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# Surface Modeling - IV

This tutorial will introduce you to some of the basic curve and Surface commands. It will also show you how to modify and edit these curves and surfaces and come out with a beautiful teapot in the end.

## Table of Contents

1. Step 1: I'm a Little Teapot...	1
2. Step 2: Short and Stout...	8
3. Step 3: Here is My Handle...	14
4. Step 4: Here is My Spout...	19
5. Step 5: When I Get All Steamed Up...	22
6. Step 6: Then I Shout...	24

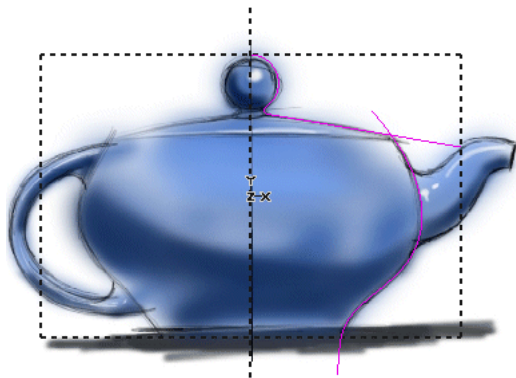
## 1. Step 1: I'm a Little Teapot...

In this step, we'll create some reference lines to represent the rough size of the teapot. Next, we'll learn how to insert an image into our model file, then, using curves, trace over the image to define the main shape of the teapot body. Finally, we'll experiment with some curve editing commands. Be aware that in thinkdesign lines, arcs, circles, splines, etc. are collectively called curves.

### NOTE:

With a double click on the exe file you can run the webtraining session. ThinkDesign will be open with the right model to start.

If request to open a file, you can find it in the C:\MyTraining path.



Make sure the Image, Curve and Surface toolbars are active, you'll need them for this task.

Before we start, we need to set some options.

- Start a **New Model** file.
- Right click in the graphics area and click Options/Properties.
- Click Document Properties tab and Grid option.

- In the Hidden Dynamic Grid area uncheck both Enable and Flexible step and click OK.

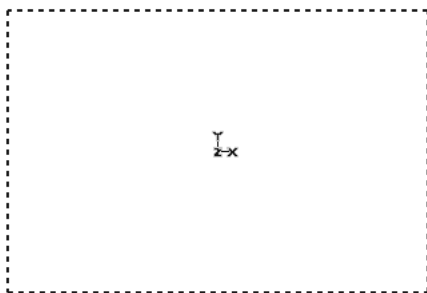
This turns off the dynamic grid settings so that we can work more freely with the geometry we need to draw.

We're not going to give you a lot of exact dimensions in this exercise. We want you to get a feel of surfacing, which is more of a creative experience. We will, however, create a bounding box to use as a guide for the proportions of the teapot.

- Set the **Line Type** to dash line.
- Set the **Line Width** to 2.

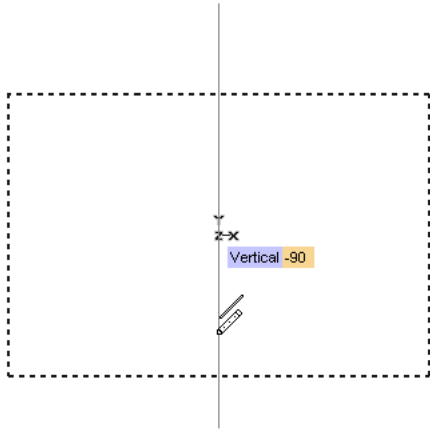
This set of geometry is just for a reference so by changing the line type and weight, we will be able to distinguish them easier.

- Activate the **Rectangle** command and change Mode Cen+Sizes in the Selection List.
- Set the X size300 and the Y size200.
- Place the rectangle in the center by using the **Work Plane Origin** snap.
- Hit or click Cancel



Now, let's add a vertical axis reference line in the center of the bounding box. We'll use this several times throughout the process.

- Start the **Two-point Line** Line command.
- Type Unlimited
- Sequence Single
- Option Polar (P)
- Select the **Mid Point Snap** at the top of the bounding box as the first point.
- Select the second point which is the mid point of the bottom line of the bounding box; in the minidialog will appear Vertical-90 and
- Then hit or click Cancel



Since we've determined what size teapot we want, let's try something a little different. Let's insert a teapot image and scale it according to the bounding box we just created and use it to trace over the front view of the teapot.

- Select **InsertImage** from the pull down menu
- Change the Files of this type to Joint Photographics Experts Group (\*.jpg)
- Select Options... from the open pop-up.
- Under Setting, select None in the Convert to:: pull down.
- Leave Fast as the Resize::

This lets us insert the image as it is.

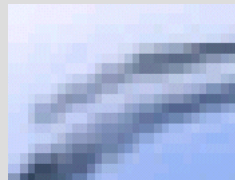
**Convert to:**

Gray Scale : Image is inserted using Gray Scale. Error diffusion bitmap : Colors are converted to black and white using a smoothing and interpolation algorithm (higher quality but more memory consuming than the raw bitmap option). Raw bitmap : Colors are converted to black and white with no smoothing and interpolation algorithm(lower quality and less memory consuming).

This inserts the image faster, but of a lower quality (as is).

**Resize:**

Fast : pixels are enlarged when the image is zoomed in (also known as 'point sampling', this may result in a jagged appearance).



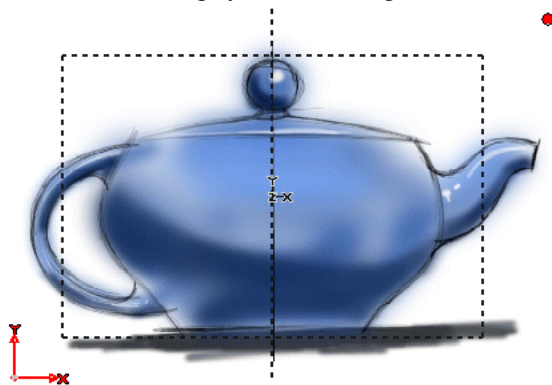
Bilinear Interpolation : A smoother/interpolating algorithm preserving details(slower, but of higher quality).



- Select the teapot.jpg file and click Open.

The position of the image must be selected. The Origin will be the left bottom corner.

- Select **ModifyImageEdit** from the pull down menu
- Select the image you want change.



Select the circle at the intersection of the red X,Y axis on the image to move the image and the upper right circle to scale the image.

You can also use the center line in the image to line up the image with the bounding box in order to get the final result as shown below. It takes some time getting used to it, but we're not looking for a pixel-perfect model here, just something we can use to trace the outline of the teapot.

#### What do those other editing features do?

If you select the either the X or Y it will rotate the image on that axis. What happens if I make a mistake? Select **Modify/Image/Move to Workplane** and this will reset the image back to the initial 0,0 and undo any rotation that you did by mistake.

