

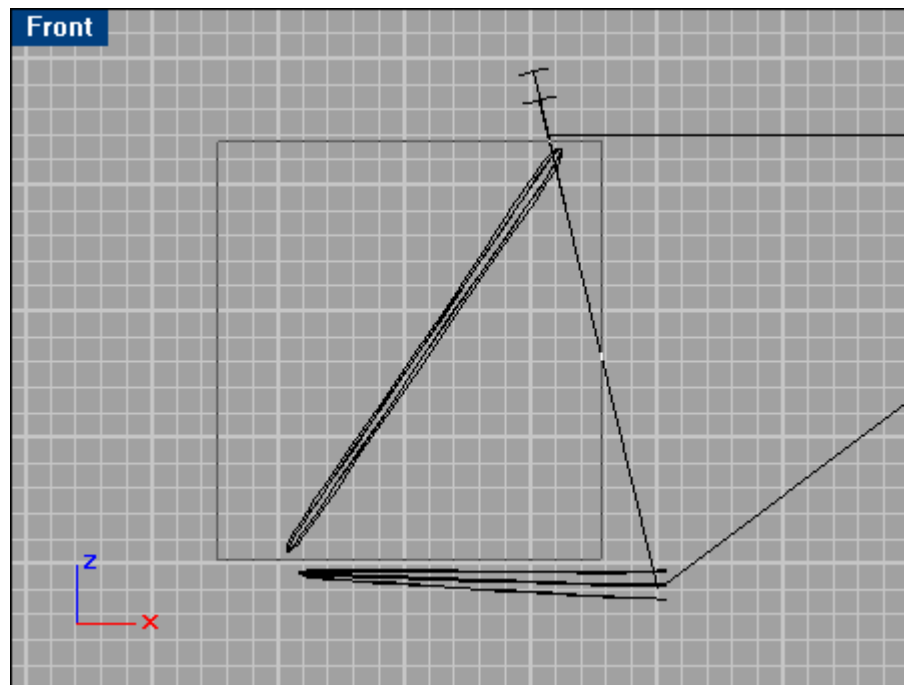
Modeling a Mountain Bike



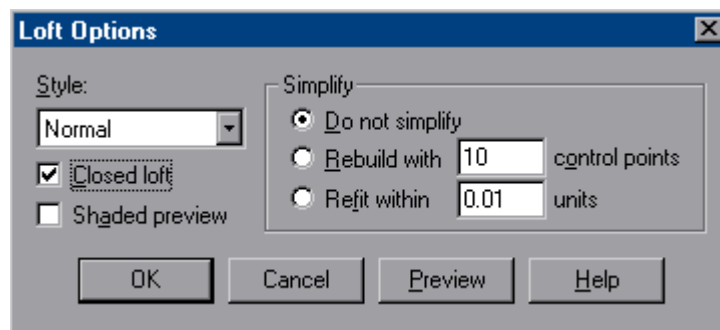
Original Model & Rendering by Chen Lizra
Tutorial by Daniel Ljunggren

This tutorial covers every step in building the realistic Mountain Bike shown above. By the time you're done, you'll have practiced a lot of the modeling techniques you need to use to build detailed designs in Rhinoceros. To speed things up, all the curves required in the tutorial are already available on the Secrets of Rhinoceros CD-ROM, along with the final .3dm file you'll build, and some intermediate versions along the way.

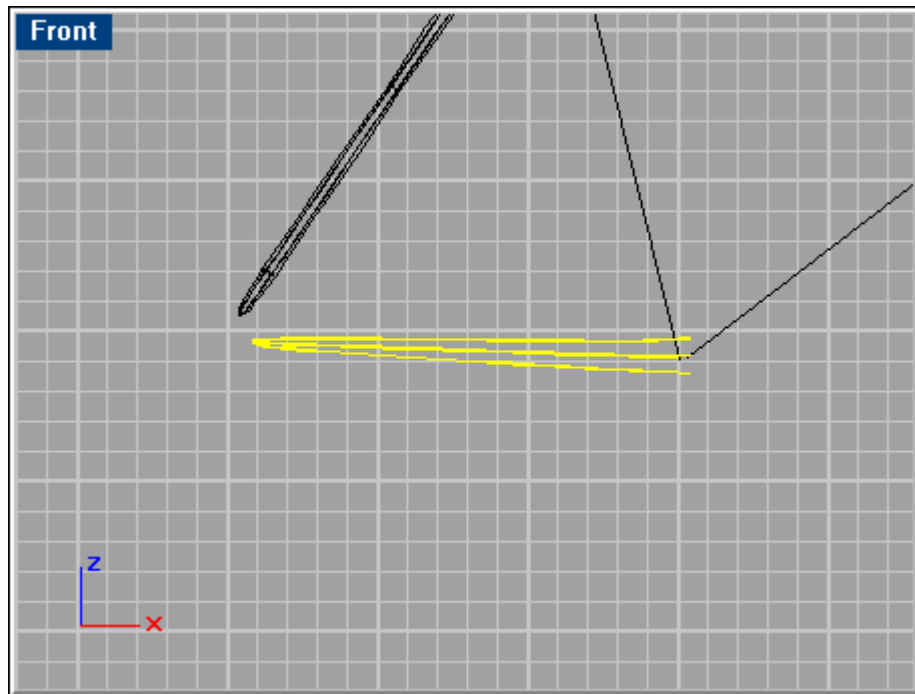
Load the scene 'Curves1.3dm' from the CD-ROM. This file contains the curves necessary to create the frames of the bike. You will be starting with the back frames of the bike. In the Front viewport, hold down left button mouse and drag a rectangle as shown below. This selects the curves within that area.



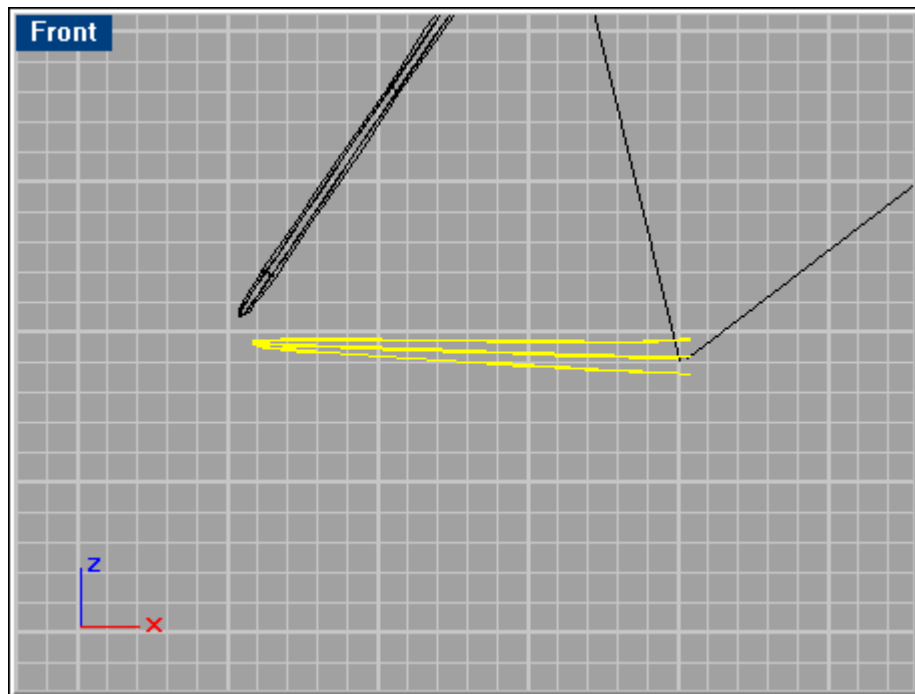
To make a surface out of these curves, go to 'Surface/Loft' in the Menu panel. There are several options to how the surface will be lofted. Use the settings shown below. The 'Closed loft' box makes the surface go all the way back to the beginning curve, making the surface closed.



Select the curves shown below, and repeat this step with these curves to loft the second rear frame.

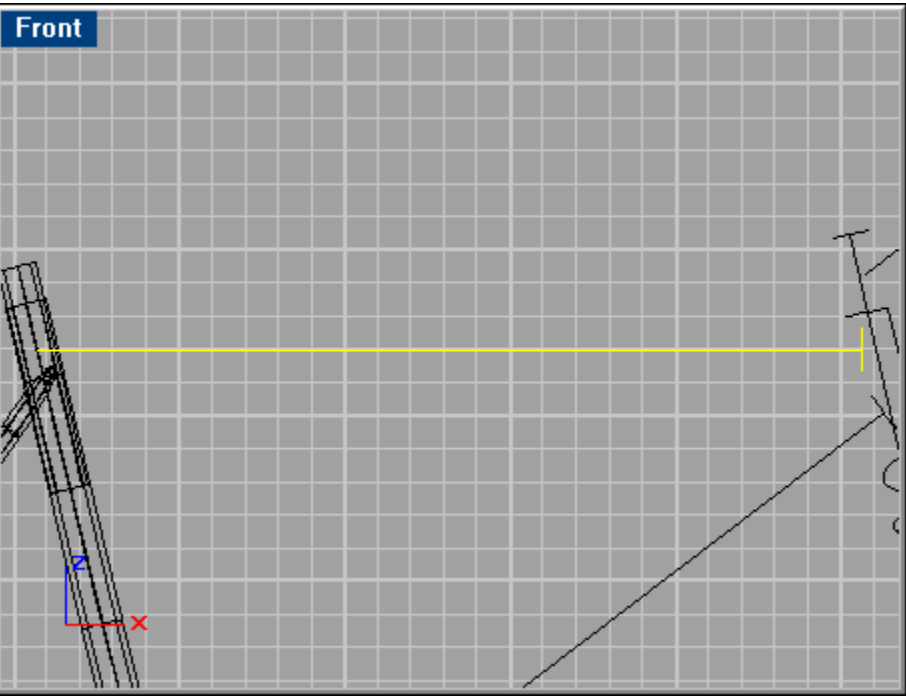
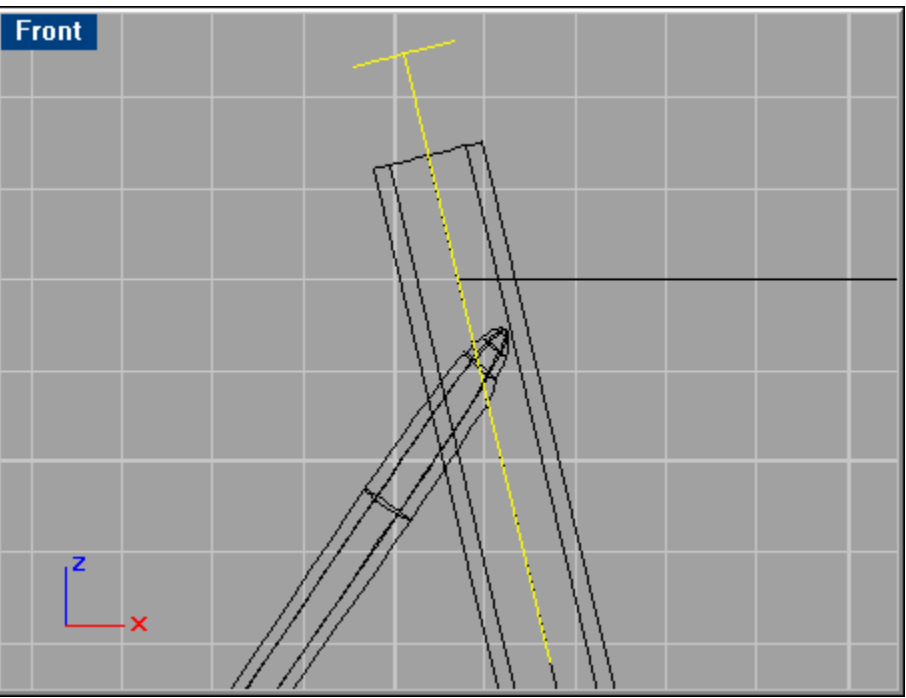


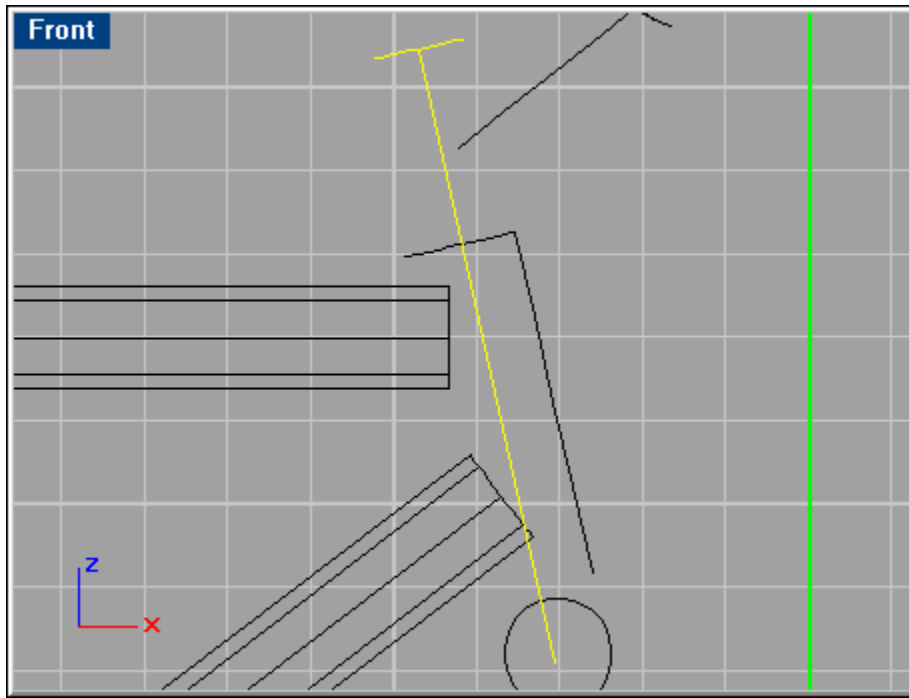
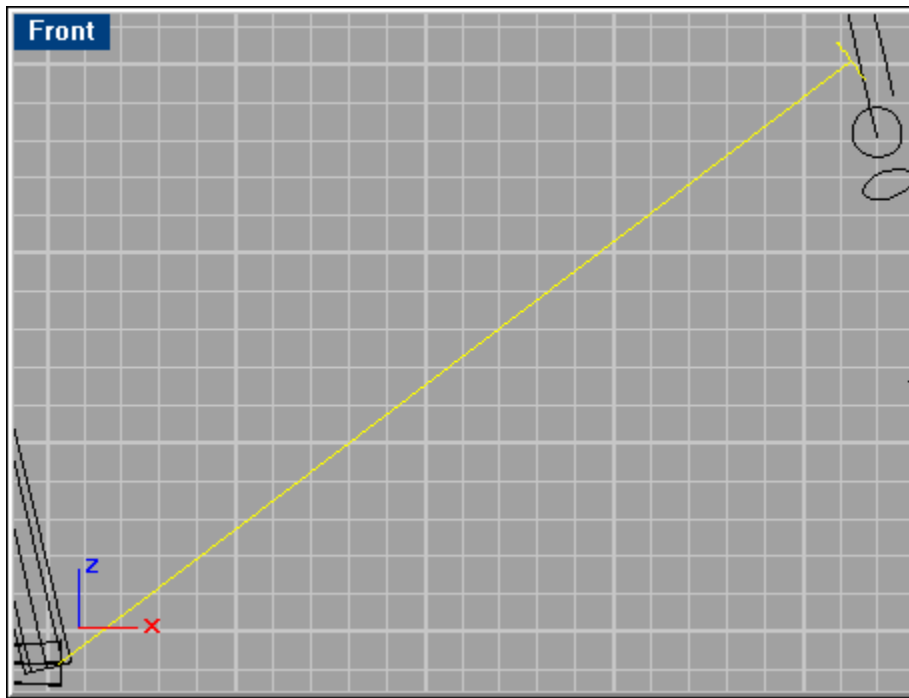
Select the curves shown below, using Shift-LMB (left mouse button) to click for multiple selections.

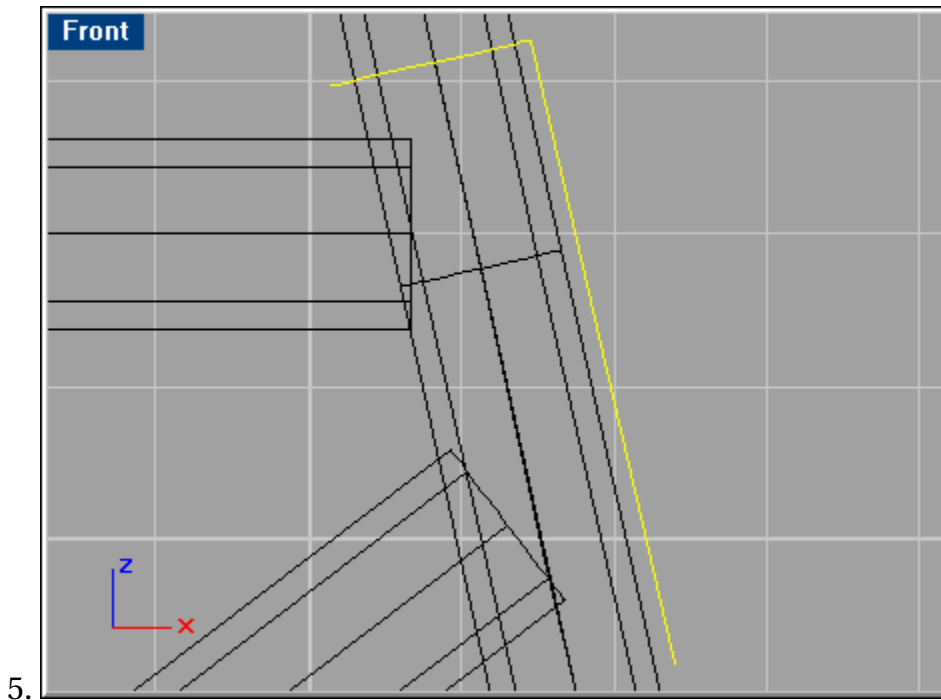


Then go 'Surface/Sweep 1 Rail' in the Menu to see the options. Rhinoceros often selects what curve would be the rail / profile curve, which makes the modeling process very fast. Use the default settings.

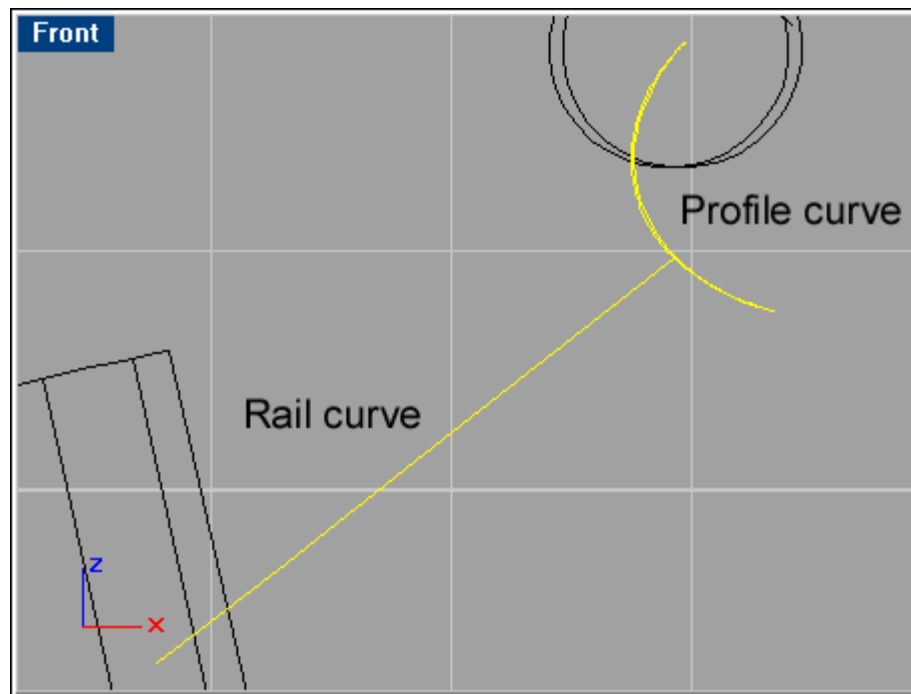
Repeat this function with the curves shown in the 5 figures below:





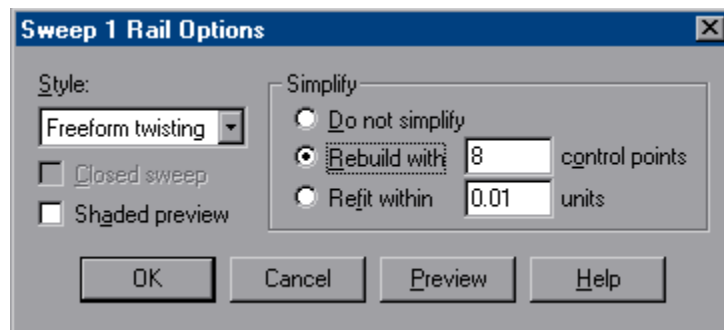


Without any curves selected, go to 'Surface/Sweep 1 Rail'. Rhinoceros will ask you to pick the rail curve. Pick it as labeled below.

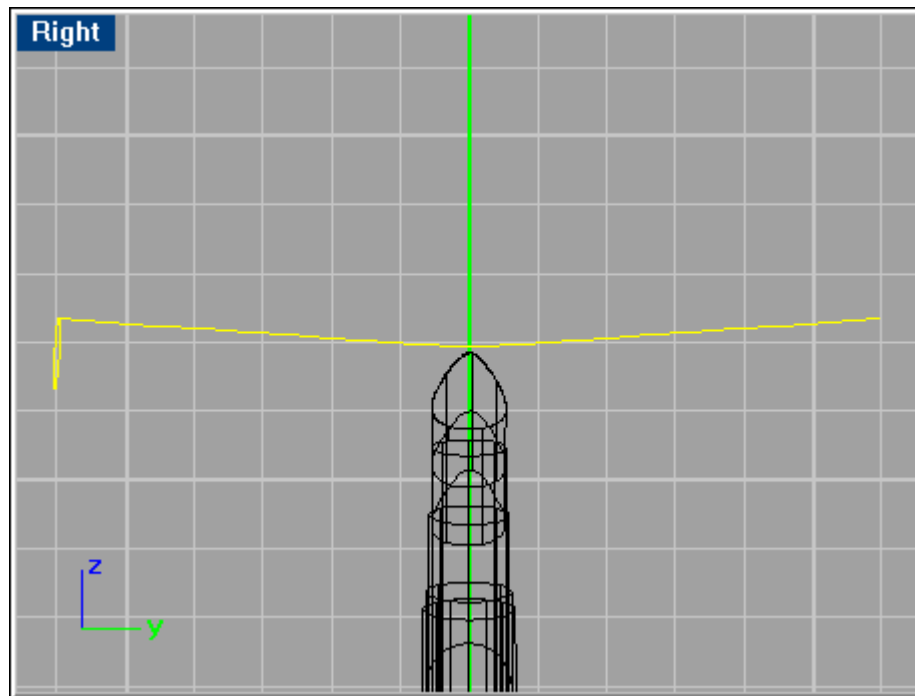


Next, select the profile curve. NOTE: The reason that you cannot select both curves prior to the 'Sweep 1 Rail' command, is that the profile curve (due to its shape) could be like a rail, and Rhino then couldn't tell which was which.

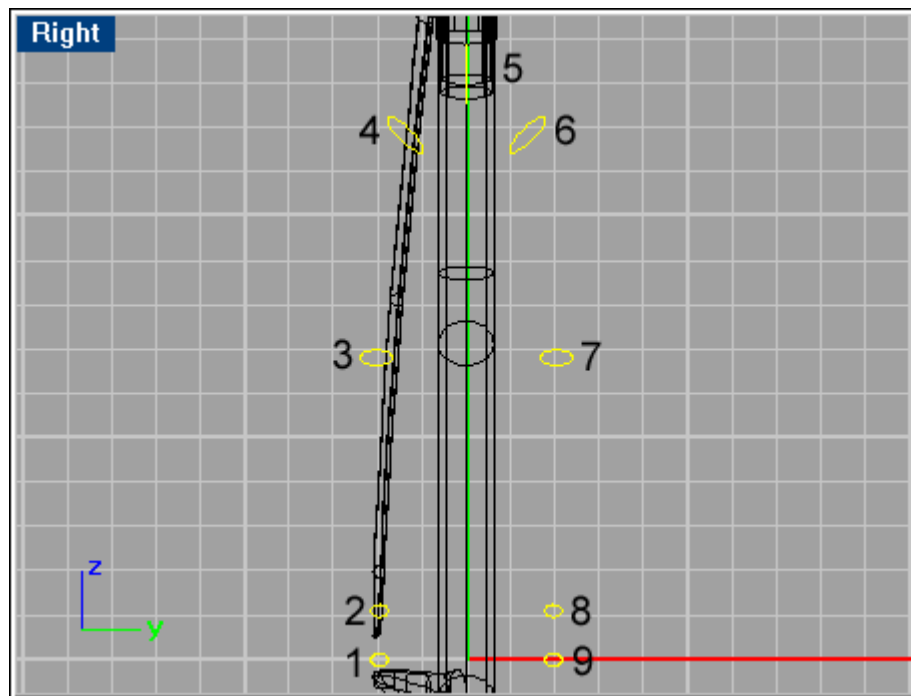
As you can see, the resulting surface is quite dense compared with the other frames. Instead of using the default settings, use the Rebuild option as seen below. This makes the surface less dense, but still smooth.



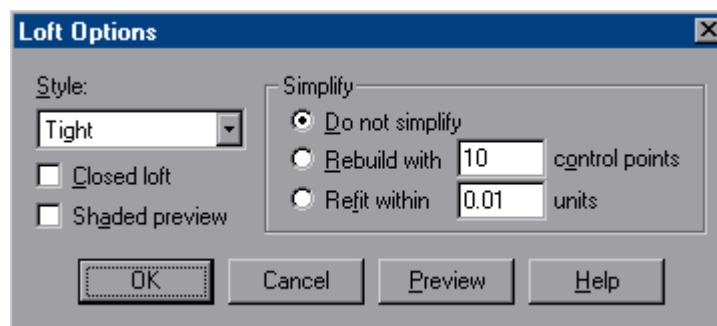
Model the handlebars by selecting the curves (below), and do a 'Sweep 1 Rail,' with default settings.



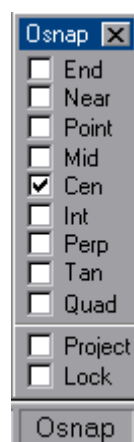
You'll still have to make the frame supporting the front wheel. The curves selected in the figure below are the ones you will loft. Here you need to select each profile in the order numbered below after you start the loft command.



Use the 'Tight' style in the Loft options, as shown below.



In order to Mirror the two rear frames, the first thing to do is activate the Object Snap 'Cen' in the osnap dialog box shown below. This will make the pointer snap to the center of surfaces close by.

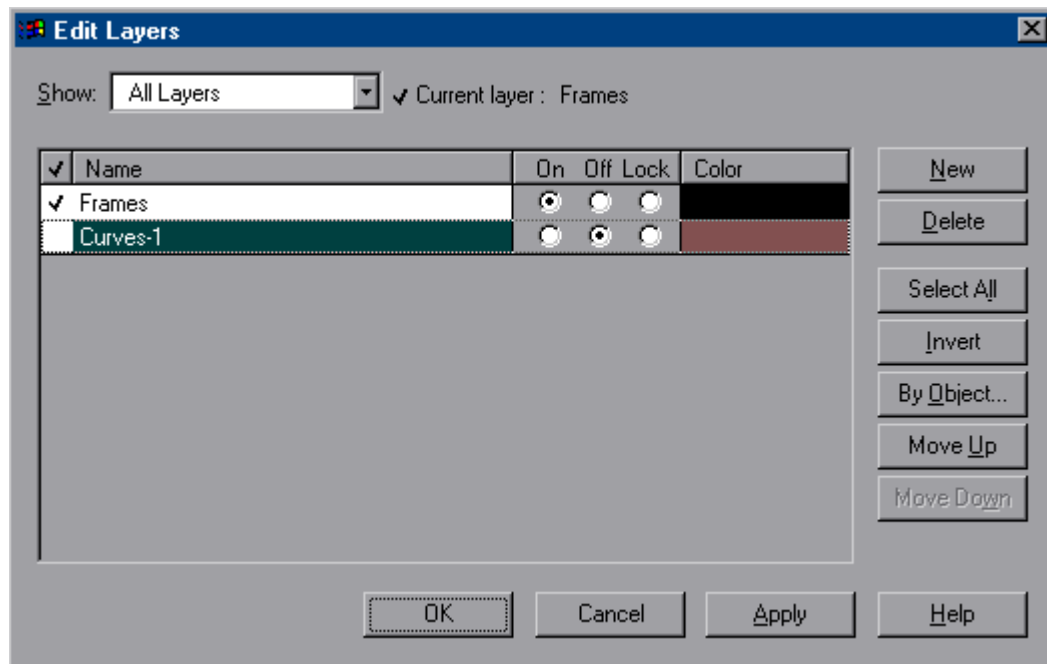


In the Top viewport, select the rear frames and start the 'Mirror' command. Snap to the center of any of the surrounding frames, then hold Shift (for straight lines) and drag to the left, and click the left mouse button.

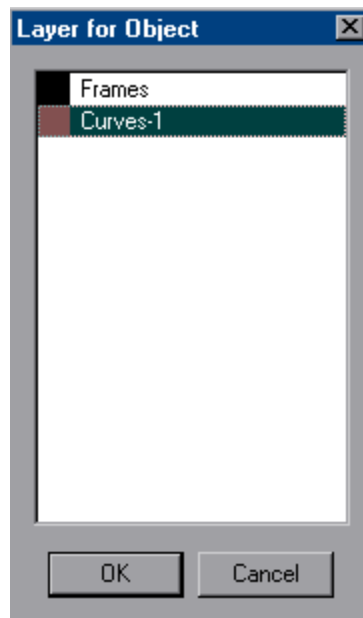
Now would be a good time to organize your work with layers. Layers are used in order to provide better control over the objects in the scene, as well as to accelerate your display by optionally

turning off unneeded layers.

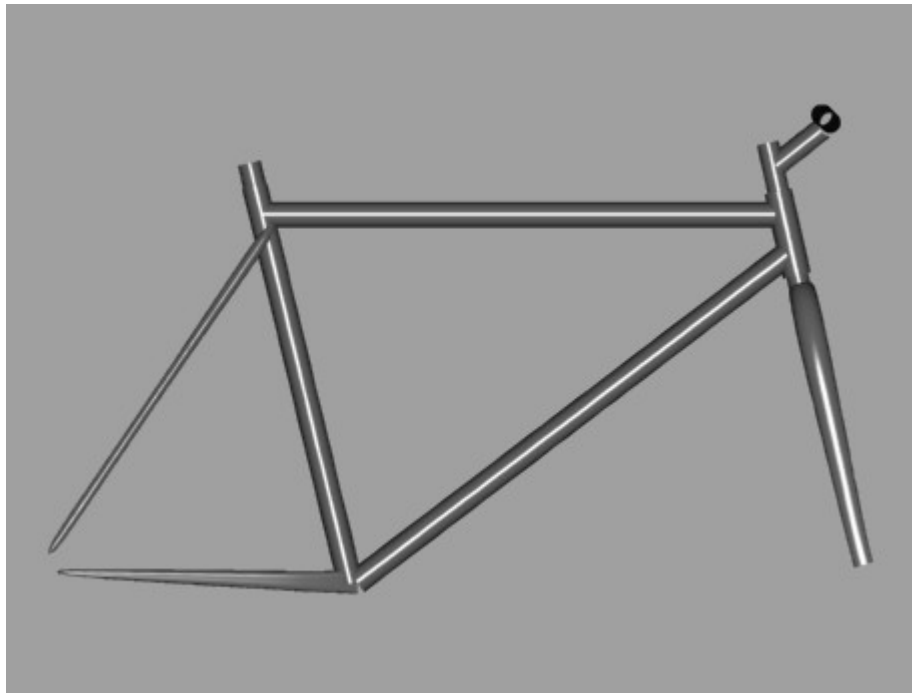
Because the curves won't be of use any longer, it would be good idea to move them to an inactive layer. Go to 'Edit/Layers/Edit...' The 'Edit Layers' panel is displayed, as shown below. Click the 'New' button, and name the new layer 'Curves-1'. Select 'Off' to have them invisible in the viewports, and click OK.



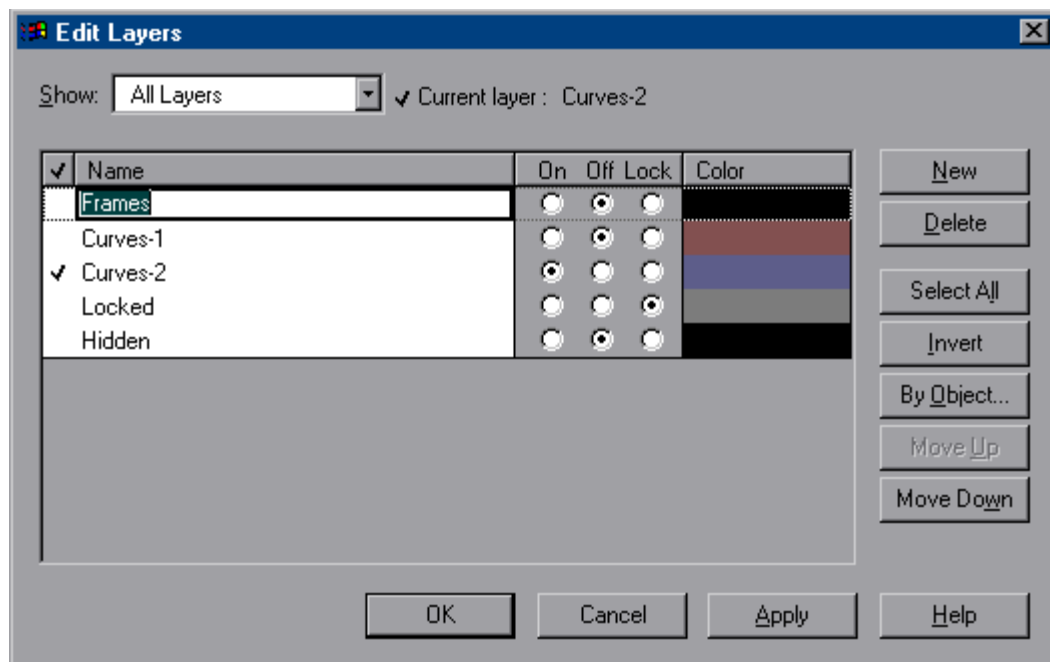
To change all the curves to the new layer, go to 'Edit/Select/All/Curves' to select all the curves. Then use 'Edit/Layers/Change Object Layer'. Select the 'Curves-1' layer and hit OK as shown below. The curves should now disappear from the viewports.



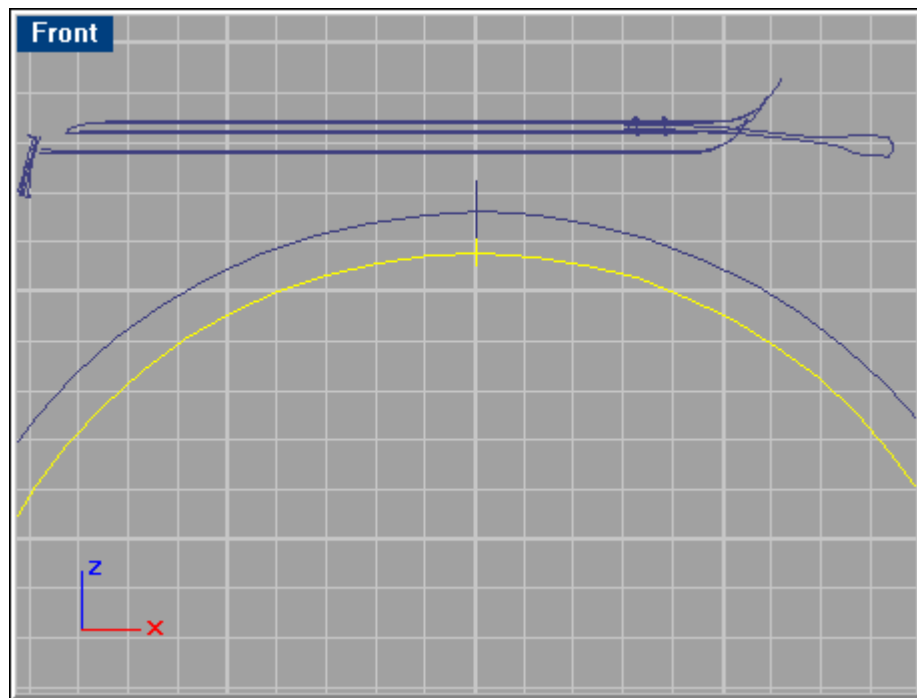
Your model should now look similar to the sample file 'Bike1.3dm.' Be sure to save your work before continuing.



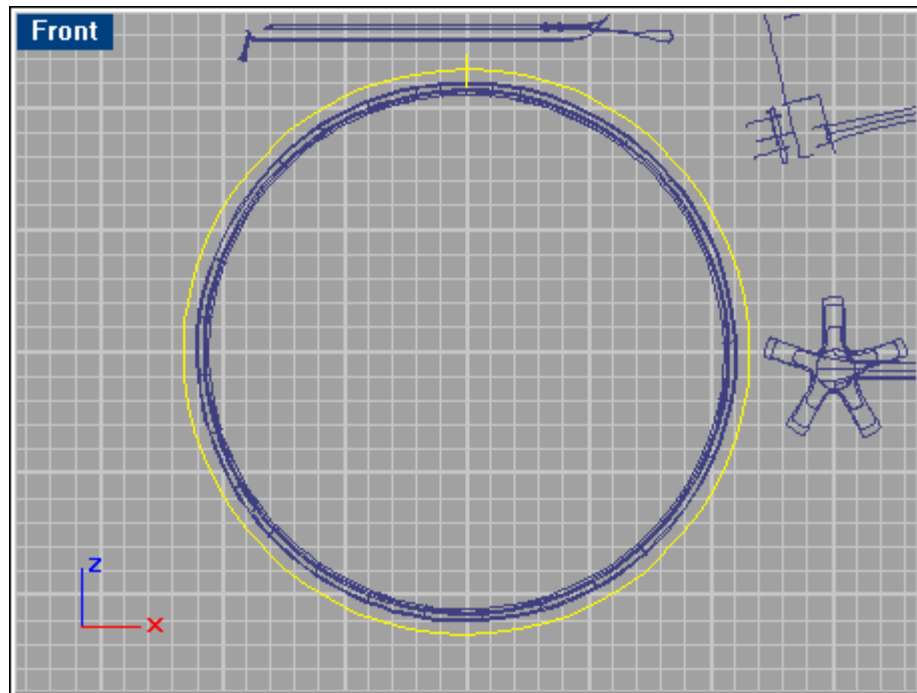
Choose 'File/Import/Merge' and select 'Curves2.3dm'. The curves come with a new layer called 'Curves-2' which has another color. Go into Layer Control and turn off the 'Frames' layer.



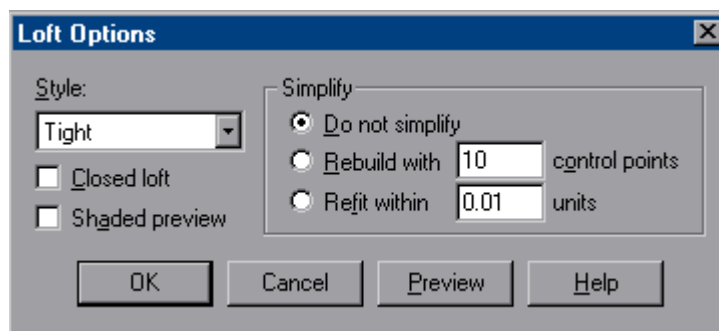
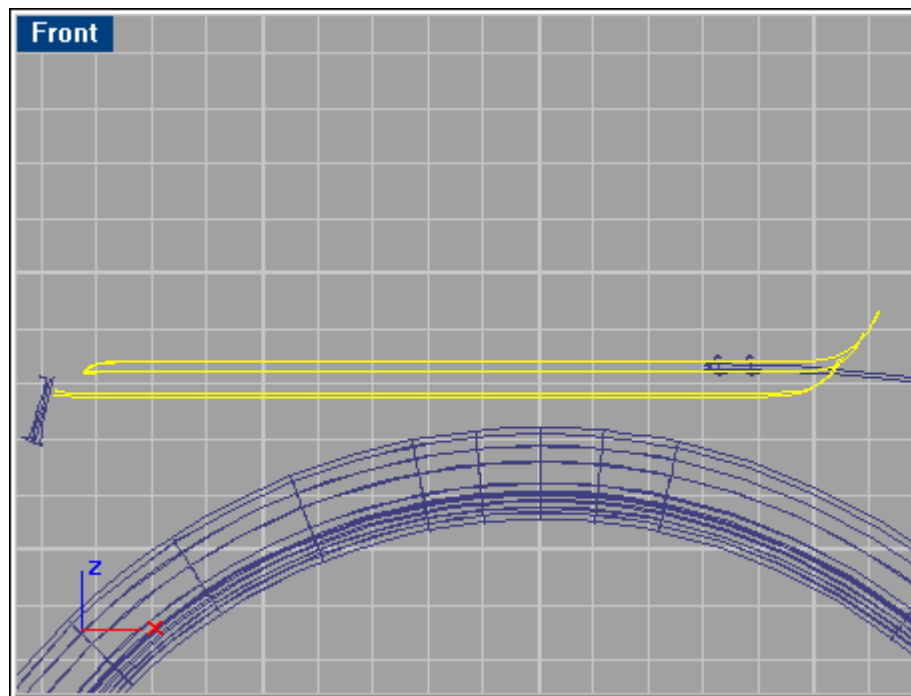
Start with modeling the back wheel. Select the 2 curves seen below.



Make a 'Sweep 1 Rail', using the default options. Do the same with the curves shown below to create the tire. Repeat these steps for the front wheel as well.

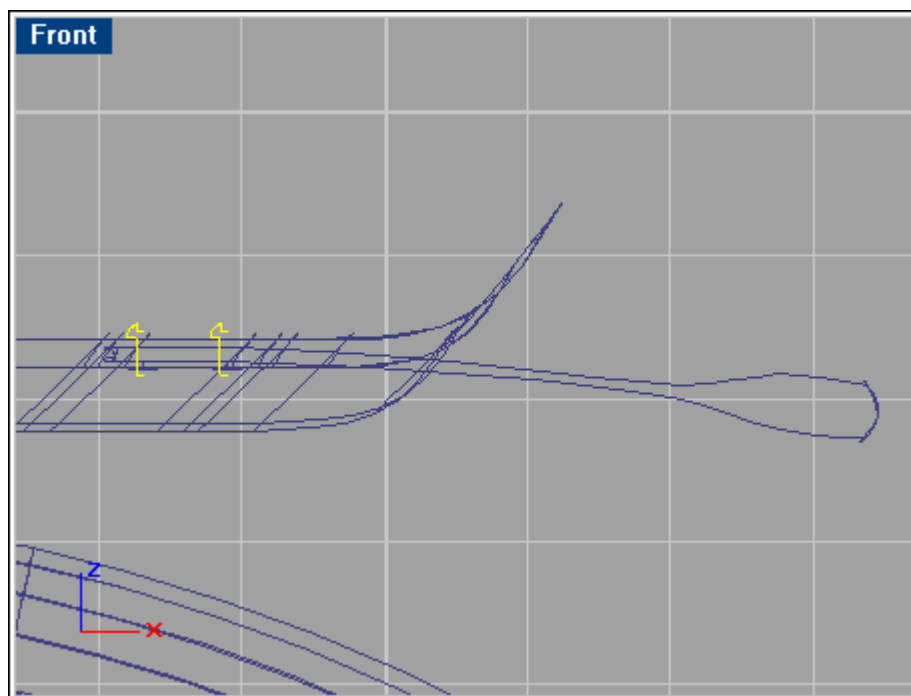


Select the curves shown below and loft these to create the rear rack.



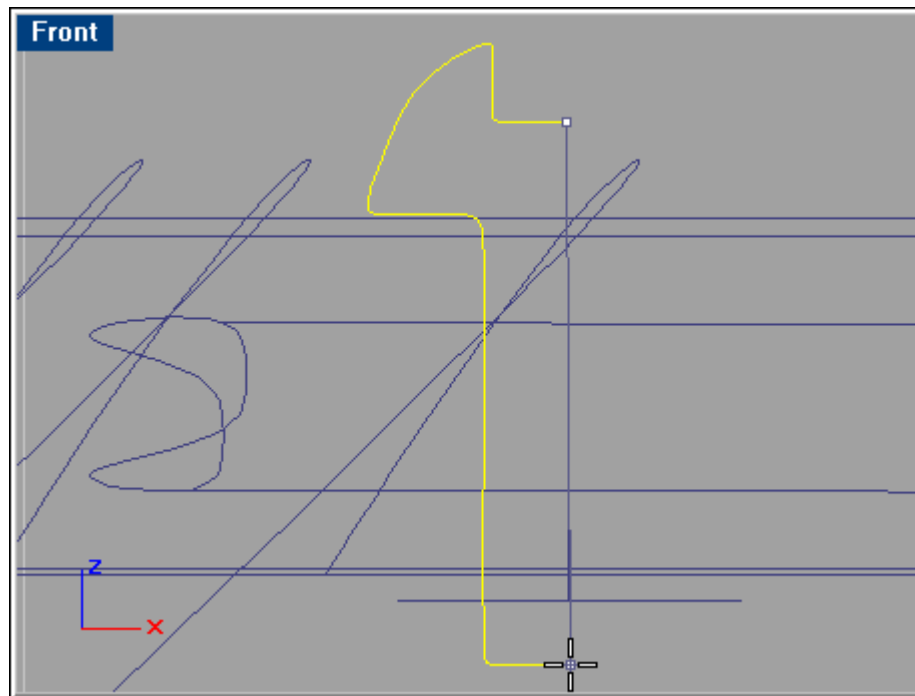
Use these options:

Zoom in on the area where the screws are positioned.



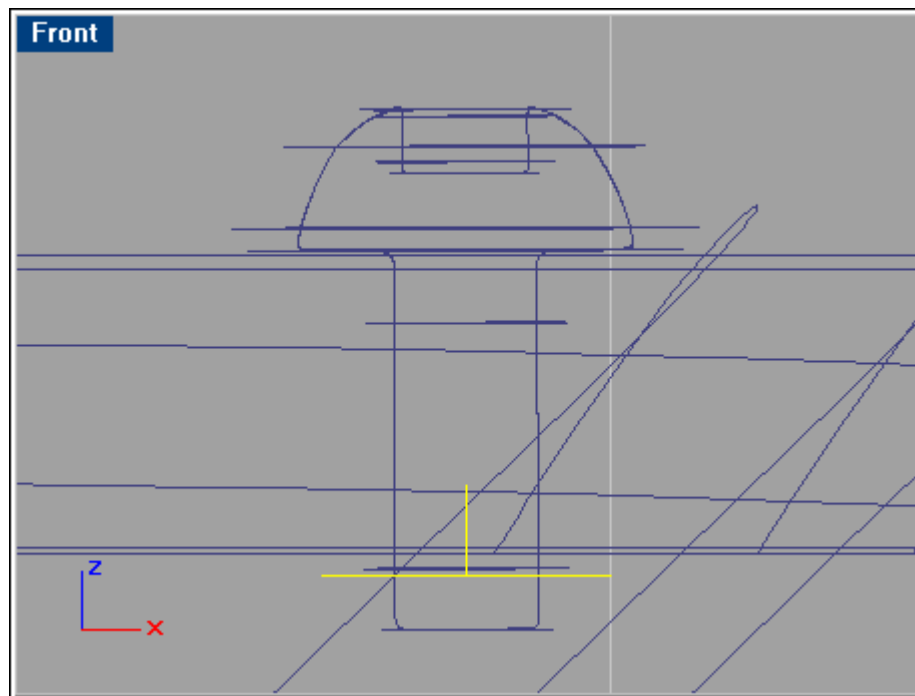
Select one of the screws, and go to 'Surface/Revolve'. Use Object Snap 'End' (right) when

you select the Start and End of the revolve axis, as shown below.

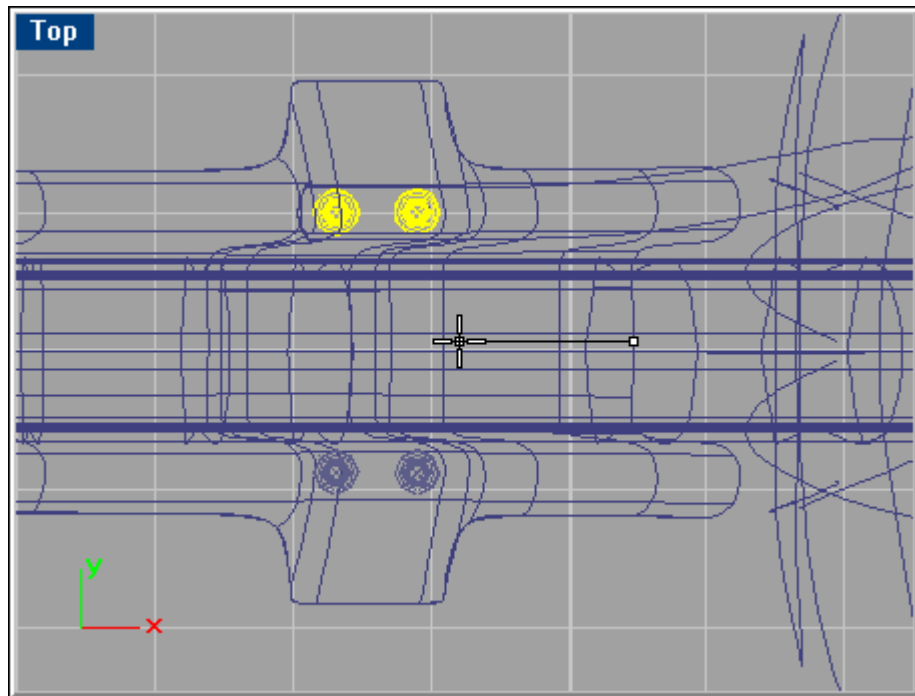


Use the default settings in the 'Revolve Options' panel. Repeat this step with the other screw curve.

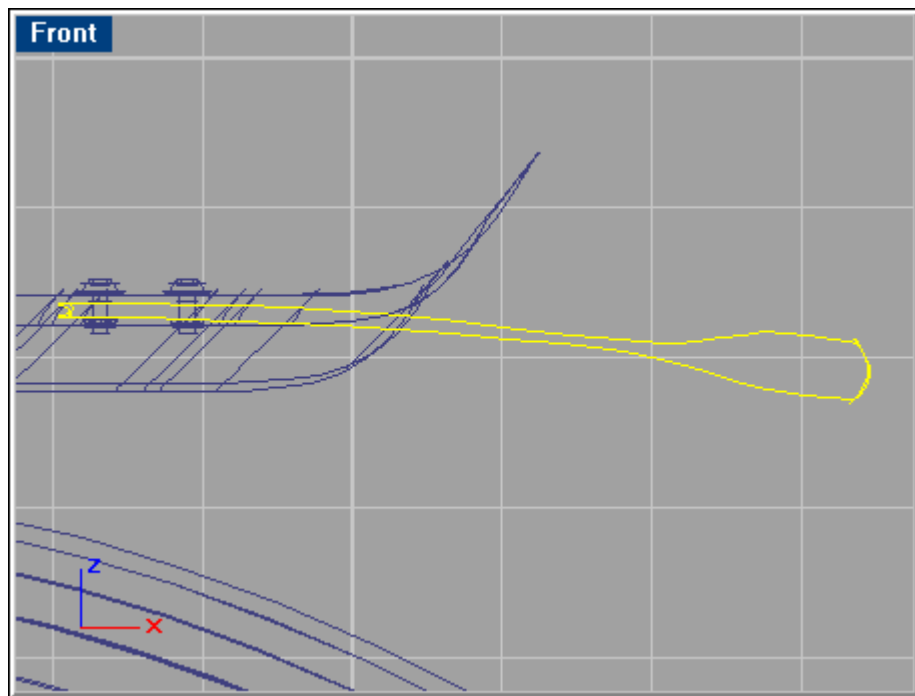
Select the curves shown below and make a 'Sweep 1 Rail' to create the bolt. Repeat for the other screw bolt.



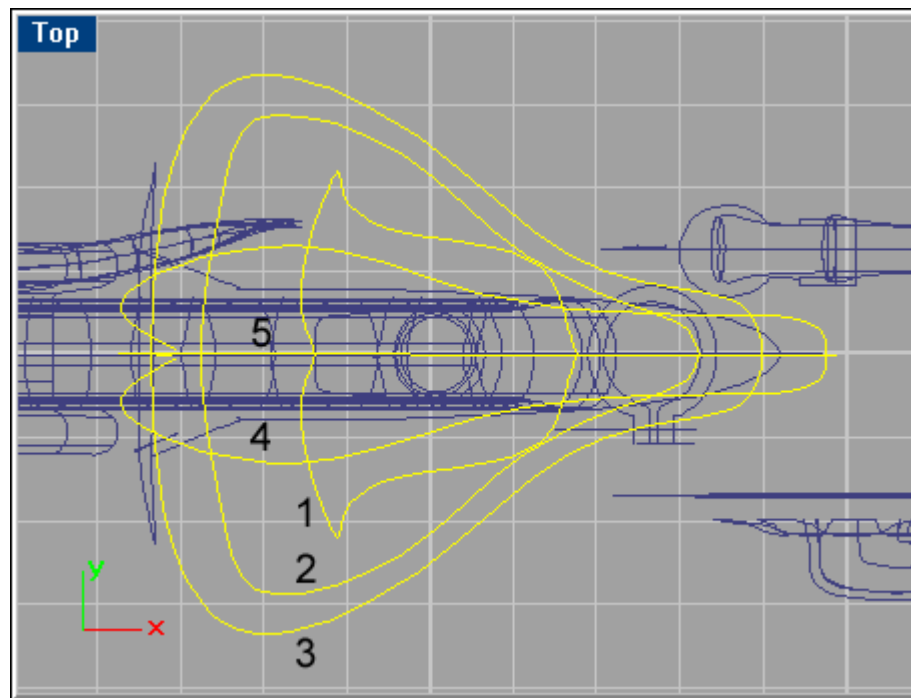
Set the Object Snap to 'Mid' and uncheck the 'End' snap. This makes the pointer snap to the middle of surfaces nearby. Select both screws and bolts and go 'Transform/Mirror'. Move the pointer close to the area shown below so it snaps to the middle of the package holder, press LMB then hold Shift and drag the pointer straight in any horizontal direction. Make sure it doesn't snap to anything. Press LMB again to finish.



