# Industrial design with T-Splines, NURBS, and polygons

Claas Kuhnen,
Assistant Professor Industrial Design
Kendall College of Art and Design
of Ferris State University

T-Splines brings industrial designers a third approach, alongside NURBS and solids, for creating models.

Traditional approach: NURBS and solids

NURBS and solids, the traditional methods, are precise, but have the disadvantages of being complex and inflexible when it comes to very organic surface modeling. Surfaces created by skinning profiles must always be arranged into four-sided patches. Only through a series of intricate tool tasks can complex surfaces be created. This is not always intuitive nor fast.
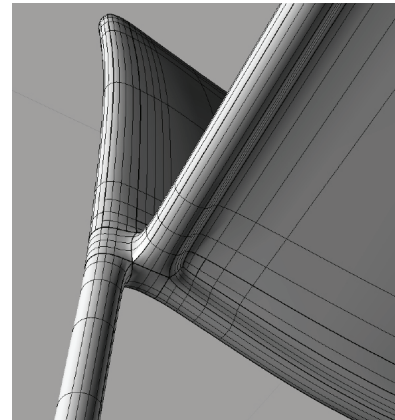
Easy to use: polygons and subdivision surfaces

Meanwhile, polygon and subdivision surfaces can be used to create organic models and fluid shapes very quickly by extruding and translating faces, edges, or points. Smooth and regular meshes can be built in a short amount of time. Polygons hold a major advantage over NURBS modeling in that they can contain any topology, such as holes, branches, and handles. What's more, when the polygonal mesh is made out of four sided faces, the resulting subdivision surface behaves very similarly to a NURBS surface. However, polygons are in general ignored in industrial design because of their lack of precision. Also, trimming is not yet possible with polygons and subdivision surfaces.

Bridging the gap: T-Splines

T-Splines helps mitigate these limitations. Since it was originally implemented to be compatible with Catmull-Clark subdivision surfaces, T-Splines can function as a bridge between the two worlds of polygons and NURBS. In Rhino, the T-Splines plugin can load a low polygon count mesh and create a NURBS-compatible subdivided surface. T-Splines also allows the import of five-sided faces, and thus local subdivisions, without any surface curvature distortion. Once the model is in T-Splines, you can move points, extrude faces, and refine the shape. T-Splines surfaces can than be converted into perfectly matching, 100% industrial strength NURBS patches for further refinements.

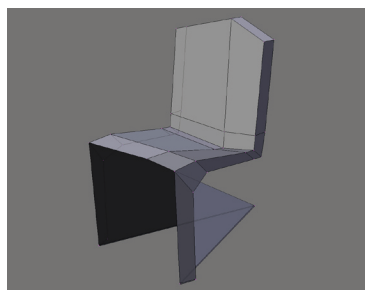The basic workflow to use T-Splines as a translator is as follows:

- Generate a low polygon count (under 5000 faces) mesh
- Convert into T-Splines
- Convert into NURBS Patches
- Trim and Clean Up

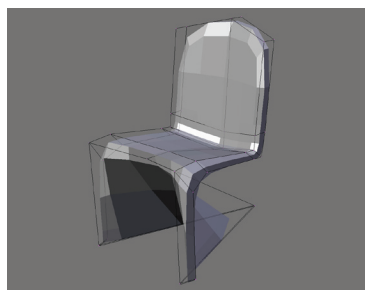Three different chair models are presented below to illustrate this workflow.

1 Modeling a chair with a single patch

Step 1: Inside the polygon modeler

A low-polygon chair is modeled by extruding the edges of a four-sided polygon.

The normal can be smoothed to hide the internal linear faces.

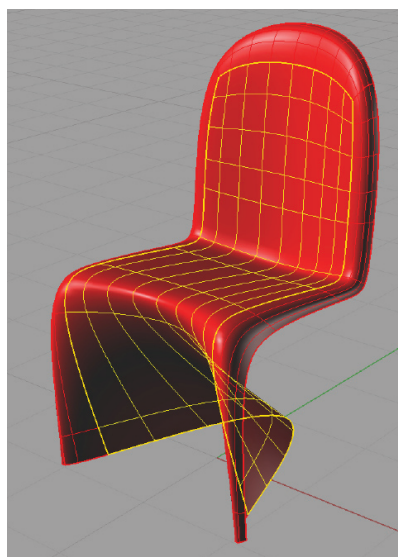With subdivision turned on the object can be globaly subdivided.

