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FRIENDSHIP SYSTEMS a DNV GL company

Robust Design Optimization for Operational Profiles

La Spezia – February 17th, 2014

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EMship Advanced Design

EMShip - *Advanced Master in Naval Architecture*

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EMship Advanced Design

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Where the research was performed?

- Potsdam – Germany

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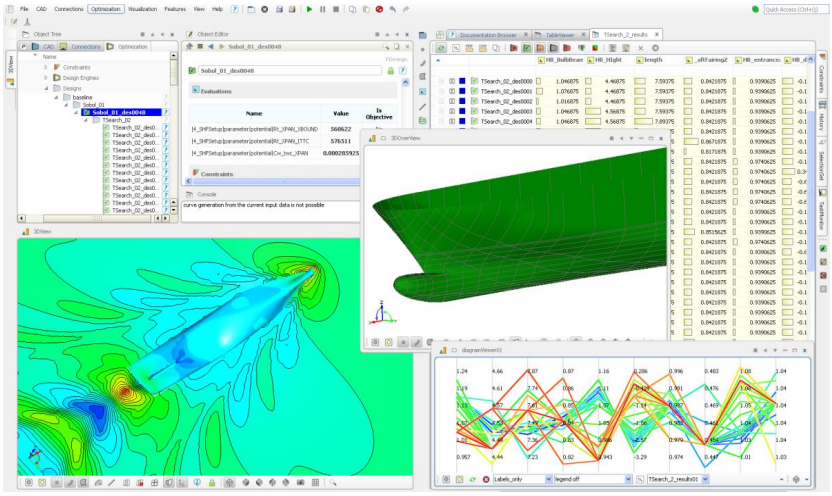

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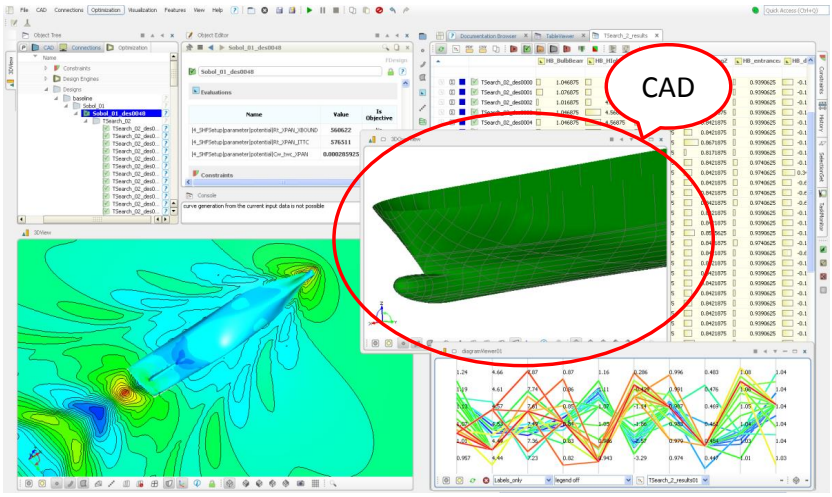

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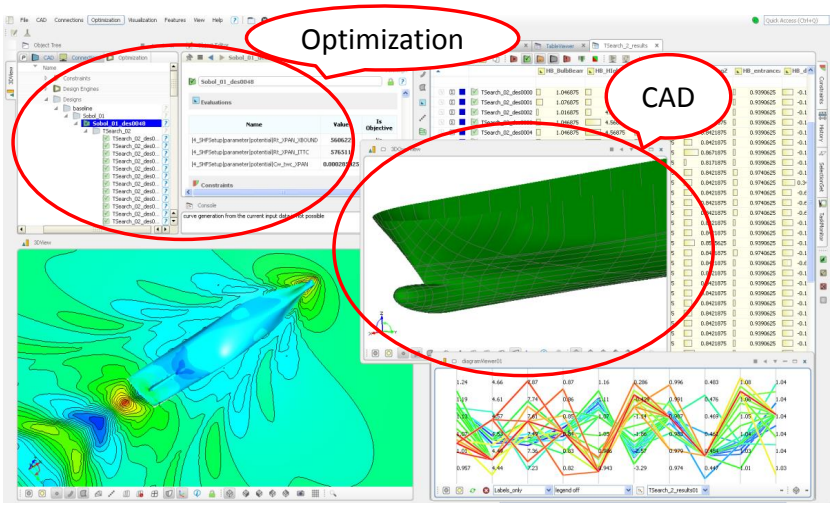

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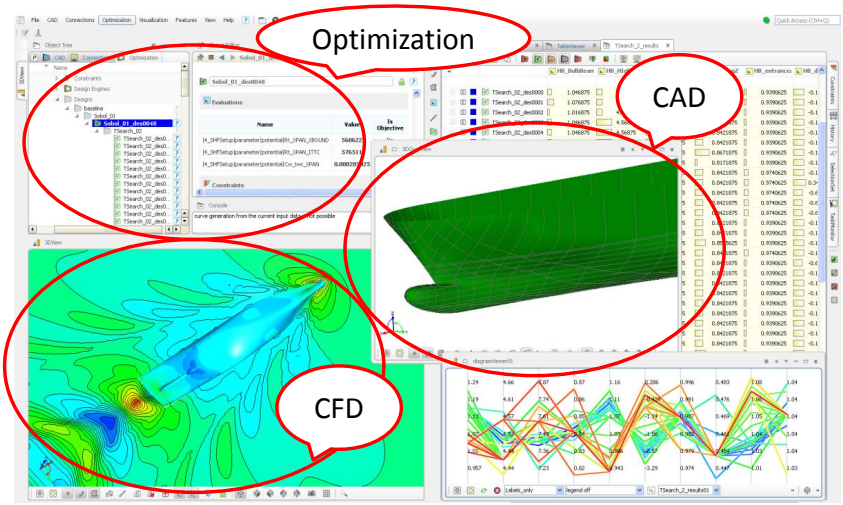
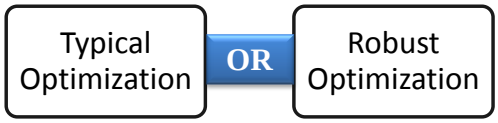
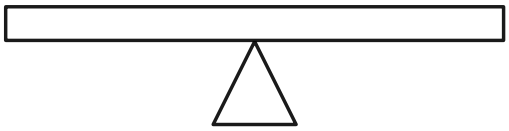


Typical Optimization or Robust one?





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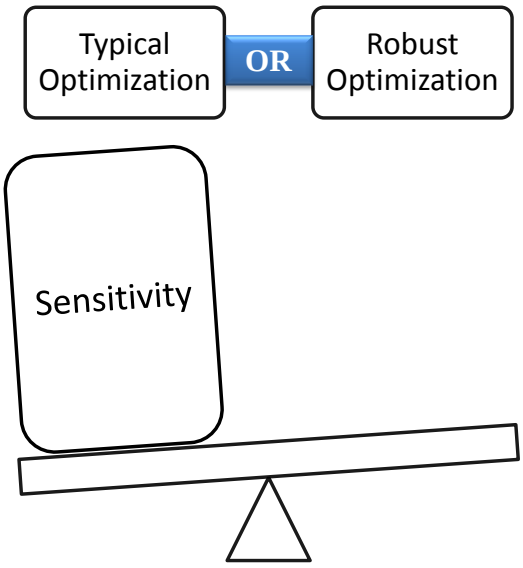

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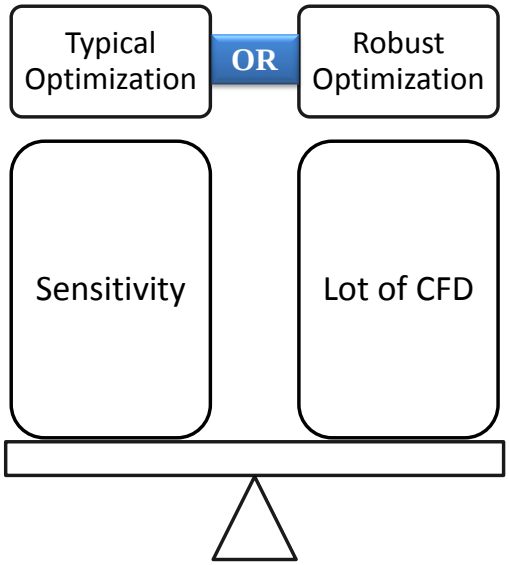

