T·Splines

Free-form Architecture with T-Splines and Rhino® 4

A tutorial in free-form architecture

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Overview

Organic architecture is often difficult to create using traditional NURBS techniques of sweeping, blending, and filleting. This tutorial presents a new method for accurately creating complex architectual forms using a single surface with T-Splines and Rhinoceros® 4.
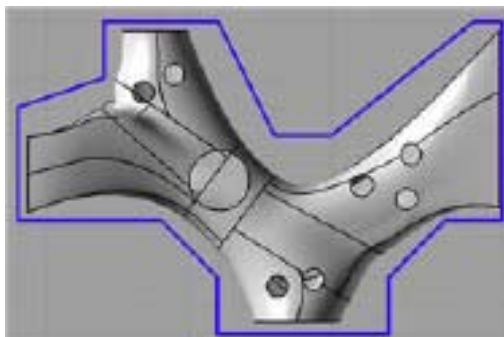
1 Laying out the reference

1. Begin with either a 2d sketch of the model, or a roughed out NURBS or mesh model to get your proportions. In this case, we started with a NURBS model that had the right dimensions, but had incorrect transitions and undesirable kinks.
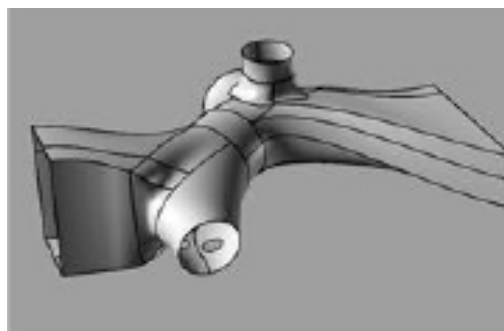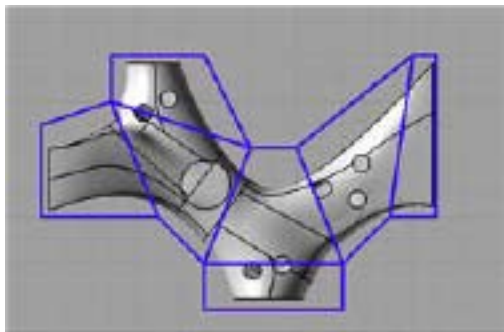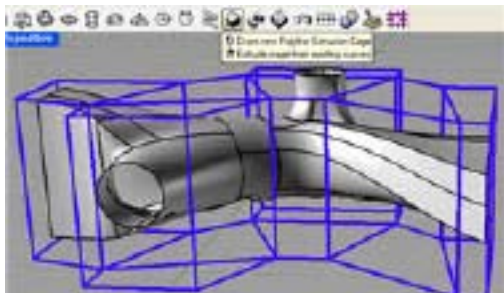