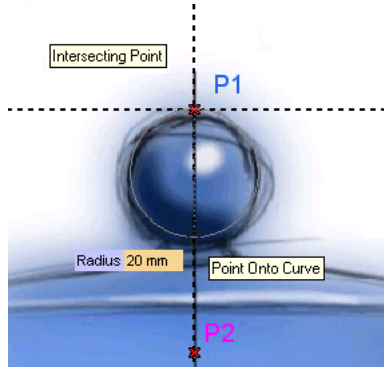
- Hit when you're done adjusting the image.

With our image and reference lines in place, we're going to start sketching some curves to create the outline of the teapot by tracing over the front view. We'll start with the curves for the lid of the teapot. We'll revolve these curves around the axis line later to create the surface.

- Set the **Line Type** back to solid, the **Line Width** to 1, and the **Color** to something different.

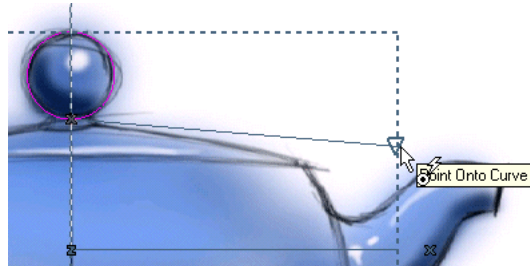
Let's start with the knob on top of the lid first and use the **Radius Circle** command to create a circle. We'll then use the **Two-point Line** command to continue with outline of the lid.

- Start the **Radius Circle** command.
- Mode Circle
- Given Point
- Option Radius

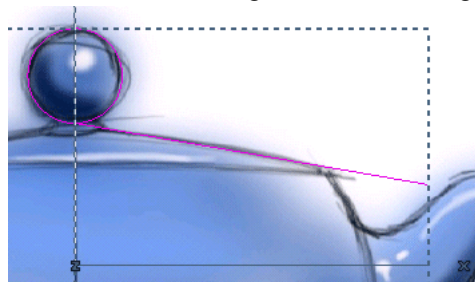


- Select the **Intersection Point Snap** of the axis and the top of the rectangle (P1 ).
- Change Radius20
- Now use the **Point on Curve Snap** to place the center of the circle on the vertical axis line (P2 ).

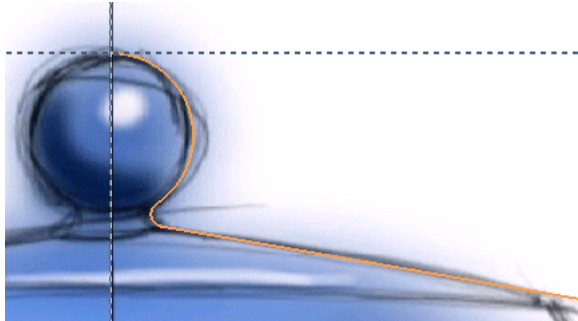
- Start the **Two-point Line** command.
- Type Limited
- Sequence Single
- Option Polar (P)



- Start from the lower **Intersection Point Snap** of the circle and axis line.
- Trace over the image and end on the right bounding box line as shown below.

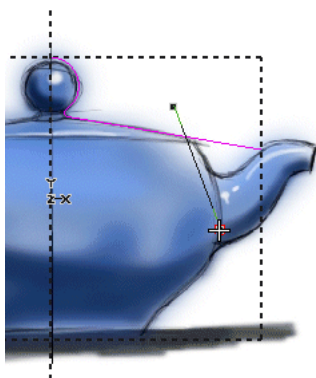


- Trim off the left half of the circle using the **Smart Delete** command.
- Finally, use the **Insert Fillet** command to add a small fillet of Radius3 between the arc and line.
- Hit or click Cancel

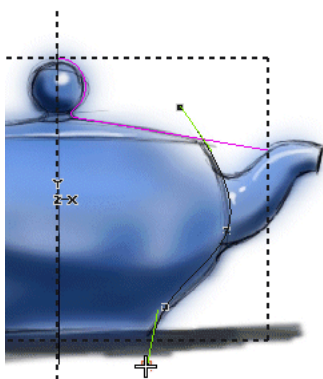


Next, we'll create the silhouette curve for the pot. We'll use the **Insert Curve through Interpolation Points** command for this since we want a nice rounded shape. This command has a lot of different options available, but we'll keep it pretty simple.

- Start the **Insert Curve through Interpolation Points** command from the Curve toolbar.
- Select a point above the lid line, and select the points by tracing the outline of the image.



Don't worry if you didn't get the exact curve you wanted, you can edit the curve easily by changing Mode Edit Interpolation Points in the Selection list.



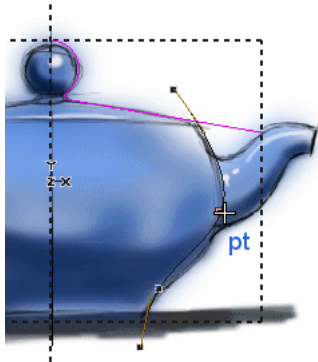
Let's try editing the spline to see how this command works.

- Mode Edit Interpolation Points in the Selection list drop down.

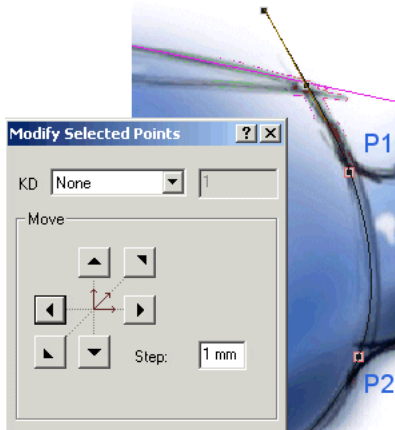
In edit mode, you can modify the position of one or more points and adjust the tangency at the end points of the spline. Let's experiment a little and see how easy it is.

- Select the second point from the top and drag it to the right.

The point moves and the curve shape is modified.



- Hold down the key and select the third point. Two points are now selected to modify.
- Hit Tools and then Step in the Selection list.
- Hit any of the arrow buttons in the dialog box to move the two points in the direction of the arrow. Each time you hit the button, the points are moved by the step value in the respective directions (X, Y and Z).



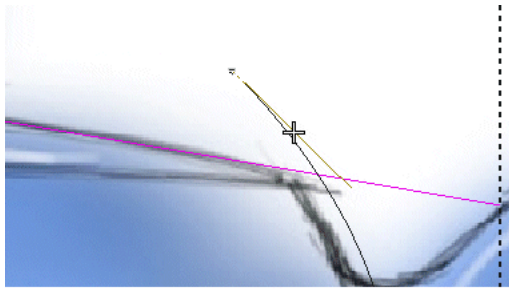
- Hit the to close the Step dialog box.

