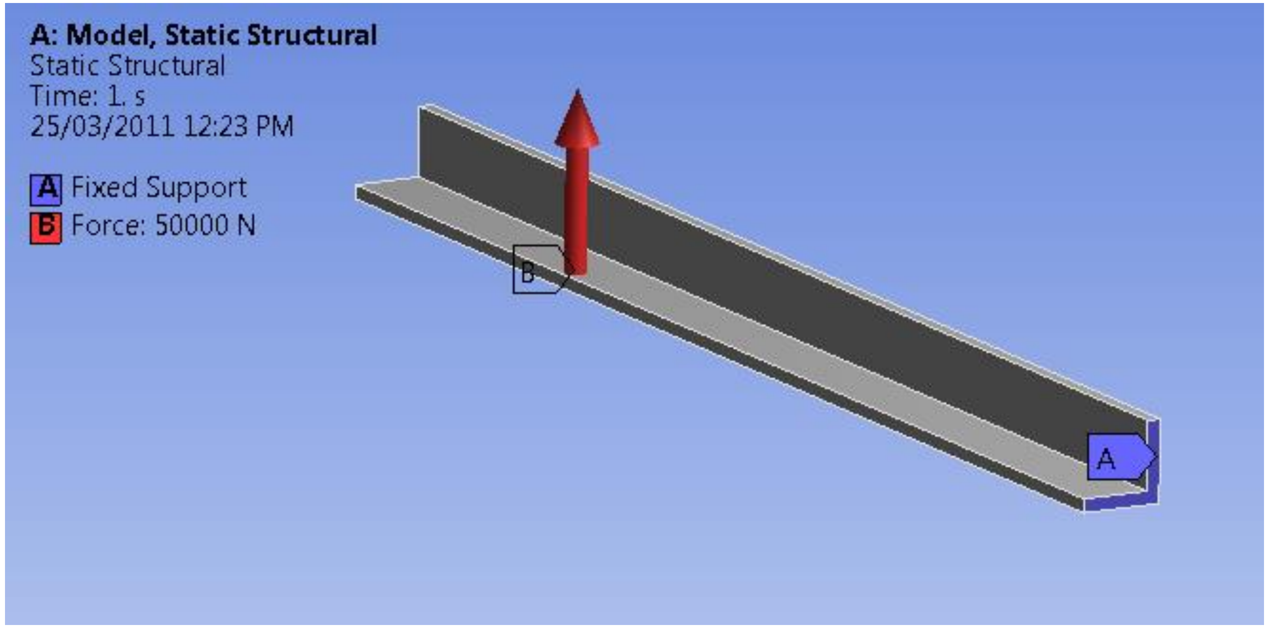
Optimum Design Course
Fall 2016

Ansys Tutorial 4

Cantilever L Beam

Overview

- **Goal**
  - To use the Sparse Grid Method to create a response surface where the gradients with respect to one input parameter is much greater than that with respect to another
- **Model Description**
  - The boundary conditions have been applied as shown here



