Autodesk® PowerMill® 2019

User Guide

PowerMill Additive



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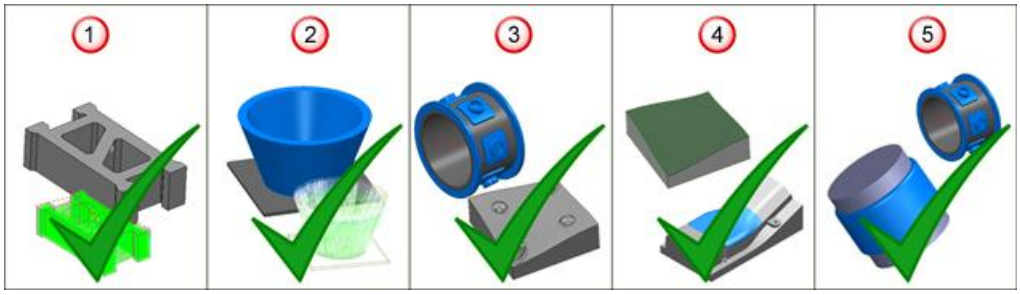
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About PowerMill Additive

PowerMill Additive is a plugin that enables you to create toolpaths for additive or hybrid manufacturing, that is driven by directed energy deposition. It utilizes PowerMill's existing multi-axis CNC and robot capabilities to create multi-axis additive toolpaths with detailed process parameter control along every point of the toolpath. These process parameters enable you to finely control the operations of deposition at a toolpath point level.

PowerMill Additive is targeted to address the part classes 1 to 5.



1. Linear 2.5D extrusions — walls and bricks.
2. Surfaces of revolution — buckets.
3. Features on: cylinders, planes, and arbitrary bases.
4. Surface coating — patches and single layers.
5. Coaxial features — 360 degrees.

Part classes 6 to 10 require a combination of functionality available in PowerShape and PowerMill in addition to the PowerMill additive plugin to create suitable toolpaths.



6 Blades and blisks — varying cross-section.

7 Multi-axis sweep — varying cross-section tubes.

8 Non-adaptive repair.

9 Adaptive repair.

10 Artisan.

Working with PowerMill Additive

When you install PowerMill Additive the plugin adds a new tab to the PowerMill ribbon. The ribbon is organised into sections:

- **Create Toolpaths** contains a collection of methods to create additive toolpaths. These range from dedicated strategies and the commands to create their drive curves, to manually converting a subtractive toolpath .
- **Editing** contains options to edit the layering of calculated toolpaths and modify their process parameters.
- **Visualisation** contains tools to view toolpaths by layer and an additive ViewMill animation of material build-up.
- **Export** contains the option to export your toolpaths to Netfabb Simulation Utility.

There are three types of additive toolpath strategies, each optimized for increasingly complex geometry:

- Use Netfabb strategies to deposit 2.5D components on planar base surfaces.
- Use Surface Coating to coat an existing shape with new material, providing it with a protective layer. Surface Coating works with: planar, cylindrical, surface of revolution, or arbitrary base surfaces.
- Use Feature Construction to build complete features on a base surface, for example a blade on a cylindrical hub. Feature Construction works with: planar, cylindrical, surface of revolution, or arbitrary base surfaces.

Each strategy supports process parameters. These enable you to finely control physical actions in the deposition process along the toolpath, for example: wire-feed speed, powder-flowrate, or power.

This workflow leads you through the steps to create an additive toolpath in PowerMill:

1. Prepare your models
   a. Create workplanes with maximum Line of Sight.
   b. Organise your surfaces into Levels and Sets.
2. Choose a strategy.
3. Specify a base surface.
4. Specify the:
   - Region to deposit for Surface Coating strategies.
   - Feature surfaces to deposit for Feature Construction strategies.
5. Specify the style of deposition.
6. Specify the layering information.
7. Set the process parameters.
8. Calculate the toolpath.



This document assumes that you have basic PowerMill knowledge including the use of Levels and Sets, installing plugins, and creating Patterns with the Curve Editor.

Model preparation

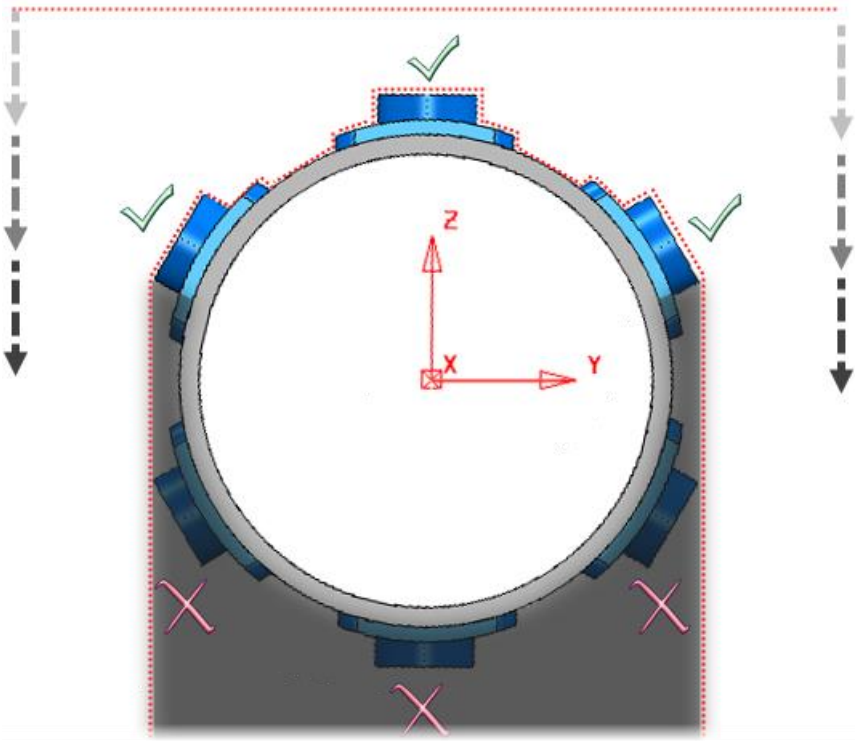
Additive toolpaths are calculated from the surfaces of your CAD model. To calculate additive toolpaths you must prepare the surfaces of your CAD model to meet the additive manufacturing requirements in PowerMill:

- Surfaces must be organised into Levels and Sets.
  - Surfaces can be included in one Level only, but can be included in multiple Sets.
  - If you want to use a feature surface as a base surface of another feature, it must exist on its own Level or Set.
- Your base surface must:
  - be isolated on a single Level or Set.
  - be a continuous surface, or multiple contiguous surfaces, with no holes.
  - be larger than the feature it supports.

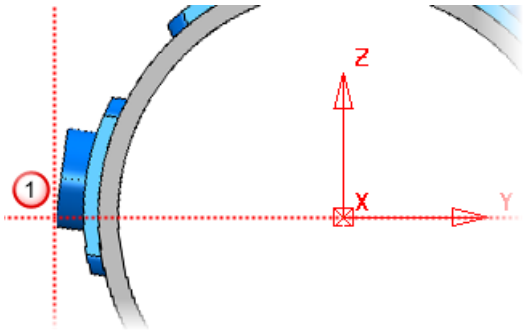
Additionally where sharp junctions occur in your geometry try to replace them with fillets before calculation. This is to avoid rapid changes in the tool axis or its velocity, which can negatively affect the flow of deposition. After deposition the junctions can then be machined to their final shape.

About Line of Sight

When calculating additive toolpaths, PowerMill considers only the surfaces that are visible to a plane projected down the Z-axis of a specified workplane. The visible surfaces are said to be in the Line of Sight of the workplane. If a surface is obscured and therefore not within the Line of Sight, it is not included in the calculation.



Surfaces with faces that are near-vertical to the Line of Sight (1) can lead to sub-optimal toolpaths.



To prevent sub-optimal toolpaths try to create a toolpath from a different workplane, with a more suitable Line of Sight.

Organizing your surfaces into Levels and Sets

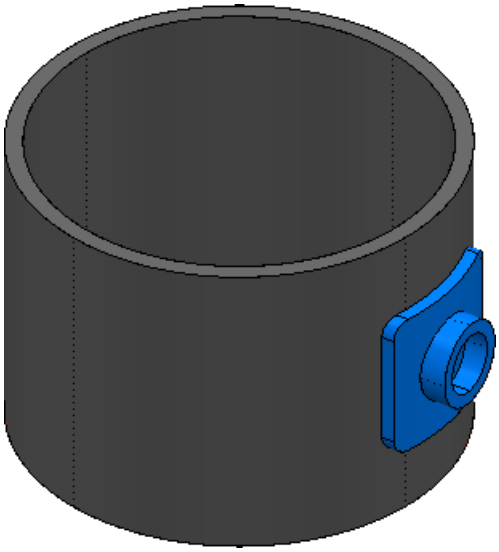
Organize your model surfaces into Levels and Sets to ensure optimum results when calculating an additive toolpath.