While we're experimenting, let's look at the Tangent Vectors (these are the little lines we can see at each end point of the curve). These are the yellow lines that are on the ends of your spline as shown below. Just by clicking and dragging the vector, you can modify its magnitude, direction or both.

**magnitude, direction or both.**

Click on the vector near midpoint to modify its direction. Click on the halfway between the midpoint and end-point to modify its magnitude. Click on the vector near the endpoint to modify both its magnitude and direction.

Select the upper tangent vector near the midpoint and drag it to change the tangency direction.

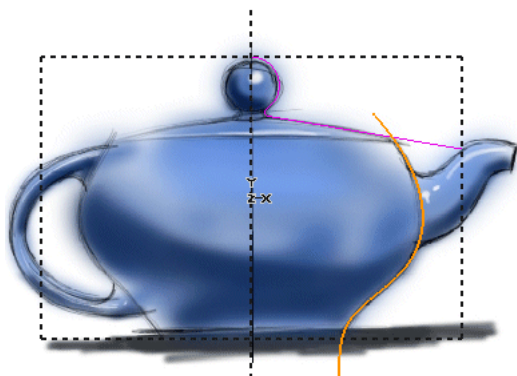


- Now select the vector between the midpoint and the outer endpoint and drag it to change the magnitude of the vector.
- Finally, select the vector at the outer endpoint and drag.

This allows you to modify both the magnitude and direction at the same time.

We've just scratched the surface of these editing tools, but you're starting to get the idea. For more information on **Insert Curve through Interpolation Points**, check out the **thinkdesign Help**.

- Use the editing tools to make the silhouette curve close to what the image looks like.
- Hit



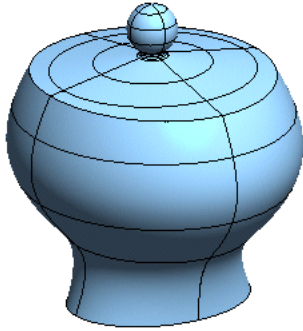
- If the curve is too distorted while you were experimenting, end the command and use **Undo** to get back to your original curve.

In the next step, we'll use these curves to make some rotational surfaces.

## 2. Step 2: Short and Stout...

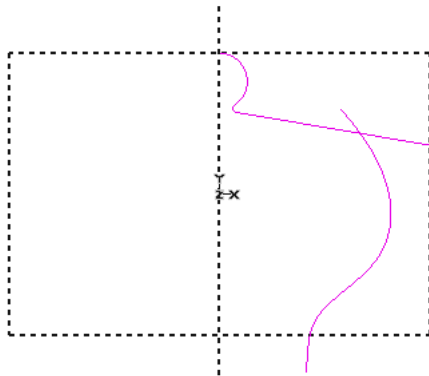
In this step we'll create surfaces from the curves we made in the last step. Then, we'll use several editing tools to shape the body of the teapot.





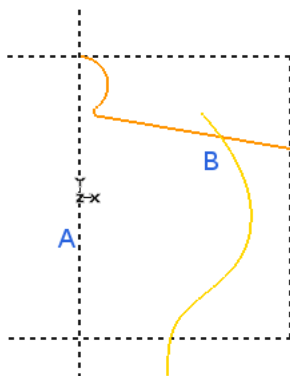
At this point we don't need the image anymore, in the steps to follow we will create the curves and surfaces more freely.

- Select **Hide Image** to hide the image. This works as a toggle so we can bring the image back at anytime.



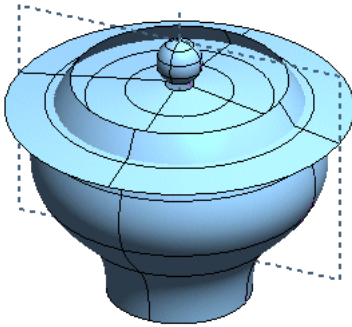
With the main curves created, let's jump right into creating surfaces. We'll use the **Rotational Surface** command to generate the main surfaces of the teapot. Note that each curve creates its own surface.

- Set the **Color** to something different.
- Start the **Rotational Surface** command and make sure the three lid curves and the spline are all selected for the Curves in the Selection List.



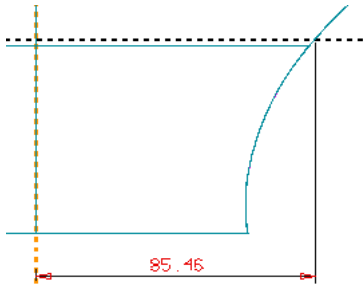
- The Axis has five options to choose from in it's drop down list. For this exercise, we" use the Line option and select the vertical line same to Y axis (A ).

- We want a fully **Rotational Surface**, so make sure Angle360 and click OK to create the surfaces.



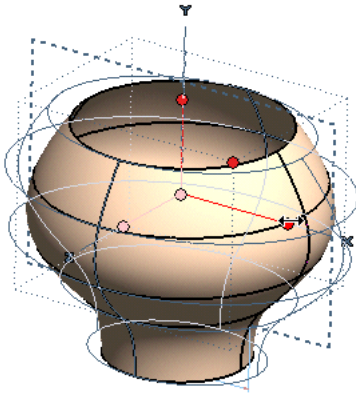
Okay, that's good, but we do have a design constraint on the size of the base. Let's add a dimension to see how close we are.

- Change to **Wireframe View** to make the next step easier.
- Start the **Smart Dimension** command.
- Place a horizontal dimension between the vertical axis line and the **Intersection Point Snap** of the spline curve and the bottom line of the bounding box.



That's close, but we need to make this dimension 70 mm . You should write down the value you've got for the next step. We'll use the **Scale Entities** command to stretch the surface to the correct size.

- Start the **Scale Entities** command and pick the main teapot surface (is better to hide the lid surfaces) and the dimension for the Entities
- A set of orthogonal handles appears. Click and drag the Handle Origin to the midpoint of the vertical axis.
- Click the X-handle to reveal the mini-dialog.
- Set Scale70/your actual value



For the scale value, we used a fraction based on the actual value.

- Click **Apply** to accept the changes and leave the command active.

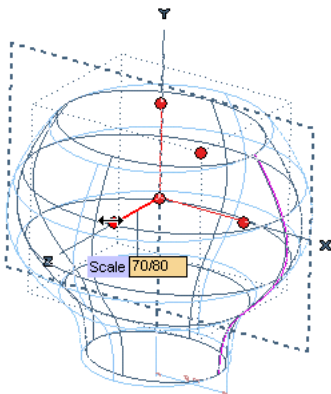
To keep it round, we'll apply the same stretch scale to the Z axis.

- With the **Scale Entities** command still active
- Click the Z-handle to reveal its mini-dialog and set  $Scale_{70}/your\ actual\ value$ .

The shape is nice, but let's get a little more creative. Let's stretch it a bit more to give it a more elliptical shape.

