WOST2018

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COST & FUNCTION OPTIMIZATION

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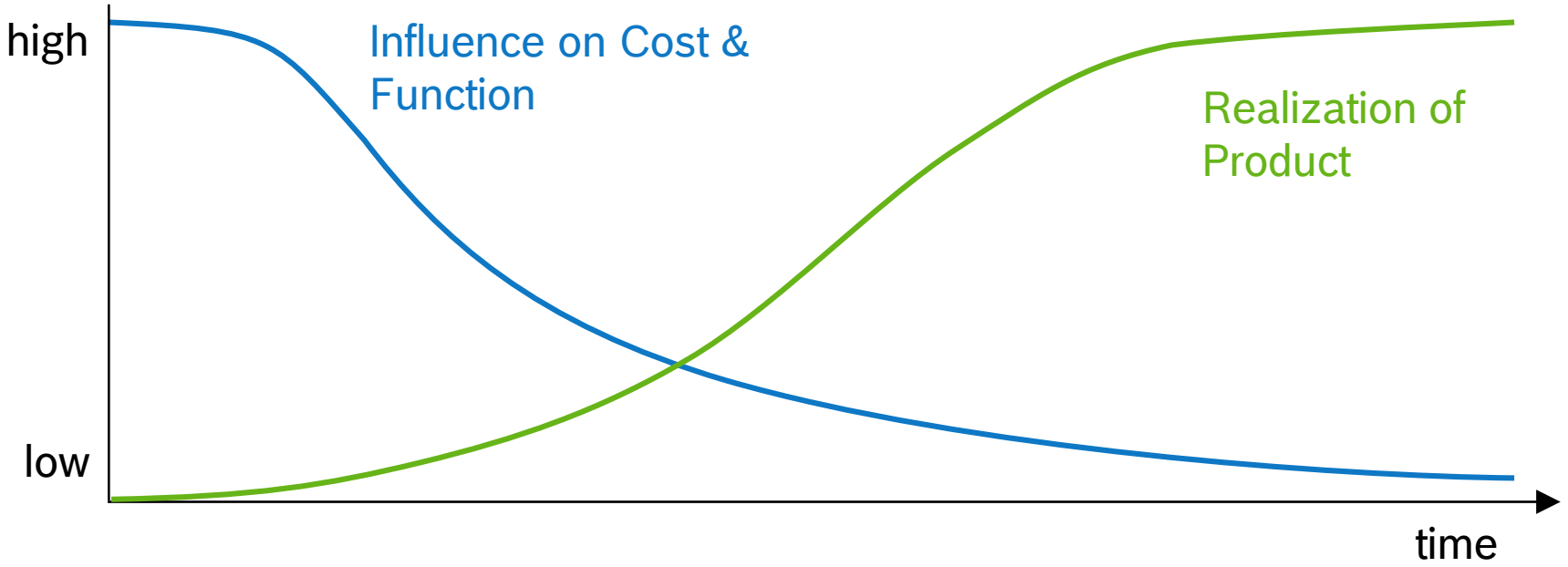
BOSCH

Agenda

1. Dilemma of the Product Development
2. Innovation Hypothesis
3. Linear Force Solenoid for Automated Transmissions
4. Requirements to Set Up a Cost and Function Optimization
5. Workflow
6. Topology Variation – Details and First Evaluation
7. Tolerance Variation – Details and First Evaluation
8. Conclusion

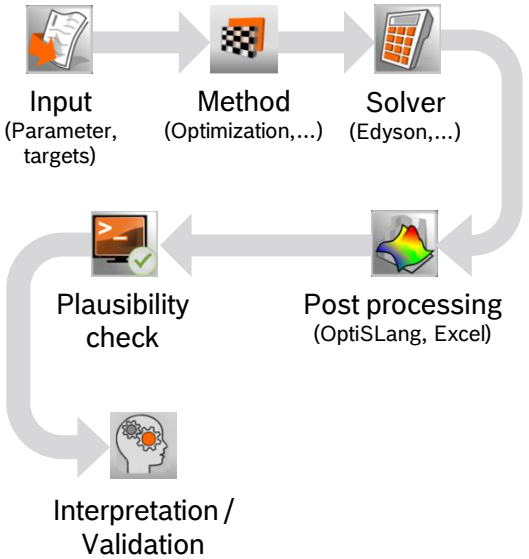
Cost & Function Optimization
Dilemma of the Product Development