Input parameters

- Beam length

- Beam thickness

Output parameters

- Total Deformation

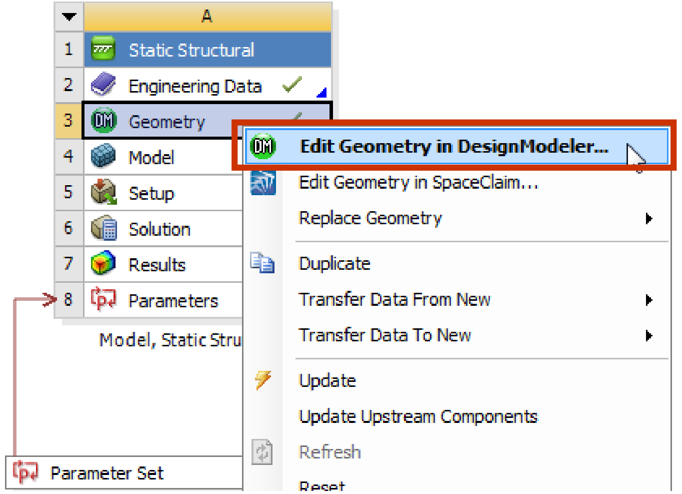
- Safety Factor Minimum

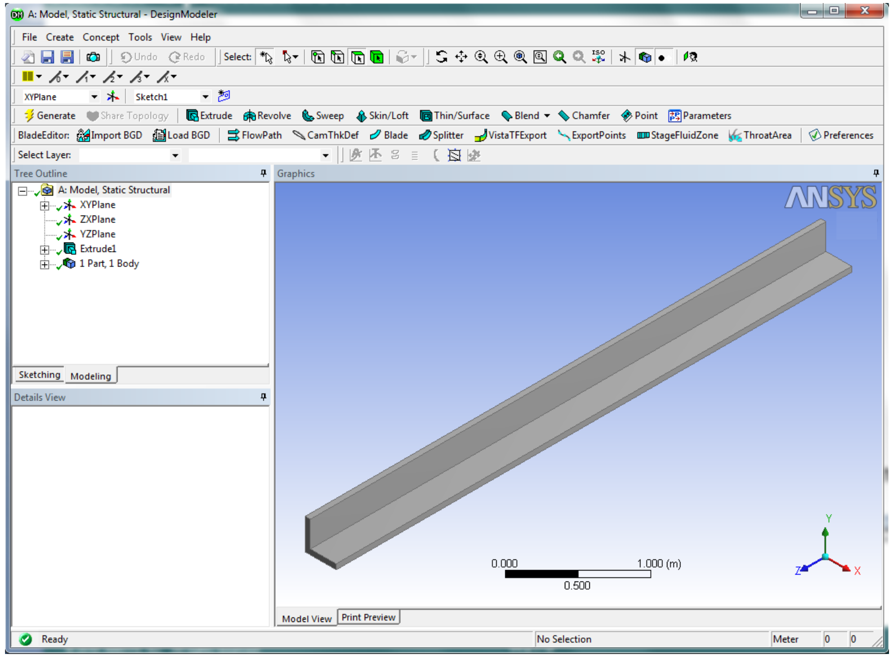
Project Startup

1. File > Open > Sparse Grid. wbpj

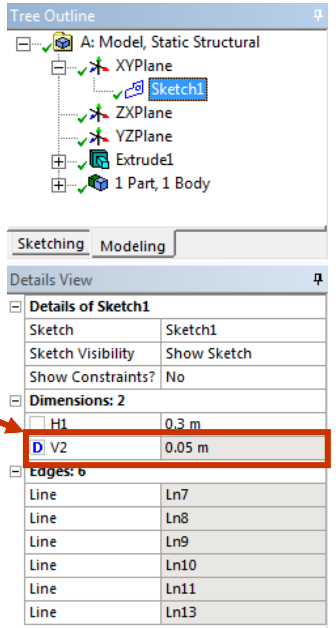
Geometry Parameterization in DesignModeler

