BIAS MÜHENDİSLİK

Yenilikçiler için Çözümler

Solutions for Innovators

Optimization Study of Bumper Structure

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Agenda

- Scope of the study
- Design
- Process Automation
- Analysis Workflow
- DoE
- Optimization
- Conclusions

Optimization of Bumper Structures

- Absorb as much energy as possible
- Must have high strength
- Should be light
- Should be has long lifetime

Ref:https://arabakocu.com.tr/index.php/2020/09/17/tampon-demiri/

Ref:https://forums.overclockers.co.uk/threads/broken-bumper-is-this-an-mot-failure.18367911/

Design

Design parameters:

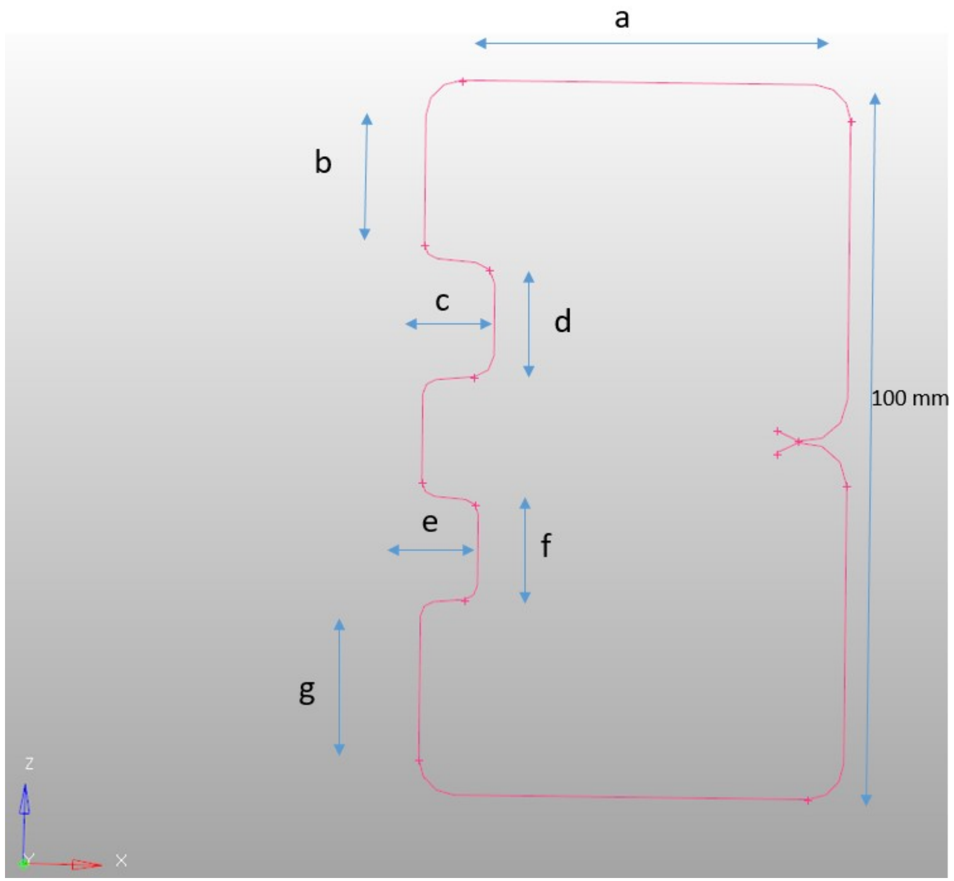
- a, b, c, d, e, f, g (dimensions)
- Profile thickness

Outputs:

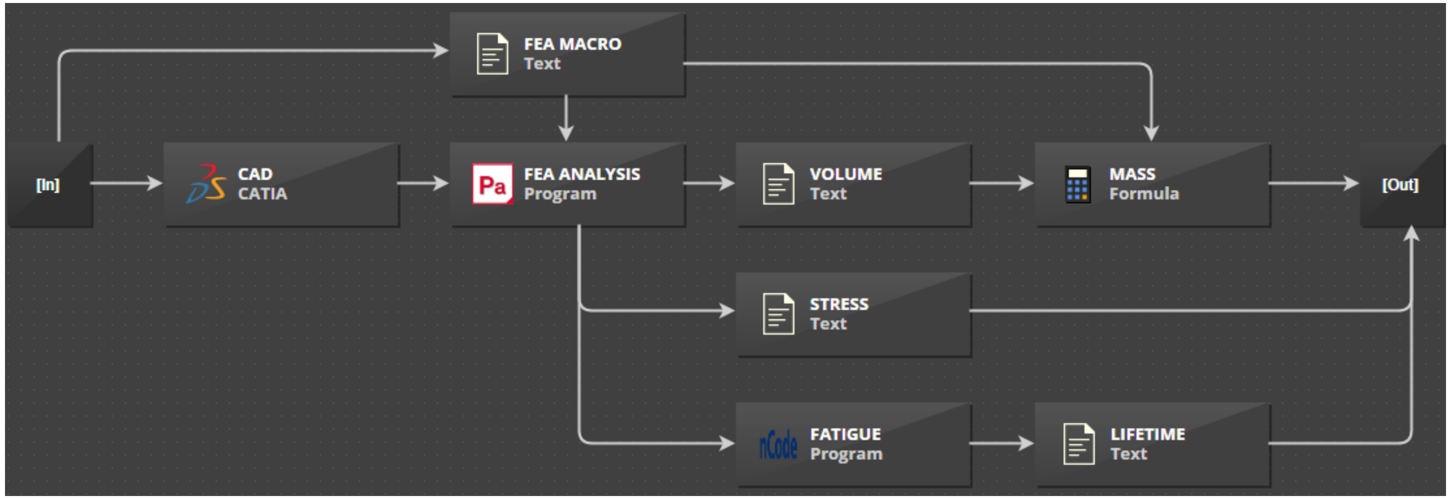
- Mass
- Max. stress

Optimization goals:

- Minimum mass
- Max. Stress < Yield stress



Process Automation

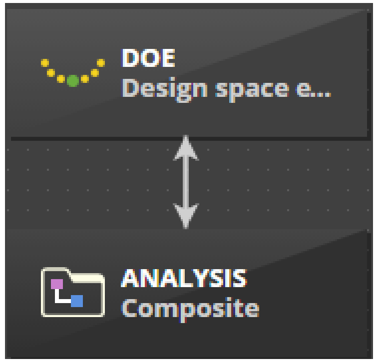


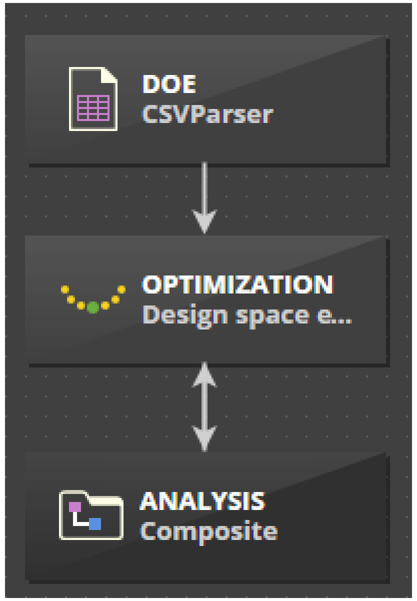
Geometry Preparation Steps;

- Preparing the bumper profile in Catia

Linear Solving Steps;

- Preparation of the automated FEM model (SOL101)
- Preparation of the automated Fatigue analysis model
- Creating pSeven Workflow
- Analyzing with pSeven
- DoE (Design of Experiment)
- Optimization
- Post-Process of the outputs





