European Commission

Horizon 2020
European Union funding
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AffordabLe LIghtweight Automobiles AlliaNCE

# ALLIANCE Final Event

## September 19, 2019

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# Opel demonstrator (virtual):
# Strut tower, wheel house and integrated rail

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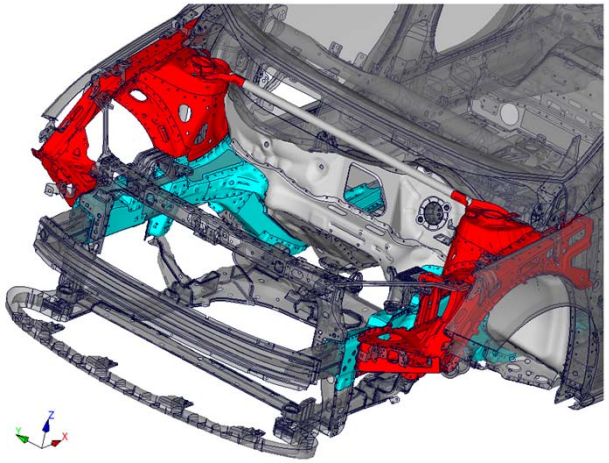
# Objectives

## Motivation & Relevance

Lightweighing of the front compartment is essential for the weight balance of the entire vehicle.



## Targets

Opel virtual demonstrator: Integrated rails, wheel house and strut tower

- lightweighing costs: < 3 €/kg_saved
- weight: 22% improvement
- GWP: 6% improvement

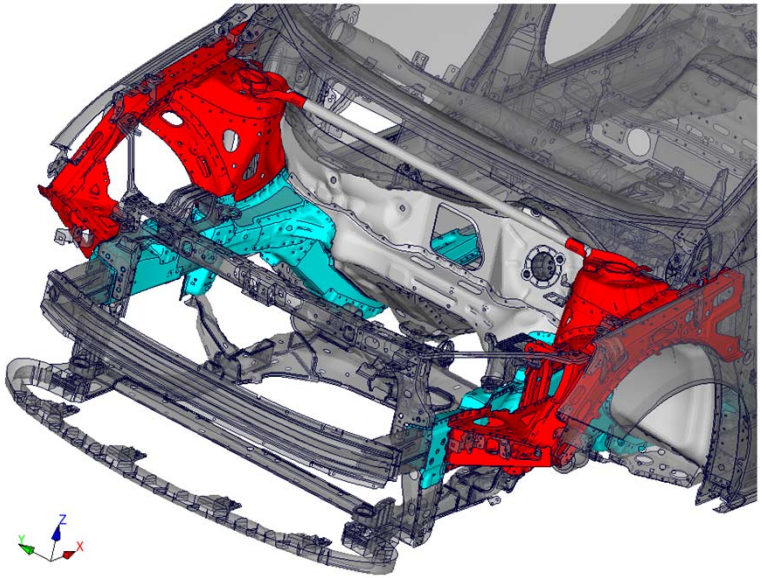
In addition, the lightweight solutions must fulfill the following load cases:

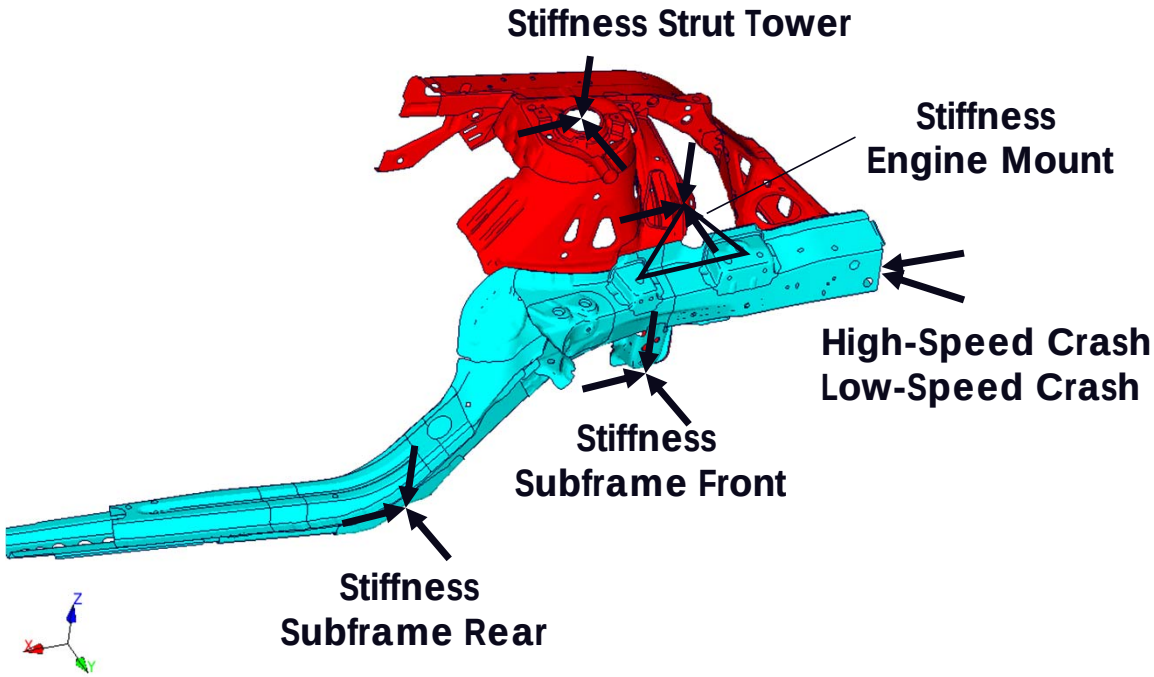
- Crash: Euro NCAP Frontal Crash
- Stiffness: local chassis and powertrain attachment stiffness, front end dynamic modes

# Reference model

**Submodule 1: Strut tower and Wheel house**

**Submodule 2: Rails**





# Conceptual Approach

## Identify and develop a lightweight solution by applying 2 systematic methods:

1. Extended Target Weighing Approach (ETWA -> KIT, WP4)
2. Novel multidisciplinary optimization techniques (MDO -> Opel and LBF, WP4)

and by

3. using the design and material experience of experts (IKA, TKS, Novelis, WP4)

| Part name | Mass | LCA in kgCO2-eq | Cost in % | Provide carrier structure | | | Restrict degrees of freedom | | Stabilise front frame | Enable assembly | | Fulfil comfort targets | Fulfil driving dynamics targets | Absorb deformation energy | Check |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Transmit strut forces | Transmit subframe forces | Transmit engine forces | Withstand engine mount forces | Withstand strut forces | Stabilise in case of crash | Ensure Carcass Assembly | Ensure General Assembly | Fulfil comfort targets | Fulfil driving dynamics targets | Absorb deformation energy | |
| PANEL-FRT W/H RR LH | 0.86 | 11.20 | 4.47% | 40.0% | 10.0% | 10.0% | | | 5.0% | 7.5% | 7.5% | 10.0% | 10.0% | | 100.0% |
| SUPPORT-FRT W/H PNL, LH | 0.68 | 7.93 | 3.80% | 15.0% | 30.0% | 15.0% | | | 5.0% | 7.5% | 7.5% | 10.0% | 10.0% | | 100.0% |
| BRACE-FRT W/H PNL,LH | 0.69 | 7.96 | 2.45% | 30.0% | 5.0% | 5.0% | | | 15.0% | 10.0% | 5.0% | 5.0% | 5.0% | 10.0% | 100.0% |
| REINFORCEMENT-FRT W/H FRT PNL FRT,LH | 0.21 | 2.49 | 1.42% | 15.0% | 10.0% | 5.0% | | | 25.0% | 10.0% | 5.0% | 10.0% | 10.0% | 5.0% | 100.0% |