A Level or Set can contain multiple surfaces, however individual surfaces can only belong to one Level at a time. Use Levels for surfaces that are only used once. Additionally, base surfaces must exist on a Level or Set as the only surfaces on that Level or Set.

Individual surfaces can belong to multiple sets, which enables the surfaces to be used in many combinations with other surfaces. Use Sets for surfaces that have multiple roles.

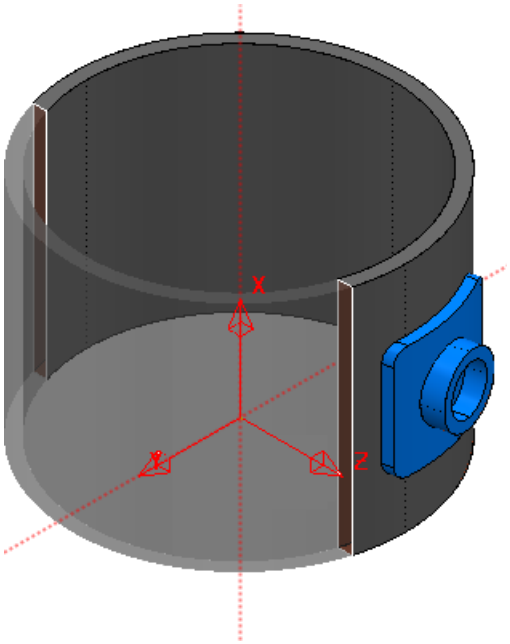
The following example demonstrates how you can separate your surfaces into Levels and Sets:

1. Import your model.

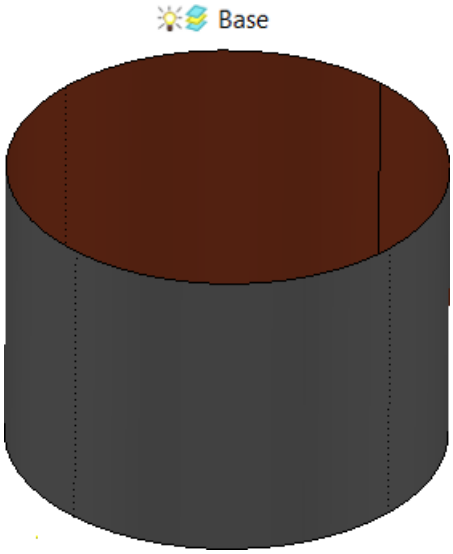


2. Orient the Z-axis of your workplane to provide the best Line of Sight of the feature.

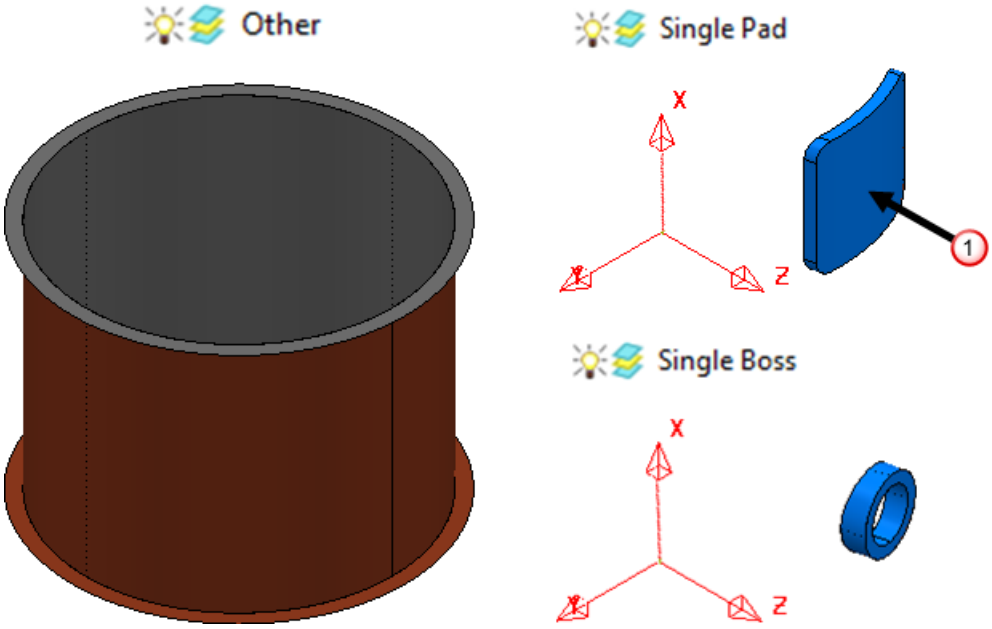
The X-axis needs to be aligned with the axis of revolution for cylinders and surfaces of revolution.



3 Select the cylindrical base surface and add it to a new Level.

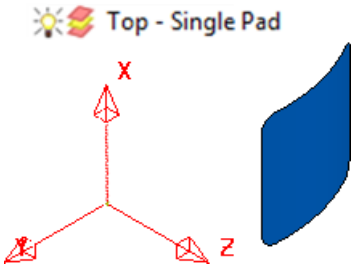


4 Separate the surfaces of the features onto their own Levels.



The boss feature is deposited onto the pad feature. This means that the top pad-surface (1) is used as the base surface for the boss-feature calculation in addition to being part of the pad-feature calculation. Therefore, this surface must be included in a Set.

5 Create a new Set and add the top pad-surface to it:



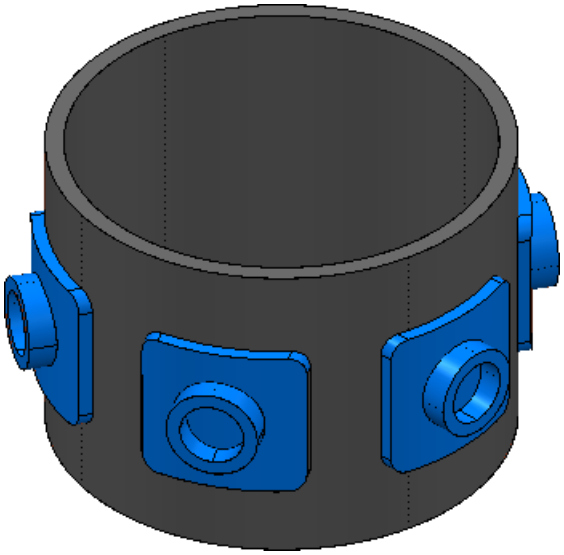
This enables you to re-use the top pad-surface as a base surface for the boss feature without including the wall pad-surfaces. Using the entire pad feature as a base for the boss feature could lead to the toolpath rolling over the junctions between the top and wall surfaces.

Organizing surfaces for a base with multiple features

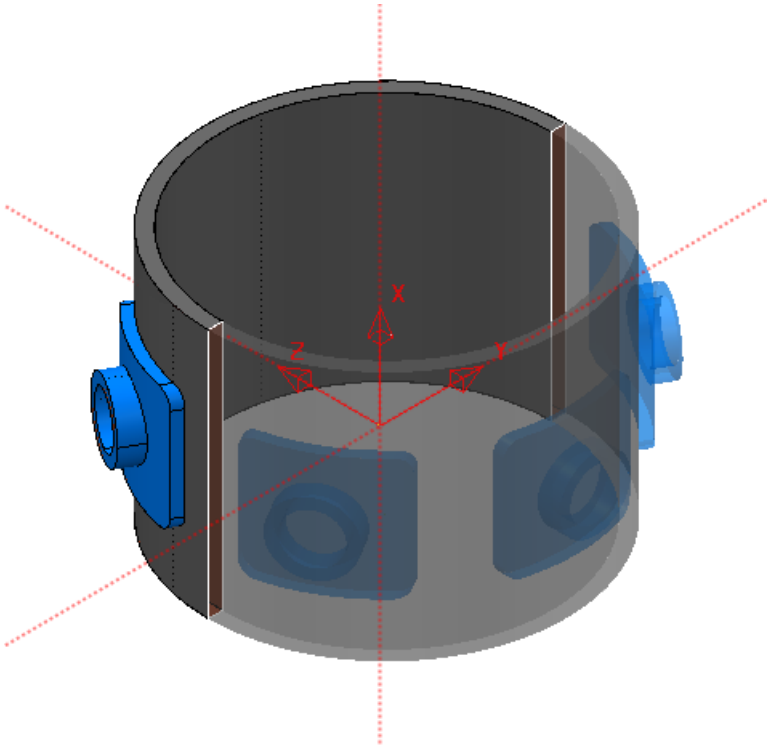
For a base which houses multiple features where Line of Sight might be an issue you must calculate multiple toolpaths using different workplanes. This ensures all the features are contained within the Line of Sight of a workplane.

