

# Become a simulation expert within 60 minutes

Wasim Younis

Simulation Manager @ Symetri

Join the conversation #AUCity #AU2018





## About the speaker

### Wasim Younis – Symetri

Very passionate about Simulation and a strong believer that simulation is easy and is for all designers out there in the world making great innovative products. I have been teaching simulation for many years, lost count. I know I don't look that old. Any how here are my contact details in case you would like to reach out to me.

Email: [wasim.younis@symetri.com](mailto:wasim.younis@symetri.com)

LinkedIn: <https://www.linkedin.com/in/wasimyounis/>

# So we all want to become Stress Experts



.... So we can effectively reduce stress  
in our day-to-day workplace 😊.....



# Well actually to make great products



.... Need something more than just hand calculations and guess work (I mean to say intuition) .....

# Which are also not over-designed



.... As we can explore more digitally  
as physical testing takes to much  
time and costs £££££ .....



# Simulation – Digital Testing



To explore – what if?

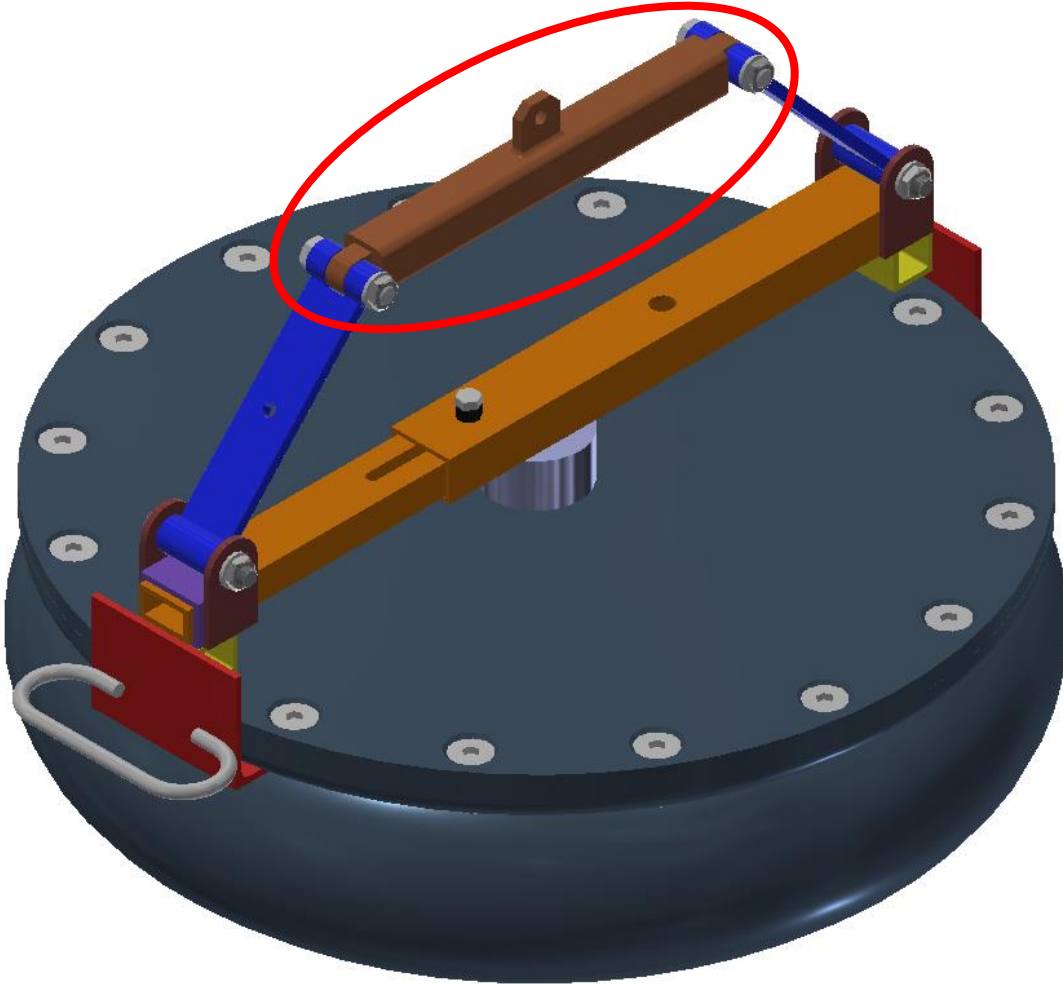
1. Do I need a thicker plate?
2. Can I remove more material?
3. Do I need to add more stiffening rings?
4. Can I increase load?
5. And more.....?

# Lets take a simple example

.... To see benefits of simulation .....



Benefits of Simulation–  
Lets take a simple example



Tools Available



# Benefits of Simulation– Lets take a simple example

## Tools Available

### 1. Hand Calculations

$$\sigma = Mx \frac{y}{I}$$

Load is applied centrally on the beam, therefore to find the maximum bending moment, we can use:

$$M = P \times L / 4$$

$$= 780\text{N} \times 390\text{mm} / 4$$

$$= 76050 \text{ Nmm}$$

$$y = \text{Distance to neutral axis}$$

$$= \text{Section height} / 2$$

$$= 40\text{mm} / 2 = 20 \text{ mm}$$

$I = 2\text{nd Moment of Area (for box section)}$

$= \text{Outer 2nd Moment of Area} - \text{Inner 2nd Moment of Area}$

$$= (BD^3 / 12) - (bd^3 / 12)$$

$$= (40 \times 40^3 / 12) - (30 \times 30^3 / 12)$$

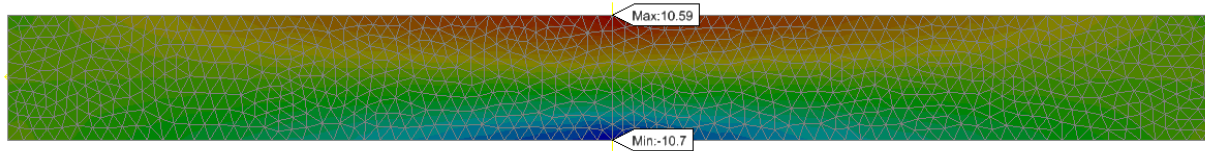
$$= 2560000 - 675000$$

$$= 145833 \text{ mm}^4$$

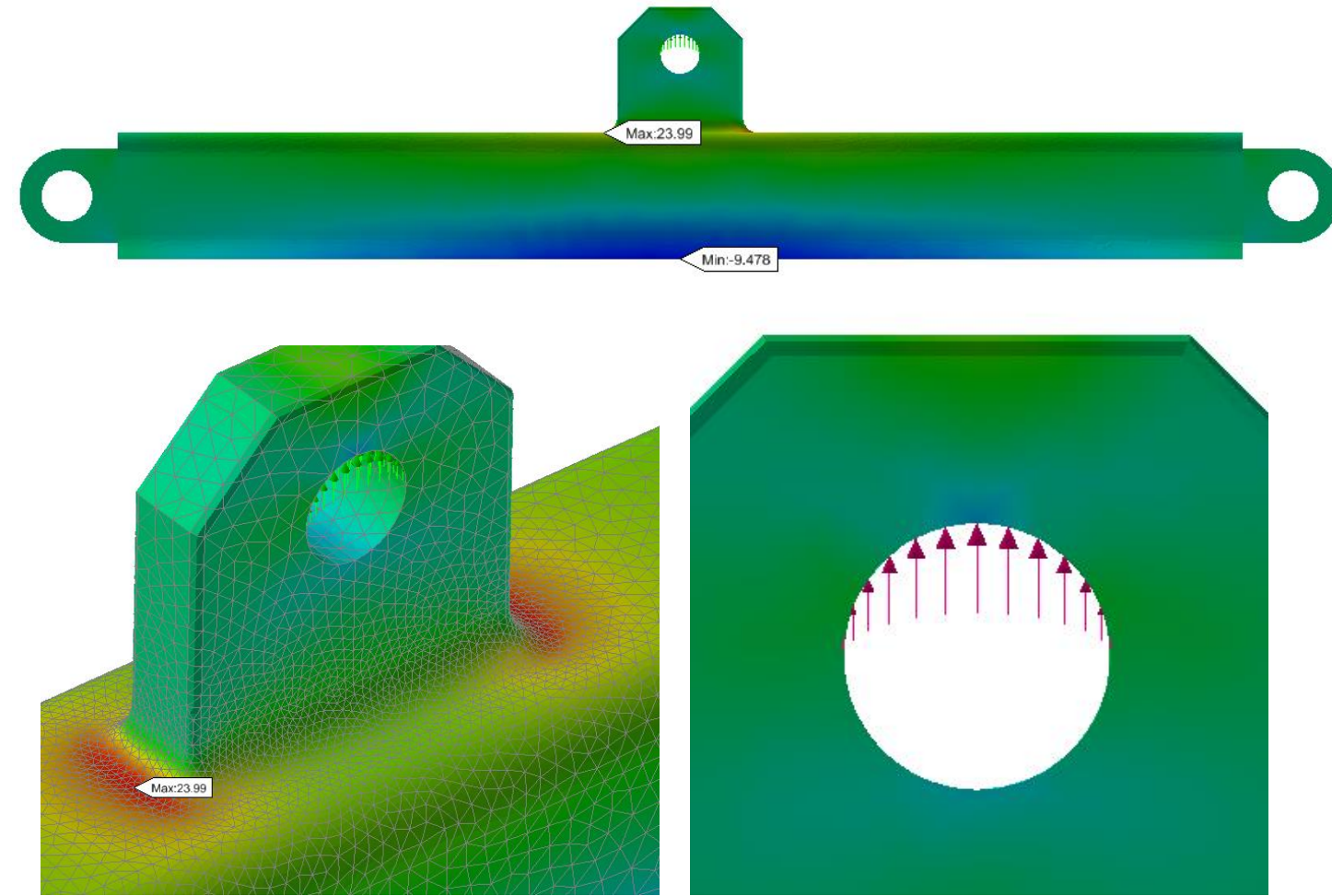
Therefore, Max Tensile or Compressive Stress due to bending is:

$$\sigma = 76050 \times 20 / 145833$$

$$= 10.43\text{N/mm}^2 = 10.43 \times 10^6 \text{ N/m}^2 = \mathbf{10.43 \text{ MPa}}$$



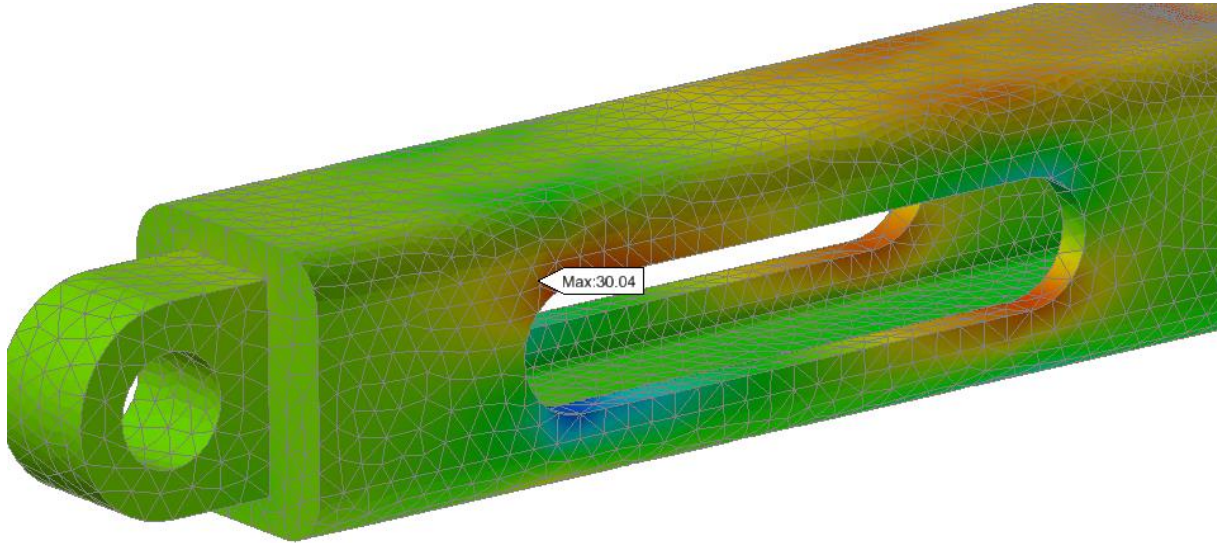
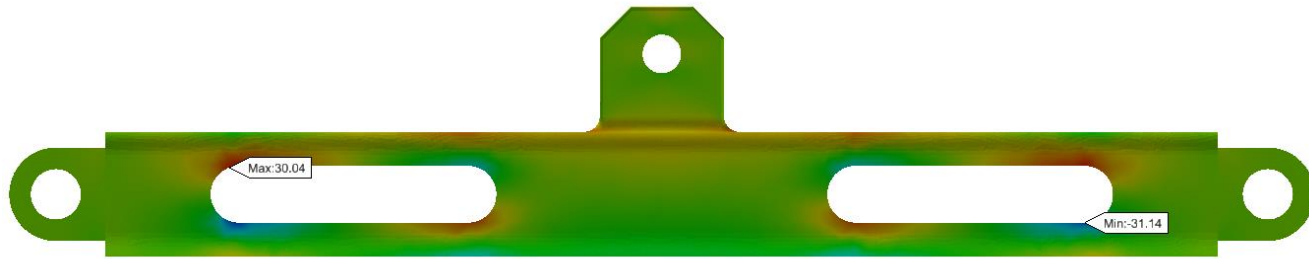
# Benefits of Simulation– Lets take a simple example



## Tools Available

1. Hand Calculations
2. Upfront Simulation

# Benefits of Simulation– Lets take a simple example



## Tools Available

1. Hand Calculations
2. Upfront Simulation
3. Optimisation

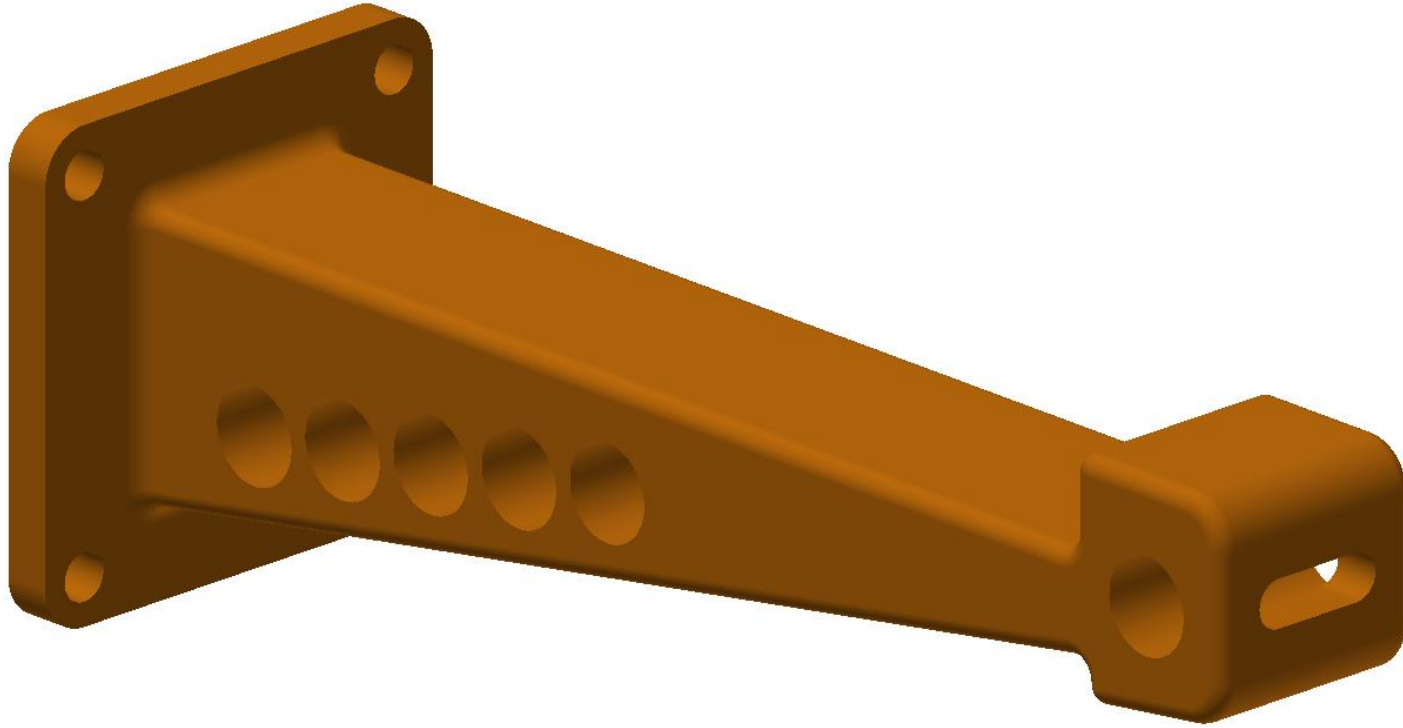


# We got 45 mins lefts

.... Can we really master  
Simulation in that  
time????..

