PROBABILISTIC STRUCTURE MECHANICAL ASSESSMENT CONSIDERING GEOMETRY VARIATIONS AND DETAIL OPTIMISATION USING PROSI

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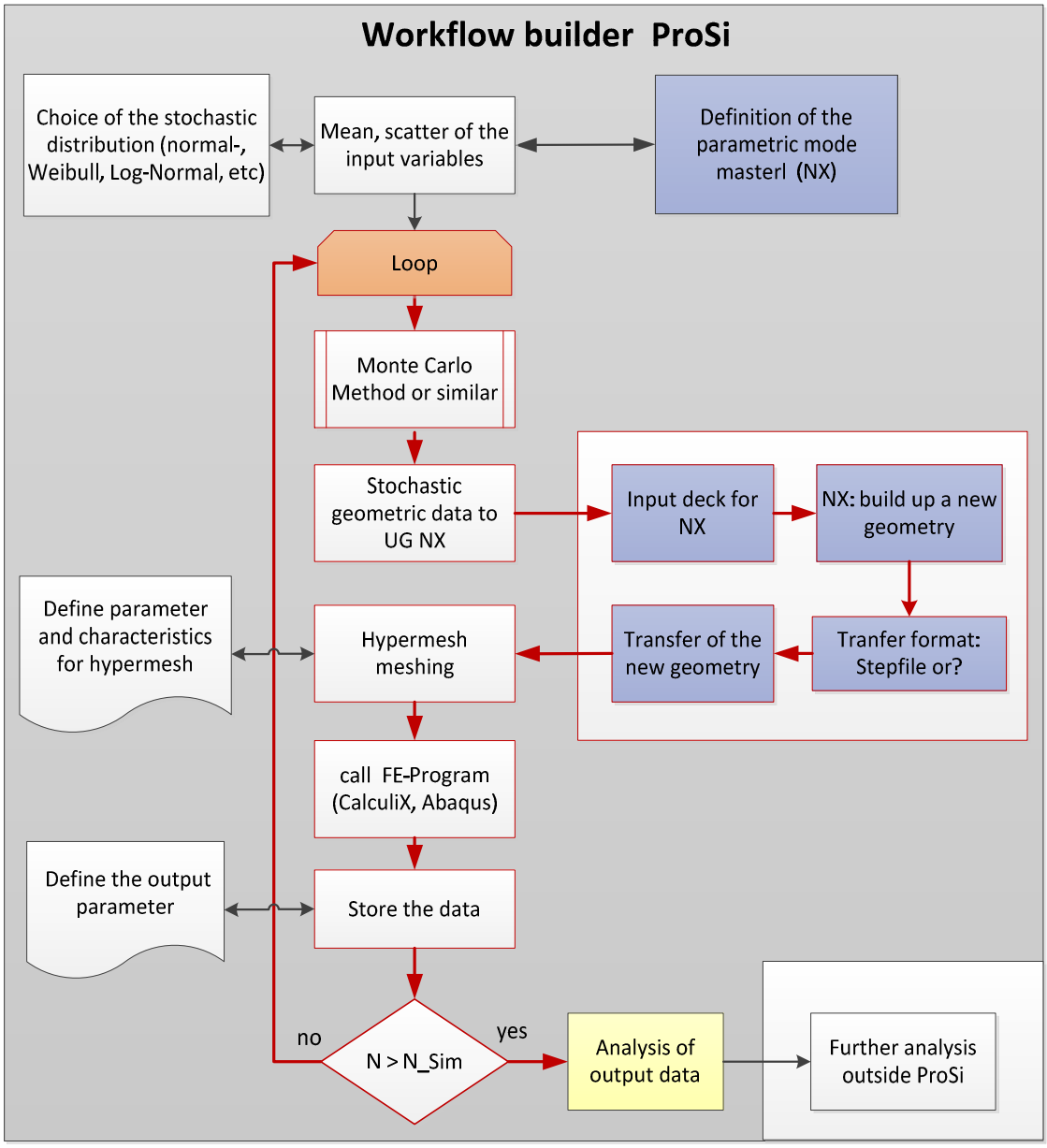
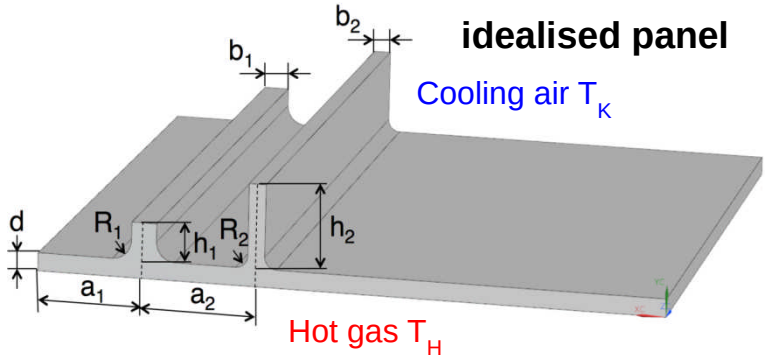
ABSTRACT