The following example demonstrates how you can separate your surfaces into Levels and Sets for multiple features:

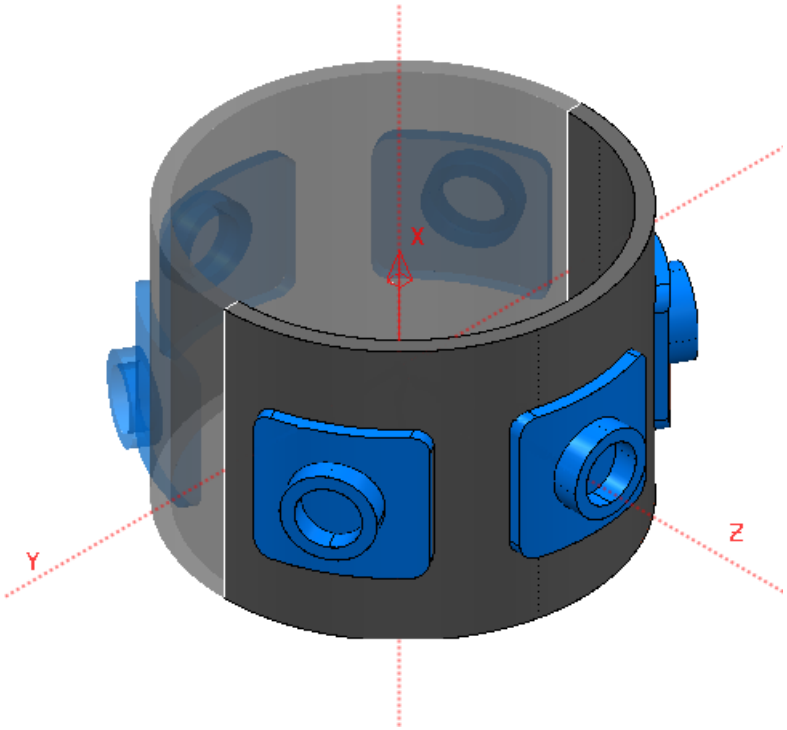
1 Import your model.



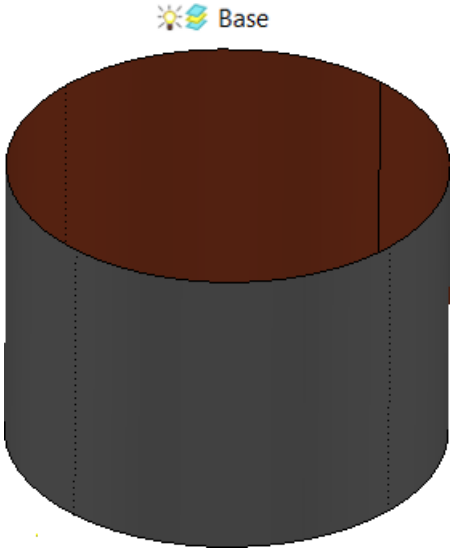
2 Orient the Z-axis direction of your workplane to provide a suitable Line of Sight for a group of features.



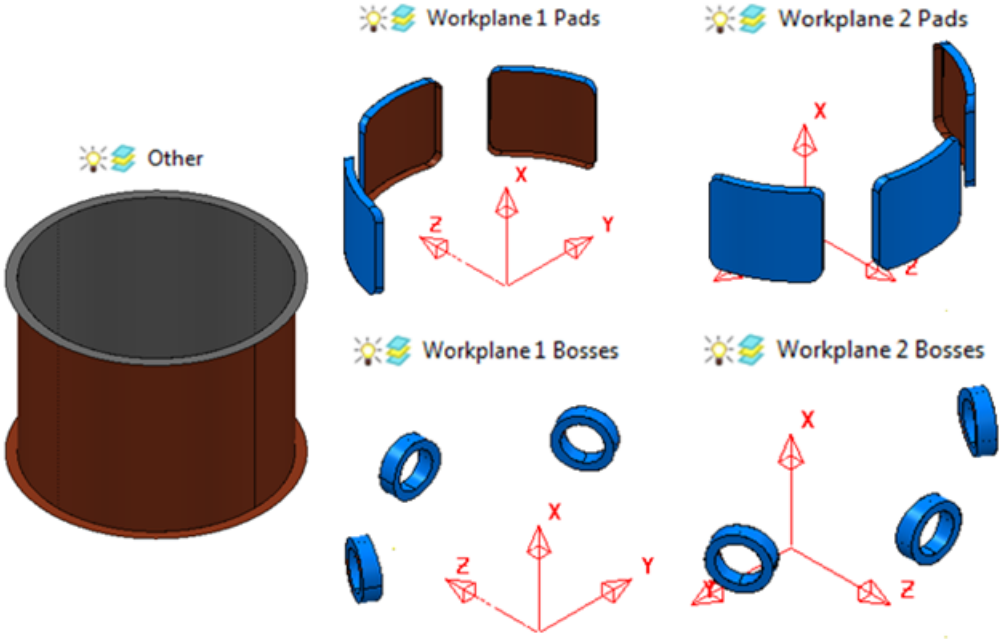
3 Create another workplane and orient its Z-axis direction to capture the remaining features within its Line of Sight.



4 Select the cylindrical base surface and add it to a new Level.

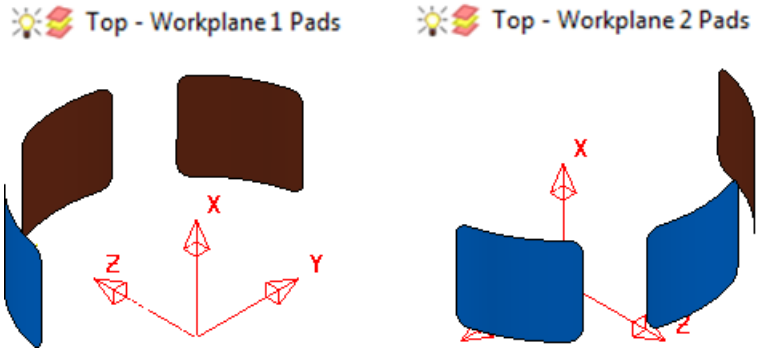


5 Separate the surfaces of the features onto their own Levels.



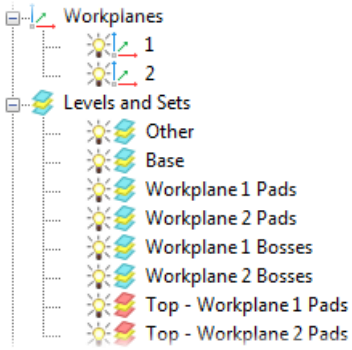
The boss features are deposited onto the pad features. This means the top pad-surfaces are used as the base surfaces for the boss-feature calculations in addition to being part of the pad-feature calculations. Therefore, these surface must be included in their own Sets.

6 Create new Sets for the top pad-surfaces and add the surfaces for their appropriate workplanes to the Sets:



This enables you to re-use the top pad-surfaces as base surfaces for the boss features without including the wall pad-surfaces. Using an entire pad feature as a base for a boss feature could lead to the toolpath rolling over the junctions between the top and wall surfaces.

Your surfaces are now organized to calculate toolpaths for multiple features:

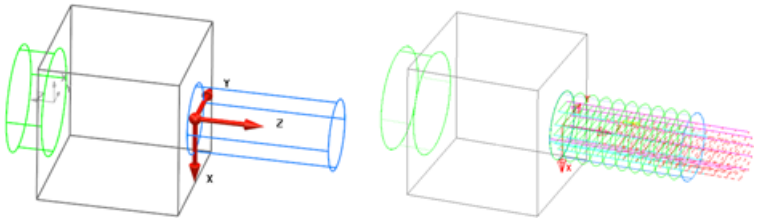


Additive toolpaths and strategies

About Netfabb strategies

Toolpaths created from a Netfabb strategy are generated by analysing and slicing 3-dimensional models into 2.5-dimensional information, as a collection of two-dimensional layers with thickness, known as slice stacks.

Slicing is performed by creating a cross-sectional image of the model geometry along the positive Z-axis (+Z) of a specified workplane. Any model geometry below the origin of the workplane is ignored during slicing.



To create a Netfabb strategy toolpath

Use a Netfabb strategy to create a toolpath for a 2.5D part.

1. Click Netfabb for PowerMill tab > Create Toolpaths Panel > Netfabb Strategies to display the **Netfabb Strategies** dialog.
2. Enter a name for the toolpath.
3. Choose an option from the **Initialised From** list to create a new toolpath or to recycle the settings from an existing toolpath. Select:
   - **<default>** to create a new toolpath.
   - an existing toolpath to copy its settings.
4. Select the **Model** page and specify which **Surfaces** of your model to use to calculate the toolpath.
5. Select the **Workplane** page and choose an item from the **Workplane** list to specify the axis system to use to create the toolpath.
6. Select the **Strategy** page.
7. Choose an option from the **Strategy** list to specify the method of toolpath calculation:
   - **Centreline Offset** — Creates a toolpath with passes that are offset parallel relative to the centreline of the surfaces.
   - **Oscillation** — Creates a toolpath with raster passes that alternate direction within a layer.
   - **SolidPart** — Creates a toolpath with raster passes and optional contour passes.

