

Vom Betriebspunkt zur kennfeldbasierten Dichtungsauslegung

WOST 2019

Dipl.-Ing. Rolf Johannes

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Introduction - EagleBurgmann at a glance

Revenue

789,4 million Euro

Leading market position

with experience in sealing technology
for more than

130 years

Strong backbone

a member of EKK/Freudenberg
since 2004



Balanced product portfolio



**Mechanical Seals
Seal Supply Systems**



Specialties



Expansion Joints

Production

worldwide



20 production sites

Manpower



5,550 employees

Worldwide presence

60 subsidiaries, 132 service centers
and 162 sales offices



in more than **60** countries

EagleBurgmann.

a member of EKK and FREUDENBERG

Introduction – Product range

Mechanical Seals

Mechanical seals
for pumps



Mechanical seals
for agitators



Mechanical seals
for compressors (DGS)



Specialties

Carbon floating
ring seals



Expansion Joints

Metall expansion joints



Magnetic couplings



Seal supply systems



Gaskets &
Stuffing box packings



Special products &
couplings



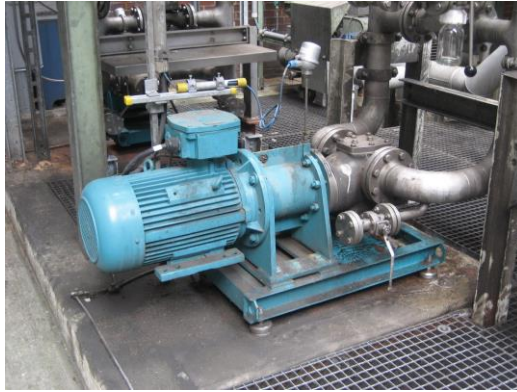
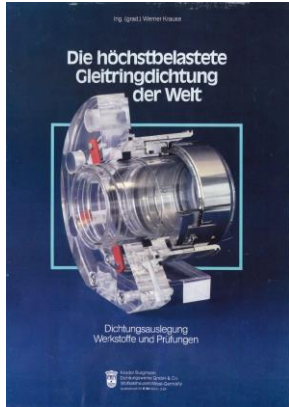
Fabric expansion
joints



TotalSealCare

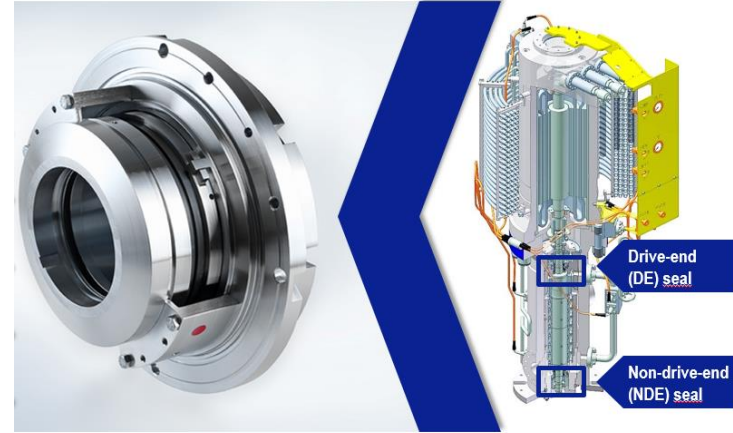
Motivation

30 Years ago:



- Water
- $v_g = 48 \text{ m/s}$
- $\Delta p = 100 \text{ bar}$
- $t_E = 55 \text{ }^\circ\text{C}$
- Cost of downtime: $\sim 10.000,-$

Today:

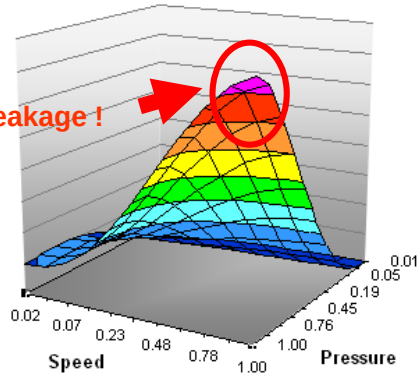


- Multiphase
- $v_g = 3 - 100 \text{ m/s}$
- $\Delta p = 10 - 250 \text{ bar (400 bara)}$
- $t_E = -20 - 250 \text{ }^\circ\text{C}$
- Cost of downtime: $\sim 1.500.000,-$

Seal simulation

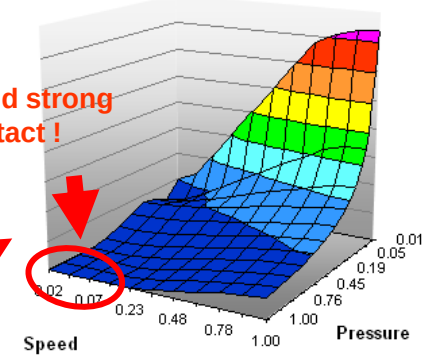
Leakage

minimize leakage !