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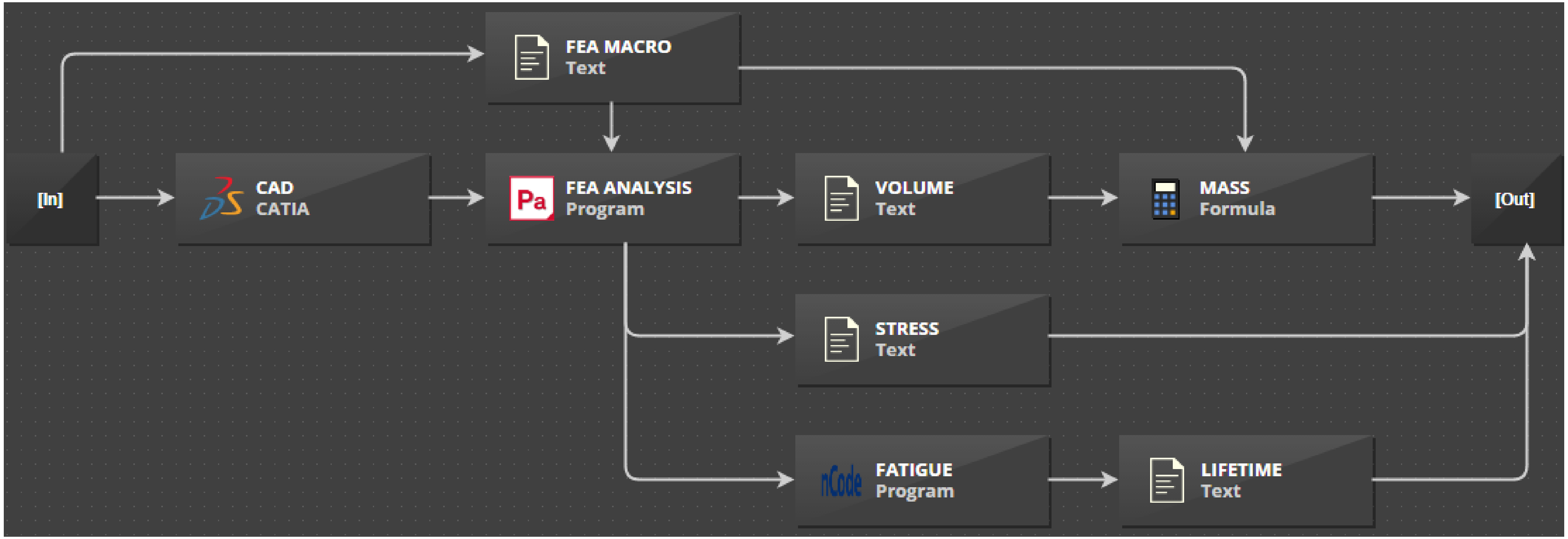
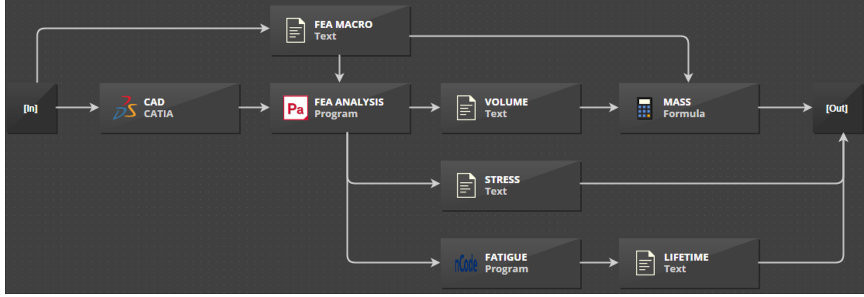
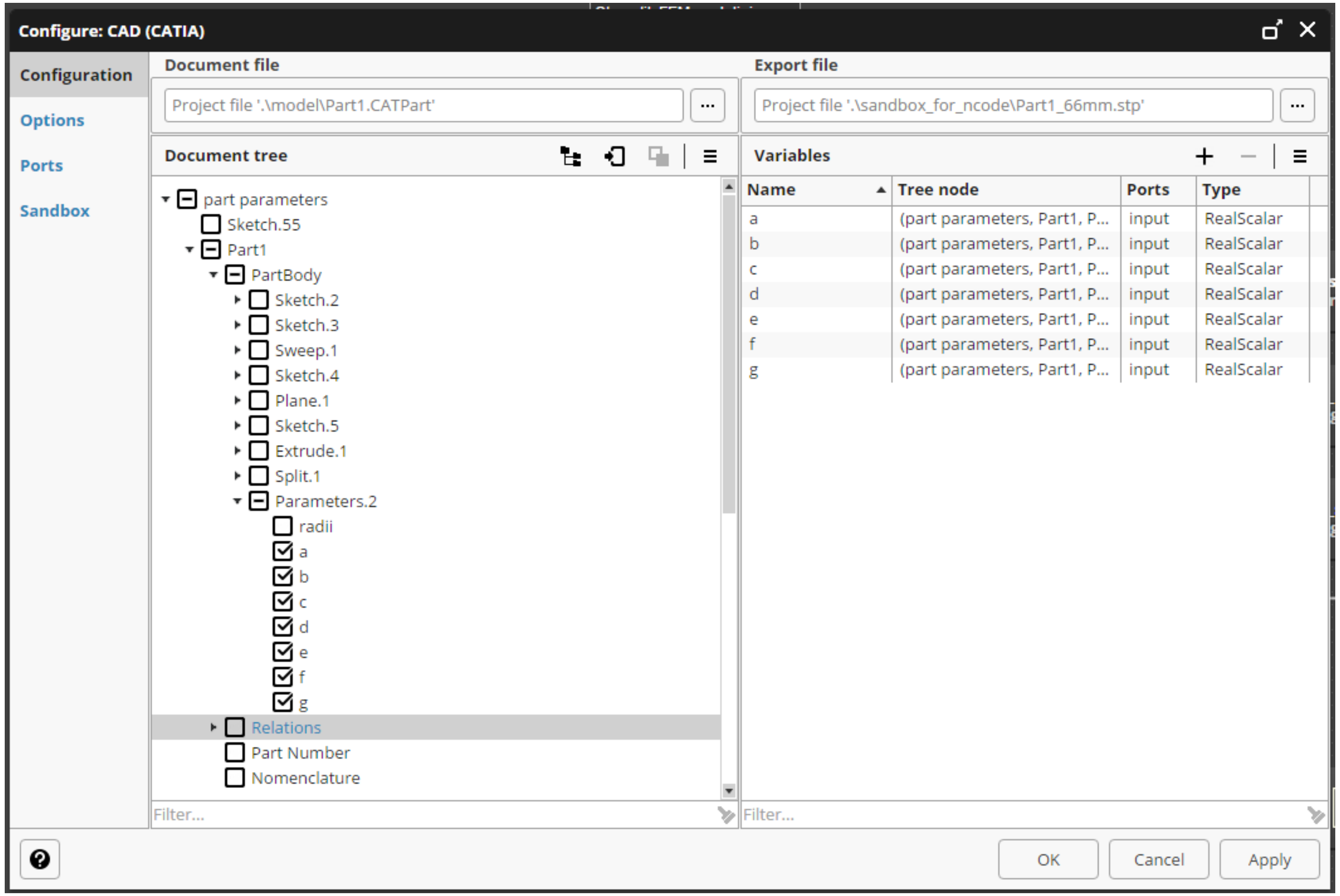
Analysis Workflow



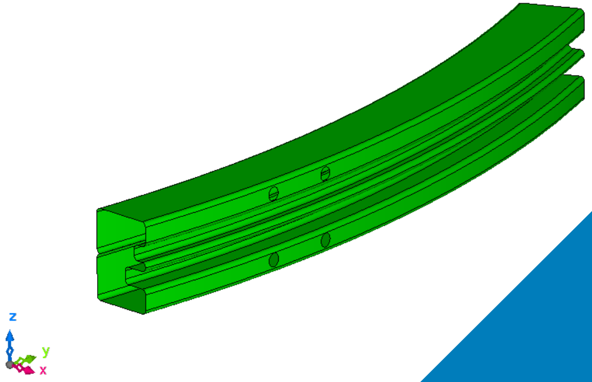
CAD Integration





Modeling of the bumper design was done in CATIA software as 3D Shell model.

The CATIA block in pSeven allows you to access the parameters and feature tree in a .catpart.



