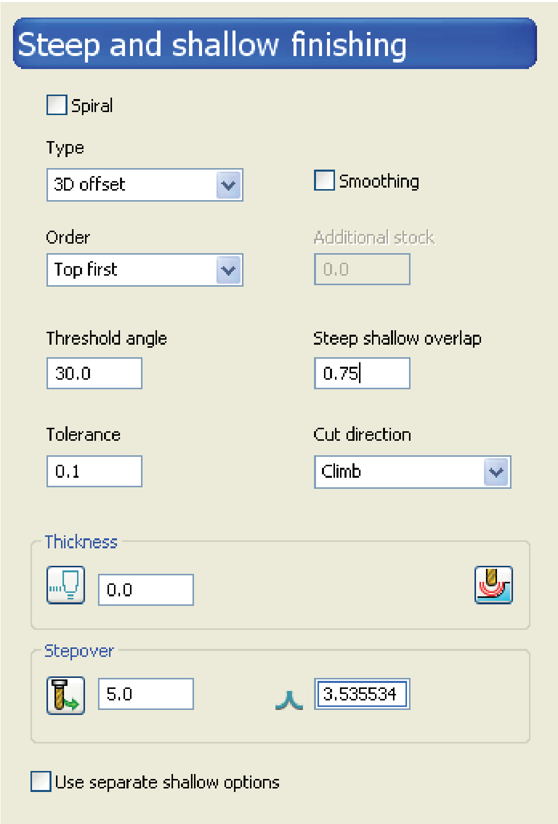



- **Steep and shallow finishing** (see page 92) **-** the main page used to define a steep and shallow finishing toolpath.
- **Shallow** (see page 100) **-** defines the options for the shallow portion of the toolpath. This page is only available if you select **Use separate shallow options**.
- **Raster** (see page 102) **-** defines the raster options for the toolpath. This page is only available if you select a **Type** of **Raster**.

- **Automatic verification** (see page 105) **-** enables automatic verification of toolpaths on creation.

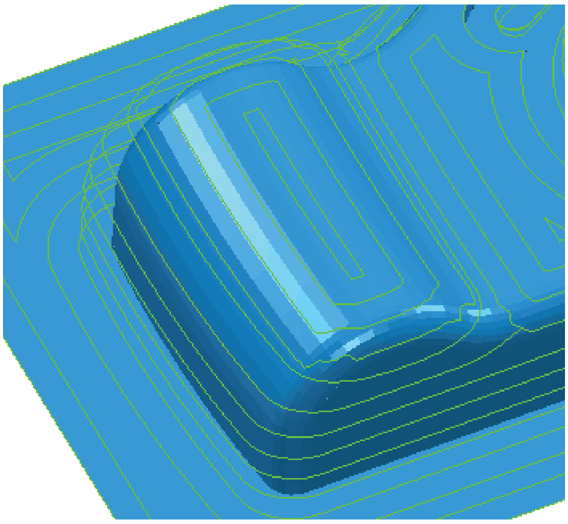
## Steep and shallow finishing

**Steep and shallow finishing** strategy creates a **Constant Z** toolpath in the steep areas of a model and a **3D offset** or **Raster** toolpath in the shallow areas. This differs from **Optimised constant Z finishing** as you can specify when to change from 3D offset machining to constant Z machining using the **Threshold angle** field, and you can specify an **Overlap** where both steep and shallow toolpaths are created.

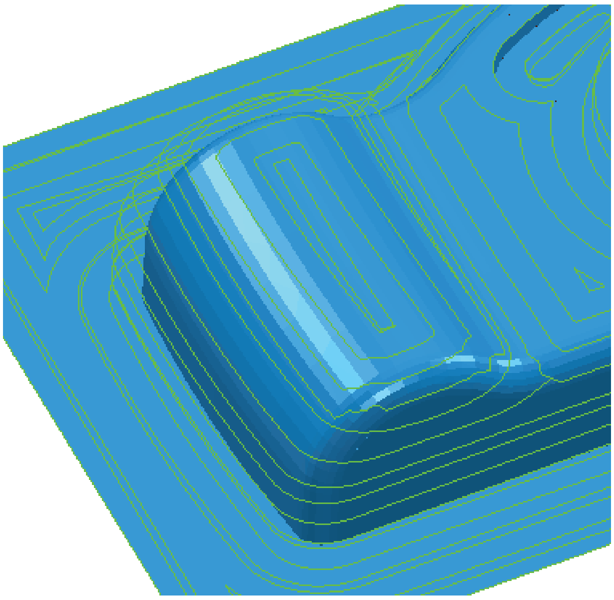



Also, optimised constant Z finishing only uses whole segments, whereas steep and shallow finishing will split segments at the shallow boundary. This means that steep and shallow finishing toolpaths have far more retracts than optimised constant Z toolpaths.

**Spiral -** produces a spiral path between two consecutive closed contours. This minimises the number of lifts of the tool and maximises cutting time while maintaining more constant load conditions and deflections on the tool. It converts this:

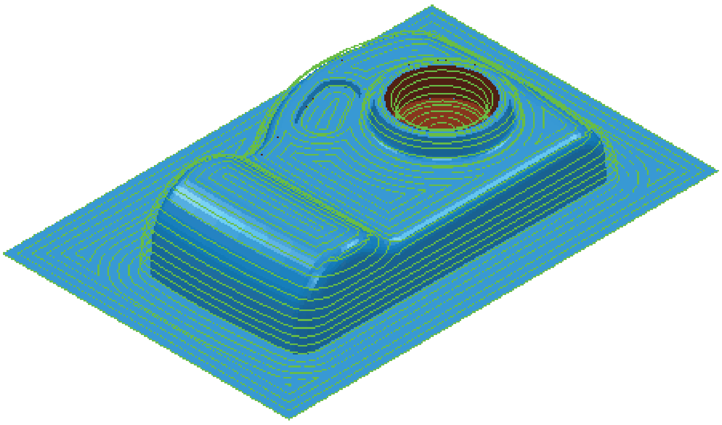


to this:

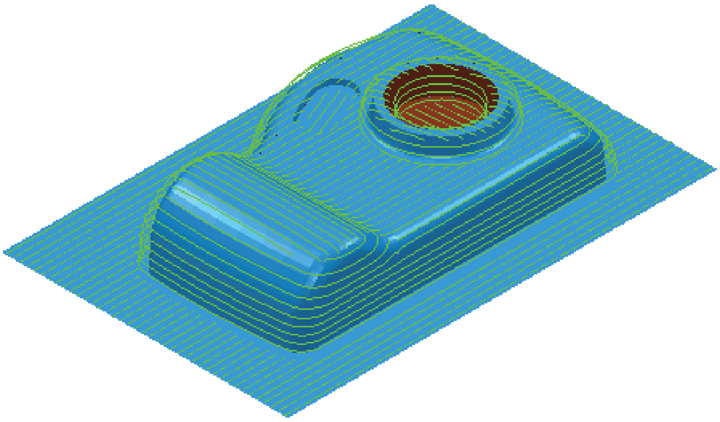


**Type -** determines whether a **Raster** or **Offset** toolpath is created in the shallow regions.

**Type - Offset**



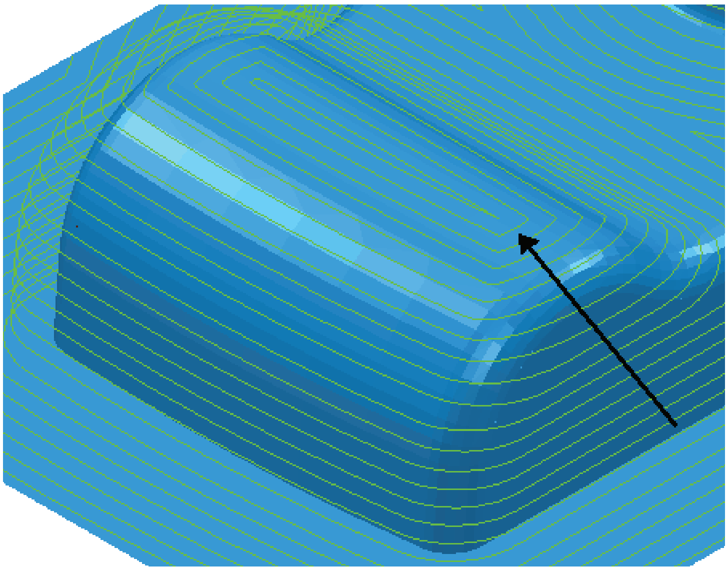
**Type - Raster**



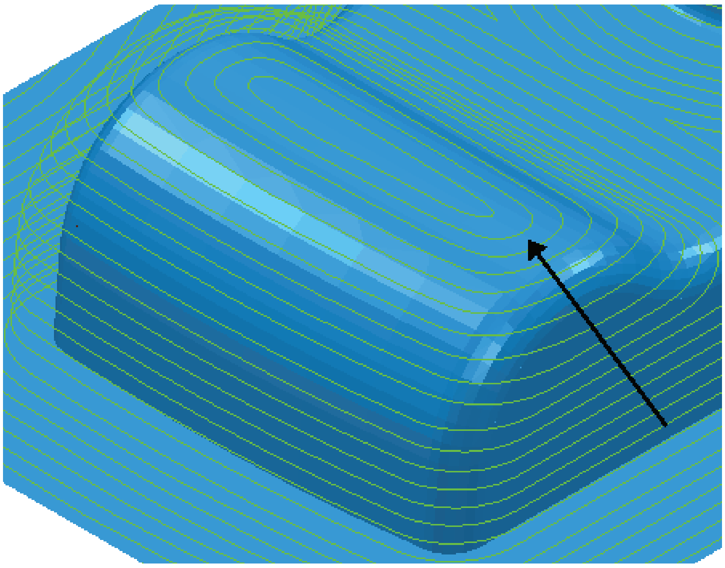
*As a general rule, use raster on open edged parts and 3D offsets at the bottom of a pocket.*

**Smoothing -** smooths offsets of toolpath segments over the model.

Selecting the **Smoothing** option converts this:



to this:



*This option is only available if you have a* ***Type*** *of* ***3D offset****.*

**Order -** determines the order in which the steep and shallow portions are machined.

**Top First -** machine from the top regions downwards. If you have a boss, the shallow regions at the top of the boss are machined before the constant Z sections (steep regions) down the sides.

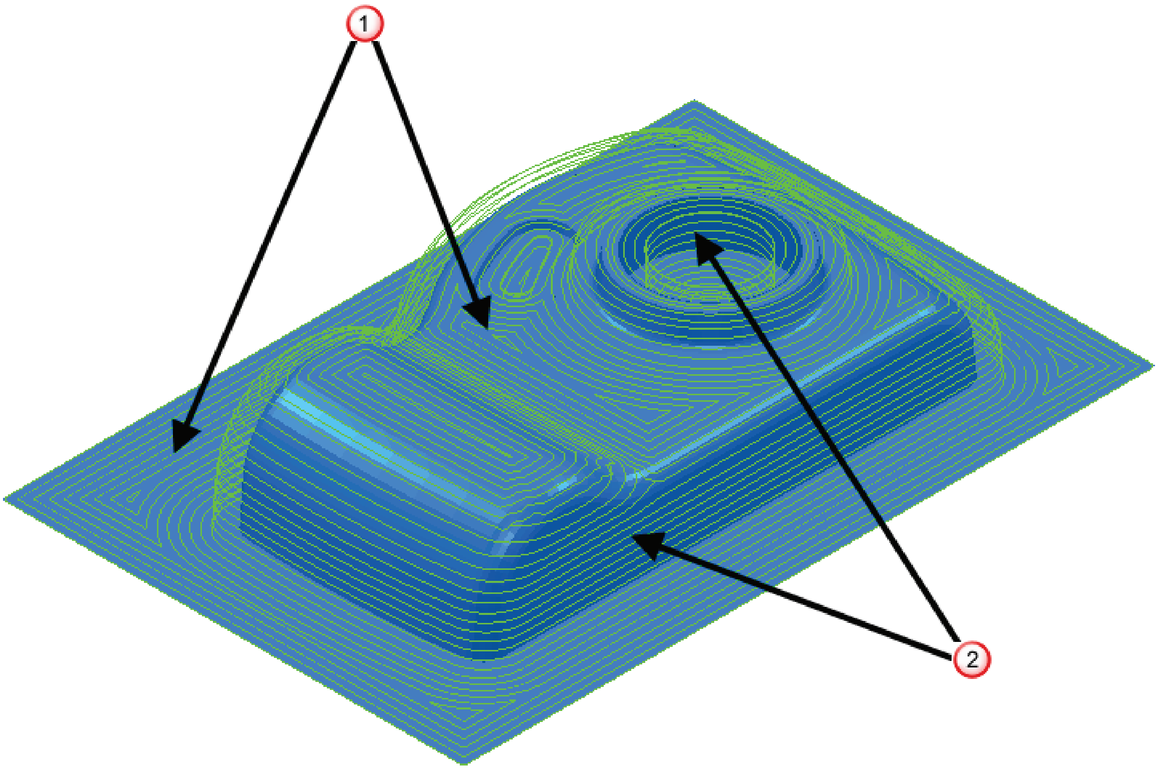
**Steep First -** machines the steep sections before the flat. If you have a boss, the constant Z sections (steep regions) are machined before the shallow regions.

**Additional stock -** aids ordering when machining between two steep walls. It produces a safe order with the level of stock specified here. Providing the passes are within the distance specified, an alternating toolpath is created, machining at one Z height on one wall, and then at the same Z height on the neighbouring wall before descending to the next Z height.

*If the* ***Additional stock*** *is zero then a default value of one tenth of the tool radius is used.*

*This option is only available if you have an* ***Order*** *of* ***Steep first****.*

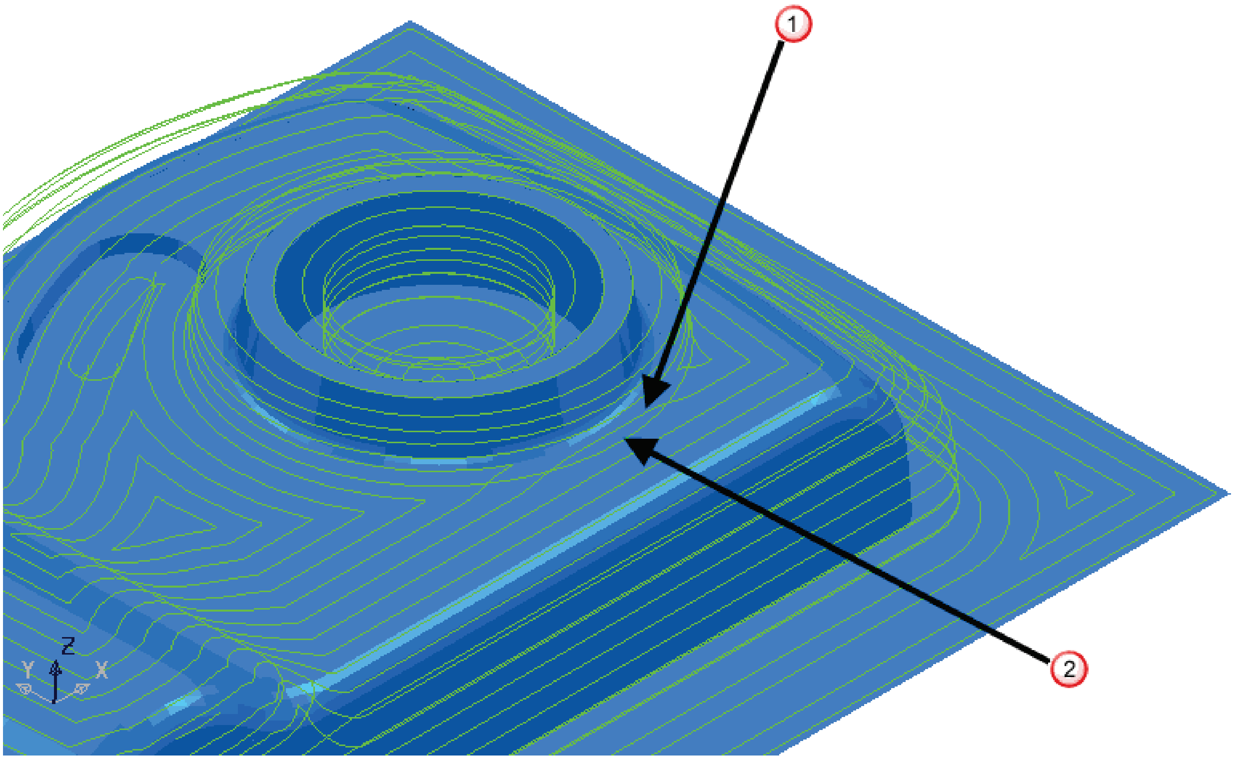
**Threshold angle -** the surface slope, measured from the horizontal, that determines the split between constant Z (steep) and shallow machining.




1 - Shows the **3D Offset** toolpath in the shallow areas.

2 - Shows the **Constant Z** toolpath in the steep areas.

**Steep shallow overlap -** the size of the overlap area where constant Z (steep) and shallow machining occur. This minimises marks on the model caused by a sudden switch from constant Z to shallow machining.




1 Shows the **3D Offset** toolpath overlapping into the steep areas.

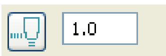
2 Shows the **Constant Z** toolpath.

**Tolerance -** determines how accurately the toolpath follows the contours defined by the model.

**Cut direction -** determines the milling strategy.

> **Climb -** creates toolpaths using only climb milling.
>
> **Conventional -** creates toolpaths using only conventional or 'upcut' milling.
>
> **Any -** creates toolpaths using both conventional and climb milling, as appropriate. This minimises the tool lifts and tool travel.

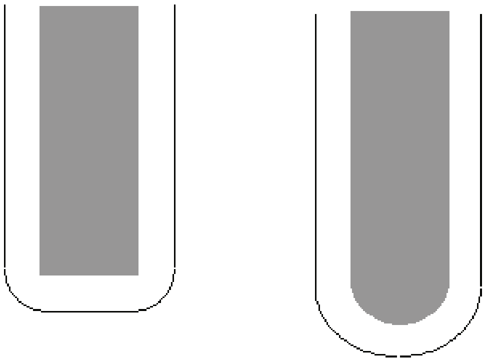
**Thickness -** specifies the amount of material to be left on the part, within tolerance.



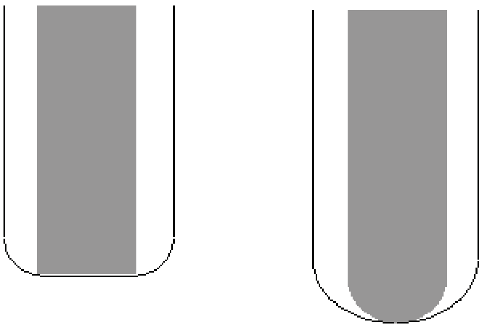
- clicking the **Thickness**  button changes the **Thickness** field to **Radial thickness**  and the **Axial thickness**  field appears. Now you can specify separate **Radial** and **Axial thickness** values 

.

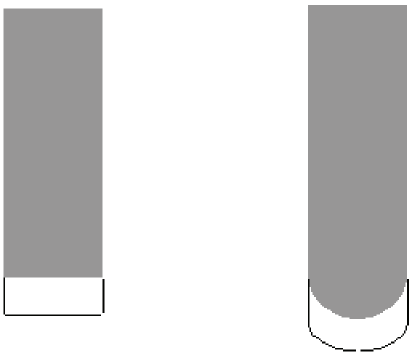
 **Thickness -** applies the thickness as an offset to the tool in all directions:



 **Radial thickness -** applies the thickness as an offset to the tool radially. This can be useful where you want to leave material on vertical walls.

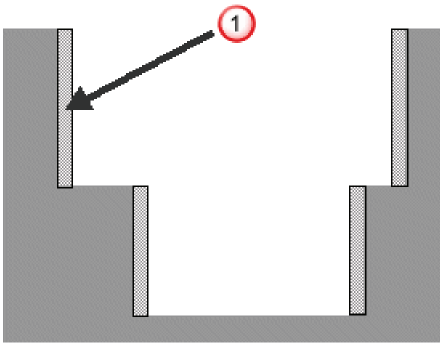


 **Axial thickness -** applies the thickness as an offset to the tool, in the tool axis direction only. This controls the tip position of the tool used for machining, relative to the tool defined in PowerMILL.



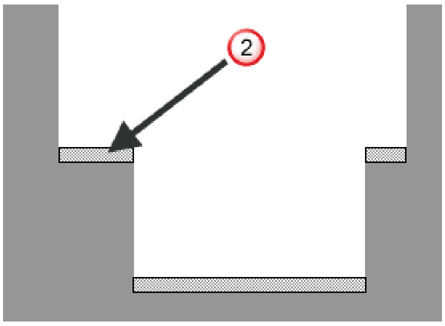
Variable thickness (that is to say, separate **Radial** and **Axial thickness** values) is particularly useful for orthogonal parts. It is possible to use variable thickness on sloping walled parts, although it is more difficult to predict the results.

In thin-walled aerospace parts, you may want the area clearance toolpath to finish the floor of the pocket, but to leave material on the thin vertical walls. In this case, specify a positive **Radial thickness** value and an **Axial thickness** of 0:




1 - Radial thickness

Alternatively, you can also use this method to finish the steep side walls and leave material on the bottom. In this case, specify a **Radial thickness** of 0 and a positive **Axial thickness** value:

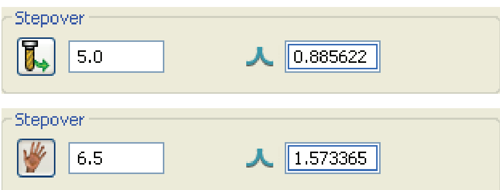



2 - Axial thickness

Typically, it is used on flat-bottomed parts with pockets.

*To avoid too much material being removed,* ***Thickness*** *should be greater than* ***Tolerance****.*

**Stepover -** the distance between successive machining passes.




**Set stepover from tool -** automatically defines the stepover from the tool geometry.

**Edited -** the value is entered by you (or another user). Click to change this to the automatically calculated value.

**Stepover -** the distance between successive machining passes.

*If you enter a* ***Stepover*** *value, then* *changes to* .

**Cusp height -** specify the desired maximum cusp height to determine the stepover. PowerMILL calculates the stepover value to give a cusp height of the machining tolerance using the current tool, when machining a plane inclined at 45°. This is the worst case cusp height for any given tolerance.

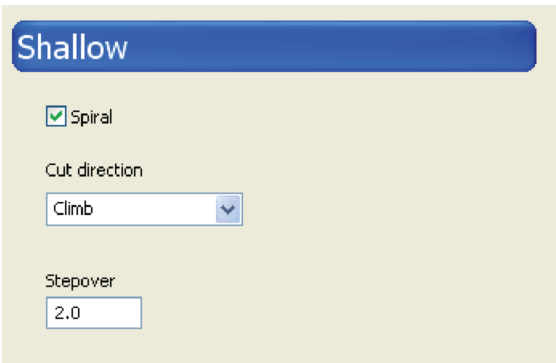
For more information see Linkage between stepover and cusp height (see page 124).

**Use separate shallow options -** allows you to define a different stepover for the steep and shallow portions of the toolpath. Normally, the stepover is defined by the **Stepover** field on the left hand side of the dialog. If you select this option, then only the steep (or Constant Z) portion of the toolpath is defined by the **Stepover** field on the left hand side of the dialog.

