CAE-Driven Design Methodology for Semi-Autonomous Product Development

Designing the next generation light weight vehicle structures

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DLR – Overview

- German national research center for aeronautics and space
- Development of environmentally-friendly technologies
- Promote mobility, communication and security

7 400 employees are working at 32 research institutes and facilities in ■ 9 locations and ● 7 branch offices.

SPACE	AERONAUTICS	TRANSPORTATION	ENERGY

DLR

Motivation

Global Challenges

- shortage of ressources
- climate change

Challenges in Mobility

- reduce fuel consumption
- reduce emissions
- adapt concepts for new mobility

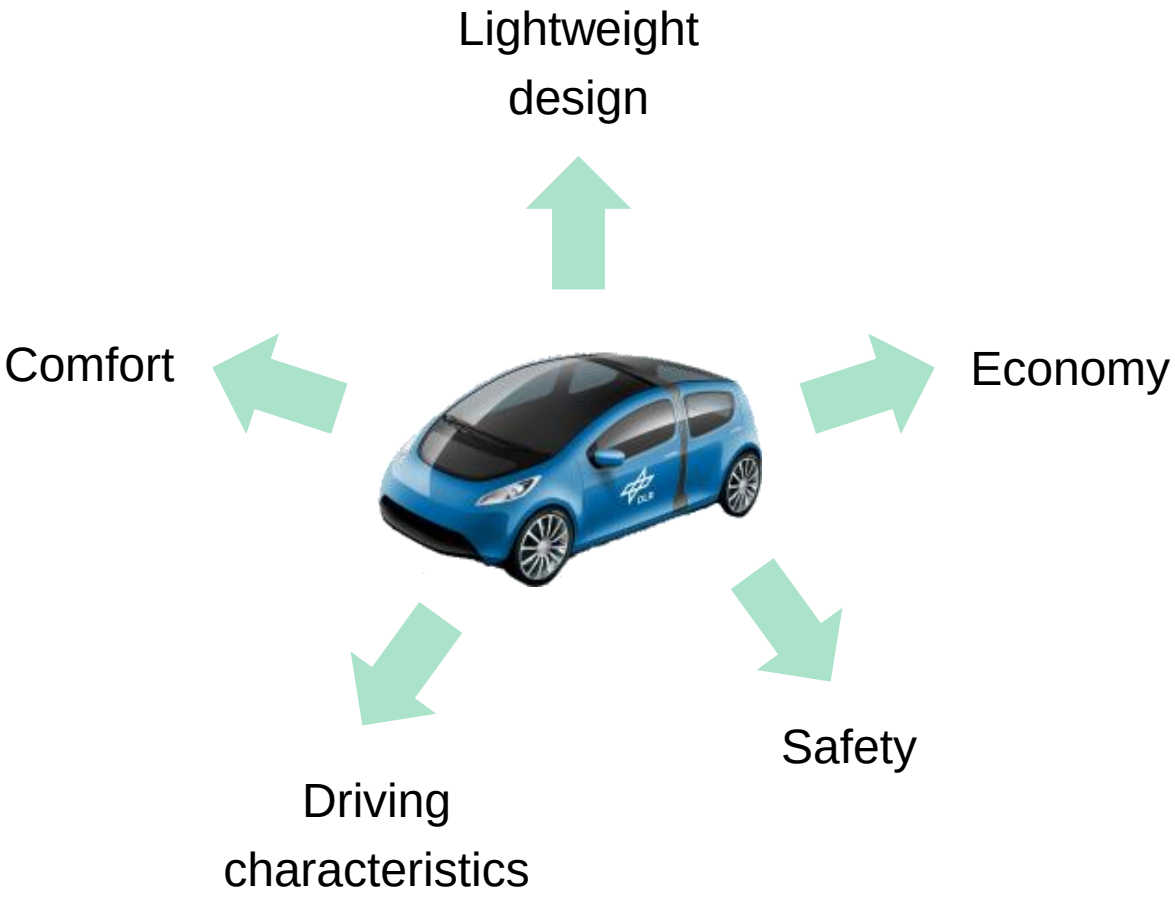
Challenges for Vehicle Concepts

- short development time
- increase economic efficiency

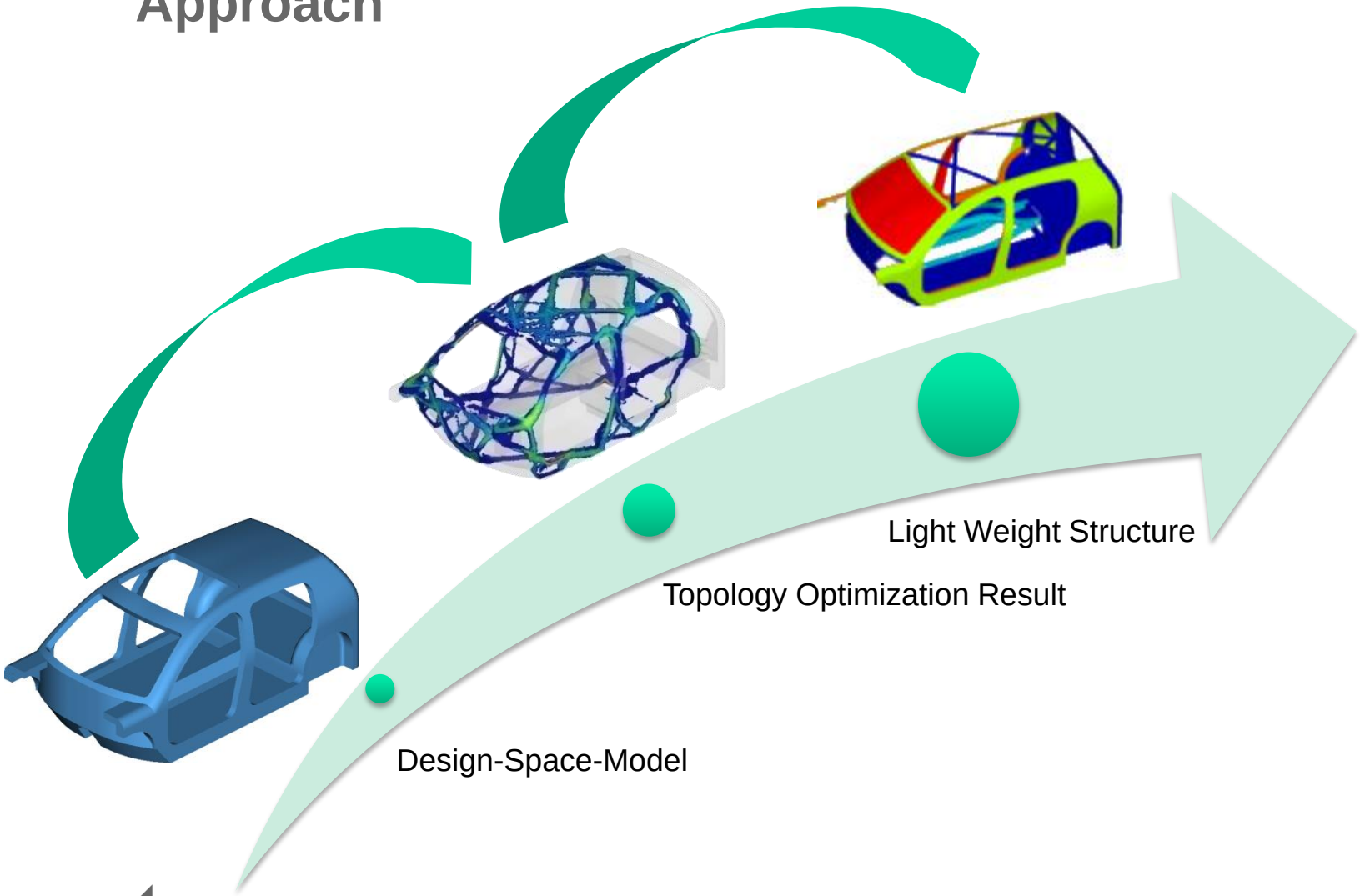
CAE-based design methodology for BIW-concepts

