Up and Running with Autodesk Inventor Nastran

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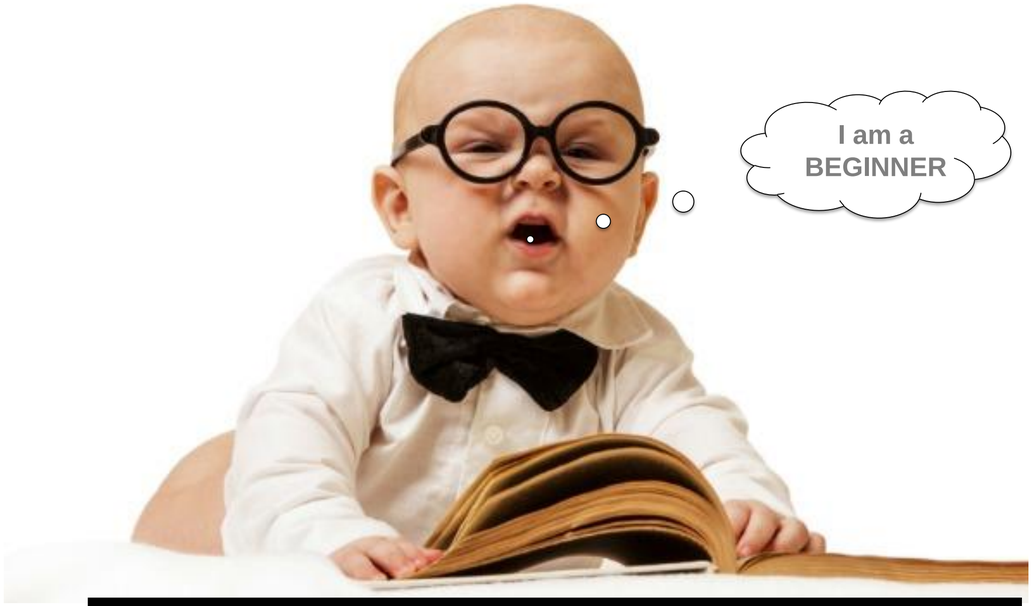
AUTODESK. UNIVERSITY

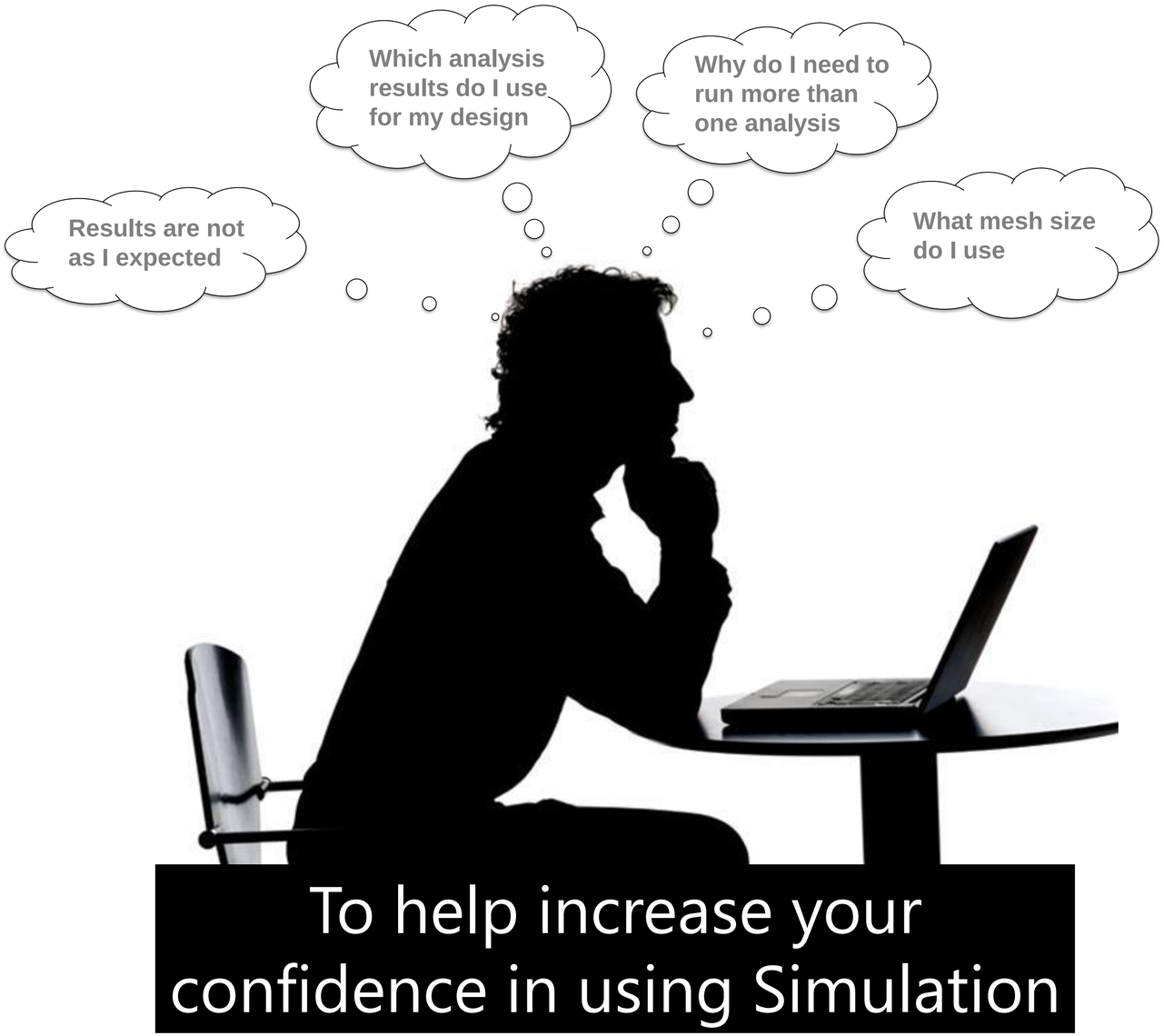
This Class is for…



Users just starting out in Life (Simulation!)

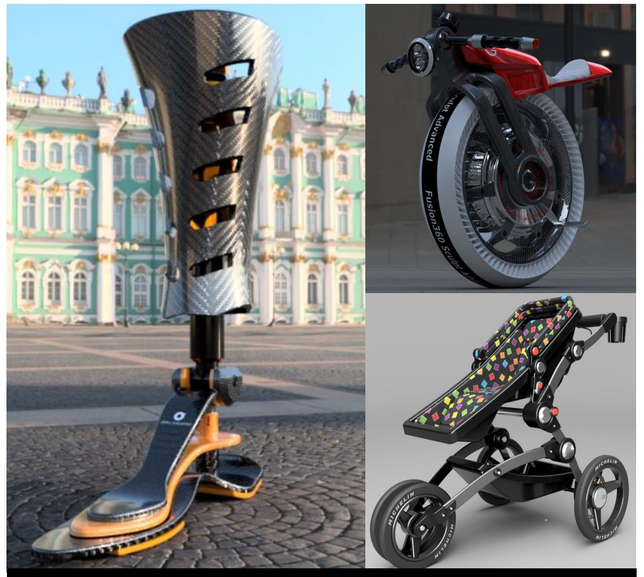
I hope experts may pick up one or two tips.

