Parametric Simulation

The Key for Understanding and Improvment

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Introduction

Motivation

- Understand a Design
- Design Improvement
- Safe Designs
- Match Tests and Simulation
- System Behavior

Introduction

Understand a Design

Design
Part Assembly
Brake Pressure
Friction
Material
Manufacturing

Which one is most important? Is a larger value better or a smaller value?

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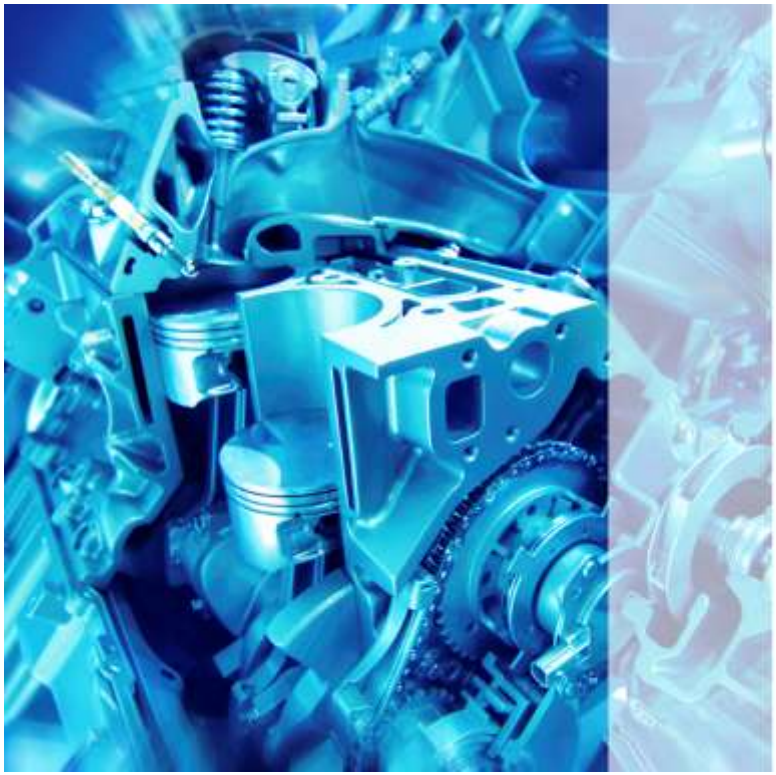
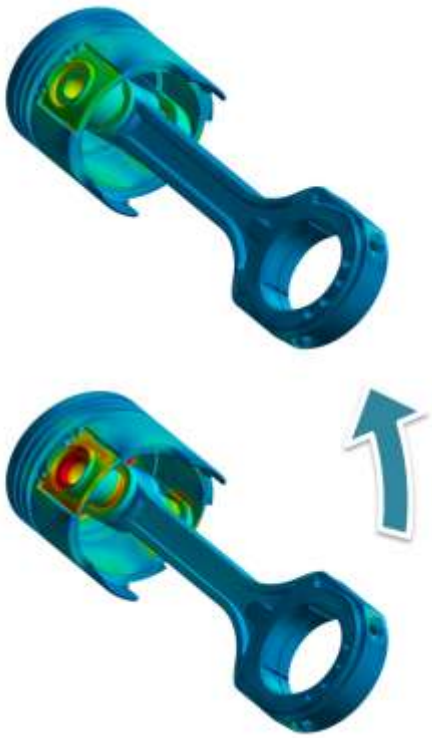
Design Improvement

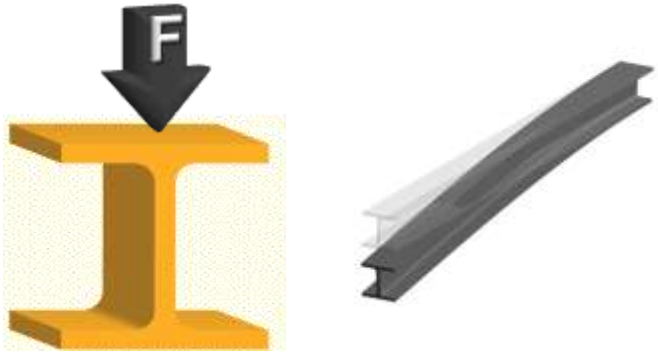
- Find designs fitting to your requirements
  - Reduced mass
  - Reduced stress
  - Increased fatigue life
  - Increased efficiency
  - …
- Find a good balance between requirements

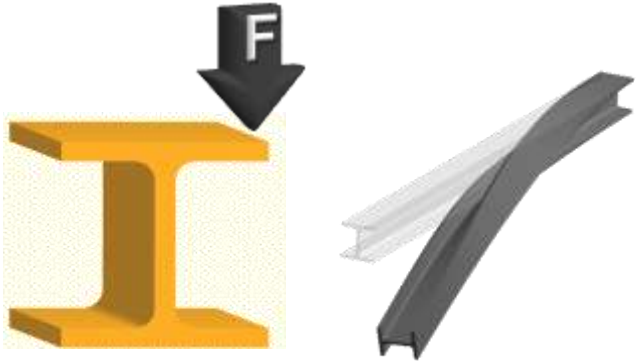




Safe Designs

- Consider scatter in input variables
  - Load
  - Geometry
  - Material
  - …
- Find a design, where the influence of scatter is low
  - High robustness
  - High reliability
  - High product safety





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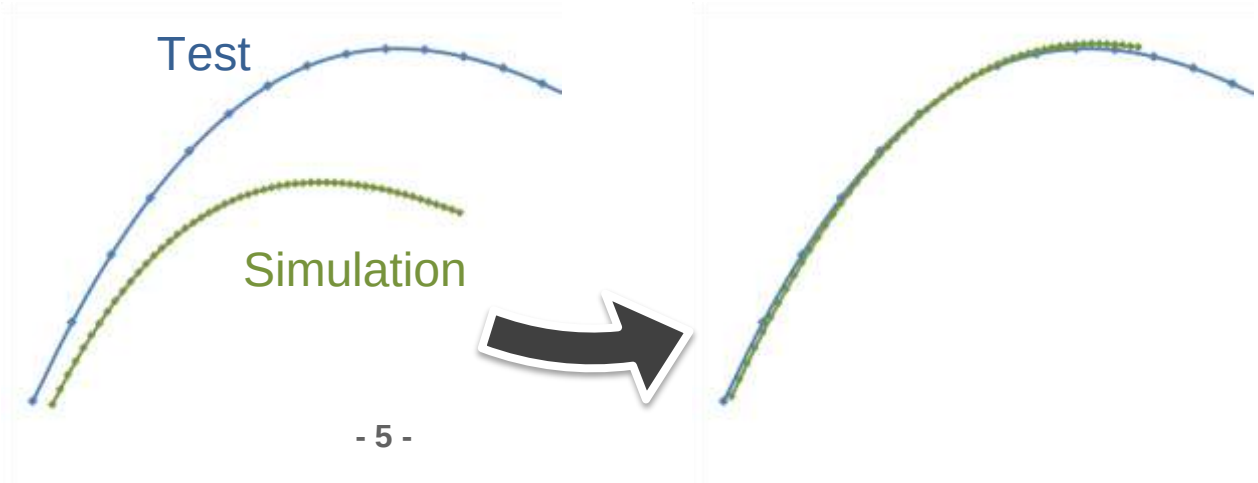
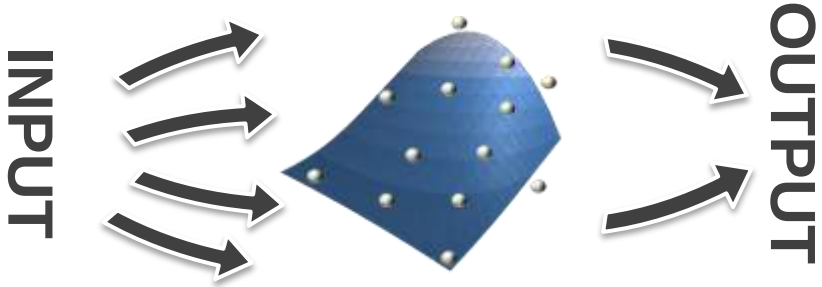
Match Test and Simulation

- Find the reason for non-matching results
- Understand the driving parameters
- Adjust parameters for numerical models
  - Friction
  - Damping
  - Material
  - …



System Simulation

- Describe components for a system simulation by a characteristic diagram
- Extract the relation between input and output of the simulation model



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Behavior Model

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Introduction

Would you benefit …

… from systematic design improvements where knowledge can be easily transferred to colleagues?

