AUTODESK. UNIVERSITY

MFG467991 Leveraging Simulation to Explore Design with Recycled Carbon Fiber

Mason Myers

James Kubli

About the speaker

Mason V. Myers

Mason Myers is a Principal Implementation Consultant and has been with Autodesk over 4 years. He is a Certified Moldflow Expert and currently works with Moldflow customers to implement and adopt simulation software. Mason has experience in both the thermoplastic and thermoset industries. When Mason is not running Moldflow, he enjoys spending time with his family, woodworking and hunting.

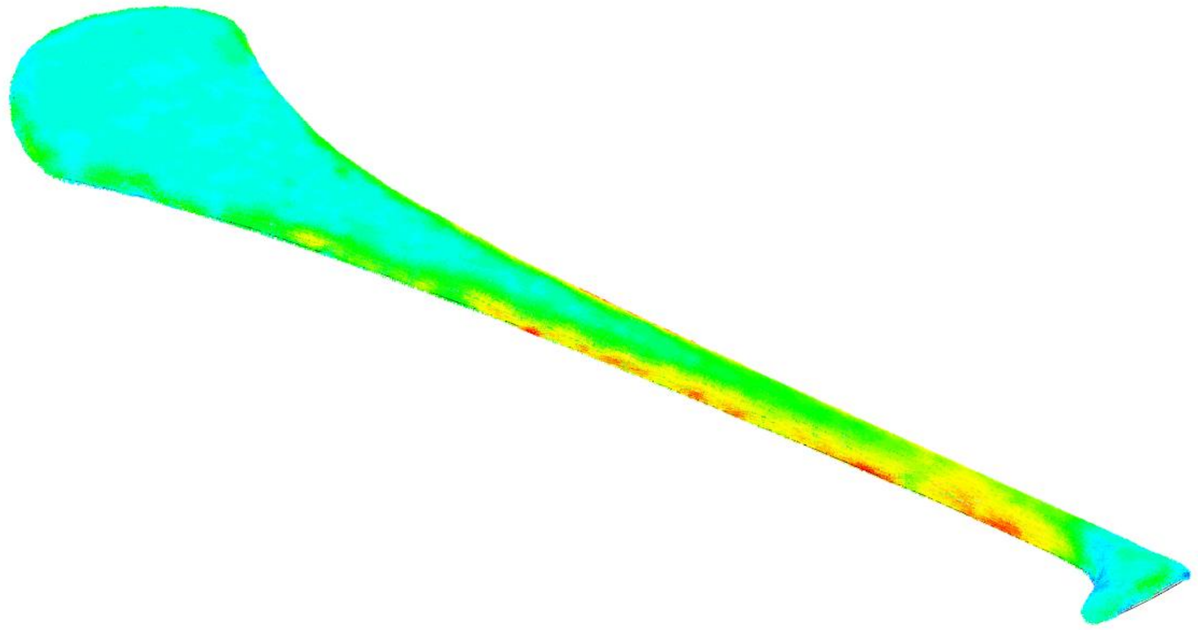
About the speaker

James Kubli

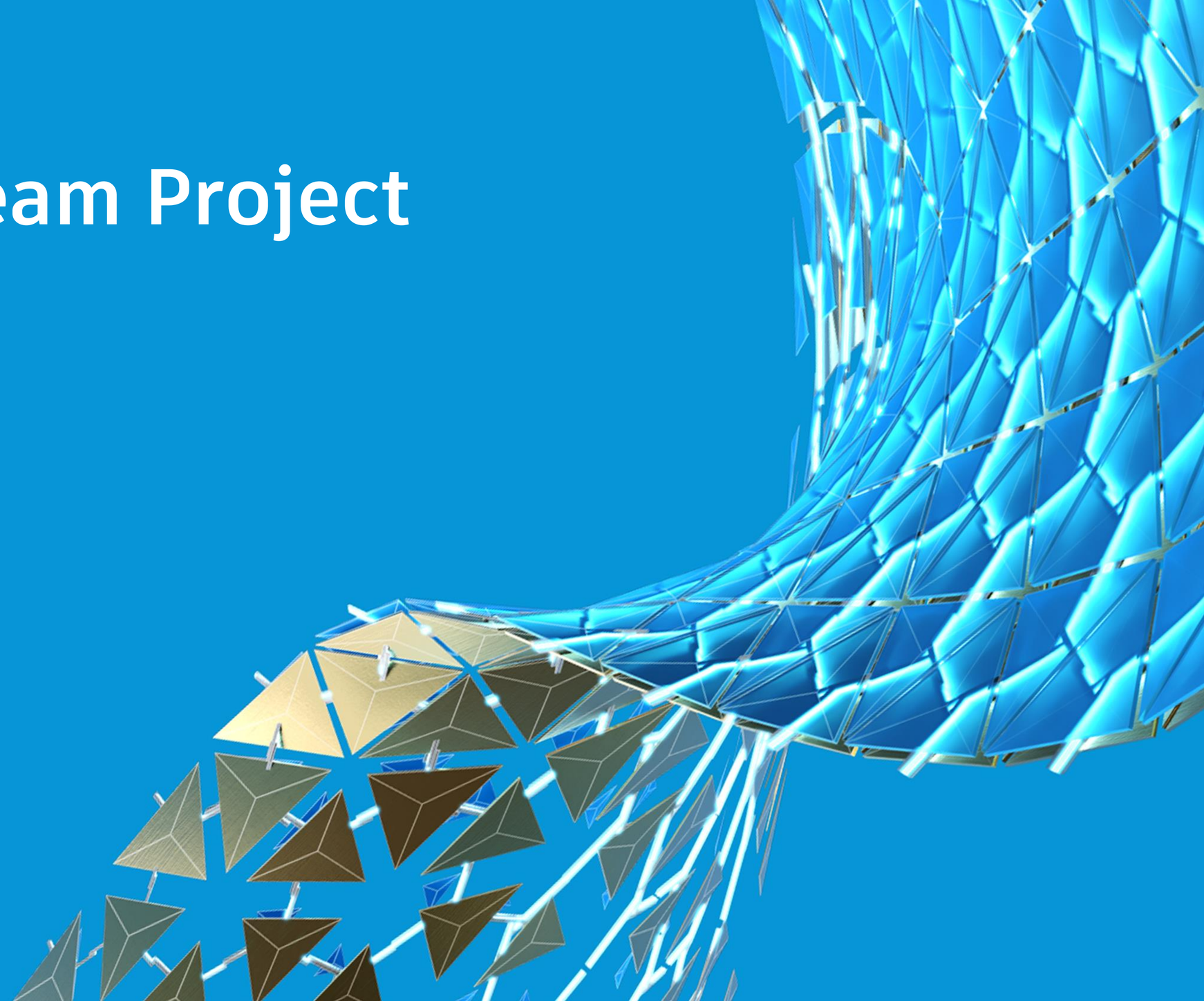
James Kubli is a Technical Support Specialist and has been with Autodesk for over 9 years. He is a mechanical engineer and currently supports customers with structural and fluid dynamic simulations.

Outline

- Pro-Bono at Autodesk
- Explain the Capabilities of Simulation
- Best Practices for Multiple Mesh Types
- Existing vs New Hurling Stick Design



Pro Bono Team Project



Autodesk Pro Bono Consulting

Through Autodesk's Pro Bono Consulting, employees can apply their expertise to solve a critical capacity building challenge with some of our most impactful customers

Pro Bono Team Projects

1:1 Pro Bono Consulting

Pro Bono Immersion

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Hurling 101

National sport of Ireland and oldest field game in the world

- Considered the fastest game on grass, Hurling combines skills of Lacrosse, Field Hockey, and Baseball
- 15 players per side competing on a field that is 140 meters long and 90 meters wide
- Majority of the players use handmade sticks "hurls" made from Ash to move a leather stitched ball ("Sliotar")
- Points are scored by hitting the ball through the uprights (1 point) or in the goal (3 points) which is defended by a goalkeeper

Traditional Ash Hurl

Usually 60-90 cm in length and 0.5 kg

Composite Redesign Hurl

2-piece construction with inner “core” and outer composite “skin”

Attempting to match weight of traditional ash hurl

Autodesk

Mason Myers

James Kubli

Doug Mandic

Vartega

Andrew Maxey

X-Hurl

Michael Schaefer

Johns Manville

Mingfu Zhang

Nicholas Fitzpatrick

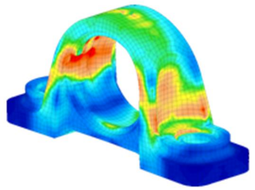
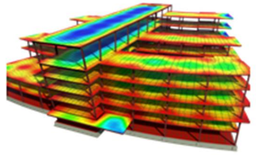
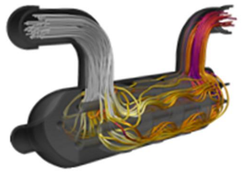
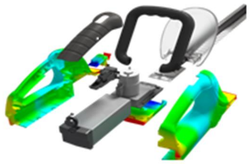
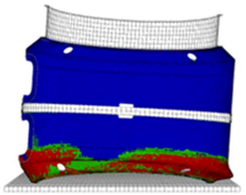
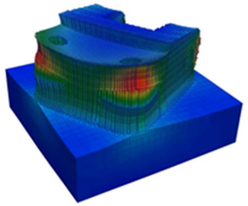
Pro Bono Consulting Team

Autodesk

Mason Myers

James Kubli

Doug Mandic

Structural Mechanics	Structural Architecture	Flow & Thermal Analysis	Molding Processes	Composite Materials	Additive MFG Optimization
					
AUTODESK NASTRAN IN-CAD AUTODESK NASTRAN AUTODESK FUSION 360	AUTODESK ROBOT STRUCTURAL ANALYSIS PROFESSIONAL	AUTODESK CFD	AUTODESK MOLDFLOW ADVISER AUTODESK MOLDFLOW INSIGHT	AUTODESK HELIUS PFA AUTODESK HELIUS COMPOSITE	AUTODESK NETFABB