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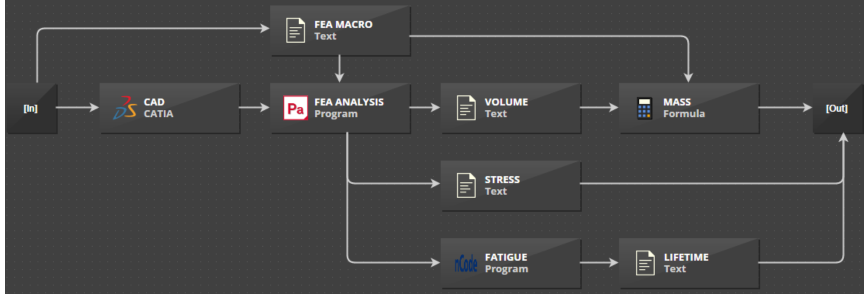
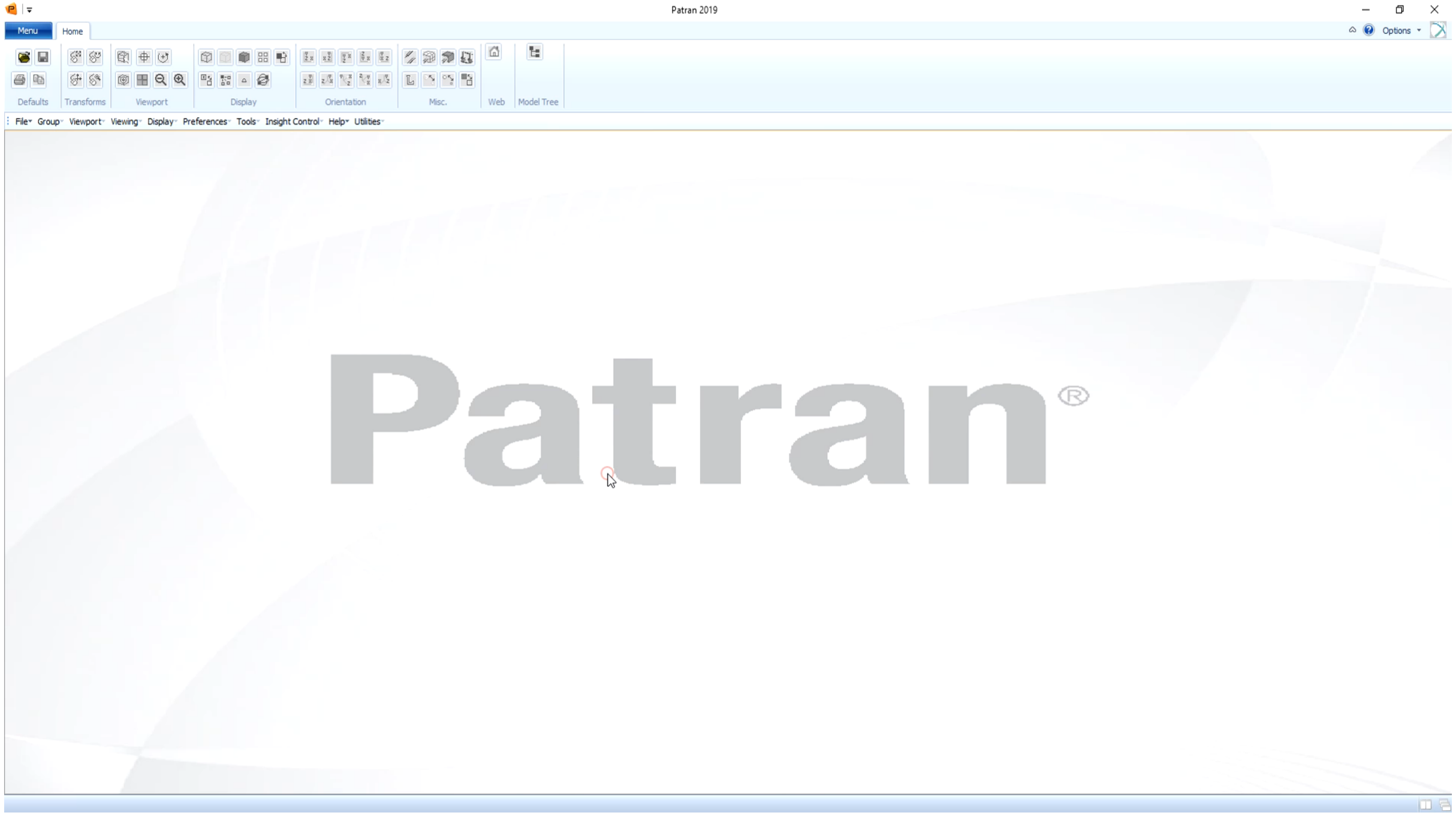
FEA Model & Analysis





With Patran macro (.ses) ;

- Importing .stp file
- Creating 2D mesh
- Defining the thickness
- Defining loads
- Defining report contents

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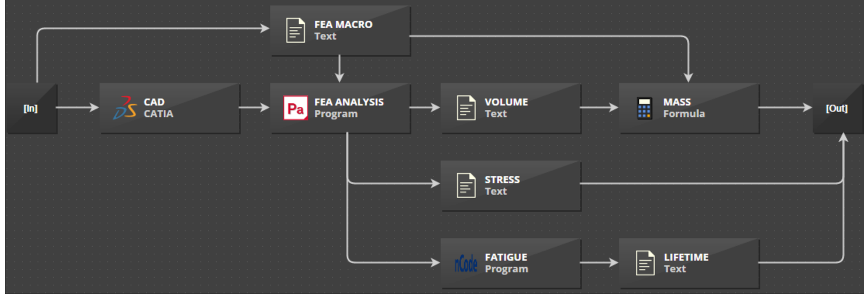
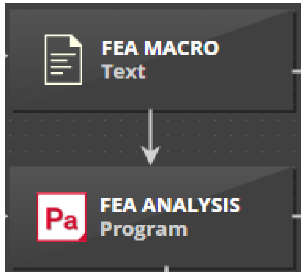
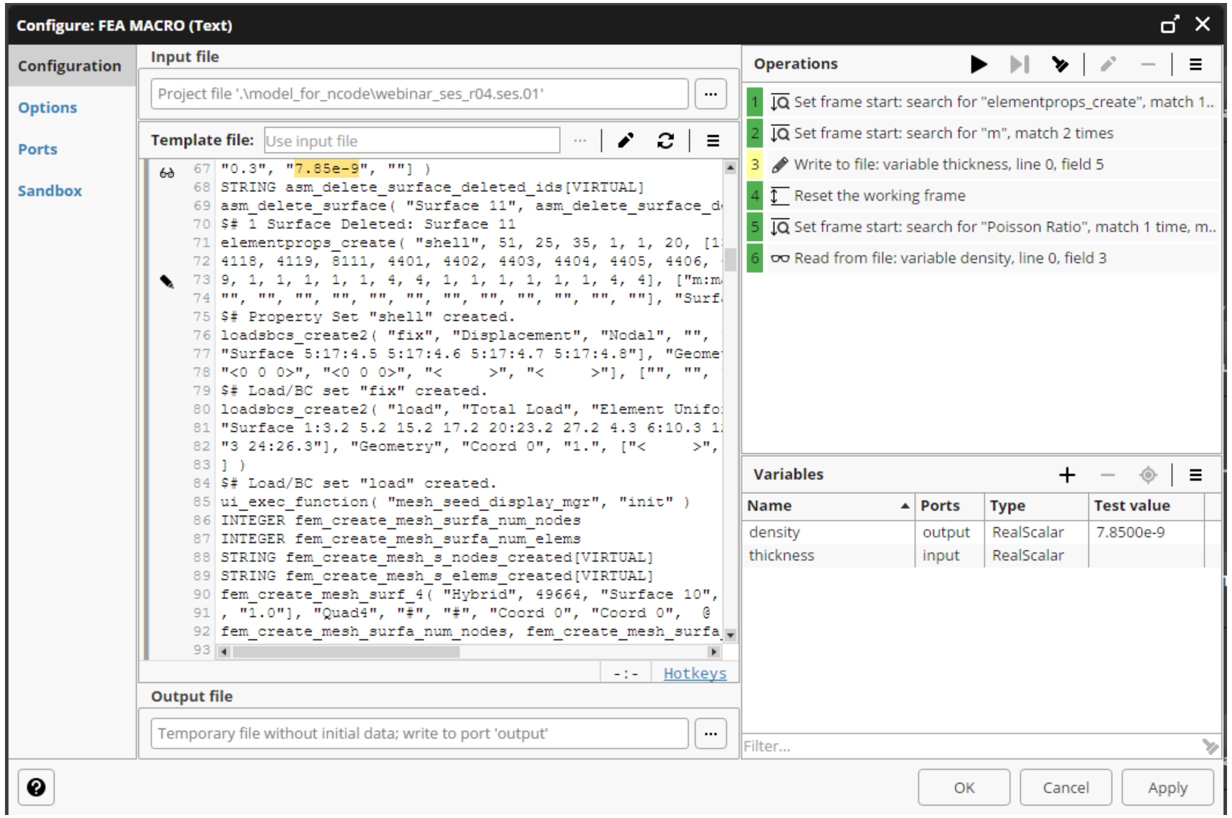
FEA Model & Analysis



