midas NFX

"In Practice" Series

PART 1 - GEOMETRY SIMPLIFICATION

MIDAS

MIDAS

midas NFX

GEOMETRY SIMPLIFICATION

Speaker: Piotr Stepien

piotr.stepien@midasit.com

midas NFX

Webinar Topic Structure

Contents

Introduction

Why to simplify?

The decision to suppress or preserve a feature strongly depends upon the analysis context and the application.

For example, holes, fillets, and chamfers often do not significantly affect the analysis results.

Presence of small geometrical details influence size of the FEM model. (number of elements is getting high)

Meshing issues – due to topological issues meshing process cannot be accomplished

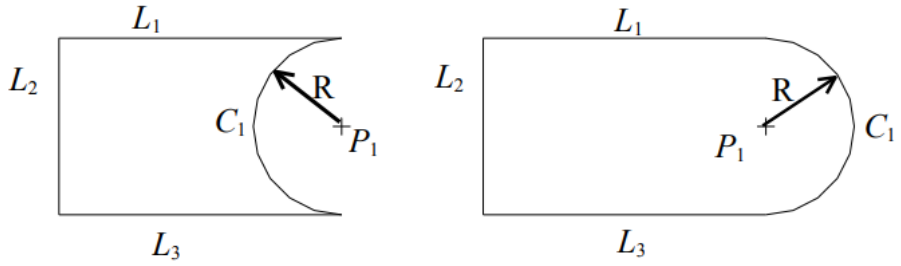
Presence of wrong topology can lead to creation of highly distorted elements, which affects solution stability and accuracy.

Back to basics

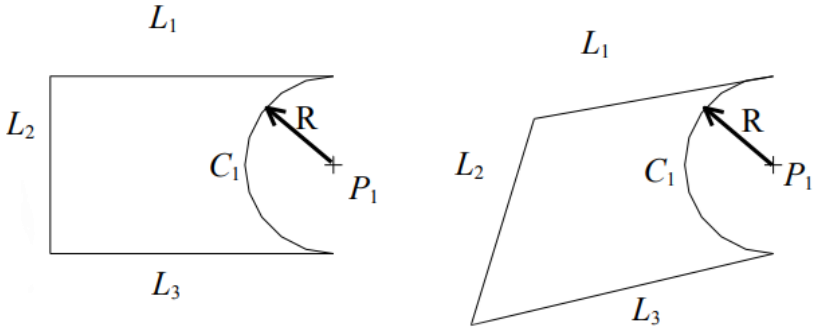
Geometry vs. Topology

Geometry (sometimes called metric information) is the actual dimensions that define the entities of the object.

Topology (sometimes called combinatorial structure), on the other hand, is the connectivity and associativity of the object entities.



Same geometry, but different topology

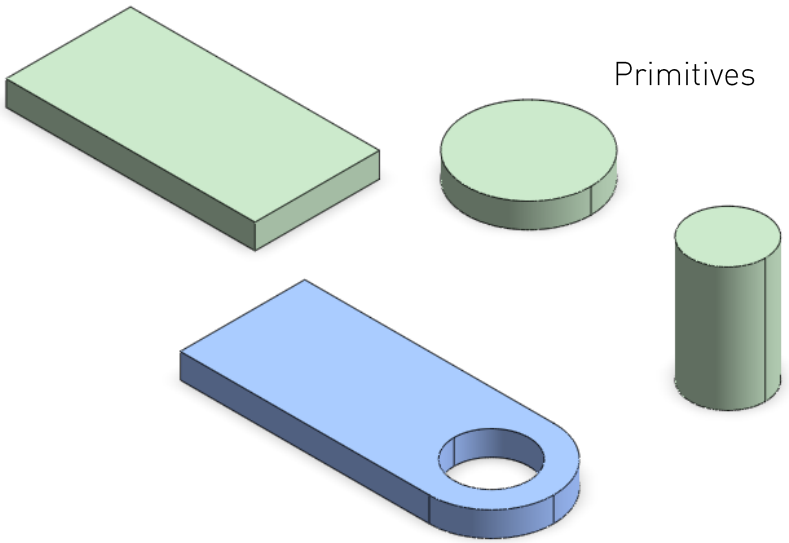


Same topology, but different geometry

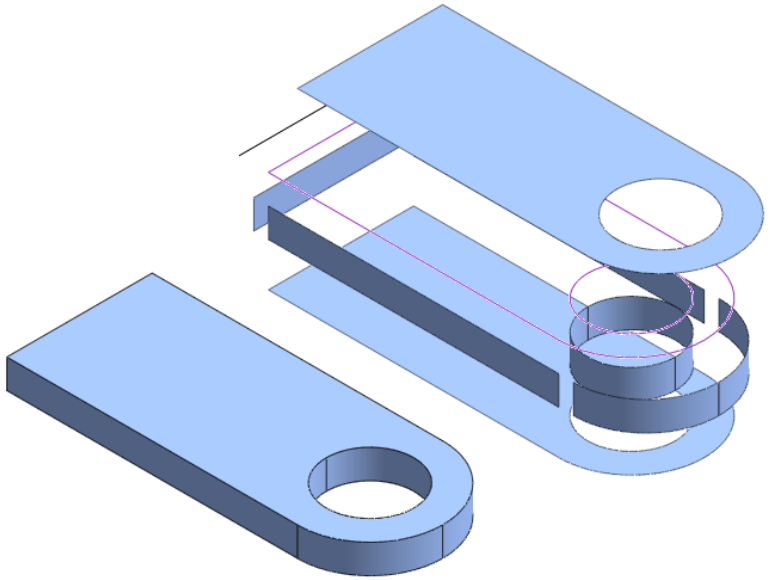
3D Geometry representation

Solid in “Digital” modeler

Constructive Solid Geometry -> modelling with Primitives with Boolean operations
B-Rep -> Boundary Representation



Initial Model



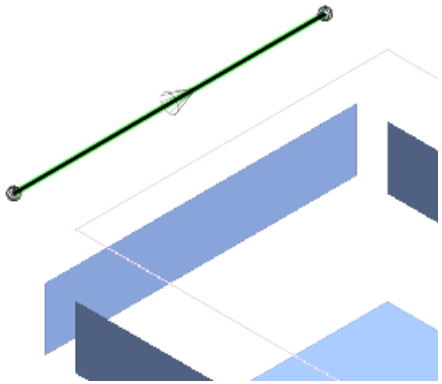
B-Rep model with sub shapes
“skin representation” – faces, etc.

3D Geometry representation

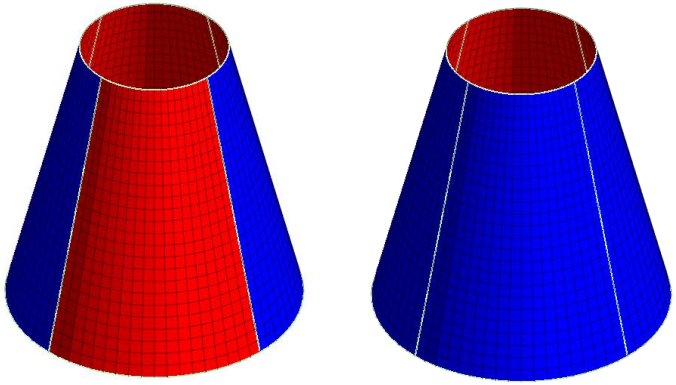
Solid as Boundary Representation (B-Rep)

• The geometric information: it consists into a set of surfaces defining the boundary of the solid and locating it in 3D space. These surfaces are bounded by trimming curves.

• The topological information: closure, orientation (important for description of shells, faces, wires, edges, vertices), expressing the adjacency relationships between the topological entities.