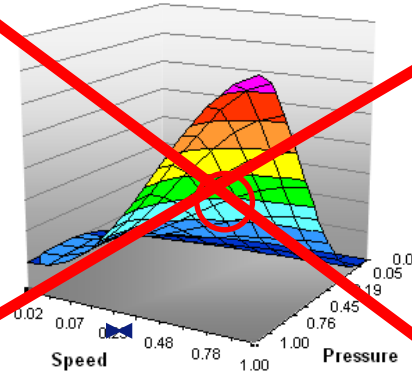


Gap

avoid strong contact !

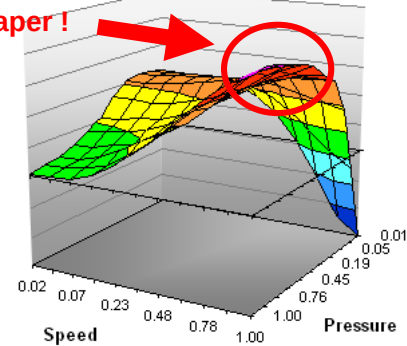


~~One operating point~~



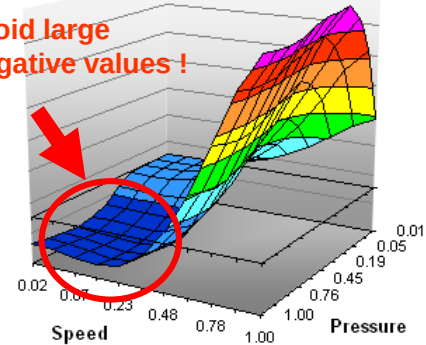
Deformation

minimize taper !



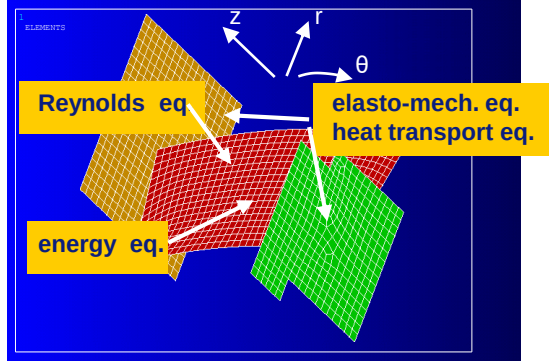
Stability criterion

avoid large negative values !



- 4 – 8 field parameters
- Different critical location
- Changing location depending on application

Seal simulation



2d coupled fluid-structure solver designed to calculate mechanical seals.

- 50 geometry parameters
- 8 discrete forces
- 4 boundary conditions
- 6 material properties
- 4 calibration parameters
- 8 dependent or correlating parameters
- **TOTAL: 85 Parameters**

- Typical execution time: Minutes!
- Unlimited parallel execution

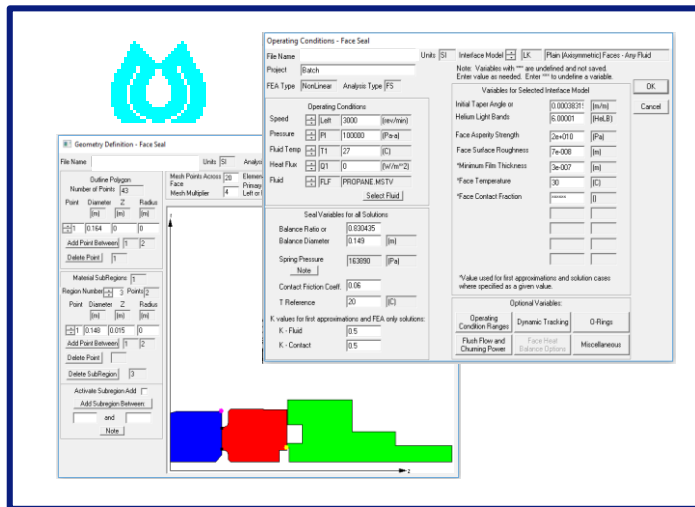
- Define dependencies and correlations
- Geometry tolerances according to drawings
- Get information from additional calculations
- Extract data from company standards
- Fall back to best practice and literature
- Document sources and values
- **Most time consuming part of the workflow**