Pro Bono Consulting Team

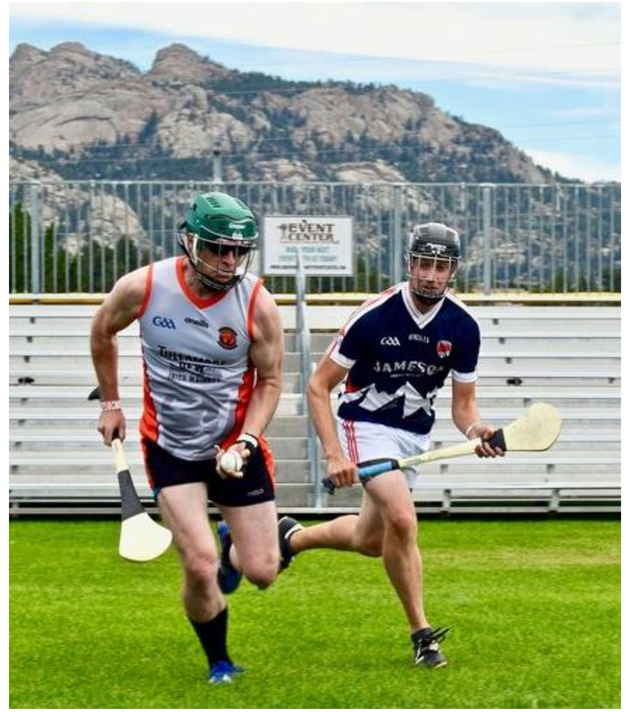
Vartega

Andrew Maxey

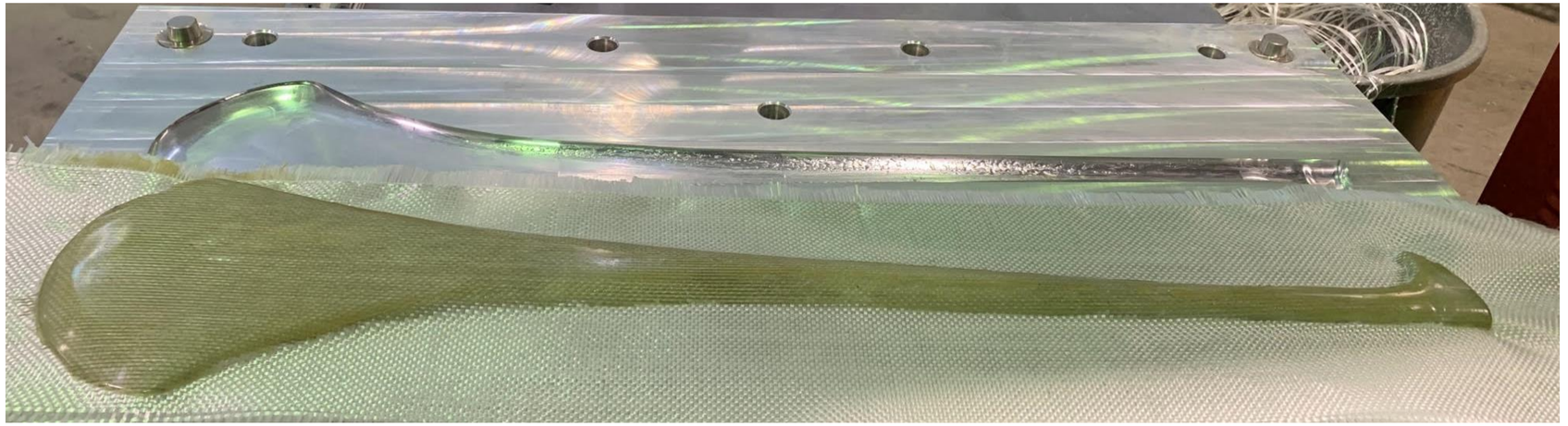
Pro Bono Consulting Team

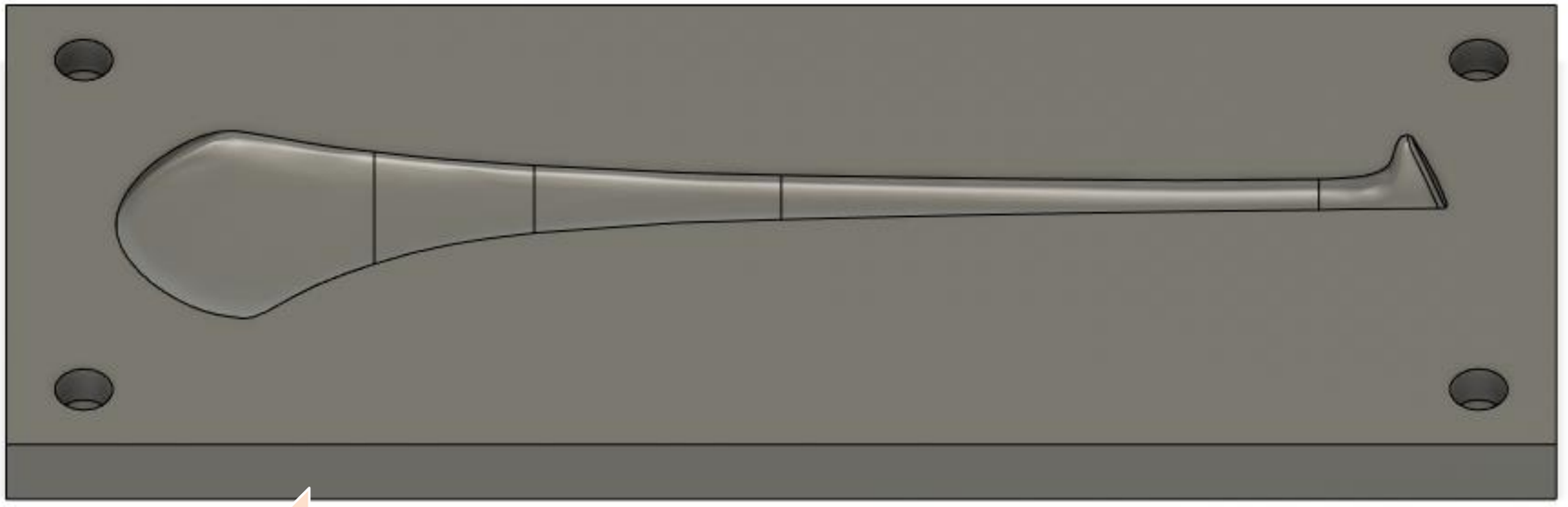
X-Hurl

Michael Schaefer



Pro Bono Consulting Team





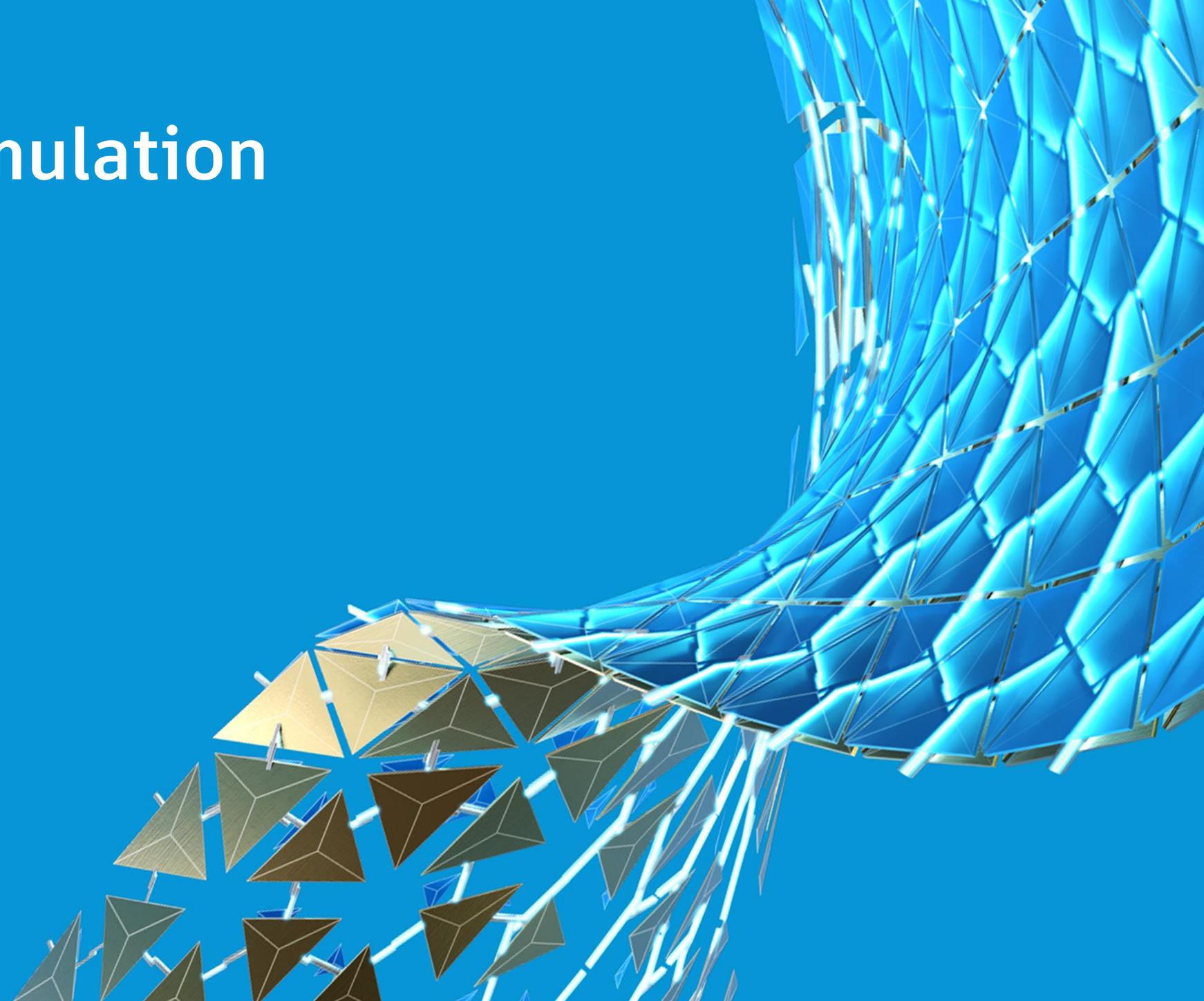
Johns Manville

Mingfu Zhang

Nicholas Fitzpatrick

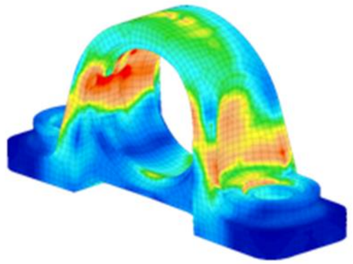
Pro Bono Consulting Team

Autodesk Simulation Capabilities



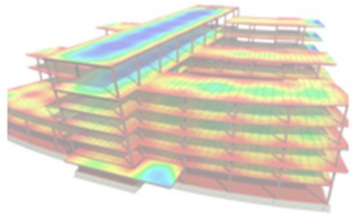
Autodesk Simulation Capabilities

Structural Mechanics



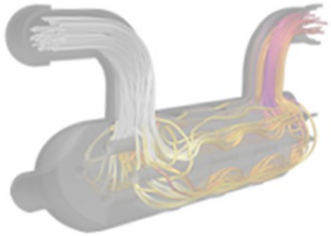
- AUTODESK NASTRAN IN-CAD
- AUTODESK NASTRAN
- AUTODESK® FUSION 360™

Structural Architecture



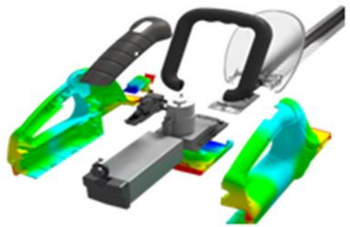
- AUTODESK® ROBOT™ STRUCTURAL ANALYSIS PROFESSIONAL

Flow & Thermal Analysis



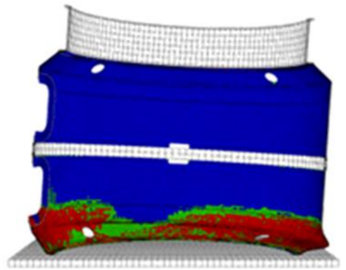
- AUTODESK CFD

Molding Processes



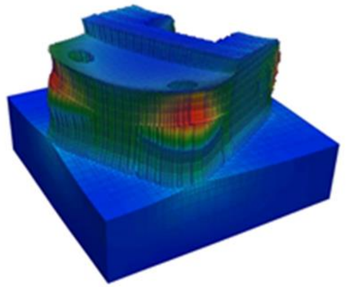
- AUTODESK® MOLDFLOW® ADVISER
- AUTODESK® MOLDFLOW® INSIGHT

Composite Materials



- AUTODESK® HELIUS PFA
- AUTODESK® HELIUS COMPOSITE

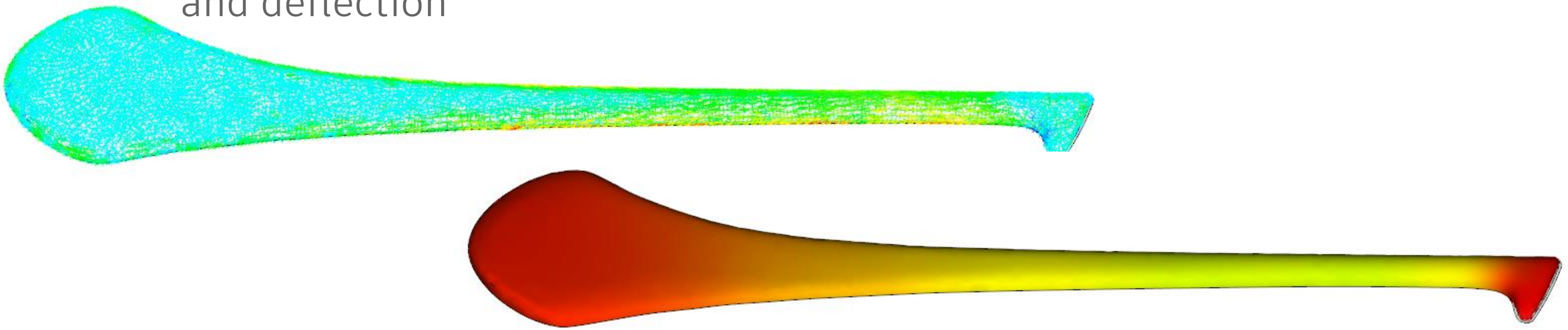
Additive MFG Optimization



- AUTODESK® NETFABB®

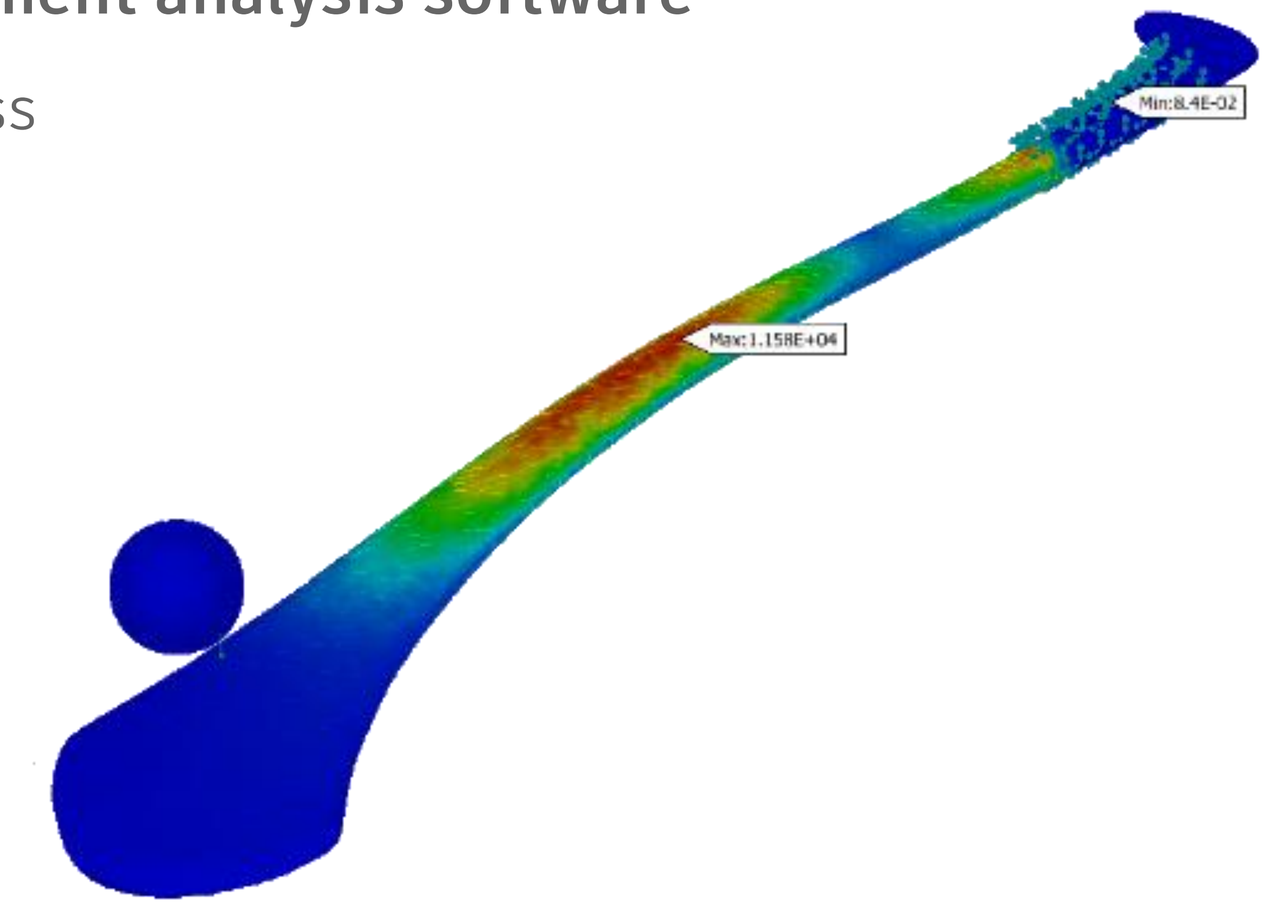
Moldflow Insight

- **Mold filling simulation software for design and manufacturing**
  - Thermoplastics and thermosetting materials
  - Various molding methods can be simulated
  - Provides results such as filling patterns, fiber orientation, shrinkage, and deflection



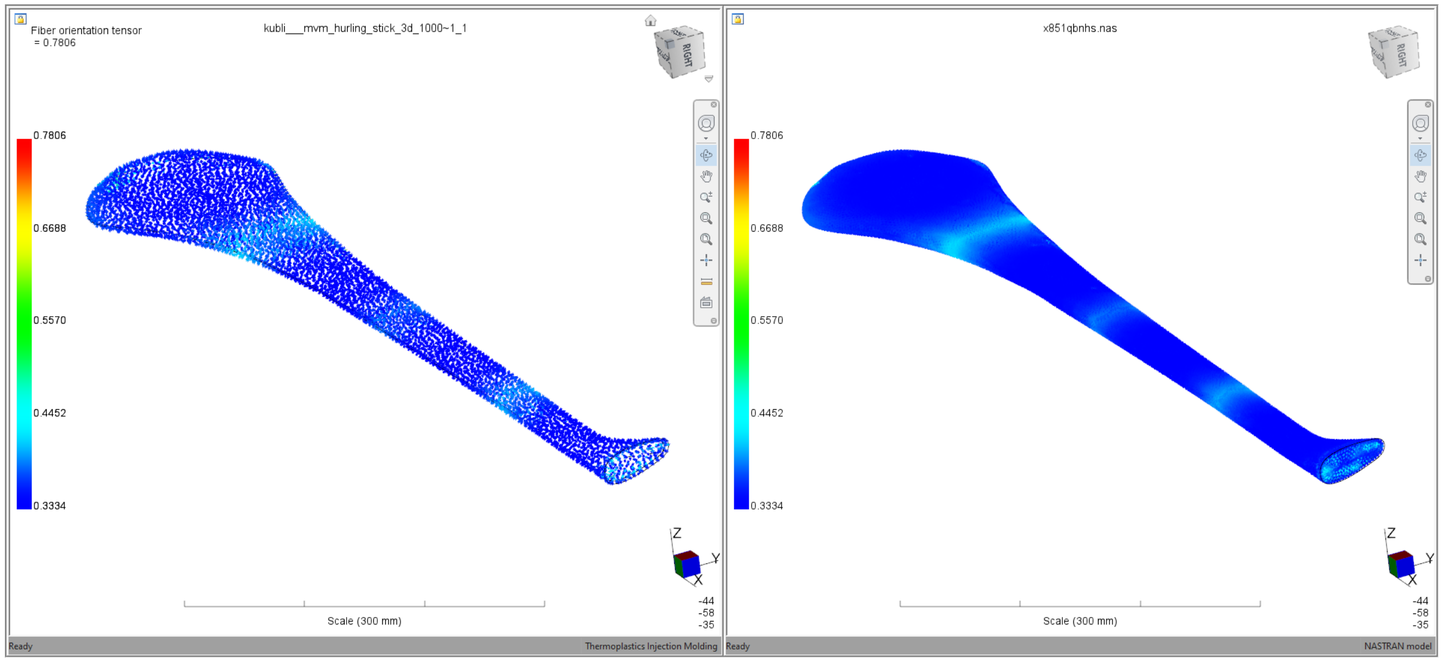
Inventor Nastran

- **CAD-embedded finite element analysis software**
  - Linear and Nonlinear Stress
  - Dynamics
  - Heat transfer