Direction of the Edge



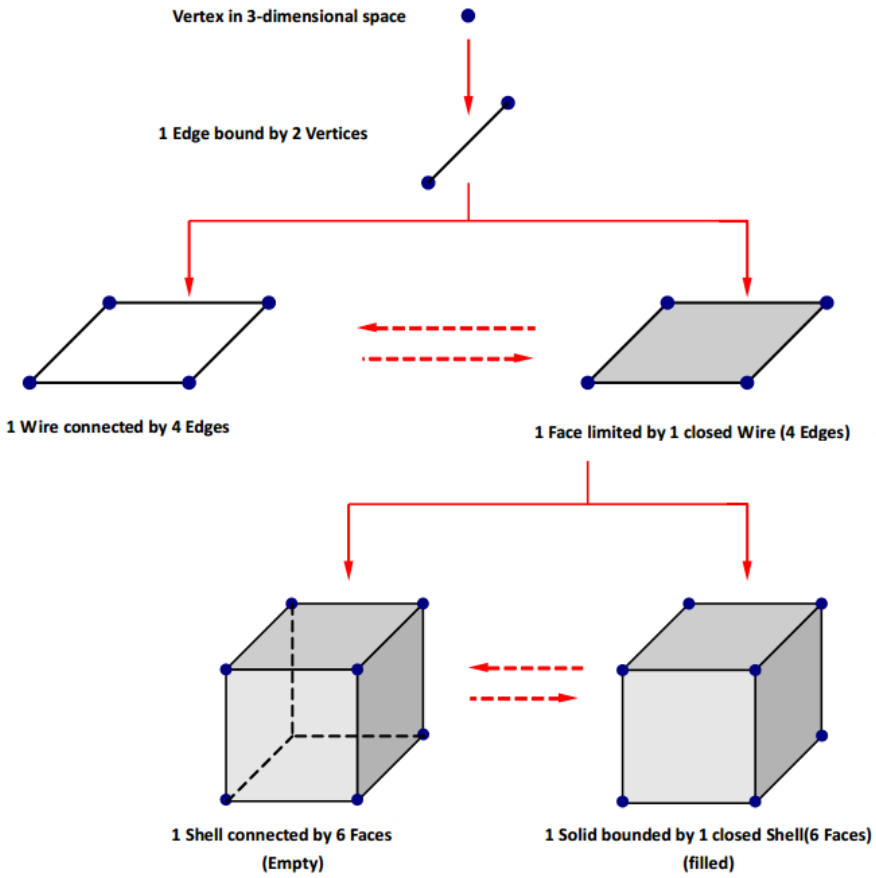
Orientation of Face influence orientation of 2D element

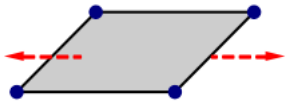
Topology of geometric entities

Higher Level Entity

Lower Level Entity

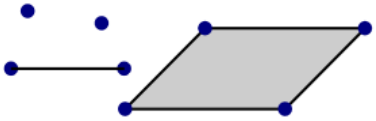
Entity		Definition	
Compound		Group of independent entities	
Shape		General term to call an independent entity (An entity that is not forming any other entity)	
Solid		Part of 3D space bound by a shell	
		Property	Volume
Surface	Shell	A group of Faces connected by shared Edges	
	Face	Part of a plane (in 2-D geometry) or a surface (in 3D geometry) bounded by a closed Wire	
		Property	Area
Curve	Wire	A group of Edges connected by shared Vertices	
	Edge	A shape corresponding to a curve, and bound by a Vertex at each extremity <ex> Straight line, circle, ellipse, arc, etc	
		Property	Length
Vertex		A point in a 3-dimensional space	
		Property	Coordinate





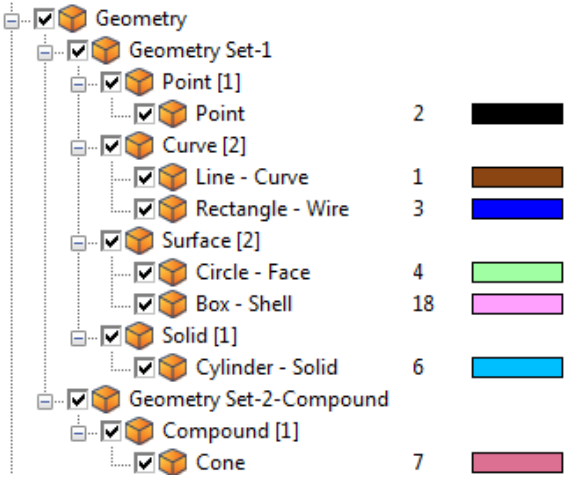
Face is a Shape which exists independently

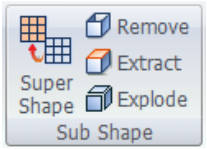
A Wire and 4 Edges cannot be a Shape because they are sub-Shapes of a Face

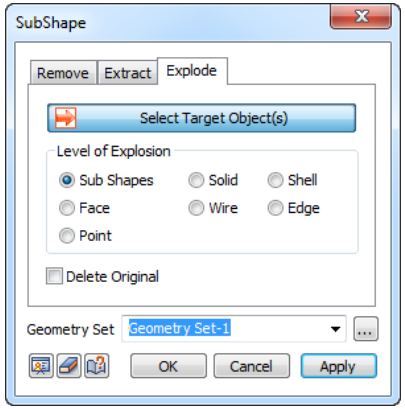


A Compound which is grouped by 4 independent Shapes
(No longer a shape when grouped as a compound)

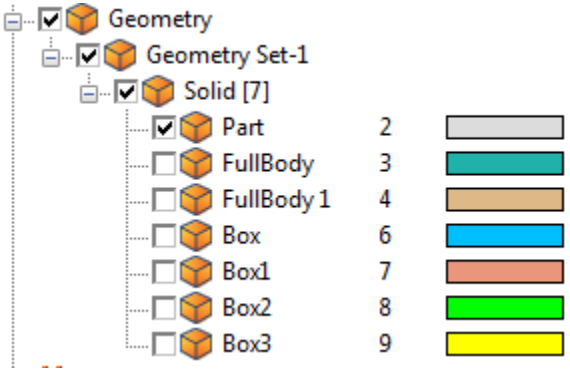
Geometrical objects in NFX



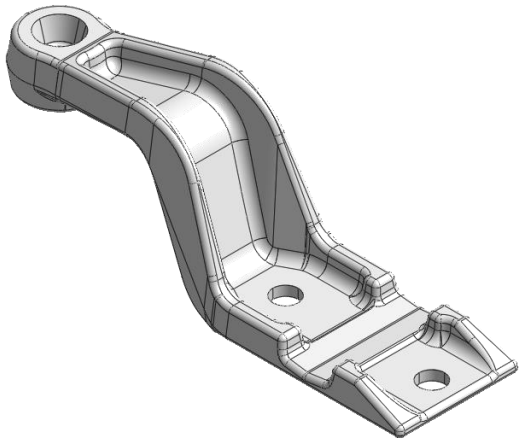




Higher level of geometry can be exploded to lower level: Solid to Shell, Shell to Face etc.