Scalar based evaluation

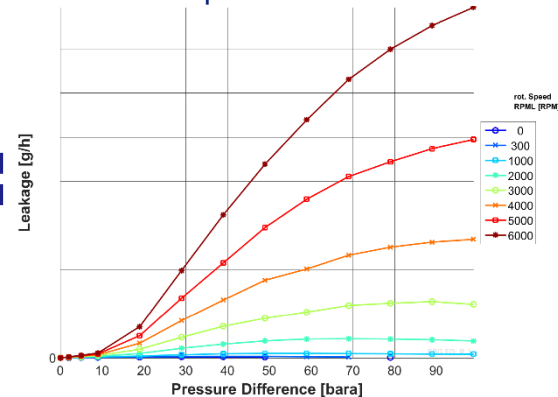
Nominal input for field

c_PO	c_PI	c_RPML	c_T1	c_T2
1.00E+05	1.00E+05	0	30	20
3.00E+05	1.00E+05	0	30	20
6.00E+05	1.00E+05	0	30	20
1.00E+06	1.00E+05	0	30	20
2.00E+06	1.00E+05	0	30	20
3.00E+06	1.00E+05	0	30	20
4.00E+06	1.00E+05	0	30	20
5.00E+06	1.00E+05	0	30	20
6.00E+06	1.00E+05	0	30	20
7.00E+06	1.00E+05	0	30	20
8.00E+06	1.00E+05	0	30	20
9.00E+06	1.00E+05	0	30	20
1.00E+07	1.00E+05	0	30	20
1.00E+05	1.00E+05	300	30	20
3.00E+05	1.00E+05	300	30	20
6.00E+05	1.00E+05	300	30	20
1.00E+06	1.00E+05	300	30	20
2.00E+06	1.00E+05	300	30	20
3.00E+06	1.00E+05	300	30	20
4.00E+06	1.00E+05	300	30	20
5.00E+06	1.00E+05	300	30	20
6.00E+06	1.00E+05	300	30	20
7.00E+06	1.00E+05	300	30	20
8.00E+06	1.00E+05	300	30	20
9.00E+06	1.00E+05	300	30	20

Simulation framework



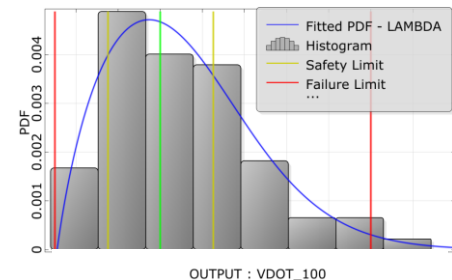
Nominal performance for field



==

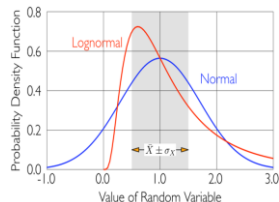
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OptiSlang Postprocessing
Varying performance for single OP