The goal of this lab is…



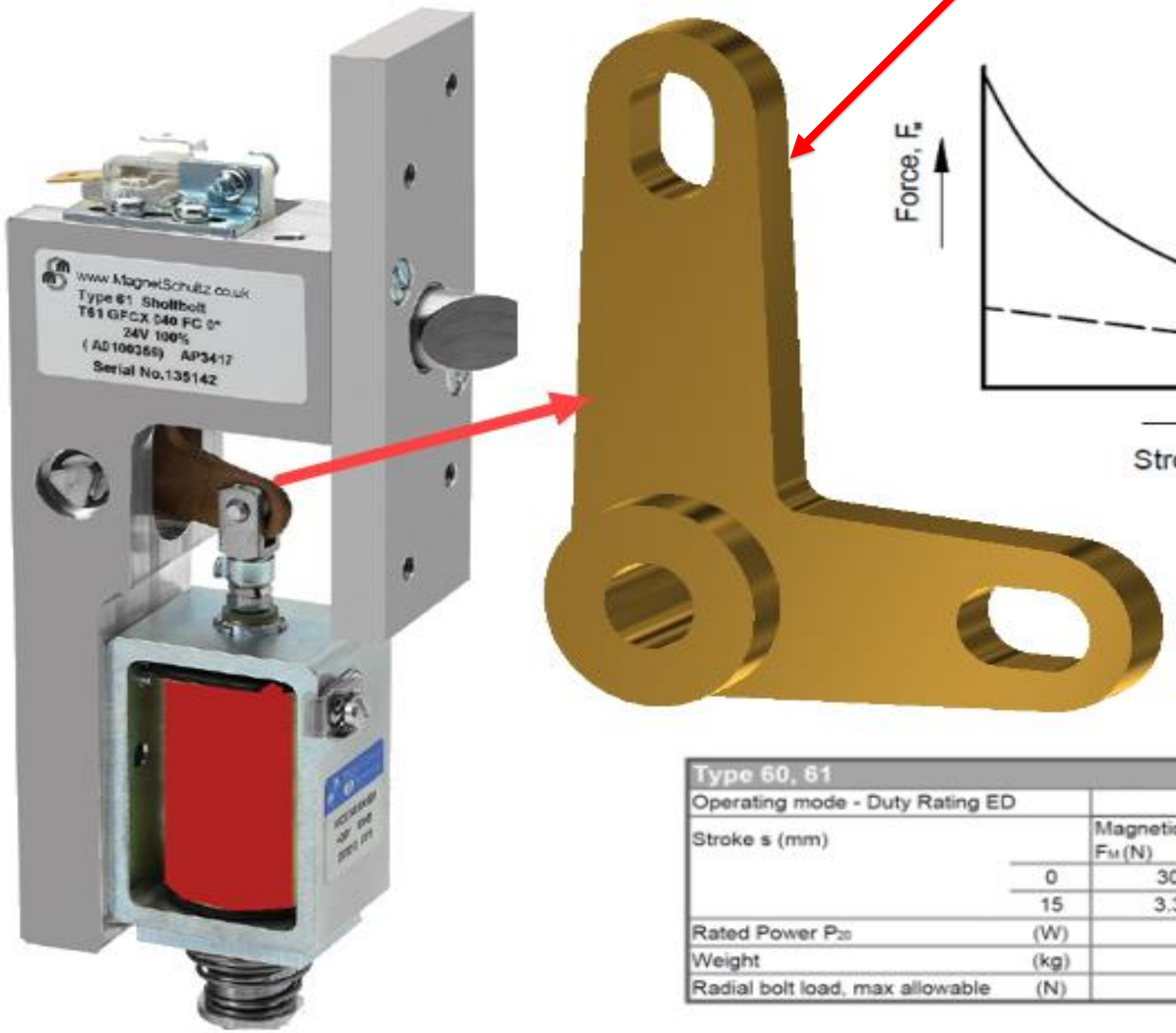
To help increase your confidence in using Simulation

Create great products

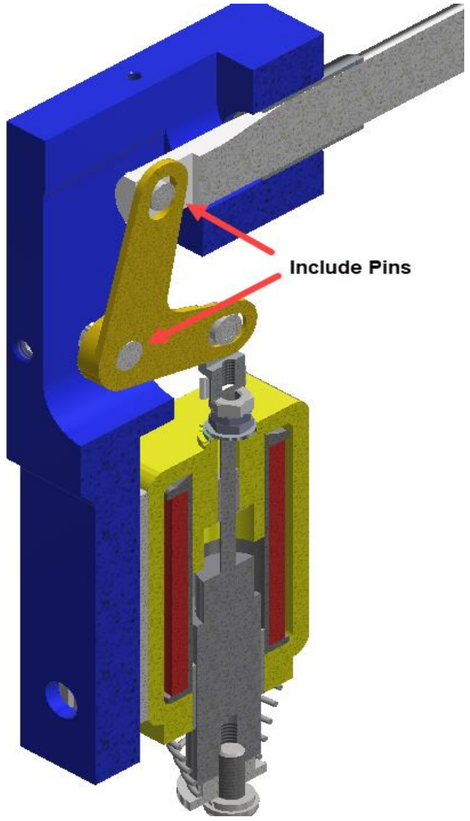


Avoid Over-engineering

Design Problem… Analyse the lever



Type 60, 61			
Operating mode - Duty Rating ED		S1 100%	
Stroke s (mm)		Magnetic force F_M (N)	Spring return-force (N)
	0	30	9
	15	3.3	2.8
Rated Power P_{20}	(W)	14	
Weight	(kg)	1	
Radial bolt load, max allowable	(N)	3000*	



Single Part or Assembly

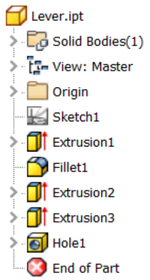
Part or Assembly ?

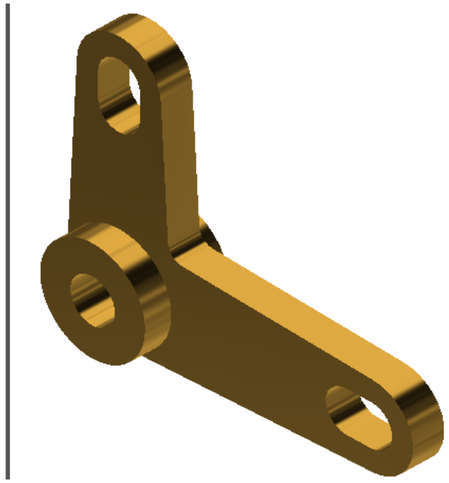
Pro
Easier setup
Less Elements
No contacts

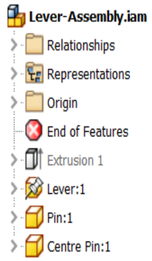
Cons
Over stiffness

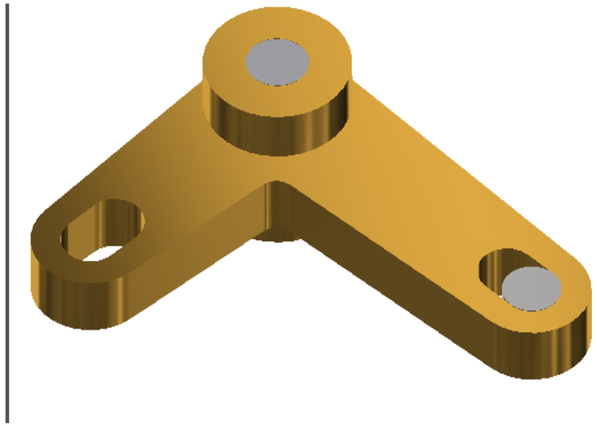
Pro
Better Pin/Lever behaviour

Cons
Longer runtimes





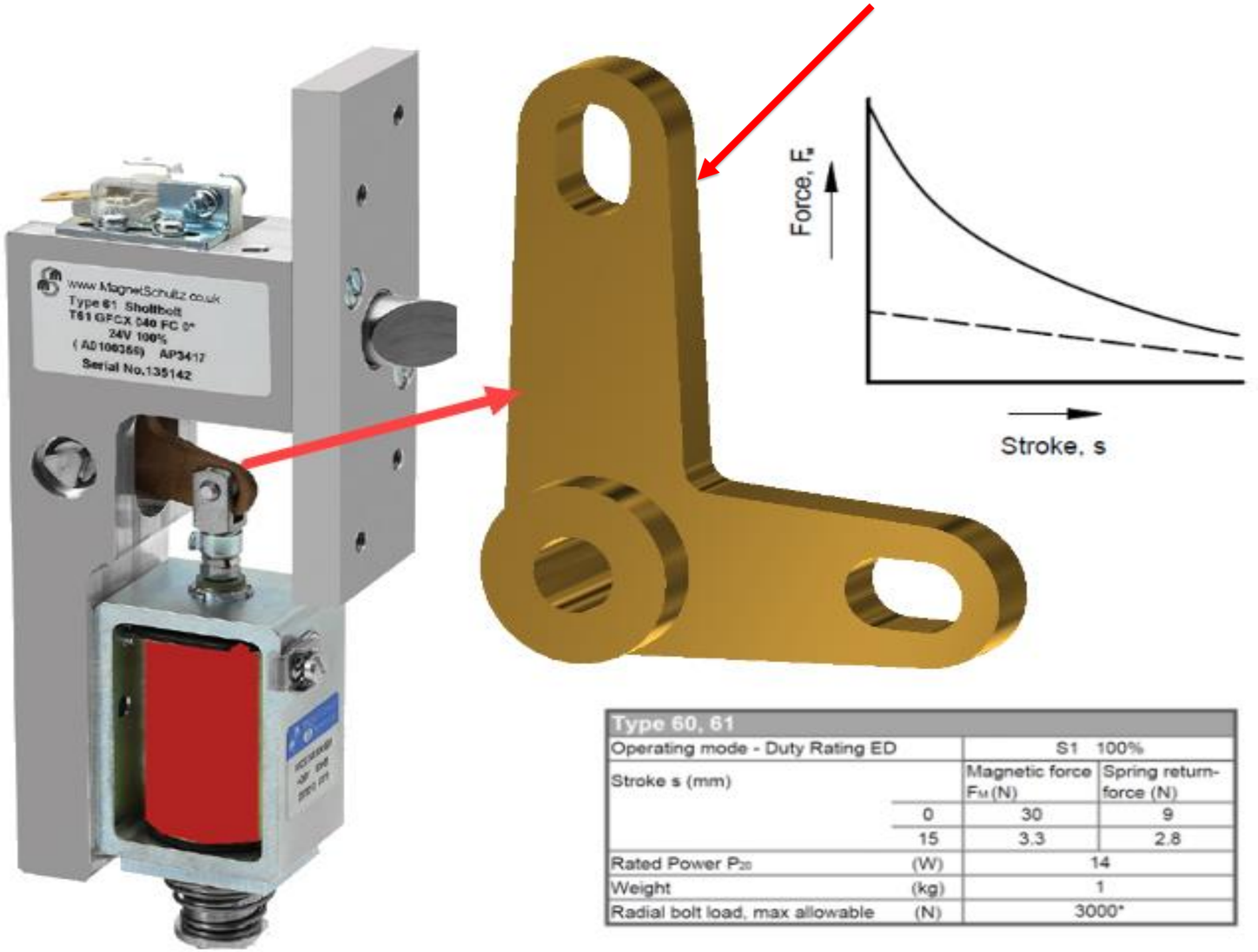




6 Million $?

…. How do I know my results are correct?

