7

Free Form Modeling

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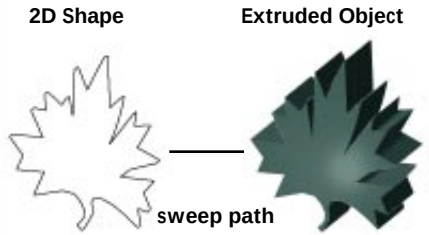
The **Free Form** modeler lets you create objects by converting 2D shapes into 3D objects. The modeler's tools let you draw 2D shapes called *cross sections* and then convert them to 3D object by extruding them. Once you've created a 3D object, you can refine its shape using an extrusion envelope.

This chapter covers the concepts involved in Free Form modeling and describes how to use the **Free Form** modeler.

Free Form Modeling Concepts

The **Free Form** modeler is based on a concept called extrusion. You create an object by drawing a 2D shape, then drawing a sweep path perpendicular to the shape. Ray Dream 3D sweeps the shape along the path to form a 3D object.

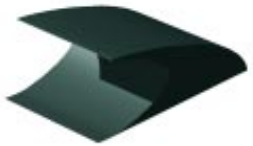


A 3D object is created by extruding a 2D shape along a sweep path.

Straight Extrusion

Straight extrusion is the most basic type of Free Form modeling. In a straight extrusion, a 2D shape is swept along a straight sweep path, creating a sort of "cookie cutter" effect.

The 2D shape doesn't have to be a single outline—it can consist of several distinct outlines. You can even extrude a compound path to create an object with a hole in it. For more on extrusions, refer to "Cross Sections and the sweep path" on page 111.



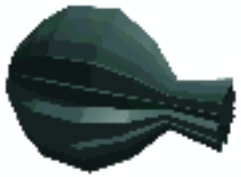
Object created using straight extrusion.

Scaling

Scaling creates objects by changing the scale of the 2D shape as it's extruded along the sweep path.

More complex objects can be created by using different sized cross sections.

Simply changing the scale of a shape produces very basic shapes, but when combined with an extrusion or scaling envelope, you can create a much wider variety of objects. For more on scaling, refer to "Understanding the Envelope" on page 113.



The same scale object can be modeled further by using an extrusion envelope.

Lathing

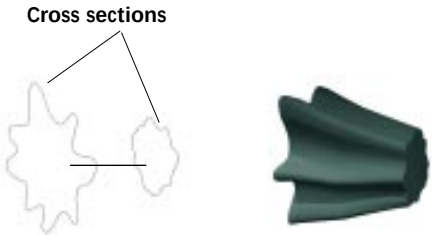
You can model many symmetrical objects using a technique called lathing. Lathed objects are created by extruding the lathe profile around a sweep path. You can think of the lathe profile as the outline of the object when it's cut in half. For more on lathing, refer to "Lathing with the Extrusion Envelope" on page 115.

Lathed objects are created 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 the act as the skeleton of your object. The **Free Form** modeler extrudes from each cross section to the next, basing the contours of the object's surface on the shapes in the cross sections.

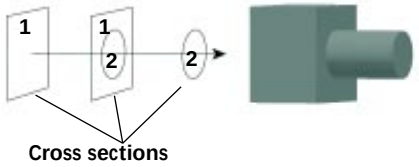


Ray Dream 3D creates an object by extruding between cross sections.

This modeling technique is sometimes referred to as skinning—the **Free Form** modeler stretches a "skin" over the various shapes in the cross sections.

A skinned object is created 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. The modeler's shape numbering feature allows you to specify which shapes should be connected from one cross section to the next. If a particular shape has no corresponding shape in the next cross section, it is simply not extruded. For more on working with cross sections, refer to "Modeling with Multiple Cross Sections" on page 105.



Ray Dream 3D uses corresponding cross section numbers to determine how to extrude a shape.

Complex sweep paths

The sweep path controls the general direction of the extruded object. A straight sweep path creates a straight object while 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 **Free Form** modeler allows you to draw a true 3D sweep path, meaning that it can be adjusted in X, Y and Z axes. You can also close the sweep path, to create a continuous object like a chain link. Ray Dream 3D also provides tools for automatically creating complex sweep paths like spirals. For more on working with the sweep path, refer to "Drawing the sweep path in 3D" on page 109.

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

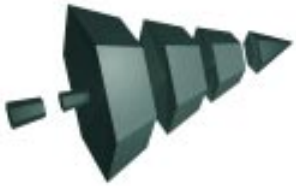
How do you Choose a Modeling Technique?

The **Free Form** modeler offers you a number of ways of creating **Free Form** objects, but you'll need to decide which technique is best suited for your object before you begin modeling.

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

To determine which 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 identical shapes that only differ in size, use the scaling technique.



When you slice a tree, you can see that all the cross sections are the same. However, they have different sizes. So the easiest way to create this object is to use the scaling method.

If shapes vary dramatically in size and shape you may need to use a more complex modeling technique. Use **Lathing** if the shapes are symmetrical. If not, use the shape number and multiple cross sections technique.

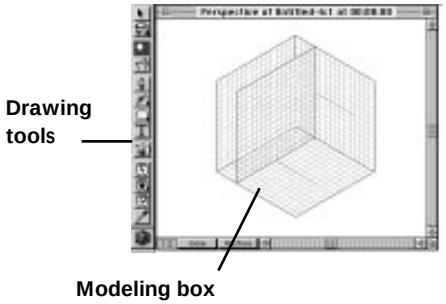
When you slice a glass you can see that the cross sections are symmetrical and vary in size so the lathe technique should be used.

The Free Form Modeling Window

The **Free Form** modeler is where you create new Free Form objects. When the **Free Form** modeling window opens it temporarily replaces your scene's **Perspective** window. New menus appear in the menu bar, and drawing tools appear in the toolbar. Your view of the scene is replaced with a close-up view of the object.