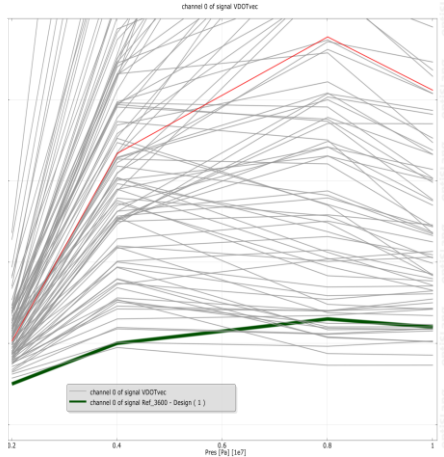
optiSlang optiSlang

Varying input for single OP

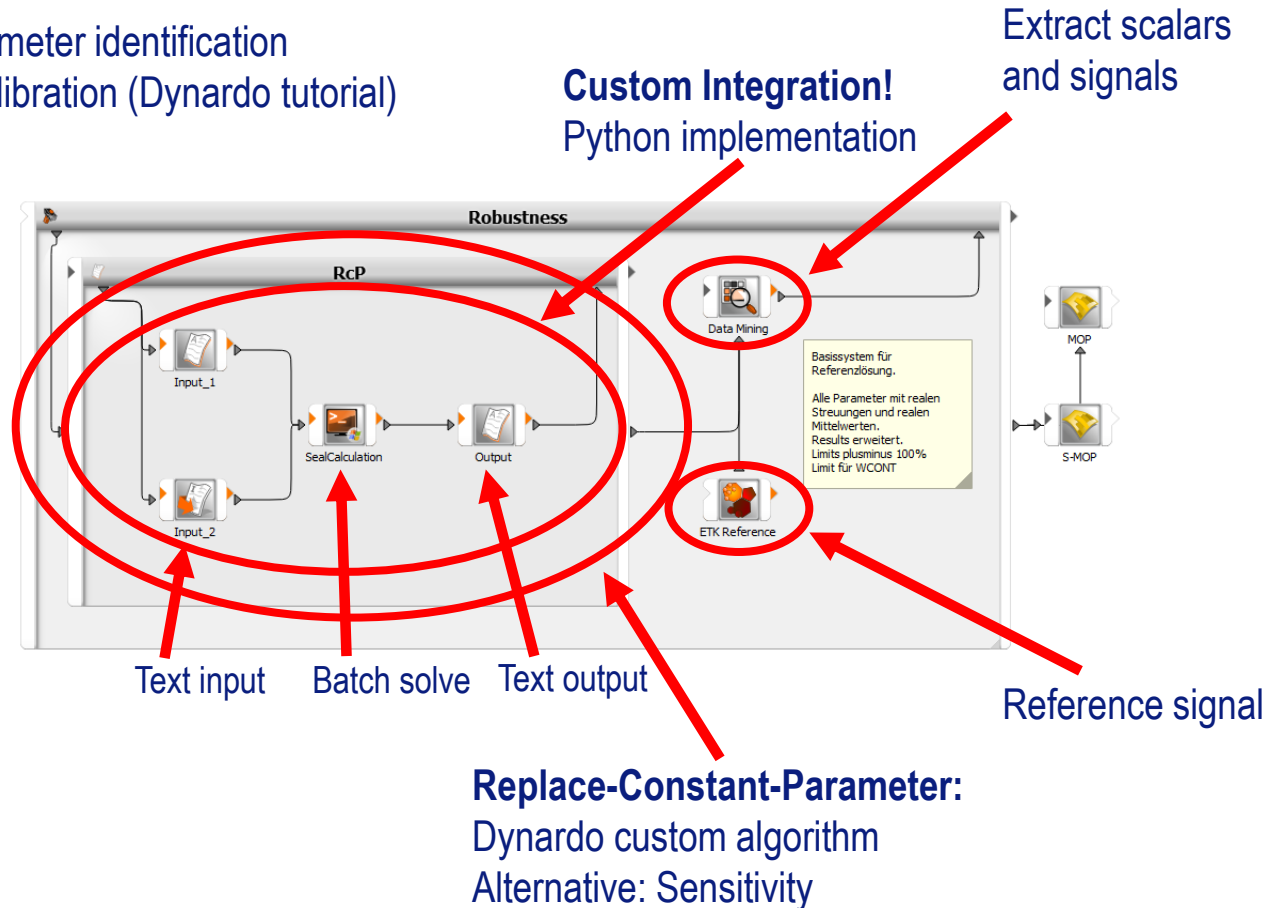


Signal based evaluation

- Limits of current approach: Parameter identification
- Solution: Signal processing – calibration (Dynardo tutorial)
 - Use one signal for fit
 - Use other signal for validation

