Super Light Car

Sustainable Production Technologies for CO_2 Emission Reduced Light weight Car concepts (SLC)

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Automotive engineering conflict…

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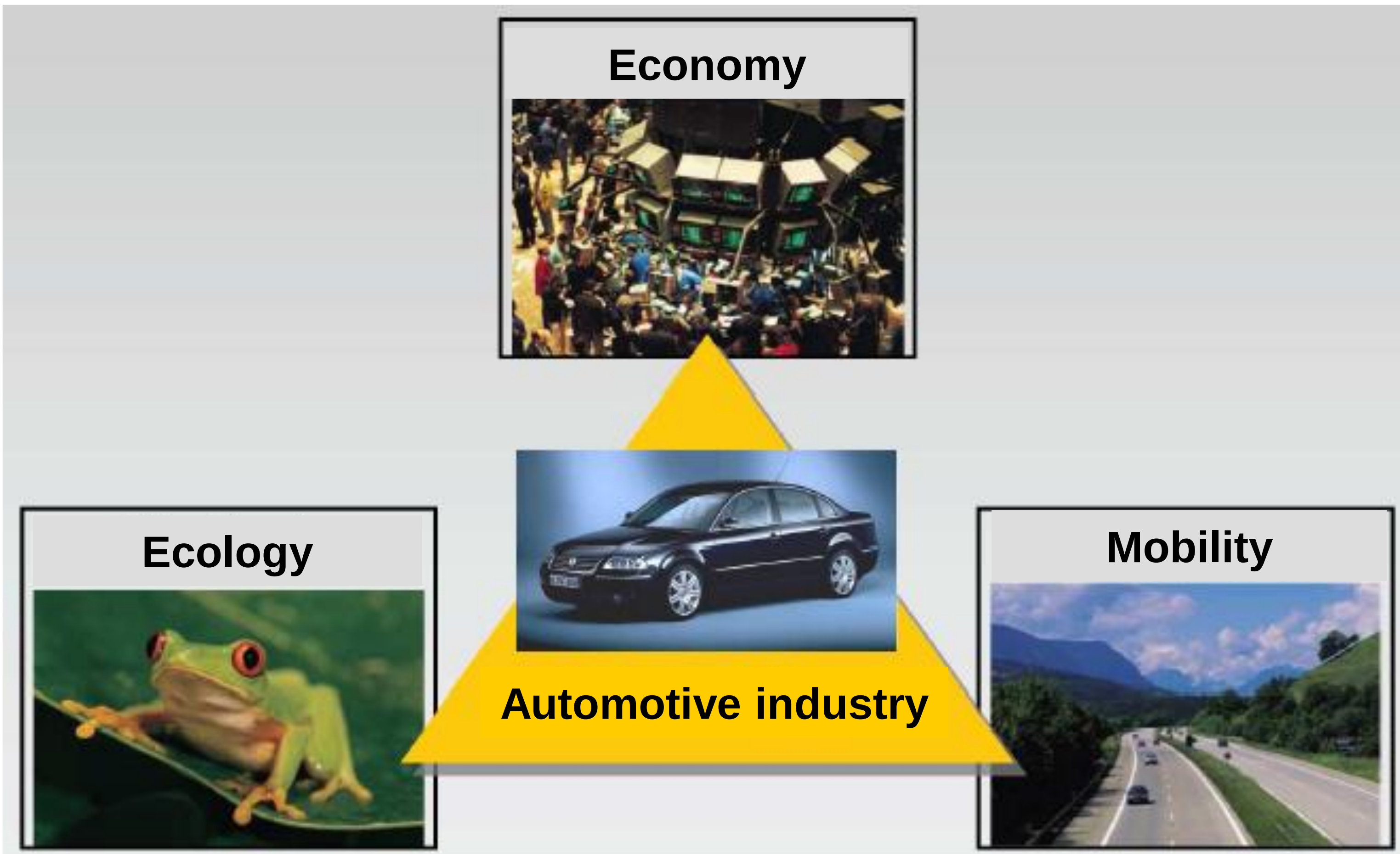

