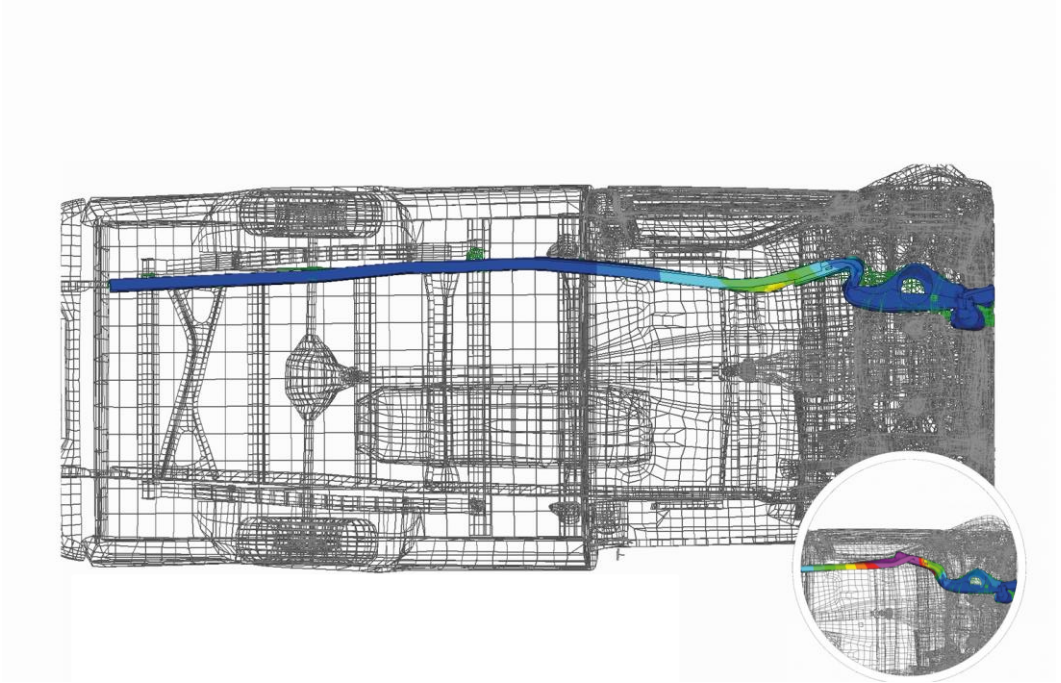
Process to improve optimization with combined robustness analysis results



