



Complex Topology & Class-A Surface Modelling with Fusion 360

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Class summary

Learn how to create curvature continuous 'organic' 3D models with Fusion 360.

Key learning objectives

At the end of this class, you will be able to:

- Use the language of curvature continuity with confidence
- Use Fusion 360 software's hidden surfacing tools
- Understand how to build complex topology from individual surface patches
- Understand how to convert surfaces into a solid model

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CP122682 - The Inventor 7 Deadly Sins of 3D Part Modeling

Wednesday, Nov 15, 8:00 AM - 9:00 AM – San Polo 3404

<http://cadso.co/Inventor7Sins2017>

Inderjeet Wilkhu

LO-HL13: 7 Deadly Sins of 3D Part Modelling in Inventor & Fusion 360

<http://cadso.co/7deadlySins3D>

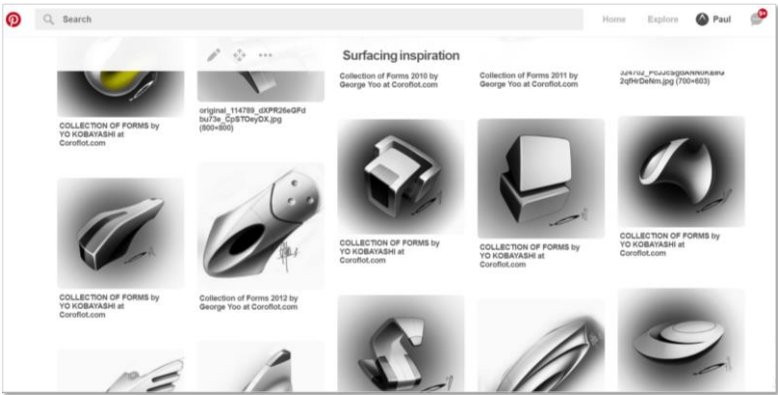


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Download the handout

- Download the presentation and dataset from the AU website, or using the AU App.
- Surfacing inspiration on Pinterest



<https://www.pinterest.co.uk/Cadsetterout/surfacing-inspiration/>

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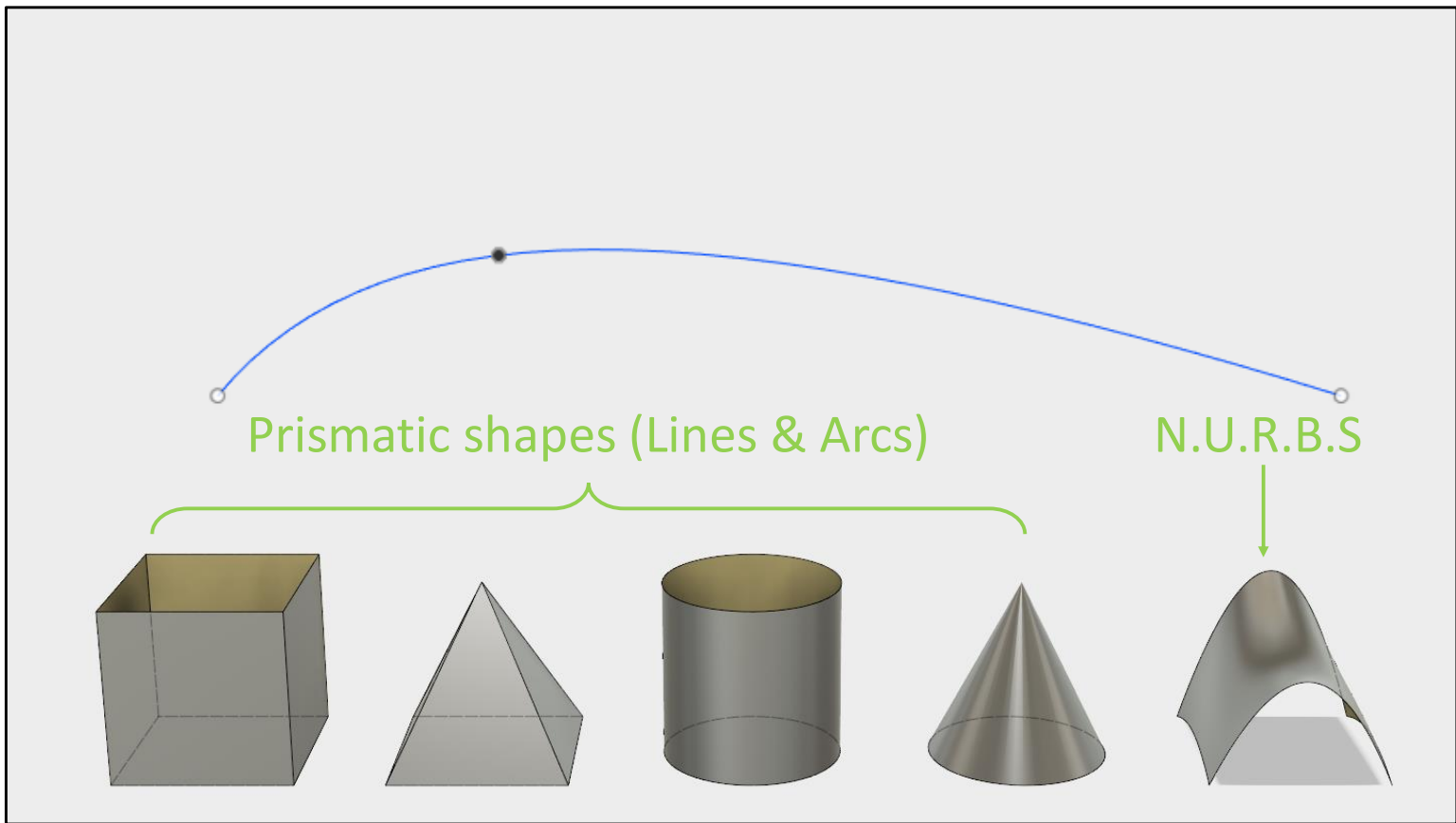
What is surfacing?



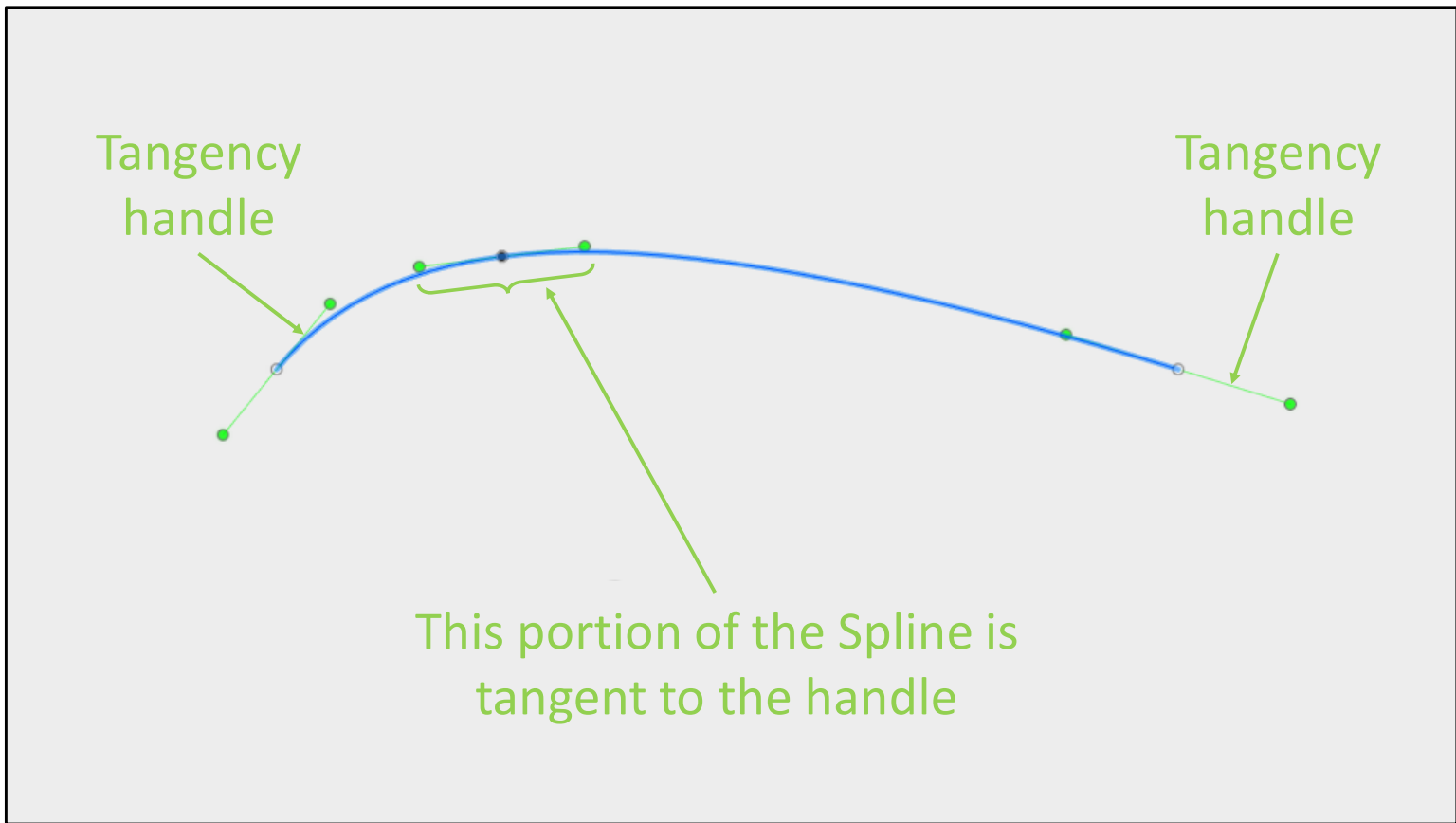
[Mindagus Petrikas](#)



‘Surfacing’ is a technique for 3D modelling used principally in Product design, Industrial design and Automotive design to build curvature continuous models from individual surfaces.

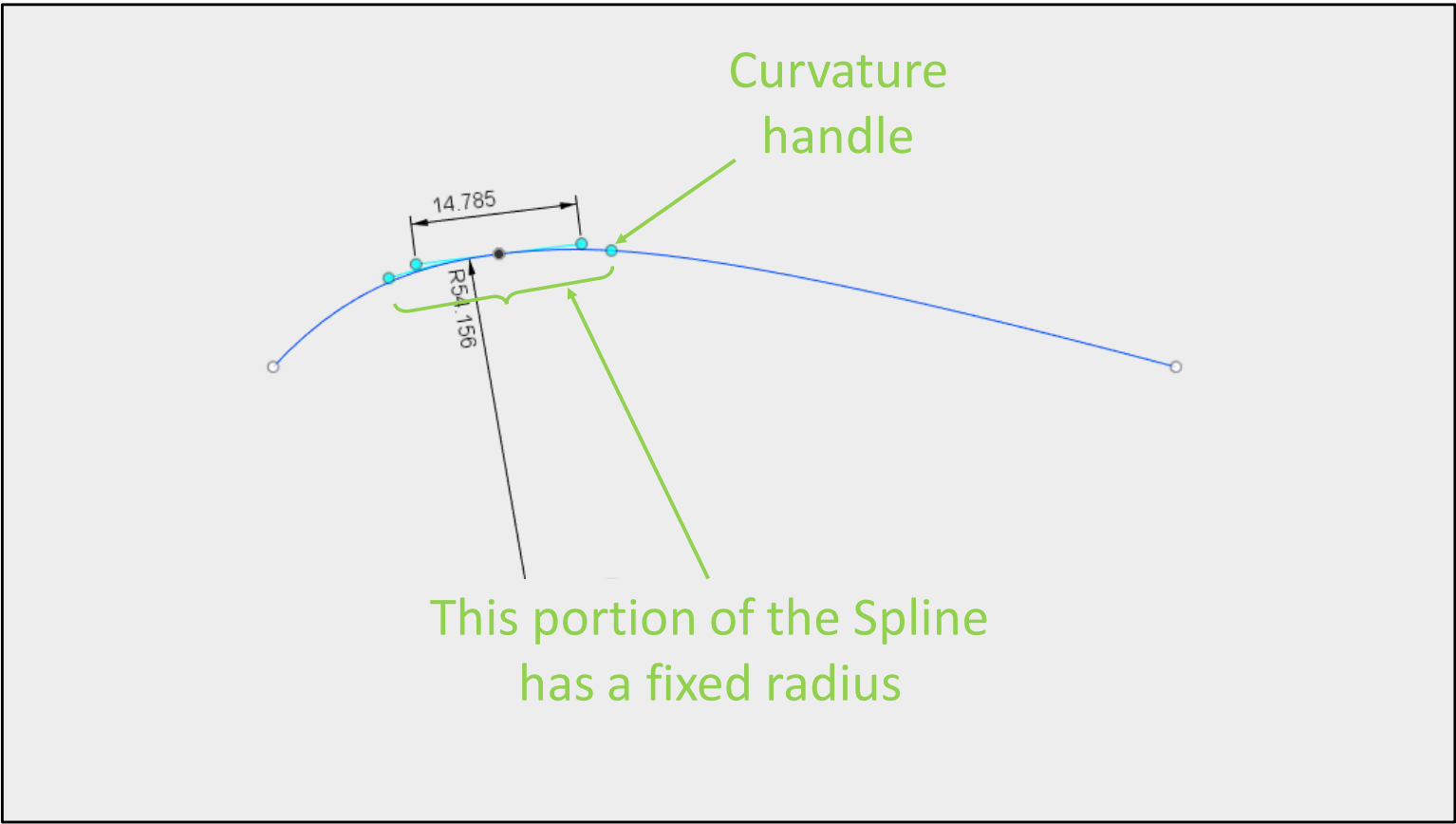


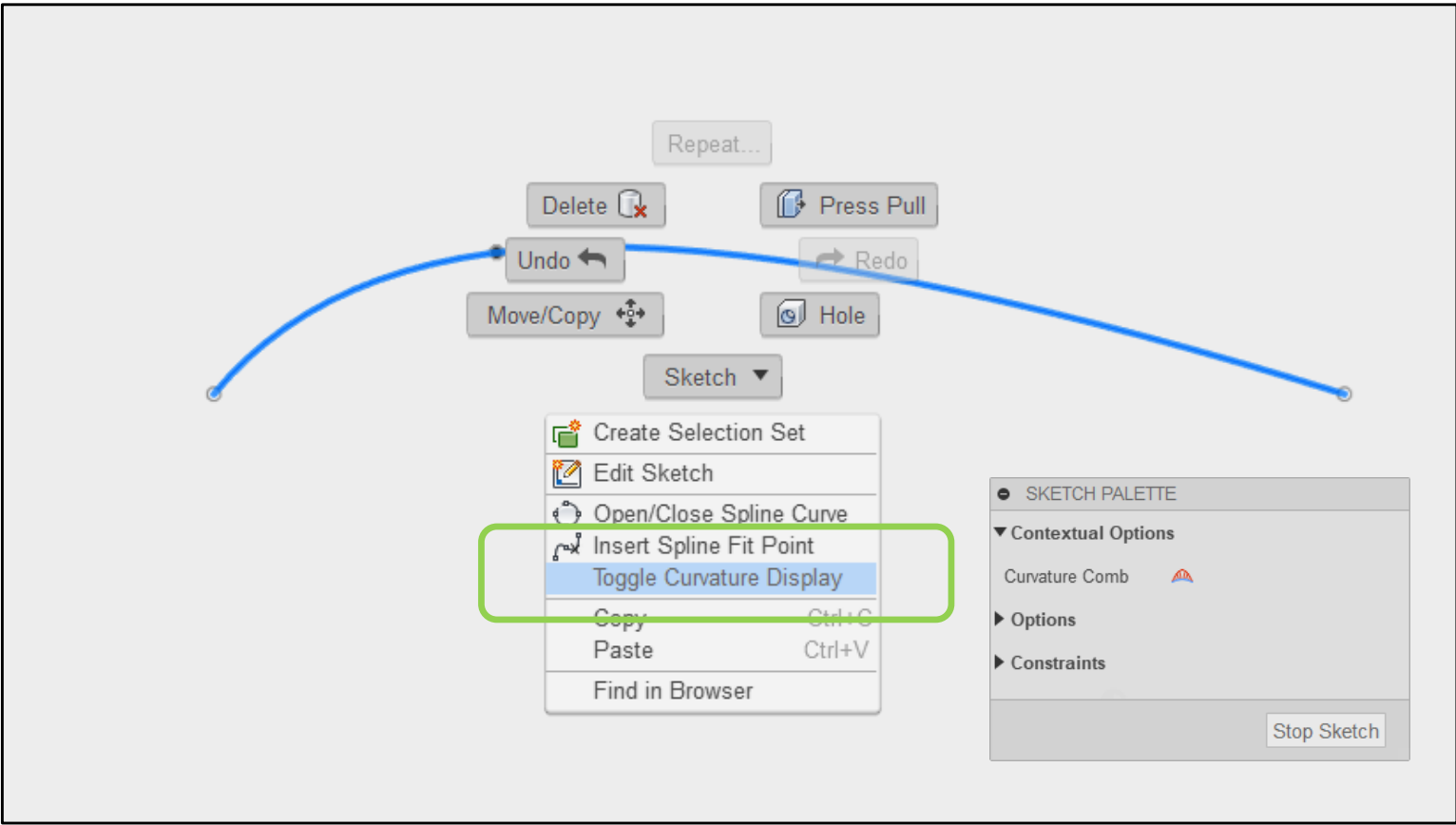
The basis of surface modelling are 'NURBS' surfaces, built on Spline curves.



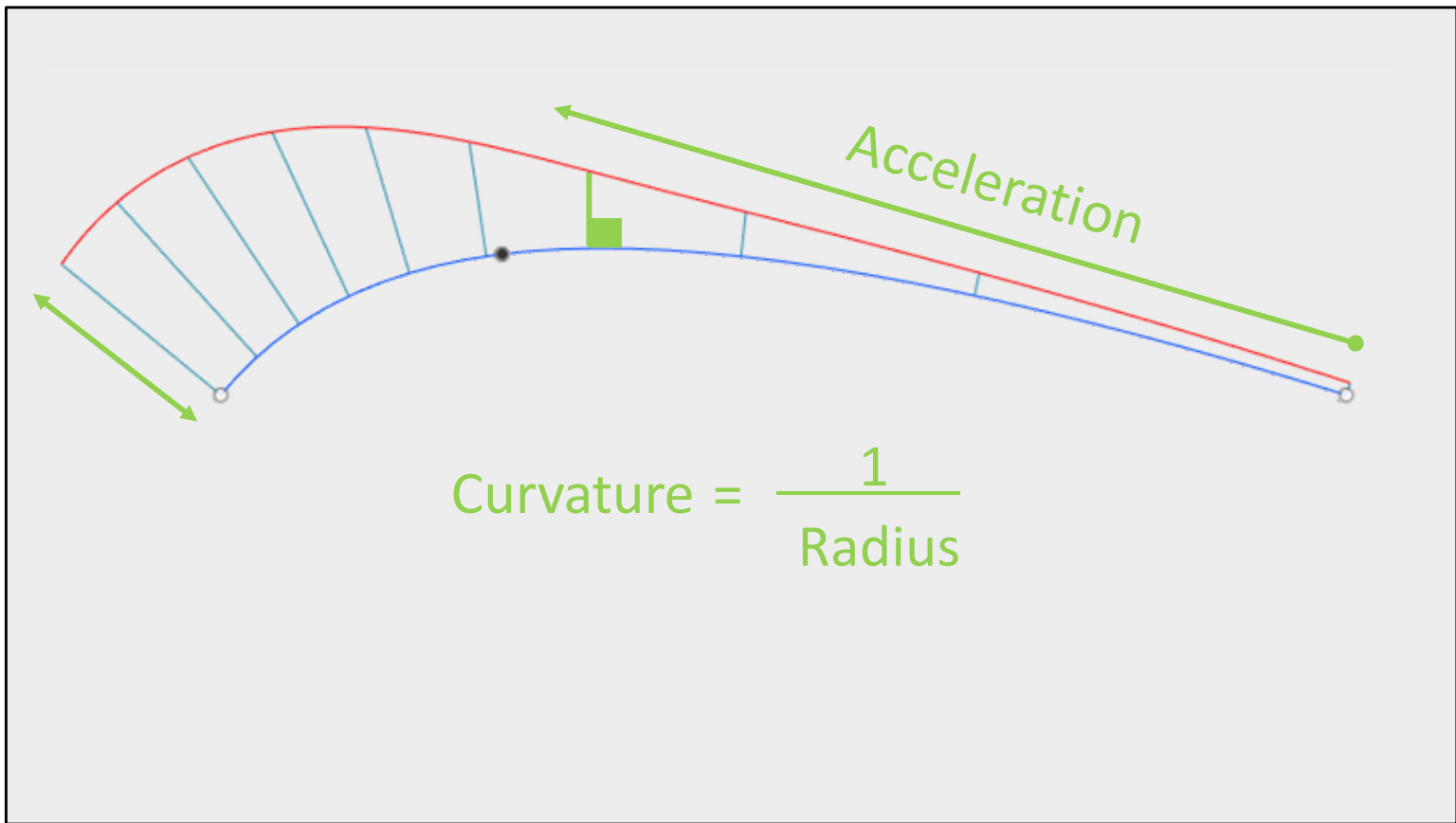
Splines are curves that can change their curvature along their length.