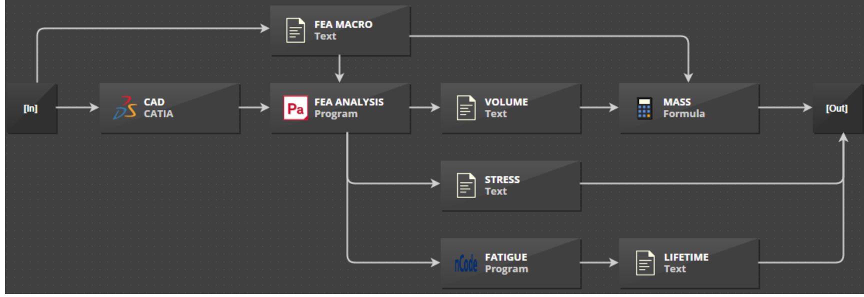


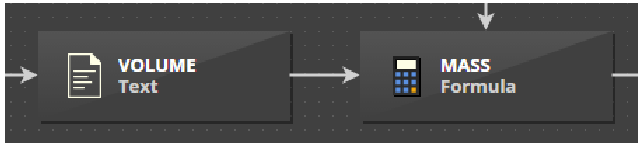


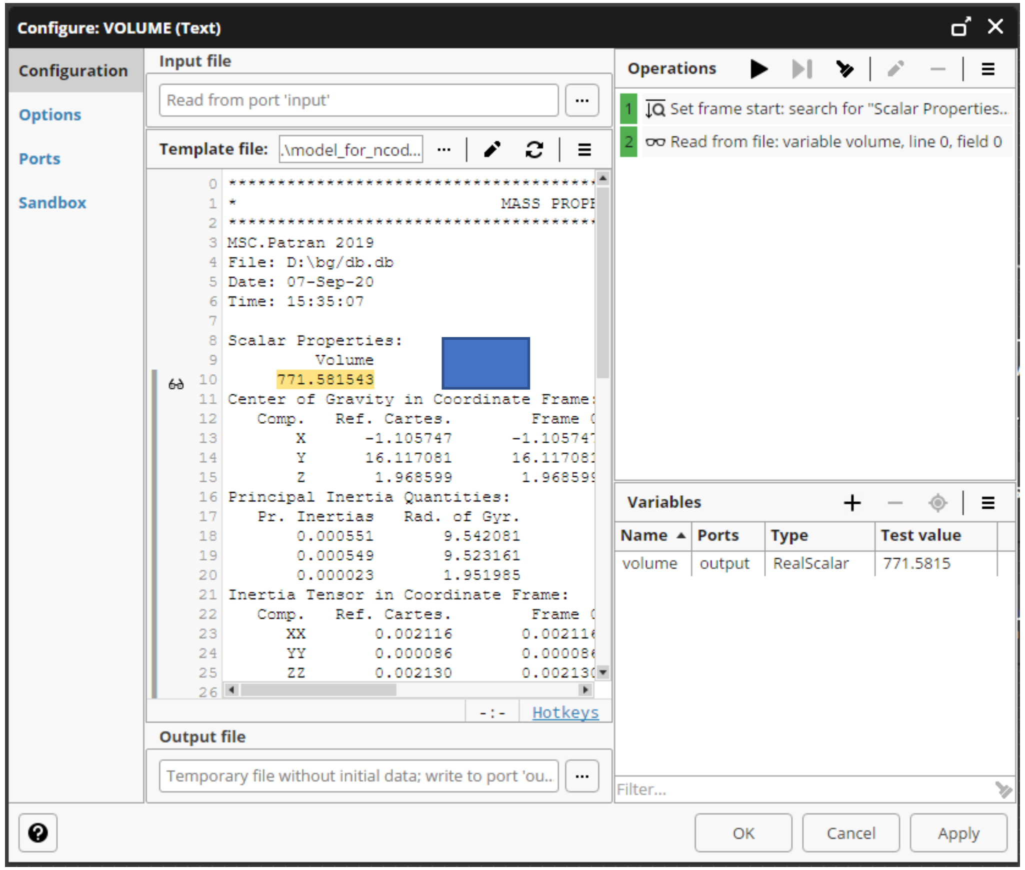
With Text block;

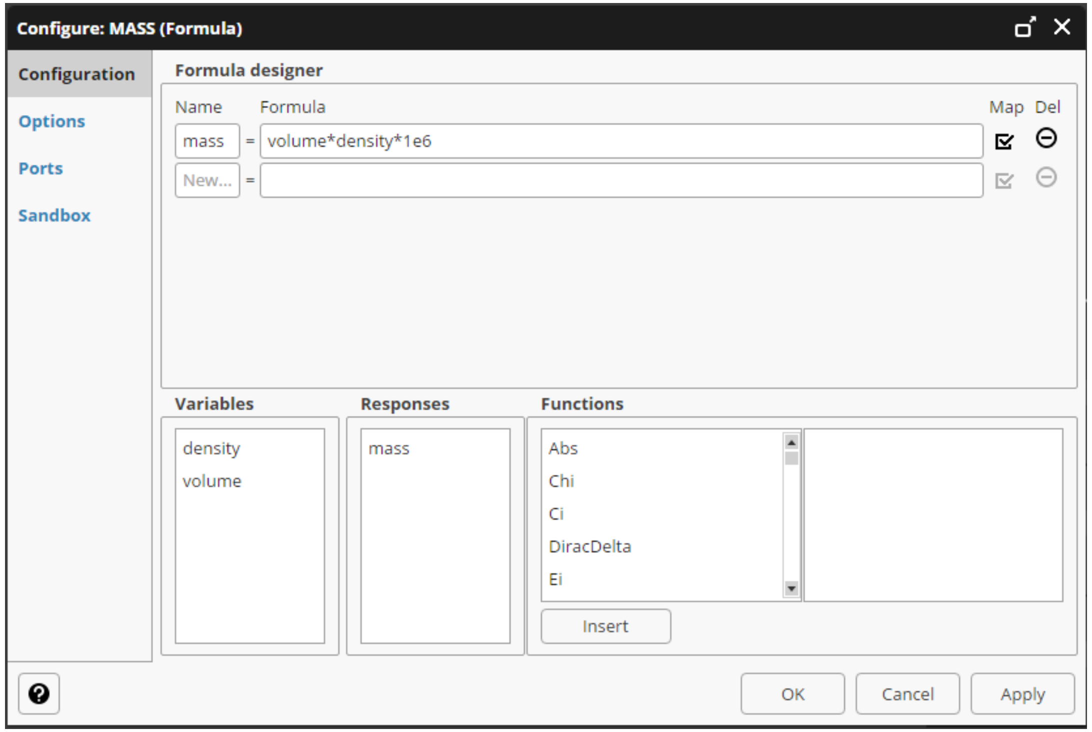
- Data read from macro file (density)
- Change data (thickness) within the macro file

Mass Calculation









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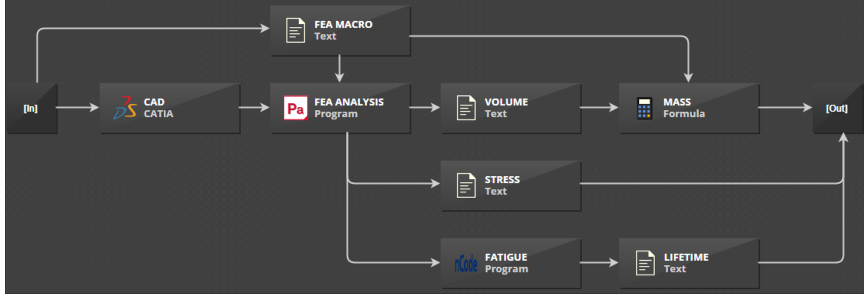
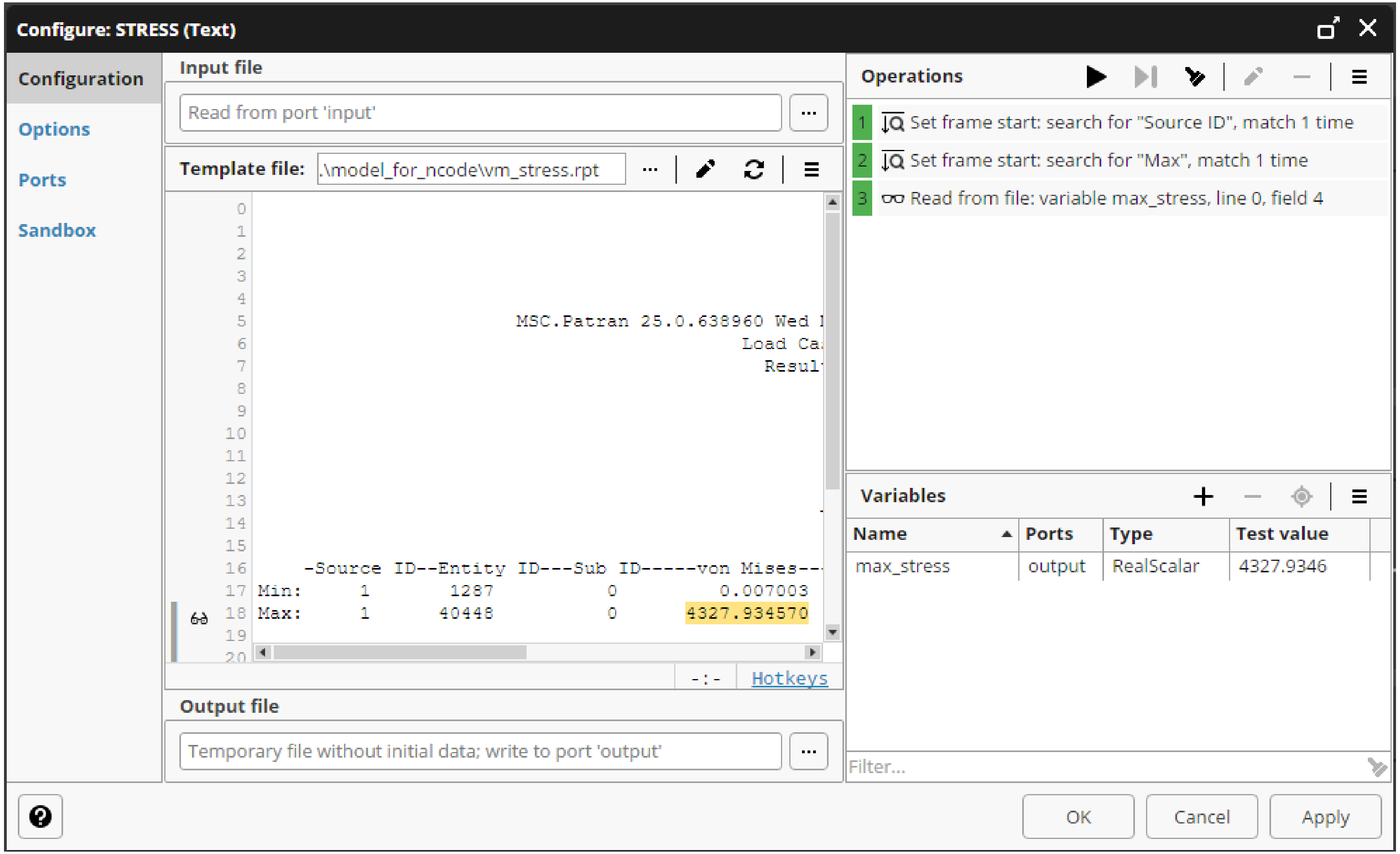
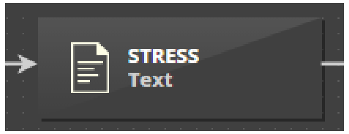
Reading Stress