Cost and Function Optimization
Innovation Hypothesis

State of the Art – Functional Optimization

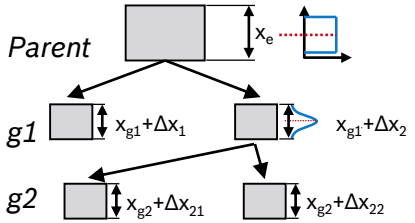
Workflow



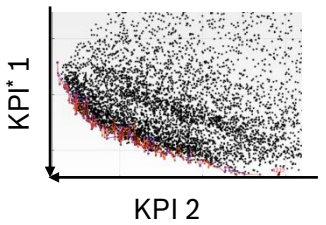
Evolutionary Algorithm

An evolutionary development process creates a pareto front of the best designs

Variation of design parameters with evolutionary algorithm

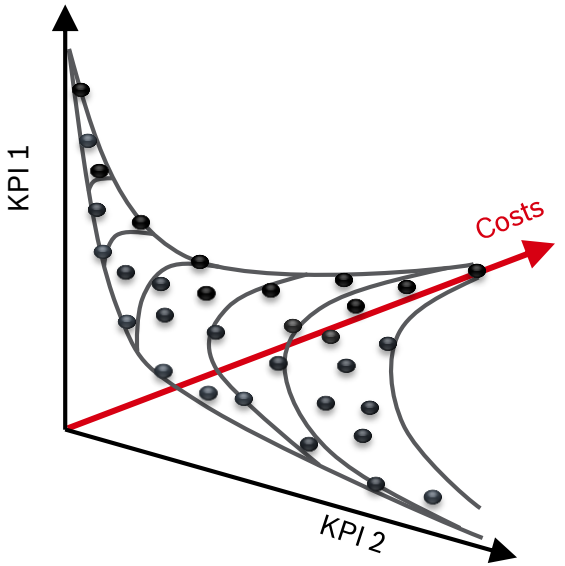


Result: Optimized technical behavior based on simulation



Cost & Functional Optimization

Cost function extends parameter search room (third axis).



* KPI: key performance indicator

Enhance function optimization with cost optimization to develop in shorter time competitive products.

Cost and Function Optimization
Linear Force Solenoid (LFS) for Automated Transmissions

Product Description

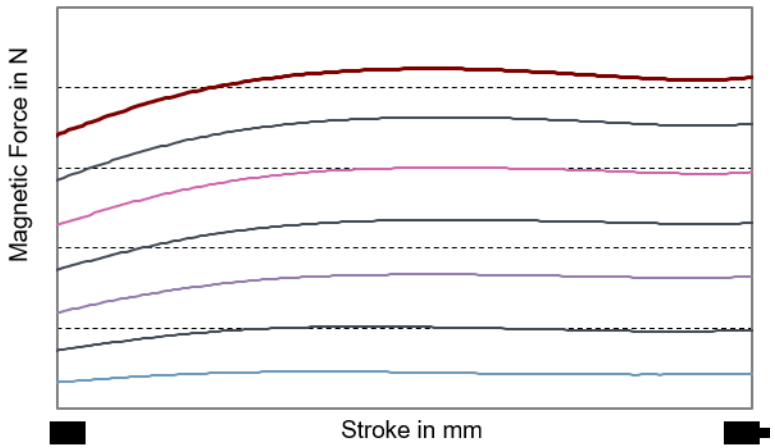
- LFS for transmissions with direct shift control

Customer Benefits

- High accuracy, low hysteresis
- Curve of magnetic force adaptable
- Variability of the connectors

