The European SuperLight Car project

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Summary
The SuperLight Car project is a joint European effort of 38 partners from the automotive industry and research institutions. The goal of the project is to develop technology for a new significantly lighter body for a mass-market car in the Golf-class. Reduced weight means reduced fuel consumption, so this is a step toward a more ecologically sustainable transport system.

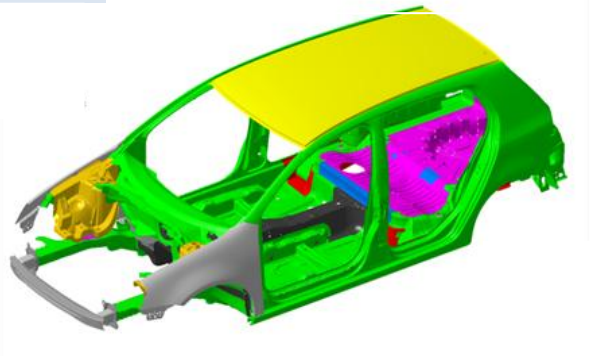
The focus of this article is on simulation based design. The development of the SLC concept body relies heavily on simulation based design, as does all car development today. Engineering Research, a specialist consultant in the field, has supported the SLC project with know how in crash simulation as well as special simulation tools for the new materials and joining methods that are used in the SuperLight Car project.

Lower weight for the environment
Weight is one of the factors affecting the fuel consumption of cars, i.e. increased weight leads to increased fuel consumptions.

The car body of a modern Golf-size car is typically made of steel and has a weight of around 280 kg, see the figure at the top of the page. Thus, the body is one of the major parts of a car. In light of the above facts it is therefore not surprising that a number of research projects have been carried out with the goal to reduce the weight of the car body:

- ULSAB and ULSAB-AVS - WorldAutoSteel organization
- NewSteelBody – ThyssenKrupp Steel
- NextGenerationVehicle – stainless steel (www.ngvproject.org)

Despite the emergence of new light materials the mass market car of today is still based on a steel body.



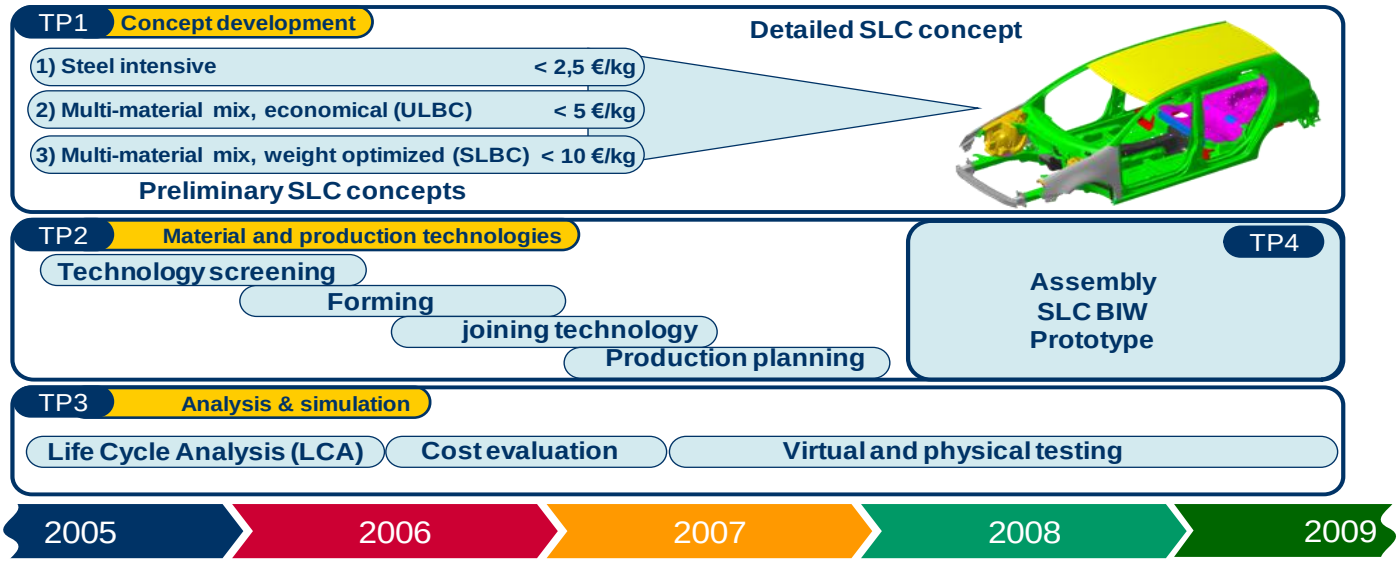
SLC Concept body – each part is to use the optimal material. Each color represents a different material type: green - aluminium, yellow - magnesium, magenta - glassfiber reinforced plastics, et c.

The SuperLight Car (SLC) project
A key feature of the SuperLight Car project is the use of a multi-material strategy which aims at selecting the material and manufacturing process for each part of the car body that minimizes both weight and cost.