2 Constructing the cage

2. Draw a polyline from the top view to rough out the shape.

3. Connect the polyline with interior line segments to make quads wherever possible.

4. Extrude the polyline cage to create a control polygon. A quick way to do this is by using the Polyline Extrude Cage option on the JBWirecage toolbar (download at www.tsplines.com/wiki/).
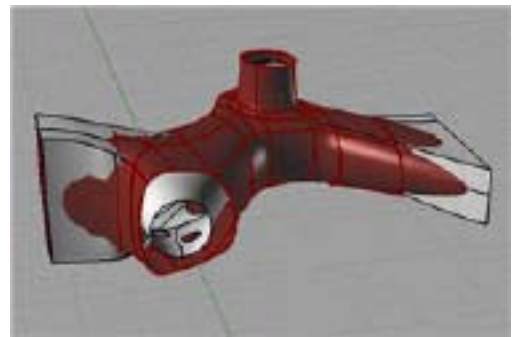
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5.Using the T-Splines manipulators (tsManip), scale and transform the control polygon so it hugs the model more tightly.
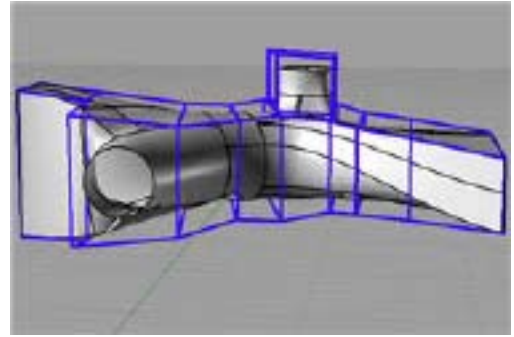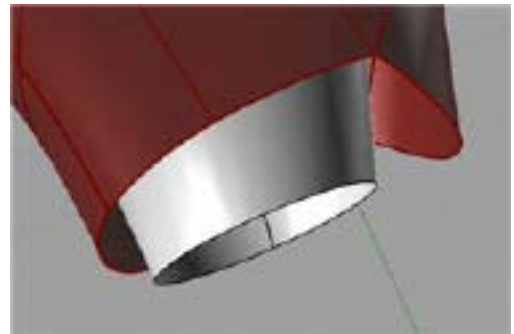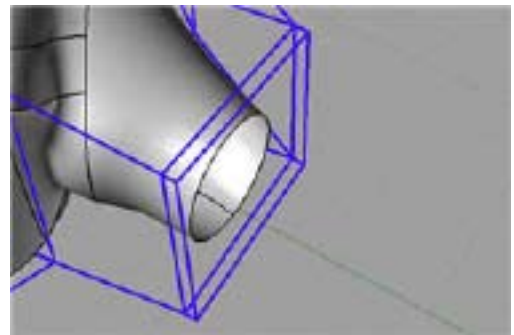

3 Creating the model

6. Create a surface from the control polygon using tsControlPolygonToSrf (see Appendix 1 for details.) The new surface is in red, while the reference model is grey.

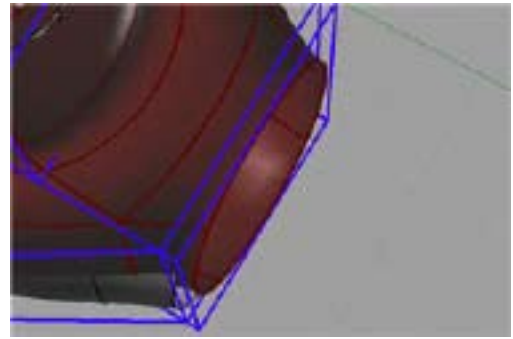7. We still have some problems on these side parts.

8. We'll solve this by deleting the surface and adding another section to our control polygon.
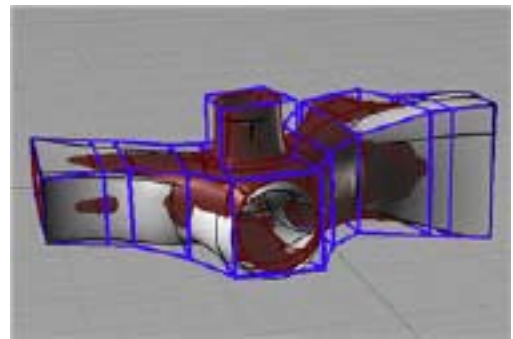
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9. After resurfacing the model, it now has much better behaved surface edges.
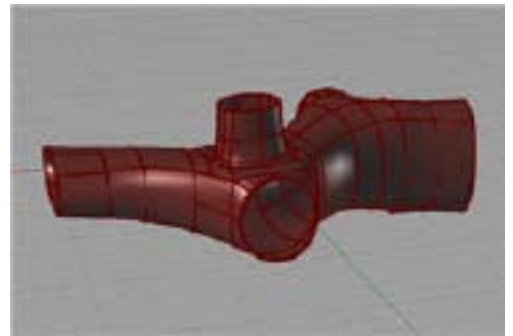