… from knowing if you used 100% of your products potential?

… if you could identify areas requiring higher / lower manufacturing accuracy?

… from considering uncertainties your product faces in its real world working environment?

… if you could identify why tests and simulations do not match?

… from a mathematical representation of your product behavior?

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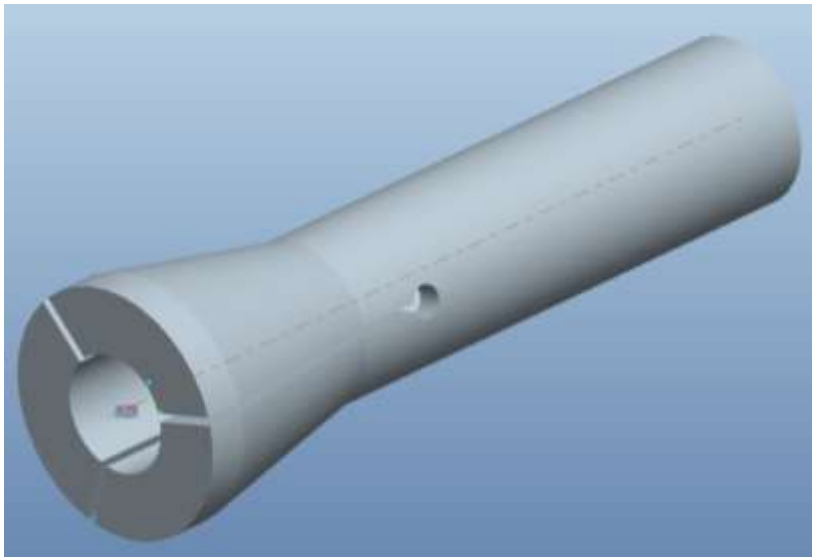
Demo Parametric Simulation – Clamp Sleeve

- Apply Force
- Apply Supports
  - Cone can slide
  - Cutter fixes radial
  - Symmetry
- Apply local mesh refinement
- Single simulation

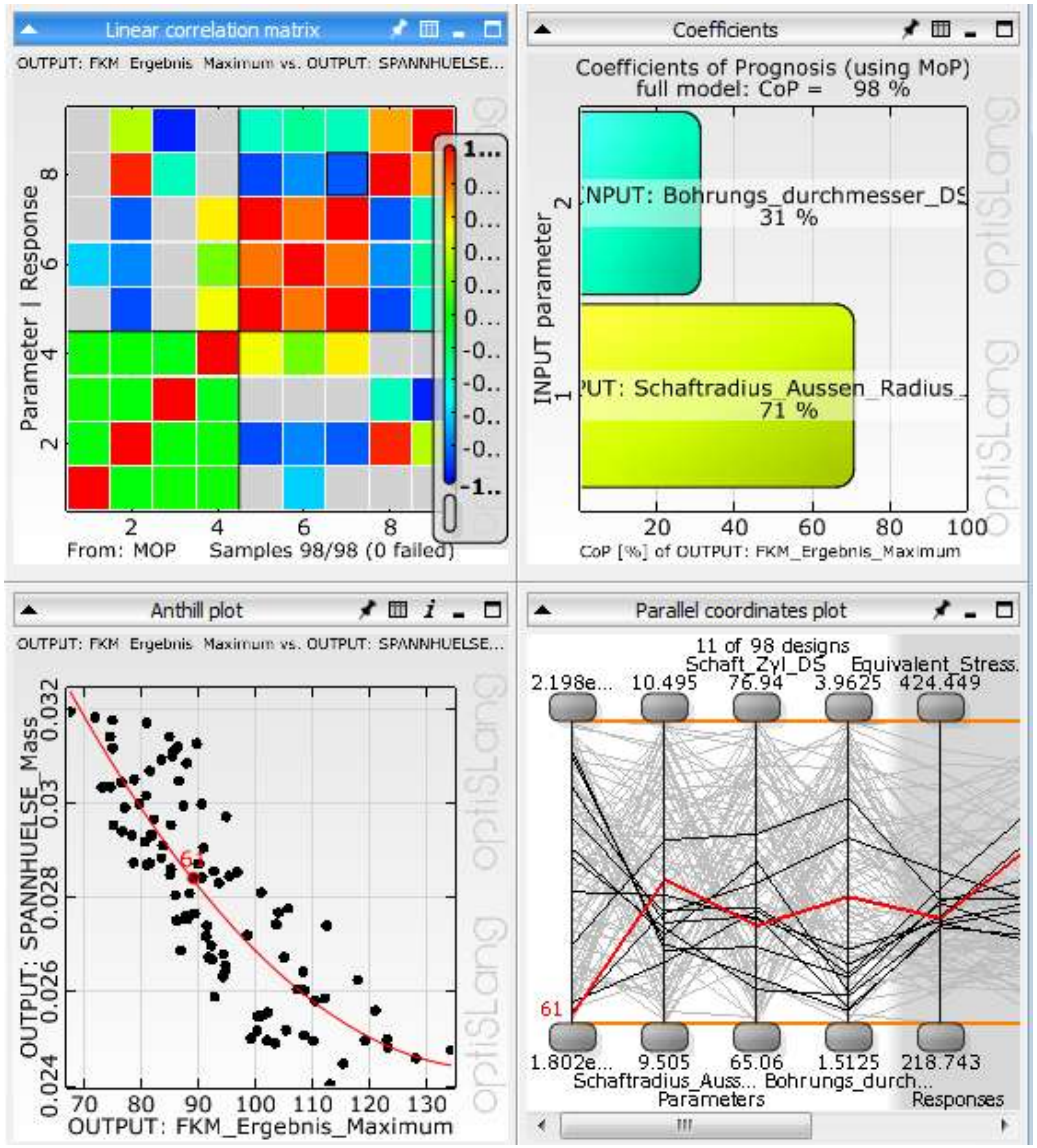
- Manual Update from CAD
- Sensitivity and Optimization by optiSLang inside Workbench



Live Workflow

Clamp Sleeve Results

- Sensitivity = Understanding
  - What are the most important design variables?
  - Is there a correlation between parameters?
  - What is the range of results?
- Optimization
  - How to find the best result
- Robust Design
  - Consider scatter in input



