

T-splines 3 ways

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Class Overview

- Basic overview of T-Splines
- Best Applications for T-Splines in your workflows
- Beginner, intermediate, and advanced T-Spline workflows
- How to troubleshoot T-Splines
- How to ensure clean surfaces for conversion to BREP



Entry Level T-Splines

Working with Simple Surfaces, and Primitives

- Learn how to use simple surfaces for blending organic and orthogonal design together
- How to use edit form as the heart of your T-Splines workflow
- Basic principles of overmodelling

Intermediate T-Splines

How to get smarter with T-Spline surfaces

- Advanced features of edit form
- How to use subdivision and modification tools to T-Splines
- Modelling with reference geometry
- Box mode

Advanced T-Splines

Learn how to edit your generative design results and work with the data

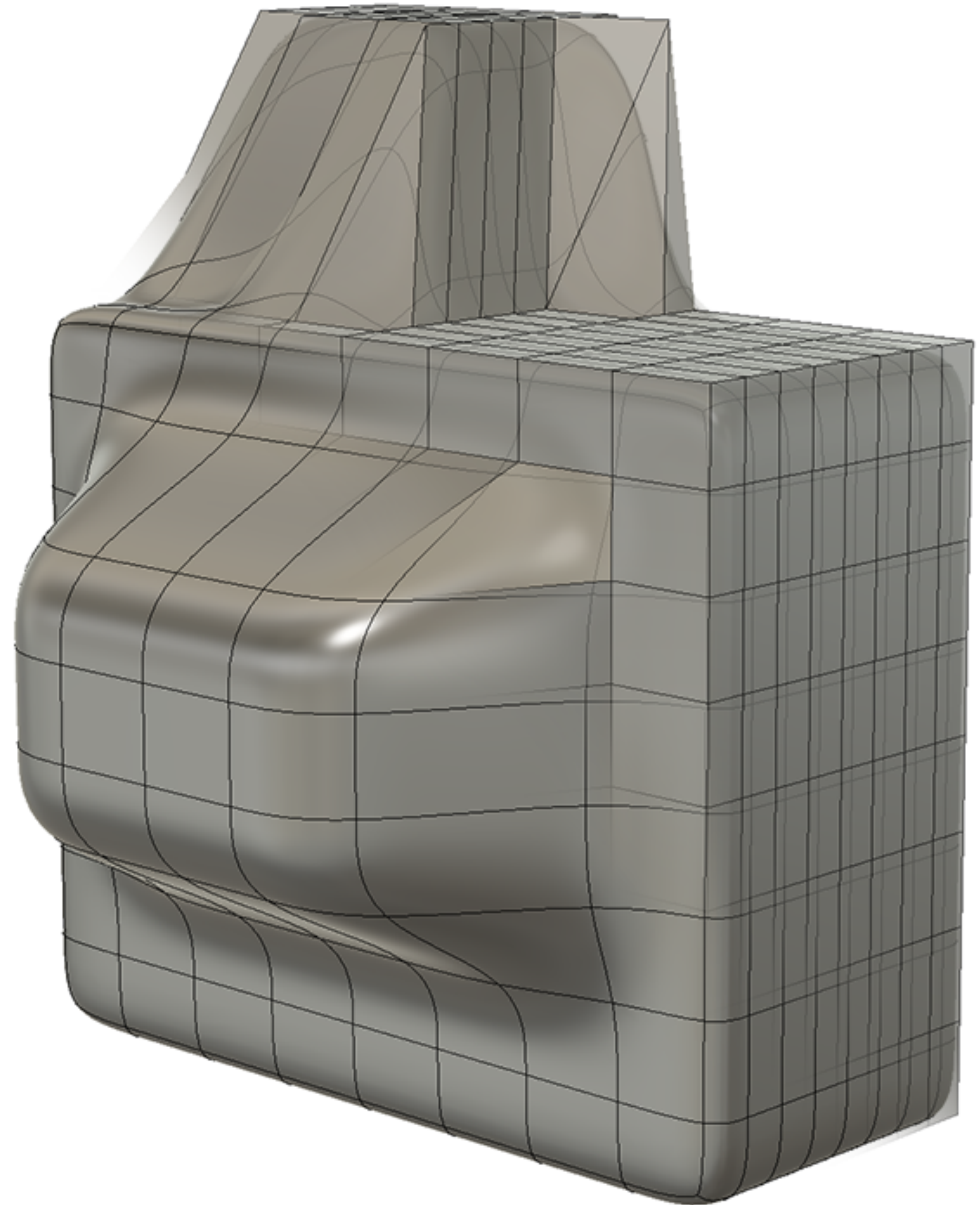
- How to model an object from scratch
- How to use insert points for complex surfaces
- How to analyze t-spline surfaces for cleanliness
- Healing and troubleshooting surfaces

What are T-Splines?



How do T-Splines Work?

- A **T-spline** surface can be thought of as a [NURBS](#) surface for which a row of control points is allowed to terminate without traversing the entire surface. The control net at a terminated row resembles the letter "T". Modeling surfaces with T-splines can reduce the number of control points in comparison to NURBS surfaces and make pieces easier to merge, but increases the book-keeping effort to keep track of the irregular connectivity. T-splines can be converted into NURBS surfaces, by knot insertion, and NURBS can be represented as T-splines without T's or by removing knots
- TL;DR – T-Spline is inherently different maths at the back end. Treat it accordingly! T-Splines are very complex!



Frame of Mind

If you are new to T-Splines, the method of modelling is very different to what you are accustomed to in the design space of Fusion 360, it's best to treat it like learning a new program! Little of what you are accustomed to in CAD will translate over to T-splines



Approach

- You will get the most out of T-Splines if you treat it like modelling with Clay.
- You shouldn't try and jump straight into adding details from the beginning! You will take multiple passes at the overall geometry to arrive at the final object

