DAIMLER

Fully automated simulation and optimization process for CAE applications

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3. Optimization – Challenges
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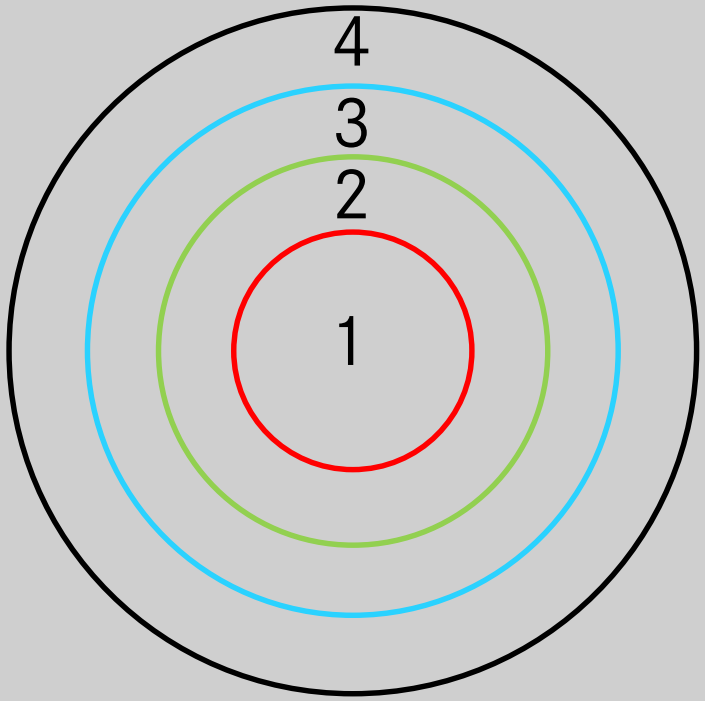
Motivation

- Reduction of prototypes in development process
- Hardware in early phases of development process not available
- Reduction of measurement time in costly measurement devices (e.g. wind tunnels)
- Deeper insight in physical phenomena

Optimization – Basic Needs



Main Steps of the Optimization Process

1. Fully automated simulation process for every application
2. Parameterized input data
   (numerical values or parameterized geometry)
3. Optimizer or DOE (Design of Experiments)
   (control of parameter variations)
4. Post-processing of Results

The importance of the different steps is decreasing from 1 to 4. For example it is not necessary to define a DOE when the simulation process at hand is not fully automated.

The most important and most time consuming step is the definition of the parameters including their variation range as well as the target value.