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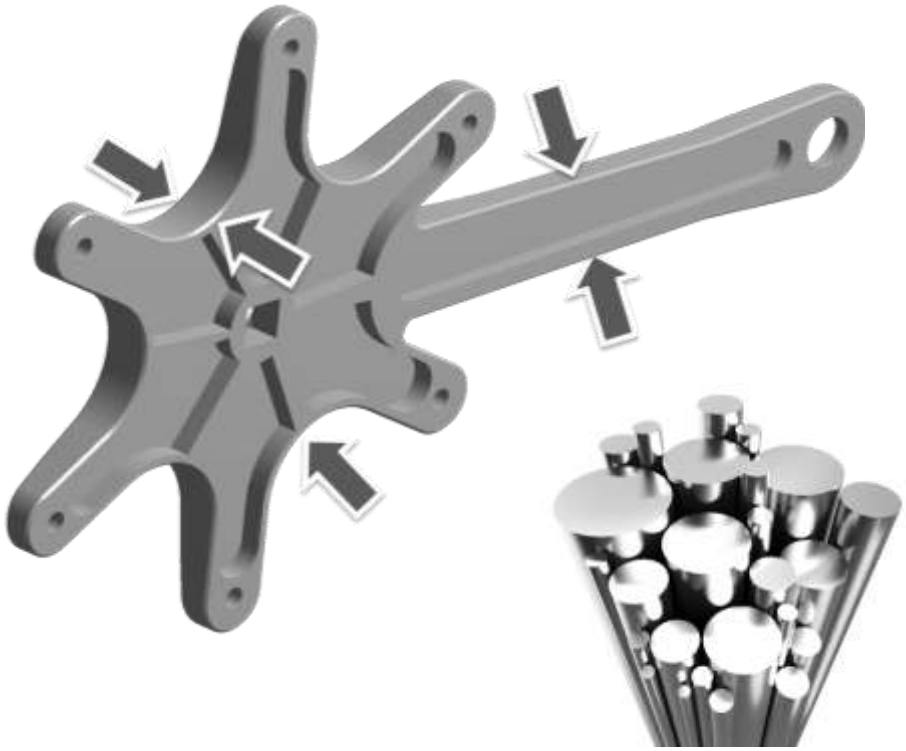
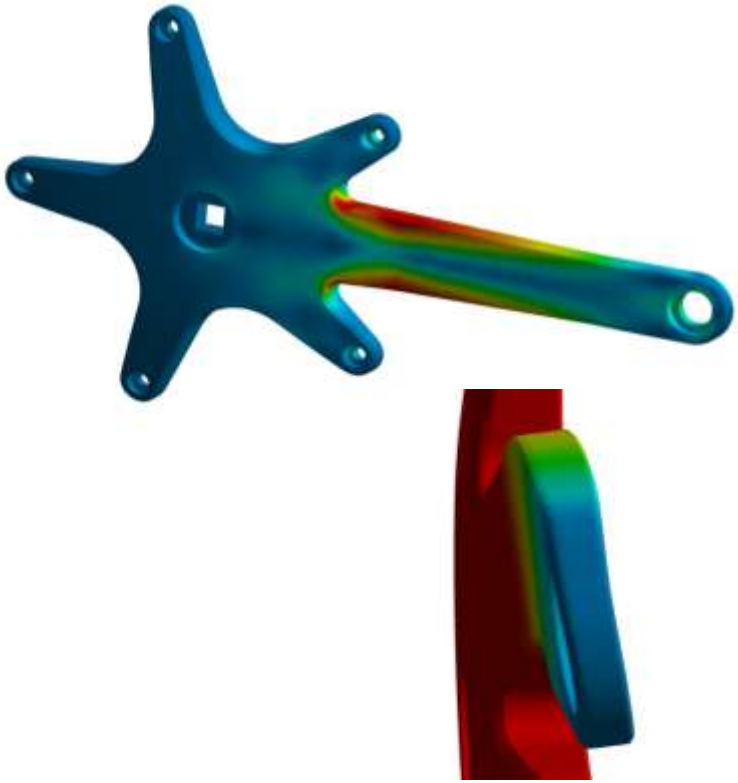
Engineering a Design





Input of engineers defines a final design

Input is based on design evaluations and results

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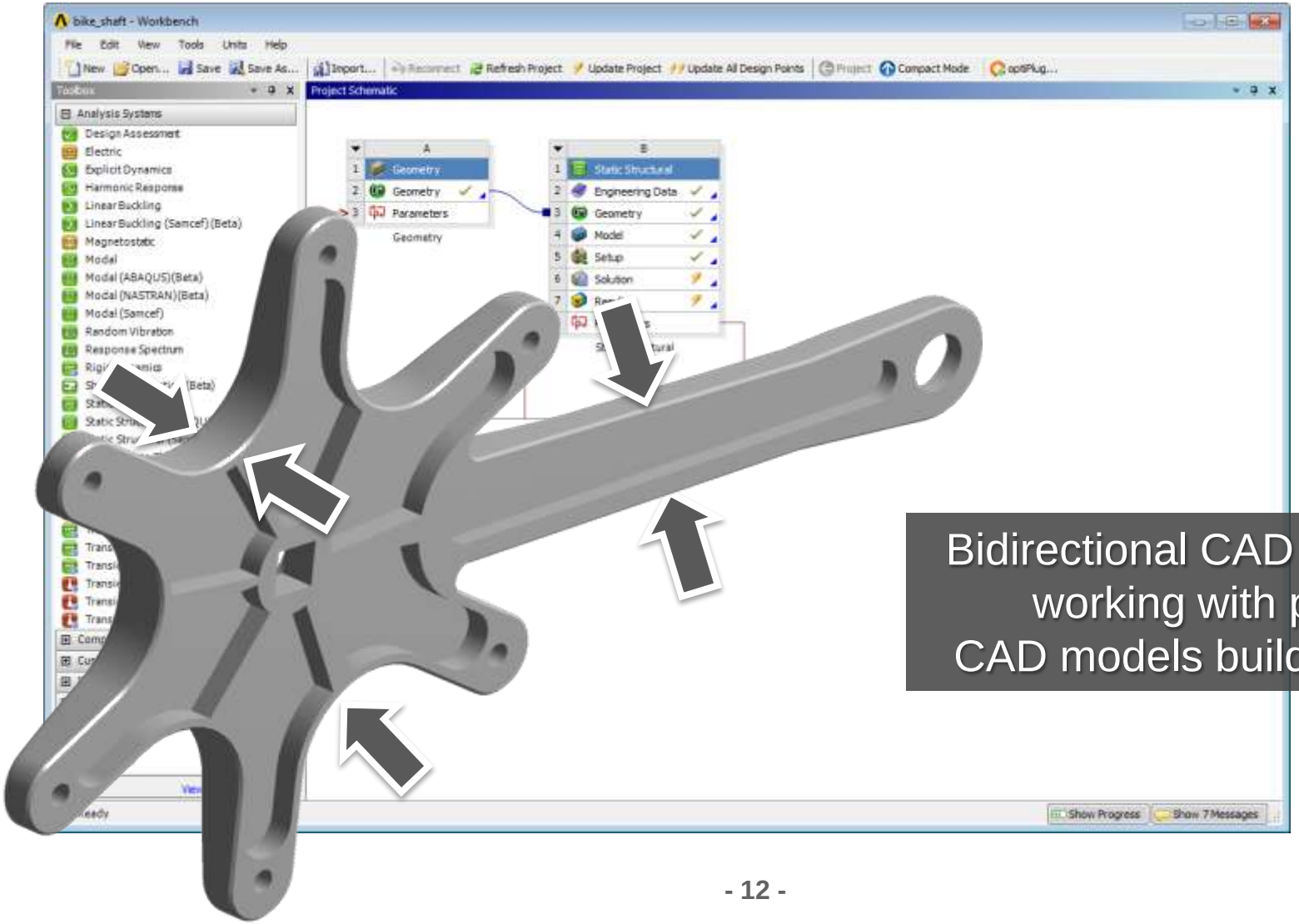
How it Works