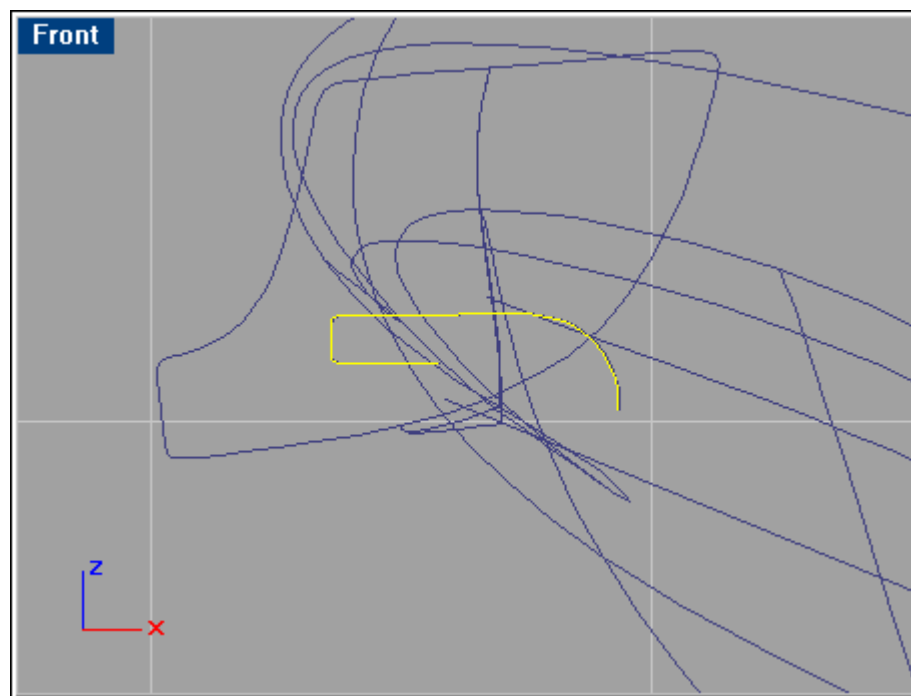
Select the curves shown below, and go 'Surface/Sweep 2 Rails'. Use the default options.



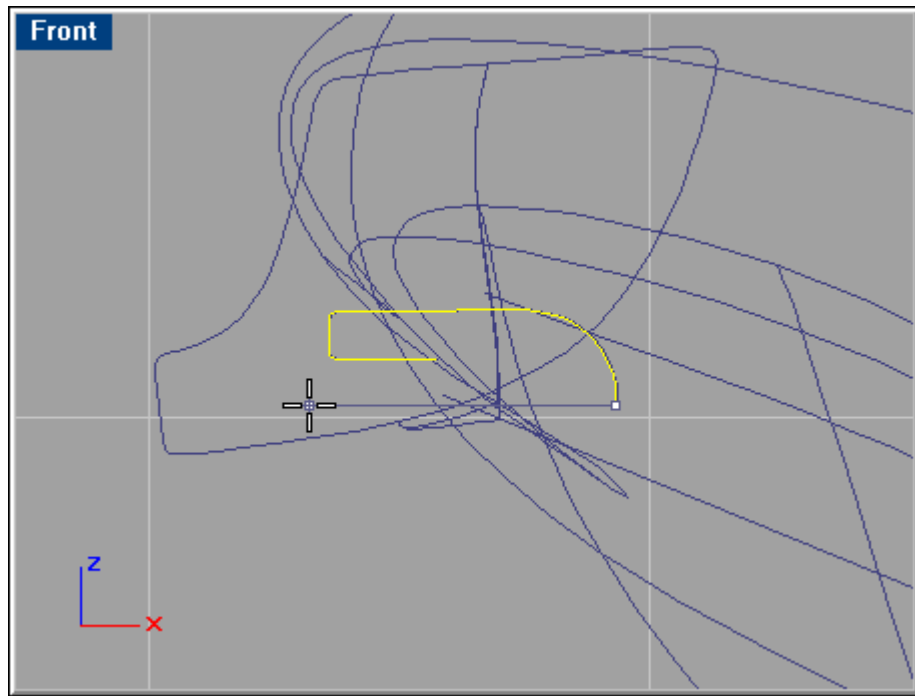
To construct the saddle, deselect all and use 'Surface/Loft'. The figure below shows in what order the first half of the curves should be lofted, and when you continue selecting the curves on the upper half of the image, the order is mirrored.



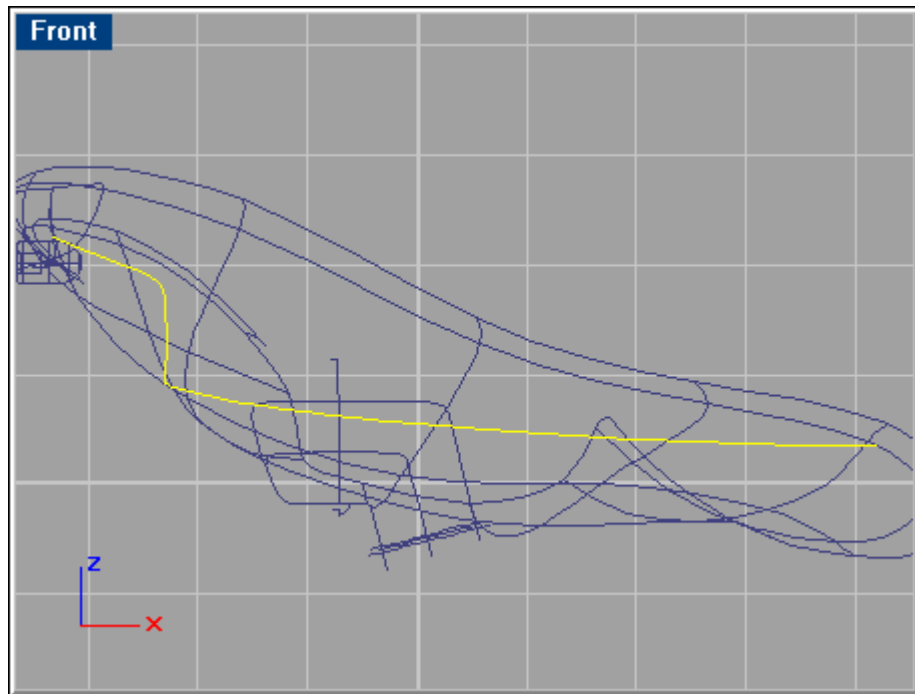
To make the screws under the saddle, select the curve shown below.



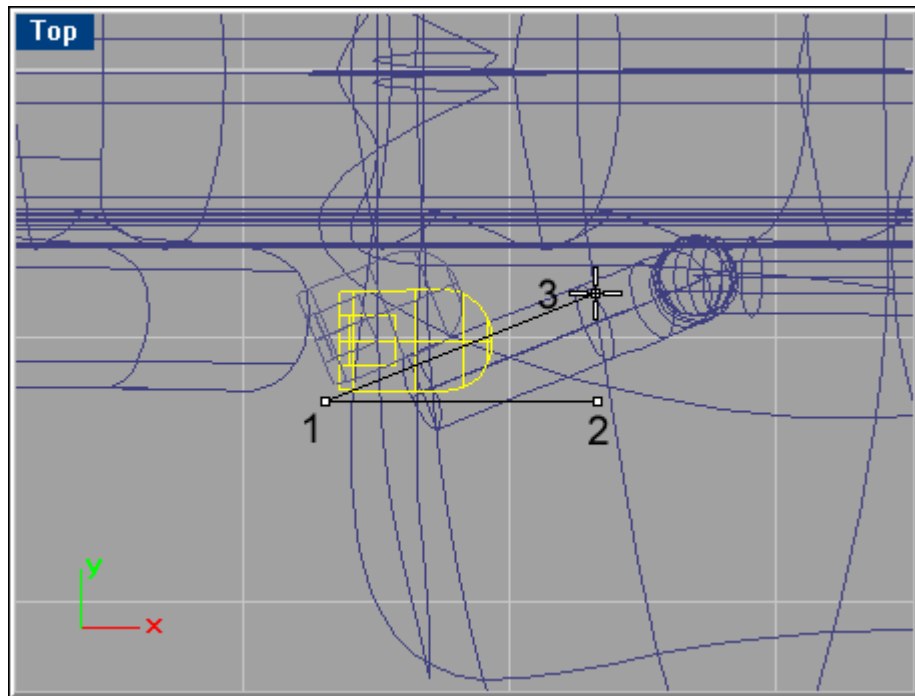
When done, go 'Surface/Revolve', and while using the Object Snap 'End', make the cursor snap the right end of the curve and hit LMB, hold Shift and drag to the left and hit LMB to finish the revolve process.



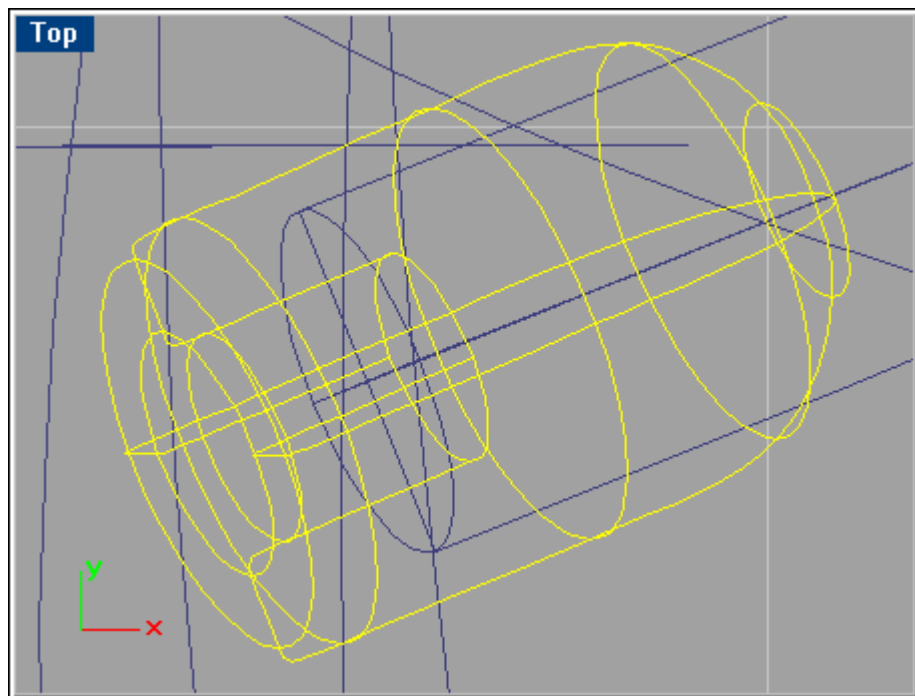
Select the curve shown below, and go 'Solid/Pipe'. Rhinoceros asks for the Starting and End radius, type in 0.15 in the command line and hit Enter for the starting radius, then just hit Enter again as Rhinoceros remembers the value. If you want the End radius to be different from the Starting radius, type in another number.



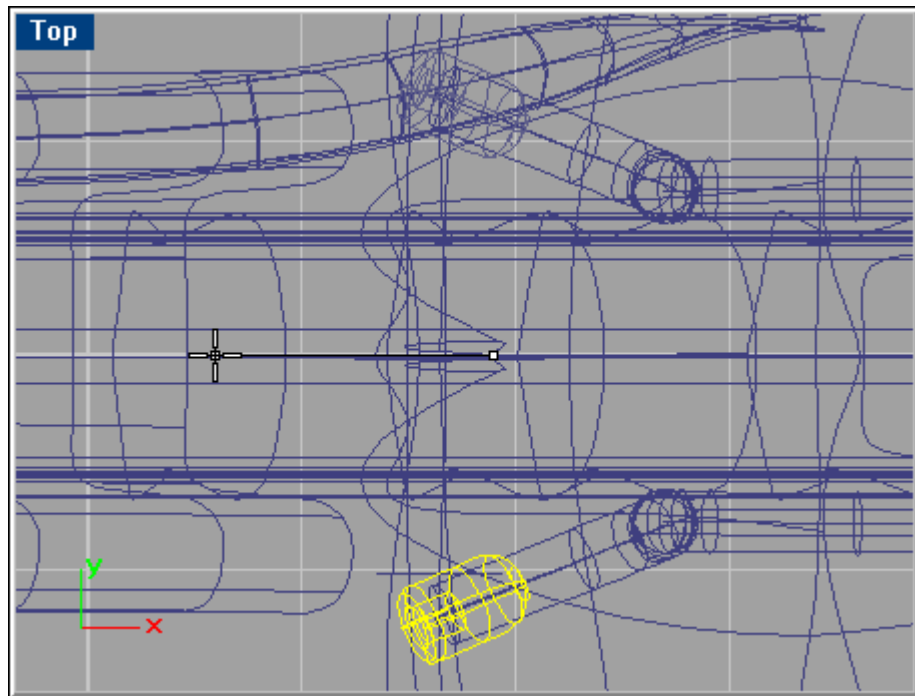
Now you have a good idea of what direction the screw should point to. Go 'Transform/Rotate' and when Rhinoceros asks for 'Center of rotation', hit LMB at point 1 as shown in the figure below.



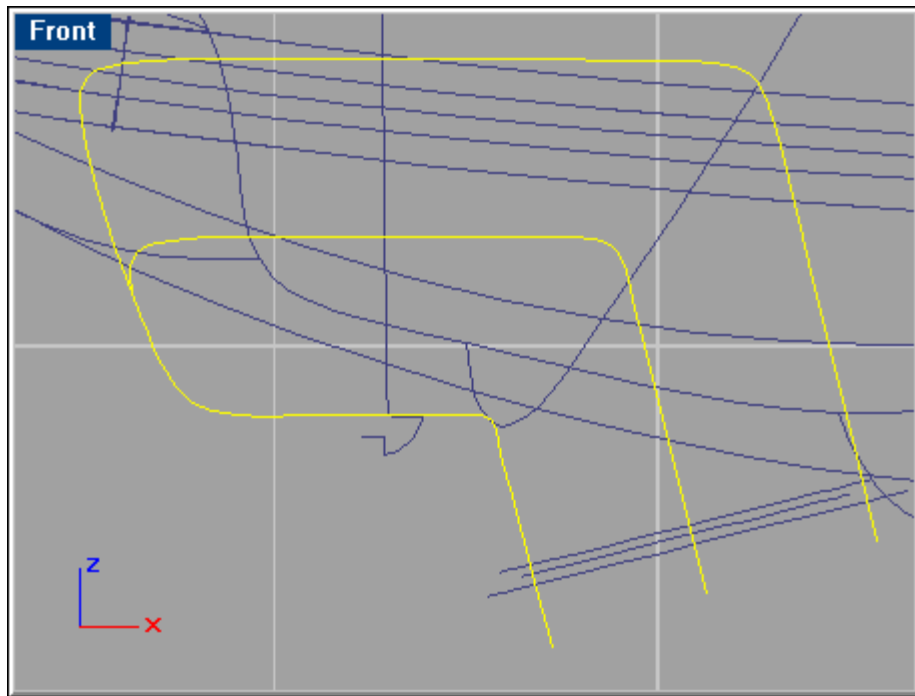
At 'Angle or first reference point', set the pointer at point 2. Then rotate the screw up so the rotation line lines up with the pipe you created in the previous step. Repeat this step in the Front viewport so the screw lines up with the pipe from that view as well. Then move the screw so it looks like it is attached to the pipe as shown below. (You need to move it in the Front viewport as well.)



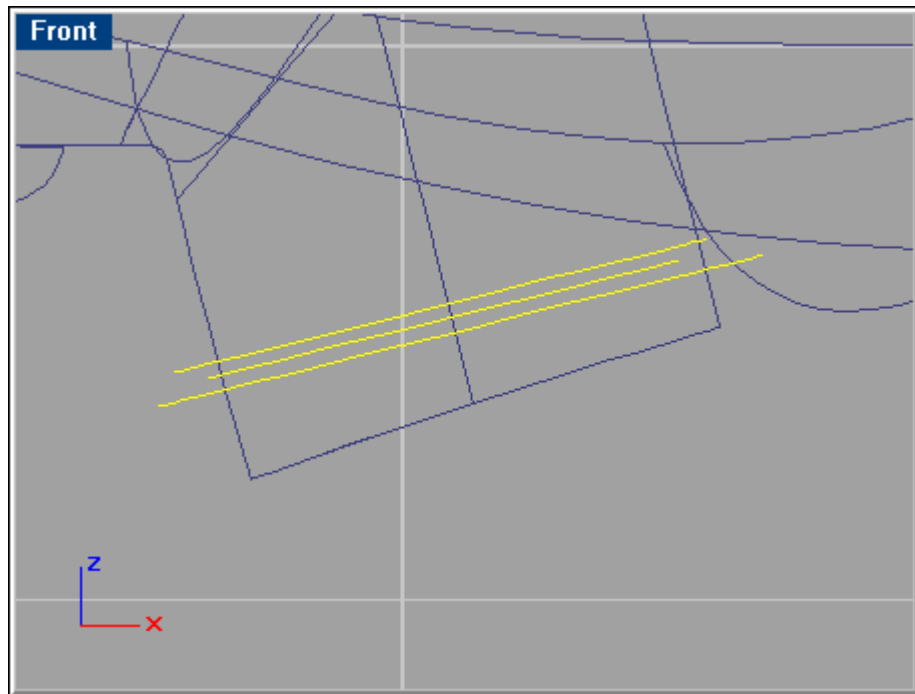
Use the Object Snap 'Mid', and when the screw is selected in the Top viewport, mirror it to the other side as shown below.



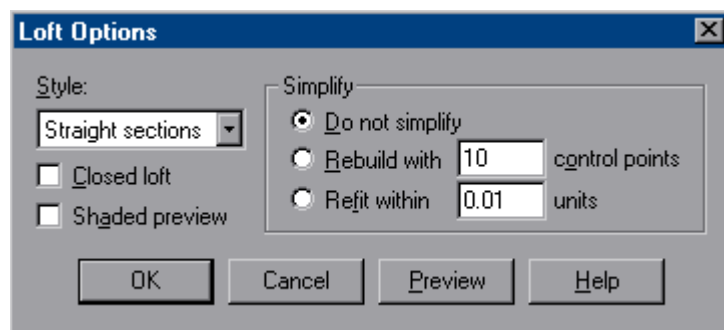
Select the curves shown below (there are two curves in the middle, so make sure both curves are selected). Then loft these together with the 'Closed' option.



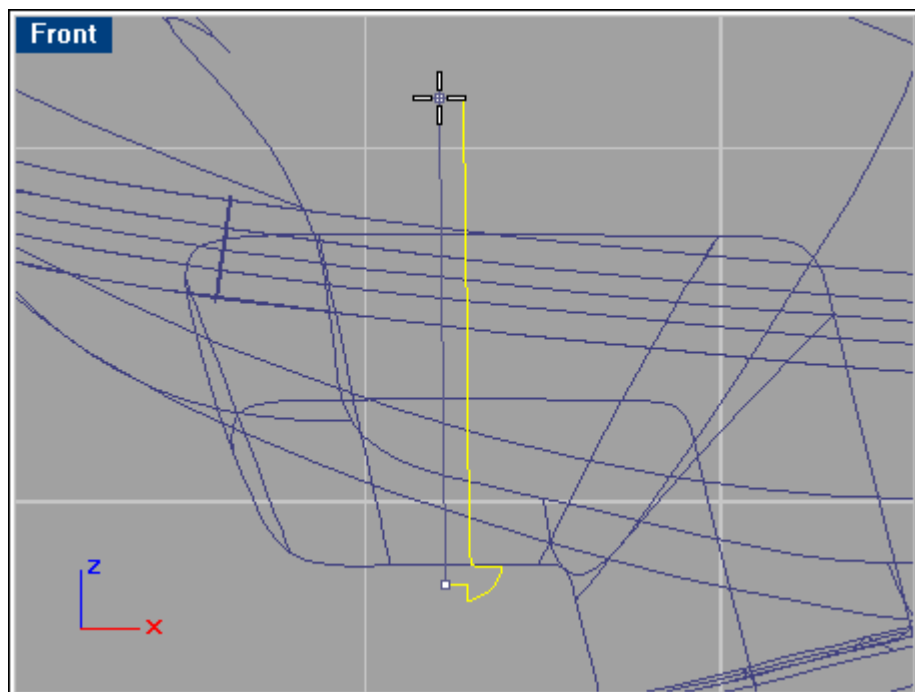
Loft the curves selected below with the order middle-top-bottom curve. NOTE: To set the order of the loft, you must start the loft command with everything deselected.



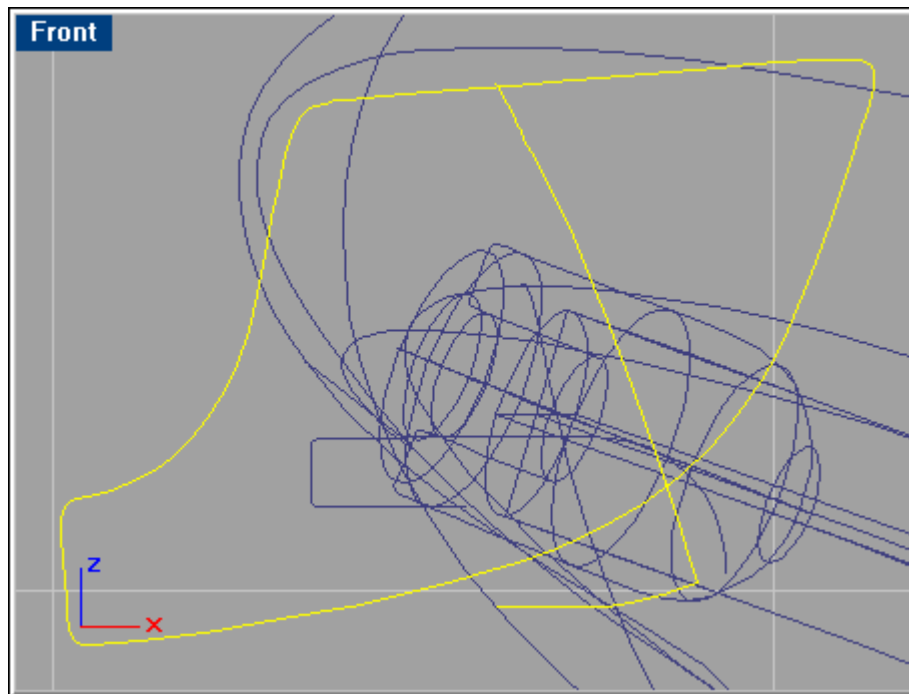
Hit Enter when Rhinoceros asks for the direction of the curves. Use the options shown below.



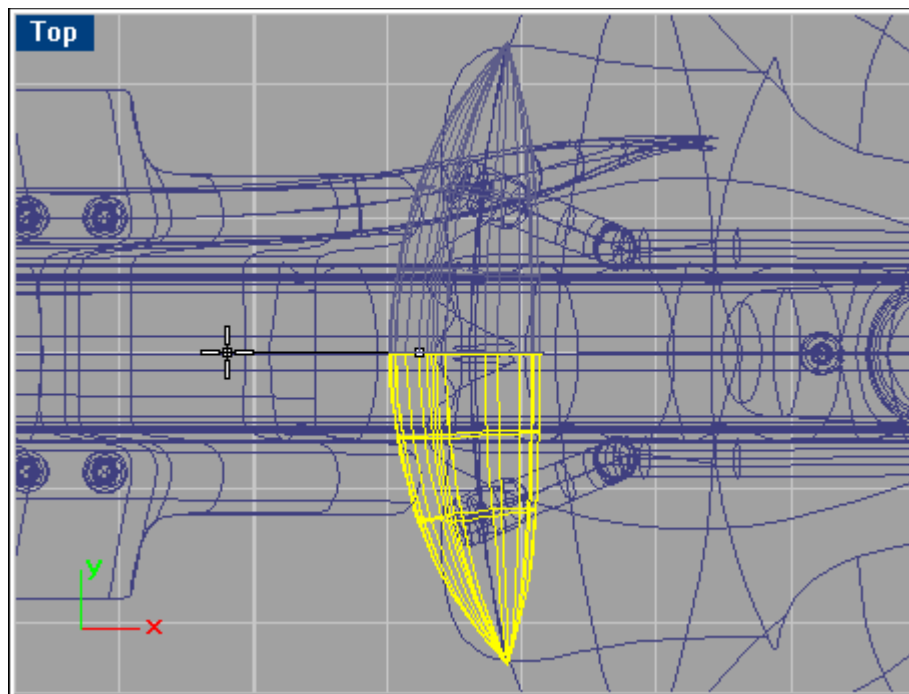
Make the screw under the saddle with a revolve. As usual, use Object Snap 'End'.



Select the curves shown below, and do a 'Sweep 2 Rails'. Use the default options.

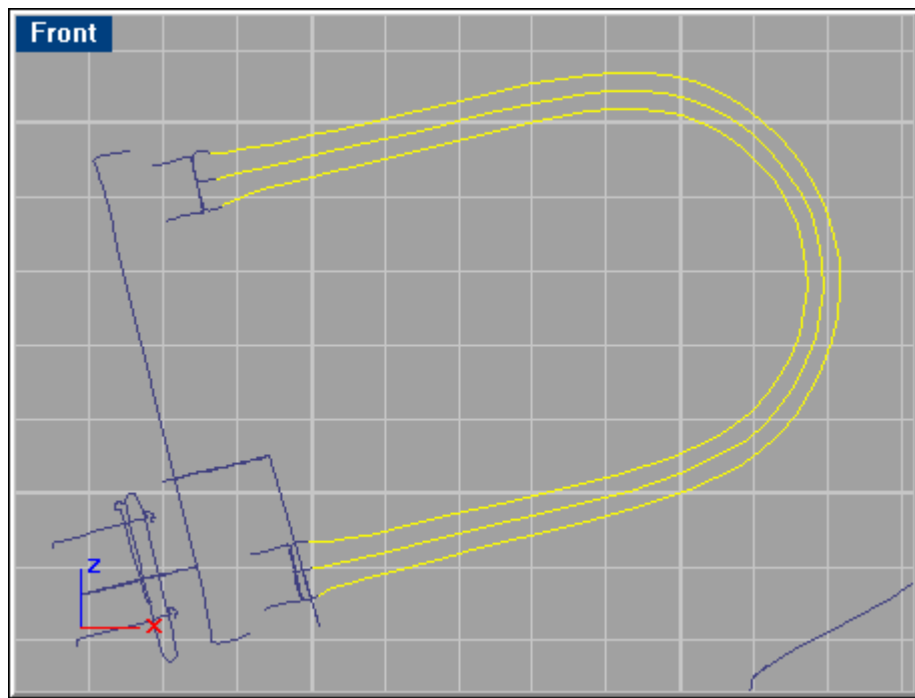


As you can see, only half of the rail is swept, because the sweep starts from middle, where the profile curve is positioned. Select the surface and mirror it in the Top viewport as shown below. NOTE: Object Snap 'Near' would be appropriate to use here.

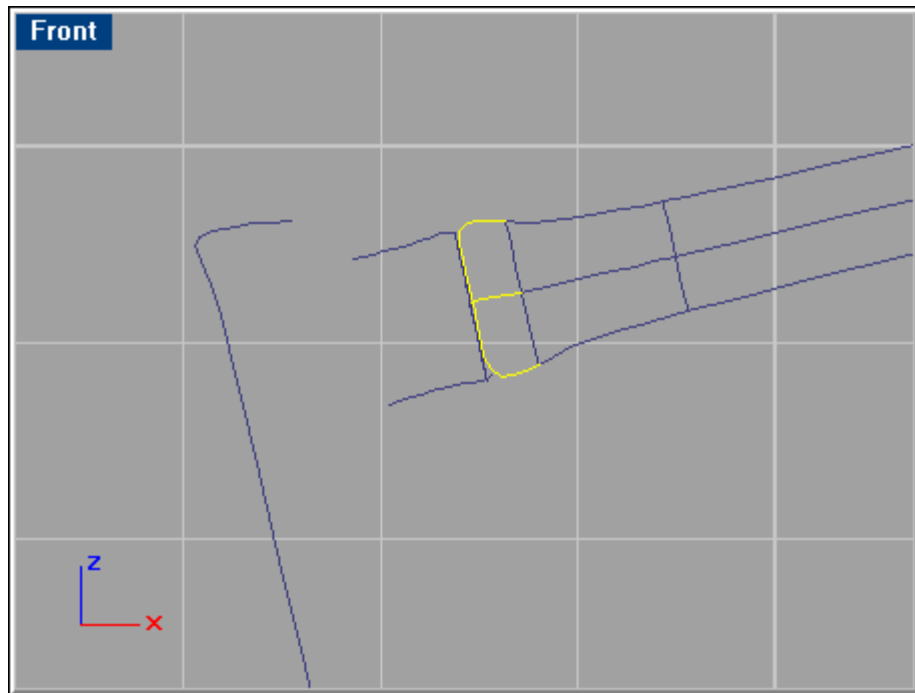


Finally, go 'Surface/Edit Tools/Merge' and select both surfaces to merge them into one.

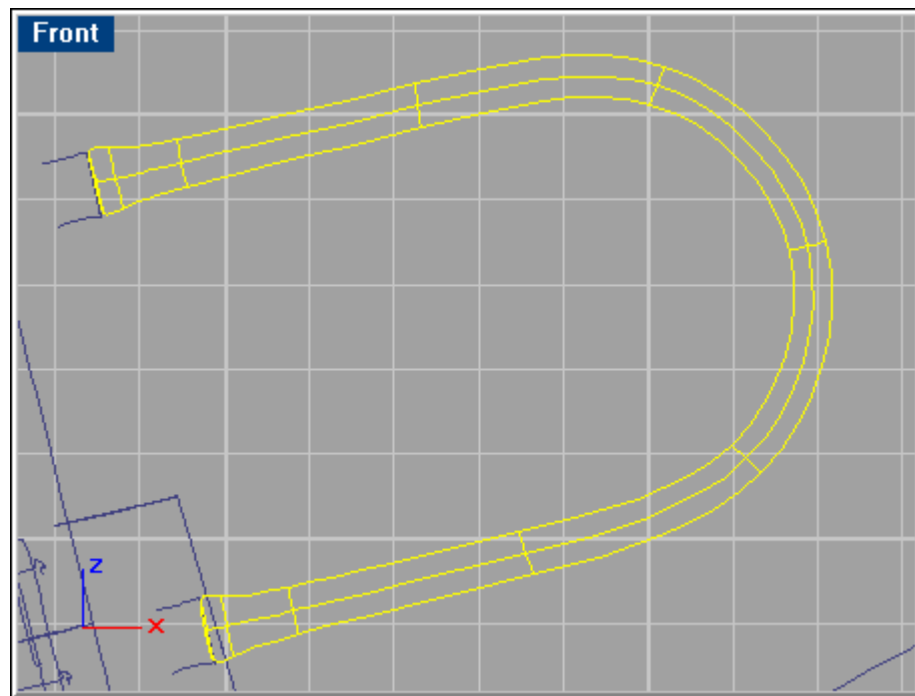
To build the lock, zoom in on the curves shown below. This time you need to pick the order of the loft as well. Deselect all and then go 'Surface/Loft', then in the Front viewport pick the top curve, one of the middle curves, the bottom curve and the other middle curve and hit Enter. Use the 'Closed' option.



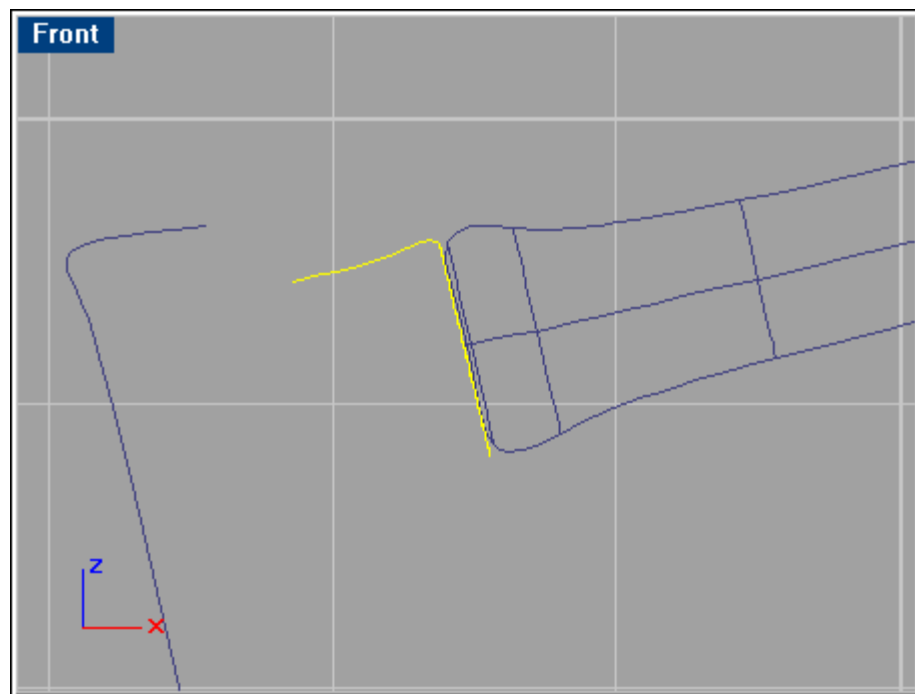
Select the curves shown below, and loft these together with the 'Closed' option. Do the same with the curves in the lower end of the lock.



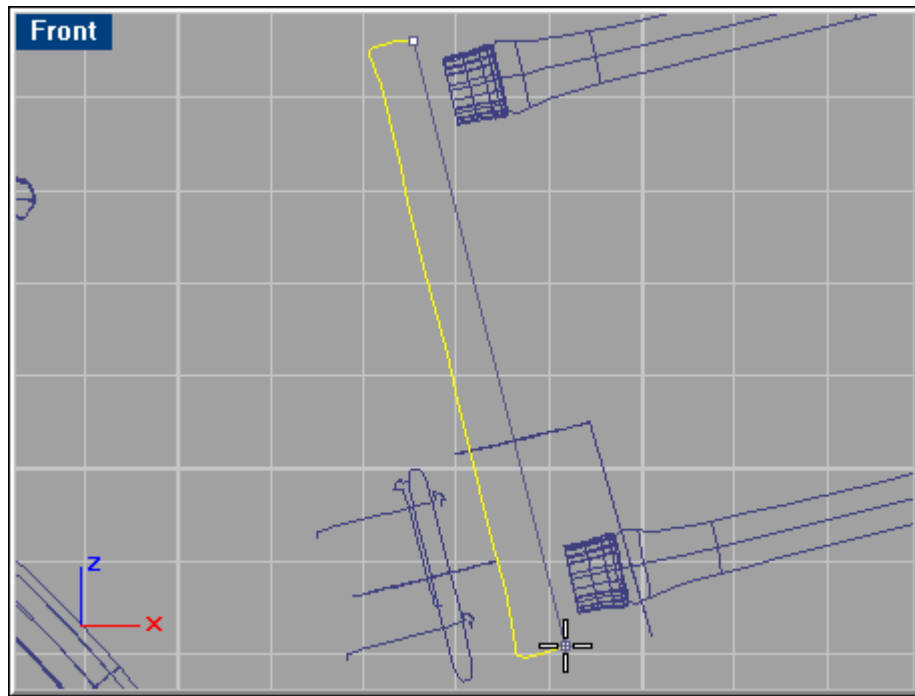
Finally, go to 'Edit/Join' and select the three surfaces shown below.



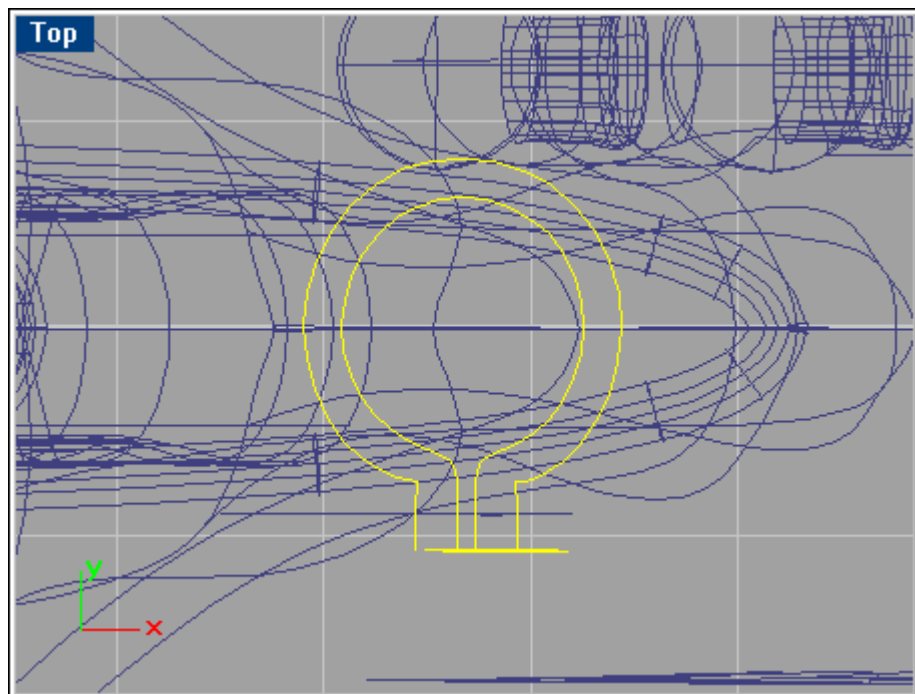
Select the curves shown below, and make a 'Sweep 1 Rail' with the default options. Repeat this step with the other end of the lock part.



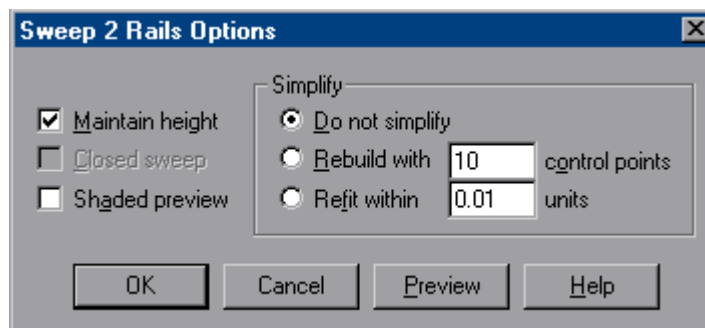
Select the curve shown below and make a 'Revolve'.



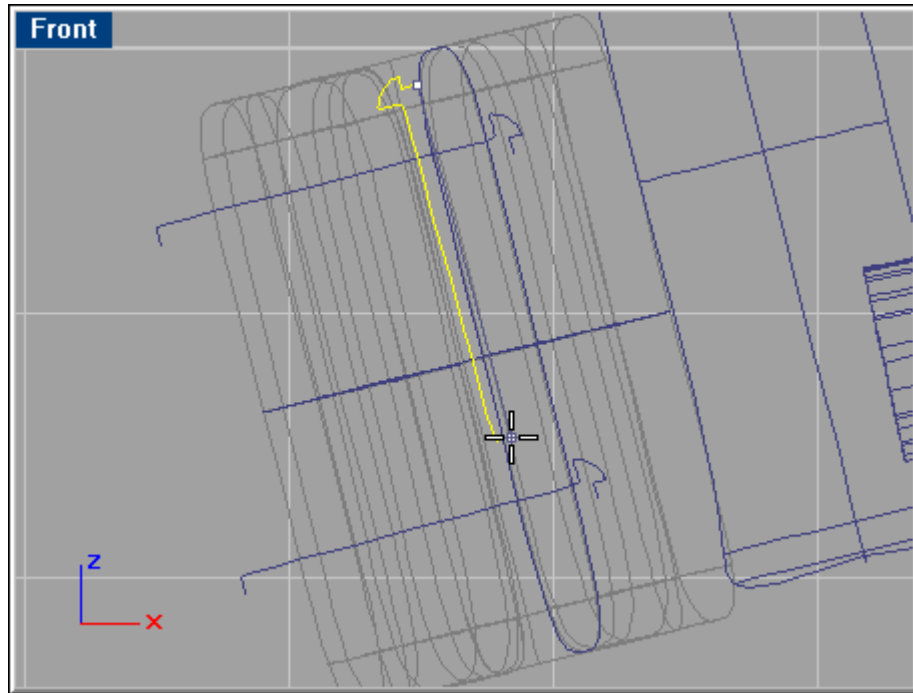
Select the curves shown below and make a 'Sweep 2 Rails'.



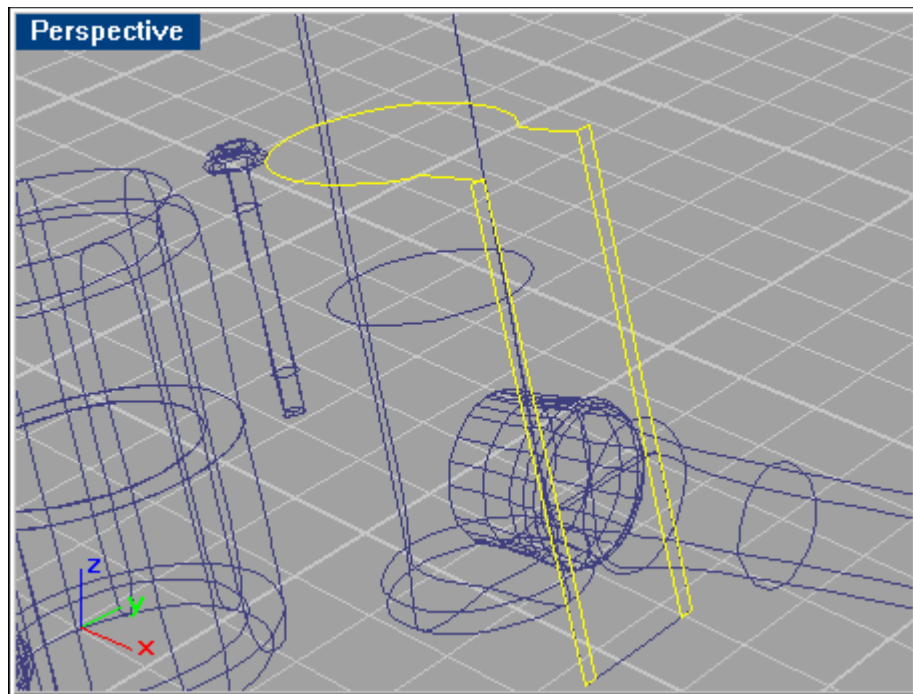
This time you need to use the 'Maintain height' option as seen below.



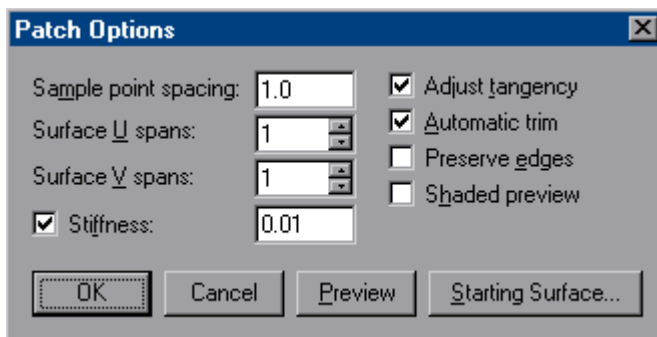
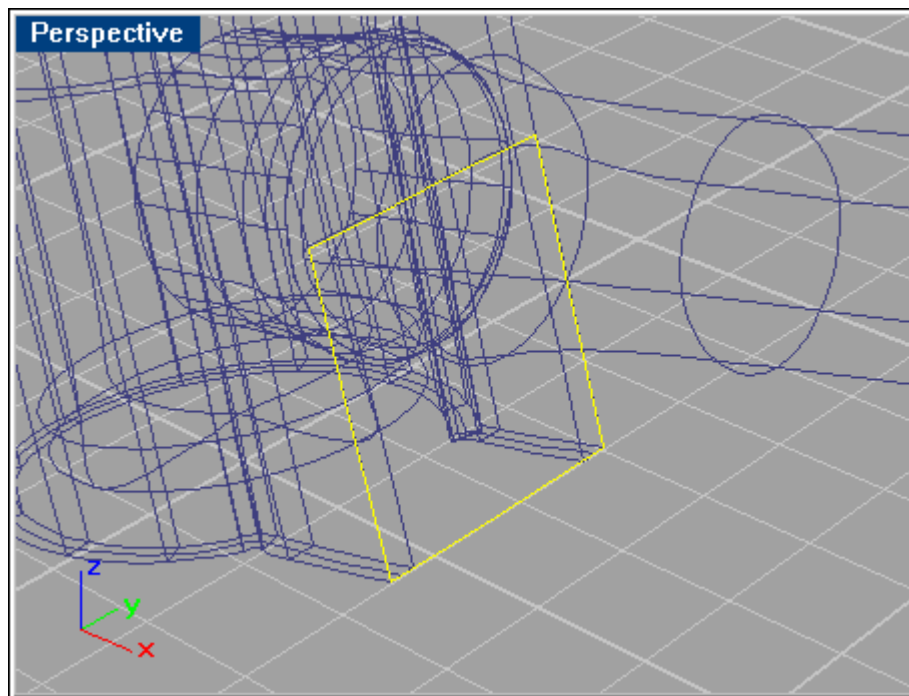
There are three screw curves that need to be revolved. The figure below shows the vertical screw curve the way it should revolve (the surface created in the previous step is frozen ('Edit/Visibility/Lock') making it easier to see the curves used in this step)). Repeat with the two other curves.



Select the curves shown below, and make a 'Sweep 1 Rail' with default options. When done go 'Solid/Cap Planar Holes' to make 'lids' at the openings of the surface.

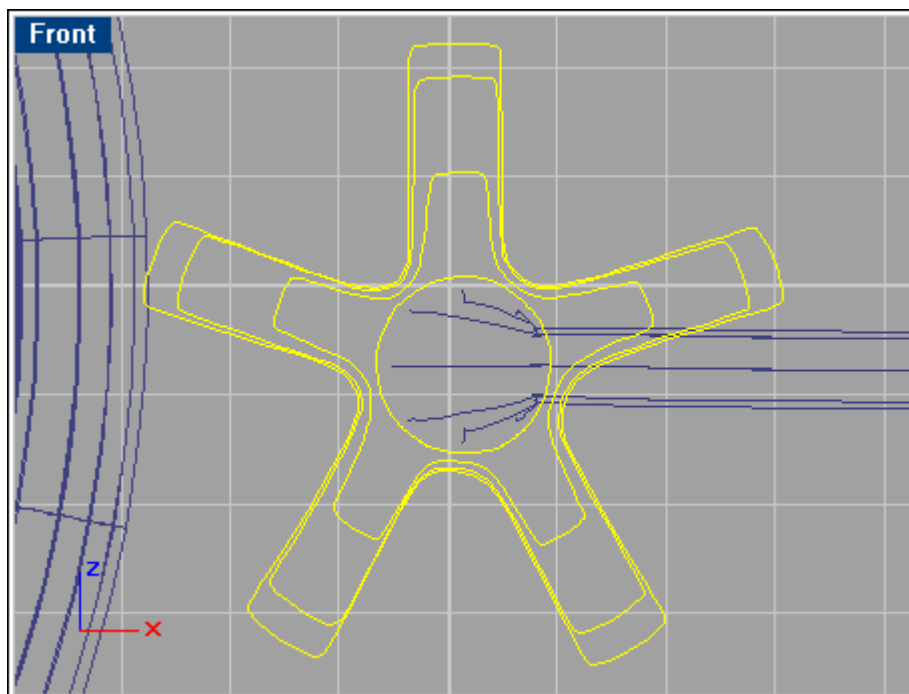


Select the curve below and go to 'Surface/Patch'.

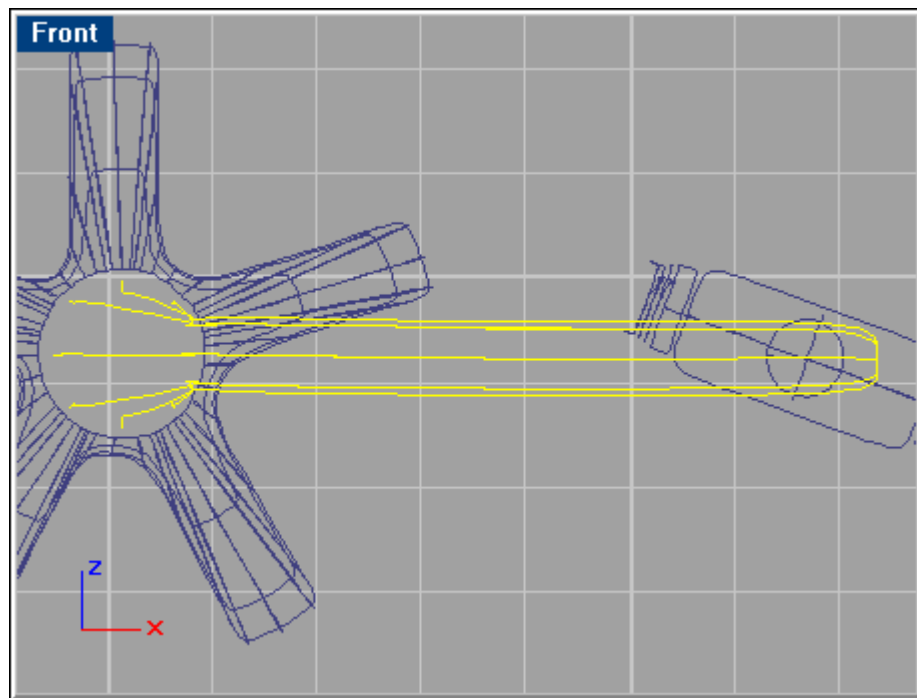


Use these settings:

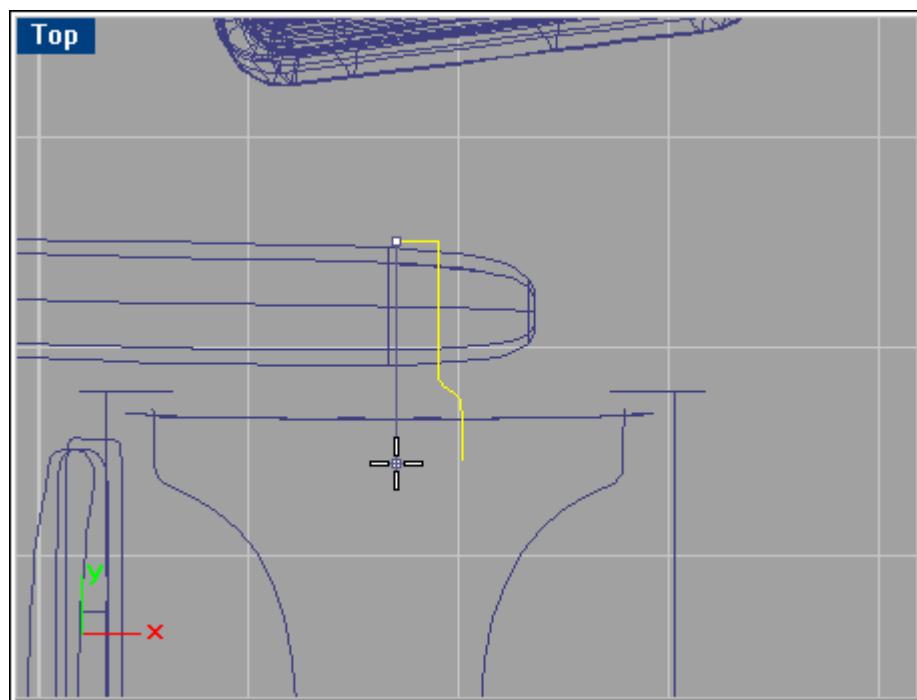
To start making the crank area, Loft all five curves below:



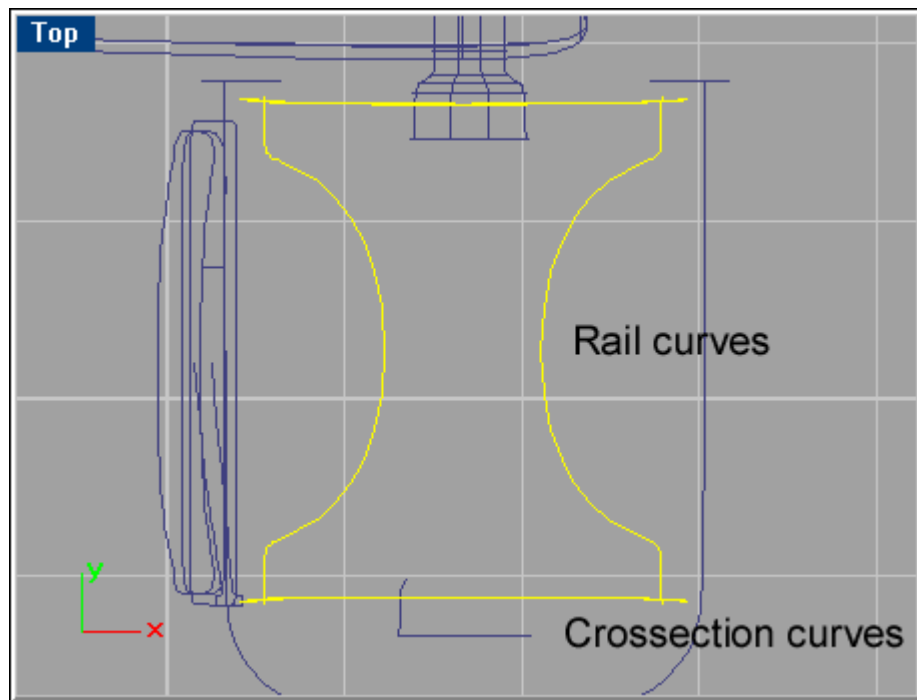
Also loft the eight curves shown below. For the latter loft, use the 'Closed' option.