Exercise 1 – Part Analysis



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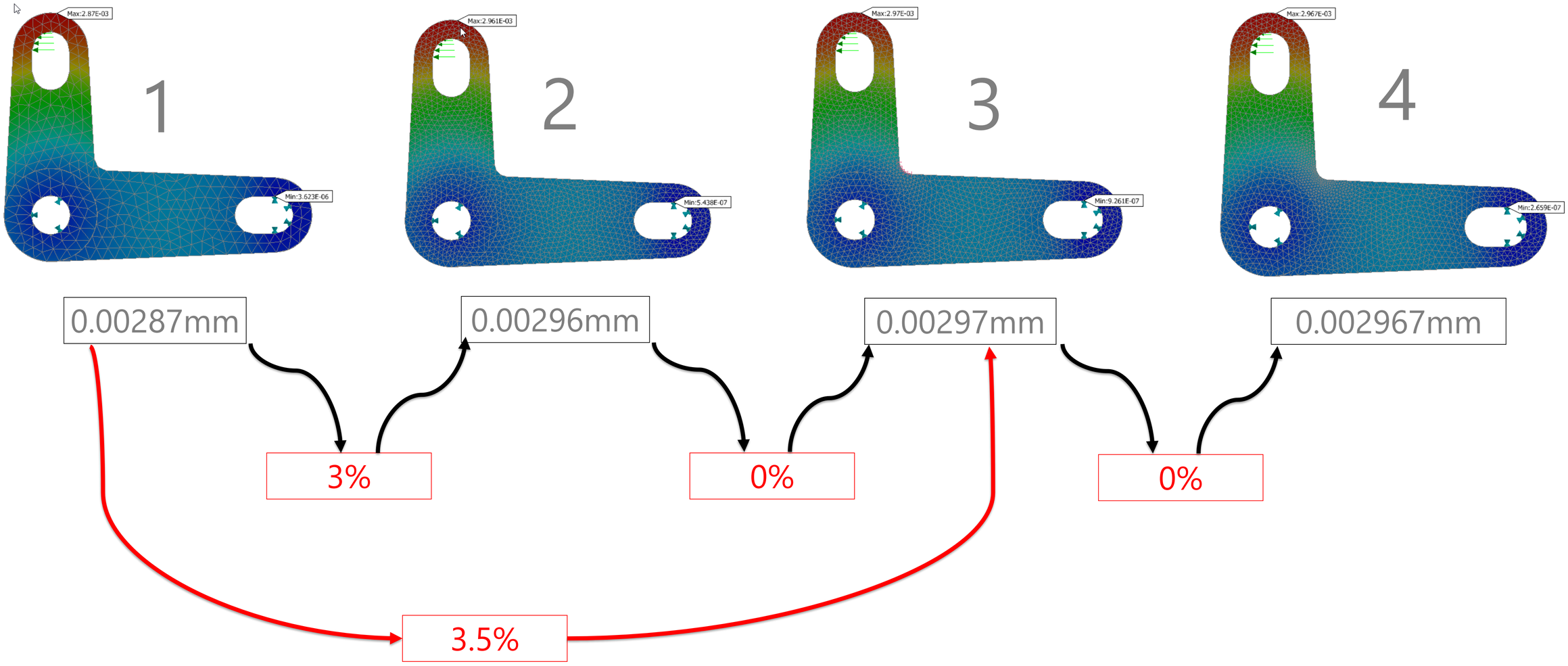
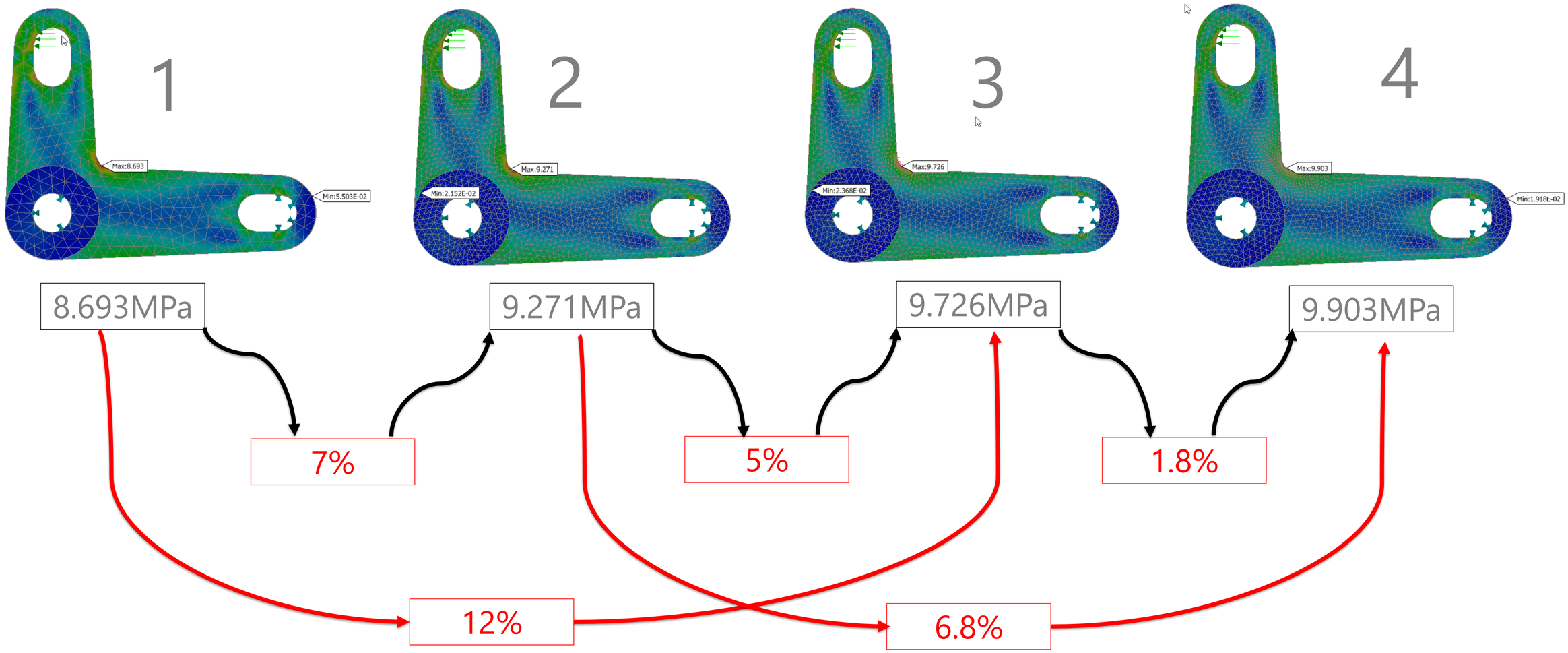
Rated Power P_{20}	(W)	14	
Weight	(kg)	1	
Radial bolt load, max allowable	(N)	3000*	