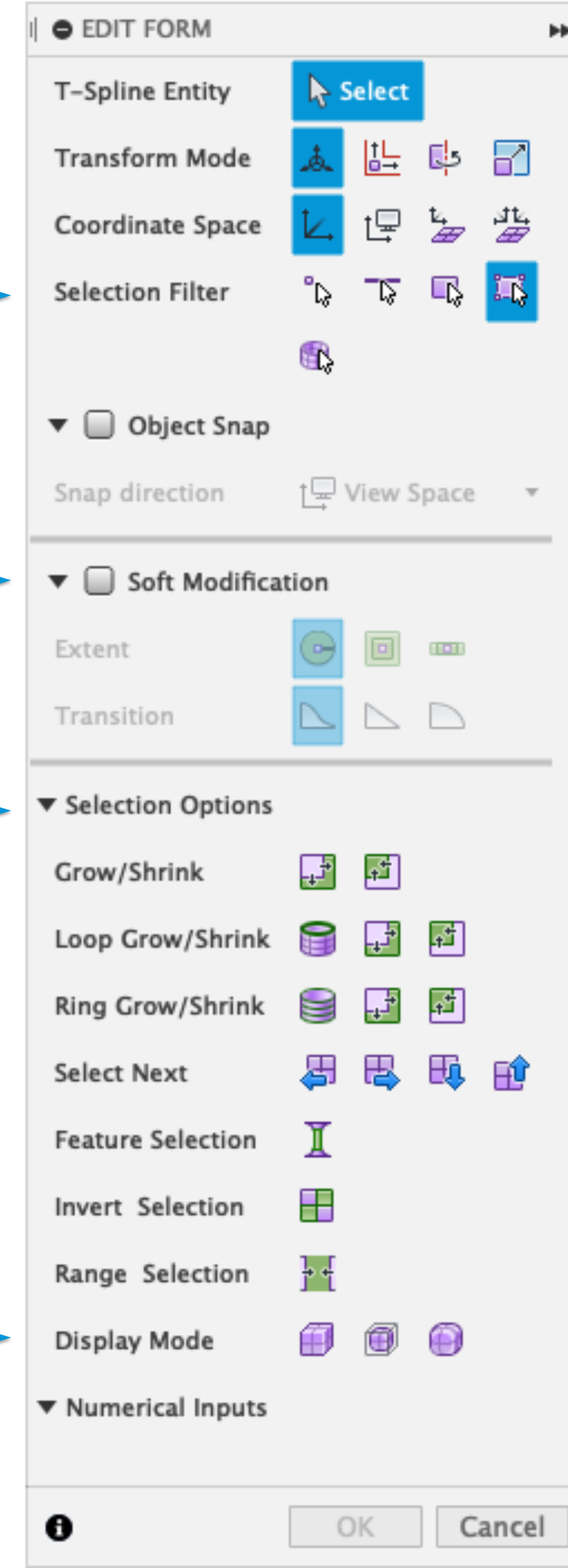


Essential Tools



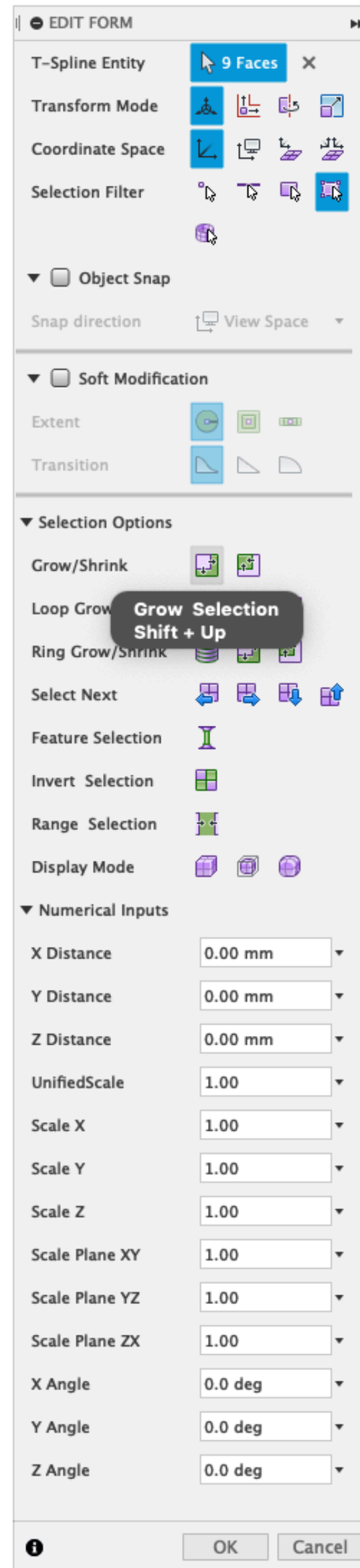
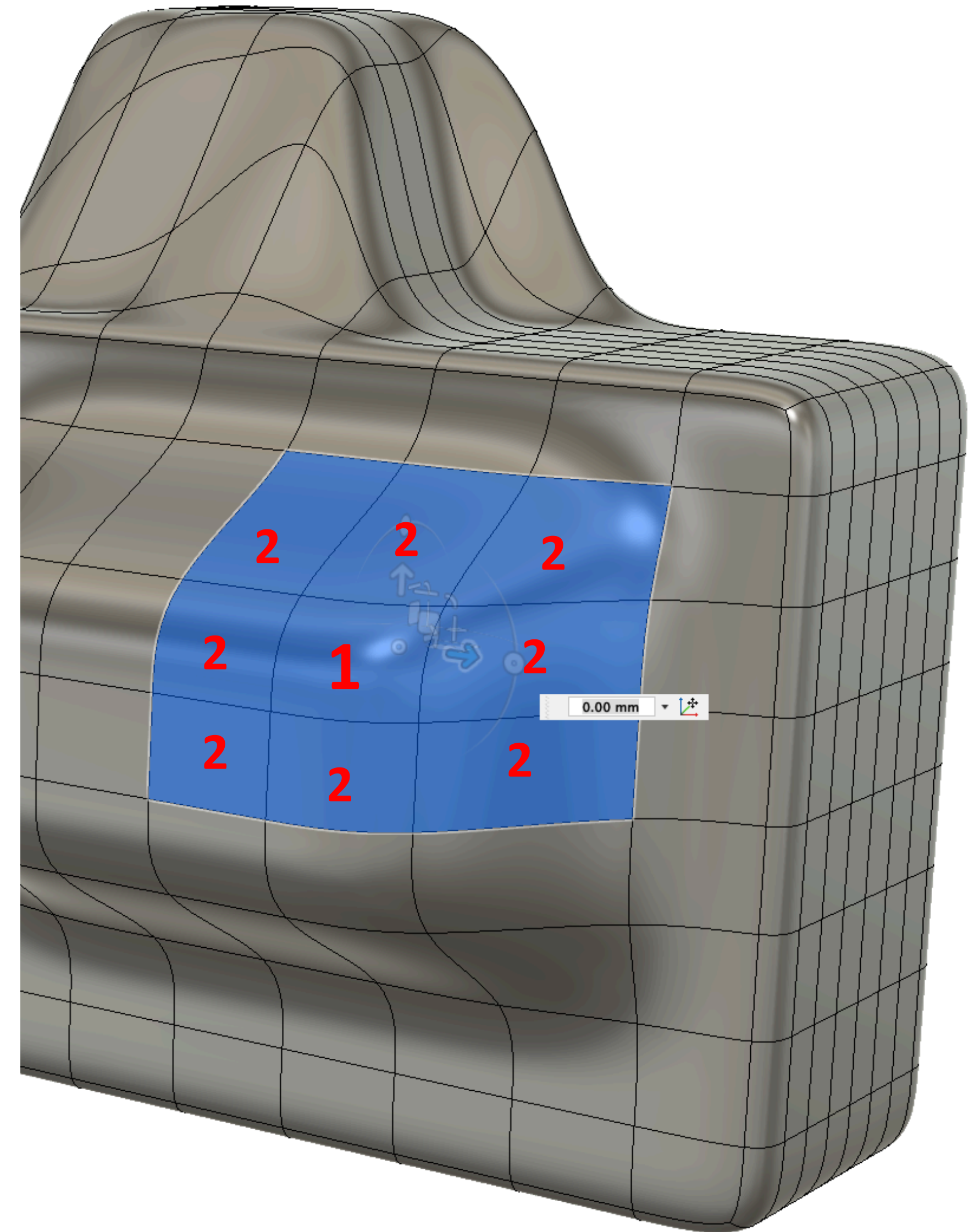
Edit Form

- The most important tool when editing t-Spline geometry in Fusion 360
- Critical functions
 - Selection options
 - Soft modification
 - Selection Filters
- Quick access to display modes



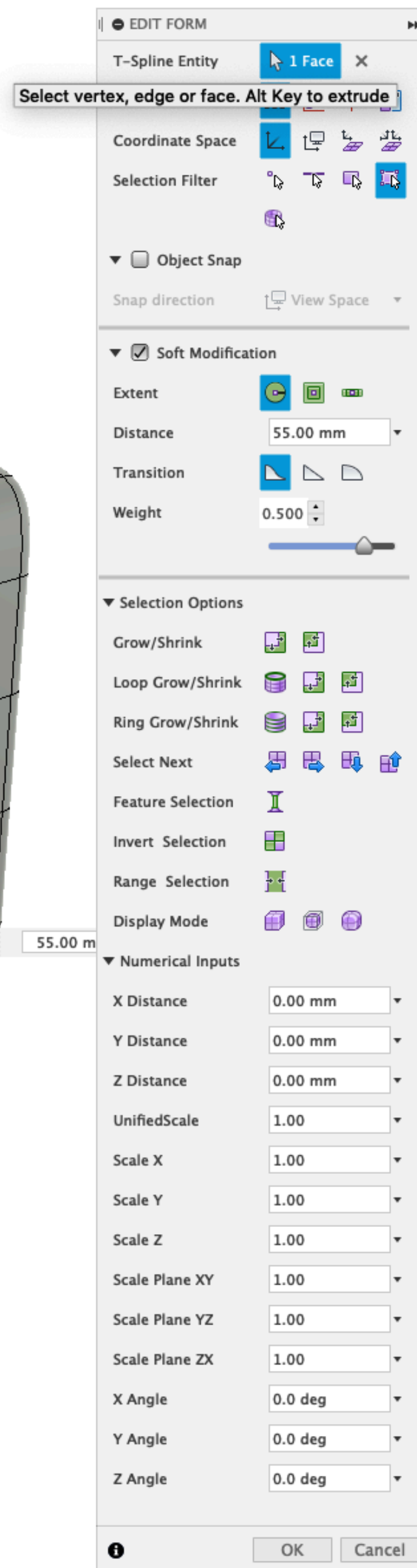
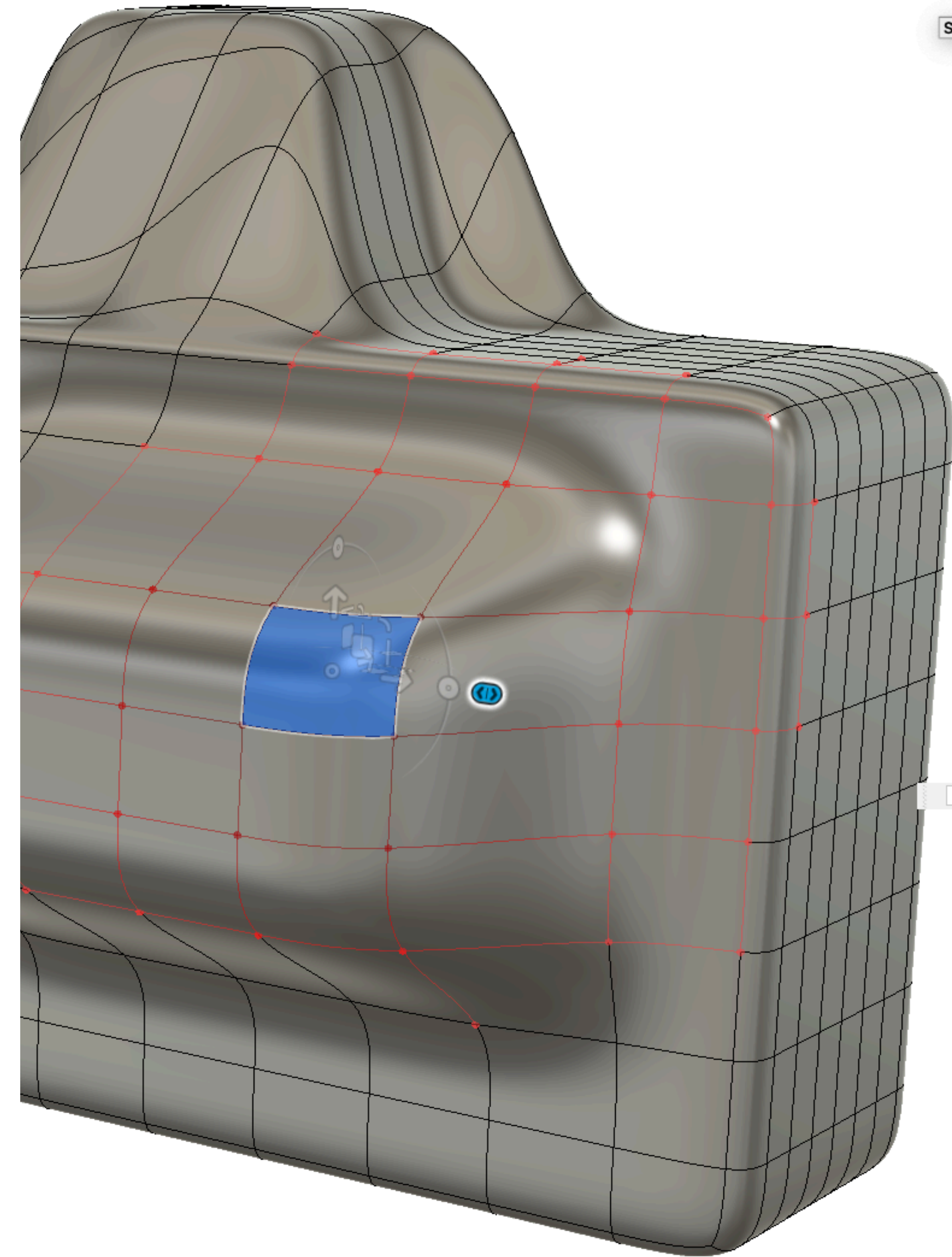
Selection Options

