DYNAmore Infoveranstaltung

Integrierte Optimierung mit ANSA, LS-OPT und META

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Einordnung Lineare / Nichtlineare Optimierung

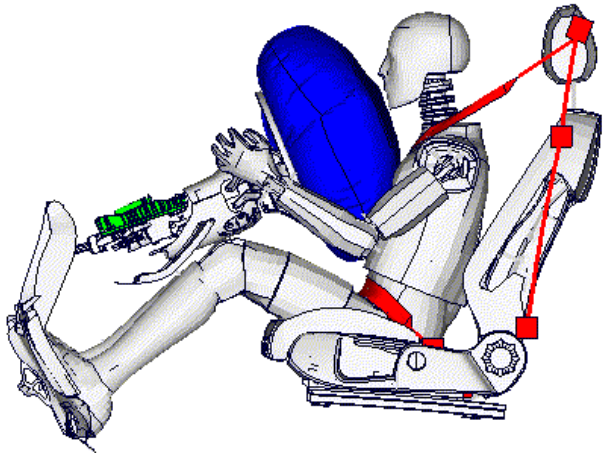
Introduction Optimization

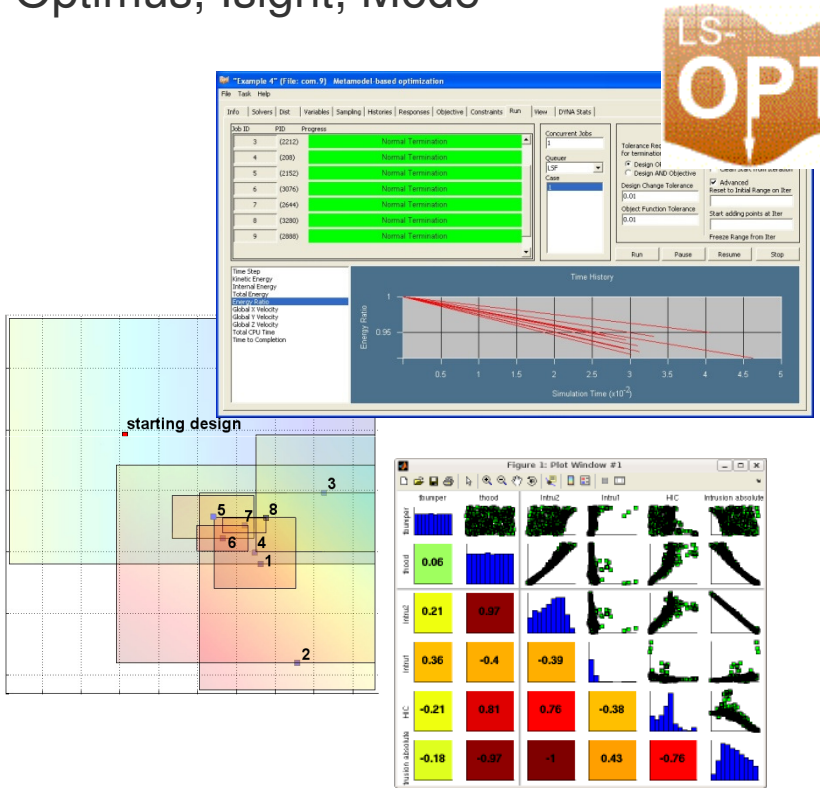
Non-Linear Optimization

- Available Software Products: **LS-OPT,** Optimus, Isight, Mode Frontier…

Non-linear / Parametric

- Parameterization of input files
- Shape/Sizing Optimization
- Possible for general nonlinear applications: Crash, Fluid Dynamics, Nonlinear Static/Dynamic

