Chapter 8: Spline Modeling

The Spline modeler in Carrara lets you create objects by converting 2D shapes into 3D objects. You use the Spline modeler tools to draw 2D shapes, known as cross-sections, and then convert them to 3D objects by extruding them. Once you've created a 3D object, you can refine its shape using an extrusion envelope.

This chapter covers spline modeling concepts and describes how to use the Spline modeler.

Spline Modeling Concepts

The Spline modeler is based on a concept called **extrusion**. You create an object by drawing a 2D shape, then drawing a path perpendicular to the shape. Carrara extrudes the shape along the path to form a 3D object.

A 3D object is created by extruding a 2D shape along a sweep path.

**Straight Extrusion**

Straight extrusion is the most basic type of spline modeling. In a straight extrusion, a 2D shape is placed on a cross-section and swept along a straight sweep path, creating a “cookie cutter” effect.

Object created using straight extrusion.

The cross-section doesn't have to consist of a single 2D shape—it can consist of several distinct shapes. You can even create an object with a hole in it by extruding a shape along a compound path. For more information on extrusions, refer to Cross-Sections and the Sweep Path.

**Scaling**

You can also shape objects by changing the scale of the 2D shape as it's extruded along the sweep path.

You can create more complex objects by using different sized cross-sections.

Simply changing the scale of a shape produces very basic shapes, but when combined with an extrusion envelope, you can create a much wider variety of objects. For more information on scaling,
Lathing

You can model many symmetrical objects using a technique known as lathing. Carrara creates lathed objects by extruding a lathe profile around a sweep path. You can think of the lathe profile as the outline of the object when it's cut in half. For more information on lathing, refer to Lathing with the Extrusion Envelope.

Carrara creates lathed objects by extruding a lathe profile around a sweep path.

The more complex the lathe profile, the more complex the object.

Cross-Sections

Cross-sections are 2D shapes that act as the skeleton of your object. The Spline modeler extrudes from each cross-section to the next, basing the contours of the object's surface on the shapes in the cross-sections.

Carrara creates an object by extruding between cross-sections.

This modeling technique is sometimes referred to as skinning—the Spline modeler stretches a “skin” over the shapes in the cross-sections.

Carrara creates a skinned object by stretching a “skin” over a series of cross-sections.

Each cross-section can have any number of 2D shapes. However, the more shapes you add, the more complicated your extrusion gets.

For more information on cross-sections, refer to Working with Cross-Sections.

Complex Sweep Paths

The sweep path determines the shape and size of the extrusion. A straight sweep path creates a straight object; a more complex sweep path creates objects with bends and curves.
A sweep path with curves will result in an object with bends and curves.

The Spline modeler allows you to draw a true 3D sweep path, meaning it can be adjusted in the X, Y, and Z axes. You can also close the sweep path to create a continuous object like a chain link. Carrara also supplies tools for automatically creating complex sweep paths like spirals. For more information on working with the sweep path, refer to Drawing a Sweep Path in 3D.

You can create complex shapes like spirals using Carrara sweep path presets.

For a mini-tutorial on creating different types of spirals, refer to Using Extrusion Presets.

Choosing a Spline Modeling Technique

The Spline modeler offers several ways of creating spline objects—lathing and skinning between different 2D shapes, to name two. You must decide which technique is best suited for your object before you begin modeling.

An easy way of determining which technique you must use is to take an imaginary knife and cut your object into slices. The slices you end up with will tell you which technique you should use.

To determine which spline modeling technique you should use, slice an object with an imaginary knife. The size and shapes of the slices determine which modeling technique is the most appropriate.

If you get identical shapes, use straight extrusion. If you get congruent shapes that differ only in size, use an extrusion envelope.

When you slice a tree, you can see that all the cross-sections are similar. However, they have different sizes. So the easiest way to create this object is to use an extrusion envelope.

If shapes vary dramatically in size and geometry, you must use a more complex modeling technique. Use lathing if the shapes are symmetrical. If not, use shape numbering and multiple cross-sections.

When you slice a glass, you can see the cross-sections are symmetrical while varying in size, so lathing should be used.

The Spline Modeling Window

The Spline modeling window.
The Spline modeling window defines the drawing environment and provides you with planes for drawing sweep paths, cross-sections, and extrusion envelopes.

When you are using the Spline modeler, the Spline modeling window opens, new menu commands are available, different tool sets appear, and the Properties tray describes your object. Your view switches to a close-up view of your object.

As well, the Scene Preview window shows how your object will look in the Assemble room.

As with the Assemble room, the Spline modeling room provides up to four separate panes, each offering a different view of your object. For information on changing this display, use the pane layout controls, described in Changing Views.

**The Spline Modeler's 3D View**

The Spline modeler's 3D view shows a working box (also known as the Modeling box) that contains the features for creating cross-sections and paths.

![The Spline modeler's working box.](image)

The Drawing plane is highlighted as a darker shade. By default, each side of the working box measures 14 inches, with a grid line drawn every inch. For information on changing these dimensions, refer to Resizing the Modeling Box.

You can move and rotate the working box along with the object to get a better view of your work. You can also resize the working box and choose whether to resize the object along with it.

**The Drawing Plane**

The Drawing plane is the plane you're currently working on, whether you're drawing a shape, adjusting a sweep path, or viewing your object. In 3D view, the Drawing plane is highlighted as a darker shade.

![The Drawing Plane.](image)

**Cross-Section Planes**

The cross-section planes are where you create the 2D cross-sections that make up the skeleton of your object. You use the Spline primitives and drawing tools to draw and edit shapes on the cross-section planes.

A cross-section plane contains only one cross-section, which can consist of any number of 2D shapes.
Each cross-section has its own plane known as a cross-section plane.

A cross-section can contain more than one shape.

For more information on cross-sections and cross-section planes, refer to Working with Cross-Sections.

**The Sweep Path**

The sweep path, also known as the *extrusion path*, is the path along which cross-section shapes are extruded. The path is indicated by two lines that appear on the bottom and side walls of the working box.

You can tell the exact position of the sweep path by its path description lines.

You can think of these lines as horizontal and vertical projections of the same sweep path. They let you edit the sweep path in both the XY and YZ plane. You can draw a sweep path of any shape or angle including curved, straight, or closed paths.

For more information on the sweep path, refer to Working with the Sweep Path.

Because the sweep path exists in 3D, it can be edited both horizontally and vertically using its projections.

**The Extrusion Envelope**

The extrusion envelope lets you control the curvature of the 3D object around (as opposed to along) its sweep path. You do this by scaling the object's cross-sections. You can scale cross-section shapes symmetrically or asymmetrically.

The extrusion envelope lets you adjust an object's shape.

Carrara does not display the envelope when you first open the Spline modeling window. You add it using one of the Extrusion Envelope commands in the Geometry menu. It is indicated by four Bézier curves, two on each sweep path plane. Separate colors are assigned to the YZ and XY plane. Corresponding colored dots appear on the cross-section plane indicating where these curves cut through it. You can scale the object's cross-sections by editing these Bézier curves.