2. RMB on Geometry and click Edit Geometry in DesignModeler to launch DesignModeler

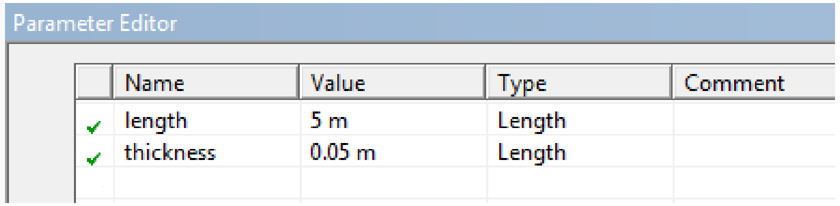




3. Select Sketch1 under XYPlane and check that V2 is parameterized Check that FD1 under Extrude1 is also parameterized



4. Take a look at the parameter manager

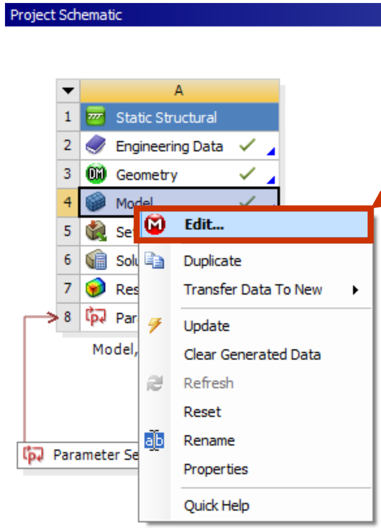


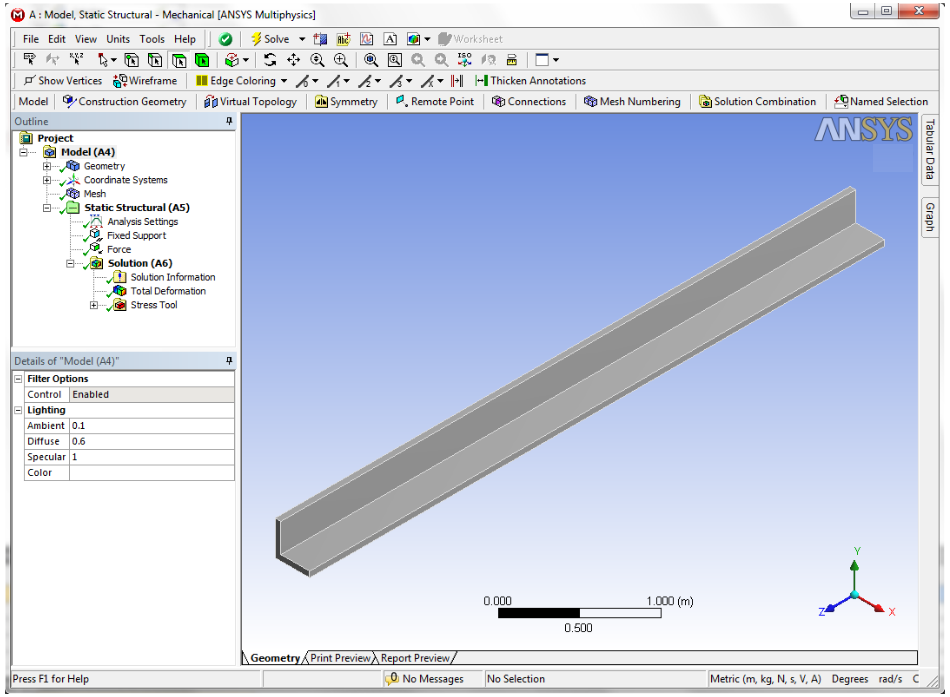
Parameter Editor

Name	Value	Type	Comment
length	5 m	Length	
thickness	0.05 m	Length	

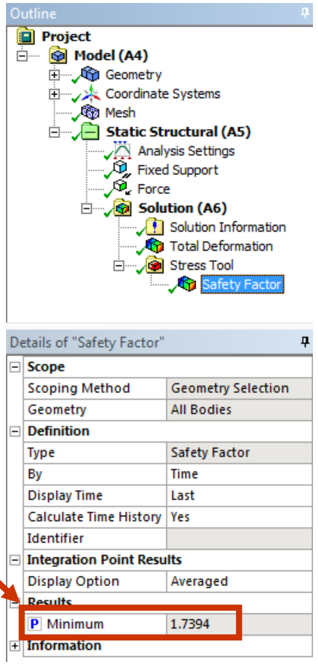
Mechanical Parameterization

5. RMB on Model and click Edit to launch the Mechanical Application



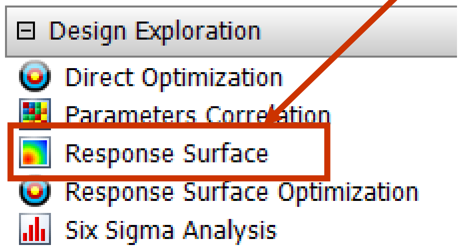


6. Select Safety Factor under Stress Tool and check that Minimum is parameterized Check that Maximum under Total Deformation is also parameterized