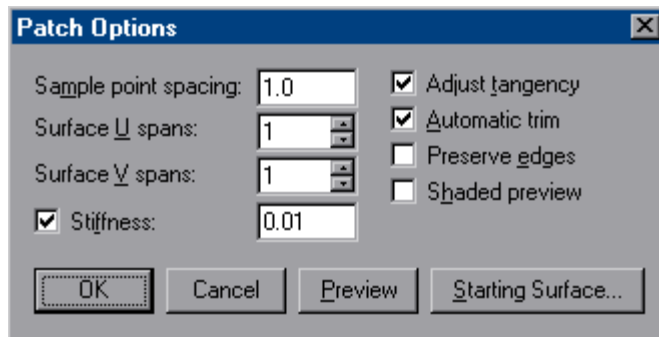
Revolve the curve shown below:



Deselect all, and go 'Surface/Sweep 2 Rails'. Select the rail curves, and then the cross-section curves, as shown below.

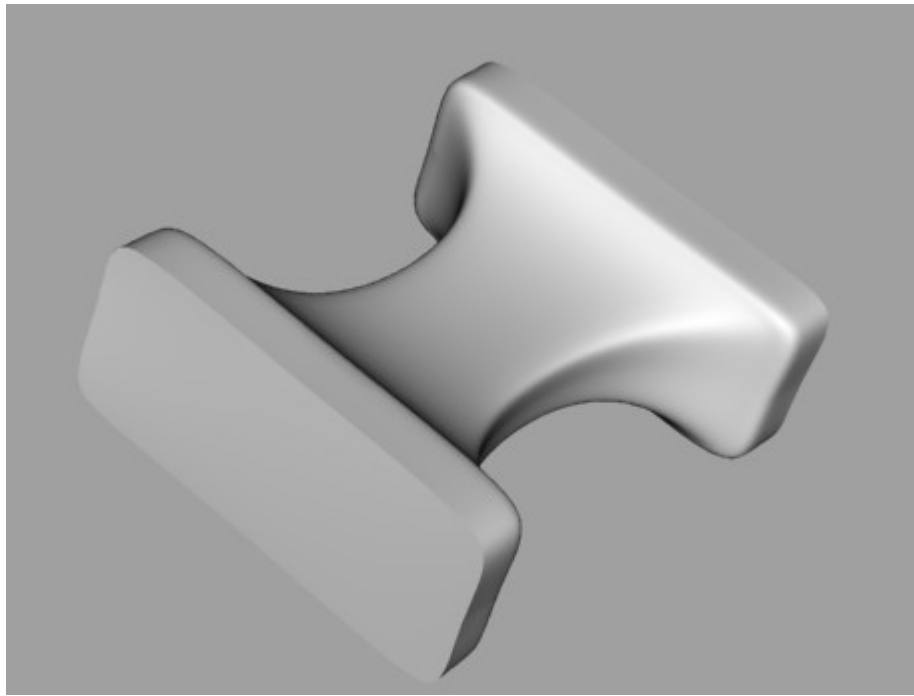


Use the default options. Since the open holes in this surface aren't planar, you should patch the cross-section curves. Select one cross-section curve, and go 'Surface/Patch.'

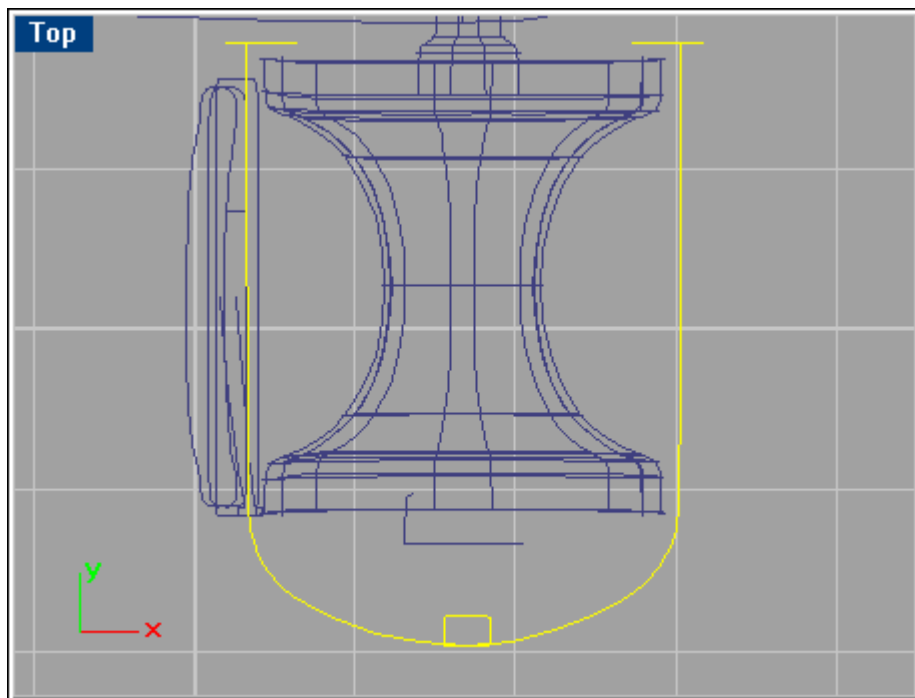


Use these settings:

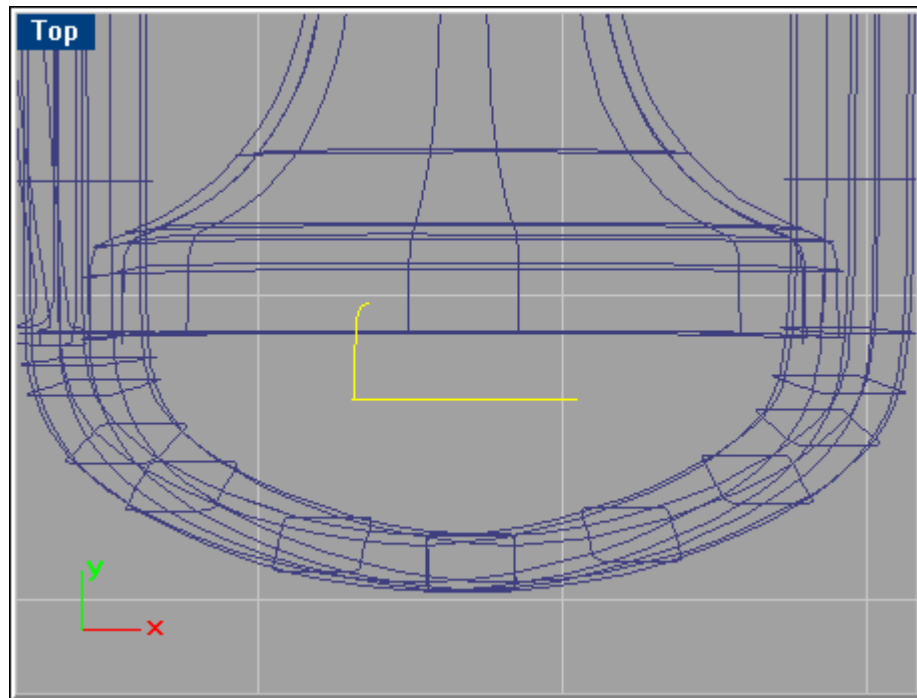
Finally, join together the surface with the patch lids on both sides.



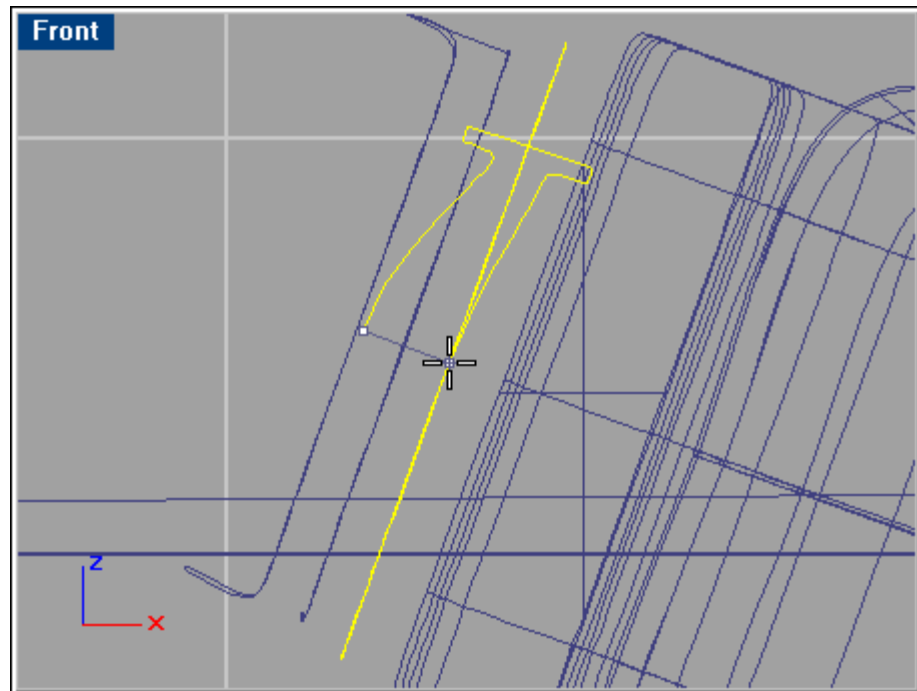
Select the curves shown below, and do a 'Sweep 1 Rail'. Cap the surface.



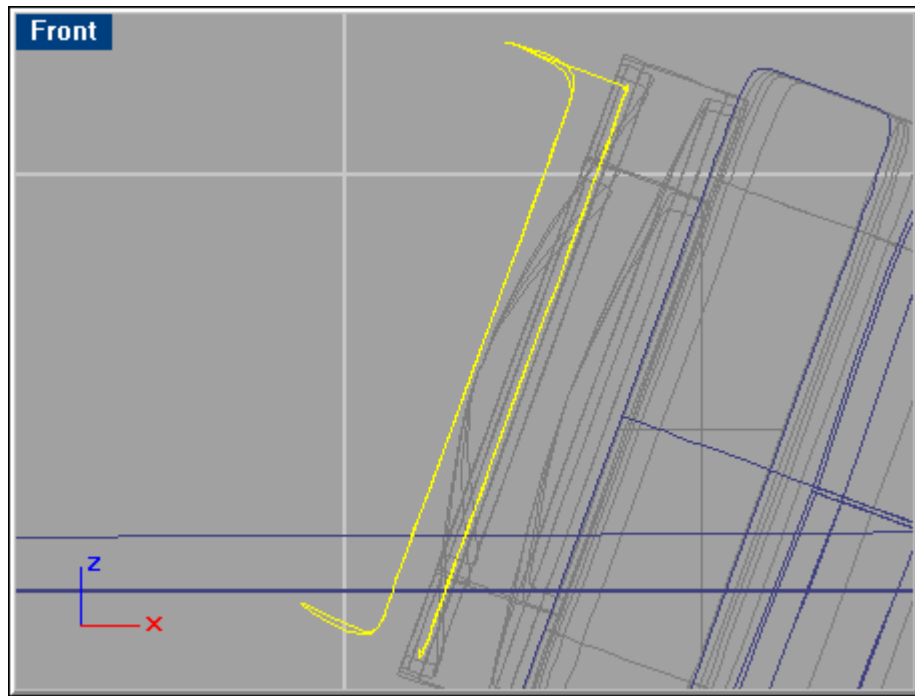
If Rhinoceros only caps one end, repeat the capping. Join them all together. Make a 'Sweep 1 Rail' with the curves shown below.



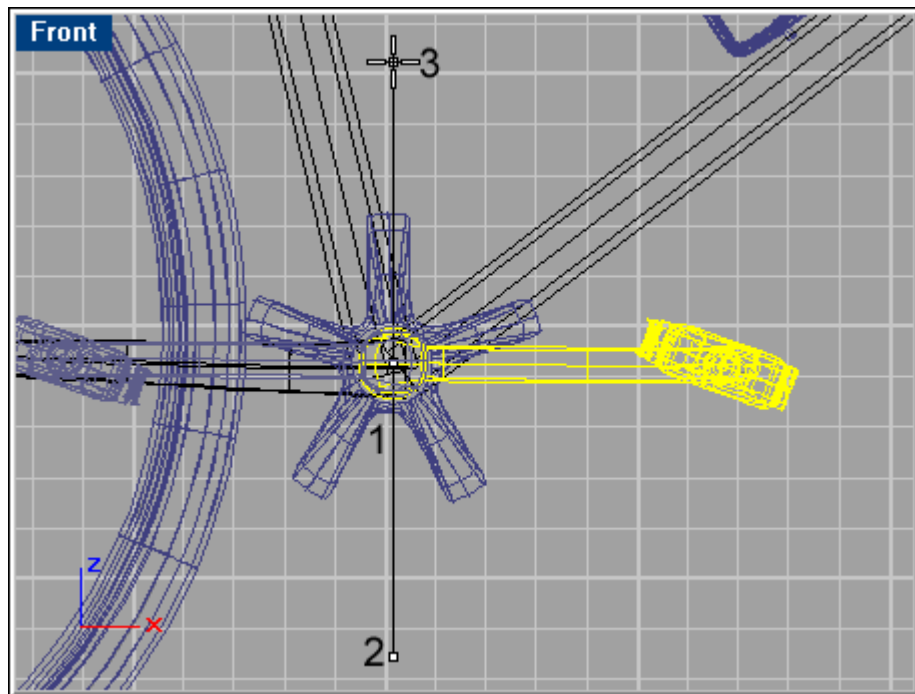
Go 'Surface/Rail revolve, and select the profile curve followed by the path curve shown below. Use Object Snap 'End' while setting the start and end of the revolve axis.



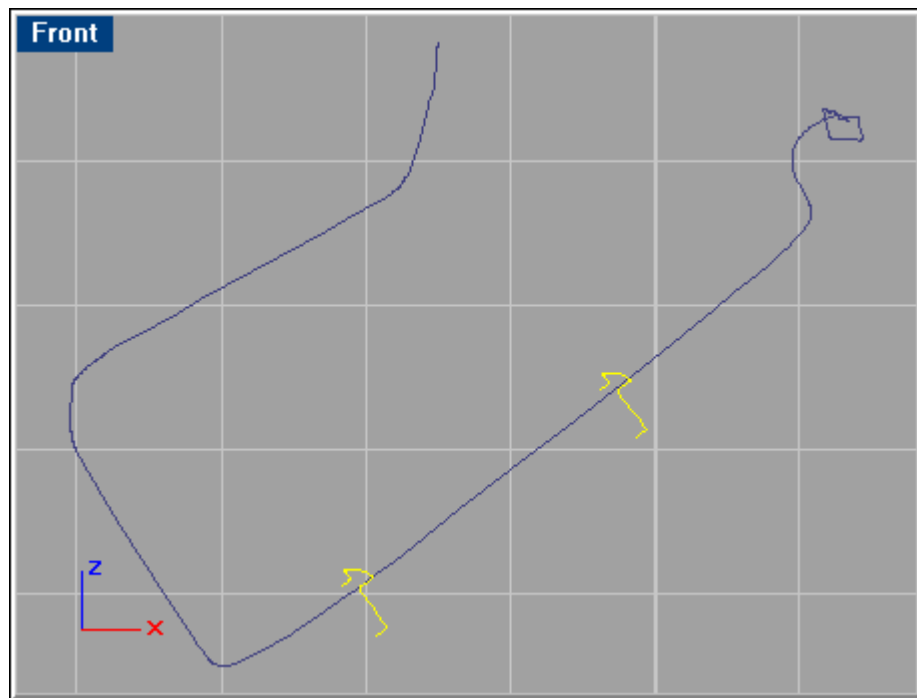
Select the three curves shown below and do a 'Sweep 2 Rails' with default options. The pedal and its components are finished.



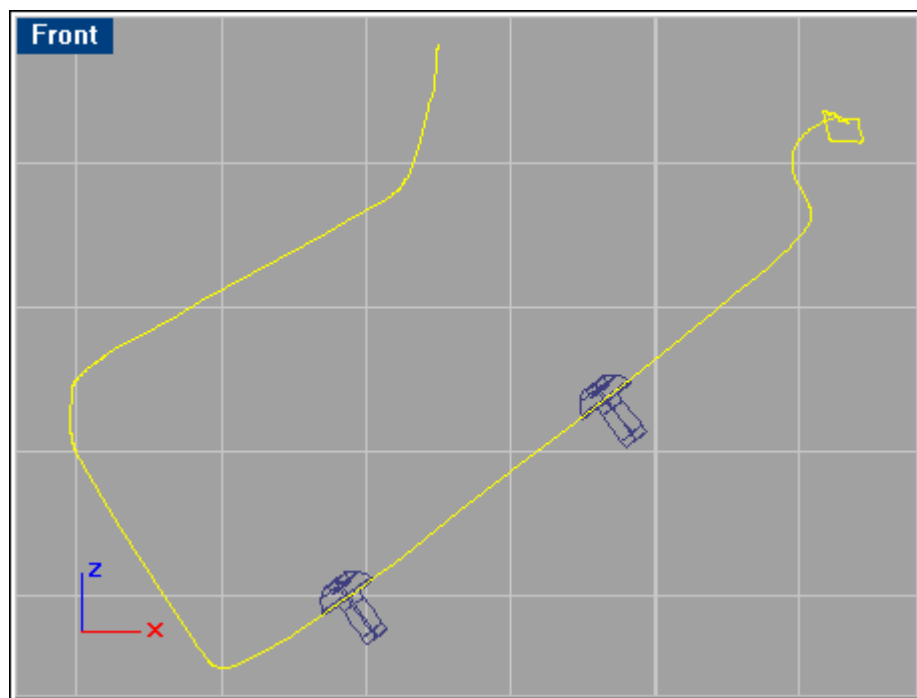
In the Top viewport, mirror the pedal surfaces using Object Snap 'Mid.' In the Front viewport, go 'Transform/Rotate' and find a spot near #1 in the figure below, then hold Shift and set the first reference point near #2, and second reference point near #3.



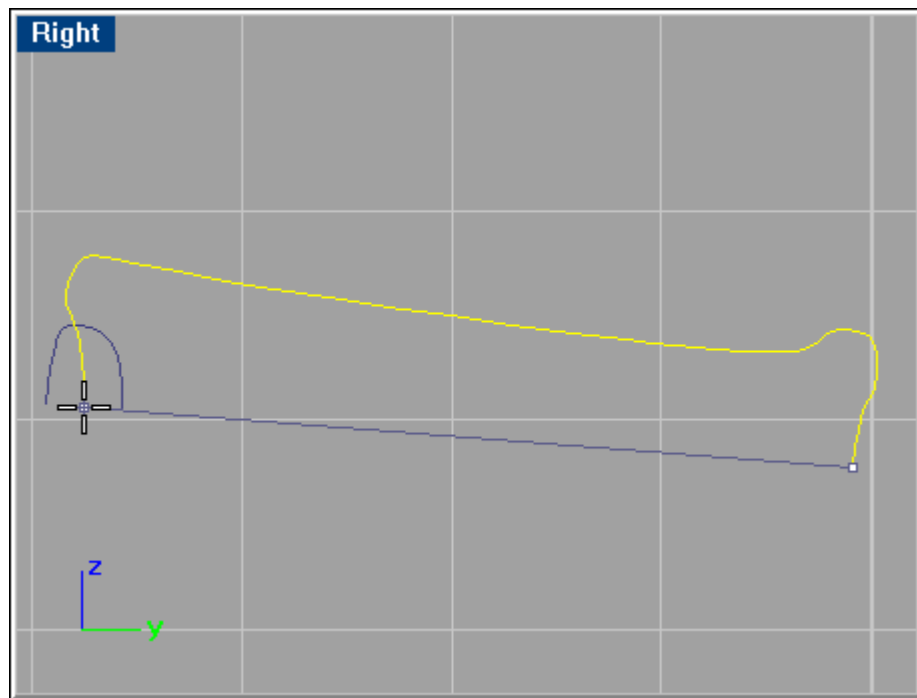
There are more accessories to model! Revolve the screw curves shown below.



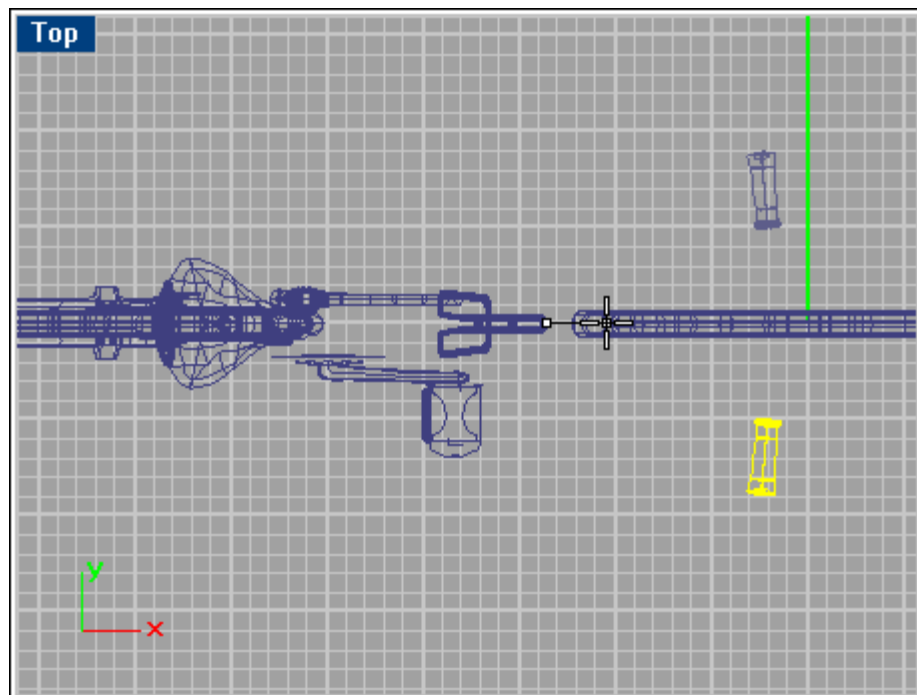
Select the curves shown below, and make a 'Sweep 1 Rail'.



Make the handle by revolving the curve shown below. Do the same for the button in the end of the handle. Use Object Snap 'End'.

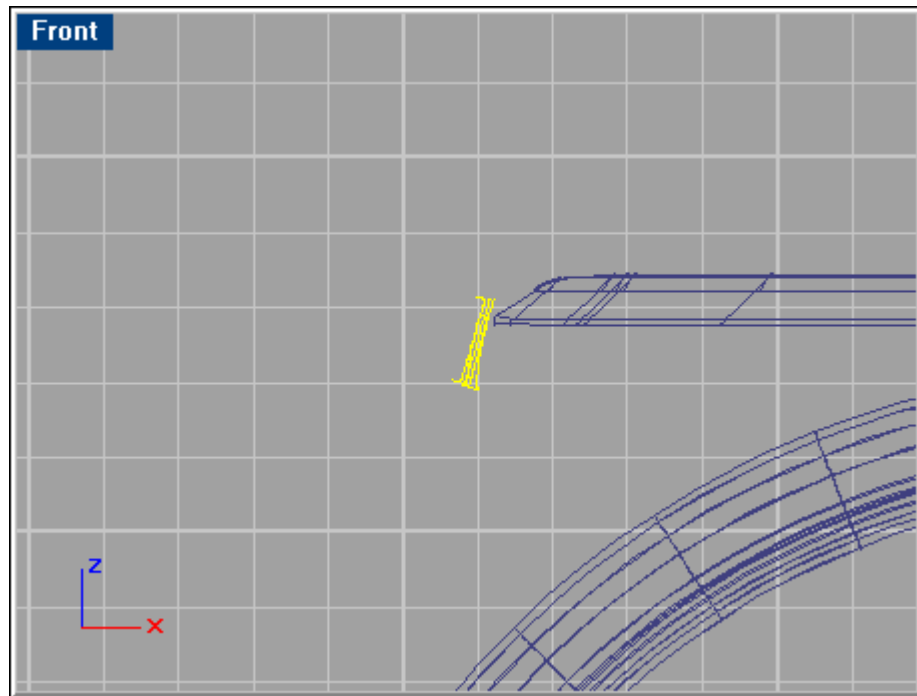


In the Top viewport, select the handle and the button. Mirror the surfaces, using Object Snap 'Mid.'



To create the rear light, select the curves shown below and repeat the steps used to complete the pedals: Go 'Surface/Rail revolve', and select the profile curve followed by the path curve. Use Object Snap 'End' on while setting the start and end of the revolve axis.

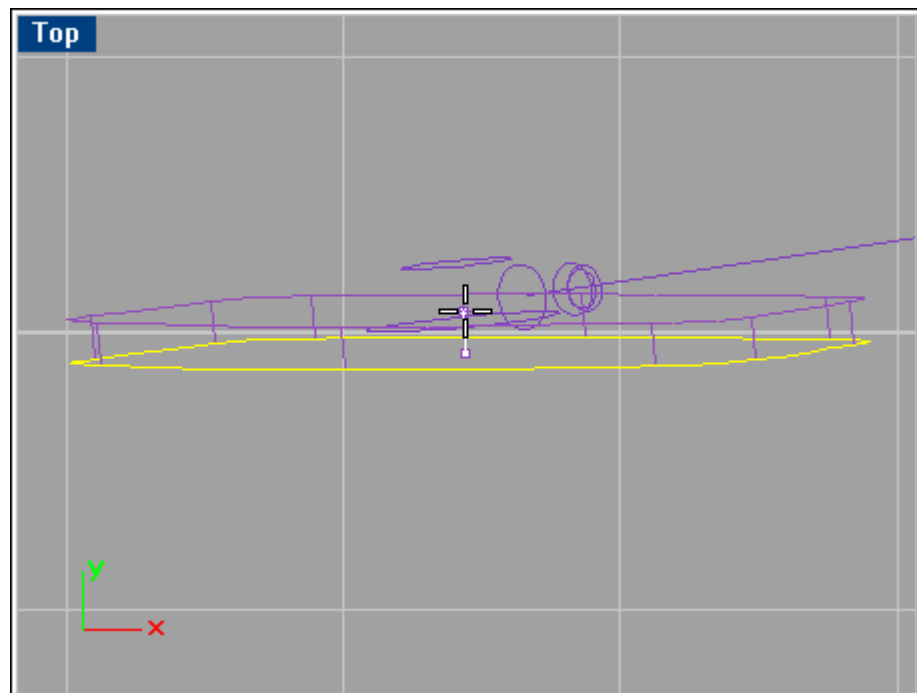
Select the three curves and do a 'Sweep 2 Rails' with default options.



Now make a new layer called 'Details-1.' Then use 'Edit/Select/All/Surfaces' to select all surfaces. Then use 'Edit/Select/All/Polysurfaces' to select Polysurfaces as well. Then move the selected objects into this layer.

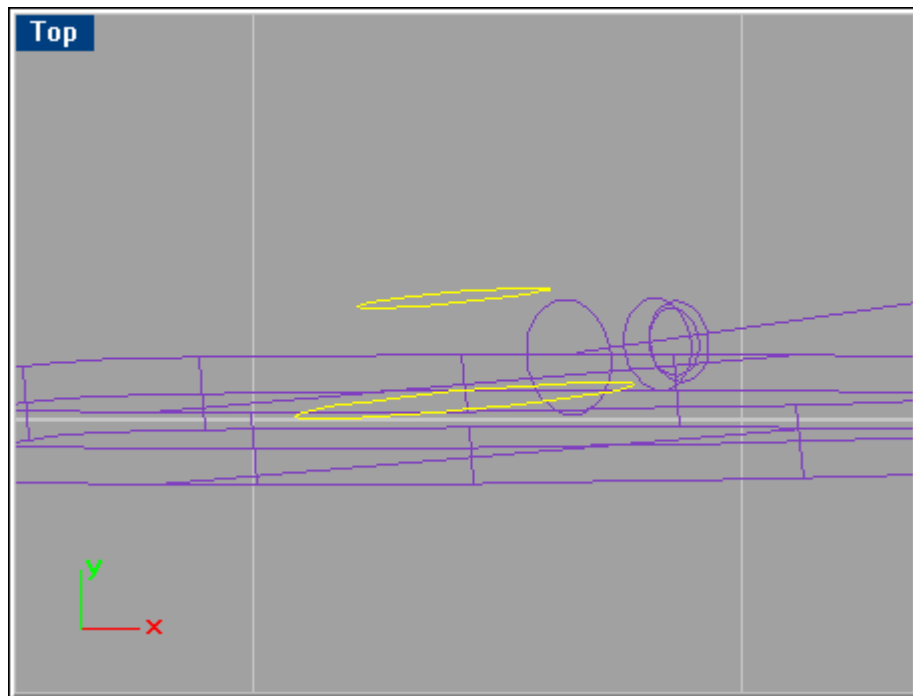
Either open 'Bike2.3dm' or import 'Curves-3.3dm' into your existing bike scene. The new curves define many of the smaller details of the bike. If importing, create a new layer called 'Curves-3' and move the imported curves into this. Set it to the only layer visible in the 'Edit Layers' panel.

Zoom in on the reflector in the rear of the bike, and in the Top viewport, select the reflector curve and go 'Surface/Extrude/Straight'. At the command prompt, type C for Cap=Yes, (capping the open ends) and enter a value of -0.15 .

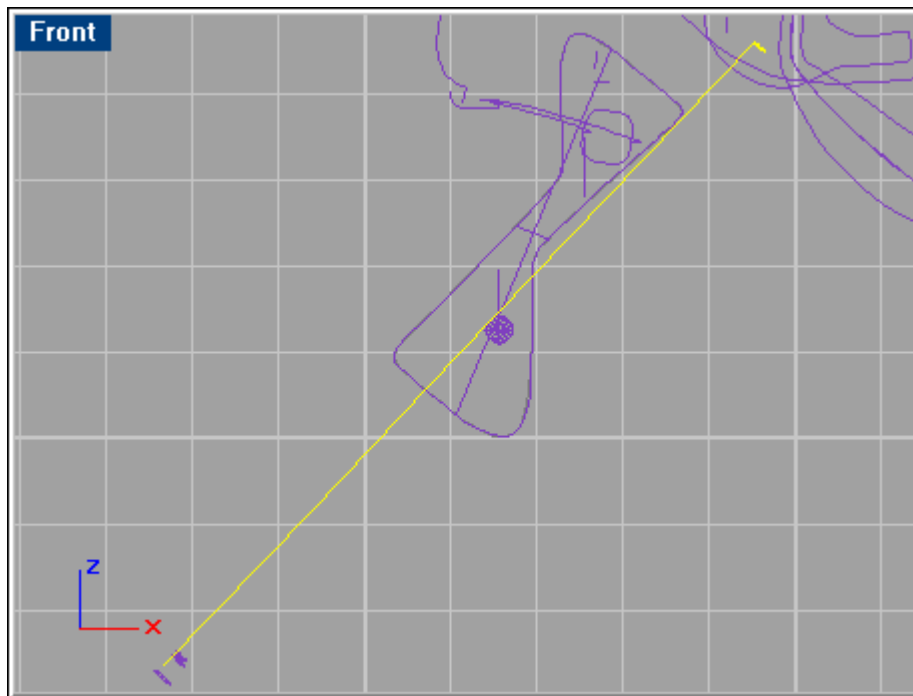


Select the curves shown below and loft them. When done, cap the openings and join all three

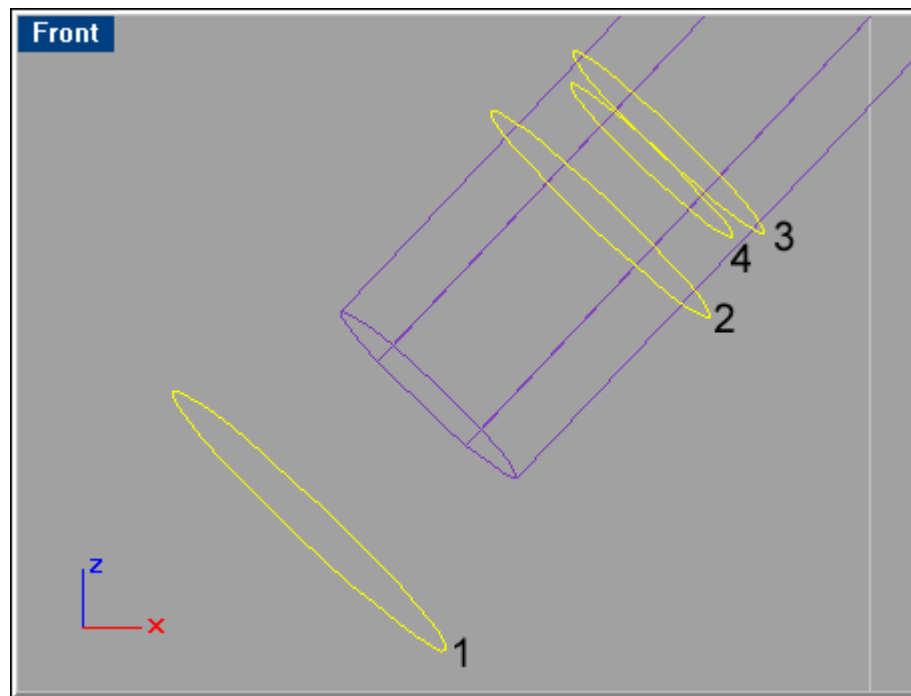
surfaces. Repeat this step for the front wheel reflector.



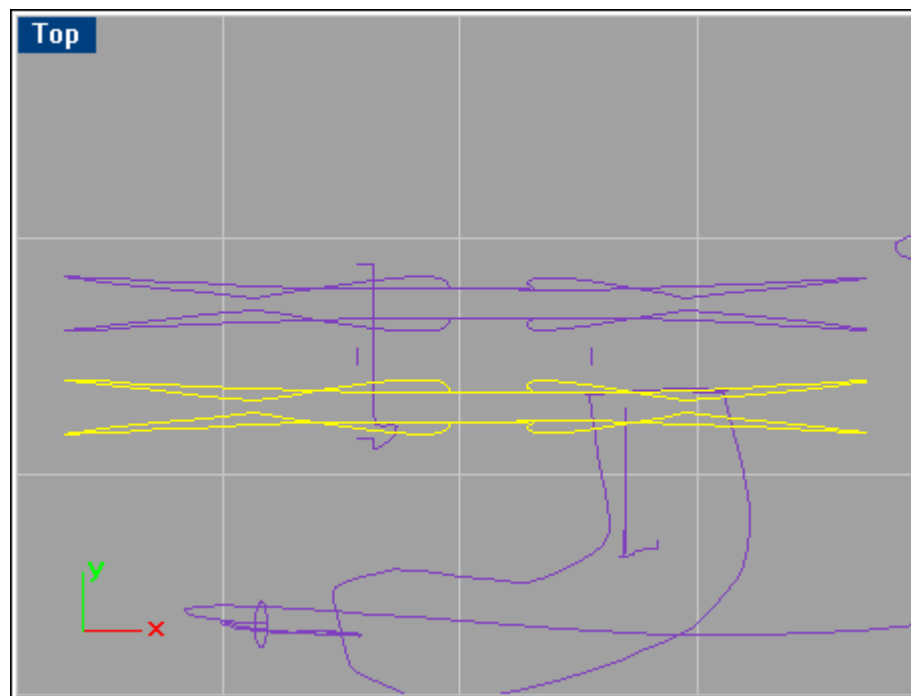
Select the curves below and do a 'Sweep 1 Rail' with default options to create the spoke, which later on will be arrayed.



Zoom in on the bottom end of the lofted surface and skin together the curves in the order shown below. NOTE: Execute the loft command before selecting anything, so that you can select the curves in order. Use automatic direction when you see the arrows of the curves. In the 'Loft options' panel choose 'Tight' lofting style.

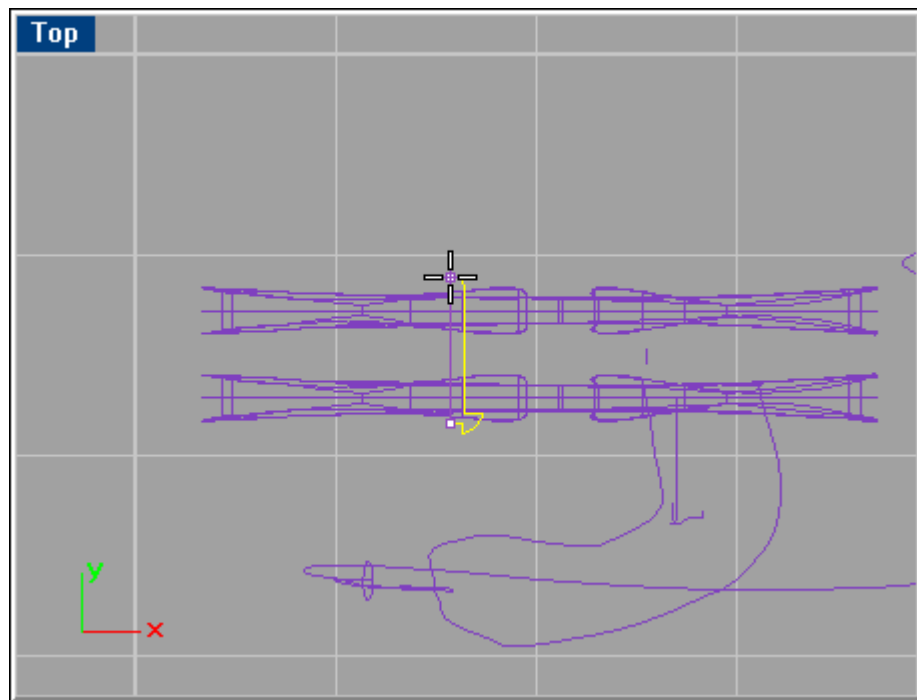


In the Top viewport, find the curves selected below and loft them together using the default options. Select one of the curves once again, and patch it with the same options used above. Do the same with the other curve.

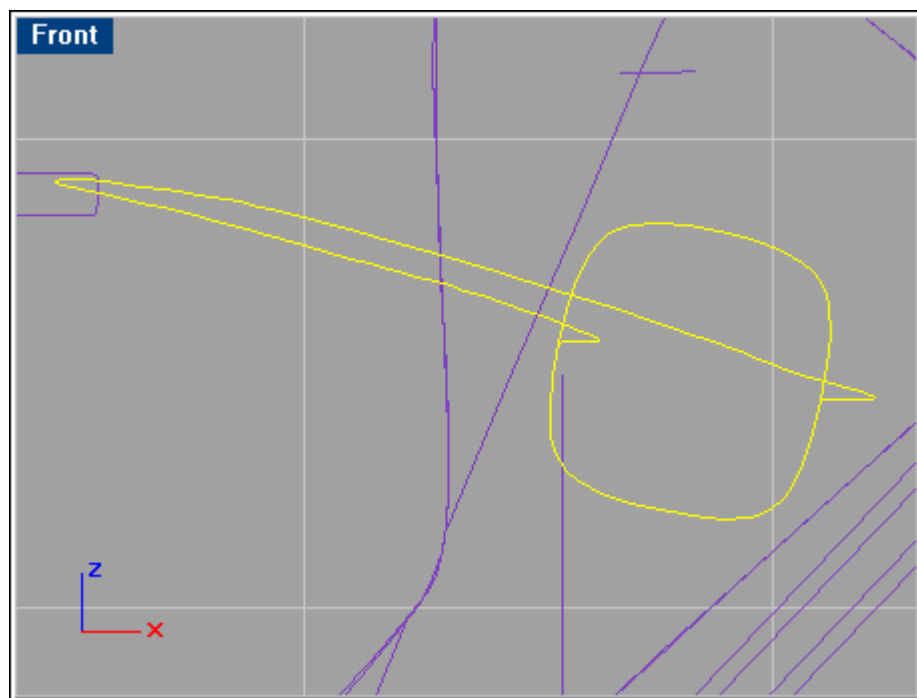


Repeat this step with the two curves just above the ones selected here.

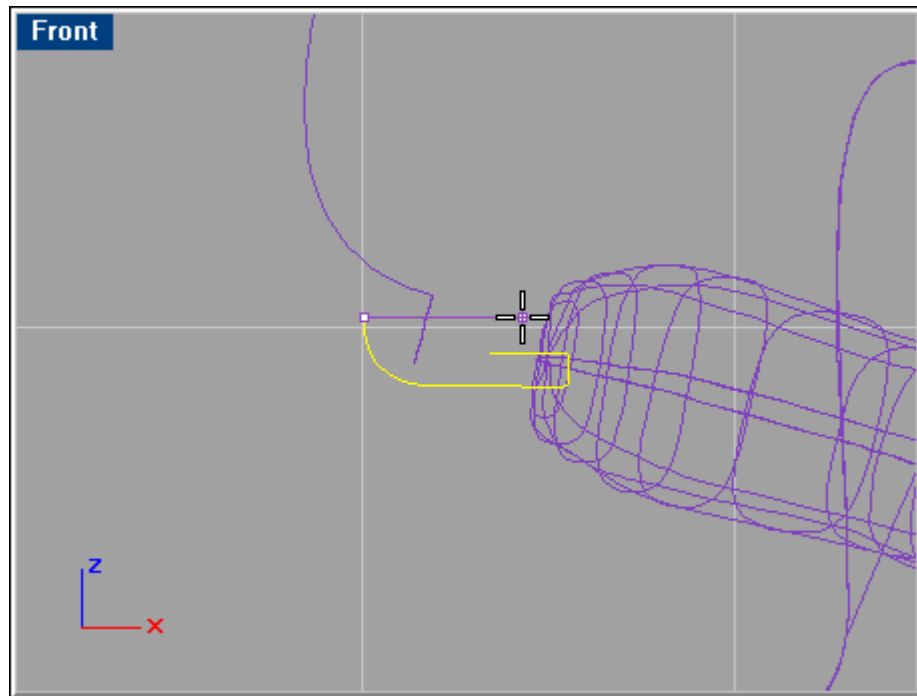
Make a screw out of the curve shown below using a standard Revolve.



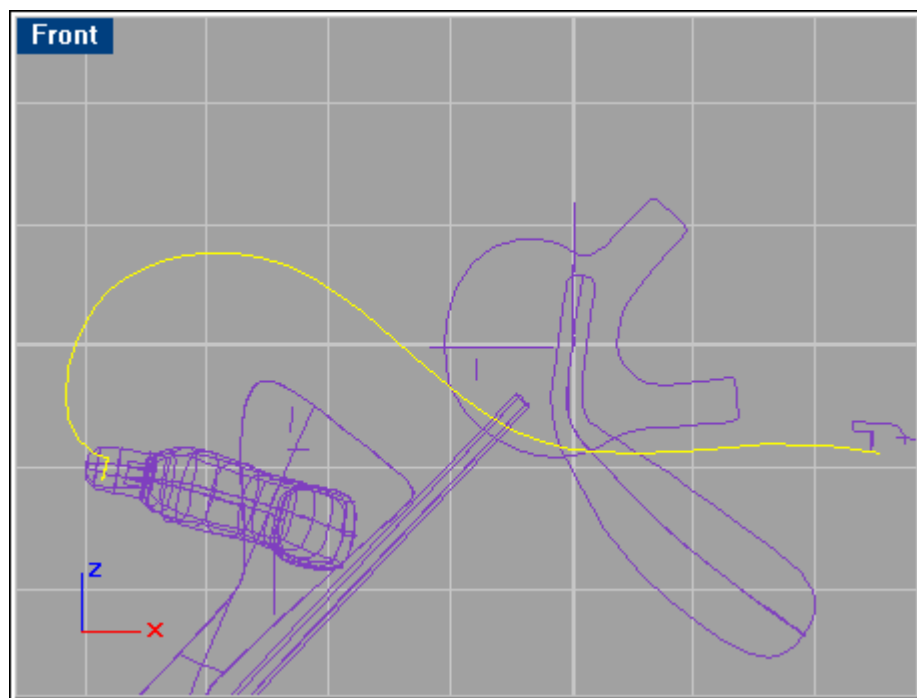
Select the curves shown below and make a 'Sweep 2 Rails' with default options.



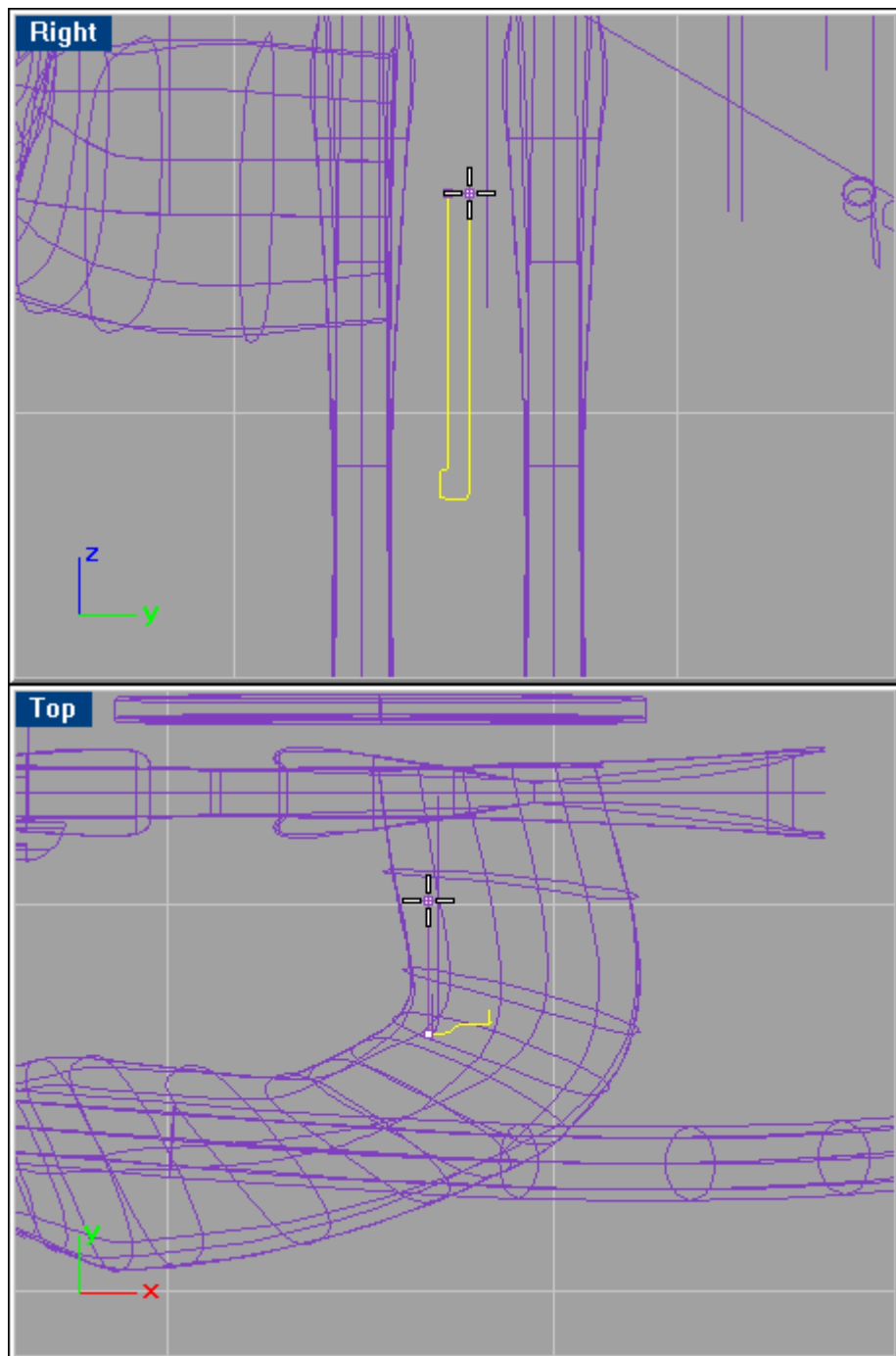
Do a Revolve out of the curve shown below, and rotate the result by -10 degrees.



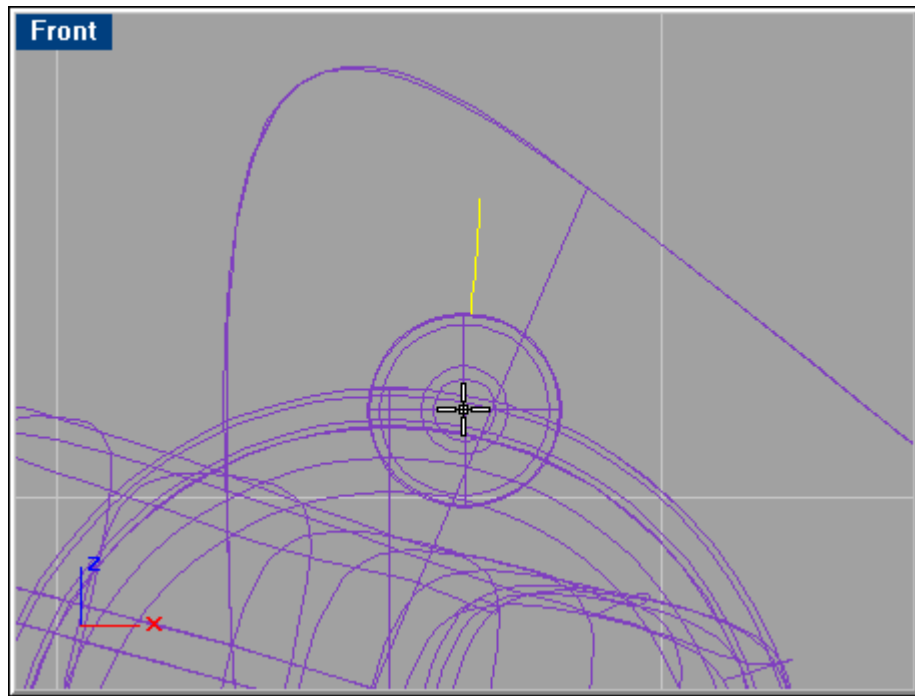
Select the curves shown below and make a 'Sweep 1 Rail'.



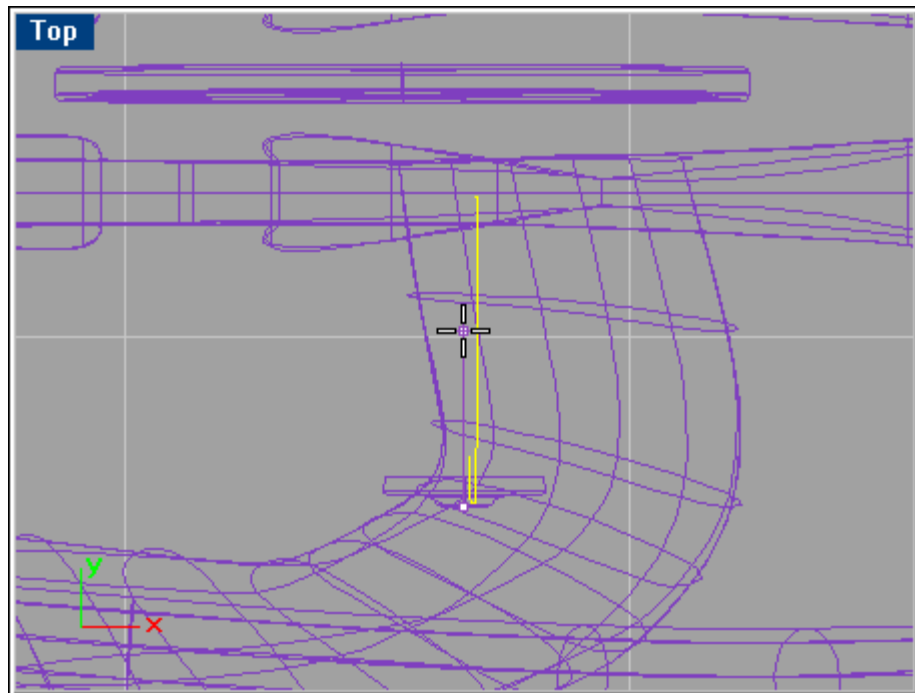
Locate the curve selected in the two figures below and make a Revolve while using Object Snap 'End' (Leave the snap on for further operations).



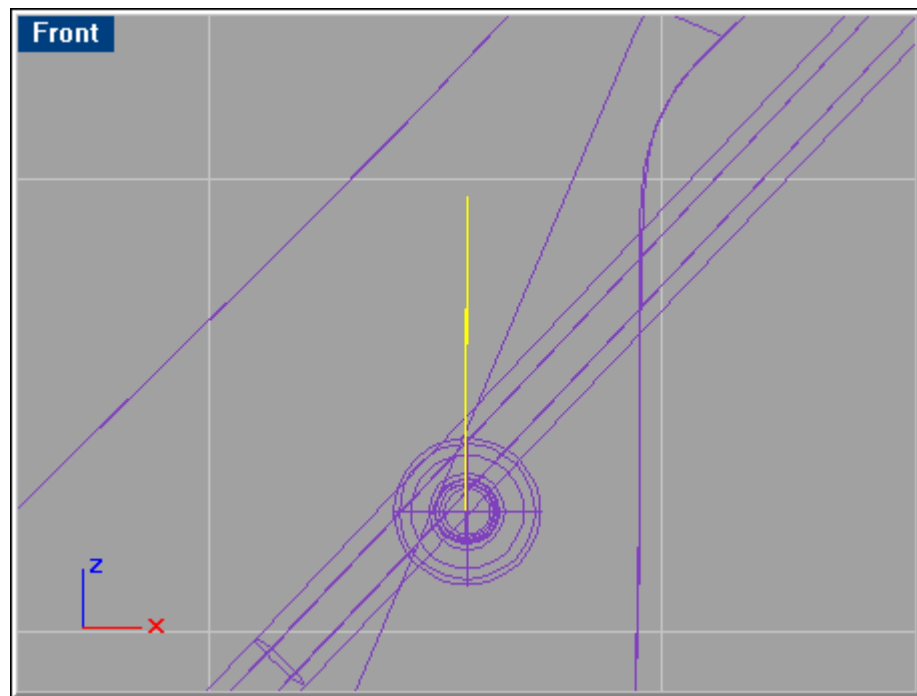
Select the curve shown below and do a Revolve. Make the pointer snap to the center shown in the same image.