*When 3D offsetting the bottom of a pocket, PowerMILL machines from outside, inwards. However, when machining the top of a boss (an area with no steep regions above it) PowerMILL machines from inside, outwards.*

## Shallow

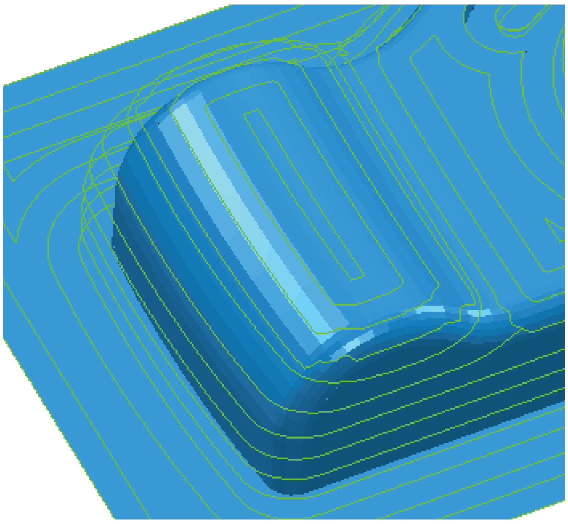
**Shallow** defines different spiral options, cut directions, and stepover values for the shallow and steep portions of the toolpath. The shallow portion of the toolpath is defined by the **Stepover** field on the left hand side of the dialog.



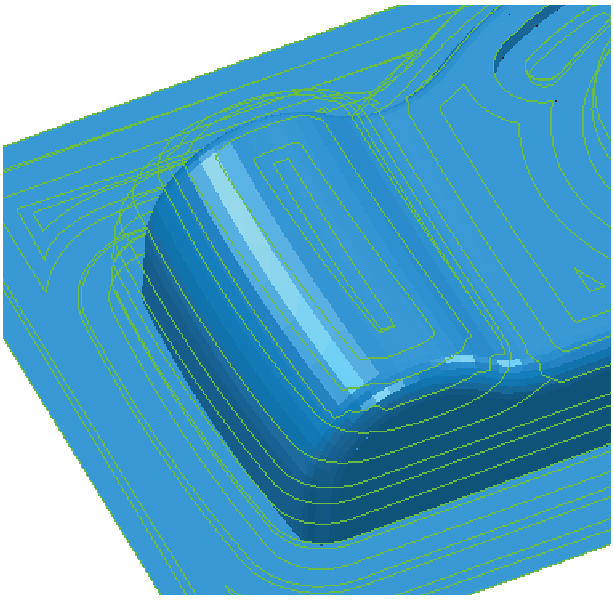

*This page is only available if you select* ***Use separate shallow options*** *on the main page.*

**Spiral -** produces a spiral path between two consecutive closed contours. This minimises the number of lifts of the tool and maximises cutting time while maintaining more constant load conditions and deflections on the tool.

It converts this:



to this:



**Cut direction -** determines the milling strategy.

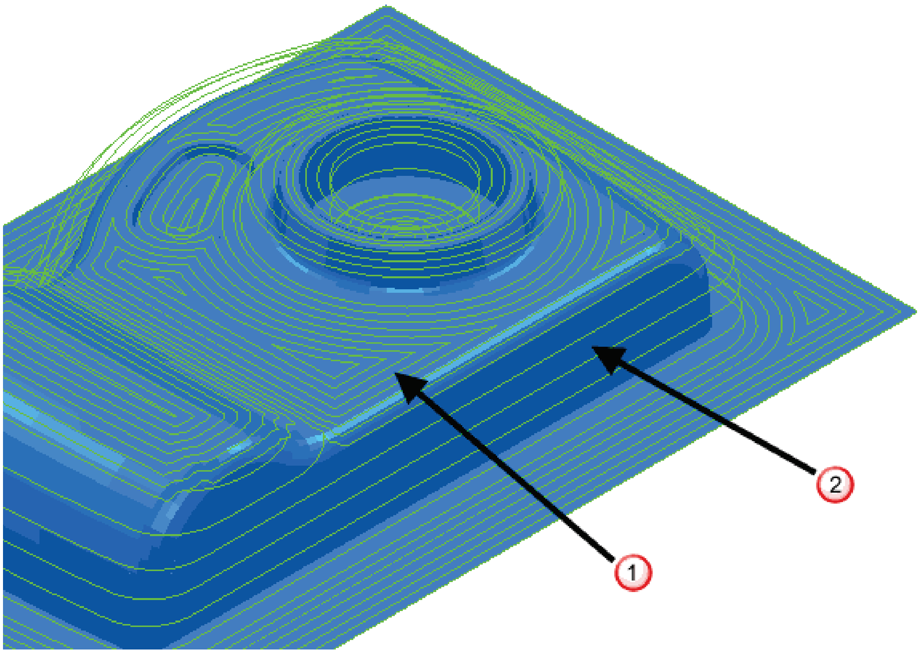
**Climb -** creates toolpaths using only climb milling.

**Conventional -** creates toolpaths using only conventional or 'upcut' milling.

**Any -** creates toolpaths using both conventional and climb milling, as appropriate. This minimises the tool lifts and tool travel.

**Use separate shallow stepover -** allows you to define a different stepover for the steep and shallow portions of the toolpath.

**Stepover -** the distance between successive machining passes. This is the **Stepover** for the shallow portions of the toolpath. The **Stepover** for the steep portions is defined on the main page (see page 92).




1 Shows the **3D Offset** toolpath stepover in the shallow areas.

2 Shows the **Constant Z** toolpath stepover in the steep areas.

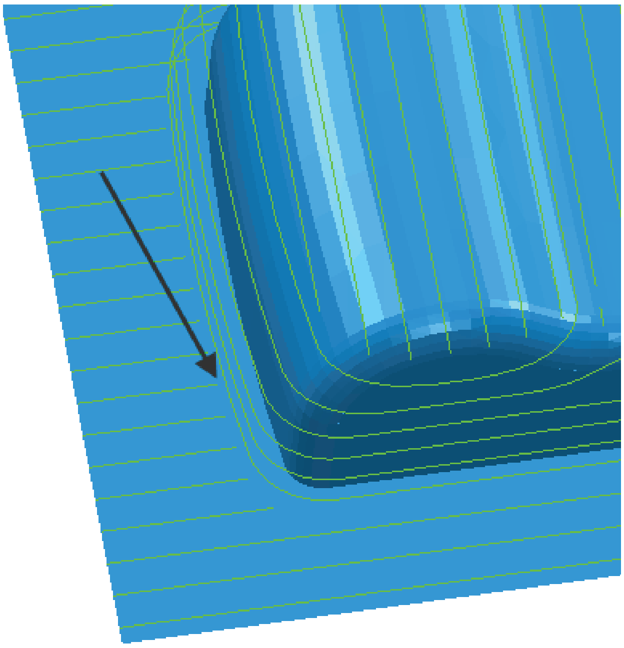
## Raster

**Raster** defines the raster options for the toolpath.

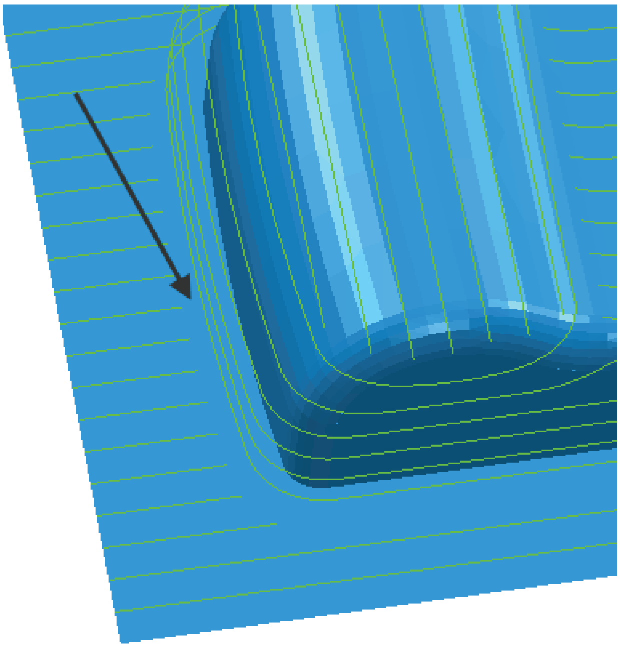

*This page is only available if you select a* ***Type*** *of* ***Raster*** *on the main page.*

**Wall clearance -** used to prevent raster spans at the bottom of a steep area from hitting that steep area. This prevents dwell marks on the steep areas.

**Wall clearance -** 0

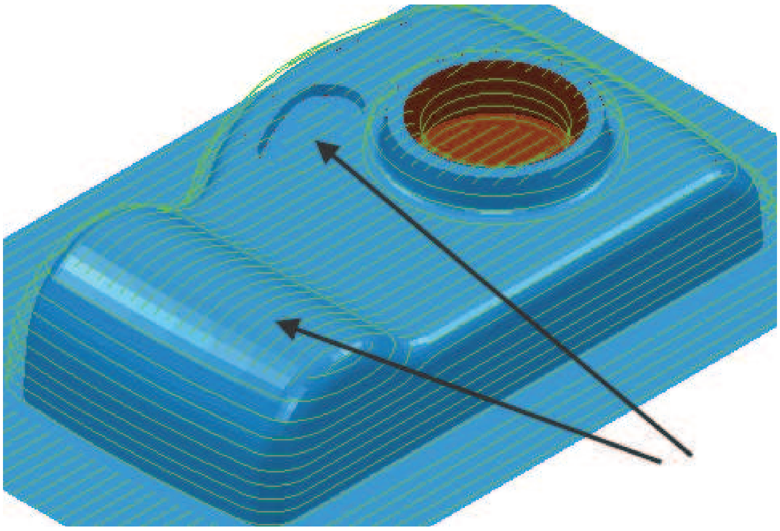


**Wall clearance -** 2

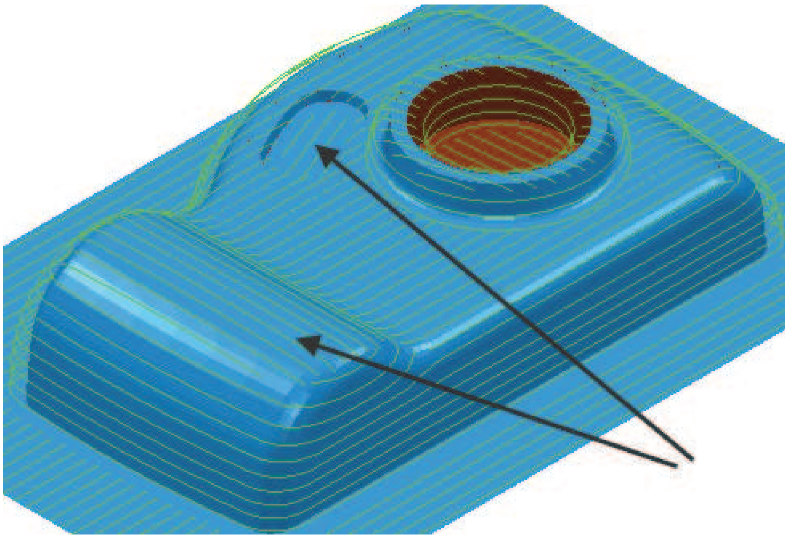


**Auto angle -** PowerMILL automatically calculates the most appropriate angle for each shallow region.

**Auto angle -** deselected

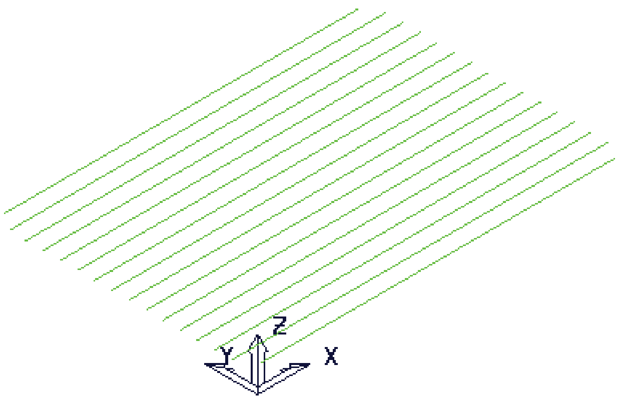


**Auto angle -** selected

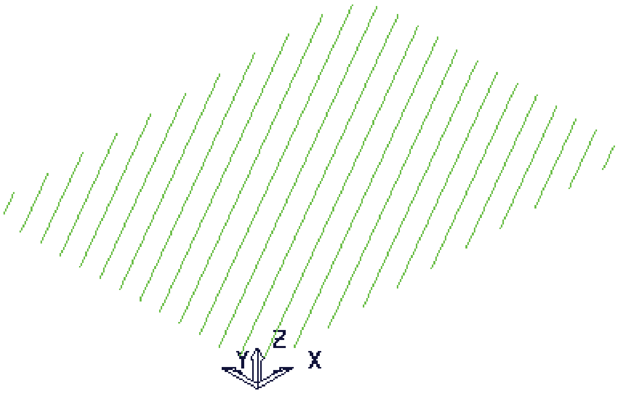


**Angle -** defines the angle of passes relative to the X axis.

**Angle -** 0°

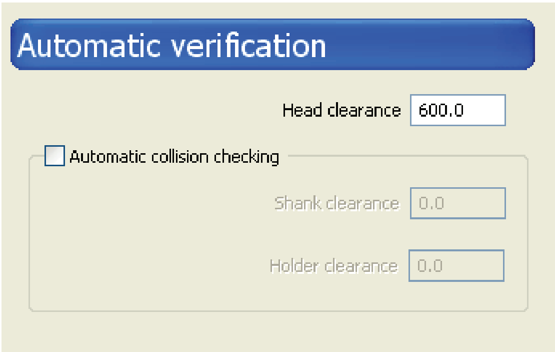


**Angle -** 30°

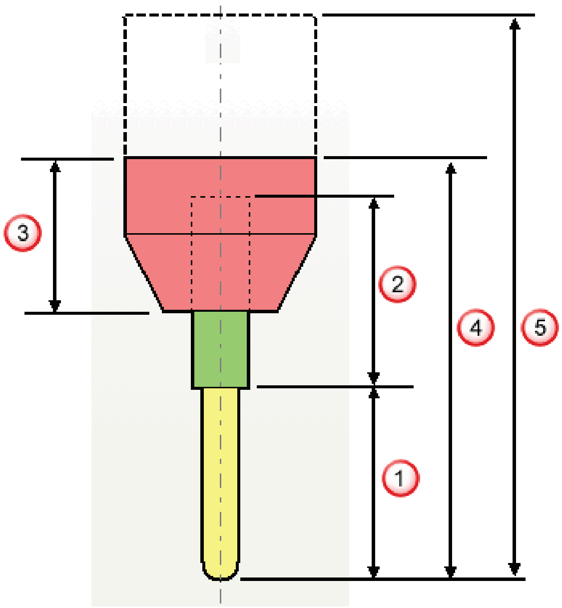



# Automatic verification

**Automatic verification** enables verification of toolpaths on creation.



**Head clearance -** represents the notional combined length of the tool tip, shank, and holder. The default value is set to **600** mm. This value can be set even if you do not define a shank or holder. If the height of the tool assembly is less than the **Head clearance** value, then an additional component is added internally to the tool assembly. This component has the same diameter as the uppermost item in the tool assembly (if **Automatic collision checking** is **On**), and a length such that the total tool assembly length specified is the same as the **Head clearance** value.




1 - tool length

2 - shank length

3 - holder length

4 - minimum head clearance value

5 - if a head clearance value is greater than the tool assembly height, then an additional component is added.

- The height of the tool assembly is just the cutter (1) if **Automatic collision checking** is **Off** and is the tip, shank, and holder (4) if **Automatic collision checking** is **On**.
- If you define a tool assembly which is longer than the **Head clearance** value, then the **Head clearance** value is ignored.
- For disc cutters, if a shank is defined, then additional components are added to give the total tool assembly a length equal to the **Head clearance** value.

**Automatic collision checking -** controls collision checking of toolpaths during toolpath calculation.

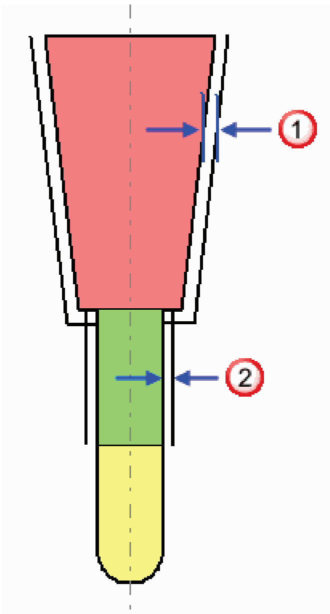
When selected, the tool shank and holder are collision checked. The resulting toolpath only contains the non-colliding (safe) moves. This can lead to gaps in the toolpath.

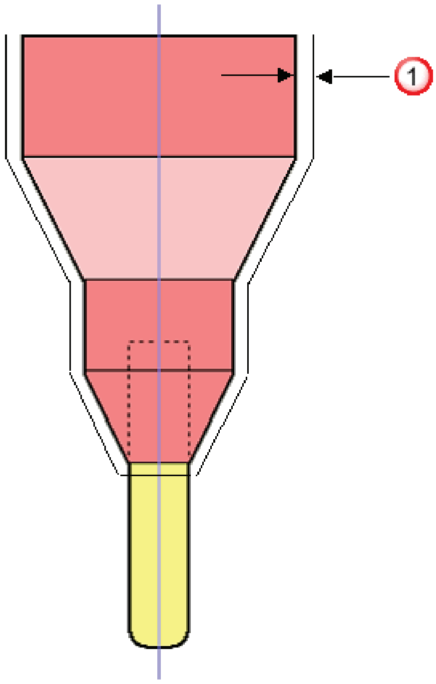
If unselected, the tool shank and holder are not collision checked.

*Collision checking using the **Toolpath Verification** dialog*  *will check against shank and holder regardless of this option.*

**Shank clearance -** represents a specified "safe" area around the tool shank which is taken into account when checking for collisions.

**Holder clearance -** represents a specified "safe" area around the tool holder which is taken into account when checking for collisions.



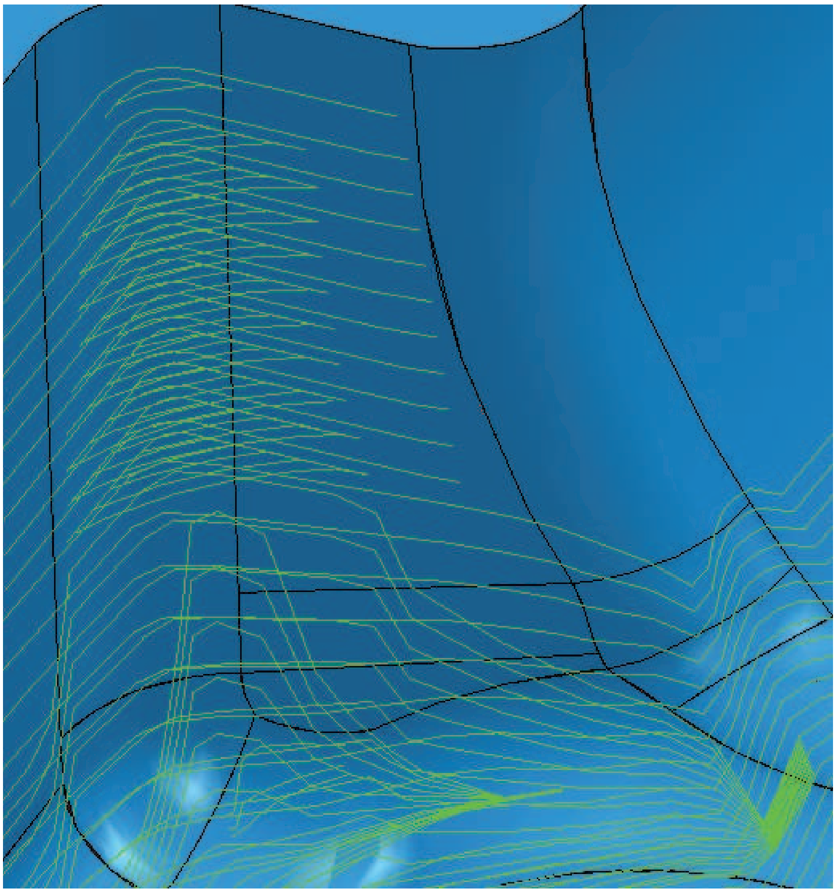



1 Holder clearance

2 Shank clearance

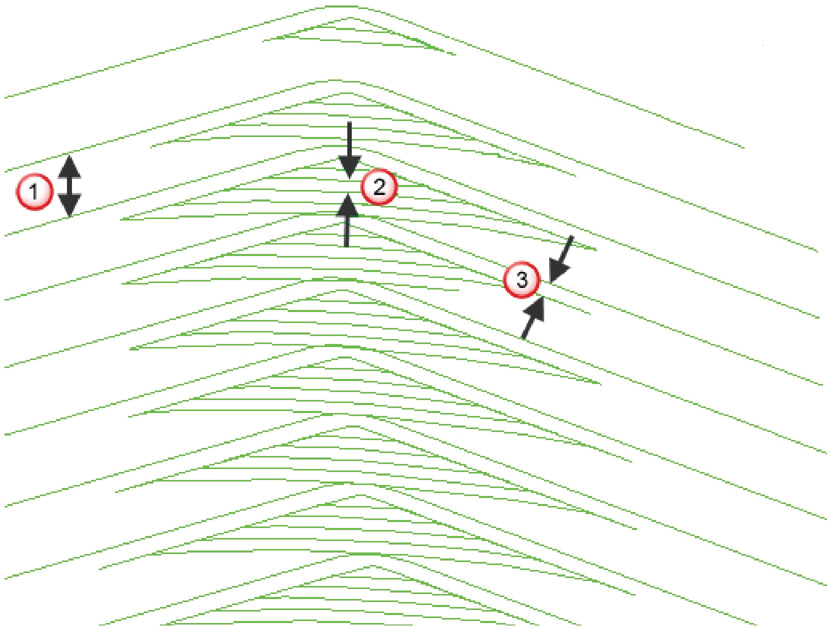
# Corner Clearance - overview

The new **Corner Finishing** strategy allows you to define a toolpath to remove material left in corners. The toolpath is generated such that the the rest material is removed in successive stages, using horizontal and vertical stitch movements, or along passes.



Steep regions are machined with horizontal stitches by default. You can select **Along passes** to machine steep regions.

