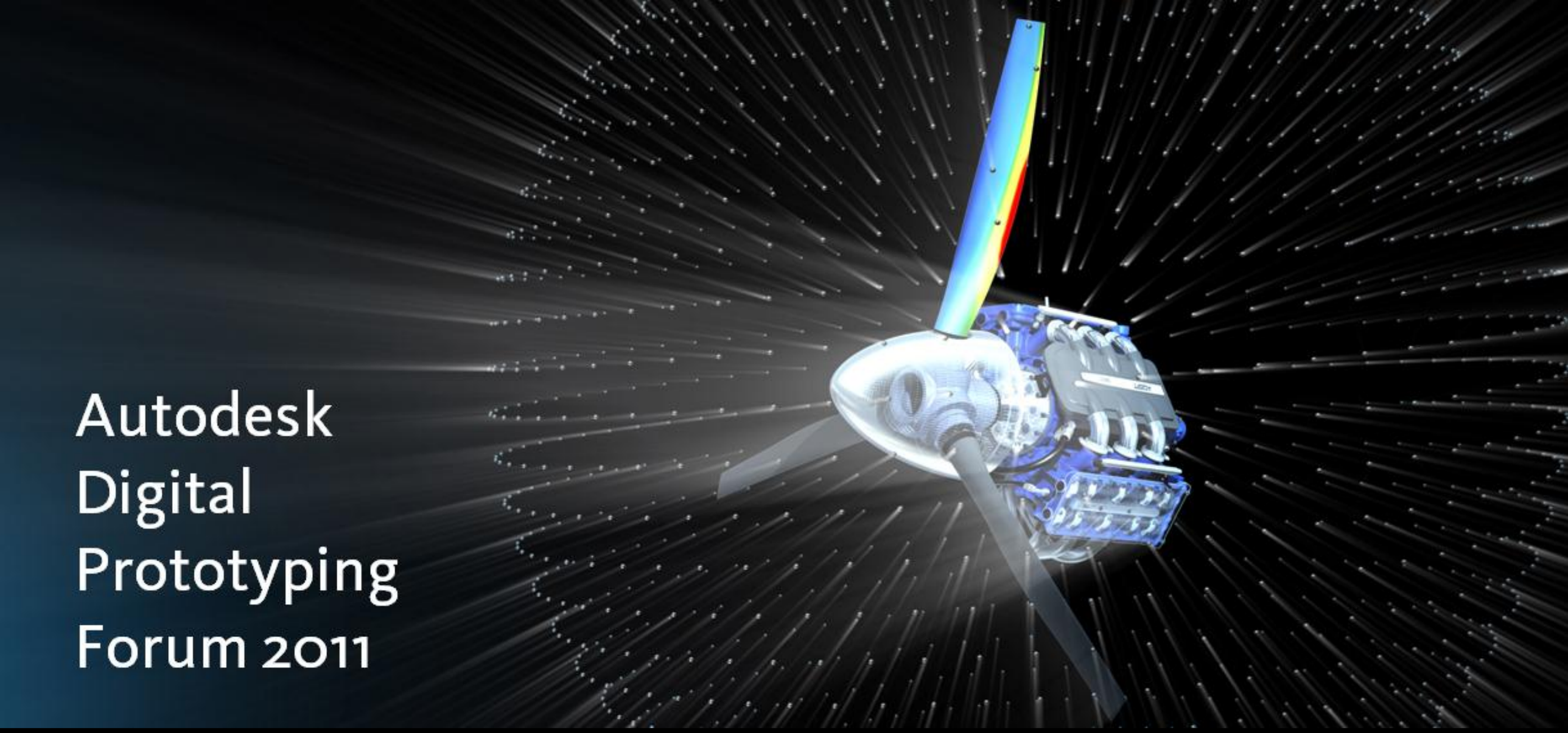

Complex Shapes Creation with Hybrid Modelling

Peter De Strijker
Technical Sales Executive MFG - Benelux

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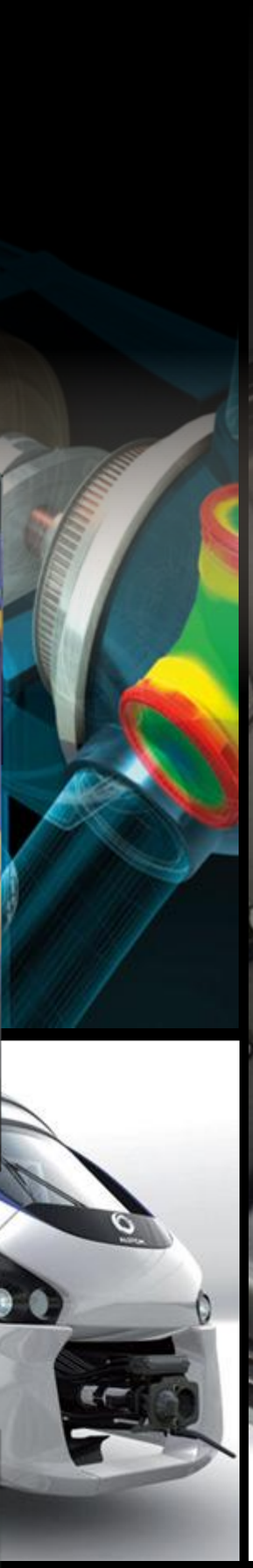
Our Customer's Industries

Discrete product manufacture



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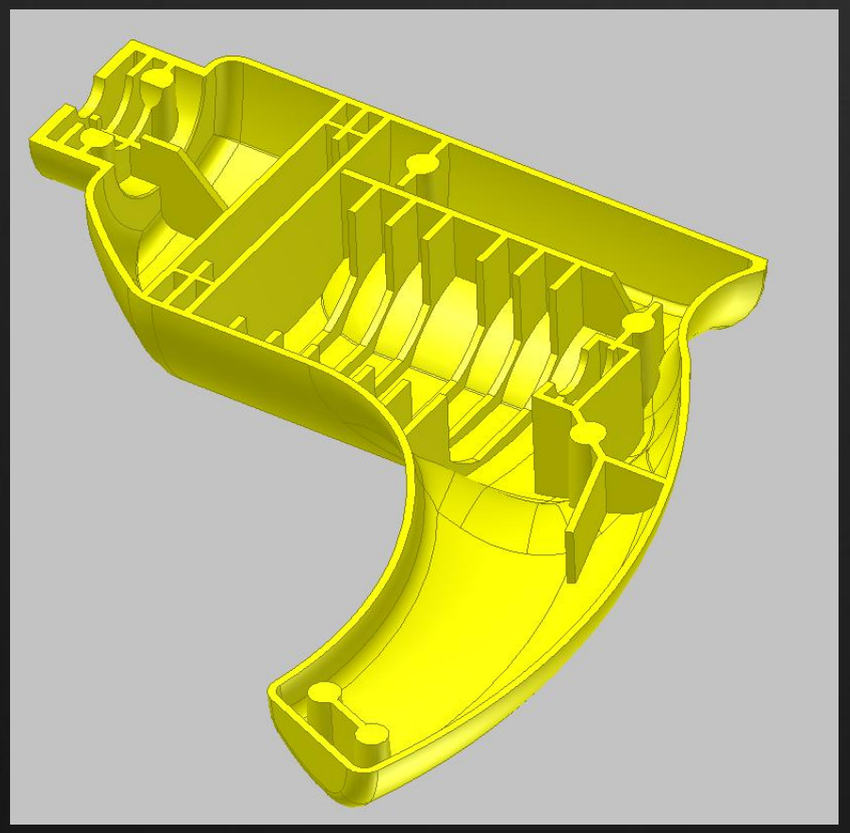
Agenda

- Quality Analyses of sketches and surfaces
- Fillets and Surfaces
- Combining Surface and Solid Modelling
- Plastic parts – Best Practice
- Bonus: Brep



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Quality Analyses

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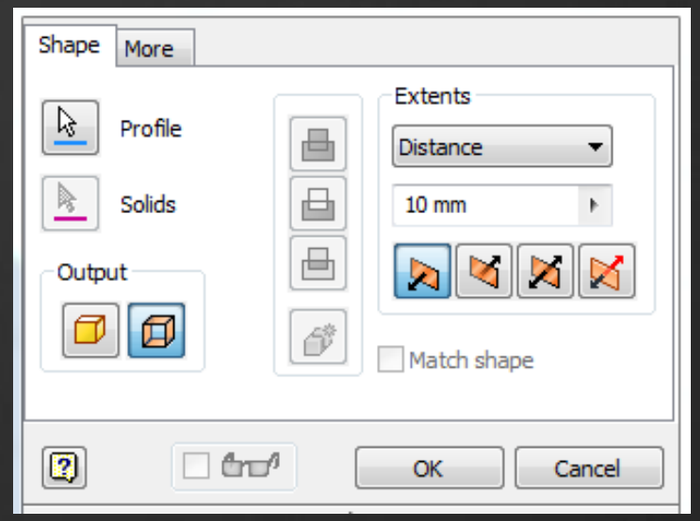
Surface Modelling with Autodesk Inventor?

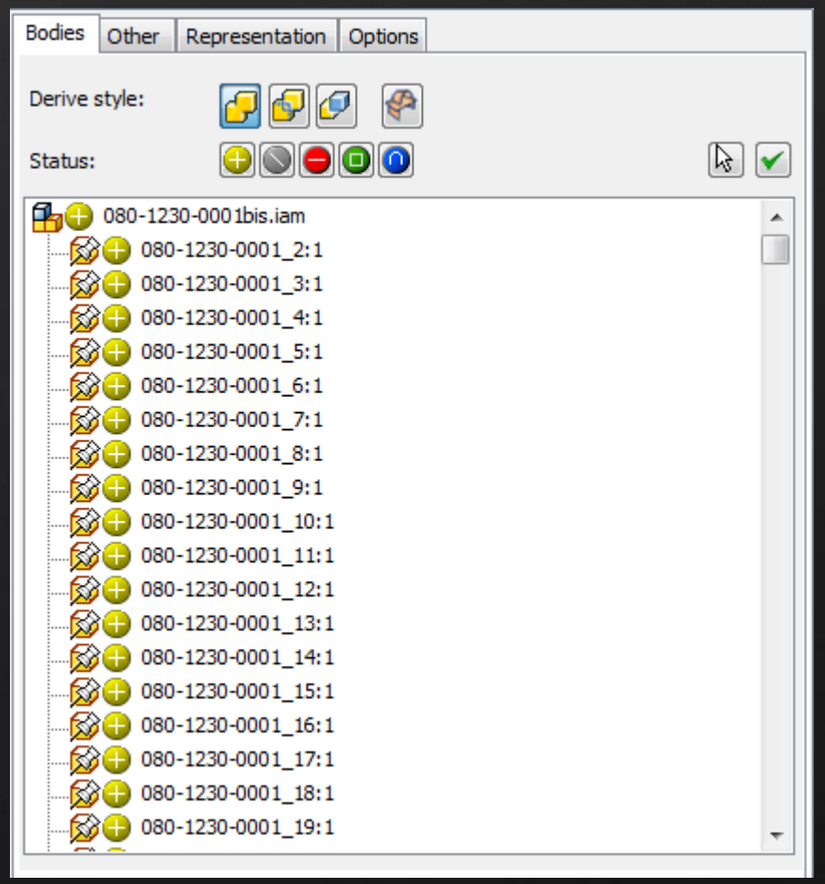
- Extrude
- Revolve
- Loft
- Sweep
- Coil
- Fillet
- Chamfer
- Split
- Thicken/Offset
- Sculpt

- Delete Face
- Boundary Patch
- Trim Surface
- Extend Surface
- Stitch Surface

- Rectangular Pattern
- Circular Pattern
- Mirror

- Copy Object
- Derived Component





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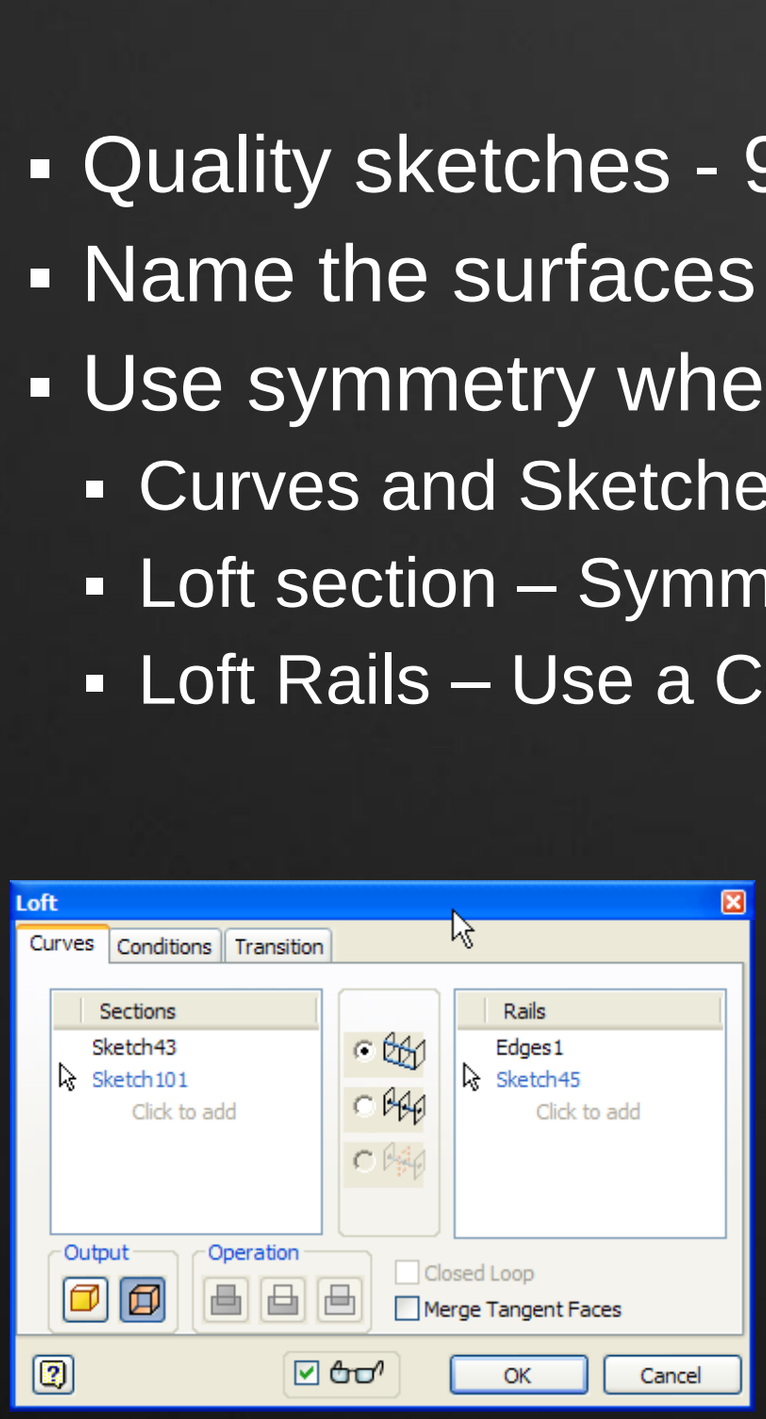
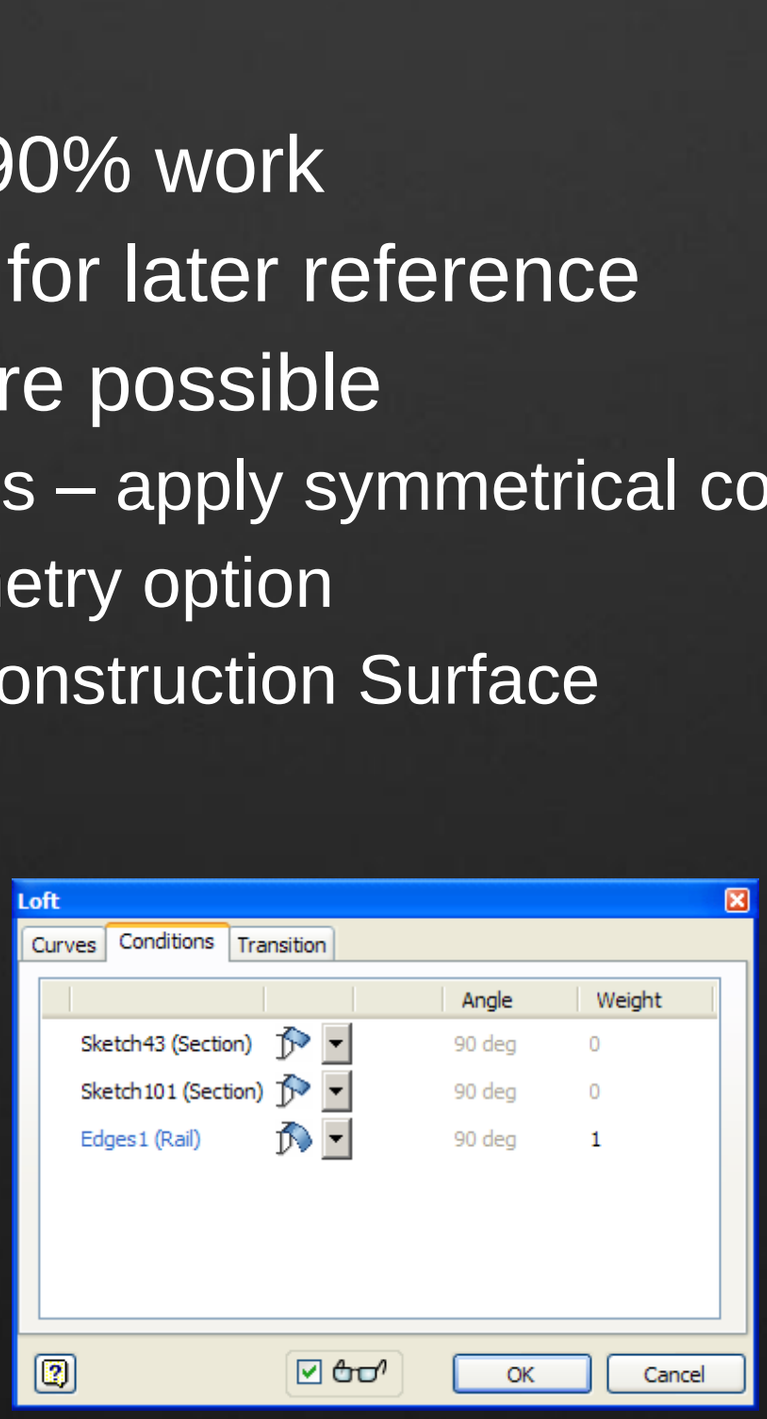
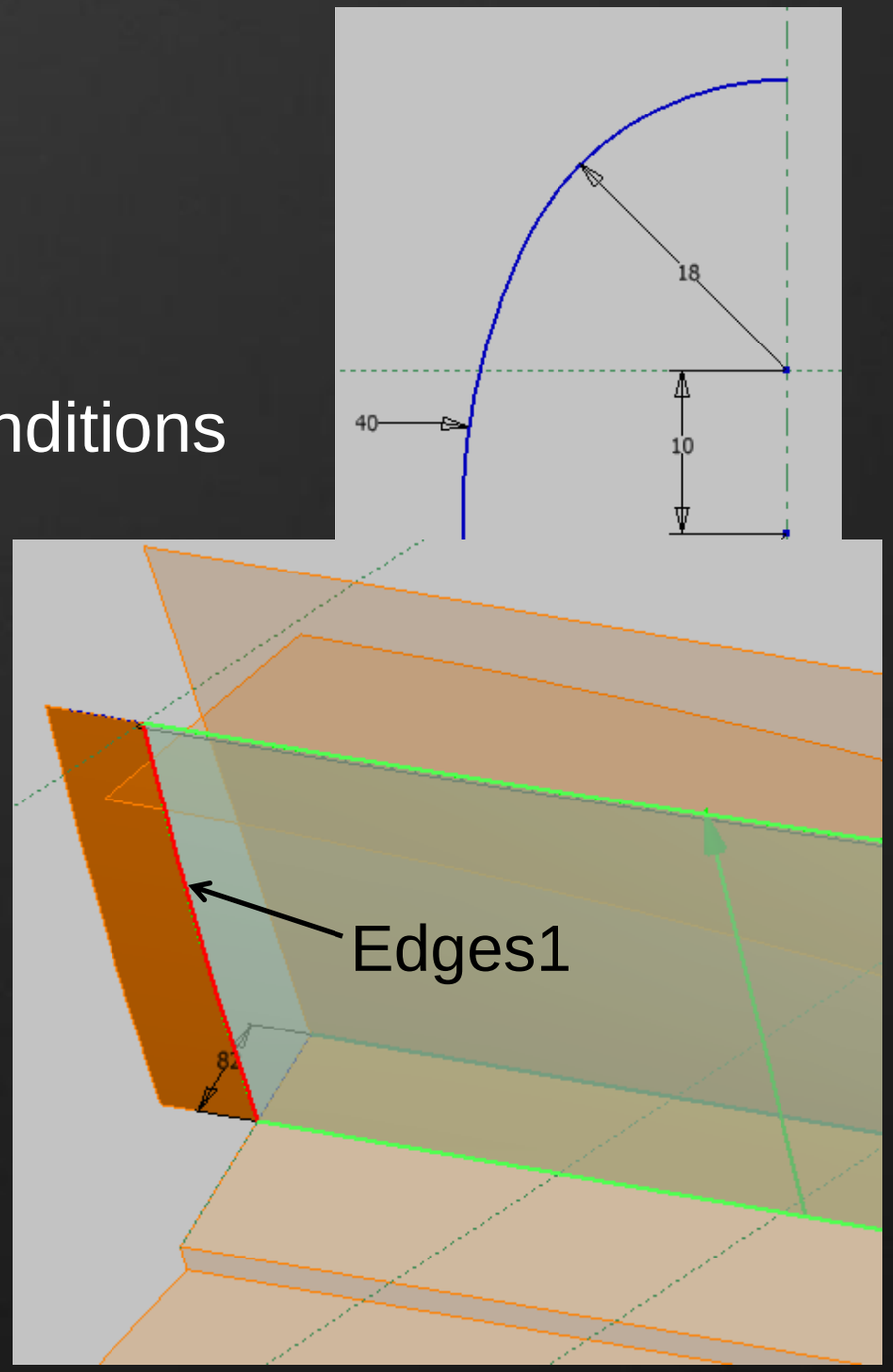
Surface modelling – Best Practice.