Objective

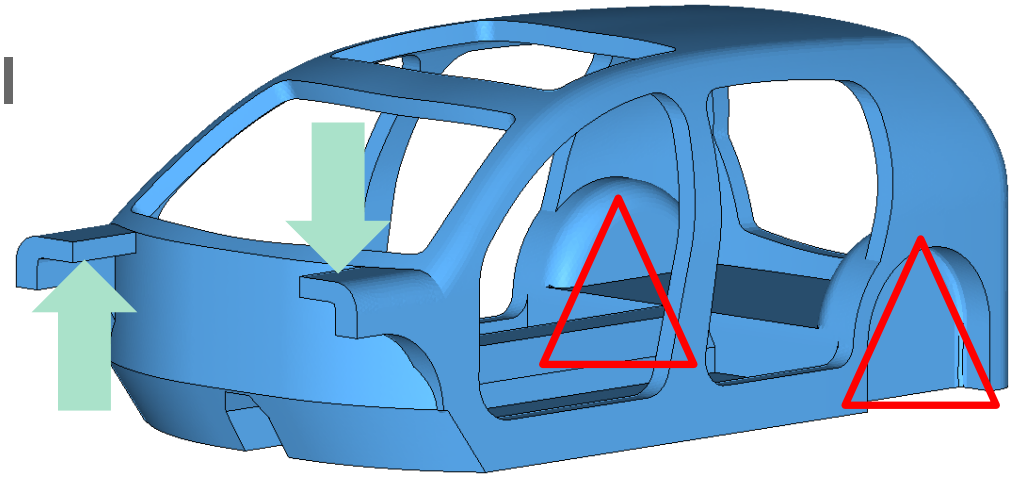
CAE-based design methodology



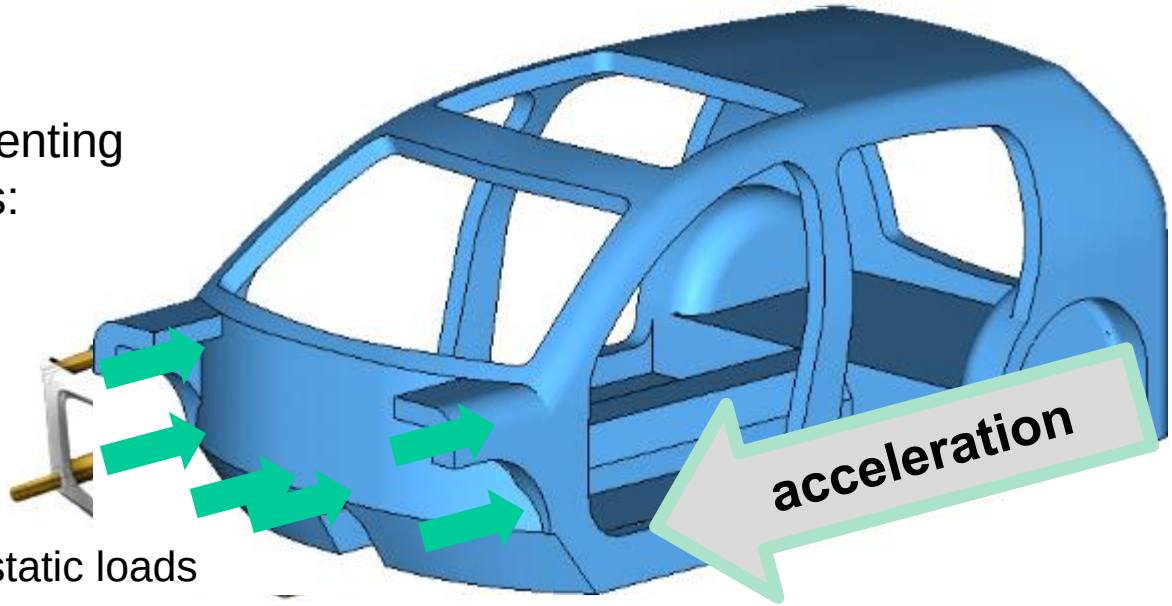
Approach


Light Weight Structure
Topology Optimization Result
Design-Space-Model

Optimization Model

