PowerSHAPE 2015 R2

Reference Help

Wireframe modelling

PowerSHAPE

Acknowledgements

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Patent Information

Emboss functionality is subject to patent number GB 2389764 and patent applications US 10/174524 and GB 2410351.

Morphing functionality is subject to patent application GB 2401213.

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Wireframe modelling

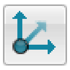
Use the following sections to find information on wireframe modelling:

Wireframe modelling

Wireframe objects (points, workplanes, lines, arcs, and curves) are described in terms of how to create and edit them.

The buttons for creating wireframe objects are on the main toolbar.

Selecting one of the following buttons displays the appropriate toolbar.

 **Workplane** — For full details see Creating a workplane (see page 4) and Creating a point (see page 30).

 **Line** — For full details see Creating a line (see page 38).

 **Arc** — For full details see Creating an arc (see page 60).

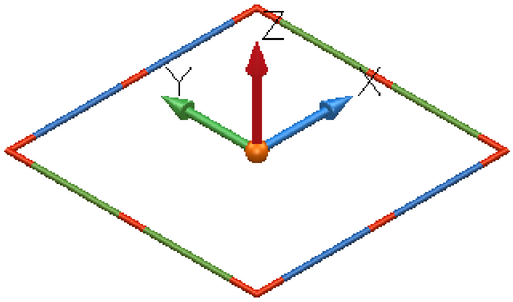
 **Curve** — For full details see Creating a curve (see page 83).

Workplanes

Use the following sections to find out more about workplanes:

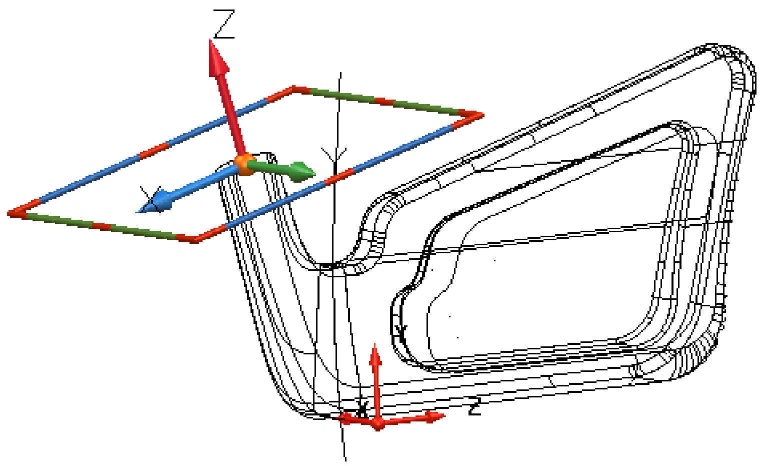
What is a workplane?

A workplane is an entity that provides a local workspace from which you can create geometry.



When creating an object such as a surface or curve, it is often easier to create a new workplane and introduce a new local workspace rather than perform complex calculations to position it correctly with respect to the world workspace.

Workplanes also enable you to work on a plane that is aligned with a specific face of a model.



An active workplane represents the current workspace.

You can have any number of workplanes in your model, but only one can be active at a time. You can activate and deactivate workplanes at any time.

Master workplanes

A Master workplane automatically becomes active when the existing active workplane is deleted, cut, or deactivated.

Grouped workplanes

You can group or ungroup workplanes. Ungrouped workplanes (the default) are simple 3D local workspaces. Grouped workplanes have an association with all the objects created while they are active. For example, if you move a grouped workplane, all associated objects are moved.

Creating a workplane

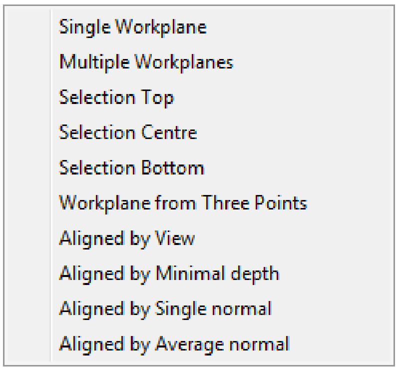
You can create many workplanes in one model. You can switch between them by activating and deactivating each one as required.

When created, a workplane is automatically activated so that any new coordinates entered are local XYZ values relative to its origin. You may also enter positions on the principal plane of the workplane by clicking with the mouse.

You can also create workplanes which align with objects. If the object is wireframe, then the workplane's Z axis aligns along its tangent. If it is a surface or a solid, the Z axis of the workplane lies along its normal.

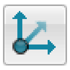
To create a workplane from the Object menu:

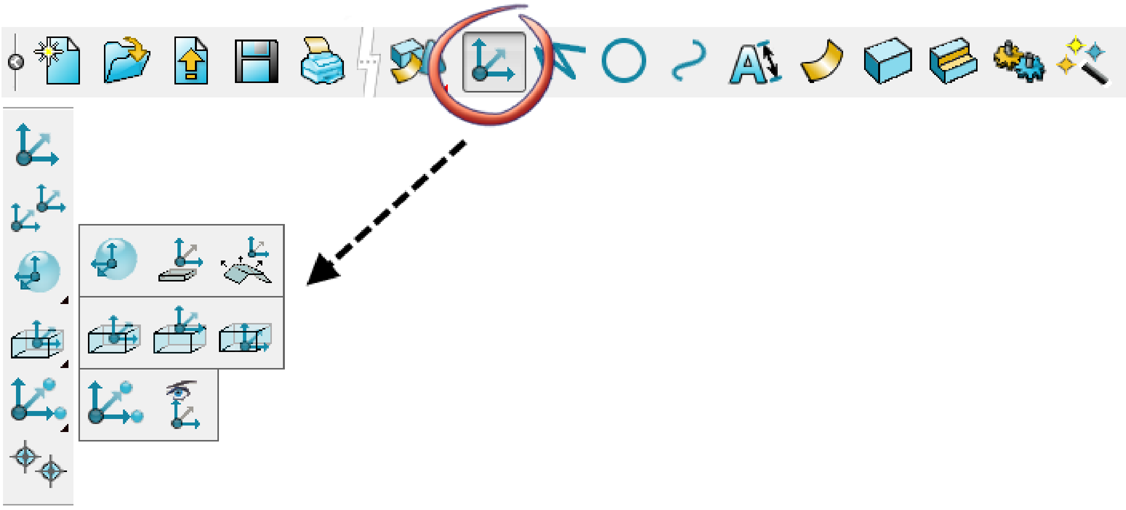
1. Select **Object > Workplane** from the menu to display the **Workplane creation** menu options.



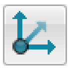
2. Select the appropriate workplane option.

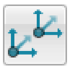
To create a workplane using the toolbars:

1 On the Main toolbar, select the **Workplane** button  to display the Workplane toolbar at the left of the screen.



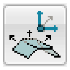
2 On the Workplane toolbar, select the type of workplane you want to create.

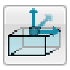
 **Single** (see page 6) — Click this button to create a single workplane.

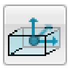
 **Multiple** (see page 6) — Click this button to create multiple workplanes.

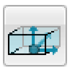
 **Geometry** (see page 7) — Click this button to create a workplane aligned to the selected geometry point.

 **Minimal Depth** (see page 8) — Click this button to create a workplane aligned with the minimal depth of a selection.

 **Average normal** (see page 9) — Click this button to create a workplane aligned with the average normal.

 **Top** (see page 7) — Click this button to create a workplane aligned with the top of a selection.

 **Centre** (see page 10) — Click this button to create a workplane aligned with the centre of a selection.

 **Bottom (see page 10)** — Click this button to create a workplane aligned with the bottom of a selection.

Three points (see page 11) — Click this button to create a workplane from three points.

Current view (see page 12) — Click this button to create a workplane from the current view.

Point (see page 30) — Click the button to create a point.

Creating a single workplane

1 On the Workplane toolbar, select the **Single** button.

2 Click in the graphics area to position the workplane on the screen.

   The axes of the new workplane lie in the same direction as the active workplane (if it exists) or the World workspace (if no workplane is active).

   The active workplane (if it exists) is deactivated and the new workplane becomes active and current.

3 Edit the workplane to orientate it to your requirements.

   You can use the graphical handles around the workplane to position it.

   You can also position the workplane using the **Workplane** dialog (see page 17). Double-click the workplane to display the **Workplane** dialog.

Creating multiple workplanes

1 On the Workplane toolbar, select the **Multiple** button.

2 Click in the graphics area to position the workplane on the screen.

   The axes of the new workplane lie in the same direction as the active workplane (if it exists) or the world workspace (if no workplane is active).

   The active workplane (if it exists) becomes deactivated and the new workplane becomes active and current.

3 Edit the workplane to orientate it to your requirements.

   You may use the graphical handles around the workplane to position it.

   You may also position the workplane using the **Workplane** dialog. Double-click the workplane to display the **Workplane** dialog.

4 Click in the graphics area again to place another workplane.

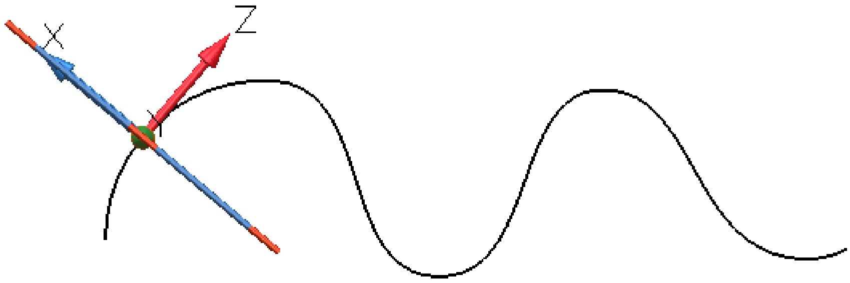
Creating workplanes aligned with geometry

1 On the Workplane toolbar, click the **Align to Geometry**  button.

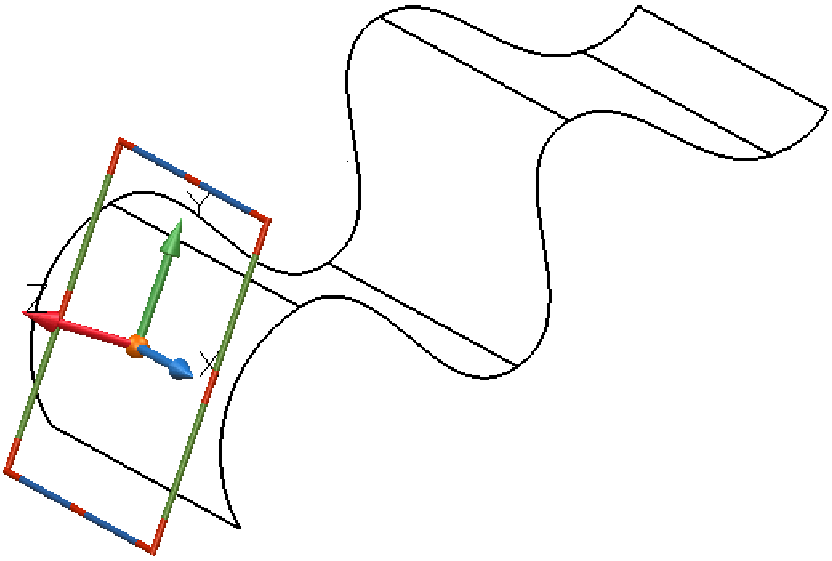
2 Click a position on an object on the screen to create a workplane.

A new workplane is displayed on the screen. The active workplane (if it exists) becomes deactivated and the new workplane becomes active and current.

If you click on a wireframe object, the Z axis of the workplane lies along the tangent of the object at the clicked point.

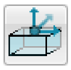


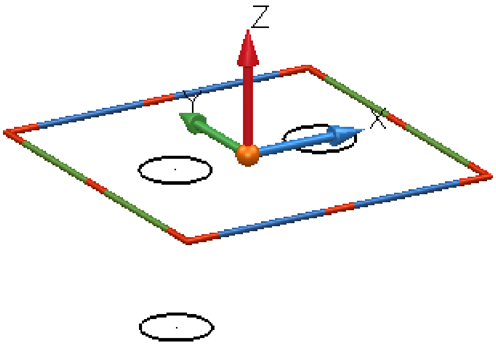
If the object is a surface or a solid, the Z axis of the workplane lies along the normal at the clicked point. To snap to points within patches, press and hold the **Shift** key.



Creating a workplane at the top of a selection

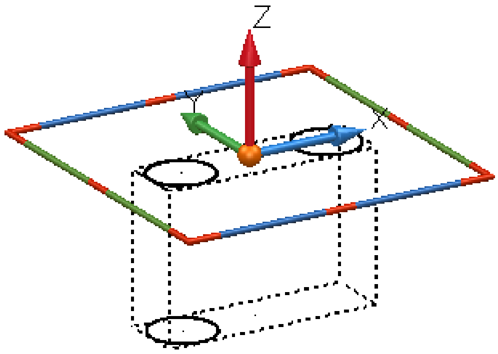
1 Select some objects.

2 On the Workplane toolbar, click the **Top of selection**  button.



The workplane is created at the top of the selection.

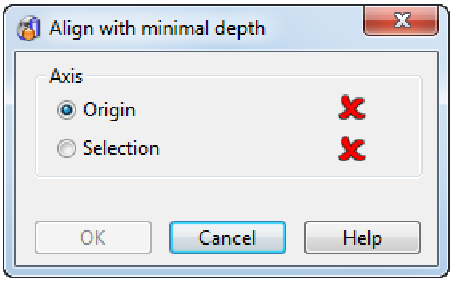
The workplane is positioned relative to a theoretical bounding box around the selected objects.



The bounding box is based on the active workplane.

Creating a workplane aligned with minimal depth

1 On the Workplane toolbar, click the **Minimal Depth**  button.



2 Select the **Origin**.

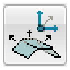
The cross ✘ icon changes to a tick ✔ icon.

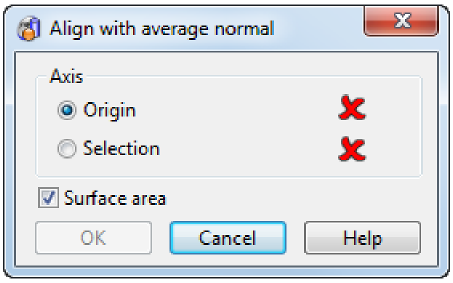
3 Make your **Selection**.

The cross ✘ icon changes to a tick ✔ icon.

4 Click **OK** to create a workplane that is aligned with the minimum depth of the selection.

Creating a workplane aligned with average normal

1 On the Workplane toolbar, click the **Average Normal**  button.



2 Select the **Origin**.

The cross icon changes to a tick icon.

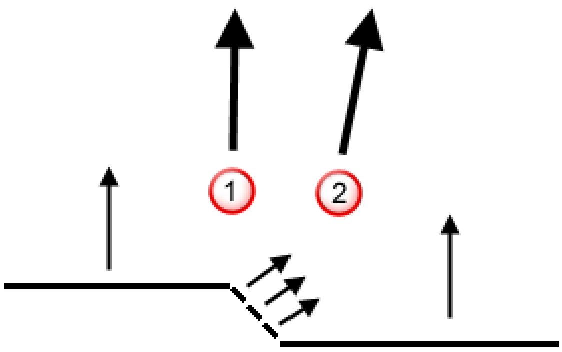
3 Make your axis **Selection**.

The cross icon changes to a tick icon.

4 Specify the **Surface area** option. If *ON*, the surface area of the surfaces in the selection is more important than the number of surfaces. In the following example there are 2 large surfaces and three minor surfaces in the selection.

If **Surface area** is *ON*, the average normal of the selection is indicated by 1.

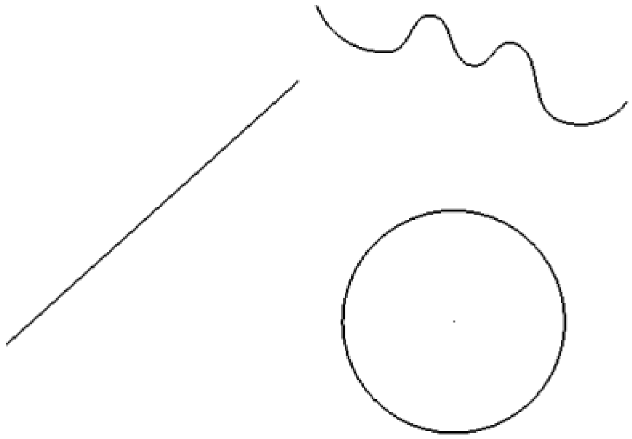
If **Surface area** is *OFF,* the average normal of the selection is indicated by 2.

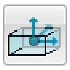


5 Click **OK** to create the workplane.

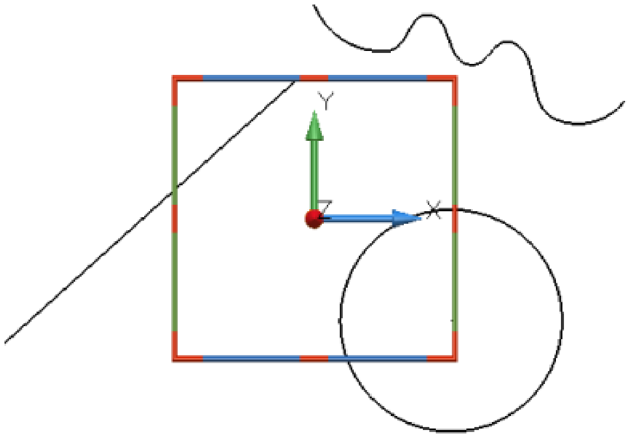
Creating a workplane at the centre of a selection

1 Select some objects.



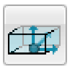
2 Click the **Centre**  button on the Workplane toolbar.

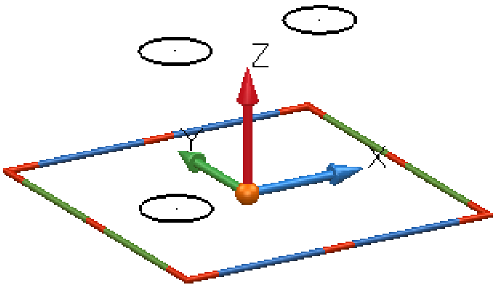
The workplane is created at the centre of the selected items.



Creating a workplane at the bottom of a selection

1 Select some objects.

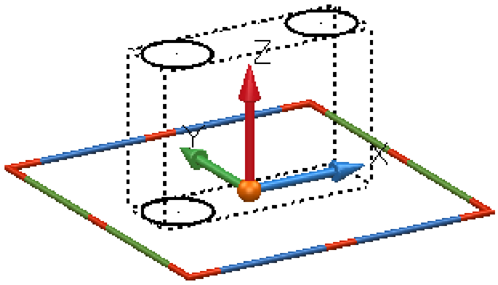
2 Click the **Bottom**  button on the Workplane toolbar.



3 The workplane is created at the bottom of the selection.

The workplane is positioned relative to a theoretical bounding box around the selected objects, as shown below.

The bounding box is based on the active workplane.

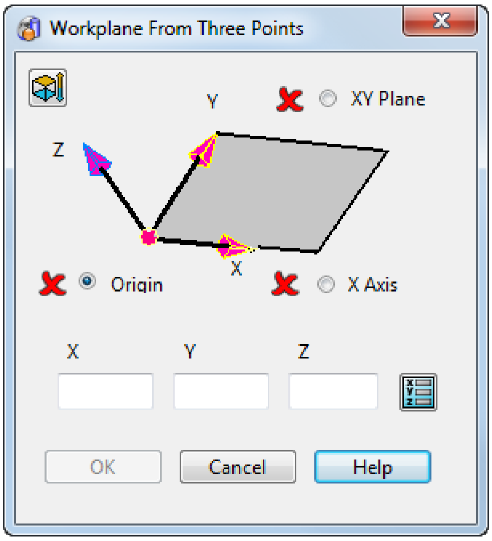


Creating a workplane from three points

1. On the Workplane toolbar, click the **Three Points** button.
2. Use the Workplane from Three Points dialog (see page 11) to define the following points.
   - The **Origin**.
   - Any point on **X Axis**.
   - Any point on **XY Plane**.

Workplane from Three Points dialog

Use the **Workplane From Three Points** dialog to create a workplane by specifying three points.



After connecting to the Arm, this dialog is displayed automatically so you can specify the three points to create a workplane ready to digitise any physical geometry.

A workplane is displayed in the dialog with a selection option for the three points:

- **Origin**
- **XY Plane**

- **X Axis**

Select each option in the dialog in turn and set the coordinates by entering the **X**, **Y**, and **Z** values or clicking in the graphics area. When the coordinates are entered, the ✘ changes to ✔. You must set the coordinates for all three points. An error is displayed if you set coincident points, or if all three points are on the same axis.

You can enter the coordinates for the points by using the **Arm** as well as by entering them using the keyboard or mouse.

Toggle Z-axis direction — Click this button to rotate the Z axis by 180° around the X axis. The Z axis remains fixed during rotation.

X, Y, Z — Enter the coordinates for each of the points on the workplane.

Position — Click this button to use the **Position** dialog to set the coordinates.

OK — This becomes available only when the coordinates for all three points are entered. The workplane is created and the dialog is removed.

Creating a workplane aligned with the current view

1. On the Workplane toolbar, click the **Current View** button.
2. Click a position on an object on the screen to create a workplane.
3. A new workplane is displayed on the screen, with the XY plane of the workplane aligned with the screen.. The active workplane (if it exists) becomes deactivated and the new workplane becomes active and current.

Because you can rotate the view to any angle, this command is not normally suitable for setting up workplanes when constructing accurate geometry. But it can be useful for setting up workplanes for machining into difficult areas for example. You can rotate the view until you see the area you want to machine into and quickly align the workplane to the view.

Creating a master workplane

To make a workplane into the master, do one of the following:

- Select **Master** in the **Workplane** dialog. Double-click the workplane to display the **Workplane** dialog (see page 17).
- Right-click the workplane to display the **Workplane** menu and select **Master**.

The master workplane is drawn in a bolder line style when deactivated and appears at the bottom of the list in the **Workplane** selector list in the **Status bar**.

You can have only one master workplane.

Creating a grouped workplane

When a grouped workplane is active, any geometry created is grouped with the workplane. A relationship is built between this geometry and the workplane. A grouped workplane has a dashed line style appearance when deactivated.

To make an existing workplane into grouped, use one of the following methods:

- Select **Group** in the **Workplane** dialog. Double-click the workplane to display the **Workplane** dialog (see page 17).
- Right-click the workplane to display the **Workplane** menu select **Group**.

To stop creating geometry grouped with a workplane, use one of the following methods:

- Deselect **Group** on the **Workplane** dialog. Double-click the workplane to display the **Workplane** dialog (see page 17).
- Right-click the workplane to display the **Workplane** menu and deselect **Group**.
- Deactivate the workplane.

To create all future workplanes as grouped:

1. Select **Tools > Options** from the menu to display the **Options** dialog.
2. In the **Options** dialog, select the **Object > Workplanes** page.
3. Select **Grouped**.
4. Click **OK**.

Adding objects to the grouped workplane

To add objects to an active workplane group:

1. Ensure the group workplane is active.
2. Select the objects.
3. Select **Edit > Add to active workplane group** from the menu.

Removing objects from the grouped workplane

To remove objects from any grouped workplane:

1 Select the objects.

2 Select **Edit > Remove from workplane group** from the menu.

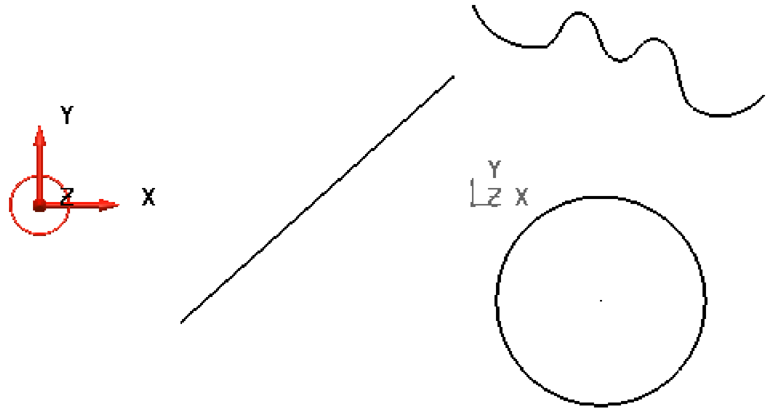
Creating a temporary workplane

To create a temporary workplane:

1 Click the **Temporary Workplane** button at the start of the Status bar.

2 Click in the graphics area.

The temporary workplane is drawn in red (white when selected).



You can have only one temporary workplane in a model. You can move it by dragging, but cannot edit it in the normal way.

The temporary workplane is deleted when you:

- deselect the **Temporary Workplane** button on the Status bar.
- create a new workplane.
- activate an existing workplane.

Activating and deactivating a workplane

You can add geometry relative to a workplane only when it is activated. When you are using multiple workplanes in a model, you must activate or deactivate them accordingly.

Only one workplane is active at a time. The active workplane is coloured red when deselected and its name is displayed in the **Workplane** list on the Status bar.

If an active workplane is deactivated and a master workplane exists, the master workplane becomes active. If no master workplane exists, the World workspace becomes the active workspace.

To activate a workplane:

- Select **Active** in the **Workplane** dialog (see page 17).
- Select **Active** in the **Workplane** context menu.
- Select the workplane from the **Workplane** list on the Status bar.

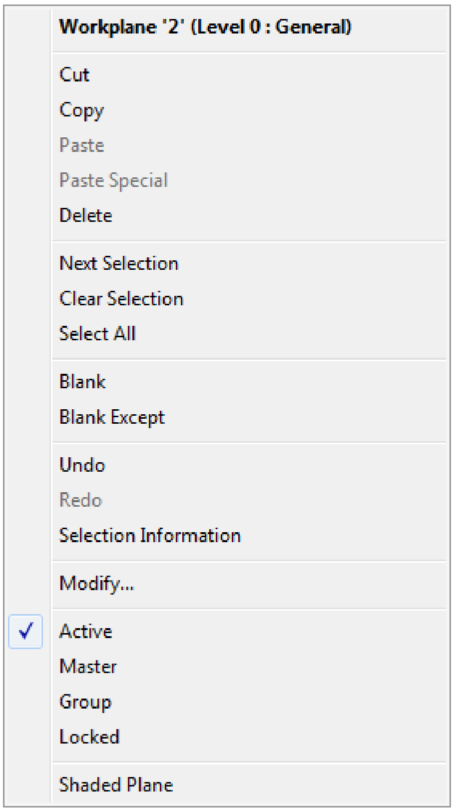
To deactivate a workplane:

- Deselect **Active** in the **Workplane** dialog (see page 17).
- Deselect **Active** in the **Workplane** context menu.
- Select a different workplane from the **Workplane** list on the Status bar.

Editing a workplane

Use one of the following methods to edit a workplane:

- Select the workplane and use the graphic handles (see page 24) to change the orientation of the workplane.
- Select the workplane and select **Edit > Modify** from the menu to display the **Workplane** dialog (see page 17).
- Double-click the workplane to display the **Workplane** dialog (see page 17).
- Right-click on the workplane to display the Workplane menu. The name of the workplane and the level on which it lies is at the top of the menu.



The following options are unique to this menu:

Active — Activates or deactivates a workplane.

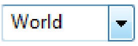
Master — Workplane becomes the master.

Group — Workplane becomes grouped.

Locked — Locks or unlocks a workplane.

Rename a workplane using the Workplane list on the Status bar. Click to highlight the text and input a new name. The new name is saved automatically.

Workplane selector

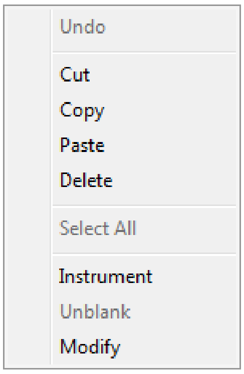
The **Workplane** list 

on the **Status bar** enables you to activate and deactivate workplanes. The name of the active workplane is displayed in the list. If no workplane is active, **World** is displayed.

To activate a workplane, select it in the list. Any existing active workplane becomes inactive.

To deactivate all workplanes, select **World** from the list.

Right-click on the **Workplane** list to display a menu:



- **Instrument** — Selects and instruments the active workplane. The current selection now contains only the active workplane.
- **Unblank** — Select this option to unblank the active workplane.
- **Modify** — Select this option to open the **Workplane** dialog (see page 17) for the active workplane.

If you enter a name in the list, the workplane with that name becomes active. If no workplane has that name then the name of the currently selected workplane changes to the name entered.

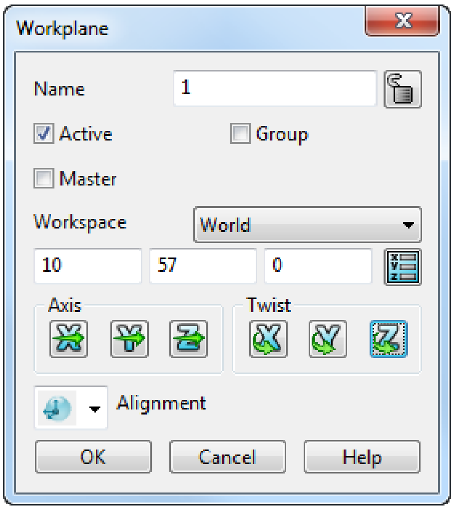
The names of the workplanes (except **Master**, **World**, and **Temporary**) are sorted alphabetically in the **Workplane** list.

The Master workplane is always displayed at the bottom of the list. If no master workplane exists, the **World** workplane is displayed at the bottom.

You can use a filter to display only certain names in the **Workplane** list. Enter a **Filter** pattern on the **Workplane** page of the **Options** dialog.

Workplane dialog

Use the **Workplane** dialog to edit a workplane.



Name — Enter the name of the workplane. The name of the workplane is used in macros to identify a workplane. The name that is given to a workplane can be used in many ways - for example, it can indicate the job that is used in.

Active — Select this option to activate the workplane.

Master — Select this option to make the workplane the Master workplane.

Group — Select this option to group the workplane.

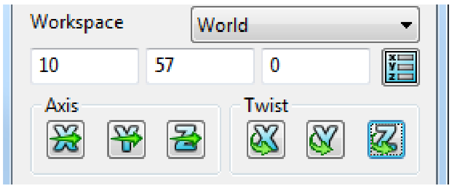
  **Lock/Unlock** — Use these toggle buttons to lock or unlock the workplane.

Ensure that the **Locked**  icon is displayed to lock a workplane. You cannot delete or edit a locked workplane. This is particularly useful if a workplane has been set up for a specific purpose and you wish to avoid accidentally changing it.

When you lock a workplane, its graphical handles and the options on the **Workplane** dialog are unavailable.

Ensure that the **Unlocked**  icon is displayed to unlock a workplane.

The following section of the dialog contains the plane editing options.

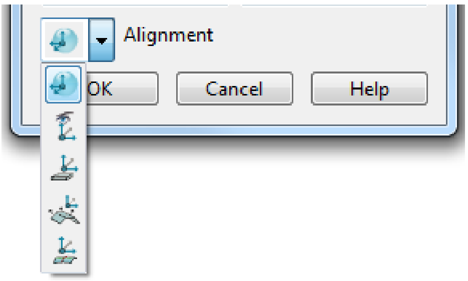


These options enable you to:

- define the workspace in which to edit the workplane.
- move the workplane's origin.
- change the direction of the workplane's axes.
- twist the workplane about its axes.

Plane-editing options are also used in dialogs of other items such as primitive surfaces.

Alignment — Select the alignment of the workplane from the list.



 **Geometry** — Select this option to align the workplane to the selected geometry (see page 19).

 **Current View** — Select this option to align the XY plane of the workplane with the current view.

 **Minimal Depth** — Select this option to align the workplane so that the workplane is set at the minimum depth of the geometry (see page 21).

 **Average Normal** — Select this option to align the workplane to the average normal of the selected geometry (see page 20).

 **Control Section** — Select this option to align the workplane with a control section to minimise undercuts (see page 21).

OK — Saves the edits carried out on the workplane and closes the dialog.

Cancel — Closes the dialog without saving any changes.

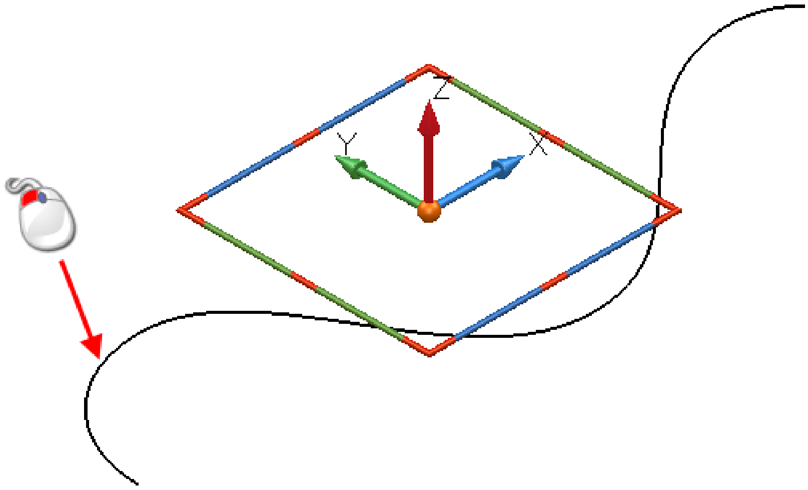
Editing a workplane - Align to the selected geometry

Align the Z axis of the workplane with the tangent of the object at the clicked point.

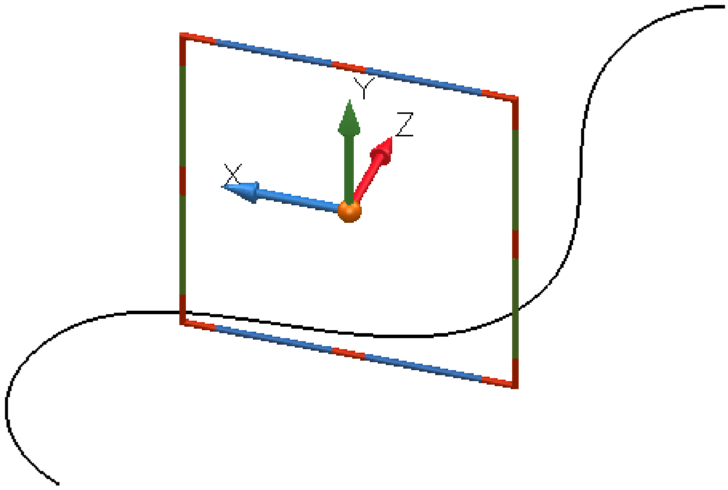
1 Open the **Workplane** dialog (see page 17).

2 Select the **Geometry**  option from the **Alignment** list

3 Click a point on the wireframe.

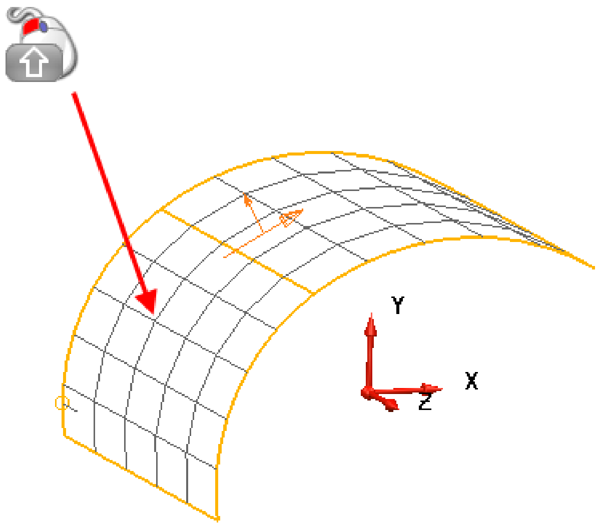


4 The workplane is aligned as shown below:

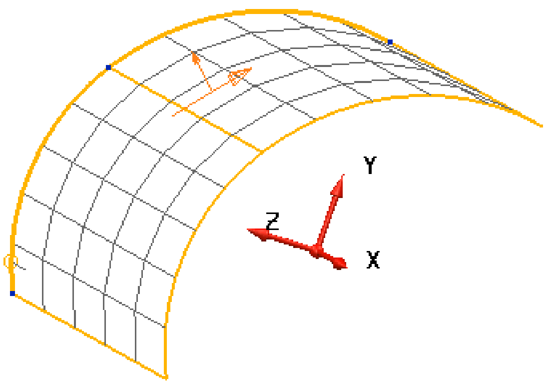


If the object is a surface or a solid, the Z axis of the workplane aligns with the normal at the clicked point.

You can snap to points within patches by using on a point on a surface like the one below:



The workplane is aligned as shown below:

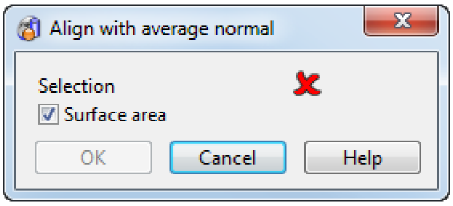


The workplane does not move, it rotates its axes.

Editing a workplane - Align with average normal

1 Select the **Average Normal** option from the **Alignment** list on the **Workplane** dialog (see page 17).

2 The **Align with average normal** dialog is displayed.

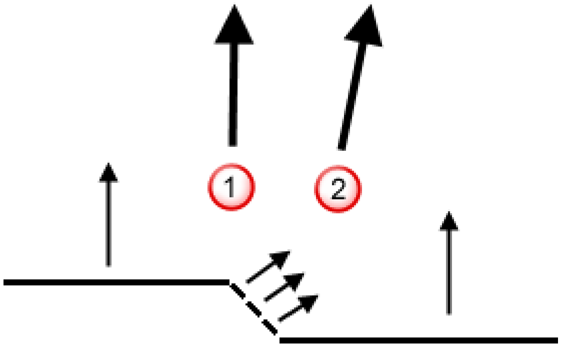


Selection — Select the objects to be used for the workplane orientation. The cross icon changes to a tick icon.

Surface area - If *ON*, the surface area of the surfaces in the selection is more important than the number of surfaces. In the example there are 2 large surfaces and three minor surfaces in the selection.

If **Surface area** is *ON*, the average normal of the selection is indicated by 1.

If **Surface area** is *OFF,* the average normal of the selection is indicated by 2.



3 Click **OK**.

Editing a workplane - Align with control section

1 Select the **Control Section** option from the **Alignment** list on the **Workplane** dialog (see page 17).

2 Use the dialog to align an existing workplane with a section.

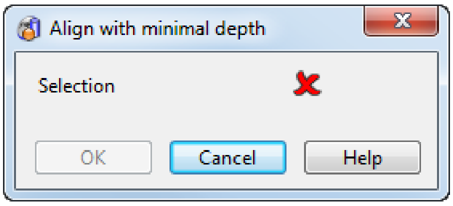
3 **Selection** — Select the objects to be used for the workplane orientation. The cross icon changes to a tick icon..

4 Click **OK.**

Editing a workplane - Align with minimal depth

1 Select the **Minimal Depth** option from the **Alignment** list on the **Workplane** dialog (see page 17).

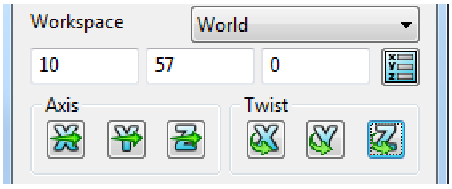
The **Align with minimal depth** dialog is displayed.



Selection — Select the objects to be used for the workplane orientation. The cross icon changes to a tick icon.

2 Click **OK** to align the workplane with the minimum depth of the selection.

Plane-editing options



To define the workspace in which to edit the workplane:

Use the **Workspace** list to select either **World** or **Workplane**. **World** is the world workspace and **Workplane** is the workspace defined by the active workplane.

To move the workplane's origin:

Enter the **X Y Z** coordinates or click the **Position** button to open the **Position** dialog where you can use position entry tools.

To change the direction of the workplane's axes:

1 Click the button of the axis you want to change (**Axis** options).

2 Complete the **Direction** dialog (see page 23).

3 Click **OK**.

To twist the workplane about its axis:

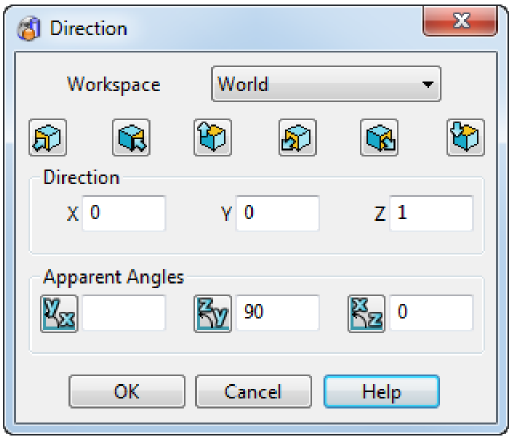
1 Click the button of the axis you want to twist (**Twist** options).

2 Use the **Calculator** dialog to input the twist value

3 Click **OK**

Direction dialog

Edit the direction of the selected item using the **Direction** dialog. A direction is defined in terms of a unit vector.



Workspace — Select the workspace in which to define the direction.

Align the selected item to the chosen axis, using the following buttons:

 **Positive X axis**

 **Positive Y axis**

 **Positive Z axis**

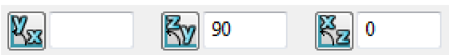
 **Negative X axis**

 **Negative Y axis**

 **Negative Z axis**

Direction — Enter the **X**, **Y**, and **Z** coordinates for the unit vector.

Apparent Angle — The apparent angle of the unit vector from the axis of the plane shown by the icon. The button next to each field raises the calculator that allows you to enter more complex expressions.



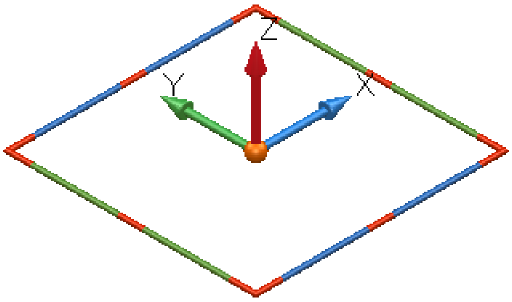
If an item is selected on the screen, the unit vector will align with that item. How the vector aligns with the item depends upon the item and where it is selected. For example, selecting an arc at its centre aligns the vector perpendicular to the arc, whereas selecting the arc itself aligns the vector with the tangent to the arc at the selection position.

OK — Saves the edits carried out on the direction of the selected item and closes the dialog.

Cancel — Closes the dialog and discards any changes made.

Graphically editing workplanes

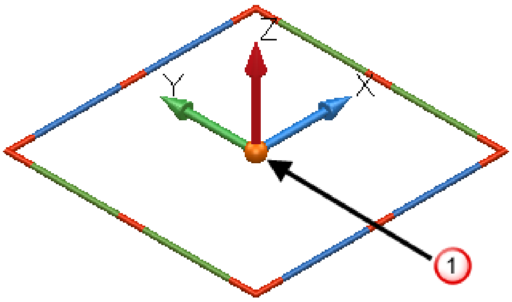
1 Select the workplane to display its graphical handles.



2 Select the handle for the edit you wish to carry out and drag it to the required position.

For each graphical edit, the handle to select is shown below.

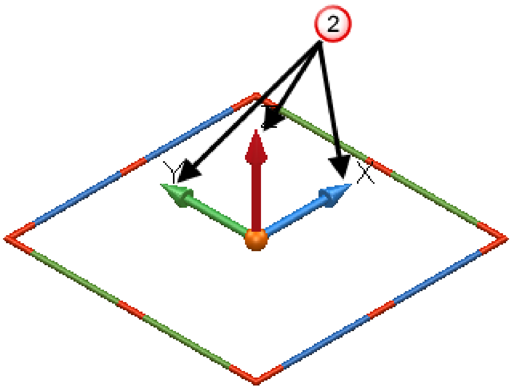
Moving the workplane's origin:



Select the handle 1 to move the workplane's origin.

The coordinates of the origin of the active workplane are displayed (in red) in the **Status** bar, next to the **Workplane** drop-down list.

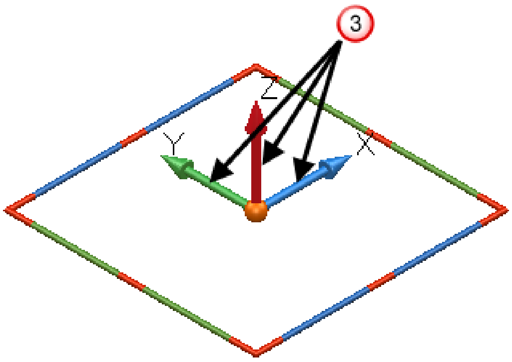
Changing the direction of an axis:



Select a handle 2 to change the direction of the **X**, **Y**, or **Z** axes.

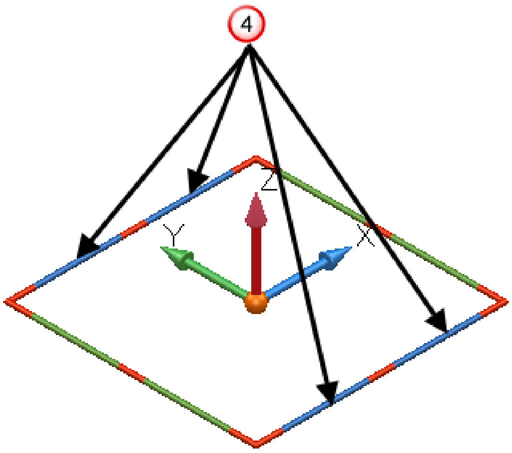
If the mouse button is released over an item, then the axis points directly to that item.

Moving the workplane along one of its axes:

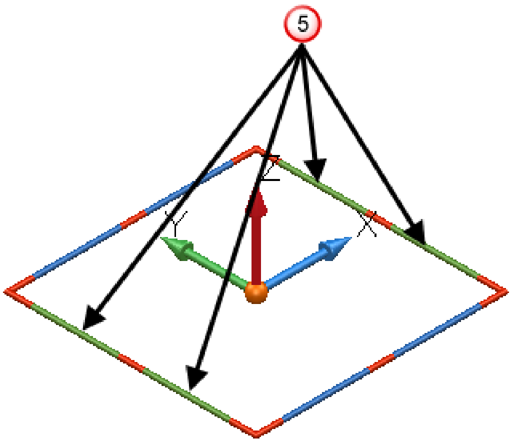


Select a handle 3 to move the workplane along the **X**, **Y**, or **Z** axes.

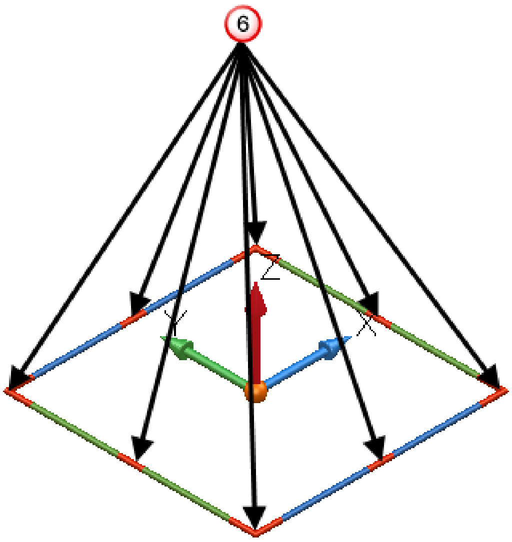
Twisting it around one of its axes:



Select any blue handle 4 to twist the workplane around its **X** axis.



Select any green handle 5 to twist the workplane around its **Y** axis.



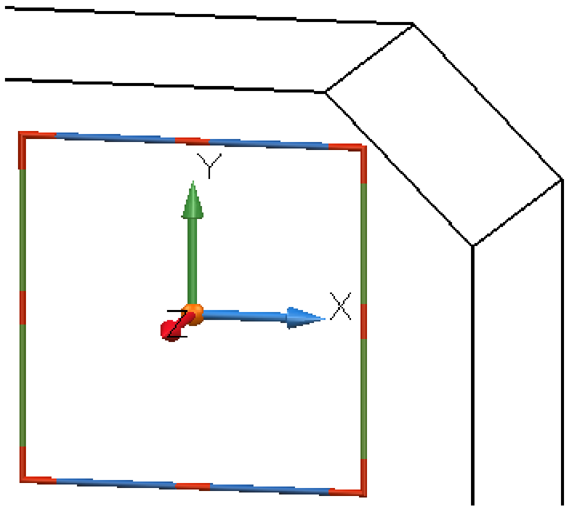
Select any red handle 6 to twist the workplane around its Z axis.

If the mouse button is released over an item, then the rotation snaps to that item. For example if the handle at the end of the Y axis was dragged and dropped over an item, then looking down Z axis, the Y axis would be pointing directly at that object.

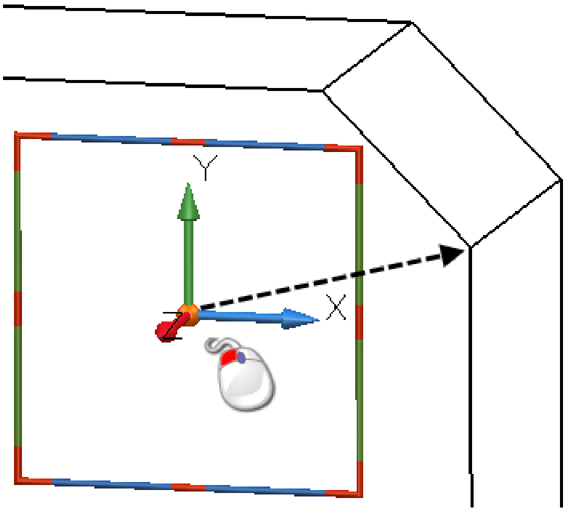
Editing a workplane - Aligning with an inclined face on the model

To align an existing workplane with an inclined face on your model:

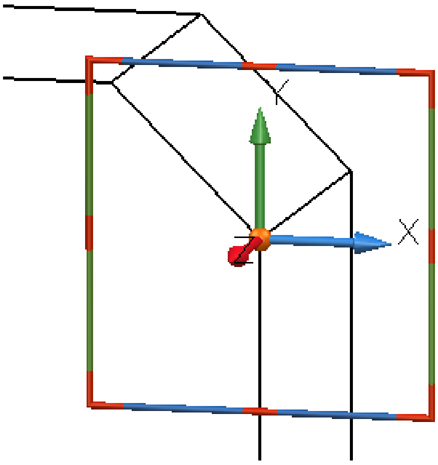
1 Select the workplane to display its graphical handles.



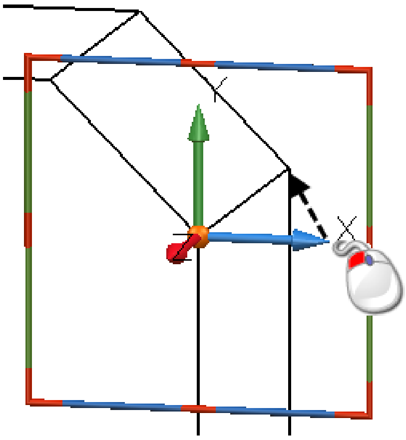
2 Move the workplane by snapping it to existing geometry on the inclined face.



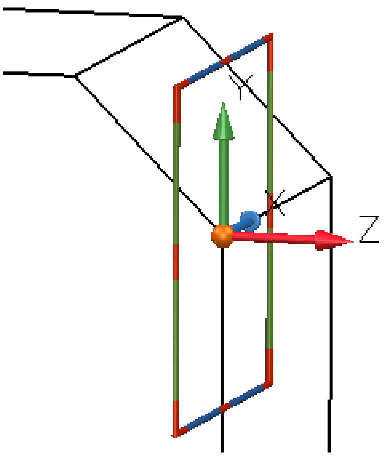
The workplane moves to its new position.



3 Drag one of the workplane's axes to point towards another piece of existing geometry.

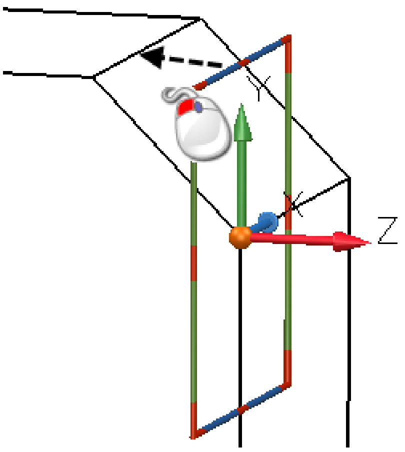


The direction of the X-axis is changed so that it lies on the inclined face.

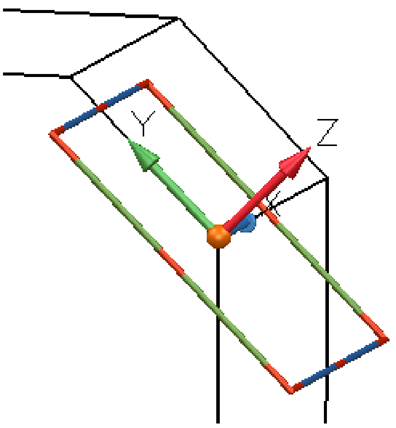


PowerSHAPE makes its best guess as to how to align the other two axes (changing them as little as possible).

4 To align the other axes on the inclined face, twist the workplane about the axis that has just been positioned.

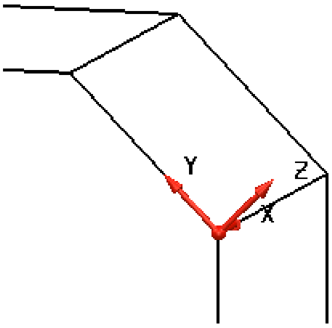


The workplane is twisted around its X-axis so that the Y-axis lies on the inclined face.



If we had dragged the Y-axis instead of twisting the workplane about its X-axis, the X-axis would have moved.

The workplane is now aligned with the inclined face on the model. You may now work directly on the inclined face of your model.



Points

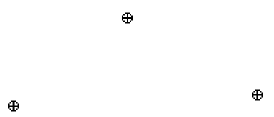
Use the following sections to find out more about points:

What is a point?

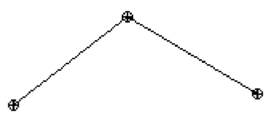
A point is an object representing a position in the workspace. It is marked using a small cross enclosed in a circle.

You can snap other objects onto points.

For example, if you have three points in the workspace



you can create two lines by snapping onto the points.

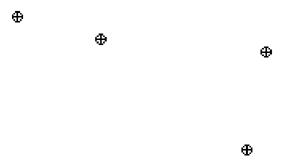


Many CAD systems require point objects to be created whenever a position is specified for an object such a line or a surface (except for the very simplest method of defining a position). PowerSHAPE provides powerful ways of specifying a position as part of every command. Therefore explicit point objects are not usually required. Nonetheless, they can be useful to mark key locations, or for imported or digitised point data.

Creating a point

1 On the Workplane toolbar, click the **Point** button.

2 Click in the graphics area to create points.

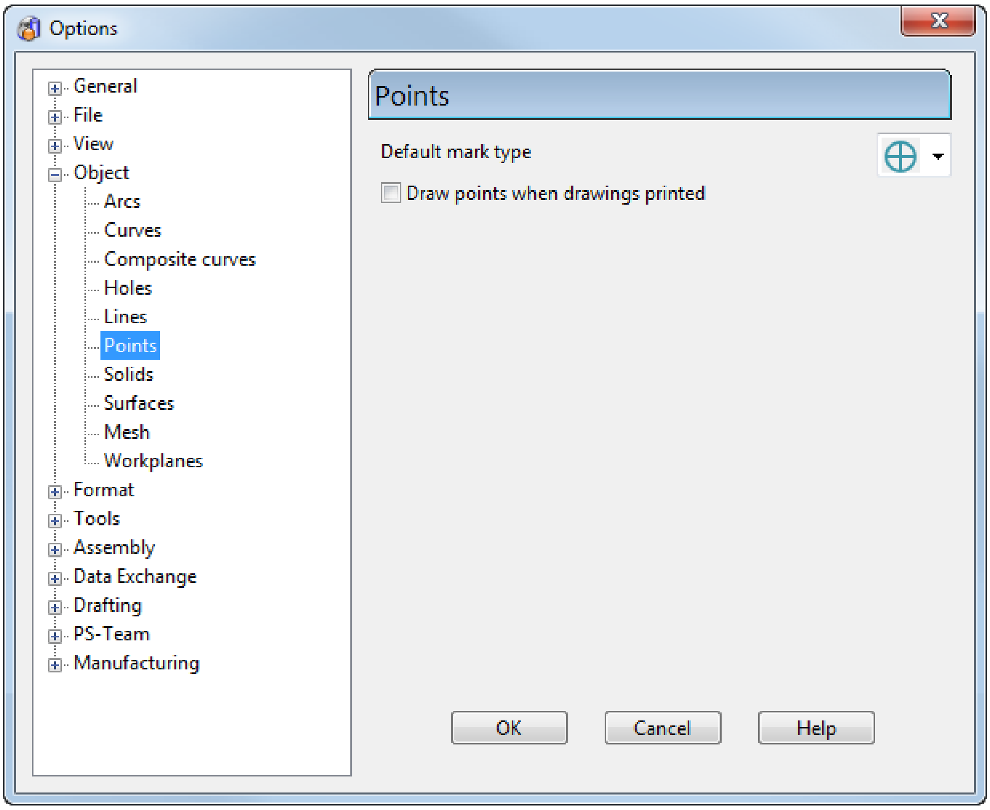


3 When you have finished creating points, click the **Select**  button to exit point-creation mode.

Setting the options for points

1 Select **Tools > Options** from the menu to display the **Options** dialog.

2 In the **Options** dialog, select the **Object > Points** page.



3 Select the settings to be used when creating and using points.

Default mark type — Select a symbol to represent the mark from the drop down list. The possible options are:

Draw points when drawings printed — If selected, points are drawn when you print a drawing.