- Quality sketches - 90% work
- Name the surfaces for later reference
- Use symmetry where possible
  - Curves and Sketches – apply symmetrical conditions
  - Loft section – Symmetry option
  - Loft Rails – Use a Construction Surface







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Sketches, Curves,…
2D and 3D Curve continuity

- Importance of high quality curves
  - What is curvature continuity – Curvature = 1/radius
  - G0 – Coincident
  - G1 - Tangent Continous
  - G2 - Radius of Curvature Continous
  - G3 - Radius of Curvature Continous and Rate of Change of Radius of Curvature Continous (Class A surface - Autodesk Alias)
  - G4 - Radius of Curvature Continous, Rate of Change of Radius of Curvature continous and Rate of Change of Rate of Change of Radius of Curvature continous (Class A surface - Autodesk Alias)

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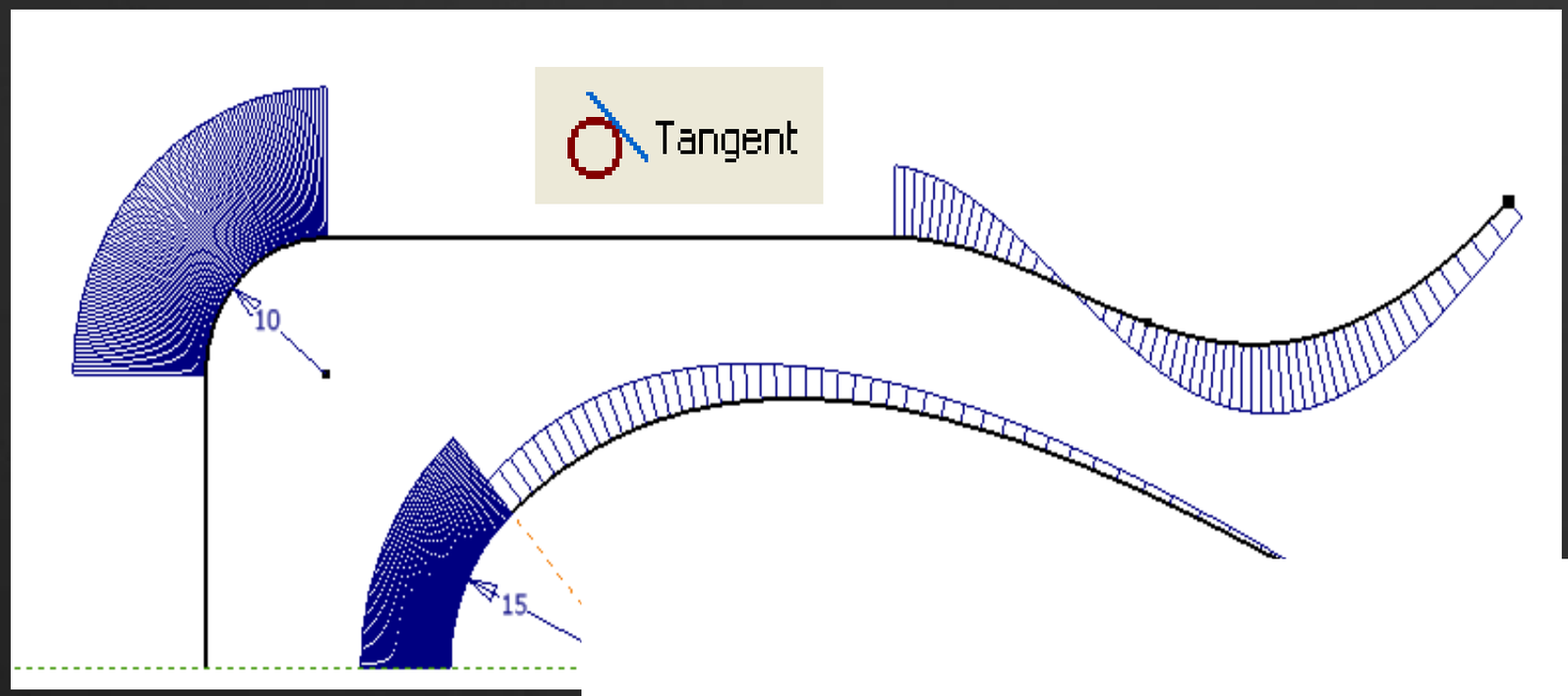
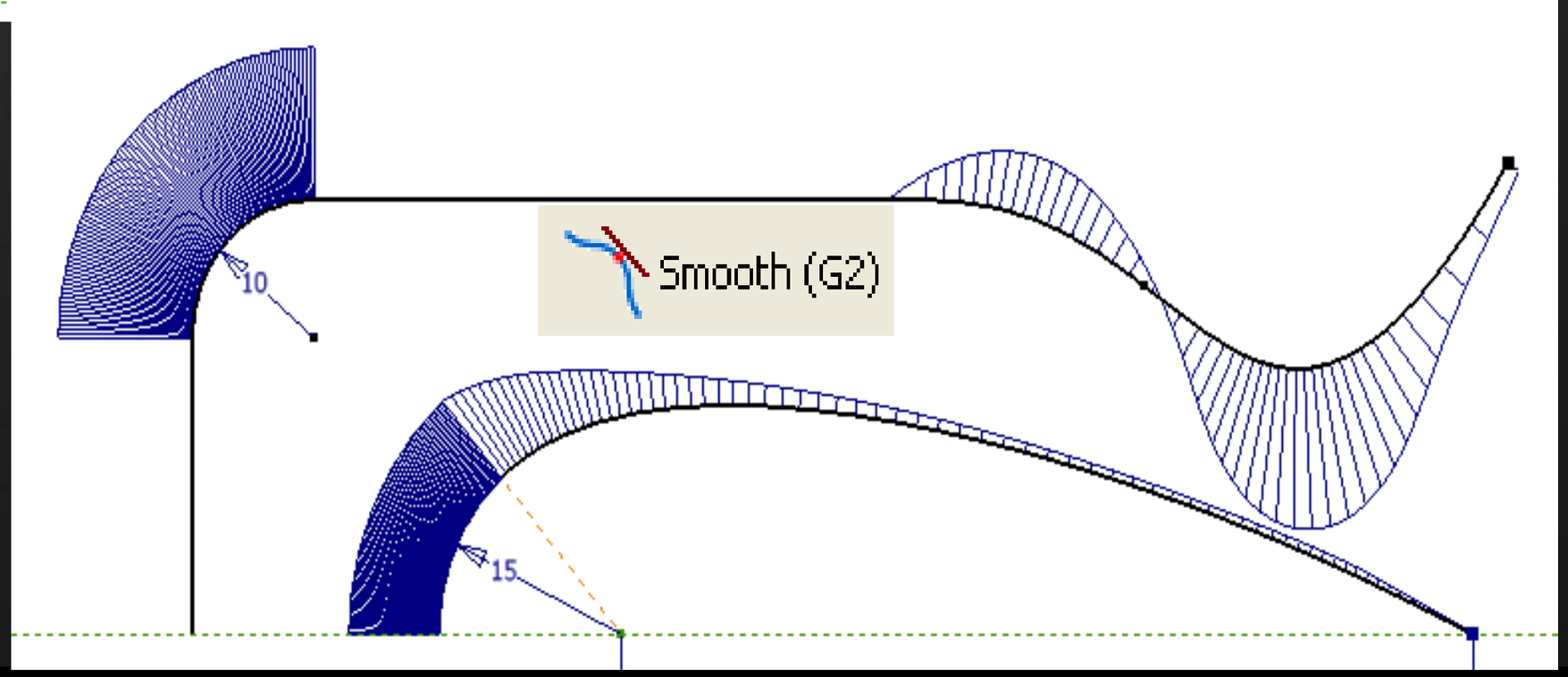
Sketches, Curves,…
2D and 3D Curve continuity





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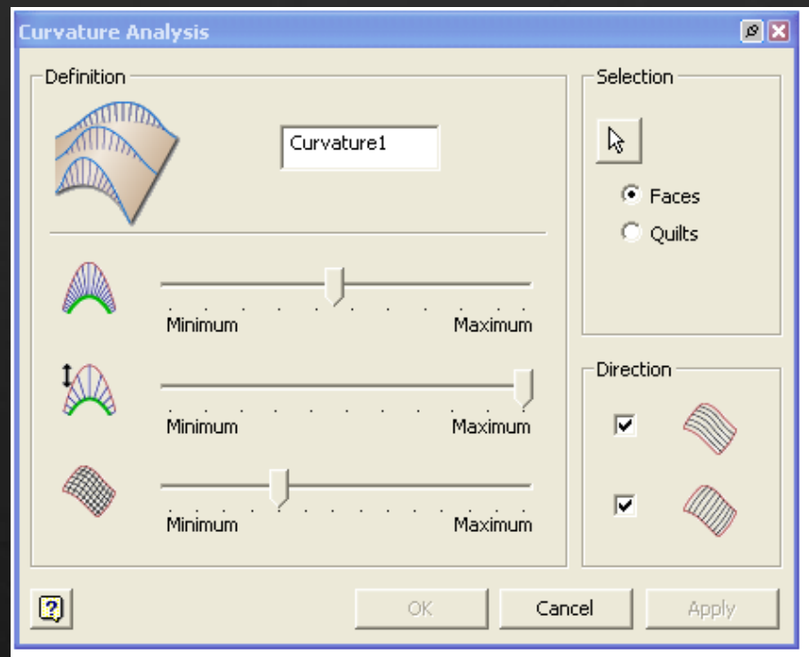
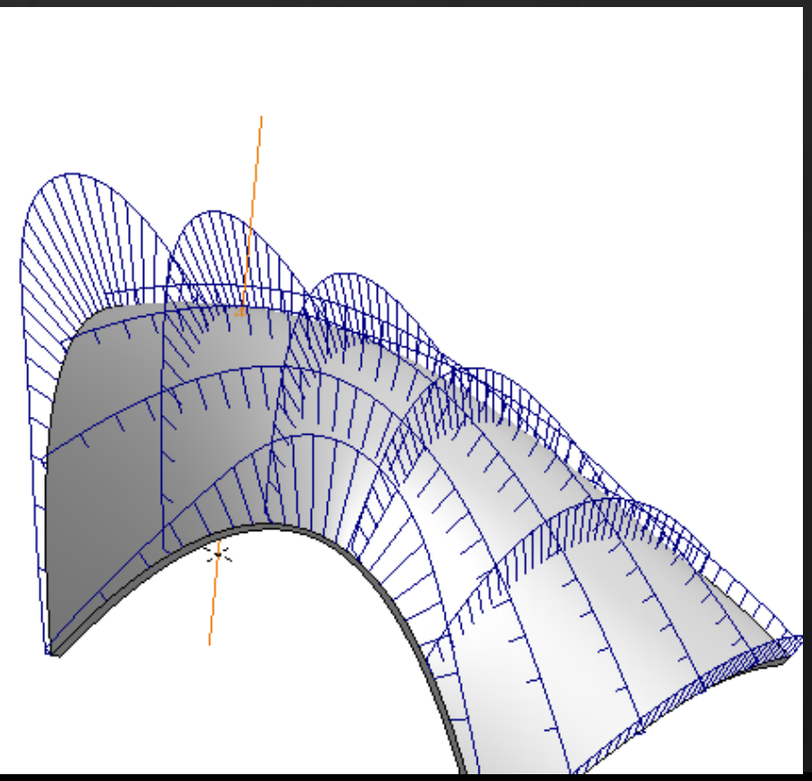
Surface Continuity
Curvature

- Curvature – Same as for 2D and 3D curves
- Loft – G1 and G2 option
- Fillet – G2
- Extended Surface – internal G2
- Boundary Patch – G1 constraint on edges – G2 internal.





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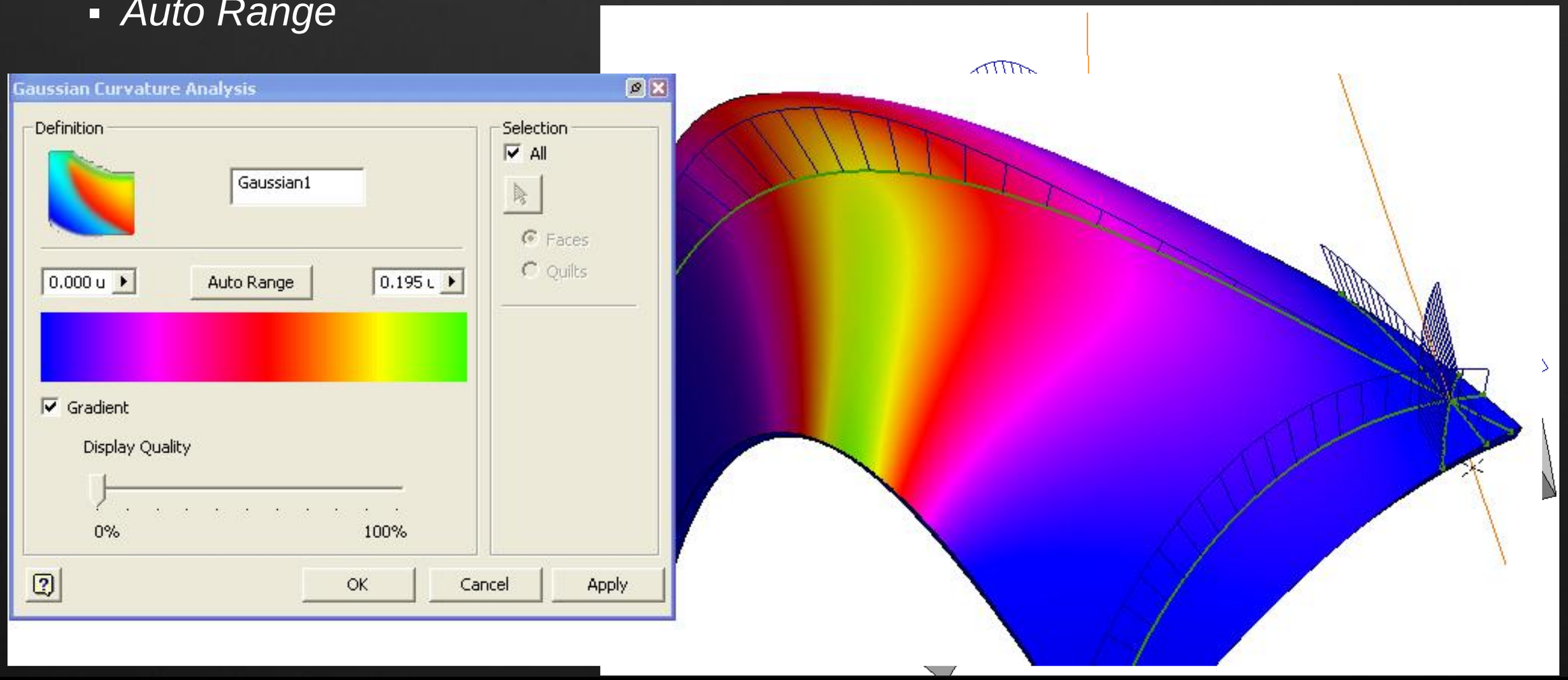
Surface Continuity
Curvature Analysis

- Gaussian Curvature definition:
  - The Gaussian curvature of a surface at a point is the product of the principal curvatures at that point.
  - Gaussian curvature = Cmax * Cmin
  - *Auto Range*



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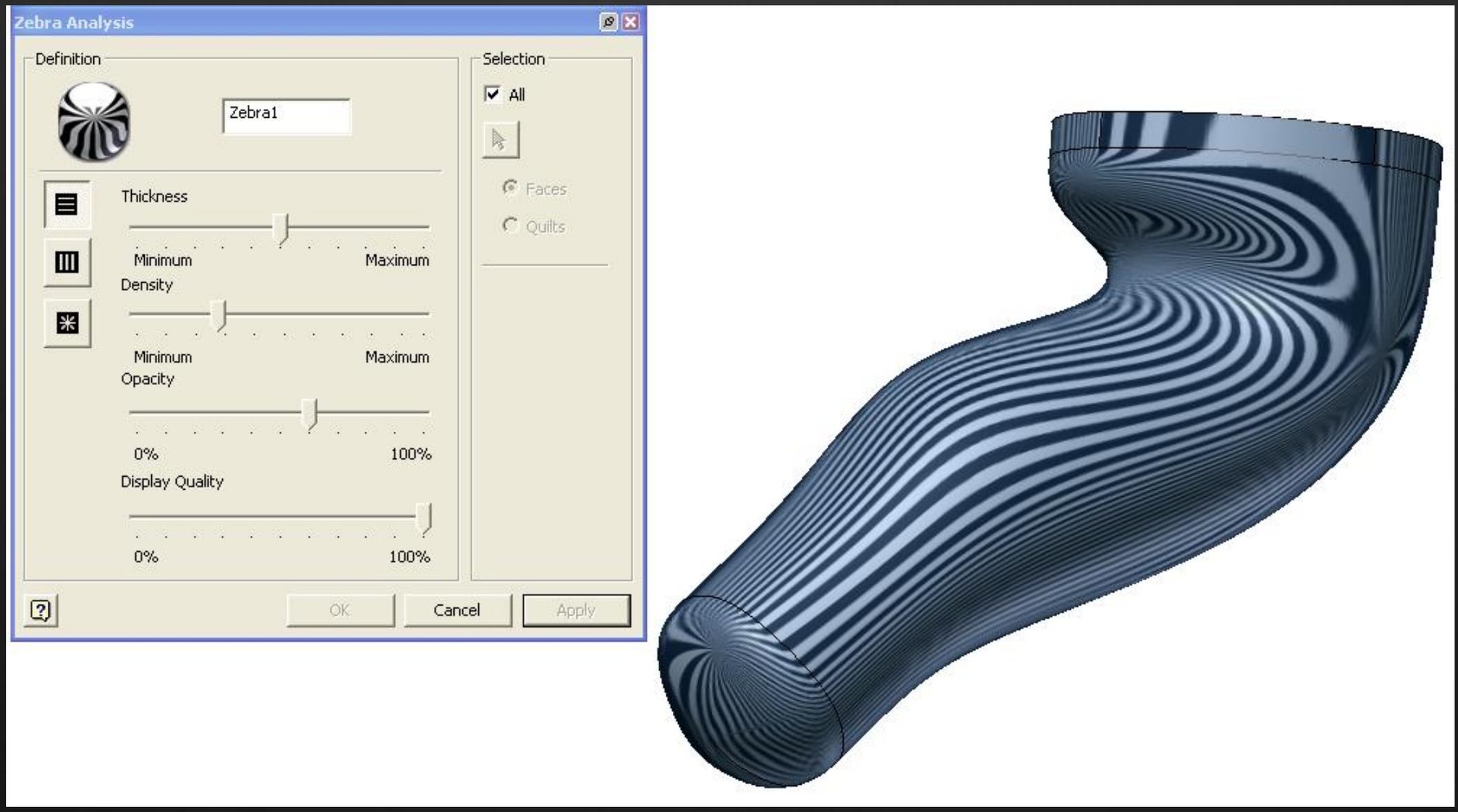
Surface Continuity

Zebra

Simulates the reflection of linear light source.



