

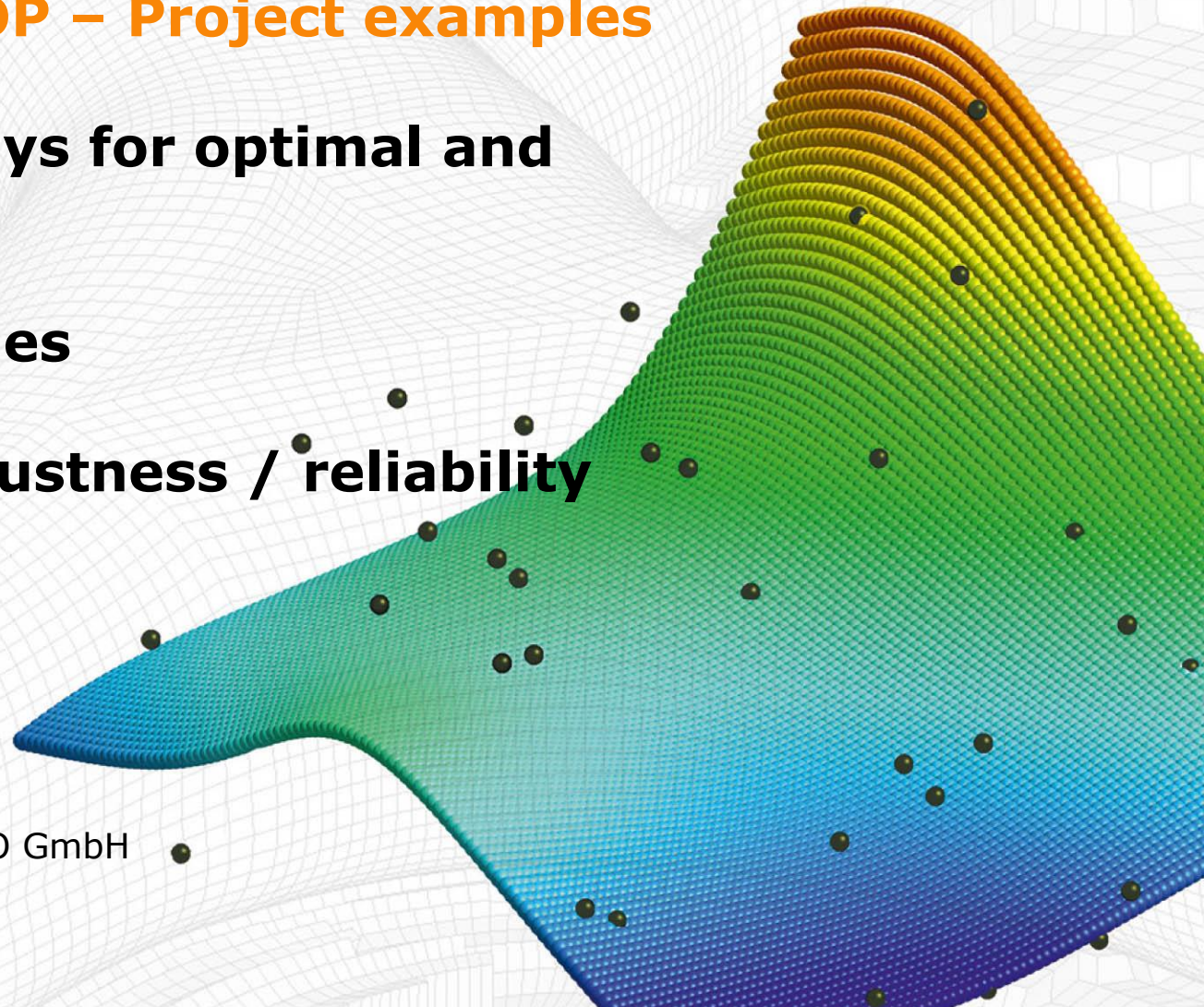
The Power of MOP – Project examples

Cost efficient ways for optimal and robust products

Support your Sales

Evaluate the robustness / reliability

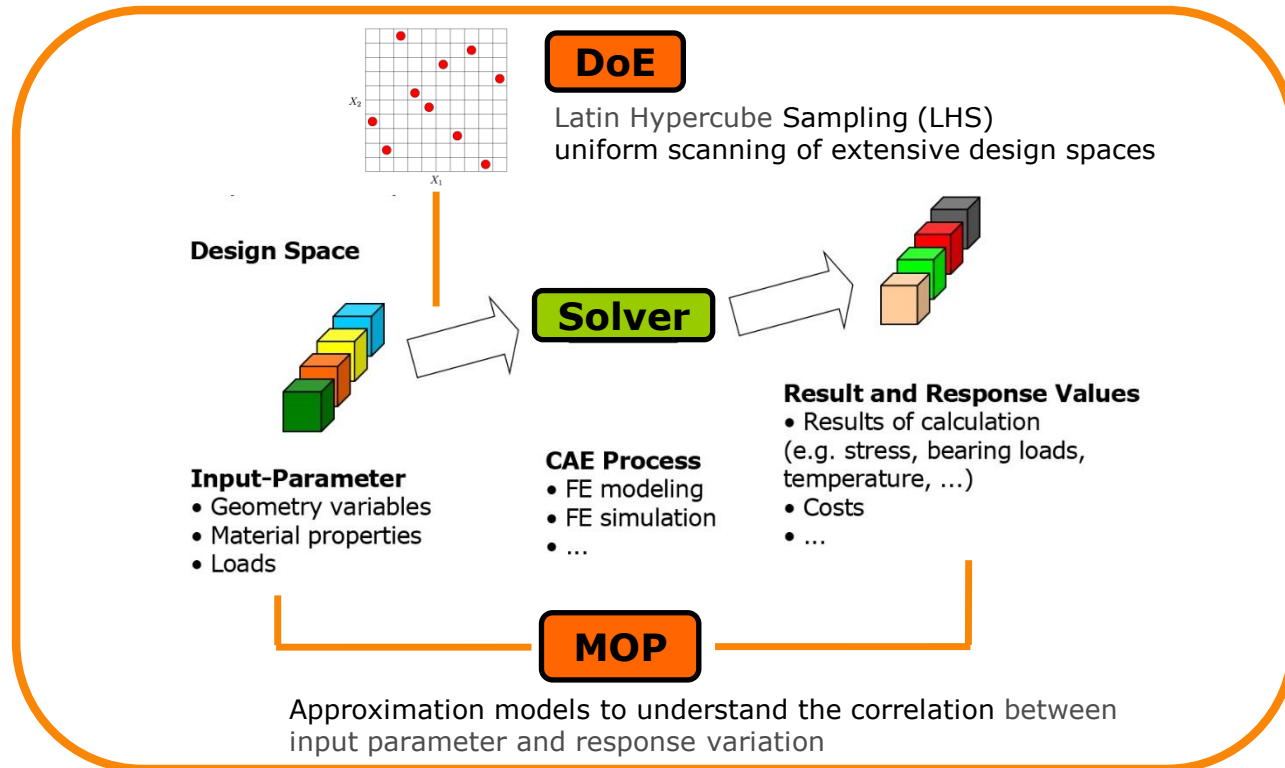
Dr.-Ing. Roger Schlegel
Consulting director DYNARDO GmbH