## Horizontal stitches

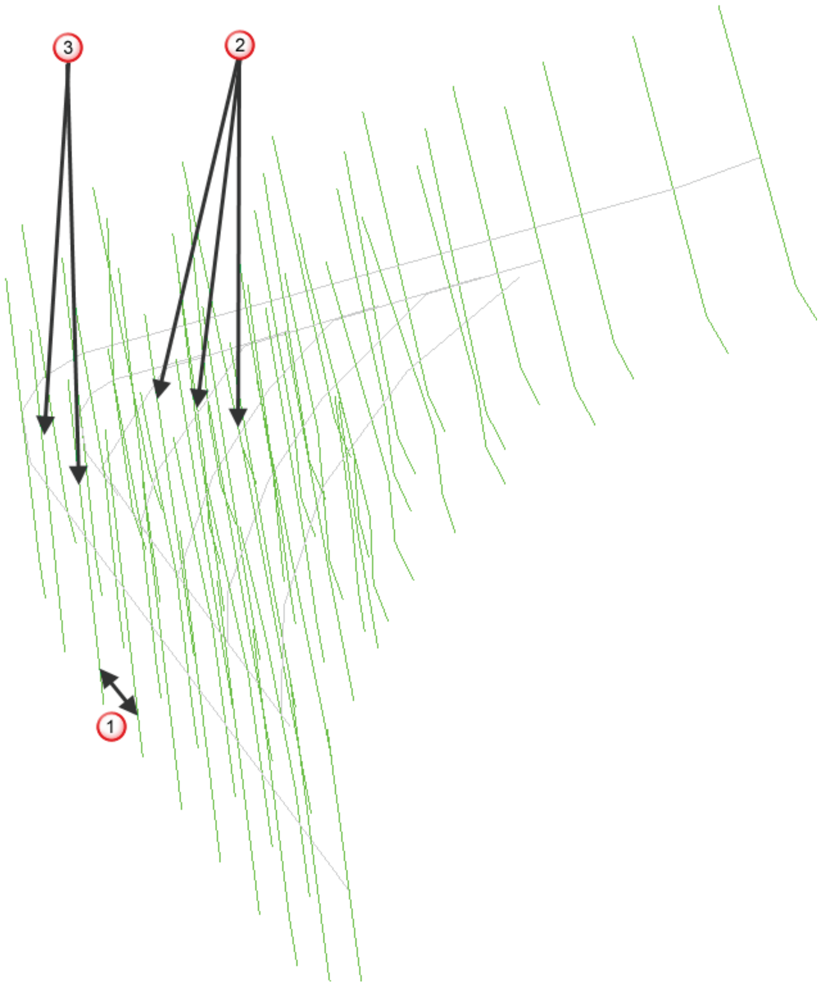



1 - Steep stepover

2 - Steep depth of cut

3 - Steep final depth of cut

## Along passes




1 - Steep stepover

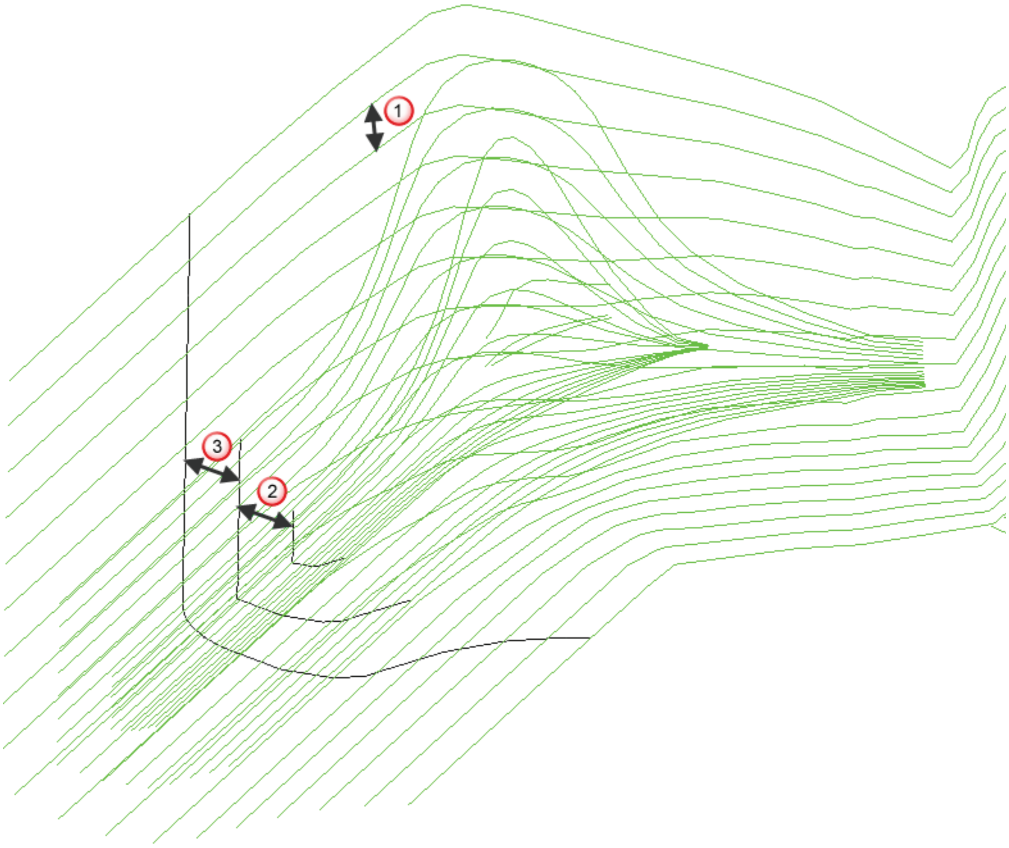
2 - Steep depth of cut

3 - Steep final depth of cut

*For comparison, the horizontal stitch toolpath is shown in grey.*

Shallow regions are machined with along passes by default. You can select **Vertical stitches** to machine shallow regions.

## Along passes

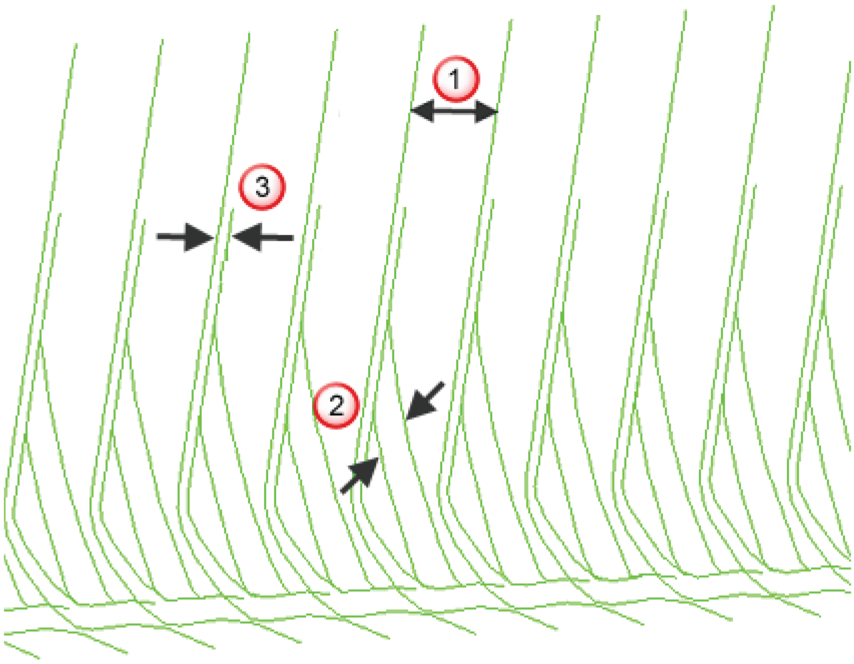



1 - Shallow stepover

2 - Shallow depth of cut

3 - Shallow final depth of cut

## Vertical stitches

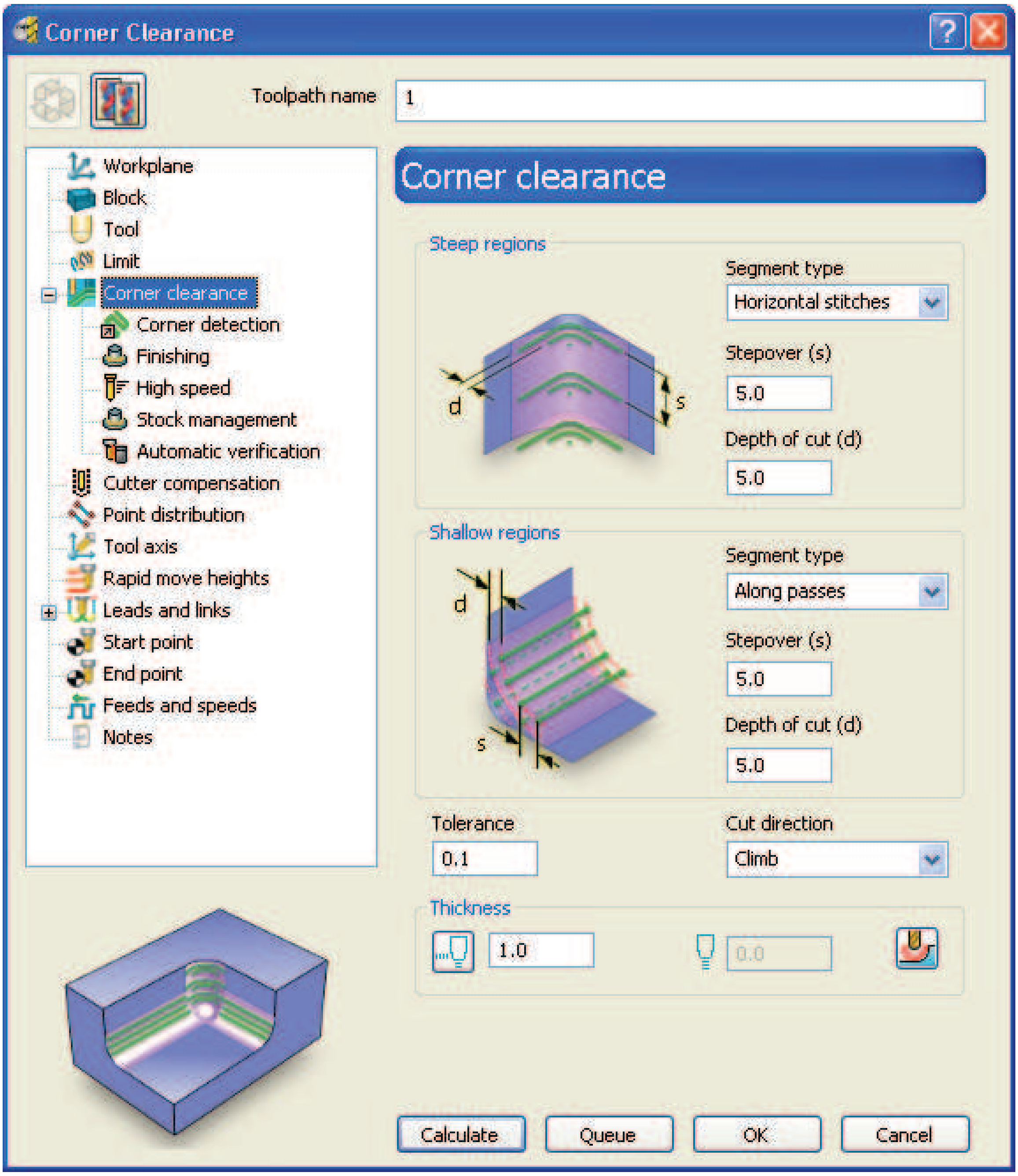



1 - Shallow stepover

2 - Shallow depth of cut

3 - Shallow final depth of cut

There are several tabs associated with **Corner clearance:**



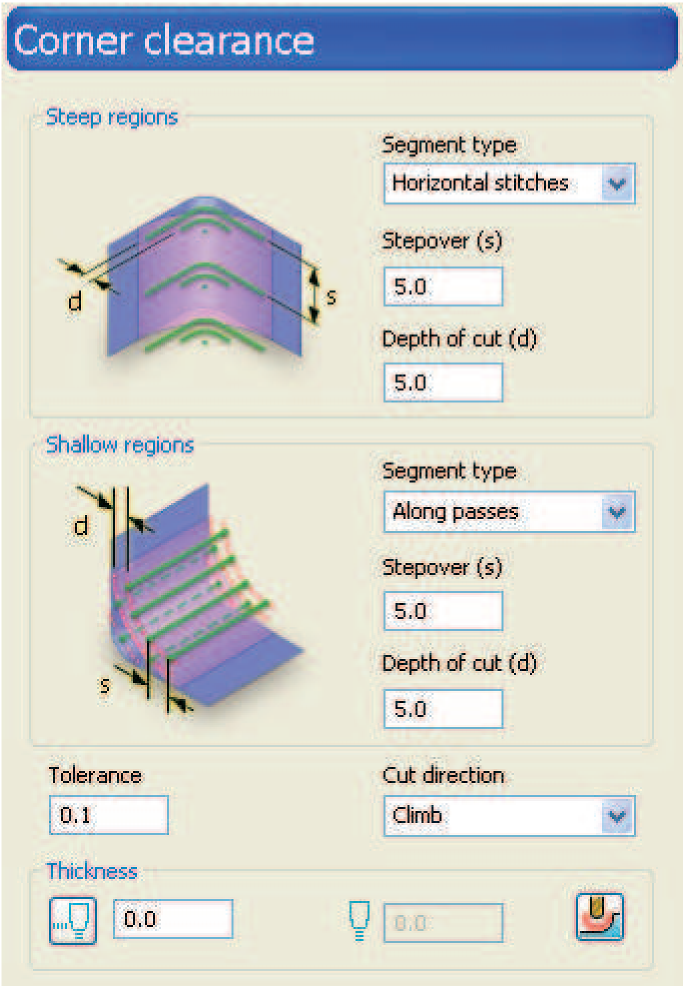

- **Corner clearance** (see page 115)**-** the main page used to define a corner clearance toolpath.
- **Corner detection** (see page 118) **-** determines the location of the toolpath.
- **Finishing** (see page 119) **-** allows you to specify a final depth of cut value which is different from the normal depth of cut value.
- **High speed** (see page 119) **-** enables arc fitting in internal corners to eliminate sudden changes in tool direction. This is essential for high speed machining.

- **Stock management** (see page 121) **-** enables you to use a stock model and gives you options to specify material thickness.
- **Automatic verification** (see page 105) **-** enables automatic verification of toolpaths on creation.

The remaining tabs are common toolpath creation controls.

## Corner clearance

**Corner clearance** is used to remove material left in corners, in successive stages.




**Segment type -** selects the type of machining.

- **Horizontal stitches -** is the default setting for steep region machining.
- **Vertical stitches -** can be used for shallow region machining.
- **Along passes -** is the default setting for shallow regions. Along passes can be used on both steep and shallow regions.

**Stepover -** the distance between successive machining stitches or passes.

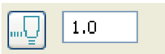
**Depth of cut -** the thickness of material to be removed by each cut.

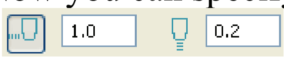
**Tolerance -** determines how accurately the toolpath follows the contours defined by the model.

**Cut direction -** determines the milling strategy.

> **Climb -** creates toolpaths using only climb milling.
>
> **Conventional -** creates toolpaths using only conventional or 'upcut' milling.
>
> **Any -** creates toolpaths using both conventional and climb milling, as appropriate. This minimises the tool lifts and tool travel.

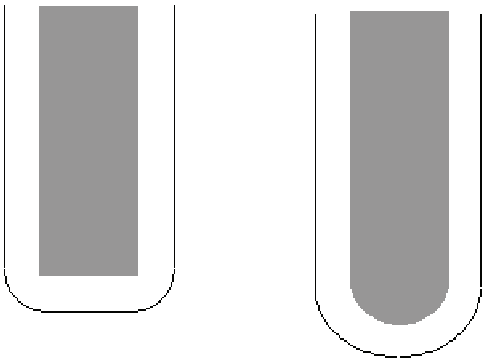
**Thickness -** specifies the amount of material to be left on the part, within tolerance.



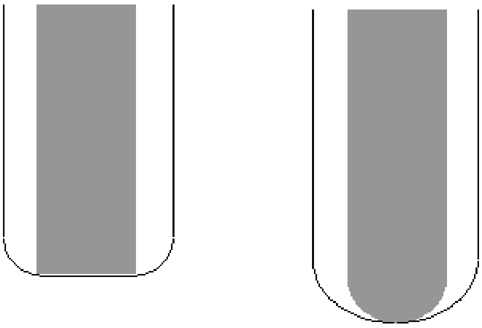
**-** clicking the **Thickness**  button changes the **Thickness** field to **Radial thickness**  and the **Axial thickness**  field appears. Now you can specify separate **Radial** and **Axial thickness** values 

.

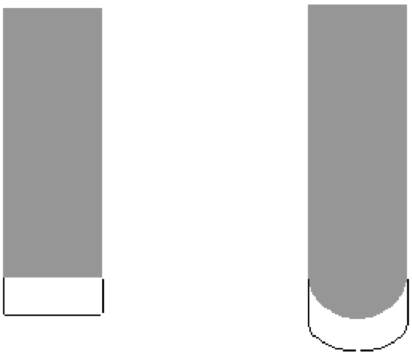
 **Thickness -** applies the thickness as an offset to the tool in all directions:



**Radial thickness -** applies the thickness as an offset to the tool radially. This can be useful where you want to leave material on vertical walls.

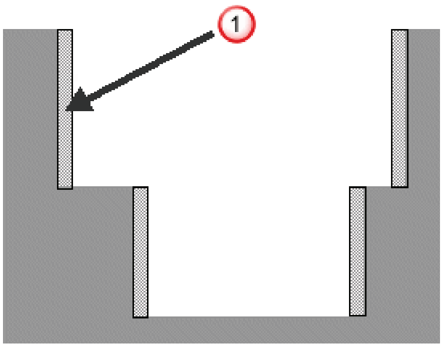


**Axial thickness -** applies the thickness as an offset to the tool, in the tool axis direction only. This controls the tip position of the tool used for machining, relative to the tool defined in PowerMILL.



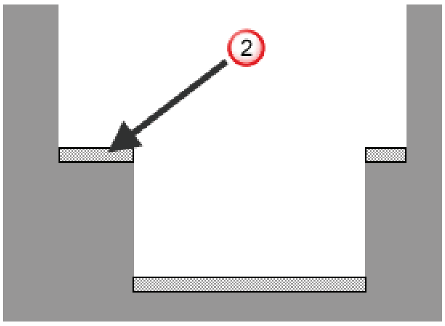
Variable thickness (that is to say, separate **Radial** and **Axial thickness** values) is particularly useful for orthogonal parts. It is possible to use variable thickness on sloping walled parts, although it is more difficult to predict the results.

In thin-walled aerospace parts, you may want the area clearance toolpath to finish the floor of the pocket, but to leave material on the thin vertical walls. In this case, specify a positive **Radial thickness** value and an **Axial thickness** of 0:




1 - Radial thickness

Alternatively, you can also use this method to finish the steep side walls and leave material on the bottom. In this case, specify a **Radial thickness** of 0 and a positive **Axial thickness** value:




2 - Axial thickness

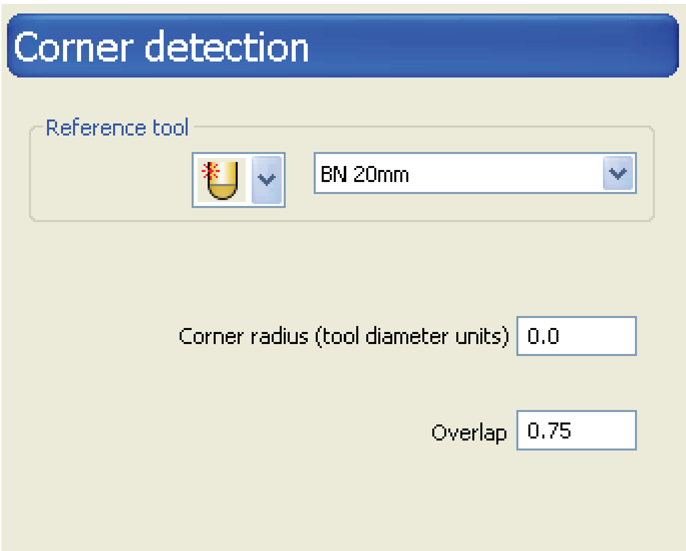
Typically, it is used on flat-bottomed parts with pockets.

*To avoid too much material being removed,* ***Thickness*** *should be greater than* ***Tolerance****.*

**-** displays the **Component thickness dialog**, which allows you to specify the thicknesses of the different surfaces.

## Corner detection

**Corner detection** determines the location of the toolpath.



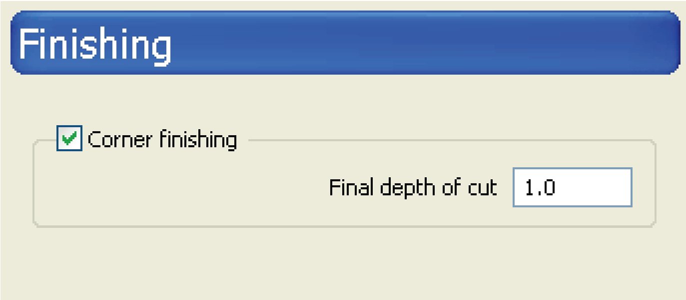

**Reference Tool -** specifies the tool used to create the previous toolpath. Either define the tool geometry here or select it from the tool list.

**Corner radius (tool diameter units) -** the value for arc fitting used on the previous toolpath.

**Overlap -** specifies the amount by which the toolpath extends beyond the borders of the un-machined region.

## Finishing

**Finishing** allows you to specify a final depth of cut value which is different from the normal depth of cut value.

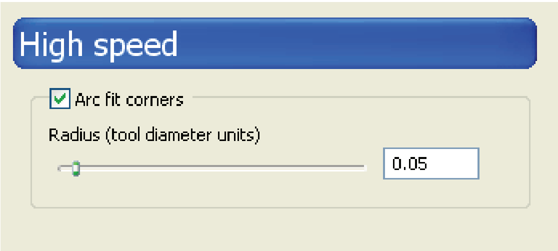



**Corner finishing -** enables you to specify a final depth of cut.

**Final depth of cut -** specifies the final depth of cut value.

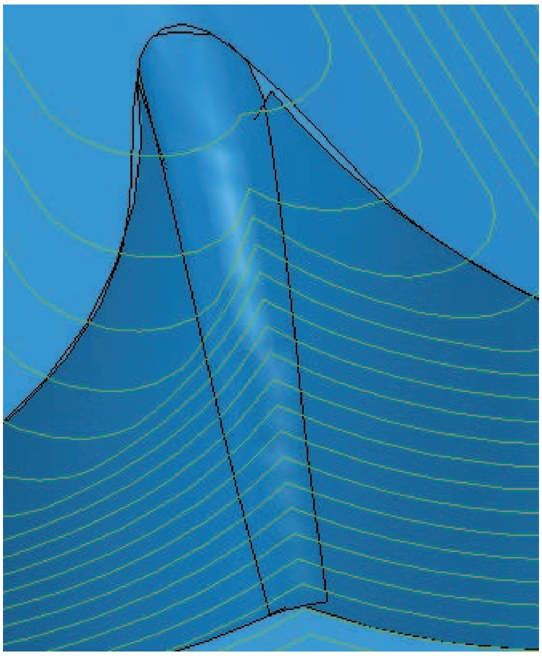
## High speed

**High speed** enables arc creation in all internal corners of a toolpath, using the **Radius** specified.

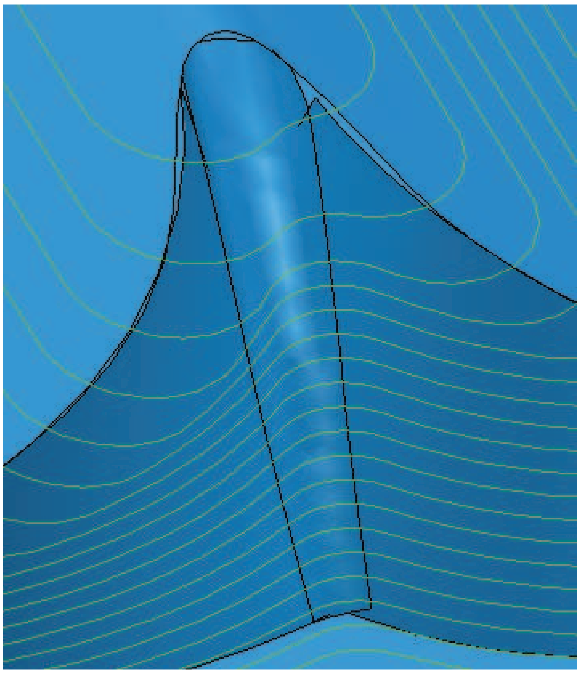



This example looks at a constant Z toolpath, but the principles are the same for all toolpaths.

When **Arc fit corners** is deselected, sharpening is carried out on all internal corners.