Main Challenge in body design
Multi-Material Concepts

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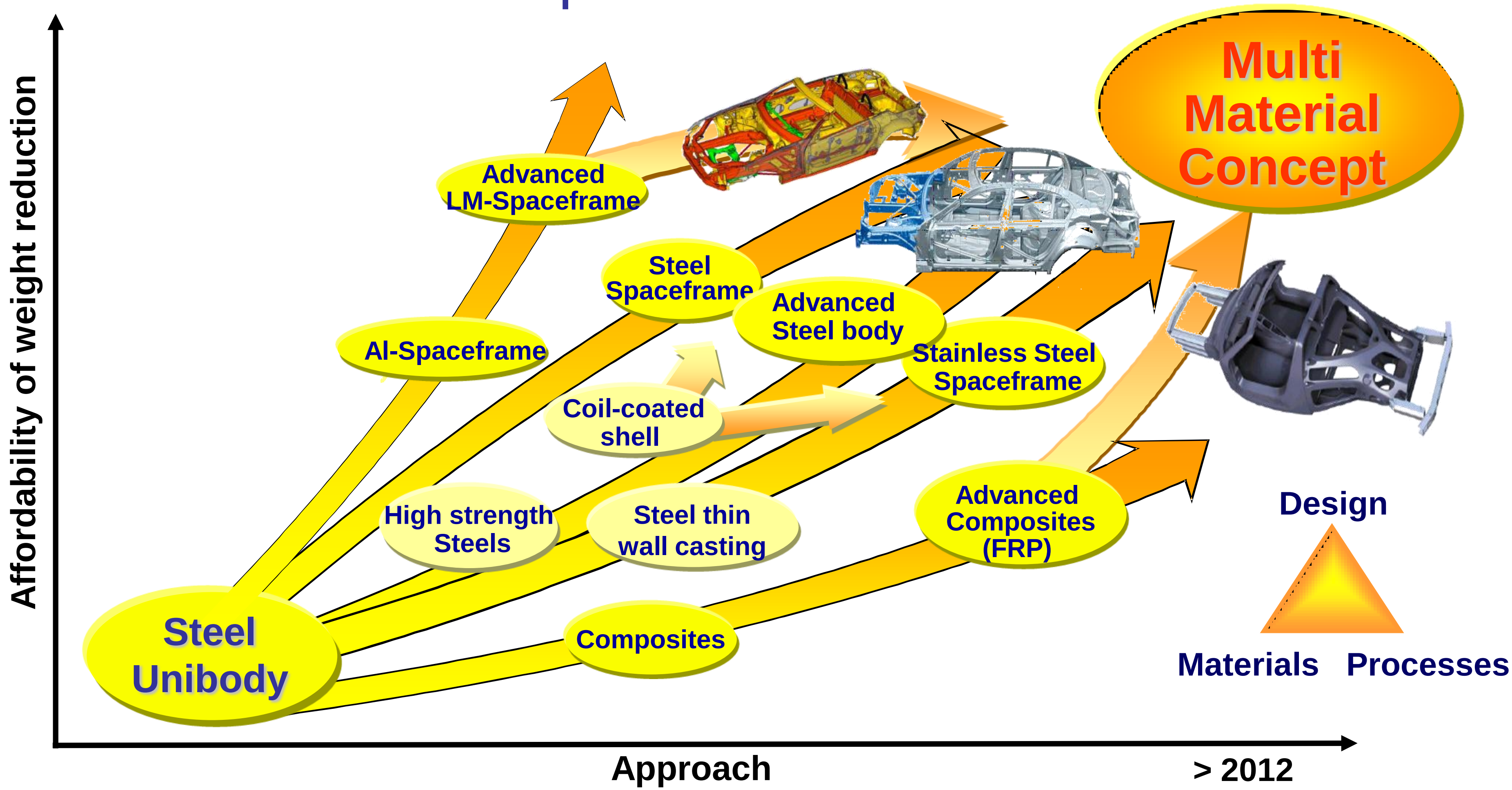

General information

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Project full title:	**Su**stainable **P**roduction Technologies of **E**mission **R**educed **Light** weight **Car** concepts (**SLC**)
IP Number:	516465 (Call 2B „Surface Transport")
IP Coordinator:	Volkswagen; Dr. Martin Goede
Project partners:	7 OEM's: C.R.F., DC, Porsche, Renault, Volvo, Opel, VW 10 R&D Companies 10 Suppliers 7 Universities 3 SME
Start Date of contract:	01/02/2005 — **Duration:** 48 months
Total Budget:	19,2 MEUR — **Funding:** 10,5 MEUR

SLC: Motivation & Objectives

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Motivation:

The Mission of "SuperLightCar" is the realization of advanced multi-material vehicle structures using break-through technologies for economic, lightweight design. It is the aim to apply advanced light weight materials, modular vehicle architectures and advanced manufacturing meeting series production feasibility.

Objectives

The main objective of SLC is the development of innovative multi-material lightweight design for vehicle structures achieving:

- 30% weight reduced vehicle structure (BIW)
- Cost reduced multi-material manufacturability
- High volume capability
- Benchmark performance (C-class segment)
- Recyclability / Sustainablity

Superlight-Car Consortium

37 research partners + 5 associated external partners

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OEM

VOLVO
DAIMLERCHRYSLER
Porsche Engineering
CENTRO RICERCHE FIAT
RENAULT

DESIGN & ENGINEERING

ika RWTH INSTITUT FÜR KRAFTFAHRWESEN AACHEN
ARUP
Stuttgart DLR
RICARDO
ALSTOM
IVM Automotive Member of Edscha Group

STEELS

arcelor Steel solutions for a better world
University of Ancona

JOINING

COMAU
cea
University Torino
LZH LASER ZENTRUM HANNOVER e.V.