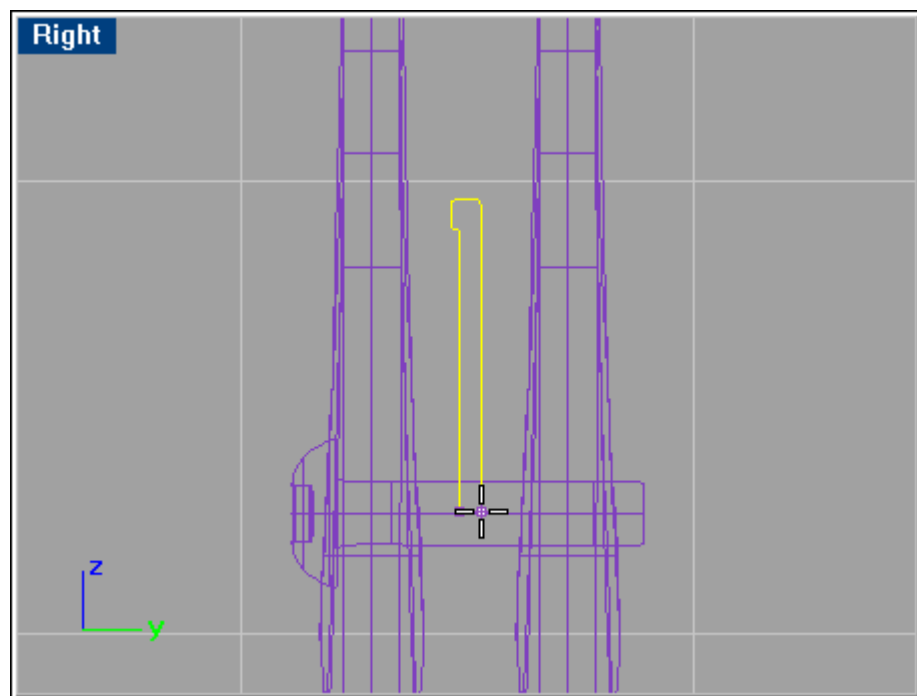
Then hit LMB, and go to the Top viewport and while holding Shift key to make the line straight, drag it straight upwards and hit LMB again.



Select the curve shown here:



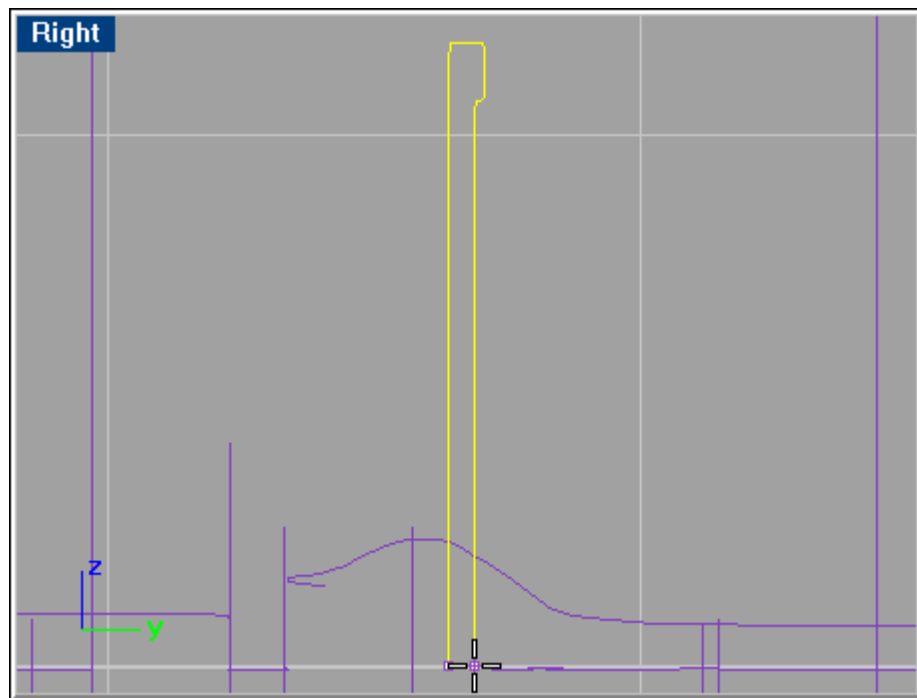
Make a Revolve:



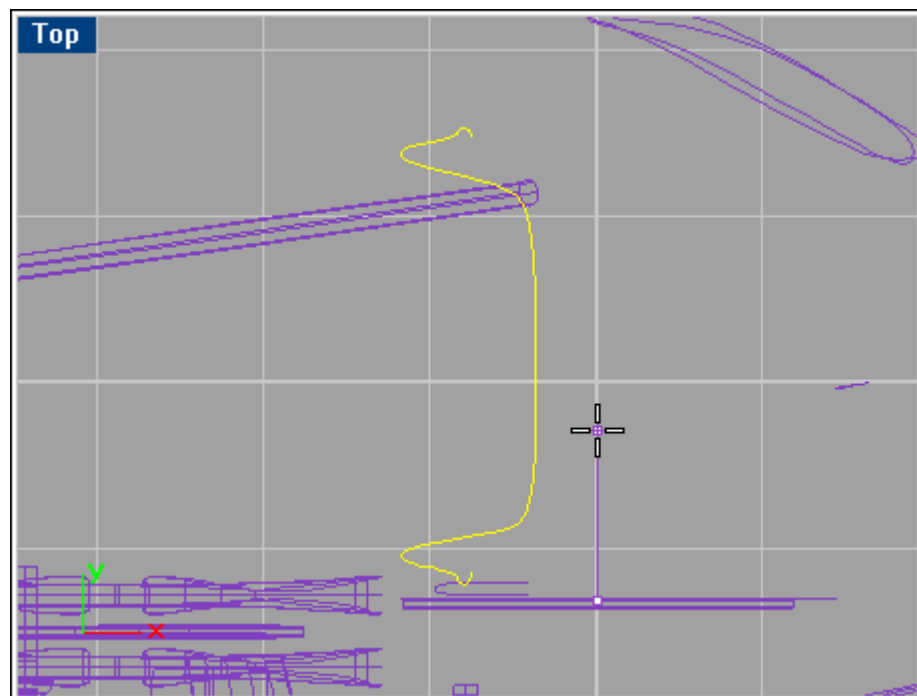
Repeat with the curves shown in the two figures below.



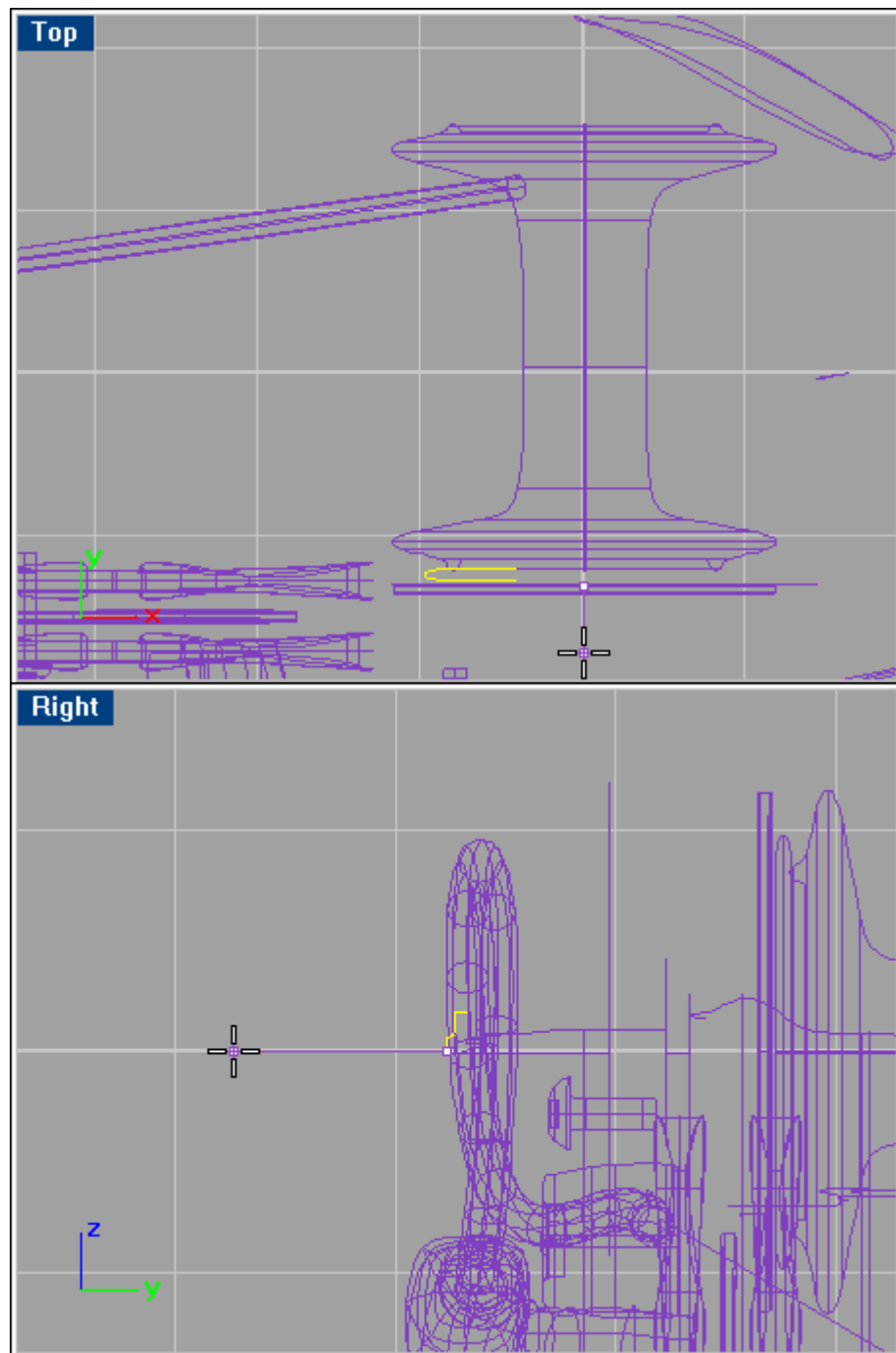
This is how the same curve should look from the right:



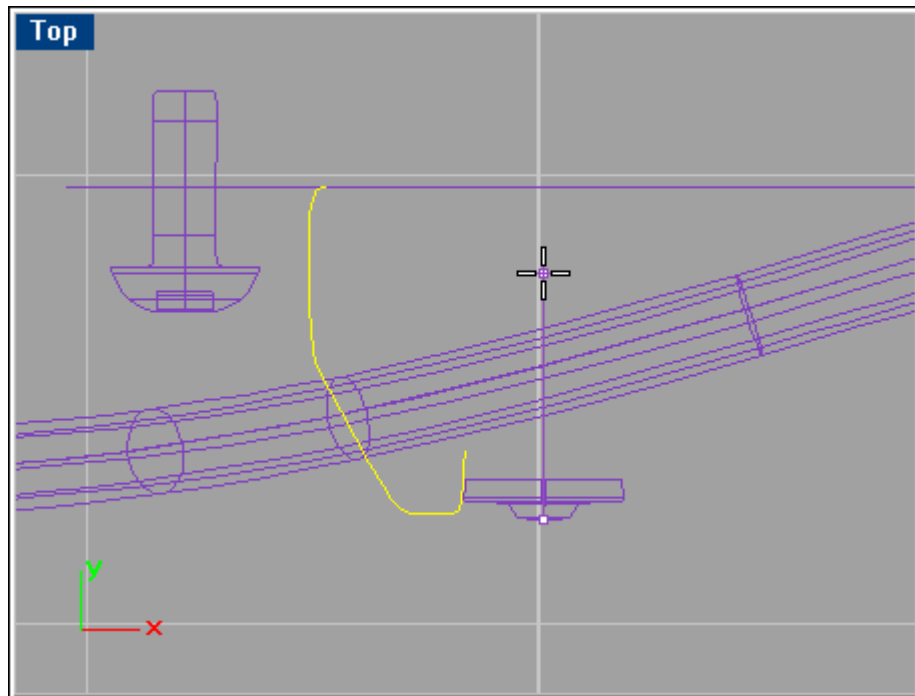
Select the curve shown below and make a Revolve. For the first reference point let the pointer snap to the center of previously created surface.



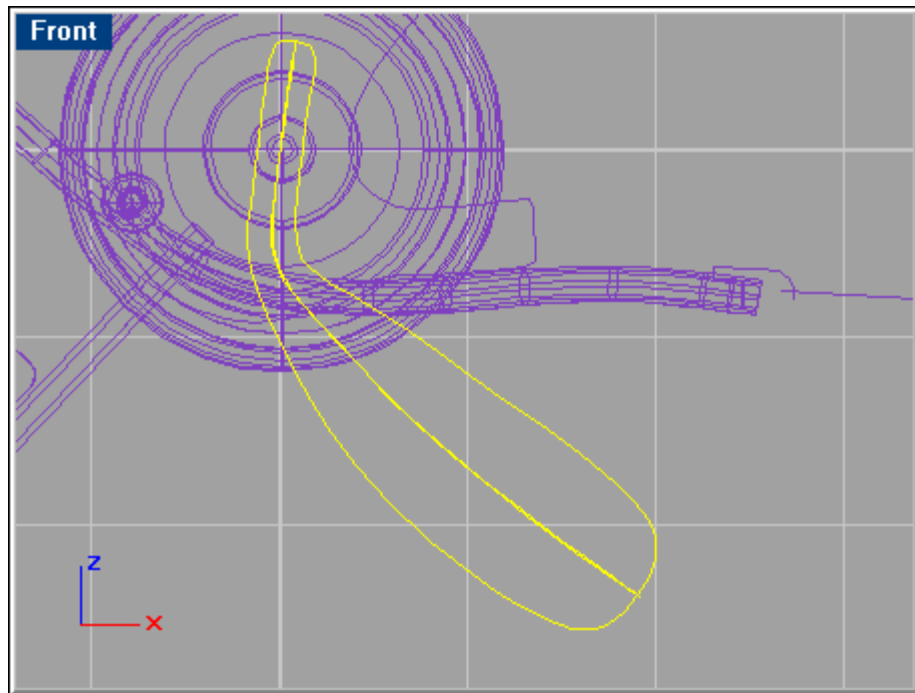
Repeat with the curve shown below:



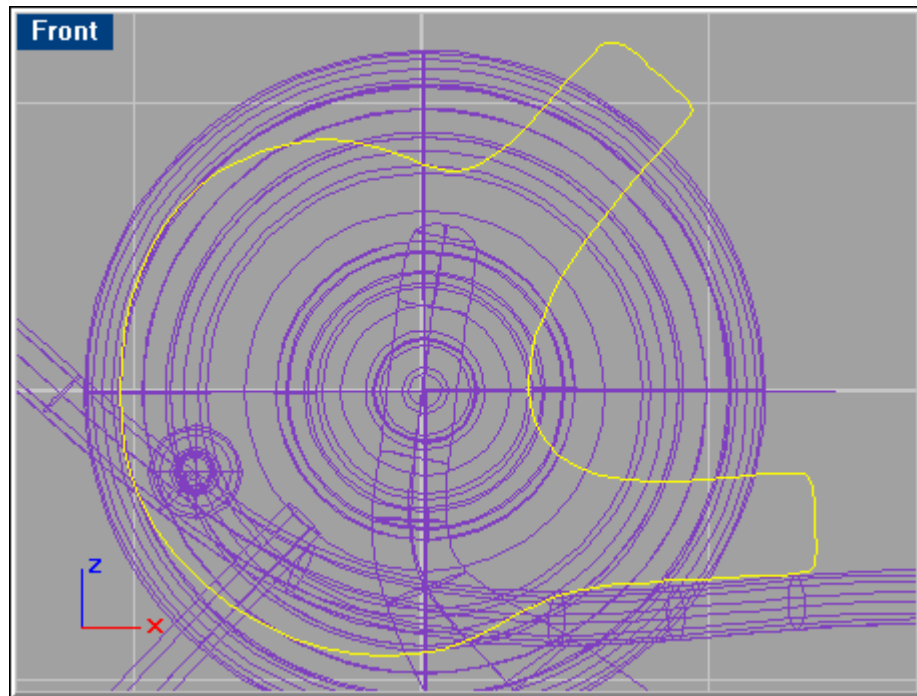
Select the curve shown below and make a Revolve with the first reference point in the center of the previous created surface.



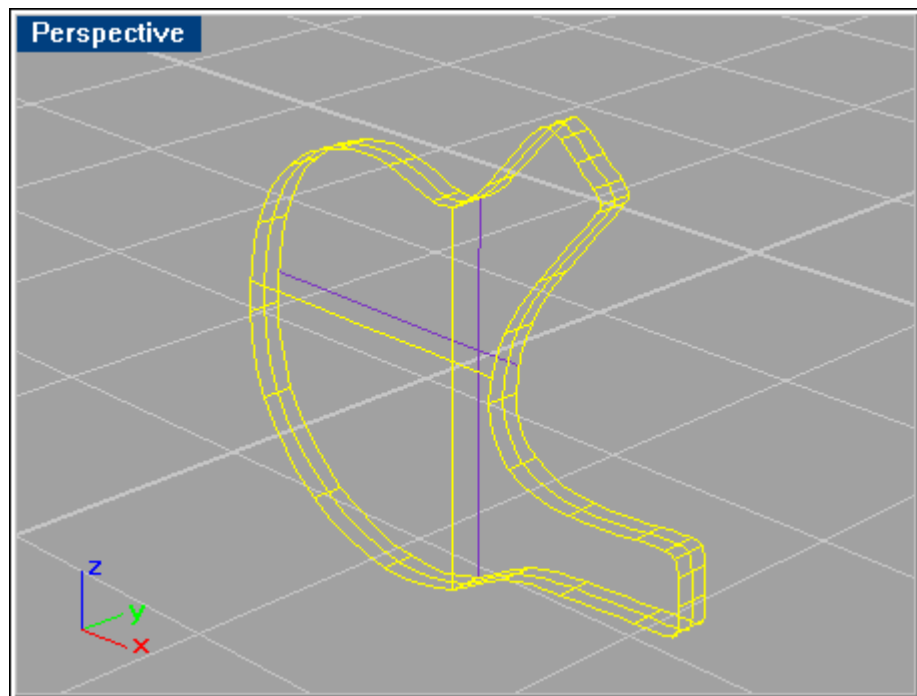
Go 'Surface/Loft', then select the curves shown below, and mind the order of the curves. Check 'Closed' in the 'Loft Options' panel.



Select the curve shown below, and go 'Surface/Extrude'.

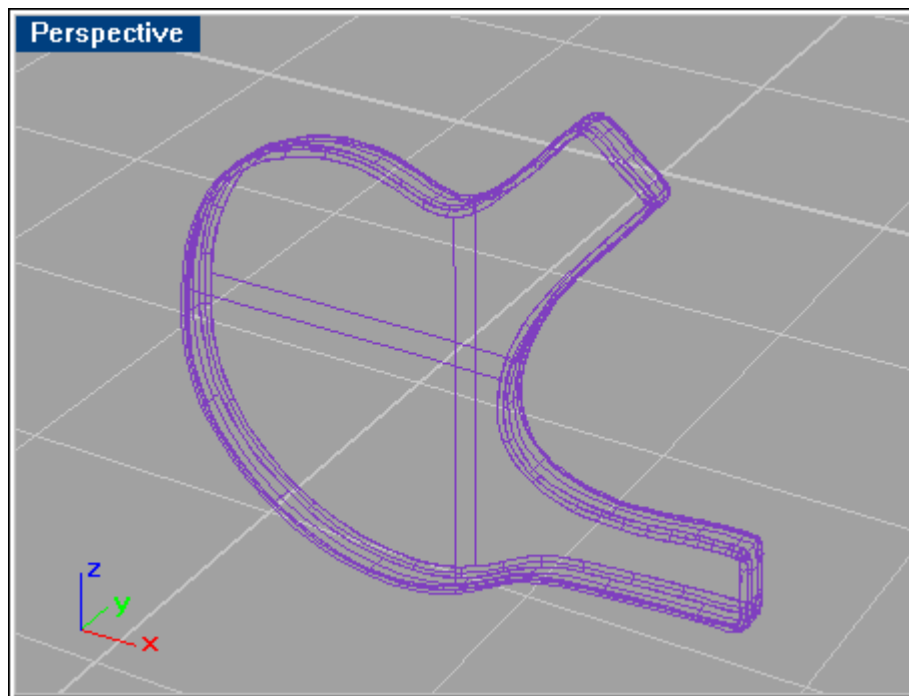


In the options shown in the command panel, type C for Cap=Yes, then type 0.15 following by hitting Enter to finish the process. Now you want round edges on this surface. Go to 'Surface/Fillet', and in the command panel type R, then enter a value of 0.03. When done, select one of the cap surfaces, then the extruded surface.

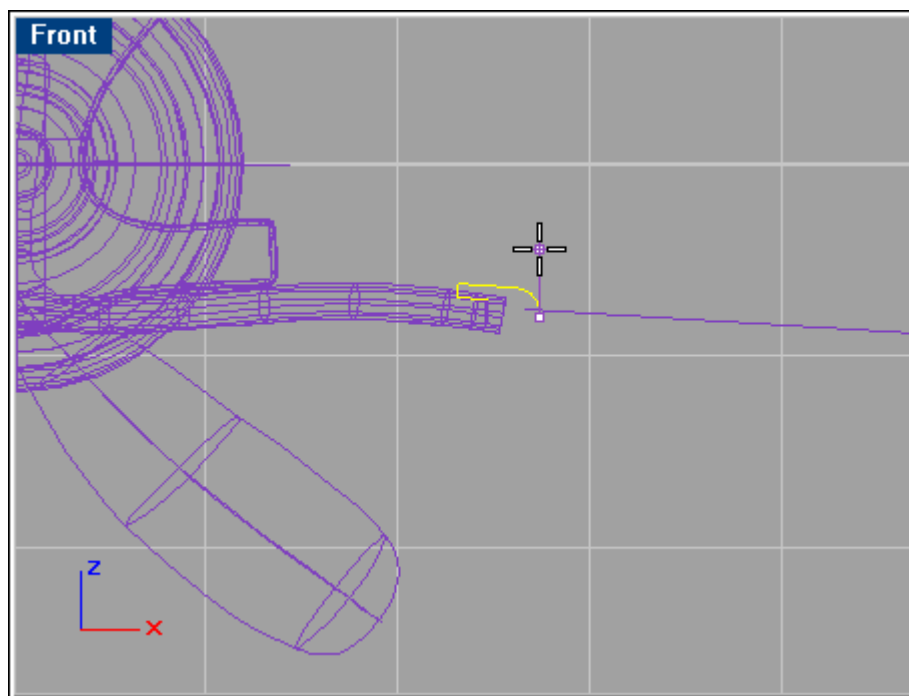


(In this figure, all other surfaces are hidden to improve visibility. If you need to do the same, select the surfaces you recently created, then go 'Edit/Select/Invert' and finally 'Edit/Visibility/Hide'.)

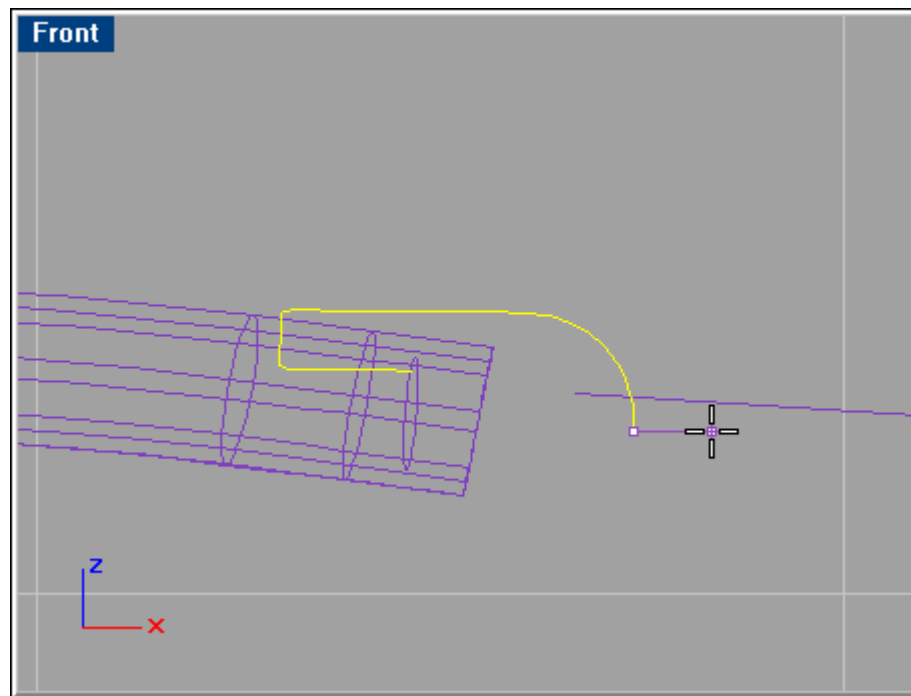
Repeat filleting with the other capped surface and the extruded one to make rounded edges on the other side as well.



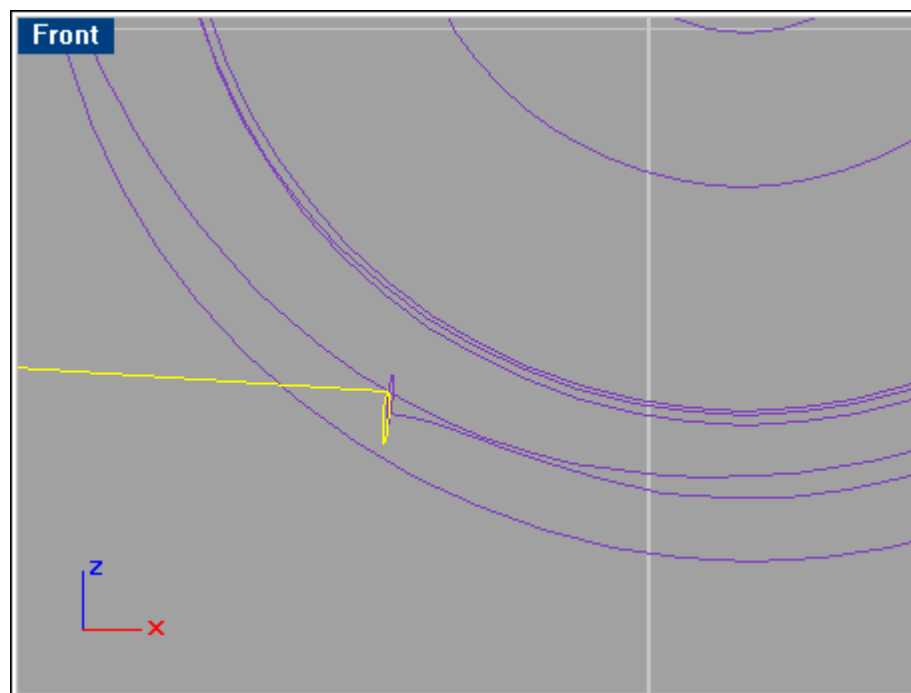
Rotate the curve shown below by 3.6 degrees.

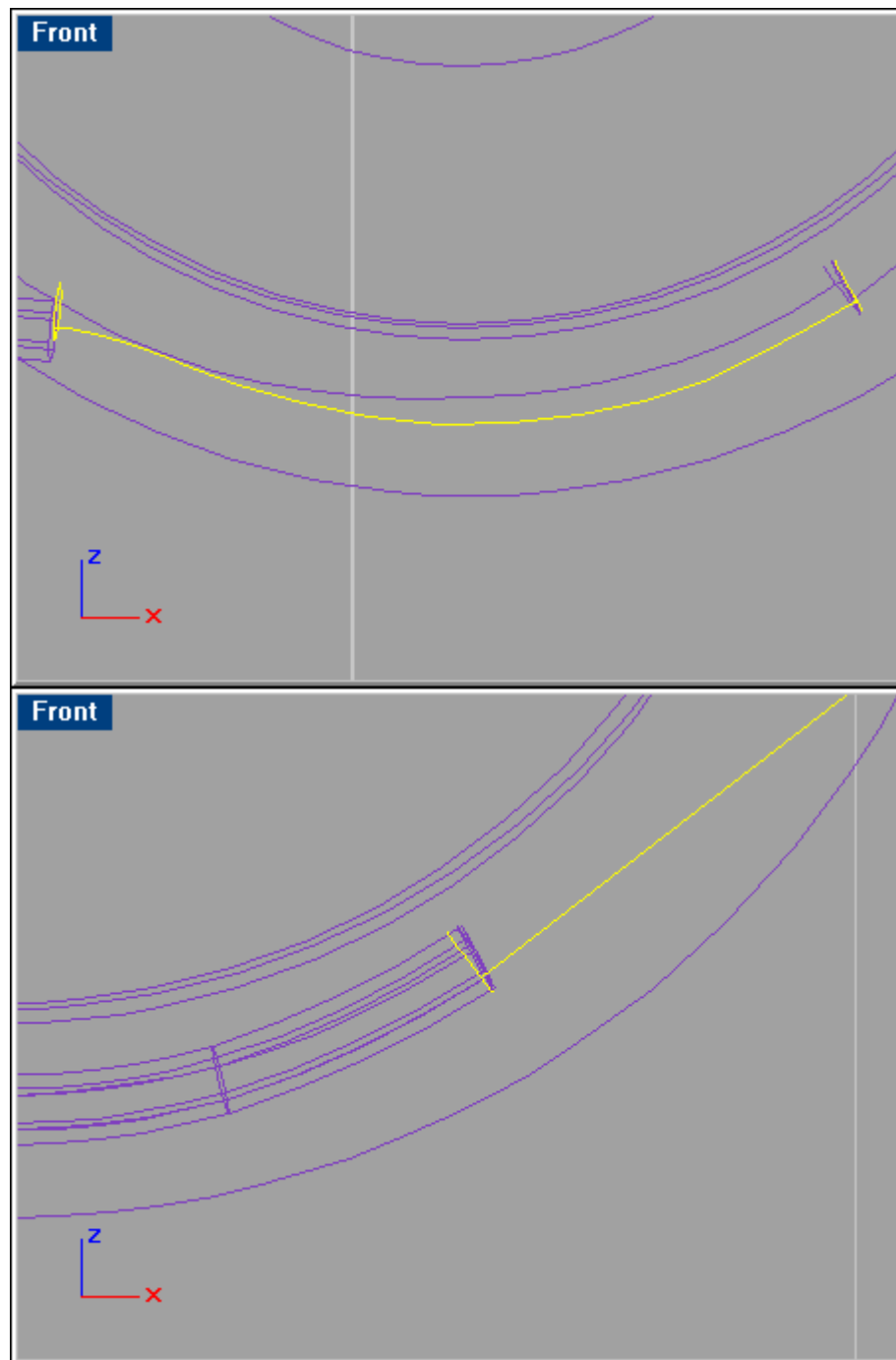


Then revolve it in usual manner and rotate it back (-3.6 degrees)

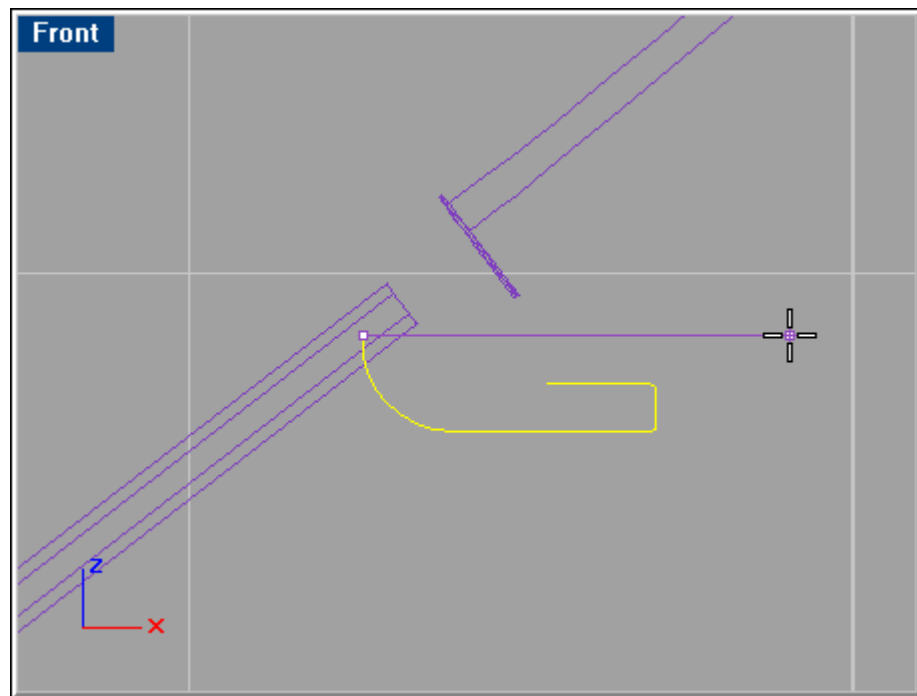


Make a 'Sweep 1 Rail' out of the curves selected in the three figures below.

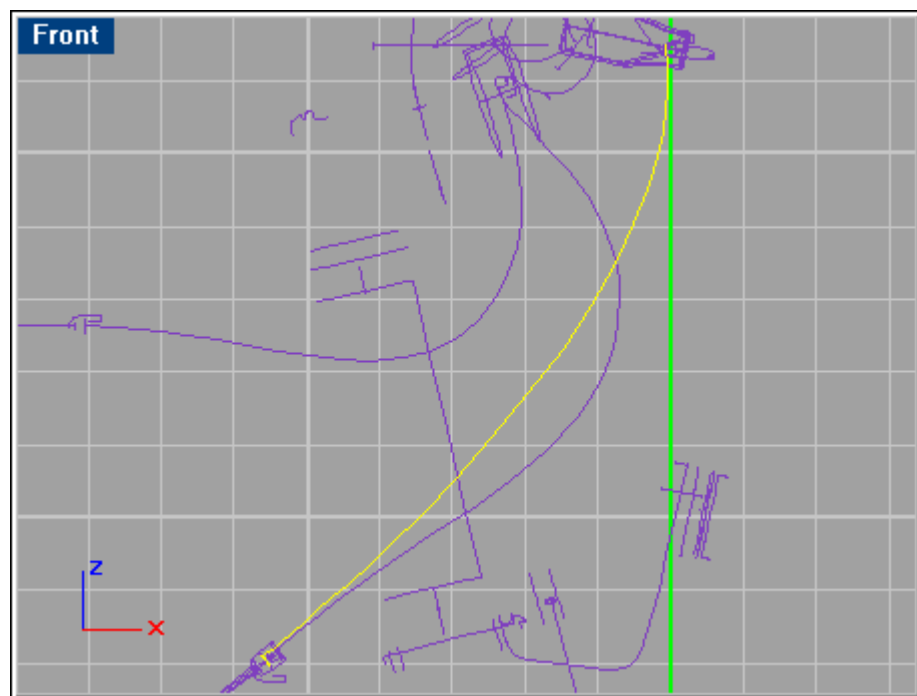


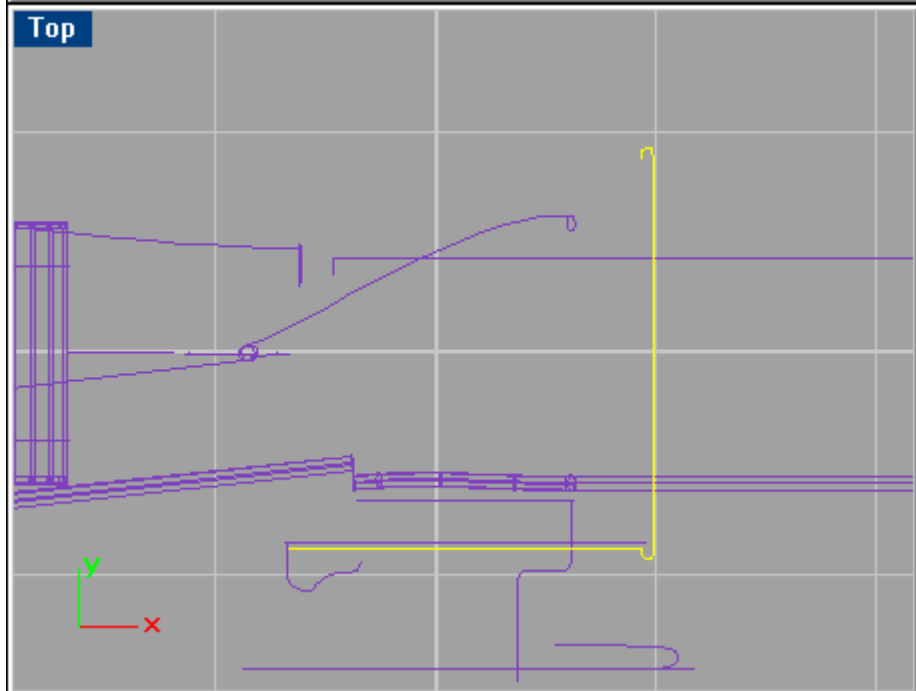
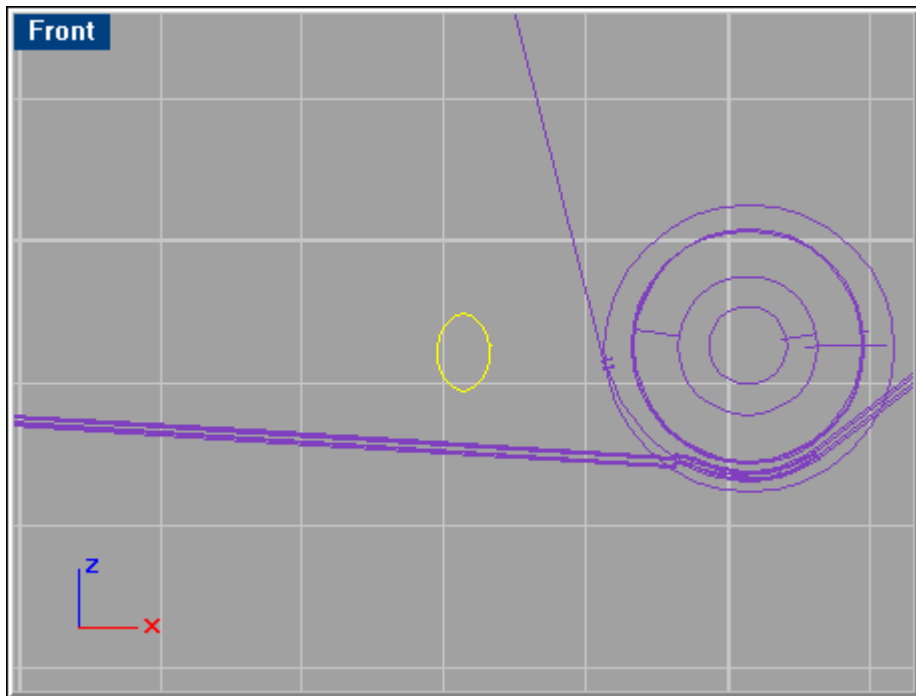


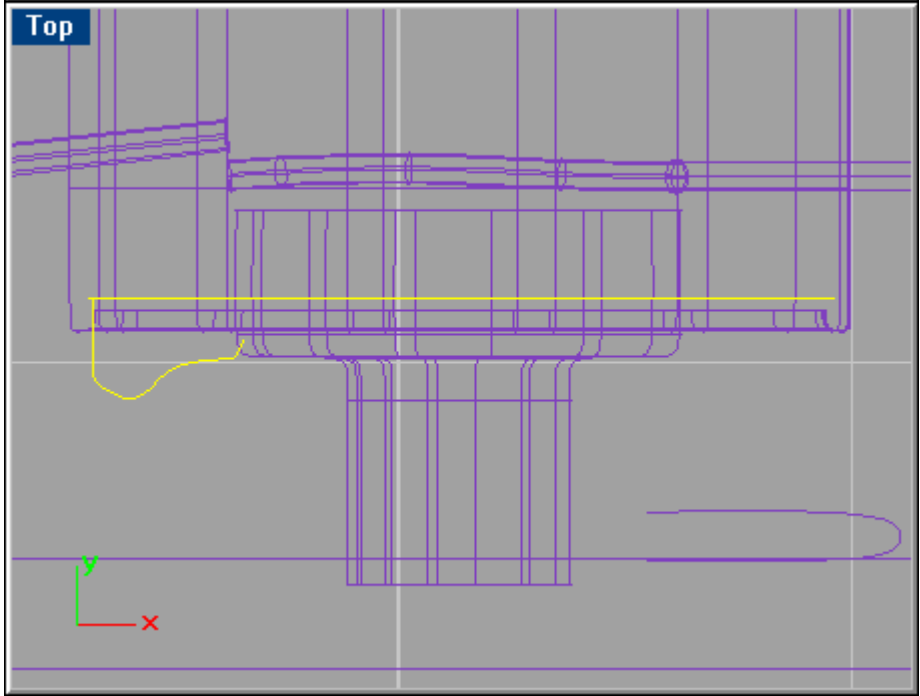
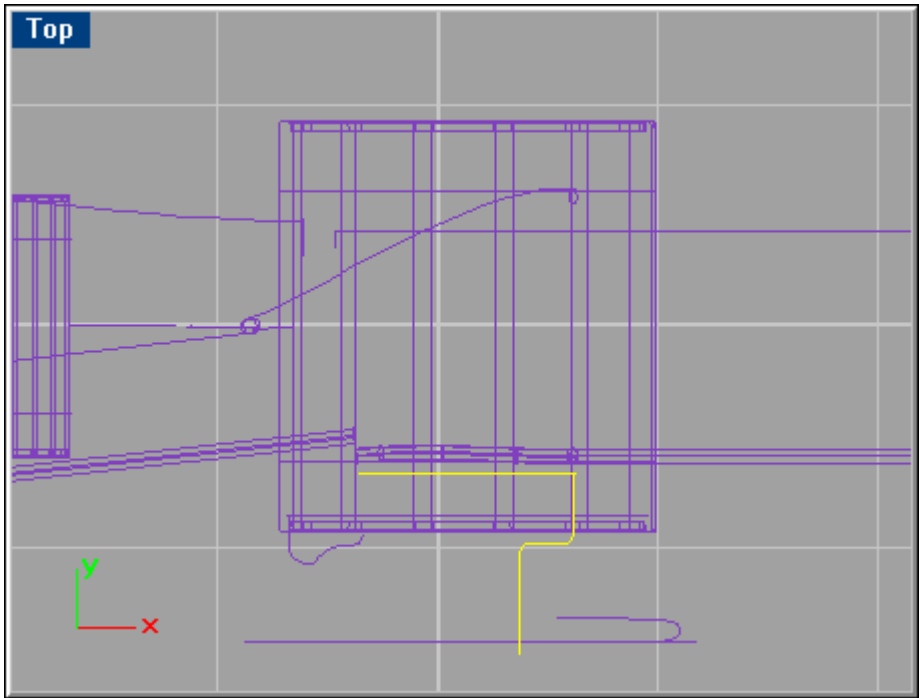
Make a revolve of the curve shown below and rotate it 37 degrees using Object Snap 'End' to snap the first reference point to the left end of the surface.

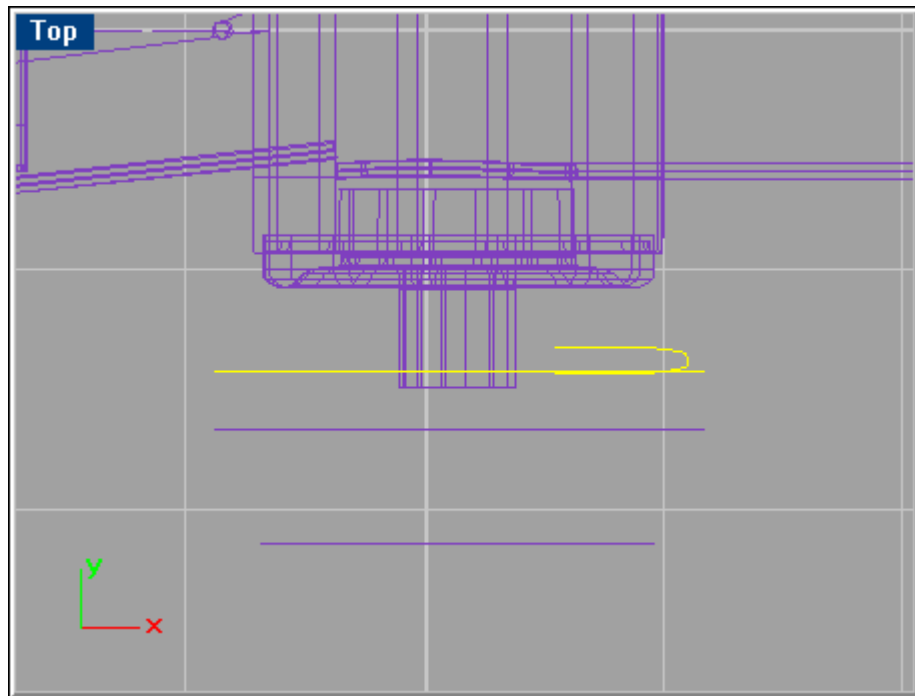


Make a 'Sweep 1 Rail' out of all the curves shown below.

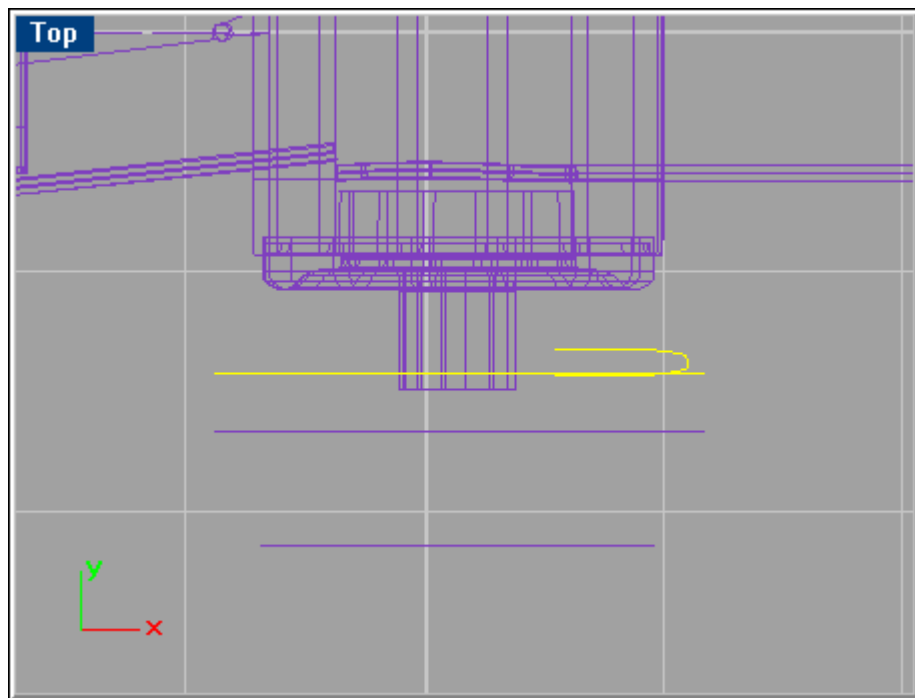


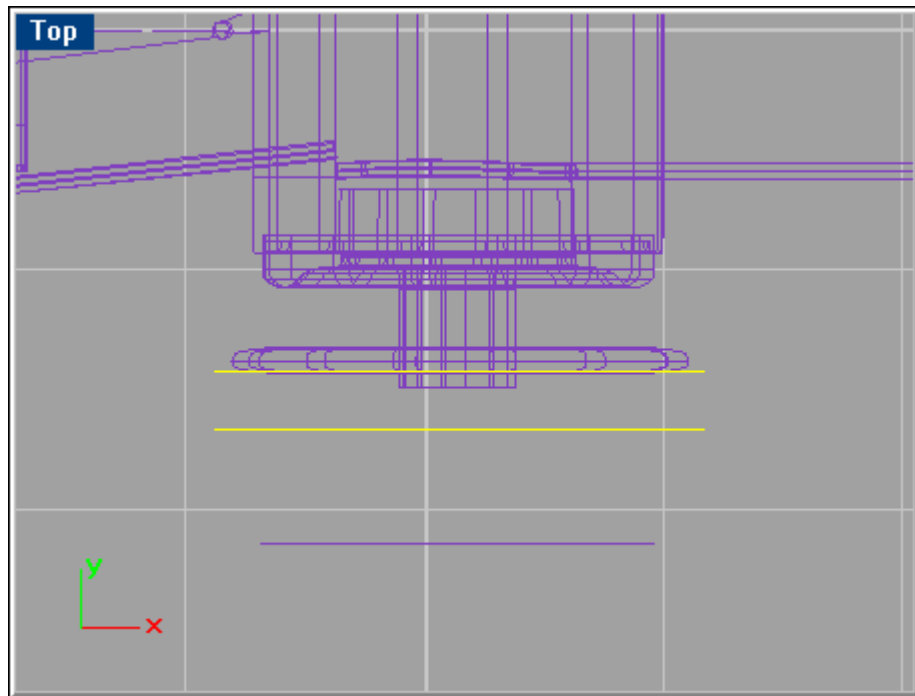




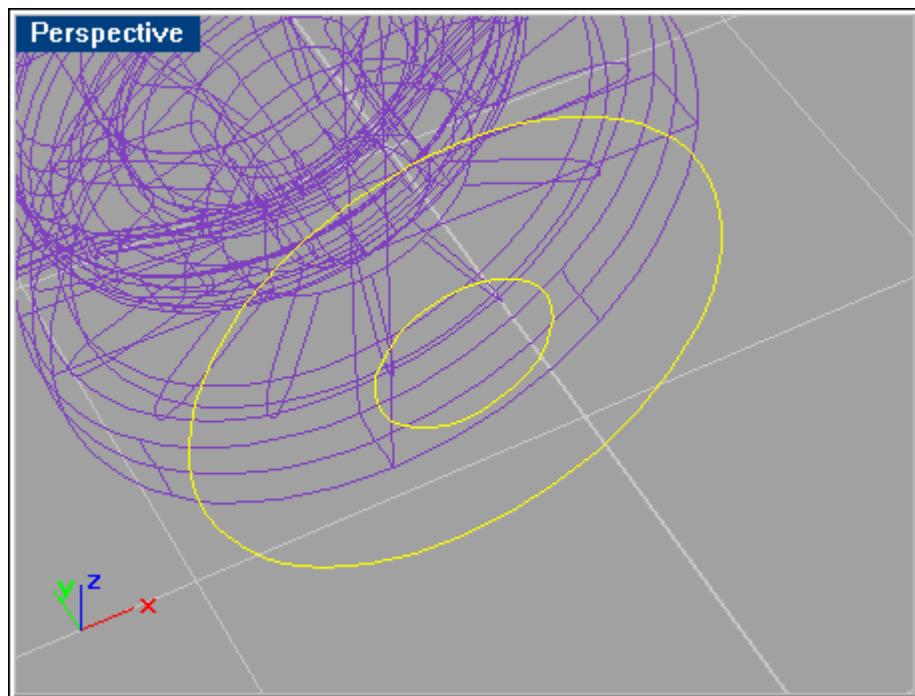


Loft the two curves shown below. Then cap the open ends.