When **Arc fit corners** is selected for the same example, arcs are created in all internal corners, using the **Radius** specified:



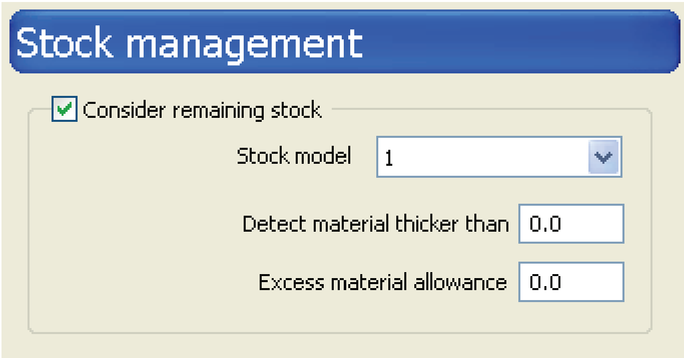
Arc fitting is of particular importance when high speed machining as it eliminates sudden changes in tool direction.

**Radius (Tool Diameter Units) -** defines the radius used if you select **Arc fit corners**. The radius is defined as a proportion of the tool diameter. The default value is 0.05. So, if you have a tool of diameter 10 mm (radius 5 mm), then the arc radius will be 0.5 mm.

*The **Radius** slider can have a value between 0 and 0.2.*

## Stock management

**Stock management** enables you to use a stock model and lets you specify material thickness options.




**Consider remaining stock -** enable this option to select a stock model and associated options.

**Stock model -** select the stock model from the list.

**Detect material thicker than -** the calculation ignores rest material thinner than the threshold specified here. This helps to avoid thin regions being rest machined, where the benefit of a second cut is negligible. These thin regions can be caused by cusps from the previous toolpath.

**Excess material allowance -** the amount of excess stock material to be considered.

The toolpath expects the stock to be close to what would be left after machining with the reference tool. If there is any excess material to be considered over and above this, specify the value here.

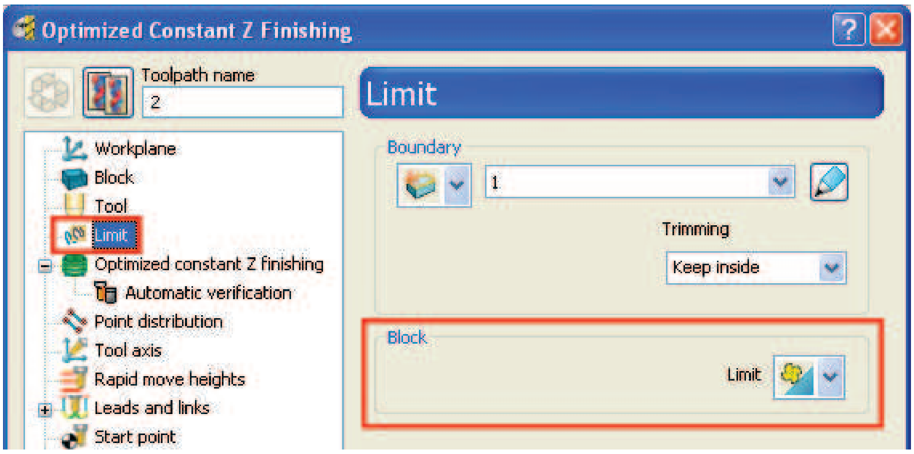
# Allow tool centre outside block

Finishing strategies now have the option to allow the tool centre to go outside the block. In previous versions, this option was only available for area clearance strategies.

The advantage of this is that you can machine from outside the block and you no longer need to make the block larger than the part in order to get the tool to move outside the part. The block can now represent the stock.

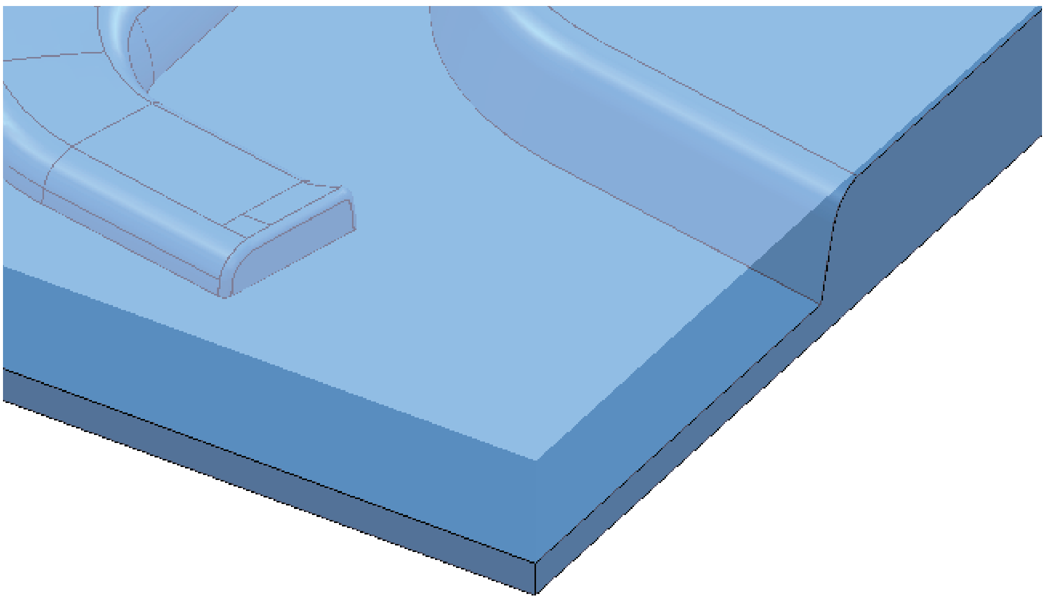
In 5-axis, the criteria is that any part of the tool should be inside the block. Again, this allows machining bits of the part very close to the edge of the block from the outside.

This is available on the **Limit** page of the strategy dialogs.

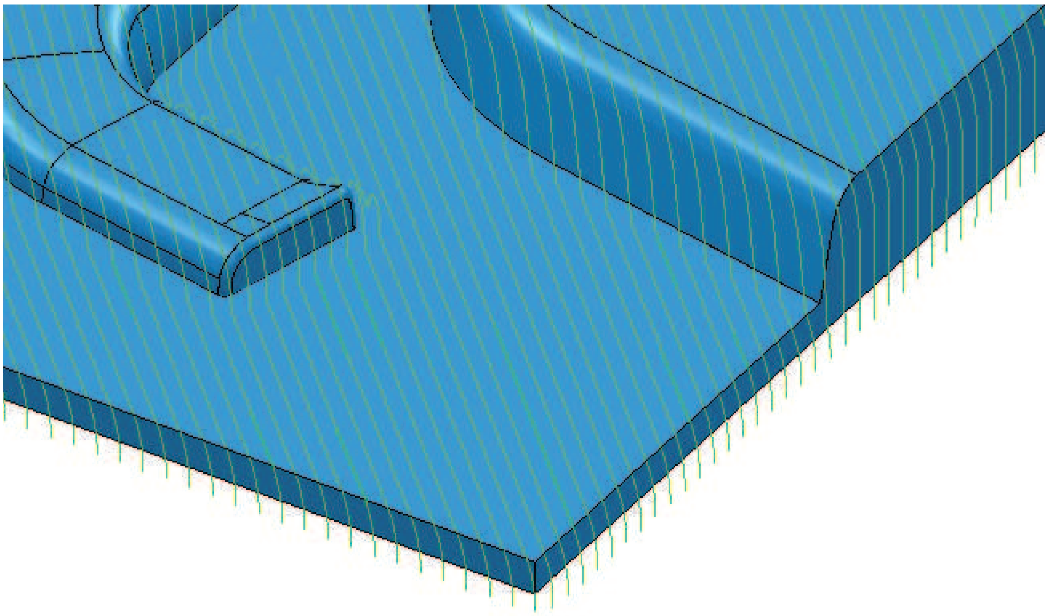



**Block -** determines whether the tool is allowed outside the block.

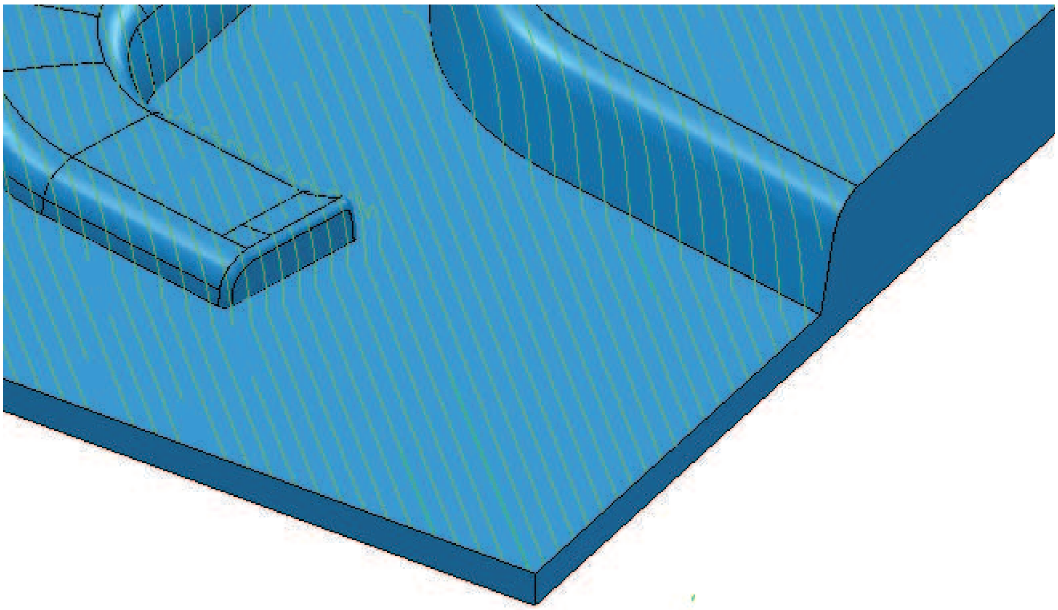
If you start with this model and block:



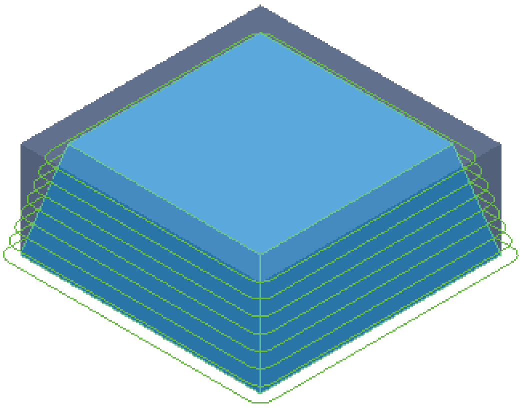
Selecting  gives:



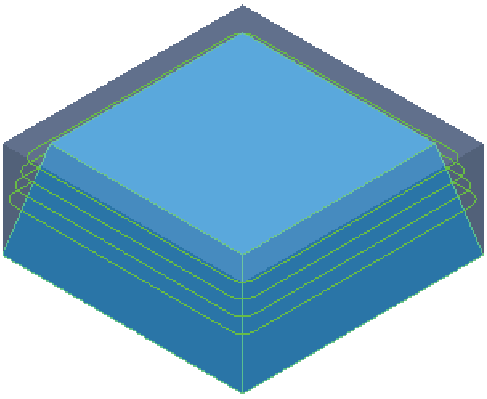
Selecting  gives:



 **-** allows the tool outside the confines of the block. This option should always be selected if the block has been defined to represent the actual size of stock you are machining. This will maximise the removal of material during area clearance and avoid plunge or ramp entries wherever possible.



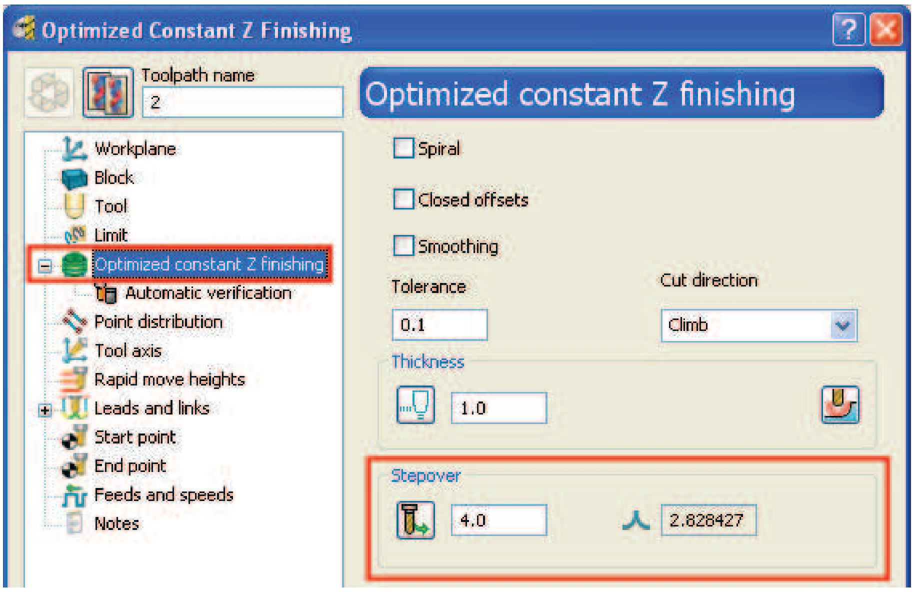
 **-** the tool tip is contained within the block.



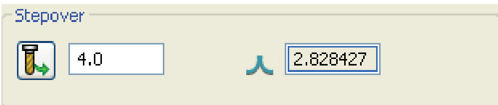
# Linkage between stepover and cusp height

The cusp height and stepover are now linked on finishing dialogs. Entering a **Stepover** value automatically calculates the **Cusp height** . Similarly, entering a **Cusp height**  automatically calculates the **Stepover** value.

To see this effect, see the main page of any finishing strategy that uses a **Stepover**, such as **Optimised constant Z finishing**.




Click to automatically define the stepover from the tool geometry.




*The extra border round the* ***Cusp height*** *field shows that it has been calculated automatically, and not entered by you.*

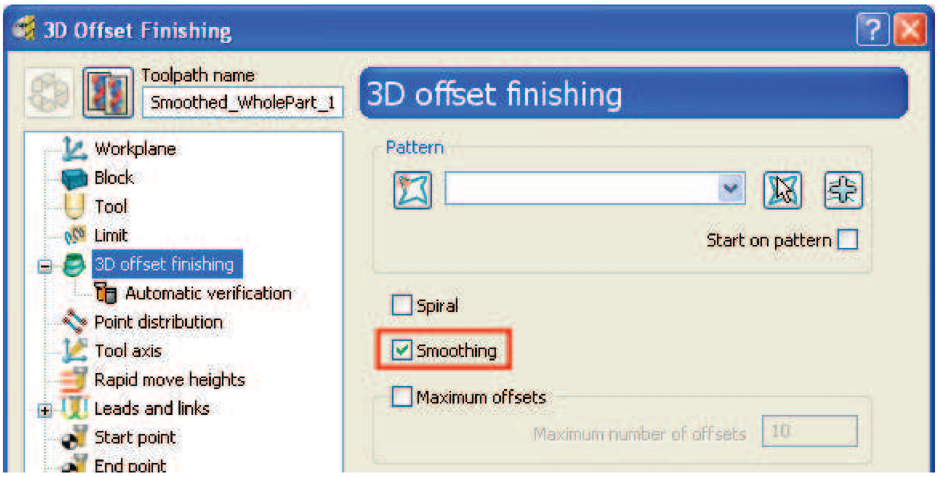
Change the **Stepover** value to 5.


You can see that changes to as the value was manually edited and the **Cusp height** value has changed.

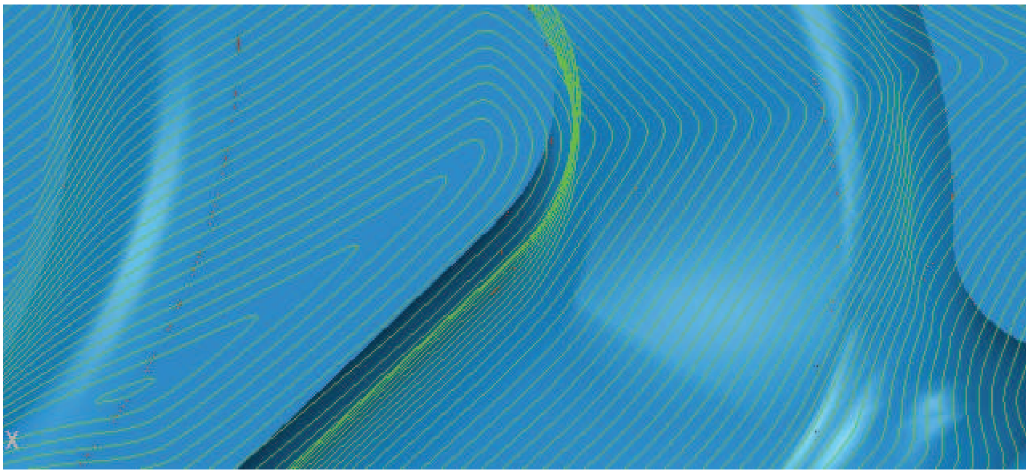
Change the **Cusp height** value to 3.

# Smoothing 3D offsets

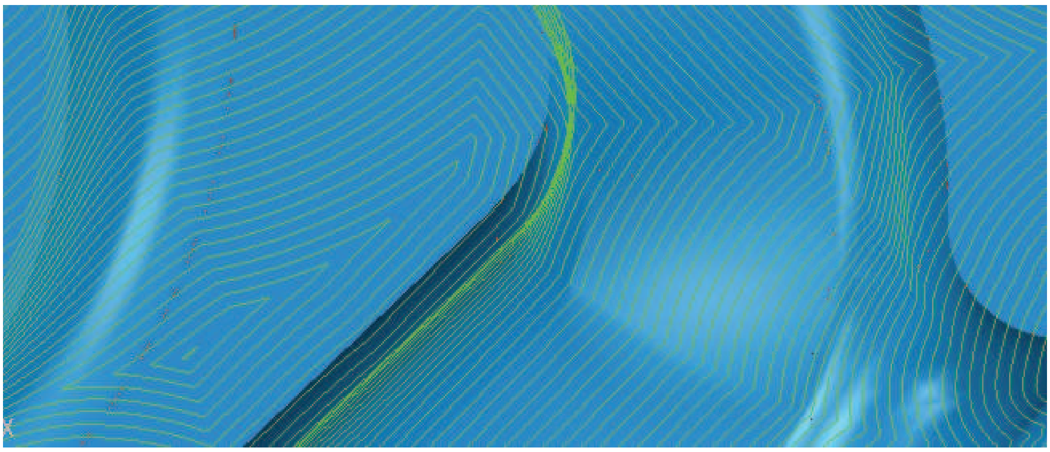
There is a new option of **Smoothing** on the 3D offset finishing dialog. This smooths offsets of toolpath segments over the model. It smooths sharp corners, blends angular offsets and maintains the feed rate momentum. This blending gives a result similar to raceline machining.




**Smoothing** selected:



**Smoothing** deselected:

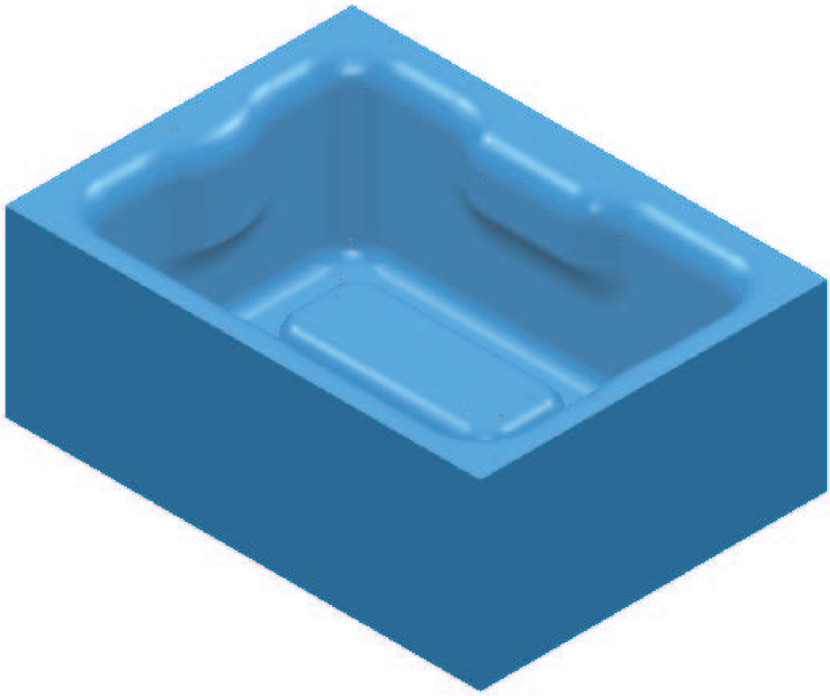


# Constant Z improvements

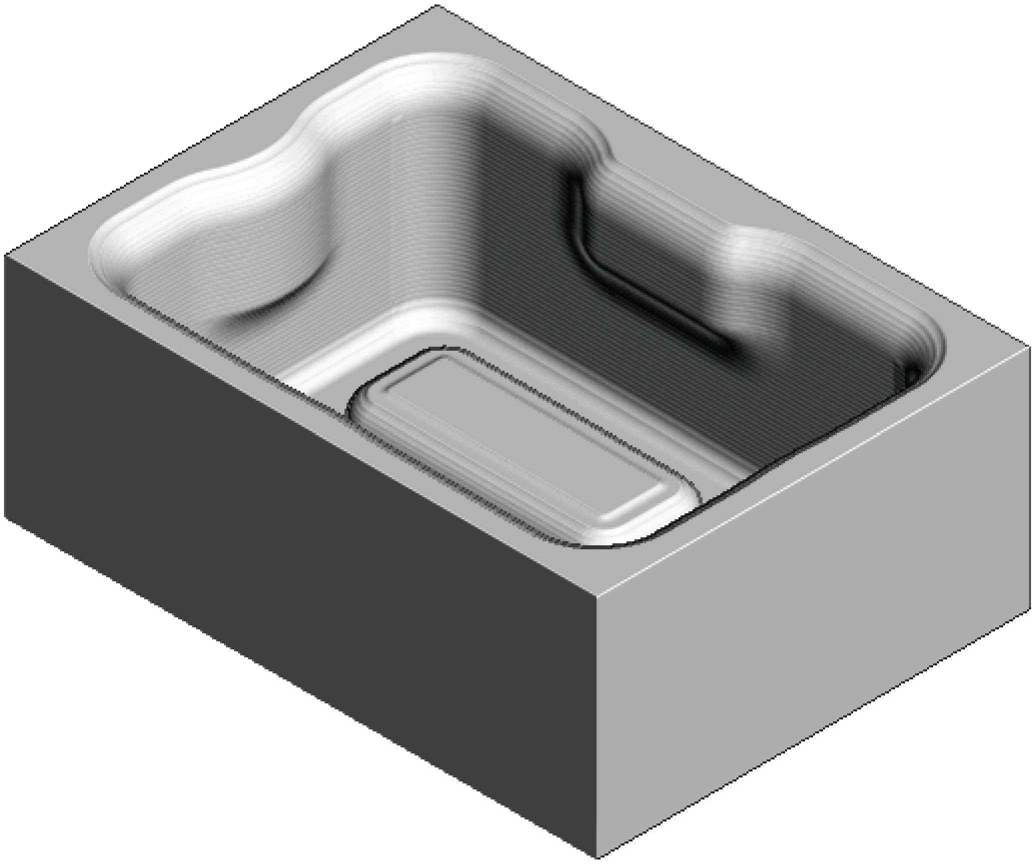
There are a couple of new options on the **Constant Z finishing** dialog:

- **Undercut -** allows you to machine areas with undercuts. This works for lollipop (tipped disc) tools.