4 Click **OK**. From now onwards, new points use the mark you selected.

Editing a point

1 Use one of the following methods to display the **Point Editor** dialog (see page 32) and edit a point:

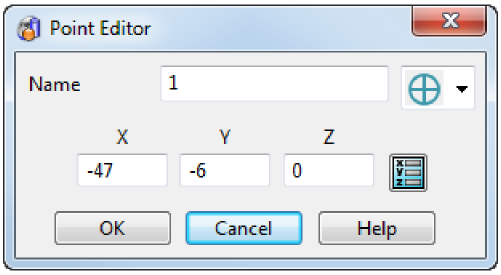
- Select a point and select **Edit > Modify** from the menu.
- Double-click the point to display the dialog.
- Right-click the point and select **Modify** from the menu.

2 Use the options on the **Point Editor** dialog (see page 32) to edit the position and the mark of the point.

Point Editor dialog

Use this to edit the selected point.

Use the box selection technique to select a different point to edit. The information on the dialog is updated to reflect the new selection. Edit the newly selected point in the normal way.



Name — Enter the name of the selected point.

Mark type — Select the symbol used to represent the mark of the selected point.

X, **Y**, **Z** — Enter the coordinates of the selected point.

Position — Click this button to display the **Position** dialog, which enables you specify the coordinates of the point.

OK — Applies the changes entered in the dialog to the point and the dialog is removed.

Cancel — Removes the dialog without altering the point.

Editing the mark used by multiple points

You can edit the mark used by multiple points.

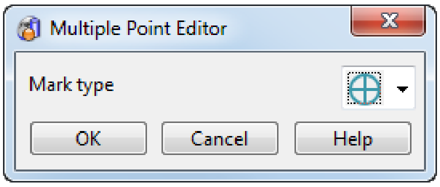
1 Select two or more points.

2 Select **Edit > Modify** from the menu to display the **Multiple Point Editor** dialog. You can also double-click the selected points.

3 Use the **Multiple Point Editor** dialog (see page 33) to edit the marks.

Multiple Point Editor dialog

Use this to edit the mark of the selected points.



Mark type — Select a symbol from the list to represent the mark of the selected points.

OK — Applies the changes to the selected point and removes the dialog from the screen.

Cancel — Removes the dialog without altering the point.

Lines

Use the following sections to find out more about lines:

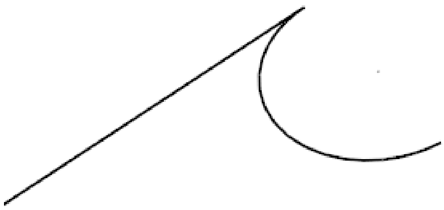
What is a line?

A line is the shortest path between two points. It is input by entering its start and end positions.

The following methods of line creation exist:

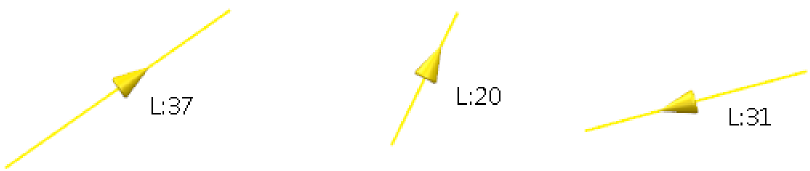
- Single lines
- Continuous lines (default)
- Rectangles
- Polygons
- Box around selected items
- Shortest distance between two objects
- Chamfers

You may also create lines which are tangent to arcs.



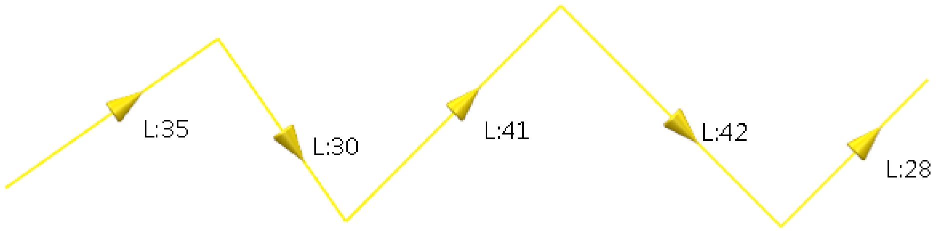
Single lines

Single lines are created between a distinct pair of points.



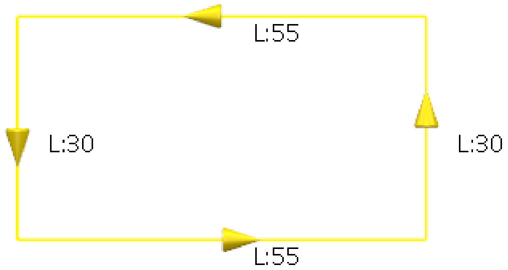
Continuous lines

Continuous lines are lines in which the end of the previous line becomes the start of the next line.



Rectangles

Rectangles are constructed from four lines, and are created by entering two positions. The first position defines the top left corner and the other the bottom right corner.

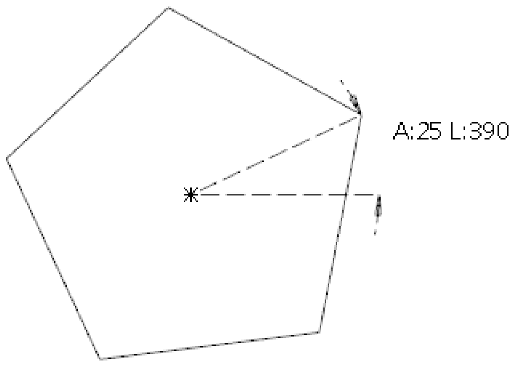


Rectangles are constructed of four individual lines, which have coincident points.

When you edit the rectangle, only the lines are edited and not the rectangle.

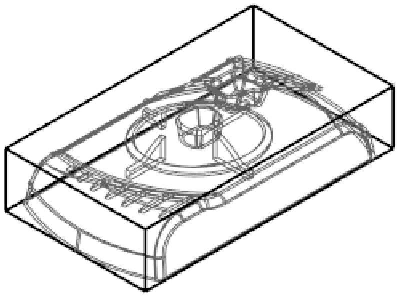
Polygons

You create polygons by entering start and end points. When you enter the end point, a polygon is created. Choose one of three polygon creation methods from the **Polygon** dialog (see page 42).



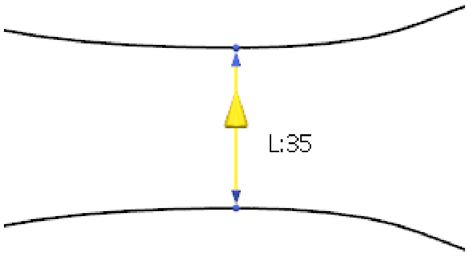
Selection box

You can create a bounding box around the current selection.



Shortest line between two objects

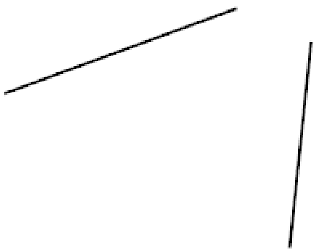
A line is created at the shortest distance between two selected objects.



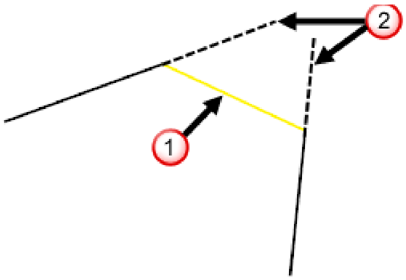
Introduction to Chamfers

A special case of line drawing is chamfers. This allows creation of lines between two lines providing certain details are given.

Suppose we have two lines as shown below:



A chamfer between these two lines is shown below 1. The two original lines can be trimmed back to the chamfer 2.

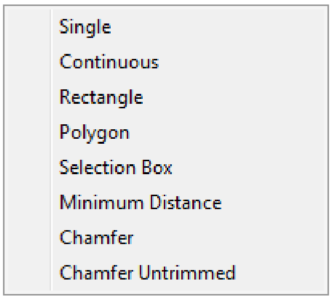


Creating a line

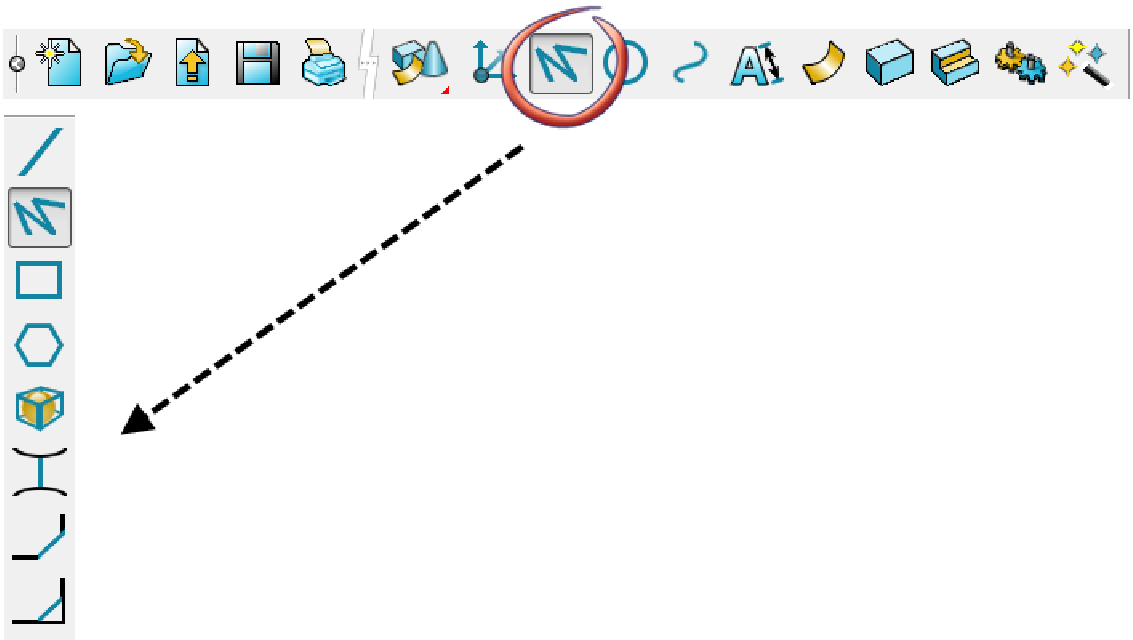
To create a line:

1 Select **Object > Line** from the menu.

The line creation submenu is displayed:



This is equivalent to clicking the **Line**  button to display the **Line creation** toolbar.



2 Select a **Line creation** type. The following options are available:

Single — Click this button to create a single line.

Continuous — Click this button to create a continuous line.

Rectangle — Click this button to create a rectangle.

Polygon — Click this button to create a polygon.

Selection box — Click this button to create a selection box.

Shortest — Click this button to create the shortest line between two selected objects

Chamfer — Click this button to create a chamfer

Untrimmed chamfer — Click this button to create an untrimmed chamfer.

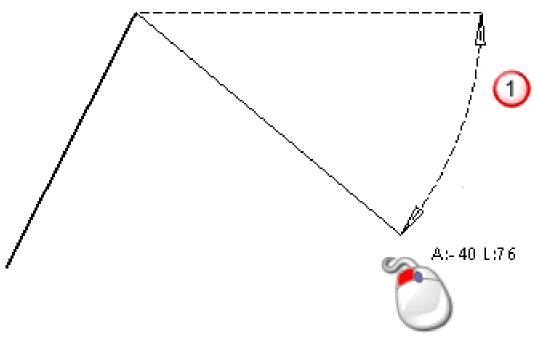
Creating a single line

1 Click the **Single** button on the Line toolbar.

2 Input positions to create your lines.

As you enter positions, a rubber banded line is displayed from the start position of a new line to the current cursor position.

The angle and length of the line from the horizontal are also shown, depending on whether gridding is set on the **Options** dialog. For further details, see Blanking and Grid (*Menus and Toolbars*).



1 When you move the cursor, the angle and length of the line are displayed. These values change as you move the cursor.

When the end position of a line is entered, the rubber banded line disappears. It is displayed if you enter the start position of a new line.

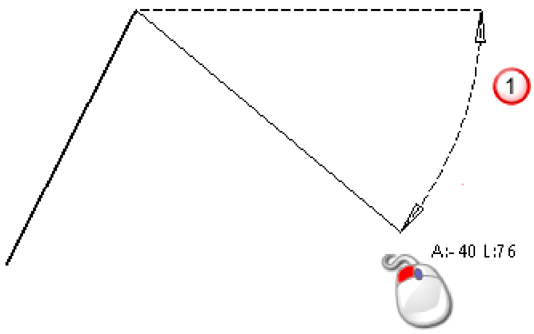
Creating a continuous line

1 Click the **Continuous** button on the Line toolbar.

2 Input positions to create a series of continuous lines.

   As you enter positions, a rubber banded line is displayed from the last position entered to the current cursor position.

   The angle and length of the line from the horizontal are also shown, depending on whether gridding is set on the **Options** dialog. For further details, see Blanking and Grid (*Menus and Toolbars*).



   1 When you move the cursor, the angle and length of the line are displayed. These values change as you move the cursor.

   If you press the **Undo** button , only the last point entered is removed from the screen.

3 To stop creating a series continuous lines, do one of the following:

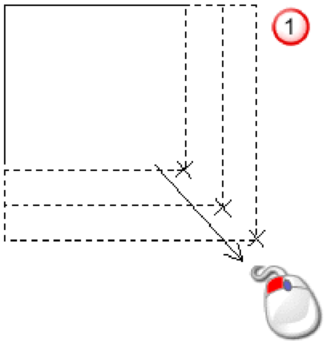
   - Click on top of the last position entered.
   - Click the **Select** button .
   - Choose any option from the **Line creation** menu.

Creating a rectangle

1 Click the **Rectangle** button on the Line toolbar.

2 Input two positions to create a rectangle.

After entering the first position, a rubber banded rectangle is displayed from the start position to the current cursor position. The dimensions of the rectangle are also displayed. When the end position is entered, a rectangle is created.



1 As you move the cursor, the size of the rectangle changes.

You cannot create a rectangle that has a side of zero length.

To stop creating rectangles, do one of the following,

- Click the **Select** button .
- Choose an option from the **Line creation** menu.

Creating a polygon

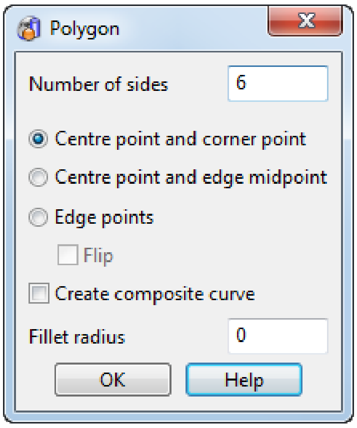
1. Click the **Polygon**  button on the Line toolbar.
2. Enter the number of sides for the polygon. The minimum is 3.
3. Choose one of three methods in the dialog to create the polygon. Whichever method you use, you must enter two points.

   After entering the first point, a rubber banded polygon is displayed from the start position to the current cursor position. The dimensions of the polygon are also displayed.

   When you click the end point, a polygon is created.
4. If you want to create a composite curve, select the **Create composite curve** option.
5. If you want the polygon to have fillet arcs, specify the radius in the **Fillet radius** box in the **Polygon** dialog (see page 42).

Polygon dialog

Use this dialog to create a polygon.

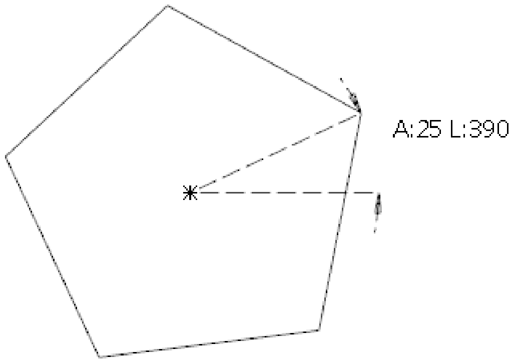


Number of sides — Enter the number of sides for the polygon. The minimum is 3.

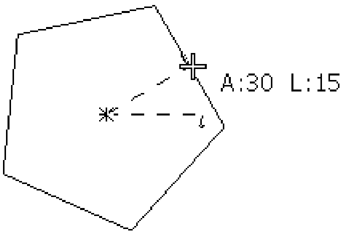
Choose one of three methods in the dialog to create the polygon. Whichever method you use, you must enter two points.

After entering the first point, a rubber banded polygon is displayed from the start position to the current cursor position. The dimensions of the polygon are also displayed. When the end point is entered, a polygon is created.

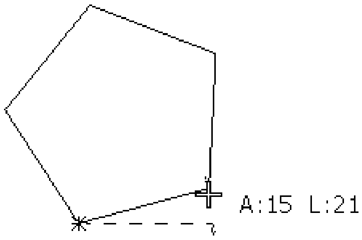
Centre point and corner point — Click the centre point and drag the cursor to the corner point to create the polygon.



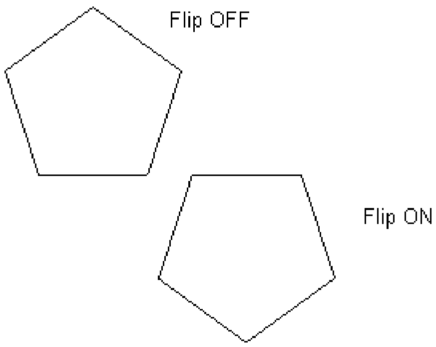
Centre point and edge midpoint — Click the centre point and drag the cursor to the mid-point of an edge to create the polygon.



Edge points — Click the start and end points of an edge to create the polygon. The **Flip** option becomes available if you choose this method.



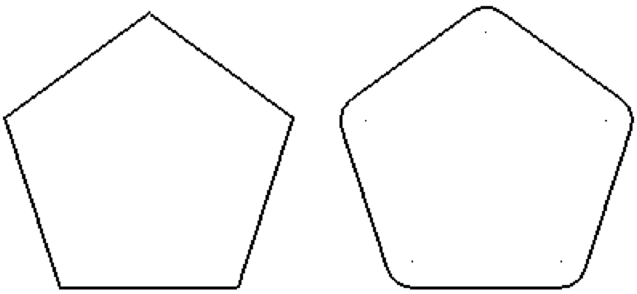
Flip — This option becomes available when you select the **Edge points** method. If selected this flips the centre of the polygon to lie on the other side of the defining edge as it is created.



Create composite curve — Select this option to create a composite curve automatically from the lines and arcs of the polygon you want to create.

Fillet radius — Enter a radius to create fillet arcs between each straight edge of the polygon. If set to zero, no arcs will be created.

The example below shows two, five-sided polygons. The polygon on the left was created with a **Fillet radius** of *0*. The polygon on the right was created with a **Fillet radius** of *4*.



OK — Removes the dialog.

Creating a selection box

1 Select a group of objects.

2 Click the **Selection Box**  button on the Line toolbar.

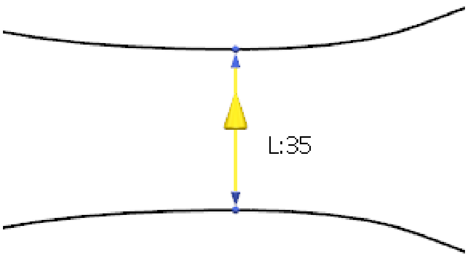
A bounding box is created around the selected objects.

Shortest distance between two objects

1 Select two objects.

2 Click the **Shortest**  button on the Line toolbar.

This measures the distance between the two selected objects and creates the shortest line between them.



A line is created at the shortest distance between the two objects.

The types of objects that can be selected are: arcs, lines, curves, composite curves, surfaces and points. This can be used instead of the **Measure minimum distance** button on the calculator in order to create a line at the distance measured.

Lines tangent to arcs

There are 3 different ways of creating a line tangent to an arc. These are:

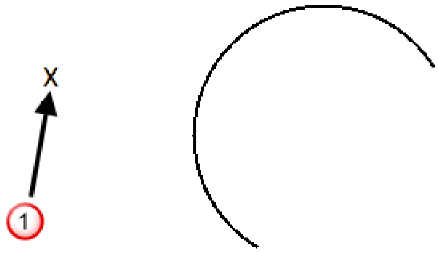
- creating a line with the start position already defined.
- creating a line with start position as a tangent point on the arc.
- creating a line between two arcs.

If you want to create a line tangent to an arc when its start position is already defined, its second position is defined by clicking the arc. The arc is automatically trimmed to where the line is tangent with it.

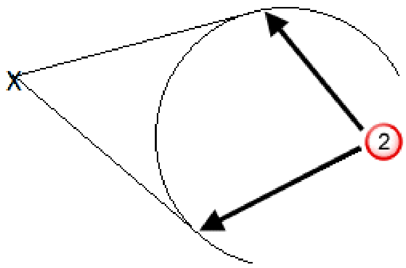
The position at which you select the arc is important, because it decides:

- where the tangent solution is.
- which portion of the arc to trim.

For example, suppose you have a start position of a line 1 and an arc as shown below:



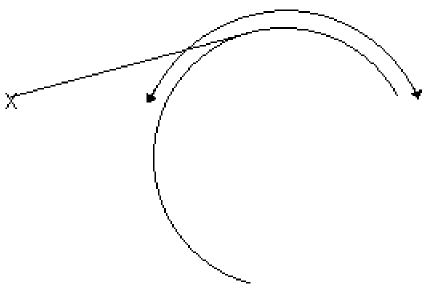
In this case, the line is tangent to two positions on the arc 2.



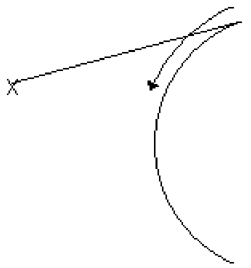
Select the arc at a position nearest to the required tangent.

The arc has three key points (its end points and midpoint) which are used to snap on to. If you select any of these key points on the arc, the end of the line is positioned there and no tangency position is found. To find a tangency point on an arc, hover the cursor over the arc until the word 'Tangent' appears.

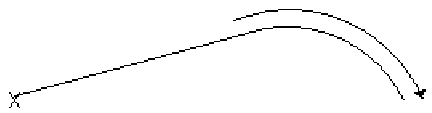
If you require the top tangent, then the arc is selected in any of the positions (apart from the arc's key points) shown below.



The selection positions lie on either side of the position where the line falls tangent to the arc. Which side of the arc is selected determines how the arc is trimmed. If the arc is selected to the left, it is trimmed as shown below.

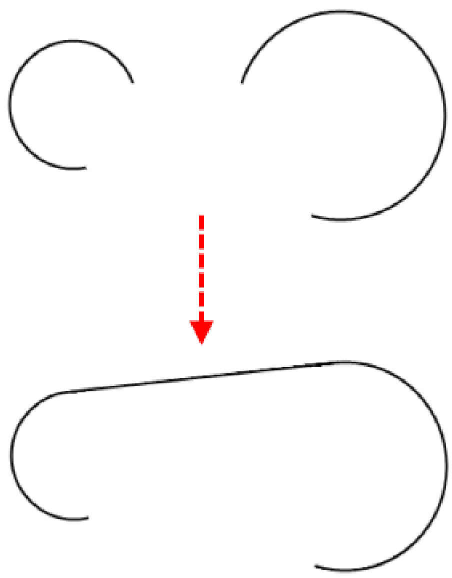


If the arc is selected to the right, it is trimmed as shown below.



You can click the arc first and then input the end position of the line. The tangent on the arc is determined in the same way in both cases.

You can also create a line which is tangent to two arcs. A line tangent to both arcs is given in the figure below.



For a full arc (circle), its start and end points move to coincide at the position where the line is tangent to it.

If the tangent position lies off the arc, then the nearest end point of the arc to the tangent position extends to this position.

Line and arc must lie in the same plane.

Creating a line tangent to an arc

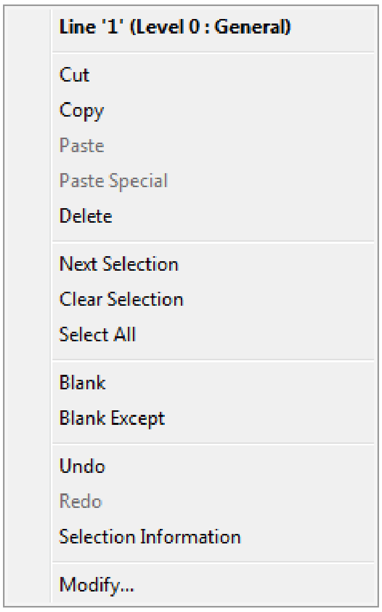
1 Click the **Single**  button or the **Continuous**  button on the Line toolbar.

2 Input positions to create your lines and where you want a line tangent to an arc, select the arc instead of entering a position.

Editing a line

Use one of the following methods to edit a line:

- Select the line.
  - Use the default graphical handles to move it (see page 47).
  - Use the workplane handles to move it (see page 49).
- Select **Edit > Modify** to display the **Line Editor** dialog (see page 49)
- Double-click the line to display the **Line Editor** dialog (see page 49).
- Right-click the line and select **Modify** on the **Line** context menu to display the **Line Editor** dialog (see page 49). The name of the line and the level on which it lies is displayed at the top of the menu.

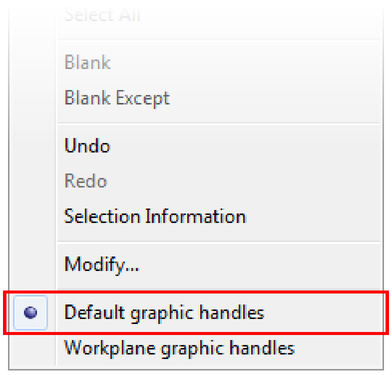


- You can also simultaneously edit multiple lines (see page 51).

Graphically moving a line (default handles)

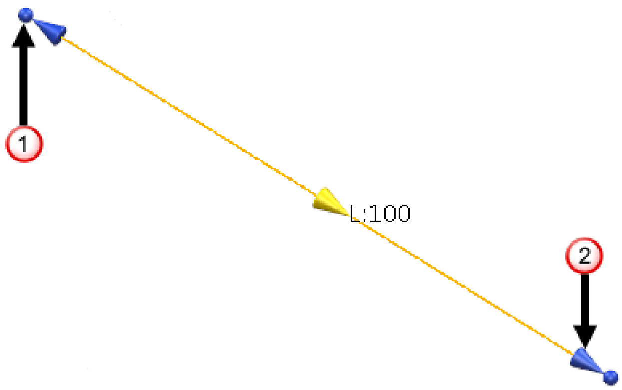
1 Select a line.

2 Right-click on the line and select **Default graphic handle** from the menu.



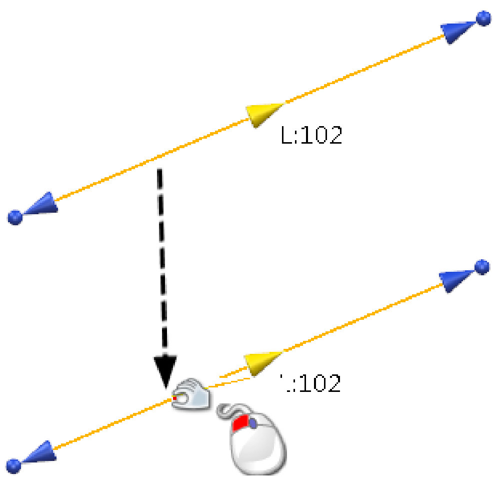
3 To edit the line, drag the various handles :

- Use the spherical handles 1 to move a line point freely.
- Use the arrow tip handles 2 to move a line point along the direction of the line.



Moving the cursor over a handle highlights the handle, indicating that you can move it.

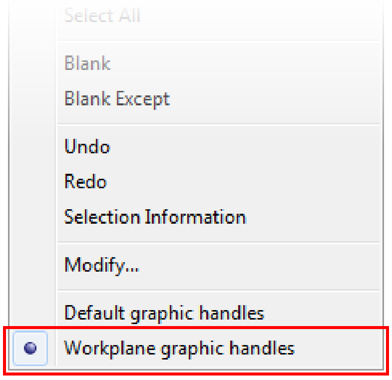
If you select the line at a position other than a handle, then the whole line moves to the new position. This is illustrated below:



Graphically editing a line (workplane handles)

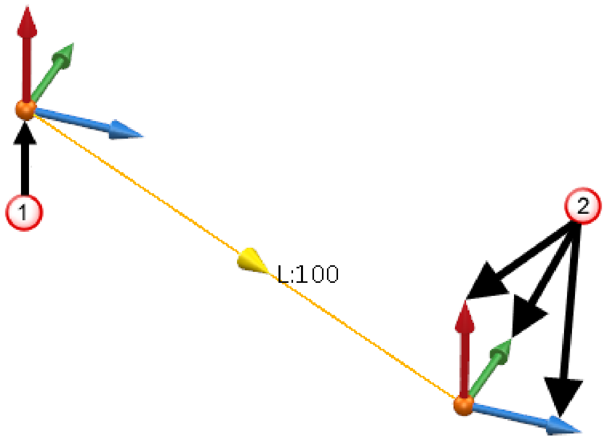
1 Select a line.

2 Right-click on the line and select **Workplane graphic handles** from the menu.



3 To edit the line, drag the handles:

- Use the workplane spherical handles 1 to move a line point freely.
- Use the workplane arrow handles 2 to move a line point along a fixed axis.



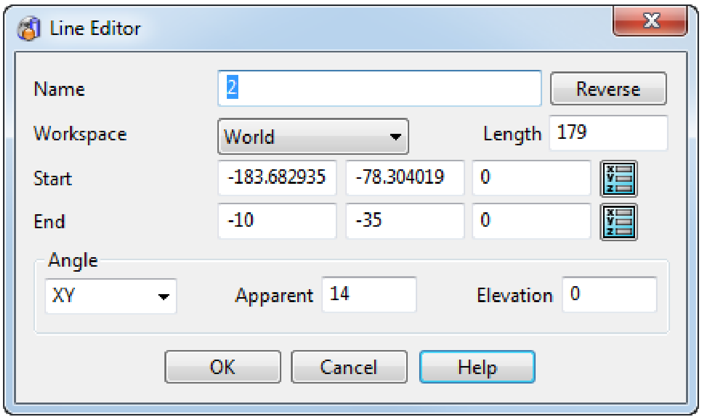
Moving the cursor over a handle highlights the handle, indicating that you can move it.

Line Editor dialog

Use this dialog to edit a line.

Change the line selection when the dialog is displayed by clicking a different line. Edit the newly selected line in the normal way.

*The **Line Editor** dialog is also used to edit multiple lines (see page 51), with a number of slight differences.*



Name — Displays the name of the selected line. You may also use it to edit the name.

Reverse — Click this button to reverse the line so that the start coordinates become the end coordinates and the end coordinates the start.

Workspace — Enables you edit 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 — Enter the length of the line. If you edit the existing length, the end of the line moves to increase or decrease the length.

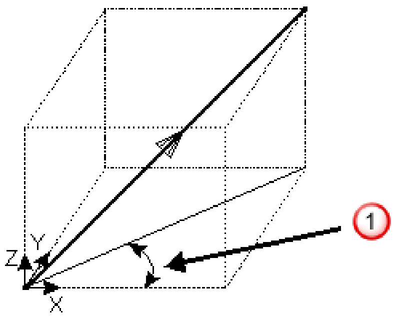
Start — Edits the start coordinates of the line.

End — Edits the end coordinates of the line.

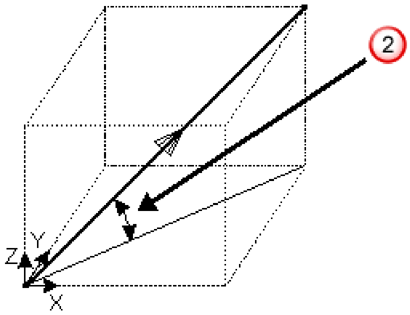
Angle — The angle of line is defined in terms of apparent and elevation angles on the selected plane.

— Use the plane selector to change the selected plane.

Apparent — The apparent angle is measured between the projection of the line onto the selected plane and an axis of the plane 1. The axis used is the X axis if the selected plane is XY, Y if it is YZ and Z if it is ZX.



Elevation — The elevation angle is measured between the line and the projection of the line onto the selected plane 2.



OK — saves the edits carried out on the line and removes the dialog from the screen.

Cancel — Removes the dialog and discards any edits carried out on the line whilst it was displayed.

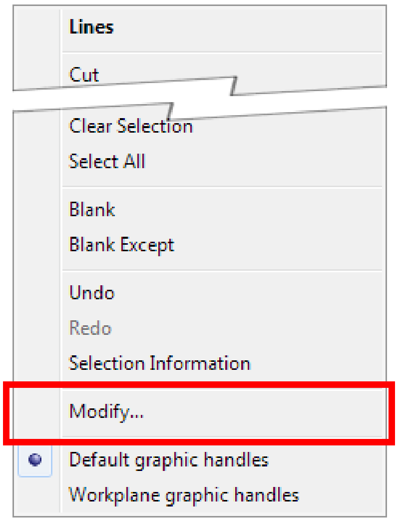
Editing multiple lines

To edit multiple lines at the same time:

1 Select a number of wireframe lines that you want to edit with one of the following methods:

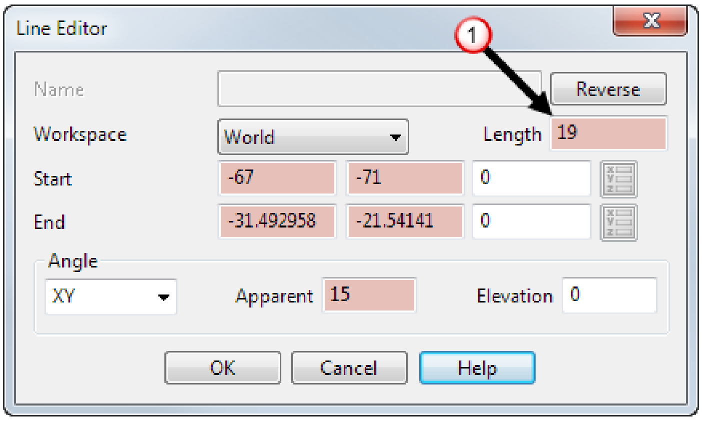
- Press and hold the **Shift** key and click the lines.
- Press and hold the **Ctrl** key and click the lines.
- Click and drag the cursor over the lines.

2 Right-click one of the selected lines, and select **Modify**.

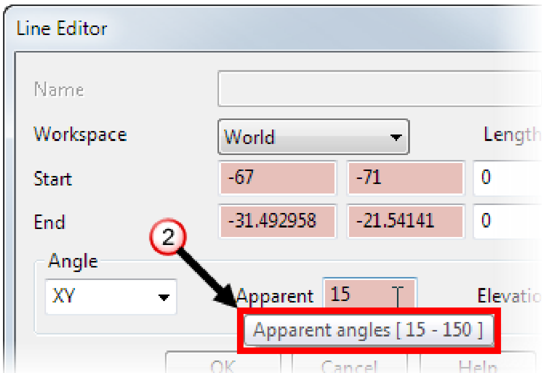


The **Line Editor** dialog (see page 49) is displayed. It is similar to that of editing a single line, with the following differences:

1 — The properties that differ between the selected lines are highlighted in pink.



2 — The range of values is displayed when you hover the cursor over a property.



*You can also double-click one of the selected lines to display the **Line Editor** dialog.*

3 Edit the properties.

4 Click **OK** to apply the changes to the selected lines and close the dialog.

You can change your selection of lines whilst the dialog is displayed by selecting new lines in the graphics area. Any edits that you made to your initial selection are kept.

*When multiple wireframe lines are selected graphical instrumentation is only displayed whilst the **Line Editor** dialog is displayed*

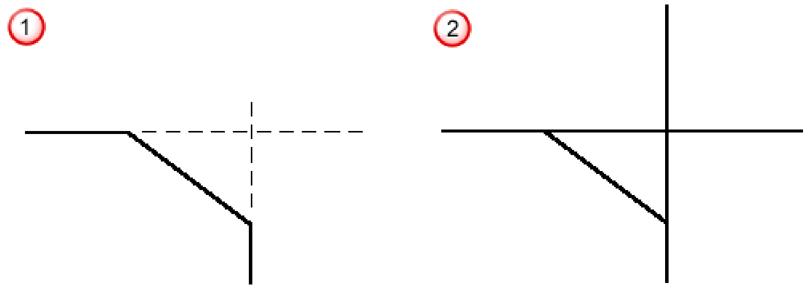
Chamfers

A chamfer is a special line created between two lines (see page 54).

Two chamfer options are available:

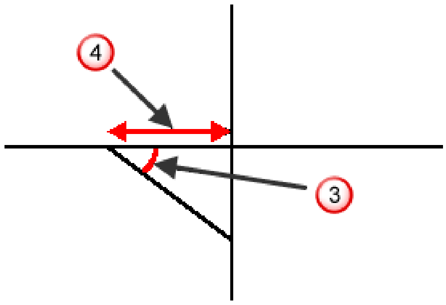
- lines are trimmed back to the chamfer 1

- lines are left untrimmed 2.

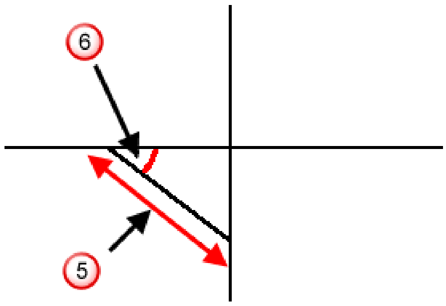


A chamfer is defined in one of the following ways:

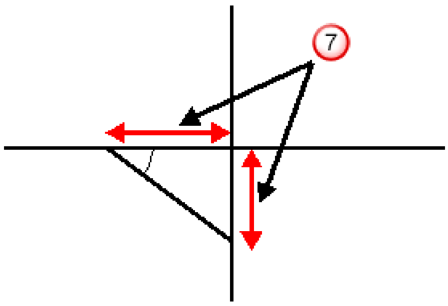
- **Angle Distance** (default) — angle from the first line 3 and its distance along the first line 4 (measured from the point intersection of the two lines)



Angle Length — its length 5 and angle 6 from the first line.



- **Distance Along** — distances along both lines 7 (measured from the point of intersection of the two lines)



Specify the default chamfer type and size using the **Options** dialog (see page 54).

You can also:

- *create custom chamfers by specifying the line length and angle (see page 55).*
- create a chamfer by specifying the line length or angle (see page 56).

Creating a chamfer

1 Click the **Chamfer**  button or the **Untrimmed Chamfer**  button on the Line toolbar.

2 Select two lines or click the intersection point of two intersecting lines.

On the screen, a default chamfer is added to your two lines.

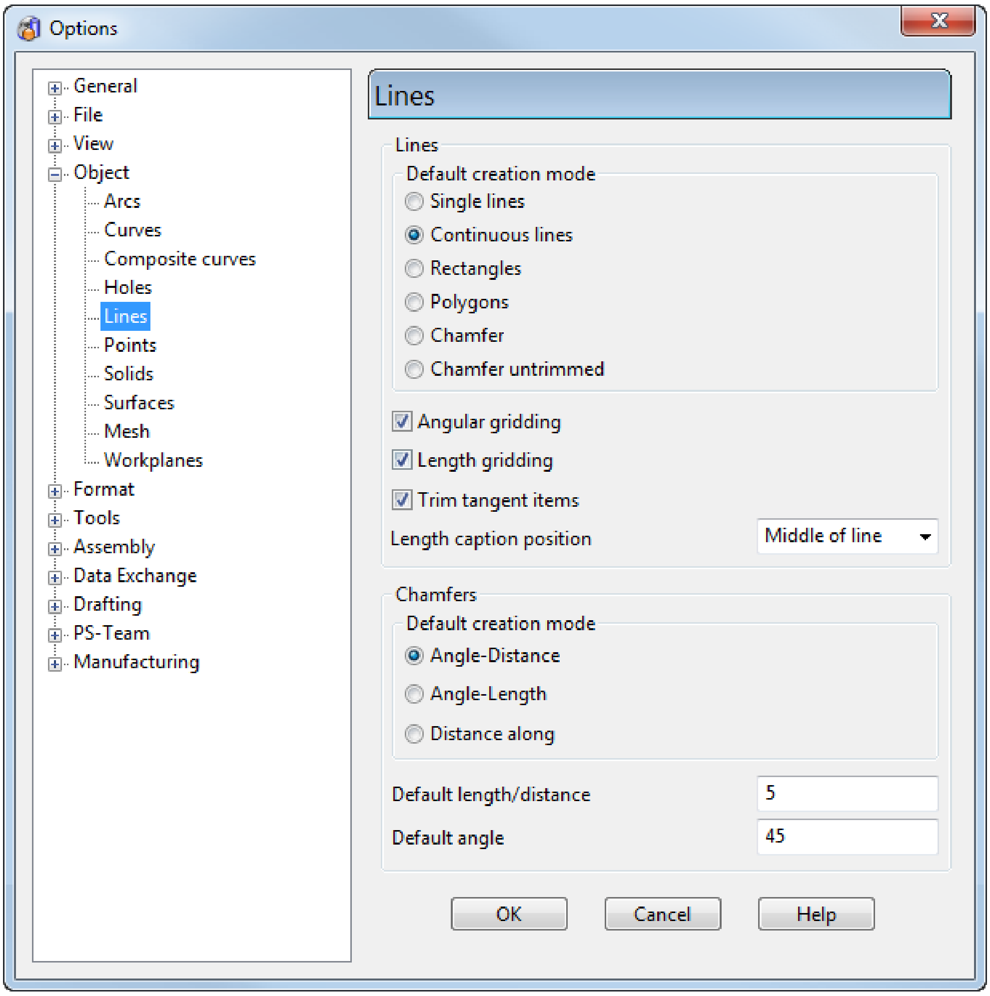
If the two lines cross, the chamfer is created in the same quadrant where you click the two lines.

3 Edit the chamfer as necessary. You are still in chamfer creation mode and can continue creating chamfers as required.

Setting the default chamfer

Use the **Options** dialog to specify the default type of chamfer to create and the default values.

1 From the **Tools** menu, select **Options > Object > Lines** to display the **Lines** page.



2 Specify the chamfer options:

Default Creation Mode — You can set the default chamfer creation mode so that when you create a chamfer, this type of chamfer is automatically created.

Default length/distance — This is the length or distance used by the definition of the chamfer.

Default angle — This is the default angle of the chamfer with the first line when the **Default Creation Mode** is **Angle-Length** or **Angle-Distance**.

3 Click **OK**.

Creating a custom chamfer

Create a custom chamfer between two connected lines:

1 Draw two connected lines.

2 Click the **Chamfer**  button.

3. Enter values in the command line. For example, the following specifies a line length of `50` and an angle of `30`:

   ```
   l 30
   a 30
   ```

4. Press and hold the **Ctrl** key and select the two lines to create the chamfer.

Setting the length or angle of the next chamfer

Set the length or angle of the next chamfer as follows:

1. Create two lines.
2. Click the **Chamfer**  button.
3. Enter *one* of the following:

   length *xx*

   angle *xx*

   where *xx* is the required length or the angle.
4. Select the lines.

The chamfer is created with the length and angle that you specified.

Editing a chamfer

A chamfer is not edited like an ordinary line. It has its own special editing features that enable you to change its definition from one type to another.

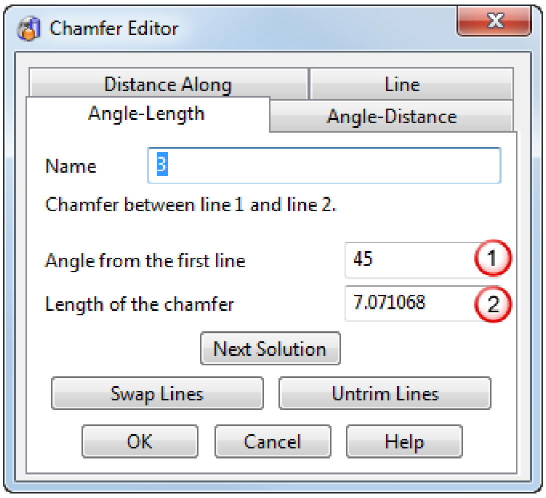
1. Double-click the chamfer to display the **Chamfer Editor** dialog. (see page 56)
2. Use the dialog to specify the editing of the chamfer.

Chamfer Editor dialog

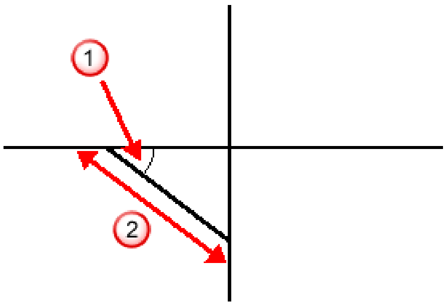
Use this dialog to edit a chamfer. There are four tabs to change the type of chamfer definition.

- **Angle-Length**
- **Angle-Distance**
- **Distance Along**
- **Line**

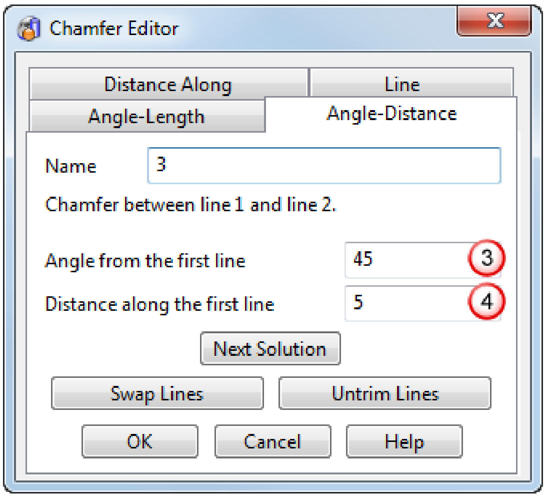
Angle Length — Converts the chamfer to an **Angle-Length** chamfer.



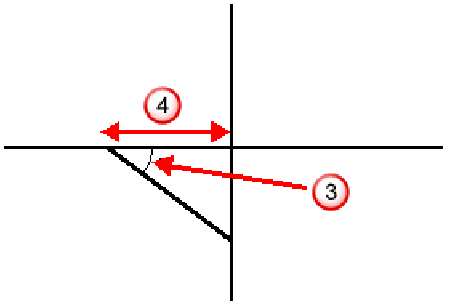
The figure below shows how the chamfer is defined using this page.



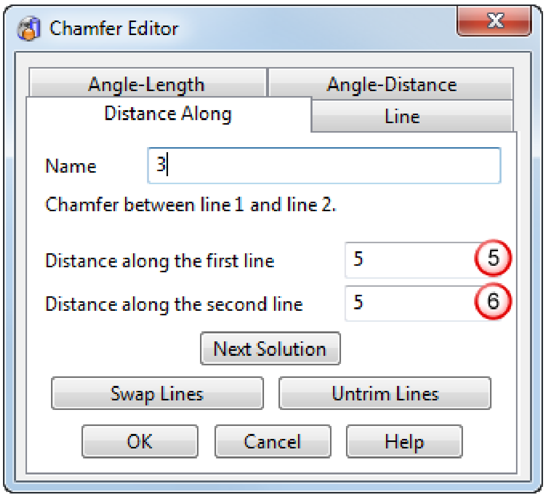
Angle Distance — Converts the chamfer to an **Angle-Distance** chamfer.



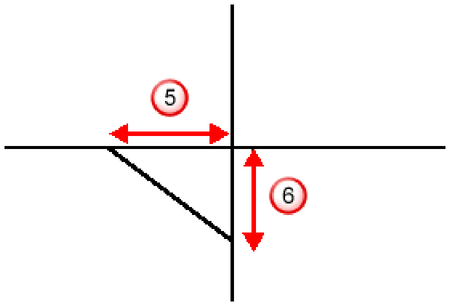
The figure below shows how the chamfer is defined using this page.



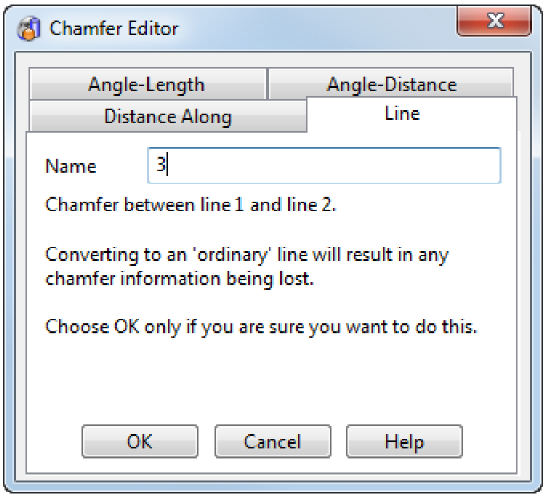
Distance Along — Converts the chamfer to a **Distance Along** chamfer.



The figure below shows how the chamfer is defined using this page.



Line — The chamfer is converted to an ordinary line. Chamfer editing facilities will no longer be available for that line.



Name — Displays the name of the selected chamfer. You can also use it to edit the name.

Next Solution — Displays another chamfer solution for the two lines (if one exists). Repeatedly clicking this button will cycle through all the solutions.

Swap Lines — Treats the second line as the first line.

Untrim Lines — Untrims the two lines back to their original size.

OK — Saves the edits carried out on the chamfer and closes the dialog.

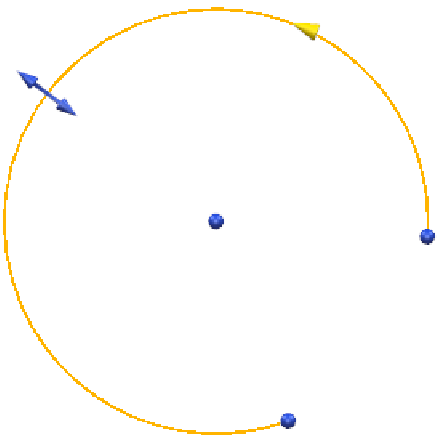
Cancel — Closes the dialog and discards any edits carried out on the chamfer whilst it was displayed.

Arcs

Use the following sections to find out more about arcs:

What is an arc?

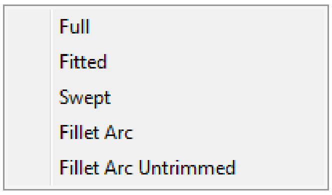
An arc is a sector of a circle.



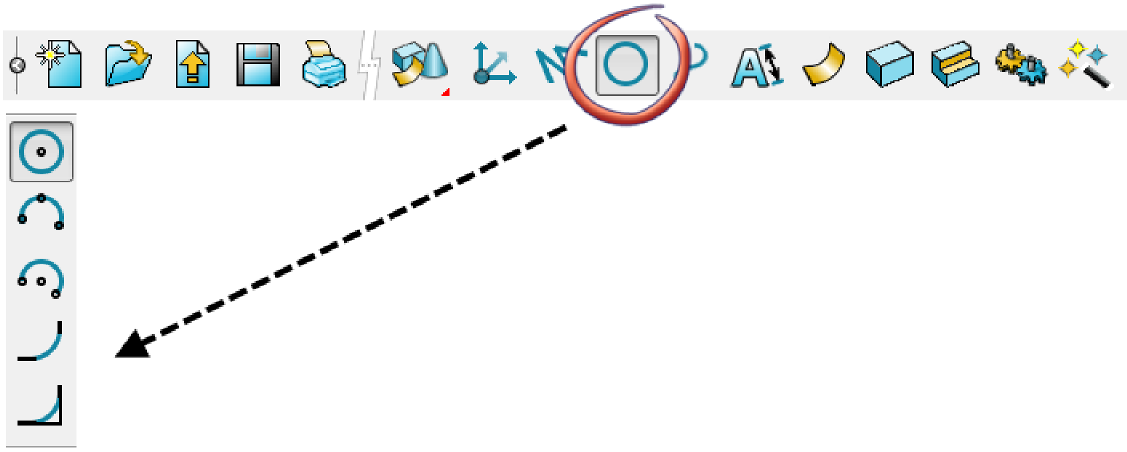
Two types of arc exist: full (circle) and partial. A full arc has a span of 360° with start and end points which coincide and a single key point at its centre. A partial arc has three key points: at the start, end, and centre positions.

Creating an arc

1 Select **Object > Arc** from the menu to display the **Arc creation** submenu.



This is equivalent to clicking the **Arc** button to display the **Arc creation** toolbar.



2 Select an **Arc creation** type. The following options are available:

Full arc — Click this button to create a full arc (circle).

Three points — Click this button to create an arc through three points/items.

Centre, radius, span — Click this button to create an arc through centre, radius, and span.

Fillet — Click this button to create a fillet arc.

Untrimmed fillet — Click this button to create an untrimmed filled arc.

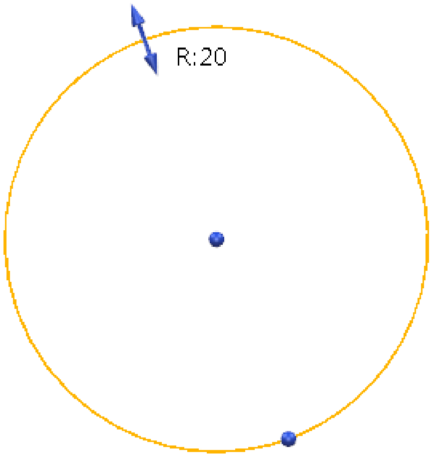
Creating a full arc (circle)

1 Click the **Full Arc** button on the Arc toolbar.

Notice the shape of the cursor. It appears as a circle in the active plane of the current workspace.

2 Input a position for the centre point of the arc.

A circle is created on the screen.



You can edit the circle created.

You can continue creating more circles while in this creation mode. The radius of the next arc is the same as the previous one, unless you specify a new radius. You can do this by typing the radius command **r** directly in the graphics window, followed by the new value. For example,

r 50

3 Press the **Enter** key.

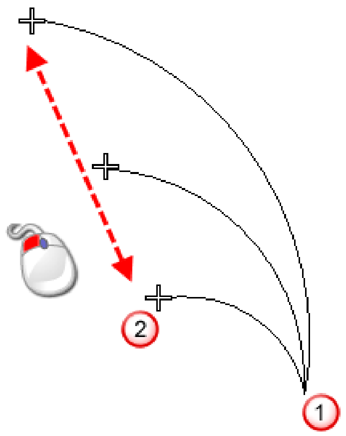
Creating an arc through three points/items

1 Click the **Three Points**  button on the Arc toolbar.

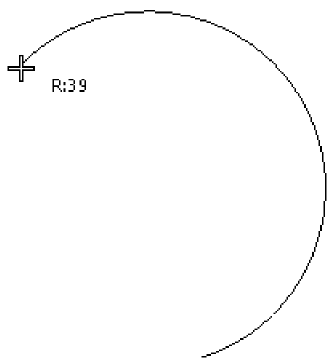
2 Input the first position to define the start of the arc.

You may also select an item to define the start tangent of the arc.

On the screen, a rubber band (in the shape of an arc) is attached to the start point 1 and the cursor 2. As the cursor moves, the rubber band moves. PowerSHAPE is waiting for the next position to be entered.



3 Input the second position to define the end of the arc.

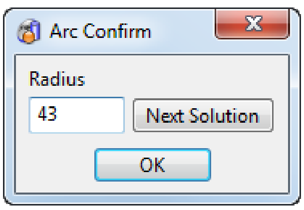


You may also select an item to define the end tangent of the arc.