Dominik Borsotto, Lennart Jansen, Clemens-August Thole

Dominik Borsotto

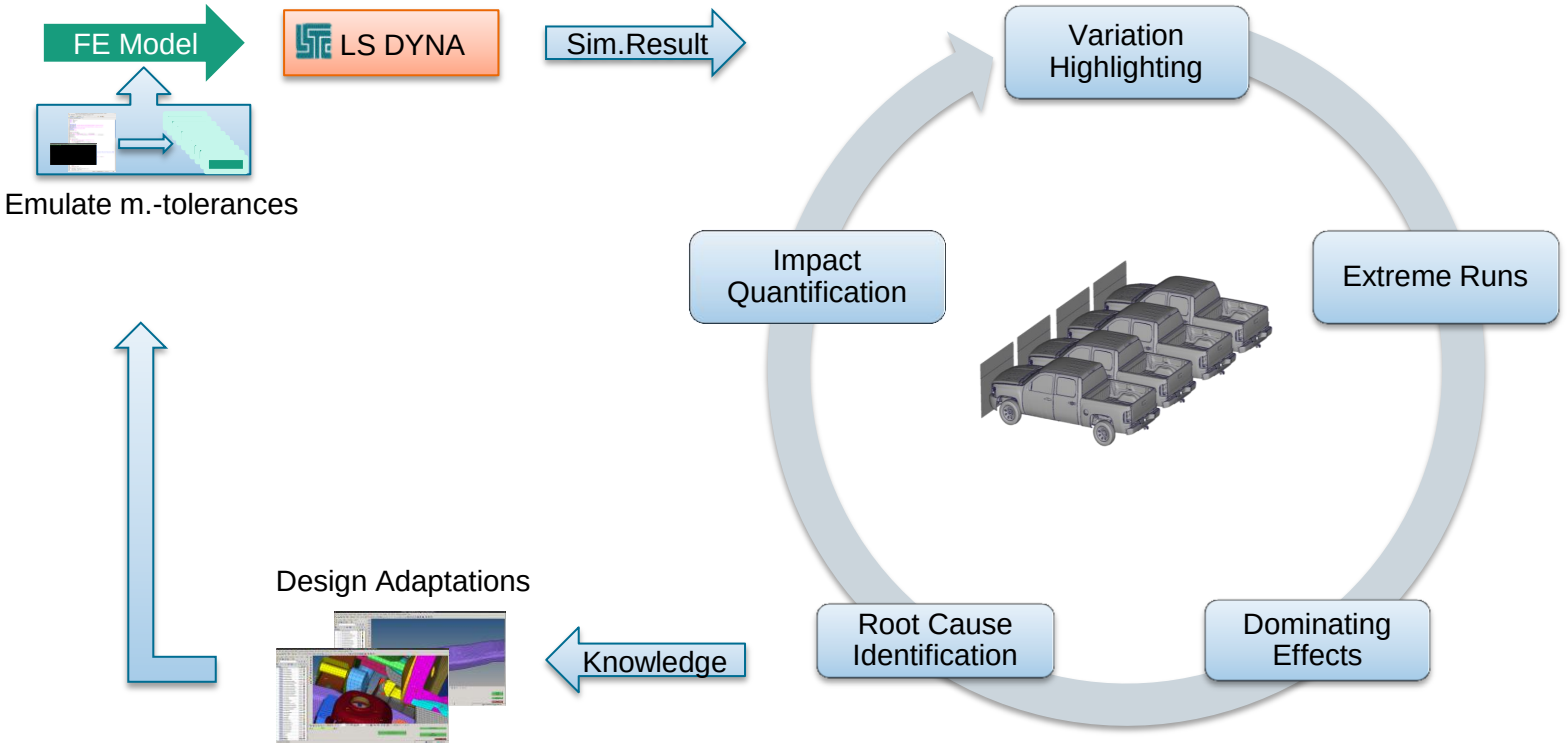
SIDACT GmbH

Agenda

Introduction

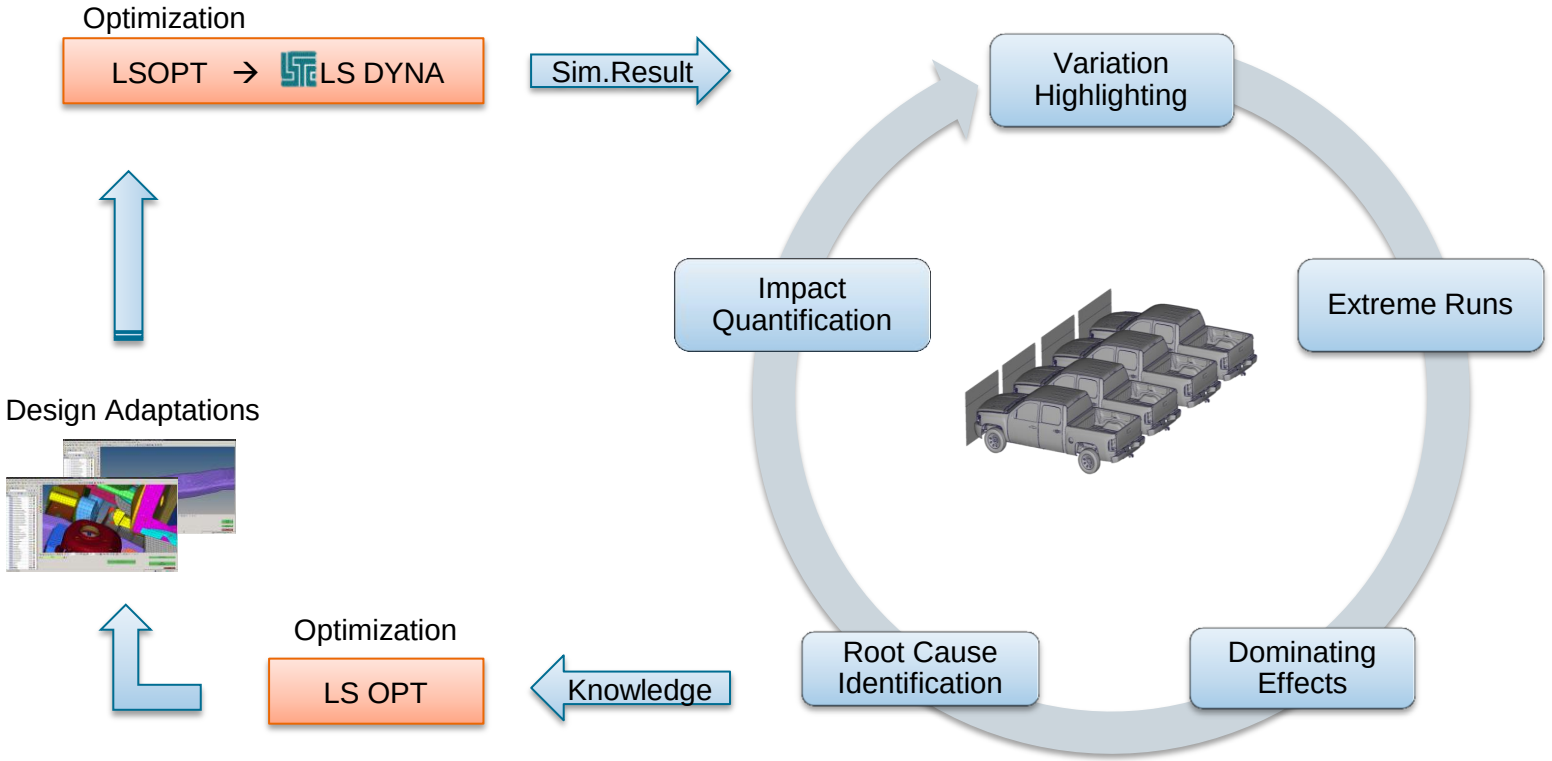
Combined Optimization & Robustness Analysis

Introduction
Robustness Workflow



"The model has been developed by The National Crash Analysis Center (NCAC) of The George Washington University under a contract with the FHWA and NHTSA of the US DOT“
http://www.ncac.gwu.edu/vml/models.html

Introduction
Robustness & Optimization Workflow



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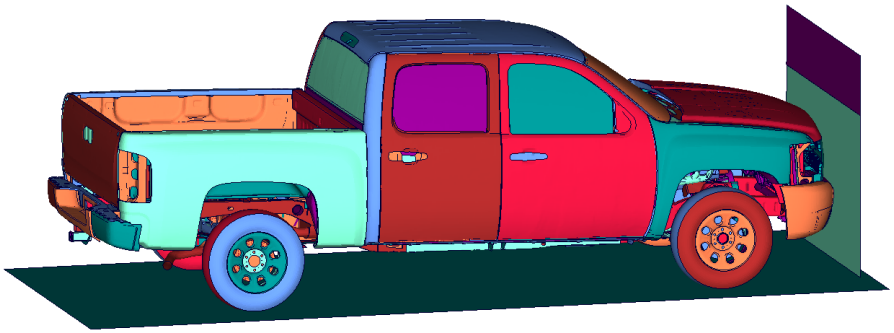
http://www.ncac.gwu.edu/vml/models.html

Optimization: Chevrolet Silverado

Chevrolet Silverado

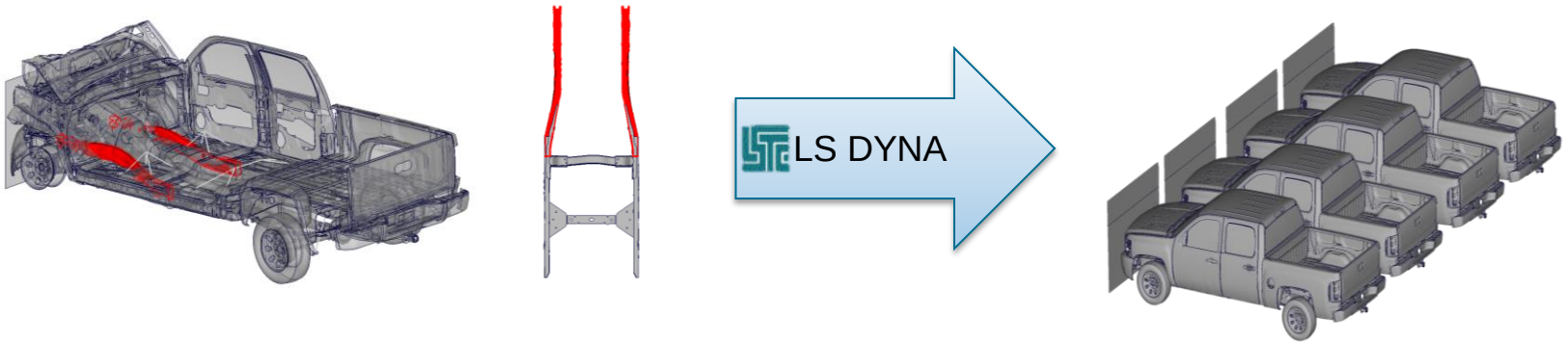


Model	Chevrolet Silverado
Year	2007
Number of Parts	679
Finite-Elements	929,131

"The model has been developed by The National Crash Analysis Center (NCAC) of The George Washington University under a contract with the FHWA and NHTSA of the US DOT“
http://www.ncac.gwu.edu/vml/models.html

Optimization: Dataset

77 Simulation runs with random thickness variations of the longitudinals



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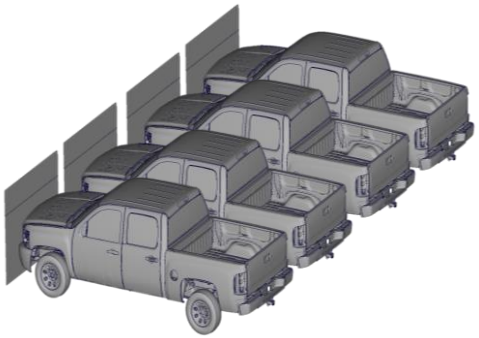
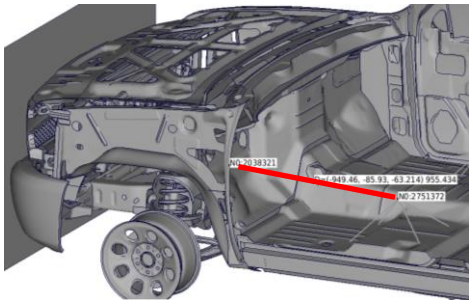
http://www.ncac.gwu.edu/vml/models.html

