Automobile Body Structure
Project: Future EV body structure

2016201432

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Outline

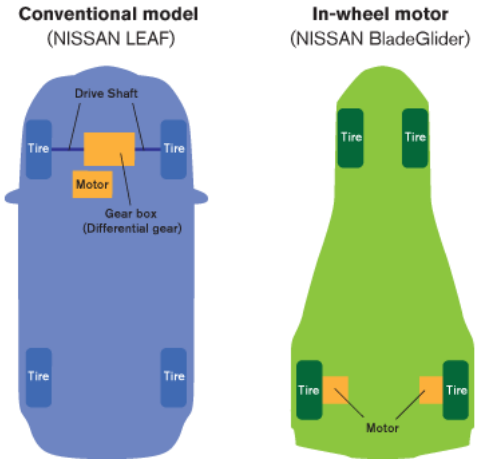
- Motivation
- Process
  - Packaging layout
  - Topology optimization
- Result
- Consideration

Motivation

- Much more variety of structure configuration for future EV
- Change of regulation and perception

사이드미러 없는 자동차, 국토교통부 개정안 입법 예고…이르면 내년부터 가능
서울경제 | 2016.11.08 | 네이버뉴스
이르면 내년부터 사이드미러 없는 자동… 중부일보 | 2016.11.08
사이드미러 없는 車, 내년부터 나온다 조선일보 | 2016.11.08 | 네이버뉴스
사이드미러 없는 車, 내년부터 허용 동아일보 | 2016.11.08 | 네이버뉴스

카메라모니터시스템 기술은 오래전에 개발됐지만 상업화하지는 못했습니다. 그동안 국내 현행법은 사이드미러 장착을 의무화하고 있었거든요.