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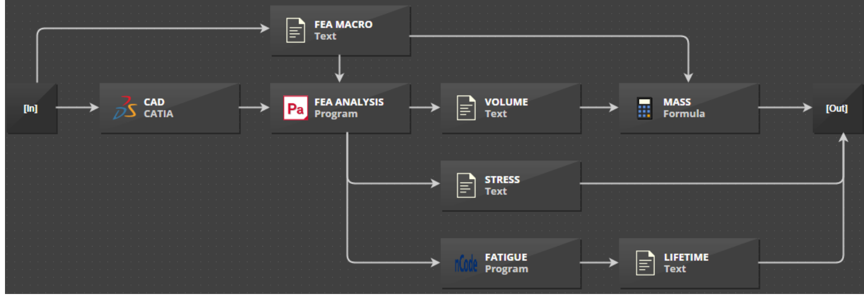
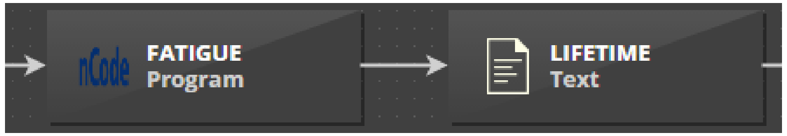
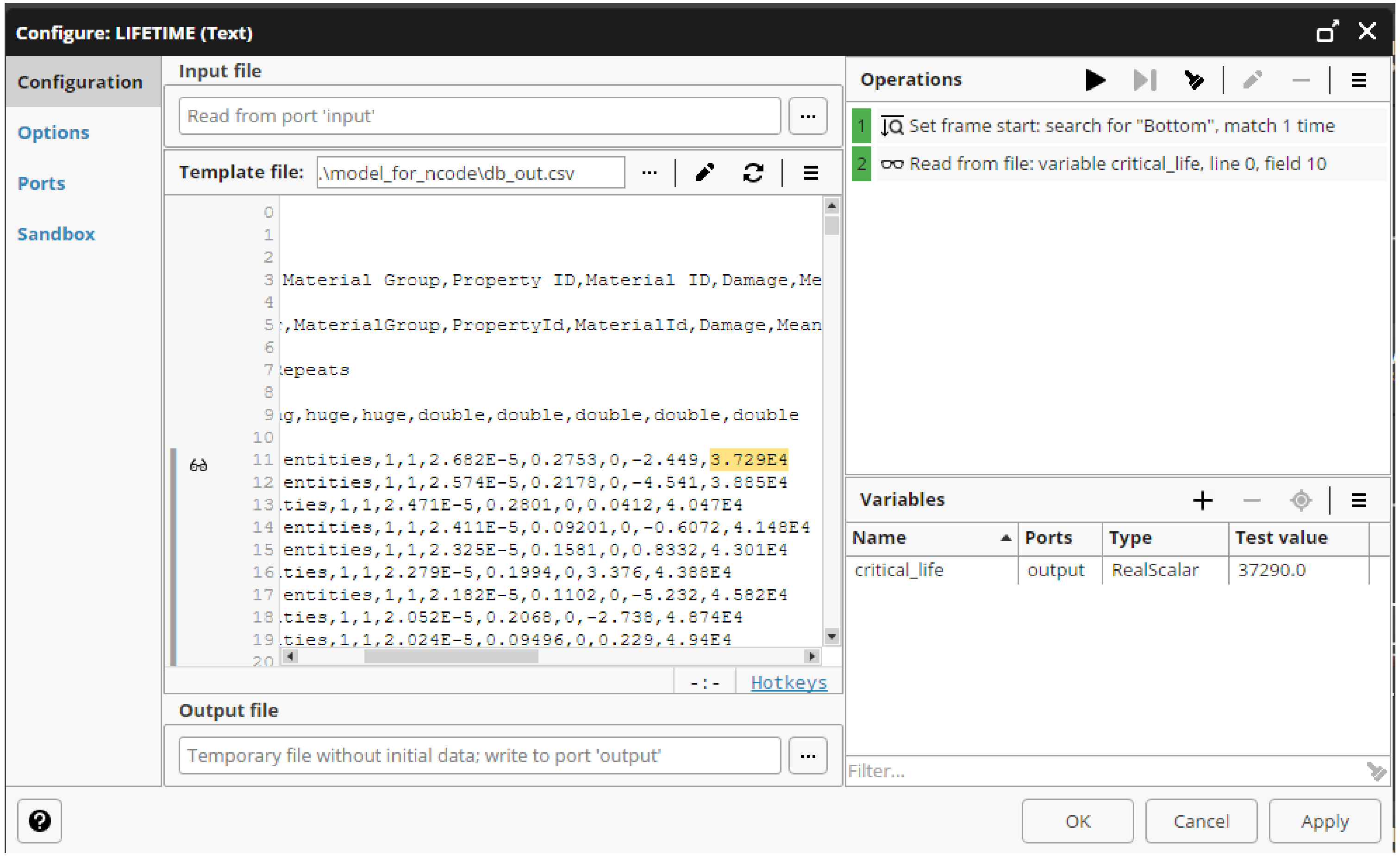
Lifetime Calculation







- Fatigue analysis is performed using the outputs of the Nastran solver.
- Result output is taken from nCode software in .csv format.
- The critical lifetime value is read from the .csv file.