Optimization: Goals

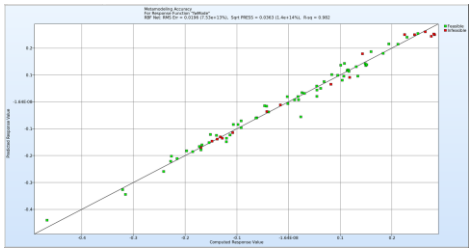


LSOPT



Maximize node distance

Minimize thicknesses (material)

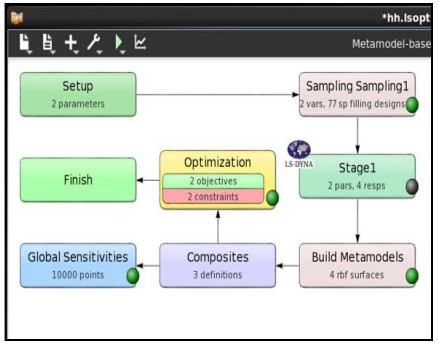


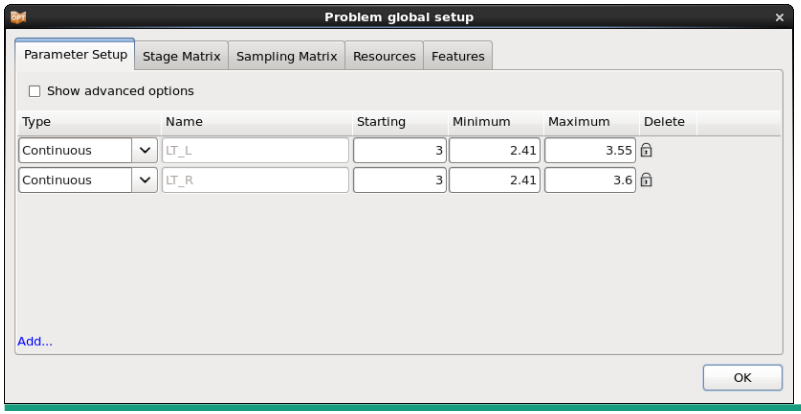
Provide accurate metamodel

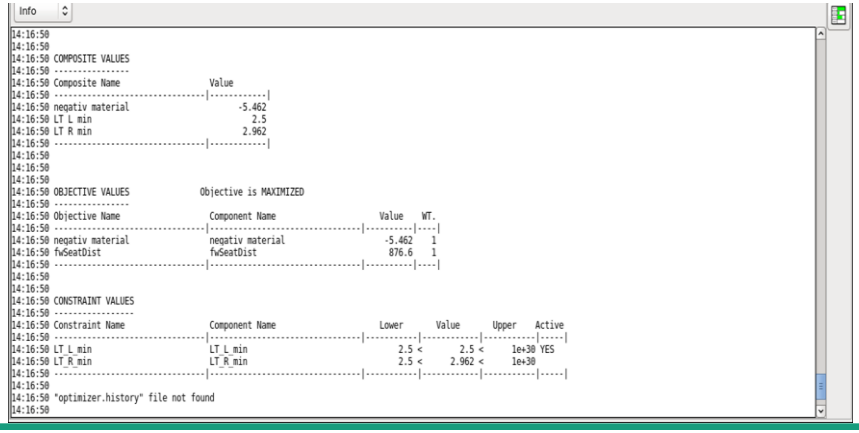
Optimization: LSOPT

DIFFCRASH

- Metamodel optimization
- Input variables: longitudinal thicknesses
- Maximize node distances (between firewall and seat)
- Minimizing the sum of the thicknesses







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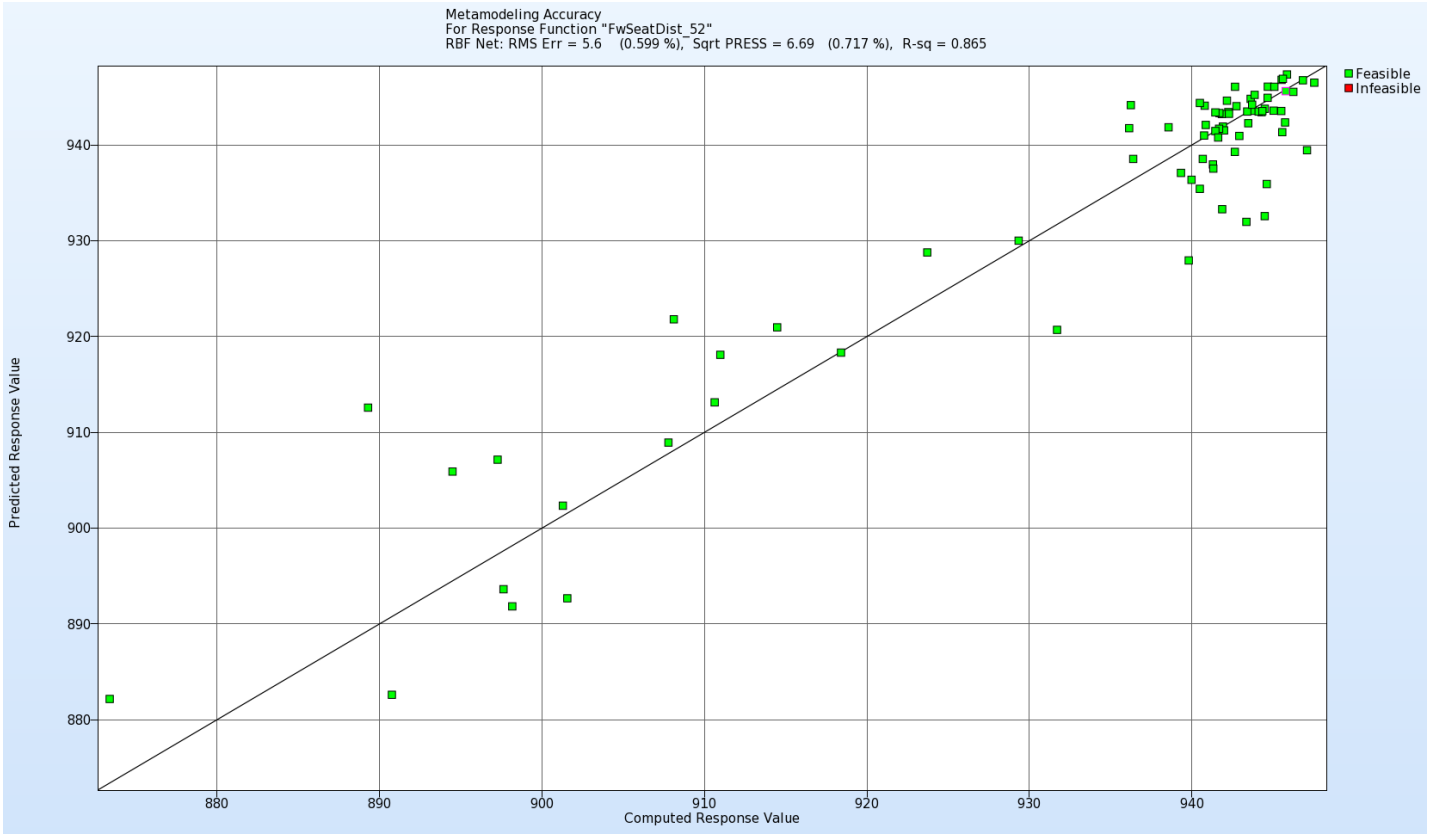
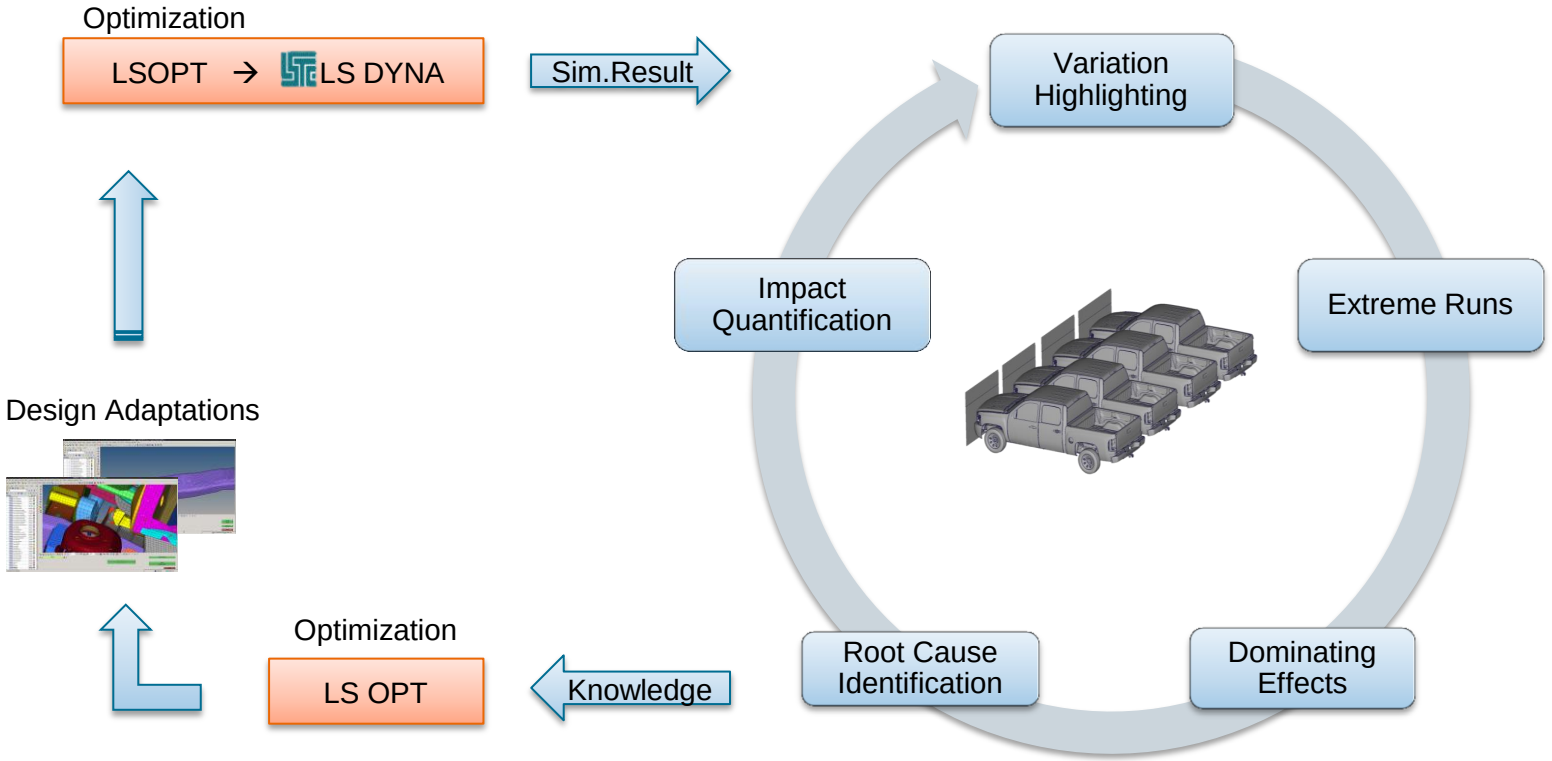
Optimization: Meta Model Quality Node Distance