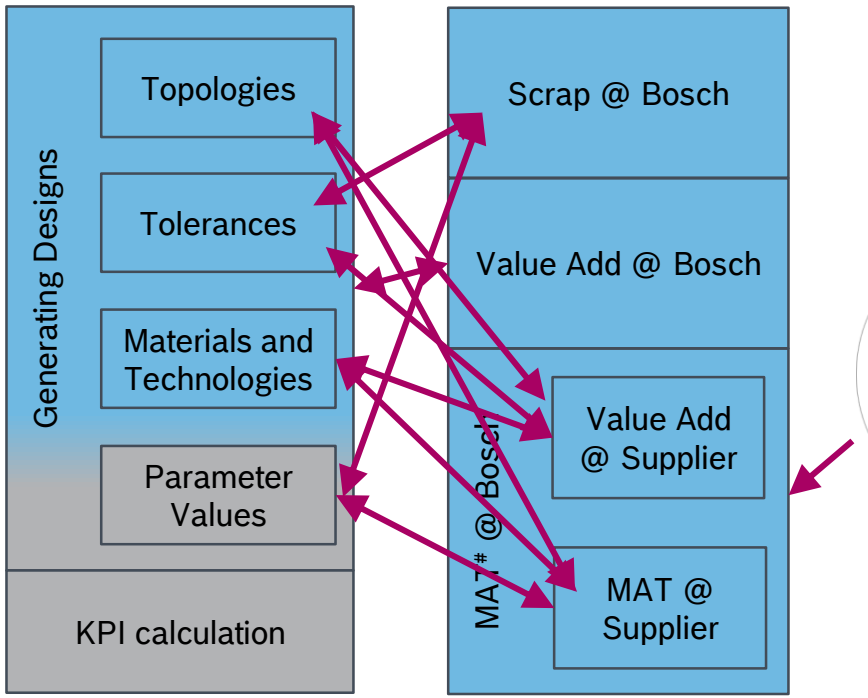
Specification

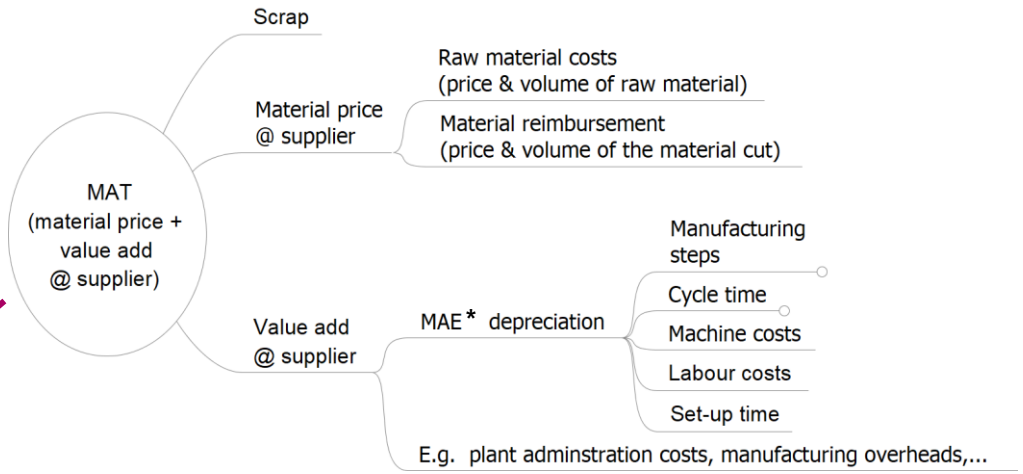
- Current range: 1.2 A
- Range of resistance: 1.5 – 6.3 Ω
- Diameter: 28.4 and 32.5 mm
- Lenght: 33 and 40 mm
- Stroke range: 2.2 – 3.5 mm
- Force Level: up to 25 N