The environment for components of an aircraft engine is characterized by high temperatures, complex service conditions and high stresses in critical areas. These requirements are a major challenge in structural mechanics. Instead of using safety factors a probabilistic approach is considered as the variation of the geometrical parameters has a strong influence on the physical system behaviour.



Within this paper the behaviour of a model panel is assessed with regards to its sensitivities and to enable local optimisation of the panel. To suit this purpose a process chain was developed and embedded into a Monte Carlo Simulation (MCS). As input parameters geometrical parameters, temperatures the manufactering tolerances and their optimization ranges are used. First the behaviour of the nominal data are checked with manufacturing

tolerance using ProSi (see table above). Then a study is following using for all input variables uniform distribution within their allowable range (see figure below) using ProSi again. For optimisation we use response surface methods instead of the complex finite-element model and run a lot of shots (20.000-30.000) in ProSi. From these results a suitable optimum is chosen and recalculated with finite element method and using the manufacturing tolerance to see if the new optimum is stable.



input variables:

- 9 geometry parameter
- hot gas-/ cooling air temperature
- uniform distribution for optimization (normal for robustness)

Monte Carlo simulation

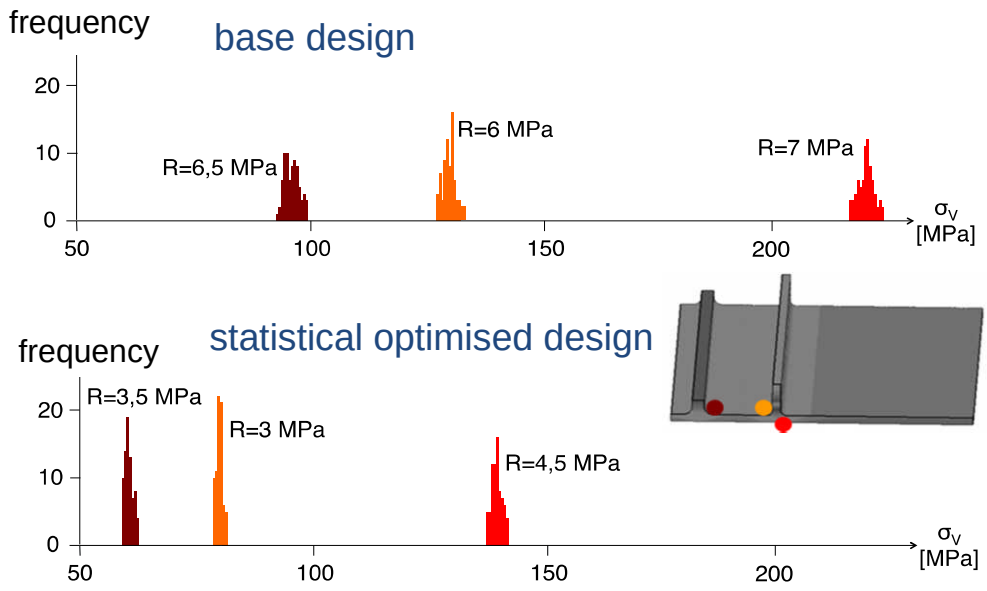
- Descriptive Sampling
- 75 shots
- Result variable: v. Mises-stress

Geometry parameter [mm]		
parameter	**mean**	**range**
a_1	17	15 - 30
a_2	18	15 - 40
b_1	4	3,5 - 4,5
b_2	2,7	2,5 - 3,5
h_1	5,8	5 - 10
h_2	13	10 - 15
R_1	3	2 - 4
R_2	1,9	1,5 - 2,5
d	2,8	2,5 - 3

Fluid temperature in [K]		
parameter	**mean**	**range**
T_H	1100	1050 - 1150
T_K	680	630 - 730

The calculations are carried out with ProSi as a workflow builder using NX for CAD and CalculiX for CAE. The output parameters such as stress are no longer deterministic, they are distributed with a mean value and a scatter. The closer the scatter the more robust the solution. This is shown in the results figure below.

result of an optimised and robust solution



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