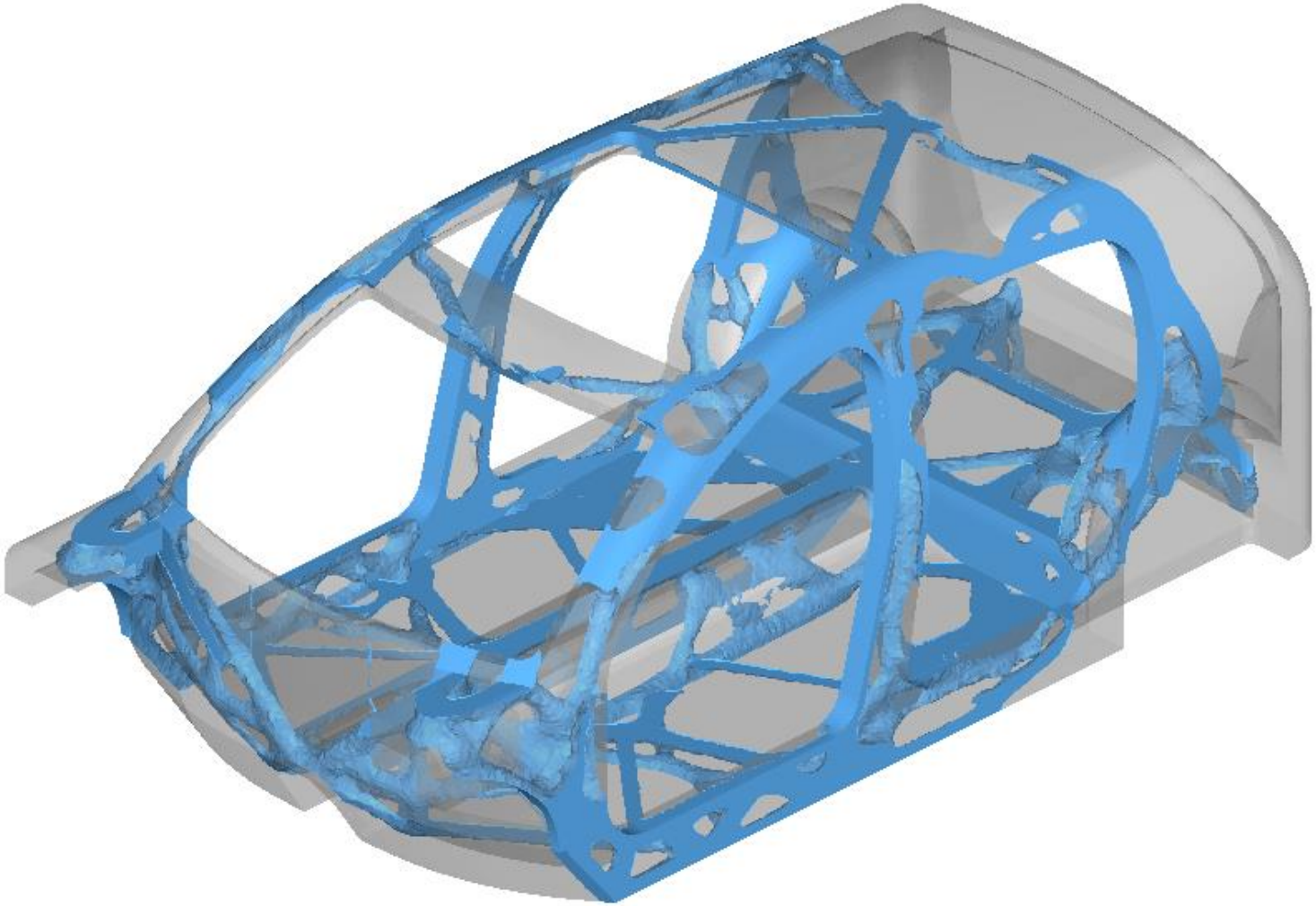


- Units and loads are point masses
- Static loadcases:
  - Torsion
  - Bending
- Static loads representing dynamic conditions:
  - Front crash
  - Rear crash
  - Side crash