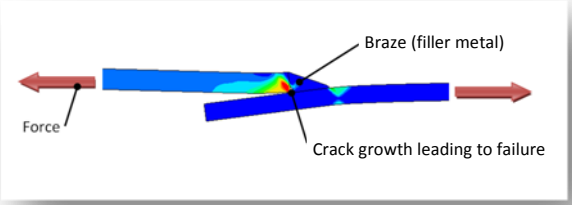
The result of the SLC project is a 30 % lighter car body concept for an affordable and recyclable mass market car of the Golf-type.

SLC organization
The SLC project is a research and development project headed by Volkswagen and partly financed by the European Commission under the 6th Framework Programme. It involves 38 partners from the European automotive industry and research institutions and has a €20m budget. For more information about the project visit www.superlightcar.com.

The project has several different phases as is shown in the figure below. The end result of the project is a 30 % lighter multi-material body for the VW Golf (the reference vehicle of the project).



SuperLight Car project outline for the project life from 2005 to July 2009



LS-DYNA simulation of a bend test of a Laser Brazed crash beam profile in aluminium and steel.

Simulation based concept development
The development of the SLC concept car relies on simulation based design, as does all car development today.

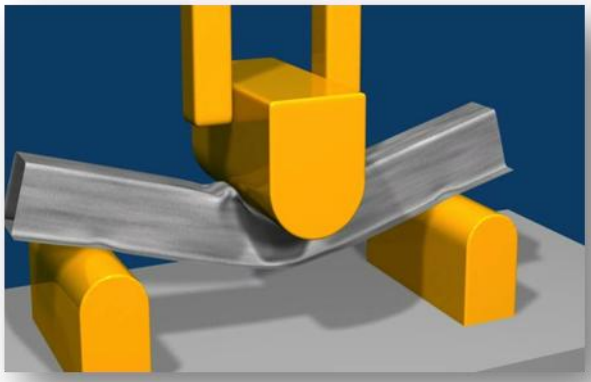
The body development team consists of car makers (VW, Fiat, Opel, Porsche and Volvo Technology), IKA (German institute), and ARUP (UK automotive consultant). The development team develops a series of body concepts made out of a mixture of steel, aluminum, magnesium, and fiber reinforced plastics. To understand the performance of a given concept with respect to crash-worthiness, vibrations and handling, simulations are performed of the EURO-NCAP crash tests as well as tests to determine torsional stiffness and eigen-frequencies. These performance feedbacks from the simulations are then used by the development team to improve the body design. The development process continues in this iterative manner until an acceptable design is found that fulfills the performance requirements, which are no less than for the reference vehicle (the VW Golf).

All simulations including the modal analyses are performed using LS-DYNA, which is the leading crash analysis software in the industry. The choice to use LS-DYNA also for the modal analyses instead of more established software in this area, such as MSC/NASTRAN, was made to save development time by being able to use the same simulation model for all analyses.

Engineering Research Nordic AB
Engineering Research, an expert consultant in simulation based design using LS-DYNA, takes part in the SLC project by being responsible for the two following tasks:

- Responsible for crash evaluation methodology for the computerized concept optimization.
- Responsible for simulation tools for the new materials and joining technologies used in the SLC body concept.

Computerized concept optimization
After the design of the SLC concept is finished by the body development team a final step is carried out with the goal to squeeze out the last kilograms of weight from the body. This final step is a computerized optimization of the design concept and is carried out by Volvo Technology with support by Engineering Research.



LS-DYNA simulation of a bend test of a Laser Brazed crash beam profile in aluminium and steel. Simulation results are validated against tests performed at IKA.

The optimization tool used is LS-OPT and it is used together with massive parallel computers to fine tune the concept by reducing the weight of the body through optimizing the thickness of the hundreds of parts in the body without decreasing the performance of the body with respect to crash performance, stiffness and eigen-frequencies.

This optimization is very large scale and believed to be the first full scale design optimization of a car body.

Simulation of new materials and joining techniques
Being a multi-material concept, many materials and joining techniques are used in the SuperLight Car for which there is no established modeling approach. This could be a problem as the body development team heavily relies on simulations to predict the performance of the body design. Here Engineering Research comes into play by supporting the body development team with simulation models, including failure prediction, for the simulation software LS-DYNA for:

- Materials: New advanced steel alloys, Composites, Aluminum-magnesium alloys.
- Joining methods: Adhesives, laser welding, Laser brazing.

The simulation models are based on test data provided by SLC partners such as Light Weight Structures as well as theoretical analyses. The developed joining models are verified in component tests, see the figure at the top.

Conclusion
The SuperLight Car project shows how the weight of a mass market car body can be reduced using a multi-material design concept. The project takes us a step closer to a less energy consuming car.

The article highlights how modern, state of the art, simulation methods contribute to make the most out of the multi-material concept ideas from the designers and how it leads to a safer and lighter design than would else be possible.

References

Engineering Research Nordic AB, www.erab.se
SuperLight Car project, www.superlightcar.org
Volvo Technology, www.volvo.com

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