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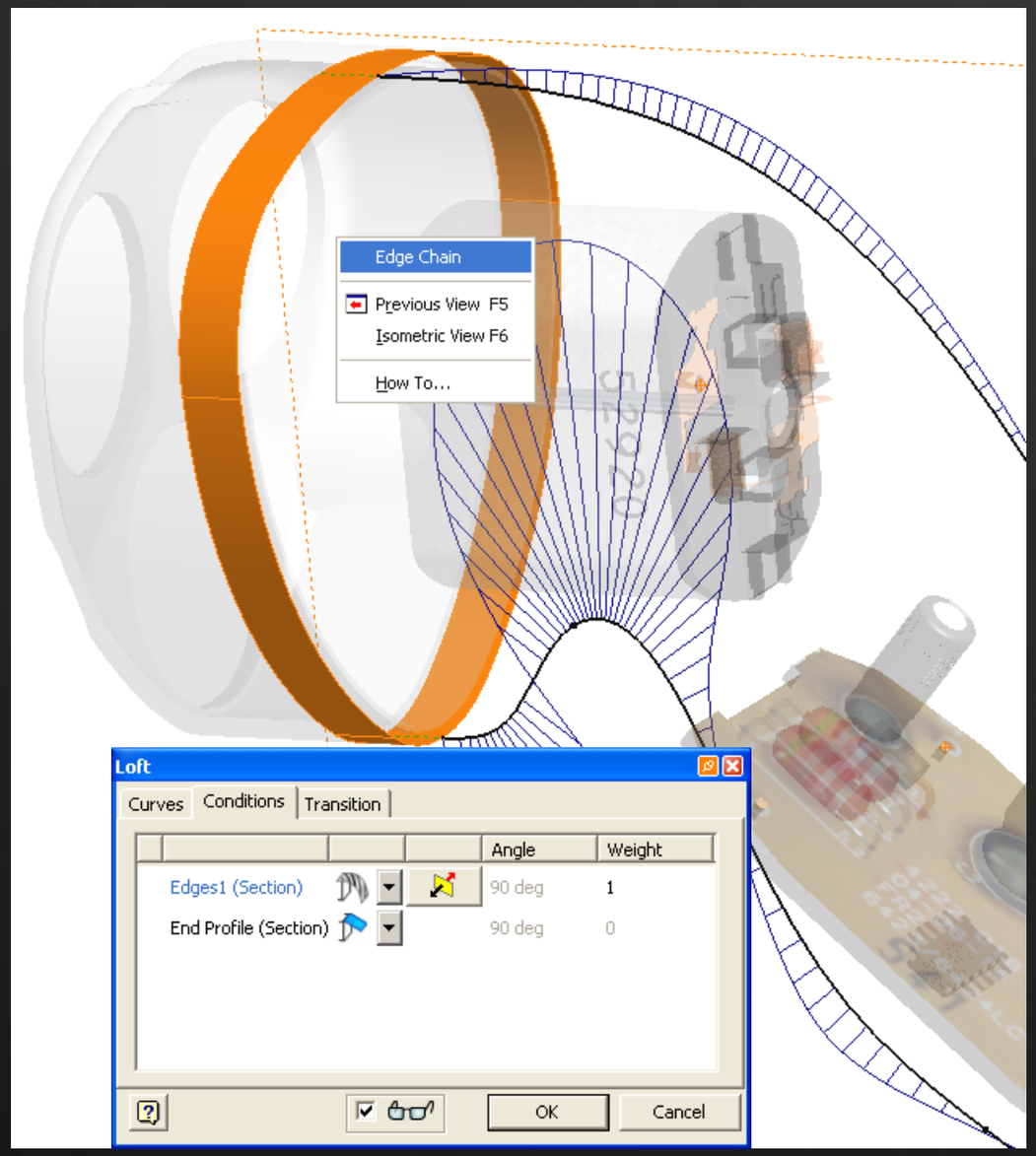
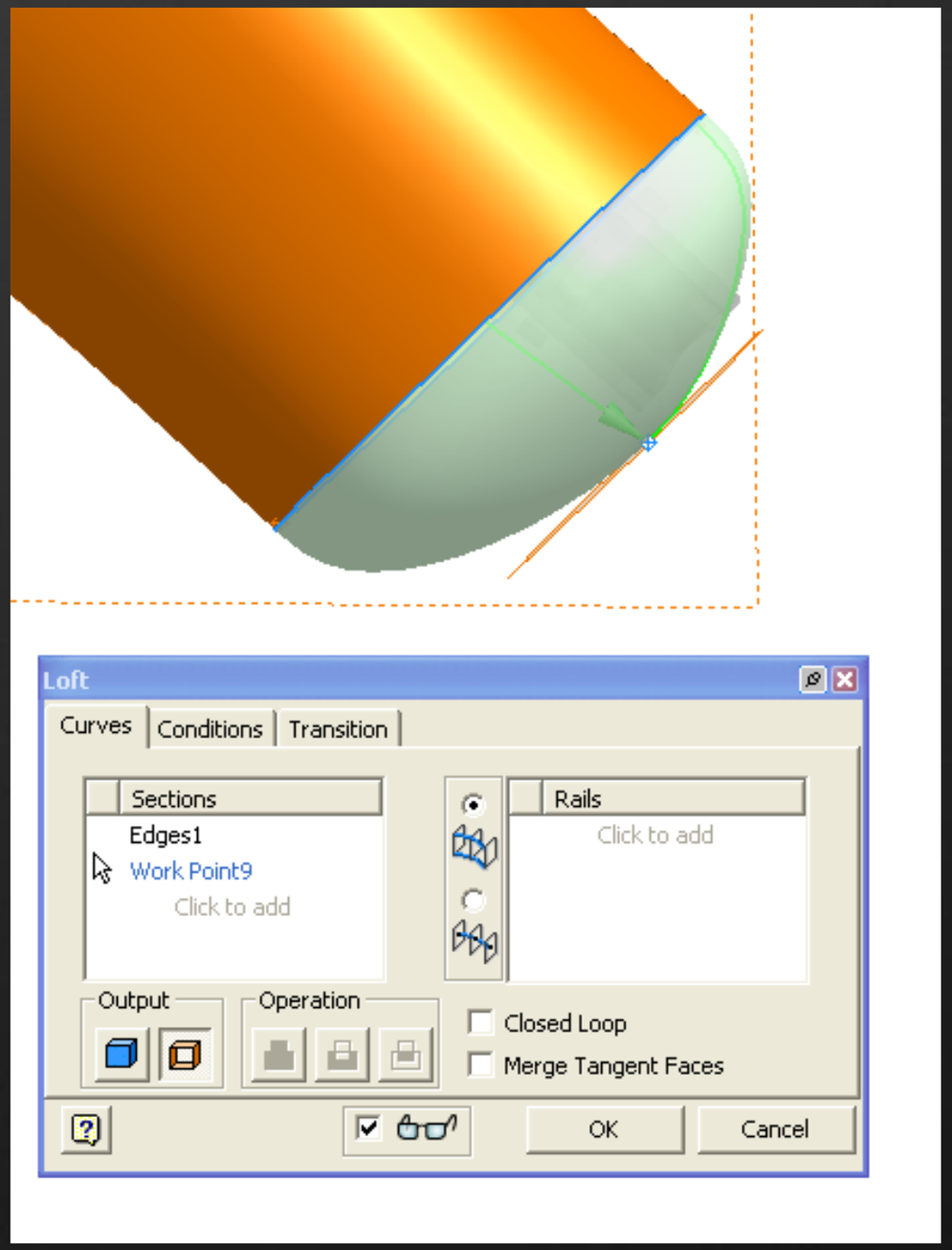
Surface Modelling – Loft Feature

- Loft – example





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Fillets and Surfaces

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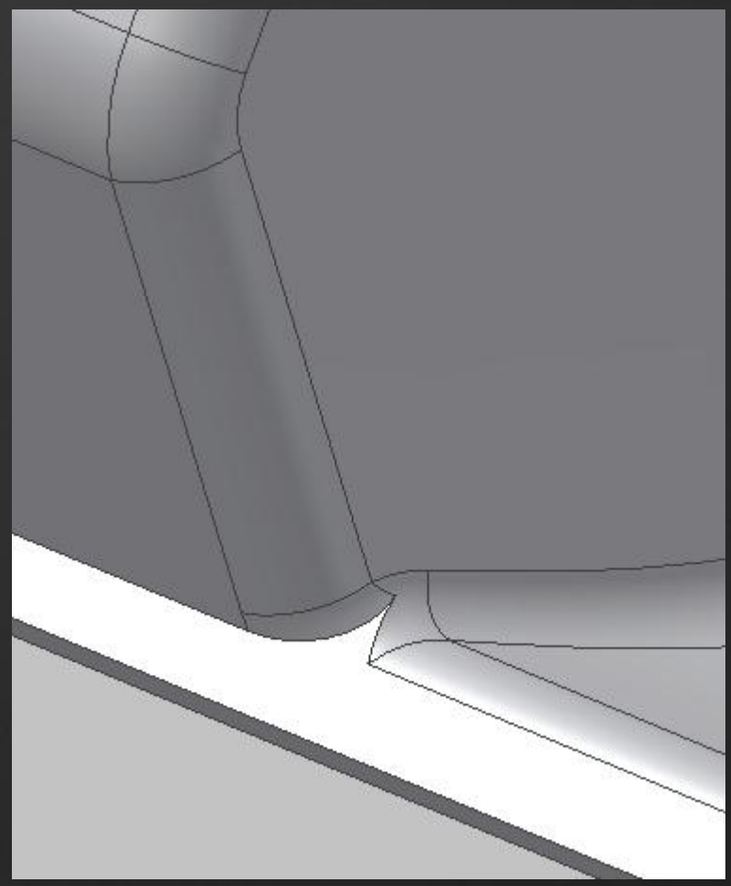
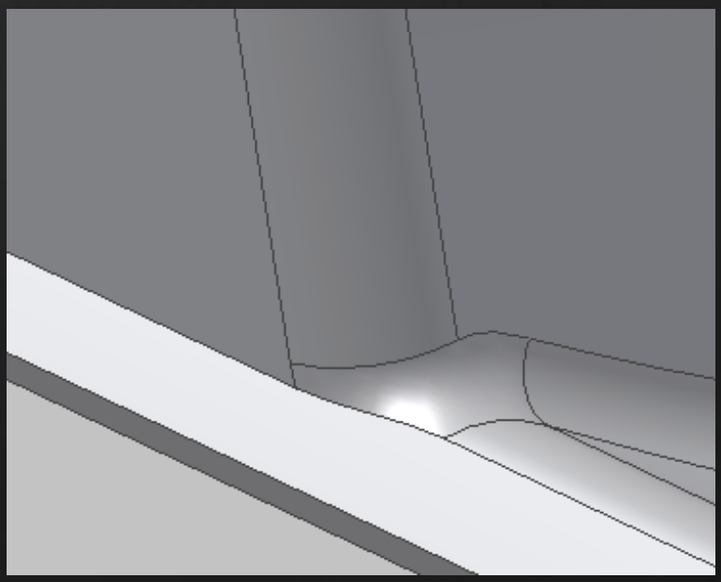
Solid vs. Surface Modelling

- Solid Modelling
  - Automation – Every feature results in a solid
  - Easy to understand – machine or weld operations
    - Exception is the “union”
  - What if the Automation does not gives the desired result or Fails?
- Surface Modelling
  - Local modelling
  - Sheet metal parts
  - Thin Parts
  - Split up the complexity
  - Shape continuity





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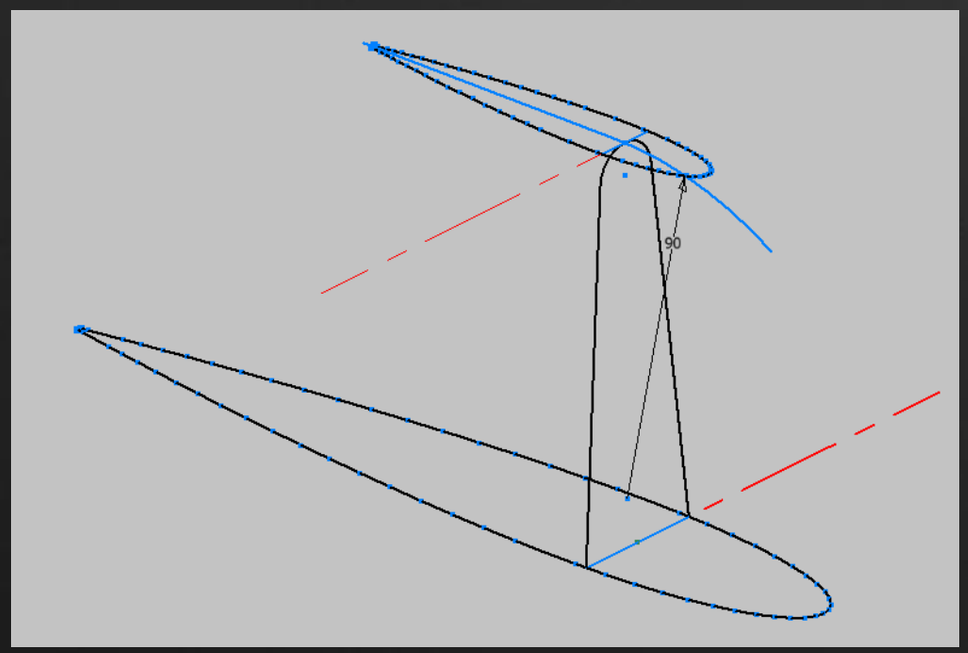
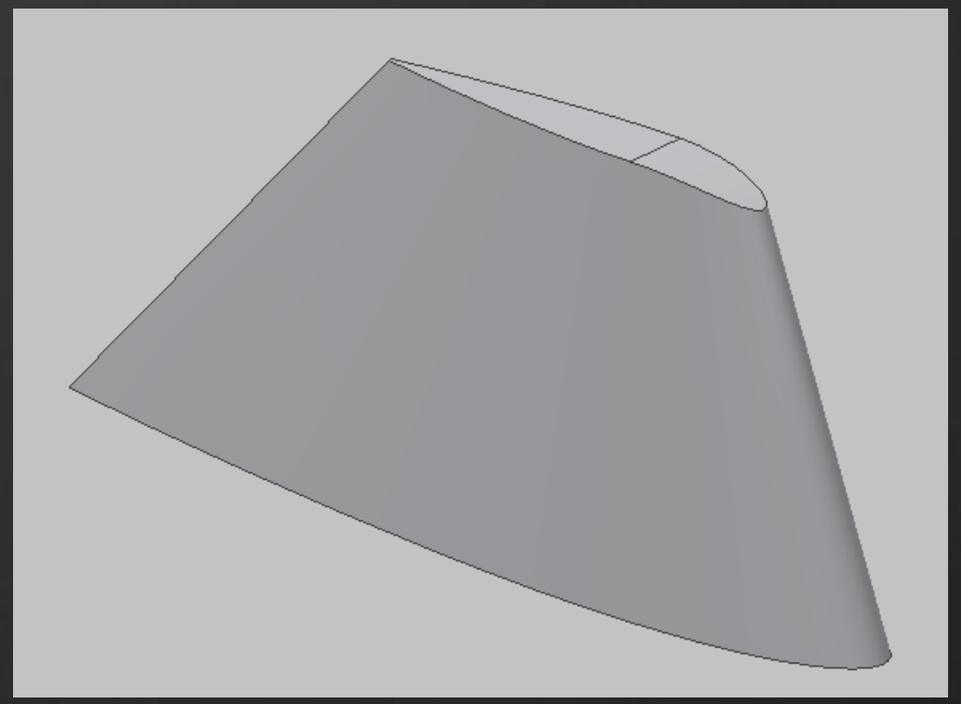
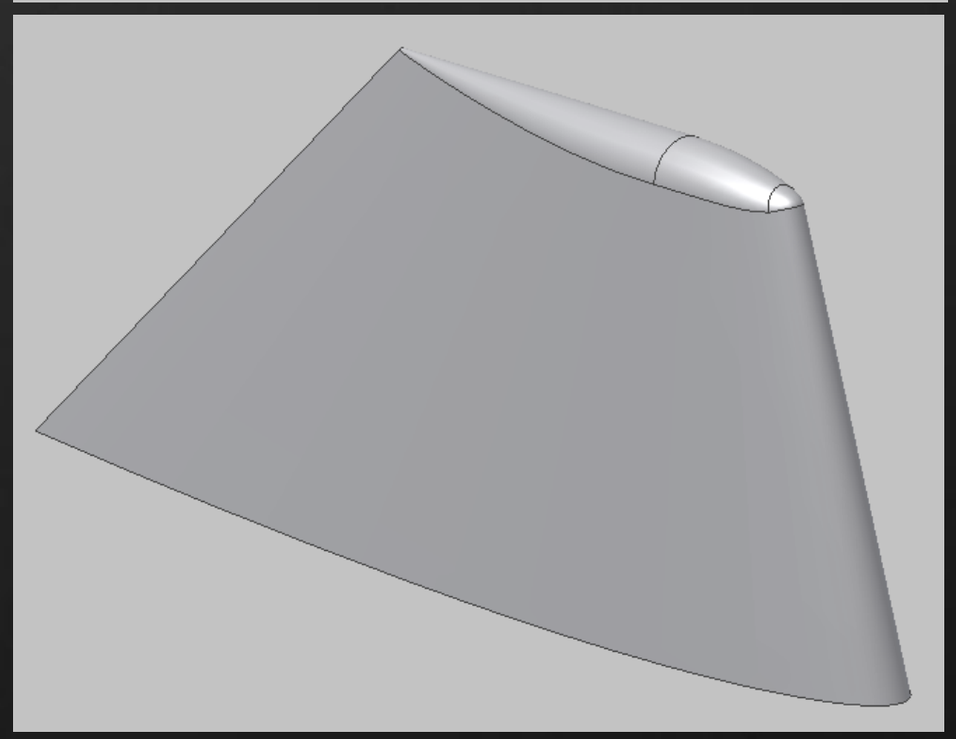
Surfaces and Fillets

- Full Round Fillet
  - Needs 3 Faces Sets
  - Faces Sets NOT tangent to each other.







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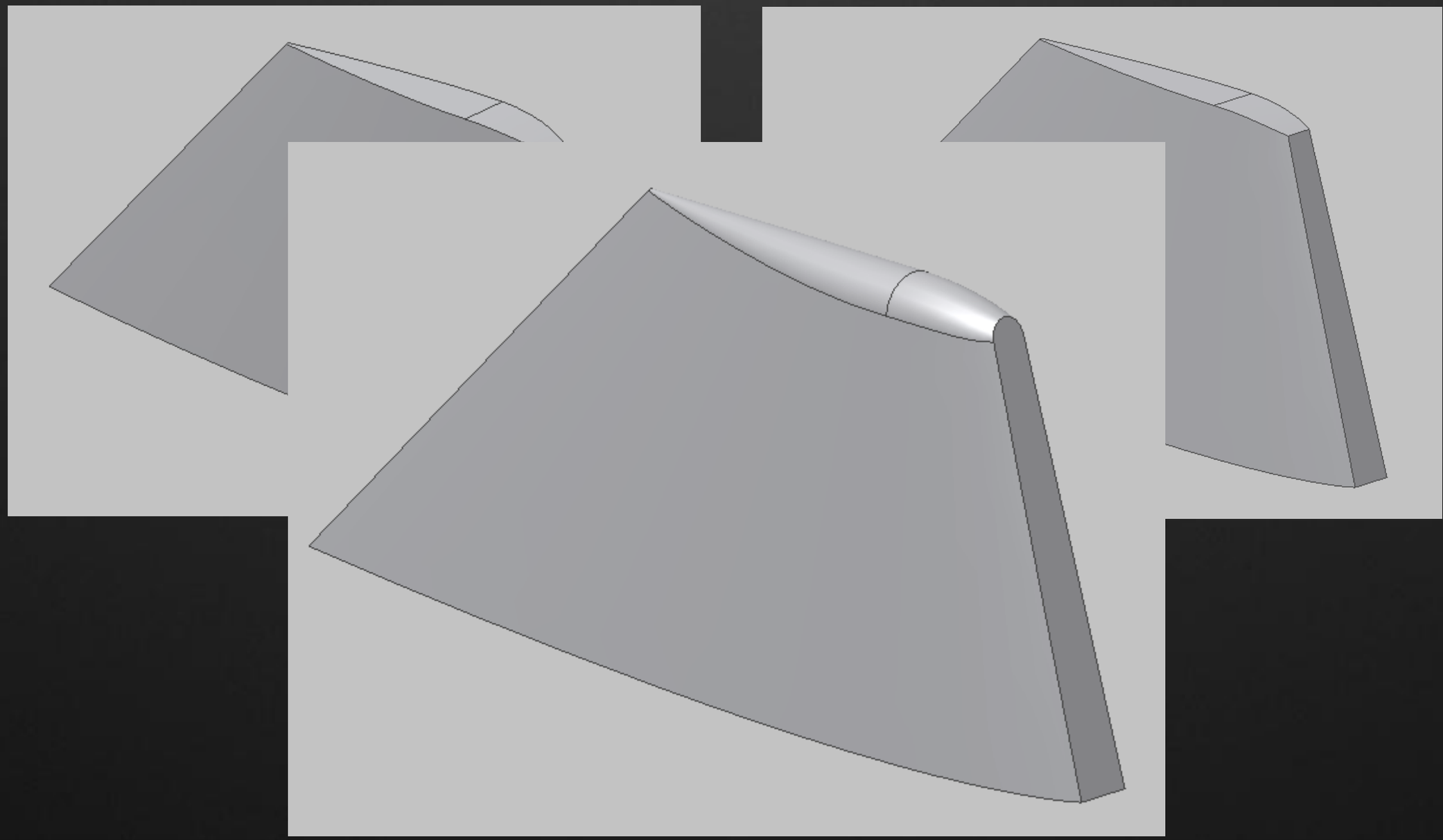
Surfaces and Fillets

- Full Round Fillet - Create 3 Faces



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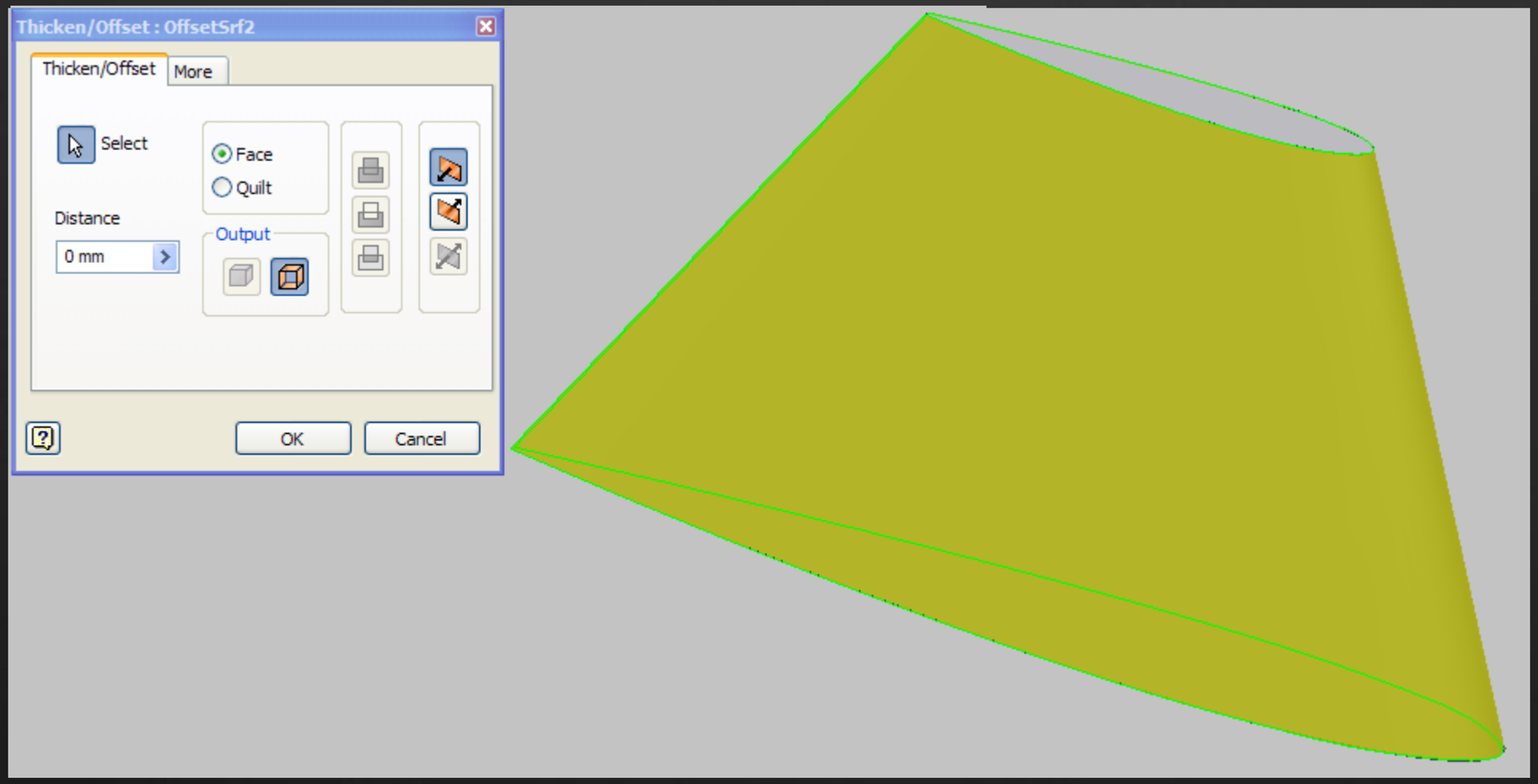
Surfaces and Fillets