Bidirectional CAD interfaces working with parametric CAD models build the basis

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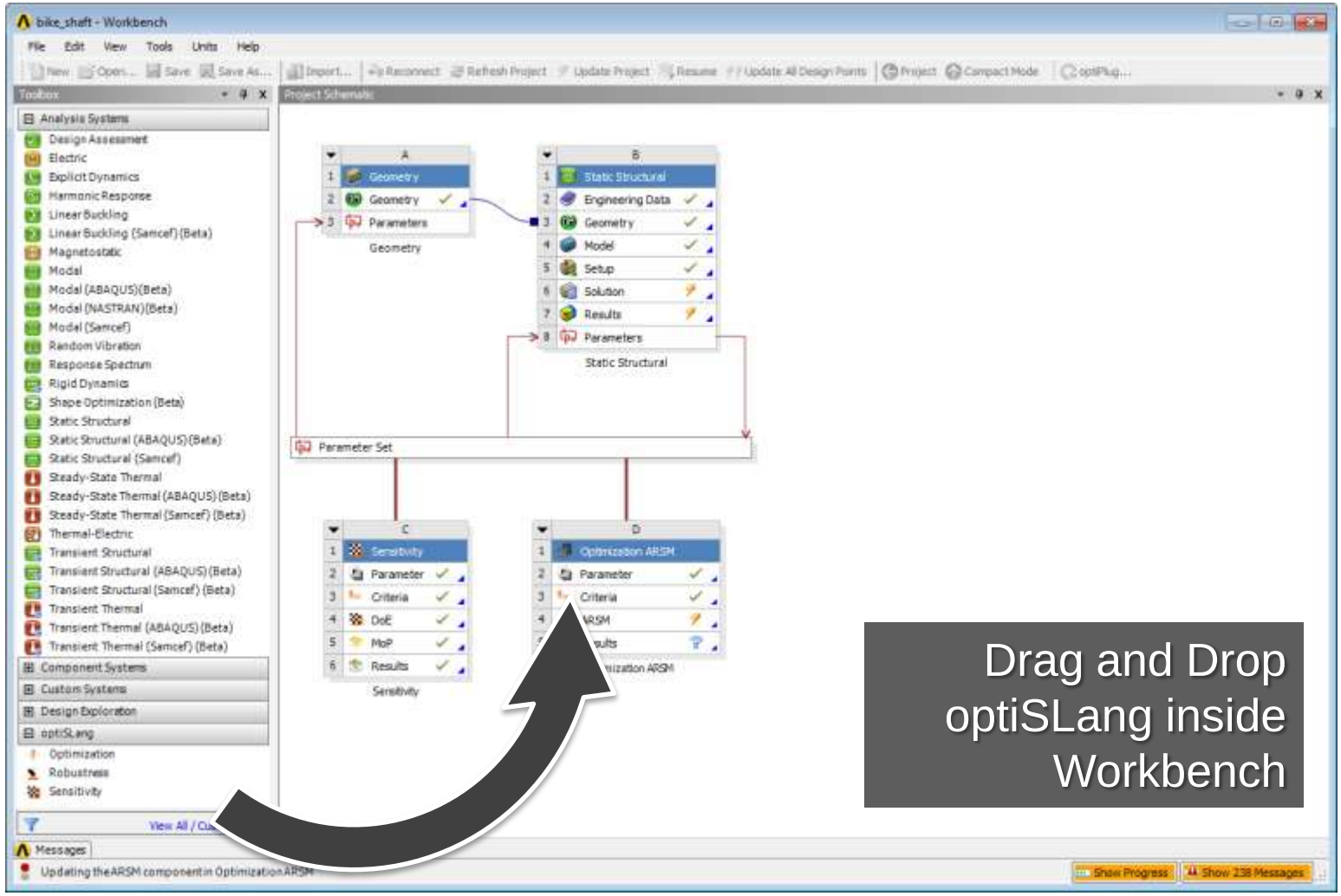
How it Works



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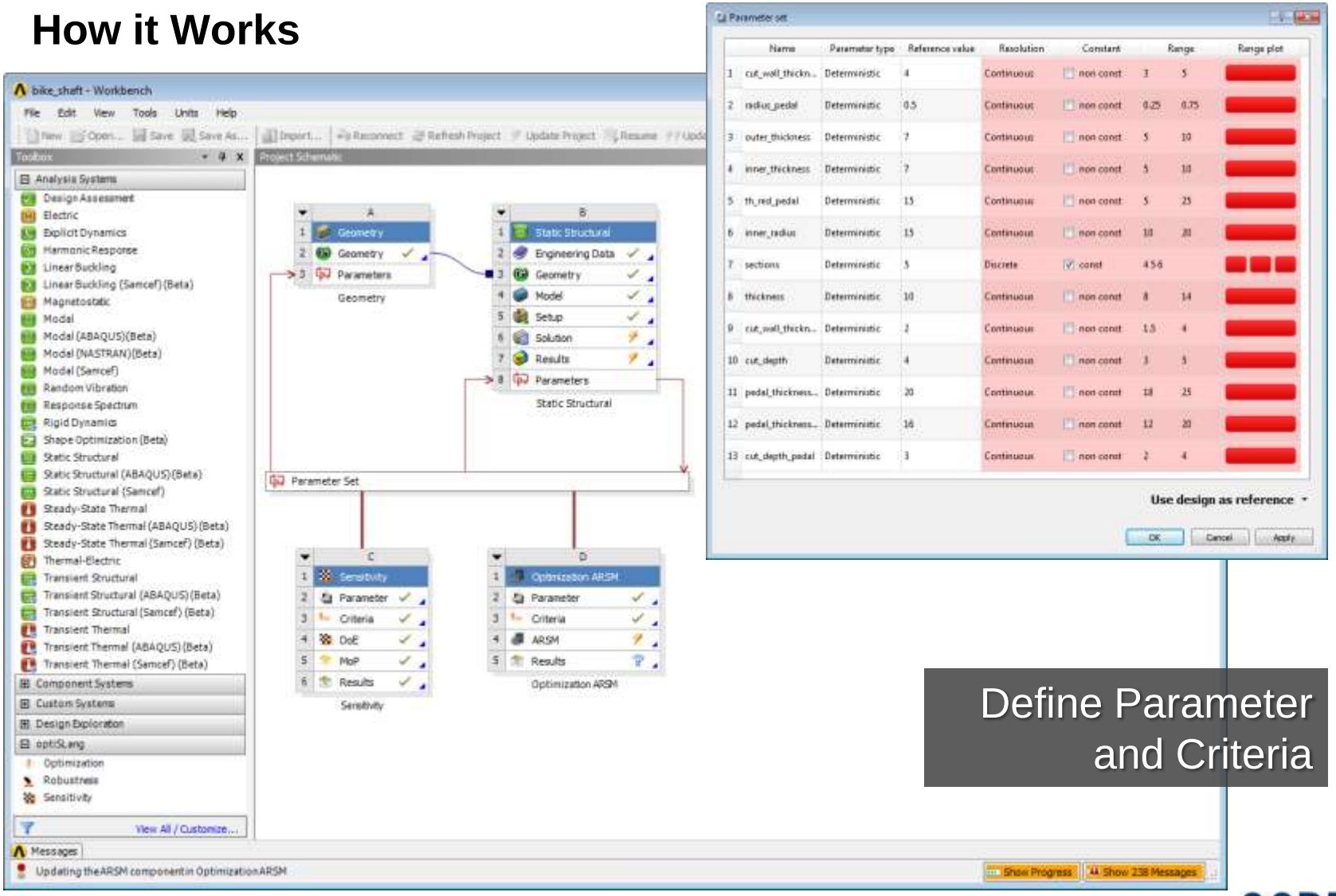
How it Works



