Lightweighting automotive past, present and future collaborative R&D&i

Brussels, 16th December 2015
Laszlo Bax
Open Innovation consultants, specialized in the conceptualization and implementation of collaborative innovation initiatives

Experience in the creation of spin-offs and venturing, exploitation of R&D results

EU wide activity working with actors in the triple helix (large enterprises, SMEs, R&D centres and academia, public administration and EU associations and networks)
SOME OF OUR CLIENTS
CONTENT OF THE PRESENTATION

1. Why lightweighting is important

2. Players are joining forces around the world

3. A vision on tomorrow’s opportunities

4. So what?
WHY IS LIGHTWEIGHTING IMPORTANT
VEHICLE WEIGHT HAS BEEN HISTORICALLY RISING

Main causes are the rising customer demands for additional:

- performance
- comfort
- safety
- electronics

Figure 1-1: Increasing trend in automobile curb mass since 1980.
BUT HEAVIER CARS AREN’T VERY SUSTAINABLE...

- In the year 2050 more than 9 billion humans will live on Earth, of which more than 5 billion will live in cities. (UN)
- By 2030, there will be more than 500 cities in the world with populations of more than 1 million each; more than half will be in Asia. More than 27 will be megacities with over 10 million inhabitants.

⇒ Increasing demand on urban mobility

… with zero-emissions ideally

![CO2 Emission Development Chart](https://www.cai.blogware.com)
LIGHTWEIGHT CAN PROVIDE THE SOLUTION

Data from: Helms, LCA case studies – 2006
Barcelona has more than 600,000 vehicles, producing about half of all emissions. A reduction of vehicles’ weight by 100 kg could lead to a total annual reduction of CO2 emissions in the city of Barcelona of some 30,000 tonnes of CO2 per year. The substitution of perhaps 100,000 conventional vehicles in Barcelona with EVs would eliminate some 90,000 tonnes CO2 emissions annually, while save €28 million annually on environmental costs of the city.
Lightweighting is necessary in order to meet the CO₂ targets of ICE-driven cars (-100 kg = 8.5 gCO₂/km) … but with the same safety and comfort!
...WHEREAS FOR EV IT HELPS IMPROVE THE DRIVING RANGE...
...AND REDUCE THE SIZE AND COST OF THE BATTERY

- Lightweight materials & design
- Reduced body mass
- Reduced total vehicle weight
- Reduced structural mass
- Reduced battery & powertrain mass
- Primary weight savings
- Reduced battery capacity needed for same range

Secondary weight savings: +50%

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PLAYERS ARE JOINING FORCES
LARGE COALITIONS ARE FORMED
A growing trend materialised in new continental initiatives

- Networks of other lightweight solutions in Europe are joining forces
- Actors of automotive composites worldwide are creating flagship initiatives too

Metallurgy Europe

180 European companies in a billion-euro effort

IACMI - US

122 companies, $250 million manufacturing innovation institute
**Magna, Kraus Maffei, Zoltek**
strategic collaboration for A-class finish exterior panels fabricated by SMC process for two 2016 series vehicles, in lower cost and high volumes.

**Momentive** has worked the most with Italian machinery manufacturer Cannon (Borromeo, Italy) and KraussMaffei/Dieffenbacher (Munich, Germany and Eppingen, Germany), to find the right combination of resin system, process and tool design, with the goal to achieve 1’ cycle time.

**Huntsman** composites has been collaborating with RTM specialist Frimo on a suitable processes for their advanced PU resins.

**Plasan Carbon Composites** has been working with press manufacturer Globe Machine Manufacturing Co. and toolmaker Weber Manufacturing Technologies Inc. on a rapid-cure, out-of-autoclave system for molding thermoset-based carbon-fiber composites with a cycle times of about 17 minutes, and is targeting 10 minutes.
Carbures quotes car OEMs for large volume multi-point RTM produced automotive parts.

SMEs like Berbetores develop serious volume (C)FRP capabilities.
SEAM: THE LARGEST EU CLUSTER ON LIGHTWEIGHT AUTOMOTIVE DESIGN

ALIVE
Advanced high volume affordable lightweighting for future electric vehicles
Coordinator: Jens Meschke

ENLIGHT
Enhanced lightweight design by advanced lightweight materials
Coordinator: Thilo Bein

MATISSE
Modeling and testing for improved safety of key composite structures in alternatively powered vehicles
Coordinator: Roland Wohlecker

SafeEV
Safe small electric vehicles through advanced simulation methodologies
Coordinator: Andreas Teibinger

Associated projects:

www.seam-cluster.eu
SEAM CLUSTER: 54 PARTNERS, 11 COUNTRIES
RELATION OF DIFFERENT LIGHTWEIGHT INITIATIVES

**SmartBatt**
- Fully integrated battery housing
- Lightweight battery concept
- New materials for battery systems

**SuperLIGHT-Car**
- Economic demonstration of multimaterial vehicle structures for high-volume produced combustion cars

**ELVA**
- Concept of light BiW for EV’s
- Space frame design
- Modularity in battery and BiW design

**MATISSE**
- Modeling and testing
- Safety of composite structures

**ALIVE**
- High volume
- Low weight
- Low costs

**ENLIGHT**
- medium volume
- Novel materials
- Low weight

**SafeEV**
- Modeling and testing of small EVs
- Safety of vulnerable road users

Source: Fraunhofer LBF, “SmartBatt” project
Source: “ELVA” project, 2013
Source: „SuperLIGHT-Car" project, 2009
Source: „ELVA” project, 2013
Source: M. Kurz, Volkswagen Group Research, K-EFFG/L, 2013
A PEAK INTO: HIVOCOMP PROJECT (2010-2014)

- Two material for cost effective, higher-volume production of high performance carbon fibre reinforced parts:
  
  i. Advanced polyurethane (PU) thermoset matrix materials with superior processability
  
  ii. Thermoplastic PP- and PA6-based self-reinforced polymer composites, hybridised with continuous carbon fibre reinforcements

- Validation and demonstration of the materials through the 5 car part demonstrators.

www.hivocomp.eu
Affordable weight reduction is one key for a more intensive market introduction of electric vehicles (EV).