As well, the **Time Line** window automatically switches to the **Masters** tab, since changes you make in the **Free Form** modeler affect Master objects, not individual copies of objects.

For a discussion of the relationship between objects and Master objects, refer to "Working with Master Objects" on page 193.



When you're creating a free form object, the Free Form modeling window replaces the Perspective window.

You can also open the **Free Form** modeler by jumping into an existing free form object. The **Free Form** modeler opens showing you the components of the object.

To jump into an object:

1. Double-click the object in the **Perspective** or **Time Line** window,

   or

   Select the object and choose **Edit menu▸ Jump In**.

When you're finished modeling, you can jump out of the object and return to the Reference view of your scene.

To jump out of an object:

1. Click **Done** at the bottom of the **Modeling** window,

   or

   Choose **Edit menu▸ Jump Out**.

Features of the Modeling Window

The Modeling Box

The Modeling Box is the primary feature of the **Modeling** window. The box defines the drawing environment and provides you with planes for drawing sweep paths, cross sections and extrusion envelopes.

You can only work on a single plane at a time. The plane you're currently working on is called the Drawing plane. By default, it is highlighted in green.

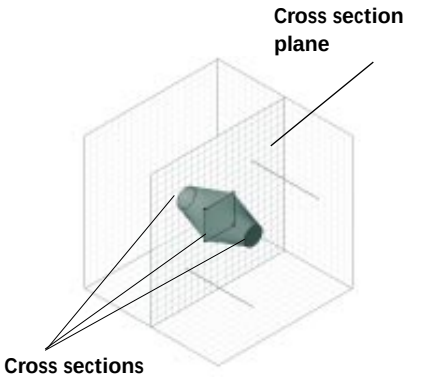
For a description of the Drawing plane environment and the Drawing tools, refer to "Working on the Drawing Plane" on page 96.

Cross Section Planes

The Cross section planes are the shapes you use to create the surface of your object. These planes act like the paper in a 2D drawing application. You can use the Drawing tools to draw and edit shapes to create cross sections.

Every time you create a cross section, you create a new Cross section plane. Since a cross section can contain any number of 2D shapes, you may have more than one shape per Cross section plane.

By default, Cross section planes are oriented according to the shape of the sweep path. As the sweep path bends or twists, the cross sections reorient themselves to remain perpendicular to it.



Each cross section has its own plane called a Cross section plane.

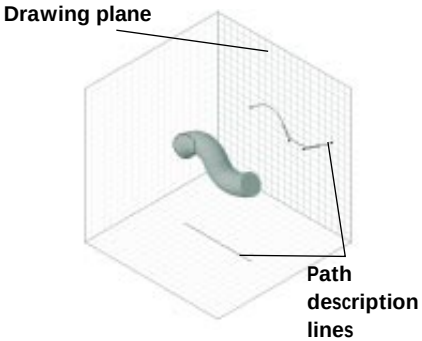
For more information, refer to "Working with Cross Sections" on page 105.

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 defined by two red lines which appear on the bottom and side walls of the Modeling Box.

You can think of these description lines as horizontal and vertical projections of the same sweep path. These two lines let you edit the sweep path in both the XY plane and YZ plane.

You can draw a sweep path of any shape or angle, including curved, straight or closed paths.



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

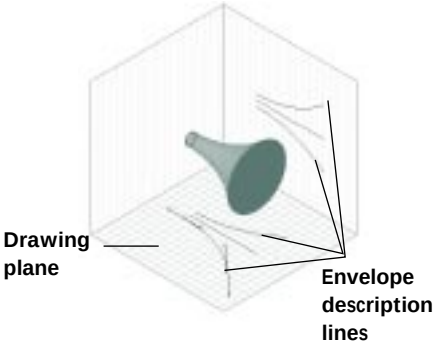
For more information, refer to "Working with the sweep path" on page 109.

The Extrusion Envelope

The Extrusion envelope lets you control the curvature in an object's form. The envelope is not displayed when you first open the modeling window. You need to add it to an object using one of the Extrusion envelope commands in the **Geometry** menu.

The Extrusion envelope is represented by four blue Bezier curves, two on each sweep path plane. By editing these envelope description lines, you can scale an object's cross sections as they're extruded along the sweep path. You can scale cross section shapes either symmetrically or asymmetrically.

For more information, refer to "Using the Extrusion Envelope" on page 112.



Extrusion envelope lets you adjust an object's shape.

Working in the Modeling Window

Changing the Drawing Plane

The Drawing plane is the plane you're currently working on. It is used as a reference for viewing objects, such as **View menu▸ Drawing plane**, and for positioning.

To change the Drawing plane:

Click on different plane in the Modeling Box. The plane you click becomes the Drawing plane.

For more Information on moving between multiple cross sections, refer to "Modeling with Multiple Cross Sections" on page 105.

Changing Your View of the Object

Since you're working with a 3D object, you can view it from any angle. You can change your view of an object using either the **View** menu commands or the **Virtual Trackball** tool.

When you change your view of the object, your view of the Modeling Box changes as well. However, the object maintains its spatial relationship to the Modeling Box at all times.

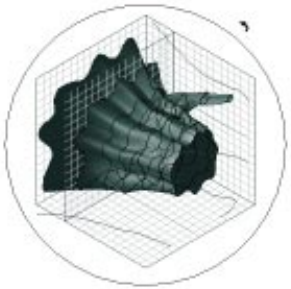
To select a different view:

Choose **View menu▸ Preset Position▸ Reference** (the default view), **Drawing Plane**, **Top**, **Bottom**, **Left**, **Right**, **Front**, or **Back**.

The **Drawing Plane** view provides a direct view of the selected Drawing plane. So you should probably use this view when you're drawing detailed shapes.

To rotate the object:

1. Choose the **Virtual Trackball** tool from within the **Free Form** modeler.
2. In the **Free Form** modeling window, drag the object in the direction you want to rotate it.