Define Parameter and Criteria

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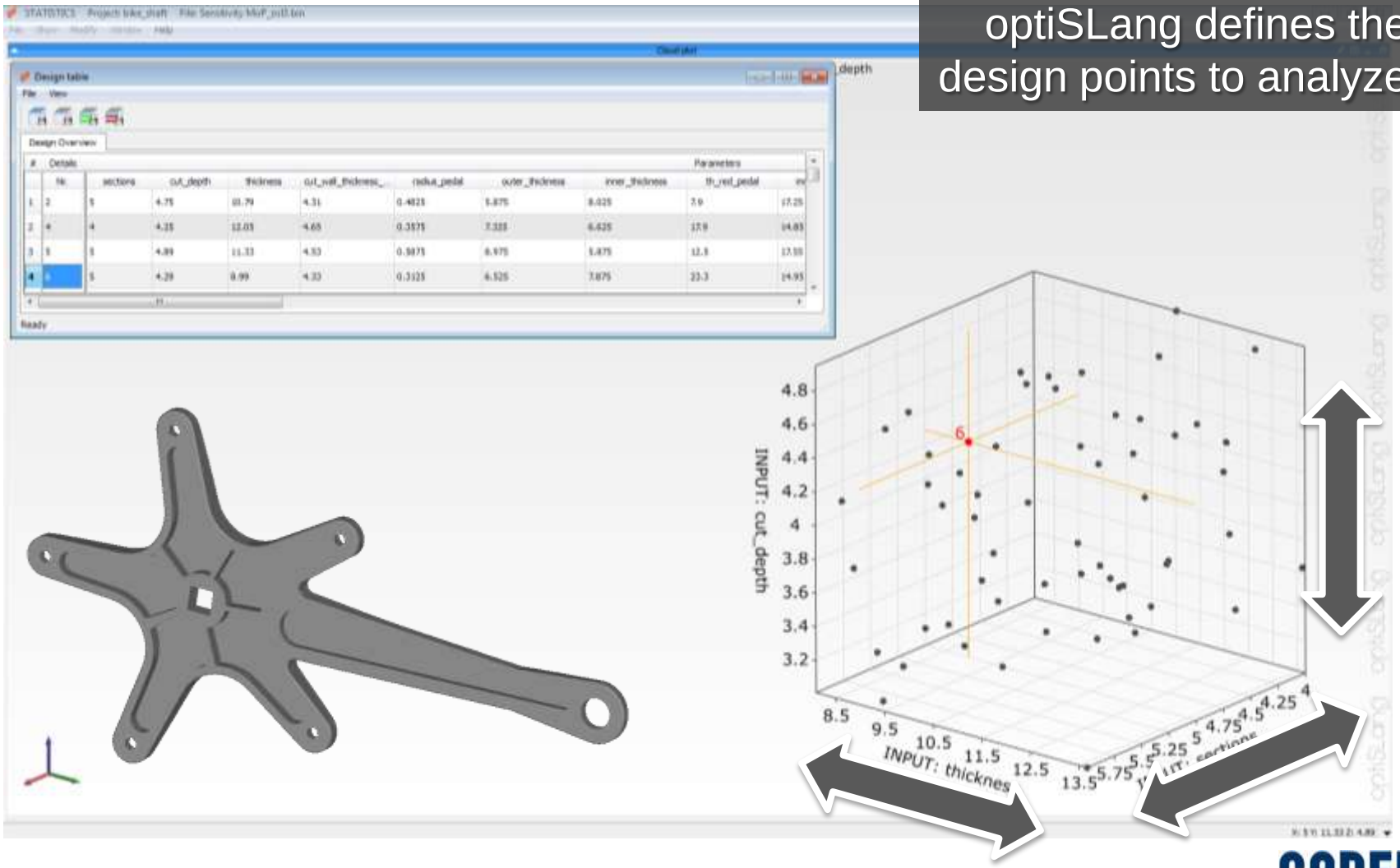
How it Works

optiSLang defines the design points to analyze



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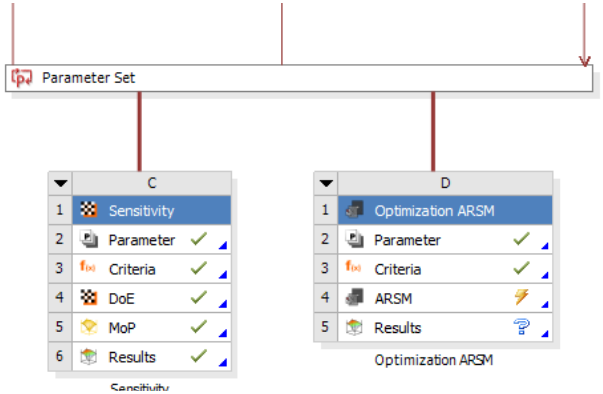
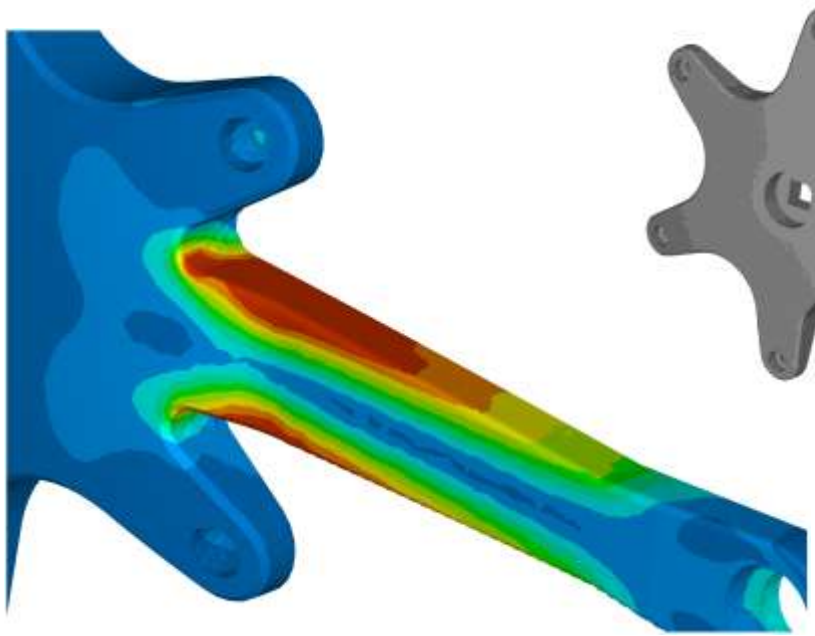
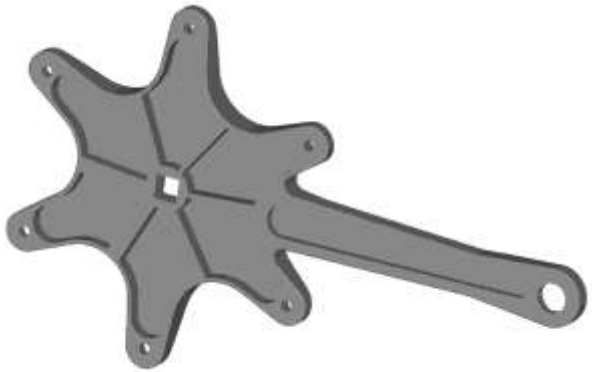
How it Works



