# IM11234 – Goal-Driven Design
# Using Simulation and Optimization in the Design Process

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# Class Summary

Traditionally CAD and CAE have mostly been used for documenting designs and providing feedback on how they perform in operation. Improved tools, expanded computing power, and new manufacturing technology are now opening up new possibilities for computational design and engineering, where CAD and CAE are used to actually generate part geometry directly. These tools help engineers explore an array of design strategies and create lighter, stronger, or more-efficient parts by driving the design with functional goals, not just a handful of dimensions on a sketch. This course will provide some context for optimization tools as they exist today and introduce several new tools aimed at this goal-driven design concept.

# Agenda

- Optimization and the Design Process
- Optimization Strategies
- The Future of Optimization
- Workflow Review: Topology Optimization with Project Arro
- Q&A

# Key learning objectives

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

- Understand where optimization can fit into the design process
- Understand various types of design optimization
- Understand the basic workflow for completing a topological optimization on a structural part using Project Arro

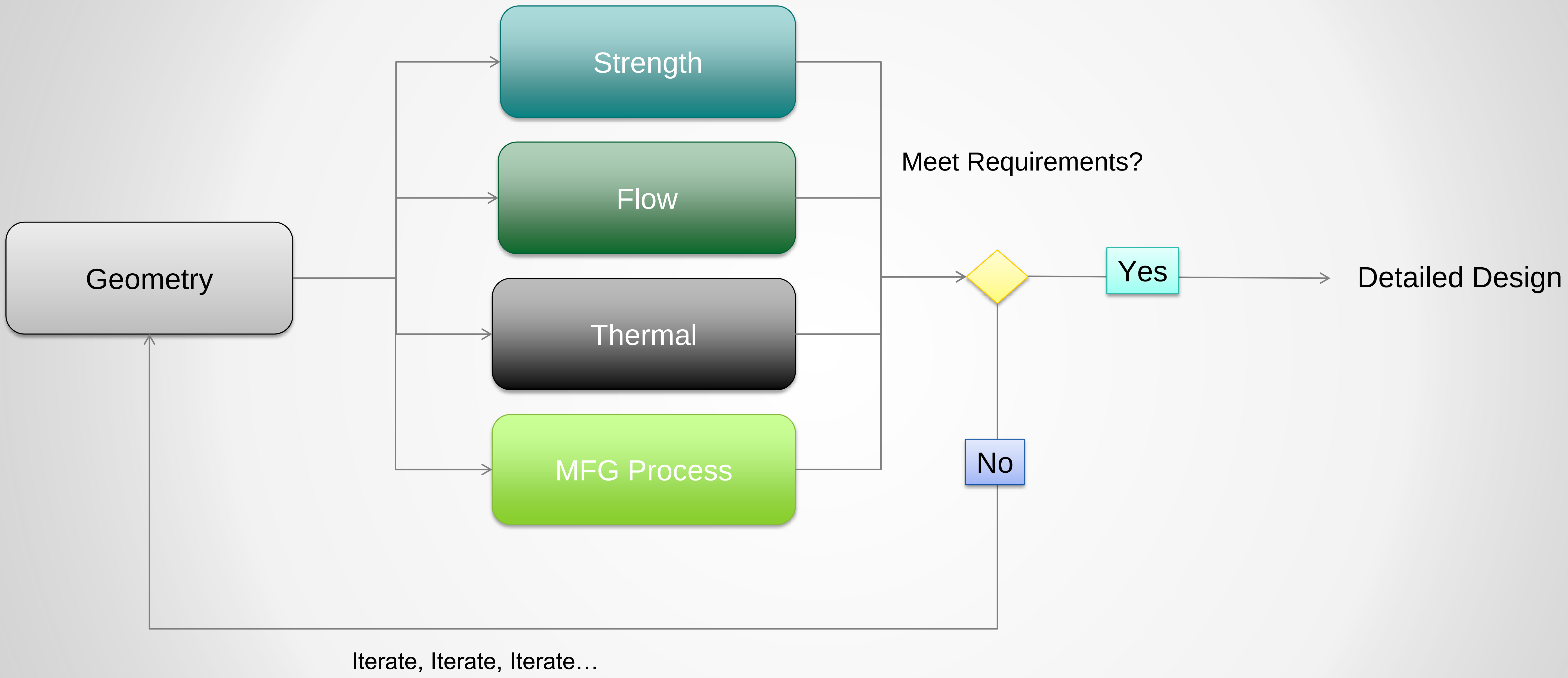
# Safe Harbor

- We may make statements regarding planned or future development efforts for our existing or new products and services. These statements are not intended to be a promise or guarantee of future availability of products, services or features but merely reflect our current plans and based on factors currently known to us. These planned and future development efforts may change without notice. Purchasing decisions should not be made based upon reliance on these statements.

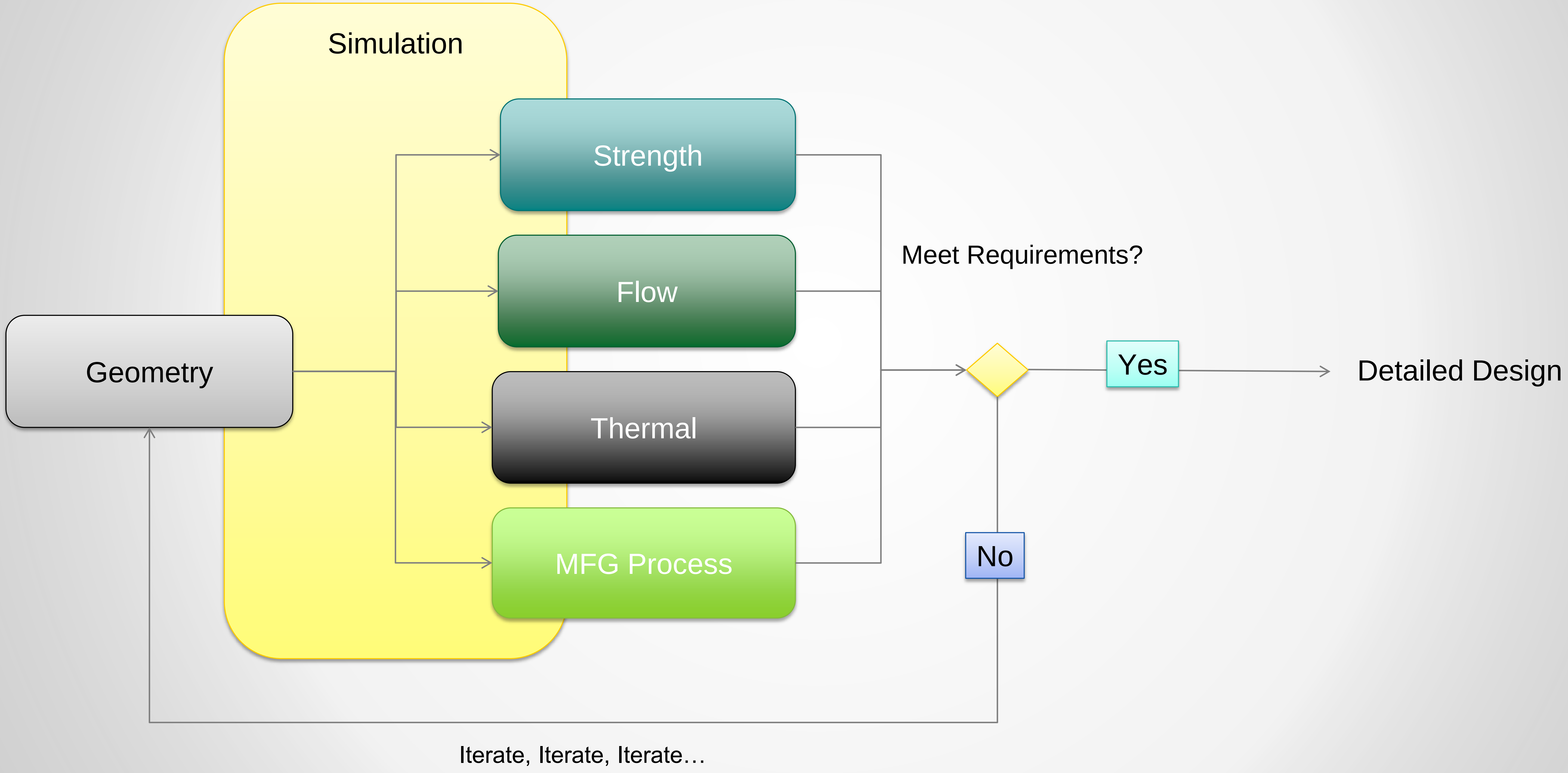
- These statements are being made as of Wednesday December 2, 2015 and we assume no obligation to update these forward-looking statements to reflect events that occur or circumstances that exist or change after the date on which they were made. If this presentation is reviewed after Wednesday December 2, 2015, these statements may no longer contain current or accurate information.