No parametric history dependent modeling



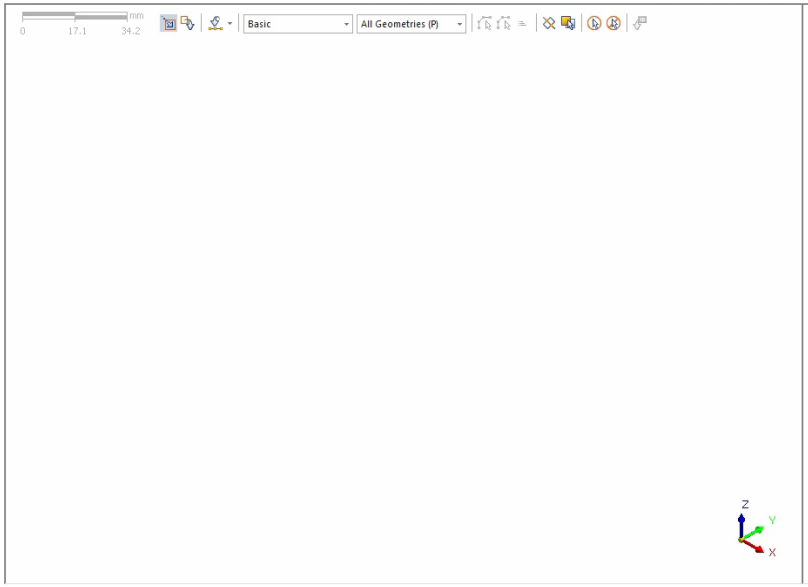
Imported shape

Feature Based modelling

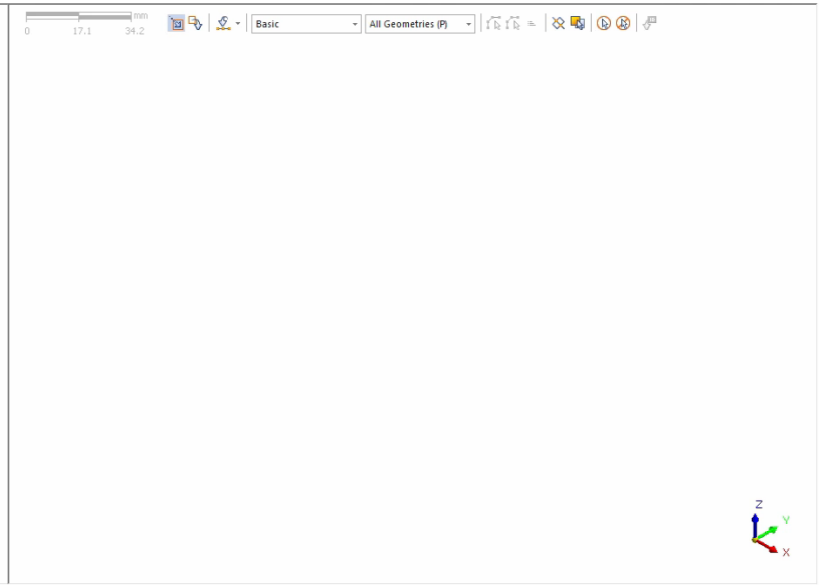
Concept of Feature:

The features can represent machining operations such as holes, pockets, protrusions or more generic areas contributing to the design process of 3D components like extrusions or revolutions.

The principle of feature-based modeling is to construct a part "**from a simple shape to a complex one**" and it is similar to the CSG principle.



"Addition"

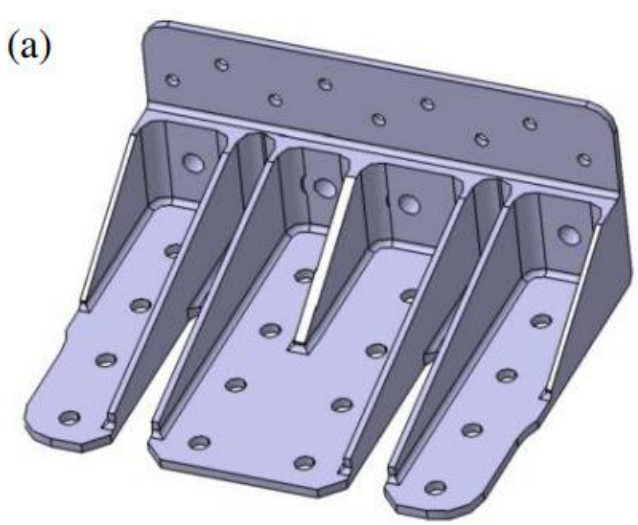


"Subtraction"

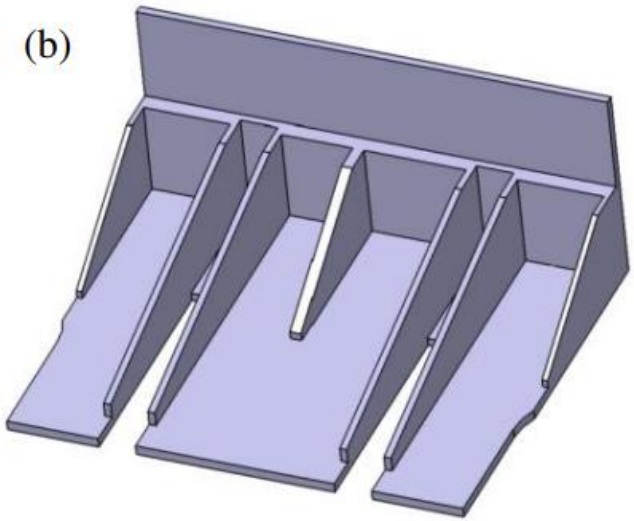
Simplification process

3D CAD geometry – Solid geometry

In order to build analysis models dedicated to the structural analysis by finite element method, the simplification of CAD geometry consists to remove details, considered as useless details and/or to reduce dimensions of the part.