For more information on the extrusion envelope, refer to Using the Extrusion Envelope.
Setting Preferences for the Spline Modeler

In the Spline modeler's Preferences dialog you can set preferences for the grid, for naming objects, and for resizing shapes and groups of shapes.

To set preferences for the Spline Modeling window:

1. Choose **File menu > Preferences**. The Preferences dialog appears.
2. Click the menu and choose Spline Modeler from the list.

The Preferences dialog lets you set preferences for the display and behavior of the Spline modeler.

1. Set options as desired:

   - **Resize Shapes And Groups** specifies whether an object is resized from its center or from its opposite corner when you resize by dragging.
   - **Grid Settings** specifies grid settings for the Spline modeler.
   - **Spacing** adjusts the spacing between grid lines in the box and specifies units of measure.
   - **Draw a line every** controls how often grid lines are drawn.
   - **Snap to** causes objects to “snap” to the nearest grid line as you drag them.
   - **Show** toggles the display of grid lines.
   - **Colors** lets you set up a specific color scheme for the Modeling box. When you click a color swatch, the Color Picker appears. Refer to Color Pickers for more on choosing colors.
   - **Show 3D Object in Preset 2D Views** lets you display the 3D object even in the preset 2D views such as Front, Top, and Left.

1. Click OK.

The Grid settings in the Preferences dialog are identical to the **Geometry menu > Grid** command.

Opening the Spline Modeling Window

You open the Spline modeling window by doing one of the following:

- Double-click the object in the Sequencer or the scene window.
- Select a spline object, then click the Model button.

The Model button

- If you're creating a new spline object, the modeling window opens automatically.

When you're finished modeling, you can save your changes and enter a different room by clicking the appropriate room button.

Note: To avoid the memory-consuming accumulation of windows, always close the modeling window when you are finished modeling.
To create a new spline object:

1. Open or create a document in the Assemble room. (For more information, refer to Creating an Empty Scene.)
2. Depending on the desired location of the spline object, do one of the following:
   - To insert a spline object of default size at the center of the universe, choose **Insert menu > Spline Object** or drag the Spline Object tool into the Sequencer.
   - To insert a spline object in any other location, drag the Spline Object tool into the scene window, to any location

The Spline Object tool.

To insert a spline object of a specific size, select the Spline Object tool, then click and drag anywhere in the scene window.

**Working with the Modeling Window**

As with the document window, the Spline modeling window can simultaneously display up to four separate panes. Each pane gives you a different view of your object.

For information on changing the display of panes, refer to Changing Views.

You can work in any view you want. For instance, you might find it convenient to work in a 2D view when drawing a sweep or extrusion path, then switch to the 3D view when you want to work in 3D. To work in a different view, simply click in the pane.

| Note | Use the “Show 3D Object in Preset 2D Views” option in the spline modeler Preferences dialog to hide or show your object in the isometric views of the modeler (Front, Left, Current Section...). |

To make your work flow easier, you can change different features of the Spline modeling window:

- Change the display and behavior of the grid. For more information, refer to Setting Preferences for the Spline Modeler.
- Resize the Modeling box.

**Resizing the Modeling Box**

The Modeling box opens at a scale consistent with the proportions of objects in the scene. If you want to work with an object at some other scale, you can reset the Modeling box's size. You also have the option to resize the object along with the box.

To set Modeling Box and object size:

1. Choose **Geometry menu > Modeling Box Size**. The Modeling Box Size dialog appears.
2. Set the options you want.
The Modeling Box Size lets you adjust the size of the Modeling box in the Spline modeler.

- **Box Size** sets the length of one side of the (square) Modeling box.
- **Scale object with Modeling Box** resizes the object along with the Modeling box.

1. Click OK.

### Changing Your Point of View

Without changing your point of view to examine an object from all sides, it can be difficult to determine its position relative to other objects in the model. When you perform a Boolean operation such as subtraction, this is particularly important—you must be sure the objects are actually overlapping for it to work.

You can dolly, zoom, bank, and track the Director's Camera using the camera controls, and you can pan and zoom the view in 2D using the pan and zoom controls. You can also use the camera list in the upper left corner of the Spline modeling window to switch among the Director's Camera (3D view) and isometric views of the working box's sides.

Use the camera controls to dolly, pan, bank, and track your view through the Director's Camera. For information on using these controls, refer to Camera Navigation.

Use the pan and zoom controls to perform 2D panning and zooming. For information on using these controls, refer to 2D View Tools.

Use the camera list to switch between the Director's Camera and isometric views of the working box sides or of the current section. For information on using these controls, refer to Changing Views.

### Previewing Objects

You can preview objects in the Spline Modeling window at seven different levels of quality.

For more information on the Preview modes, refer to Previewing Objects.

### Creating Shapes and Objects

To create spline objects, you create cross-sections and extrusion paths on the appropriate planes in the Spline Modeling window.

All 2D shapes and paths you draw in the Spline modeler are Bézier curves. A Bézier curve is an interpolated curve whose shape is determined by the relative positions of its vertices and control points. Each segment of a Bézier curve connects two vertices. The control points (handles) extending from each vertex determine the curvature of the path segments.
Use the handles to determine the curvature of the path segments.

Carrara's drawing tools are similar to those found in traditional Bézier-based 2D drawing applications. The drawing tools enable you to create curves and shapes, and to edit and modify those shapes point-by-point.

**Working on the Drawing Plane**

This section discusses tools and techniques you'll need when creating objects in the Spline modeler.

**Inserting Primitive Shapes**

The most basic way to create an object in the Spline modeler is to start with a 2D primitive shape.

The Spline Primitive tools are located on a single pop-up.

You can place a rectangle, rounded rectangle, ellipse, or polygon on a cross-section plane and then apply a spline modeling technique such as extrusion or sweeping.

After creating a shape with one of the Spline Primitive tools, you will not immediately be able to edit its points—you must ungroup it first. For more information, refer to Grouping Shapes.

To insert a rectangular shape:

1. Click the Spline Primitive tool and choose the rectangular shape tool.

   The rectangular shape tool.

   1. On the Drawing plane, drag from one corner of the shape to the opposite corner. Release the mouse button when the shape is the desired size.

   To create a square, choose the rectangle shape and hold down the Shift key while dragging.

To insert a circular shape:

1. Click the Spline Primitive tool and choose the circular shape tool.

   The circular shape tool.

   1. Drag on the Drawing plane.

   To create a circle, choose the ellipse shape and hold down the Shift key while dragging.

To insert a rounded rectangle shape:
1. Click the Spline Primitive tool and choose the rounded rectangle shape tool.

The rounded rectangle shape tool.


Use the Round Rectangle dialog to round the corners of rectangles.

1. Set the curvature on the corners and click OK.

To create a square with rounded corners, hold down the Shift key while dragging.

To insert a polygonal shape:

1. Click the Spline Primitive tool and choose the polygon shape tool.

The polygon shape tool.

1. Drag on the Drawing plane. The Number of Sides dialog appears.

Use the Number of Sides dialog to create a polygon with any number of sides.