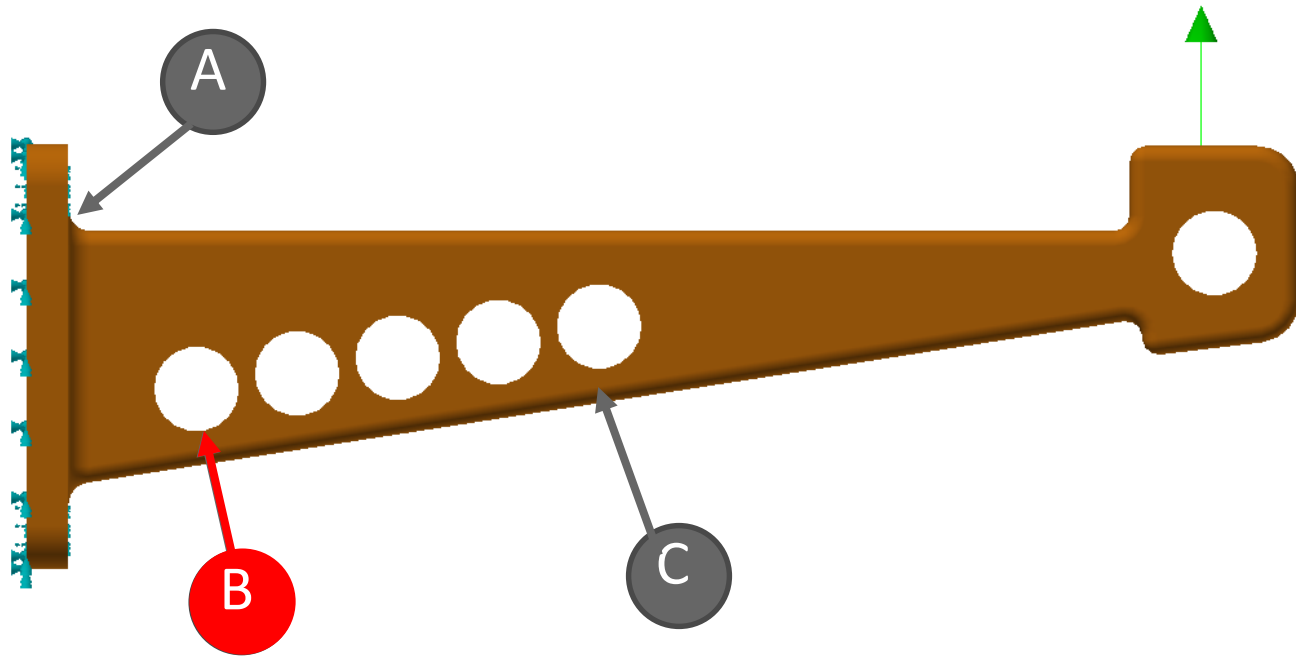


# The big Myth – Stopping widespread adoption of Upfront Simulation



Are my results correct?

# The big Myth – Stopping widespread adoption of Upfront Simulation



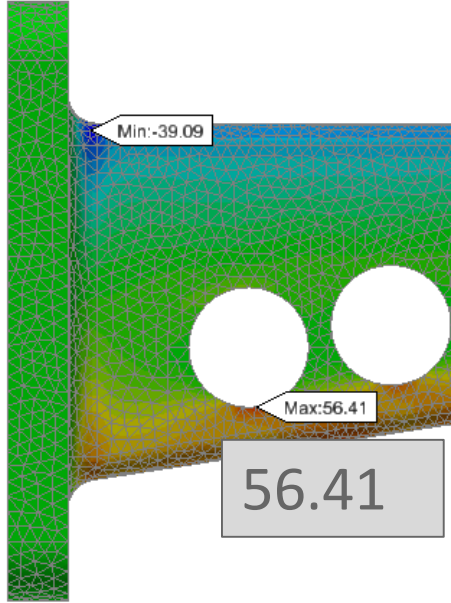
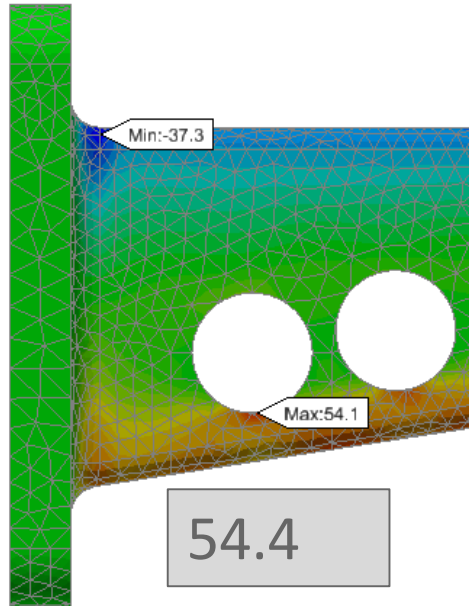
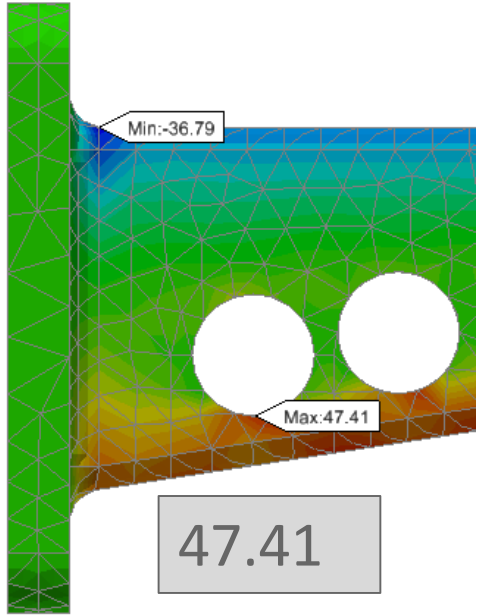
Are my results correct?



1. Max-Stress – You have an idea



# The big Myth – Stopping widespread adoption of Upfront



Are my results correct?

