

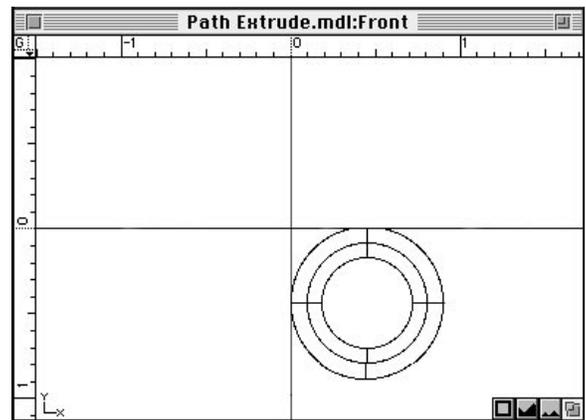
### Part V - Creating a Path Extruded Object

Path extrusion is the process where a 2-D contour is swept along a designated path to make pipes, joints, and elongated 3-D forms quickly and easily. In this example, you will draw a pipe through two donut-shaped collars.

#### Getting Started

In Part IV, you will use the Spline, Torus, Ellipse and the Path Extrude tools for design and the Clone and Move To commands to duplicate and accurately place objects. You will use the spline to draw a tube created from a path extruded circle through two adjacent toruses.

If you are not in ModelPro, launch ModelPro by double-clicking on its icon. If you are in ModelPro, select New under the File Menu to start with a fresh drawing environment.



#### Preparing the Drawing Environment

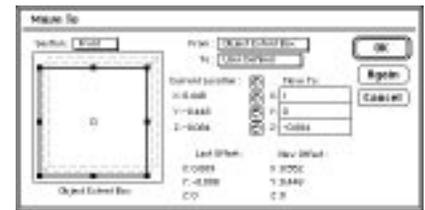
In this part of the tutorial, we want direct access to all objects and do not want them placed automatically in a folder after a 3-D operation. Select the Edit menu and choose Preferences to display the General dialog. The box next to 3-D Operations Create Folders should be un-checked. If it's checked, click in the box and click in the OK box. If it's un-checked, click in the OK box.

#### Placing the Torus

Select the Torus Primitive by clicking and holding on the Cube Primitive to show the 3-D primitives pop-up. Drag over to the Torus at the end of the pop-up and release. To draw the torus, place the cursor at the Galactic Core (0,0,0), where the two Origin Lines meet. While holding the Shift key down, click, hold and drag down and to the right until the torus has an outer diameter of slightly less than one inch.

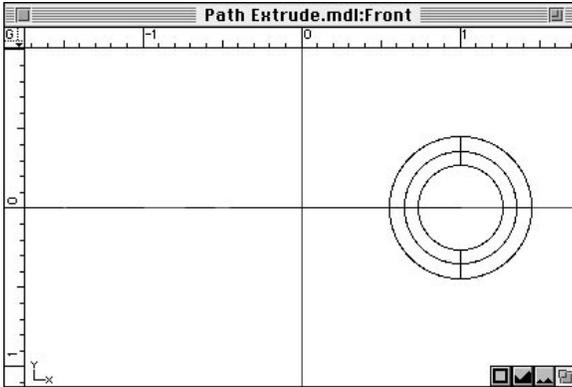
Use the Selector Tool to select the torus if it is not already selected. Under the Operations Menu, select Move To to display the Move To dialog. Click on the center of the Object Extent Box, the small, empty square in the center of the Object Extent Box. This sets the front-center of the torus as the point on the object to be moved.

**Note:** The shift key constrains the torus to a circular shape.



Move To dialog for torus

**Note:** The Object Extent Box can be set at three positions; Front, Middle, and Back. Click on the Section pop-up to select another position.

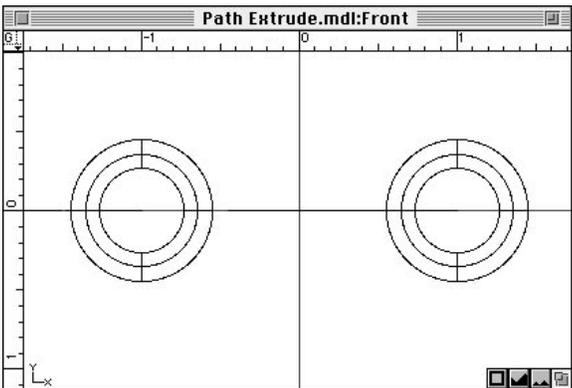


Reposition torus

The torus is to be moved so it is sitting evenly on the X-axis, its center one inch to the right of the vertical Origin Line. Type 1 in the X box of the Move To data fields, 0 in the Y Box, and the value of Z shown under the Current Location. The Z value stays the same because we are making a lateral move in the Front View and not moving the torus in or out. Click OK to automatically re-position the torus.