Notice that the rubber band is fixed to the two ends of the arc. As you move the mouse, the rubber band displays the shape of the arc as if the cursor is the third position. Also, the radius is displayed and updated as you move the mouse. For smaller increments of the radius, zoom in, for larger increments, zoom out.

4 Input the third position to define a position on the circumference of the arc.

When you input the third position, the **Arc Confirm** dialog is displayed showing the radius value of the arc.



This dialog enables you to enter correct radius values without moving the start and end positions of the arc. When you create an arc there may be more than one solution.

5 Click **Next Solution** to display other solutions.

When using gridding, there may be occasions where the arc radius you require is not snapped to. For example, when working with large grid numbers and the increment between the grid points is 50, you may find it difficult to enter a radius of 3005. This dialog enables you to modify the radius value to 3005.

6 Change the radius value of the arc, if you wish.

7 Click **OK**.

*If you do not want the **Arc Confirm** dialog to display every time a fitted arc is created, you can switch it off. From the **Tools** menu, select **Options... > Object > Arcs** to display the **Arcs** page. Deselect the **Confirm Radius** option.*

Creating an arc tangent to a wireframe object

This is very similar to creating an arc by inputting positions except wireframe objects are clicked to define the end tangents of an arc.

The wireframe objects must lie in the same plane. If they don't lie in the same plane, use the Create an untrimmed blend (see page 116) option on the curve creation toolbar.

1 Click the **Three Points** button on the Arc toolbar.

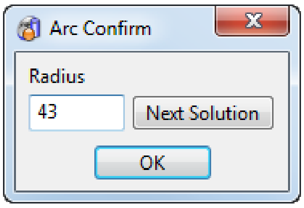
2 Input the first position to define the start of the arc or click a wireframe object to define the start tangent of the arc.

If you move the cursor over a wireframe object and the intelligent cursor is switched on, the word **Tangent** is displayed where tangency is defined, otherwise the program assumes a start point is being specified.

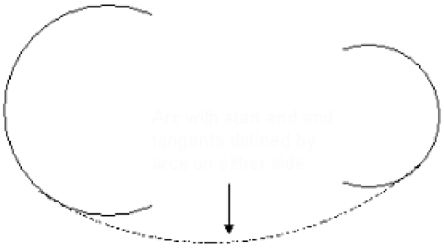
If a wireframe object is clicked where tangency is defined, then the tangency is worked out as the cursor moves and displays the solution as a rubber band.

3 Input the second position to define the end of the arc or click a wireframe object to define the end tangent of the arc.

4 If one of the objects is a curve, the arc is drawn and the **Arc Confirm** dialog is displayed showing the radius value of the arc.



5 If none of the objects is a curve, input the third position to define a position on the circumference of the arc.



When you input the third position, the **Arc Confirm** dialog is displayed showing the radius value of the arc.

6 Change the radius value of the arc or the solution, as required.

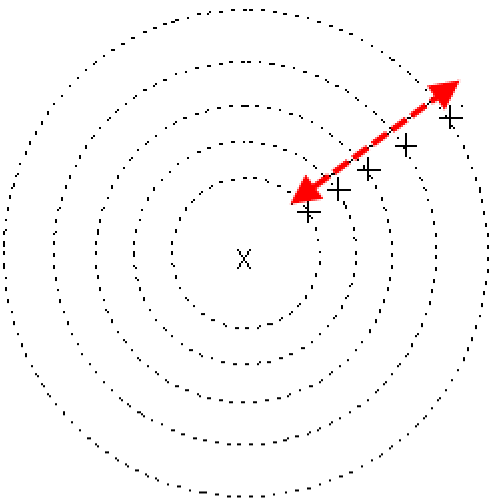
7 Click **OK**

Creating an arc through centre, radius and span

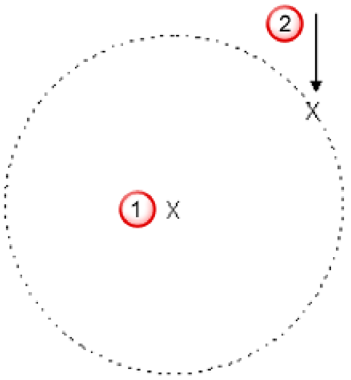
1 Click the **Centre, Radius, Span**  button on the Arc toolbar.

2 Input the first position to define the centre position of the arc.

On the screen, a circle is displayed to help you input the second position. As the cursor moves, the circle changes size and displays the radius at that position.



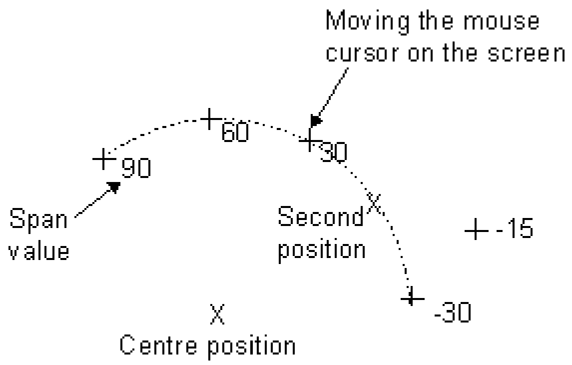
3 Input the second position to define the radius of the arc.



1 Centre position

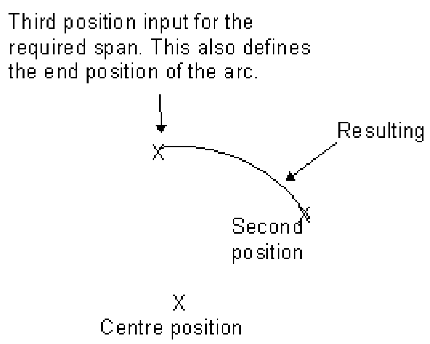
2 Position of arc radius. This also defines the start position of the arc.

A visual aid is displayed to help you input the third position. This time as the cursor moves, an arc is displayed. It shows the span values from the start position of the arc.



4 Input the third position to define the span of the arc. This also defines the end position of the arc.

The resulting arc is drawn on the screen.



Creating a fillet arc

A fillet arc is an arc created between two objects such that the tangents of the arc lie on each object.

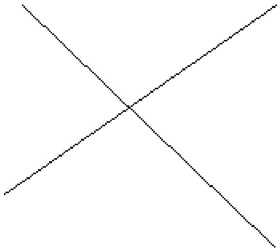
You can also create fillet arcs on composite curves where two lines meet.

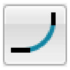
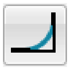
Fillet arcs between two objects

1. Create two objects you wish to create the fillet arc between.

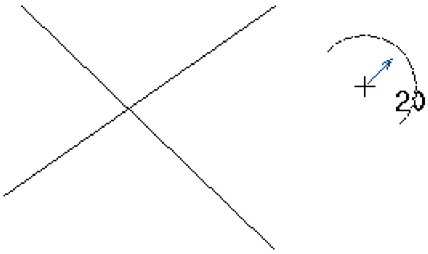
   The two objects can be one of the following: two lines; two arcs; one arc and one line.

   Suppose we have the following lines.



2. Click  for a trimmed fillet arc or  for an untrimmed fillet arc (*arc toolbar*).

   Notice that the mouse cursor has changed to an arc with a value attached and an arrow. The attached value is the default radius value.



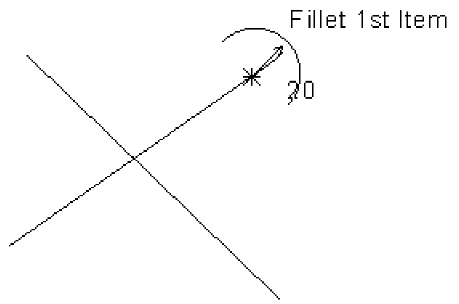
   To change the default radius during the fillet arc creation, type the radius command **r** directly in the graphics window, followed by the new value. For example,

   r 50

   Press **Enter**.

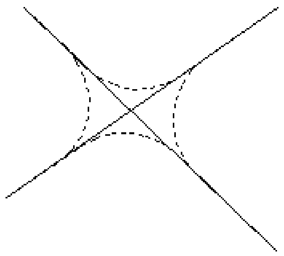
   The new radius value becomes the default radius value and is now attached to the cursor. You can also change the default radius value using the **Options** dialog.

If you move the cursor over a suitable object, the intelligent cursor tells you that you can select this object as the first item.



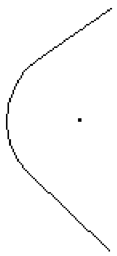
3 Select one object and then the other.

For two lines which cross, there are four fillet arc solutions as shown below. Therefore, where you select the lines is important.

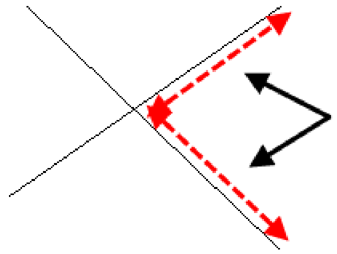


Make sure you select the lines on the same side of the intersection where you want the fillet arc to lie.

Suppose we want the following fillet arc.



We can select the two lines anywhere as shown below.



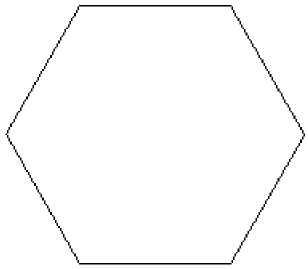
Once you select the first line and hover the cursor over the second line, a fillet arc is displayed showing you where it will be created. You are also told that this line can be selected as the second line.

Dependencies exist between the two objects and the fillet arc. This implies if you edit any of the three objects, the other two update accordingly.

Fillet arcs on composite curves

Fillet arcs are added to composite curves where two lines meet. These fillet arcs become part of the composite curve.

1 Create a composite curve, for example:



2 Click (arc toolbar).

Notice that the cursor has changed to an arc with a value attached and an arrow. The attached value is the default radius value.

To change the default radius type the radius command **r** directly in the graphics window, followed by the new value. For example,

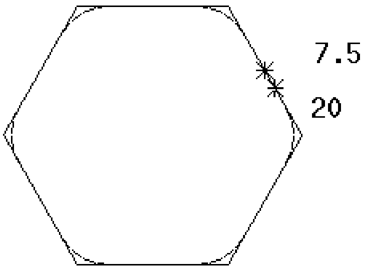
r 50

Press **Enter**.

The new radius value is now attached to the cursor. You can also change the default radius value using the **Options** dialog.

When you hover the mouse over the composite curve, the intelligent cursor shows where the new fillet arcs will lay (see figure below).

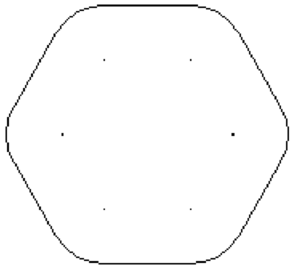
In the figure below, 20 is the default radius value and 7.5 is the gridding distance from the nearest key point on the composite curve.



1 Select the composite curve.

If two lines meet anywhere in the composite curve, a fillet arc is added.

In our example, six fillet arcs are added to our composite curve.



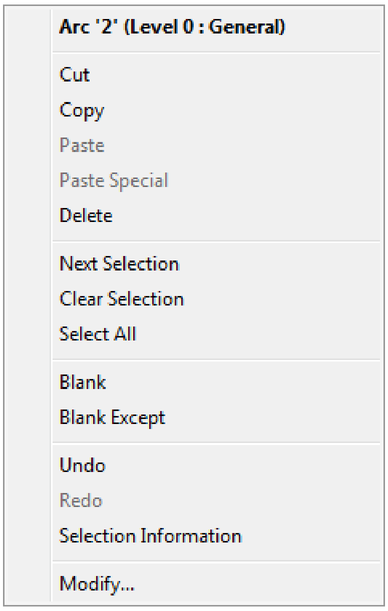
The fillet arcs are edited as part of the composite curve.

Editing an arc

To edit an arc, use one of the following methods:

- Select the arc and use the graphical handles to edit it.
- Select **Edit > Modify** to display the **Arc** dialog (see page 72).
- Double-click the arc to display the **Arc** dialog. (see page 72)

- Right-click the arc and select **Modify** from the **Arc** context menu to display the **Arc** dialog (see page 72). The name of the arc and the level on which it lies is at the top of the context menu.

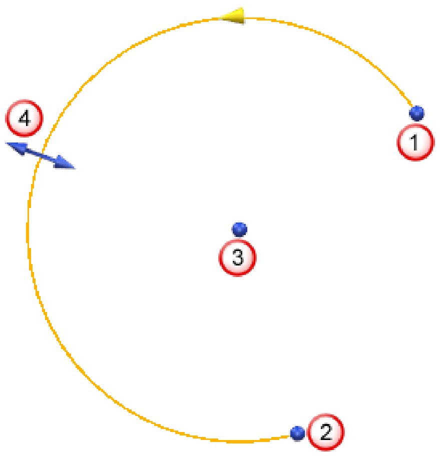


- You can also simultaneously edit multiple arcs (see page 77).

Graphically editing arcs

1 Select the arc to display its graphical handles.

The graphical handles that appear are shown below.



Handle 1 moves the start point of the arc and handle 2 moves the end point. In a full arc, handles 1 and 2 coincide.

Handle 3 moves the centre position of the arc.

Handle 4 edits the radius of the arc.

2 Select the handle of the feature you wish to edit.

3 Drag the handle to the required value or position.

Where a dimension of an arc is edited, for example the radius, it is displayed on the screen as you drag the handle. How the dimension value increases and decreases depends upon the zoom factor.

In the case of a full arc, when the handle made of handles 1 and 2 is dragged, it splits into two handles. One handle moves with the mouse cursor and the other remains stationary. The full arc turns into a partial arc.

If handles 1 and 2 on a partial arc are dragged so that they coincide, the arc turns into a full arc.

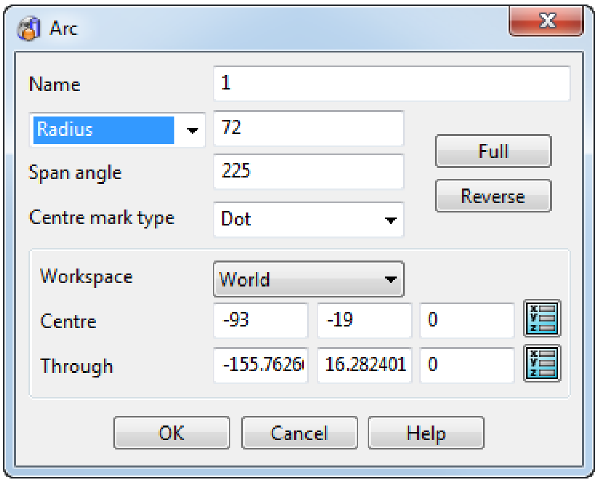
If you are editing a fillet arc, the results of the edits affect the two lines.

Arc dialog

Use this dialog to edit arcs. If you are editing a fillet arc, the results of the edits affect the two lines.

Change the arc selection whilst the dialog is displayed by clicking a different arc. Edit the newly selected arc in the normal way.

*The **Arc** dialog is also used to edit multiple arcs (see page 77), with a number of slight differences.*

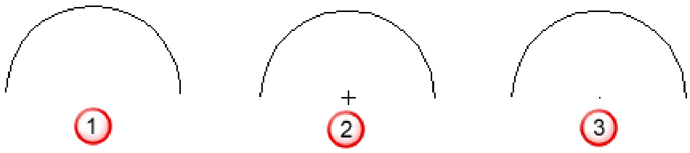


Name — Displays the current name of the selected arc. Type in a new name if required.

Radius/diameter — Shows the radius/diameter of the selected arc and allows you to edit the value.

Span Angle — Shows the span of the arc sector in degrees and allows you to edit the value.

Centre mark type — This option menu does the following to the mark of an arc centre: turn it off 1 or display it as a cross 2 or a dot 3.



Full — Converts a partial arc into a full arc.

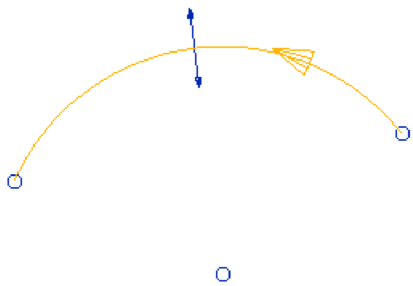
Reverse — This reverses the arc so that the start coordinates become the end coordinates and the end coordinates the start.

Workspace — Select the workspace (world or active) in which to edit the arc from the drop-down list.

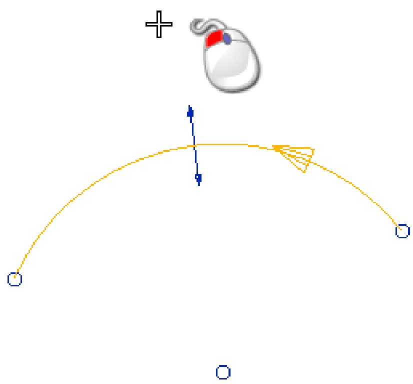
Centre — This shows the centre coordinates of the arc. To edit the values, Enter the **X Y Z** coordinates or click the **Position** button to open the **Position** dialog where you can use position entry tools.

Through - This allows you to enter a point that the arc must pass through. The arc is edited depending on the through point chosen; this is shown below.

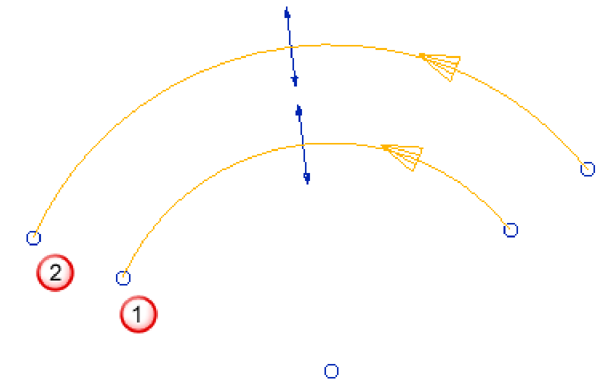
1 Select an arc to edit.



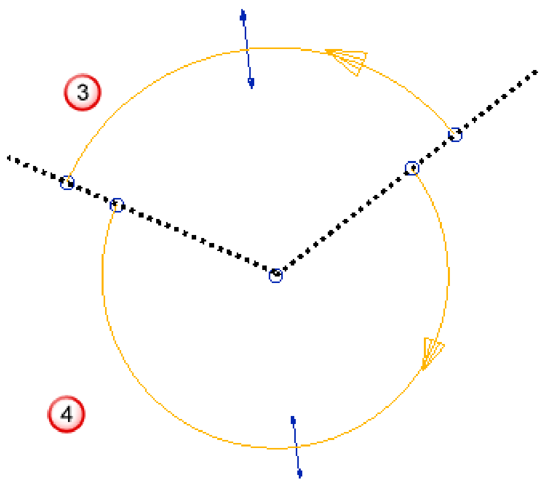
2 Click the **Position** button and select a point for the arc to pass through:



The edited arc 2 passes through the point entered and the tangents of the end points remain the same as the original arc 1.



If you select a through point that falls outside of the end point tangencies 4 of the original arc 3, the arc is reversed:



The tangents at the end points remain the same for the original arc and the edited arc.

Results of editing a fillet arc

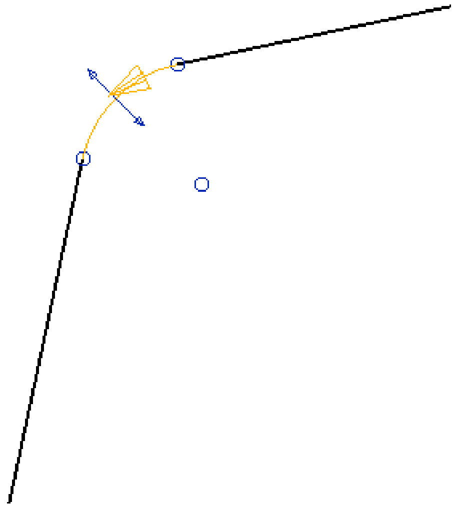
A fillet arc is edited in exactly the same way as other arcs, except the results of the edits affect the two objects from which it was created. This is because the fillet arc is dependent on the two objects.

This section shows the results of editing a fillet arc. For details on editing arcs, see Editing an arc (see page 70).

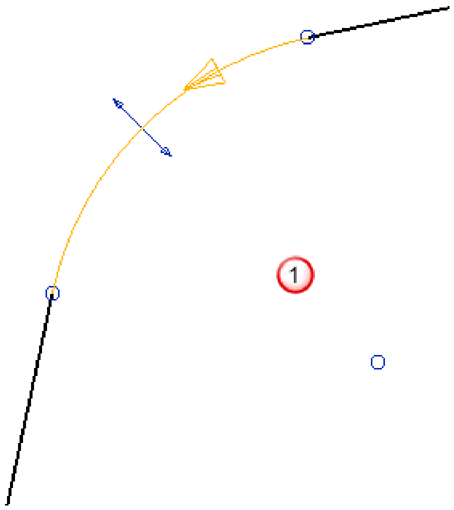
Dependencies are relationships created between objects. If you edit an object, any other object dependent on it will update automatically. Certain edits break dependencies between objects.

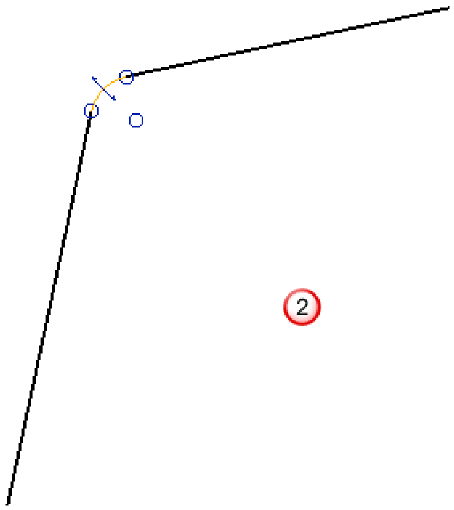
Editing a fillet arc.

1 Select a fillet arc.

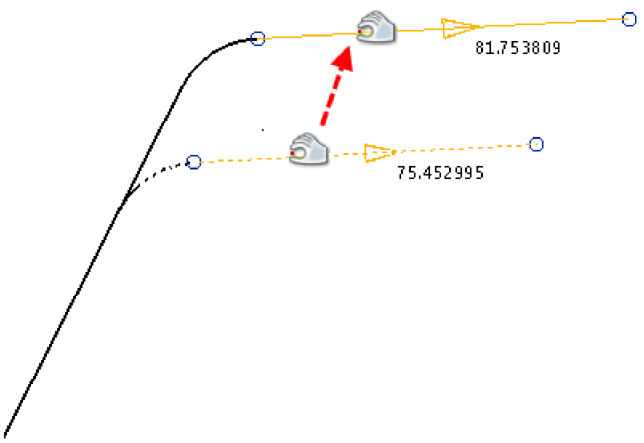


2 Edit the radius. The two lines either side of it can be trimmed 1 or extended 2 to fit the fillet arc.

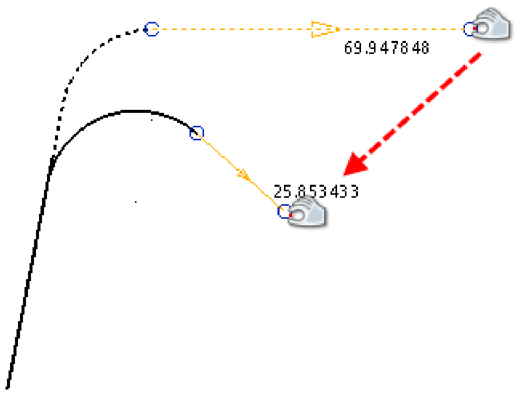




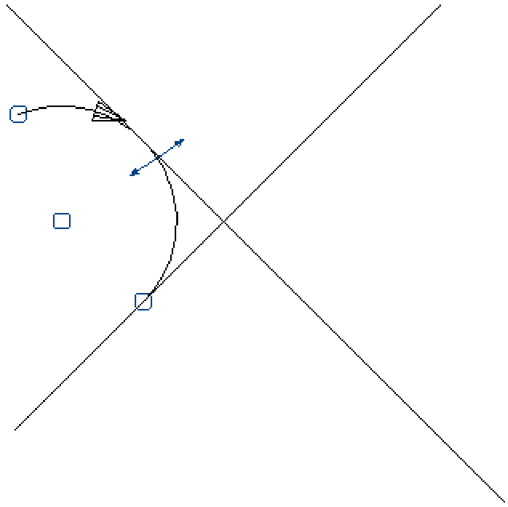
If you move the position of one of the lines, the arc and the other line update too.



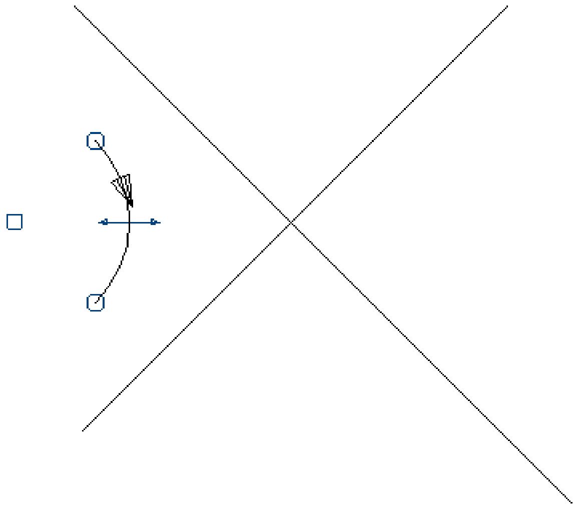
If you move the position of one of the end points of the lines, the arc and the other line update too.



If you move the start or end positions of the fillet arc, you break the dependencies and the lines go back to their original lengths.



If you edit the centre of the fillet arc, you break the dependencies and the lines go back to their original lengths.



Editing multiple arcs

To edit multiple arcs at the same time:

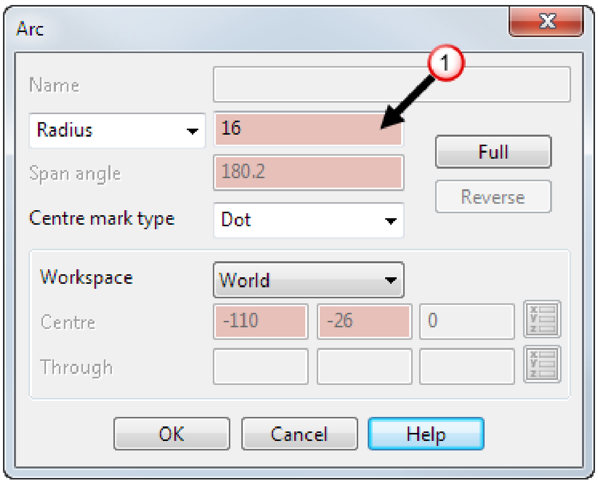
1 Select a number of wireframe arcs that you want to edit with one of the following methods:

- Press and hold the **Shift** key and click the lines.
- Press and hold the **Ctrl** key and click the lines.
- Click and drag the cursor over the lines.

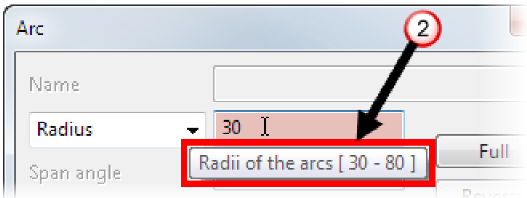
2 Right-click one of the selected arcs, and select **Modify**.

The **Arc** dialog (see page 72) is displayed. It is similar to that of editing a single arc, with the following differences:

1 — The properties that differ between the selected arcs are highlighted in pink.



2 — The range of values is displayed when you hover the cursor over a property.



*You can also double-click one of the selected arcs to display the **Arc** dialog.*

3 Edit the properties.

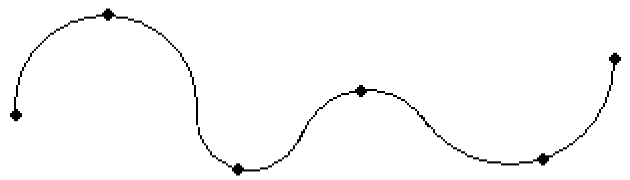
4 Click **OK** to apply the changes to the selected arcs and close the dialog.

Curves

Use the following sections to find out more about curves:

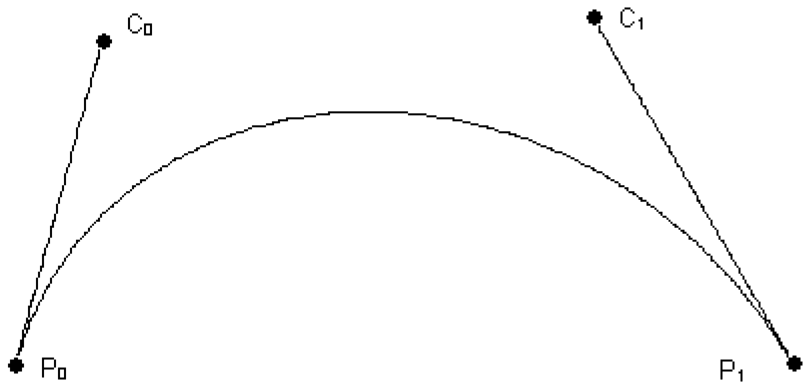
What is a curve?

A curve is a path which joins a series of points.

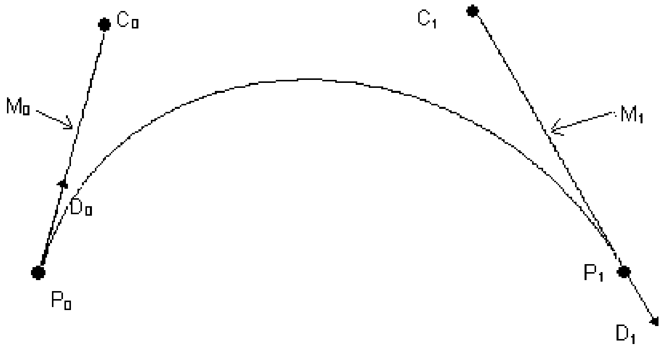


To create a curve, you input the points and PowerSHAPE automatically joins them with a curve. By editing the curve, you can then control how the curve enters and leaves a point.

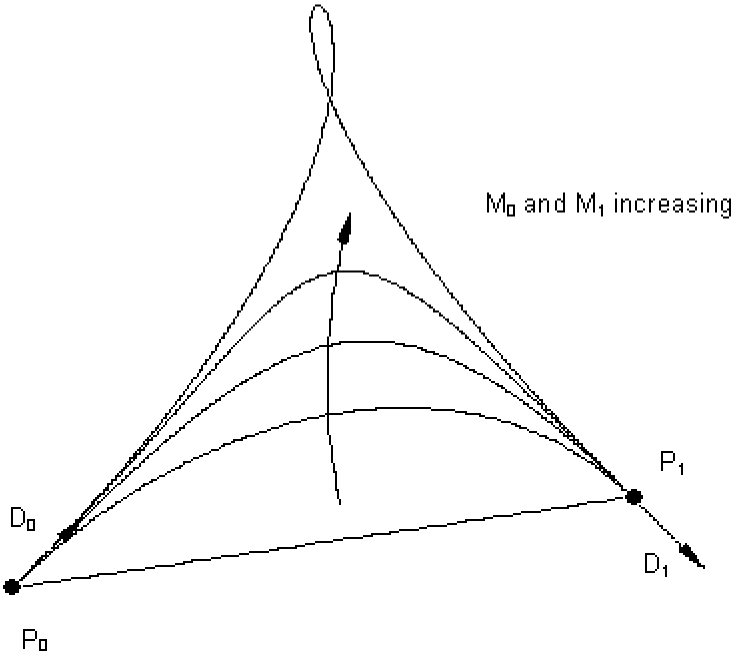
Generally, curves created within PowerSHAPE are parametric cubic curves known as Bezier curves. In this representation, a span of the curve is defined by two control points which lie on its tangents at its end points. See figure below. C_0 is the control point at end point P_0 and C_1 at P_1.



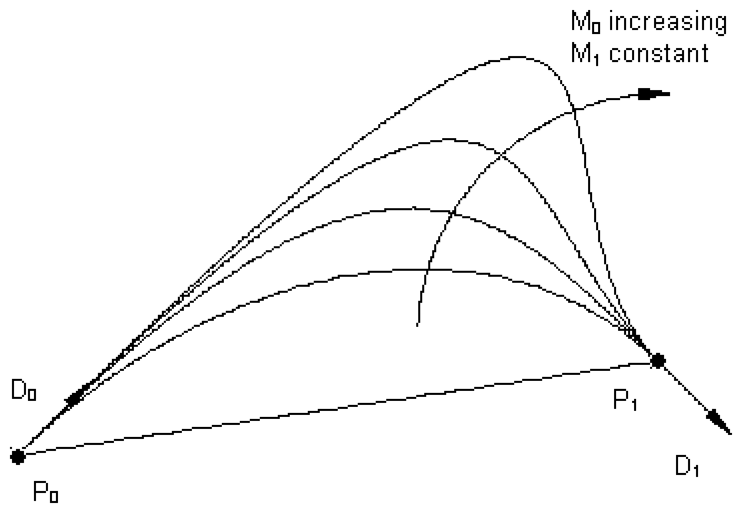
These control points also define the tangent directions (D_0 and D_1) and tangent magnitudes (M_0 and M_1) at the end points (P_0 and P_1).



The effect of increasing both the tangent magnitudes simultaneously is to give more fullness to the curve as shown below.



An increase in only one of the magnitudes causes the curve to follow the tangent direction at that point for a greater part of its length before turning into the other tangent direction. This is shown below.



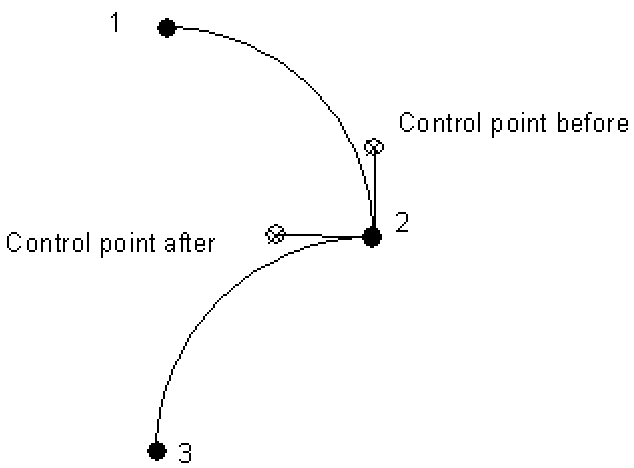
The tangent direction and magnitude before, after or along each point in the curve can be set or freed.

By changing the tangent directions and magnitudes you can get considerable control over the shape of the curve, including introducing discontinuities at key-points and making spans into straight lines, circular or conic arcs.

A curve can be open or closed (that is the end point of the curve is joined to the start point by the last span in the curve).

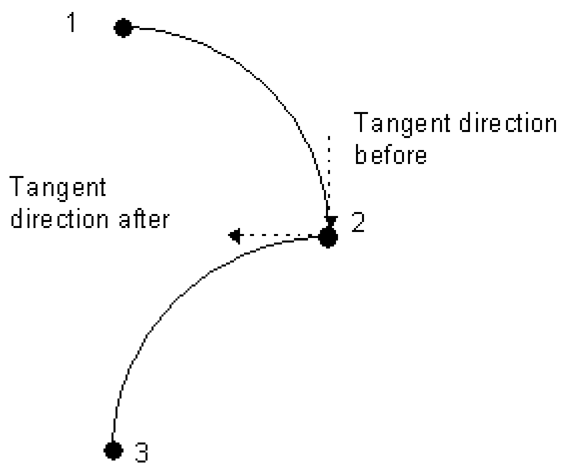
Tangents at current point

Each point on a curve has at most two control points: one for the curve entering the point and the other for the curve leaving it. On the following curve, the control points are shown for point 2.

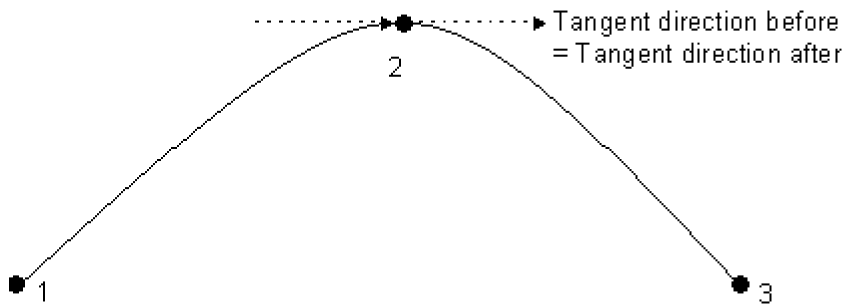


These control points determine the tangent directions and magnitudes of the curve through the point.

Two tangent directions may exist at a point: one before the point and the other after it. In the figure, the tangent directions before and after are shown for point 2. Notice that the position of the tangent direction before is away from its control point and the position of the tangent direction after is towards its control point.



You may set the tangent directions before and after the point independently or both together. If they are set together, then the curve will be smooth with respect to its tangents at that point. The figure below shows an example where the tangent direction before is equal to the tangent direction after at point 2.

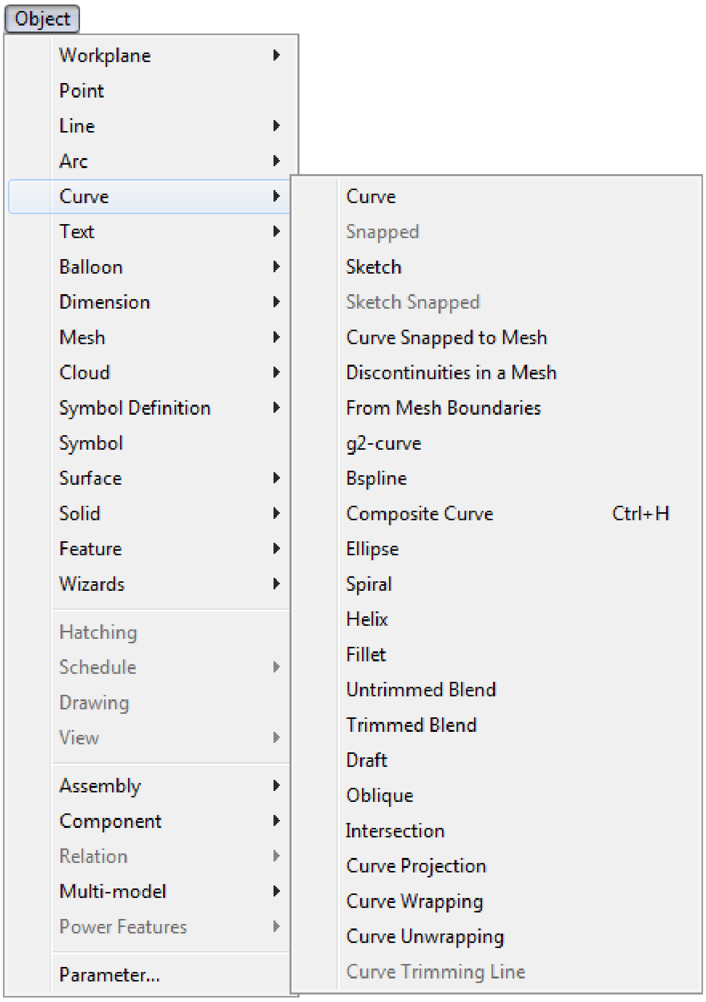


You may introduce discontinuities on the curve by setting the tangent directions before and after independently.

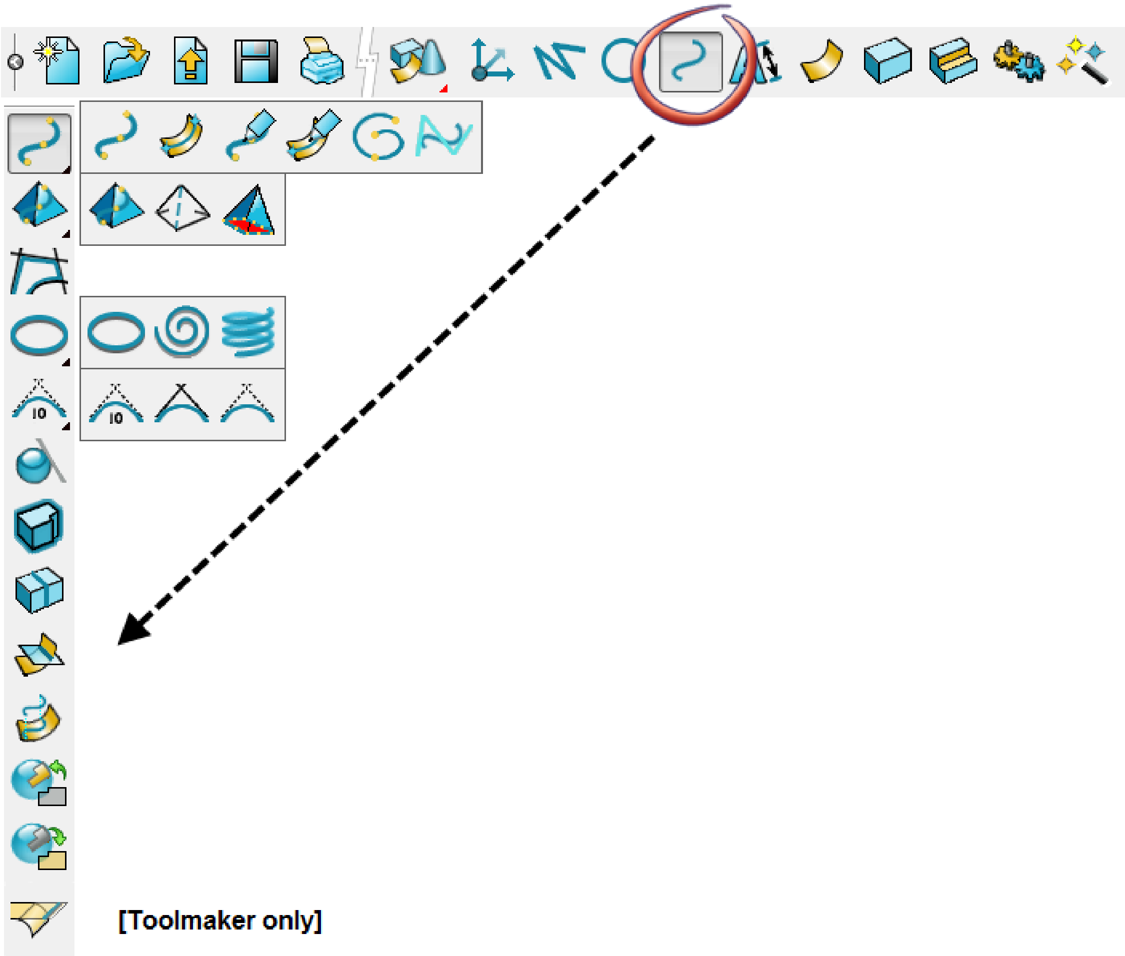
Tangent magnitudes have a more subtle effect than tangent directions. Like tangent directions, these may also be set before and after each point simultaneously or individually. See What is a curve? (see page 79) for further information on how tangent magnitudes change the shape of a curve.

Creating a curve

1 From the **Object** menu, select **Curve** to display the **Curve creation** options.



This is equivalent to clicking the **Curve** button  to display the **Curve** toolbar and the different curve creation methods.



2 Select a **Curve creation** type. The following options are available:

 **Bézier** (see page 86) — Click this button to create a Bézier curve.

 **Snapped Bézier** (see page 91) — Click this button to create a snapped Bézier curve.

 **Sketch Bézier** (see page 93) — Click this button to sketch a Bézier curve.

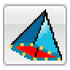
 **Sketch Snapped Bézier** (see page 94) — Click this button to sketch a snapped Bézier curve.

 **G2** (see page 95) — Click this button to create a G2 curve.

 **B-spline** (see page 100) — Click this button to create a B-spline curve.

 **Snapped to mesh** — Click this button to create a curve that is snapped to mesh. (PowerSHAPE Pro only)

 **Mesh Discontinuities** — Click this button to create curves at discontinuities in mesh. (Delcam Designer and PowerSHAPE Pro)

 **Mesh boundaries** (see page 111) — Click this button to create curves from mesh boundaries. (Delcam Designer and PowerSHAPE Pro)

 **Ellipse** (see page 109) — Click this button to create an ellipse.

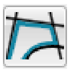
 **Spiral (see page 111)** — Click this button to create a spiral.

 **Helix** (see page 112) — Click this button to create a helix.

 **Fillet** (see page 115) — Click this button to create a fillet.

 **Untrimmed Blend** (see page 116) — Click this button to create an untrimmed blend.

 **Trimmed Blend** (see page 118) — Click this button to create a trimmed blend.

 **Composite Curve** (see page 104) — Click this button to create a composite curve by tracing.

 **Draft curve** (see page 121) — Click this button to create a Draft curve.

 **Outline curve** (see page 123) — Click this button to create an Outline curve.

 **Oblique sections on surface** (see page 124) — Click this button to create a curve from oblique sections on a surface.

 **Surface/solid intersection** (see page 129) — Click this button to create a curve at a surface or solid intersection.

Projection (see page 131) — Click this button to create a curve from a projection.

Wrap (see page 134) — Click this button to wrap a curve.

Unwrap (see page 157) — Click this button to unwrap a curve.

Trimline (see page 163) (Toolmaker only).

Creating a Bézier curve

A curve is first created by entering its key points. You then edit it to your requirements using the curve edit facilities.

1. Click the **Bézier** button on the Curve toolbar.
2. Enter positions for the key points of the curve.

   As you enter key points, a rubber-band curve is displayed showing how the curve is forming.

   You can input points on surfaces by pressing and holding the **Shift** key and clicking on them.

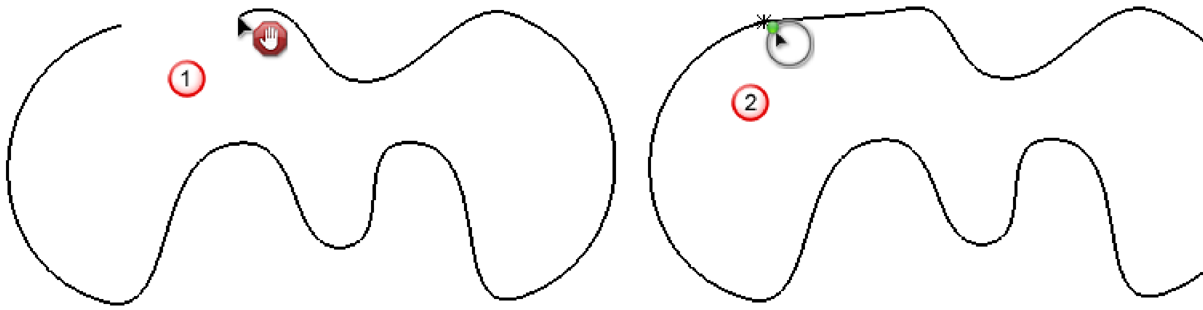
   To force the curve to form a straight span between two key points, do one of the following when you enter the second of these points:

   - Press and hold the **Ctrl** key while you are clicking the point
   - Type straight and press *enter* before you enter the position using the status bar or the **Position** dialog

   To inherit the tangency from an existing curve, hold down the **Shift** key when you click a point. The tangency before and after of the new point matches that of the position clicked on underlying curve.
3. To finish creating the curve, do one of the following:

   - Click on top of the last key point entered. If the intelligent cursor is enabled, an end symbol is displayed 1 to indicate when clicking completes the curve

- Click the first key point to create a closed curve. The image on the right shows the icon that is displayed over the start point of the curve indicating the point of closure 2.



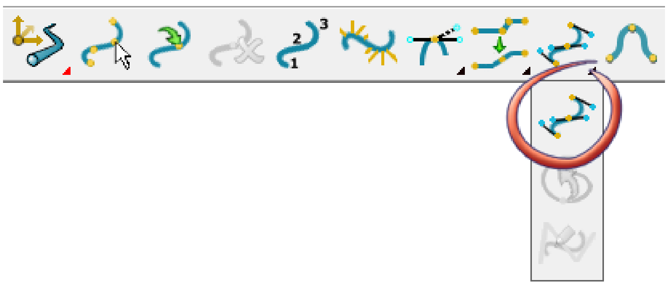
- Click **Select** .
- Choose an option from the **Curve** toolbar

The curve is now ready to edit to your requirements.

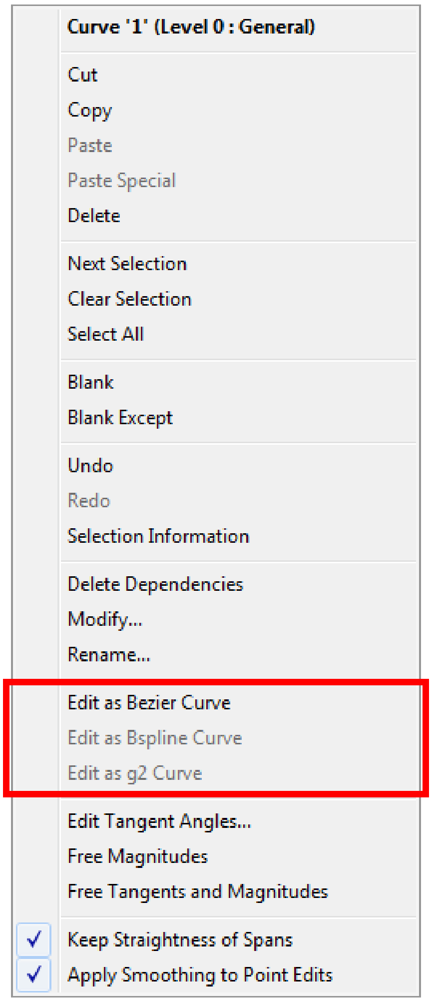
Editing a Bézier curve

To edit a Bézier curve:

1. Select the Bézier curve to automatically display the Curve editing toolbar.
2. Select the **Edit as a Bezier curve**  option from the **Curve Edit** toolbar.



Alternatively, right-click on the Bézier curve to display the Curve Edit menu.



The **Edit as Bezier curve** option is available on the Curve Edit menu and the Curve Edit toolbar. Bézier curve graphics handles are displayed on the curve to be edited. For further details, see Editing a curve (see page 166).

You can use these options to edit surface curves on a power surface.

Creating a curve on a surface

When you can create a Bézier curve on a surface, a relationship is created between the curve point and the surface it lies on. This relationship is useful when editing the point and the surface.

1 Click the **Bézier**  button on the Curve toolbar.

2 Input the points of the curve.

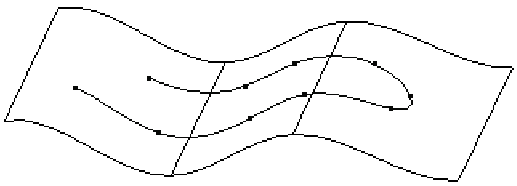
To input a point on a surface patch in shaded mode, click on the surface.

To input a point on a surface patch in wireframe mode, press and hold the **Shift** key and click on the surface.

The word *In* is attached to the cursor when the input point is projected onto the surface and the word *On* at positions on surface curves.

The curve points on the surface have the same tangents as the surface points on which they lie.

In the example below, you can see that the tangency of the curve matches the surface. If you want the curve to flow along the exact shape of the surface, you may need to put in extra points along the curve.



Any curve point, that does not lie on the surface, has no relationships.

3 To finish the curve, do one of the following:

- Click on top of the last key point entered. If the intelligent cursor is enabled, an end symbol is displayed to indicate when clicking completes the curve.
- Click the first key point to create a closed curve.
- Click the **Select**  button.
- Choose an option from the **Curve creation** menu.

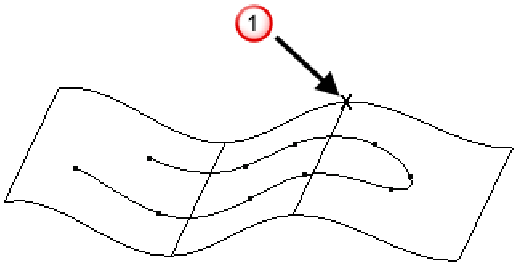
The curve is now ready to edit to your requirements.

Editing points of a curve on a surface

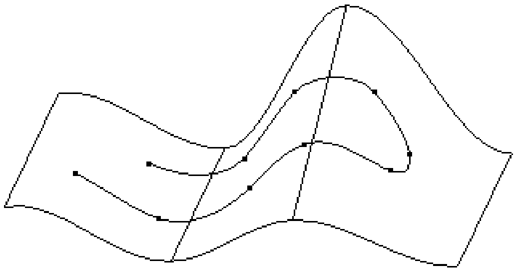
When you create a curve point on a surface, a relationship is created between the curve point and the surface it lies on.

When you move or edit the surface, the curve points on the surface update too.

When you move a point on the surface 1

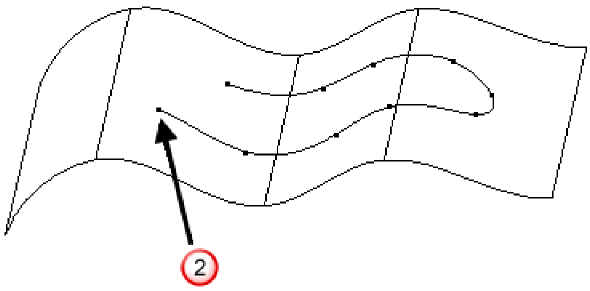


the curve changes as the surface changes shape.

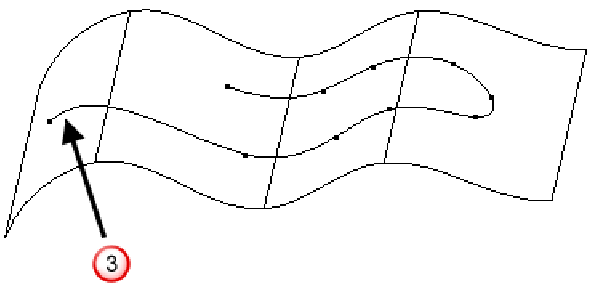


When you edit the curve such that its points are within the surface, it remains on the surface. The edited curve points have the same tangents as the new surface points on which they lie.

When you drag a curve point 2 along the surface



it remains on the surface and the tangents through it are updated too 3.



If you drag curve points off the surface, they lose their dependency.

If you drag a curve point back onto a surface, it gains a new dependency. Press and hold the **Shift** key to place a point inside a surface patch. (Ensure the word *In* is attached to the cursor to indicate the point is inside the patch).

To delete the dependencies:

- Select **Edit > Surface and Curve Edits > Curve edits > Delete dependencies** from the menu.
- Right-click the curve and select **Delete dependencies** from the menu.

Snapped Bézier curve

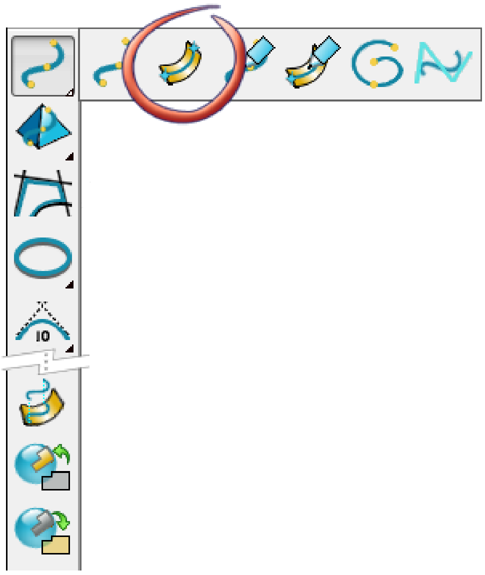
You can:

- Create a Snapped Bézier curve (see page 91)
- Edit a Snapped Bézier curve (see page 92)
- Offset a Snapped Bézier curve (see page 93)

Creating a Snapped Bezier curve

Use this option to sketch curves on a surface, solid, or a shoe last.

1 Click the **Snapped Bezier**  button on the **Curve** toolbar.

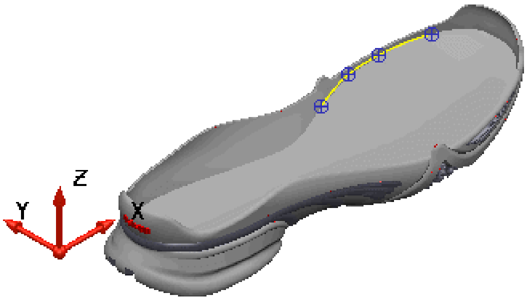


2 Click on the model (solid or surface).

3 Start sketching a curve on the model.

- Press the **Alt** key to move the point onto the nearest surface edge as shown below.
- Press **Ctrl + Alt** to move the point to the surface edge while maintaining the straight nature of the curve.