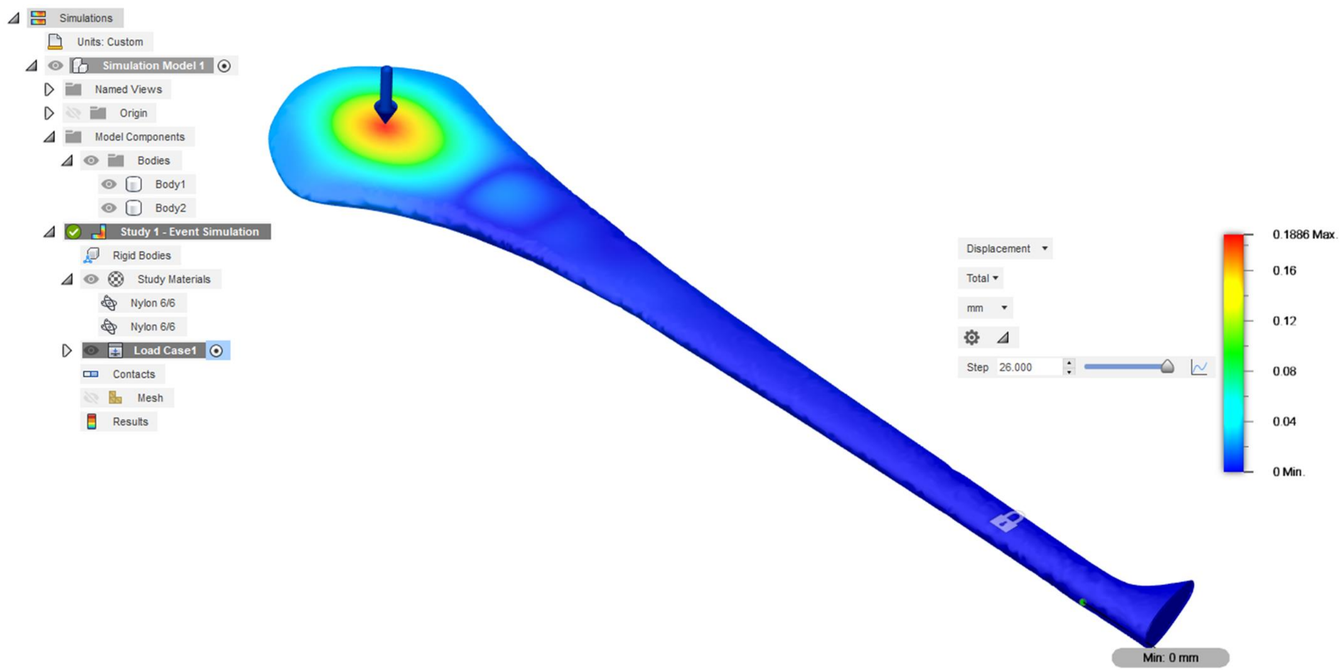
Helius AME & Helius PFA

- **Helius Advanced Material Exchange/Progressive Failure Analysis**
  - Map Moldflow results to FEA
  - Composite failure analyses
  - Direct FEA integration



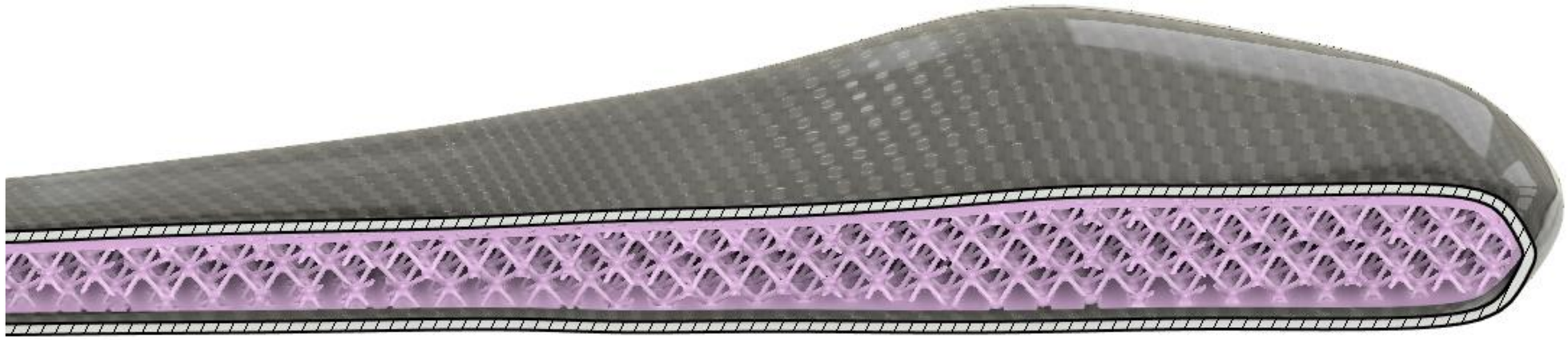
Fusion Simulation

- **Integrated CAD, CAM, CAE, and PCB Software**
  - Static Stress
  - Modal Frequency
  - Thermal & Thermal Stress
  - Buckling
  - Non-linear Stress
  - Event Simulation
  - Shape Optimization

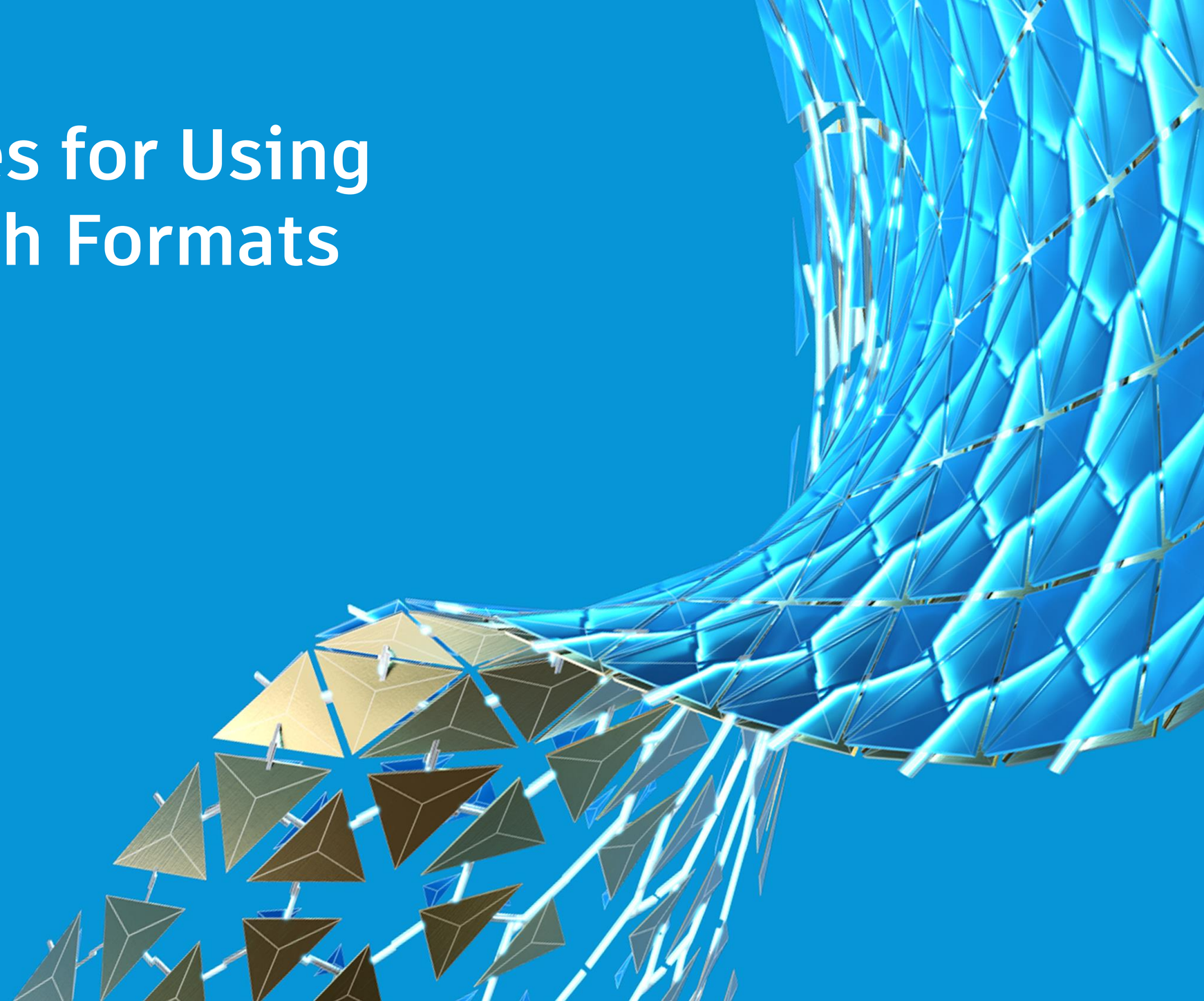


Netfabb

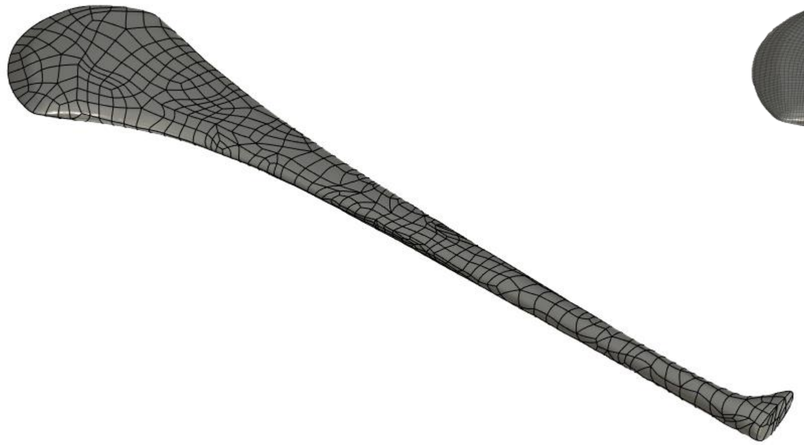
- **3D Printing Software from Design to Manufacture**
  - Build preparation
  - Design optimization for additive manufacturing
  - Simulate thermomechanical properties during printing (metal only)

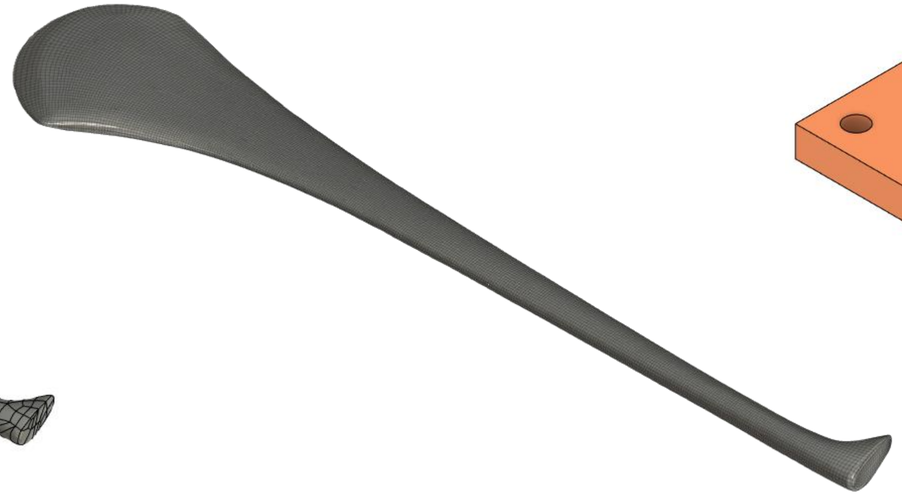


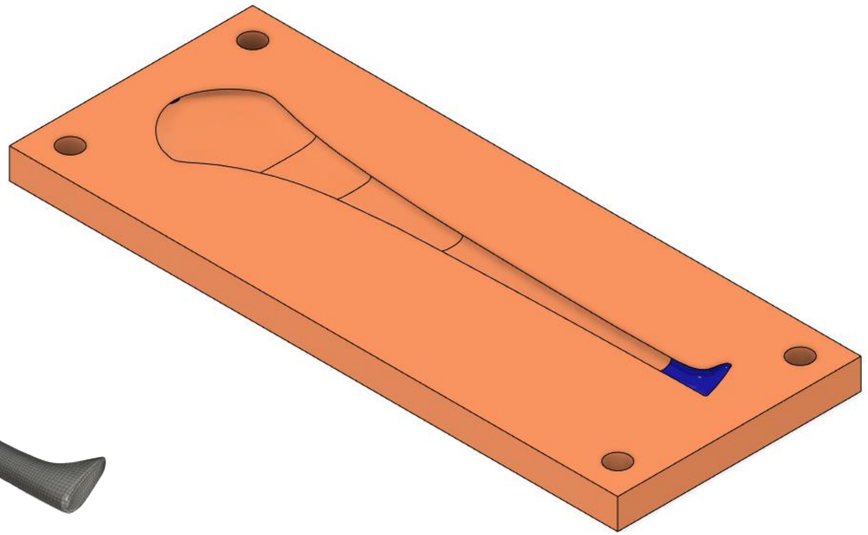
Best Practices for Using Multiple Mesh Formats