Hands on Session 1 – Lets Start

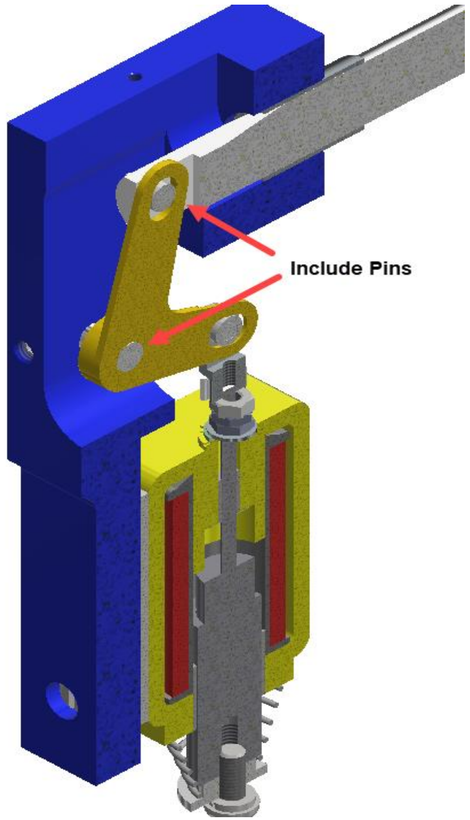
Exercise 1 – Displacement Results

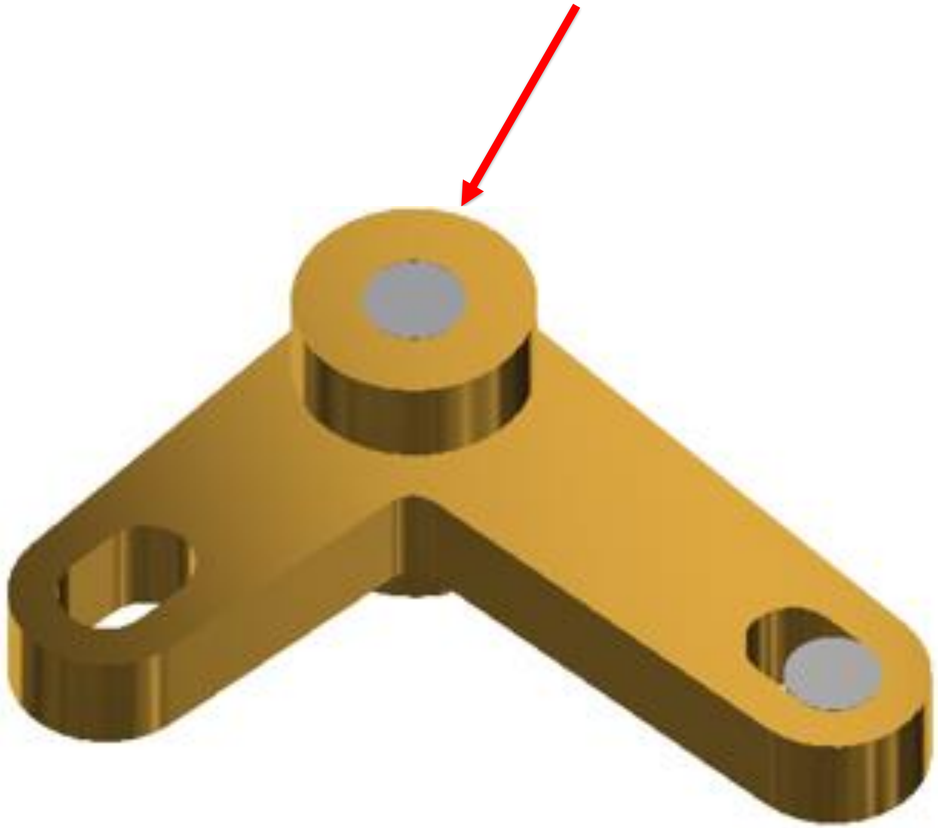


Exercise 1 – Stress Results Convergence



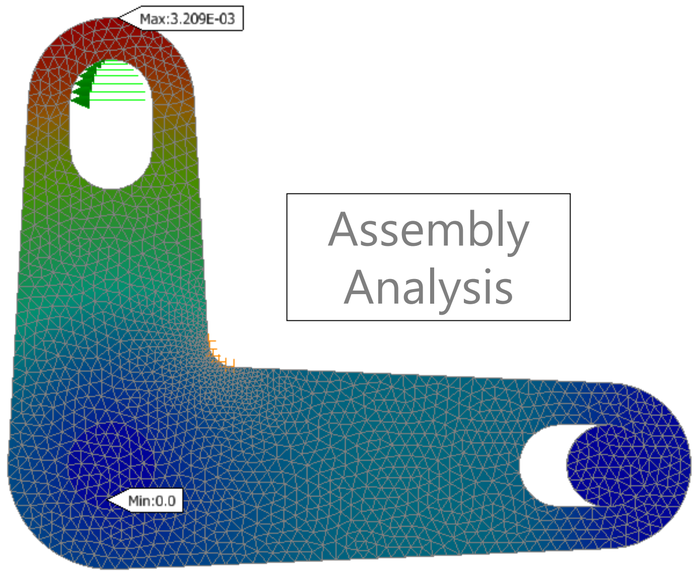
Exercise 2 – Assembly Analysis



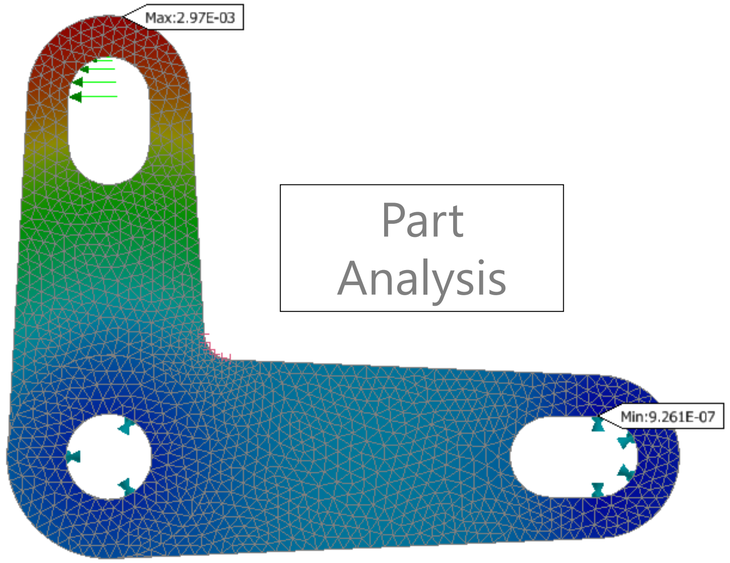


Hands on Session 2 – Lets Continue

Exercise 2 – Displacement Results



Assembly Analysis