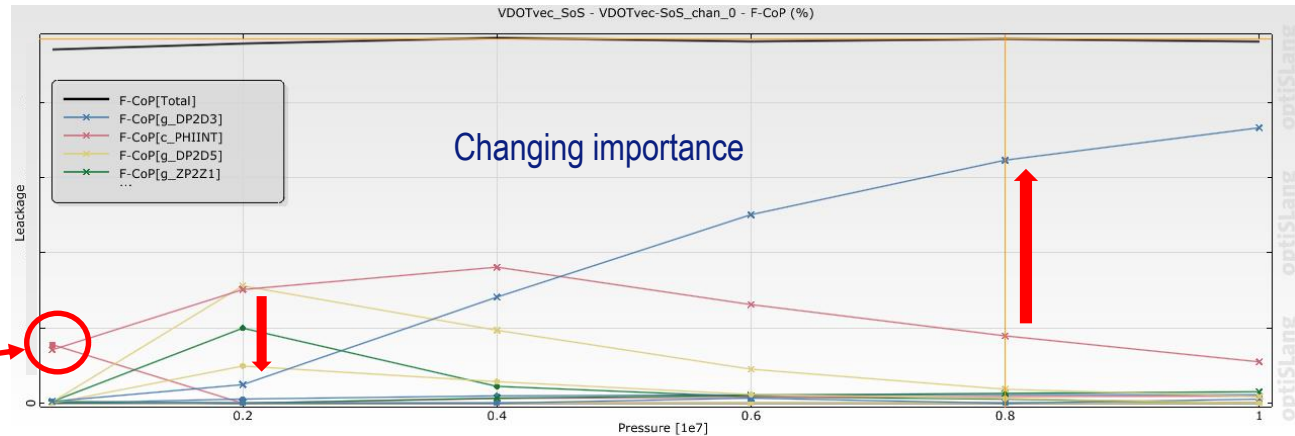
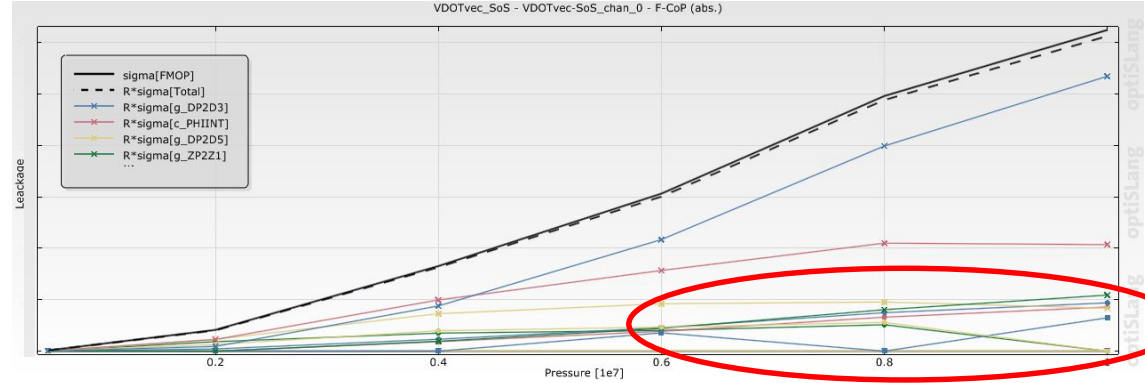
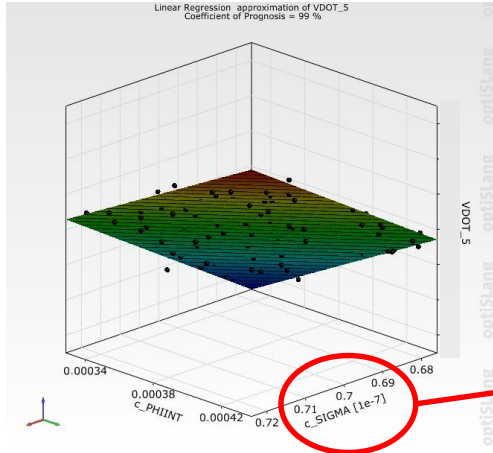
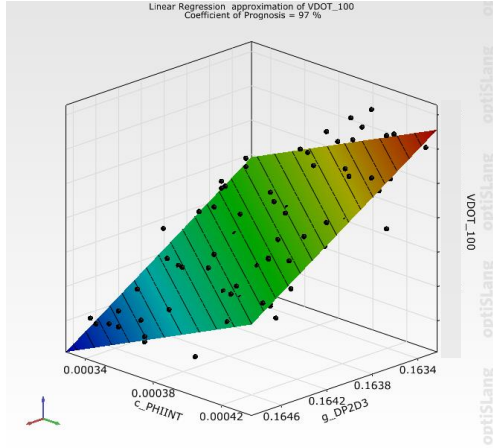


Very successful!