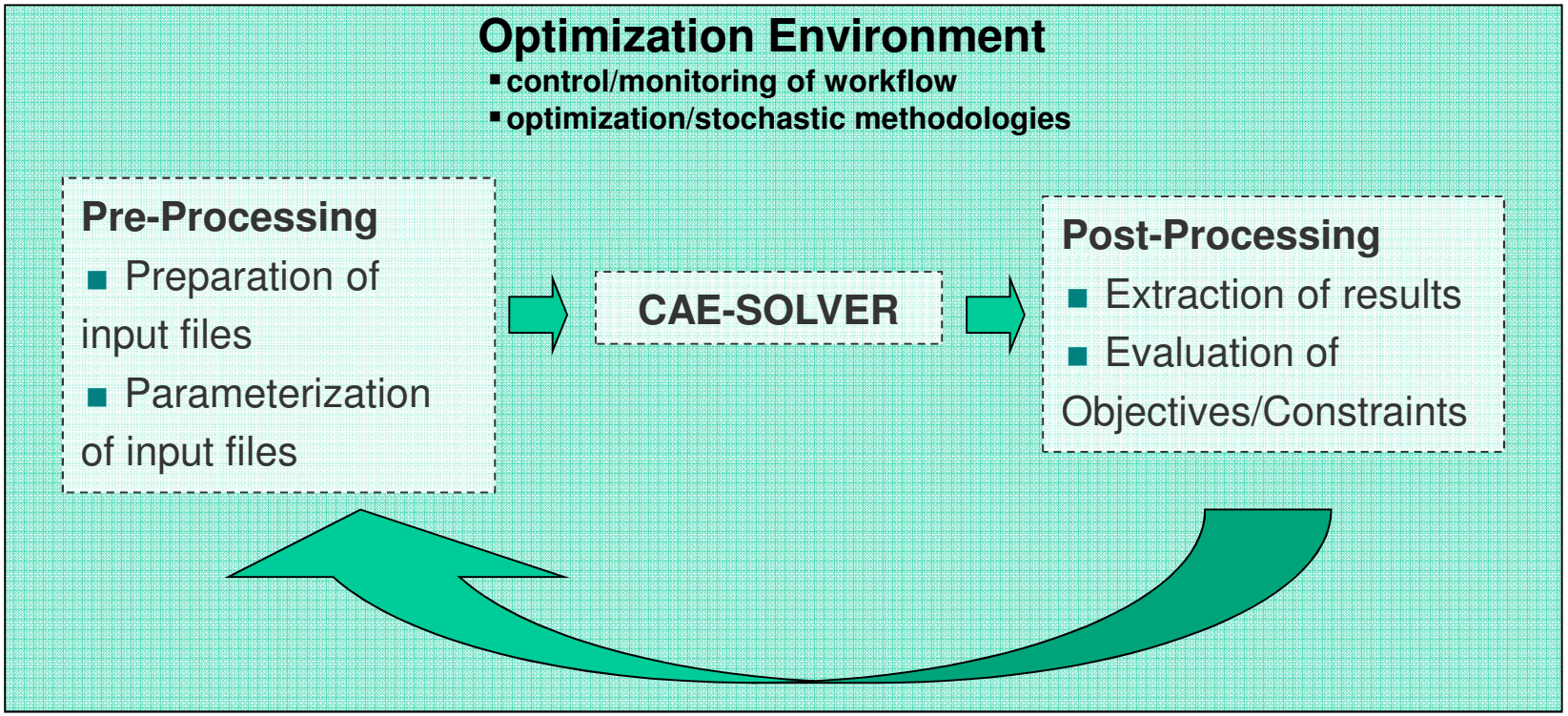




Introduction Optimization

Non-Linear Optimization

- Process Flow for Parametric Optimization - Simplified Representation



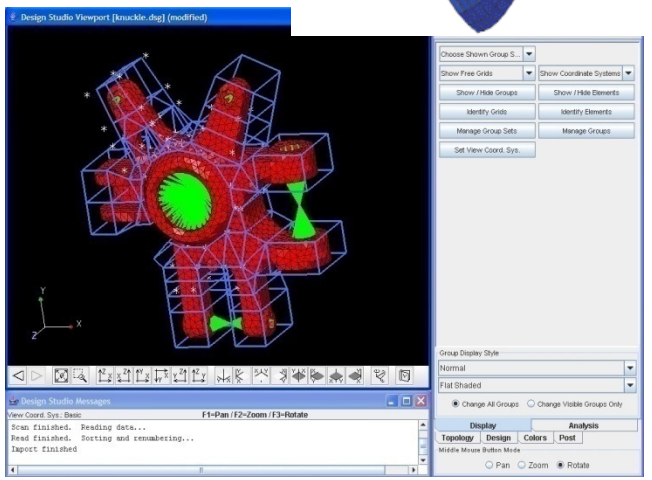
Introduction Optimization

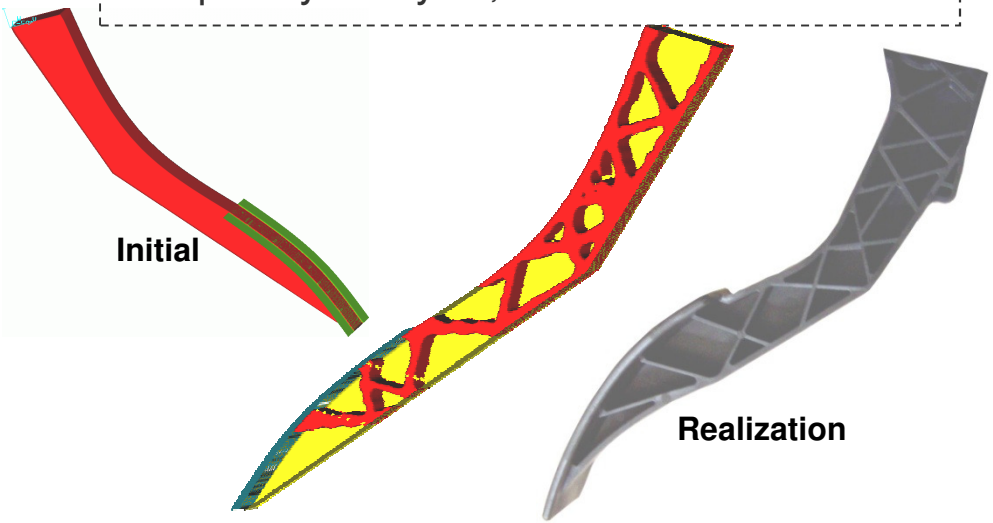
Linear Optimization

- Available Software Products: **Genesis,** Optistruct, Tosca…

Non-Parametric

- Topology / Topometry Optimization
- Usually Linear FE-Problems
- Gradient based solvers – many design variables > 1000000
- CAE-Applications: Static Loads, Frequency Analysis, NVH

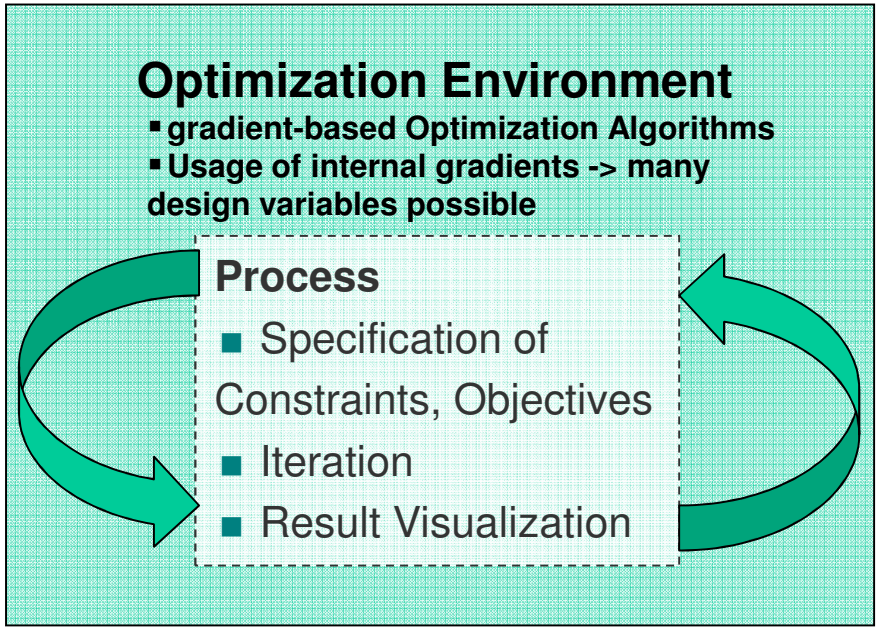


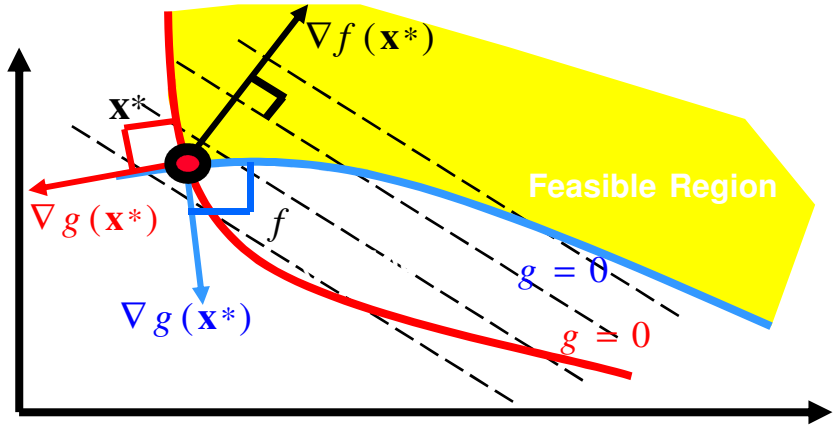


Introduction Optimization

Linear Optimization

- Usually Integrated FE-Solver

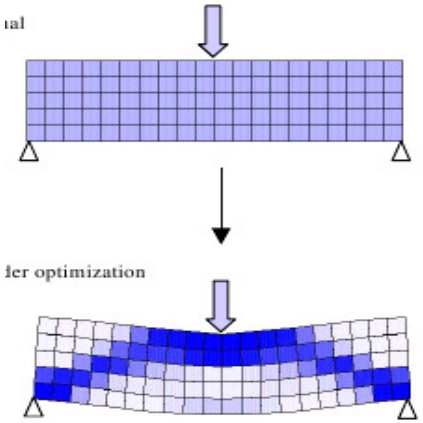




Introduction

Topology Optimization for Crash

- For topology optimization each element is a design variable - can be switched on/off
  → many variables
  - *Can not be solved with LS-OPT (too many variables)*
  - *Can not be solved for crash with gradient based topology solvers like e.g. Genesis (strong non-linearities)*
- Two considerable approaches
  - *Equivalent Static Loads Method – ESLM Genesis / LS-DYNA*
  - *Hybrid Cellular Automata – HCA LS-TaSC*