| RAIL-F/CMPT UPR SI, LH | 0.5 | 7.91 | 3.42% | 25.0% | 5.0% | 5.0% | | | 20.0% | 10.0% | | 5.0% | 5.0% | 10.0% | 100.0% |
| HOUSING-FRT SUSP STRUT LH | 1.5 | | 5.01% | 40.0% | | | | | 10.0% | 5.0% | 5.0% | 15.0% | 15.0% | | 100.0% |
| [illegible] | 1.02 | 12.00 | 4.06% | 25.0% | 5.0% | | | | | | | | 10.0% | 5.0% | 100.0% |
| BRACE-FRT SUSP STRUT RSS LH | 0.[illegible] | | 2.30% | 30.0% | | | | | | 10.0% | 15.0% | 20.0% | 25.0% | | 100.0% |
| REINFORCEMENT-FRT W/H PNL FRT BR,LH | 0.[illegible] | | 2.95% | 15.0% | 10.0% | 5.0% | | | 30.0% | 5.0% | 5.0% | 10.0% | 10.0% | 5.0% | 100.0% |
| REINFORCEMENT-FRT W/H PNL LH | 0.48 | 5.12 | 2.70% | 10.0% | 5.0% | 20.0% | 30.0% | | 5.0% | 5.0% | 5.0% | 10.0% | 5.0% | | 100.0% |
| cast part | 0.38 | 6.15 | 5.74% | 25.0% | | | | 25.0% | | 10.0% | 10.0% | 15.0% | 15.0% | | 100.0% |
| varnish | 0.02 | | 2.08% | | | | | | | | | | | | 100.0% |
| KTL corrosion protection | 0.03 | | 2.84% | | | | | | | | | | | | 100.0% |
| **Mass per function** | 7.24 | 86.31 | 42.23% | 2.00 | 0.50 | 0.43 | 0.14 | 0.10 | 0.88 | 0.55 | 0.41 | 0.78 | 0.76 | 0.23 | 7.24 |
| relative mass ratio | | | | 27.66% | 6.88% | 5.97% | 1.98% | 1.33% | 12.13% | 7.63% | 5.68% | 10.74% | 10.57% | 2.92% | 100.00% |
| **Emission per function in kgCO2-eq** | | | | 24.09 | 5.92 | 5.11 | 1.54 | [illegible] | 10.32 | 6.75 | 4.99 | 9.31 | 9.19 | 2.57 | 86.31 |
| relative emission ratio | | | | 27.92% | 6.85% | 5.92% | 1.78% | [illegible] | 11.96% | 7.82% | 5.78% | 10.78% | 10.65% | 2.98% | 100.00% |
| **Cost per function in %** | | | | 9.87% | 2.55% | 2.22% | 0.81% | 1.44% | 3.85% | 3.04% | 2.42% | 4.21% | 4.19% | 0.96% | 42.23% |
| relative cost ratio | | | | 23.37% | 6.05% | 5.26% | 1.92% | 3.40% | 9.12% | 7.20% | 5.73% | 9.96% | 9.91% | 2.27% | 100.00% |