→ Inspired by BladeGlider of Nissan

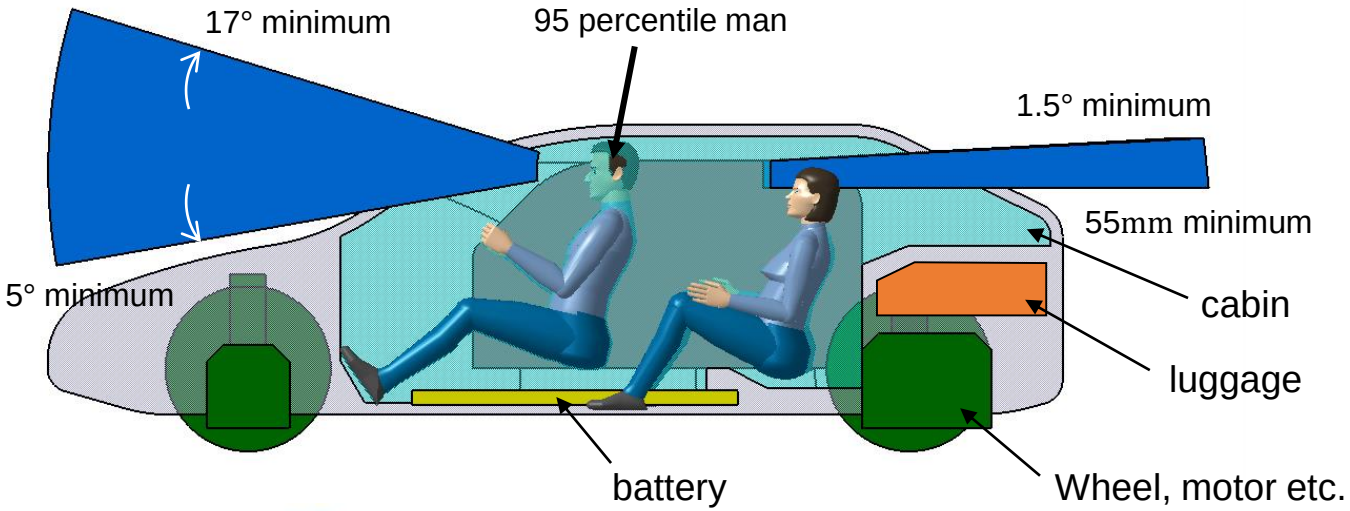
Motivation

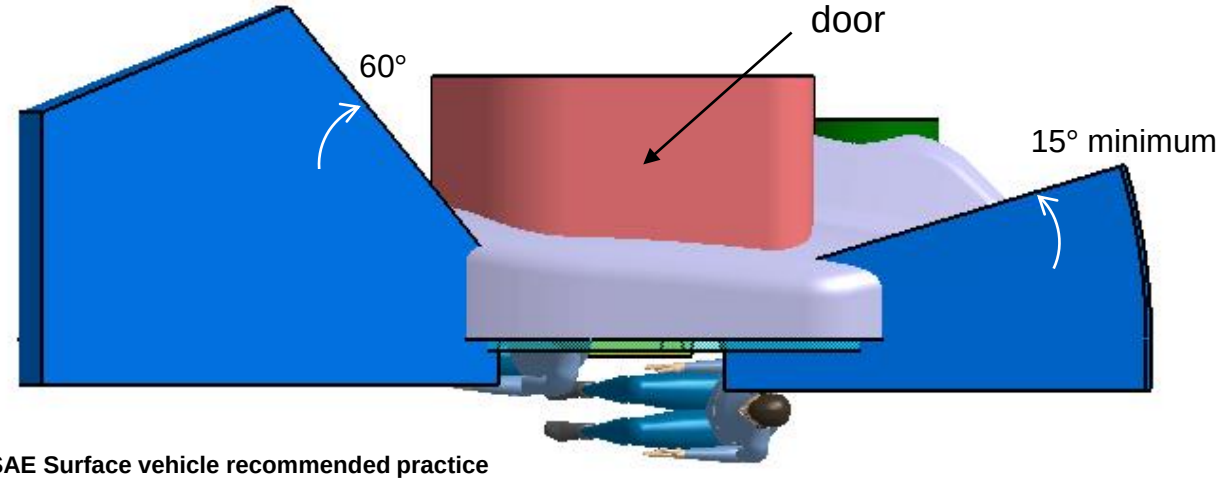
- **Benchmark dimension**

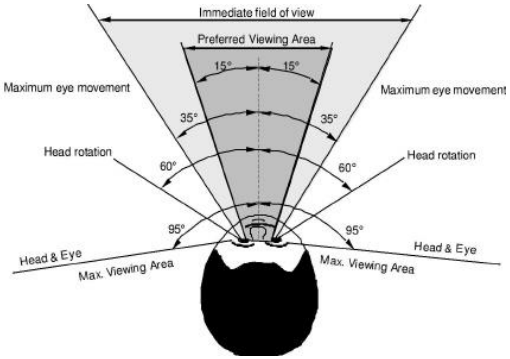
Nissan BladeGlider key statistics	
Top speed	>190km/h (115mph)*
Acceleration 0-100km/h (62mph)	< 5 seconds*
Power	200kW (268 hp)
Torque	707Nm
Weight	1300kg
Length	4300mm
Width	1850mm
Height	1300mm
Wheelbase	2800mm

Process

- **Package layout**





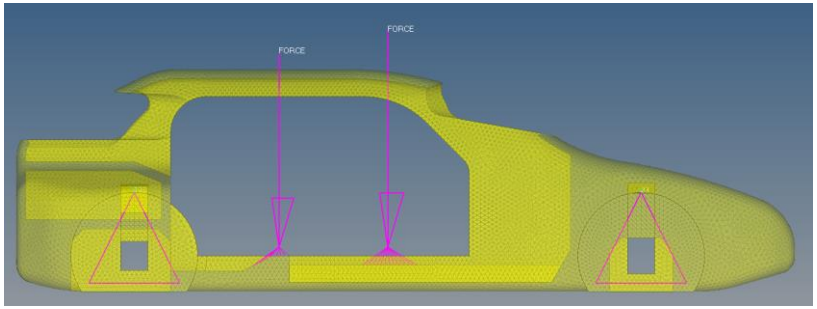


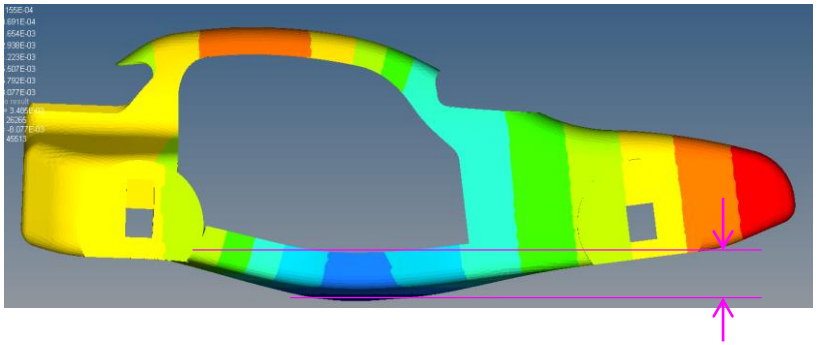
SAE Surface vehicle recommended practice