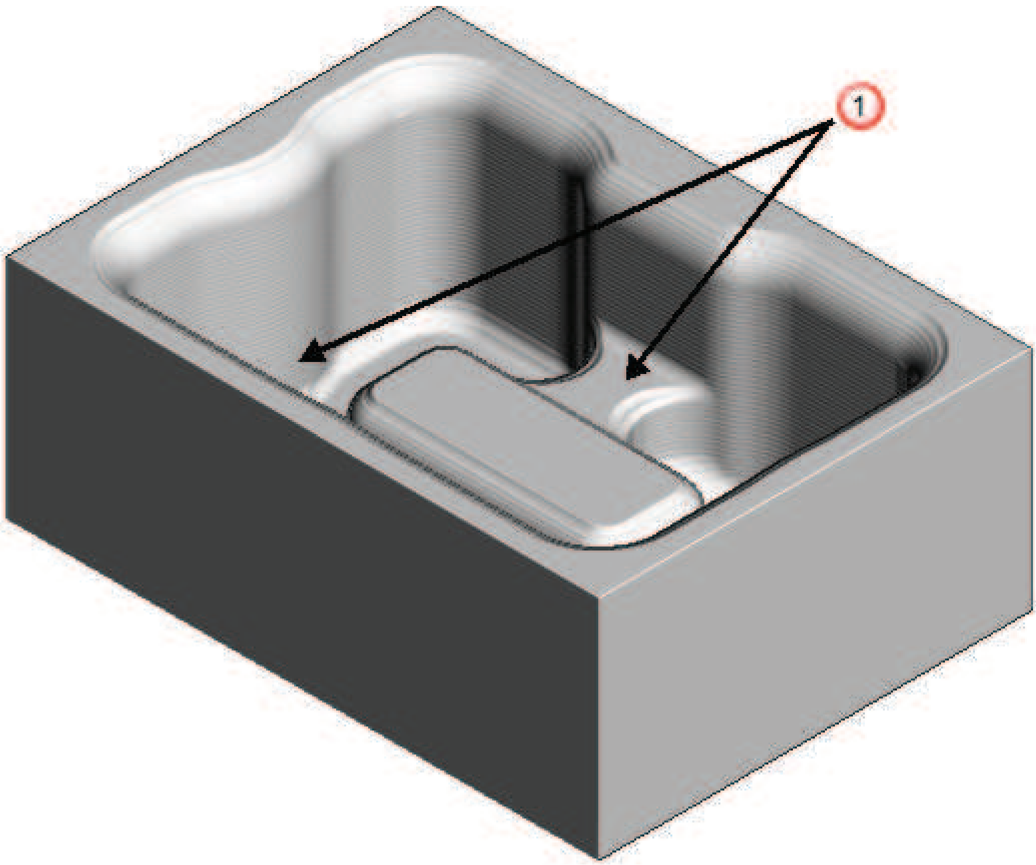
If you start with this model:



**Undercut -** selected:



**Undercut -** deselected:



① - areas not fully machined.

- If a vertical tool axis is used, undercuts work with ball nosed, tapered spherical and tipped disc tools.
- If the tool axis is not vertical then undercuts work with ball nosed, tapered spherical and spherical tipped disc tools.

*Not all tipped disc tools work with a non-vertical axis, only those with a (hemi)spherical end, (where diameter=2*tip radius).*

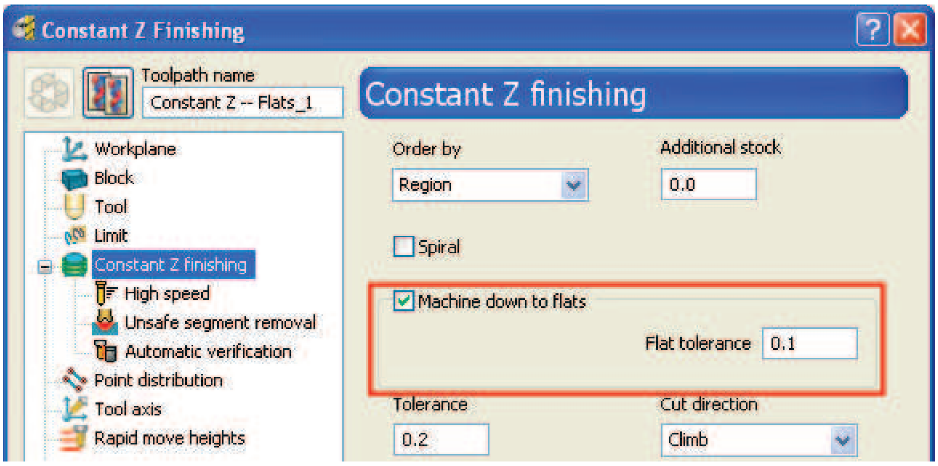
*When undercuts is selected, the Additional stock and Machine down to flats options are greyed out. The Unsafe segment removal page is also unavailable.*

- **Machine down to flats** (see page 129) allows you to machine exactly on the flat areas of the model.
- **High speed** (see page 130) enables arc creation in all internal corners of a toolpath, using the Radius specified.
- **Unsafe segment removal** (see page 132) prevents machining of small areas, especially in small pockets.

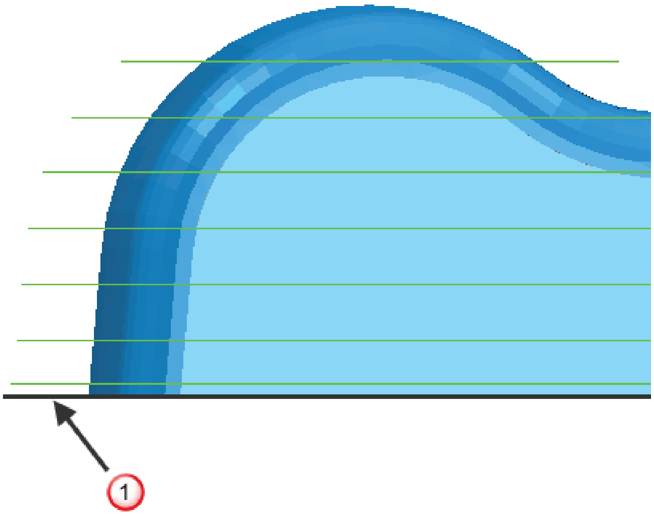
*This is the same functionality that is available on area clearance toolpaths.*

## Machine down to flats

**Machine down to flats** adds a constant Z slice on flat surfaces at the bottom of steep features. This option eliminates the need to create a separate pencil toolpath at the flat height.

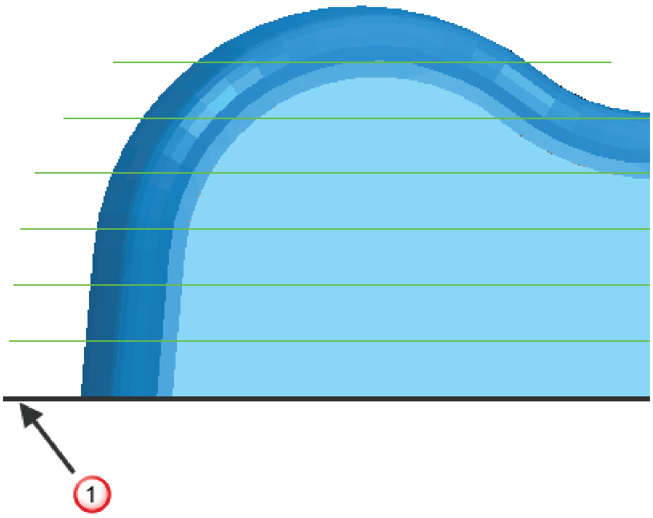


**Machine down to flats** selected:

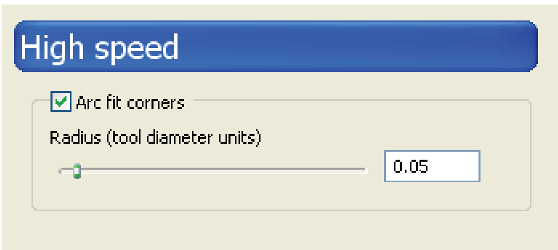



1 - flat surface

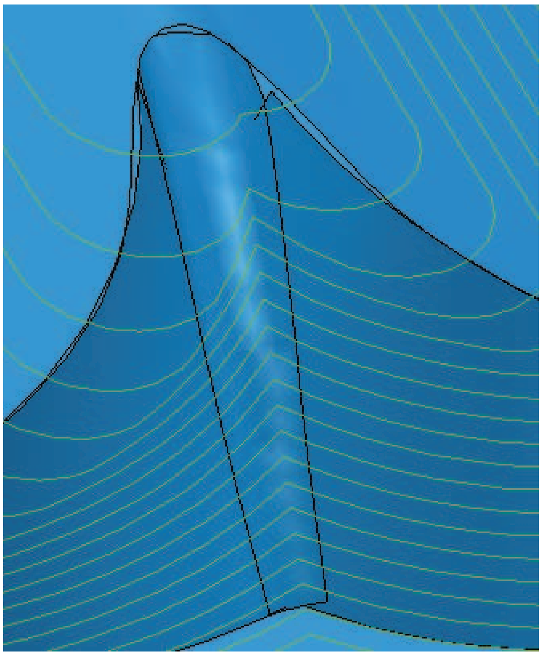
**Machine down to flats** deselected:



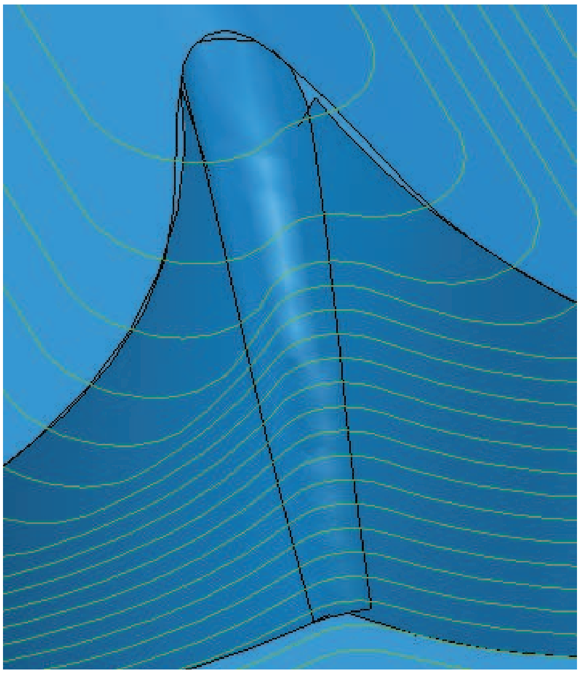

## High speed



When **Arc fit corners** is deselected, sharpening is carried out on all internal corners.



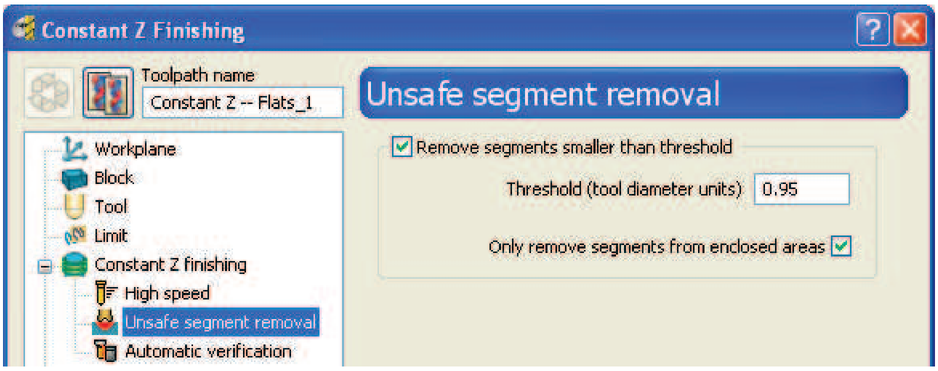
When **Arc fit corners** is selected for the same example, arcs are created in all internal corners, using the **Radius** specified:



Arc fitting is of particular importance when high speed machining as it eliminates sudden changes in tool direction.

## Unsafe segment removal

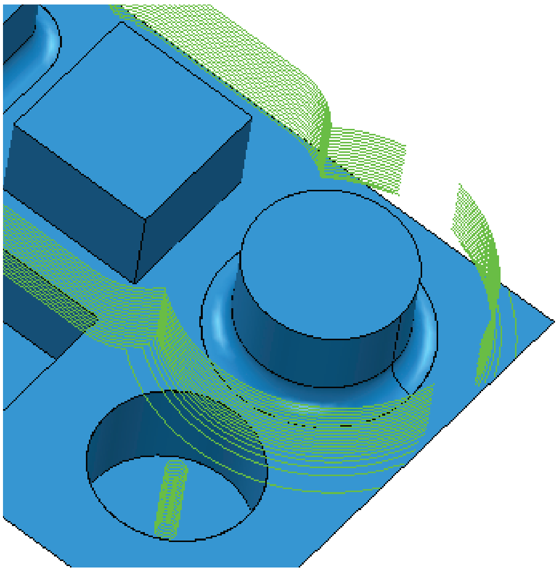
There is a new option of **Unsafe segment removal** which has its own page on the Constant Z finishing dialog. This removes small toolpath segments to prevent damaging tools with a non-cutting centre.



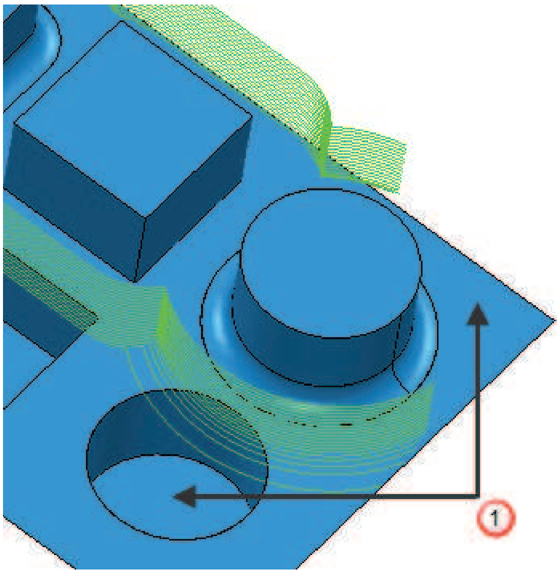

**Unsafe segment removal** removes small toolpath segments to prevent tool damage when using non-centre cutting tools. When machining down into small pockets, removing small segments stops the central, non-cutting underside of the tool from hitting non-machinable material.

**Remove segments smaller than threshold -** removes segments that are smaller than the **Threshold** value, unless they surround a boss.

**Remove segment smaller than threshold -** deselected:



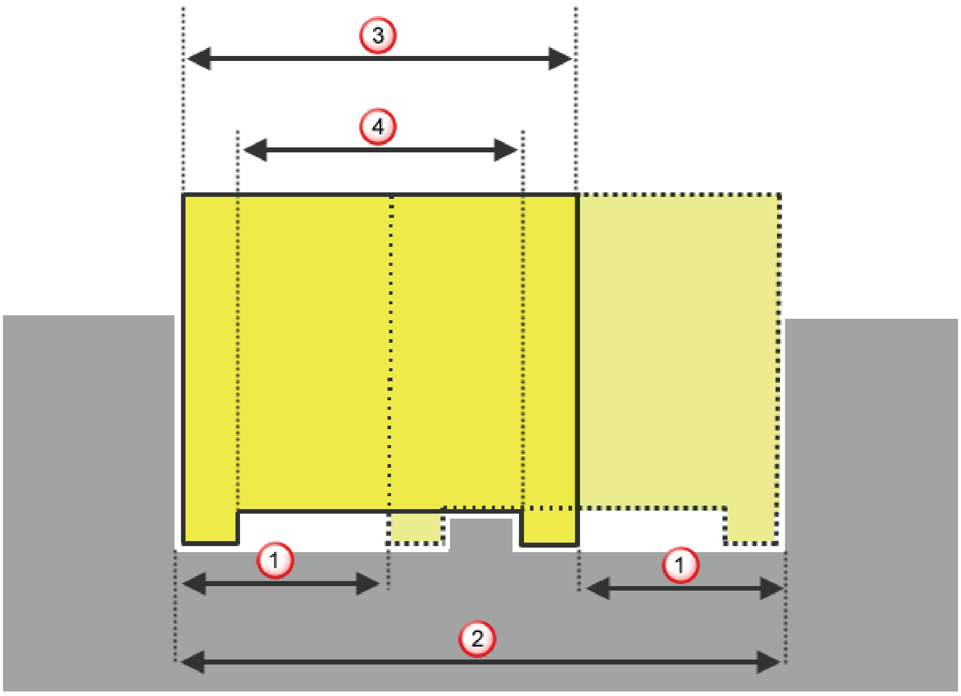
**Remove segment smaller than threshold -** selected:




1 - areas where segments have been removed as these segments are smaller than the **Threshold** value.

**Threshold (tool diameter units) -** is the size against which all segments are compared. The higher the threshold value, the more segments are removed.

*The minimum suggested threshold value is derived by dividing the non-cutting diameter by the full tool diameter. Values smaller than this will not remove all unsafe segments. A value of 1 will always remove all unsafe segments, but may also remove some safe segments.*



1 - Segment length (Ls)

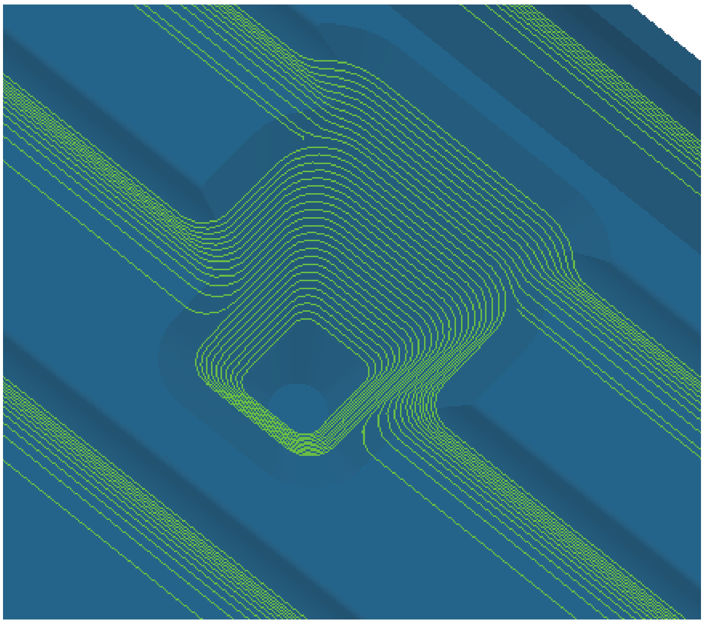
2 - Pocket length (Lp)

3 - Tool diameter (D)

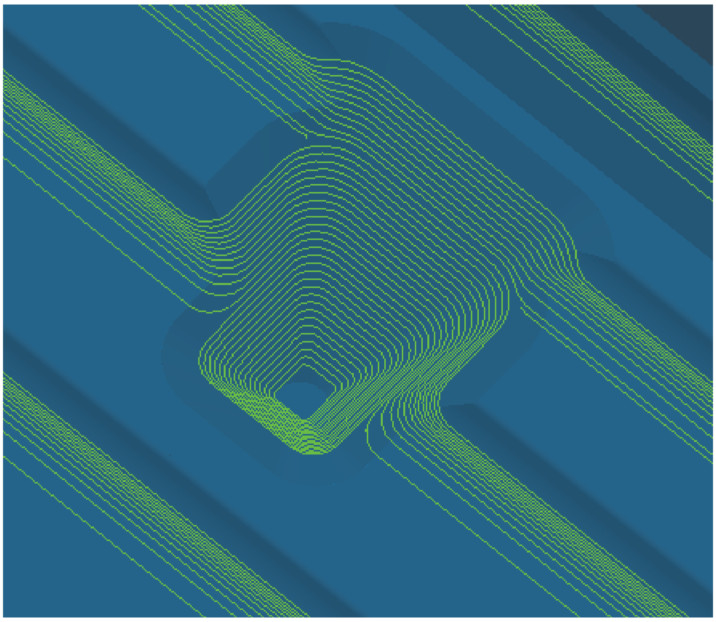
4 - Non-cutting tool diameter (d)

This example uses a constant Z toolpath.

**Threshold (tool diameter units) -** 1.5:

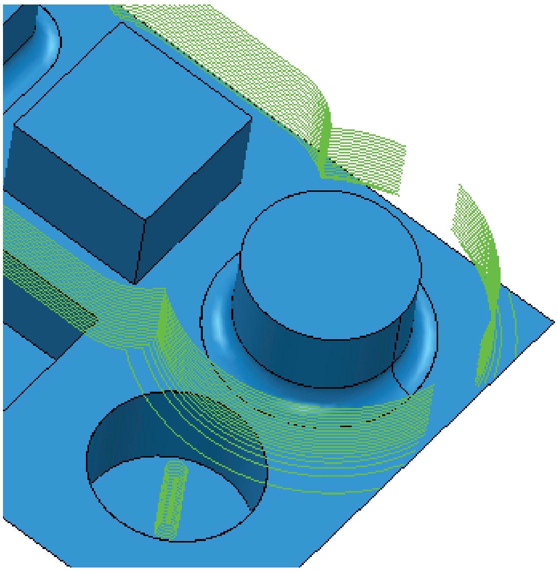


**Threshold (tool diameter units) -** 0.7:



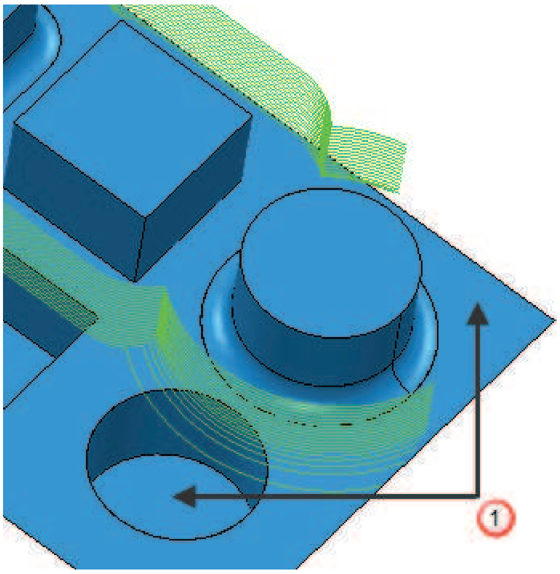
**Only remove segments from enclosed areas -** only removes segments in areas enclosed by material.

**Remove segments smaller than threshold -** deselected:



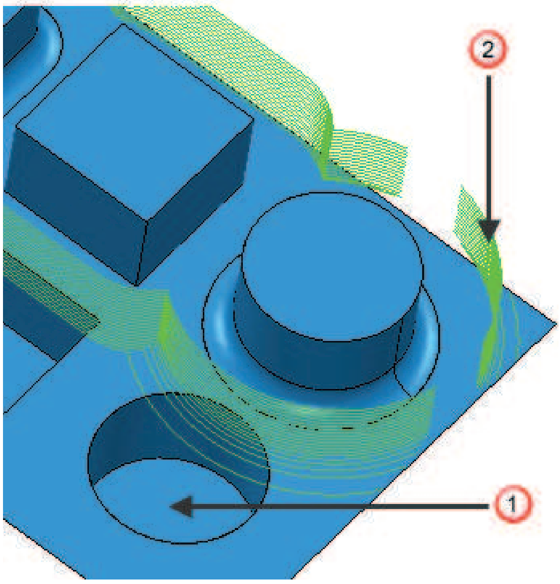
**Remove segments smaller than threshold** - selected

**Only remove segments from enclosed areas** - deselected:




**Remove segments smaller than threshold** - selected

**Only remove segments from enclosed areas** - selected:




1 - areas where segments are removed as these segments are smaller than the **Threshold** value.