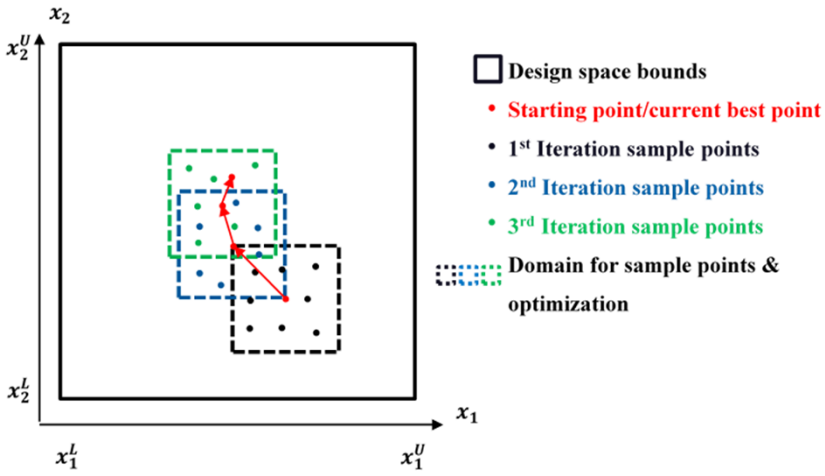
Parts list

Part data

Functions

Function weighing factors

Effort per function

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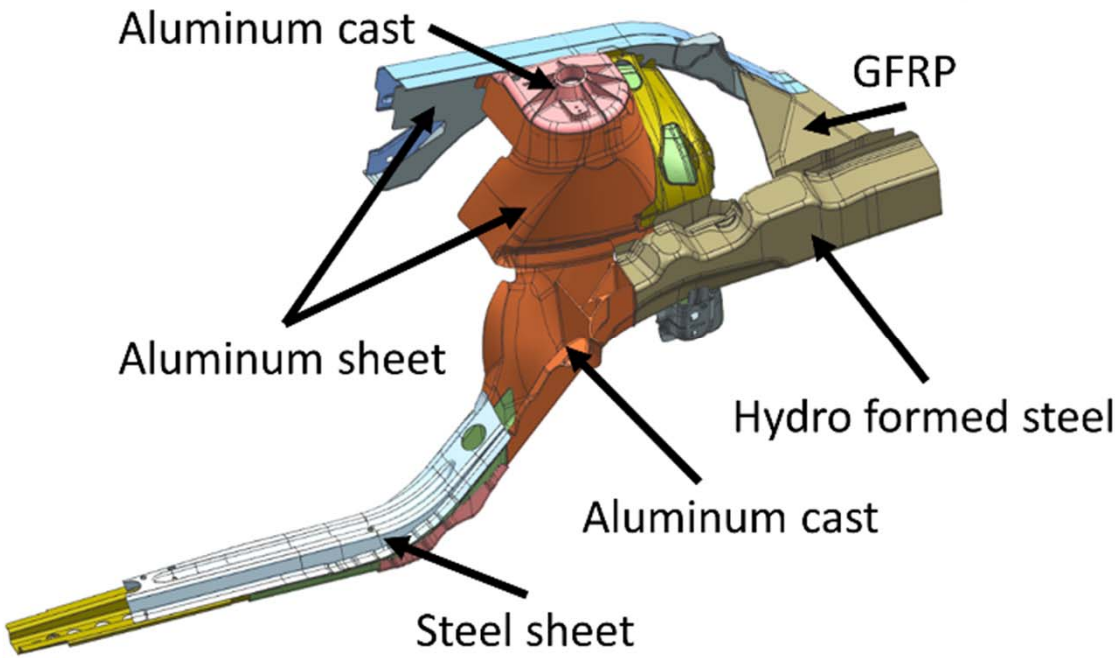
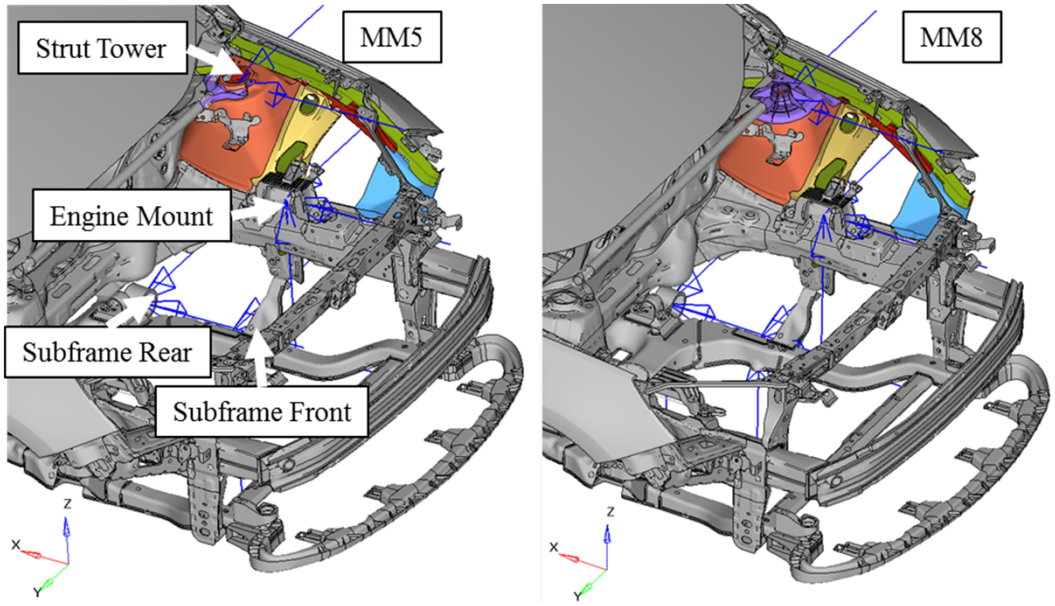
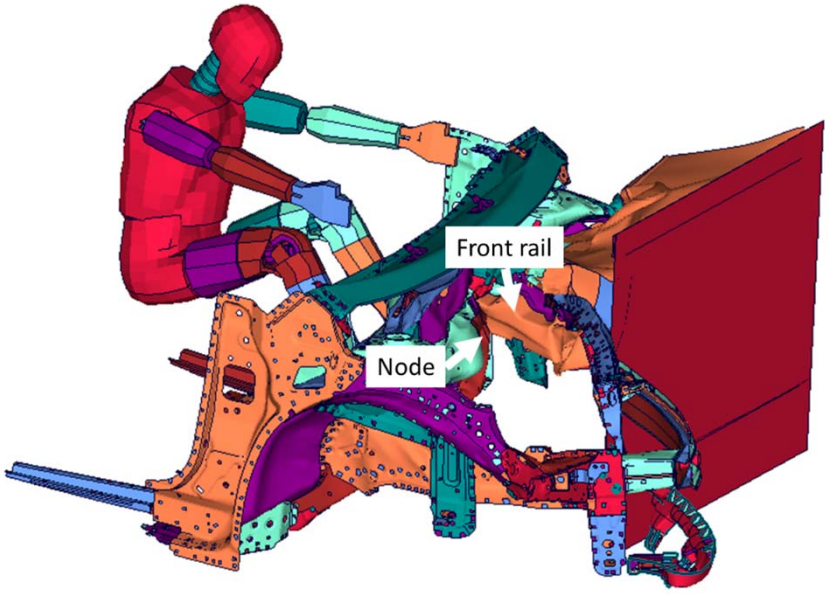
# Final Concept