- Use Thicken – Copy Original



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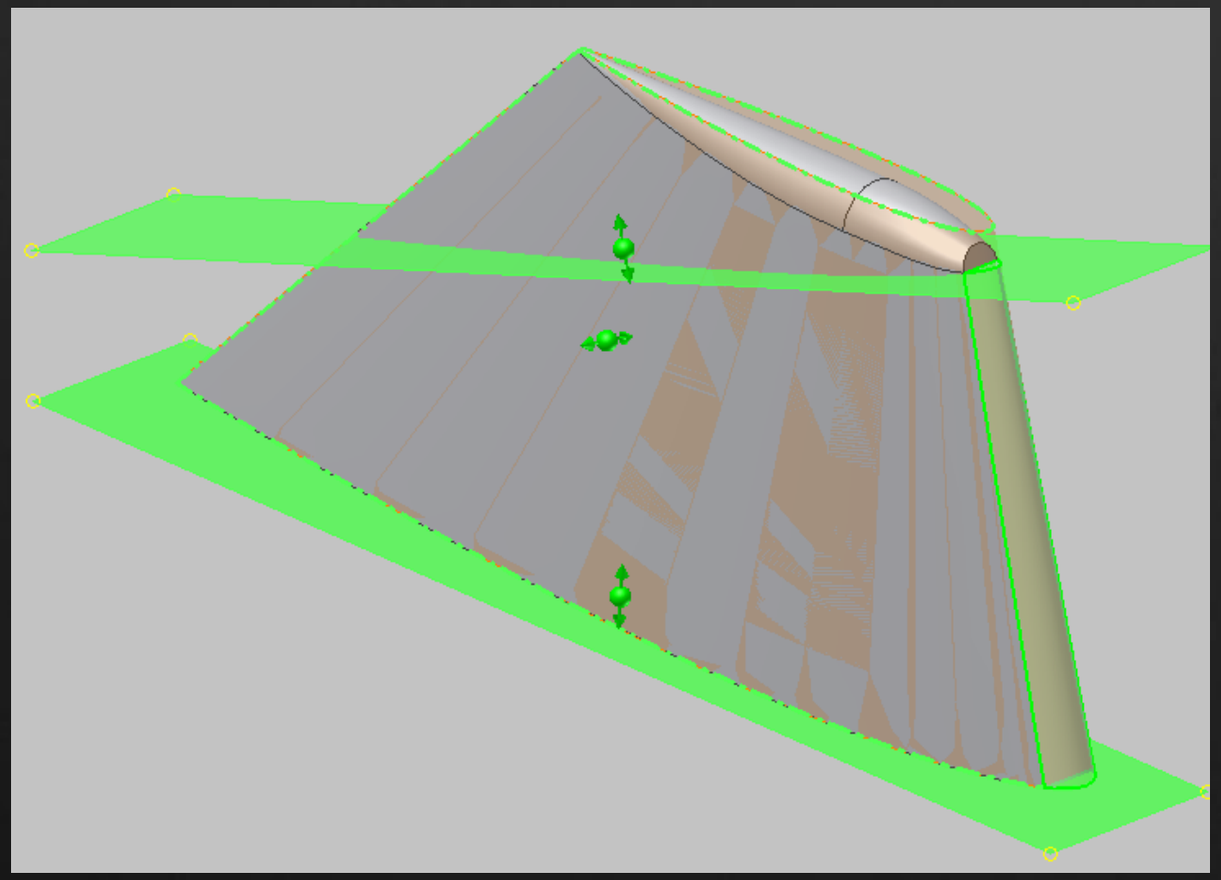
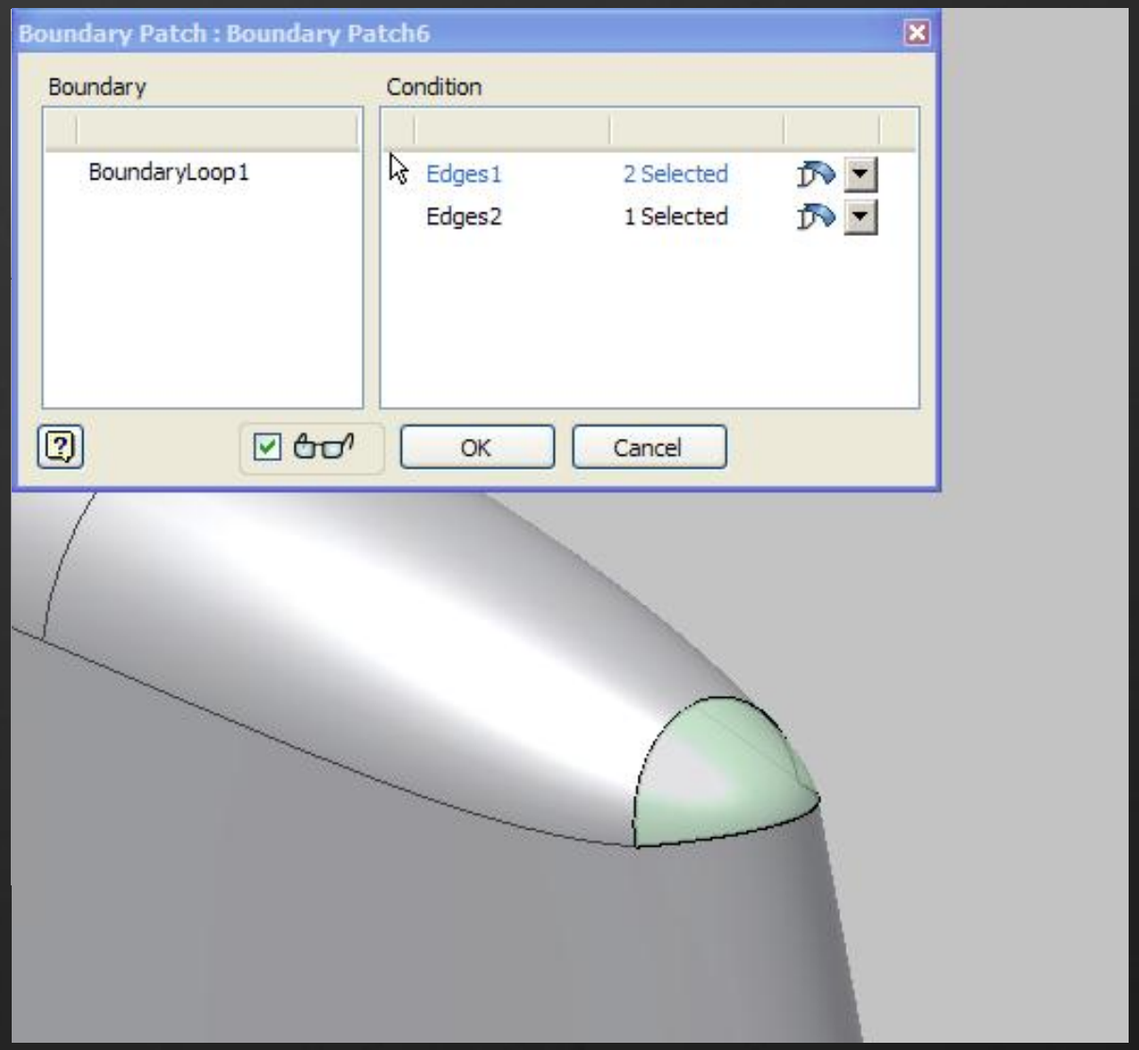
Surfaces and Fillets

- Sculpt
- Delete Face
- Boundary Patch





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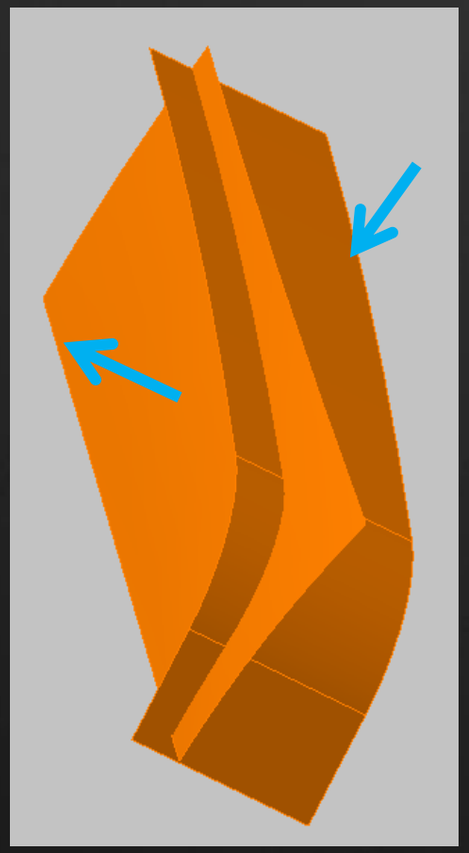
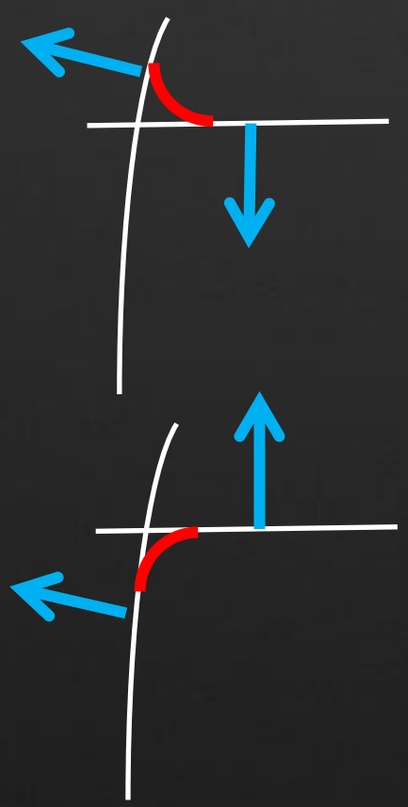
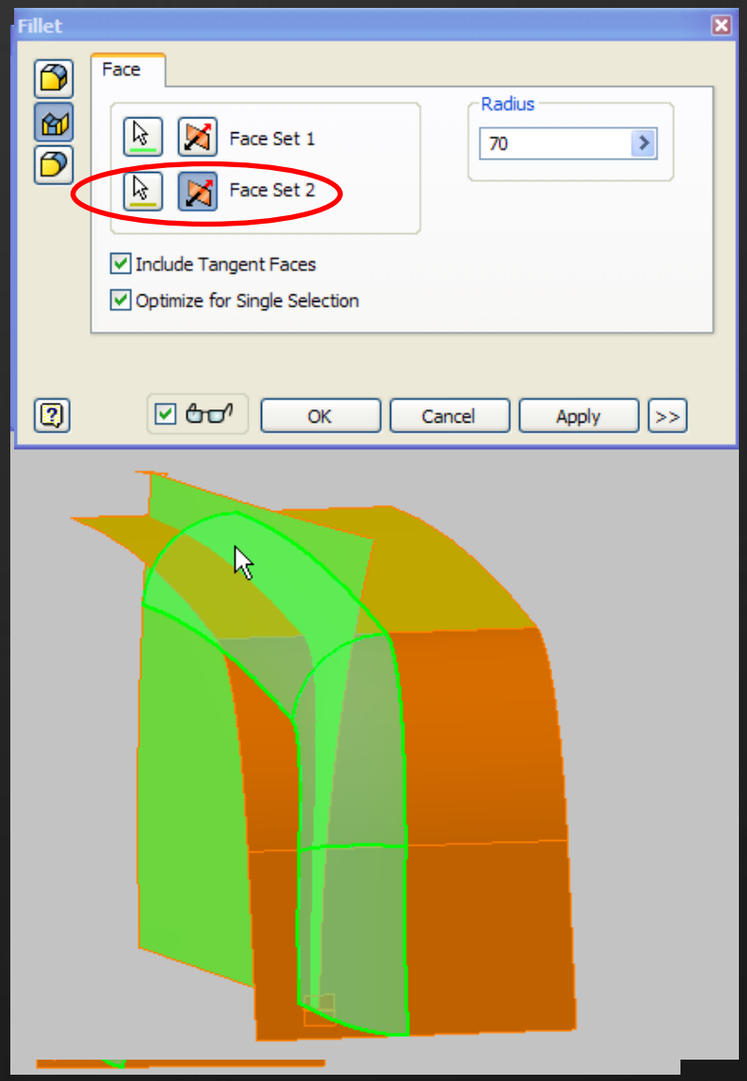
Surfaces and Fillets

- Face – Face fillets
  - The reflection side represent the outside (Face Normal)







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Variable Helix

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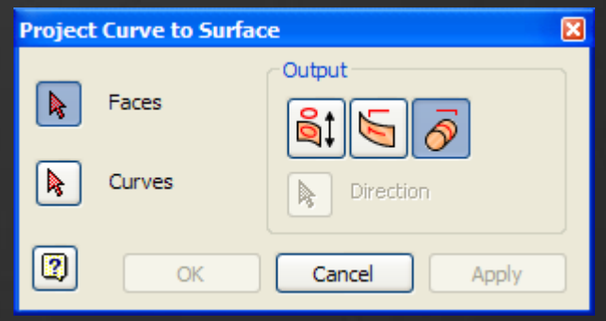
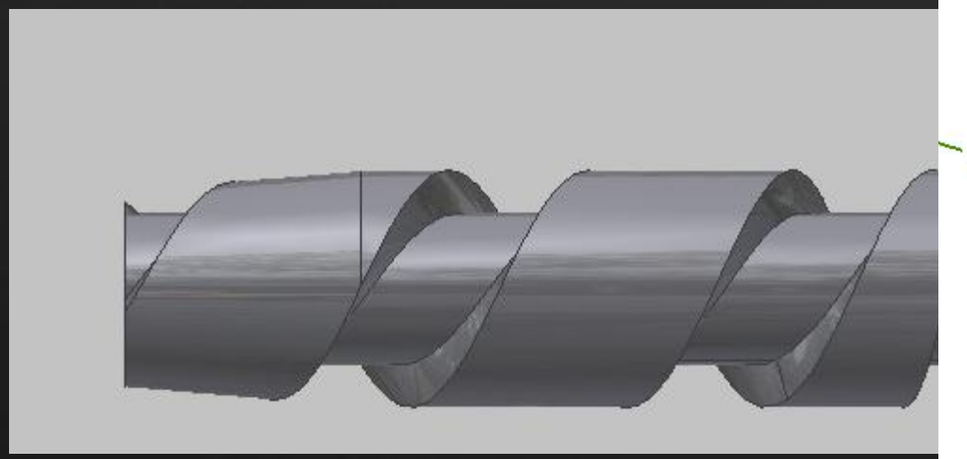
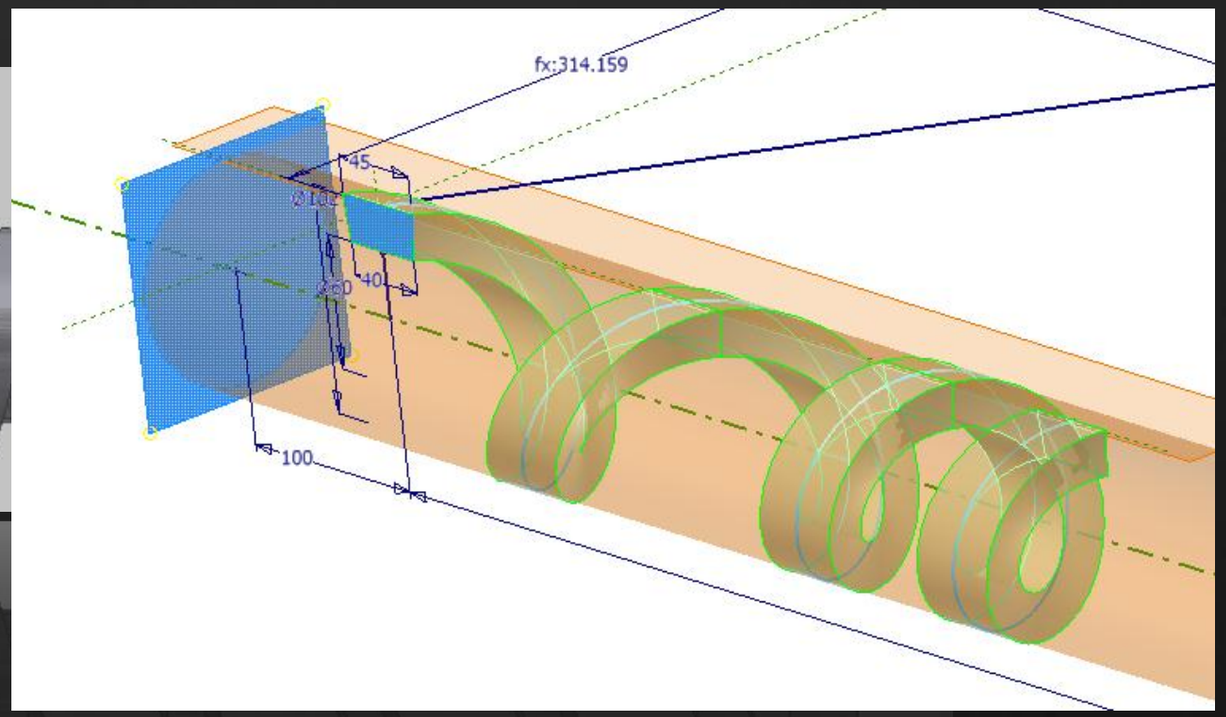
Helix with Variable Pitch

- Sweep - Path & Guide Surface
  - Path – Project Curve to Surface
  - Guide surface
    - Cylinder Face
    - Work plane (perpendicular to the cylinder axis)
  - Profile – orientation best practice
    - Guide surface = Cylinder Face – Profile perpendicular to Path
    - Guide surface = Work Plane – Profile perpendicular to Work Plane







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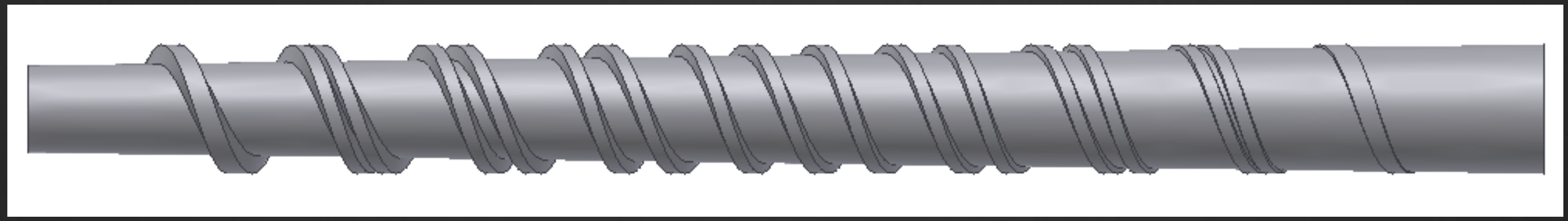
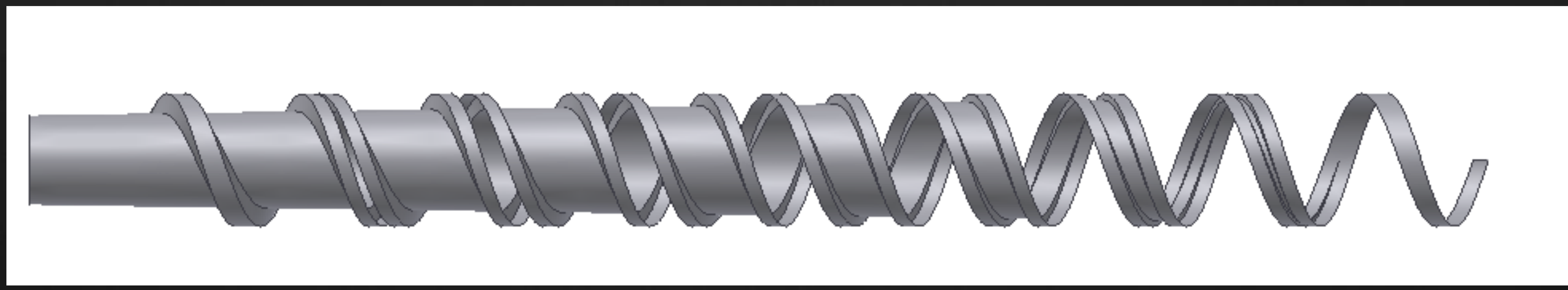
Assemble from different surfaces

- Step 1



- Delete the surfaces you do not need



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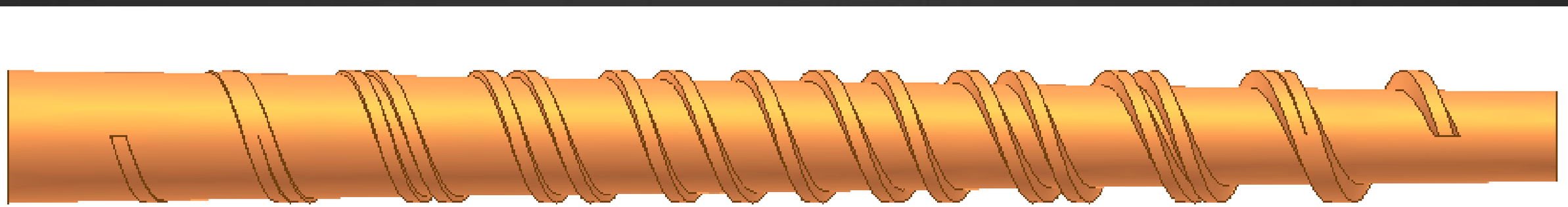
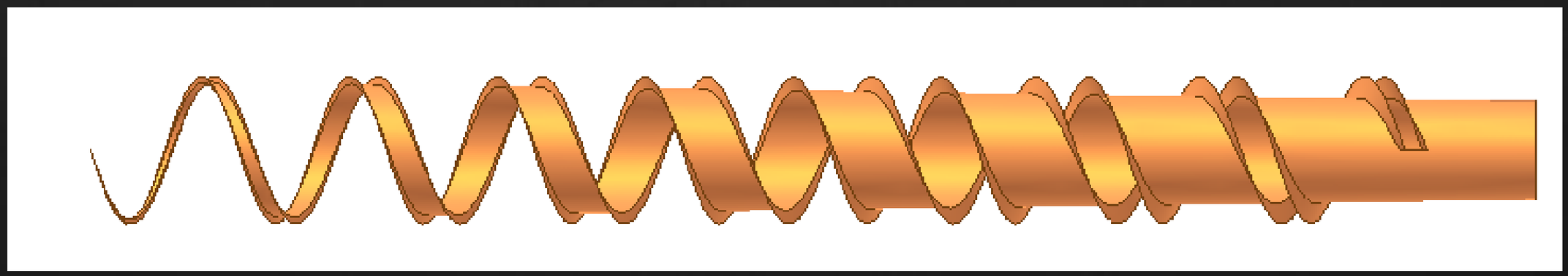
Assemble from different surfaces

