We shall next model the abacus as a boundary sweep. We shall first need to draw a path and a source shape.

- The shown path shape can be drawn by combining the Vector Line and the Arc tools. It can be drawn as a single shape or a quarter of it can be drawn first, then copy-rotated 3 times, and then joined into a single object.
- The source shape, which is the section of the abacus, can be drawn as a combination of 3 arcs.

Once the shapes have been drawn the boundary sweep can be generated, as follows:

- In the Sweep Options dialog select Boundary Sweep and with the Sweep tool active click on the source, then the path.

The result is the abacus form shown. After the sweep is generated, you can still edit it to make adjustments, using the Edit Controls tool.

We shall next construct the little cross-like shapes that decorate the abacus.

- In the Polygon Options dialog, select Construct Through Segment, By # Of Segments and the octagon icon. Under the Pattern tab, select Pattern, the lower-middle icon, and Lower First.
- With the Polygon tool active, click three points along a horizontal axis to create the shape, as shown. Note that the shape we show is a lot larger than its real size.

You can use this shape as it is, or you can refine it further, as follows:
- You can move points to adjust the shape, as shown.
- You can then use the Nurbz Curve tool to click on the shape and create a smooth profile, as shown.

Once an appropriate shape has been derived, it can be extruded to a solid, moved inside the abacus, and copy rotated 3 times, as shown. These can now be unioned to add little ornaments to the abacus. Four more copies of the ornament can also be placed in the middles of the curvy sides of the abacus.

Now that all the parts have been modeled, the final assembly is created by moving each part into position, then copy-rotating it around the capital. At the very end, we used the hammered gold from form-Z’s predefined materials to render the column.

Building the back of the chair from its boundary shape
- Draw 4 curves that outline the boundary shape of the upper part of the chair, roughly as shown.
- From the Nurbz Options dialog select Nurbz By Boundary Curves.
- With the Nurbz tool select the four curves in any order. A nurbz surface is generated, which you can still edit to make adjustments, using the Edit Controls tool. Or you can use the Reconstruct tool to change the density of the control points, as we did. This makes it easier to edit its shape, if desired.

Building the seat of the chair from its U/V curves
- Draw 3 or more curves that define sections of the intended shape in the U (horizontal) direction, roughly as shown below.
- Also draw 3 or more curves that define sections of the intended shape in the V (vertical) direction, as shown.
- In the Nurbz Options dialog select Nurbz By U/V Curves and set Number In Length (U) = 3 and Number In Depth (U) = 3.
- With the Nurbz tool active select the U curves in order, then the V curves. The order of selection is significant.

After the nurbz surface is generated, you can still Reconstruct and Edit it to make adjustments.

Attaching the seat and back
- In the Attach Nurbz Options dialog select Merge.
- With the Attach Nurbz tool click on the lower edge of the back and the upper edge of the seat, as shown. The two surfaces are attached and the result is a single continuous nurbz surface.

This tutorial is about modeling the shown lawn chair exclusively as a nurbz object. As we shall see, different nurbz operations are better suited for different parts of the chair.
Trimming the nurbs surface to shape it further

The beauty of nurbs surfaces is that they can be trimmed to open holes or to adjust their boundary shape and they can still be edited to refine their curvatures and overall form. Different methods are available for applying trimming. One method is to draw a shape away from a nurbs surface and then place it on the surface and use it for trimming. Another method allows you to draw directly on the nurbs surface. We shall do examples of both.

• Draw a 2D profile on the XY plane, roughly as shown.
• In the Curve On Nurbs Options dialog select Map Existing Curve, Trimmed Nurbs, and Curves Enclose Holes.
  • With the Curve on Nurbs tool, click on the profile, then the nurbs surface. The profile is placed on the surface and is trimmed from it, as shown.
• Use the Edit Curve On Nurbs tool to move the trimmed profile, as shown.
• In the Curve On Nurbs Options dialog select Sketch On Surface and choose the Vector Line or Spline icon.
  • With the Curve on Nurbs tool active, click once on the nurbs surface to select it, then draw the desired profile, roughly as shown. Draw as many slots as desirable. The drawing of each shape (slot) is completed by triple-clicking.

Note that the drawing conventions are as when you use the regular drawing tools and that the sketching conforms to the nurbs surface. As soon as a shape is drawn, it is trimmed from the surface. You may also use the Edit Curve On Nurbs tool to make adjustments.

We shall next cut the front legs and arm rest.

• Working in Front view, draw an open profile, as shown.
• With the Trim/Split tool set to Trim With Line, click on the surface, then on the profile, as shown.

Note that the click location on the surface is significant.

• Working on Right view, draw a closed profile, as shown.
• With the Trim/Split tool set to Trim With Line, click on the surface, then the profile, as shown.

Next we shall cut more slots from the upper portion of the chair. We shall do it using solids.

• Working in Front view, draw two extruded solids to the left of the existing hole. Then copy-reflect them on the other side of the hole.
• With the Join tool, join them into a single object.
• With the Trim/Split tool set to Trim First Object, click on the surface then the solid, as shown.

Adding the back legs of the chair

We shall first cut two symmetric notches, where the back legs will attach to the chair.

• Generate a 3D surface extrusion and place it inside the chair, where the leg should attach.
• Copy-reflect this surface to the opposite side of the chair, for the other leg, as shown.
• With the Trim/Split tool set to Trim First Object, click on the chair surface, then the trimming surface. Repeat the operation for the other trimming surface.

We shall next generate the back legs and attach them.

• With the Vector Line tool, draw cross sections for the leg, roughly as shown. You may next round the corners to make them smoother.
• In the Nurbs Options dialog select By Tight Lofting.

• With the Pick tool select the profiles from top to bottom with the Nurbs tool active click anywhere on the screen. The result should be as shown. After the nurbs surface is generated, you can still edit it to make adjustments.

We shall next make the transition from the back legs to the chair.

• Position the leg close to the corresponding notch of the chair and draw an intermediate profile between the leg and the chair, roughly as shown.
• With the Pick tool active and Topological Level set to Segment, select the top segment of the leg, the intermediate profile, and the trimmed edge on the chair.
• With the Loft tool active click anywhere on the screen. The leg is attached to the chair with a transitional piece. Repeat the operation for the other leg.

Finishing the chair

After stitching, the chair is now a continuous surface. To complete it, we shall first apply some thickness to it and then some rounding.

• In the Parallel Options dialog select Double Parallel and Out. Enter 1/16" to all the fields, select Relative To Curvature, and for Max Normal Deviation enter 5°.
  • With the Parallel tool click on the chair. The surface is converted into a solid of uniform thickness.
• In the Stitch Round Options dialog, set Radius to the desired size.
  • With the Stitch Round tool active, click on an edge of the boundary or hole line you wish to round.

form-Z automatically determines the continuous closed path boundary and applies the specified smooth rounding, as shown. You can repeat this operation for as many of the chair’s boundary curves as you desire.