Splines are influenced by Fit points. Each fit point has a tangency and curvature handle, which influences the curvature of the spline along it's entire length.





The curvature of a Spline can be assessed by using curvature comb graphs.



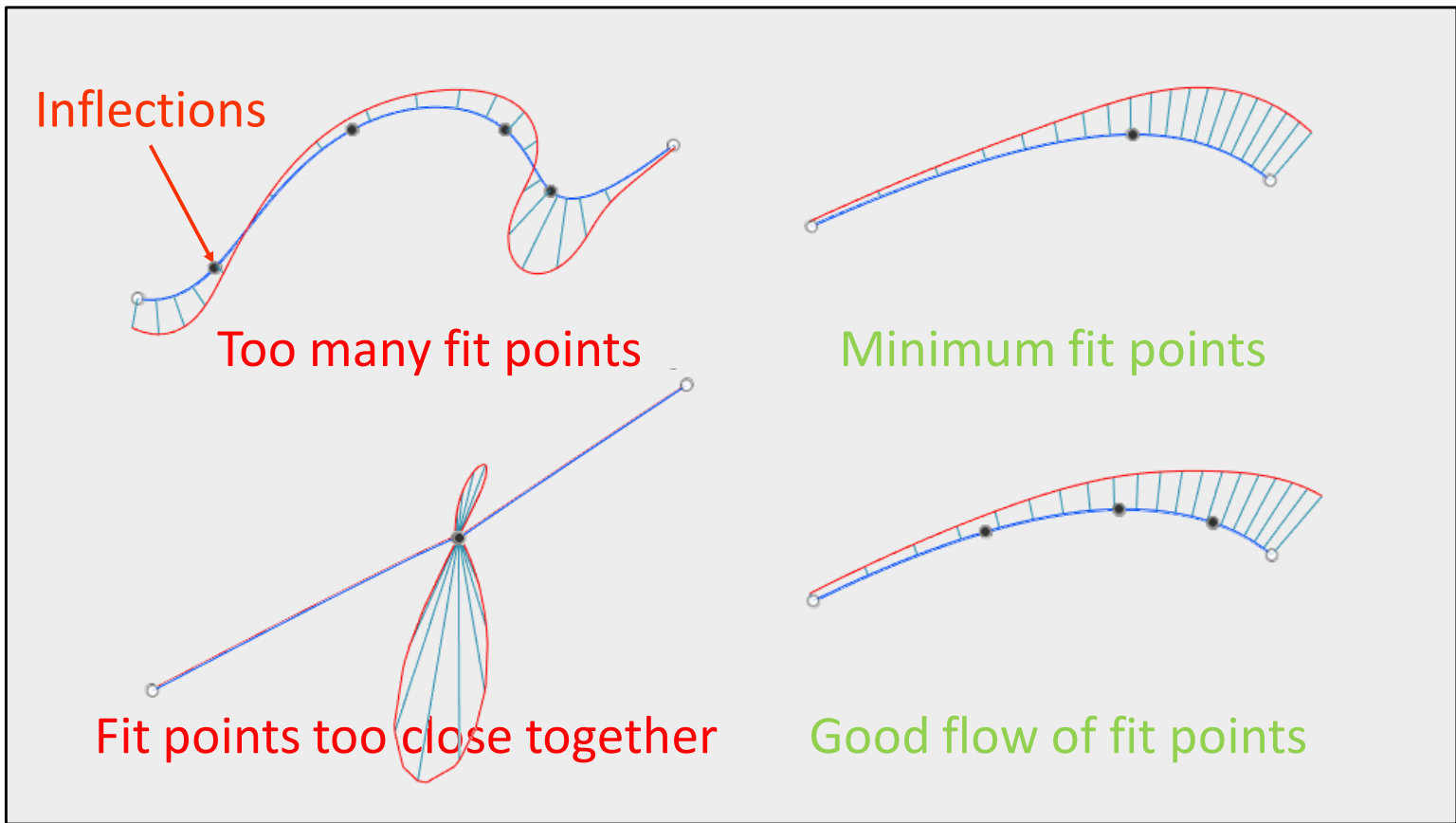
The 'spines' of the curvature comb are always perpendicular to the curve.

The length of the spines is proportional to the curvature.

The change in curvature along the length of the Spline is known as 'Acceleration'.



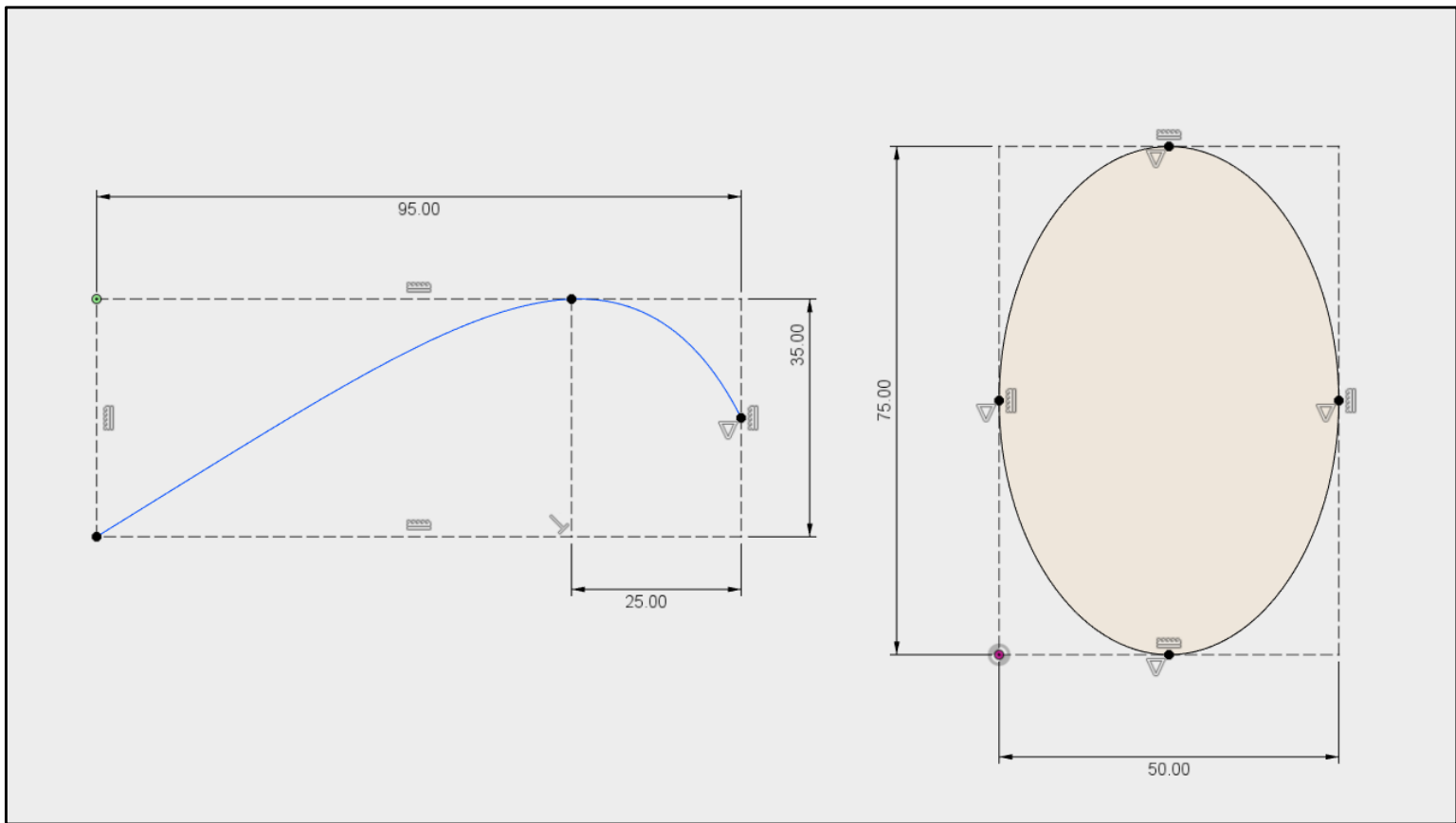
[Video of spline being created]



Good splines should have the minimum number of fit points, and good flow between fit points.

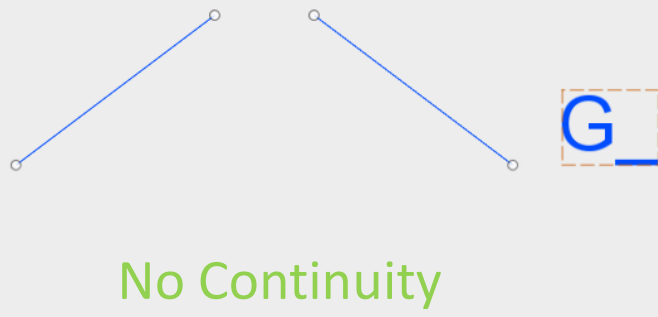


‘Flow’ is the relationship between fit points.



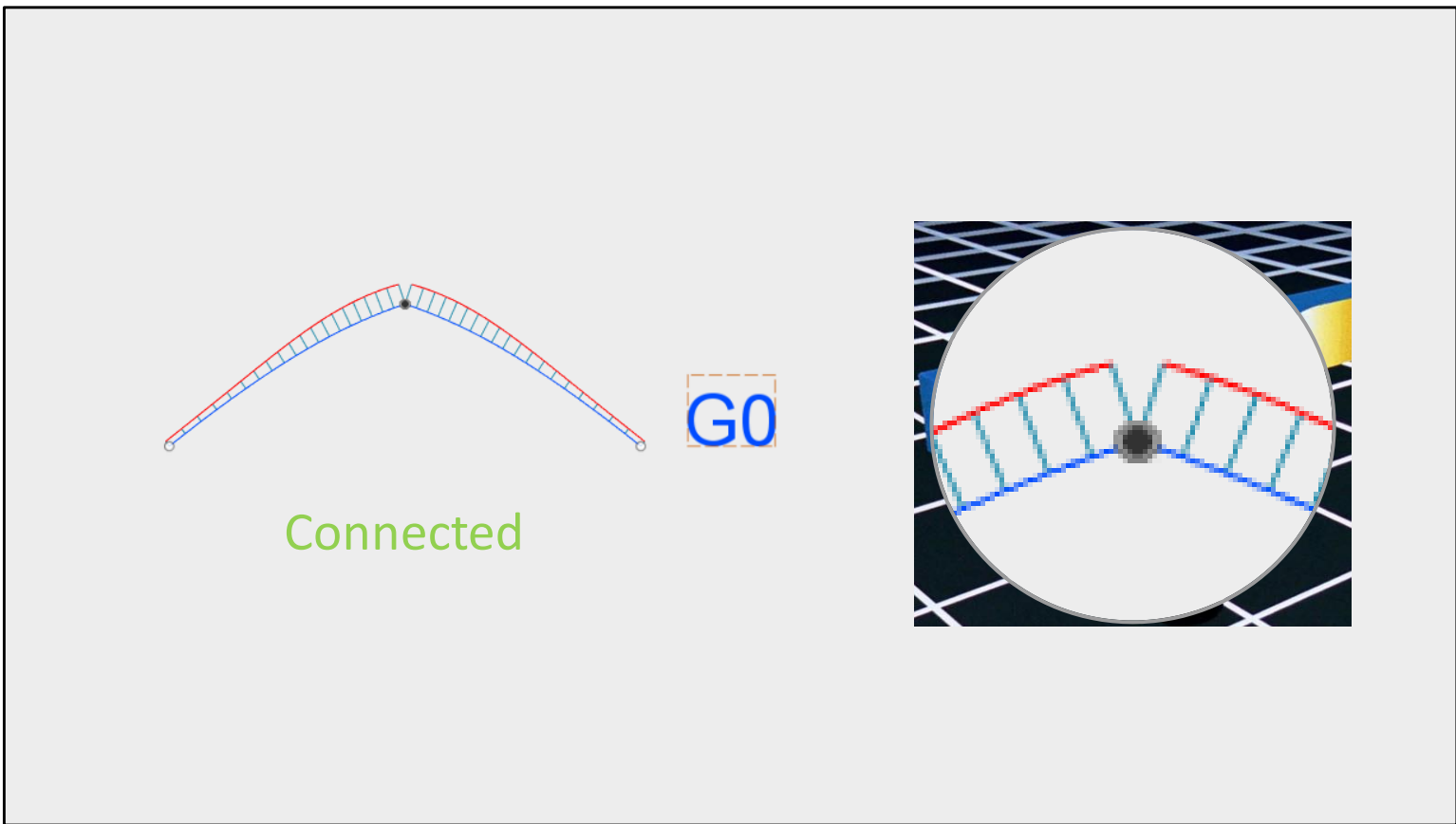
This type of spline is known as a 'Bezier spline'. Bezier splines can create closed loops.

Splines can be difficult to fully constrain. Try constraining your Spline fit points to a 'control frame' built from construction geometry.



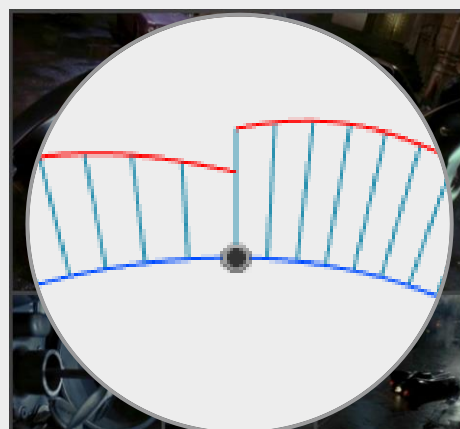
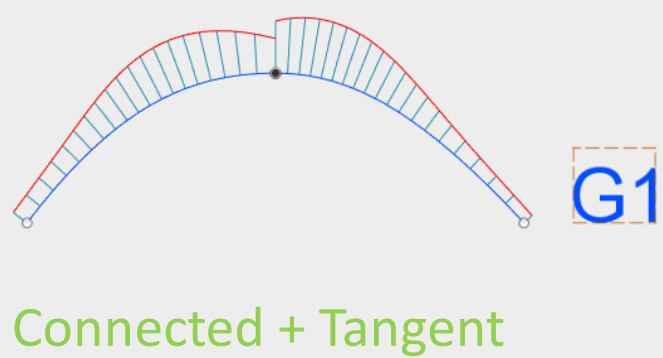
Continuity between curves is measured in 'G'.

Curves that don't touch have no 'G'.

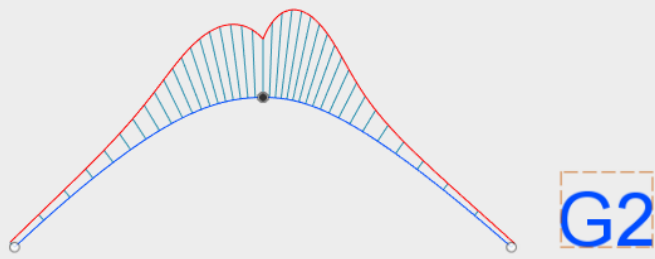


Splines that are Connected share one property – the location of their end points.

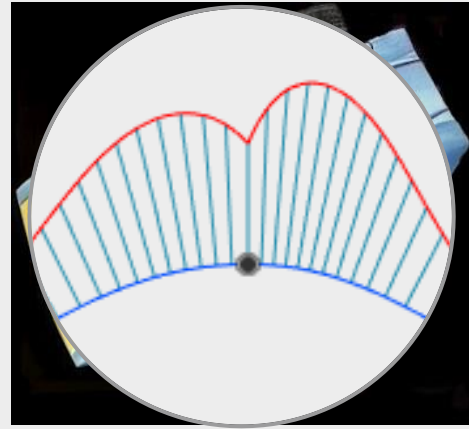
This is a G0 relationship.



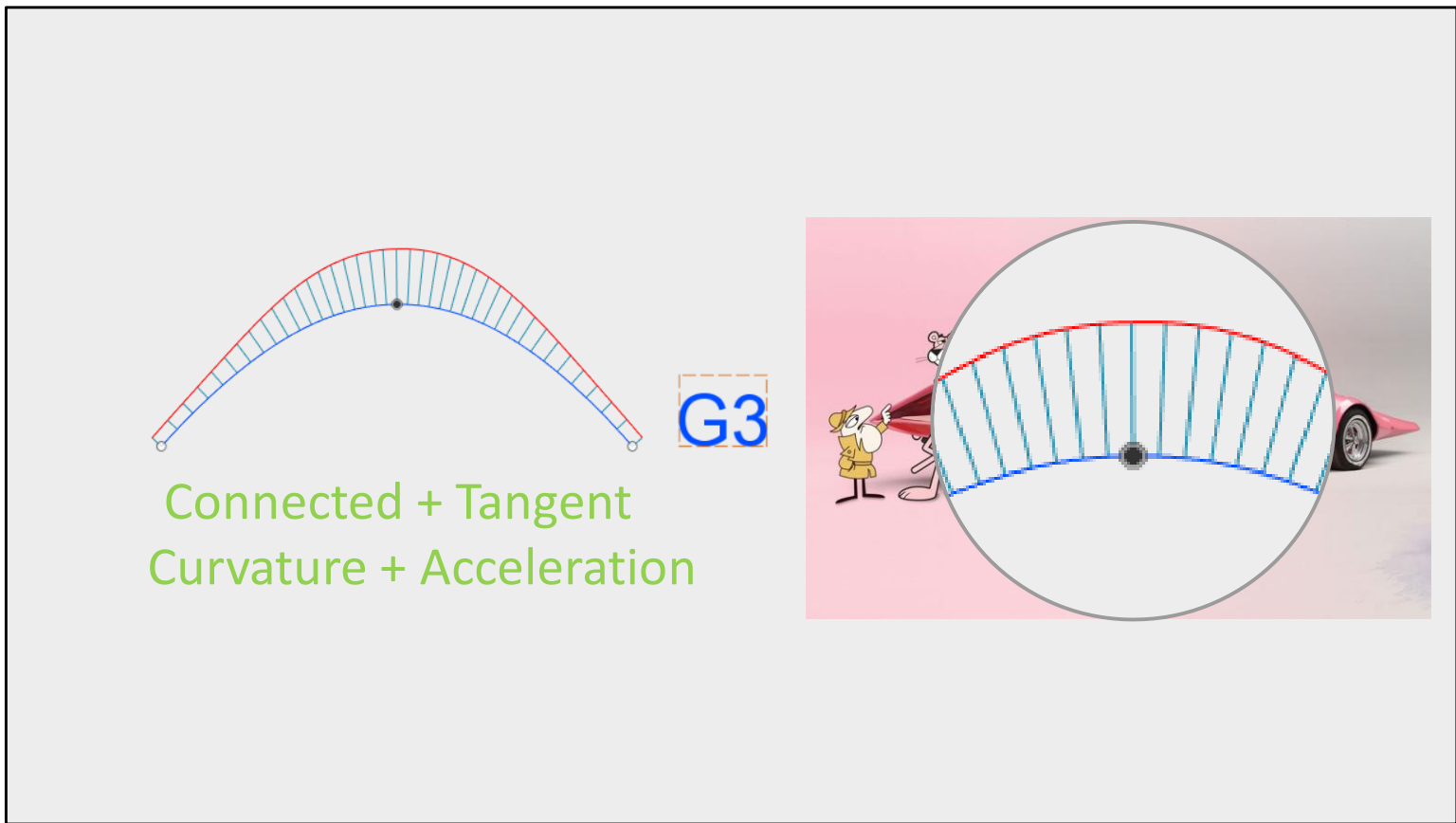
Splines that match two properties, Position of their end points and Tangency of the curves, are G1.