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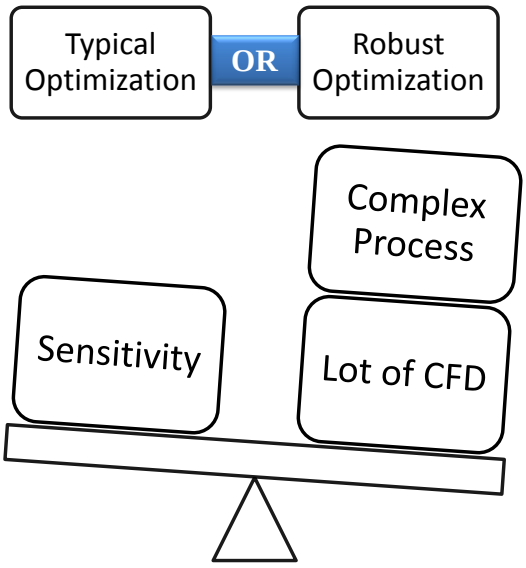

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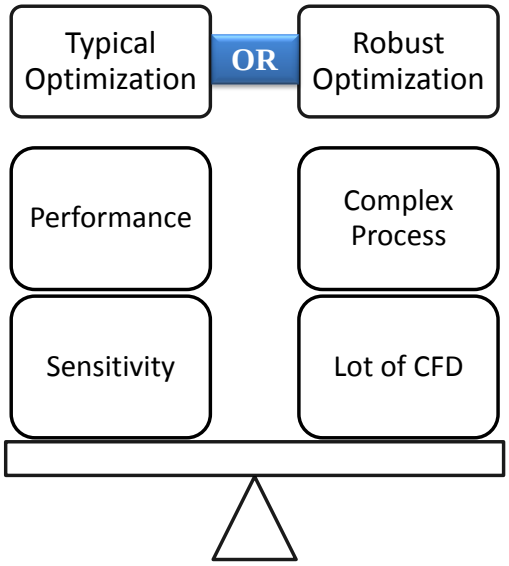

What was performed?

- Several Optimization processes

What was performed?

- Several Optimization processes
  - Single Objective

What was performed?

- Several Optimization processes
  - Single Objective
  - Weighted Function

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What was performed?

- Several Optimization processes
  - Single Objective
  - Weighted Function
  - Single Objective + Constraints

What was performed?

- Several Optimization processes
  - Single Objective
  - Weighted Function
  - Single Objective + Constraints
  - Multi-Objective

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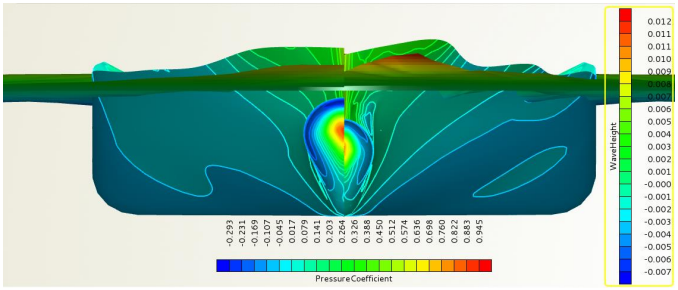
What was performed?

- Several Optimization processes
  - Single Objective
  - Weighted Function
  - Single Objective + Constraints
  - Multi-Objective

More than 1000 CFD runs



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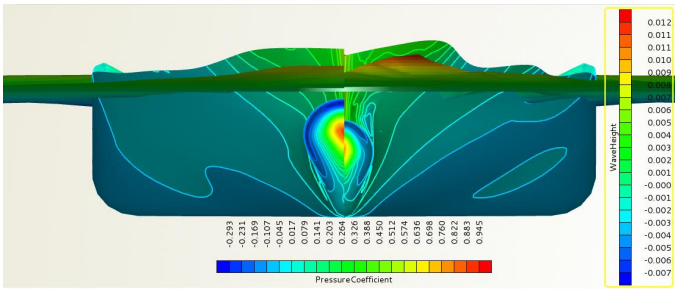

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What was performed?

- Several Optimization processes
  - Single Objective
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  - Single Objective + Constraints
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More than 1000 CFD runs

- Hybrid Optimization

What was performed?

- Several Optimization processes
  - Single Objective
  - Weighted Function
  - Single Objective + Constraints
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More than 1000 CFD runs

- Hybrid Optimization
  - Gauss-Markov estimation

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What was performed?

- Several Optimization processes
  - Single Objective
  - Weighted Function
  - Single Objective + Constraints
  - Multi-Objective

More than 1000 CFD runs

- Hybrid Optimization
  - Gauss-Markov estimation

Reduced number of CFD runs

What was performed?

- Several Optimization processes
  - Single Objective
  - Weighted Function
  - Single Objective + Constraints
  - Multi-Objective

More than 1000 CFD runs

- Hybrid Optimization
  - Gauss-Markov estimation

Reduced number of CFD runs

- Results and Analysis

What was performed?

- Several Optimization processes
  - Single Objective
  - Weighted Function
  - Single Objective + Constraints
  - Multi-Objective

More than 1000 CFD runs

- Hybrid Optimization
  - Gauss-Markov estimation

Reduced number of CFD runs

- Results and Analysis
  - Application to Design Phase

How the study was performed?

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- Case of Study

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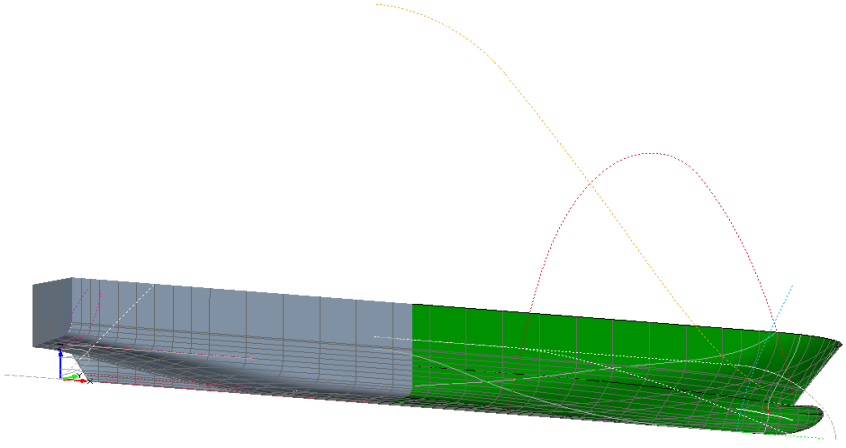
- Case of Study
- Parametric model



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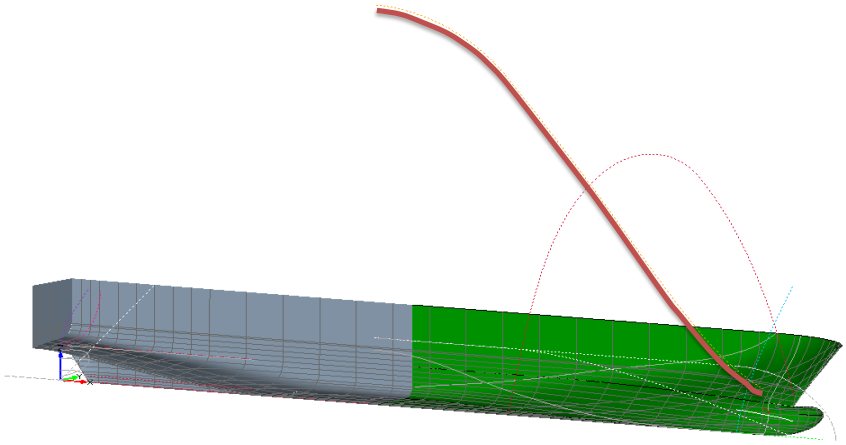