# Optimization and the Design Process

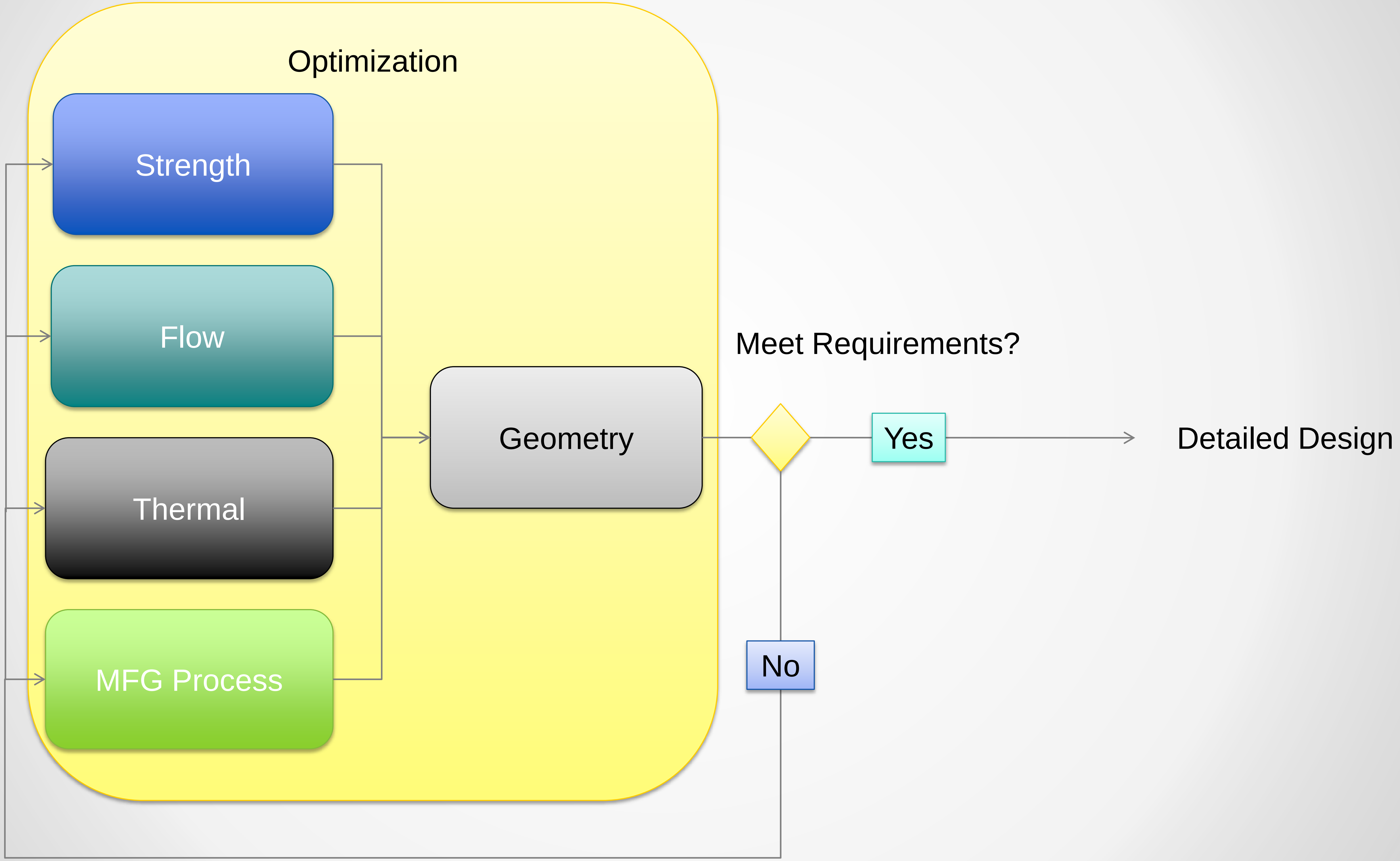
# Traditional Design Process



# Traditional Design Process + Simulation



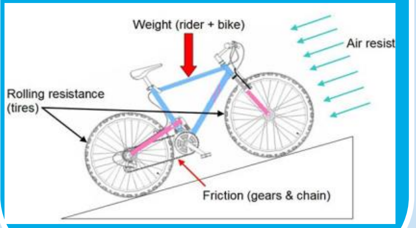
# Goal-Driven Design Process



# Optimization and the Design Process

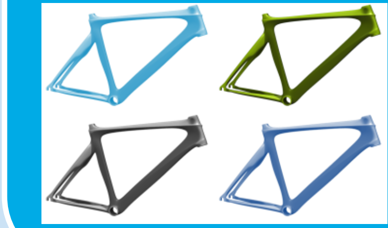
**Topology**
**Evolutionary**

Requirements Definition

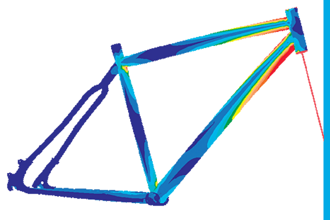



Conceptual Design

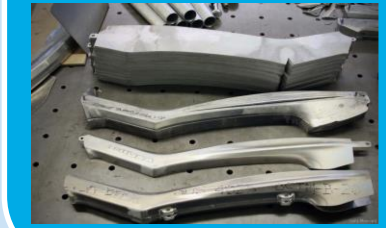
Detailed Design



Design Verification

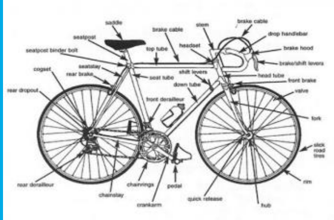


Manufacturing



Delivery

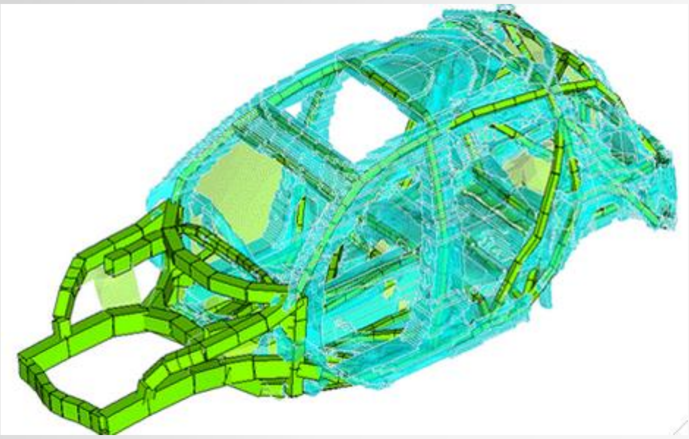
Operations and Support



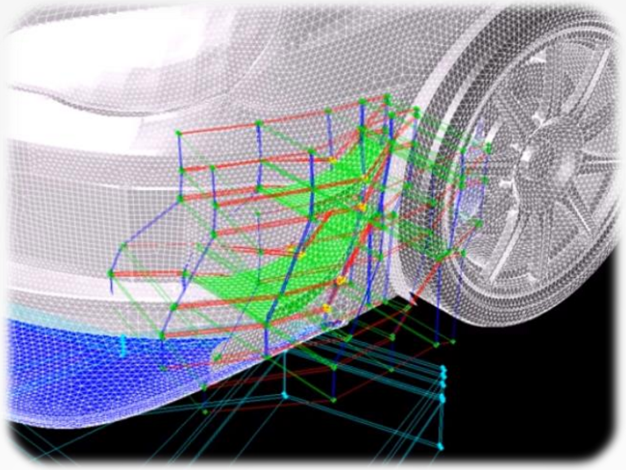
**Parametric**
**Lattice**
**Size and Material**
**Free Shape**

# Optimization Strategies

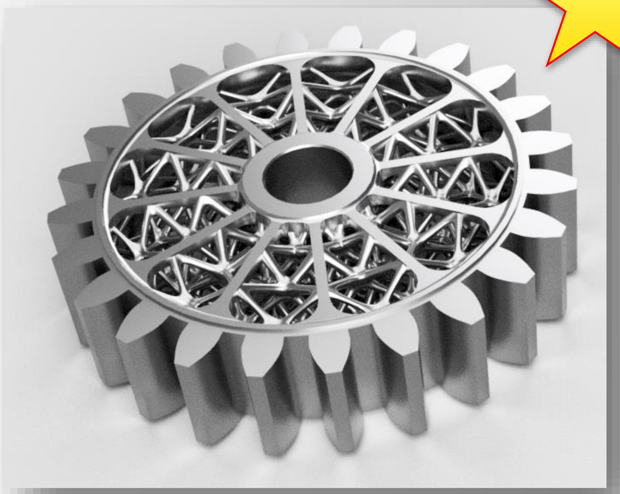
# Optimization Strategies for Goal-Driven Design



