

# PERMAS



## From design space to optimized design

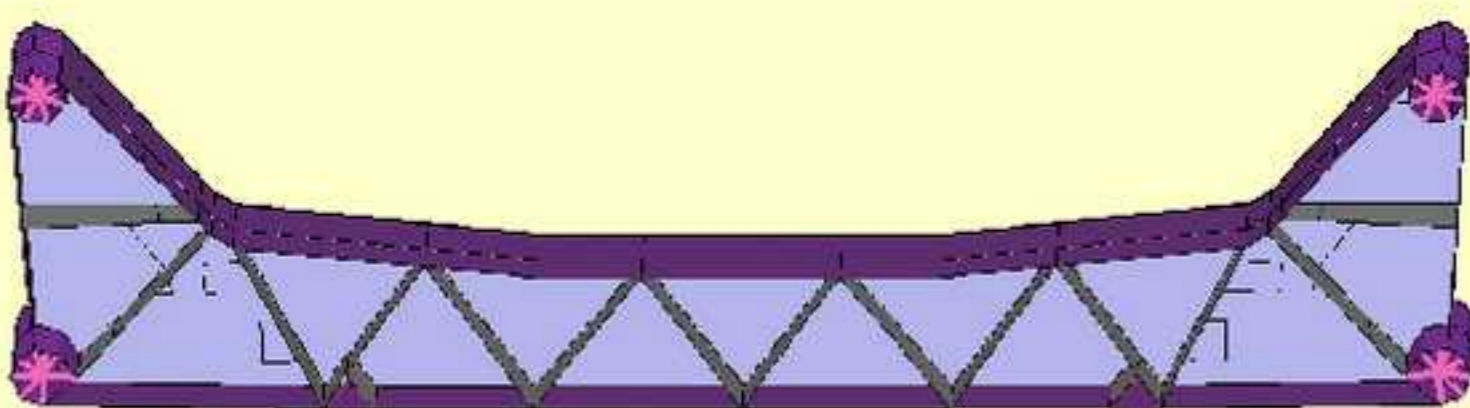
**Integrated optimization supports complex workflows:**

- **Topology optimization for the design concept**
- **Shape optimization for the detailed design**
- **To meet classical optimization objectives:**
  - ✓ **Low weight**
  - ✓ **High stiffness**
  - ✓ **Low stresses for high durability**

*Example:  
Idealized  
transverse  
control arm*

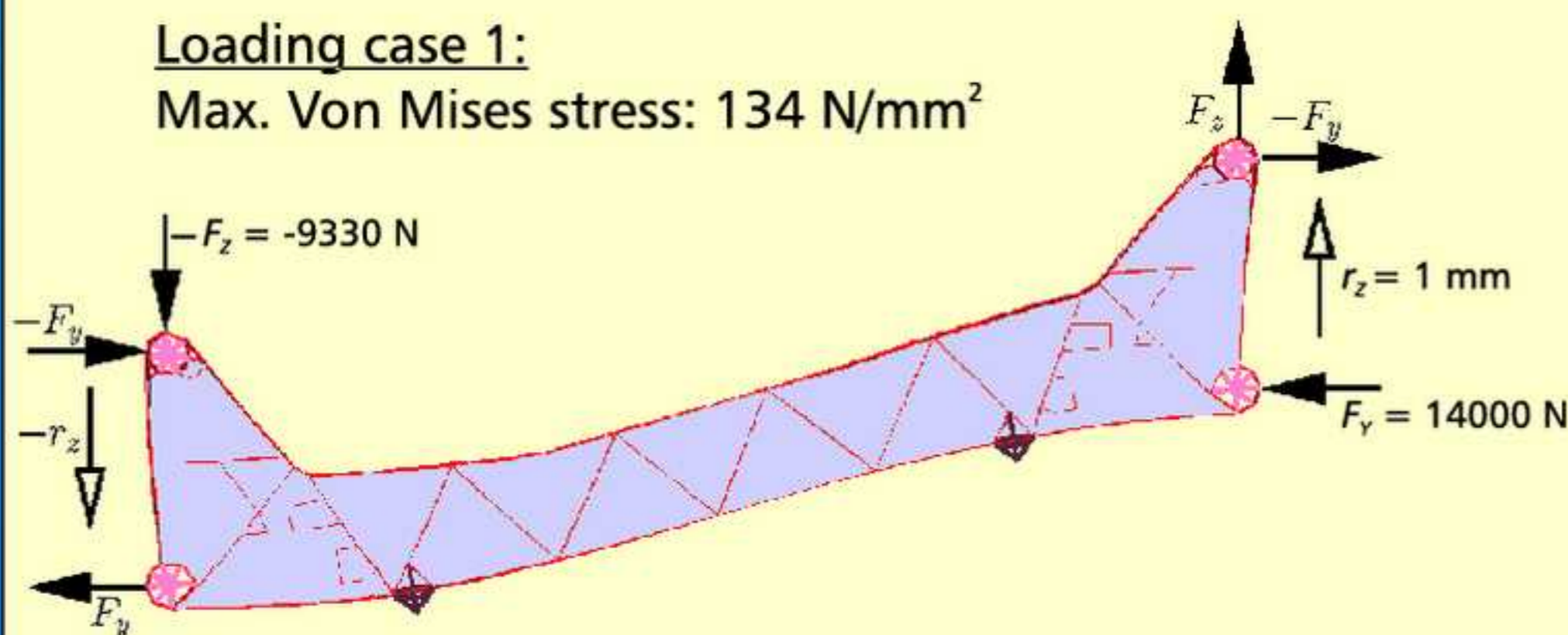
### Initial Design

Mass: 3.18 kg



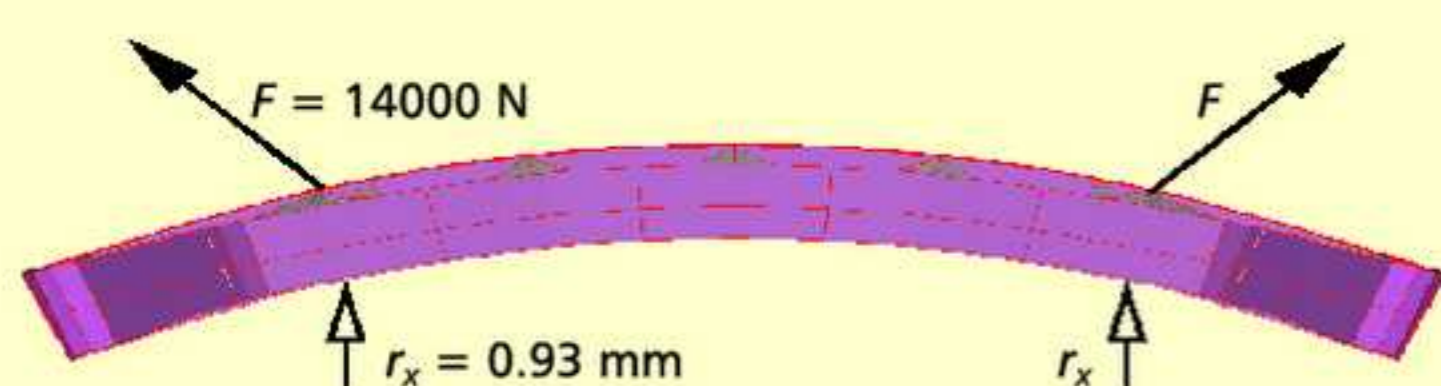
#### Loading case 1:

Max. Von Mises stress: 134 N/mm<sup>2</sup>



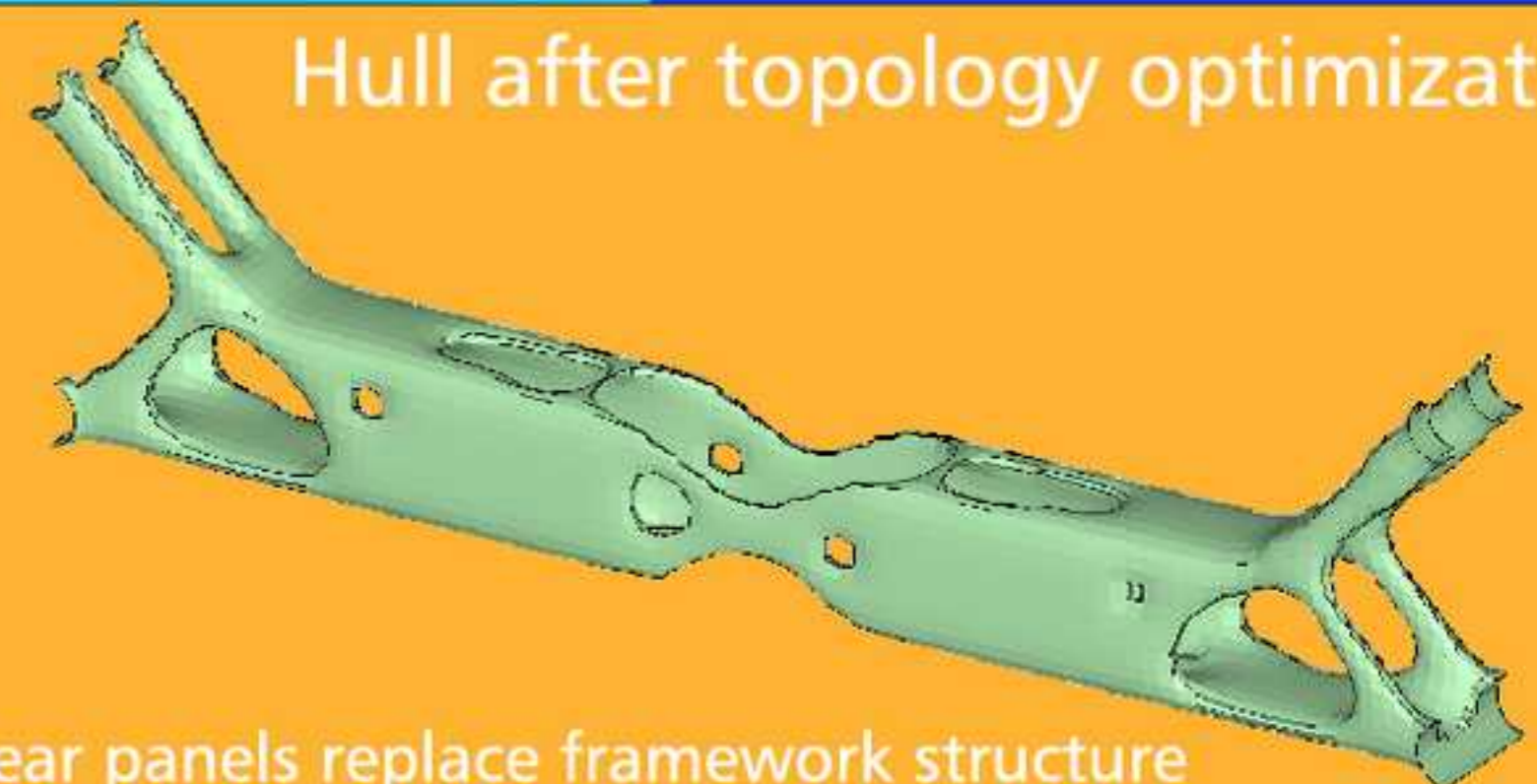
#### Loading case 2:

Max. Von Mises stress: 109 N/mm<sup>2</sup>



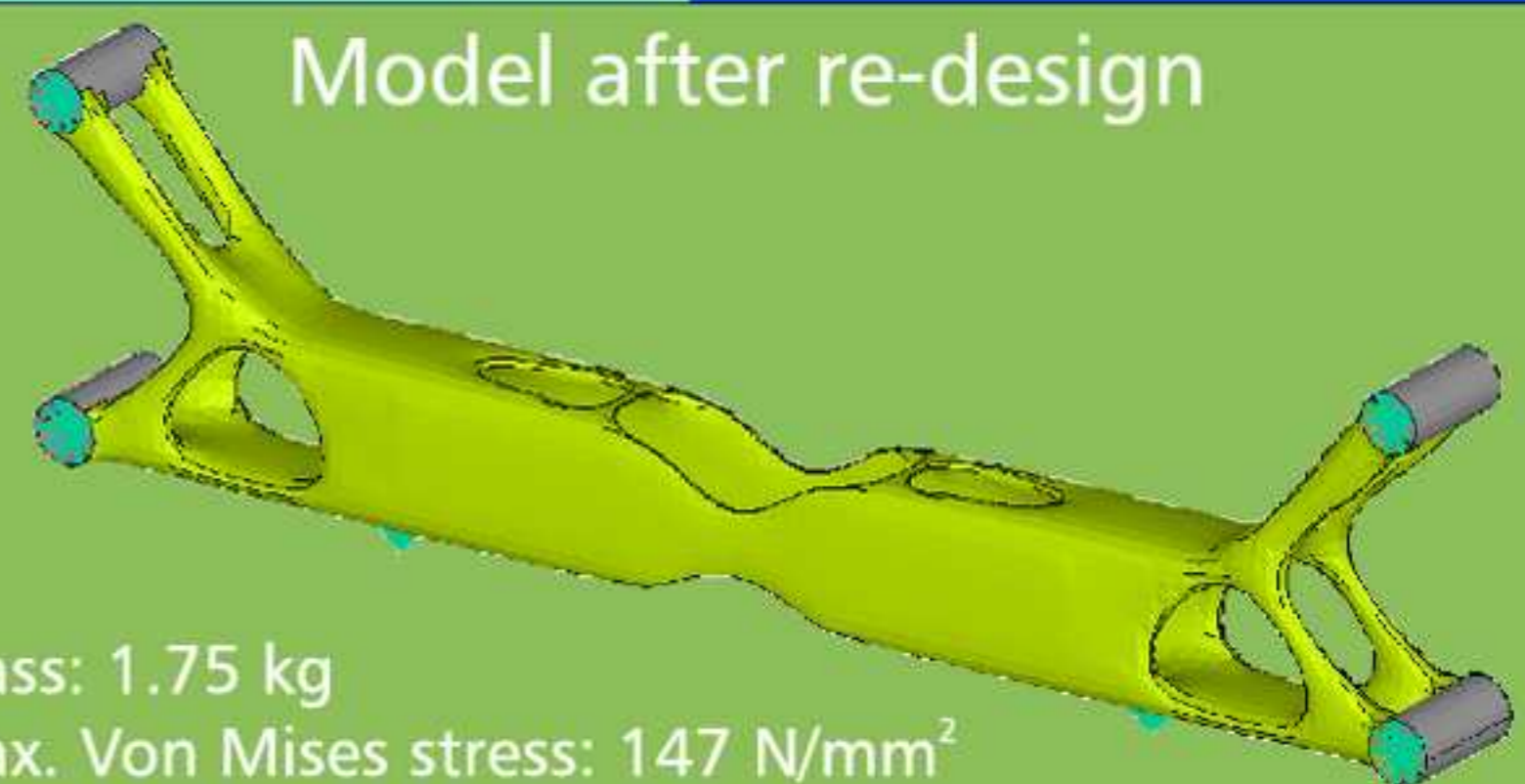
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### Hull after topology optimization