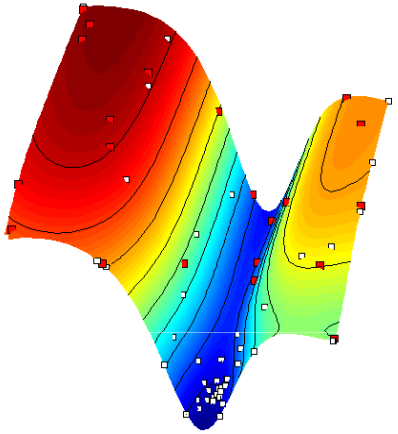


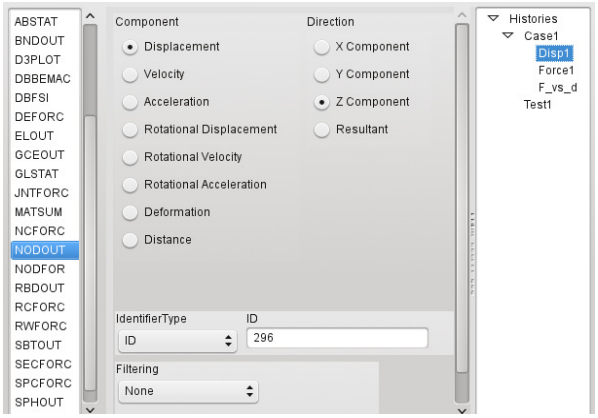
LS-OPT

LS-OPT – State of the Art Optimization Software

About LS-OPT

- LS-OPT can be linked to any simulation code – stand alone optimization software, but perfect suitable with LS-DYNA
- LS-OPT is available for Windows and Linux
- Current production version is LS-OPT 4.2 – Release of Version 5.0 is planned for middle of 2012
- LS-DYNA Integration
  - Checking of Dyna keyword files (*DATABASE_)
  - Importation of design parameters from Dyna keyword files (*PARAMETER_)
  - Monitoring of LS-DYNA progress
  - Result extraction of most LS-DYNA response types
  - Mode Tracking LS-DYNA/Implicit
  - …

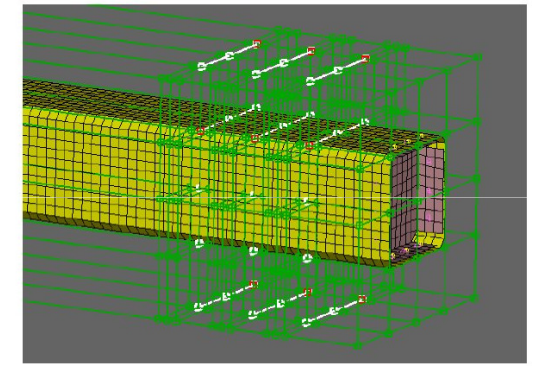


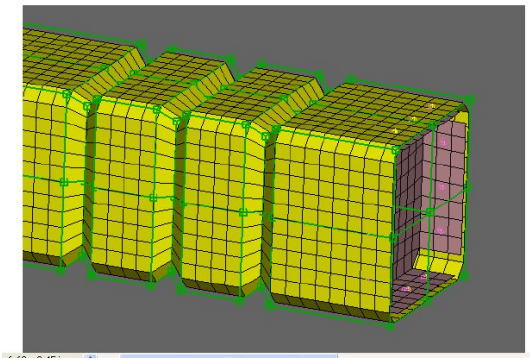


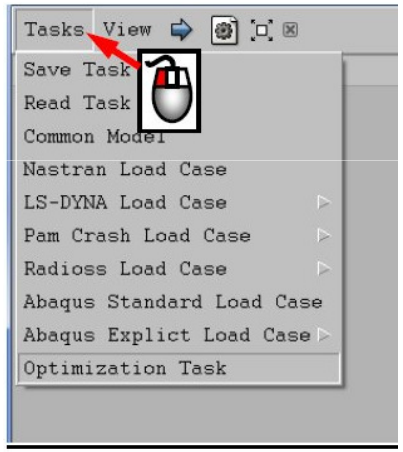
LS-OPT – State of the Art Optimization Software

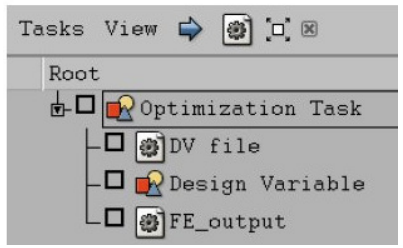
About LS-OPT

- Job Distribution - Interface to Queuing Systems
  - PBS, LSF, LoadLeveler, SLURM, AQS, etc.
- LS-OPT might be used as a “Process Manager”
- Shape Optimization
  - Interface to ANSA, HyperMorph, DEP-Morpher, SFE-Concept
- META Post interface
  - Allows extraction of results from any package (Abaqus, NASTRAN, …) supported by META Post (ANSA package)





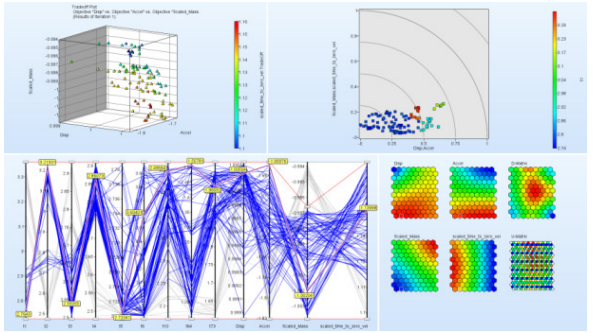




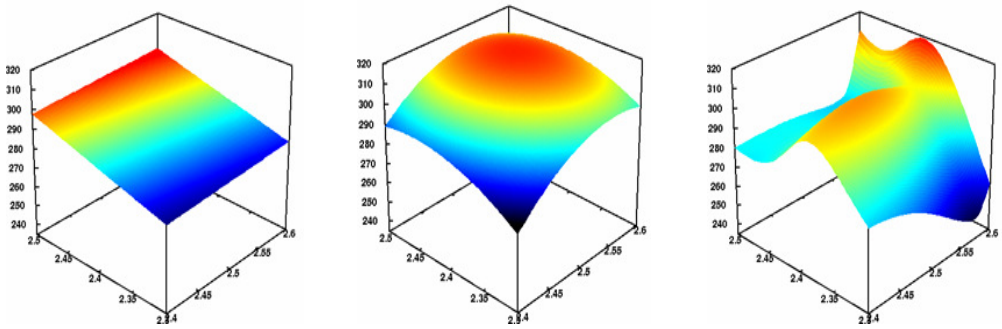
LS-OPT – State of the Art Optimization Software

Applications of LS-OPT

- Optimization
  - Size-/Shape optimization
  - Constraints, mixed continuous/discrete variables, multiple load cases, etc.
  - Multi-Objective optimization (Pareto Frontier)
  - Reliability based design optimization