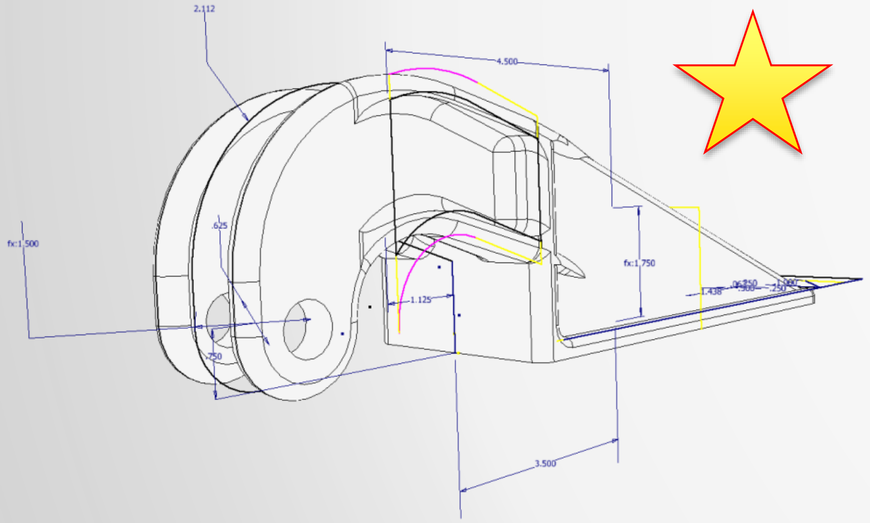
**Size & Material**



**Free Shape**

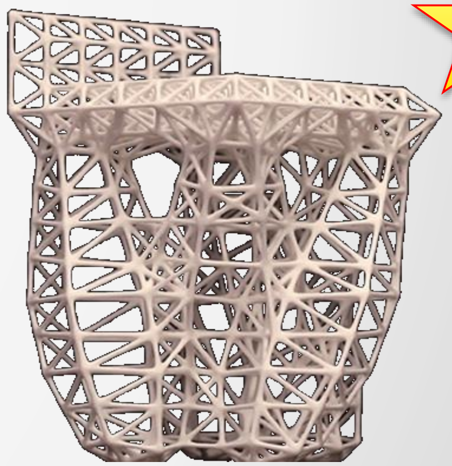


**Lattice**



**Parametric**

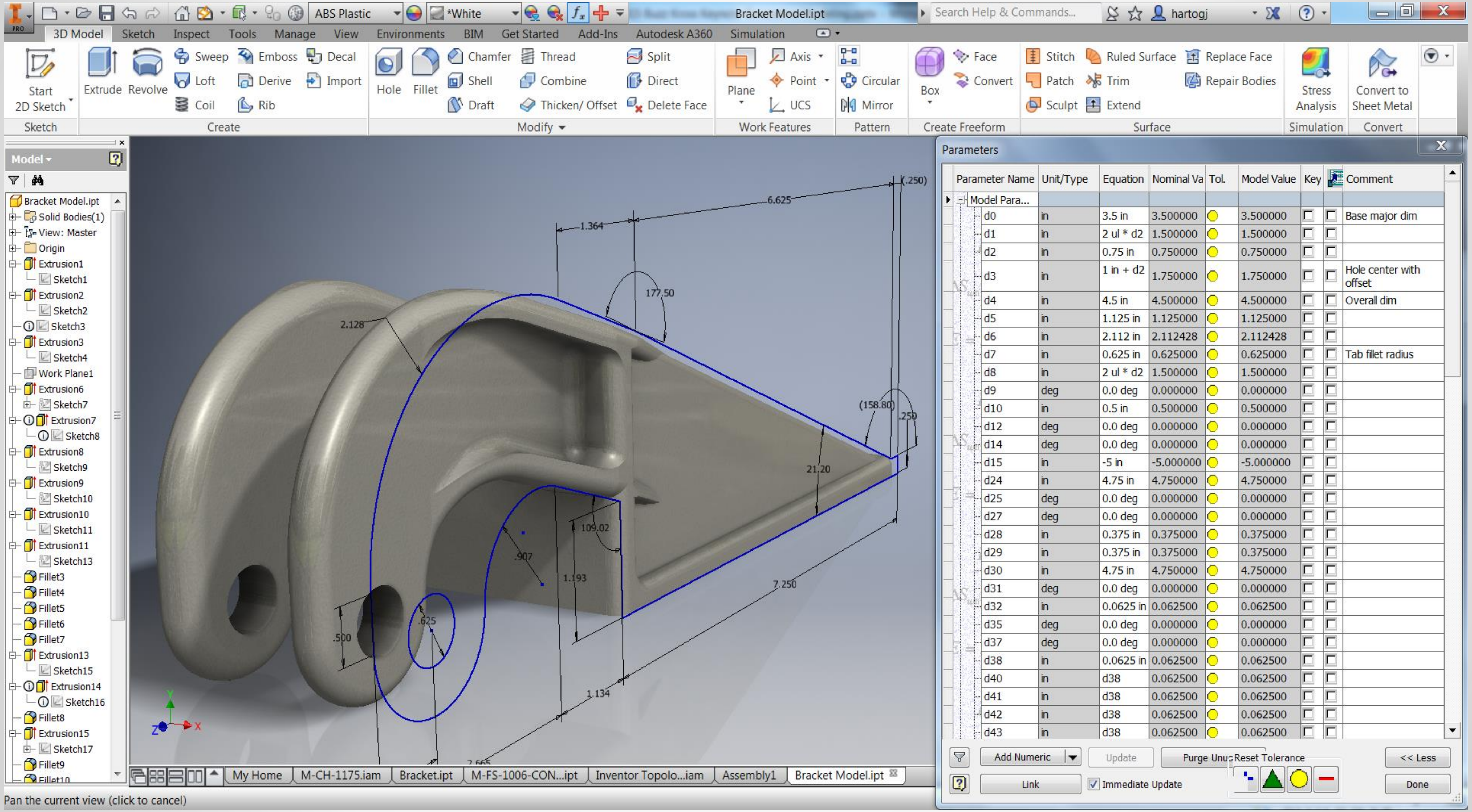
**Topology**



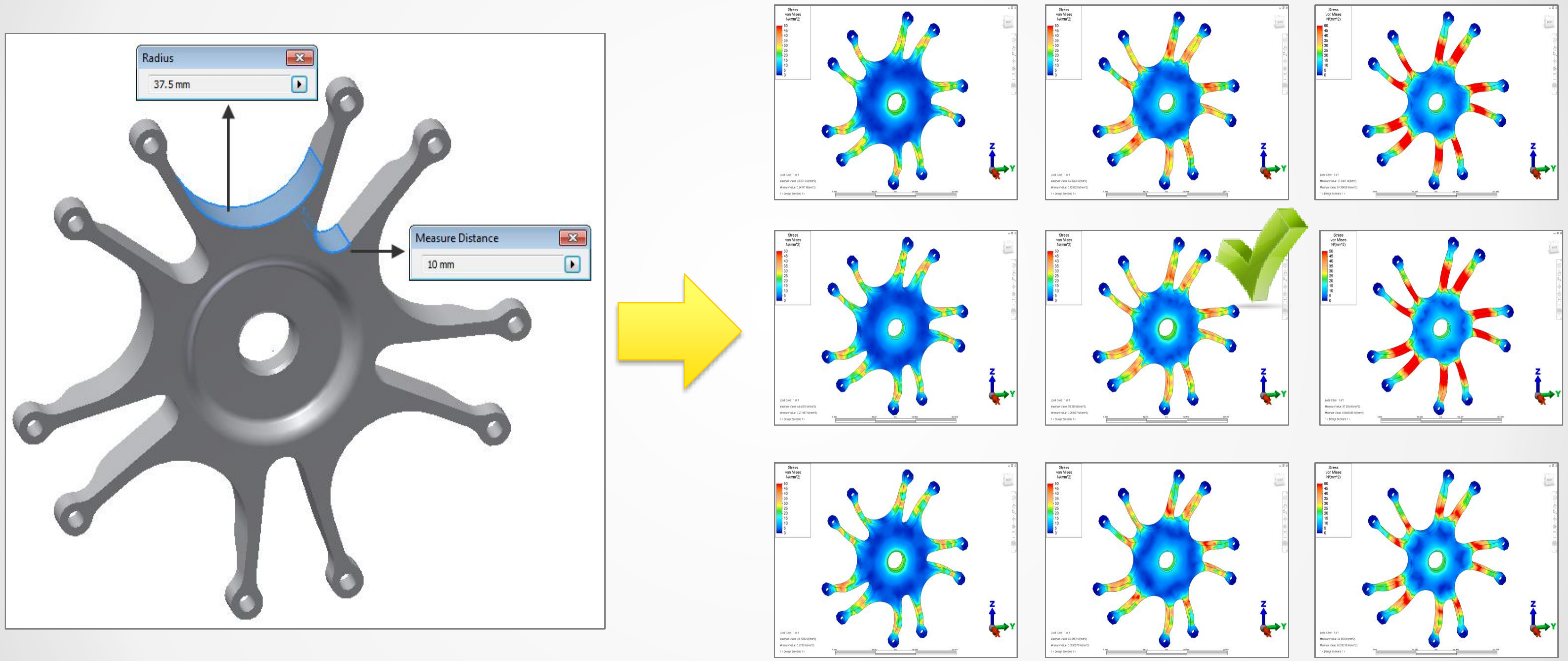
**Evolutionary**

***Traditional*** → ***Radical***

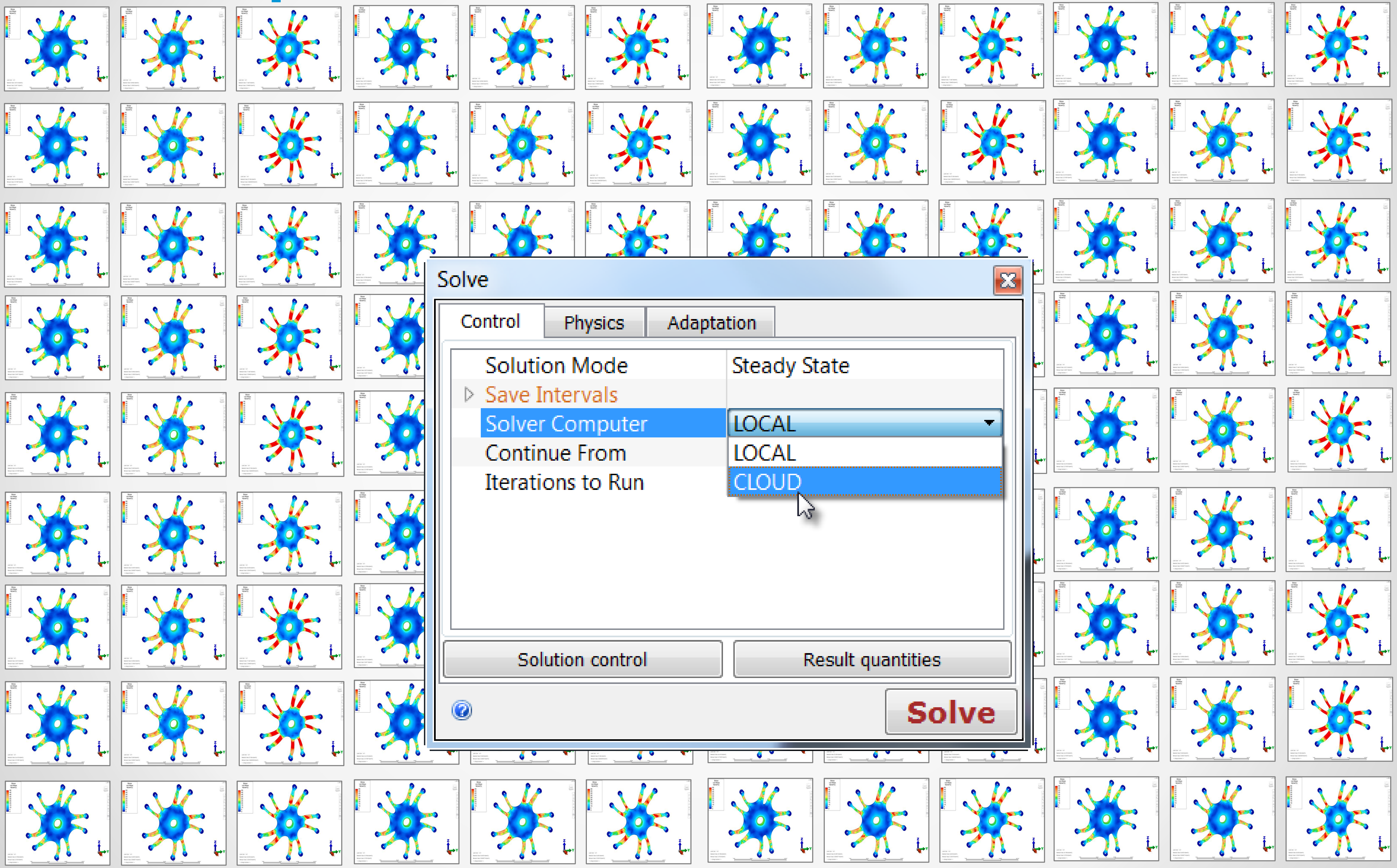
# Parametric Optimization



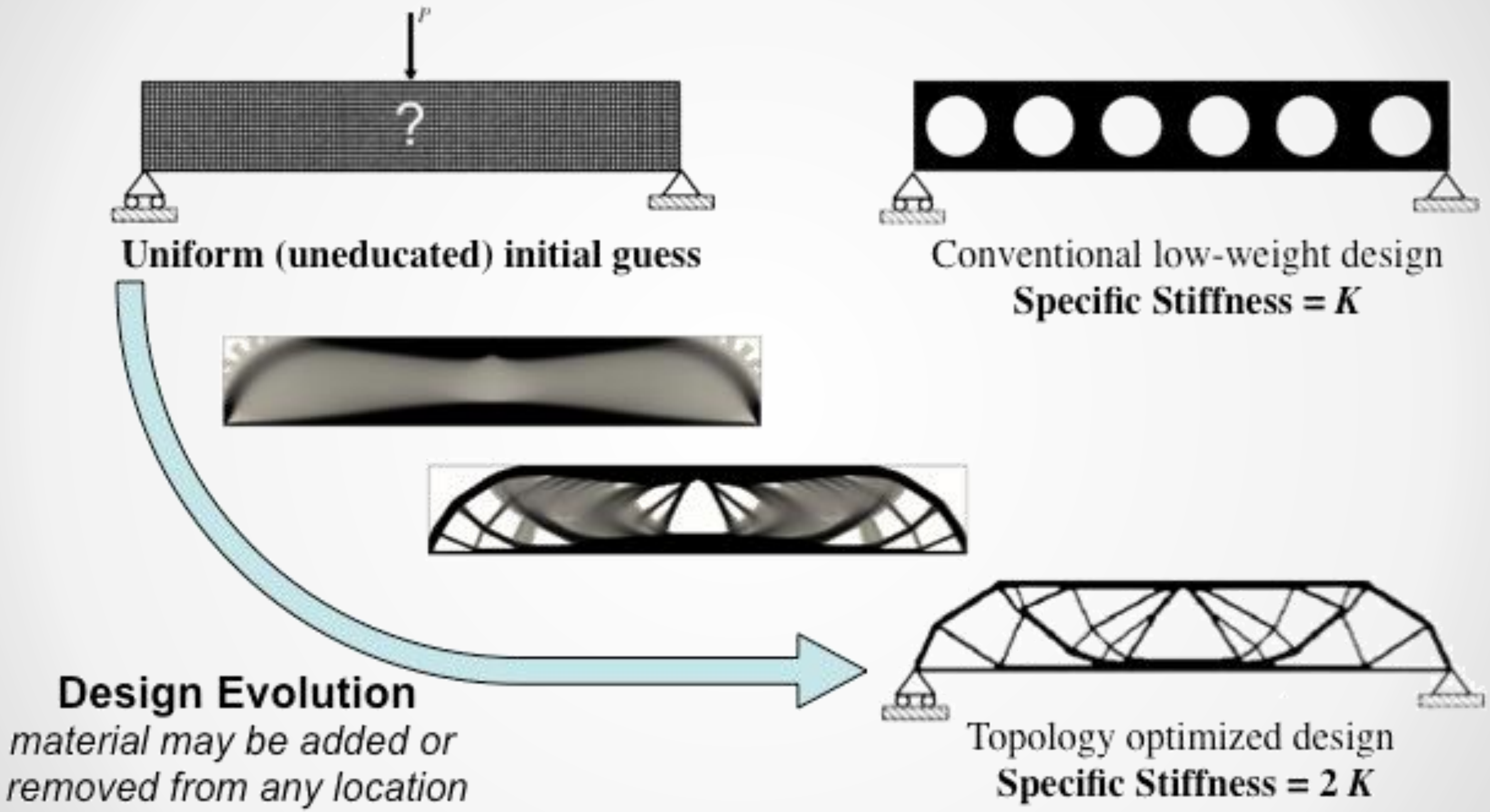
# Parametric Optimization – Simulation Mechanical



# Parametric Optimization – Simulation Mechanical

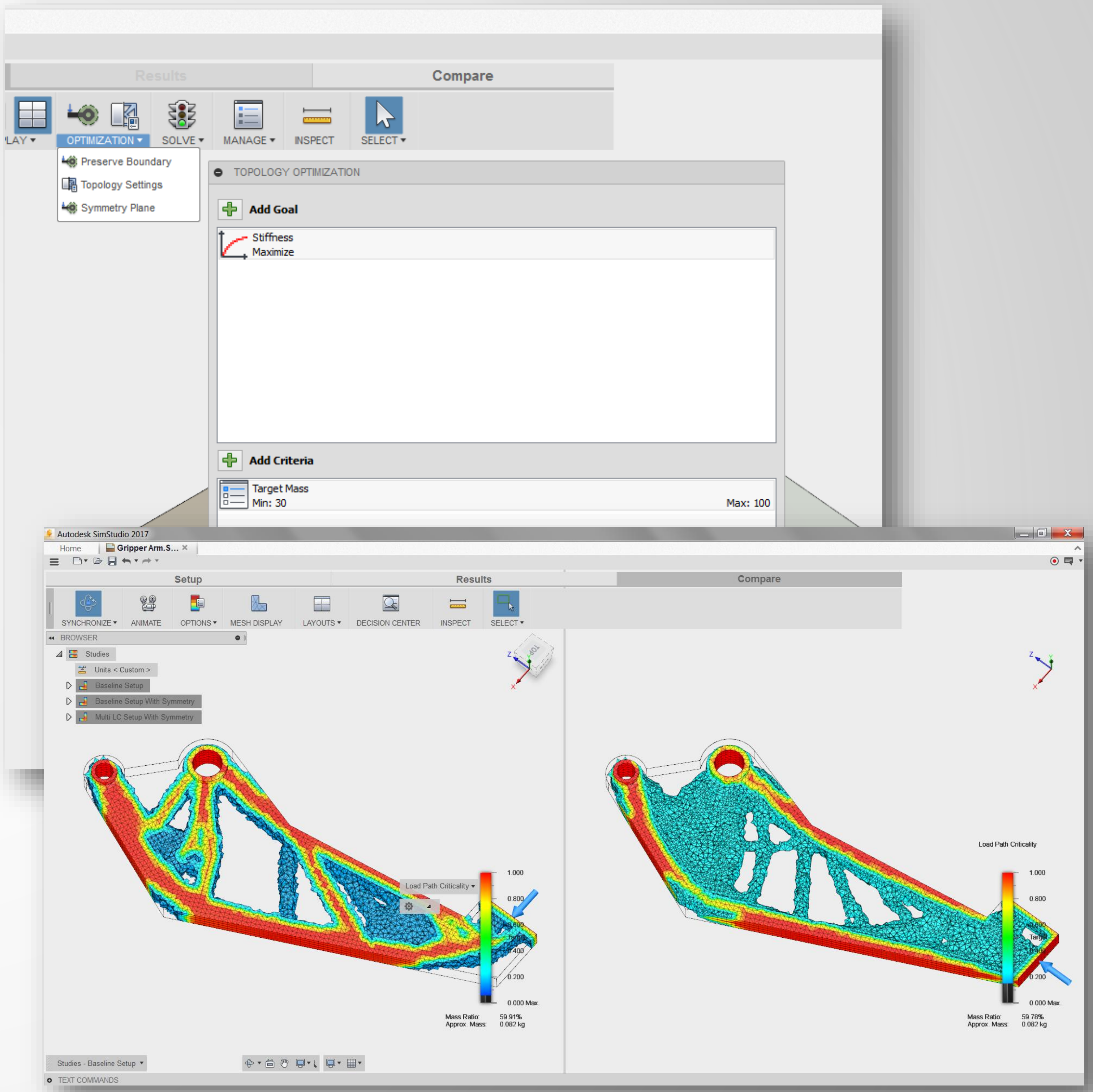


