

# Up and Running with Autodesk Inventor Nastran

Wasim Younis

Simulation Manager @ Symetri



# This Class is for...



Users just starting out in Life (Simulation!)



I hope experts may pick up one or two tips.

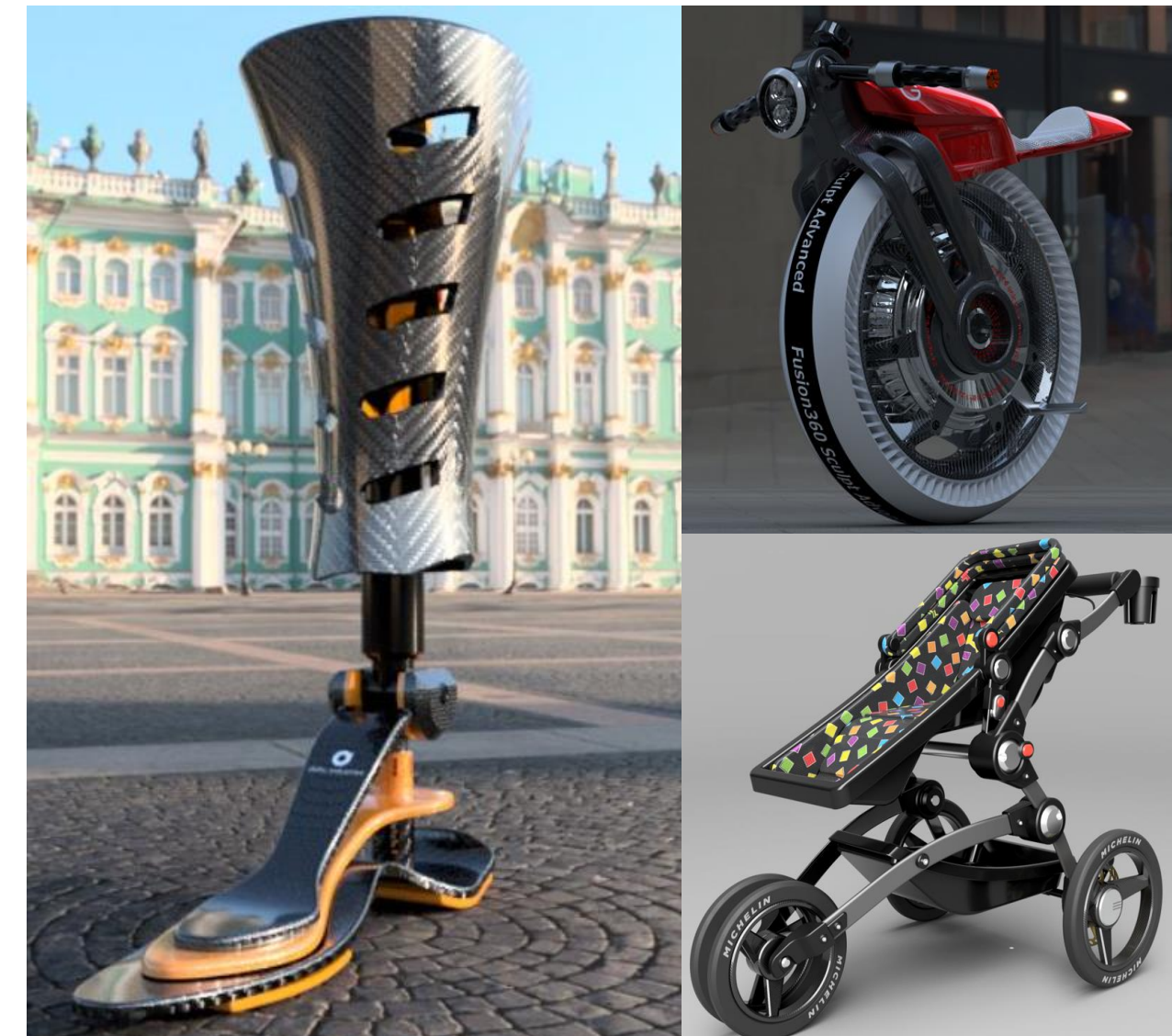


# The goal of this lab is...



To help increase your confidence in using Simulation

Create great products

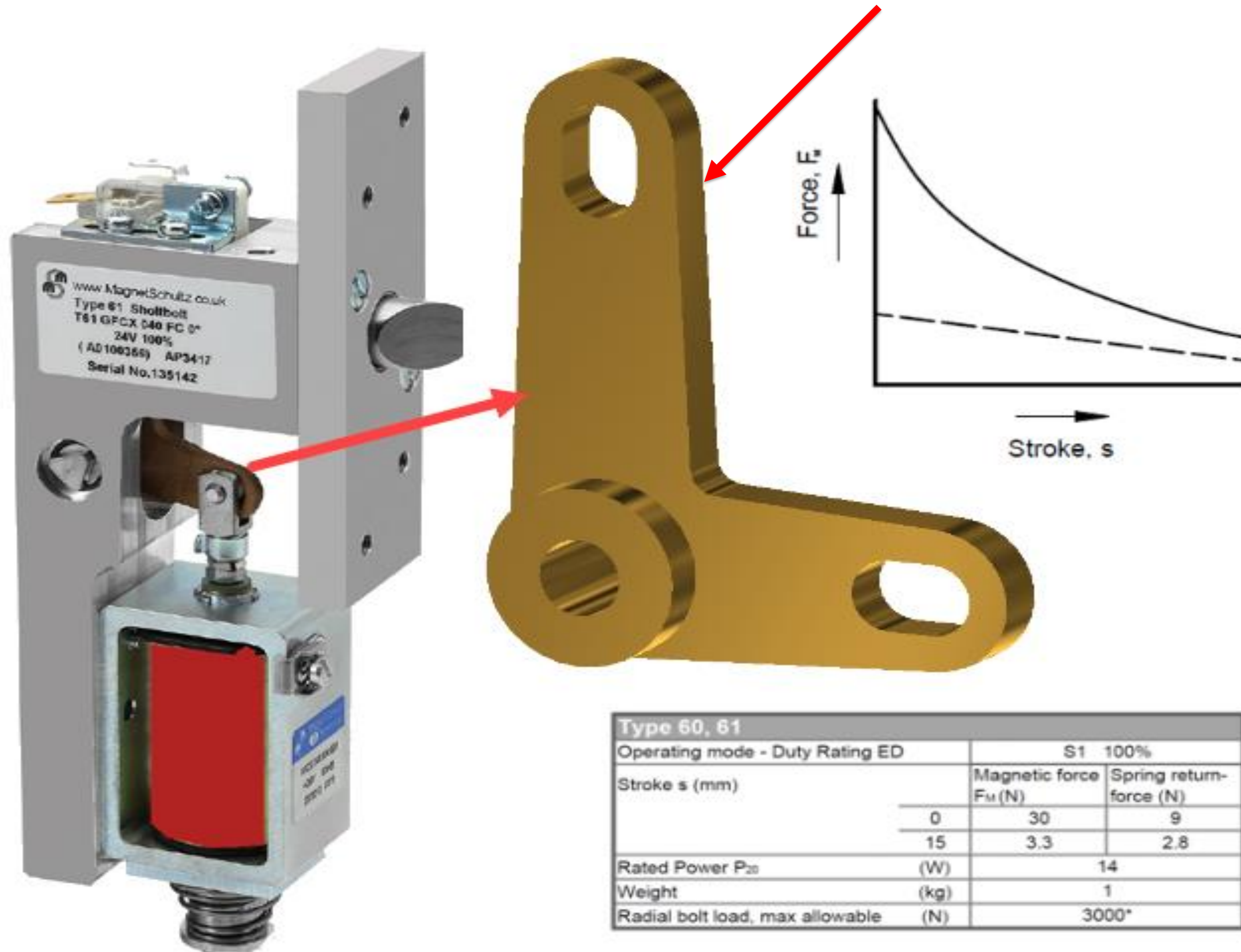


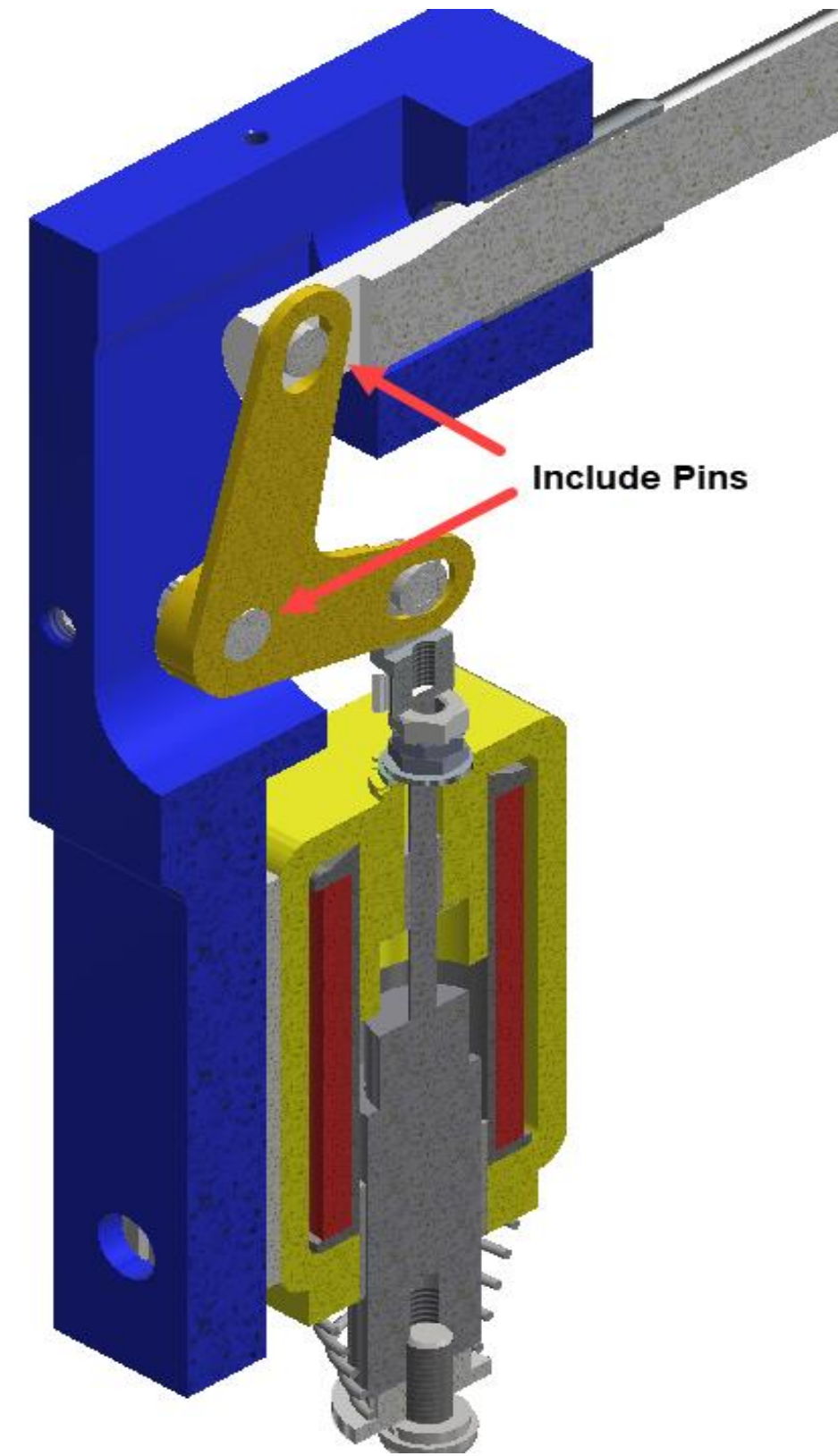
Avoid Over-engineering





# Design Problem... Analyse the lever





Single Part or Assembly

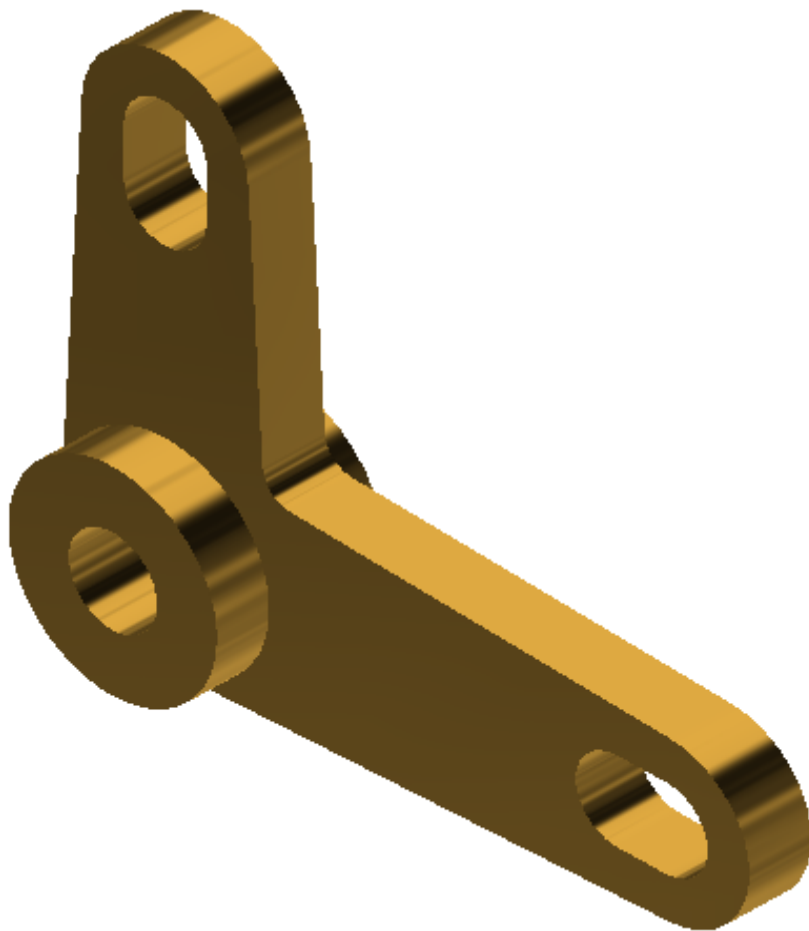


# Part or Assembly ?

**Pro**  
Easier setup  