### Placing the Second Torus

Use the Selector Tool to select the torus if it is not already selected. Under the Edit Menu, select Clone to make a copy of the torus. The copy will be drawn right on top of the first torus. Under the Operations Menu, select Move To to display the Move To dialog. Click on the center of the Object Extent Box.



Clone and drag torus

The torus is to be moved so it is at the same height as the first torus, but on the other side of the X-axis, its center one inch to the left of the vertical Origin Line. Type -1 in the X box of the Move To data fields, the other values remain the same. Click OK to automatically re-position the torus.

**Note:** Clone can also be selected by holding the Command key and pressing the W key. Move To can also be selected by holding the Command key and pressing the M key.

### Create the Path

A spline will be used to create a path that goes straight through the first torus, bends, and comes straight back through the second one.

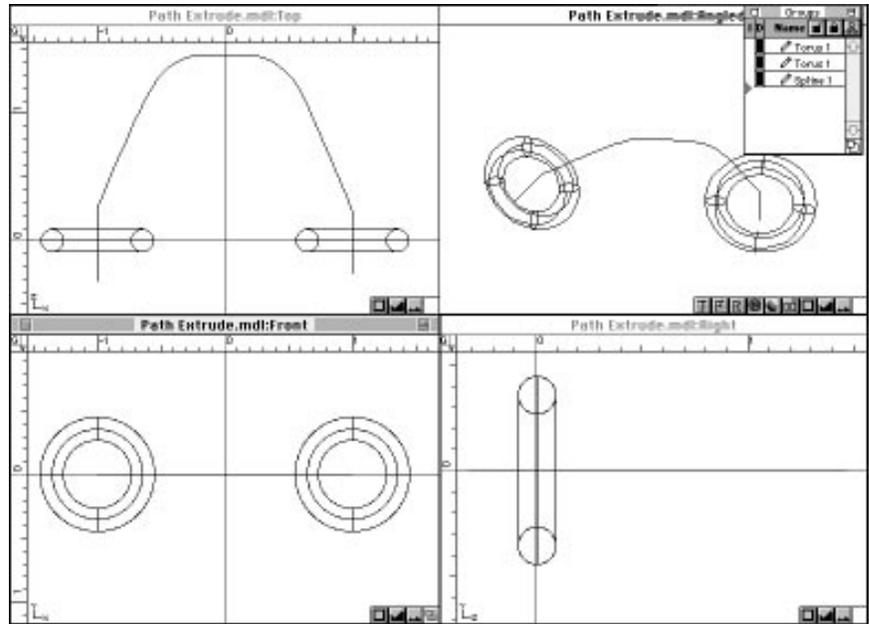
In the Front View, drag a guide line from the ruler at the left and position it so it cuts the first torus in half to help you draw the straight portions of the spline. Drag another one for the other torus. You can use the Grid Snap option from the Snap palette to help you draw the straight portion of the splines. You may want to turn it off for the curved portion. With the Snap Grid selected, each point will be snapping the the current grid values set in the Grid Preference dialog under the Edit Menu and will limit the positioning of the vertices and the tangent line at each vertex.

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## Path Extrude Tutorial

### Creating a Path Extruded Object

Select the Spline tool. In the Top View, click a point directly below the first torus and even with the center of that torus and release without dragging. Move the cursor above and still even with the center of that torus. Click and release without dragging. This completes the straight part of the spline. Move the cursor up so that it sits on the vertical Origin Line at a height of about 1.5 inches. Don't worry if you run out of room at the top, the screen will automatically scroll down to give you more room. Click, hold, and drag about a half inch to the right to give the spline a broad bend.



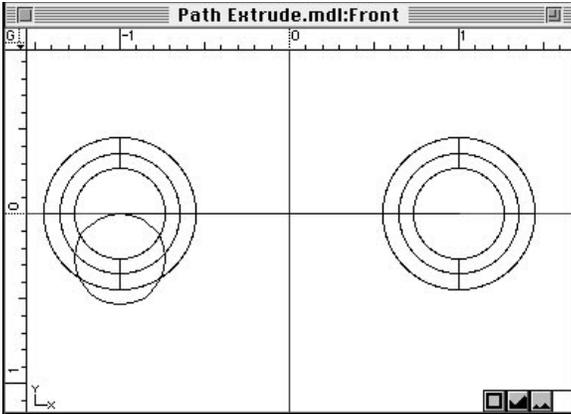
Spline path drawn through toruses.