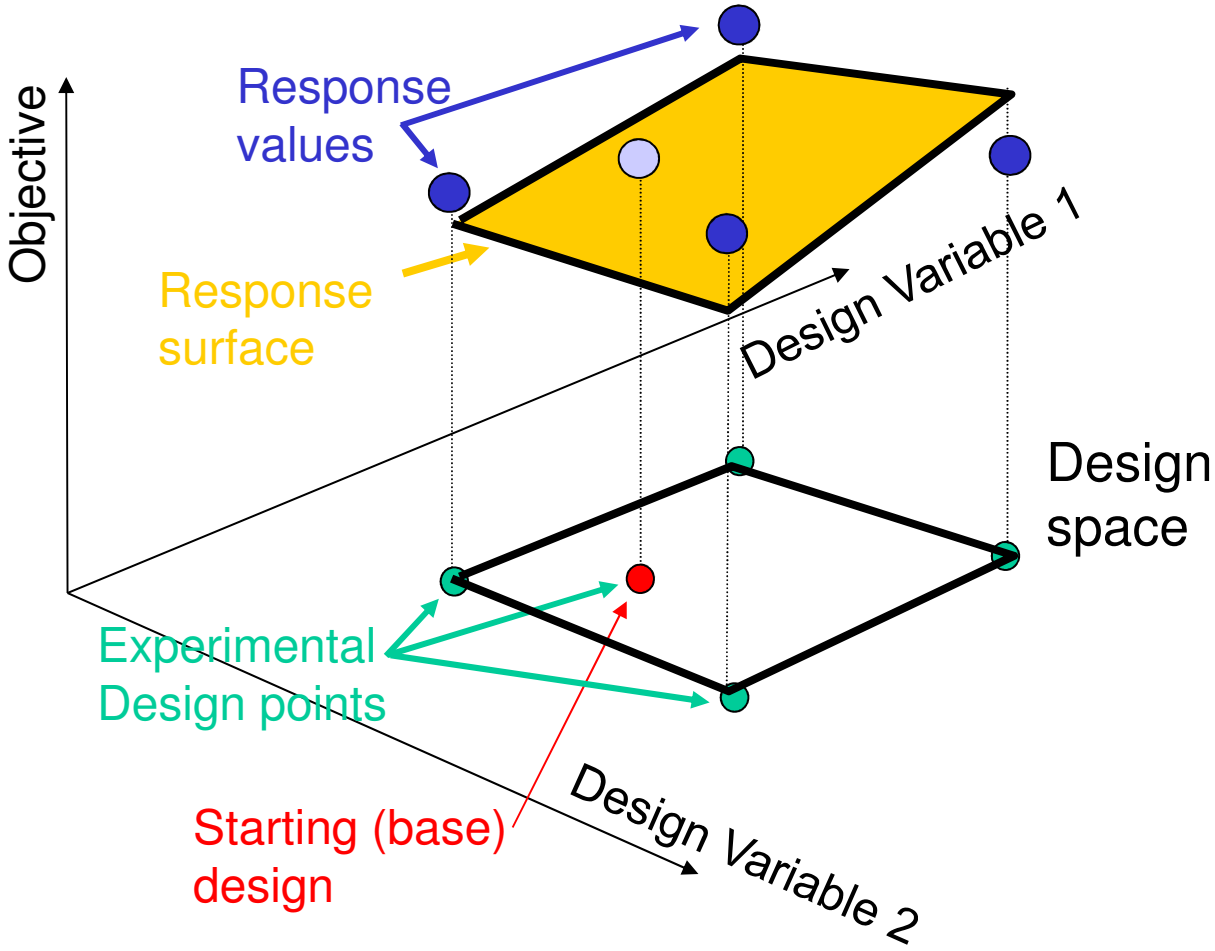


- DOE-Studies, Design Exploration
  - Samplings: Factorial, Latin Hypercube, Space Filling, …
  - Meta-models: Polynomials, Radial Basis Functions, Neural Nets (FFNN),…



LS-OPT – State of the Art Optimization Software

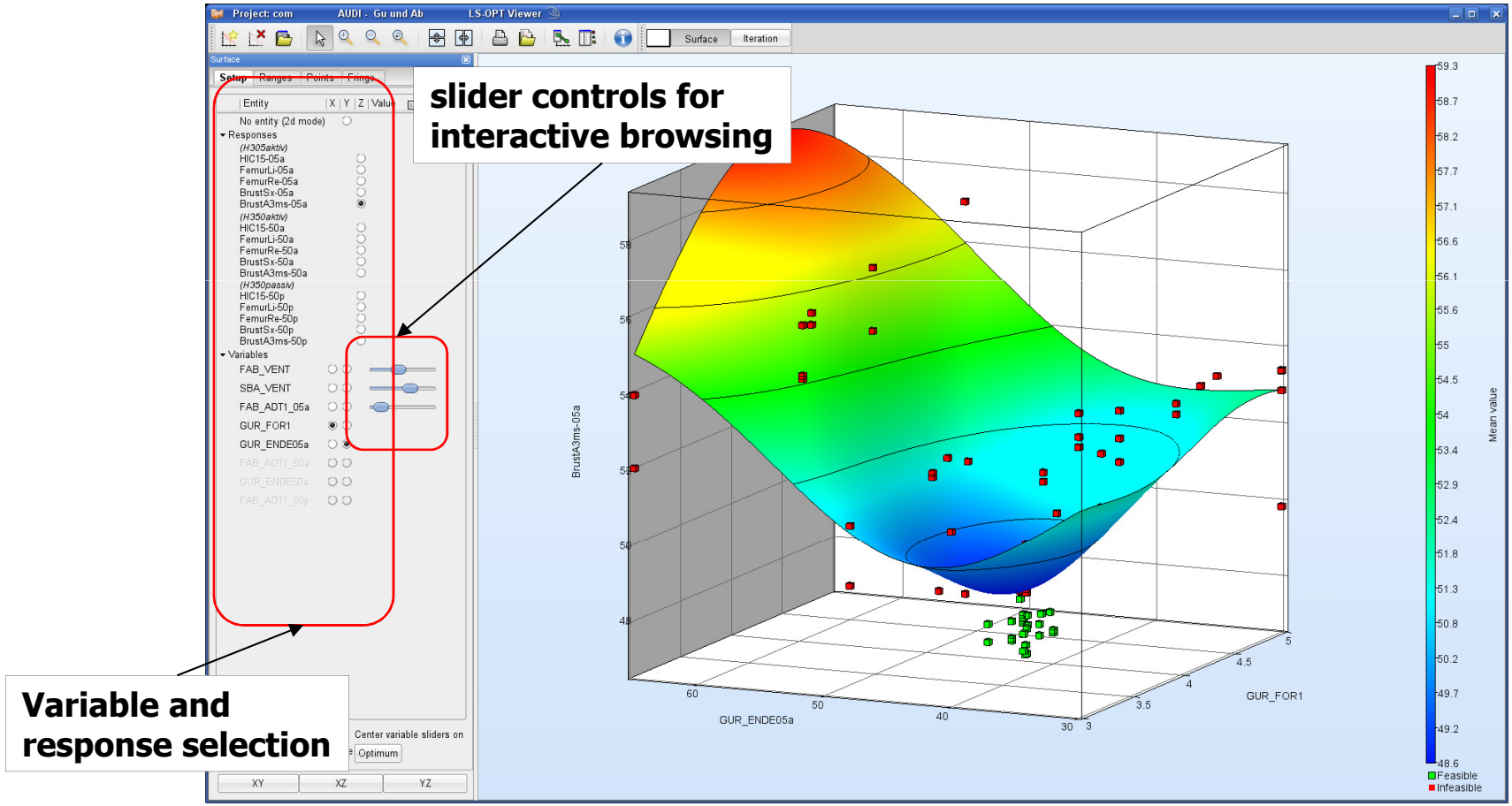
- What is a Meta-Model ?
  (Synonyms: Approximation, Response Surface, Surrogate model,…)