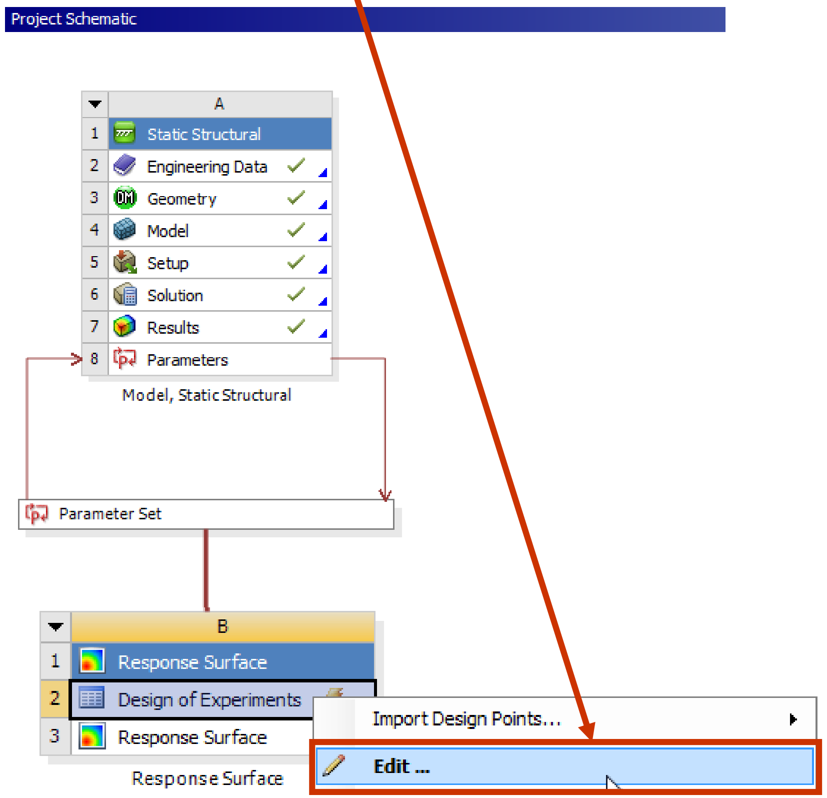


Response Surface

7. Drag a Response Surface onto the Project Schematic

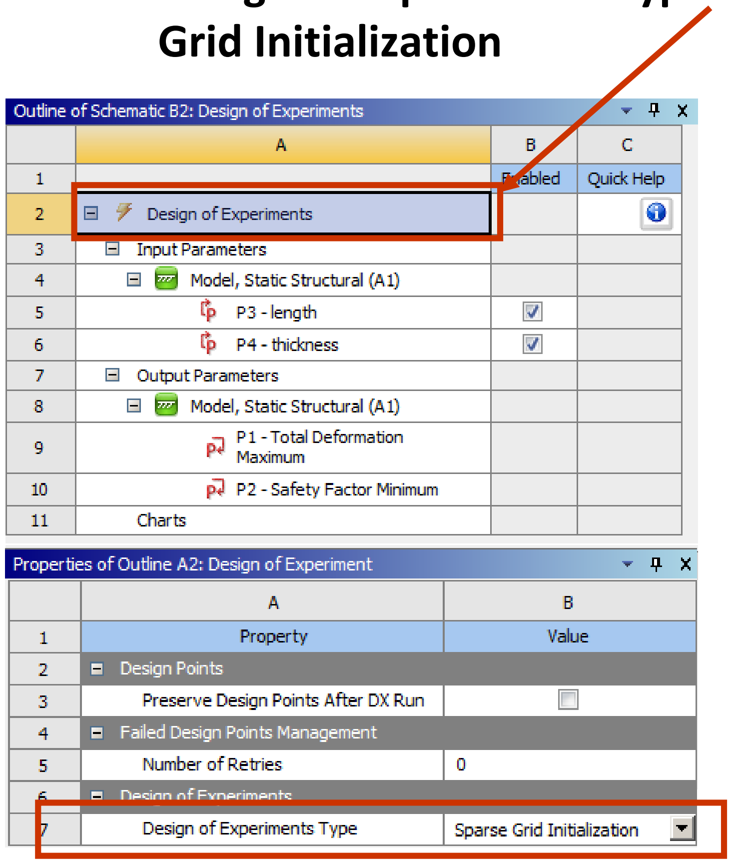


8. RMB Design of Experiments and click Edit

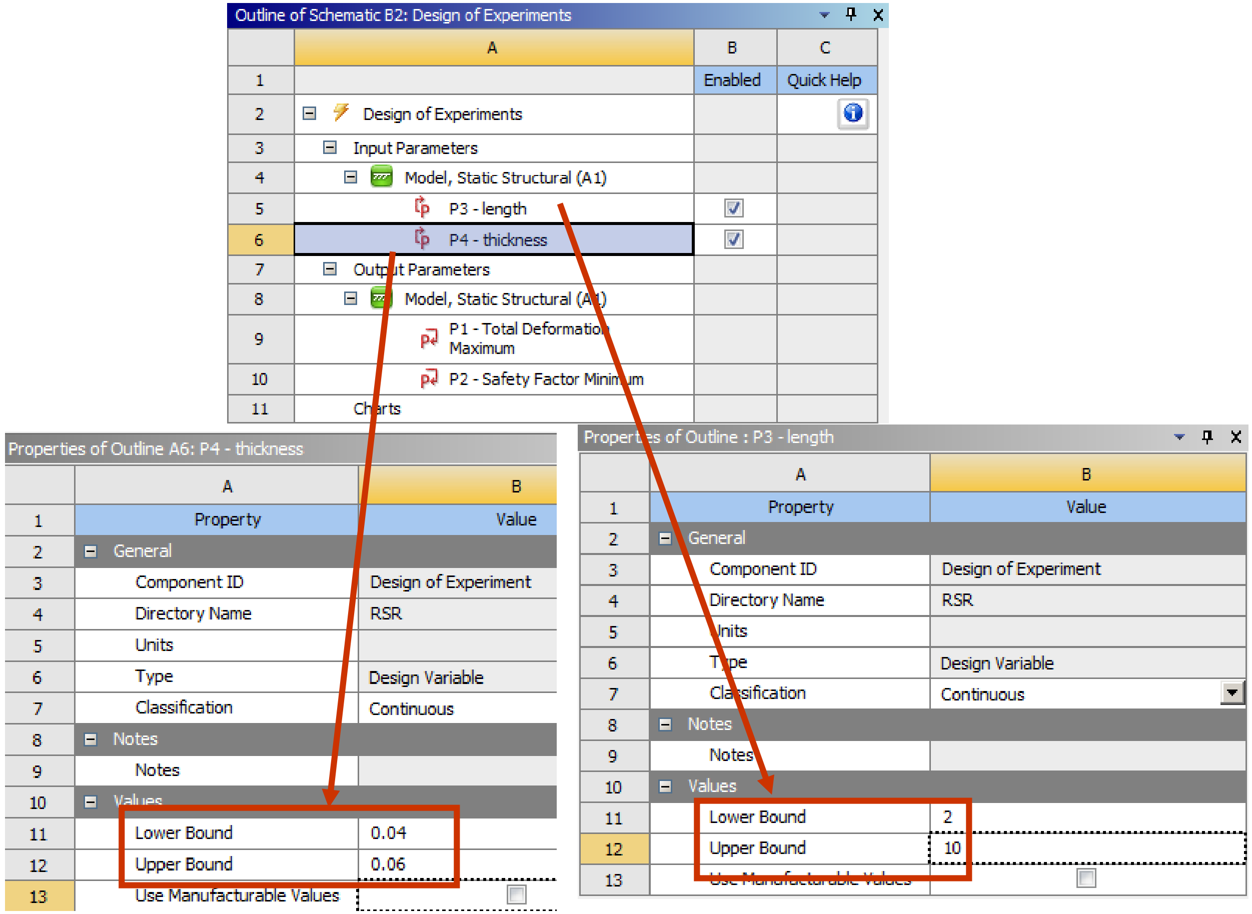


Response Surface Setup

9. Select Design of Experiments and set Design of Experiments Type to Sparse Grid Initialization



10. Set the DOE parameter ranges as shown



DOE Update

11. Preview the DOE

Update | Preview

Table of Schematic B2: Design of Experiments

	A	B	C	D	E
1	Name	P3 - length	P4 - thickness	P1 - Total Deformation Maximum (m)	P2 - Safety Factor Minimum
2	1	6	0.05		
3	2	2	0.05		
4	3	10	0.05		
5	4	6	0.04		
6	5	6	0.06		