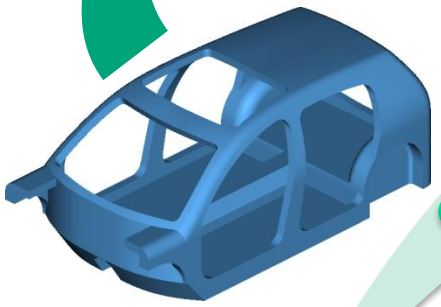


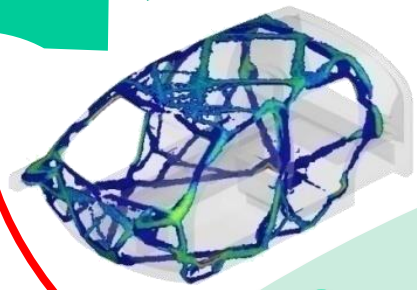
Crash equivalent static loads

Topology Optimization Result



Approach





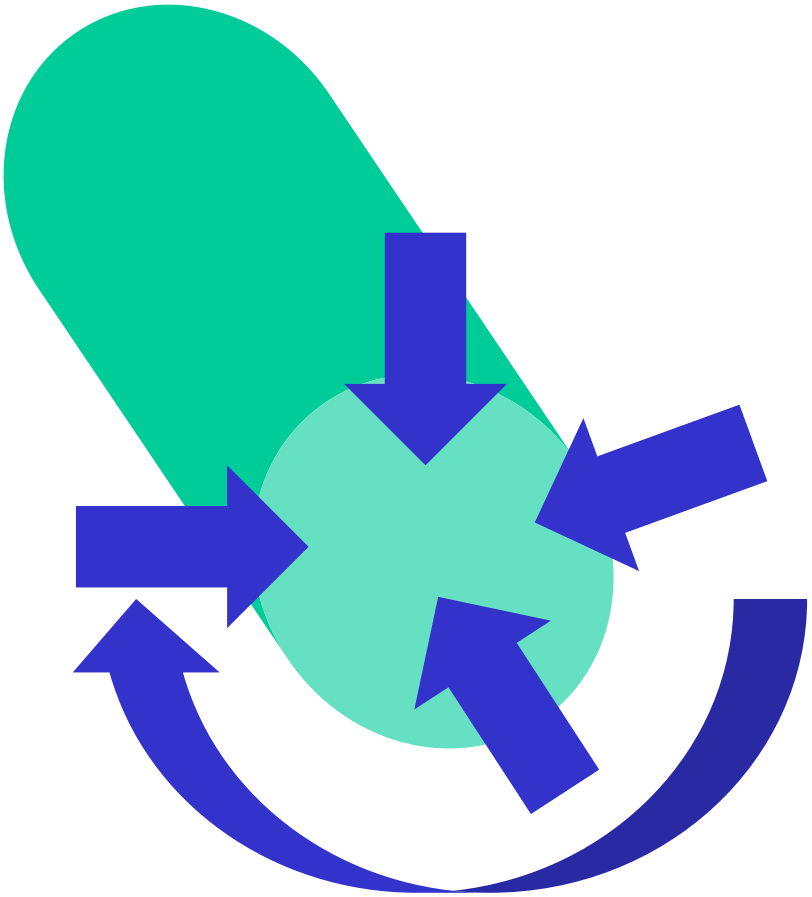
Design-Space-Model

Topology Optimization Result

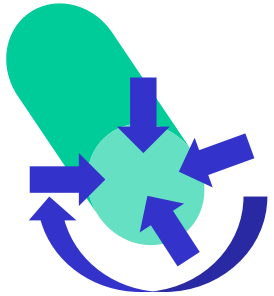
Light Weight Structure

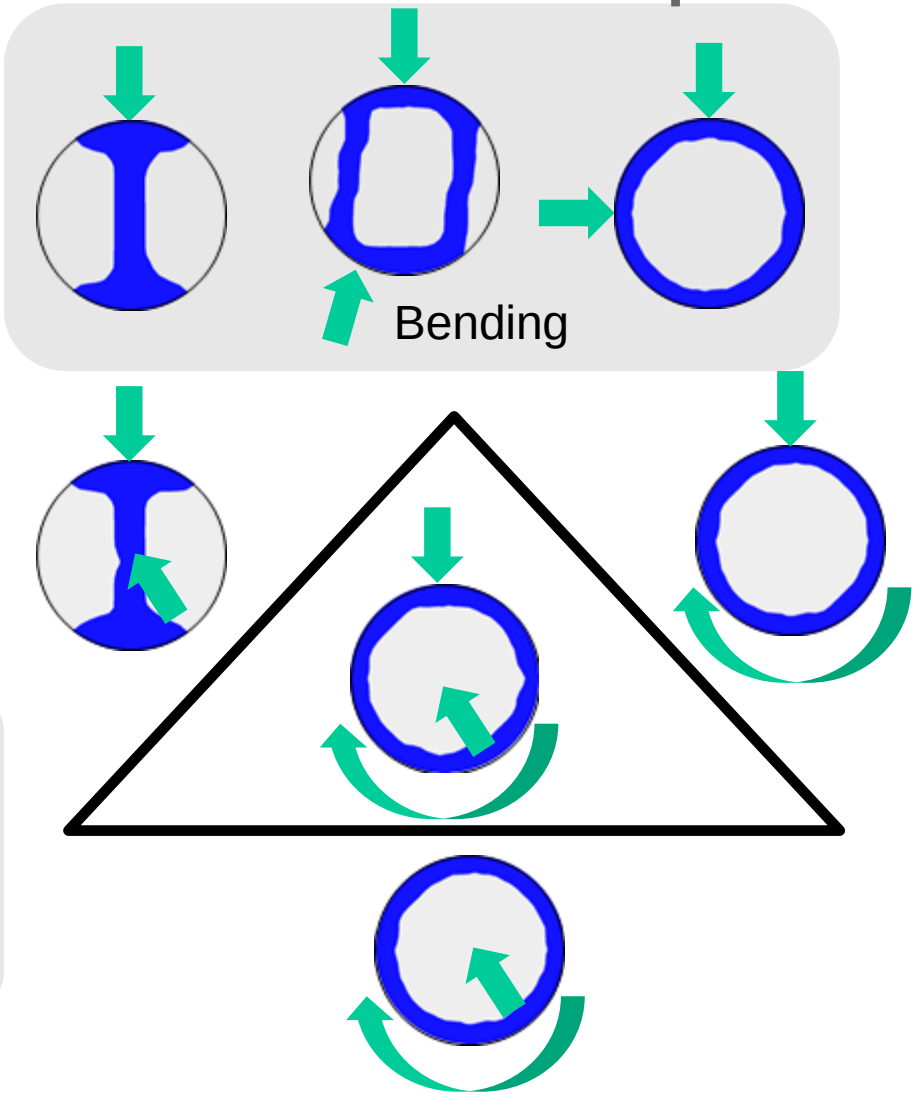