Initial Model

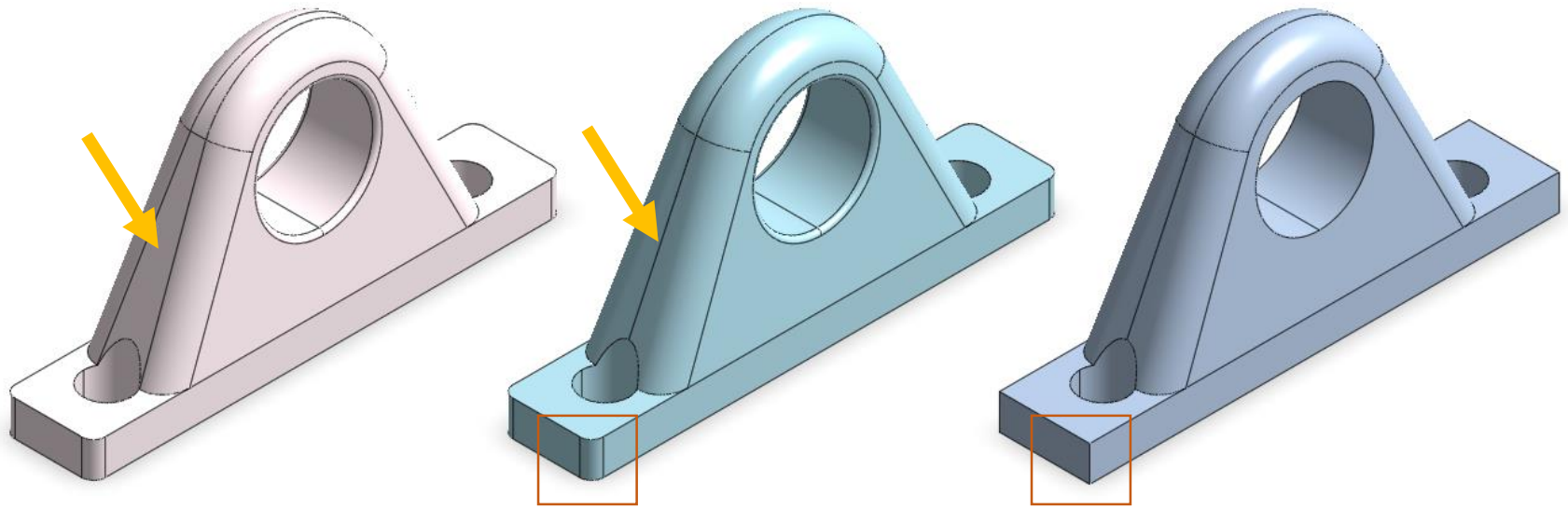


Fillets removal
Chamfers removal
Holes removal

Simplification process

3D CAD geometry – Solid geometry

- Feature removal (called as well as Defeaturing)
- Topology adaption



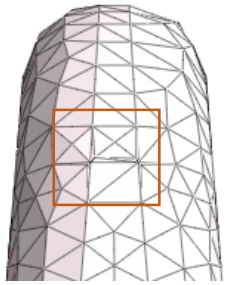
Changed topology

Fillet operation removal

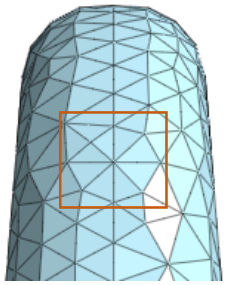
Simplification process

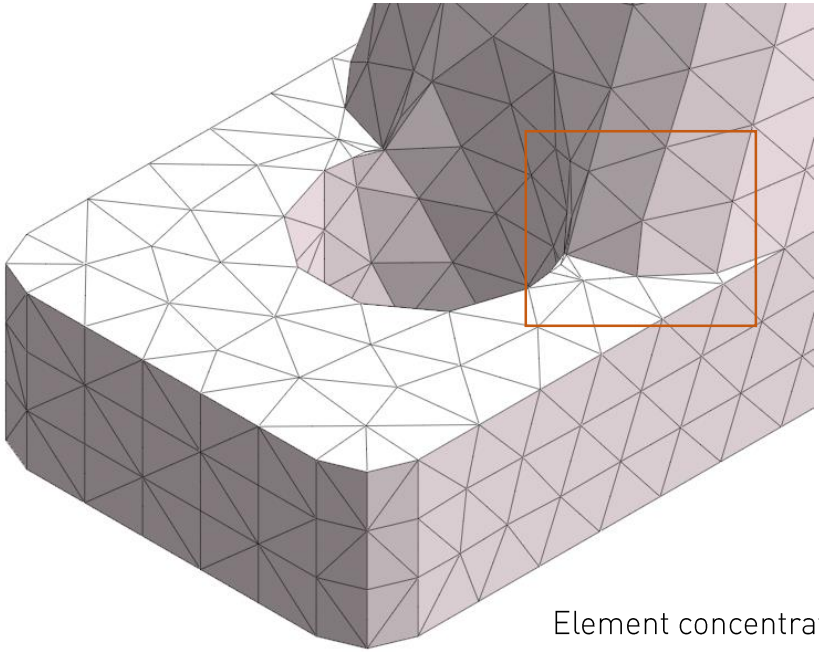
3D CAD geometry – Solid geometry

- Meshing Result

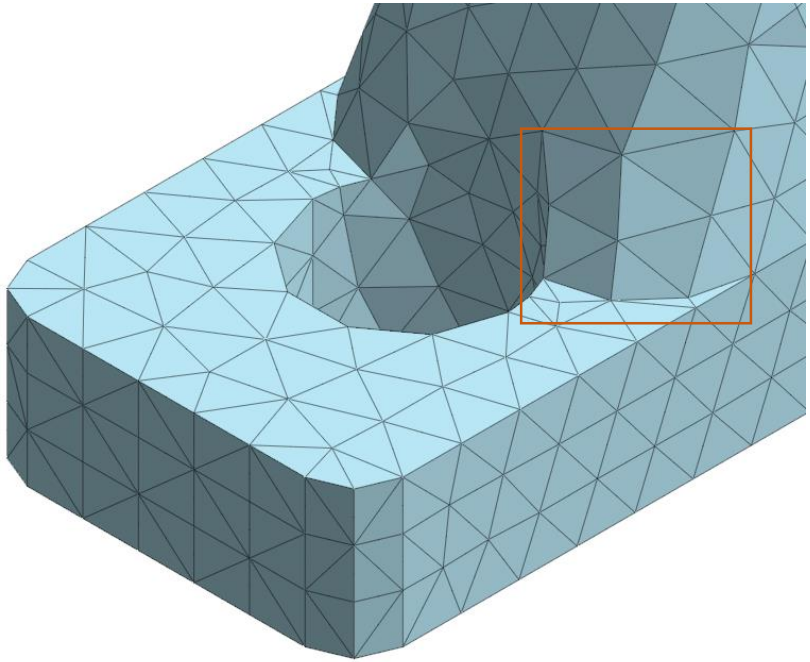


Elements with high aspect ratio,
Surface disturbance





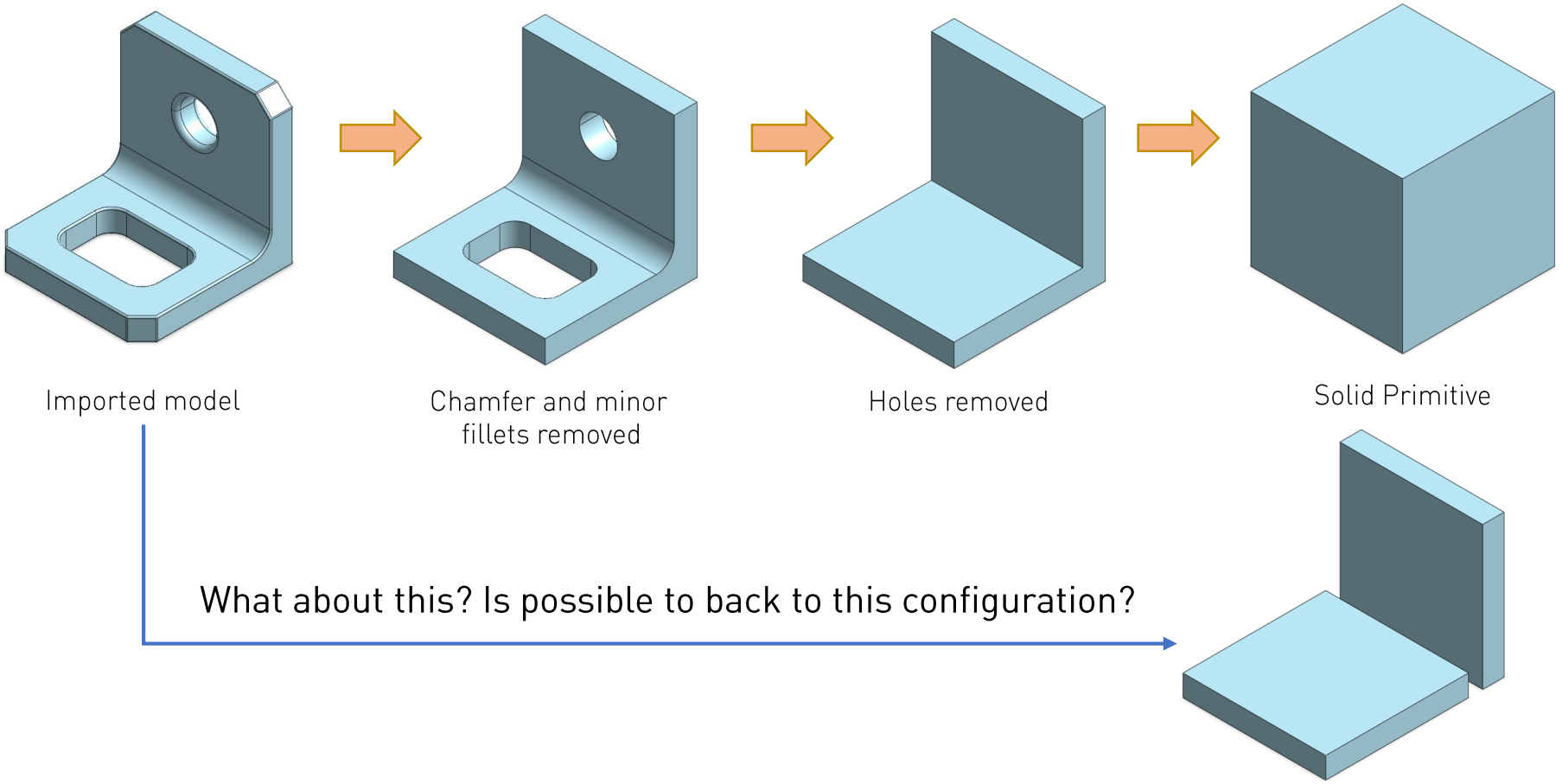
Element concentration



Simplification process

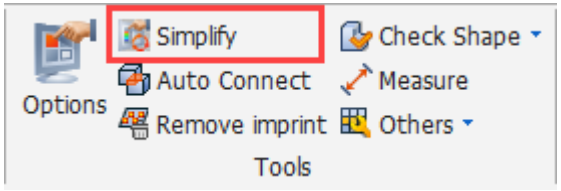
3D CAD geometry – Solid geometry

- Defeaturing as the process to back to primitive shape

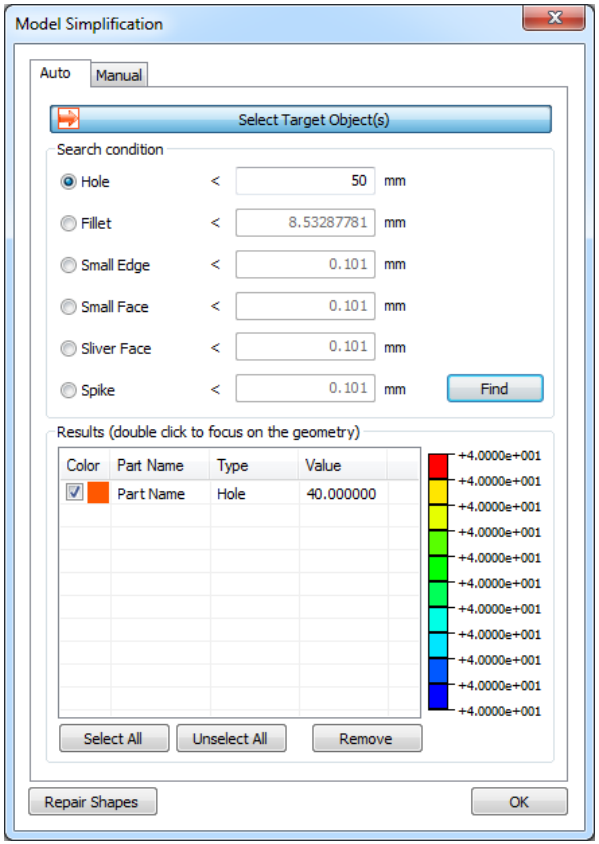


Simplification process

NFX Simplification Tools



- Automatic detection



Hole (Radius): Input radius of hole

Fillet (Radius): Input radius of fillet

Small Edge: Input the length of edge (any edge)