12. Update the DOE

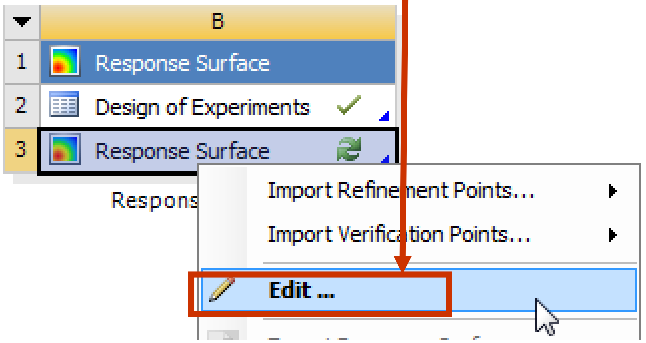
Update | Preview

Table of Schematic B2: Design of Experiments (Sparse Grid Initialization)

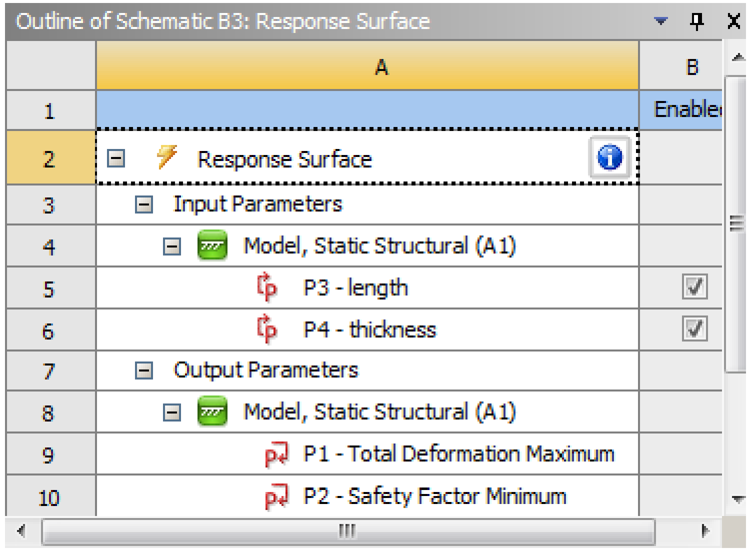
	A	B	C	D	E
1	Name	P3 - length	P4 - thickness	P1 - Total Deformation Maximum (m)	P2 - Safety Factor Minimum
2	1	6	0.05	0.055189	1.4793
3	2	2	0.05	0.0027861	3.5002
4	3	10	0.05	0.24717	0.86594
5	4	6	0.04	0.05864	1.4125
6	5	6	0.06	0.052239	1.5042

Response Surface Setup

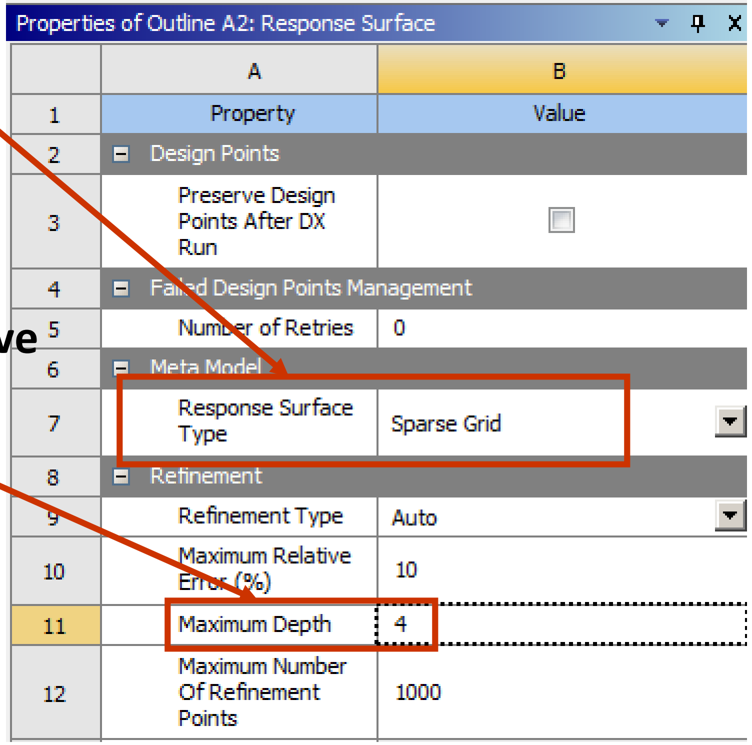
13. Return to the Project Schematic, RMB Response Surface and click Edit