   *The option you choose here changes the options available on the **Path control** page.*
8. Specify the **Stepover**, **Layer thickness**, and **Layer slicing tolerance**.
9. Use the **Path control** page (see page 16) to fine-tune the toolpath calculation settings for the selected strategy.
10. Use the **Layer control** page (see page 18) to specify the thickness of the deposition layers.
11. Use the **Process parameters** page (see page 19) to specify the values of the deposition parameters that are applied at the start of the first segment.
12. Click **Calculate**.

Path control — Netfabb strategy

Use the options on the **Path control** page of the **Netfabb Strategies** dialog to fine-tune the toolpath calculation settings for the selected strategy. The available options are dependent on the selected strategy:

Centreline Offset

Parameter	Description
Wall offset	Distance from wall to be rejected by centreline segment for open or non-continuous segments.
Offset terminal portion	Branch termination distance of the centreline segment. Controls how the end points are treated.
Number of parallel passes	The number of parallel passes for each layer.
Stepover	The distance between parallel passes in a layer.
Point reduction	Enable to reduce the number of points on a curve where possible.
Point reduction tolerance	Specify the maximum distance between points when point reduction is enabled.

Oscillation

Parameter	Description
Stepover	Distance between parallel oscillation paths.
Oscillation angle	Angle of the raster oscillation. 0 degrees oscillates parallel to the X-axis, 90 degrees oscillates parallel to the Y axis.
Two angle rotation	Enable to use an absolute angle change between two angles instead of a continuous change.
Reverse oscillation orientation	Enable to reverse the raster oscillation direction between layers.
Oscillation angle increment	Enter an angle to incrementally rotate the raster oscillation-direction between layers.
Rotate oscillations with section	Enable to rotate the oscillation direction to be perpendicular to the wall width.

Fixed zero origin	Enable to use the fixed global origin to specify the start position of the oscillation path. Disable to use a local origin relative to the slice boundary.
Joints distance	Distance between two opposing oscillation paths.
Part offset	Offset distance of the outer part boundary. A positive offset creates larger material areas.
Contour path	Enable to create a contour path around the oscillation path.
Contour path offset	Offset distance of the contour path from the outer edge of the part.
Treat narrow walls	Enable to create oscillated paths for narrow walls.
Narrow wall width	The upper wall-width limit to which narrow walls will be treated with a single bead deposition path.
Narrow oscillation width	Smallest wall width on which to create oscillation paths.
Small segment tolerance	The distance used to specify when small line segments are removed from paths.
Join segments factor	Whole number tolerance used to control when to join adjacent oscillation segments together.

SolidPart

Parameter	Description
Stepover	Distance between raster paths.
Raster to border distance	Distance between the part border and the raster paths.
Raster angle	Angle of the raster paths.
Two angle rotation	Enable to use an absolute angle change between two angles instead of a continuous change.
Reverse raster direction	Enable to reverse the raster direction between layers.
Raster angle increment	Enter an angle to incrementally rotate the raster direction between layers.

Part offset distance	Distance from the part outer boundary, to the start of the rasters (or the contour).
Contour path	Enable to create a contour path around the raster paths.
Additional offset count	The number of additional contour paths around the raster paths.
Additional offsets distance	Offset distance of the additional contour paths.
Fixed zero origin	Enable to use the fixed global origin to specify the start position of the raster path. Disable to use a local origin relative to the slice boundary.
Smart sorting	Enable to order the raster paths to minimize their retract moves.
Flexible raster spacing	Enable to allow a variable step over distance.
Alternating raster direction	Enable to alternate the direction of adjacent raster paths.
Join segments	Enable to join adjacent raster segments. It is possible only to join segments when raster directions are alternating.
Width tolerance to join segments	Whole number tolerance used to control when to join adjacent raster segments together.
Create contour path only	Enable to calculate only the internal and external part-boundary contours.

Layer control — Netfabb strategy

Use the **Layer control** page of the **Netfabb Strategies** dialog to specify the thickness of the initial layers and the general layers. You might want to vary the thickness of the initial deposition layers as the thermal properties of the substrate will be different depending on whether you deposit onto the base surface or onto another layer.

This page contains the following:

- **First layer thickness** — Enter the thickness of the layer deposited onto the base surface.

- **Second layer thickness** — Enter the thickness of the layer deposited onto the first layer.
- **Third layer thickness** — Enter the thickness of the layer deposited onto the second layer.
- **Default layer thickness** — Enter the thickness of the subsequent layers deposited after the initial layers.

Process parameters — Netfabb strategy

Use the **Process parameters** page of the **Netfabb Strategies** dialog to specify the values of the deposition parameters that are applied at the start of the first segment. The deposition parameters are identified with a user-defined **Tag**. You must configure your post-processor to interpret the tags and translate them to physical changes in the deposition parameters.

This page contains the following:

- **From defined process** — Select this option to apply the process parameters from a pre-defined template to the toolpath.
  - **Base template** — Select an option from the list to specify the template of process parameters. The process parameters included in a template are displayed in a table. Double-click the **Value** of a process parameter to change it.
- **From toolpath** — Select this option to copy all the process parameter recipes from an existing toolpath.
  - **PowerMill toolpath** — Specify the toolpath to copy the process parameters from.

To recycle a Netfabb strategy toolpath

When you calculate a toolpath using a Netfabb strategy it is added to the **Toolpaths** node in the Explorer and is displayed as a Feature Construction toolpath. The settings used to specify the toolpath are displayed in a read-only PowerMill strategy dialog.

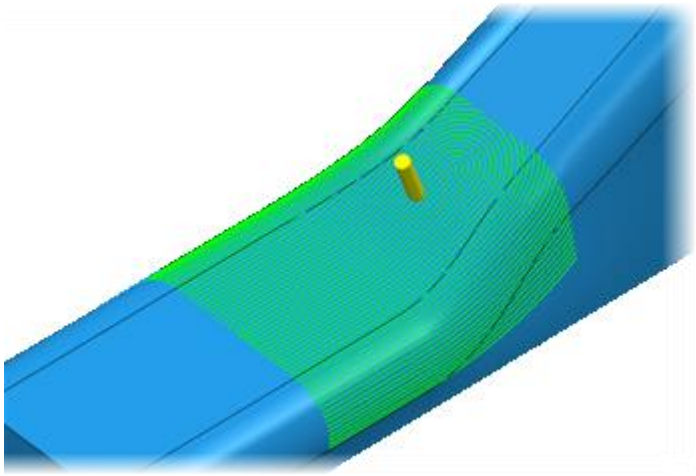
You cannot recycle a Netfabb strategy toolpath, instead you must create a new toolpath that is initialised from the original toolpath and then edit its settings.

To recycle a Netfabb strategy toolpath:

1. Click Additive tab > Create Toolpaths panel > Netfabb Strategies to display the Netfabb Strategies dialog.
2. Select the toolpath you want to edit from the **Initialised from** list.
3. Make your changes to the toolpath settings.
4. Click **Calculate**.

About Surface Coating strategies

Surface Coating strategies deposit single or multiple layers on a specified region of a base surface. They utilize PowerMill's multi-axis abilities, enabling the toolpaths to be calculated from non-planar base surfaces. They are useful for situations where you want to emboss a design or reinforce specific areas of a part.



Use a Surface Coating strategy when the region of deposition remains uniform at increasing heights above the base surface. For regions that vary with increasing height use a Feature Construction (see page 23) strategy.

To create a Surface Coating toolpath

Use a Surface Coating strategy to create a toolpath within a bounded region of a base surface.

1. Click Additive tab > Create Toolpaths panel > Surface Coating to display the **Surface Coating** dialog.
2. Enter **Toolpath name**.
3. Select the **Workplane** page and choose an item from the **Workplane** list to specify the axis system to use to create the toolpath.
4. Select the **Surface coating** page and in the **Base** area:
   a. Choose an option from the **Type** list to specify the base surface geometry.
   b. Select the Level or Set that contains the base surface from the **Surfaces** list.
5. Select a toolpath **Style** to use for depositing material:
   - **Raster** — Consists of parallel straight-line moves.

- **Offset** — Repeatedly offsets an initial drive curve until no further offset is possible.
- **Emboss** — Traces the toolpath directly on an embedded pattern.

6 Specify the limits of the deposition.

- For toolpaths with a **Style** of **Raster** or **Offset** define the deposition **Region** from: a boundary, surfaces, or specific coordinates.

  *The available options are dependent on the **Type** of base surface.*

- For toolpaths with a **Style** of **Emboss** specify the embedded pattern from the **Drive curve** list.

7 Specify the:

- **Tolerance** — Determines how accurately the toolpath follows the contours of the model.
- **Focal length** — The distance from the energy source to the tip where the bead forms. This is represented as a tool shank, and is required to provide correct simulation results for robot arms.
- **Bead width** — The width of the bead of material deposited.