Optimization - Challenges

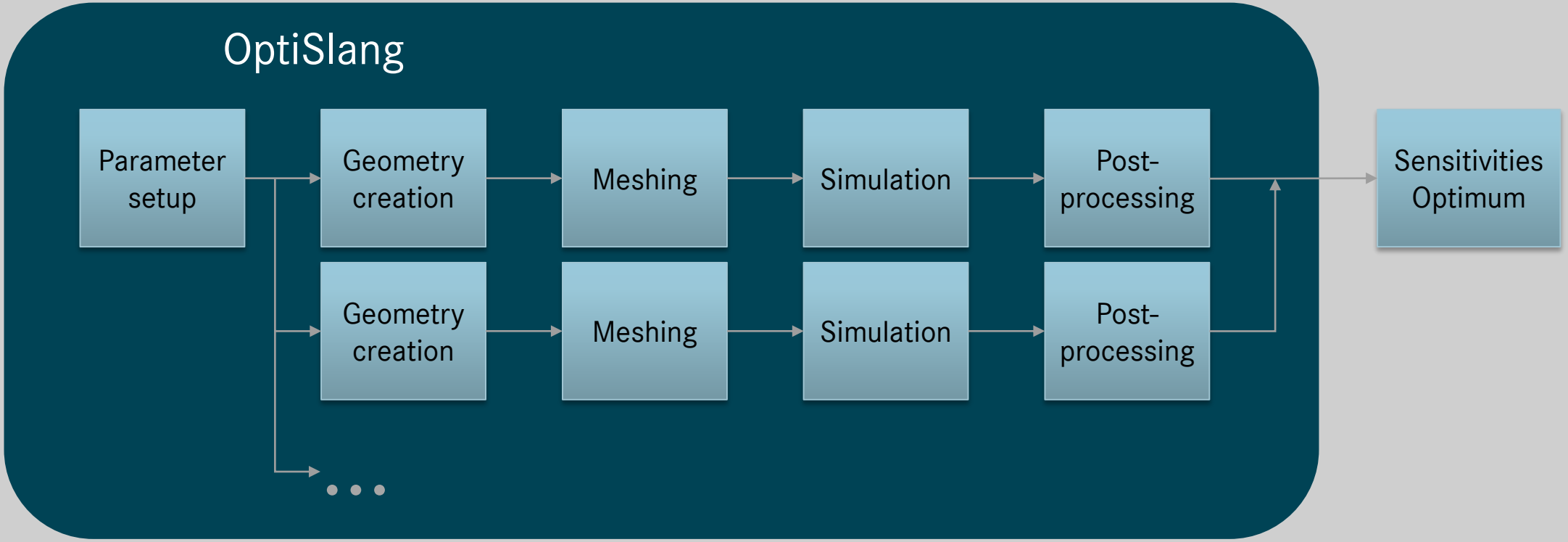
- Definition of parameter range

- Fully automated simulation process
- Control of input parameters
- Automated post-processing of target values

- High robustness of simulation process
- Huge amount of data (memory requirements, data transfer)
- Huge amount of simulations (availability of CPUs)