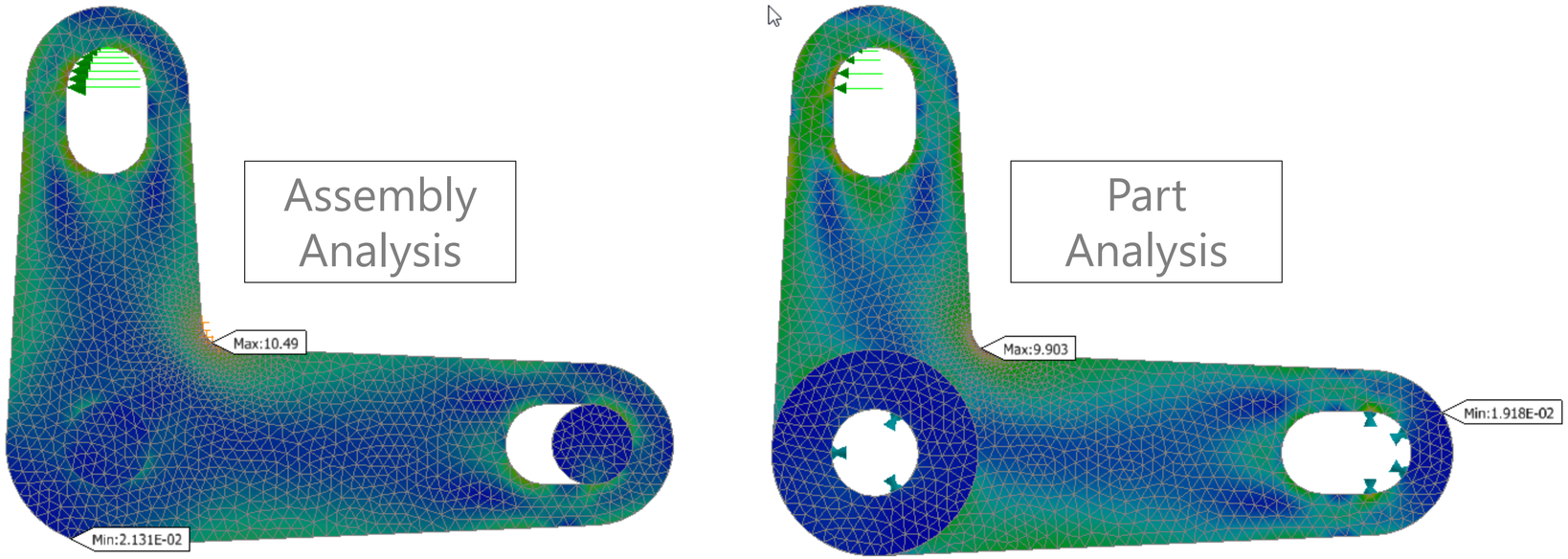
Part Analysis

0.0032mm

0.00297mm

8%

Exercise 2 – Stress Results Comparison

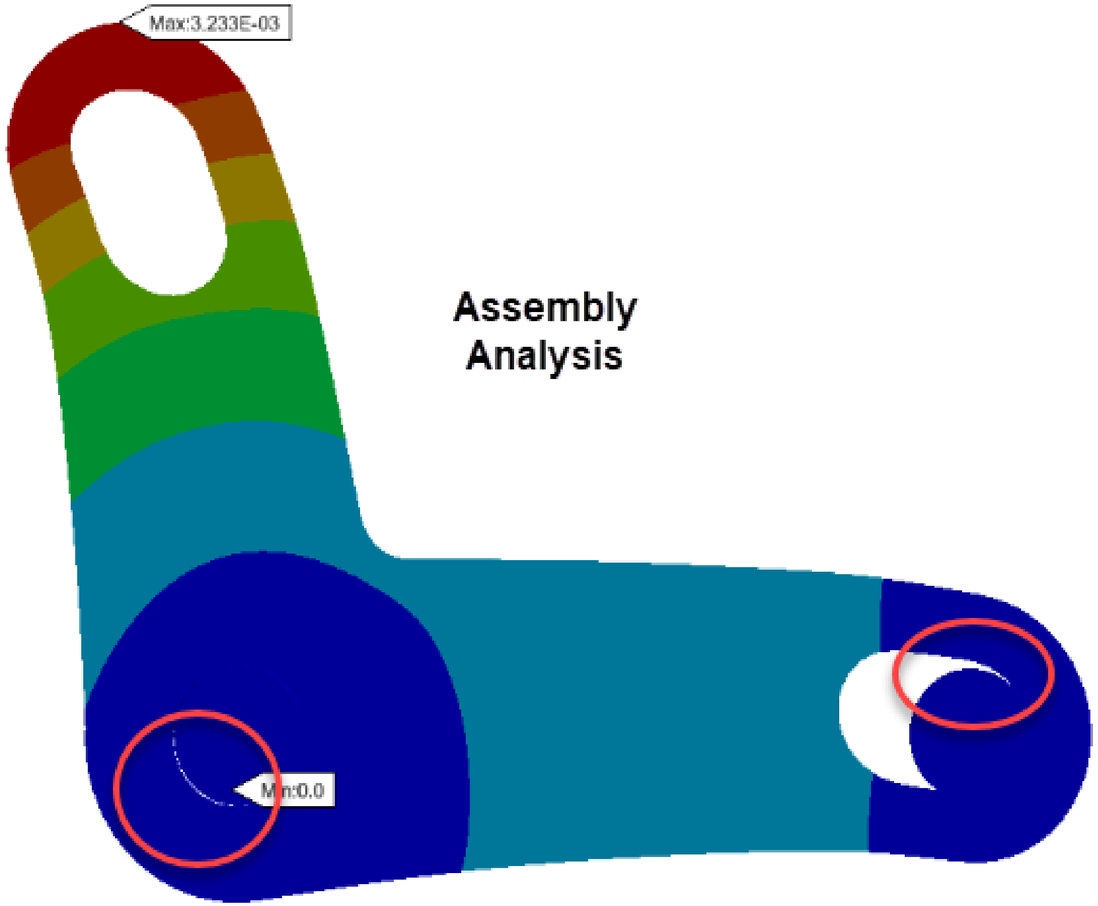


10.49MPa

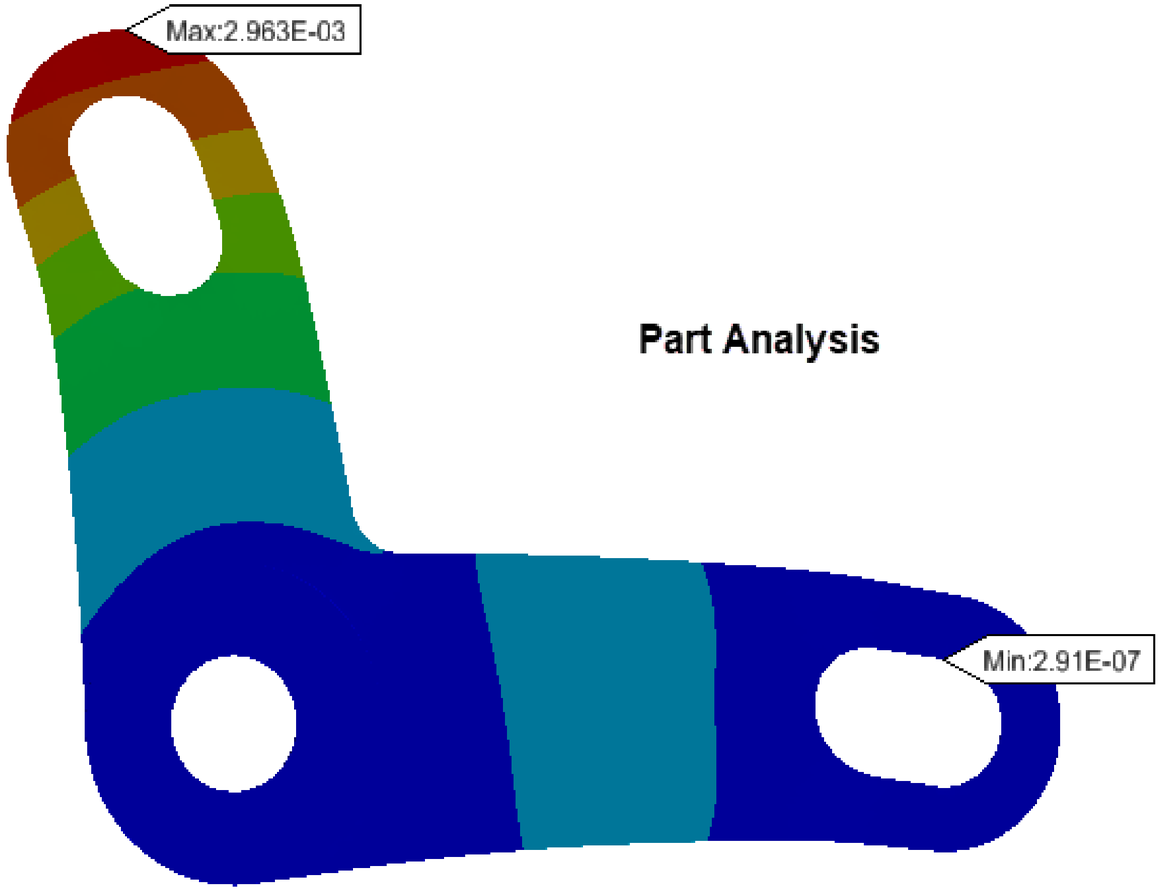
9.903MPa

5.9%

Exercise 2 – Why is there a difference

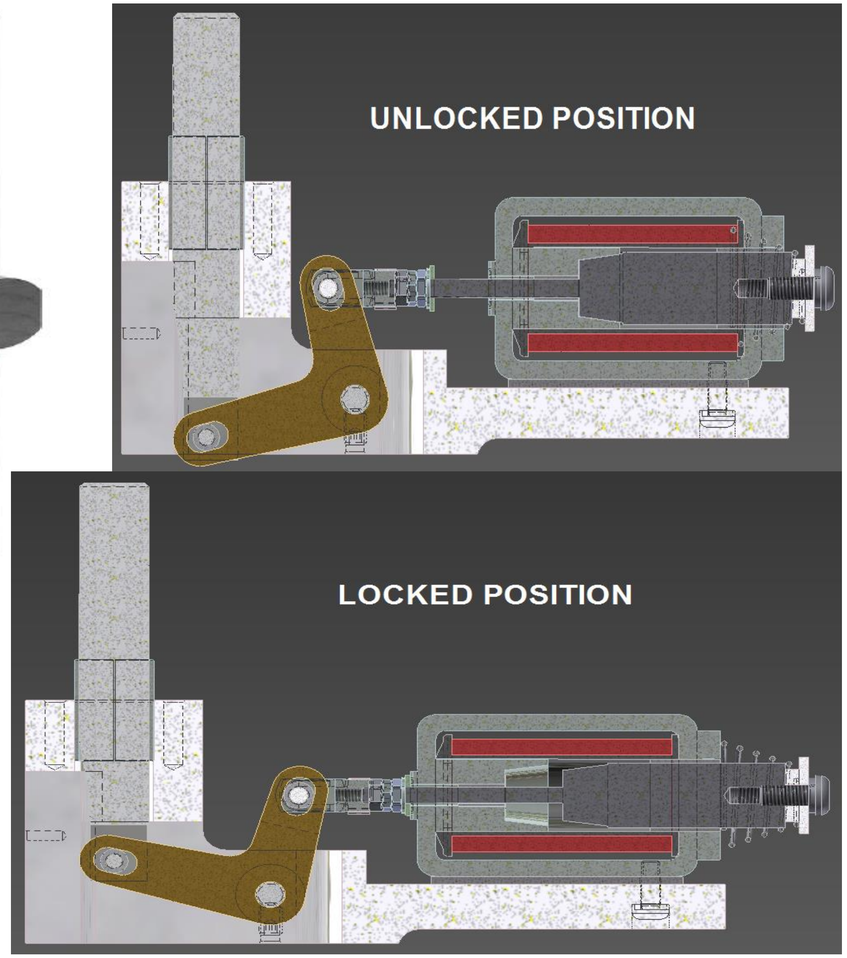


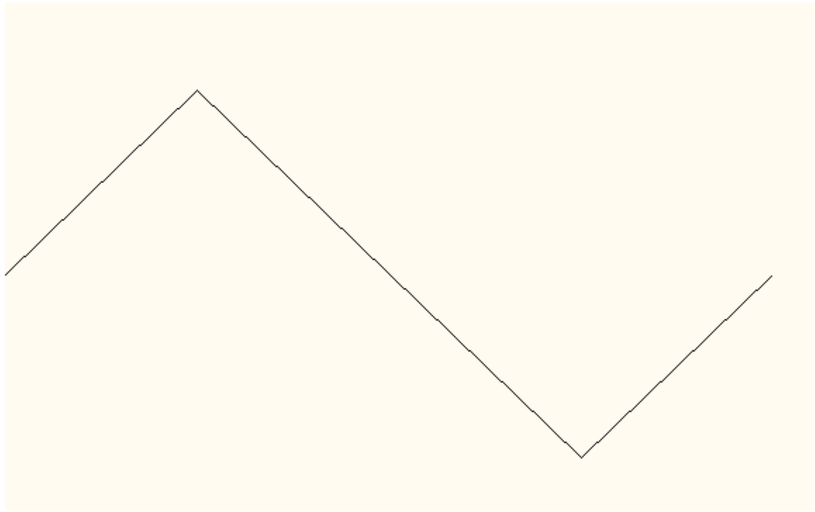
Assembly Analysis



Part Analysis

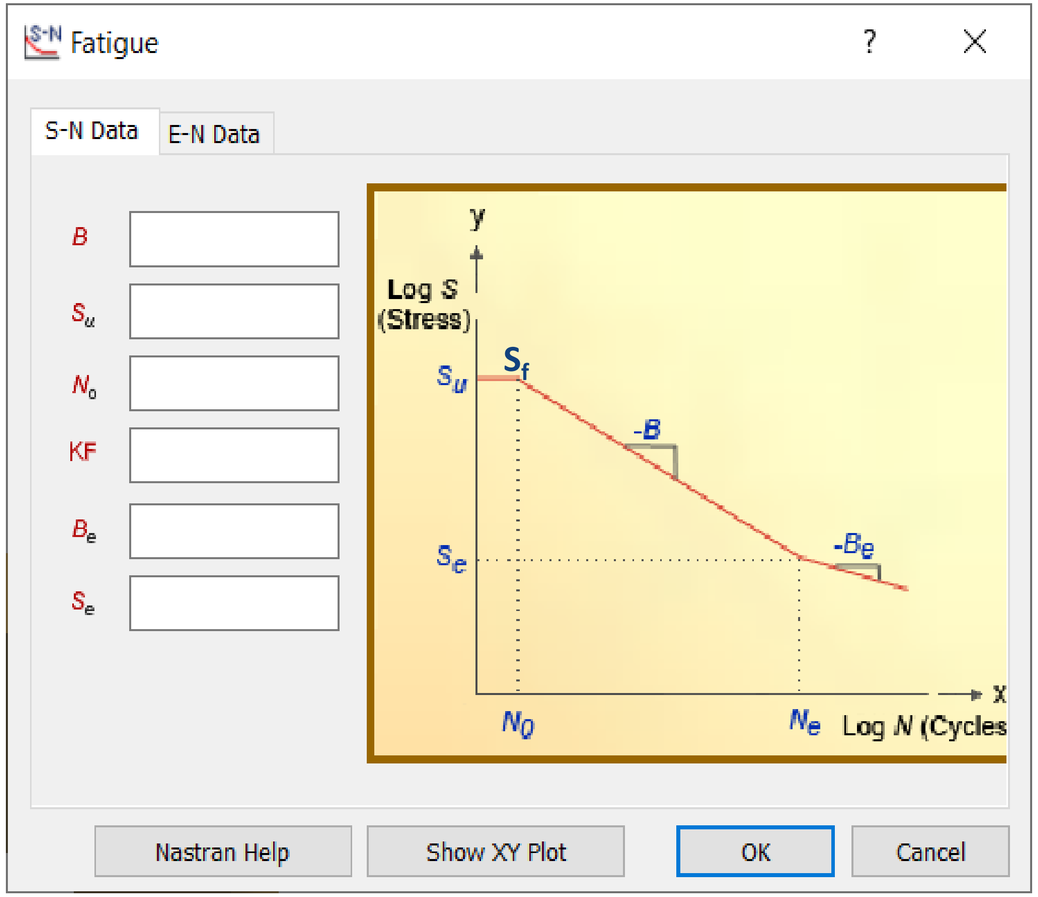