- Step 2



- Delete the surfaces you do not need



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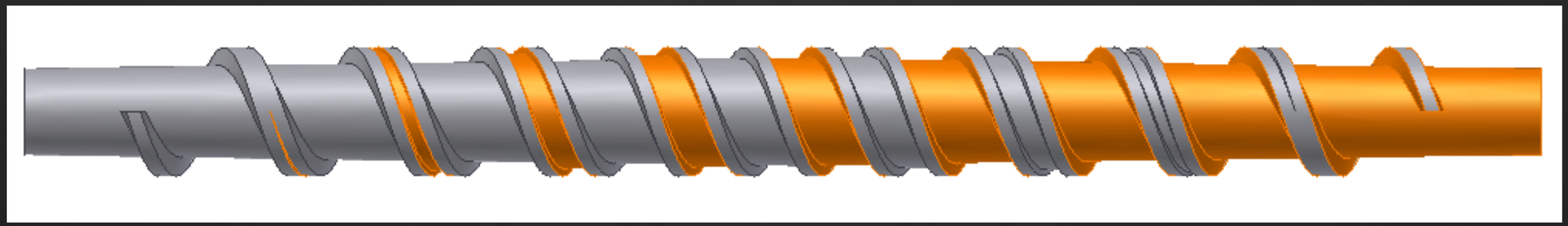
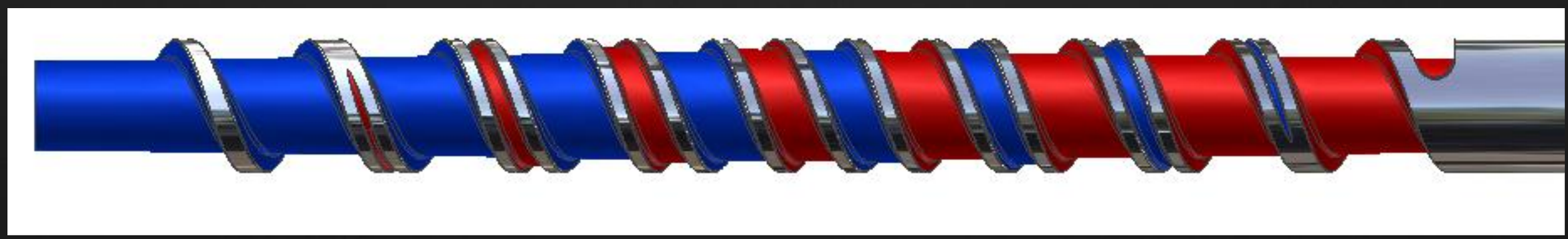
Assemble from different surfaces

- Surface 1 & surface 2 together in 1 part file with derived part.





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Assemble from different surfaces

- Extrusion screw with 2 different tapered kernel diameters.

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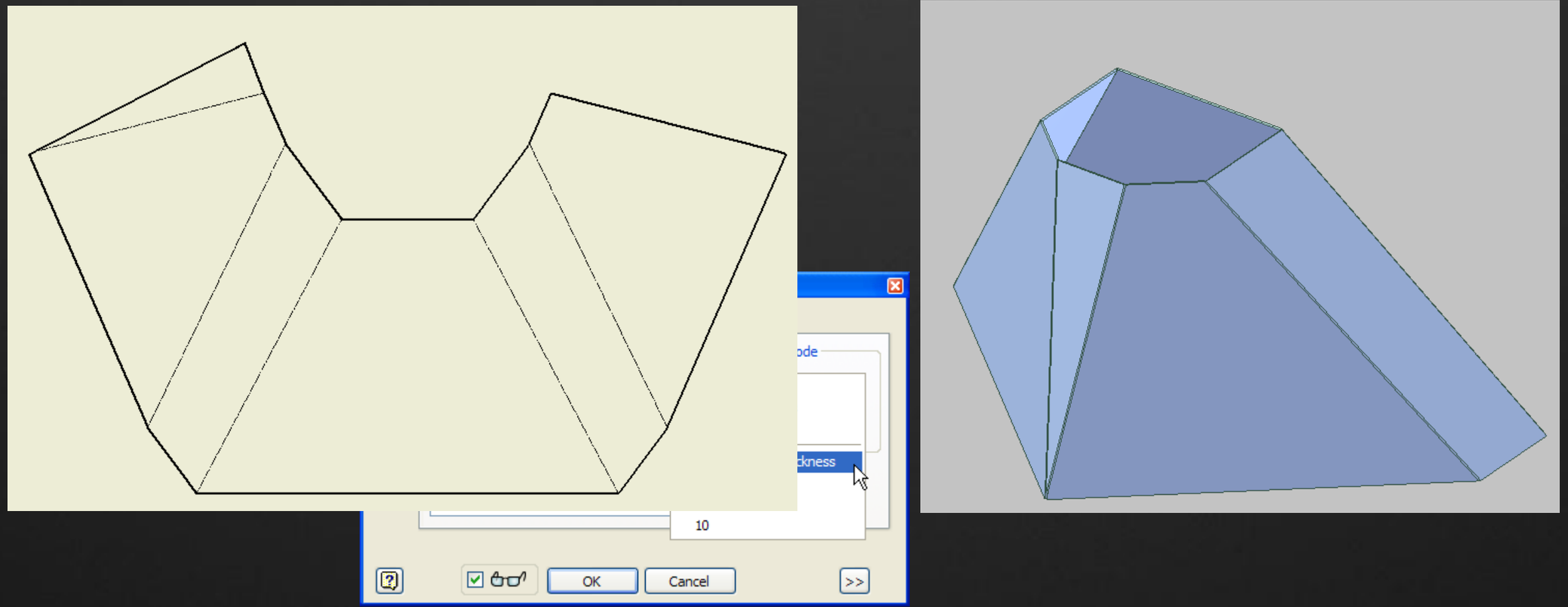
Surface Modelling – Sheet Metal

- Example



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Complex casting parts

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3D Casting Design

- **Existing Casting Designs**
  - Reuse the Same Casting for new Machined Parts
  - 2D drawing available bud not very accurate with the reality
  - Very difficult to understand the relations between the views
  - Information between views contradictory.
  - Fillets is drawn in the 2D space.
  - Sometime Reverse Engineering Casting Parts or Tooling
    - Result can be problematic (wooden models)
- **New Casting Designs**
  - The designer creates a functional model (not a casting model)
  - Add material, draft angles and fillets

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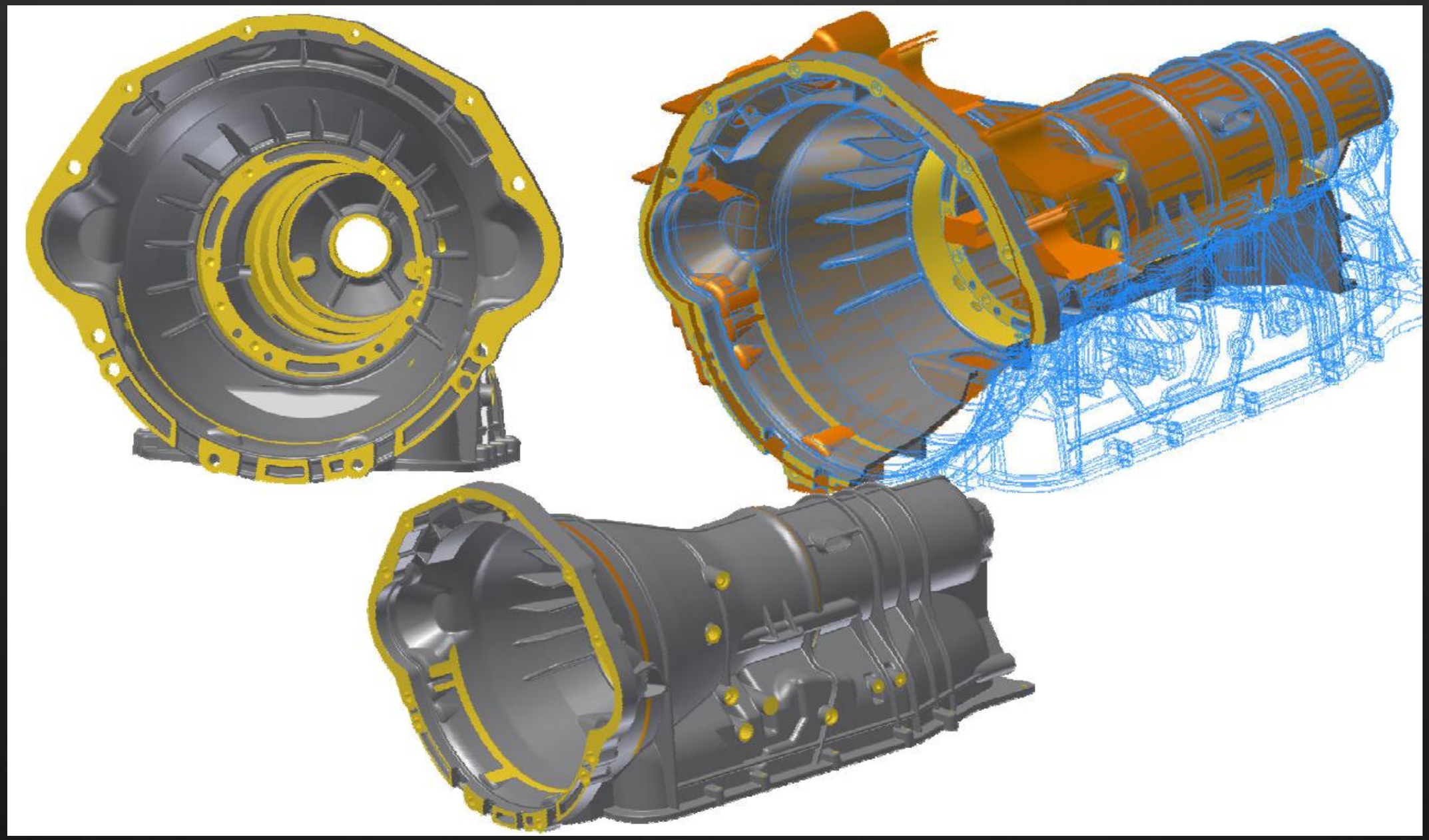
Local Modifications – Casting Examples



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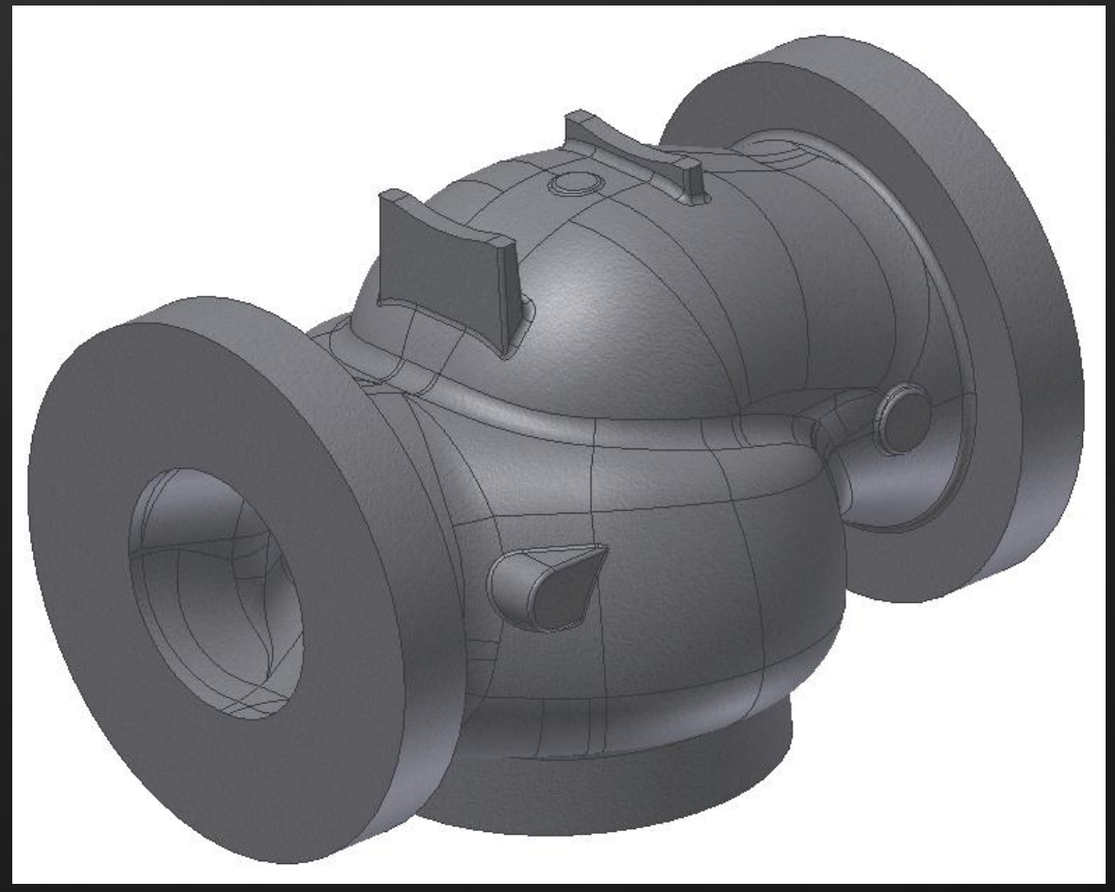
Castings Parts – Best Practice

- 2 representations
  - Casting Model
  - Machined Finished Model
- Model Casting Part – Not Finished one
  - Fillets, Draft easier



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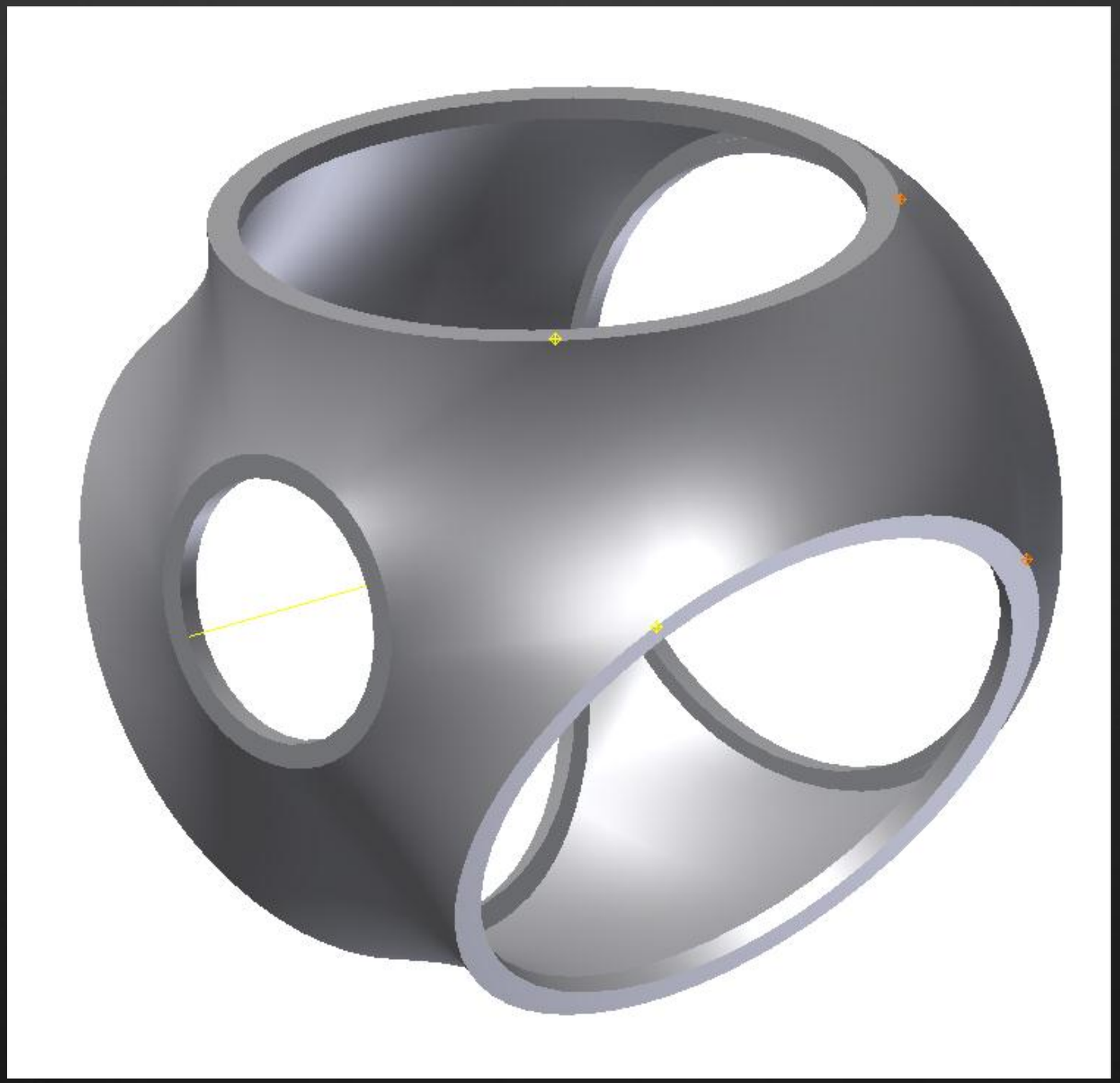
Castings Parts – Best Practice



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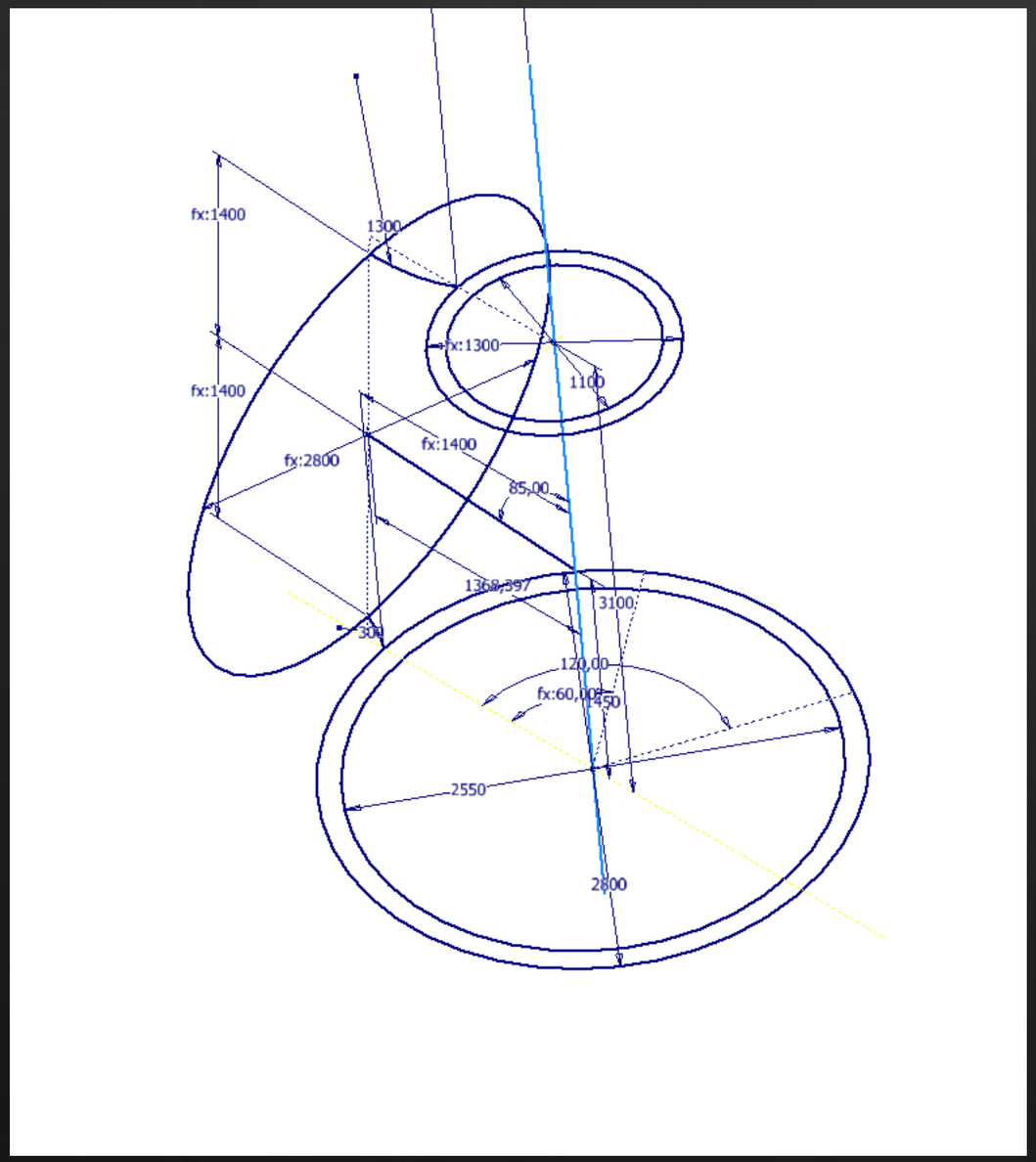
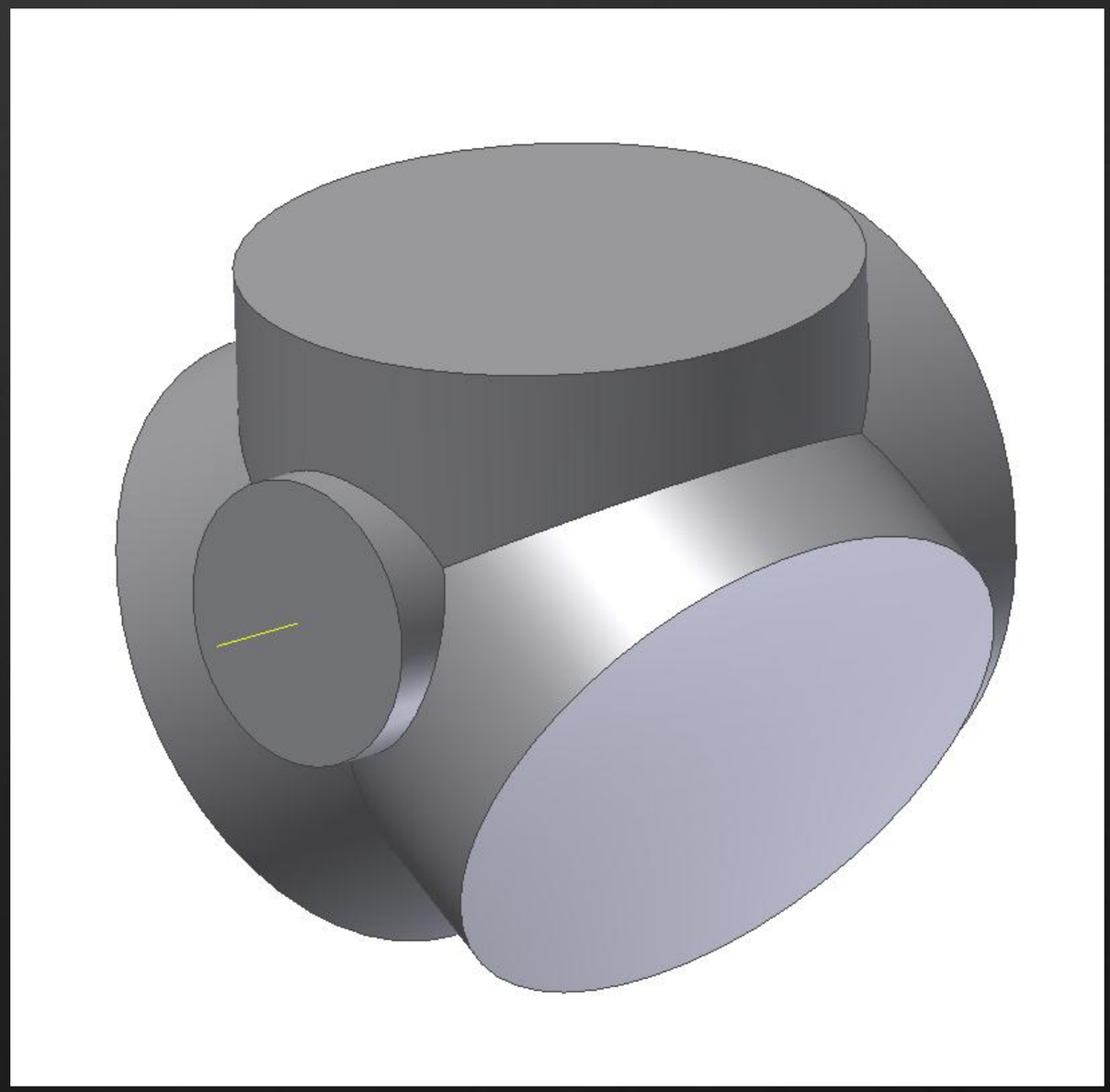
Castings Parts – Best Practice