Designs are analyzed by ANSYS





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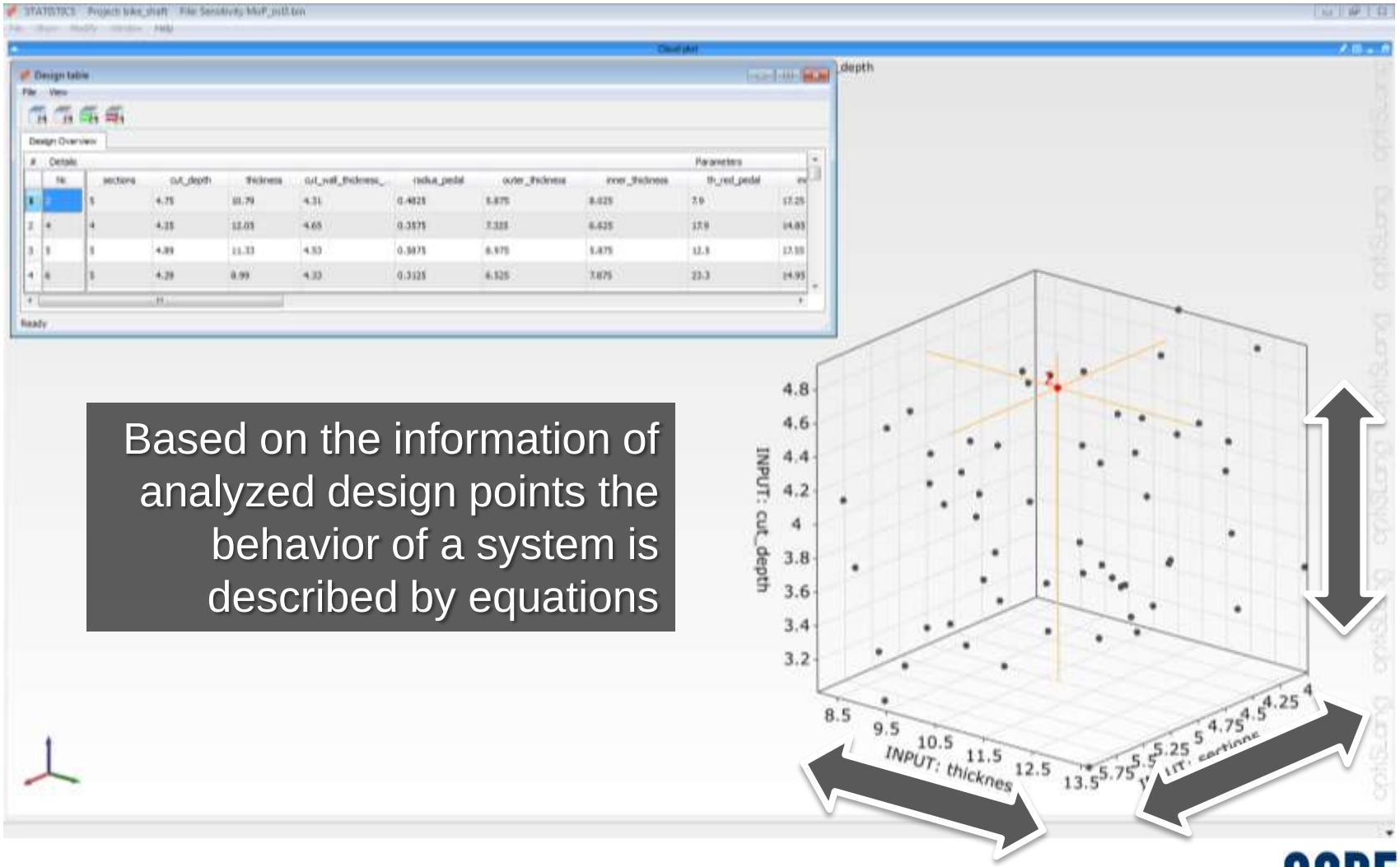
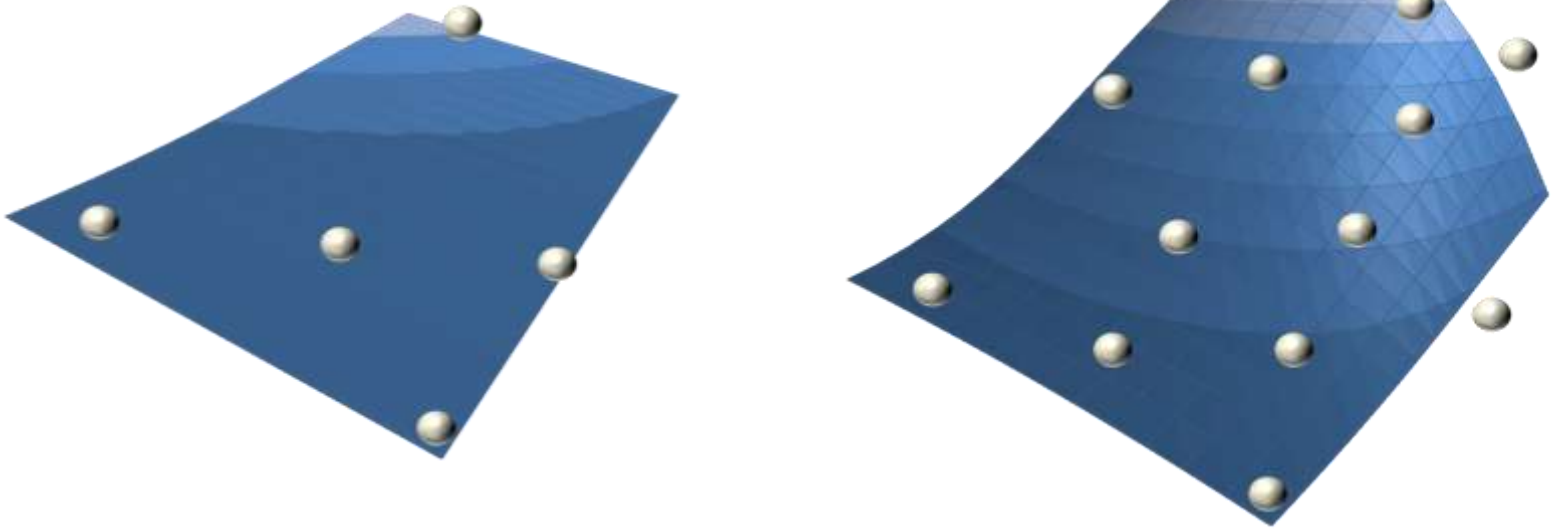
How it Works - optiSLang Defines the Behavior Model



Based on the information of analyzed design points the behavior of a system is described by equations

CADFEM

How it Works - optiSLang Defines the Behavior Model

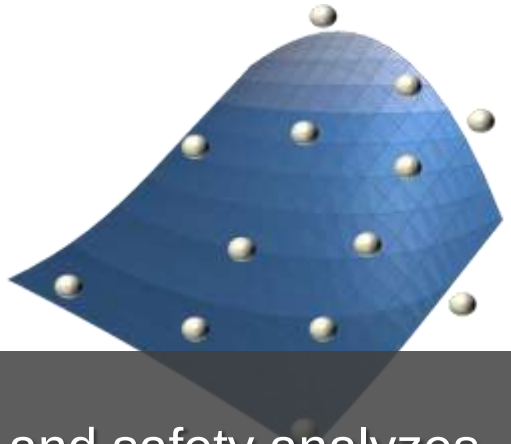


More design points provide more information to define a better model but also require more solver runs.

Which is the best model?

How it Works - optiSLang Defines the Behavior Model

optiSLang automatically eliminates parameter without importance and defines the best fit - the optiSLang behavior model.



The Behavior Model allows design improvements and safety analyzes on the fly - no solver runs, no complicated and time intensive system setup.

optiSLang also validates how good the behavior model represents the systems.

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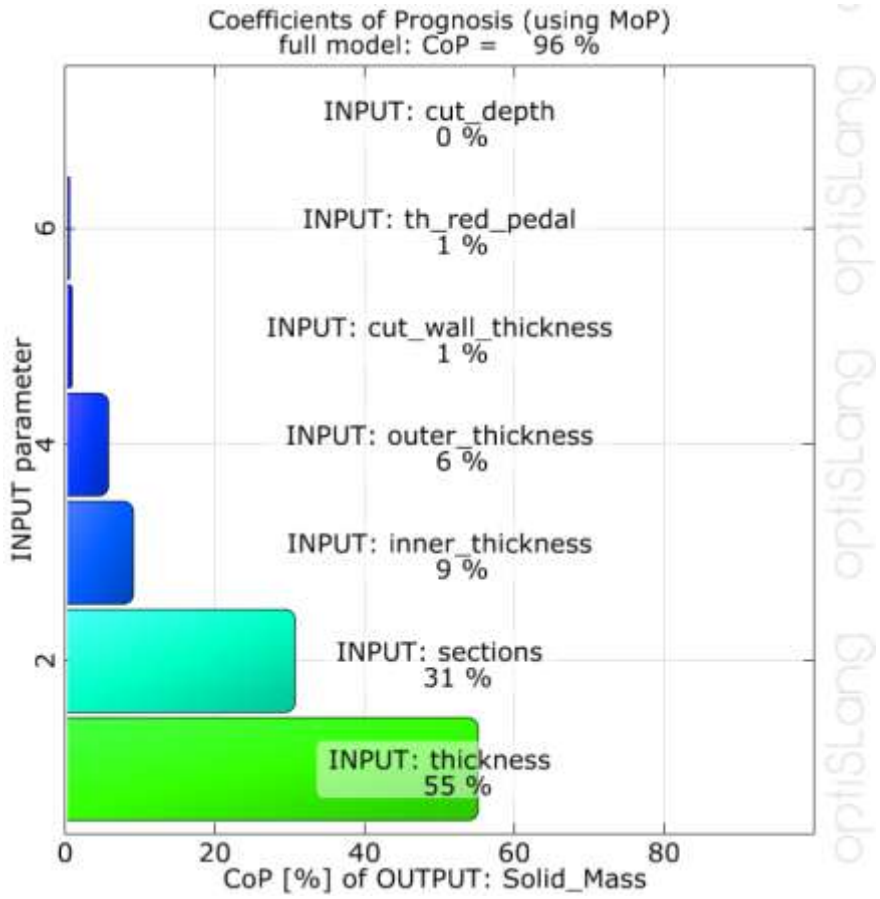
Using optiSLang to Understand a Design