14. Select Response Surface. Note that Sparse Grid is automatically selected

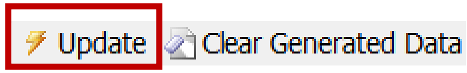


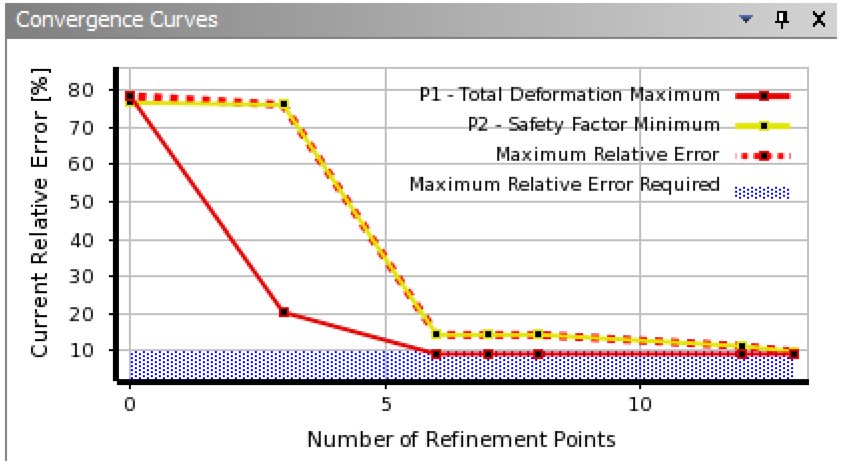
15. Set the Maximum Relative Error to 10 so that we get quicker convergence



Response Surface Update

16. Update the Response Surface. This update can take some time to converge.





Here we can see the convergence of the response surface for each parameter. We can get more accurate response surfaces by decreasing the Maximum Relative Error, but more Design Points will need to be run to do so

Table of Schematic B3: Response Surface

	A	B	C	D	E
1	Name	P3 - length	P4 - thickness	P1 - Total Deformation Maximum (m)	P2 - Safety Factor Minimum
2	Refinement Points				
3	1	8	0.05	0.12776	1.0864
4	2	10	0.04	0.26044	0.8468
5	3	10	0.06	0.2362	0.88672
6	4	4	0.05	0.017297	2.0598
7	5	2	0.04	0.0031667	3.1398
8	6	2	0.06	0.0024736	3.8632
9	7	6	0.045	0.056845	1.4493
10	8	6	0.055	0.053653	1.492
11	9	3	0.05	0.0078503	2.5828
12	10 DP 0	5	0.05	0.032587	1.7394
13	11	4	0.04	0.018626	1.921
14	12	4	0.06	0.016173	2.1919
15	13	2	0.055	0.0026192	3.687
16	Response Points				
17	Response Point	6	0.05	0.055189	1.4793
*	New Response Point				
19	Verification Points				
*	New Verification Point				

Here we can see all of the Refinement Points that were automatically generated by the Sparse Grid method in order to generate the Response Surface. Notice that there are 9 different values of length whereas there are only 5 different values of thickness

Response Surface Results

17. Select Response to start plotting Response Surfaces

Outline of Schematic B3: Response Surface

	A	B
1		Enabled
2	Response Surface	
3	Input Parameters	
4	Model, Static Structural (A1)	
5	P3 - length	☑
6	P4 - thickness	☑
7	Output Parameters	
8	Model, Static Structural (A1)	
9	P1 - Total Deformation Maximum	
10	P2 - Safety Factor Minimum	
11	Min-Max Search	☑
12	Metrics	
13	Convergence Curves	
14	Goodness Of Fit	
15	Response Points	
16	Response Point	
17	Response	
18	Local Sensitivity	
19	Local Sensitivity Curves	
20	Spider	