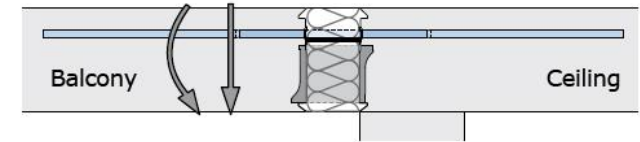
MOP- key to generate best possible functional models

- During a sensitivity analysis, **MOPs** (**M**etamodel of **O**ptimal **P**rognosis) functional models are determined by optiSLang to approximate and understand as best as possible the correlation between input parameter variation and response variation.

Sensitivity Analysis



Optimization using MOP



five analysis each per design:

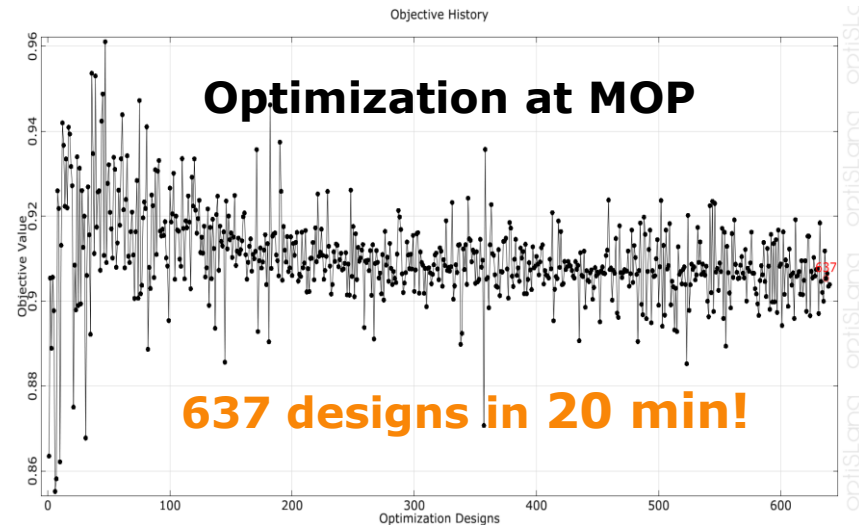
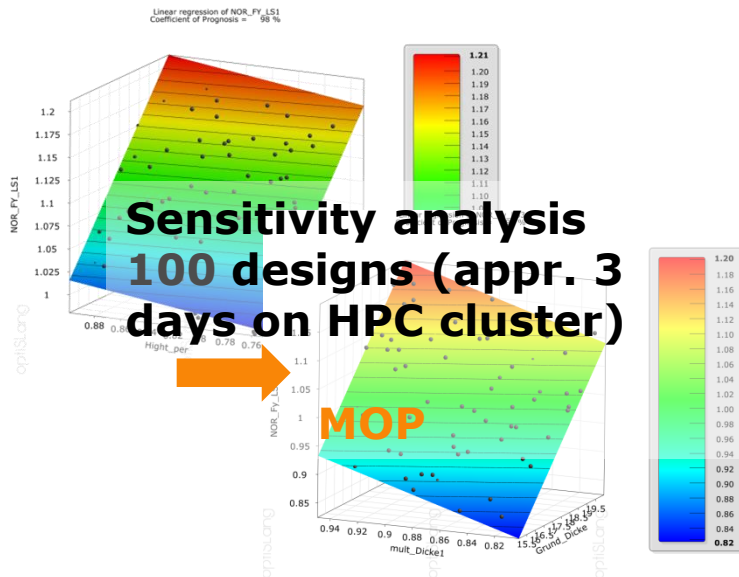
- two stationary thermal analysis (each with different constraints)
for simulation of the PSI-value and
for simulation of the FRSI-value and

Duration of calculation 2x 5 Min

- three non-linear mechanical analysis for the three load cases
LF1 - Concrete edge failure,
LF2 – Support – compression failure
LF3 – Support – shear failure

Duration of calculation 3 x 6 hr

**approx.
18 hr/design**



Include MOP's in your web services to provide customer best possible product selection



zurück zur Übersicht

Kataloge

- Verankerungstechnik
- Bewehrungstechnik**
- Transportankersysteme
- Betonfassade
- Verblendmauerwerk
- Natursteinverankerungen
- Stabsysteme
- Montagetechnik
- Powerclick
- Schrauben, Zubehör



2015-02-11 - HIT ISO-Element
Produktinformation Technik
HIT 15
(HIT_15.pdf - 9.49 MB)



2014-04-03 - HIT ISO-Element
DD - für durchgehende Platten
Produktinformation Technik
HIT DD-14
(hit-dd-d.pdf - 481.33 kB)



2014-08-13
ZV - für Balken
Produktinfo
HIT-ZV 14
(HIT-ZV_14.pdf - 1.01 MB)