4 Click the **Select**  button to complete the curve. The Snapped Bézier curve lies on the surface as shown below.

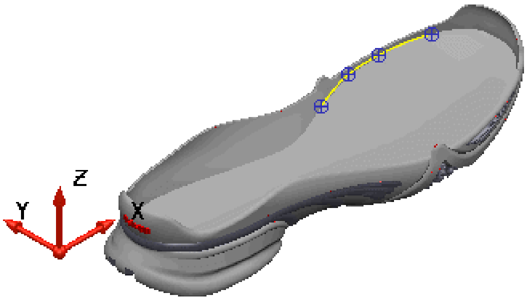


Editing a snapped Bézier curve

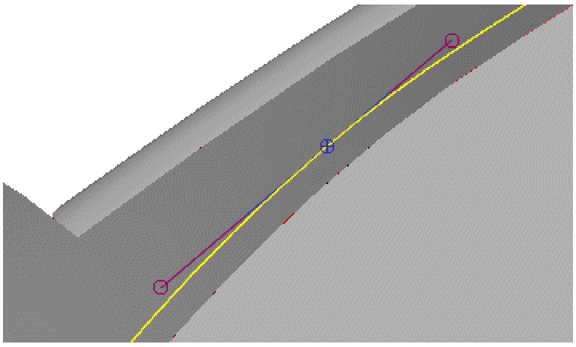
To edit the snapped Bézier curve,

1 Select the snapped Bézier curve.

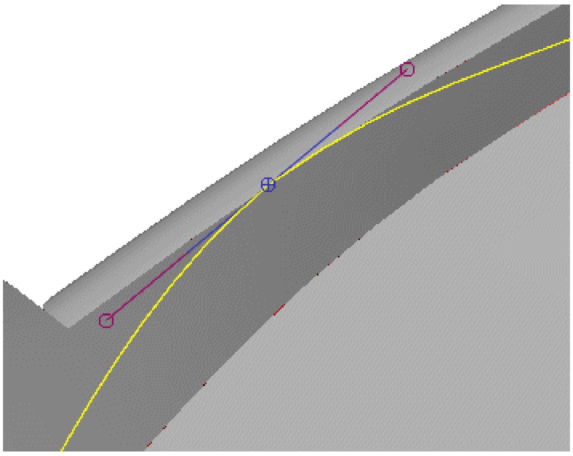
The keypoints on the curve are displayed.



2 Select a keypoint on the curve

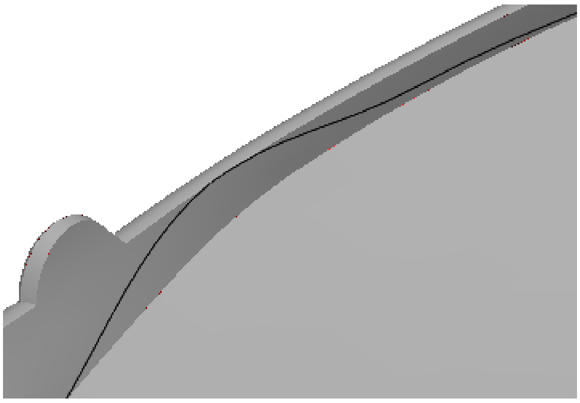


3 Drag the point to change the shape of the curve.



4 Click away from the model to deselect the curve.

The **Snapped Bezier Curve** forms the new shape and remains on the surface of the model.



Offsetting a snapped Bézier curve

You can use a keyboard shortcut to offset points on a snapped Bézier curve where the points have dependencies on a surface.

To offset points on a snapped Bézier curve:

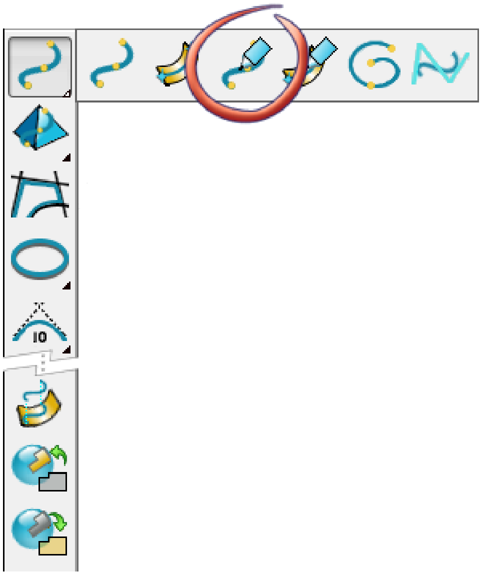
1 Select the points on the curve.

2 Press **Ctrl** and  or **Ctrl** and  to offset the curve points. If the curve points have dependencies to a surface, they are offset along the surface normal on the curve.

Sketch a Bézier curve

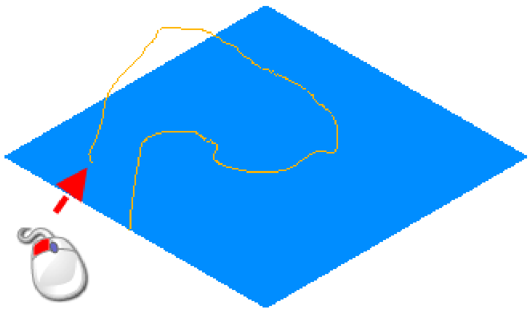
Use this option to sketch a curve on a surface, solid or shoe last.

1 Click the **Sketch Bezier**  button on the Curve toolbar.



2 Click on the model.

3 Drag the mouse to start sketching a curve on the model.



4 Release the mouse button to complete the curve.

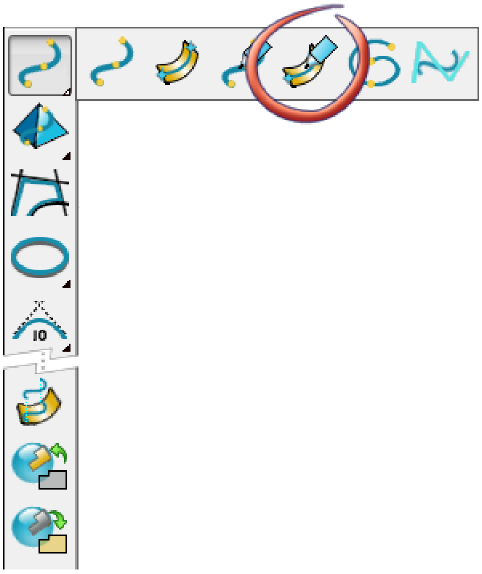
You can edit the Bézier curve in the normal way.

Sketch a Snapped Bezier curve

 *This option is available in Footwear mode only.*

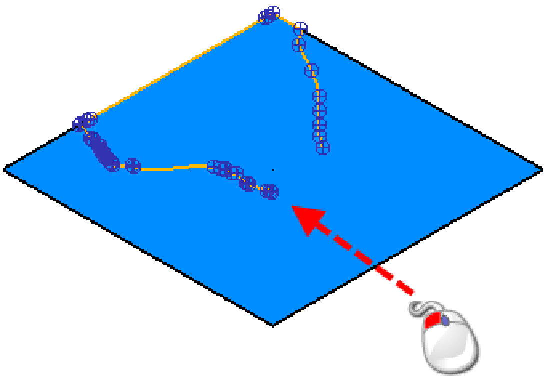
Use this option to sketch a curves on a single surface.

1 Click the **Sketch Snapped Bezier**  button on the **Curve** toolbar.



2 Click on a surface on the model.

3 Drag the mouse to sketch a curve on the surface. If you attempt to sketch outside the selected surface, the curve is snapped to the edge, as shown below.



4 Release the mouse button to complete the curve.

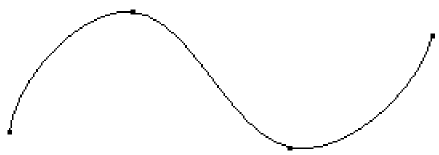
You can edit the Bézier curve in the normal way, but you cannot move a point to a position outside the surface.

Creating a G2 curve

G2 curves are mathematically smoother than Bézier curves.

1 Click the **G2**  button on the Curve toolbar.

2 Input positions for the points of the curve.



As you enter key points, a rubber-band curve is displayed showing how the curve is forming.

If you want the curvature to be zero at the start point or end points, set the **Curvature continuous** options on the **Curve** page of the **Options** dialog (which is displayed by choosing **Options** from the **Tools** menu).

Zero curvature has a flattening effect on the curve.

3 To finish curve creation, do one of the following:

- Click on top of the last key point entered; if the intelligent cursor is enabled, the end symbol  is displayed to indicate when clicking completes the curve.
- Click the first key point to create a closed curve
- Click the **Select**  button.
- Choose an option from the **Curve** toolbar.

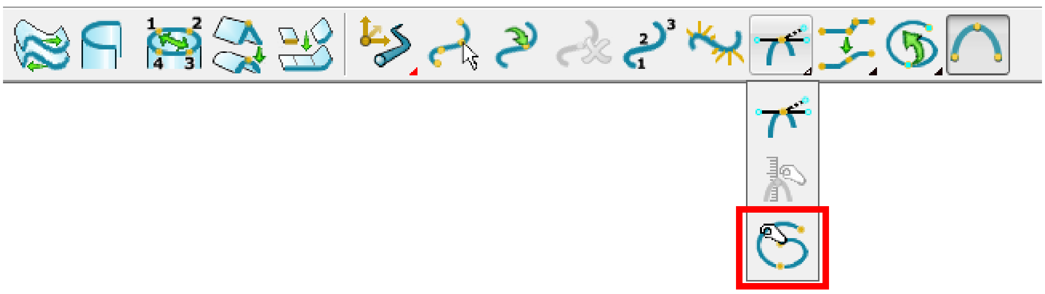
Editing a G2 curve

1 Click on the G2 curve to automatically display the **Curve edit** toolbar.

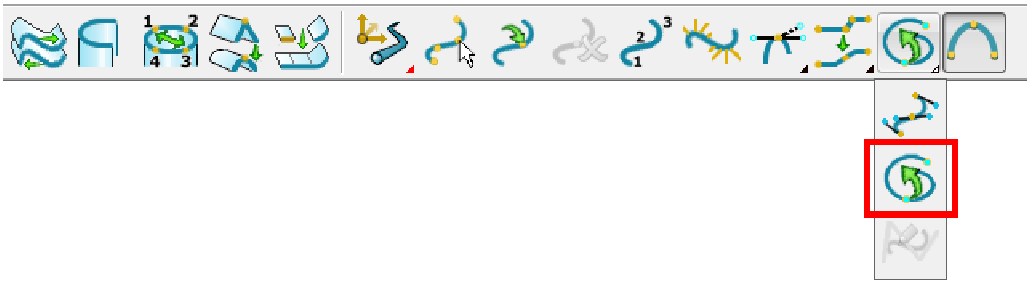
2 Select a point on the G2 curve you want to edit.

You can edit a G2 curve in the following ways:

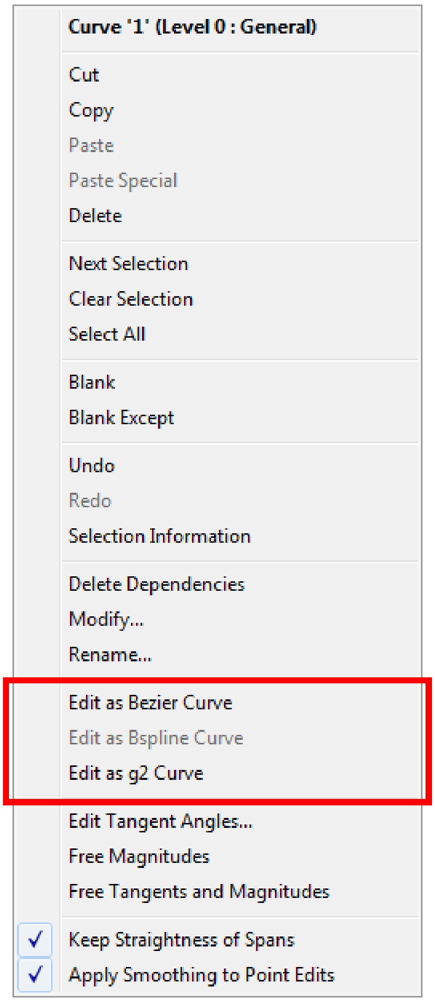
- Select the **G2 Edit** option  from the *Edit Tangent Angles* flyout to display the **G2 Curve Fairing** dialog (see page 98).



- Select the **Edit as a g2 curve**  option from the *Bezier/Bspline/G2* flyout.



This is the same as clicking on the G2 curve using the right mouse button. The curve-editing options are also displayed on the curve context menu and reflect the curve you are editing.



The following editing options are available on the curve popup and the curve edit toolbar:

- **Edit as Bezier curve** - Select this option to display Bezier curve graphics handles on the G2 curve. The G2 curve loses its G2 editing ability and can be edited only as a Bezier curve.

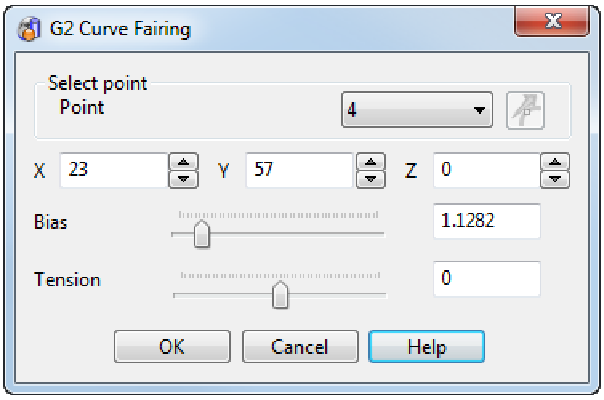
- **Edit as a G2 curve** - Select this option to display Bezier curve graphics handles on the curve for editing. The curve remains a G2 curve if you drag the handles.

You can use these options to edit surface curves on a power surface.

G2 Curve Fairing dialog

Use this dialog to edit the shape of a G2 curve.

*If you change the shape of the G2 curve using the **G2 Curve Fairing** dialog, it remains a G2 curve. If you use other curve editing methods, the curve is likely to lose its G2 curve properties.*

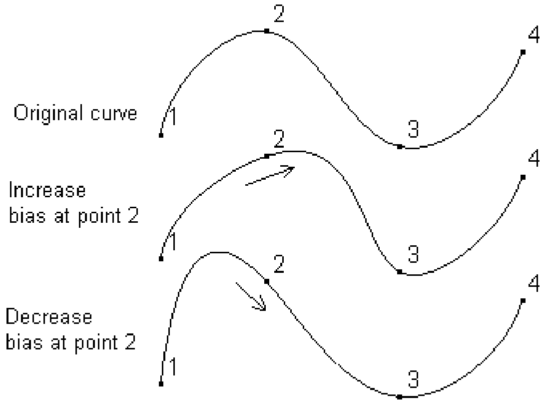


Point — This is the selected point. You can change this using the selector.

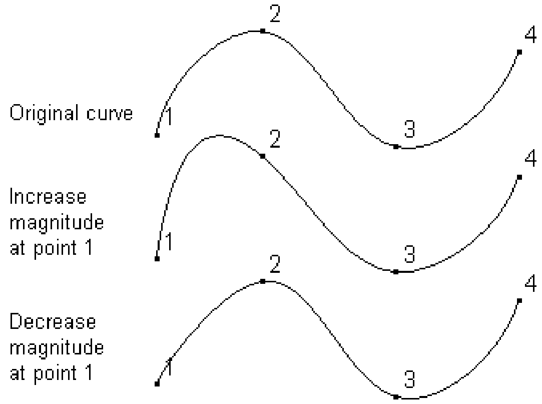
 — To set the tangent direction precisely, click this button to display the **Direction** dialog. Fill in this dialog with new direction values and press **OK**.

X Y Z — These are the coordinates of the selected point. You can use the arrow buttons to increase or decrease the values by 1mm (even if the units are imperial).

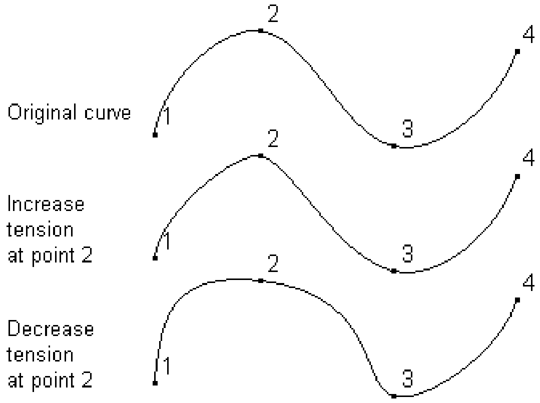
Bias — (Not available for end points on open curves) Changes the direction of the curve as it passes through the point. You can also use the slider to change the bias value.



Magnitude — (Available only for end points on open curves). Edits the tangent magnitude of the point. You can also use the slider to scale the magnitude value.



Tension — (Not available for end points on open curves) Edits how sharply the curve bends on either side of the point. You can also use the slider to change the tension value.

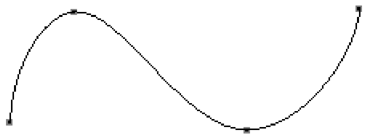


OK — Saves the changes and closes the dialog.

Creating a B-spline curve

1 Click the **B-spline**  button on the Curve toolbar.

2 Input positions for the points of the curve.

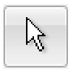


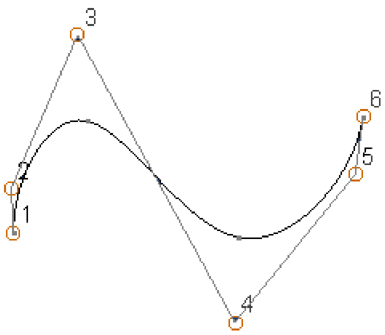
As you enter key points, a rubber-band curve is displayed showing how the curve is forming.

If you want the curvature to be zero at the start point or end points, set the **Curvature continuous** options on the **Curve** page of the **Options** dialog (displayed by choosing **Options** from the **Tools** menu).

Zero curvature has a flattening effect on the curve.

3 To finish creating the curve, do one of the following:

- Click on top of the last key point entered; if the intelligent cursor is switched on, the end symbol  is displayed to indicate when clicking completes the curve.
- Click the first key point to create a closed curve.
- Click the **Select**  button. When you click this button, the edit handles are displayed on the curve. The handles edit the shape of the curve.



- Choose an option from the **Curve** toolbar.

You can create a B-spline surface from a set of separate B-spline curves.

Editing a B-spline curve

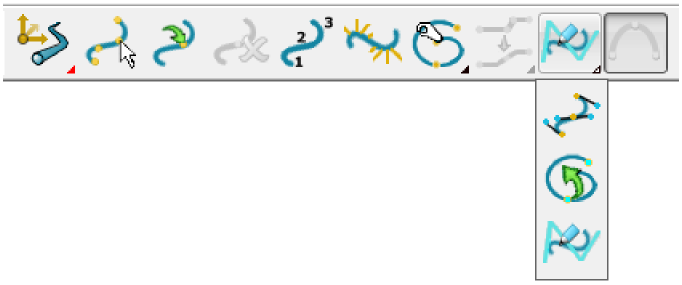
To edit a B-spline curve:

1 Click on the B-Spline curve to display the **Curve Edit** toolbar showing the editing options for a B-spline curve :

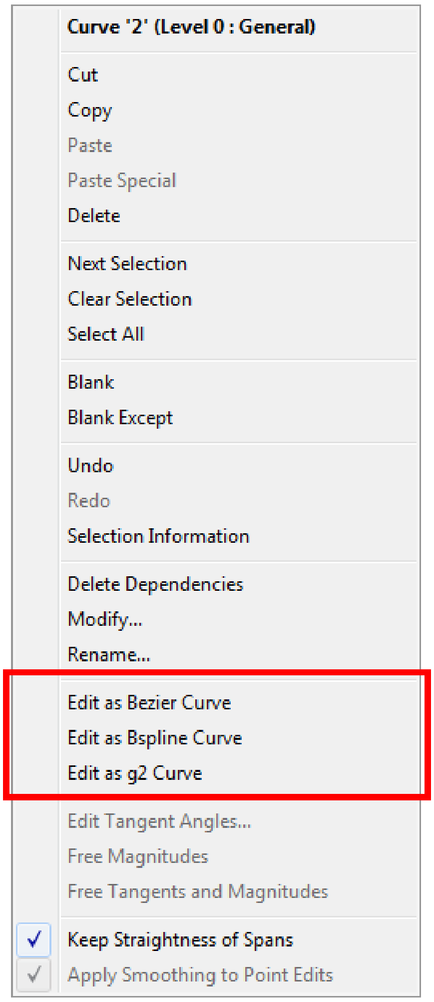
- Reverse the curve
- Select points on a curve
- Add new point
- Turn point labels on/off
- Turn curvature combs on-off
- Edit as Bezier/B-spline curve/G2 edit

To access other edit options you must convert the B-spline curve to a Bezier curve.

2 Click the **Edit as Bspline**  button on the **Curve Edit** toolbar.



Alternatively, right-click on the B-spline curve to display the curve-editing menu.



The following editing options are available on the Edit Curve toolbar and menu:

- **Edit as Bézier curve** — Select this option to display Bézier curve graphics handles on the bspline curve. The curve loses its B-spline editing ability and can be edited only as a Bézier curve.
- **Edit as a G2 curve** — Select this option to display Bézier curve graphics handles on the curve for editing. The curve remains a G2 curve if you drag the handles.
- **Edit as a Bspline curve** — Select this option to display the B-spline graphics handles for curve editing.

You can use these options to edit surface curves on a power surface.

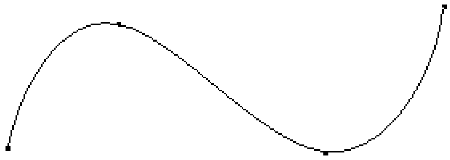
Edit surface curves on a power surface

You can use these options to edit surface curves on a power surface.

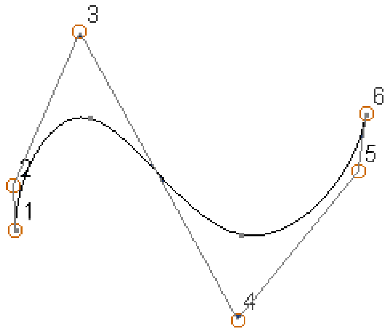
Editing the shape of a B-spline curve

You can edit the shape of a B-spline curve by moving the control points.

1 In selection mode, select the B-spline curve.

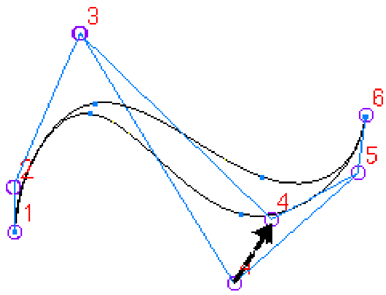


The control points are displayed on the curve. Each point has a label.

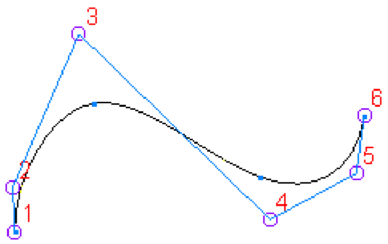


2 Drag a control point to change the shape of the curve.

In the example below, control point 4 is dragged upwards.



When you drag the control points that are not at the end of the curve, the shape of the curve changes and some of its points move too.



The end points always remain fixed, unless you drag them. If you drag an end point, only that point moves.

You can also move a selected control point using the **Position** dialog.

1 On the Edit Curve toolbar, click the **Select point** button to display the **Select Point** dialog.
2 Use the **Select Point** dialog to select a control point.
3 Click the **Position** button to display the **Position** dialog.
4 Use the **Position** dialog to move the selected control point.

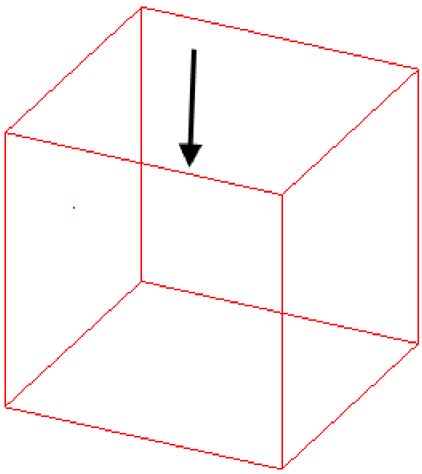
Creating a composite curve by tracing

A composite curve is a continuous boundary of objects such as lines, arcs, curves, and surface edges. You can also create a composite curve along the edges of an open, triangulated symbol (.stl or .dmt files).

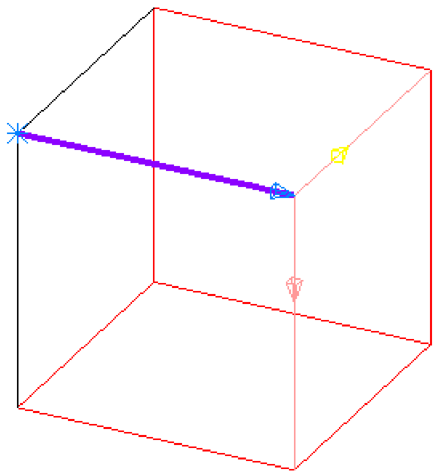
1 Create the items from which you wish to create a composite curve.
2 Click the **Composite** button on the Curve toolbar.

You may set start and end markers before selecting an item to indicate where the composite curve starts and ends.

3 Click one of your items.



PowerSHAPE automatically continues to select items from the end of the item nearest the click position.



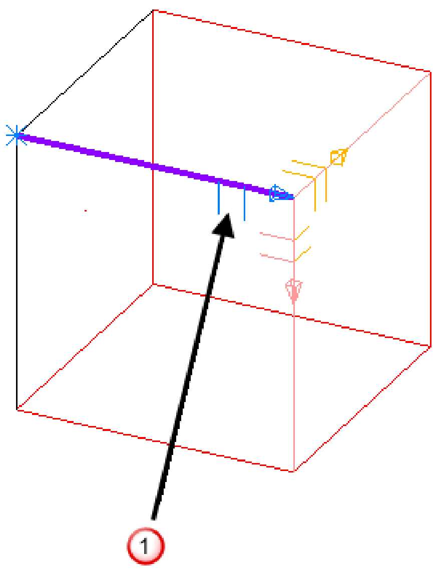
The start of a composite curve is marked with an asterisk.

4 Use the control panel to define the composite curve from your group of items.

Each button on the control panel is described below:

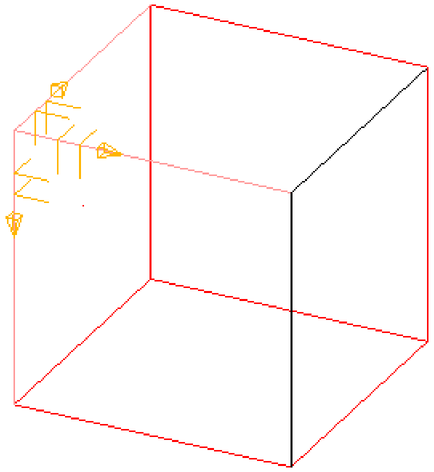
Surface tags — Toggle this button to show or hide surface tags. You can show or hide surface tags at any time while creating a composite curve.

If **Surface tags** is selected, the selected item is automatically marked with two parallel lines on its underlying surface 1. These parallel lines are the surface tags.



If you want to change the underlying surface for the first item selected, click the **Backwards** button or the **Rewind** button on the **Composite curve** control panel and then select the surface tag on the required surface.

When you rewind the composite curve, the item becomes unselected and all the possible routes for the composite curve are marked with surface tags and arrows.



A surface tag exists for each surface along a particular route.

If you click a surface tag, the route is selected and becomes dependent on the surface for the tag.

Composite curves preserve any dependent points when the composite curve is created on a curve.

If you click the **Forward** button on the **Composite curve** control panel, the pink item and surface tag are selected.

Reset — Click this button to remove all the items from the current selection. This enables you to start creating a new composite curve.

Start marker — Click this button to set the start marker.

Rewind — Click this button to rewind the selection to the last branch or the start (if no branches exist).

If you click this button when the first item is selected, the item becomes unselected and all the possible routes for the composite curve are marked at the start of the item. If you click it again, all the markers are removed and you can start creating a new composite curve.

If you click this button after clicking **Fast forward**, the composite curve is returned to its position before the Fast forward was performed.

Backwards — Click this button to remove the last item in the selection.

If you click this button when the first item is selected, the item becomes unselected and all the possible routes for the composite curve are marked at the start of the item. If you click it again, all the markers are removed and you can start creating a new composite curve.

Forwards — Click this button to move forward to the next branch point. Choose the next piece of geometry.

When you have a selection of routes, the one that will be selected when you click the **Forward** button is pink (using the default colour scheme).

You can select an object that is not connected to the current selection. If you do this, a dialog is displayed asking if you want a straight span or one that preserves the tangents from the end of the last object to the new one.

Fast forward — This continues selecting items to either the end marker or last item. How PowerSHAPE continues selecting items is determined by the **Direction Strategy** set in the **Composite curves** page on the **Options** dialog.

End marker — Click this button to set the end marker.

Reverse — Click this button add or remove objects from the other end of the composite curve.

Save — Click this button to save the selection as a composite curve. Alternatively, you can right-click on the curve to save it.

Branch Point Direction — This allows you to choose which direction to go when in **Fast Forward** mode.

Options — This raises the **Curve** page of the **Options** dialog.

Eject — This removes the **Create Composite Curve** control panel from the screen.

1 When you have created your composite curve, either continue creating composite curves or click **Select** or **Eject** to remove the control panel. Alternatively, right-click to close the **Composite curve** toolbar.

*You can convert a composite curve to its individual objects using the **Edit > Convert > to wireframe** command.*

Using start and end markers

When creating composite curves, start and end markers enable you to restrict the region in which you select items. They also enable you to select a portion of length of a single item. Once you add the markers, begin selecting the composite curve close to the start marker.

To add a start marker:

1 From the **Create Composite Curve** control panel, select the **Start marker** button.

2 Input a position to add the start marker. A start marker is added to your model. This is only a visual aid which is displayed whilst the **Create Composite Curve** control panel is displayed.

To add an end marker:

1 From the **Create Composite Curve** control panel, select the **End marker** button.

2 Input a position to add the end marker. An end marker is added to your model. This is only a visual aid which is displayed whilse the **Create Composite Curve** control panel is displayed.

To remove a marker:

1 From the **Create Composite Curve** control panel, select the button of the marker you want to remove, that is, either a Start or End marker.

2 Click on the marker you wish to remove.

To move a marker:

1 From the **Create Composite Curve** control panel, select the button of the marker you wish to move.

Input the new position.

You may have only one marker of each type displayed at any one time.

Other methods for creating composite curves

You can also create composite curves using the following methods:

- In selection mode, press and hold the **Alt** key and click on an object.

This automatically selects all the other objects which are joined to the selected object to form a composite curve. This mode automatically follows connected curves (of whatever type — line, arc, curve, visible trim boundary, lateral, longitudinal) and (silently) makes a single composite-curve from them.

You are provided with only one option which behaves like the **Fast forward** option in the curve creation mode. This provides a quick method for creating composite curves.

- There is a command to convert selected wireframe items into a composite curve. This is equivalent to using **Alt** +click. To use it, select the wireframe and in the command window type:

  "convert_to_compcurve"

- Select wireframe objects and, from the **Edit** menu, select **Convert** followed by **Wireframe to composite curve**.

  This creates composite curves from all the selected objects, attempting to connect adjoining pieces.

Setting composite curves options

To change the composite curve settings:

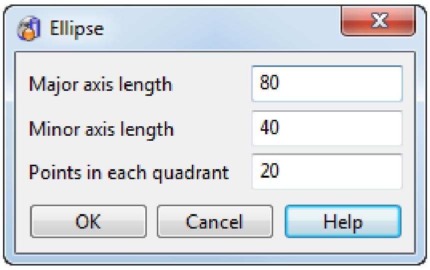
1. Select **Tools > Options** from the menu to display the **Options** dialog.
2. Select the **Object > Composite curves** page.
3. Use the **Composite curve** page to set the options.
4. Click **OK**.

Creating an ellipse

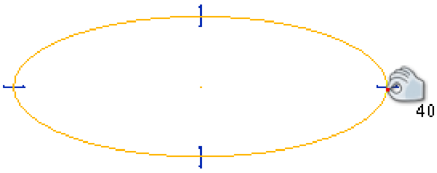
1. Click the **Ellipse**  button on the Curves toolbar.
2. Position the cursor and click to enter the point of origin for the ellipse.
3. Use the **Ellipse** dialog (see page 110) to specify the dimensions for the ellipse curve.
4. If necessary, use the **Curve editing** toolbar to make changes to the wireframe curve.

Ellipse dialog

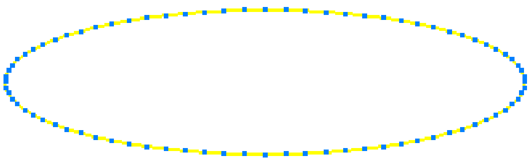
Use this dialog to specify the dimensions of the wireframe ellipse.



1. Enter the **Major axis length** of the ellipse. Alternatively, use the drag the handles to increase or decrease the size. The value is displayed alongside the cursor as the handles are dragged. The dialog is updated with the new value.
2. Enter the **Minor axis length** of the ellipse. Alternatively, use the drag the handles to increase or decrease the size. The value is displayed alongside the cursor as the handles are dragged. The dialog is updated with the new value.



3. Enter the number of **Points per quadrant** to indicate the number of points in each section of the ellipse. Increasing the number of points per quadrant increases the accuracy of the curve that is produced.
4. Click **OK** to create the ellipse.
5. If required, create another ellipse. Alternatively click the **Select**  button to end ellipse creation; the points on the ellipse are then displayed.



Creating a curve snapped to a mesh

Functionality to create a curve snapped to a mesh is available only with a PowerSHAPE Pro licence.

For further details see Create curve snapped to mesh.

Creating a curve at discontinuities in mesh

This functionality is only available with a Delcam Designer or PowerSHAPE Pro licence.

For further details see Creating curve at discontinuities in mesh.

Creating curves from mesh boundaries

This functionality is only available with a Delcam Designer or PowerSHAPE Pro licence.

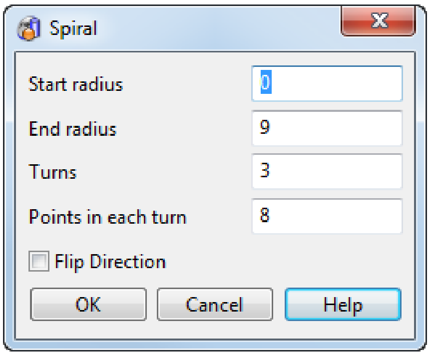
For further details see Create curves from mesh boundaries.

Creating a spiral

1 Click the **Spiral**  button on the Curves toolbar.
2 Enter the point of origin for the spiral.
3 Use the **Spiral** dialog (see page 111) to specify the dimensions for the spiral curve.
4 If necessary, use the Curve Edit toolbar to make changes to the curve.

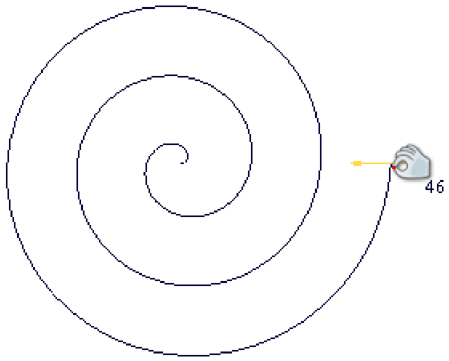
Spiral dialog

Use this dialog to specify the dimensions of the **Spiral**.

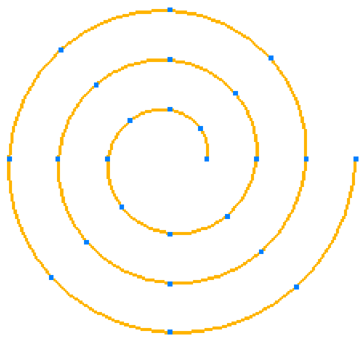


1 Enter the **Start radius**.
2 Enter the **End radius**. Alternatively, use the drag the handles to increase or decrease the size. The value is displayed alongside the cursor as the handles are dragged. The dialog is updated with the new value.
3 Enter the number of **Turns** to be created on the spiral.

4. Enter the number of **Points in each turn** to indicate the number of points to be created on each turn of the spiral. Increasing the number of points per turn increases the accuracy of the curve that is produced.



5. Click **OK** to create the spiral.
6. If required, create another spiral. Alternatively click the **Select**  button to end spiral creation; the points on the spiral are then displayed.

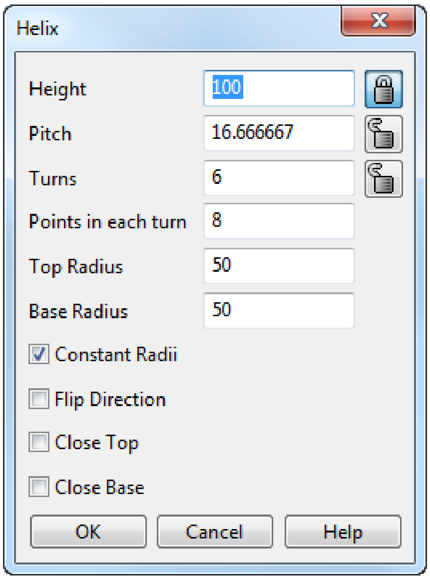


Creating a helix

1. Click the **Helix**  button on the Curves toolbar.
2. Enter the point of origin for the helix.
3. Use the **Helix** dialog (see page 113) to specify the dimensions for the helix curve.
4. Use the Curve Edit toolbar to make changes to the wireframe curve.

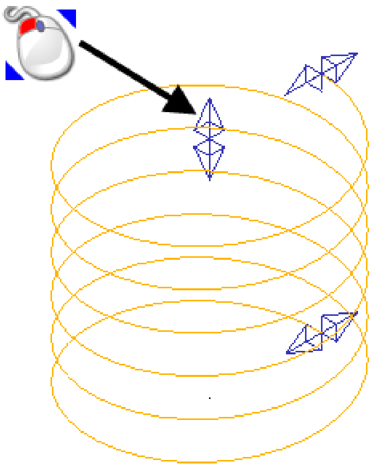
Helix dialog

Use this dialog to specify the dimensions for the helix.



Height — Enter the overall vertical height of the helix. This is measured from the point of origin.

Whilse the **Helix** dialog is displayed, you can also change the height of the helix by dynamically dragging the arrow handle at the top of the helix.



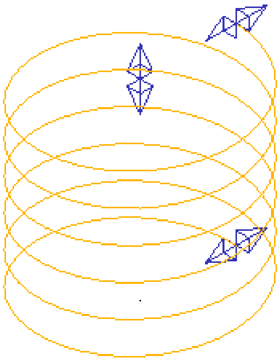
*The **Height**, **Pitch**, and number of **Turns** are related. If you change one value another value must also change in order to keep the definition of the helix consistent.*

Pitch — Enter the vertical distance between consecutive turns.

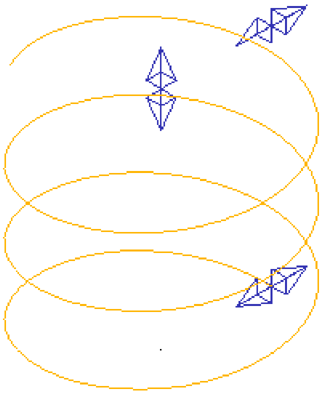
Turns — Enter the number of turns in the helix.

Lock/Unlock — Lock or unlock the **Height**, **Pitch**, and number of **Turns** for the helix. When a dimension is locked it does not change when you change another dimension. For example, if the height is locked and you change the pitch, the number of turns changes to keep the definition consistent.

In the example below, the height is **100**, the pitch is **16.6**, and there are **6** turns.



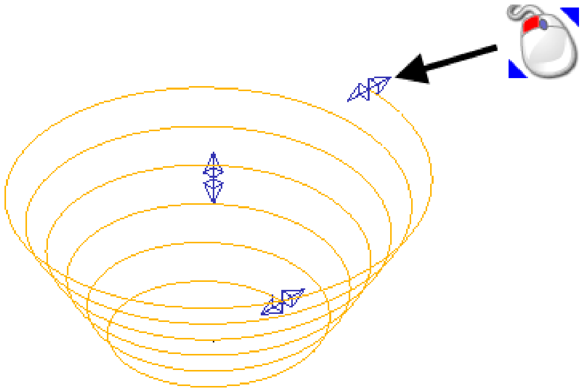
The example below shows the same helix with the height locked and the pitch increased to **30**. The number of turns has decreased to maintain consistency.



Points in each turn — Specify the number of points per turn. Increasing the number of points per turn increases the accuracy of the curve that is produced.

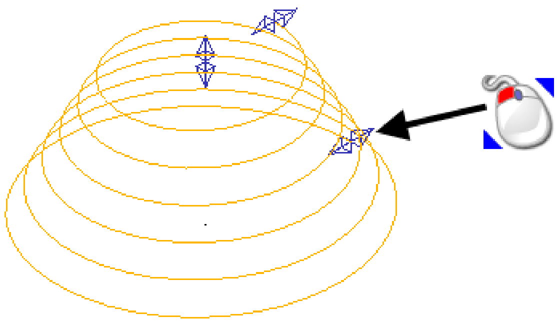
Top Radius — Enter the radius for the top of the helix.

Whilse the **Helix** dialog is displayed, you can change the top radius of the helix by dynamically dragging the arrow handle at the top of the helix.



Base Radius — Enter radius for the bottom of the helix.

Whilst the **Helix** dialog is displayed, you can change the base radius of the helix by dynamically dragging the arrow handle at the bottom of the helix.



Constant Radii — If selected (default), the base and top radii remain equal.

Flip Direction — Select this option to flip the direction of the helix between clockwise and anti-clockwise.

Close Top — Select this option to create a closed 360° loop at a constant height around the top of the helix.

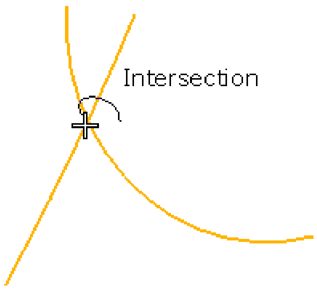
Close Base — Select this option to create a closed 360° loop at a constant height around the base of the helix.

The axis of the helix aligns with the normal of the active workplane.

Creating a fillet

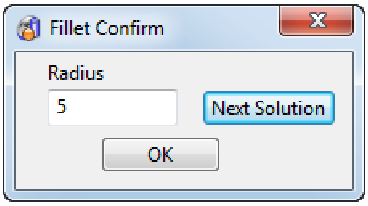
This creates a fillet between two intersecting curves where you can specify the fillet radius.

1 Select the intersecting curves, or the **Intersection** point.

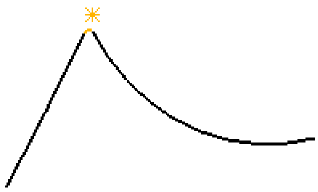


2 Click the **Fillet**  button on the Curve toolbar.

The **Fillet Confirm** dialog is displayed, where you can enter a different radius.



The fillet is created on the intersecting curves.



3 Click **Next solution** to display up to four possible fillet solutions.

4 Click **OK** or click in the graphics area to accept the displayed solution.

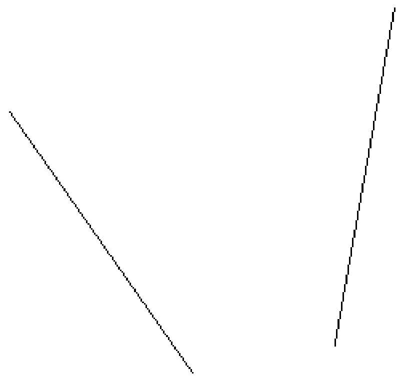
*For further details, see Curve Options (*Menus and Toolbars*).*

Creating an Untrimmed Blend

This option is generally used when you want to create a fitted, circular curve between non-planar wireframe objects.

1 Click the **Untrimmed Blend**  button on the Curve toolbar.

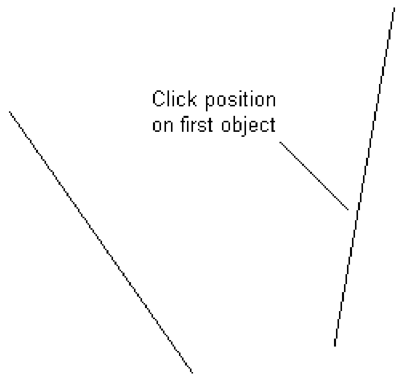
To create a fillet between the following lines.



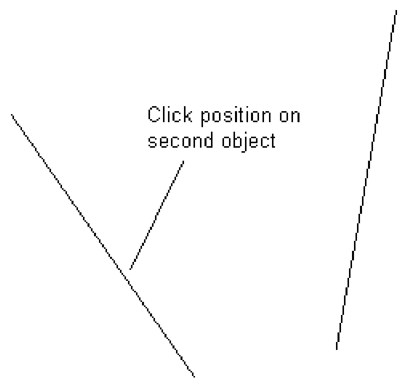
2 Input the first position to define the start of the curve or click a wireframe object to define the start tangent of the curve.

If the cursor is moved over a wireframe object and the intelligent cursor is switched on, the word *'Tangent'* is displayed where tangency is defined, otherwise (for example, if *'End'* is displayed) the program assumes a start point is being specified.

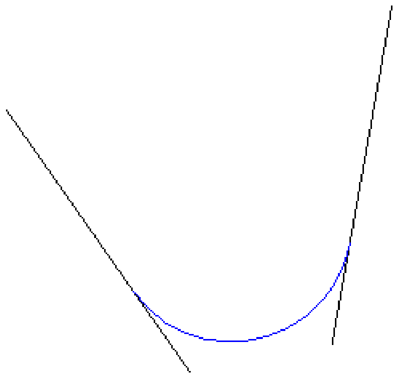
If a wireframe object is clicked where tangency is defined, then the program works out the tangency as the mouse cursor moves and displays the solution as a rubber band.



3 Input the second position to define the end of the curve or click a wireframe object to define the end tangent of the curve.



The new fillet curve is created. It is a two point Bezier curve.



The curve approximates to an arc when projected onto the principal plane.

Creating a Trimmed Blend

This option can be used to

- Create a fitted, circular curve between two non-planar wireframe objects and trim the unwanted parts.
- Create a fillet between two discontinuous corners of a single curve

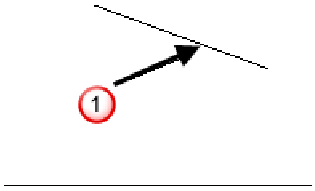
The items that can be filleted with this option are: lines, arcs, curves and composite curves. There are 8 trim solutions.

1. Click the **Trimmed Blend**  button on the Curve toolbar.
2. Click the first position to define the start tangent of the curve.
3. Click the second position to define the end tangent of the curve. The new fillet curve is created and the objects are trimmed. It is a two point Bézier curve.
4. Use the **Trim Solution** dialog to display each of 8 trimmed fillet solutions.

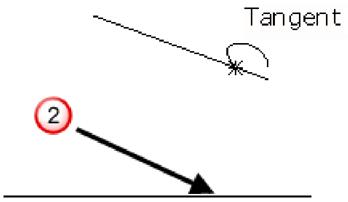
Curve between non-planar wireframe objects

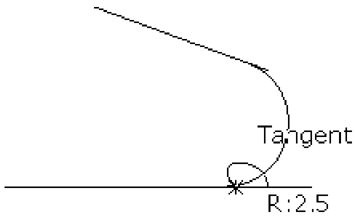
1. Click the **Trimmed Blend**  button.
2. Click the first position to define the start tangent of the curve .

If the cursor is moved over a wireframe object and the intelligent cursor is switched on, the word *'Tangent'* is displayed where tangency is defined, otherwise PowerSHAPE assumes a start point is being specified.

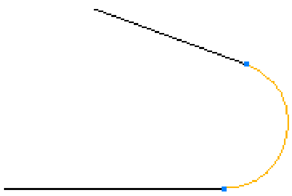


3 Click the second position to define the end tangent of the curve 2.





The new fillet curve is created and the objects are trimmed. It is a two point Bezier curve.



4 Use the **Trim Solution** dialog (see page 121) to display each of 8 trimmed fillet solutions.

*For further details, see Curve Options (*Menus and Toolbars*)..*

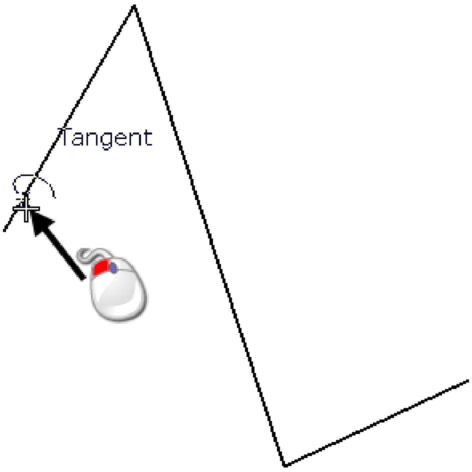
Fillet between two discontinuous corners of a single curve

The **Trimmed Blend** option on the **Curve** creation menu can be used to create a fillet between two discontinuous corners of a single curve.

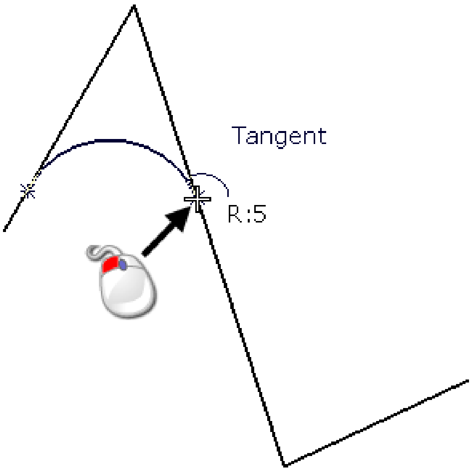
1 Click the **Trimmed Blend**  button on the Curve toolbar.

2 Click on the first position to define the start tangent of the curve.

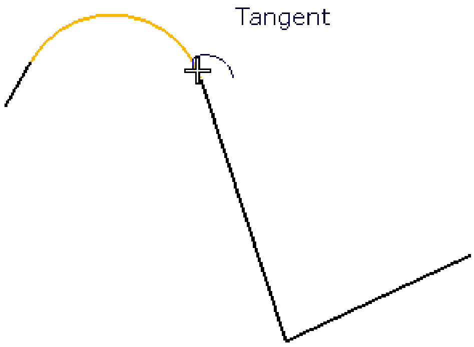
If the cursor is moved over a wireframe object and the intelligent cursor is switched on, the word *'Tangent'* is displayed where tangency is defined, otherwise (for example, if *'End'* is displayed) the program assumes a start point is being specified.



3 Click the second position to define the end tangent of the curve where the blend needs to be defined.



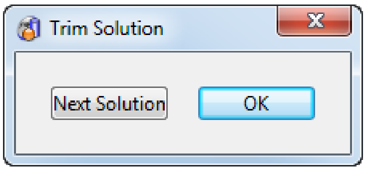
4 The new fillet curve is created and the objects are trimmed. It is a two point Bezier curve.



*If the **Prompt for Trimming Solutions** option is selected on the **Curves** page of the **Options** dialog, the Trim Solution dialog (see page 121) is displayed where you can display each of 8 trimmed fillet solutions.*

Trim Solution dialog

This dialog is used to display the next trimming solution when using the **Trimmed Blend**  button (curves toolbar) on a wireframe object.



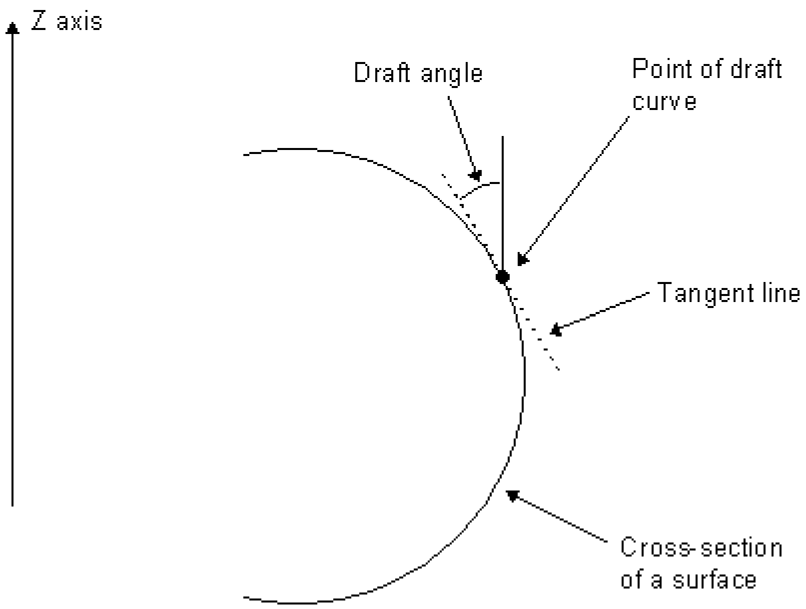
Next Solution — Click to display each of 8 trimmed fillet solutions.

OK — Click to accept the solution displayed.

Creating a draft curve

You can create draft curves from surfaces, solids, and components. A draft curve is used to create a draft surface.

The points of the draft curve are determined along a surface. The points are taken as positions on the surface where the tangent makes the draft angle with the axis normal to the principal plane.



These points are used to define the draft curve.

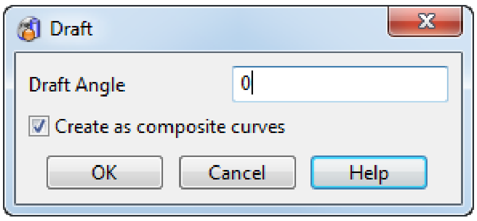
Draft curves are similarly created on solids and components.

To create draft curves,

1 Select the surfaces, solids, and components.

2 Click the **Draft**  button on the Curve toolbar.

3 Use the **Draft** dialog to define the draft curve.



Draft Angle — Input the draft angle.

Create as composite curves — Select this option to create the draft curves as composite curves. Deselectt it to create them as wireframe curves. The colour of the wireframe curves is the same as the underlying surfaces.

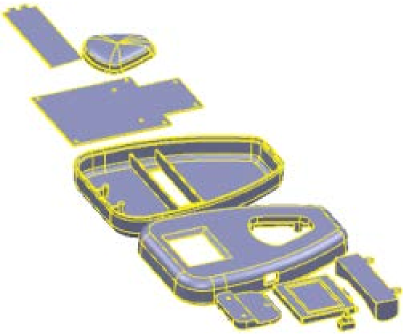
4 Click **OK** to generate the draft curves.

Creating a draft curve is not available in Delcam Designer.

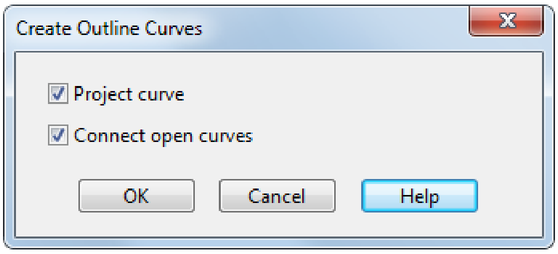
Creating an outline curve

Create a composite curve outline around the selected surfaces, solids and components.

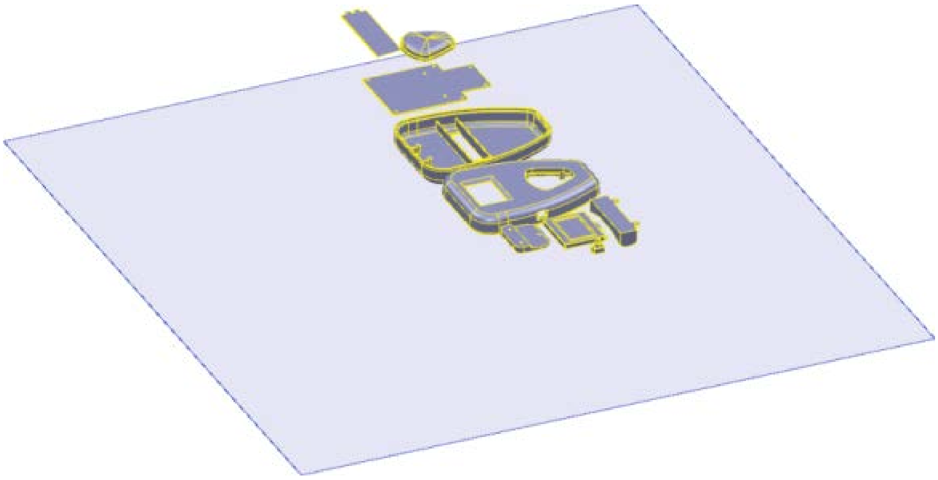
1 Select the objects that will be used to create the outline curve.