- Selection options are hugely valuable to the t-splines workflow
 - As you are working with lots of faces and soft organic forms, the selection tools make life easier when needing to do specific functions to specific areas
- Each function in selection options has its own behavior, with different application
- In this example, one face was selected and then grow is used to expand to each face in proximity



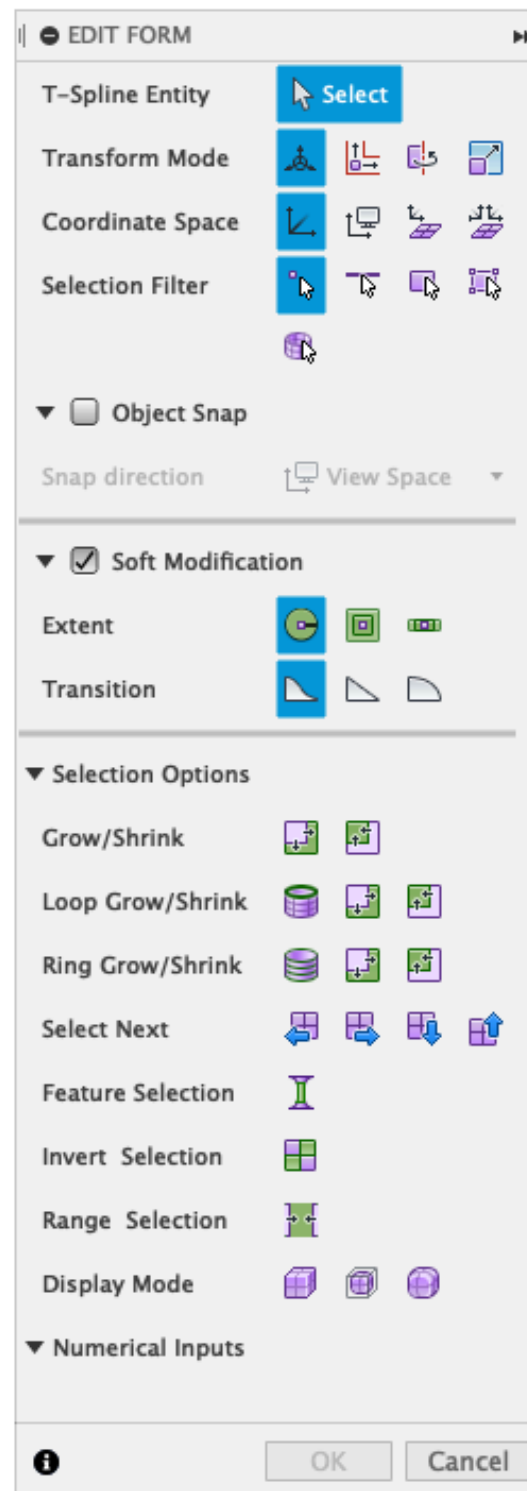
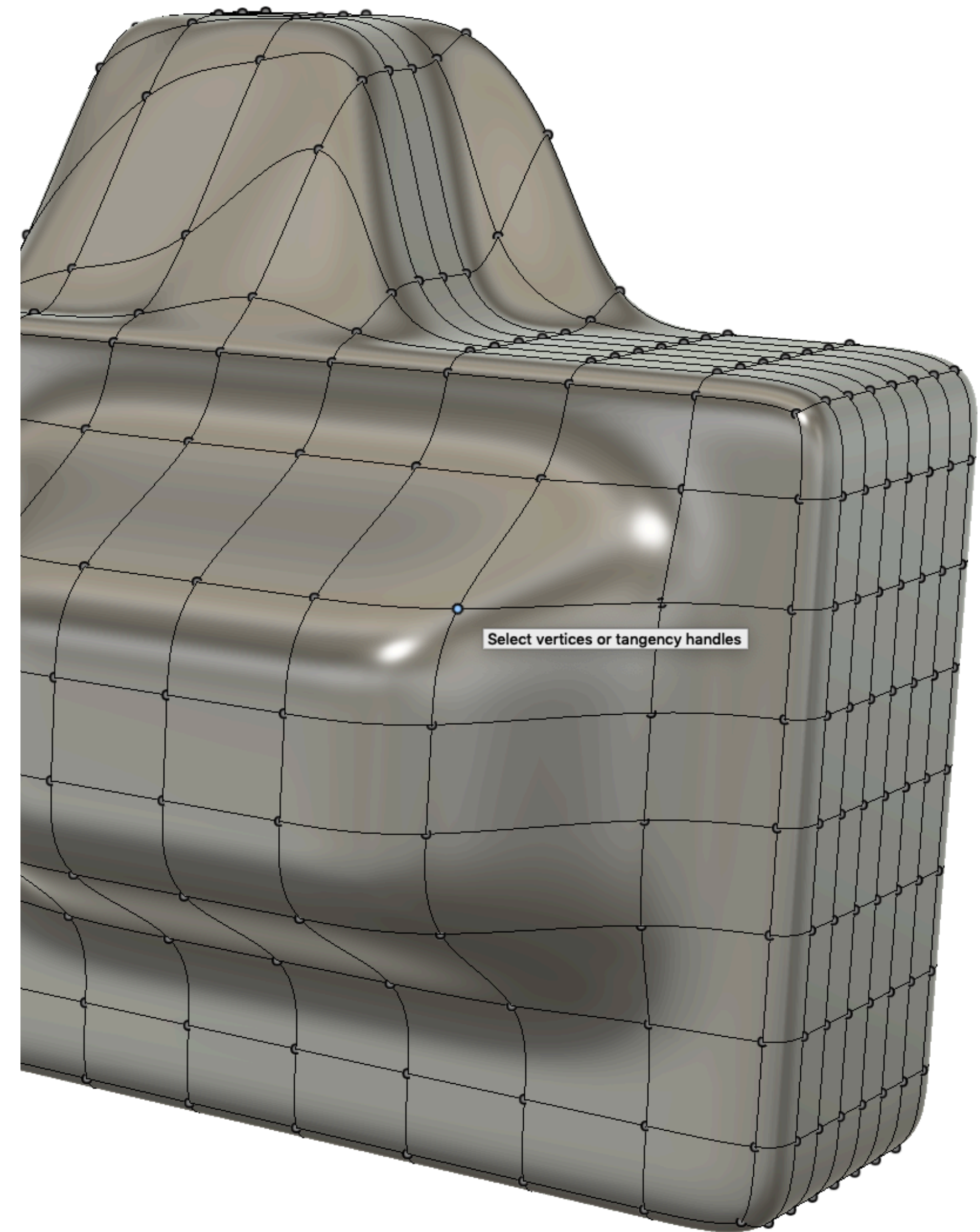
Soft Modification

- When you select a face and move in T-Splines, you are editing that face only. This can make creating smooth transitions from one feature to another a challenge
- Soft modification adds an “area of effect” to your selection, to create a smooth fall off from the edited surface, to the rest of the surface
- Soft modification can operate in a circular function, a specific face count, or in a linear U or V direction
- In this example, one face is selected, using the distance area of effect, with a smooth transition across the area of effect. You can see this demonstrated by the gradient of red to white across the selection area



Selection Filters

- Sometimes you don't want to be able to pick anything, you need that finer control
- Selection filters in T-Splines operate the same way as they do in the Model space
- Each selection filter will make only that specific function selectable
- In this example, the filter is set to vertex, which makes faces and edges unselectable
- This is particular useful when needing to make finer controls over a large high face count surface
- NOTE: the vertex selection mode makes all vertexes visible with a point for ease of use

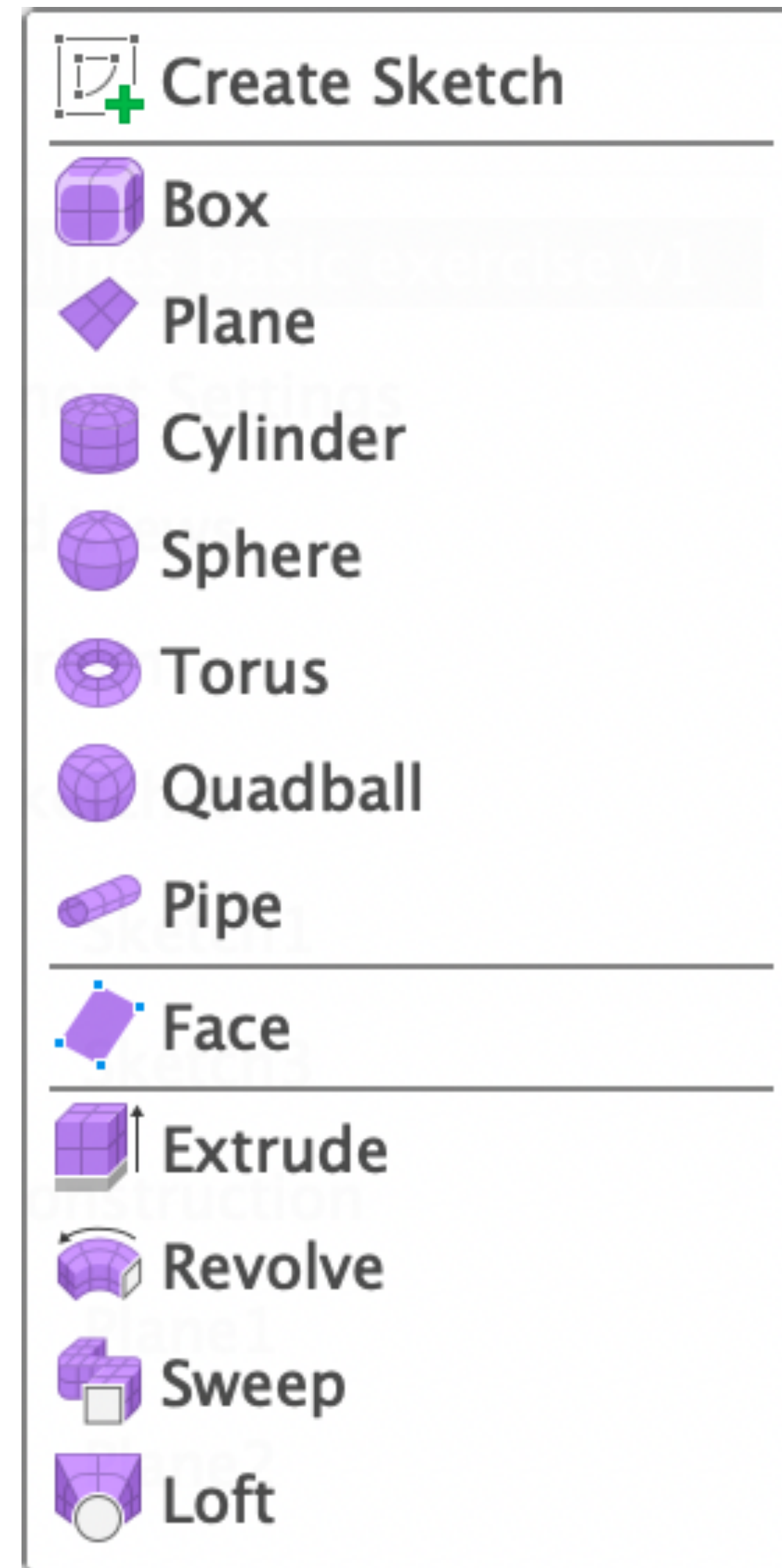


Exercise 1: the basics



How to use primitives

- Box – it's a...box
- Plane – create a flat plane against any surface or construction plane
- Cylinder – this uses a collapsed star to close itself. Take note as this may cause you challenges down the line
- Sphere – created with a closed point
- Torus – mmmmmm, donuts
- Quadball – like a sphere, but has quad faces all over, so no collapsed faces!
- Pipe – it's a pipe, but it's open!