- ✓ Mass improvement 35%
- ✓ GWP improvement 28%
- ✓ Cost 1,53 €/kg_saved

# Validation




✓ **Stiffness performance**

✓ **Crash performance**

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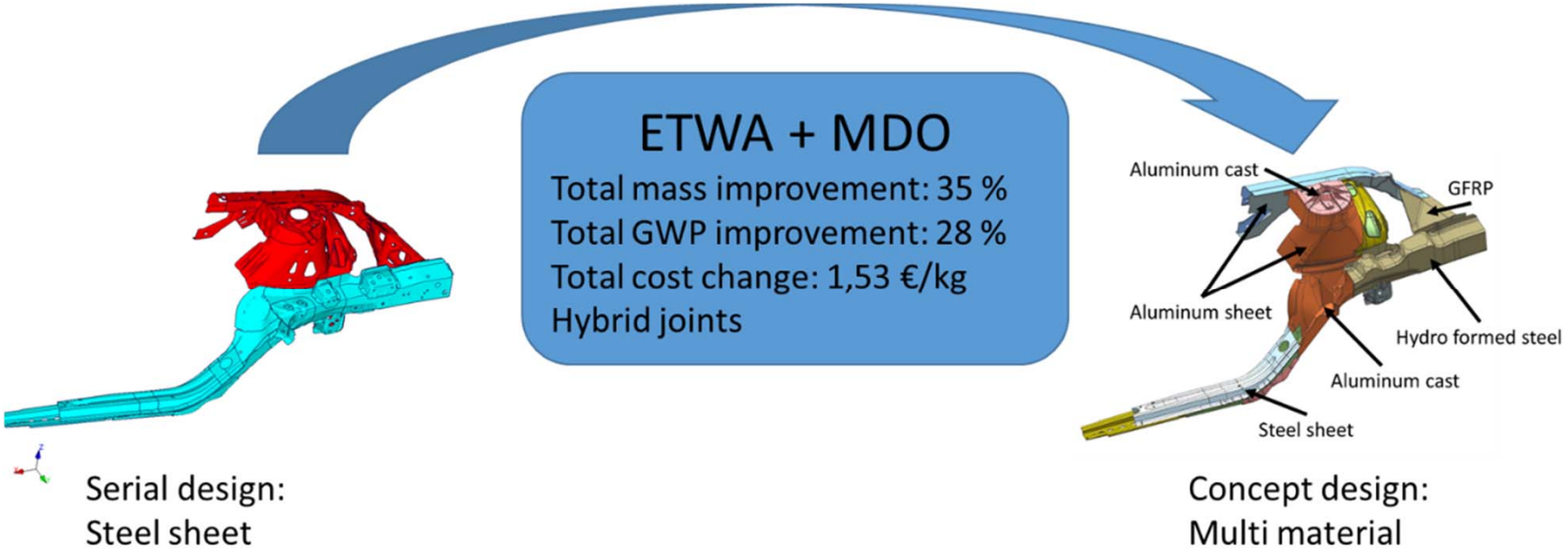
# Final Design and Results




**All project targets were reached!**

# Lessons Learned

- ETWA is a powerful tool to make design decisions based on data (cost, weight, GWP figures)
- Full scale MDOs require huge computational power and high quality models

➢ **Using these tools cost effective light weight design is still possible in automotive!**