Less Elements  
No contacts

**Cons**  
Over stiffness

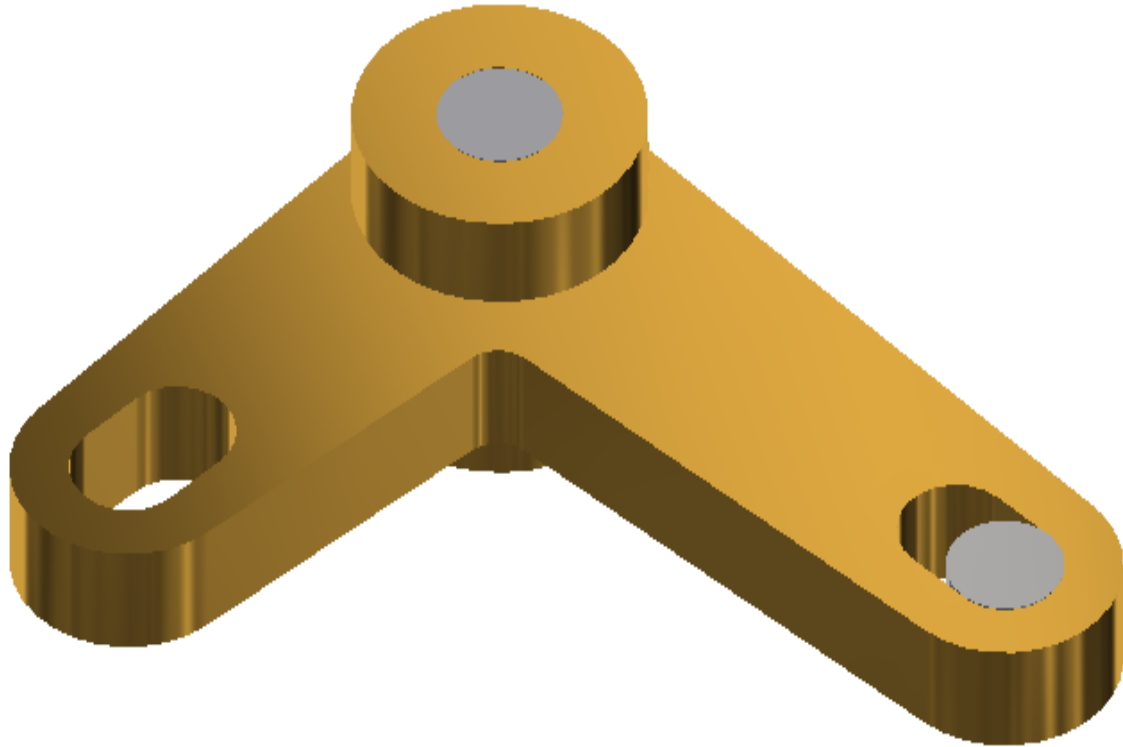
- Lever.ipt
- Solid Bodies(1)
- View: Master
- Origin
- Sketch1
- Extrusion1
- Fillet1
- Extrusion2
- Extrusion3
- Hole1
- End of Part



**Pro**  
Better Pin/Lever  
behaviour

**Cons**  
Longer runtimes

- Lever-Assembly.iam
- Relationships
- Representations
- Origin
- End of Features
- Extrusion 1
- Lever:1
- Pin:1
- Centre Pin:1





# 6 Million \$ ?

.... How do I know my results are correct?



Results are not  
as I expected

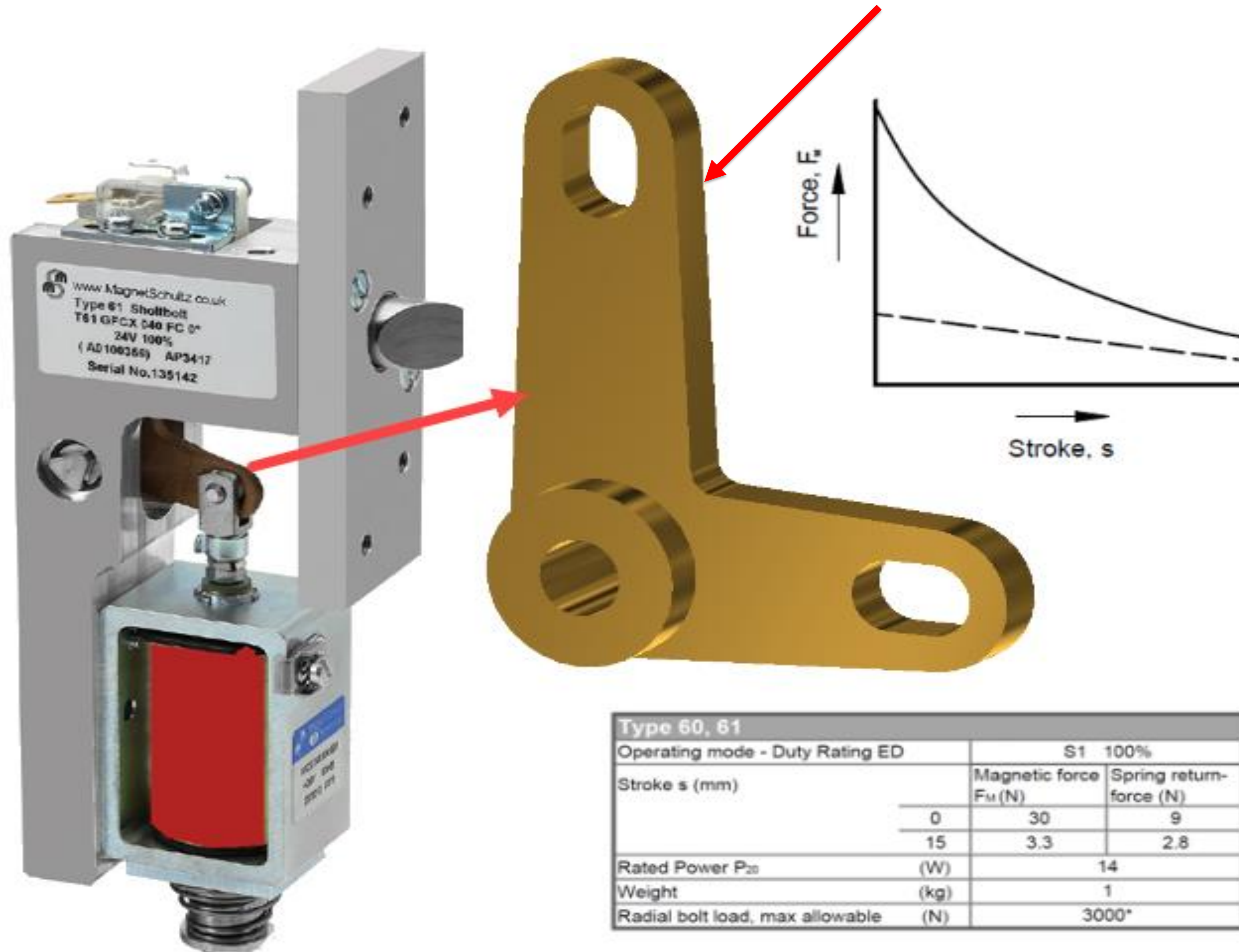
Which analysis  
results do I use  
for my design