Robustness Analysis:



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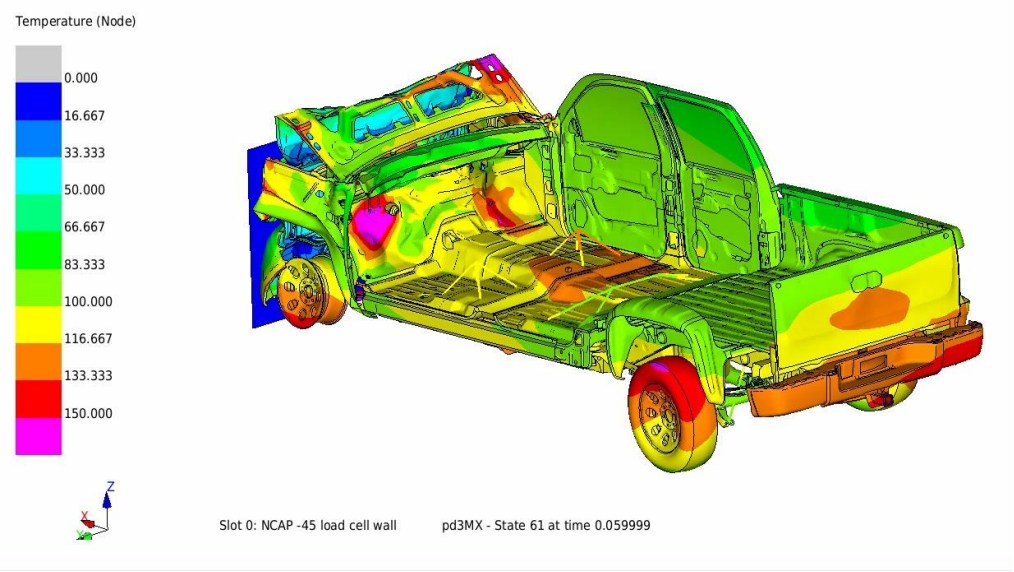
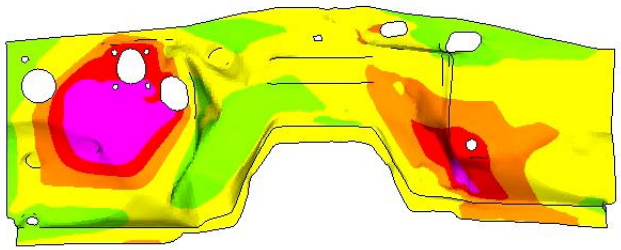
Robustness Analysis: DIFFCRASH

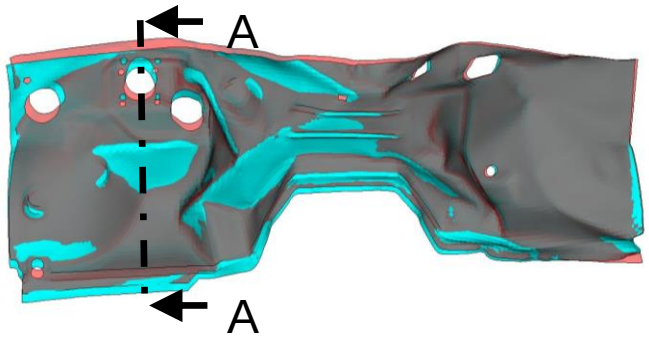
Scatter Overview

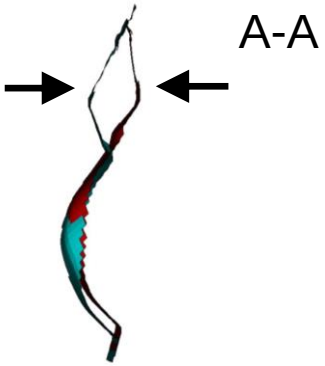


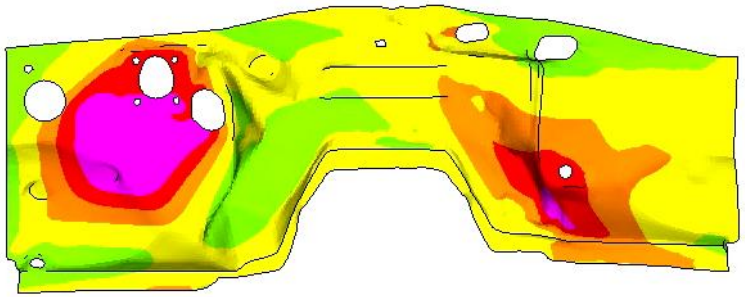


Maximum variation of node position in [mm]

Robustness Analysis: Mode information







→ Intrusion information

→ Replacement for node distance?

