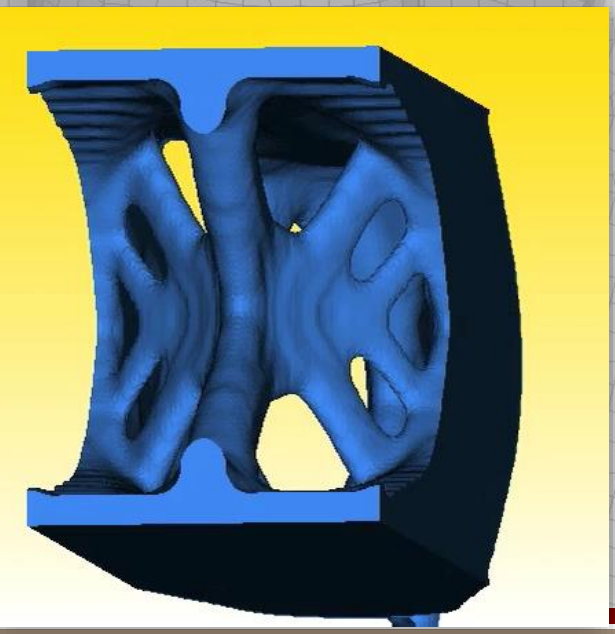
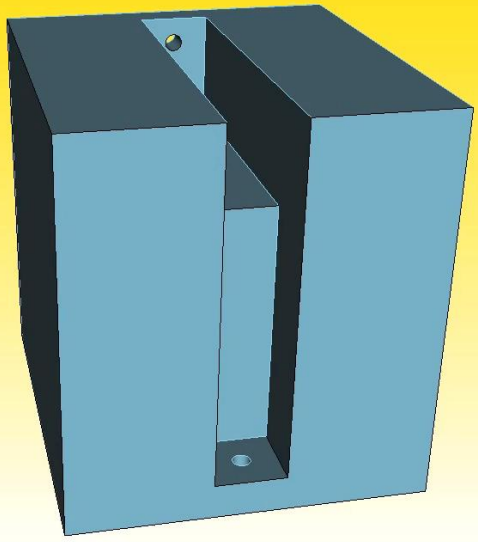
Generative Design:

A New Class of CAE Challenges



Dr. Ted Blacker

Manager
Simulation Modeling Sciences
Sandia National Laboratories

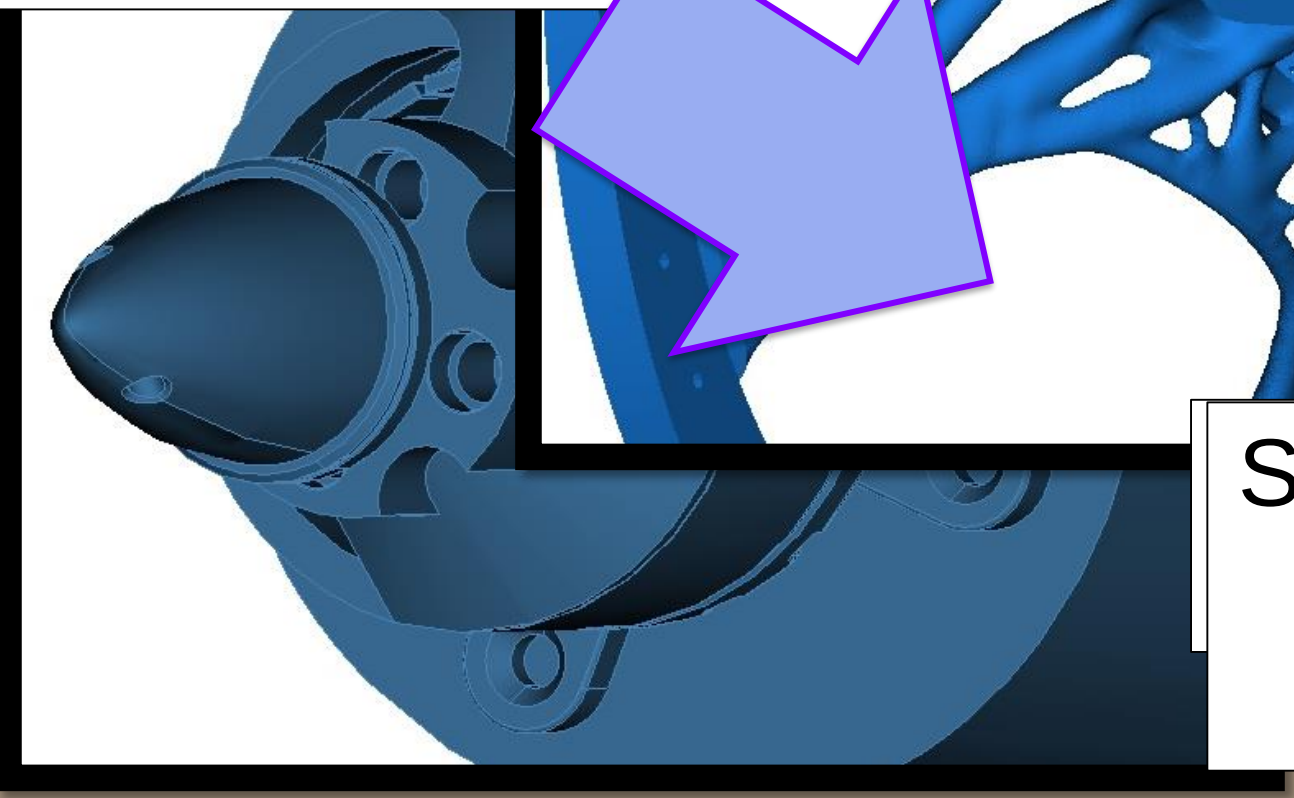


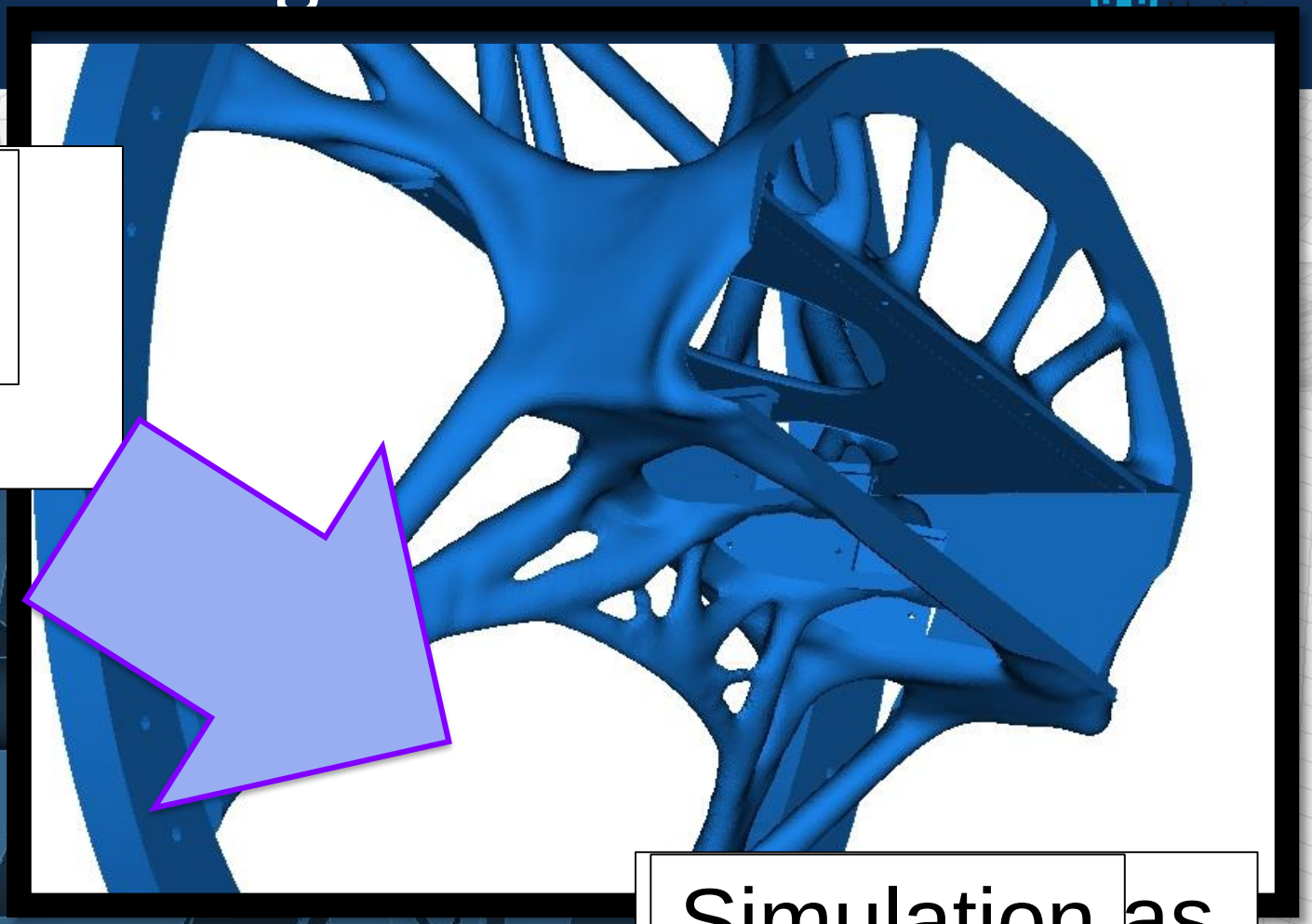
U.S. DEPARTMENT OF ENERGY | NNSA National Nuclear Security Administration

SAND2017-9767 C

Generative Design

Define Function (CAD)