Replace Face

- In the model space, it is possible to replace a face, and rebuild the entire geometry with a surface you created in T-Splines!
- When you combine this with overmodelling principles in T-Splines, you can very rapidly bring orthogonal and organic designs together!



Exercise 2: Getting Schwifty

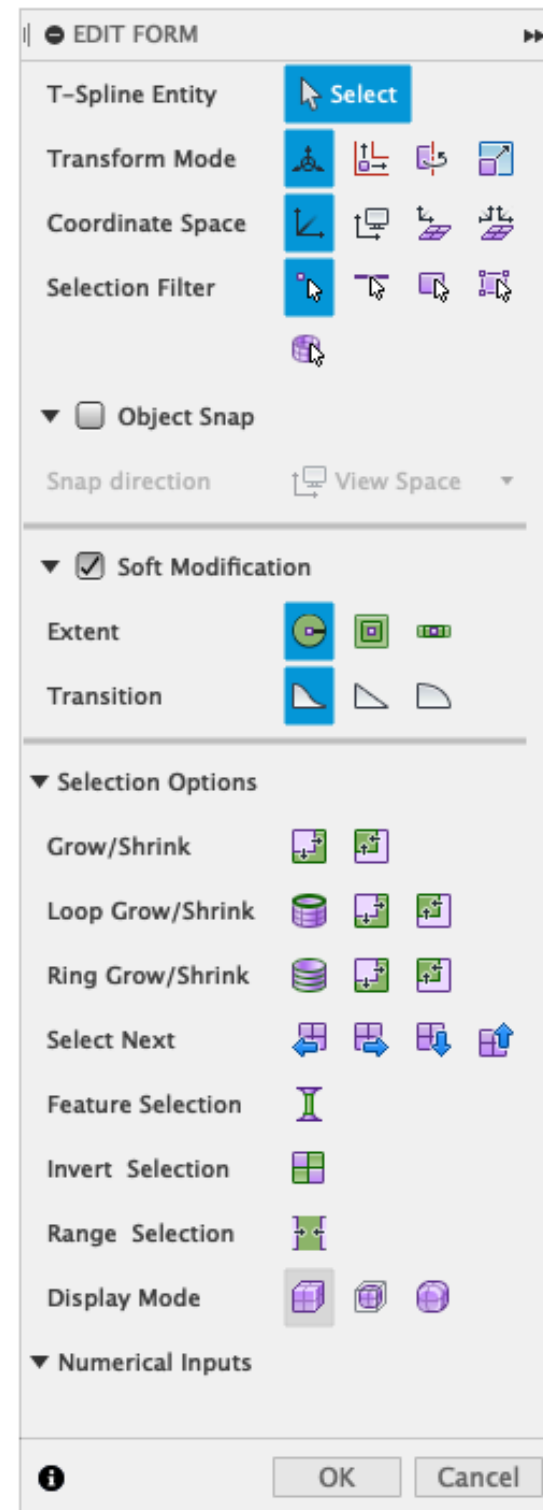
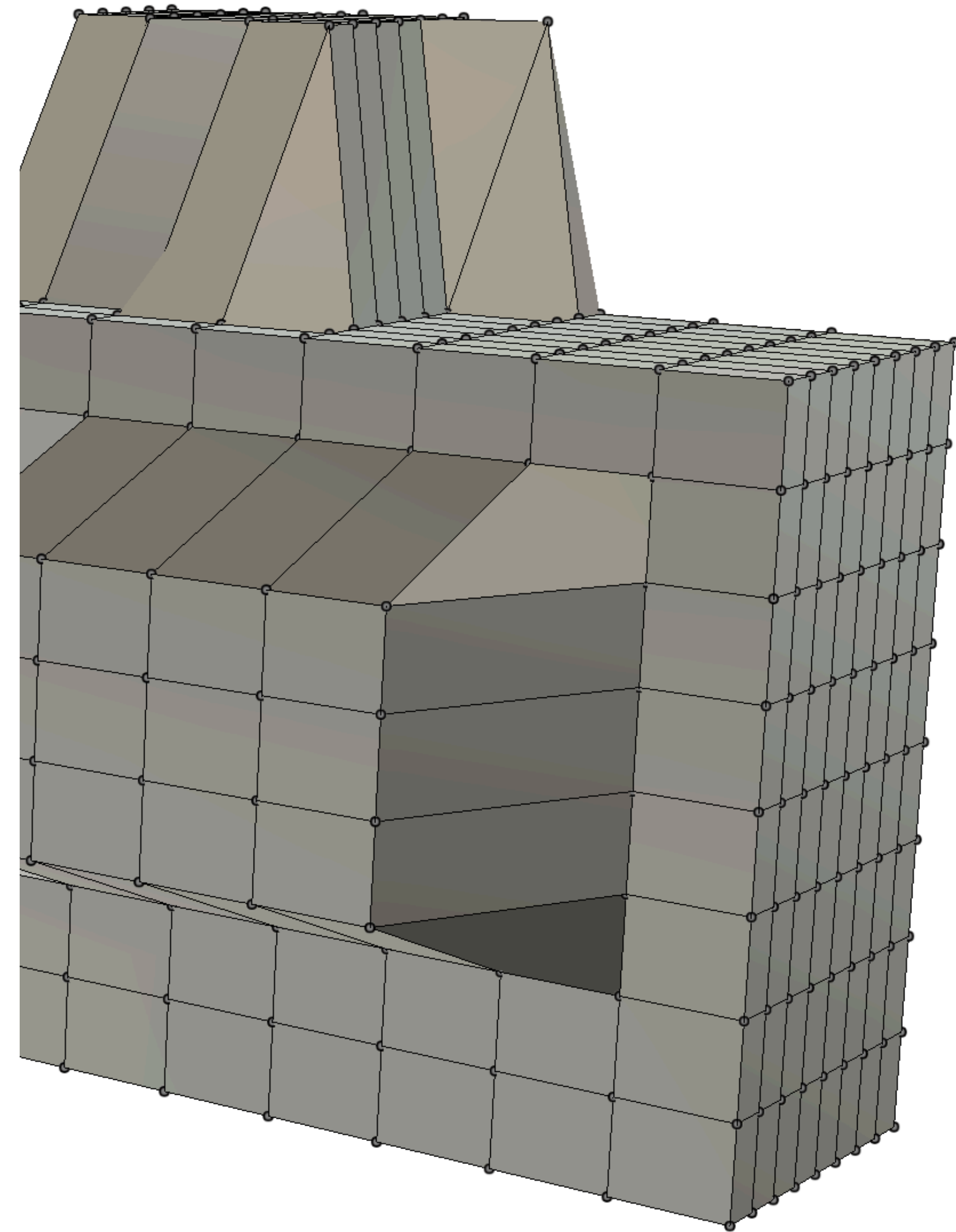