LS-OPT – State of the Art Optimization Software

Applications of LS-OPT

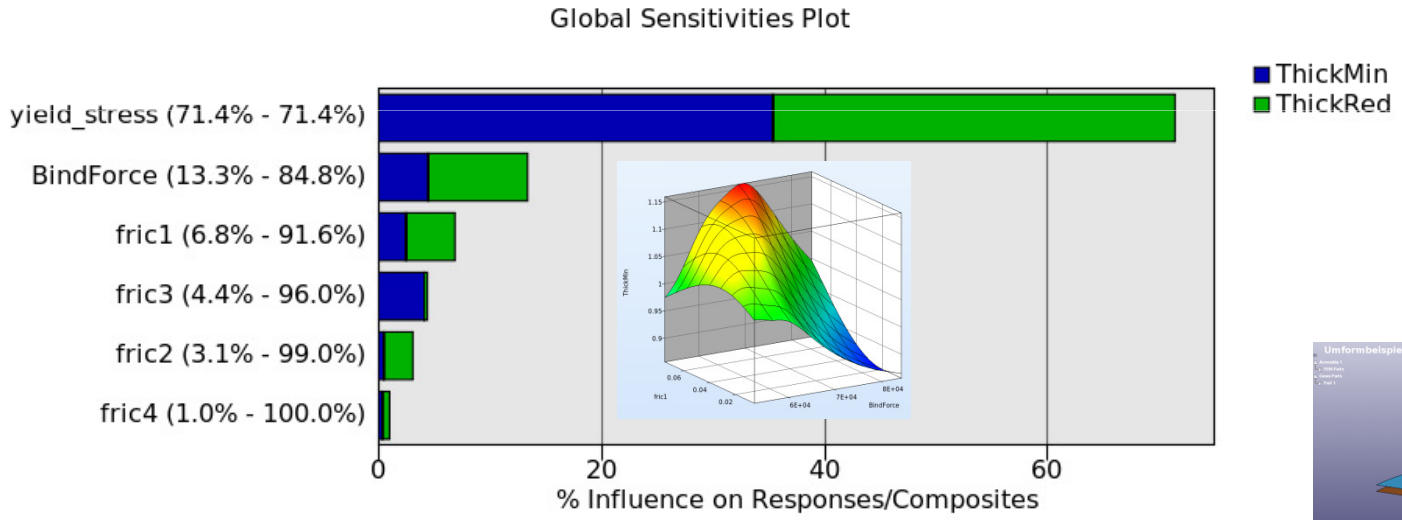
- DOE-Studies, Design Exploration
  - Visualization: 2D/3D sections of the surfaces, 1 or 2 selected variables vs. any response

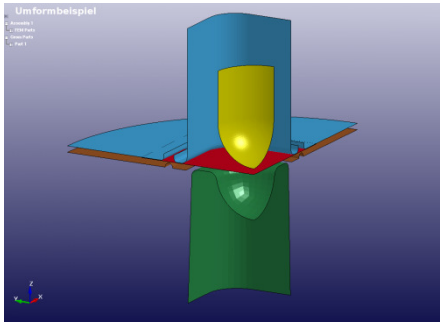


LS-OPT – State of the Art Optimization Software

Applications of LS-OPT

- Sensitivity Studies
  - Contribution of variables to system performance
  - Identification of significant and insignificant variables
  - Ranking of importance