MATERIAL TESTING

LBF Institut Betriebsfestigkeit
ZÁPADOČESKÁ UNIVERZITA V PLZNI
merl complete engineering solutions

PLASTICS

DIEFFENBACHER
ALCAN
DOW
University Perugia
ICT Institut Chemische Technologie
POLYTEC GROUP
Advanced Processes and Systems

SIMULATION

ESI GROUP THE VIRTUAL TRY-OUT SPACE COMPANY
ENGINEERING RESEARCH AB

SUSTAINABILITY

TUDelft
TECHNISCHE UNIVERSITÄT DARMSTADT
TNO
PE EUROPE GMBH Life Cycle Engineering

LIGHT METALS

HYDRO
corus
HEATform FREEDOM IN METAL

Sub project overview

SP1	SP2
SP3	SP4

Preliminary SLC body concepts

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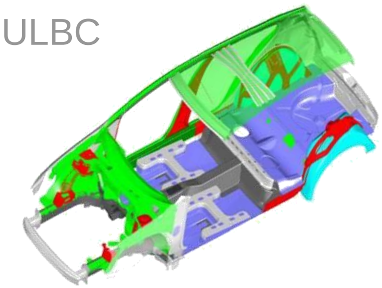
Steel intensive

Weight reduction: **40 kg (14 %)***

Additional part costs: **< 2,5 €/kg**

Highlights:
- Strut tower in FeMn-Steel
- Tunnel in hot-formed steel (Usibor 1500)
- Body side and B-pillar in dualphase-steel
- Roof in Quietsteel
- Fender in Steel polymer composite

ULBC



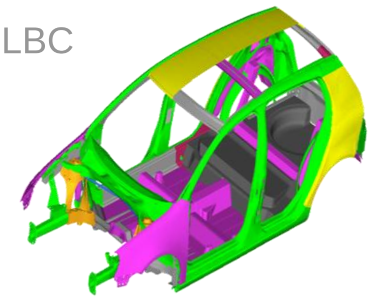
Multi-Material, economic

Weight reduction: **62 kg (22 %)***

Additional part costs: **< 5,0 €/kg**

Highlights:
- Longitudinal rail in FeMn tailored welded blanks
- Suspension-strut mount as Al-diecast
- Tunnel in FeMn-blank
- Rear wheelhouse in Al-diecast
- Inner B-pillar in Al-diecast
- Roof in Al-blank

SLBC



Multi-Material, advanced

Weight reduction: **114 kg (41 %)**

Additional part costs: **< 10,0 €/kg**

Highlights:
- Longitudinal rail in HSS tailored welded blanks
- Strut tower in Mg-diecast
- Floor panel in Al- and Mg-blank
- Wheelhouse and rear longitudinal rail in Al-blank
- Inner B-pillar in hot formd steel
- Roof in Mg-blank

* Equivalent structural performance vs. SLC reference body structure

SLC body structure concept

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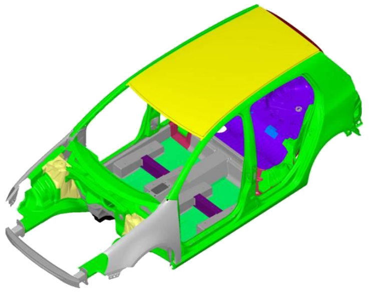
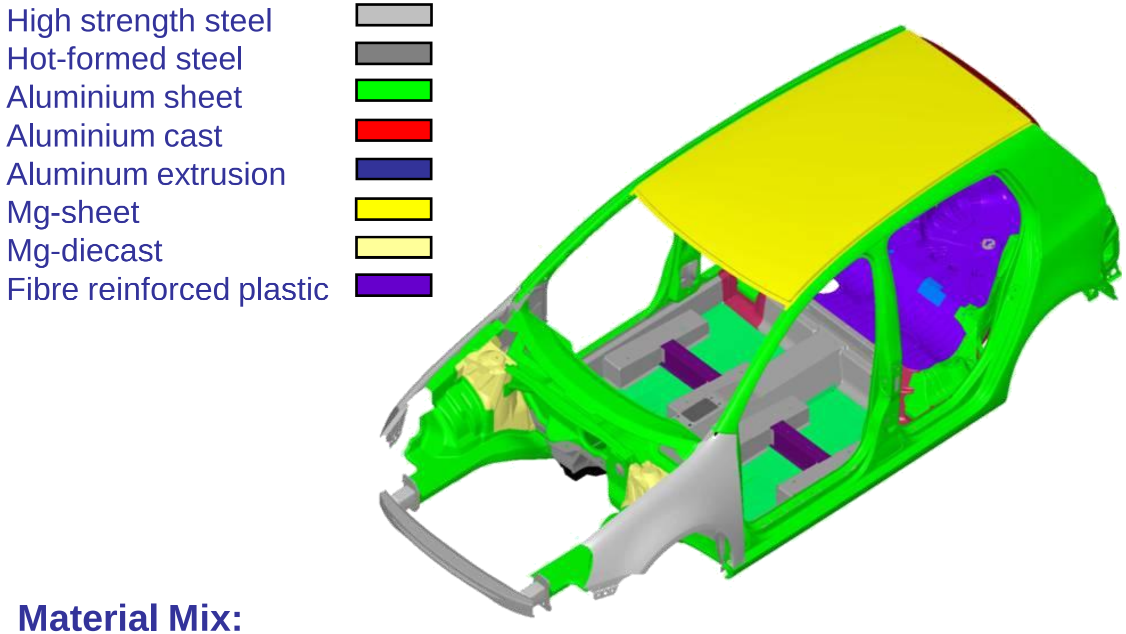