Simulation Creates Design

as

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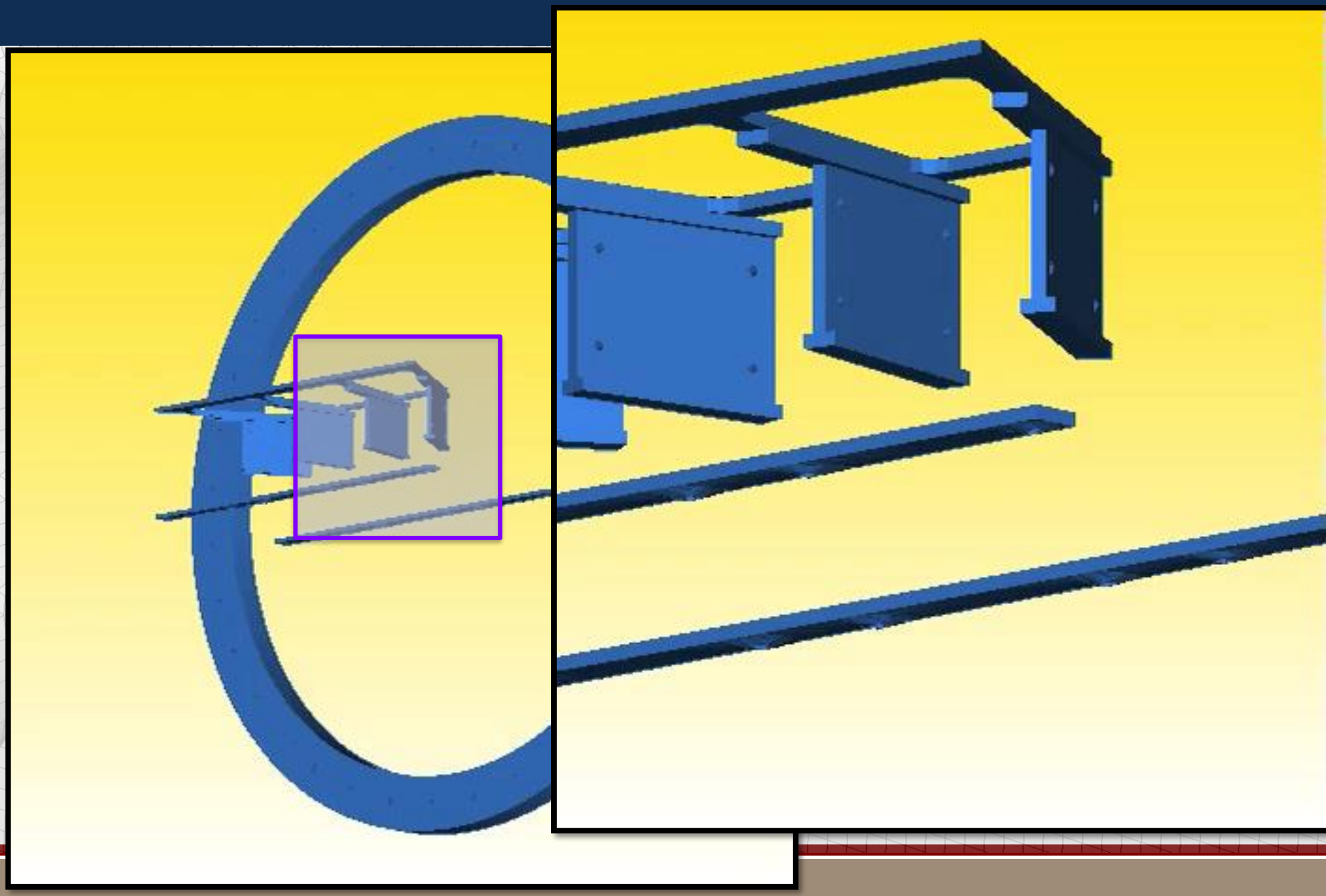
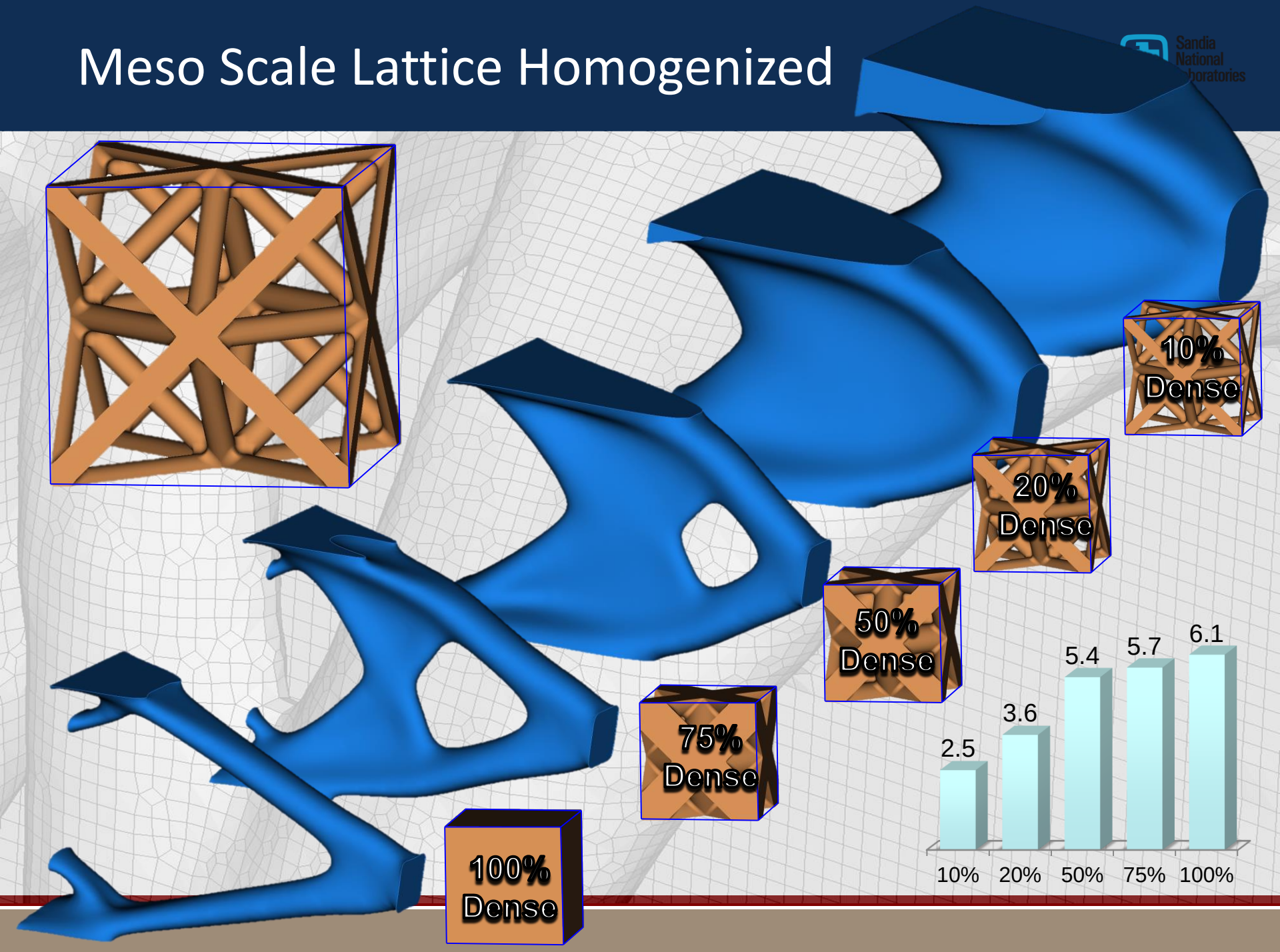
Satellite Component Design