Why do I need to  
run more than  
one analysis

What mesh size  
do I use



# Exercise 1 – Part Analysis

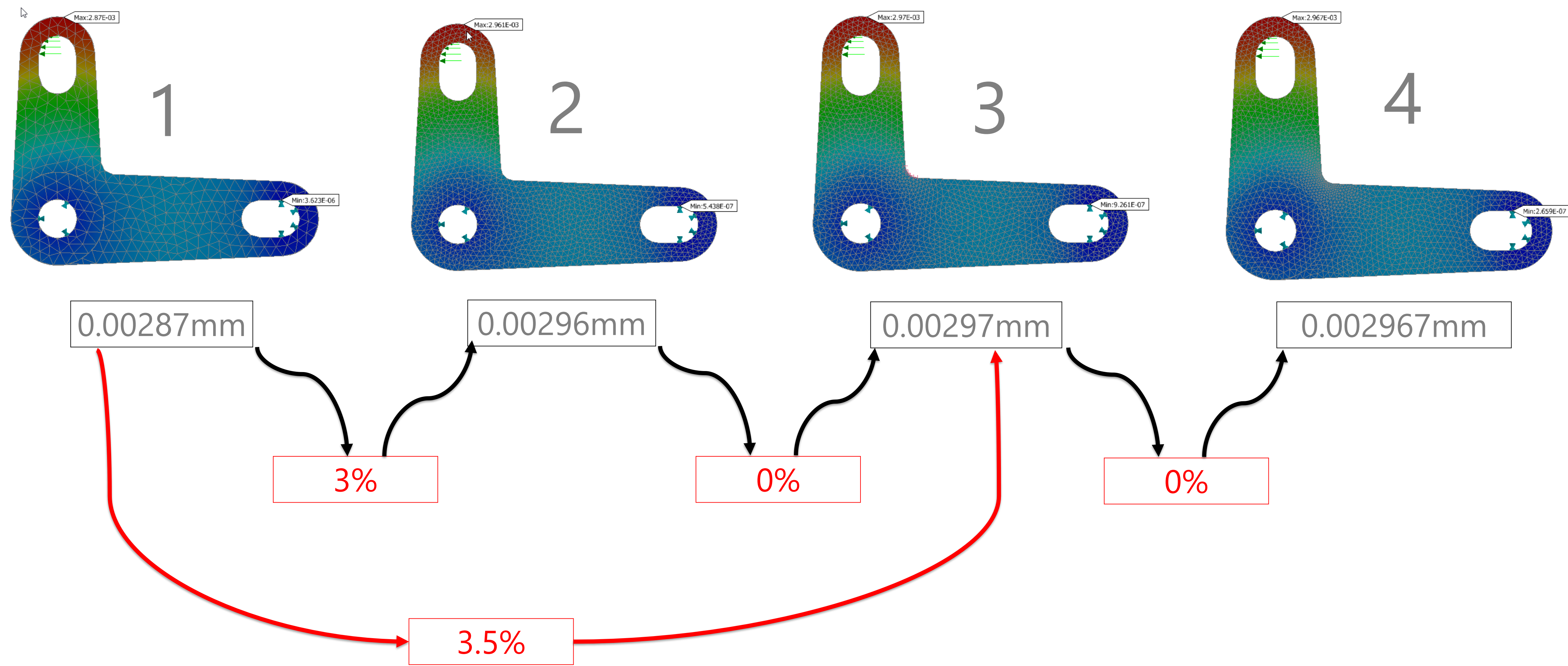




# Hands on Session 1 – Lets Start

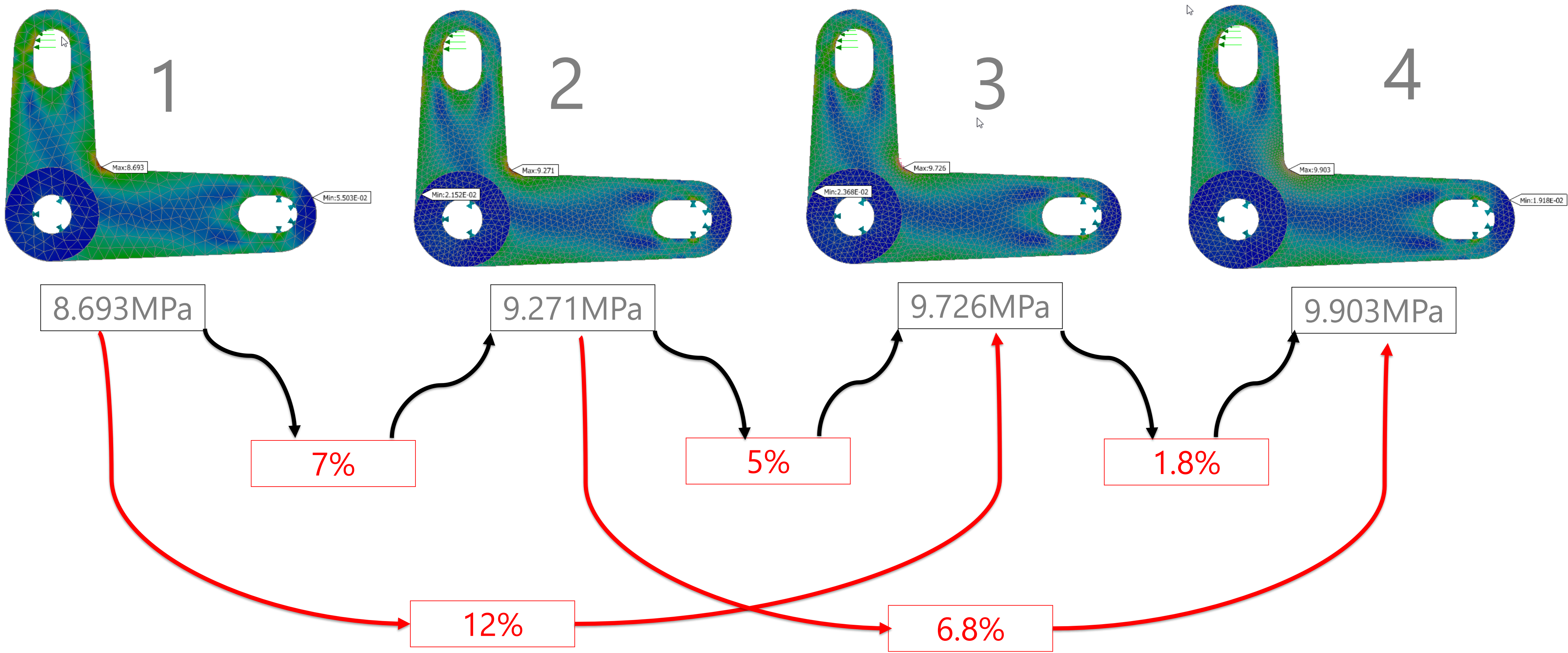


# Exercise 1 – Displacement Results

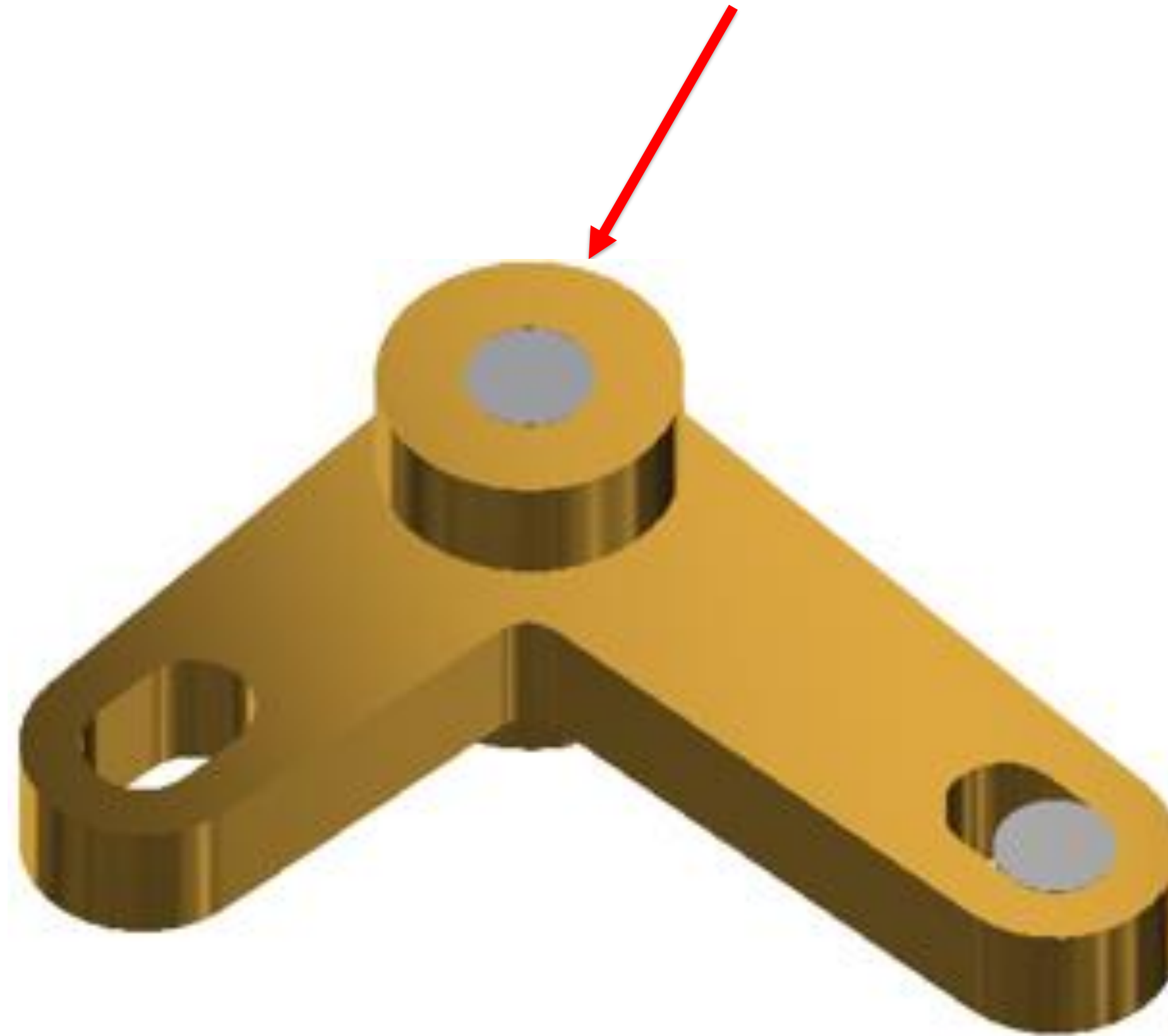
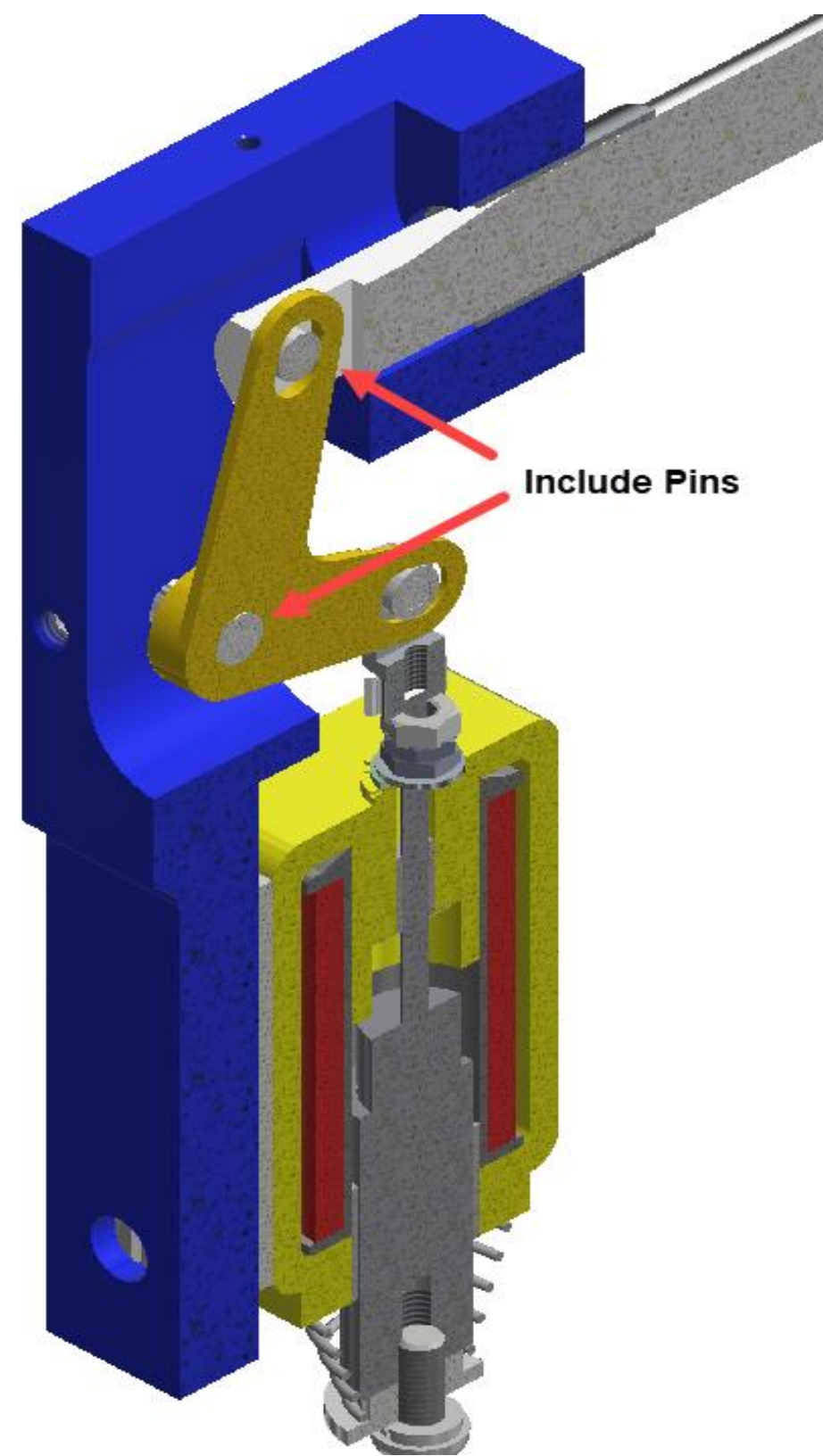