Cost and Function Optimization

Requirements to Set Up a Cost and Function Optimization

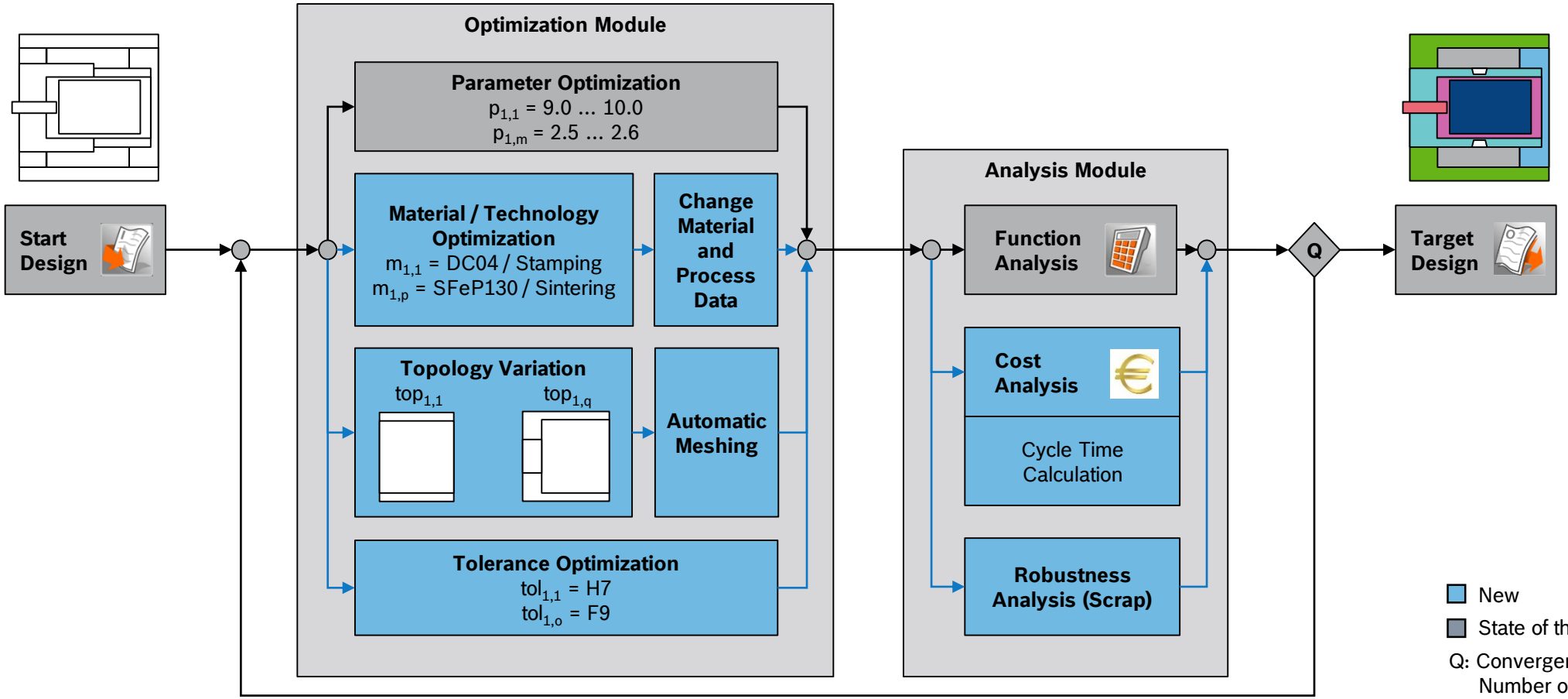




#) MAT: direct material costs
*) MAE: machinery and equipment

New State of the art

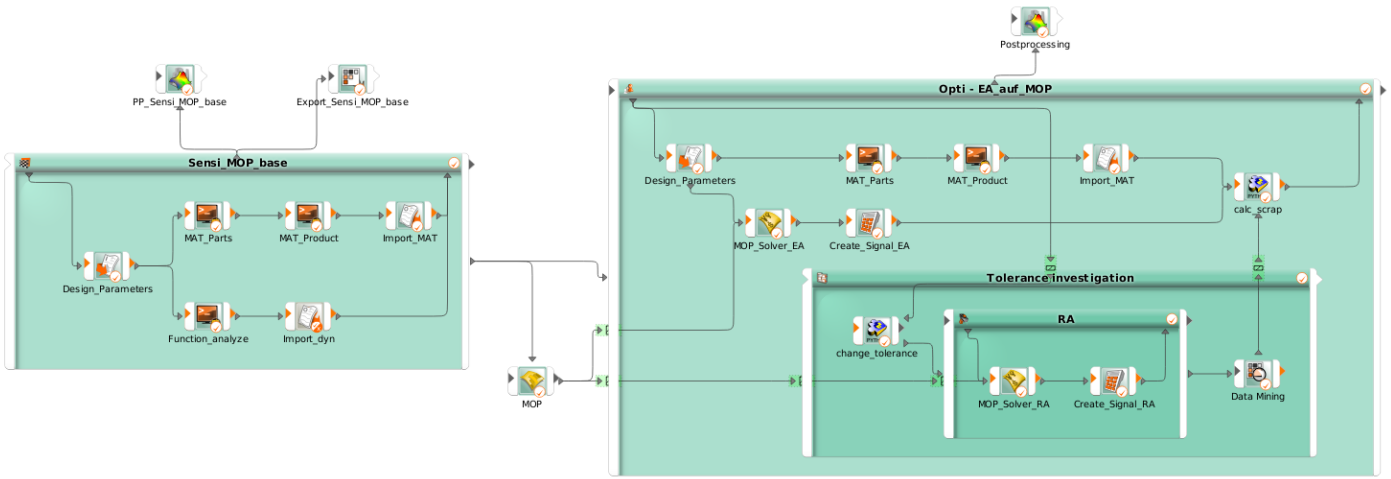
Cost and Function Optimization
Workflow



Cost and Function Optimization
Workflow realized in optiSLang

Realized workflow of the cost and function optimization includes

- Sensitivity analyse (4000 designs)
- Metamodel of optimal prognosis
- Evolutionary algorithm
- Integrated robust design analysis
