



Vorstellung von LS-OPT[®] Version 5 und Schnittstelle zu ANSA/ μ ETA

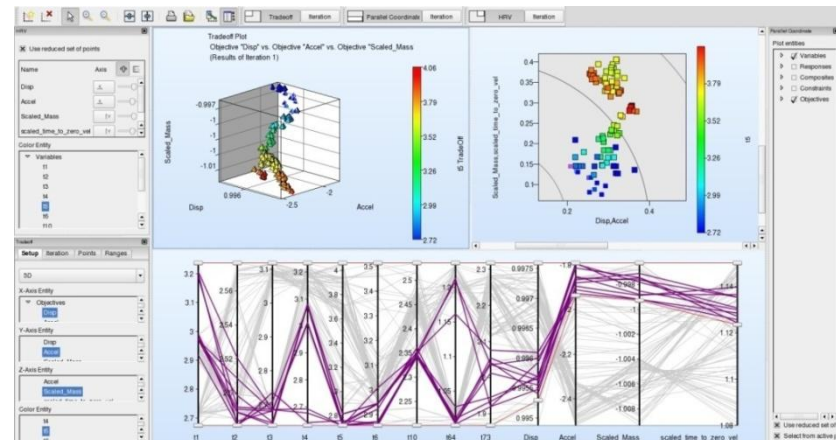
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Outline

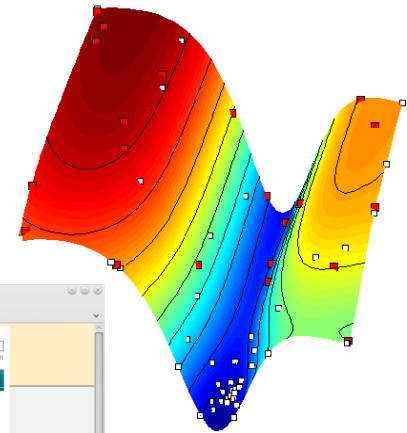
- Overview of methodologies and applications of LS-OPT
- Example: Shape optimization with ANSA, LS-OPT and μ ETA
 - Problem description
 - Interface to ANSA
 - Interface to μ ETA Post
- Visualization of optimization results



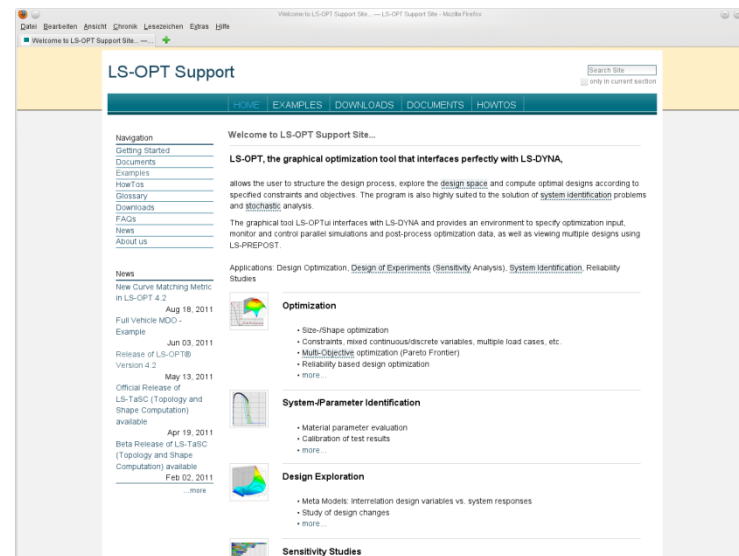
Introduction

➔ About LS-OPT

- Two main products LS-OPT and LS-TaSC (Topology and Shape Computation)
- LS-OPT can be **linked to any simulation code** – stand alone optimization software, but perfect suitable with LS-DYNA
 - Interface to LS-DYNA and MSC-Nastran
 - User-defined Interface
- Current production version is LS-OPT 5.0
- LS-OPT Support web page
-> www.lsoptsupport.com



- *Download of Executables*
- *Tutorials*
- *HowTos / FAQs*
- *Documents*
-



Introduction

➔ About LS-OPT – General Aspects

■ Job Distribution - Interface to Queuing Systems

- *PBS, LSF, LoadLeveler, SLURM, AQS, User-defined, etc.*

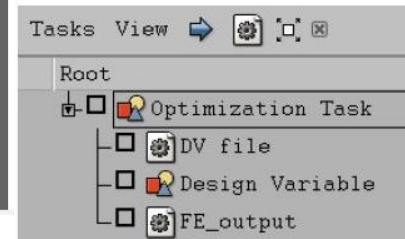
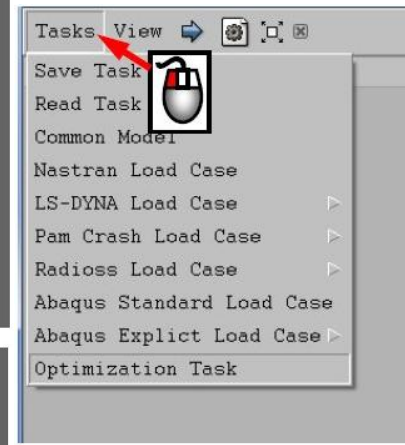
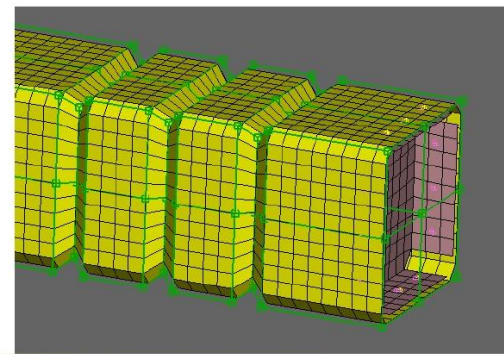
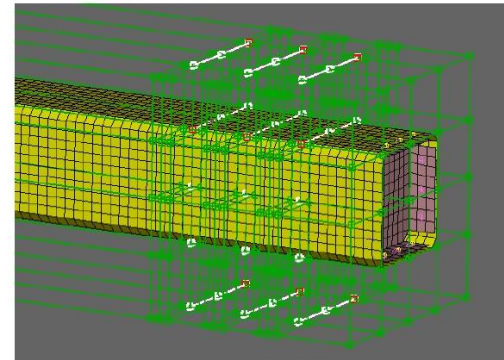
■ LS-OPT might be used as a “Process Manager”