# Exercise 1 – Stress Results Convergence



# Exercise 2 – Assembly Analysis

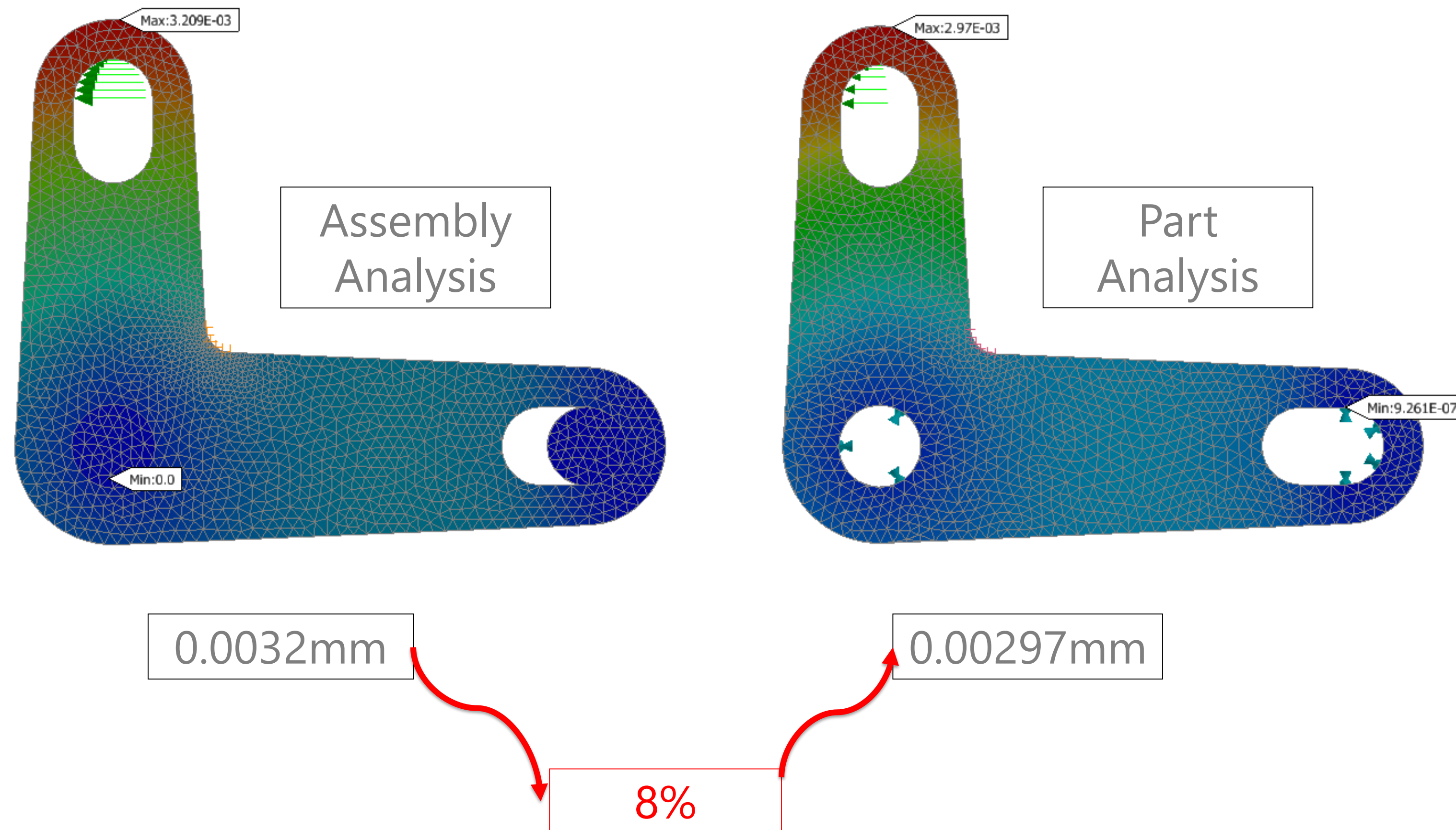




# Hands on Session 2 – Lets Continue

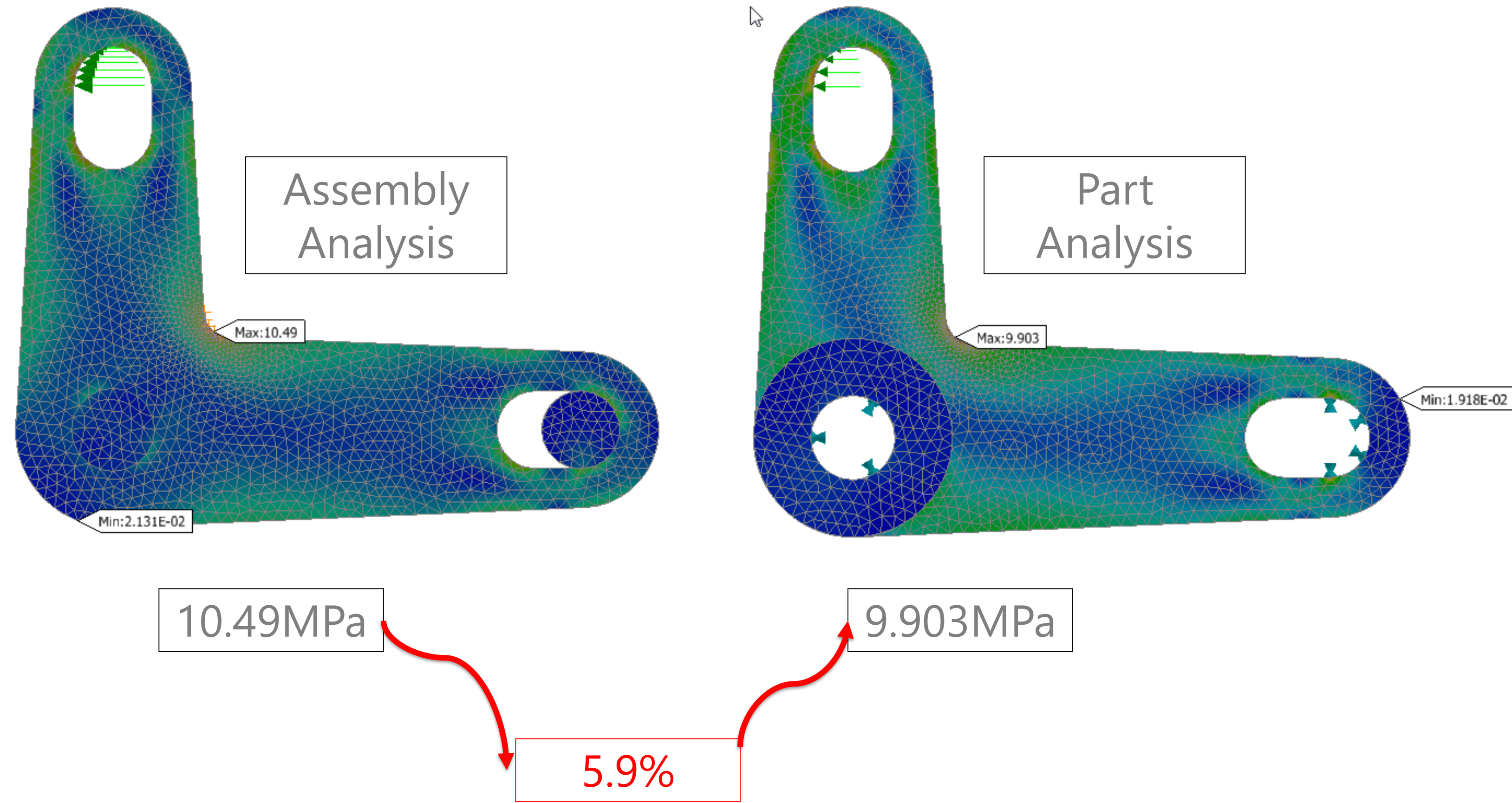


# Exercise 2 – Displacement Results

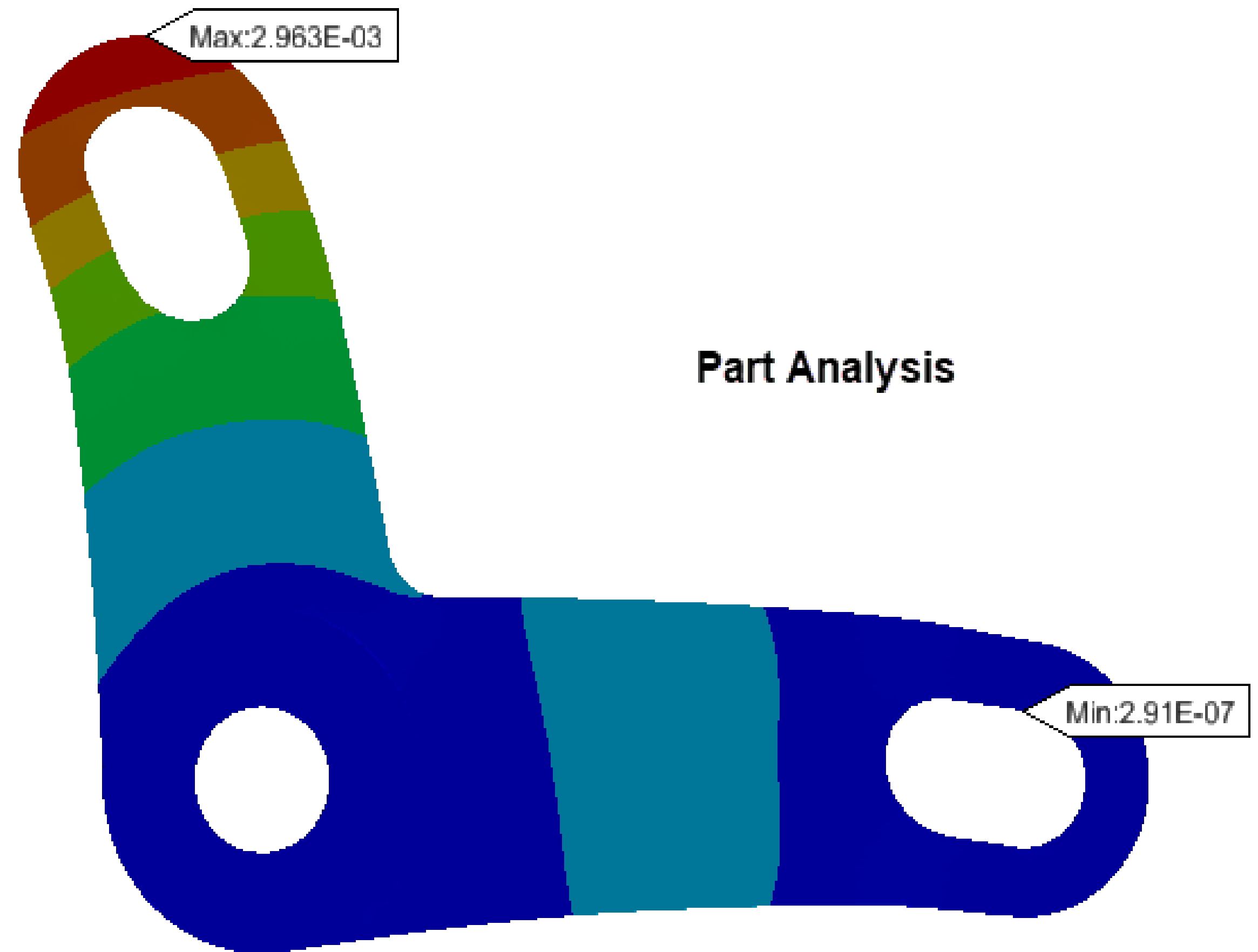
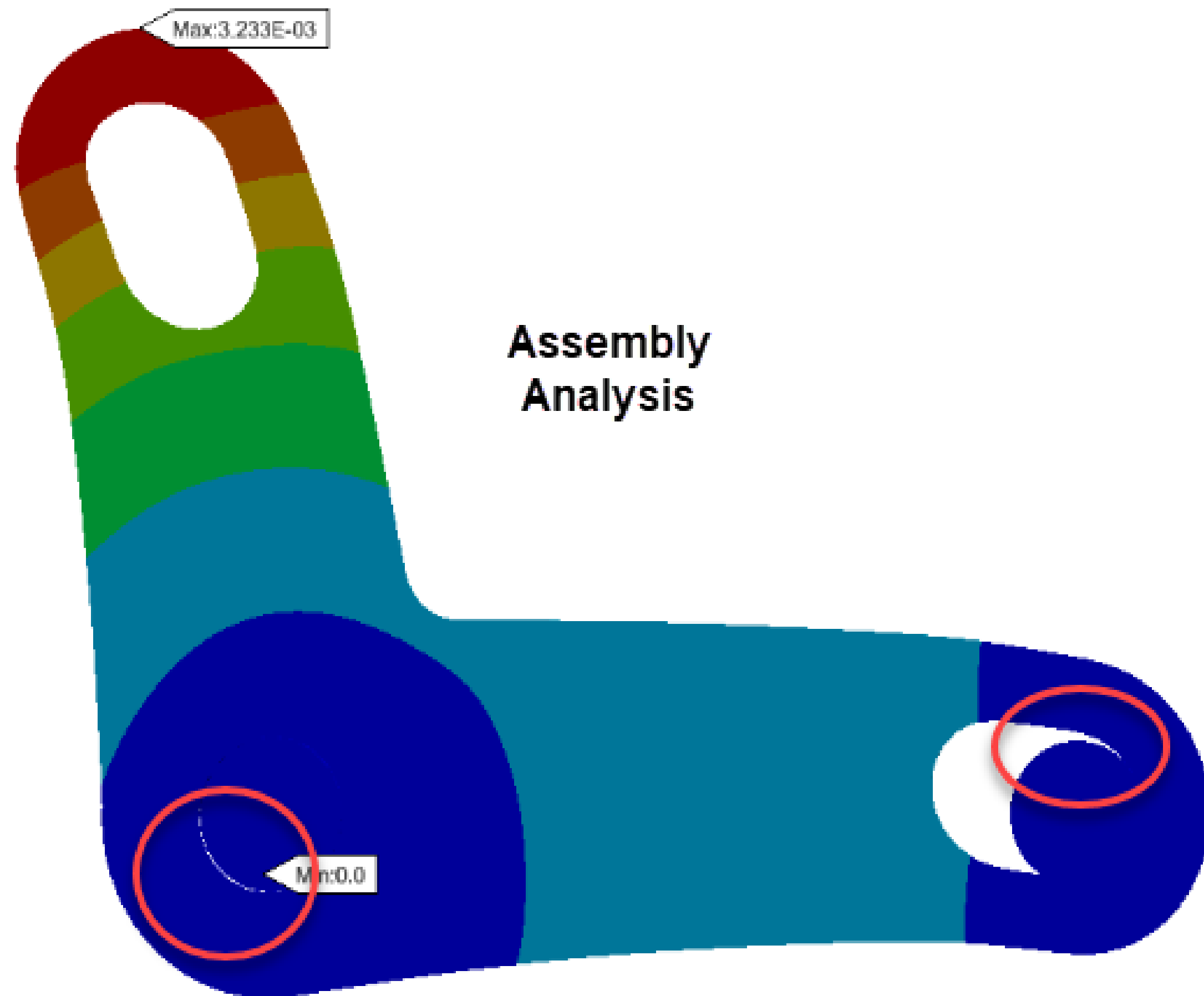