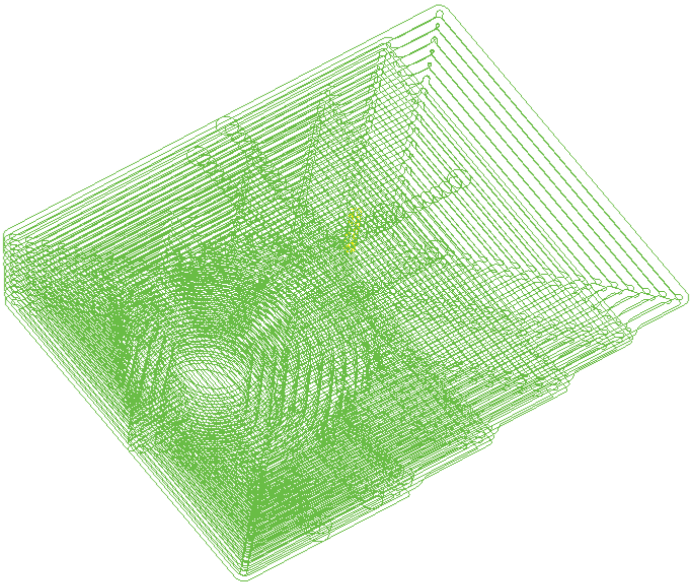
2 - areas where segments are not removed as these segments are not in an enclosed area even though they are smaller than the **Threshold** value.

# View Toolpath by Z height

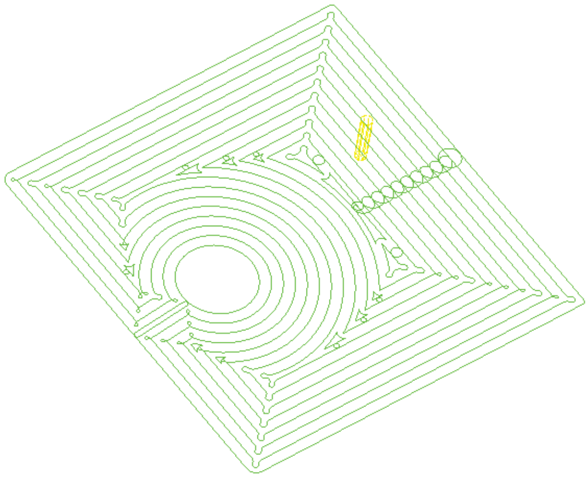
Use the **View Toolpath by Z height** button on the **Toolpath** toolbar to view a toolpath isolated at a particular Z height. This is helpful when viewing any Z height dependent toolpath. For example, toolpaths created using an area clearance, constant Z, or flat finishing strategy.

The Z height viewing options are not available for other types of toolpaths.

### Viewing a toolpath without isolating a Z height level

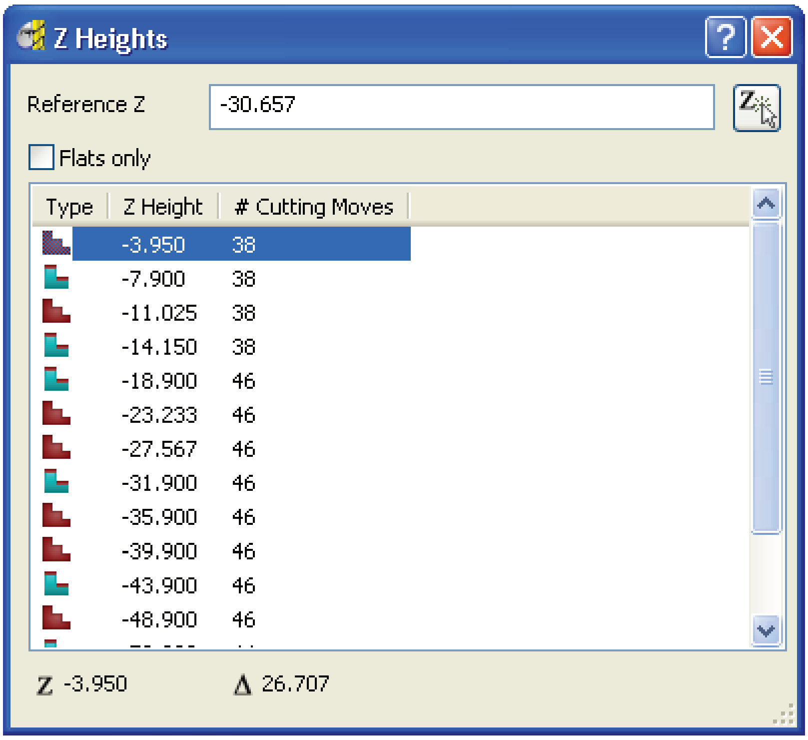


### Viewing a toolpath at an isolated Z height level



*Even though you are viewing a particular isolated level in the toolpath, any changes you make at a Z height will be applied to the toolpath as a whole.*

To view an individual Z height slice of a toolpath, with the toolpath activated, click to bring up the **Z Heights** dialog, click through the **Z Height** list to examine the toolpath segments at the particular Z height.



**Number -** divides the block equally into the defined number of Z Heights, the lowest of which will be at the bottom of the block.

**Stepdown -** creates a Z Height at the top of the block and then steps down a defined height in Z. The final Z Height will be at the bottom of the block.

**Value -** adds in additional Z Heights at a specified height.

**Intermediate -** adds in additional Z Heights between existing ones.

**Flat -** identifies flat areas of the model and creates Z Heights on these areas.

**Reference Z -** enter a Z value to view the toolpath segment nearest to the entered value.

**Pick a Z height from the model using the mouse -** click this button to select and set a reference Z from a particular feature of the model.

**Flats only -** select this option to view the part of the toolpath associated with flat regions of the model.

**Z -** the current Z height.

**Δ -** the difference between the current Z height and the reference Z.

To simulate tool movements at a particular Z height, right-click on the toolpath segment that you want to simulate, and select **Toolpath > Simulate from Nearest Point**.

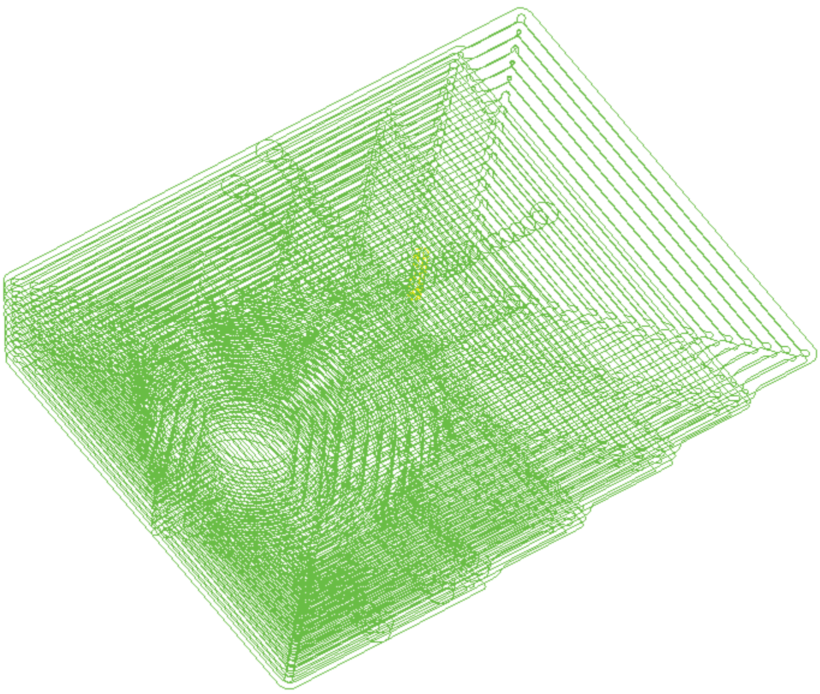
*You can also right-click on a toolpath and select the **View Picked Z Height** option to access the **Z Heights** dialog.*

## Viewing toolpaths by Z height

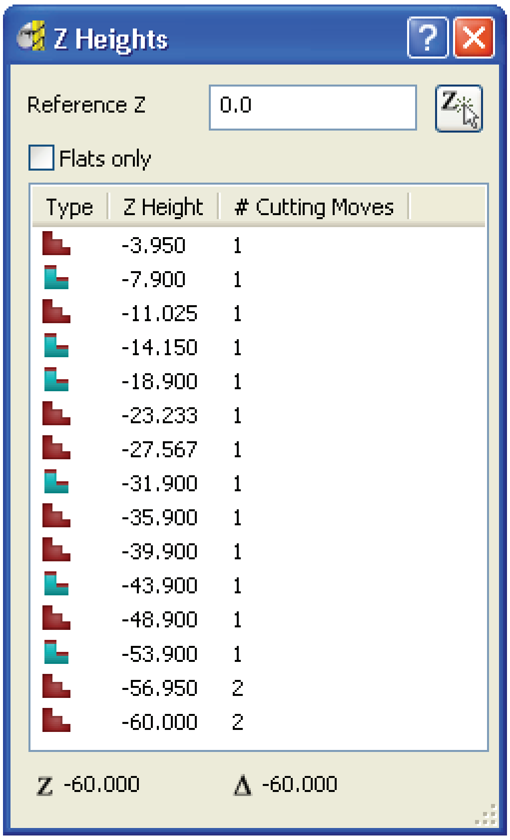
This is a simple example to demonstrate how to use the **View Toolpath by Z height** button and the **Z Heights** dialog. This example uses the **flats.dgk** in the **Examples** folder.

1. Define a **Block** around the model.
2. Create a **Model Area Clearance** strategy, and:
   a. Select **Style** as **Offset all**.
   b. Enter a **Stepover** value of 5.0.
   c. Create an end mill tool with a **Diameter** of 5.0.
   d. Click **Calculate** to create the toolpath.

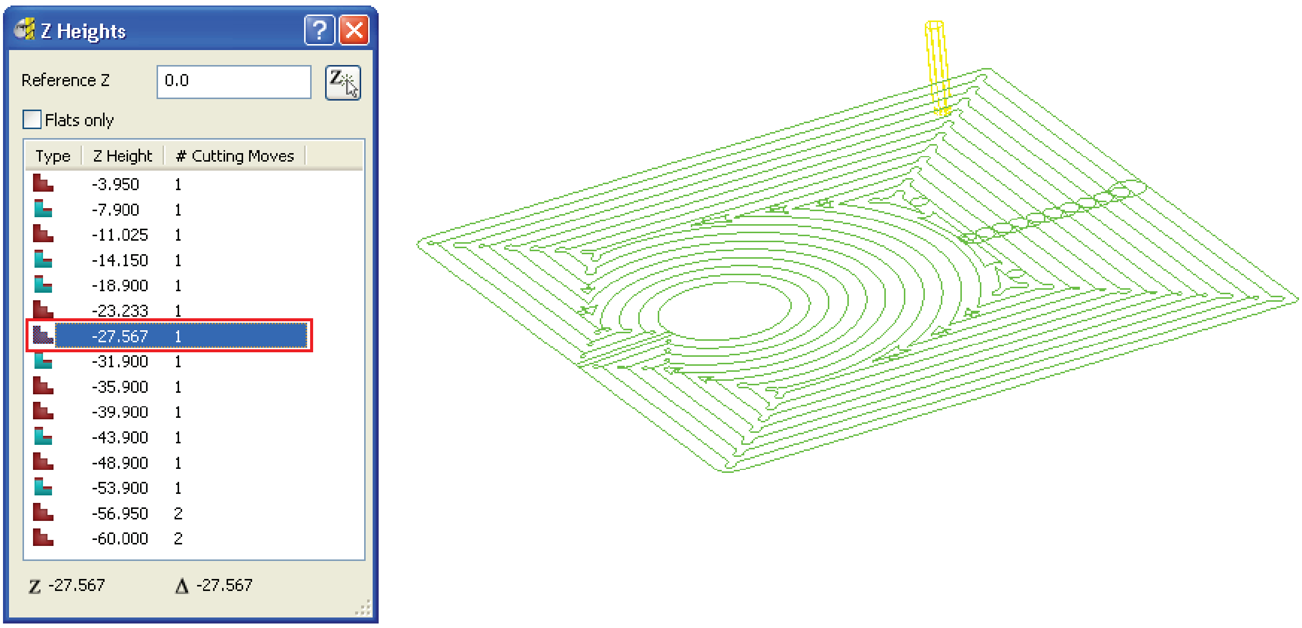
   The toolpath is now calculated for the model.



3. On the **Toolpath** toolbar, click  to display the **Z Heights** dialog. The Z heights available in the toolpath are listed in the **Z Height** list.

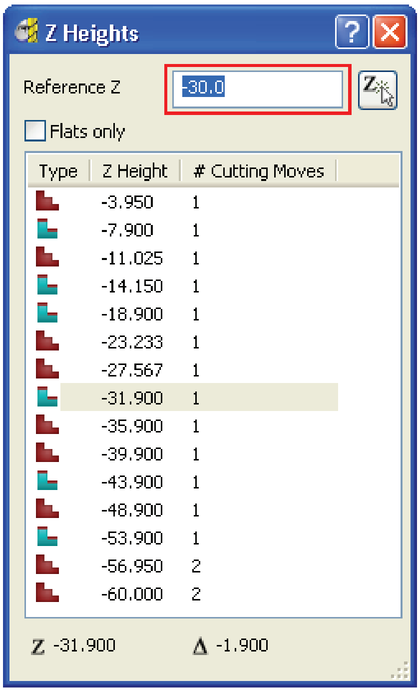


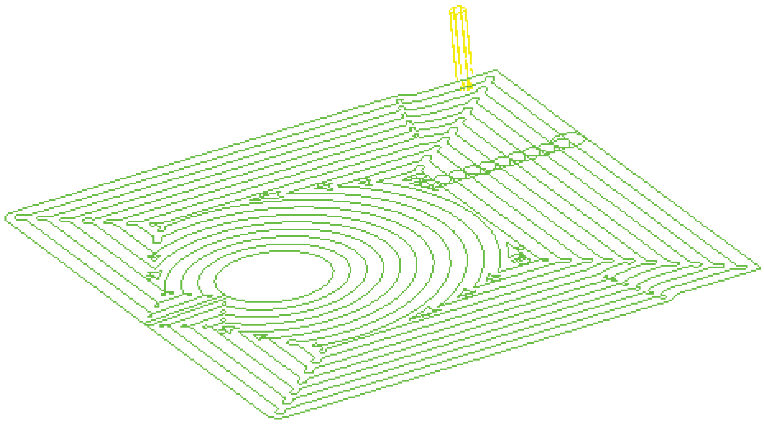

Click through the list to view the toolpath segment at a particular Z height.



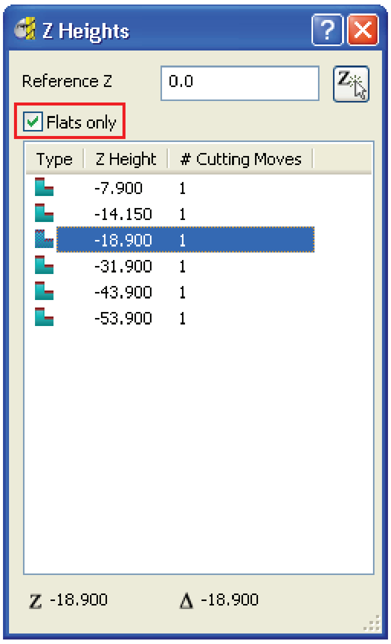
You can also:

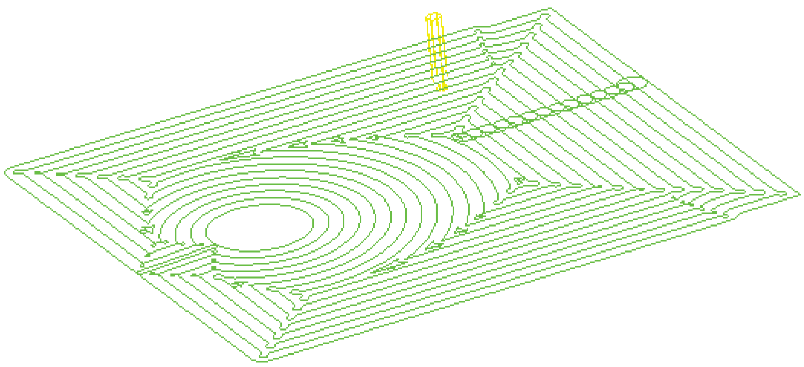
- Enter a **Reference Z** - to view the toolpath segment nearest to the entered value.



- Use  to pick a Z height from the model to use as the reference Z.
- Select **Flats only -** to view the toolpaths segments associated with only flat regions of the model.

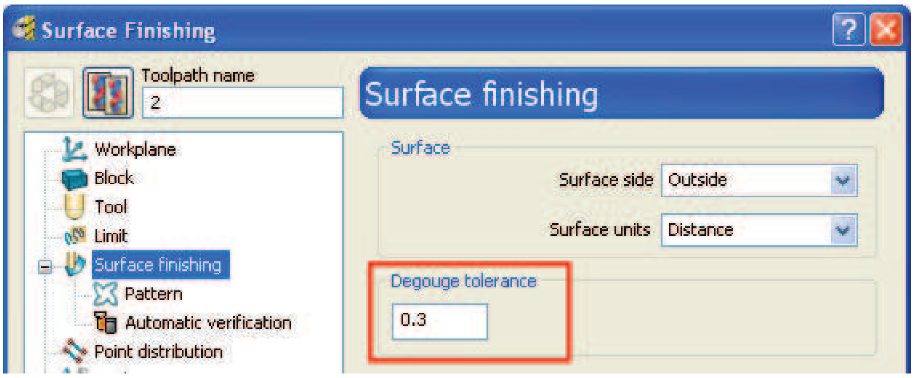


 *If you select a segment and click* *, the Z height view will start on the selected Z height.*

# Surface finishing improvements

Surface finishing has a new option of **Degouge tolerance**.




**Degouge tolerance -** the maximum distance, normal to the surface, that the toolpath can move to find a safe position. If gouges greater than this value are detected, then the tool is lifted axially to avoid the gouge.

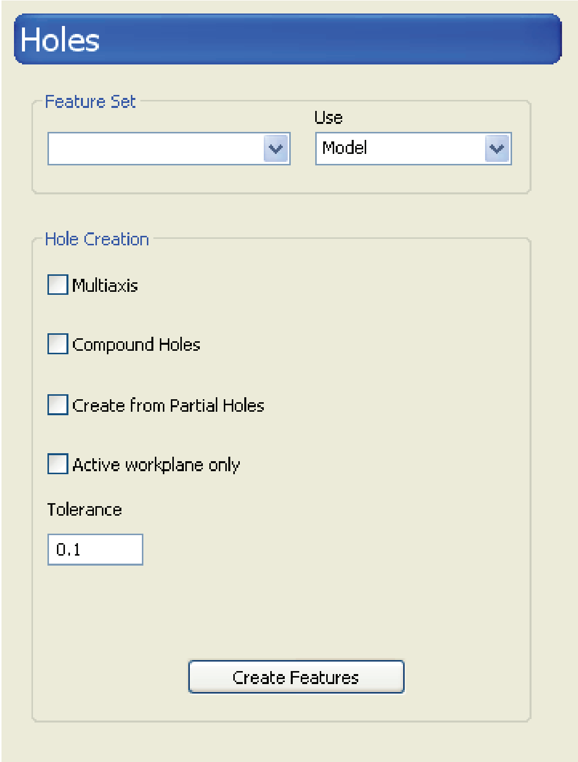
# Flat machining improvements

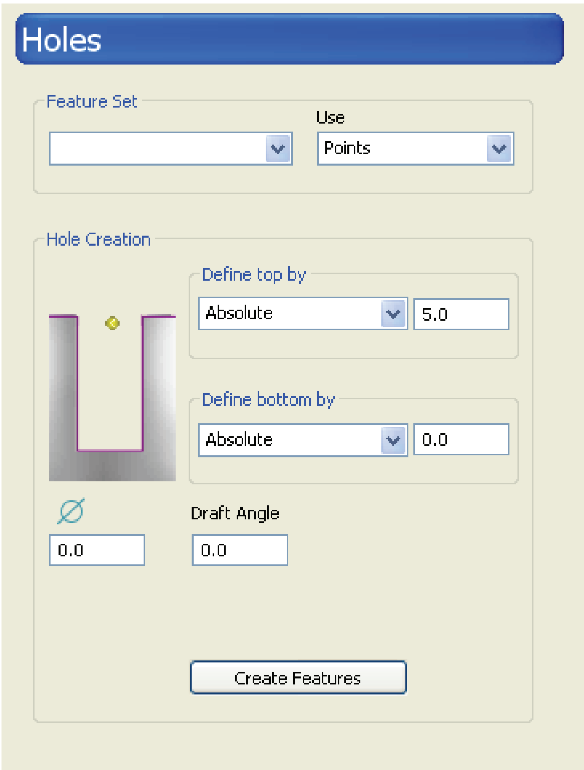
Flat machining now works on triangle models as well as surface models.

# Drilling improvements

You can now create holes from the drilling dialog. You no longer have to create a feature set and then create the holes in the explorer.

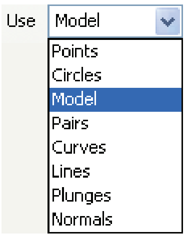
The options displayed depend on the **Use** option selected.




- the feature set in which the holes are created.

**Use -** determines how the holes are recognised.




**Points -** creates holes from points in the pattern. These points define the centre of the hole.

**Circles -** creates holes from circles in the model. The **Diameter** field is greyed out since the circles define this for you.

**Model -** creates holes which have been fully defined in the surface model as a single surface with a defined top and bottom.

**Pairs -** creates holes from pairs of circles in the model.

**Curves -** creates holes from any curve in the model that will flatten into a circle in the given workplane.

**Lines -** creates holes from lines in the pattern. These lines define the top, bottom, and axis of a hole.

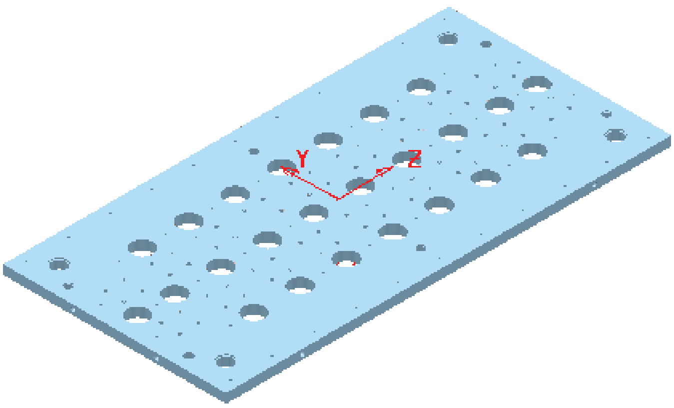
**Plunges -** creates holes from the plunge moves of the active toolpath.

**Normals -** creates holes from the contact normal moves of the active toolpath.

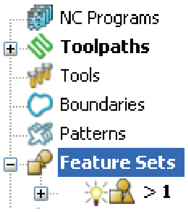
**Hole creation** allows you to select how and which holes are created.