■ Shape Optimization

- *Interface to LS-PrePost, ANSA, HyperMorph*
- *User-defined interface*

■ META Post interface

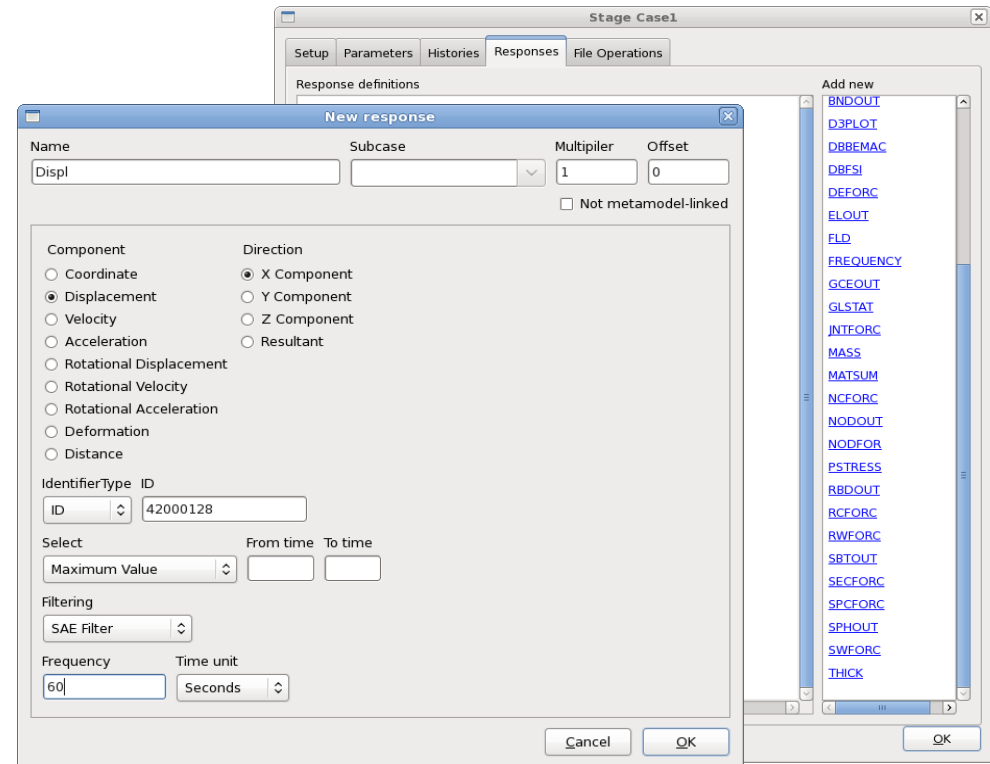
- *Allows extraction of results from any package (Abaqus, NASTRAN, ...) supported by META Post (ANSA package)*



➔ About LS-OPT

■ LS-DYNA Integration

- *Checking of LS-DYNA keyword files (*DATABASE_)*
- *Importation of design parameters from LS-DYNA keyword files (*PARAMETER)*
- *Support of include files (*INCLUDE)*
- *Monitoring of LS-DYNA progress*
- *Result extraction of most LS-DYNA response types*
- *D3plot compression (node and part selection)*



LS-OPT – Overview Methodologies

■ Response Surface Method (RSM)

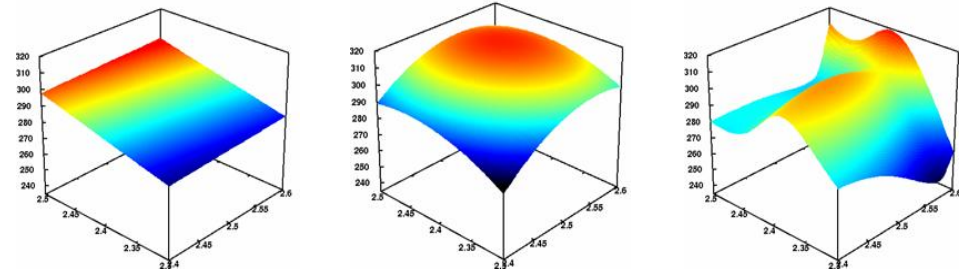
■ *Sequential Response Surface Method (SRSM)*

→ Metamodels

■ *Polynomials*

■ *Radial Basis Functions*

■ *Feedforward Neural Networks ...*



■ Genetic Algorithm (MOGA->NSGA-II)