Connected + Tangent + Curvature

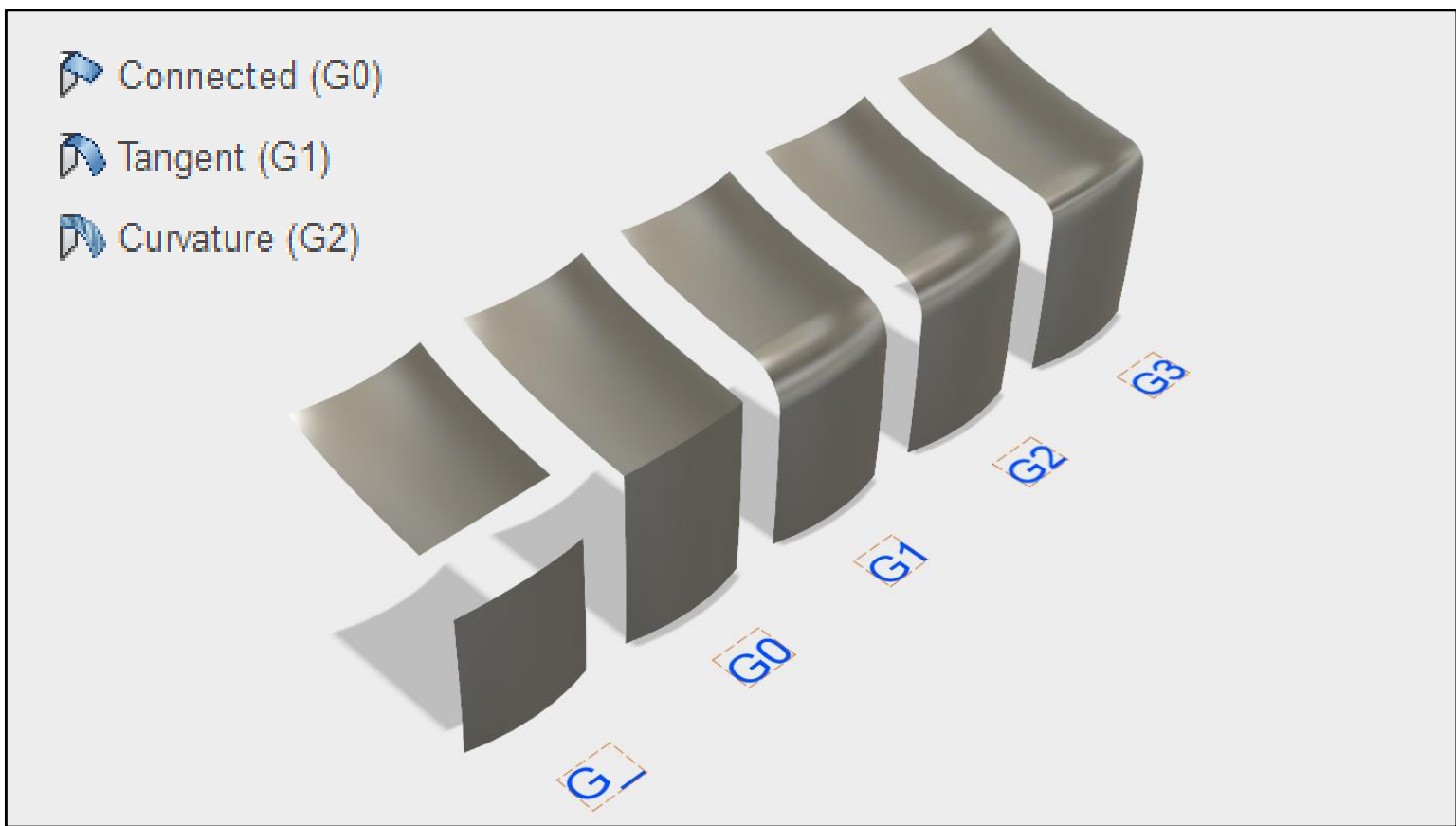


G2 matches three properties. Position of end points, tangency and curvature – the same radius at the point where the two curves touch.



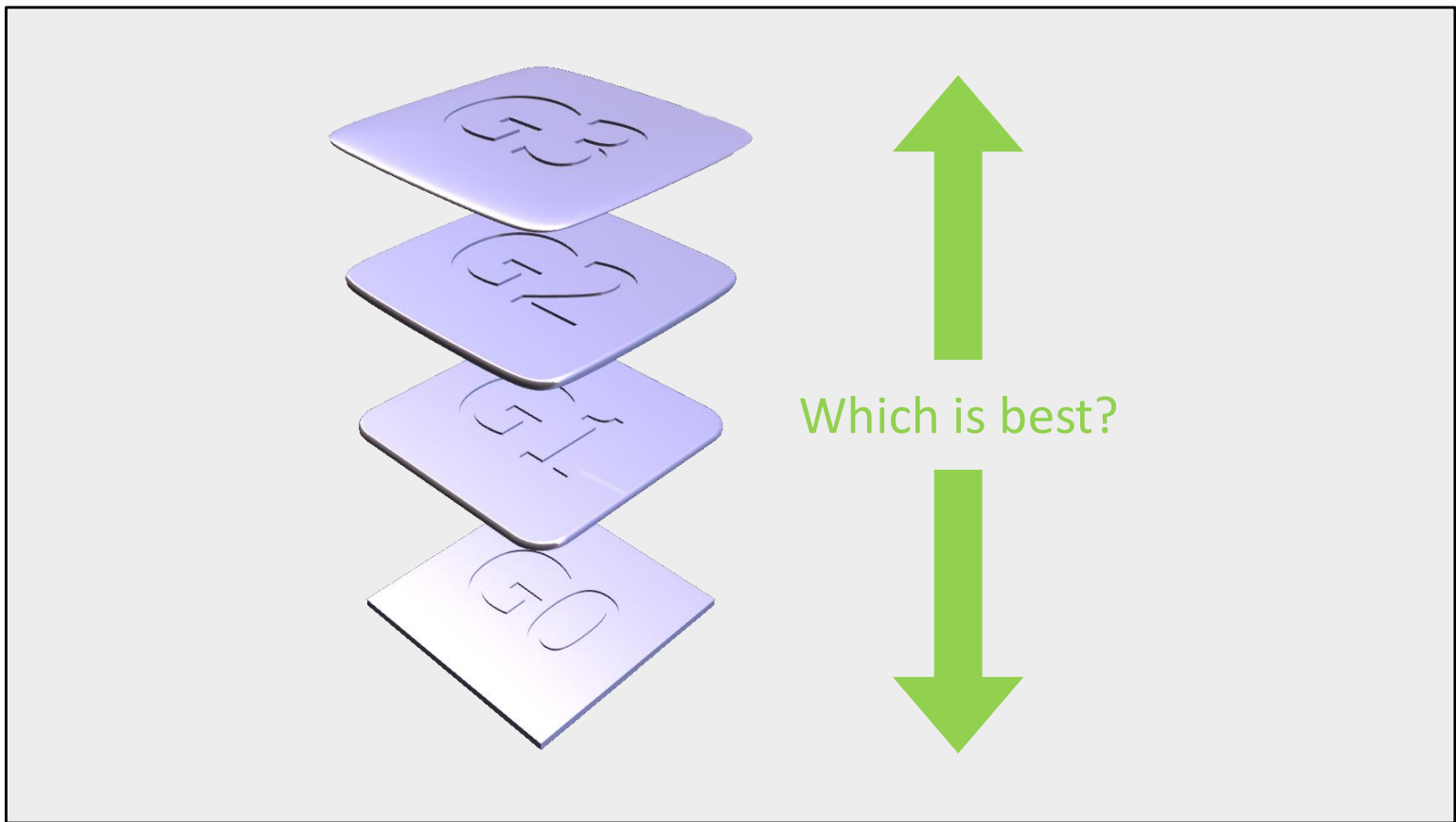
G3 cannot be created automatically in Fusion360. But it can be created manually with a little patience.

A G3 Relationship matches position, tangency, curvature and acceleration – this can be seen by looking at the top line of the curvature comb graph, which is also tangent.



3D curvature relationships can be built with the following conditions.

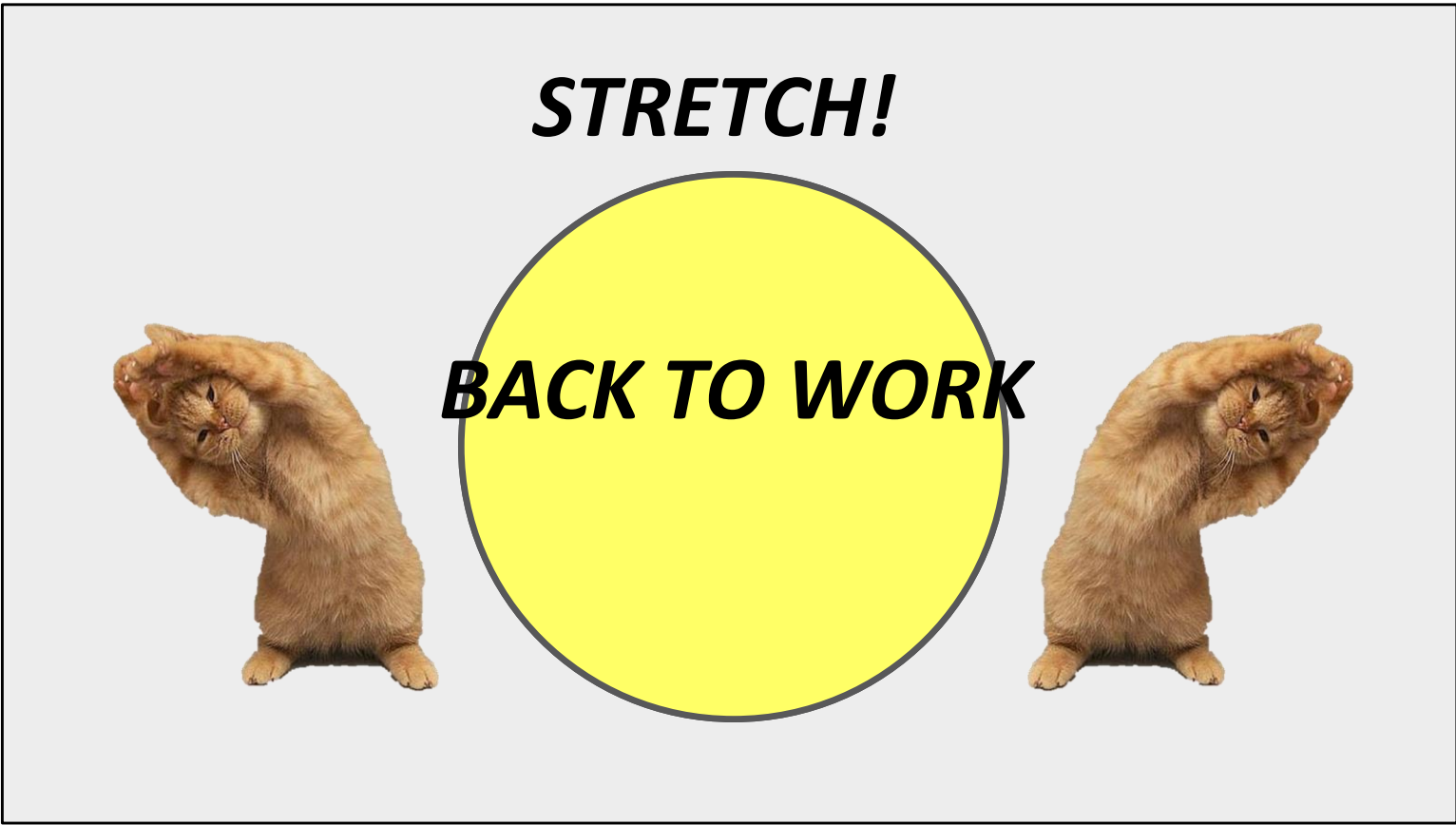
- G0 = Connected
- G1 = Tangent
- G2 = Curvature



The question we should ask – *which is most appropriate?*

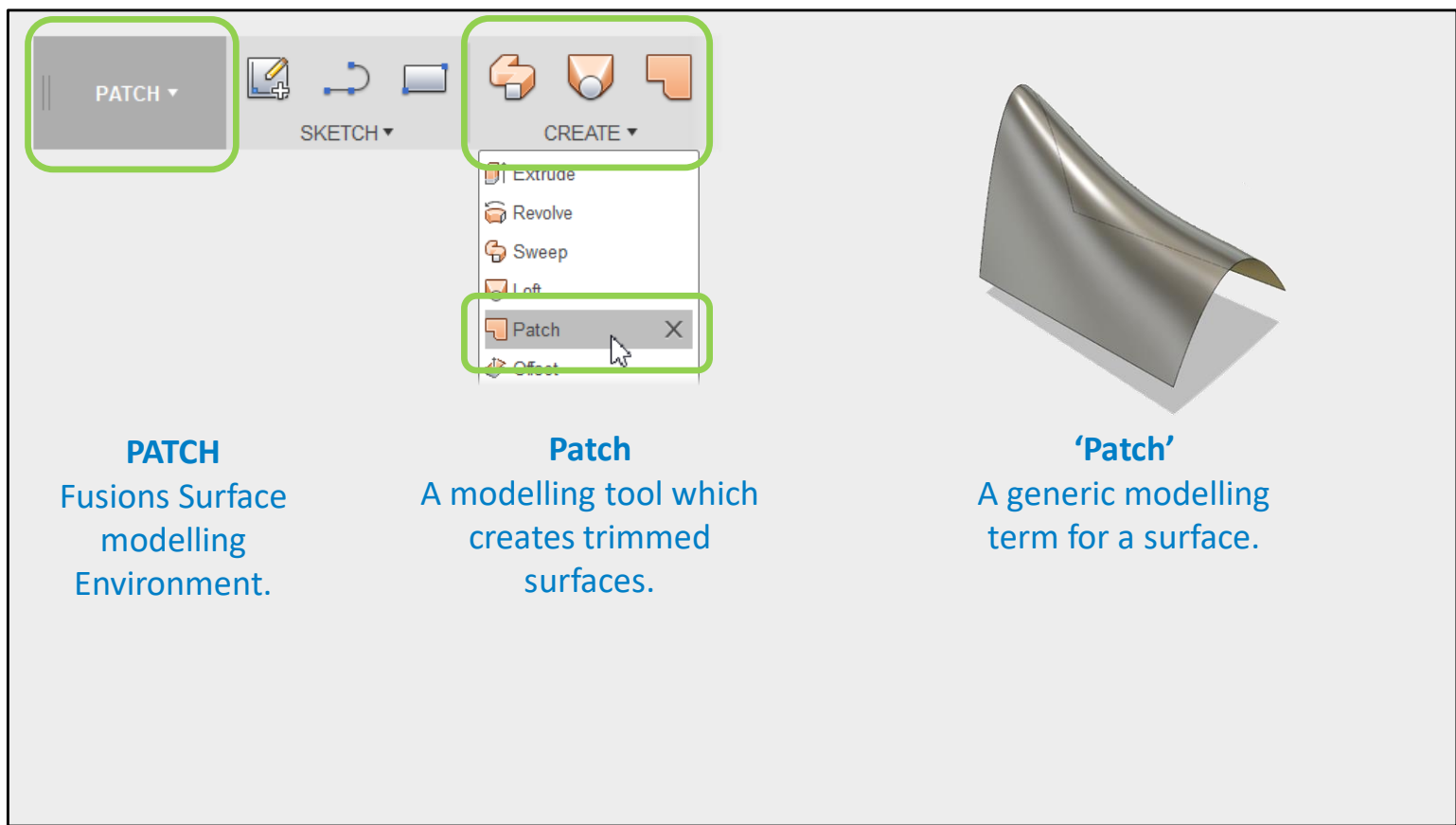


Plan your inputs in preparation for your blends. There is no point trying to build a G3 surface from an input which is a straight line!



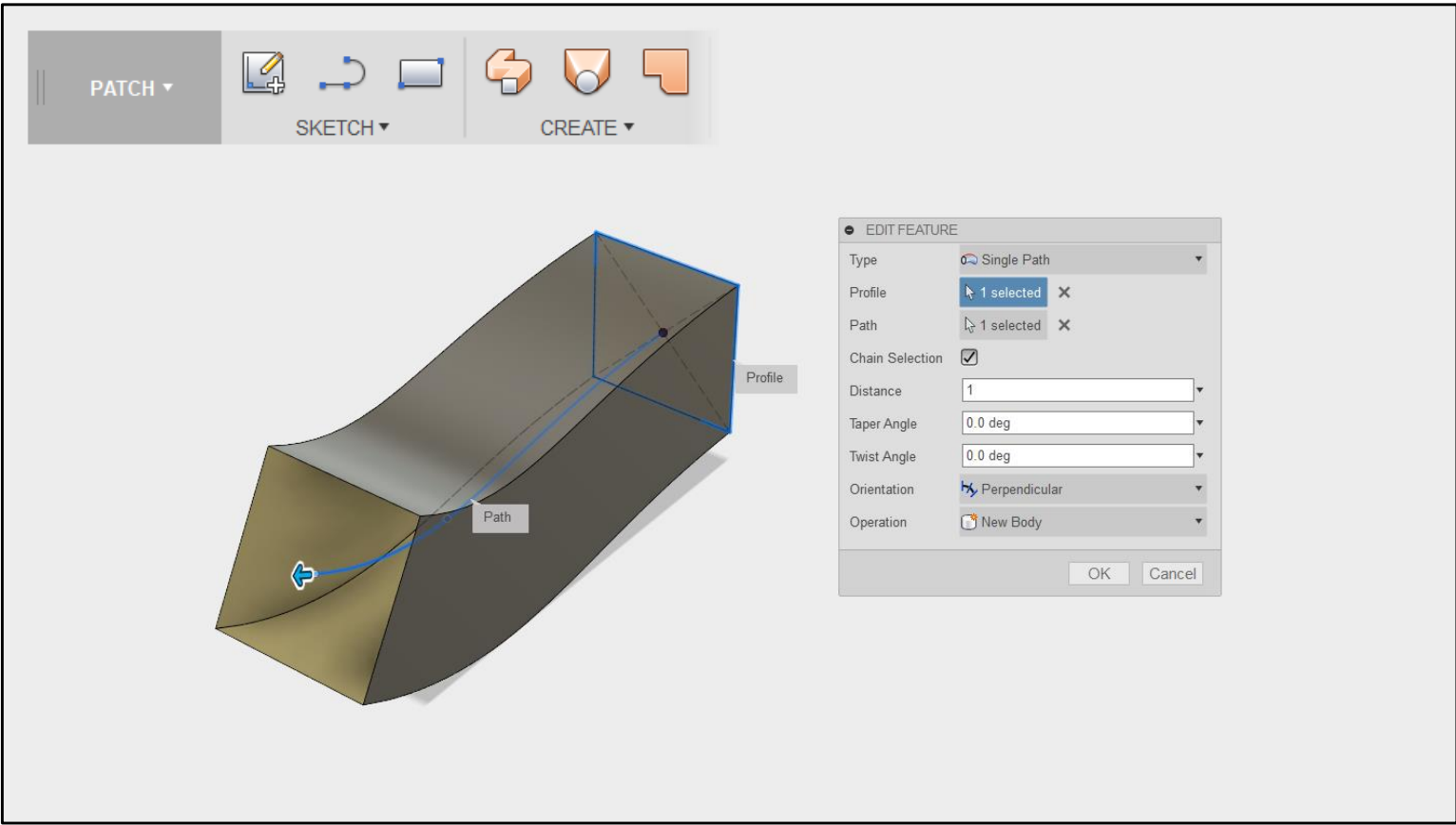
The brain can retain what the Ass can endure!