Shear panels replace framework structure

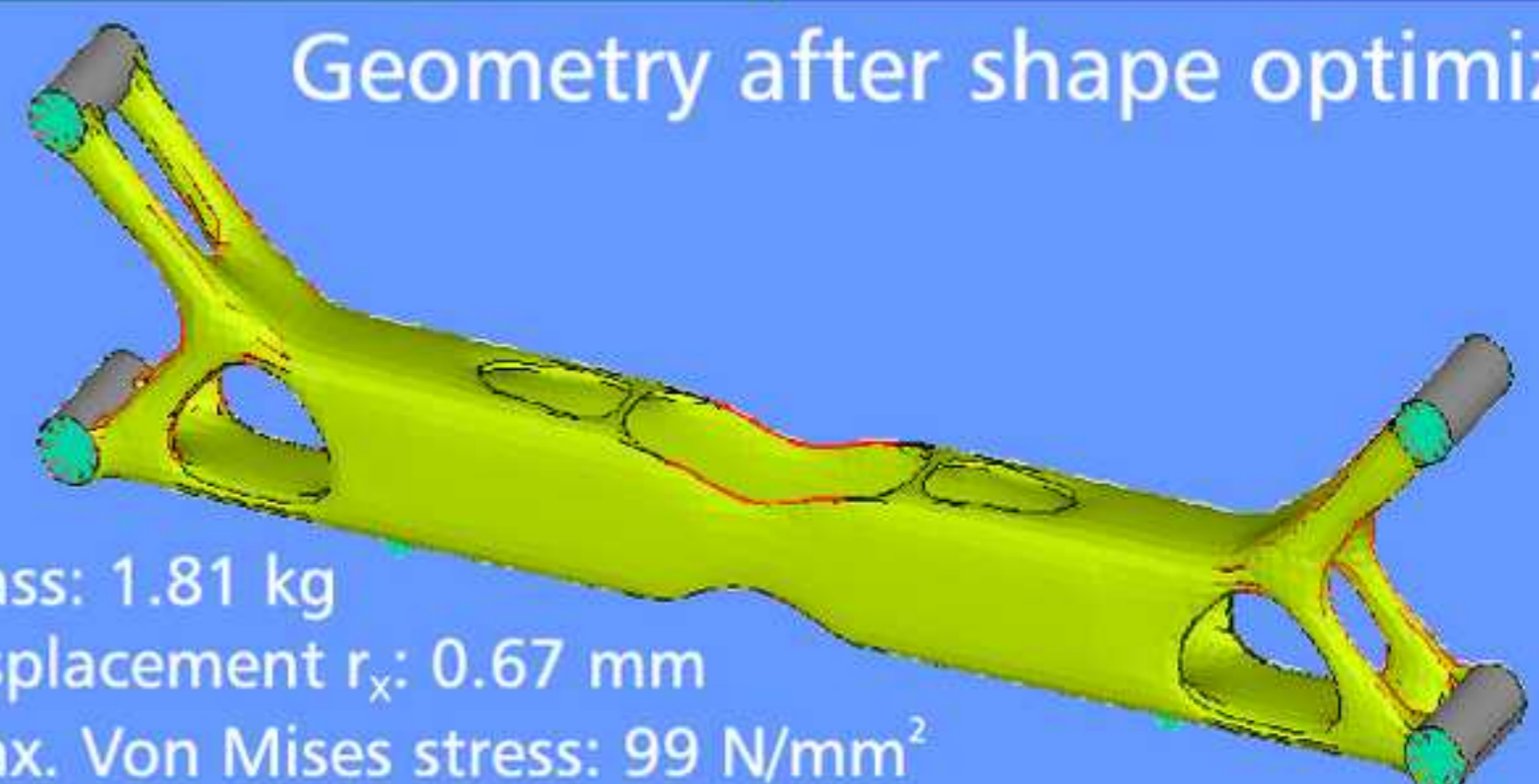
### Model after re-design



Mass: 1.75 kg

Max. Von Mises stress: 147 N/mm<sup>2</sup>