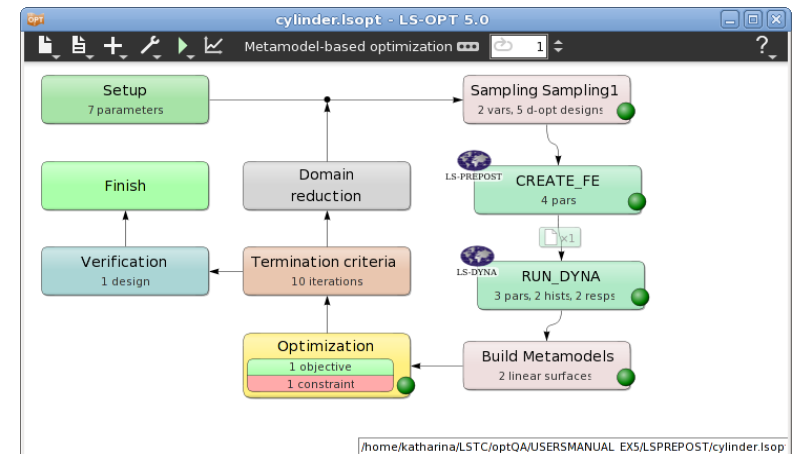
■ *Direct*

■ Metamodel-based

■ Monte Carlo Analysis

■ *Direct*

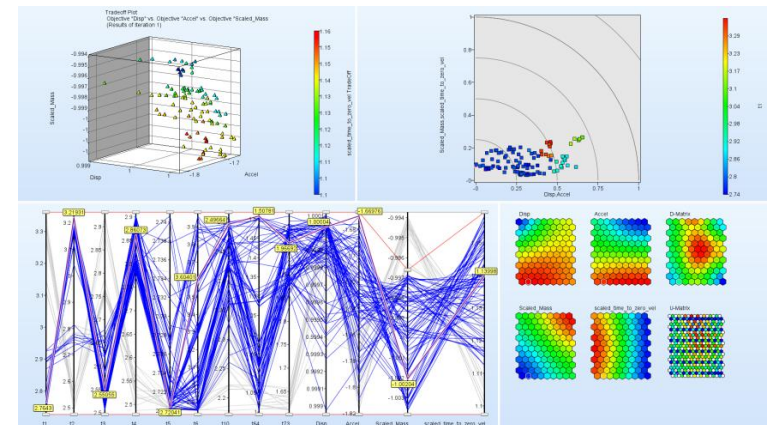
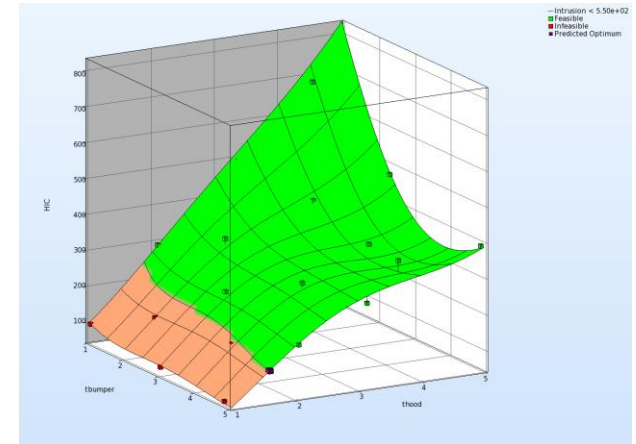
■ Metamodel-based



Applications of LS-OPT

■ Optimization

- *Size-/Shape optimization*
- *Constraints*
- *Mixed continuous/discrete variables*
 - *Specify sets of discrete variables (e.g sheet thicknesses)*
- *Multiple load cases*
 - *Multi-disciplinary Optimization (MDO)*
- *Multi-objective optimization (Pareto Frontier)*
- *Reliability based design optimization*
- *Methodologies*
 - *Meta-model based approaches*
 - *Genetic Algorithms (MOGA->NSGA-II)*



Applications of LS-OPT

■ Parameter/System Identification

- Calibration of test and simulation curves or scalar values
- Visualization of test and simulation curve for comparison

$$\frac{1}{P} \sum_{p=1}^P W_i \left(\frac{F_i(\mathbf{x}) - G_i}{s_i} \right)^2$$



History matching composite

Name:

Algorithm:

Mean Square Error (difference in curve Y values)

Curve Mapping (size of area between curves)

Target curve: add new file history

Computed curve:

Regression points

From target curve

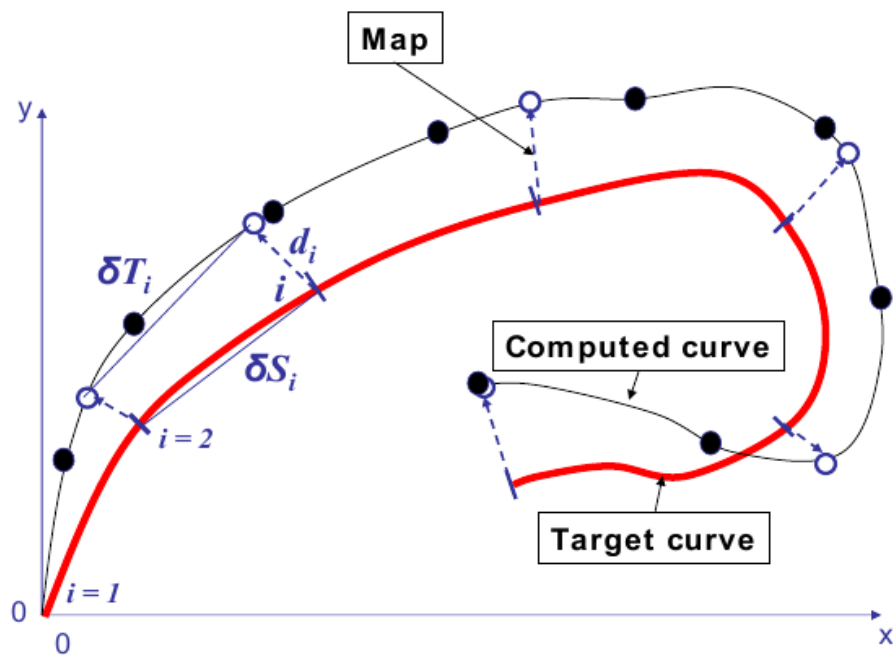
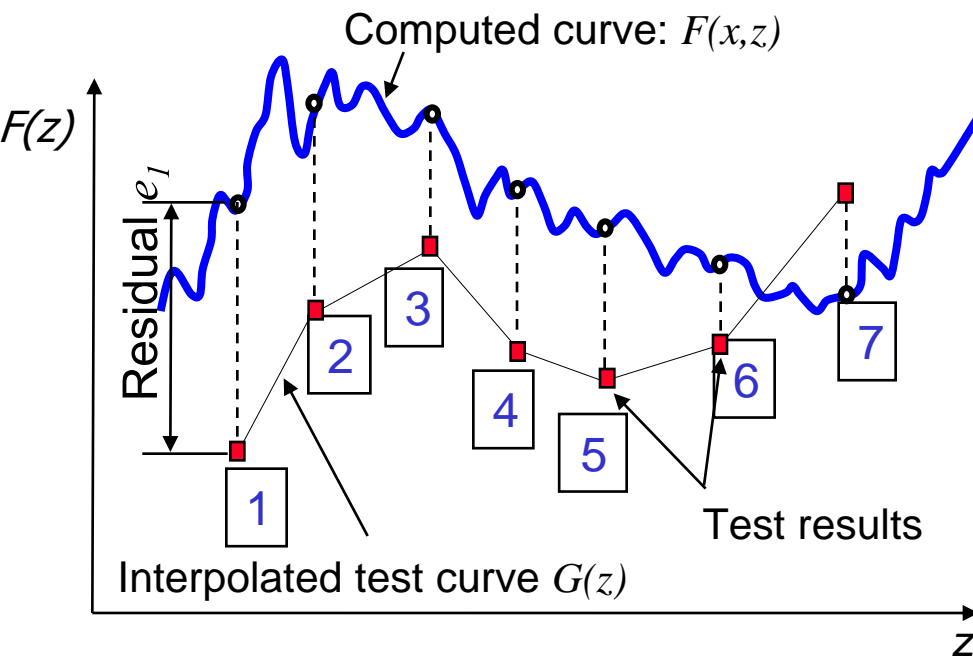
Fixed number (equidistant, interpolated)