Complexity Tools



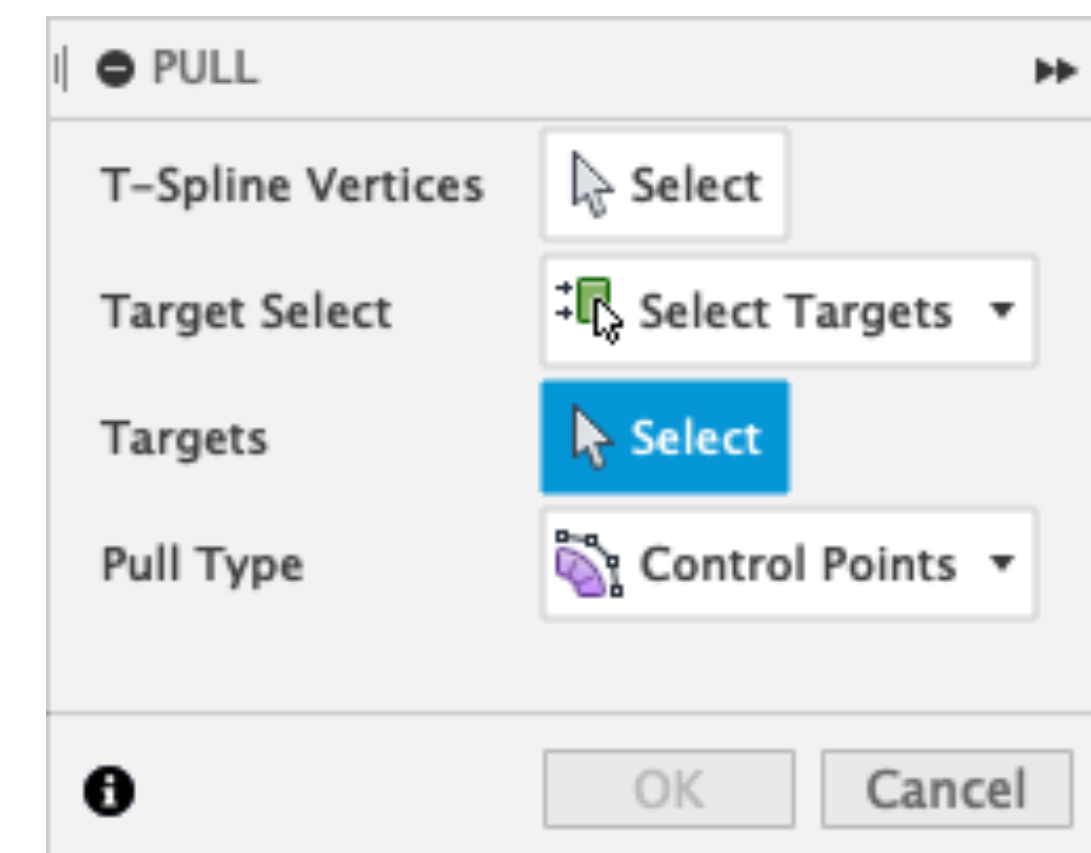
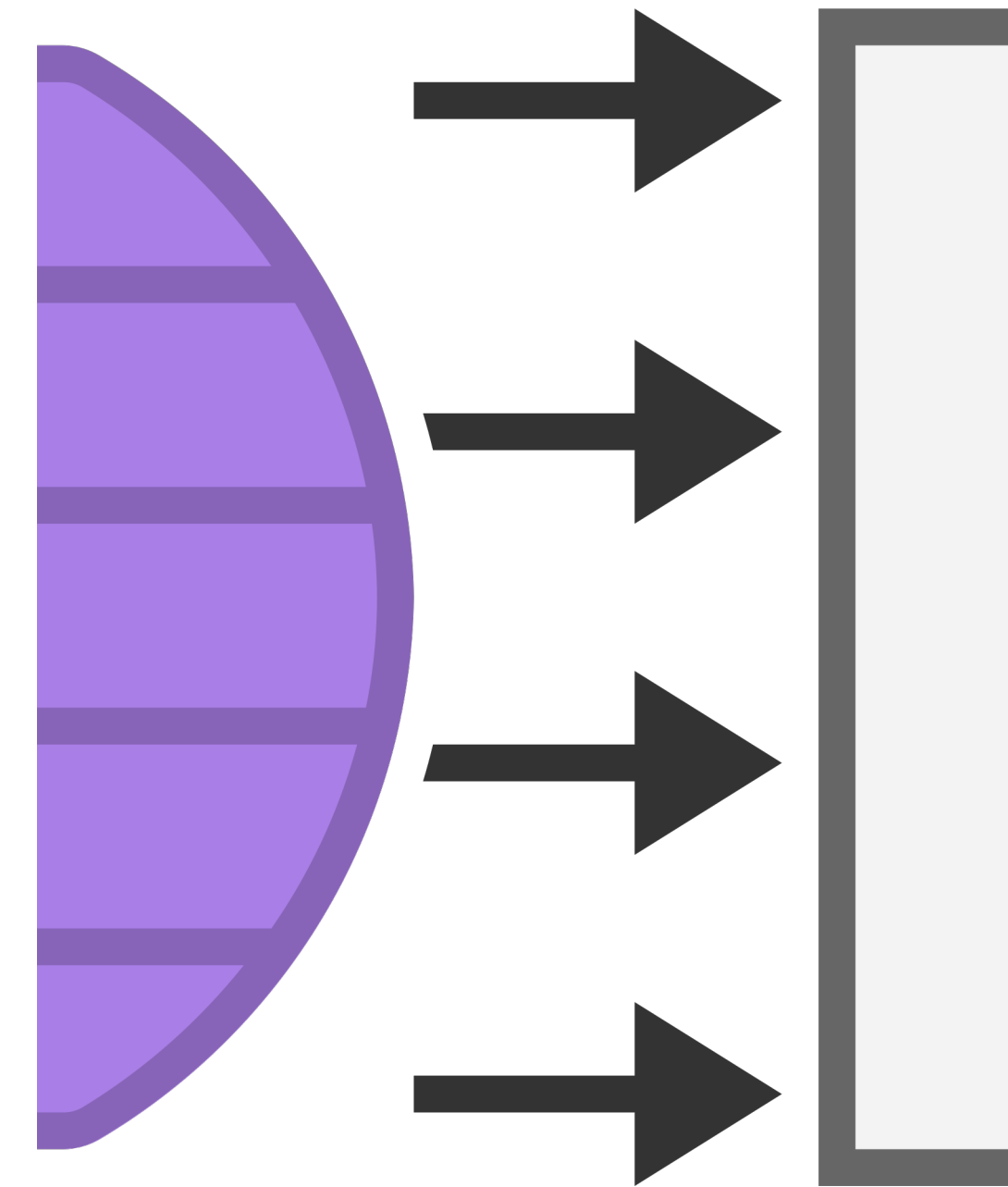
Display Modes

- Display mode shows you what's happening “under the hood” with T-Splines
- T-Splines are made by the net surrounding the object to create smooth grids
- As a result, when viewing in smooth mode only, you may make changes that seem acceptable, until you look at the box mode and see self intersecting elements
- This geometry will calculate and convert to BREP, but as a result of this underlying issue, you may run into challenges with other modifications to the geometry down the line
- It is always worth switching back and forth from box to smooth to ensure clean geometry



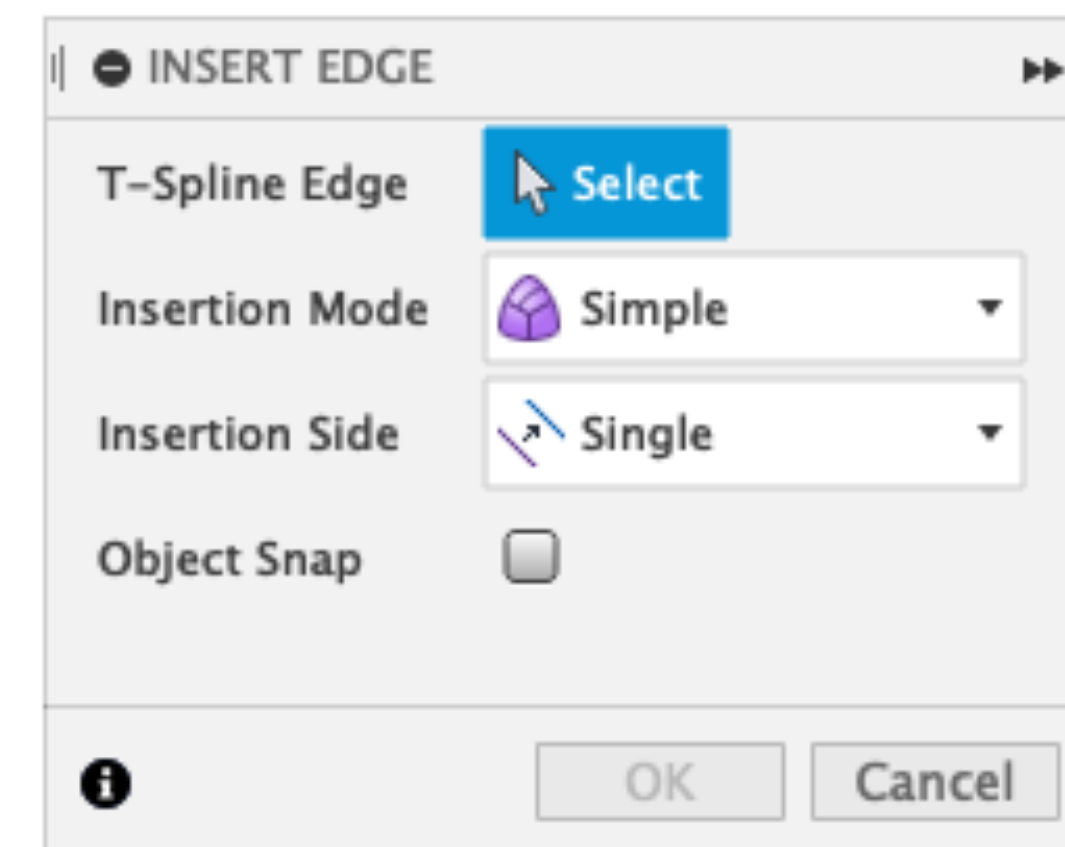
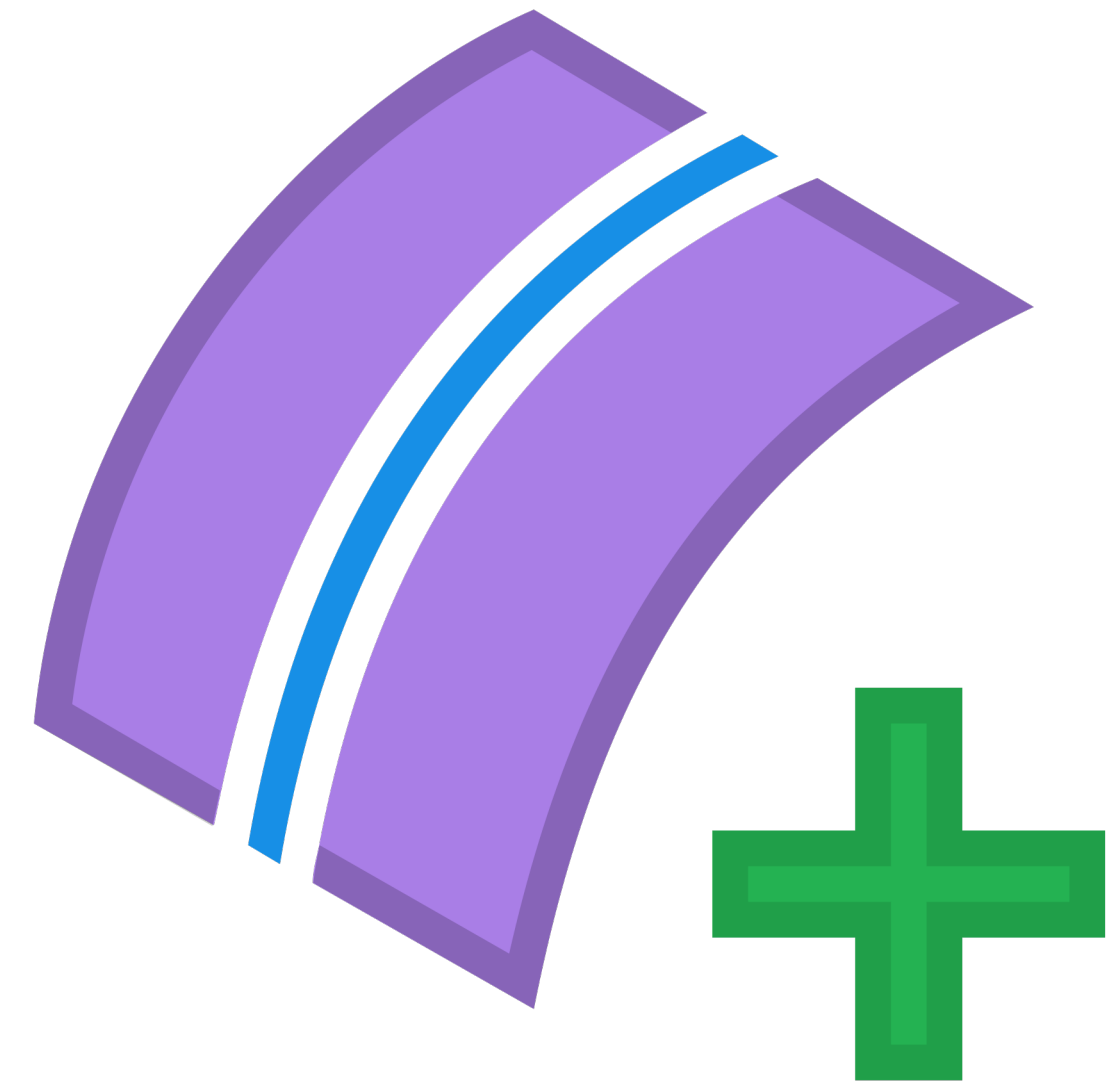
Pull Tool