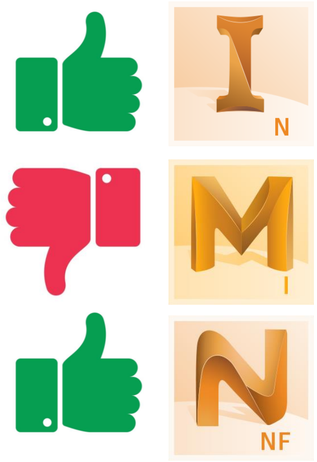
CAD Files Supplied to Autodesk - Meshing



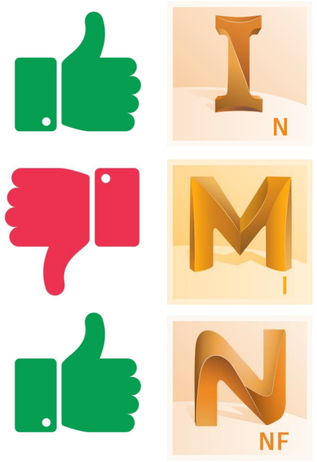




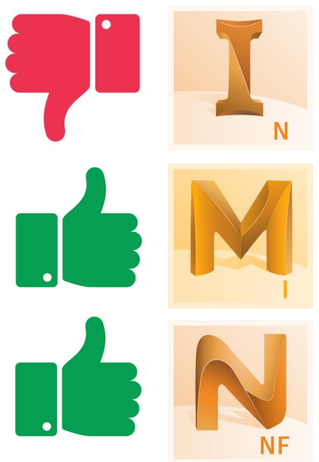
STEP file of 3D Scan



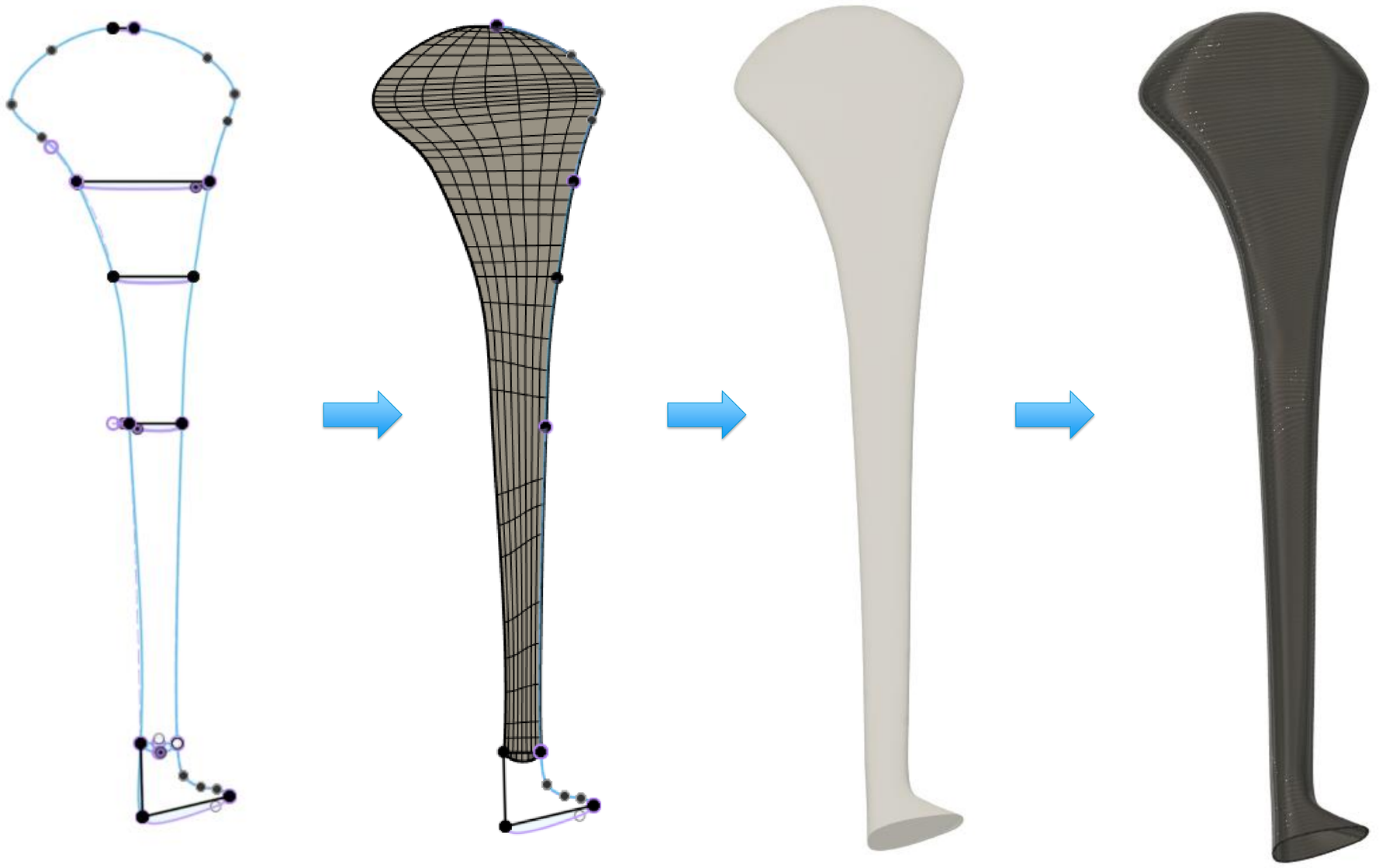
Stl of 3D Scan

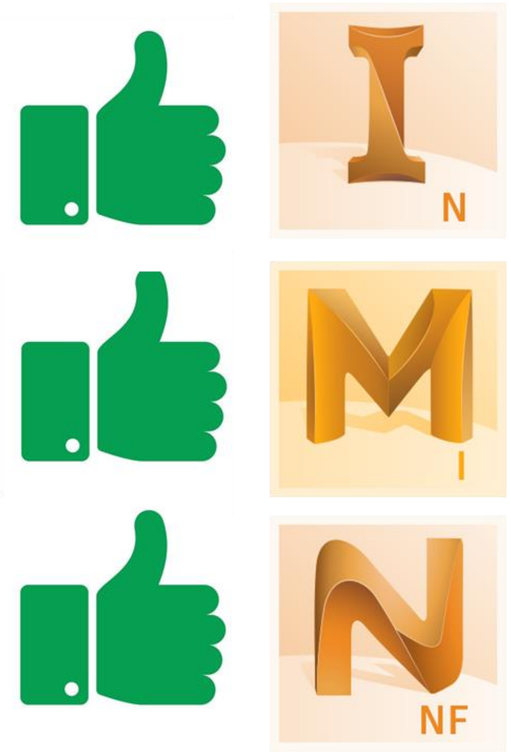


Mold Plates.xt



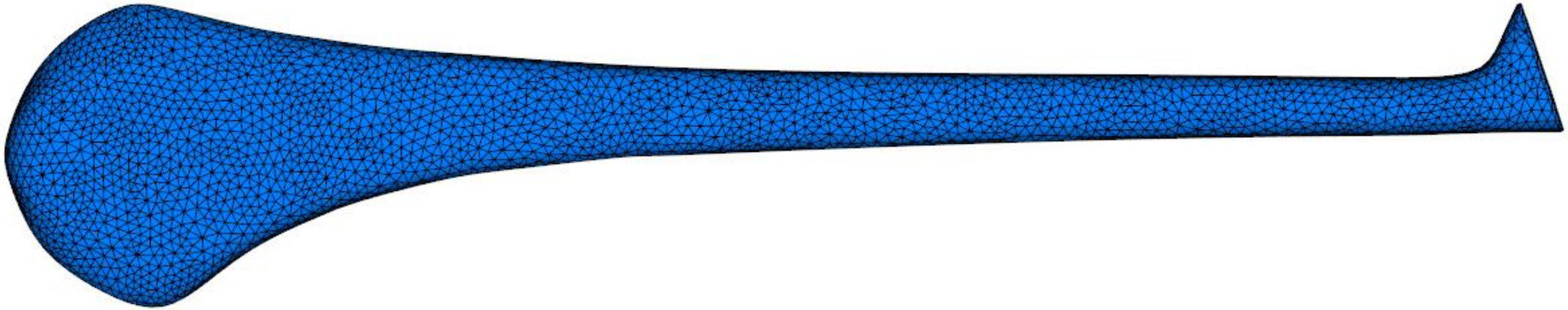
Fusion360 Surface Reconstruction to Solid CAD





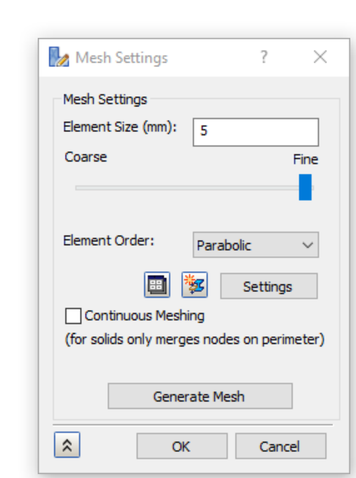
Meshing in Moldflow

- **Native CAD and STEP files work best**
  - IGES and STL files can be meshed with less automatic mesh features
  - Clean, water-tight CAD preferred
- **Various mesh types available**
  - 3D preferred given molding technique and export to Helius PFA



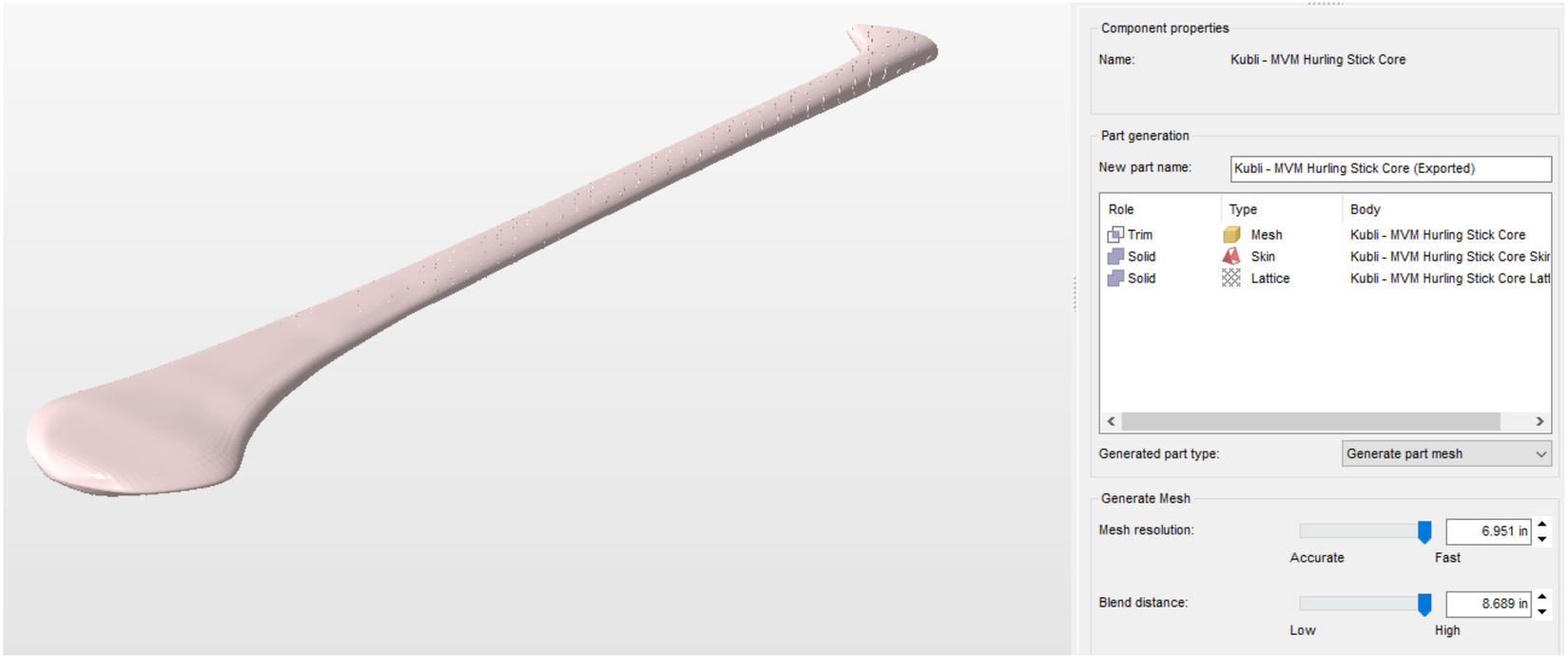
Meshing in Nastran

- **Accepts a wide range for file formats**
- **Tetrahedral mesh used for solids**
  - Clean CAD meshes fine with defaults



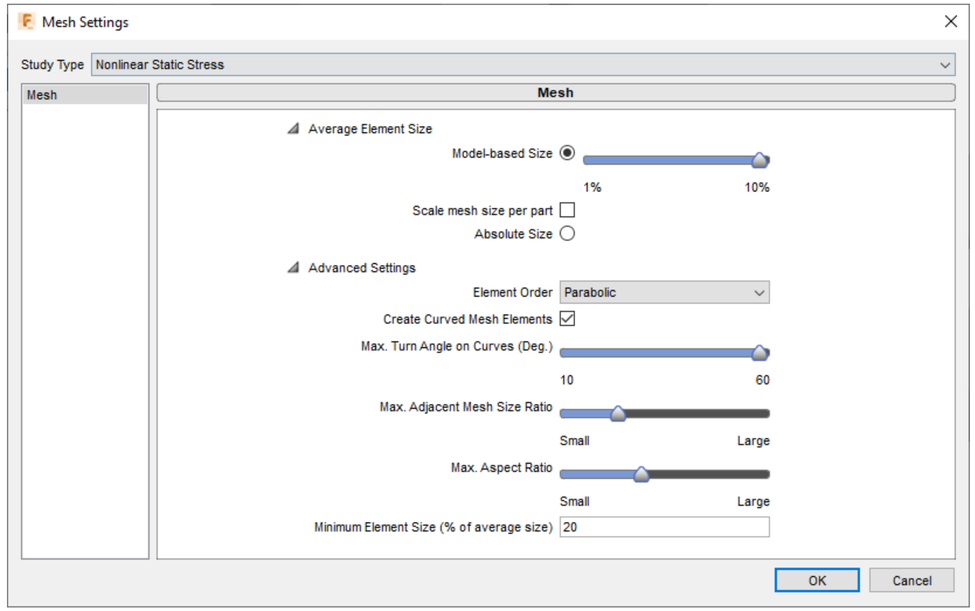
Meshing in Netfabb

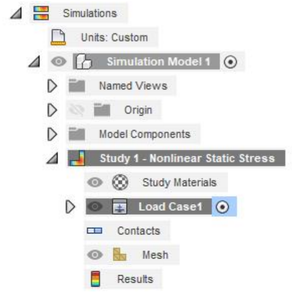
- **Triangle mesh utilized**
  - Lattices and skins can be derived from mesh body
  - This mesh used in designing supports, slicing, or simulation