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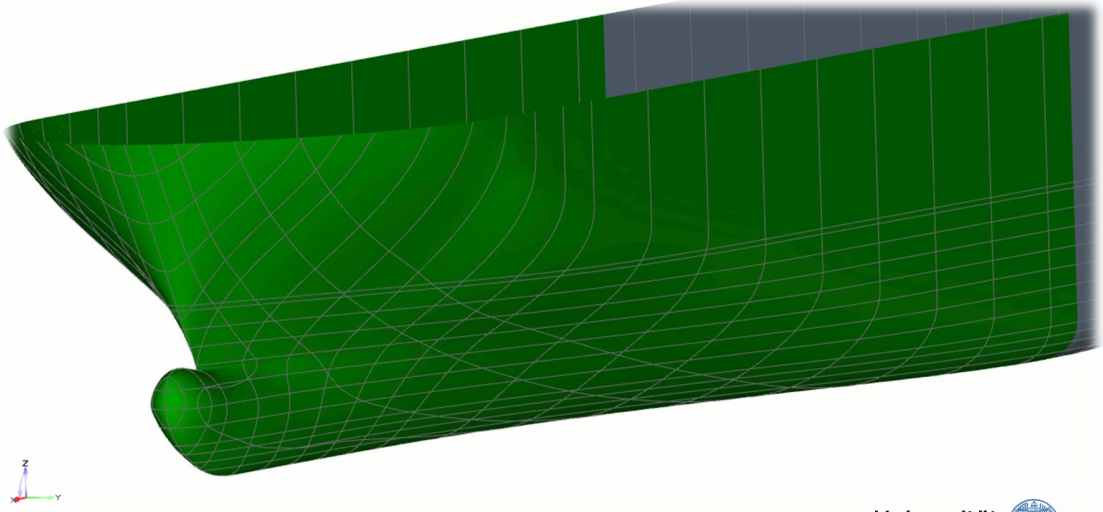

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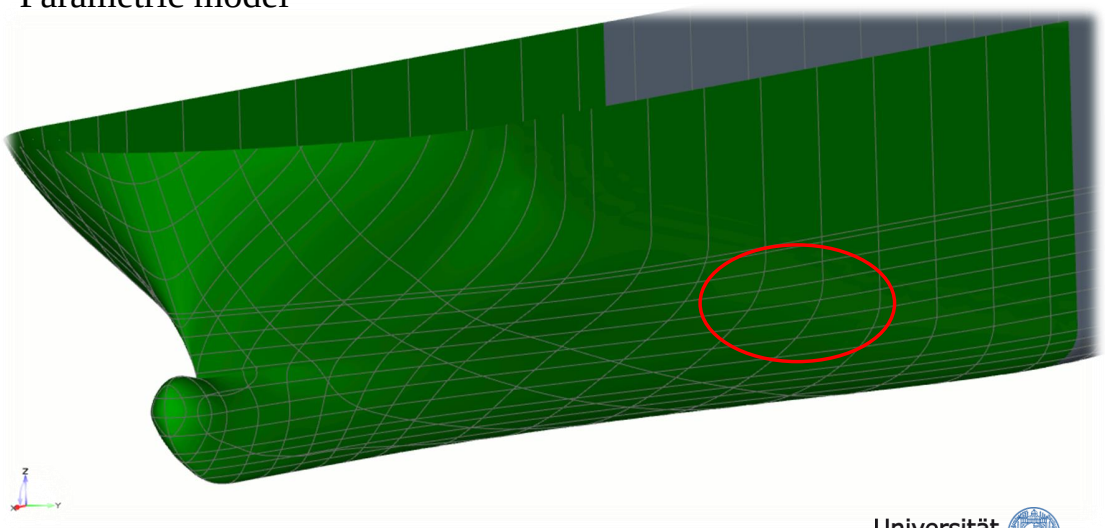

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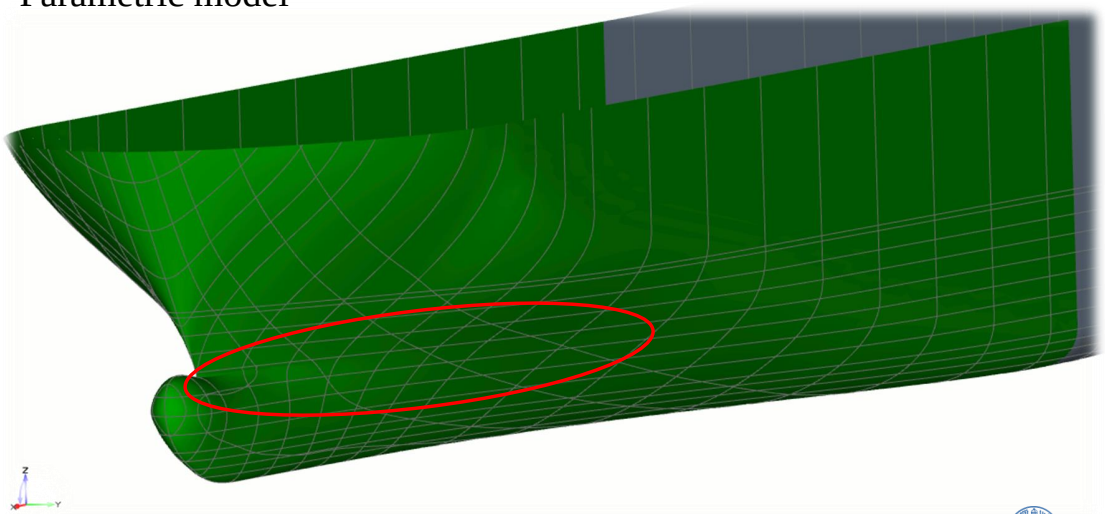

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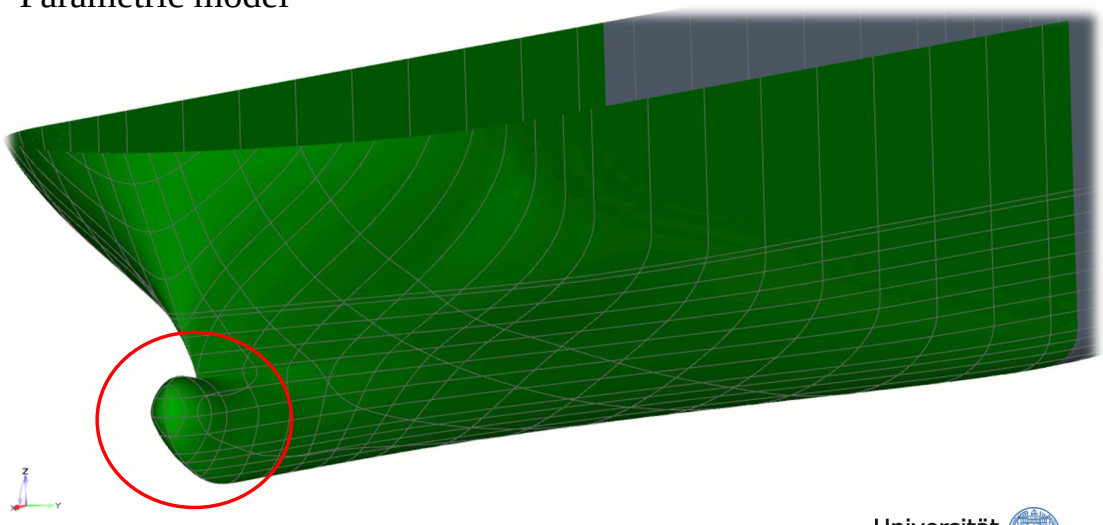

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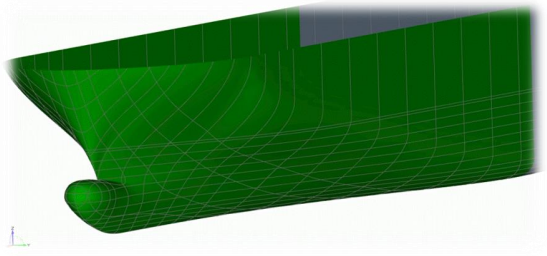
The problem setup

- 10 Design variables (forebody)



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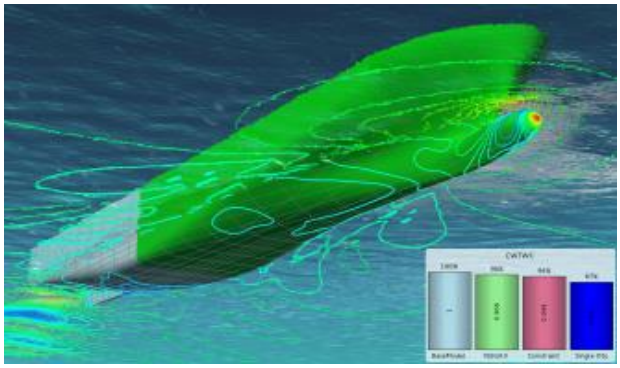
The problem setup