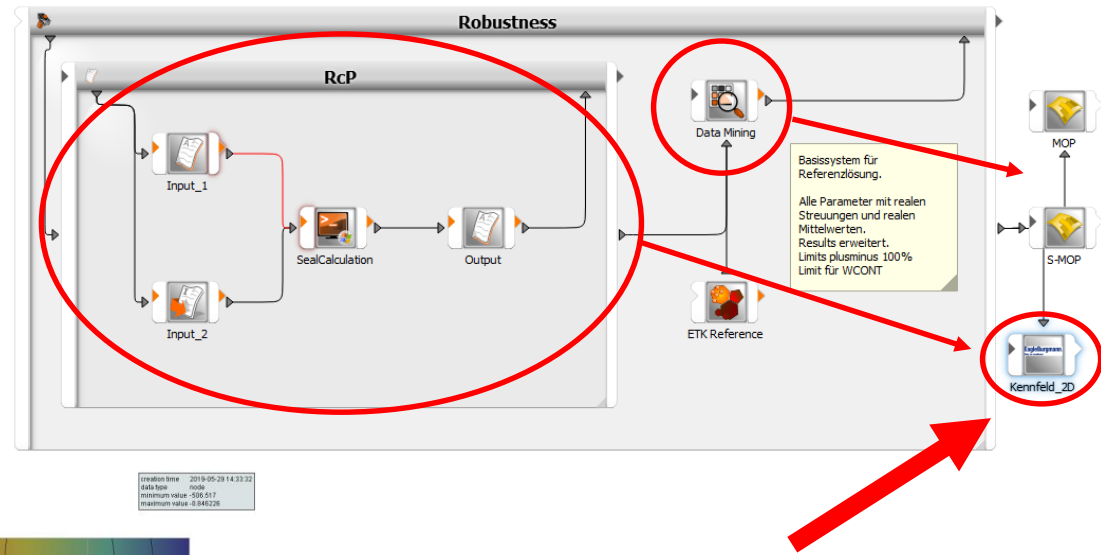
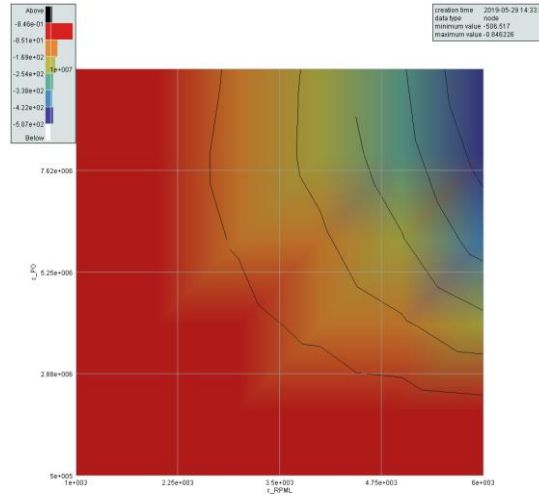
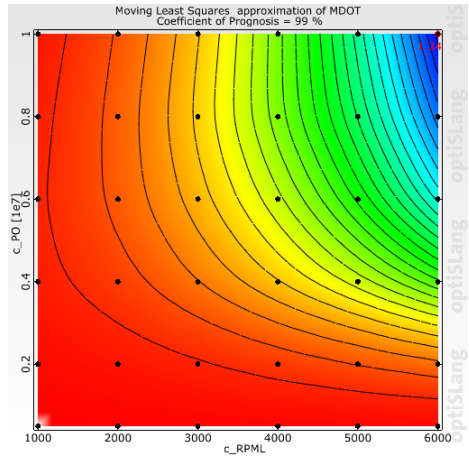
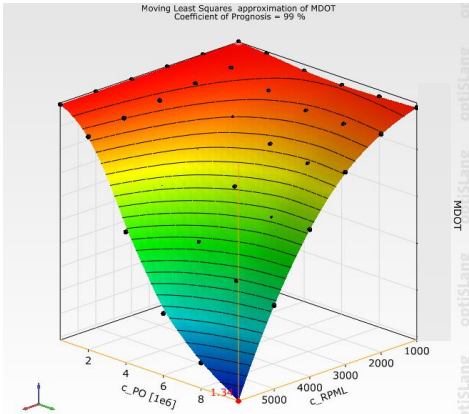