~ Matt Murphy

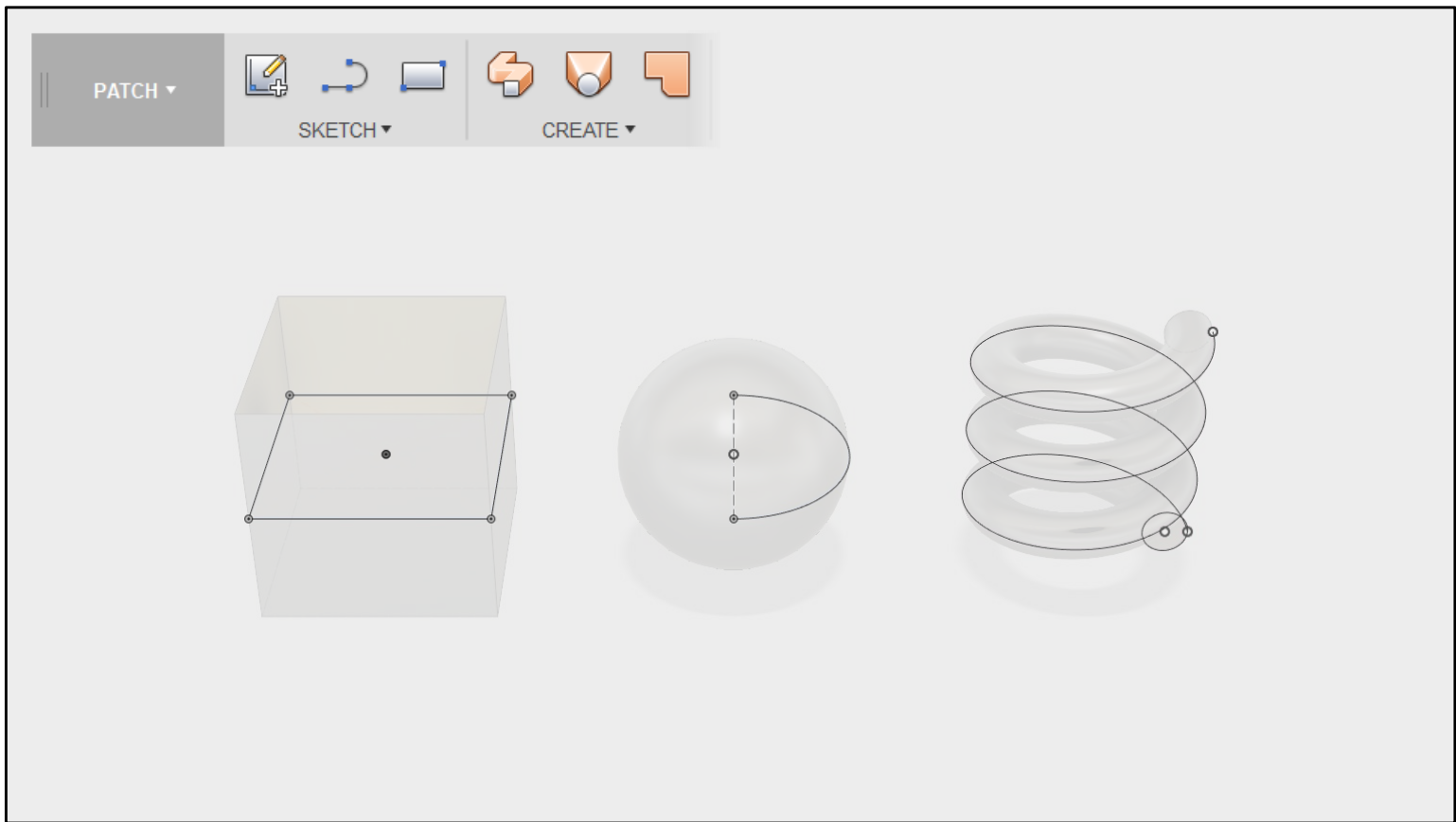


'Patch' can mean:

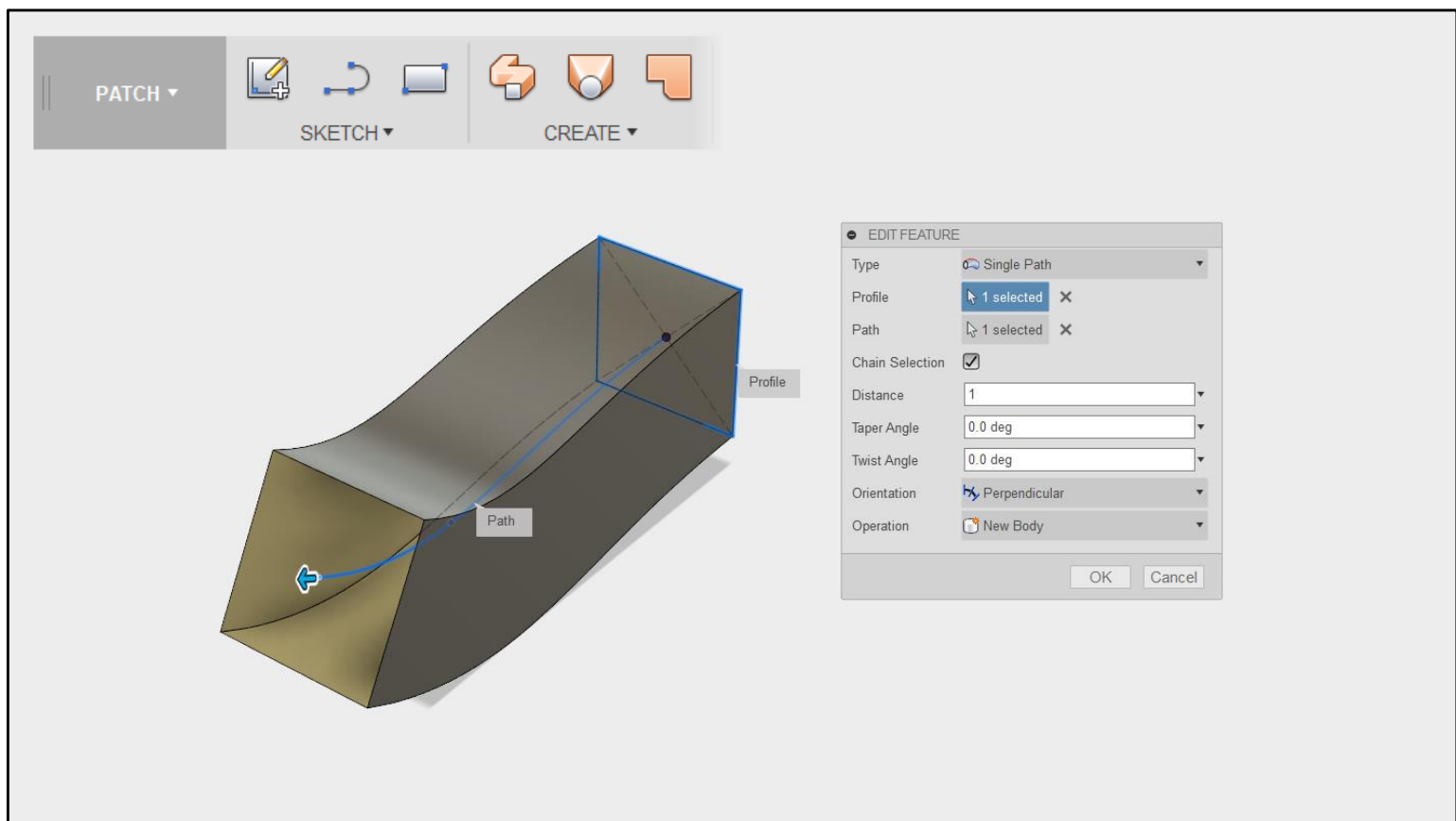
- Fusion 360's surface modelling environment.
- A tool which creates surfaces.
- A generic term for any surface.



A sweep is a shape which translates a profile along a path.

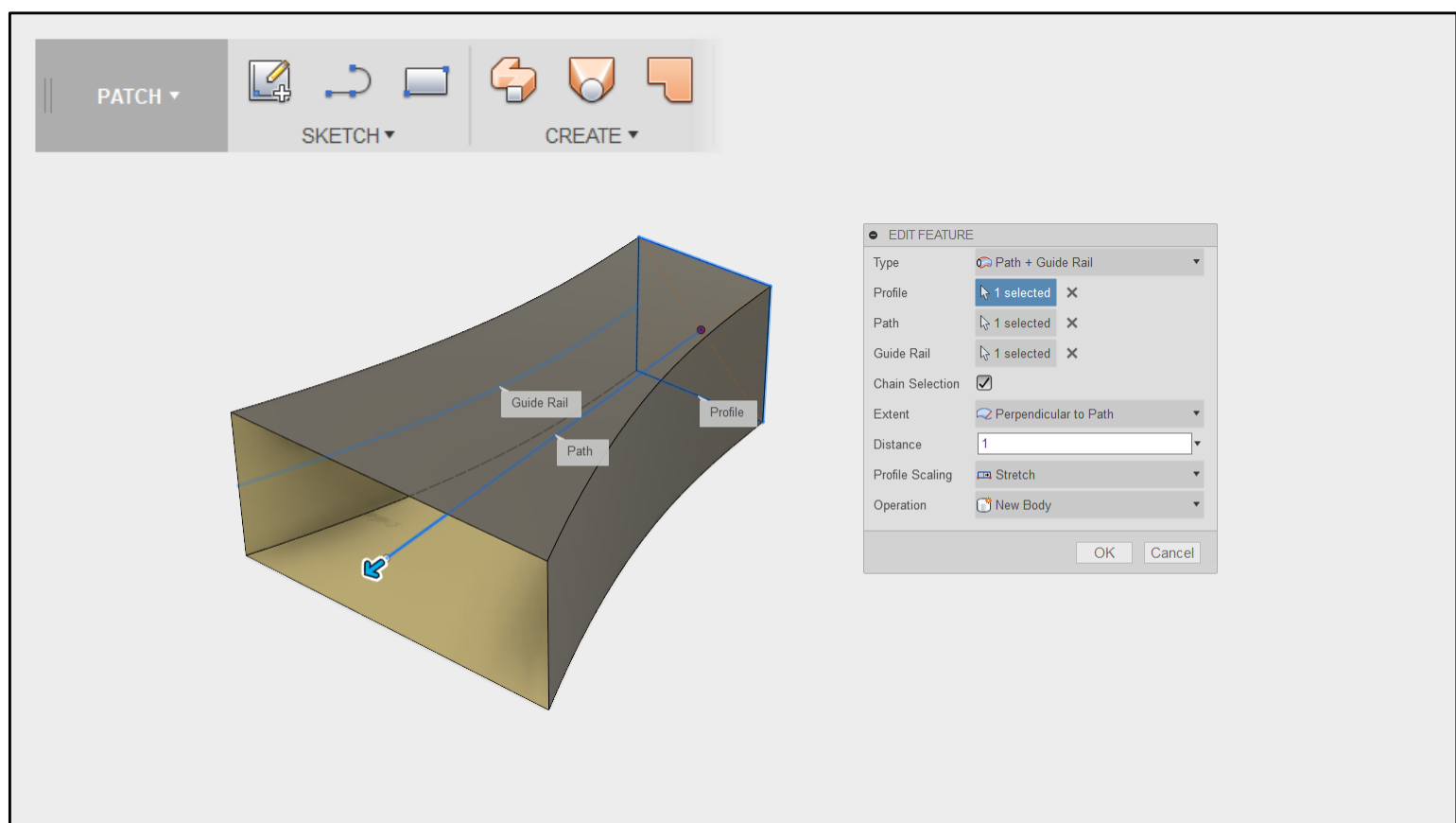


Lofts, Revolves and coils are all ‘Sweeps’.

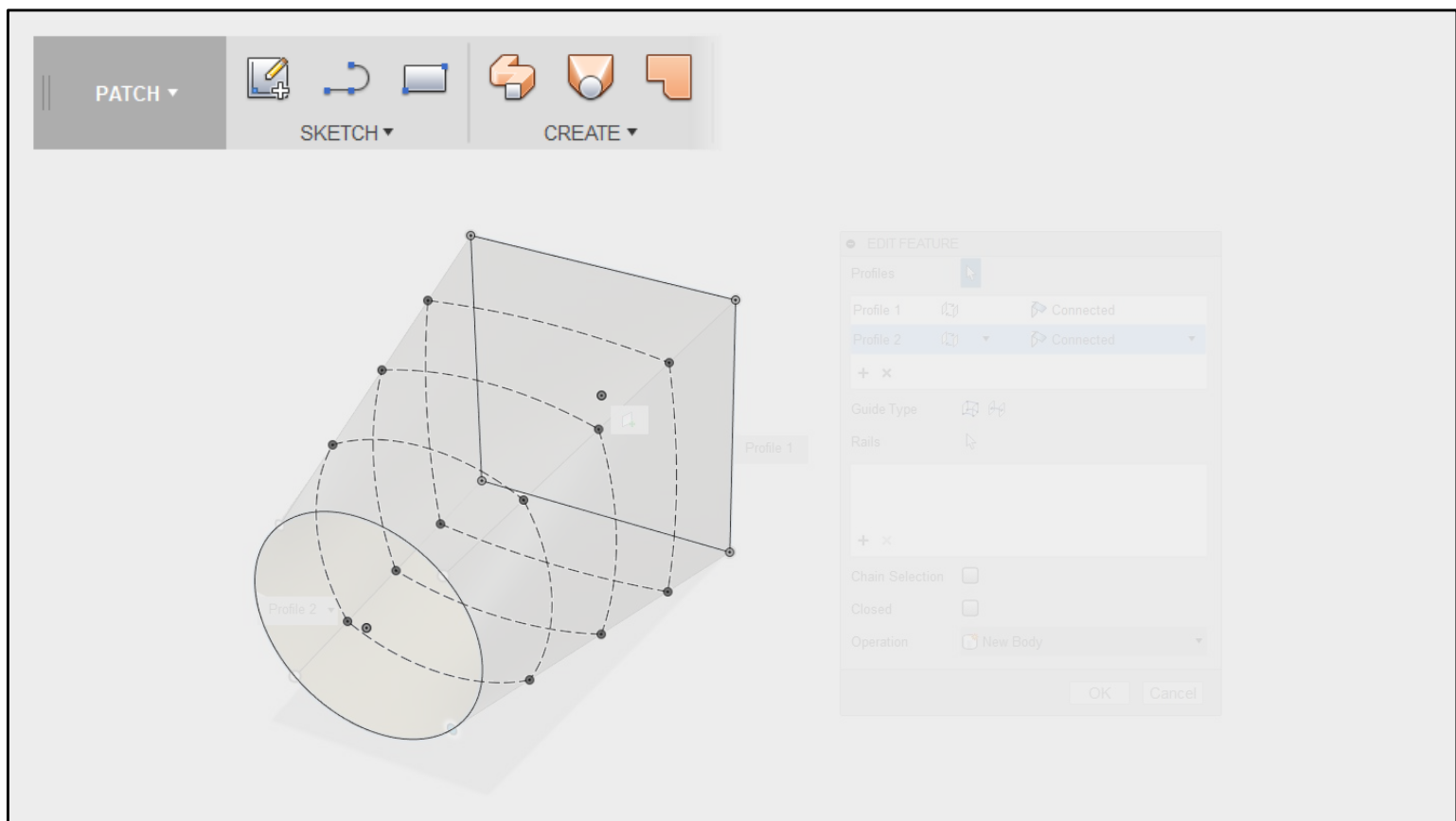


Because a Sweep has a consistent profile, we can't set end conditions for the surface.

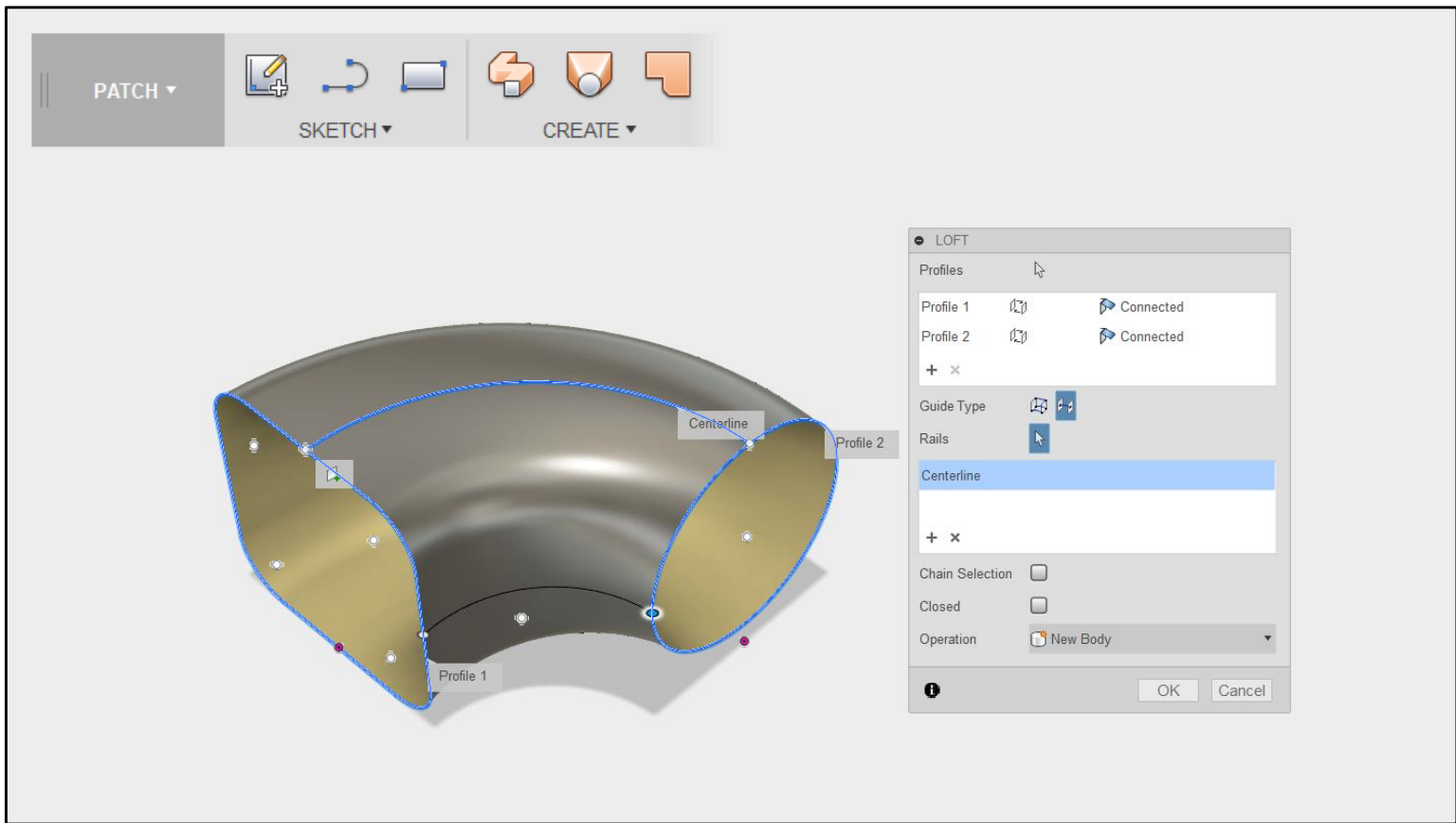
For this reason, we usually build 'Sweeps' first.