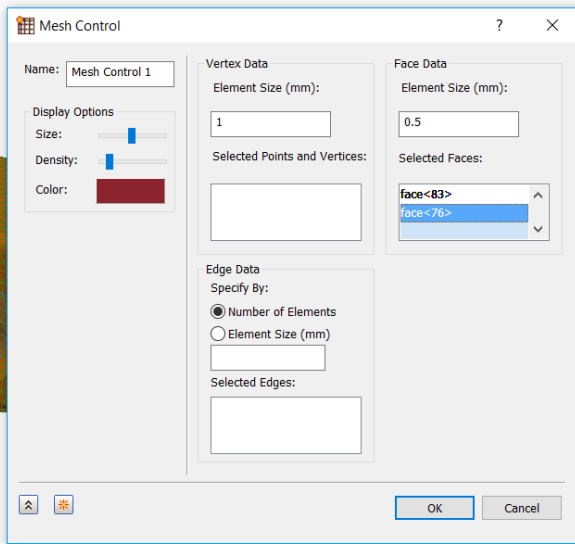
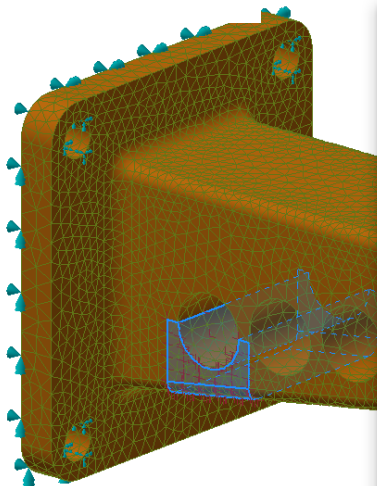
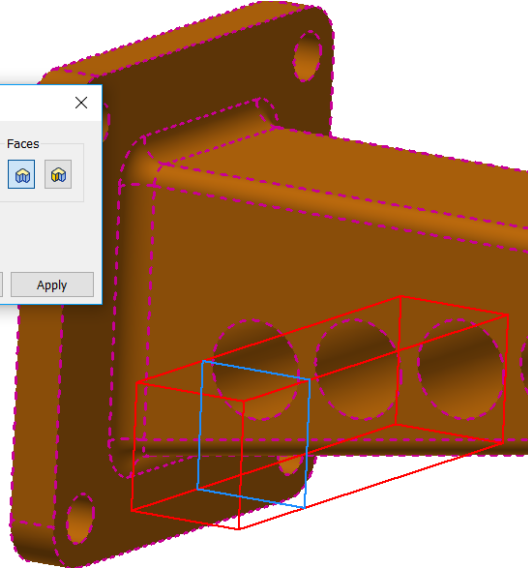
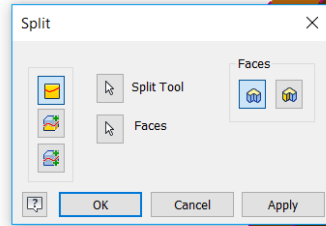
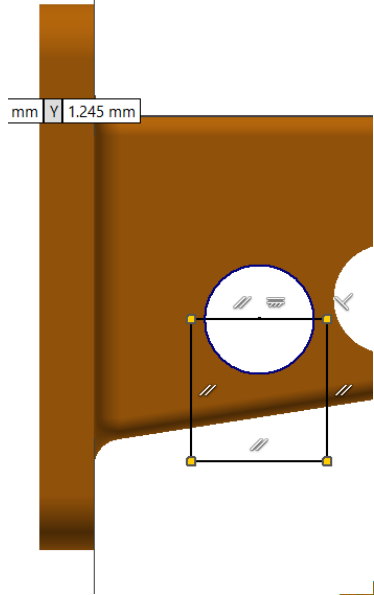


1. Max-Stress – You have an idea



2. Analyse with 3 mesh sizes

# The big Myth – Stopping widespread adoption of Upfront Simulation



Are my results correct?

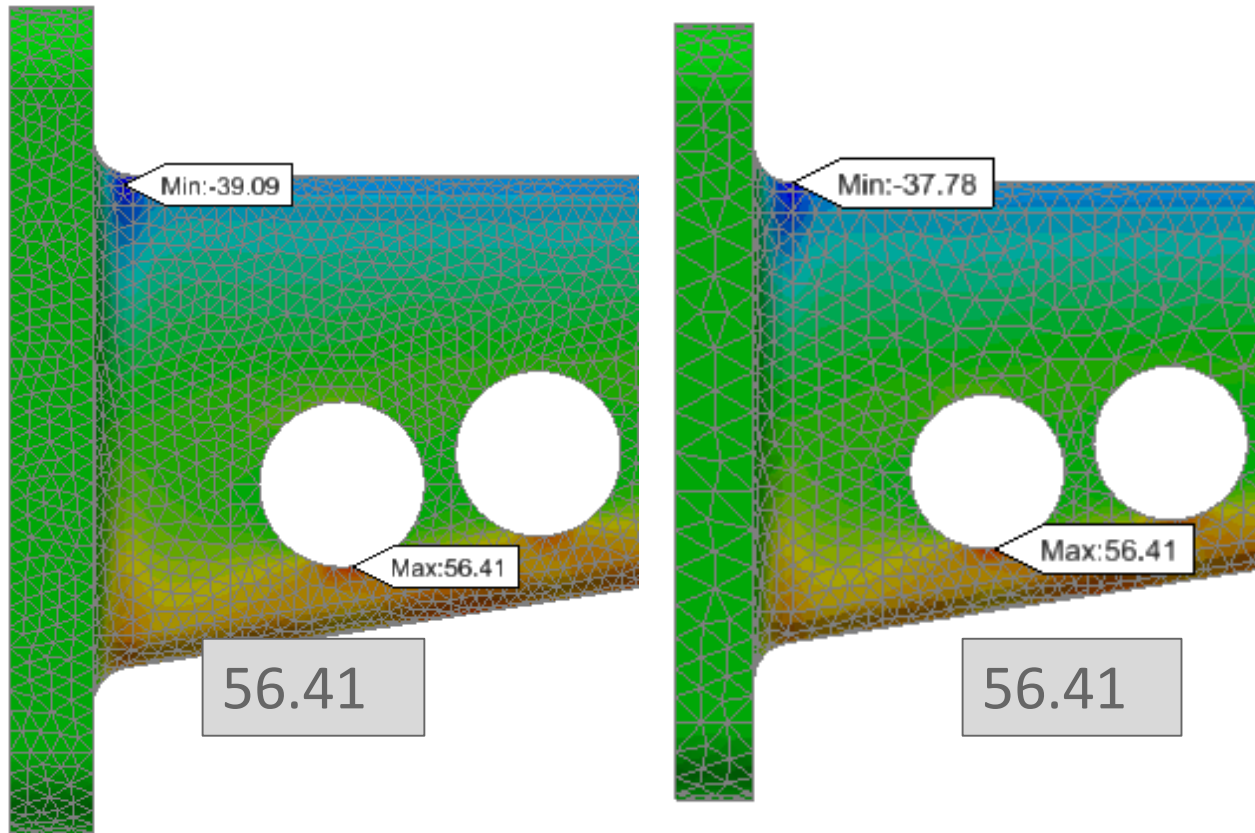


1. Max-Stress – You have an idea

2. Analyse with 3 mesh sizes

3. Split faces to define local mesh

# The big Myth – Stopping widespread adoption of Upfront Simulation



Global Mesh Control

Local Mesh Control

Are my results correct?



1. Max-Stress – You have an idea



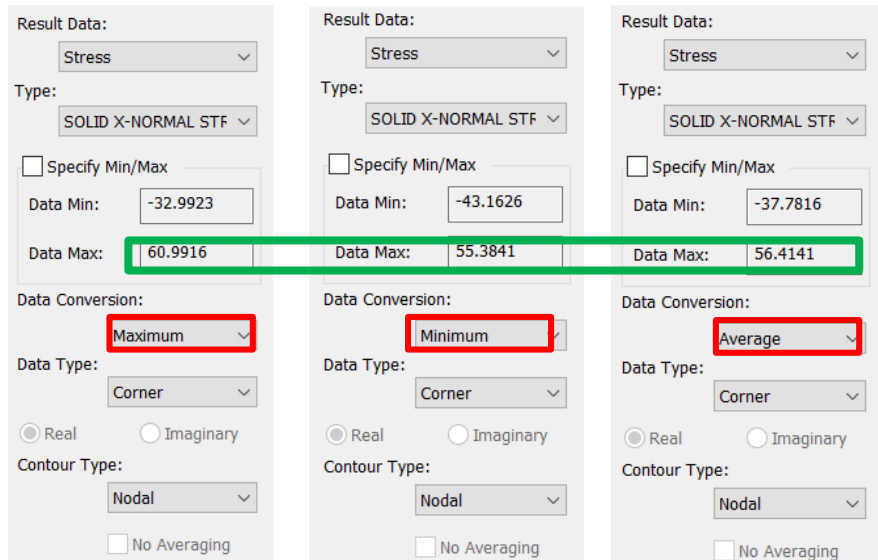
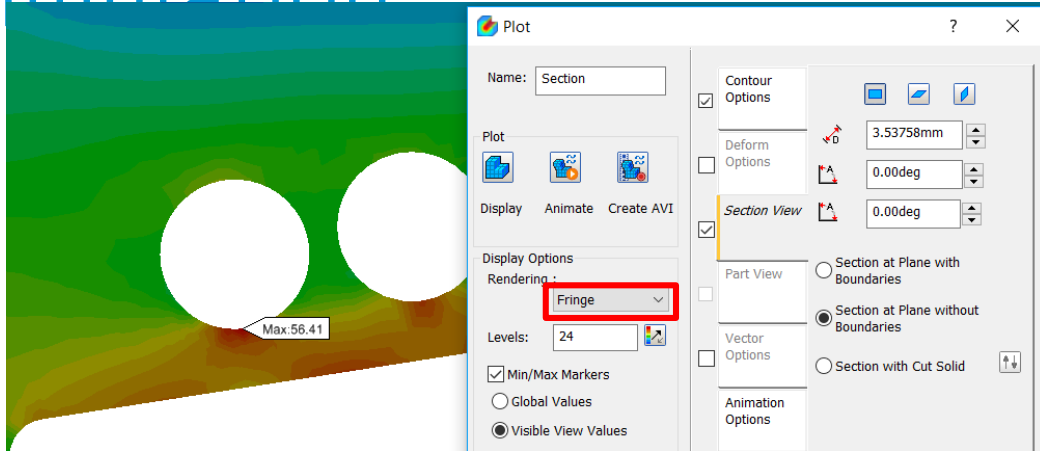
2. Analyse with 3 mesh sizes