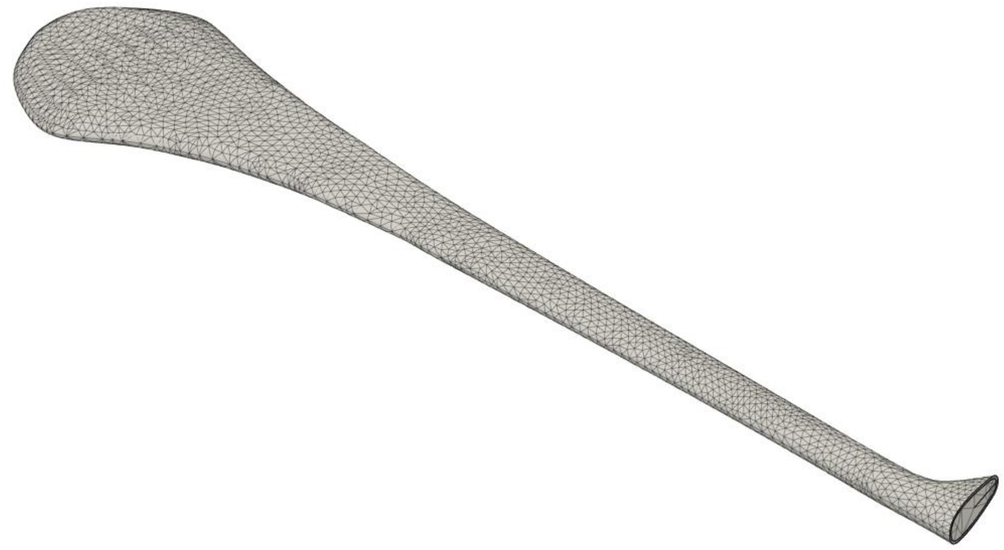


Meshing in Fusion

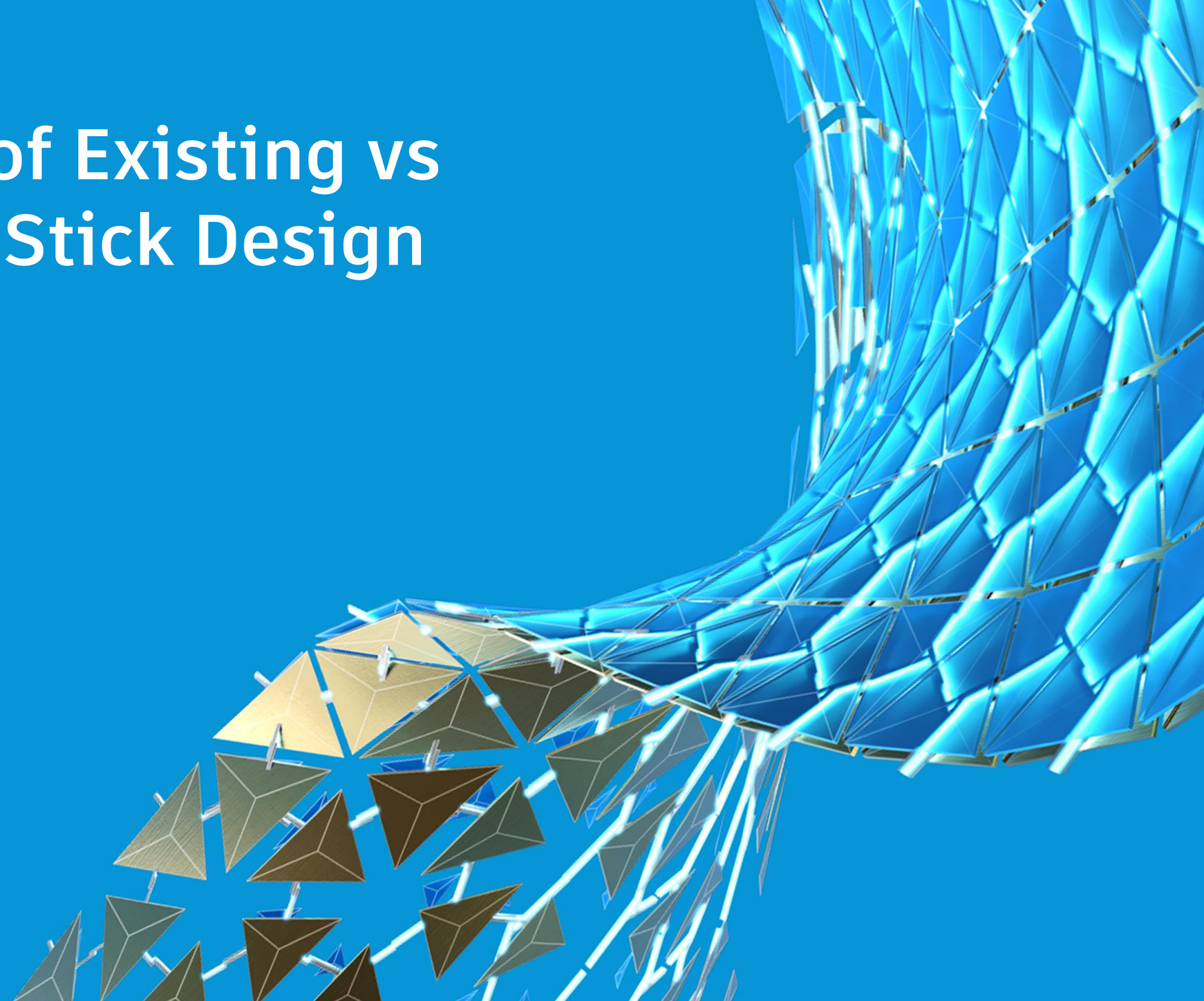
- **3D Tetrahedral Mesh utilized**
  - Default settings usually ideal
  - Extreme thin walled applications can be problematic



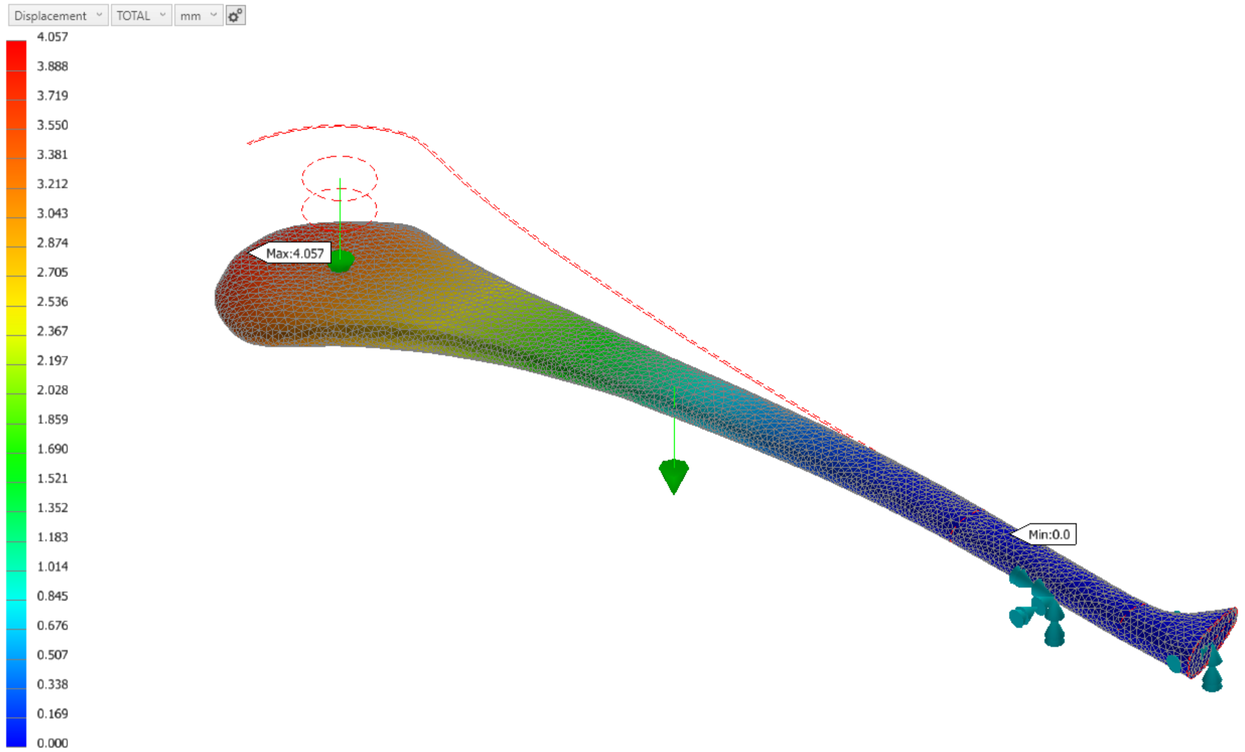




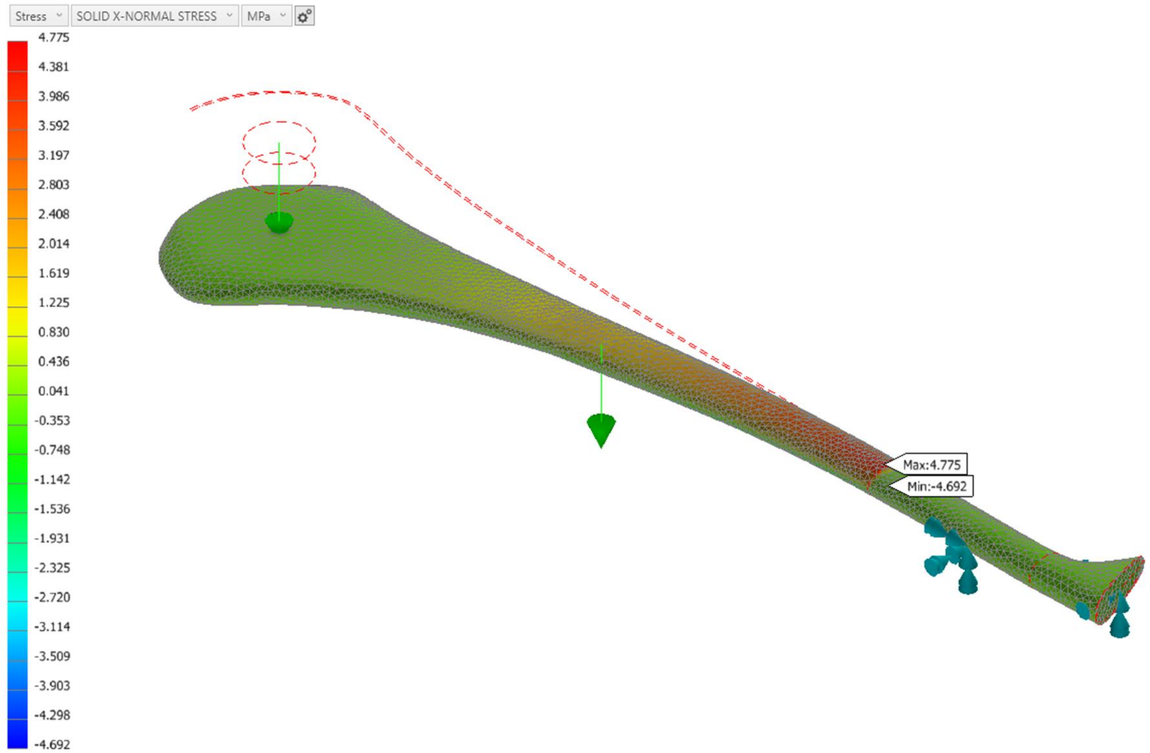
Comparison of Existing vs New Hurling Stick Design