8 In the **Stepover** area, specify the:

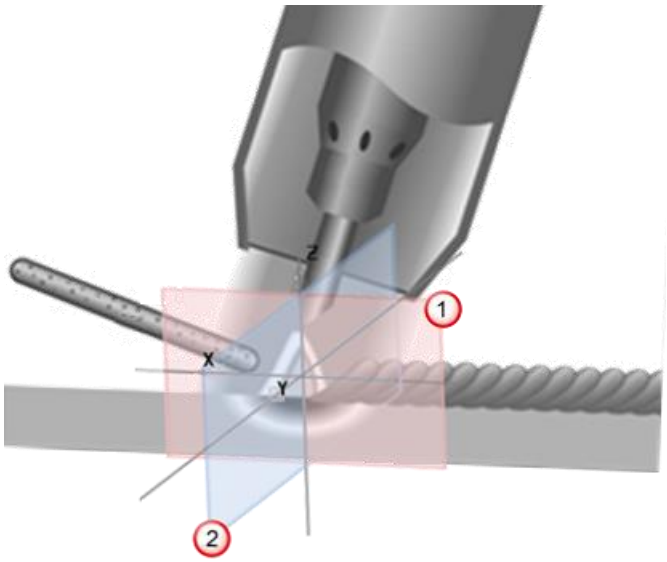
- **Nominal value** — The ideal distance between toolpath passes.
- **Allowance (%)** — The percentage deviation from the ideal stepover. Toolpath points with stepover deviations larger or smaller than the allowance are labelled with the point parameter _STEPOVER. This enables future compensation using other process parameters.

9 Click **Machining mode** and use the **Component Thickness** dialog to specify which surfaces to avoid or ignore (see page 28).

10 Specify the orientation of the **Tool axis.** The angle at which material is deposited and therefore drawn across the base surface affects the properties of the bead. By default the tool axis is always normal to the base surface.

- **Lead** — The angle of the tool measured in the plane parallel to the feed direction 1.

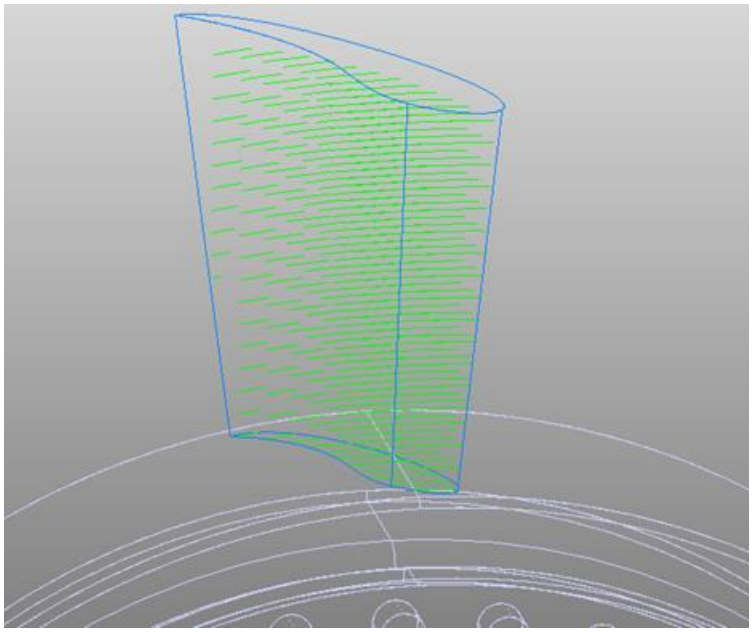
- **Lean** — The angle of the tool measured in the plane perpendicular to the feed direction ②.



11 Click **Calculate**.

About Feature Construction strategies

Use Feature Construction strategies to build features on a base surface. They utilize PowerMill's multi-axis abilities, enabling the toolpaths to be calculated from non-planar base surfaces.



You can use Feature Construction strategies for regions that vary with increasing height, such as blisks, blades, and cones.

To create a Feature Construction toolpath

Use a Feature Construction strategy to create a toolpath from a base surface and selected surfaces of the features.

1. Click Additive tab > Create Toolpaths panel > Feature Construction.
2. Enter **Toolpath name**.
3. Select the **Workplane** page and choose an item from the **Workplane** list to specify the axis system to use to create the toolpath.
4. Select the **Feature construction** page and in the **Base** area:
   a. Choose an option from the **Type** list to specify the base surface geometry.
   b. Select the Level or Set that contains the base surface from the **Surfaces** list.
5. In the **Feature** area select the Level or Set that contains the surfaces of the feature from the **Surfaces** list.

6 Select a toolpath **Style** to use for depositing material:

- **Raster** — Consists of parallel straight-line moves.
- **Offset** — Repeatedly offsets an initial drive curve until no further offset is possible.
- **Profile** — Creates the toolpath around the outline of the feature. This is useful for constructing thin-walled or hollow parts.

7 Specify the:

- **Tolerance** — Determines how accurately the toolpath follows the contours of the model.
- **Focal length** — The distance from the energy source to the tip where the bead forms. This is represented as a tool shank, and is required to provide correct simulation results for robot arms.
- **Bead width** — The width of the bead of material deposited.

8 In the Stepover area, specify the:

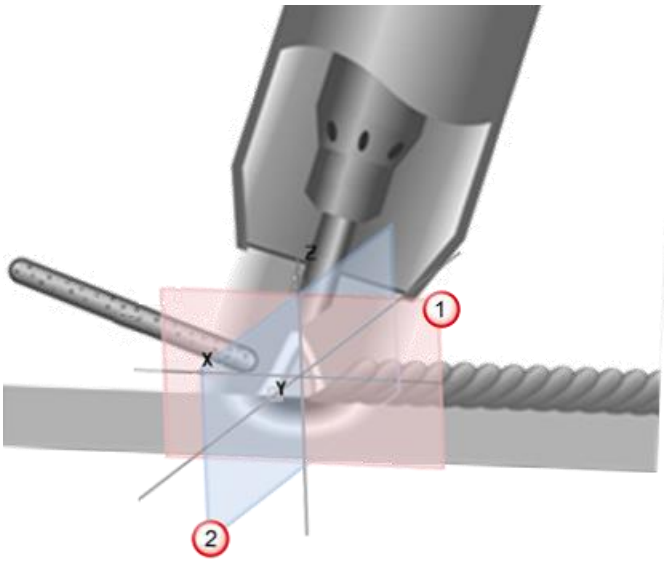
- **Nominal value** — The ideal distance between toolpath passes.
- **Allowance (%)** — the percentage deviation from the ideal stepover. Toolpath points with stepover deviations larger or smaller than the allowance are labelled with the point parameter _STEPOVER. This enables future compensation using other process parameters.

9 Click **Machining mode**  and use the **Component Thickness** dialog to specify which surfaces to avoid or ignore (see page 28).

10 Specify the orientation of the **Tool axis.** The angle at which material is deposited and therefore drawn across the base surface affects the properties of the bead. By default the tool axis is always normal to the base surface.

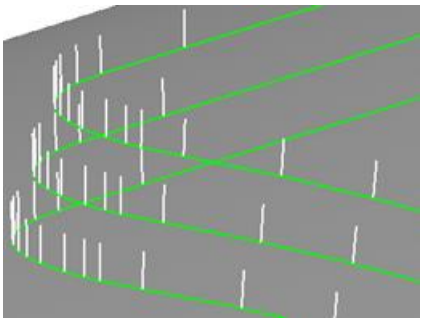
- **Lead** — The angle of the tool measured in the plane parallel to the feed direction ①.

- **Lean** — The angle of the tool measured in the plane perpendicular to the feed direction (2).

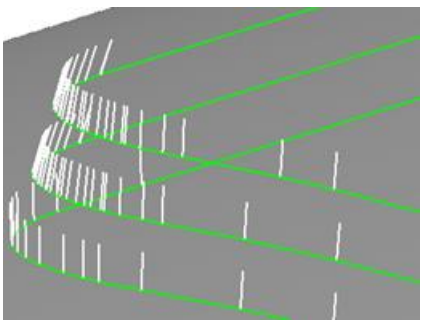


11 For **Profile** toolpaths, select the **Mode**:

- Select **Base surface normal** to keep the tool axis normal to the base surface.



- Select **Towards previous layer** to align the tool axis tangent to the surface slope.



Toolpath Style parameters reference

There are additional options specific to each Style that control how your toolpath is calculated. On the main page of the strategy dialog select a Style to enable its page in the dialog.

Raster page

The following options are dependent on the Type of base surface you choose.

Ordering — Specify whether the toolpath deposits in one direction only, or alternates direction.

Start corner/position — Choose the position to start the toolpath calculation from.

Angle — Specify the angle of the raster passes, measured counter-clockwise from the X-axis around the Z-axis.

Rotation angle — Specify the angle to rotate raster passes between layers.

Rotary direction — Choose the direction around the X axis that the raster passes rotate around.

Direction — Choose how to align the raster passes against the axis of the cylindrical base.

Start point control — Enter the angle to rotate the start position of passes, within and between layers.

Offset page

Drive curve — Specify the drive curve for the toolpath offset. Choose:

- **Region perimeter** to offset from the border of the specified region.
- **Medial axis** to offset from an automatically calculated medial axis of the specified region.
- A named pattern to offset from the curves contained within the pattern.