You can rotate an object in 3D space using the Virtual Trackball.

An object's orientation in the modeler has no connection to its orientation in the scene. You may rotate the object without worrying about its orientation in the scene.

Selecting an Object Preview Mode

There are four levels of object preview in the **Free Form** modeler. Listed from lowest to highest they are:

- No Preview
- Wireframe
- Preview
- Shaded Preview
- Better Preview

Higher preview modes take longer to redraw. So it's a good idea to use Wireframe or Preview mode when you're drawing.

To change the object preview:

Choose **View menu▸ No Preview**, **Wireframe**, **Preview**, **Shaded Preview** or **Better Preview**.

The mode is enabled when a checkmark appears next to the command.

You can also click one of the preview buttons on the toolbar to change modes.

Selecting Modeling Box Display

By default, the Modeling Box appears displaying all three planes. If you find that the sweep path projections or cross section previews are too distracting, you hide their planes. You can hide or display the Modeling Box planes using the **Display Plane** tool.

To change plane display:

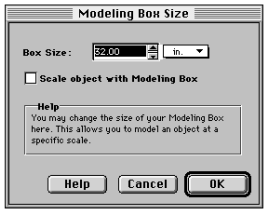
Click on the plane you want to hide or show on the **Display Plane** tool.

Setting Scale and Object Size

The modeling window 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.

To set Modeling Box and object size:

1. Choose **View menu▸ Modeling Box Size**. The **Modeling Box Size** dialog appears.



The Modeling Box Size dialog lets you adjust the size of the Modeling Box in the Free Form modeler.

2. Enter a dimension and select the units you want.

3. Enable the **Scale object with Modeling Box** checkbox if you want to resize the object along with the Modeling Box.

4. Click **OK**.

Setting Surface Fidelity

When Ray Dream 3D is rendering, it breaks each object down into hundreds of tiny polygons. This helps the renderer understand the contents of the scene.

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

If a particular object does not render as smoothly as you'd like, however, you can force Ray Dream 3D to break it down into a greater number of polygons. Ray Dream 3D allows you to set a value for each object's surface fidelity.

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 "Renderers" on page 252.

To set surface fidelity:

1. Choose **Geometry menu▸ Surface Fidelity**. The **Surface Fidelity** dialog appears.

2. Drag the slider to increase or decrease the object's surface fidelity. The default value is 100%.

3. Click **OK**.

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 low resolution, it should yield good results at higher resolutions as well.

Working on the Drawing Plane

To create an object, you will need to draw cross section shapes and Extrusion paths on the appropriate planes in the **Free Form** modeling window. Each plane in the modeling window is a separate 2D drawing environment with a grid. At any given time, you will work on a single plane. The currently selected plane is called the Drawing plane.

This section provides general instructions for working on the Drawing plane. These instructions pertain to both the cross section and sweep path planes. For specific information on cross sections and sweep paths and how they relate, refer to "Working with Cross Sections" on page 105 and "Working with the sweep path" on page 109.

All 2D shapes and paths you draw in Ray Dream 3D are Bezier curves. A Bezier curve is an interpolated curve whose shape is determined by the relative positions of its vertices and control points. Each segment of a Bezier curve connects two vertices. The control points (handles) extending from each vertex, determine the curvature of the path segments.

Ray Dream 3D's drawing tools are similar to those found in traditional Bezier-based 2D drawing applications. The drawing tools enable you to create curves and shapes, and to edit and modify those shapes point-by-point.

Ray Dream 3D allows you to import shapes from many popular 2D graphics programs. For more information, refer to "Importing Shapes" on page 104.

Don't confuse the Drawing tools with the **3D Paint** tools, which appear below the drawing tools in the toolbar. The **3D Paint** tools are discussed in Chapter 9, "Creating Shaders."

Drawing Tools

Pen Tool

The **Pen** tool allows you to:

- Draw a new path.
- Add points to either end of an existing open path.

Drawing with the **Pen** tool is like playing connect the dots. You draw a shape by adding one point at a time. As you add points, Ray Dream 3D connects them by drawing lines called *segments*.

Depending on the state of its handles, each point can be classified as a *corner point* or a *curve point*. 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 be moved independently of one another, or retracted completely, allowing you to create abrupt changes in the direction of the path.

Corner points have no handles, curve points have controls handles extending from the point.

To add a corner point:

1. Choose the **Pen** tool from within the **Free Form** modeler.
2. Click (do not drag) at a point on the Drawing plane.

   Hold down the **Shift** key to constrain the position of a new point in relation to the previous point. The angle between the two points is constrained to increments of 45°.

To add a curve point:

1. Choose the **Pen** tool from within the **Free Form** modeler.
2. Drag the **Pen** tool at a point on the Drawing plane.

   As you drag, a pair of handles extends from the vertex. 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 constrain the angle of the handles to 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.

To close a path:

1. Choose the **Pen** tool from within the **Free Form** modeler.
2. Click on the first point you added.

To draw a new path:

1. Deselect all paths and points by clicking in an empty area of the Drawing plane with the **Selection** tool.
2. Choose 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, the segments are drawn to connect the path.

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. Choose the **Pen** tool.
3. Click or drag to add the next point. A segment is drawn to continue the path to the new point.
4. Continue adding points until you're satisfied with the path.

Selection Tool

In the **Free Form** modeling window, the **Selection** tool allows you to:

- View the points on the path.
- Select, deselect and move points.
- Drag handles.

The **Selection** tool is also used for scaling shapes. For additional information, refer to "Scaling Shapes" on page 104.

To view points on a path:

1. Choose the **Selection** tool from within the **Free Form** modeler.

2. Click on a path in the **Free Form** modeling window.

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

   - Hold down the **Shift** key and click on additional paths to view the points on multiple paths.
   - Hold down the **Shift** key and click on 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:

1. Choose the **Selection** tool from within the **Free Form** modeler.
2. Click on a point in the **Free Form** modeling window 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 and click on additional points to increase your selection.
   - Hold down the **Option**/**Alt** key and click on a path to select all of the points on the path.
   - Hold down the **Shift** key and click on a selected point to deselect it.
   - Click in an empty area of the Drawing plane to deselect all points.