10. The final model (red). There will be one control point per line segment intersection.
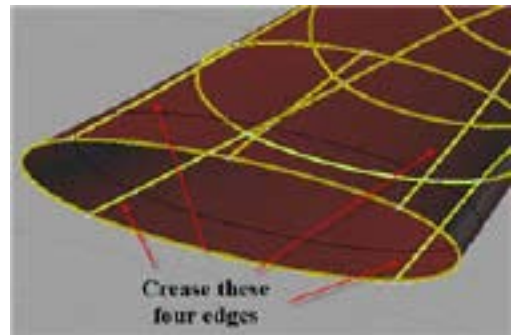

11. The final model.

At this point, we have the general surface shape, but some detail work remains to be done. We will focus on two steps: adding creases and adding control points.
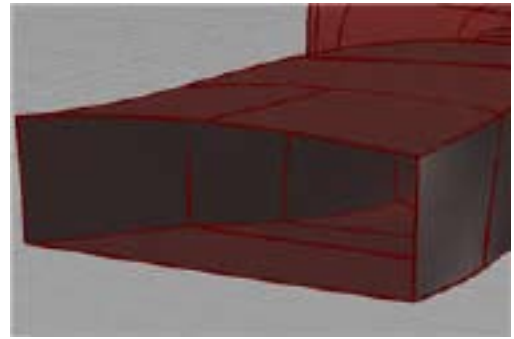

4 Adding creases

12. To obtain sharp edges in the model, we'll add local creases. (Use tsCrease: Sharpness=1, InsertionType=Simple).
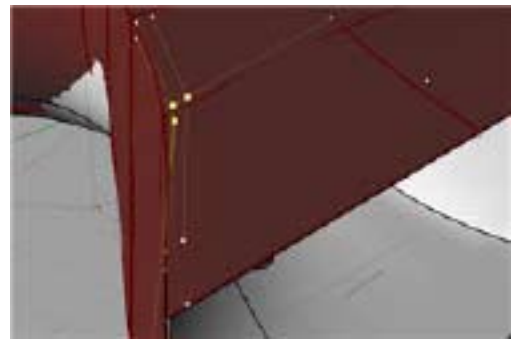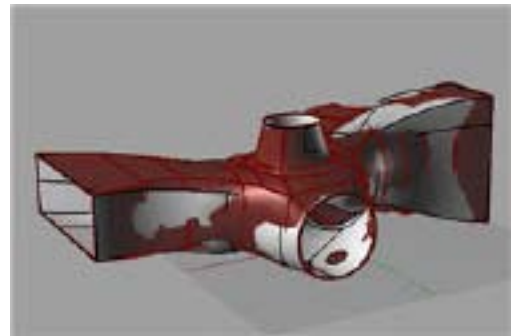

Crease these four edges

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13. The creased model. We'll repeat this method on both creased ends.

14. We can move control points to position the model like we want it. The creased edges will stay creased, while the smooth edges will remain smooth.
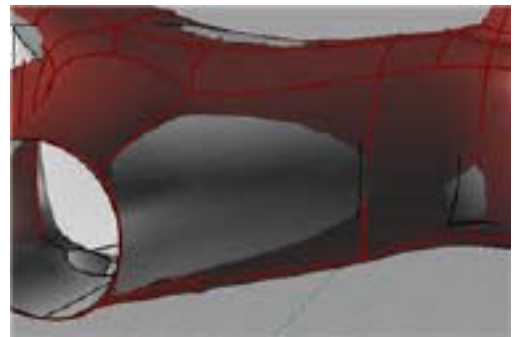

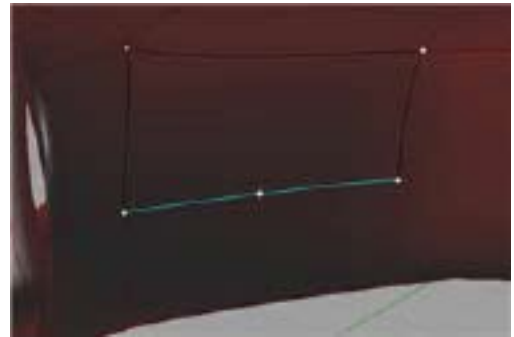15. The T-Splines model (red) and the NURBS model (grey).