- Duration of simulation ~38 h
- 99 variables
- 3 objectives and 9 constraints

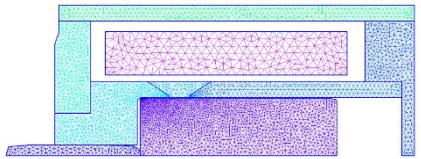


Cost and Function Optimization
Topology Variation - Workflow

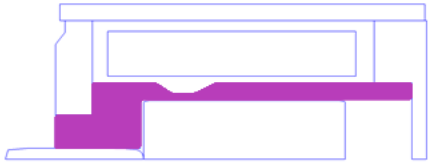
Description of components → optiSLang creates design variants based on predefined topologies → Automatic geometry update → Automatic mesh update → Automatic start of simulation

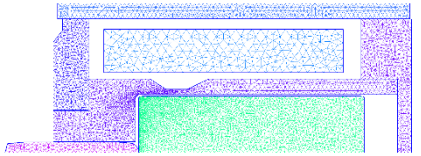
Points
$p_{1.1}=(x_{1.1},y_{1.1})$
$p_{1.2}=(x_{1.2},y_{1.2})$
...
Lines
$l_{1.1}=(p_{1.1},p_{1.2})$
...
Areas
$a_1 = (l_{1.1},l_{1.2}...)$