- Describing and Measuring the Driver's Field of View, J1050
- Motor Vehicle Driver's Eye Locations, J941

Process

- **Topology optimization(bending)**

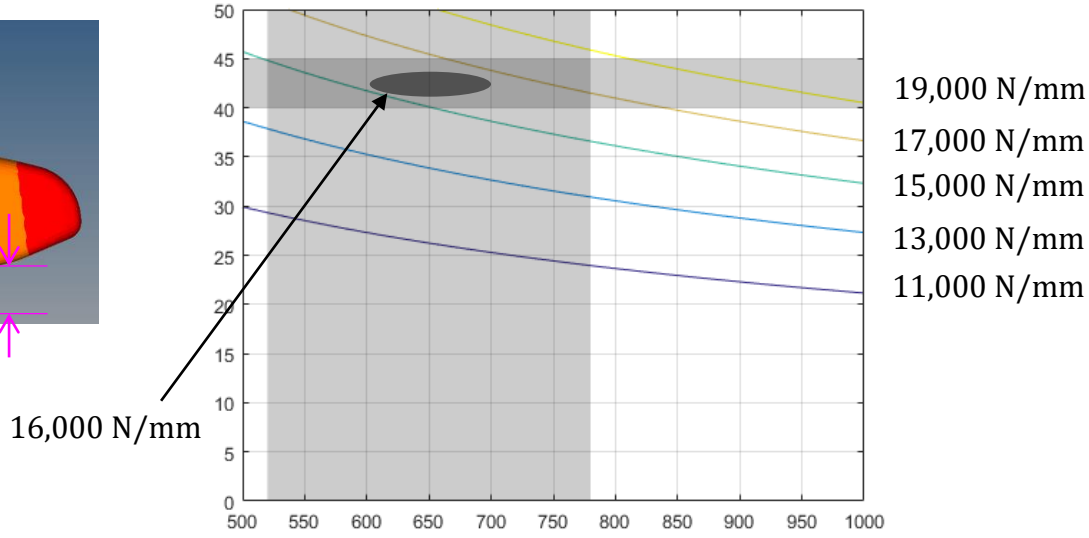




$$\omega_n = \frac{22.4}{\sqrt{48}}\left(\frac{l}{L}\right)^{\frac{3}{2}}\sqrt{\frac{K}{M}}$$