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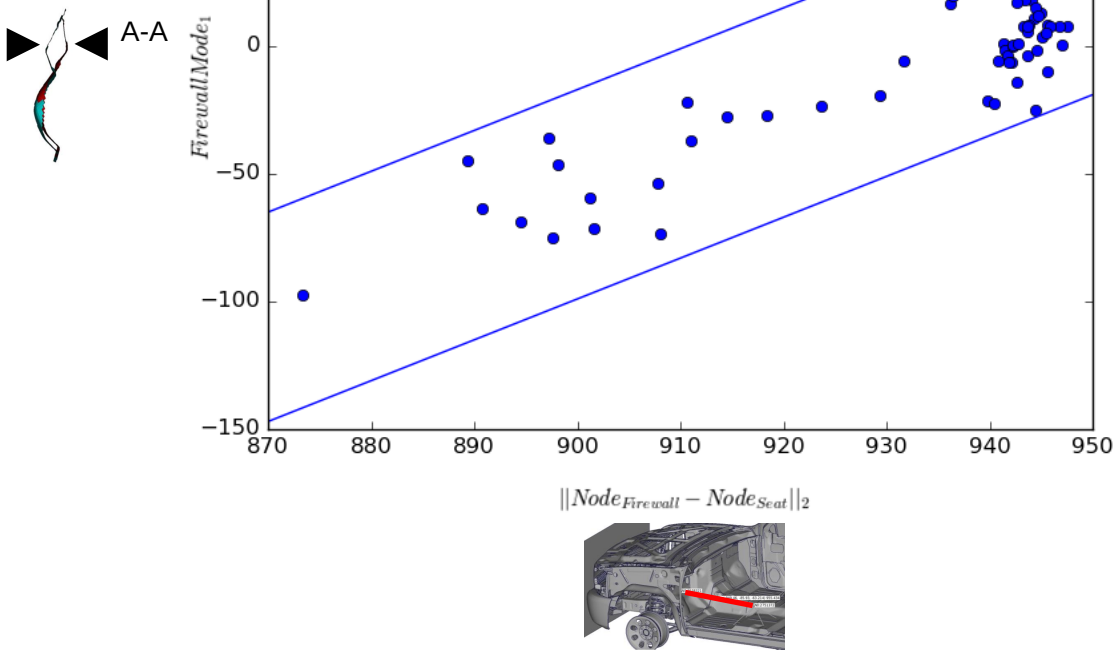
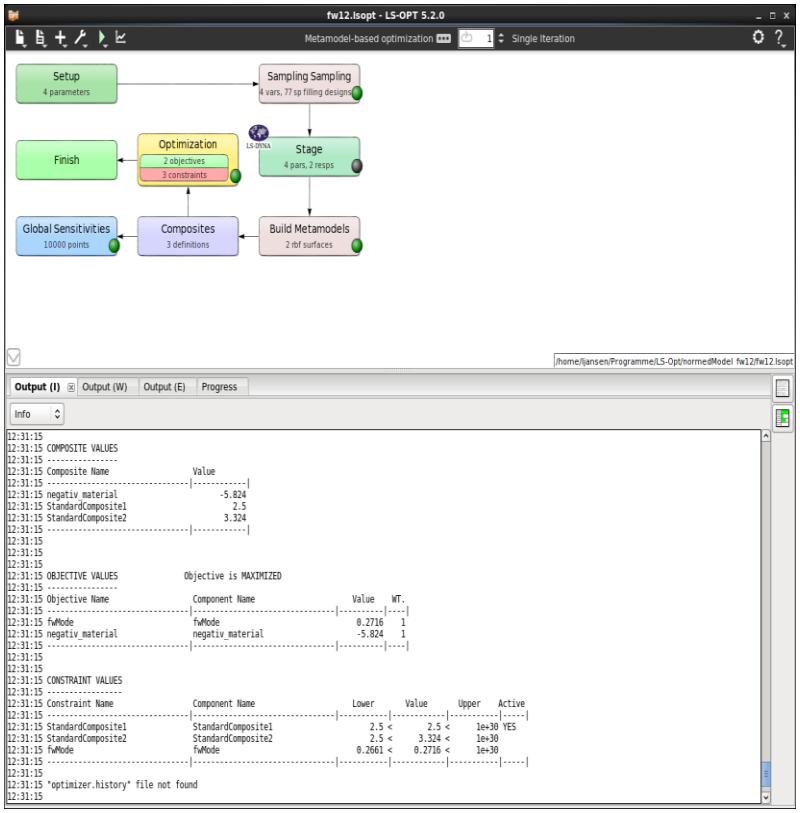
Robustness Analysis: Mode information