- Pull enables you to snap geometry to Sketch lines or other Geometry
- There are 2 core modes, Auto, and Select Targets
 - Only lazy people use Auto :P
 - Make sure you set your targets first and vertices after, as it will give you a better idea of what's going to happen
- The pull function is “black box”
 - If you need dimensionally exact geometry, you can do this with match (separate tool)



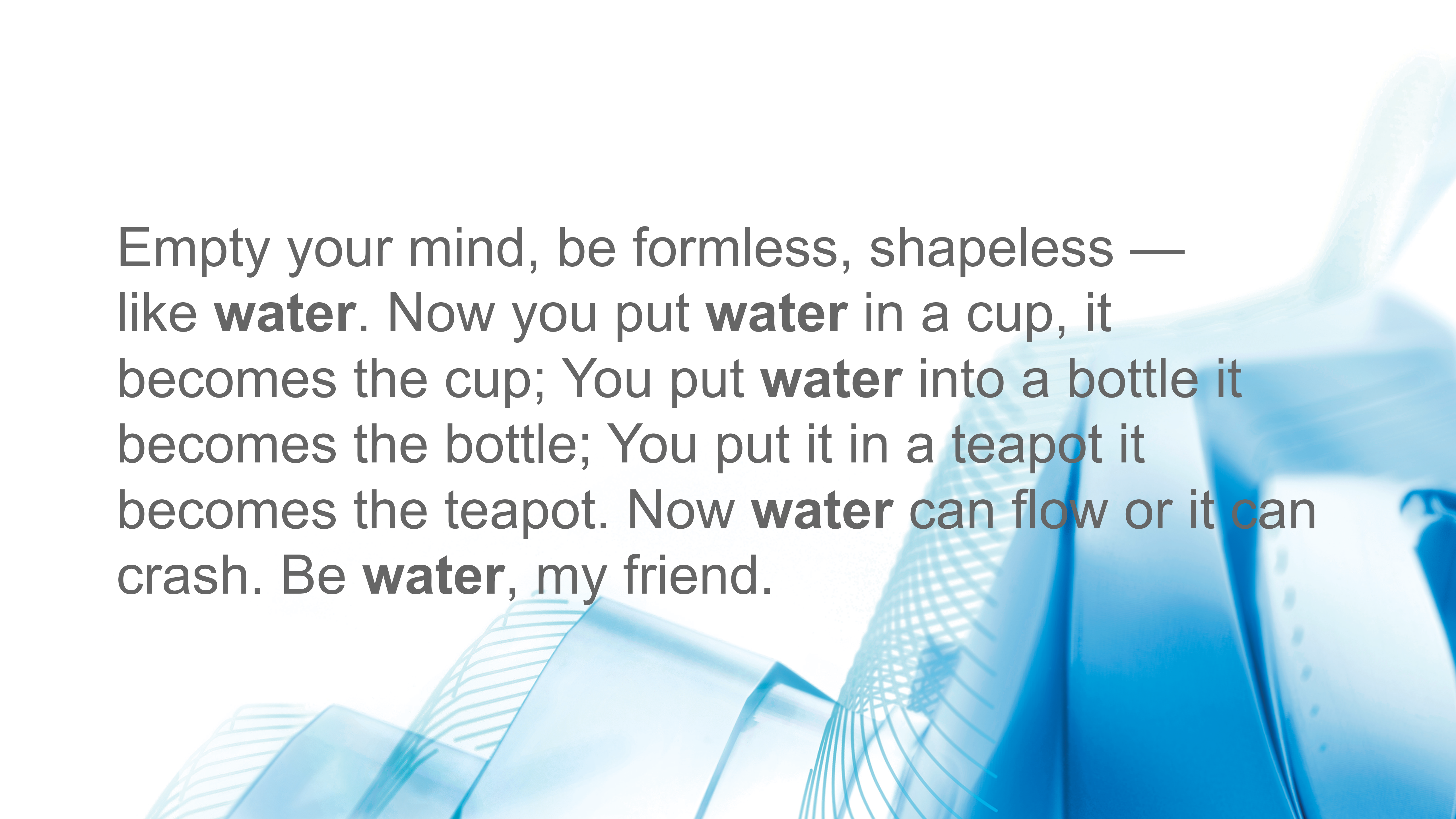
Insert Edge

- You are not limited to the face count you started with.
- You can add as many edge divisions and complexity as you like
- NOTE: Like most surface modification tools in T-Splines, they do *not* operate with absolute dimensions, rather they are a function of an integer. Their distance is measured from 0-1 with .5 being the middle (as it should be, duh.)
- Insertion can be simple, or exact
 - Simple: adds the edge line, without preserving the geometry as it currently exists (you will see the geometry shift)
 - Exact: adds the edge line, and automatically subdivides and adds complexity as necessary, to maintain the surface continuity already in place
- Insert edge adds an surface division along the U OR V lines



Exercise 3: Master of your Domain

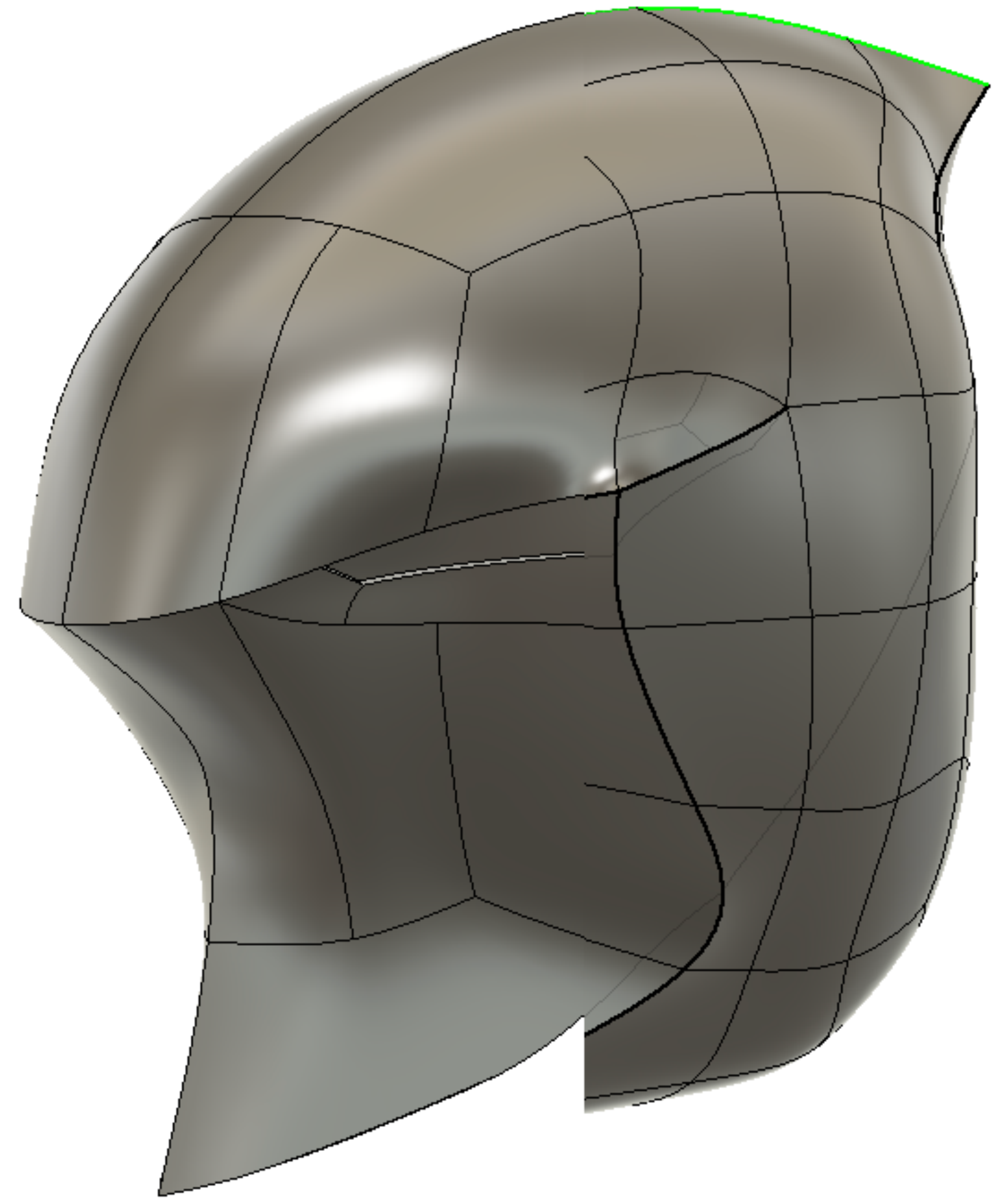




Empty your mind, be formless, shapeless —
like **water**. Now you put **water** in a cup, it
becomes the cup; You put **water** into a bottle it
becomes the bottle; You put it in a teapot it
becomes the teapot. Now **water** can flow or it can
crash. Be **water**, my friend.