1. Set the number of sides for the polygon and click OK.

To keep all angles equal, hold down the Shift key while dragging.

**Drawing Shapes**

You can create open and closed paths of any shape you like with the Pen tool.

Draw paths on the Drawing Plane with the Pen tool.

The Pen tool works in two ways: you can click and drag to draw curves, or you can add one point at a time like playing connect the dots. As you add points, Carrara connects them by drawing segments.

- Points are classified as either corner points or curve points:
- A curve point's handles are bound together, creating a straight tangent for the path and resulting in a smooth curve.
- A corner point's handles can move independently of one another or retract them completely, allowing you to create abrupt changes in the direction of the path.
Corner points have no handles; curve points have control handles extending from the point.

To use the Properties tray to transform shapes you create with the Pen tool, you must group them first. For information on grouping shapes, refer to Grouping Shapes. For information on setting object properties, refer to Setting Object Properties.

To draw a new path:

1. Deselect all existing paths and shapes by clicking in an empty area of the Drawing plane with the Selection tool.
2. Click the Pen tool.
3. Click anywhere on the Drawing plane to start the new path with a corner point. Or, drag to start with a curve point.
4. Click or drag to add each subsequent point. As you add each point, Carrara draws the segments to connect the path.

To add a corner point:

1. Choose the Pen tool.
2. Click (do not drag) at a point on the Drawing plane.

Hold down the Shift key to draw the path in 45° increments.

To add a curve point:

1. Choose the Pen tool.
2. Drag the Pen tool at a point on the Drawing plane. As you drag, a pair of handles extends from the point. By default, each pair of handles is bound together, creating a curve point—the two handles remain parallel to one another.

   • Hold down the Shift key while dragging to move the handles in 45° increments.
   • Hold down the Option/Alt key while dragging to break apart a pair of handles, creating a corner point. You can then move each handle independently. Continue to hold the Option/Alt key down while dragging. If you release the key before releasing the mouse button, the handles snap back together.

When you click a curve handle, the handles extending from the point will move independently.

To close a path:

• With the Pen tool, click the first point you added.

Editing Shapes

You can edit custom or primitive shapes and paths in the following ways:

• Add and delete points
• Delete segments
• Convert corner and curve points
• Move points
• Adjust curves
To view all points on a path or shape:

1. Click the Selection tool.
2. Click a path or shape.

All the points on the curve become visible, but none are individually selected. A point appears black when it is selected and white when it is deselected.

- Hold down the Shift key, then click additional paths to view the points on multiple paths.
- Hold down the Shift key, then click a path whose points are visible to make them invisible.
- Click in an empty area of the Drawing plane to make all points invisible.

To select points one at a time:

1. Click the Selection tool.
2. Click a point on a path or shape to select it.

The point color changes from white to black and its handles, if it has any, become visible.

- Hold down the Shift key, then click additional points to increase your selection.
- Hold down the Command/Control key, then click a path to select all the points on the path. Or, double-click the path.
- Hold down the Shift key, then click a selected point to deselect it.
- Click in an empty area of the Drawing plane to deselect all points.

To select points by dragging:

1. Click the Selection tool.
2. Drag a marquee around the points you want to select.

To add points to either end of an open path:

1. Select one of the endpoints of an open path with the Selection tool.
2. Click the Pen tool.
3. Click or drag to add the next point. Carrara draws a segment to continue the path to the new point.
4. Continue adding points until you're satisfied with the path.

To add a point between two existing points:

1. Click the Add Point tool.

The Add Point tool.

1. Click anywhere on a path or shape. Carrara determines whether to add a corner point or a curve point, depending on the shape of the path. The new point is automatically selected so it can be moved with the Selection tool.

When you add a point to the sweep path, you can simultaneously add a cross-section plane at that point—just hold down the Option/Alt key as you click.
To delete a point:

1. Click the Delete Point tool.

The Delete Point tool.

1. Click a point on a shape or path. When you delete a point in the middle of a path, the points on either side of the deleted point become connected by a new segment, changing the shape of the path.

When you delete the endpoint of an open path, the last path segment disappears, leaving a new endpoint.

If you delete a point on the sweep path, any cross-section associated with that point is deleted as well.

To delete a segment:

1. Click the Delete Point tool.
2. Click a path segment on a shape. Removing a path segment leaves adjacent path segments unchanged. When you delete a path segment from a closed path, the path becomes an open path.

When you delete a path segment from an open path, the path is split into two separate open paths.

The delete segment feature applies to cross-section shapes only—you cannot delete a segment from the sweep path or the extrusion envelope.

To convert a corner point to a curve point:

1. Click the Convert Point tool.

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1. Click the Convert Point tool.

To convert a curve point to a corner point using the tools:

1. Choose the Convert Point tool.
2. Click a curve point on a shape or path. The point's handles retract.

To convert a curve point to a corner point using the Properties tray:

1. Select a point on a cross-section plane.
You can only use the properties tray controls for points on a cross-section plane.

1. In the Properties tray, click either the Corner Point or Smooth Point button.

To move points:

1. Click the Selection tool.
2. Select the points you want to move. To move an entire path, select all the points on the path.
3. Drag the selected points to a new location.

   - Hold down the Shift key while you drag to move the points in 45° increments.
   - You can also move points in cross-sections in the Properties tray. Select a point and enter values for X and Y.
   - All selected points move together. As you drag, Carrara redraws the path segments affected by the move.

To adjust a curve interactively:

1. Click the Selection tool.
2. Click a point on a path or shape to select it.
3. Drag the point's handles.
4. As you drag, Carrara redraws the curve.

   - When you move a curve point handle, the opposite handle moves to remain parallel to the one you are moving.
   - Hold down the Shift key while you drag to move the handle in 45° increments.
   - Hold down the Option/Alt key while you drag to break apart a pair of parallel handles. You can then move each handle independently.

To adjust a curve numerically:

1. Select a point on a cross-section plane. You can only use the properties tray controls for points on a cross-section plane.
2. In the Properties tray, enter values for Next and Previous Control Handle.

The Properties tray in the Spline modeler shows the position of points and control handles.

The Next and Previous Control Handle identify the two control points for the selected vertex. The Next and Previous Controls are relative to the selected control point, based on the order in which points were drawn.

The curve above shows the order in which points were added. Using this order, the Next Control Handle would be to the right of the selected vertex and the Previous Control Handle would be to the left.

Here the order is reversed so the Next Control Handle would be to the left of the selected point and the Previous Control Handle would be to the right.
The dx and dy values refer to the distance from the selected vertex along the X and Y axis.

**Adding and Editing Text**

The Text tool lets you create text on a cross-section plane. The Text tool works differently than the Text Modeler.

Use the Text tool when you want to extrude text along a curved path. Use the Text modeler when you want to extrude text along a straight path and add bevels. Refer to Creating Text Objects for more on the modeler.

To draw text on the cross-section plane:

1. Click the Text tool.

   ![The Text tool.](image)

   The Text tool.