Signal based evaluation

- „Performance at a glance“
- Identify anomalies and localized effects



Field based evaluation

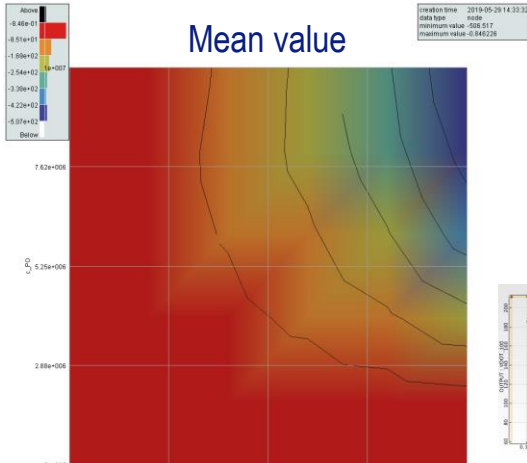


Custom node provided by Dynardo AT

- Extend existing system (36 – 110 designs)
- FMOP based on designs (Alternative: MOP, AMOP)
- Evaluate signals and fields from single run

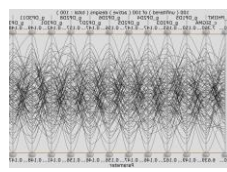
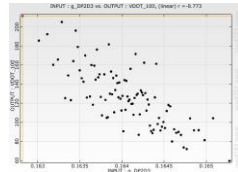
Field based evaluation

Mean value



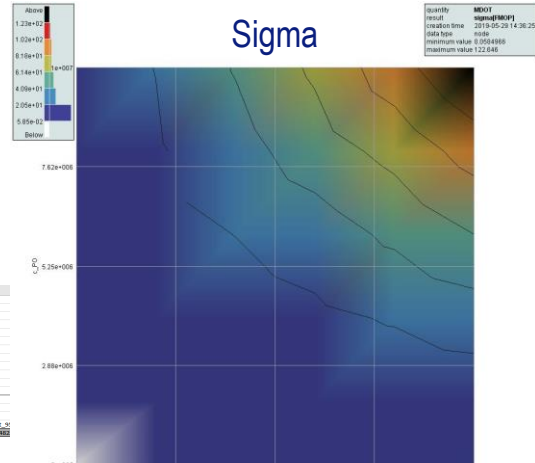
SoS Post processing

- „Plausibility at a glance“
- Absolute vs. relative importance
- Exact values are difficult to extract
- ➔ Export data back to OptiSlang

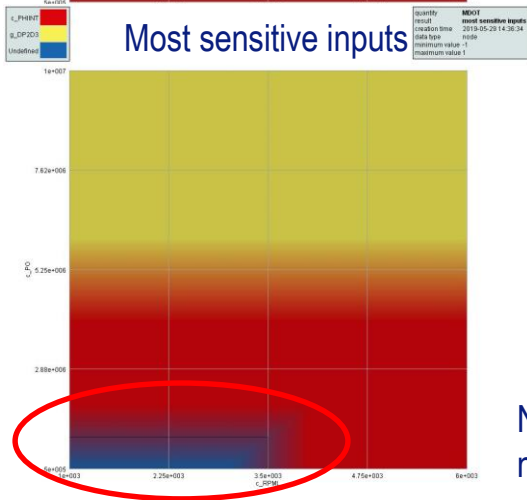


	A	B	C	D	E
1	OptiSlang MOP solver version 7.3.2				
2	Meta model database was imported from:				
3	Interpolated				
4					
5		Speed	Pressure	Full model	
6	MDOT_Var	50.00%	100.00%	100.00%	100.00%
7	MDOT_Eigen	50.00%	100.00%	100.00%	100.00%
8	MDOT_Aeros	50.00%	100.00%	100.00%	100.00%
9	MDOT_Mat	50.00%	100.00%	100.00%	100.00%
10	MDOT_Max	50.00%	100.00%	100.00%	100.00%
11	MDOT_Quant_55	50.00%	100.00%	100.00%	100.00%
12	MDOT_Quant_5	50.00%	100.00%	100.00%	100.00%
13					
14					
15	Lower Bound	1000	300000	Responses	
16	Upper Bound	6000	3000000		
17	Co	Speed	Pressure	MDOT_Quant_5	MDOT_Quant_55
18		6000	1.00E+07	255.7229983	255.7229983