Weight reduction: ~30%

Additional part costs: < 5,0 €/kg

Highlights:
- Mg-Strut tower (die cast)
- Mg-Roof
- Hot formed steel door aperture
- FR plastic roof cross beam
- FR plastic rear floor
- Al-Casting rear longitudinal
- Polymer reinforced seat cross-member



Material Mix:

Steel parts weight:	approx. 50 %
Al parts weight:	approx. 35 %
Mg parts weight:	approx. 8 %
Plastic parts weight:	approx. 7 %

Sub project overview

Concepts & Design

- Multi-attribute vehicle optimization
- Parts/modules concepts
- Design guidelines

Multi-M

SP2

SP3

SP4

LFT and Mg sheet hot forming

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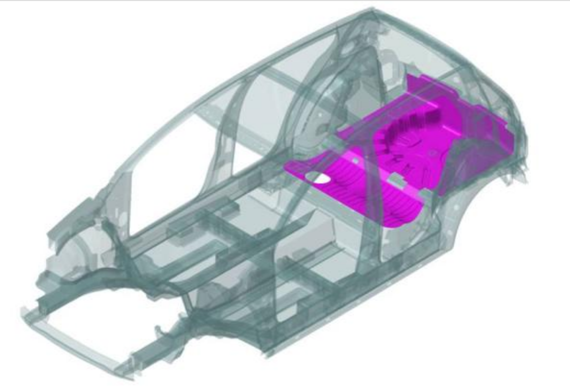
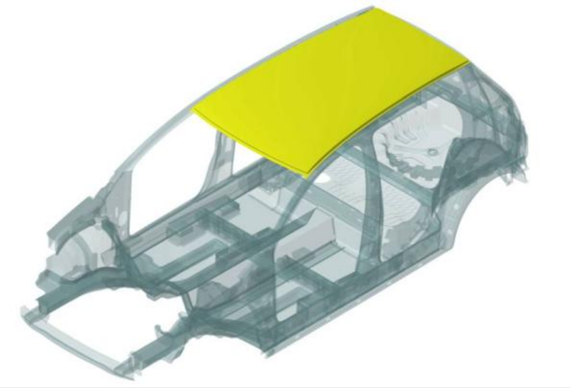
LFT Panels Forming

- Low material and production cost requirements
- LFT technology is available as state of the art for high volume production
- 2 technology demonstrator parts will be produced (parts rear floor)



Magnesium hot Forming

- virtual and experimental activity focused on magnesium warm forming on the **roof**



Resin Transfer Moulding

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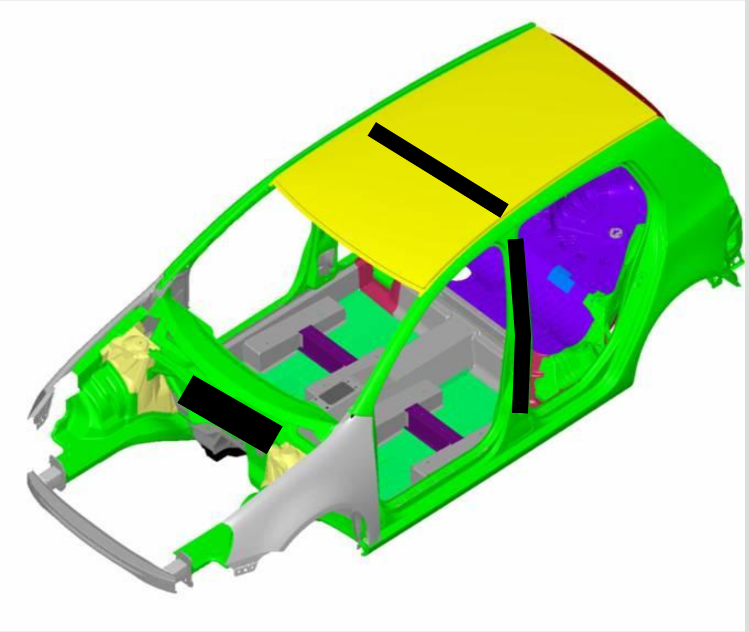
RTM process

- FRP structural parts offer a very high weight saving potential
- Process and material are being optimized for cost reduction
- Matrix materials thermo set and thermo-plastic resins are both investigated
- Processes are ready for large volumes but costs are still not on the level of light metal parts



Applications of interest:
– Roof crossbeam,
– B-pillar reinforcement,
– front structure fire wall