CAE-AutoWorkflow

Application: Aerodynamics

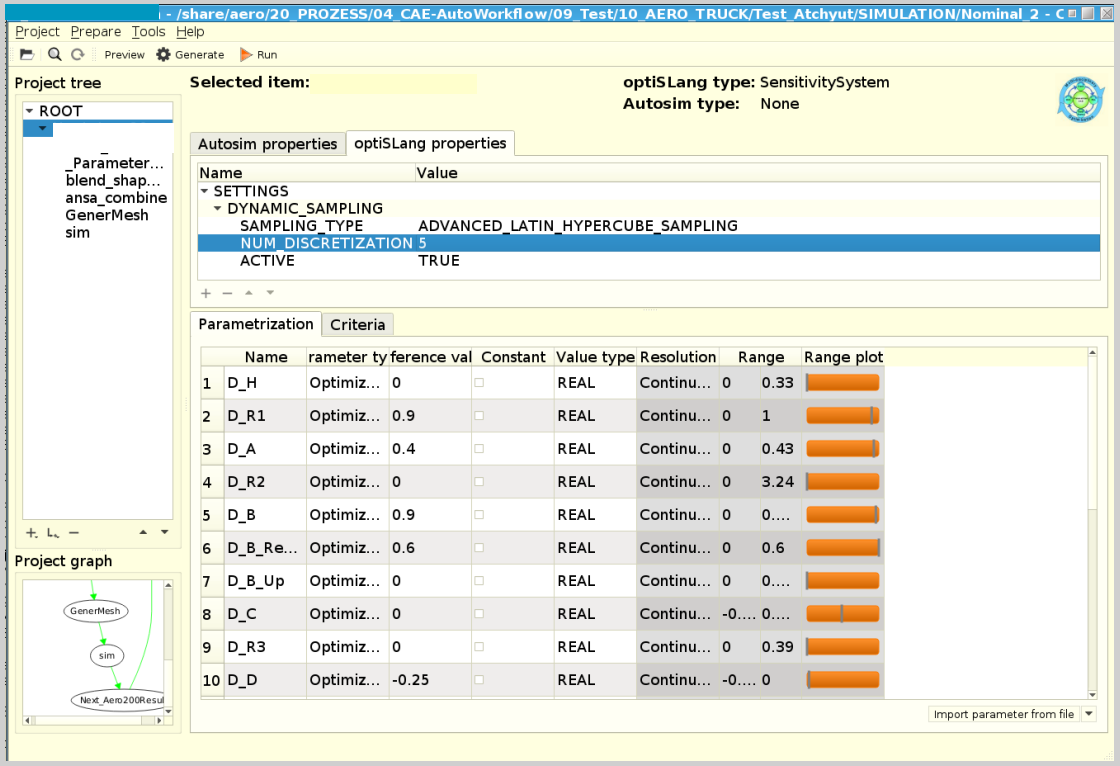


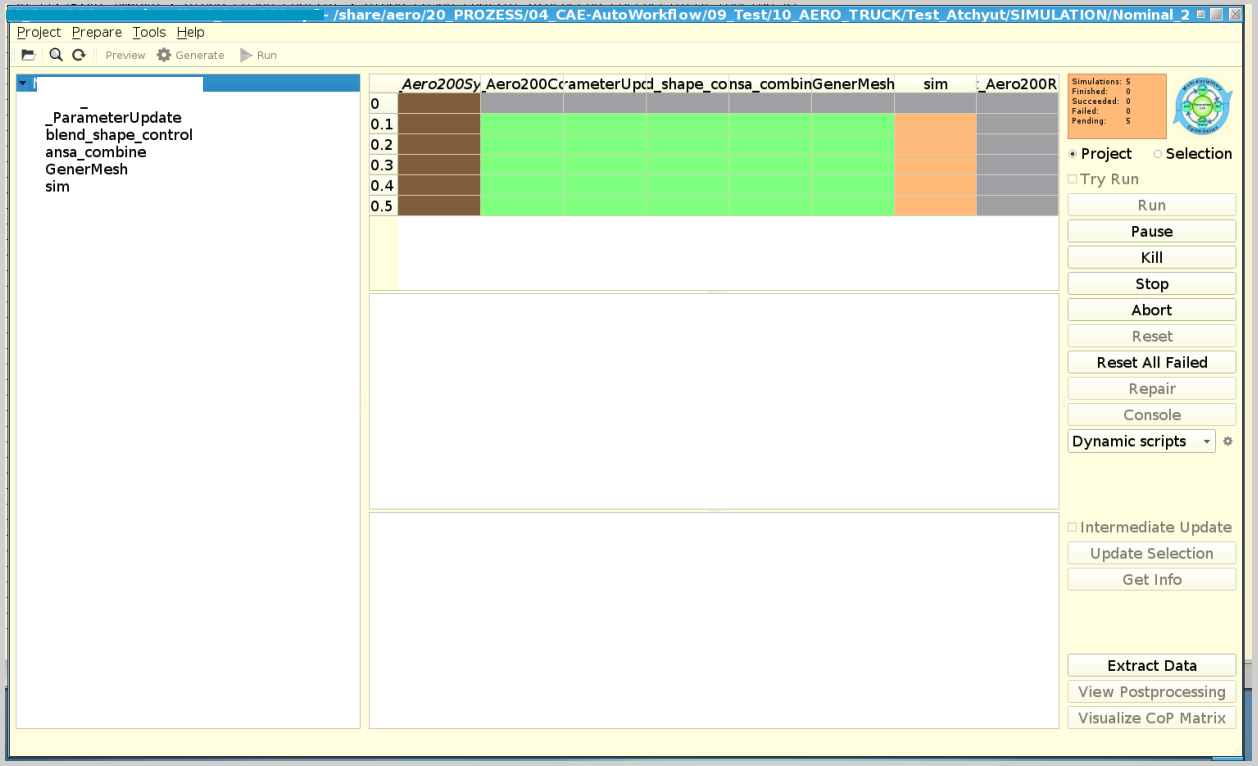
Software-Tools: STAR-CCM+ LS-DYNA NX NASTRAN ANSA SIEMENS NX MIDAS .....