where $l = 2800$ mm, $L = 4300$ mm

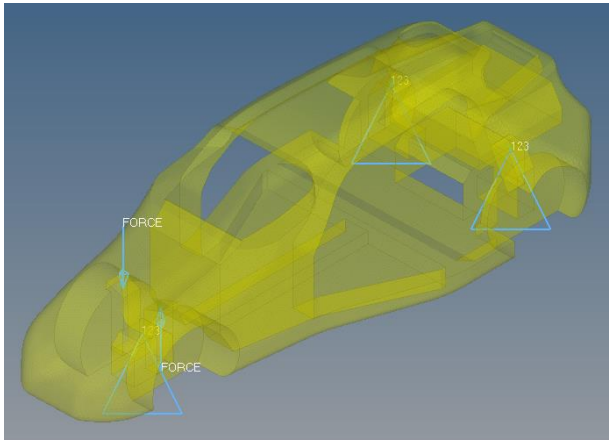
$520 \leq M \leq 780$ kg

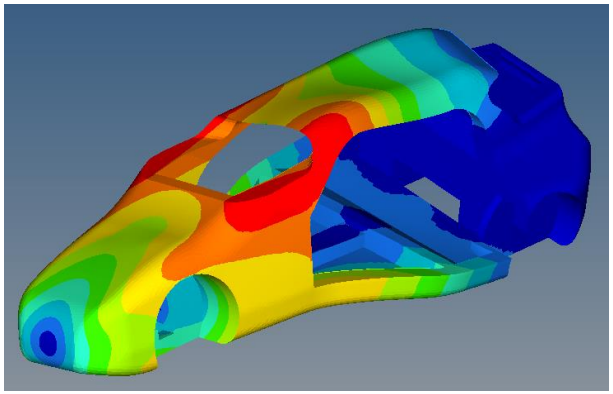


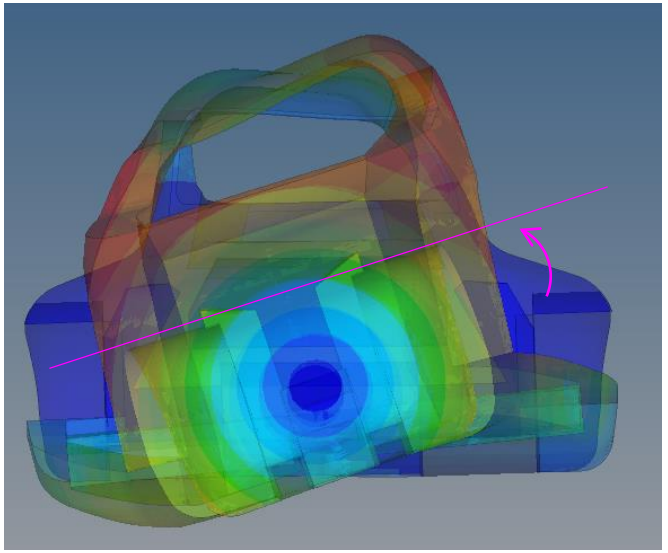
Cf. FSV bending stiffness target: 12 kN/mm

Process

- **Topology optimization(torsion)**





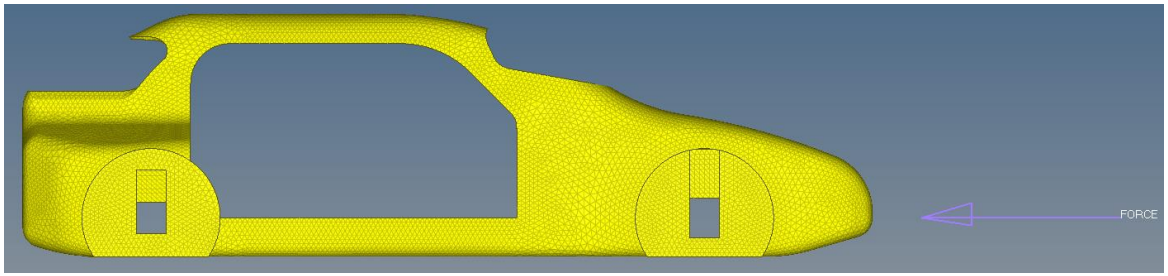


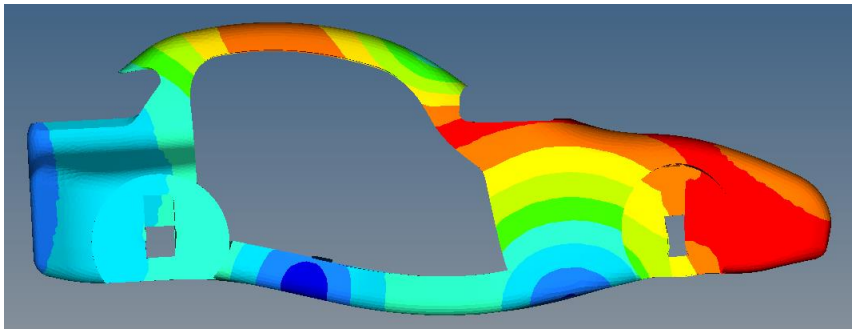
Torsional stiffness $20\ \mathrm{kN/mm}$

Cf. FSV torsional stiffness target: $20\ \mathrm{kN/mm}$

Process

- **Topology optimization(full frontal)**





Original target (USNCAP)
- Foot well intrusion: $< 100\ \mathrm{mm}$
- Peak Pulse: $< 35\ \mathrm{G's}$ after $30\ \mathrm{ms}$

Topology optimization purpose
- To find efficient distribution of material
- By eliminating low strain energy element

⇳

Minimize compliance problem

ISSUES
1. How to solve non-linear optimization
2. How to treat unconstrained analysis