HBB, HTF, HTT - Schalle

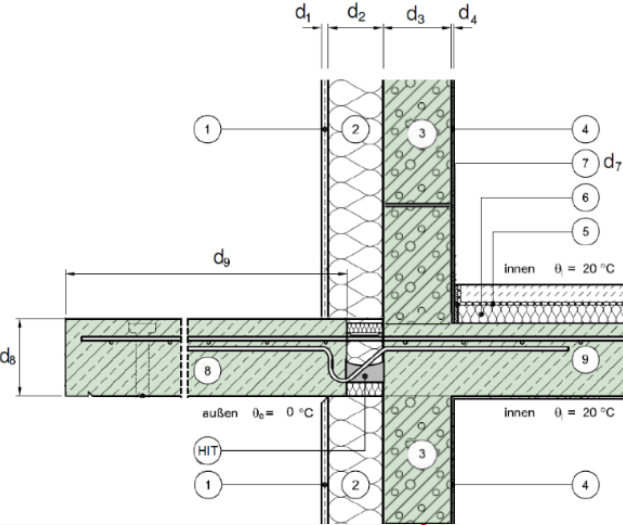


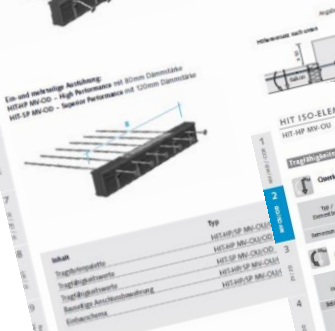
2012-02-10
Produktinfo
ISI 09
(isi-d.pdf - 1.01 MB)

HBS-05 - Schraubanschli



2013-05-29





PSI Berechnungstool

Lorem ipsum dolor sit amet, justo eu ut tristique eu phasellus, magnis vel vestibulum lectus praesent pharetra vulputate. Lectus pellentesque ad vestibulum tempor. Habitant at netus, velit dui parturient elit velit in, mus dui in ut suscipit metus velit.

Berechnung in 4 Schritten

- > Wandbau
- > Wandbeschaffenheit
- > Dekorbeschaffenheit
- > Fenster/Türenbeschaffenheit
- > ISO Element

Neue Berechnung starten

Gespeicherte Berechnungen

Hier finden Sie Ihre bereits erstellten Berechnungen

1. Generate parametric CAE models to calculate product performance

2. Validate the CAE models with available measurements

3. Scan possible product assemblies in advance using LHS sampling & Sensitivity analysis

MOP Service

PSI Berechnungstool

5. Use MOP's in Customer's sales tool to support product selection and assembly

- > Wandbeschaffenheit
- > Deckenbeschaffenheit
- > Fenster/Türenbeschaffenheit
- > ISO Element

Neue Berechnung starten

Projekt aufrufen

4. Generation and Verification of Meta models to have functional representation of possible variants

Design Space



Input-Parameter

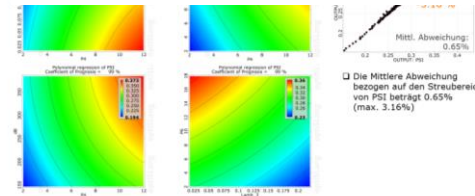
- Geometry variables
- Material properties
- Loads

CAE Process

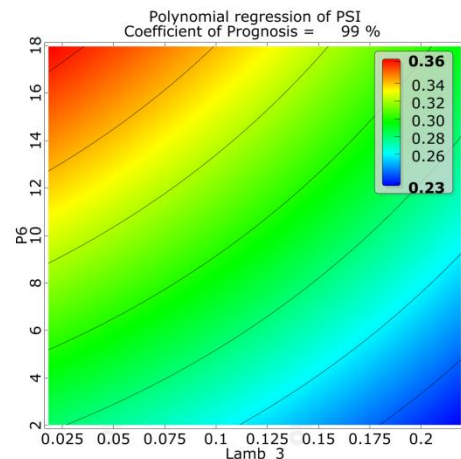
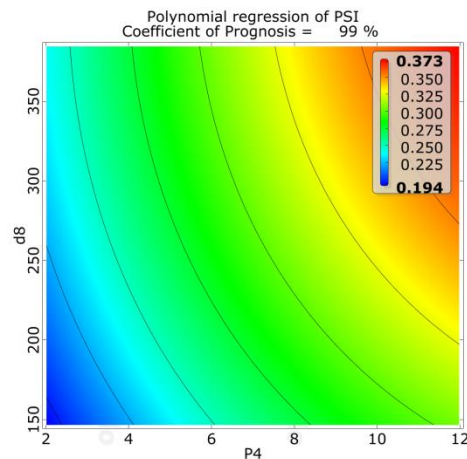
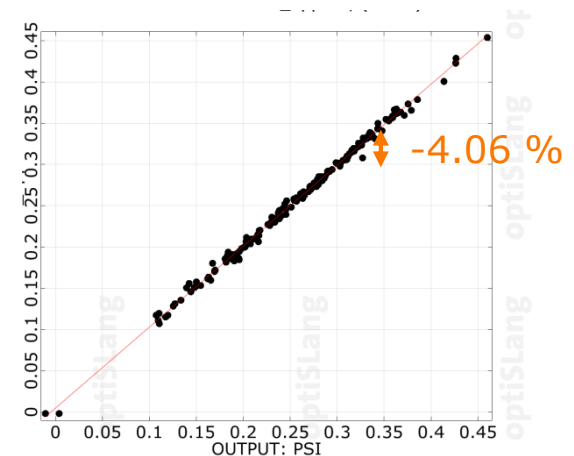
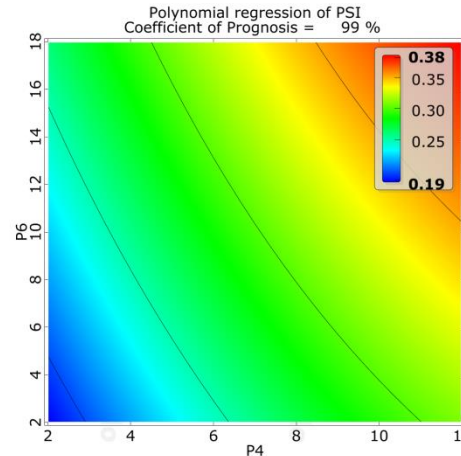
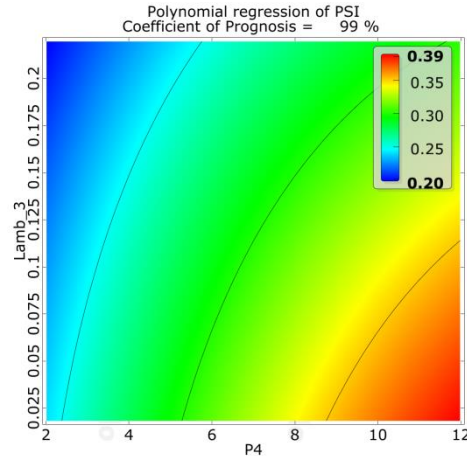
- FE modeling
- FE simulation
- ...