- 10 Design variables (forebody)
- R_{tV1} and R_{tV2} as objective



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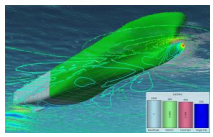
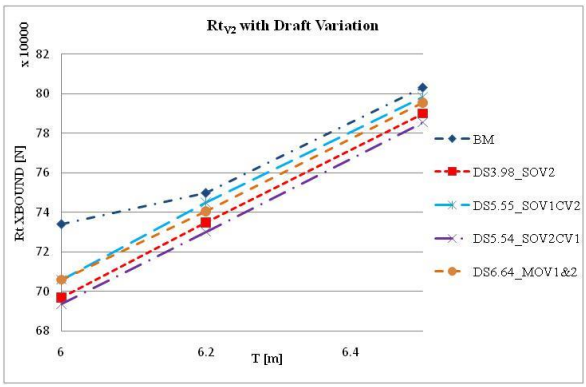
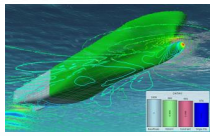


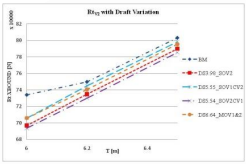
- 10 Design variables (forebody)
- R_{tV1} and R_{tV2} as objective
- Robustness: ΔT

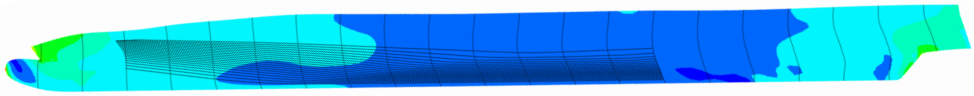


The problem setup

- 10 Design variables (forebody)
- R_{tV1} and R_{tV2} as objective
- Robustness: ΔT
- CFD: Shipflow (Potential + Momentum integration [XBound])
  ± 15min each calculation







How the optimization was performed?

- 1st Design of Experiments

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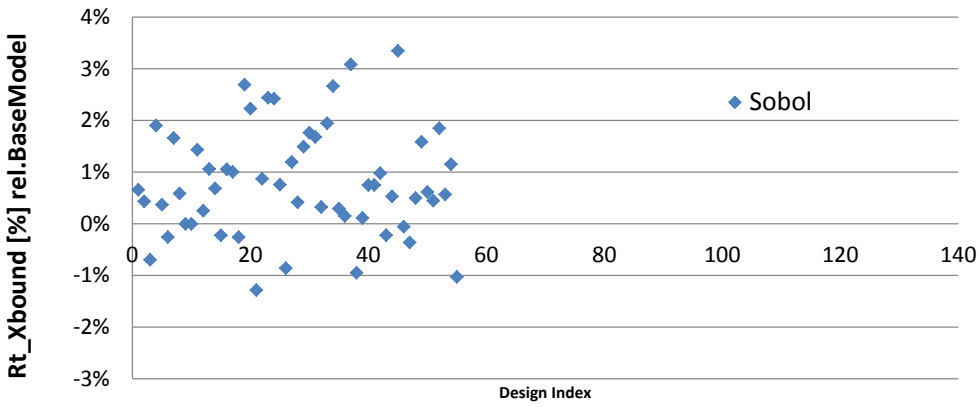

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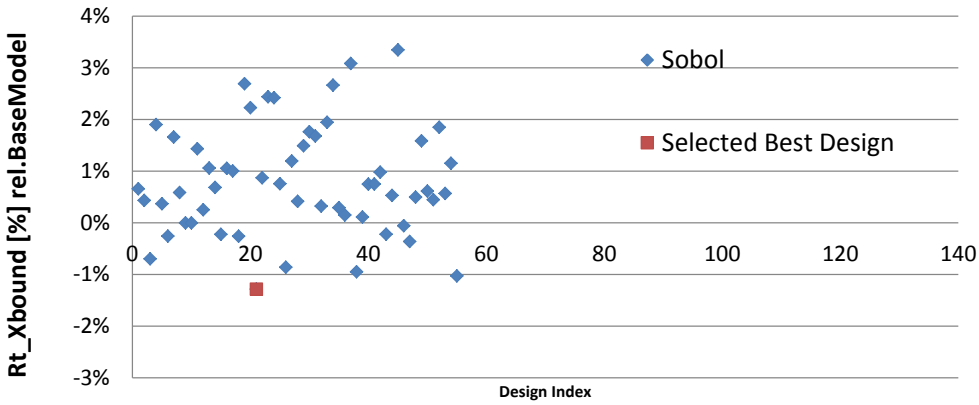

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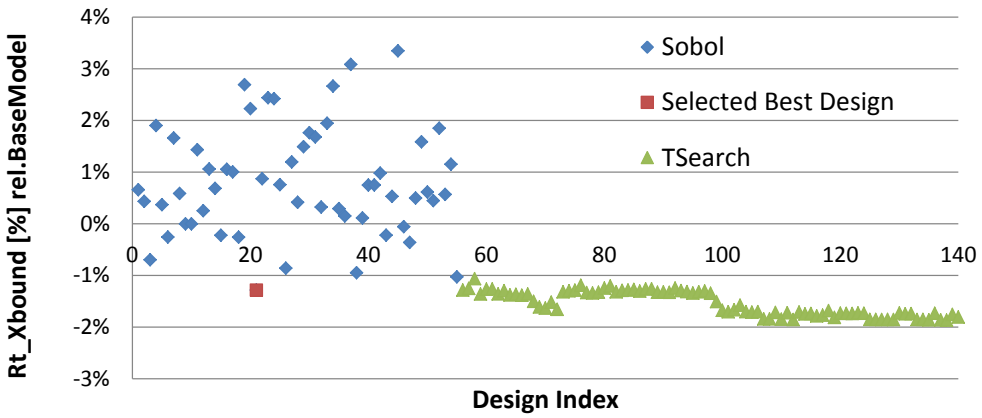
How the optimization was performed?

- 1st Design of Experiments
- Optimization algorithm



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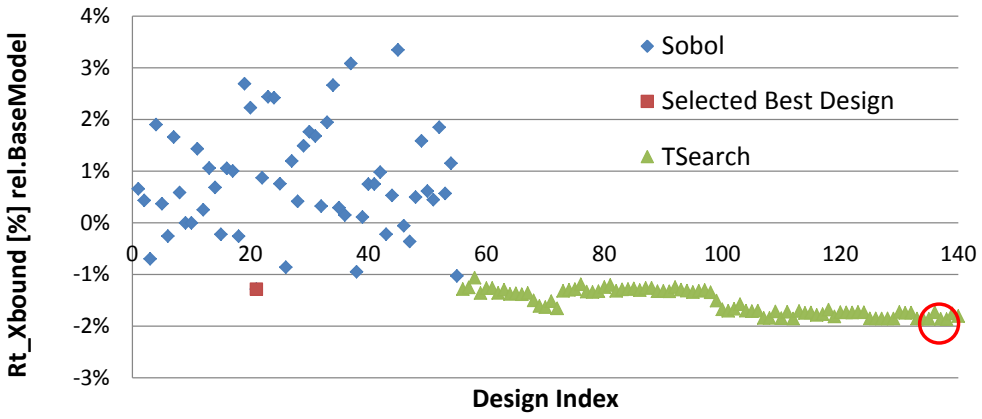