- Model the Function -





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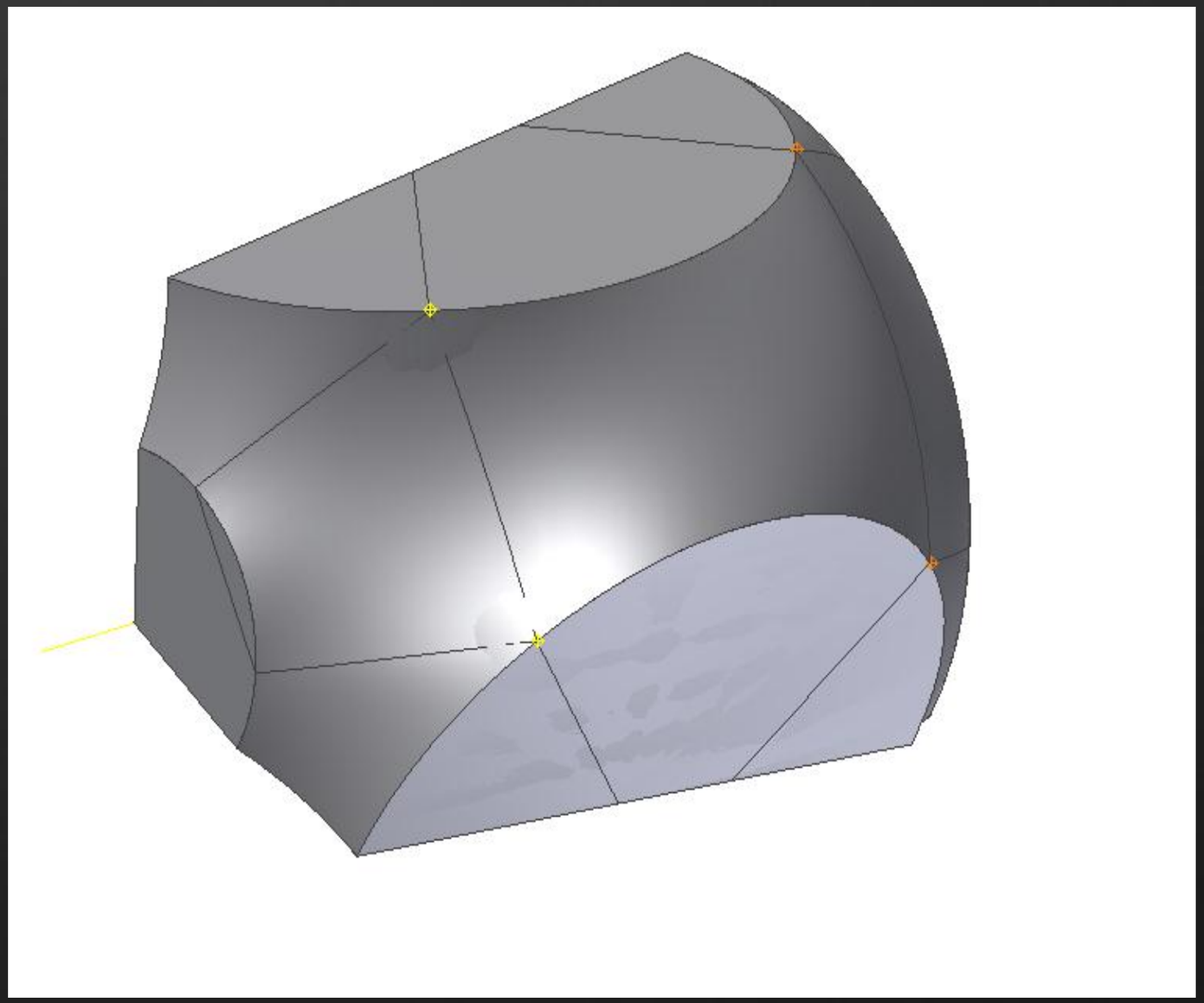
Castings Parts – Best Practice

- Sculpt
  - Solution derive
  - Solid body as work surface.



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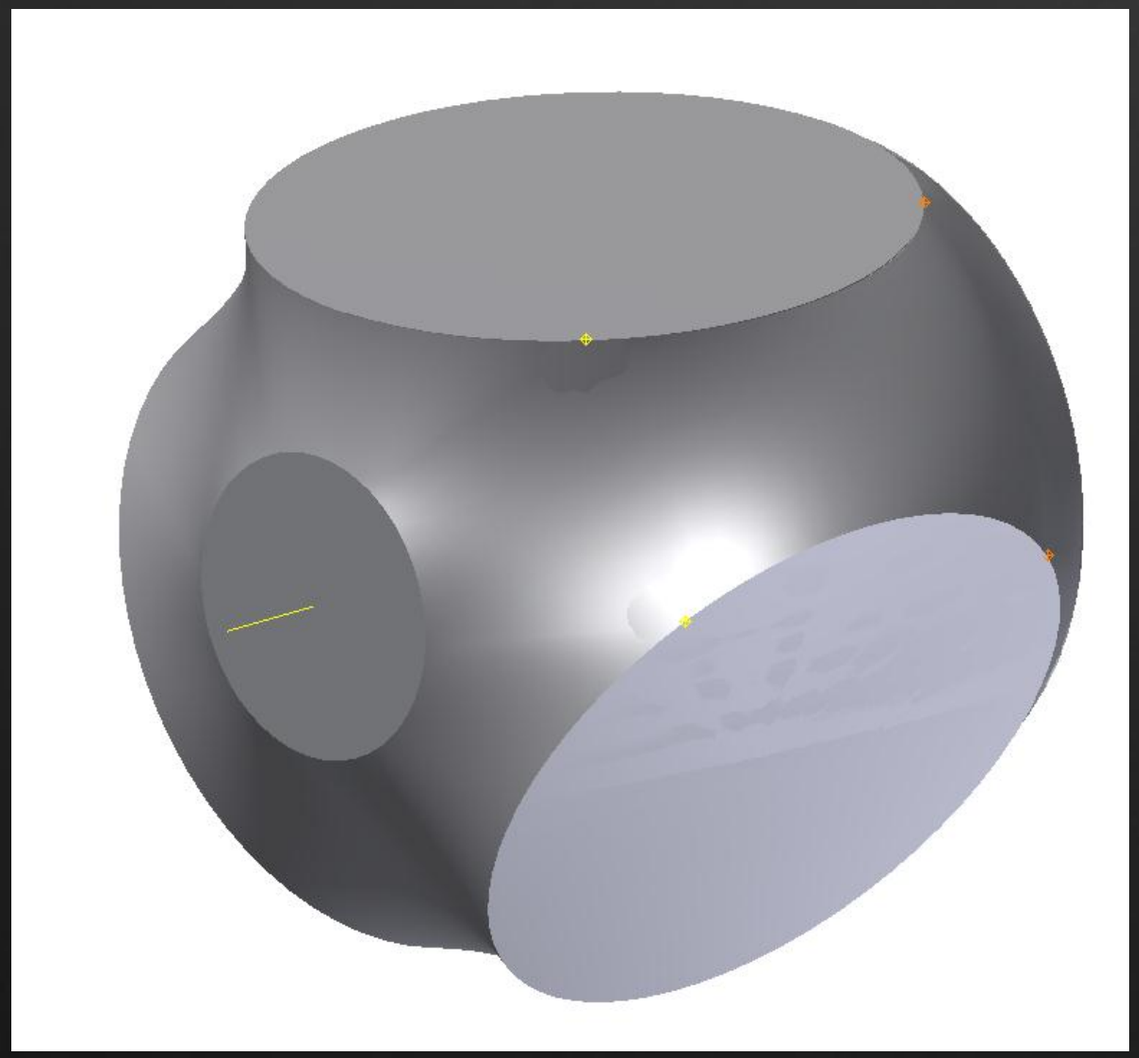
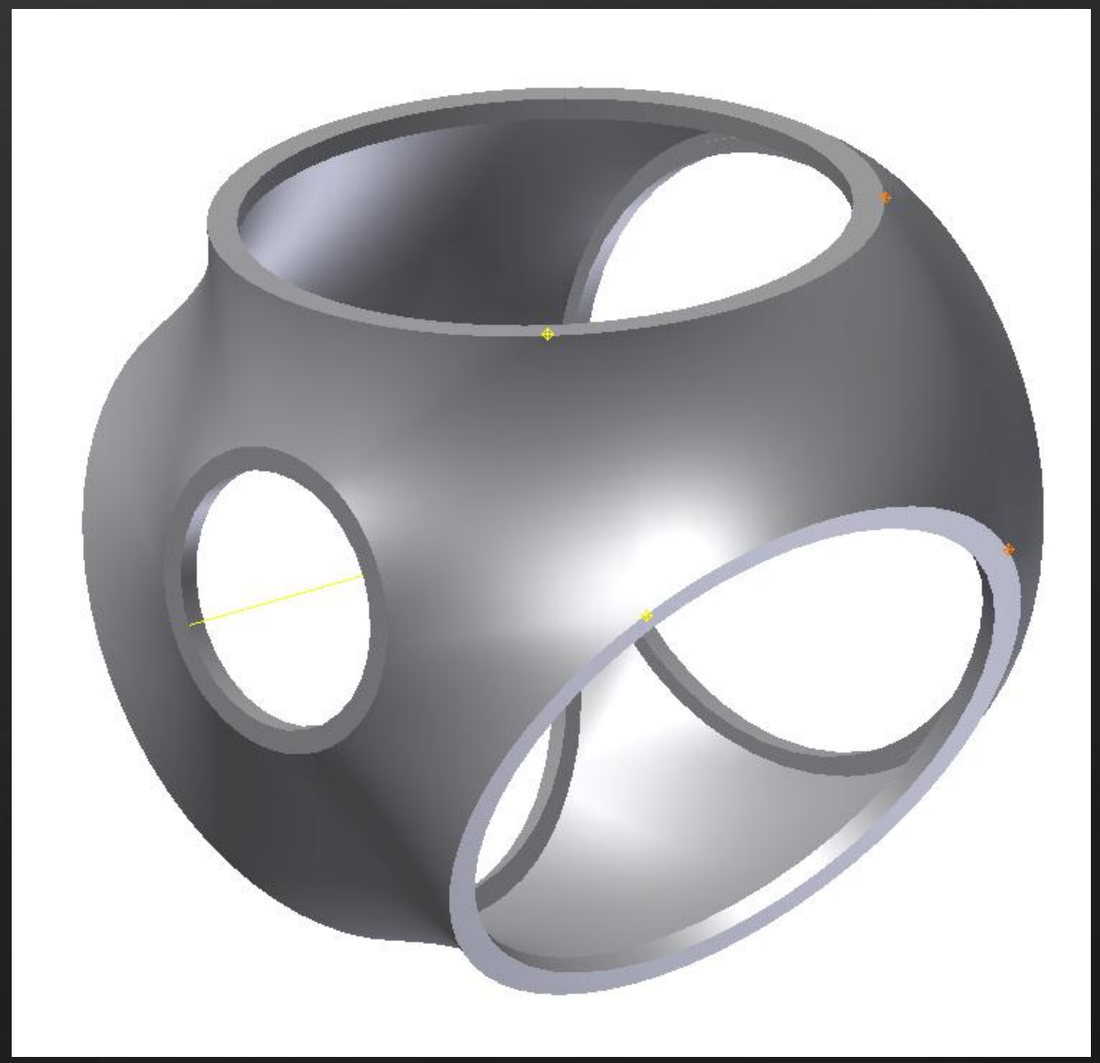
Castings Parts – Best Practice

- Derive to generate the machine version.





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Consumer Products

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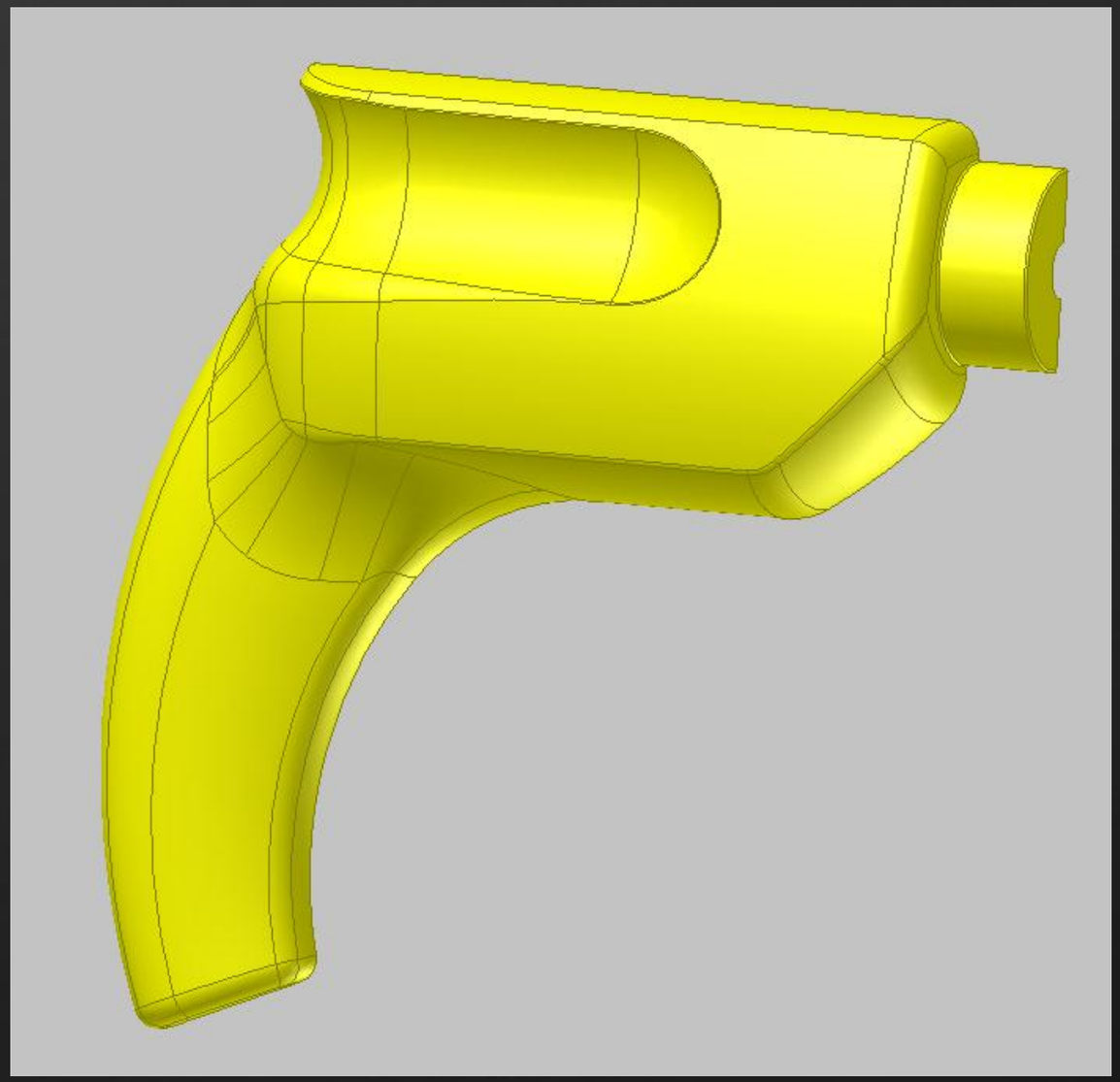
Consumer Products

- Alternative Workflow
  - A-Side Different Part
  - B-Side Different Part
  - Finished Derive B-Side in A-Side
  - Sculpt



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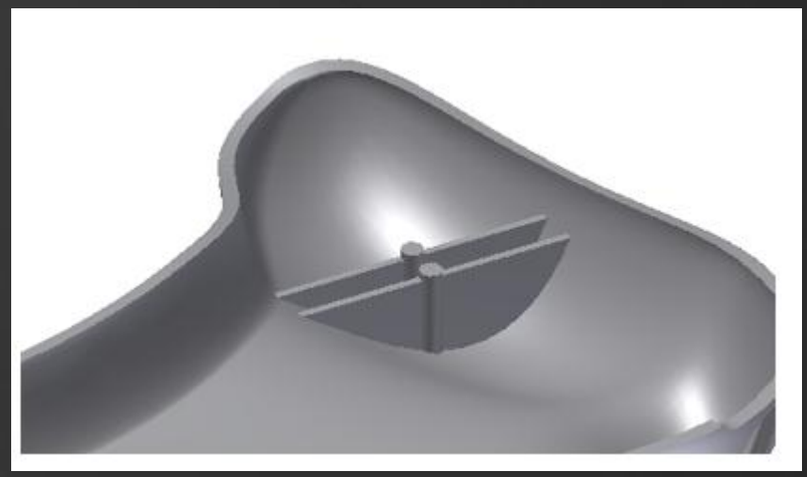
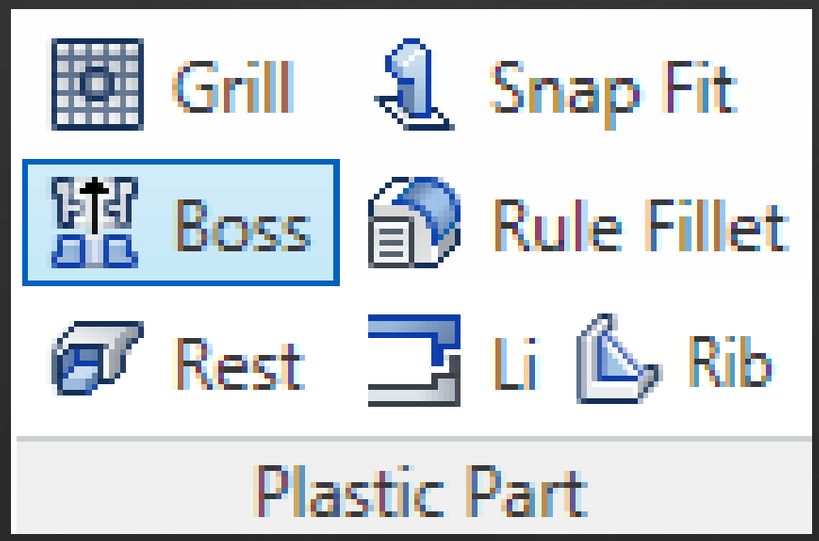
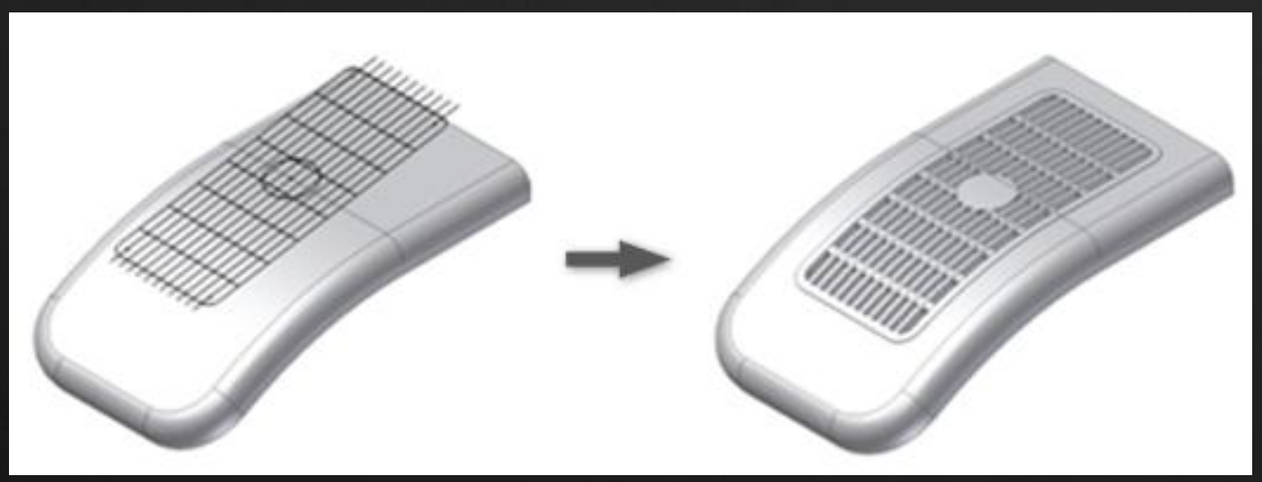
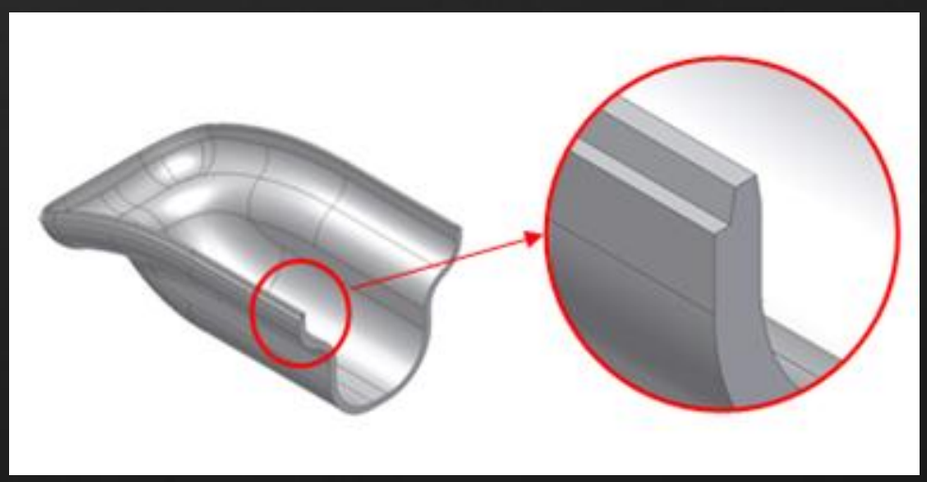
Consumer Products