Result and Response Values

- Results of calculation (e.g. stress, bearing loads, temperature, ...)
- Costs
- ...

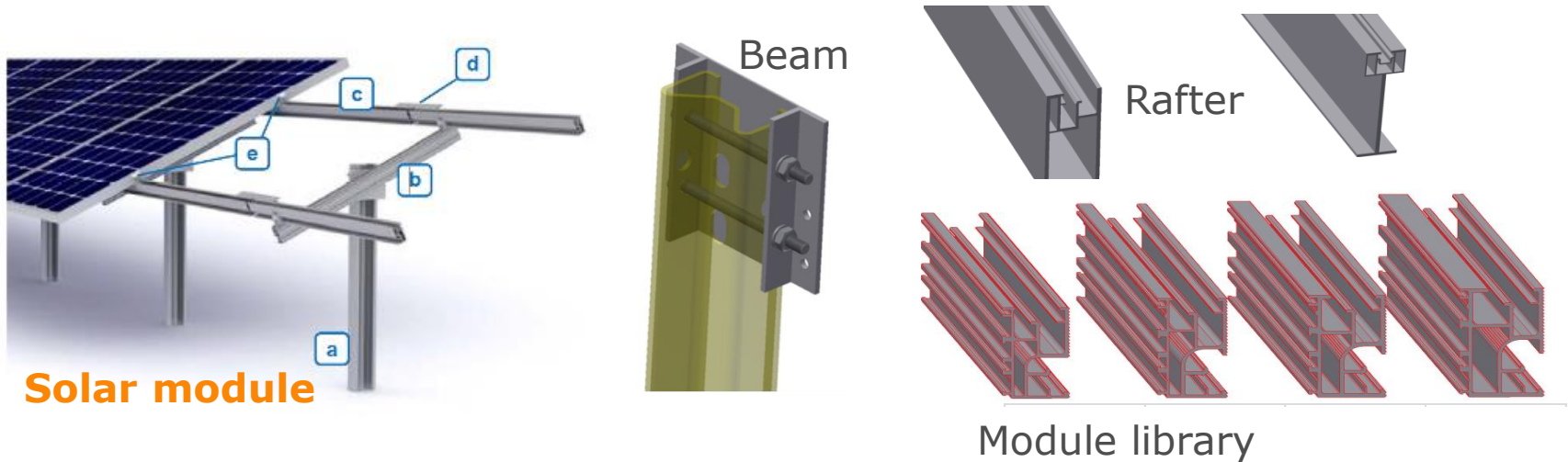


Verification of MOP's for mean (COP) and max error is very important



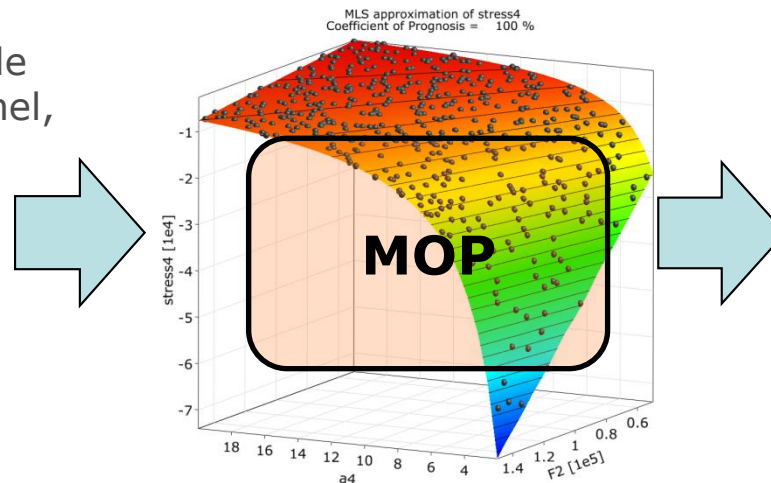
- ❑ mean error of the MOP is 0.69%
- ❑ max. error at MOP is 4.06% (local)

Select the optimal system configuration using MOP



Optimization Goal: Module requirements like m^2 panel, solar surface, module arrangement

System Loading:
Dead weight, wind load, snow load, structure/foundation interaction)