2 Click the Outline  button on the Curve toolbar to display the **Create Outline Curves** dialog.

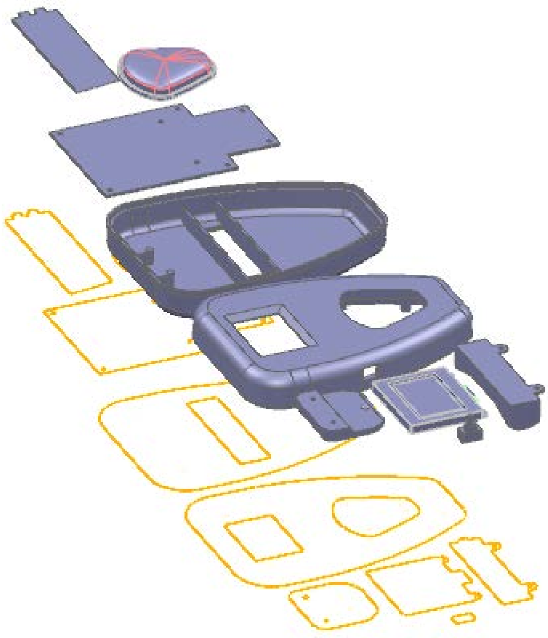


The projection plane is displayed aligned normal to the principal plane.



3 Use  to change the principal plane.

4 Click **OK** to create outline curves for the selected objects.

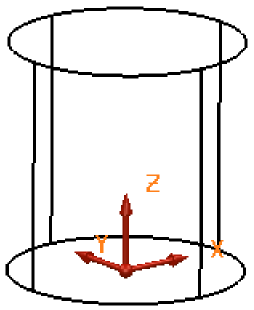


If **Project curve** is selected (default), the outline curves are drawn on the projection plane, as shown.

If **Project curve** is deselected, the outline curves are created in the same position as the objects. Blank the objects to see the outline curves.

Creating curves from oblique sections

1 Create a workplane.



The principal plane of the active workplane is used to define the plane which intersects the surfaces and solids to create the oblique curve.

If no workplane is active, then the principal plane of the world workspace is used.

2 Position the workplane so that its principal plane is at the angle you wish to create the oblique curve.

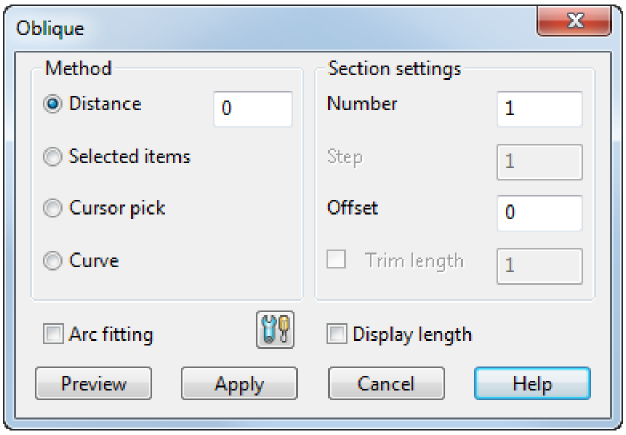
3 Select the surfaces, solids, meshes and components.

4 Click the **Oblique**  button on the Curve toolbar.

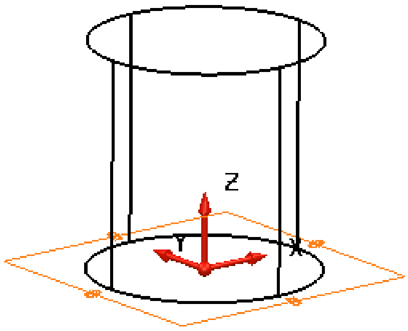
5 Use the **Oblique** dialog (see page 125) to define your oblique curve.

Oblique dialog

Use this dialog to create curves from oblique sections on surfaces, solids, meshes, and components.

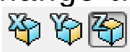


A plane is displayed to show where the oblique curves cut the objects.

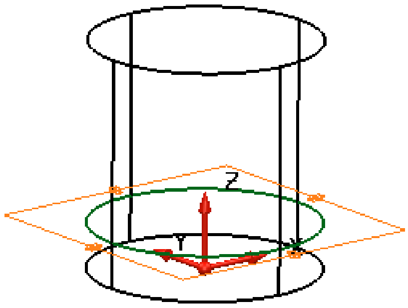


Method

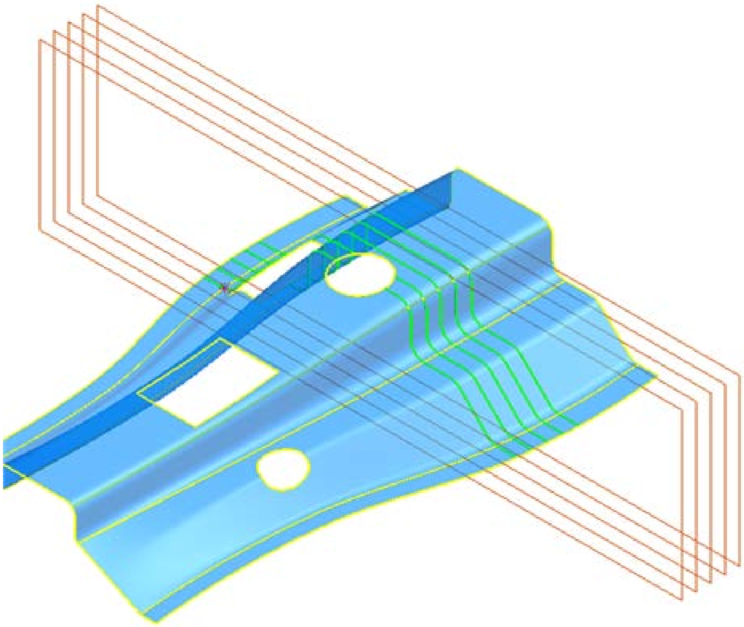
Select one of the following methods to create the curve:

- Select **Distance** and set the distance along the principal axis from the principal plane where you want the oblique curves to cut the objects. If necessary, change the principal axis using the principal plane buttons  on the status bar.

When you enter a distance, the plane moves to the new position of the oblique curve. Enter a value of **20**. The plane moves to reflect the change.



- Select **Selected Items** to automatically create a **Number** of sections through the selection.
- Select **Cursor Pick** to set the required position for the creation of the oblique sections by selecting a point. The oblique sections are created using the selected point as shown in the model below:

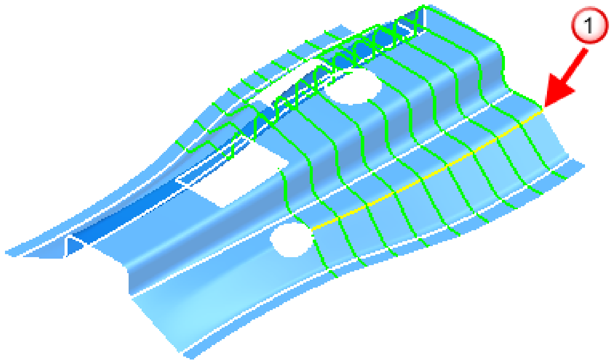


- Select **Curve** to create oblique curves normal to a 3D drive-curve, at a given distance or with a specified number of sections:

  a. Select the curve to be used as a drive curve 1.

  b. Adjust the settings on the other options as required. The model below shows ten oblique curves.

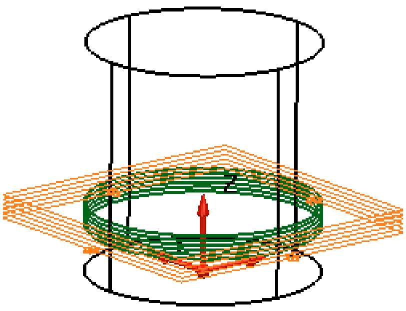
c Click **Preview** to view the curves.



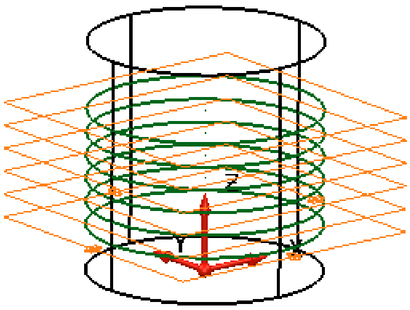
Section settings

Use the following options to create one or more oblique curves from the plane, along the principal axis.

- Enter the **Number** of oblique curves.

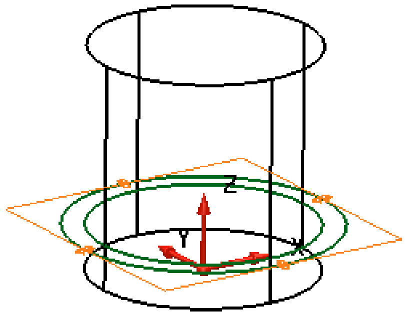


- Enter the **Step** to set the distance between each oblique curve. If **Selected items** is selected, **Step** cannot be modified.

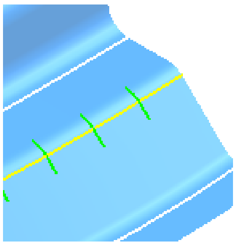


- Set the distance the oblique curves are **Offset** from the objects. The offset is along the plane, on the same side as the surface normal at each point. If the offset is zero, the new curve is dependent on the underlying surface.

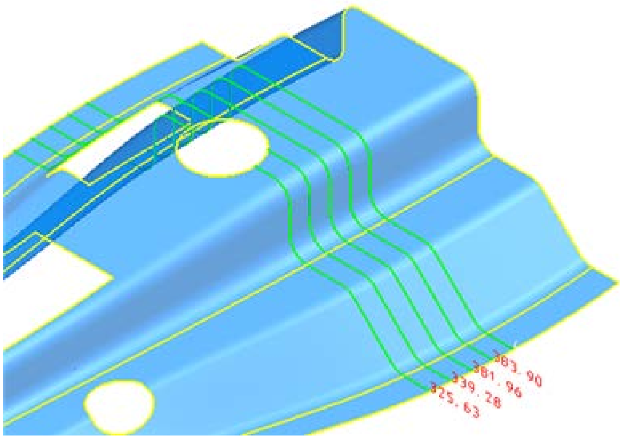
An offset value of **5** was used in the example below.



- Select **Trim length** to trim oblique curves to the specified length. The oblique curves on the following model have been trimmed to **10**.



- Select **Display length** to display the length labels as shown below:



- Select **Create as composite curves** to create the oblique curves as composite curves. Deselect this option to create the oblique curves as wireframe curves.

The colour of the wireframe curves is the same as the underlying objects, whereas composite curves use their default colour.

- Select **Arc fitting** to automatically apply Arc fitting (see page 205) to any curves created using the dialog. You can also click the **Arc fitting options** button to open the Arc Fitting dialog (see page 206).
- Click **Apply** to generate the oblique curves and continue adding further oblique curves to the objects.

- Click **OK** to accept the changes and close the dialog.

Surface, solid, or mesh intersection

You can create composite curves at the intersection of surfaces, solids, meshes and components. You can also create composite curves where the objects would intersect, if offset by a specified distance.

1 Select the objects that you want to create the curve of intersection from.

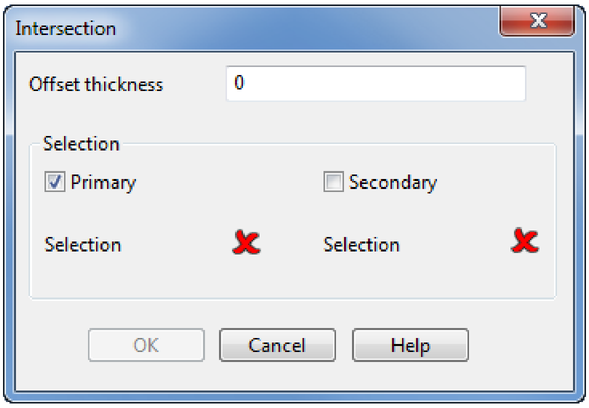
2 Click the **Intersection**  button on the Curve toolbar.

3 Use the **Intersection** dialog (see page 129) to create the curve.

If a component is a sub-assembly, the objects in the sub-assembly are not intersected with each other, unless you activate the sub-assembly and perform the intersection on that.

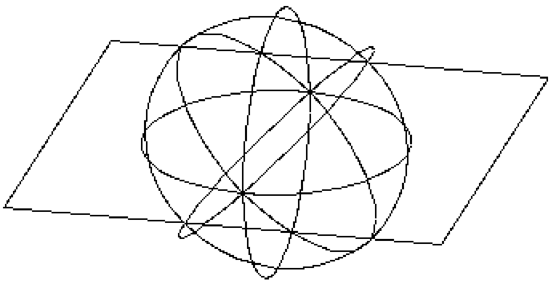
Intersection dialog

Use this dialog to create curves from intersecting meshes, surfaces, solids, and components.

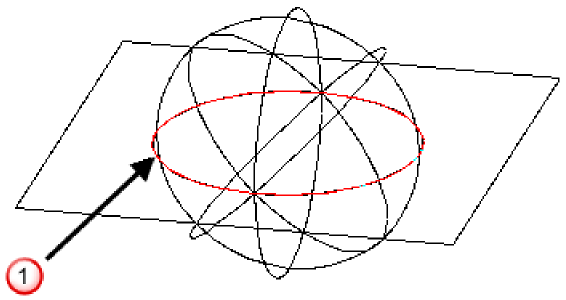


Offset thickness — Enter an offset value. Initially this is set to zero; however the dialog remembers the last value entered.

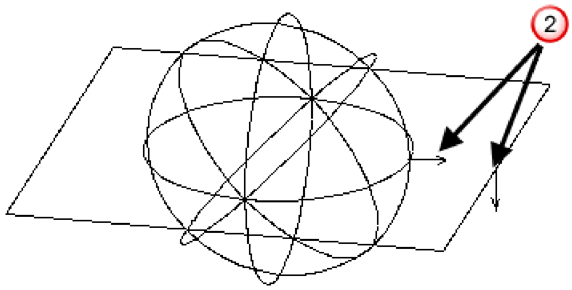
Suppose we have the following intersecting surfaces on the screen.



If you enter an **Offset thickness** of **0** and click **OK**, composite curves are created at the intersection of the objects 1.

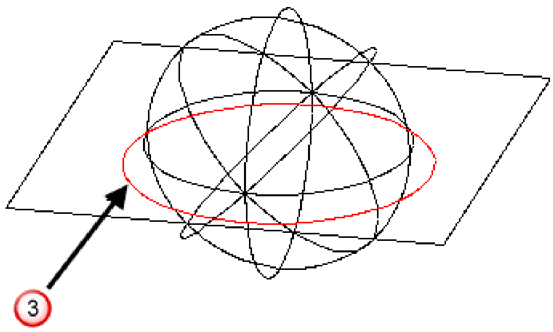


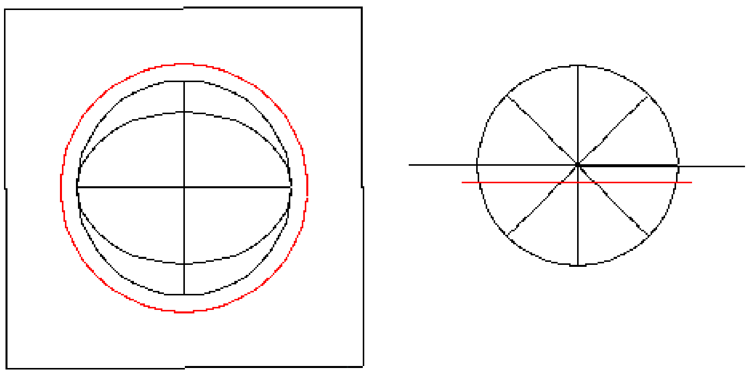
However if you enter a non-zero value as the **Offset thickness**, the surface normals of the selected surfaces are shown 2.



The offset is in the direction of the surface normal at each point where the objects intersect. You can click on the surface normals to change their direction. This changes the way that the objects intersect when offset.

When you click **OK**, the program calculates where the surfaces intersect if offset by the thickness and creates curves at the intersection 3.





Top and side view of the surfaces showing the composite curve created when the Offset thickness is non-zero

Selection — Enables you to create composite curves at the intersection of two groups of objects.

Select the **Primary** option and then select one group of objects.

Select the **Secondary** option and then select the other group.

If objects are selected before the dialog is displayed, they are automatically put in the primary group.

If there are no objects in the secondary group, the new curves are created at the intersections of the objects in the primary group.

OK — This generates composite curves at the points where the objects would intersect depending on the value of **Offset thickness** and removes the dialog from the screen.

Cancel — This removes the dialog from the screen without generating any composite curves.

Curve projection

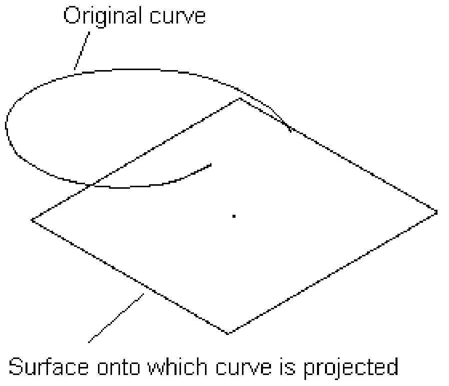
You can create composite curves by projecting multiple wireframe objects or highlighted edges onto:

- surfaces, solids, meshes and components.

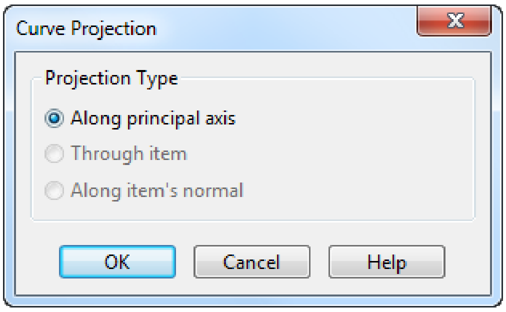
- principal plane.

To create the composite curves,

1 Select the wireframe objects or highlighted edges and the objects to project onto. If no surfaces, solids, meshes or components are selected, the wireframe objects or highlighted edges are projected onto the principal plane.

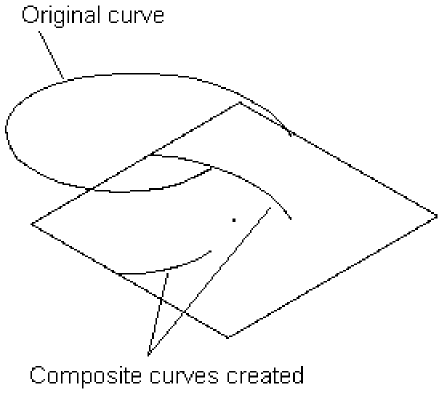


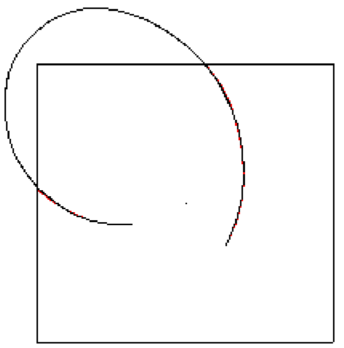
2 Click the **Projection**  button on the Curve toolbar.



3 Use the dialog to choose one of the following **Projection Types** and create the curve:

Along principal axis — This projects the wireframe along the principal axis onto the selected objects.





This shows how the curves match one another when in top view.

If no surfaces, solids, meshes, or components are selected, the wireframe objects are projected onto the principal plane.

Through item — (Valid only when surfaces, solids, meshes, or components are selected.) This projects the wireframe through the objects along the principal axis. A new curve is created on each surface that the wireframe touches.

Along item's normal — (Valid only when surfaces, solids, meshes, or components are selected.) This projects the wireframe onto the selected objects along the surface normals.

4 Click **OK**. Composite curves are created where the wireframe objects are projected.

The new composite curves are dependent on the underlying surfaces if projected onto objects.

Wrapping wireframe onto surfaces/solids

1 Click the **Wrap**  button on the Curve toolbar to start the **Wrap Wizard.**

2 Ensure your wireframe objects are orientated correctly in the XY plane.

During wrapping, the wireframe objects are converted to 2D by projecting them onto the XY plane of the world space or the objects' group workplane (if one exists).

If your wireframe geometry isn't correctly orientated in the XY plane, follow the steps below:

a Create a grouped workplane.

b Align the workplane so that its Z axis is normal to the plane of the geometry.

c Select the wireframe objects.

d Select **Edit > Add to active workplane group** to add the wireframe objects to the workplane's group.

e Deactivate the grouped workplane.

3 Create a workplane, if necessary, to position the wireframe on the solid and surface objects.

The wireframe is centred on the workplane origin and its Y axis is aligned with the workplane's Y axis (if you decide to use the workplane option).

4 Select **View > Shaded** to shade your model.

5 Select all the wireframe, solid, and surface objects that you want to use.

The **Wrap Wizard** is also available on the **Surface** toolbar.

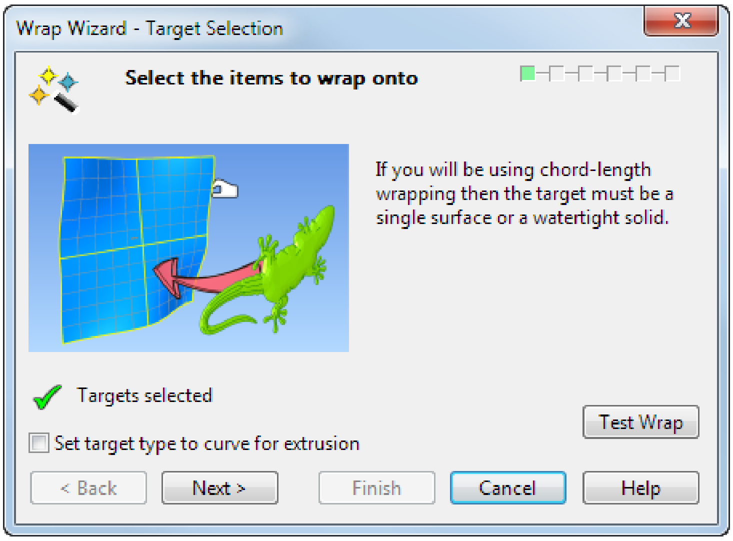
Wrapping Wireframe using the Wrap Wizard

1 Click the **Wrap**  button on the Curve toolbar to start the **Wrap Wizard**.

2 Use the **Wrap Wizard** to create and edit the wrapped curves. The Target Selection (see page 135) page of the **Wrap Wizard** is displayed.

Wrap Wizard - Target Selection (wireframe)

Use this page to select the target surfaces and/or solids for wrap.



Targets Selected — Select the target surface for the wrap and The cross icon changes to a tick icon.

Set target type to curve for extrusion — This option is used for wrapping curves more easily in shoe design where you have a curve representing a cross section of the shoe sole instead of an existing sole surface. Any type of curve can be used as long as it is a single, planar curve.

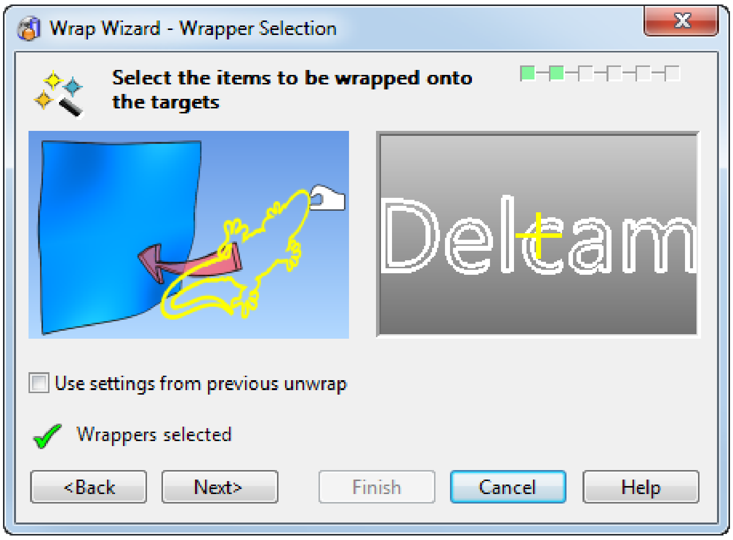
Select this option on the dialog then select the cross section curve as the target. An extruded surface is created automatically from the cross section curve which is then used as the target for wrapping.

Test Wrap — Click this button to create a test wrap for the selected wireframe and target object to see the viability of the results before proceeding through the **Wrap Wizard**.

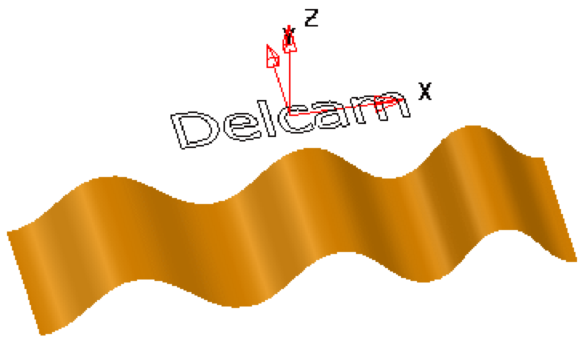
Next — Click this button to move to the Wrapper Selection (see page 136) page of the **Wrap Wizard**.

Wrap Wizard - Wrapper Selection (wireframe)

This page displays the selected wireframe to be wrapped onto the target surface or solid.



The example below shows the **Reference** workplane.



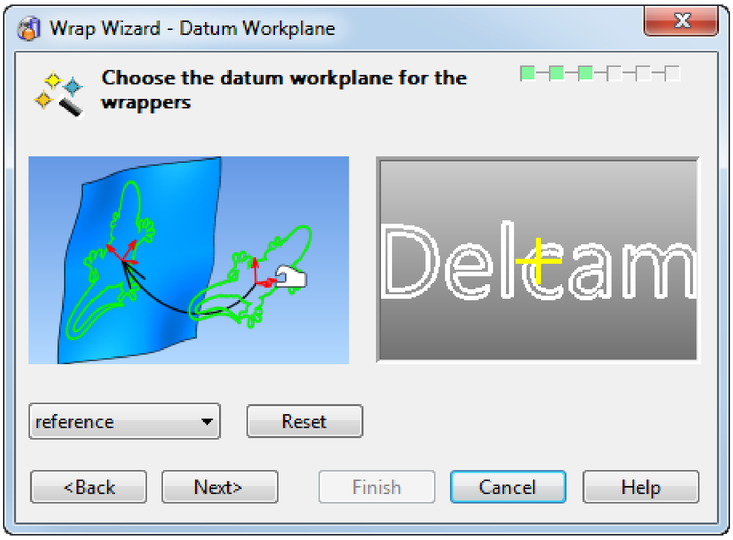
Use settings from previous unwrap — This is selected automatically if wireframe has been previously unwrapped. For further details, see What is Wrapping? (Surface modelling manual)..

Wrappers selected — Select the wireframe to be wrapped onto the target surface. The cross icon changes to a tick icon..

Next — The Datum Workplane (see page 137) page of the **Wrap Wizard** is displayed.

Wrap Wizard - Datum WorkPlane (wireframe)

Use this page to select the workplane for the selected wireframe.

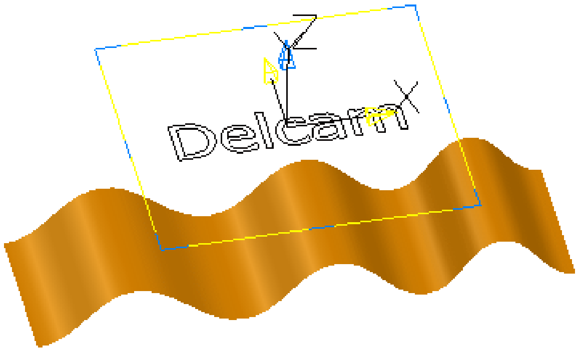


Select one of the following workplanes:

Reference — The wireframe is wrapped onto the target object in a position relative to the reference workplane.

World — The wireframe is wrapped onto the target object in a position relative to the world workplane.

The workplane is displayed on the selected wireframe. The example below shows the **Reference** Workplane.



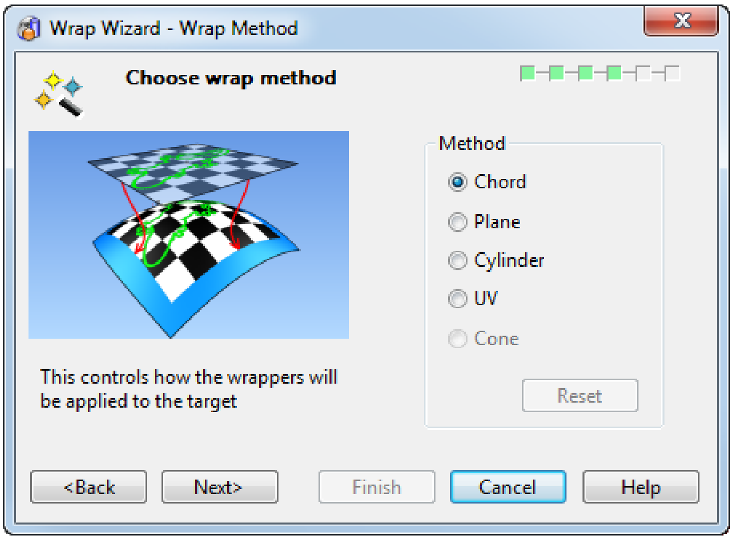
Reset — Click this button to reset the reference workplane to align with the workplane of the selection.

Next — The Wrap Method (see page 138) page of the Wrap Wizard is displayed.

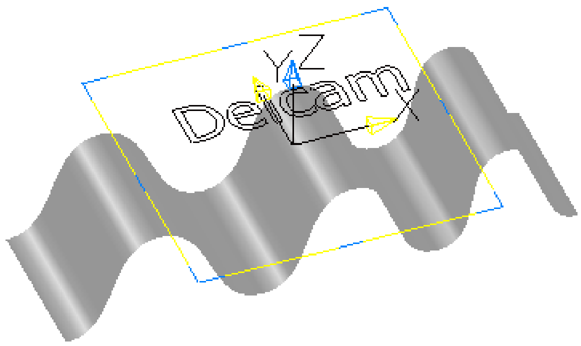
Back — Reverses the Wrap Wizard.

Wrap Wizard - Wrap Method (wireframe)

Use this page to select the method to apply the wrappers to target objects.



The target object changes colour.



Chord — Select this method to wrap wireframe triangles onto the target object minimising distortion.

You define how the **Chord** wrapper is applied to the target object on the Chord Length Wrap Map Creation (see page 140) page of the Wrap Wizard.

Plane — Select this method to project the wireframe as a plane onto the objects.

To position the wireframe correctly, view the objects on the screen so that you are looking directly at the area where the wireframe lies. Then select the **Plane** option.

If the option was already selected before you adjusted the position of the objects, select it again after adjusting the position.

If a single primitive plane is selected, the wireframe is fitted onto it, regardless of its orientation.

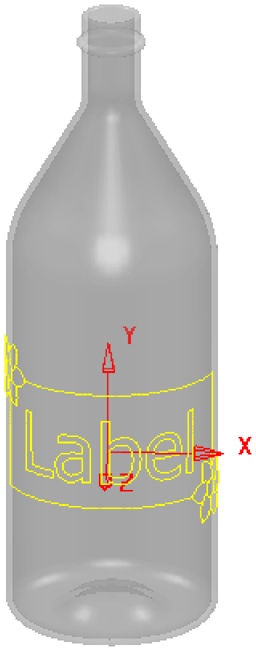
Cylinder — This projects the wireframe as a cylinder onto the objects.

The wireframe is wrapped onto the objects along the vertical axis of the screen. It is then projected on the objects from the bounding cylinder around them.

Before selecting this option, make sure the objects are viewed such that the vertical axis of where you want to put the wrapped curves is aligned with the vertical axis of the screen.

If a single primitive cylinder is selected, the wireframe is fitted onto it, regardless of its orientation.

The example below uses the cylindrical projection and the active workplane lies on the surface of the bottle.



The wireframe is wrapped around the bottle. It is also centred on the workplane origin and its Y axis is aligned with the workplane's Y axis.

UV — This projects the wireframe using the parameter space of each object.

Cone — This option is selected when creating a 360 degree conical wrap and is greyed out when other wrap methods are in progress. For further details, see Creating a 360 degree conical wrap (see page 143)

Next — Different pages of the wizard are displayed depending on which method is selected:

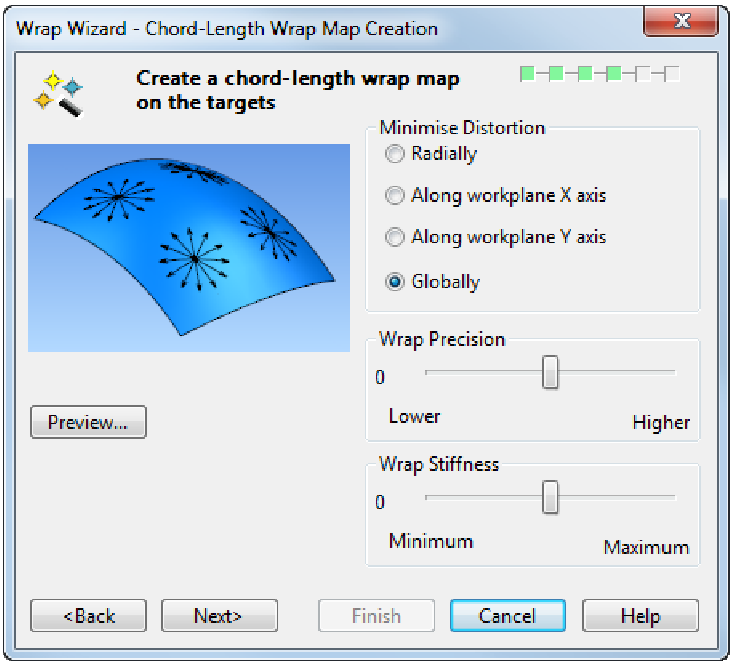
Plane, **Cylinder**, or **UV** methods — The Wrapper Layout (see page 141) page of the Wrap Wizard is displayed.

Chord method — The Chord Length Wrap Map Creation (see page 140) page of the Wrap Wizard is displayed.

Wrap Wizard - Chord Length Wrap Map Creation (wireframe)

Use this page to define how the Chord wrapper is applied to the target object.

The wrap map is a 2D coordinate system for a triangulated surface. It is displayed as a black and white chequerboard effect on the target object.



Minimize Distortion — This option enables you to select where to minimize the distortion caused by the wrapping process. Select one of the following:

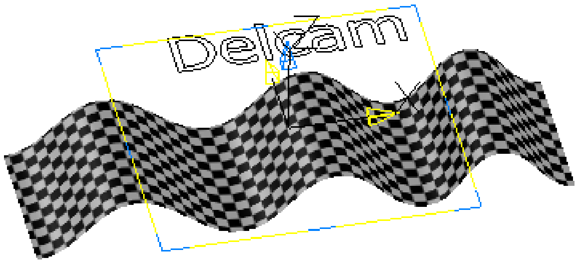
- **Radially**
- **Along workplane X axis**
- **Along workplane Y axis**
- **Globally**

For further detail on these options, see Wrap Wizard - Chord Length Map Creation (*Surface Modelling*).

Wrap Precision — Drag the slider to adjust the precision of the wrap map to reduce distortion if necessary. **Higher** gives the best wrap quality but the wrap map takes longer to create. The default position is **Normal**.

Wrap Stiffness — Move the slider to adjust the wrapping angle. **Maximum** stiffness reduces wrapping angles and preserves large map areas. **Minimum** stiffness increases wrapping angle of the wrap map for greater curvature. The default position is Normal.

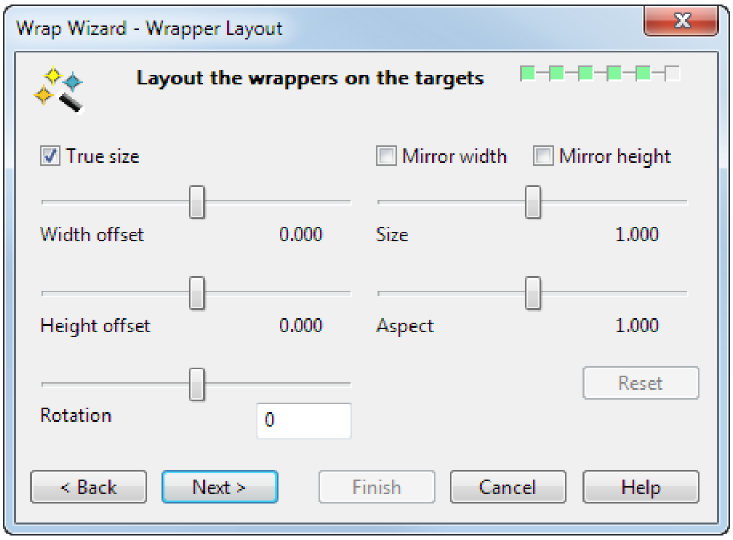
Preview — Click this button to display the wrap map on the target surface or solid to visualise the results of the wrap. This is represented by a chequerboard effect in order to show any distortions.



Next — The **Wrapper Layout (see page 141)** page of the Wrap Wizard is displayed.

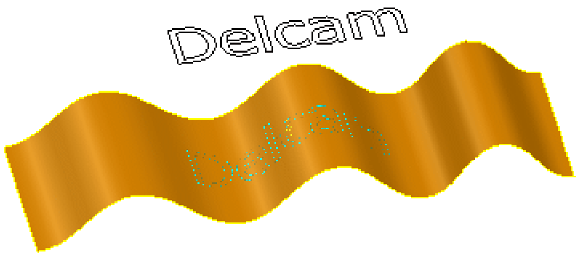
Wrap Wizard - Wrapper Layout (wireframe)

Use this page to adjust the position of the wireframe using the sliders.



The wireframe wrapper is projected onto the target surface or solid. The projected image changes as you move the sliders. The values are proportions of the projection space.

To finely adjust the sliders, use the arrow keys on the keyboard or the mouse wheel.



True size — Select this option to maintainthe aspect ratio and size of the wireframe.

Mirror Width:

Mirror Height:

Width Offset — Offsets the wireframe along the width.

Size — This scales the wireframe in all directions.

Height Offset — Offsets the wireframe along the height.

Aspect — This scales only the height of the wireframe.

Rotation — Use the slider to rotate the wireframe or enter the angle of rotation.

Next — Displays the **Wrap Wire** (see page 143) page of the Wrap Wizard.

Wrap Wizard - Wrap Wire

Use this page to **Preview** or **Finish** the wrap.

Preview — Displays the results of the wrap using the options selected.

Back — Reverses the Wrap Wizard to allow you to select other options.

Finish — Completes the Wrap Wizard and creates the final wrap.

The selected wireframe object is wrapped onto the target surface or solid.

Creating a 360 degree conical wrap

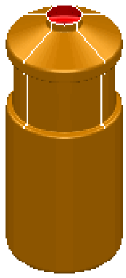
There are three stages to creating a 360 degree wrap on a cone shaped object.

1. Conical wrapping can only be done as a **rewrap**, so it first has to be unwrapped. Unwrapping flattens the shape so the additional relief can be added. In order to unwrap the cone you first need to create a **Cone Primitive** to guide the conical projection of the unwrap.
2. Create the pattern on the unwrapped curves.

3 Rewrap the additional detail onto the model.

The cone shaped top on the bottle shown below is an example of where 360 degree conical wrapping can be used.

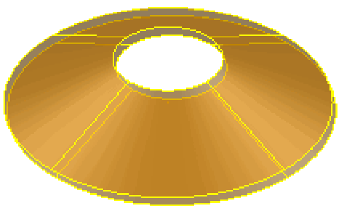
360 degree conical wrapping is not available for solid wrap features or for wrapping wireframes.



Unwrapping the cone

1 The conical projection in this type of unwrapping is guided by a primitive cone surface that you have to create first. You need to create a **Cone Primitive** that closely matches the conical shape of the object you want to unwrap.

   The image below shows a cone primitive positioned closely to the original cone surface of the bottle example.

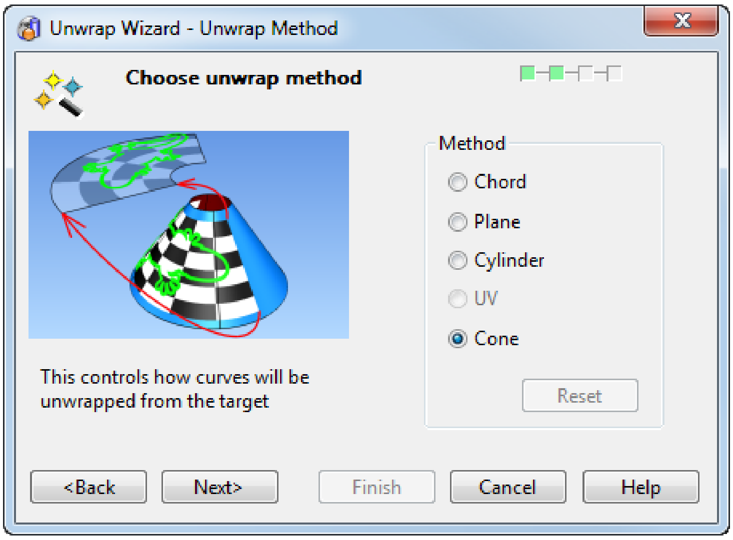
   

2 Select both the original cone and the cone primitive.

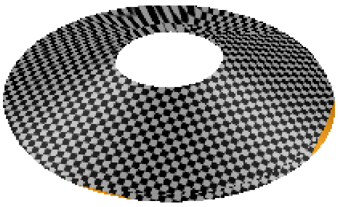
3 Click the **Unwrap**  button on the Curve toolbar.

4 Click **Next**.

The **Cone** wrap method option is selected automatically.

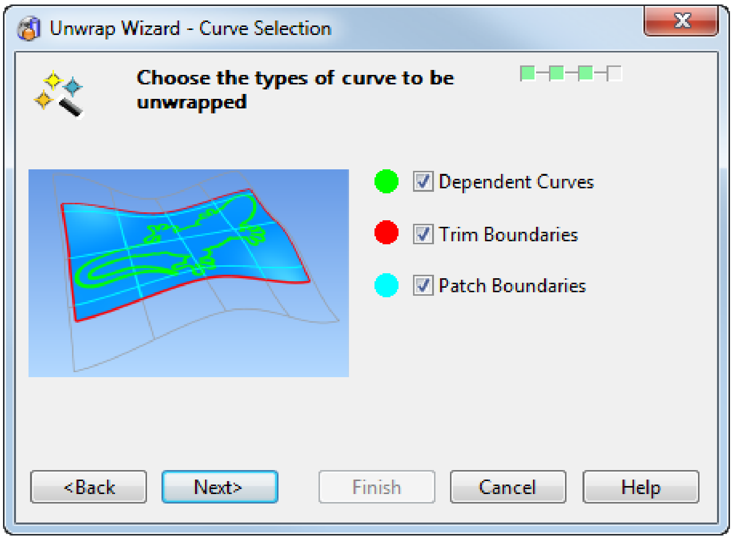


A chequerboard visual effect is displayed on the target object to show the effect of the **Cone** wrap method.

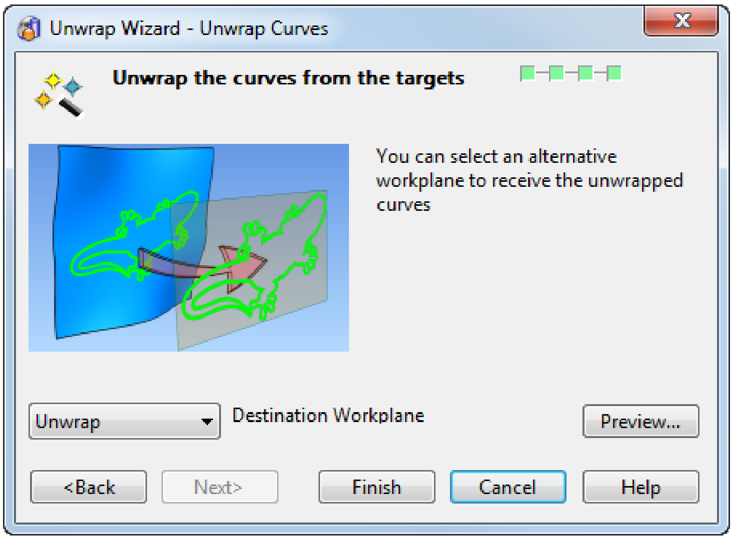


5 Click **Next**. The **Curve Selection** page of the **Unwrap Wizard** is displayed.

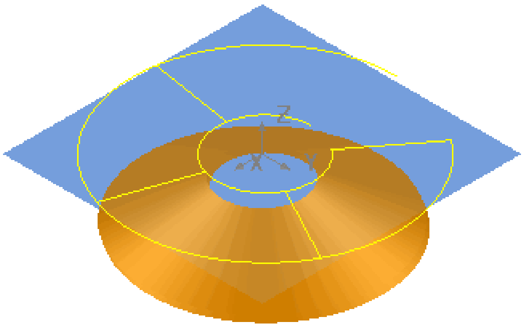
6 Select the **Patch Boundaries** option. This displays useful guidelines in the unwrapped curves.



7 Click **Next**. The **Unwrap Curves** page is displayed.



8 Click **Preview...**.

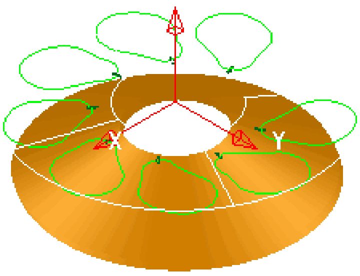


9 Click **Finish**. The curves are unwrapped and the guidelines are displayed

Creating the pattern on the unwrapped cone

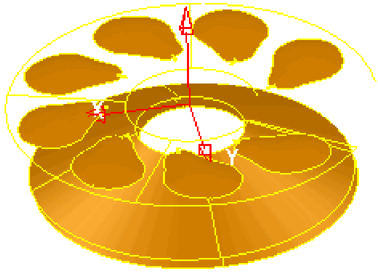
1 Create a pattern in the unwrapped curves.

In the example below, the pear pattern has been previously created and imported into position using the guidelines of the unwrapped curves.



2 The pattern now needs to be exported as a picture file to be created into 3D reliefs in ArtCAM. The 3D reliefs are then imported back into PowerSHAPE.

The example below shows the imported 3D reliefs.



Rewrapping the pattern onto the cone

To rewrap the 3D relief pattern onto the cone:

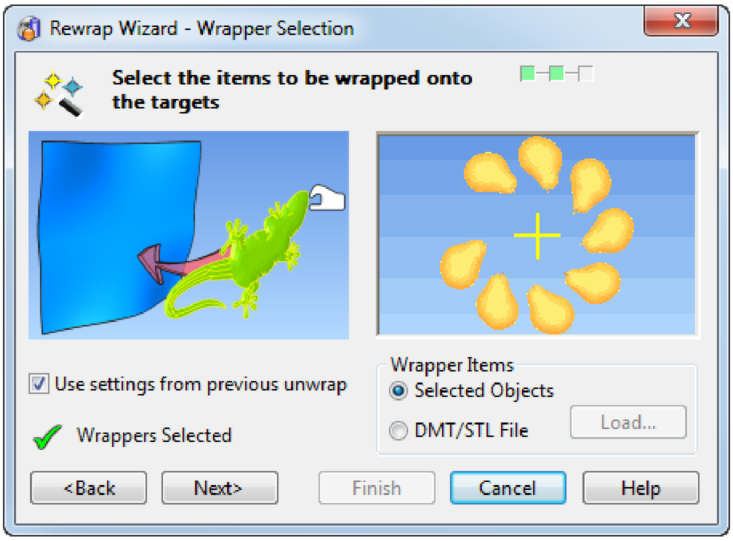
1 Click **Wrap Triangles**  on the Surface toolbar.

The **Target Selection** page of the **Rewrap Wizard** is displayed.

2 Select the cone and click **Next**.

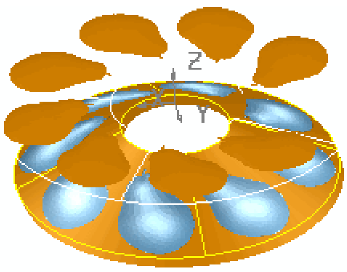
The **Wrapper Selection** page is displayed.

3 Select the pear pattern on the unwrapped curves. The pattern is displayed in the dialog.

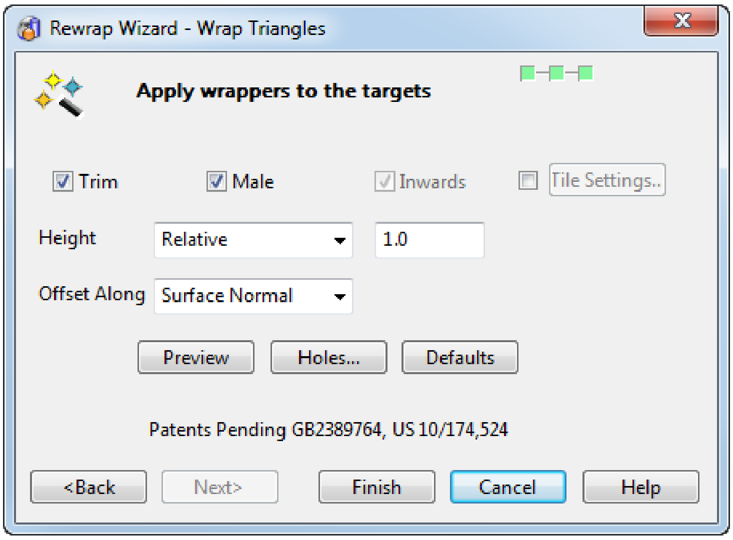


4 Ensure the **Use settings from previous unwrap** option is selected.

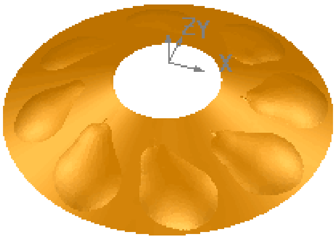
5 Click **Next**. The pattern is projected onto the cone surface.



The **Wrap Triangles** page is displayed.



6 Click **Finish**

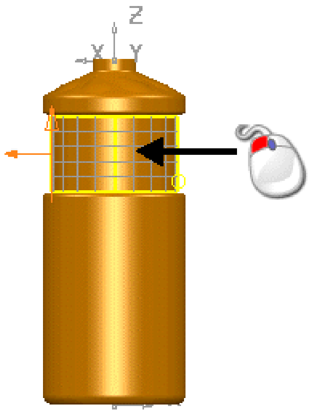


The bottle example shows the effect of this 360 degree conical wrap.

Creating a 360 degree cylindrical wrap

1 Select the cylindrical surface you want to wrap on to.

The cylindrical shape of the bottle shown below is an example of where 360 degree cylindrical wrapping can be used.

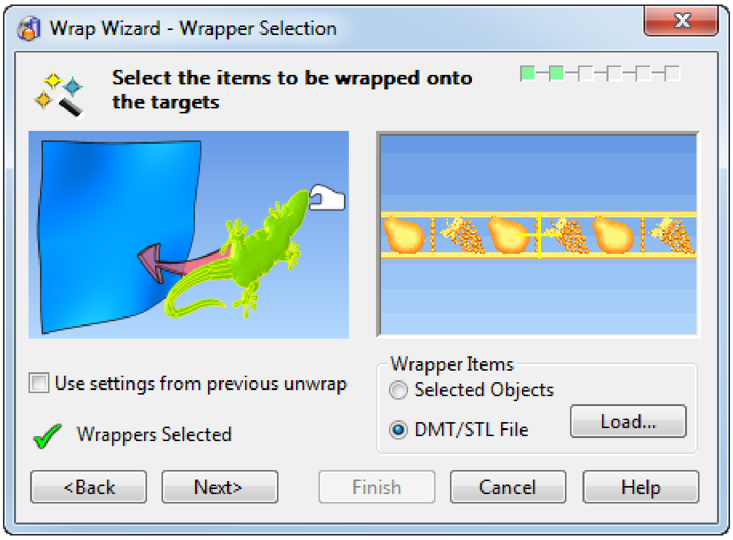


2 click **Wrap Triangles**  on the Surface toolbar. The **Target Selection** page of the **Wrap Wizard** is displayed.

3 Click **Next**. The **Wrapper Selection** page is displayed.

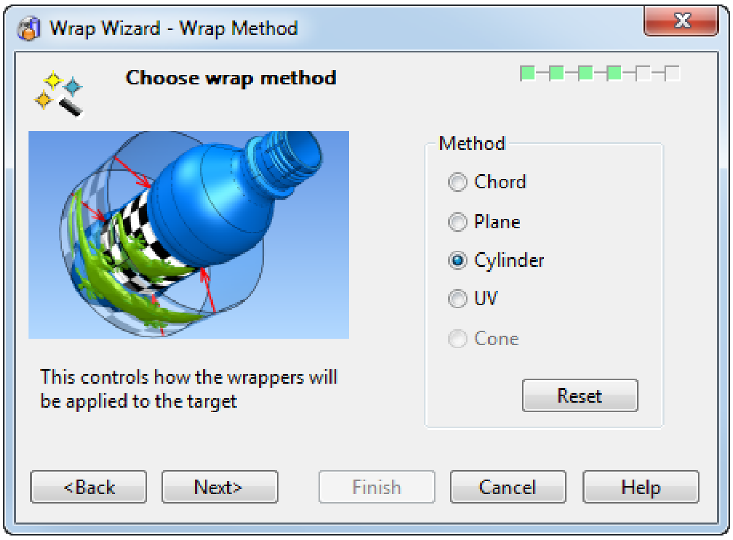
4 Select the **DMT File** option.

5 In the **Load DMT File** dialog, select the dmt file you want to use for the wrap. The image is displayed in the dialog.

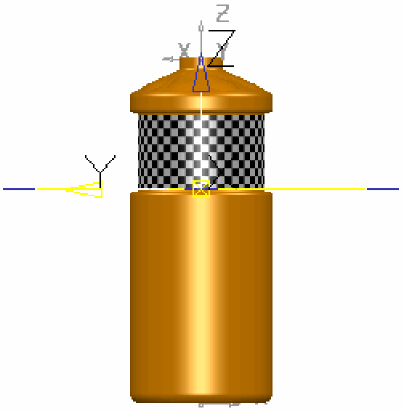


6 Click **Next**.

7 Select the **Cylinder** wrap method.

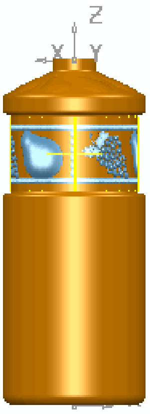


A chequerboard visual effect is displayed on the target object to show the effect of the **Cylinder** wrap method.



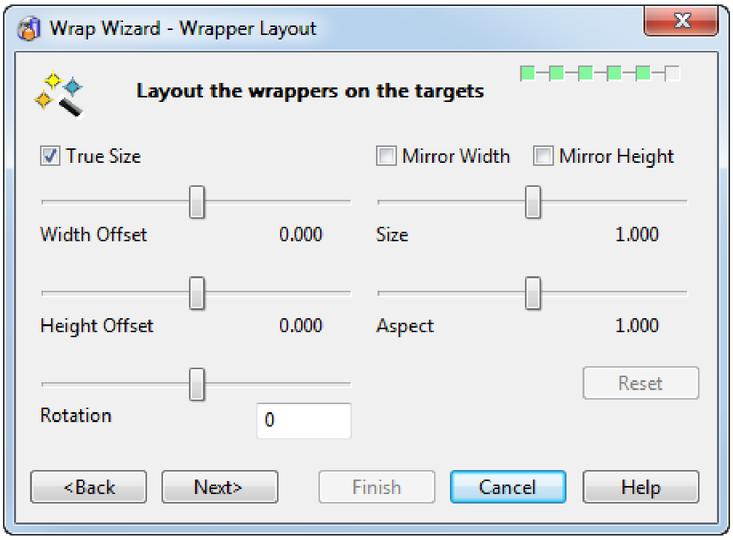
8 Click **Next**.

9 The wrap is displayed on the cylinder.



The **Wrapper Layout** page is displayed where you adjust the layout settings for the wrap on the object.