Topology 1
part 1.1
part 1.2
part 1.3

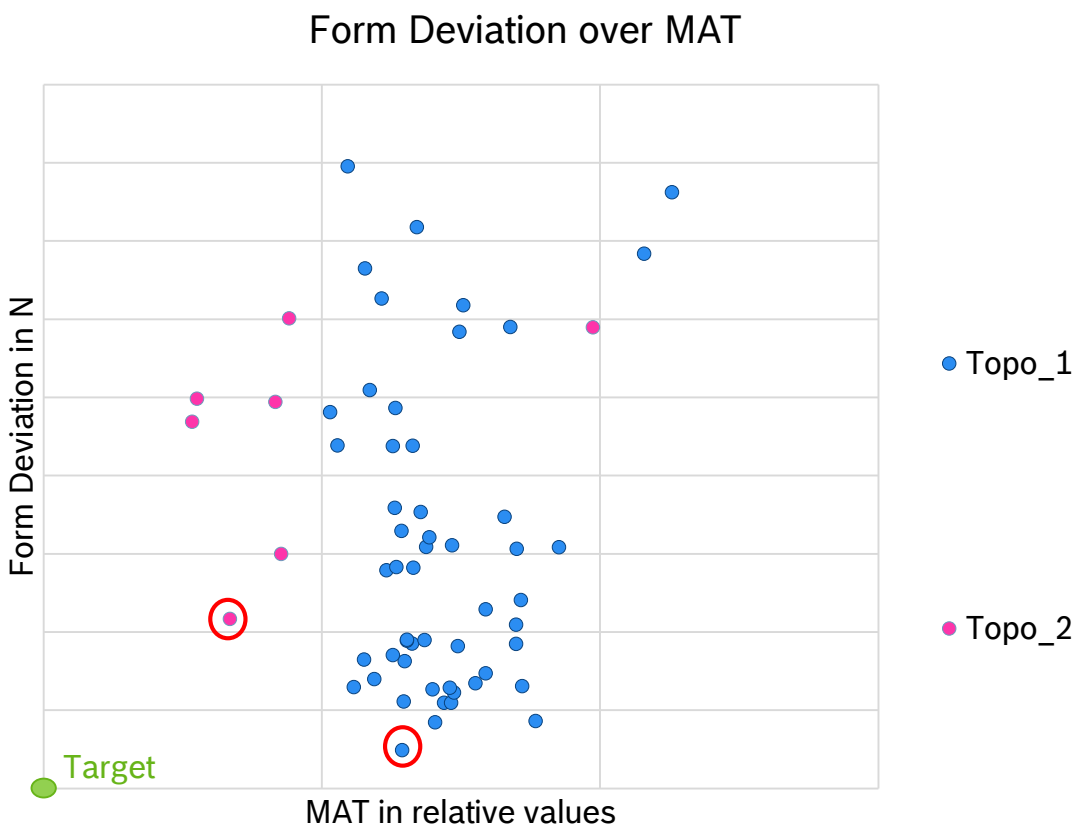


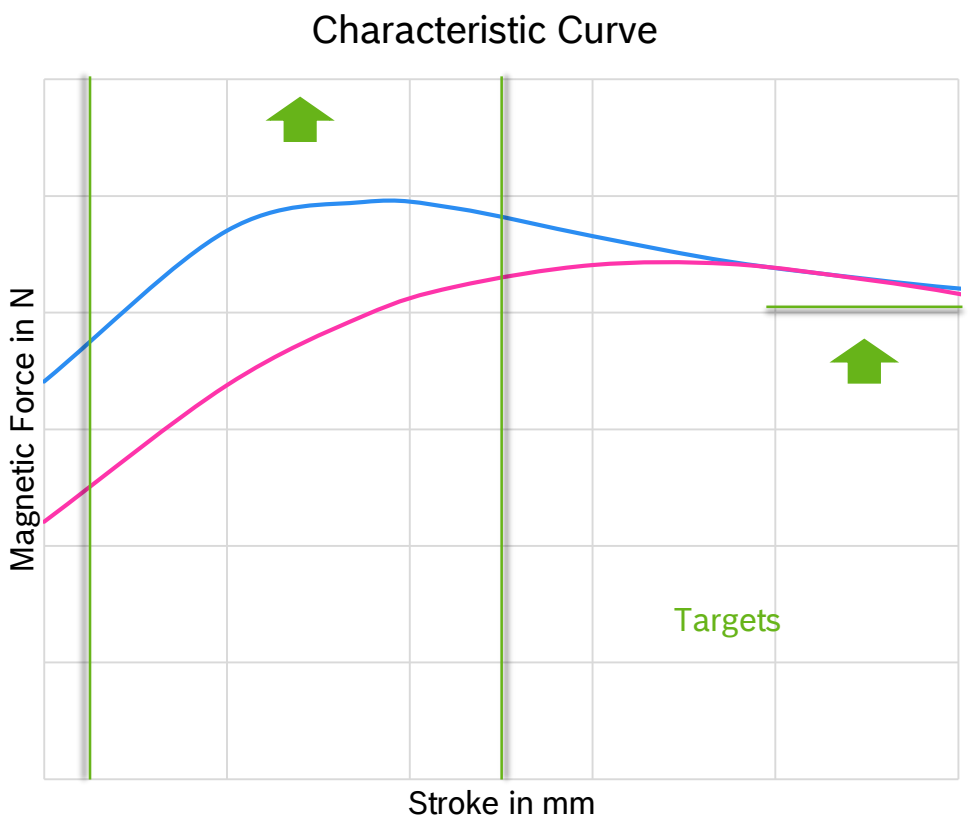
Topology 2
part 1.4





Cost and Function Optimization
Topology Variation – First Evaluation



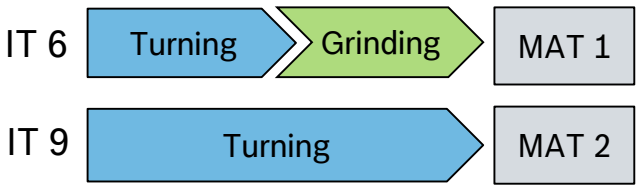


Cost and Function Optimization
Tolerance Optimization – Details

MAT – Calculation

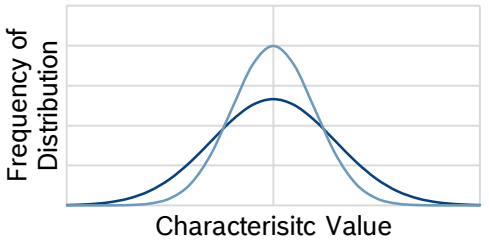
1. Create new designs with different dimensions and tolerance classes