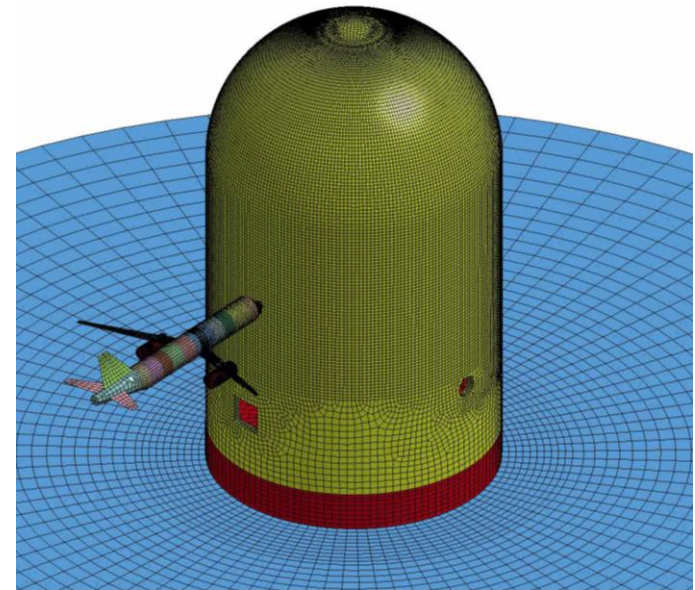
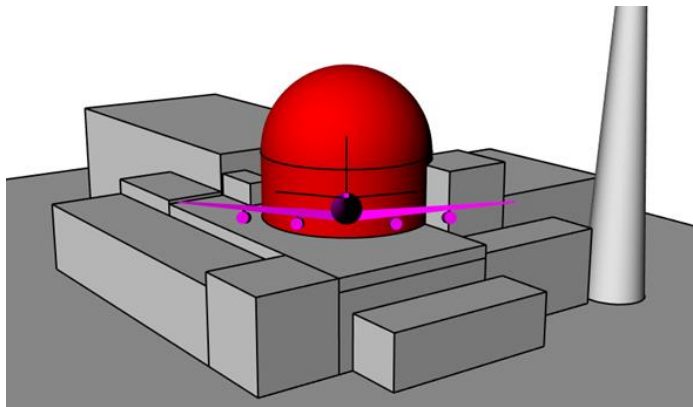


Search for cost-efficient configuration of System (minimized material consumption) from existing profile library

CAE-based reliability evaluation of critical construction components



airplane impact on nuclear power plant

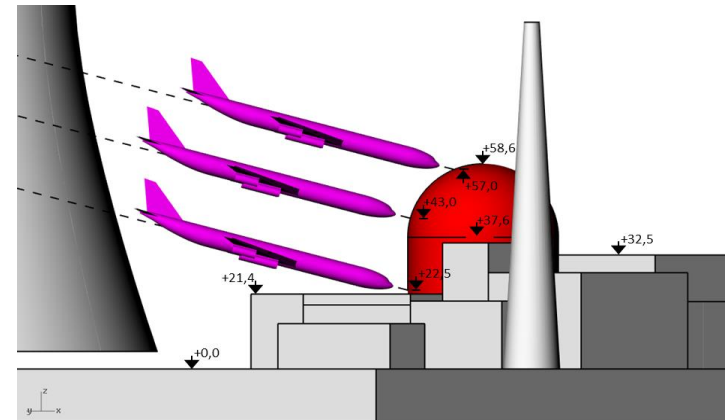
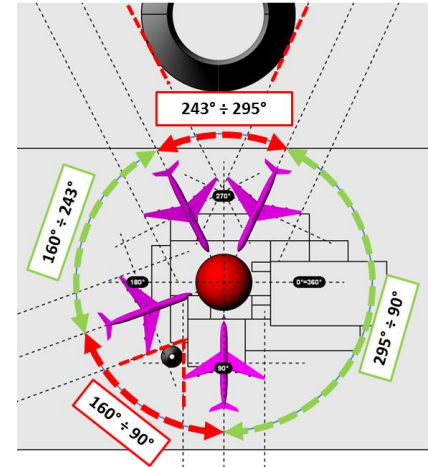




CAE-based reliability evaluation of critical construction components

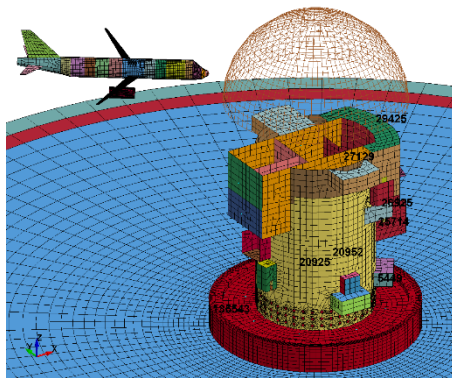
Motivation:

- Using Worst-case analysis is problematic?
What is the worst-case and which safety factors needs to be chosen?
How useful is the worst case criterion to evaluate an existing structure?
How likely is the worst-case?
- As alternative to worst case scenarios stochastic analysis is possible. But stochastic analysis of non-linear CAE models in large dimensions of uncertainties needs many thousand's of design evaluations.
- Solution: scan the whole uncertainty space-
generate MOP-apply stochastic analysis to the MOP
– verify the estimated reliabilities

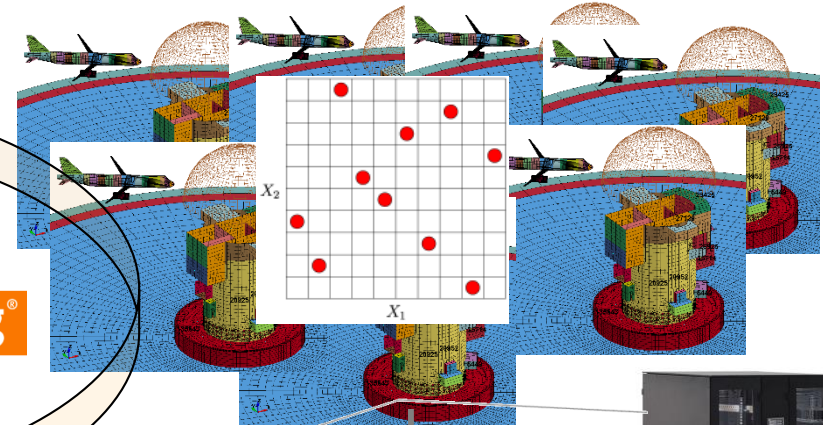


CAE-based stochastic analysis- generate MOP's

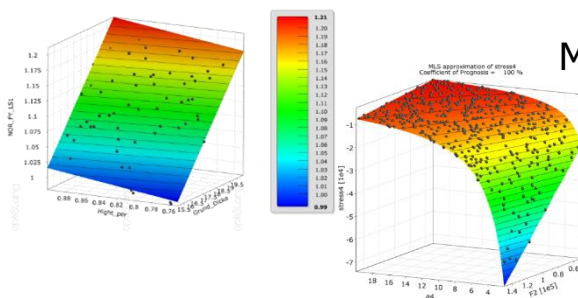
- 1) **Parametric CAE simulation model** to simulate an airplane impact with all known **uncertainties of loading and resistance**