To create a straight spline you click and release and move to the next point. To make a curved spline, you click and drag the cursor to set the desired curvature and release and move to the next point. Dragging after placing a spline vertex, pulls the tangent at that vertex out and broadens the curve. To make a narrower bend in the curve, click on a vertex and first drag one end of the tangent toward the vertex and then the other. You will notice that the ends of the tangent are not tided together. This enables you to shorten or broaden the curve on one side of the vertex without shortening or broadening the curve on the other side.

Click a point directly above the first torus and even with the center of that torus and release without dragging. Move the cursor below and still even with the center of that torus. Click and release without dragging. This completes the straight end of the spline. Look at the Groups palette. You will notice the Three drawing elements you just created listed there.

**Note:** Refer to the Tool palette chapter for more information on spline usage.

**Note:** The Snap palette provide eight snapping options: Free, Grid, Vertex, On Contour, Marker, Midpoint, Center, and Intersection. For a detailed description of these options refer to the Snap palette chapter.



Circle drawn to fit inside torus.

**Tip:** It's important to change the screen layout and object size to fit the current task being performed. Using ModelPro's window and object sizing tools effectively will improve your modeling productivity. Remember to use the Zoom box, the Zoom In and Out icons, the Fit To Window icon, and the Hand Tool to give you the most effective drawing space for the task at hand. In the Angled View, the Hand Tool can be used in two ways. Using it normally it allows the view to be rotated. With the Option key held down, it can be used to scroll and pan the screen as in the other views.

### Create the Contour to be Extruded on the Path

The tube will be made to just fit inside each torus. Select the Ellipse Tool to draw a circle which will be the contour to be extruded along the path. Move the cursor to the left-most part of the inside edge of the torus at the left. Hold the Shift key down, click and drag to the right-most part of the inside of the torus and release. You now have a circle the exact dimension of the inside diameter of the torus.

You can leave the circle where it's at or move it down and away from the torus.

### Perform the Path Extrude

Click on the Selector Tool (or type the letter S) and click on the circle in the Front View to select it as the object to be extruded along the spline path.

Select the Path Extrude tool from the Tool pallet. Click on the On Path button in the Path Extrude Info palette to have the extrusion start and end exactly where the spline begins and ends.

Holding the Option key down, click on the spline drawn through the toruses to start the path extrusion. You now have a preview of the extruded tube. You may have to click on the Fit to Window icon in the Top View to have the preview visible in the window.

Click on the Path Extr. button on the Path Extrude Tool Info palette to complete the path extrusion.

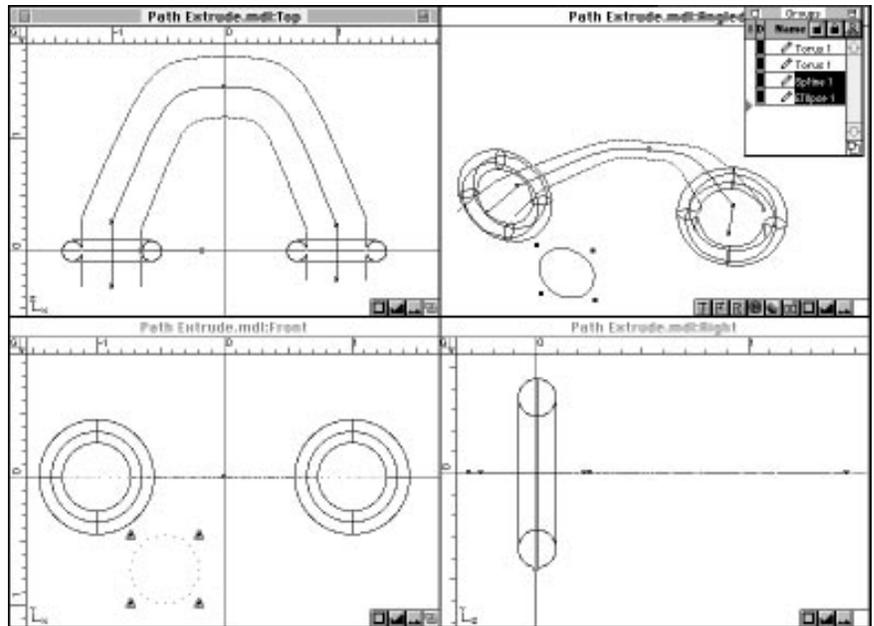
Go to the File Menu and select Save As. At the prompt for a name, type Tube.mdl.