1. Click the Drawing plane to position the text. The Text dialog appears.

   ![Enter text in the Text dialog.](image)

   Enter text in the Text dialog.

   1. In the blank window at the bottom of the dialog, type the text you want.

   2. Set the Text controls to achieve the desired effect.

   3. Select a font from the list. You can use any TrueType and Type 1 fonts in your system for creating text objects.

   4. Select a font style from the list.

      - **Font size** measured in points, sets the size of the font.
      - **Scaling** scales the length of the text without affecting the height (Font size) or Depth. A setting of 200% doubles the width of the text object.

   ![The same text scaled at 100% and at 200%](image)

   The same text scaled at 100% and at 200%.

      - **Alignment** aligns text on the left, right, or center.

   ![The Alignment icons.](image)

   The Alignment icons.

      - **Leading** sets the spacing between lines.
      - **Word Spacing** measured in points, sets the spacing between words.
      - **Letter Spacing** measured in points, sets the spacing between letters.

   1. Click OK.

To edit a text object:

- Select the Text tool and click the text object. The text dialog appears and you can change all...
the current settings.

**Breaking Apart Text Objects**

Once you have created text, you can break the text object into individual characters, which you can reposition, rotate, and continue modeling like any other object.

To break apart a text object:

1. Select the text object.
2. Select *Arrange menu > Convert Text to Outlines*. The letters are separated into discrete cross-section shapes on the Drawing plane.

**Working with Shapes**

Working on the Drawing plane, you can manipulate shapes and cross-sections in several ways:

- Perform simple operations such as changing the scale, position, and orientation of individual shapes.
- Group shapes in a cross-section to edit them together.
- Compound the shapes on a cross-section to hollow out a 3D object.

This section includes general instructions for working on the Drawing plane. For specific information on cross-sections and sweep paths and how they relate, refer to Working with Cross-Sections and Working with the Sweep Path.

**Importing 2D Shapes**

Carrara lets you import cross-section shapes, sweep paths, and envelopes in Adobe Illustrator, or EPS format. The file can include one or several 2D shapes. You should, however, avoid unnecessary complexity.

Some information from the imported file will be translated or lost:

- Paint characteristics such as stroke and fill are ignored.
- Compound paths are preserved.
- Text is automatically converted to outlines.

For more information on importing files, refer to Importing 3D Objects.

To import shapes to a cross-section:

1. Click the cross-section plane you want to work with. You can also create a new cross-section plane using *Sections menu > Create*.
2. Choose *File menu > Import*. The Import dialog appears.
3. In the dialog, select the file you want, then click Open. Carrara places the artwork on the Drawing plane.
4. Click OK.

To import a shape as a sweep path or envelope:

1. Choose **Geometry menu > Extrusion Envelope** to turn on the extrusion envelope. You can use any type of envelope.
2. Click one of the sweep path planes to make it the Drawing plane.
3. Choose **File menu > Import**. The Import dialog appears.
4. Select the file you want, then click Open.

- If the file you choose contains more than one path, only the first path will be imported.
- Another dialog appears, allowing you to specify whether the path should be used as the sweep path or the envelope.

1. Specify sweep path or envelope.
2. Click OK. Carrara imports the sweep path or envelope.

**Note**: Importing a sweep path or envelope replaces the current sweep path and envelope.

**Grouping Shapes**

You can group one or more shapes using the Group command. Grouping two or more shapes lets you manipulate them all at once.

**Note**: Grouping is allowed only on cross-section planes, not the sweep path.

To group shapes:

1. Select the shape(s) you want to group.
2. Choose **Edit menu > Group**.

A bounding box encompassing the grouped shapes indicates the size and location of the group.

To ungroup:

1. Select the group you want to ungroup.
2. Choose **Edit menu > Ungroup**.

**Scaling Shapes**

You can scale a shape or group of shapes directly by using the Resize tool, or numerically by using the Scale dialog. For information on using the Resize tool to scale objects, refer to 3D Object Manipulation Tools.

**Note**: Scaling is allowed only on cross-section planes, not the sweep path.

You can also scale an entire object by scaling the Modeling box. Refer to Resizing the Modeling Box.

Scaling shapes directly is not always necessary. The extrusion envelope, described in Using the Extrusion Envelope, can often accomplish the same results more simply and powerfully.

To scale shapes numerically:
1. If necessary, group the curves or shapes you want to resize.
2. Choose **Arrange menu > Scale**. The Scale dialog appears.

Use the Scale dialog to numerically resize shapes.

1. Enter horizontal and vertical scale factors.
2. Click OK.

**Moving Shapes**

You can move shapes using standard dragging techniques.

To move shapes manually:

1. If necessary, group the curves or shapes you want to move.
2. Click the Selection tool.
3. Drag the shape wherever you like.

To move shapes numerically:

1. With the Selection tool, click the shape.
2. In the Properties tray, enter values in the top and left fields.

Shape position is measured relative to the top and left edge of the Drawing Plane.

**Rotating Shapes**

You can rotate an object in two ways:

- Free rotate an object in relation to the Drawing plane (2D rotation).
- Rotate an object a specific angle using the Rotation dialog.

The Rotation tool rotates a shape around its center. The Rotation dialog can rotate a shape around either its center or the Drawing plane's center.

**Note** Rotating is allowed only on cross-section planes, not the sweep path.

To free rotate a cross-section in 2D:

1. Set the Drawing plane to the plane on which you want to rotate the shape. If necessary, group the curves or shapes you want to rotate.
2. Click the Rotation tool.

The Rotation tool.

1. Drag the shape in a circular motion. Hold down the Shift key to rotate the shape in 45°
To numerically rotate a cross-section on the Drawing plane:

1. If necessary, group the curves or shapes you want to rotate.
2. Select the shape(s), and choose **Arrange menu > Rotate**. The Rotation dialog appears.

Use the Rotation dialog to numerically rotate an object.

1. Enter the Angle of rotation.
2. Enable degrees clockwise (CW) or counterclockwise (CCW).
3. Enable the Twist Surface option if you want to twist the surface of the object as you rotate. For more information on this option, refer to Twisting An Object.
4. Enable a rotation center—the shape's center or the Drawing plane's center.
5. Click OK.

**Beveling Shapes**

The bevel menu contracts or expands a shape: it replaces the original shape by one that follows its outline at a given distance.

A 0.5inch bevel was applied to the outer shape to produce the middle shape. In comparison, the inner shape is the result of a 50% scaling of the outer shape.

To apply a bevel to one or more shapes:

1. Select the shapes(s) you want to bevel.
2. If you want to keep the original shape(s), select Edit>Copy and then Edit>Paste.
3. Choose Arrange menu > Bevel.
4. Enter a bevel value (a negative value will expand the shapes).
5. Click OK.

**Centering Selections**

You can center selected shapes on the Drawing plane using the Center Selection command. If several shapes are selected, they maintain their spatial relationship to each other.

Unlike using the Center command in the Sections menu, Center Selection only centers the selected shape, not all shapes in the cross-section. This makes it ideal for creating compound cross-sections.