Small face: Input the length for the longest edge of face

Sliver Face: Input the width of strip

Spike: Input the width of spike

Result: All entities which meet criteria are listed in the dialog

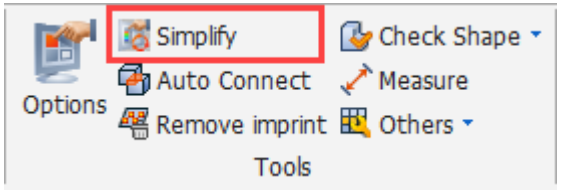
Selected entities will be **highlighted** in the model view

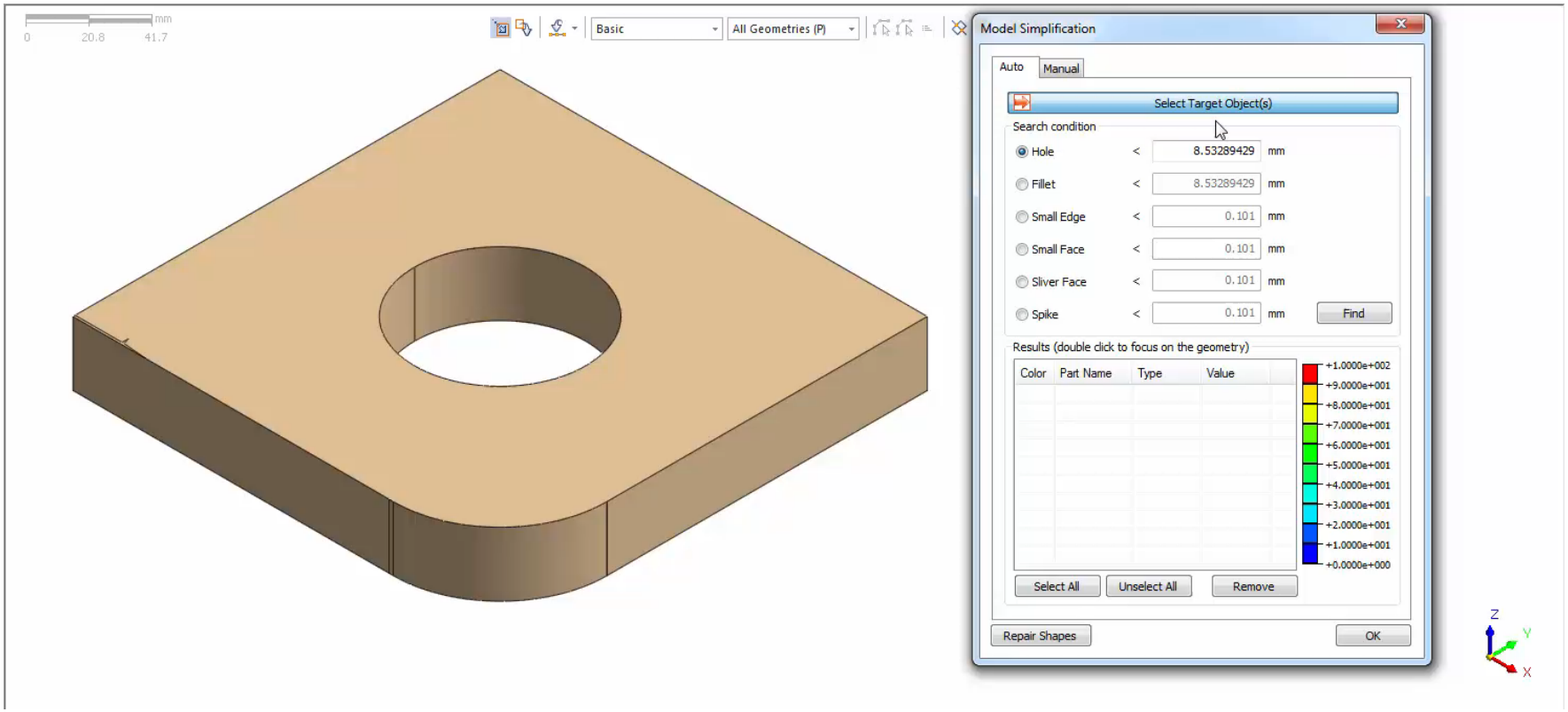
Double click on the selected entity to **zoom** to window