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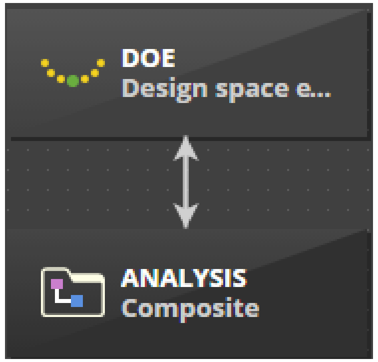
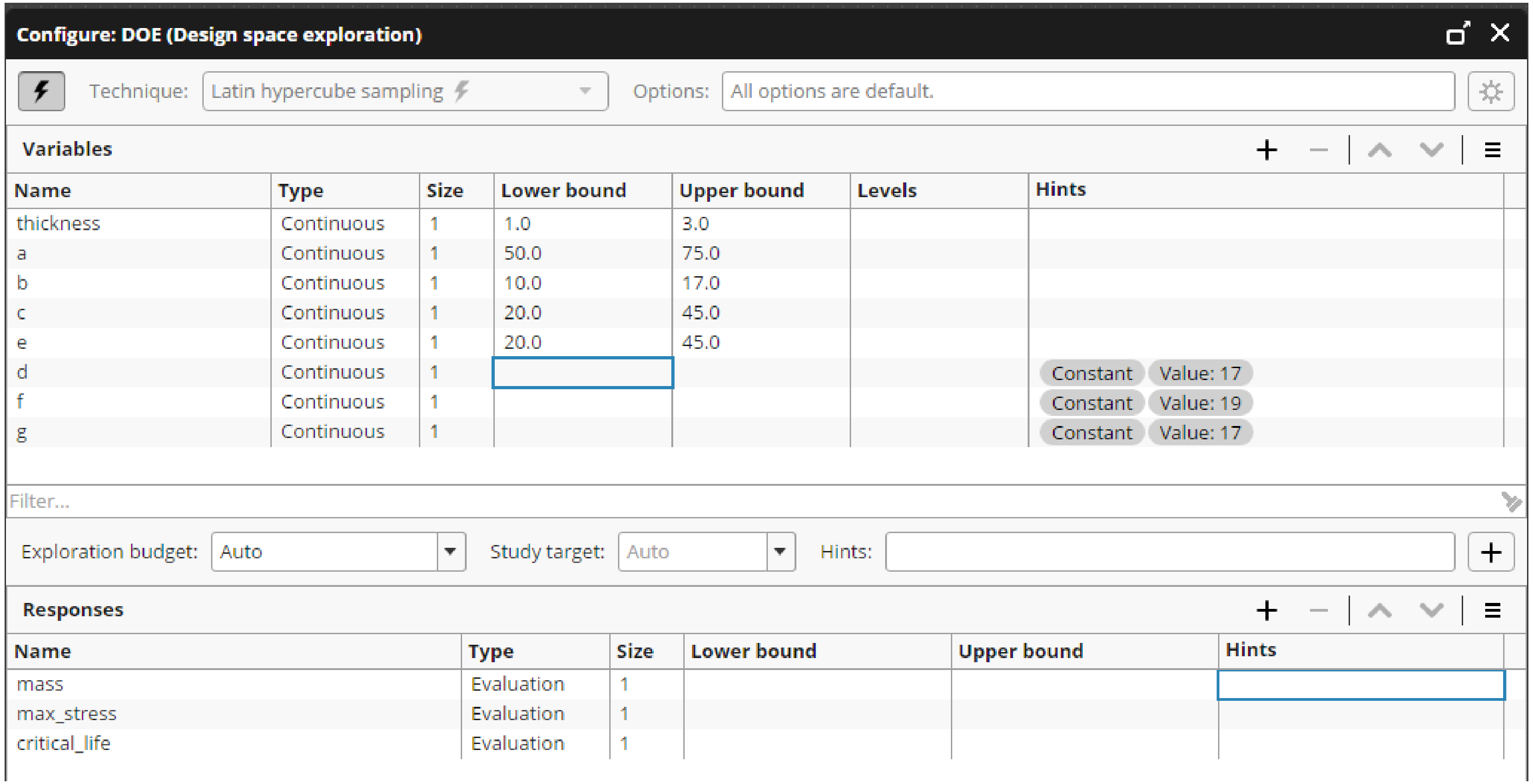
Design of Experiment





Configure: DOE (Design space exploration)

Technique: Latin hypercube sampling — Options: All options are default.

Variables

Name	Type	Size	Lower bound	Upper bound	Levels	Hints
thickness	Continuous	1	1.0	3.0		
a	Continuous	1	50.0	75.0		
b	Continuous	1	10.0	17.0		
c	Continuous	1	20.0	45.0		
e	Continuous	1	20.0	45.0		
d	Continuous	1				Constant Value: 17
f	Continuous	1				Constant Value: 19
g	Continuous	1				Constant Value: 17

Filter...

Exploration budget: Auto — Study target: Auto — Hints:

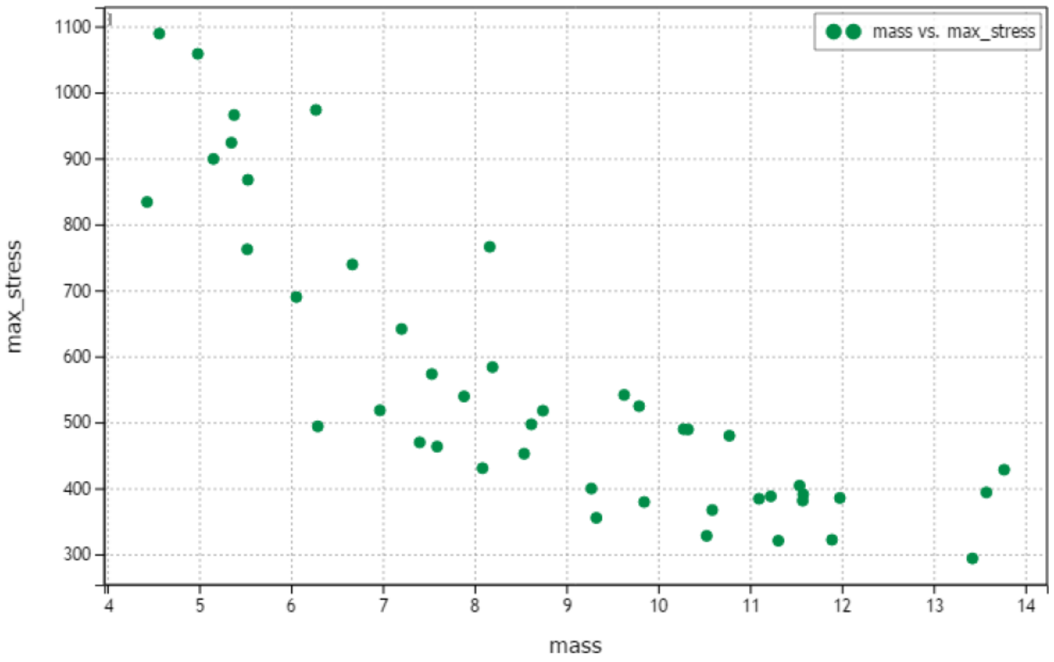
Responses

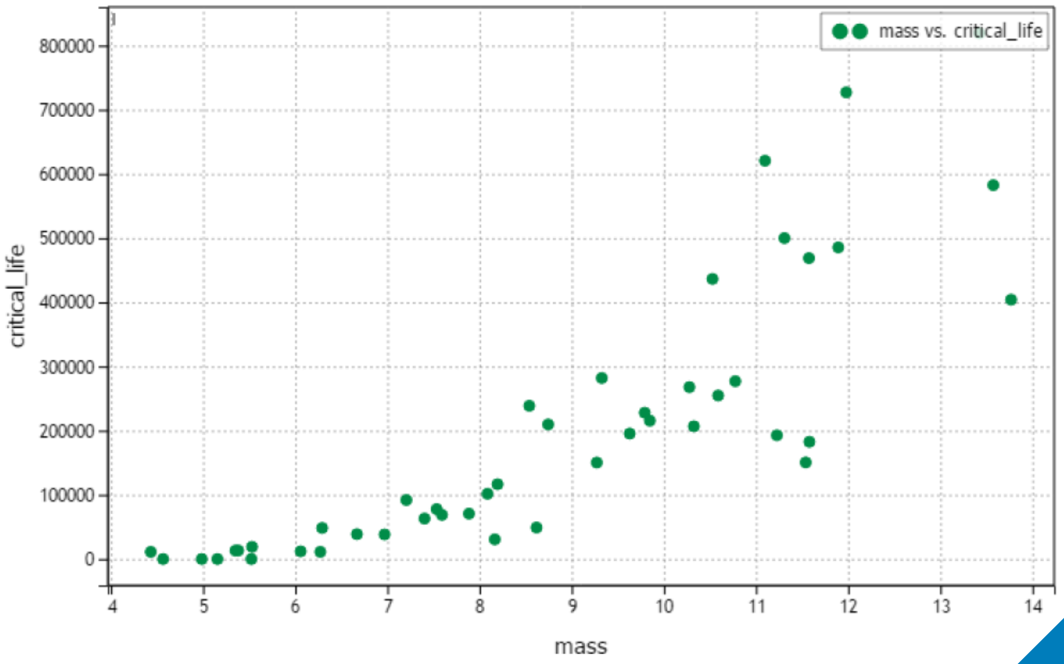
Name	Type	Size	Lower bound	Upper bound	Hints
mass	Evaluation	1			
max_stress	Evaluation	1			
critical_life	Evaluation	1			