- **Note**: You can also center everything on the cross-section, maintaining the spatial relationships among shapes. For more information, refer to Centering Cross-Sections.

To center a selected shape on the Drawing plane:

1. Select the shape or shapes you want to center.
2. Choose **Arrange menu > Center Selection**.
With *Sections menu* > *Center*, every shape on the drawing plane is centered regardless of your selection. With *Arrange menu* > *Center Selection*, only the selected shape is centered.

### Setting Object Properties

The Properties tray displays the properties of the selected point, control handle, shape, group, or compound cross-section.

You can edit shapes and cross-sections by making numerical adjustments in the Properties tray. When you select a point, Carrara displays the X and Y coordinates.

- When you select a curve point, Carrara displays the X and Y positions of its handles (Control Handle). When these controls are active, you can retract a control handle using the Retract button.
- When you select a grouped cross-section, Carrara shows its height and width, top and left coordinates, and shape number.
- No information is available for ungrouped shapes or for partially selected shapes.

By default, Carrara shows all values in inches. You can change the units of measure using the Preferences: General dialog. For more information, refer to Setting Application Preferences.

To change the properties of a cross-section:

1. Drag open the Properties tray if needed.
2. Select a cross-section group or point.
3. Adjust the values you want.
   - If you selected a closed cross-section:
     - Enable the Keep Proportions checkbox to maintain the shape's aspect ratio as you resize it.
   - If you selected points on a cross-section:
     - Click the Corner Point button to convert the curve point to a corner point.
     - Click the Smooth Point button to convert the corner point to a curve point.
   - If you selected a curve point:
     - Click the Retract button to retract the point's handles.

### Setting Surface Fidelity

Carrara renders an object by breaking it into hundreds of tiny polygons. This helps the renderer understand the contents of the scene.

The number of polygons Carrara uses for each object is based on the size of the object, its distance from the camera, and the rendering resolution. This calculation usually results in a smooth object.

If an object does not render as smoothly as you'd like, you can increase its surface fidelity. This forces Carrara to break it down into a greater number of polygons.
If none of the objects in your scene renders as smoothly as you would like, you can increase the rendering Silhouette Quality, instead. However, this option uses more memory and increases rendering time. For more information, refer to Rendering Engines.

The surface fidelity value is resolution-independent. That is, if a particular value yields good results for a given object in a given scene at high resolution, it should yield good results at lower resolutions as well.

To set surface fidelity:

1. Choose Geometry menu > Surface Fidelity. The Surface Fidelity dialog appears.

Use the Surface Fidelity dialog to control the smoothness of an object's rendering.

1. Enter a percentage to increase or decrease the object's surface fidelity. The default value is 100%.
2. Click OK.

**Working with Cross-Sections**

A basic spline object, such as a box, has one cross-section at the start of the path. The shape on this first section is swept to the end of the extrusion path. To create more complex forms, you can add any number of cross-sections along the path. Because each cross-section, in turn, can contain any number of shapes, you can use multiple cross-sections to model intricate objects.

As you begin to work with the Spline modeler, you will find that the sweep path and cross-sections are closely tied. Although separated here for the sake of clarity and organization, these concepts go hand in hand. Be sure to read Working with the Sweep Path.

**Creating and Removing Cross-Sections**

You can add as many cross-sections as you like to an object. Each cross-section must correspond to a point on the sweep path. If you want to create a cross-section where there is no point, you must first add a point.

A simple object can become complex just by adding additional cross-sections.

Although modeling with multiple cross-sections enables you to achieve otherwise impossible effects, be careful not to add cross-sections unnecessarily. Editing an object with too many cross-sections can become difficult and tedious. Often, you can accomplish similar results using the extrusion envelope. Refer to Using the Extrusion Envelope.

To create a new cross-section:

1. If there is a point on the sweep path where you want the new cross-section:
• Select the sweep path and choose **Sections menu > Create**.

1. If there is no point:
   
   • Choose the Add Point tool.
   • Hold down the Option/Alt key and click the sweep path at the point where you want to create the new cross-section.

   Carrara adds a point to the sweep path and creates a new cross-section at that point.

   1. If you're working on a cross-section plane:

      • Choose **Sections menu > Create**.

   If there is a shape on the previous cross-section, Carrara copies it to the new cross-section. You can delete the new shape without deleting the new cross-section.

   To remove a cross-section:

   1. Click the cross-section you want to remove, or select the corresponding point on the sweep path.
   2. Choose **Sections menu > Remove**.

   To remove a cross-section and its sweep path point:

   • Use the Delete Point tool to delete the point from the path.

### Generating Intermediate Cross-Sections

You can have Carrara create a specific number of cross-sections between the current cross-section and the next one.

To generate intermediate cross-sections:

1. Click a cross-section plane.
2. Choose **Sections menu > Create Multiple**. The Create Multiple Cross-Sections dialog appears.

   Use the Multiple cross-sections dialog to insert identical cross-sections.

   1. Enter the number of sections you want.
   2. Click OK.

   Carrara creates the intermediate cross-sections, spacing them evenly between the current cross-section and the next one. Carrara adds a new point to the sweep path for each cross-section it creates.

   The shapes on the new cross-sections are interpolated from the shapes on the existing cross-sections. This process is similar to blending between two shapes in a 2D illustration program—each shape on the new cross-sections is like one “step” in the blend.
**Moving Among Cross-Sections**

If you have multiple cross-sections, you can move the Drawing plane to any cross-section.

To move to an adjacent cross-section:

Do one of the following:

- Choose *Sections menu > Next* or *Previous*.
- Hold down the Command/Ctrl key and press the right or left arrow key to move to the next or previous cross-section.

To move to a specific section:

1. Choose *Sections menu > Go to*. The Go To cross-section dialog appears.

The Go To cross-section dialog lets you navigate quickly among multiple cross-sections.

1. Enter the number of the section you want to go to.
2. Click OK.

Cross-sections are numbered from back to front.

**Displaying Cross-Sections**

If you have multiple cross-sections, you can display them all at once or show only the current one. Displaying only the current one gives you a better idea of the appearance of your object; displaying all lets you easily identify the cross-section shapes you have to work with.

To show all cross-sections or only the current one:

- Select *Sections menu > Show > Current* or *All*.

**Centering Cross-Sections**

Often when you're creating cross-sections, you can end up with a number of sections whose centers aren't aligned, which can lead to unexpected results. It's usually a good idea to center sections when you're finished drawing them.

To center a cross-section on the sweep path:

1. Select the section you want to center.
2. Choose *Sections menu > Center*. The shape(s) on the cross-section will be centered around the sweep path.

*Note* You can also center specific selections. For more information, refer to Centering Selections.
Compounding Shapes

Compounding shapes is like grouping them, with one significant difference–any shape completely enclosed by another in the same compound “cuts away” from the larger shape. This leaves a hollowed out shape, which can be extruded to produce an object such as a pipe or a hollow log.

This hollow log was created by extruding two compound cross-sections.