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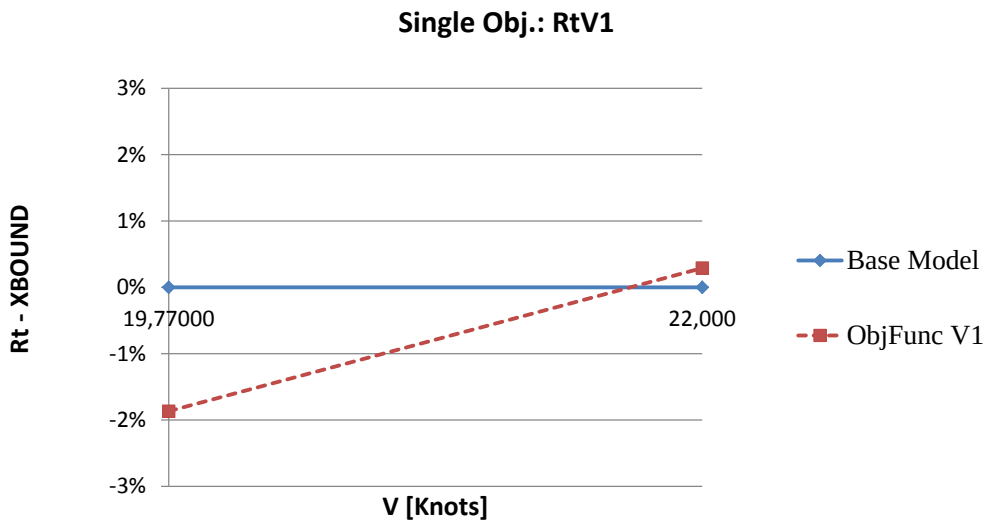
Single optimization method



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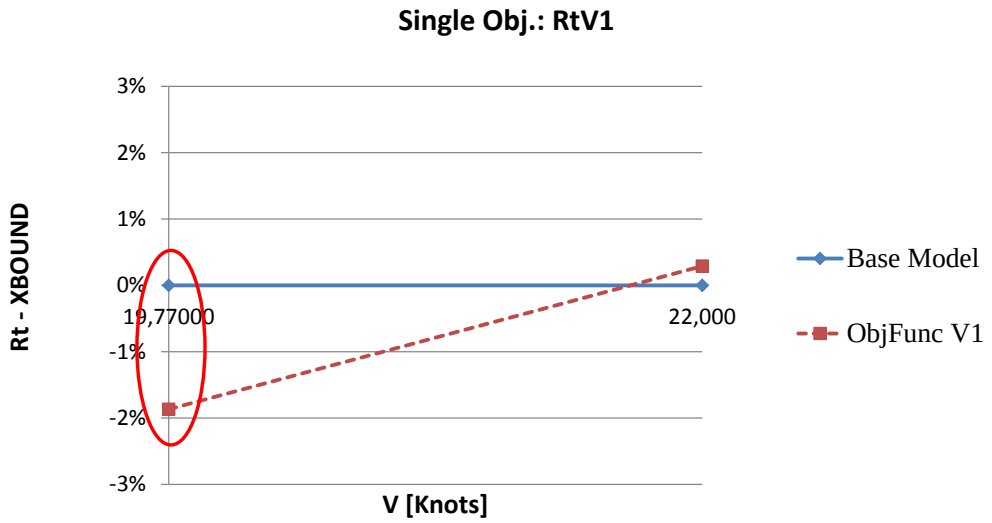

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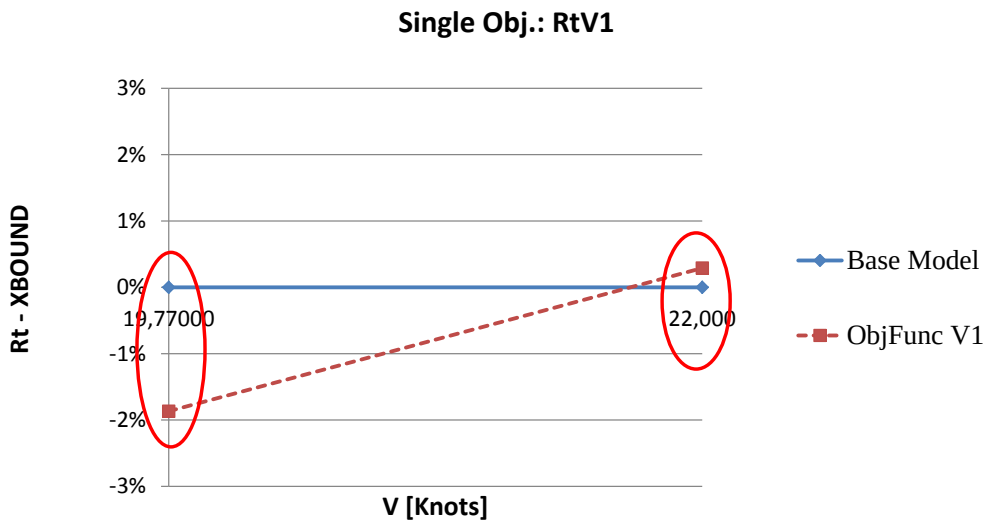
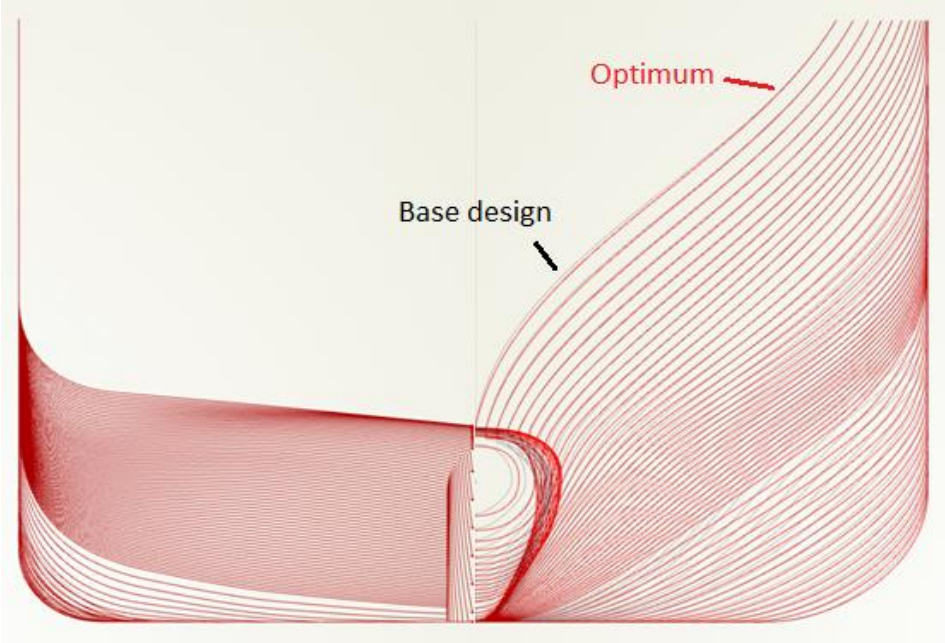


Form variation



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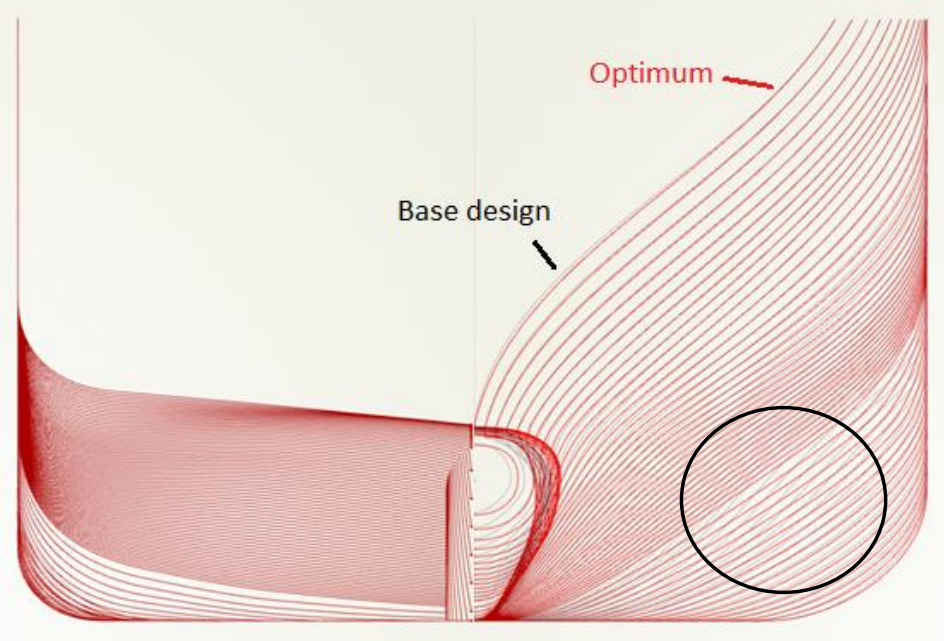