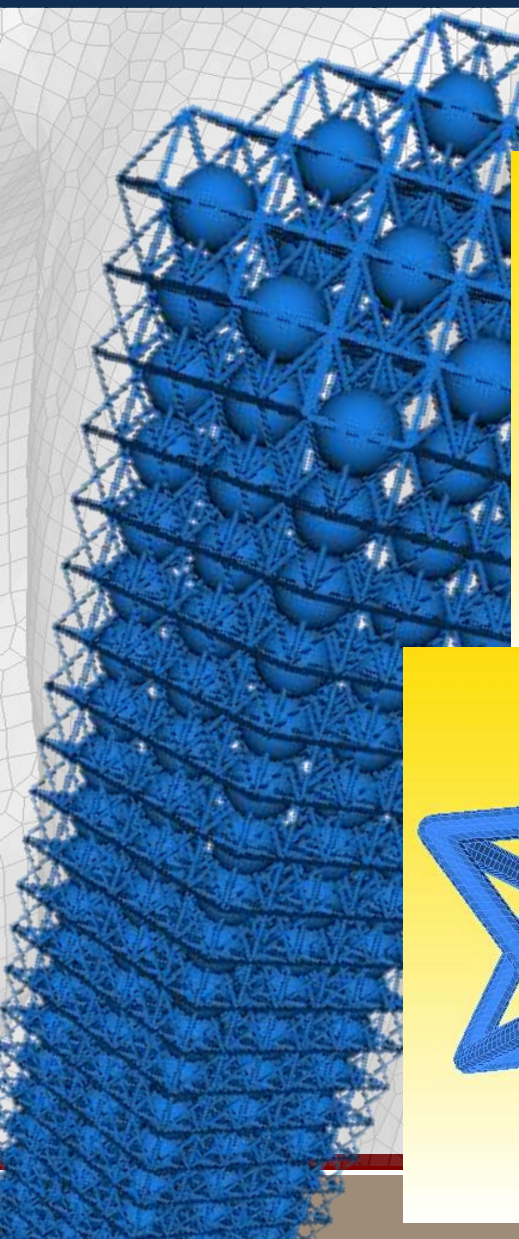


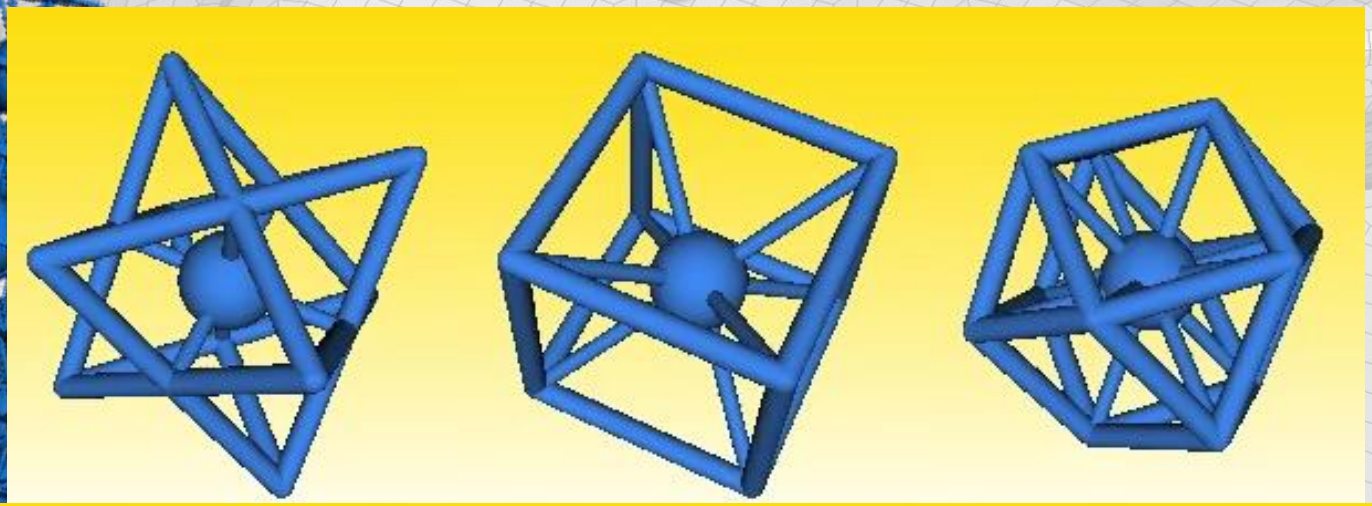
Meso Scale Lattice Homogenized



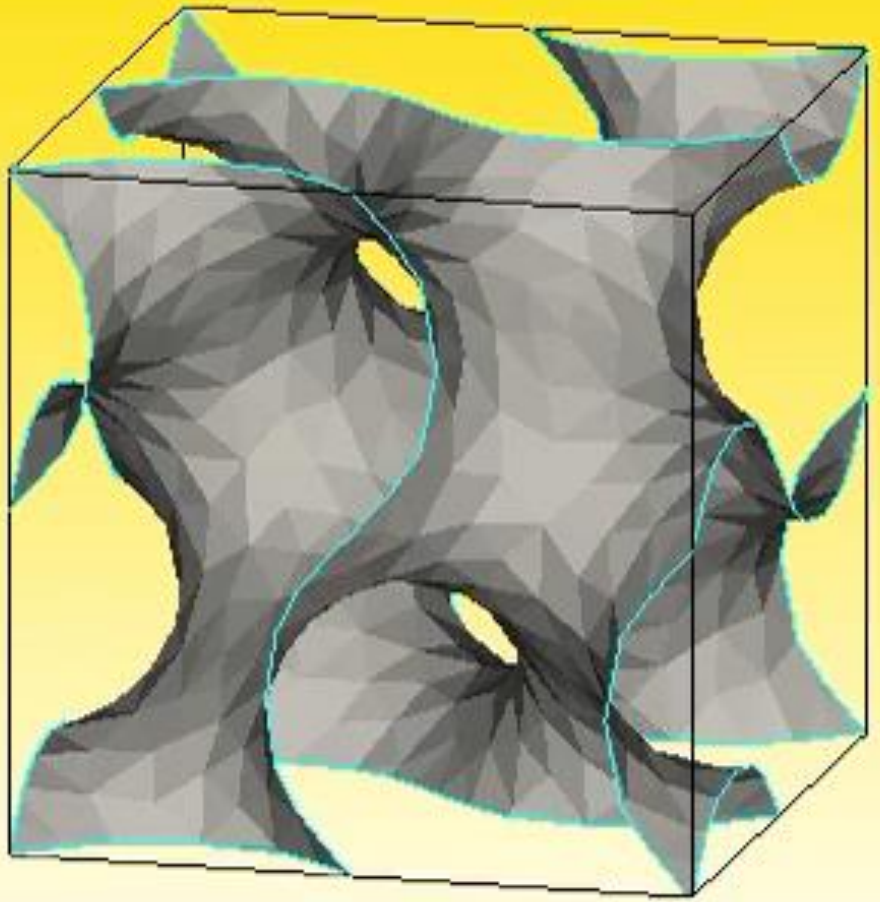
Transient Response Tailoring

- Shock mitigation & redirection





Exploring Minimal Surface Lattices



Brave New World for CAE

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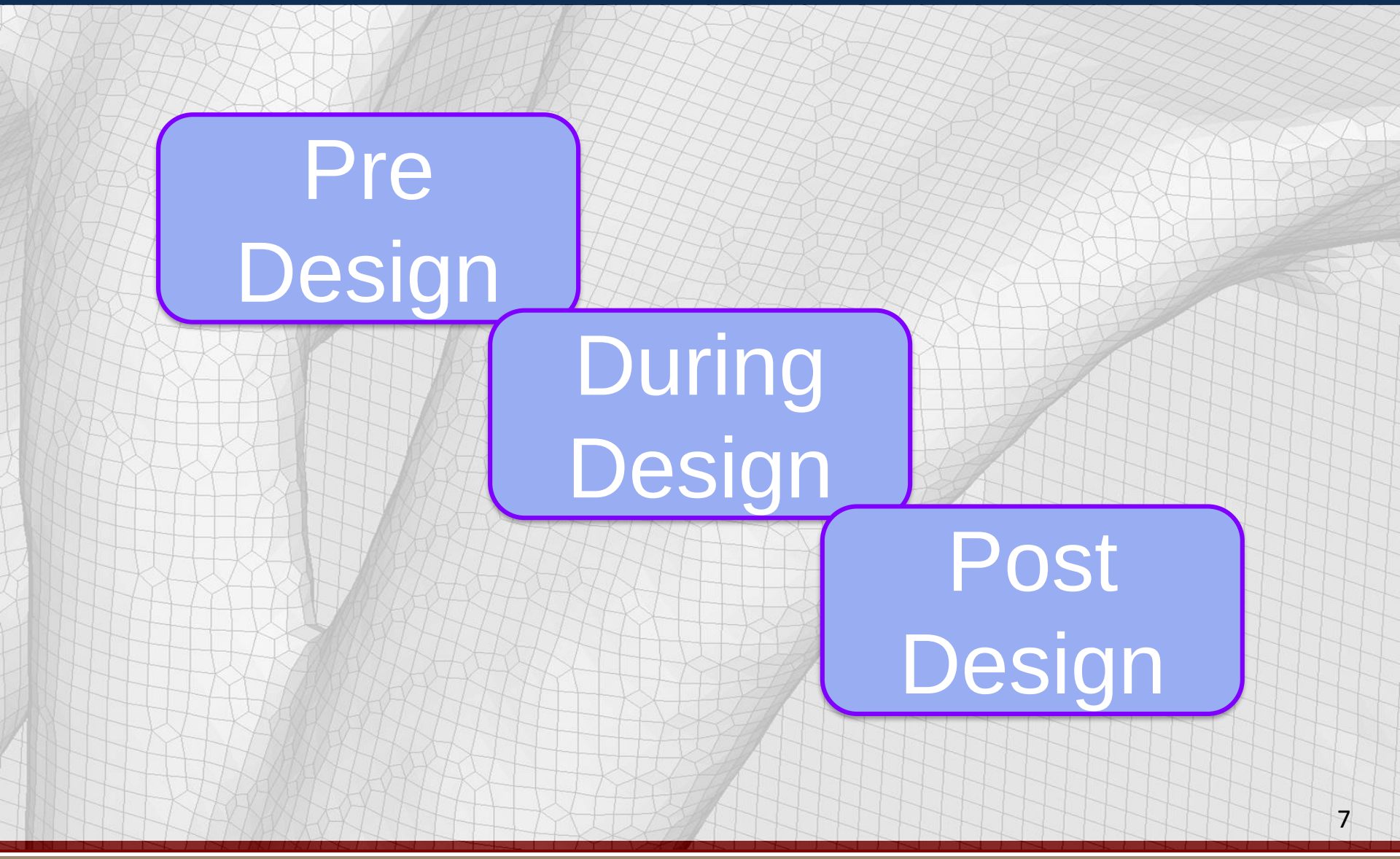
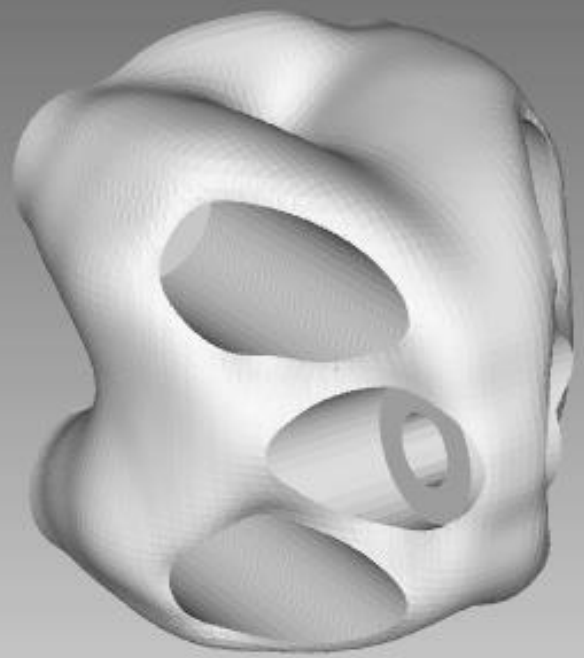


Pre Design

Sandia National Laboratories