To compound shapes:

1. Select the shapes you want to compound.
2. Choose **Arrange menu> Combine as Compound**.

To break apart a compound:

1. Select the compound you want to release.
2. Choose **Arrange menu> Break Apart Compound**.

**Note** Compound shapes are allowed only on cross-section planes.

Compound Shapes: Tutorial

The section that follows is a step-by-step tutorial that shows you how to create a simple compound shape.

To create a compound shape:

1. Use the Rectangle primitive tool to draw a square on the Drawing plane.

First, draw a square.

1. On the same Drawing plane, use the Oval primitive tool to draw a circle within the square.

Next, draw a circle within the square, on the same Drawing plane.

1. Select both shapes by pressing Command/Ctrl+A, Shift-clicking, or dragging a marquee around both shapes with the Selection tool.
2. Choose **Arrange menu> Combine as Compound**. The circle cuts away from the square.

Although much simpler, this figure uses the same techniques as the hollowed-out log.
### Filling and Emptying Cross-Sections

You can fill a cross-section to make an object “solid.” For example, a cylinder with its endcaps filled would be something like a solid can; a cylinder with its endcaps emptied would be a tube that you could look through.

An object's first and last cross-sections are often referred to as endcaps—you can turn endcaps “on” by filling them or “off” by leaving them unfilled.

To fill and empty cross-sections:

1. Click a cross-section plane.
2. Choose **Sections menu > Cross-Section Options** to open the cross-section Options dialog.

   ![Cross-Section Options dialog](image)

   The Cross-Section Options dialog.

   1. Enable Fill Cross-Sections to create solid sections, or disable the option to create empty sections.

You can also use the cross-sections dialog to disconnect cross-sections and choose skinning options. For more information, refer to Disconnecting Cross Sections.

### Modeling with Multiple Cross-Sections

Modeling with multiple cross-sections lets you increase your control over the shape of your object's surface.

With each section you add, you increase your control over how the surface is created. You can add subtle variations in your object's surface by creating more cross-sections with different shapes.

![Cross-sections](image)

By adding more cross-sections, you can vary the surface of your object.

Of course, the more cross-sections you add, the more complicated it becomes to work in the modeler. However, the Spline modeler has some features to help you model with multiple cross-sections, described in this section.

### Numbering Shapes

Carrara automatically numbers the shapes in each cross-section, establishing a correspondence between the shapes in adjacent cross-sections. In cross-sections containing multiple shapes, this shape numbering determines which shape sweeps to which other shape.

You can renumber the shapes to change the shape-to-shape correspondence. Each shape's number is displayed in the Properties tray.
Cross-section shape numbers let you control how sections are extruded along a sweep path.

To control shape-to-shape correspondence:

1. Select a shape to number. You must select every point on the shape, or regroup the shape.
2. Do one of the following:
   - Choose **Sections menu > Set Shape Number**. The Shape Number dialog appears.

The Shape Number dialog identifies the currently assigned number of the selected shape.

- Display the Properties tray.
1. In the Shape Number field, type in the number you want.
   - If you enter the number of another shape in the same plane, Carrara swaps those numbers.
   - If you enter a unique number, make sure you assign the same number to the appropriate shape in the adjacent cross-section(s).
   - Carrara does not extrude any shape that has no correspondence (that is, its number does not match any shape number in an adjacent section).
1. Click OK.

**Disconnecting Cross Sections**

You can create multiple and “intermittent” objects by disconnecting adjacent cross-sections.

Object created using the Disconnect from next cross-section option.

To disconnect cross-sections:

1. Select the cross-section you want to disconnect.
2. Choose **Sections menu > Cross-Section Options**, or open the properties.
3. Enable the **Disconnect from next cross-section** checkbox.

Carrara turns off extrusion between the selected cross-section and the next one.

**Setting Skinning Options**

The Spline modeler automatically extrudes between each cross-section and the next, basing the surface of the object on the shapes in the cross-sections and on the skinning options.

The skinning options make your surface either sharp-edged or smoothed.

Shape-to-shape and point-to-point skinning.
To set skinning options:

1. Choose Sections menu > Cross-Section Options to open the cross-section Options dialog, or open the properties.
2. Set a Skinning option:

   - **Skin shape-to-shape** is especially well suited for creating smooth, organic surfaces whose cross-section shapes are significantly different from one another. In fact, if adjacent cross-sections have different numbers of vertices, shape-to-shape skinning is the only option available.
   - **Skin point-to-point** can be used when adjacent cross-sections contain very similar shapes and you want each vertex in one cross-section to be connected directly to the corresponding vertex in the next cross-section. This option is useful when you model an object that requires straight, sharp edges.

1. Click OK.

### Twisting an Object

When you rotate a cross-section shape, you can specify that the rotation be applied to the surface of the object to give it a twisted appearance.

You can twist an object by rotating its cross-sections.

To twist an object:

1. Select a cross-section.
2. Hold down the Option/Alt key while rotating the cross-section with the Rotation tool.

Hold down the Shift key to rotate the shape in 45° increments.

To twist an object numerically:

1. Select a cross-section.
2. Choose Arrange menu > Rotate. The Rotation dialog appears.
3. Specify the direction and degree to rotate the selection.
4. Enable the Twist Surface option.

Carrara twists the surface the specified number of degrees.

Use rotation values greater than 360° to specify multiple twists.

### Twisting: Tutorial

The following section is a step-by-step tutorial that shows you how to create a simple twisted object.

To create a twisted bar:

1. Place a square on the first cross-section.
First create a square cross-section on the Drawing plane.

1. Select the final point on the sweep path and choose **Sections menu > Create** to create another cross-section.
2. Select each cross-section and choose **Sections menu > Center**.

Then center the two cross-sections.

1. Choose **Arrange menu > Rotate**.
2. In the Rotate dialog, enter an angle of 720°.
3. Enable Twist Surface.
4. Click OK.

The completed twisted bar.

**Adding bevels to a Cross-Section**

With controls very similar to those used by the text object (Creating Text Objects), you can add a front and a back bevel to a cross-section. The shapes in the beveled section will stay the same, but one or two automatic cross-sections will be created. In those sections, new shapes will be automatically calculated from those contained in the beveled section, and updated if you modify the originals.

To bevel a cross section:

1. Select the cross section that you want to bevel. The properties tray displays the options available for that section.

The properties of the current Cross-Section.

1. Click the Front Face box if you want to add a bevel between the selected section and the next point on the sweep path.
2. Click the Back Face box if you want to add a bevel between the selected section and the previous point on the sweep path.
3. Enter a Depth value for the front/back face. It determines the size of the bevel along the sweep path. This value must be smaller than the distance between the selected section and the next/previous sweep path point.
4. Enter a Height value for the front/back face. This determines the size of the bevel along the cross section plane.

A negative value will expand the section's shapes. A positive value will contract them.

When using a positive value, it should be much smaller than the size of the shapes in the section.
1. Select a bevel Type for the front/back face. This determines the shape of the bevel by modifying the envelope of the object.