# Exercise 2 – Stress Results Comparison

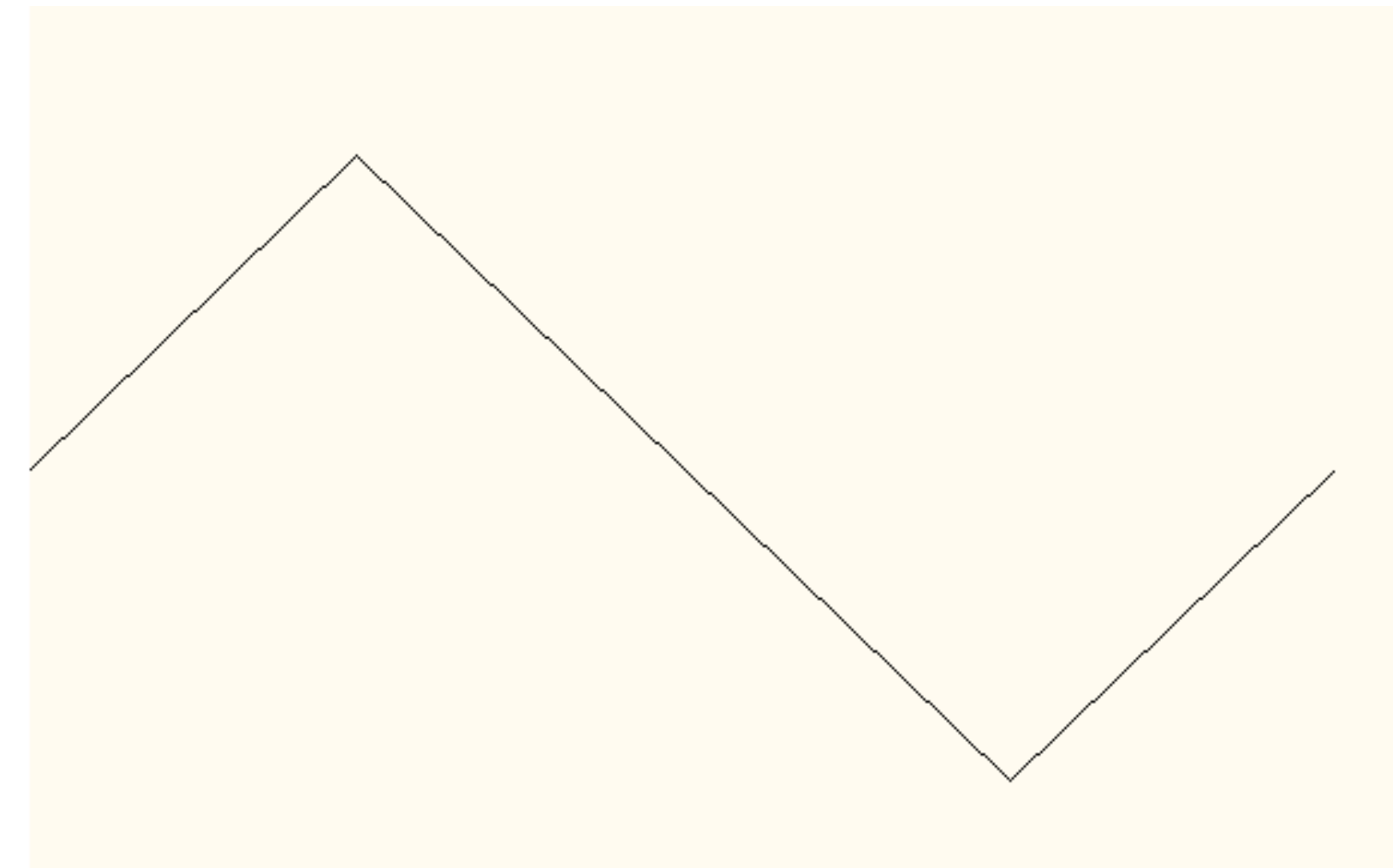
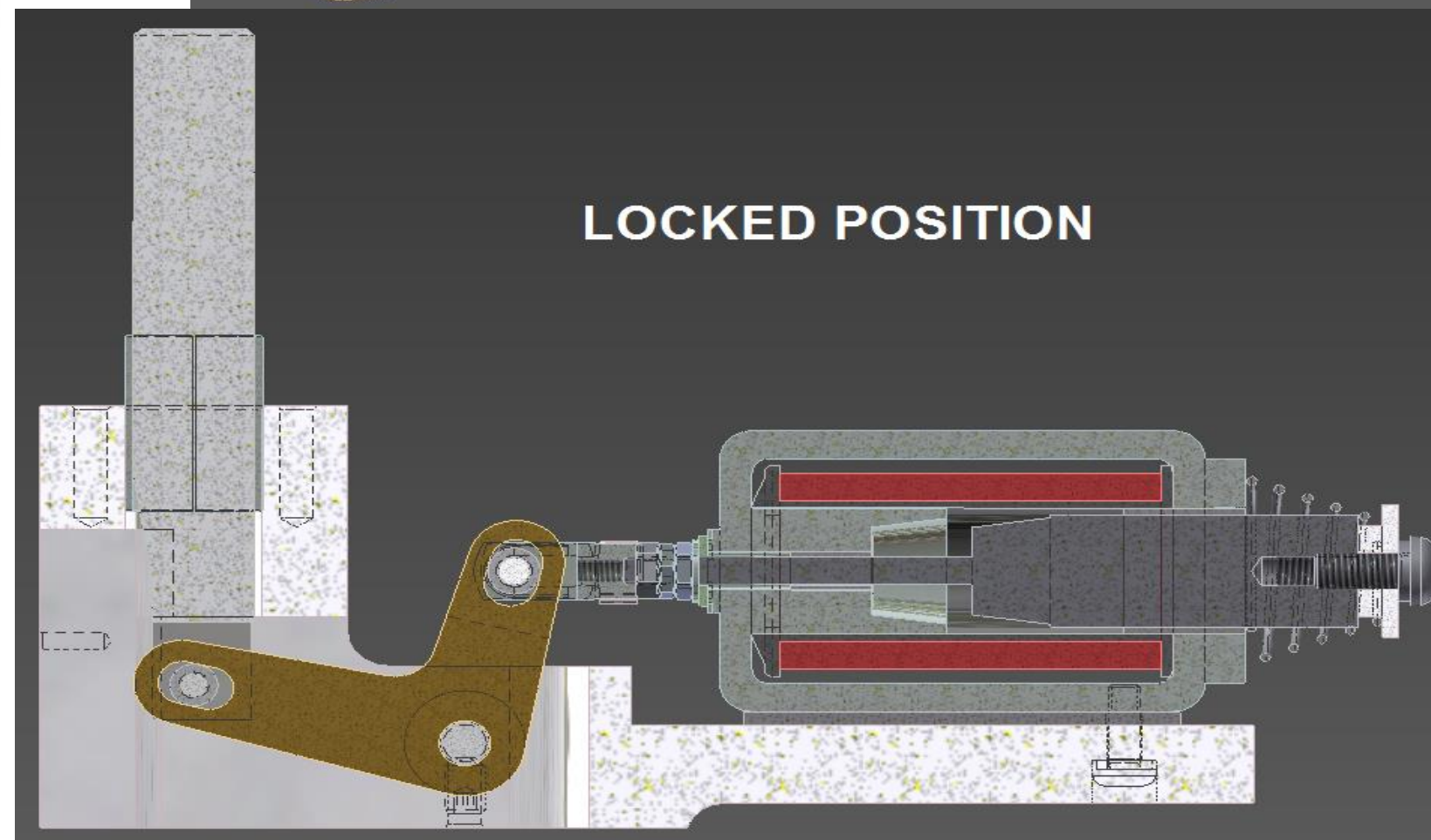
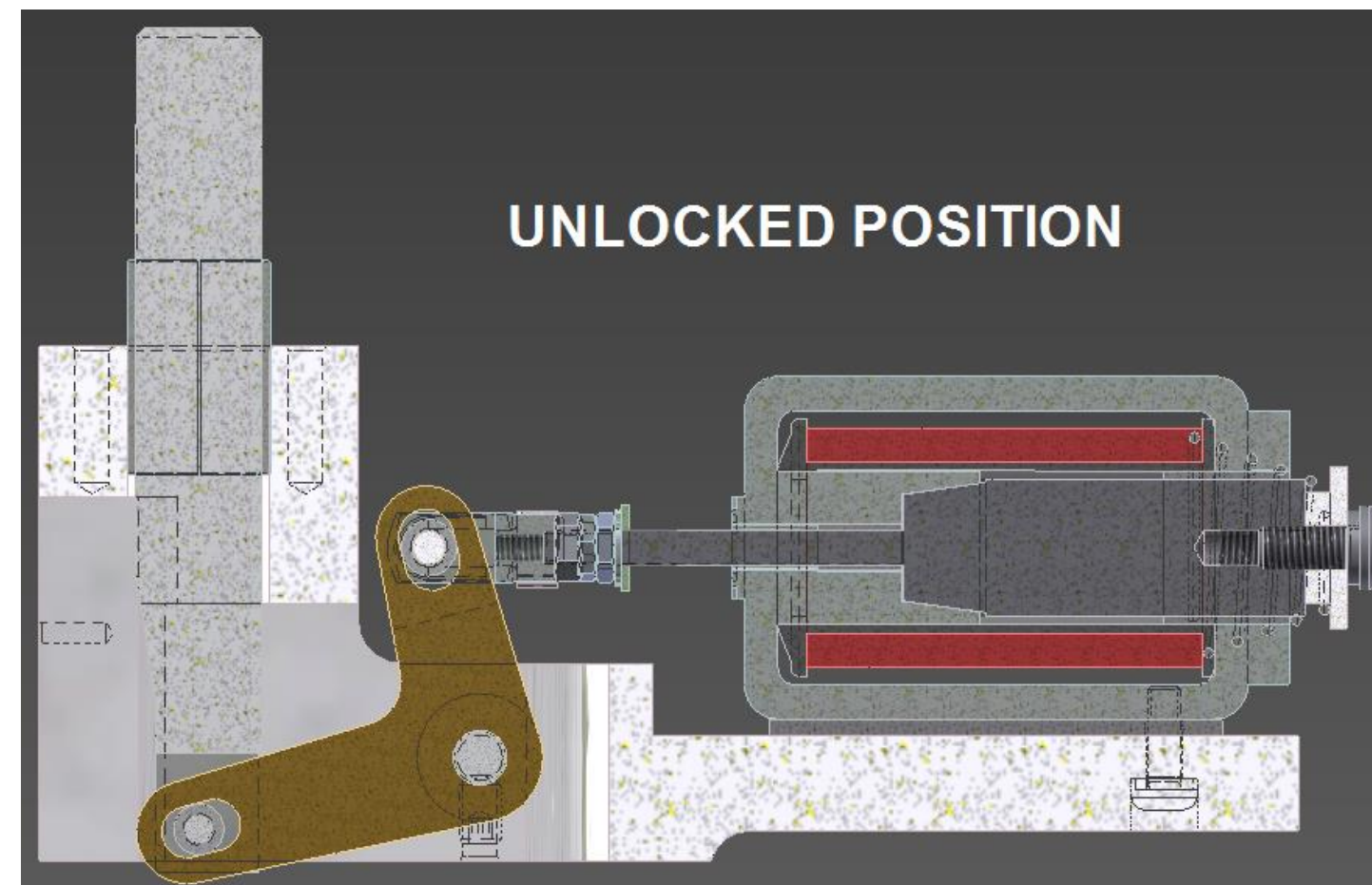


# Exercise 2 – Why is there a difference





# Exercise 3 – Fatigue Analysis



Assuming fully reverse loading

# Exercise 3 – Fatigue Analysis

**S-N Fatigue** ? X

S-N Data E-N Data

$B$

$S_u$

$N_0$

KF

$B_e$

$S_e$

Nastran Help Show XY Plot OK Cancel

Typically we only need to specify the following values.