# Topology Optimization

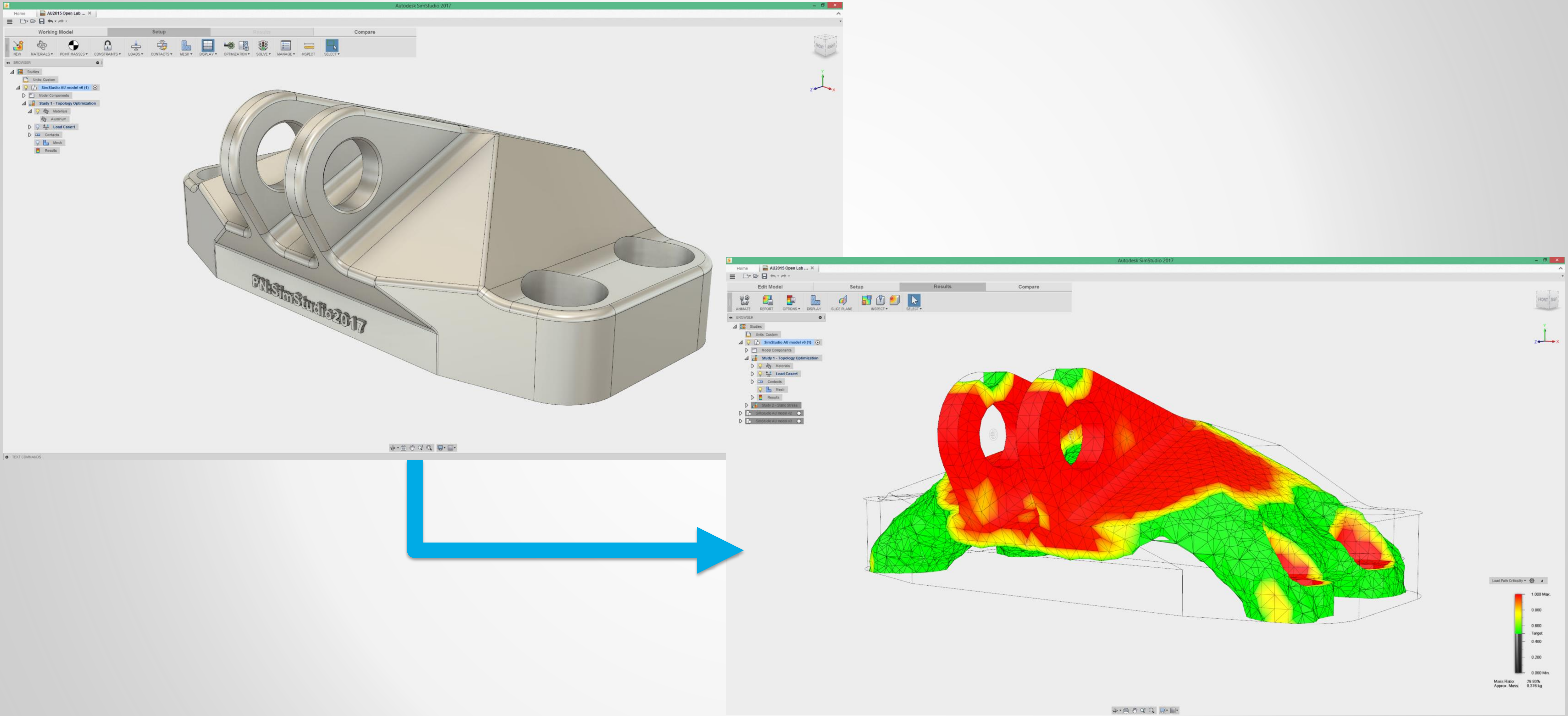


# Topology Optimization – Project Arro

- Optimize material layout based on:
  - Defined design space and preserved regions
  - Standard FEA loads and constraints
  - Multiple loading scenarios
  - Design constraints and objectives
- Well suited to support the conceptual design phase
- SIMP – Solid Isotropic Material Penalization
  - Based on iteration of material density distribution and suppression of fractional densities
  - Well proven
  - Computationally efficient