Not an Analyst



Pre Design

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Objective Function

Example:
Design that supports the payload without buckling, resists multiple shocks, transfers a heat load uniformly through a cross flowing medium and is very light.

Pre Design

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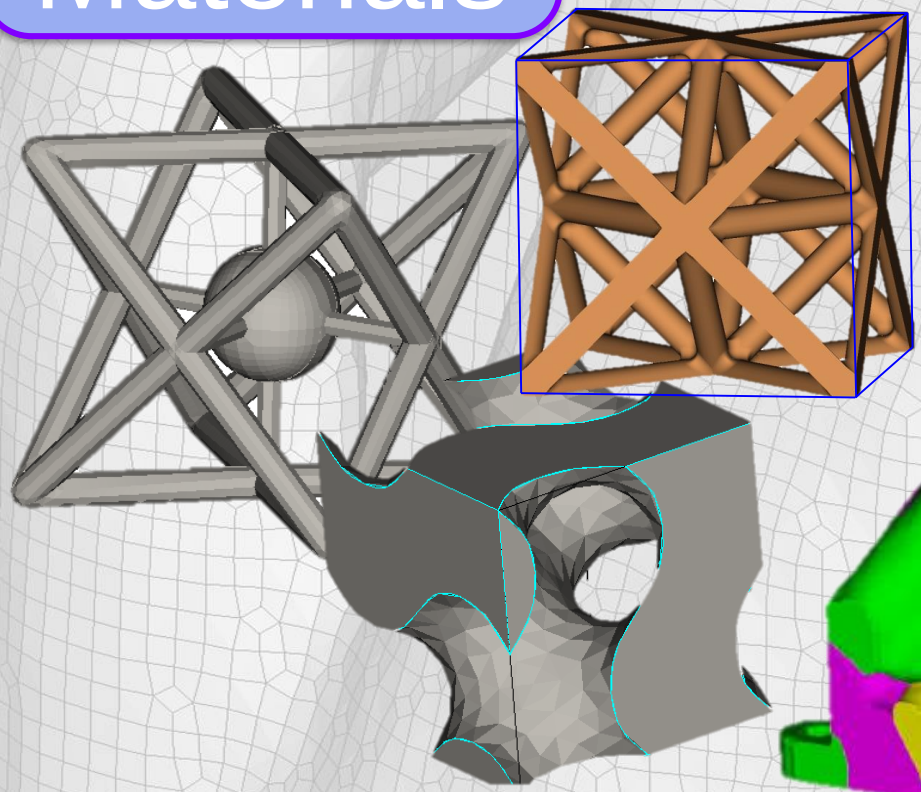
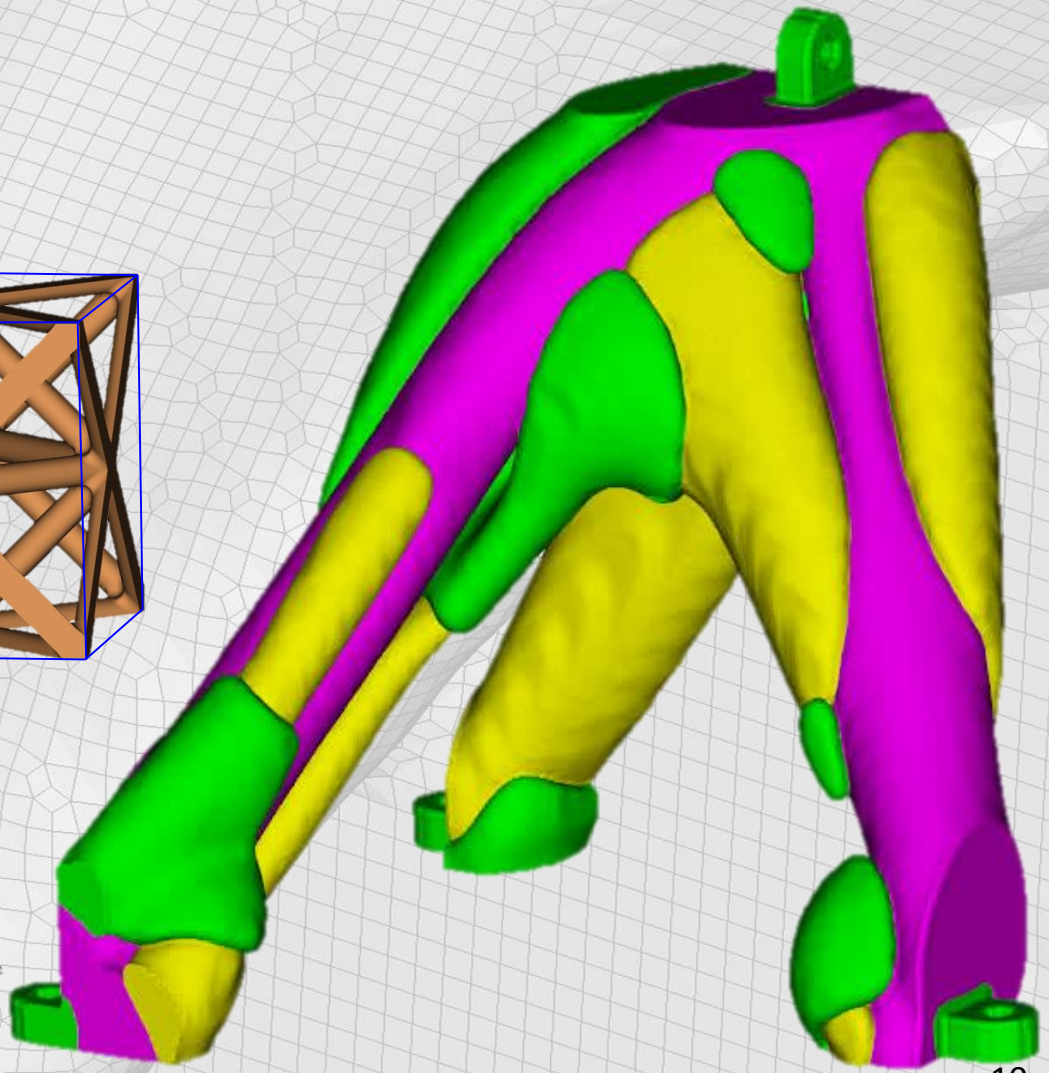
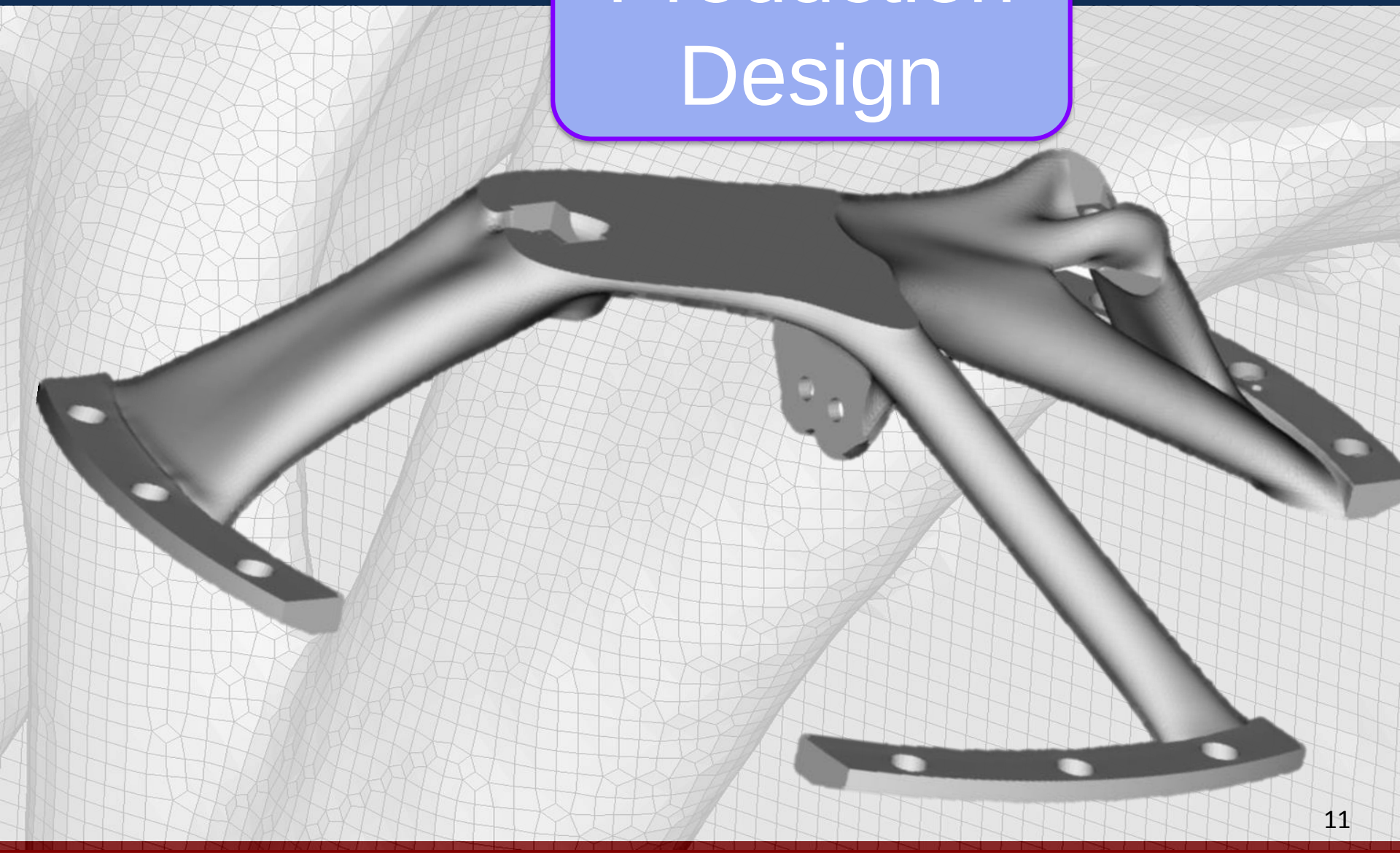
Meta Materials