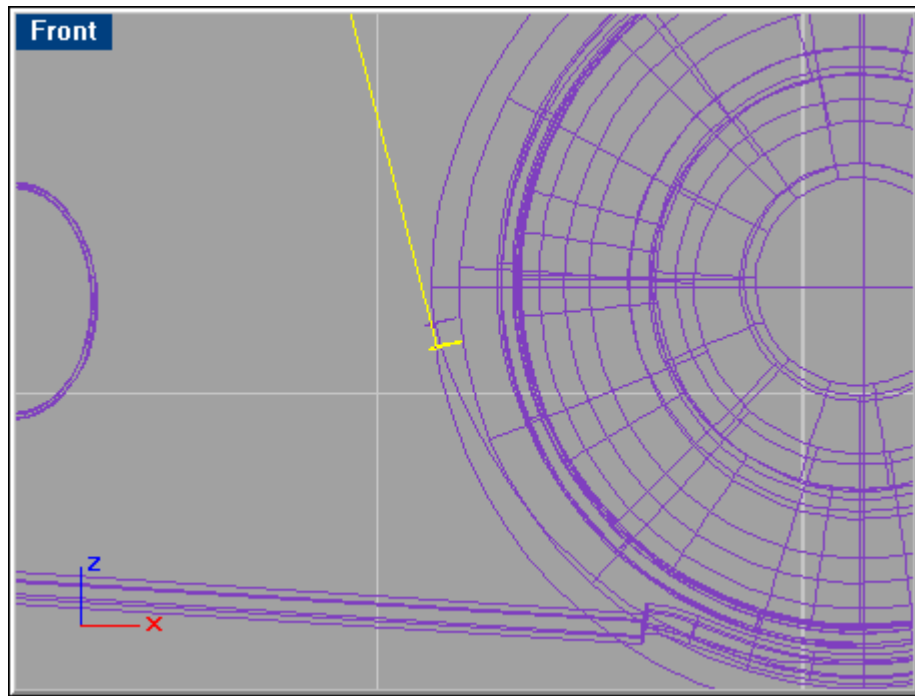




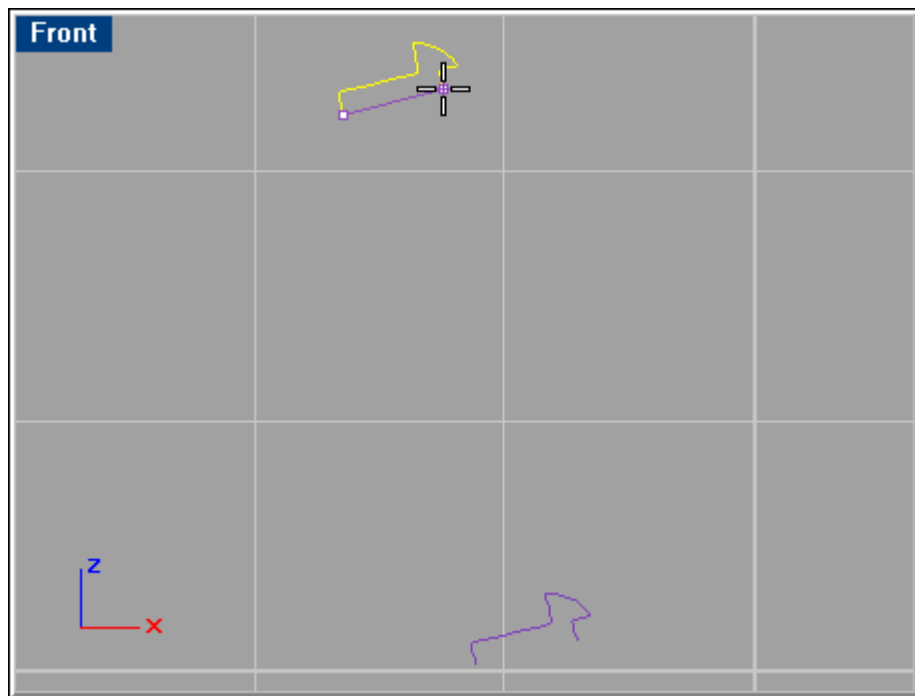
Loft together the curves shown below:

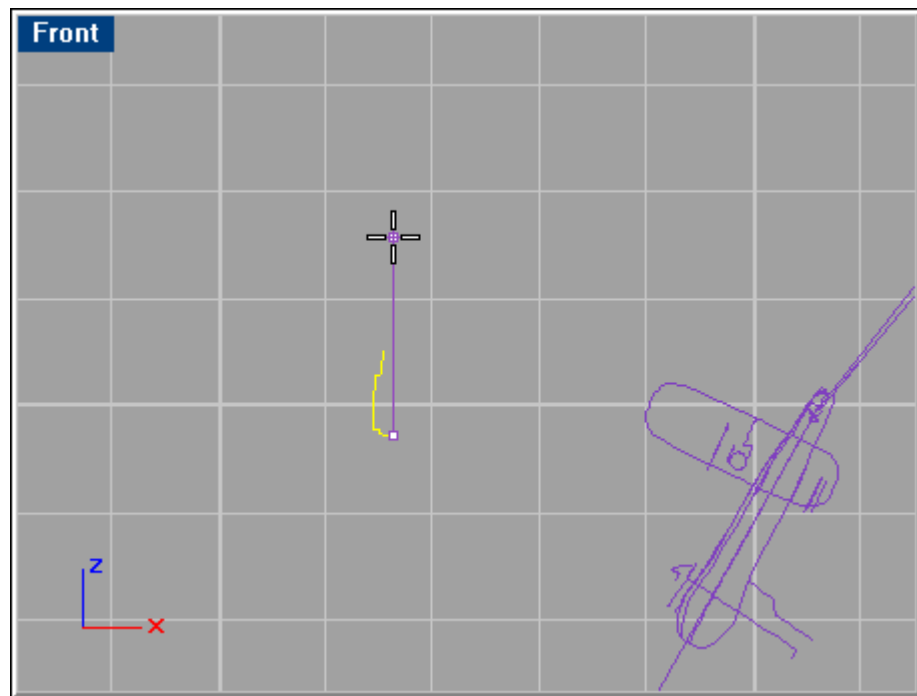


Make a 'Sweep 1 Rail' with the curves selected in the figure below.

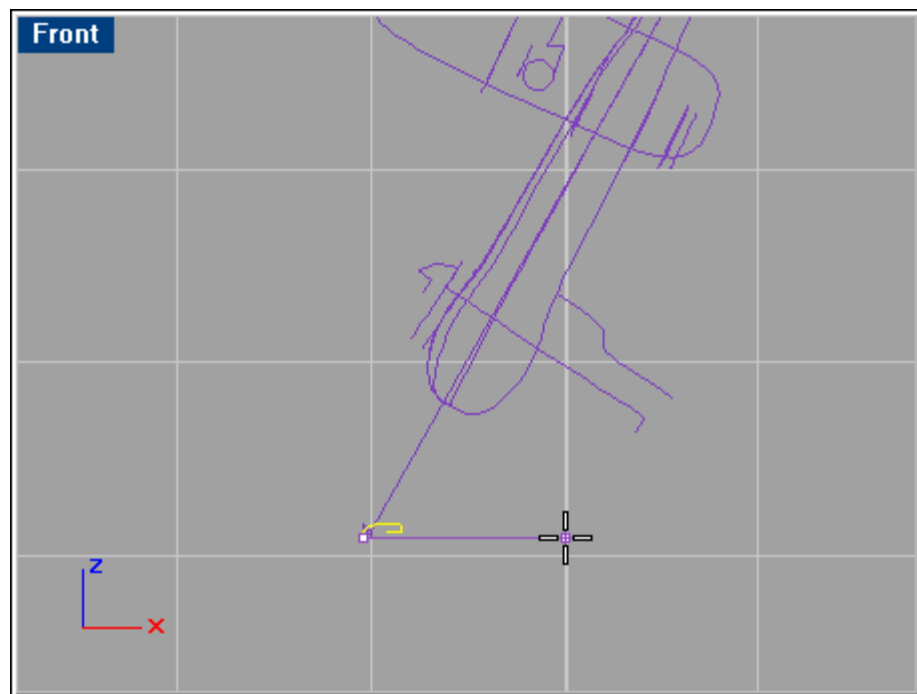


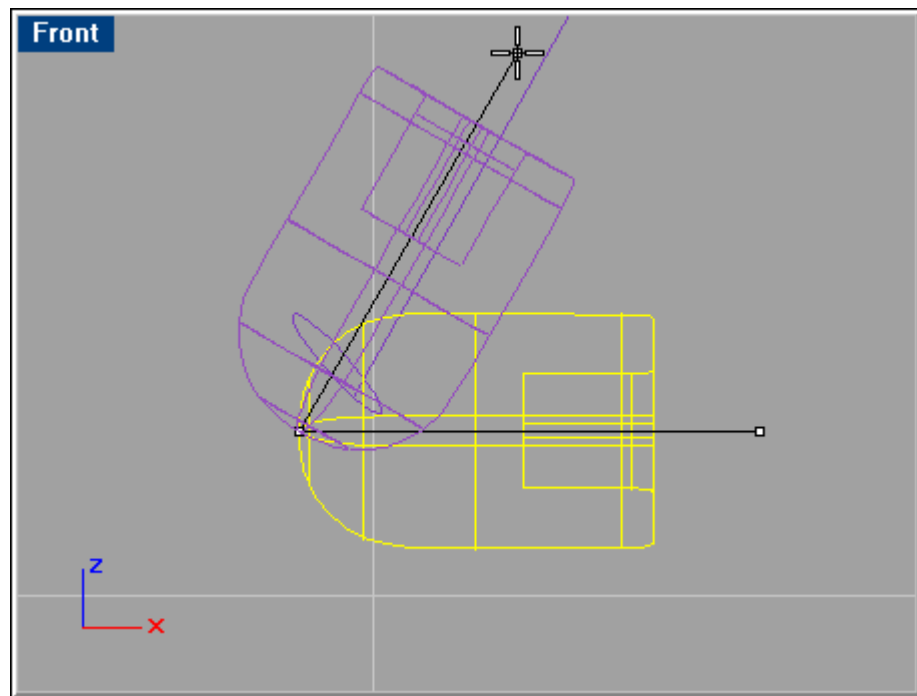
Revolve the 2 screw curves shown below (left), and the one selected below (right).



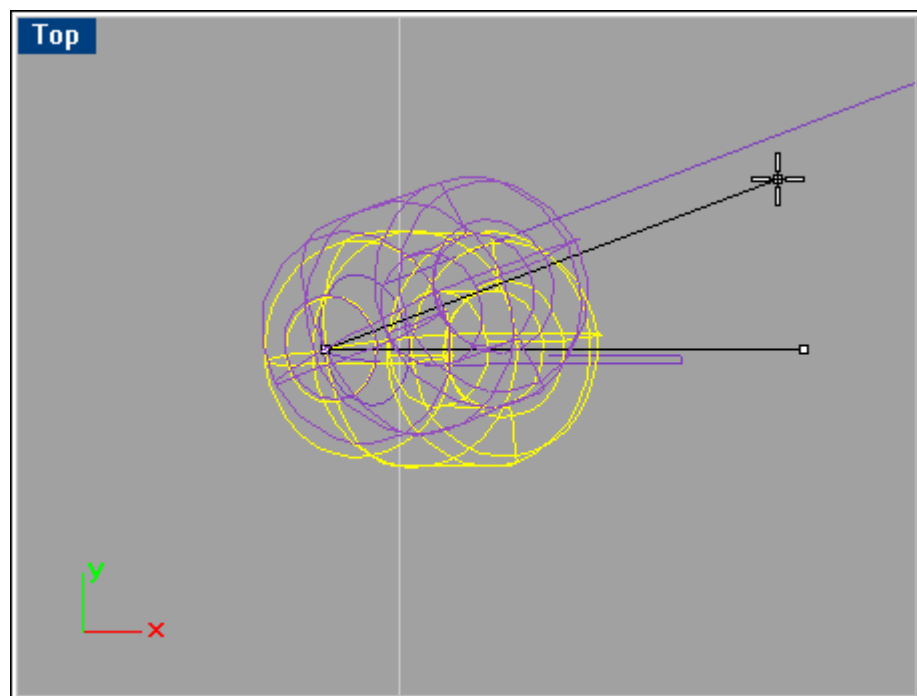


Revolve the curve shown below (left), and rotate it in the same direction as the curve next to it – below (right).

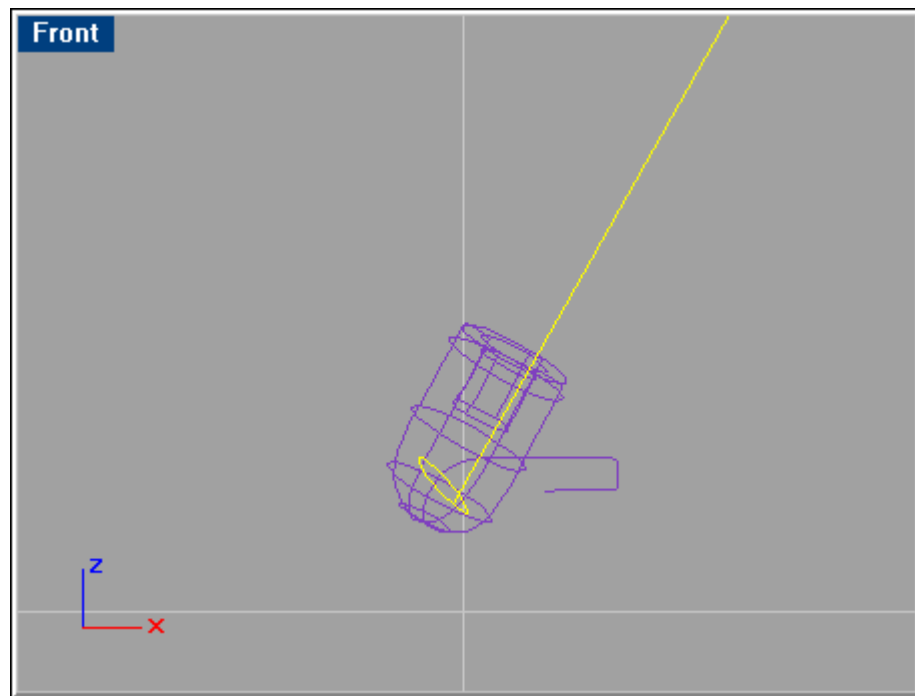




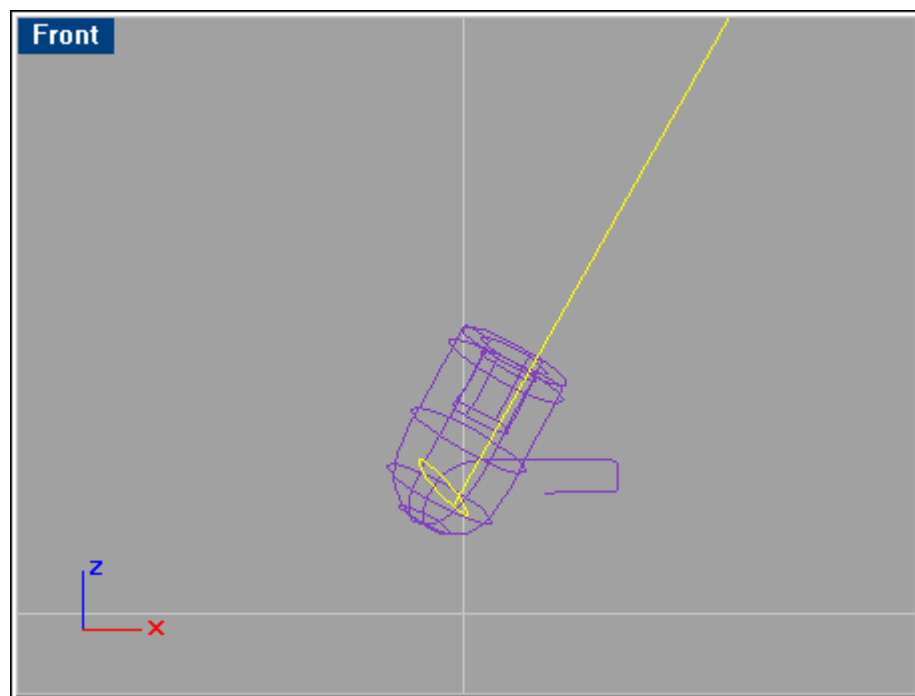
Make it the same direction in the Top viewport as well.

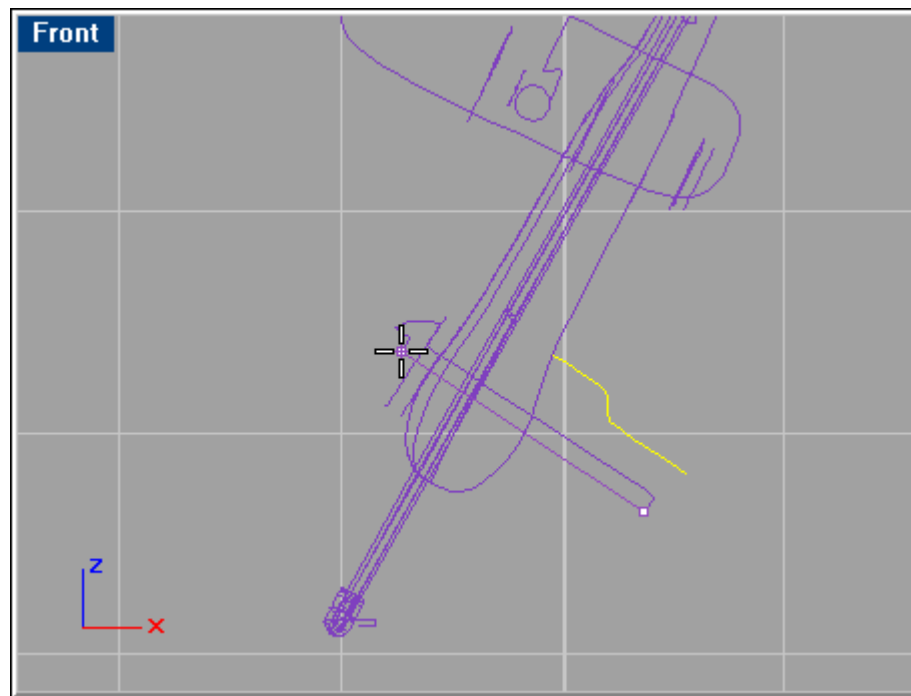


Make a 'Sweep 1 Rail' out of the curves shown below.

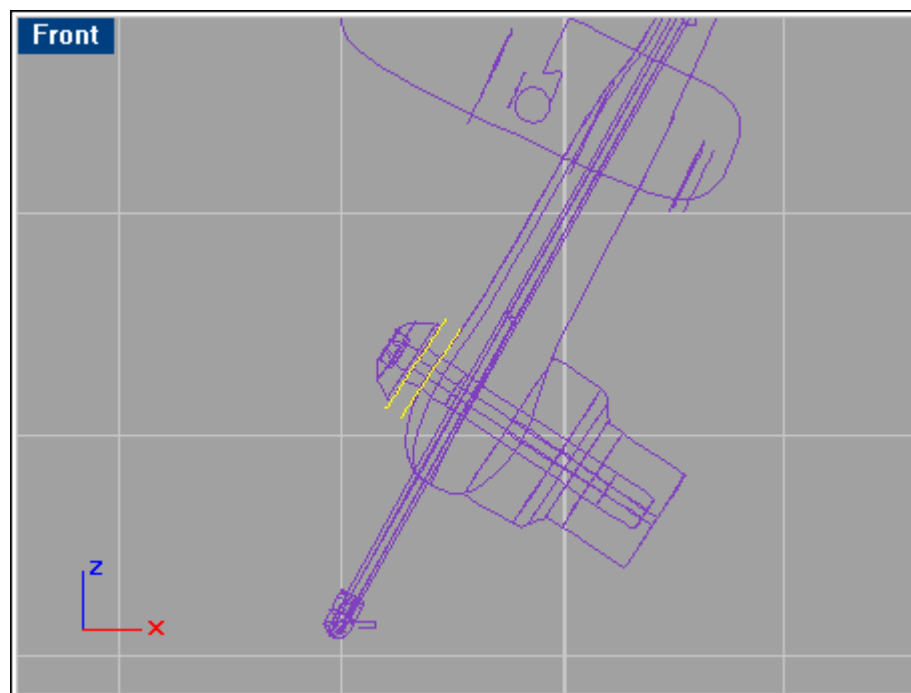


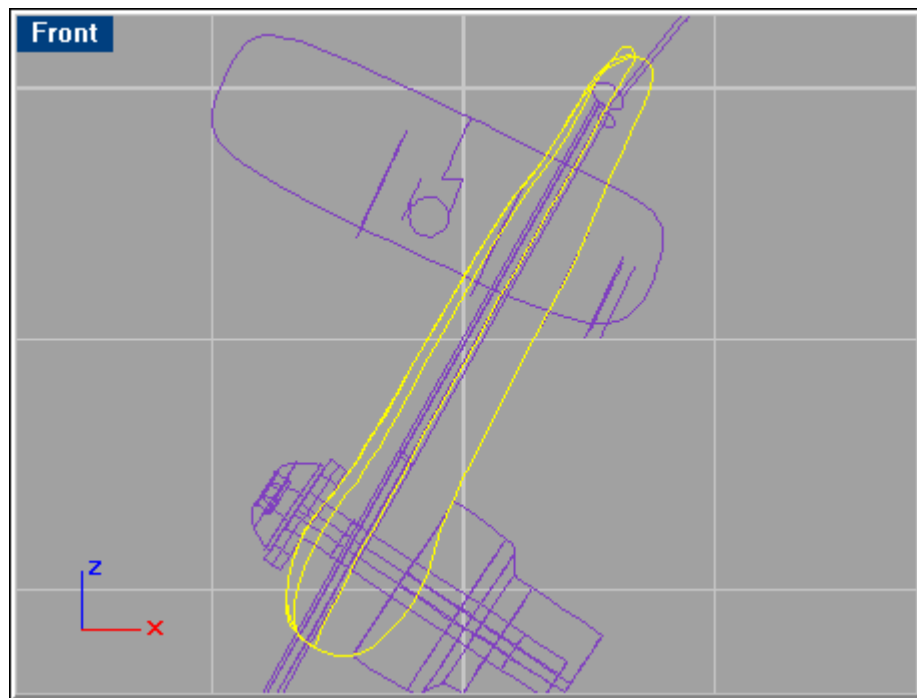
Revolve the curves shown in the two figures below.



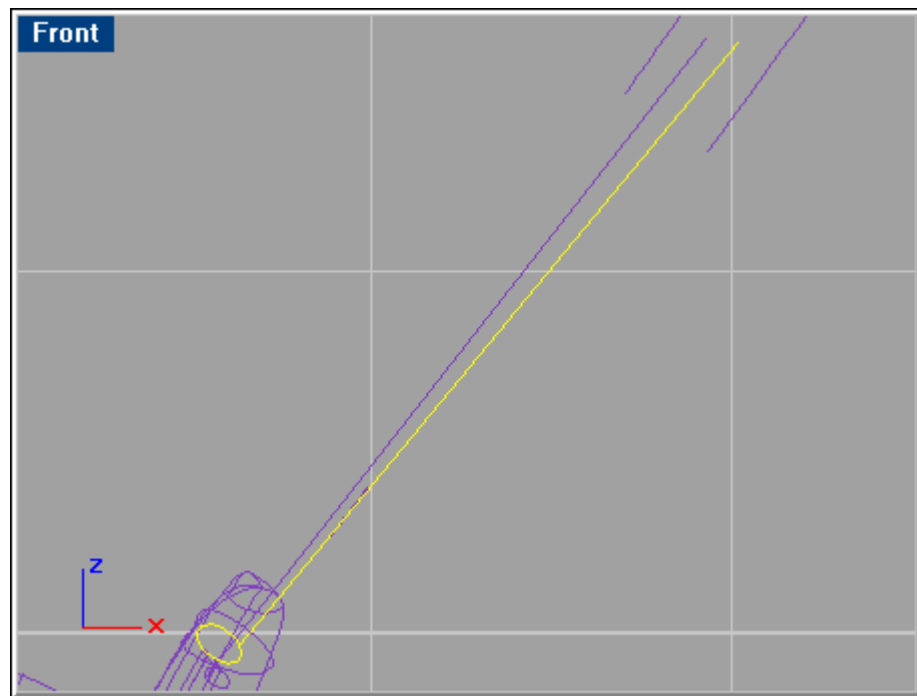


Loft together the curves shown in below left (also cap and join all surfaces) and below right.

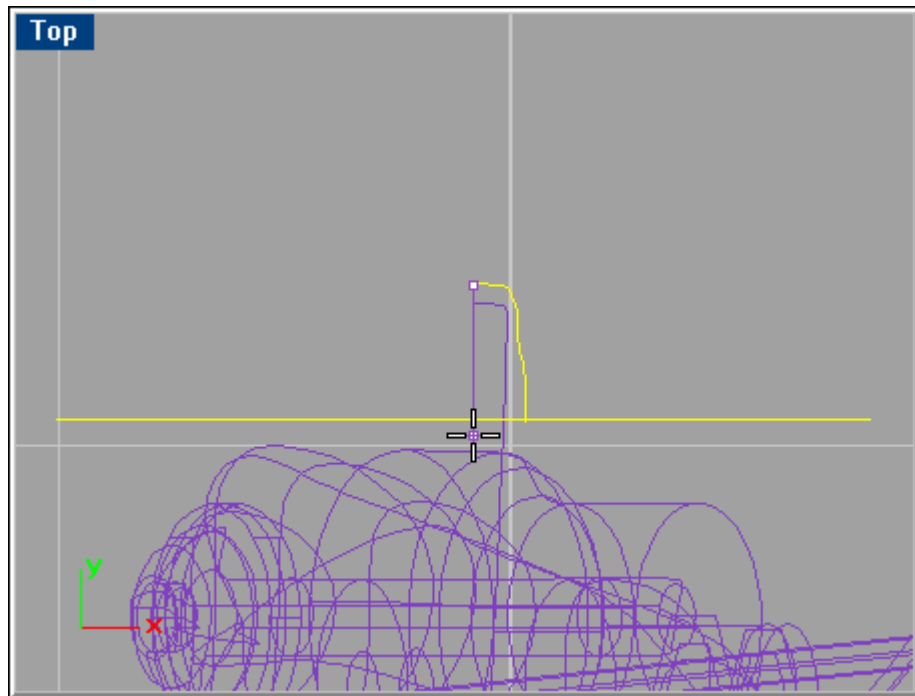




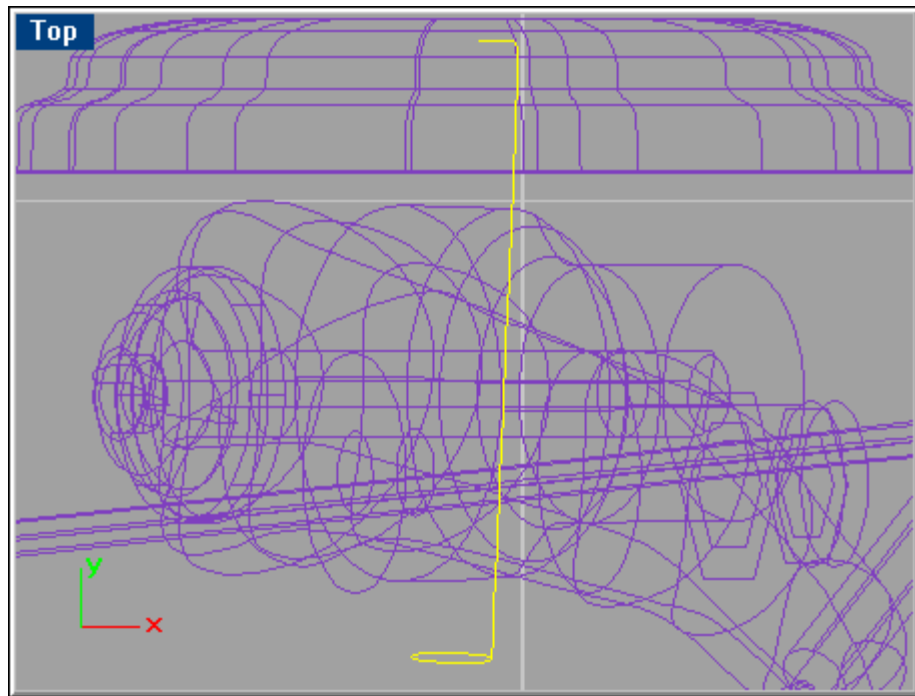
Make a 'Sweep 1 Rail' from the curves shown below.



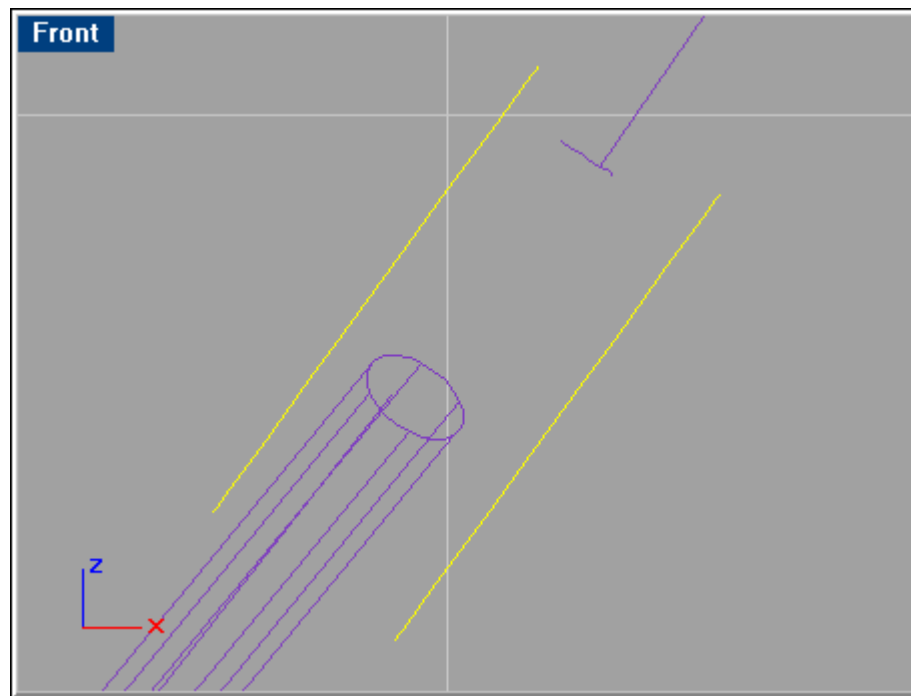
Go 'Surface/Rail revolve', and select the curves shown below.



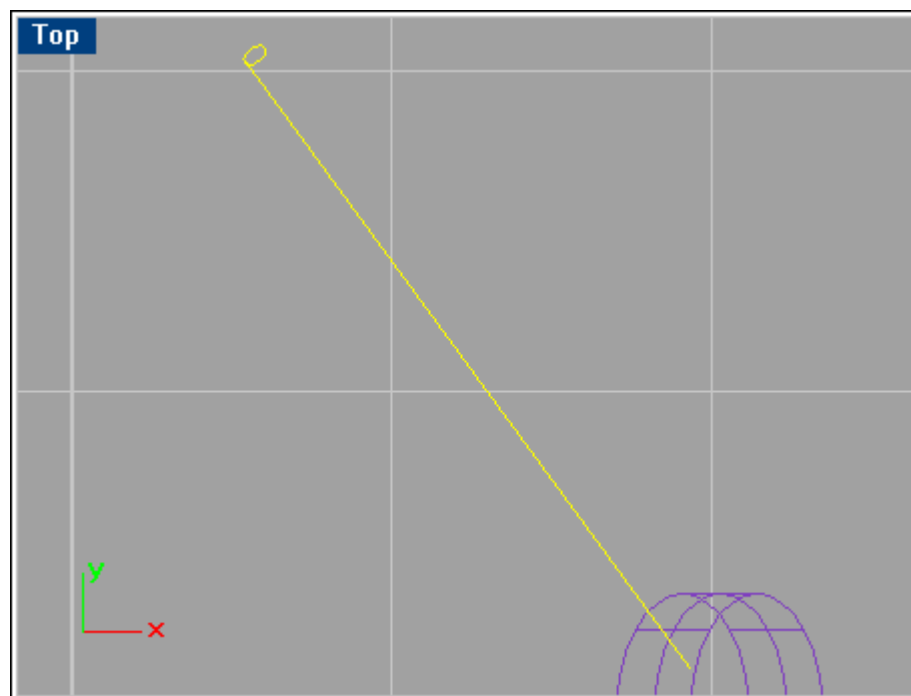
Go 'Surface/Sweep 1 Rail' and then select the long curve below as profile curve, and the circle curve for the path.

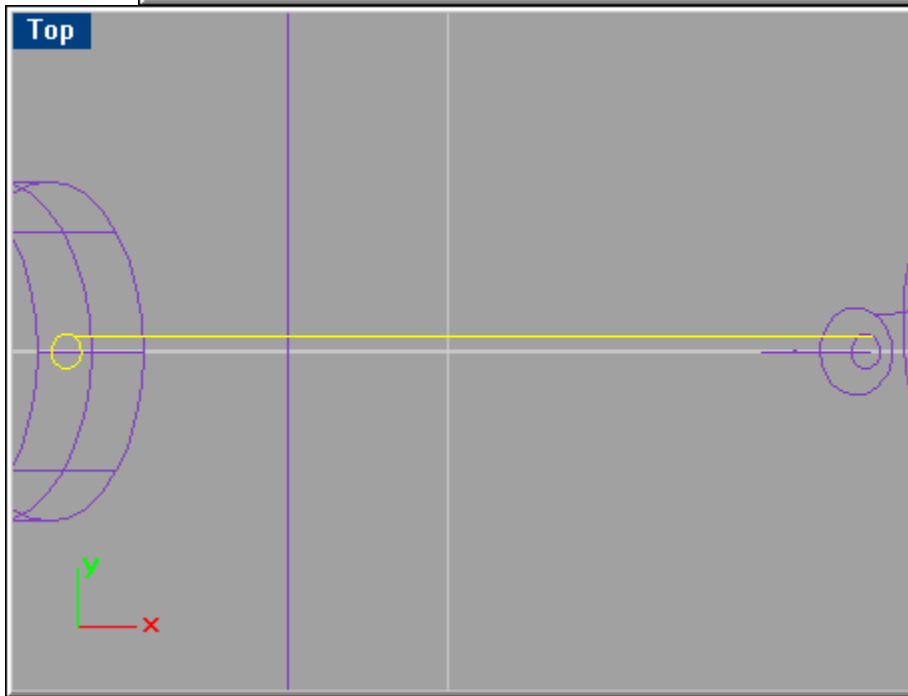
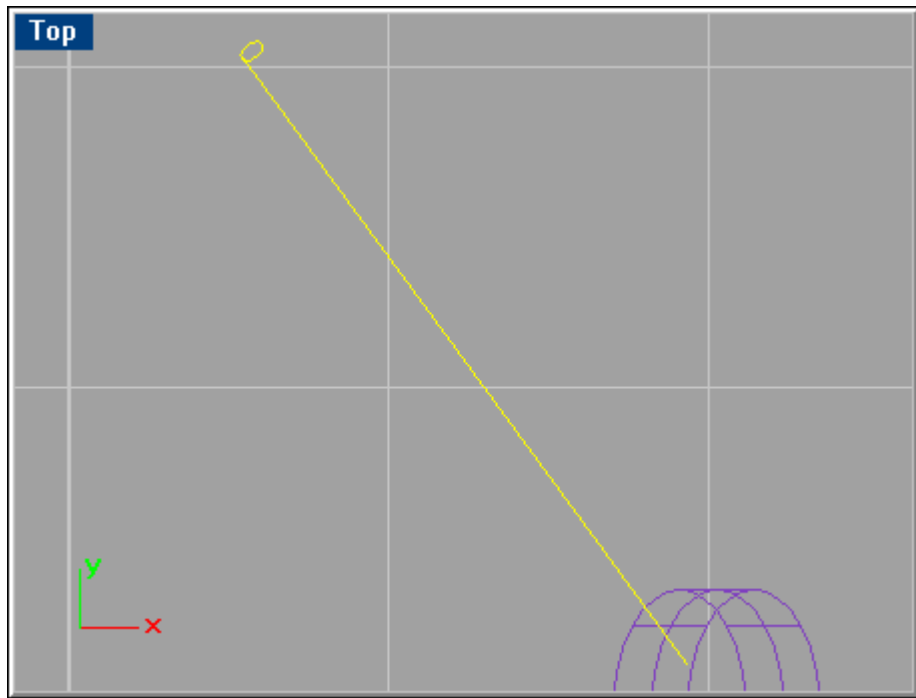


Loft together the curves selected below and cap + join.

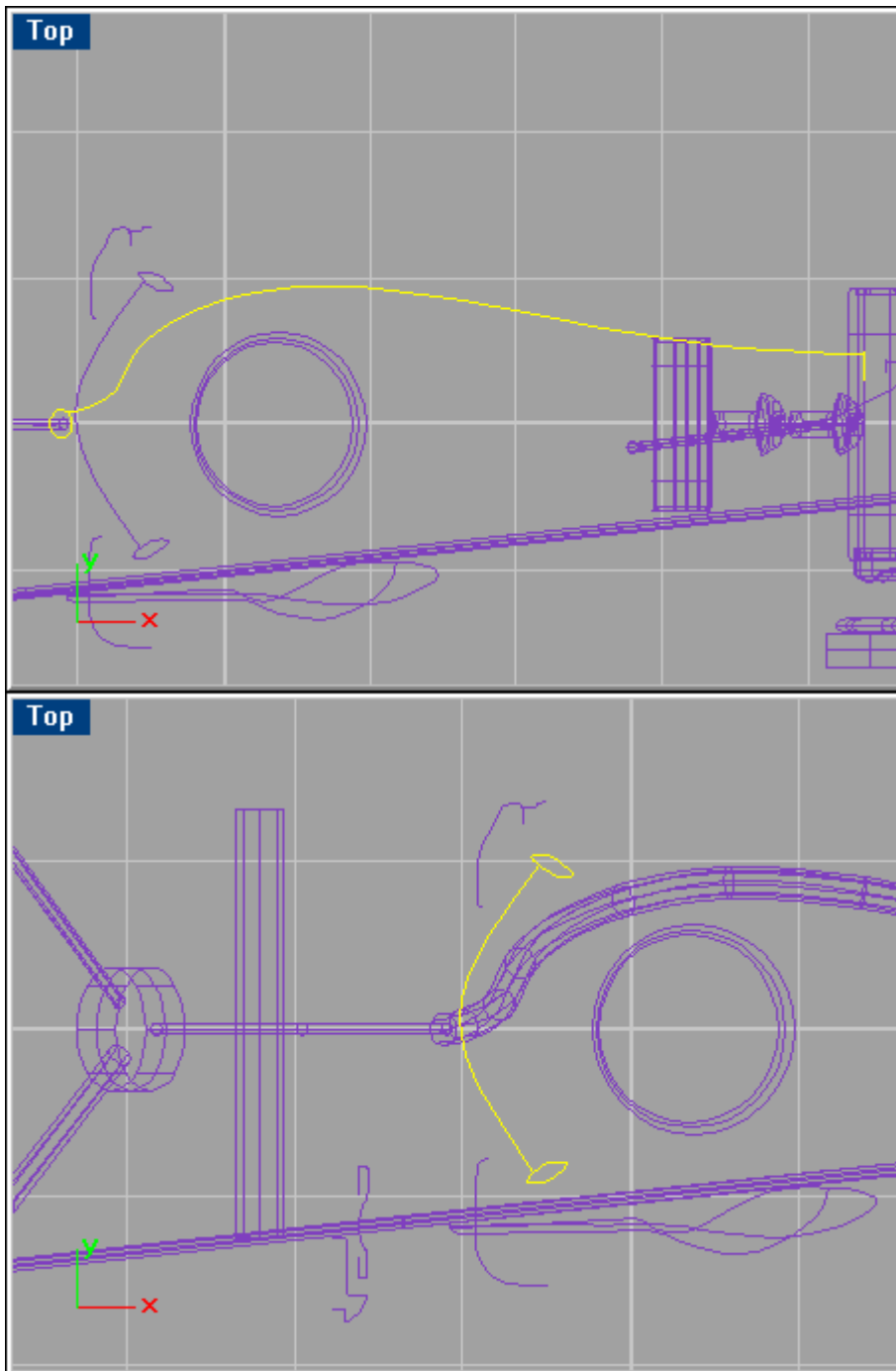


Do a 'Sweep 1 Rail' with the curves in the 5 figures below:

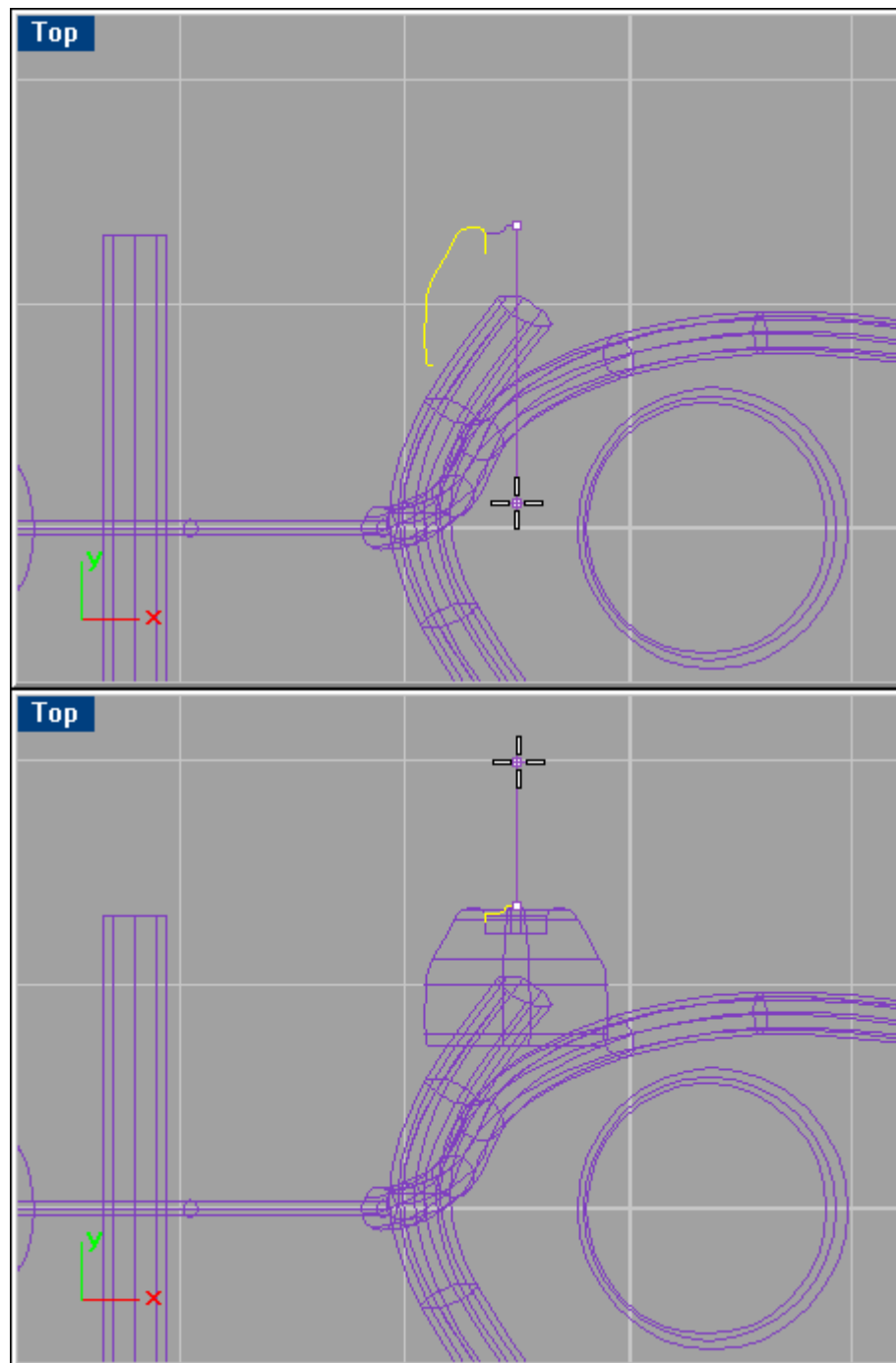




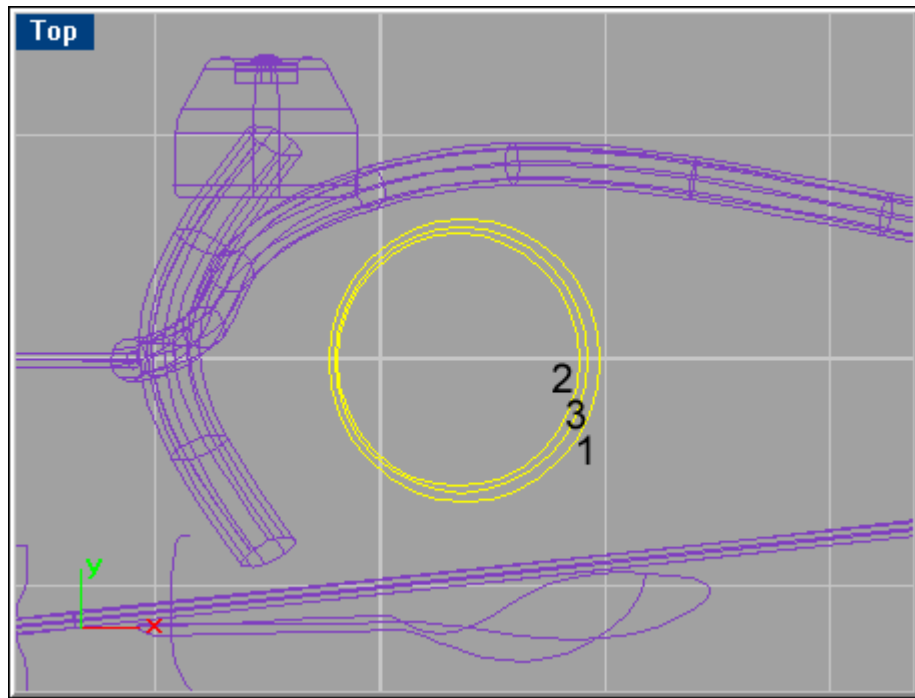
(Cap and join this)



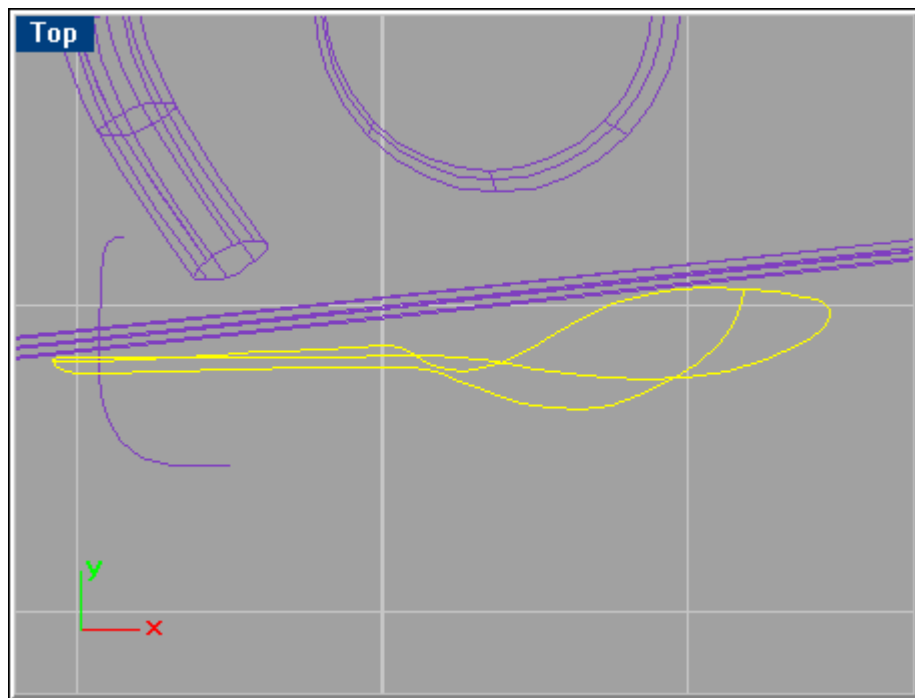
Make a revolve of the curves shown in below:



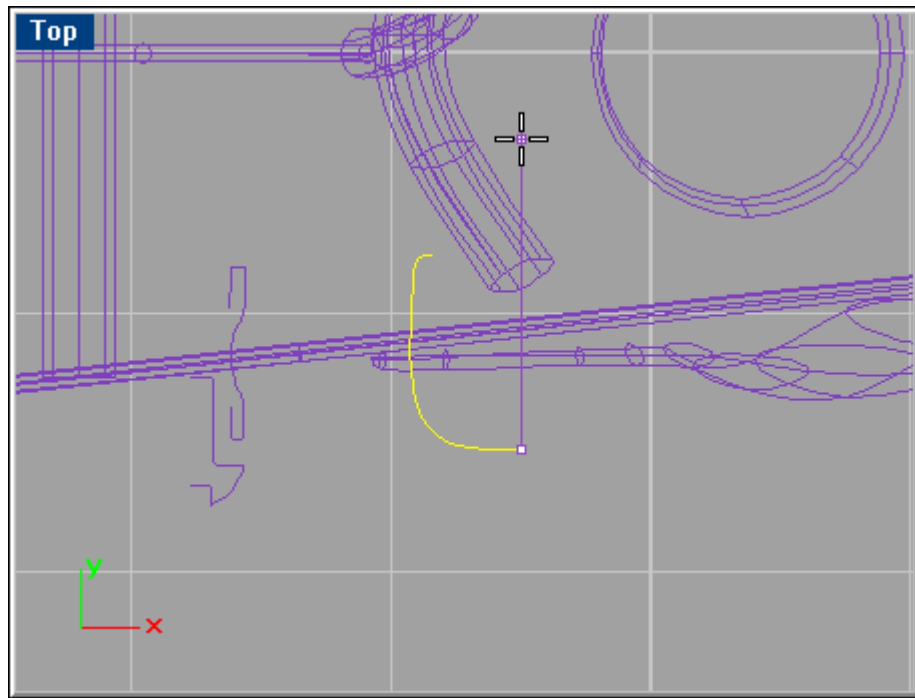
Loft together the curves shown below, in the order as numbered.



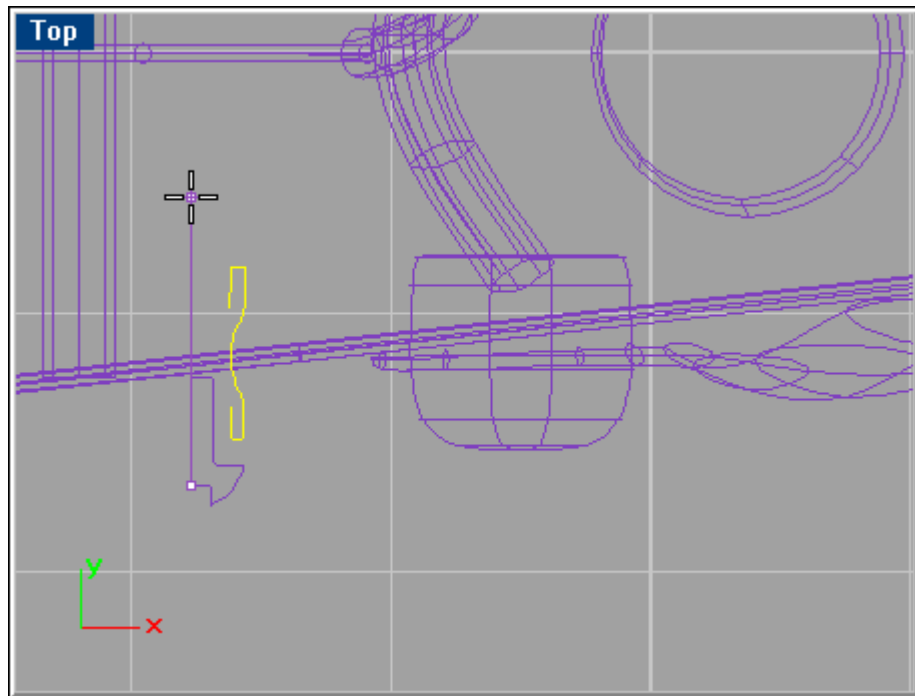
Loft together the curves shown below with 'Closed' box checked in the 'Loft options' panel.



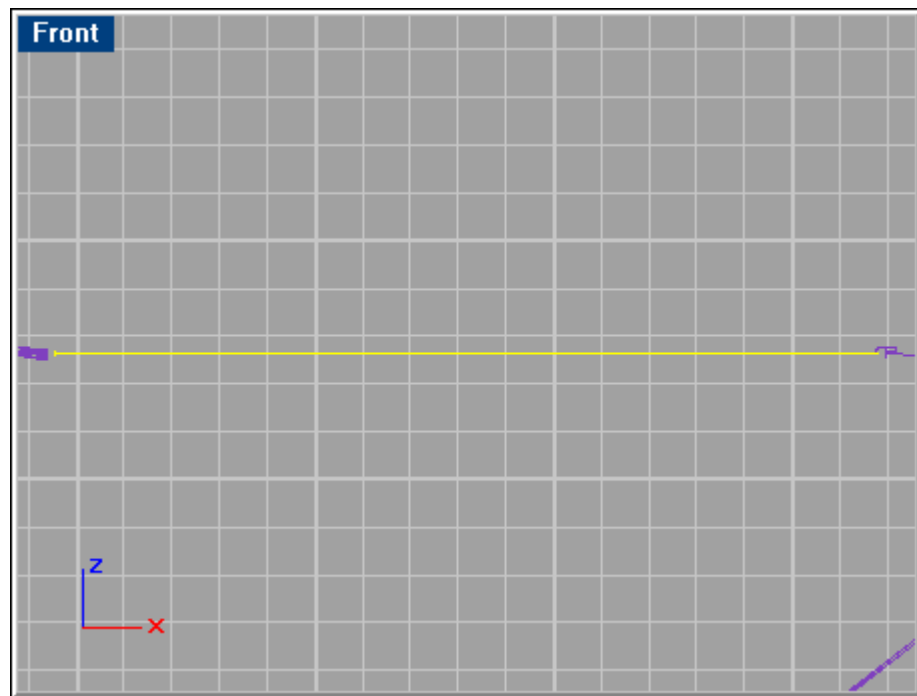
Revolve the curves shown below...