- Click the Z-handle and change  $Scale_{70}/80$

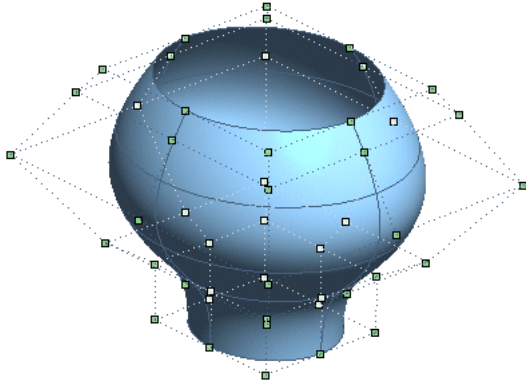
Notice that the shape of the pot is still symmetric after the stretch.



- Click **OK**

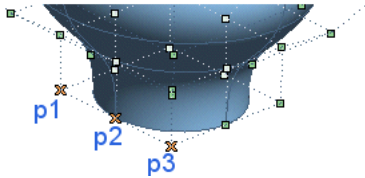
It is a nice shape, but the bottom of the pot still needs to be round not an ellipse. We'll make this happen by editing the control points of the surface using **Modify Surface Control Points**.

- Double click on the body surface to view the control points. If you get a message telling you that your surface will be converted to NURBS, click **Yes**.



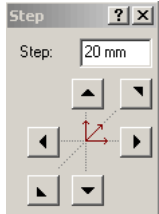
This puts us in Mode Edit Control Points

- Pick the bottom-left control point.
- Hold the key and pick the bottom-right control point to select all three control points as the points we want to change.

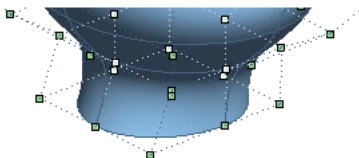


With the control points selected, we'll use the Step tool and move them 20mm in the positive Z direction. Then we'll move the points on the other side in the opposite direction.

- Hit Tools and then Step in the Selection list and change the Step: value to 20 in the dialog box.



- Now hit one time the arrow button to move all the points 20mm in the positive Z direction

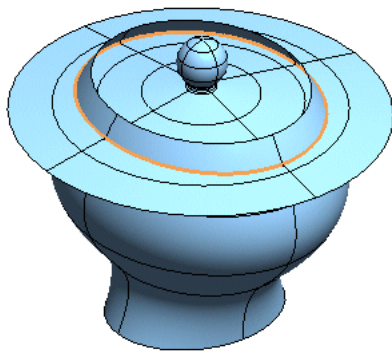


- With the dialog box still active, select the three control points on the opposite side and hit the arrow button to move them 20mm in the negative Z direction.
- Hit the the to close the Step dialog box.
- Click OK to complete the command.

Before we move on, let's trim the lid and body surfaces back to the intersection of the surfaces. To do this, we'll create a boundary curve that we can use to trim both surfaces with the Intersect command.

- Set the **Color** to something different and set your line width to 2.
- Change to **Shaded View and Boundaries**.
- Start the **Intersect Curve** command.
- Select the body and main lid surface to create the intersection curve.
- Click OK

A curve representing the intersection of the surfaces is generated.



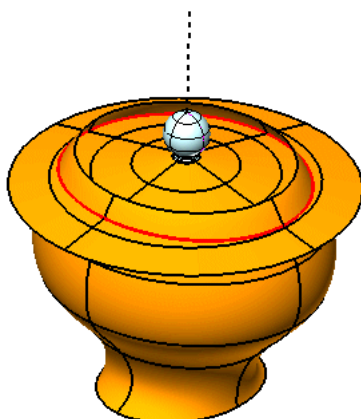
Now we'll use this curve as a boundary to trim both surfaces with Trim Surface with Limits.

- Start the **Trim Surface with Limits** command.
- Select the intersection curve for Limits.

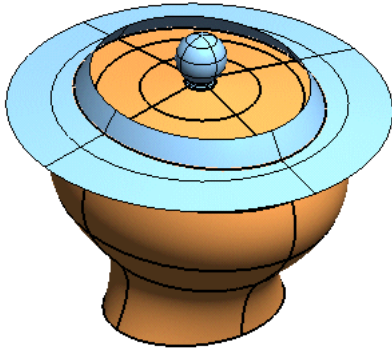
**Speed Tip:**

Try to double click -Really Fast- with your left mouse button. This will end your selection. Left double clicking also acts as an Apply action on a command.

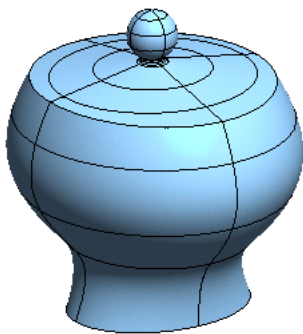
- Select the body and main lid surface to trim.



- Select the area of the highlighted body and lid surfaces that you want to keep.



- Click OK

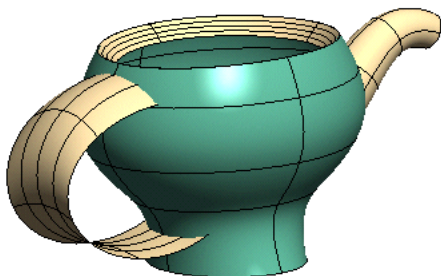


That should do it. Let's clean up the display so you can admire your handiwork.

- Use **Hide Entities** to hide all the dimensions and all the curves except the vertical axis - we're not done with that yet.
- You can switch to a **Shaded View** to get a better look if you want.

### 3. Step 3: Here is My Handle...

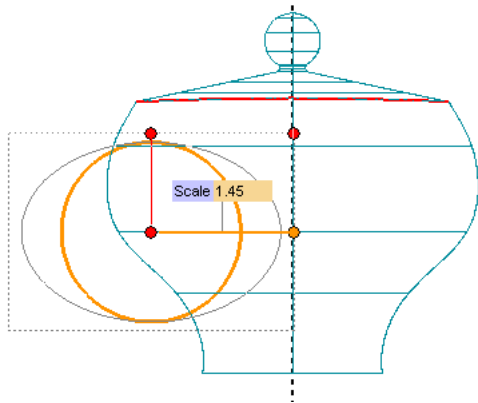
It's time to make the handle. We'll work on some new curve concepts for this, then we'll look at two new surface types. We'll create two different handle surfaces and then choose the one you like.



Let's get creative with the handle, to go with the shape we've created for the body. We'll define the handle shape in two views, then combine them to get the 3D shape.