**Multi-axis -** when selected, all the holes are placed in one feature set (so PowerMILL assumes that you can handle multi-axis drilling). When deselected, the holes are sorted into feature sets by workplane (so PowerMILL assumes that you can handle 3+2-axis drilling).

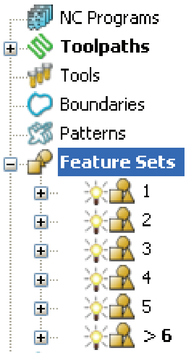
Starting with the **RetainerPlate.dgk** model, an active workplane, and the whole model selected:



**Multi-axis** selected:

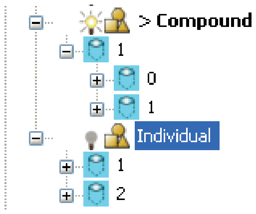



**Multi-axis** deselected:




**Compound holes -** when selected, one compound hole containing several components is created. When deselected, several individual holes are created (superimposed on each other).

You can see the difference between the representation of a compound hole and an individual hole in the explorer.



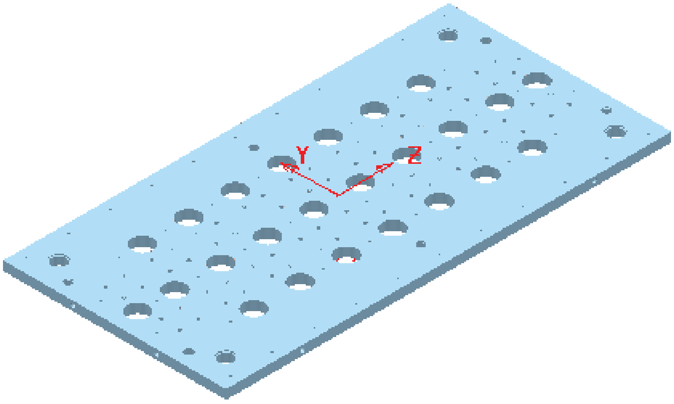

For more information, see **Compound Holes**.

**Create from partial holes -** enables the creation of holes from a model that has poorly or incompletely defined holes. For example, PowerMILL will create a hole from a pair of arcs.

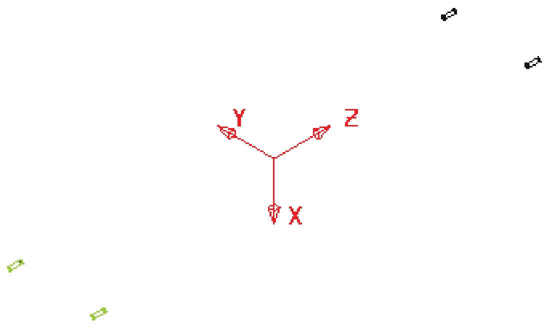
*This option should always be used as a last resort as it may find many unwanted (or unexpected) holes.*

**Active workplane -** only creates holes whose Z axis aligns with the Z axis of the active workplane.

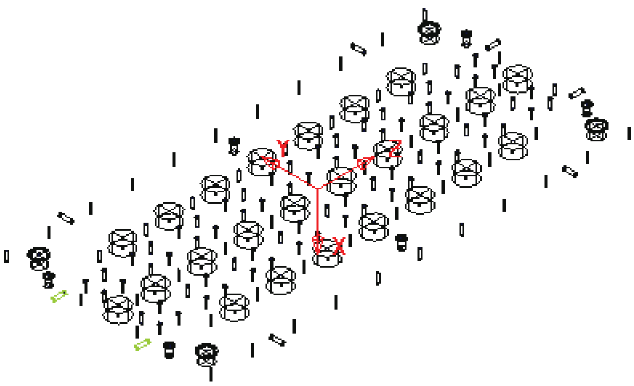
Starting with the **RetainerPlate.dgk** model, an active workplane, and the whole model selected:




**Active workplane only** selected:

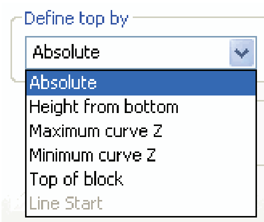



**Active workplane** deselected:



**Tolerance -** the distance below which two end points are considered coincident.

**Define top by -** the height of the top of the hole.

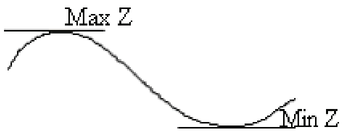



**Absolute -** defines the Z height at the top of the feature as an asolute Z height.

**Height from Bottom -** defines the top as a distance from the bottom of the feature.

**Maximum Curve Z -** all features use a curve (bits of model or pattern) as the input data . These curves have a minimum and a maximum z value which can be used for feature definition. This input method is also very useful for hole definition where you have a set of Z positions that represent the top or bottom of the hole. So this is the maximum Z height of the selected curve to determine the top of the feature.

**Minimum Curve Z -** this is the minimum Z height of the selected curve to determine the top of the feature

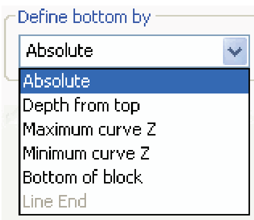



**Top of Block -** defines the top as the height of the top of the block.

**Line Start -** defines the top as the start of the line. This option is only available if you have a **Use** of **Lines**.

**-** specifies the value of the height of the top of the feature.

**Define bottom by -** the height of the bottom of the hole.




**Absolute -** defines the Z height at the bottom of the feature.

**Depth from Top -** defines the bottom as a distance from the top of the feature.

**Maximum Curve Z -** this is the maximum Z height of the selected curve to determine the bottom of the feature.

**Minimum Curve Z -** this is the minimum Z height of the selected curve to determine the bottom of the feature.

**Bottom of Block -** defines the bottom as the height of the bottom of the block.

**Line End -** defines the top as the end of the line. This option is only available if you have a **Use** of **Lines**.

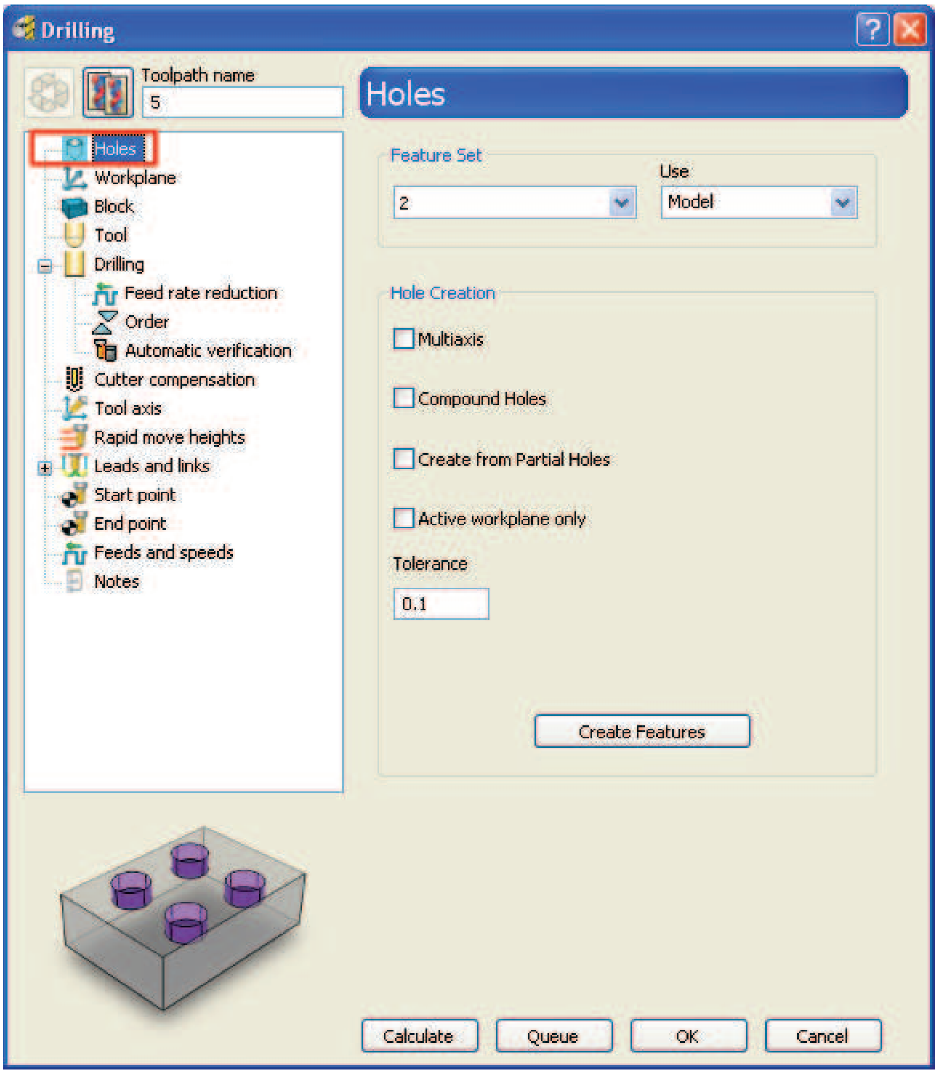
**-** specifies the value of the height of the bottom of the feature.


**-** diameter of the hole.

**Draft angle -** creates a hole with a draft angle.

**Create features -** creates a new feature, in the active feature set, with the parameters defined here.

*You must select the model, or part of the model,where you want to create holes.*




The options displayed depend on the **Use** option selected.

These options are the same as those available from the **Create** tab on the **Feature** dialog (available from the **Feature sets** right click menu).

# Parallel processing

As with PowerMILL 10.0, one of the most important, but least visible improvements in PowerMILL 2010 is the use of parallel processing.

In PowerMILL 2010 parallel processing has been implemented on:

- Basic 3-axis strategies including:
  - Corner finishing strategies, especially corner pencil finishing which calculates twice as fast on a quad core machine in PowerMILL 2010 than it did in PowerMILL 10.0.
  - Area clearance, especially roughing.
  - Constant Z, especially when using low tolerances.
  - 3D offset, especially when using low tolerances.
- Some of the new functionality including:
  - Tool holder profile.
  - Smooth 3D offsets.
  - Corner clearance.
- Tool axis smoothing in:
  - 3D offset.
  - Constant Z.
  - Steep and shallow.

Parallel processing works automatically if your computer is suitable, you don't need to do anything to activate it.

# Toolpath verification

When verification splits a toolpath, the leads and links are preserved where appropriate, on the resulting toolpaths. This includes any leads and links that are defined through selective editing.

Simulation can now synchronise the movement of two axes of a robot. This enables you to keep one arm of the robot stationary whilst jogging a different arm.

ViewMill now allows a negative overhang.

The **Table attach point** at the top of an .mtd file now defines the position of the PowerMILL origin. This is useful when machine tools are defined with an origin somewhere on the floor at the base of the machine. When the machine is loaded into PowerMILL, the PowerMILL origin then corresponds to the machine tool origin, and so the model, block.... are located at an inappropriate position on the machine. To correct this, so that the PowerMILL origin is located on the table of the machine tool, specify a **Table attach point** to locate the PowerMILL origin. You can still use a workplane to reorientate the position, if required.

This is backward compatible with existing mtd files since the table attachment point is:

- not defined, in which case it defaults to 0 0 0.
- defined to be 0 0 0, in which case the PowerMILL origin is at the machine tool origin.

*This functionality is especially useful for robots where the origin in the cell may be somewhere unrelated to the machine.*

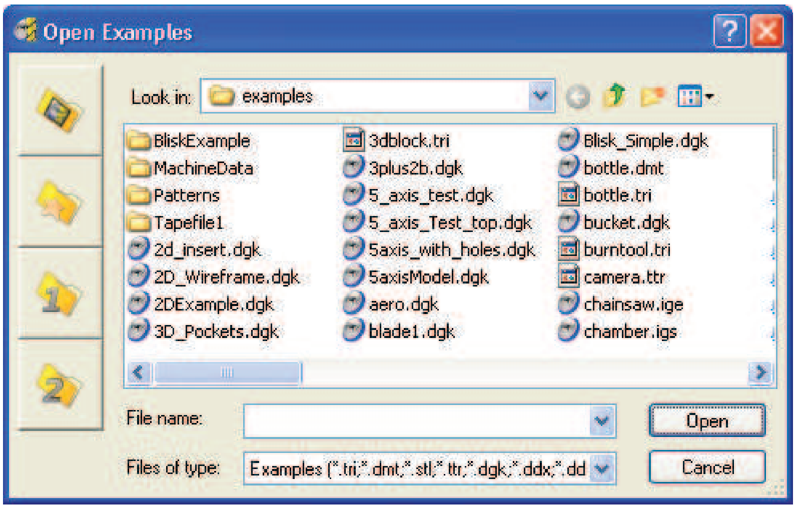
# Toolpath output

This topic has not been fully documented yet.

# User interface

## Open and Save dialogs

The project **Open** and **Save** dialogs now have customisable buttons. These are very similar to the **File Open** and **Save** dialogs, which themselves have been updated.

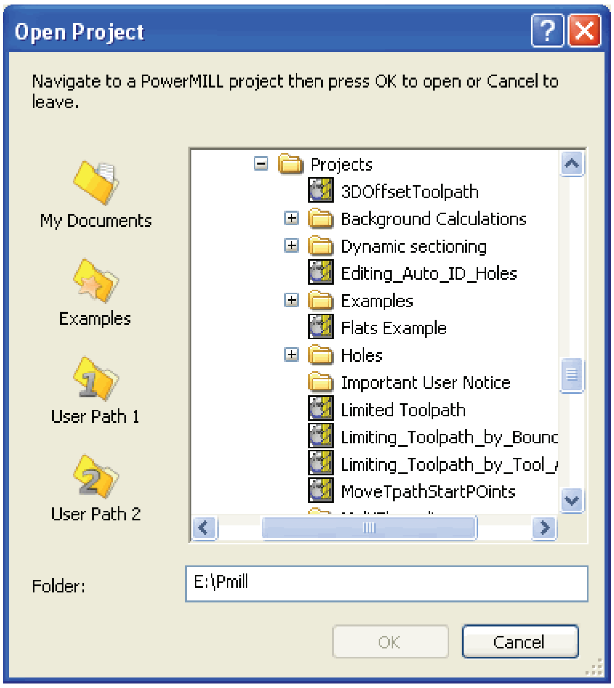


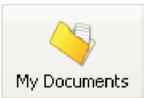

 **-** changes the directory to the current **Project** directory.

 **-** changes the directory to the **Examples** directory. This is defined using **Tools > Customise Paths**.

 **-** changes the directory to the user defined directory. This is defined using **Tools > Customise Paths**.

 - changes the directory to the user defined directory. This is defined using **Tools > Customise Paths**.



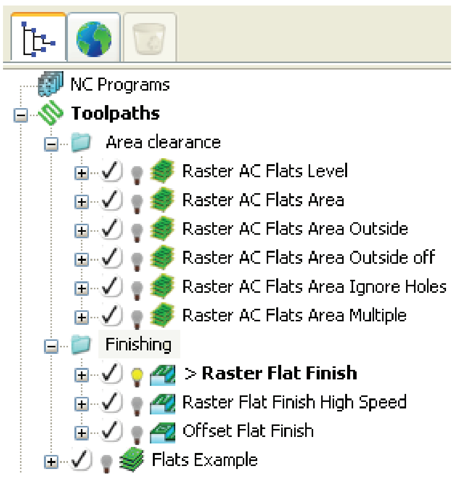



- changes the directory to the **My Documents** directory.

# Entity lists show folder structure

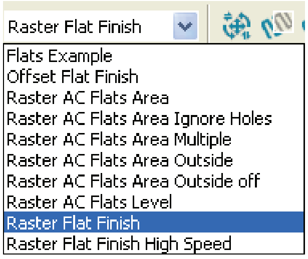
Entities in drop down lists, now show the same folder structure and icons as in the explorer.

Looking at these toolpaths in the explorer:



In PowerMILL 2010, the active toolpath list on the **Toolpath** toolbar displays the folder structure and icons, which makes it far easier to find the required toolpath:


In PowerMILL 10.0, the active toolpath list on the **Toolpath** toolbar doesn't display the folder structure or icons, it displays a flat list which makes it harder to find the required toolpath:



# General enhancements

When you start PowerMILL 2010 for the first time, you are asked if you want to upgrade to the new tool database. Clicking **Yes** upgrades to the new version and creates a backup of your old database. This enables your existing database to use all the latest database functionality, such as the new tool holder functionality (see page 19).

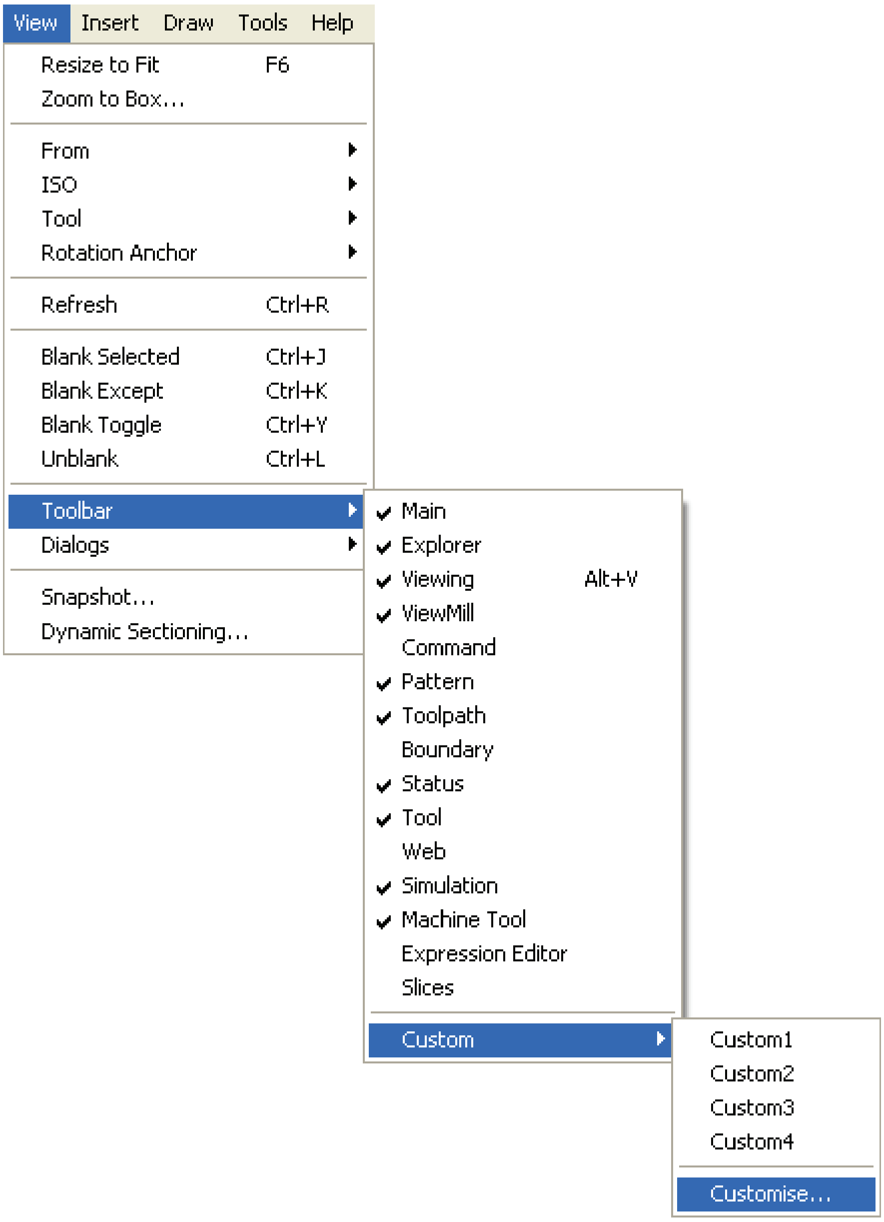
# Custom toolbars

Using a custom toolbar, you can have the menu options, toolbar buttons, commands, and macros that you use frequently, available at a single location.

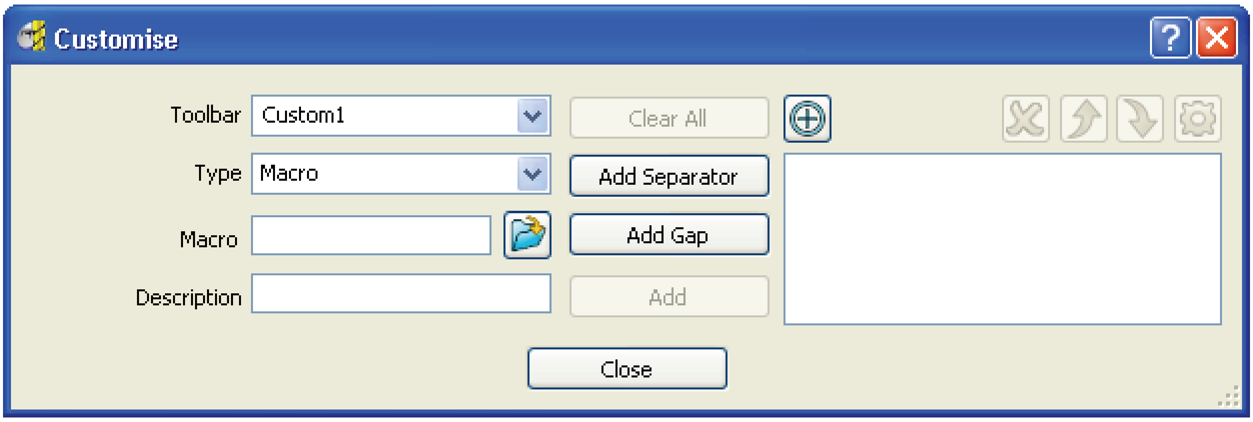
You do not need to remove these from an existing toolbar or menu, you can duplicate them on your custom toolbar and they will work in exactly the same way as the original menu or button.

Like a normal toolbar, custom toolbars can be moved around the screen to have them in the place that you find most convenient.

To create a custom toolbar, from the PowerMILL main menu, select **View > Toolbar > Custom > Customise...**.



Use the **Customise** toolbar dialog to create or modify a custom toolbar.




*You can create up to four custom toolbars. By default, custom toolbars are named Custom1, Custom2, and so on. You can rename them in the* ***Customise*** *dialog.*

To select a custom toolbar, from the PowerMILL main menu, select **View > Toolbar > Custom** and select the custom toolbar.

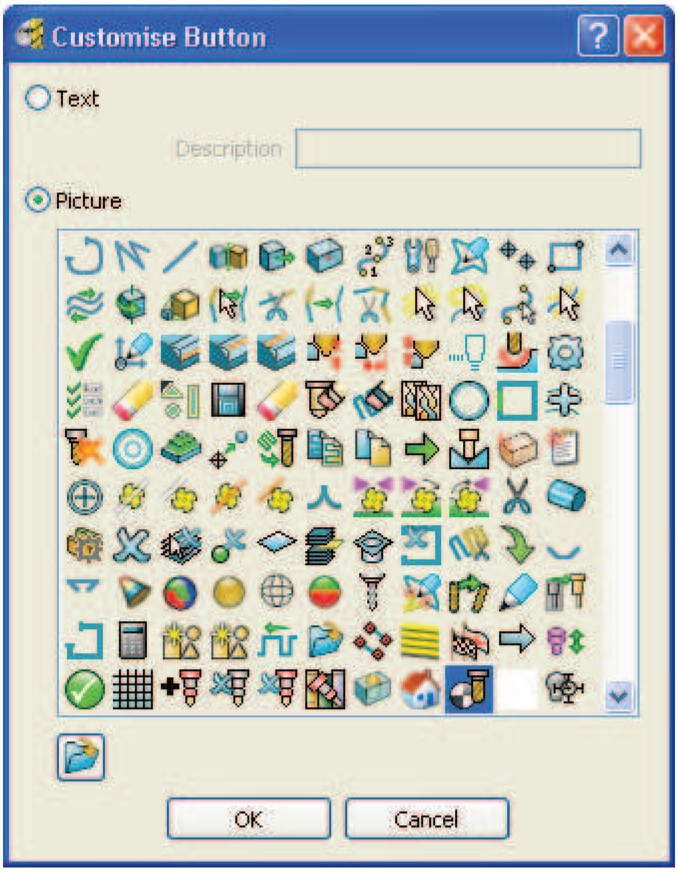
## Creating and modifying a custom toolbar

To create a custom toolbar:

1. From the main PowerMILL menu, select **View > Toolbar > Custom > Customise...**. The **Customise** toolbar dialog appears.
2. In the **Toolbar** list, enter the name of your toolbar or select a toolbar from the list.
3. In the **Type** list, select:
   - **Menu** (see page 160) **-** to select items from the PowerMILL main menu.
   - **Toolbar** (see page 160) **-** to select items from various PowerMILL toolbars.
   - **Command** (see page 161) **-** to add a PowerMILL command to the custom toolbar.
   - **Macro** (see page 161) **-** to select a macro to be represented as a button on the toolbar.