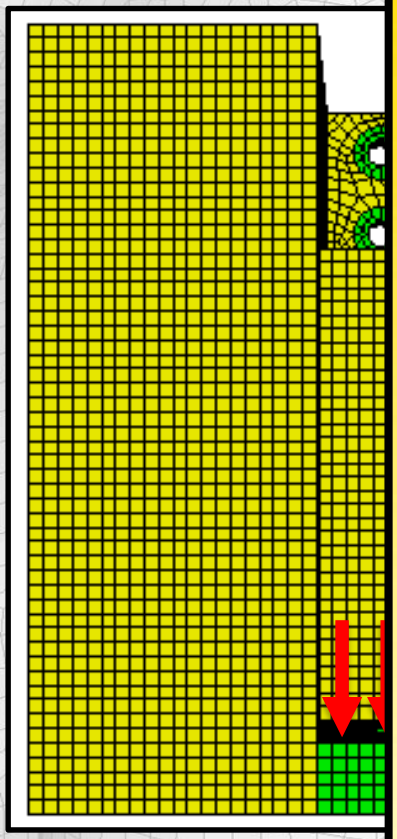
During Design

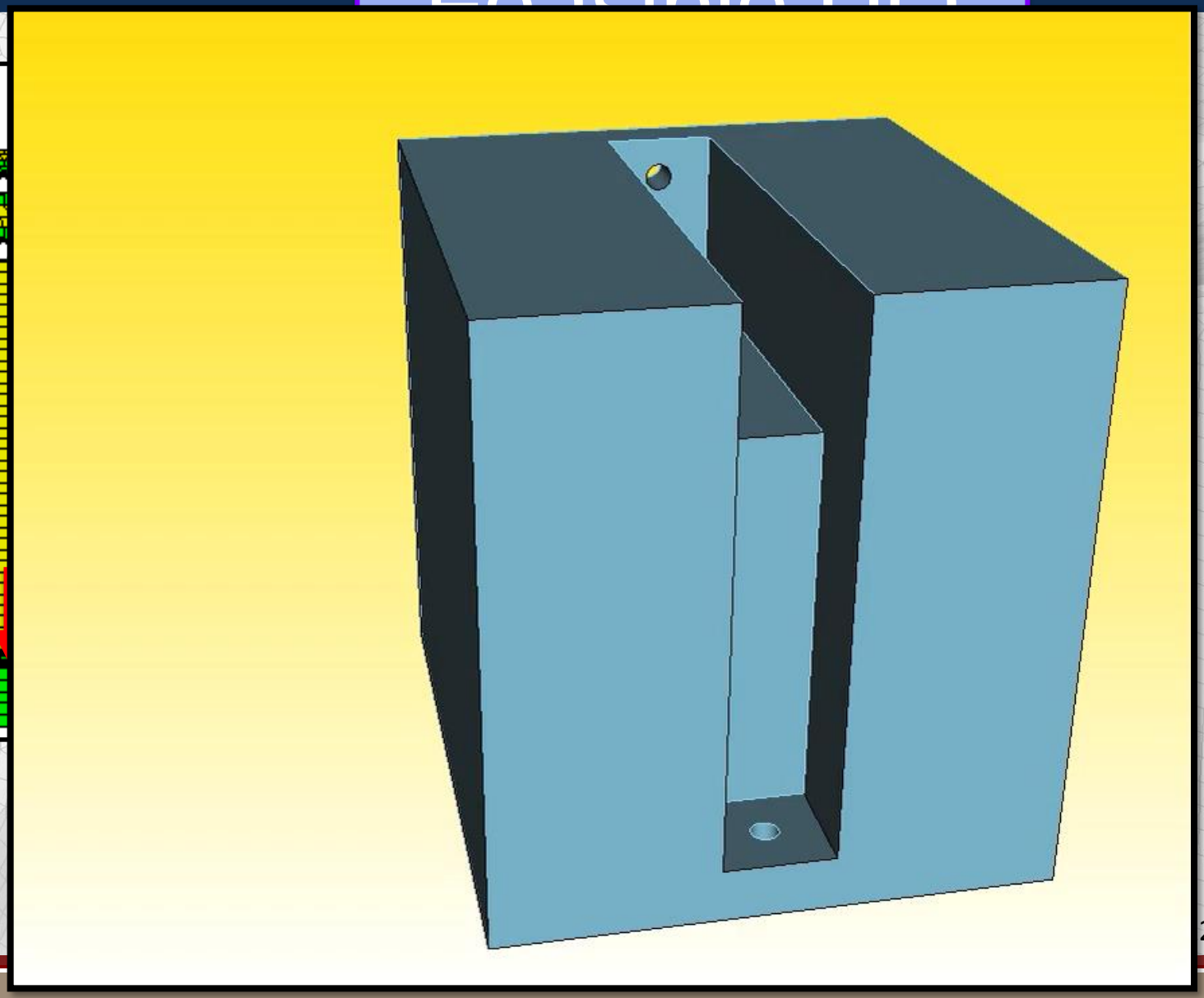
Production Design



During Design

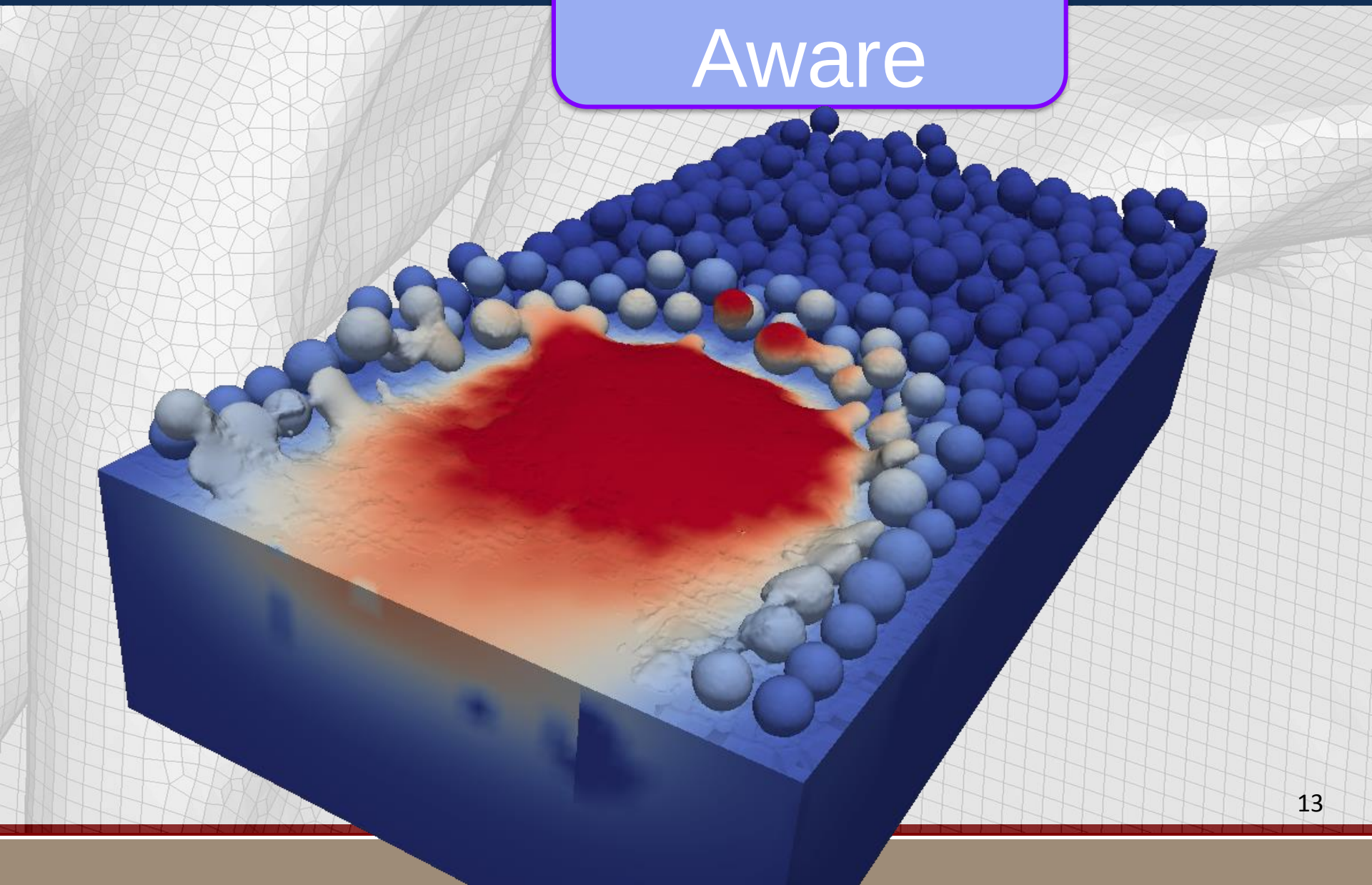
Feasible UQ





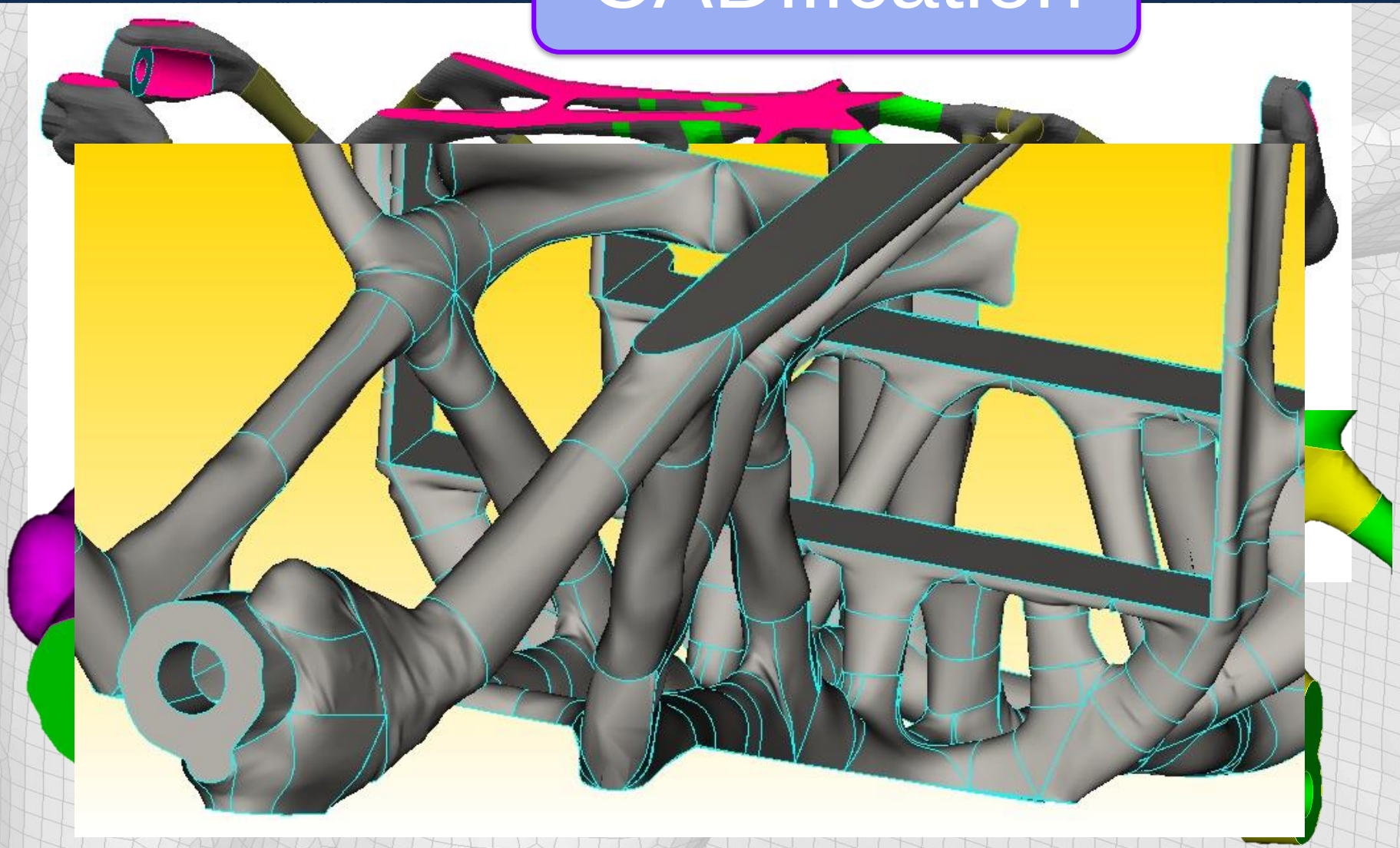
During Design

AM Process Aware



Post Design

CADification



Post Design

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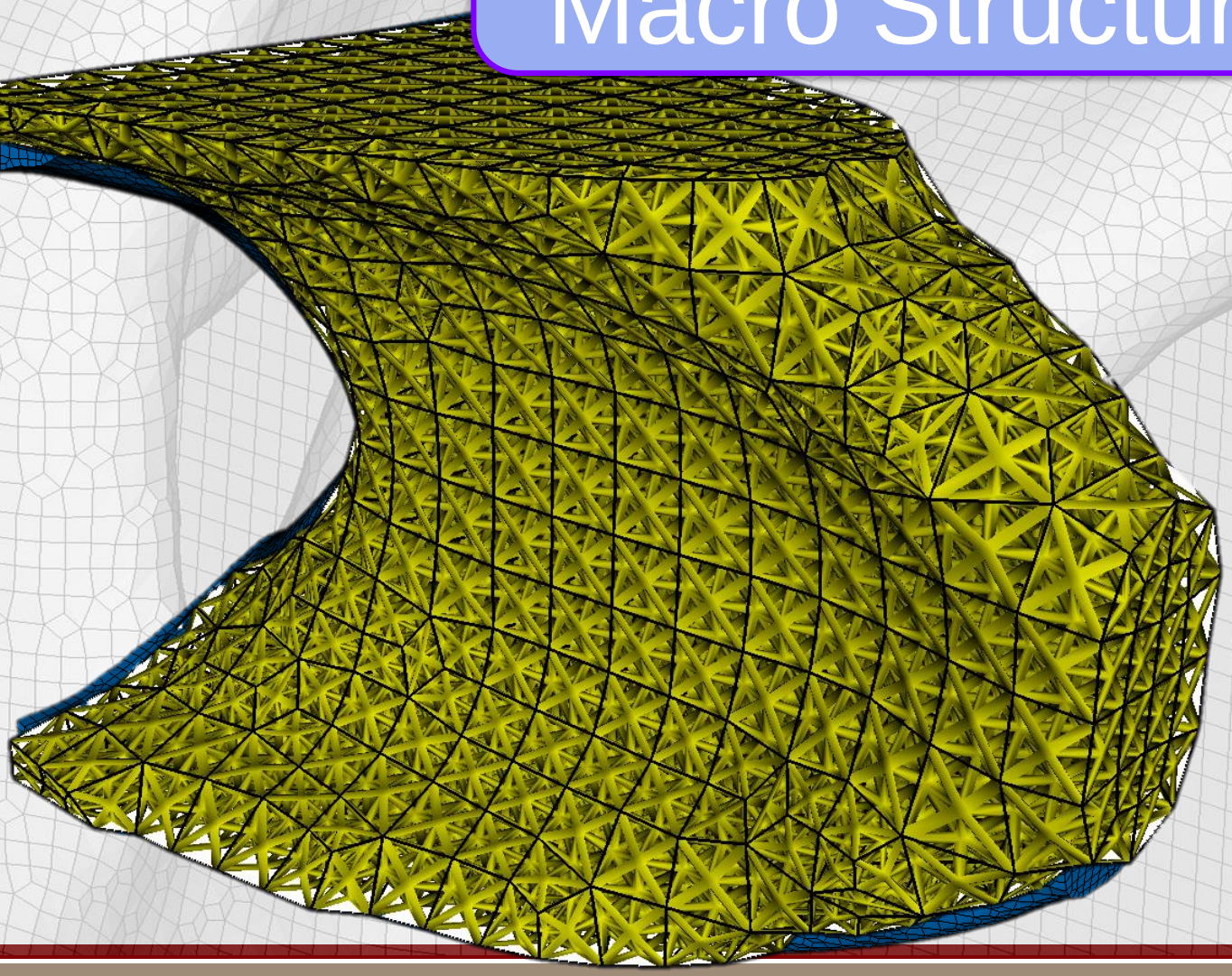
Definition of Macro Structure



Post Design

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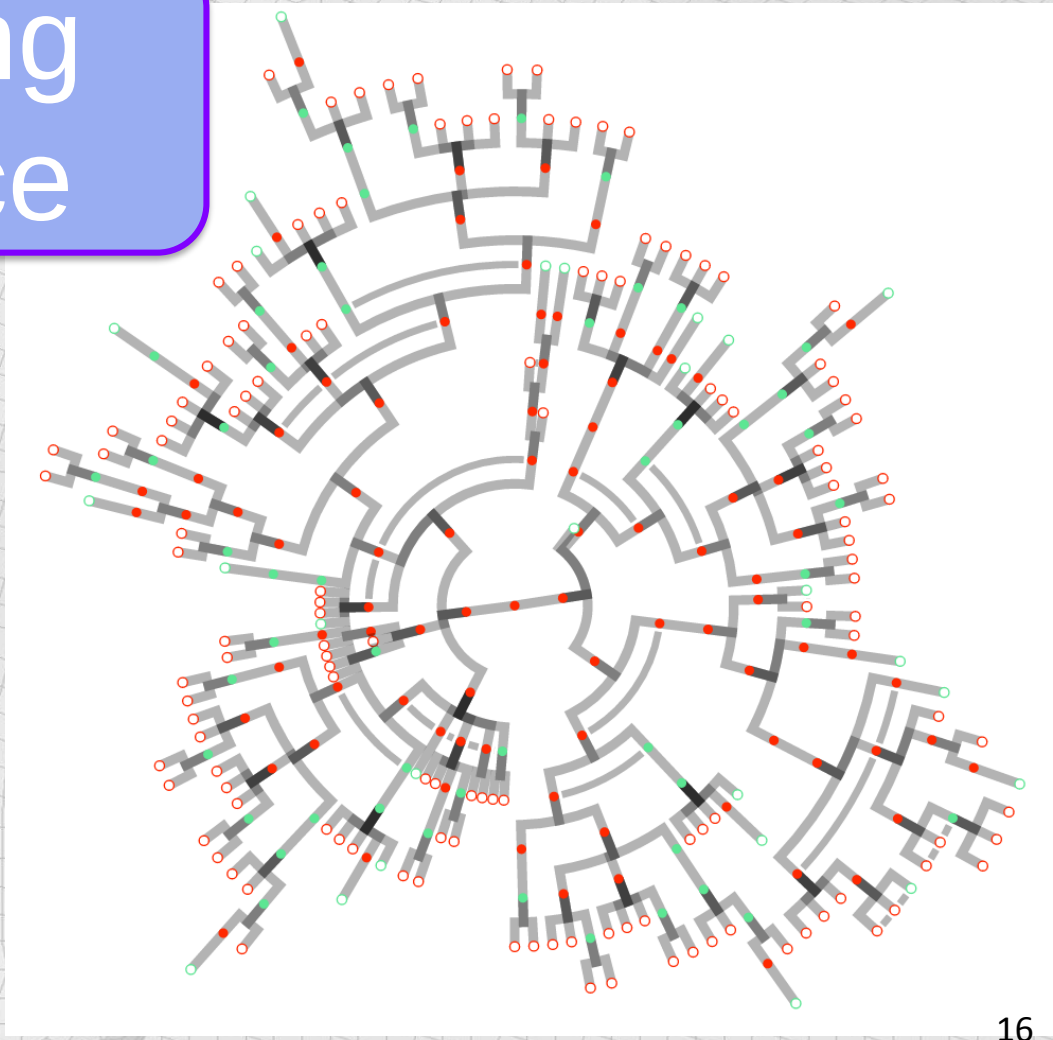
Overwhelming Design Space



Let’s get moving…

Backup Slides

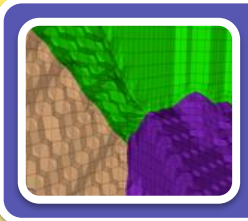
Leveraged Components

Topology Optimization

- PLATO

Solvers

- SIERRA / ALBANY / ...