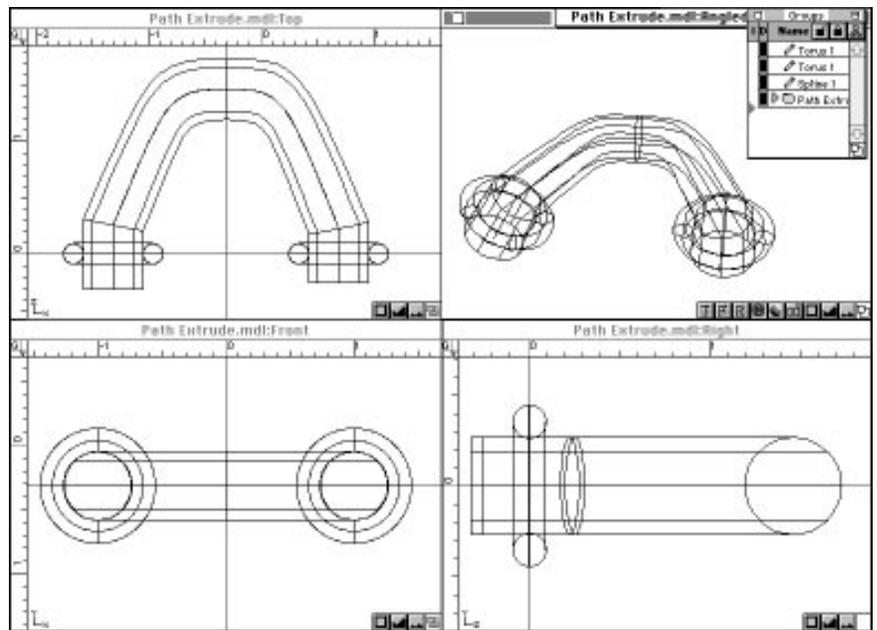
Path Extrude Info palette

## Path Extrude Tutorial

### Creating a Path Extruded Object

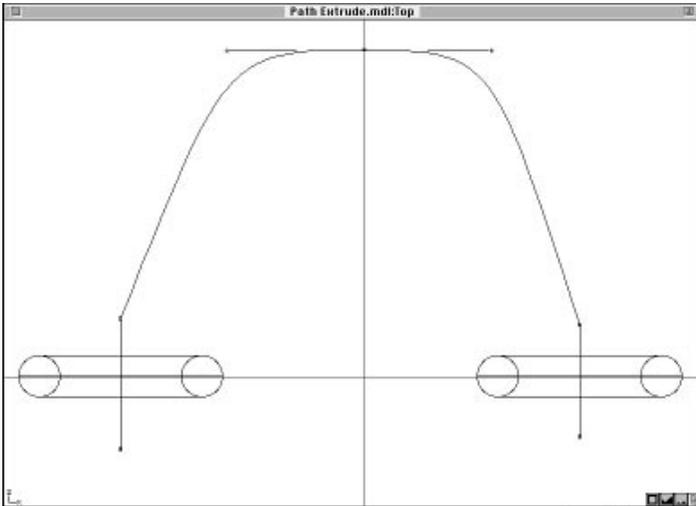


Path extrude preview

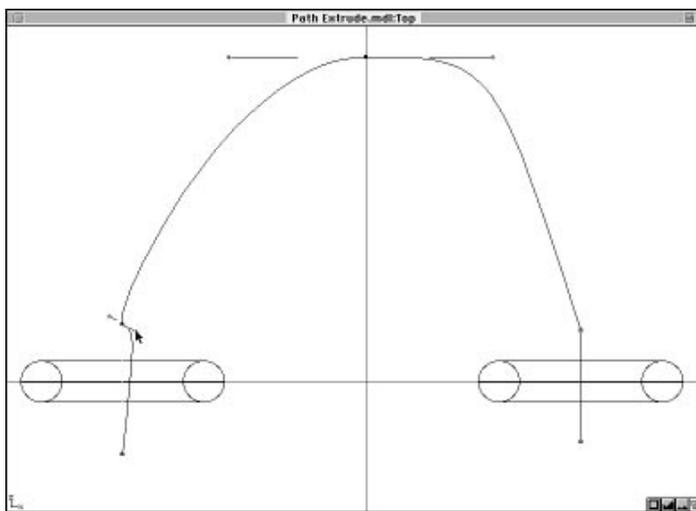


Completed Path Extrude

**Tip:** If you had moved the circle inside the torus, you could have used the On Contour option as well. To try it where it is, Undo the path extrusion. Hold the Shift key down while selecting the Path Extrude Tool to reset the parameters. Otherwise, it will automatically do the On Path extrusion. Click on the On Contour button in the Path Extrude Info palette to have the extrusion start from the position of the circle.



Selecting the vertices



Converting a sharp-cornered vertex

## Creating a Smoother Path

Take a look at the extruded tube. The angle is quite sharp at the edges where the straight spline segments meet the smooth spline segments and the curve at the top is quite broad and could be more rounded. The following will show you some ways for making the path smoother.

In order to smooth out the spline path, you first need to “undo” the previous path extrude. Under the Edit menu, choose Undo or hold the Command key down and type Z.

Under the Windows menu, choose Re-display (or hold the Command key down and type D). This removes the path extruded object from the windows and the Groups palette.