Process

- **Topology optimization(full frontal)**

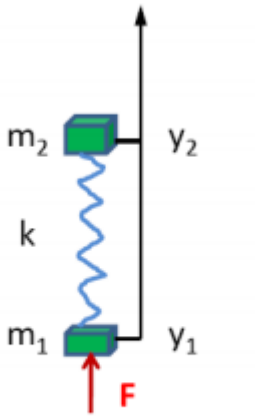
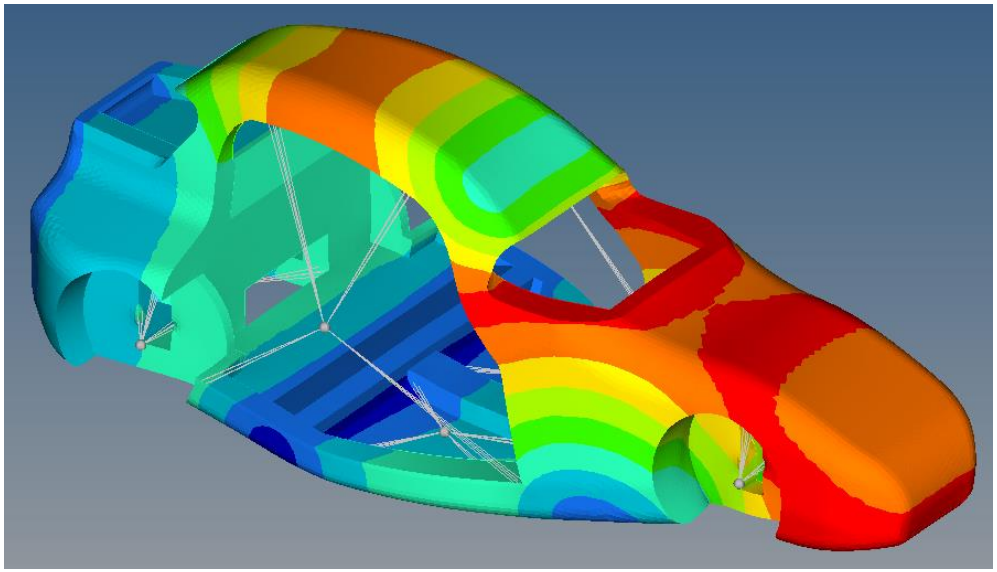
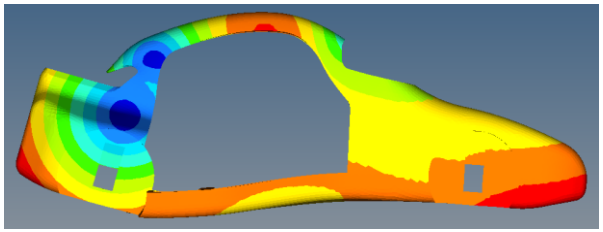


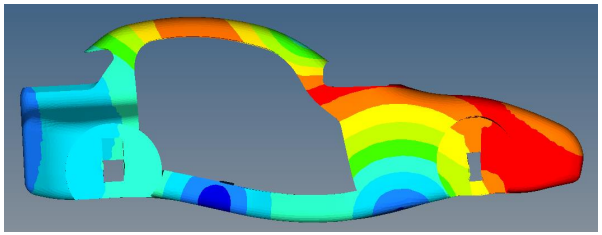
Figure 1. A spring-mass structure.



Parts	Weight [kg/EA]
Front tire	30
Rear tire	40
Door	16
Battery	200
Powertrain	50