CAE-AutoWorkflow

```
workflow = ansa_combine,GenerMesh,sim
casename = Aero_Test
starccm_version = 9.04.009
...
[sim]
type  = starccm_generic
input = VolMesh.sim
result_file = VolMesh_Result.sim
```

Input-File





Example: Truck Aerodynamics

- **Computing Mesh:**

  100 million computational cells

  Computational domain : l : b : h = 115 : 90 : 36 m

  Size of result files : 60 GB

- **Resources:**

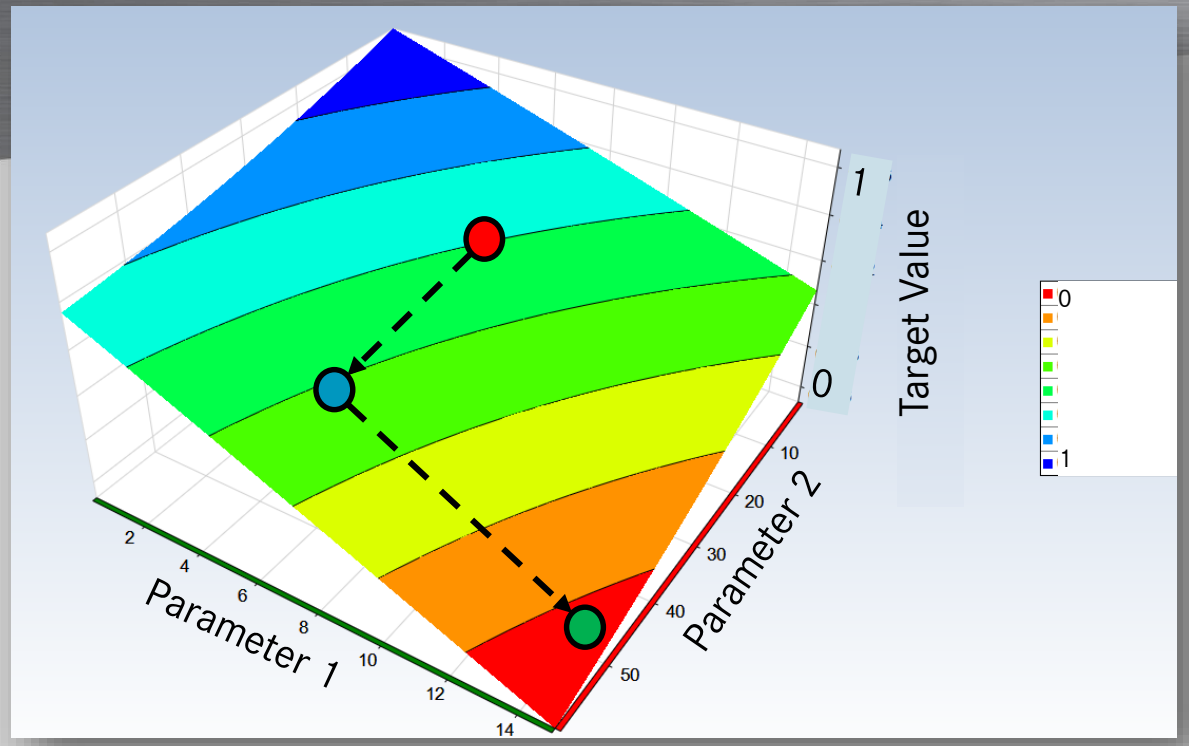
  Pre- / Post Processing : min. 200 GB memory