*To achieve the best results from a 360 degree cylindrical wrap, it is advisable to adjust the **Size** so the edges of the wrap overlap slightly where they meet.*



In this bottle example the **True Size** option is deselected and the **Size** is adjusted to 1.005.

1 Click **Next**.

2 Click **Finish**.

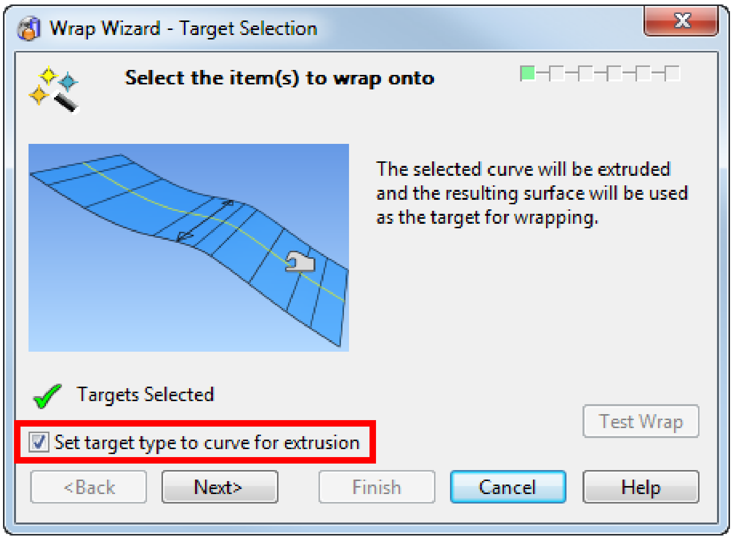
The bottle example shows the effect of this 360 degree cylindrical wrap.

Creating a shoe sole wrap

1 Click **Curve Wrapping**  on the Curve menu.

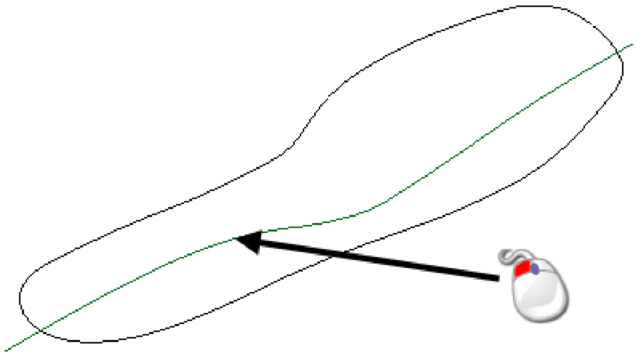
The **Target Selection** page of the **Wrap Wizard** is displayed.

2 Select the **Set target type to curve for extrusion** option.



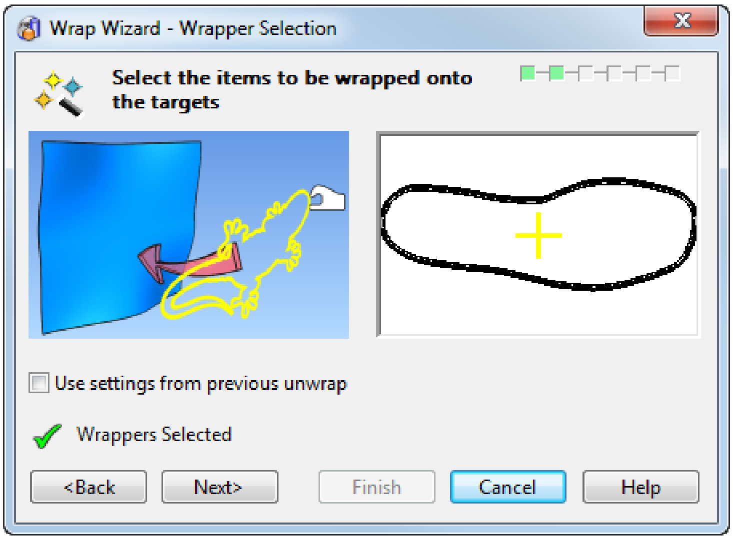
3 The example image below shows a shoe sole outline and a curve representing a cross section of the shoe sole. This cross section curve is extruded automatically to create the shoe sole that the sole outline can be wrapped onto.

4 Select the cross section curve.

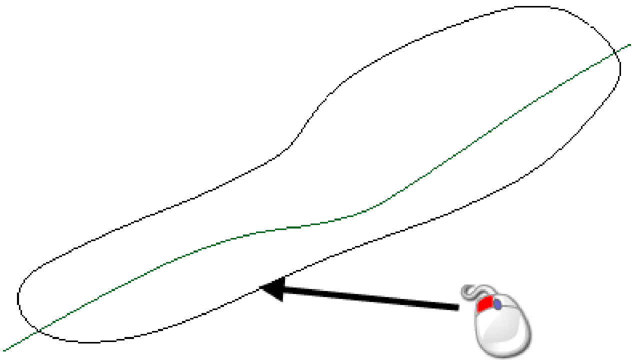


When the target is selected ✘ next to **Targets Selected** changes to ✔.

5 Click **Next**.



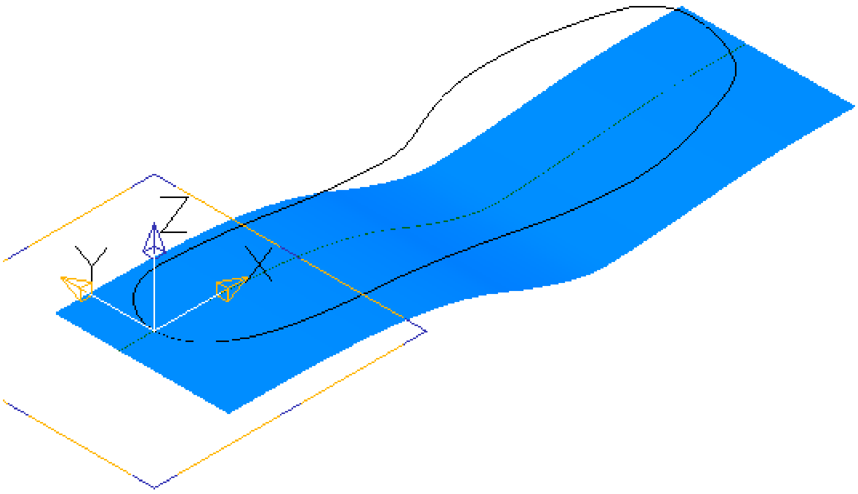
6 Select the sole outline to wrap onto the extruded cross section curve.



When the wrapper is selected next to **Wrappers Selected** changes to .

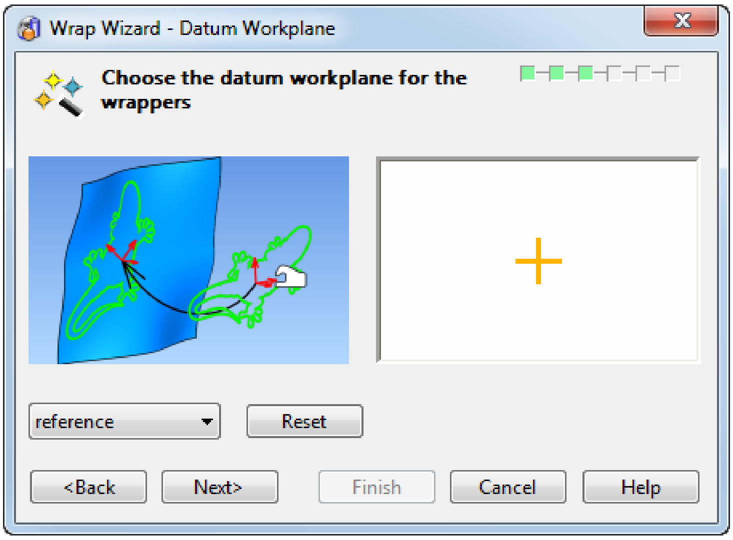
7 Click **Next**.

An extruded surface is created from the cross section curve.



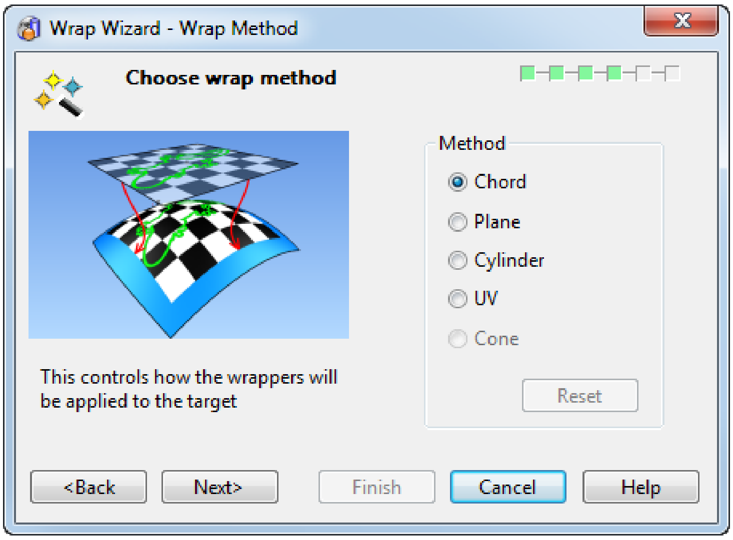
The **Datum Workplane** page of the wrap wizard is displayed.

8 Select the datum workplane you want to use for the wrappers. The **Reference** workplane is selected automatically in this example.



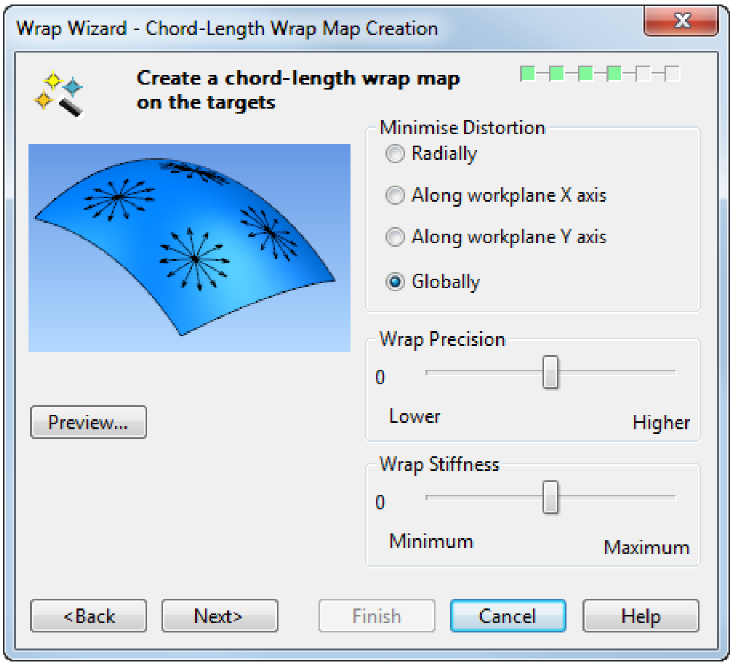
If the wrapper (outline) curve intersects the extrusion curve, the datum workplane is positioned at the intersection, as shown in the example model. If the two curves do not intersect, the datum workplane is positioned in the default position at the centre of the wrapper. The workplane can be repositioned and edited if required.

9 Click **Next**. The **Wrap Method** page is displayed.

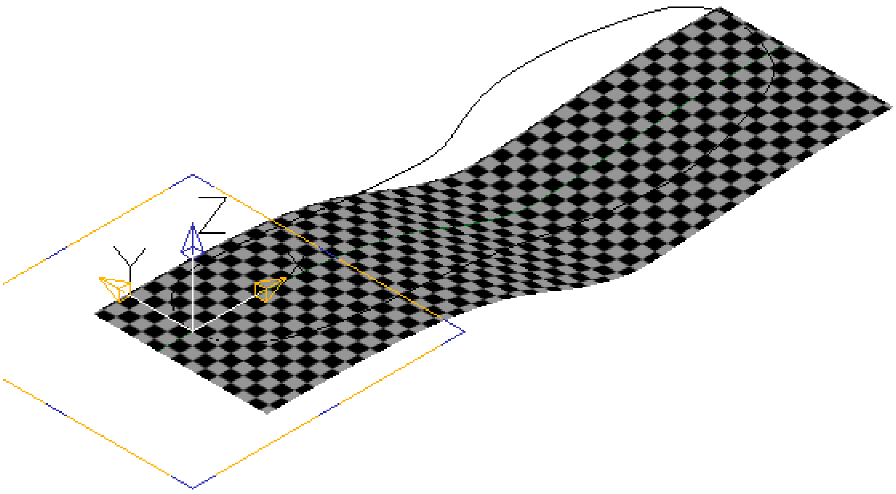


The **Chord** length option is selected by default. This option is recommended for best results when wrapping onto shoe soles.

10 Click **Next**. The **Chord-Length Wrap Map Creation** page is displayed.

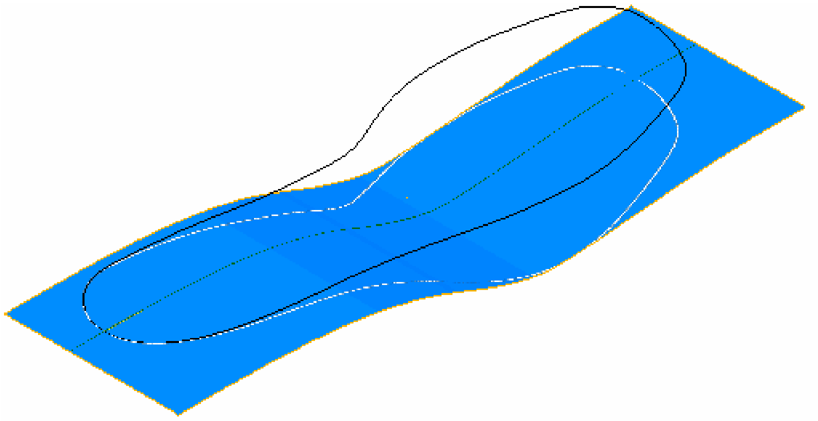


11 Click **Preview**. The wrap map is created.



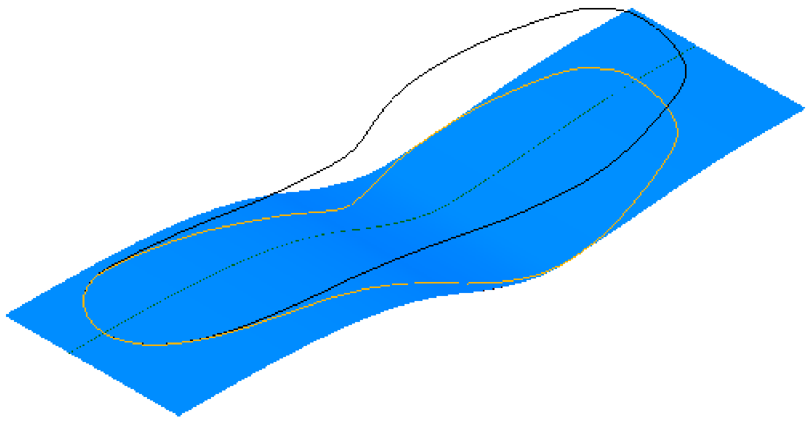
A chequerboard visual effect is displayed on the target object to show the effect of the **Chord Length** wrap method.

12 Click **Next**. The **Wrapper Layout** page is displayed where you may adjust the layout settings for the wrap on the target.



13 Click **Next**. The **Apply wireframe wrappers** page is displayed.

14 Click **Finish** to create the wrapped curve.



Curve Unwrapping

Curve Unwrapping uses the **Unwrap Wizard** to unwrap curves from surfaces and solids. It unwraps, or flattens, a shape so that additional wireframe items or symbols can be added. The modified shape can then be wrapped back on to the target object. For further details, see Wrapping (Surface modelling manual).

You can unwrap the following:

- Dependent curves
- Trim curves
- Patch boundaries

*To wrap the shape back on to the target surface, click the **Wrap Triangles** option on the **Surface** toolbar. This starts the **Wrap Wizard** that is automatically renamed **Rewrap Wizard** as it identifies a previously unwrapped surface.*

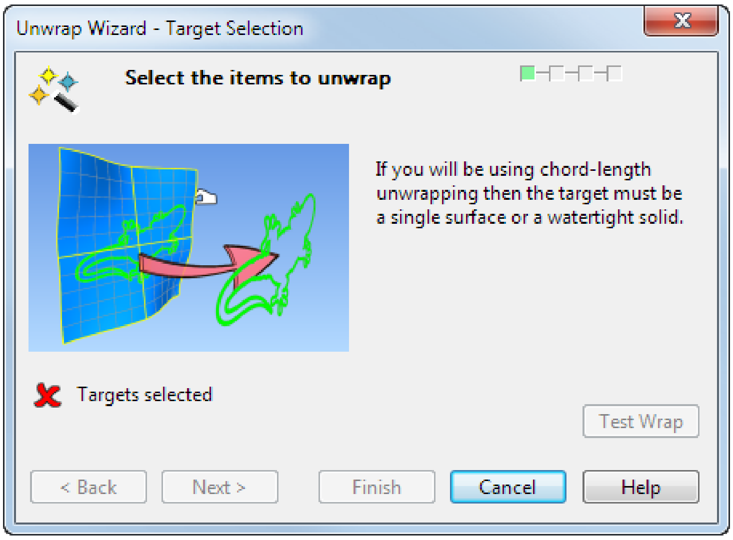
Using the Unwrap Wizard

1. Click the **Unwrap**  button on the Curve toolbar to start the **Unwrap Wizard**.
2. Select the curves you want to unwrap.

   The **Target Selection** page of the Unwrap Wizard is displayed.

Unwrap Wizard - Target Selection

Use this page to select the target object that you want to unwrap.



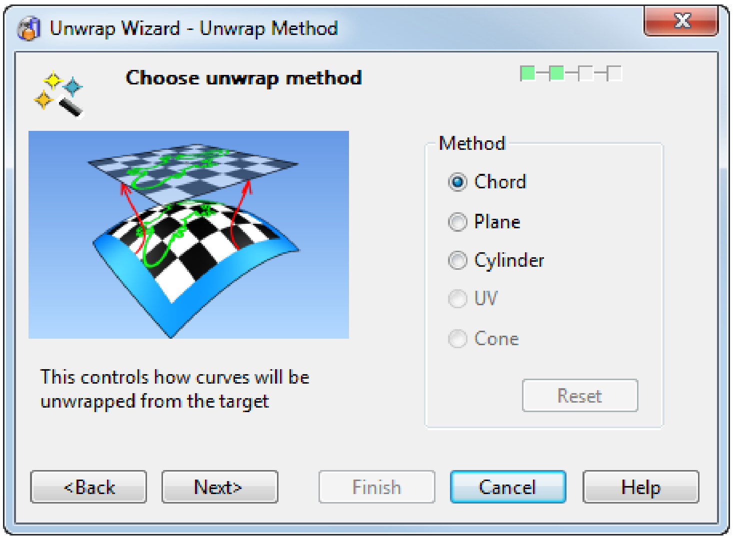
Targets selected — Select the item to unwrap. The cross icon changes to a tick icon..

Test Wrap — This displays the **Chord Length Wrap Map Creation** page of the Wizard. It enables you to preview the results of a Chord-Length wrap on the targets before loading the triangle files.

Next — Click this button to display the **Unwrap Method** page of the Unwrap Wizard.

Unwrap Wizard - Unwrap Method

Use this page to select the method for unwrapping the target object.



Method — Choose one of the following unwrap methods:

Chord — This method unwraps curves from the target object minimising distortion. You define how the target is unwrapped on the **Chord Length Wrap Map Creation** page of the Unwrap Wizard. For further details, see Unwrap Wizard > Chord Length Wrap Map Creation (see page 159).

Plane — This projects the unwrapped curves onto a plane from the target object. You can modify the plane in the graphics window.

Cylinder — This projects the unwrapped curves onto a cylinder from the target object. You can modify the cylinder in the graphics window. A chequerboard visual effect is displayed on the target object to show the effect of the unwrap method.

UV — This option is not available when using the Unwrap Wizard.

Cone — This option is selected automatically when creating a 360 degree conical wrap. A chequerboard visual effect is displayed on the target cone object to show the effect of the unwrap method. For further details, see Creating a 360 degree conical wrap (see page 143)

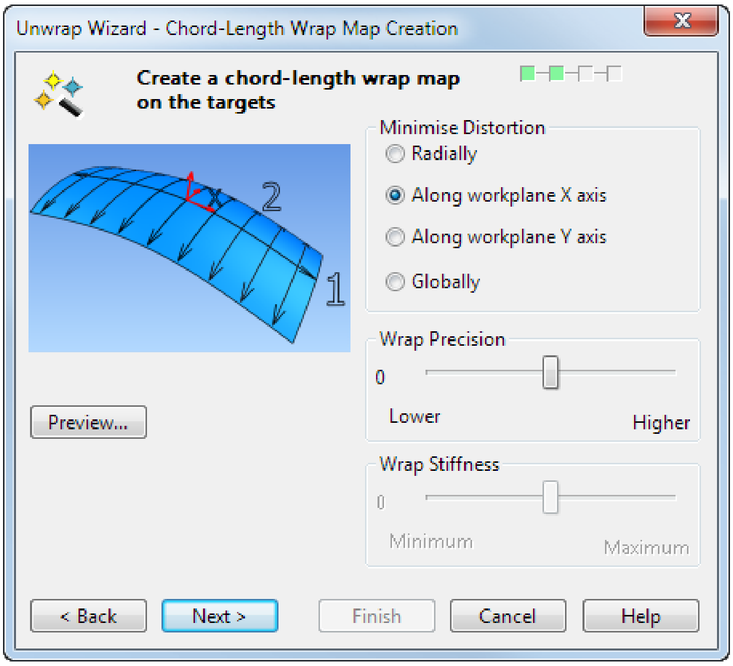
Reset — This reverts the settings back to the default values.

Next — Different pages of the wizard are displayed depending on the method that is selected:

- **Plane**, **Cylinder** methods - the **Curve Selection** page of the Unwrap Wizard is displayed.
- **Chord** method - the **Chord Length Wrap Map Creation** page of the Unwrap Wizard is displayed.

Unwrap Wizard - Chord Length Wrap Map Creation

Use this page to define how the **Chord** wrapper unwraps from the target object.



The wrap map is a 2D coordinate system for a triangulated surface. It is displayed as a black and white chequerboard effect on the target object.

Minimize Distortion — This enables you to select where to minimise the distortion caused by the unwrapping process. Select one of the following:

Radially — This option works most successfully with square shaped target objects.

Along workplane X axis — This is the default option. This provides straighter lines and more even spacing along the X axis of the target object.

Along workplane Y axis — This provides straighter lines and more even spacing along the Y axis of the target object.

Globally — (*recommended*) minimises the distortion equally over the whole surface, preserving the shape of the wrapper as well as possible. When this option is selected, **Wrap Precision** is unavailable.

This method is suitable only for open targets; the target cannot be closed or tubular. The target may contain holes.

Wrap Precision — Move the slider to adjust the precision of the wrap map to reduce distortion if necessary. **Higher** gives the best wrap quality but the wrap map takes longer to create. The default position is **Normal**.

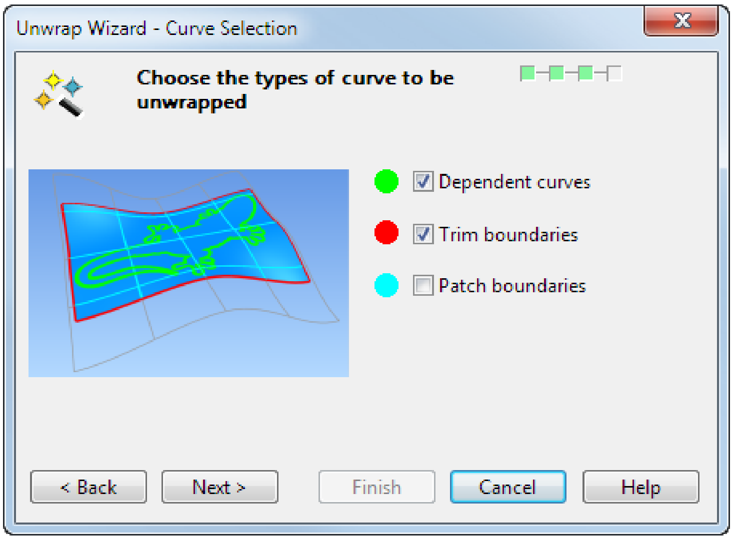
Wrap Stiffness — Move the slider to adjust the wrapping angle. **Maximum** stiffness reduces wrapping angles and preserves large map areas. **Minimum** stiffness increases wrapping angle of the wrap map for greater curvature. The default position is Normal.

Preview — This creates the wrap map and displays it as a chequerboard effect on the target object.

Next — The Curve Selection page (see page 160) of the Unwrap Wizard is displayed.

Unwrap Wizard - Curve Selection

Use this page to choose the types of curve to be unwrapped.



Dependent curves — This unwraps the dependent curves. These are curves that have a relationship with a surface.

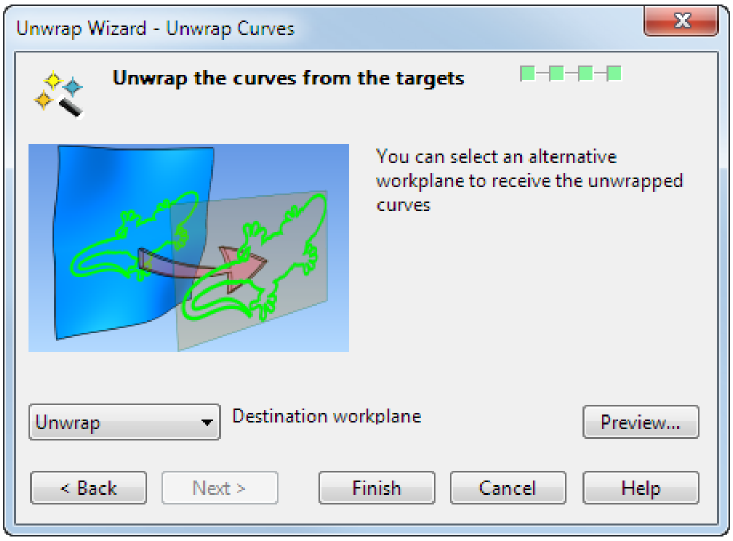
Trim boundaries — This is the defining outer edge of the target object.

Patch boundaries — This unwraps the internal laterals and longitudinals that are displayed visibly on the surface.

Next — The Unwrap Curves page (see page 161) of the Unwrap Wizard is displayed.

Unwrap Wizard - Unwrap Curves

Use this page of to preview and finish the unwrap.



Select the destination workplane for the unwrapped curve from the following:

Unwrap — This is the default workplane.

World — Refers to the world workplane. The curves will be positioned relative to the world workplane when it is unwrapped from the target object.

Preview — This unwraps and positions the curves on the selected workplane. This enables the unwrapped curves to be modified and then wrapped back onto the target object using the Rewrap Wizard.

Finish — Completes the unwrapping process.

Using the Rewrap Wizard

When a surface is unwrapped and the additional design has been added, you rewrap the curves, symbols or triangles onto surfaces or solids.

Use the following menu options to **rewrap** the items specified:

- Use the **Wrap**  button on the Curve toolbar to rewrap wireframe items.
- Use the **Wrap Triangles**  button on the Surface toolbar to rewrap symbols or DMT files and to rewrap a triangle file onto a surface or solid.

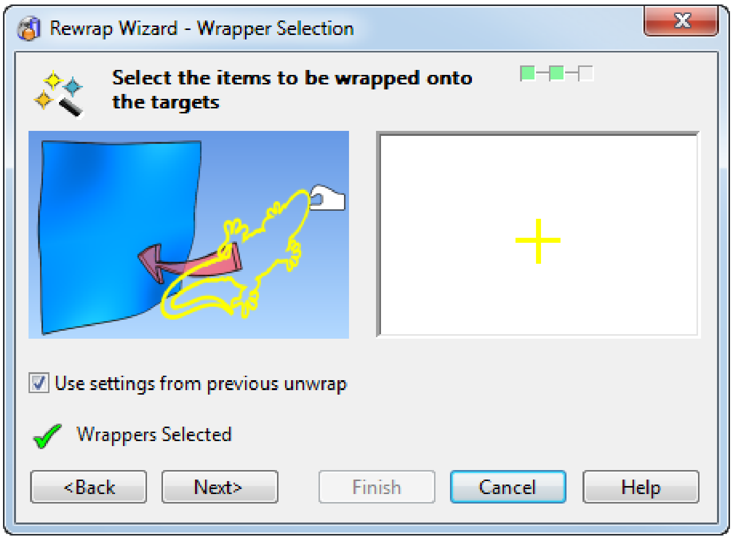
A selected surface that has previously been unwrapped is recognised automatically when you start the **Wrap Wizard**. The Wrap Wizard turns into the **Rewrap Wizard** and takes you through the Wrap Wizard pages to **rewrap** the item onto the target object.

You cannot rewrap onto a solid using the Solid Wrap option on the Feature menu, because the solid feature is not created. To rewrap onto a solid, use the Wrap Triangles option on the Surfaces menu.

For further details, see What is Wrapping? (Surface modelling manual).

Rewrap Wizard - Wrapper Selection

Select the items to be rewrapped onto the target object. The **Rewrap Wizard** pages are the same as the **Wrap Wizard** pages and guide you through the rewrap process.

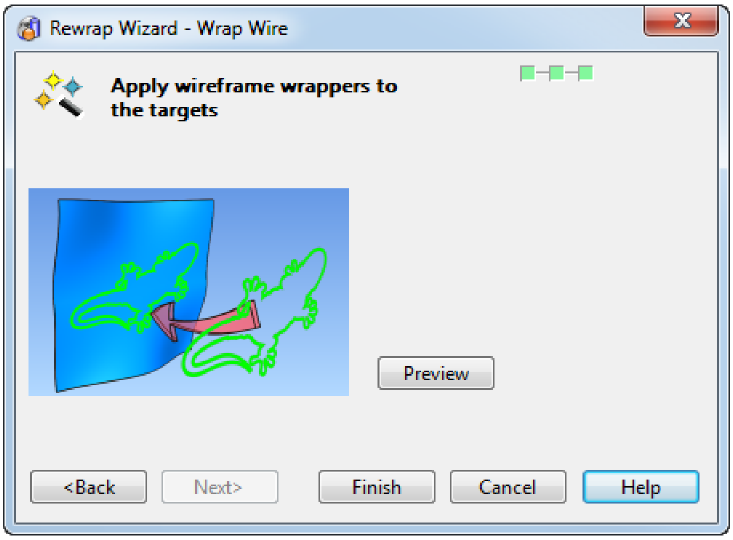


Use settings from previous unwrap — This option is selected automatically if the selected surface or solid has been unwrapped previously.

For further details, see What is Wrapping? (Surface modelling manual).

Rewrap Wizard - Wrap Wire

If you are rewrapping wireframe objects, this page is where you apply the wrapper to the target object.



Preview — Select to preview the results of the rewrap.

Finish — This completes the rewrap process.

The Rewrap Wizard pages are the same as the Wrap Wizard pages and guide you through the rewrap process.

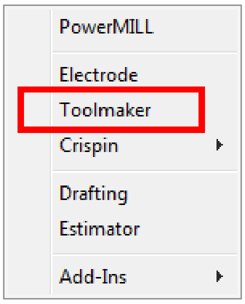
For further details, see What is Wrapping? (Surface modelling manual)..

Creating a Trimline

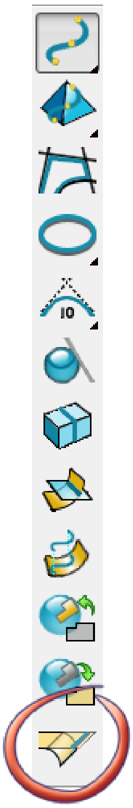
This option is available only in Toolmaker mode.

You can create a **Trimline** using the option on the **Curve** toolbar.

1 With PowerSHAPE running, click **Module > Toolmaker**.

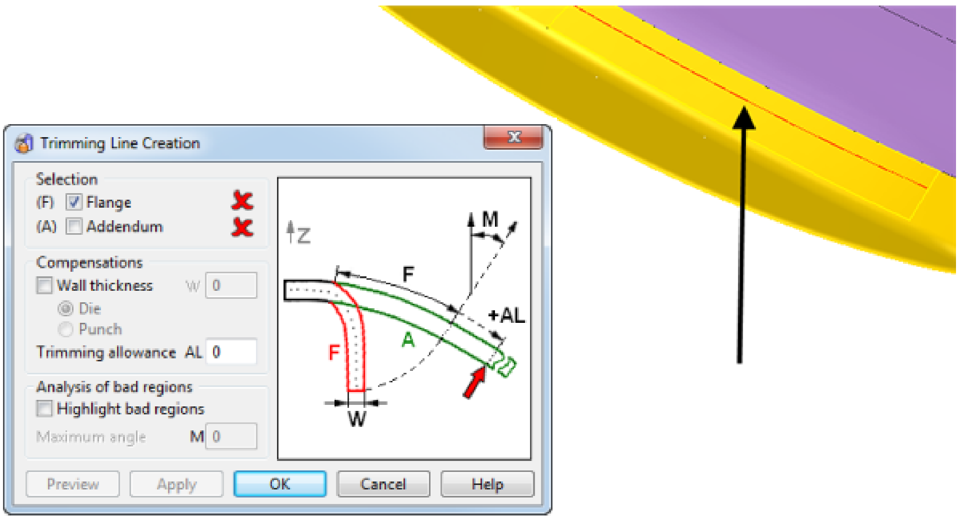


2 Select **Curve**  from the main toolbar. The curve toolbar is displayed.



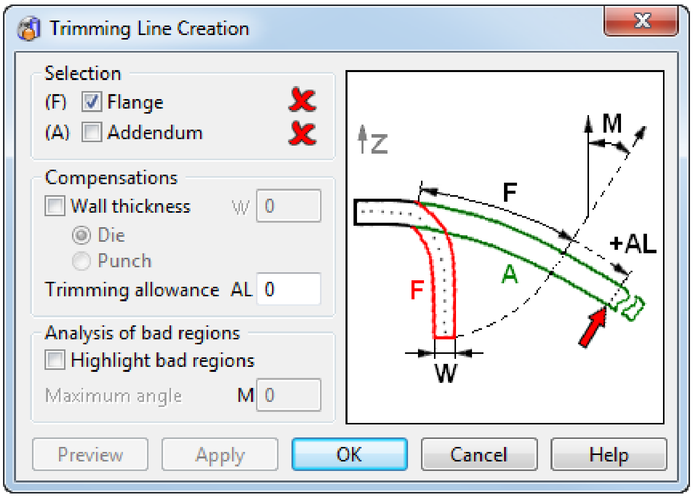
3 Select **Trimline**  from the curve toolbar to display the Trimming Line Creation dialog (see page 165).

4 Use the options in the dialog to create the trim line.



Trimming Line Creation dialog

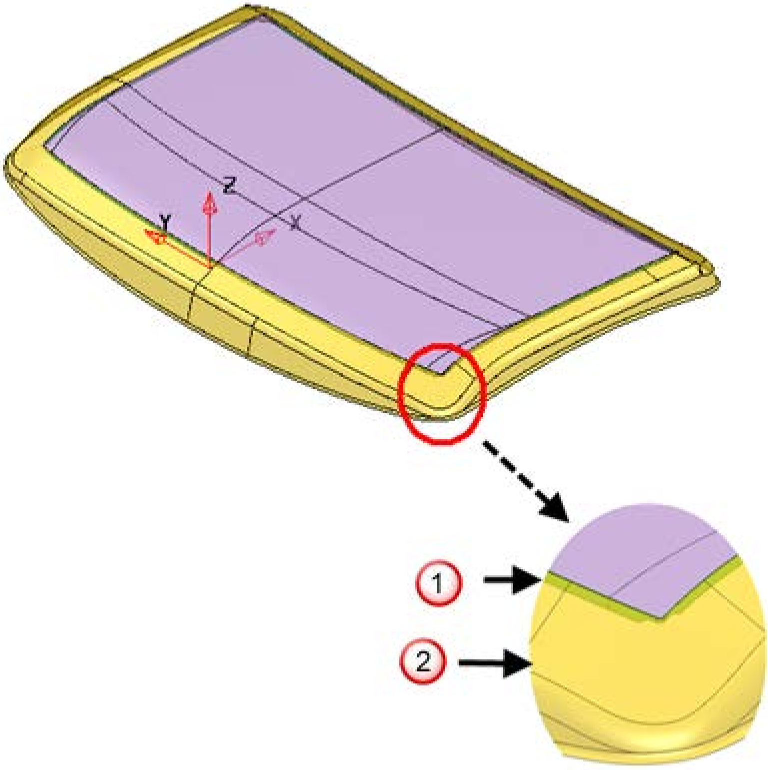
You can use this dialog to apply appropriate options to the selected flange and addendum surfaces



Selection

Flange - Select the flange surface (F). The cross icon changes to a tick icon.. On the model below, this surface is indicated by 1. If the flange surface contains holes, the trimming lines of these holes will be created as composite curves.

Addendum - Select the addendum surface (A). The cross icon changes to a tick icon.. On the model below, this surface is indicated by 2



Compensations

The values set in this section are incorporated into the calculation of the Trimline.

Wall thickness - Thickness of the flange. If *ON*, the thickness (**W)** will be used when calculating the Trimline.

Die - If *ON*, the wall thickness applies when you are creating a die.

Punch - If *ON*, the wall thickness applies when you are creating a punch.

Trimming Allowance - Additional allowance to ensure that there is sufficient metal to create the required flange surface.

Analysis of bad regions

Highlight bad regions - If *ON*, trim lines that are on a slope that is too steep will be highlighted. The slope of the addendum surface where the Trimline is created should be as gentle as possible.

Maximum of good angle - If **Highlight bad region** is *ON*, you can enter an angle. Any Trimline that is created on a slope that is steeper than this angle will be highlighted.

Editing a curve

Edit curves, composite curves, and surface curves using one of the following methods.

- Select the curve.

  Select a point on the curve to display its graphical handles. Use the following menus to select one of the various graphical handles:

  - **Edit > Surface and Curve Edits > Common Edits > Selected Point Graphical Handles**
  - Curve point context menu

  Use its graphical handles to edit the curve.

  Select multiple points. Any edits that apply to a particular point are carried out on all the selected points. If no points are selected, then the edits are carried out on all the points.

- You can reposition the points on the curve.

  With a curve selected, choose one of the following options from the **Edit** menu.

  Edit > Convert > To wireframe breaks a composite curve into its individual wireframe objects.

  Edit > Modify displays the **Curve edit** toolbar.

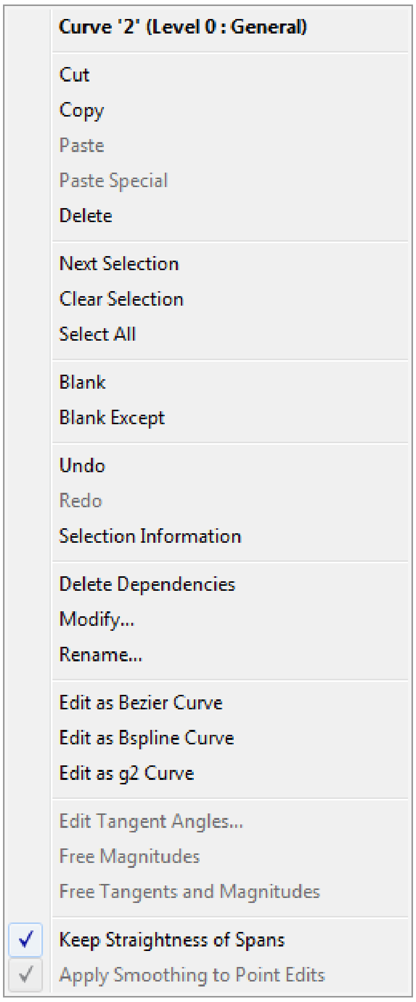
Edit > Surface and Curve Edits > Curve edits > Delete Dependencies removes any dependencies from a curve or composite curve.

- Double-click the curve to display the **Curve edit** toolbar (see page 181). Commands on this toolbar can also be reached via **Edit > Surface and Curve Edits > Curve Edits**.

  If a curve can be edited as a B-spline curve, the **Edit as Bezier or B-spline**  button is available on the **Curve edit** toolbar.

  If it can be edited as a G2 curve, the **G2 Edit**  button is available on the **Curve edit** toolbar.

- Right-click the curve to display the edit options available for curves. The name of the curve and the level on which it lies is at the top of the menu.



The following options are unique to the curves:

Delete Dependencies — When a curve or composite curve is created on an object (for example, a surface), it may be dependent upon that object. This option removes any such relationships that may exist between the curve and other objects.

Edit as a Bspline Curve — If a curve can be represented in B-spline form, this option lets you to edit it using the B-spline handles or as a Bezier.

Edit Tangent Angles... — This displays the **Tangent Editor** dialog, which lets you to edit the tangent directions and magnitudes of curves.

Free Magnitudes — This frees tangent magnitudes through selected points along a curve. If no points are selected, the whole curve is freed.

Free Tangents and Magnitudes — This frees the tangent directions and magnitudes through selected points along a curve. If no points are selected, the whole curve is freed.

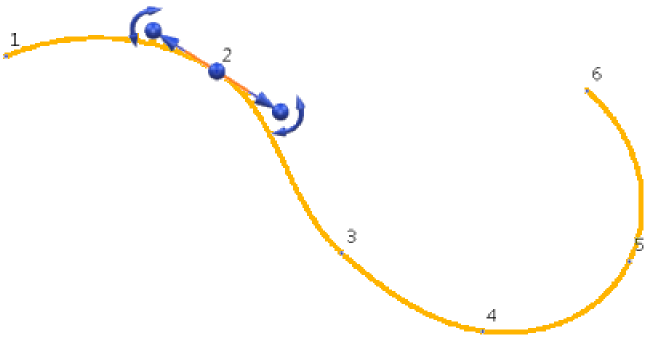
The menu for composite curves contains an additional option:

Convert to Wire — This breaks a composite curve into its individual wireframe objects.

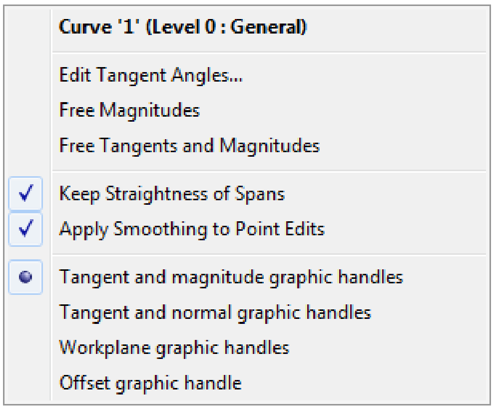
Graphically editing curves

To graphically edit a curve.

1. Select a curve.
2. Select a point on the curve to display its default handles.



3 Right-click on the point to display the curve point menu.



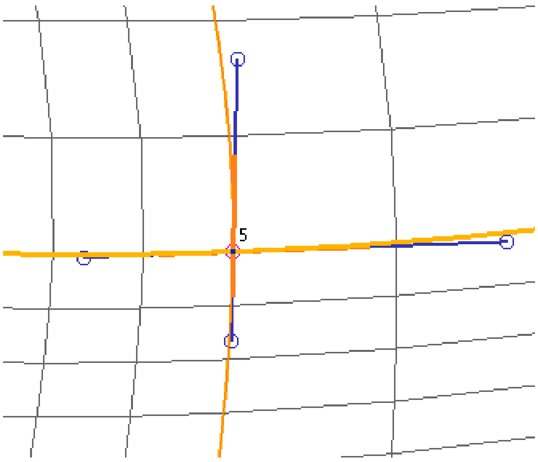
4 Select one of the following handles:

- **Tangent and magnitude graphic handles** (see page 170).
- **Tangent and normal graphic handles** (see page 171).
- **Workplane graphic handles** (see page 173).
- **Offset graphic handle** (see page 174).

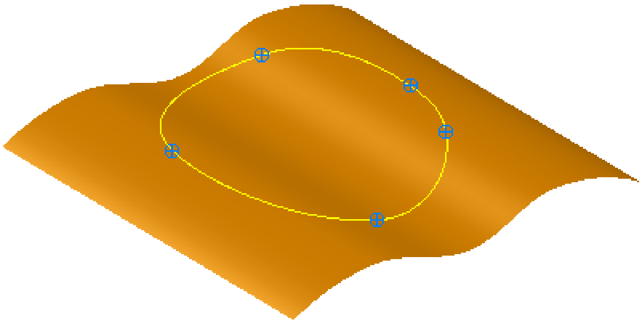
Use these handles to:

- move the point.
- insert new points on the curve.
- edit the properties of the curve either side of the point.

When editing surface curves, graphical handles are present for both the laterals and longitudinals at the selected point.



Dependent curve points on a curve are drawn with a large crossed circle instead of a small circle.



5 Select any handle and drag it to a new position.

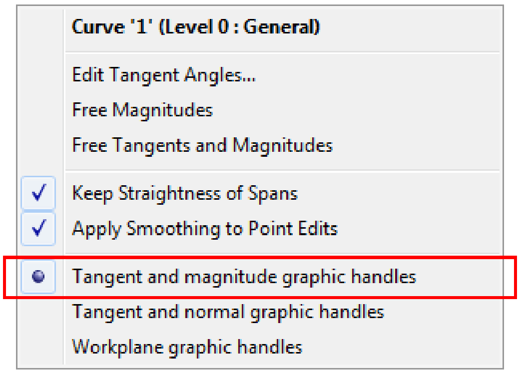
You can graphically edit multiple points simultaneously by selecting multiple points and using the graphic handles as you would for single curve points.

Tangent and magnitude graphic handles

1 Select a point on the curve.

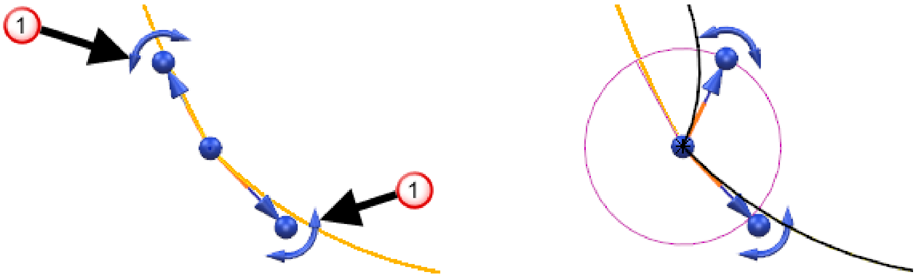
2 To display the context menu  the point.

3 Select Tangent and magnitude graphic handles from the context menu.

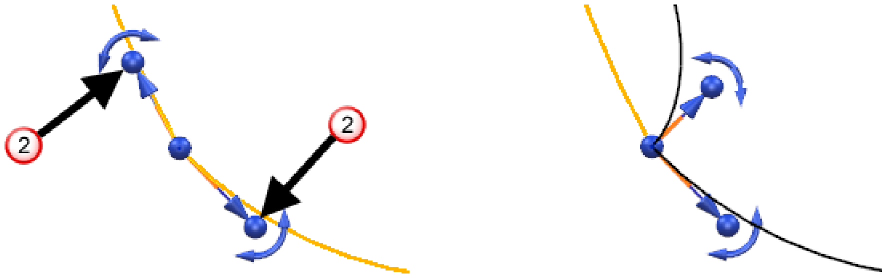


4 To edit the curve  the various handles:

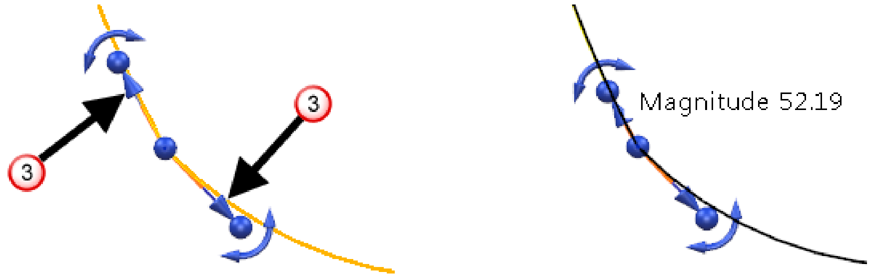
- Use the arced handles  to modify the tangent angle of the curve, without changing the magnitude. A circle is drawn in a fixed plane relative to its starting position.



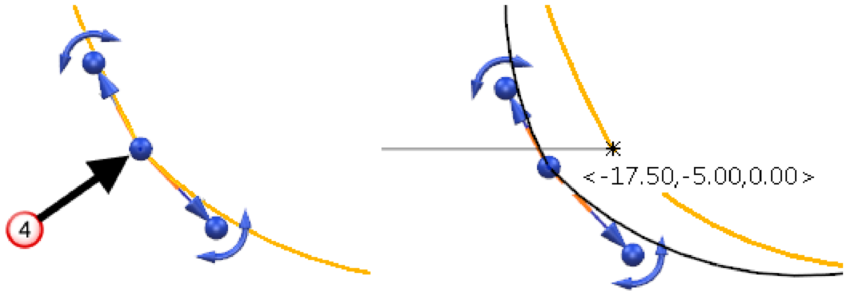
- Use the spherical handles 2 to freely modify the magnitude of the curve in any direction.



- Use the arrow tip handles 3 to modify the magnitude of the curve along the fixed tangent.



- Use the centre handle 4 to move the curve point freely.



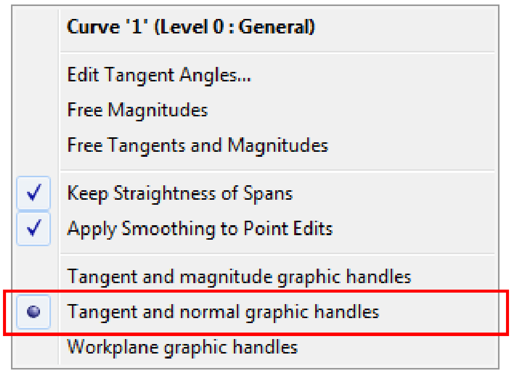
Moving the cursor over a handle highlights the handle, indicating that you can move it.

Tangent and normal graphic handles

1 Select a point on the curve.

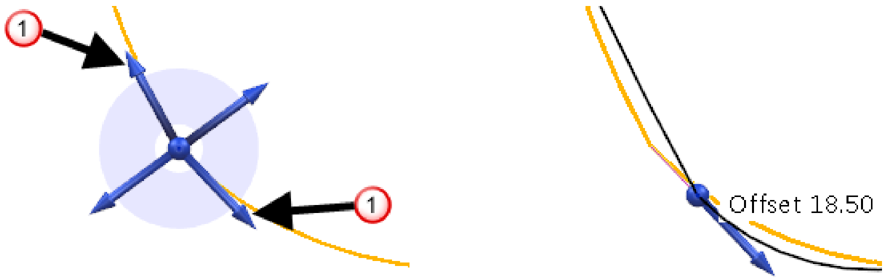
2 To display the context menu  the point.

3 Select **Tangent and normal graphic handles** from the context menu.

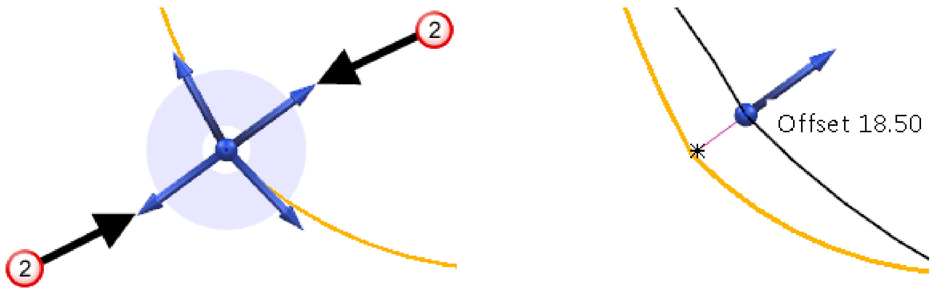


4 To edit the curve, drag the various handles:

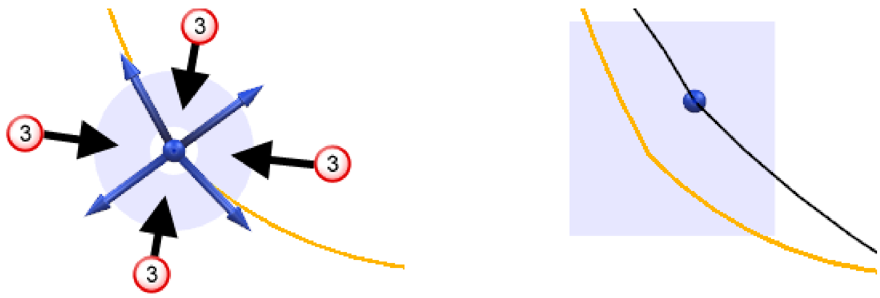
- Use the arrow handles *tangent* to the curve 1 to move the point, in a fixed direction, along the tangent.



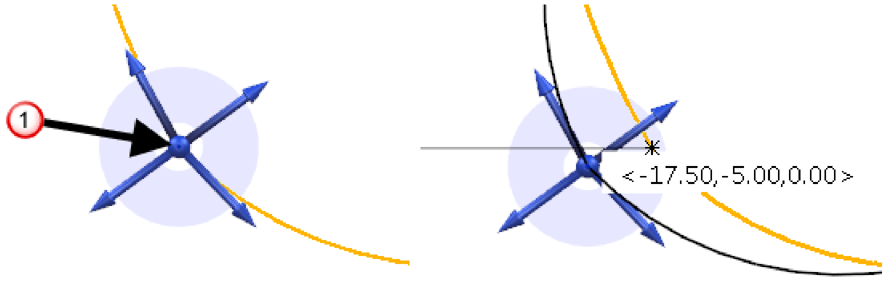
- Use the arrow handles *normal* to the curve 2 to move the point, in a fixed direction, along the normal.



- Use the planar handles 3 to move the point across a 2D plane.



- Use the centre handle 4 to move the point freely.



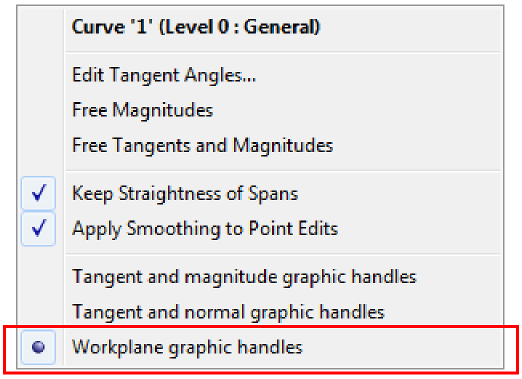
Moving the cursor over a handle highlights the handle, indicating that you can move it.

Workplane graphic handles - curves

1 Select a point on the curve.

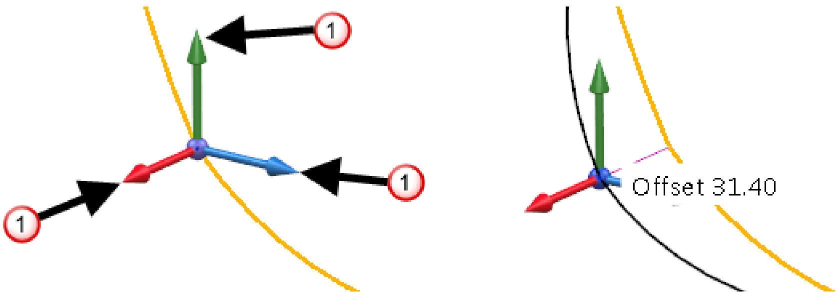
2 Right-click on the point to display the Curve point menu.

3 Select **Workplane graphic handles** from the context menu.

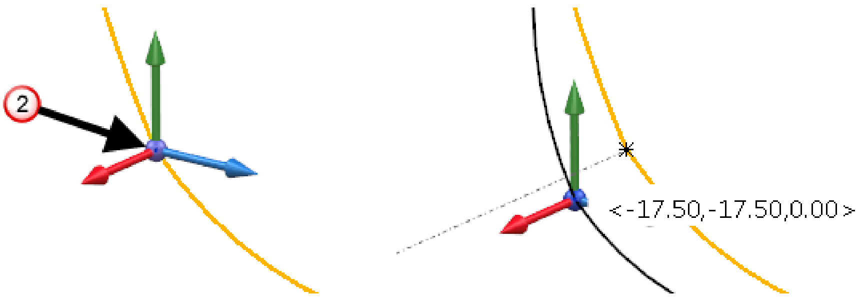


4 To edit the curve, drag the various handles:

- Use the workplane arrow handles 1 to move the point along a fixed axis.