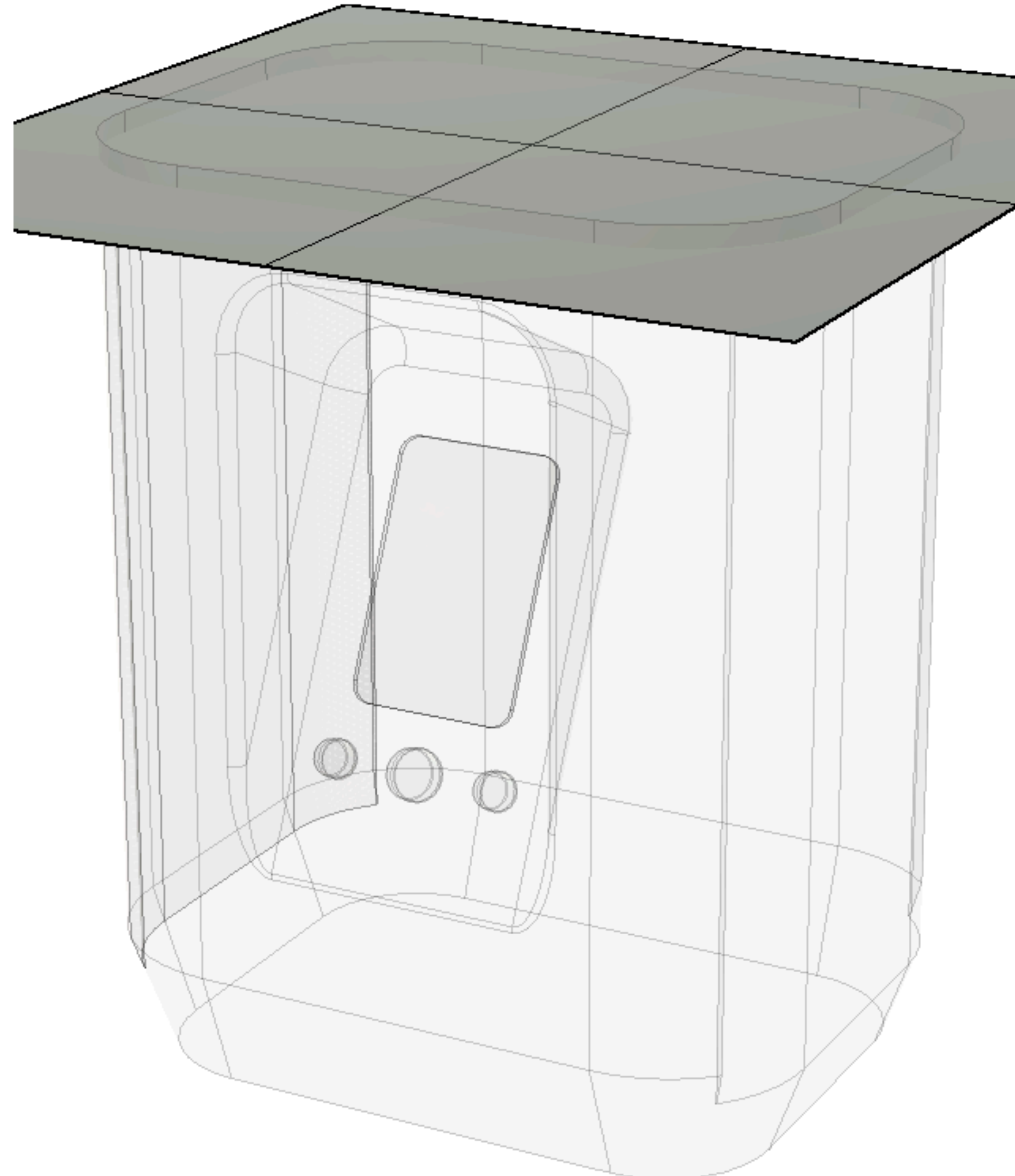
Intuitive Reason

- When building elements from scratch in T-Splines, you will hybridise direct modelling workflows with abstract modelling workflows
- Overmodelling techniques will be applied *liberally*
- You will combine a plethora of different tools in different ways to achieve your target geometry
- Always make reference geometry to ensure your design is within specifications of your project
- Don't treat any t-spline geometry as "precious" if it doesn't work, delete the trouble area and rebuild it, it doesn't take as long as you might think!
- T-Splines is fluid, try to be fluid too!



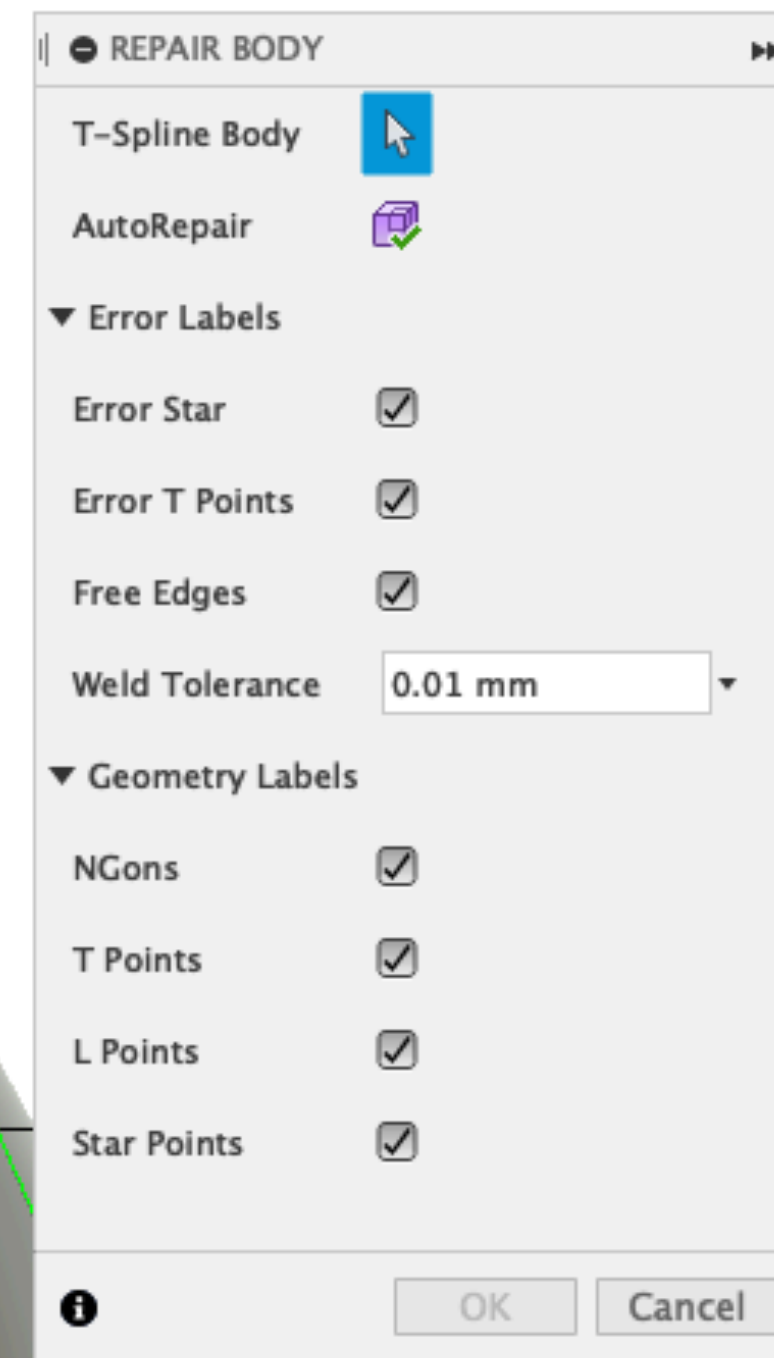
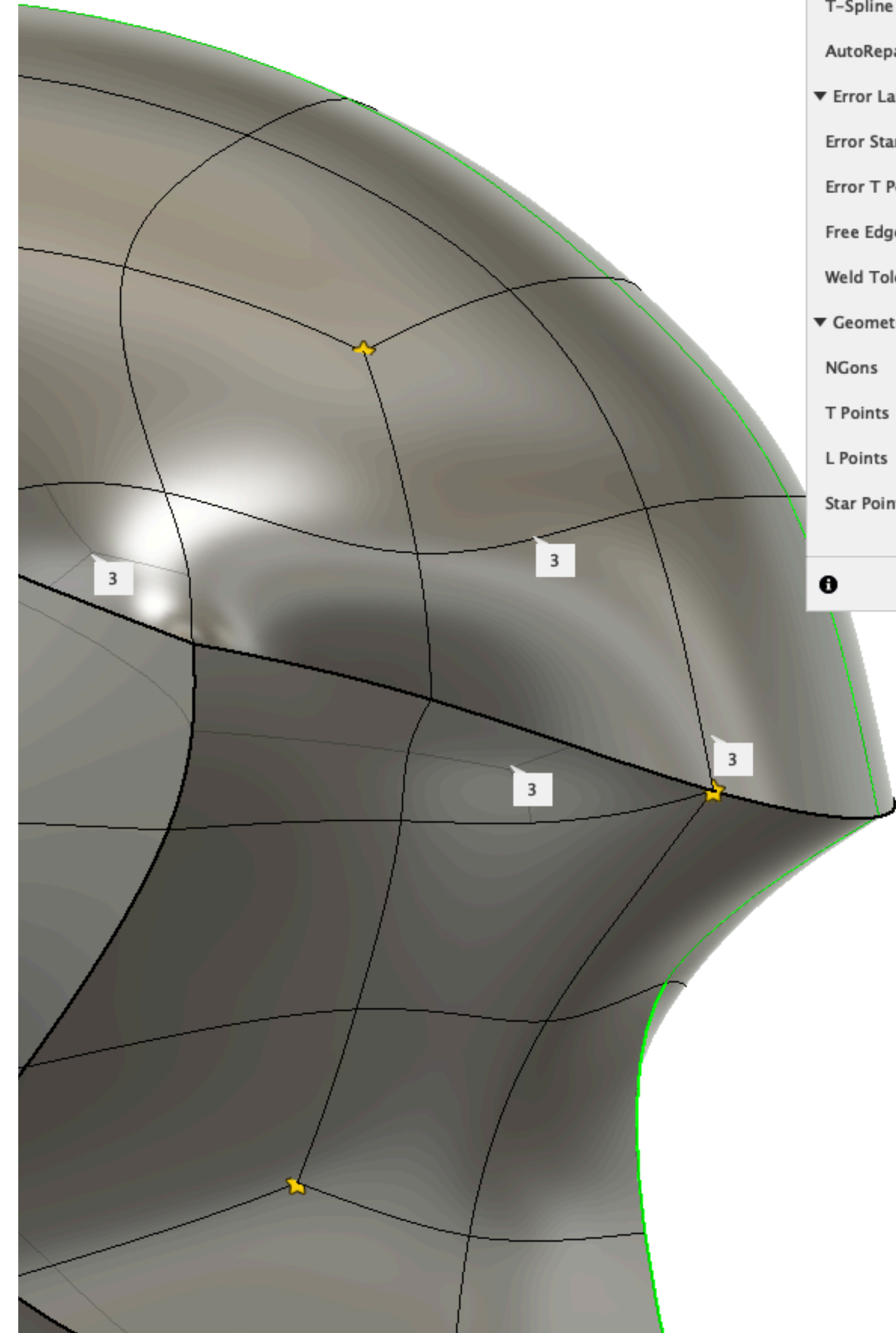
Timeline Behavior