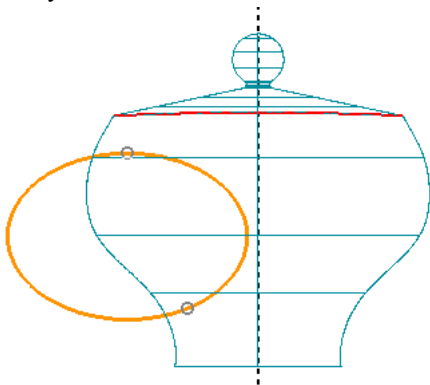
Starting from the **View on Work Plane** (F8), we'll create an elliptical shape for the handle using a circle and stretching it.

- Change back to the **Wireframe View**
- Start the **Center Circle** command and draw a circle on the left side of the teapot as shown below.
- With the circle selected, start the **Scale Entities** command.
- Click the X-handle and with your mouse, dynamically drag it until you get a shape similar to the one below.
- Click OK

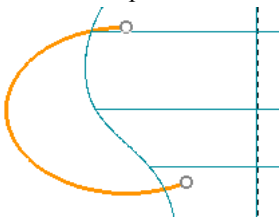


We only need a portion of the ellipse, so we'll use the **Trim/Extend Curves with Limits** command to trim away the part we don't need.

- Start the **Trim/Extend Curves with Limits** command and change the Boundaries Points.
- Select a point on the top of the ellipse inside the body of the teapot body as the first trimmed boundary. Look at the image below for clarification.
- Select a point on the bottom of the ellipse inside the body of the teapot body as the second trimmed boundary.



- Pick the left side of the ellipse that is outside the body of the teapot as the curve to trim. This is the portion of the ellipse that we'll keep.



You should end up with something similar to the image below.

- Hit or Click Cancel

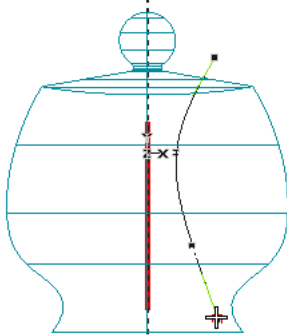
Next, we'll define the shape in the front view. Before we start, we need to rotate the Work Plane 90° around the Y axis.

- Double click on the Work Plane.
- Rotate the Work Plane of 90° about the Y axis and click OK.

From the front, the handle should have a curved shape, wider at the top and bottom and narrow through the middle. We'll use the **Insert Curve through Interpolation Points** command to create another curve for this shape. The elliptical curve in this view will define the top and bottom of the handle, so use it as a guide for the curvature of the spline.

- From the Work Plane View, draw a curve using **Insert Curve through Interpolation Points** command to get one similar to the image below. This is exactly what we did to create the outside shape of the tea pot.

If you cannot see the elliptical curve in the Work Plane view, edit the line width with **Properties** to make it thicker To do this, right click on the curve and select **Properties**.

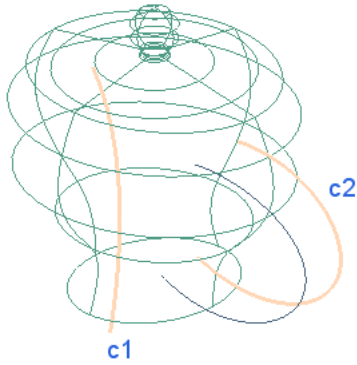


Now we'll combine these two planar curves to make a 3D curve that we can use for the handle surface. The **Two D to Three D Curve** command is perfect tool for this job.

- Change your color to a different color than your 2 curves.
- Start the **Two D to Three D Curve** command.
- Select the two planar curves we just created (c1 and c2 ).

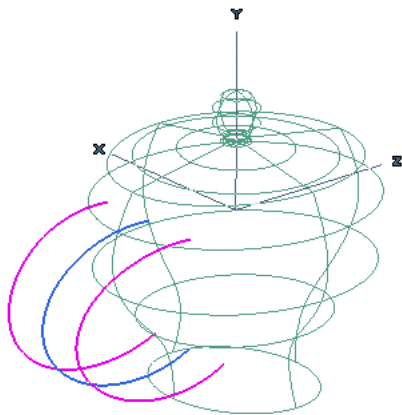
A new 3D curve is generated based on the two planar curves.





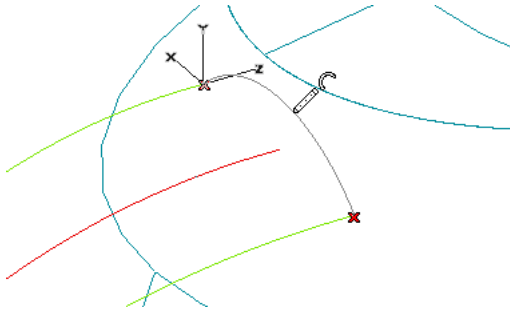
Now we'll **Mirror Entities** the 3D curve to define the other side of the handle.

- Select the 3D curve and start the **Mirror Entities** command.
- Check Copy box.
- Pick Symmetry plane: and set to Perpendicular to axis & through point.
- Like Axis choose X or select it on workplane; pick the **Work Plane Origin** or any point on the vertical axis line for the .
- Click OK



We need one more curve to define the curvature along the length of the handle. We'll just use a 3-point arc.

- Move the Work Plane to the upper endpoint of one of the 3D curves.
- Start the **Three-Point Circle** command and set the Mode to Arc - Start End Middle in the Selection list.
- Pick the two endpoints of the 3D curves as the first two points of the arc.
- The third point defines the bulge of the arc, so drag the arc up and pick a point.
- Hit or click Cancel

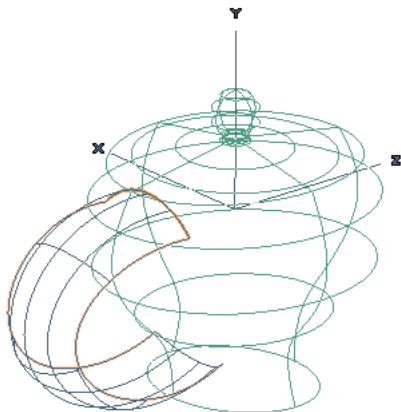


We have a couple of options for the handle surface. A proportional surface will give us a rounded effect through the entire length of the handle while a stretched surface will start rounded at the top and make the handle flatter as it gets to the bottom. To see the effect, we'll create both, then you can choose the one you like. Let's start with the proportional surface.

- Change to **Shaded View and Boundaries**.
- Select **Hide Entities** and hide the body and lid surfaces, then start the **Lofted Surface** command.
- Select the two 3D curves as the Boundary Set A.
- Select the arc as the Boundary Set B.

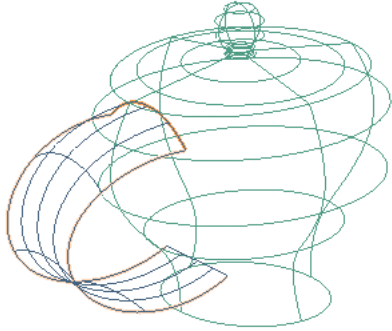
thinkdesign creates a preview of a grid surface as the default surface; change it on Proportional.

