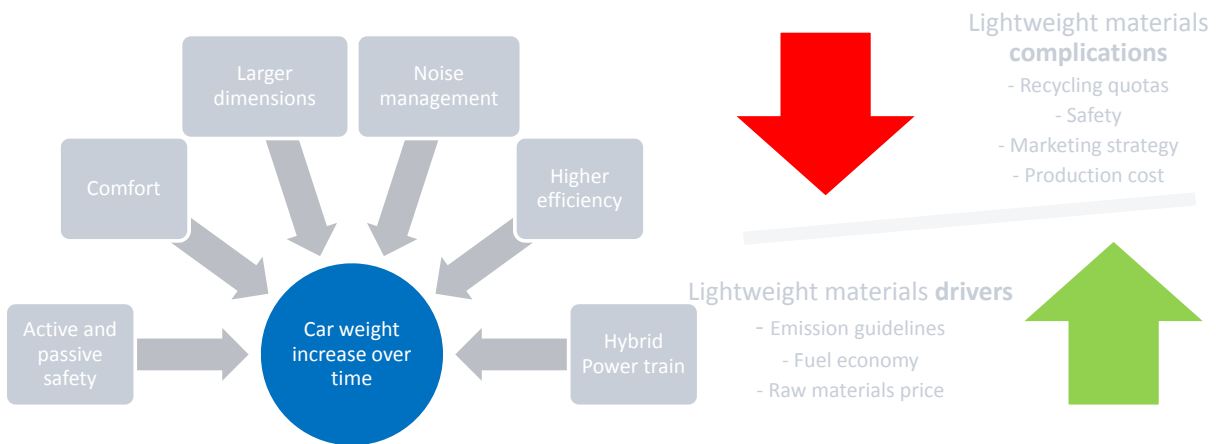


# A Lightweight Functional Door Demonstrator

Development Research Innovation Vehicle Engineering



## LWD project



## LWD project objectives



Develop new materials & technologies for weight reduction & functions integration



Integrate & validate the developed technologies in door demonstrator



Focus on materials & technologies for high volume production

Build up knowledge to be applied also in other car area's



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## LWD project partners

**BEKAERT**  
better together  
steel wire and coating



**sapa:**  
aluminium extrusions



**hegge ID**  
industrial design studio  
design support



**umicore**  
materials for a better life  
advanced materials



**NITTO DENKO**  
sealing and bonding materials



**ArcelorMittal**  
Tailored Blanks

**COCAS**  
we catalyse your growth  
steel research

**DRIVE Flanders**  
durable lightweight  
vehicle systems

**D&M**  
Premium Sound Solutions  
sound systems

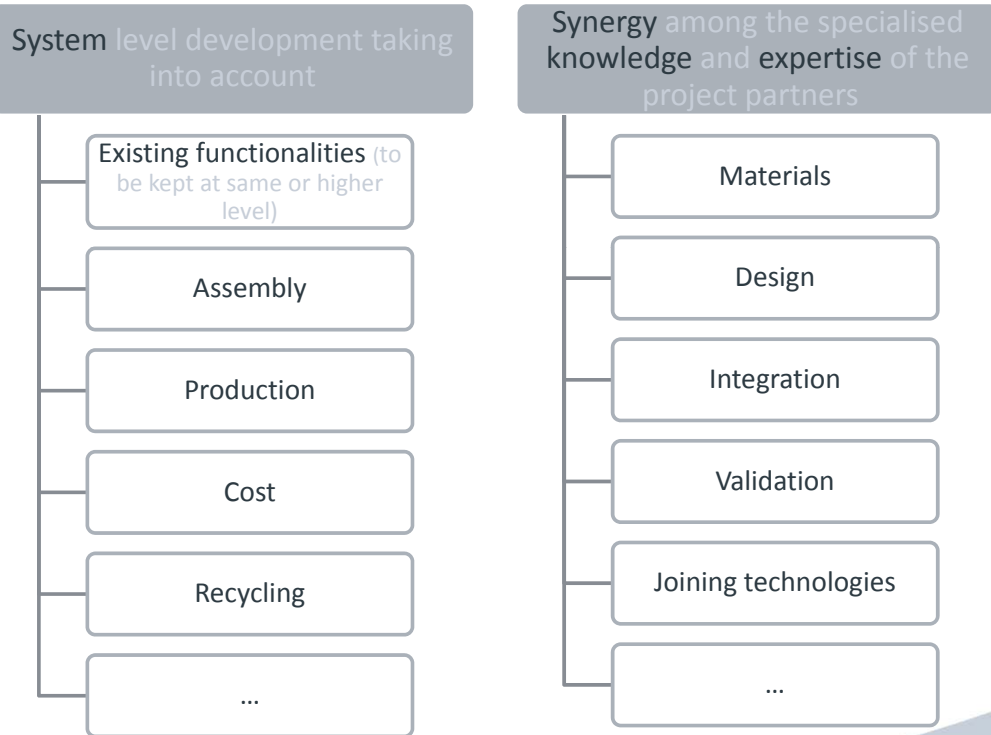
**RECTICEL**  
The passion for comfort  
interior trim