Pick the Selector Tool and click on the spline. Holding the Shift key down, click on all the points. The reason why this path isn't very smooth is now clear. There is only one smooth point (the one at the top with the tangent line showing) in the whole spline. To make the whole curve smoother, the two sharp-cornered vertices that connect to the smooth segments will be converted to smooth-cornered vertices.

The Selector Tool, with the Control key held down, is used to convert sharp-cornered vertices to smooth-cornered vertices and vice versa. Hold The Control key, click, hold and drag on the vertex. As you drag, you will see that the two segments are now joined as a continuous smooth curve.

## Path Extrude Tutorial

### Creating a Path Extruded Object

You will also observe that the curve is now bent at this point. To smooth it out, click, hold, and drag on one of the control handles on the tangent to move them into a vertical position.

Repeat this procedure for the other sharp-cornered vertices. With just three smooth-edged vertices, this gives you a much smoother curve. Refer to the tip below to see how adding points can help create even smoother curves.

#### Perform the Path Extrude

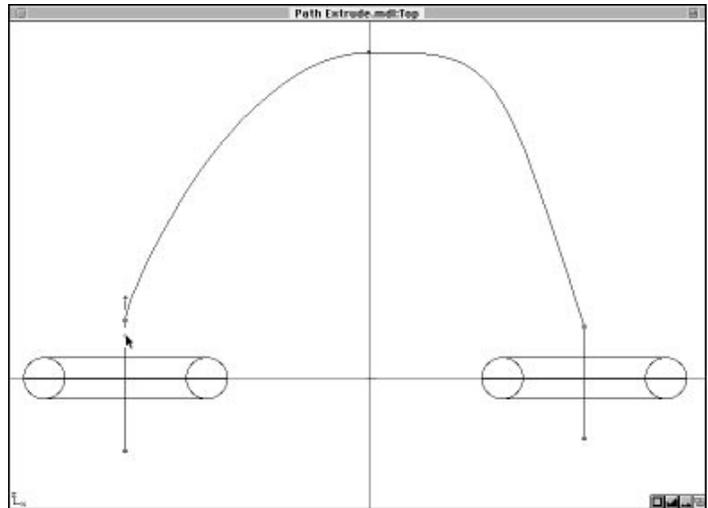
Click on the Selector Tool (or type the letter S) and click on the circle in the Front View to select it as the object to be extruded along the spline path.

Select the Path Extrude tool from the Tool pallet. Make sure that the On Path option in the Path Extrude Info palette is selected. Holding the Option key down, click on the spline drawn through the toruses to start the path extrusion. You now have a preview of the smoother tube.