How important are inputs for a result



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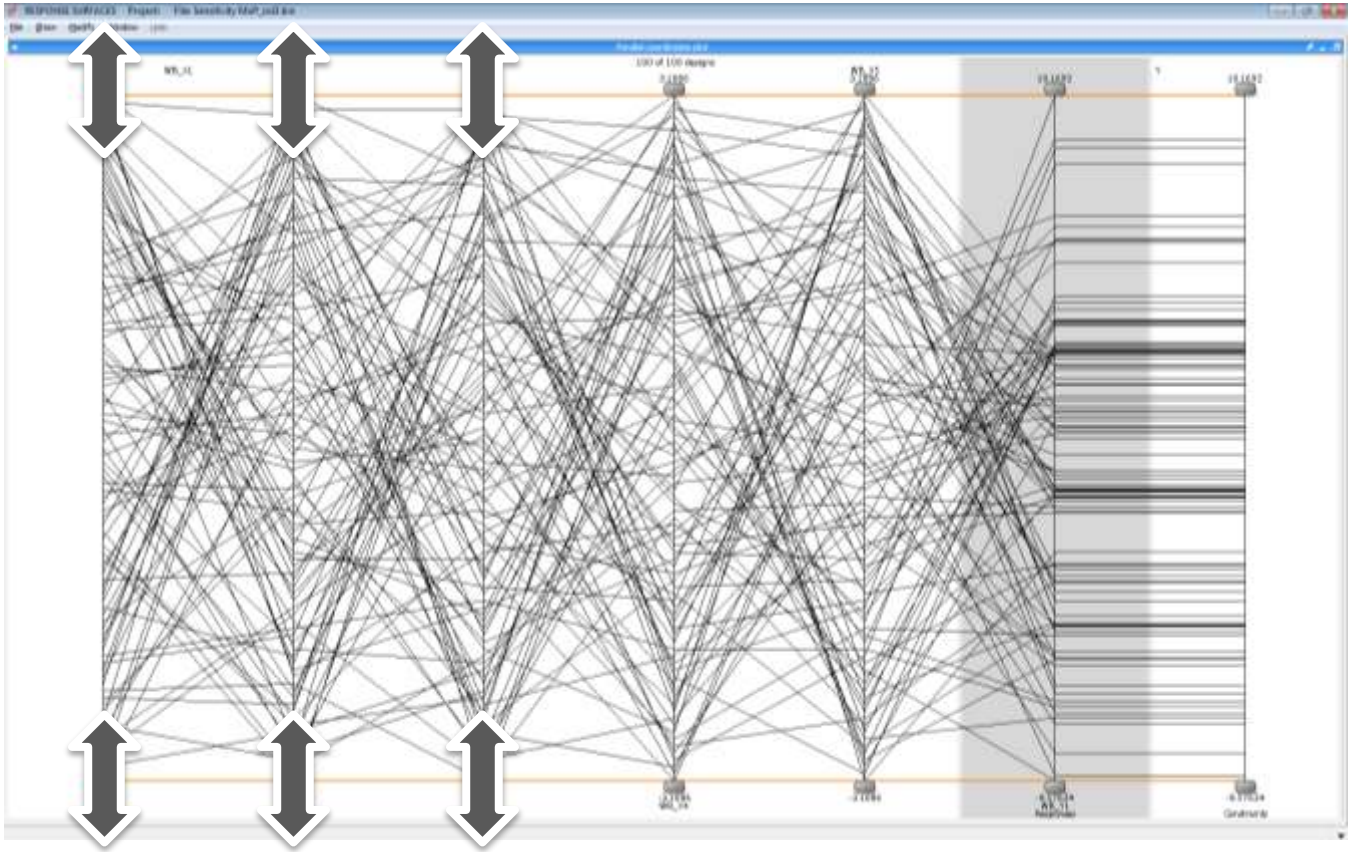
Using optiSLang to Understand a Design

How do I need to change my input



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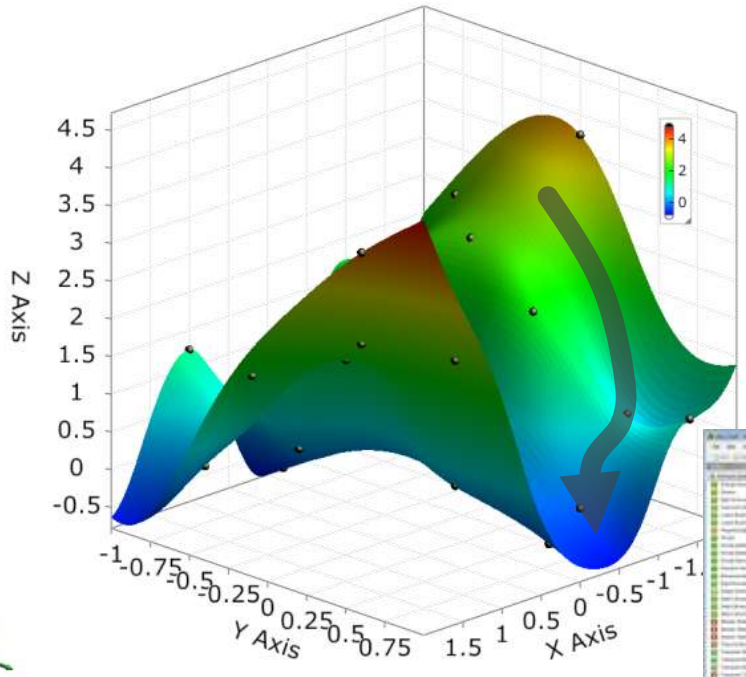
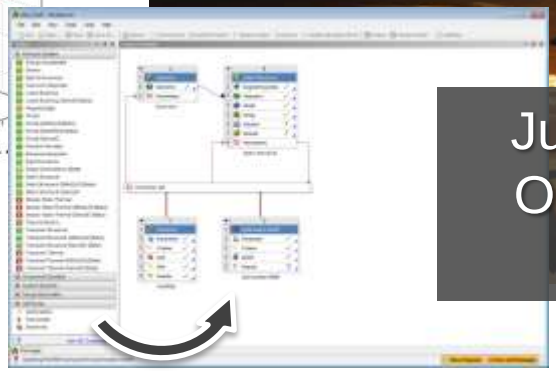
optiSLang Workflow

Improve the Design

Gradient Based Optimization

Nature Inspired Optimization





Just Drag and Drop Optimization on the model

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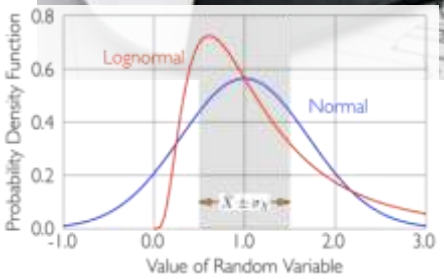
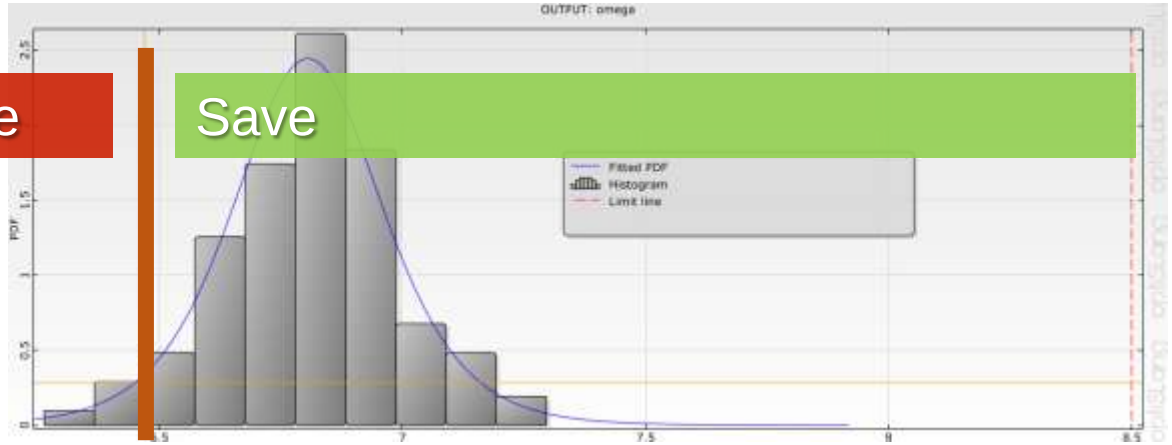
Considering Uncertainties

Analyze the effect of uncertainties and variations on your design. Evaluate failure probabilities using optiSLang.