2. Automatic manufacturing steps selection based on given dimension and tolerance class



Robustness Analysis

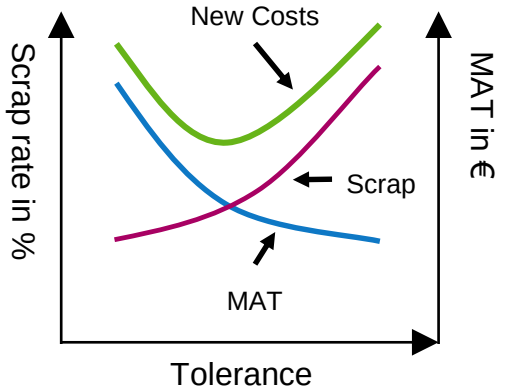
3. Automatic adjustment of individual dimension range based on given tolerance class



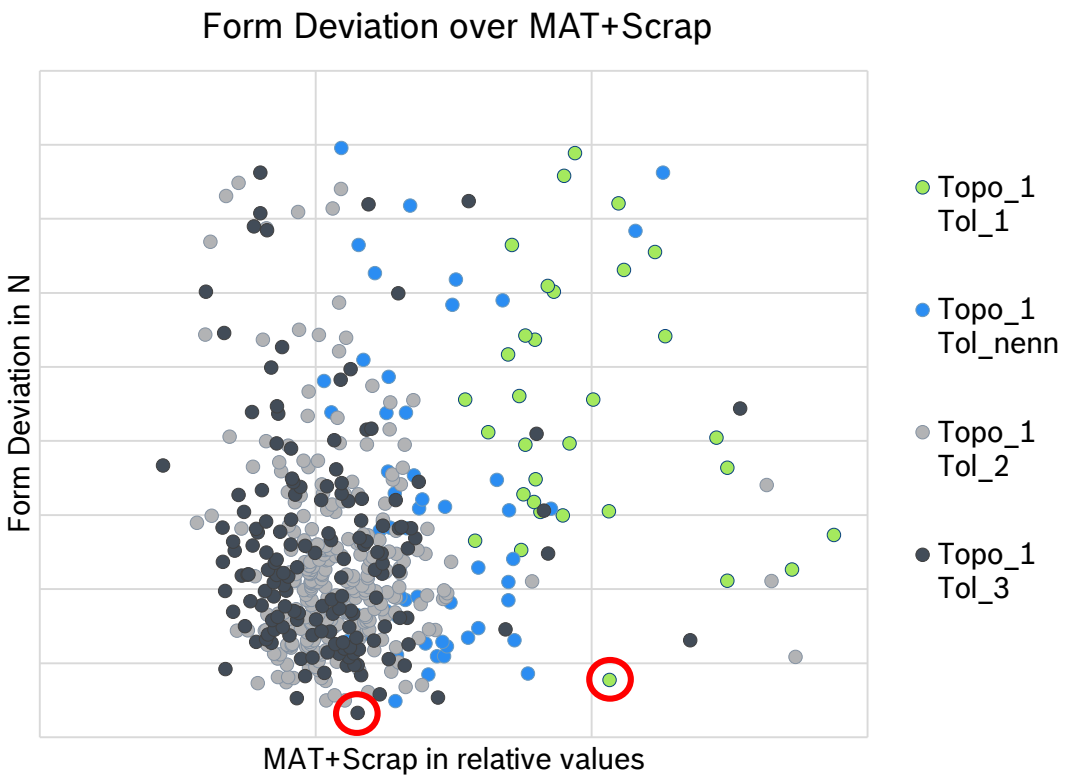
4. Run robust design analysis for each design