Joining Technologies

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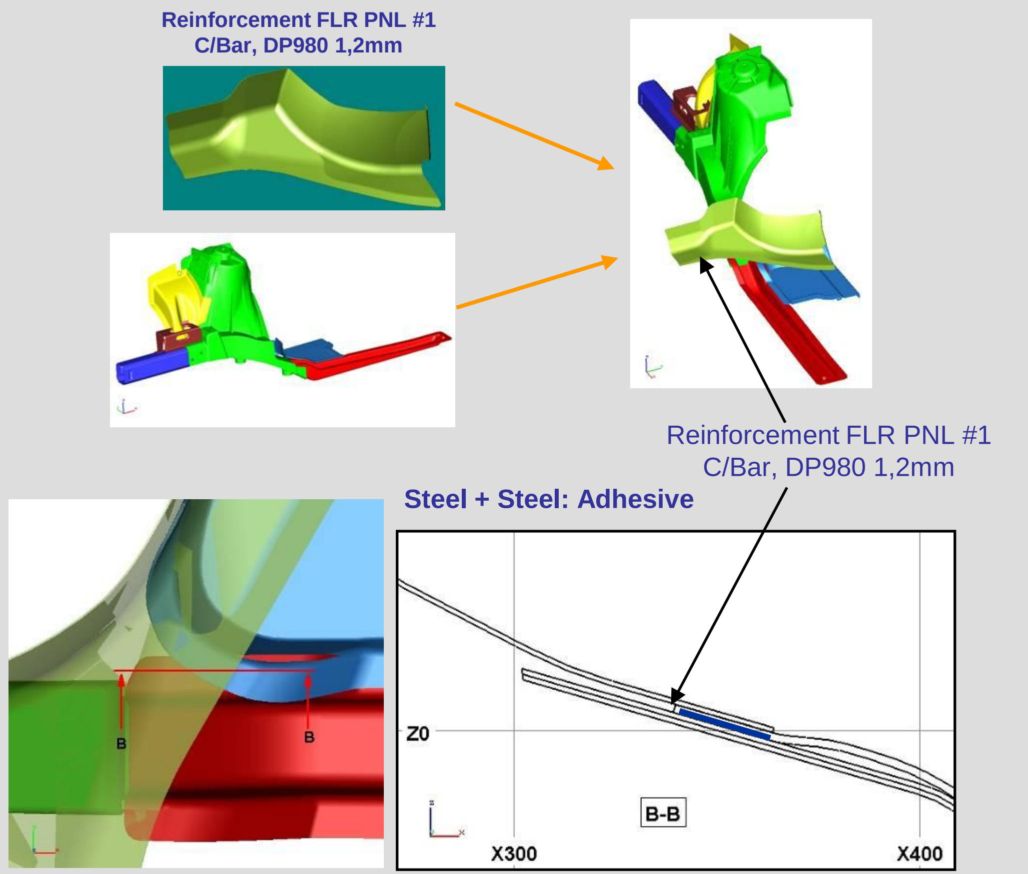
Joining definition

- Precise definition of all necessary joining steps for complete assembly of the BiW
- Analysis of state-of-the-art and new joining technologies for their application within SLC
- Materials combination review and joining feasibility
- Definition of joining methods, processing parameters and setup for each subassembly



Assembly Cycle Layout

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Assembly layout tasks

- Definition of a standard production layout for the production of 1000 car/day
- Development of a first prototype of the mathematical model (excel base) to test the first evaluation on data
- Implementation of the model on a real application case
- Evaluation of the surface and costs needed

Greenhouse Assembly

Platform Assembly

Sub project overview

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Concepts & Design

- Multi-attribute vehicle optimization
- Parts/modules concepts
- Design guidelines

Manufacturability

- Joining and Assembly
- Technology monitoring
- Uniform class A surfaces
- Low cost high volume manufacturability

Multi-Material

SP3

SP4

New Materials Characterization for Failure Prediction

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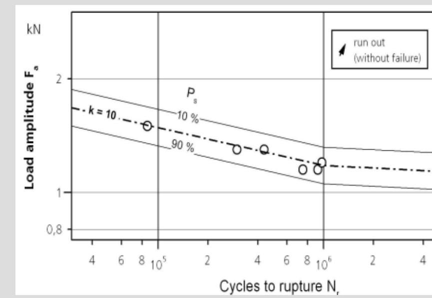
Work tasks:

- Test of shear-tension specimens with various joining techniques
- Woehler curves are derived from fatigue tests of specimens
- Create a model to simulate the fatigue behaviour of joints based on FE analyses and material's data
- Validate the FE model based on experimental data (measured strains)
- Data characterising the crash behaviour are derived from high-speed tensile tests
- Static and dynamic hat profile component tests
- The results of tests will optimize the virtual simulation model