### Geometry after shape optimization

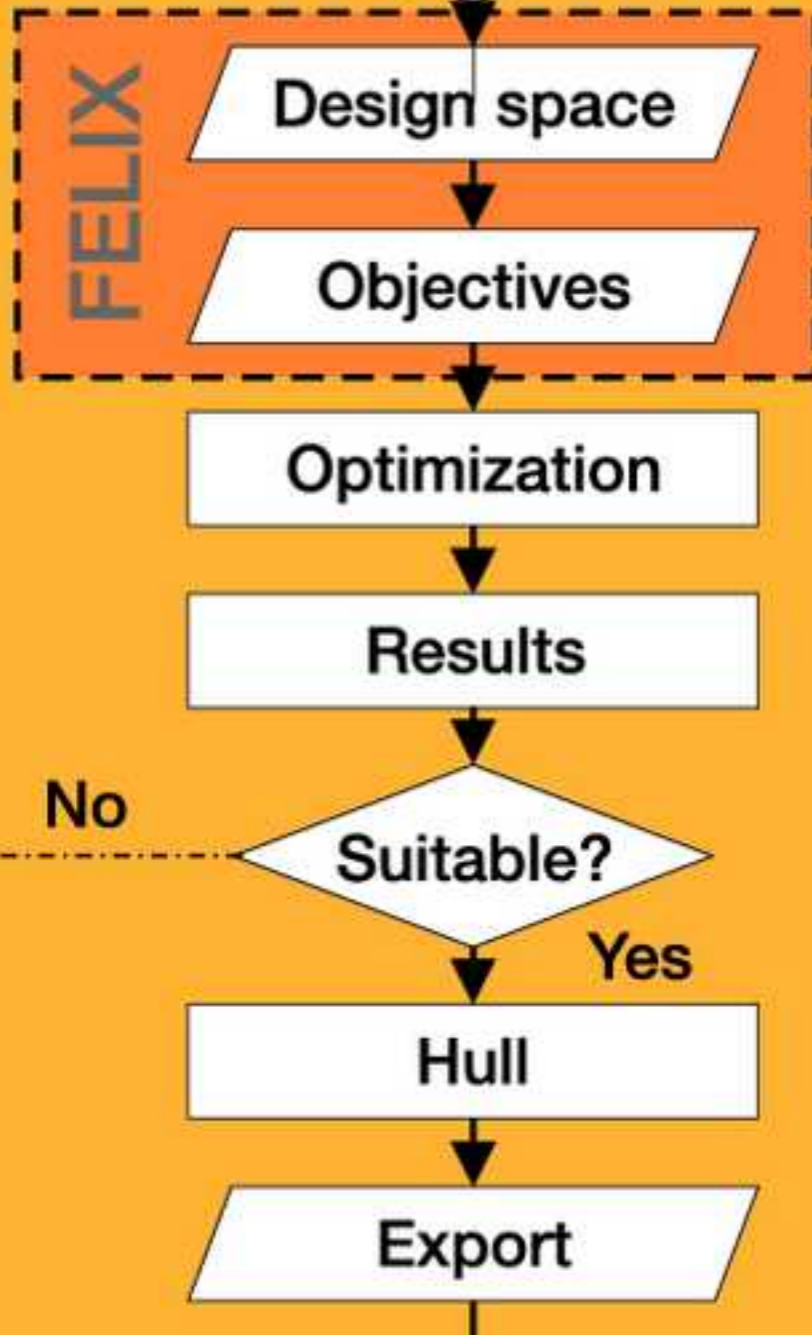


Mass: 1.81 kg

Displacement rx: 0.67 mm

Max. Von Mises stress: 99 N/mm<sup>2</sup>