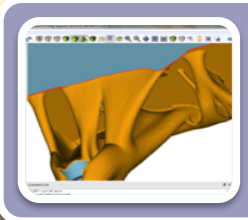


Meshing and Geometry

- CUBIT / ACIS / KCM

Optimization and UQ

- DAKOTA / ROL

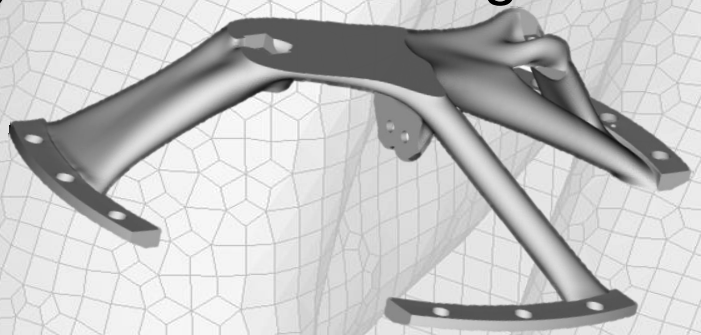


Design Environment

- SAW

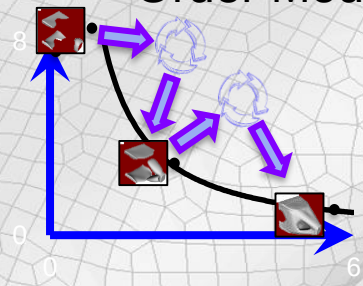
PLATO Differentiators

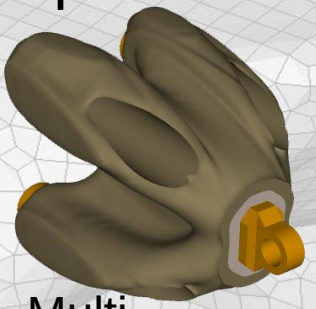
1) Production Design



3) Research Explosion

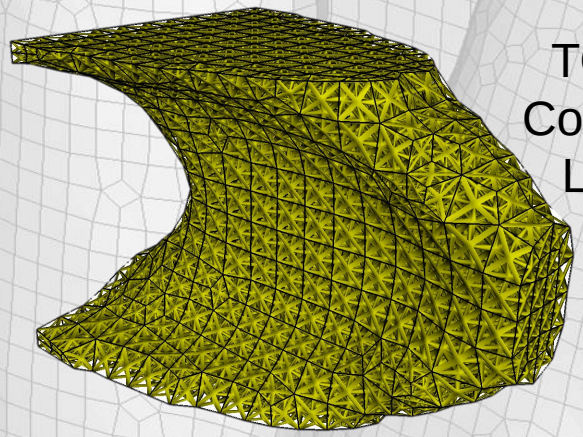
Reduced Order Models





Multi Materials

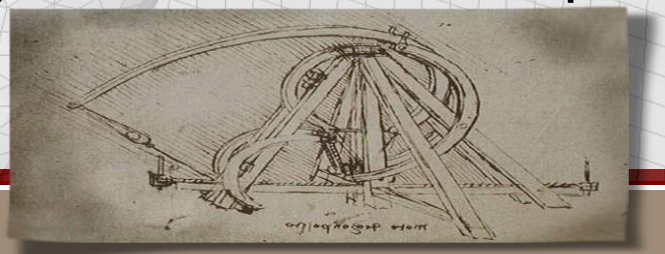
2) Meta-Material Design



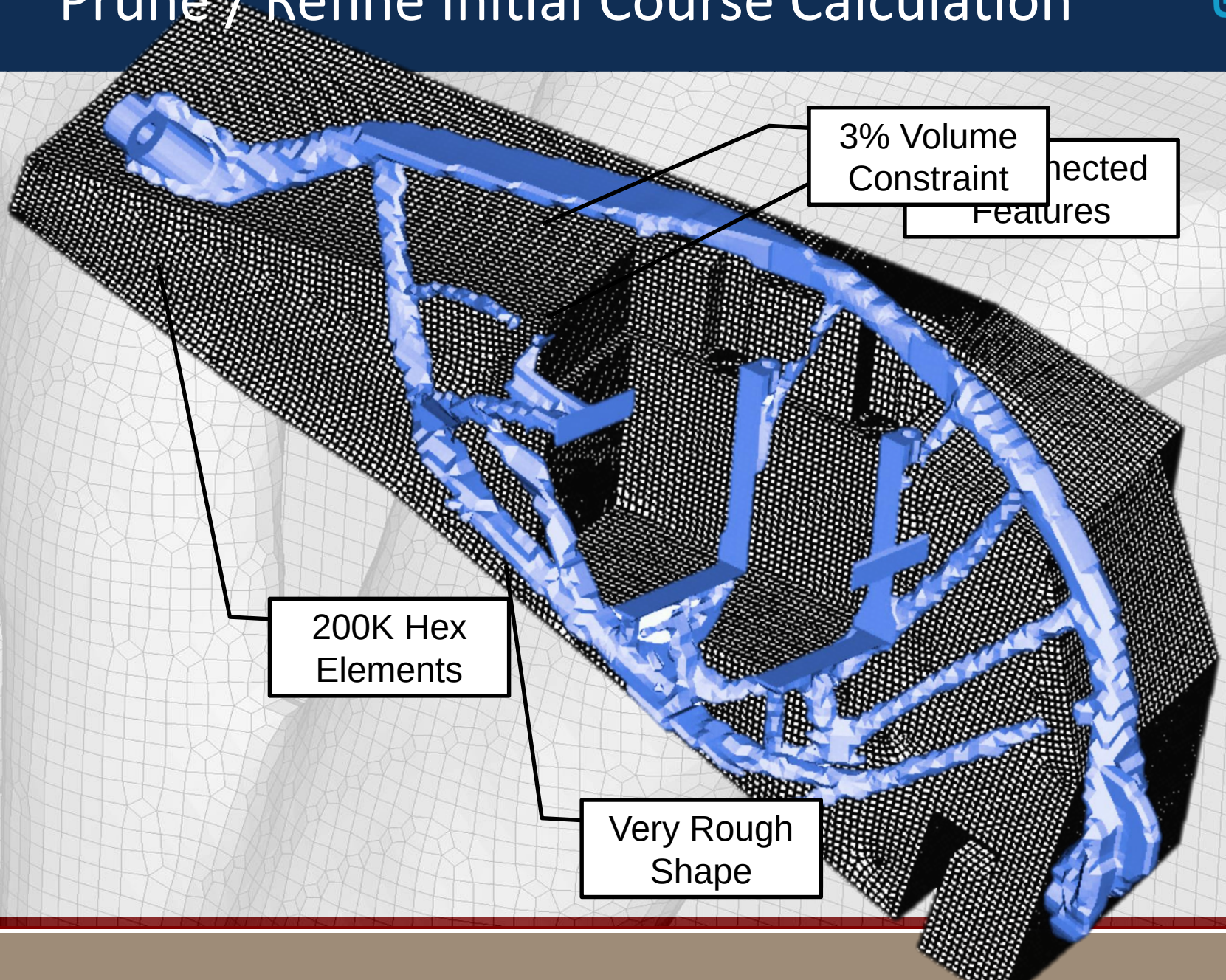
TO with Conformal Lattice

4) Massive Scaling

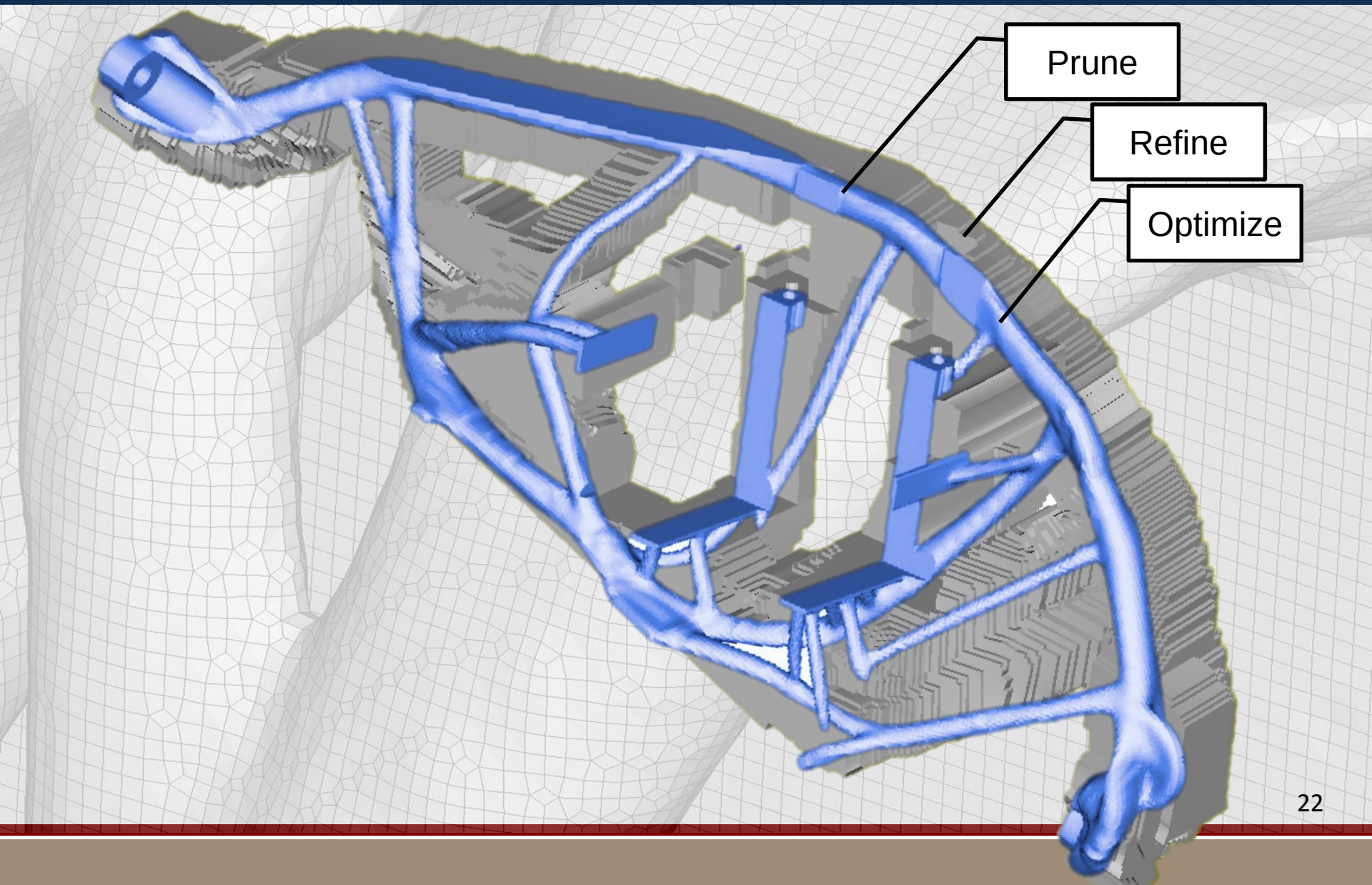
5) Collaboration Catapult



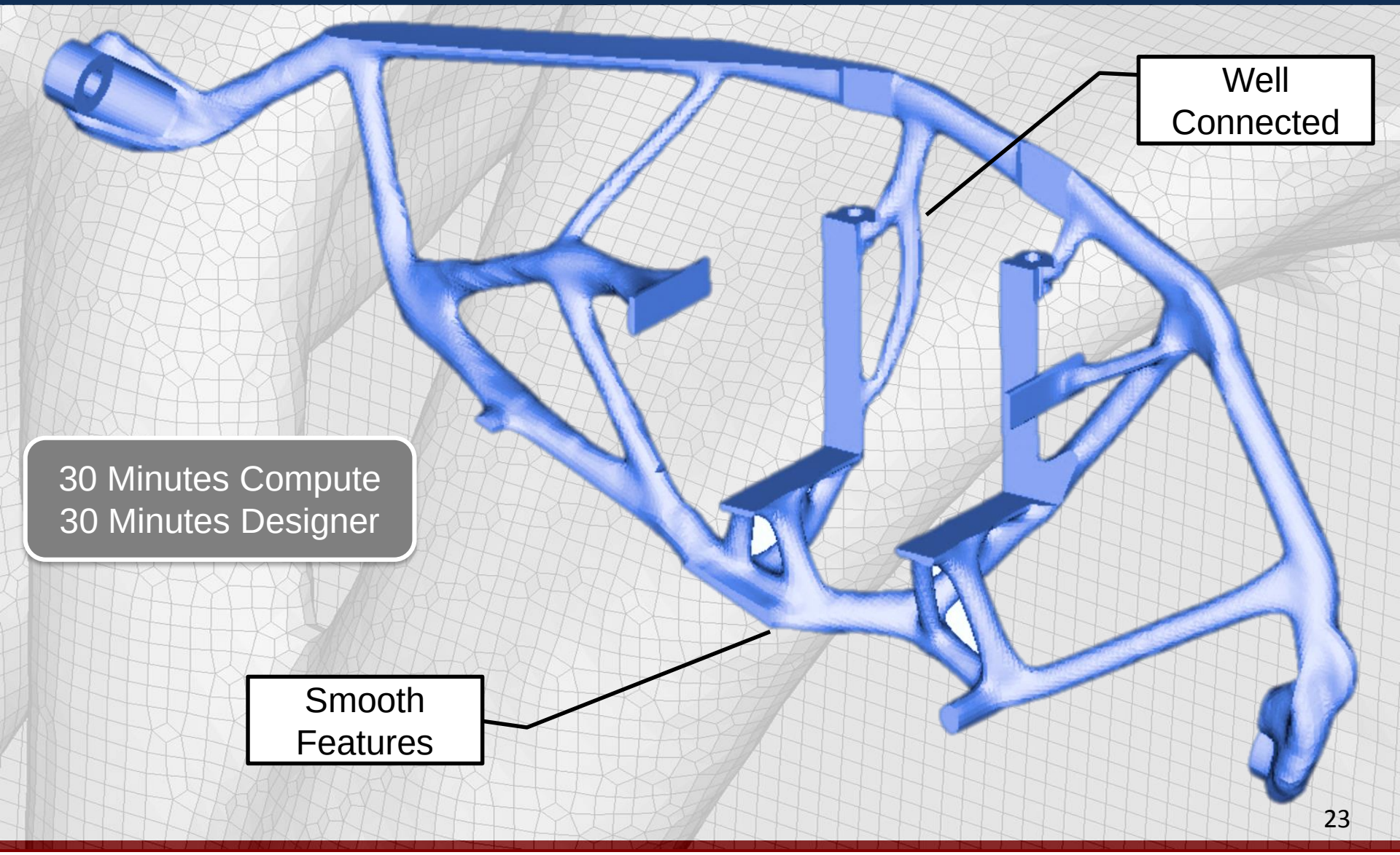
Prune / Refine Initial Course Calculation