DLR

Interpretation of Structural Requirements



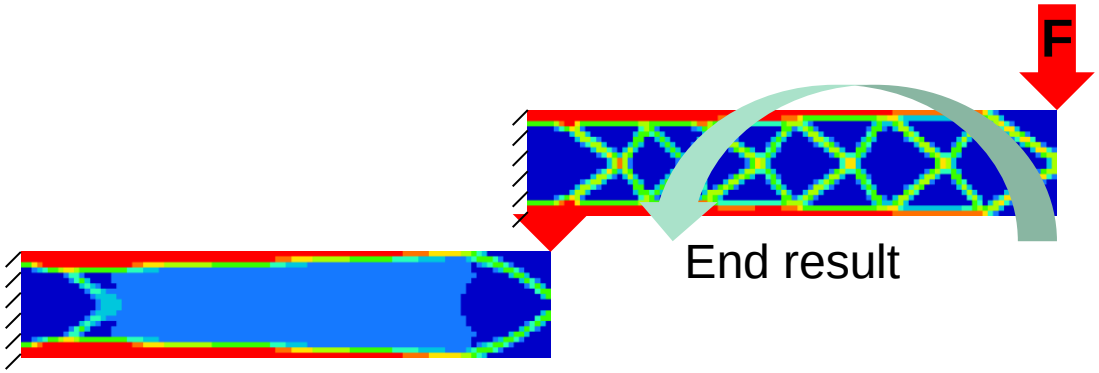
Interpretation of Structural Requirements



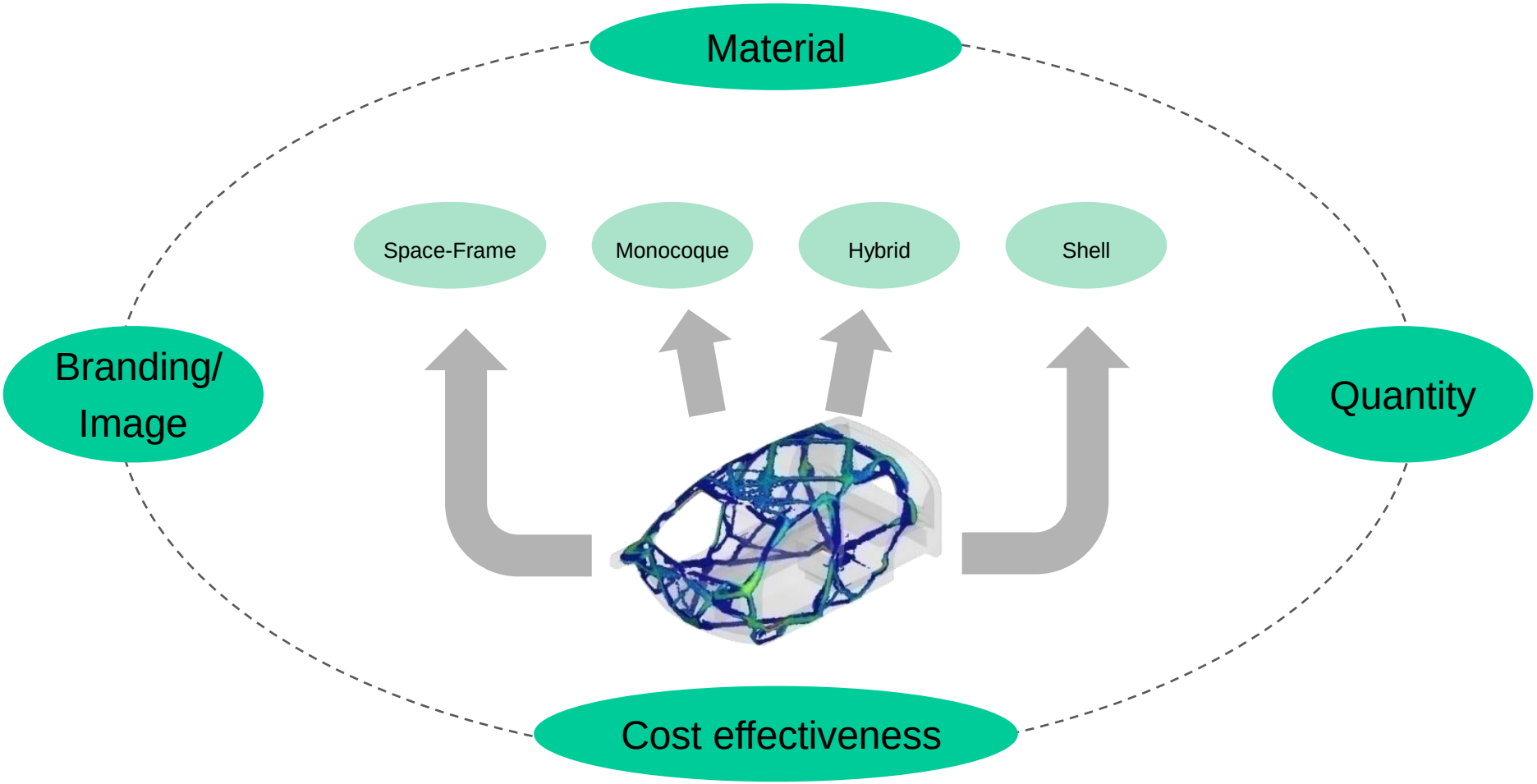


Identifying Shear Locations

- Optimization algorithm disadvantages shear planes
- Identification necessary
- Plane structures are easy to manufacture