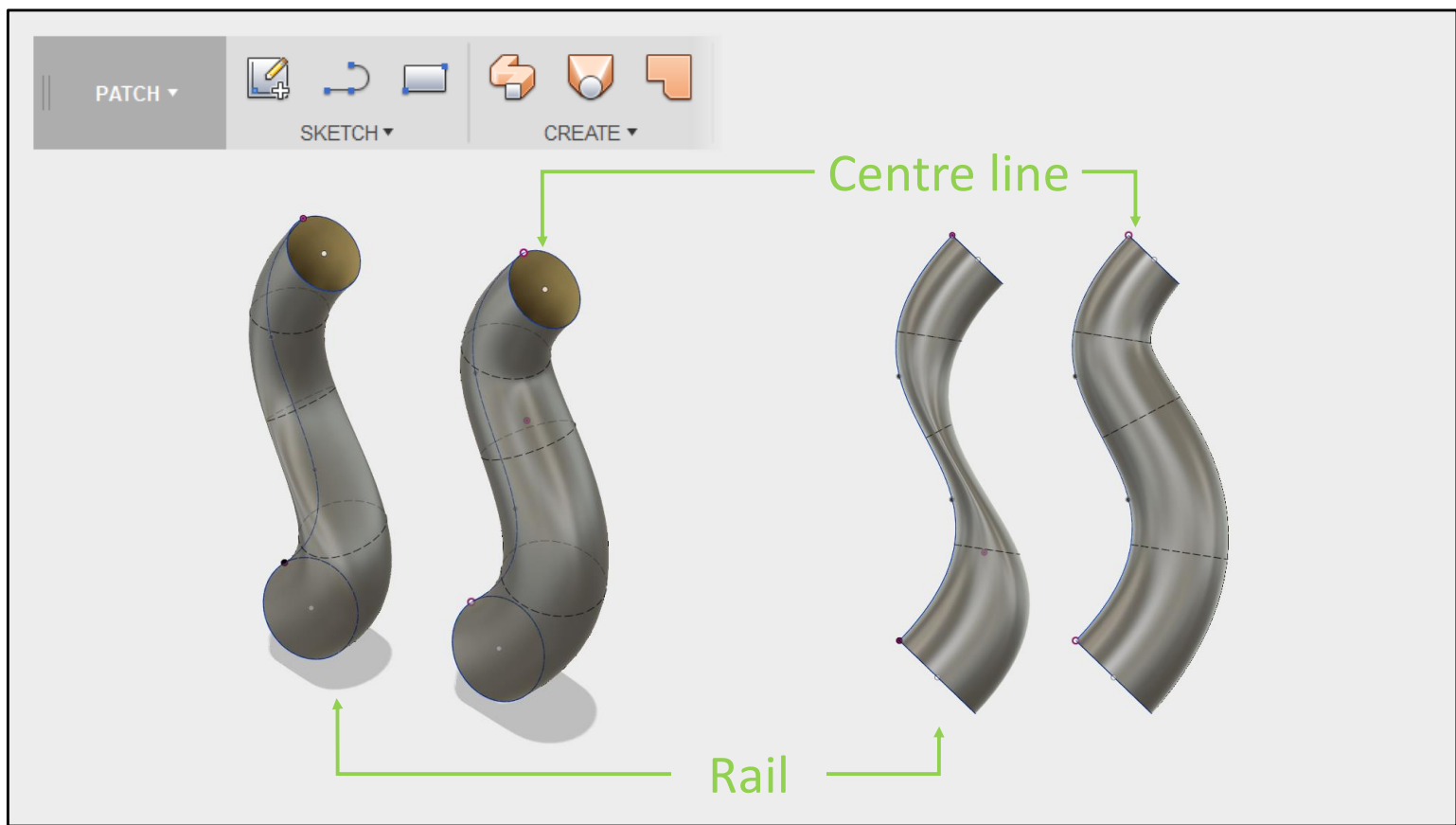
Tip: Try using ‘Sweep with guide rail’ as an alternative to Loft.



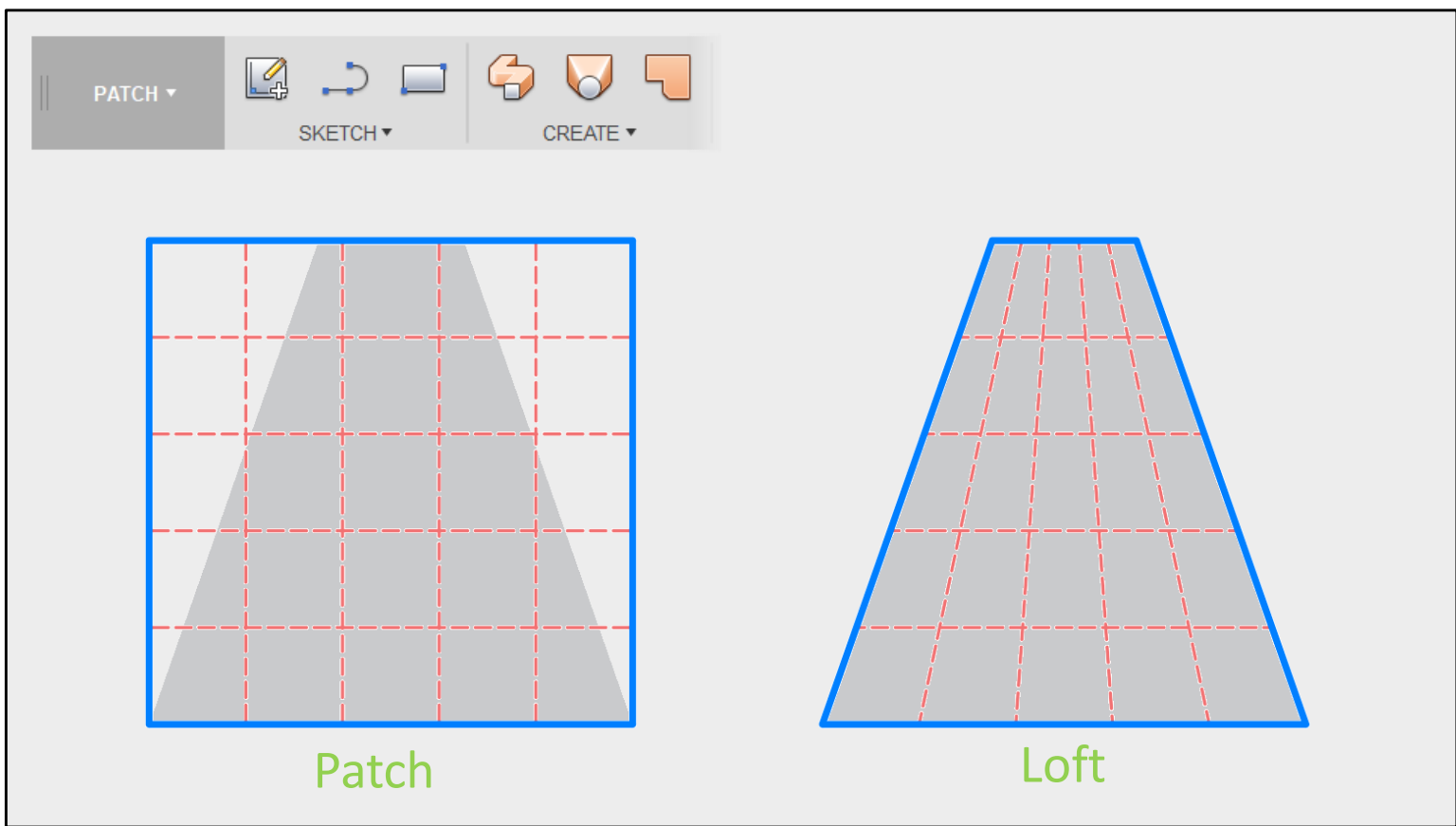
Lofts interpolate from one shape to another.



Tip: Try using ‘Loft with centreline’ to get a combination of sweep and loft.

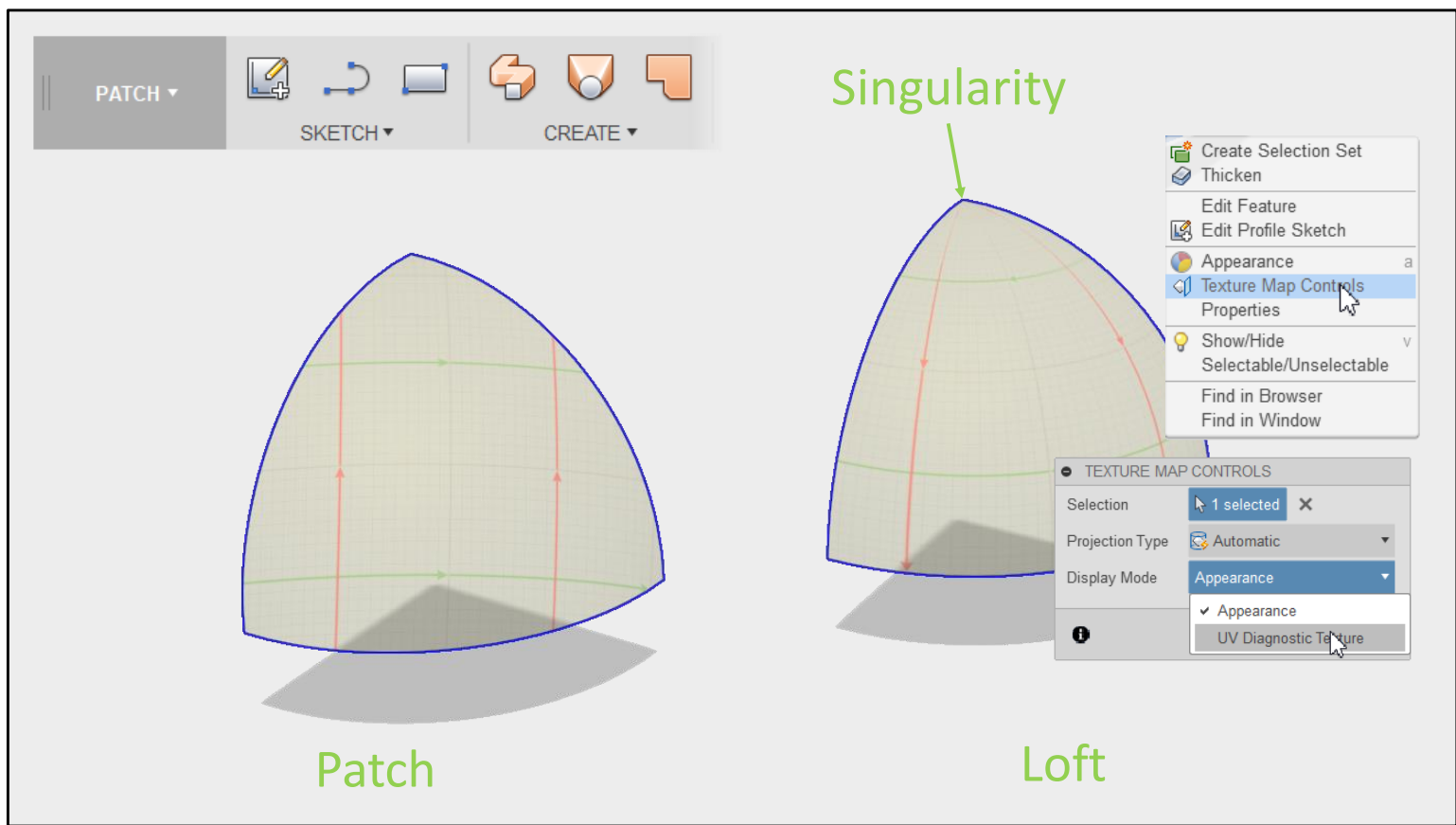


A Loft with centreline behaves something like a sweep. This is the smoothest way to translate between two profiles.

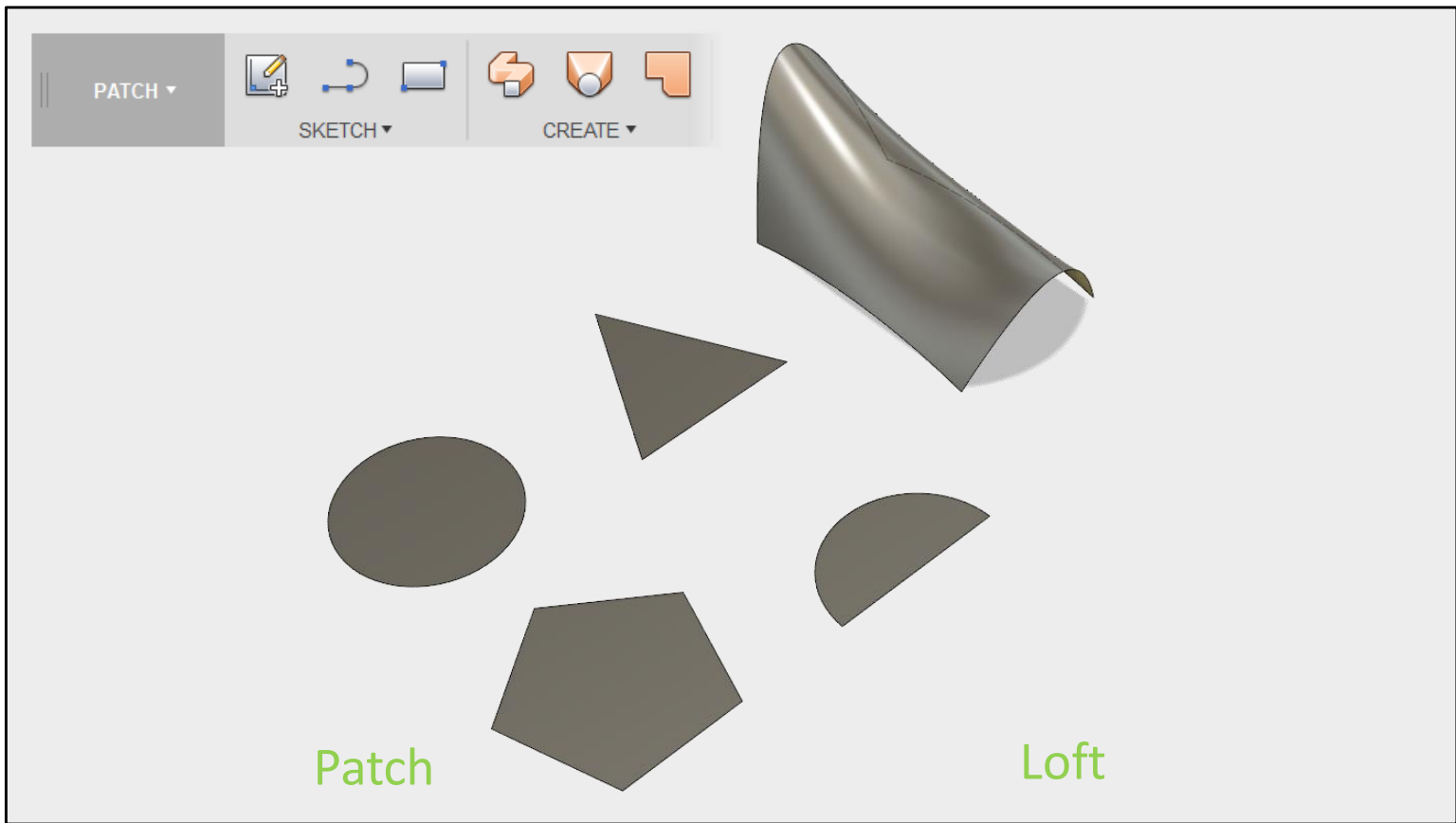


The Patch command creates a four sided surface which is trimmed back to the input geometry.

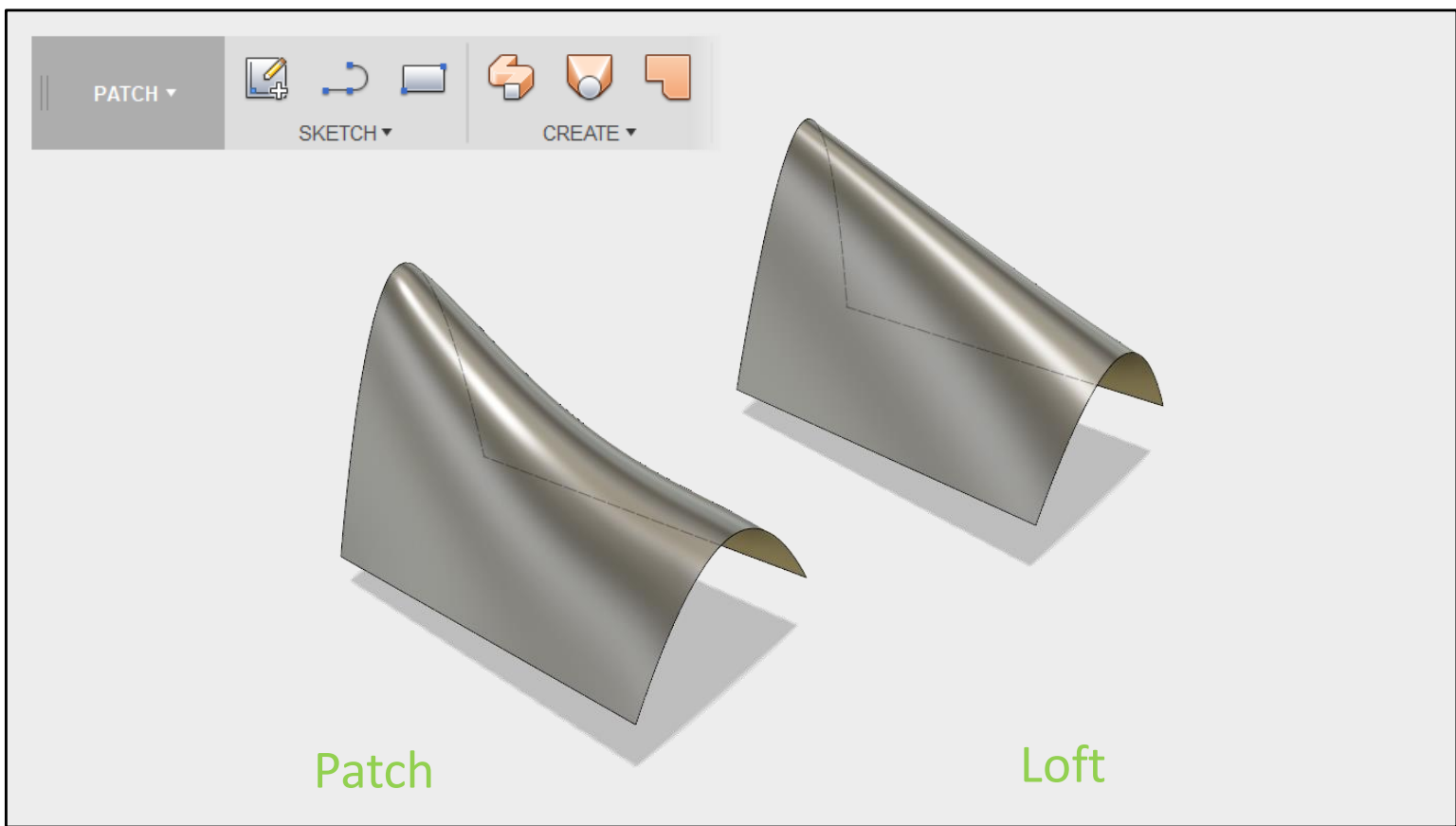
The Loft command creates a four sided surface which is Fitted to the input geometry.



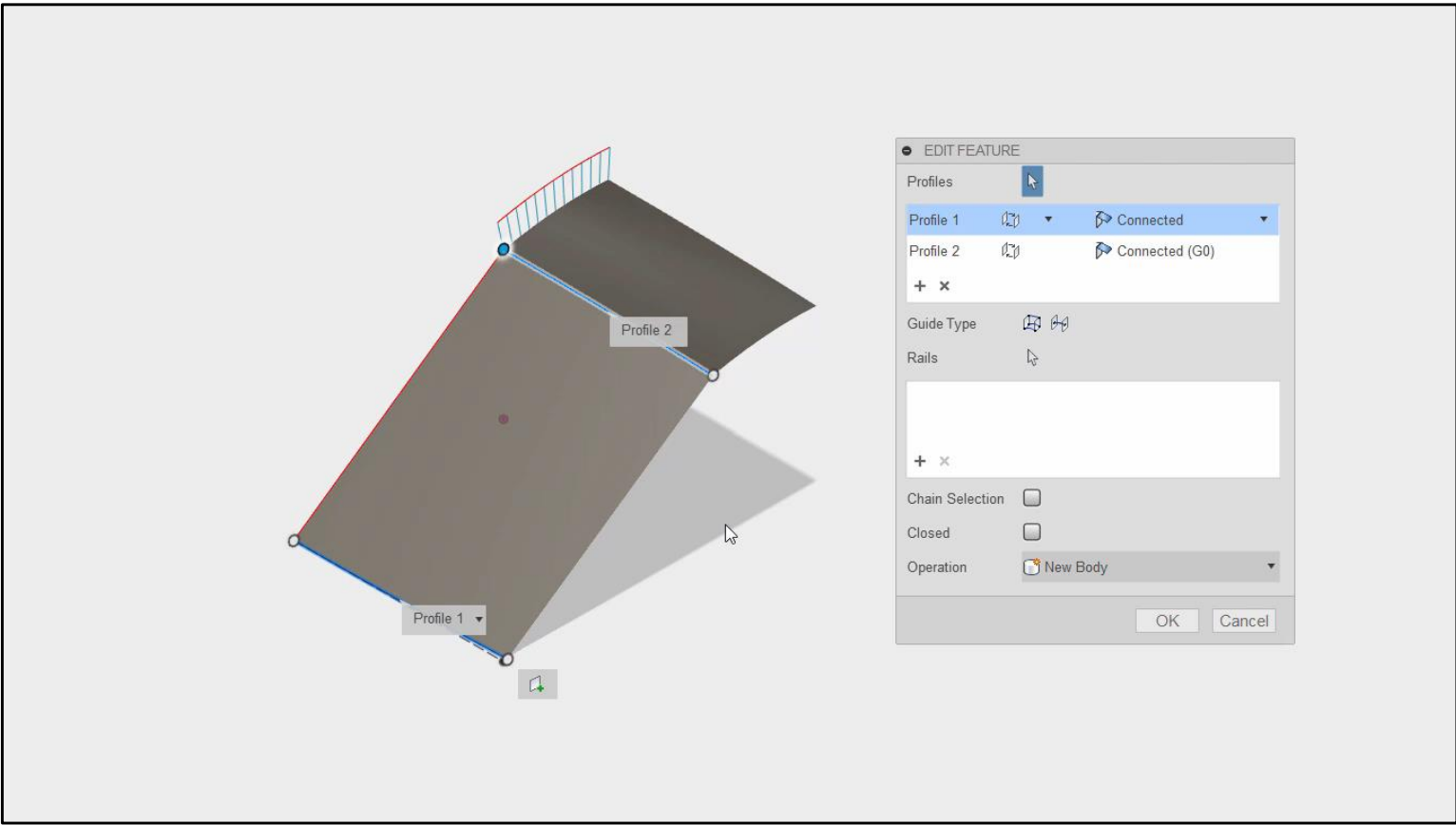
Be careful when lofting to a point – this can create a singularity which can be difficult to work with.