You can [convert this composite to an expression](#) for further fine-tuning.

OK

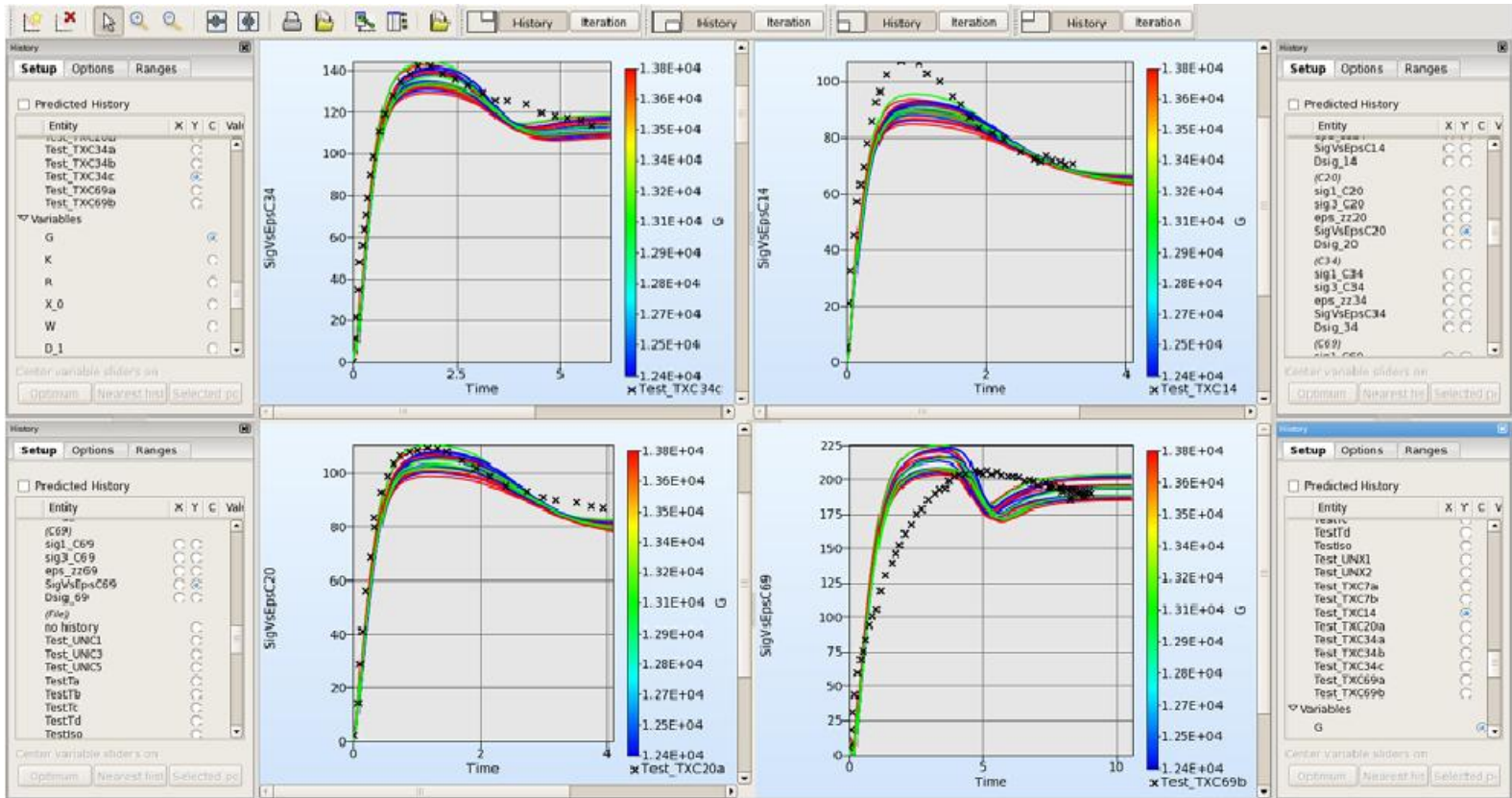
Applications of LS-OPT

Parameter Identification with Test Curves



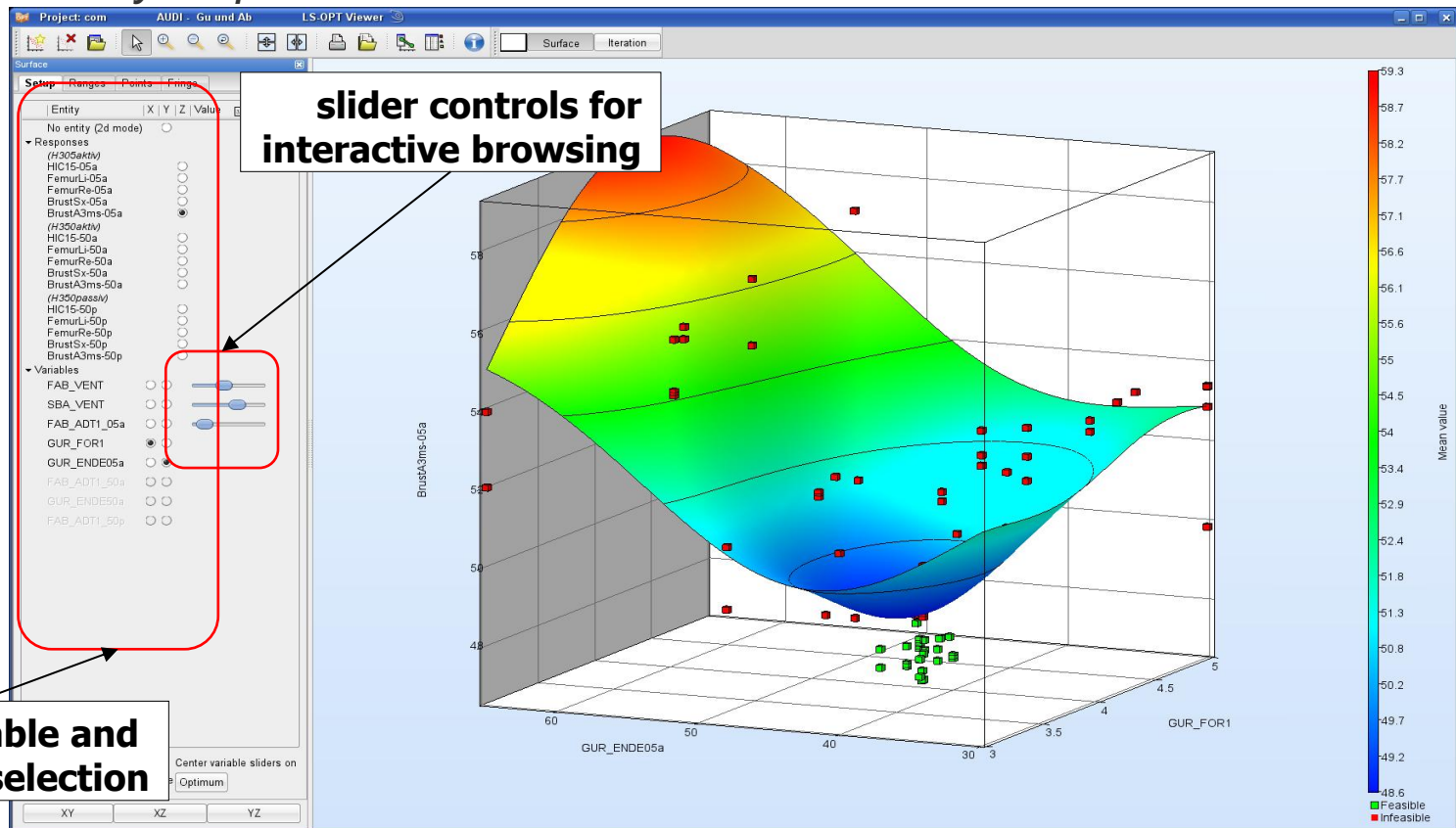
Applications of LS-OPT