- Use the workplane centre handle 2 to move the point freely.



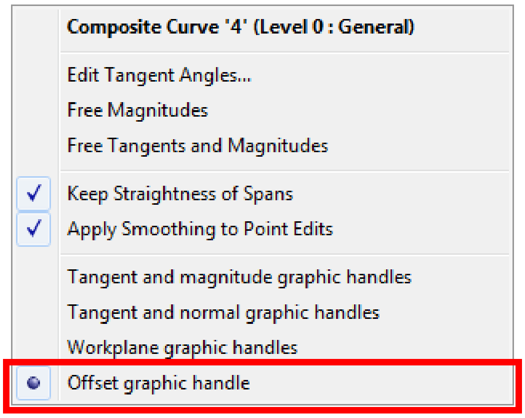
Moving the cursor over a handle highlights the handle, indicating that you can move it.

Offset graphic handle

Use the **Offset graphic handle** to graphically modify a single wireframe curve, or composite curve, point.

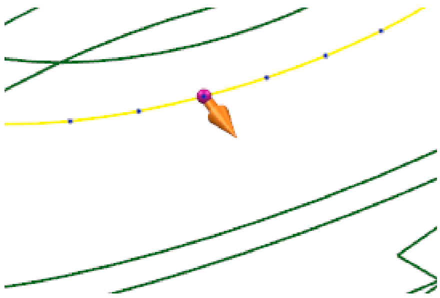
1 Select a point on the wireframe.

2 Right-click the point and select **Offset graphic handle** from the **Curve** or **Composite Curve** context menu.

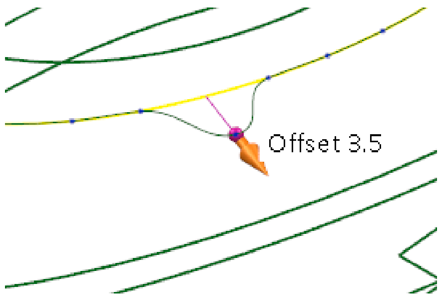


3 Click and drag the handle to edit the wireframe:

Before



After



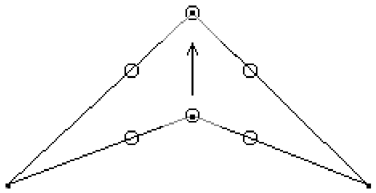
The point is offset a set distance away from its original position.

Moving the cursor over a handle highlights the handle, indicating that you can move it.

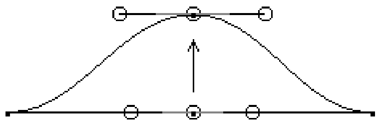
Moving points

When you drag the handle for the position of a point, the point moves in a plane through itself where the plane is parallel to the principle plane of the current workspace.

If spans are straight on either sides of the point and not collinear, they are still straight when the point is moved.



If spans are straight on either side of the point and collinear, tangent continuity is preserved through the point.



If the point is on a surface, you can hold down the **Shift** key and drag it along the laterals and longitudinals on the surface. The tangent handles change to reflect the tangents on the surface as the point is moved. This results in the surface changing shape far less.

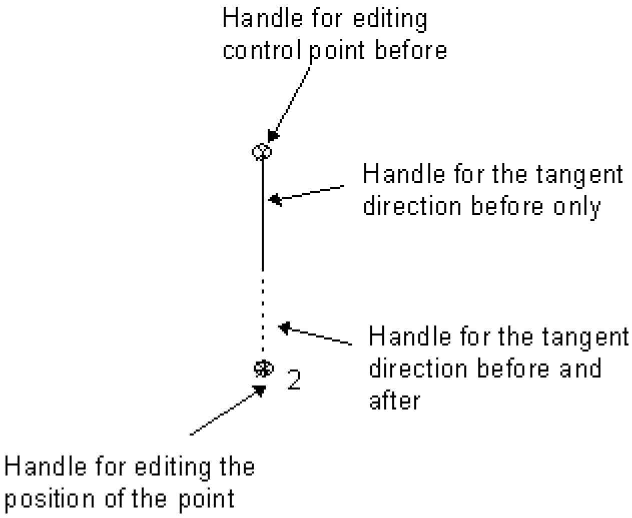
Inserting new points

If you press and hold the **Ctrl** key and drag the handle for the position of a point, a new point is inserted onto the curve. If the point is on a surface, a new curve is added too.

Editing the tangent direction and magnitude

The handles for the control points edit both the tangent directions and magnitudes of the curve. When you drag these handles, the magnitude value is displayed on the screen. To edit only the magnitude, drag the handle so that it does not waver more than 5° either side of the original direction. Deviations greater than this cause the tangent direction to change too.

If you look closely at the tangent direction handle, which is the line between the curve point and the control point, you will notice that it is two colours.



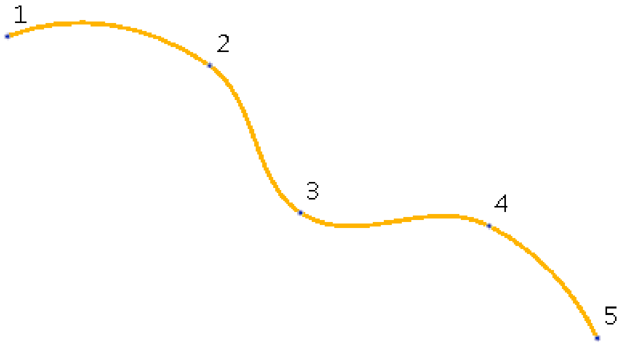
The half nearest the control point edits only the tangent direction before (or after) the point, whereas the other half edits both the tangent direction before and after. When these handles are dragged, the magnitude remains constant.

If you click or drag the handle for the tangent direction before and after, then the tangent direction handle on the other side of the point is forced to line up with the selected handle.

Graphically selecting points on a curve or power surface

Select the curve or power surface and display its points. When you select a curve, its points are not labelled by default. The points are labelled here to identify individual points.

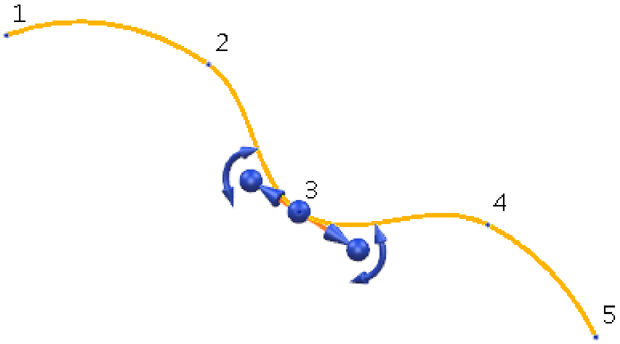
You can label points on curves by selecting the **Point labels**  button on the Curve Edit toolbar.



The following methods can be used to select points:

- Clicking a point selects it and displays its graphical handles.

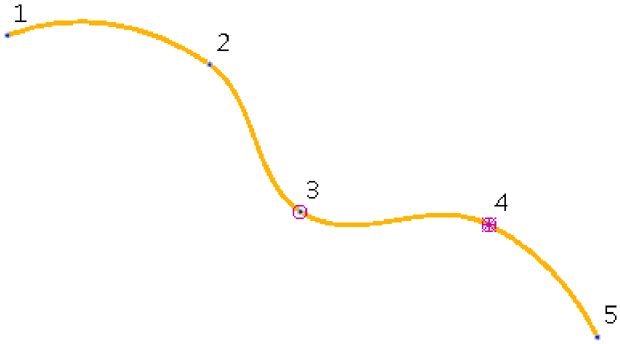
Click point 3 to select it and display its graphical handles.



- **Shift** + **click** adds a point to the selection.

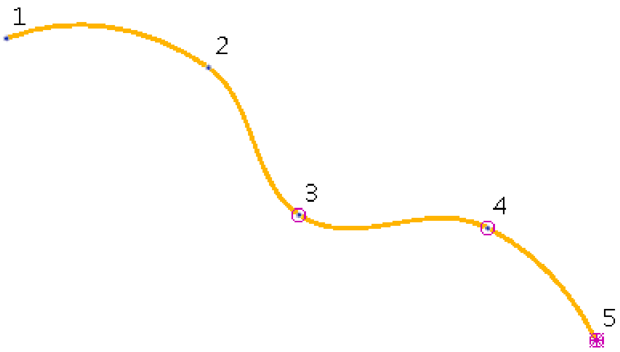
The last point selected is used when moving the points in world workspace.

If we now **Shift** + **click** point 4, it is marked with a star enclosed in a circle to show that it is the last point selected. Point 3 no longer displays its graphical handles and is marked with a circle to show that it is selected.



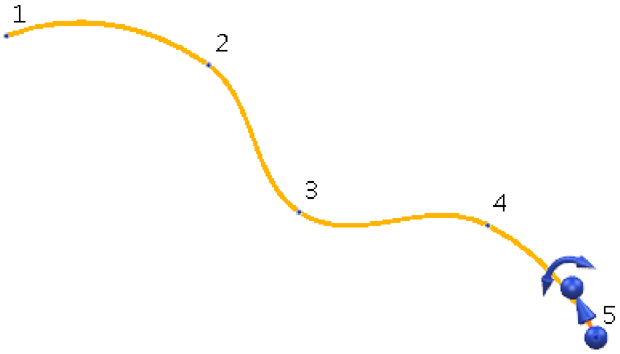
- **Ctrl** + **click** - removes a point from the selection if is already selected, otherwise it is added to the selection.

If we **Ctrl** + **click** point 5, it is added to the selection. It is now marked as the last point selected and point 4 is marked with a circle to show that it is still selected.



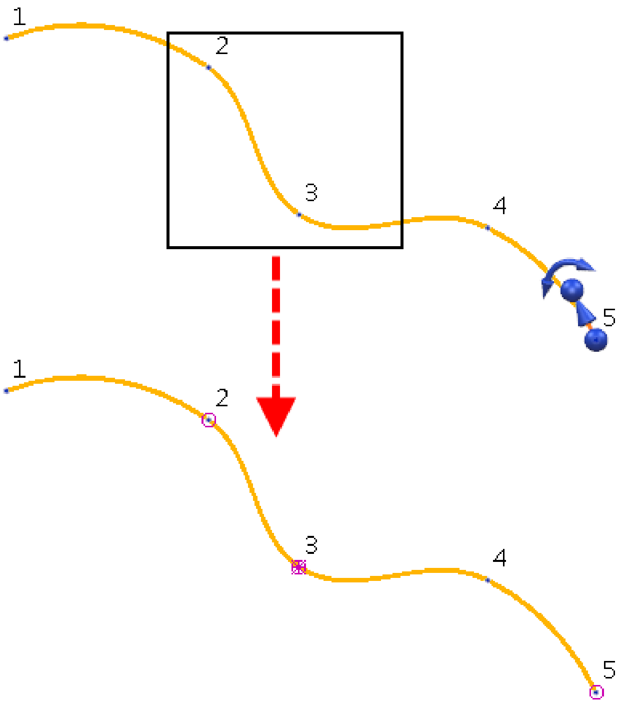
- **Shift** + **Ctrl** + **click** removes a point from selection.

Use **Shift** + **Ctrl** + **click** to remove points 3 and 4 from the selection. Since point 5 is the only point selected, it displays its graphical handles.



- You can similarly use the **Shift** and **Ctrl** modifier keys with box selection to add and remove points from the selection.
- Pressing the **Shift** key and box selecting any part of the curve or power surface adds any points within the box to the selection.

  Press the **Shift** key and box select points 2 and 3.

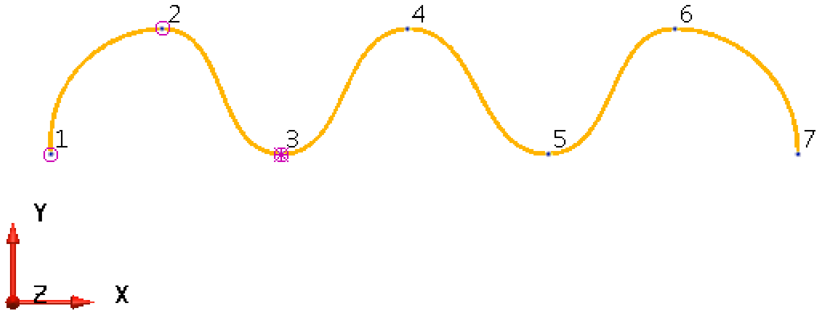


  One of the points in the box selection becomes the last point selected. In this case, point 3 has become the last point selected.
- Similarly, pressing the **Ctrl** and **Shift** keys at the same time and box selecting removes points from the selection.

If you use the Shift and Control modifier keys and box select objects other than the selected curve or power surface, nothing happens. If you want to select other objects, you must first ***Shift*** *+* ***click*** *any one of the other objects.*

Moving points

1 Select one or more points on the curve or power surface.



The last point selected is used when moving the points in world and workplane workspace.

To change the last selected point, **Ctrl + double-click** another point in the selection.

In this example, point 3 is the last selected point.

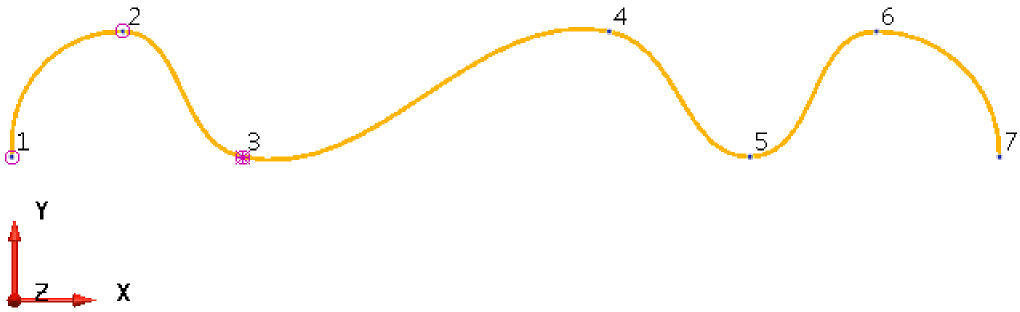
2 Click the **Position** button to display the **Position** dialog.

3 Use the **Position** dialog to edit the position of the points.

On the **Position** dialog, you can choose the **Workspace** as world, workplane or relative.

If you choose world or workplane, the last selected point moves to the new position you define on the **Position** dialog. All the other points move by the same distance the last selected point moves.

Enter the values **-50 0 0** in the **Position** dialog. Point 3 moves to position **-50 0 0** and the other points follow.



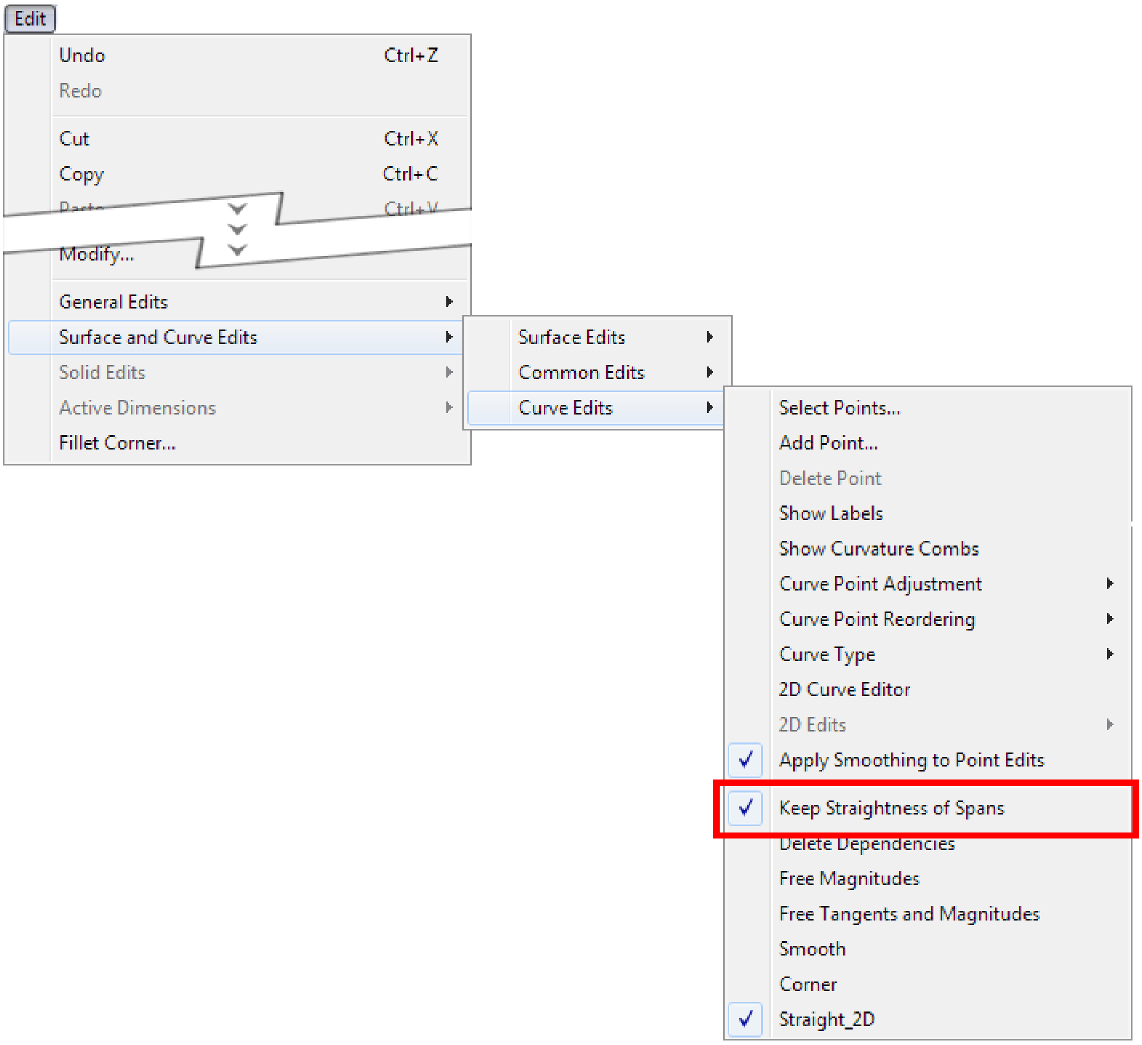
If you choose relative, then the new position you define on the **Position** dialog defines the relative distance for all the points to move.

If spans are straight on either side of the point and not collinear, they are still straight when the point is moved. If spans are collinear too, tangent continuity is preserved through the point.

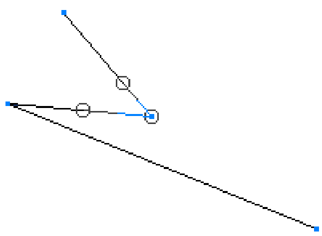
Keeping straightness of spans

The **Keep straightness of spans** option is available from:

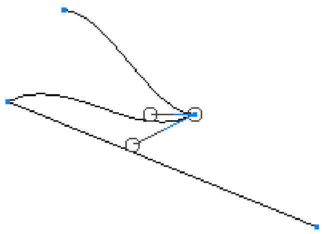
- The Curve Edit context menu.
- The **Edit** menu as shown below. It enables you to keep a span straight when you edit a point.



If the **Keep straightness of spans** option is selected and you edit a point that is at the end of a straight span, the straightness of the span is preserved.



If the **Keep straightness of spans** option is deselected the straightness of the span is not preserved.

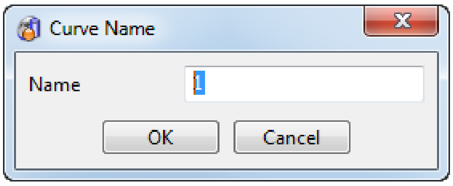


If three points are collinear and you edit the middle point, the straightness is never preserved.

Renaming a curve

By default, each curve is given a unique number. You can change this to a name of your choice in the same way as you can for other objects.

1. Select a curve.
2. Select **Rename** from the context menu or from **Edit > Surface and Curve Edits > Common Edits**. The **Curve Name** dialog is displayed.

3. In the **Name** text box, type the new name for the curve.
4. Click **OK**.

Using the Curve Edit toolbar

1. Select a curve to display the Curve Edit toolbar.

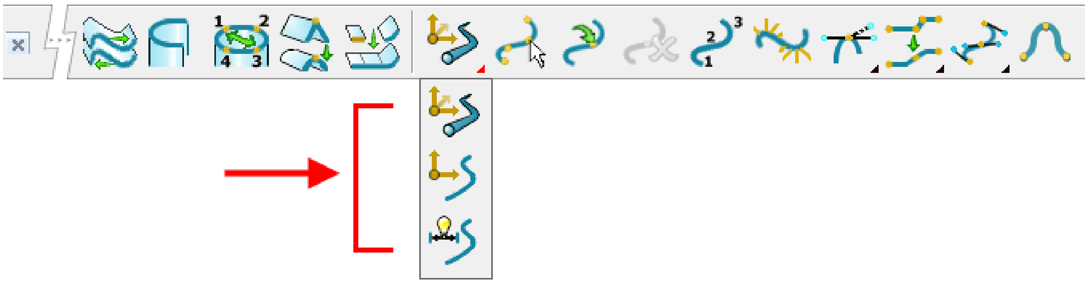
   The options that are available are grouped to reflect the type of curve you have selected and the type of curve editing you are doing.

2. Select the mode of curve editing from the flyout . This determines the appearance of the Curve Editing toolbar. The following modes are available:

    **Edit the curve in 3D** (see page 182) (default). This contains the main curve editing functionality

    **Edit the curve in 2D** **(see page 217)**

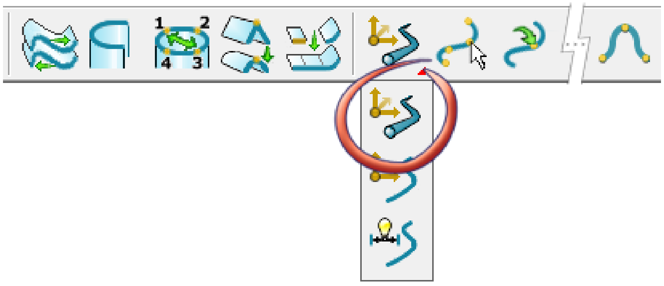
 **Edit the curve using active dimensions** (see page 224). The active dimension options from curve editing toolbar in the previous version are available in this mode.



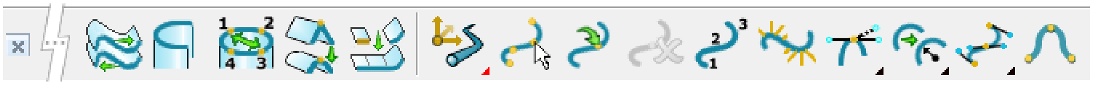
3 Select the editing option required.

Editing a curve in 3D

1 Select the **Edit the curve in 3D**  button on the Curve Edit toolbar.



2 The **3D Curve Editing** toolbar is displayed. The buttons that are active on the toolbar below depend on the type of curve you are editing.



3 Edit the curve using the options below.

 **Reverse** (see page 199) — Click this button to reverse the curve.

 **Close** (see page 202) — Click this button to close the curve.

 **Open** (see page 201) — Click this button to open the curve.

 **Renumber points** (see page 200) — Click this button to renumber the curve points.

Spline (see page 202) — Click this button to spline the curve.

Join (see page 212) — Click this button to join two curves.

Select points (see page 184) — Click this button to select points on a curve.

Create point (see page 185) — Click this button to create a curve point.

Delete point (see page 185) — Click this button to delete a curve point.

Label points (see page 198) — Click this button to label curve points.

Curvature combs (see page 198) — Click this button to create curvature combs.

Tangent angle (see page 190) — Click this button to edit the tangent angle.

Fine tune (see page 214) — Click this button to fine tune the curve.

G2 edit (see page 96) — Click this button to edit a G2 curve.

Merge and spline (see page 204) — Click this button to merge and spline a curve.

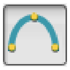
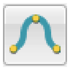
Fit arcs to curves (see page 204) — Click this button to fit arcs to a curve.

Arc fitting (see page 205) — Click this button to fit arcs and lines to planar curves.

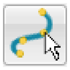
Repoint (see page 207) — Click this button to repoint a curve.

Edit as Bézier (see page 214) — Click this button to edit the curve as a Bézier curve.

 **Edit as B-spline** (see page 214) — Click this button to edit the curve as a B-spline curve.

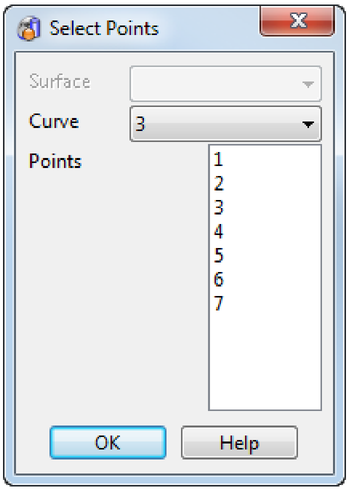
  **Smoothing** (see page 216) — Use this toggle button to control smoothing.

Selecting a point on a curve

1. Select the curve.
2. If you are selecting points on surfaces, select all the curves from which you want to select points.
3. Click  from the **Curve Edit** toolbar.
4. Use the **Select Points** (see page 184) dialog to select points.

Select Points dialog

This selects points on curves.



Surface - (Only valid for surface curves) This is name of the surface whose curves are displayed in the **Curve** list. You can select another surface and its selected curves are displayed in the list of curves.

Curve - This is the name of the curve whose points are displayed in the **Points** list. You can select another curve and its points are displayed in the list of points.

Points - These are the points on the curve named in the **Curve** selector. You can select points from the list by clicking to select single points, **Shift** + **click** to add a point to the selection and **Ctrl** + **click** to toggle a point from the selection. Selected points are highlighted on the screen.

When you choose another surface or curve from the selector, PowerSHAPE remembers the selected points of the previously selected surfaces.

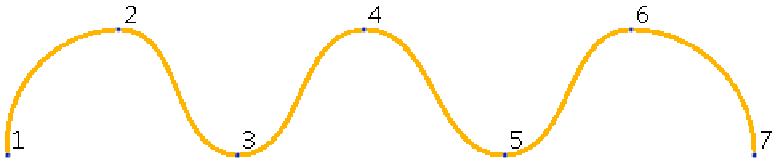
OK - Removes the dialog from the screen. You can keep the dialog displayed while you edit the points.

You can also graphically select multiple points.

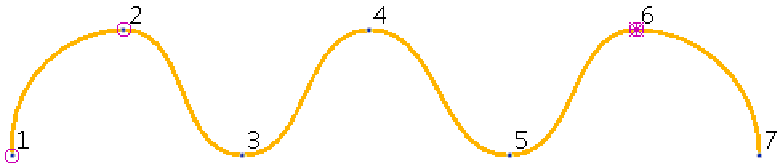
Deleting points on a curve

To delete points on a curve:

1 Select a curve to display the points.

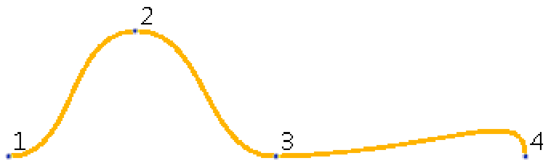


2 Select one or more points on the curve.



3 Click  (*Curve edit toolbar*).

The selected points are deleted and the remaining points on the curve are renumbered.

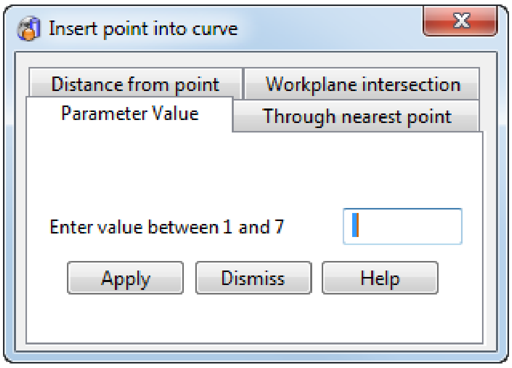


If all the points are selected except one, then no points are deleted.

Creating a point on the curve

1 Click  (*Curve edit toolbar*).

2 Use the **Insert point into curve** dialog to insert a new point into the curve.



The following methods are available:

- **Parameter value** (see page 186)
- **Through nearest point** (see page 187)
- **Distance from point** (see page 188)
- **Workplane intersection** (see page 188)

Apply - Inserts a new point in the curve.

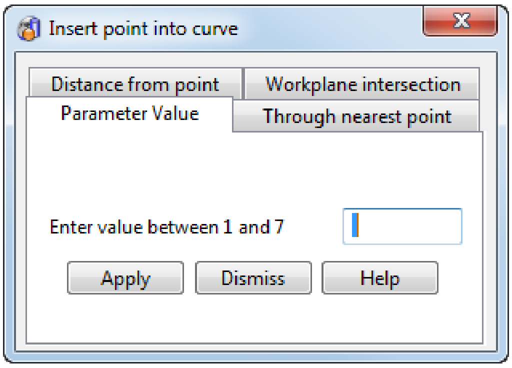
OK - Removes the dialog from the screen.

When you insert points in B-spline curves, the shape may change significantly.

Insert point into curve - Parameter value

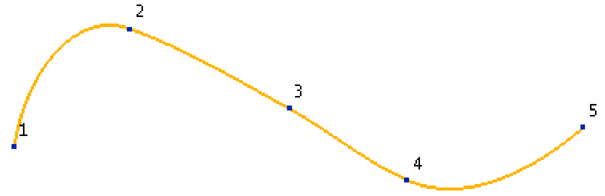
This inserts a point at a specific parameter value.

When the **Parameter Value** tab is selected, the **Insert point into curve** dialog displays the following page.



Value - Input the parametric value of where you want the new point to lie.

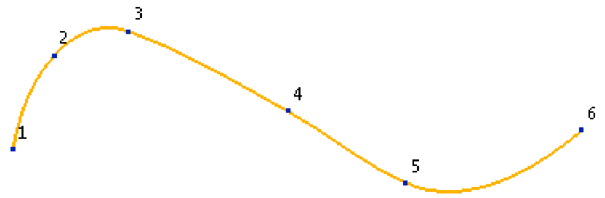
Suppose we wanted to add a new point half way between points 1 and 2.



We input a **Value** of 1.5. This is the parametric value half way between points 1 and 2.

Apply - Inserts the new point. This also renumbers the other points to reflect the change.

In our case, a new point is added halfway between points 1 and 2. This point is numbered 2 and point 2 has become point 3. Point 2 now becomes the selected point.

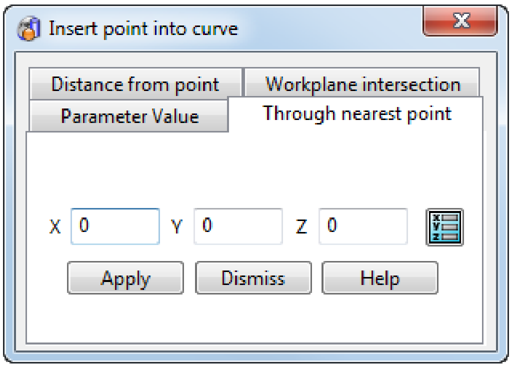


If you want to add another point halfway between 3 and 4, you need to enter 3.5. The points are then renumbered.

Insert point into curve - Through nearest point

This inputs a point on the curve nearest a specified point.

When the **Through nearest point** tab is selected, the **Insert point into curve** dialog displays the following page.



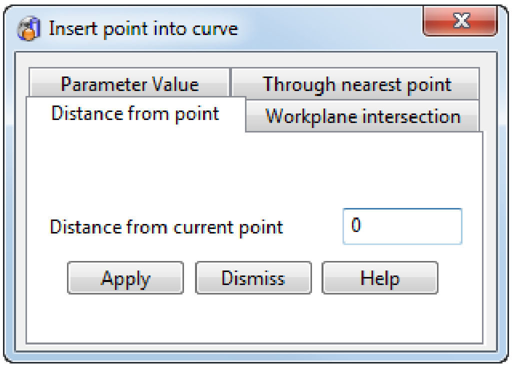
Enter the **X Y Z** coordinates or click the **Position**  button to open the **Position** dialog where you can use position entry tools.

Apply - Inserts the new point on the curve. This also renumbers the other points to reflect the changes.

Insert point into curve - Distance from point

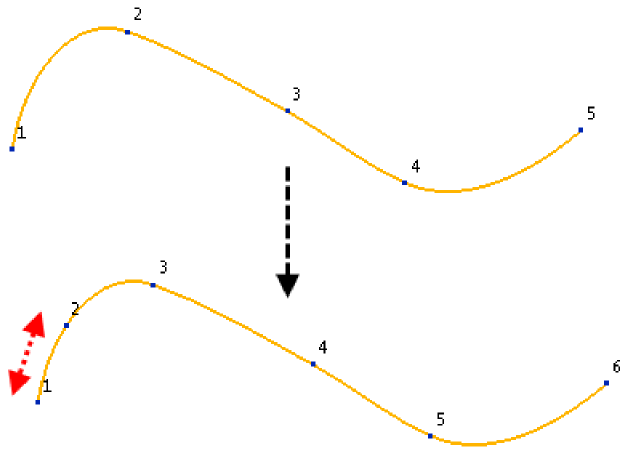
This inputs a point on the curve at a specified distance from the currently selected point. If no point is selected then point 1 is used.

When the **Distance from point** tab is selected, the **Insert point into curve** dialog displays the following page.



Distance - Input the distance from the current point where you want the new point to lie.

To add a new point 10 units from point 1, input the **Distance** as 10.



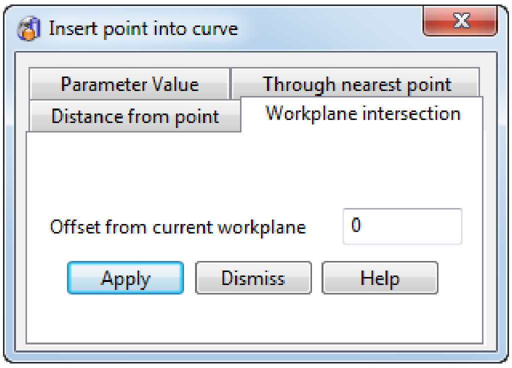
Apply - Inserts the new point. This also renumbers the other points to reflect the change.

The new point becomes the current point.

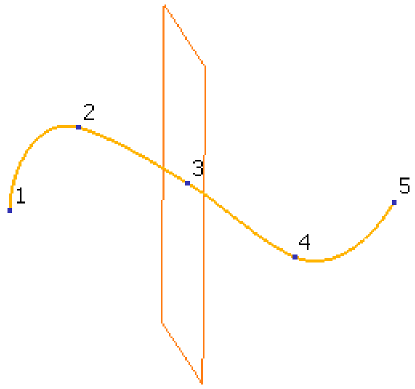
Insert point into curve - Workplane intersection

This inserts a point where the principal plane of an active workplane intersects a point.

When the **Workplane Intersection** tab is selected, the **Insert point into curve** dialog displays the following page.



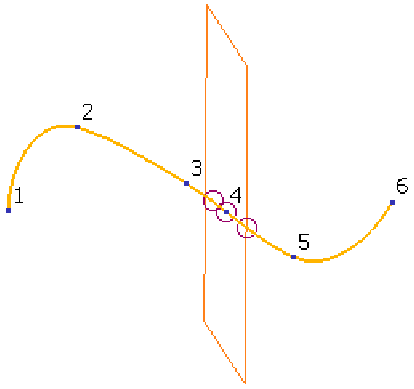
The YZ plane of the active workplane is displayed as intersecting the curve at point 3.



Offset - Enter a value from the workplane where you want the new point to lie on the curve. The plane graphic updates to show the new value.

Apply - Inserts the new point. This also renumbers the other points to reflect the change.

In the example below, an offset value of 20 was entered. A new point is added where the YZ plane of the active workplane intersects at the offset point.



The new point is numbered 4 and the other points are renumbered.

Setting the position of the current point

1 Select a point on the curve.

2 Click on the status bar to display the Position dialog.

3 Use the dialog to edit the position of the selected point.

If you move a point that defines a straight span, the span remains straight.

Setting/freeing tangents at the selected points

1 Select a curve or points on a curve.

2 Click (*Curve edit toolbar*).

3 Use the Tangent Editor dialog (see page 190) to edit the tangents.

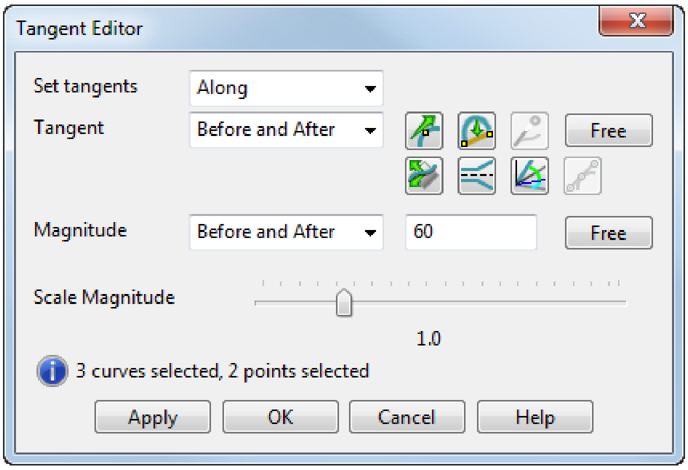
Tangent Editor dialog

Whilst the dialog is displayed, select the curves and curve points you want to edit using the following:

- graphical editing techniques.
- options on the **Surface/Curve Edit**toolbar 1.

Using the Tangent Editor dialog

Use this dialog to edit the tangents at the selected points.



Set tangents Along/Across curve - (Surface curves only) This allows the tangents at the selected points to be set along or across the curve in the current surface direction. For non-surface curves, this selector is fixed at **Along**.

Tangent editing works with multiple curve selections.

Tangent - Edits the tangent directions.

Choose one of the following to indicate which tangent direction you wish to edit:

- **Before and After**
- **Before**
- **After**

Seven buttons are provided to help you edit the tangent directions:

 - To set the tangent direction precisely, click this button to display the **Direction** dialog. Fill in this dialog with new direction values and press **OK**

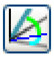
 - This straightens spans before or after the selected points. If a whole curve is selected, then all its spans are straightened. Surface curves are only straightened 'along' the surface.

 - If you choose **Tangent** as **Before** or **After**, then you may edit the position of the control point for that tangent. To do this, click this button to display the **Position** dialog. Fill in this dialog with new position data for the control point and press **OK**.

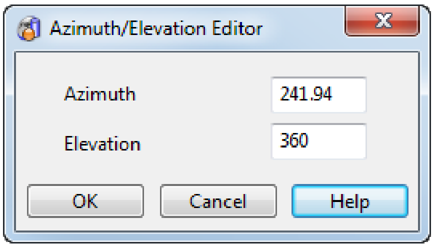
Free - This frees the tangent directions (before and after) to fit a smooth curve through each selected point. If tangent magnitudes are assigned, just the tangent directions are recalculated.

 - (Laterals/longitudinals only) To set the plane in which the tangent direction lies, click this button to display the **Direction** dialog. Fill in this dialog and press **OK**. This sets the plane's normal.

 - (Laterals/longitudinals only) To set the flare and twist angles, click this button to display the Flare/Twist Editor dialog (see page 195).

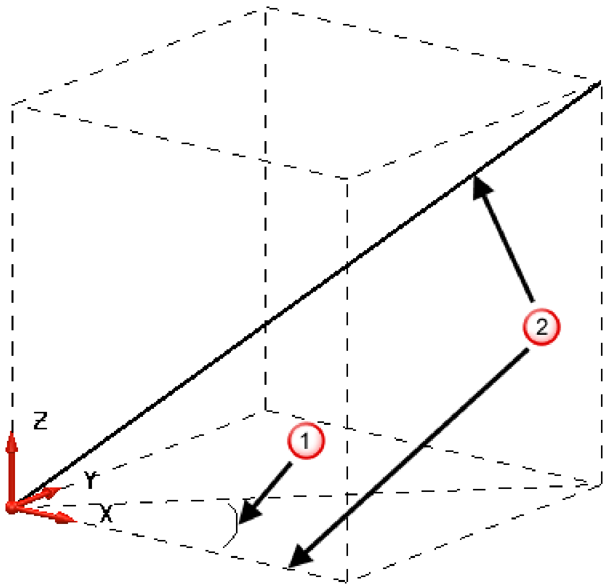
 - To set the azimuth and elevation angles, click this button to display the Azimuth/Elevation Editor dialog.

This edits azimuth and elevation angles on all curve points.



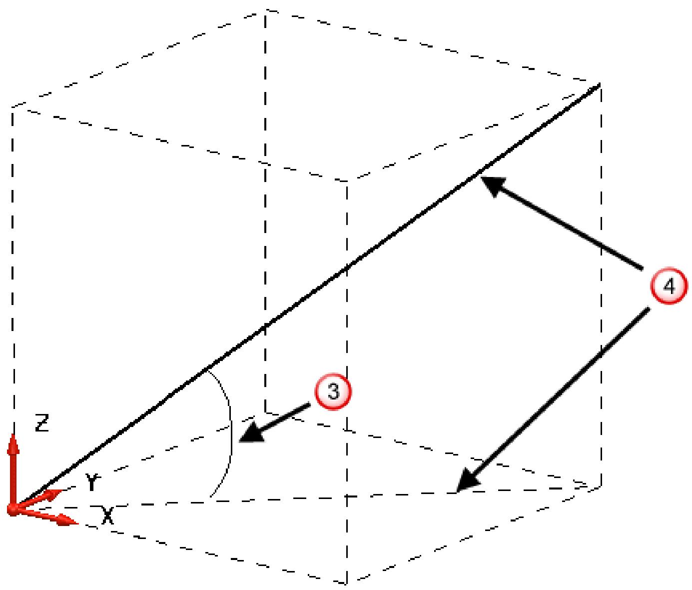
The azimuth and elevation angles are measured using the principal plane. To help explain azimuth and elevation angles, we will assume that the principal plane is the XY plane. Therefore, the Z axis is perpendicular to the principal plane.

Azimuth - If you look vertically downward onto the XY plane, the azimuth 1 is the angle made by the tangent of the curve and the X axis 2.



It can take any value in a 360° range, but you may find it easier to work with values in the range -180° to +180°. For example, azimuth angles of 270° and -90° are the same.

Elevation - The elevation angle 3 is the one between the tangent of the curve and the XY plane 4.



Elevation angles make sense only between 0° and 90°, and between 270° and 360°. You can enter any angle for elevation, it will be displayed as the equivalent angle between the two valid ranges. For example, if you enter a value of -45°, the elevation is displayed as 315° in the dialog.

If the elevation angle is 90° or 270° (that is along the Z axis), you cannot modify the azimuth angle.

 - Align the before and after tangents.

Magnitude - Edits the tangent magnitudes. Choose one of the following to indicate which tangent magnitude you wish to edit:

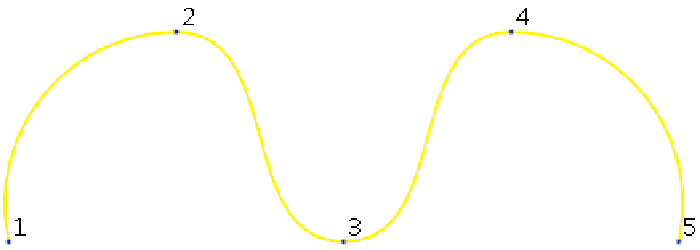
- **Before and After**
- **Before**
- **After**

You may enter a value for the magnitude in the text box provided.

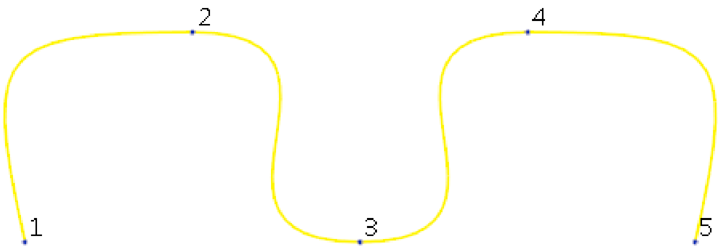
Free - This frees the magnitudes to fit a smooth curve through each selected point.

Scale Magnitude - This edits the tangent magnitudes by scaling the values using the slider. The higher the value, the fuller the curve.

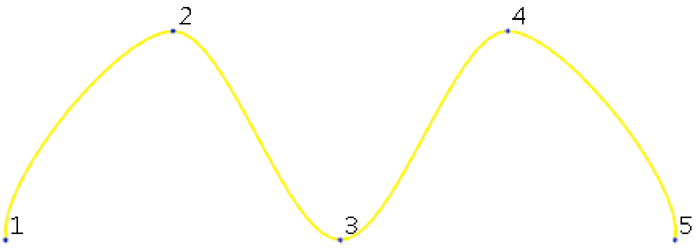
In the example below, the slider value is 1.



If we increase the value to 2, the curve grows larger as the magnitudes increase.



If we decrease the value to 0.5, the curve tightens as the magnitudes decrease.



The scale display always resets to 1 when the directions or type of edit are changed on the dialog. This does not affect the magnitudes of the curve.

The number of curves and points selected are displayed within the dialog.

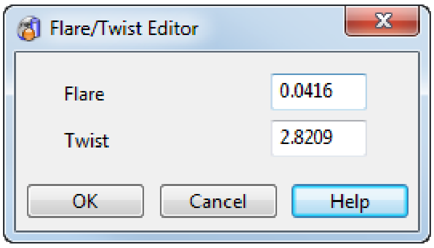
Apply - Saves the changes made to the tangent without closing the dialog.

OK - Saves the changes made to the tangents and removes the dialog.

Cancel - Discards any edits made to the curve whilst the dialog was open and closes the dialog.

Flare/Twist Editor dialog

This edits the flare and twist angles.

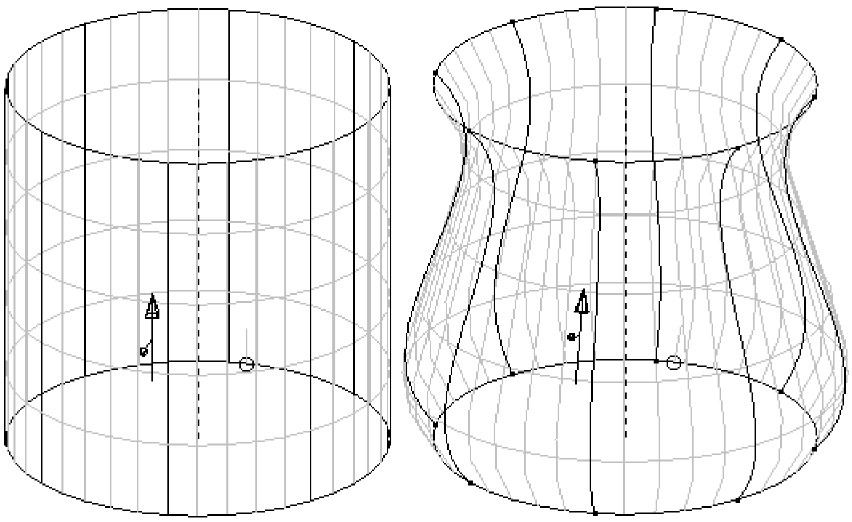


You can modify the flare and twist angles, that are defined either along a longitudinal or across a lateral.

Flare and twist can only be modified if

- surface curves or points on surface curves are selected; or
- the surface has a spine. (You can create a spine using the **Create spine** button on the **Surface editing** toolbar).

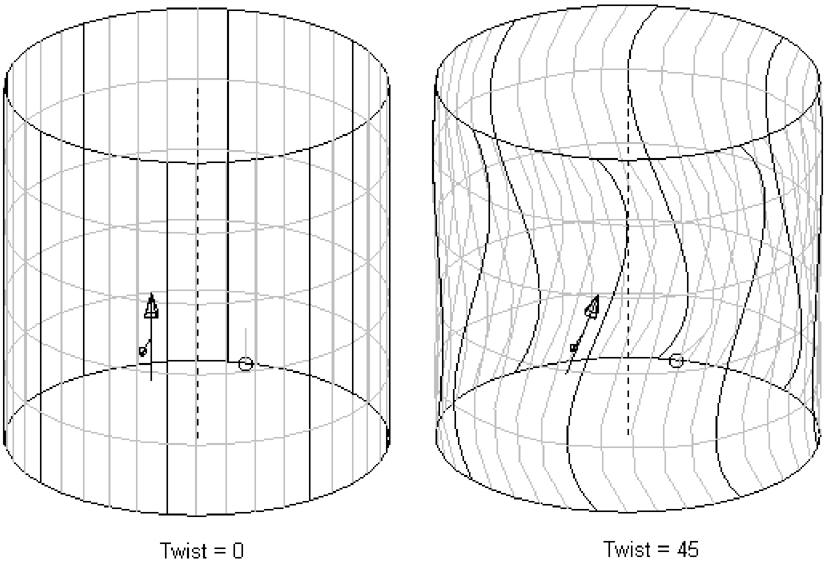
Flare - The flare angle defines the direction of the longitudinal tangent relative to the spine tangent.



Flare = 0 Flare = 45

If the flare angle is positive, the longitudinal diverges from the spine; if it is negative, the longitudinal converges with the spine.

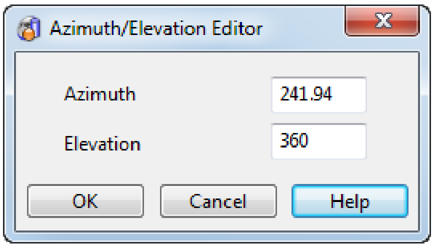
Twist - Twist forces the longitudinal to twist about the spine.



If the twist angle is positive, the longitudinal rotates in an anticlockwise direction as it passes through the lateral.

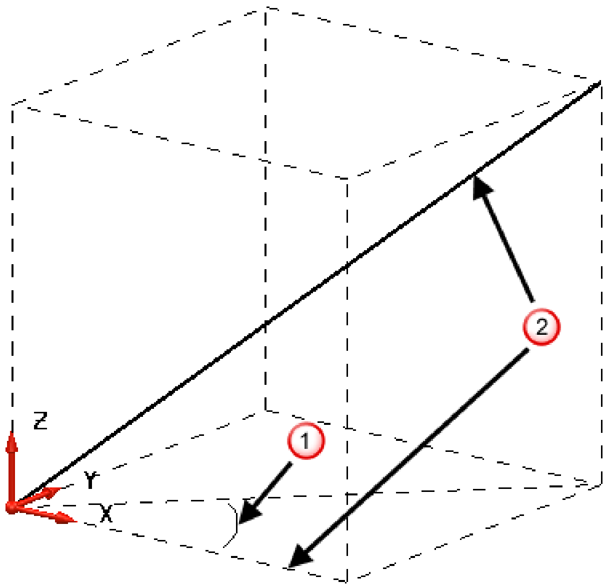
Azimuth/Elevation Editor dialog

This edits azimuth and elevation angles on all curve points.



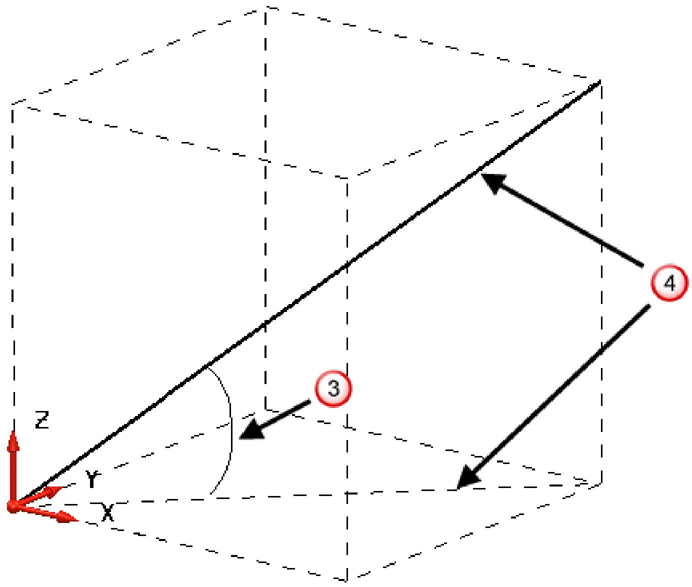
The azimuth and elevation angles are measured using the principal plane. To help explain azimuth and elevation angles, we will assume that the principal plane is the XY plane. Therefore, the Z axis is perpendicular to the principal plane.

Azimuth - If you look vertically downward onto the XY plane, the azimuth 1 is the angle made by the tangent of the curve and the X axis 2.



It can take any value in a 360° range, but you may find it easier to work with values in the range -180° to +180°. For example, azimuth angles of 270° and -90° are the same.

Elevation - The elevation angle 3 is the one between the tangent of the curve and the XY plane 4.

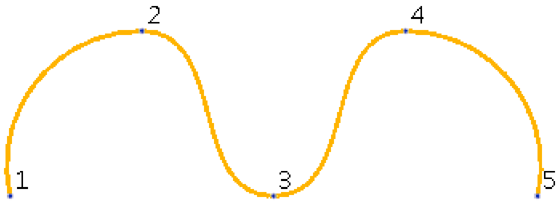


Elevation angles make sense only between 0° and 90°, and between 270° and 360°. You can enter any angle for elevation, it will be displayed as the equivalent angle between the two valid ranges. For example, if you enter a value of -45°, the elevation is displayed as 315° in the dialog.

If the elevation angle is 90° or 270° (that is along the Z axis), you cannot modify the azimuth angle.

Labelling points on curves

You can display the labels of the points on selected curves.



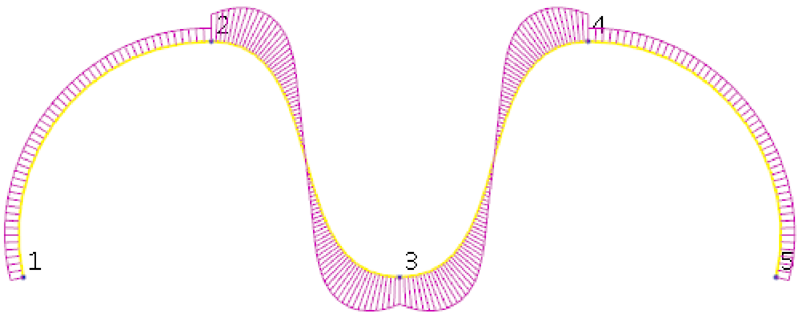
To turn on curve point labels:

1. Select a curve.
2. Click  (*Curve edit toolbar*). The icon of the button changes to this . This indicates that the option is switched on.

   The points are now labelled on any selected curves.
3. To stop displaying the labels, select a curve and click .

Curvature combs on curves

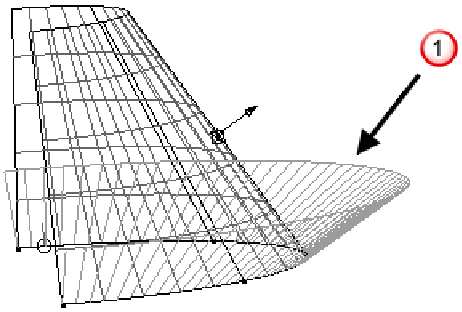
You can display curvature combs on selected curves, composite curves and surface curves.



Curvature combs represent the curvature along a curve. The curvature combs are shorter where there is less curvature and larger where there is more curvature.

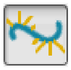
By default, two curvature combs are drawn: one along the normal to the curve and the other along the normal to the view. You can decide which curvature combs to display using the options on the **Curve Analysis** page of the **Options** dialog.

Curvature combs along the normal to surface curves represent the normal curvature along the curves and point along the normal to the surface 1.



To display curvature combs:

1 Select a curve.
2 Click  (*Curve Edit toolbar*). The curvature combs are drawn on any selected curves.

   To stop displaying curvature combs, select a curve and click the **Curvature combs on/off** button .

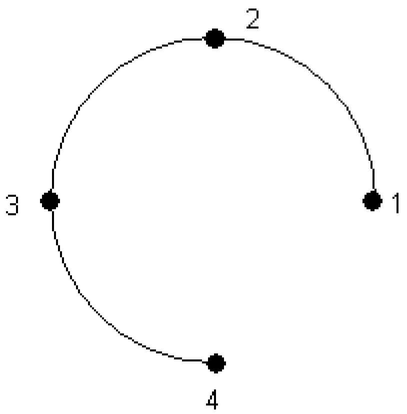
   You can set the size and density of the combs using the **Comb Scale** option on the **Curve Analysis** page of the **Options** dialog.

Reversing a curve

You can reverse the numbering of the points in selected curve.