To move points:

1. Choose the **Selection** tool from within the **Free Form** modeler.
2. Drag a selected point to a new location.

   All selected points move together. As you drag, the path segments that are affected by the move are redrawn.

- Hold down the **Shift** key while you drag to constrain the movement of the points in relation to their previous positions. Their movement is restricted to angles of 45° increments.
- Select all of the points on a path and drag them to move the entire path.

To adjust a curve:

1. Choose the **Selection** tool from within the **Free Form** modeler.
2. Drag the point's handles.

   As you drag, the curve is redrawn. 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 constrain the angle of a handle's motion to 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.

Convert Point Tool

The **Convert Point** tool lets you:

- Convert a corner point to a curve point.
- Convert a curve point to a corner point.

To convert a corner point to a curve point:

1. Choose the **Convert Point** tool from within the **Free Form** modeler.

2. Drag a point in the **Free Form** modeling window. As you drag, a pair of handles extend from the point.

   or

   Drag one of a corner point's handles.

   When you click a corner point, the two handles extending from the point will move together.

To convert a curve point to a corner point:

1. Choose the **Convert Point** tool from within the **Free Form** modeler.
2. Click on a curve point in the **Free Form** modeling window. The point's handles retract.

   or

   Drag one of a curve point's handles.

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

Delete Point Tool

The **Delete Point** tool allows you to:

- Delete a point.
- Delete a path segment.

To delete a point:

1. Choose the **Delete Point** tool from within the **Free Form** modeler.

2. Click on a point in the **Free Form** modeling window.

   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 simply 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. Choose the **Delete Point** tool from within the **Free Form** modeler.
2. Click on a path segment in the **Free Form** modeling window.

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

Removing a path segment leaves adjacent path segments unchanged. When you delete a path segment from a closed path, the path simply becomes an open path.

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

Add Point Tool

The **Add Point** tool lets you add a new point between two existing points on the same path.

To add a point:

1. Choose the **Add Point** tool from within the **Free Form** modeler.

2. Click anywhere on an existing path in the **Free Form** modeling window.

   Ray Dream 3D 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 that it can be moved with the **Selection** tool.

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

2D Primitive Tools

The **2D Primitive** tools allow you to easily create closed paths in a variety of shapes. These tools work only on the cross section planes.

After creating a shape with one of the **2D Primitive** tools, you will not immediately be able to edit its points—you will need to ungroup it first. For more information, refer to"Grouping Shapes" on page 103.

Rectangle Tool

To draw a rectangular cross section:

1. Choose the **Rectangle** tool from within the **Free Form** modeler.

2. In the **Free Form** modeling window, drag from one corner of the rectangle to the opposite corner.

   Hold down the **Shift** key while dragging to create a square.

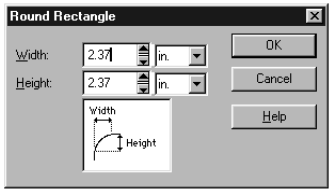
Rounded Rectangle Tool

To draw a rounded rectangular cross section:

1. Choose the **Rounded Rectangle** tool from within the **Free Form** modeler.

2. In the **Free Form** modeling window, drag from one corner of the rectangle to the opposite corner. Release the mouse button when the rectangle is the desired size.

   Hold down the **Shift** key while dragging to create a square with rounded corners. The **Round Rectangle** dialog appears.



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

3. Set the curvature on the corners.

4. Click **OK**.

Ellipse Tool

To draw an ellipse cross section:

1. Choose the **Ellipse** tool from within the **Free Form** modeler.

2. Drag in the **Free Form** modeling window to draw an ellipse.

   Hold down the **Shift** key while dragging to create a circle.

Polygon Tool

To draw a polygon cross section:

1. Choose the **Polygon** tool from within the **Free Form** modeler.

2. Drag the tool in the **Free Form** modeler Cross section plane. Release the mouse button when the polygon is the desired size.

   Hold down the **Shift** key while dragging to keep all angles equal. The **Number of Sides** dialog appears.

3. Set the number of sides for the polygon.

4. Click **OK**.

2D Text Tool

The **2D Text** tool allows you to create text on a cross section plane.

To draw text on the cross section plane:

1. Choose the **2D Text** tool from within the **Free Form** modeler.

2. Click in the **Free Form** modeling window to position the text. The **Text** dialog appears.

3. Enter text and specify type settings.

4. Click **OK**.

Use this 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. For more information on the Text modeler, refer to "Creating Text Objects" on page 86.

Precision Editing

The Drawing Plane Grid

You can use the Drawing Plane grid to help you precisely position lines and points as you draw.

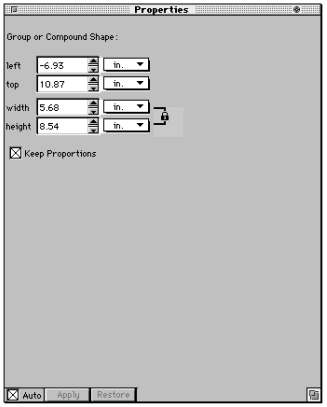
You can set the size of each grid increment, and specify whether a line should be drawn at every increment. As well as enabling the Snap To feature. When this feature is enabled any object you drag along the plane will "jump" to the nearest grid intersection.

To set up the grid:

1. Choose **View menu▸ Grid**. The **Grid** dialog appears.
2. Change the **Spacing** value to control the amount of spacing between grid lines in the box. You can also change the value using the scroll buttons.
3. Choose a unit of measure from the pop-up.
4. Change **Draw a line every** value to control how often grid lines are drawn.
5. Enable **Snap to** if you want objects to "jump" to the nearest grid line as you drag them.
6. Disable **Show** if you want to hide the grid lines.
7. Click **OK**.