■ Computed history curves vs. Target curves



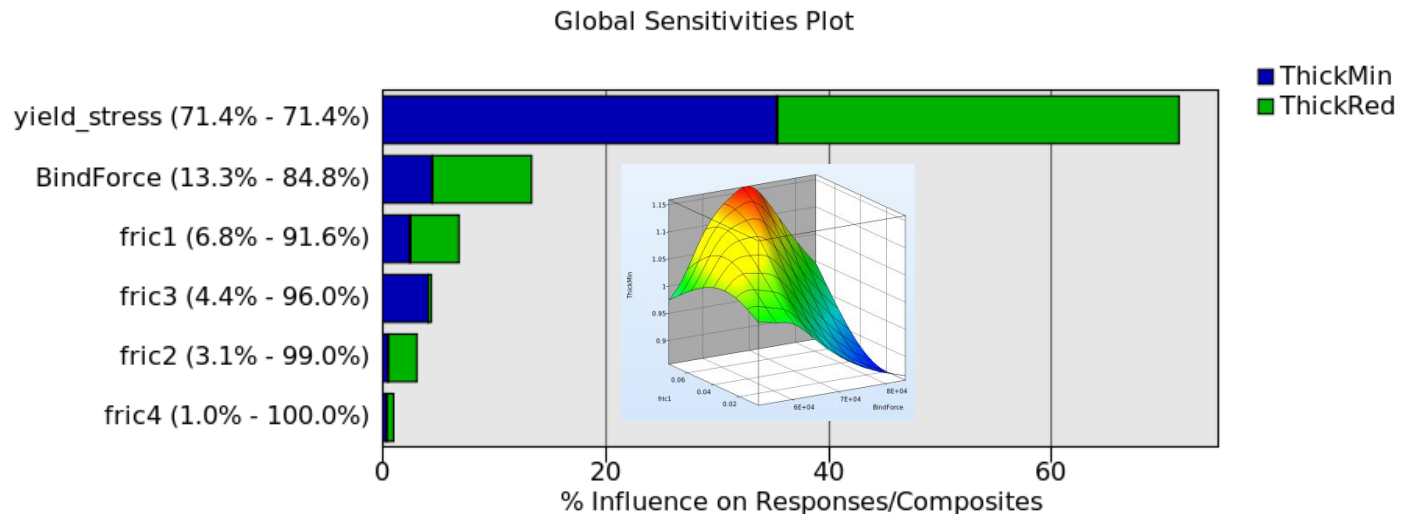
Applications of LS-OPT

- DOE-Studies, Design Exploration
 - *Visualization: 2D/3D sections of the surfaces, 1 or 2 selected variables vs. any response*