Design of Experiment

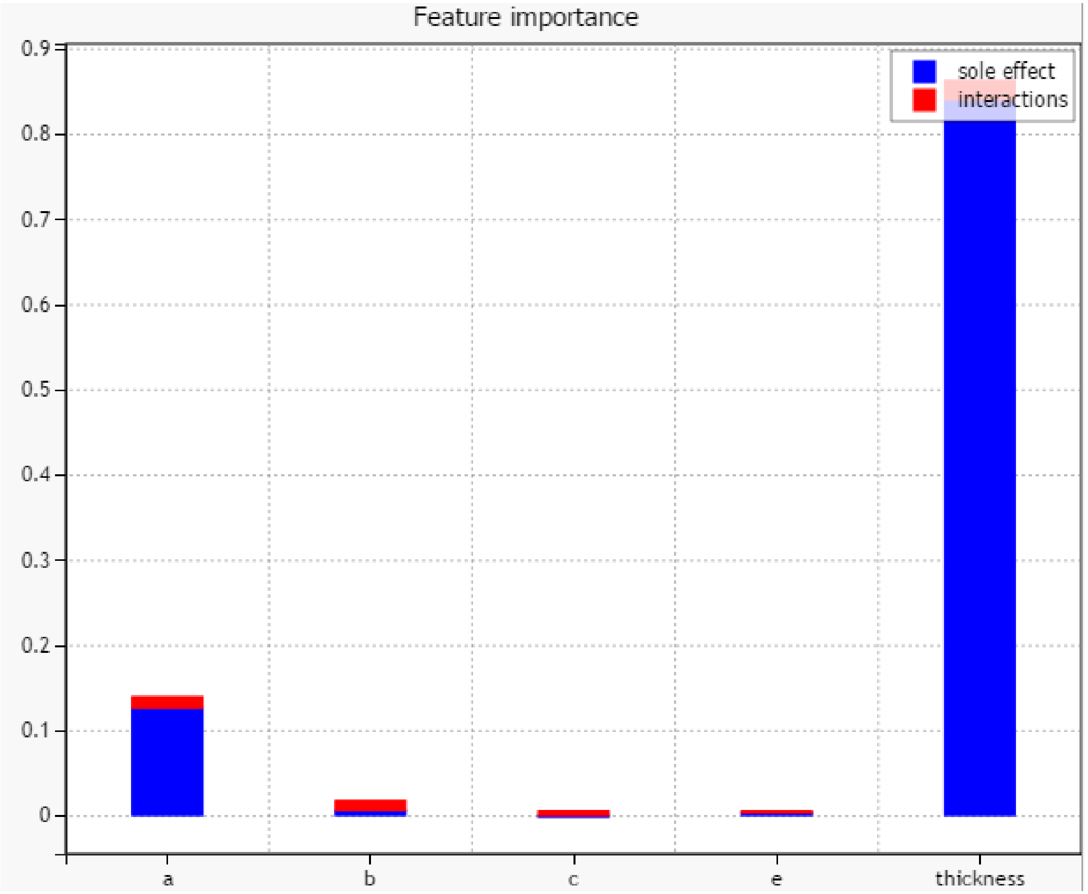
Data | Statistics | Correlations | Dependency

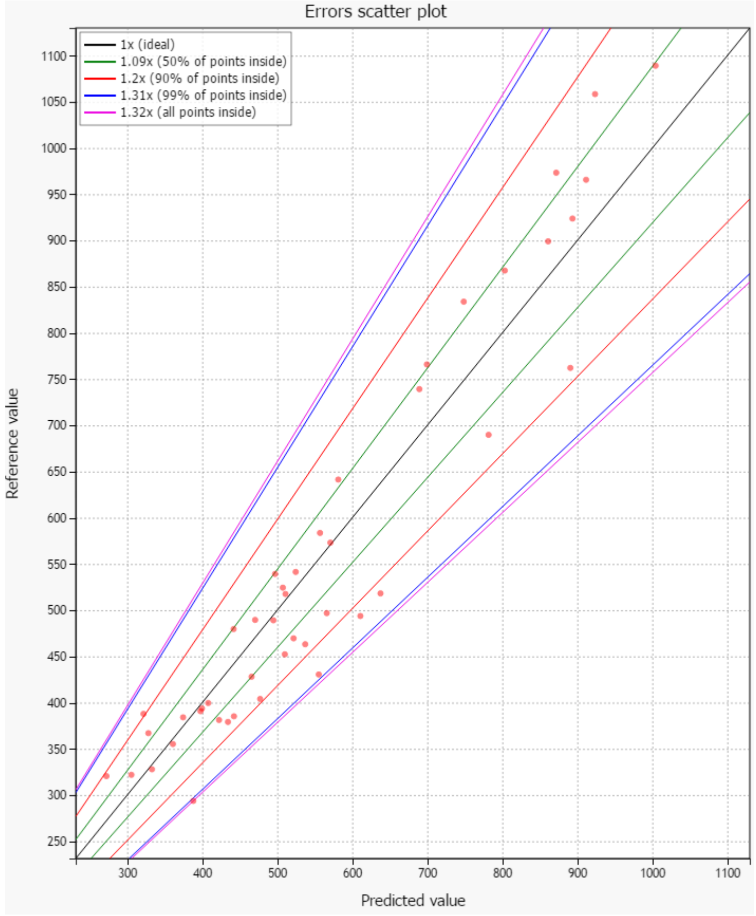
index	a	b	c	critica...	e	mass	max_s...	thickn...
25	72.250	14.130	29.250	282000.000	22.750	9.327	355.204	2.100
26	64.250	16.650	38.750	195500.000	24.750	9.629	541.435	2.140
27	59.250	14.550	42.250	404100.000	42.250	13.769	428.060	2.860
28	58.750	14.970	40.250	30670.000	44.250	8.166	765.913	1.700
29	56.250	10.350	38.250	13200.000	31.250	5.352	923.735	1.340
30	67.750	13.150	20.250	68710.000	32.750	7.592	463.204	1.740
31	62.750	10.910	33.750	209700.000	27.250	8.745	517.549	2.180
32	54.750	11.890	22.750	215500.000	23.250	9.848	379.126	2.500
33	68.750	13.570	35.750	582500.000	41.750	13.575	393.673	2.780
34	60.750	14.690	41.250	267800.000	20.750	10.277	489.494	2.340
35	73.750	13.990	25.750	500000.000	32.250	11.309	320.543	2.460
36	64.750	15.810	21.250	227900.000	29.750	9.792	524.393	2.300
37	69.250	13.290	36.250	0.000	39.750	5.156	899.069	1.060
38	57.750	13.850	26.750	277000.000	27.750	10.775	479.629	2.580
39	72.750	10.770	36.750	436400.000	40.750	10.528	327.897	2.380
40	52.250	11.470	33.250	70690.000	31.750	7.886	539.234	2.060
41	65.750	11.330	20.750	620600.000	38.750	11.098	384.095	2.820
42	63.750	10.630	24.250	91960.000	30.750	7.206	641.374	1.860
43	67.250	14.270	27.250	38250.000	34.250	6.970	518.191	1.540
44	57.250	16.230	23.250	11200.000	43.750	6.273	973.318	1.420