Exercise 3 – Fatigue Analysis





Assuming fully reverse loading

Exercise 3 – Fatigue Analysis



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_o – Beginning of high cycle fatigue

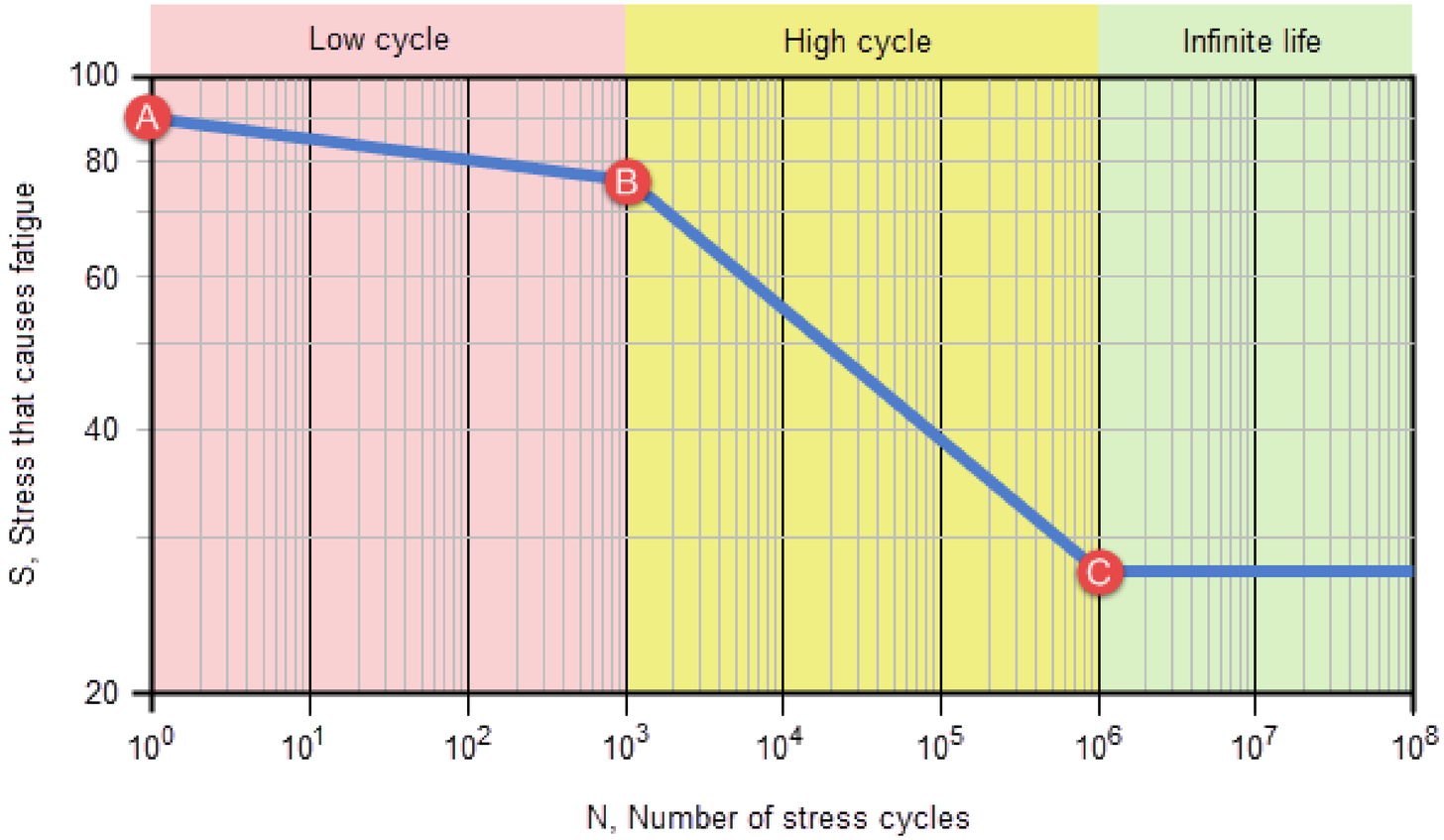
Exercise 3 – Fatigue Analysis

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

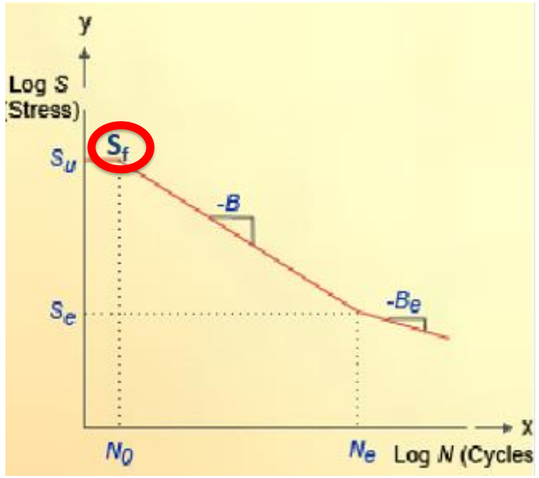
UTS information is widely available.