**Tip** To get better results, you should set the point-to-point skinning option on the beveled cross-section.

**Bevel: Tutorial**

The following section is a step-by-step tutorial that shows you how to create a text with a bevel in the Spline modeler.

To bevel a text in the Spline modeler:

1. Select the text tool and click in the first cross section.
2. Type “DAZ 3D” or another text, set the Font Size to 200 and click OK.
3. Choose Arrange menu> Center Selection.

![Image]

The text without bevels.

1. In properties, check Back Face, set the depth to 0.50 in and choose a bevel type.

![Image]

![Image]

The bevel on the back face of the first cross section and its properties.

1. Select the final point on the sweep path and choose the Sections menu> Create, then select the last cross section (#2).
2. In properties, make sure Skin point-to-point is pressed, then check Front Face, set the depth to 0.50 in and choose a bevel type.

![Image]

![Image]

The bevel on the front face of the last cross section and its properties.

**Working with the Sweep Path**

The key to working with the sweep path is understanding how the 2D path description lines define the 3D sweep path. There are two path description lines, one on each sweep path plane. Although the path description lines appear to be two separate planes, they are actually projections of the same path.

![Image]

You can tell the exact position of the sweep path by its path description lines.

Each point on one path description line corresponds to a point on the other path description line. In
fact, each pair of points represents a single 3D point on the sweep path.

The sweep path projection on the ground plane describes the sweep path's horizontal position; the projection on the side plane describes its vertical position.

The projection on the ground plane displays the sweep path's horizontal position. The projection on the side plane displays the sweep path's vertical position.

A sweep path curved on the side plane but straight on the ground plane would create an object whose shape curves up and down, but not side to side.

A sweep path curving in 2D will create an object that curves only up and down.

A path that curves on both planes would create an object whose shape curves both side to side and up and down.

A sweep path curving in 3D will create an object that curves both up and down and side to side.

Drawing a Sweep Path in 3D

The best way to start drawing a sweep path is to consider how you want your object to look, both from the side and from the top. An object that has a lot of curves when viewed in profile, but looks straight when viewed from the top, indicates that the sweep path will remain straight on the ground plane and curved on the right plane.

An object that has many curves when viewed in profile, but appears straight when viewed from above.

Unfortunately, few objects are this simple. Most objects have some variation from both the top and the profile. You can easily draw this type of sweep path by adjusting the point on the two sweep path projections.

In some cases, simple adjustment might not be enough. You might want to draw the sweep path continuously from the first point to the last, switching back and forth between the two planes as you work.

Drawing a Sweep Path in 3D: Tutorial

The picnic table frame in this tutorial is modeled by drawing a continuous path in 3D—the diagrams that follow illustrate the process.
To draw a sweep path in 3D:

1. Create a small circular cross-section and center it. This will give you a round bar.
2. Extend the sweep path to the end of the working box by moving its points.
3. Click the Pen tool.
4. On the left plane, draw a point down perpendicular to the sweep path. As you draw, Carrara adds points on the ground plane as well.

1. On the ground plane, add a point to the right, perpendicular to the sweep path.

1. Switch to the left plane and select the last point. Then draw a point up from the selected point, as shown.

1. Switch back to the ground plane, select the last point and extend the line to the right as shown.

1. Continue switching from the left and ground plane, adding points as shown.

1. Finally, working on the left plane, close the path by drawing from the last point to the original point.

1. To complete the table, just add some boards for the table-top and seats.

**Cross-Sections and the Sweep Path**

When you're working with the sweep path, it's important to understand the relationship between the path and the cross-sections. You can think of the sweep path as an object's spine. Whenever you move a point on the sweep path, any cross-section at that point will move as well.

The opposite is not true, however. When you drag a cross-section shape along the cross-section plane, the sweep path is not affected; you are simply moving the cross-section off its center.
Cross-sections don't have to be centered around the sweep path. You can move a cross-section off the center of the sweep path.

**Translation vs. Pipeline**

The Spline modeler can extrude cross-sections along the sweep path using one of two extrusion methods: translation or pipeline.

With the translation method, each cross-section remains perpendicular to the ground plane of the Spline Modeling window, regardless of the sweep path's curvature.

With the pipeline method, the orientation of each cross-section depends on the direction of the sweep path at the point where the cross-section is located—all cross-sections remain perpendicular to the sweep path, rather than to the ground plane.

Translation compared with pipeline.

Note: Changing methods can reset your sweep path and extrusion envelope.

To choose an extrusion method:

- Choose *Geometry menu > Extrusion Method > Translation* or *Pipeline*.

Tip: With the pipeline extrusion method, using the Current Section view makes working on the shapes of the current cross-section much easier.

**Using Extrusion Presets**

Carrara has three extrusion presets, which automatically generate specific types of sweep paths. When you apply an extrusion preset, Carrara replaces the current sweep path and envelope with the preset path.

To straighten the sweep path:

- Choose *Geometry menu > Extrusion Preset > Straight*.

Carrara moves all of the points on the sweep path into a straight line. Cross-section shapes are unaffected.

**Working with Spirals**

When you use the Spiral extrusion preset, only the first cross-section of your existing object is kept—the remaining cross-sections, sweep path, and envelope are all replaced.

To make a spiral:
1. Draw a 2D shape on the cross-section plane and select the shape.
2. Choose *Geometry menu > Extrusion Preset > Spiral*. The Spiral dialog appears.

The Spiral dialog lets you create different spiral-shaped objects.

1. Set the options you want.
   - **Number of turns** is the number of loops in your spiral. One turn equals 360°.
   - **Length** determines the length of the sweep path. This affects how tightly the spiral will be wound.

The length of the sweep path affects how tightly the coil will be wound.

   - **Distance to axis** determines the size of each coil by setting the distance between the cross-section shape and the spiral's central axis. The relationship between the number of turns and the length determines how tightly the coils of the spiral are spaced.

Relationship between length and distance.

   - **Cross-Section Scaling** lets you shrink or enlarge the cross-section shape as it sweeps along the spiral path. Values less than 100% shrink the shape; values greater than 100% enlarge the shape.
   - **Spiral Scaling** lets you decrease or increase the distance to the axis as the cross-section shape sweeps along the path. Values less than 100% taper the spiral; values greater than 100% widen it.

1. Click OK.

Carrara creates the spiral sweep path you have specified and automatically switches to pipeline extrusion.

**Spirals: Tutorials**

The following sections provide step-by-step instructions for creating different types of spirals.

To make a “snail” spiral:

1. Place a circle on the Drawing plane.
2. Open the Spiral dialog.
3. Specify 5 or more as the Number of turns.
4. Decrease the cross-section Scaling to approximately 10%.
5. Decrease the Spiral Scaling to approximately 10%.
6. Click OK.

The completed snail spiral.
To make a “tunnel” spiral:

1. Place a circle on the Drawing plane.
2. Open the Spiral dialog.
3. Specify 5 or more as the Number of turns.
4. Increase the Spiral Scaling (to 300%, for instance).
5. Click OK.

The completed tunnel spiral.