Applications of LS-OPT

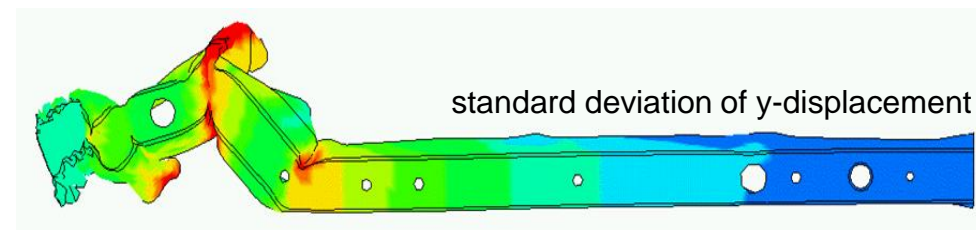
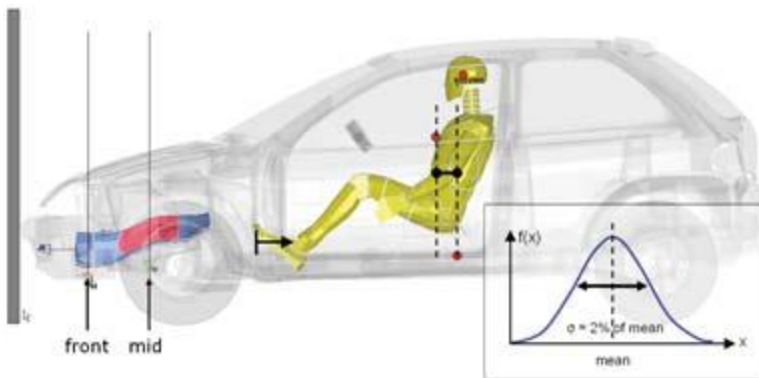
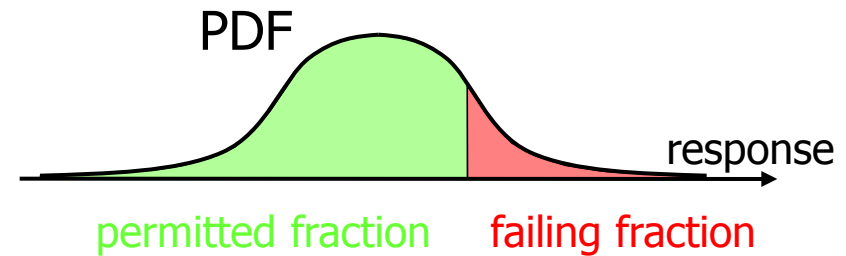
- Sensitivity Studies (ANOVA, Sobol)
 - *Contribution of variables to system performance*
 - *Identification of significant and insignificant variables*
 - *Ranking of importance*



Applications of LS-OPT

- Robustness/Reliability Analysis

- *Consideration of uncertainties*
- *Evaluation of reliability (probability of failure)*
- *Statistics (mean, std, ...)*
- *Correlation Analysis*
- *Confidence Intervals*
- *Outlier Analysis*
- *Fringe statistical results on FE model*



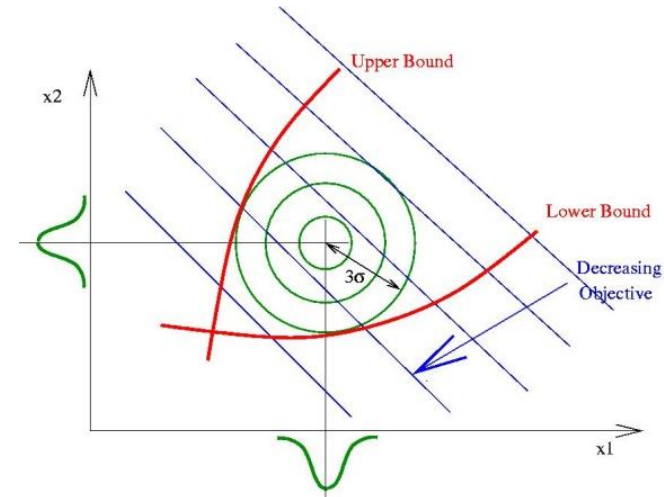
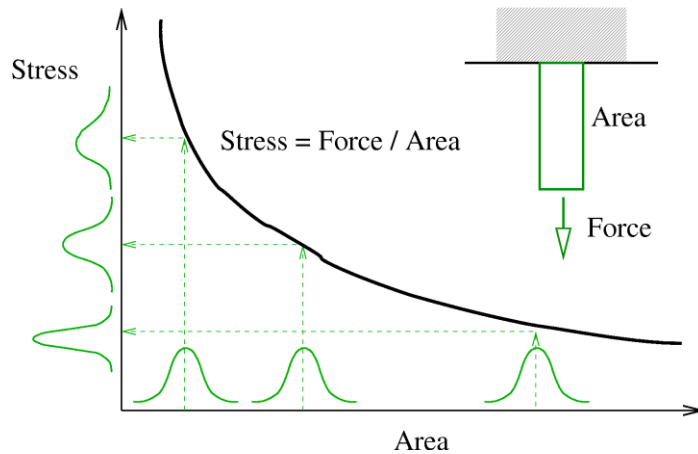
Applications of LS-OPT

■ Robust Parameter Design (RDO)

- *Improve/Maximize the robustness of the optimum*

■ Reliability Based Design Optimization (RBDO)

- *Improve failure probability of optimum*





Interface to ANSA/ μ ETA in LS-OPT 5.0 - Example

Example

- Model and Load case

- *front rail crash*

- Variables

- *Depth and width of embosses*
- *Distance between embosses*
- *Thickness of rail*