For an EV with 200 km range (and with battery capacity of 200 – 300 Wh/kg) the allowable costs of weight saving would be around €8/kg.

For above mentioned €8/kg (= $10/kg) more than 40% of lightweighting seem to be obtainable.

However, further weight reduction leads to an exponential cost increase.

Avoiding such cost increase is the main challenge of ALIVE.
A PEAK INTO: ENLIGHT PROJECT (2012-2016)

- Innovative lightweight material technologies for application in structural vehicle parts: thermoplastics, CF thermosets, biocomposites and hybrids.
- Holistic and integrated conceptual design and manufacturing, focusing on a representative medium-volume EV (50k units/year) destined to reach the market around 2020-25.
- Ambitious weight reduction targets, in some cases close 50% in comparison to current market EVs!

- 5 demonstrator modules fabricated and evaluated according to performance, manufacturability, cost effectiveness and lifecycle impact criteria.

www.project-enlight.eu
ARE COMPOSITES FINALLY ARRIVING?
GALM POLL SEEMS TO INDICATE COMPOSITES TAKEN SERIOUSLY

What Remains The Greatest Challenge To Further Reducing Vehicle Weight On Your Automotive Projects?

- 46% Cost & Time Of Joining Multi-Material Architectures
- 29% Design Challenges & Limitations Of New Materials
- 17% Cost Of Material Supply
- 8% Cost & Time Of Forming Components

Which Material Do you Feel Is The Greatest Priority For Research And Development For The Next 3 Years To Most Significantly Reduce Vehicle Weight?

- 45% Composites
- 30% Aluminium
- 13% Magnesium
- 8% Ultra-Light Steel
- 4% Titanium

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STRONGEST GROWTH POTENTIAL COMES FROM LIGHTWEIGHTING TECHNOLOGIES THAT ENTER MASS-MARKET VEHICLES

### Carbon fiber potential in 5 years at 50% of current price

<table>
<thead>
<tr>
<th>Car Type</th>
<th>Global automotive production by car type</th>
<th>Expected vehicle production</th>
<th>Expected use of CF in cars</th>
<th>Demand for CF at 50% of current price (pounds)</th>
<th>Market for CF at 50% of current price ($M)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Super cars</td>
<td>97 million</td>
<td>6,000</td>
<td>100%</td>
<td>1.3 million</td>
<td>$7M</td>
</tr>
<tr>
<td>Super luxury cars</td>
<td></td>
<td>600,000</td>
<td>10%</td>
<td>101.2 million</td>
<td>$506M</td>
</tr>
<tr>
<td>Luxury cars</td>
<td></td>
<td>4 million</td>
<td>10%</td>
<td>101.2 million</td>
<td>$506M</td>
</tr>
<tr>
<td>Other/regular cars</td>
<td></td>
<td>92 million</td>
<td>1%</td>
<td>202.4 million</td>
<td>$1,012M</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>97 million</strong></td>
<td><strong>305 million</strong></td>
<td><strong>$1,525M</strong></td>
<td></td>
</tr>
</tbody>
</table>

Source: Lucintel, ACMA Composites 2012

*Managed by UT-Battelle for the U.S. Department of Energy.*

- 3x current global CF demand for **all applications**;
- 10B lb potential automotive demand at full market penetration;
- Potential to reduce US petroleum demand by 2-3 Mbd (≈10-15%)
CFRP WILL BE USED IN MULTI-MATERIAL APPROACH

Composite plastics are not the only solution!

Source: M.Goede, VW Group Research, SLC – adapted by B&W
ADDITIONAL MANUFACTURING COSTS

The diagram shows the relationship between additional manufacturing costs and mass reduction for different materials:

- **HS Steel**
- **GF**
- **SMC**
- **Al Space Frame**
- **Al Unibody**
- **Magnesium**
- **Carbon Fiber**

The costs are measured in dollars per kilogram ($/kg) on the y-axis, and the mass reduction is shown on the x-axis, with percentages ranging from 0% to 60%. Values are estimated based on a collection of MSL vehicle cost analyses and other sources.

Source: Fine, Roth, MIT MSL, MIT Manufacturing Round Table, 2010

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EUROPEAN FRP CLUSTERS
A strong network of regional hubs
AUTOMOTIVE LIGHTWEIGHT IN EUROPE
Joint figures, higher impact

3000 researchers
€100,000,000 yearly
800 partners
6 research facilities
POSSIBLE SYNERGIES
Can clusters help each other address their challenges?
SO WHAT?
SOME IDEAS FOR THE PANEL DEBATE

✓ CFRP is fast approaching larger volume feasibility and soon will hit the market

✓ some key issues remain: simulation & recycling perhaps most urgent to address internationally

✓ EU should connect it’s regional clusters to compete with other parts of the world

✓ Can SMEs play a bigger role when networked?
WE LIKE TO EXCHANGE IDEAS!

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thanks to:

SusChem
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FIAT CHRYSLER AUTOMOBILES

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