Notice that the curve of the boundary arc is carried through the entire proportional surface.



Now let's see how a stretched surface differs. The stretched surface uses a straight span on the open boundary end of the surface.

- Pick **More Options** and then Type **Stretched** in the Selection list drop down.
- The preview of the surface will update to a **Stretched** surface.

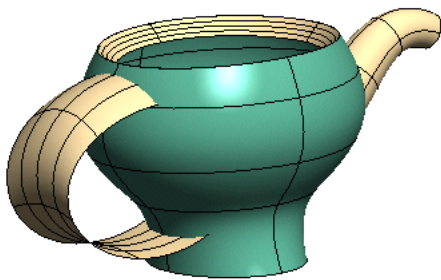


- Choose the surface you like better and click OK.

We can use the same curves to create different shape surfaces. Let's continue and see how the new handle surface looks with the body of the teapot.

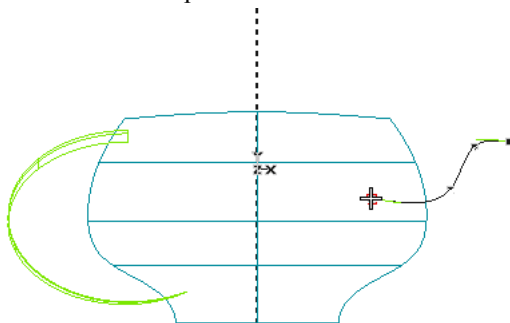
#### 4. Step 4: Here is My Spout...

Now, it's time for the spout. This will be easy, so we'll do some work on the lid as well.



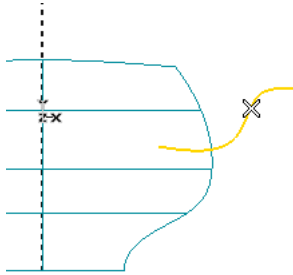
We'll use a **Pipe Surface** to make a spout, but we need a curve to define the path of the surface.

- Reset the Work Plane to World with the Set to World command.
- Start the **Insert Curve through Interpolation Points** command and sketch a curve similar to the one below. Since we'll use this curve to create our Spout surface, make sure you create a smooth curve so as to avoid kinks in the spout surface.

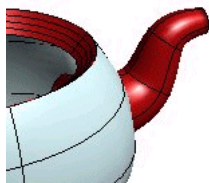


Now we'll use the spline for the spine of the Pipe.

- Start the **Pipe Surface** command and select the curve as the Drive Curves in the Selection list.
- Hit Preview.



- Change the value in the minialog about Radius 1.
- Move the pointer on the drive curve and through right button pick on Add Radius.
- Drag it at the end and change Radius 2.



Make sure that when you increase the diameter of the inside portion of the spout, that it doesn't become too large and break away from the edge of the teapot.

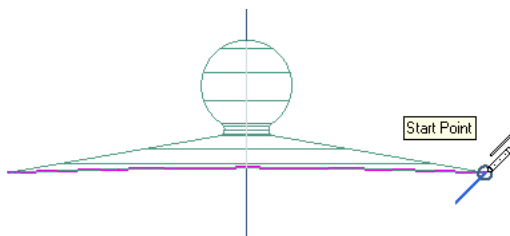
- Click OK.

Now we'll add a lip to the lid. We'll use a Proportional Surface, driving a short line around the boundary curve.

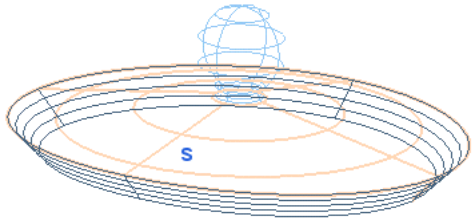
- **Unhide Entities** the lid surfaces and the curve we used as the trim boundary (the intersection curve).
- Use **Hide Entities** to hide the spout, body and handle surfaces.
- Draw a **Two-point Line**

Use the **End Point Snap** of the trim boundary curve with a Length20 at an Angle-135

- Hit or click Cancel

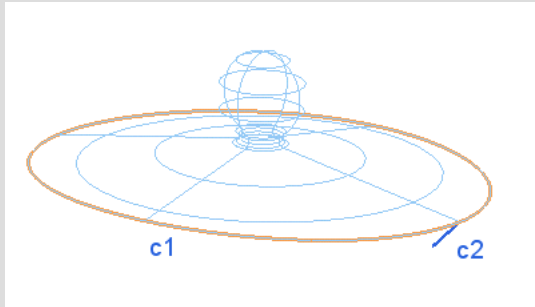


- Start the **Lofted Surface** command.
- Select Boundary Set A and assign it to the boundary of the lid surface.

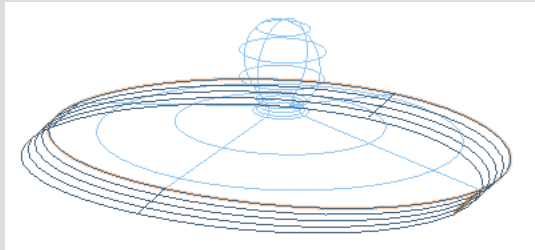


**NOTE: Orientation**

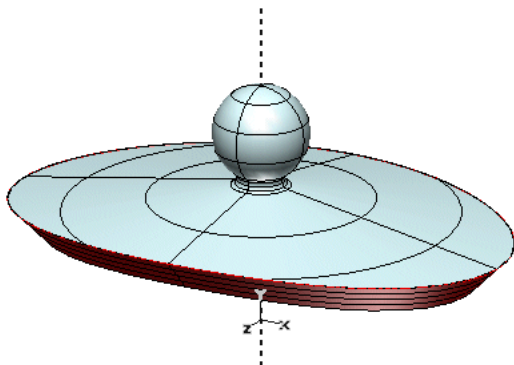
When creating surfaces, you can use the surface boundaries or generic curves to create a surface. If we only want to use the boundary curve, hit the key to apply the curve filter.



You'll obtain the below surface as result. Hit More Options in the Selection list and set Type Proportional and under Surface Type Options set Orientation Curve-based to final geometry.



- Select the angled line as Boundary Set B.
- Hit More Options in the Selection list and set Type Proportional and under Surface Type Options set to Orientation Constant.



**NOTE: Orientation**

The hypothetical guide curve in this last case will be assigned to the UV orientation of the lid surface. So the resulting Lofted "lip" surface keeps always the -135 degree around the perimeter of the lid surface.

- Click OK.

The lid is done for now, so let's move all the lid surfaces to **Output Layers** and turn it off. Then we'll **Unhide Entities** the other surfaces.

- Select the four lid surfaces and change their layer.