3. Split faces to define local mesh



# The big Myth – Stopping widespread adoption of Upfront Simulation



Are my results correct?



1. Max-Stress – You have an idea



2. Analyse with 3 mesh sizes

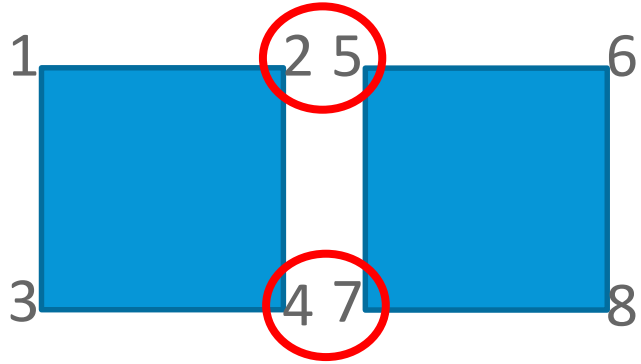


3. Split faces to define local mesh



4. More post-processing tools

# The big Myth – Stopping widespread adoption of Upfront Simulation



Result Data: Stress

Type: SOLID X-NORMAL STF

☐ Specify Min/Max

Data Min: -37.7816

Data Max: 56.4141

Data Conversion: Average

Data Type: Corner

☒ Real ☐ Imaginary

Contour Type: Nodal

☐ No Averaging

Result Data: Stress

Type: SOLID X-NORMAL STF

☐ Specify Min/Max

Data Min: -30.3809

Data Max: 47.605

Data Conversion: Average

Data Type: Centroidal

☒ Real ☐ Imaginary

Contour Type: Nodal

☐ No Averaging

Are my results correct?



1. Max-Stress – You have an idea



2. Analyse with 3 mesh sizes



3. Split faces to define local mesh



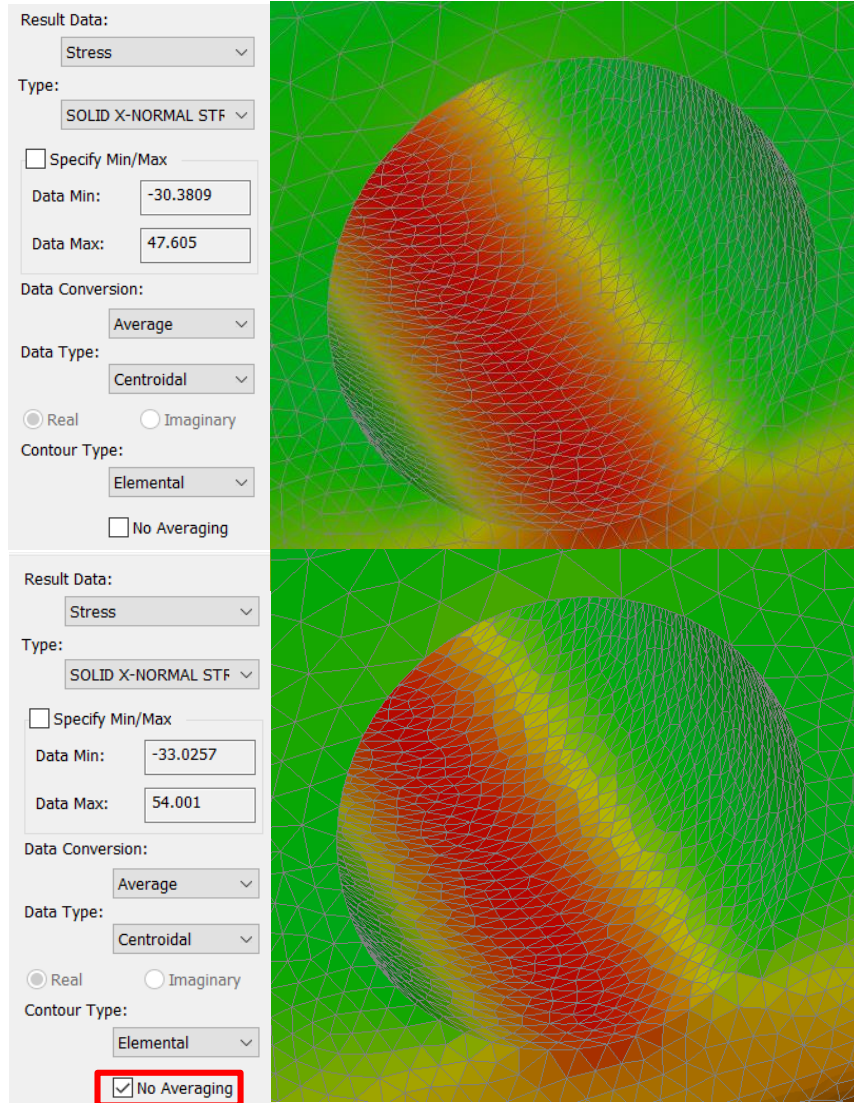
4. More post-processing tools

.... That was tooooo much information ...  
To much information can't hurt I suppose...





# The big Myth – Stopping widespread adoption of Upfront Simulation



Are my results correct?



1. Max-Stress – You have an idea



2. Analyse with 3 mesh sizes



3. Split faces to define local mesh



4. More post-processing tools

.... That was more like it.....



# What if my results don't converge?

.... Whaaaaaat can it happen?  
Now I am really confused!  
I thought you said the  
simulation was easy.....





What if my results don't  
converge?  
A simple L-shape bracket



Are my results correct?