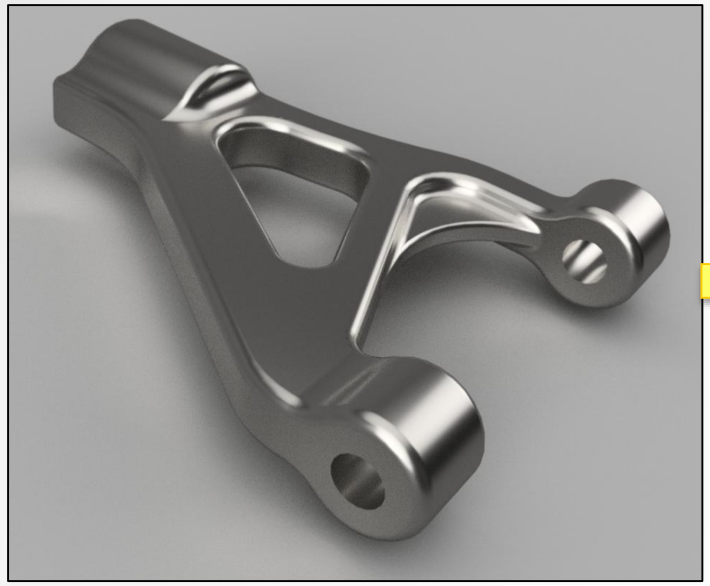
# Topology Optimization – Project Arro



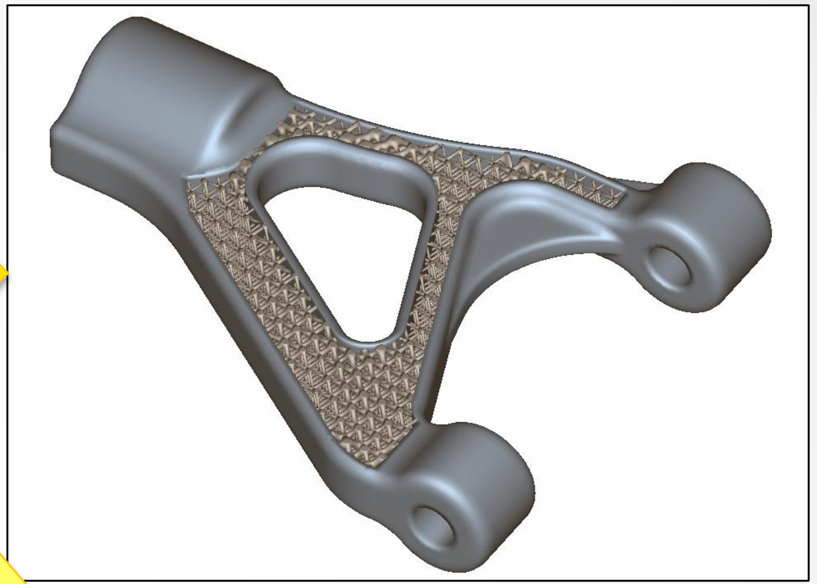



AUTODESK.

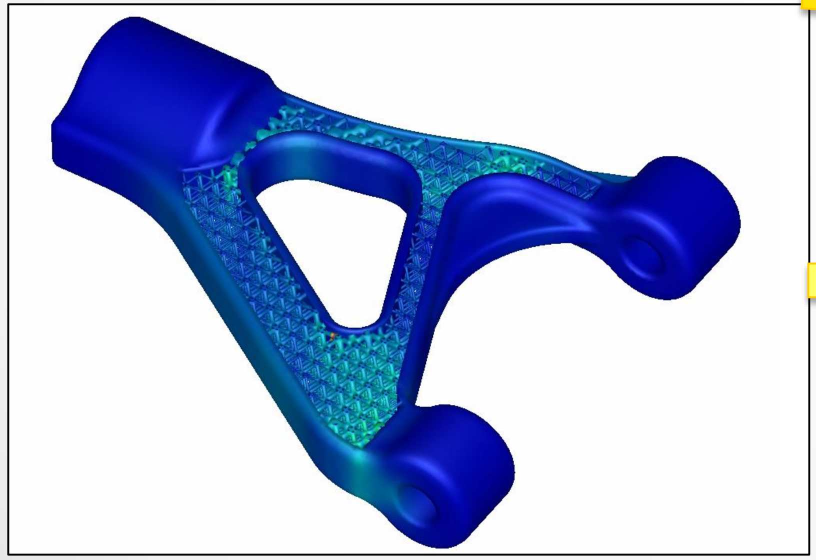
# Lattice Optimization



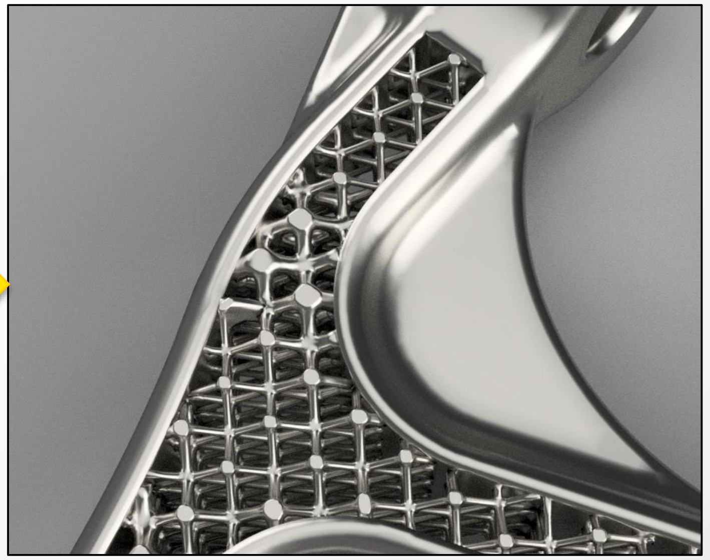
Start with an existing solid component



Replace internals with lattice and skin



Simulate load cases



Optimize based on simulation

# Lattice Optimization – Autodesk Within

Automatically optimize parts for:

- Lightweighting
- Load requirements
- Tunable displacement
- 3D printability

Focus on Manufacturability:

- Design for specific additive manufacturing machines
- Ensure proper wall thickness and internal angles
- Design self supporting structures
- Export clean STL surfaces

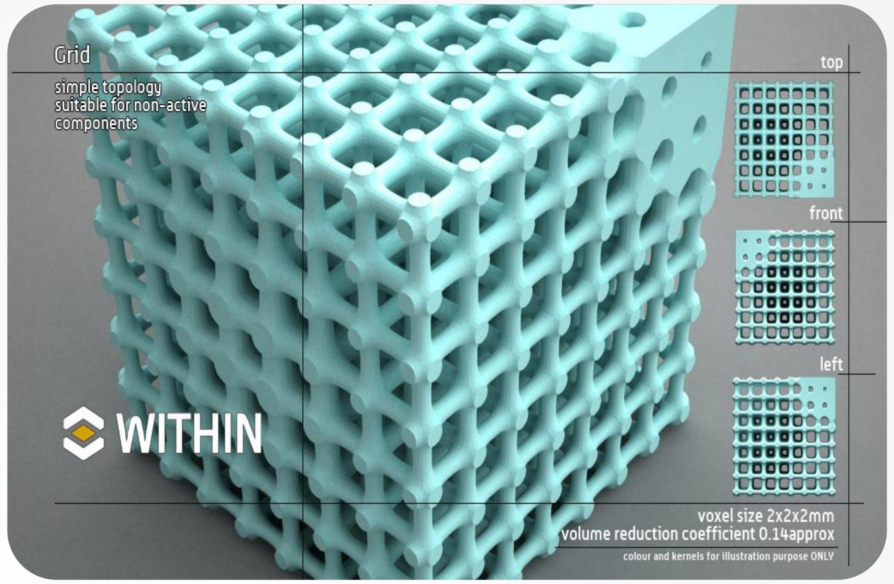
# Lattice Optimization – Autodesk Within

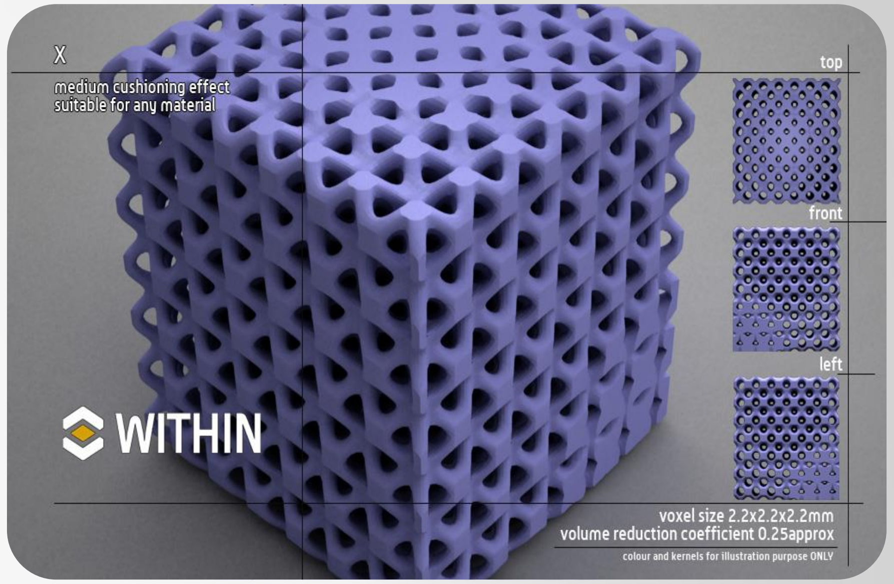
Design Features:

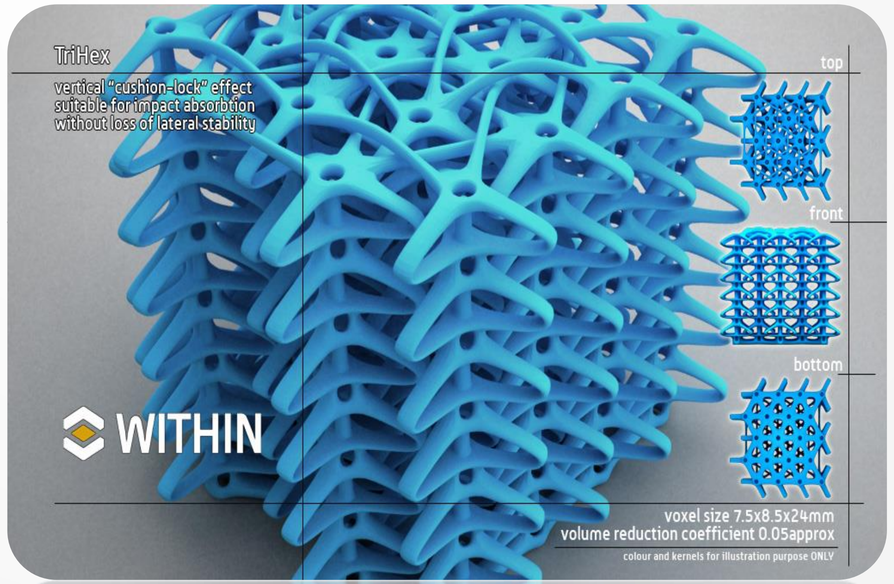
- Lattice Libraries
- Adjustable Unit Size
- Variable Density
- Variable Skin Thickness