} → ANSA Morphing Tool

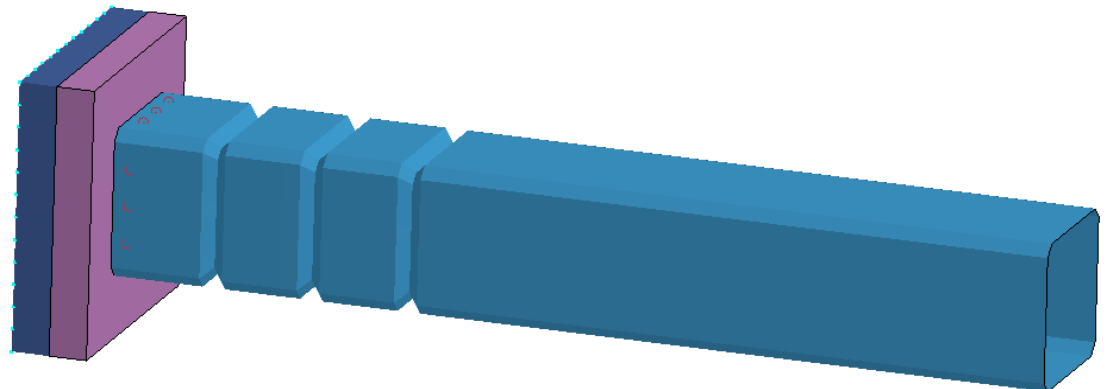
- Objective

- *Minimize Acceleration*

- Constraints

- *Intrusion < 300*
- *Mass < 1.8*

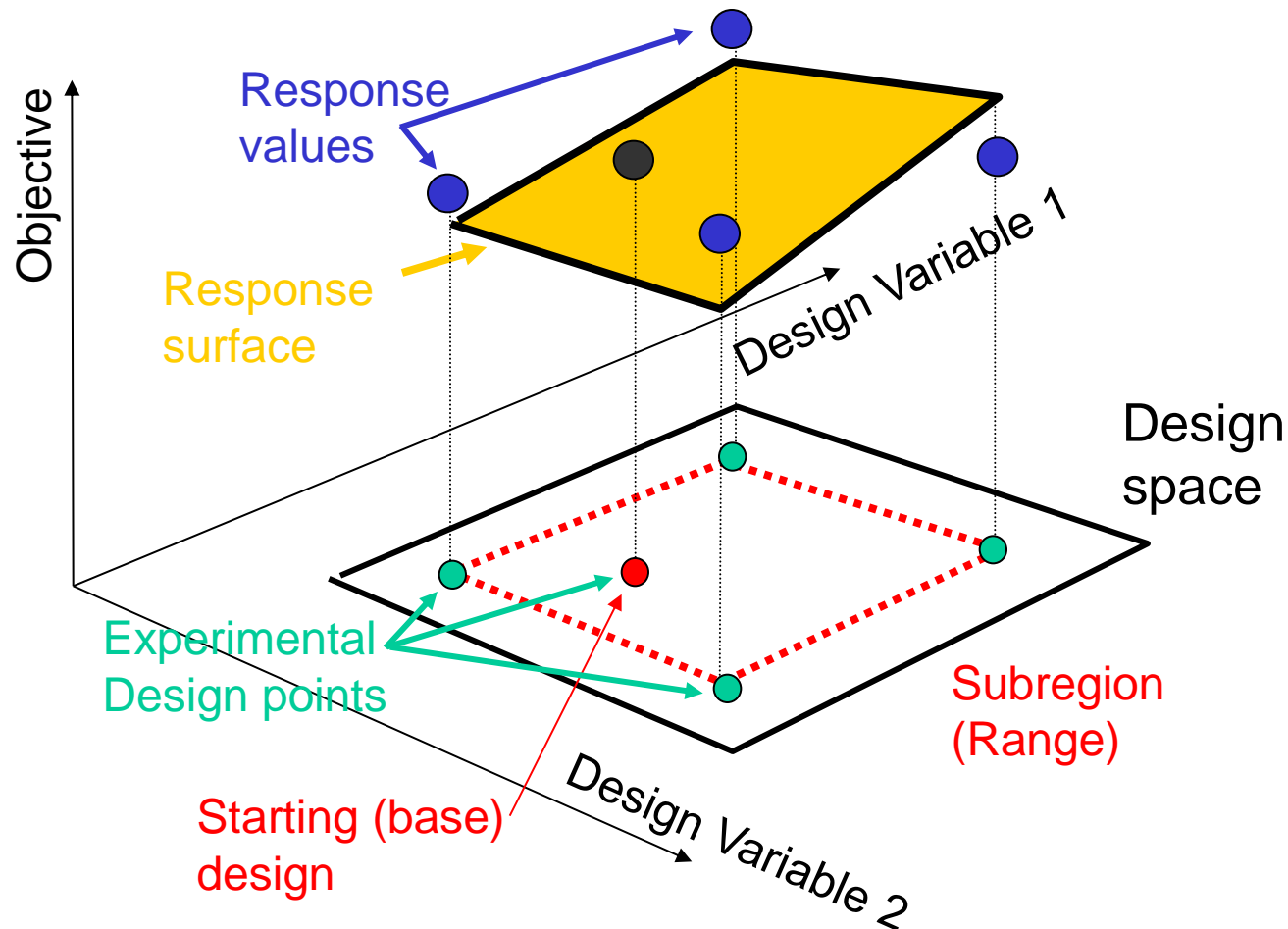
} → μETA Post



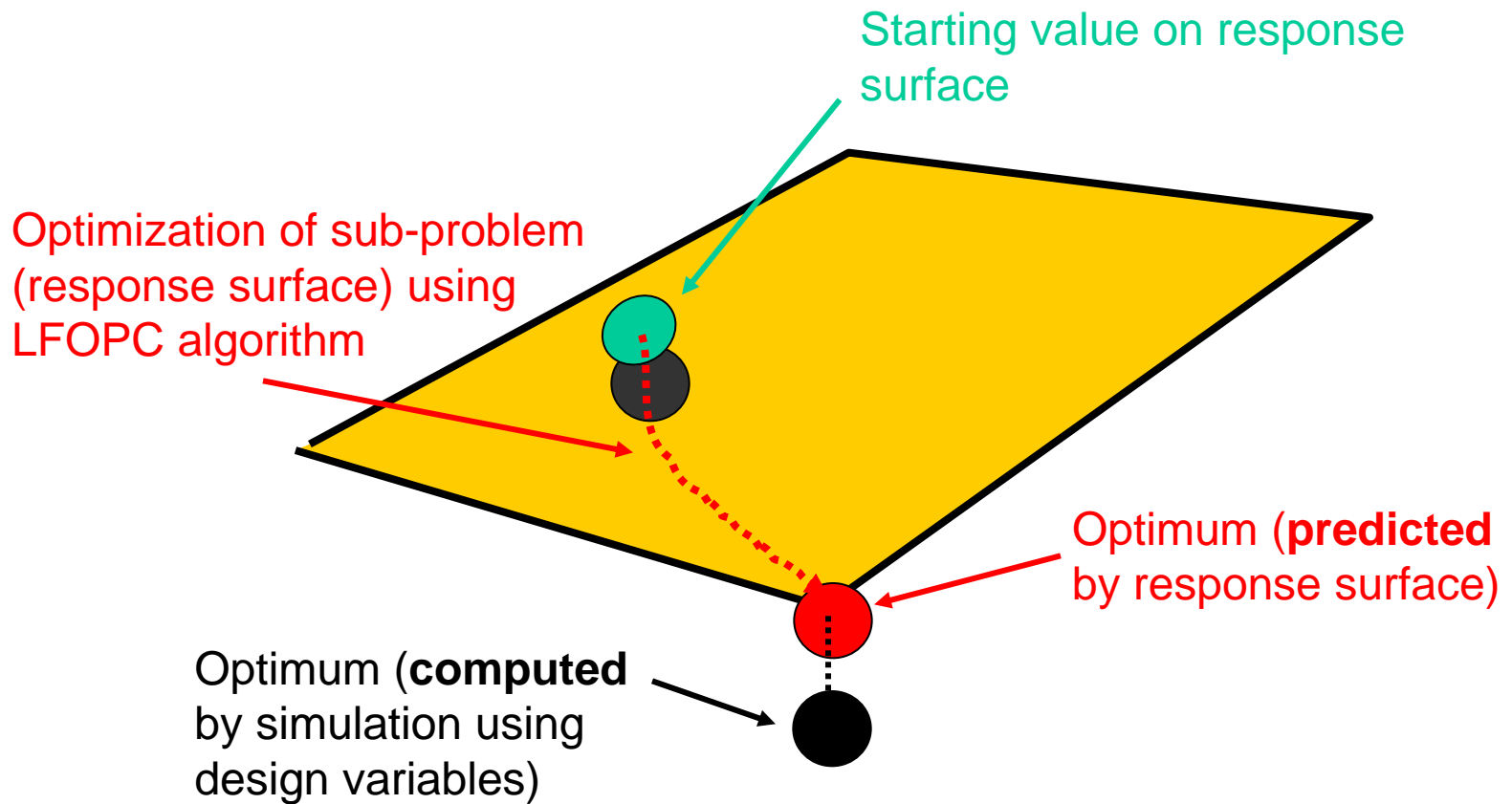


Sequential Response Surface Method (SRSM)

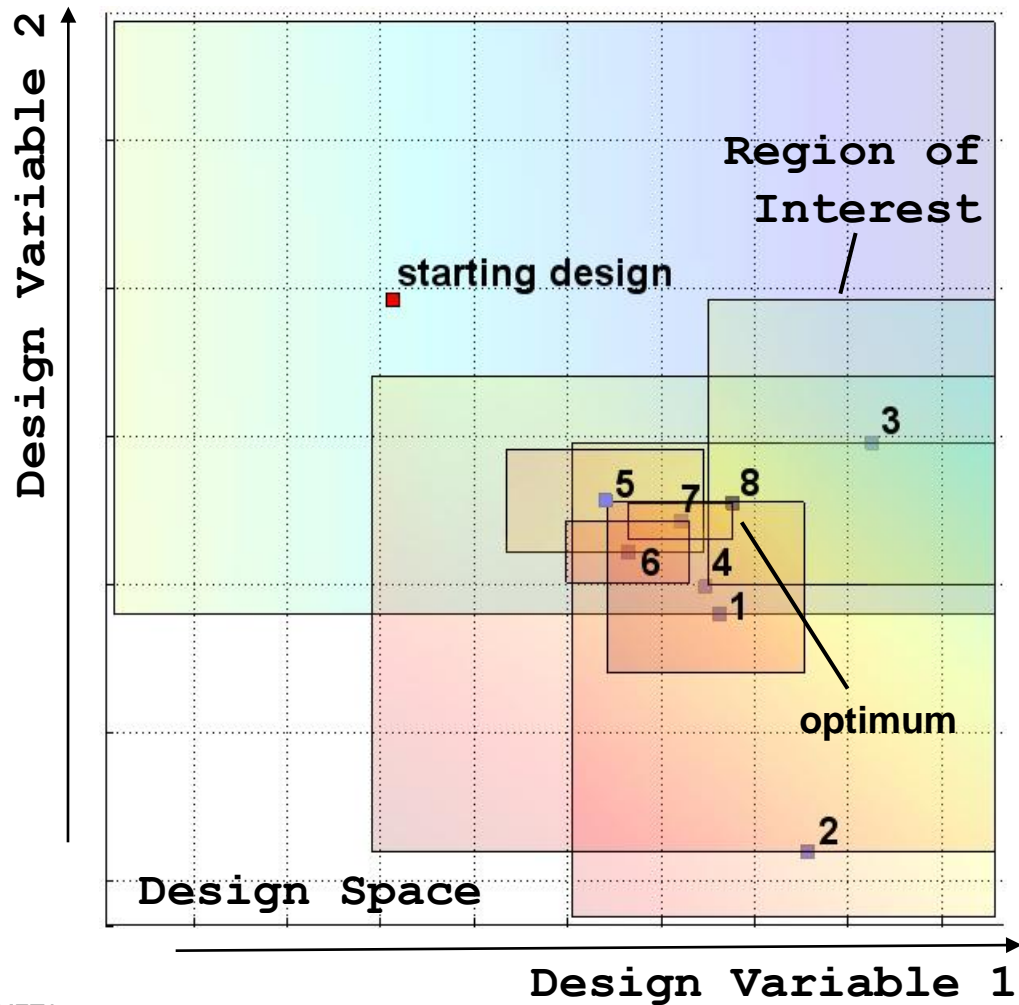
Response Surface Methodology - Optimization Process



Find an Optimum on the Response Surface (one iteration)



Successive Response Surface Methodology





Outlook LS-OPT 5.1

- Interface to Excel as a stage
- Multi-level optimization
 - *Define LS-OPT as a stage*
- Deactivation of variables
 - *Seamless deactivation between iterations*
- Response variables
 - *Transfer of output variables (responses) from one stage as input variables to the next stage*
- Collaborative optimization
 - *De-activate selected cases in an MDO problem*
 - *Allows synthesis and decomposition of MDO setup*
- Mathematical formulas of meta-model functions
- Global Sensitivity Analysis in sub-domain of design space