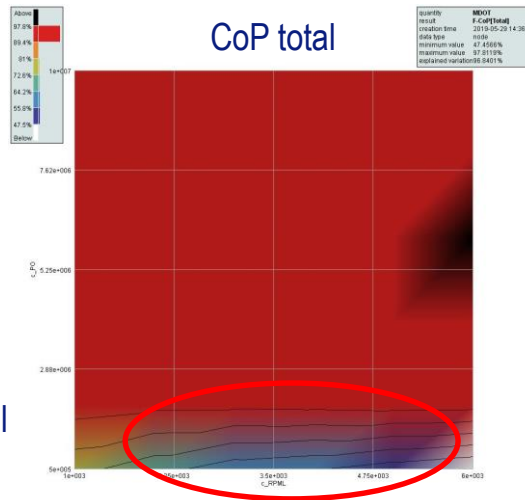
Sigma



Most sensitive inputs

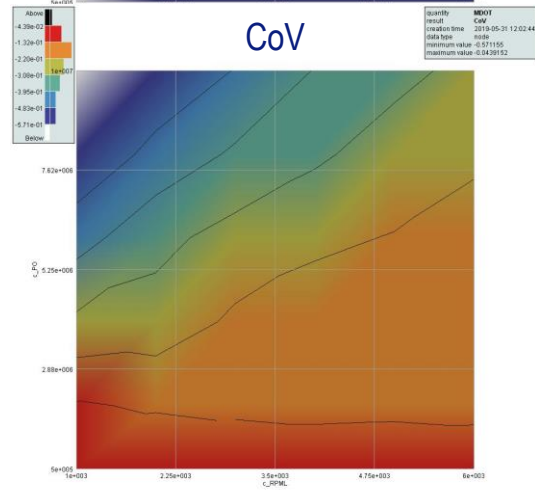


CoP total



Numerical noise

CoV



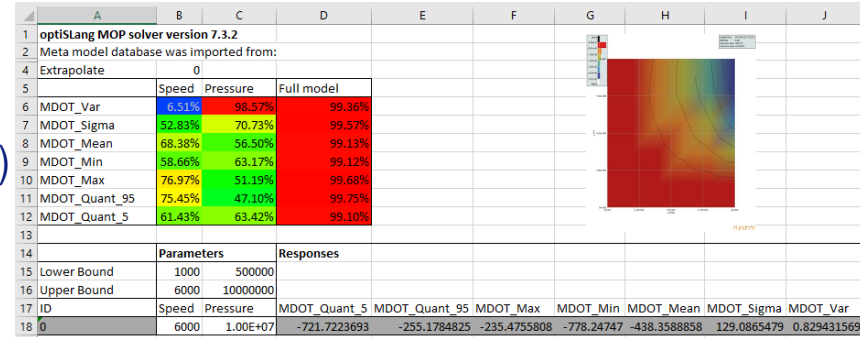
Results and outlook

Results:

- Distribute information within the company (EXCEL-Add-In)
- Quantify overall robustness
- Quantify safe operation envelope
- Deeper insight
-> simplify future problems (optimization)
- Identify impossible challenges
- Better visualization

Outlook:

- Distribute information:
Use MOP-DLL as container
- Improve efficiency:
Data transfer
Speed of calculation (CI, parallelism)
- Simplify workflows and systems

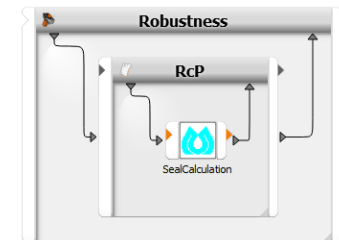


dynardo

optiSlang®



Sun Microsystems Solaris computer cluster, CC BY 2.0



Summary

- Complex customer requirements can be met
 - Some answers can not be provided on scalar basis but on signal level
 - From signal to field it is just a small step
 - Field data provides great overview
 - Export to OptiSlang leverages full potential
-
- Greater insight during the design process
 - Easy distribution and visualization of statistical information
 - Better product and customer satisfaction

**Thank you
for your attention!
Questions?**

EagleBurgmann Germany GmbH & Co. KG

Aeussere Sauerlacher Str. 6-10
82515 Wolfratshausen, Germany
info@eagleburgmann.com
eagleburgmann.com



Learn more
about EagleBurgmann