Direction — Specify the offset direction from the drive curve.

Start point control — Enter the angle to rotate the start position of closed passes, within and between layers.

Emboss page

Start point control — Enter the angle to rotate the start position of passes, within and between layers.

Profile page

Extent — Specify how additional profile passes are added to the toolpath.

Outward number of offsets — Enter the number of passes outwards from the profile curve.

Inward number of offsets — Enter the number of passes inwards from the profile curve.

Minimum outward distance — Enter the minimum distance to offset outwards from the profile curve.

Minimum inward distance — Enter the minimum distance to offset inwards from the profile curve.

Direction — Specify the order, from the profile curve, in which the offsets are performed.

Start point control — Enter the angle to rotate the start position of passes, within and between layers.

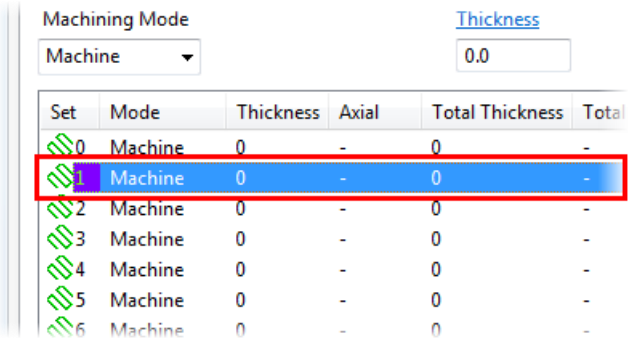
To specify which surfaces to avoid or ignore

You can choose surfaces of your model to avoid or ignore when calculating a toolpath.

Specify surfaces to be avoided to prevent colliding into them, for example: clamps or features you have already deposited.

Specify surfaces to be ignored to eliminate unnecessary tool moves, for example: features you have not yet deposited or subsequent surfaces of compound features.

1. On the main page of the **Strategy** dialog, click **Machining mode** .
2. On the **Component Thickness** dialog, click a row in the table to select a machining-mode **Set**.



3. From the **Machining Mode** list choose:
   - **Machine** to use surfaces in the machining-mode set for material deposition.
   - **Collision** to avoid the surfaces in the machining-mode set when calculating the toolpath.
   - **Ignore** to ignore the surfaces in the machining-mode set when calculating the toolpath. This enables the tool to move through the surfaces.
4. Click to display the **Selection** dialog.
5. From the **Select by** list choose **Level or Set**.
6. On the **Selection** dialog, select the Levels and Sets that contain the surfaces you want to consider and click to add them to the machining mode Set.
7. Click **Apply** and then click **Close**.
8. Click **Accept**.

To specify the thickness of successive layers

1. Display the **Layering** page of the Strategy dialog.
2. Enter an **Offset from base** to specify the distance between the base surface and the first layer.
3. Set the total extent of the toolpath. In the **Defined by** list, choose:
   - **Number of layers** to enter the total number of layers.
   - **Height above base** to specify the minimum distance spanned by the combined thickness of all the layers.
   - **Feature extent** to calculate toolpath passes for the entire feature.
4. Enter a **Default layer thickness**. This is the thickness applied to a layer if no other layer information is specified.
5. To change the step thickness for individual layers:
   a. Select **Set layer thicknesses individually**.
   b. Click  to add a layer.
   c. Click in the **Layer thickness** column for the specific **Layer index**.
   d. Enter the thickness for that layer.
6. Click **OK**.

To create a drive curve for toolpath offsetting

You can create curves from the surfaces of your model to drive the offset of a toolpath. Creating your own drive curve gives you precise control over the starting shape and location of a toolpath offset. This enables you to calculate toolpaths with a constant stepover. There are various methods to create drive curves.

Planar section

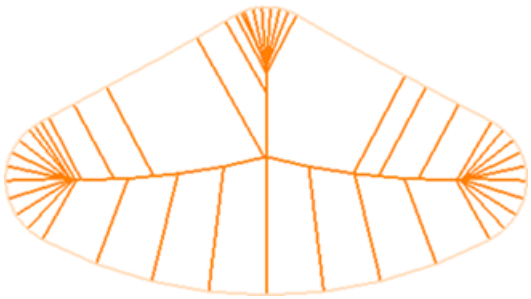
A planar section creates a pattern that contains curves from the intersection of a 2D plane with the surfaces of a model.

1. Click Additive tab > Create Toolpaths panel > Planar Section.
2. Use the **Planar Section** dialog to position the slicing plane.
3. Click **Create**.
4. Click Curve Editor tab > Finish panel > Accept.

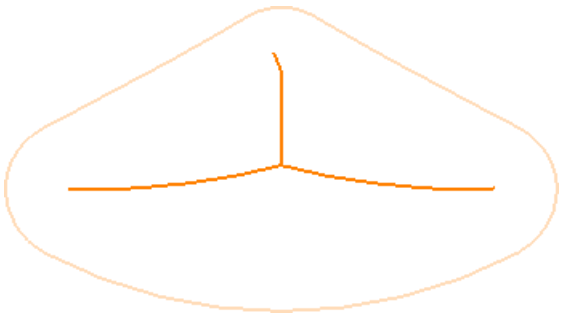
Medial axis

The medial axis is a curve representing the 'backbone' of a closed pattern, such as a planar section. Each point along the medial axis is equidistant to two or more points of the closed pattern. Toolpaths calculated from offsetting a medial axis are more likely to maintain a constant stepover.

1. Activate the pattern you want to create a medial axis from.
2. Click Additive tab > Create Toolpaths panel > Medial Axis. The medial axis is projected down the Z-axis of the active workplane.



3 Click a curve in the graphics window and press the **Delete** key to delete it. Use this method to trim the medial axis curve to a desired shape.



Curve editor

The curve editor enables you to create curves, or to make final adjustments to a drive curve from a previous method:

1 Click Additive tab > Create Toolpaths panel > Curve Editor.

2 Use the options on the Curve Editor tab to modify the curve.

3 Click Curve Editor tab > Finish panel > Accept.

To import a toolpath from Netfabb

1. Generate a toolpath in Netfabb, and export it to XML.
2. In PowerMill, select Additive tab > Create Toolpaths panel > Import Netfabb Toolpath.
3. Locate and select the XML file of the exported toolpath.
4. Click **Open**.

   The Netfabb toolpath is imported as a Feature Construction toolpath without the recalculation option.

To create an additive toolpath from a subtractive toolpath

1. Activate the calculated toolpath.
2. Click Additive tab > Create Toolpaths panel > Convert to Additive.
3. Use the **Convert to Additive** dialog to:
   a. Specify the shape of the base surface from the **Type** list.
   b. Choose the Level or Set for the base surface from the **Surfaces** list.
   c. Specify the layering options for the layer-bands.
4. Click **Apply**.
5. Click **Close**.

To specify which strategy templates are used

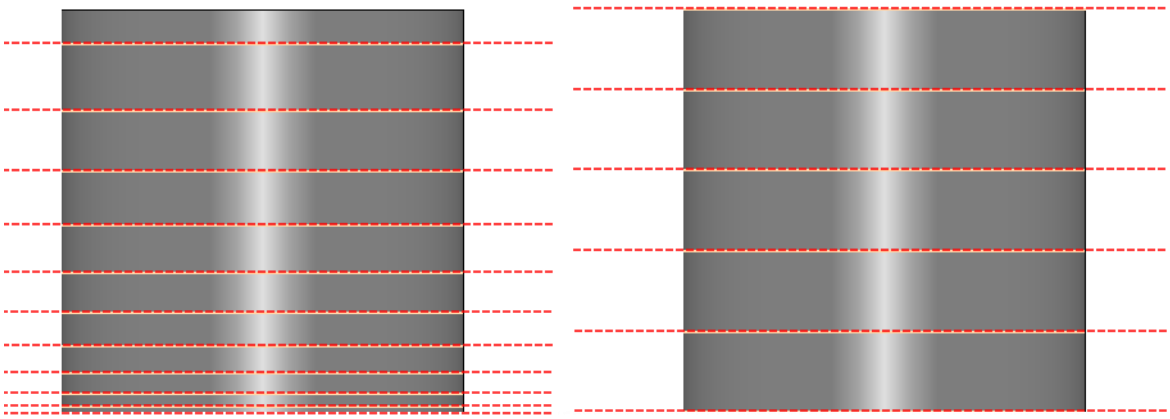
1. Click File tab > Options > Manage Installed Plugins.
2. On the **Plugin Manager** dialog select **PowerMill Additive** and click **Options**.
3. On the **Additive Options** dialog click **Browse** for a strategy type.
4. Search for and select the PowerMill Template file.
5. Click **Open**.
6. Click **Close**.