- Plastic Features
  - Grill
  - Boss
  - Lip
  - Rib
  - Snap
  - Rest







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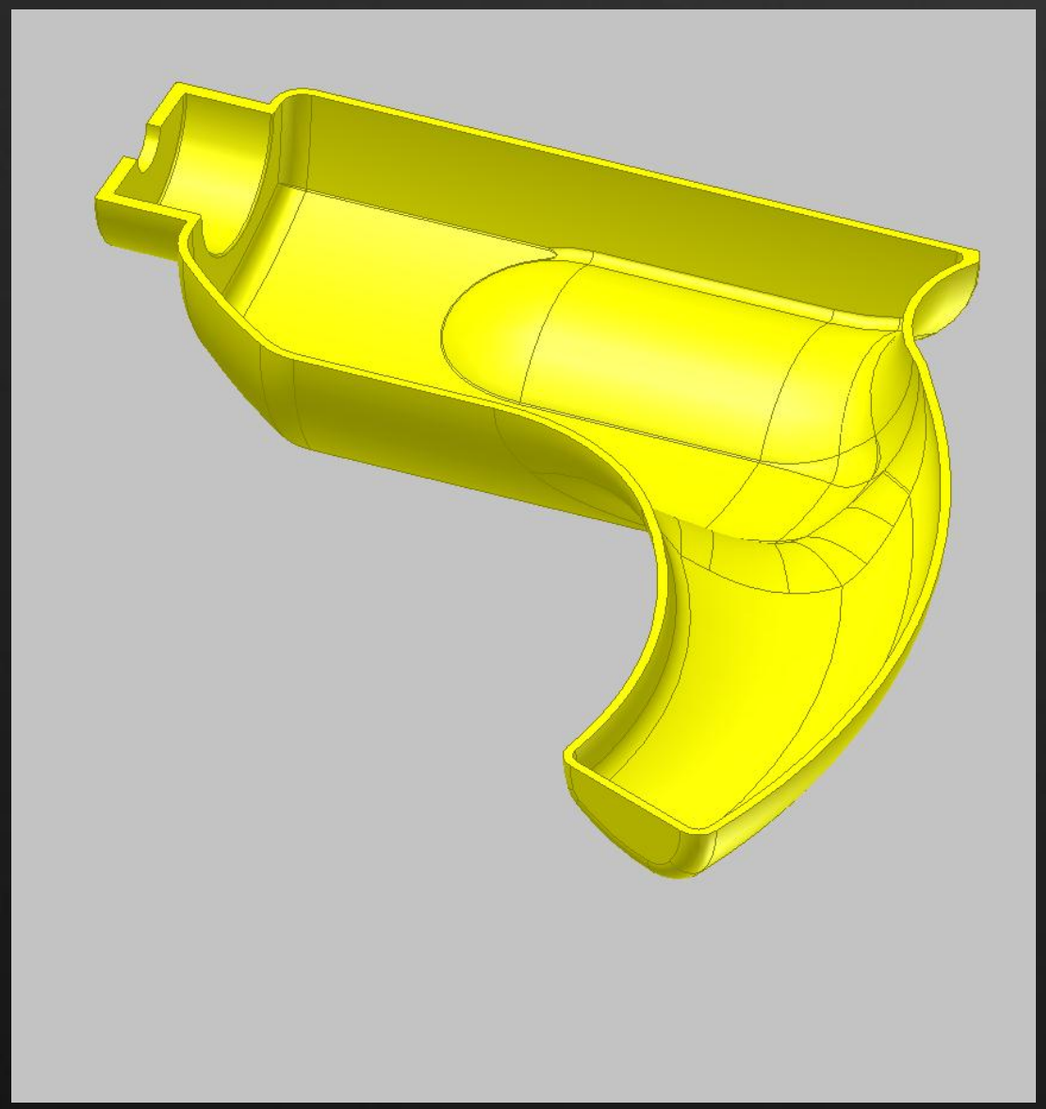
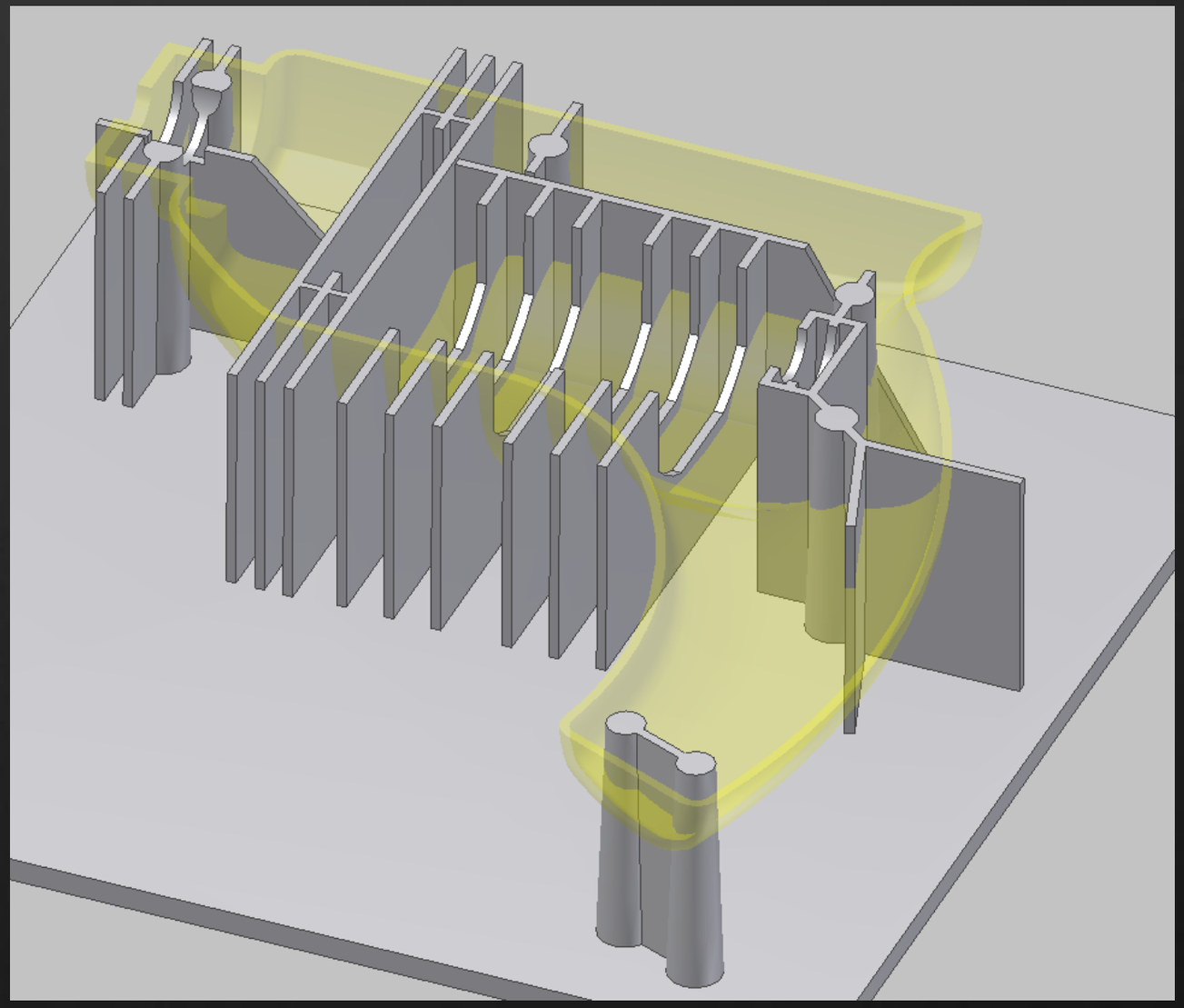
Consumer Products - Alternative Workflow

- B-side





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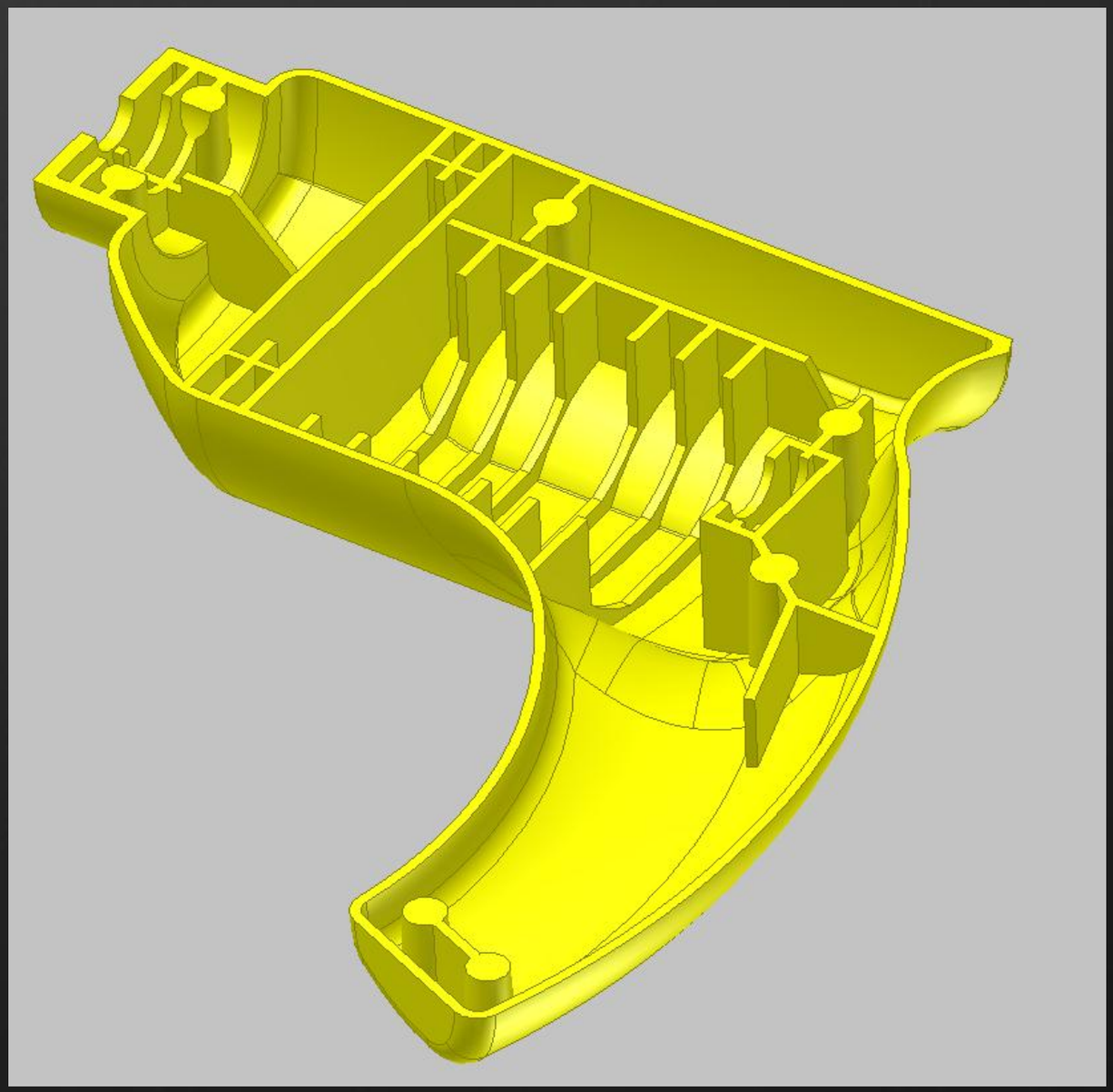
Consumer Products – Alternative Workflow

- Sculpt Result
- Mould makers love this
  - Supply both models
  - Ideal Core and Cavity split



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BREP – Boundary Representation – Appendix

- Why the theory?
- Theory behind solid modelling.
  - Topological Data
    - Structure and relationships between solid, surfaces (faces), loops , edges and vertex
  - Geometrical Data
    - flat face , cylindrical face, freeform face,...
    - Math ...

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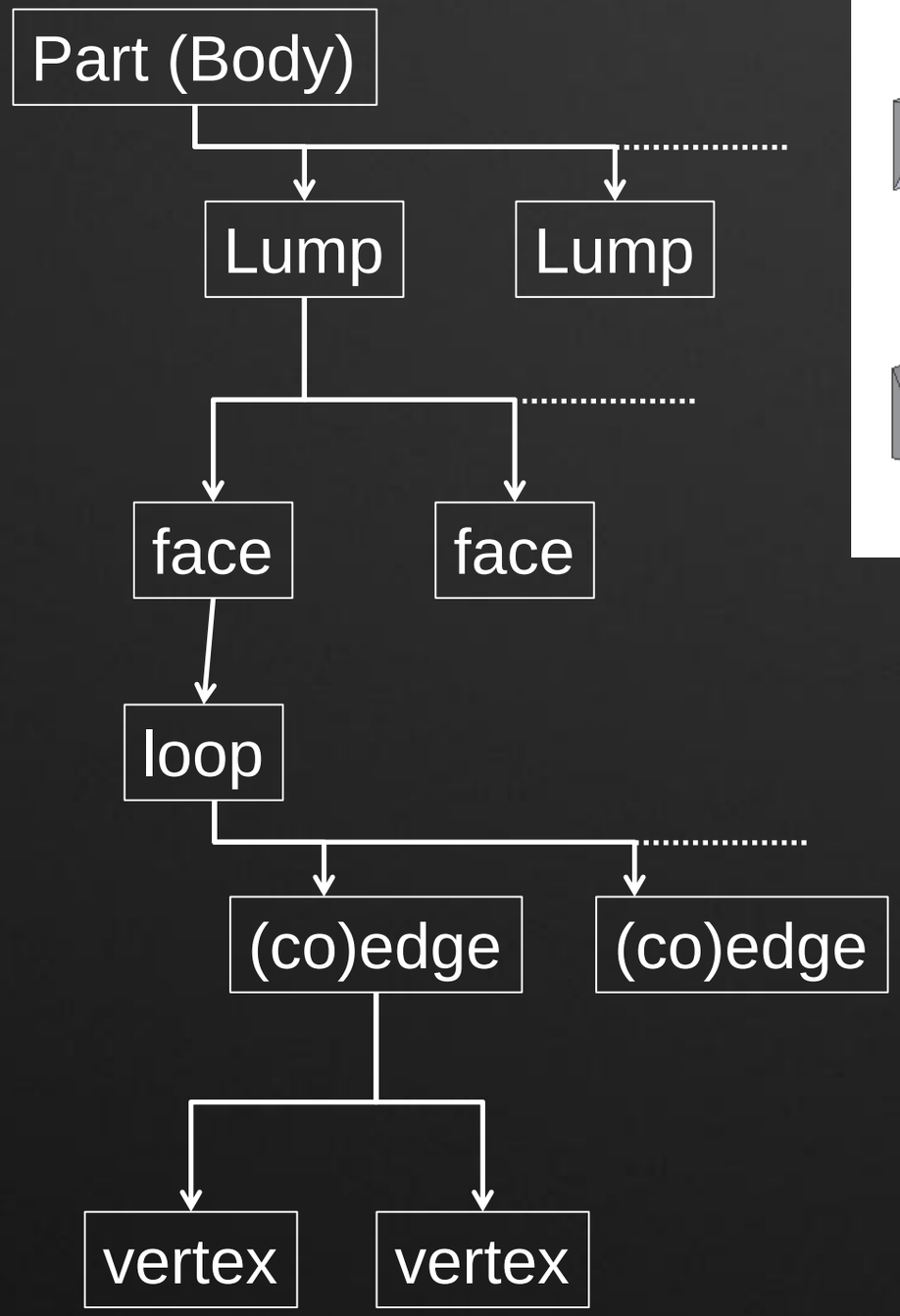
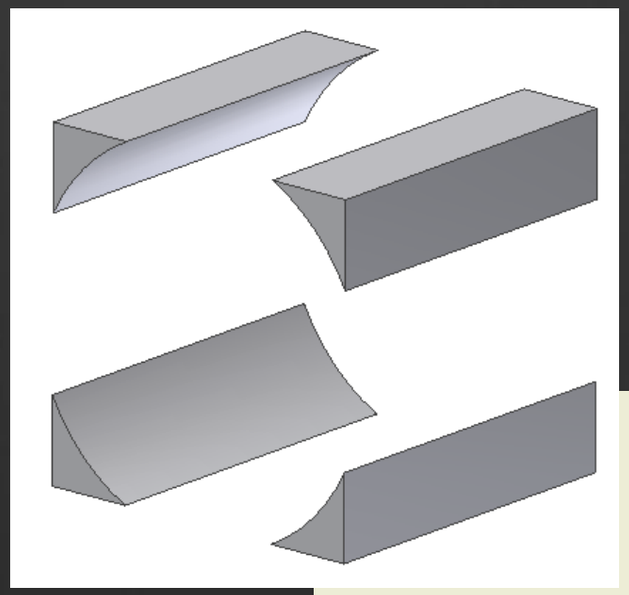
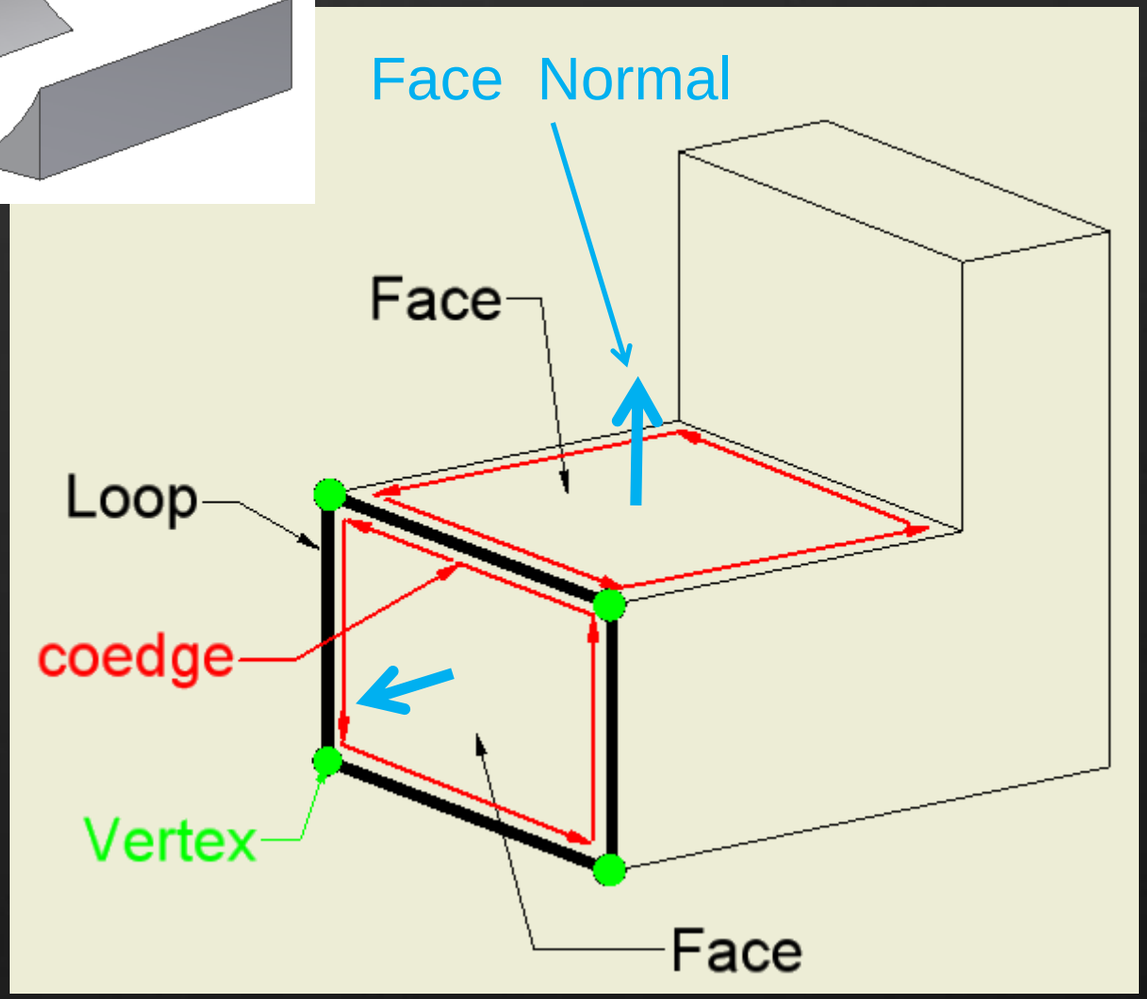
BREP – Boundary Representation - Topology