# Topology Optimization

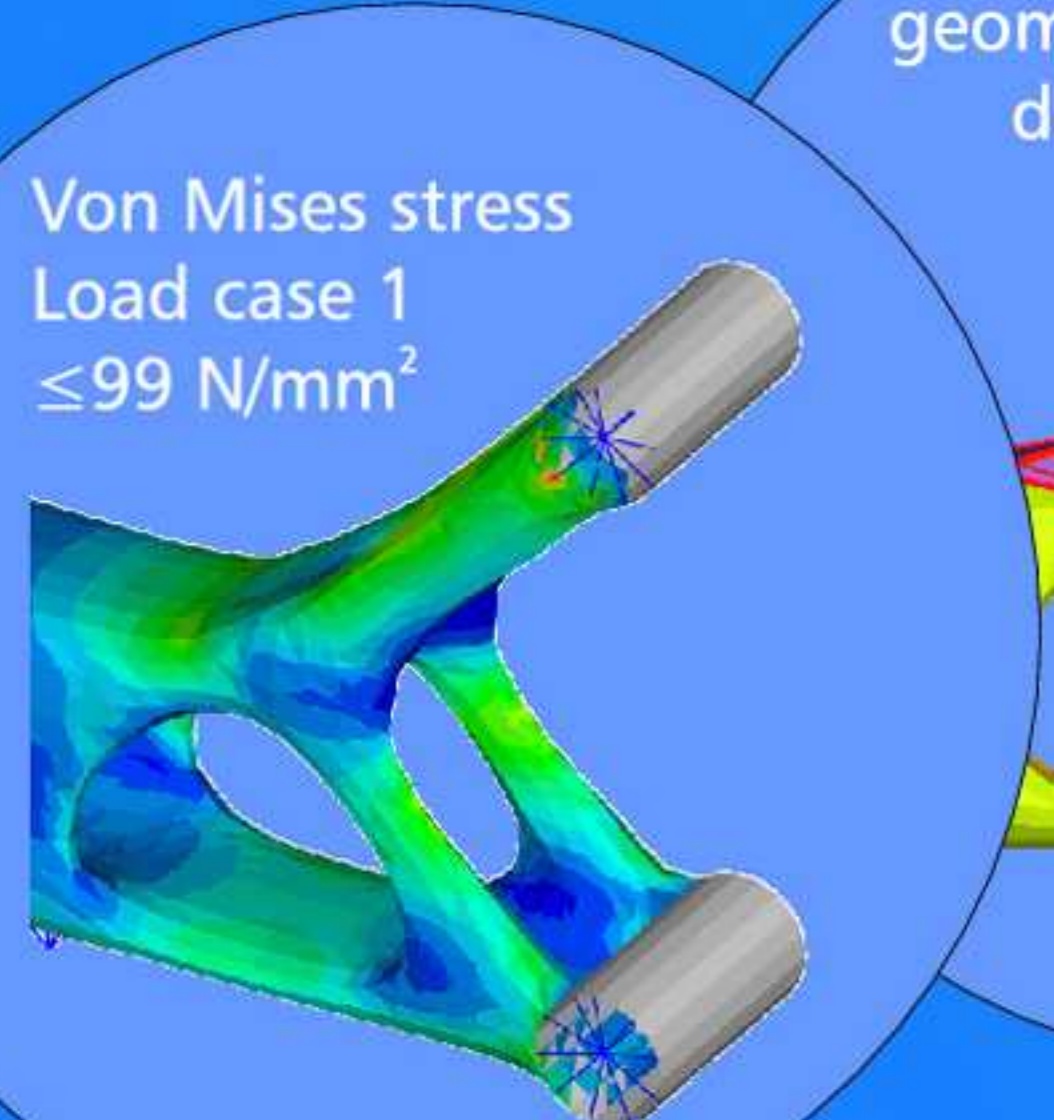
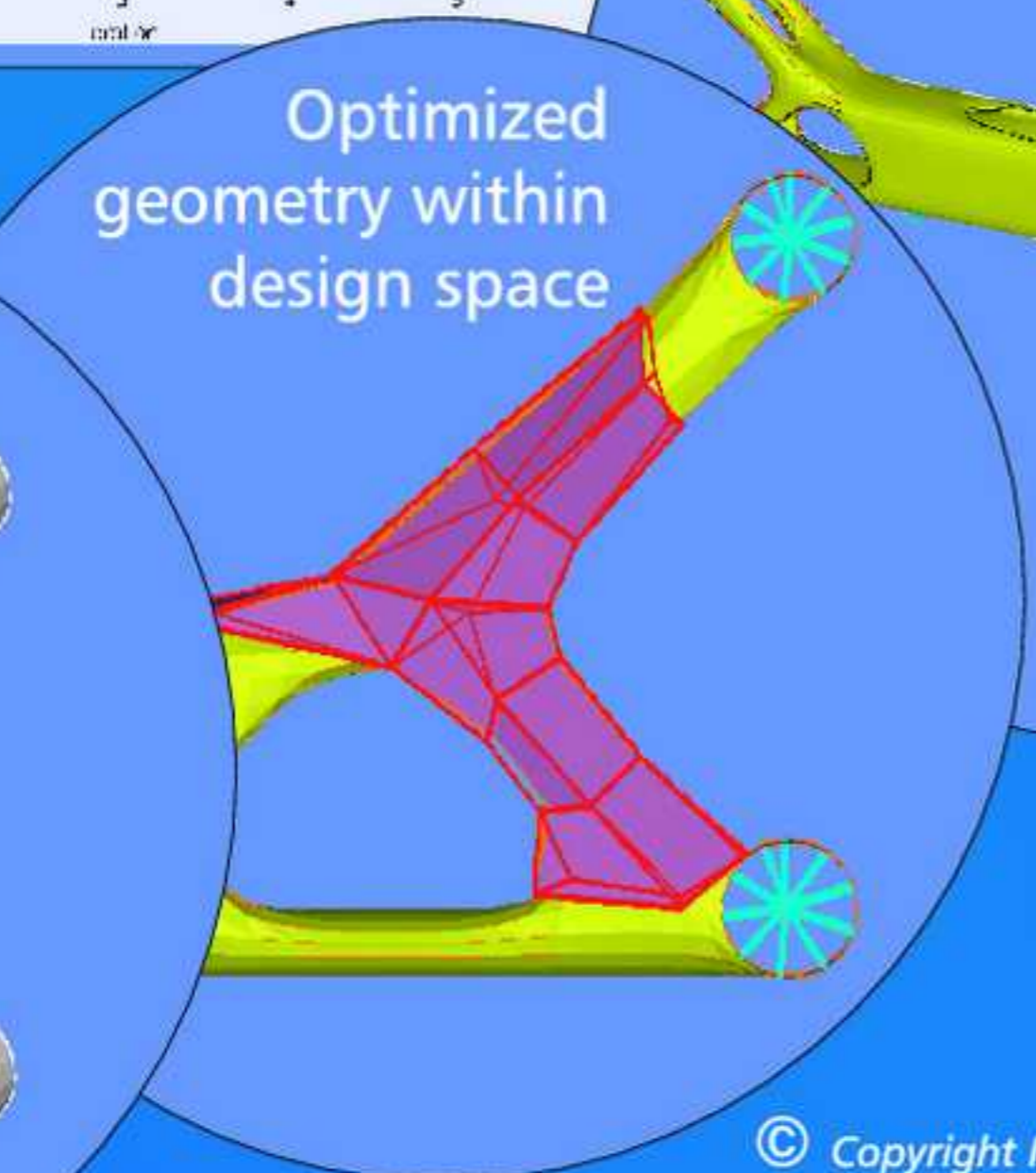
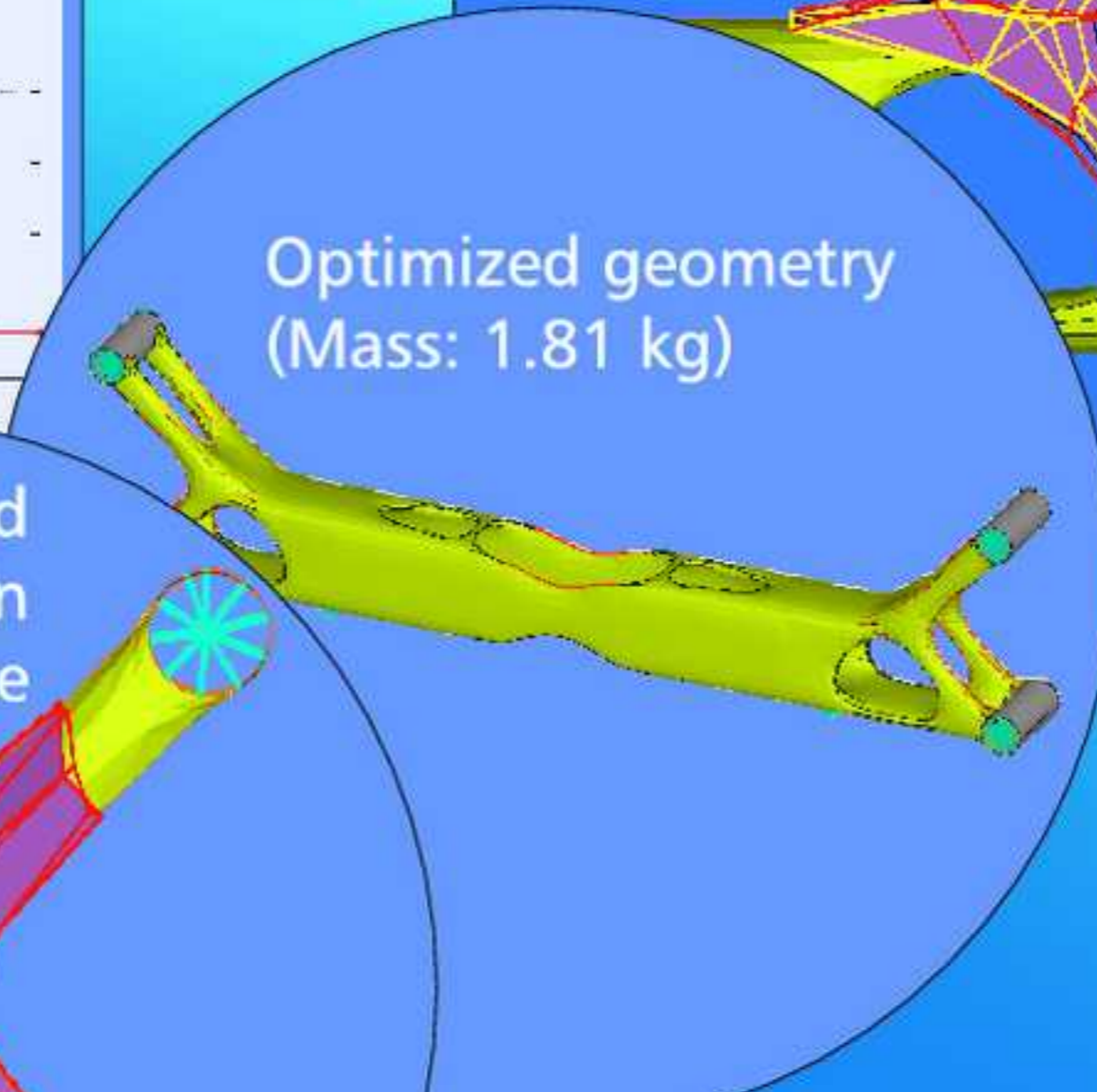