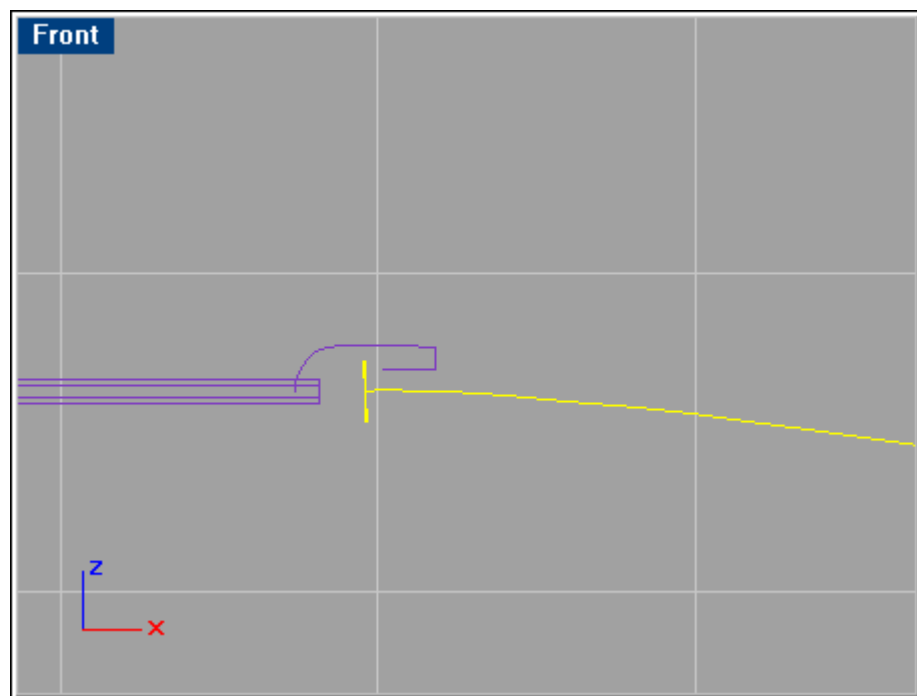
...with this screw curve as well:



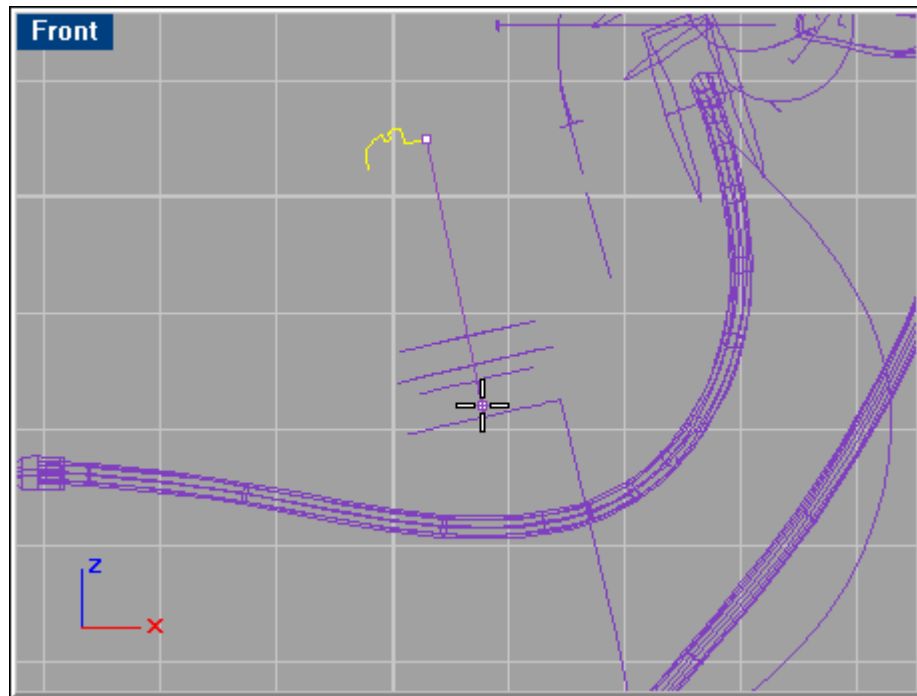
Make a 'Sweep 1 Rail' with the curves shown below.



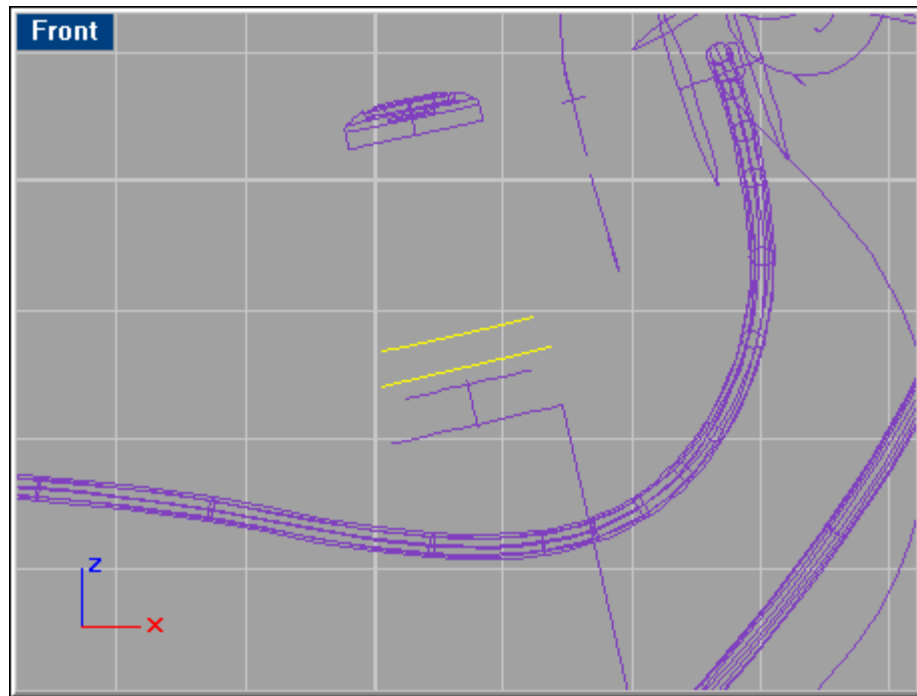
Do the same with the curves shown in below, and revolve the curve to the left as well.



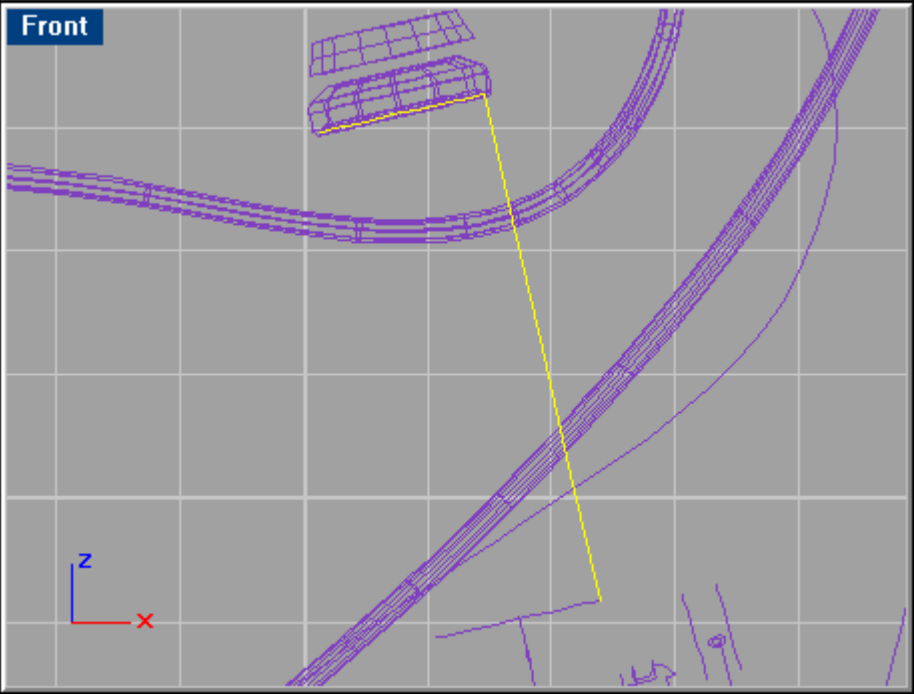
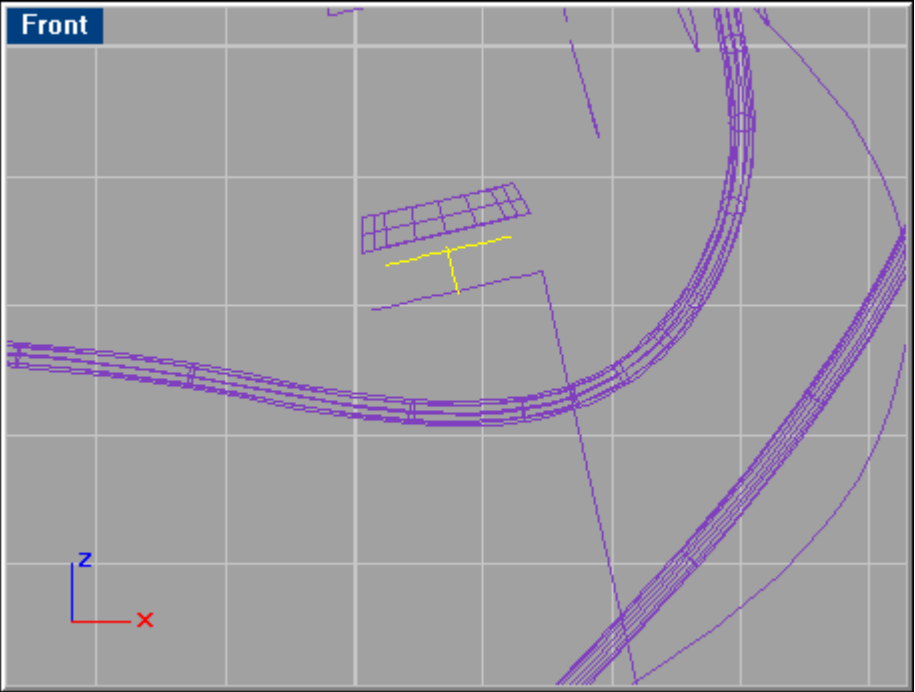
Revolve the curve shown below.

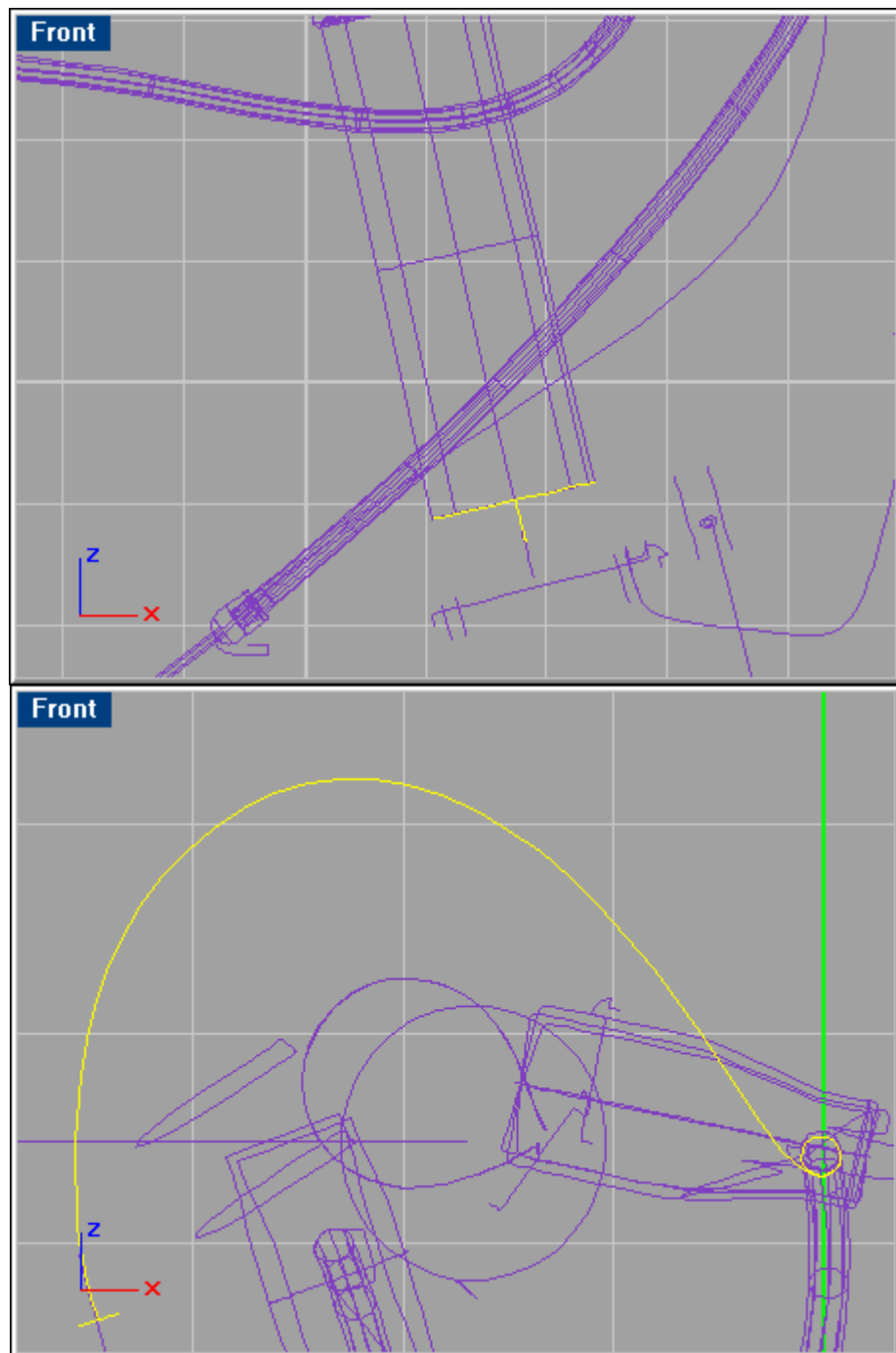


Loft the curves shown below and cap the resulting surface following with joining the 3 surfaces together.

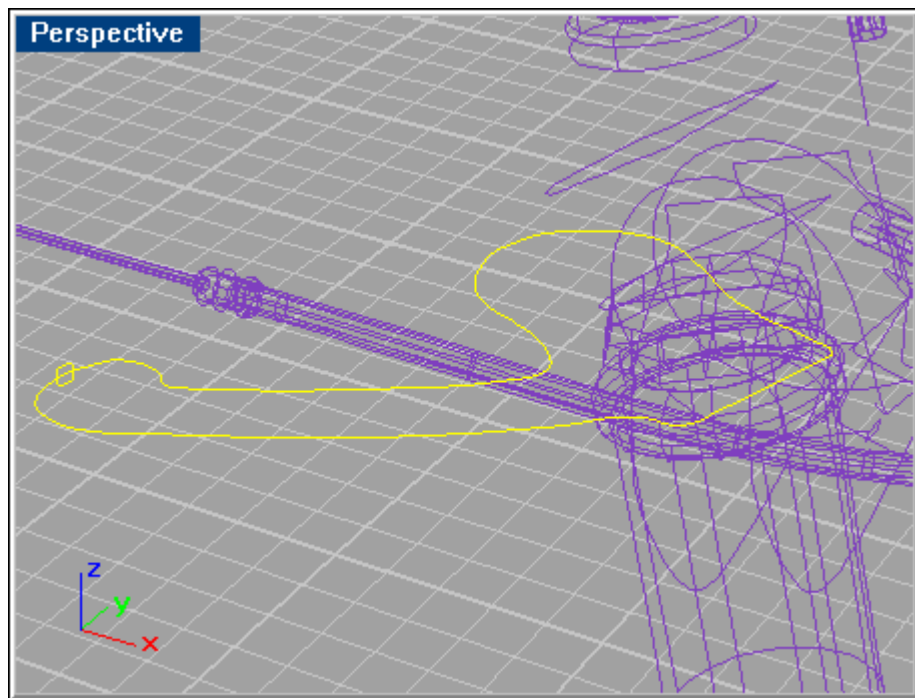


Make a 'Sweep 1 Rail' with the curves selected in the four figures below.

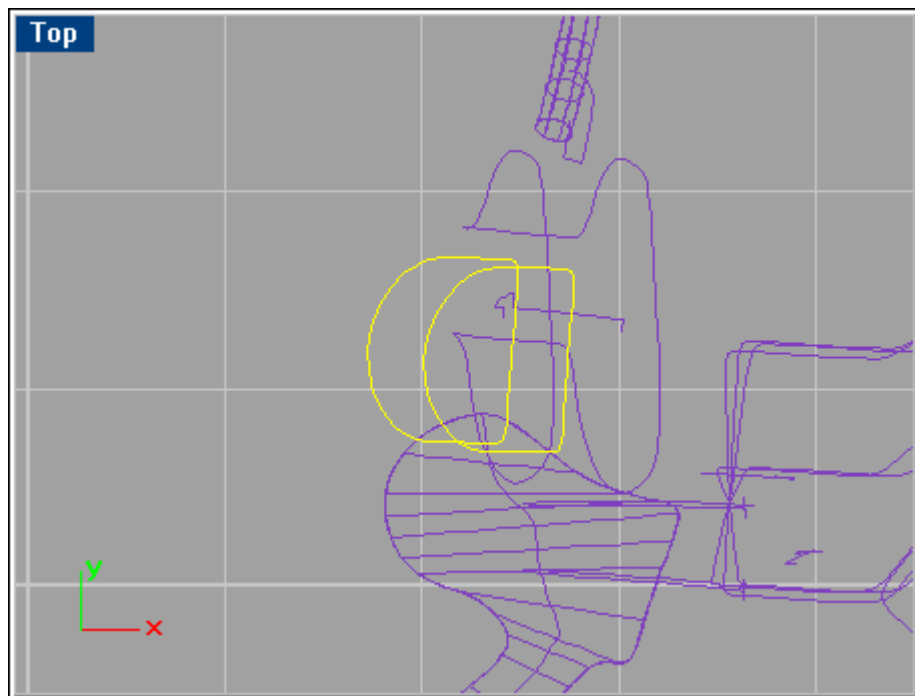




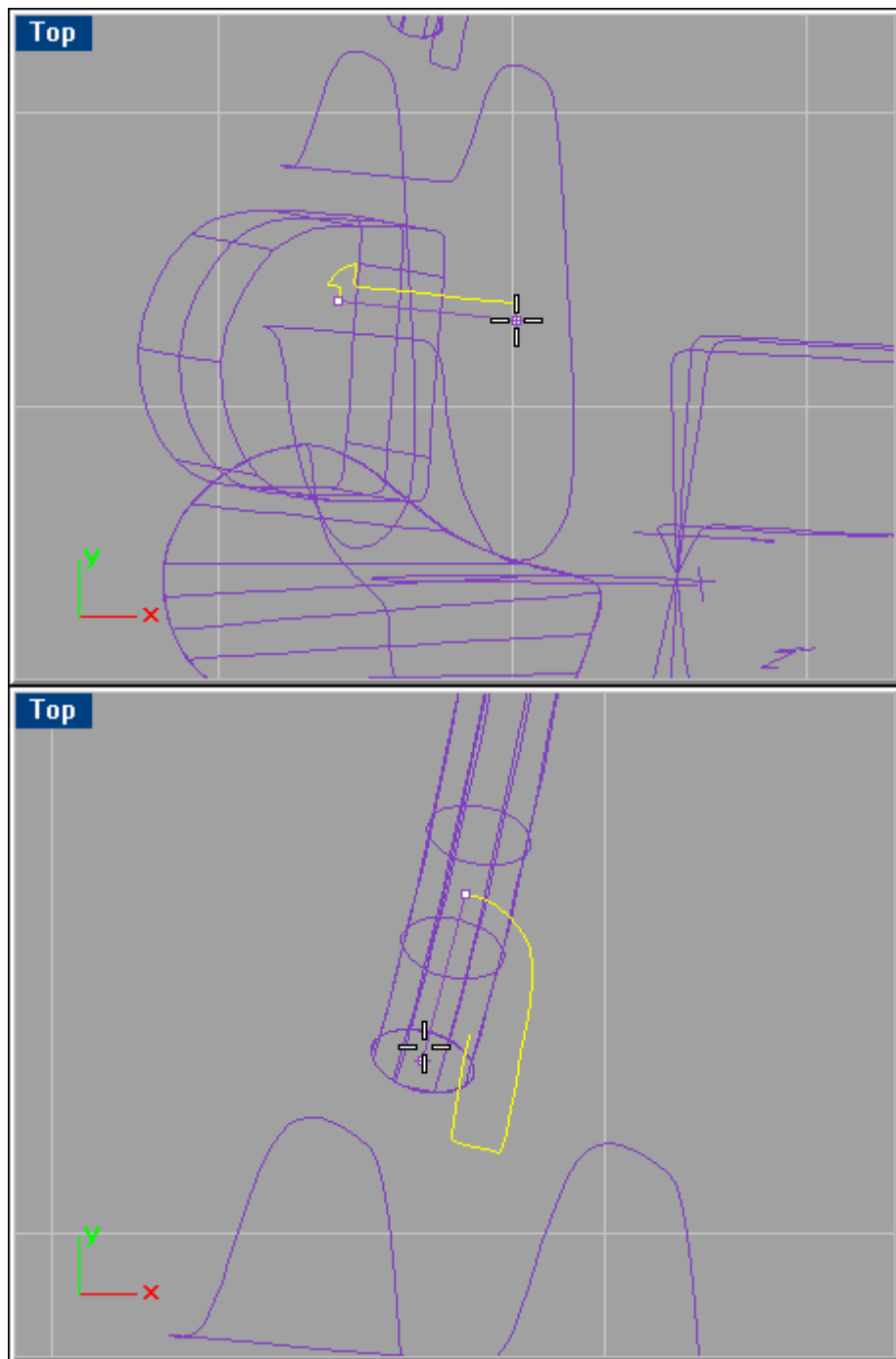
Select the curves shown below and perform a 'Sweep 2 Rails'. Use the default options and cap the resulting surface.



Loft together the curves shown below. Cap the resulting surface.

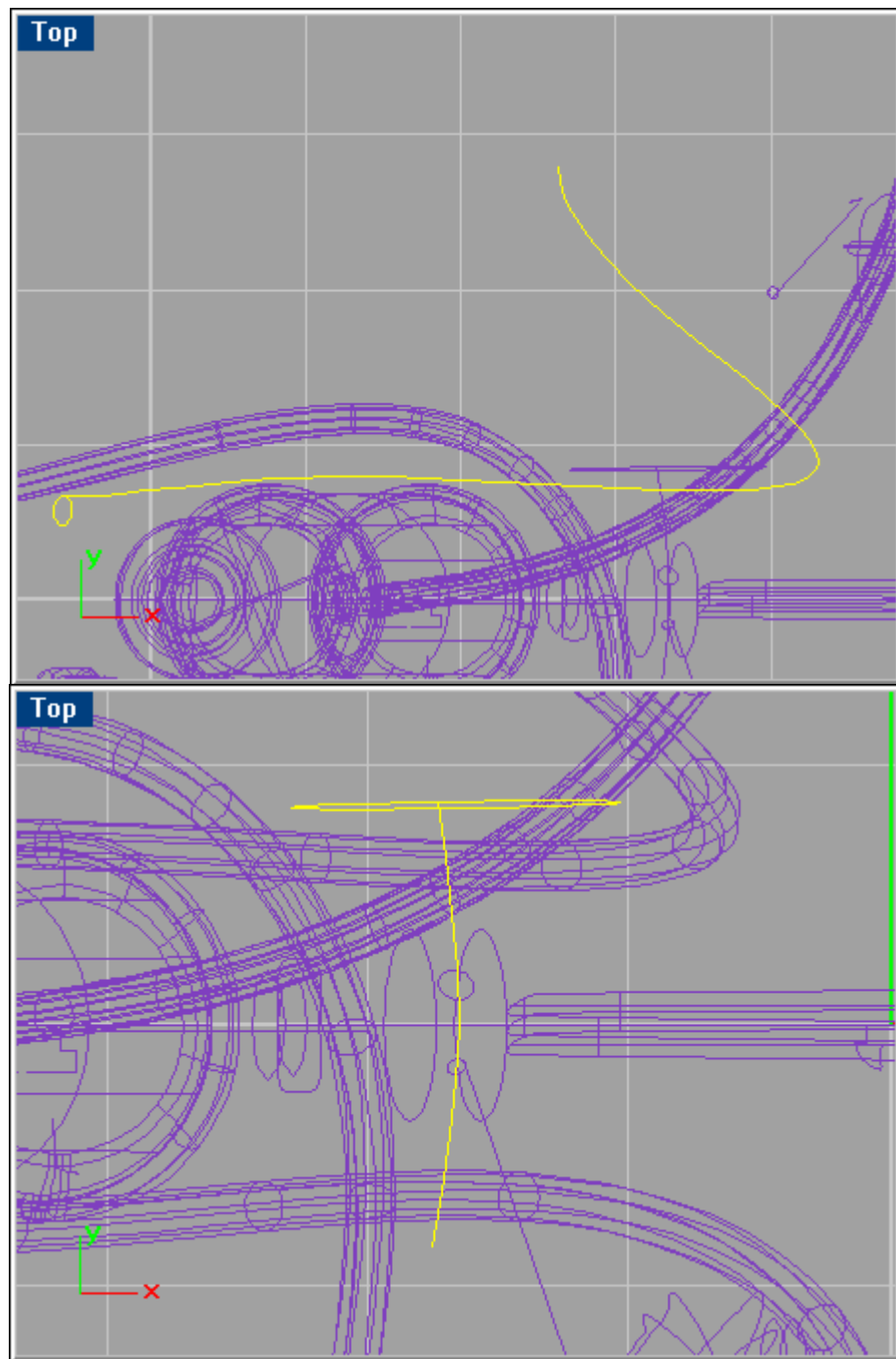


Revolve the curves shown in the two figures below.



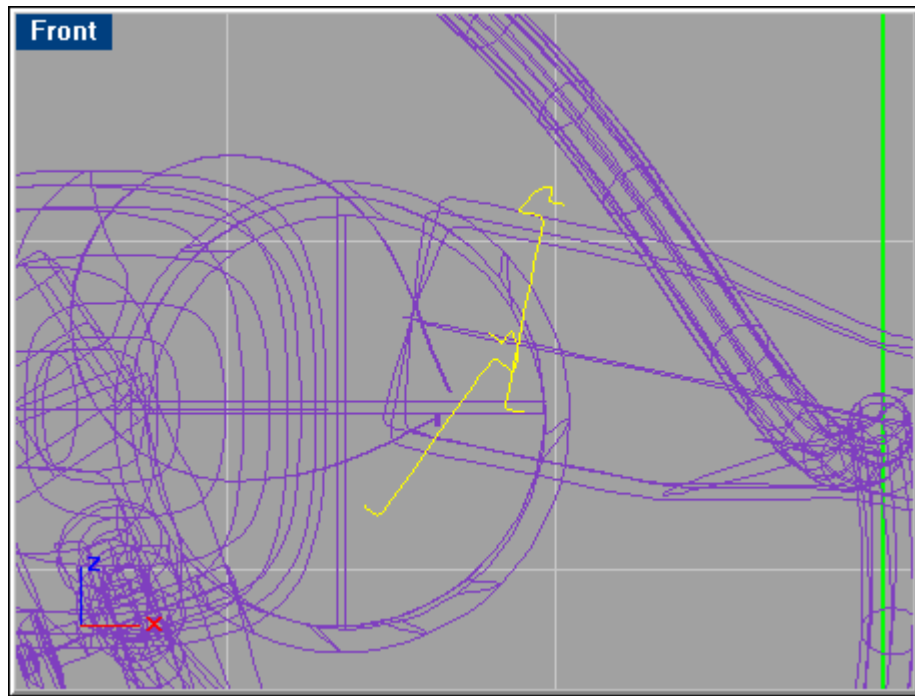
In the later curve, also use the Object Snap 'Center' and snap to the center of the closeby surface.

Make a 'Sweep 1 Rail' with the curves shown in the two figures below.

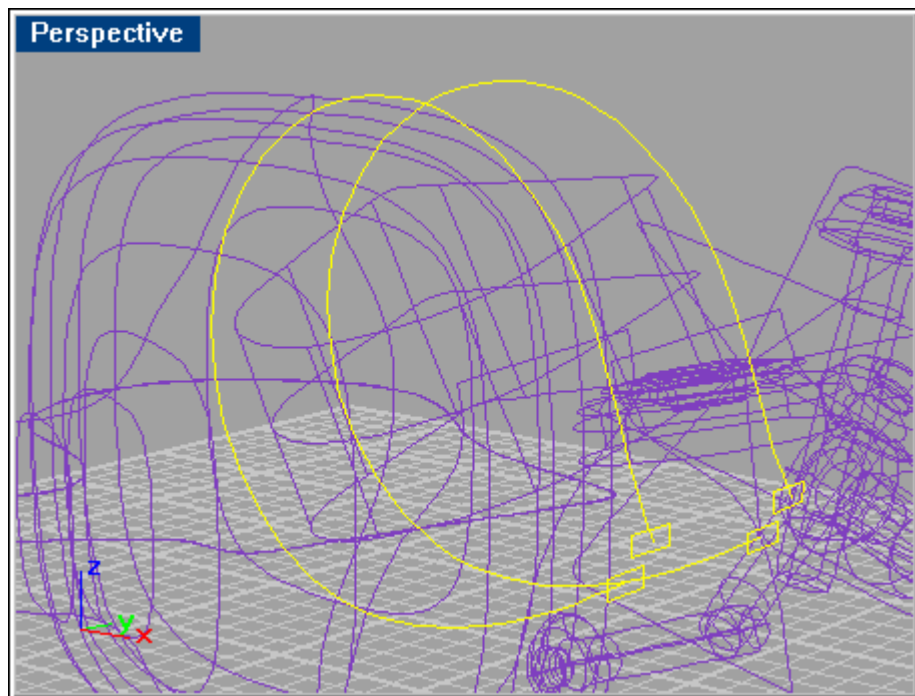


Cap the resulting surface.

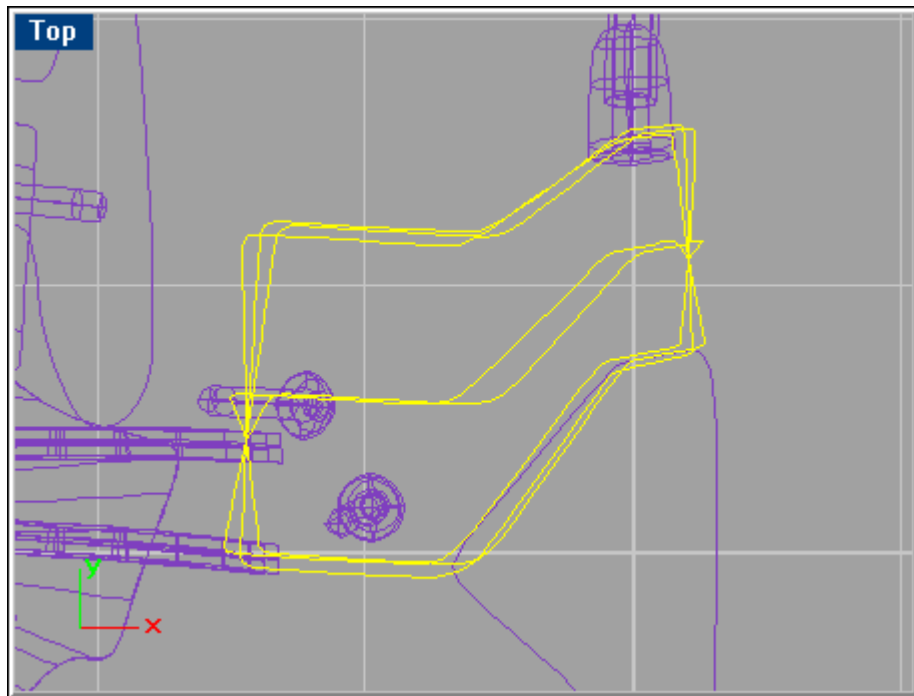
Revolve the screw curves shown below.



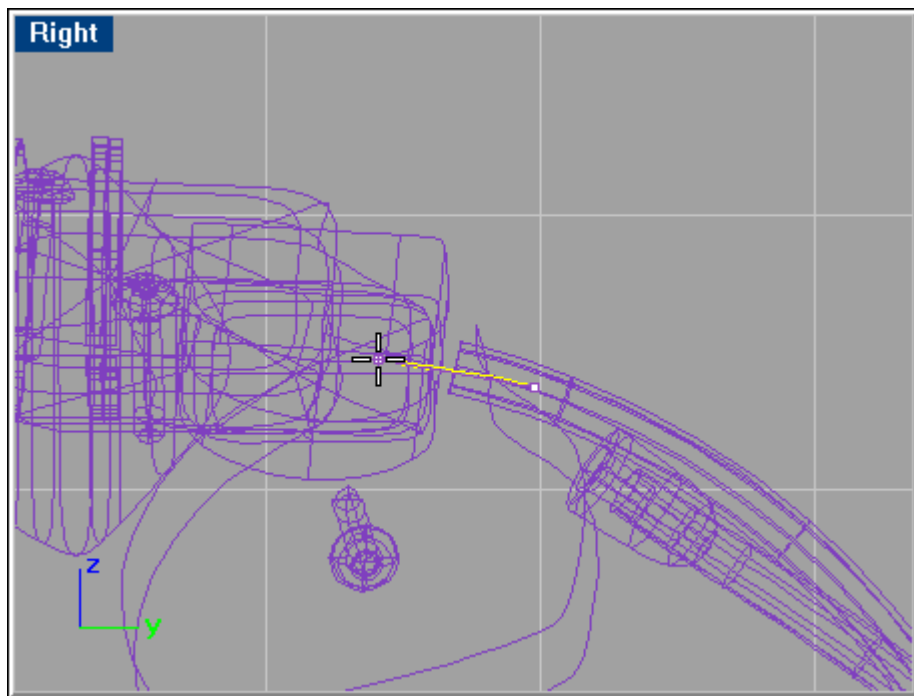
Do a 'Sweep 1 Rail' on both pair of curves shown below, and cap.



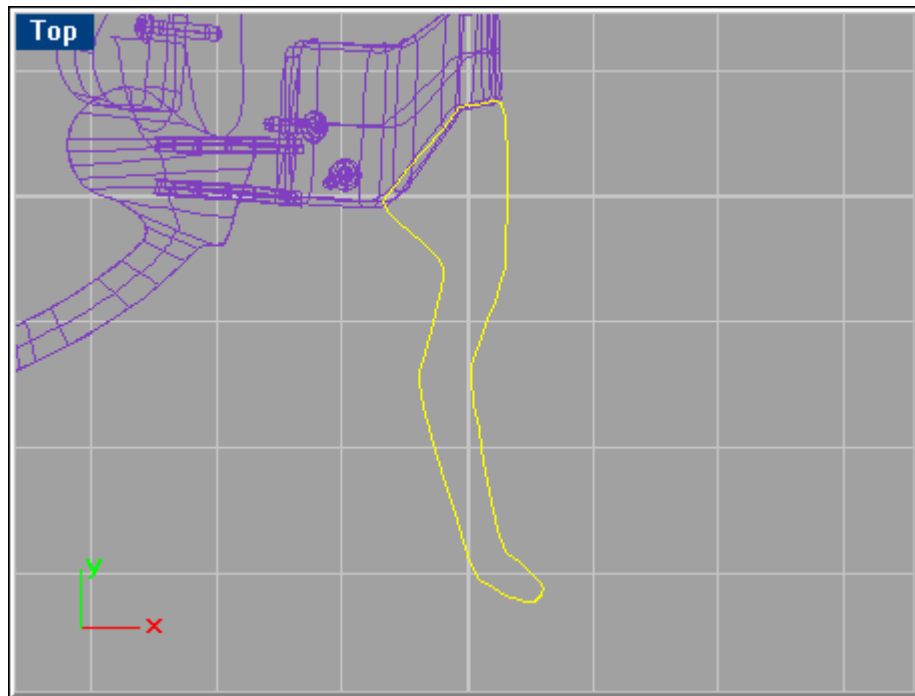
Loft the curves shown below with 'Closed' box checked and 'Tight' lofting style.



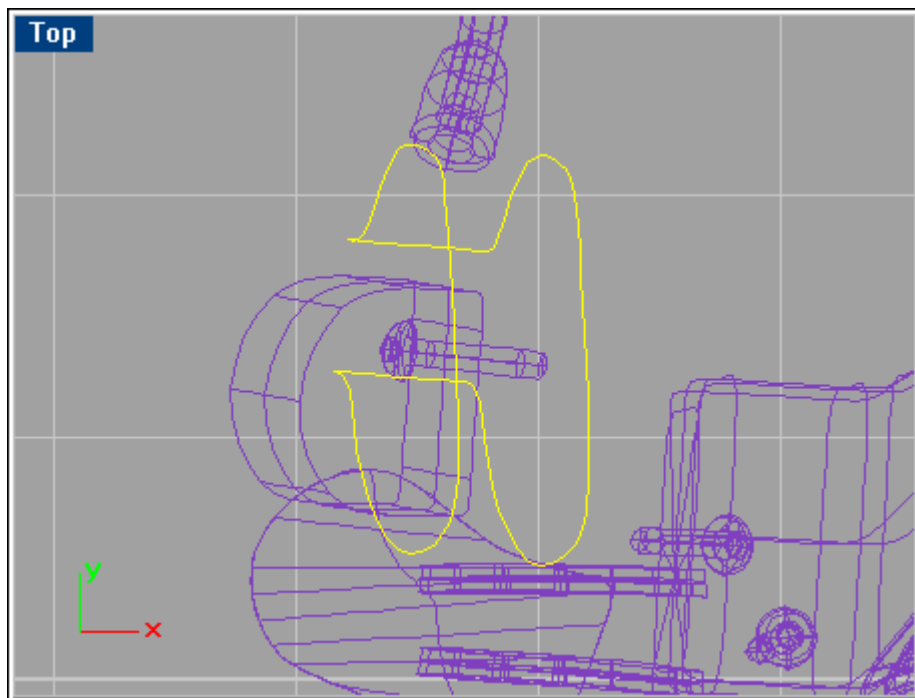
Locate the curve shown below and revolve it as shown.



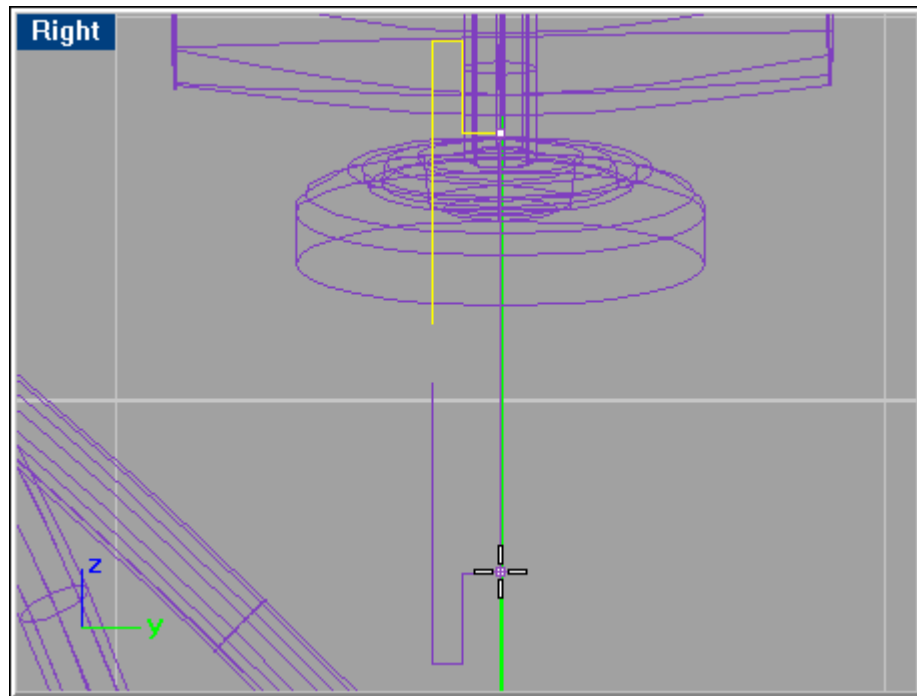
Make a 'Sweep 2 Rails' using the default options with the three curves shown below. Cap the resulting surface.



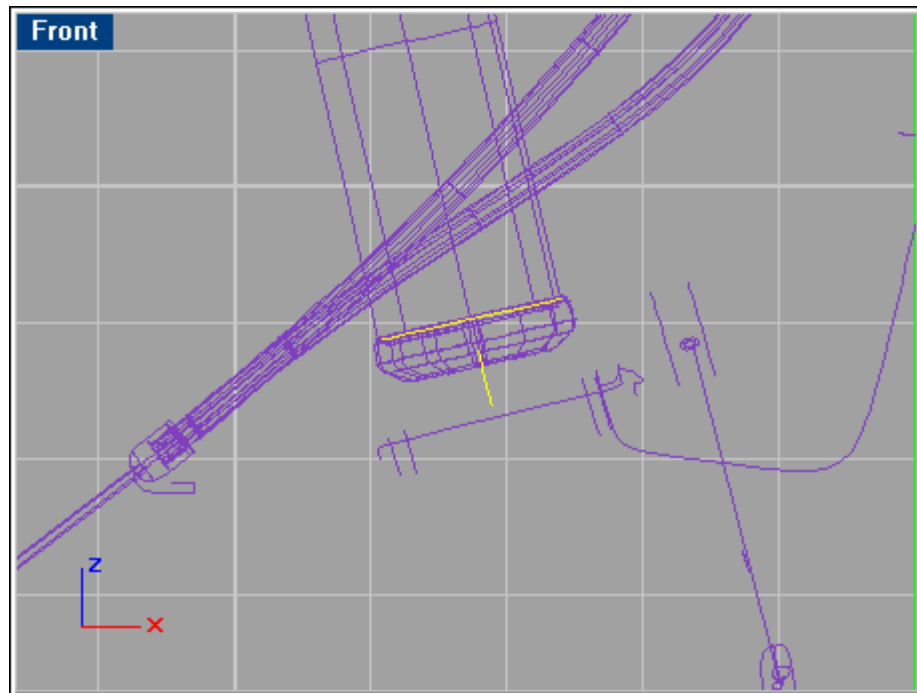
Repeat with the curves shown below.



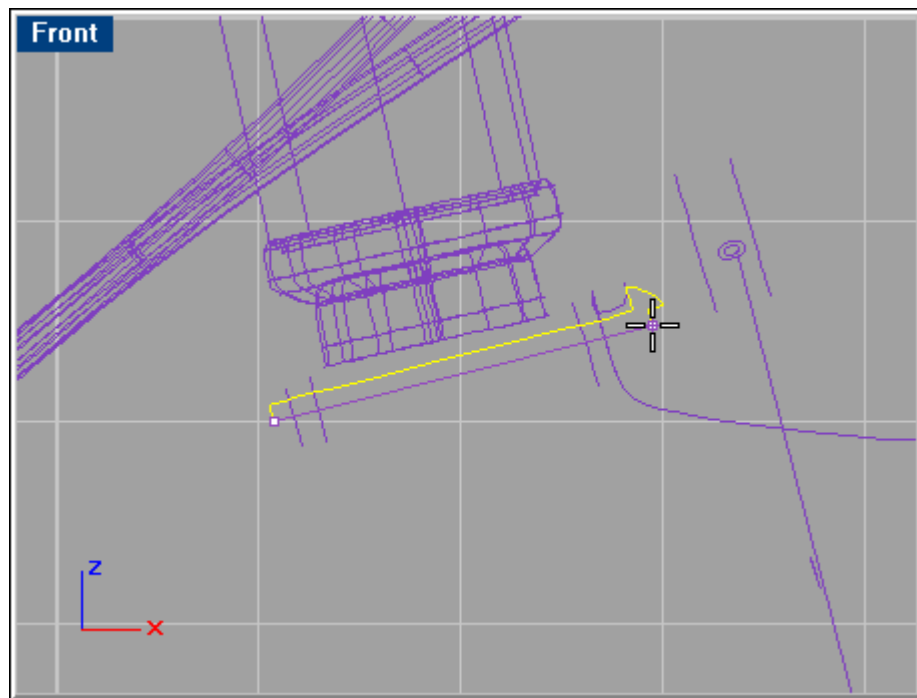
Revolve the curve shown below the way described. Repeat it with the curve beneath. Make sure the pointer snaps correctly.



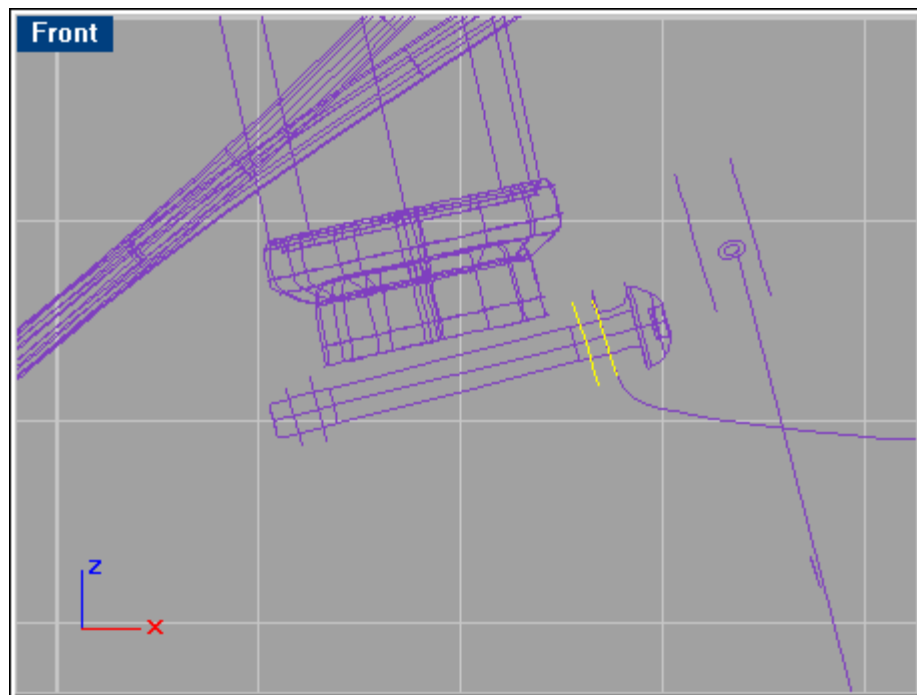
Select the curves shown below and make a 'Sweep 1 Rail'. As you can see the path curve is one already used in a previous step.



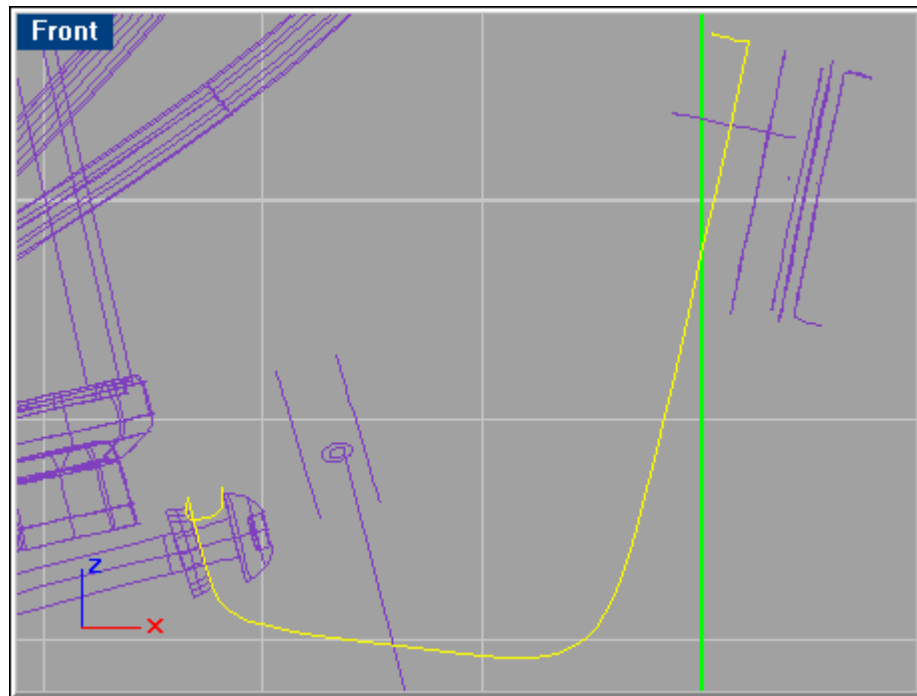
Revolve the screw curve shown below.



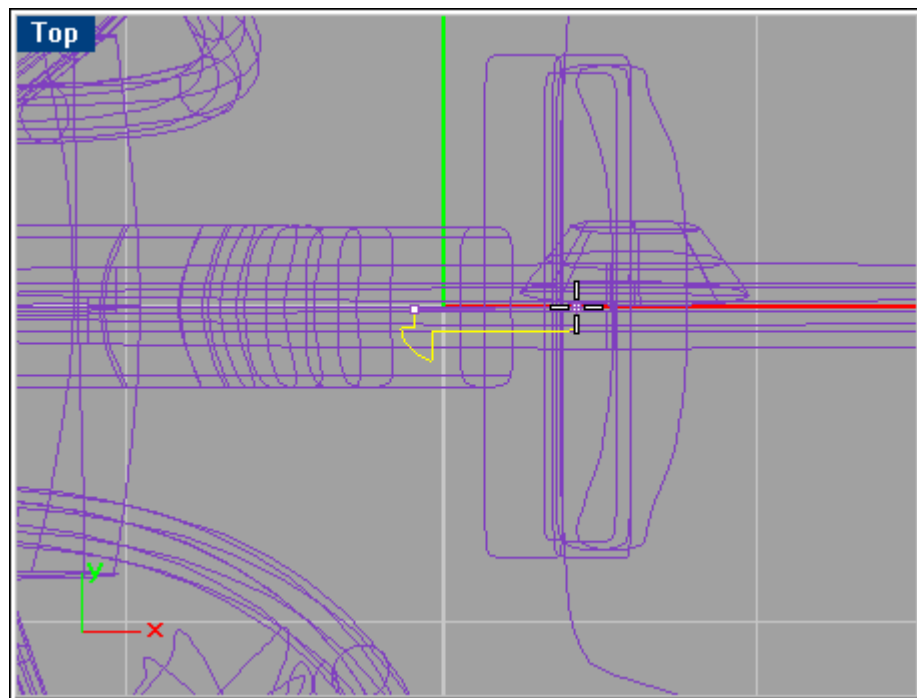
Loft the curves shown below and cap and join the resulting surface. Do the same with the pair of curves in the end of the screw.



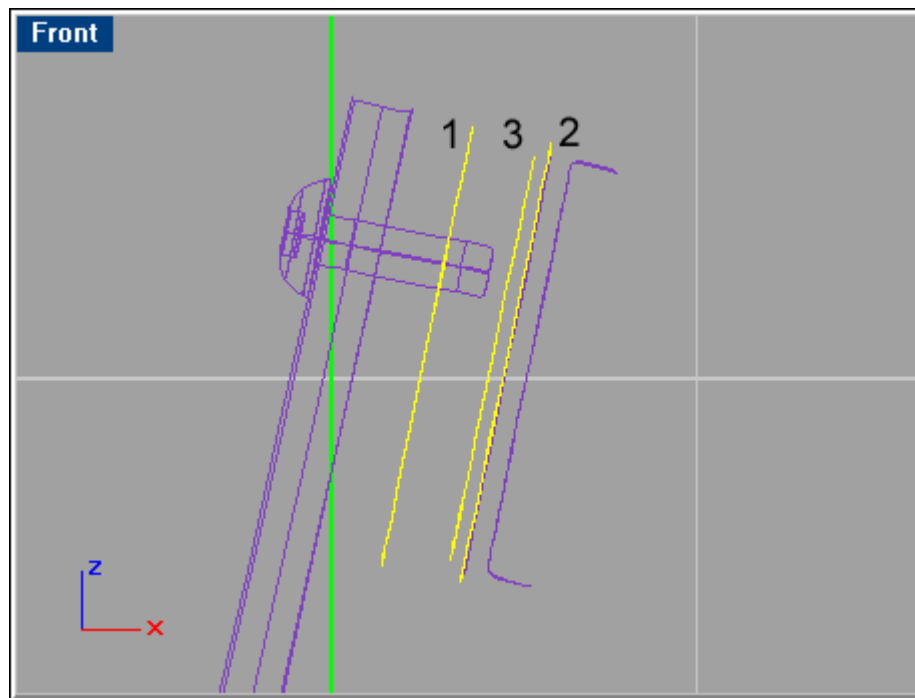
Make a 'Sweep 1 Rail' from the curves shown below.



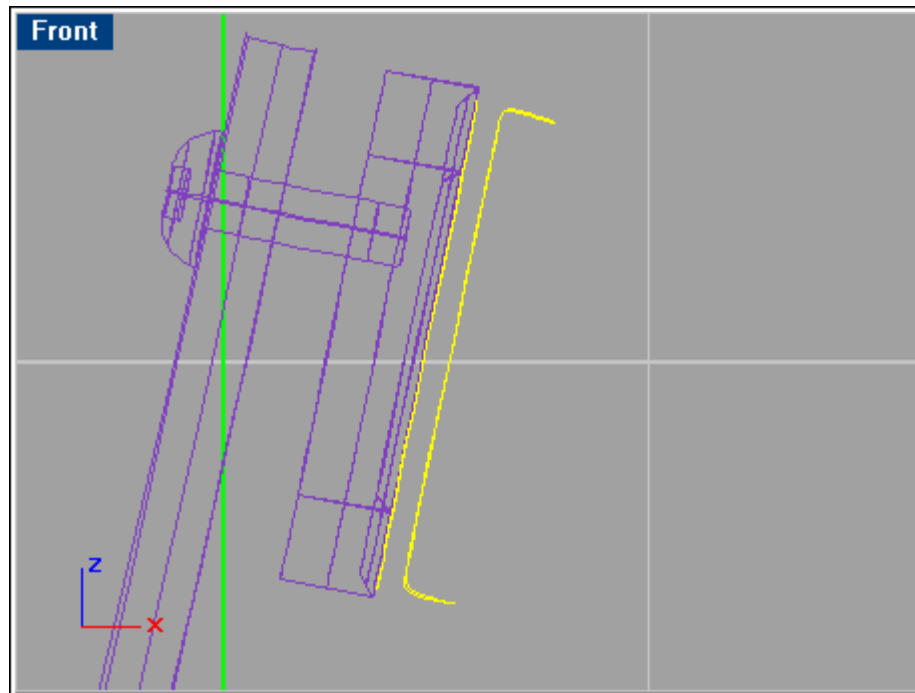
Revolve the screw curve shown below.



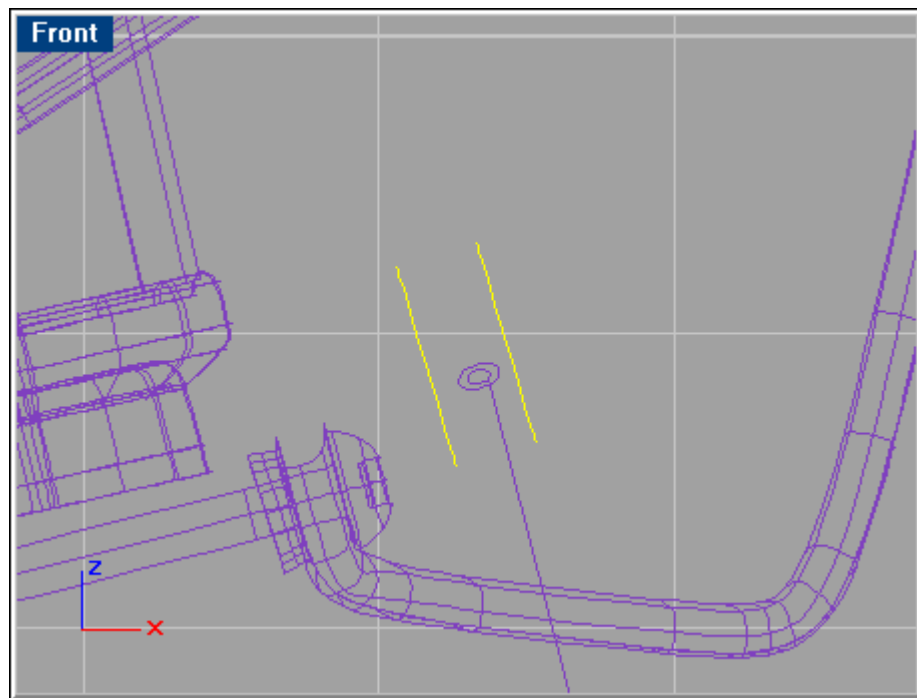
Loft the curves shown below in the order described. Hit A for automatic before Enter. Use 'Straight sections' for lofting style.