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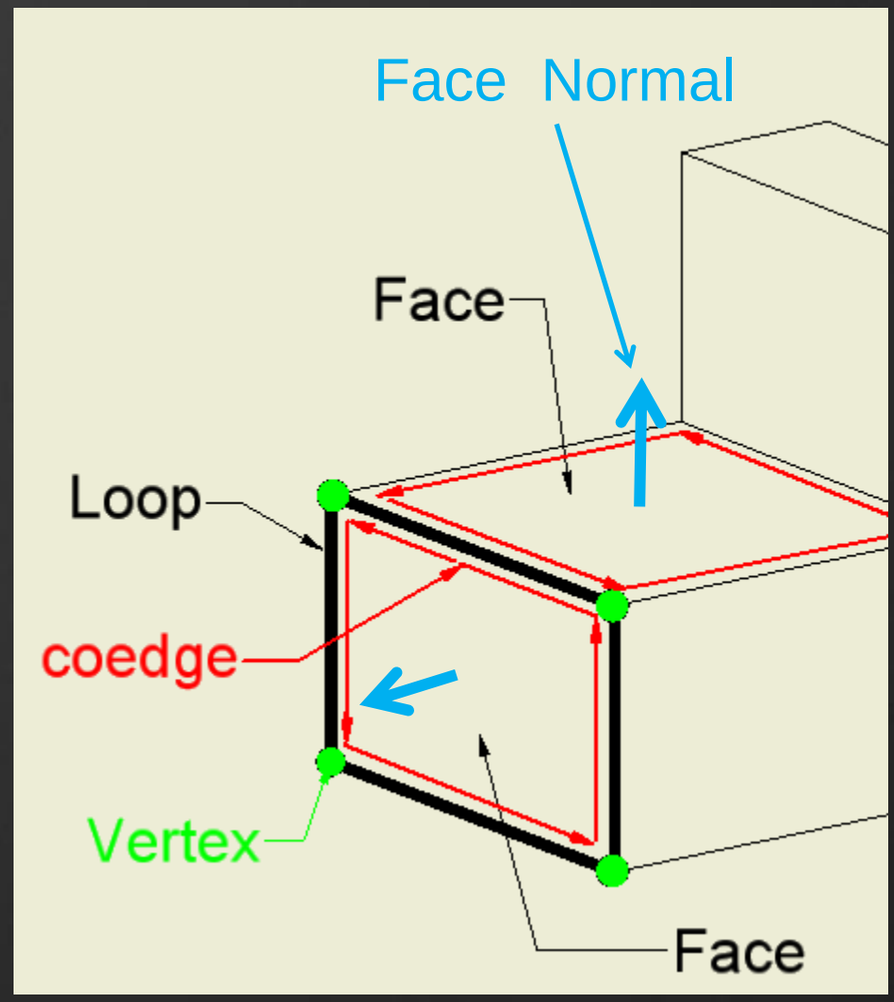
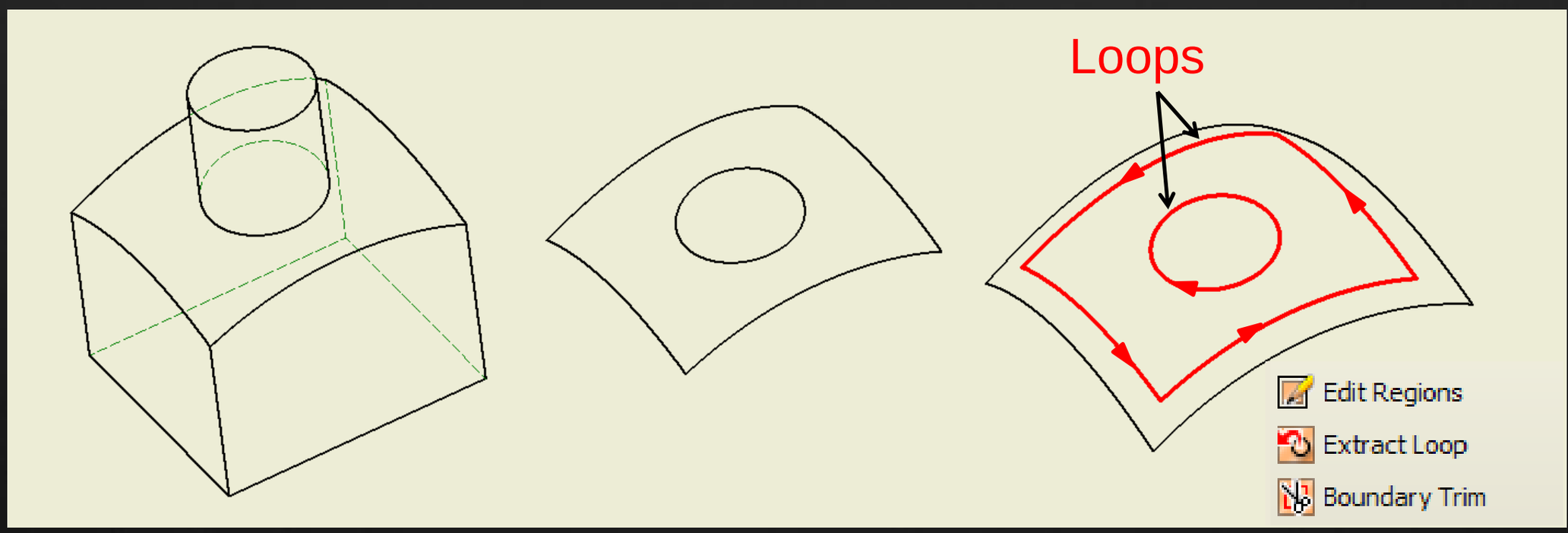
BREP – Theory in practice

- Tolerances
  - Intersections
  - Co-edges
- Trimmed faces (regions)





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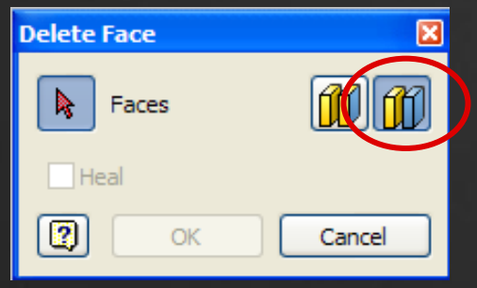
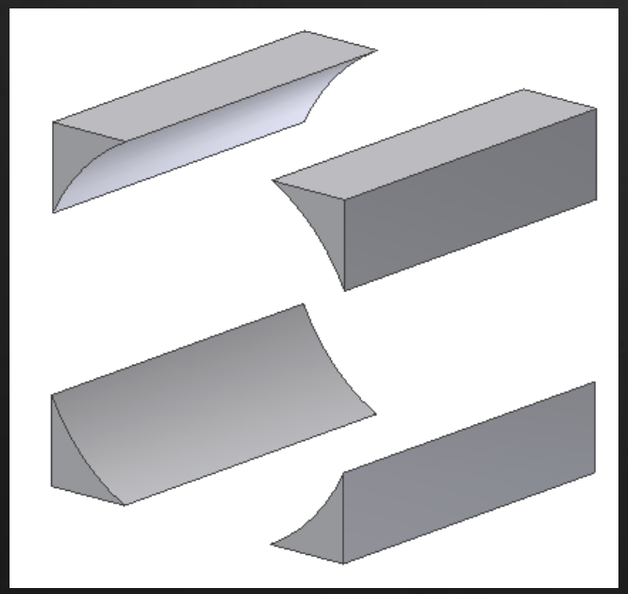
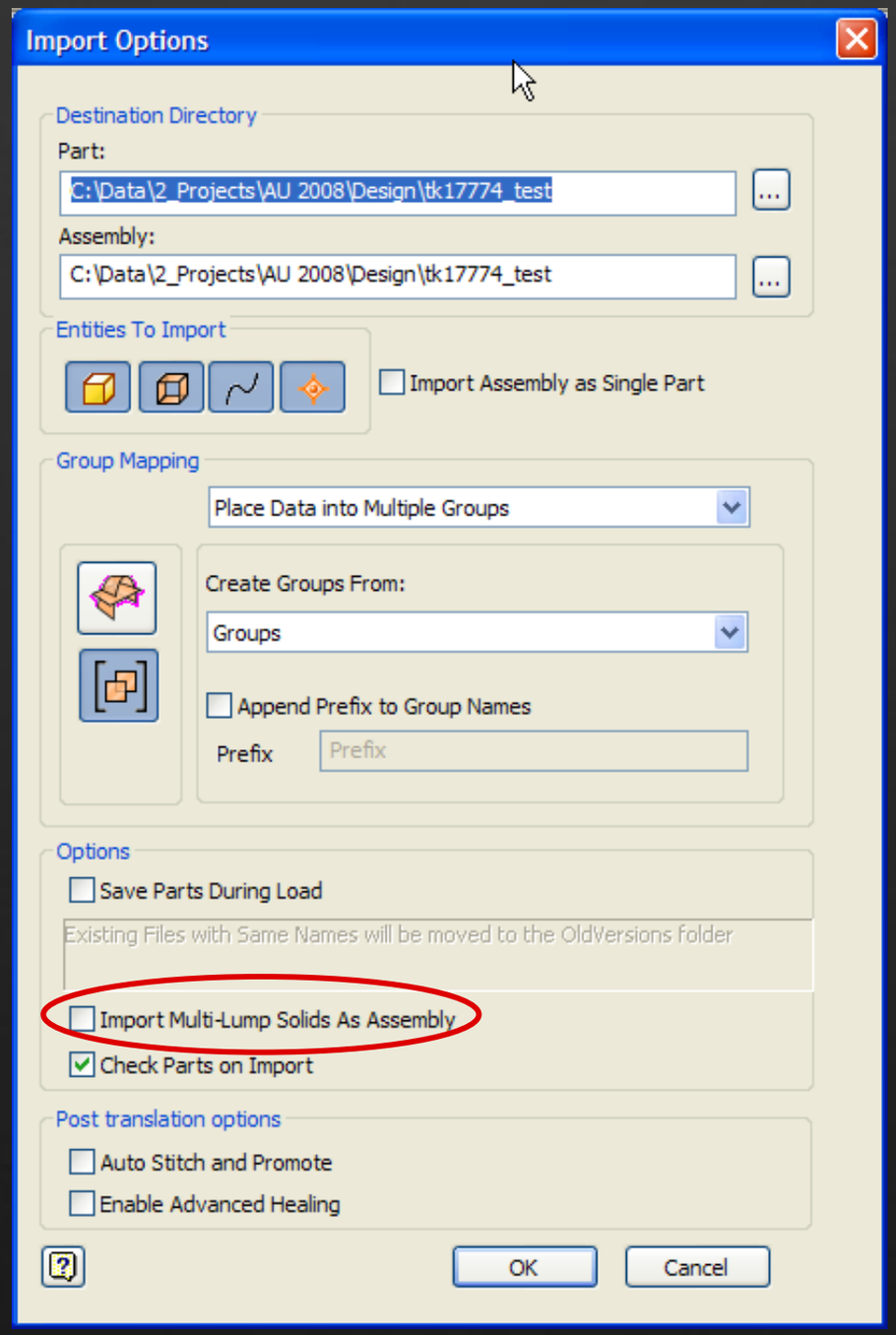
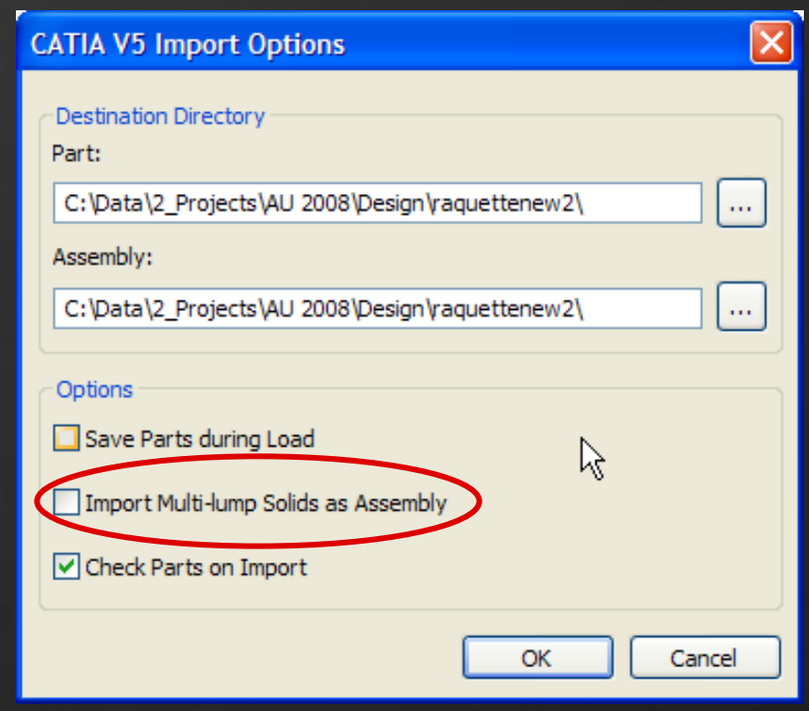
BREP – Theory in practice

- Lump









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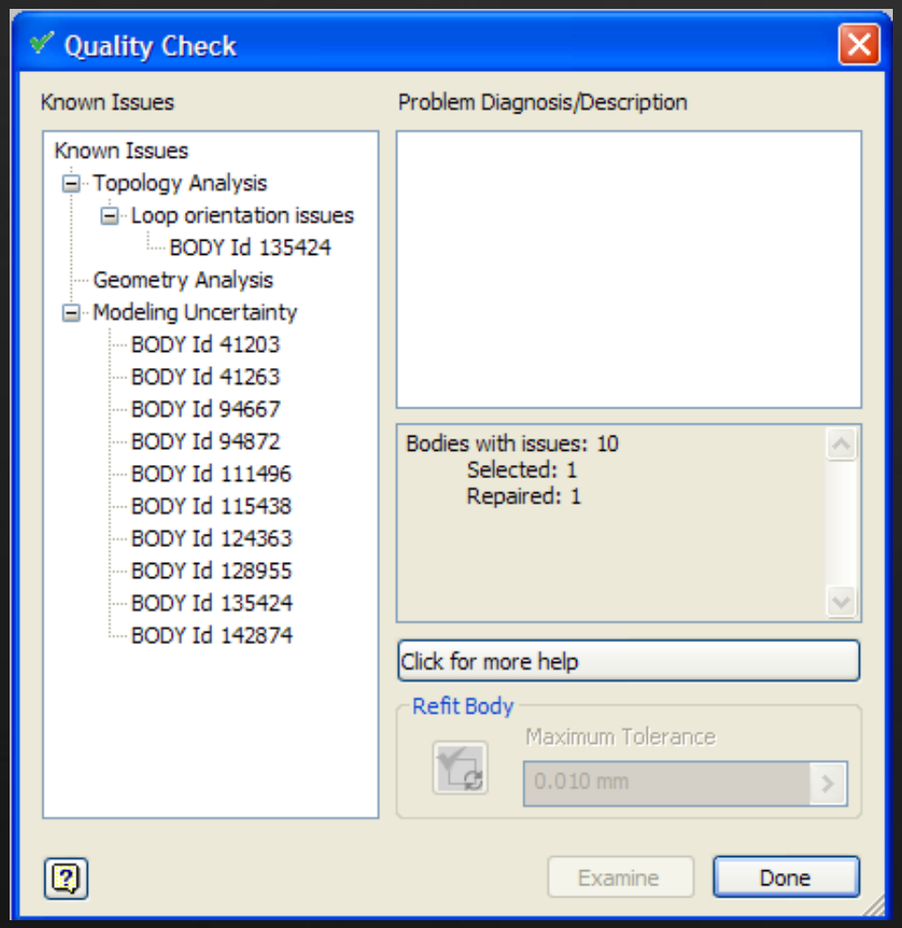
BREP – Theory in practice

- Quality Check - Construction Environment
  - Topology Analysis
  - Geometry Analysis
  - Model Uncertainty



Topology errors

Loop orientation	The outer loop is going in a wrong direction compared to the face normal direction. If the face has islands (loops enclosed within the outer loop), the normal direction of the islands must point opposite to the outer loop. Loop direction is defined by the start and endpoints and direction indicator. In addition to the loop and islands having the same direction, a surface has a normal direction that must agree with the loop direction. If any of the directions are opposite the others, an error is found.
Face orientation	The top side of a face is referred to as the surface normal. Adjacent faces within a solid must all have the same normal direction. For example, all six faces of a box must point in to be a valid solid. The loop direction is inconsistent with the normal direction of the face or inner loops do not agree with each other.
Loop connectivity	Geometry such as lines, arcs, and splines are combined into structures. Many edges and geometry can be combined into structures referred to as loops. Loops are used as boundaries on surfaces and trim a potentially infinite size to a face. Sometimes the structure of the loop is incorrect in the neutral IGES or STEP file.
Duplicate vertices	Start and endpoints of an edge are vertices. During translation, attempts are made to merge vertices that fall within the system tolerances. Duplicate vertices may occur when small edges make up a complex object.
Bad face missing data	The face does not have its underlying geometric definition and is incomplete. Typically, the face cannot be used for modeling.
Bad edge missing data	The edge does not have its underlying geometric definition and is incomplete. Typically, the edge cannot be used for modeling.

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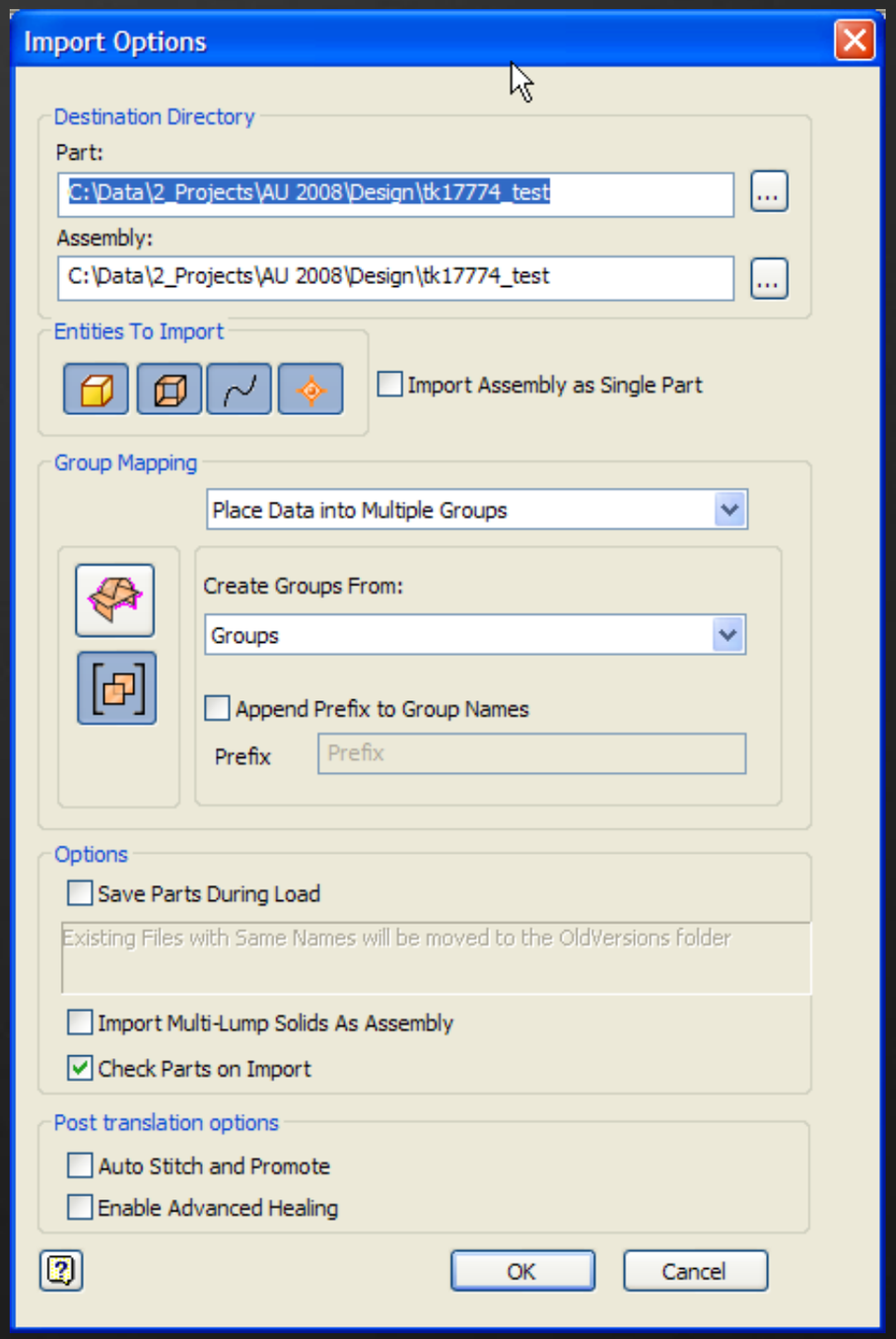
Importing Data

Overview

- Import - options
  - Save Parts During Load
  - Create Group or Composite Feature
- Translation Report
- Construction Environment
  - Quarantine Folder
  - Quality Check – Refit
  - Edit Regions
  - Extract Loop
  - Boundary Trim
  - Stitch
- Copy Object



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