The polygon control cage can be projected onto the subdivided surface.

Step 2: Inside T-Splines/Rhino

The model is converted to T-Splines. The T-Spline chair shows the same curvature as the subdivided surface in the polygon modeler.

T-Splines converts the object into perfectly matching NURBS patches. A material thickness can be now added to the model.
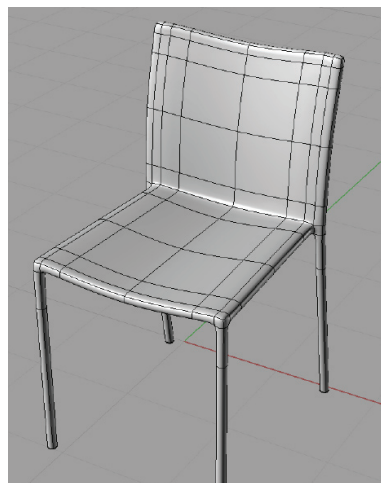
T•Splines

2 Box modeling a solid chair with complex compound curvature

Step 1: Inside the polygon modeler

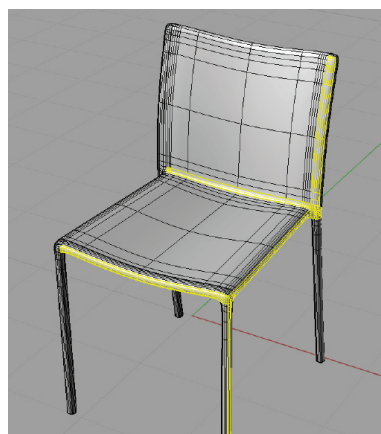This model originated from simply extruding the faces of a cube and building the rough proportions.
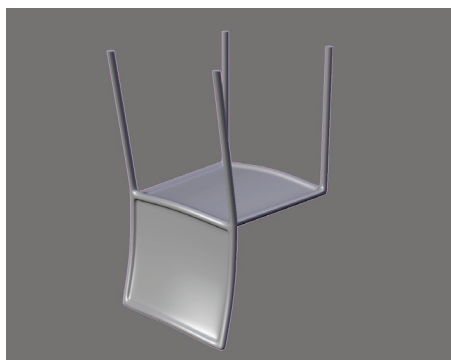

The smoothed model.

Note how the curvature of the frame flows perfectly into the seating and back rest areas.

Step 2: Inside T-Splines/Rhino

Mesh converted to T-Splines

T-Splines converted to NURBS
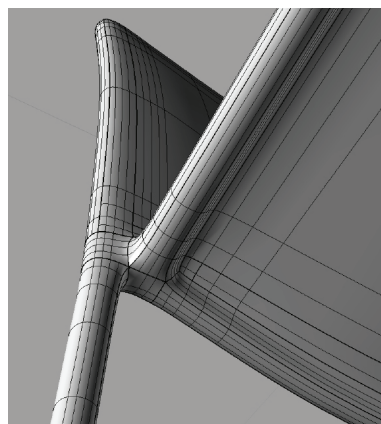
This detailed image focuses on the benefit of this workflow: a model with very complex and perfect curvature created in less than 10 minutes.

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# 3 Modeling a chair with rounded edges/ fillets

Designers can choose to either round the edges by hand in the polygon modeler or create all sides separately and round the edges with the fillet or blend tool in Rhino.

## Making fillets in the polygonal modeler

To create rounded edges for the seat of this chair by hand, insert extra loop cuts around required locations to generate sharper edges.

With care and skill, good fillets can be modeled this way. When there is a variation in the thickness, the added loop-cuts will also reflect that. Fluid changes can be modeled in a snap.