Inertia relief without SPC

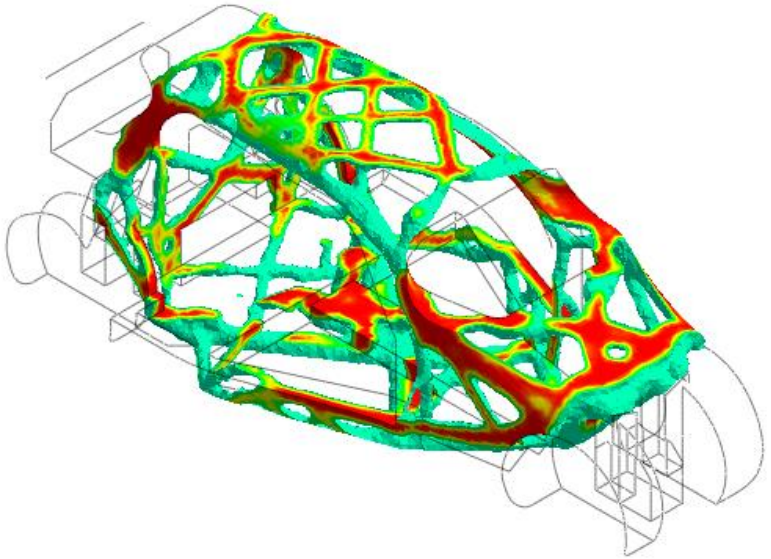


Static analysis with SPC

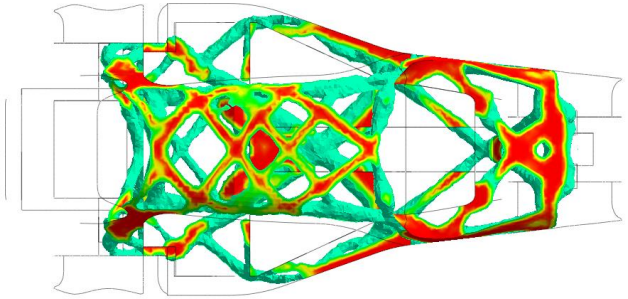
Liao, L. (2011, April). A study of inertia relief analysis. In *Pro- ceedings of the 52nd AIAA/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference. Denver, Colorado: AIAA* (pp. 1-10).

Result

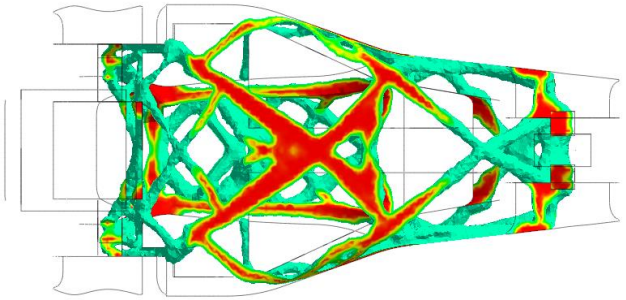
- **Bending + torsional stiffness requirement (NFX)**



10 % volume fraction



top



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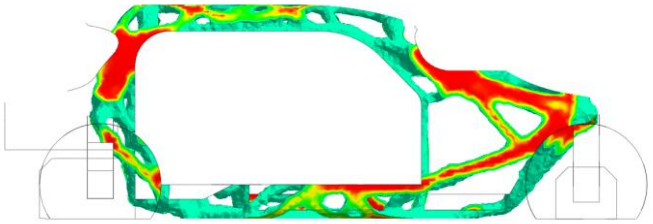
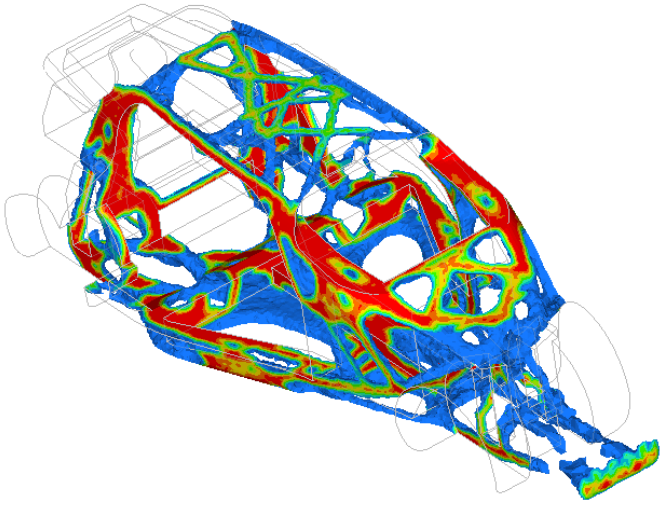


side

TO with inertia relief is not supported.