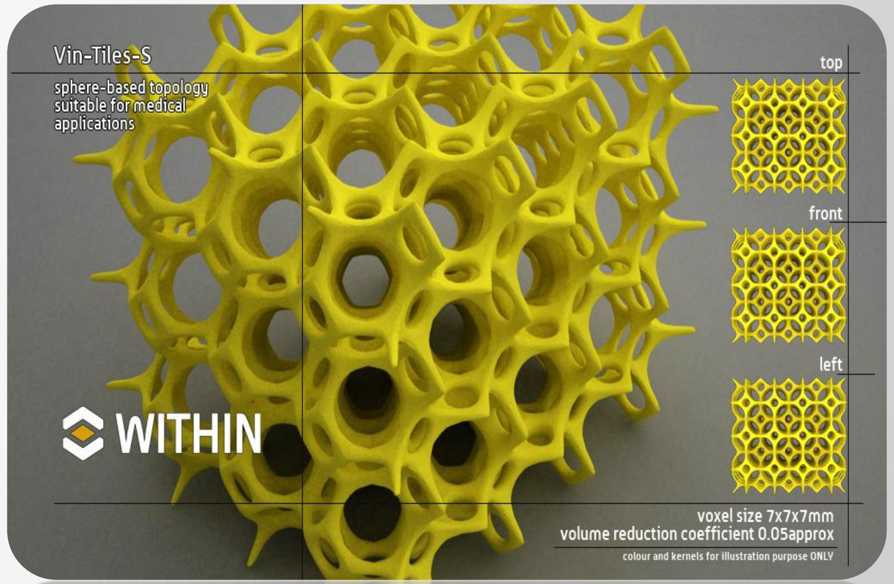
Simulation Features:

- Full FEA analysis capabilities
- Optimization based on simulation results

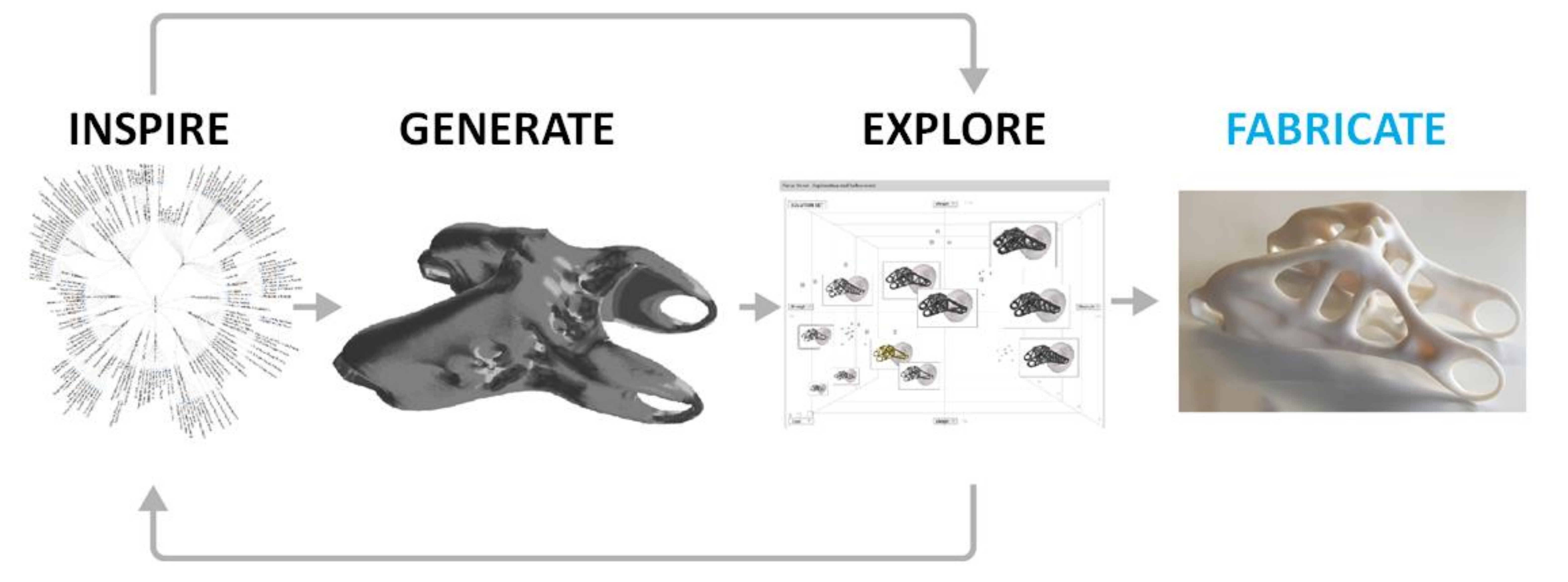


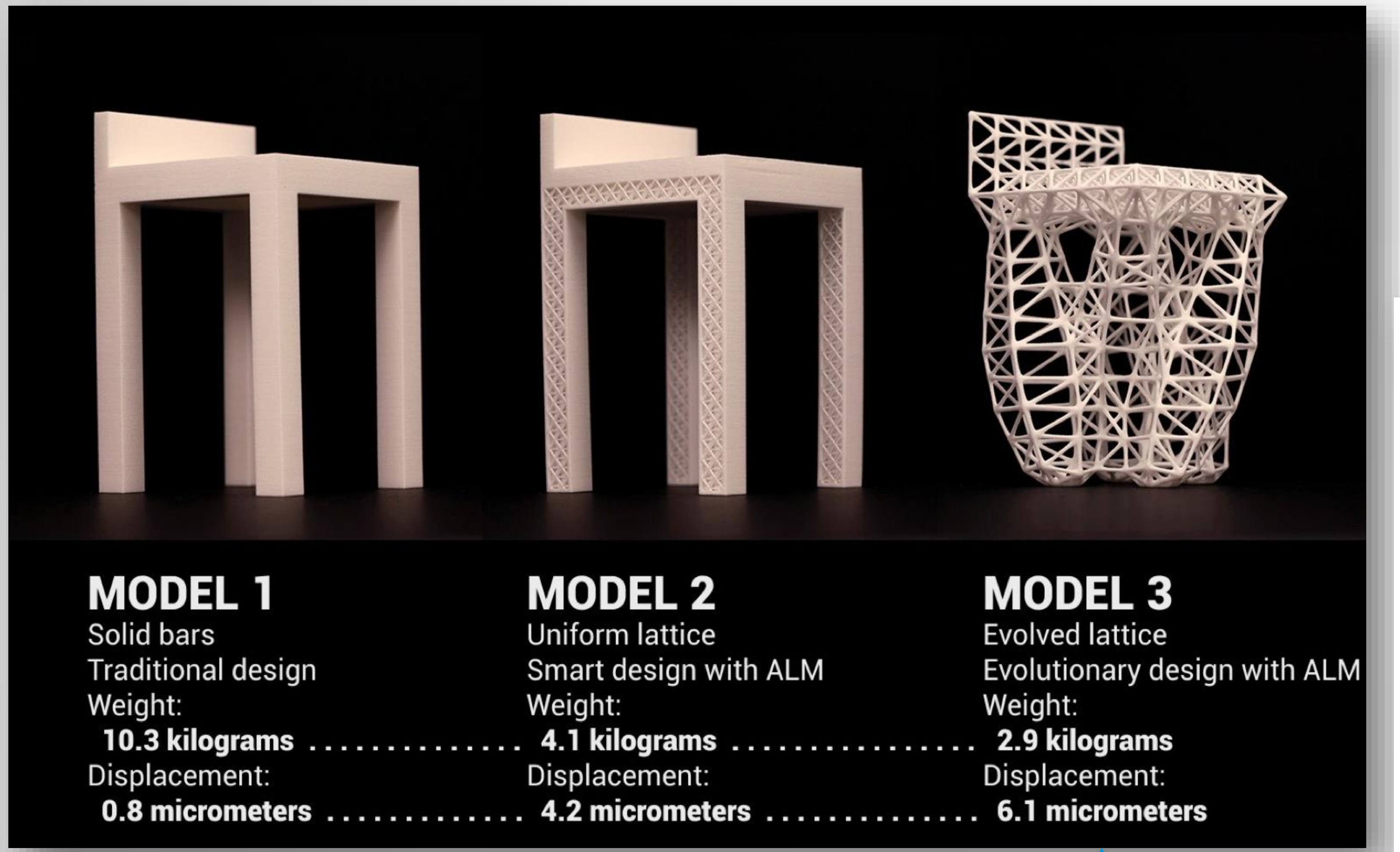



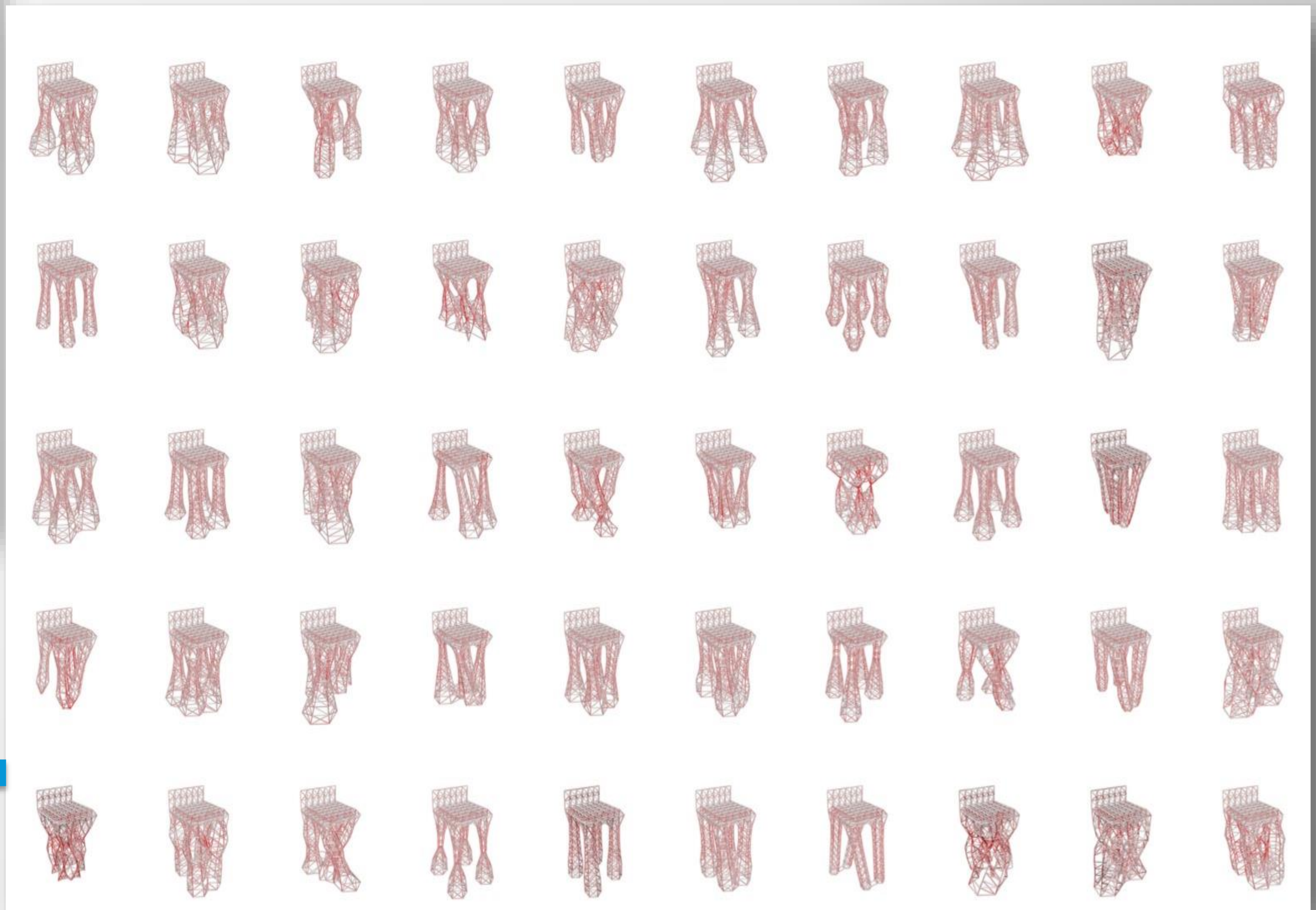



# Evolutionary



# Evolutionary

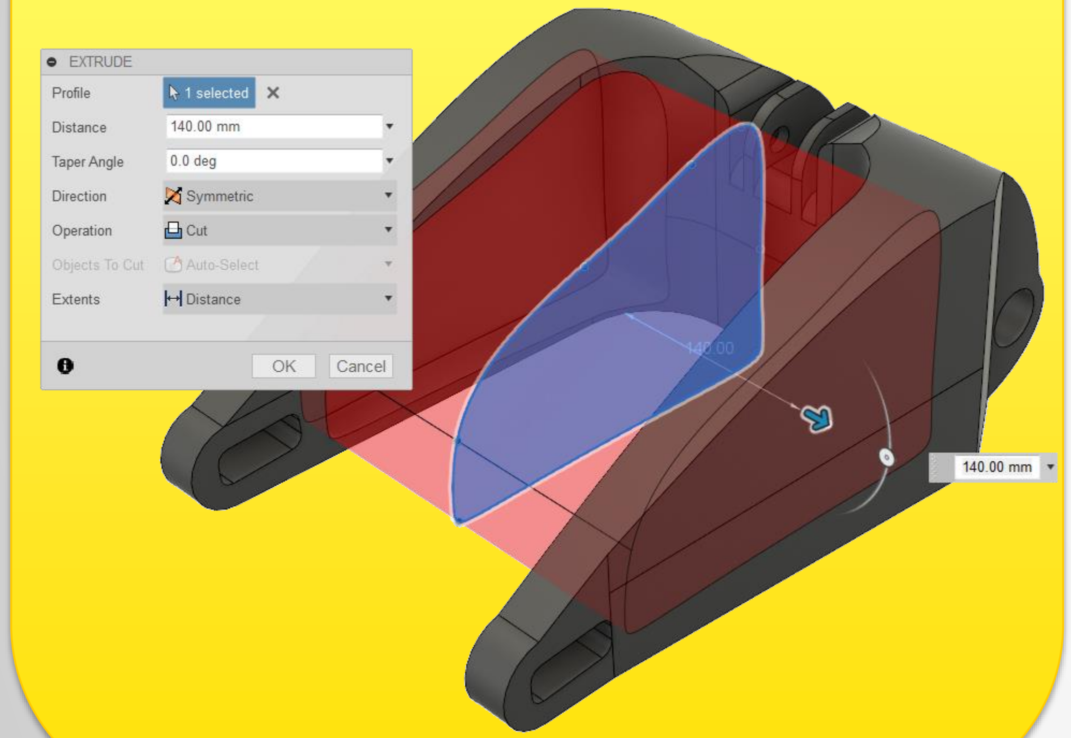


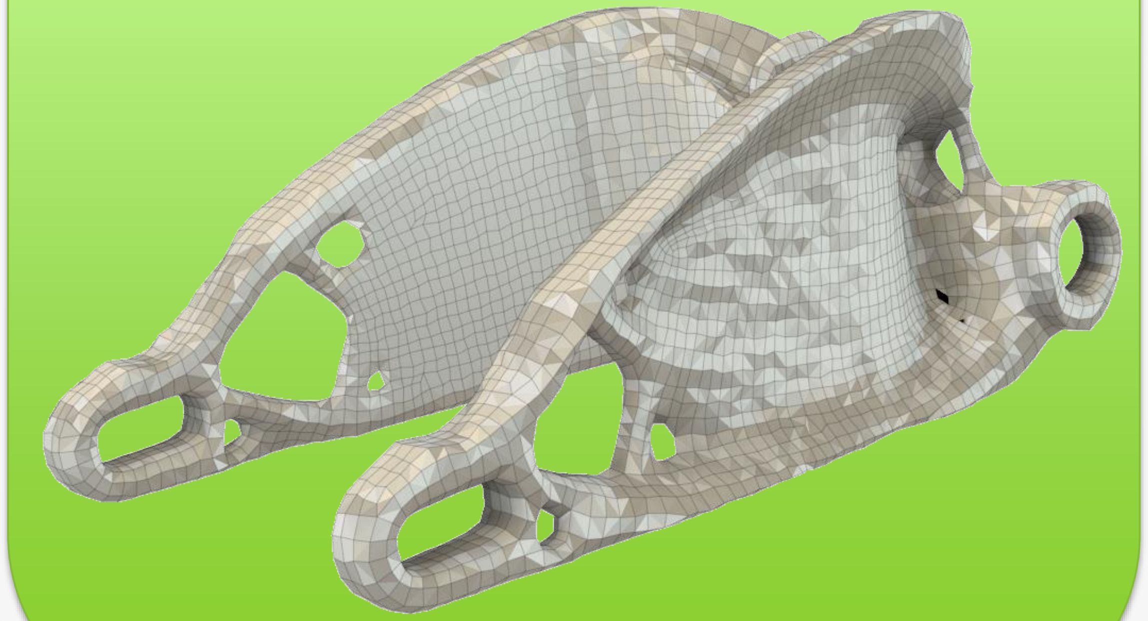
# The Future of Optimization

# Future of Optimization – Geometry Creation

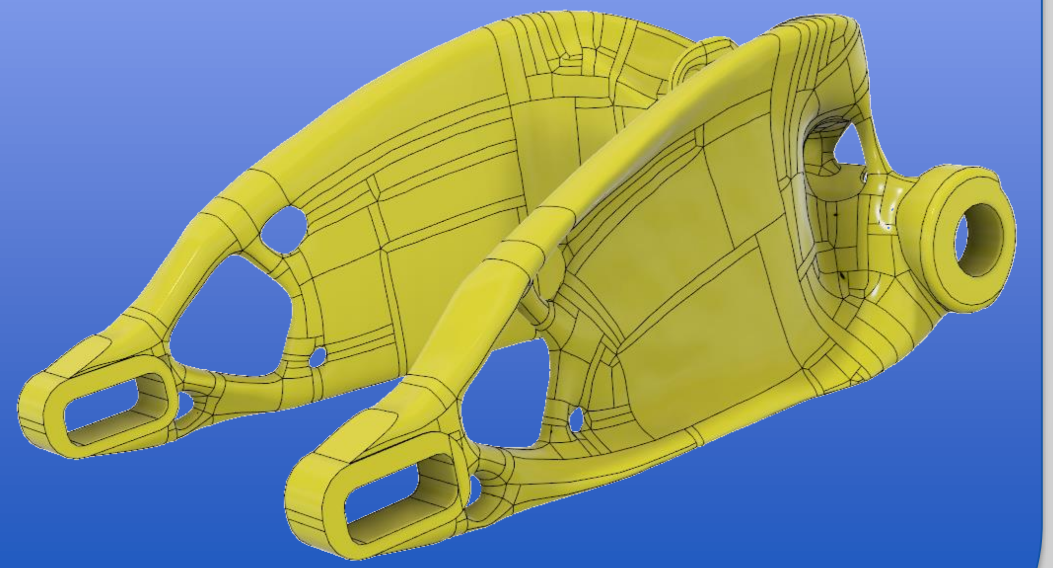
Modify design space using output as a reference (manual)




Smooth/edit mesh and convert into usable BREP (semi-automated)



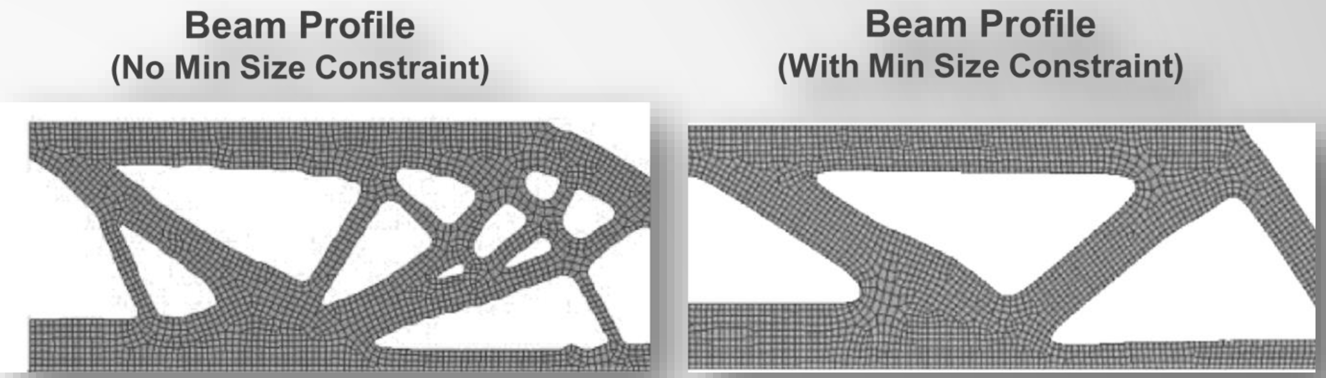
Convert output into smoothed BREP with preserved faces (automated)