S_u – 340

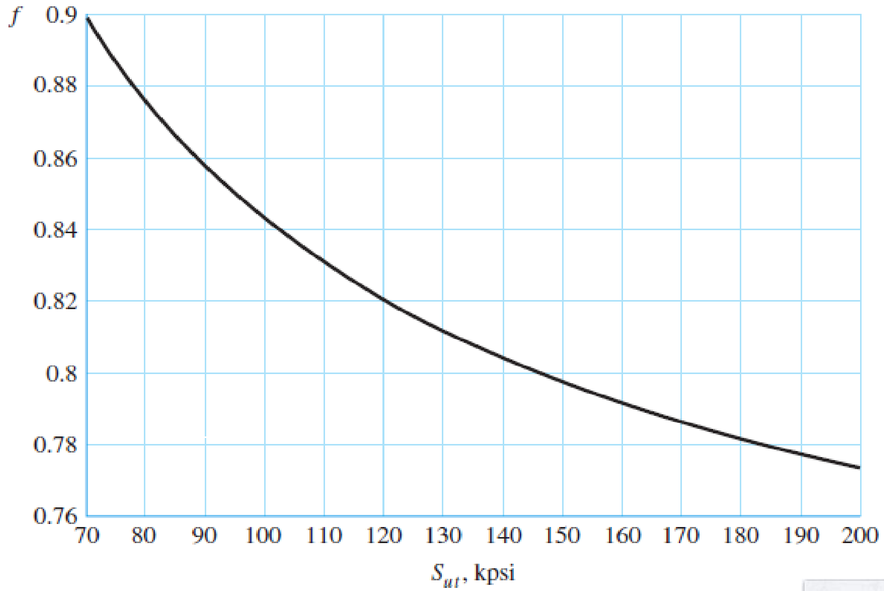
We need to specify S_f

Where S_f is defined as

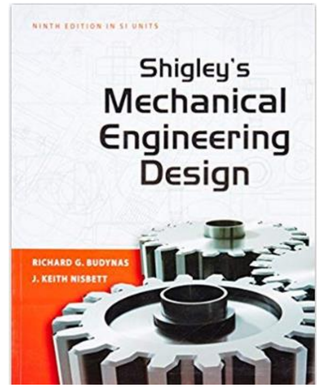
$S_f = S_u$ X f



70 kpsi = 482MPa & 200 kpsi = 1379MPa



S_f – 340 x 0.9 = 306



Exercise 3 – Fatigue Analysis

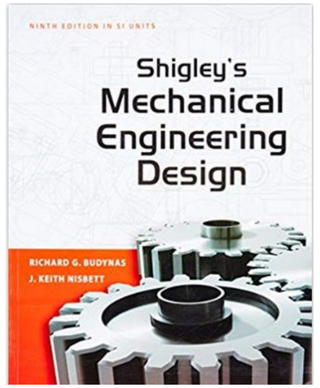
Now Endurance limit is not so obvious

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

Typically for Steel component

$S'_e = 0.5 S_u$

- 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

$S_e = k_a S'_e$

$k_a = a S_u^{\ b}$

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

$k_a = 4.51 \times 0.2134 = 0.962$

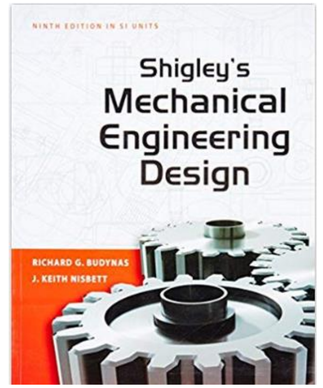
So

$S_e = 0.962 \times 0.5 S_u$

$S_e = \mathbf{0.962 \times 0.5 \times 340}$

$\mathbf{S_e = 163.54}$

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.

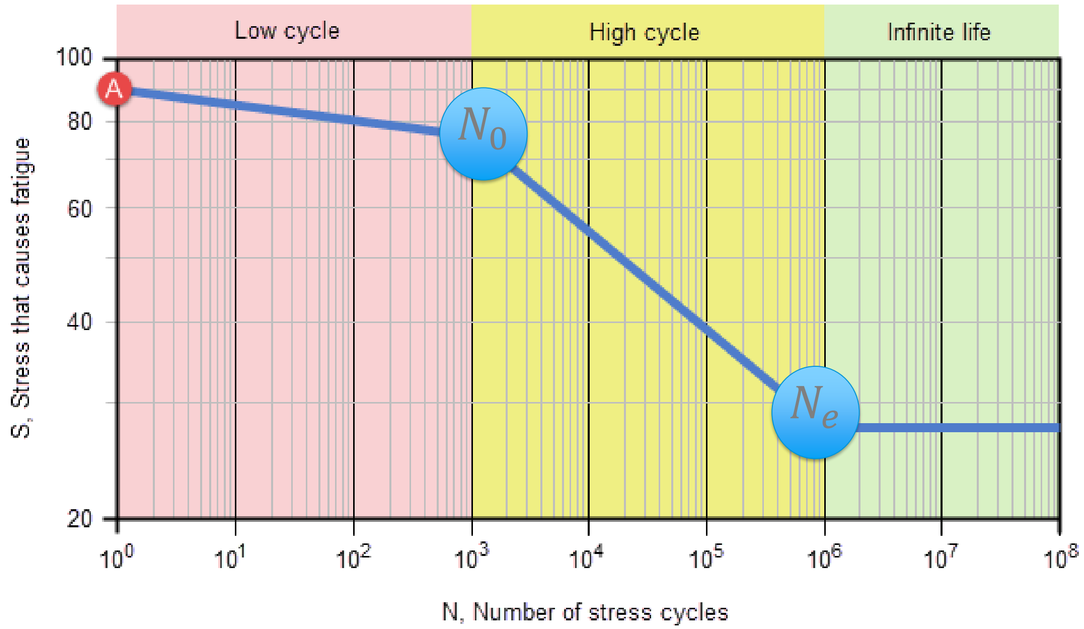
$$B = \frac{\log(S_f) - \log(S_e)}{\log(N_e) - \log(N_0)}$$

Typically we assume infinite life after 1 million cycles

This gives us

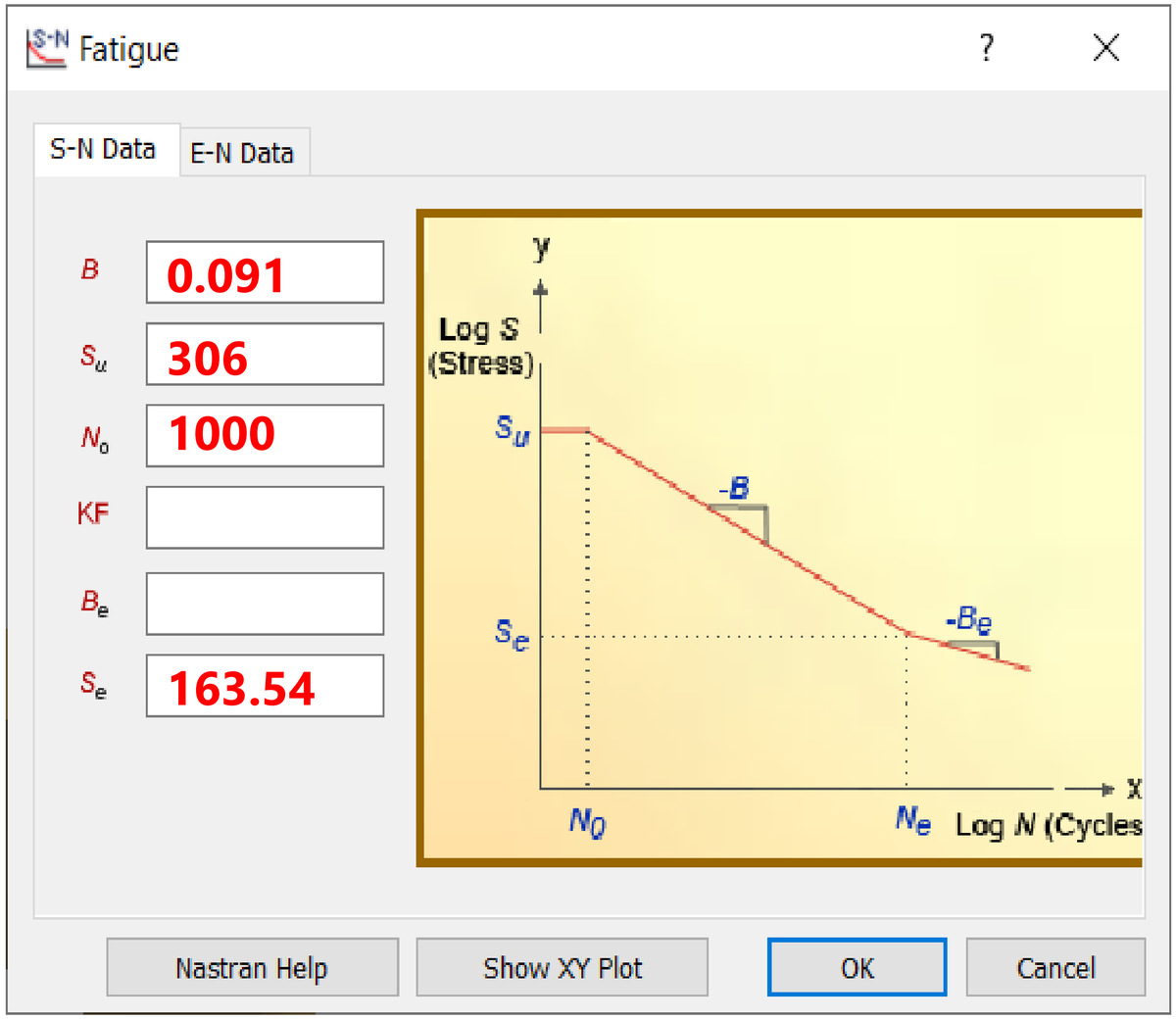
$$B = \frac{\log(306) - \log(163.54)}{\log(1e6) - \log(1e3)}$$