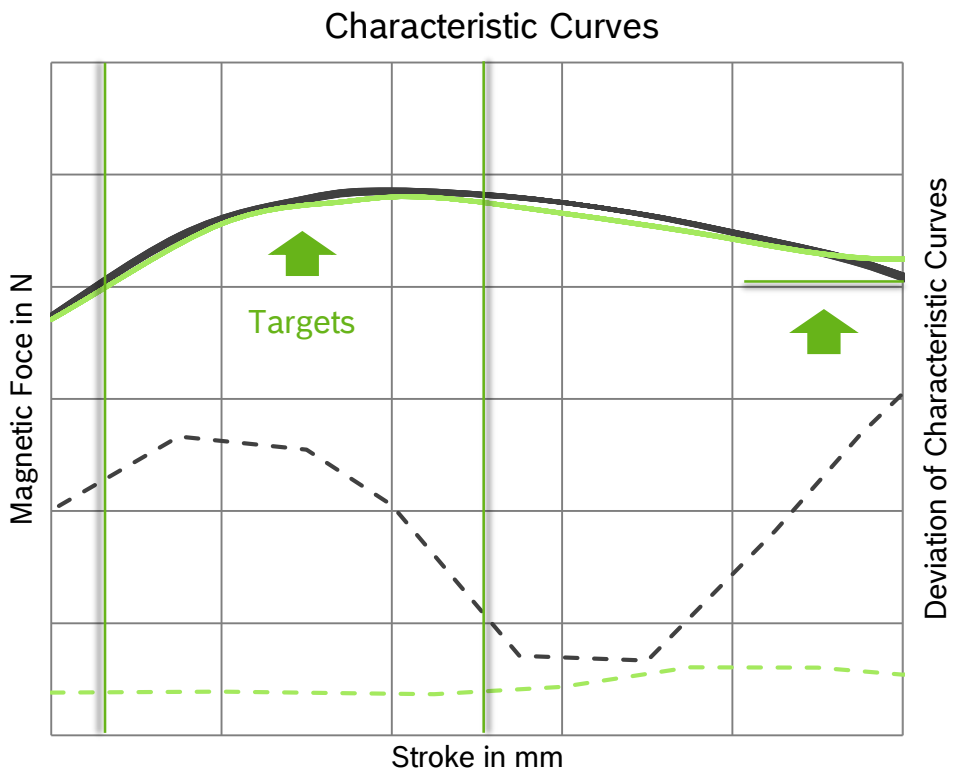
Component Cost

5. Calculate new component costs based on scrap cost and MAT cost



Cost and Function Optimization
Tolerance Optimization – First Evaluation

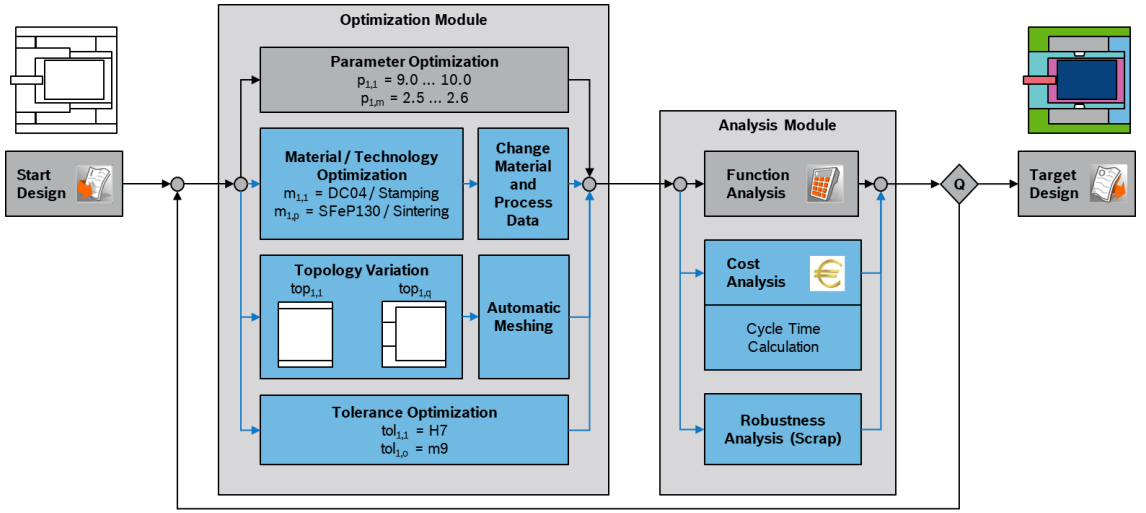




Influences on Costs of different Tolerances up to 12 %

Cost and Function Optimization
Conclusion

- Procedure indicates optimal designs regarding function and cost
  - Which fulfil requirements
  - Save money
- Relationships between function, design features and costs are transparent
- Useful in concept phase to compare different designs
- Individual adaptable
  - Manufacturing processes
  - Products (proportional magnet, e-machine,…)



THANK YOU

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