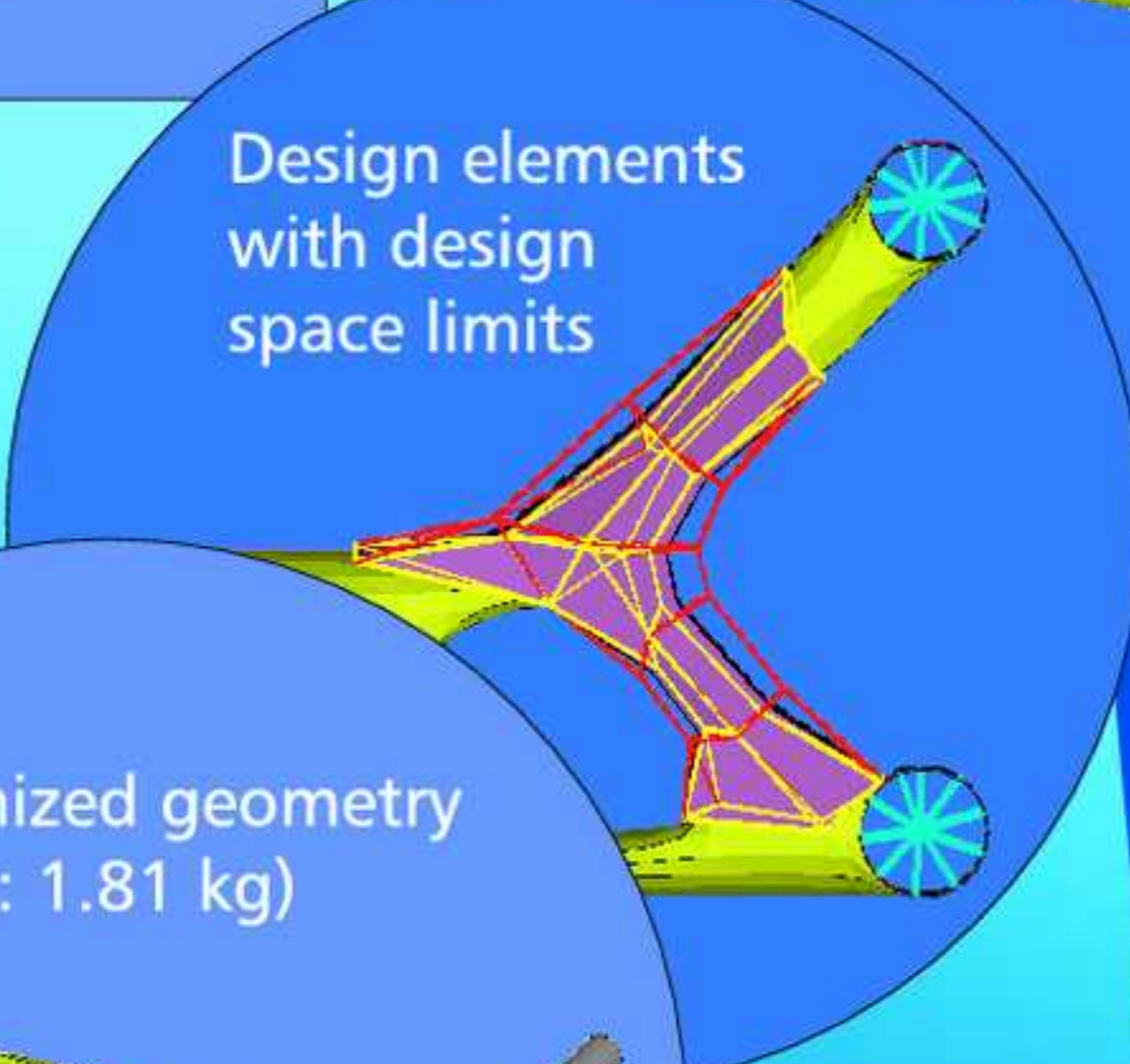
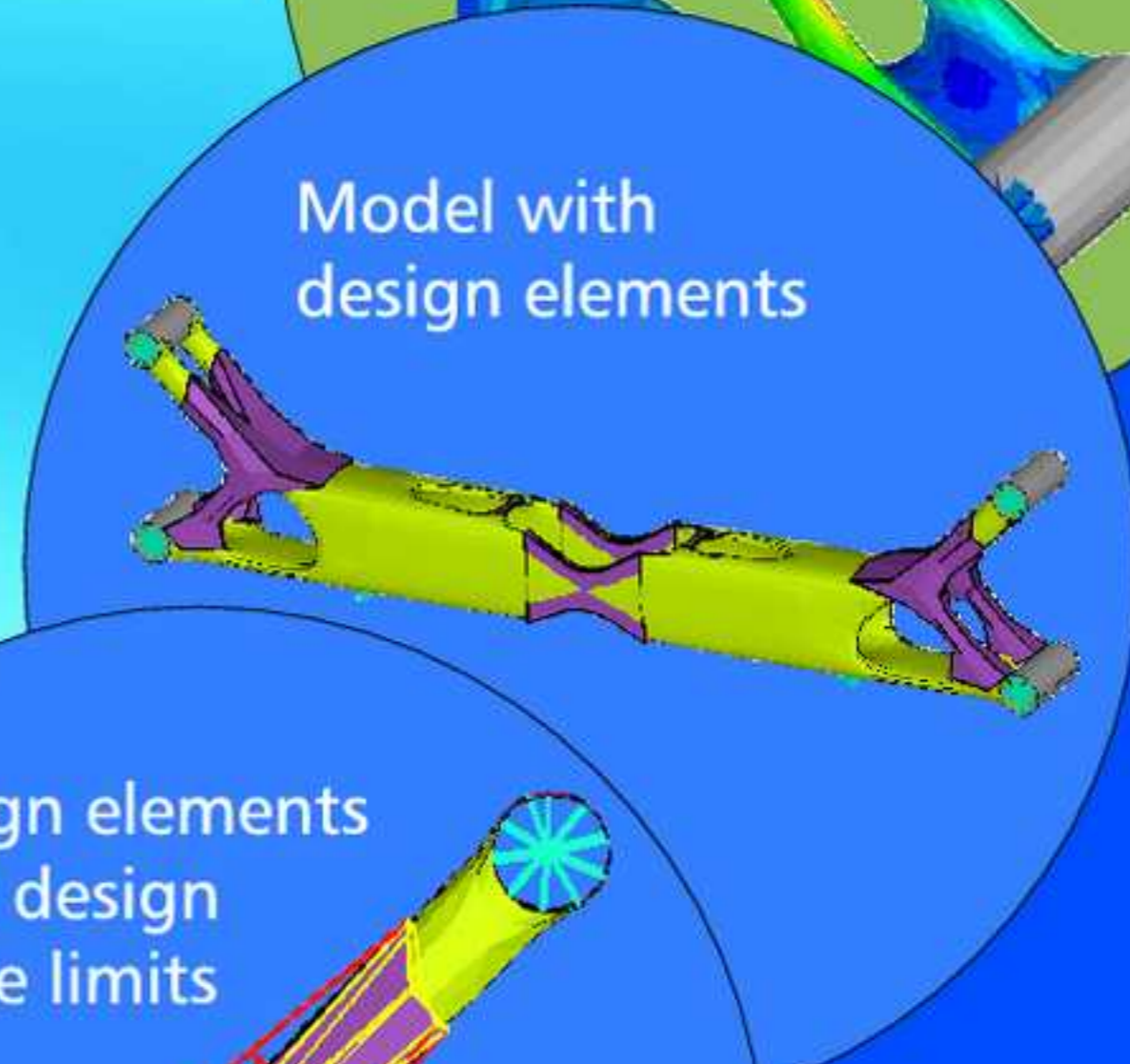
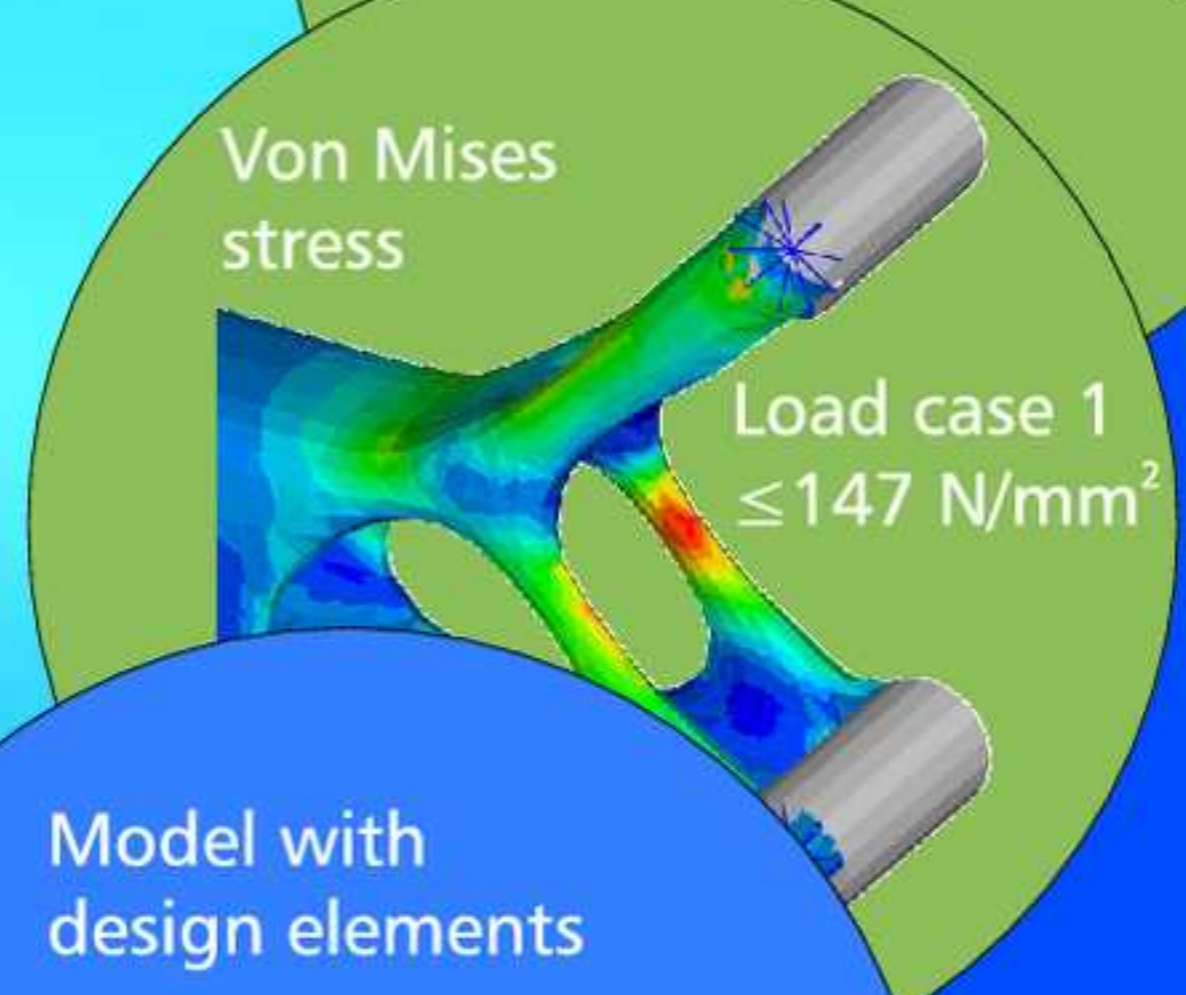
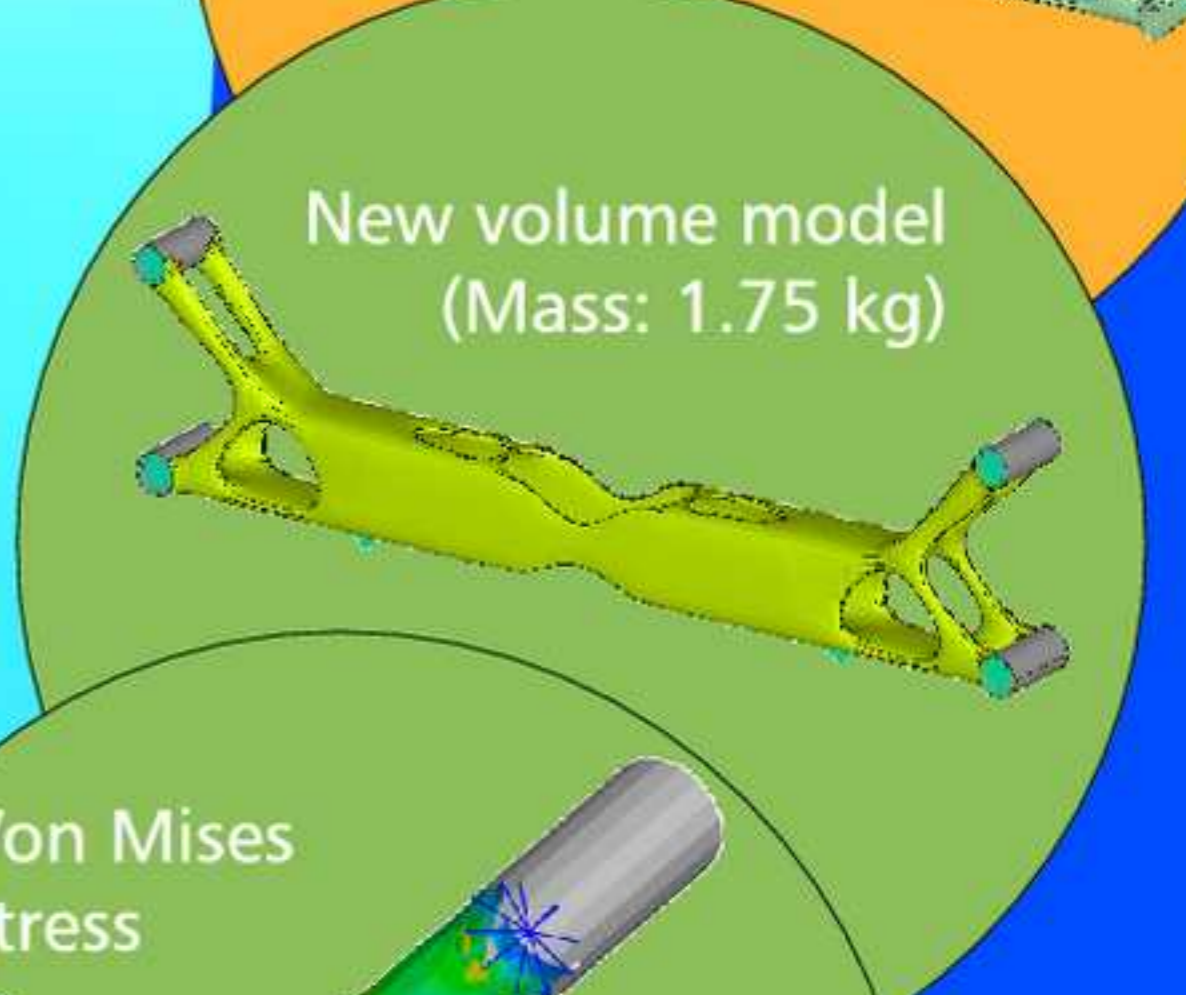