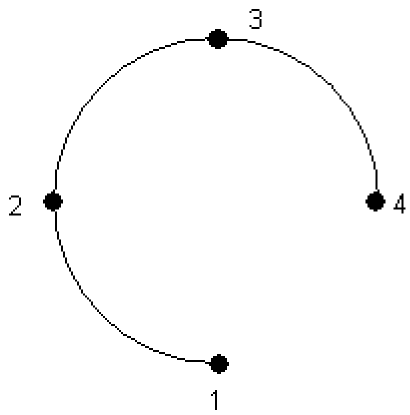
To reverse a curve:

1 Select a curve.



   You can select multiple wireframe curves and composite curves to reverse in one go.

2 Click (*Curve Edit toolbar*).



If a closed curve is reversed, the first point remains the same.

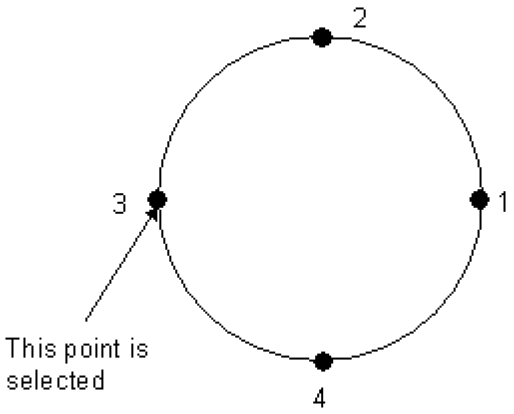
If you reverse a composite curve made from a surface, all the normal information is remembered.

Renumbering a curve

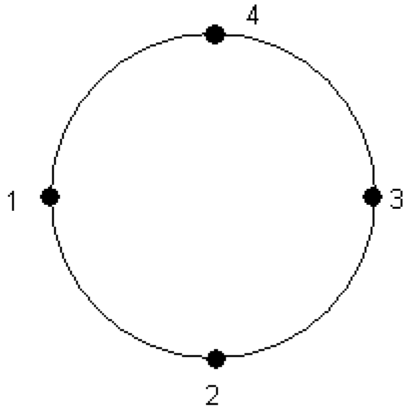
Points in a curve may be renumbered so that the selected point becomes numbered one. The curve must be closed.

To renumber a curve:

1 Select the point you want numbered as one.



2 Click  (**Curve edit** toolbar).

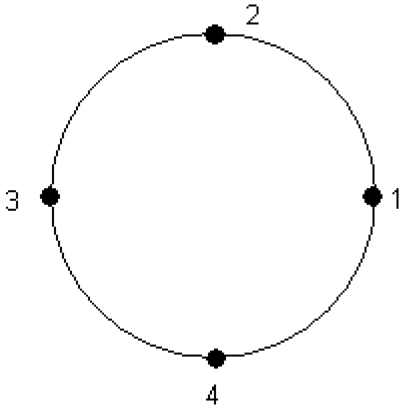


Opening a curve

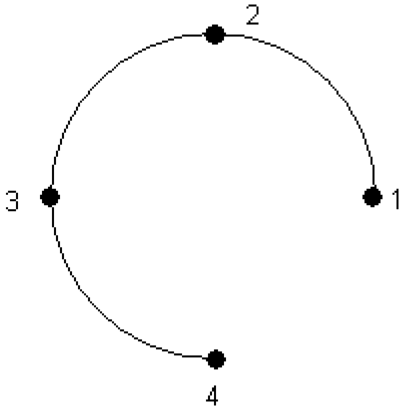
You can create an opening between the first and last points in a closed curve.

To open a curve:

1 Select a curve.



2 Click  (**Curve edit** toolbar).

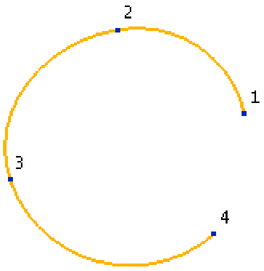


Closing a curve

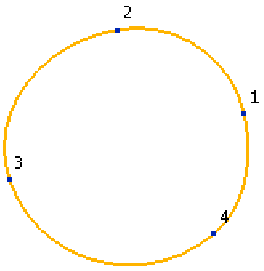
You can close a curve between the first and last points of an open curve.

To close a curve:

1 Select a curve.



2 Click  (*Curve edit toolbar*).

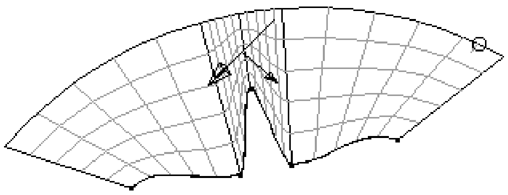


Splining curves

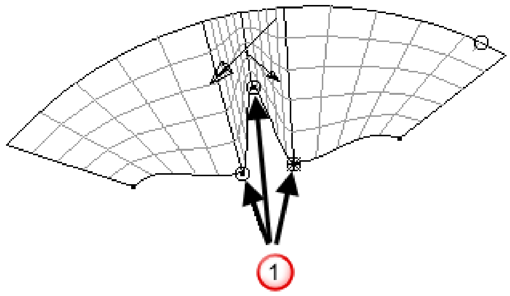
Splining smoothes curves to give tangency continuity on selected points. (Tangent continuity is a smooth change in tangent direction as you move across the curve). The positions of the selected points are changed during this operation.

To spline a curve:

1 Select a curve.

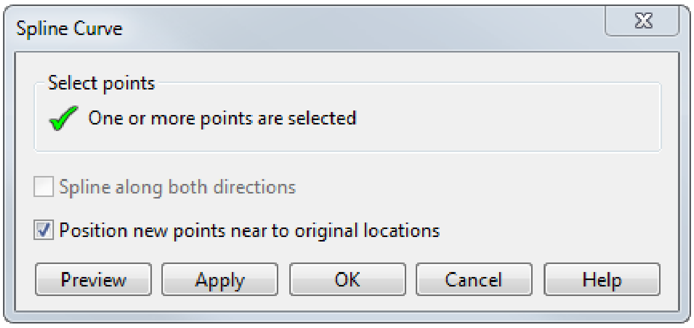


Select the points on the curve to be splined (smoothed) 1.



At least two points must be selected on the curve. On open curves, the start or end points must not be selected.

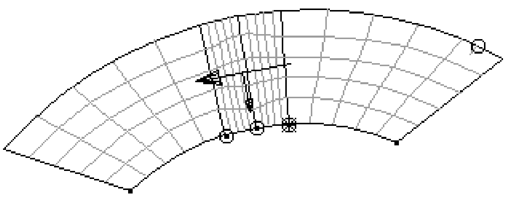
2 Click  (*Curve edit toolbar*).



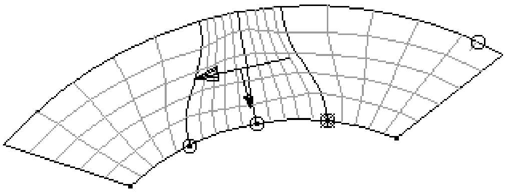
If you have not selected points, or the current selection of curve points is not correct, you can select different curve points using the Select Point dialog or use the mouse to select curve points.

3 Use the options on the dialog to spline the points on the curve.

Position new points near to original location - If selected, the points are positioned near their original locations on the splined curve.



Otherwise, they are evenly distributed along the splined curve.



Preview - If you are not sure how to position the points, click the **Preview** button to see what the curve will look like.

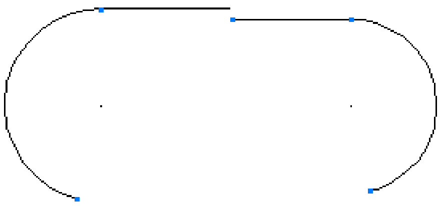
4 Click **OK**.

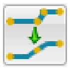
Merge and spline curve

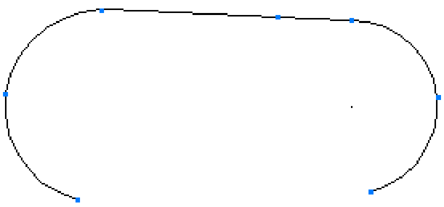
In composite curves, **merge and spline** removes gaps and redefines points within tolerance. In curves, merge and spline just redefines points within tolerance.

To merge and spline a curve:

1 Select one or more curves.



2 Click  (*Curve edit toolbar*).



3 You can change the tolerance to which the curve is merged and splined using **Tol** on the **Status bar**.

Arc fitting

You can fit arcs to curves using one of the following methods:

- Fitting arcs to curves (see page 204).
- Fitting arcs and lines to planar curves (see page 205).

Fitting arcs to curves

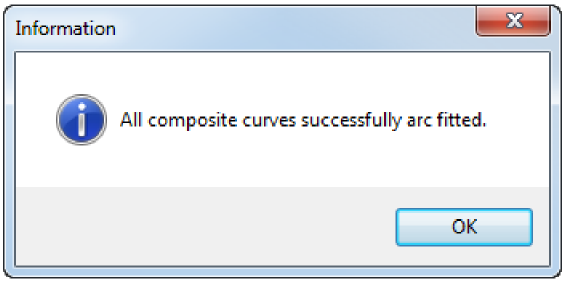
You can fit arcs to curves.

1 Select one or more curves.

2 Click  (*Curve edit toolbar*).

The curve is converted to a composite curve and the underlying geometry of the composite curve contains the fitted arcs.

If all the composite curves have been successfully arc fitted, the following message will be displayed.

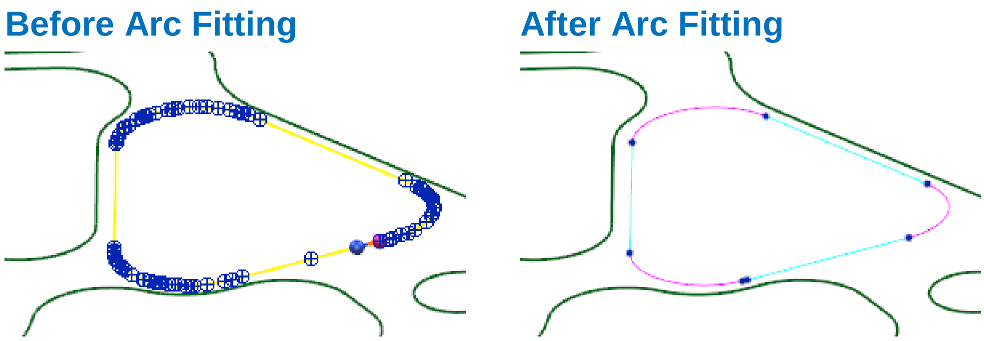


If any composite curves have failed to be arc fitted, an error message is displayed, listing all the names of the failed composite curves.

***Tol** on the **Status bar** changes the tolerance. At low tolerances, a large number of arcs may fit a curve. To reduce the number of arcs, increase the tolerance.*

Fitting arcs and lines to planar curves

The Arc Fitting tool simplifies and re-fits composite curves with arcs and lines.



Use the Arc Fitting tool to simplify composite curves that have been created from meshes, solids, or surfaces. Creating surfaces and solids from wireframe becomes much easier by converting a composite curve with many points, into a collection of arcs and lines with few points.

You can control the Arc Fitting settings using the **Arc Fitting** dialog (see page 206).

Access Arc Fitting from the:

- **Surface/Curve Edit** toolbar.
- **Dynamic Sectioning** dialog.
- **Oblique** dialog.

Surface/Curve Edit toolbar

Select the **Arc Fitting** button to display the **Arc Fitting** dialog (see page 206).

Dynamic Sectioning dialog

Select the **Arc fitting** option to automatically apply Arc fitting to any curves created using the dialog.

Select the **Arc fitting options** button to display the **Arc Fitting** dialog (see page 206).

A preview of the original curve is shown when using Arc Fitting from the Surface/Curve Edit toolbar.

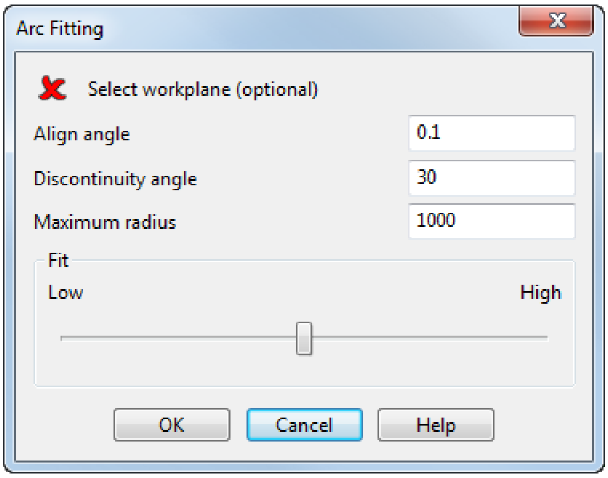
Oblique dialog

Select the **Arc fitting** option to automatically apply Arc fitting to any curves created using the dialog.

Select the **Arc fitting options** button to display the **Arc Fitting** dialog (see page 206).

Arc Fitting dialog

Use the **Arc Fitting** dialog to change the Arc fitting settings:



- **Select workplane** — If a workplane is not selected then the best-fit workplane is used. You can select a workplane to use, and the curve will be projected onto its XY plane.

- **Align angle** — This option controls alignment of lines within the workplane. Lines that lie close the principal axes with an angle less than the entered value, are snapped to the principal axes. Set to **0** to disable principle axis alignment. Takes values between **0** and **10**.
- **Discontinuity angle** — Enter a value to set the maximum angle allowed between lines on the composite curve. If the angle between two lines is greater than this angle, additional spans are added to reduce the angle. Takes values between **0** and **90** degrees.
- **Maximum radius** — Enter a value to set the radius limit at which arcs will be drawn. Curves with a radius greater than this value become arcs, and curves with a radius lower than this value become lines.
- **Fit** — Use the slider to control the fit tolerance. A **Low** fit sacrifices quality by increasing simplicity and reduces the number of curves. A **High** fit sacrifices simplicity by creating more curves, however retains a high accuracy to the original curve.

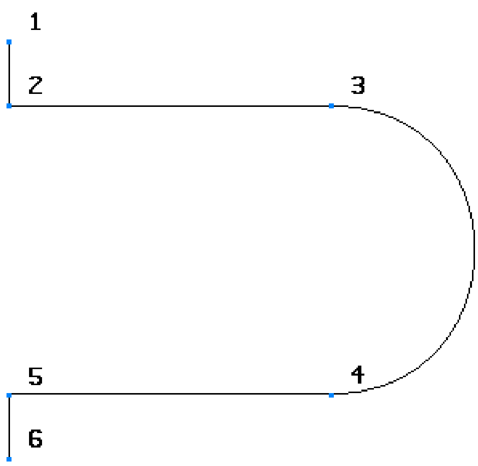
Repointing curves

You can change a segment of a curve or a composite curve to contain a certain number of points, which lie equidistant from each other.

For a surface curve, you can only redistribute its points between two points, but not insert new ones.

To repoint a curve:

1 Select one or more curves.



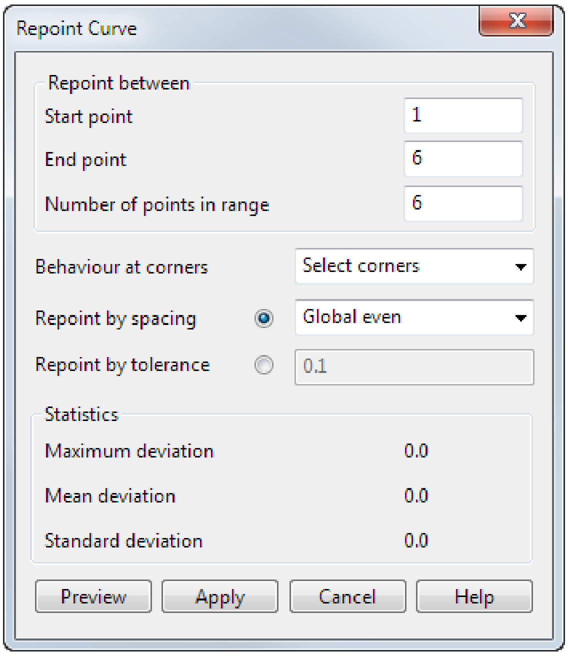
You can only repoint multiple curves on a single surface and all the curves must lie in the same direction.

2 Click  (*Curve Edit toolbar*).

3 Use the Repoint curve dialog (see page 208) to redistribute the points along the curve.

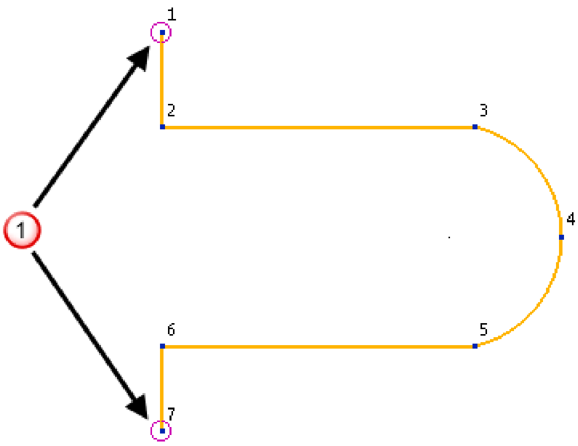
Repoint curve dialog

Use this dialog to redistribute points along a curve.



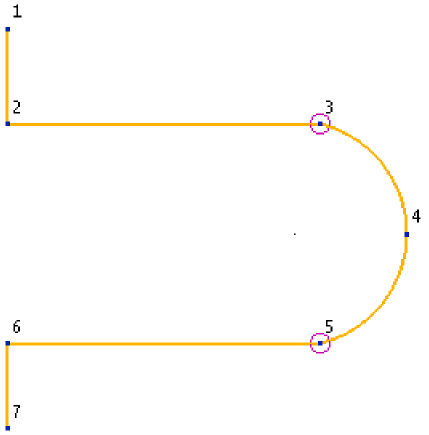
Repoint between — The options in this section are used to define the points that you want to repoint:

Start point and **End point** — You can select the start and end points of the segment of the curve where you want to repoint. By default, the start and the end points of the curve are given 1. Markers are automatically placed at the named points.

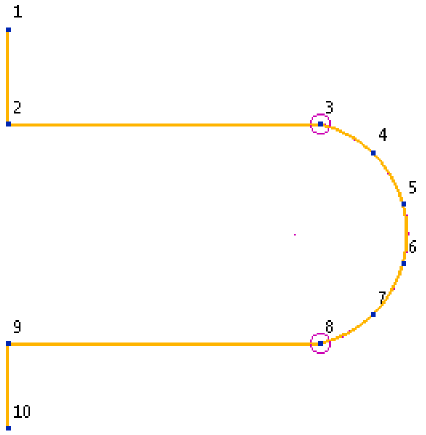


Number of points in range — (*Wireframe curves and composite curves only*.) This is the number of new points that are added to the curve and evenly distributed between the start and end points.

In this example, point **3** is selected as the **Start point** and point **5** as the **End point**.

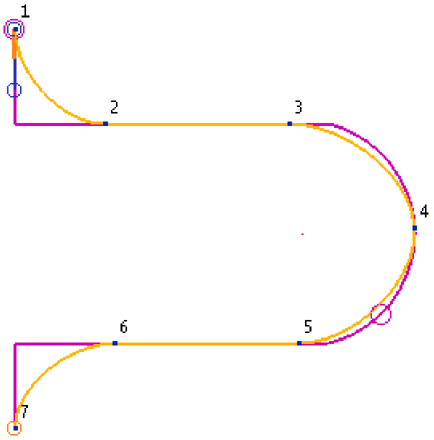


If you enter 6 as the **Number of points in range** value, the following curve is produced:



Behaviour at corners — (*Wireframe curves and composite curves only*.) You can select points that you don't want to remove. These points are marked as corners.

If we have no corners selected and use the default settings (that is, **Start Point** = 1, **End Point** = 7 and **Number of points in range** = 7), we get the following curve.



- New points are added equidistant from each other.
- All original points are removed from the curve.
- The tangent magnitudes of the new points are freed.

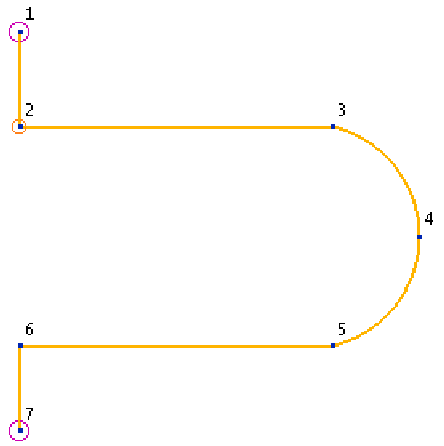
When corners are added, the same thing happens except the corner points remain fixed in the curve.

*Corner points are not included in the points in the **Number of points in range**.*

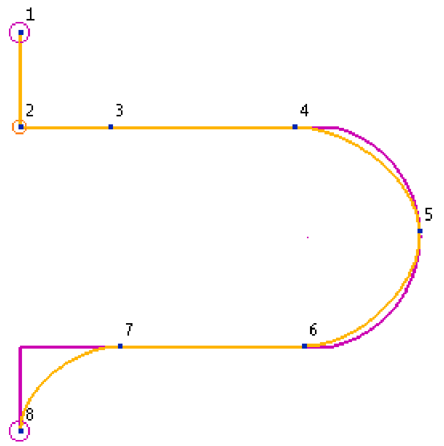
Behaviour at corners option menu has three options:

- **Selected corners** — This option enables you to select corners. To select corners, select this option and click points.

  In this example, point **2** is selected. A corner marker is added to the curve.

  This creates the following curve.

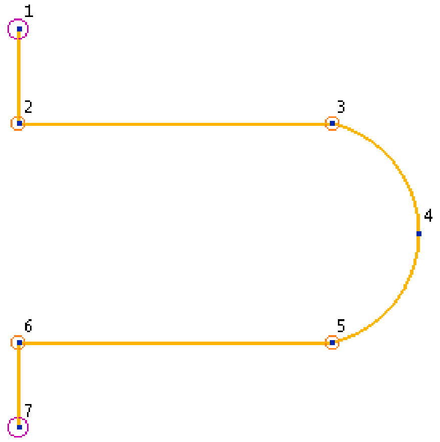
  

  You cannot select corners on multiple wireframe curves using the **Select corners** option, but you can choose the **Keep all discontinuities** option to add corner points.

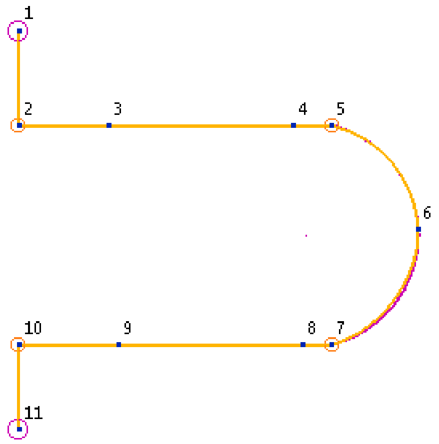
- **Remove all corners** — This removes all corners from the curve.

- **Keep all discontinuities** — This adds corner markers at all discontinuities along the curve. Any other corners already marked, remain marked.

  In this example, points 2 and 6 are discontinuous and are therefore marked as corners.

  This gives the following curve.

  To remove a corner marker, click the corner.

Repoint by spacing — Select this option to repoint a curve using a spacing defined method:

- **Global even** — This option repoints the curve by spacing the points evenly along the curve, depending on the curve length and the number of points. A larger number of points provides a more accurate repoint.
- **Regular** — This option repoints the curve by taking the smallest distance between two points and uses this spacing along the whole curve, between the currently existing points.

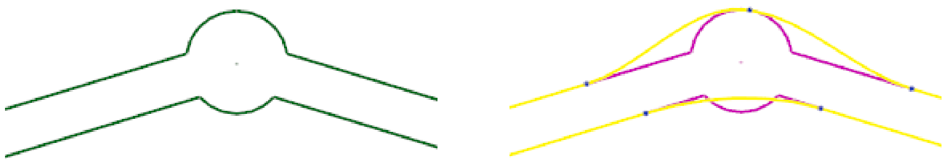
- **Linear** — This option repoints the curve by taking the smallest distance between two points and uses this spacing along the whole curve, between the currently existing points. The spacing is stretched and compressed slightly between the existing points to provide a linear blend.

Repoint by tolerance — Select this option to repoint the curve to fit a specific tolerance. When this option is selected the number of points is automatically calculated by PowerSHAPE.

Statistics — The fit accuracy of a repointed curve to the original curve is represented by the following values:

- **Maximum deviation** — the maximum value that the repointed curve varies from the original curve.
- **Mean deviation** — the average value that the repointed curve varies from the original curve.
- **Standard deviation** — a representation of the amount of variation from the mean.

Preview — Updates the Statistics area with the repointed curve data. The original and repointed curves are also displayed.



OK — Saves the changes made to the curve and removes the dialog.

Cancel — This makes no changes to the curve and removes the dialog.

Appending curves to form a single curve

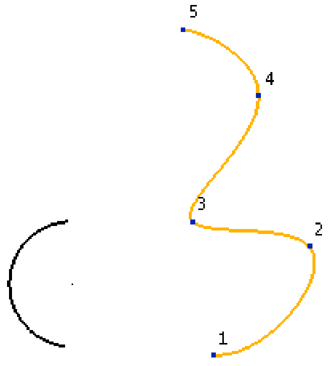
You can append:

- any wireframe object to a composite curve
- a curve to a curve

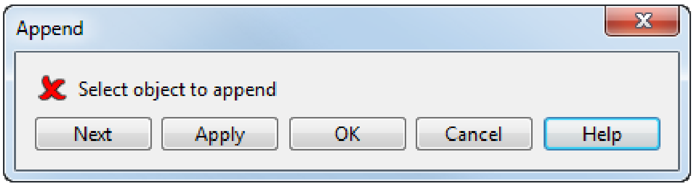
If the ends of the two objects do not join, a span is added to the ends.

To append a curve:

1 Select a curve.



2 Click  (*Curve Edit toolbar*).

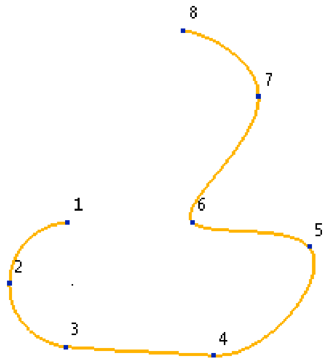


3 Choose the object to append.

If you are appending to a composite curve, any wireframe object can be selected. If appending to a curve, only a curve can be selected.

The ✗ next to **Select object to append** changes to ✓.

By default, the ends of the objects nearest to each other are appended. If the two ends don't touch, they are joined by a span. The tangency at the ends of the new span matches the ends of the existing objects.



4 If this is not the solution you want, select **Next** on the dialog to give the other solutions.

As you click **Next**, the other solutions are displayed on the screen.

5 Once you have the required solution, click either **Apply** or **OK**.

If you want to append more objects to the current curve, click **Apply** and then select another object.

If you do not want to append any more objects, click **OK**.

Editing a curve as a Bezier or B-spline curve

You don't have to create a B-spline curve to use the B-spline control points. If a curve or surface curve can be represented in B-spline form, you can edit it as a B-spline curve.

You can switch a curve from one form to another using the **Edit as Bezier or B-spline** button ( or ) on the **Curve edit** toolbar. This button is only available if the curve can be represented in B-spline form.

If you alter the Bezier handles on a B-spline curve, it may no longer be represented as a B-spline curve.

*Remember that many of the buttons on the **Curve edits** toolbar are not available when editing a curve as a B-spline curve.*

Fine Tuning

You can use fine tuning to slightly move points on a curve, composite curve and surface curve.

To fine tune a curve:

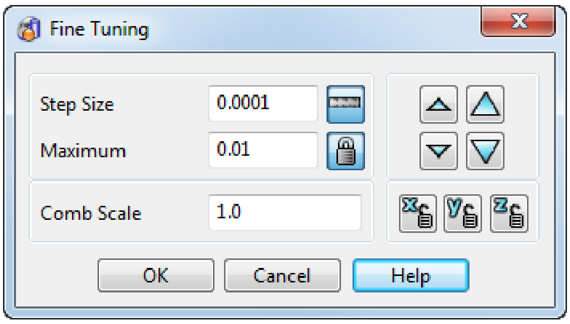
1 Select points on the curve.

2 Click  (**Curve edit** toolbar).

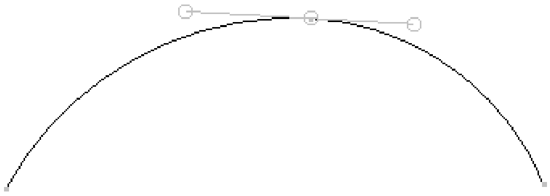
3 Use the Fine Tuning dialog (see page 214) to move the point as required.

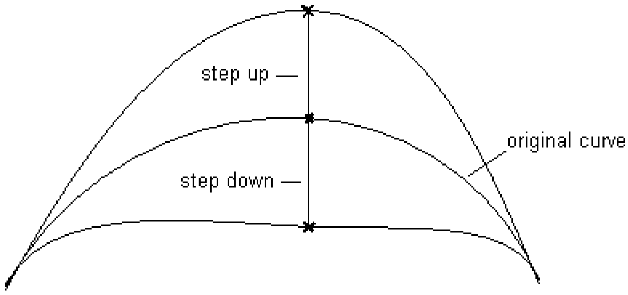
Fine Tuning dialog

Use this dialog to slightly move points on a curve, composite curve and surface curve.

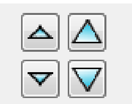


Step size - This is the increment that the point will move each time the small up arrow or down arrow is clicked. The value can be entered either as a percentage of the **Maximum** or as actual units .



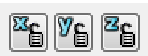


Maximum - This value is the maximum distance that the point can be moved from its original position. If this is locked , you can only move the point to a position that is less than this value from the original position. If this is unlocked , there is no limit to how far you can move the point.



- These arrows allow you to move the point up or down. Each click on a small arrow moves the point in X, Y and Z by the increment specified in **Step Size**. Each click on a large arrow moves the point by five times the increment specified in **Step Size**.

You can also use the up and down cursor keys on the keyboard to move the point by the increment specified in the **Step Size**.



- These buttons allow you to independently lock/ unlock movement in the X, Y or Z direction.

Comb Scale - This sets the size of the curvature combs displayed.

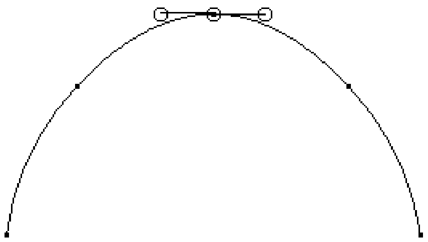
You can display them by selecting the **Curvature combs** button (*Curve edits toolbar*).

OK - Saves the edits made to the curve and removes the dialog from the screen.

Keep smooth

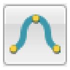
Keep smooth applies extra smoothing to and around points as they are edited in an attempt to keep the shape of the curve smooth. This is done by freeing tangents and magnitudes about the edited points.

1 Select a curve.

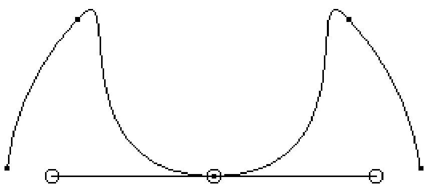


2 Click the **Keep Smooth** button to turn it on or off.

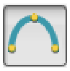
3 Edit the curve as necessary.

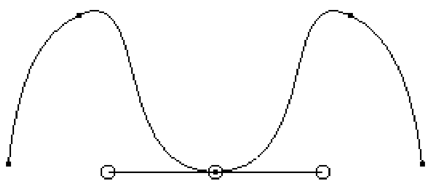
If the **Keep smooth** option is *OFF* , only the original edit is done. This is the default.

In our example, we have moved the selected point downwards. Here is the result if the **Keep smooth** option is *OFF*.



If the **Keep smooth** option is *ON*, points on either side of the edited point (unless they themselves are being edited) have their tangent directions and magnitudes freed.

Here is the result of our example if the **Keep smooth** option is *ON* .



If the edit is positional only, the tangent directions and magnitudes at the edited point are also freed.

There are some limitations on the freeing of tangents.

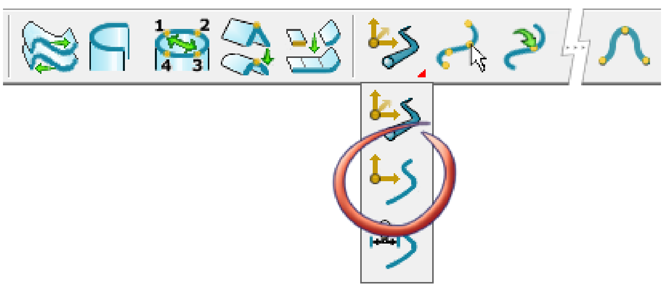
- If there is a discontinuity at the edited point, then neither the before nor after tangents are freed. The discontinuity is preserved. However, the magnitudes will be freed.
- If there is a discontinuity at adjacent points, then only the inner tangent direction and magnitudes get freed, that is the after tangent on the point before and the before tangent on the point after.

The **Keep smooth** option applies to position editing, tangent editing and the general edits (edit sub-components mode).

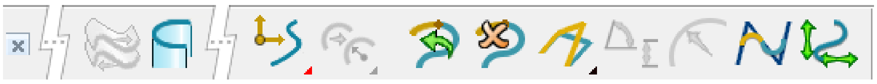
Editing a curve in 2D

To edit a curve in two dimensions:

1 Select  **Edit the curve in 2D** from Curve Editing flyout.



2 The 2D curve editing toolbar is displayed.



When entering 2D Editing, the program zooms automatically into the selected object. You can select/deselect this option using the Composite curve options dialog.

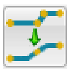
3 Edit the curve using the options below.

 Close curve (see page 202)

 Open curve (see page 201)

 Create point (see page 185)

 Delete point (see page 185)

 Merge and spline curve (see page 204)

Fit arcs to curve (see page 204)

Apply smoothing (see page 216)

Add span (see page 218)

Delete span (see page 218)

Set mode - single dragging (see page 218)

Set mode - group dragging (see page 218)

Set mode - group dragging and keep angle (see page 218)

Set span width and angle (see page 218).

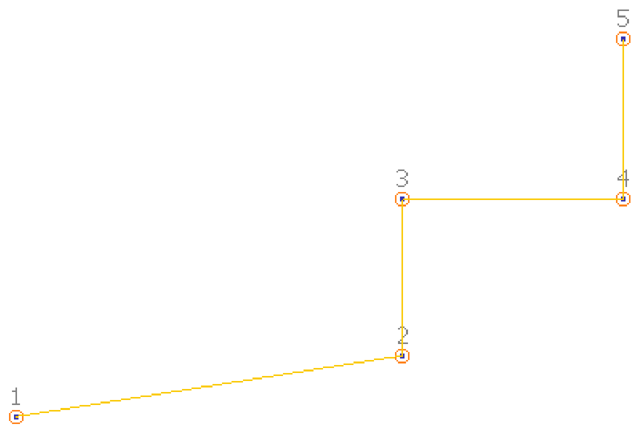
Set selected corner radius (see page 218)

Switch solution for arc intersection (see page 222)

Change size of composite curve (see page 223)

Using the 2D curve editor

1 Ensure a composite curve is selected.

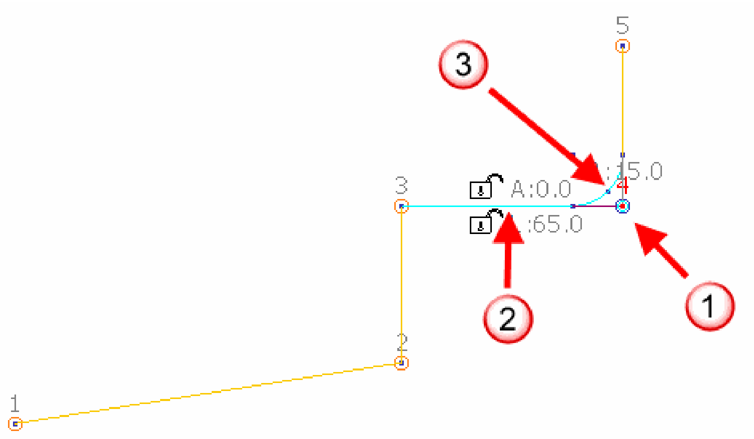


2 Select **Edit the curve in 2D**.

When entering 2D Editing, the program zooms automatically into the selected object. You can turn the zoom setting OFF, or back ON, on the Composite curve options dialog.

 *To zoom out, select **Edit the curve in 3D***  *(curve edit flyout).*

3 Click **Set Selected Corner Radius** and enter a value of *15*.



The following are shown on the model above

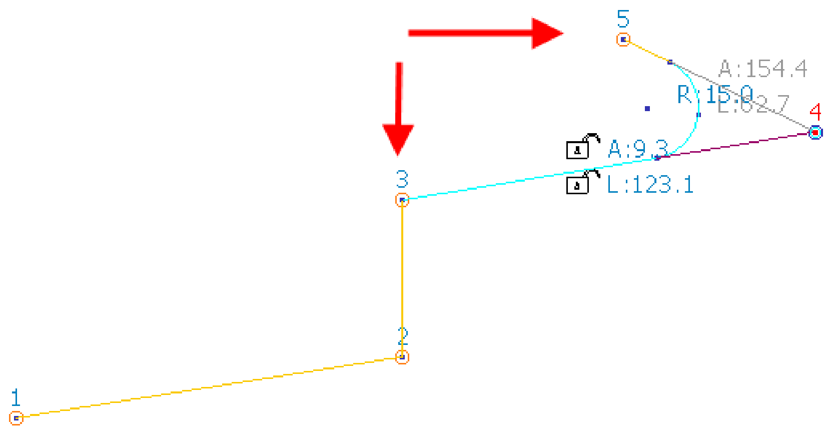
Point 1

Span 2

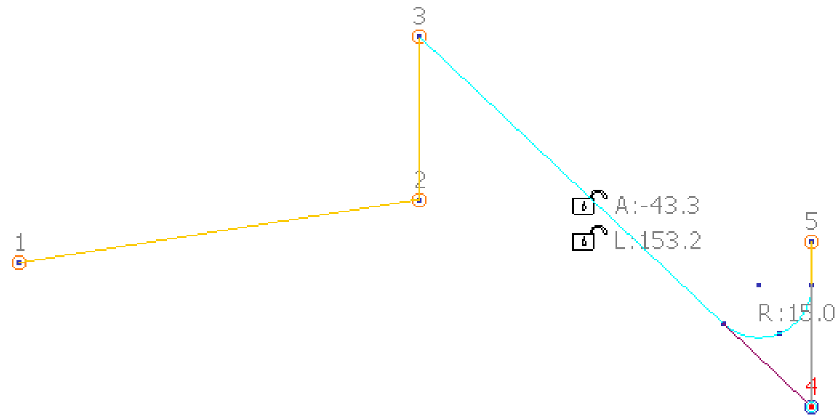
Radius 3

4 Using the point indicated on the curve above, use each of the dragging modes in turn to modify the curve to help understand the differences between them.

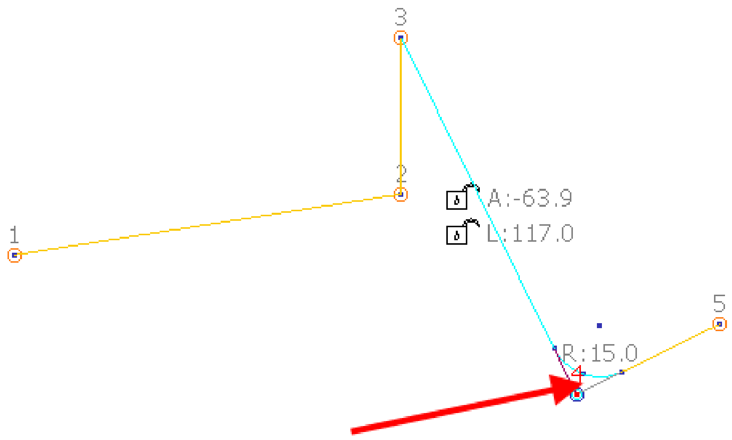
 **Single dragging** - A single point is dragged. Using this mode on the point indicated, you can produce a curve that looks something like the one below. The points either side of the dragged point retain their original position as indicated by arrows on the diagram below.



 **Group dragging** - Select one point and drag this. The rest of the points will be dragged, whilst maintaining the radius of the arc between the two adjacent points or angles where possible.



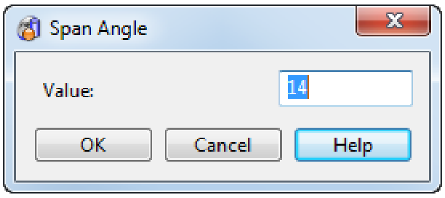
 **Group dragging and keep angles** - The points beyond the selected point will be dragged, whilst maintaining the angle between the spans adjacent to the selected point. The constant angle is indicated by the arrow on the diagram below.



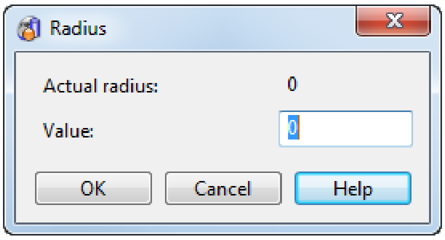
5 Try changing the curve using the following:

- **Create a point** - highlight a point and select **Add a point**  button or **Insert** key. A point is inserted in the middle of the selected span
- **Delete a point** - Highlight a point and select **Delete a point**  button or the **Delete** key
- **Add a span** - Use the **Add a Span**  button or the plus (+) key to add a span to the end of the previous span. The new span will have the same length and will be in the same direction as the previous span.

- **Delete a span** - Use the **Delete a Span**  button or the minus (-) key.
- **Changing the angles of spans** - Click **Set Selected Span Width and Angle**  button to display the **Span Angle** dialog.



- **Setting a corner radius** - You can change the radius at the selected point using the **Set Selected Corner Radius**  button to display the **Radius** dialog. An arc will be added if one does not already exist.



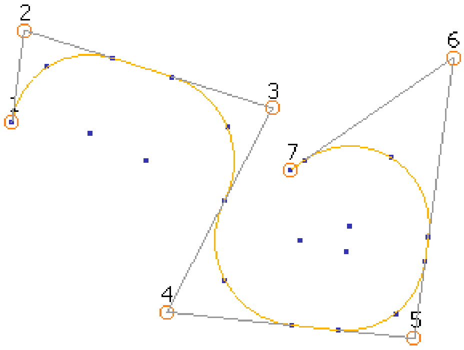
- **Locking/unlocking angles and lengths of spans** - Locked dimensions are shown in red and unlocked dimensions in white. You can lock as many points on the curve as required.

  If you double click a span, the dialog that is displayed will depend on the values that are locked. The possible options are shown below:

Angle locked and Length locked	No dialog displayed
Angle locked and Length unlocked	**Span Length** dialog displayed
Angle unlocked and Length locked	**Span Angle** dialog displayed
Angle unlocked and Length unlocked	**Span Angle and Length** dialog displayed

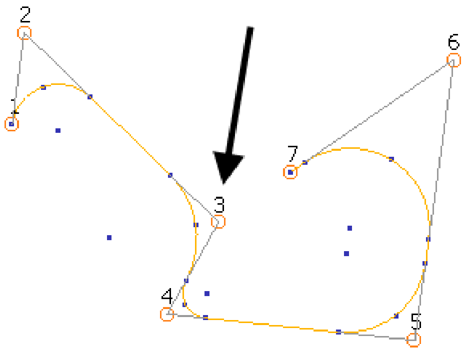
Switch selection for arcs intersection

Use the following model to see the effect of using the   buttons.



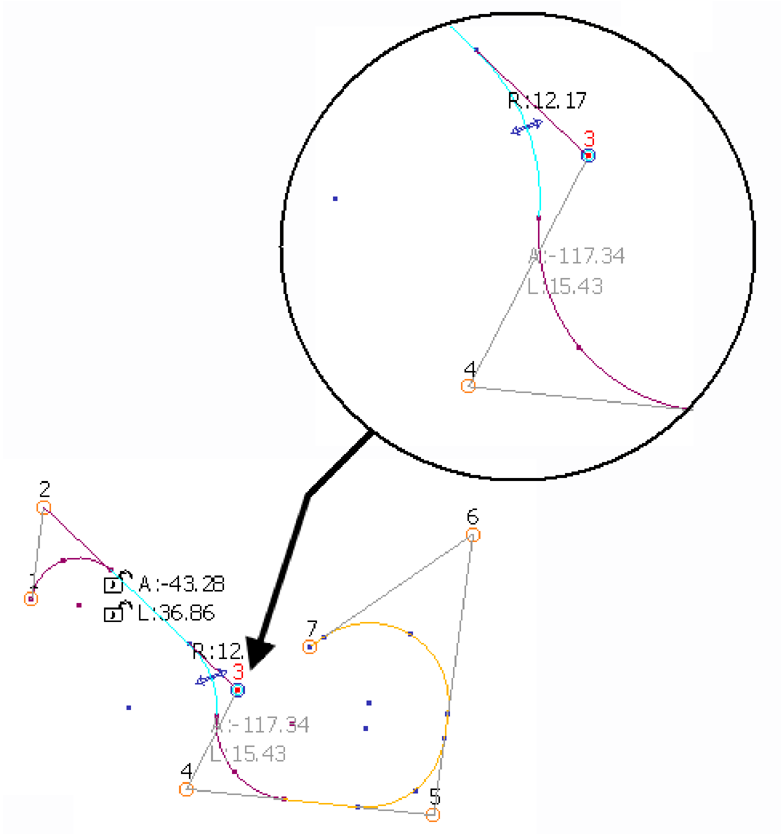
Using this model, try each of the following in turn:

- With  deselected (default), move point 3 to the position shown below.



As you move point 3, the radii A and B are constant until it is no longer possible to maintain the radii and alter the curve. From this point onwards, the radii are altered appropriately to preserve the integrity of the curve.

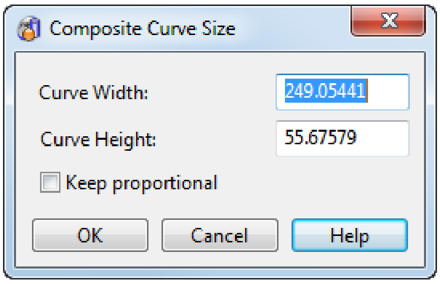
- With  selected, move point 3 to the position shown below.



As you move point 3, the radii A and B are maintained throughout, moving the intersection point along the curve to allow the radii to remain constant.

Change size of composite curve

Use the **Composite Curve Size** dialog to change the size of the composite curve.



1 Enter new values for **Curve Width** and **Curve Height** as required. If a dimension is locked, you will need to unlock the dimension before entering a new value.

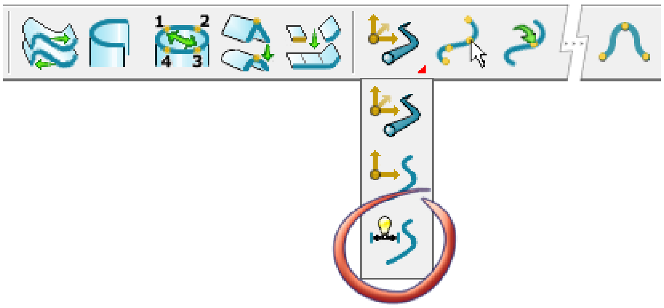
2 Select **Keep proportional** to maintain the aspect ratio of the curve.

Editing using active dimensions

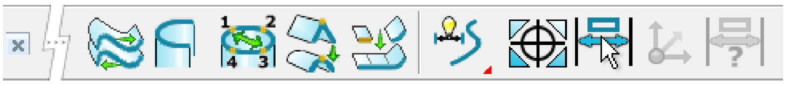
You can add active dimensions to a composite curve. An active dimension allows the geometry of a composite curve to be altered by changing the dimension value.

1 Select a composite curve.

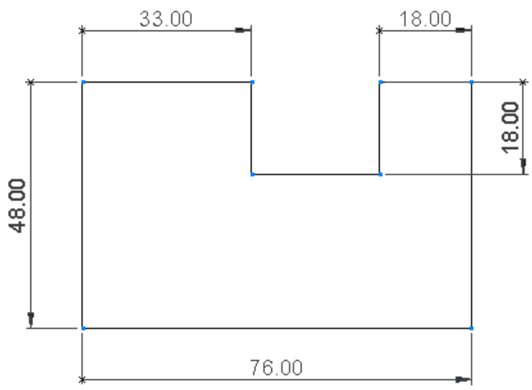
2 Select  **Edit the curve using active dimensions** from Curve Editing flyout.



3 The Curve Editing toolbar displays the options for editing the curve using active dimensions.

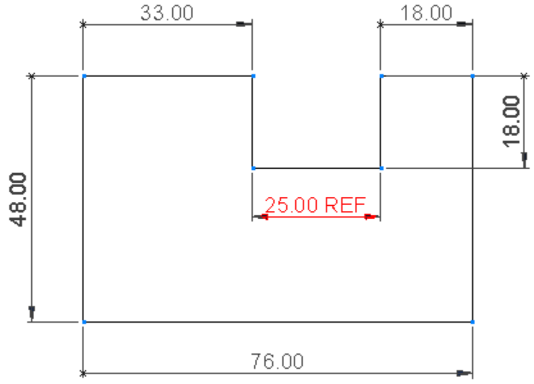


The geometry of the composite curve is fully dimensioned.



These dimensions are only displayed when the composite curve is selected on its own.

If you add any additional dimensions by using the **Create dimensions manually button**, these will be labelled as reference only.



Once an active dimension is created you can drag and move it, in the same way as regular dimensions. The **Dimension toolbar** is available to edit the attributes of active dimensions.

4 You can edit the curve and create various types of dimensions using the options below

Reverse the curve (see page 199)

Close curve (see page 202)

Open curve (see page 201)

Renumber curve points (see page 200)

Spline curve (see page 202)

Join two curves (see page 212)

Apply smoothing (see page 216)

Modify origin (see page 226)

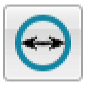
Create dimensions manually (see page 226)

3 point radius

Automatic dimension

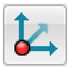
 Radius

 Parallel dimension

 Diameter

 Major angle

 Minor angle

 Pick profile origin (see page 227)

 Edit selected dimension (see page 228)

5 To turn off active dimensions, select  at the top of the **Curve Editing** flyout. The dimensions will no longer be displayed and the **Dimension toolbar** will be closed.

Active dimension commands

There are two macro commands available when creating active dimensions. These generate a third point automatically to align the dimension with the required axis. To use, select the first two points and enter one of the following commands in the command window:

auto_x

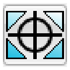
create a dimension parallel to the X axis.

auto_y

create a dimension parallel to the Y axis.

Modify origin

To change the origin when dimensioning a model:

1 Click .

2 Move the cursor and click to position the new origin. Dimensions are updated accordingly.

Create dimensions manually

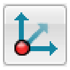
To manually add a dimension to your model:

1 Click .

2 Click the ends of the item to be dimensioned and move the cursor away from the model.

3 Click to fix the position of the text.

Pick profile origin

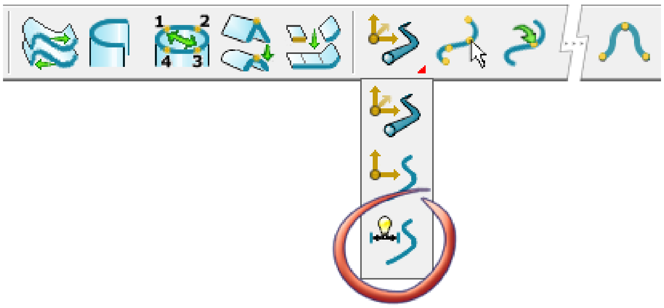
 - You can create dimensions manually on the composite curve from an origin defined by the position of the workplane which was active when the curve was created.

Creating dimensions from the current active workplane

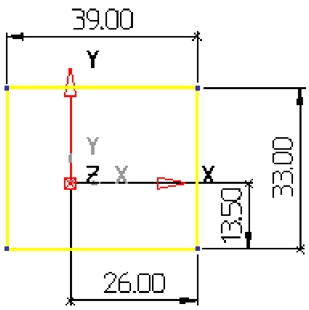
To create dimensions on your wireframe from the active workplane:

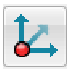
1 Double click the composite curve to display the **Curve Edits** toolbar.

2 Select  **Edit the curve using active dimensions** from Curve Editing flyout.

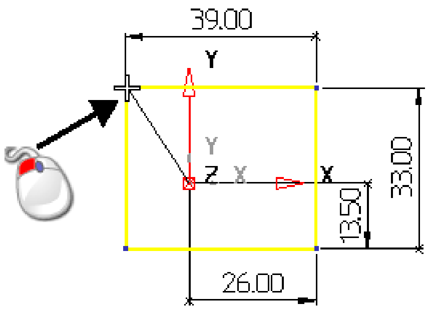


3 Click **Create dimensions manually** . The dimensions are displayed.

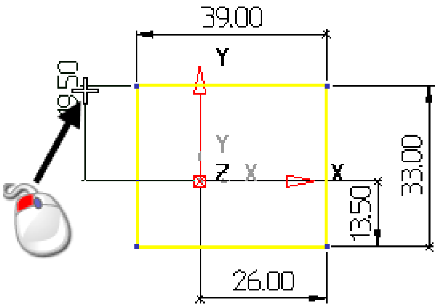


4 Click **Pick profile origin** 

5 Click on the composite curve at the point you want to create a dimension. A dimension is displayed from the origin.



6 Move the cursor to the position you want and click to fix the dimension.



Edit selected active dimension

 - **Edit selected active dimension** - This displays the **Dimension Value** dialog where you enter the value, or parametric expression, for the new dimension.

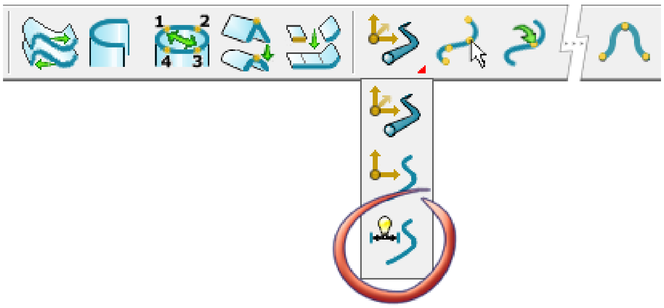
For further details, see Editing a selected active dimension (see page 228).

Editing a selected active dimension

To edit an active dimensions:

1 Double click the composite curve to display the **Curve Edits** toolbar.

2 Select  **Edit the curve using active dimensions** from Curve Editing flyout.



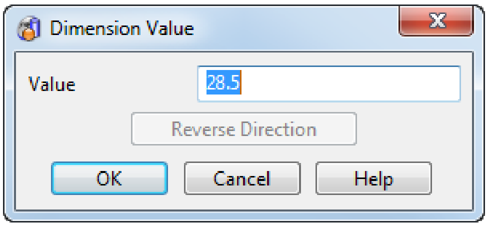
3 Select the dimension you want to edit.

4 Click **Edit selected active dimension** .

5 The Dimension Value dialog (see page 229) is displayed where you enter the new dimension value.

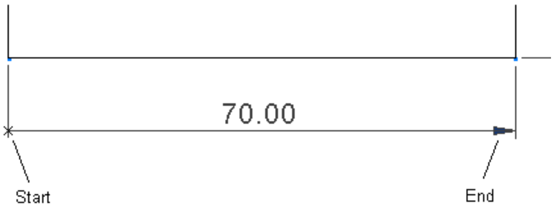
*You can also double-click on the active dimension to be changed to display the **Dimension value** dialog*

Dimension Value dialog



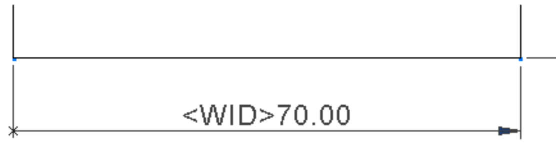
Value - Enter a new value to change the dimension of the geometry.

Each linear active dimension has a start mark and an end arrow.



When you change the dimension value, the start point remains fixed and the end point moves.

The value may also be set to a previously created parameter by right-clicking in the value box to activate the calculator. If **Value** is set to a parameter, the parameter's name and value are displayed as the dimension text.



Reverse Direction - This changes the direction of the start and end points.

OK - the wireframe model is displayed with the new dimensions.

Deleting active dimensions

To delete an active dimension:

1 Select one of more dimensions.

2 Either click the **Delete** button  or press the **Delete** key.