Simplification process

NFX Simplification Tools

- Automatic detection

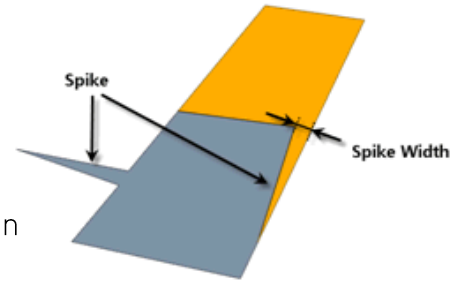




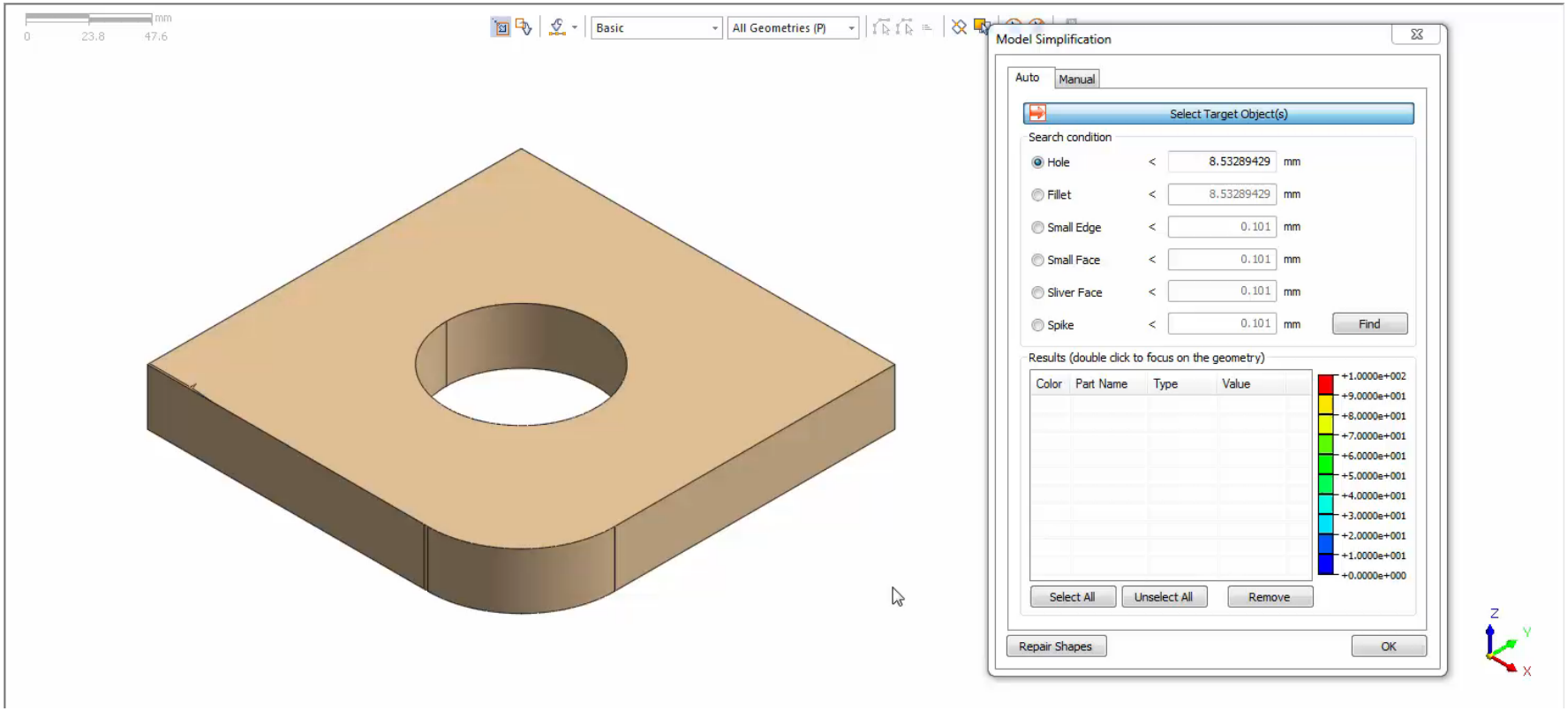
Simplification process

NFX Simplification Tools

- Auto removal



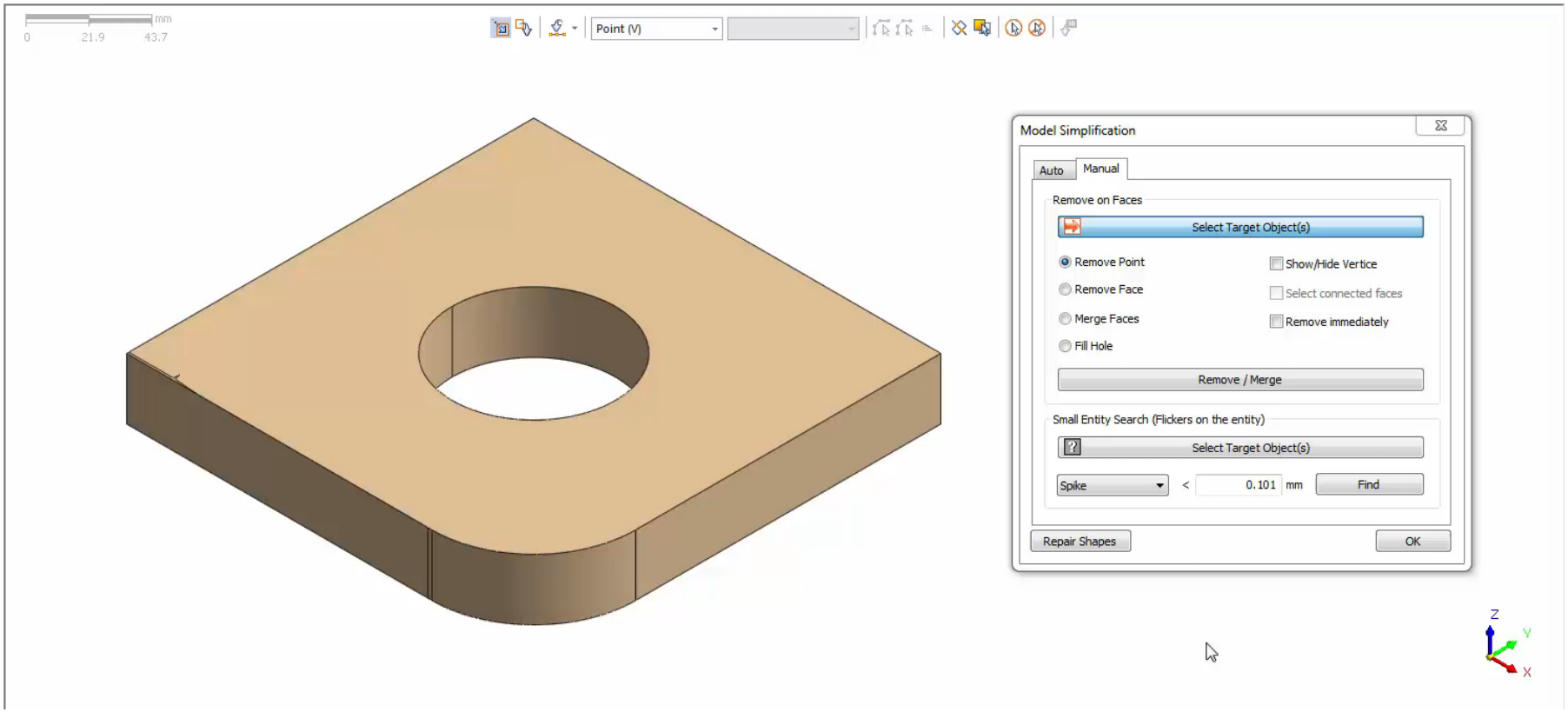
Spike definition



Simplification process

NFX Simplification Tools

- Manual selection and removal

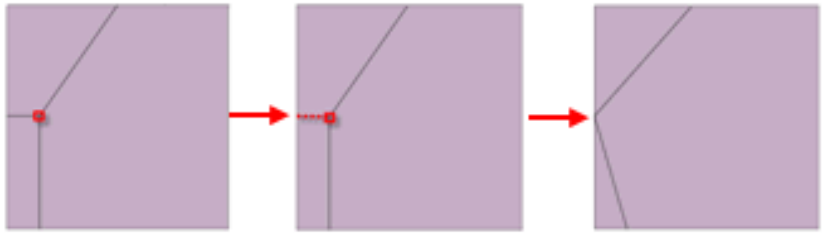


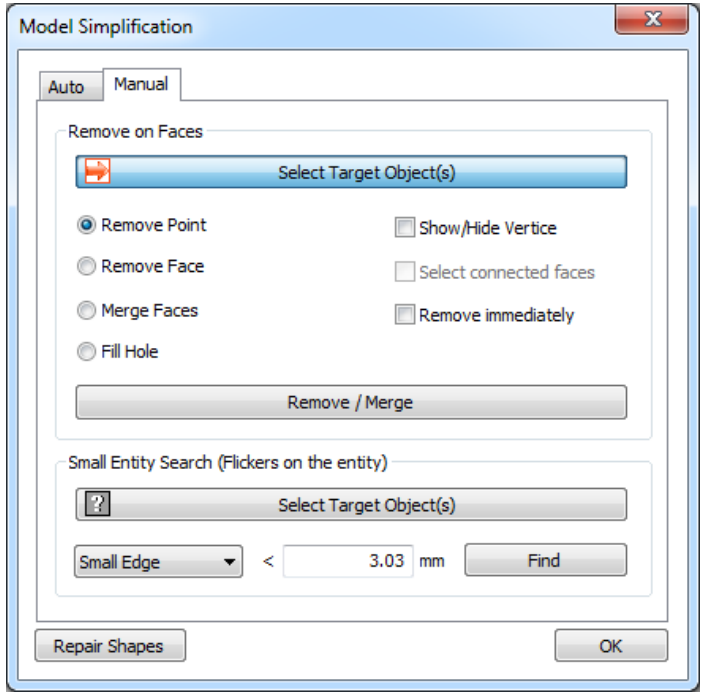
Simplification process

NFX Simplification Tools