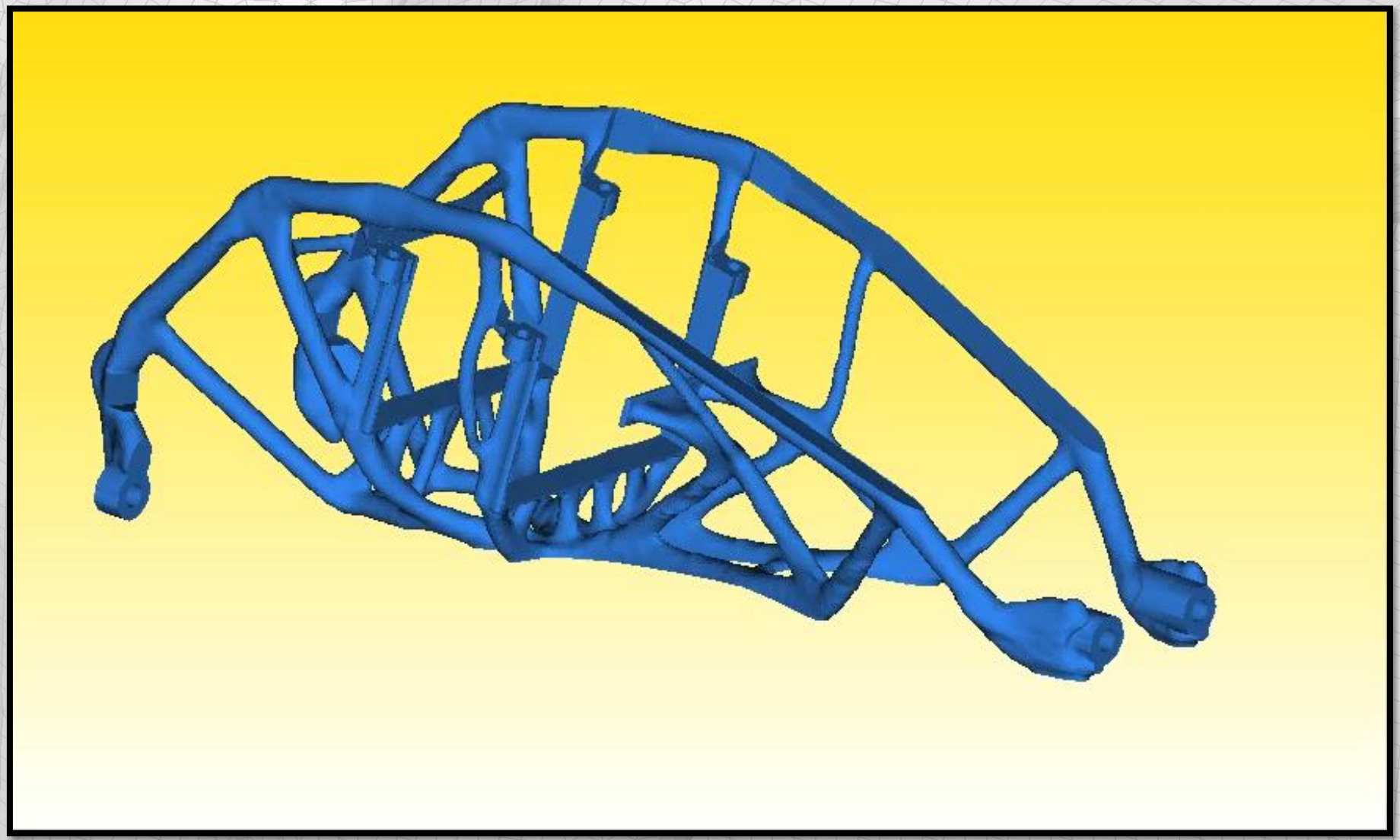
Prune / Refine Process



Prune / Refine Finished Design



Full Bracket



Conversion to Geometric CAD

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Conversion to Geometric CAD

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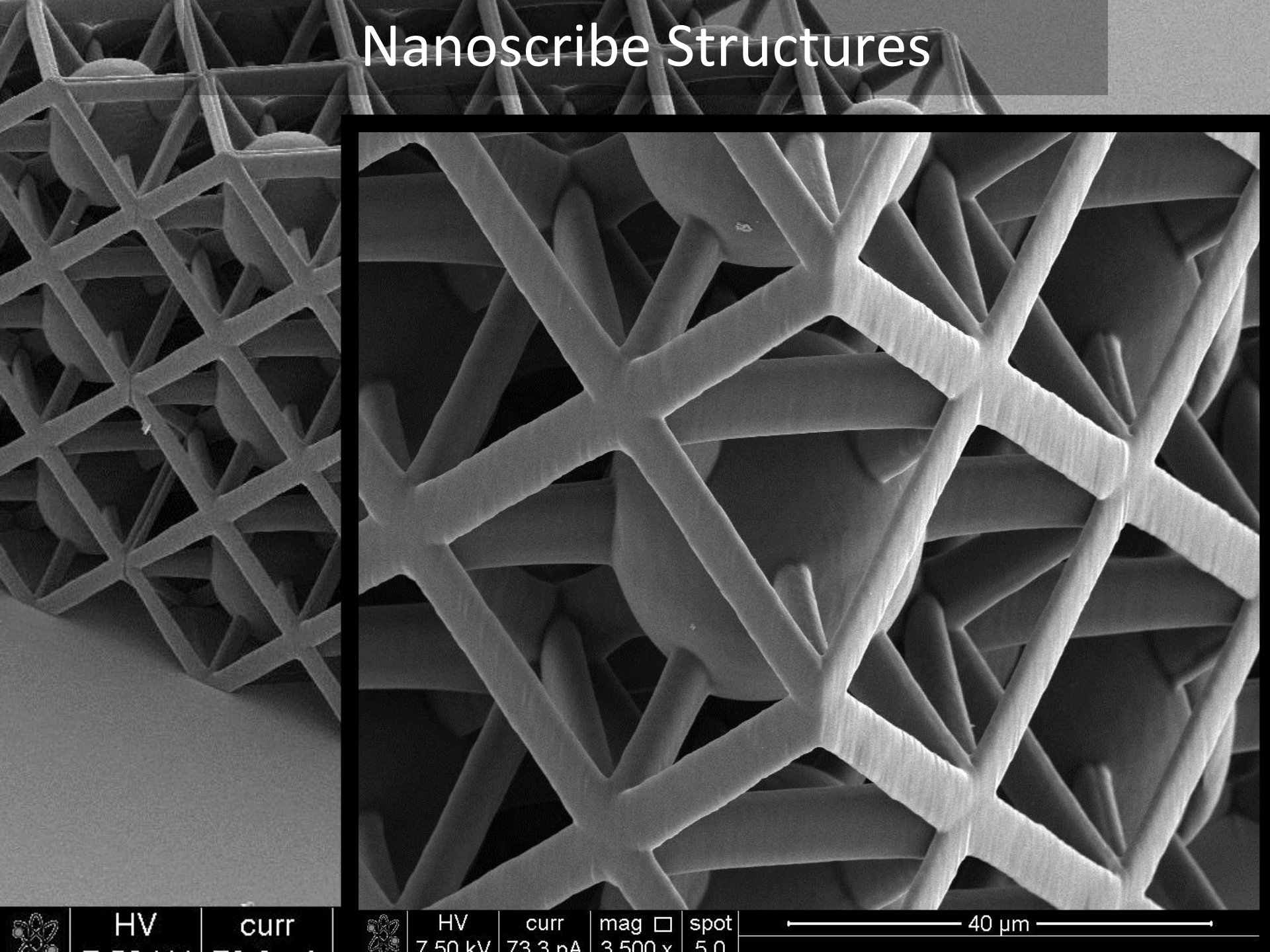
Nanoscribe Structures



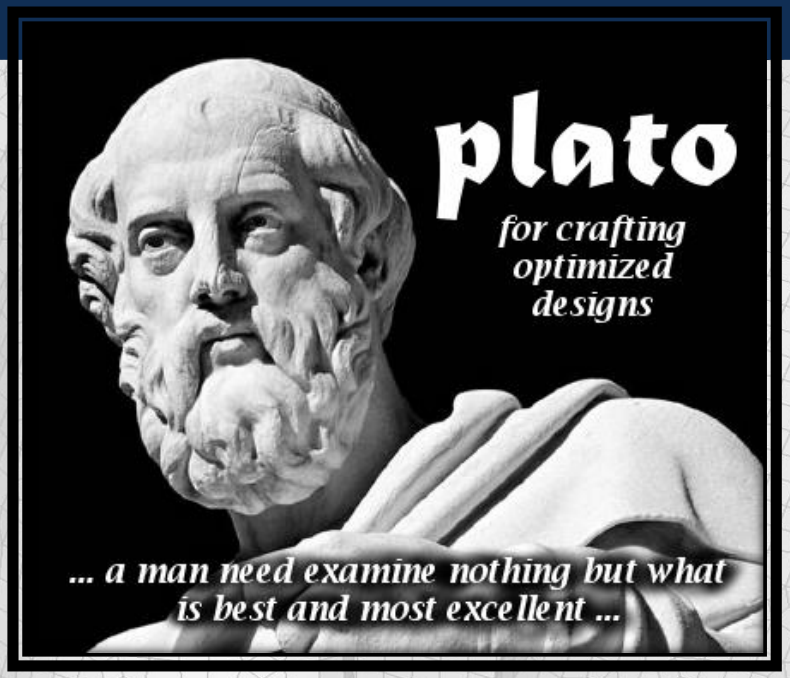
PLATO Logistics

1. Government = FREE
2. Needs a Government Use Notice (GUN)

   sierradist.sandia.gov
3. Questions?:

   plato3d-help@sandia.gov
4. Windows (sort of), Linux and Mac
5. Jobs can be run locally or on massively parallel environments
6. Includes user's manual and tutorials

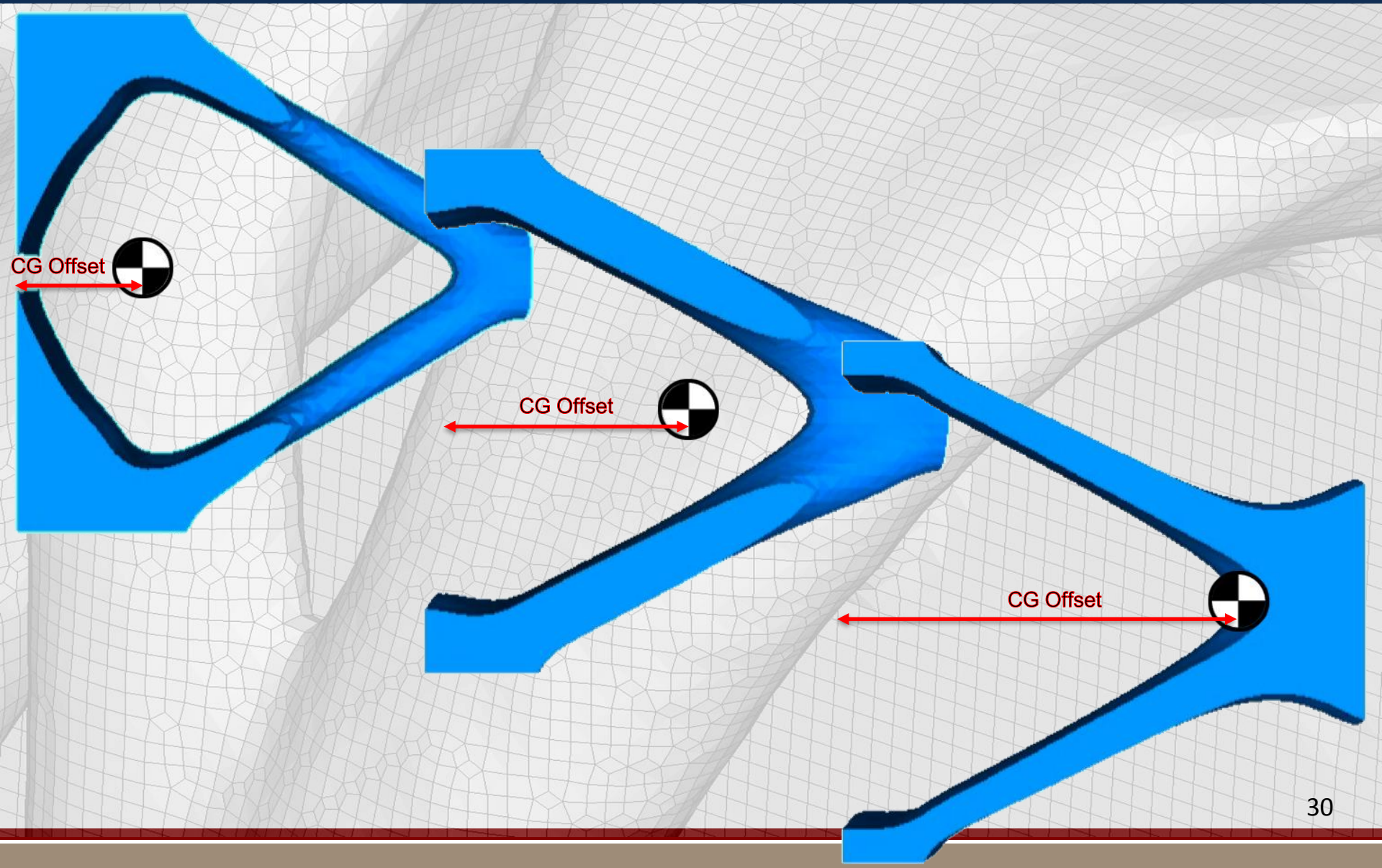
Revolution: Where Does It Go From Here?