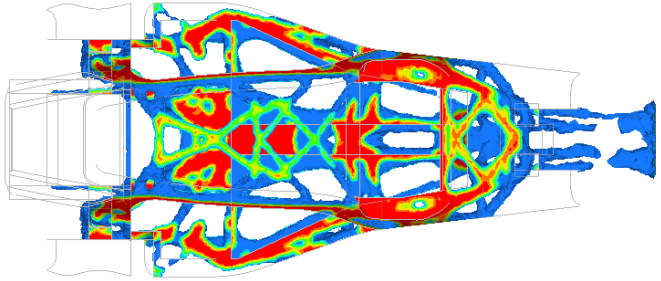
Result

- **Bending + torsional stiffness and full frontal (Optistruct)**



10 % volume fraction

top



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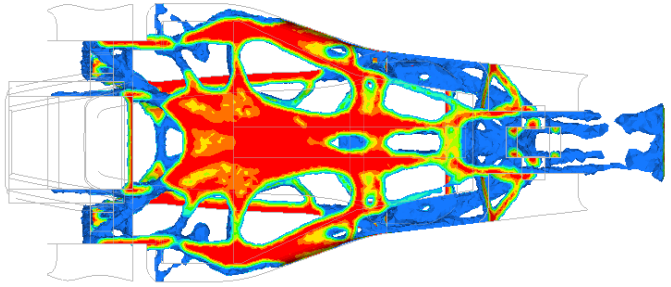
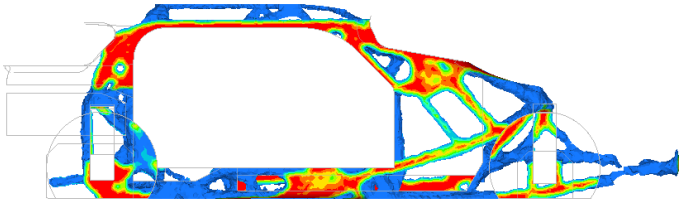


side

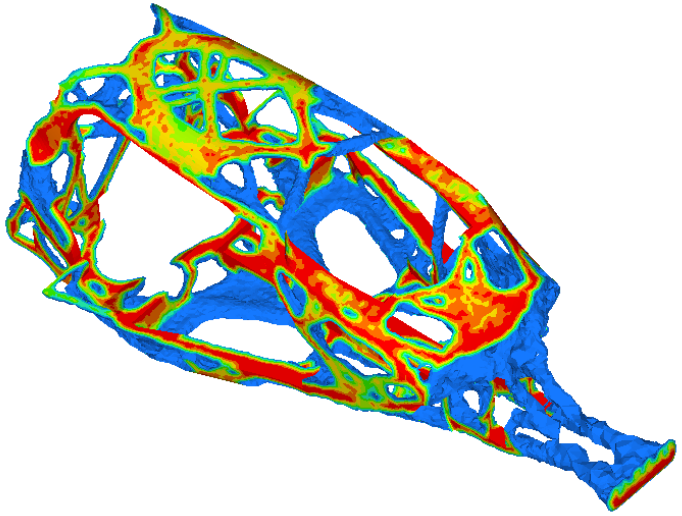


ISSUES

1. Discrete solution
2. Weight of objectives

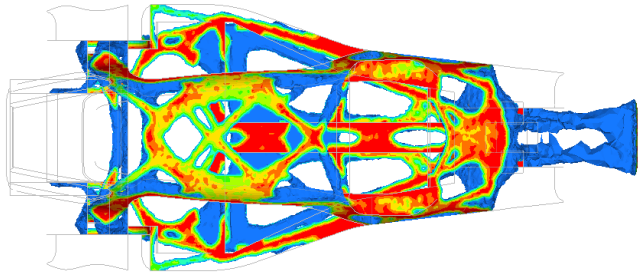
Result

- **Bending + torsional stiffness and full frontal (Optistruct)**

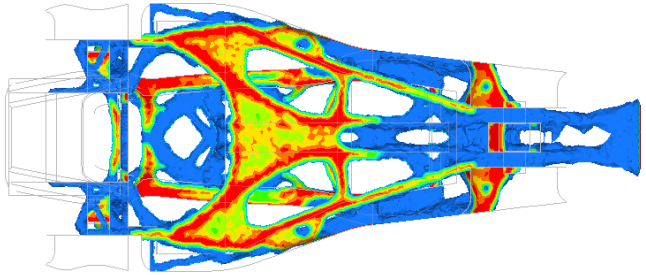


Subcase	Compliance		Weight
1	2.211226E+01	⇒	0.1
2	2.376609E-01		10
3	2.351300E-01		10