Nastran In-CAD on Ash Hurl

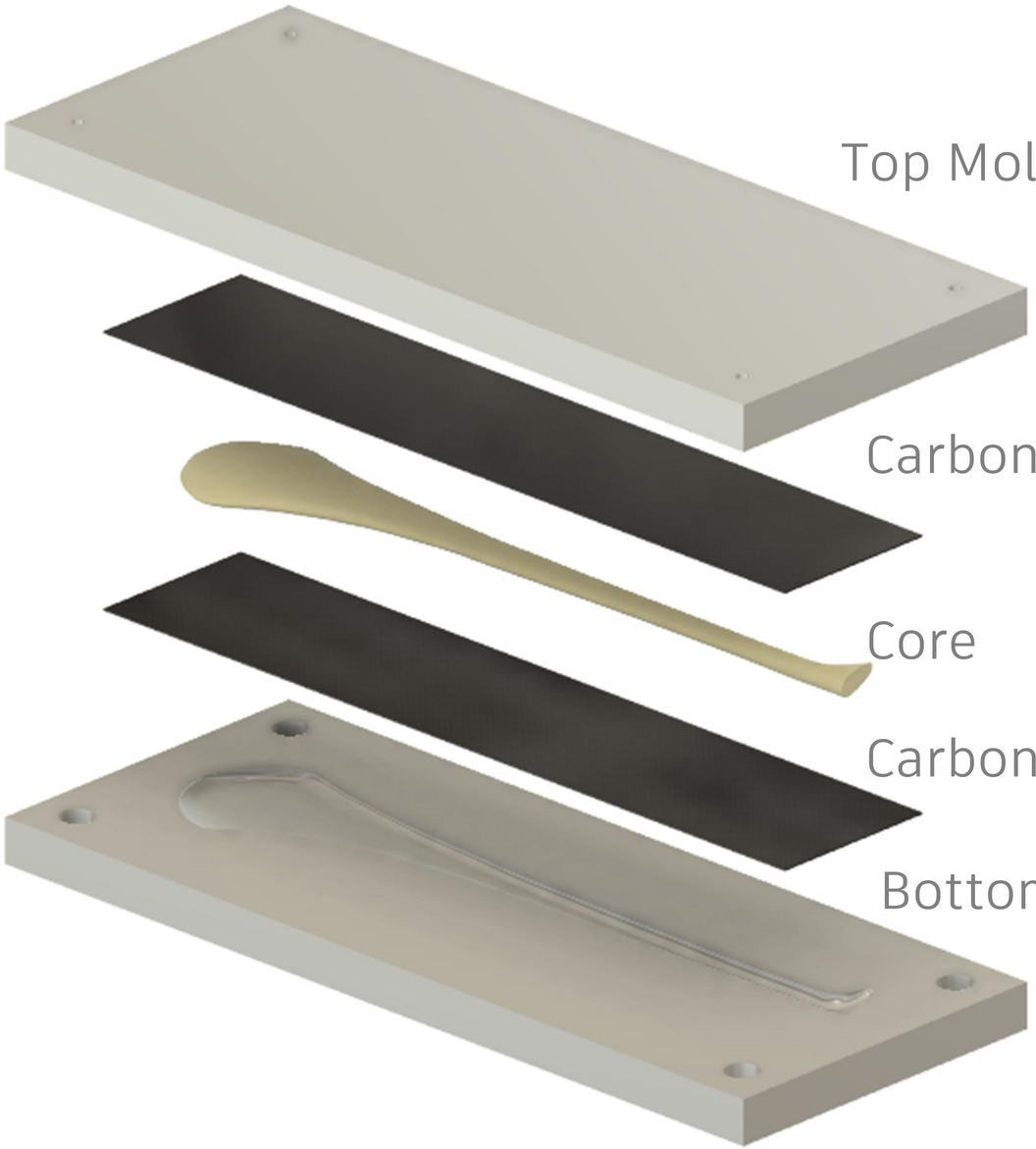


Ash Hurl - Displacement



Ash Hurl - Stress

Current Prototype Compression Molding



Top Mold Plate

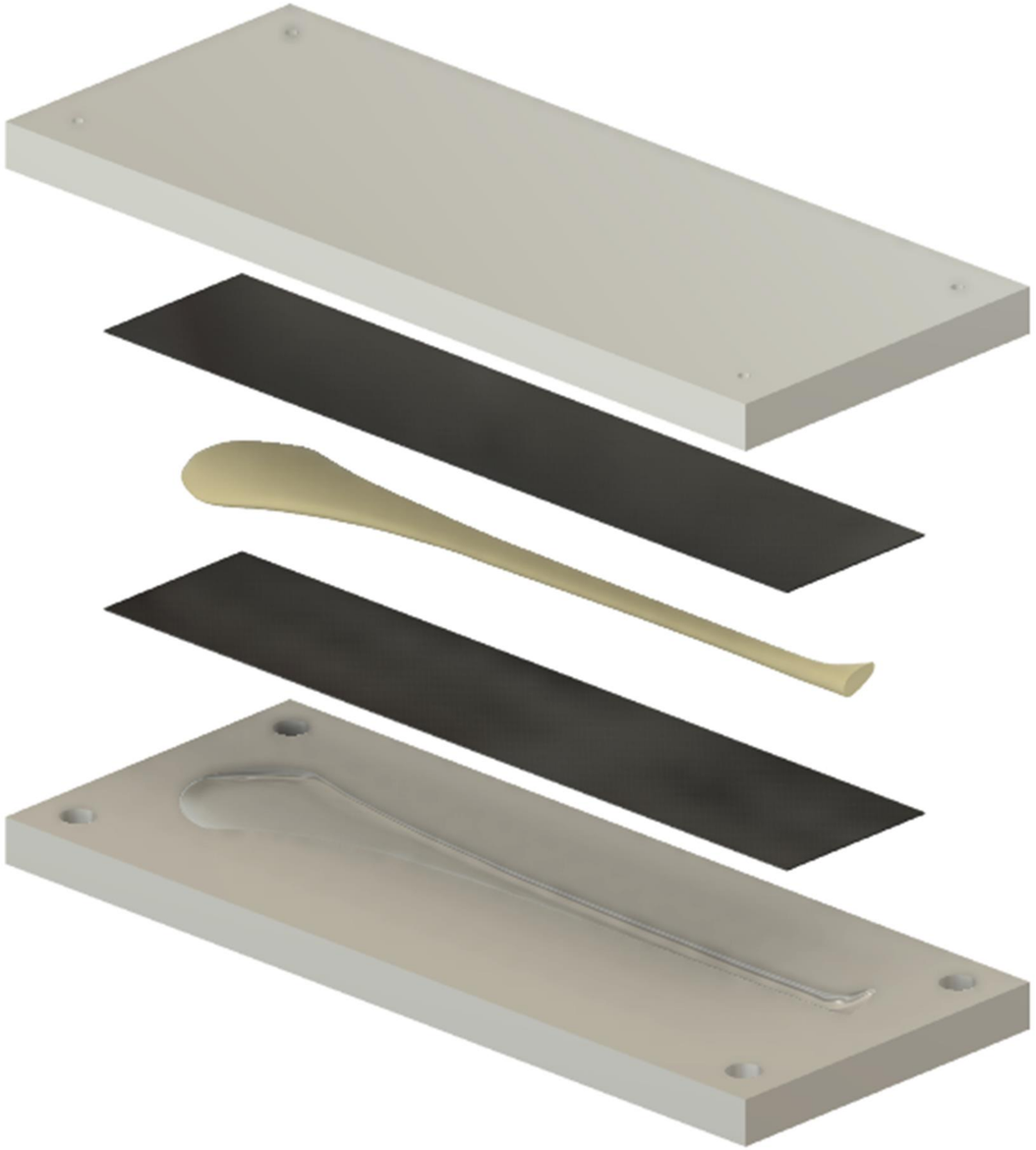
Carbon Fiber Prepreg

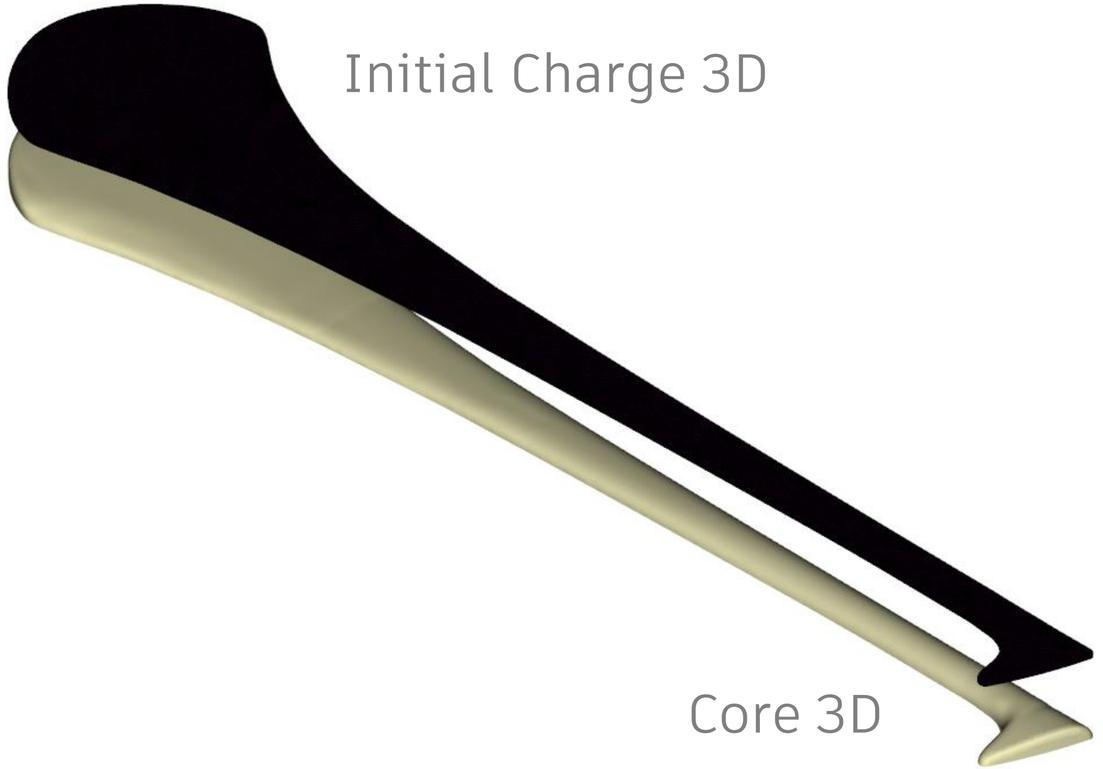
Core

Carbon Fiber Prepreg

Bottom Mold Plate

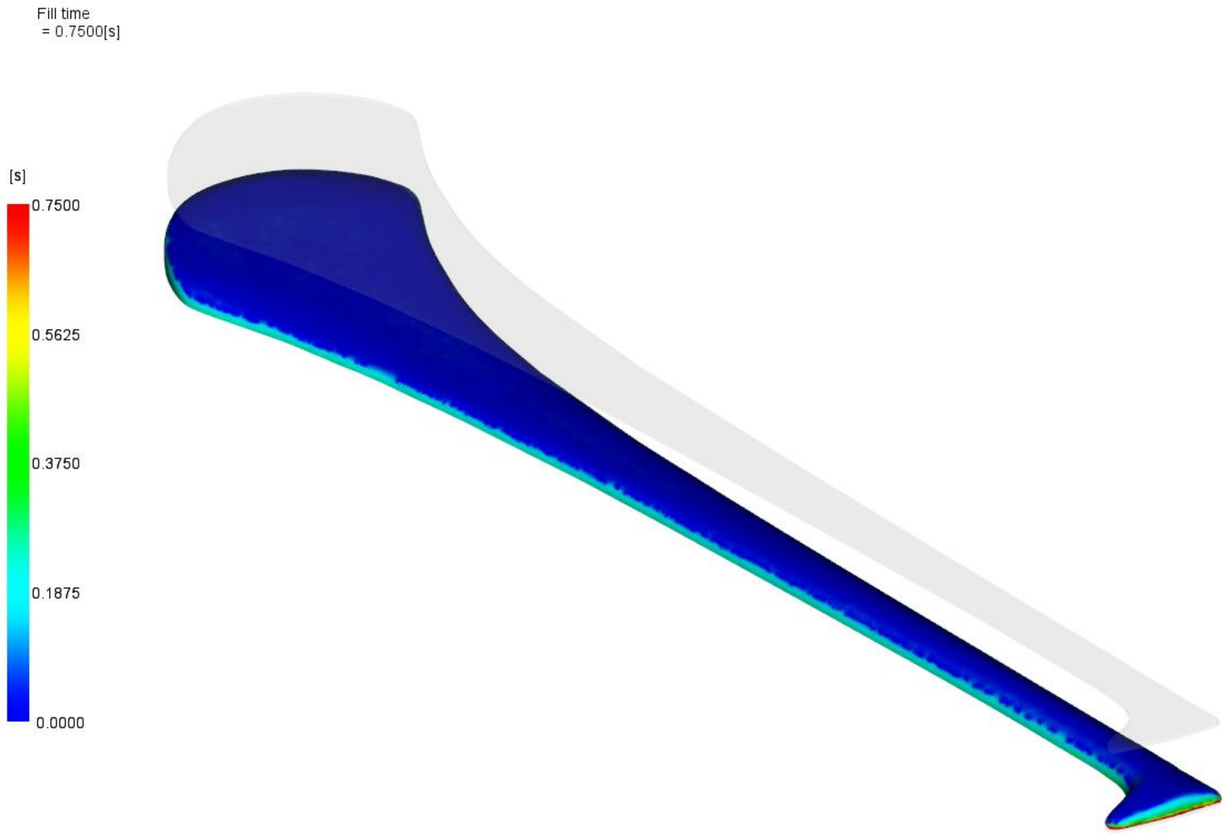
Moldflow Compression Molding



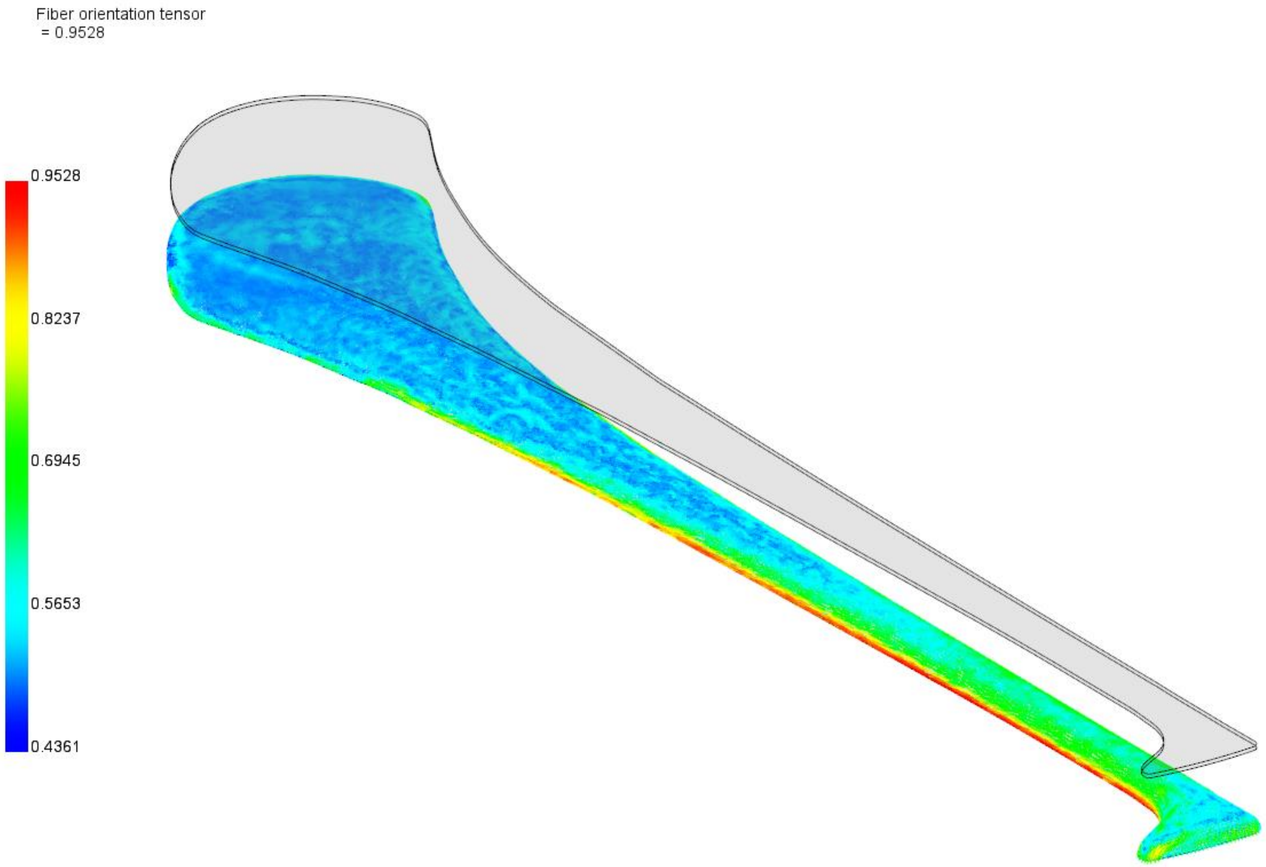


Moldflow does not simulate charges placed on top and bottom of the core, so ½ model was simulated