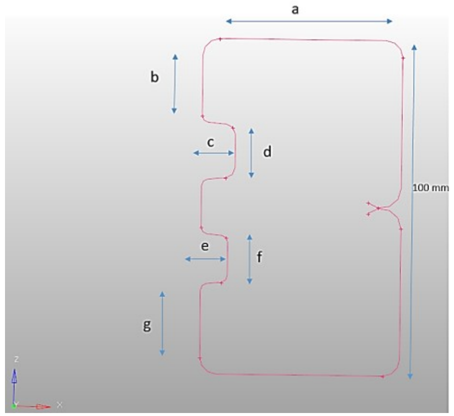




Design of Experiment







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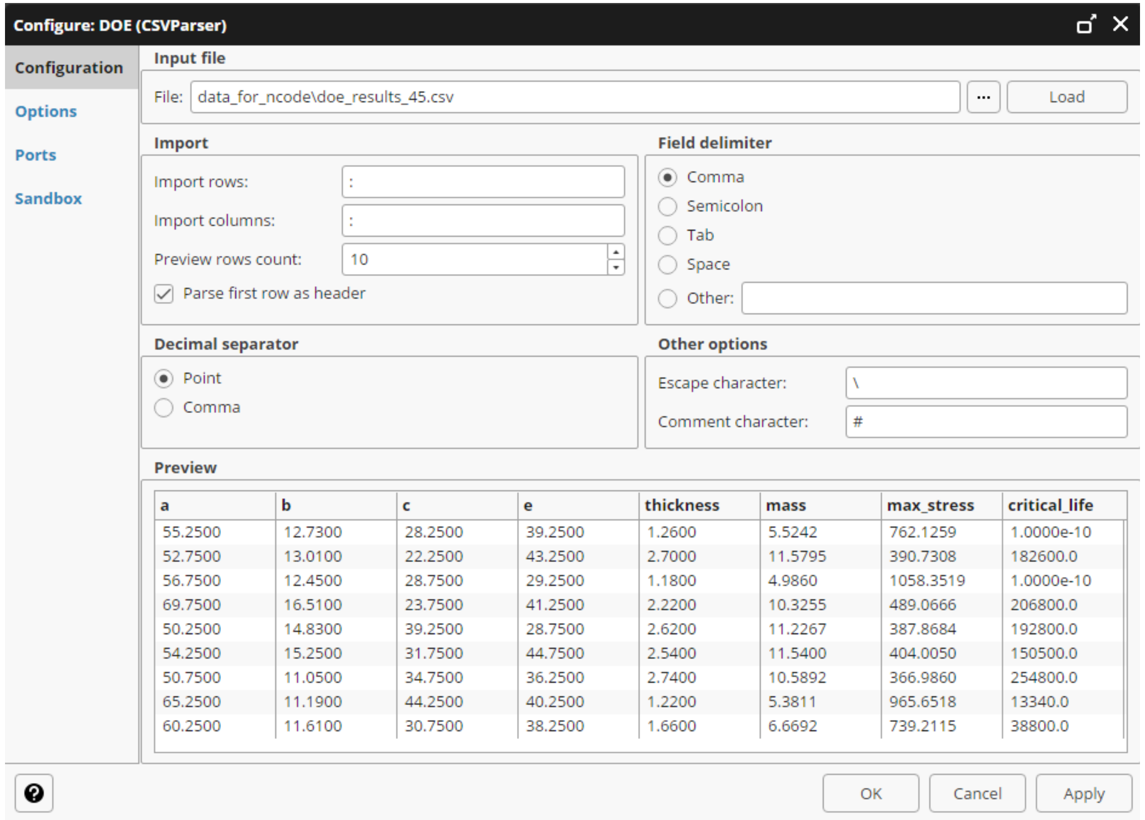
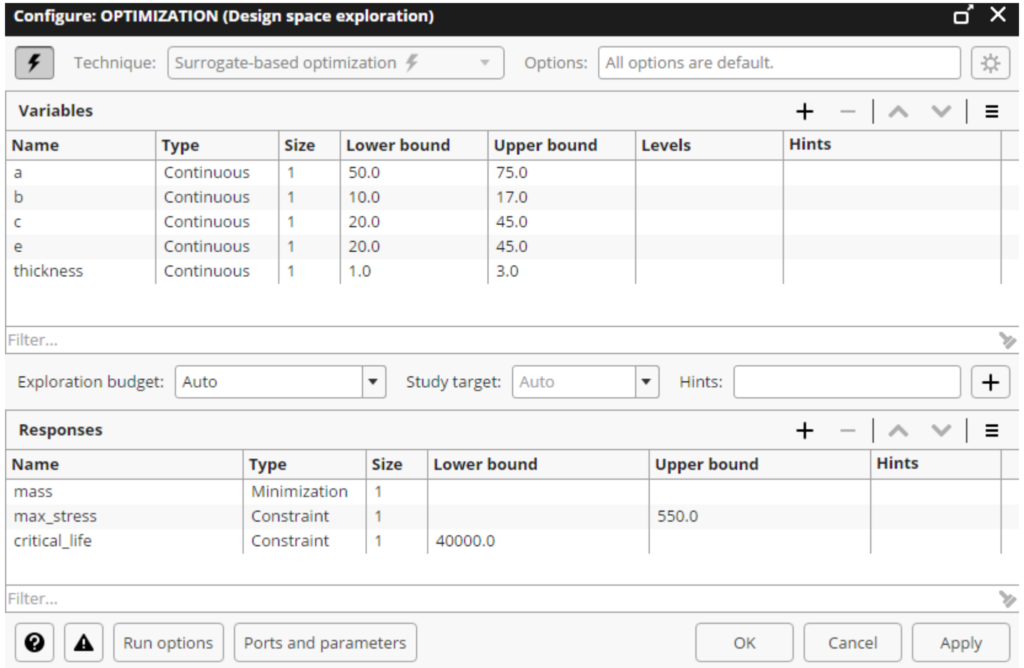
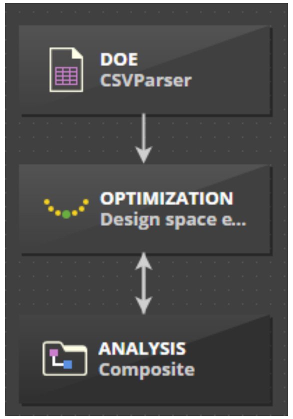
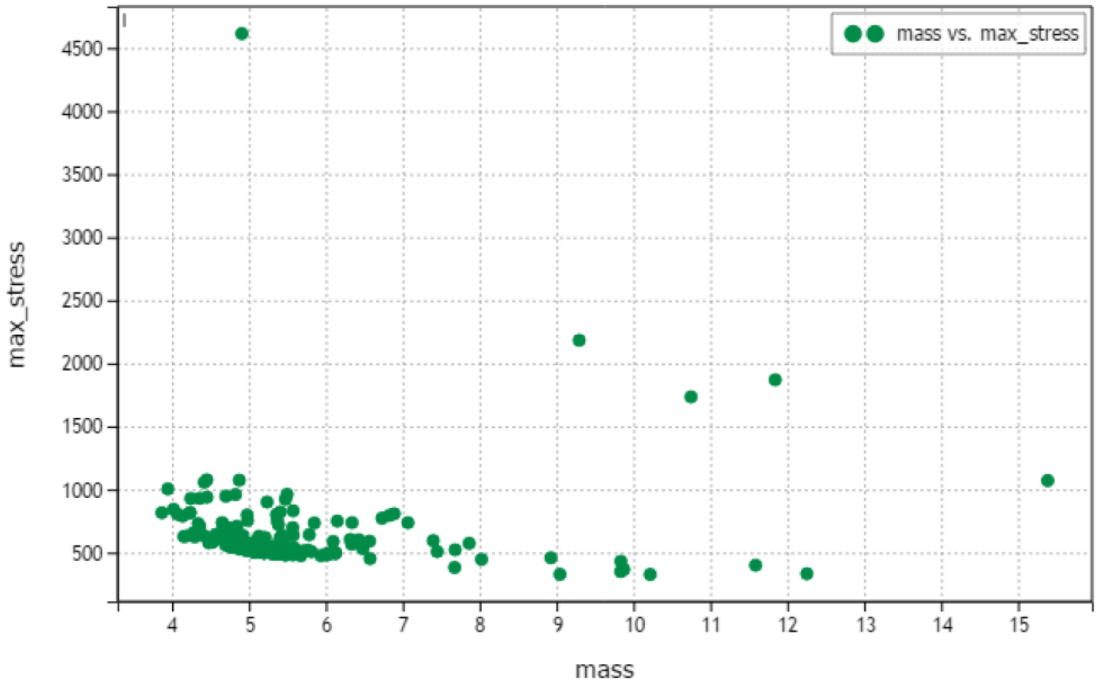
Optimization

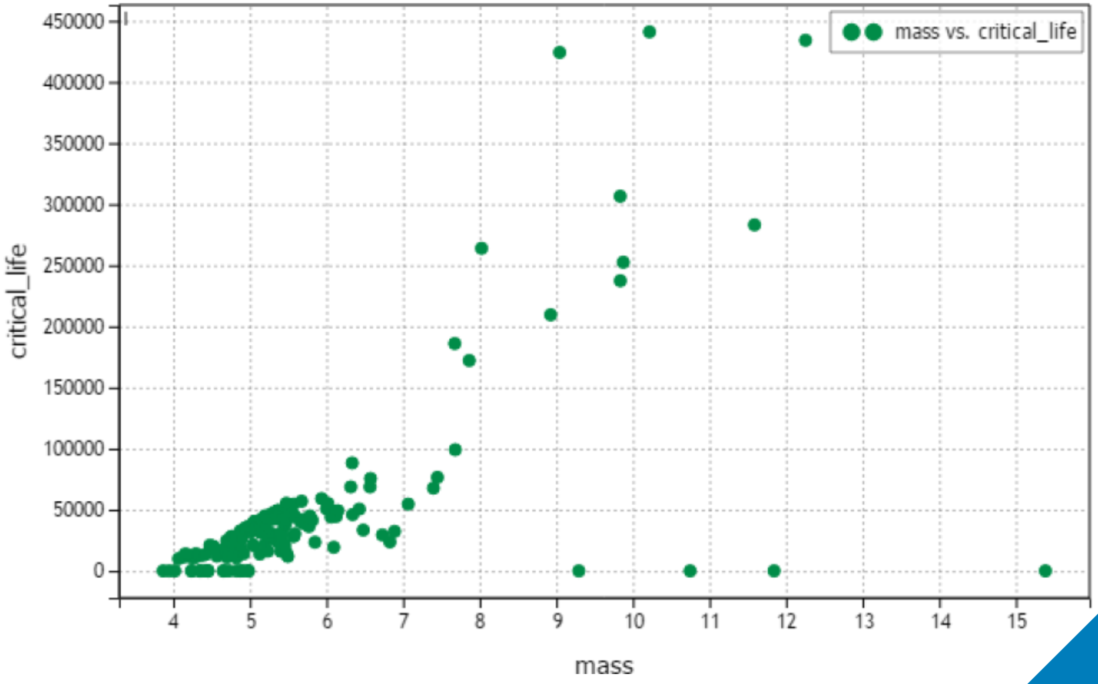






Optimization





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Conclusions

- The bumper CAD file has been parameterized.
- Both the structural and fatigue analysis process have been automated.
- Integration of statistical tools into the design process was ensured.
- DoE and Optimization studies were carried out in line with the design criteria.
- The required dimensional values have been obtained for a bumper design that is both light, strength and long-lifetime.


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