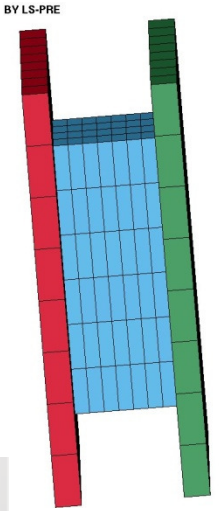




LS-OPT – State of the Art Optimization Software

Applications of LS-OPT

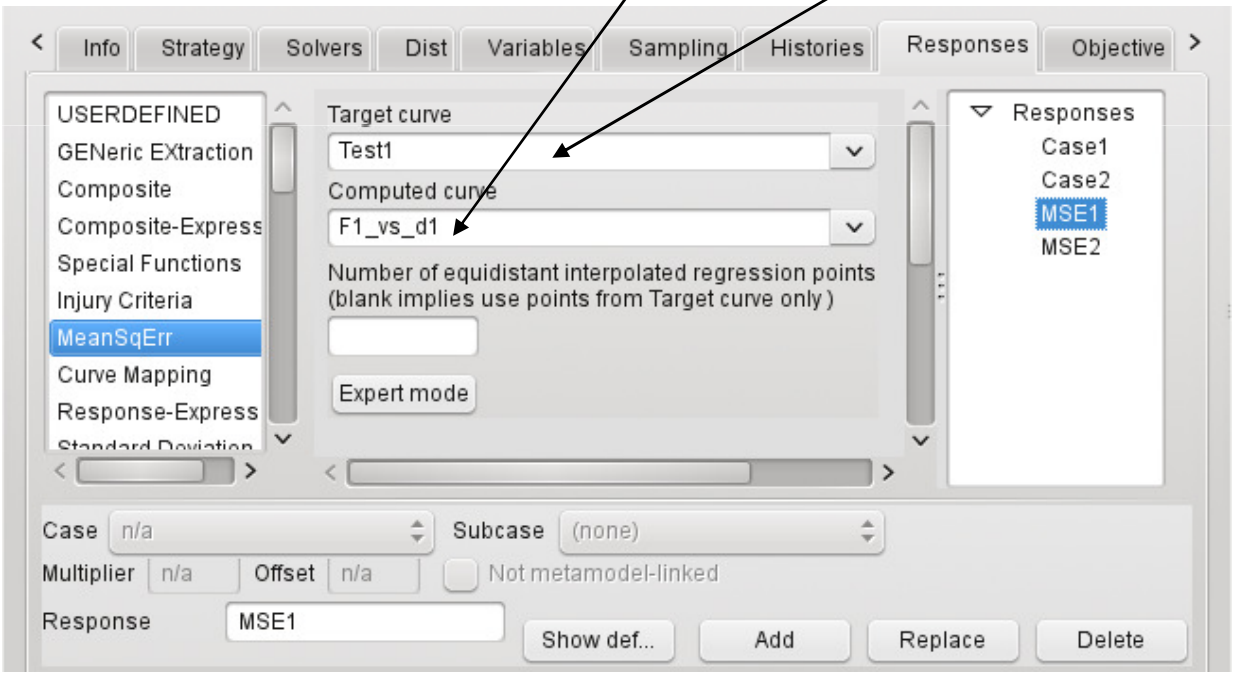
- Parameter Identification



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

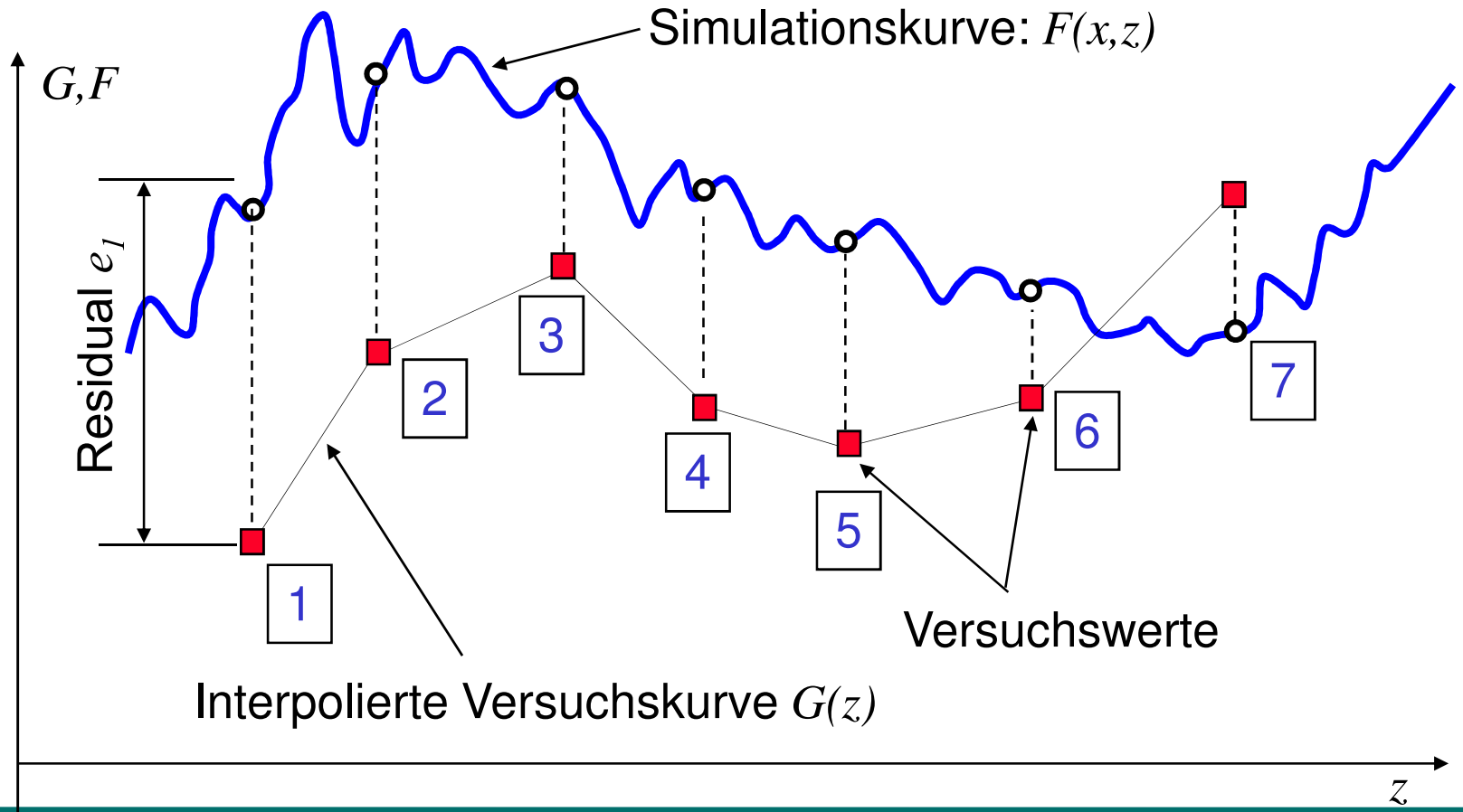
Test curve

Simulation curve



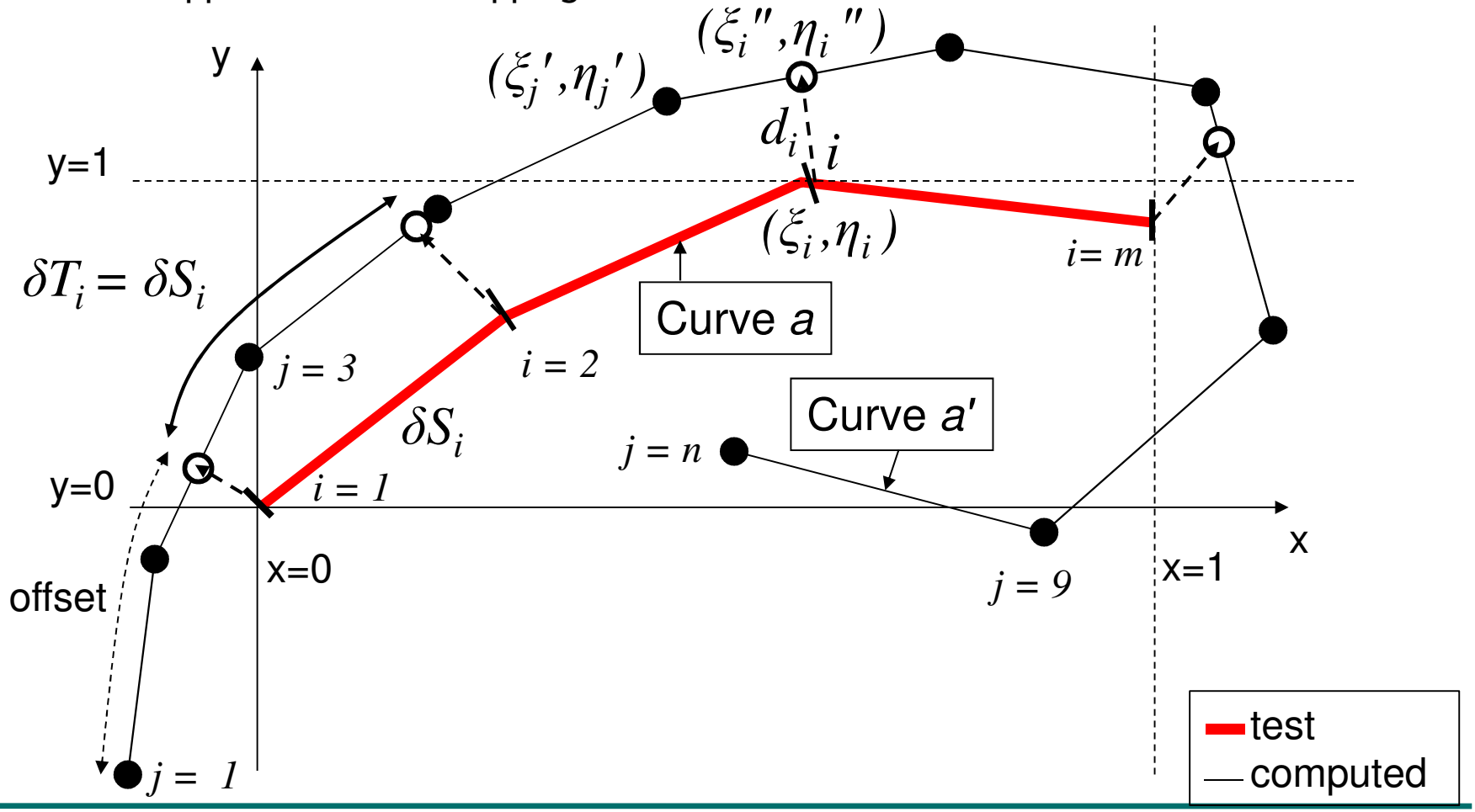
Applications of LS-OPT

- Parameter Identification
  - Ordinate based mean square error function (MSE)



Applications of LS-OPT

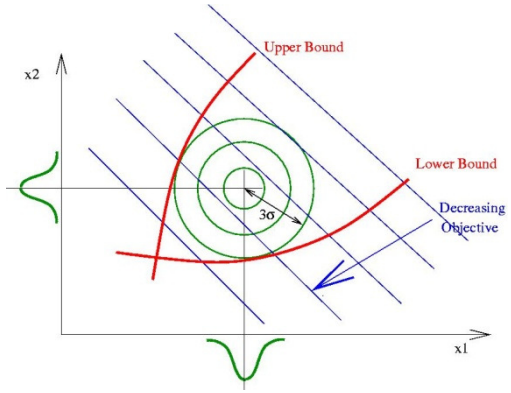
- Parameter Identification
  - New Approach: Curve mapping