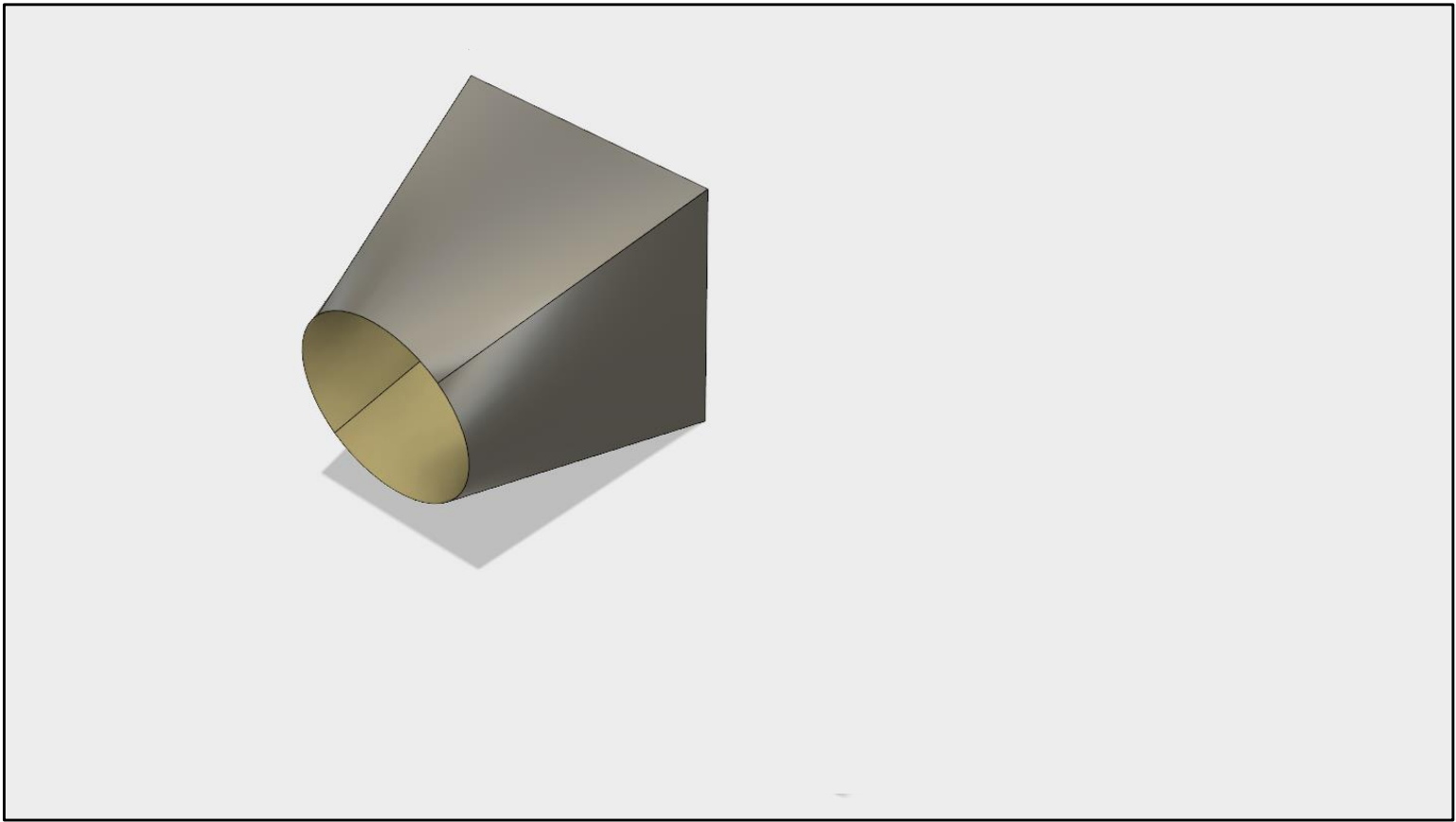
Patch is usually the best command for surfaces that are NOT four sided.



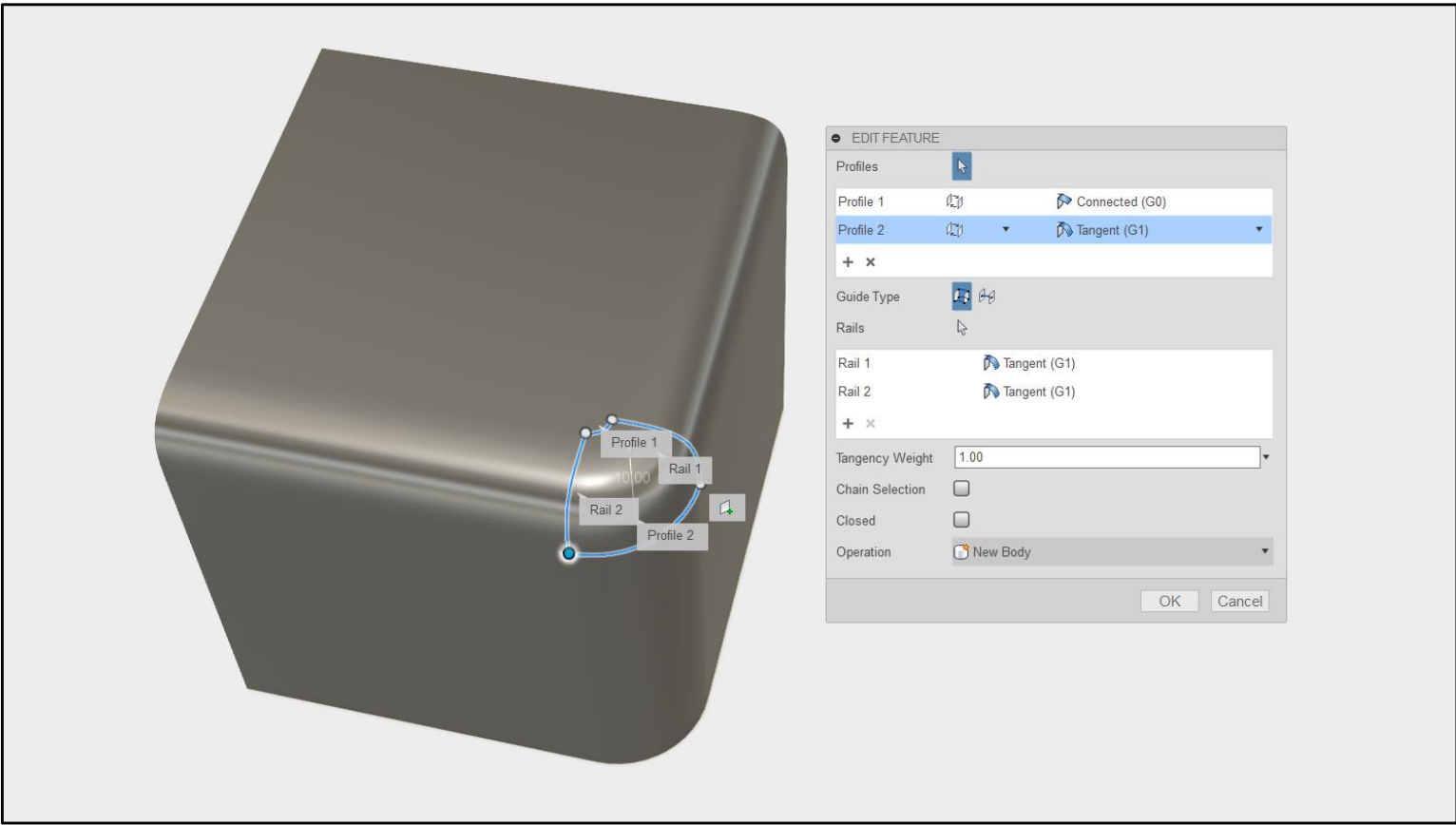
Loft is usually the best command when the input geometry IS four side – or where that are large distances and high curvature involved.



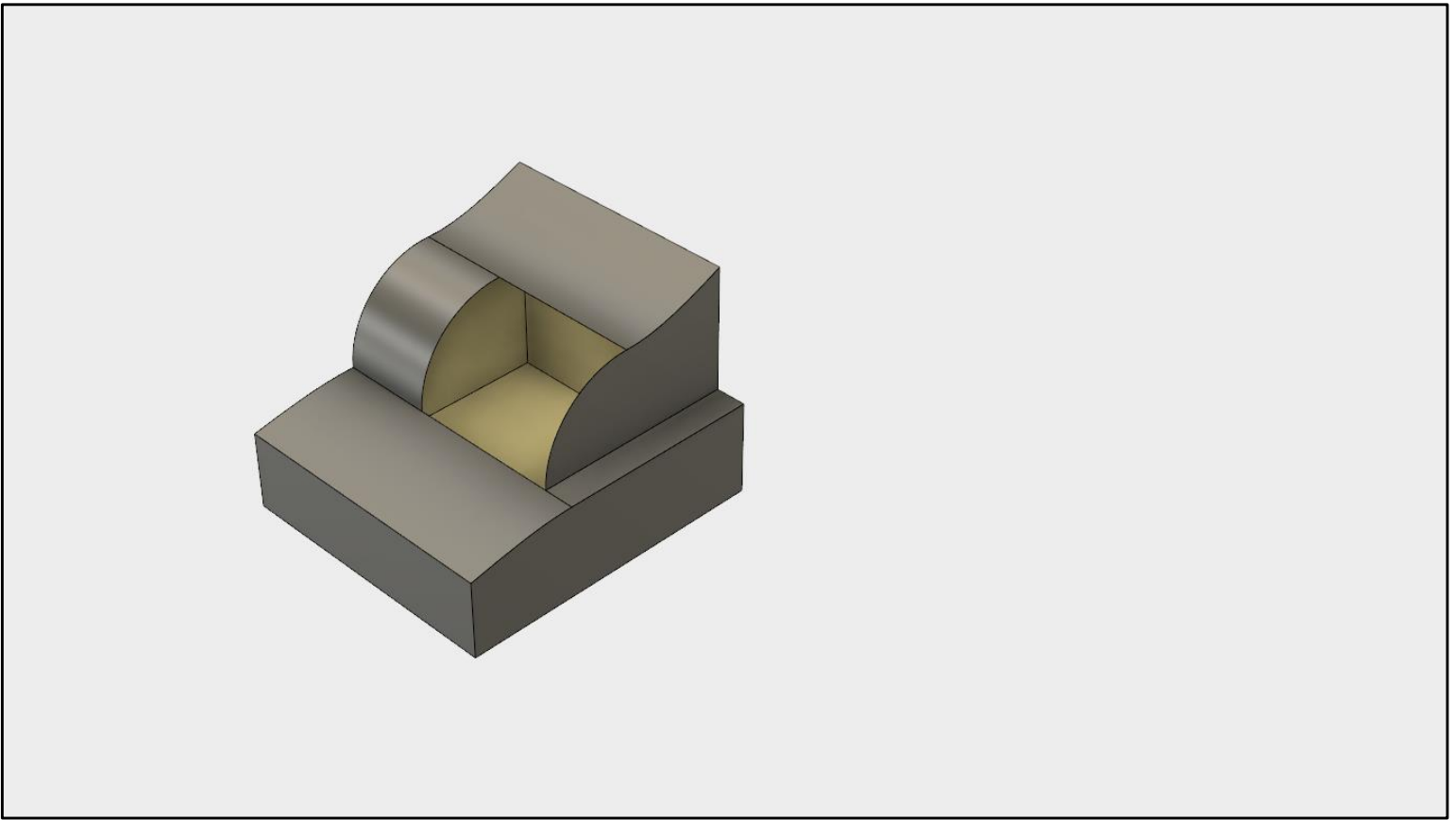
[Animation of a lofted surface being created]



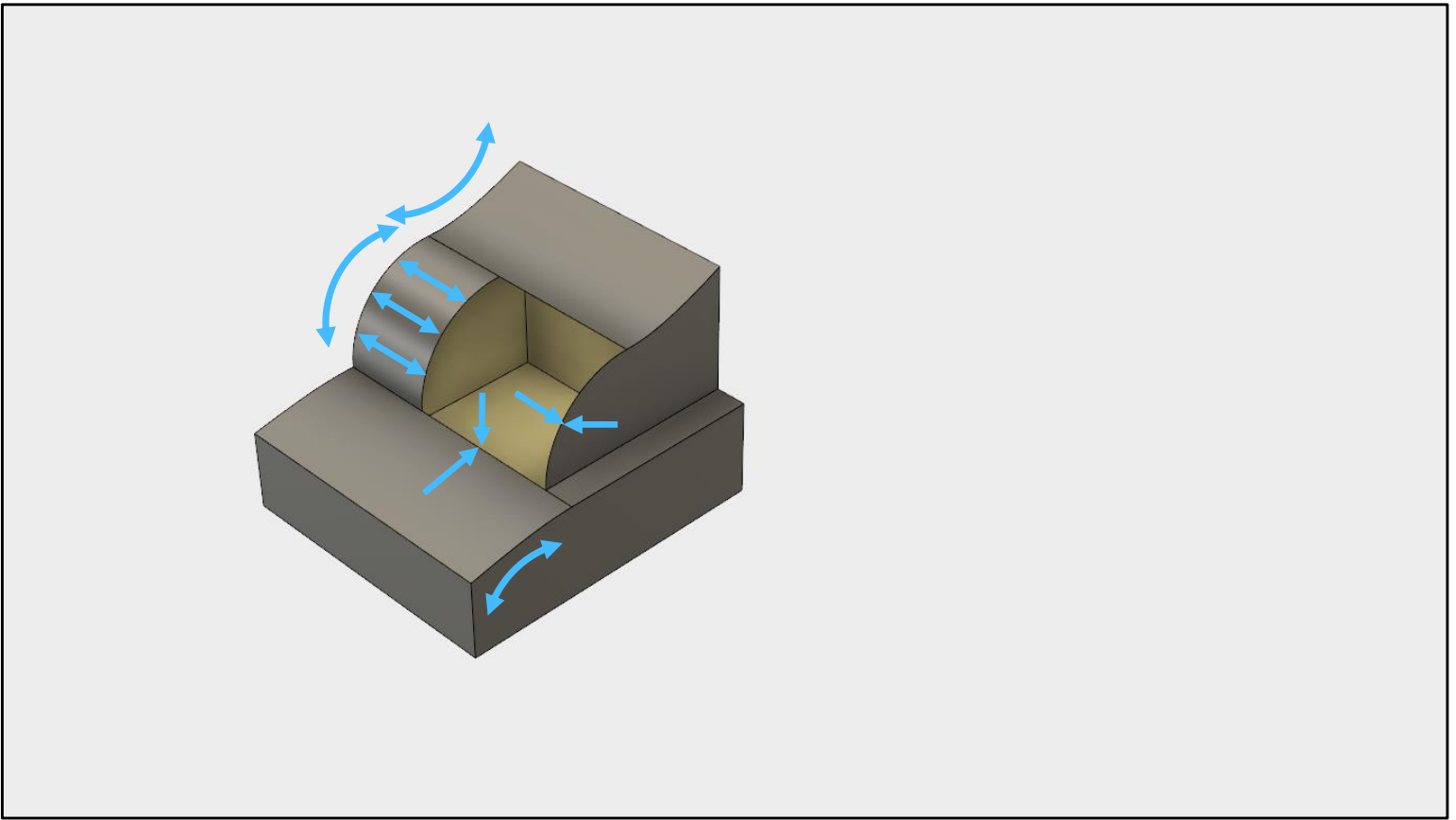
Tip: Create Lofts using equal input and output geometry.



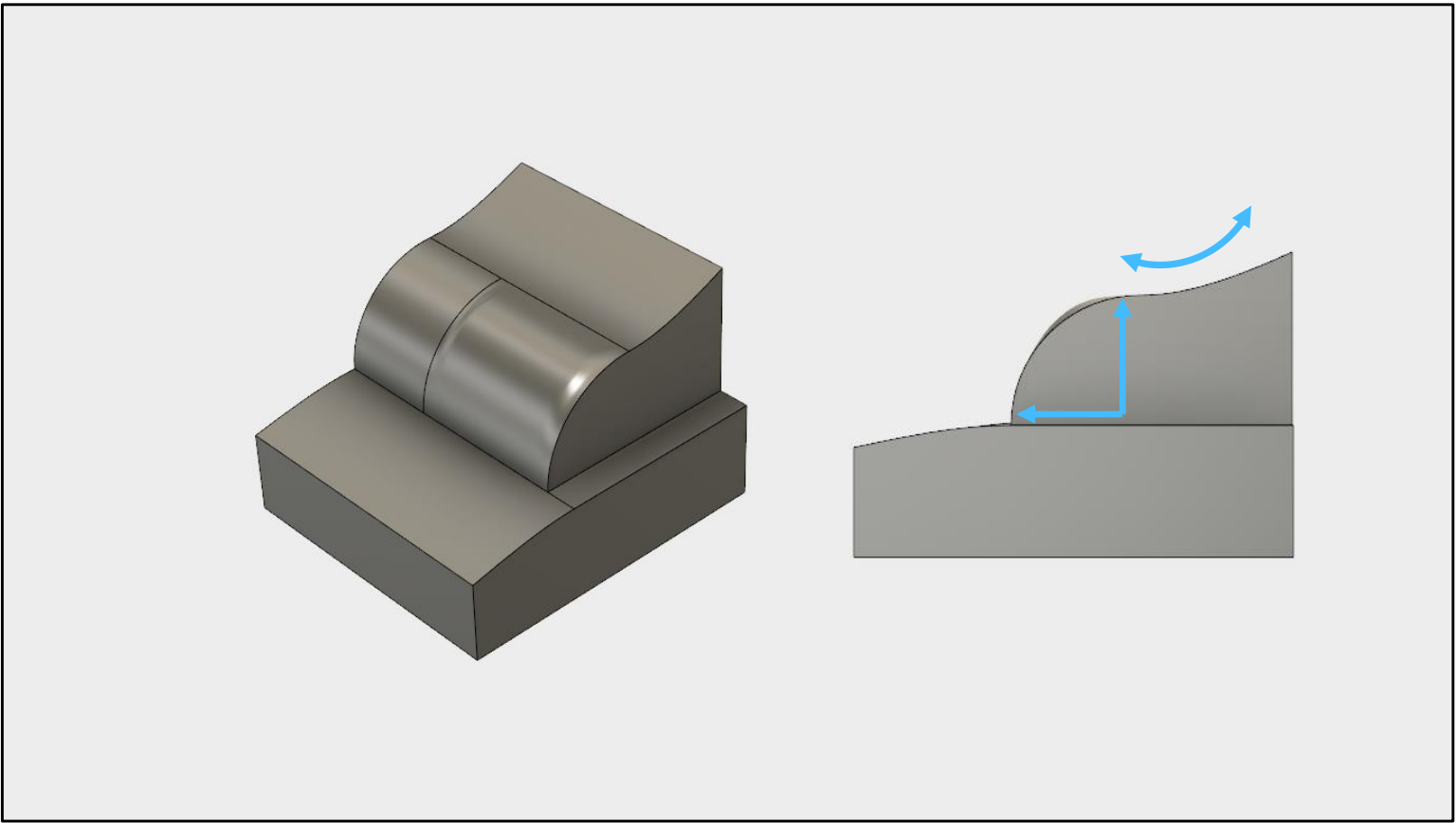
Tip: Make sure that input geometry for a Loft is four-sided.