Step 1: Inside the polygon modeler
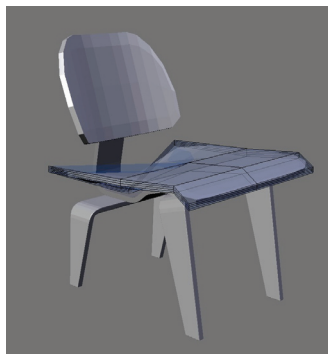
Step 2: Inside T-Splines/ Rhino
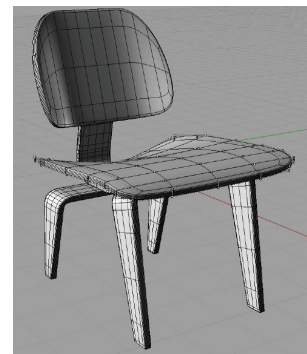
Filleting the model in Rhino

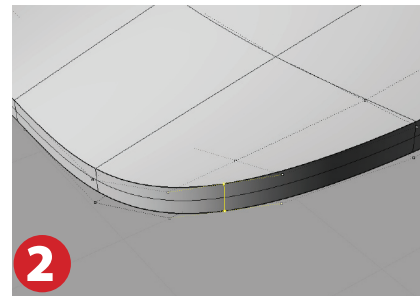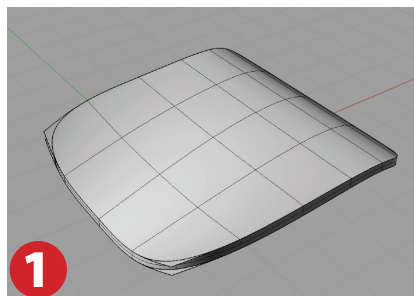### Step 1: Inside the polygon modeler

To fillet the seat of the chair in Rhino, model the sides of the seat separately in the polygon modeler.
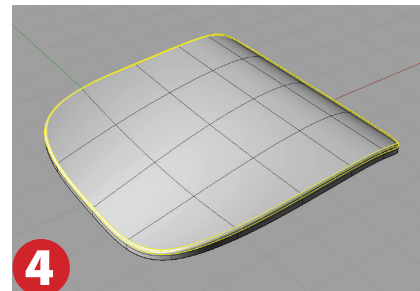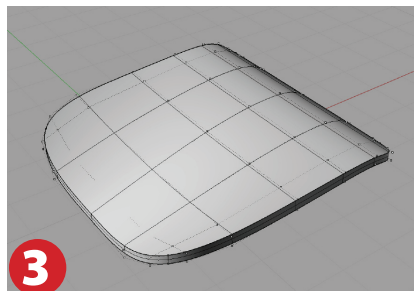

Step 2: Inside T-Splines/Rhino

1 Import each surface into Rhino and convert to T-Splines.

The side profile imports fine. However, the top and bottom surface have the corner points sticking out.

2
3 Those points can be pulled back using the Snap to Knot function to eliminate naked edges.

4 Now the T-Spline surfaces can be converted to NURBS, where the fillet tool can be used.

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Afterthoughts

These three examples illustrate the major addition T-Splines is to the toolbox of product designers. Combined with polygon mesh modeling, it is a very powerful tool in addition to NURBS and solids. Objects can be created in minutes which could take hours if modeled only in Rhino.

I am an educator; in education, T-Splines helps students be more successful with creating the surfaces they desire—especially when they are new to NURBS modeling and do not yet fully understand the importance of surface continuity and how to control it. As a side note, all the mesh models shown here were created in Blender, a free polygon and subdivision surface modeler, which when bundled with lab licenses of T-Splines and Rhino presents a very budget-friendly package.

C l a a s E i c k e K u h n e n
Artist : Designer : Educator

Assistant Professor Industrial Design
Kendall College of Art and Design
of Ferris State University

info@ckbrd.de
www.ckbrd.de

For more information about T-Splines for Rhino, and for a free trial, visit www.tsplines.com, or contact:

T-Splines, Inc. 34 E 1700 S Suite A134 Provo, UT 84606 801.841.1234 info@tsplines.com

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