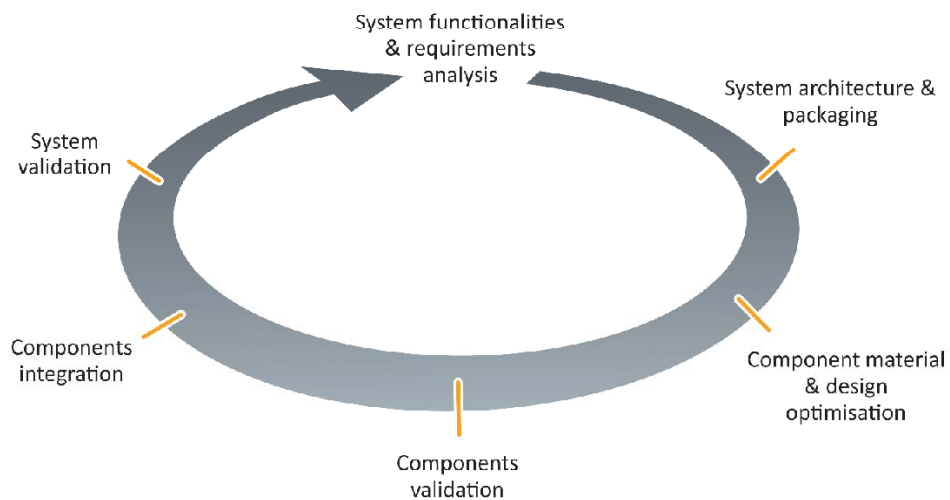
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## LWD project approach