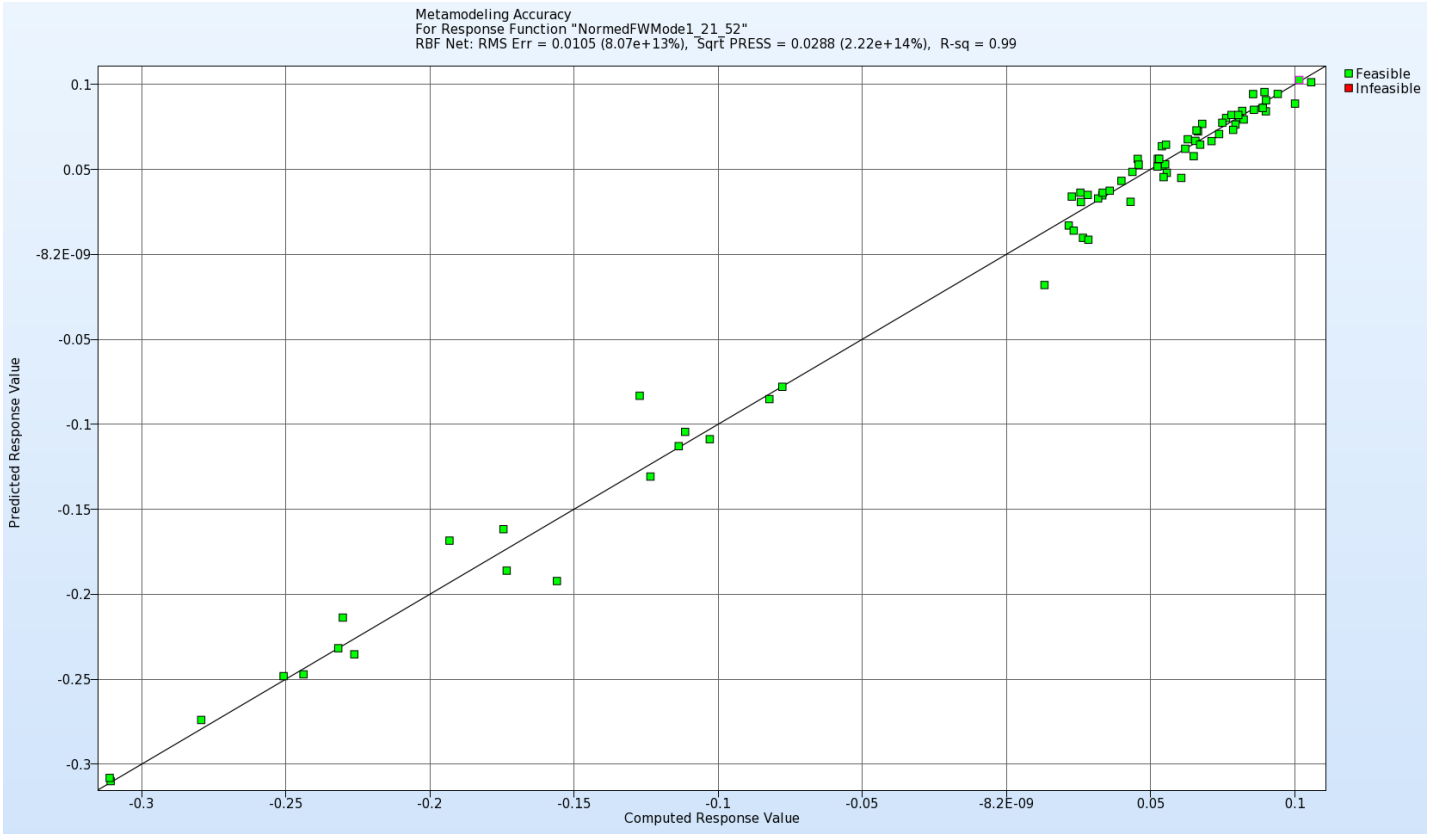


LS-OPT – Mode as objective and variable

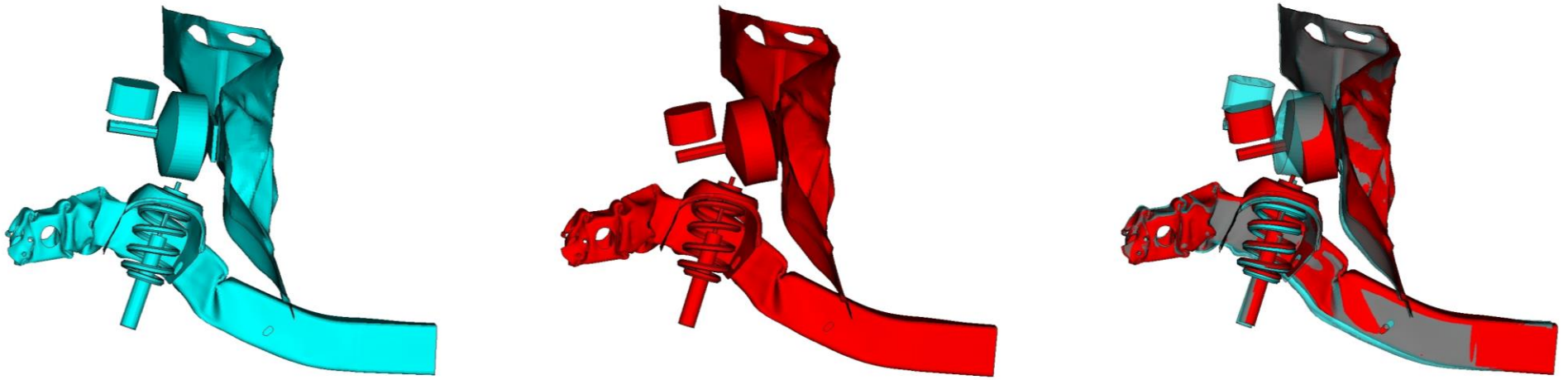
- Firewall mode (intrusion)
- Input variables: longitudinal thicknesses
- Maximize node distances (between firewall and seat)
- Minimizing the sum of the thicknesses