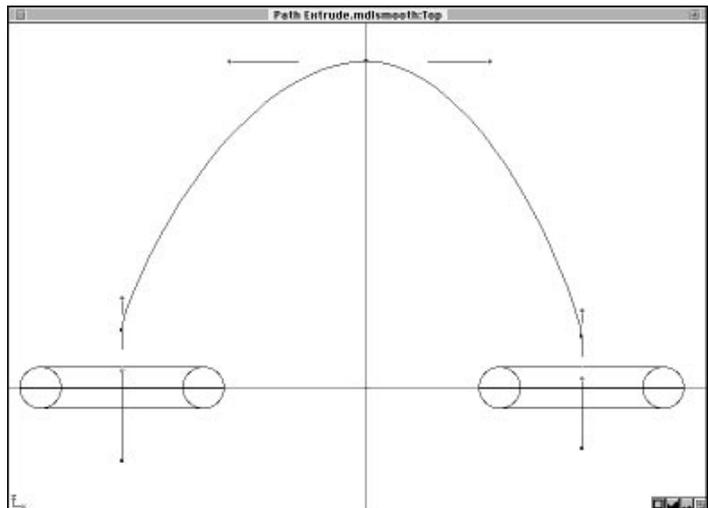
Click on the Path Extr. button on the Path Extrude Tool Info palette to complete the path extrusion.

Go to the File Menu and select Save As. At the prompt for a name, type Smooth Tube.mdl. Take a look at the tip below before you quit or continue on to the next part.

In order to smooth out the spline path, you need to “undo” the path extrude. Under the Edit menu, choose Undo or hold the Command key down and type Z. Under the Windows menu, choose Re-display or hold the Command key down and type D This removes the path extruded object from the windows and the Groups palette.

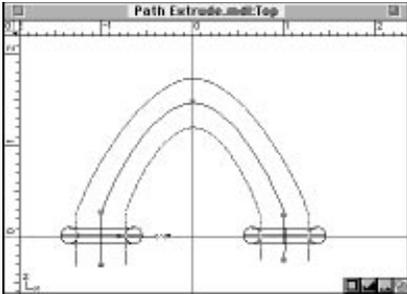


Lining the control handles in a vertical position



Completing the conversion to smooth-cornered vertices

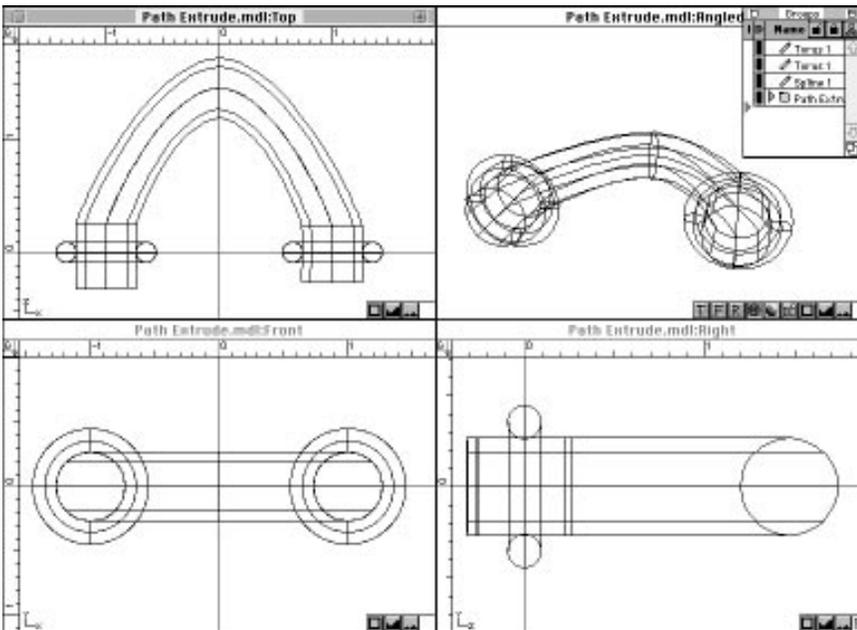
**Note:** Clicking and dragging on the control handle of a tangent to a vertex while holding the Control key separates the action of the handles. This allows you to edit the curves on each side of the vertex separately.



Preview of Path Extrude

To select the spline, click on the spline with the Command key held (this lets you select objects without having to change tools). Select the Add Vertex Tool and click twice on the spline at two different points near and to the left of the point on the bend you want to smooth. Now click twice on the spline at two different points close and to the right of the point on the bend you want to smooth. This adds two points to the left and right of the point on the bend.

Repeat the instructions in the “Perform the Path Extrude” step outlined in this tutorial. If the bend is still “pinched”, you will need to add more points around the bend until the path extruded object is smooth.



Final extrude

**Smoothing a Sharp Bend in the Path**  
 Sometimes a “pinch” occurs on a path extruded object where the spline has a sharp bend. When this happens, you can either change the spline so that it has no sharp bends or you can add more point around the bend.