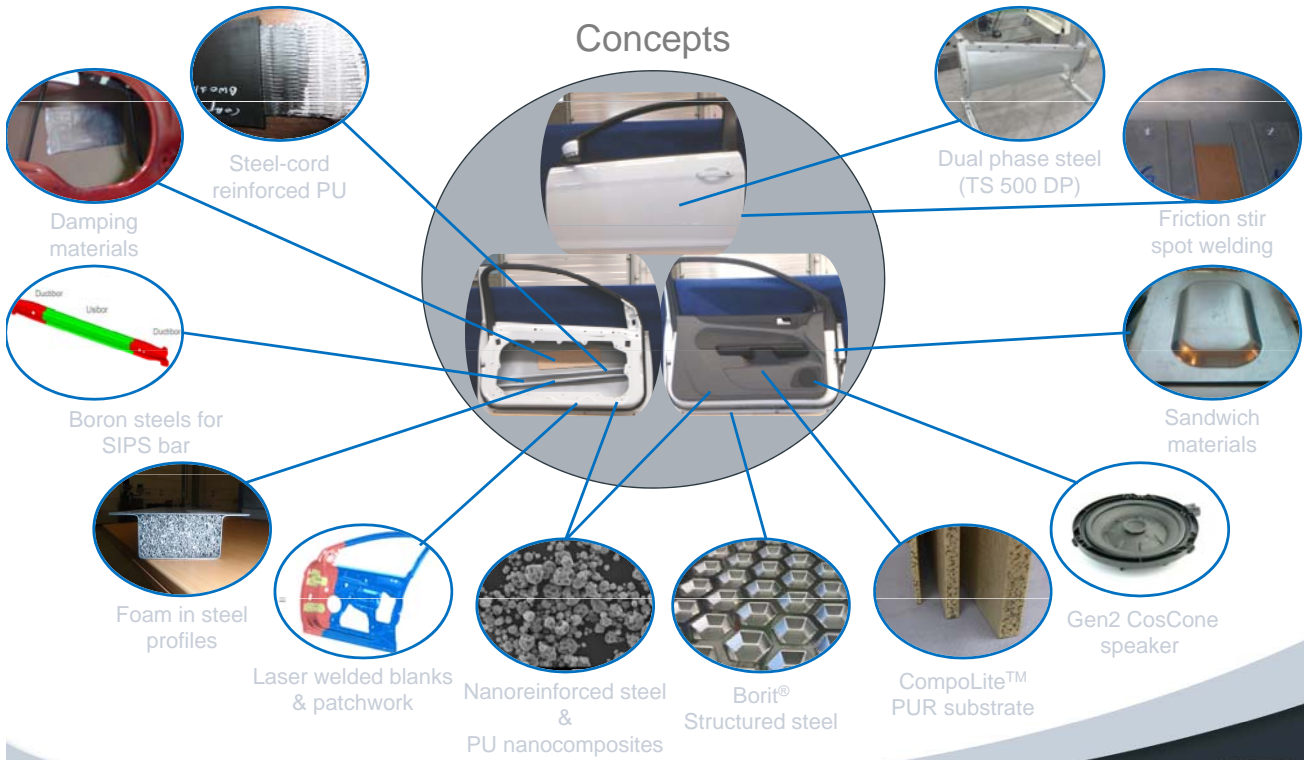


## LWD project approach



# Materials & Technologies

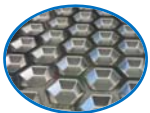
## Concepts



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# Materials & Technologies



## Structured steel

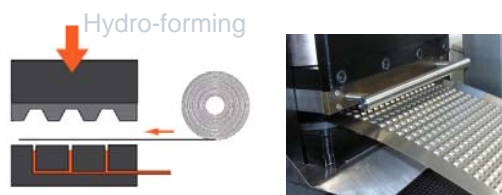
### Concept

- Forming embossments in single sheet in a continuous process (patented)
- Assemble 2 sheets (e.g. adhesive bonding)

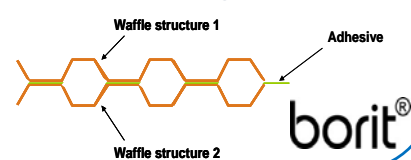
### Characteristics

- High stiffness, by top-top set-up
  - Low weight (e.g. steel skins 2 x 0.25 mm)
- Extra energy adsorption during impact loading
  - Additional features
    - allows internal (air) flow for heating and cooling
  - advanced "design" look, different cavity shapes possible
- available in various steel grades (strength, coloured pre-coat)

### Process



### Adhesive joint



### Estimated Bending Stiffness

Borit steel structure	Bending Stiffness [Nm <sup>2</sup> /m]	Weight [Kg/m <sup>2</sup> ]	Equivalent monolithic plate thickness [mm]	Equivalent monolithic plate weight [Kg/m <sup>2</sup> ]	Weight ratio
2 x 0.25 mm	314	3,9	2,62	20,4	5,2

**Borit top-top structure 81% lighter**

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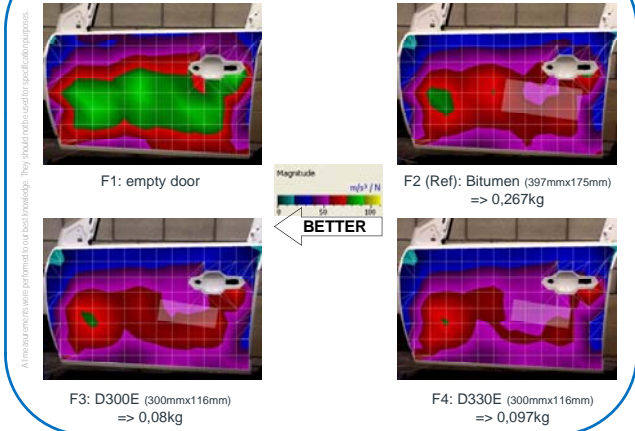