$B$  – Gradient of the curve in the high cycle region.

$S_e$  – Endurance limit.

$S_u$  – UTS value of material (Need to specify  $S_f$ )

$N_0$  – Beginning of high cycle fatigue



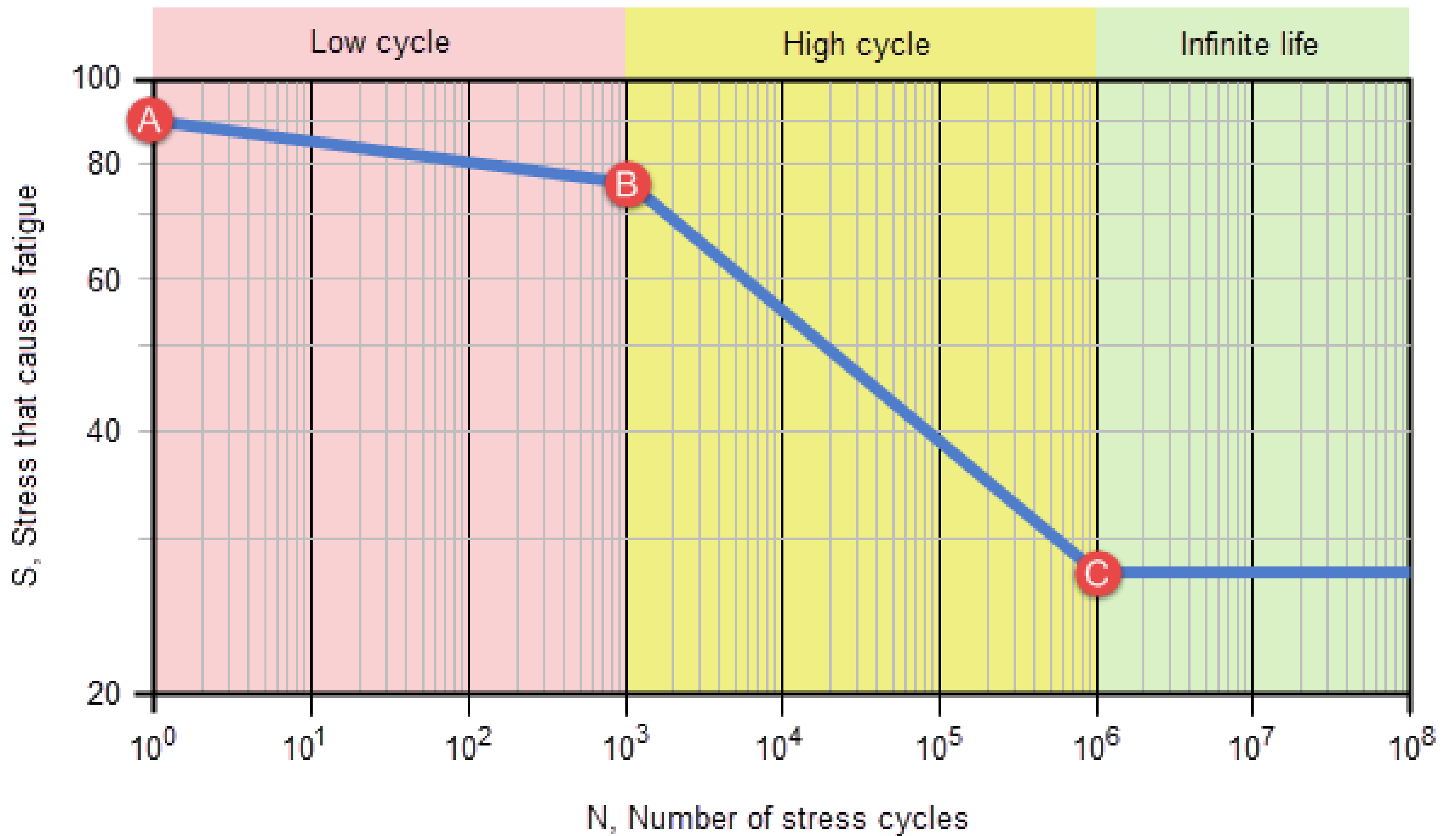
# Exercise 3 – Fatigue Analysis

Lets first have a look at  $N_o$

$N_o$  – Is the number of cycles at the beginning of High Cycle Fatigue region (B).

And typically is 1000 cycles

$N_o$  – 1000



# Exercise 3 – Fatigue Analysis

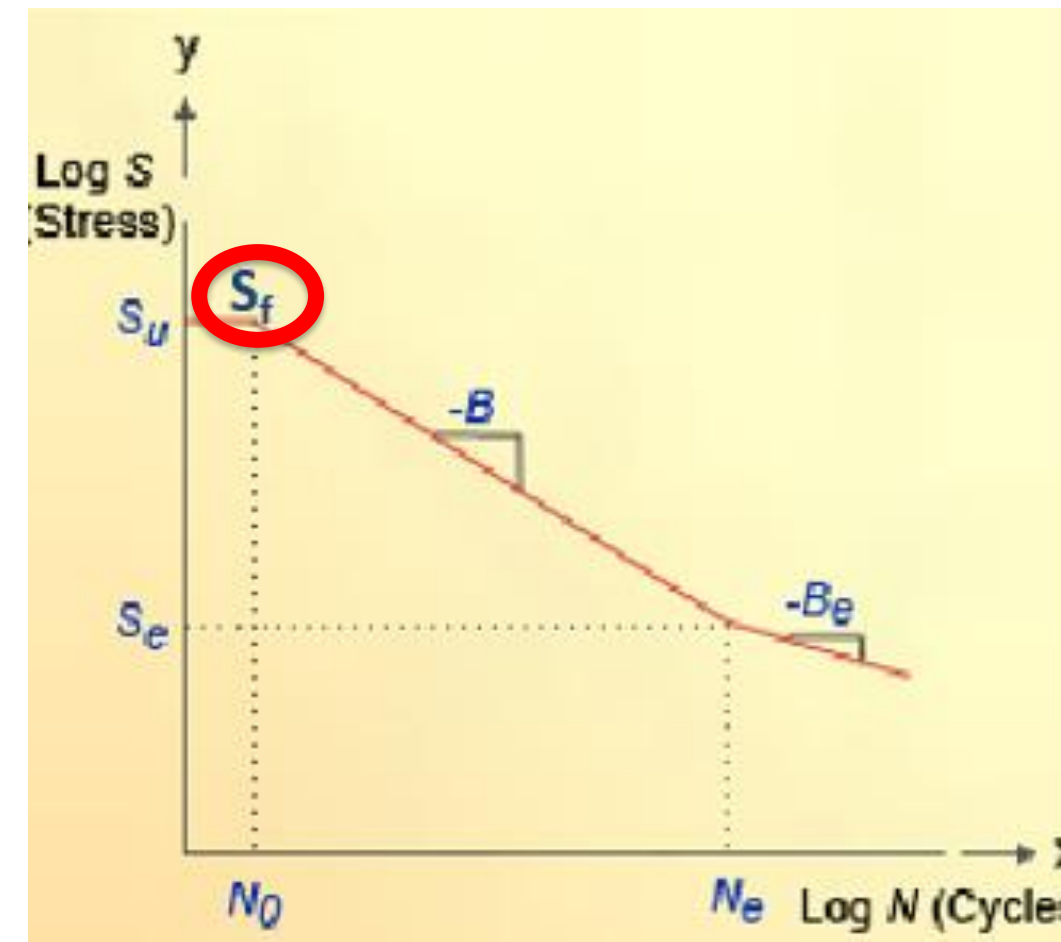
UTS information is widely available.