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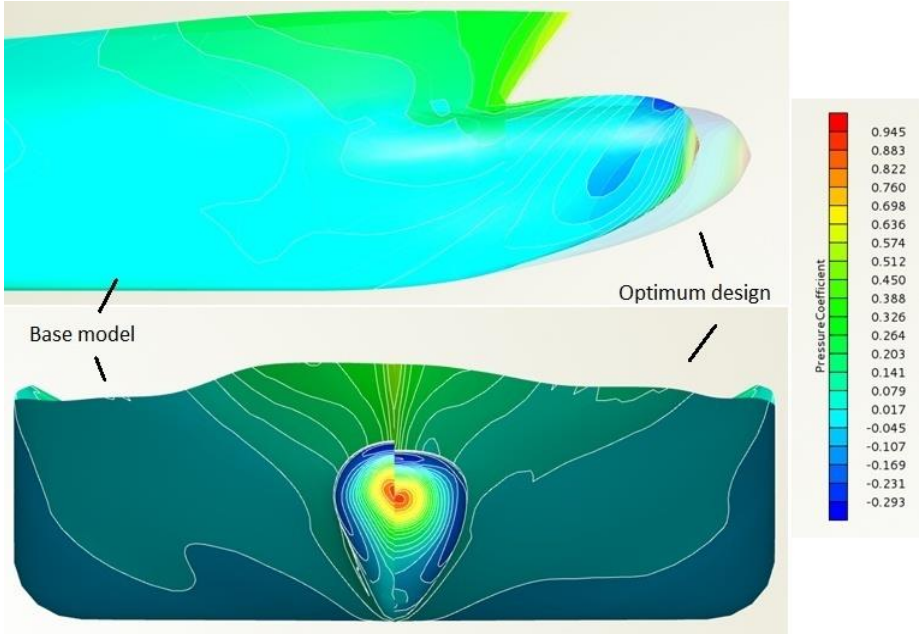
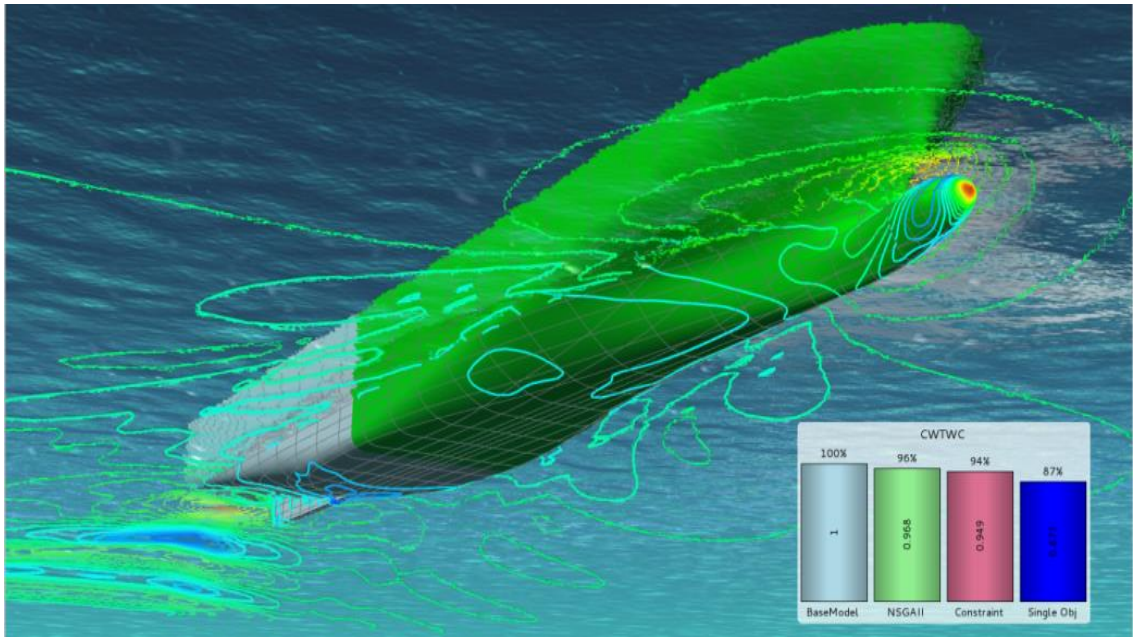


Comparison between methods



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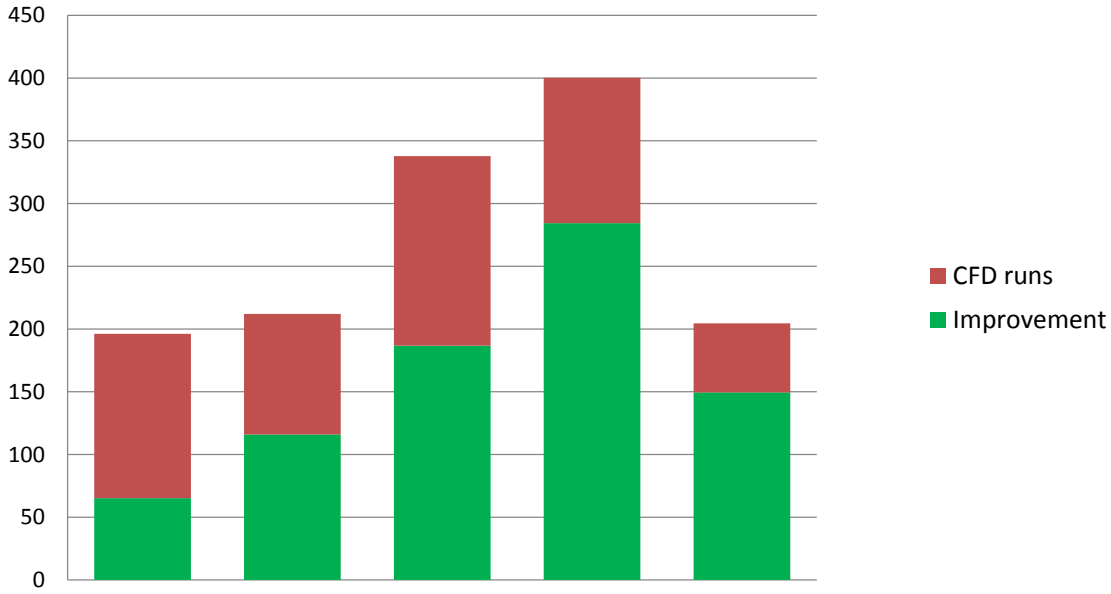

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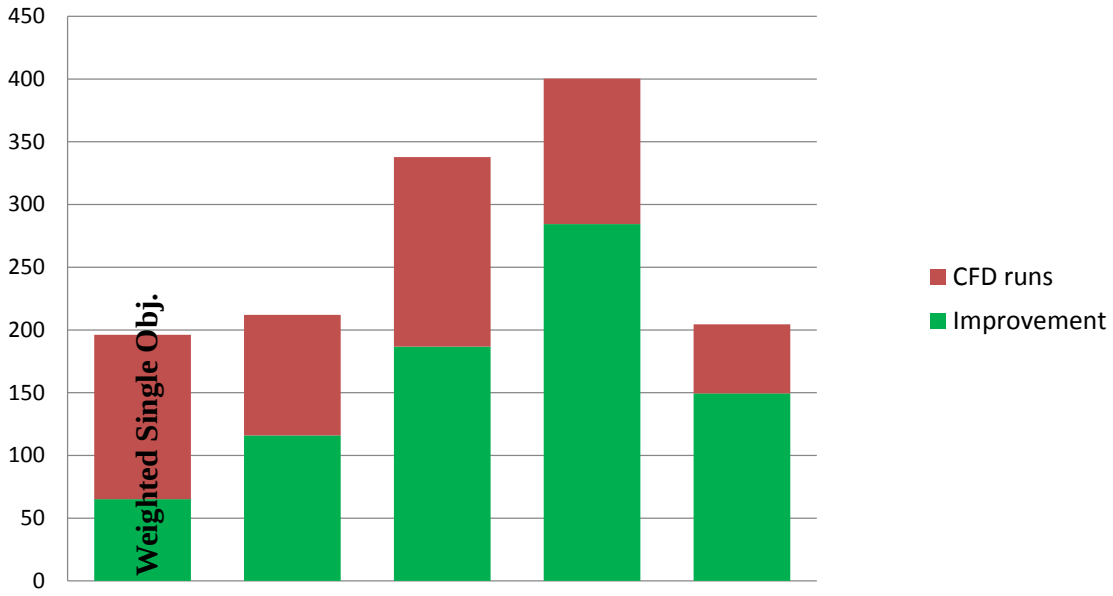