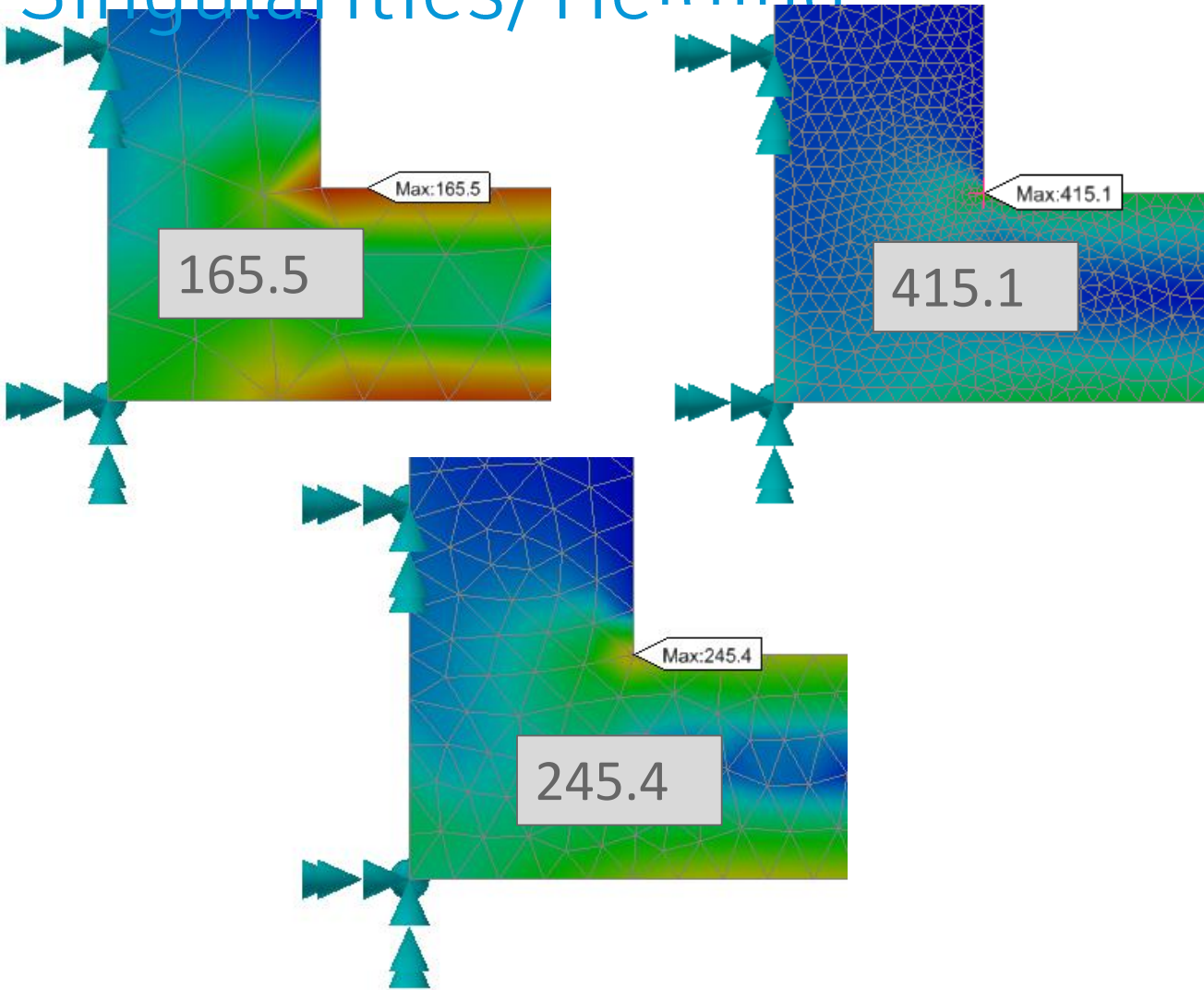


1. Max-Stress – You have an  
idea

What if my results don't converge?

Hotspots/Stress

Singularities/Yielding



Are my results correct?

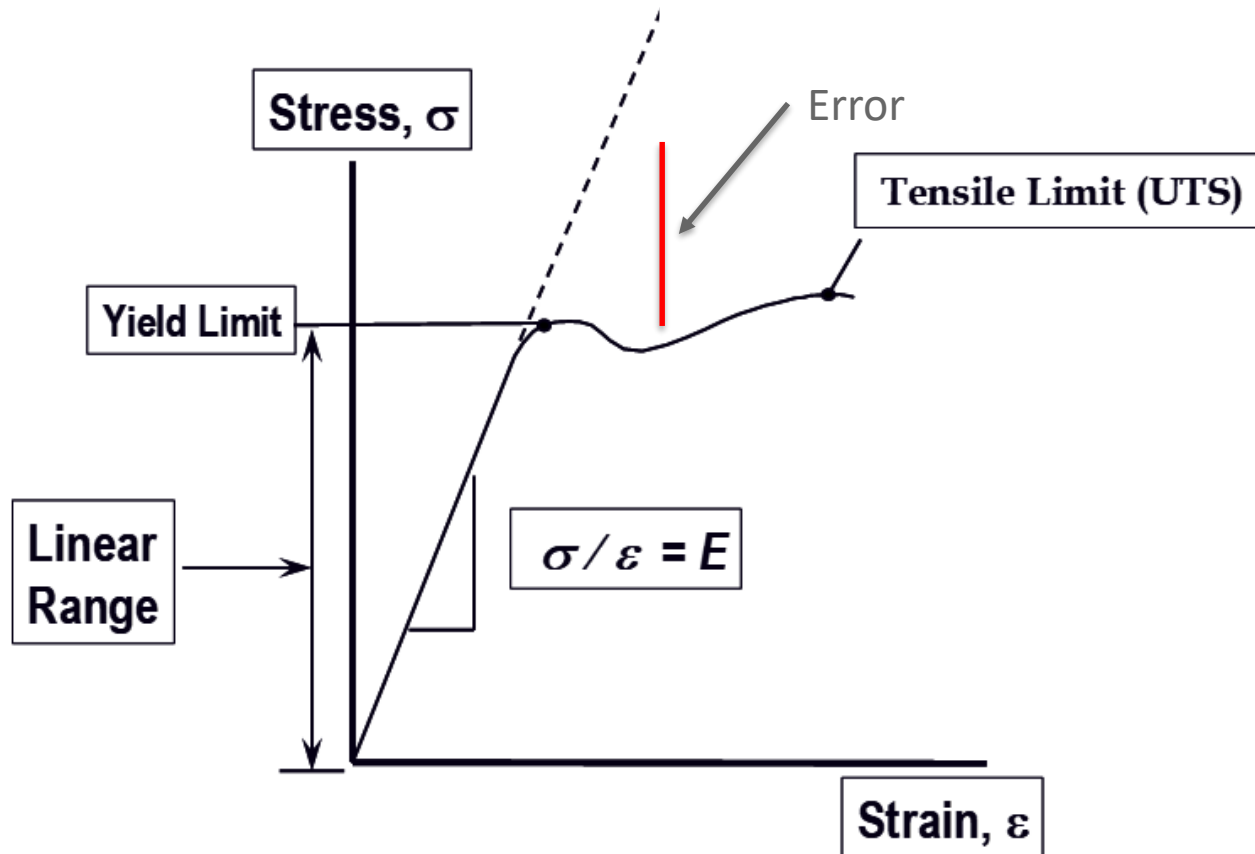


1. Max-Stress – You have an idea



2. Analyse with 3 mesh sizes

# What if results don't converge? Stress Strain Curve



Are my results correct?



1. Max-Stress – You have an idea



2. Analyse with 3 mesh sizes



3. Non-Linear Analysis

# What if my results don't converge?

## Non-Linear Analysis

Nonlinear Material Data ? X

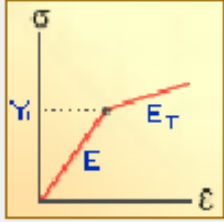
Type

☐ None

☐ Nonlinear Elastic

☒ Elasto-Plastic (Bi-Linear)