The Properties Palette

The **Properties** palette displays the properties of the selected point, control handle, group or compound cross section.



The Properties palette in the Free Form modeler shows the position of points and control handles.

- When a point is selected, the X and Y coordinates are displayed.
- When a curve point is selected, the X, and Y position of its handles are displayed. When these controls are active, you can retract a control handle using the **Retract** button.
- When a group or compound cross section is selected, its top, and left coordinates are shown as well as the shape's height and width.
- No information is available for ungrouped shapes or multiple point selections.

By default, all values are shown in inches.

To change the properties of a cross section:

1. If the **Properties** palette is not visible, choose **Windows menu▸ Properties**.
2. Select a cross section group or point.
3. Adjust the position values.
   - If you selected a closed cross section, you can enable the **Keep Proportions** checkbox to maintain the shapes aspect ratio as you scale it.
   - If you selected a curve point, you can click the **Retract** button to retract the point's handles. You can also click the **Corner Point** button to convert the curve point to a corner point.

Rotating Shapes

You can use the **2D Rotation** tool to rotate the cross section freely, or the **Rotate** dialog to rotate it numerically.

Note: You can only rotate cross sections, not the sweep path.

To free rotate a cross section:

1. Select a shape on the cross section plane.

2. Choose the **2D Rotation** tool from the **Free Form** modeler.

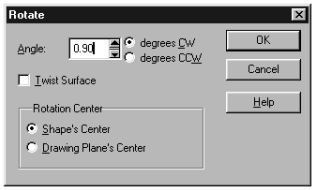
3. Drag the shape in a circular path.

A shape rotated with the **2D Rotation** tool always rotates around its center.

If the **Properties** palette is open, the cross section's position values will update as you rotate it.

To numerically rotate a cross section:

1. Select a shape, and choose **Geometry menu▸ Rotate**. The **Rotate** dialog appears.



Use the Rotate dialog to numerically rotate an object.

2. Select the rotation center—the shape's center, or the Drawing plane's center.

3. Enter a value for degree of rotation and select clockwise (CW) or counterclockwise (CCW).

4. 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:

Hold down the **Option**/**Alt** key while rotating a cross section shape with the **2D Rotation** tool.

For precise twisting, enable the **Twist** checkbox in the **Rotation** dialog. When **Twist** is enabled, Ray Dream 3D twists the surface the specified number of degrees.

Rotation values greater than 360° make sense when twisting the object's surface—you can use them to specify multiple twists.

Grouping Shapes

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

Note: Grouping is allowed only on the Cross section planes.

To group shapes:

1. Select the shape(s) you want to group.

2. Choose **Arrange menu▸ Group**.

To ungroup:

1. Select the group you want to ungroup.

2. Choose **Arrange menu▸ Ungroup**.

Compounding Shapes

Compounding shapes is like grouping them, with one significant difference—any shape which is completely enclosed by another shape in the same compound "cuts away" from the larger shape. When a compound is extruded, the inner shapes create holes through the extrusion.

Note: Compound shapes are allowed only on Cross section planes.

Compound shape

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**.

Scaling Shapes

You can scale a shape directly by dragging its bounding box, or numerically using the **Scale** dialog.

Note: Scaling is allowed only on cross section planes.

Scaling a cross section shape directly is not always necessary. The scaling envelope, described in "Using the Extrusion Envelope" on page 112, can often accomplish the same results more simply and powerfully.

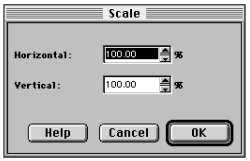
To scale shapes:

1. Group the curves or shape you want to resize.
2. Drag a corner of the shapes bounding box with the **Selection** tool to resize it. Drag towards the shape to reduce it's scale, or away from it to increase its scale.

   Hold down the **Shift** key to maintain proportions.

To scale shapes numerically:

1. Select the shape you want to resize.
2. Choose **Geometry menu▸ Scale**. The **Scale** dialog appears.



Use the Scale dialog to numerically resize objects.

3. Enter horizontal and vertical scale factors.
4. Click **OK**.

Importing Shapes

Ray Dream 3D lets you import cross section shapes, sweep paths, and envelopes from 2D drawing programs that support Bezier curves, like Adobe Illustrator or CorelDRAW!.

To import shapes to a cross section:

1. Click the cross section you want to work with.

   You can also create a blank cross section 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**.

   Ray Dream 3D places the artwork on the Drawing plane.

   The file may include one or several two-dimensional shapes. You should, however, avoid unnecessary complexity. Paint characteristics, like stroke and fill are ignored. Compound paths are preserved. Text is automatically converted to outlines.
4. Click **OK**.

To import a path as a sweep path or envelope:

1. Choose **Geometry menu▸ Extrusion Envelope** to turn on the extrusion envelope.

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

2. Click one of the path 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.

5. Specify sweep path or envelope, and click **OK**.

Ray Dream 3D imports the sweep path or envelope.

Working with Cross Sections

A basic free form object, like 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 length of the path. Since each cross section, in turn, can contain any number of shapes, you will be able to model even very intricate objects.

The **Free Form** modeler automatically extrudes between each cross section and the next, basing the surface of the object on the shapes contained in the cross sections.

As you begin to work with the **Free Form** 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" on page 109.

Modeling with Multiple Cross Sections

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

If you just use a few cross sections, Ray Dream 3D automatically extrudes a surface between the cross sections creating a flat surface.

When you only use a few cross sections to define an object, Ray Dream 3D creates a flat surface over the entire object.

With each section you add, you reduce the amount of surface areas that is automatically calculated. You can add subtle variations in your object's surface by placing more sections with different shapes in between cross sections.