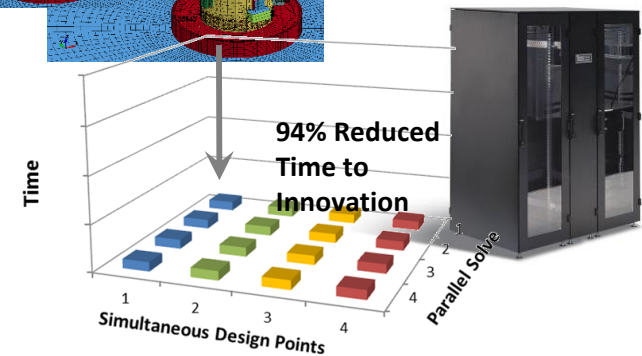
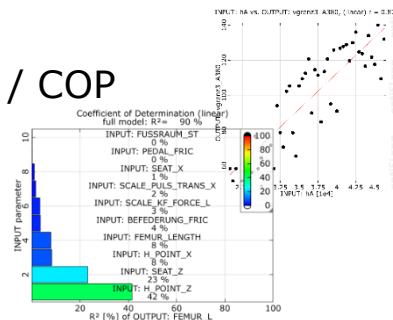
- 2) Sampling **Latin Hypercube Sampling** (LHS) and simulation of n possible scenarios (approx. 100..200)



- 3) Definition of assesment criteria, **Sensitivity analysis** / Generation of **meta-models**



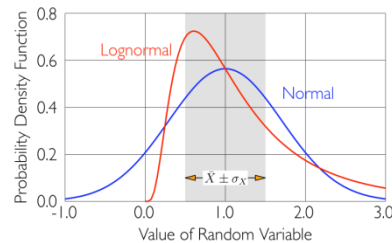
MOP / COP



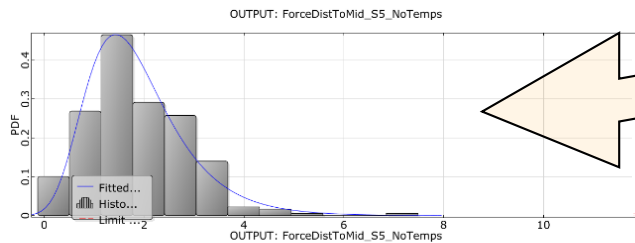
The Power of using MOP – for robustness / reliability evaluation

CAE-based stochastic analysis – run stochastic analysis

4) Definition of distribution functions of input parameter



optiSLang®



Statistic data	
Min: -0.13	Max: 7.489
Mean: 1.886	Sigma: 1.012
CV: 0.5368	
Skewness: 1.011	Kurtosis: 5.755
Fitted PDF: Gumbel (Extreme Typ I Max)	
Mean: 1.886	Sigma: 1.012
Limit x = 11.82	
P_rel: 1	1 - P_rel: 0
P_fit: 0.999998	1 - P_fit: 1.91989e-006
Sigma-Level: 9.81328	
Probability P(X<x) = 1	
x_rel = 7.489	x_fit = 10.5174

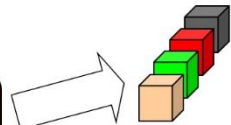
5) Perform reliability analysis replacing CAE with MOP's

MOP as Solver: 10000 designs in 30 MIN

Design Space



MOP



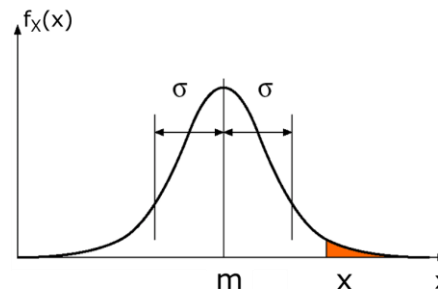
Result and Response Values

- Evaluation criteria

Input-Parameter

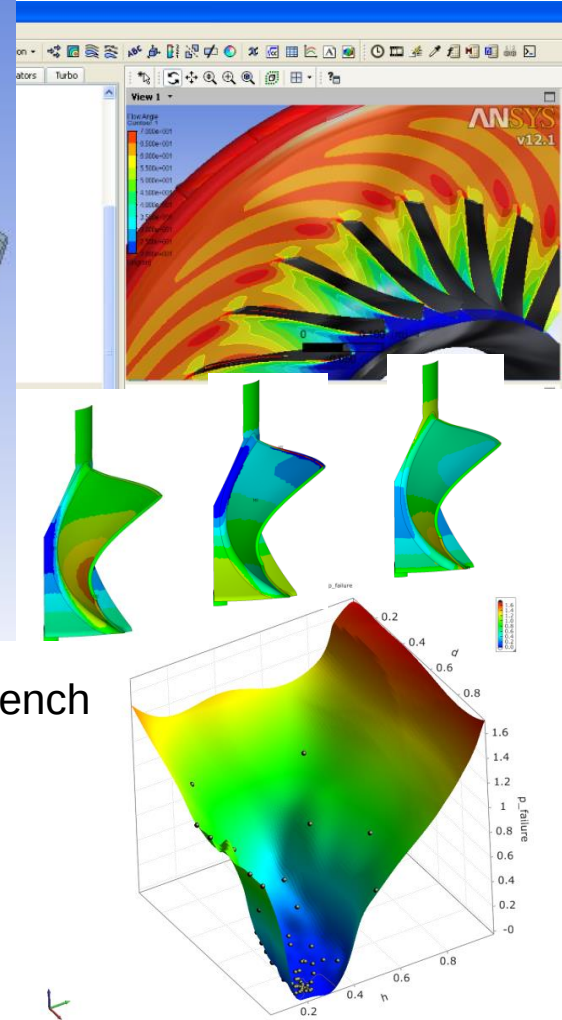
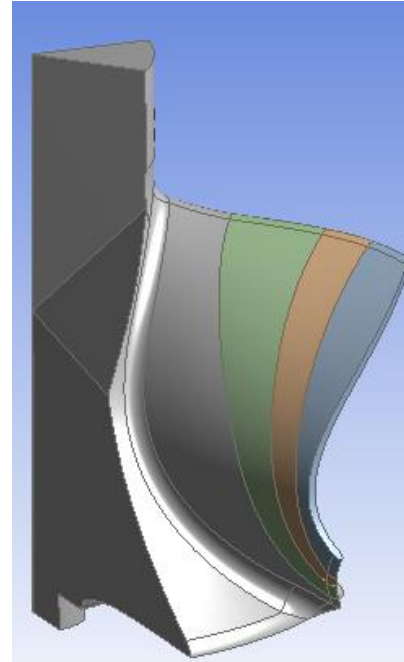
- Direction of approach, height
- Mass of plane
- Approach velocity, ...