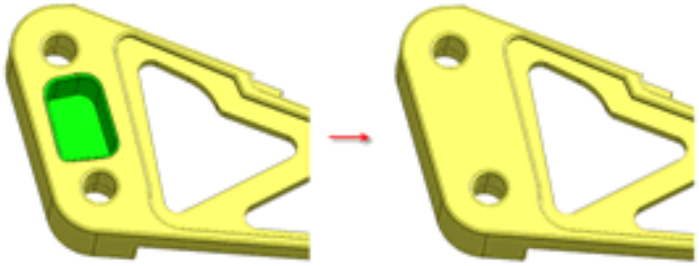
- Manual selection and removal

Remove Point

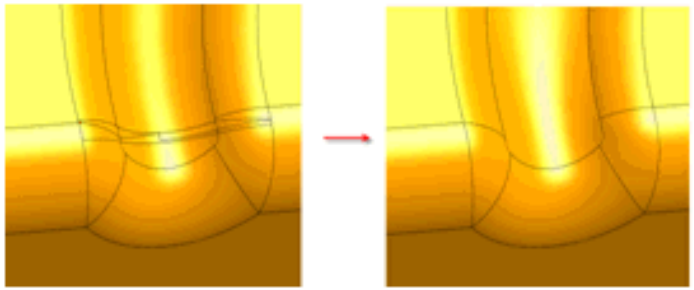




Remove Face



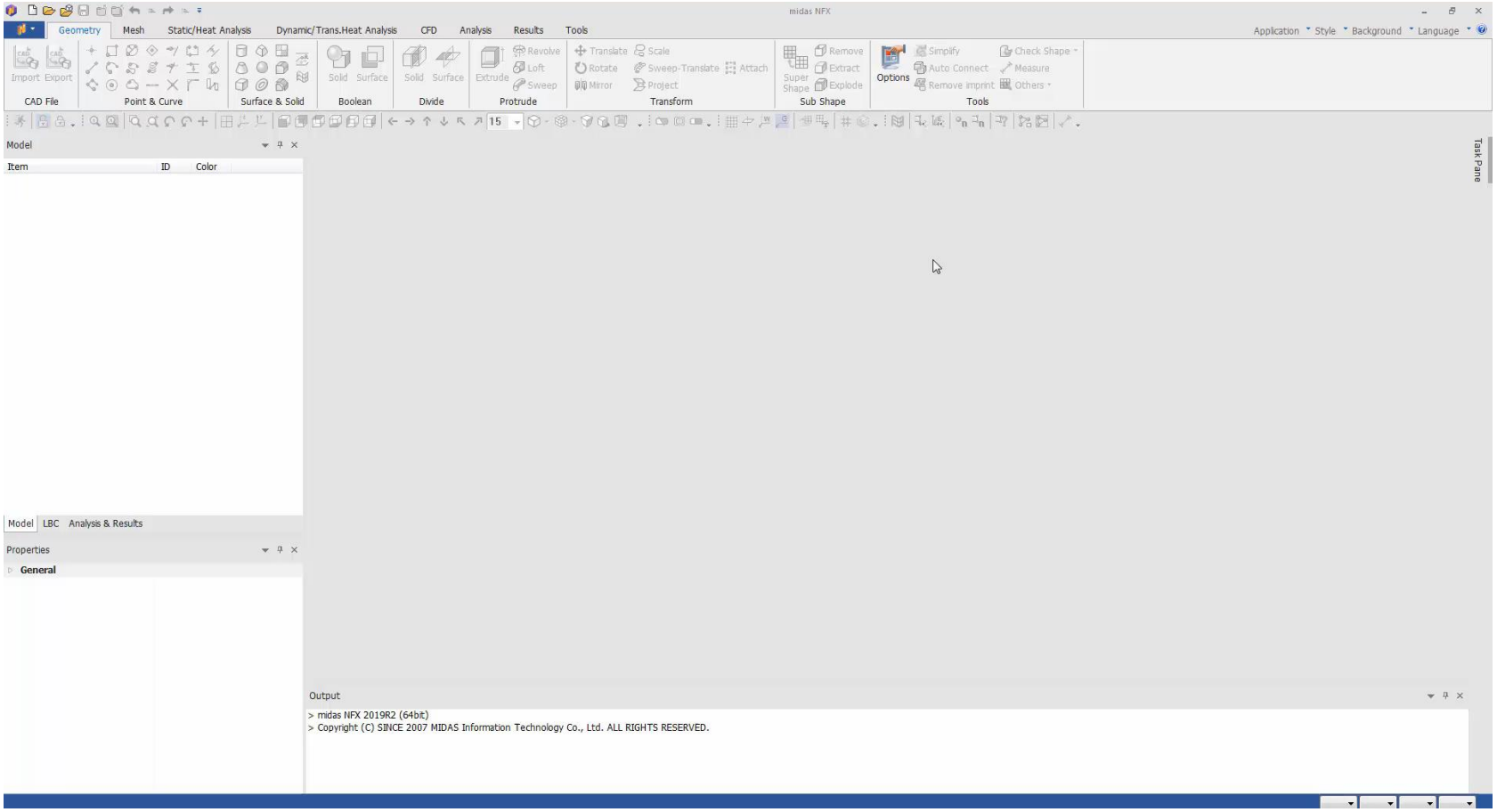
Merge Face



Simplification process

NFX Simplification Tools

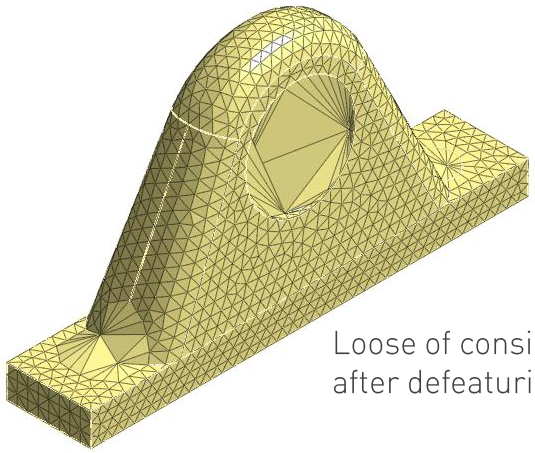
- Topology Adaptation



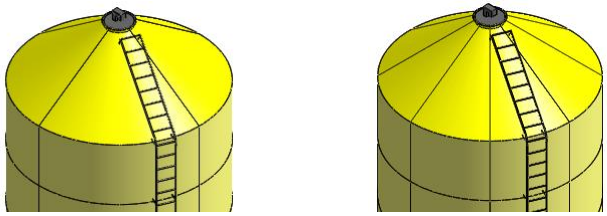
Simplification process

NFX Simplification Tools

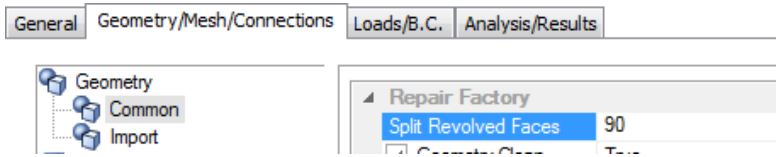
- Topology Adaptation – Split Revolved Faces