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 **Free Form** modeler has a number of features to help you model with multiple cross sections. The modeler lets you:

- Add or delete cross sections.
- Move between cross sections.
- Add shape numbering to sections to control the extrusion between section shapes.
- Control whether the surface is extruded from shape to shape or point to point.

Adding and Removing Cross Sections

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

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 scaling envelope. Refer to "Using the Extrusion Envelope" on page 112.

To create a new cross section:

1. If a sweep path point exists where you want the new cross section:
   - Select the sweep path and choose **Sections menu▸ Create**.
2. If there is no point:
   - Choose the **Add Point** tool from within the **Free Form** modeler.
   - Hold down the **Option**/**Alt** key and click on the sweep path at the point where you want to create the new cross section.

   Ray Dream 3D adds a point to the sweep path and creates a new cross section at that point.
3. If you're working on a cross section plane:
   - Choose **Sections menu▸ Create**.

   Ray Dream 3D adds a new cross section at the next vertex.

Generating Intermediate Cross Sections

You can have Ray Dream 3D create a specific number of cross sections between the current cross section and the next one

To generate intermediate cross sections:

1. Click on a cross section plane.
2. Choose **Sections menu▸ Create Multiple**. The **Create Multiple Cross-Sections** dialog appears.
3. Enter the number of sections you want.
4. Click **OK**.

   Ray Dream 3D creates the intermediate cross sections, spacing them evenly between the current cross section and the next one. A new point is added to the sweep path for each cross section created.

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.

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 simultaneously remove a cross section and delete its corresponding sweep path vertex, use the **Delete Point** tool to delete the point from the path.

Moving the Drawing Plane Between Sections

If you have multiple cross sections, you can choose **Next** or **Previous** from the **Sections** menu to move the Drawing plane between adjacent cross sections.

To move between sections using the keyboard:

Hold down the **Command**/**Ctrl** key and press the right or left arrow key to move to the next or previous cross section, respectively.

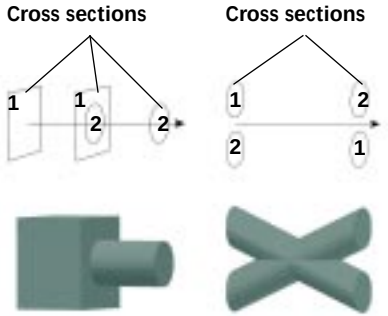
To move to a specific section:

1. Choose **Sections menu▸ Go to**. The **Go To Cross Section** dialog appears.
2. Enter the number of the section you want to go to and click **OK**.

   Cross sections are numbered from left to right.

Correspondence and Shape Numbering

Normally, there is a direct correspondence between the number of shapes in adjacent cross sections. You can, however, use a different number of shapes in adjacent sections, or change which shape sweeps to which. You control multiple shape correspondence through shape numbering.



Cross section shape numbers let you control how sections are extruded along a sweep path.

To control shape-to-shape correspondence:

1. Choose **Sections menu▸ Show Shapes Numbers**.

   Ray Dream 3D displays a number beside each shape in the Drawing plane. A group or compound is assigned a single shape number.

   Each numbered shape is swept to the corresponding numbered shape in the next cross section.
2. Click on the number you want to change. The **Shape Number** dialog appears.
3. Type in the number for the corresponding shape.

   - If you enter the number of another shape in this plane, the program swaps the correspondence number with that shape.
   - If you enter a unique number, make sure that you assign the same number to the appropriate shape in the adjacent cross section(s).
4. Click **OK**.

Any shape that has no correspondence (i.e., its number does not match any shape number in an adjacent section) is not extruded.

Cross Section Options

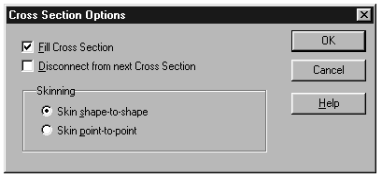
The **Cross Section Options** dialog lets you specify the following:

- Whether the cross section should be "filled."
- If the cross section should be connected to the next cross section.

- What type of "skinning" should be used between the cross section and the next cross section.

To set cross section options:

1. Click on a cross section.
2. Choose **Sections menu▸ Cross-Section Options**. The **Cross Section Options** dialog appears.



Use the Cross Section Options dialog to fill or disconnect cross sections.

3. Enable the **Fill Cross Section** checkbox if you want to fill the section. For example, a cylinder with its first and last sections not filled 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.

4. Enable the **Disconnect from next Cross Section** checkbox to turn off extrusion between this section and the next one. In this way, you could create an "intermittent" object.

Object created using the Disconnect from next Cross Section option.

5. Enable 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 which requires straight, sharp edges.

Use shape-to-shape skinning **Use point-to-point skinning**

Two cases where you would use shape-to-shape and point-to-point skinning.

6. Click **OK**.

Centering a Cross Section

Often when you're creating cross sections, you may end up with a number of off centered sections which can lead to unexpected results when they're extruded. It's usually a good idea to center sections when you're finished drawing them.

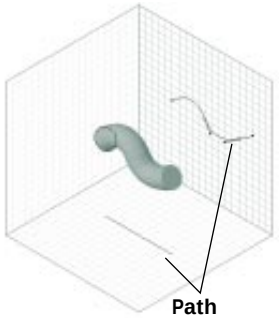
To center a cross section on the sweep path:

1. Click 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.

Tip: You can also use **Command-Shift-C**/**Ctrl+Shift+C**.

Working with the sweep path

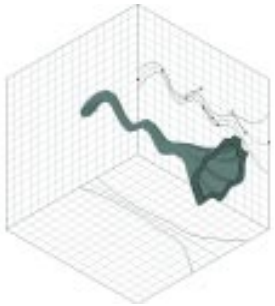
The key to working with the sweep path is understanding how the 2D path description lines define the 3D sweep path. There are two red path description lines, one on each sweep path plane. Although the path description lines appear to be two separate paths, they are actually just projections of the same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



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 while the projection on the side plane describes its vertical position. A sweep path that is curved on the side plane but straight on the ground plane would create an object whose's shape curves up and down but not side to side.