5 Adding control points

16. On this side of the model, the T-Splines model is not curved enough.
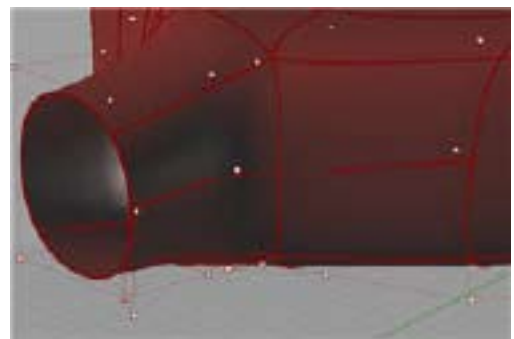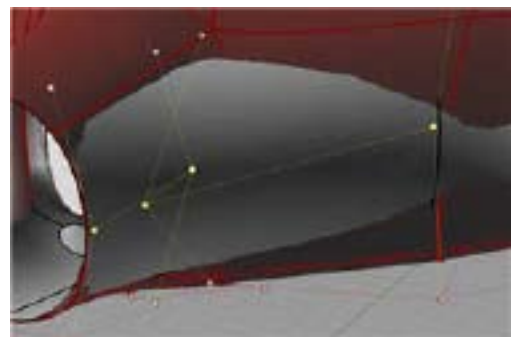
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17. To get enough curvature, we'll need to add four more control points. (See Appendix B.)
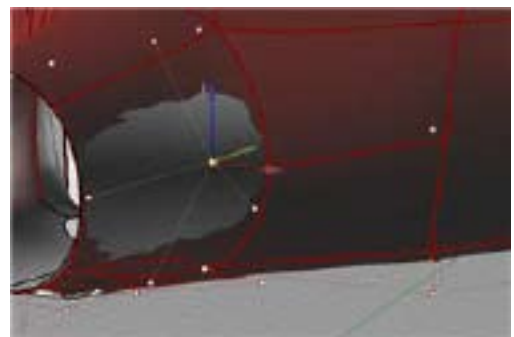

18. Here's the model with new control points added.

19. The new control points highlighted.

20. These control points can be moved, rotated, and scaled using the T-Splines manipulators until the desired curvature is reached.

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21. The curvature of the model--smooth everywhere except creased on the ends.

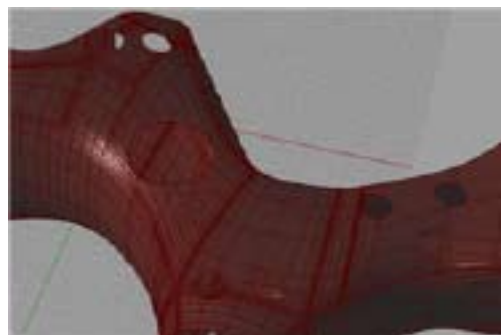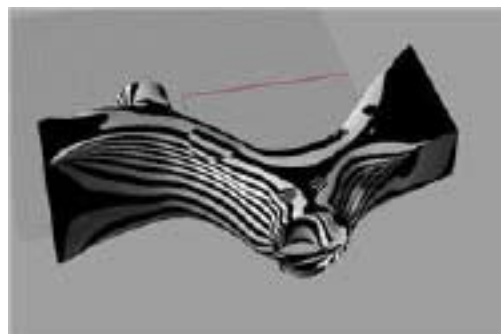# 6 Final details