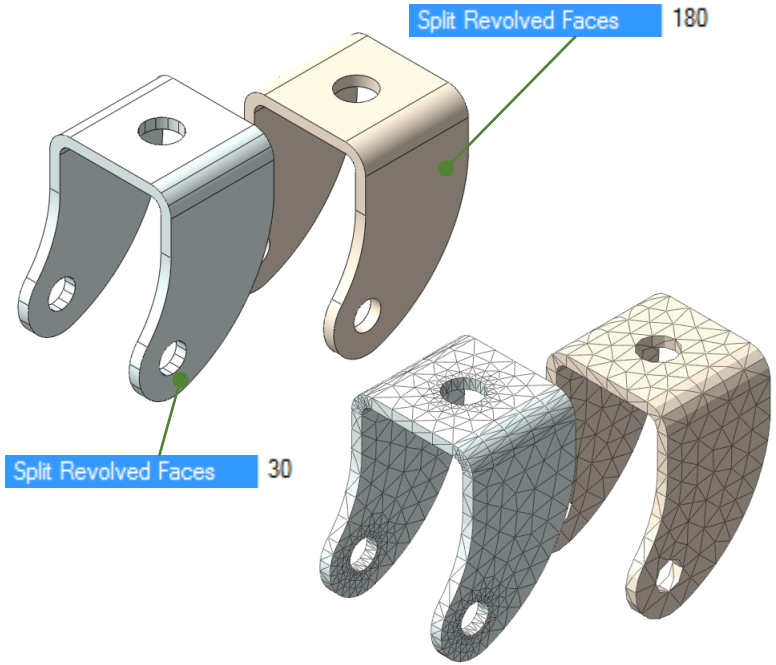


Loose of consistency
after defeaturing- meshing issues



Difference between 90 degree and 45 degree split angle

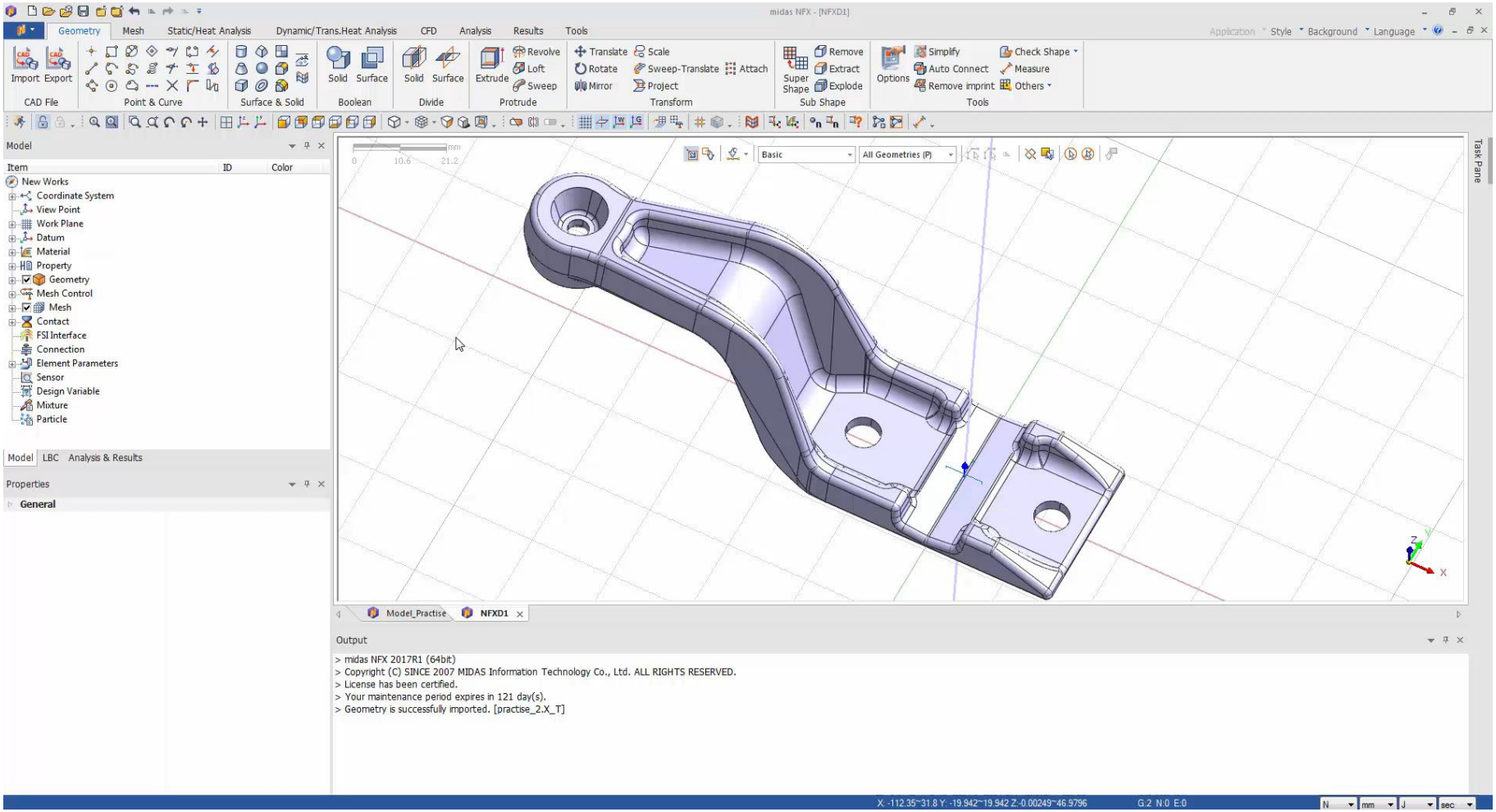




Comparison of meshes according to split angle

Simplification process

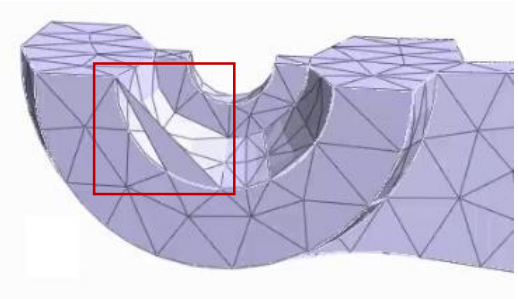
Single Part Simplification example



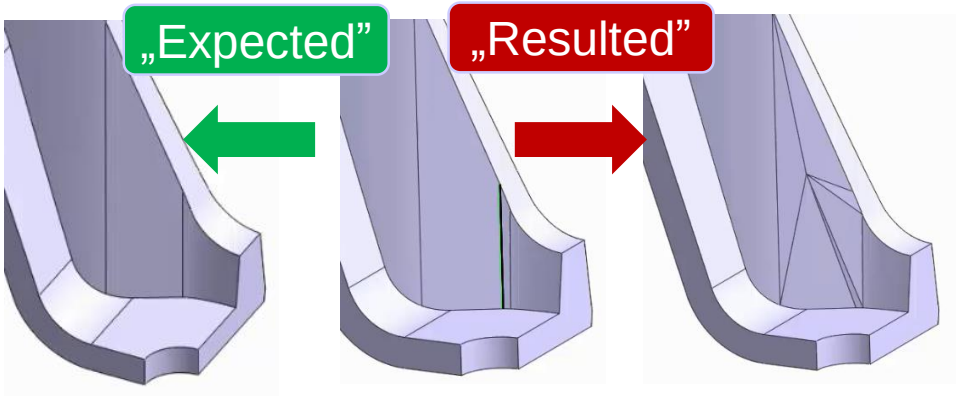
Simplification process

Single Part Simplification example

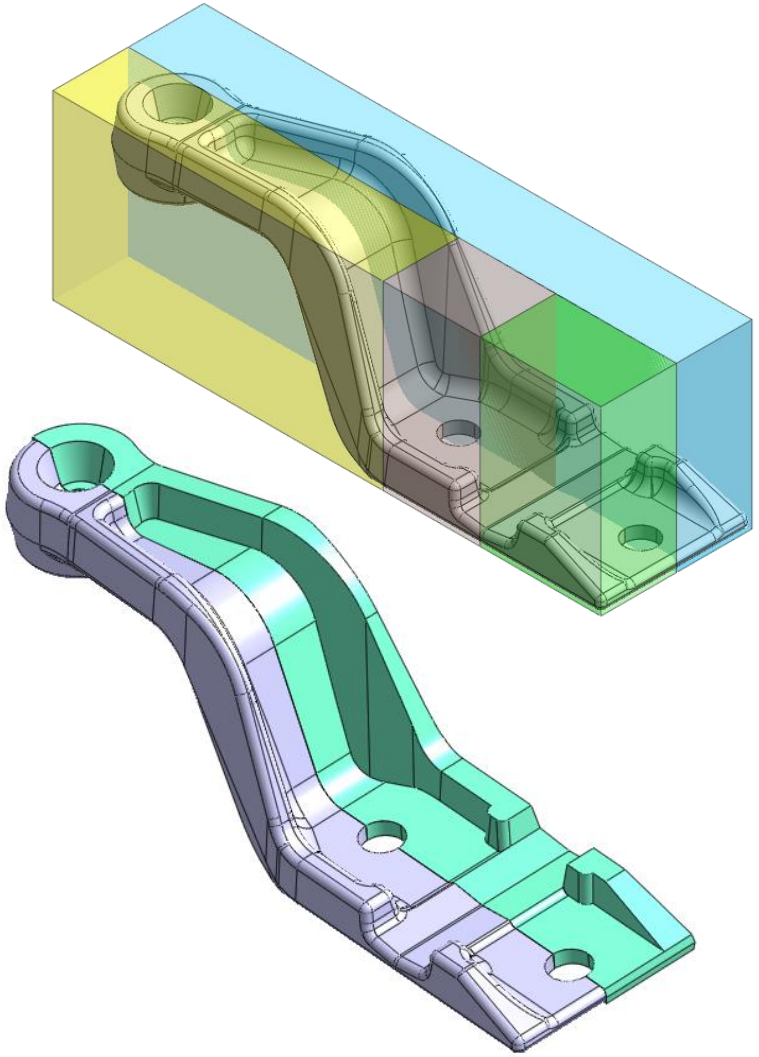
- Plan your Simplification strategy



Always verify meshing result



Practice to understand your tool and topology



Use Symmetry of your geometry

THANK YOU
Q&A