To make a “rope” spiral:

1. Place a circle on the Drawing plane.
2. Open the Spiral dialog.
3. Specify 5 or more as the Number of turns.
4. Decrease the Distance to axis setting (from 8.00 to 2.00, for instance).
5. Click OK.

The completed rope spiral.

**The Torus Extrusion Preset**

The Torus extrusion preset automatically creates a perfect circular sweep path. For more information, refer to Lathing.

**Using the Extrusion Envelope**

To a large extent, the contours of a spline object are determined by the cross-sections you place along the sweep path. Wherever you change the size or shape of a cross-section, the object’s surface changes accordingly.

To create some complex objects, you might find that you’ll need a finer degree of control than cross-sections alone can provide. The extrusion envelope lets you specify how an object's surface should curve from one cross-section to the next, giving you precise control over the object's form.

For the best results, you should model the object as completely as possible using the sweep path and cross-sections, then adjust the extrusion envelope as a final step.

**Understanding the Envelope**

By default, Carrara does not use the extrusion envelope— it stretches the object’s surface over the cross-sections as simply as possible. When you turn the envelope on, it appears as four description lines, two on each sweep path plane. (The different colored line on each sweep path plane is a path
description line–refer to Working with the Sweep Path.)

Initially, the envelope conforms to the dimensions of the object's cross-sections, widening and narrowing if the cross-sections vary in size.

Object with envelope.

The envelope description lines are Bézier curves. By editing these curves, you can alter an object's contours. The envelope has three modes: Symmetrical, Symmetrical in Plane, and Free.

With the Symmetrical envelope setting, all the envelope lines maintain symmetry.

Symmetrical envelope.

Symmetrical in Plane lets you edit the envelope description lines in pairs.

Symmetrical in Plane.

Free lets you edit each line individually. This allows you to model asymmetrical objects.

Free envelopes.

**How the Envelope Relates to the Sweep Path**

Each point on the extrusion envelope corresponds to a point on the sweep path. When you add a point to the extrusion envelope, Carrara also adds a point to the sweep path. Likewise, when you delete a point from the envelope, Carrara deletes the corresponding point from the sweep path.

Moving an envelope point perpendicular to the sweep path controls the scaling of the object at that point on the path. Moving an envelope point parallel to the sweep path moves the corresponding point on the sweep path as well.

When you are using the pipeline extrusion method, envelope points can move only perpendicular to the sweep path.

**How the Envelope Relates to Cross-Sections**

Editing the extrusion envelope can also affect an object's cross-section shapes. If you edit the envelope at a point where there is no cross-section, only the surface between cross-sections is affected. However, if you edit the envelope at a point where a cross-section exists, the shapes on the cross-section are scaled accordingly. If you delete a point from the envelope, you will also delete any cross-section located at that point.
When you use the extrusion envelope on multiple-shape cross-sections, the center point is the sweep path—not the center of each shape. If you want to scale a cross-section's individual shapes around their own center points, you should resize each shape individually on the cross-section plane rather than use the extrusion envelope.

**Using the Envelope**

To use the envelope, you turn it on and set a symmetry constraint other than the default of None. After that, you can directly modify it.

To use the envelope:

- Choose **Geometry menu > Extrusion Envelope**> select one of the options described below.
- If the envelope is not already enabled, the four envelope description lines appear on the sweep path planes.
- **Symmetrical** uses the same curve for all four envelope description lines—when you edit one line, the others update automatically.
- **Symmetrical in Plane** uses the same curve for the description lines in either plane—when you edit one line, the other in its plane updates (as a mirror image) automatically.
- **Free** allows each description line to have a unique curve.

To modify the extrusion envelope:

- Use the drawing tools to edit the envelope description lines.
- You can add and delete points, as well as adjust existing points and control handles. As you adjust one of the envelope description lines, the other lines are updated in real time.
- For instructions, refer to Editing Shapes.

To reset the extrusion envelope:

- Choose **Geometry menu > Reset Envelope**. Or, choose **Geometry menu > Extrusion Envelope**> None.

**Lathing**

Lathing lets you create symmetrical objects by rotating a 2D profile around a straight axis. Rotation can be circular or angular, a full 360º or less.

Because your lathe object is actually a spline object, you can edit it in ways that traditional lathing tools do not allow. For example, you can create a symmetrical lathe object, then deform it using the spline modeler's other tools.

You can choose from two different lathing methods:

- Lathing with the extrusion envelope
- Lathing with a circular sweep path
Lathing with the Extrusion Envelope

You can create nearly any lathe object by extruding a circle or a regular polygon and using the extrusion envelope to draw the object's lathe profile.

For more information on the extrusion envelope, refer to Using the Extrusion Envelope.

To create a lathe object with the extrusion envelope:

1. Click a cross-section plane.
2. Draw a cross-section using one of the Spline primitive tools or the Pen tool.

Use an appropriate size and shape for the object you are creating. The initial diameter of your object depends on the size of the cross-section. For example, the size of the first circular cross-section determines the diameter of the glass's base.

Hold down the Shift key to create circles or squares.

1. Choose Sections menu> Center to center the cross-section on the sweep path.
2. Choose Geometry menu> Extrusion Method> Translation.
3. Choose Geometry menu> Extrusion Envelope> Symmetrical.

Don't worry about trying to edit the envelope's description lines—they disappear when you start drawing your own lathe profile.

1. Click one of the sweep path planes to make it the Drawing plane.

You might find it easier to draw the lathe profile in a 2D view.

1. Click an empty space on the plane, being careful not to select the sweep path or either of the envelope description lines.
2. Using the Pen tool, place the second point of the lathe profile. To create a curve point, drag the Pen tool.

As you draw the top portion of the lathe profile, the bottom portion automatically appears.

Make sure you draw the lathe profile above the sweep path.

1. Continue drawing the lathe profile, placing additional points with the Pen tool.

Completed lathe profile.

You can also use the drawing tools to edit the points you have already placed. For best results, be careful not to cross over the sweep path as you draw the lathe profile.
Lathing with a Circular Sweep Path

Some lathe objects are difficult to create with the extrusion envelope. An object with a hole in the center can be particularly difficult. To create this type of object, you can draw the lathe profile in the cross-section plane and sweep it around a circular sweep path.

The Torus extrusion preset, available from the Geometry menu, creates a precise circular path.

Working with a Circular Sweep Path: Tutorial

To create a lathe object using a circular sweep path:

1. Draw your lathe profile in the cross-section plane.

    ![Lathe profile in cross-section plane](image)

2. Choose Geometry menu > Extrusion Preset > Torus. The Torus dialog appears.

    ![Use the Torus dialog to create a circular sweep path](image)

3. Enter a value in the Distance to axis entry box. This value specifies the distance of the cross-section from the torus’ central axis, which is the radius of the object.

    ![Lathed object using Torus preset](image)

4. Click OK.

You might need to experiment with the radius of the torus to achieve the effect you want. Simply repeat steps 2 and 3, and enter a different dimension—Carrara replaces the old torus with the new one.