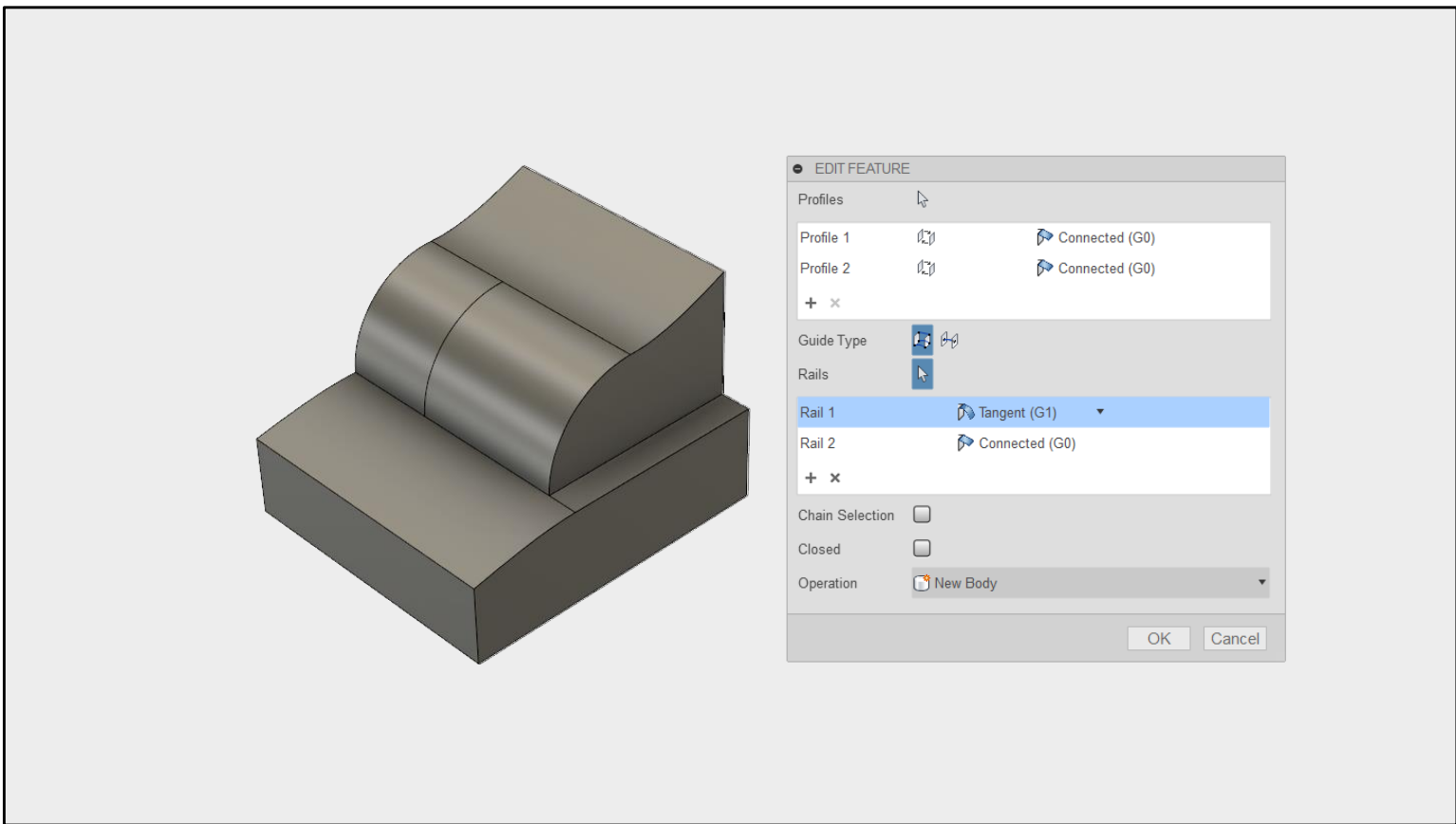
Applying curvature continuity conditions to lofted or patched surfaces.



What are the correct conditions to choose?



Over ‘constraining’ the surface can lead to undesirable results.



Fusion 360's patch command cannot apply different conditions for each edge.

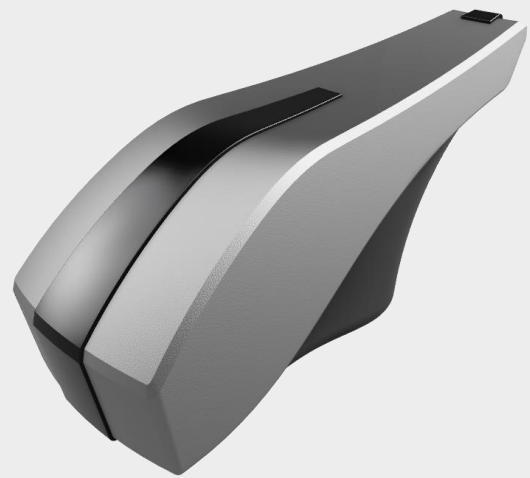
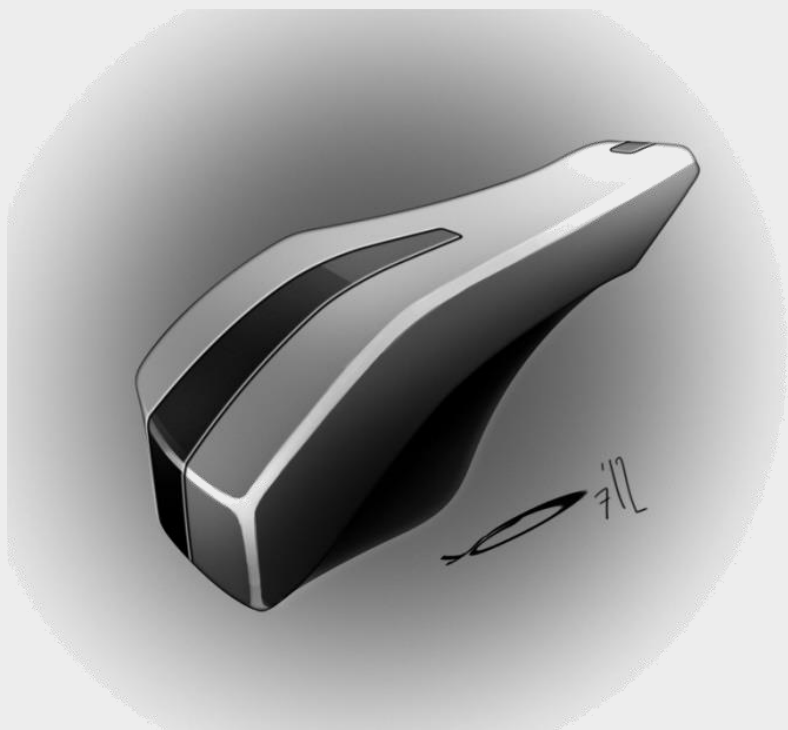
A loft allows us to choose the best condition for each edge.

STRETCH!

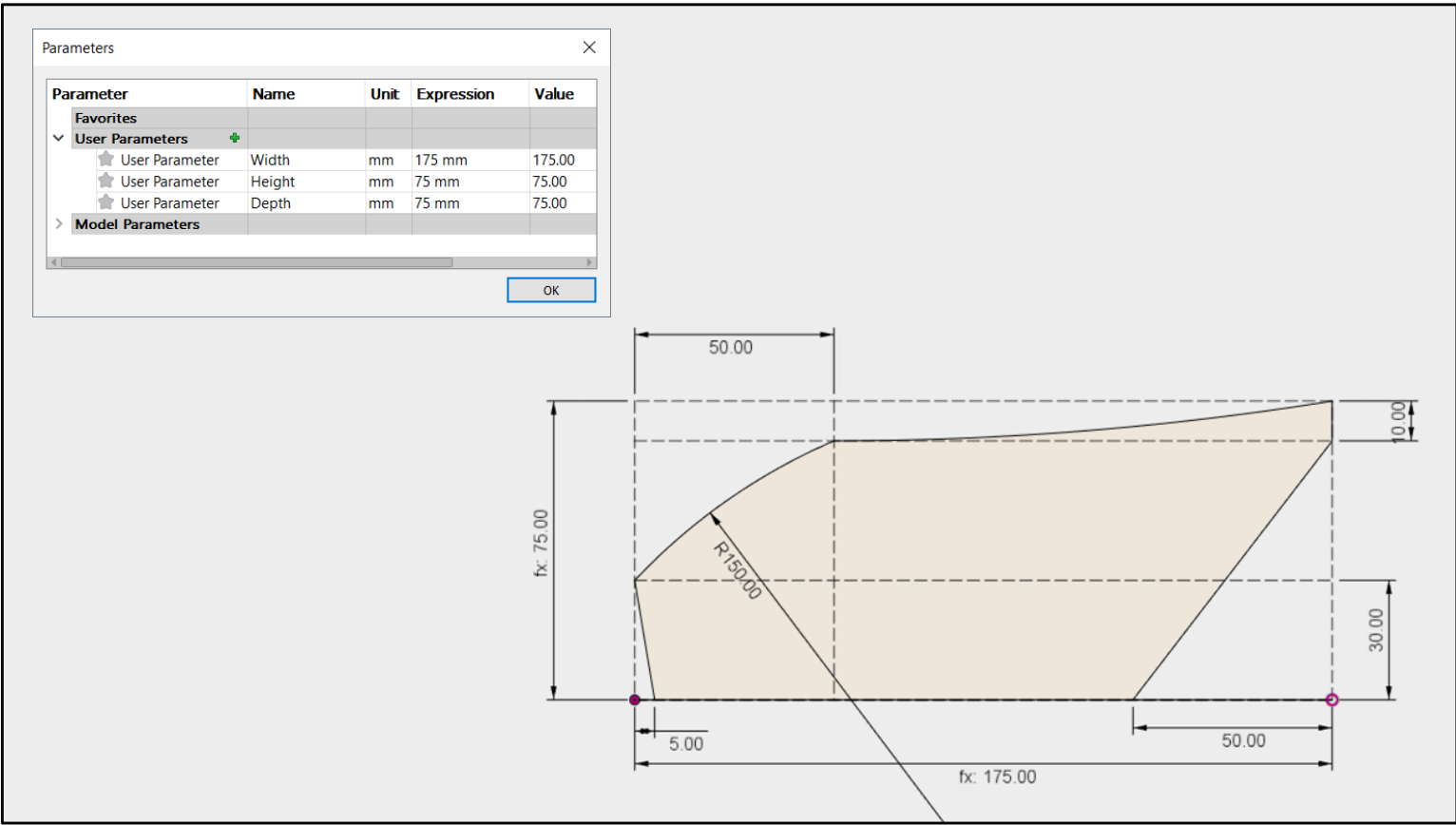


BACK TO WORK





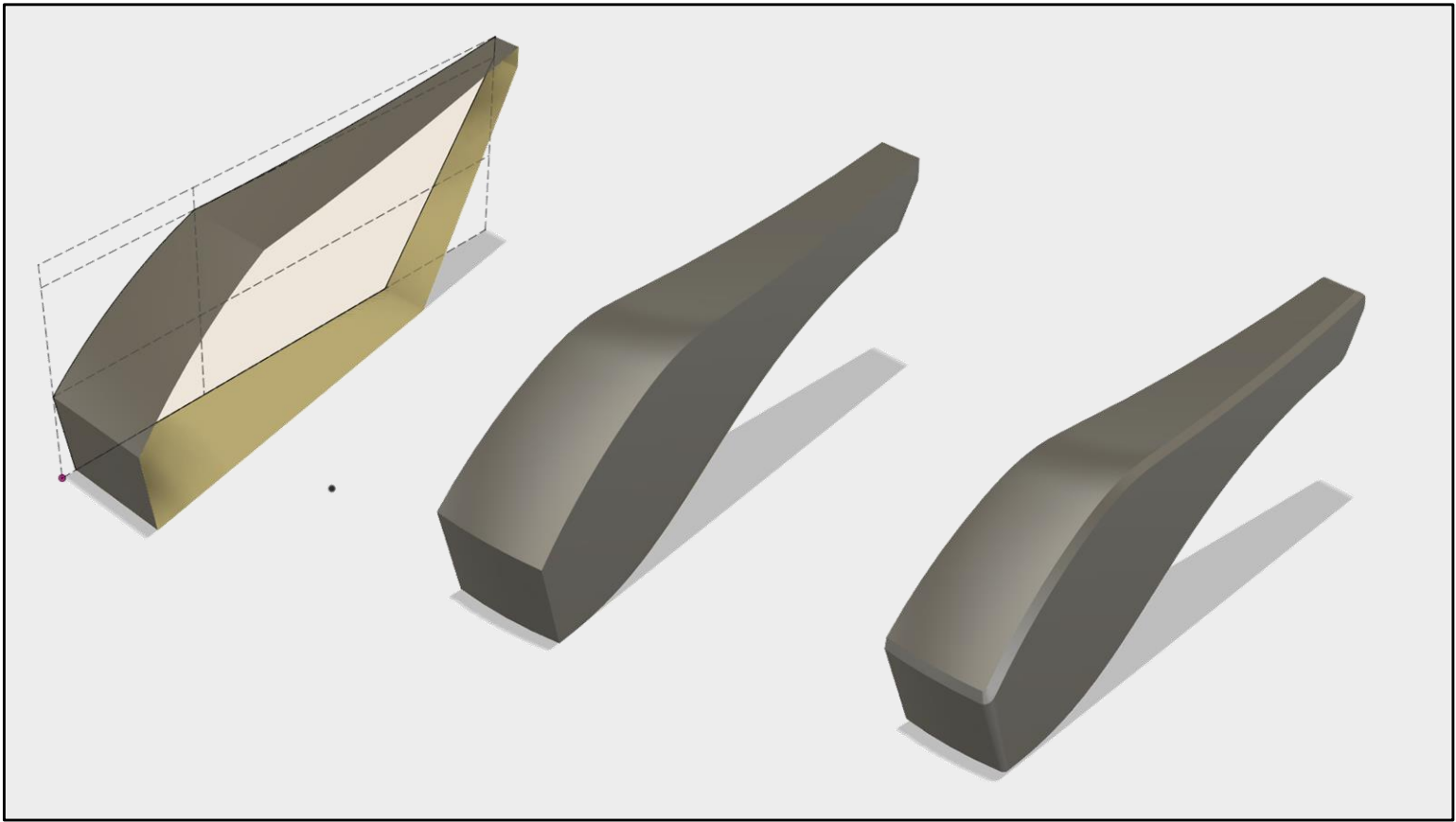
<http://www.coroflot.com/yoxkobayashi/COLLECTION-OF-FORMS>



Tip: Create user parameters to control your design.

Tip: Constrain curves to a ‘Control frame’ of construction geometry.

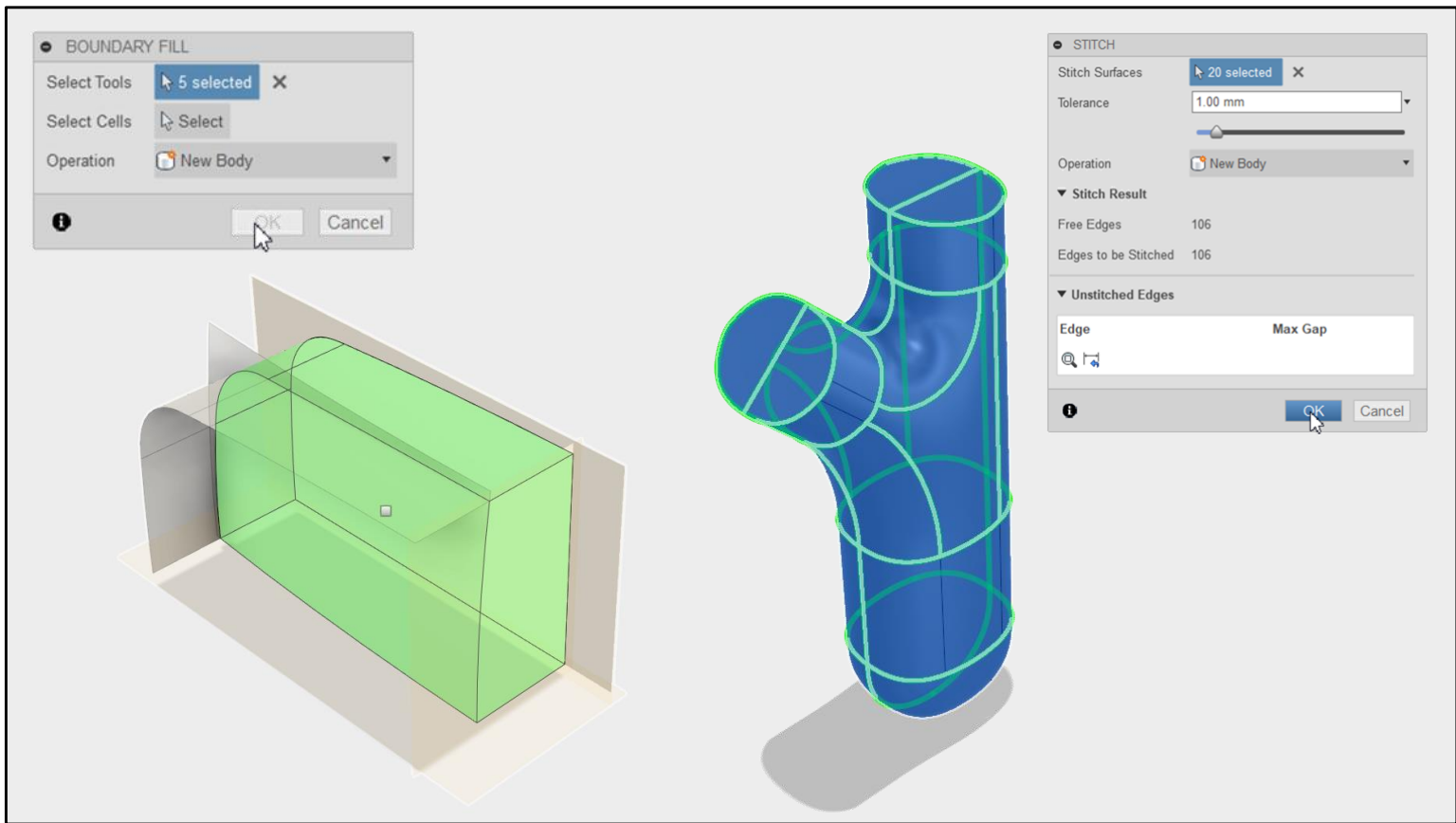
Tip: Work to theoretical sharp corners – build fillets and blends as features.



- Extrude sketch (sweep)
- Trim surface, blend and cap with a patch.
- Edge conditions come last.