22. Finally, we'll trim the model by projecting the holes onto the surface.

23. Splitting the model with the curves will convert the T-Splines model to a NURBS without any loss of detail.

24. The model retains its continuity.
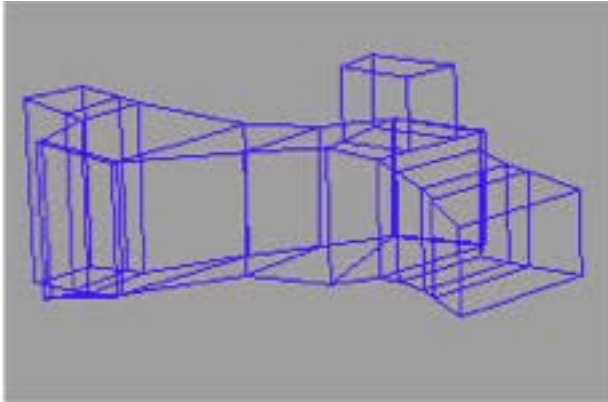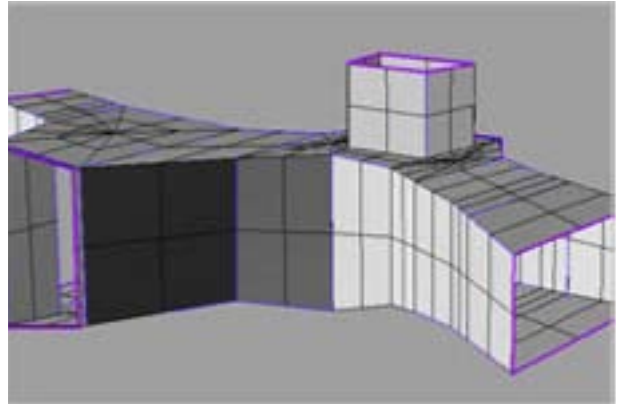
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7 Rendered

8 Manufactured

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Appendix 1: Creating a surface using the tsControlPolygonToSrf command

Creating a surface from a control polygon is a five step process. For more information about this command visit the T-Splines Rhino wiki: www.tsplines.com/wiki/.
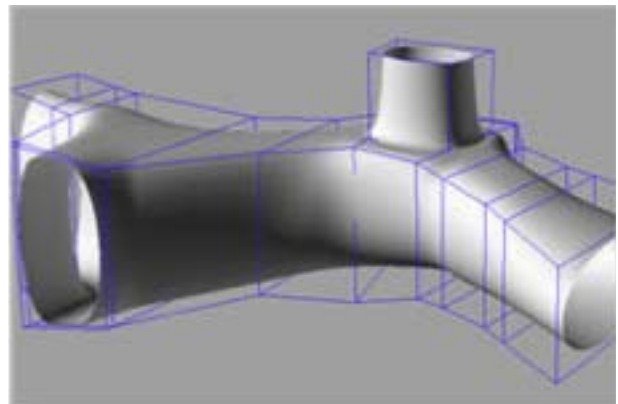

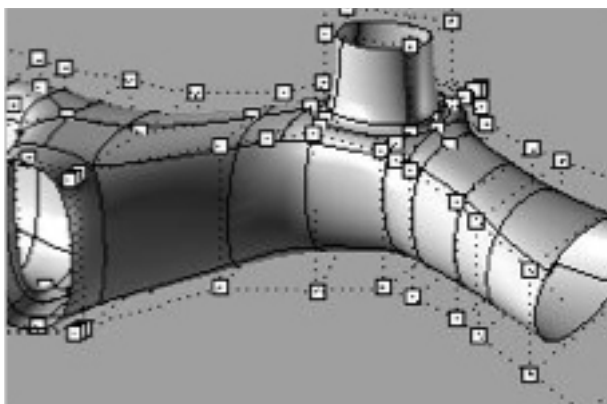**Step 1:** Lay out line segments to define your control polygon.

Step 3: Click the "Faces" button to modify the topology to make sure the rough layout of the shape is correct.

Step 2: Enter the tsControlPolygonToSrf command.


Step 4: Preview the surface.