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

A path that curves on both planes would create an object whose shape curves in 3D.

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

Drawing the 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.

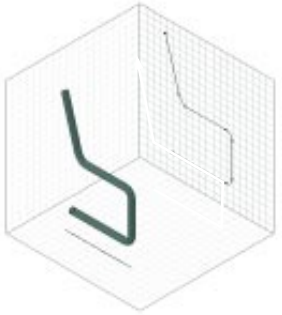
Unfortunately few objects are this simple. Most objects have some variation from both the top and the profile. You can easily handle this type of sweep path by adjusting the point on the two sweep path projections.

You can create more realistic objects by making the sweep path curve in 3D.

In some cases, simple adjustment may not be enough. You may 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. The chair frame shown below is modeled using this technique—the diagrams that follow illustrate the process.

To draw a sweep path in 3D:

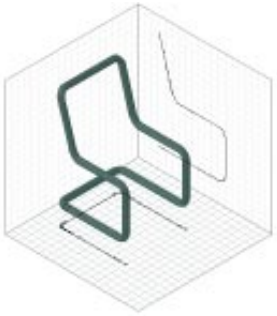
1. On the side plane, draw one side of the chair using the **Pen** tool As you draw, points are added on the ground plane, as well.



2. Switch to the ground plane and select the last point. Then continue drawing to add the chair's horizontal bar as shown.

3. Switch back to the side plane, and trace back over the path to add the other side of the chair.

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



Cross Sections and the sweep path

When you're working with the sweep path it's important to understand the relationship between cross sections and the sweep path. 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 move a cross section shape up or down, left or right along the cross section plane, the sweep path is not affected.

This allows you to create cross sections that are not centered around the sweep path.

Cross sections don't necessarily have to be centered around the sweep path. They can be off-center.

Translation vs. Pipeline

The **Free Form** modeler can extrude cross sections along the sweep path using one of two extrusion methods: the **Translation** method or the **Pipeline** method.

With the **Translation** method, each cross section remains perpendicular to the ground plane of the Modeling Box, 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 method

Pipeline method

Translation vs. Pipeline.

To choose an extrusion method:

1. Choose **Geometry menu▸ Extrusion Method▸ Translation** or **Pipeline**.

You can switch extrusion methods at any time, however, changing methods may reset your sweep path and extrusion envelope. In general, you should try to determine which extrusion method is appropriate before you start work on an object.

Extrusion Presets

Ray Dream 3D provides three extrusion presets, which automatically generate specific types of sweep paths. When you apply an extrusion preset, the current sweep path and envelope are replaced with the preset path.

To straighten the sweep path:

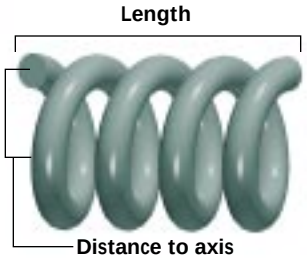
1. Choose **Geometry menu▸ Extrusion Preset▸ Straight**.

   All of the points on the sweep path are moved into a straight line. Cross section shapes are unaffected.

Note: 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 in the cross section plane.
2. Choose **Geometry menu▸ Extrusion Preset▸ Spiral**. The **Spiral** dialog appears.
3. Enter the **Number of turns** you want—one turn equals 360°.
4. Enter the **Length** of the spiral sweep path. 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.

5. Enter a value in the **Distance to axis** entry box. This value determines the size of each coil by setting the distance between the cross section shape and the spiral's central axis.
6. Enter a percentage in the **Cross Section Scaling** entry box if you want to 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.
7. Enter a percentage in the **Spiral Scaling** entry box if you want to 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.
8. Click **OK** to close the **Spiral** dialog. Ray Dream 3D creates the spiral sweep path you have specified, and automatically switches to **Pipeline** mode.

The Torus Extrusion Preset

The **Torus** extrusion preset automatically creates a perfect circular sweep path. This feature is described in "Lathing" on page 114.

Using the Extrusion Envelope

To a large extent, the contours of a Free Form 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.

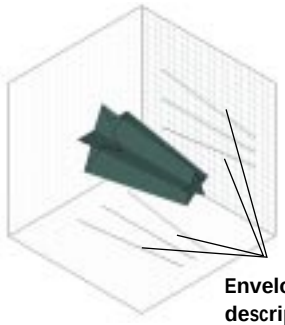
To create some complex objects you may find that you'll need a finer degree of control than cross sections alone can provide. The extrusion envelope lets you specify how an object's surface should curve from one cross section to the next, giving you precise control over the object's form.

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

Understanding the Envelope

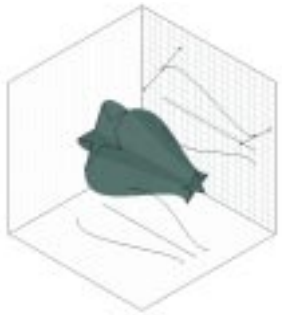
By default, the extrusion envelope is not used—Ray Dream 3D stretches the object's surface over the cross sections as simply as possible. When you turn the envelope on, it appears as four blue Envelope description lines, two on each sweep path plane. (The red path on each sweep path plane is a path description line—refer to "Working with the sweep path" on page 109.)

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



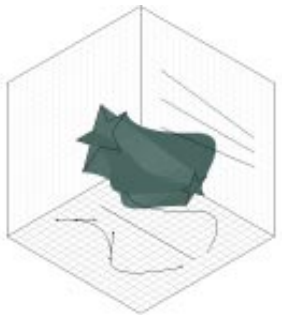
Object with envelope.