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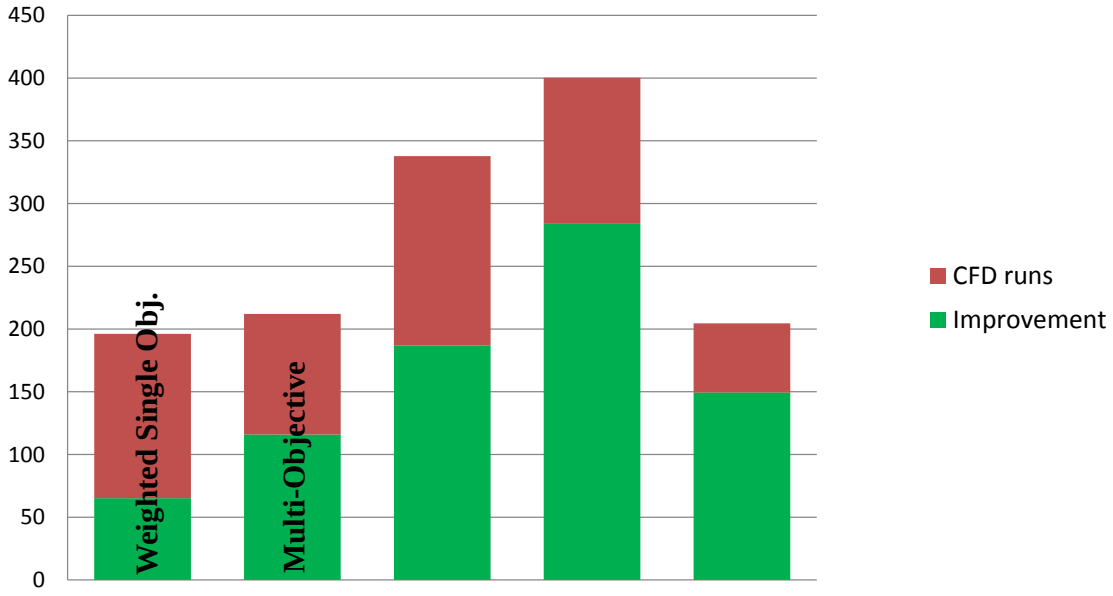

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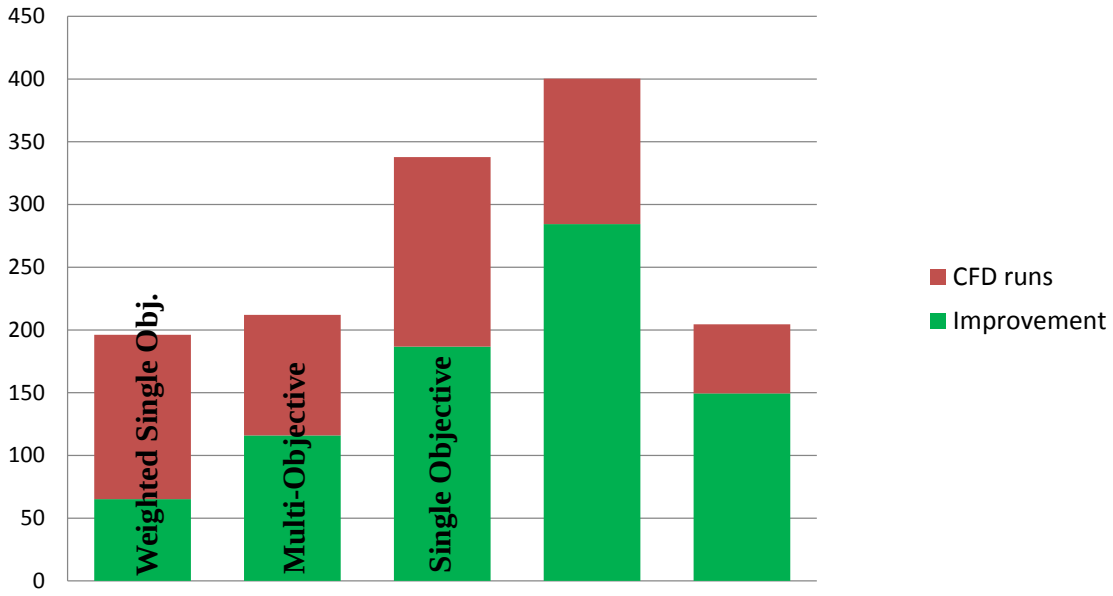

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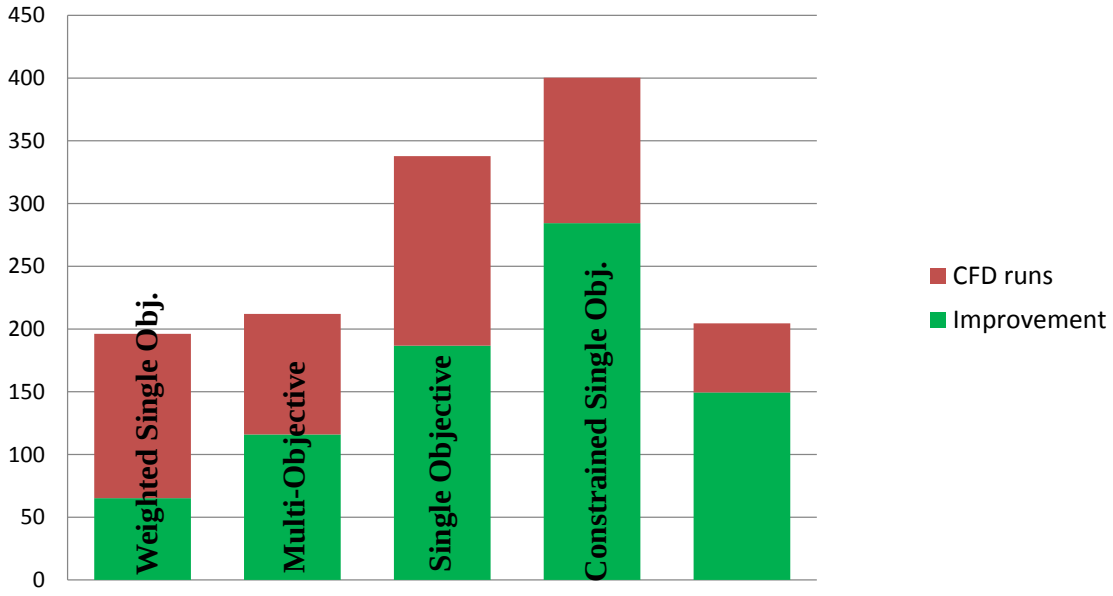

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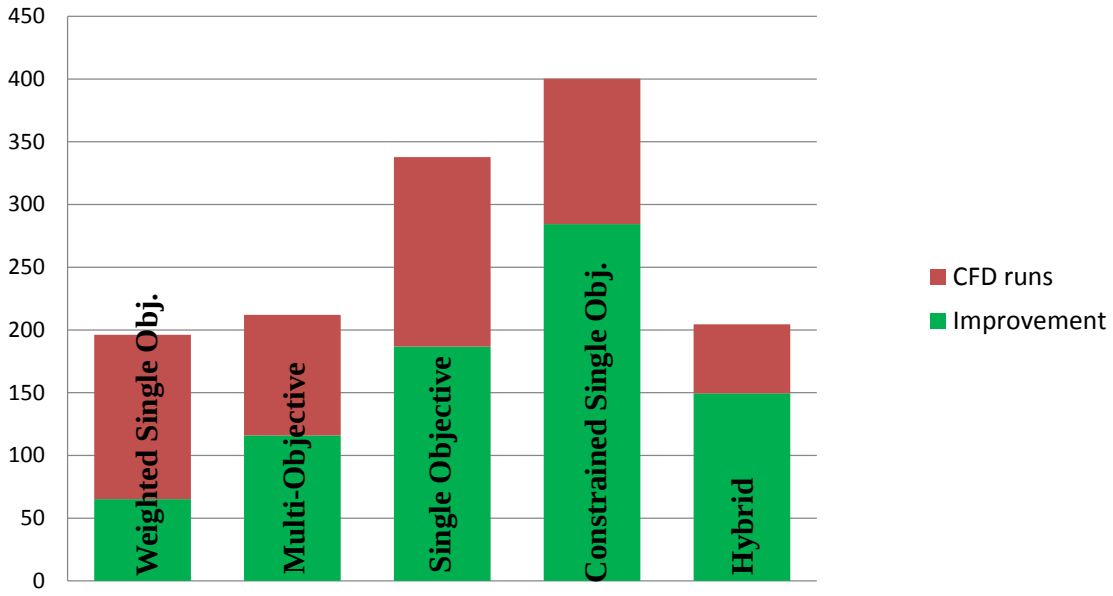