To further modify the toolbar, click:

- **Add Separator** - if you want to add a separator between the buttons.
- **Add Gap** - if you want to add spaces between your toolbar buttons.
- **Clear All** - to remove all buttons from the custom toolbar.
- To remove individual buttons, select the button you want to remove and click .
- To change the order of the buttons, select the button you want to rearrange and click  or  to move it.
- To modify the button text or image, click  to open the **Customise Button** dialog and make modifications.

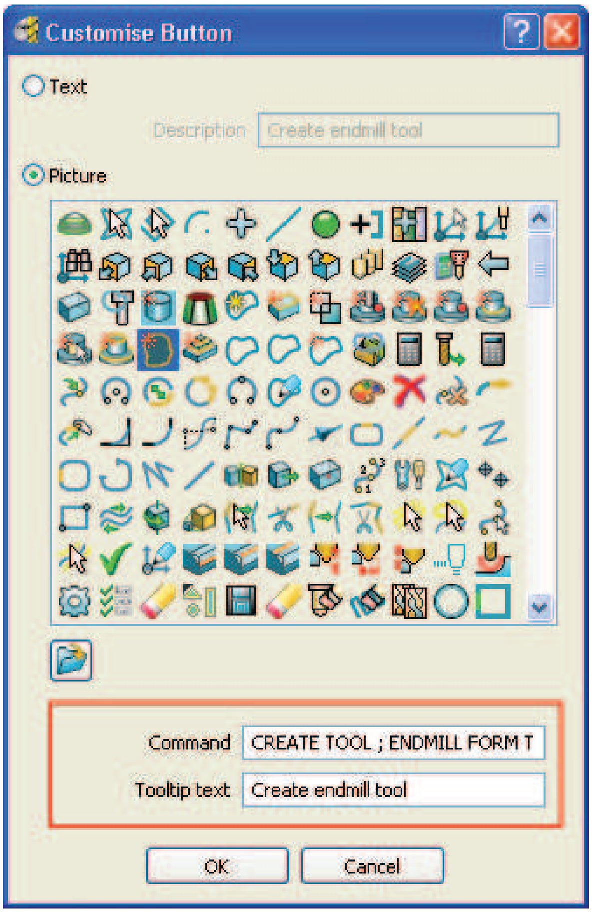


To modify buttons for **Menu** and **Toolbar**:

- Select the **Text** option and enter a **Description** for the button name;
- or select the **Picture** option and choose an icon from the list to represent your button;
- or click  to select a custom image for your button.

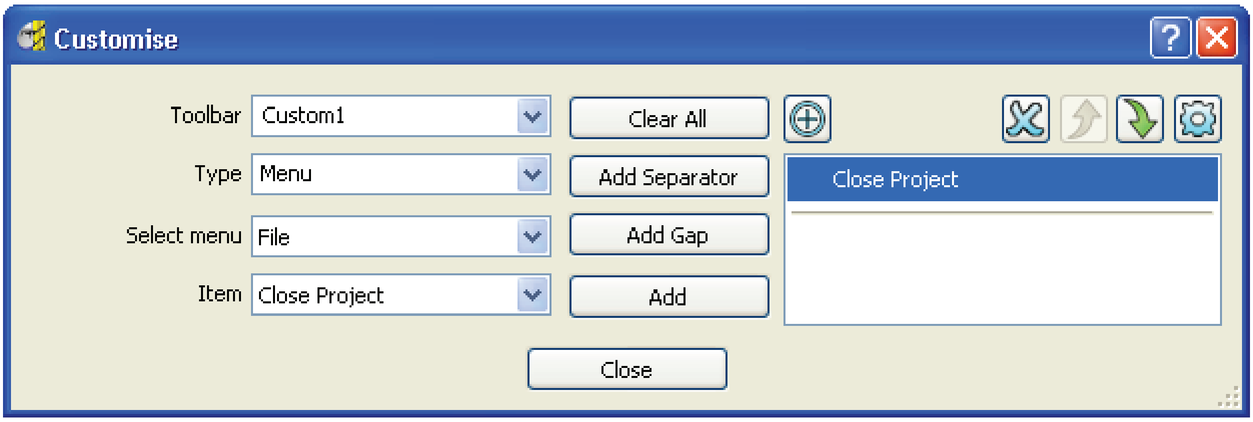
When you select a **Command** or a **Macro** button to modify, the **Customise Button** dialog enables you to make modifications to the original command or macro.

## Custom Command




## Custom Macro

## Customise Toolbar - Menu




To add a menu to the custom toolbar:

a. Select **Menu** from the **Type** list.

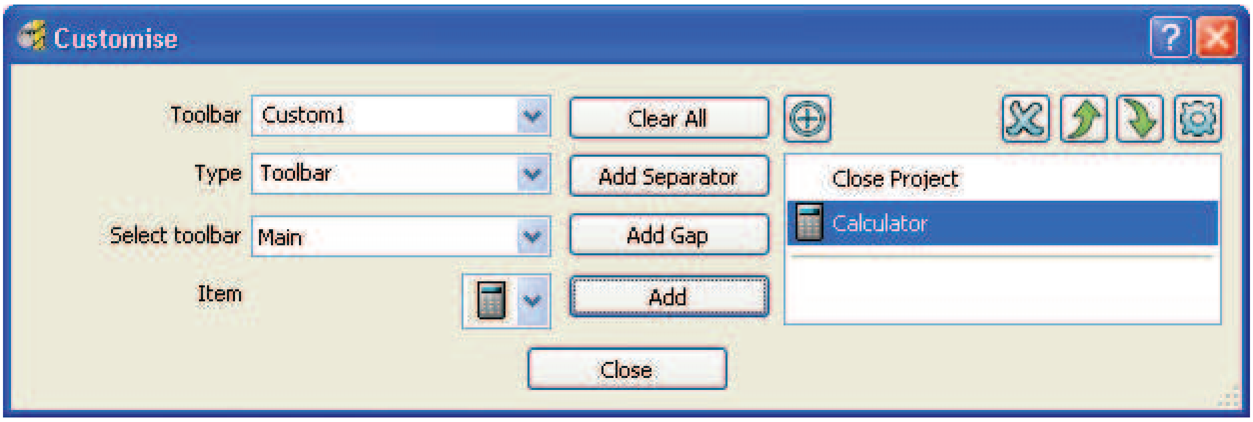
b. Select the menu you want from the **Select menu** list, for example, **File**.

c. Select a sub menu from the **Item** list, for example, **Close Project**.

d. Click **Add**.

A button with the name of the menu you selected is added to the custom toolbar.

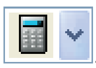
## Customise Toolbar - Toolbar




To add a button from any PowerMILL toolbar to the custom toolbar:

a. Select **Toolbar** from the **Type** list.

b. Select the toolbar you want from the **Select toolbar** list, for example, **Main**.

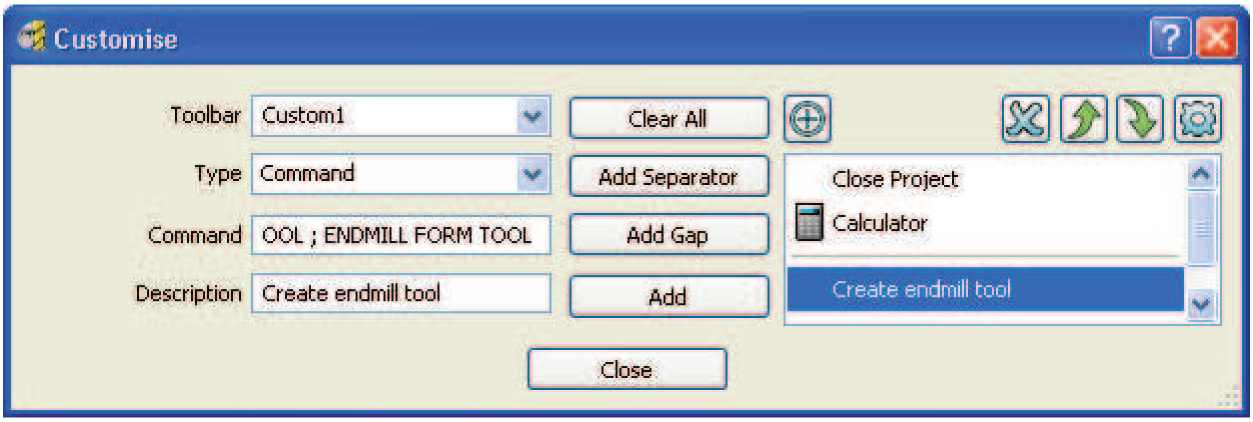
c. Select a toolbar item from the **Item** list, for example, .

d. Click **Add**.

The toolbar button you selected is added to the custom toolbar.

*You can also click and drag the button and drop it onto the button that you want to add to the custom toolbar.*

## Customise Toolbar - Command




To add a PowerMILL command to a custom toolbar:

a. Select **Command** from the **Type** list.

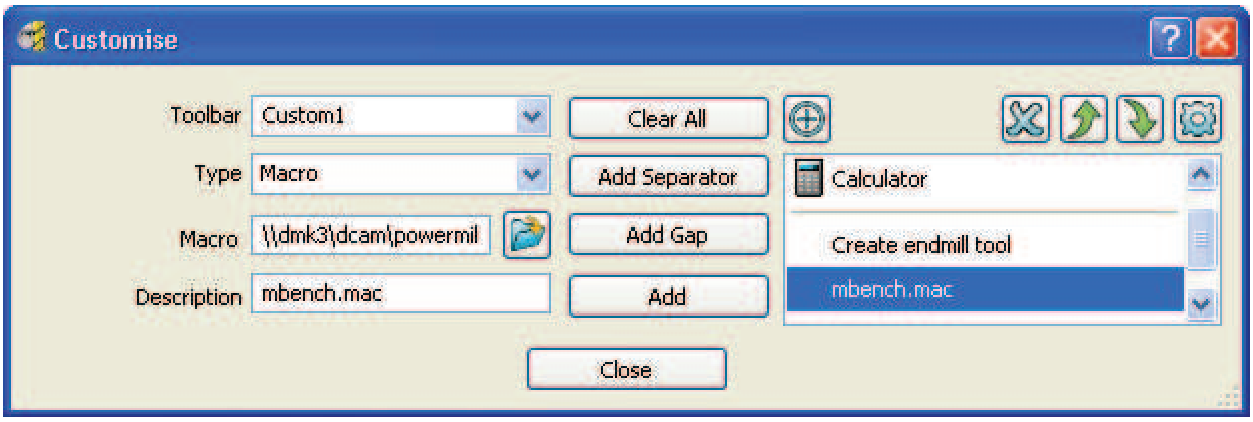
b. In **Command,** enter the PowerMILL command, for example, CREATE TOOL ; ENDMILL FORM TOOL.

c. Enter a name for the command button in **Description**, for example, Create endmill tool.

d. Click **Add**.

The command button you created is added to the custom toolbar as a button.

## Customise Toolbar - Macro




To add a PowerMILL macro to a custom toolbar:

a. Select **Macro** from the **Type** list.

b. In **Macro**, enter the path or click and select the macro file.

c. Enter a name for the macro button in **Description**.

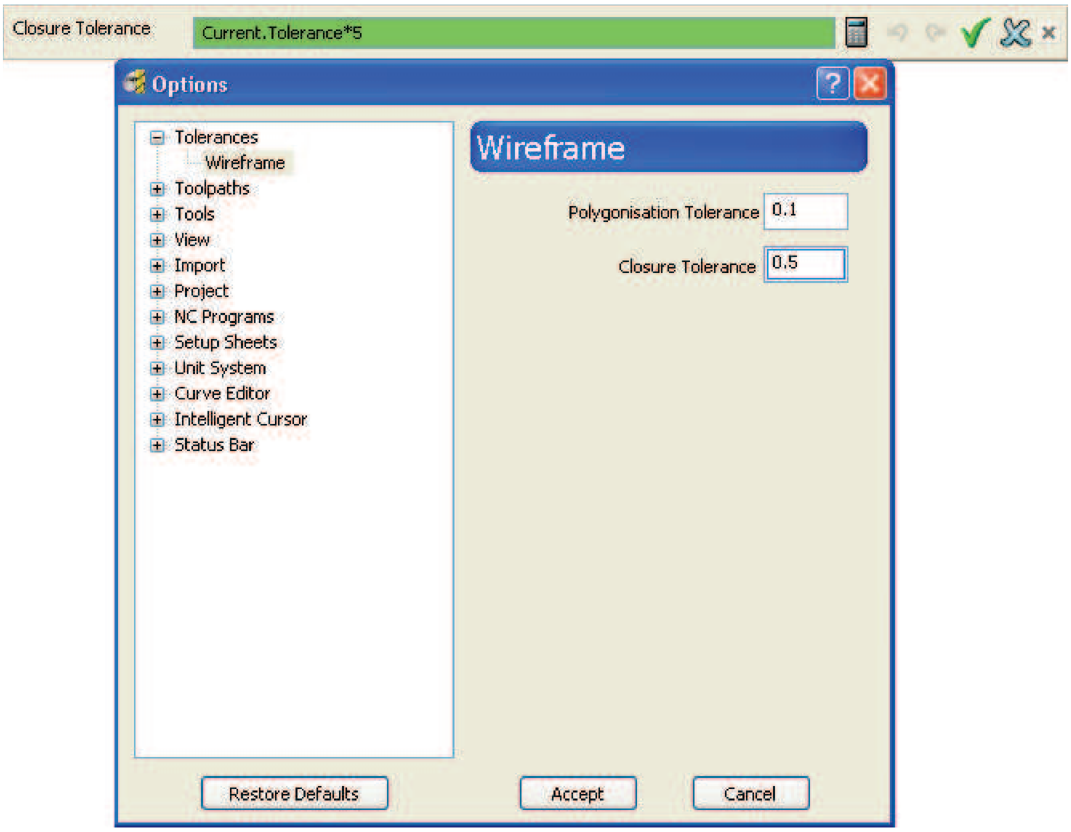
d. Click **Add**.

The macro button you created is added to the custom toolbar as a button.

# Tools > Options system parameters

The user definable values available under **Tools > Options** are system parameters. These parameters can be used to create expressions; and the fields which allow user definable values retain expressions for further use.

In this example, the **Closure Tolerance** is defined as the expression Current.Tolerance*5, and the expression is viewed on the **Expression Editing** toolbar.



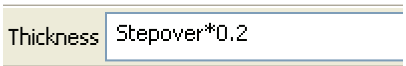

The fields which contain retained expressions are shown as . Click inside the field to view the expressions (see page 163) on the **Expression Editing** toolbar.

# Expression Editor

**Expression Editor** lets you create and calculate expressions in PowerMILL.

*If the **Expression Editor** is not displayed, from the PowerMILL main menu, select **View > Toolbar > Expression Editor** to display it.*

*By default, the **Expression Editor** displays the values in the PowerMILL fields that is currently selected.*



- the name and value of the currently selected field is displayed on the toolbar. If the field contains an expression, it is displayed.

 **Evaluate expression -** toggles between displaying calculated value and expression.

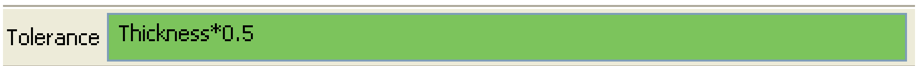
 **Undo -** undo last edit.

 **Redo -** redo last edit.

 **Accept -** accept expression or value after evaluation. If you click  when an expression is displayed, the expression is copied into the field; when a value is displayed, only the value is copied into the field.

 **Cancel -** cancels all edits. This cancels any changes you made and reverts the field to what it was before you started editing.

To activate the **Expression Editor** to perform calculations and evaluate expressions, click inside a PowerMILL field so that the field value is displayed in the toolbar, and then click the field inside the **Expression Editor**. The field changes colour to indicate it is selected.

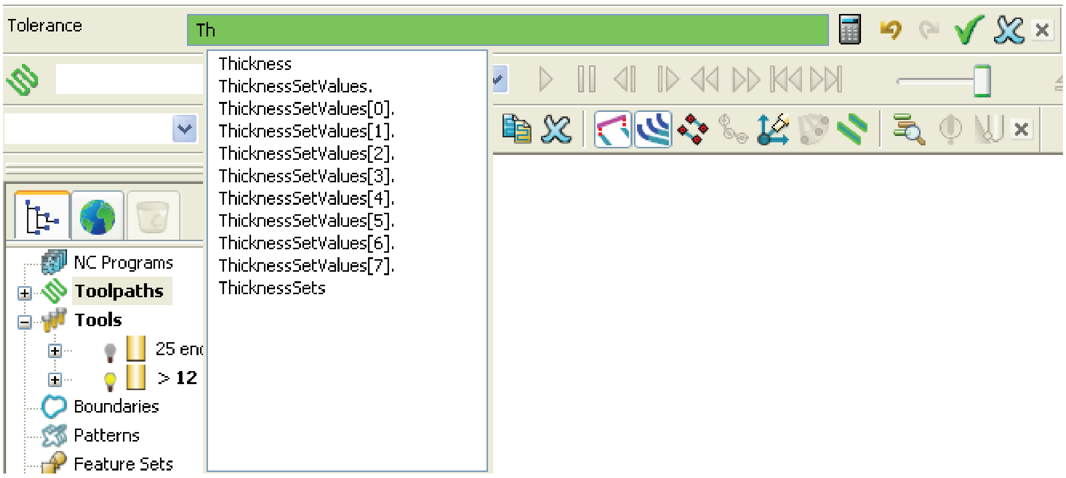



*You can also right-click inside a field and select **Expression Editor** from the context menu to activate it.*

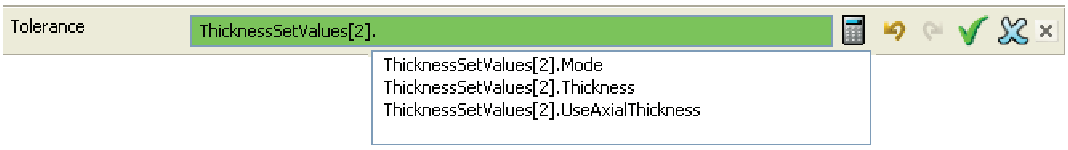
The expressions can be as simple as tool.diameter/2 or it can be as complex as cos(45)*sqrt(((tool.diameter/2)^2)-(((tool.diameter/2)-tolerance)^2))*2.

*The toolbar calculates parameter values based on the context it is used. For example, if you enter tolerance when the value is checked from the boundary dialog, it is calculated as boundary tolerance and when checked from the toolpath dialog, it is calculated as toolpath tolerance.*

You can create expressions by typing parameters into the **Expression Editor** or by selecting a field in a dialog. The **Expression Editor** suggests parameters which start with the same characters you have entered. For example, typing Th into the toolbar lists all parameters available which start with the word Th, such as, **Thickness, ThicknessSets, ThicknessSetValues**, and so on.




The parameter names which have a "**.**" after them require an additional value to complete it. When you select the parameter name which contains a "**.**", a list which contains the possible values to create the complete parameter, is displayed.




*The list of parameters to construct expressions in PowerMILL is available from:*

- ***Help > Parameters > Reference** - contains detailed documentation of expression parameters available in PowerMILL.*
- ***Help > Parameters > Summary** - contains a summary of expression parameters available in PowerMILL.*

When you have finished constructing the expression, click ✓ to accept the expression into the field from where it was initially called.

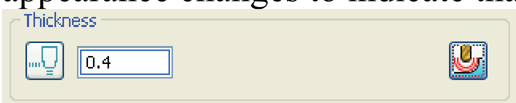
*When you click the currently displayed entry is copied into a field.*

*So, if an expression is displayed, it is copied into the field and the field changes to to indicate it contains a retained expression.*

*If a calculated value is displayed when you click , only the value is copied into the field and the expressions used to calculate the value is discarded.*

## Using the Expression Editing toolbar

This example demonstrates how to use the **Expression Editing** toolbar when working with retained expressions in the **Model Area Clearance** strategy dialog.

1. On the **Main** toolbar, click to display the **Strategy Selector** dialog.
2. From the **3D Area Clearance** tab, select the **Model Area Clearance** toolpath strategy.
3. In the **Thickness** field, enter the expression tolerance*4 and press **Enter**. The result is displayed in the **Thickness** field and the field appearance changes to indicate that it now contains an expression 

.

   *If any of the values cannot be zero, PowerMILL displays the value in the field as* ***@error****.*

   Click inside the **Thickness** field to view the expression in the **Expression Editing** toolbar.

   PowerMILL calculates and displays the **Thickness** value based on the tolerance and retains the expression to use in future calculations.

   If you make any changes to the **Tolerance** value, PowerMILL automatically recalculates the **Thickness**.

### To make changes to the expression using the Expression Editing toolbar:

1. Click inside the **Thickness** field to display the expression in the **Expression Editing** toolbar.

2. Click inside the **Expression Editing** tool bar to activate it. The **Expression Editing** toolbar appears green.
3. Change the expression to tolerance*10.


*To see the result of the calculation, click  to toggle between the result and the expression.*

4. Click  to accept the expression and copy it into **Thickness** field.

*If you want to copy just the result but not the expression into a field, click  to display the result and then click .*

*You can use imperial values in a metric project or metric values in an imperial project. For example, if the thickness of the toolpath is tolerance times 1/8 of an inch, you can enter tolerance*(1/8 in).*

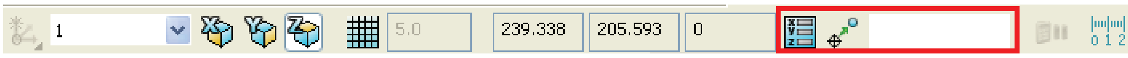
*The list of parameters to construct expressions in PowerMILL is available from:*

***Help > Parameters > Reference -*** *contains detailed documentation of expression parameters available in PowerMILL.*

***Help > Parameters > Summary -*** *contains a summary of expression parameters available in PowerMILL.*

# Status bar additons

The Status bar has some extra options.




The **Position** button is new and the coordinates buttons were on the **Curve Editor** toolbar.

**Position -** moves entities using typed coordinate input rather than using the cursor. This is a new option.

**Relative/Absolute Coordinates -** toggles between relative and absolute coordinates.

**Relative Coordinates -** the entities are moved by the amount specified in .

**Absolute Coordinates -** the origin of the entities is moved to the coordinates specified in .

**Coordinates -** enter the coordinates here in the form x y z. For example, to move the origin by 10.4 in x, 25.6 in y, and 12.2 in z, enter 10.4 25.6 12.2.

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