About layers and layer-bands

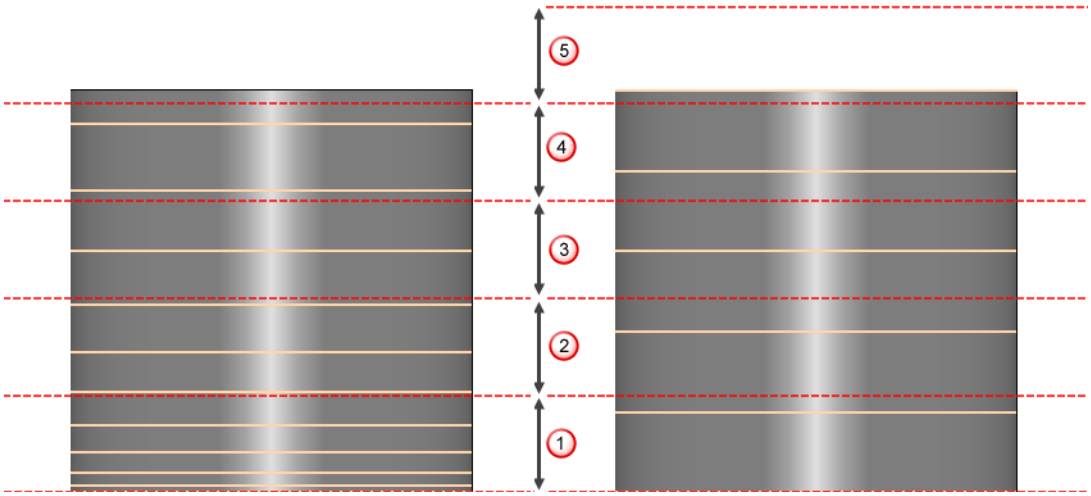
Additive toolpaths are created in layers. Material for each physical layer is successively deposited on top of existing layers. You can adjust the thickness of individual layers to address the dynamic attributes of the deposition material such as its thermal properties.

Layer-bands are used to create a common layering index for multiple features. This enables you to group together the toolpath passes of different features, which deposit material in various thickness ranges above the base surface.

When a toolpath is initially calculated each layer is indexed, according to the consecutive passes above the base surface, into layer-bands. In this state the thicknesses and indices of each layer-band correspond to those of the physical layers.



After a toolpath has been calculated you can modify the thicknesses of the layer-bands and re-index them with respect to a common base surface. This results in each layer-band containing various amounts of physical layers.

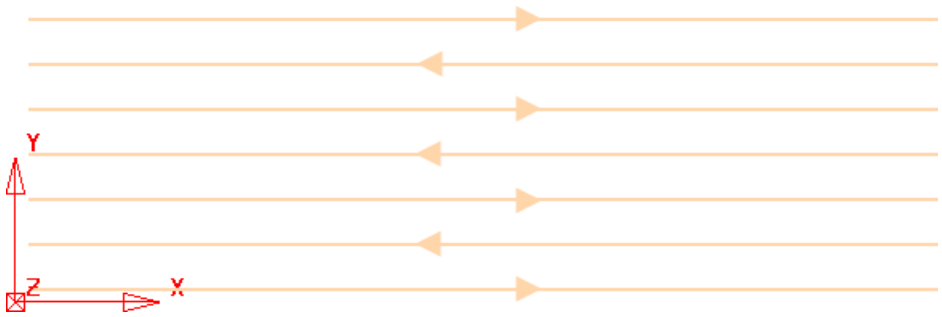


When you have grouped your toolpath passes into layer-bands, you can split the original toolpaths by layer-band, into new toolpaths. This enables you to arrange the toolpaths so that material is deposited from the passes in each layer-band (for all features), before continuing onto the next layer-band.

To reverse the segments within layers

You can reverse the direction of toolpath segments within layers. Alternating the direction of deposition can reduce the build up of material on one end of a layer.

1. Click Additive tab > Editing panel > Reverse Layers.
2. In the **Reverse Layers** dialog specify **What to edit**. Select:
   - **Entire toolpath** to apply your edits to the whole toolpath.
   - **Range of layers** to apply your edits to a selection of layers in the toolpath. Enter the layer-band indices in the **From** and **To** fields.
3. In the **What to reverse** area, specify which segments are reversed for your selection. Select:
   - **All segments within a layer** to reverse the direction of each segment in a layer.
   - **Alternate segments within a layer** to reverse the direction of alternate segments in a layer.



   - **All segments within alternate layers** to reverse the direction of each segment in every other layer.
4. Click **Apply**.

To edit the layer-band indexing for selected toolpaths

You can re-index the layer-bands for calculated toolpaths:

1. Click Additive tab > Editing panel > Layer Indices.
2. In the Explorer select the toolpaths that you want to re-index the layer-bands for.
3. In the **Layer Indices** dialog select **What to edit** > **Selected toolpaths**.
4. From the **Type** list choose the shape of the base surface to use for re-indexing.
5. From the **Surfaces** list choose the Level or Set that the base surface belongs to.
6. Enter an **Offset from base** to specify a height above the base surface that the first layer-band starts from.
7. Enter the **Default layer-band thickness**.
8. To change the thickness for individual layer-bands:
   a. Select **Set layer-band thickness individually**.
   b. Click  to add a layer-band to the table.
   c. Click its value in the **Layer-band thickness** column and enter the individual thickness for that layer-band.
9. Click **Apply**.



You can view your toolpaths by layer (see page 41) to inspect their new layer-band indices.

To split selected toolpaths by layer-band

You can split the layer-bands of a toolpath into several new toolpaths. This enables you to:

- Group passes from several toolpaths together with the desired build order.
- Apply user-defined parameters to each split of a toolpath.

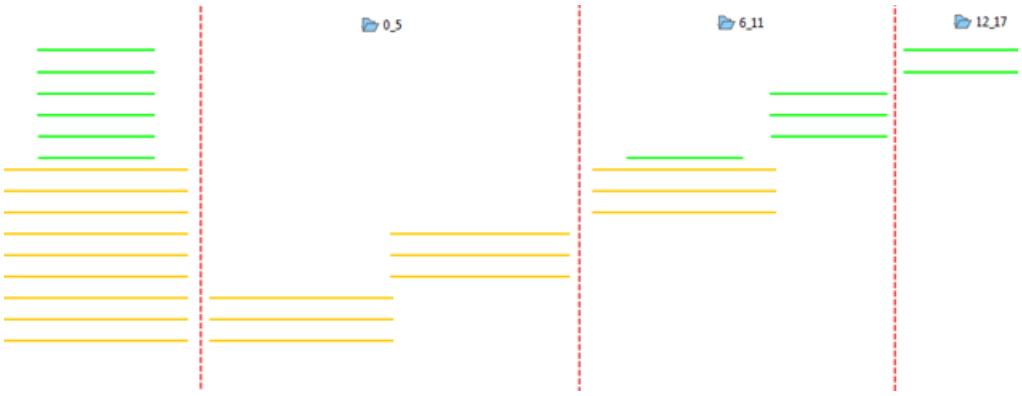
To split selected toolpaths:

1. Click Additive tab > Editing panel > Split Layers.
2. In the Explorer select the toolpaths that you want to split.
3. Under **What to split**, select **Selected toolpaths**.
4. Enter the **Number of layers in each split** to determine the maximum number of layer-bands used for each new toolpath.
5. Select **Reapply process parameters** to apply the process parameter recipes specified in the original toolpaths to each new toolpath.
6. Select:
   - **All splits in one folder** to place all the new toolpaths together into a single folder.
   - **Number of splits in each folder** to enter the maximum number of new toolpaths in each folder.
7. Enter the **Folder name**. The folders are given this name with a numerical suffix indicating the included layer-bands.
8. Enter the **Toolpath suffix**. The new toolpaths are given the name of the original toolpath, followed by this suffix, followed by a numerical suffix indicating the included layer-bands.
9. Click **Apply**.

The example below illustrates two toolpaths with:

- Splits every third layer-band.

- A maximum of two splits in each folder.



The first split in folder **6_11** contains layer-bands 6-8 and includes passes from both toolpaths. This is because the passes of these toolpaths both intersect the 8th layer-band.

The final folder is named **12_17** indicating that it can include passes from layer-bands 12-17, however layer-bands 14-17 contains no passes.

To view toolpath segments by layer-band

1. Activate your toolpath.
2. Click Additive tab > Visualisation panel > View Layers.

   The **View Layers** dialog displays the number of deposition segments in each layer-band of the active toolpath.
3. Click a row in the table to display the deposition moves for the selected layer-band in the graphics window.

About process parameters

Process parameters are user-defined attributes, with associated values, attached to individual points along a toolpath. They enable you to apply instructions about the deposition process to individual points along a toolpath.

Use process parameters to control the deposition of material at any point along a toolpath. For example, you can reduce the feedrate to deposit more material, or include wait commands to allow the material to cool before proceeding.



You need to configure your post-processor to interpret the user-defined attributes as machine operations.

Toolpaths are created with the default PowerMill parameters. At any point along the toolpath, you can use process parameter 'recipes' to override the default values.

A recipe contains the following information:

- A recipe name.
- A Tag that relates to an operation in the NC program.
- Locations along the toolpath where the parameter is attached.
- The value associated to the Tag.