## Damping and reinforcements materials

### Concept

- Local application on outer panel
  - Legetolex®: butyl rubber based damping material
  - Nitohard®: epoxy foam based reinforcement material
- Combination with thinner steel
  - Characteristics
  - Superior vibration damping
- Excellent reinforcement (dent resistance)
  - Wide functional temperature range
  - Weight reduction

### Damping performance - Legetolex®



### Dent resistance – Nitohard®



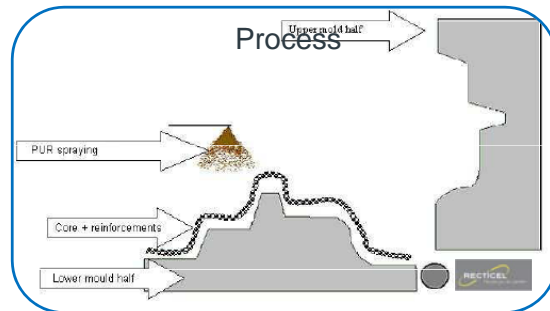
Force (N)	25	50	75	100	125	150	175	200
Steel A - 0,64 mm	< 0,01	0,03	0,03	0,03	0,05	0,07	0,14	0,19
Steel A - 0,64 mm with NitoHard	< 0,01	< 0,01	< 0,01	< 0,01	< 0,01	< 0,01	< 0,01	0,01
Steel A - 0,7mm	< 0,01	0,01	0,02	0,03	0,04	0,07	0,12	0,13
	mm denting							



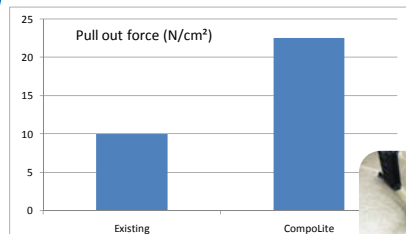
## Lightweight PUR substrate (CompoLite™)

### Concept

- Structural sandwich based on
- PUR foam core
  - Different types of reinforcement mats (GF, Basalt, NF)
    - Sprayed PUR rigid foam
    - Patented technology
- ### Characteristics
- Excellent strength to weight ratio (up to 40% weight reduction)
    - High bending stiffness
    - Thickness variations possible
  - One step in-mould decoration & inserts
  - Easy to shape in 3D without loss of properties

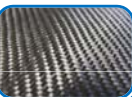


### Inserts



### Basalt reinforcement

Comparison at equal surface weight	Glass fibre	Basalt
Impact strength (kJ/m²)	18	24,5
E-modulus (N/mm²)	842	857
Bending stiffness (Nmm)	108000	112000





## Gen2 CosCone speaker

### Concept

- Rigid cone with controlled break-up
  - Nd motor
  - Patented technology

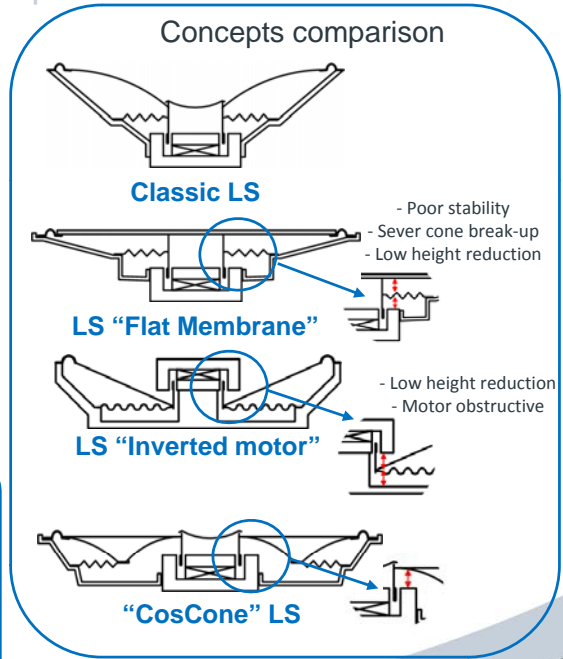
### Characteristics

- Low weight and shallow profile
- Equal/better performance on all acoustic specs than standard cone alternatives
- Balanced frequency response
  - Very low distortion
  - Increased design flexibility