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

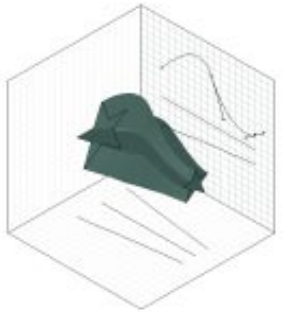


Symmetrical envelope.

When you work with the **Symmetrical** envelope setting, all the envelope lines maintain symmetry. **Symmetrical in Plane** lets you edit the envelope description lines in pairs. **Free** lets you edit each line individually. This allows you to model asymmetrical objects.



Symmetrical in Plane.



Free Envelopes.

How the Envelope Relates to the sweep path

The envelope and the sweep path are closely related. In fact, each point on the extrusion envelope corresponds to a point on the sweep path.

Moving an envelope point perpendicular to the sweep path controls the scaling of the object at that point on the path. When you move an envelope point parallel to the sweep path, the corresponding point on the sweep path moves as well—the points are "locked" together in the direction of the sweep path.

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

To maintain the relationship between the sweep path and the envelope, when you add a point to the scaling envelope, a point is also added to the sweep path. Likewise, when you delete a point from the envelope, the corresponding point is deleted from the sweep path.

How the Envelope Relates to Cross Sections

Editing the Extrusion envelope may 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 using the extrusion envelope in conjunction with multiple-shape cross sections, note that the scaling reference point is the sweep path—not the center of each shape. If you want a cross section's individual shapes to scale around their respective center points, you should resize each shape individually on the cross section plane, rather than use the scaling envelope.

Editing the Envelope

To enable the envelope or change its symmetry constraint:

Choose **Geometry menu▸ Extrusion Envelope▸** and pull right to select a symmetry constraint setting: **Symmetrical**, **Symmetrical in Plane** or **Free**.

If the envelope was not already enabled, the four blue 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 the two Envelope description lines in either plane use the same curve—when you edit one line, the other in its plane updates (as a mirror image) automatically.

Free each line may have a unique curve.

To modify the extrusion envelope:

1. 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 "Working on the Drawing Plane" on page 96.

To reset the extrusion envelope:

1. Choose **Geometry menu▸ Reset Envelope**.

   or

   Choose **Geometry menu▸ Extrusion Envelope▸ None**.

Lathing

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

Because your lathe object is actually a Free Form 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 Free Form modeler's other tools.

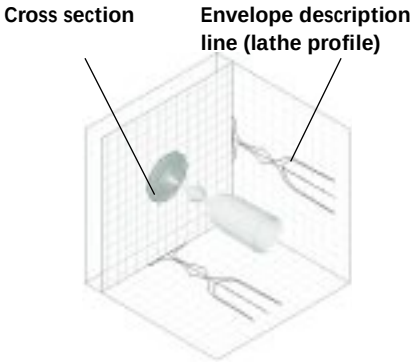
Depending on the specific object you want to create, you can choose from two different lathing methods:

- using the Extrusion envelope
- using 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 on the Extrusion envelope, refer to "Using the Extrusion Envelope" on page 112.



Lathed object using the extrusion envelope.

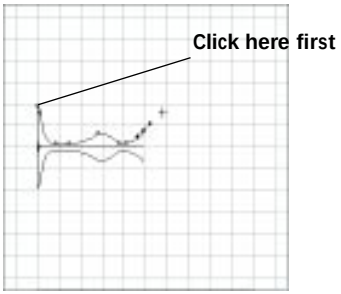
To create a lathe object with the extrusion envelope:

1. Click a cross section plane.
2. Draw a cross section using the **Ellipse**, **Rectangle**, or **Polygon** tool.

   Draw your circle (or polygon) at an appropriate size for the object you are creating, since 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' base.

   Hold down the **Shift** key to create circles or squares.
3. Choose **Sections menu▸ Center** to center the cross section on the sweep path.
4. Choose **Geometry menu▸ Extrusion Method▸ Translation**.
5. Choose **Geometry menu▸ Symmetrical▸ Extrusion Envelope**.

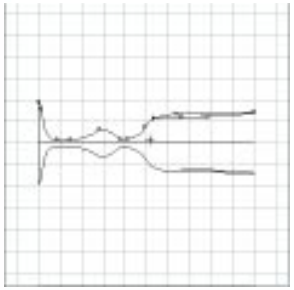
   Do not worry about trying to edit the envelope's description lines—they disappear when you start drawing your own lathe profile.
6. Click one of the sweep path planes to make it the Drawing plane.
7. Click an empty space on the plane, being careful not to select the sweep path or either of the Envelope description lines.
8. Choose **View menu▸ Preset Position▸ Drawing Plane**. This allows you to draw in the plane of the screen.
9. Using the **Pen** tool, place the second point of the lathe profile. You may need to drag the **Pen** tool to create a curve point.



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.

10 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 the best results, be careful not to cross over the sweep path as you draw the lathe profile.

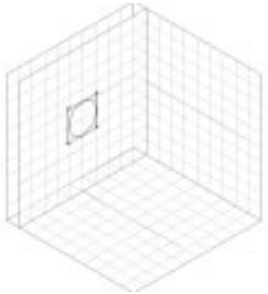
Lathing with a Circular sweep path

Some lathe objects are difficult to create with the scaling envelope. An object with a hole in the center can be particularly difficult. To create these type of objects, 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.

To create a lathe object using a circular sweep path:

1 Draw your lathe profile in the cross section plane.

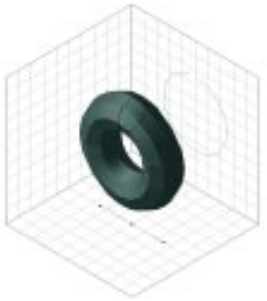


Lathe profile in cross section plane.

2 Choose **Geometry menu▸ Extrusion Preset▸ Torus**. The **Torus** dialog appears.

3 Enter a value in the **Distance to axis** entry box, and click **OK**.

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.

You may 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—Ray Dream 3D replaces the old Torus with the new one you have specified.