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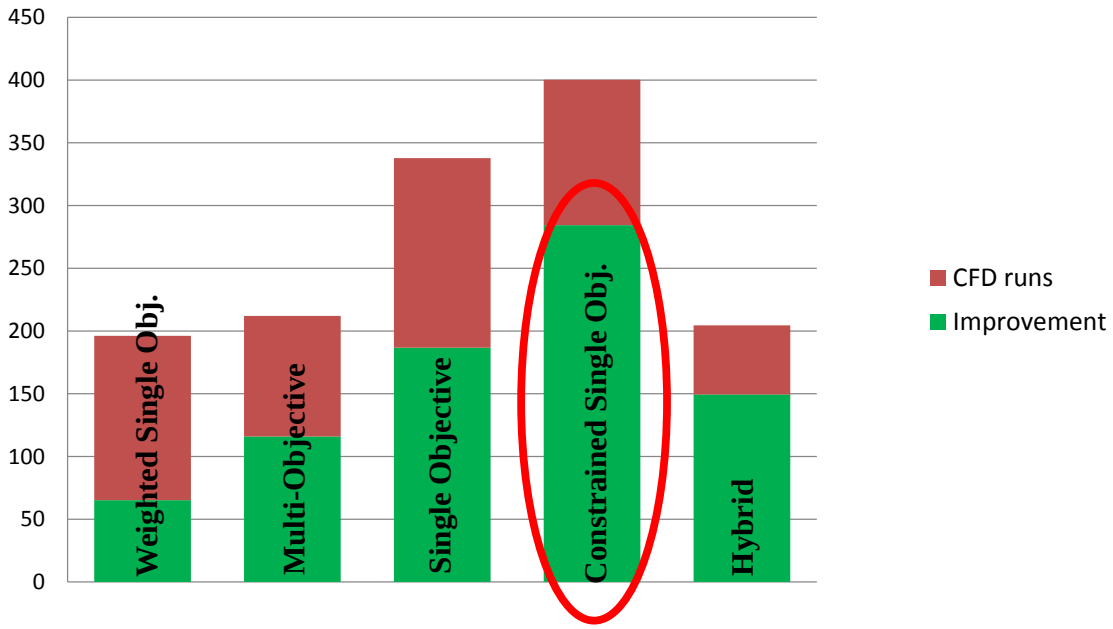

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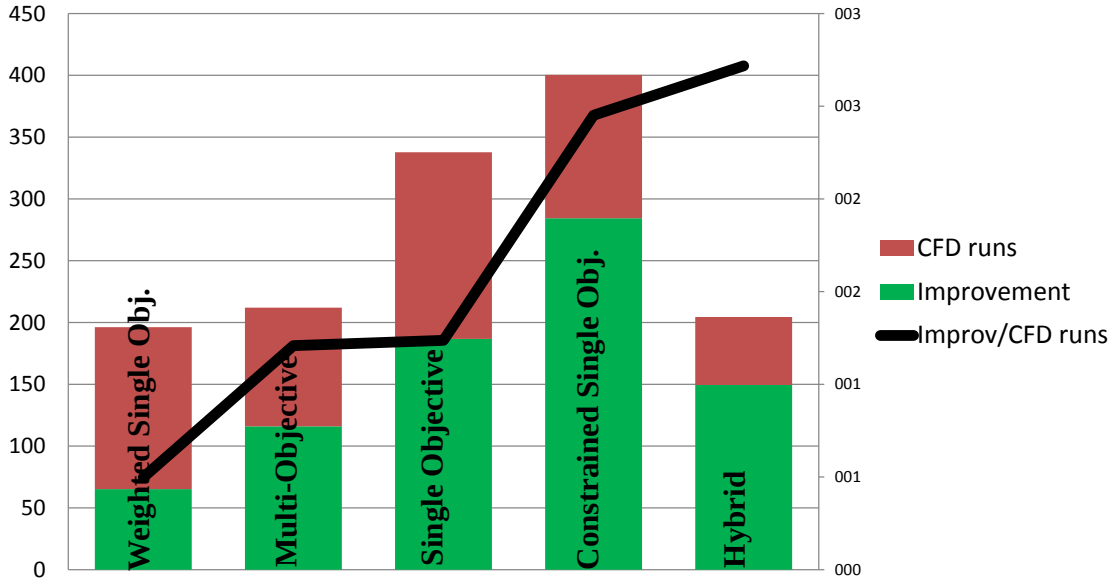

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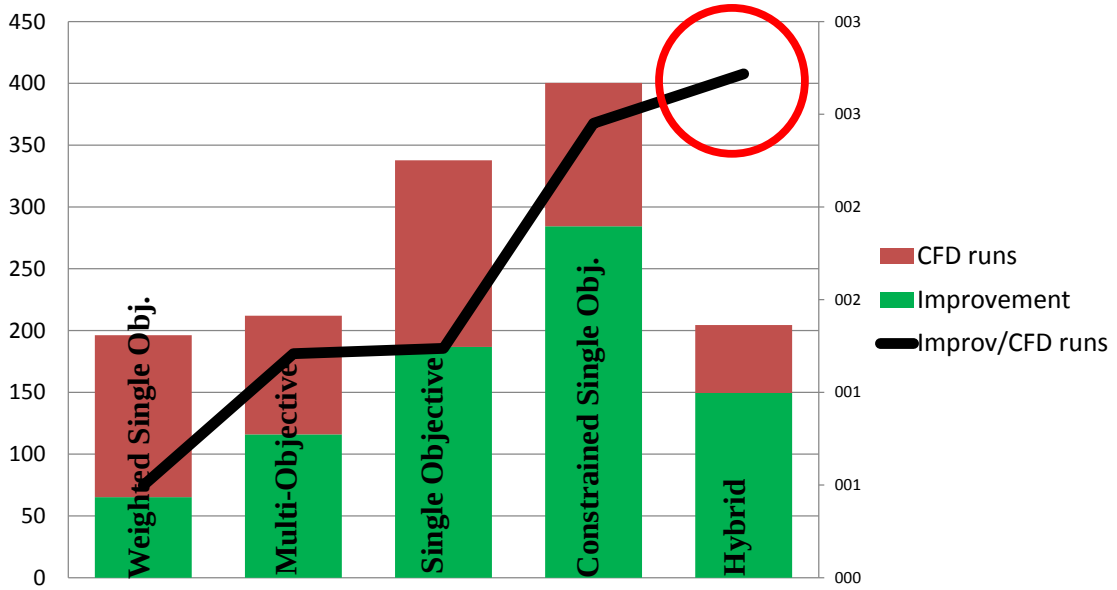

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Conclusion

- Suitable optimization method for each case

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- Check of the necessity of a Robust Optimization (e.g. Sensitivity)

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- Suitable optimization method for each case
- Check of the necessity of a Robust Optimization (e.g. Sensitivity)
- Meta-models for Robust Optimization (reduced CFD runs)

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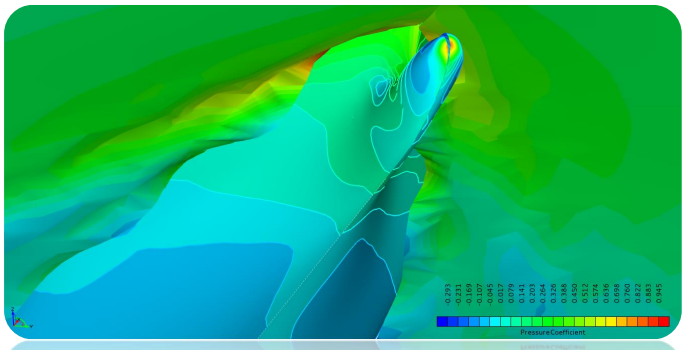

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