6) Estimate the probability of limit violations of evaluations criteria based on MOP.



7) Verify the estimated probabilities using CAE-model

Optimization & robustness of turbocharger



MOP as fast Generator

Parametric geometry definition using ANSYS BladeModeler & Workbench (Bézier-Parameter for blade geometry increase the complexity)

Task: robustness evaluation in a defined geometry tolerance range

Solution:

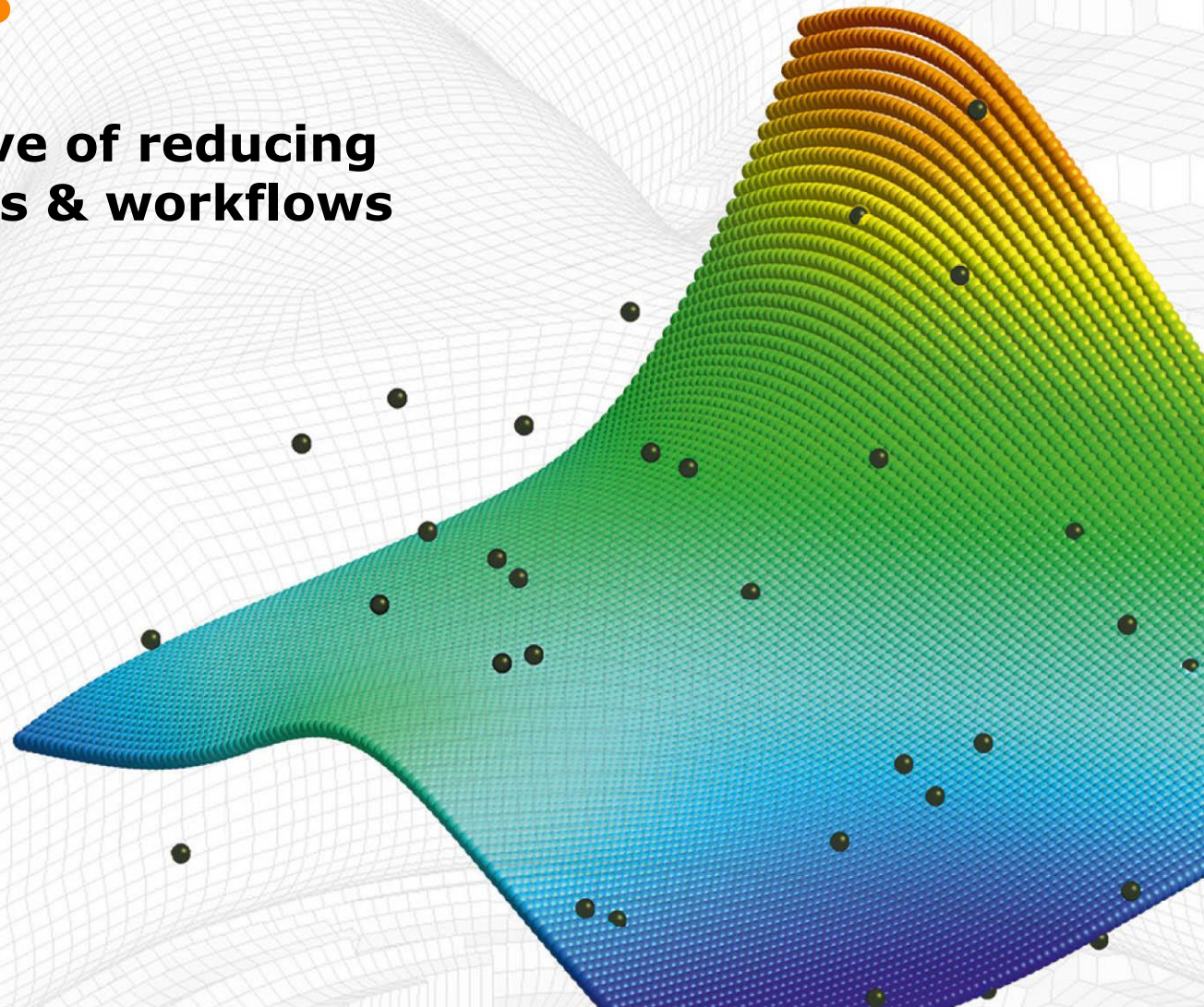
using Metamodel as fast Generator for imperfect geometry designs

using optiSLang as Filter for relevant design - space

The Power of MOP

**Attractive alternative of reducing
complex CAE models & workflows**

Dr.-Ing. Johannes Will
CEO DYNARDO GmbH



Simulation is the key for time to market

offers to the market:

- **Software**

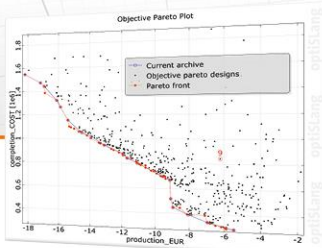
- Parametric CAX modelling environment like **ANSYS Workbench** together with **general purpose variation analysis tool optiSLang** to support **virtual prototyping & product optimization**

- **Consulting service** to establish virtual product optimization at your company at different levels

- establish parametrized CAX models & CAX process automation and integration
- establish parametrized CAE workflows (vertical applications) and calibrated CAX models to be used in variation studies
- establish functional relationships (MOP's) to approximate variation windows of optimization parameters or uncertainties based on simulation or/and tests