SLC Bridge

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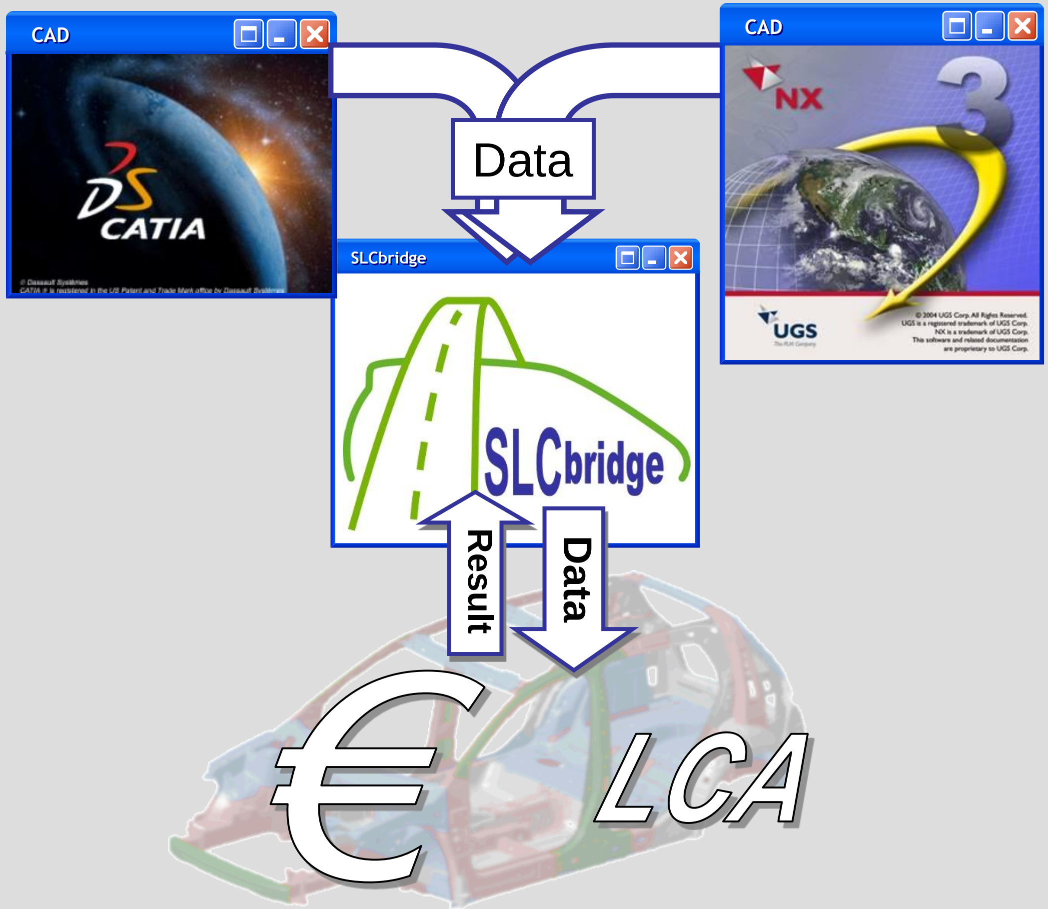
SLC bridge tasks:

- The SLC bridge provides design engineers with a quick and easy tool for Life Cycle Assessment and Cost comparisons between design and concept alternatives based on CAD data
- Enables Trend Statements in early design phases to support concept decisions based on CAD information.



Life Cycle Analysis

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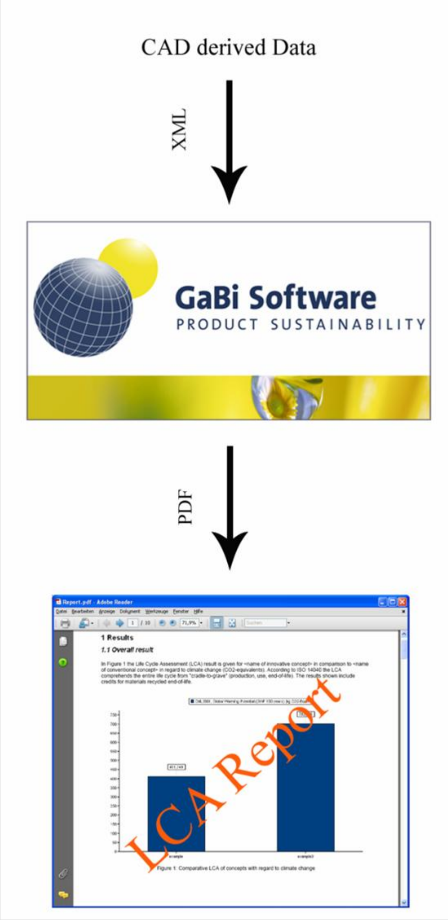
LCA tasks:

- Mapping of materials with SLC labels to GaBi processes
- Integration of a fuzzy logic module to calculate credits for recycling
- Automated calculation of LCA results
- Generation of an application executable with command line parameters that offers completely automated LCA result generation from CAD.



SLC Cost Tool

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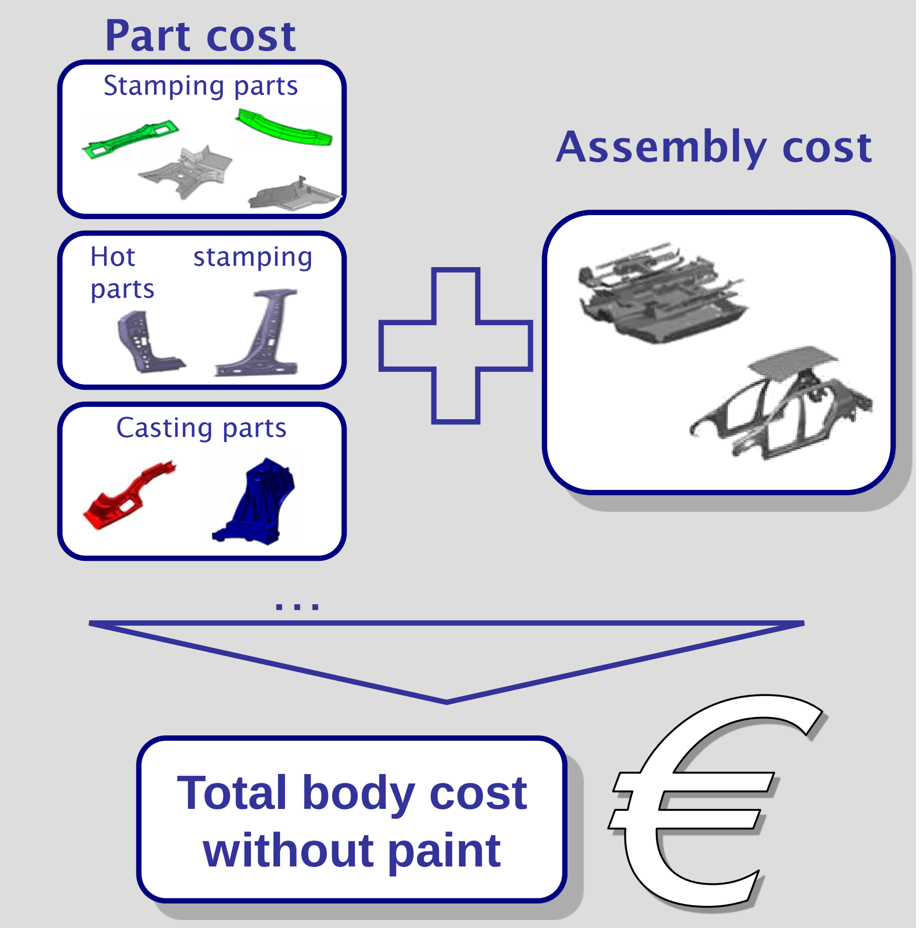
Cost tool:

- Detailed cost breakdown for each concept stage
- Single part costs separated by technology and assembly costs
- Single parts costs are divided into material, labour, machine, tool, building and energy cost
- Management-like summary to quickly identify key figures of the concept – overall weight, weight by module, overall cost, cost by module



SLC Recycling Tool

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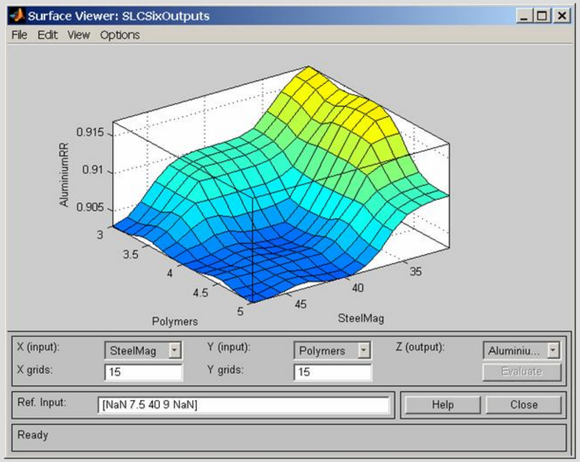
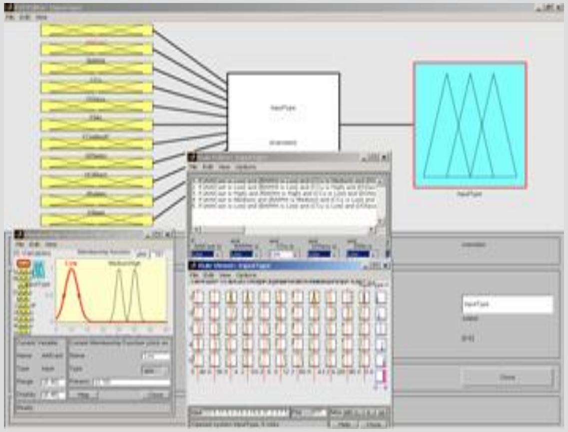
Recycling tool

- Recycling models predict the total recycling/recovery yields of the SLC concepts as well as the recycling yield for each material
- Recycling models capture the detailed knowledge of the earlier developed first principles recycling models in an easy to use tool





Virtual and Physical Testing

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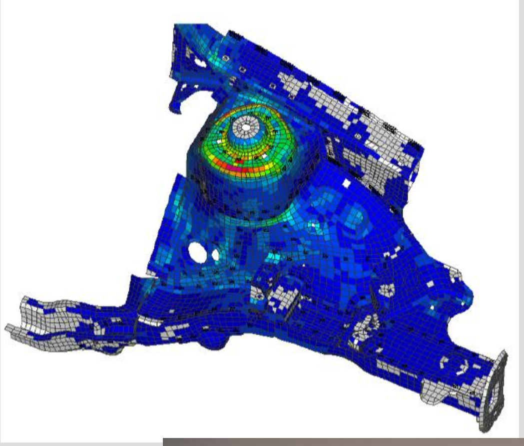
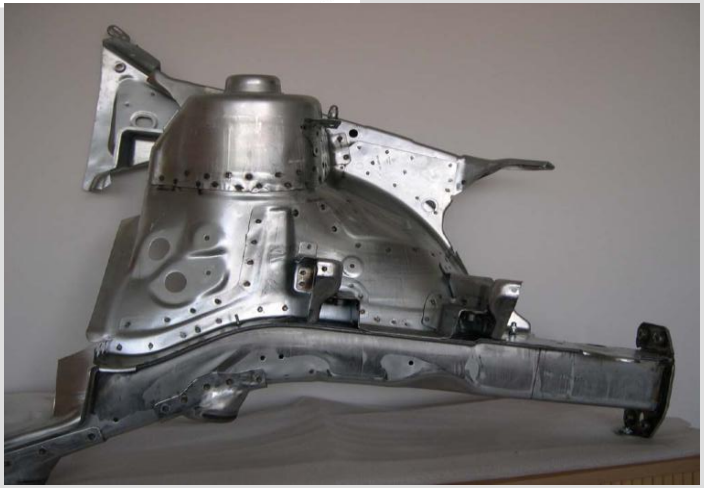
Component testing approach:

- Derive loading for demonstrator using "Real Road" vehicle test
- Set up simulation model for reference module
- Find clamping conditions and loading for reference module
- Evaluate simulation models based on reference tests





Sub project overview

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Concepts & Design

- Multi-attribute vehicle optimization
- Parts/modules concepts
- Design guidelines

Manufacturability

- Joining and Assembly
- Technology monitoring
- Uniform class A surfaces
- Low cost high volume manufacturability

Multi-Material
Lightwe

Enabling Technology/Tools

- Cost simulation
- Crash/Fatigue simulation
- Fatigue prediction
- Design for environment

SP4

Number of prototypes planned

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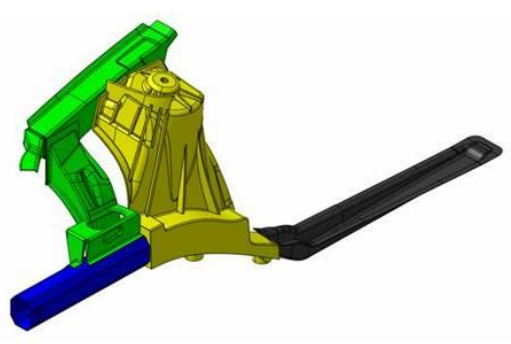
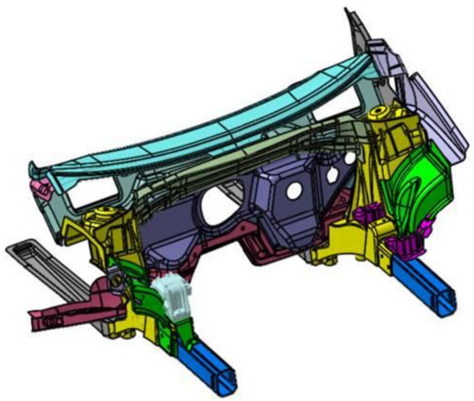
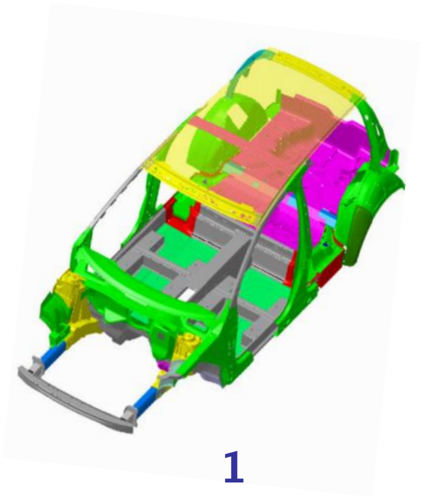
Longitudinal rail	Front end	Complete BIW
		
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Assembled by Renault	Assembled by Renault	Complete demonstrator assembled by VW
Tested by LBF		

SLC Approach – Final Step

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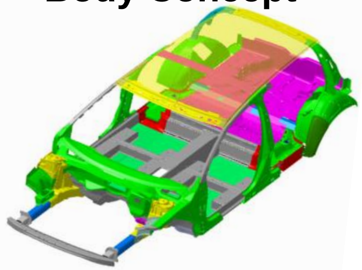
SP1 Design Concepts

1) Steel intensive < 2,5 €/kg
2) Multi material, economic (ULBC) < 5 €/kg
3) Multi material, advanced (SLBC) < 10 €/kg

Preliminary Concepts

SLC Body Concept



SP2 Materials & Manufacturing Technologies

- Technology-Benchmarking
- Forming
- Joining
- Assembly

SP4 End of 2008
Complete Multi-Material Body structure Prototype Demonstration

SP3 Simulation & Testing

Life Cycle Analysis (LCA) | Cost assessment | Virtual and physical Testing

2005 | 2006 | 2007 | 2008 | 2009

Conclusions

- **Automotive light weight solutions are necessary more than ever to reduce CO_2 emissions.**
- All the car manufacturers are working on advanced multi-material concepts that better exploit materials lightening potential combining steel, aluminum, magnesium, plastics and composites.
- The principle idea is to **use the "best" material for the appropriate functions.**
- The additional goal is to achieve an overall cost efficient lightweight design. **Multi-Material-Concepts promise cost effective light weight solutions.**
- Sustainable weight reduction demands affordable manufacturing technologies within complete processing chain.
- **SLC results will survey the basis for innovative overall vehicle downsizing strategies.**

Acknowledgments

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All research activities are integrated in the european funded project **SLC** (**S**ustainable **P**roduction Technologies of **E**mission **R**educed **Light** weight **Car** concepts) with 6th Framework Programme

The coordination team kindly thanks:

- **SLC Sub-project & task leaders**
- **SLC consortium partners**
- **Supporting external organizations**
- **European Community**

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Thank you for your attention