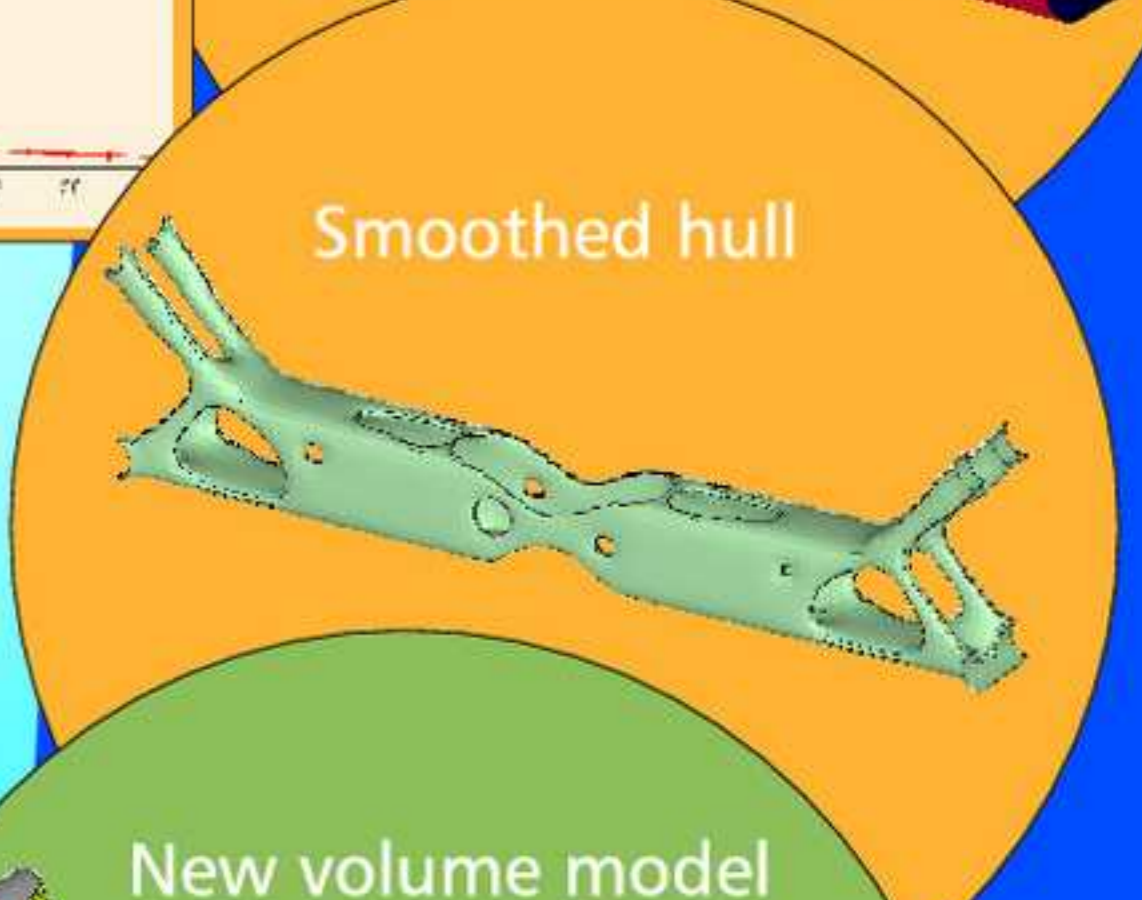
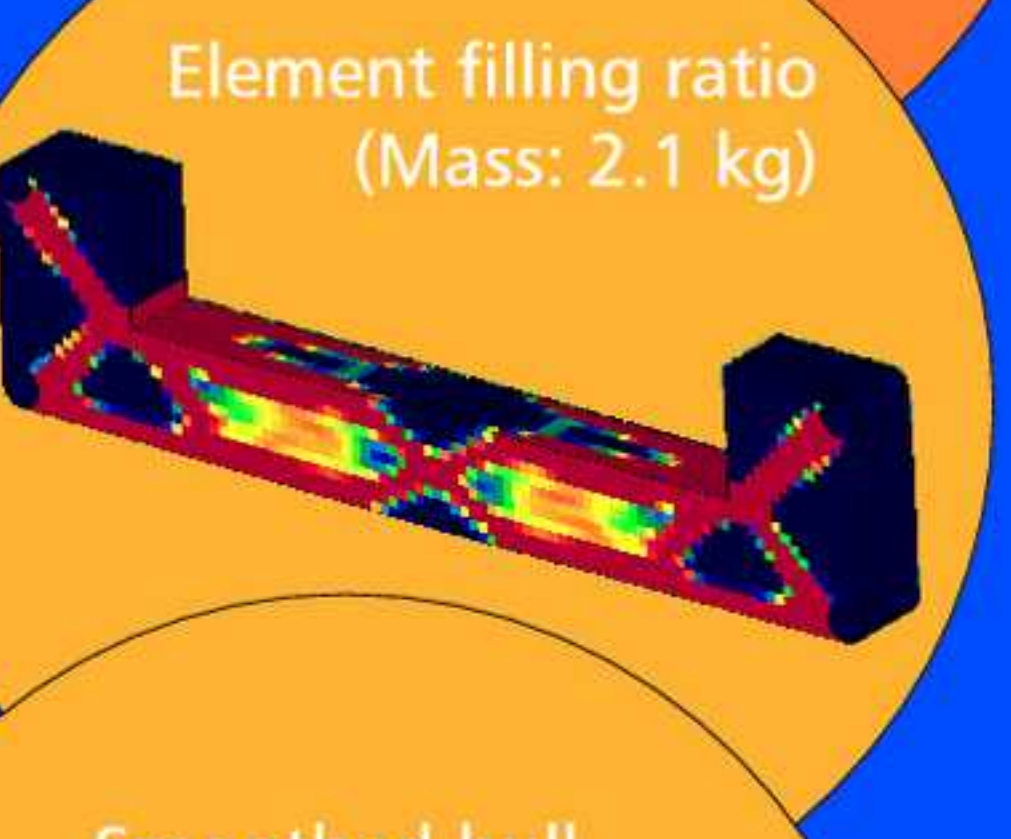
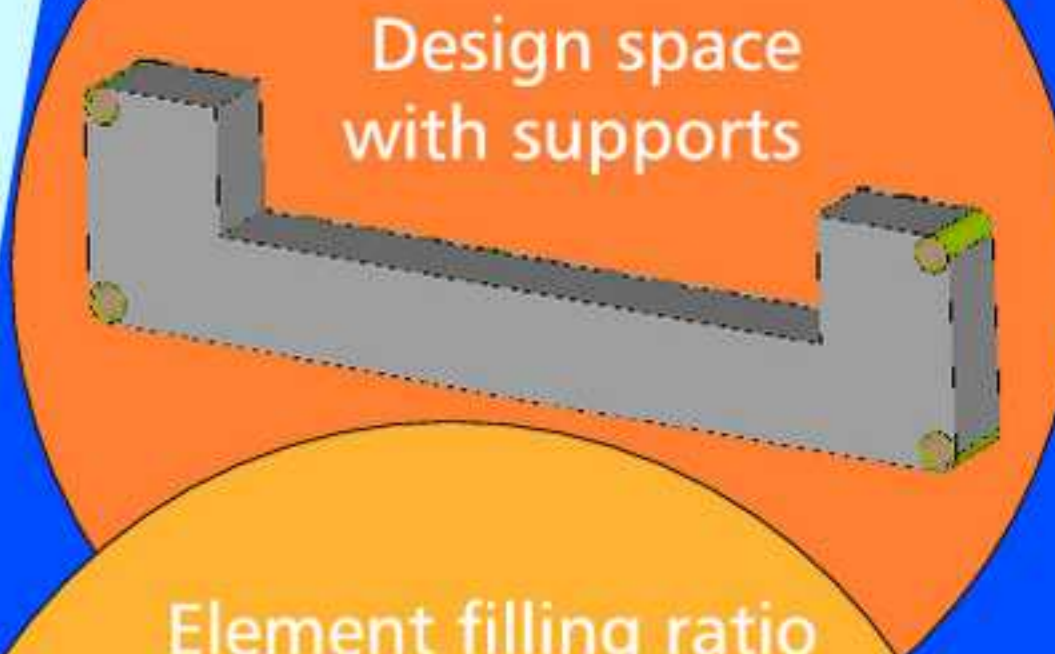
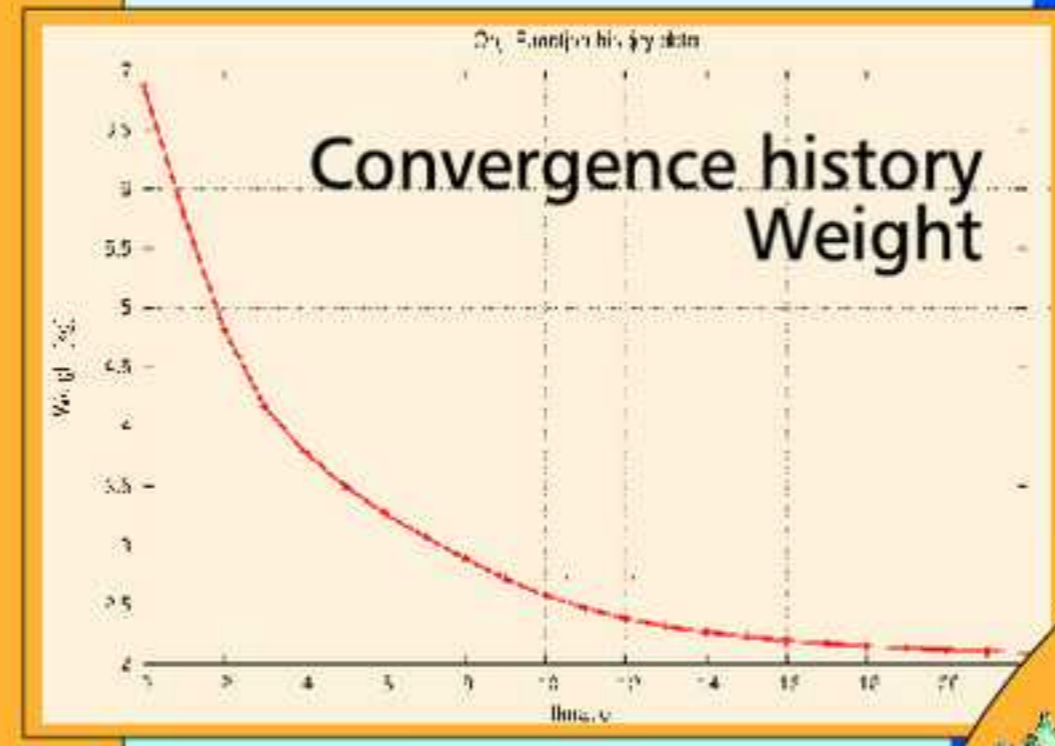