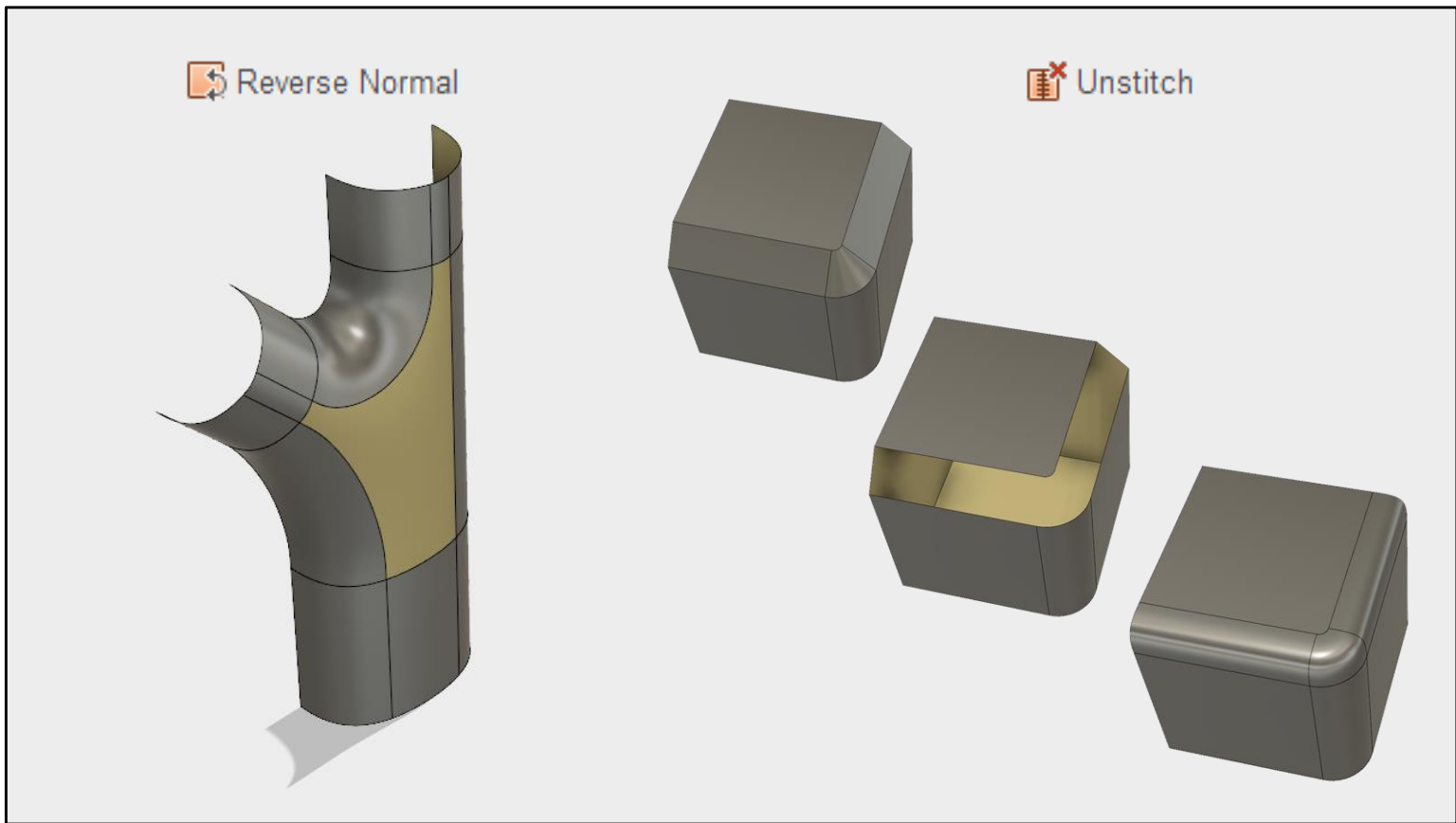
[Live – planning a patch layout for a branching model]



Turning surfaces into solids:

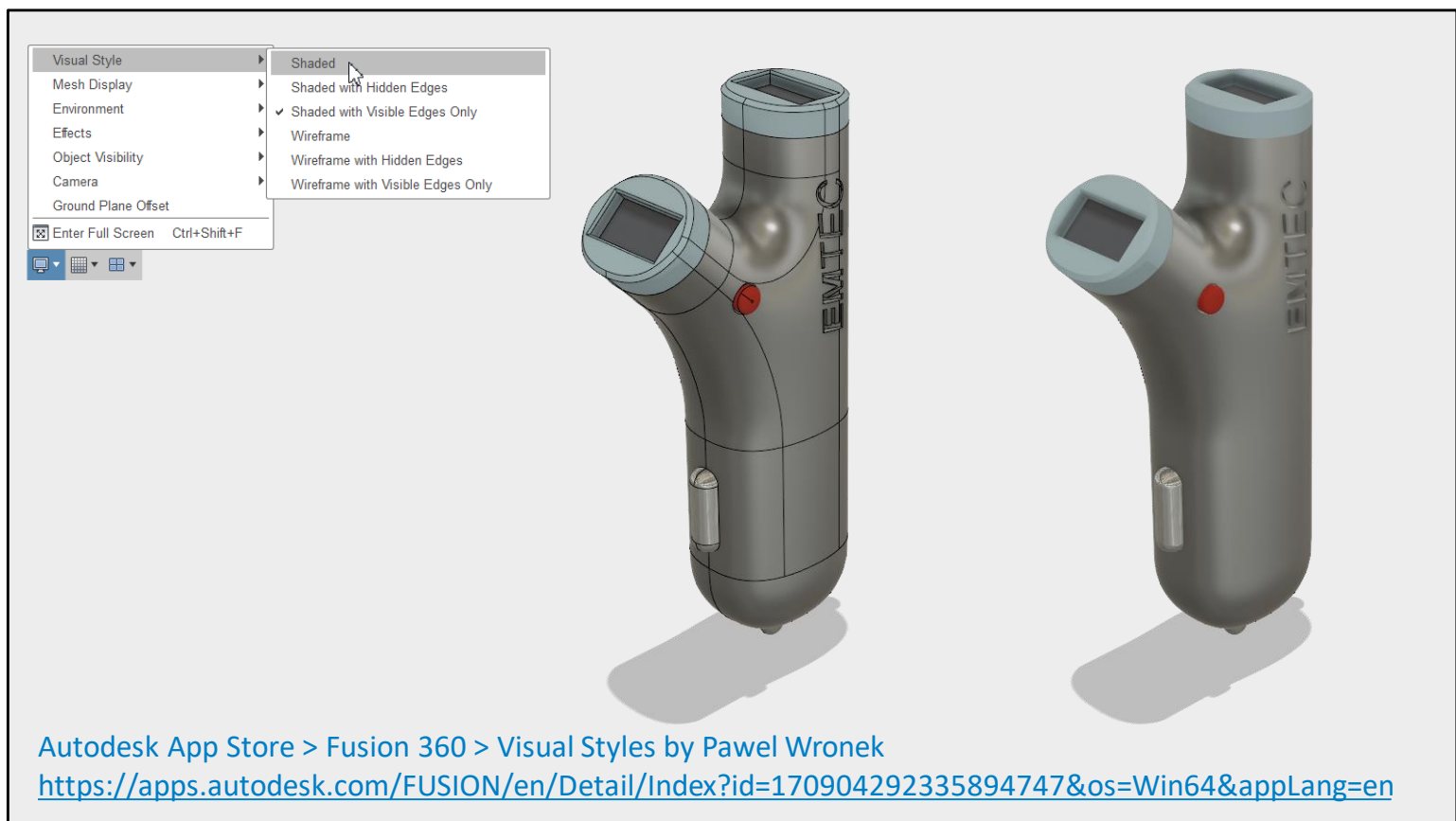
- Boundary fill
- Stitch

Tip: Thicken can also be used.



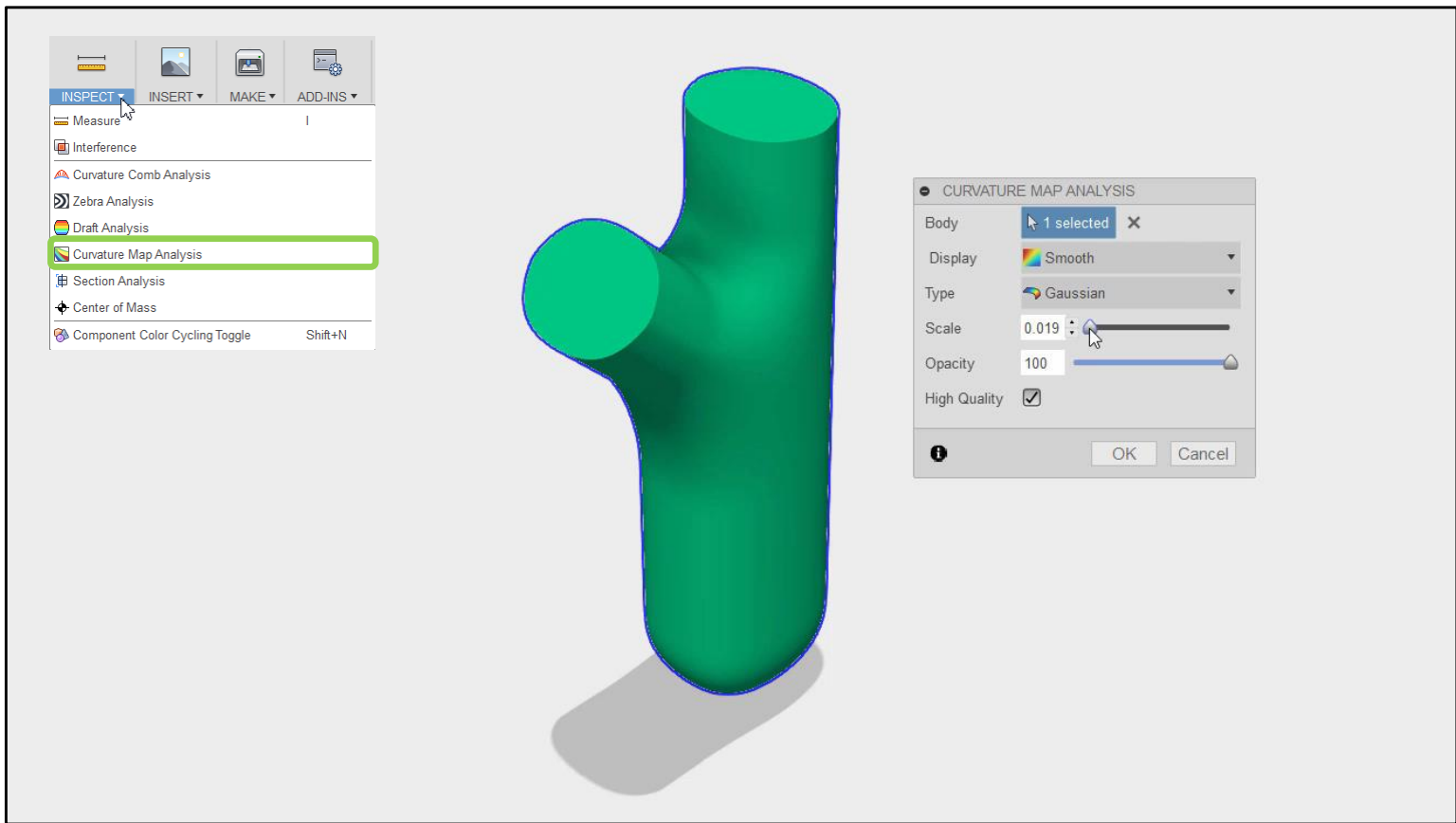
Surfaces have a front and a back. The back face is Yellow. If you see a Yellow face, try using the 'Reverse Normal' command to switch it around.

The unstitch command can be used to convert a solid model to a surface model.



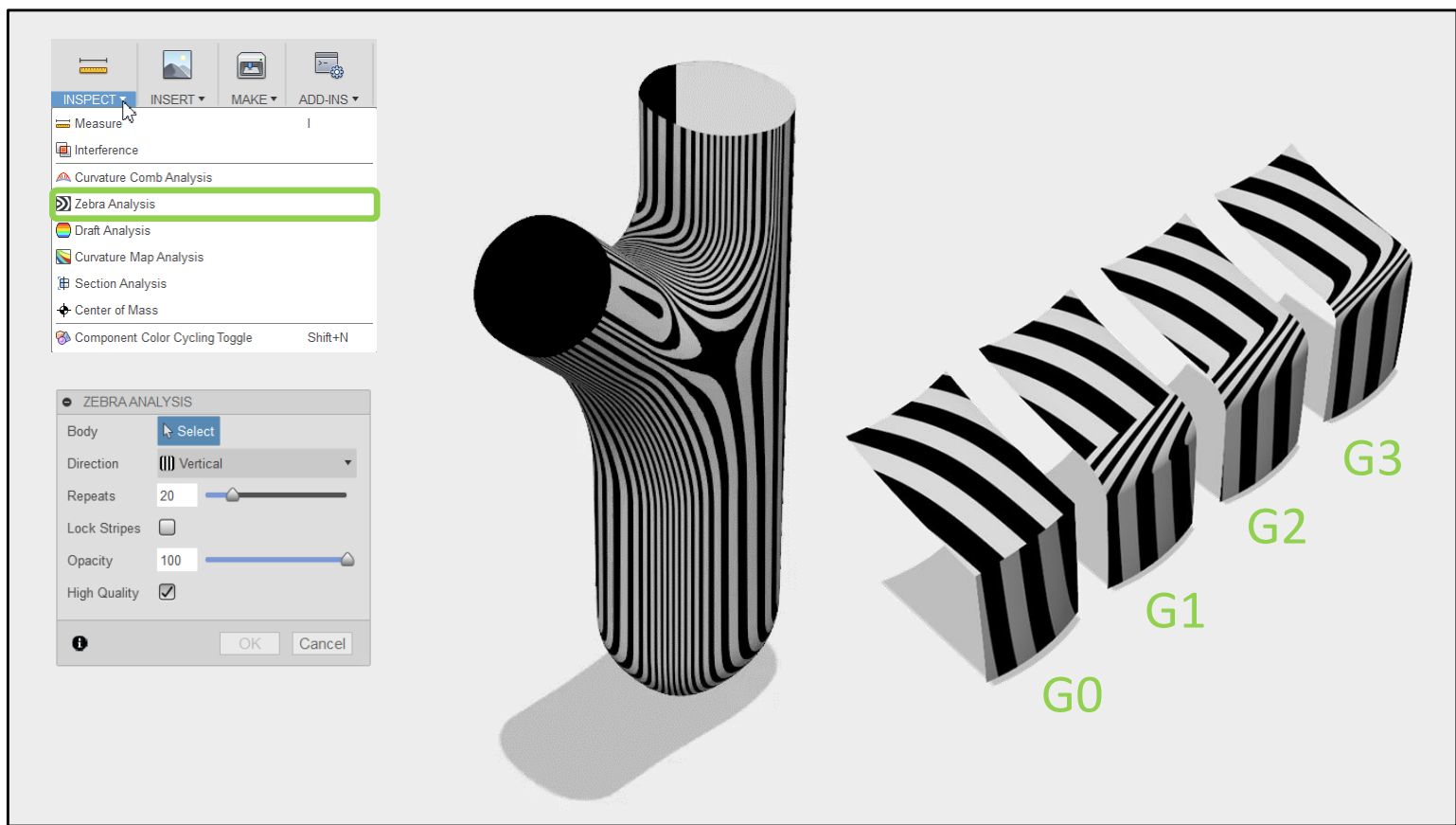
Ways of analysing surfaces:

- Switch from 'Visible edges' to 'Smooth Shaded'.



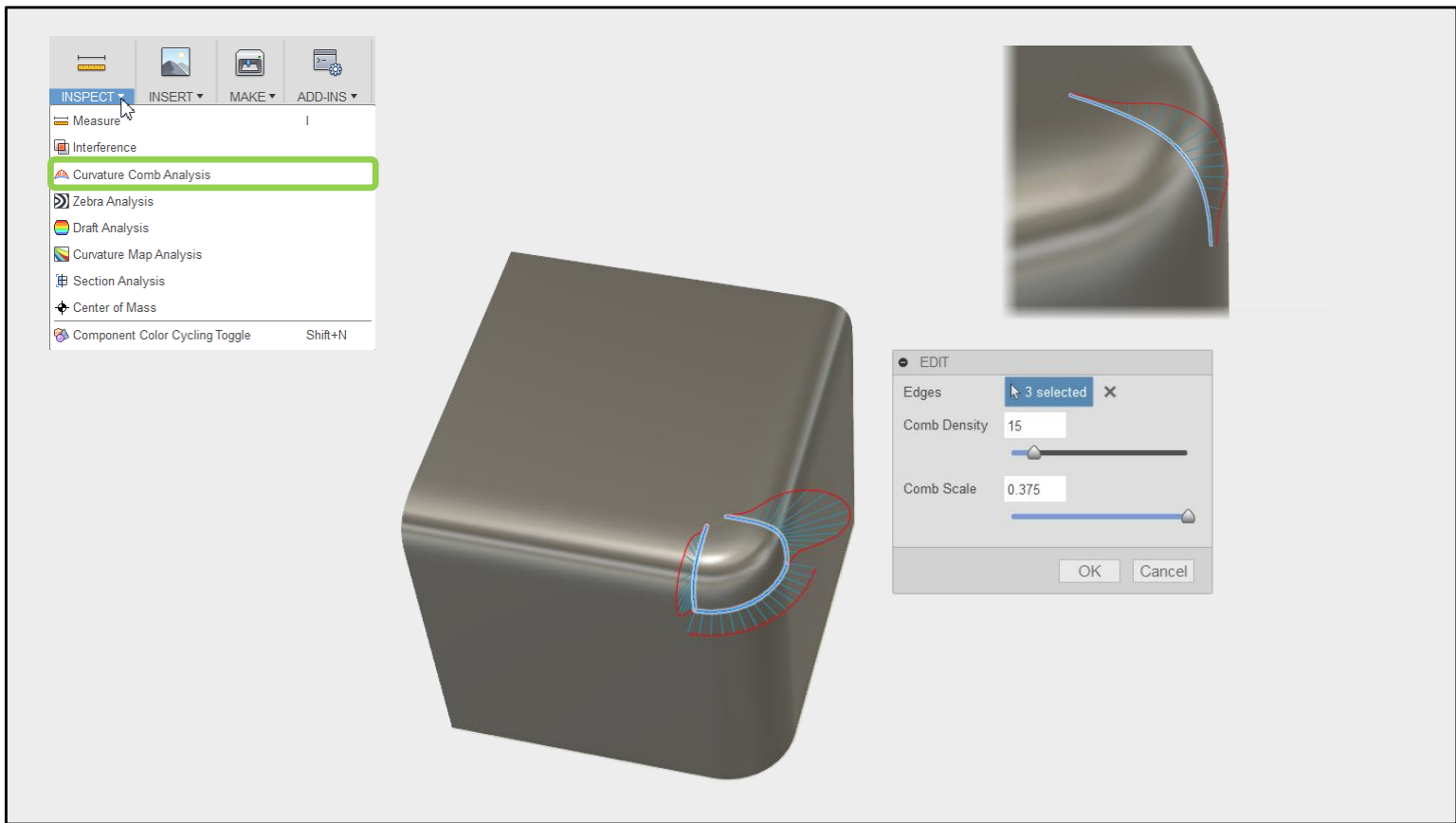
Ways of analysing surfaces:

- Use Curvature Map Analysis.



Ways of analysing surfaces:

- Use Zebra Analysis.



Ways of analysing surfaces:

- Curvature comb analysis can be used to check edges of surfaces.

F360 Surfacing Q&A (My Turn!)

Q: Curvature continuity is the process of matching _____ between surfaces.

A: *Properties.*

Q: Which four properties can we match between surfaces?

A: *Connected (G0) Tangent (G1) Curvature (G2) Acceleration (G3)*

Q: Name three commands that are used to convert surfaces to solids?

A: *Boundary Fill, Stitch, Thicken.*

Q: Name three tools that are used to inspect the quality of surfaces?

A: *Curvature Map, Zebra and Comb Analysis.*

My questions for you...

Surface Modelling with Fusion 360 Summary

- Consider curvature Continuity.
- Plan your patch layout.
- Build 'clean' graceful splines as inputs.
- Use curvature combs to check splines.
- Work to Theoretical sharp edges.
- Overbuild surfaces and trim back.
- Don't over constrain your blends.
- Use Fill or Stitch to turn surfaces in solids.
- Use Curvature or Zebra Analysis to inspect surfaces for problems.
- 'Flex' parametric designs to check for re-build problems.
- Have fun!

Summary



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Q&A



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Please fill out your class surveys on the AU APP!

Jake Fowler

*MA2843: Get Smart with Autodesk®
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Inderjeet Wilkhu

*LO-HL13: 7 Deadly Sins of 3D Part Modelling
in Inventor & Fusion 360*

<http://cadso.co/7deadlySins3D>

Your questions for me...



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