To define a process parameter recipe

1. On the **Process parameters** page of the Strategy dialog, click .
2. Enter a **Recipe name**.
3. Enter an **Output tag** that corresponds to a parameter in the post processor.
4. In the **Relative to** list, select:
   - **Component** to locate the recipe in relation to a toolpath component, such as a segment, lead, or link. You can locate the recipe at every instance of this component, or at a specific instance.
   - **Toolpath** to locate the recipe in relation to a toolpath. When using this option, toolpath moves of the selected type are chained together and considered as a single item.
   - **Layer** to locate the recipe in relation to the layer. When using this option, all components of the selected type in the layer are chained together and considered as a single item.
   - **Parameter** to locate the recipe in relation to an existing parameter. Enter a **Reference tag** to locate the recipe in relation to all instances of the tag, or enter a **Reference value** to locate the recipe only where parameters with that tag have a specific value.
   - **Boundary crossing** to locate the recipe where the toolpath intersects a boundary. Select the **Boundary** to use and specify the **Crossing** points where process parameters are applied.
5. To limit the recipe, select:
   - **Single component/layer only** to apply the recipe to a single instance of the selected component/layer, and enter the instance number. Deselect this option to apply the recipe to every instance of the selected component/layer.
   - **Restrict layers** to apply the recipe only to instances of the selected component/layer within a range of layers.
   - **Layer interval** to apply the recipe on intervals of layers, such as every second or third layer. Deselect this option to apply the recipe on every layer.
   - **Restrict to boundary** to apply the recipe only to segments inside or outside a boundary.
6. To locate the recipe at a point:
   a. Under **Set parameter value** select **Point**.

b In the **From** list, select where to locate the recipe in relation to the selected item, and enter an **Offset**.
For example, to locate the recipe 0.5mm/inches before the end of a toolpath, in the **From** list select **End** and enter an **Offset** of **0.5**.

c Enter the **Value** to be applied at this location.

7 To locate the recipe over a range of points:

a Under **Set parameter value**, select **Over range**.

b To define the start of the range, select an item in the **From** list and enter an **Offset**.

c To define the end of the range, select an item in the **To** list and enter an **Offset**.

d Enter a **Value** at the start and end of the range.

e To interpolate between the values along the defined range, select **Interpolate**, and enter a **Step interval** or a **Number of steps**.

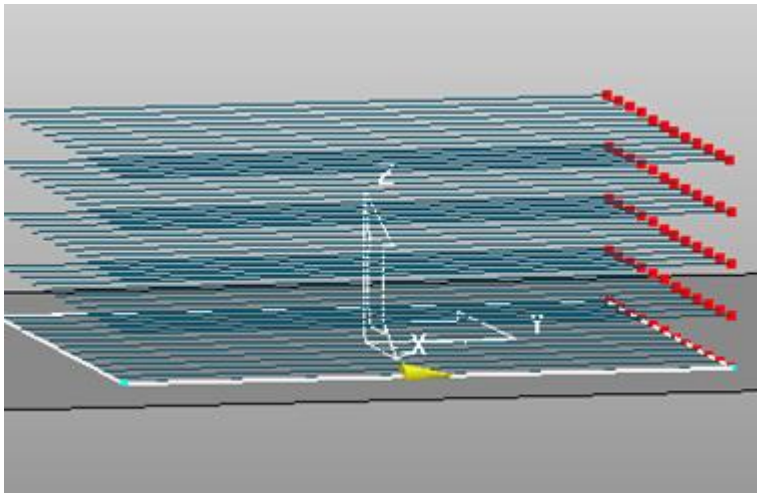
Interpolated ranges must contain numerical values only.

To delete a recipe, select it and click .

Process parameter recipe examples

These examples show where you might use process parameters. The red decorations are toolpath points with point parameters:

- at the final point of each toolpath segment on every layer.



Relative to: Component

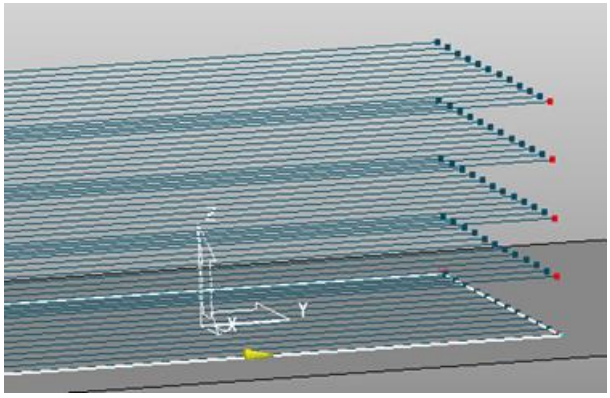
Move type: Segment

Set parameter value: Point

From: End

Offset: 0

- at the final point of the final toolpath segment on every layer.



Relative to: Layer

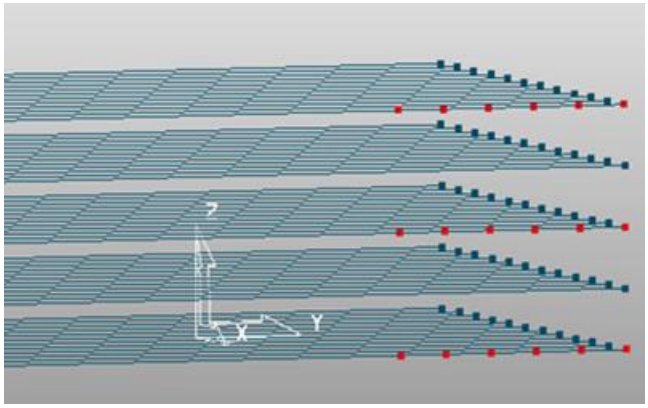
Move type: Segment

Set parameter value: Point

From: End

Offset: 0

- over a range of points at the end of the final toolpath segment on every second layer.



Relative to: Layer

Move type: Segment

Layer interval: 2

Set parameter value: Over Range

From: End, Offset: 25

To: End, Offset: 0

Offset: 25

Interpolate: enabled

Number of steps: 5

To view and delete process parameters

Use the **Process Parameters** dialog to see all the process parameters set in the document, and delete process parameters from individual points.

1. Calculate and activate a toolpath.
2. Click Additive tab > Editing panel > Process Parameters.
3. Click Toolpath Process Parameters tab > View panel > Inspect.
4. In the **Process Parameters** dialog, select a **Move type**.
5. Select a parameter and layer.

   The **Points** list displays all the points that have the selected parameter applied to it. Points are displayed in the format **component index:point index**.
6. Select a point to display the parameters applied to that point.

    displays the distance from the selected point to the start of the component.

    displays the distance from the selected point to the end of the component.
7. Click  under a column to delete the process parameters from the points in your selection from that column.

To edit process parameters

1. Calculate and activate a toolpath.
2. Select Additive tab > Editing panel > Process Parameters.
3. Select Edit tab > Recipes panel > Edit.
4. Use the **Process Parameter Recipes** dialog to define the process parameter recipes.
5. Click **Accept** to close the **Process Parameter Recipes** dialog.
6. Click Edit tab > Finish panel > Accept.

To animate the deposition

1. Click Additive tab > Visualisation panel > View Deposition to display the **Additive Animation** dialog
2. In the **Entity** area, select:
   - **Toolpath** to simulate an individual toolpath.
   - **NC program** to simulate all toolpaths in an NC program.
3. In the **Tool** area, select:
   - **Automatic** to animate the tools used in the toolpath calculations.
   - **Selected** to animate a specific tool.
4. Click **Play**.



*To start a new animation click **Reset**.*

To export a toolpath for Netfabb Simulation

You can export a toolpath, to a suitable file-type, to simulate with Netfabb Simulation. Before you export the toolpath you need to initialize the process parameter tags that are pre-defined for your deposition process.

Process	Pre-defined Tag	
Arc and wire	Voltage	Current
Electron beam and powder	AccelerationVoltage	BeamCurrentEngage
Laser and powder	LaserPower	

Initialize the process parameters

Create a process parameter recipe that sets the values for the pre-defined tags at the first point of the first segment.

1. Activate the toolpath you want to export.
2. Click Additive tab > Editing panel > Process Parameters.
3. Click Toolpath Process Parameters tab > Recipes panel > Edit.
4. On the **Process Parameter Recipes** dialog click .
5. Enter a **Recipe Name**.
6. Enter a pre-defined **Output Tag** for your deposition process.
7. In the **Define parameter location** area:
   a. Choose a **Relative to** of **Toolpath**.
   b. Choose a **Move type** of **Segment**.
8. In the Set parameter value area:
   a. Select **Point**

b Choose a **From** of **Start**.

c Enter an **Offset** of **0**.

d Enter the **Value**.

Export the toolpath

1 Click Additive tab > Export panel > Netfabb Simulation.

2 On the **Netfabb Simulation Export dialog** choose your **Deposition Process**.

3 Click **Browse** and choose your export location.

4 Enter the **File Name** of the export and click **Save**.

5 Click **Export**.

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