18. Change the Response Chart Type to 3D

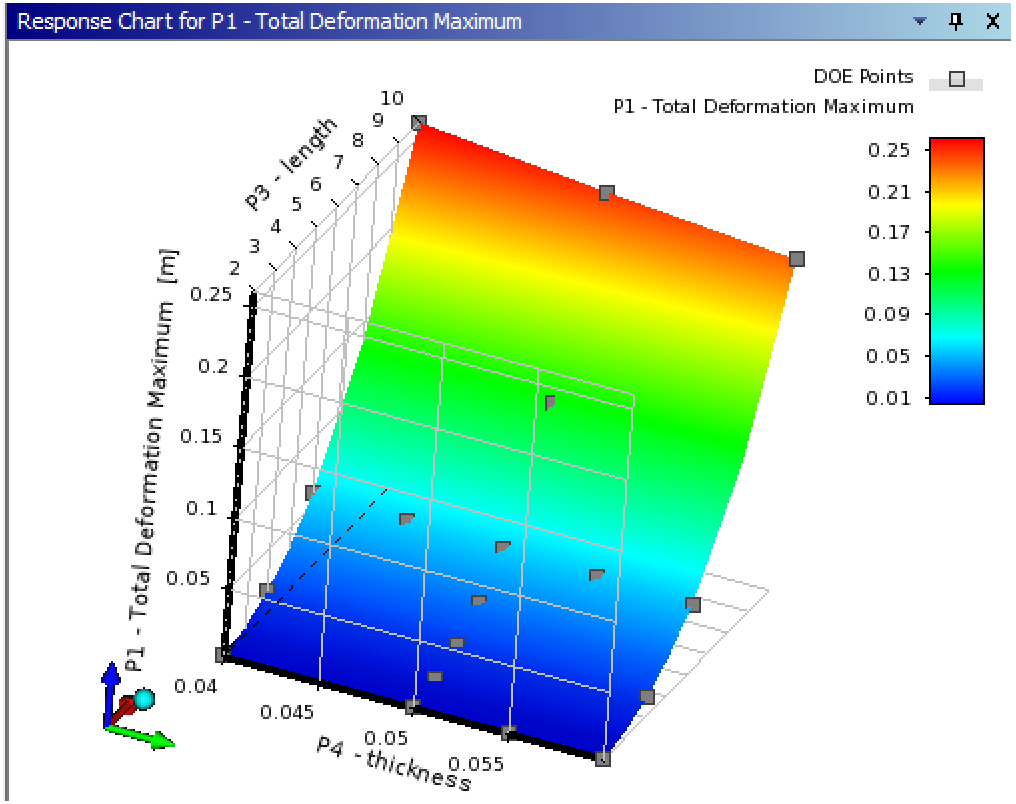
Properties of Outline A17: Response

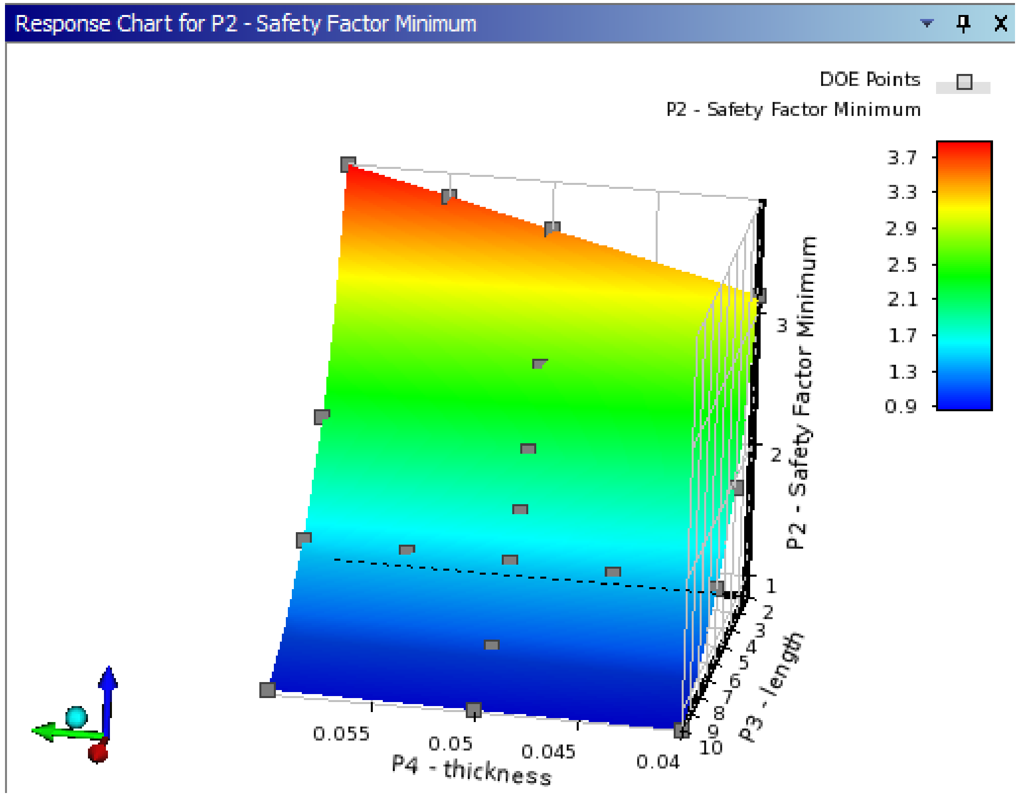
	A	B
1	Property	Value
2	Chart	
3	Display Parameter Full Name	☑
4	Mode	3D
5	Chart Resolution Along X	25
6	Chart Resolution Along Y	25
7	Show Design Points	☑
8	Axes	
9	X Axis	P3 - length
10	Y Axis	P4 - thickness
11	Z Axis	P1 - Total Deformation Maximum
12	Input Parameters	
13	P3 - length	6
14	P4 - thickness	0.05
15	Output Parameters	
16	P1 - Total Deformation Maximum	0.055189
17	P2 - Safety Factor Minimum	1.4793

19. Enable Show Design Points

20. Leave the X and Y axis at thickness and length respectively. Plot each of Total Deformation and Safety Factor on the Z axis