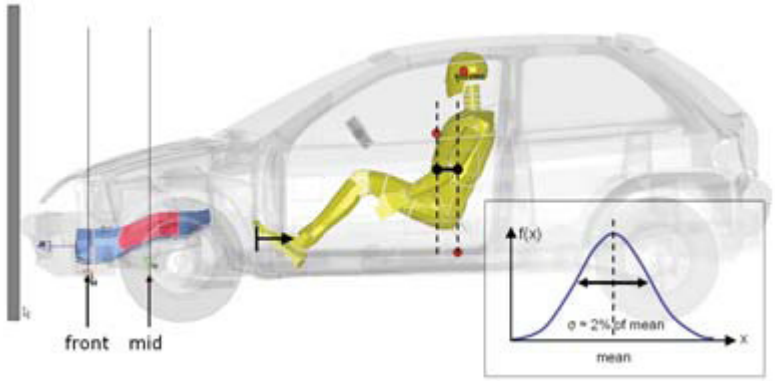


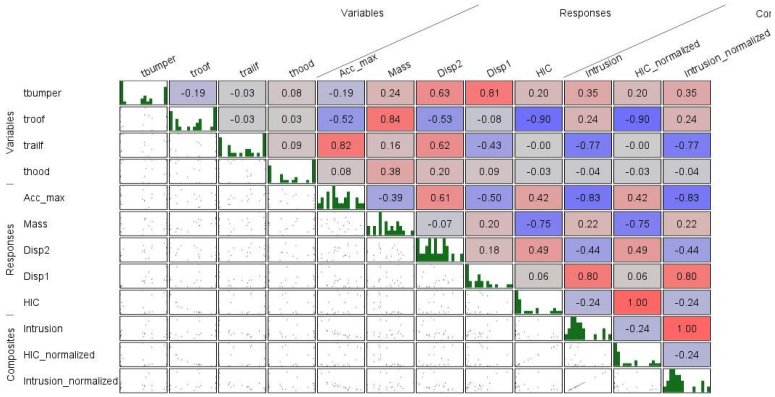
LS-OPT – State of the Art Optimization Software

Applications of LS-OPT

- Robustness / Reliability Analysis
  - Consideration of uncertainties
  - Evaluation of reliability (probability of failure)
  - Statistics
  - Correlation Analysis
  - Outlier Analysis

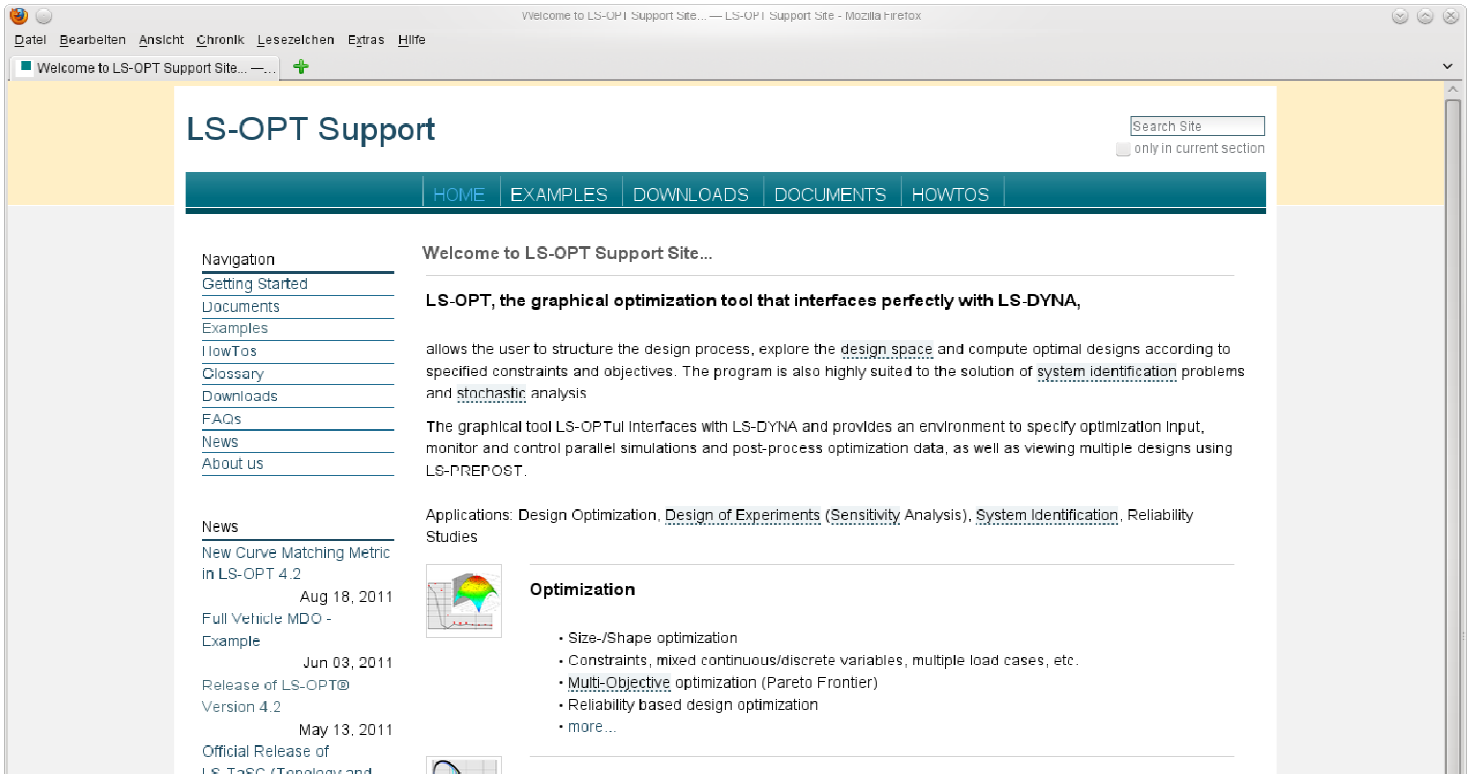






LS-OPT – State of the Art Optimization Software

- LS-OPT can be linked to any simulation code – open system and stand alone optimization software
- LS-OPT Support-Webpage -> www.lsoptsupport.com
  - Many examples, tutorials, FAQs, HowTos…



Licensing of LS-DYNA, LS-OPT, LS-PrePost

- **LS-DYNA Solver**
  - classic explicit solver
  - implicit features
  - SPH and EFG
  - Euler, ALE-Method and FSI
  - corpuscular method
  - CFD solver
  - SMP and MPP platforms
  - network and node locked license
  - all features includes

- **LS-PREPOST**
  - supports all LS-DYNA features
  - unlimited number of license

- **LS-OPT**
  - optimization, stochastic analysis
  - advanced methodologies
  - no additional fee