$$S_u - 340$$

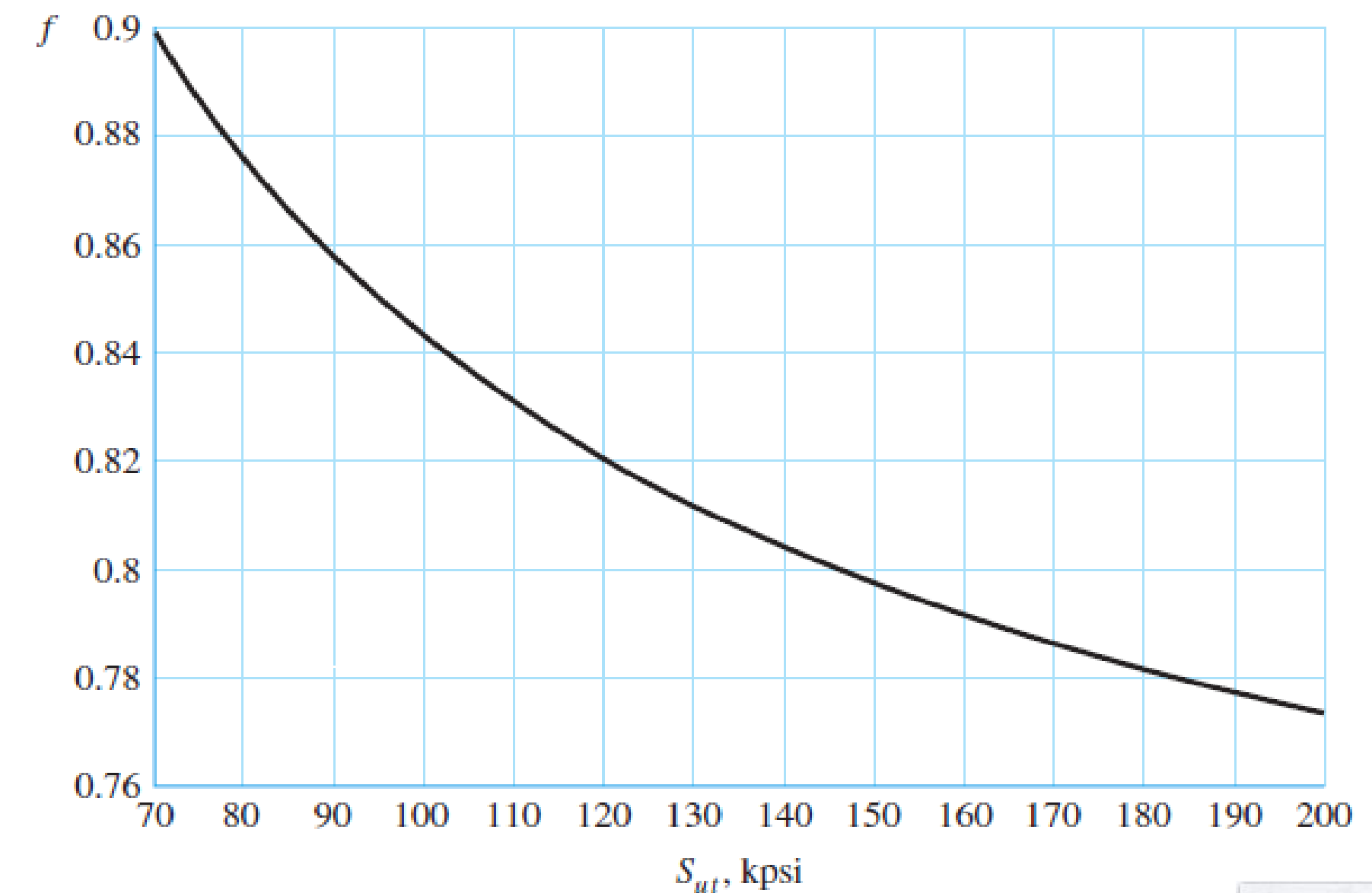
We need to specify  $S_f$

Where  $S_f$  is defined as

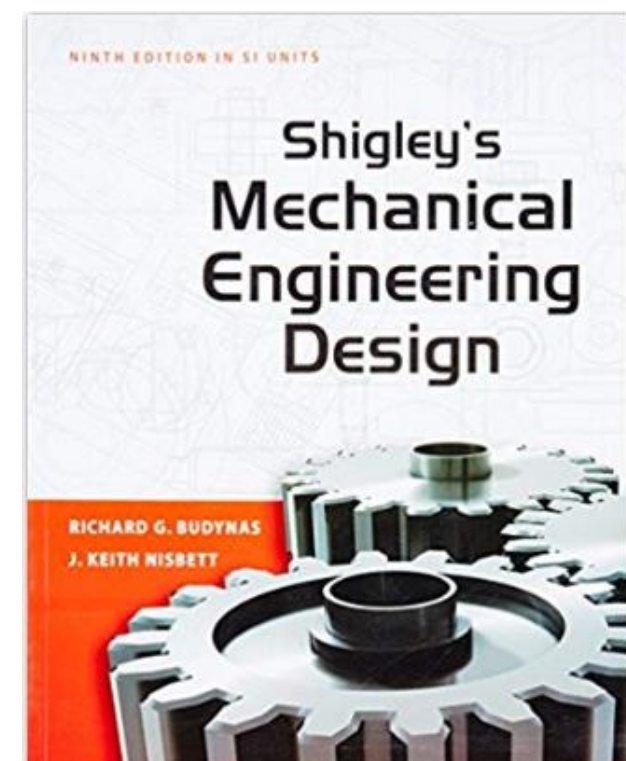
$$S_f = S_u \times f$$



70 kpsi = 482MPa & 200 kpsi = 1379MPa



$$S_f - 340 \times 0.9 = 306$$





# Exercise 3 – Fatigue Analysis

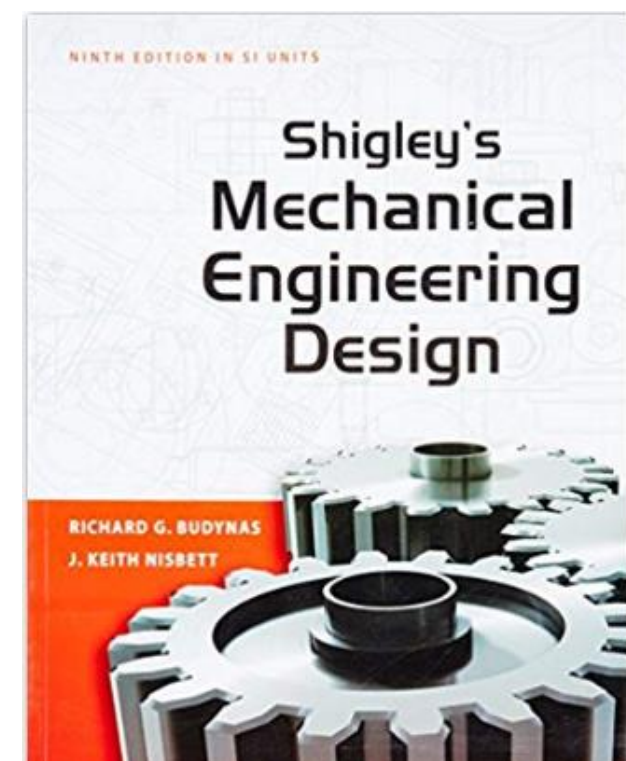
Now Endurance limit is not so obvious

$$S_e = k_a k_b k_c k_d k_e k_f S'_e$$

Typically for Steel component

$$S'_e = 0.5S_u$$

- $S'_e$  is endurance limit of a test specimen
- $k_a$  is a surface factor that accounts for the finish (ground, machined, forged, and so on).
- $k_b$  is a size factor that accounts for the size of the part.
- $k_c$  is a loading factor that accounts for different types of loading (bending, axial, torsion).
- $k_d$  is a temperature factor.
- $k_e$  is a reliability factor to account for scatter in the test results from one specimen to another.
- $k_f$  is a miscellaneous factor to account for everything else (residual stress, directional characteristics, corrosion, electrolytic plating, and so on).



# Exercise 3 – Fatigue Analysis

In this example we are going to assume all  $k$  values as 1 except  $k_a$

$$S_e = k_a S'_e$$

$$k_a = a S_u^b$$

$$k_a = 4.51 \times 340^{-0.265}$$

$$k_a = 4.51 \times 0.2134 = 0.962$$

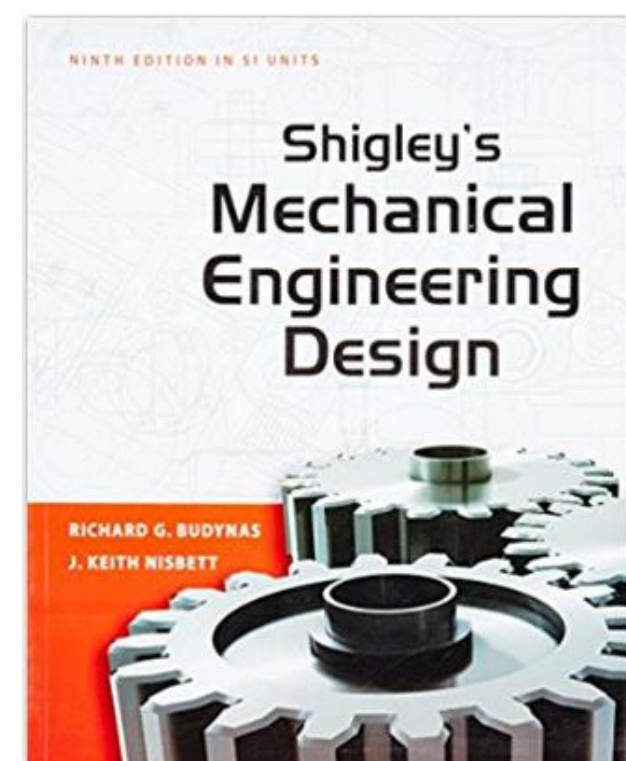
So

$$S_e = 0.962 \times 0.5 S_u$$

$$S_e = 0.962 \times 0.5 \times 340$$

$$S_e = 163.54$$

| Surface Finish         | Factor a (MPa) | Exponent b |
|------------------------|----------------|------------|
| Ground                 | 1.58           | -0.085     |
| Machined or cold-drawn | 4.51           | -0.265     |
| Hot-rolled             | 57.7           | -0.718     |
| As-forged              | 272            | -0.995     |





# Exercise 3 – Fatigue Analysis

Now finally we need to define B the slope of the S-N Curve for the high cycle region.

$$B = \frac{\log(S_f) - \log(S_e)}{\log(N_e) - \log(N_0)}$$

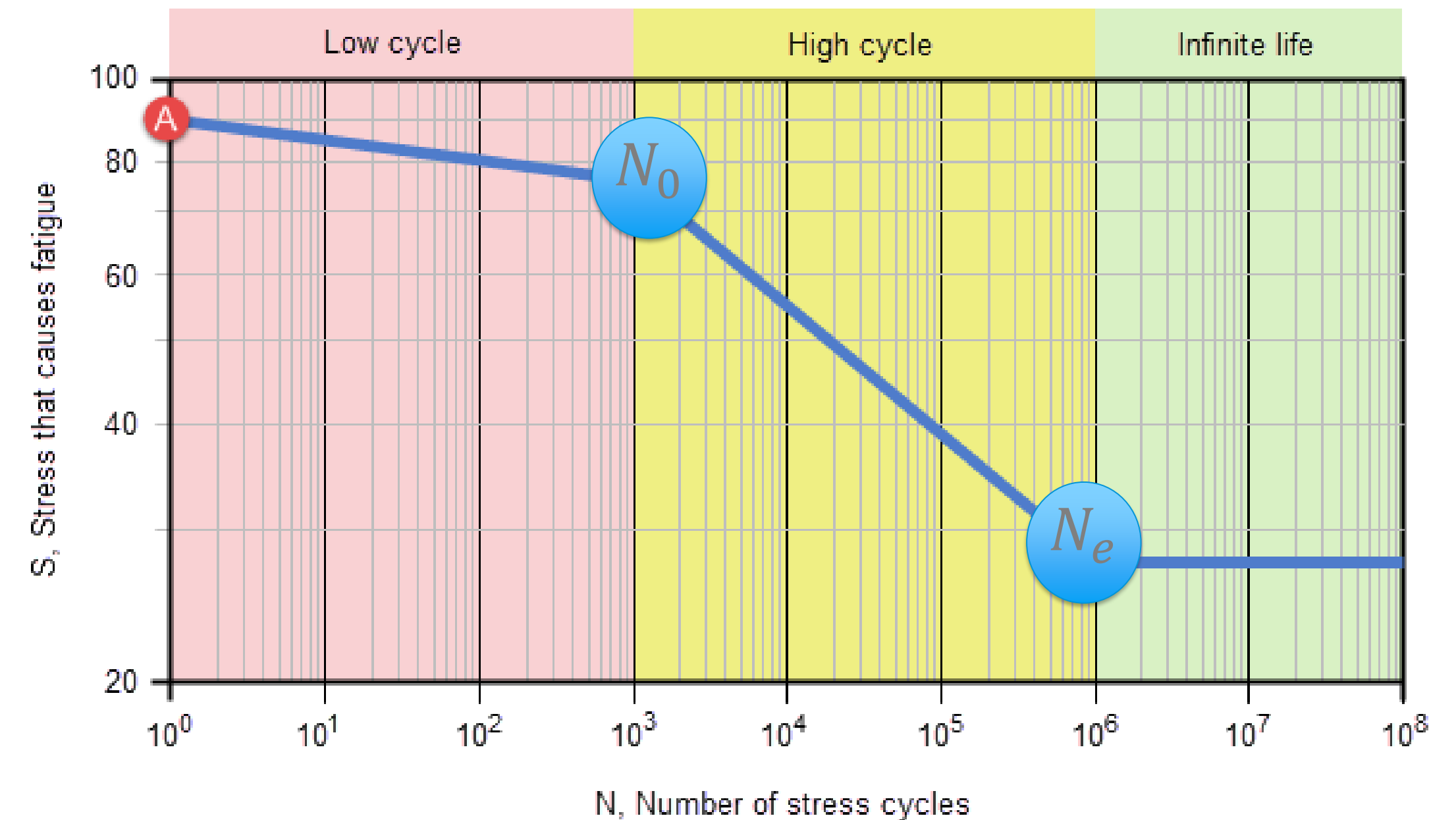
Typically we assume infinite life after 1 million cycles