The design space is used for optimization, the supports remain fixed

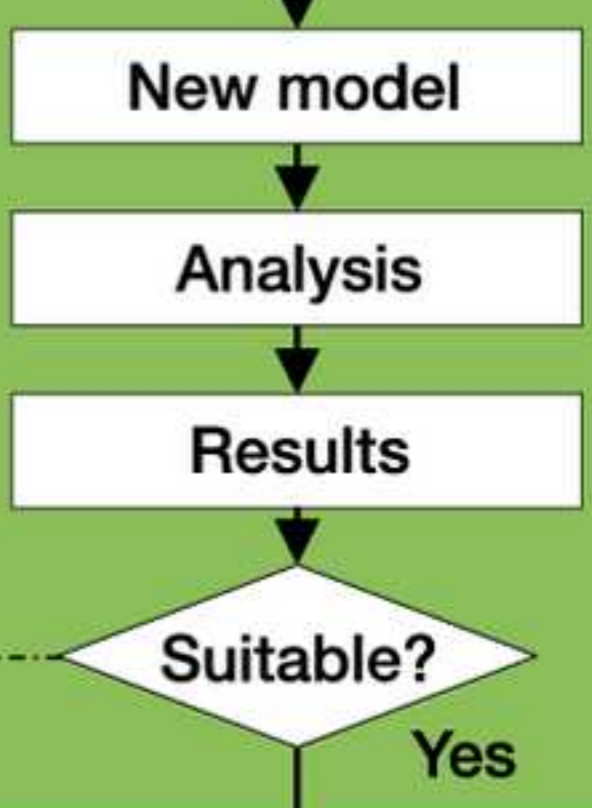
The model parts for optimization can be described by the graphical user interface FELIX.

Stiffness, mass, stresses (outside of design space), etc.

Convergence history, element filling ratio, smoothed hull (e.g. STL)



# Re-Design

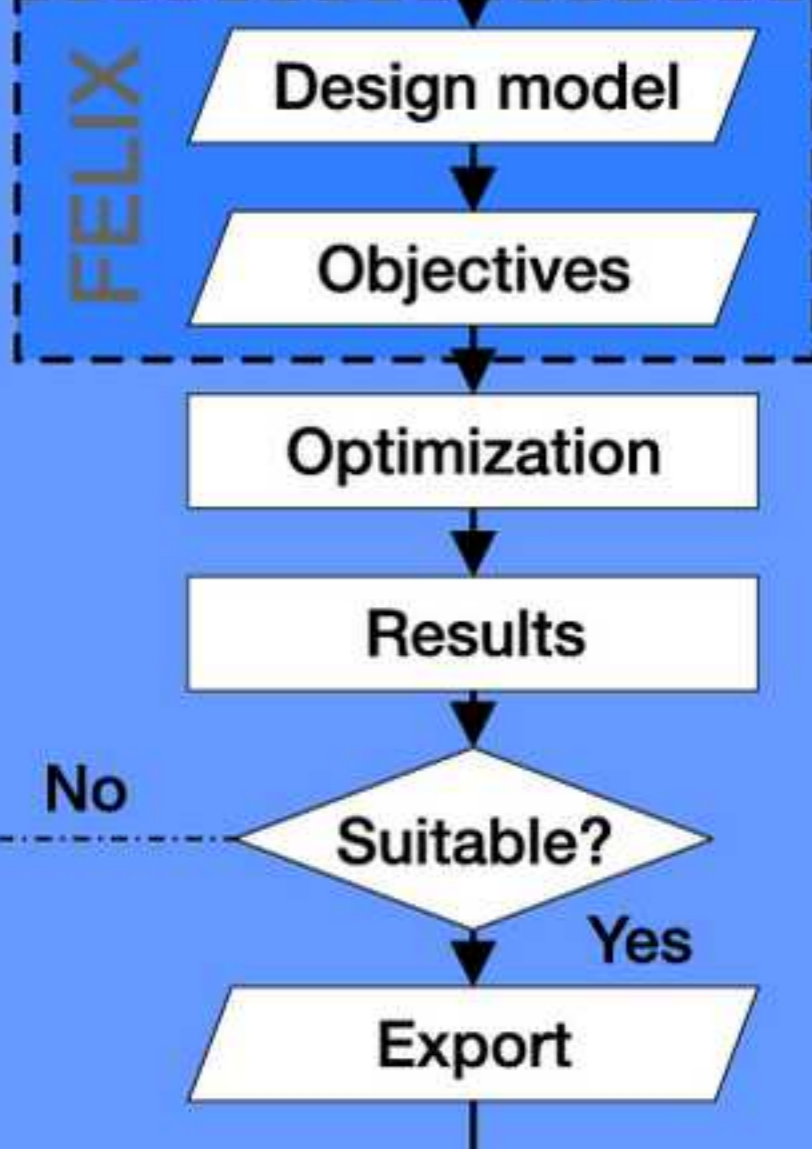


Using the design concept achieved by topology optimization

Stiffness, mass, stresses, etc.

After re-design the objectives must be sufficiently met!

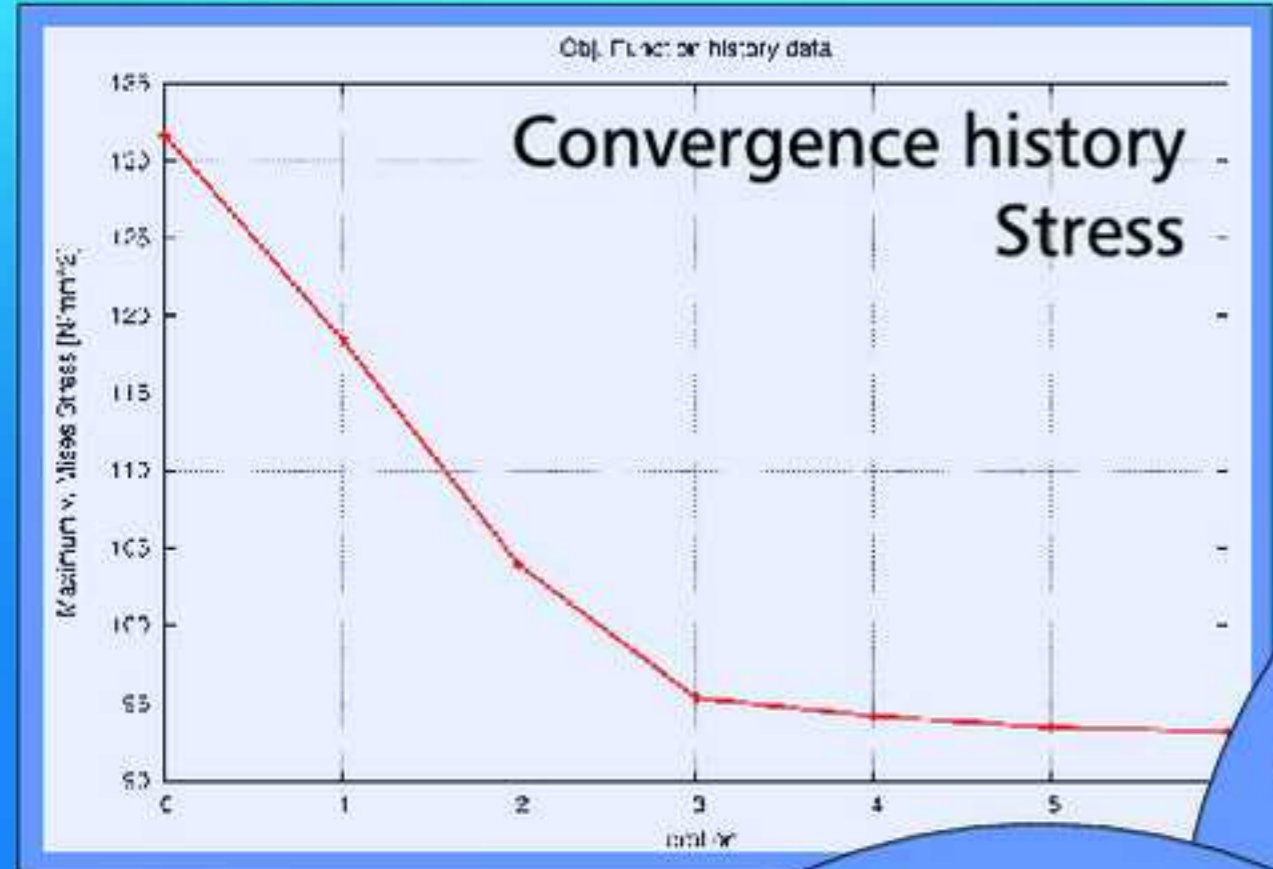
# Shape Optimization



Additional improvements of part thru minor modifications of geometry

Stiffness, mass, stresses, etc.

Convergence history, shape modifications, new geometry



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