- **DYNA*more* Toolbox**
  - many tools for daily work
  - no additional fee

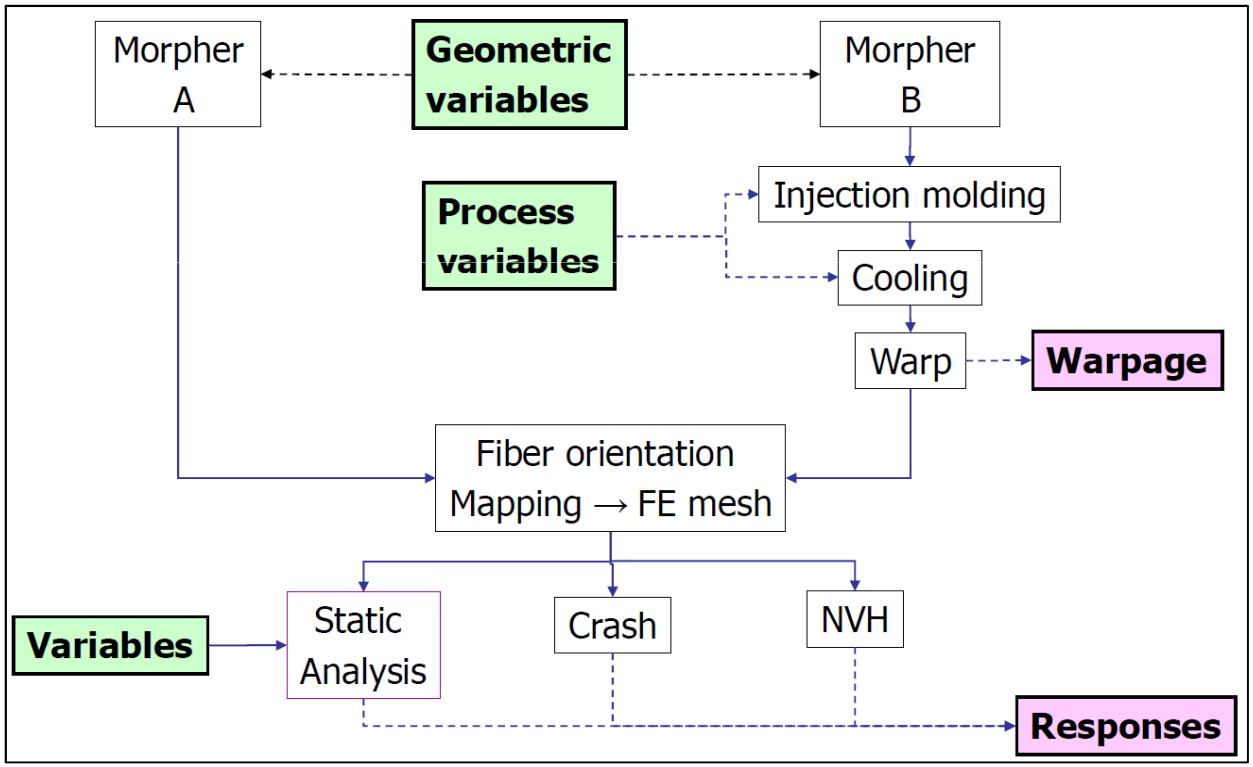
- **Support by DYNAmore**
  - experienced staff give support
  - telephone or e-mail support included
  - direct access to staff of DYNAmore
  - full supports for all three products
  - info support mails

Ausblick auf LS-OPT 5.0

Ausblick auf LS-OPT 5.0

- **Bisher mögliche Prozessketten innerhalb Optimierung mit LS-OPT:**

- **Neue Anforderungen: komplexere Prozessketten, Verzweigungen**

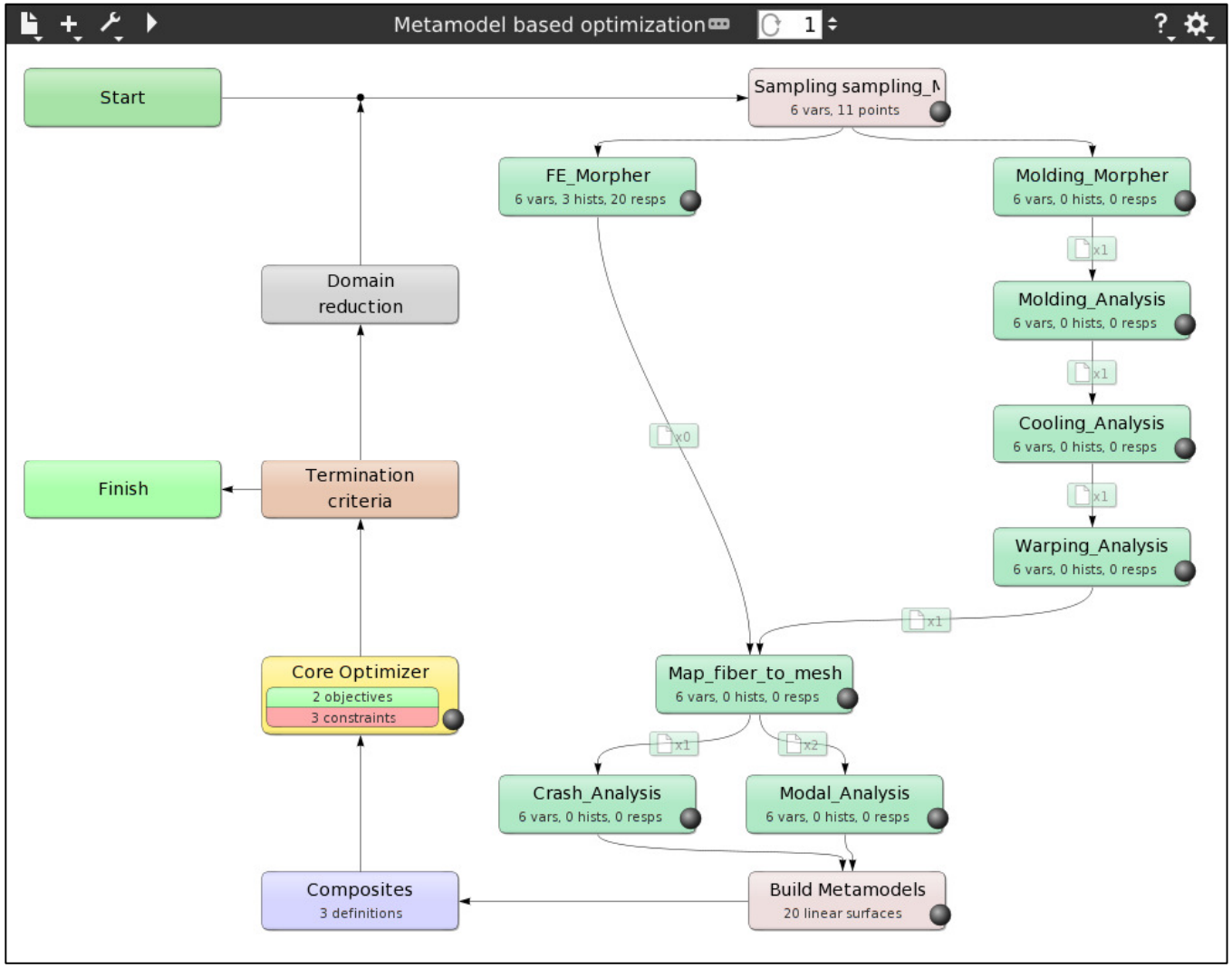


Ausblick auf LS-OPT 5.0 - Ziele

- **Prozesssimulation & Optimierung**
  - Prozess-Ablauf mit Verzweigungen und Zusammenführen
  - Ausgabe-Dateien: kopieren, löschen, verschieben, …
- **Schrittweise Ausführung möglich**
  - z.B. nur Sampling
  - oder einzelner Teilschritt der Prozesskette
- **Status der Berechnungen bzw. Optimierung wird dargestellt**

Ausblick LS-OPT 5.0

- Neue graphische Oberfläche (Entwicklungsstand)



Vielen Dank
für Ihre Aufmerksamkeit!