Optimization: Quality of the Meta Model Firewall Mode

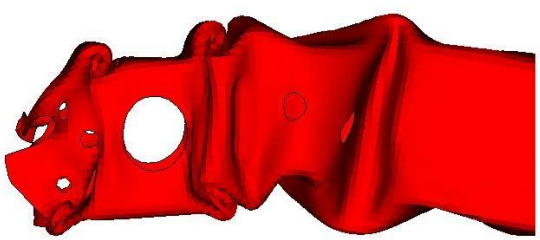


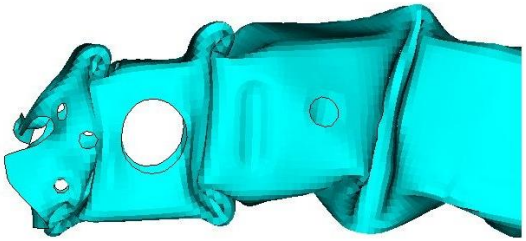
Robustness Analysis: Mode information

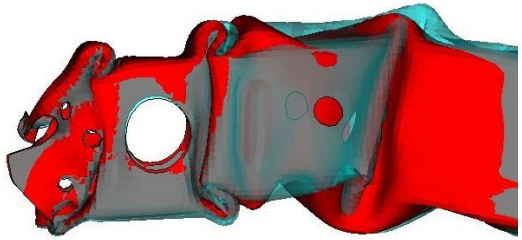


Firewall scatter mode at power-brake

Robustness Analysis: Mode information



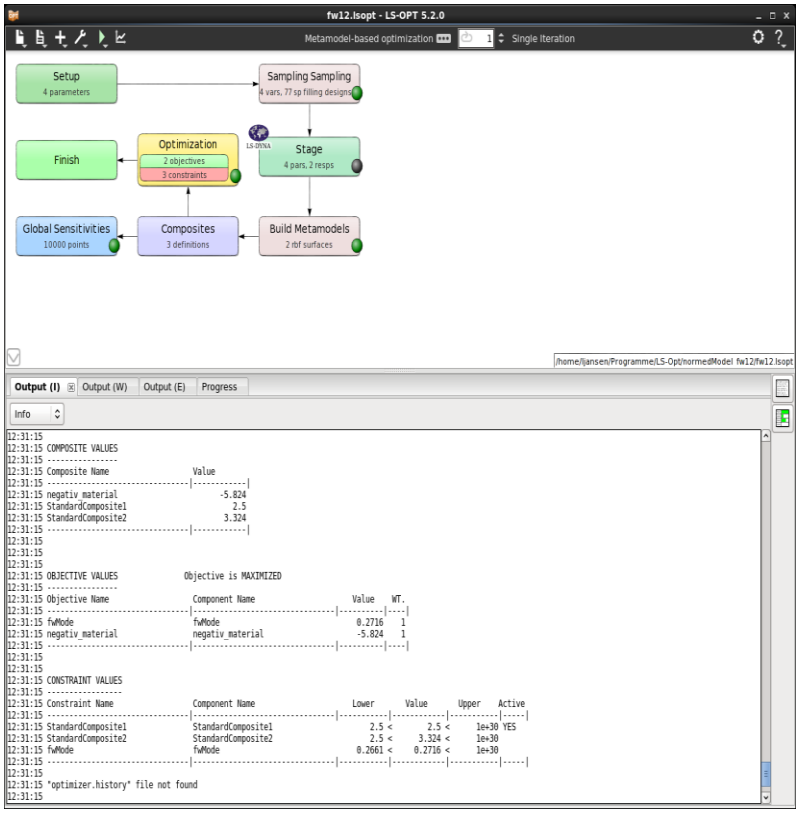




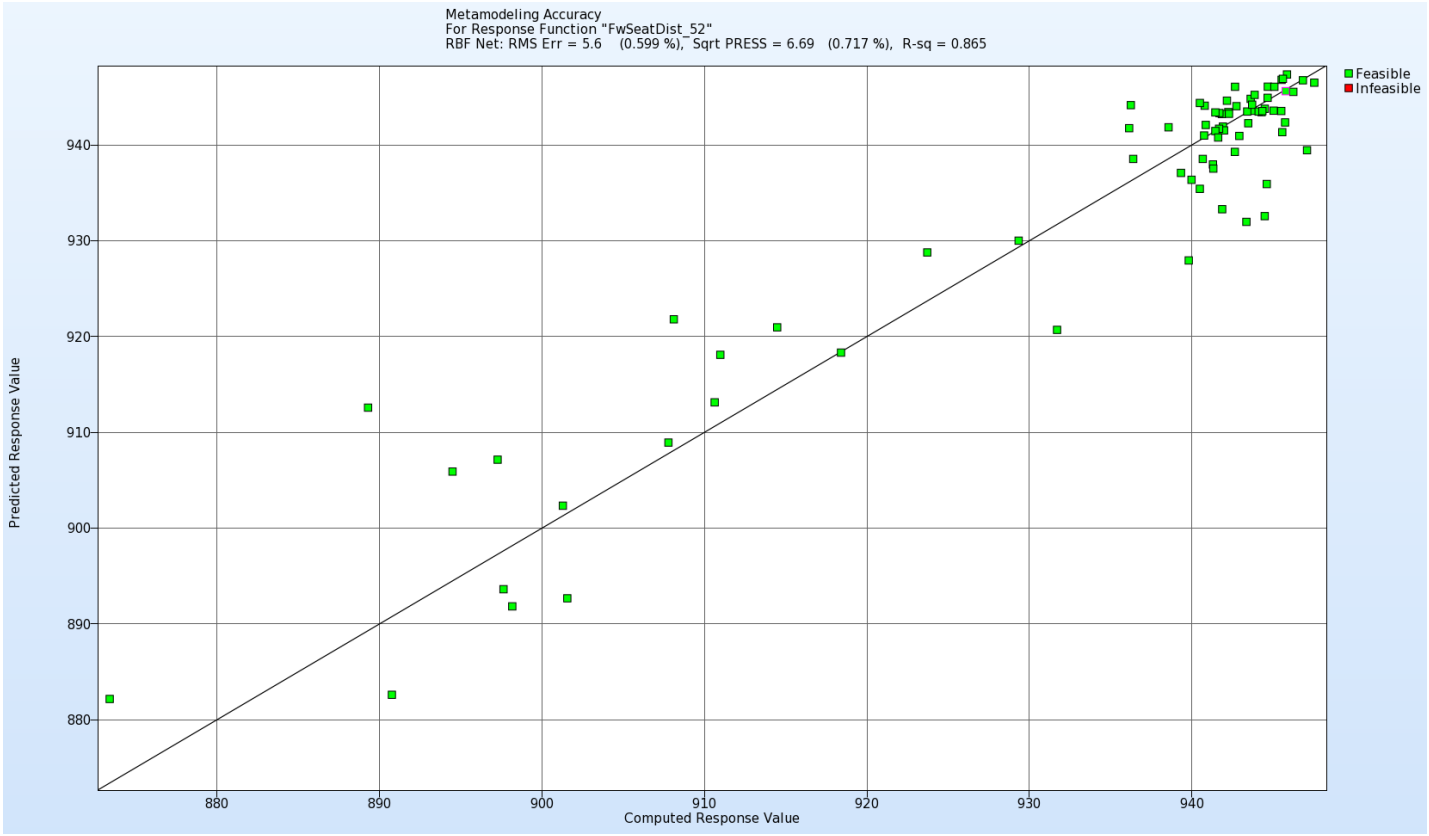
Dominating firewall scatter mode at longitudinal rail

LS-OPT – Mode as objective and variable

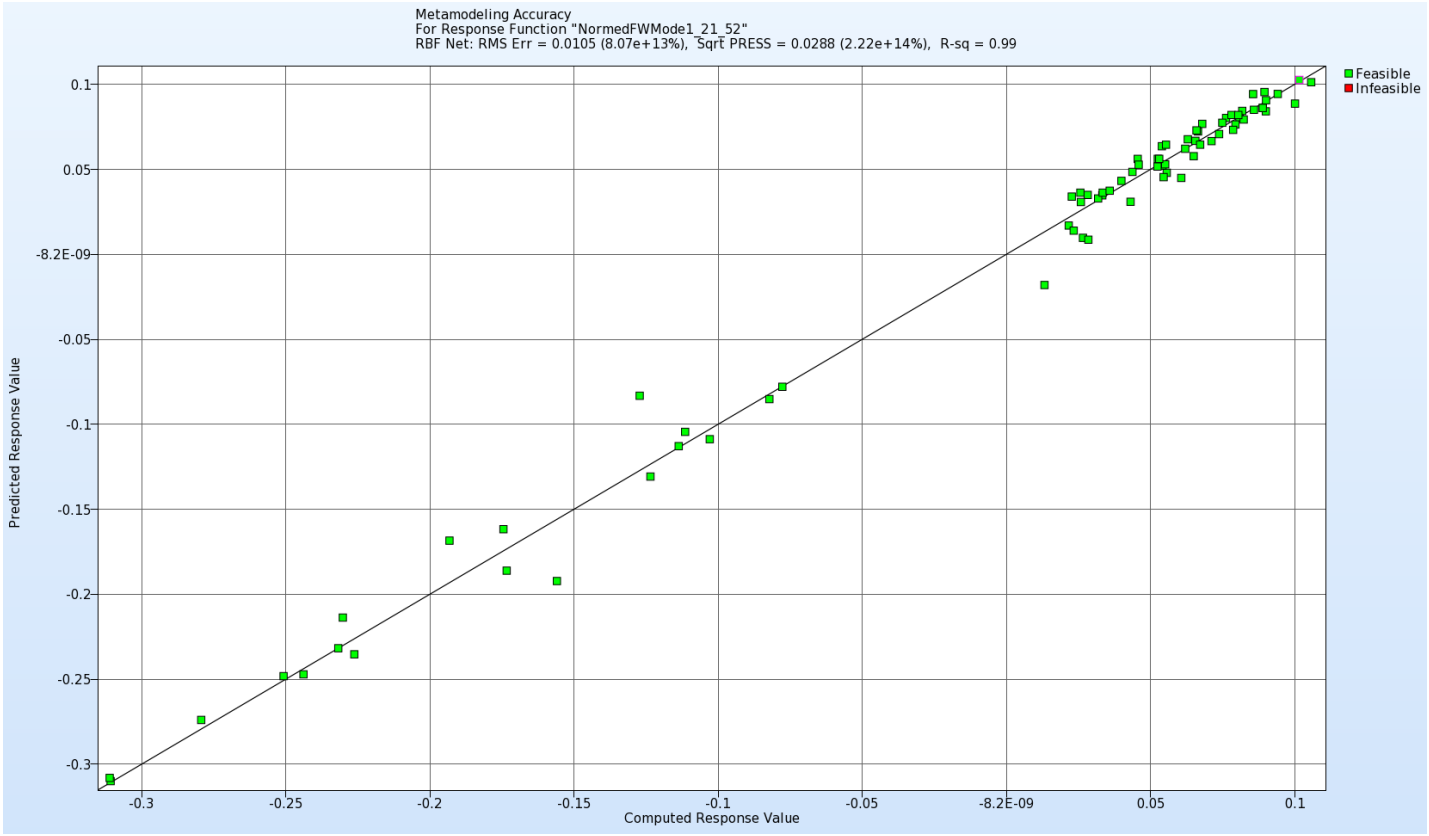
- Firewall mode (intrusion)
- Variables: Brake booster & left longitudinal buckling modes
- Possibility to choose best specification of the modes for our objectives.