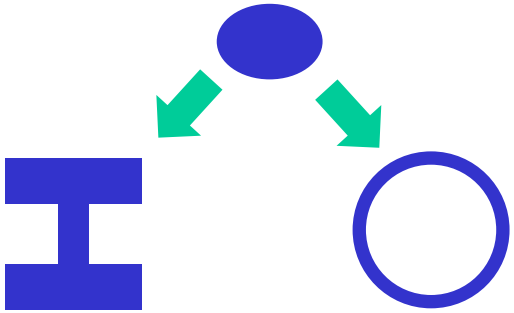


Techno-Economic Criteria

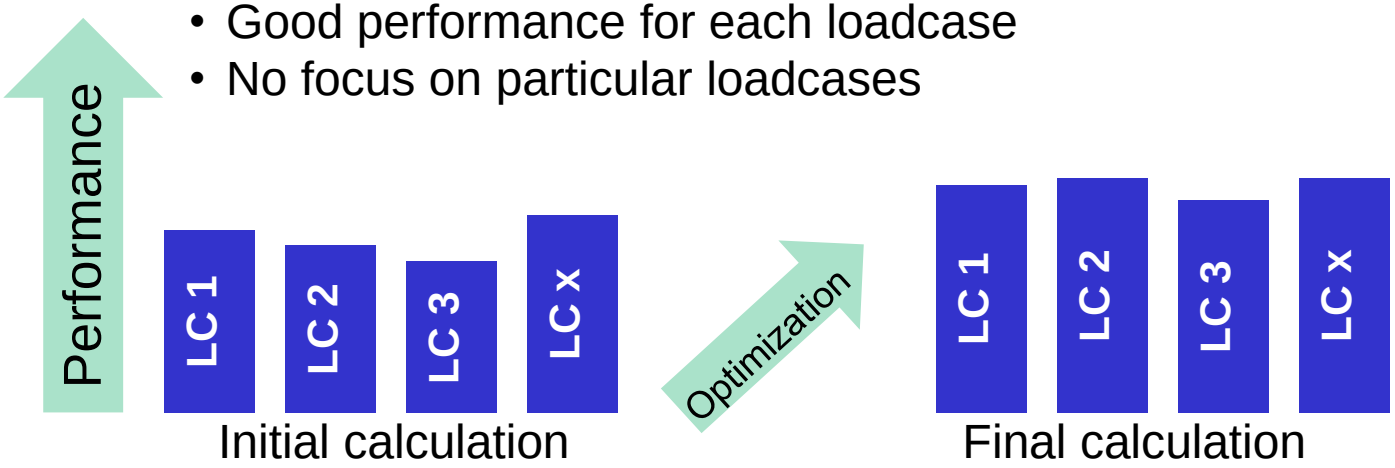


Interpreting the Results

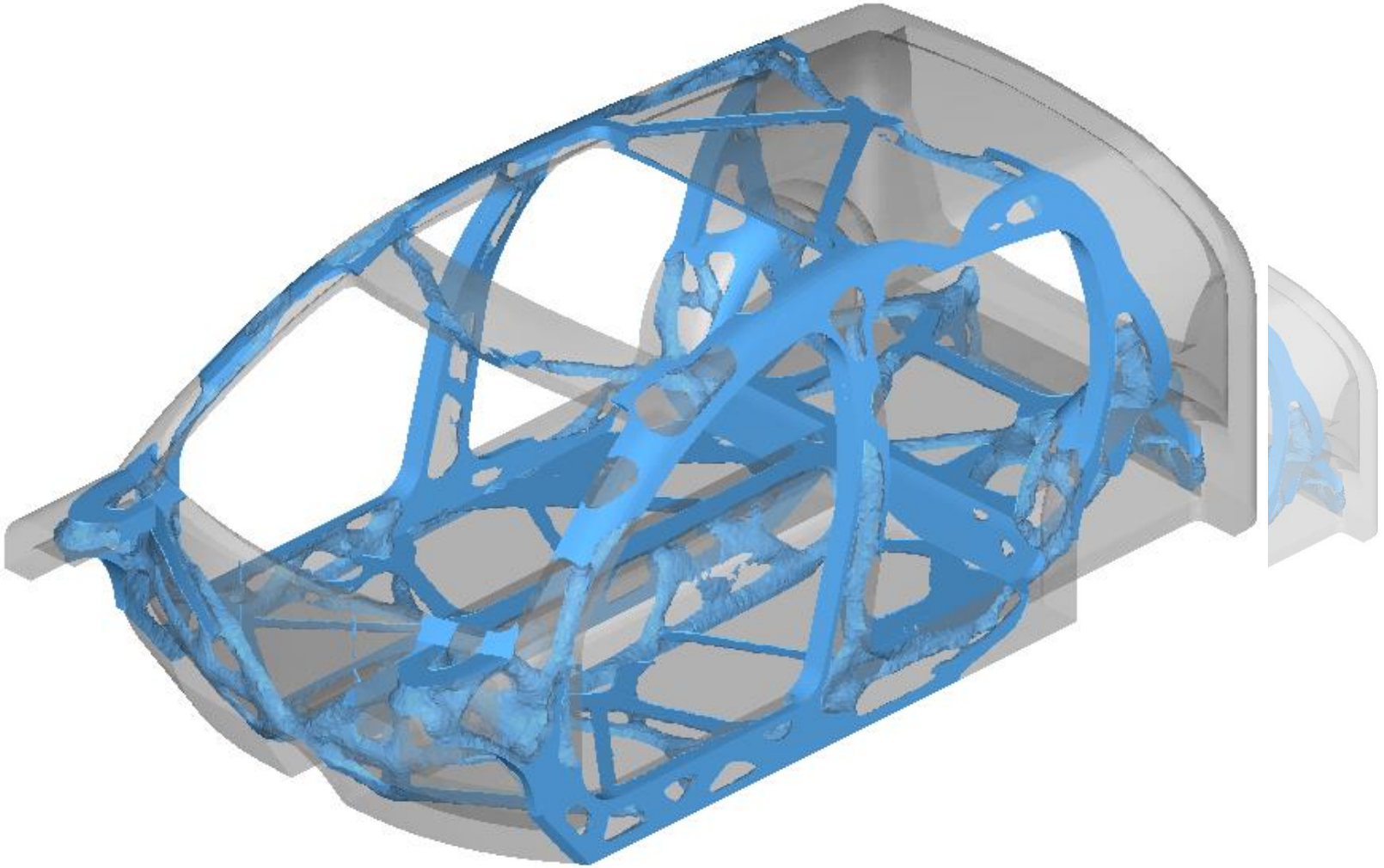
- One purpose per loadcase (LC) and member