Moldflow Compression Molding

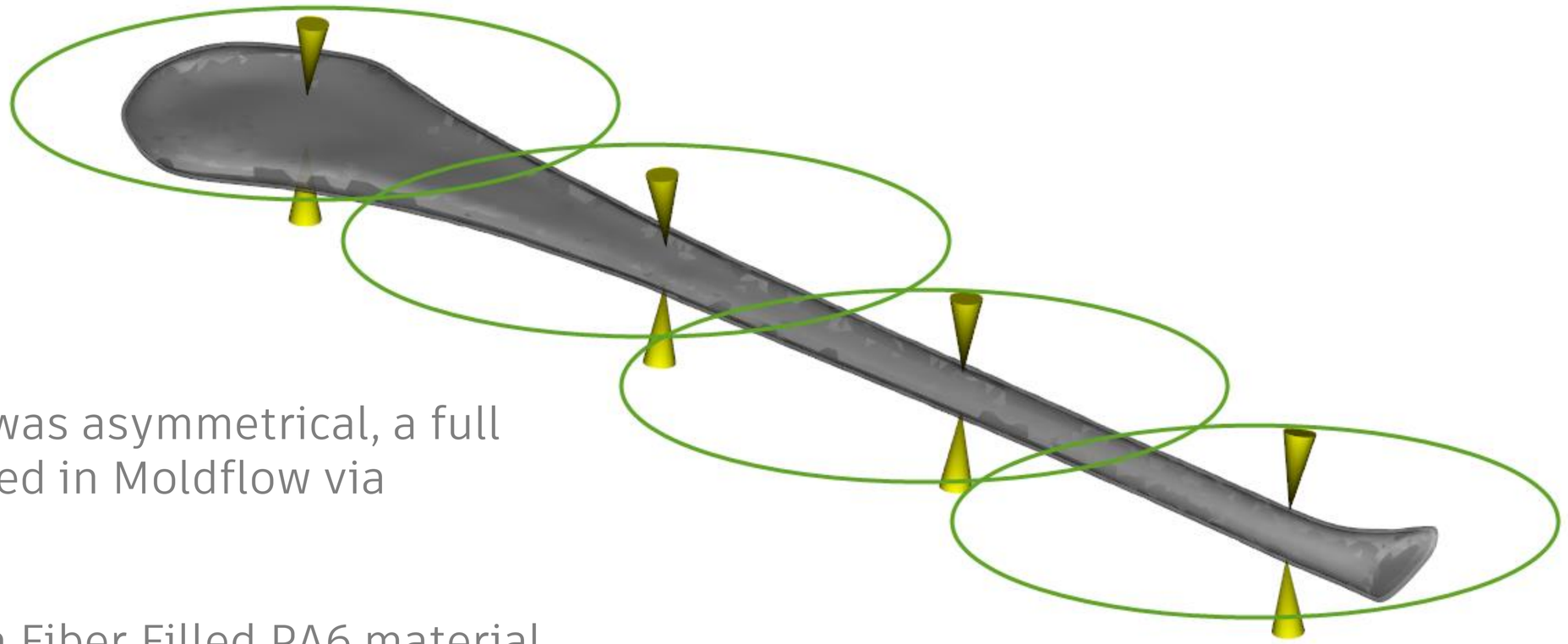


Fill Time



Fiber Orientation

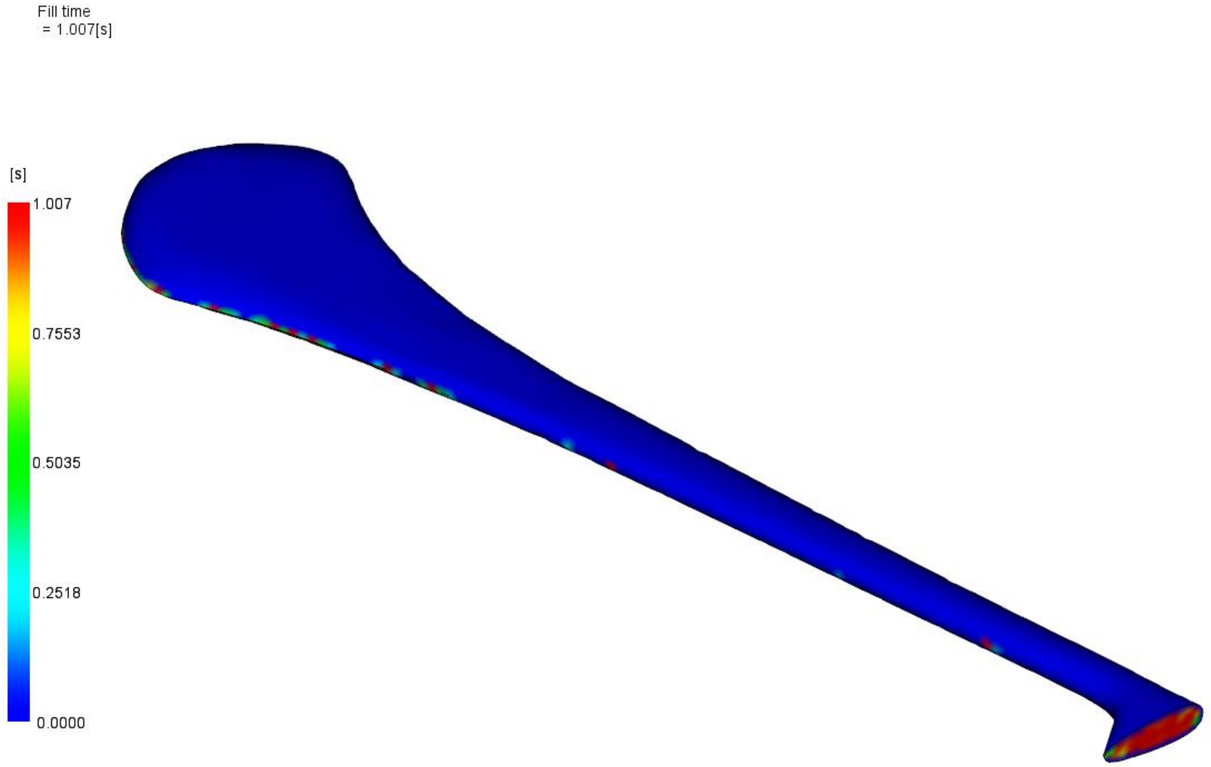
Moldflow Injection Molding



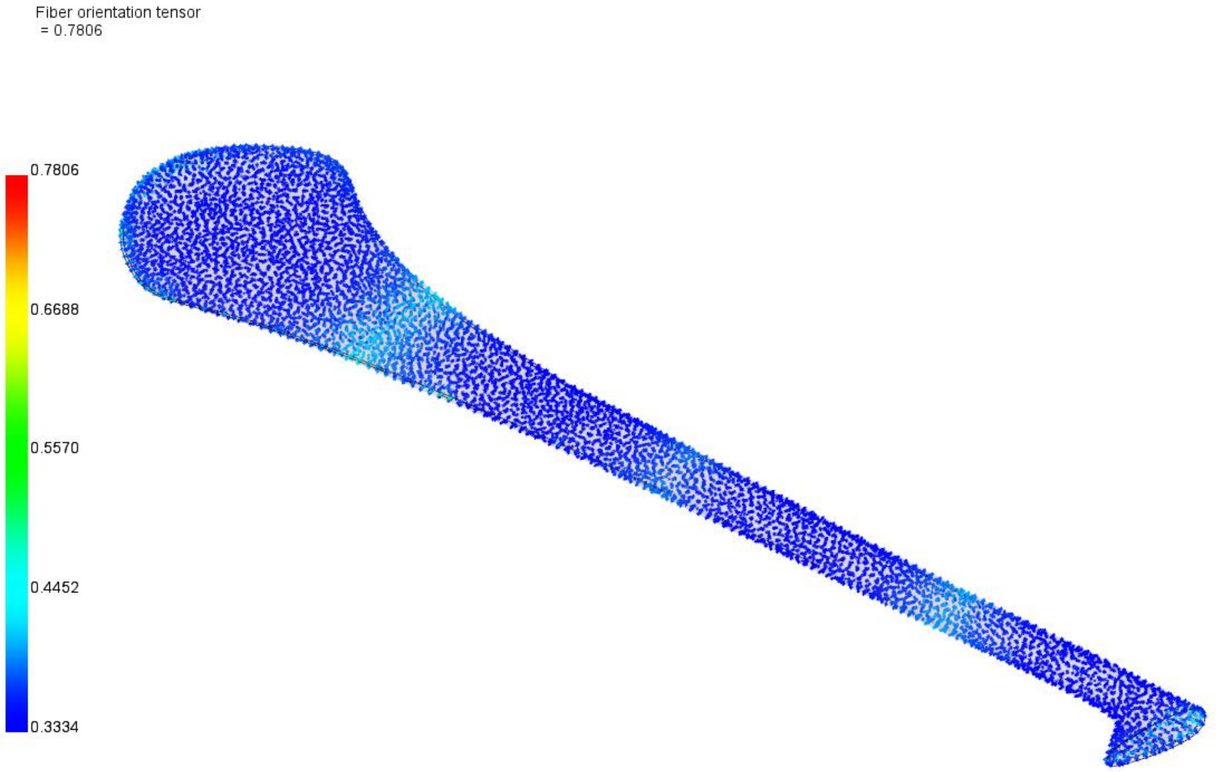
Since FEA loading was asymmetrical, a full model was simulated in Moldflow via Injection Molding

A 45% Long Carbon Fiber Filled PA6 material was selected from Moldflow's existing database