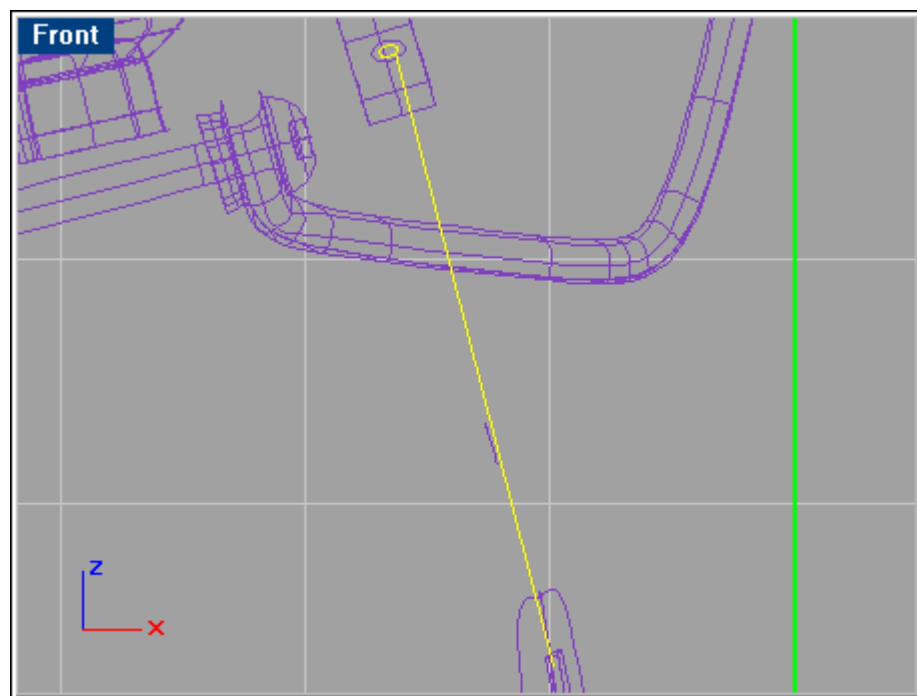
Loft the curves shown below with default options. When done, select the right curve and patch it with 1 span in each direction. Join the lofted surface with the patch surface.

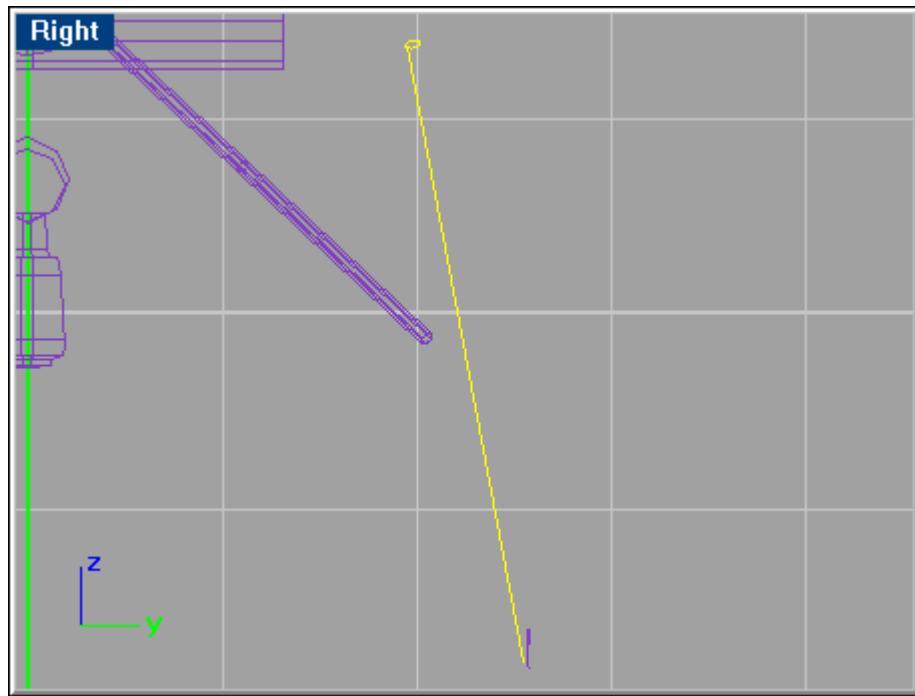


Loft the curves shown below and cap the resulting surface.

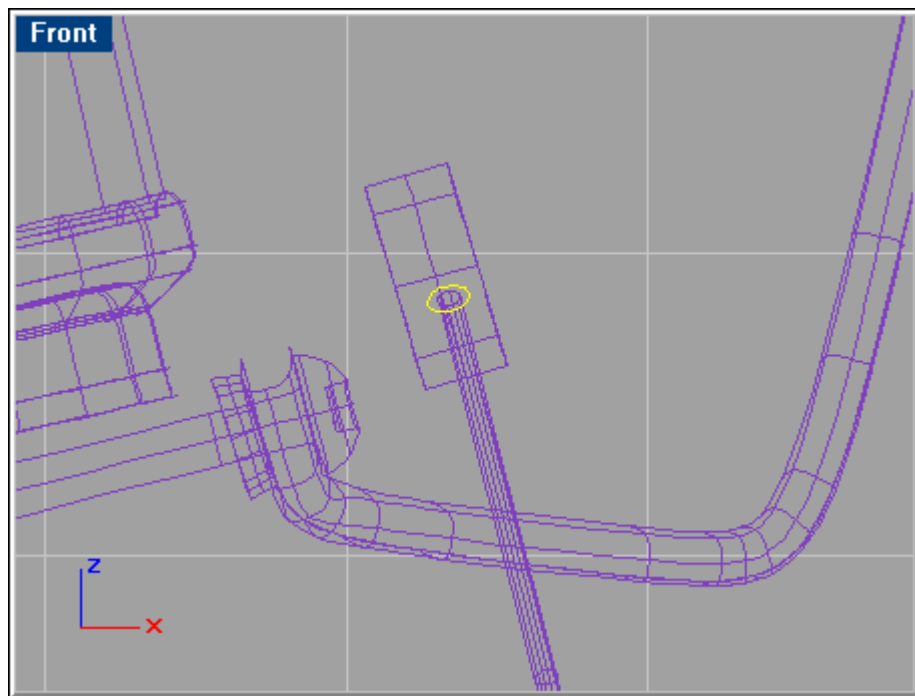


Make a 'Sweep 1 Rail' with the curves in the two figures below.

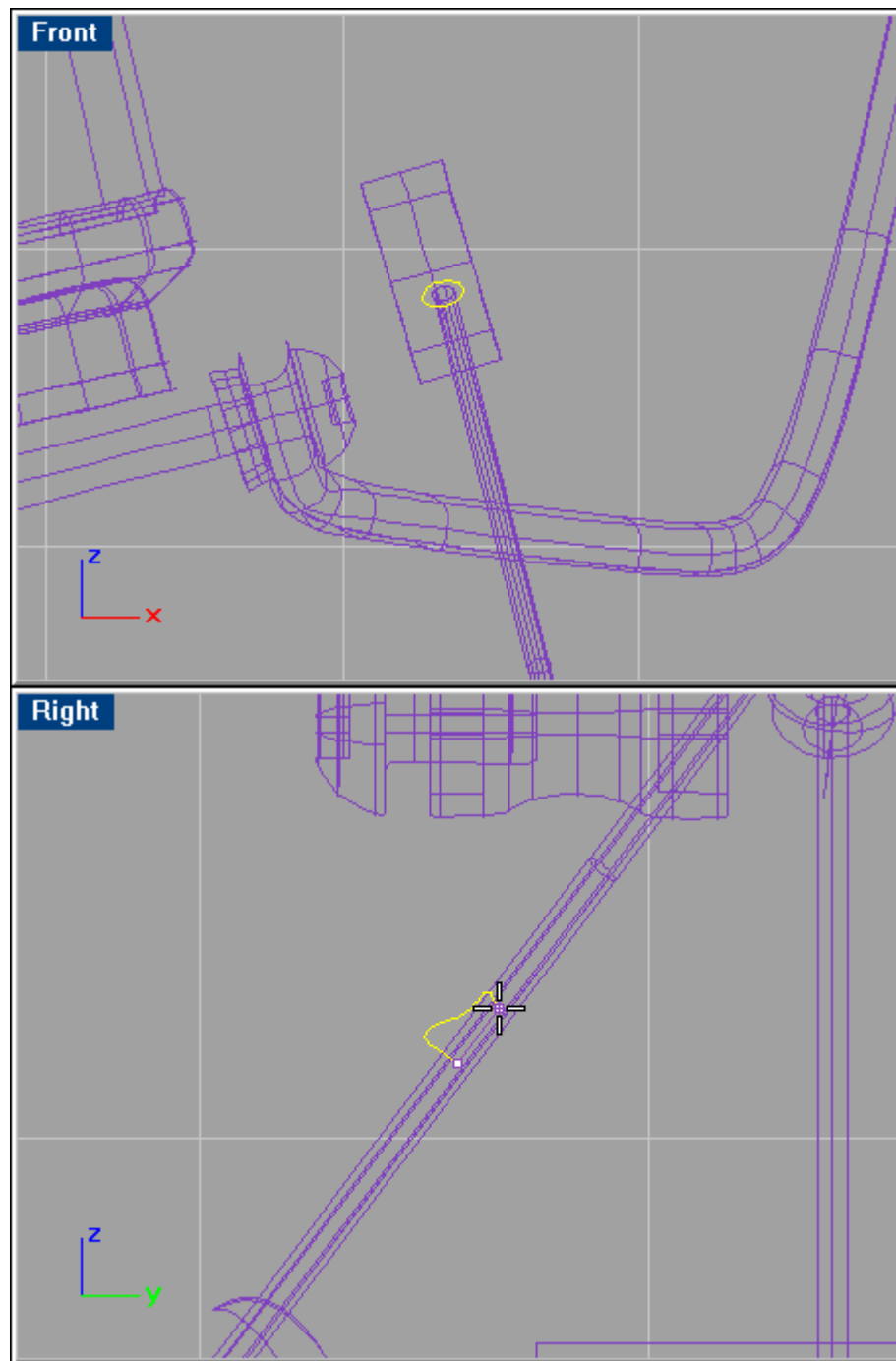




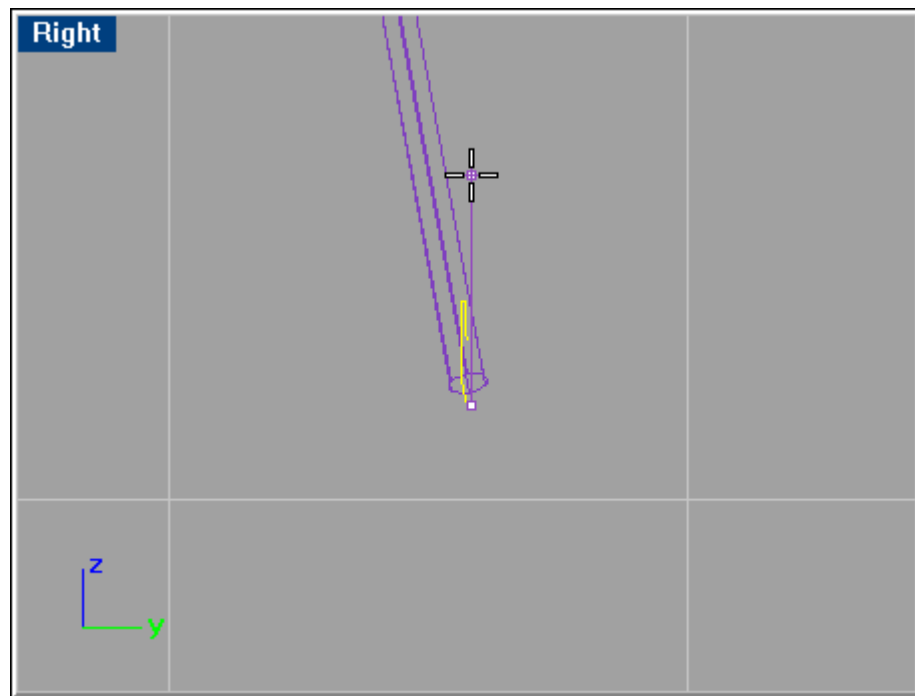
Select the curve shown below and go 'Surface/Extrude/Straight'. Enter a value of 3.2.



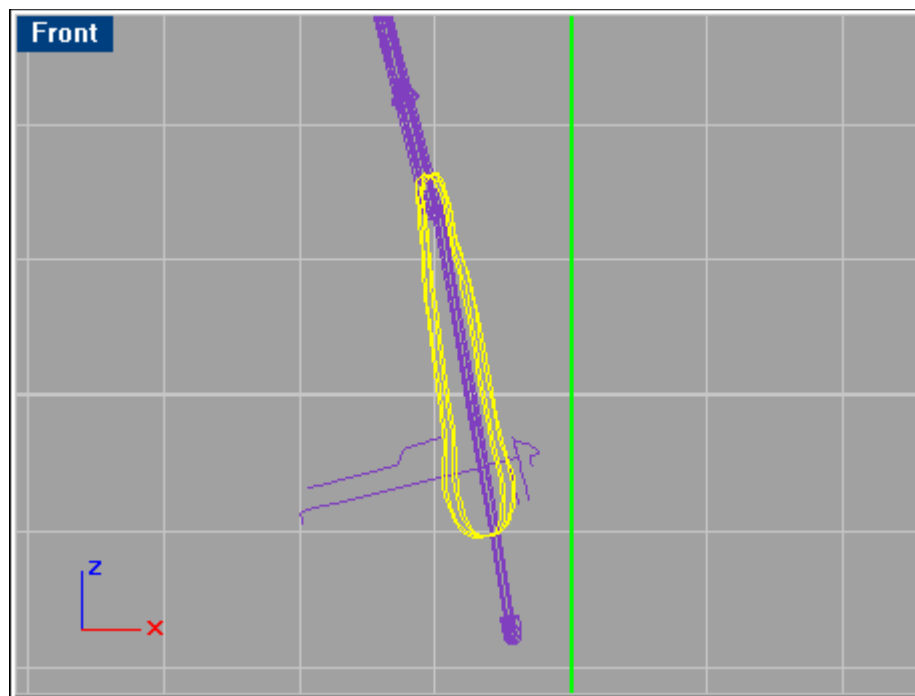
Revolve the curve shown in the two figures below.



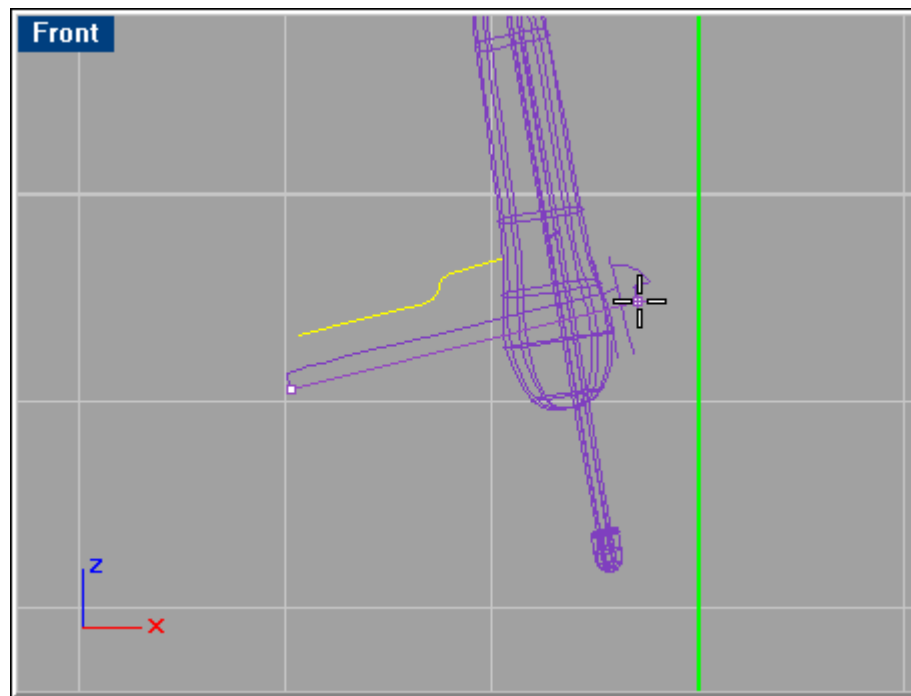
Rotate the resulting surface from the curve below so it fits around the nearby pipe.



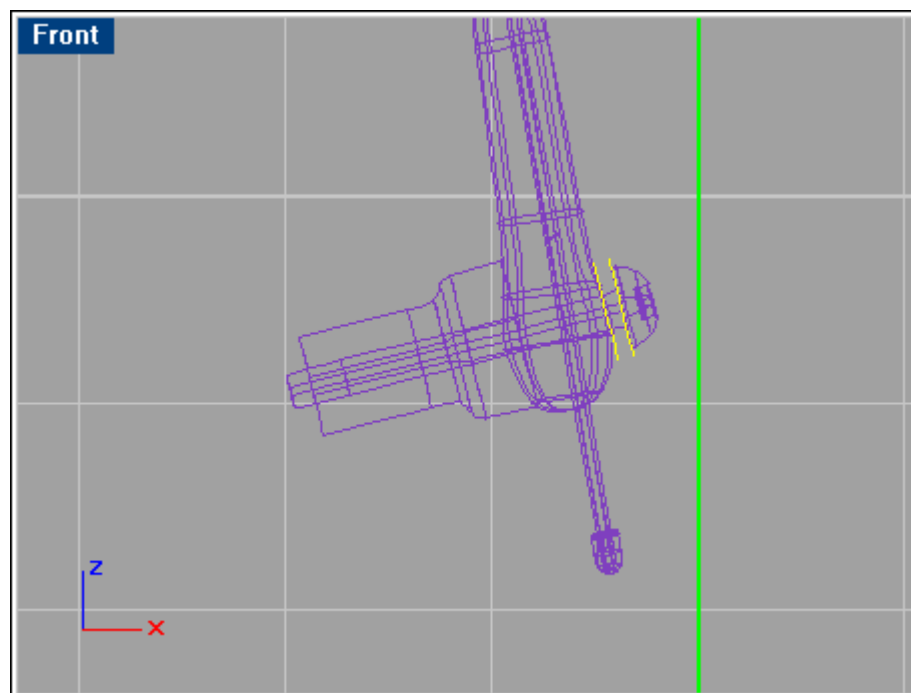
Loft the curves shown below.



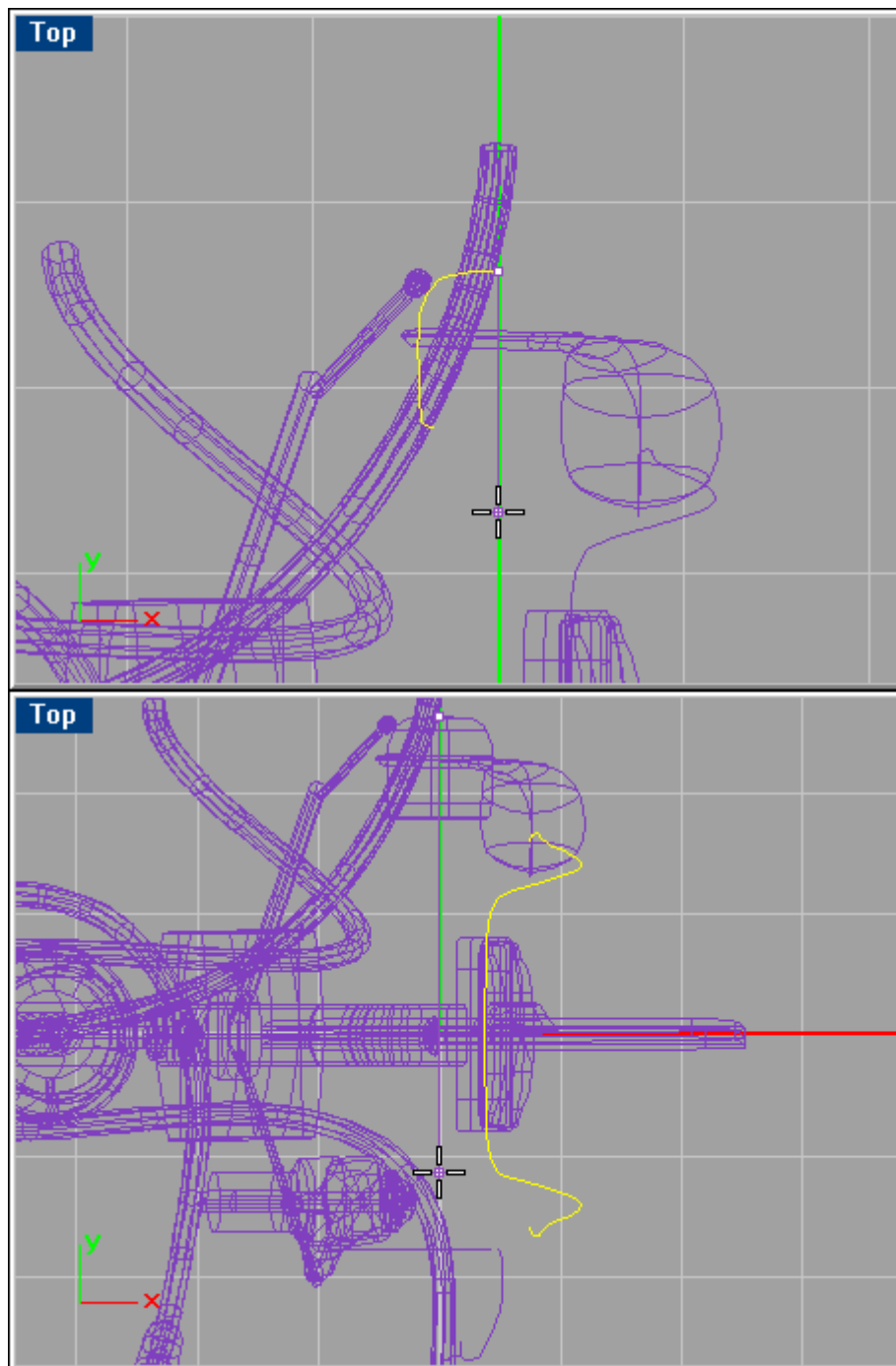
Revolve the curve shown below, as well as the screw curve you used as a reference point.



Loft the curves shown in below and cap the resulting surface.

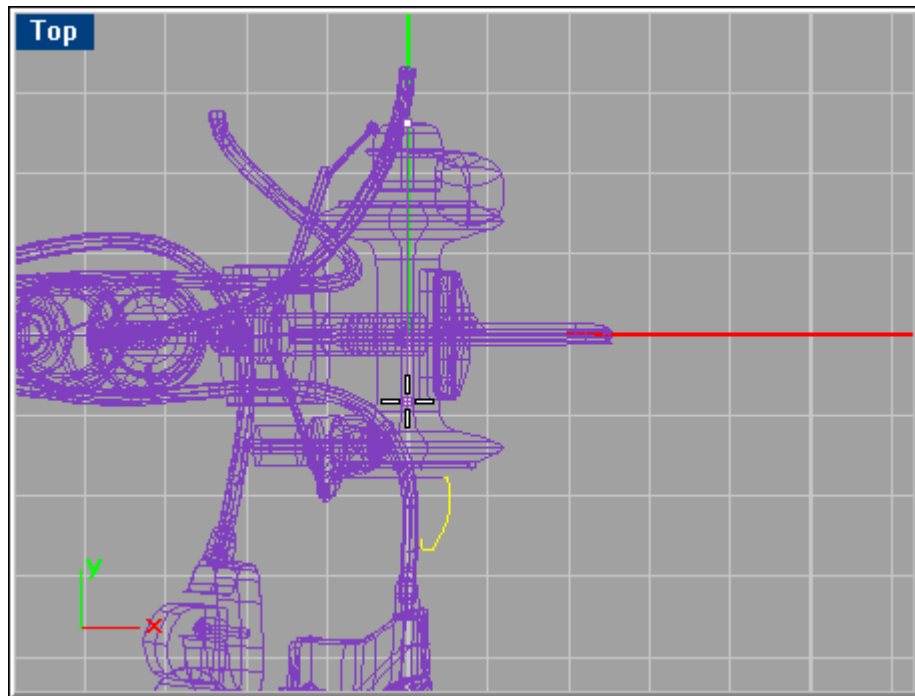


Revolve the curve shown in the figures below.

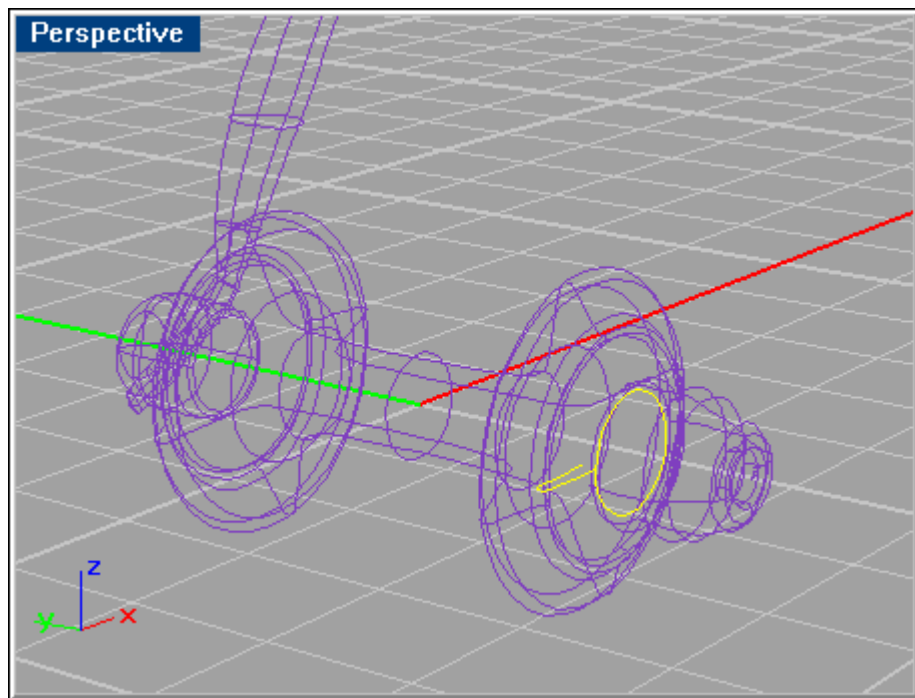


For the curve from the right, make the pointer snap to the end of the revolved surface from the curve on the left.

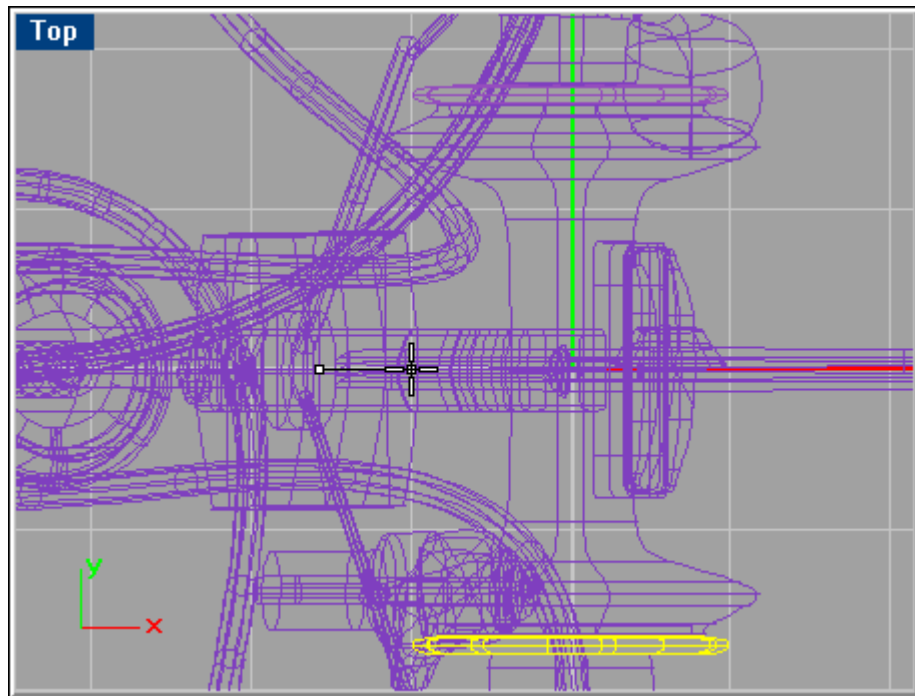
Do the same thing for the curve shown below:



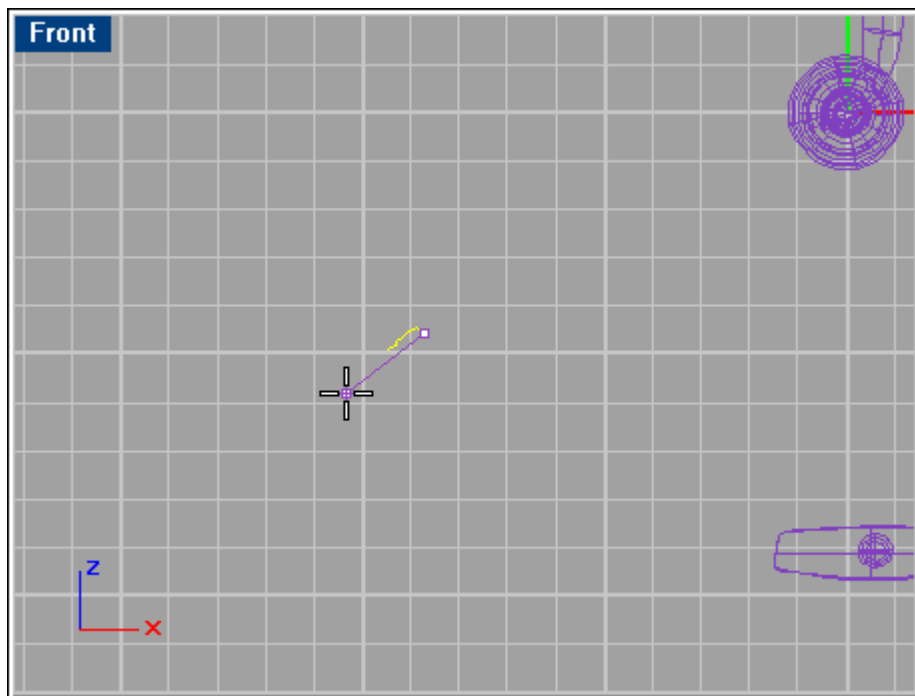
Make a 'Sweep 1 Rail' for the curves shown in below.



Mirror the resulting surface to the other side using Object Snap 'Cen' as described below:

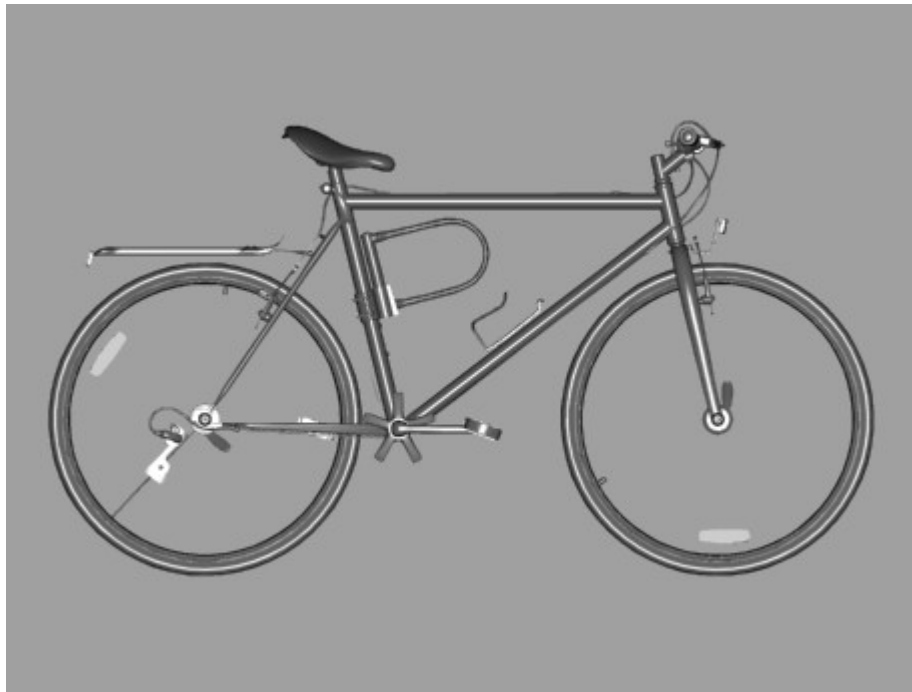


Revolve the curve shown below:

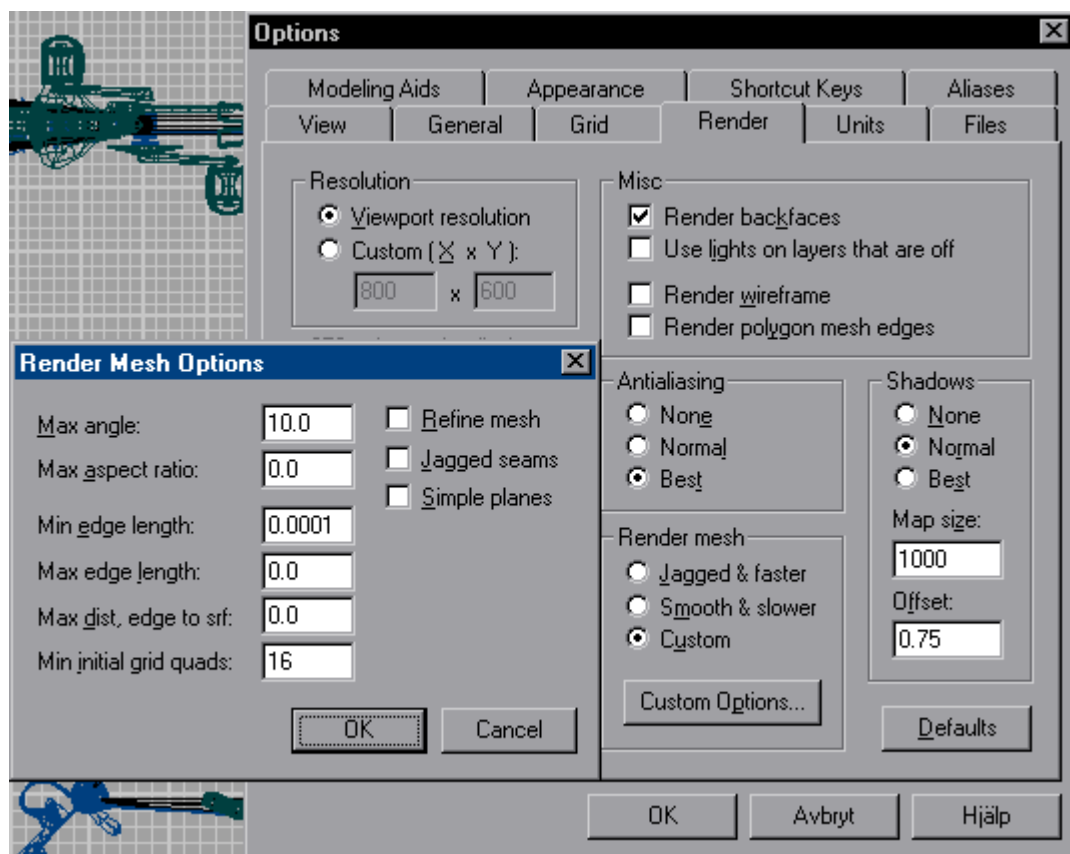


Select all the surfaces and Polysurfaces created from the curves in the current layer, and create a new layer called 'Details-2' and move these into that layer.

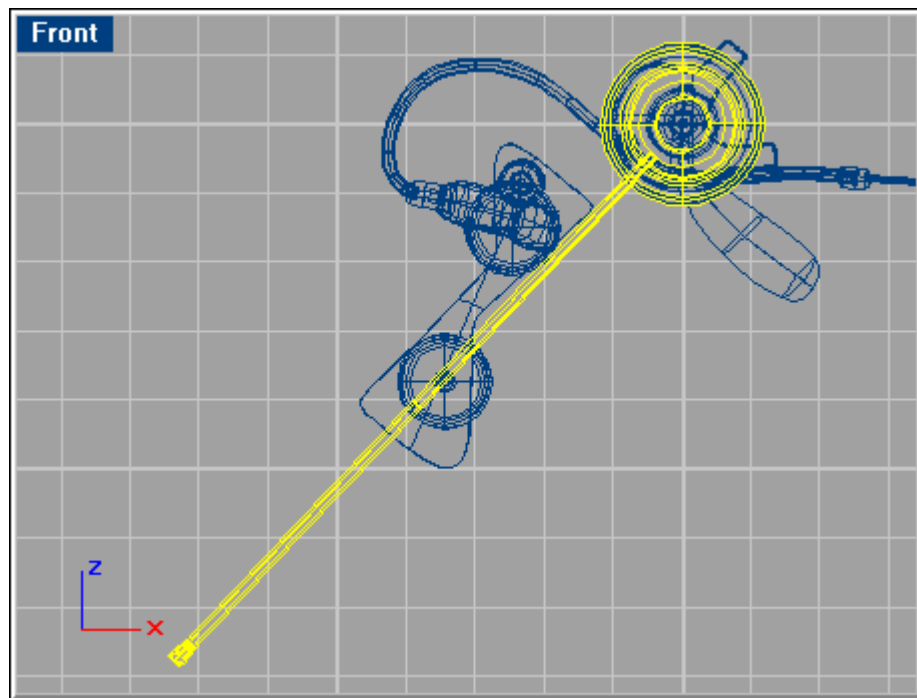
Be sure to save your work. Your current state in the modeling progress should look like the sample file 'Bike3.3dm' from the CD-ROM (turn on all of the layers containing surfaces.) Also, before rendering all of these surfaces at once you should go 'Render/Options', and choose 'Custom' in the 'Render mesh' area.



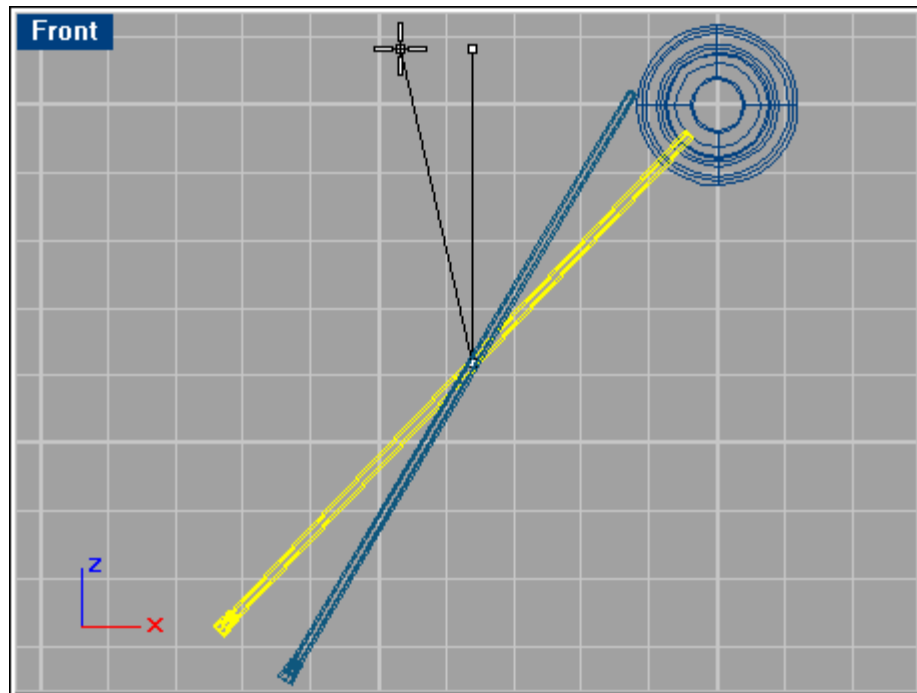
Use the settings shown below, which gives a pretty low polygon amount while having a decent smoothness. When doing renders with only a small number of objects, the preset 'Jagged & faster' works fine.



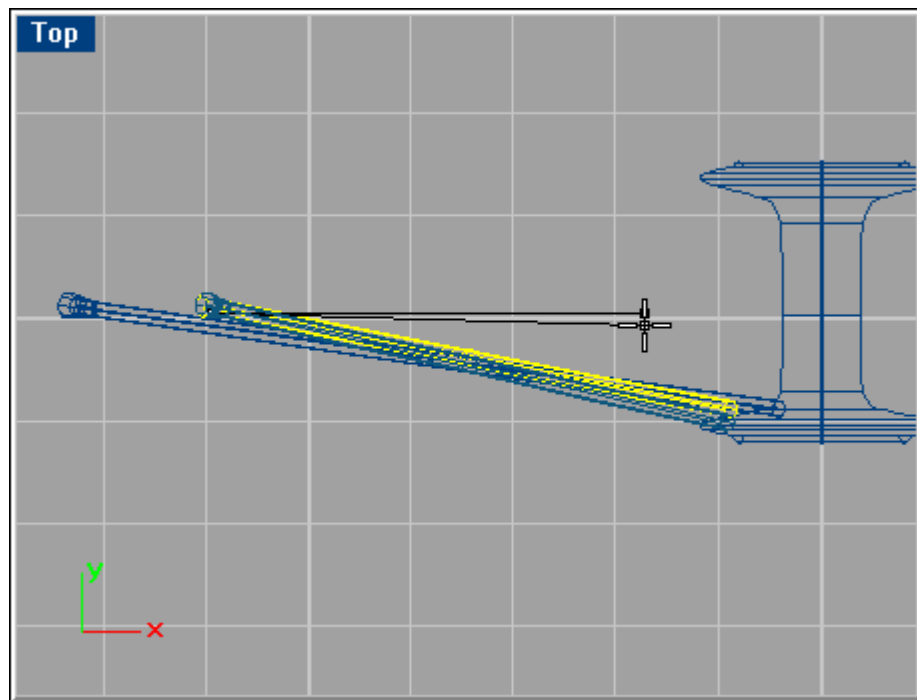
Have the 'Details-2' layer visible and the others hidden. Select the two objects (the spokes) along with the third surface seen below, then go 'Edit/Select/Invert'. Hide the selected objects ('Edit/Visibility/Hide').



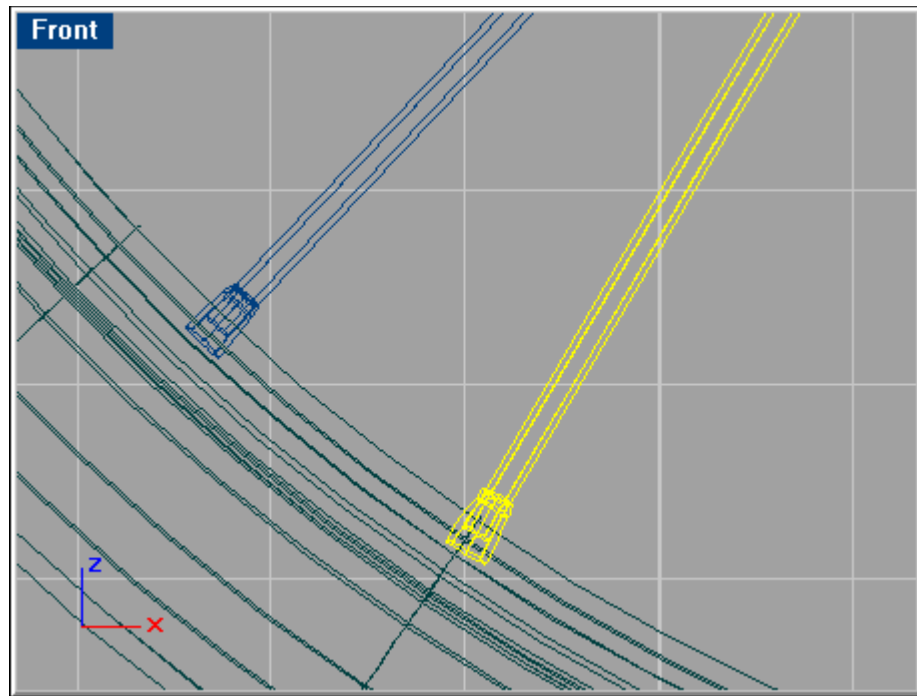
Rotate the spoke objects 13 degrees (type C + Enter for copy, and 13 + Enter for the angle) as shown below.



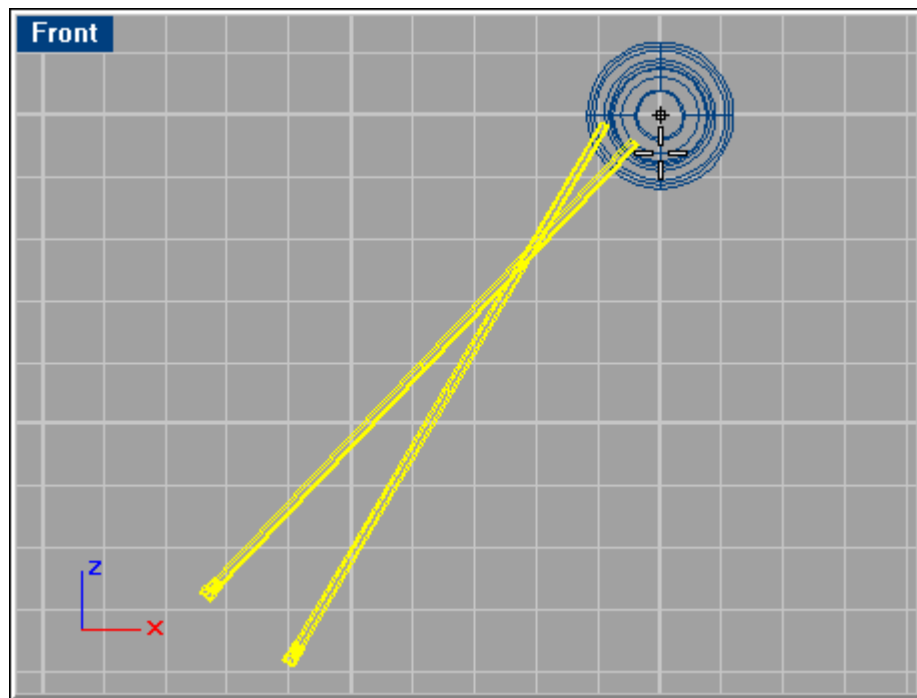
In the Top viewport, rotate the spoke objects selected below by -1.5 degrees.



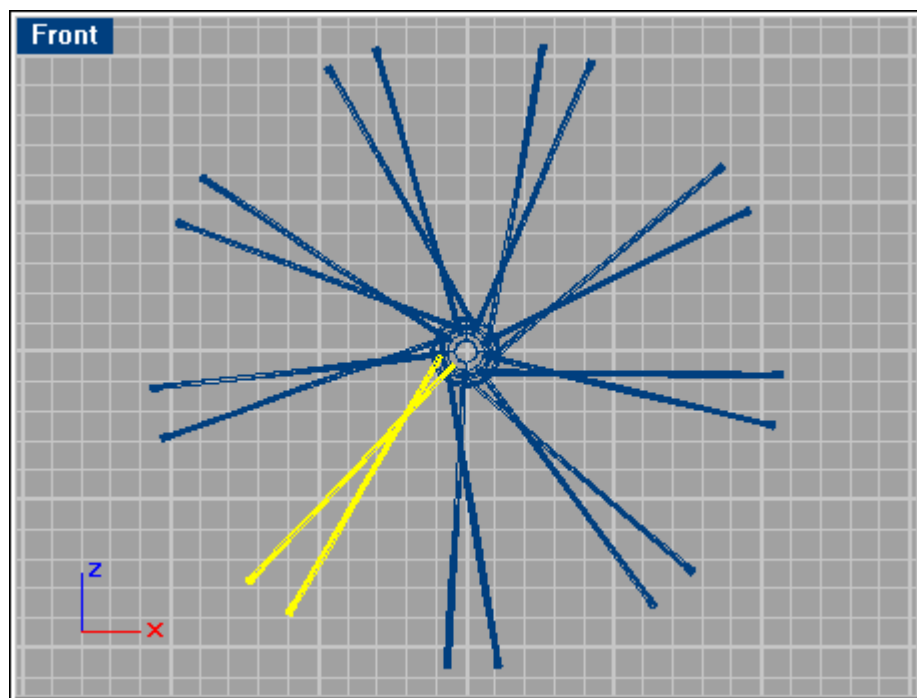
Make the 'Details-1' layer visible so you can move the rotated spoke objects to a position similar to the first spoke in relation to the wheel (below). Then hide the layer again.



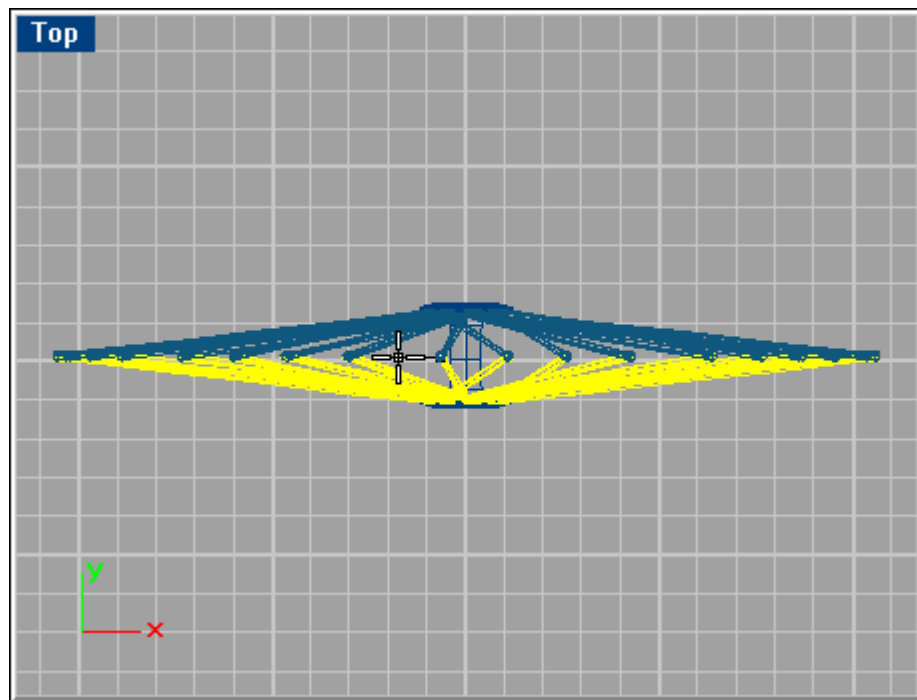
Select the four spoke objects and go 'Transform/Array/Polar' and while using the Object Snap 'Cen', make the pointer snap to the center of the surface shown below.



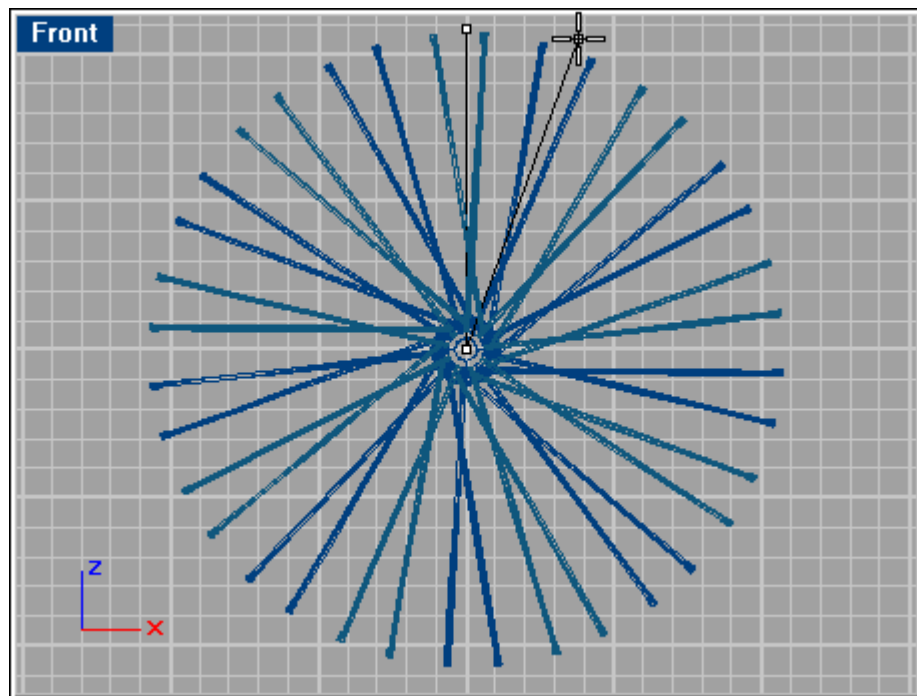
Set the number of spokes to 9, and because the default degree is 360, just hit Enter.