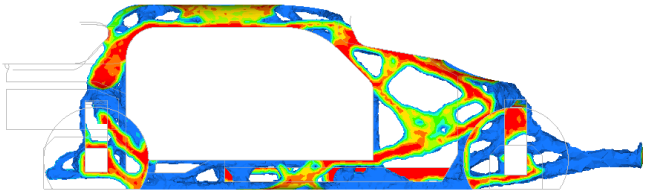
top



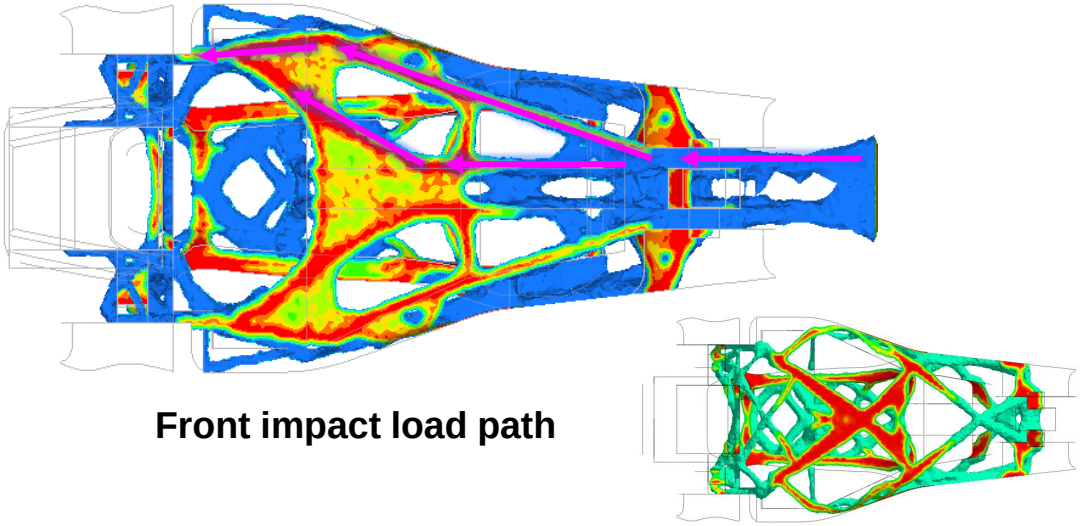
bottom



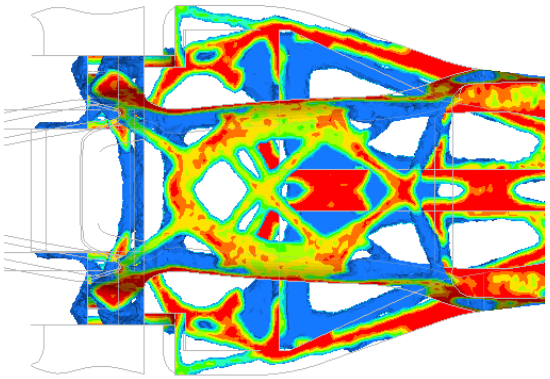
side



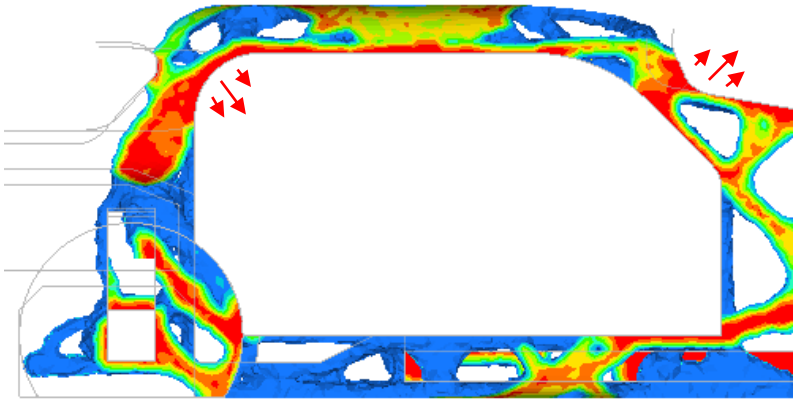
Consideration



Front impact load path



Cross members: torsion



Design domain dependency