  Per simulation about 2 days on 400 cores

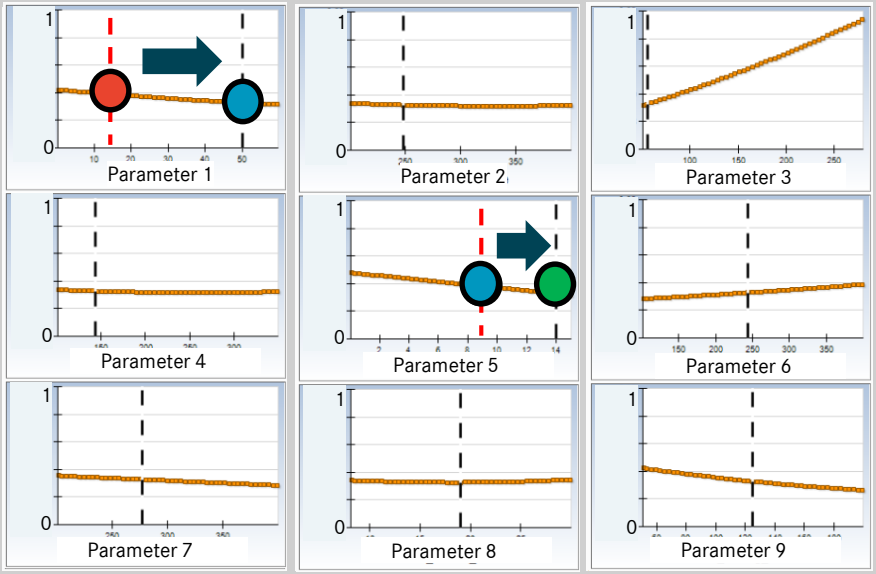
  9 parameters: 200 CFD runs

  Total amount of data per sensitivity analysis : **approximately 8TB**

Analysis in Meta-Model



9-dimensional parameter space

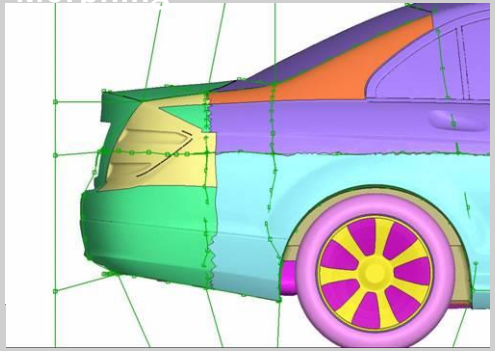


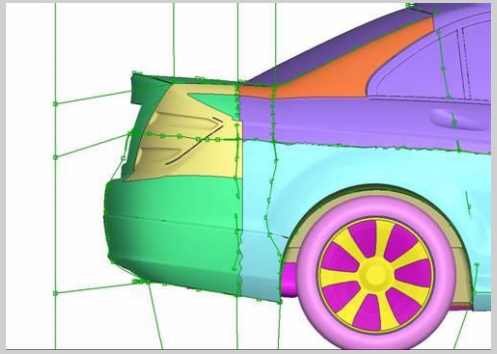
- In the meta - model relationships can be analyzed in real time and discussed in the development team
- Determining optimum

- The above sensitivities are only valid for exactly one parameter combination
- With the postponement of a parameter , all other functional relationships change

Example: Passenger Car Aerodynamics

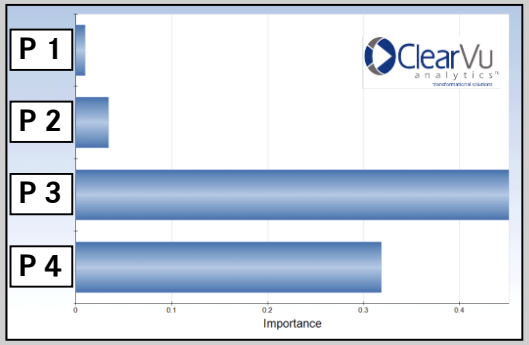
ANSA
Morphing



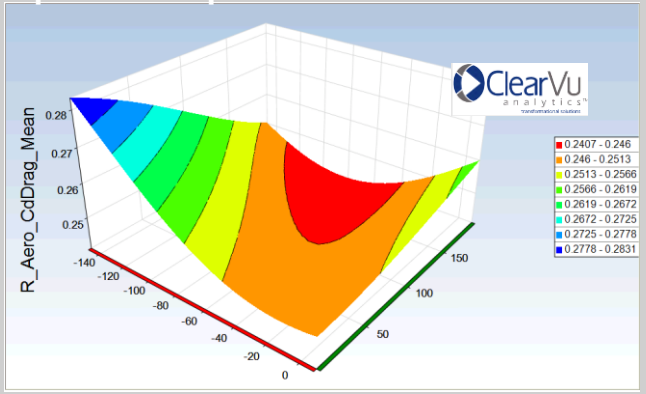


STAR-CCM+

Sensitivities



Optimal Shapes



Conclusions and Future Work

- CAE-AutoWorkflow successfully implemented
- High robustness of simulation process
- Highly appreciated insight in parameter sensitivities
- Extension to more applications ongoing