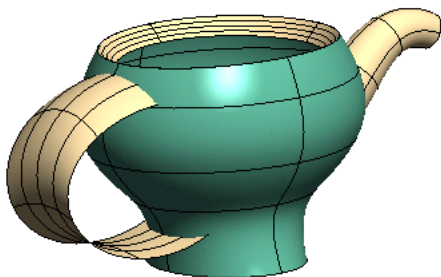
**Speed Tip:**

To Select ONLY the four surfaces quickly, hit the keys to filter only surfaces. Then, click and drag your cursor from right to left over a portion of all four surfaces. This will select any surface touching within the pick window. If you were to drag your cursor left to right, you would have to completely envelope all the surfaces with the pick window for them to be selected.

- Change the Layer10 for all lid surfaces.

We'll need a lip inside the body to match the one on the lid, so we might as well do that now.

- Use **Unhide Entities** to unhide the body, handle and spout surfaces.
- Start the **Lofted Surface** command.
- As Boundary Set A select the top boundary of the pot surface.
- As Boundary Set B assign the same straight curve used before.
- Hit More Options in the Selection list and set Type Proportional and under Surface Type Options set to Orientation Constant.
- Click OK.

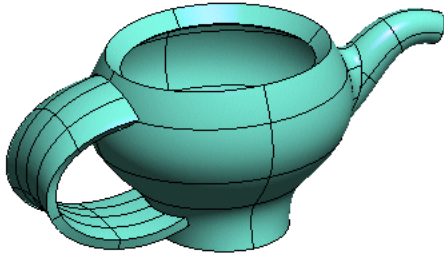


That will do it for this step. In the next step, we'll make a bottom for the tea pot.

## 5. Step 5: When I Get All Steamed Up...

This pot's not going to steam if we don't put a bottom on it. We'll work on that in this step and we'll also look at

continuity.



The bottom of the pot seems to be a little too tall. Remember that bounding box way back in Step 1? Well, it's time to take another look at it and see where we stand.

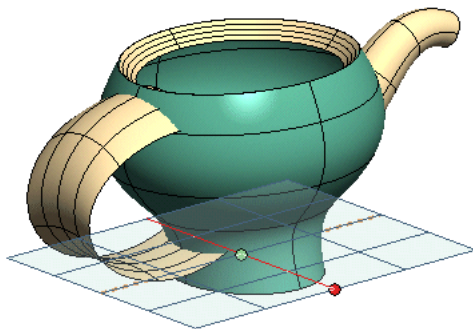
- Use **Unhide Entities** to unhide the bottom bounding box line.
- If the line is too high and intersects the handle, you should drag it down so that it's below the handle instead.

**Modeling Technique:**

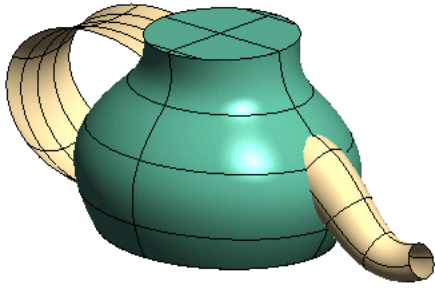
If you click on an entity (line, curve, surface, etc.) you can dynamically drag it to another position. You can also snap it to another entity. If you hold down the key while dragging, a copy of the original entity will be created.

We need to make the bottom of the pot meet this line. To do this, we'll create a **Linear Surface** from the bounding box line and use it to trim the body surface.

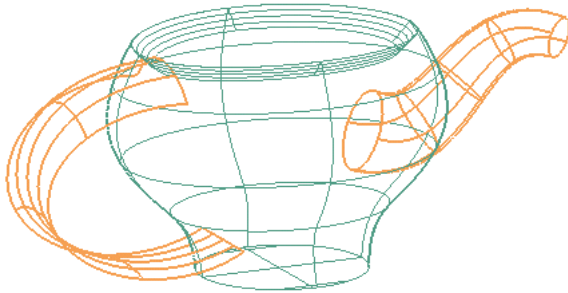
- Start the **Linear Surface** command and select the bounding box line as the Curves in the Selection List.
- Set the Direction Z, set Length175 and right click the mini dialog box and select Symmetric. Click OK to create the surface.



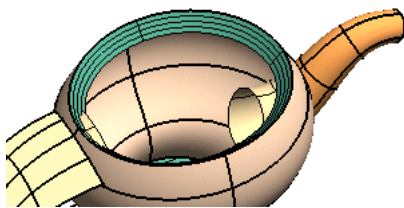
- Now start the Trim Surface with Limits command and trim surfaces to obtain the result as below.



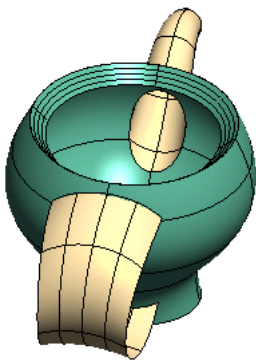
Now we have to make a unique body. We'll use to different mode to add handle and spout.



Use again two times **Trim Surface with Limits** to trim spout and the main body.



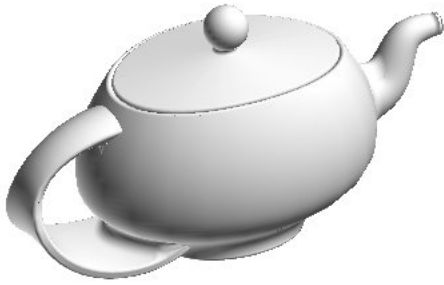
You have to obtain a shape as shown below.



## 6. Step 6: Then I Shout...

To finish up, we'll make the teapot a solid.

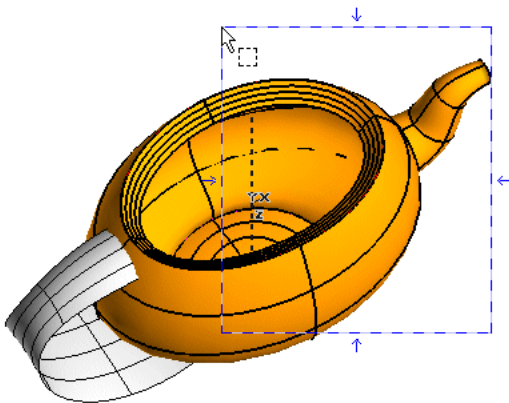




Let's start by making the handle surface a Solid with the **Make Solid** command.

Now we'll make the rest of the pot solid.

- Start **Make Solid** again and select the body, spout, bottom and lip surfaces.



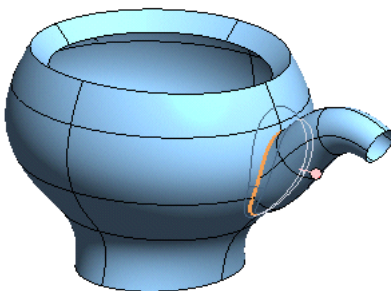
- Click OK.
- The open solid warning message is displayed.