**Step 5:** Click OK. The generated surface will have control points at the line segment intersections.

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Appendix 2: Inserting points in T-Splines

Inserting control points in T-Splines is slightly different than Rhino's "Insert Knot." In T-Splines, click on each edge where you'd like a new control point. By default the new point is inserted halfway across the edge; but you can change these magnets to snap to any interval or turn them off altogether. More information about this command is available at the T-Splines Rhino wiki: www.tsplines.com/wiki/.
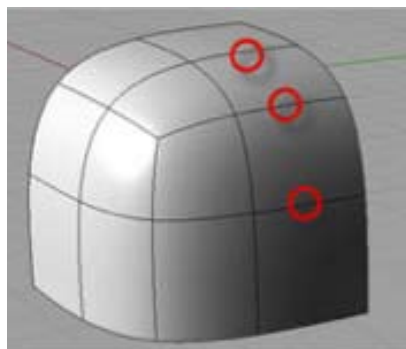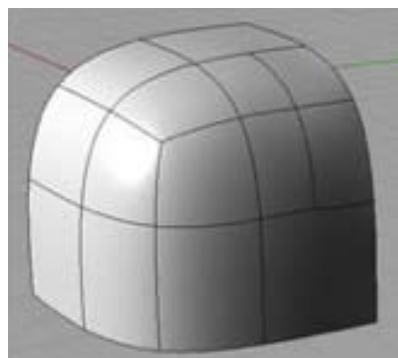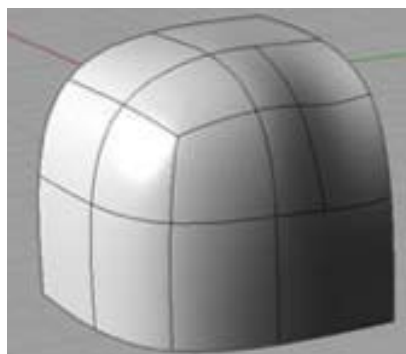

1. It is desired to insert control points here.
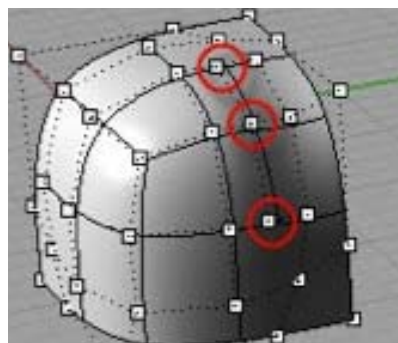
4. Here are the additional control points added in simple mode.
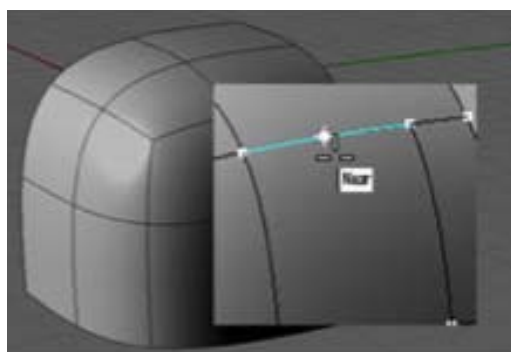
2. Click on each edge where new control points are desired while in the tsInsertPoint command. There are three modes in the command.

5. In "**Fitting**" mode, the surface won't change much. Sometimes a few more control points need to be added.

3. In "**Simple**" mode, no additional control points will be added, but the surface will probably change. This is a good mode if you will be sculpting your model.
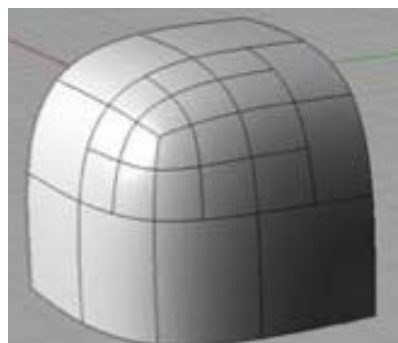
6. "**Exact**" mode won't change the surface at all, but a lot of control points may be added. This is useful when the model is almost done.

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