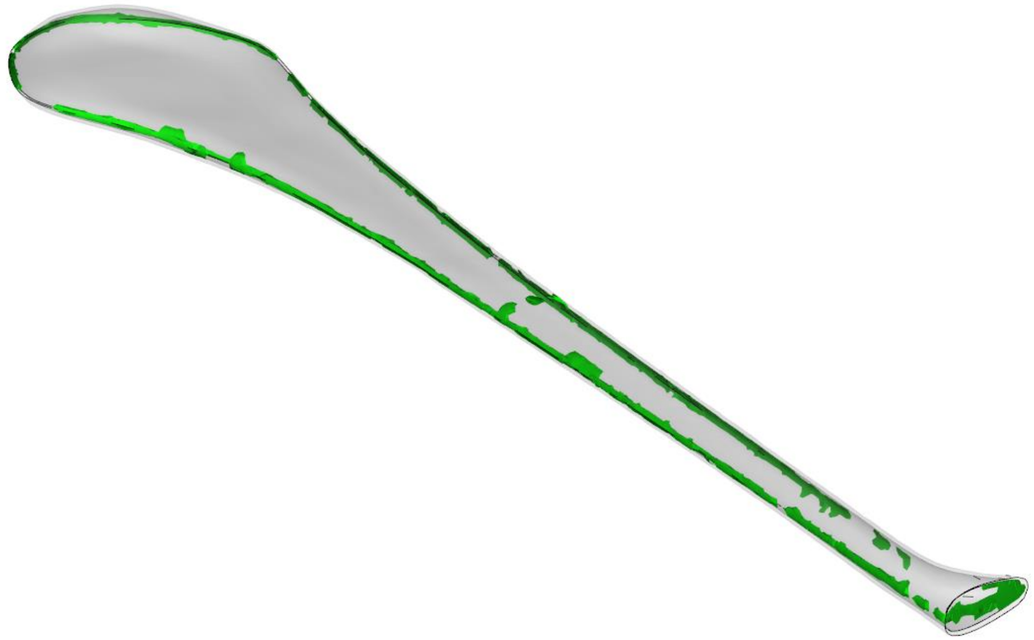
Moldflow Injection Molding



Fill Time

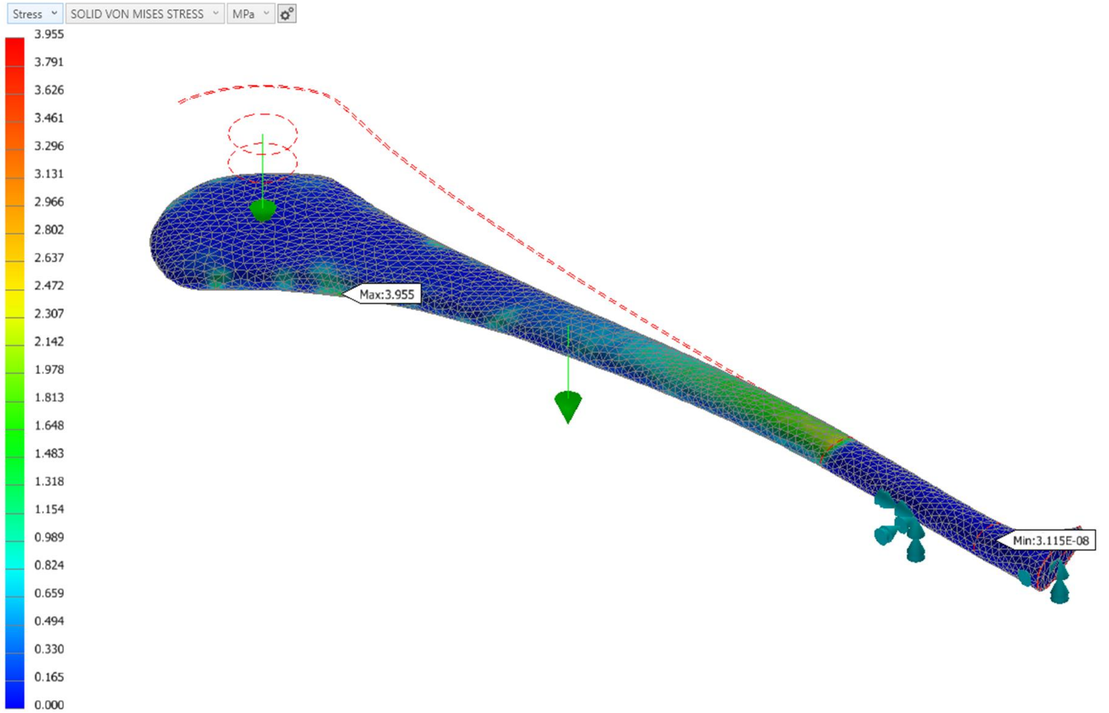


Fiber Orientation



Moldflow Analyses

Typically completed independently of FEA

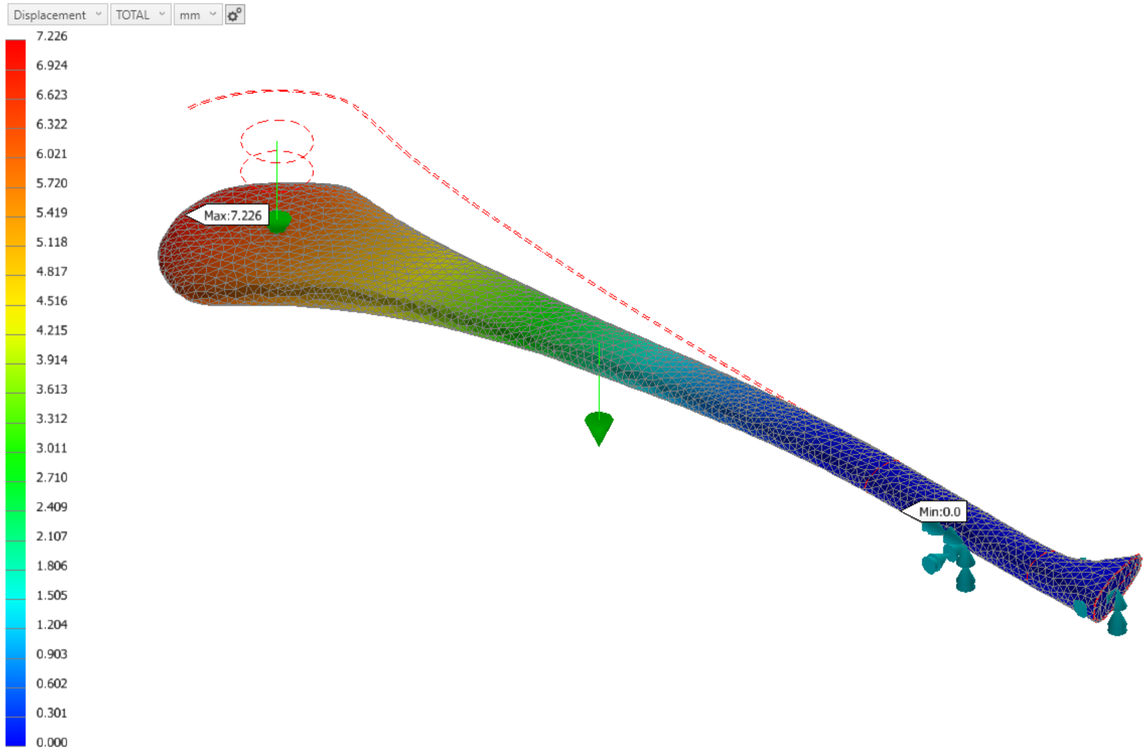


FEA Nastran Analyses

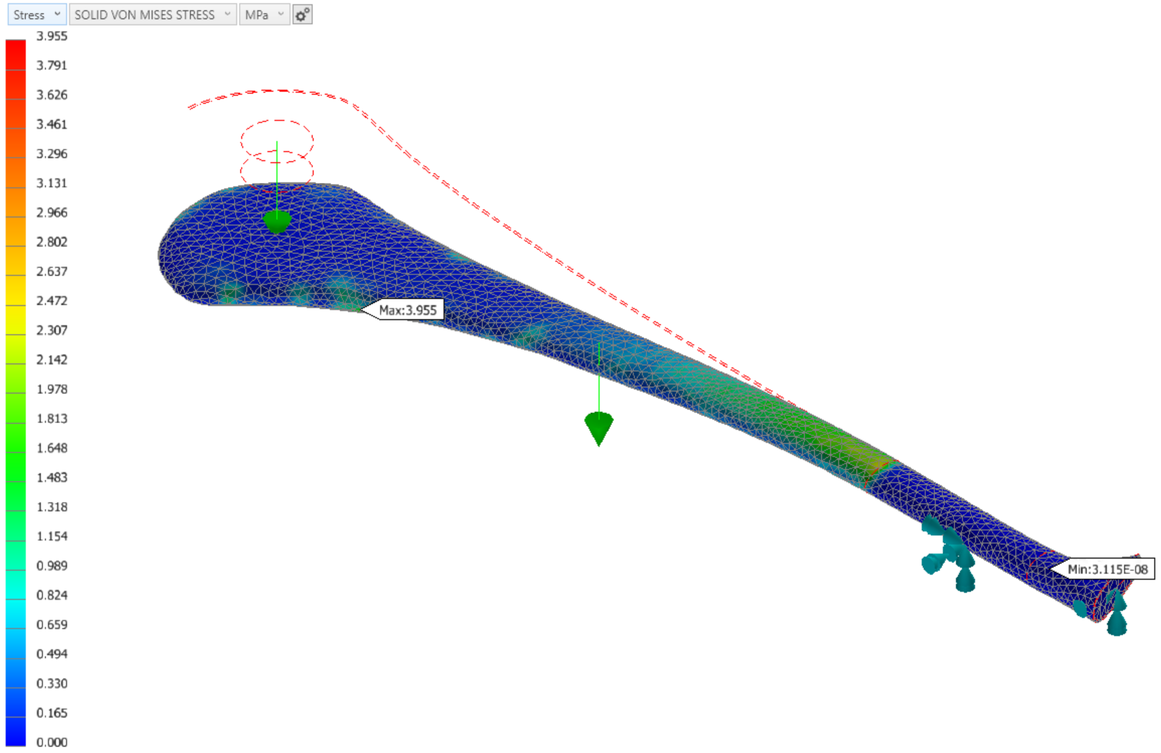
Typically completed independently of Moldflow

Limited material database compared to Moldflow

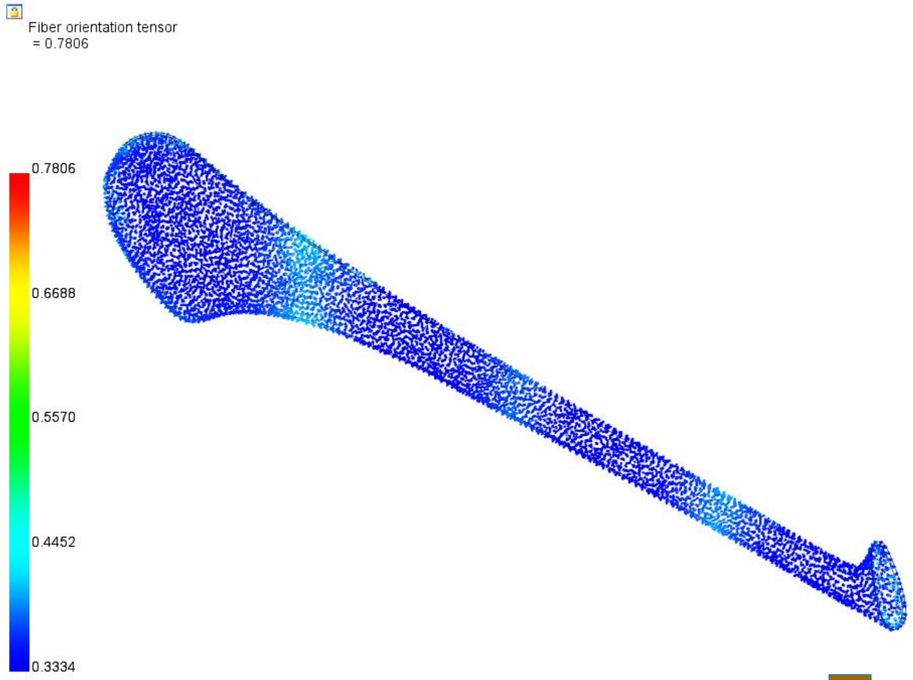
Traditional Nastran with Generic Material

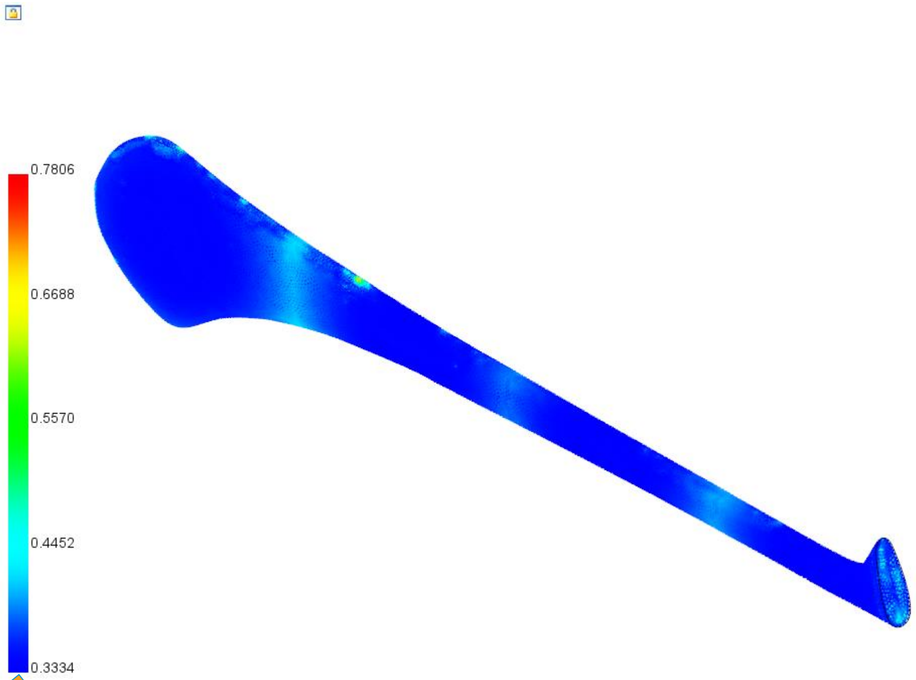


Generic Material - Displacement



Generic Material - Stress





PFA

Moldflow Analyses

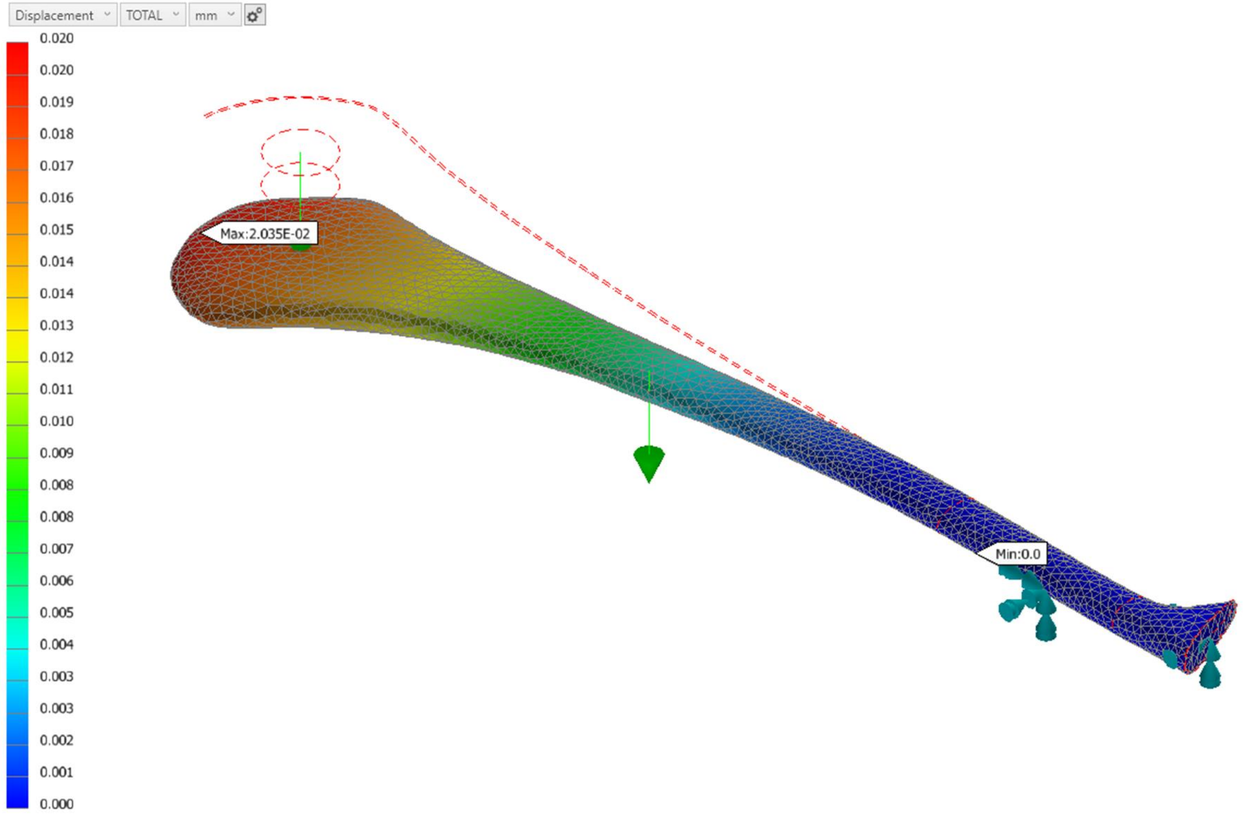
Stress, fiber orientation, and weld line properties can be calculated in Moldflow and passed through Helius

FEA Nastran Analyses

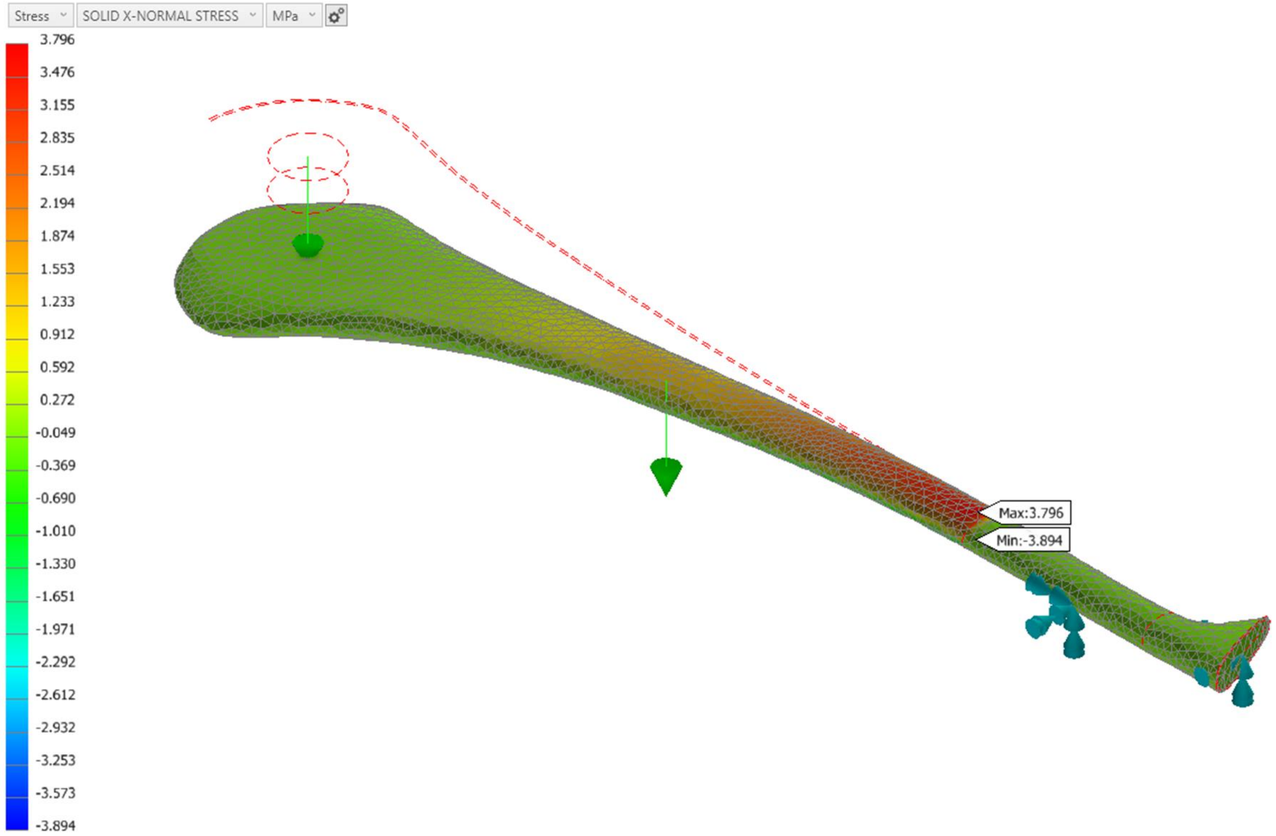
Nastran file is also populated into Helius to accept the modified material properties

Nastran is simulated again with Moldflow material data

As Manufactured Nastran In-CAD Results



Moldflow/AME Material - Displacement



Moldflow/AME Material - Stress

Summary and Future Work

- Multiple tools may be required to accurately simulate simple and complex analyses
- Autodesk Pro Bono program benefits customers and employees
- Limitations on versions and supported analysis types

- Incorporate Netfabb Core through Moldflow – Helius AME – Nastran In-CAD
- Attempt to simulate 2-piece bonded parting line