This gives us

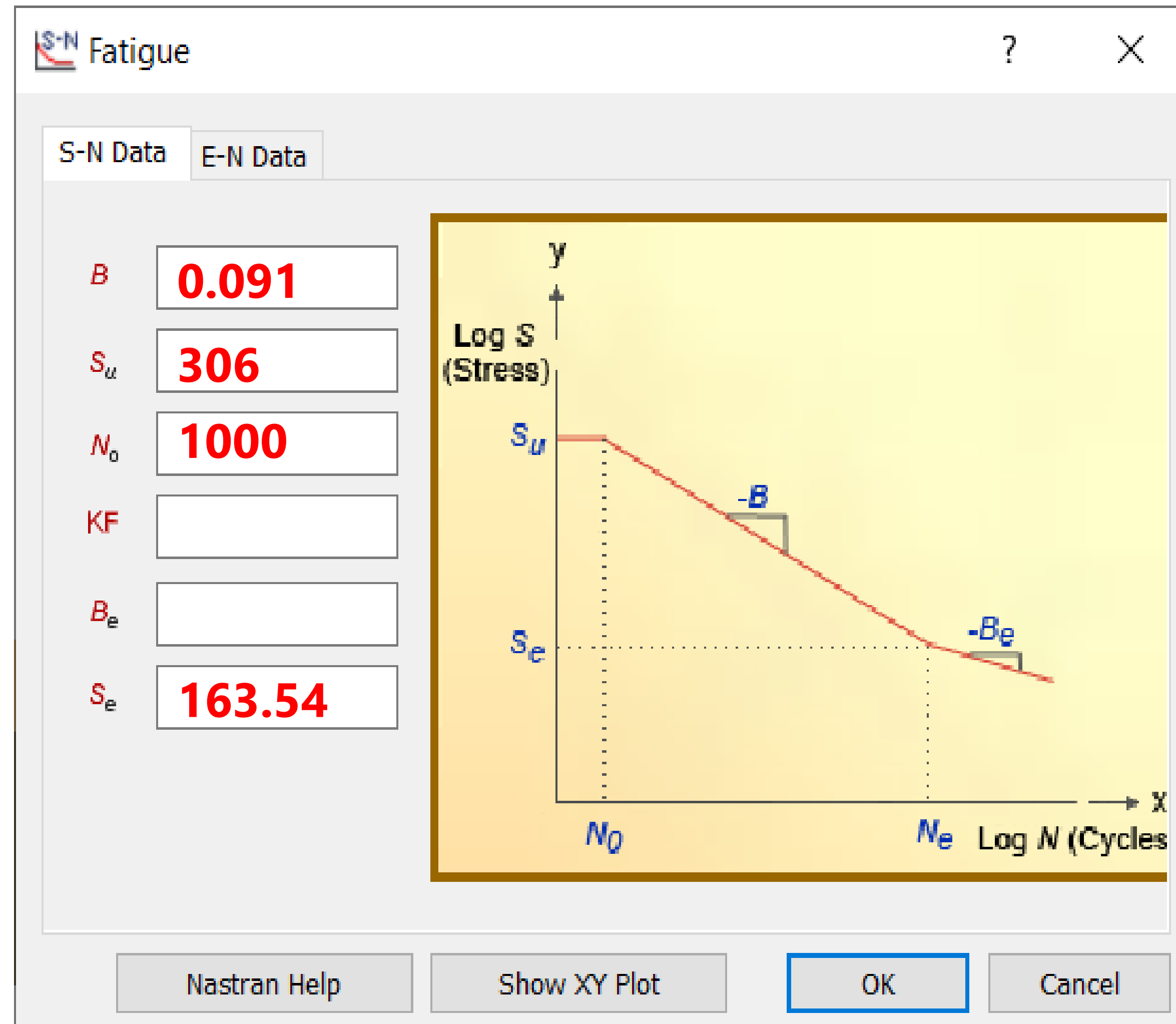
$$B = \frac{\log(306) - \log(163.54)}{\log(1e6) - \log(1e3)}$$

$$B = \frac{\log(306) - \log(163.54)}{3}$$

$$B = 0.091$$



# Exercise 3 – Fatigue Analysis





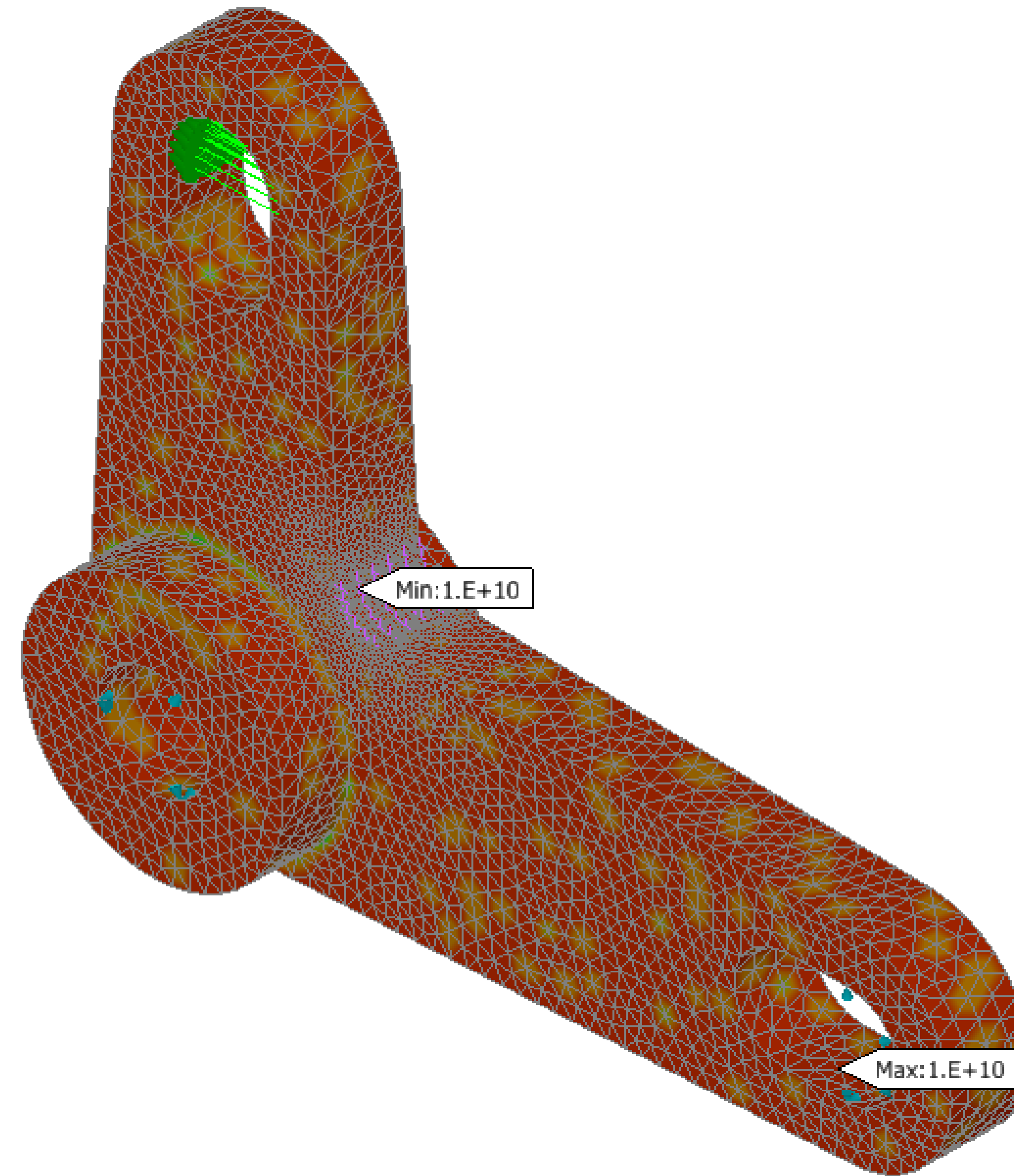
# Hands on Session 3



# Exercise 3 – Fatigue Analysis

Fatigue life is  $1e10$ .

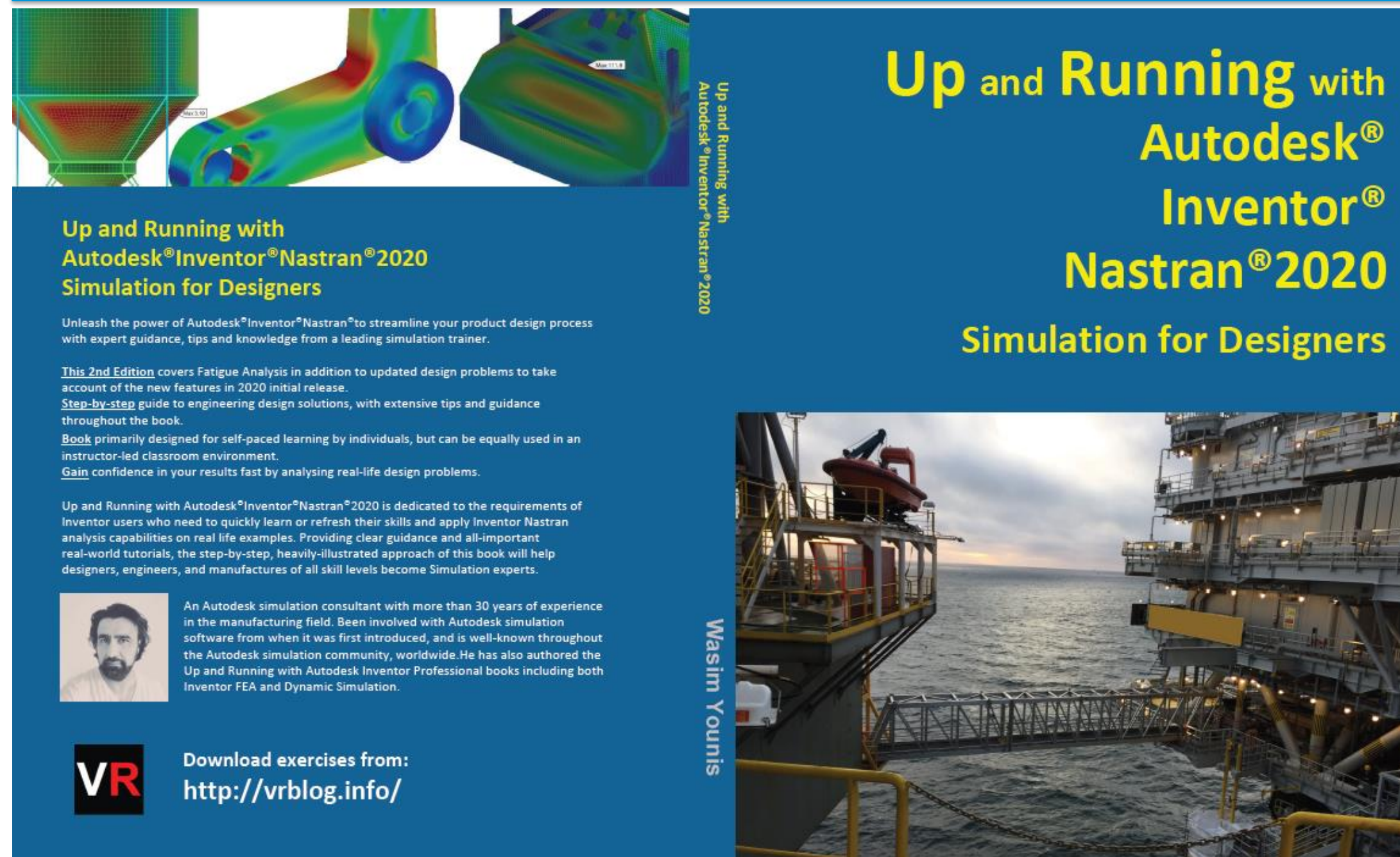
Because Maximum Stress value  
is below Endurance Limit





# Resources to help you accelerate learning...

Available on Amazon worldwide



Self –paced learning with real world examples.

<https://forums.autodesk.com/t5/nastran-in-cad-forum/bd-p/75>

Cannot apply constraints/loads on beam idealisations automatically created

I have a simple test model and have the following issues

1. When entering the nastran environment the solid geometry does not automatically hide. I have to select/unselect cad bodies from object visibility to hide them so can select beam elements
2. I can get warning not selected on valid FEA geometry when running the model.

I have attached model for your attention

Tags: Beam Elements

Report

simple-model.zip

0 LIKES

REPLY

MESSAGE 2 OF 2



KubliJ in reply to: wasim.younis

Friday

Re: Cannot apply constraints/loads on beam idealisations automatically created

Hi @wasim.younis,

Thanks for sharing your experience with In-CAD and the use of frame generated models. There are some known issues with the workflow currently. Solid Object visibility being one of them, the other is with the selection process when applying loads and constraints. The problem with the loads and constraints is that they are being applied to the original sketch entities and not being translated/transferred to the meshed model. It can be resolved easily, you just need to hide the sketch used to create the frame. A more [detailed explanation can be found here](#).

Nastran In-CAD Forum - Excellent resource for any questions you may have





# AUTODESK®

## Make anything™

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.

© 2019 Autodesk. All rights reserved.