We know that the top lip and the end of the spout are open.

- Click Continue to create the solid.

Let's add a **Fillet Edges** between the body and the spout.

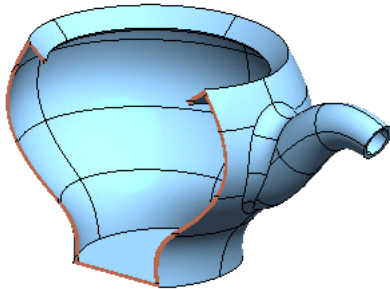
- Start the **Fillet Edges** command.
- Select the joint between the body and the spout.
- Set the Radius15.



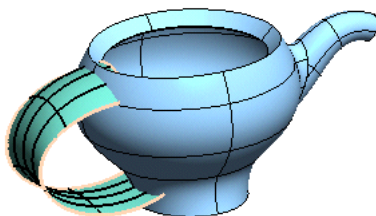
- Click OK.

Let's add thickness with the **Solid Shell** command.

- Start **Solid Shell** command
- Set Mode Add thickness in the Selection List drop down.
- Select the teapot body as the Solid in the Selection list.
- Set Global Thickness3

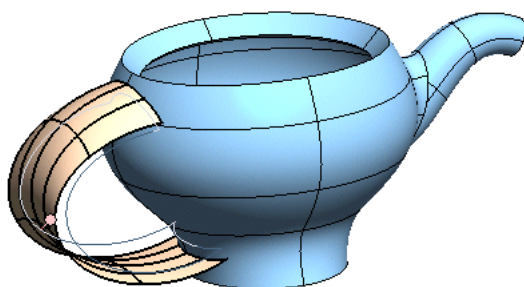


- Click OK.
- Start the **Make Solid** command and select the handle surface.
- Hit OK and Continue when warned This solid is open to make the Solid



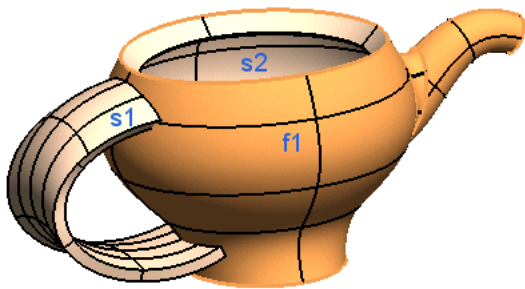
Continuing with **Solid Shell**, let's make the handle 10 mm thick.

- Select the handle Solid in the Selection list..
- Set the Global Thickness10.
- Click OK.

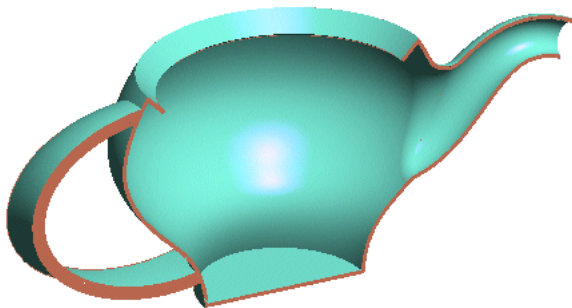


The next step is to join the handle to the body. Traditional Boolean Union Modeling would result in the ends of the handle that stick inside the pot and that just won't do. In thinkdesign we can use what's called a Local Boolean. This will allow us to specify only the faces of the solids that we want to apply the boolean function.

- Start the **Solid Union** command.
- Change the Boolean from Global to Local
- Select Both the solids to Union together. That satisfies the command's need for two solids to be joint together and the Faces input becomes active in the selection list.

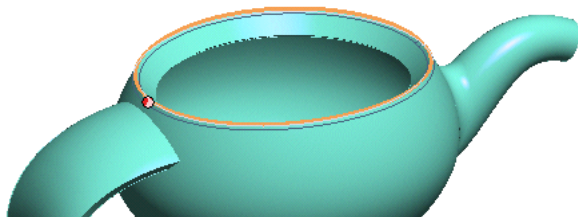


- Select the outside face of the main body and the four long faces of the handle (f1 ).
- Click on the Preview button. If the inside of the teapot is smooth, then you did it right!
- Click OK.



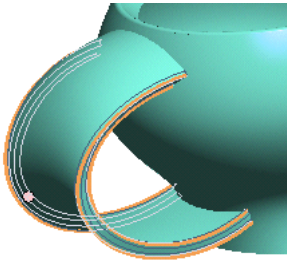
With that done, let's finish it off with a few fillets using the **Fillet Edges** command.

- Start the **Fillet Edges** command and set Radius3. Select the top edge between of the body

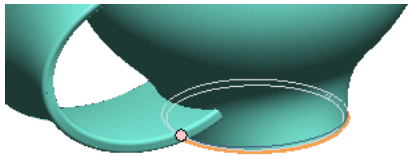


- Click Apply.

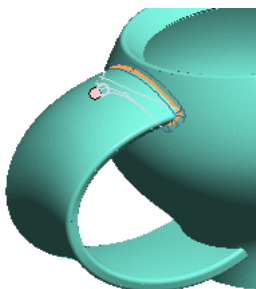
- Select the four edges along the length of the handle and set Radius3.



- Click Apply.
- Select the bottom edge of the body. Set Radius3.



- Click Apply.
- Finally the edges between the handle and the body and set Radius3.
- Click OK.



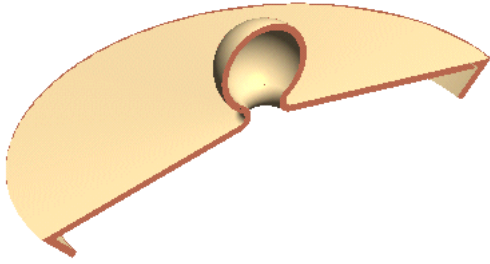
Let's repeat same steps used in the tea pot to finish the lid.

- Make visible the lid's surfaces.

Now to make the lid solid with **Make Solid**.

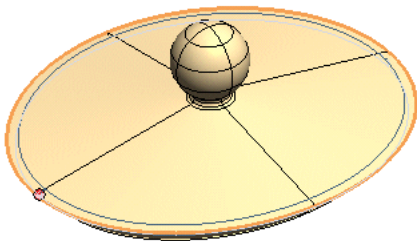
Now use **Solid Shell** to make the lid 3mm thick.

- Start **Solid Shell** and select the lid.
- Set Global Thickness3.
- Click OK.



And finally, add a fillet to the edge.

- Start **Fillet Edges** and select the edge of the lid.
- Set the Radius3.
- Click OK.



Let's turn on the visibility for layers having both the solids.

Excellent job! You are now ready to move into more advanced surface modeling web tasks. Look at your My-Training curriculum to see what the next step should be.