☐ Plastic



Properties

Tangent Modulus, Et (MPa): 21000

Hardening Rule: Isotropic

Yield Function

Yield Criterion: von Mises

Initial Yield Stress (MPa): 205

Friction Angle: (deg): 0

## Are my results correct?



1. Max-Stress – You have an idea



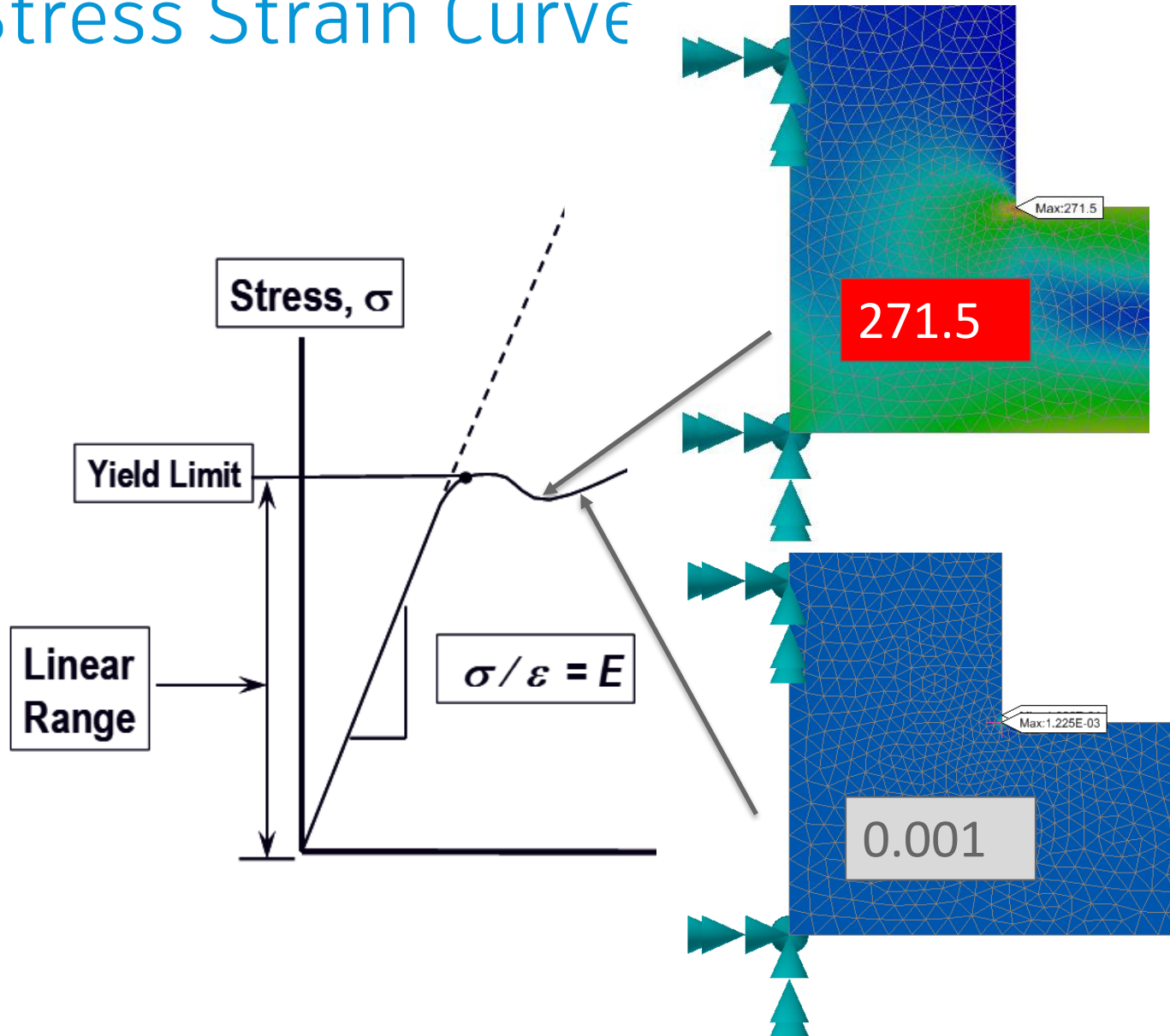
2. Analyse with 3 mesh sizes



3. Non-Linear Analysis



# What if results don't converge? Stress Strain Curve



Are my results correct?



1. Max-Stress – You have an idea



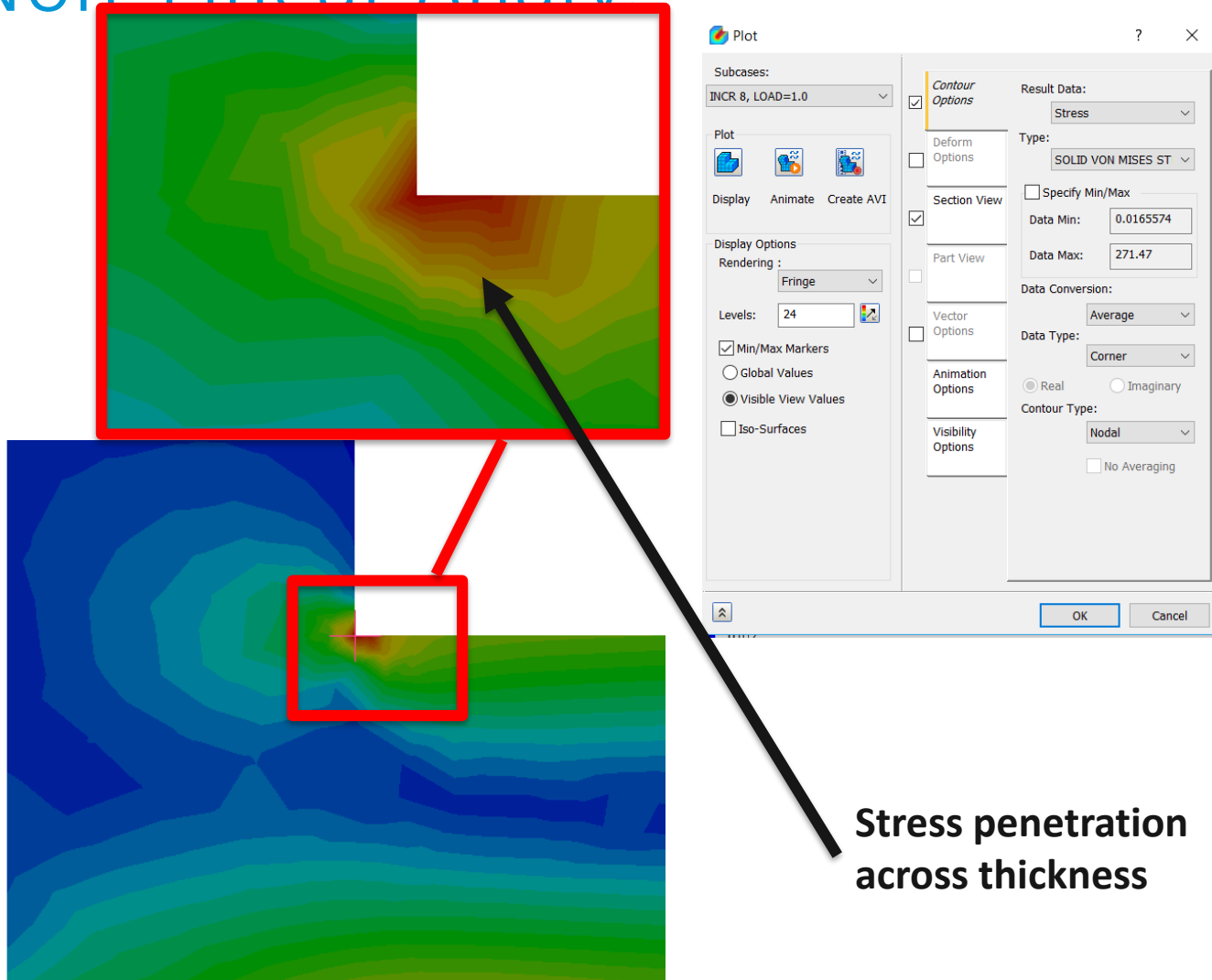
2. Analyse with 3 mesh sizes



3. Non-Linear Analysis

# What if my results don't converge?

## Non-Linear Analysis



**Stress penetration  
across thickness**

# Are my results correct?



1. Max-Stress – You have an idea



2. Analyse with 3 mesh sizes



3. Non-Linear Analysis



4. Section View

.... That made absolute sense.....  
Now I consider myself an expert.....



# Finally can I trust Nastran results?

.... Of course who wouldn't.....