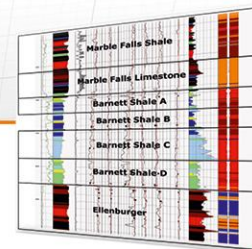


Generate Pareto optimality between estimated ultimate recovery uplift and related unit development costs



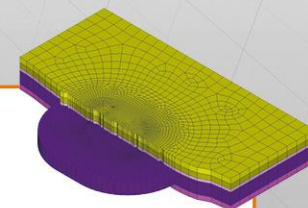
1

All available reservoir data is used for input



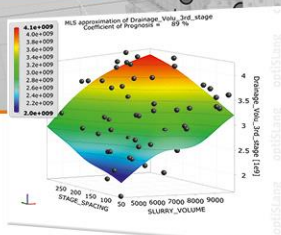
2

Automatic generation of a parametric 3D reservoir model of one or multiple wells



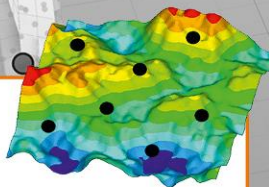
5

Forecast neighboring wells and verify prognosis quality of the simulator to ultimate recovery



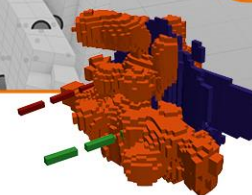
4

Scan of possible completion scenarios and their effect on accessible hydro carbon uplift



3

Reservoir model calibration to the best available measurements of hydraulic fracturing performance



DYNARDO HYDRAULIC FRACTURING SIMULATOR

**ANSYS PRE +
APDL PROGRAMMING**

- Parametric 3D modelling
- in-situ stress initialization
- in-situ pre pressure initialization

Input files of parametric
reservoir, well and completion

1

2

**ANSYS MECHANICAL +
APDL PROGRAMMING |
USER MAT | USER ELEMENT**

Parametric hydraulic fracturing simulation

Output files of stimulated
rock volume, drainage volume,
Estimated Ultimate Recovery (EUR)

3

**ANSYS POST +
DYNARDO POST PROCESSOR "TAMINO"**

Parametric postprocessing

DYNARDO OPTISLANG

**GENERATION OF THE METAMODEL OF OPTIMAL PROGNOSIS (MOP)**

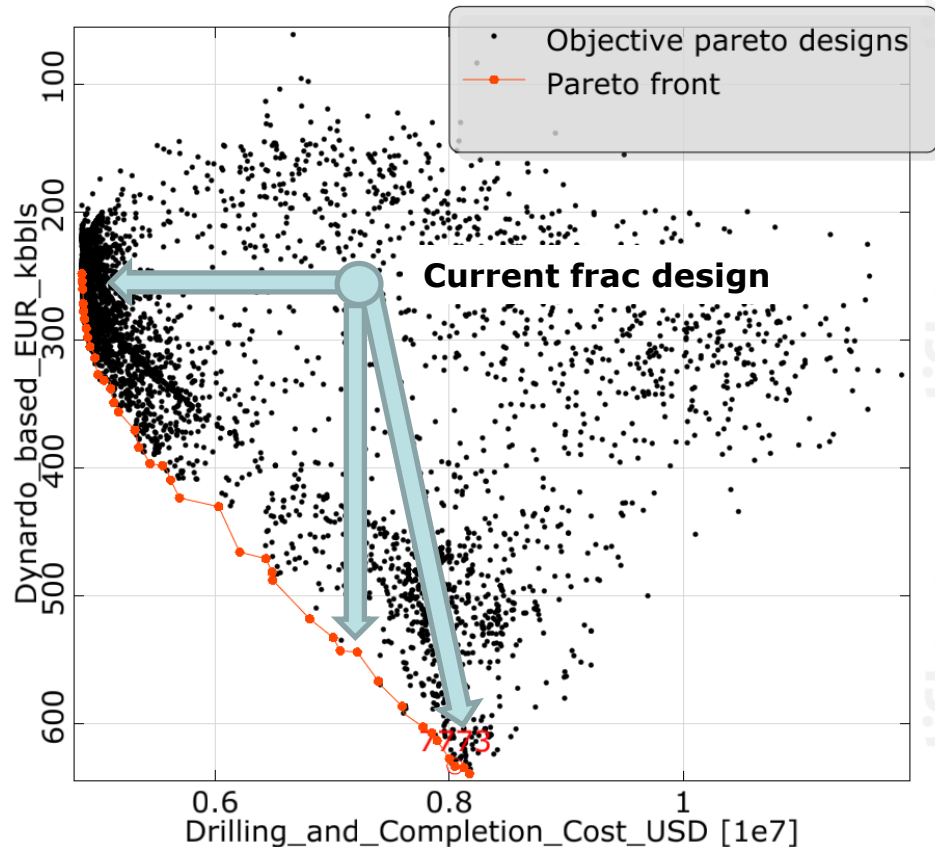
- Calibration of reservoir measurement
- Sensitivity analysis of operational parameter

OPTIMIZATION ESTIMATED ULTIMATE RECOVERY (EUR) / UNIT DEVELOPMENT COSTS (UDC)

Workflow over all relevant disciplines

We needed to include all relevant disciplines being able to convince the asset teams.

Objective Pareto Plot



By using cost function and Dynardo meta models (MOP) we can produce Pareto Frontier between conflicting goals Cost reduction and EUR optimization.

- optimal EUR, highest costs
- Reduce cost, stay with EUR
- Stay with cost, optimize EUR

Example hydraulic fracturing in Oil and Gas

- **Software**

- Classic approach: Deliver the software (ANSYS, Dynardo HF Extension, optiSLang) environment to the customer
 - But to establish the complex CAX workflow requires implementation time and team of experts

- **Consulting service** to establish the workflow

- Deliver calibrated, parametrized reservoir models including software environment to the customer to continue with variation studies
- Deliver MOP's to approximate variations windows of operational parameters and reservoir uncertainties and combine with cost functions in EXCEL

Use of MOP

- **Integrate cast model via EXCEL node and couple to production model MOP in optiSLang**