- Topology Optimization results contain complex equilibrium
  - No loadcase disregarded
  - Good performance for each loadcase
  - No focus on particular loadcases

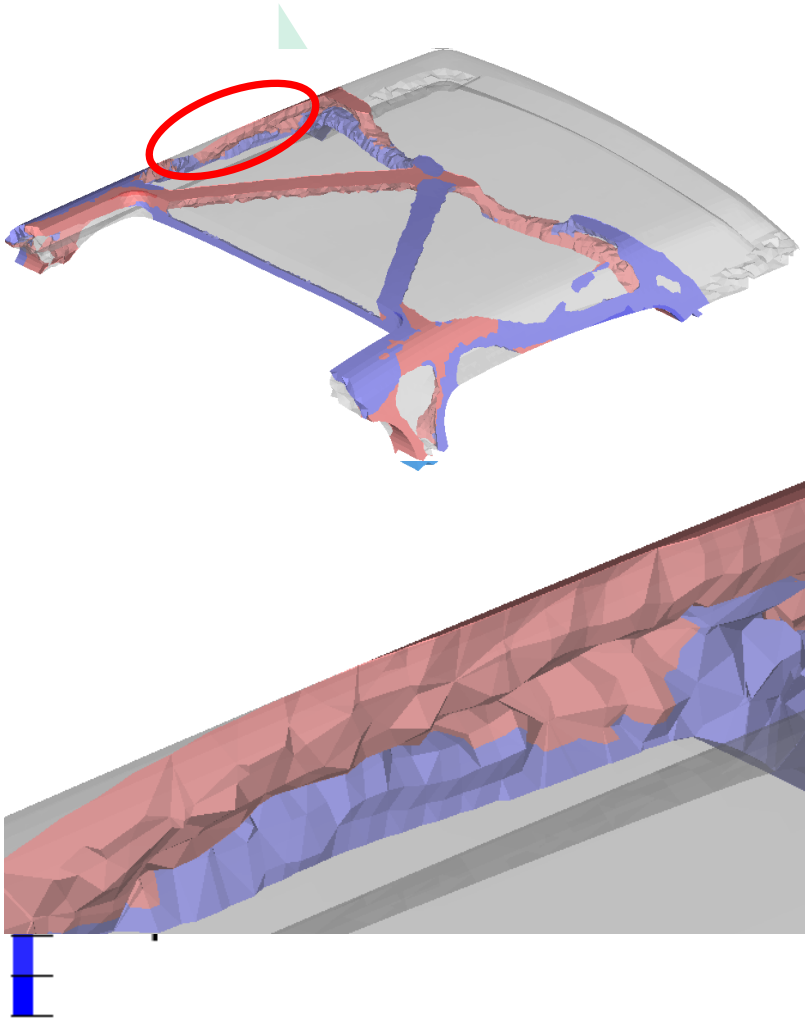


Example: Side-Rail

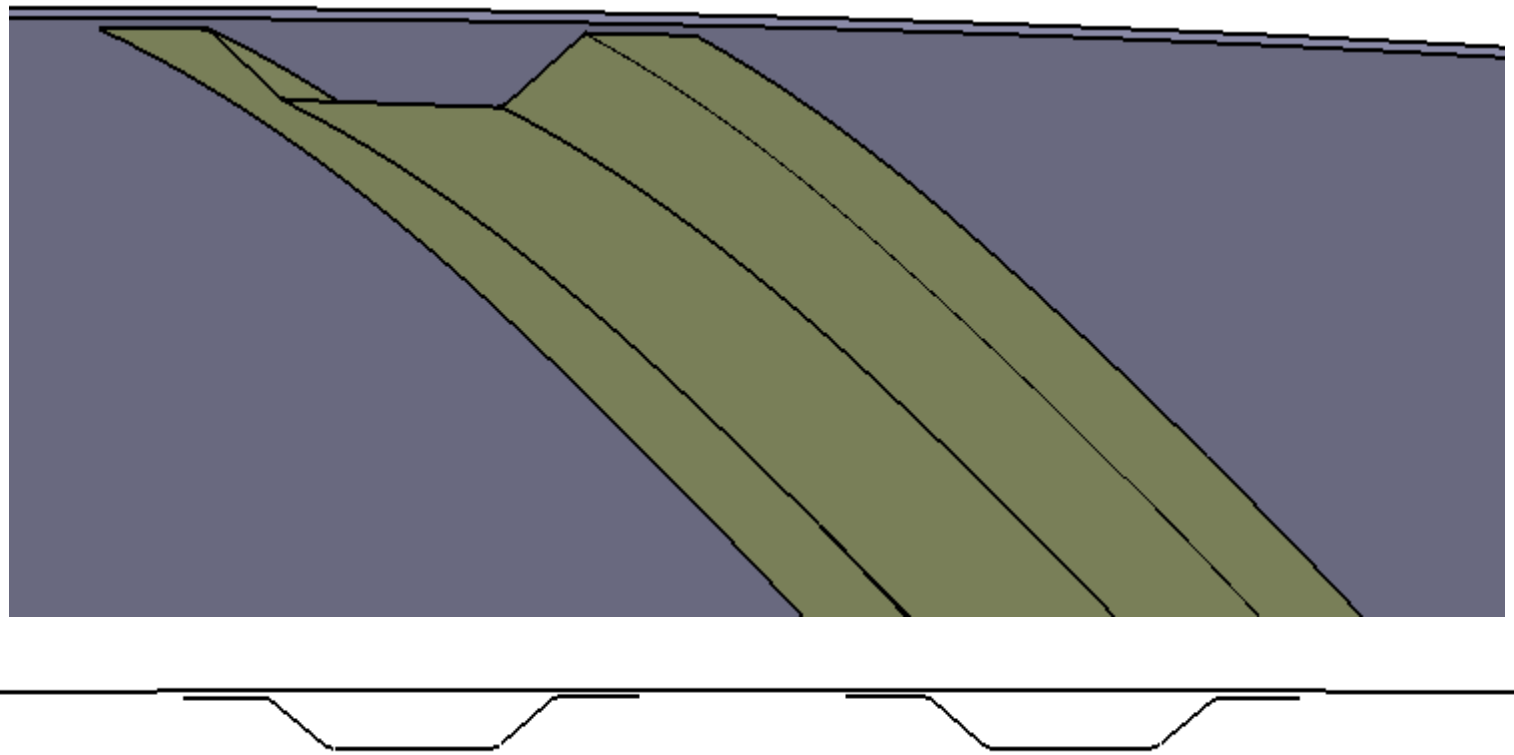


Example: Roof-Structure

- No information in cross-section
- Further interpretation:
  - Contour Signed VonMises
  - Bending detected?
  - In this case no Bending

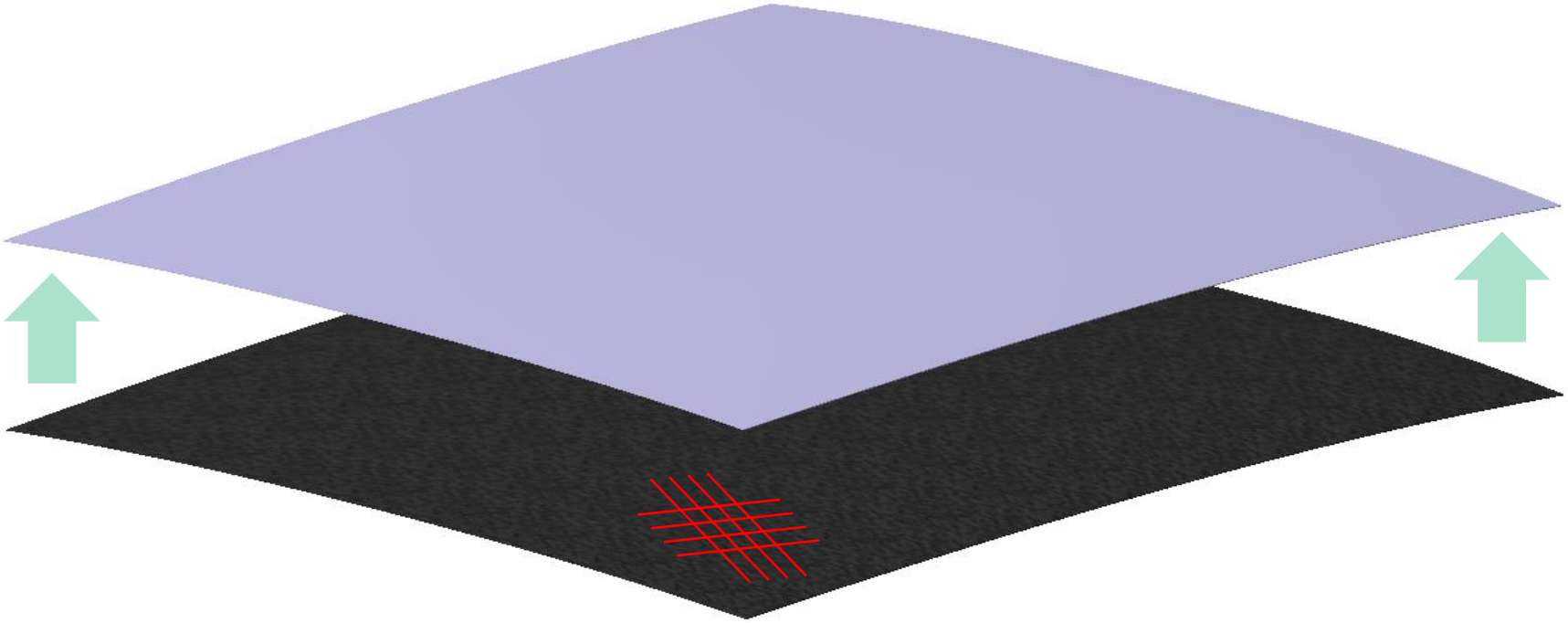


Example: Roof-Structure



Cross-section shell structure

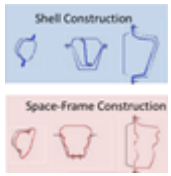
Example: Roof-Structure

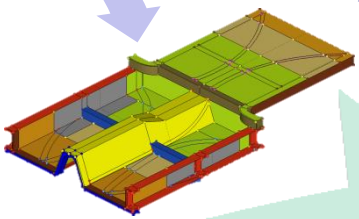


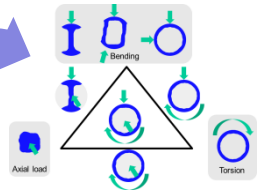
Roof structure, reinforced with FRP +/-45°

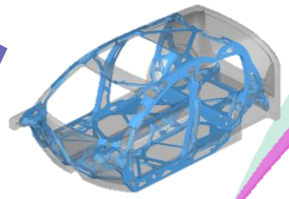
Decision Making in Design Process

Loadstep	Bending, axis	X [%]
Bending	Yes, Y	0,118
Torsion	No	0,972
Front crash	Yes, Z	0,132
Front crash 40%	No	1,059
Side crash	No	0,698
Rear crash	Yes, Z	0,051









technology based

economic based

Thank you for your attention

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