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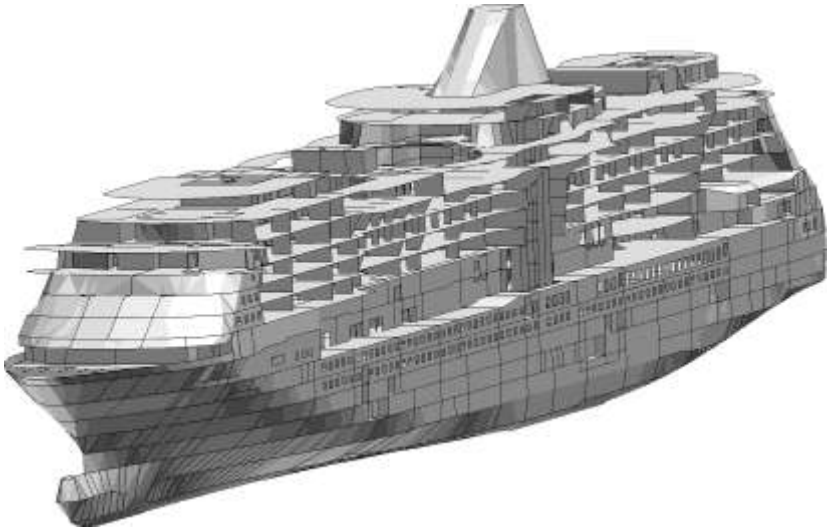
Case Studies optiSLang

Optimizing the Total Weight of a Ship

- 30,000 parameters
- Discrete variables of the sheet thicknesses
- Nature Inspired Optimization
- Reduce the amount of steel used



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10% Weight Savings

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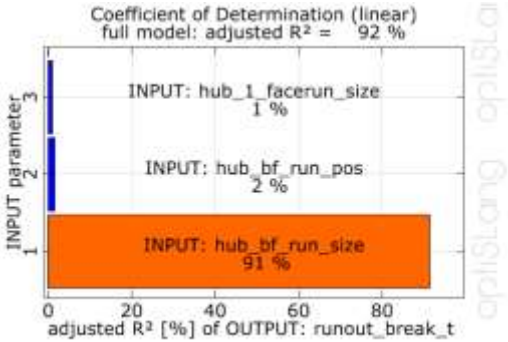
Case Studies optiSLang

Tolerance Check of a Truck Wheel Component

- Manufacturing Tolerances checked
- 43 dimensions analyzed within the tolerance limits
- Possible costs savings in high manufacturing costs



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High manufacturing costs reduced for all but one dimension

Courtesy of TIMKEN Where You Turn

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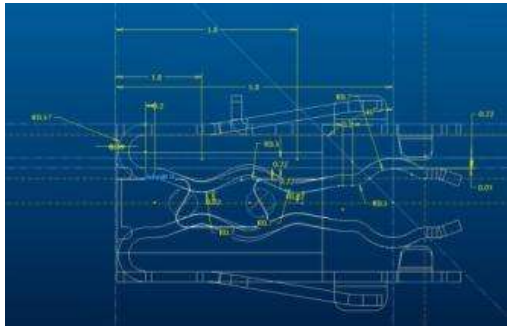
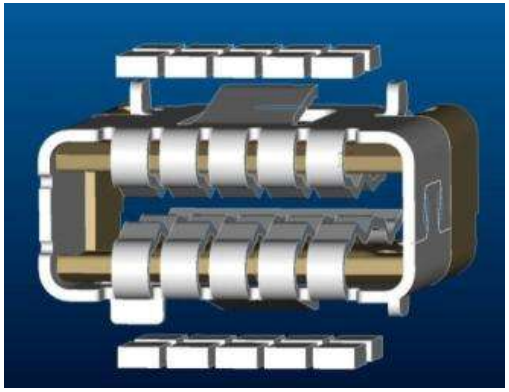
optiSLang Application

Case Studies optiSLang





Electronic Connector

- 31 Design parameters
- Failure occurs when contact forces are smaller than 1N
- Initial failure probability of the design was 89%
- Failure probability less than 1 out 4.300.000 required (6 Sigma Design)

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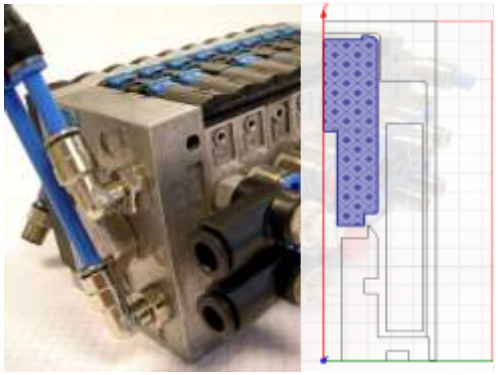
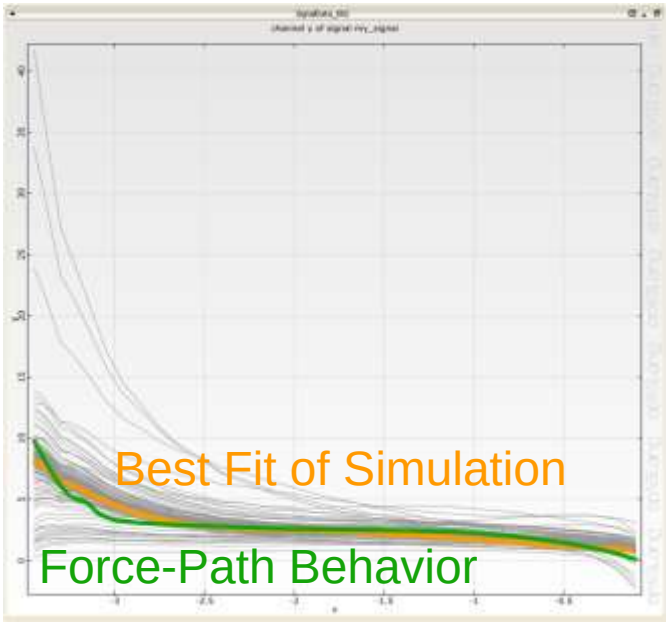
Failure probability reduced to near zero

Case Studies optiSLang



Magnet Valve

- Nonlinear force-path characteristic
- Match system to a specific characteristic
- Complex coupled system simulation in ANSYS Workbench



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optiSLang behavior model used to fit the required characteristic. System parameter determined to match force-path behavior.

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optiSLang Benefits

optiSLang

- Sensitivity - Understand a Design
- Optimization - Use the full potential of a design
- Robustness - Ensure a safe design in real world conditions and don’t get surprised by uncertainties

- Easy to Use - Safe to Use
- Efficient Processing of
  - Systems with nonlinearities and multiple physic domains
  - Design spaces including design failures
  - Low and high number of parameters

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optiSLang Customers

optiSLang Customer