*Near term* → *Future*

# Future of Optimization – MFG Awareness

- Optimized member thickness
- Manufacturing processes
  - Forgings
  - Castings
  - Extrusions

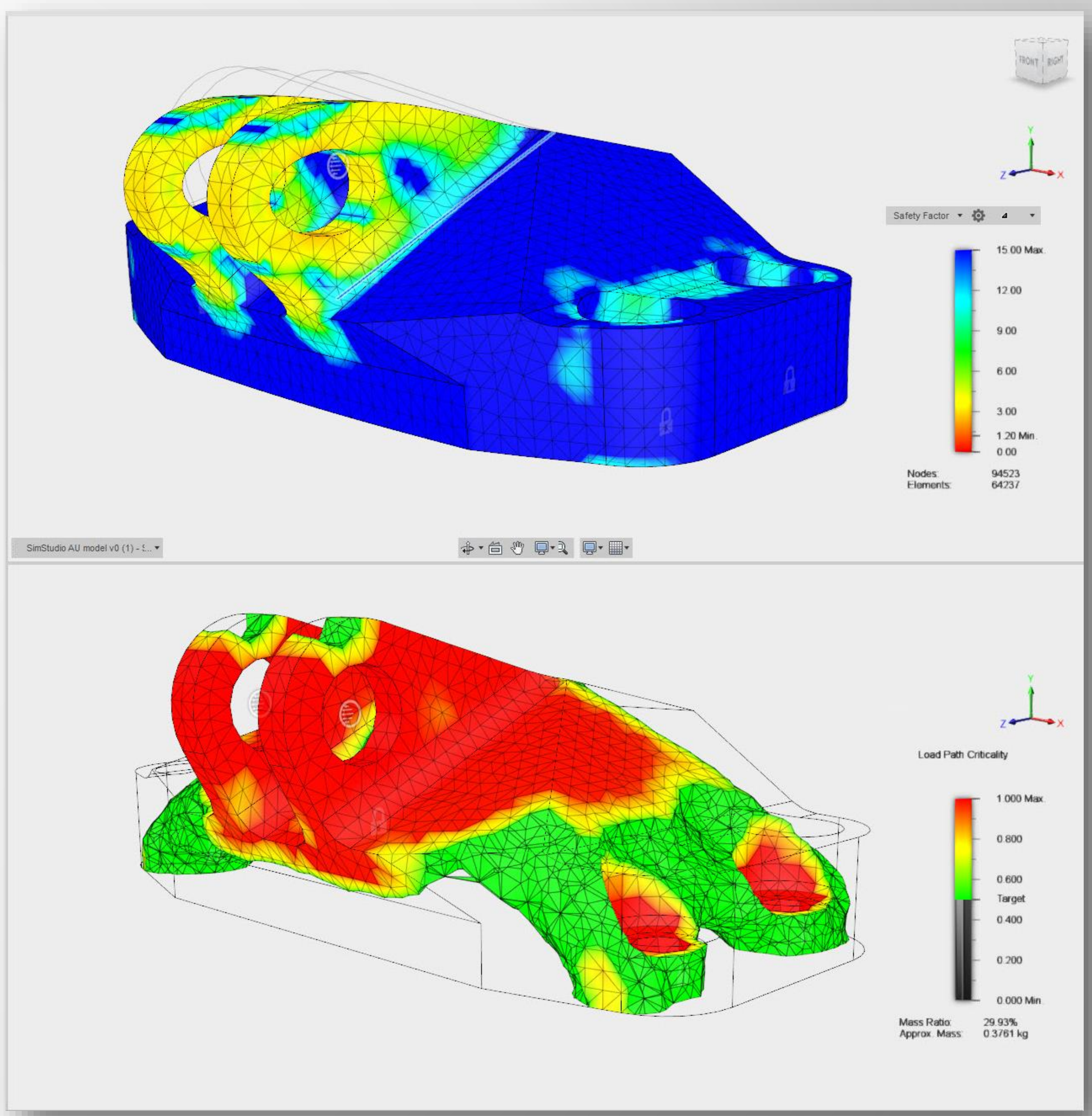



# Future of Optimization – Speed and Flexibility

# Topology Optimization with Project Arro

# AU Open Lab - Hands on with Project Arro

- *13147-L*
- *Thursday – 10:00 AM – 10:30AM*
- *Level 2 Artist Foyer*
- *Arrive early to reserve your spot!*



# Don’t miss our speaker panel!

## How do the experts see Simulation in the Future of Making Things?

Wednesday, Dec. 2nd
4:30 – 5:30 PM
Murano 3301 Level 3

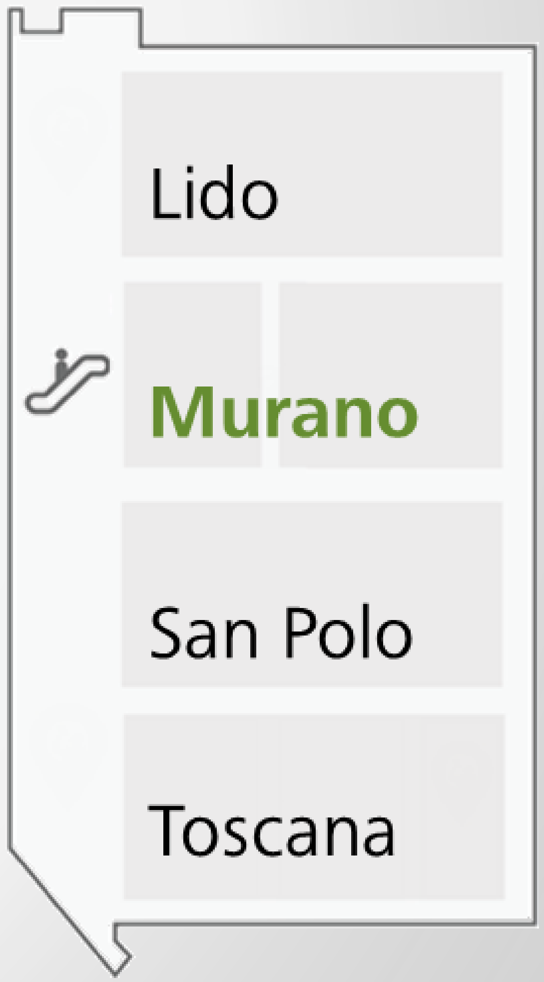
**Scott Borduin**
CTO
Manufacturing Product Group, Autodesk

**Greg Fallon**
Vice President
Simulation Product Group, Autodesk

**Roger Corn**
Mechanical Engineer
Sony Visual Products

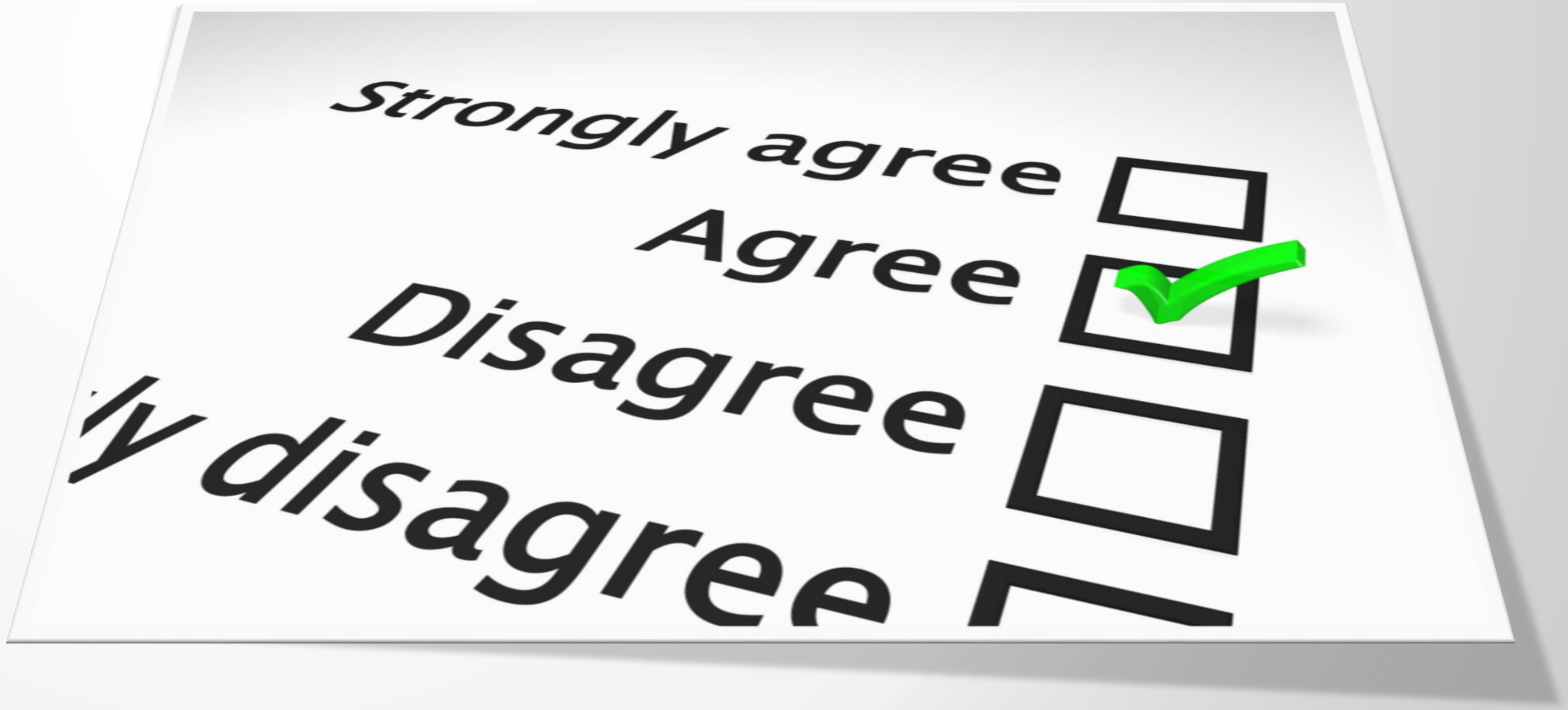
**Rick Arthur**
Director
Advanced Computing Research, General Electric

**Venetian Level 3**



# Be heard! Provide AU session feedback.

- Via the Survey Stations, email or mobile device.
- AU 2016 passes awarded daily!
- Give your feedback after each session.
- Give instructors feedback in real-time.



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