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



B = 0.091

Exercise 3 – Fatigue Analysis

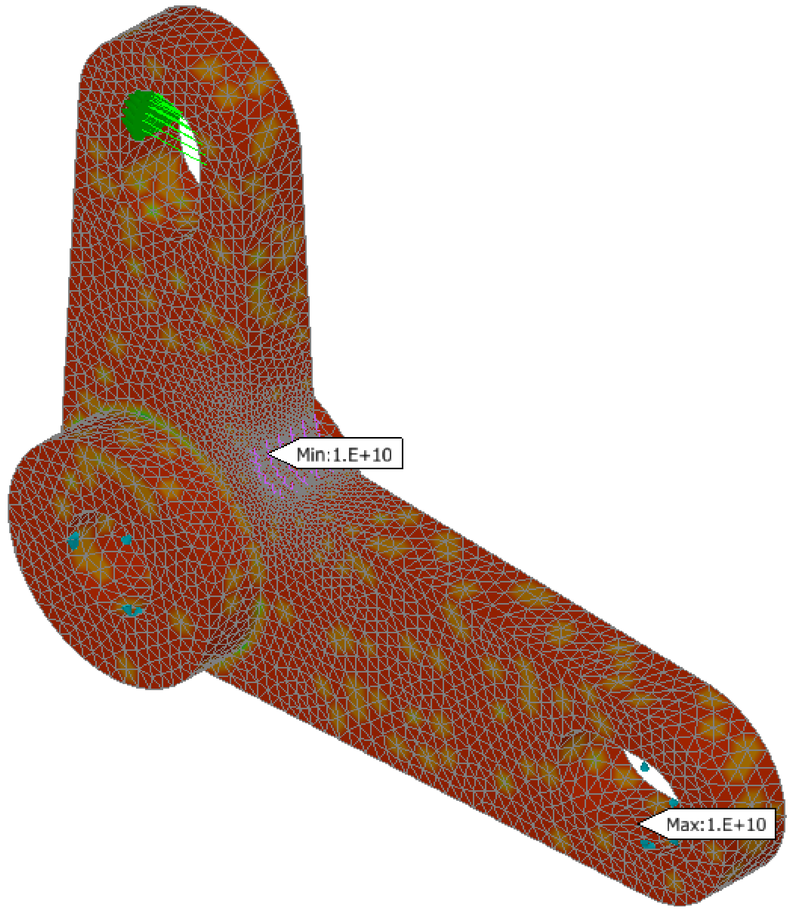


Hands on Session 3

Exercise 3 – Fatigue Analysis

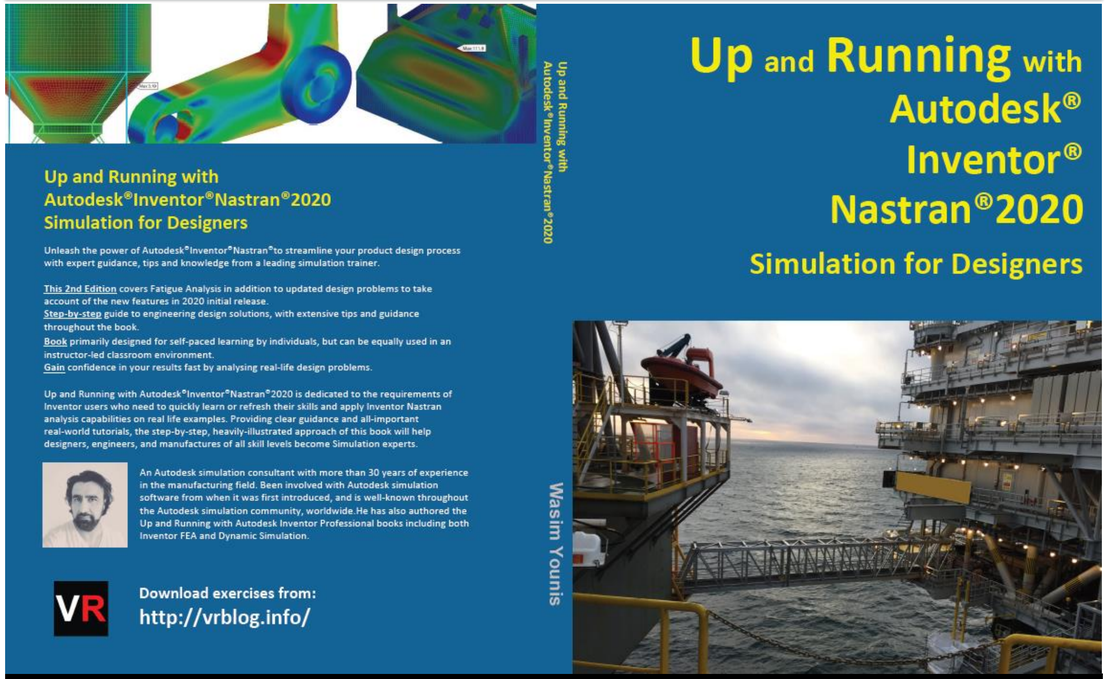
Fatigue life is 1e10.

Because Maximum Stress value is below Endurance Limit



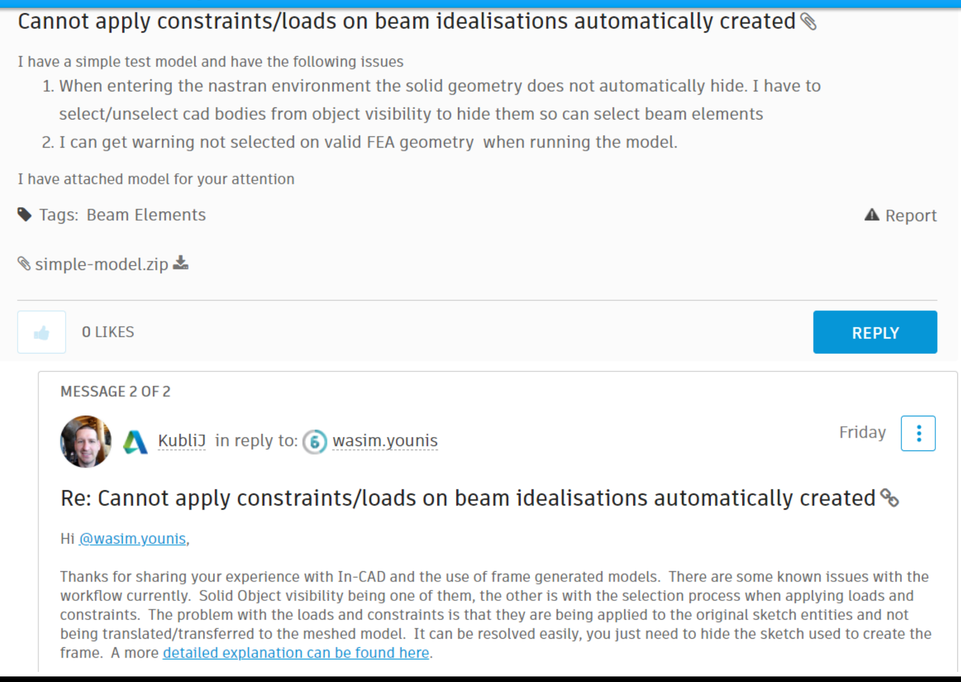
Resources to help you accelerate learning…

Available on Amazon worldwide



Self –paced learning with real world examples.

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



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

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