### Cost reduction => Gen2



### Concepts comparison



# Door Trim Panel demonstrator

Physical door demonstrator leading to weight reduction (~20%) while adding new functionalities



## Door demonstrator

### Extra functionality: **soundbox** Concept

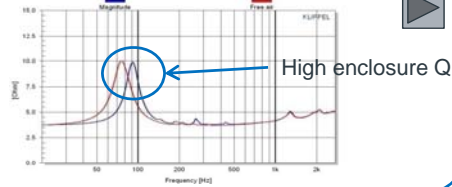
- Integration of speaker and soundbox in armrest
  - Closed box being 2<sup>nd</sup> order system exhibits superior impulse behaviour compared to higher order systems (e.g. classic door systems)

#### Characteristics

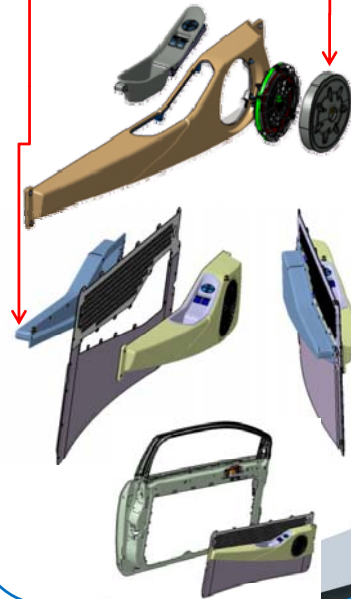
##### Closed box systems

- Are easier to predict & to design to a specific target
  - Are less susceptible to parameter variation
- Reduce effects of loudspeaker parameter variation
  - Have low efficiency loss (high enclosure Q)
- Have high transmission loss for outside sound sources

#### Evaluation of enclosure in CompoLite™



#### Soundbox and speaker integration in armrest



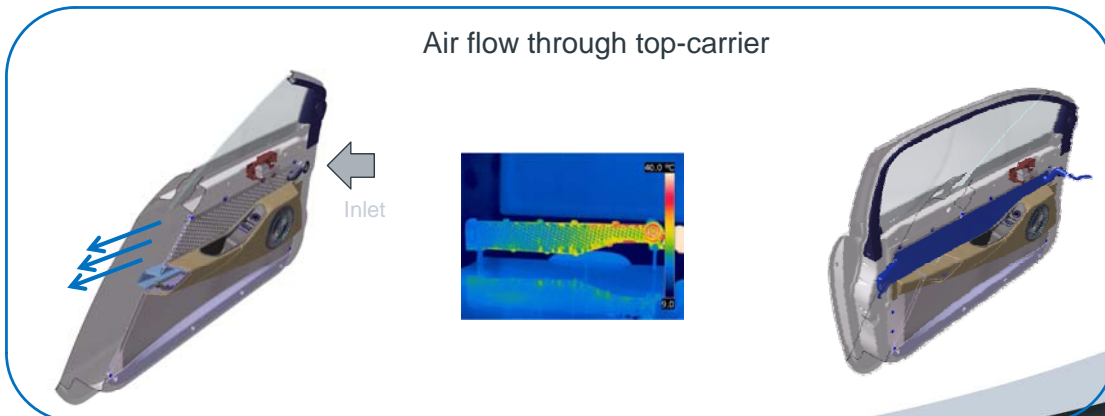
## Door demonstrator

### Extra functionality: **heating / cooling**

#### Concept

- Heating and cooling within the door
- Air intake from the dashboard channelling
- Outlet towards rear passengers (through an extra ventilation hole in the door trim)
- Alternative to channelling in the body structure

#### Air flow through top-carrier



### LWD project has resulted in

- Materials & technologies
  - with high weight reduction potential both for interior and exterior applications
    - applicable to other automotive systems and components
    - suitable for high volume production
- Physical door demonstrator integrating some of the developed technologies
- Stand-alone physical and virtual demonstrators validating the developed technologies
- Weight reduction and extra functionalities by combining multi-materials construction and innovative design