Response Surface Results

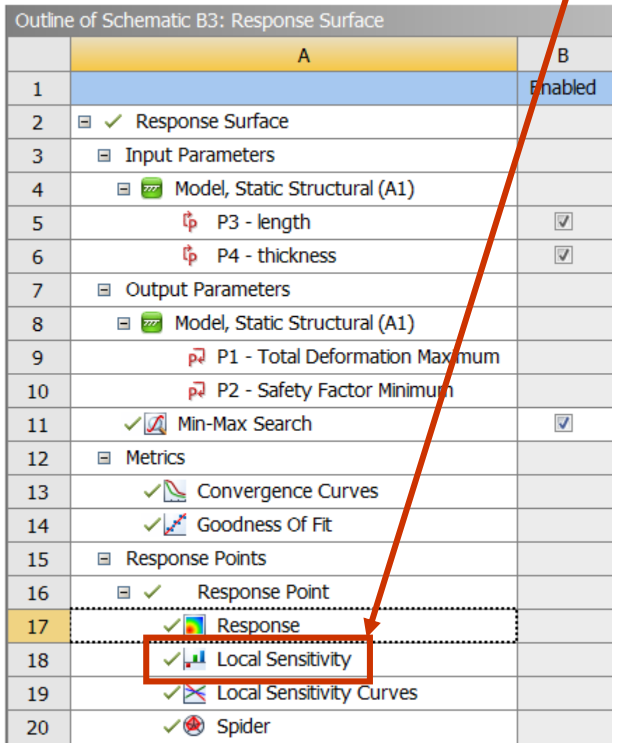


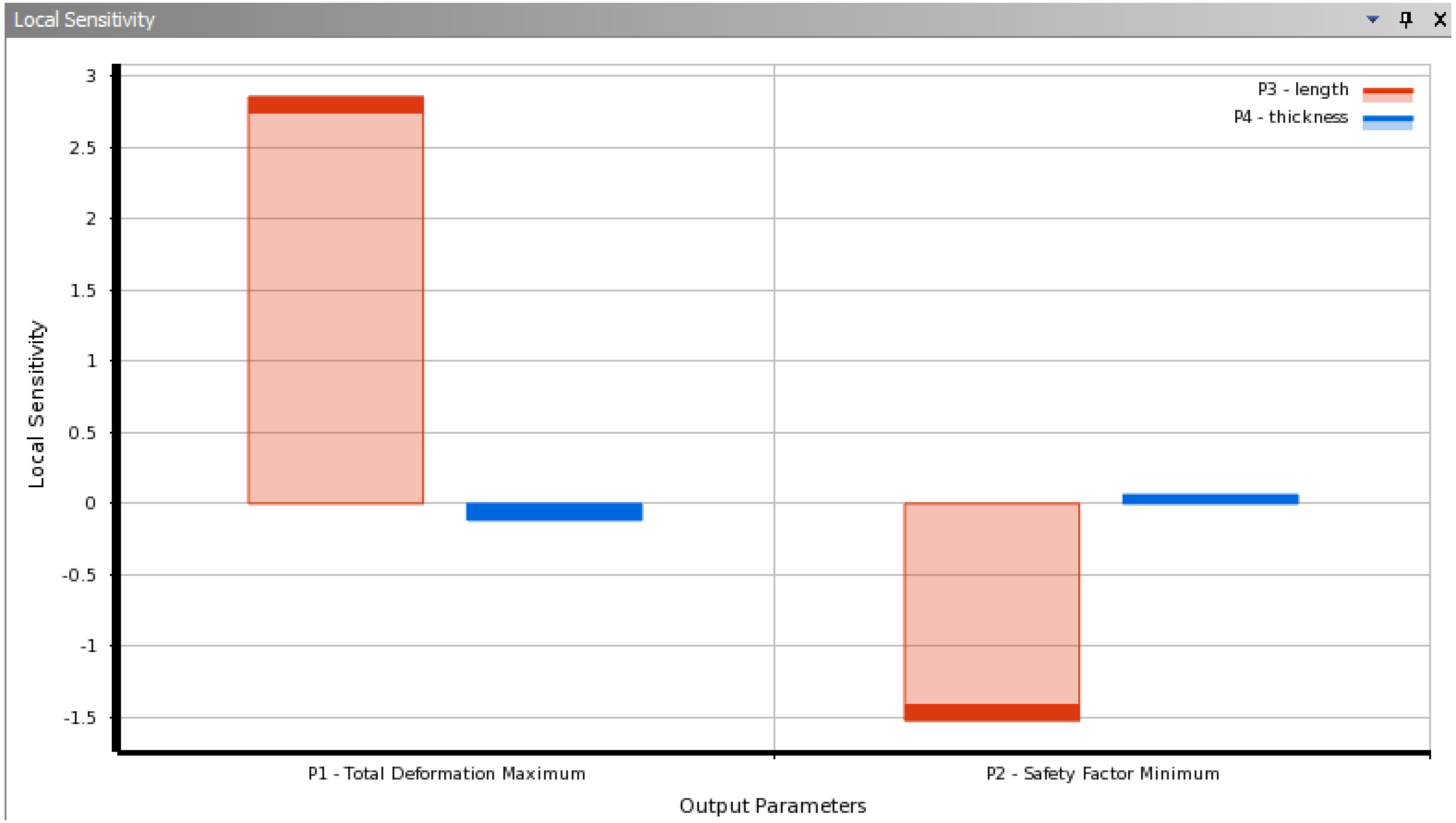


From the Response Surfaces, it is apparent that the gradient with respect to length is much larger than that with respect to thickness. To better resolve this gradient, the Sparse Grid method inserted more design points across the range of length values (9) than it did for thickness (5)

Response Surface Results

21. Select Local Sensitivity





This plot shows how large of an impact each input parameter has on each output parameter at the current response point. It can be seen that length has a larger impact on both Total Deformation and Safety Factor at the center of our response surface