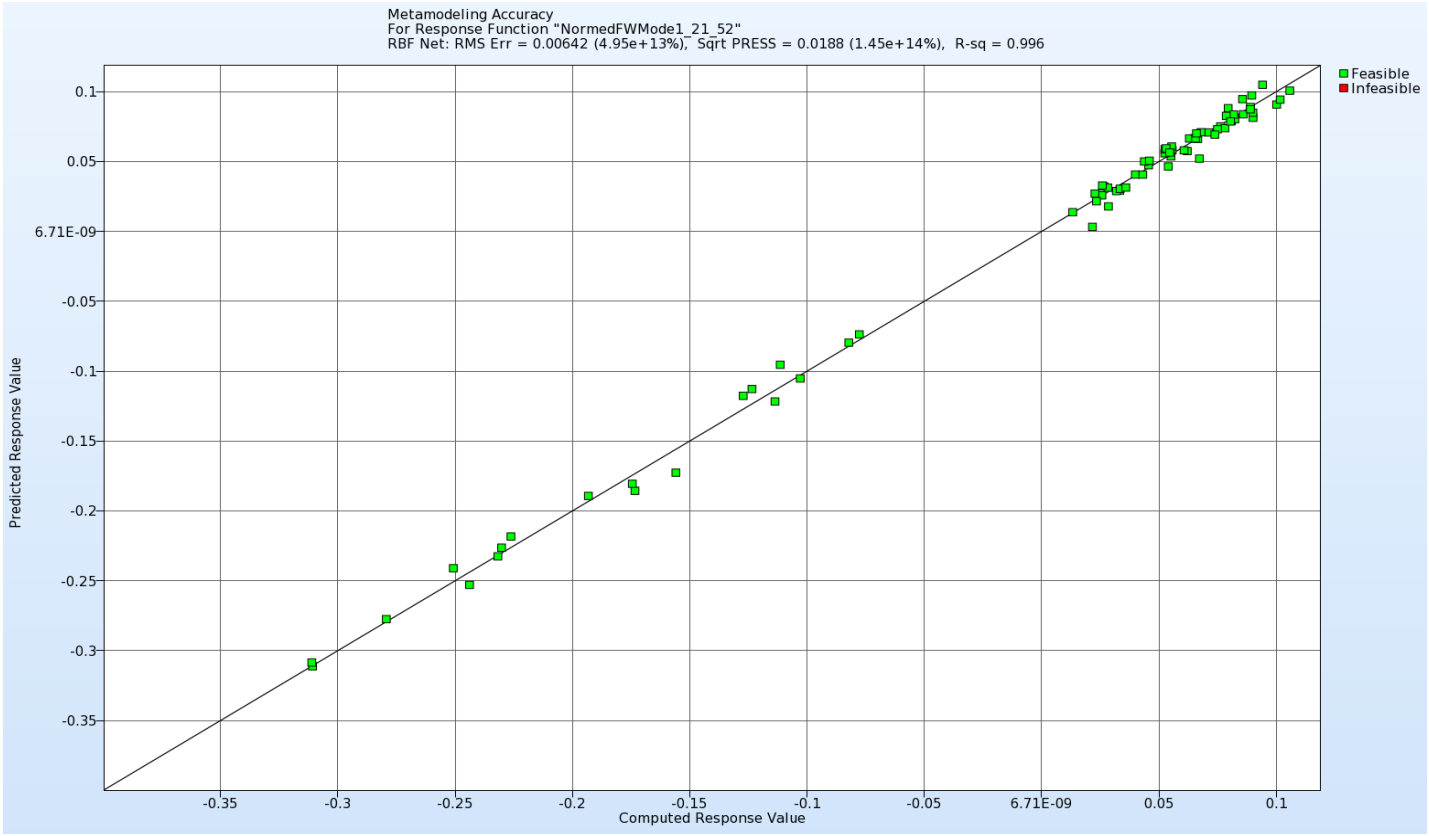
Optimization: Quality of the Meta Model Node Distance



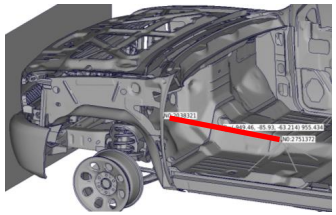
Optimization: Quality of the Meta Model Firewall Mode



Optimization: Meta-Model Accuracy Firewall/BreakBooster



Robustness Analysis: Mode information



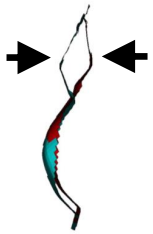
$$LSDYNA\ (D_1, D_2)$$

$$intrusion\big(LSDYNA\ (D_1, D_2)\big)$$

$$\alpha_{FW}\ (D_1, D_2) \cdot M_{\alpha_{FW}}$$

$$\beta_{FW}\ (D_1, D_2) \cdot M_{\beta_{FW}}$$

...



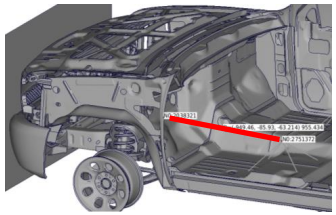
$$intrusion\big(\bar{f} + \alpha_{FW}\ (D_1, D_2) \cdot M_{\alpha_{FW}} + \beta_{FW}(D_1, D_2) \cdot M_{\beta_{FW}} \dots\big)$$

$$intrusion\big(\bar{f} + \alpha_{FW}\ (D_1, D_2, \boldsymbol{I_{BB}}) \cdot M_{\alpha_{FW}} + \beta_{FW}(D_1, D_2, \boldsymbol{I_{BB}}) \cdot M_{\beta_{FW}} \dots\big)$$

$\alpha_{FW}\ (D_1, D_2)$	Metamodel of 1st FW Mode
$\beta_{FW}\ (D_1, D_2)$	Metamodel of 2nd FW Mode
$M_{\alpha_{FW}}$	1st FW Mode
$M_{\beta_{FW}}$	2nd FW Mode
D_i	Thicknesses

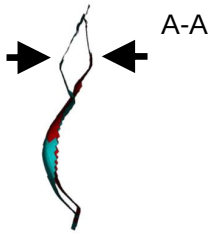
$intrusion$	Function to determine intrusion
$\bar{f}$	Average simulation result

Robustness Analysis: Mode information



Modes describe geometrical deformation of an area compared to single points

Less prone to locale effects (e.g creasing)



Modes can be used as additional input variables as well as objectives

Describing effects, modes allow a classification (preferred behavior vs bad behavior)

This enables us to use a combined optimization with robustness knowledge

Thank you for your attention!

Dominik Borsotto