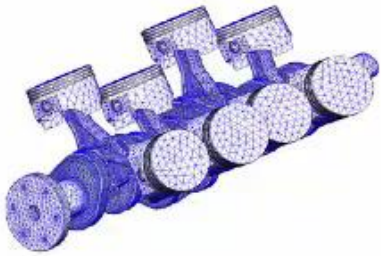




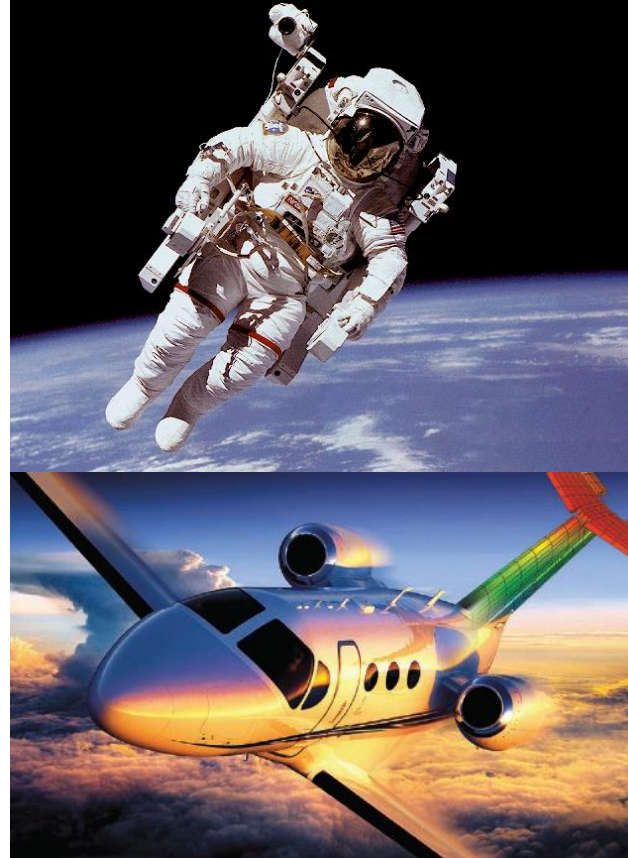
# Can I trust Nastran results

Autodesk® Nastran® In-CAD 2019

Verification Manual



 AUTODESK



## Absolutely

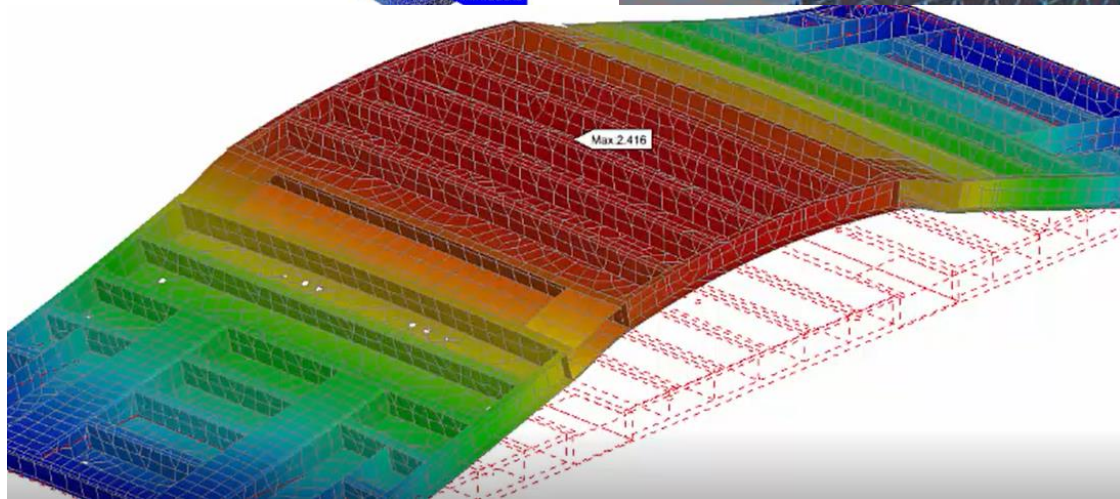
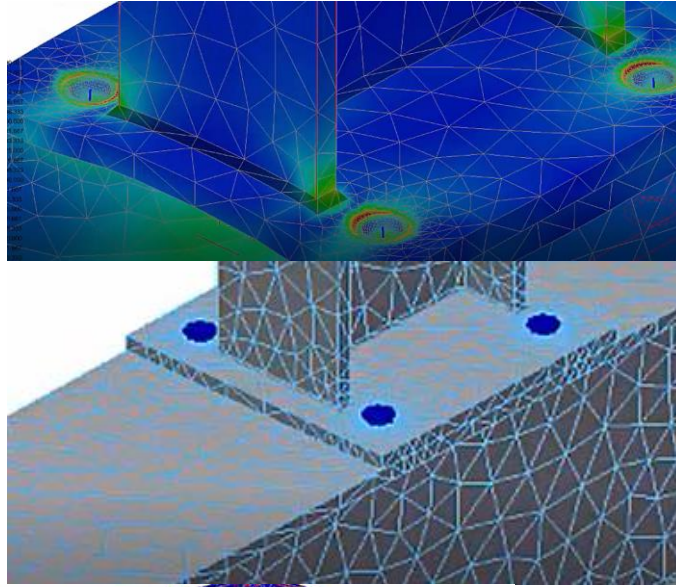
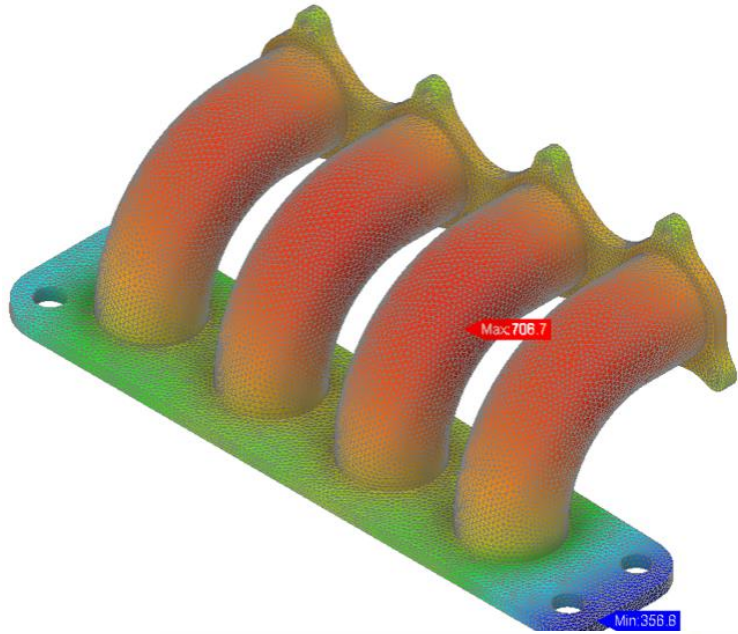
1. Verification Document
2. NASA
3. Most planes verified with Nastran if not all.
4. Industry Standard Solver

# Nastran In-CAD in action





# Nastran In-CAD in action



## Typical Examples

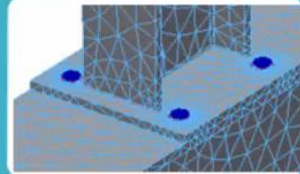
Above and Beyond Inventor FEA

1. Bolted Connections
2. Thermal Analysis
3. Fabrications

# Nastran In-CAD in action

## Complete workflow - Setup to results

### Bolt Analysis



SYMETRI  
SOFTWARE GROUP

## Typical Applications

1. Bolted Connections
  - Local Mesh Control
  - Surface Contact with Friction
  - Bolt Stress



# Nastran In-CAD in action

## Manifold

## Typical Applications

1. Bolted Connections
2. Thermal Analysis
  - Start Thermal Analysis
  - Determine temperatures
  - Start New Static Analysis
  - Use temperatures as load
  - Determine stresses

Thermal Analysis



SYMETRI

# Nastran In-CAD in action

## Shell Analysis – 3 different ways

### Fabrication Analysis

1. Mid Surface extraction of thin parts
2. Is to create surfaces to represent thin parts/structures
3. Is to select external faces of parts/structures

### Typical Applications

1. Bolted Connections
2. Thermal Analysis
3. Fabrications

.... Well that didn't seem difficult I think!  
..... Are you all ready to use simulation.....  
..... And start innovating.....



.... Or perhaps you have some questions?  
..... So fire away .....







Autodesk and the Autodesk logo are registered trademarks or trademarks of Autodesk, Inc., and/or its subsidiaries and/or affiliates in the USA and/or other countries. All other brand names, product names, or trademarks belong to their respective holders. Autodesk reserves the right to alter product and services offerings, and specifications and pricing at any time without notice, and is not responsible for typographical or graphical errors that may appear in this document.

© 2018 Autodesk. All rights reserved.