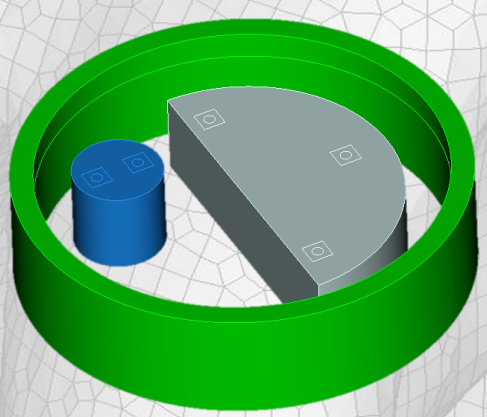
- Research to Production
- Meta-Material Design
- Micro-Material Design
- AM Process-Aware / Process Optimal

- Frequency Response Function matching
- Performance
- More Physics (Thermal / EM / Fluids)
- Inverse Optimization Methods

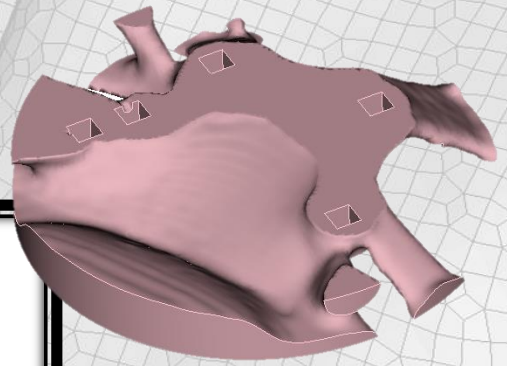
CG Constraint:
Min Compliance with fixed CG Location

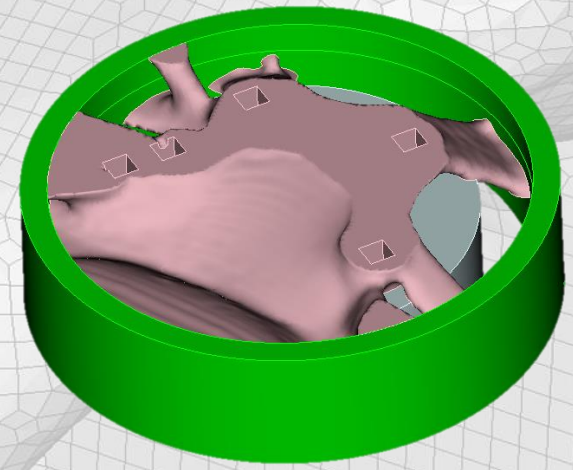


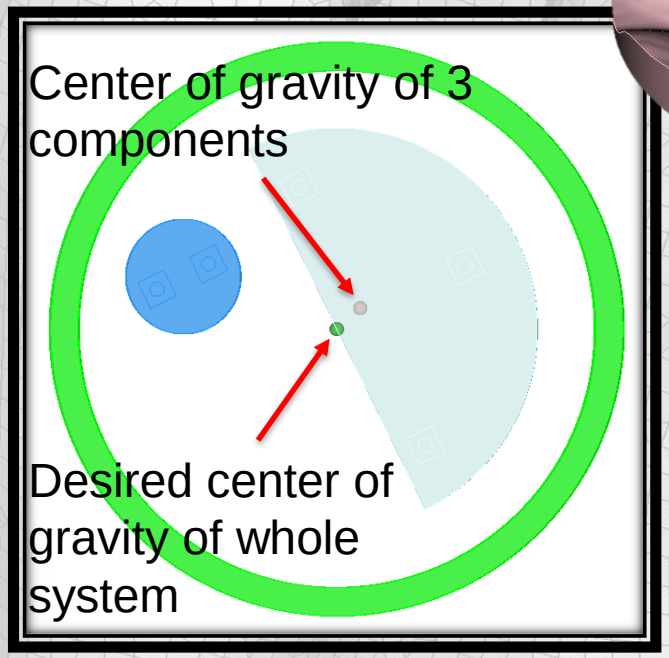
Center of Gravity Constraint

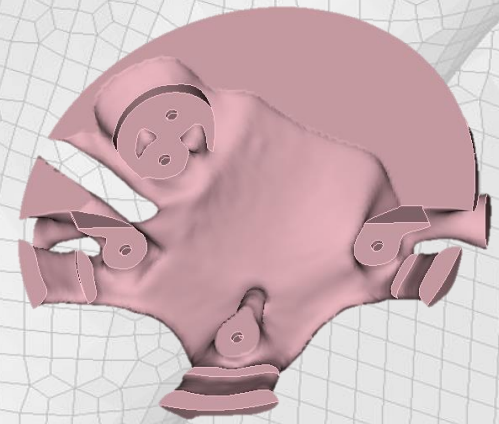


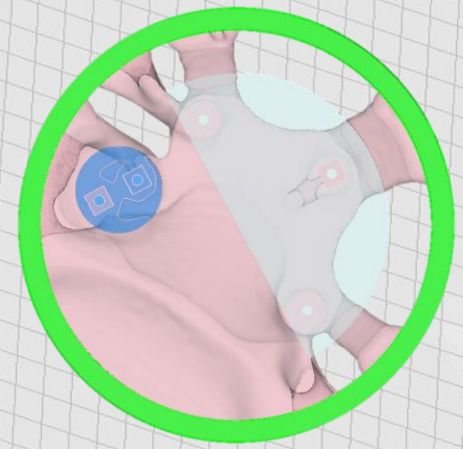
Goal: Design a bracket to secure the components and also move the center of gravity to the desired location



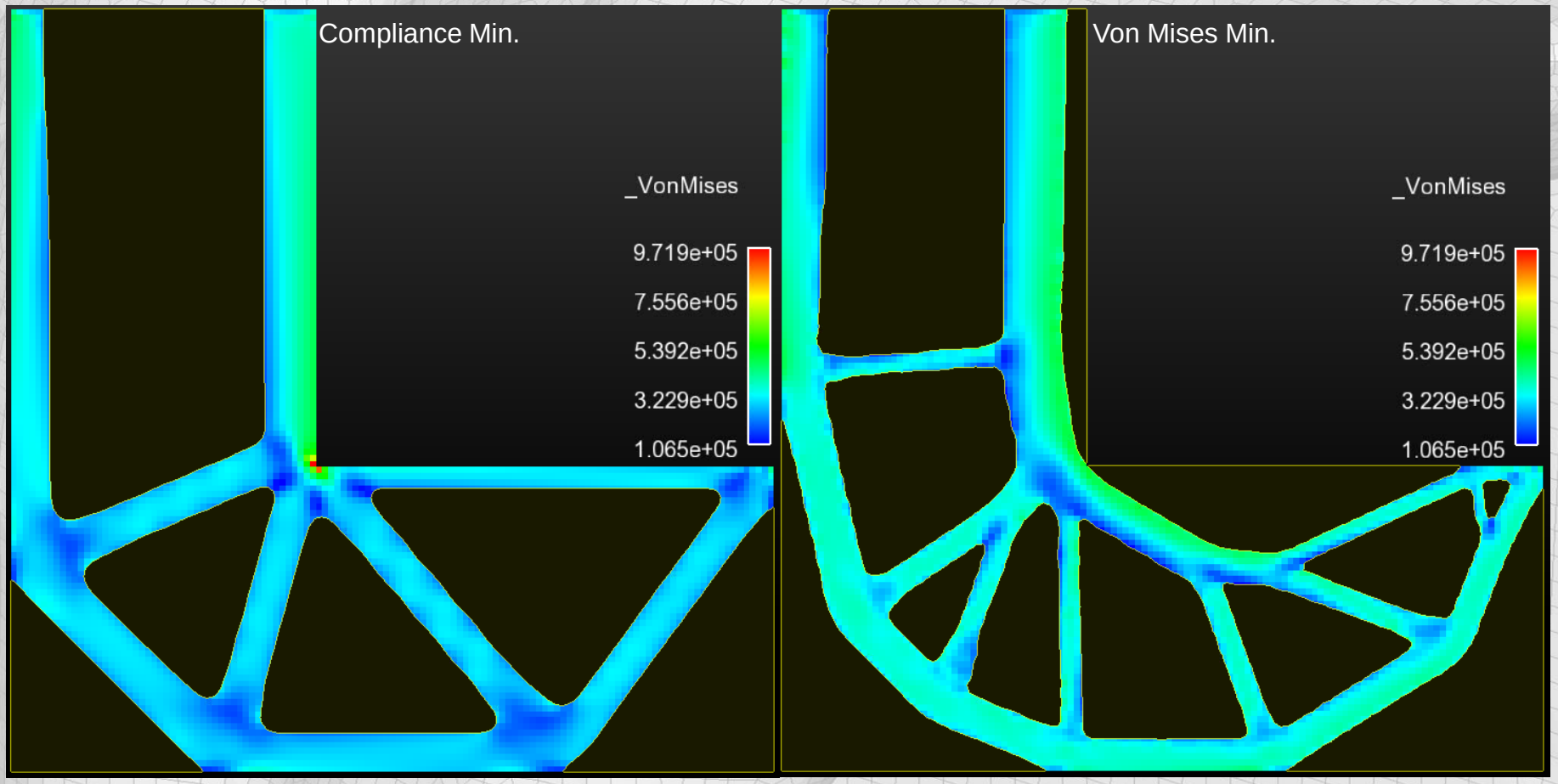








Stress Minimization



Lattice & Solid Optimization

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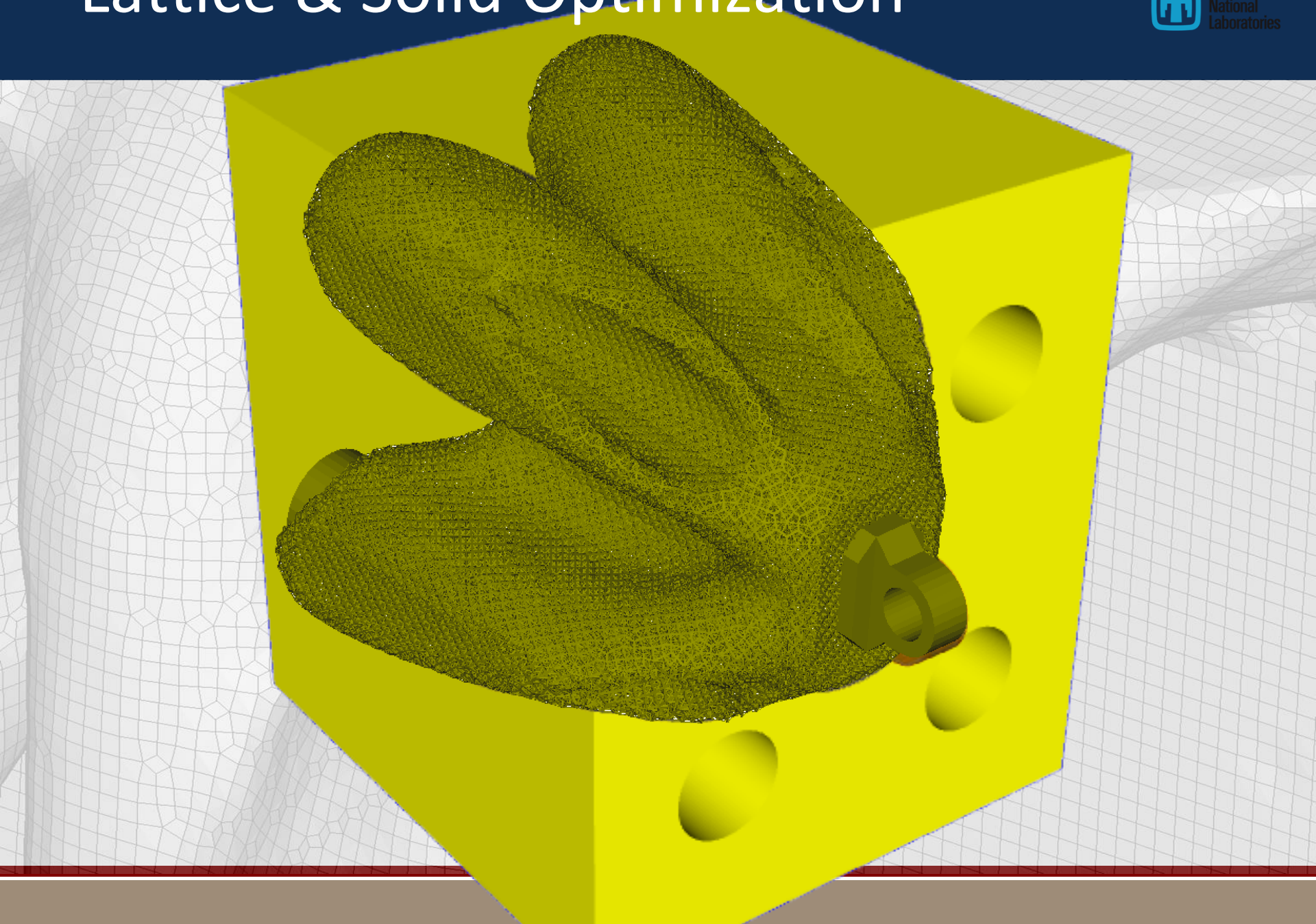

Effect of Lattice Density

Min: (1-α)* compliance + α*thermal