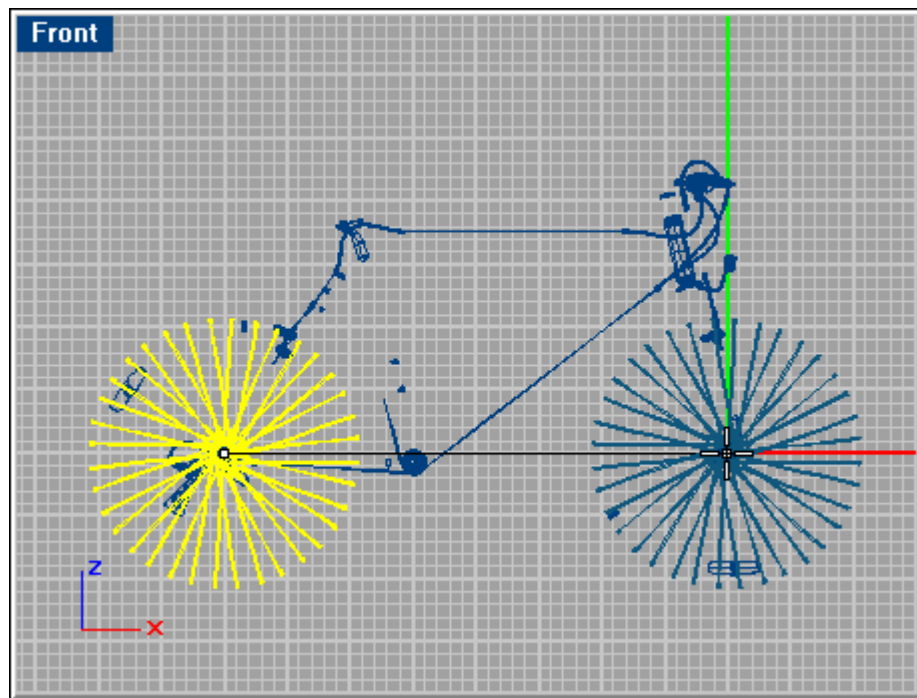
In the Top viewport, select all of the spoke objects and mirror them using Object Snap 'Cen'.



In the Front viewport, rotate the curves already selected -20 degrees.

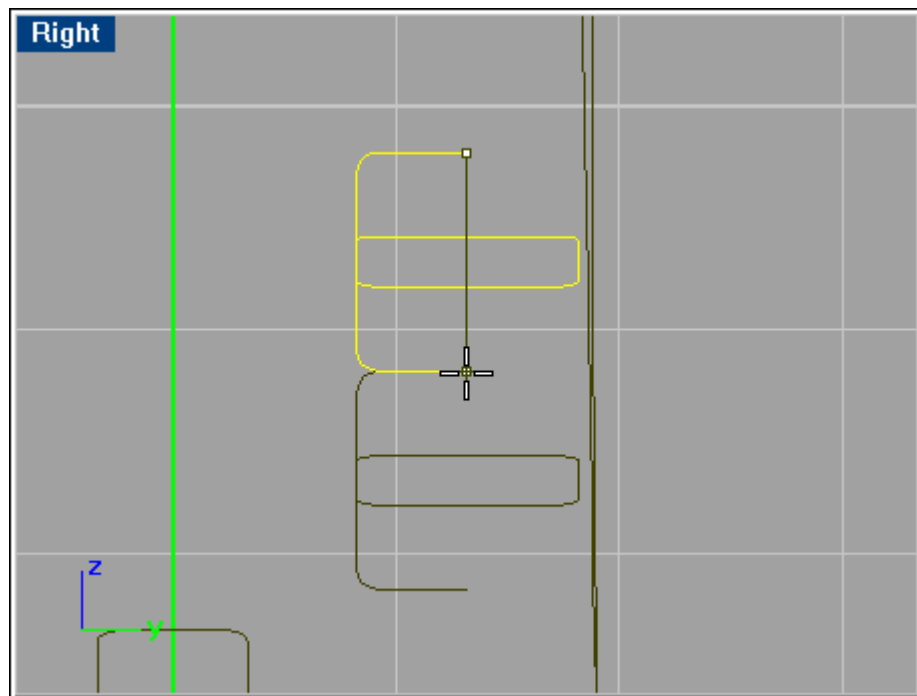


Select all of the spoke objects, have the hidden objects shown again, and snap the copied spokes to the surface shown below.

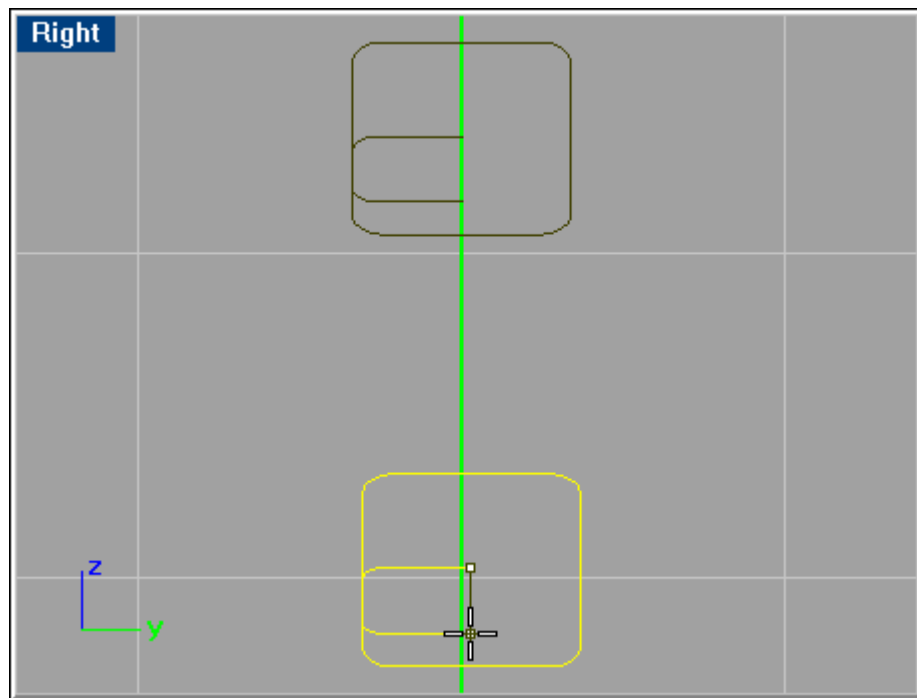


Import the file 'Curves4.3dm' from the CD-ROM. The curves are already in a new layer called 'Curves-4'. Notice a second layer called 'Curves-5', which contains curves you will create surfaces from later on. Make the 'Curves-4' layer the only one visible.

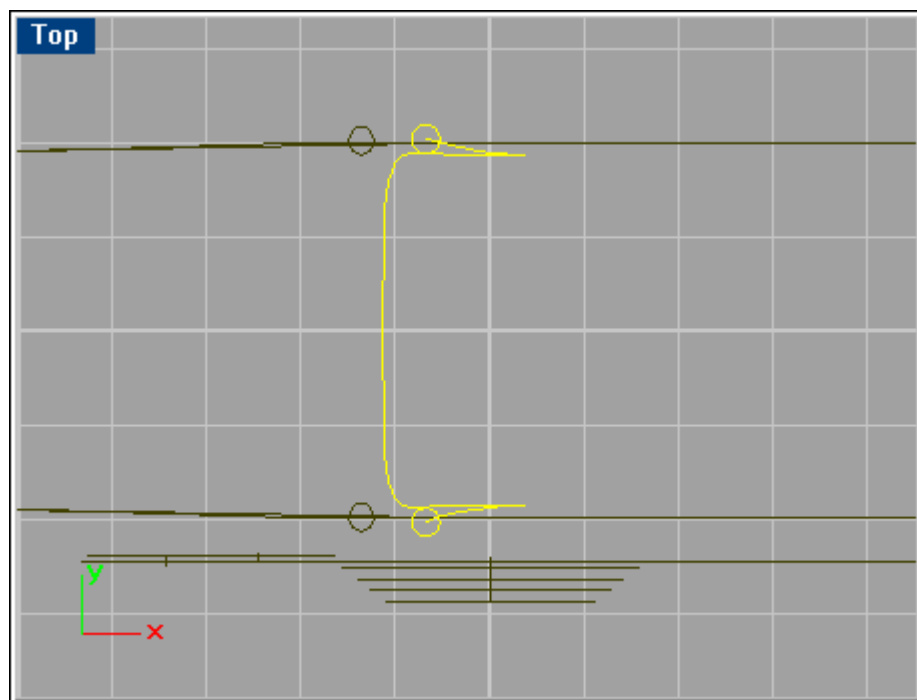
Make a 'Rail Revolve' with the curves shown below, and repeat this with the curves below.



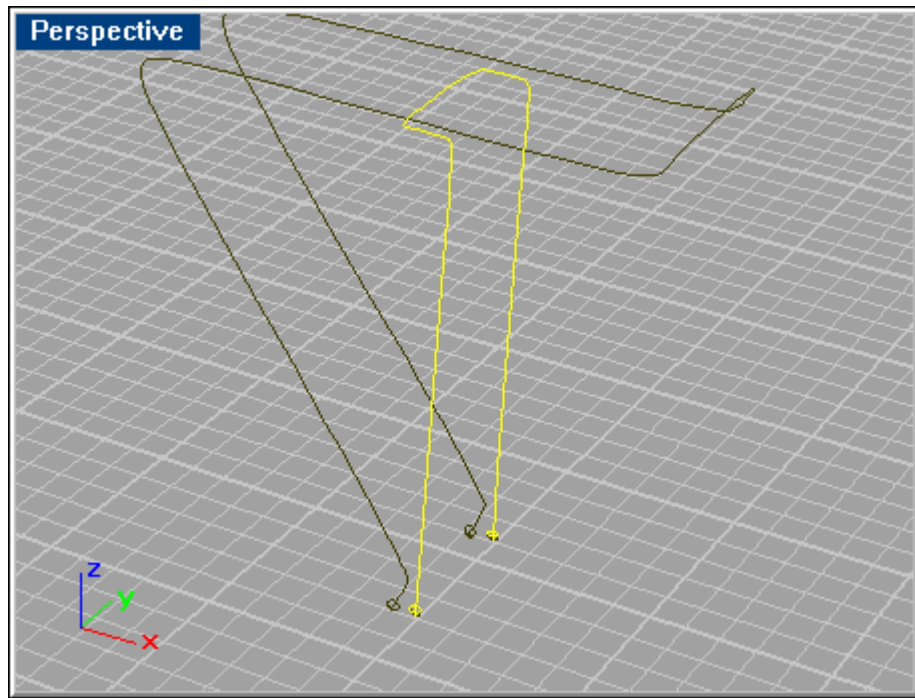
Do this with the curves shown here as well:



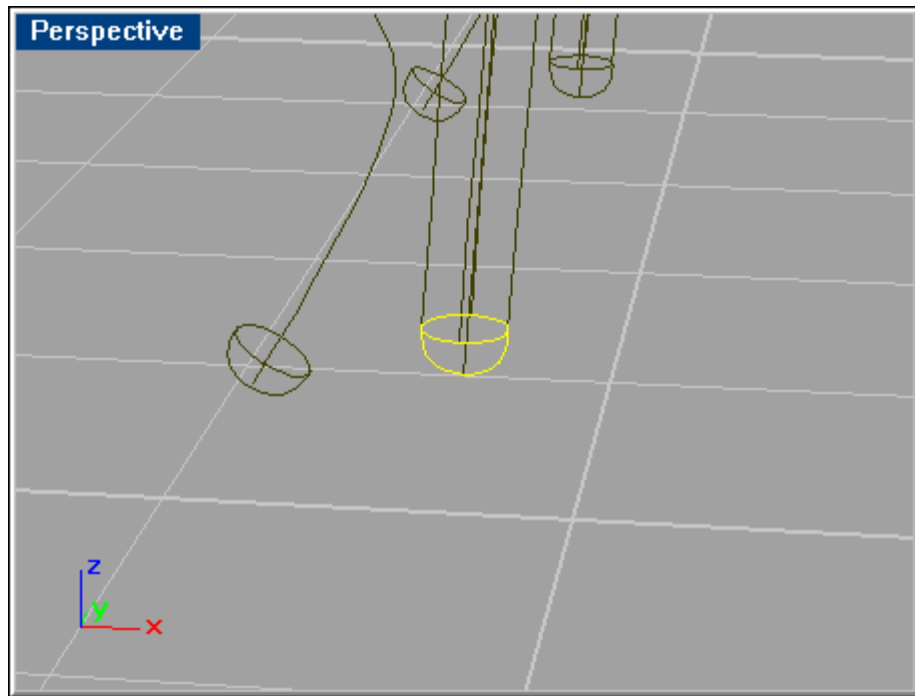
Do a 'Sweep 1 Rail' with the curves shown below.



Repeat this with the curves shown below. (The other curves are hidden for better visibility).



Repeat again, with the curves selected below. Do the same with the three curves in the other end. Then join the three surfaces together.

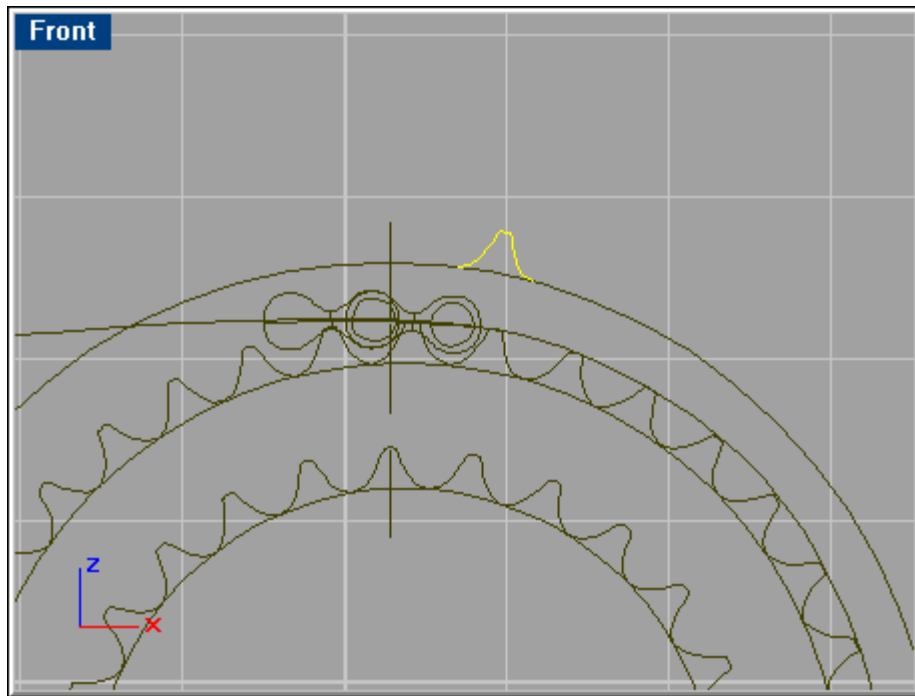


Repeat the same steps with the curves shown below.

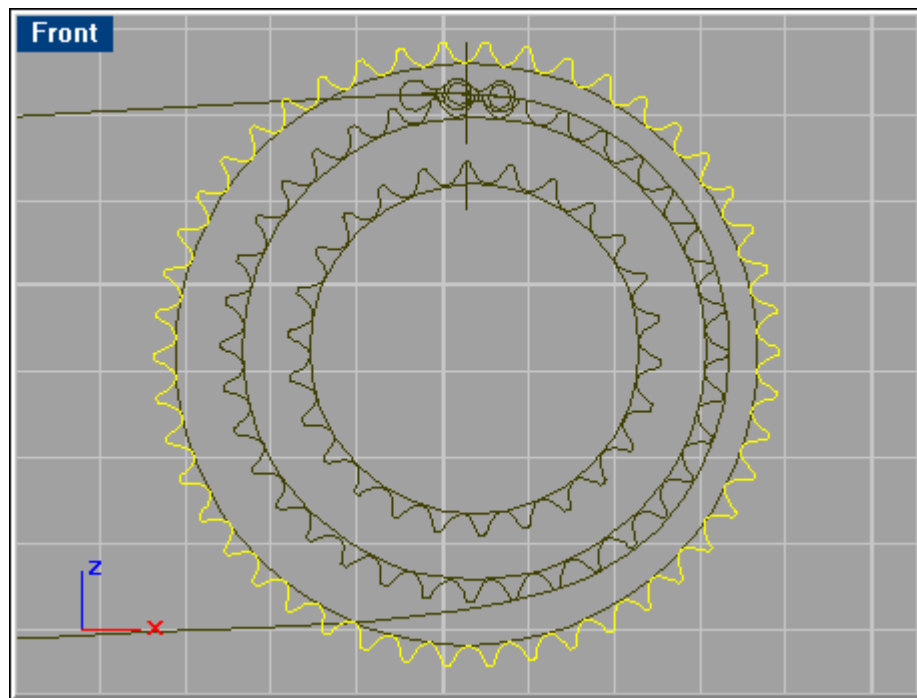


To model all of the gears, an array function will be used with existing gear curves.

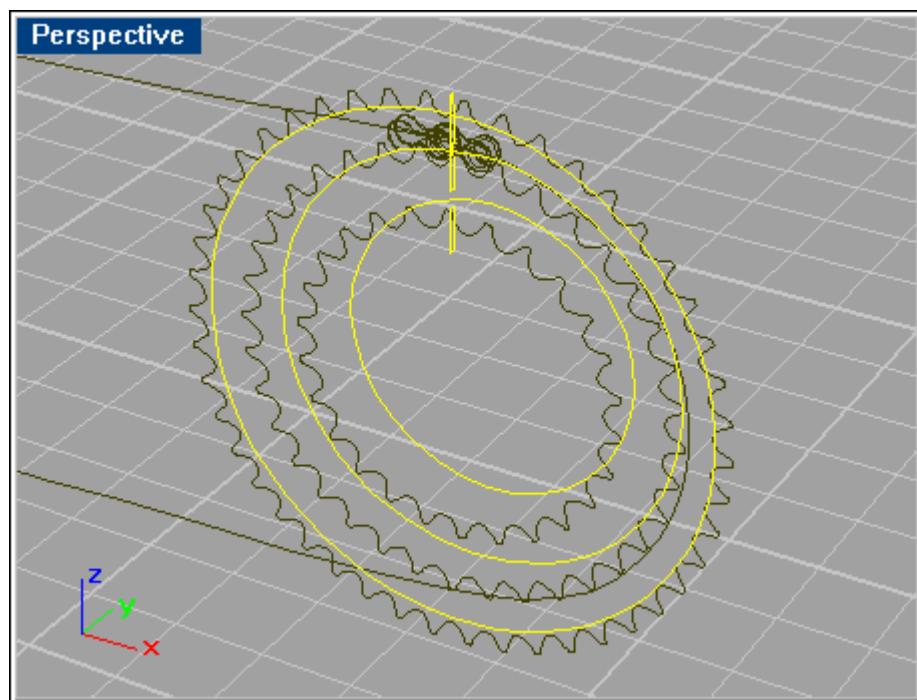
Select the curve shown below, and go 'Transform/Array/Along Curve'.



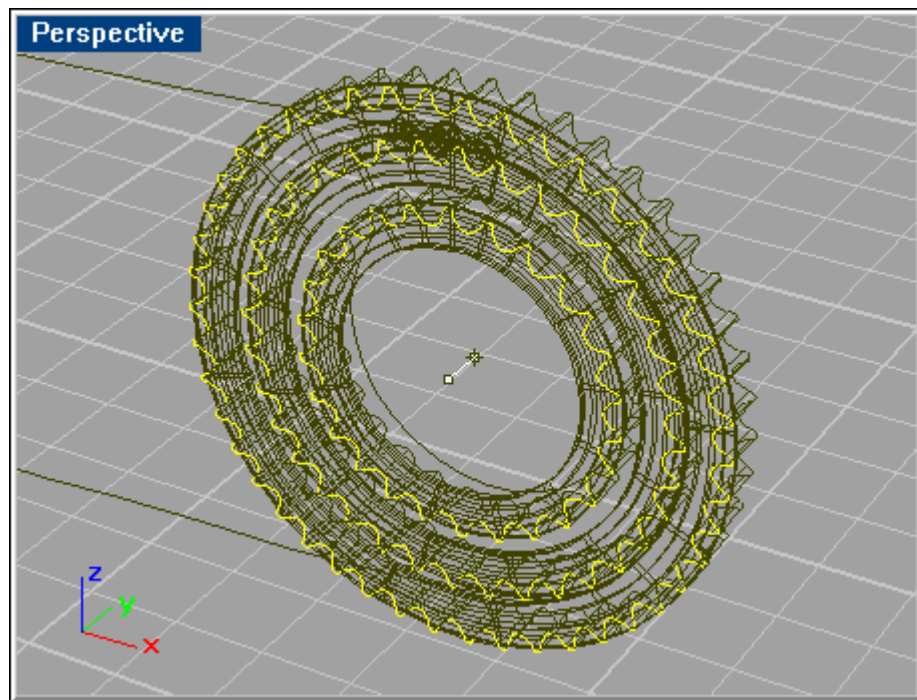
Select the circle curve just beneath it and for number of items in the options panel, type 46. Delete the original gear curve, and then select all the arrayed ones and join them.



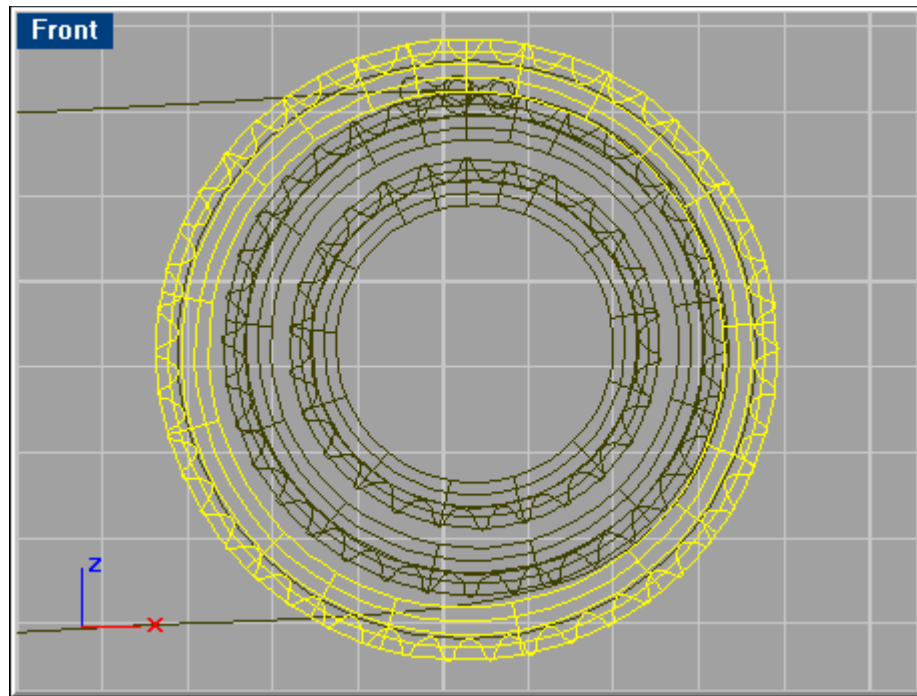
Make a 'Sweep 1 Rail' for each pair of curves selected below.



Select all third gear curves and extrude them in the direction shown below.

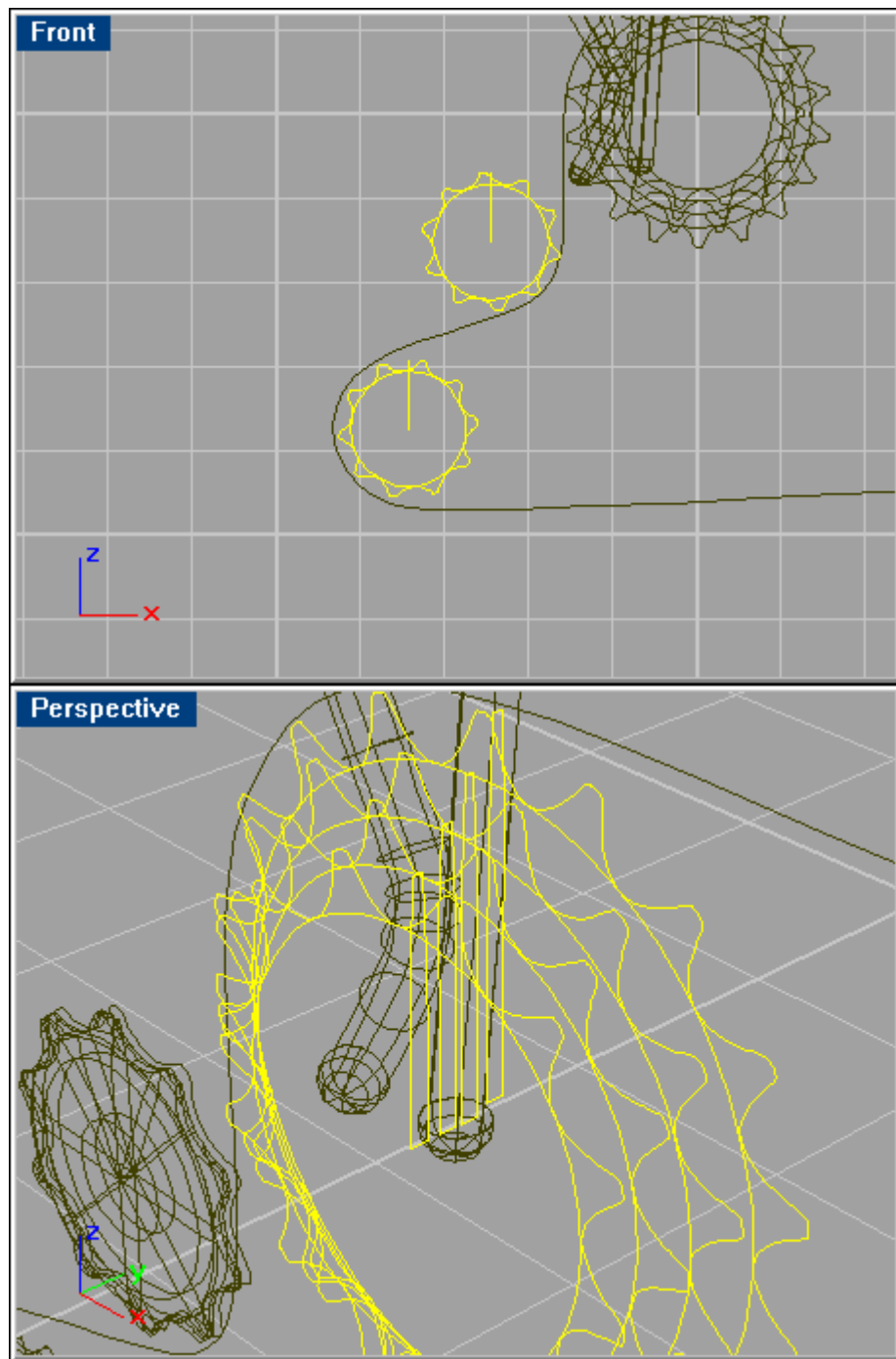


Next go 'Solid/Difference', and select the largest Sweep 1 Rail surface, then the largest extruded gear surface.

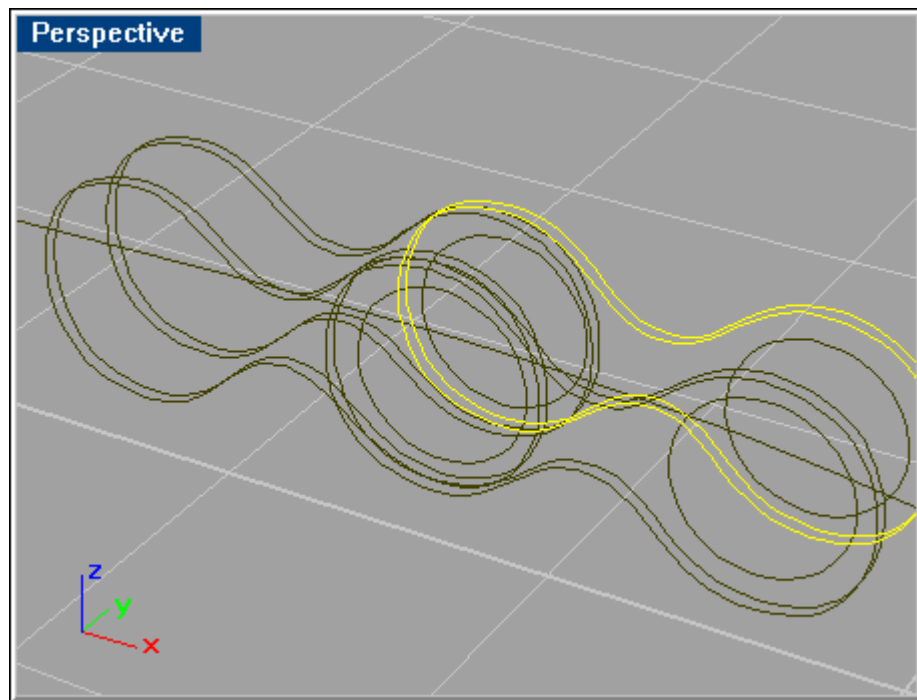


Repeat this step for the two gears below.

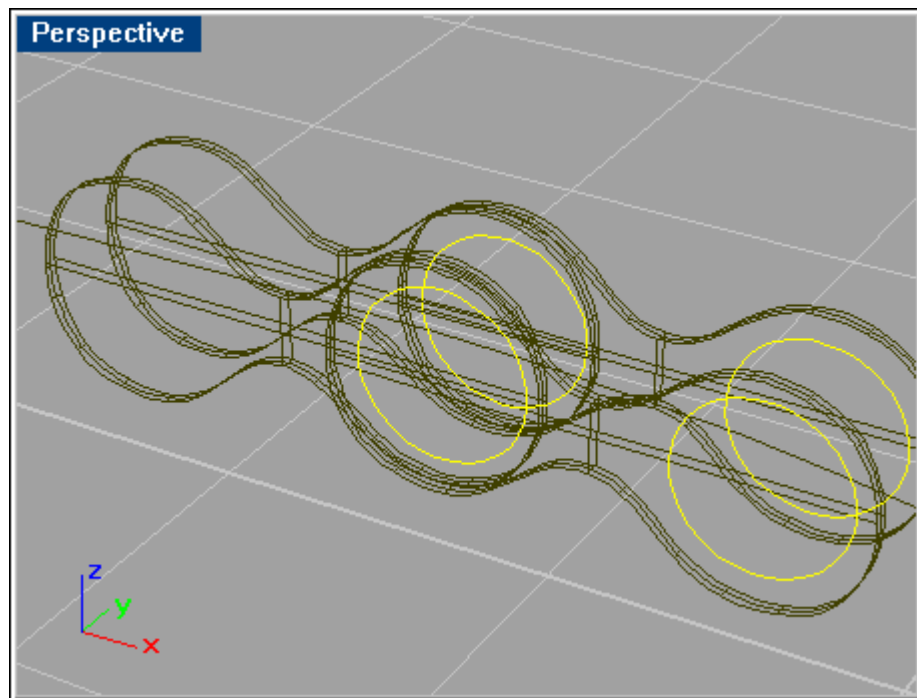
Repeat the same process with the other gears shown here:



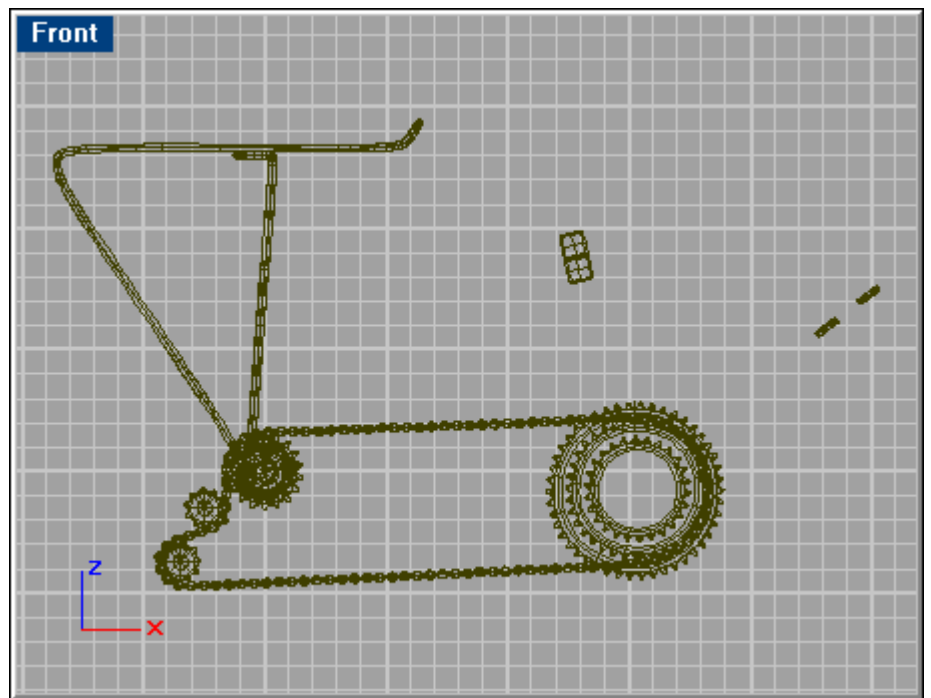
Making the chain is another case for an array, this time an array along a curve. For better visibility, all but the curves used for this step is hidden. Left the curves shown below, and the other three pair of curves similar to these. Cap them as well.



Loft the pair of curves shown below.



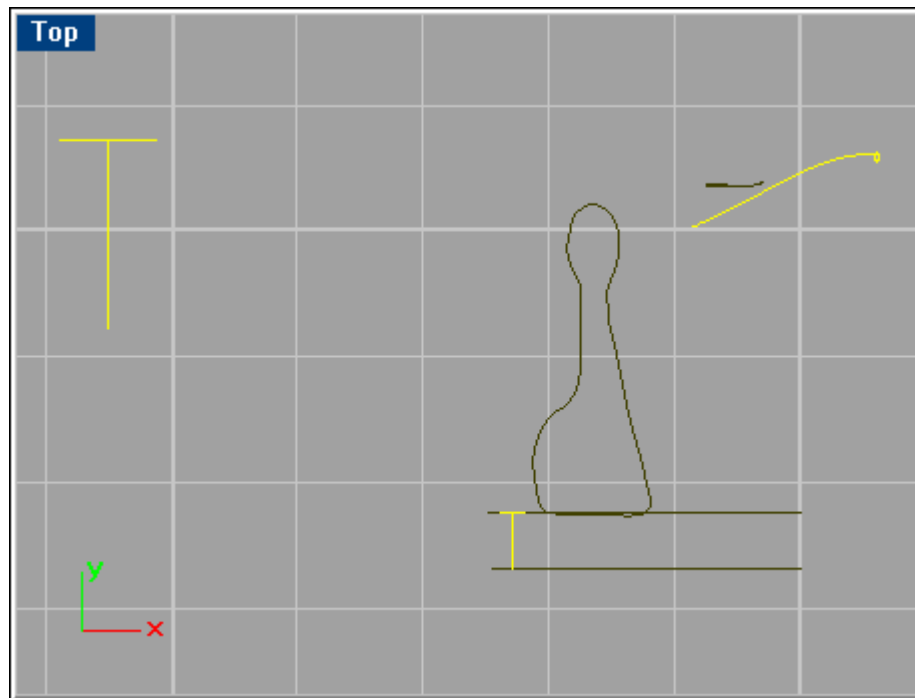
Now, select the created chain surfaces / polysurfaces, and go 'Transform/Array/Along Curve', and select the curve running through them. Set the 'number of items' to 51.



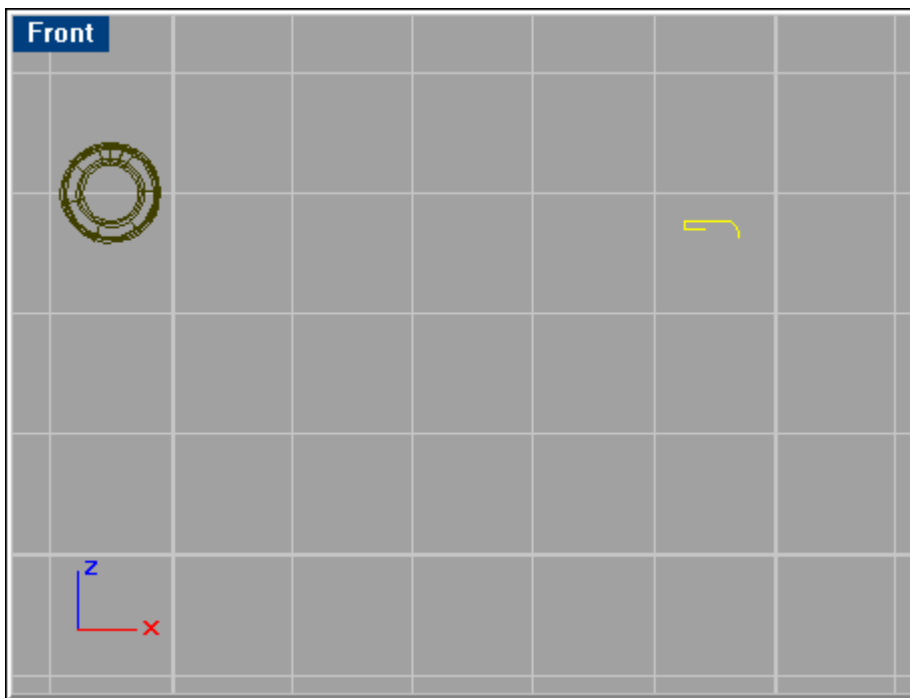
The result should look like this:

Make the 'Curves-5' layer the only one visible.

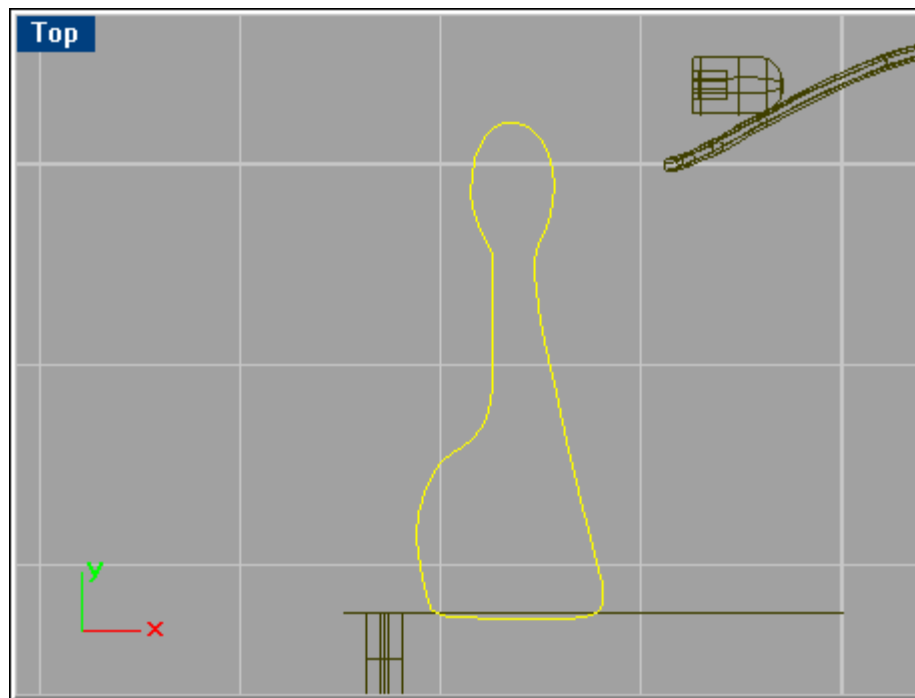
Perform a 'Sweep 1 Rail' with the pair of curves selected below:



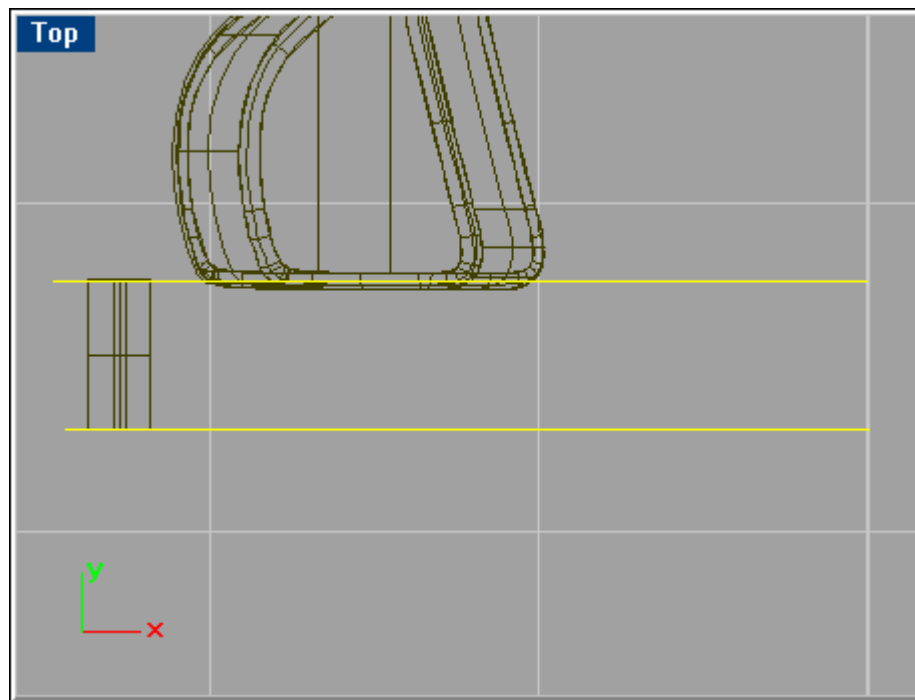
Make a 'Revolve' out of the curve selected here:



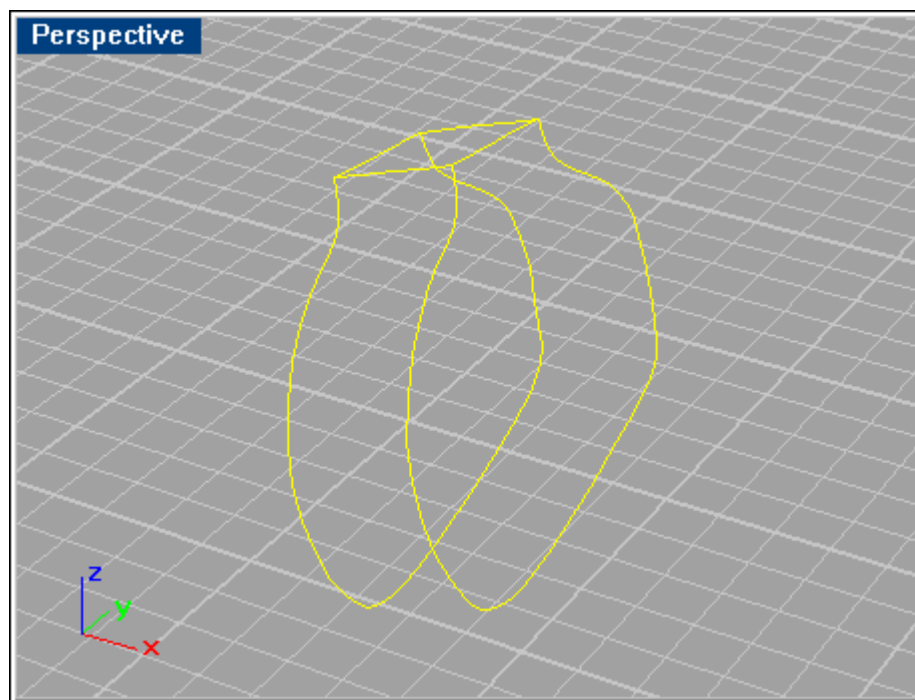
Extrude the curve shown below, with a distance of 0.7 and 'Cap' set to 'Yes'. Fillet between the cap surfaces and the extruded one with a fillet radius of 0.05.



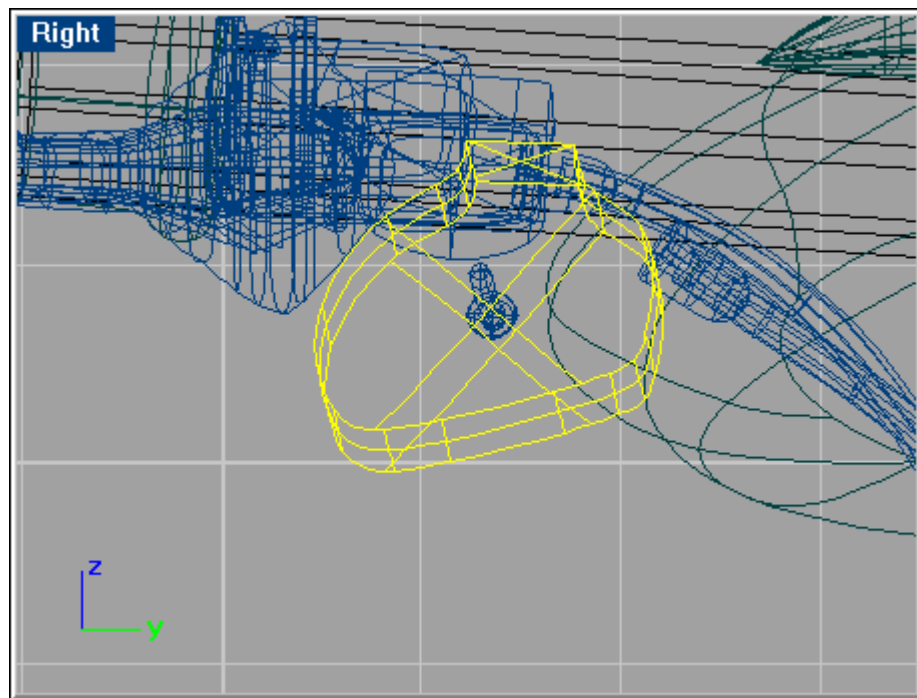
Extrude each of the selected curves below towards the center between them. Use a distance value of 0.03 for the lower one and -0.03 for the one above. Cap here as well.



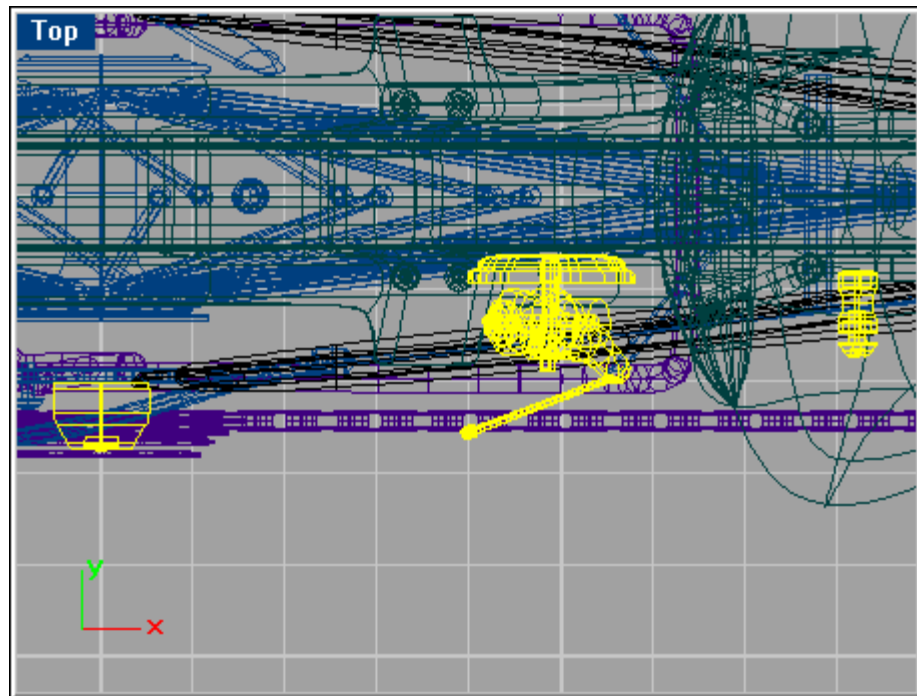
Patch all 3 curves below and use a span count of 2 in both directions.

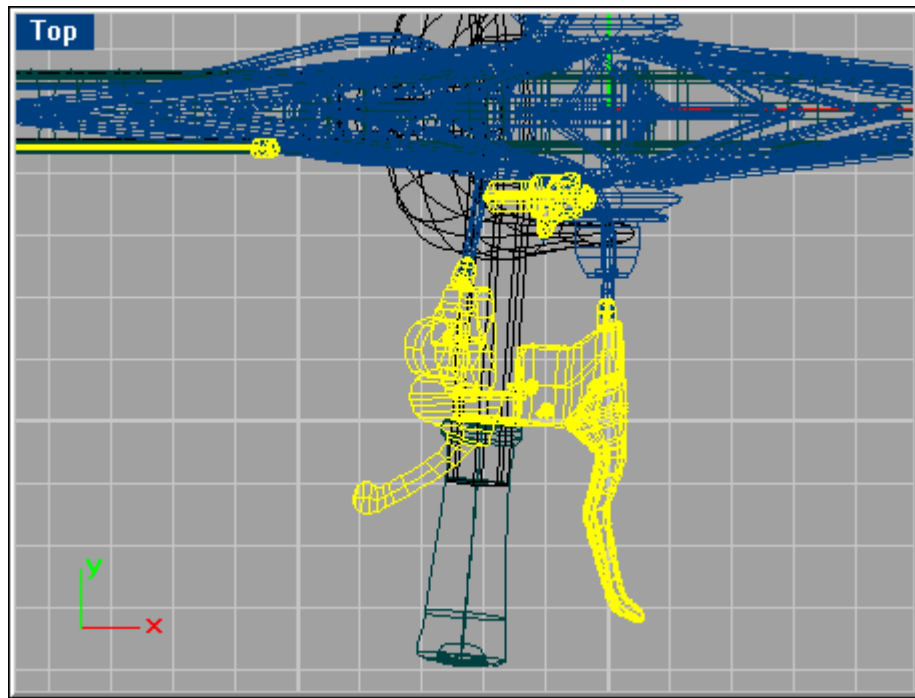


Show the other layers again, and join together the three patch surfaces from the previous step together with the lofted one shown below.

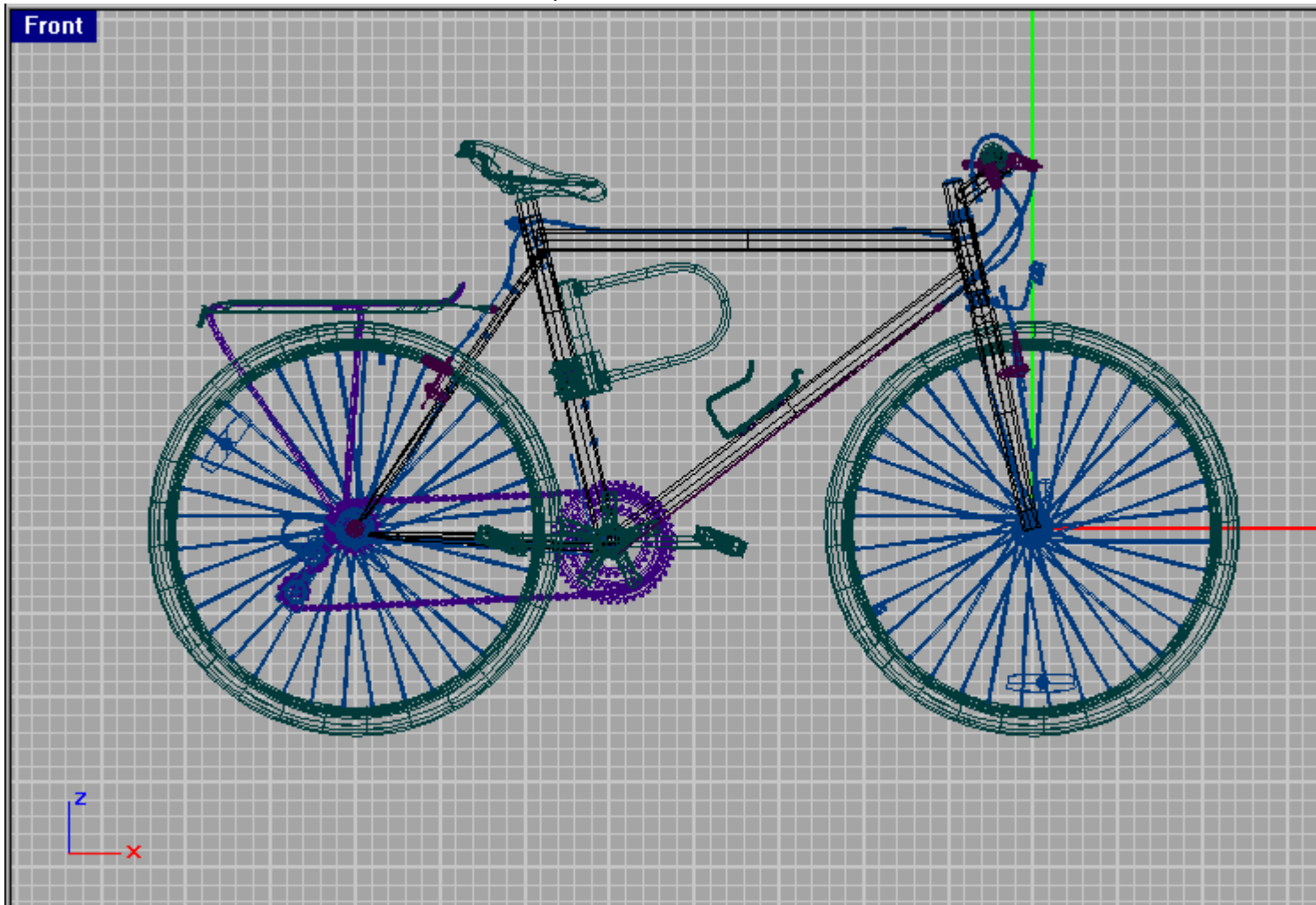


Finally there are surfaces you need to mirror. Select the surfaces shown in the two figures below, and mirror them to the other side.





Your mountain bike is now complete! Your result should look like the sample file 'Bike4.3dm' (the surfaces that were mirrored as well as the copies are moved into a new layer called 'Mirrored surfaces') from the CD-ROM.



Congratulations - this may have taken some time, but accurately building a real machine such as

this is an accomplishment that you can be proud of.