- T-Splines will carry the timeline "snapshot" with it
- This means that irrespective of where the T-Spline was created in the timeline, it will switch to the T-Spline workspace based on where your timeline header is
- This is useful when fleshing ideas out and then reforming them as a product develops
- T-Splines ARE NOT parametric
- T-Splines work seamlessly with BREP Geometry



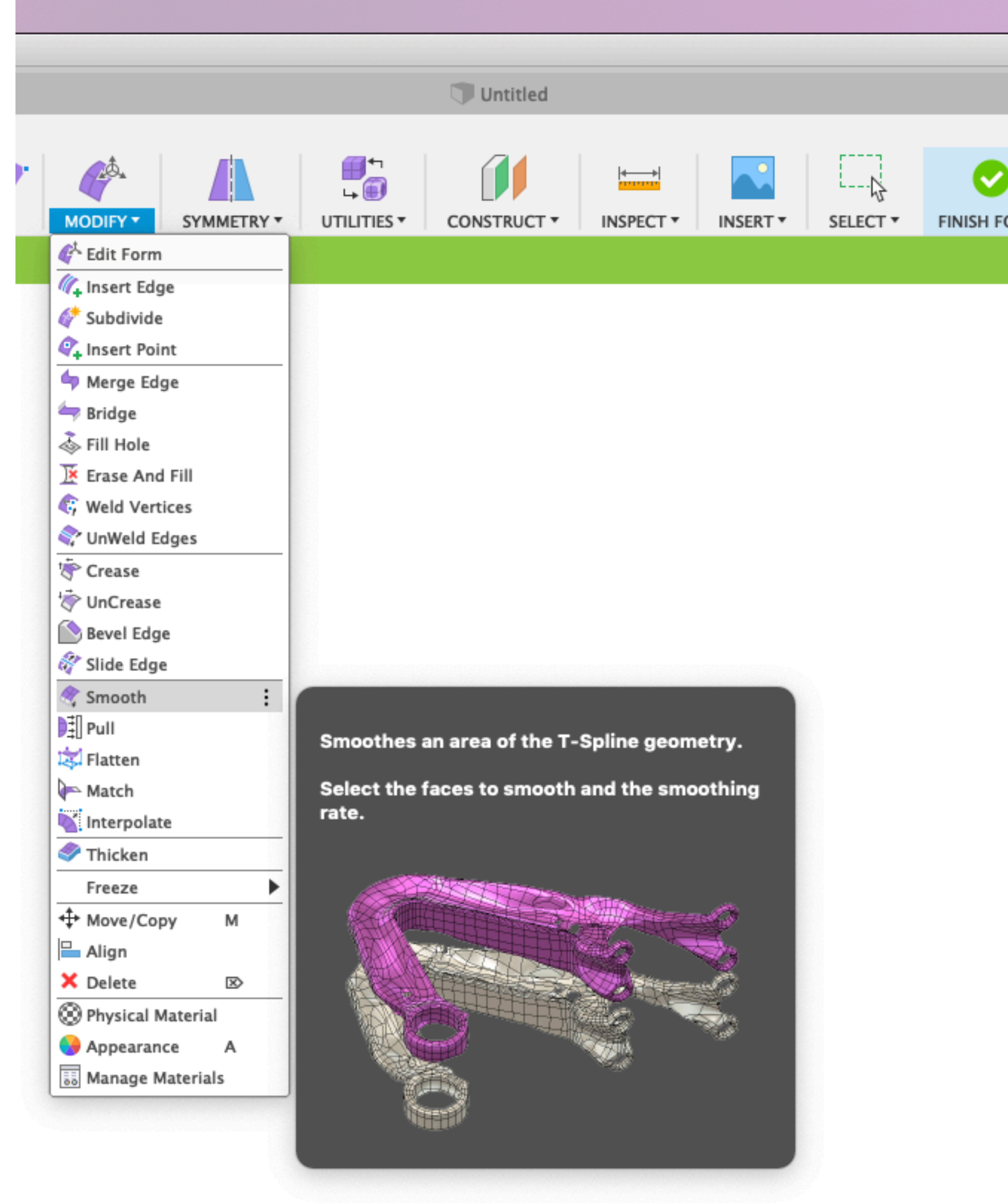
Repair Body

- An ideal T-Spline is made exclusively of 4 sided faces
- During the process of adding complexity and detail to your model, you may unintentionally create Ngons, T Points, L Points, or Star Points
- These aren't inherently bad, but if left unchecked, will cause complications down the line
- Ngon – any t spline face more than 4 sides
- T Point – where 2 faces only meet 1, creating a T edge pattern instead of a cross
- L Point same as above, but creates an L intersection
- Star Points – where multiple faces all connect to a single point, creating a star shape pattern of vertices



Smoothing

- Does exactly what it says on the tin!
- Smooth operates by averaging each surface against the surface adjacent to it, creating a smoother surface continuity as a result
- Based on this method, smoothing is calculated as an integer between 0 and 1 (no smooth, to smoothest possible)
- This function can be run multiple times in order
- This function will effect your GD parts structural integrity to a small degree. Run FEA after if using this to guarantee part is suitable for use



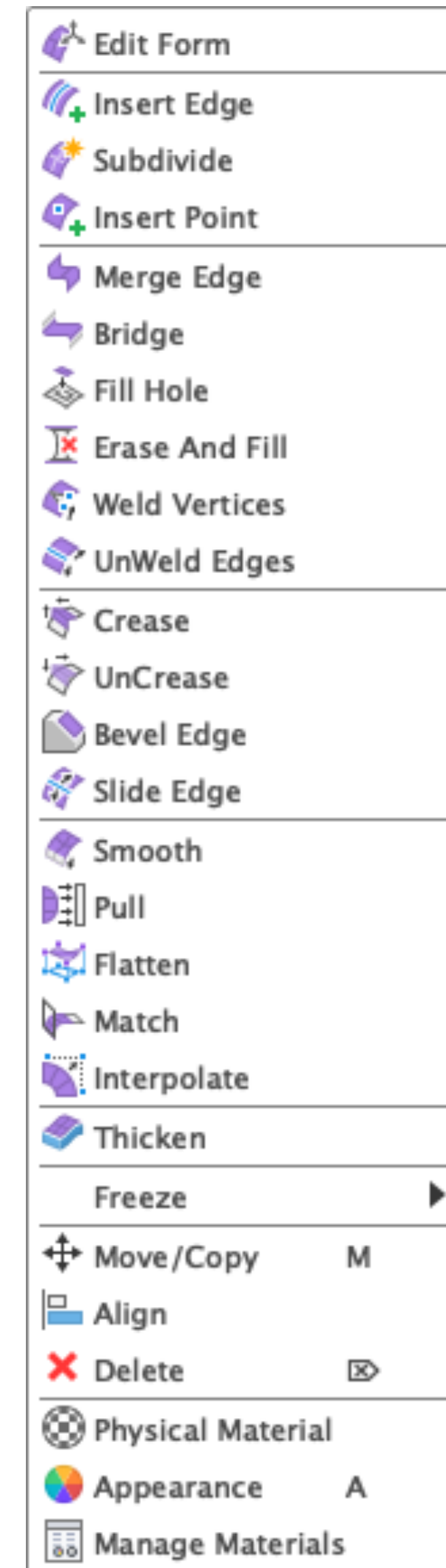
Quick Summary

- Work in multiple passes, do not dive straight into detail modelling
- Frequently switch between smooth and box mode to see how the geometry health is
- Don't forget to check the state of your body with Auto-Repair
- Soft modification is a life saver, use it often!
- The selection filters are important
- Always overmodel
- Don't be precious with the geometry
- Take your time, it's an entire extra CAD package built right into Fusion 360!



Next Steps

- Try these Next!
 - **Match** – matches a T-Spline edge to a sketch or surface edge
 - **Bevel edge** – the “chamfer” of the T-Spline space
 - **Slide edge** – need to adjust a chain but don’t want to add a whole new one
 - **Interpolate** – switch the control points and surfaces, can be useful for fitting object to other surfaces, or to exaggerate the features of a sculpt
 - **Subdivide** – split a T-Spline face into 4 faces, a quick and easy way to start implanting detail





Thank You!



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